

## Robert W. Schunk

### Education

- 9/61 – 6/65 New York University, New York, Aeronautical and Astronautical Engineering B.S., 6/65.  
9/65 – 3/70 Yale University, New Haven, Connecticut, Physics of Fluids and Plasmas, Ph.D., 6/70.

### Employment

- 3/70 – 6/71 University of Michigan, Ann Arbor, Michigan, I.S.T. Post-doctoral Fellow.  
6/71 – 6/72 Yale University, New Haven, Connecticut, Research Staff Geophysicist.  
6/72 Arcibo Observatory, Arcibo, Puerto Rico, Research Associate.  
6/72 – 3/73 Yale University, New Haven, Connecticut, Research Associate.  
3/73 – 7/74 University of California at San Diego, LaJolla, California, 92093 – Assistant Research Physicist (III).  
7/74 – 7/75 Assistant Research Physicist (IV).  
7/75 – 9/76 Associate Research Physicist (I).  
9/76 – 7/79 Utah State University, Department of Physics, Logan, Utah, 84322 – Associate Professor.  
7/79 – Professor  
11/83 – Director, Center for Atmospheric and Space Sciences, Utah State University.

### Honors, Awards

- New York University Scholarship (9/62–6/65).
- Dean's Honor List at NYU (9/61–6/65).
- Graduated cum laude from NYU (1965).
- NYU Founders Day Award (1965).
- William R. Bryans Medal in Engineering Mechanics (1965).
- NASA Predoctoral Fellowship at Yale (9/65–9/68).
- Gibbs Prize Fellowship at Yale (9/65–9/68).
- Yale Fellowship (9/68–3/70).
- D. Wynne Thorne Research Award, USU's highest research honor, 1983.
- Citation for Excellence in Refereeing, American Geophysical Union, 1984.
- 73<sup>rd</sup> Faculty Honor Lecture at USU, 1986.
- Governor's Medal for Science & Technology from the State of Utah, 1988.
- Fellow, American Geophysical Union, 1997.
- Nicolet Lecture, American Geophysical Union, 2002.
- Survey Committee Member, National Academy of Sciences Committee that produced the first Decadal Survey for Solar and Space Physics, 2000-2002.
- Elected to the International Academy of Astronautics, Corresponding Member, 2006; Full Member, 2011.
- Associate Fellow, American Institute of Aeronautics and Astronautics, 2014.

- AGU Editor's Choice Award: Gardner, L. C. and R. W. Schunk: Large-scale gravity wave characteristics simulated with a high-resolution global thermosphere-ionosphere model, *J. Geophys. Res.*, 116, A06303, doi:10.1029/2010JA015629, 2011.
- AGU Eos Research Spotlight: Schunk, R. W., et al., Space weather forecasting with a Multimodel Ensemble Prediction System (MEPS), *Radio Sci.*, 51, doi:10.1002/2015RS005888, 2016.
- 2020 CEDAR Distinguished Lecture

## **Funding Activity:**

Dr. Schunk has been a Principal Investigator (PI) on numerous NASA, NSF, Air Force and Navy grants relevant to Theory, Modeling, Simulation and Data Analysis, including:

- 44 years as PI of continuous funding from the NSF Aeronomy Program (1973-present);
- 29 years as PI of the pre-eminent NASA Theory Program starting at its inception (1980-2009);
- 21 years as PI of continuous ONR funding (1995-2016);
- PI of a 6-year AFOSR program to establish ‘Centers of Excellence in Theory and Analysis of the Geo-Plasma Environment;’
- PI of a 5-year DoD Multi-Disciplinary University Research Initiative (MURI) grant that produced an operational data assimilation model of the ionosphere called “Global Assimilation of Ionospheric Measurements” (USU-GAIM);
- PI of a 4-year USTAR program funded by the State of Utah to create a Space Weather Center;
- PI of multi-year Air Force funding connected with the operational GAIM model;
- Co-PI of a 5-year NASA/NSF Collaborative Space Weather Modeling Program entitled “Physical Processes Governing Energy and Momentum Flows on Multiple Scales in Near-Earth Space Using a First-Principles-Based Data Assimilation System (DAS) for the Global Ionosphere.”

*\$31M in Federal and State grant/contract funding in 39 year*

## **Commercialization Activity**

Dr. Schunk has been involved in several efforts to produce commercial space weather products and services, including:

- One of four founding members and Chief Executive Officer (CEO) of Space Environment Corporation (SEC), which was established in 1989. SEC is a small high-tech company created to develop software and hardware solutions for space weather specifications and forecasts.
- SEC developed the Ionospheric Forecast Model (IFM), the Ionosphere Plasmasphere Model (IPM), the Data-Driven D Region Model (DDDR), and others. The IFM and IPM are the physics-based models behind the USU GAIM-GM and GAIM-FP models, respectively. The DDDR model extends the GAIM models into the D region.
- Data assimilation activities were started in SEC in 1998 with the Schunk and Sojka project entitled Assimilation Ionosphere Model (AIM), which was the forerunner to the USU GAIM program.
- In 2012, SEC received the prestigious “Moving America Forward Award”, as one of the leading commercial space weather companies.
- PI of a 4-year USTAR program funded by the State of Utah to create a Space Weather Center
- One of five founding members of Q-up, a small high-tech company formed in 2012 to market space weather products based on the USU GAIM data assimilation models.
- One of four founding members of the American Commercial Space Weather Association (ACSWA), which was created in 2010. ACSWA is an association of companies that promotes space weather risk mitigation for critical national infrastructure related to daily life, economic strength, and national security. ACSWA is now composed of 16 space weather companies.

**Research Activities:**

Dr. Schunk co-authored a book entitled *Ionospheres*, edited three books, authored or co-authored 420 scientific publications, and gave or contributed to more than 800 presentations at national and international meetings. He has over forty-five years of experience in theory, numerical modeling, and data analysis in the general areas of plasma physics, fluid mechanics, kinetic theory, space physics, planetary ionospheres/atmospheres, and space weather.

He developed numerous computer models of space physics phenomena, regions, and spacecraft-environment interactions. With colleagues, he developed physics-based *global* models of the ionosphere, polar wind, plasmasphere, thermosphere, exosphere and solar wind. He also developed models to describe plasma cloud expansions in the ionosphere, and ionosphere/high-voltage sphere and ionosphere/solar cell interactions. He studied processes in the solar wind, Venus, Jupiter, and comets, as well as basic plasma physics phenomena, such as plasma transport, contact potentials, electron-beam plasma interactions, shocks, and nonlinear wave-particle and wave-wave coupling. He also used generalized transport, kinetic, hybrid, and PIC techniques to study hot/cold plasma interactions and the consequent non-Maxwellian velocity distributions. In addition, he conducted numerous studies comparing model predictions with measurements, using data from several coherent and incoherent scatter radars, ionosondes, rockets, satellites, and the Space Shuttle. In recent years, Dr. Schunk's research has focused on the development of physics-based data assimilation models of the thermosphere, ionosphere, and high-latitude electrodynamics using Kalman filters, as well as on the effect that upward propagating waves from the lower atmosphere have on the ionosphere-thermosphere system.

## **Books, Editorial Service**

Book, *Ionospheres*, Schunk and Nagy, Cambridge University Press, 2000; Second Edition, 2009.  
Editor, *AGARD/NATO Conference Proceedings*, 1988.  
Editor, *STEP Handbook of Ionospheric Models*, 1996.  
Associate Editor, *Journal of Geophysical Research*, 1977-1980.  
Editorial Advisory Board, *Planetary and Space Science*, 1985-1992.  
Editorial Advisory Board, *Journal of Atmospheric and Solar-Terrestrial Physics*, 1991-Present.  
Editor, Chapman Monograph on 'Modeling the Ionosphere-Thermosphere System' (J. D. Huba, R. W. Schunk and G. V. Khazanov), AGU Monograph 201, 2013.  
Editor, Chapman Monograph on 'Magnetosphere-Ionosphere Coupling in the Solar System', (C. R. Chappell, R. W. Schunk, P. M. Banks, R. M. Thorne and J. L. Burch), AGU Monograph 222, 2017.

## **Listings**

"American Men and Women of Science"  
"Who's Who in Technology Today"  
"International Directory to Geophysical Research"  
"Who's Who in the West"  
"Who's Who in Frontier Science and Technology"

## **International Memberships, Committees, etc.**

Member, International Union of Radio Science, Commission H, 1984–  
Member, International Union of Radio Science, Commission G, 1986–  
Convenor, International Association of Geomagnetism and Aeronomy, Division II Symposium on "Auroral and Equatorial Plasma Phenomena", Prague, Czechoslovakia, 1985  
Member, Program Committee, International Symposium on Large-Scale Processes in the Ionosphere-Thermosphere System, 1985  
Convenor, URSI-G session on "Global Ionospheric Variations", 1987 National Radio Science Meeting, Boulder, Colorado  
Co-Chairman, AGARD/NATO Symposium on "Ionospheric Structure and Variability on a Global Scale and Interactions with the Atmosphere, Magnetosphere", Munich, Germany, 1988  
Member, Sub-Commission C.1 on the Earth's Upper Atmosphere and Ionosphere, COSPAR, a Scientific Committee of the International Council of Scientific Unions, 1988–  
Member, Program Committee for the Quadrennial Symposium on Solar-Terrestrial Physics, SCOSTEP, 1988–1990.  
Member, Editorial Advisory Board, *Journal of Atmospheric and Terrestrial Physics*, 1991–  
Chairman, Working Group on an Aeronomical Reference Ionosphere, WITS Program, 1988–1995  
Member, Technical Program Committee, U.R.S.I. Symposium, "A Decade of Advances in Radiowave Probing of the High-Latitude Ionosphere and Atmosphere," Geophysical Institute, Alaska, 1992.  
Member, STEP Informatics Project 6.7: Directory of Solar-Terrestrial Models, 1993.  
Member, Program Committee for a Joint Commission C/D COSPAR Symposium on 'Space Weather,' 1995.

Member, International Program Committee, URSI Workshops on ‘The Plasmasphere Rediscovered: A Tribute to Donald Carpenter,’ 1999.

Member, Science Team, International Space Science Institute (ISSI), Brussels, Belgium, 2000.

Member, European Geophysical Society, 2000–2002.

Vice-Chair, Commission C, COSPAR, a Scientific Committee of the International Council of Scientific Unions, 1996–2004.

Chair, Commission C, COSPAR, a Scientific Committee of the International Council of Scientific Unions, 2004–.

Vice-Chair, Division II, International Association of Geomagnetism and Aeronomy (IAGA), 1999–2003.

Chair, Division II, International Association of Geomagnetism and Aeronomy (IAGA), 2003–2007.

Member, Scientific Program Committee, 36<sup>th</sup> COSPAR Scientific Assembly, Beijing, China, 16-23 July 2006.

Member, COSPAR Scientific Advisory committee (CSAC), 2005-

Member, Program Committee, Greenland Space Science Symposium, 3-6 May 2007.

Member, Program Committee, 37<sup>th</sup> COSPAR Scientific Assembly, Montreal, Canada, 13-20 July 2008.

Member, Program Committee, 38<sup>th</sup> COSPAR Scientific Assembly, Bremen, Germany, July, 2010.

Member, Panel on International Space Education Board (ISEB), European Space Agency, 38<sup>th</sup> COSPAR Scientific Assembly, Bremen, Germany, 18-25 July 2010.

Convenor, (I. Galkin, R. W. Schunk and Nava), URSI GASS session on “Data Assimilation Modeling”, Montreal, Canada; August 19-26, 2017.

Team Leader, (Qinghe Zhang, J. C. Foster, Yong-Liang Zhang and R. W. Schunk), International Space Science Institute (ISSI) program entitled “Multiple-instrument observations and simulations of the dynamical processes associated with polar cap patches/aurora and their associated scintillations”, Beijing, China, 2017-2018.

### **National Memberships, Committees, etc.**

Member, Sigma Pi Sigma

Member, Society of the Sigma Xi

Member, American Geophysical Union

Member, American Association for the Advancement of Science

Member, Atmosphere Explorer Satellite Team, 1971–1973

Associate Editor, Journal of Geophysical Research, 1977–1980

Participant, NSF Radar Workshop, Position Paper for CSTR Summer Study, December 12–15, 1977

Member, Thermal Plasma Science Group, NASA, 1978–1985

Member, Committee on Solar-Terrestrial Research, Geophysics Research Board, National Academy Sciences,  
 First Term: 1979–1982  
 Second Term: 1984–1987

Principal Investigator, Solar Terrestrial Theory Program, NASA, 1980–

Member, NCAR Scientific Computing Division’s Advisory Panel, 1980–1983

Participant, NSF Workshop on Incoherent Scatter Data Base, February 1–2, 1982

Member, Organizing Committee for a “Theory Conference in Solar Terrestrial Physics”, Boston College, 1982

Member, Center for Atmospheric and Space Sciences’ Advisory Committee, USU, 1982–1983

Member, Committee on Geophysical Data, Geophysics Research Board, National Academy of Sciences, 1982–1985

Member, Ionospheric Physics Subcommittee of the Solar Terrestrial Physics Workshop, 1982

Chairman, Working Group on “Assessment of Plasma Transport and Convection at High Latitudes” of the Solar Terrestrial Physics Workshop, 1982

Participant, Second NSF Workshop on the Incoherent Scatter Radar Database, NCAR, February 9–10, 1983

Discussion Leader, Gordon Conference in Space Plasma Physics, Plymouth State College, June 13–17, 1983

Member, AGU Subcommittee on Electronic Transmission and Publishing of Geophysical Science, 1983–1984

Member, Organizing Committee and Program Committee, “Chapman Conference on the Magnetospheric Polar Cap,” University of Alaska, 1984

Member, Subcommittee for Upper Atmospheric Facilities, National Science Foundation, 1983–1985

Member, Research Council, Utah State University, 1983–1995

Member, Utah Academy of Arts and Sciences, 1983–

Member, Board of Trustees, Upper Atmosphere Research Corporation, 1983–1988

Member, Program Committee, AGU Chapman Conference on Ion Acceleration Processes in the Ionosphere and Magnetosphere, Wellesley College, 1985

Member, Organizing Committee, NASA Solar Terrestrial Theory Program Workshop, Los Alamos, 1984

Member, Steering Committee and Modeling Subcommittee, Ground-Based Optical Aeronomy Program, National Science Foundation, 1984–1986

Member, Editorial Advisory Board, Planetary and Space Science, 1985–1992

Member, Steering Committee, SUNDIAL Workshop, 1985

Institutional Representative, Universities Space Research Association, 1985–1988

Member, Space Program Council, Utah State University, 1985–1990

Member, Program Committee, Workshop on Magnetosphere/Ionosphere Plasma Models, 1985

Member, Steering Committee, Global Ionosphere-Thermosphere Coupling and Dynamics (GITCAD) Program, 1988

Member, Mesosphere-Thermosphere-Ionosphere panel for the NASA-SPD Strategic Implementation Study, 1989–1990

Member, AGU Awards Committee, 1990–1992

Member, Ad-hoc NSF Panel on the National Space Weather Program, 1995.

Convenor, Workshop on CEDAR Contributions to the Study of ‘Space Weather,’ 1995.

External Reviewer for a Space Weather Program at the Naval Research Laboratory, 1996.

External Reviewer, Physics Department, University of Texas at Dallas, 1996.

Representative, University Corporation for Atmospheric Research, 1997.

Member, Program Committee, Workshop on Space Weather Effects on Navigation and Communication Systems, 1997.

Member, New York Academy of Science, 1997–

Member, NSF Panel for ‘Establishing Metrics for the National Space Weather Program,’ 1998.

Member, American Institute of Aeronautics and Astronautics, 1998-present.  
Chair, SPA Fellows Committee, American Geophysical Union, 1998–2000.  
Member, SPA Executive Committee, American Geophysical Union, 1998-2000.  
Convenor, Special Session on ‘Ionosphere-Magnetosphere Coupling,’ Spring AGU Meeting, 1999.  
Member, Committee on Solar and Space Physics, Geophysics Research Board, National Academy of Sciences, 2000–2004.  
Convenor, Special Session on ‘Data Assimilation in Space Physics and Aeronomy,’ Fall AGU Meeting, 2000.  
Member, Living With a Star Geospace Missions Definition Team, NASA, 2000–2003.  
Member, Review Panel for the NCAR High Altitude Observatory, 2001.  
Member, Survey Committee, Decadal Survey for Solar and Space Physics, National Academy of Sciences, 2000–2002.  
Member, Panel on Theory, Modeling, and Data Exploration, National Academy of Sciences, 2000–2002.  
Member, Ad Hoc Committee on Distributed Arrays of Small Instruments for Research and Monitoring in Solar-Terrestrial Physics: A Workshop, CSSP, National Academy of Sciences, 2004.  
Member, Ad Hoc Committee on the Exploration of the Outer Heliosphere: A Workshop, CSSP, National Academy of Sciences, 2004.  
Member, National Academy Sciences Ad Hoc Committee on Distributed Arrays of Small Instruments for Research and Monitoring in Solar-Terrestrial Physics, 2005.  
Member, Visiting Committee for the National Astronomy and Ionosphere Center (NAIC), Cornell University, 2006–2009.  
Member, Program Committee, Huntsville 2006 Workshop on ‘Challenges to Modeling the Sun-Earth System,’ Nashville, Tennessee, 2-6 October 2006.  
Member, Naval Research Laboratory, External Review Panel, 12-15 August 2008.  
Chair, Space Weather Prediction Center Interest Group, 2009–2014  
Member, Ad hoc Committee on a Research-to-Operations (R2O) Developmental Testbed Center (DTC), 2008-2009.  
Organizer/Session Chair/Speaker, ORION Conference, Dayton, Ohio, January, 2010.  
Member, Organizing Committee, Chapman Conference on ‘Computational Challenges in Ionosphere/Thermosphere Physics,’ 2010.  
Consultant, Air Force Scientific Advisory Board (SAB), 2010.  
Convenor, CEDAR Session; Recent Advances in Modeling the Ionosphere (with J. Huba and A. Ridley); CEDAR Meeting, Boulder, Colorado, 2010.  
Convenor (with C. R. Chappell and D. Welling), Four Joint CEDAR-GEM Sessions: (1) Measurements of ion outflow, (2) Modeling ionospheric outflow, (3) Merging outflow and GGCM models, (4) Outflow modeling, measuring and merging planning session; Santa Fe, New Mexico, 2011.  
Member (with C. R. Chappell and D. Welling), GEM Focus Group on ‘Ionospheric Source of Magnetospheric Plasma: Measuring, Modeling and Merging into the GGCM’  
Organizer, Chapman Conference on ‘Modeling the Ionosphere/Thermosphere System’ (with J. Huba and A. Ridley), Charleston, South Carolina, May 9-12, 2011.

Organizer, GEM Focus Group on ‘Ionospheric Source of Magnetospheric Plasma: Measuring, Modeling and Merging into the GGCM’ (with C. R. Chappell and D. Welling), June 2012-June 2016.

Subject Matter Expert, Deep Dive into Ionospheric Impacts on RF Systems (IONO) Review, Albuquerque, NM, September, 2012.

Consultant, Air Force Scientific Advisory Board (SAB), 2013.

Convenor (R. W. Schunk, R. Chappell, and D. Welling), Four sessions on “The Ionospheric Source of Magnetospheric Plasma – Measuring, Modeling and Merging into the GEM GGCM,” GEM 2013 Summer Workshop, Snowmass, Colorado, June 16-21, 2013.

Member, AIAA Atmospheric and Space Environments Committee on Standards (ASECoS), 2010-Present.

Member, Panel on Strengthening the U. S. Space Weather Enterprise, American Meteorological Society Meeting, February 5, 2014, Atlanta, Georgia.

Organizer, Chapman Conference on ‘Magnetosphere-Ionosphere Coupling in the Solar System,’ (with R. Chappell, A. Nagy, P. Banks, J. Burch, and D. Baker), Yosemite, CA; February 9-14, 2014.

Member, Scientific Organizing Committee, LWS Heliophysics Science Technical Interchange Meeting, NASA Ames Research Center, CA, 2014.

Convenor (R. W. Schunk, R. Chappell, and D. Welling), Four sessions on “The Ionospheric Source of Magnetospheric Plasma – Measuring, Modeling and Merging into the GEM GGCM,” GEM 2014 Summer Workshop, Norfolk, Virginia, June 15-20, 2014.

Member, Scientific Organizing Committee, LWS Heliophysics Science Technical Interchange Meeting, NASA Ames Research Center, CA, 2015.

Member, Scientific Organizing Committee, LWS Heliophysics Science Technical Interchange Meeting, NASA Ames Research Center, CA, 2016.

Member, Scientific Organizing Committee, LWS Heliophysics Science Technical Interchange Meeting, NASA Ames Research Center, CA, 2017.

## Robert W. Schunk

### Publications

1. Discussion of paper by L. P. Block and C. G. Falthammer, "Effects of Field-Aligned Currents on the Structure of the Ionosphere," (R. W. Schunk and J. C. G. Walker), *J. Geophys. Res.*, 74, 3747–3748, 1969.
2. Thermal diffusion in the topside ionosphere for mixtures which include multiply-charged ions, (R. W. Schunk and J. C. G. Walker), *Planet. Space Sci.*, 17, 853–868, 1969.
3. Ionospheric transport processes, Ph.D. thesis, Engineering and Applied Science Department, Yale University, 170 pages, June 1970, Dissertation Abstracts 31 (7): Order No. 71–60.
4. Thermal diffusion in the F2-region of the ionosphere, (R. W. Schunk and J. C. G. Walker), *Planet. Space Sci.*, 18, 535–557, 1970.
5. Minor ion diffusion in the F2-region of the ionosphere, (R. W. Schunk and J. C. G. Walker), *Planet. Space Sci.*, 18, 1319–1334, 1970.
6. Transport properties of the ionospheric electron gas, (R. W. Schunk and J. C. G. Walker), *Planet. Space Sci.*, 18, 1535–1550, 1970.
7. Photoelectron energy losses to thermal electrons, (R. W. Schunk and P. B. Hays), *Planet. Space Sci.*, 19, 113–117, 1971.
8. Energy losses of low-energy photoelectrons to thermal electrons, (R. W. Schunk, P. B. Hays and Y. Itikawa), *Planet. Space Sci.*, 19, 125–126, 1971.
9. Transport processes in the E-region of the ionosphere, (R. W. Schunk and J. C. G. Walker), *J. Geophys. Res.*, 76, 6159–6171, 1971.
10. Theoretical  $N_2$  vibrational distribution in an aurora, (R. W. Schunk and P. B. Hays), *Planet. Space Sci.*, 19, 1457–1461, 1971.
11. Oxygen and hydrogen ion densities above Millstone Hill, (R. W. Schunk and J. C. G. Walker), *Planet. Space Sci.*, 20, 581–589, 1972.
12. The theory of charged particle temperatures in the upper atmosphere, (R. W. Schunk and J. C. G. Walker), *Progress in High Temperature Physics and Chemistry V*, Ed. C. A. Rouse, 1–62, 1973.
13. Ambipolar diffusion in the F1-region of the ionosphere, (R. W. Schunk and J. C. G. Walker), *Planet. Space Sci.*, 21, 526–528, 1973.
14. Ion velocity distributions in the auroral ionosphere, (R. W. Schunk and J. C. G. Walker), *Planet. Space Sci.*, 20, 2175–2191, 1972.
15. Auroral ion velocity distributions using a relaxation model, (J.-P. St-Maurice and R. W. Schunk), *Planet. Space Sci.*, 21, 1115–1130, 1973.
16. Theoretical ion densities in the lower ionosphere, (R. W. Schunk and J. C. G. Walker), *Planet. Space Sci.*, 21, 1875–1896, 1973.
17. Behavior of ion velocity distributions for a simple collision model, (J.-P. St-Maurice and R. W. Schunk), *Planet. Space Sci.*, 22, 1–18, 1974.
18. Transport equations for aeronomy, *Planet. Space Sci.*, 23, 437–485, 1975.
19. Temperature and density structure of thermal proton flows, (P. M. Banks, R. W. Schunk and W. J. Raitt), *J. Geophys. Res.*, 79, 4691–4702, 1974.
20.  $NO^+$  and  $O^+$  in the high latitude F-region, (P. M. Banks, R. W. Schunk and W. J. Raitt), *Geophys. Res. Lett.*, 1, 239–242, 1974.

21. A comparison of the temperature and density structure in high and low speed thermal proton flows, (W. J. Raitt, R. W. Schunk and P. M. Banks), *Planet. Space Sci.*, 23, 1103–1117, 1975.
22. Effect of electric fields on the daytime high-latitude E- and F-regions, (R. W. Schunk, W. J. Raitt and P. M. Banks), *J. Geophys. Res.*, 80, 3121–3130, 1975.
23. Auroral  $N_2$  vibrational excitation and the electron density trough, (R. W. Schunk and P. M. Banks), *Geophys. Res. Lett.*, 2, 239–242, 1975.
24. High latitude ionospheric model development study, (R. W. Schunk and P. M. Banks), La Jolla Sciences Report, February, 1975.
25. Use of generalized orthogonal polynomial solutions of Boltzmann's equation in certain aeronomy problems: Auroral ion velocity distributions, (J.-P. St-Maurice and R. W. Schunk), *J. Geophys. Res.*, 81, 2145–2154, 1976.
26. Ionospheric composition in SAR-arcs, (W. J. Raitt, R. W. Schunk and P. M. Banks), *Planet. Space Sci.*, 24, 105–114, 1976.
27. The topside ionosphere: A region of dynamic transition, (P. M. Banks, R. W. Schunk and W. J. Raitt), *Annual Review of Earth and Planetary Sciences*, 4, 381–440, 1976.
28. Effects of electric fields and other processes upon the nighttime high latitude F-layer, (R. W. Schunk, P. M. Banks and W. J. Raitt), *J. Geophys. Res.*, 81, 3271–3282, 1976.
29. Auroral ion velocity distributions for a polarization collision model, (J.-P. St-Maurice and R. W. Schunk), *Planet. Space Sci.*, 25, 243–260, 1977.
30. The influence of convection electric fields on thermal proton outflow from the ionosphere, (W. J. Raitt, R. W. Schunk and P. M. Banks), *Planet. Space Sci.*, 25, 291–301, 1977.
31. Diffusion and heat flow equations for the mid-latitude topside ionosphere, (J.-P. St-Maurice and R. W. Schunk), *Planet. Space Sci.*, 25, 907–920, 1977.
32. Plasma transport in the topside Venus ionosphere, (R. W. Schunk and J.-P. St-Maurice), *Planet. Space Sci.*, 25, 921–930, 1977.
33. Mathematical structure of transport equations for multispecies flows, *Rev. Geophys. Space Phys.*, 15, 429–445, 1977.
34. Effect of diffusion-thermal processes on the high-latitude topside ionosphere, (R. W. Schunk, W. J. Raitt and A. F. Nagy), *Planet. Space Sci.*, 26, 189–191, 1978.
35. On the dispersal of artificially-injected gases in the nighttime atmosphere, *Planet. Space Sci.*, 26, 605–610, 1978.
36. Helium ion outflow from the terrestrial ionosphere, (W. J. Raitt, R. W. Schunk and P. M. Banks), *Planet. Space Sci.*, 26, 255–268, 1978.
37. Electron temperatures in the F-region of the ionosphere: Theory and observations, (R. W. Schunk and A. F. Nagy), *Rev. Geophys. Space Phys.*, 16, 355–399, 1978. – 300 citations
38. Quantitative calculations of helium ion escape fluxes from the polar ionospheres, (W. J. Raitt, R. W. Schunk and P. M. Banks), *J. Geophys. Res.*, 83, 5617–5623, 1978.
39. Ion velocity distributions in the high latitude ionosphere, (J.-P. St-Maurice and Schunk), *Rev. Geophys. Space Phys.*, 17, 99–134, 1979.
40. Diffusion and heat flow equations with allowance for large temperature differences between interacting species, (J. R. Conrad and R. W. Schunk), *J. Geophys. Res.*, 84, 811–822, 1979.
41. Comparison of solutions to the thirteen-moment and standard transport equations for low speed thermal proton flows, (R. W. Schunk and D. S. Watkins), *Planet. Space Sci.*, 27, 433–444, 1979.

42. Transport equations for multispecies plasmas based on individual bi-Maxwellian distributions, (H. G. Demars and R. W. Schunk), *J. Phys. D: Appl. Phys.*, *12*, 1051–1077, 1979.
43. On the validity of the Navier-Stokes equations for thermosphere dynamics calculations, (J. R. Conrad and R. W. Schunk), *J. Geophys. Res.*, *84*, 5355–5360, 1979.
44. Effect of displaced geomagnetic and geographic poles on high latitude plasma convection and ionospheric depletions, (J. J. Sojka, W. J. Raitt and R. W. Schunk), *J. Geophys. Res.*, *84*, 5943–5951, 1979.
45. High latitude convection: Comparison of a simple model with incoherent scatter observations, (J. J. Sojka, J. C. Foster, W. J. Raitt, R. W. Schunk and J. R. Doupnik), *J. Geophys. Res.*, *85*, 703–709, 1980.
46. High latitude plasma convection: Predictions for EISCAT and Sondre Stromfjord, (J. J. Sojka, W. J. Raitt and R. W. Schunk), *Geophys. Res. Lett.*, *6*, 877–880, 1979.
47. Atomic nitrogen and oxygen ions in the daytime high-latitude F-region, (R. W. Schunk and W. J. Raitt), *J. Geophys. Res.*, *85*, 1255–1272, 1980.
48. A comparison of model predictions for plasma convection in the northern and southern polar regions, (J. J. Sojka, W. J. Raitt and R. W. Schunk), *J. Geophys. Res.*, *85*, 1762–1768, 1980.
49. Ionospheres of the terrestrial planets, (R. W. Schunk and A. F. Nagy), *Rev. Geophys. Space Phys.*, *18*, 813–852, 1980.
50. Density and temperature structure of helium ions in the topside polar ionosphere for subsonic outflows, (J. A. Ottley and R. W. Schunk), *J. Geophys. Res.*, *85*, 4177–4190, 1980.
51. Electron temperature anisotropy in the polar wind, (R. W. Schunk and D. S. Watkins), *J. Geophys. Res.*, *86*, 91–102, 1981.
52. A plasma convection model, (J. J. Sojka, R. W. Schunk and W. J. Raitt), Center for Atmospheric and Space Sciences Report, USU, 28 pages, March, 1980.
53. Momentum and energy exchange collision terms for interpenetrating bi-Maxwellian gases, (A. R. Barakat and R. W. Schunk), *J. Phys. D: Appl. Phys.*, *14*, 421–438, 1981.
54. A theoretical study of the high-latitude winter F-region at solar minimum for low magnetic activity, (J. J. Sojka, W. J. Raitt and R. W. Schunk), *J. Geophys. Res.*, *86*, 609–621, 1981.
55. Modelling the high latitude ionosphere, (W. J. Raitt, R. W. Schunk and J. J. Sojka), *Proceedings of the AGARD/NATO Symposium on "The Physical Basis of the Ionosphere in the Solar-Terrestrial System,"* Pozzuoli, Italy, 9.1–9.14, 1980.
56. Theoretical predictions for ion composition in the high-latitude winter F-region for solar minimum and low magnetic activity, (J. J. Sojka, W. J. Raitt and R. W. Schunk), *J. Geophys. Res.*, *86*, 2206–2216, 1981.
57. F-region theory, contribution to chapter 8: E- and F-region dynamics, *Review of Radio Science 1978–1980*, (ed. S. A. Bowhill), Brussels: International Union of Radio Science, 1981.
58. Ion temperature anisotropy and heat flow in the Venus lower ionosphere, (R. W. Schunk and J.-P. St-Maurice), *J. Geophys. Res.*, *86*, 4823–4827, 1981.
59. Transport equations for multicomponent anisotropic space plasmas: A review, (A. R. Barakat and R. W. Schunk), *Plasma Phys.*, *24*, 389–418, 1982.
60. High-latitude ionospheric model: First step towards a predictive capability, (R. W. Schunk, W. J. Raitt and J. J. Sojka), *Proceedings of the Symposium on "Effect of the Ionosphere on Radiowave Systems,"* 599–609, Alexandria, Virginia, 1981.

61. Plasma density features associated with strong convection in the winter high-latitude F-region, (J. J. Sojka, W. J. Raitt and R. W. Schunk), *J. Geophys. Res.*, *86*, 6908–6916, 1981.
62. Ion-neutral momentum coupling near discrete high-latitude ionospheric features, (J.-P. St.-Maurice and R. W. Schunk), *J. Geophys. Res.*, *86*, 11,299–11,321, 1981.
63. Observations of the diurnal dependence of the high-latitude F-region ion density by DMSP satellites, (J. J. Sojka, W. J. Raitt, R. W. Schunk, F. L. Rich, and R. C. Sagalyn), *J. Geophys. Res.*, *87*, 1711–1718, 1982.
64. Dynamical features of moving double layers, (N. Singh and R. W. Schunk), *J. Geophys. Res.*, *87*, 3561–3580, 1982.
65. Proton temperature anisotropy in the polar wind, (R. W. Schunk and D. S. Watkins), *J. Geophys. Res.*, *87*, 171–180, 1982.
66. Seasonal variations of the high-latitude F-region for strong convection, (J. J. Sojka, R. W. Schunk and W. J. Raitt), *J. Geophys. Res.*, *87*, 187–198, 1982.
67. Energization of ionospheric ions by electrostatic hydrogen cyclotron waves, (N. Singh, R. W. Schunk and J. J. Sojka), *Geophys. Res. Lett.*, *8*, 1249–1252, 1981.
68. The flow of plasma in the solar terrestrial environment, Center for Atmospheric and Space Sciences Report, USU, 36 pages, October, 1981.
69. Comparison of transport equations based on Maxwellian and bi-Maxwellian distributions for anisotropic plasmas, (A. R. Barakat and R. W. Schunk), *J. Phys. D: Appl. Phys.*, *15*, 1195–1216, 1982.
70. Current carrying properties of double layers and low frequency auroral fluctuations, (N. Singh and R. W. Schunk), *Geophys. Res. Lett.*, *9*, 446–449, 1982.
71. Predicted diurnal variations of electron density for three high-latitude incoherent scatter radars, (J. J. Sojka and R. W. Schunk), *Geophys. Res. Lett.*, *9*, 143–146, 1982.
72. Ion temperature variations in the daytime high-latitude F-region, (R. W. Schunk and J. J. Sojka), *J. Geophys. Res.*, *87*, 5169–5183, 1982.
73. Composition and characteristics of the polar wind, (W. J. Raitt and R. W. Schunk), In “Energetic Ion Composition in the Earth’s Magnetosphere”, ed. R. G. Johnson, 99–141, 1983.
74. Comparison of Maxwellian and bi-Maxwellian expansions with Monte Carlo simulations for anisotropic plasmas, (A. R. Barakat and R. W. Schunk), *J. Phys. D: Appl. Phys.*, *15*, 2189–2203, 1982.
75. Expansion of a multi-ion plasma into a vacuum, (N. Singh and R. W. Schunk), *Phys. Fluids*, *26*, 1123–1128, 1983.
76. Ionospheric hot spot at high latitudes, (R. W. Schunk and J. J. Sojka), *Geophys. Res. Lett.*, *9*, 1045–1048, 1982.
77. Numerical calculations relevant to the initial expansion of the polar wind, (N. Singh and R. W. Schunk), *J. Geophys. Res.*, *87*, 9154–9170, 1982.
78. Cyclotron resonance effects on stochastic acceleration of light ionospheric ions, (N. Singh, R. W. Schunk and J. J. Sojka), *Geophys. Res. Lett.*, *9*, 1053–1056, 1982.
79. Analysis and interpretation techniques for the “RIMS” experiment on DE-A, (J. J. Sojka and R. W. Schunk), Center for Atmospheric and Space Sciences Report, USU, 33 pages, May, 1982.
80. Preferential perpendicular acceleration of heavy ionospheric ions by interactions with electrostatic hydrogen cyclotron waves, (N. Singh, R. W. Schunk and J. J. Sojka), *J. Geophys. Res.*, *88*, 4055–4066, 1983.

81. A theoretical study of the high latitude F-region's response to magnetospheric storm inputs, (J. J. Sojka and R. W. Schunk), *J. Geophys. Res.*, 88, 2112–2122, 1983.
82. Current-driven double layers and the auroral plasma, (N. Singh and R. W. Schunk), *Geophys. Res. Lett.*, 9, 1345–1348, 1982.
83. The terrestrial ionosphere, In “Solar-Terrestrial Physics”, Eds. R. L. Carovillano and J. M. Forbes, 609–676, 1983.
84. Models of the ionospheric environment, *Proceedings of the “Workshop on Natural Charging of Large Space Structures in Near-Earth Polar Orbit,” AFGL-TR-83-0046*, 311–319, 1983.
85. Monte Carlo calculations of the O<sup>+</sup> velocity distribution in the auroral ionosphere, (A. R. Barakat, R. W. Schunk and J.-P. St-Maurice), *J. Geophys. Res.*, 88, 3237–3241, 1983.
86. Comparison of model high-latitude electron densities with Millstone Hill observations, (J. J. Sojka, R. W. Schunk, J. V. Evans, J. M. Holt, and R. H. Wand), *J. Geophys. Res.*, 88, 7783–7793, 1983.
87. Numerical simulations of counterstreaming plasmas and their relevance to interhemispheric flows, (N. Singh and R. W. Schunk), *J. Geophys. Res.*, 88, 7867–7877, 1983.
88. Electrostatic hydrogen-cyclotron wave emission below the hydrogen-cyclotron frequency in the auroral acceleration region, (N. Singh, R. W. Schunk and J. R. Conrad), *J. Geophys. Res.*, 89, 1650–1654, 1984.
89. Comparison of the characteristics of potential-drop and current-driven double layers, (N. Singh and R. W. Schunk), *J. Geophys. Res.*, 88, 10,081–10,090, 1983.
90. Large-scale counterstreaming of H<sup>+</sup> and He<sup>+</sup> along plasmaspheric flux tubes, (P. G. Richards, R. W. Schunk and J. J. Sojka), *J. Geophys. Res.*, 88, 7879–7886, 1983.
91. Characteristics of thermal and suprathermal ions associated with the dayside plasma trough as measured by the Dynamics Explorer retarding ion mass spectrometer, (J. J. Sojka, R. W. Schunk, J. F. E. Johnson, J. H. Waite, and C. R. Chappell), *J. Geophys. Res.*, 88, 7895–7911, 1983.
92. Simulation of auroral current sheet equilibria and associated V-shaped potential structures, (N. Singh, H. Thiemann and R. W. Schunk), *Geophys. Res. Lett.*, 10, 745–748, 1983.
93. Formation of V-shaped potentials, (H. Thiemann, N. Singh and R. W. Schunk), Sixth ESA Symposium on European Rocket & Balloon Programs (ESA SP-183), 269–275, 1983.
94. O<sup>+</sup> ions in the polar wind, (A. R. Barakat and R. W. Schunk), *J. Geophys. Res.*, 88, 7887–7894, 1983.
95. Diurnal transport effects on the F-region plasma at Chatanika under quiet and disturbed conditions, (J. Murdin, J. J. Sojka, and R. W. Schunk), *Planet. Space Sci.*, 32, 47–61, 1984.
96. Collisionless electron shocks in electron-beam-plasma systems, (N. Singh and R. W. Schunk), *Phys. Fluids*, 26, 2781–2783, 1983.
97. Problems with deducing ionospheric plasma convection patterns, (J. J. Sojka and R. W. Schunk), *J. Geophys. Res.*, 91, 259–269, 1986.
98. Energization of ions in the auroral plasma by broadband waves: Generation of ion conics, (N. Singh and R. W. Schunk), *J. Geophys. Res.*, 89, 5538–5546, 1984.
99. A theoretical F-region study of ion compositional and temperature variations in response to magnetospheric storm inputs, (J. J. Sojka and R. W. Schunk), *J. Geophys. Res.*, 89, 2348–2358, 1984.
100. Plasma response to the injection of an electron beam, (N. Singh and R. W. Schunk), *Plasma Phys.*, 26, 859–890, 1984.

101. Assessment of plasma transport and convection at high latitudes, In “Solar Terrestrial Physics – Present and Future,” (R. Schunk, A. R. Barakat, H. Carlson, J. B. Evans, J. Foster, R. Greenwald, M. C. Kelley, T. Potemra, M. H. Rees, A. D. Richmond, and R. G. Noble), Chapter 11, 36 pages, *NASA Reference Publication 1120*, 1984.
102. Dynamical features and electric field strengths of double layers driven by currents, (N. Singh, H. Thiemann and R. W. Schunk), *J. Geophys. Res.*, *90*, 5173–5186, 1985.
103. A possible mechanism for the observed streaming of O<sup>+</sup> and H<sup>+</sup> ions at nearly equal speeds in the distant magnetotail, (N. Singh and R. W. Schunk), *J. Geophys. Res.*, *90*, 6361–6369, 1985.
104. Effect of hot electrons on the polar wind, (A. R. Barakat and R. W. Schunk), *J. Geophys. Res.*, *89*, 9771–9783, 1984.
105. O<sup>+</sup> charge exchange in the polar wind, (A. R. Barakat and R. W. Schunk), *J. Geophys. Res.*, *89*, 9835–9839, 1984.
106. Report on data center for solar-terrestrial physics, (with M. A. Shea and R. L. McPherron), In *Committee on Geophysical Data Status Report - 1985*, 61–71, National Academy Press, Washington, D. C., 1986.
107. Electrostatic ion-cyclotron, beam-plasma and lower hybrid waves excited by an electron beam, (N. Singh, J. R. Conrad and R. W. Schunk), *J. Geophys. Res.*, *90*, 5159–5172, 1985.
108. Temporal behavior of density perturbations in the polar wind, (N. Singh and R. W. Schunk), *J. Geophys. Res.*, *90*, 6487–6496, 1985.
109. The relationship between the electric fields associated with plasma expansion and double layers, (N. Singh and R. W. Schunk), *Proceedings of the Second Symposium on Plasma Double Layers and Related Topics*, 272–277, 1984.
110. Can Buneman double layers be driven in auroral plasmas? (N. Singh and R. W. Schunk), *Proceedings of the Second Symposium on Plasma Double Layers and Related Topics*, 364–369, 1984.
111. Current fluctuations and dynamical features of double layer potential profiles, (N. Singh, H. Thiemann and R. W. Schunk), *Proceedings of the Second Symposium on Plasma Double Layers and Related Topics*, 278–283, 1984.
112. High frequency turbulence in a plasma driven by a current sheet, (H. Thiemann, N. Singh and R. W. Schunk), *Proceedings of the Second Symposium on Plasma Double Layers and Related Topics*, 315–320, 1984.
113. Some features of auroral electric fields as seen in 2D numerical simulations, (H. Thiemann, N. Singh and R. W. Schunk), *Adv. Space Res.*, *4*, 511–514, 1984.
114. Numerical simulations of double layers and auroral electric fields, (N. Singh, R. W. Schunk and H. Thiemann), *Adv. Space Res.*, *4*, 481–490, 1984.
115. A theoretical study of the global F region for June solstice, solar maximum, and low magnetic activity, (J. J. Sojka and R. W. Schunk), *J. Geophys. Res.*, *90*, 5285–5298, 1985.
116. Ionosphere, (R. W. Schunk and A. F. Nagy), In “*Encyclopedia of Physical Science and Technology*”, Vol. 7, 19–33, Academic Press, 1987.
117. Theoretical study of anomalously high F-region peak altitudes in the polar ionosphere, (J. J. Sojka and R. W. Schunk), *J. Geophys. Res.*, *90*, 7525–7532, 1985.
118. Electrostatic ion cyclotron waves in a plasma with an ion beam and counterstreaming bulk electrons: Waves in the zero-frequency band, (N. Singh, J. R. Conrad and R. W. Schunk), *J. Geophys. Res.*, *90*, 12,219–12,229, 1985.

119. Diurnal variation of the dayside, ionospheric, mid-latitude trough in the southern hemisphere at 800 km: Model and measurement comparison, (with J. J. Sojka, W. J. Raitt, R. W. Schunk, J. L. Parish, and F. J. Rich), *Planet. Space Sci.*, 33, 1375–1382, 1985.
120. Comparison of simultaneous Chatanika and Millstone Hill observations with ionospheric model predictions, (C. E. Rasmussen, R. W. Schunk, J. J. Sojka, V. B. Wickwar, O. de la Beaujardiere, J. C. Foster, J. M. Holt, D. S. Evans, and E. Nielsen), *J. Geophys. Res.*, 91, 6986–6998, 1986.
121. Numerical simulation of spacecraft charging by impact-induced plasmas during a cometary flyby, (H. Thiemann, N. Singh, R. W. Schunk, and R. Grard), *J. Geophys. Res.*, 91, 2989–3000, 1986.
122. A theoretical study of the production and decay of localized electron density enhancements in the polar ionosphere, (J. J. Sojka and R. W. Schunk), *J. Geophys. Res.*, 91, 3245–3253, 1986.
123. Is Jupiter’s ionosphere a significant plasma source for its magnetosphere? (A. F. Nagy, A. R. Barakat and R. W. Schunk), *J. Geophys. Res.*, 91, 351–354, 1986.
124. Numerical simulations of auroral plasma processes: Electric fields, (N. Singh, H. Thiemann and R. W. Schunk), In, “Ion Acceleration in the Magnetosphere and Ionosphere,” ed. T. Chang, *AGU Monograph*, 38, 343–347, 1986.
125. Numerical simulations of auroral plasma processes: Ion beams and conics, (N. Singh, H. Thiemann and R. W. Schunk), In, “Ion Acceleration in the Magnetosphere and Ionosphere,” ed. T. Chang, *AGU Monograph*, 38, 340–342, 1986.
126. Ion acceleration in expanding ionospheric plasmas, (N. Singh and R. W. Schunk), “Ion Acceleration in the Magnetosphere and Ionosphere,” ed. T. Chang, *AGU Monograph*, 38, 362–365, 1986.
127. Effects of different convection models upon the high-latitude ionosphere, (C. E. Rasmussen, R. W. Schunk, and J. J. Sojka), *J. Geophys. Res.*, 91, 6999–7005, 1986.
128. Studies on counterstreaming plasma expansion, (N. Singh, H. Thiemann and R. W. Schunk), *Physica Scripta*, 33, 355–369, 1986.
129. An interplanetary magnetic field dependent model of the ionospheric convection electric field, (J. J. Sojka, C. E. Rasmussen and R. W. Schunk), *J. Geophys. Res.*, 91, 11,281–11,290, 1986.
130. Temporal features of the refilling of a plasmaspheric flux tube, (N. Singh, R. W. Schunk and H. Thiemann), *J. Geophys. Res.*, 91, 13,433–13,454, 1986.
131. Theoretical study of the electron temperature in the high latitude ionosphere for solar maximum and winter conditions, (R. W. Schunk, J. J. Sojka and M. D. Bowline), *J. Geophys. Res.*, 91, 12,041–12,054, 1986.
132. Solutions to bi-Maxwellian transport equations for SAR-arc conditions, (H. G. Demars and R. W. Schunk), *Planet. Space Sci.*, 34, 1335–1348, 1986.
133. Solar-terrestrial physics: A space-age birth, Utah State University Press, 23 pages, 1986.
134. Magnetospheric control of the bulk ionospheric plasma, (J. J. Sojka and R. W. Schunk), AGARD/NATO Symposium on, “The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications,” *AGARD Conference Proceedings*, 406, 2.1–2.13, 1987.
135. Plasma processes driven by current sheets and their relevance to the auroral plasma, (N. Singh, H. Thiemann and R. W. Schunk), *IEEE Transactions on Plasma Science*, 14, 805–822, 1986.

136. Electric fields and double layers in plasmas, (N. Singh, H. Thiemann and R. W. Schunk), *Laser and Particle Beams*, 5, 233–255, 1987.
137. Simulations of auroral plasma processes: Electric fields, waves and particles, (N. Singh, H. Thiemann and R. W. Schunk), *Planet. Space Sci.*, 35, 353–395, 1987.
138. Charging effects in the cometary environment of Halley, (H. Thiemann, R. Grard, N. Singh and R. W. Schunk), *Adv. Space Res.*, 5, 227–230, 1985.
139. An updated theory of the polar wind, *Adv. Space Res.*, 6, 79–88, 1986.
140. Modelled ionospheric  $T_e$  profiles at mid-latitudes for possible IRI application, (J. J. Sojka, R. W. Schunk and M. D. Bowline), *Adv. Space Res.*, 7, (6) 107–110, 1987.
141. Stability of the polar wind, (A. R. Barakat and R. W. Schunk), *J. Geophys. Res.*, 92, 3409–3415, 1987.
142. Comparison of solutions to bi-Maxwellian and Maxwellian transport equations for subsonic flows, (H. G. Demars and R. W. Schunk), *J. Geophys. Res.*, 92, 5969–5990, 1987.
143. Ionospheric convection driven by NBZ currents, (C. E. Rasmussen and R. W. Schunk), *J. Geophys. Res.*, 92, 4491–4504, 1987.
144. Interactions between the polar ionosphere and thermosphere, *Physica Scripta*, T18, 256–275, 1987.
145. Can the high latitude ionosphere support large field-aligned ion drifts? (R. J. Sica, R. W. Schunk and C. E. Rasmussen), *J. Atmos. Terr. Phys.*, 50, 141–152, 1988.
146. Theoretical study of the high latitude ionosphere's response to multi-cell convection patterns, (J. J. Sojka and R. W. Schunk), *J. Geophys. Res.*, 92, 8733–8744, 1987.
147. Theoretical study of the effect of ionospheric return currents on the electron temperature, (R. W. Schunk, J. J. Sojka and M. D. Bowline), *J. Geophys. Res.*, 92, 6013–6022, 1987.
148. Temperature anisotropies in the terrestrial ionosphere and plasmasphere, (H. G. Demars and R. W. Schunk), *Rev. Geophys.*, 25, 1659–1679, 1987.
149.  $O^+$  and  $H^+$  escape fluxes from the polar regions, (A. R. Barakat, R. W. Schunk, T. E. Moore, and J. H. Waite), in, *Modeling Magnetospheric Plasma*, Eds. T. E. Moore and J. H. Waite, *AGU Geophysical Monograph*, 44, 241–245, 1988.
150. The polar wind, in *Modeling Magnetospheric Plasma*, Eds. T. E. Moore and J. H. Waite, *AGU Geophysical Monograph*, 44, 219–228, 1988.
151. Ion escape fluxes from the terrestrial high-latitude ionosphere, (A. R. Barakat, R. W. Schunk, T. E. Moore, and J. H. Waite), *J. Geophys. Res.*, 92, 12,255–12,266, 1987.
152. First-principle and empirical modelling of the global-scale ionosphere, (R. W. Schunk and E. P. Szuszczewicz), *Ann. Geophysicae*, 6, 19–30, 1988.
153. SUNDIAL: A worldwide study of interactive ionospheric processes and their roles in the transfer of energy and mass in the sun-earth system, (E. P. Szuszczewicz, B. G. Fejer, E. C. Roelof, R. Schunk, R. A. Wolf, R. Leitinger, M. A. Abdu, B. M. Reddy, J. C. Joselyn, P. Wilkinson, and R. Woodman), *Ann. Geophysicae*, 6, 3–18, 1988.
154. Processes in the quiet and disturbed equatorial low-latitude ionosphere: SUNDIAL campaign 1984, (M. A. Abdu, B. M. Reddy, G. O. Walker, R. Hanbaba, J. H. A. Sobral, B. G. Fejer, R. F. Woodman, R. W. Schunk and E. P. Szuszczewicz), *Ann. Geophysicae*, 6, 69–80, 1988.
155. Interhemispheric comparison of SUNDIAL  $F$ -region data with global-scale ionospheric models, (P. J. Wilkinson, R. Schunk, R. Hanbaba, and H. Mori), *Ann. Geophysicae*, 6, 31–38, 1988.
156. Giotto-spacecraft charging due to impact generated plasma in the presence of dielectric materials, (H. Thiemann, R. W. Schunk, N. Singh, and R. Grard), *AGARD/NATO*

- Symposium on “The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications,” *AGARD Conference Proceedings*, 406, 11.1–11.7, 1987.
157. Ionospheric features induced by magnetospheric processes, (R. W. Schunk and J. J. Sojka), In, *Quantitative Modeling of Magnetosphere-Ionosphere Coupling Processes*, 11–16, Kyoto Sangyo University, Japan, 1987.
  158. A model study of how electric field structures affect the polar cap *F*-region, (J. J. Sojka and R. W. Schunk), *J. Geophys. Res.*, 93, 884–896, 1988.
  159. A theoretical study of the lifetime and transport of large ionospheric density structures, (R. W. Schunk and J. J. Sojka), *J. Geophys. Res.*, 92, 12,343–12,351, 1987.
  160. A mathematical model of the middle and high latitude ionosphere, *PAGEOPH*, 127, 255–303, 1988.
  161. Ionospheric convection inferred from IMF dependent Birkeland currents, (C. E. Rasmussen and R. W. Schunk), *J. Geophys. Res.*, 93, 1909–1921, 1988.
  162. Comparison of simultaneous Chatanika and Millstone Hill temperature measurements with ionospheric model predictions, (C. E. Rasmussen, J. J. Sojka, R. W. Schunk, V. B. Wickwar, O. de la Beaujardiere, J. C. Foster, and J. M. Holt), *J. Geophys. Res.*, 93, 1922–1932, 1988.
  163. A photochemical equilibrium model for ionospheric conductivity, (C. E. Rasmussen, R. W. Schunk and V. B. Wickwar), *J. Geophys. Res.*, 93, 9831–9840, 1988.
  164. Polar wind theory, In, “Physics of Space Plasmas,” *SPI Conf. Proc. and Reprint Series*, 7, 183–202, 1987.
  165. Ionospheric climate and weather modelling, (R. W. Schunk and J. J. Sojka), *EOS*, 69, 153–165, 1988.
  166. Thermosphere-ionosphere-magnetosphere coupling, *Proceedings of the Workshop on Atmospheric Density and Aerodynamic Drag Models for Air Force Operations*, Report GL-TR-90-0033, 6.129–6.149, 1990.
  167. Future thermospheric general circulation model (TGCM) needs, *Proceedings of the Workshop on Atmospheric Density and Aerodynamic Drag Models for Air Force Operations*, Report GL-TR-90-0033, 6.109–6.128, 1990.
  168. Modeled *F*-region response to auroral dynamics based upon Dynamics Explorer auroral observations, (J. J. Sojka, R. W. Schunk, J. D. Craven, L. A. Frank, J. R. Sharber, and J. D. Winningham), *J. Geophys. Res.*, 94, 8993–9008, 1989.
  169. A comparative study of plasma expansion events in the polar wind, (T. Gombosi and R. W. Schunk), *Planet. Space Sci.*, 36, 753–764, 1988.
  170. Discrete events and solar wind energization, (W.-H. Yang and R. W. Schunk), *Ap. J*, 343, 494–498, 1989.
  171. Ionospheric responses to coupling processes in the solar-terrestrial system: SUNDIAL perspectives, (E. P. Szuszczewicz, R. A. Wolf, R. W. Spiro, B. G. Fejer, R. W. Schunk and E. C. Roelof), In, “Physics of Space Plasmas,” *SPI Conf. Proc. and Reprint Series*, 7, 215–225, 1988.
  172. Stability of H<sup>+</sup> beams in the polar wind (A. R. Barakat and R. W. Schunk), *J. Geophys. Res.*, 94, 1487–1494, 1989.
  173. Modelling ionospheric density structures, (R. W. Schunk and J. J. Sojka), AGARD/NATO Symposium on, “Ionospheric Structure and Variability on a Global Scale and Interaction with Atmosphere, Magnetosphere,” *AGARD Conference Proceedings*, 441, 14.1–14.12, 1989.

174. Early-time plasma expansion characteristics of ionized clouds in the ionosphere, (R. W. Schunk and E. P. Szuszczewicz), *J. Geophys. Res.*, *93*, 12,901–12,915, 1988.
175. A comparison of  $f_oF_2$  obtained from a time-dependent ionospheric model with Argentine Islands data for quiet conditions, (J. J. Sojka, R. W. Schunk and G. L. Wrenn), *J. Atmos. Terr. Phys.*, *50*, 1027–1039, 1988.
176. Multistream hydrodynamic modeling of interhemispheric plasma flow, (C. E. Rasmussen and R. W. Schunk), *J. Geophys. Res.*, *93*, 14,557–14,565, 1988.
177. Solutions to bi-Maxwellian transport equations for the polar wind, (H. G. Demars and R. W. Schunk), *Planet. Space Sci.*, *37*, 85–96, 1989.
178. A fluid model of high voltage spheres in the ionosphere, (T.-Z. Ma and R. W. Schunk), *Planet. Space Sci.*, *37*, 21–47, 1989.
179. SUNDIAL: An international program in solar-terrestrial physics, (E. P. Szuszczewicz, B. G. Fejer, R. W. Schunk, E. C. Roelof, and R. A. Wolf), *WITS Handbook, Vol. 1*, 208–213, Eds. C. H. Liu and B. Edwards, SCOSTEP, 1988.
180. A fluid model of high voltage spheres in an unmagnetized plasma, (T.-Z. Ma and R. W. Schunk), *Plasma Phys. & Cont. Fusion*, *31*, 399–421, 1989.
181. Coordinated multi-parameter measurements and predictions of the global-scale ionosphere, (with E. P. Szuszczewicz, R. A. Wolf, B. G. Fejer, R. W. Schunk and E. C. Roelof), AGARD/NATO Symposium on, “Ionospheric Structure and Variability on a Global Scale and Interaction with Atmosphere, Magnetosphere,” *AGARD Conference Proceedings*, *441*, 38.1–38.16, 1989.
182. Dynamic PIC-simulations of charging phenomena related to the ICE-spacecraft in both cometary and solar wind environments, (H. Thiemann, R. W. Schunk and R. Zwickl), *Adv. Space Res.*, *9*, 389–392, 1989.
183. Polar wind tutorial, In, “Physics of Space Plasmas,” *SPI Conf. Proc. and Reprint Series*, *8*, 81–134, 1988.
184. Theoretical study of the seasonal behavior of the global ionosphere at solar maximum, (J. J. Sojka and R. W. Schunk), *J. Geophys. Res.*, *94*, 6739–6749, 1989.
185. A real-time high-latitude ionospheric specification model, (R. E. Daniell, L. D. Brown, D. N. Anderson, J. J. Sojka and R. W. Schunk), In, “Physics of Space Plasmas,” *SPI Conf. Proc. and Reprint Series*, *8*, 373–378, 1988.
186. Particle-in-cell simulations of sheath formation around biased interconnectors in a low-earth-orbit plasma, (H. Thiemann and R. W. Schunk), *J. Spacecraft and Rockets*, *27*, 554–562, 1990.
187. Response of the ionosphere-thermosphere system to magnetospheric forcing, *Adv. Space Res.*, *10*, 133–142, 1990.
188. A three-dimensional time-dependent model of the polar wind, (R. W. Schunk and J. J. Sojka), *J. Geophys. Res.*, *94*, 8973–8991, 1989.
189. Solutions to bi-Maxwellian transport equations for radial solar wind beyond  $28 R_S$  (H. G. Demars and R. W. Schunk), *Planet. Space Sci.*, *39*, 435–451, 1991.
190. A three-dimensional time-dependent model of the plasmasphere, (C. E. Rasmussen and R. W. Schunk), *J. Geophys. Res.*, *95*, 6133–6144, 1990.
191. A study of the undisturbed mid-latitude ionosphere using simultaneous multiple site ionosonde measurements during the Sundial-86 Campaign, (R. J. Sica, R. W. Schunk and P. J. Wilkinson), *J. Geophys. Res.*, *95*, 8271–8279, 1990.
192. A test of convection models for IMF  $B_z$  north, (N. C. Maynard, J. J. Sojka, R. W. Schunk, J. P. Heppner, and L. H. Brace), *Planet. Space Sci.*, *38*, 1077–1089, 1990.

193. Magnetosphere-ionosphere-thermosphere coupling processes, Proceedings of a SCOSTEP Symposium on *Solar-Terrestrial Energy Program (STEP): Major Scientific Problems*, 52–110, 1988.
194. Solar arrays in the LEO-plasma environment: A model for leakage current phenomena deduced from experimental and theoretical studies, (H. Thiemann, R. W. Schunk and L. Gerlach), *Proceedings of the European Space Power Conference ESA SP-294*, 809–813, 1989.
195. Solar wind proton velocity distributions: Comparison of the bi-Maxwellian based 16-moment expansion with observations, (H. G. Demars and R. W. Schunk), *Planet. Space Sci.*, 38, 1091–1103, 1990.
196. A two-dimensional model of plasma expansion in the ionosphere, (T.-Z. Ma and R. W. Schunk), *Planet. Space Sci.*, 38, 723–741, 1990.
197. The longitude dependence of the dayside *F* region trough: A detailed model-observation comparison, (J. J. Sojka, R. W. Schunk and J. A. Whalen), *J. Geophys. Res.*, 95, 15,275–15,280, 1990.
198. Where do negatively biased solar arrays arc?, (H. Thiemann, R. W. Schunk and K. Bogus), *J. Spacecraft & Rockets*, 27, 563–565, 1990.
199. A high latitude ionospheric specification model (HLISM), (R. E. Daniell, L. D. Brown, D. N. Anderson, J. A. Whalen, J. J. Sojka and R. W. Schunk), *STP Workshop Proceedings - 1989*, 1989.
200. A global ionospheric conductivity and electron density (ICED) model, (R. E. Daniell, Jr., D. T. Decker, D. N. Anderson, J. R. Jasperse, R. W. Schunk and J. J. Sojka), *Proceedings of the Ionospheric Effects Symposium*, 1993.
201. Plasma expansion characteristics of ionized clouds in the ionosphere: Macroscopic formulation, (R. W. Schunk and E. P. Szuszczewicz), *J. Geophys. Res.*, 96, 1337–1349, 1991.
202. Latitudinal dynamics of steady solar wind flows, (W.-H. Yang and R. W. Schunk), *Ap. J.*, 372, 703–709, 1991.
203. Interpreting vertical plasma drift in the mid-latitude ionosphere using ionosonde measurements, (R. J. Sica and R. W. Schunk), *Planet. Space Sci.*, 38, 1567–1571, 1990.
204. Plasma cloud expansion in the ionosphere: 3-D simulation, (T.-Z. Ma and R. W. Schunk), *J. Geophys. Res.*, 96, 5793–5810, 1991.
205. High-latitude ionospheric model, (L. Bossy, S. Pallaschke, K. Rawer, R. W. Schunk, J. J. Sojka, and H. Thiemann), *Adv. Space Res.*, 11, 11–14, 1991.
206. Field formation around negatively biased solar arrays in the LEO-plasma, (H. Thiemann and R. W. Schunk), *Adv. Space Res.*, 12, (12)143-(12)146, 1992.
207. High voltage spheres in an unmagnetized plasma: Fluid and PIC simulations, (H. Thiemann, T.-Z. Ma and R. W. Schunk), *Adv. Space Res.*, 12, (12)57-(12)60, 1992.
208. Model and observation comparison of the universal time and IMF  $B_y$  dependence of the ionospheric polar hole, (J. J. Sojka, R. W. Schunk, W. R. Hoegy, and J. M. Grebowsky) *Adv. Space Res.*, 11, 39–42, 1991.
209. Model studies of ionosphere/thermosphere coupling phenomena on both large and small spatial scales and from high to low altitudes, *J. Geomag. and Geoelect.*, 43, 501-512, 1991.
210. Ionospheric simulation compared with Dynamics Explorer observations for November 22, 1981, (J. J. Sojka, M. D. Bowline, R. W. Schunk, J. D. Craven, L. A. Frank, J. R. Sharber, J. D. Winningham, and L. Brace), *J. Geophys. Res.*, 97, 1245–1256, 1992.

211. Advanced model of solar array-plasma interactions, (H. Thiemann and R. W. Schunk), *Proceedings of the ESA Space Environment Analysis Workshop, ESA WPP-23*, 9 pages, 1990.
212. Monte Carlo study of the transition from collision-dominated to collisionless polar wind flow, (A. R. Barakat, R. W. Schunk, I. A. Barghouthi, and J. Lemaire), *SPI Conf. Proc. and Reprint Series*, 10, 431–437, 1991.
213. Approaches to ionospheric modelling, simulation and prediction, (R. W. Schunk and J. J. Sojka), *Adv. Space Res.*, 12, 317-326, 1992.
214. Comparison of semikinetic and generalized transport models of the polar wind, (H. G. Demars and R. W. Schunk), *Geophys. Res. Lett.*, 18, 713–716, 1991.
215. Ionization in the magnetized ionosphere surrounding a high voltage sphere, (T.-Z. Ma and R. W. Schunk), *Planet. Space Sci.*, 39, 1325–1342, 1991.
216. Comparison of the USU ionospheric model with the UCL-Sheffield coupled thermospheric-ionospheric model, (J. J. Sojka, R. W. Schunk, D. Rees, T.-J. Fuller-Rowell, R. J. Moffett and S. Quegan), *Adv. Space Res.*, 12, 89–92, 1992.
217. High voltage spheres in an unmagnetized plasma: Long term evolution and rise time effects, (T.-Z. Ma and R. W. Schunk), *Plasma Phys. & Cont. Fusion*, 34, 767-781, 1992.
218. Field-aligned current associated with a distorted two-cell convection pattern during northward IMF, (L. Zhu, R. W. Schunk and J. J. Sojka), *J. Geophys. Res.*, 96, 19,397–19,408, 1991.
219. Semikinetic and generalized transport models of the polar and solar winds, (H. G. Demars and R. W. Schunk), *J. Geophys. Res.*, 97, 1581-1595, 1992.
220. High negative voltage spheres in an unmagnetized plasma: Fluid simulation, (T.-Z. Ma and R. W. Schunk), *Plasma Phys. & Cont. Fusion*, 34, 783-799, 1992.
221. Arc discharges at negatively biased solar arrays, (H. Thiemann and R. W. Schunk), *Proceedings of the ESA Space Power Conference, ESA SP-320*, 589-595, 1991 .
222. Plasmaspheric wind, (J. Lemaire and R. W. Schunk), *J. Atmos. Terr. Phys.*, 54, 467–477, 1992.
223. On the discontinuity in kinetic solutions of the collisionless polar wind, (A. Khoyloo, A. R. Barakat and R. W. Schunk), *Geophys. Res. Lett.*, 18, 1837–1840, 1991.
224. Ionization and expansion of barium clouds in the ionosphere, (T.-Z. Ma and R. W. Schunk), *J. Geophys. Res.*, 98, 323-336, 1993.
225. Comparison of generalized transport and Monte Carlo models of the escape of a minor species, (with H. G. Demars and A. R. Barakat), *J. Atmos. Terr. Phys.*, 55, 1583-1594, 1993.
226. Field-aligned currents, conductivity enhancements, and distorted two-cell convection for northward IMF, (with L. Zhu and J. J. Sojka), *Proceedings of the XXth General Assembly of IUGG*, Vienna, Austria, Aberdeen University, Scotland, August 1991.
227. A time-dependent model of polar cap arcs, (L. Zhu, J. J. Sojka, R. W. Schunk and D. J. Crain), *J. Geophys. Res.*, 98, 6139-6150, 1993.
228. Modelling and measurement of global scale ionospheric behavior under solar minimum, equinoctial conditions, (with E. Szuszczewicz et al.), *Adv. Space Res.*, 12, 105-115, 1992.
229. Parameterized study of the ionospheric modification associated with sun-aligned polar cap arcs, (D. J. Crain, J. J. Sojka, R. W. Schunk, and L. Zhu), *J. Geophys. Res.*, 98, 6151-6162, 1993.
230. A first-principle derivation of the high latitude total electron content distribution, (D. J. Crain, J. J. Sojka, R. W. Schunk, P. H. Doherty, and J. A. Klobucher), *Radio Sci.*, 28, 49-61, 1993.

231. Monte Carlo study of the transition region in the polar wind: An improved collision model, (I. A. Barghouthi, A. R. Barakat and R. W. Schunk), *J. Geophys. Res.*, *98*, 17,583-17,591, 1993.
232. Comparing semi-kinetic, generalized transport and Monte Carlo predictions for steady state flows of interest in space science, (H. G. Demars, R. W. Schunk and A. R. Barakat), *Rarefied Gas Dynamics: Space Science and Engineering*, (ed. B. D. Shizgal and D. P. Weaver), Vol. 160 of *Progress in Astronautics and Aeronautics*, 488-499, 1993.
233. Influence of horizontal inhomogeneity in the ionosphere on the reflection of Alfvén waves, (L. Zhu, J. J. Sojka, R. W. Schunk and D. J. Crain), *Geophys. Res. Lett.*, *20*, 313-316, 1993.
234. Dynamics of three-dimensional plasma clouds with coupling to the background ionosphere (T.-Z. Ma and R. W. Schunk), *J. Geophys. Res.*, *99*, 6331-6344, 1994.
235. Computer experiments on arcing processes as observed in ground tests (H. Thiemann and R. W. Schunk), *J. Spacecraft & Rockets*, *31*, 929-936, 1994.
236. A comparative study of the time-dependent standard, 8, 13, and 16 moment transport formations of the polar wind (P.-L. Blelly and R. W. Schunk), *Annl. Geophys.*, *11*, 443-469, 1993.
237. Topside ionosphere: Observations with EISCAT and numerical modelling (with P.-L. Blelly, M. Blanc, and D. Alcaydé), *Proceedings of COSPAR Scientific Assembly*, Hamburg, Germany, 1994.
238. Theoretical study of polar cap arcs: Time-dependent model and its applications (L. Zhu, J. J. Sojka, R. W. Schunk, and D. Crain), *Radio Sci.*, *29*, 283-292, 1994.
239. Modeling sun-aligned polar cap arcs (D. J. Crain, J. J. Sojka, R. W. Schunk, and L. Zhu), *Radio Sci.*, *29*, 269-281, 1994.
240. Ionosphere (A. F. Nagy and R. W. Schunk), *Encyclopedia of Physical Science and Technology*, *8*, 323-337, 1992.
241. Plasmaspheric convection with non-closed streamlines (with J. F. Lemaire), *J. Atmos. Terr. Phys.*, *56*, 1629-1633, 1994.
242. Observations and model comparisons of early-time expansion characteristics of a barium-lithium release at F-region altitudes (E. P. Szuszczewicz, D. Hunton, J. R. Wygant and R. W. Schunk), *Geophys. Res. Lett.*, *20*, 2031-2034, 1993.
243. Modeling polar cap F-region patches using time varying convection (J. J. Sojka, M. D. Bowline, R. W. Schunk, D. T. Decker, C. E. Valladares, R. Sheehan, D. N. Anderson, and R. A. Heelis), *Geophys. Res. Lett.*, *20*, 1783-1786, 1993.
244. Effect of high latitude ionospheric convection on sun-aligned polar cap arcs (J. J. Sojka, L. Zhu, D. J. Crain and R. W. Schunk), *J. Geophys. Res.*, *99*, 8851-8863, 1994.
245. Correction to "Effect of high latitude ionospheric convection on sun-aligned polar cap arcs" (J. J. Sojka, L. Zhu, D. J. Crain, and R. W. Schunk), *J. Geophys. Res.*, *99*, 13281, 1994.
246. The lower ionosphere at high latitudes (R. W. Schunk and J. J. Sojka), *Geophysical Monograph*, *87*, 37-47, 1995.
247. Ionospheric modelling of climatology and weather (R. W. Schunk and J. J. Sojka), *1993 Ionospheric Effects Symposium*, (ed. J. M. Goodman), 343-352, 1994.
248. A Monte Carlo simulation of the effect of ion self-collisions on the ion velocity distribution function in the high latitude F region (I. A. Barghouthi, A. R. Barakat and R. W. Schunk), *Annl. Geophys.*, *12*, 1076-1084, 1994.
249. Patches in the polar ionosphere: UT and seasonal dependence (J. J. Sojka, M. D. Bowline and R. W. Schunk), *J. Geophys. Res.*, *99*, 14959-14970, 1994.

250. A multi-ion generalized transport model of the polar wind (H. G. Demars and R. W. Schunk), *J. Geophys. Res.*, *99*, 2215-2226, 1994.
251. The effect of the geomagnetic field on negative voltage spheres in the ionospheric plasma: Fluid simulation (T.-Z. Ma and R. W. Schunk), *Planet. Space Sci.*, *42*, 531-538, 1994.
252. Model study of multiple polar cap arcs: Occurrence and spacing (L. Zhu, J. J. Sojka, R. W. Schunk and D. J. Crain), *Geophys. Res. Lett.*, *21*, 649-652, 1994.
253. The ionospheric response to the sustained high geomagnetic activity during the March '89 great storm (J. J. Sojka, R. W. Schunk and W. F. Denig), *J. Geophys. Res.*, *99*, 21341-21352, 1994.
254. Ionospheric response to traveling convection twin vortices (R. W. Schunk, L. Zhu and J. J. Sojka), *Geophys. Res. Lett.*, *21*, 1759-1762, 1994.
255. Applications of generalized transport equations to the problem of wave-particle interactions at high latitudes (A. R. Barakat, H. G. Demars and R. W. Schunk), *SPI Conf. Proc. and Reprint Series*, Number 12, T. Chang, G. B. Crew and J. R. Jasperse, eds., Scientific Publishers, Cambridge, Mass., 1994.
256. What is the source of observed annual variations in plasmaspheric density? (S. M. Guiter, C. E. Rasmussen, T. I. Gombosi, J. J. Sojka and R. W. Schunk), *J. Geophys. Res.*, *100*, 8013-8020, 1995.
257. Parameterized ionospheric model: A global ionospheric parameterization based on first principles models (R. E. Daniell, L. D. Brown, D. N. Anderson, M. W. Fox, P. H. Doherty, D. T. Decker, J. J. Sojka and R. W. Schunk), *Radio Sci.*, *30(5)*, 1499-1510, 1995.
258. Simulations of high latitude ionospheric climatology (J. J. Sojka and R. W. Schunk), *J. Atmos. Terr. Phys.*, *59*, 207-229, 1997.
259. Field-aligned expansion of plasma clouds in the ionosphere (R. W. Schunk and T.-Z. Ma), *Adv. Space Res.*, *15*, (12)107-(12)110, 1995.
260. The interaction of high-voltage spheres with the ionosphere (T.-Z. Ma and R. W. Schunk), *Adv. Space Res.*, *15*, (12)87-(12)90, 1995.
261. Model-observation comparison study of multiple polar cap arcs (L. Zhu, C. E. Valladares, J. J. Sojka, R. W. Schunk, and D. J. Crain), *J. Geophys. Res.*, *101*, 323-333, 1996.
262. USU model of the global ionosphere (R. W. Schunk and J. J. Sojka), *STEP Handbook of Ionospheric Models*, 153-171, 1996.
263. Macroscale modeling and mesoscale observations of plasma density structures in the polar cap (St. Basu, S. Basu, J. Sojka, R. W. Schunk and E. MacKenzie), *Geophys. Res. Lett.*, *22*, 881-884, 1995.
264. Double-hump  $H^+$  velocity distribution in the polar wind (A. R. Barakat, I. A. Barghouthi, and R. W. Schunk), *Geophys. Res. Lett.*, *22*, 1857-1860, 1995.
265. Electron and ion thermal structures above 1000 km: A multi-ion generalized transport model for subsonic flows (H. G. Demars and R. W. Schunk), *J. Geophys. Res.*, *100*, 23,871-23,885, 1995.
266. Effect of polar cap patches on the polar thermosphere (T.-Z. Ma and R. W. Schunk), *J. Geophys. Res.*, *100*, 19,701-19,713, 1995.
267. An in-situ investigation of early-time multi-ion expansion processes in an F-region chemical release (with E. Szuszczewicz, G. Earle, T. Bateman, Z. Klos, and A. Kirage), *J. Geophys. Res.*, *101*, 15,749-15,763, 1996.
268. Comparison of macroscopic particle-in-cell and semikinetic models of the polar wind (with A. R. Barakat, H. Thiemann, and R. W. Schunk), *J. Geophys. Res.*, *103*, 29277-29287, 1998.

269. Report of the Thermosphere-Ionosphere-Aurora Sub-panel (with T. L. Killeen, St. Basu, R. A. Heelis, N. W. Maynard, R. R. Meier, and E. P. Szuszczewicz), *National Space Weather Program*, August, 1995.
270. Ionosphere-thermosphere space weather issues (R. W. Schunk and J. J. Sojka), *J. Atmos. Terr. Phys.*, *58*, 1527-1574, 1996.
271. Shocks in the polar wind (H. G. Demars, A. R. Barakat, R. W. Schunk and H. Thiemann), *Geophys. Res. Lett.*, *23*, 1721-1724, 1996.
272. Ambiguity in identification of polar cap F-region patches: Contrasting radio and optical observation techniques, (J. J. Sojka, R. W. Schunk, M. D. Bowline, and D. J. Crain), *J. Atmos. Terr. Phys.*, *59*, 249-258, 1997.
273. Polar cap arcs: A review (L. Zhu, R. W. Schunk and J. J. Sojka), *J. Atmos. Terr. Phys.*, *59*, 1087-1126, 1997.
274. Relationship of theoretical patch climatology to polar cap patch observations (M. D. Bowline, J. J. Sojka and R. W. Schunk), *Radio Sci.*, *39*, 635-644, 1996.
275. The effect of centrifugal acceleration on the polar wind (H. G. Demars, A. R. Barakat and R. W. Schunk), *J. Geophys. Res.*, *101*, 24565-24571, 1996.
276. Model study of ground magnetic signatures of traveling convection vortices (L. Zhu, P. Gifford, J. J. Sojka and R. W. Schunk), *J. Geophys. Res.*, *102*, 7449-7459, 1997.
277. Ionospheric models (R. W. Schunk and J. J. Sojka), in *Modern Ionospheric Science*, (eds. H. Kohl, R. Rüster and K. Schlegel), 181-215, 1996.
278. Polar wind density variations during storms (R. W. Schunk and J. J. Sojka), *Adv. Space Res.*, *22*, 1377-1380, 1998.
279. Effect of convection vortices on the ionosphere (R. W. Schunk, L. Zhu and J. J. Sojka), *Adv. Space Res.*, *22*, 1365-1368, 1998.
280. Effects of thermospheric gravity waves on the polar ionosphere (J. J. Sojka, R. W. Schunk and D. J. Crain), *Adv. Space Res.*, *22*, 1373-1376, 1998.
281. Effect of sun-aligned arcs on the polar thermosphere (T.-Z. Ma and R. W. Schunk), *J. Geophys. Res.*, *102*, 9729-9735, 1997.
282. Effect of polar cap patches on the thermosphere for different solar activity levels (T.-Z. Ma and R. W. Schunk), *J. Atmos. Terr. Phys.*, *59*, 1823-1829, 1997.
283. Global ionosphere-polar wind system during changing magnetic activity (R. W. Schunk and J. J. Sojka), *J. Geophys. Res.*, *102*, 11625-11651, 1997.
284. Intercomparison of physical models and observations of the ionosphere (with D. N. Anderson, M. J. Buonsanto, M. Codrescu, D. Decker, C. G. Fesen, T.-J. Fuller-Rowell, B. W. Reinisch, P. G. Richards, R. G. Roble, R. W. Schunk, and J. J. Sojka), *J. Geophys. Res.*, *103*, 2179-2192, 1998.
285. 3-D time-dependent simulations of the tethered satellite-ionosphere interaction (T.-Z. Ma and R. W. Schunk), *Geophys. Res. Lett.*, *25*, 737-740, 1998.
286. Ionospheric response to an auroral substorm (R. W. Schunk, L. Zhu, J. J. Sojka, and M. D. Bowline), *Geophys. Res. Lett.*, *24*, 1979-1982, 1997.
287. Model study of polar cap arcs (L. Zhu, R. W. Schunk, J. J. Sojka and D. J. Crain), in *Magnetospheric Research with Advanced Techniques*, COSPAR Colloquia Series, Vol. 9, 159, 1998.
288. Driving a physical ionospheric model with a magnetospheric MHD model (J. J. Sojka, R. W. Schunk, M. D. Bowline, J. Chen, S. Slinker, and J. Fedder), *J. Geophys. Res.*, *102*, 22209-22220, 1997.

289. Solving the Navier-Stokes systems with weak viscosity and strong heat conduction using the flux-corrected transport technique and the alternating-directional explicit method (L. Zhou, V. B. Wickwar and R. W. Schunk), *J. Comp. Phys.*, *144*, 379-401, 1998.
290. Trapped particles in the polar wind (H. G. Demars, A. R. Barakat and R. W. Schunk), *J. Geophys. Res.*, *103*, 419-429, 1998.
291. Comparison of measured high-latitude F-region ion composition climatology variability with models (J. M. Grebowsky, R. E. Erlandson, J. J. Sojka, R. W. Schunk and D. Bilitza), *Adv. Space Res.*, *22*, 885-894, 1998.
292. Dynamic features of the polar wind in the presence of hot magnetospheric electrons (A. R. Barakat, H. G. Demars, and R. W. Schunk), *J. Geophys. Res.*, *103*, 29289-29303, 1998.
293. Gradient drift instability growth rates from global-scale modeling of the polar ionosphere (J. J. Sojka, M. V. Subramaniam, L. Zhu and R. W. Schunk), *Radio Sci.*, *33*, 1915, 1998.
294. Dynamical effects of ionospheric conductivity on the formation of polar cap arcs (L. Zhu, J. J. Sojka, R. W. Schunk, and D. J. Crain), *Radio Sci.*, *33*, 1929-1937, 1998.
295. Ionospheric storm simulations driven by magnetospheric MHD and empirical models; with data comparisons (J. J. Sojka, R. W. Schunk, M. D. Bowline, J. Chen, S. Slinker, J. Fedder, and P. Sultan), *J. Geophys. Res.*, *103*, 20669-20684, 1998.
296. Effects of magnetospheric precipitation and ionospheric conductivity on the ground magnetic signatures of traveling convection vortices (L. Zhu, R. W. Schunk and J. J. Sojka), *J. Geophys. Res.*, *104*, 6773-6781, 1999.
297. Ionospheric Outflow, in Sun-Earth Plasma Connections, *Geophys. Monograph*, *109*, 195-206, 1999.
298. Ionospheric weather resulting from the magnetosphere's response to CMEs (J. J. Sojka and R. W. Schunk), *Phys. of Space Plasmas*, *15*, 313-318, 1998.
299. Effects of wave-particle interactions on the dynamic behavior of the generalized polar wind (A. R. Barakat and R. W. Schunk), *J. Atmos. Solar-Terr. Phys.*, *63*, 75-83, 2001.
300. Comparing fluid and particle-in-cell solutions for the polar wind (H. G. Demars, R. W. Schunk and A. R. Barakat), *J. Geophys. Res.*, *104*, 28535-28545, 1999.
301. Model study of ionospheric dynamics during a substorm (L. Zhu, R. W. Schunk, J. J. Sojka, and M. David), *J. Geophys. Res.*, *105*, 15807-15822, 10.10129/1999JA000352, 2000.
302. Interhemispheric comparison of TDIM E- and F-region ionospheres on 14 January 1988 (J. J. Sojka, R. W. Schunk, M. D. Bowline, J. Chen, S. Slinker, and J. Fedder), *J. Atmos. Solar-Terr. Phys.*, *61*, 1157-1168, 1999.
303. Theoretical developments on the causes of ionospheric outflow, *J. Atmos. Solar-Terr. Phys.*, *62*, 399-420, 2000.
304. The effects of multiple propagating plasma patches on the polar thermosphere (T.-Z. Ma and R. W. Schunk), *J. Atmos. Solar-Terr. Phys.*, *63*, 355-366, 2001.
305. Ionosphere-thermosphere dynamical response to a geomagnetic storm on a global scale (J. J. Sojka, R. W. Schunk and H. Thiemann), *Proceedings of the 14<sup>th</sup> ESA Symposium on European Rocket and Balloon Programmes*, ESA SP-437, 235-240, 1999.
306. Ionosphere (A. F. Nagy and R. W. Schunk), revised chapter, *Encyclopedia of Physical Science and Technology*, Vol. 8, 83-97, 2002.
307. Global ionospheric/thermospheric response to a magnetic storm—a new rocket project (with Förster et al.), *Proceedings of the 14<sup>th</sup> ESA Symposium on European Rocket and Balloon Programmes*, ESA SP-437, 247-253, 1999.

308. A theoretical model study of F-region response to high latitude neutral wind upwelling events (J. J. Sojka, R. W. Schunk, M. David, J. L. Innis, P. A. Greet, and P. L. Dyson), *J. Atmos. Solar-Terr. Phys.*, *63*, 1571-1584, 2001.
309. Ionospheric climatology and weather disturbances: A tutorial, *Geophysical Monograph*, *125*, 359-368, 2001.
310. Modeling the evolution of meso-scale ionospheric irregularities at high latitudes (J. J. Sojka, L. Zhu, M. David and R. W. Schunk), *Geophys. Res. Lett.*, *27*, 3595-3598, 2000.
311. Recent approaches to modeling ionospheric weather (R. W. Schunk, L. Scherliess and J. J. Sojka), *Adv. Space Res.*, *31*, 819-828, 2003.
312. A mid-latitude space weather hazard driven directly by the magnetosphere (J. J. Sojka, M. David and R. W. Schunk), *J. Atmos. Solar-Terr. Phys.*, *64*, 687-695, 2002.
313. Seasonal and solar-cycle variations of the polar wind (H. G. Demars and R. W. Schunk), *J. Geophys. Res.*, *106*, 8157-8168, 2001.
314. Driving the high-latitude ionosphere with variable time resolution “K-like” geomagnetic indices (D. J. Della-Rose, J. J. Sojka, L. Zhu, R. W. Schunk, and M. David), *J. Atmos. Solar-Terr. Phys.*, *62*, 773-786, 2000.
315. Assimilation Ionosphere Model (AIM): Data assimilation and validation using CIC Caribbean Measurements (J. J. Sojka, R. W. Schunk and D. C. Thompson), *Proc. Ionospheric Effects Symposium*, 519-526, 1999.
316. Assimilation Ionosphere Model: Development and testing with combined ionospheric campaign Caribbean measurements (J. J. Sojka, D. C. Thompson, R. W. Schunk, T. W. Bullett, and J. J. Makela), *Radio Sci.*, *36*, 247-259, 2001.
317. Ionospheric specification and forecast modeling (R. W. Schunk, L. Scherliess and J. J. Sojka), *AIAA-2001-0236*, 1-17, 2001. Also *J. Spacecraft and Rockets*, *39*, 314-324, 2002.
318. Ionospheric models for Earth, in *Atmospheres in the Solar System: Comparative Aeronomy*, *Geophysical Monograph 130*, 299, 2002.
319. Three-dimensional velocity structure of the polar wind (H. G. Demars and R. W. Schunk), *J. Geophys. Res.*, *107*, 1250, doi:10.1029/2001JA000252, 2002.
320. Seasonal and solar cycle dependence of the generalized polar wind with low-altitude auroral ion energization (A. R. Barakat, R. W. Schunk and H. G. Demars), *J. Geophys. Res.*, *108* (A11), 1405, 11pp, 2003.
321. Global assimilation of ionospheric measurements (GAIM) (R. W. Schunk, L. Scherliess, J. J. Sojka, D. C. Thompson, D. N. Anderson, M. Codrescu, C. Minter, T. J. Fuller-Rowell, R. A. Heelis, M. Hairston, and B. Howe), *Radio Sci.*, *39*, RS1S02, doi:10.1029/2002RS002794, 2004.
322. Ionospheric assimilation techniques for ARGOS LORAAS tomographically reconstructed equatorial electron density profiles (J. J. Sojka, R. W. Schunk, J. V. Eccles, S. Thonnard, and S. McDonald), (Ed in Chief John M. Goodman) *IES2002 Symposium*, 40-44, 2002.
323. Development of a physics-based reduced state Kalman filter for the ionosphere (L. Scherliess, R. W. Schunk, J. J. Sojka, and D. C. Thompson), *Radio Sci.*, *39*, RS1S04, doi: 10.1029/2002RS002797, 2004.
324. Effect of equatorial plasma bubbles on the thermosphere (R. W. Schunk and H. G. Demars), *J. Geophys. Res.*, *108*, 1245, doi:10.1029/2002JA009690, 2003.
325. Relative solar and auroral contribution to the polar F-region: Implications for National Space Weather Program (M. David, J. J. Sojka, R. W. Schunk and R. Heelis), *J. Geophys. Res.*, *107*, 1310, doi:10.1029/2001JA009167, 2002.

326. Evaluation of statistical convection patterns for real-time specifications and forecasts (H. A. Bekerat, R. W. Schunk and L. Scherliess), *J. Geophys. Res.*, *108* (A12), 1413, doi: 10.1029/2003JA009945, 2003.
327. Analysis of TEC data from TOPEX/Poseidon mission (G. Jee, R. W. Schunk and L. Scherliess), *J. Geophys. Res.*, *109*, A01301, doi:10.1029/2003JA010058, 2004.
328. Neutral polar wind (L. C. Gardner and R. W. Schunk) *J. Geophys. Res.*, *109*, A05301, doi:10.1029/2003JA010291, 2004.
329. Effect of the theta aurora on the polar thermosphere (H. G. Demars and R. W. Schunk), *J. Atmos. Solar-Terr. Phys.*, *67*, 489-499, 2005.
330. Ionospheric data assimilation: recovery of strong mid-latitude density gradients (J. J. Sojka, D. C. Thompson, R. W. Schunk, J. V. Eccles, J. J. Makela, M. C. Kelley, S. A. González, N. Aponte, and T. W. Bullett) *J. Atmos. Solar-Terr. Phys.*, *65*, 1087-1097, 2003.
331. Propagating polar wind jets (R. W. Schunk, H. G. Demars and J. J. Sojka), *J. Atmos. Solar-Terr. Phys.*, *67*, 357-364, 2005.
332. Polar F-layer model-observation comparison: A neutral wind surprise (with J. J. Sojka, M. David, R. W. Schunk and A. P. van Eyken), *Annales Geophysicae*, *23*, 191-199, 2005.
333. Comparison of IRI-2001 with TOPEX TEC measurements (G. Jee, R. W. Schunk and L. Scherliess), *J. Atmos. Solar-Terr. Phys.*, *67*, 365-380, 2005.
334. A modeling study of the F-region response to SAPS (J. J. Sojka, M. David, R. W. Schunk, J. C. Foster, and H. B. Vo), *J. Atmos. Solar-Terr. Phys.*, *66*, 415-423, 2004.
335. Initial 3-D neutral polar wind (L. C. Gardner and R. W. Schunk), *Adv. Space Res.*, *37*, 409-413, 2006.
336. Recent developments in ionosphere-thermosphere modeling with an emphasis on solar variability (J. J. Sojka, C. Smithtro and R. W. Schunk), *Adv. Space Res.*, *37*, 409-413, 2006.
337. Time-dependent simulations of the global polar wind, *J. Atmos. Solar-Terr. Phys.*, *69*, 2028-2047, 2007.
338. USU global ionospheric data assimilation models (R. W. Schunk, L. Scherliess, J. J. Sojka, and D. C. Thompson), in *Atmospheric and Environmental Remote Sensing Data Processing and Utilization: An End-to-End System Perspective* (ed. H.-L. A. Huang and H. J. Bloom), *Proc. Of SPIE*, 5548, doi:10.1117/12.562448, 327-336, 2004.
339. Active ionospheric role in small-scale aurora structuring (L. Zhu, J. J. Sojka and R. W. Schunk), *J. Atmos. Solar-Terr. Phys.*, *67*, 687-700, 2005.
340. On the sensitivity of Total Electron Content (TEC) to upper atmospheric/ionospheric parameters (G. Jee, R. W. Schunk and L. Scherliess), *J. Atmos. Solar-Terr. Phys.*, *67*, 1040-1052, 2005.
341. Comparison of satellite ion drift velocities with AMIE deduced convection patterns (H. A. Bekerat, R. W. Schunk, L. Scherliess and A. Ridley), *J. Atmos. Solar-Terr. Phys.*, *67*, 1463-1479, 2005.
342. Global neutral polar wind model (L. C. Gardner and R. W. Schunk), *J. Geophys. Res.*, *110*, A10302, doi:10.1029/2005JA011029, 2005.
343. Observation and modeling of mid-latitude ionospheric dynamics during solar x-ray flares (C. G. Smithtro, T. Berkey, D. Thompson, J. J. Sojka and R. W. Schunk) *2005 Ionospheric Effects Symposium*, 96-103, (ed. J. M. Goodman), JMG Associates Ltd., 2005.

344. Thermosphere weather due to mesoscale ionospheric structures (R. W. Schunk and H. G. Demars), *2005 Ionospheric Effects Symposium*, 799-806, (ed. J. M. Goodman), JMG Associates Ltd., 2005.
345. An operational data assimilation model of the global ionosphere (R. W. Schunk, L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), *2005 Ionospheric Effects Symposium*, 512-518, (ed. J. M. Goodman), JMG Associates Ltd., 2005
346. Validation of the Ionosphere Forecast Model (IFM) (L. Zhu, R. W. Schunk, G. Jee, L. Scherliess, J. J. Sojka, and D. C. Thompson), *2005 Ionospheric Effects Symposium*, 519-526, (ed. J. M. Goodman), JMG Associates Ltd., 2005.
347. Ion and neutral polar winds for northward interplanetary magnetic field conditions (L. Gardner and R. W. Schunk), *J. Atmos. Solar-Terr. Phys.*, *68*, 1279-1290, 2006.
348. The Utah State University Gauss-Markov Kalman Filter of the ionosphere: The effect of slant TEC and electron density profile data on model fidelity (D. C. Thompson, L. Scherliess, J. J. Sojka and R. W. Schunk), *J. Atmos. Solar-Terr. Phys.*, *68*, 947-958, 2006.
349. Validation study of the Ionospheric Forecast Model (IFM) using the TOPEX TEC measurements (L. Zhu, R. W. Schunk, G. Jee, L. Scherliess, J. J. Sojka, and D. C. Thompson), *Radio Science*, *41*, doi:10.1029/2005RS003336, 2006.
350. Seasonal and solar-cycle variations of propagating polar wind jets (H. G. Demars and R. W. Schunk), *J. Atmos. Solar-Terr. Phys.*, *68*, 1791-1806, 2006.
351. History of kinetic polar wind models and early observations (J. Lemaire, W. K. Peterson, T. Chang, R. W. Schunk, A. R. Barakat, H. G. Demars, and G. V. Khazanov), *Journal of Atmospheric and Solar-Terrestrial Physics*, *69* (16), 1901-1935, 2007
352. Ionospheric weather forecasting on the horizon (R. W. Schunk, L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), *Space Weather*, *3*(8), S08007, doi:10.1029/2004SW000138, 2005.
353. A 3-dimensional model of the generalized polar wind (A. R. Barakat and R. W. Schunk), *J. Geophys. Res.*, *111*, A12314, doi:10.1029/2006JA011662, 2006.
354. Utah State University Global Assimilation of Ionospheric Measurements Gauss-Markov Kalman filter model of the ionosphere: Model description and validation, (L. Scherliess, R. W. Schunk, J. J. Sojka, D. C. Thompson, and L. Zhu), *J. Geophys. Res.*, *111*, A11315, doi:10.1029/2006JA011712, 2006.
355. Extreme longitudinal variability of plasma structuring in the equatorial ionosphere on a magnetically quiet equinoctial day (S. E. McDonald, Sunanda Basu, Santi Basu, K. Groves, C. E. Valladares, L. Scherliess, D. C. Thompson, R. W. Schunk, J. J. Sojka, and L. Zhu), *Radio Science*, *41*, doi:10.1029/2005RS003366, 2006
356. Thermospheric response to ion heating in the dayside cusp (H. G. Demars and R. W. Schunk), *J. Atmos. Solar-Terr. Phys.*, *69*, 649-660, 2007.
357. Anomalous F region response to moderate solar flares (C. G. Smithtro, J. J. Sojka, F. T. Berkey, D. Thompson, and R. W. Schunk), *Radio Sci.*, *41*, doi:10.1029/2005RS003350, 2006.
358. Duration of an ionospheric data assimilation initialization of a coupled thermosphere-ionosphere model (G. Jee, A. G. Burns, W. Wang, S. C. Solomon, R. W. Schunk, L. Scherliess, D. C. Thompson, J. J. Sojka, and L. Zhu), *Space Weather*, *5*, S01004, doi:10.1029/2006SW000250, 2007.
359. Estimation of the high-latitude topside electron heat flux using DMSP plasma density measurements (H. A. Bekerat, R. W. Schunk and L. Scherliess), *J. Atmos. Solar-Terr. Phys.*, *69*, 1029-1048, 2007.

360. Assessing USU-GAIM ionospheric weather specification over Australia during the 2004 CAWSES Campaign (J. J. Sojka, D. C. Thompson, L. Scherliess, R. W. Schunk, and T. J. Harris), *J. Geophys. Res.*, 112, A09306, doi:10.1029/2006JA012048, 2007.
361. Ionospheric challenges of the International Polar Year (J. J. Sojka, R. W. Schunk, T. van Eyken, J. Kelly, C. Heinselman, and M. McCready), *EOS News*, 88, No. 15, 10 April 2007.
362. Driving the TING model with GAIM electron densities: ionospheric effects on the thermosphere (G. Jee, A. G. Burns, W. Wang, S. C. Solomon, R. W. Schunk, L. Scherliess, D. C. Thompson, J. J. Sojka, and L. Zhu), *J. Geophys. Res.*, 113, A03305, doi:10.1029/2007JA012580, 2008.
363. Spatial correlations of day-to-day ionospheric Total Electron Content variability obtained from ground-based GPS (J. S. Shim, L. Scherliess, R. W. Schunk and D. C. Thompson), *J. Geophys. Res.*, 113, A09309, doi:10.1029/2007JA012635, 2008.
364. Longitudinal variability of low-latitude Total Electron Content: Tidal influences (L. Scherliess, D. C. Thompson and R. W. Schunk), *J. Geophys. Res.*, 113, A01311, doi:10.1029/2007JA012480, 2008.
365. Propagating plasma patch and associated neutral stream flows (L. C. Gardner and R. W. Schunk), *J. Atmos. Solar-Terr. Phys.*, 69, 1884-1892, 2007.
366. Severe ionospheric weather at mid-latitudes: Will assimilation of observations with models provide a better understanding? (J. J. Sojka, R. W. Schunk, D. C. Thompson, L. Scherliess, and M. David), *Proceedings of the Chapman Conference on Mid-Latitude Ionospheric Dynamics and Disturbances*, (eds. P. M. Kintner, A. J. Coster, T. Fuller-Rowell, A. J. Mannucci, M. Mendillo, and R. Heelis), American Geophysical Union, 2008.
367. Pulsating of the generalized ion and neutral polar winds (L. Gardner and R. W. Schunk), *J. Atmos. Solar-Terr. Phys.*, 70, 1408-1418, 2008.
368. Response of the ionosphere-thermosphere system to magnetospheric processes (R. W. Schunk and L. Zhu), *J. Atmos. Solar-Terr. Phys.*, 70, 2358-2373, 2008.
369. Specification of ionospheric dynamics and drivers using the GAIM physics-based data assimilation model (L. Scherliess, D. C. Thompson and R. W. Schunk), *Proceedings of the 2008 Ionospheric Effects Symposium*, JMG Associates, National Technical Information Services, Springfield, VA, 2008.
370. Modeling and consequences of supersonic winds in the thermosphere (H. G. Demars and R. W. Schunk), *Proceedings of the 2008 Ionospheric Effects Symposium*, JMG Associates, National Technical Information Services, Springfield, VA, 2008.
371. Effect of lower atmospheric waves on the ionosphere and thermosphere (R. W. Schunk, L. Gardner, L. Scherliess, D. C. Thompson, and J. J. Sojka), *Proceedings of the 2008 Ionospheric Effects Symposium*, JMG Associates, National Technical Information Services, Springfield, VA, 2008.
372. Upper ionosphere effects on the assimilation of GPS slant TEC (D. C. Thompson, L. Scherliess, J. J. Sojka and R. W. Schunk), *Proceedings of the 2008 Ionospheric Effects Symposium*, JMG Associates, National Technical Information Services, Springfield, VA, 2008.
373. Ion and neutral streams in the ionosphere and plasmasphere (L. Gardner and R. W. Schunk), *Proceedings of the 2008 Ionospheric Effects Symposium*, JMG Associates, National Technical Information Services, Springfield, VA, 2008.

374. Are the Dst stations sufficient for describing storm-time enhancements (L. Zhu, Z. Xu, J. J. Sojka, R. W. Schunk, P. Kokoszka, and A. Jach), Technical Report, Utah State University, 2007.
375. Supersonic neutral winds and neutral streams in the thermosphere-ionosphere-plasmasphere system (L. Gardner and R. W. Schunk), *Radio Sci.*, 44, doi:10.1029/2008RS004053, 2009.
376. Assimilation of observations with models to better understand severe ionospheric weather at mid-latitudes (J. J. Sojka, R. W. Schunk, D. C. Thompson, L. Scherliess, and M. David), in *Midlatitude Ionospheric Dynamics and Disturbances, Geophysical Monograph 181*, (ed. P. M. Kintner, A. J. Coster, T. Fuller-Rowell, A. J. Mannucci, M. Mendill, and R. Heelis), pp. 35-49, AGU, Washington, DC, 2008.
377. Ionospheric dynamics and drivers obtained from a physics-based data assimilation model (L. Scherliess, D. C. Thompson and R. W. Schunk), *Radio Sci.*, 44, RS0A32, doi:10.1029/2008RS004068, 2009.
378. Plasmasphere and upper ionosphere contributions and corrections during the assimilation of GPS slant TEC (D. C. Thompson, L. Scherliess, J. J. Sojka and R. W. Schunk), *Radio Sci.*, 44, doi:10.1029/2008RS004016, 2009.
379. Neutral wind and plasma drift effects on low- and mid-latitude total electron content (J. S. Shim, L. Scherliess, R. W. Schunk and D. C. Thompson), *J. Geophys. Res.*, 115, No. A4, A04307, <http://dx.doi.org/10.1029/2009JA014488>, 2010.
380. Storm time density enhancements in the middle-latitude dayside ionosphere (R. A. Heelis, J. J. Sojka, M. David and R. W. Schunk), *J. Geophys. Res.*, 114, A03315, doi:10.1029/2008JA013690, 2009.
381. Data assimilation models: A 'new' tool for ionosphere science and applications (L. Scherliess, R. W. Schunk and D. C. Thompson), *The Dynamic Magnetosphere*, (ed. W. Liu and M. Fujimoto), IAGA Special Sopron Book Series 3, Springer, doi 10.1007/978-94-007-0501-2\_18, 2011.
382. Ionosphere data assimilation: Problems associated with missing physics (R. W. Schunk, L. Scherliess and D. C. Thompson), *Aeronomy of the Earth's Atmosphere and Ionosphere*, IAGA Springer Book, doi 10.1007/978-94-007-0326-1\_33, 2011.
383. Generation of traveling atmospheric disturbances during pulsating geomagnetic storms L. C. Gardner and R. W. Schunk), *J. Geophys. Res.*, 115, A08314, doi:10.1029/2009JA015129, 2010.
384. Demonstration of operational real-time space weather prototypes for aviation radiation and magnetospheric substorms (with W. K. Tobiska et al.) *American Institute of Aeronautics and Astronautics*, 1-7, 2010.
385. Ionospheric Ion Temperature Forecasting in Multiples of 27 Days" (Jan Sojka, Robert Schunk, and Michael Nicolls), *Space Weather*, 12, 148-160, doi:10.1002/2013SW001012, 2014.
386. The effect of downward electron heat flow and electron cooling processes in the high-latitude ionosphere (M. David, R. W. Schunk and J. J. Sojka), *J. Atmos. Solar-Terr. Phys.*, 73, 2399-2409, 2011.
387. Long-term ionosphere-thermosphere forecasting: Problems associated with uncertain parameters and missing physics (R. W. Schunk, L. Gardner, L. Scherliess, and L. Zhu), *Proceedings of the 2011 Ionospheric Effects Symposium*, JMG Associates, 2011.
388. A physics-based data assimilation model for the high-latitude ionosphere: Importance of data assimilation technique in determining the model drivers (Zhu, L., R. W. Schunk, L.

- Scherliess and V. Eccles), *Proceedings of the 2011 Ionospheric Effects Symposium*, JMG Associates, 2011.
389. Dayside midlatitude ionospheric response to storm time electric fields: A case study for 7 September 2002 (David, M., J. J. Sojka, R. W. Schunk, M. W. Liemohn, A. J. Coster), *J. Geophys. Res.*, Vol. 116, No. A12, A12302, 2011.
  390. CEDAR Electrodynamics Thermosphere Ionosphere (ETI) Challenge for Systematic Assessment of Ionosphere/Thermosphere Models 1:  $N_mF_2$ ,  $h_mF_2$ , and Vertical Drift Using Ground Based Observations (J. S. Shim, M. Kuznetsova, L. Rastätter, M. Hesse, D. Bilitza, M. Codrescu, B. Emery, B. Foster, T. Fuller-Rowell, J. Huba, A. M. Mannucci, A. Ridley, L. Scherliess, R. W. Schunk, P. Stephens, D. C. Thompson, L. Zhu, D. Anderson, J. L. Chau, J. J. Sojka, and B. Rideout), *Space Weather Journal*, 9, S12003, 2011.
  391. Thermosphere wave interactions in a global thermosphere/ionosphere model (L. C. Gardner and R. W. Schunk), *Proceedings of the 2011 Ionospheric Effects Symposium*, JMG Associates, 2011.
  392. Large-scale gravity wave characteristics simulated with a high-resolution global thermosphere-ionosphere model (L. C. Gardner and R. W. Schunk), *J. Geophys. Res.*, 116, A06303, doi:10.1029/2010JA015629, 2011.
  393. A Modeling study of the Longitudinal Dependence of Storm-Time Mid-Latitude Dayside Total Electron Content Enhancements (J. J. Sojka, M. David, R. W. Schunk, and R. Heelis), *J. Geophys. Res.*, 117, No. A2, A02315, doi:10.1029/2011JA017000, 2012.
  394. Problems Associated with Uncertain Parameters and Missing Physics for Long-Term Ionosphere-Thermosphere Forecasting (R. W. Schunk, L. Gardner, L. Scherliess, and L. Zhu), *Radio Science*, 47, RS0L23, doi:10.1029/2011RS004911, 2012.
  395. Typhoon Melor and ionospheric weather in the Asian sector: A case study (D. D. Rice, J. J. Sojka, J. V. Eccles, and R. W. Schunk), *Radio Sci.*, 47, RS0L05, doi:10.1029/2011RS004917, 2012.
  396. Importance of Data Assimilation Technique in Defining the Model Drivers for the Space Weather Specification of the High-Latitude Ionosphere (L. Zhu, R. W. Schunk, L. Scherliess, V. Eccles), *Radio Science*, 47, RS0L24, doi:10.1029/2001RS004936, 2012.
  397. Changes in Thermospheric Temperature Induced by High-Speed Solar Wind Streams (L. C. Gardner, J. J. Sojka, R. W. Schunk and R. Heelis), *J. Geophys. Res.*, 117:A12, A12304, doi:org/10.1029/2012JA017892, 2012.
  398. Ionosphere-Thermosphere Physics: Current Status and Problems, *AGU Monograph, Modeling the Ionosphere-Thermosphere System*, 201, 3-12, 10.1029/2012GM001351, 2013.
  399. CEDAR Electrodynamics Thermosphere Ionosphere (ETI) Challenge for Systematic Assessment of Ionosphere/Thermosphere Models 2: Electron density, Neutral density, NmF2 and hmF2 using Space Based Observations (J. S. Shim, M. Kuznetsova, L. Rastätter, D. Bilitza, M. Butala, M. Codrescu, B. A. Emery, B. Foster, T. J. Fuller-Rowell, J. Huba, A. J. Mannucci, X. Pi, A. Ridley, L. Scherliess, R. W. Schunk, J. J. Sojka, P. Stephens, D. C. Thompson, D. Weimer, L. Zhu, E. Sutton), *Space Weather*, 10:S10004, dx.doi.org/10.1029/2012SW000851, 2012.
  400. Sensitivity of Ionospheric Specifications to In Situ Plasma Density Observations Obtained from Electrostatic Analyzers Onboard of a Constellation of small satellites (R. Balthazor, M. G. McHarg, C. L. Enloe, A. J. Wallerstein, K. A. Wilson, B. Rinaldi, R. Raynor, R. Brown, D. J. Barnhart, L. Scherliess, and R. W. Schunk), *26<sup>th</sup> Annual AIAA/USU*

401. Terminator field-aligned currents: A new finding from the Ionospheric Dynamics and Electrodynamics Data Assimilation Model (L. Zhu, R. W. Schunk, V. Eccles, L. Scherliess, J. J. Sojka, and L. Gardner), *J. Geophys. Res.*, *119*, 4752-4757, doi:10.1002/2013JA019518, 2014.
402. Tongue-of-Ionization Originating from the Evening F Region (V. Eccles, L. Zhu, R. Schunk, and L. Scherliess), *J. Atmos. Solar-Terr. Phys.*, submitted, 2013.
403. Ionospheric Model-Observation Comparisons: E-Layer at Arecibo Incorporation of SDO-EVE Solar Irradiances (Jan J. Sojka, Joseph Jensen, Michael David, Robert Schunk, Thomas Woods, Francis Eparvier, Michael Sulzer, Sixto Gonzalez, and Vincent Eccles), *J. Geophys. Res.*, *119*, 3844-3856, doi:10.1002/2013JA019528, 2014.
404. Modeling the ionospheric E and F1 regions: Using SDO-EVE observations as the solar irradiance driver (J. J. Sojka, J. Jensen, M. David, R. W. Schunk, T. Woods, and F. Eparvier), *J. Geophys. Res.*, *118*, 5379-5391, doi:10.1002/jgra.50480, 2013.
405. Ionospheric reconstruction for various solar, seasonal, and geomagnetic conditions obtained from the Global Assimilation of Ionospheric Measurements – Gauss Markov (GAIM-GM) model, (L. C. Gardner, R. W. Schunk, L. Scherliess, L. Zhu, and J. J. Sojka), *Proceedings of the 2014 International Technical Meeting of The Institute of Navigation*, 690-694, San Diego, California, January 2014.
406. Multimodel ensemble prediction system for space weather applications, (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, M. Butala, B. D. Wilson, A. Komjathy, C. Wang and G. Rosen), *Proceedings of the 2014 International Technical Meeting of The Institute of Navigation*, ITM 2014, 725-729, San Diego, California, January 2014.
407. NASA/NSF Space Weather Modeling Collaboration: Advancing Space Weather Modeling for Improved Specification, Forecasting and Mitigation, *Space Weather*, *12*, 131, doi:10.1002/2014SW001049, 2014.
408. Ensemble Modeling with Data Assimilation Models: A New Strategy for Space Weather Specifications, Forecasts and Science (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, B. D. Wilson, A. Komjathy, C. Wang and G. Rosen), *Space Weather*, *12*, 123-126, doi:10.1002/2014SW001050, 2014.
409. Sources of Uncertainty in Ionospheric Modeling: The Neutral Wind (M. David, J. J. Sojka, and R. W. Schunk), *J. Geophys. Res.*, *119*, doi:10.1002/2014JA020117, 2014.
410. Global Assimilation of Ionospheric Measurements (GAIM) - Gauss Markov (GM) Model: Improved Specifications with Multiple Data Types (L. C. Gardner, R. W. Schunk, L. Scherliess, J. J. Sojka, and L. Zhu), *Space Weather*, *12*, 675-688, doi:10.1002/2014SW001104, 2014.
411. Mechanisms underlying the pre-reversal enhancement of the vertical plasma drift in the low-latitude ionosphere (J. V. Eccles, J.-P. St. Maurice, and R. W. Schunk), *J. Geophys. Res.*, *120*(6), 4950-4970, 2015.
412. Magnetic Meridional Winds in the Thermosphere Obtained from Global Assimilation of Ionospheric Measurements (GAIM) Model (L. Lomidze, L. Scherliess, and R. W. Schunk), *J. Geophys. Res.*, *120*, 8025-8044, doi: 2015.
413. Study of the Photoelectron Ionization Cascade in the E Region (J. J. Sojka, M. Lewis, M. David, R. W. Schunk, T. Woods, F. Eparvier, and M. Nicolls), *J. Geophys. Res.*, submitted, 2015.

414. Future of Atmosphere-Ionosphere-Magnetosphere Coupling Studies (T. E. Moore, K. Brennenman, C. R. Chappell, J. H. Clemmons, G. A. Collinson, C. M. Cully, E. Donovan, G. D. Earle, D. Gershman, R. A. Heelis, L. M. Kistler, M. K. Kepko, G. V. Khazanov, D. J. Knudsen, M. Lessard, E. MacDonald, M. J. Nicolls, C. J. Pollock, R. F. Pfaff, D. E. Rowland, E. Sanchez, R. W. Schunk, J. L. Semeter, and J. P. Thayer), *AGU Monograph 222*, (editors, C. R. Chappell, R. W. Schunk, P. M. Banks, R. M. Thorne and J. L. Burch), 357-376, 2017.
415. Coupling the Generalized Polar Wind model to global magnetohydrodynamics: Initial results (D. T. Welling, A. R. Barakat, J. V. Eccles, R. W. Schunk and C. R. Chappell), *AGU Monograph 222*, (editors, C. R. Chappell, R. W. Schunk, P. M. Banks, R. M. Thorne and J. L. Burch), 179-194, 2017.
416. Magnetosphere-Ionosphere Coupling via Ion Outflow: Past, Present and Future (R. W. Schunk), *AGU Monograph 222*, (editors, C. R. Chappell, R. W. Schunk, P. M. Banks, R. M. Thorne and J. L. Burch), 169-177, 2017.
417. A review of general physical and chemical processes related to plasma sources and losses for solar system magnetospheres (K. Seki, A. Nagy, C. M. Jackman, F. Crary, D. Fontaine, P. Zarka, P. Wurz, A. Milillo, J. A. Slavin, D. C. Delcourt, M. Wiltberger, R. Ilie, X. Jai, S. A. Ledvina, M. W. Liemohn, and R. W. Schunk), *Space Science Reviews*, in press, 2015.
418. The USU-GAIM data assimilation models for ionospheric specifications and forecasts (L. Scherliess, R. W. Schunk, L. C. Gardner, L. Zhu, J. V. Eccles, and J. J. Sojka), *Proceedings of the 14<sup>th</sup> Ionospheric Effects Symposium*, 01B Ionospheric & Space Weather Models, 402-409, 2015.
419. Space weather forecasting with a Multimodel Ensemble Prediction System (MEPS) of data assimilation models (R. W. Schunk, L. Scherliess, J. V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, M. Butala, B. D. Wilson, A. Komjathy, C. Wang, and G. Rosen), *Proceedings of the 2015 Ionospheric Effects Symposium*, 2015.
420. Effects of Geographic-Geomagnetic Pole Offset on Ionospheric Outflow: Can the Ionosphere Wag the Magnetospheric Tail? (A. R. Barakat, J. V. Eccles and R. W. Schunk), *Geophys. Res. Lett.*, 42, 8288-8293, doi:10.1002/2015GL065736, 2015.
421. Estimation of cold plasma outflow during geomagnetic storms (Stein Haaland, Eriksson, Mats Andre, Licas Maes, Lisa Baddeley, Abdallah Barakat, Charles Chappell, Vince Eccles, Christine Johnsen, Kun Li, Bjorn Lybekk, Arne Pedersen, Robert Schunk, and Dan Welling), *J. Geophys. Res.*, submitted, 2015.
422. Polar wind, In *Space Weather Fundamentals* (ed. G. Khazanov), 199-211, CRC Press, 2016.
423. Space weather forecasting with a Multimodel Ensemble Prediction System (MEPS), (R. W. Schunk, L. Scherliess, J. V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, M. Butala, B. D. Wilson, A. Komjathy, C. Wang, and G. Rosen), *Radio Sci.*, 51, doi:10.1002/2015RS005888, 2016.
424. Polar cap patches and the tongue of ionization: A survey of GPS TEC maps from 2009-2015, (M. David, J. J. Sojka, R. W. Schunk and A.J. Coster), *Geophys. Res. Lett.*, submitted, 2016.
425. Modeling and analysis of ionospheric evening anomalies with a physics-based data assimilation model, (L. Lomidze, L. Scherliess, and R. W. Schunk), *J. Atmos. Solar-Terrest. Phys.*, 140, 65-78. DOI: 10.1016/j.jastp.2016.02.009, 2016.
426. Global Real-time Dose Measurements Using the Automated Radiation Measurements for Aerospace Safety (ARMAS) system, (W. Kent Tobiska, D. Bouwer, D. Smart, M. Shea,

- J. Bailey, L. Didkovsky, K. Judge, H. Garrett, W. Atwell, B. Gersey, R. Wilkins, D. Rice, R. Schunk, D. Bell, C. Mertens, X. Xu, M. Wiltberger, S. Wiley, E. Teets, B. Jones, S. Hong, and K. Yoon), *Space Weather*, 14, doi:10.1002/2016SW001419, 2016.
427. The magnetic storms of August 3-4, 2010 and August 5-6, 2011 1. Ground and space-based observations, (C. E. Valladares, J. V. Eccles, Su. Basu, R. W. Schunk, R. Sheehan, R. Pradipta, J. M. Ruohoniemi), *J. Geophys. Res. Space Physics*, 122, 3487-3499, doi:10.1002/2016JA023359, 2017.
428. The USU GAIM-FP data assimilation model for ionospheric specifications and forecasts, (L. Scherliess, R. W. Schunk, L. C. Gardner, J. V. Eccles, L. Zhu and J. J. Sojka), 32th URSI GASS, in press, 2017.
429. Terminator field-aligned current system: Its dependencies on solar, seasonal, and geomagnetic conditions, (L. Zhu, R. Schunk, V. Eccles, L. Scherliess, J. Sojka and L. Gardner), *J. Atmos. Solar-Terr. Phys.*, 164, 10-17, 2017.
430. CEDAR-GEM Challenge for Systematic Assessment of Ionosphere/Thermosphere Models in Predicting TEC during the 2006 December Storm Event, (J. S. Shim, L. Rastaetter, M. Kuznetsova, D. Bilitza, M. Codrescu, A. J. Coster, B. A. Emery, M. Foerster, B. T. Foster, T. J. Fuller-Rowell, J. Huba, L. Goncharenko, S. E. McDonald, A. Mannucci, A. A. Namgaladze, X. Pi, B. E. Prokhorov, A. J. Ridley, L. Scherliess, R. W. Schunk, L. C. Gardner, J. J. Sojka, and L. Zhu), *Space Weather*, 15, 1238-1256, doi:10.1002/2017SW001649, 2017.
431. Polar topside ionosphere during geomagnetic storms: Comparison of ISIS-II with TDIM, (Sojka, J. J., D. Rice, V. Eccles, M. David, R. W. Schunk, R. Benson, and H. G. James), *Radio. Sci.*, 53, 906-920, 2018.
432. Modeling the Mid-Latitude Ionosphere Storm Enhanced Density Distribution with a Data Assimilation Model, (Gardner, L. C., R. W. Schunk, L. Scherliess, V. Eccles, S. Basu, and C. Valladares), *Space Weather*, 16, 1539-1548, <https://doi.org/10.1029/2018SW001882>, 2018.
433. Validation of Ionospheric Specifications During Geomagnetic Storms: TEC and foF2 during the 2013 March Storm Event, (J. Shim, I. Tsagouri, L. Goncharenko, M. Kuznetsova, D. Bilitza, M. Codrescu, A. Coster, S. Solomon, M. Fedrizzi, M. Förster, T. Fuller-Rowell, L. Gardner, J. Huba, A. Namgaladze, B. Prokhorov, A. Ridley, L. Scherliess, R. Schunk, J. Sojka, and L. Zhu), *Space Weather*, 16, 1686-1701, <https://doi.org/10.1029/2018SW002034>, 2018.
434. A Chronology of Ionospheric Responses to the 2015 St. Patrick's Day Storm Studied Using a Global Assimilative Ionospheric Model, (Pi, X., A. J. Mannucci, A. Komjathy, P. Vergadoes, C. Wang, G. Rosen, R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, and L. Zhu), *J. Geophys. Res.*, submitted, 2019.
435. A Multi-Ion, Flux-Corrected Transport Based Hydrodynamic Solution Methodology for the Plasmasphere Refilling Problem following Geomagnetic Storms, (Chatterjee, K., and R. W. Schunk), *J. Geophys. Res.*, DOI: 10.1029/2019JA026834, 2019.
436. Hemispherical Shifted Symmetry in Polar Cap Patch Occurrence: A Survey of GPS TEC Maps from 2015 – 2018, (David, M., J. J. Sojka, R. W. Schunk and A. J. Coster), *Geophys. Res. Lett.*, <https://authorservices.wiley.com/index.html#register>, 2019.
437. The Development and Validation of a “Flux-Corrected Transport” Based Solution Methodology for the Plasmasphere Refilling Problem Following Geomagnetic Storms, (Chatterjee, K., and R. W. Schunk), *Earth Planets and Space*, 72:26, <https://doi.org/10.1186/s40623-020-01150-0>, 2020.

438. Kinetic Modeling of Plasmasphere Refilling following Geomagnetic Storms and Comparison with Hydrodynamic Results, (Chatterjee, K., and R. W. Schunk), *J. Geophys. Res.*, <http://dx.doi.org/10.1029/2020JA028016>, 2020.
439. Challenges in Specifying and Predicting Space Weather, (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, A. Komjathy, C. Wang and G. Rosen), *Space Weather*, 19, Issue 2, <https://doi.org/10.1029/2019SW002404>, 2021.

## Papers Presented at Scientific Meetings

1. Theory of transport in the topside of the ionosphere, (with J. C. G. Walker), AGU Spring Meeting, Washington, D. C.; *EOS*, 52, 299, 1971.
2. Oxygen and hydrogen ion densities above Millstone Hill, (with J. C. G. Walker), AGU Spring Meeting, Washington, D. C.; *EOS*, 53, 458, 1972.
3. Behavior of ion velocity distributions for a simple collision model, (with J.-P. St-Maurice), AGU Fall Meeting, San Francisco, California; *EOS*, 54, 1148, 1973.
4. Effect of electric fields on the daytime high-latitude E- and F-regions, (with P. M. Banks and W. J. Raitt), AGU Fall Meeting, San Francisco, California; *EOS*, 55, 1155, 1974.
5. A comparison of the temperature and density structure in high and low speed thermal proton flows, (with P. M. Banks and W. J. Raitt), AGU Fall Meeting, San Francisco, California; *EOS*, 55, 1155, 1974.
6. Effect of electric fields on the nighttime high-latitude F-region, (with P. M. Banks and W. J. Raitt), AGU Spring Meeting, Washington, D. C.; *EOS*, 56, 417, 1975.
7. Ionospheric composition in SARARCS, (with P. M. Banks and W. J. Raitt), AGU Spring Meeting, Washington, D. C.; *EOS*, 56, 416, 1975.
8. Ion velocity distributions in the auroral ionosphere, (with J.-P. St-Maurice and J. C. G. Walker), presented at the May 1975 meeting of the "Institute of Electrical and Electronics Engineers," Ann Arbor, Michigan.
9. Ionospheric composition changes in SAR-arcs, (with P. M. Banks and W. J. Raitt), presented at the August 1975 meeting of the "International Union of Geodesy and Geophysics," Grenoble, France.
10. Transport coefficients for midlatitude topside ionosphere, (with J.-P. St-Maurice), AGU Fall Meeting, San Francisco, California; *EOS*, 57, 974, 1976.
11. Plasma transport in the topside Venus ionosphere, (with J.-P. St-Maurice), AGU Spring Meeting, Washington, D. C.; *EOS*, 58, 457, 1977.
12. *Invited review*, Mathematical difficulties associated with modeling the Earth's ionosphere and neutral atmosphere, presented at the international meeting of the "IAGA/IAMAP General Scientific Assembly," (August, 1977); Seattle, Washington.
13. *Invited lecturer*, University of Michigan (November, 1977); Ann Arbor, Michigan.
14. *Session chairman*, Special session at the 1978 AGU Spring Meeting. The special session dealt with "The Dynamics of the High Latitude Ionosphere and Thermosphere."
15. Helium ion outflow from the terrestrial ionosphere, (with W. J. Raitt and P. M. Banks), AGU Spring Meeting, Miami, Florida; *EOS*, 59, 344, 1978.
16. Quantitative calculations of helium ion escape fluxes from the polar ionosphere, (with W. J. Raitt and P. M. Banks), AGU Spring Meeting, Miami, Florida; *EOS*, 59, 344, 1978.
17. Comparison of solutions to the thirteen moment and standard transport equations for low speed thermal proton flows, (with D. S. Watkins), AGU Fall Meeting, San Francisco, California; *EOS*, 59, 1143, 1978.
18. Atomic nitrogen and oxygen ions in the daytime high-latitude F-region, (with W. J. Raitt), AGU Fall Meeting, San Francisco, California; *EOS*, 59, 1148, 1978.

19. *Invited review*, Thermal plasma flow in the topside ionosphere: A review, AGU Fall Meeting, San Francisco, California; *EOS*, 59, 1143, 1978.
20. Effect of displaced geomagnetic and geographic poles on high latitude plasma convection and ionospheric depletions, (with J. J. Sojka and W. J. Raitt), AGU Fall Meeting, San Francisco, California; *EOS*, 60, 915, 1979.
21. High latitude convection: Comparison of simple model with incoherent scatter observations, (with W. J. Raitt, J. J. Sojka, J. C. Foster, and J. R. Doupnik), AGU Fall Meeting, San Francisco, California; *EOS*, 60, 915, 1979.
22. A theoretical study of the high-latitude winter F-region at solar minimum for low magnetic activity, (with W. J. Raitt and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 61, 1059, 1980.
23. Theoretical predictions for ion composition in the high-latitude winter F-region for solar minimum and low magnetic activity, (with W. J. Raitt and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 61, 1059, 1980.
24. Electron temperature anisotropy in the polar wind, (with D. S. Watkins), AGU Fall Meeting, San Francisco, California; *EOS*, 61, 1092, 1980.
25. High-latitude ionospheric model: First step towards a predictive capability, (with W. J. Raitt and J. J. Sojka), presented at the symposium on the "Effect of the Ionosphere on Radiowave Systems," April 14–16, 1981; Alexandria, Virginia.
26. Theoretical models of high-latitude electrodynamics, *Invited Review*, 4th IAGA Scientific Assembly, August 3–15, Edinburgh, Scotland; *IAGA Bulletin*, 45, 289, 1981.
27. Ionospheric dynamics, *Invited Review*, Thermosphere Workshop, October 19–21, 1981; NASA Goddard Space Flight Center, Greenbelt, Maryland.
28. High-latitude ionospheric model, *Invited Review*, CSTR, National Academy of Sciences, Washington, D. C., October 1981.
29. The flow of plasma in the solar terrestrial environment, *Invited Review*, AGU Fall Meeting, San Francisco, California; *EOS*, 62, 1016, 1981.
30. Proton temperature anisotropy in the polar wind, (with D. S. Watkins), AGU Fall Meeting, San Francisco, California; *EOS*, 62, 1012, 1981.
31. Double layer motion, (with N. Singh), AGU Fall Meeting, San Francisco, California; *EOS*, 62, 1011, 1981.
32. Seasonal variations of the high-latitude F-region for strong convection, (with J. J. Sojka and W. J. Raitt), AGU Fall Meeting, San Francisco, California; *EOS*, 62, 1011, 1981.
33. Ion-neutral momentum coupling near discrete high-latitude ionospheric features, (with J.-P. St-Maurice), AGU Fall Meeting, San Francisco, California; *EOS*, 62, 1011, 1981.
34. The polar wind: A source of magnetospheric plasma, *Invited Review*, presented at the conference on, "Origins of Plasmas and Electric Fields in the Magnetosphere," January 25–29, 1982; Yosemite, California.
35. Current carrying properties of double layers and low frequency auroral fluctuations, (with N. Singh), presented at the conference on, "Origins of Plasmas and Electric Fields in the Magnetosphere," January 25–29, 1982; Yosemite, California.
36. The polar F-region response to a magnetospheric storm, (with J. J. Sojka), COSPAR, 24th Plenary meeting, May 16–June 2, 1982; Ottawa, Ontario, Canada.

37. Numerical simulations of V-shaped potential structures, (with H. Thiemann and N. Singh), AGU Spring Meeting, San Francisco, California; *EOS*, 63, 582, 1982.
38. The terrestrial ionosphere, *five one-hour lectures* presented at the “Theory Institute in Solar-Terrestrial Physics,” August 9–26, 1982; Boston College, Massachusetts.
39. Dynamical features of moving double layers, (with N. Singh), presented at the “Theory Institute in Solar-Terrestrial Physics,” August 9–26, 1982; Boston College, Massachusetts.
40. The response of the high latitude F-region to an idealized magnetospheric storm, (with J. J. Sojka), presented at the “Theory Institute in Solar Terrestrial Physics,” August 9–26, 1982; Boston College, Massachusetts.
41. Numerical calculations relevant to the initial expansion of the polar wind, (with N. Singh), presented at the “Theory Institute in Solar-Terrestrial Physics,” August 9–26, 1982; Boston College, Massachusetts.
42. Stochastic acceleration of ionospheric ions by a coherent wave, (with N. Singh and J. J. Sojka), presented at the “Theory Institute in Solar-Terrestrial Physics,” August 9–26, 1982; Boston College, Massachusetts.
43. Polar ion streams, (with J. H. Waite, J. F. E. Johnson, J. L. Green, C. R. Chappell, and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 63, 1073, 1982.
44. High-latitude ionospheric dynamics, *Invited Talk*, presented at the MITHRAS workshop, February 7–8, 1983; Boulder, Colorado.
45. Ionospheric studies using the incoherent scatter chain of radars, *Invited Talk*, presented at the “Second NSF Workshop on the Incoherent Scatter Radar Database,” February 9–10, 1983; Boulder, Colorado.
46. Comparison of model high-latitude electron densities with Millstone Hill observations, (with J. J. Sojka, J. V. Evans, J. M. Holt, and R. Wand), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 64, 278, 1983.
47. Electrodynamics of the high latitude ionosphere, *Invited Review*, IAGA Scientific Assembly, August 15–27, Hamburg, Germany; *IAGA Bulletin*, 48, 282, 1983.
48. Pertinent characteristics of the topside ionosphere in its role as a source of magnetospheric plasma, *Invited Talk*, (with J. J. Sojka), IAGA Scientific Assembly, August 15–27, Hamburg, Germany; *IAGA Bulletin*, 48, 323, 1983.
49. The applicability of the low speed formulation to the refilling of magnetic flux tubes, (with P. G. Richards and D. G. Torr), IAGA Scientific Assembly, August 15–27, Hamburg, Germany; *IAGA Bulletin*, 48, 324, 1983.
50. Polar cap models, *Invited Review*, presented at the “AFGL Polar Cap Workshop,” October 18–20, 1983; Bedford, Massachusetts.
51. Plasmopause signatures in the ionosphere, *Invited Review*, presented at the conference on, “Fundamental Magnetospheric Processes in the Plasmopause Region,” October 26–27, 1983; MSFC, Huntsville, Alabama.
52. Numerical simulations of counterstreaming plasmas and their relevance to interhemispheric flows, (with N. Singh), presented at the conference on, “Fundamental Magnetospheric Processes in the Plasmopause Region,” October 26–27, 1983; MSFC, Huntsville, Alabama.

53. The global ionosphere for quiet conditions: A model study, (with J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 64, 777, 1983.
54. Problems with deducing plasma convection patterns from multiple radar observations, (with J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 64, 777, 1983.
55. O<sup>+</sup> ions in the polar wind, (with A. R. Barakat), AGU Fall Meeting, San Francisco, California; *EOS*, 64, 778, 1983.
56. Energization of ions in the auroral plasma by broadband waves, (with N. Singh), AGU Fall Meeting, San Francisco, California; *EOS*, 64, 797, 1983.
57. Electrostatic ion cyclotron waves in a multi-ion plasma driven by an electron current, (with N. Singh and J. R. Conrad), AGU Fall Meeting, San Francisco, California; *EOS*, 64, 811, 1983.
58. Fluctuations of V-shaped potential structures in a magnetized plasma, (with N. Singh and H. Thiemann), AGU Fall Meeting, San Francisco, California; *EOS*, 64, 811, 1983.
59. A Global Ionospheric Model, *Invited Review*, presented at the “Optical Ground-Based Aeronomy Workshop II,” June 20–22, 1984; Ann Arbor, Michigan.
60. A global ionospheric model, and Comparison of ionospheric model predictions with incoherent scatter radar observations,” *two one-hour lectures* presented at the Arecibo Observatory, July 16–18, 1984; Arecibo, Puerto Rico.
61. The relationship between the electric fields associated with plasma expansion and double layers, (N. Singh and R. W. Schunk), presented at the “Second Double Layer Symposium and Related Topics,” July 5–6, 1984; Innsbruck, Austria.
62. Can Buneman double layers be driven in auroral plasmas?, (with N. Singh), presented at the “Second Double Layer Symposium and Related Topics,” July 5–6, 1984; Innsbruck, Austria.
63. Current fluctuations and dynamical features of double layer potential profiles, (with N. Singh and H. Thiemann), presented at the “Second Double Layer Symposium and Related Topics,” July 5–6, 1984; Innsbruck, Austria.
64. Numerical simulations of double layers and auroral electric fields, (with N. Singh and H. Thiemann), COSPAR, 25th Plenary Meeting, June 30–July 2, 1984; Graz, Austria.
65. Some features of auroral electric fields as seen in 2D numerical simulations, (with H. Thiemann and N. Singh), COSPAR, 25th Plenary Meeting, June 30–July 2, 1984; Graz, Austria.
66. Thermospheric structure and circulation in the polar cap, *Invited Review*, presented at the Chapman conference on the “Magnetospheric Polar Cap,” August 6–9, 1984; Fairbanks, Alaska.
67. High latitude ionospheric predictions, presented at the GISMOS workshop, October 24–26, 1984; Boulder, Colorado.
68. Global models of ionospheric parameters, presented at the GISMOS workshop, October 24–26, 1984; Boulder, Colorado.
69. Ionosphere-Magnetosphere coupling, *Invited Talk*, presented at the Solar-Terrestrial Theory Program Meeting/Workshop, November 14–16, 1984; Los Alamos, New Mexico.
70. Critical tests of a global ionospheric model, (with J. J. Sojka), *Invited Talk*, AGU Fall Meeting, San Francisco, California; *EOS*, 65, 1026, 1984.

71. The flow of plasma in the solar-terrestrial system, *Colloquium*, Department of Physics and Astronomy, Brigham Young University, Provo, Utah; January 9, 1985.
72. Electric fields in 2-D double layer simulations and their comparison with satellite observations, (with N. Singh and H. Thiemann), presented at the “2nd International School for Space Simulation,” February 4–15, 1985; Kauai, Hawaii.
73. Computer simulations of spacecraft charging by impact-generated plasmas; applications to GIOTTO, (with H. Thiemann and N. Singh), presented at the “2nd International School for Space Simulation,” February 4–15, 1985; Kauai, Hawaii.
74. Temporal behavior of density perturbations in the polar wind, (with N. Singh), presented at the “2nd International School for Space Simulation,” February 4–15, 1985; Kauai, Hawaii.
75. Modeling of the polar ionosphere, (with C. E. Rasmussen and J. J. Sojka), presented at the “2nd International School for Space Simulation,” February 4–15, 1985; Kauai, Hawaii.
76. Effect of hot electrons on the polar wind, (with A. R. Barakat), presented at the “2nd International School for Space Simulation,” February 4–15, 1985; Kauai, Hawaii.
77. A theoretical study of the global F region for June solstice and low magnetic activity, (with J. J. Sojka), *Invited Talk*, presented at the “2nd International School for Space Simulation,” February 4–15, 1985; Kauai, Hawaii.
78. Ion conics as seen in simulations of 2-D potential structures, (with N. Singh and H. Thiemann), presented at the “Chapman Conference on Ion Acceleration in the Magnetosphere and Ionosphere,” June 3–7, 1985; Wellesley, Massachusetts.
79. Ion acceleration in expanding ionospheric plasmas, (with N. Singh), presented at the “Chapman Conference on Ion Acceleration in the Magnetosphere and Ionosphere,” June 3–7, 1985; Wellesley, Massachusetts.
80. Ion beams as seen in simulations of 2-D potential structures, (with N. Singh and H. Thiemann), presented at the “Chapman Conference on Ion Acceleration in the Magnetosphere and Ionosphere,” June 3–7, 1985; Wellesley, Massachusetts.
81. A possible mechanism for the observed streaming of  $O^+$  and  $H^+$  ions at nearly equal speeds in the distant magnetotail, (with N. Singh), presented at the “Chapman Conference on Ion Acceleration in the Magnetosphere and Ionosphere,” June 3–7, 1985; Wellesley, Massachusetts.
82. Comparison of simultaneous Chatanika and Millstone Hill observations with ionospheric model predictions, (with C. E. Rasmussen, J. J. Sojka, V. B. Wickwar, O. de la Beaujardiere, J. C. Foster, J. M. Holt, D. S. Evans, and E. Nielsen), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 66, 327, 1985.
83. A model of the global ionosphere, (with J. J. Sojka), *Invited Review*, presented at the “1985 North American Radio Science Meeting,” June 17–21, 1985; Vancouver, British Columbia, Canada.
84. Theoretical study of the production and decay of localized electron density enhancements in the polar ionosphere, (with J. J. Sojka), presented at the “1985 North American Radio Science Meeting,” June 17–21, 1985; Vancouver, British Columbia, Canada.
85. Comparison of simultaneous Chatanika and Millstone Hill observations with ionospheric model predictions, (with C. E. Rasmussen, J. J. Sojka, V. B. Wickwar, O. de la Beaujardiere, J. C. Foster, J. M. Holt, D. S. Evans, and E. Nielsen), presented at the

- “1985 North American Radio Science Meeting,” June 17–21, 1985; Vancouver, British Columbia, Canada.
86. Theoretical study of anomalously high F-region peak altitudes in the polar ionosphere, (with J. J. Sojka), presented at the “1985 North American Radio Science Meeting,” June 17–21, 1985; Vancouver, British Columbia, Canada.
  87. Models of the terrestrial high latitude ionosphere, *Invited Review*, 5th IAGA Scientific Assembly, 5–17 August, Prague, Czechoslovakia; 1985.
  88. Ion escape fluxes in the terrestrial high latitude ionosphere, (with A. R. Barakat, T. E. Moore, and J. H. Waite), 5th IAGA Scientific Assembly, 5–17 August, Prague, Czechoslovakia; 1985.
  89. Is Jupiter’s ionosphere a significant plasma source for its magnetosphere? (with A. F. Nagy and A. R. Barakat), 5th IAGA Scientific Assembly, 5–17 August, Prague, Czechoslovakia; 1985.
  90. Simulation of auroral potential structures and related phenomena, (with H. Thiemann and N. Singh), 5th IAGA Scientific Assembly, 5–17 August, Prague, Czechoslovakia; 1985.
  91. Comparison of transport equations for gases and plasmas, and Convergence of the transport equations for gases and plasmas, *two one-hour lectures* presented at the Institut für Astrophysik und Extraterrestrische Forschung, Universität Bonn, August 15–16, 1985; Bonn, West Germany.
  92. Utah State University involvement in the space science consortium, presented at the “SDI Space Science Consortium Meeting,” Johns Hopkins/APL, September 19–20, 1985; Laurel, Maryland.
  93. A theoretical global ionospheric F-region model and its predictive aspects, *Invited Lecture*, presented at the SUNDIAL workshop, September 24–26, 1985; McLean, Virginia.
  94. Magnetospheric control of ionospheric processes, (with J. J. Sojka), *Invited Review*, AGU Fall Meeting, San Francisco, California; *EOS*, 66, 995, 1985.
  95. Ionospheric modelling of the GISMOS campaign, (with J. J. Sojka), *Invited Talk*, AGU Fall Meeting, San Francisco, California; *EOS*, 66, 994, 1985.
  96. Effects of different convection models upon the high-latitude ionosphere, (with C. E. Rasmussen and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 66, 996, 1985.
  97. Theoretical study of the electron temperature in the high latitude ionosphere for solar maximum and winter conditions, (with M. D. Bowline and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 66, 999, 1985.
  98. EIC waves in a plasma with an ion beam and counterstreaming bulk electrons: Waves in the zero-frequency band, (with J. R. Conrad and N. Singh), AGU Fall Meeting, San Francisco, California; *EOS*, 66, 1034, 1985.
  99. Temporal features of the refilling of a plasmaspheric flux tube, (with N. Singh and H. Thiemann), AGU Fall Meeting, San Francisco, California; *EOS*, 66, 1036, 1985.
  100. Numerical simulations of auroral plasma processes, (with H. Thiemann and N. Singh), AGU Fall Meeting, San Francisco, California; *EOS*, 66, 1050, 1985.
  101. The role of thermosphere/ionosphere modeling for the GBOA–CEDAR initiative, (with D. G. Torr, T. L. Killeen, and R. G. Roble), *Invited Talk*, AGU Fall Meeting, San Francisco, California; *EOS*, 66, 990, 1985.

102. Plasma response to the injection of an electron beam, (with N. Singh), *Invited Talk*, National Radio Science Meeting, January 13–16, 1986; Boulder, Colorado.
103. Round Table Discussion on Global Ionosphere and Aeronomy Study Program, *Invited Participant*, National Radio Science Meeting, January 13–16, 1986; Boulder, Colorado.
104. Space science: High technology now and in the future, *Invited Lecture*, Business and Professional Women’s Organization, April 21, 1986; Logan, Utah.
105. Solar-terrestrial physics: A space age birth, *73<sup>rd</sup> Faculty Honor Lecture*, Utah State University, May 1, 1986; Logan, Utah.
106. Solar-terrestrial physics, *Colloquium*, Department of Physics, University of Utah, May 8, 1986; Salt Lake City, Utah.
107. Magnetospheric control of the bulk ionospheric plasma, (with J. J. Sojka), presented at, “The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications,” (AGARD), The Hague, The Netherlands, June 2–6, 1986.
108. Theory of the electrodynamic tether, (with C. E. Rasmussen and P. M. Banks), COSPAR, 26<sup>th</sup> Plenary Meeting, June 30–July 11, 1986; Toulouse, France.
109. Results of model calculations simulating the interaction between the Giotto spacecraft and the impact induced secondary plasma, (with H. Thiemann, R. Grard, and N. Singh), COSPAR, 26<sup>th</sup> Plenary Meeting, June 30–July 11, 1986; Toulouse, France.
110. Modelled ionospheric  $T_e$  profiles at high latitudes for possible IRI application, (with J. J. Sojka and M. D. Bowline), COSPAR, 26<sup>th</sup> Plenary Meeting, June 30–July 11, 1986; Toulouse, France.
111. An updated theory of the polar wind, *Invited Review*, COSPAR, 26<sup>th</sup> Plenary Meeting, June 30–July 11, 1986; Toulouse, France.
112. A cooperative world-wide study of interactive ionospheric processes and their role in the transfer of energy and mass in the Sun-Earth system, (with E. P. Szuszczewicz, R. A. Wolf, E. C. Roelof, B. G. Fejer, T. Robinson, M. A. Abdu, and L. McNamara), SCOSTEP International Symposium on Solar-Terrestrial Physics, June 30–July 5, 1986; Toulouse, France.
113. Ionosphere’s response to an auroral storm based upon the Dynamics Explorer SAI and LAPI data bases, (with J. J. Sojka, L. A. Frank, J. D. Craven, J. D. Winningham, and J. R. Sharber), SCOSTEP International Symposium on Solar-Terrestrial Physics, June 30–July 5, 1986; Toulouse, France.
114. Interactions between the polar ionosphere and thermosphere, *Invited Review*, SCOSTEP International Symposium on Solar-Terrestrial Physics, June 30–July 5, 1986; Toulouse, France.
115. The polar wind, *Invited Review*, presented at, “The First Huntsville Workshop on Magnetosphere-Ionosphere Plasma Models,” October 13–16, 1986; Huntsville, Alabama.
116. Ion escape fluxes in the terrestrial high latitude ionosphere, (with A. R. Barakat, T. E. Moore, and J. H. Waite), presented at, “The First Huntsville Workshop on Magnetosphere Ionosphere Plasma Models,” October 13–16, 1986; Huntsville, Alabama.

117. Ionosphere-thermosphere modelling: Current status, *Invited Review*, presented at the “International Symposium on Large-Scale Processes in the Ionospheric-Thermospheric System,” December 2–5, 1986; Boulder, Colorado.
118. Comparison of simultaneous Chatanika and Millstone Hill temperature measurements with ionospheric model predictions, (with C. E. Rasmussen, J. J. Sojka, V. B. Wickwar, O. de la Beaujardiere, J. C. Foster, and J. M. Holt), “International Symposium on Large-Scale Processes in the Ionospheric-Thermospheric System,” December 2–5, 1986; Boulder, Colorado.
119. Asymmetries in the plasma characteristics of the conjugate high-latitude ionospheres, (with J. J. Sojka), “International Symposium on Large-Scale Processes in the Ionospheric-Thermospheric System,” December 2–5, 1986; Boulder, Colorado.
120. An *E* and *F* region density model for obtaining ionospheric conductivity, (with C. E. Rasmussen), “International Symposium on Large-Scale Processes in the Ionospheric-Thermospheric System,” December 2–5, 1986; Boulder, Colorado.
121. SUNDIAL: A continuing program of global-scale modeling and measurement of ionospheric responses to solar, magnetospheric, and thermospheric controls, (with E. P. Szuszczewicz, R. A. Wolf, E. C. Roelof, B. G. Fejer, M. A. Abdu, J. C. Joselyn, R. Leitinger, and R. F. Woodman), “International Symposium on Large-Scale Processes in the Ionospheric-Thermospheric System,” December 2–5, 1986; Boulder, Colorado.
122. Ionospheric physics: The impact of plasma transport, *Invited Talk*, AGU Fall Meeting, San Francisco, California; *EOS*, 67, 1126, 1986.
123. Comparison of solutions to bi-Maxwellian and Maxwellian transport equations for subsonic flows, (with H. G. Demars), AGU Fall Meeting, San Francisco, California; *EOS*, 67, 1136, 1986.
124. Stability of the polar wind, (with A. R. Barakat), AGU Fall Meeting, San Francisco, California; *EOS*, 67, 1136, 1986.
125. Theoretical study of the high latitude ionosphere’s response to multi-cell convection patterns, (with J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 67, 1137, 1986.
126. Can the high latitude ionosphere support large field-aligned ion drifts? (with R. J. Sica and C. E. Rasmussen), AGU Fall Meeting, San Francisco, California; *EOS*, 67, 1137, 1986.
127. The lifetime and transport of severe ionospheric disturbances, (with J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 67, 1137, 1986.
128. Ionospheric convection driven by NBZ currents, (with C. E. Rasmussen), AGU Fall Meeting, San Francisco, California; *EOS*, 67, 1162, 1986.
129. Ionospheric convection driven by asymmetries in NBZ currents, (with C. E. Rasmussen), National Radio Science Meeting, January 12–15, 1987; Boulder, Colorado.
130. Implications of the SUNDIAL data on first-principles global-scale models, presented at the “Third SUNDIAL Workshop,” February 24–27, 1987; La Jolla, California.
131. Ionospheric features induced by magnetospheric processes, (with J. J. Sojka), *Invited Talk*, presented at the “International Symposium on Quantitative Modeling of Magnetosphere-Ionosphere Coupling Processes,” March 9–13, 1987; Kyoto, Japan.

132. Overview of the USU center of excellence in theory and analysis of the geoplasma environment, presented at the Air Force Geophysics Laboratory, March 30–April 1, 1987; Bedford, Massachusetts.
133. Solar-terrestrial physics, *Invited Lecture*, USU Honors Program, May 14, 1987.
134. SUNDIAL: A global study of ionospheric processes and their roles in the transfer of energy and mass in the sun-earth system, (with E. P. Szuszczewicz, E. C. Roelof, B. G. Fejer, R. A. Wolf, M. A. Abdu, J. C. Joselyn, B. M. Reddy, P. Wilkinson, R. Woodman, and R. Leitinger), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 68, 364, 1987.
135. First-principle and empirical modeling of the global-scale ionosphere, (R. W. Schunk and E. P. Szuszczewicz), *Invited Talk*, AGU Spring Meeting, Baltimore, Maryland; *EOS*, 68, 364, 1987.
136. Interhemispheric comparison of Sundial *F*-region data with global-scale ionospheric models, (with P. J. Wilkinson, R. Hanbaba, and E. P. Szuszczewicz), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 68, 364, 1987.
137. Processes in the quiet and disturbed equatorial low latitude ionosphere: SUNDIAL campaign 1984, (with M. A. Abdu, B. M. Reddy, G. O. Walker, R. Hanbaba, J. H. A. Sobral, B. G. Fejer, R. F. Woodman, and E. P. Szuszczewicz), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 68, 364, 1987.
138. Characteristics of high voltage spheres in the ionosphere, presented at the SPEAR meeting, W. J. Schafer, Inc., July 30, 1987; Arlington, Virginia.
139. Polar wind theory, *Invited Review*, presented at the 1987 Cambridge Workshop in Theoretical Geoplasma Physics on “Ionosphere-Magnetosphere-Solar Wind Coupling Processes,” July 28–August 1, 1987; Cambridge, Massachusetts.
140. First-principal and empirical modelling of the global-scale ionosphere, (with E. P. Szuszczewicz), presented at the International Union of Geodesy and Geophysics, Vancouver, British Columbia, Canada; August 9–22, 1987.
141. Can the high-latitude ionosphere support large field-aligned ion drifts?, (with R. J. Sica and C. E. Rasmussen), presented at the International Union of Geodesy and Geophysics, Vancouver, British Columbia, Canada; August 9–22, 1987.
142. Ionospheric convection driven by NBZ currents, (with C. E. Rasmussen), presented at the International Union of Geodesy and Geophysics, Vancouver, British Columbia, Canada; August 9–22, 1987.
143. Stability of the polar wind: Linear theory and simulation, (with A. R. Barakat), presented at the International Union of Geodesy and Geophysics, Vancouver, British Columbia, Canada; August 9–22, 1987.
144. An *E*- and *F*-region density model for obtaining ionospheric conductivity, (with C. E. Rasmussen), presented at the International Union of Geodesy and Geophysics, Vancouver, British Columbia, Canada; August 9–22, 1987.
145. Comparison of simultaneous Chatanika and Millstone Hill temperature measurements with ionospheric model predictions, (with C. E. Rasmussen, J. J. Sojka, V. B. Wickwar, O. de la Beaujardiere, J. C. Foster, and J. M. Holt), presented at the International Union of Geodesy and Geophysics, Vancouver, British Columbia, Canada; August 9–22, 1987.

146. Future thermospheric general circulation model (TGCM) needs, presented at the Workshop on Atmospheric Density and Aerodynamic Drag Models for Air Force Operations, Boston, Massachusetts; October 20–22, 1987.
147. Ionosphere-thermosphere interaction modelling; Current status, *Invited Paper*, AGU Fall Meeting, San Francisco, California; *EOS*, 68, 1382, 1987.
148. Temperature anisotropies in the ionosphere, (with H. G. Demars), AGU Fall Meeting, San Francisco, California; *EOS*, 68, 1382, 1987.
149. A model study of how electric field structures affect the polar cap *F*-region, (with J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 68, 1385, 1987.
150. Effect of cusp  $H^+$  and  $O^+$  beams on the stability of the polar wind, (with A. R. Barakat), AGU Fall Meeting, San Francisco, California; *EOS*, 68, 1386, 1987.
151. A fluid model of high voltage spheres in the ionosphere, (with T.-Z. Ma), AGU Fall Meeting, San Francisco, California; *EOS*, 68, 1402, 1987.
152. A model of solar wind streams, (with W.-H. Yang), AGU Fall Meeting, San Francisco, California; *EOS*, 68, 1410, 1987.
153. Multi-fluid approach to study the refilling of plasmaspheric flux tubes, (with C. E. Rasmussen), AGU Fall Meeting, San Francisco, California; *EOS*, 68, 1421, 1987.
154. Motion of ionospheric flux tubes during a period of substorm activity, (with C. E. Rasmussen, R. J. Sica, J. Liu, and A. D. Richmond), AGU Fall Meeting, San Francisco, California; *EOS*, 68, 1430, 1987.
155. Modelling ionospheric density structures, (with J. J. Sojka), *Invited Talk*, presented at the National Radio Science Meeting, January 5–8, 1988; Boulder, Colorado.
156. Global-scale *F*-region distributions under quiescent and disturbed conditions: SUNDIAL campaign results, (with E. P. Szuszczewicz, B. G. Fejer, E. C. Roelof, and R. A. Wolf), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 69, 416, 1988.
157. The flow of plasma in the solar-terrestrial environment, *Invited*, (with A. R. Barakat, H. G. Demars, T.-Z. Ma, C. E. Rasmussen, J. J. Sojka, H. Thiemann, and W.-H. Yang), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 69, 423, 1988.
158. A three-dimensional time-dependent model of the plasmasphere, (with C. E. Rasmussen), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 69, 428, 1988.
159. A three-dimensional time-dependent model of the polar wind, (with J. J. Sojka), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 69, 429, 1988.
160. Stability of energetic ion outflows from the ionosphere, (with A. R. Barakat), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 69, 429, 1988.
161. Modelling ionospheric density structures and dynamic auroral features, (with J. J. Sojka), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 69, 431, 1988.
162. A two-dimensional model of plasma expansion in the ionosphere, (with T.-Z. Ma), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 69, 431, 1988.
163. A test of the applicability of magnetospheric convection models for northward IMF conditions, (with N. C. Maynard, J. J. Sojka, J. P. Heppner, and L. A. Brace), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 69, 415, 1988.
164. Maximum field-aligned plasma velocities in the *F*-region, (with R. J. Sica and C. E. Rasmussen), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 69, 443, 1988.

165. Modelling solar wind streams and the neutral current sheet, (with W.-H. Yang), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 69, 436, 1988.
166. Modelling ionospheric density structures, (with J. J. Sojka), AGARD Symposium on, "Ionospheric Structure and Variability on a Global Scale and Interaction with Atmosphere, Magnetosphere," 16–20 May, 1988; Munich, West Germany.
167. Polar wind tutorial, *Invited Lecture*, presented at the 1988 Cambridge Workshop in Theoretical Geoplasma Physics on, "Polar Cap Dynamics and High Latitude Ionospheric Turbulence," 13–17 June, 1988; Cambridge, Massachusetts.
168. A real-time high latitude ionospheric specification model, (with R. E. Daniell, L. D. Brown, D. N. Anderson, and J. J. Sojka), presented at the 1988 Cambridge Workshop in Theoretical Geoplasma Physics on "Polar Cap Dynamics and High Latitude Ionospheric Turbulence," 13–17 June, 1988; Cambridge, Massachusetts.
169. Magnetosphere-ionosphere-thermosphere coupling processes, *Invited Talk*, presented at the SCOSTEP special session on, "Solar-Terrestrial Energy Program (STEP): Major Scientific Problems," 18–29 July, 1988; Helsinki, Finland.
170. Response of the ionosphere-thermosphere system to magnetospheric forcing, *Invited Talk*, COSPAR 27<sup>th</sup> Plenary Meeting, 18–29 July, 1988; Helsinki, Finland.
171. Outflow of low energy ions in the terrestrial high-latitude ionosphere, *Invited Talk*, (with A. R. Barakat), COSPAR 27<sup>th</sup> Plenary Meeting, 18–29 July, 1988; Helsinki, Finland.
172. Stability of the polar wind in the presence of cusp H<sup>+</sup> and O<sup>+</sup> ions, (with A. R. Barakat), COSPAR 27<sup>th</sup> Plenary Meeting, 18–29 July, 1988; Helsinki, Finland.
173. Dynamic PIC simulations of charging phenomena related to the ICE spacecraft in the cometary environment of Giacobini-Zinner, (with H. Thiemann and R. Zwickl), COSPAR 27<sup>th</sup> Plenary Meeting, 18–29 July, 1988; Helsinki, Finland.
174. Solutions to bi-Maxwellian transport equations for the solar wind, (with H. G. Demars), American Physical Society Topical Conference on Plasma Astrophysics, 19–23 September, 1988; Santa Fe, New Mexico.
175. Modeling high-speed solar wind streams, (with W.-H. Yang), American Physical Society Topical Conference on Plasma Astrophysics, 19–23 September, 1988; Santa Fe, New Mexico.
176. Global polar wind variations during changing magnetospheric conditions, (with J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 69, 1340, 1988.
177. Sheath formation around biased interconnectors and current collection in a LEO-plasma as seen by PIC simulations, (with H. Thiemann), AGU Fall Meeting, San Francisco, California; *EOS*, 69, 1378, 1988.
178. Theoretical study of the seasonal behavior of the global ionosphere at solar maximum, (with J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 69, 1349, 1988.
179. Solutions to bi-Maxwellian transport equations for the solar wind, (with H. G. Demars), AGU Fall Meeting, San Francisco, California; *EOS*, 69, 1364, 1988.
180. Modelling high-speed solar wind streams, (with W.-H. Yang), AGU Fall Meeting, San Francisco, California; *EOS*, 69, 1358, 1988.

181. An empirical study of the undisturbed mid-latitude ionosphere using simultaneous, multiple site ionosonde measurements, AGU Fall Meeting, San Francisco, California; (with R. J. Sica and P. Wilkinson), *EOS*, 69, 1350, 1988.
182. Comparison of plasmaspheric measurements with a three-dimensional time-dependent model of the plasmasphere, (with C. E. Rasmussen), AGU Fall Meeting, San Francisco, California; *EOS*, 69, 1347, 1988.
183. Modelling highly non-equilibrium space plasmas, Colloquium at the National Center for Atmospheric Research, January 5, 1989; Boulder, Colorado.
184. Streamlining theoretical ionospheric models for practical applications, *Invited Talk*, presented at the National Radio Science Meeting, January 4–6, 1989; Boulder, Colorado.
185. A parameterized analytic model of the high latitude ionosphere, (with R. E. Daniell, L. D. Brown, D. N. Anderson, and J. J. Sojka), presented at the National Radio Science Meeting, January 4–6, 1989; Boulder, Colorado.
186. Ionospheric specification model, (with J. J. Sojka), presented at the Third Quarterly Meeting of the Air Weather Services (AWS) Ionospheric Specification Modelling, April 18–19, 1989; Houston, Texas.
187. A study of the undisturbed mid-latitude ionosphere using simultaneous, multiple site ionosonde measurements, (with R. J. Sica and P. J. Wilkinson), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 70, 410, 1989.
188. Current status of numerical ionospheric modelling, *Invited Talk*, AGU Spring Meeting, Baltimore, Maryland, *EOS*, 70, 406, 1989.
189. The high-latitude  $F$  region: Observation and theory, *Invited Talk*, (with V. B. Wickwar), presented at the Fourth EISCAT Scientific Workshop, 5–9 June, 1989; Sigtuna, Sweden.
190. Mid-latitude thermospheric dynamics under quiet and disturbed conditions, (with V. B. Wickwar, D. Rees, and R. Sica), IAGA Scientific Assembly, 24 July–4 August, Exeter, England; *IAGA Bulletin*, 53, 365, 1989.
191. SUNDIAL: A coordinated multiparameter measurements and modelling program on the prediction and control of the global scale ionosphere: A review of progress, (with E. P. Szuszczewicz, R. A. Wolf, B. G. Fejer, and E. C. Roelof), IAGA Scientific Assembly, 24 July–4 August, Exeter, England; *IAGA Bulletin*, 53, 350, 1989.
192. Status of GITCAD campaigns, (with V. B. Wickwar, K. L. Miller, D. Alcayde, G. S. Ivanov-Kholodny, R. W. Smith, and P. J. Wilkinson), IAGA Scientific Assembly, 24 July–4 August, Exeter, England; *IAGA Bulletin*, 53, 350, 1989.
193. A 3-D model for plasma clouds in the ionosphere, (with T.-Z. Ma), IAGA Scientific Assembly, 24 July–4 August, Exeter, England; *IAGA Bulletin*, 53, 393, 1989.
194. Secondary emission as a trigger mechanism for anomalous features in solar array-plasma interactions, (with H. Thiemann), IAGA Scientific Assembly, 24 July–4 August, Exeter, England; *IAGA Bulletin*, 53, 393, 1989.
195. Plasma expansion phenomena: Comparison of characteristics predicted by small-scale and macroscopic formulations, (with E. P. Szuszczewicz), IAGA Scientific Assembly, 24 July–4 August, Exeter, England; *IAGA Bulletin*, 53, 393, 1989.
196. Global polar wind variations driven by magnetospheric processes, (with J. J. Sojka), IAGA Scientific Assembly, 24 July–4 August, Exeter, England; *IAGA Bulletin*, 53, 309, 1989.

197. Ionosphere-thermosphere modelling requirements, presented at the NASA-SPD Strategic Implementation Study for Ionospheric-Thermospheric-Mesospheric Physics, 8–9 November, 1989; McLean, Virginia.
198. Report of the subcommittee for mesosphere-thermosphere-ionosphere-magnetosphere coupling, presented at the meeting to discuss the NASA-SPD Strategic Implementation Study, 3 December, 1989; San Francisco, California.
199. On the source-surface model, (with W.-H. Yang), AGU Fall Meeting, San Francisco, California; *EOS*, 70, 1254, 1989.
200. Solar wind proton velocity distributions: Comparison of bi-Maxwellian-based 16-moment theory with observations, (with H. G. Demars), AGU Fall Meeting, San Francisco, California; *EOS*, 70, 1263, 1989.
201. Modelling the dynamic ionosphere, *Invited Review*, presented at AGU Fall Meeting, San Francisco, California; *EOS*, 70, 1237, 1989.
202. Expansion of a three-dimensional plasma cloud in the ionosphere, (with T.-Z. Ma), AGU Fall Meeting, San Francisco, California; *EOS*, 70, 1240, 1989.
203. First OH( $\lambda = 843$  nm) observations from the Bear Lake site of the Hardware Ranch Observatory using a GaAs imaging photon detector, (with D. Rees, V. B. Wickwar, and R. J. Sica), AGU Fall Meeting, San Francisco, California; *EOS*, 70, 1245, 1989.
204. How well do we really understand the quiet-time mid-latitude ionosphere?, (with R. J. Sica, S. J. Cariglia, M. Buonsanto, J. M. Holt, and D. Sipler), AGU Fall Meeting, San Francisco, California; *EOS*, 70, 1247, 1989.
205. Modeling of annual variations in plasmaspheric density, (with C. E. Rasmussen and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 70, 1247, 1989.
206. The longitude dependence of the dayside *F*-region trough: A detailed model-observation comparison, (with J. J. Sojka and J. A. Whalen), AGU Fall Meeting, San Francisco, California; *EOS*, 70, 1248, 1989.
207. Dynamics Explorer 1 and 2 data-TDIM study for November 22, 1981, (with M. D. Bowline, J. J. Sojka, J. D. Craven, L. A. Frank, J. R. Sharber, J. D. Winningham, and J. P. Heppner), AGU Fall Meeting, San Francisco, California; *EOS*, 70, 1248, 1989.
208. Simulations of solar array-LEO plasma interactions, (with H. Thiemann), AGU Fall Meeting, San Francisco, California; *EOS*, 70, 1249, 1989.
209. Temporal variations of the polar wind, (with J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 70, 1249, 1989.
210. A parameterized version of the USU high latitude ionospheric model, (with R. E. Daniell, L. D. Brown, W. G. Whartenby, D. N. Anderson, and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 70, 1248, 1989.
211. A high latitude ionospheric specification model (HLISM), (with D. N. Anderson, J. A. Whalen, S. Basu, R. E. Daniell, L. D. Brown, W. G. Whartenby, and J. J. Sojka), National Radio Science Meeting, January 3–5, 1990; Boulder, Colorado.
212. Ionospheric dependence and sensitivity on the solar EUV flux, (with J. J. Sojka), presented at the Quarterly Space Model Development Review Meeting, Peterson Air Force Base, January 29, 1990; Colorado Springs, Colorado.
213. Ionospheric variations, *Invited Review*, (with J. J. Sojka), presented at the SUNDIAL Workshop, April 9–12, 1990; New Orleans, Louisiana.

214. Ionospheric forecast model, (with J. J. Sojka), presented at the *Ionospheric Specification Model Quarterly Review*, May 14, 1990; Boston, Massachusetts.
215. Model studies of ionosphere-thermosphere coupling phenomena on both large and small spatial scales and from high to low altitudes, *Invited Review*, presented at the Seventh International Symposium on Solar Terrestrial Physics, June 25–30, 1990; The Hague, The Netherlands.
216. Coupled modelling of the ionosphere and thermosphere, *Invited Review*, 28th COSPAR Meeting, 25 June–6 July, 1990; The Hague, The Netherlands.
217. Approaches to ionospheric modelling, simulation, and prediction, (with J. J. Sojka), *Invited Review*, 28th COSPAR Meeting, 25 June–6 July, 1990; The Hague, The Netherlands.
218. Comparison of the USU ionospheric model with the UCL self-consistent ionospheric-thermospheric model, (with J. J. Sojka, D. Rees, T. J. Fuller-Rowell, and R. J. Moffett), 28th COSPAR Meeting, 25 June–6 July, 1990; The Hague, The Netherlands.
219. Modelling and measurement of global-scale ionospheric behavior under solar minimum, equinoctial conditions, (with E. P. Szuszczewicz, P. Wilkinson, M. A. Abdu, R. Sica, R. Hanbaba, M. Sands, T. Kikuchi, R. Burnside, J. C. Joselyn, M. Lester, R. Leitinger, G. O. Walker, B. M. Reddy, and J. H. A. Sobral), *Invited Talk*, 28th COSPAR Meeting, 25 June–6 July, 1990; The Hague, The Netherlands.
220. Combined ionospheric model derived from CCIR and USA data, (with L. Bossy, S. Pallaschke, K. Rawer, J. J. Sojka, and H. Thiemann), 28th COSPAR Meeting, 25 June–6 July, 1990; The Hague, The Netherlands.
221. Model and observation comparison of the universal time and IMF dependence of the ionospheric polar hole, (with J. J. Sojka, W. R. Hoegy, and J. M. Grebowsky), 28th COSPAR Meeting, 25 June–6 July, 1990; The Hague, The Netherlands.
222. PIC-simulation for the high voltage sphere problem, (with T.-Z. Ma and H. Thiemann), 28th COSPAR Meeting, 25 June–6 July, 1990; The Hague, The Netherlands.
223. Electric field formation around negatively biased solar arrays in the LEO plasma, (with H. Thiemann), 28th COSPAR Meeting, 25 June–6 July, 1990; The Hague, The Netherlands.
224. Polar wind instability due to  $H^+$  and  $O^+$  beams, (with A. R. Barakat), presented at the 1990 Cambridge Workshop in Theoretical Geoplasma Physics on “Magnetic Fluctuations, Diffusion and Transport in Geoplasmas,” July 16–20, 1990; Cambridge, Massachusetts.
225. A Monte Carlo study of the transition layer between the collision-dominated and the collisionless regions in the polar wind, (with A. R. Barakat and I. A. Barghouthi), presented at the 1990 Cambridge Workshop in Theoretical Geoplasma Physics on “Magnetic Fluctuations, Diffusion and Transport in Geoplasmas,” July 16–20, 1990; Cambridge, Massachusetts.
226. Recent advances in modelling the coupled ionosphere-polar wind system, *Invited Talk*, presented at the 1990 Gordon Research Conference on “Modeling in Solar Terrestrial Physics,” 30 July–3 August, 1990; Plymouth, New Hampshire.
227. Advanced model of solar array-plasma interactions, (with H. Thiemann), ESA Space Environment Analysis Workshop, 9–12 October, 1990; ESTEC, Noordwijk, The Netherlands.
228. Simulations of the high-latitude ionosphere for a wide range of conditions, (with J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 71, 1502, 1990.

229. Electric field formation at solar cell edge regions, (with H. Thiemann), AGU Fall Meeting, San Francisco, California, *EOS*, 71, 1506, 1990.
230. What the magnetic clouds at IAU infer, (with W.-H. Yang), AGU Fall Meeting, San Francisco, California, *EOS*, 71, 1519, 1990.
231. Comparison of generalized transport and kinetic models of the polar wind, (with H. G. Demars), AGU FALL Meeting, San Francisco, California, *EOS*, 71, 1493, 1990.
232. Evolution of three-dimensional plasma clouds in the ionosphere, (with T.-Z. Ma), AGU Fall Meeting, San Francisco, California, *EOS* 71, 1506, 1990.
233. F-region's dependence on temporal and spectral structure in the solar EUV flux, (with J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 71, 1482, 1990.
234. Ion plasma flow in the outer plasmasphere: A semi-kinetic model, (with A. Khoyloo and A. R. Barakat), AGU Fall Meeting, San Francisco, California, *EOS*, 71, 1523, 1990.
235. H<sup>+</sup> outflow in the polar wind: A Monte Carlo study, (with A. R. Barakat, I. A. Barghouthi, and J. Lemaire), AGU Fall Meeting, San Francisco, California, *EOS*, 71, 1493, 1990.
236. High-latitude ionospheric simulations for a wide range of conditions, (with J. J. Sojka), presented at the First Annual Conference on Prediction and Forecasting of Radio Propagation at High-Latitudes for C<sup>3</sup> Systems, 12–14 February, 1991; Monterey, California.
237. High-latitude ionospheric specification model (HLISM), (with R. E. Daniell, L. D. Brown, D. N. Anderson, J. A. Whalen, and J. J. Sojka), First Annual Conference on Prediction and Forecasting of Radio Propagation at High-Latitudes for C<sup>3</sup> Systems, 12–14 February, 1991; Monterey, California.
238. Simulation of radio wave propagation through a realistically structured ionosphere, (with J. J. Sojka and P. Citrone), First Annual Conference on Prediction and Forecasting of Radio Propagation at High-Latitudes for C<sup>3</sup> Systems, 12–14 February, 1991, Monterey, California.
239. A first-principle derivation of the high latitude TEC distribution, (with D. J. Crain, J. J. Sojka, and P. H. Doherty), AGU Spring Meeting, Baltimore, Maryland; *EOS*, 72, 213, 1991.
240. Ion composition in the auroral *F* region: Comparison of EISCAT data and ionospheric model predictions, (with J. J. Sojka and C. Lathuillere), EISCAT Workshop, June 1991, Finland.
241. Dynamic changes in the ionosphere – thermosphere system during major magnetic disturbances, (with J. J. Sojka), presented on our behalf by D. J. Crain at the 20<sup>th</sup> General Assembly of the IUGG, 11-24 August, 1991; Vienna, Austria.
242. Influence of the ionospheric conductance on the feature of the field-aligned current associated with a distorted two-cell convection during northward IMF, (with L. Zhu and J. J. Sojka), presented at the 20<sup>th</sup> General Assembly of the IUGG, 11–24 August, 1991; Vienna, Austria.
243. A collisional semi-kinetic model for the polar wind, (with A. R. Barakat), presented at the 20<sup>th</sup> General Assembly of the IUGG, 11–24 August, 1991; Vienna, Austria.

244. Ionization in the magnetized ionosphere surrounding a high voltage sphere, (with T.-Z. Ma), presented at the 20<sup>th</sup> General Assembly of the IUGG, 11–24 August, 1991; Vienna, Austria.
245. On the discontinuity of the semi-kinetic model for plasma flows along geomagnetic field lines, (with A. Khoyloo and A. R. Barakat), presented at the 20<sup>th</sup> General Assembly of the IUGG, 11–24 August, 1991; Vienna, Austria.
246. Comparison of semikinetic and generalized transport models of the solar and polar winds, (with H. G. Demars), presented at the 20<sup>th</sup> General Assembly of the IUGG, 11–24 August, 1991; Vienna, Austria.
247. Comparison between 16-moment and Monte Carlo models for outflows in space, (with H. G. Demars), presented at the 20<sup>th</sup> General Assembly of the IUGG, 11–24 August, 1991; Vienna, Austria.
248. Comparison of observed and modeled electron densities from different regions of the globe, (with V. B. Wickwar and J. J. Sojka), presented at the 20<sup>th</sup> General Assembly of the IUGG, 11–24 August, 1991; Vienna, Austria.
249. A collisional semi-kinetic model for the polar wind, (with A. R. Barakat), AGU Fall Meeting, San Francisco, California, *EOS*, 72, 401, 1991.
250. Effect of ion self-collisions on the non-Maxwellian ion velocity distribution in the high-latitude F-region, (with I. A. Barghouthi and A. R. Barakat), AGU Fall Meeting, San Francisco, California, *EOS*, 72, 365, 1991.
251. A parameterized study of polar cap arcs, (with D. J. Crain, J. J. Sojka, and L. Zhu), AGU Fall Meeting, San Francisco, California, *EOS*, 72, 365, 1991.
252. Generalized transport and kinetic modeling of space plasmas, (with H. G. Demars), AGU Fall Meeting, San Francisco, California, *EOS*, 72, 382, 1991.
253. Physical and mathematical conditions for discontinuities of semi-kinetic space plasma models, (with A. Khoyloo and A. R. Barakat), AGU Fall Meeting, San Francisco, California, *EOS*, 72, 401, 1991.
254. Barium plasma clouds from high-speed gas releases in the ionosphere: A 3-D simulation, (with T. -Z. Ma), AGU Fall Meeting, San Francisco, California, *EOS*, 72, 366, 1991.
255. Ionosphere – magnetosphere coupling processes at high latitudes, (with J. J. Sojka), AGU Fall Meeting, San Francisco, California, *EOS*, 72, 363, 1991.
256. Geomagnetic and solar activity control of the F-region bottom-side composition, (with J. J. Sojka), AGU Fall Meeting, San Francisco, California, *EOS*, 72, 368, 1991.
257. A time-dependent model of polar cap arcs, (with L. Zhu, J. J. Sojka, and D. J. Crain), AGU Fall Meeting, San Francisco, California, *EOS*, 72, 356, 1991.
258. Ionosphere-magnetosphere coupling processes at high latitudes, (with J. J. Sojka), *Invited Talk*, AGU Chapman Conference on ‘Micro and Meso Scale Phenomena in Space Plasmas,’ February 17-22, 1992; Kauai, Hawaii.
259. Effect of ion self-collisions on the non-Maxwellian ion distribution and the resulting radar spectrums in the high-latitude *F* region, (with I.A. Barghouthi and A.R. Barakat), Presented at the CEDAR meeting, June, 1992; Boulder, Colorado.

260. Review of  $N_e$  and  $T_e$  discrepancies between observations and model calculations in the F region (with V. B. Wickwar and J. J. Sojka), presented at the 29th Plenary Meeting of COSPAR, September 1, 1992, Washington, D.C.
261. F-region electron temperatures, electron heating rates, and electron heat fluxes (with D. J. Della-Rose, V. B. Wickwar, and J. J. Sojka), presented at the 29th Plenary Meeting of COSPAR, September 1, 1992, Washington, D.C.
262. The lower ionosphere, *Invited Tutorial* (with J. J. Sojka), presented at the Chapman Conference on the 'Upper Mesosphere and Lower Thermosphere,' November 16-18, 1992, Pacific Grove, California.
263. Recent theoretical progress in the study of the outflow of core plasma from the high latitude ionosphere (with G. R. Wilson, J. L. Horwitz, C. W. Ho, D. G. Brown, and A. R. Barakat), presented at the Huntsville Plasma Modelling Workshop, Huntsville, Alabama.
264. Observations and model comparisons of a CRRES satellite lithium-doped barium chemical release in the F-region ionosphere (E. P. Szuszczewicz, D. Hunton, and J. R. Wygant and R. W. Schunk), AGU Fall Meeting, San Francisco, California; *EOS*, 73, 412, 1992.
265. Derivation of topside heat fluxes using incoherent scatter radar observations (with D. Della-Rose, V. B. Wickwar, and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 73, 416, 1992.
266. UT control of  $N_e$  patches in the polar ionosphere (with M. D. Bowline and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS*, 73, 416, 1992.
267. Parameterization of the volume emission, production, and heating rates for low energy Gaussian and Maxwellian electron spectra (with D. Crain, J. J. Sojka, and L. Zhu), AGU Fall Meeting, San Francisco, California; *EOS*, 73, 426, 1992.
268. Multi-ion 16-moment models of the polar and solar winds (with H. G. Demars), AGU Fall Meeting, San Francisco, California; *EOS*, 73, 415, 1992.
269. Reflection of Alfvén waves at an inhomogeneous ionosphere (with L. Zhu, J. J. Sojka, and D. Crain), AGU Fall Meeting, San Francisco, California; *EOS*, 73, 414, 1992.
270. Simulation of  $N_e$  patches in the polar ionosphere (with J. J. Sojka and M. D. Bowline), AGU Fall Meeting, San Francisco, California; *EOS*, 73, 414, 1992.
271. A model of a 3-D plasma cloud with distant coupling to the lower ionosphere (with T.-Z. Ma), AGU Fall Meeting, San Francisco, California; *EOS*, 73, 419, 1992.
272. Comparison between 16-moment and 20-moment transport equations applicability on space plasmas (with A. R. Barakat), AGU Fall Meeting, San Francisco, California; *EOS*, 73, 479, 1992.
273. TDIM Validation (with J. J. Sojka), presented at the National Radio Science Meeting, January 5-8, 1993, Boulder, Colorado.
274. Ionospheric modelling of climatology and weather, *Invited Talk* (with J. J. Sojka), presented at the Ionospheric Effects Symposium 1993, May 4-6, 1993, Alexandria, Virginia.
275. Thermal plasma outflow from the ionosphere, *Invited Talk*, AGU Spring Meeting, Baltimore, Maryland; *EOS Supplement*, 252, 1993.

276. Application of the generalized transport equations on the wave-particle-interactions at high latitudes (with A. R. Barakat and H. G. Demars), presented at the 1993 Cambridge Workshop, July, 1993; Cambridge, Massachusetts.
277. Minor ions in the polar wind. A multispecies generalized transport model (with H. G. Demars), COSPAR Meeting, August, 1993, Argentina.
278. New weather models of the high-latitude ionosphere for patch and sun-aligned arc formation, *Invited Talk* (with J. J. Sojka), 24th General Assembly of URSI, August 25 - September 2, 1993; Kyoto, Japan.
279. Storm time ionospheric forecasting, *Invited Talk* (with J. J. Sojka), 24th General Assembly of URSI, August 25-September 2, 1993; Kyoto, Japan.
280. Plasma expansion characteristics of artificial plasma clouds, *Invited Talk* (with T.-Z. Ma), 24th General Assembly of URSI, August 25 - September 2, 1993; Kyoto, Japan.
281. The polar wind and its hostile environment, *Invited Talk*, AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 74, 455, 1993.
282. High resolution ionospheric response to time-dependent magnetospheric parameters (with D. J. Crain, L. Zhu, and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 74, 456, 1993.
283. Model study of multiple polar cap arcs: Spacing and occurrence (with L. Zhu, J. J. Sojka, and D. J. Crain), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 74, 456, 1993.
284. Ionospheric response to traveling convection twin vortices (with L. Zhu and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 74, 463, 1993.
285. Heat flow processes on SAR-arc field lines: A multi-ion generalized transport model (with H. G. Demars), AGU Fall Meeting, San Francisco, California, *EOS Supplement*, 74, 464, 1993.
286. Patches in the polar ionosphere: Plasma source variability (with M. Bowline and J. J. Sojka), AGU Fall Meeting, San Francisco, California, *EOS Supplement*, 74, 463, 1993.
287. Computer experiments on arcing processes as observed in ground tests (with H. Thiemann), AGU Fall Meeting, San Francisco, California, *EOS Supplement*, 74, 466, 1993.
288. Current closure and image cloud formation associated with a 3-D plasma cloud in the ionosphere (with T.-Z. Ma), AGU Fall Meeting, San Francisco, California, *EOS Supplement*, 74, 471, 1993.
289. Patches and scintillations in the polar ionosphere: UT and seasonal dependence (with St. Basu, S. Basu, and J. J. Sojka), AGU Fall Meeting, San Francisco, California, *EOS Supplement*, 74, 94, 1993.
290. Model-observation comparisons that show the polar cap patch UT dependence in winter (with J. J. Sojka, M. D. Bowline and E. J. Weber), AGU Fall Meeting, San Francisco, California, *EOS Supplement*, 74, 94, 1993.
291. Advances in modeling the polar ionosphere, *Invited Talk*, AGU Spring Meeting, Baltimore, Maryland; *EOS Supplement*, 75, 249, 1994.
292. Modeling polar cap F region patches: A review of the last two years (with D. T. Decker, C. E. Valladares, D. N. Anderson, and J. J. Sojka), Second Joint Workshop for CEDAR HLPS/STEP GAPS, 27-29 June 1994, Lyons, Colorado.

293. Relationship of theoretical patch climatology to polar cap patch observations (with M. D. Bowline and J. J. Sojka), Second Joint Workshop for CEDAR HLPS/STEP GAPS, 27-29 June 1994, Lyons, Colorado.
294. Ionospheric signatures of traveling convection vortices (with L. Zhu and J. J. Sojka), Second Joint Workshop for CEDAR HLPS/STEP GAPS, 27-29 June 1994, Lyons, Colorado.
295. High resolution ionospheric response to a weak midnight sector sun-aligned polar cap arc (with D. J. Crain, J. J. Sojka, L. Zhu, and R. Doe), Second Joint Workshop for CEDAR HLPS/STEP GAPS, 27-29 June 1994, Lyons, Colorado.
296. A model-observation study of multiple polar cap arcs (with L. Zhu, C. E. Valladares, J. J. Sojka, and D. J. Crain), Second Joint Workshop for CEDAR HLPS/STEP GAPS, 27-29 June 1994, Lyons, Colorado.
297. Macroscale modelling and mesoscale observations of plasma density structures in the polar cap (with S. Basu, S. Basu, and J. J. Sojka), Second Joint Workshop for CEDAR HLPS/STEP GAPS, 27-29 June 1994, Lyons, Colorado.
298. Results from theoretical models for IRI (with J. J. Sojka), *Invited Talk*, 30th COSPAR Scientific Assembly, 11-21 July 1994, Hamburg, Germany.
299. Simulations of ionospheric and thermospheric structure at high latitudes (with J. J. Sojka), *Invited Talk*, 30th COSPAR Scientific Assembly, 11-21 July 1994, Hamburg, Germany.
300. Field-aligned expansion of plasma clouds in the ionosphere (with T.-Z. Ma), 30th COSPAR Scientific Assembly, 11-21 July 1994, Hamburg, Germany.
301. The interaction of high voltage spheres with the ionosphere (with T.-Z. Ma), 30th COSPAR Scientific Assembly, 11-21 July 1994, Hamburg, Germany.
302. Plasma clouds with coupling to the ionosphere: A 3-D simulation (with T.-Z. Ma), AGU Western Pacific Geophysics Meeting, 25-29 July 1994, Hong Kong.
303. Can double-hump ion velocity distributions occur in the polar wind? (with A. R. Barakat and I. A. Barghouthi), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 75, 491, 1994.
304. Comparison between macroscopic PIC and semikinetic models of the polar wind (with H. Thiemann and A. R. Barakat), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 75, 491, 1994.
305. Ambiguity in multi-instrument technique identification of polar cap F region patches (with J. J. Sojka, M. D. Bowline, and D. J. Crain), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 75, 496, 1994.
306. The effect of polar cap patches on the polar thermosphere (with T.-Z. Ma), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 75, 496, 1994.
307. A model study of horizontal electrojets associated with sun-aligned polar cap arcs (with L. Zhu, J. J. Sojka, and D. J. Crain), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 75, 497, 1994.
308. An examination of the global heat flux associated with low energy electron precipitation (with D. J. Crain and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 75, 497, 1994.

309. Hemispherical asymmetries in the thermosphere inferred from the ionospheric seasonal anomaly (with M. D. Bowline and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 75, 505, 1994.
310. A multi-ion generalized transport model of the solar wind (with H. G. Demars), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 75, 528, 1994.
311. Signatures of traveling convection vortices (with L. Zhu and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 75, 550, 1994.
312. Ionospheric variations at high latitudes during geomagnetic storms and substorms, Colloquium, Boston University, February 23, 1995; Boston, MA.
313. Ionospheric-thermospheric science: A key element of a National Space Weather Program (with J. J. Sojka), *Invited Talk*, AGU Spring Meeting, Baltimore, Maryland; *EOS Supplement*, 76, 257, 1995.
314. Bill Hanson's appreciation of instrument performance will be sorely missed in the National Space Weather arena (with J. J. Sojka), AGU Spring Meeting, Baltimore, Maryland; *EOS Supplement*, 76, 214, 1995.
315. Simulations of mesoscale ionospheric structures at high latitudes (with J. J. Sojka), AGU Spring Meeting, Baltimore, Maryland; *EOS Supplement*, 76, 214, 1995.
316. Ionospheric/thermospheric space weather issues (with J. J. Sojka), *Invited Tutorial*, CEDAR Meeting, 29 June 1995, Boulder, Colorado.
317. The coupled ionospheric-thermospheric forecast model (CITFM): Backbone for real-time operational space weather forecasting (with W. Borer, D. Anderson, T. Fuller-Rowell, and J. Sojka), presented at the NRL Workshop on *Space Weather: Needs, Capabilities and Science*, 19-22 September 1995, Washington, DC.
318. Ionospheric weather issues, *Invited Talk*, presented at the NRL Workshop on *Space Weather: Needs, Capabilities and Science*, 19-22 September 1995, Washington, DC.
319. An anomalous, F-region, density maximum at midlatitudes—Comparison of observations and detailed model calculations (with V. B. Wickwar, L. Zhou, C. Lathuillere, and J. Lilensten), presented at the EISCAT Workshop, 29 September - 6 October 1995, Cargèse, Corsica.
320. Dynamics and energetics of light ions in the plasmasphere, *Invited Talk*, AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 76, 443, 1995.
321. The effects of polar cap patches and sun-aligned arcs on the polar thermosphere (with T.-Z. Ma), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 76, 440, 1995.
322. Storm simulation using a hybrid coupled ionosphere-thermosphere forecast model (with W. S. Borer, D. N. Anderson, J. V. Eccles, J. J. Sojka, and T.-Z. Fuller-Rowell), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 76, 442, 1995.
323. A systematic modeling study of ground magnetic signatures of traveling convection vortices (with L. Zhu, P. G. Gifford, and J. J. Sojka), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 76, 440, 1995.
324. Using RINEX TEC observations to determine weather effects in the mid-latitude ionosphere (with J. J. Sojka, D. J. Crain, and P. H. Doherty), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 76, 446, 1995.

325. Storm-enhanced density structures in the polar ionosphere (with M. D. Bowline, J. J. Sojka, and J. C. Foster), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 76, 449, 1995.
326. Comparison of observed high latitude F-region climatological variability with models (with J. M. Grebowsky, J. J. Sojka, and D. Bilitza), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 76, 449, 1995.
327. The "macroscopic PIC" versus the "semikinetic" models for space plasmas (with A. R. Barakat and H. Thiemann), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 76, 525, 1995.
328. Assessment of the effect of centrifugal acceleration on the polar wind (with H. G. Demars and A. R. Barakat), AGU Fall Meeting, San Francisco, California; *EOS Supplement*, 76, 525, 1995.
329. Driving a physical ionospheric model with magnetospheric MHD Model Outputs (with J. J. Sojka, M. D. Bowline, J. Chen, J. Fedder, and S. Slinker), AGU Spring Meeting, Baltimore, Maryland, May 20-24, 1996.
330. Polar ionosphere's response to combined magnetospheric and thermospheric dynamics (with J. J. Sojka and D. J. Crain) AGU Spring Meeting, Baltimore, Maryland, May 20-24, 1996.
331. Critical drivers of the ionosphere-thermosphere system, *Invited Talk*, CEDAR Meeting, Boulder, Colorado, June 17-22, 1996.
332. Developments in polar cap patch physics (with J. J. Sojka), presented at the Australian Institute of Physics, 'APPLEPHYS' Meeting, Hobart, Australia, July 1-5, 1996.
333. Effect of convection vortices on the ionosphere (with L. Zhu and J. J. Sojka), presented at the 31st COSPAR Scientific Assembly, Birmingham, UK, July 14-21, 1996.
334. Effects of thermospheric gravity waves on the polar ionosphere (with J. J. Sojka and D. J. Crain), presented at the 31st COSPAR Scientific Assembly, Birmingham, UK, July 14-21, 1996.
335. Global polar wind variations during storms (with J. J. Sojka), presented at the 31st COSPAR Scientific Assembly, Birmingham, UK, July 14-21, 1996.
336. Spatial resolution needed for global ionospheric/thermospheric weather modeling (with J. J. Sojka), presented at the 31st COSPAR Scientific Assembly, Birmingham, UK, July 14-21, 1996.
337. Theoretical storm variability in the ionosphere (with J. J. Sojka), presented at the 31st COSPAR Scientific Assembly, Birmingham, UK, July 14-21, 1996.
338. Ionospheric simulation driven by magnetospheric MHD inputs: Comparison with empirical input simulations and observations (with M. D. Bowline, J. J. Sojka, J. Chen, J. Fedder, and S. Slinker), AGU Fall Meeting, San Francisco, CA, December 15-19, 1996.
339. Model study of the global ionospheric response to auroral substorms: Preliminary results (with L. Zhu, J. J. Sojka, and M. D. Bowline), AGU Fall Meeting, San Francisco, CA, December 15-19, 1996.
340. Ionospheric features during northward interplanetary magnetic field (with J. J. Sojka and M. D. Bowline), AGU Fall Meeting, San Francisco, CA, December 15-19, 1996.

341. High resolution modeling of the 3-dimensional airglow structure of polar cap auroral arcs (with D. J. Crain, L. Zhu, J. J. Sojka, and R. Doe), AGU Fall Meeting, San Francisco, CA, December 15-19, 1996.
342. Ionospheric simulation driven by magnetospheric MHD inputs: A case study for 14 January 1988 (with J. J. Sojka, M. D. Bowline, J. Chen, J. Fedder, and S. Slinker), AGU Fall Meeting, San Francisco, CA, December 15-19, 1996.
343. Comparison of hydrodynamic and macroscopic particle-in-cell solutions for time-dependent flows in the polar wind (with H. G. Demars and A. R. Barakat), AGU Fall Meeting, San Francisco, CA, December 15-19, 1996.
344. Dynamic features of the polar wind in the presence of hot electrons (A. R. Barakat, H. G. Demars and R. W. Schunk), AGU Fall Meeting, San Francisco, CA, December 15-19, 1996.
345. A fully 3-D time-dependent fluid model for the tethered satellite in the ionosphere (with T.-Z. Ma), AGU Fall Meeting, San Francisco, CA, December 15-19, 1996.
346. Comparison of measured F-region ion composition climatological variability with models (with J. M. Grebowsky, R. E. Erlandson, J. J. Sojka, and D. Bilitza), IRI Workshop 97, Kuehlungsborn, Germany, May 26-30, 1997.
347. Dynamical effects of ionospheric conductivity on the formation of polar cap arcs (with L. Zhu, J. J. Sojka, and D. J. Crain), Third Joint Workshop for CEDAR HLPS/STEP GAPS, Lyons, Colorado, June 15-17, 1997.
348. Determination of patches:  $N_m F_2$  versus 630 nm (with M. D. Bowline, J. J. Sojka, and D. J. Crain), Third Joint Workshop for CEDAR HLPS/STEP GAPS, Lyons, Colorado, June 15-17, 1997.
349. Thermospheric perturbations induced by high-latitude plasma structures (with T.-Z. Ma), Third Joint Workshop for CEDAR HLPS/STEP GAPS, Lyons, Colorado, June 15-17, 1997.
350. Comparison of global ionosphere-polar wind modeling with measurements (with J. J. Sojka), 8th Scientific Assembly of IAGA, Uppsala, Sweden, August 4-15, 1997.
351. Thermospheric response to mesoscale ionospheric structures (with T.-Z. Ma), 8th Scientific Assembly of IAGA, Uppsala, Sweden, August 4-15, 1997.
352. Ionospheric response to an auroral substorm (with L. Zhu, J. J. Sojka, and M. D. Bowline), 8th Scientific Assembly of IAGA, Uppsala, Sweden, August 4-15, 1997.
353. Gradient drift instability growth rates from global-scale modeling of the polar ionosphere (with J. J. Sojka, M. Subramaniam, and L. Zhu), 8th Scientific Assembly of IAGA, Uppsala, Sweden, August 4-15, 1997.
354. Ionospheric model status: The present day capabilities to predict the state of the ionosphere (with J. J. Sojka), *Invited Talk*, 8th Scientific Assembly of IAGA, Uppsala, Sweden, August 4-15, 1997.
355. Interhemispheric comparison of TDIM E- and F-region ionospheres on 14 January 1988 (with J. J. Sojka, M. D. Bowline, J. Chen, J. Fedder, and S. Slinker), 8th Scientific Assembly of IAGA, Uppsala, Sweden, August 4-15, 1997.
356. Developments in the ionosphere, *Invited Talk*, 8th Scientific Assembly of IAGA, Uppsala, Sweden, August 4-15, 1997.

357. Comparison of measured F-region ion composition climatological variability with models (with J. M. Grebowsky, R. E. Erlandson, J. J. Sojka, and D. Bilitza), 8th Scientific Assembly of IAGA, Uppsala, Sweden, August 4-15, 1997.
358. Magnetosphere-ionosphere coupling model of polar cap arcs and its requirement for global-scale polar cap measurements (with L. Zhu, J. J. Sojka, and D. Crain), 8th Scientific Assembly of IAGA, Uppsala, Sweden, August 4-15, 1997.
359. Modeling ionospheric response during a rapid change in the convection electric field observed by SuperDARN on 13 November 1996 (with M. D. Bowline, J. J. Sojka, R. A. Greenwald, and J. M. Ruohoniemi), AGU Fall Meeting, San Francisco, CA, December 8-12, 1997.
360. Ionospheric sensitivity to large vertical neutral winds in the auroral polar boundary observed at Mawson, Antarctica (with J. J. Sojka, J. L. Innis, P. A. Greet, and P. L. Dyson), AGU Fall Meeting, San Francisco, CA, December 8-12, 1997.
361. Ionosphere/thermosphere storms: Uncertainties associated with modeling and measurements, AGU Fall Meeting, San Francisco, CA, December 8-12, 1997.
362. Is there a relationship between the average polar cap ionosphere morphology and the IMF? (with J. M. Grebowsky, J. J. Sojka, and R. E. Erlandson), AGU Fall Meeting, San Francisco, CA, December 8-12, 1997.
363. 3-D time-dependent simulations of the tethered satellite-ionosphere interaction (with T.-Z. Ma), AGU Fall Meeting, San Francisco, CA, December 8-12, 1997.
364. Temporal behavior of the polar wind in the presence of hot electrons (with A. R. Barakat and H. G. Demars), AGU Fall Meeting, San Francisco, CA, December 8-12, 1997.
365. Trapped particles in the polar wind (with H. G. Demars and A. R. Barakat), AGU Fall Meeting, San Francisco, CA, December 8-12, 1997.
366. Effect of particle precipitation with various hardness on ground magnetic signatures of traveling convection vortices (with L. Zhu and J. J. Sojka), AGU Fall Meeting, San Francisco, CA, December 8-12, 1997.
367. Can storm morphology be empirically modeled (with J. J. Sojka), URSI Meeting, Boulder, CO, January 5-7, 1998.
368. Ionospheric outflow, *Invited Talk*, Yosemite Conference on "Toward Solar Max 2000: The Present Achievements and Future Opportunities of ISTP and GEM," Yosemite, CA, February 10-13, 1998.
369. Modeling the dynamic behavior of the polar wind (with A. R. Barakat), *Invited Talk*, First International Conference on Astronomy and Space Sciences, Al al-Bayt University, Jordan, May 4-6, 1998.
370. Application of neutral network technique to space plasma problems (with A. R. Barakat), *Invited Talk*, First International Conference on Astronomy and Space Sciences, Al al-Bayt University, Jordan, May 4-6, 1998.
371. 3-D time-dependent simulations of the TSS-1R sphere's interactions with the ionosphere (with T.-Z. Ma), AGU Spring Meeting, Boston, MA, May 19-22, 1998.
372. Monte Carlo simulation of non-Maxwellian ion velocity distributions in the polar wind (with A. R. Barakat), *Invited Talk*, AGU Spring Meeting, Boston, MA, May 19-22, 1998.
373. Plasma modeling status of M-I coupling: An ionospheric perspective (with J. J. Sojka), *Invited Talk*, 1998 CEDAR Meeting, Boulder, CO, June 7-12, 1998.

374. Coupling global numerical models: Ionospheric modeler's perspective, *Invited Talk*, 1998 GEM Meeting, Snowmass, CO, June 15-19, 1998.
375. Ionosphere-thermosphere weather driven by solar wind disturbances (with J. J. Sojka), *Invited Talk*, 1998 Cambridge Workshop on the Physics of Space Plasmas, Cascais, Portugal, June 22 - July 3, 1998.
376. Ionospheric weather resulting from the magnetosphere's response to CMEs (with J. J. Sojka), *Invited Talk*, 1998 Cambridge Workshop on the Physics of Space Plasmas, Cascais, Portugal, June 22 - July 3, 1998.
377. Modeling ionospheric weather, *Invited Talk*, 1998 Western Pacific AGU Meeting, Taipei, Taiwan, July 21-24, 1998.
378. The effects of multiple propagating plasma patches on the polar thermosphere (with T.-Z. Ma), 1998 Western Pacific AGU Meeting, Taipei, Taiwan, July 21-24, 1998.
379. Simulations of ionospheric dynamics for 13 November 1996. I. Driven by observations of the magnetospheric convection and auroral precipitation (with J. J. Sojka, M. D. Bowline, J. B. Sigworth, L. A. Frank, R. A. Greenwald, and J. M. Ruohoniemi), AGU Fall Meeting, San Francisco, CA; December 6-10, 1998.
380. Simulations of ionospheric dynamics for 13 November 1996. II. Driven by an MHD simulation of magnetospheric convection and auroral precipitation (with M. D. Bowline, J. J. Sojka, J. Chen, S. Slinker, and J. Fedder), AGU Fall Meeting, San Francisco, CA; December 6-10, 1998.
381. Ionospheric sensitivity to geomagnetic temporal variability on time scales less than that of the Kp (ap) geomagnetic indices (with D. J. Della-Rose, J. J. Sojka, and L. Zhu), AGU Fall Meeting, San Francisco, CA; December 6-10, 1998.
382. Comparing time-dependent fluid and macroscopic PIC solutions for the polar wind (with H. G. Demars and A. R. Barakat), AGU Fall Meeting, San Francisco, CA; December 6-10, 1998.
383. Effects of wave-particle interactions on the dynamic behavior of the generalized polar wind (with A. R. Barakat), AGU Fall Meeting, San Francisco, CA; December 6-10, 1998.
384. Relationship between the hardness of particle precipitation and the spacing of multiple polar cap arcs (with L. Zhu and J. J. Sojka), AGU Fall Meeting, San Francisco, CA; December 6-10, 1998.
385. The impact of global simulations of the magnetosphere-ionosphere-thermosphere-polar wind system on multi-spacecraft missions, *Invited Talk*, AGU Fall Meeting, San Francisco, CA; December 6-10, 1998.
386. Theoretical developments on the causes of ionospheric outflow, *Invited Talk*, AGU Fall Meeting, San Francisco, CA; December 6-10, 1998.
387. Physical modeling of M-I coupling: Global scale issues (with J. J. Sojka), *Invited Talk*, National Radio Science Meeting, Boulder, CO, January 4-8, 1999.
388. Ionospheric assimilation models (with J. J. Sojka), *Invited Talk*, National Radio Science Meeting, Boulder, CO, January 4-8, 1999.
389. Advances in ionospheric modeling (with J. J. Sojka), *Invited Talk*, 37<sup>th</sup> AIAA Aerospace Sciences Meeting, Reno, NV, January 11-14, 1999.
390. Global assimilation of ionospheric measurements (GAIM), *Invited Talk*, NOAA Space Weather Week, Boulder, CO, April 23, 1999.

391. Correctness of coupled models of the high and mid-latitude ionosphere (with J. J. Sojka), IUGG Meeting, Birmingham, England, July 18-30, 1999.
392. Global assimilation of ionospheric measurements (GAIM), Physics Colloquium, Utah State University, Logan, UT, August 31, 1999.
393. Global assimilation of ionospheric measurements, CIC Meeting, Naval Research Laboratory, Washington, DC, November 15, 1999.
394. Global assimilation of ionospheric measurements (GAIM), AGU Fall Meeting, San Francisco, CA, December 13-17, 1999.
395. Specification of ionospheric weather: A space weather model development (with M. David, J. J. Sojka, and L. Zhu), AGU Fall Meeting, San Francisco, CA, December 13-17, 1999.
396. H-O<sup>+</sup> counterstreaming in the polar region (with H. G. Demars), AGU Fall Meeting, San Francisco, CA, December 13-17, 1999.
397. The propagation of disturbances in the thermosphere created by multiple plasma patches (with T.-Z. Ma), AGU Fall Meeting, San Francisco, CA, December 13-17, 1999.
398. Model study of the ionosphere-originated field-aligned currents and electric field structures (with L. Zhu and J. J. Sojka), AGU Fall Meeting, San Francisco, CA, December 13-17, 1999.
399. Assimilation of ionospheric measurements into a mid-latitude physics model (with D. Thompson and J. J. Sojka), AGU Fall Meeting, San Francisco, CA, December 13-17, 1999.
400. Global assimilation of ionospheric measurements (GAIM), National Radio Science Meeting, Boulder, CO, January 4-8, 2000.
401. Ionospheric data quality issues for ionospheric measurements: A GAIM strategy (with J. J. Sojka and D. Thompson), National Radio Science Meeting, Boulder, CO, January 4-8, 2000.
402. Ionospheric models—Earth, presented at the Yosemite 2000 Meeting on ‘Comparative Aeronomy in the Solar System,’ Yosemite, CA, February 8-11, 2000.
403. Ionospheric climatology and weather, *Tutorial*, presented at the AGU Chapman Conference on “Space Weather: Progress and Challenges in Research and Applications,” Clearwater, Florida, March 20-24, 2000.
404. Model study of ionospheric dynamics during a substorm (with L. Zhu and J. J. Sojka), presented at the AGU Spring Meeting, Washington, DC, May 30-June 3, 2000.
405. Global assimilation of ionospheric measurements (GAIM), *Invited*, Space Weather Week, Boulder, Colorado, May 1-5, 2000.
406. Importance of the convections associated with the reflected Alfvén waves and the ionosphere-originated Alfvén waves in the global M-I coupling (with L. Zhu and J. J. Sojka.), presented at the NSF GEM Meeting, Snowmass, Colorado, June 19-23, 2000.
407. The role of wave-particle interactions on ionosphere-magnetosphere coupling (with A. R. Barakat), 2000 NSF CEDAR Meeting, Boulder, Colorado, June 26-30, 2000.
408. Specification of ionospheric parameters, *Invited*, 2000 NSF CEDAR Meeting, Boulder, Colorado, June 26-30, 2000.
409. Model study of electrodynamics of polar cap arcs (with L. Zhu and J. J. Sojka), presented at the 2000 NSF CEDAR Meeting, Boulder, Colorado, June 26-30, 2000.

410. Recent approaches to modeling ionospheric weather, *Invited Review*, 33<sup>rd</sup> COSPAR Scientific Assembly, Warsaw, Poland, July 16-23, 2000.
411. Ionospheric data assimilation (with L. Scherliess and J. J. Sojka), *Invited*, AGU Fall Meeting, San Francisco, CA, December 15-19, 2000.
412. Impact of storms and substorms on the ionosphere, *Invited*, AGU Fall Meeting, San Francisco, CA, December 15-19, 2000.
413. Effects of low-altitude auroral ion energization on the dynamic behavior of the generalized polar wind (with A. R. Barakat), AGU Fall Meeting, San Francisco, CA, December 15-19, 2000.
414. Ionospheric storm simulation driven by AMIE output, magnetospheric MHD output, and by empirical models, with data comparisons (with C. M. Groves, J. J. Sojka, B. A. Emery, and D. J. Knipp), AGU Fall Meeting, San Francisco, CA, December 15-19, 2000.
415. Solar EUV and auroral generation of the F-region tongue of ionization (with M. David, J. J. Sojka, and R. A. Heelis), AGU Fall Meeting, San Francisco, CA, December 15-19, 2000.
416. Theoretical modeling of global ground magnetic disturbance patterns of substorms (with L. Zhu and J. J. Sojka.), presented at the AGU Fall Meeting, San Francisco, CA, December 15-19, 2000.
417. Ionospheric specification and forecast modeling (with L. Scherliess and J. J. Sojka), 39<sup>th</sup> AIAA Aerospace Sciences Meeting, Reno, NV, January 8-11, 2001.
418. Global assimilation of ionospheric measurements (GAIM), Space Weather Week, Boulder, CO, May 1-4, 2001.
419. Ionospheric mass extraction processes, *Invited*, AGU Spring Meeting, Boston, MA, May 29 – June 2, 2001.
420. Input for decadal survey: Theory, computation, and data exploration, CEDAR Meeting, Longmont, CO, June 17-22, 2001.
421. Data assimilation for the ionosphere, *Invited*, CCMC Workshop, Maui, Hawaii, October 30 – November 2, 2001.
422. Ionosphere-thermospheric metrics, *Invited*, CCMC Workshop, Maui, Hawaii, October 30 – November 2, 2001.
423. Defining structure in tongues of ionization (with C. M. Groves, J. J. Sojka, and D. J. Knipp), presented at the AGU Fall Meeting, San Francisco, CA, December 10-14, 2001.
424. Model study of magnetic disturbances during substorms (with L. Zhu, J. J. Sojka, and J. Liang), presented at the AGU Fall Meeting, San Francisco, CA, December 10-14, 2001.
425. Determination of ionospheric high-latitude drivers for GAIM using DMSP data (with H. A. Bekerat, L. Scherliess, and V. Eccles), presented at the AGU Fall Meeting, San Francisco, CA, December 10-14, 2001.
426. Three-dimensional velocity structure of the polar wind (with H. G. Demars), presented at the AGU Fall Meeting, San Francisco, CA, December 10-14, 2001.
427. A global 3-D Kalman filter for ionospheric data assimilation in GAIM (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the AGU Fall Meeting, San Francisco, CA, December 10-14, 2001.
428. On the determination of the global neutral wind field using TEC observations (with G. Jee and L. Scherliess), presented at the AGU Fall Meeting, San Francisco, CA, December 10-14, 2001.

429. Ionospheric impact of magnetospheric ring current polarization electric fields (with M. David, C. M. Groves, J. J. Sojka, and J. C. Foster), presented at the AGU Fall Meeting, San Francisco, CA, December 10-14, 2001.
430. Will data assimilation techniques open a new frontier for aeronomy? (with J. J. Sojka), *Invited Talk*, presented at the AGU Fall Meeting, San Francisco, CA, December 10-14, 2001.
431. Global assimilation of ionospheric measurements (GAIM) (with L. Scherliess, J. J. Sojka, D. C. Thompson, D. N. Anderson, M. Codrescu, C. Minter, T.-J. Fuller-Rowell, R. A. Heelis, M. Hairston, and B. Howe), presented at the AGU Fall Meeting, San Francisco, CA, December 10-14, 2001.
432. Ionospheric tomography and data assimilation models (with L. Scherliess and J. J. Sojka), presented at the International Union of Radio Science, Boulder, Colorado, January 9-12, 2002.
433. Development of a physics-based reduced state Kalman filter for the ionosphere in GAIM (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the International Union of Radio Science, Boulder, Colorado, January 9-12, 2002.
434. Determining a 'break-even' point for Kalman data assimilation in the ionosphere (with J. J. Sojka, L. Scherliess, and D. C. Thompson), presented at the International Union of Radio Science, Boulder, Colorado, January 9-12, 2002.
435. Global Assimilation of Ionospheric Measurements (GAIM), presented at NOAA Space Environment Center, Boulder, Colorado, February 14, 2002.
436. Global Assimilation of Ionospheric Measurements (GAIM), presented at the Air Force Weather Agency, Offut Air Force Base, Omaha, Nebraska, March 21, 2002.
437. Global Assimilation of Ionospheric Measurements (GAIM) (with L. Scherliess, J. J. Sojka, D. C. Thompson, D. N. Anderson, M. Codrescu, C. Minter, T. J. Fuller-Rowell, R. A. Heelis, M. Hairston, and B. Howe), presented at Space Weather Week, Boulder, Colorado, April 16-19, 2002.
438. Ionospheric assimilation techniques for ARGOS LORAAS tomographically reconstructed equatorial electron density profiles (with J. J. Sojka, V. Eccles, S. Thonnard, and S. McDonald), presented at the Ionospheric Effects Symposium 2002, Alexandria, VA, May 7-9, 2002.
439. Global Assimilation of Ionospheric Measurements (GAIM) (with L. Scherliess, J. J. Sojka, D. C. Thompson, D. N. Anderson, M. Codrescu, C. Minter, T. J. Fuller-Rowell, R. A. Heelis, M. Hairston, and B. Howe), presented at the Ionospheric Effects Symposium 2002, Alexandria, VA, May 7-9, 2002.
440. Development of a physics-based reduced state Kalman filter for the ionosphere in GAIM (with L. Scherliess, J. J. Sojka, and D. Thompson), presented at the Ionospheric Effects Symposium 2002, Alexandria, VA, May 7-9, 2002.
441. MURI Update on Data Assimilation, *Invited Talk*, presented at the CEDAR Meeting, Longmont, Colorado, June 16-21, 2002.
442. MURI Global Assimilation of Ionospheric Measurements (GAIM) Program Update, *Invited Talk*, presented at the COSMIC Meeting, Boulder, Colorado, August 22, 2002.
443. A physics-based Kalman filter for the ionosphere (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the COSPAR Meeting, Houston, Texas, October 16-18, 2002.
444. Application of data assimilation techniques for ionospheric prediction (with L. Scherliess), presented at the COSPAR Meeting, Houston, Texas, October 16-18, 2002.
445. A modeling study of the ionospheric response to SAPS (with M. David, J. J. Sojka, J. C. Foster, and H. B. Vo), presented at the 2002 Fall AGU Meeting, San Francisco, California, December 6-10, 2002.

446. The closure of the Hall currents during substorms and its ground magnetic effects (with L. Zhu and J. J. Sojka), presented at the 2002 Fall AGU Meeting, San Francisco, California, December 6-10, 2002.
447. Effect of equatorial plasma bubbles on the thermosphere (with H. G. Demars), presented at the 2002 Fall AGU Meeting, San Francisco, California, December 6-10, 2002.
448. Aeronomy: from exploration to data assimilation, *Invited*, presented at the 2002 Fall AGU Meeting, San Francisco, California, December 6-10, 2002.
449. Seasonal and solar activity dependence of the generalized polar wind with low-altitude auroral ion energization (with A. R. Barakat and H. G. Demars), presented at the 2002 Fall AGU Meeting, San Francisco, California, December 6-10, 2002.
450. On using the Weimer statistical model for real-time ionospheric specifications and forecasts (with H. A. Bekerat and L. Scherliess), presented at the 2002 Fall AGU Meeting, San Francisco, California, December 6-10, 2002.
451. The analysis of TEC data from the TOPEX/Poseidon mission (with G. Jee), presented at the 2002 Fall AGU Meeting, San Francisco, California, December 6-10, 2002.
452. Ionospheric sensitivity to different representations of EUV spectra (with C. Smithro, J. J. Sojka, and J. Lean), presented at the 2002 Fall AGU Meeting, San Francisco, California, December 6-10, 2002.
453. Penetration electric field observations and modeling in the pre-noon mid-latitude ionosphere (with S. M. Nolin, D. J. Della-Rose, J. J. Sojka, M. David, and F. T. Berkey), presented at the 2002 Fall AGU Meeting, San Francisco, California, December 6-10, 2002.
454. Data assimilation into physics-based models via Kalman filters (with L. Scherliess and J. J. Sojka), *Invited*, presented at the 2002 Fall AGU Meeting, San Francisco, California, December 6-10, 2002.
455. Resolving MIT electrodynamic processes by analyzing GEC data streams (with J. J. Sojka, M. David, L. Zhu, and T. J. Fuller-Rowell), presented at the 2002 Fall AGU Meeting, San Francisco, California, December 6-10, 2002.
456. A physics-based Kalman filter for the ionosphere in GAIM (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the 2002 Fall AGU Meeting, San Francisco, California, December 6-10, 2002.
457. Global Assimilation of Ionospheric Measurements (GAIM), Seminar, presented at the Air Force Research Laboratory, Hanscom Air Force Base, Massachusetts, March 4, 2003.
458. Ionospheric data assimilation (with L. Scherliess, J. Sojka, and D. Thompson), presented at the EGS-AGU-EUG Joint Assembly, Nice, France, April 6-11, 2003.
459. Storm-time behavior of the generalized polar wind (with A. R. Barakat), presented at the EGS-AGU-EUG Joint Assembly, Nice, France, April 6-11, 2003.
460. How will GEC resolve MIT structures? (with J. J. Sojka, M. David, and T.-J. Fuller-Rowell), presented at the EGS-AGU-EUG Joint Assembly, Nice, France, April 6-11, 2003.
461. Initial validation of 3-D ionospheric plasma densities in GAIM (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the EGS-AGU-EUG Joint Assembly, Nice, France, April 6-11, 2003.
462. Global Assimilation of Ionospheric Measurements (GAIM) (with L. Scherliess, J. J. Sojka, D. C. Thompson, D. N. Anderson, M. Codrescu, C. Minter, T. J. Fuller-Rowell, R. A. Heelis, M. Hairston, and B. M. Howe), *Invited Talk*, presented at Space Weather Week, Boulder, Colorado, May 19-22, 2003.
463. Evaluation of statistical convection patterns for real-time ionospheric specifications and forecasts (with H. A. Bekerat and L. Scherliess), presented at Space Weather Week, Boulder, Colorado, May 19-22, 2003.

464. Initial validation of 3-D ionospheric plasma densities in GAIM (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at Space Weather Week, Boulder, Colorado, May 19-22, 2003.
465. GAIM Validation and steps toward a storm-time VTEC empirical model (with E. A. Araujo-Pradere, T. J. Fuller-Rowell, P. S. Spencer, L. Scherliess, D. C. Thompson, and J. J. Sojka), presented at Space Weather Week, Boulder, Colorado, May 19-22, 2003.
466. Global Assimilation of Ionospheric Measurements (GAIM) (with L. Scherliess, J. J. Sojka, D. C. Thompson, D. N. Anderson, M. Codrescu, C. Minter, T. J. Fuller-Rowell, R. A. Heelis, M. Hairston, and B. M. Howe), *Invited Talk*, presented at the CEDAR Meeting, Longmont, Colorado, June 17-20, 2003.
467. Data assimilation for the global ionosphere, *Invited Talk*, presented at the IUGG 2003 General Assembly, Sapporo, Japan, June 30-July 11, 2003.
468. Ionospheric data assimilation in GAIM (with L. Scherliess, J. J. Sojka, and D. C. Thompson), *Invited Talk*, presented at the IUGG 2003 General Assembly, Sapporo, Japan, June 30-July 11, 2003.
469. Global Assimilation of Ionospheric Measurements (GAIM) (with L. Scherliess, J. J. Sojka, D. C. Thompson, D. N. Anderson, M. Codrescu, C. Minter, T. J. Fuller-Rowell, R. A. Heelis, M. Hairston, and B. M. Howe), presented at the IUGG 2003 General Assembly, Sapporo, Japan, June 30-July 11, 2003.
470. Improvements in global ionospheric specification using ionospheric occultation measurements (with P. C. Anderson, P. R. Straus, L. Scherliess, and J. J. Sojka), presented at the IUGG 2003 General Assembly, Sapporo, Japan, June 30-July 11, 2003.
471. New insights into a thermospheric wind influence on the high-latitude F-region (with J. J. Sojka, M. David, and A. van Eyken), presented at the EISCAT Workshop, SRI, Palo Alto, California, August 22-28, 2003.
472. Mid-latitude ISR observations at Millstone Hill raise questions about how modelers describe the thermospheric wind (with M. David, J. J. Sojka, and J. M Holt), presented at the EISCAT Workshop, SRI, Palo Alto, California, August 22-28, 2003.
473. Global Assimilation of Ionospheric Measurements (GAIM) (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the CCMC Workshop, Maui, Hawaii, October 28-31, 2003.
474. Ionospheric Metrics, presented at the CCMC Workshop, Maui, Hawaii, October 28-31, 2003.
475. Ionospheric Data Assimilation (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the CCMC Workshop, Maui, Hawaii, October 28-31, 2003.
476. Global Assimilation of Ionospheric Measurements (GAIM) (with L. Scherliess, J. J. Sojka, D. C. Thompson, D. N. Anderson, M. Codrescu, C. Minter, T. J. Fuller-Rowell, R. A. Heelis, M. Hairston, and B. M. Howe), presented at the 2003 Fall AGU Meeting, San Francisco, California, December 8-12, 2003.
477. Hazards of coupling models of different physical and regional properties: Sun-Earth EUV link (with J. J. Sojka, M. David, and C. Smithtro), presented at the 2003 Fall AGU Meeting, San Francisco, California, December 8-12, 2003.
478. Effect of the theta aurora on the polar thermosphere (with H. G. Demars), presented at the 2003 Fall AGU Meeting, San Francisco, California, December 8-12, 2003.
479. The neutral polar wind (with L. Gardner), presented at the 2003 Fall AGU Meeting, San Francisco, California, December 8-12, 2003.
480. Active role of the ionosphere in M-I coupling (with L. Zhu and J. J. Sojka), presented at the 2003 Fall AGU Meeting, San Francisco, California, December 8-12, 2003.
481. On the effect of modified high-latitude drivers (convection and precipitation) on the ionospheric plasma density distribution (with H. Bekerat, L. Scherliess, and V. Eccles),

- presented at the 2003 Fall AGU Meeting, San Francisco, California, December 8-12, 2003.
482. Comparison of IRI-2001 with TOPEX TEC measurements (with G. Jee and L. Scherliess), presented at the 2003 Fall AGU Meeting, San Francisco, California, December 8-12, 2003.
  483. Comparison of 30-day continuous EISCAT Svalbard ISR data with an ionospheric model driven by SuperDARN convection patterns (with M. David, J. J. Sojka, R. A. Greenwald, and T. van Eyken), presented at the 2003 Fall AGU Meeting, San Francisco, California, December 8-12, 2003.
  484. Observation and modeling of ionospheric dynamics during major solar flares (with C. Smithtro, T. Berkey, D. Thompson, and J. J. Sojka), presented at the 2003 Fall AGU Meeting, San Francisco, California, December 8-12, 2003.
  485. The USU GAIM data assimilation model for the ionosphere (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the 2003 Fall AGU Meeting, San Francisco, California, December 8-12, 2003.
  486. Global Assimilation of Ionospheric Measurements (GAIM) (with L. Scherliess, J. J. Sojka, D. C. Thompson, D. N. Anderson, M. Codrescu, C. Minter, T. J. Fuller-Rowell, R. A. Heelis, M. Hairston, and B. M. Howe), presented at the 2004 National Radio Science Meeting, Boulder, Colorado, January 5-10, 2004.
  487. Global Assimilation of Ionospheric Measurements (GAIM) (with L. Scherliess, J. J. Sojka, D. C. Thompson, D. N. Anderson, M. Codrescu, C. Minter, T. J. Fuller-Rowell, R. A. Heelis, M. Hairston, and B. M. Howe), *Invited Talk*, presented at the Symposium on Space Weather, American Meteorological Society, Seattle, Washington, January 11-15, 2004.
  488. Global Assimilation of Ionospheric Measurements (USU GAIM) (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the Air Force Weather Agency, Omaha, Nebraska, March 17, 2004.
  489. USU GAIM: The need for real-time neutral wind measurements (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the Passive Optics Workshop, Boulder, Colorado, April 8, 2004.
  490. Global Assimilation of Ionospheric Measurements: USU GAIM (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at Space Weather Week, Boulder, Colorado, April 16, 2004.
  491. Data assimilation studies of the equatorial ionosphere using the USU GAIM model (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at AGU Spring Meeting, Montreal, Canada, May 16-21, 2004.
  492. 3-D dynamic behavior of the generalized polar wind with low-altitude auroral ion energization (with A. R. Barakat), presented at AGU Spring Meeting, Montreal, Canada, May 16-21, 2004.
  493. The 3-D extended ionosphere, *Invited Tutorial*, presented at the GEM Workshop, Snowmass, Colorado, June 21-25, 2004.
  494. Ionospheric data assimilation and forecasting methods (with L. Scherliess, J. J. Sojka, and D. C. Thompson), *Invited Talk*, presented at the 2004 CEDAR Workshop, Santa Fe, New Mexico, June 27-July 2, 2004.
  495. Data sources for ionospheric data assimilation models (with L. Scherliess, J. J. Sojka, and D. C. Thompson), *Invited Talk*, presented at the 2004 CEDAR Workshop, Santa Fe, New Mexico, June 27-July 2, 2004.
  496. Comparison of one year of DMSP F13 cross-track ion drift velocities with real-time AMIE results (with H. Bekerat, L. Scherliess, and A. Ridley), presented at the 2004 CEDAR Workshop, Santa Fe, New Mexico, June 27-July 2, 2004.

497. Comparison of IRI-2001 with TOPEX TEC measurements (with G. Jee and L. Scherliess), presented at the 2004 CEDAR Workshop, Santa Fe, New Mexico, June 27-July 2, 2004.
498. Neutral polar wind (with L. Gardner), presented at the 2004 CEDAR Workshop, Santa Fe, New Mexico, June 27-July 2, 2004.
499. TDIM model studies for the October-November 2002 HLPS campaign (with J. J. Sojka, L. Zhu, and M. David), presented at the 2004 CEDAR Workshop, Santa Fe, New Mexico, June 27-July 2, 2004.
500. USU GAIM: A global ionospheric data assimilation model (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the 35<sup>th</sup> COSPAR Scientific Assembly, Paris, France, July 18-25, 2004.
501. Specification of the global ionosphere using the USU GAIM data assimilation model (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the 35<sup>th</sup> COSPAR Scientific Assembly, Paris, France, July 18-25, 2004.
502. Recent developments in ionosphere-thermosphere modeling with an emphasis on solar variability (with J. J. Sojka and C. Smithtro), presented at the 35<sup>th</sup> COSPAR Scientific Assembly, Paris, France, July 18-25, 2004.
503. The neutral polar wind (with L. Gardner), presented at the 35<sup>th</sup> COSPAR Scientific Assembly, Paris, France, July 18-25, 2004.
504. Propagating polar wind jets (with H. G. Demars and J. J. Sojka), presented at the 35<sup>th</sup> COSPAR Scientific Assembly, Paris, France, July 18-25, 2004.
505. USU global ionospheric data assimilation model (with L. Scherliess, J. J. Sojka, and D. C. Thompson), *Invited Talk*, presented at the Space Weather Symposium, Optical Science and Technology, SPIE 49<sup>th</sup> Annual Meeting, Denver, Colorado, August 2-6, 2004.
506. Ionosphere Tutorial, *Invited*, three 1.5-hour lectures presented at the Radar Workshop at the Arecibo Observatory, Arecibo, Puerto Rico, August 16-18, 2004.
507. Global Assimilation of Ionospheric Measurements (USU GAIM): Overview (August 23) and Validation (August 24) (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the SUMMIT-II Meeting at the Air Force Weather Agency, Omaha, Nebraska, August 23-24, 2004.
508. Polar wind/ion outflow, *Invited Talk*, presented at the CISM Meeting, Boston, Massachusetts, September 20-22, 2004.
509. Global Assimilation of Ionospheric Measurements (USU GAIM), *Invited Talk*, presented at the CISM Meeting, Boston, Massachusetts, September 20-22, 2004.
510. 3-D neutral polar wind (with L. C. Gardner), presented at the Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.
511. Seasonal and solar cycle variation of polar cap patches (with H. G. Demars), presented at the Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.
512. Comparison of DMSP F13 cross-track ion drift velocities with AMIE results (with H. A. Bekerat, L. Scherliess, and A. Ridley), presented at the Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.
513. USU GAIM: An operational data assimilation model of the ionosphere (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.
514. Relative abundance and escape flux composition during storm time: 3-D model (with H. Gajulapalle and A. R. Barakat), presented at the Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.
515. USU GAIM: Validation of the Ionospheric Forecast Model (IFM) using TOPEX TEC measurements (with L. Zhu, G. Jee, L. Scherliess, J. J. Sojka, and D. C. Thompson),

- presented at the Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.
516. Day-to-day variability of the F-layer at sunrise (with M. David, J. J. Sojka, and J. M. Holt), presented at the Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.
  517. Validation of the USU GAIM data assimilation model of the ionosphere (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.
  518. Assimilated low latitude ionospheric variability during the first CAWSES space weather campaign (with J. J. Sojka, L. Scherliess, and D. C. Thompson), presented at the Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.
  519. On the sensitivity of Total Electron Content (TEC) to upper atmospheric/ionospheric parameters (with G. Jee and L. Scherliess), presented at the Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.
  520. Multi-instrument observations of the development of the equatorial ionization anomaly and links to scintillation (with S. E. McDonald, S. Basu, S. Basu, K. Groves, L. Scherliess, D. C. Thompson, J. J. Sojka, and L. Zhu), presented at the Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.
  521. Comparison between GAIM and LLIONS in the Jicamarca low latitude sector during the first CAWSES space weather campaign (with D. N. Anderson, A. Anghel, J. J. Sojka, L. Scherliess, D. C. Thompson, and V. Eccles), presented at the Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.
  522. Data availability and its effect on the USU GAIM data assimilation model (with D. C. Thompson, L. Scherliess, J. J. Sojka, and L. Zhu), presented at the Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.
  523. Data assimilation for the global ionosphere, Seminar, presented in the Mechanical and Aerospace Engineering Department, Utah State University, November 22, 2004.
  524. Global Assimilation of Ionospheric Measurements (GAIM): An operational space weather model (with L. Scherliess, J. J. Sojka, and D. C. Thompson), *Invited*, presented at the 85<sup>th</sup> American Meteorological Society Annual Meeting, January 9-13, 2005, San Diego, California.
  525. Data assimilation for the global ionosphere, *Invited*, presented at the Royal Observatory of Belgium, March 18, 2005, Brussels, Belgium.
  526. The global ionosphere, *Invited Tutorial*, presented at the RF Ionospheric Interactions Workshop, April 17, 2005, Santa Fe, New Mexico.
  527. Thermospheric weather due to mesoscale ionospheric structures (with H. G. Demars), presented at the Ionospheric Effects Symposium, May 35, 2005, Alexandria, Virginia.
  528. Extreme longitudinal variability of plasma structuring in the equatorial ionosphere on a magnetically quiet equinoctial day (S. E. McDonald, Sunanda Basu, Santi Basu, K. Groves, C. E. Valladares, L. Scherliess, D. C. Thompson, R. W. Schunk, J. J. Sojka, and L. Zhu), presented at the Ionospheric Effects Symposium, May 35, 2005, Alexandria, Virginia.
  529. An operational data assimilation model of the global ionosphere (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the Ionospheric Effects Symposium, May 35, 2005, Alexandria, Virginia.
  530. Validation of the Ionosphere Forecast Model (IFM) using the TOPEX TEC measurements (with L. Zhu, G. Jee, L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the Ionospheric Effects Symposium, May 35, 2005, Alexandria, Virginia.

531. Observation and modeling of mid-latitude ionospheric dynamics during solar x-ray flares (with C. Smithtro, T. Berkey, D. C. Thompson, J. J. Sojka, and R. W. Schunk), presented at the Ionospheric Effects Symposium, May 35, 2005, Alexandria, Virginia.
532. Global neutral polar wind model (with L. C. Gardner), presented at the 2005 Joint Assembly of the American Geophysical Union, May 23-27, 2005, New Orleans, Louisiana.
533. Comparison of the USU GAIM ionospheric plasma densities with Arecibo ISR observations (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the 2005 Joint Assembly of the American Geophysical Union, May 23-27, 2005, New Orleans, Louisiana.
534. An operational data assimilation model of the global ionosphere (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), *Invited Talk*, presented at the 10<sup>th</sup> IAGA Scientific Assembly, July 18-29, 2005, Toulouse, France,
535. The USU GAIM physics-based data assimilation model of the ionosphere (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the 10<sup>th</sup> IAGA Scientific Assembly, July 18-29, 2005, Toulouse, France,
536. Ion and neutral polar winds for northward interplanetary magnetic field conditions (with L. C. Gardner), presented at the 10<sup>th</sup> IAGA Scientific Assembly, July 18-29, 2005, Toulouse, France,
537. Ionospheric physics and data assimilation, Physics Colloquium, presented for the Department of Physics, Utah State University, September 27, 2005, Logan, Utah.
538. Thermospheric response to ion heating in the dayside cusp (with H. G. Demars), presented at the Fall Meeting of the American Geophysical Union, December 5-9. 2005, San Francisco, California.
539. Mesoscale ionosphere-thermosphere structures and consequences for the magnetosphere, *Invited Talk*, presented at the Fall Meeting of the American Geophysical Union, December 5-9. 2005, San Francisco, California.
540. Aeronomy: Challenges of Data Assimilation (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), *Invited Talk*, presented at the Fall Meeting of the American Geophysical Union, December 5-9. 2005, San Francisco, California.
541. Three-dimensional simulation of high-latitude ionospheric neutral and ion outflows during magnetic storm conditions, and northward turning of the Interplanetary Magnetic Field (with L. Gardner), presented at the Fall Meeting of the American Geophysical Union, December 5-9. 2005, San Francisco, California.
542. Estimation of the high-latitude topside heat flux using DMSP in situ plasma densities (with H. Bekerat and L. Scherliess), presented at the Fall Meeting of the American Geophysical Union, December 5-9. 2005, San Francisco, California.
543. Initializing the TING model with GAIM electron densities during a geomagnetic storm (with G. Jee, W. Wang, A. G. Burns, S. Solomon, L. Scherliess, D. Thompson, and J. J. Sojka), presented at the Fall Meeting of the American Geophysical Union, December 5-9. 2005, San Francisco, California.
544. Ionospheric indices based on GPS TEC (with C. Noguera, J. J. Sojka, and D. C. Thompson), presented at the Fall Meeting of the American Geophysical Union, December 5-9. 2005, San Francisco, California.
545. Active role of the ionosphere in the electrodynamic M-I coupling (with L. Zhu and J. J. Sojka), presented at the Fall Meeting of the American Geophysical Union, December 5-9. 2005, San Francisco, California.
546. The longitude dependence of the mid-latitude ionospheric effect of large geomagnetic storms (with M. David and J. J. Sojka), presented at the Fall Meeting of the American Geophysical Union, December 5-9. 2005, San Francisco, California.

547. Comparison of nighttime UV radiances from the USU GAIM data assimilation model with limb scan observations from the LORAAS and SSULI instruments (with L. Scherliess, J. J. Sojka, D. C. Thompson, L. Zhu, P. Dandenault, S. A. Budzien, and S. E. Thonnard), presented at the Fall Meeting of the American Geophysical Union, December 5-9, 2005, San Francisco, California.
548. Challenges and opportunities for ionospheric-thermospheric research (with P. Kintner et al.), presented at the Fall Meeting of the American Geophysical Union, December 5-9, 2005, San Francisco, California.
549. A data assimilation model of the ionosphere, 86<sup>th</sup> Annual Meeting, American Meteorological Society, 29 January-2 February, 2006, Atlanta, Georgia.
550. Data assimilation models for specifications and forecasts (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), *Invited Talk*, Presented at Space Weather Week, 25-28 April 2006, Boulder, Colorado.
551. Ionospheric research at USU (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), *Invited Talk*, University of New Mexico, 16 May 2006, Albuquerque, New Mexico.
552. Data assimilation panel discussion, Panel Presentation, CEDAR Workshop, 19-23 June 2006, Santa Fe, New Mexico.
553. Three-dimensional high-resolution, storm-time simulation of the ion and neutral polar winds (with L. C. Gardner), CEDAR Workshop, 19-23 June 2006, Santa Fe, New Mexico.
554. Ionosphere: Past, Present and Future Problems, *Invited Tutorial*, CEDAR Workshop, 19-23 June 2006, Santa Fe, New Mexico.
555. IT status, *Invited Talk*, presented at the International Living with a Star (ILWS) Meeting, 23 July 2006, Beijing, China.
556. Ionosphere-thermosphere weather at middle and low latitudes, *Keynote Talk*, 36<sup>th</sup> COSPAR Scientific Assembly, 16-23 July 2006, Beijing, China.
557. Magnetosphere-ionosphere-thermosphere coupling at high latitudes via plasma structures, *Invited Talk*, 36<sup>th</sup> COSPAR Scientific Assembly, 16-23 July 2006, Beijing, China.
558. Magnetosphere-ionosphere-thermosphere coupling on a range of spatial scales, *Invited Talk*, Huntsville 2006 Workshop, 2-6 October 2006, Nashville, Tennessee.
559. Spatial correlations of day-to-day ionospheric total electron content variability obtained from ground-based GPS (with J. Shim, L. Scherliess, and D. C. Thompson), presented at the 2006 Fall AGU Meeting, 11-15 December 2006, San Francisco, California.
560. The operational USU GAIM model (with D. C. Thompson, L. Scherliess, and J. J. Sojka), presented at the 2006 Fall AGU Meeting, 11-15 December 2006, San Francisco, California.
561. An ionospheric metric study using operational models (with J. J. Sojka, D. C. Thompson, L. Scherliess, and T. J. Harris), presented at the 2006 Fall AGU Meeting, 11-15 December 2006, San Francisco, California.
562. Storm-time dynamic response of high-latitude plasma outflow: A 3-D mac-PIC model (with A. R. Barakat), presented at the 2006 Fall AGU Meeting, 11-15 December 2006, San Francisco, California.
563. Ion and neutral atom outflow structure in the high-latitude ionosphere (with L. C. Gardner), presented at the 2006 Fall AGU Meeting, 11-15 December 2006, San Francisco, California.
564. Strengths and limitations of data assimilation models (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the 2006 Fall AGU Meeting, 11-15 December 2006, San Francisco, California.

565. A physics-based Kalman filter electrodynamics model for the high-latitude ionosphere (with L. Zhu, L. Scherliess, V. Eccles, and J. J. Sojka), presented at the 2006 Fall AGU Meeting, 11-15 December 2006, San Francisco, California.
566. Day-to-day variability in the post-sunrise F-layer at Millstone Hill during three month-long ISR campaigns (with M. David, J. J. Sojka, and J. M. Holt), presented at the 2006 Fall AGU Meeting, 11-15 December 2006, San Francisco, California.
567. Supersonic flow in the high-latitude thermosphere (with H. G. Demars), presented at the 2006 Fall AGU Meeting, 11-15 December 2006, San Francisco, California.
568. Ionospheric/thermospheric variability at middle latitudes obtained from the global assimilation of ionospheric measurements (GAIM) model (with L. Scherliess, D. C. Thompson, and J. J. Sojka), presented at the 2006 Fall AGU Meeting, 11-15 December 2006, San Francisco, California.
569. Continual initialization of the TING model with GAIM electron densities: Ionospheric effects on the thermosphere (with G. Jee, A. Burns, W. Wang, S. C. Solomon, L. Scherliess, D. C. Thompson, J. J. Sojka, and L. Zhu), presented at the 2006 Fall AGU Meeting, 11-15 December 2006, San Francisco, California.
570. A thermosphere-ionosphere data assimilation model component for a seamless ocean-atmosphere model (with L. Scherliess, D. C. Thompson, J. J. Sojka, and L. Zhu), presented at the Fourth Symposium on Space Weather, AMS Meeting, 15-16 January 2007, San Antonio, Texas.
571. USU GAIM: An operational data assimilation model of the ionosphere (with L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the Fourth Symposium on Space Weather, AMS Meeting, 15-16 January 2007, San Antonio, Texas.
572. A thermosphere-ionosphere data assimilation model component for a seamless ocean-atmosphere model (with L. Scherliess, D. C. Thompson, J. J. Sojka, and L. Zhu), presented at the Defense Threat Reduction Agency (DTRA), 24 January 2007, Washington, DC.
573. Global assimilation of ionospheric measurements (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the Air Force Weather Agency, 7-9 March 2007, Omaha, Nebraska.
574. The full physics-based GAIM Model (with the GAIM team), presented at the Air Force Weather Agency, 7-9 March 2007, Omaha, Nebraska.
575. Operational data assimilation models for ionosphere specifications and forecasts (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the Space Weather Workshop, 24-27 April 2007, Boulder, Colorado.
576. Challenges associated with data assimilation models (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), *Invited Talk*, presented at the GEM Workshop, 21 June 2007, Midway, Utah.
577. A thermosphere-ionosphere-plasmasphere data assimilation model component for a seamless ocean-atmosphere model (with H. G. Demars, L. Gardner, L. Scherliess, J. J. Sojka, and D. C. Thompson), presented at the CEDAR Workshop, 25-29 June 2007, Santa Fe, New Mexico.
578. Neutral density holes, fountains, and supersonic winds associated with magnetic field influences (with H. G. Demars), *Invited Talk*, presented at the IAGA Symposium, 2-7 July 2007, Perugia, Italy.
579. Global assimilation of ionospheric measurements: Strengths and limitations (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), *Invited Talk*, presented at the IAGA Symposium, 2-7 July 2007, Perugia, Italy.
580. Data sources needed for data assimilation modeling of the equatorial ionosphere (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), *Invited Talk*, presented at the IAGA Symposium, 2-7 July 2007, Perugia, Italy.

581. Center for Space Weather (with L. Zhu), Space Dynamics Laboratory, Utah State University, 19 July 2007, Logan, Utah.
582. USU GAIM models (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the USU Data Assimilation Meeting, 25-26 September 2007, Logan, Utah.
583. A physics-based Kalman filter electrodynamics model for the high-latitude ionosphere (with L. Scherliess, L. Zhu, and V. Eccles), presented at the USU Data Assimilation Meeting, 25-26 September 2007, Logan, Utah.
584. Data assimilation models for ionosphere specifications and forecasts (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), *Invited Talk*, presented at FORMOSAT-3/COSMIC Data Users Workshop, 22-24 October 2007, Boulder, Colorado.
585. USU data assimilation models (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the CCMC Workshop, 5-8 November 2007, Arecibo, Puerto Rico.
586. A thermosphere-ionosphere data assimilation model component for a seamless ocean-atmosphere model (with L. Gardner, L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the DTRA Meeting, 19 November 2007, Lorton, Virginia.
587. Pulsating ion and neutral winds (with L. C. Gardner), presented at the 2007 Fall AGU Meeting, 9-14 December 2007, San Francisco, California.
588. The effect of downward electron heat flow and electron cooling processes in the high-latitude ionosphere (with M. David and J. J. Sojka), presented at the 2007 Fall AGU Meeting, 9-14 December 2007, San Francisco, California.
589. Ionospheric longitude storm dependence upon the magnitude of the Earth's magnetic field (with J. J. Sojka and M. David), presented at the 2007 Fall AGU Meeting, 9-14 December 2007, San Francisco, California.
590. Modeling supersonic flow in the high-latitude thermosphere (with H. G. Demars), presented at the 2007 Fall AGU Meeting, 9-14 December 2007, San Francisco, California.
591. Longitudinal variability of low-latitude total electron content: Tidal influences (with L. Scherliess and D. C. Thompson), presented at the 2007 Fall AGU Meeting, 9-14 December 2007, San Francisco, California.
592. Neutral density holes, patches, fountains, and jets in the Earth's upper atmosphere (with H. G. Demars), presented at the 2007 Fall AGU Meeting, 9-14 December 2007, San Francisco, California.
593. Using PFISR to enable high-latitude modeling to separate climate and weather in the ionospheric variability studies (with J. J. Sojka and M. David), *Invited Talk*, presented at the 2007 Fall AGU Meeting, 9-14 December 2007, San Francisco, California.
594. The role of electromagnetic waves in magnetosphere-ionosphere coupling (with L. Zhu and J. J. Sojka), *Invited Talk*, presented at the 2007 Fall AGU Meeting, 9-14 December 2007, San Francisco, California.
595. Testing conventional assumptions for high-latitude electrodynamics by using a self-consistent M-I coupling model (with L. Zhu and J. J. Sojka), presented at the 2007 Fall AGU Meeting, 9-14 December 2007, San Francisco, California.
596. Specification of ionospheric dynamics at low- and mid-latitude using the Global Assimilation of Ionospheric Measurements (GAIM) Model (with D. C. Thompson, L. Scherliess, and J. J. Sojka), presented at the 2007 Fall AGU Meeting, 9-14 December 2007, San Francisco, California.
597. IFM-modeled response of the high-latitude ionosphere to auroral dynamics based on auroral observations acquired with the Visible Imaging System (VIS) on the Polar spacecraft (with H. Bekerat, J. Sigwarth, and V. Eccles), presented at the 2007 Fall AGU Meeting, 9-14 December 2007, San Francisco, California.

598. Monte Carlo vs transport equations' description of outflowing fully-ionized ionospheric plasma (with A. R. Barakat), presented at the 2007 Fall AGU Meeting, 9-14 December 2007, San Francisco, California.
599. Seamless ocean-atmosphere model – effect of upward propagating waves on the thermosphere and ionosphere (with L. C. Gardner, L. Scherliess, D. C. Thompson, and J. J. Sojka), presented at the American Meteorological Society, 20-25 January 2008, New Orleans, Louisiana.
600. Global Assimilation of Ionospheric Measurements (GAIM) (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the Air Force Weather Agency, 5 March 2008, Omaha, Nebraska.
601. Data assimilation models for ionospheric specifications and forecasts (with L. Scherliess, D. C. Thompson, J. J. Sojka, and L. Zhu), *Invited Talk*, presented at Space Weather Workshop, 29 April – 2 May 2008, Boulder, Colorado.
602. Specification of ionospheric dynamics and drivers using the GAIM physics-based data assimilation model (with L. Scherliess and D. C. Thompson), presented at the 2008 Ionospheric Effects Symposium, 13-15 May 2008, Alexandria, Virginia.
603. Modeling and consequences of supersonic winds in the thermosphere (with H. G. Demars), presented at the 2008 Ionospheric Effects Symposium, 13-15 May 2008, Alexandria, Virginia.
604. Effect of lower atmospheric waves on the ionosphere and thermosphere (with L. Gardner, L. Scherliess, D. C. Thompson, and J. J. Sojka), presented at the 2008 Ionospheric Effects Symposium, 13-15 May 2008, Alexandria, Virginia.
605. Upper ionosphere effects on the assimilation of GPS slant TEC (with D. C. Thompson, L. Scherliess, and J. J. Sojka), presented at the 2008 Ionospheric Effects Symposium, 13-15 May 2008, Alexandria, Virginia.
606. Ion and neutral streams in the ionosphere and plasmasphere (with L. Gardner), presented at the 2008 Ionospheric Effects Symposium, 13-15 May 2008, Alexandria, Virginia.
607. Data assimilation models for Space Weather (R. W. Schunk, L. Scherliess, D. C. Thompson, J. J. Sojka, and L. Zhu), *Invited Talk*, presented at the workshop on “Solar Variability, Earth’s Climate and the Space Environment,” 1-6 June 2008, Bozeman, Montana.
608. Space Weather Modeling Program, *Invited Talk*, presented at the Community Modeling Workshop, 22 June 2008, Midway, Utah.
609. Ionosphere-thermosphere issues, *Invited Talk*, presented at the CEDAR Workshop, 16-21 June 2008, Midway, Utah.
610. Ion and neutral outflow, *Invited Talk*, presented at the CEDAR Workshop, 16-21 June 2008, Midway, Utah.
611. Effect of lower atmosphere waves on the thermosphere (with L. Gardner, L. Scherliess, D. C. Thompson, and J. J. Sojka), *Invited Talk*, presented at the CEDAR Workshop, 16-21 June 2008, Midway, Utah.
612. Ionosphere-thermosphere perturbations due to lower atmospheric waves (R. W. Schunk, L. Gardner, L. Scherliess, D. C. Thompson, and J. J. Sojka), *Invited Talk*, presented at the 37<sup>th</sup> COSPAR Scientific Assembly, 13-20 July 2008, Montreal, Quebec, Canada.
613. Effect of lower atmospheric gravity waves on equatorial electric fields (C. Wohllwend, J. V. Eccles, and R. W. Schunk), presented at the 37<sup>th</sup> COSPAR Scientific Assembly, 13-20 July 2008, Montreal, Quebec, Canada.

614. Study of atmosphere gravity wave seeding of plasma plumes associated with equatorial Spread F (J. V. Eccles, C. S. Wohlwend, and R. W. Schunk), presented at the 37<sup>th</sup> COSPAR Scientific Assembly, 13-20 July 2008, Montreal, Quebec, Canada.
615. Advanced solar irradiances applied to satellite and ionospheric operational systems (with W. K. Tobiska, J. V. Eccles, and D. Bouwer), presented at the 37<sup>th</sup> COSPAR Scientific Assembly, 13-20 July 2008, Montreal, Quebec, Canada.
616. Ionospheric dynamics and drivers obtained from a physics-based data assimilation model (L. Scherliess, D. C. Thompson and R. W. Schunk), presented at the Ionospheric Effects Symposium, 13-15 May, 2008, Alexandria, Virginia.
617. The operational USU GAIM model (D. C. Thompson, L. Scherliess, R. W. Schunk and J. J. Sojka), presented at the Fall AGU Meeting, 15-19 December 2008, San Francisco, California.
618. New space weather systems under development and their contribution to space weather management (with K. Tobiska, D. Bouwer, H. Garrett, C. Mertens, and B. Bowman), presented at the Fall AGU Meeting, 15-19 December 2008, San Francisco, California.
619. Ionospheric densities at low latitudes obtained from the USU physics-based data assimilation model (GAIM-FP) (with L. Scherliess and D. C. Thompson), presented at the Fall AGU Meeting, 15-19 December 2008, San Francisco, California.
620. Neutral wind and plasma drift effects on the nighttime TEC variability (J. Shim, L. Scherliess, R. W. Schunk and D. C. Thompson), presented at the Fall AGU Meeting, 15-19 December 2008, San Francisco, California.
621. Lower atmospheric gravity wave impacts on the thermosphere (with L. Gardner), presented at the Fall AGU Meeting, 15-19 December 2008, San Francisco, California.
622. Wave coupling between the lower and upper atmosphere (R. W. Schunk, L. C. Gardner, L. Scherliess, D. C. Thompson, J. J. Sojka, D. E. Siskind, S. D. Eckerman, D. P. Drob, and K. Hoppel), presented at the Fall AGU Meeting, 15-19 December 2008, San Francisco, California.
623. Storm-time mid-latitude dayside TEC enhancements: Longitudinal dependence (M. David, J. J. Sojka, R. W. Schunk and R. A. Heelis), presented at the Fall AGU Meeting, 15-19 December 2008, San Francisco, California.
624. Effect of waves from the lower atmosphere on the thermosphere and ionosphere (R. W. Schunk L. C. Gardner, L. Scherliess, D. C. Thompson, and J. J. Sojka), presented at the American Meteorological Society, January 11-15, 2009, Phoenix, Arizona.
625. Ionosphere data assimilation models for specification and forecasts (R. W. Schunk, L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the American Meteorological Society, January 11-15, 2009, Phoenix, Arizona.
626. USTAR – International Center for Space Weather Forecasting, Physics Colloquium, Utah State University, January 20, 2009, Logan, Utah.
627. Thermosphere-ionosphere perturbations due to lower atmospheric waves (with L. Gardner, L. Scherliess, D. C. Thompson, and J. J. Sojka), presented at the WACCM meeting by Aaron Ridley, March 6, 2009, Boulder, Colorado.
628. Operational and organizational issues for a space weather prediction testbed (SWPT) (with W. K. Tobiska, T. Gombosi, J. Raeder, and M. Hesse), presented at the Ionosphere,

- Mesosphere, Thermosphere Research (IMTR) Meeting, February 10-12, 2009, El Segundo, California.
629. Effects of the magnetosphere and lower atmosphere on the ionosphere-thermosphere system (with L. Gardner, L. Scherliess, D. C. Thompson, J. J. Sojka, and L. Zhu), *Invited Talk*, presented at the Space Weather Workshop, April 28 – May 1, 2009, Boulder, Colorado.
  630. The current status and challenges for upper atmosphere models (with L. Gardner, L. Scherliess, D. C. Thompson, J. J. Sojka, and L. Zhu), *Invited Talk*, presented at the AGU Spring Meeting, May 26, 2009, Toronto, Ontario, Canada.
  631. USU-GAIM data reconstructions of the ionosphere (with L. Gardner, L. Scherliess, D. C. Thompson, J. J. Sojka, and L. Zhu), *Invited Talk*, presented at the CEDAR Meeting, June 27-July 3, 2009, Santa Fe, New Mexico.
  632. The USU GAIM physics-based data assimilation model: Recent developments and results (with L. Scherliess and D. C. Thompson), presented at the 11<sup>th</sup> IAGA Scientific Assembly, August 23-30, 2009, Sopron, Hungary.
  633. Ion and neutral outflows during storms, *Invited Talk*, presented at the Ionosphere-Magnetospheric Plasma Redistribution During Storms Workshop, September 28-29, 2009, Boulder, Colorado.
  634. Avoiding communication outages during emergency operations (with W. K. Tobiska and D. Bouwer), presented at the Department of Homeland Security, FEMA, October 5, 2009 Denver, Colorado.
  635. USU-GAIM data assimilation models for ionosphere specifications and forecasts, three presentations given at Kirkland Air Force Base (Metatech, AFRL, and Joint Navigation Warfare Center), November 6, 2009, Albuquerque, New Mexico.
  636. Study of the topside ionosphere using radio occultation data (with D. C. Thompson, L. Scherliess, and J. J. Sojka), presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2009, San Francisco, California.
  637. Storm-time ion velocity distributions in the generalized polar wind (with A. R. Barakat), presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2009, San Francisco, California.
  638. Study of the ring current variability with the use of ground-based magnetometer measurements and new statistical technique: Preliminary results (with L. Zhu, J. J. Sojka, Z. Xu, and P. Kokoszka), presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2009, San Francisco, California.
  639. Ion neutral outflows in the polar cap and auroral oval, *Invited Talk*, presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2009, San Francisco, California.
  640. Hybrid description of outflowing ionospheric plasma: a Monte Carlo/n-moment transport equations model (J. Ji, and A. R. Barakat), presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2009, San Francisco, California.
  641. Operational space weather models: Trials, tribulations and rewards (L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2009, San Francisco, California.

642. Generation of traveling atmospheric disturbances during a pulsating geomagnetic storm (with L. C. Gardner), presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2009, San Francisco, California.
643. Recent advances in the ionospheric modeling using USU GAIM data assimilation models (with L. Scherliess and D. C. Thompson), presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2009, San Francisco, California.
644. A milestone in commercial space weather: USTAR Center for Space Weather (with W. K. Tobiska, J. J. Sojka, D. C. Thompson, L. Scherliess, L. Zhu, and L. C. Gardner), presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2009, San Francisco, California.
645. Ionosphere specifications and forecasts (R. W. Schunk, L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), *Invited Talk*, presented at the ORION Conference, January 12-14, 2010, Dayton, Ohio.
646. The USU USTAR space weather center (with W. K. Tobiska and J. J. Sojka), presented at the Seventh Symposium on Space Weather, American Meteorological Society, January 17-20, 2010, Atlanta, Georgia.
647. Practical 27-day plus space weather forecasting (with J. J. Sojka), presented at the Seventh Symposium on Space Weather, American Meteorological Society, January 17-20, 2010, Atlanta, Georgia.
648. Data assimilation models for space weather applications (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the Seventh Symposium on Space Weather, American Meteorological Society, January 17-20, 2010, Atlanta, Georgia.
649. Operational data assimilation models for ionospheric applications (R. W. Schunk, L. Scherliess, D. C. Thompson, J. J. Sojka, and L. Zhu), *Invited Talk*, presented at the Space Weather Workshop, April 27-30, 2010, Boulder, Colorado.
650. Advanced commercial space weather products from the USU Space Weather Center (with W. K. Tobiska, H. C. Carlson, J. J. Sojka, D. C. Thompson, L. Scherliess, L. Zhu, and L. Gardner), presented at the Space Weather Workshop, April 27-30, 2010, Boulder, Colorado.
651. Incomplete physics in models, *Invited Talk*, presented at the 2010 CEDAR Workshop, June 20-25, 2010, Boulder, Colorado.
652. Weather disturbances in the ionosphere-thermosphere system at middle and low latitudes, *Invited Paper*, presented at the 38<sup>th</sup> COSPAR Scientific Assembly, July 18-25, 2010, Bremen, Germany.
653. Generation of traveling atmospheric disturbances during pulsating geomagnetic storms (with L. Gardner), presented at the 38<sup>th</sup> COSPAR Scientific Assembly, July 18-25, 2010, Bremen, Germany.
654. A physics-based data assimilation model for the high latitude space environment (with L. Scherliess, L. Zhu, and V. Eccles), presented at the 38<sup>th</sup> COSPAR Scientific Assembly, July 18-25, 2010, Bremen, Germany.
655. Coupling of the auroral and polar ionosphere to the solar wind during the extended solar minimum (with J. J. Sojka, M. Nicolls, A. Van Eykn, and C. Heinselman), presented at the 38<sup>th</sup> COSPAR Scientific Assembly, July 18-25, 2010, Bremen, Germany.

656. Commercializing space weather using GAIM (with the GAIM team), presented at the 38<sup>th</sup> COSPAR Scientific Assembly, July 18-25, 2010, Bremen, Germany.
657. Ionosphere data assimilation models for physics and applications (R. W. Schunk, L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), *Invited Talk*, presented at the AGU Meeting of the Americas, August 9-13, 2010, Iguazú Falls, Brazil.
658. Data assimilation models for space weather (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), ACCEHS 2010 Workshop, August 16-18, 2010, Boulder, Colorado.
659. Long-term space weather forecasting: Parameters and accuracy needed for the ionosphere/thermosphere (with L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), *Invited Talk*, presented at the Fall Meeting of the American Geophysical Union, December 13-17, 2010, San Francisco, California.
660. Ionospheric sensitivity to SDO-EVE spectral variability (with J. J. Sojka, and M. David), *Invited Talk*, presented at the Fall Meeting of the American Geophysical Union, December 13-17, 2010, San Francisco, California.
661. Modeling waves in the thermosphere-gravity wave/TAD interactions (with L. Gardner), presented at the Fall Meeting of the American Geophysical Union, December 13-17, 2010, San Francisco, California.
662. Global real-time ionosphere specification for end-user communication and navigation products (with W. K. Tobiska, H. C. Carlson, D. C. Thompson, J. J. Sojka, L. Scherliess, L. Zhu, and L. C. Gardner), presented at the Fall Meeting of the American Geophysical Union, December 13-17, 2010, San Francisco, California.
663. Thermosphere-ionosphere-magnetosphere coupling and mass outflow—the thermosphere/ionosphere perspective, *Invited Talk*, presented at the Fall Meeting of the American Geophysical Union, December 13-17, 2010, San Francisco, California.
664. Mid-latitude dayside ionospheric response to storm-time electric fields (with M. David, J. J. Sojka, and M. W. Liemohn), presented at the Fall Meeting of the American Geophysical Union, December 13-17, 2010, San Francisco, California.
665. Low-latitude ionospheric dynamics: Specifications using a physics-based data assimilation model (with L. Scherliess and D. C. Thompson), presented at the Fall Meeting of the American Geophysical Union, December 13-17, 2010, San Francisco, California.
666. Equatorial-PRIMO (Problems Related to Ionospheric Models and Observations) (with the PRIMO team), presented at the Fall Meeting of the American Geophysical Union, December 13-17, 2010, San Francisco, California.
667. Uncertainty associated with modeling the global ionosphere (with J. V. Jenniges, A. O. Acebal, L. C. Gardner, L. Scherliess, D. C. Thompson, and L. Zhu), presented at the Fall Meeting of the American Geophysical Union, December 13-17, 2010, San Francisco, California.
668. CEDAR electrodynamics thermosphere ionosphere (ETI) challenge for systematic assessment of ionospheric models (with J. Shim and ETI team), presented at the Fall Meeting of the American Geophysical Union, December 13-17, 2010, San Francisco, California.

669. Possibility and demonstrations of 27-day ionospheric forecasting (with J. J. Sojka, M. Nicholls, and C. J. Heinselman), presented at the Fall Meeting of the American Geophysical Union, December 13-17, 2010, San Francisco, California.
670. Ionospheric source of magnetospheric plasma: Measuring, modeling and merging into the GGCM (with R. Chappell and D. Welling), presented at the GEM Meeting, December 12, 2010, San Francisco, California.
671. Data assimilation models for ionosphere specifications and forecasts (R. W. Schunk, L. Scherliess, J. J. Sojka, D. C. Thompson, and L. Zhu), presented at the 91<sup>st</sup> American Meteorological Society Annual Meeting, January 24-27, 2011, Seattle, Washington.
672. GPS radio occultation data use in operational ionospheric models (W. Bagby, R. Prochaska, R. Schunk, L. Scherliess, K. Landis, and D. Kim), presented at the 91<sup>st</sup> American Meteorological Society Annual Meeting, January 24-27, 2011, Seattle, Washington.
673. Global, real-time ionosphere specification for end-user communication and navigation products (K. Tobiska, H. Carlson, R. W. Schunk, J. J. Sojka, L. Scherliess, L. Zhu, and L. C. Gardner), presented at the 91<sup>st</sup> American Meteorological Society Annual Meeting, January 24-27, 2011, Seattle, Washington.
674. Commercial space weather effects: data, products, services (W. K. Tobiska, R. W. Schunk, and H. C. Carlson), presented at the Aerospace Corporation, January 28, 2011, Colorado Springs, Colorado.
675. GPS radio occultation data use in operational ionospheric models (W. Bagby, R. Prochaska, R. Schunk, L. Scherliess, K. Landis, and D. Kim), presented at the Space Weather Workshop, April 26-29, 2011, Boulder, Colorado.
676. New space weather products for HF radio, GPS navigation and aviation (with K. Tobiska et al.) presented at the Space Weather Workshop, April 26-29, 2011, Boulder, Colorado.
677. Commercial space weather products for real-time and forecast applications (Schunk et al.), *Invited Talk*, presented at the Space Weather Workshop, April 26-29, 2011, Boulder, Colorado.
678. Global Assimilation of Ionospheric Measurements (USU GAIM) (R. W. Schunk, L. Scherliess, L. Gardner, J. J. Sojka, and L. Zhu), presented at TMDE Decadal Survey Working Group, May 12, 2011, via telecon from Atlanta Airport.
679. Ionosphere-thermosphere physics: Current status and problems, *Invited Talk*, presented at AGU Chapman Conference on Modeling the Ionosphere/Thermosphere System, May 9-12, 2011, Charleston, South Carolina.
680. Charge exchange in the mid- to low-latitude ionosphere and its impact on the thermosphere (L. C. Gardner and R. W. Schunk), presented at AGU Chapman Conference on Modeling the Ionosphere/Thermosphere System, May 9-12, 2011, Charleston, South Carolina.
681. Data assimilation techniques and their use for ionospheric science and applications (L. Scherliess and R. W. Schunk), *Invited Talk*, presented at AGU Chapman Conference on Modeling the Ionosphere/Thermosphere System, May 9-12, 2011, Charleston, South Carolina.
682. Systematic assessment of ionosphere/thermosphere models using metrics (Shim et al.), *Invited Talk*, presented at AGU Chapman Conference on Modeling the Ionosphere/Thermosphere System, May 9-12, 2011, Charleston, South Carolina.

683. EISCAT Svalbard Radar (ESR) year long IPY observations: A model climate variability study (Sojka et al.), presented at AGU Chapman Conference on Modeling the Ionosphere/Thermosphere System, May 9-12, 2011, Charleston, South Carolina.
684. Ionospheric flare modeling: A new paradigm (J. J. Sojka, R. W. Schunk, T. Woods, and F. Eparvier), presented at AGU Chapman Conference on Modeling the Ionosphere/Thermosphere System, May 9-12, 2011, Charleston, South Carolina.
685. The GAIM-FP status and development (R. W. Schunk, L. Scherliess, L. Gardner, and L. Zhu), Group Meeting, May 16, 2011, Alexandria, Virginia.
686. Long-term ionosphere-thermosphere forecasting: Problems associated with uncertain parameters and missing physics (R. W. Schunk, L. Gardner, L. Scherliess, and L. Zhu), presented at the IES2011 Meeting, May 17-20, 2011, Alexandria, Virginia.
687. Ionospheric dynamics at low- to mid-latitude: Specifications using a physics-based data assimilation model (L. Scherliess and R. W. Schunk), presented at the IES2011 Meeting, May 17-20, 2011, Alexandria, Virginia.
688. A physics-based data assimilation model for the high-latitude ionosphere: Importance of data assimilation technique in determining the model drivers (L. Zhu, R. Schunk, L. Scherliess, and V. Eccles), presented at the IES2011 Meeting, May 17-20, 2011, Alexandria, Virginia.
689. Wave interactions in the ionosphere-thermosphere (L. Gardner and R. W. Schunk), presented at the IES2011 Meeting, May 17-20, 2011, Alexandria, Virginia.
690. The ionosphere over northeast Russia and Alaska around the Halloween storm radio tomography versus GAIM-GM model (E. D. Kunitsyn et al.), presented at the IES2011 Meeting, May 17-20, 2011, Alexandria, Virginia.
691. HF propagation in a real-time GAIM ionosphere (V. Eccles, R. W. Schunk, L. Scherliess, K. Tobiska, and L. Zhu), presented at the IES2011 Meeting, May 17-20, 2011, Alexandria, Virginia.
692. Outflow and Mass Flow: What is needed from the magnetosphere community, *Invited Talk*, presented at the 2011 CEDAR-GEM Joint Workshop, June 26 to July 1, 2011, Santa Fe, New Mexico.
693. Modeling ionospheric outflow, presented at the 2011 CEDAR-GEM Joint Workshop, June 26 to July 1, 2011, Santa Fe, New Mexico.
694. Elements of the generalized polar wind (A. R. Barakat and R. W. Schunk), presented at the 2011 CEDAR-GEM Joint Workshop, June 26 to July 1, 2011, Santa Fe, New Mexico.
695. Uncertainty analysis of model output, *Invited Talk*, presented at the 2011 CEDAR-GEM Joint Workshop, June 26 to July 1, 2011, Santa Fe, New Mexico.
696. Studies to improve the science in the GAIM-Full Physics model, presented at the 2011 ONR Space Peer Review, September 20-21, 2011, Arlington, VA.
697. Ionospheric data assimilation, *Invited Seminar*, (R. W. Schunk and S. Budzien), presented at the Joint Center for Satellite Data Assimilation (JCSDA), November 16, 2011, Camp Springs, Maryland.
698. Ionosphere-related products for communication and navigation (W. K. Tobiska, R. W. Schunk, J. J. Sojka, H. C. Carlson, L. C. Gardner, L. Scherliess, and L. Zhu), presented at the 2011 Fall Meeting of the American Geophysical Union, December 5-9, 2011, San Francisco, California.

699. Substitution of ionosonde data for GPS TEC data in GAIM-GM: A regional study (J. J. Sojka, R. W. Schunk, L. C. Gardner, L. Scherliess, D. Rice, W. K. Tobiska, L. E. Heaton, and J. A. Fulgham), presented at the 2011 Fall Meeting of the American Geophysical Union, December 5-9, 2011, San Francisco, California.
700. Ionospheric change and solar EUV irradiance, *Invited Talk* (J. J. Sojka, M. David, J. B. Jensen, and R. W. Schunk), presented at the 2011 Fall Meeting of the American Geophysical Union, December 5-9, 2011, San Francisco, California.
701. Data impact of the DMSP F18 SSULI UV data on the operational GAIM model (P. B. Dandenault, C. A. Metzler, A. C. Nicholas, C. Coker, S. A. Budzien, D. H. Chua, T. T. Finne, K. Dymond, P. W. Walker, R. W. Schunk, L. Scherliess, and L. C. Gardner), presented at the 2011 Fall Meeting of the American Geophysical Union, December 5-9, 2011, San Francisco, California.
702. Effects of season and solar cycle on storm-time behavior of the generalized polar wind (A. R. Barakat and R. W. Schunk), presented at the 2011 Fall Meeting of the American Geophysical Union, December 5-9, 2011, San Francisco, California.
703. Systematic climatology assessment of ionosphere/thermosphere models during November 2007 to February 2008 (B. A. Emery, L. P. Goncharenko, A. J. Coster, J. T. Emmert, M. Fedrizzi, T. J. Fuller-Rowell, J. D. Huba, M. M. Kuznetsova, L. Qian, A. J. Ridley, L. Scherliess, R. W. Schunk, J.-S. Shim, and W. Wang), presented at the 2011 Fall Meeting of the American Geophysical Union, December 5-9, 2011, San Francisco, California.
704. Systematic assessment of ionosphere/thermosphere models during the 2006 AGU storm (J.-S. Shim, M. M. Kuznetsova, M. Hesse, L. Rastaetter, D. Bilitza, M. D. Butala, M. Codrescu, B. A. Emery, B. T. Foster, T. J. Fuller-Rowell, J. D. Huba, A. J. Mannucci, X. Pi, A. J. Ridley, R. W. Schunk, P. Stevens, D. C. Thompson, D. R. Weimer, A. J. Coster, J. M. Forbes, L. P. Goncharenko, J. M. Holt, L. Scherliess, E. K. Sutton, Q. Wu), presented at the 2011 Fall Meeting of the American Geophysical Union, December 5-9, 2011, San Francisco, California.
705. A storm-time F-region density enhancement feature predicted by the TDIM/HEIDI model (M. David, J. J. Sojka, R. W. Schunk, and M. W. Liemohn), presented at the 2011 Fall Meeting of the American Geophysical Union, December 5-9, 2011, San Francisco, California.
706. Ionosphere/thermosphere climatology at low and mid-latitude during solar minimum obtained from the GAIM-Physics-Based data assimilation model (GAIM-FP) (L. Scherliess, L. Lomidze, and R. W. Schunk), presented at the 2011 Fall Meeting of the American Geophysical Union, December 5-9, 2011, San Francisco, California.
707. Coupling of the ionosphere/thermosphere system via charge exchange reactions (L. C. Gardner and R. W. Schunk), presented at the 2011 Fall Meeting of the American Geophysical Union, December 5-9, 2011, San Francisco, California.
708. Studying the space weather features of the high-latitude ionosphere by using a physics-based data assimilation model and observational data from ground magnetometer arrays (L. Zhu, R. W. Schunk, L. Scherliess, J. J. Sojka, and J. V. Eccles), presented at the 2011 Fall Meeting of the American Geophysical Union, December 5-9, 2011, San Francisco, California.
709. New Space Weather Data Sources and Products for Communication and Navigation Systems (J. Meehan, D. Hansen, W. K. Tobiska, J. Fulgham, R. W. Schunk, J. J. Sojka,

- V. Eccles, D. Rice, L. C. Gardner, L. Scherliess, L. Zhu, C. Tschan, D. Bouwer, and R. Shelley), presented at the American Meteorological Society Meeting, January 22-26, 2012, New Orleans, LA.
710. Ionosphere-related Products for Communication and Navigation (W. K. Tobiska, R. Schunk, J. Sojka, H. Carlson, L. Gardner, L. Scherliess, and L. Zhu), presented at the American Meteorological Society Meeting, January 22-26, 2012, New Orleans, LA.
711. Data assimilation models for ionosphere, thermosphere and electrodynamics applications and science studies (R. W. Schunk, L. Scherliess, L. C. Gardner, J. J. Sojka, and L. Zhu), presented at the American Meteorological Society Meeting, January 22-26, 2012, New Orleans, LA.
712. Data impact of the DMSP F18 SSULI UV data on the operational GAIM model (C. Coker, P. Dandenault, L. Scherliess, L. C. Gardner, R. W. Schunk, L. Zhu, K. F. Dymond, S. A. Budzien, A. C. Nicholas, D. H. Chua, C. A. Metzler, T. T. Finne, A. W. Stephan, and S. E. McDonald), presented at the American Meteorological Society Meeting, January 22-26, 2012, New Orleans, LA.
713. Mathematical approaches and processes relevant to the escape of planetary gases and plasmas, *Invited*, presented at the Modeling Atmospheric Escape Workshop (via telephone), February 27-28, 2012, Charlottesville, Virginia.
714. Escape of neutral gas and plasma from the Earth's upper atmosphere, *Invited Seminar*, presented at University of Michigan, April 5, 2012, Ann Arbor, Michigan.
715. Global model of polar wind and energetic ion outflow, *Invited*, presented at the GEM Workshop, June 19-22, 2012, Snowmass, Colorado.
716. Data assimilation models for ionosphere, thermosphere and electrodynamics studies (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, and L. Zhu), presented at the 39<sup>th</sup> COSPAR Scientific Assembly, July14-22, 2012, Mysore, India.
717. Studying the space weather variability of the high-latitude ionosphere by using a physics-based data assimilation model (L. Zhu, R. W. Schunk, L. Scherliess, J. J. Sojka, and V. Eccles), presented at the 39<sup>th</sup> COSPAR Scientific Assembly, July14-22, 2012, Mysore, India.
718. Global impacts of ionosphere-plasmasphere charge exchange on the thermosphere (L. Gardner and R. W. Schunk), presented at the 39<sup>th</sup> COSPAR Scientific Assembly, July14-22, 2012, Mysore, India.
719. Self-consistent multi-scale wave interactions in the thermosphere (L. Gardner and R. W. Schunk), presented at the 39<sup>th</sup> COSPAR Scientific Assembly, July14-22, 2012, Mysore, India.
720. Impact of penetration electric fields on the mid and low latitude ionosphere during some magnetic storms in solar cycle 24 (Su. Basu, S. Basu, C. Valladares, R. W. Schunk, and M. Ruohoniemi), presented at the 39<sup>th</sup> COSPAR Scientific Assembly, July14-22, 2012, Mysore, India.
721. Solar EUV irradiance variations and their impact on Earth (L. Scherliess, J. J. Sojka, R. W. Schunk, and M. David), presented at the 39<sup>th</sup> COSPAR Scientific Assembly, July14-22, 2012, Mysore, India.
722. Solar variability and its effect on the ionosphere/thermosphere at low and mid-latitudes obtained from the GAIM-Physics-Based data assimilation model (GAIM-FP) (L.

- Scherliess, J. J. Sojka, and R. W. Schunk), presented at the 39<sup>th</sup> COSPAR Scientific Assembly, July 14-22, 2012, Mysore, India.
723. Sensitivity of ionospheric specifications to in situ plasma density observations obtained from electrostatic analyzers onboard of a constellation of small satellites (R. Balthazor, M. G. McHarg, C. L. Enloe, A. J. Wallerstein, K. Wilson, R. Raynor, B. Rinaldi, L. Scherliess, R. W. Schunk, D. J. Barnhart, R. Brown) presented at Small Satellite Conference, Utah State University Research Foundation, 13-16 August 2012, Logan, Utah.
  724. Why the solar EUV is important for Earth's ionosphere and thermosphere (J. J. Sojka, J. Jensen, M. David, R. Schunk, T. Woods, F. Eparvier, S. Gonzalez, and M. Sulzer), SDO EVE Science Conference, October 30 – November 1, 2012, Yosemite National Park, California.
  725. Using SDO-EVE satellite data to model for the first time how large solar flares influence the Earth's ionosphere (J. Jensen, J. J. Sojka, R. Schunk, M. David, T. Woods, F. Eparvier), Annual Meeting of the Four Corners Section of the American Physical Society, October 26-27, 2012, Socorro, New Mexico.
  726. Escape of neutral gas and plasma from the Earth's upper atmosphere, *Invited Colloquium* presented at Baylor University, November 16, 2012, Waco, Texas.
  727. Comprehensive comparison of an ionospheric data assimilation model and the international reference ionosphere (J. Meehan, W. K. Tobiska, R. W. Schunk, L. Scherliess, and L. C. Gardner), presented at the 2012 Fall Meeting of the American Geophysical Union, December 3-7, 2012, San Francisco, CA.
  728. High-latitude patches development using a physics-based data assimilation model and data from ground magnetometer arrays (J. V. Eccles, H. C. Carlson, R. W. Schunk, L. Zhu, and L. Scherliess), presented at the 2012 Fall Meeting of the American Geophysical Union, December 3-7, 2012, San Francisco, CA.
  729. Ionosphere-thermosphere-magnetosphere coupling at mid-latitudes (R. W. Schunk), *Invited Talk*, presented at the 2012 Fall Meeting of the American Geophysical Union, December 3-7, 2012, San Francisco, CA.
  730. Multi-technique measurements and modeling of storm-enhanced densities during a moderate magnetic storm on 3-4 August 2010: Connections to low and high latitudes (S. Basu, C. E. Valladares, E. MacKenzie, R. W. Schunk, L. Scherliess, L. C. Gardner, E. G. Thomas, and J. M. Ruohoniemi), presented at the 2012 Fall Meeting of the American Geophysical Union, December 3-7, 2012, San Francisco, CA.
  731. Global impacts of ionosphere-plasmasphere charge exchange on the thermosphere (L. C. Gardner and R. W. Schunk), presented at the 2012 Fall Meeting of the American Geophysical Union, December 3-7, 2012, San Francisco, CA.
  732. The new era in operational forecasting (W. K. Tobiska, R. W. Schunk, J. J. Sojka, H. C. Carlson, L. C. Gardner, L. Scherliess, L. Zhu, J. V. Eccles, D. D. Rice, D. Bouwer, J. J. Bailey, D. J. Knipp, J. B. Blake, J. Rex, R. Fushino, C. J. Mertens, B. Gersey, R. Wilkins, and W. Atwell), presented at the 2012 Fall Meeting of the American Geophysical Union, December 3-7, 2012, San Francisco, CA.
  733. Ensemble modeling with data assimilation models: A new strategy for space weather science, specifications and forecasts (R. W. Schunk, L. Scherliess, J. V. Eccles, L. C.

- Gardner, J. J. Sojka, L. Zhu, X. Pi, A. Mannucci, B. D. Wilson, A. Komjathy, C. Wang, G. Rosen, W. Tobiska, R. K. Schaefer, and L. J. Paxton), presented at the 2012 Fall Meeting of the American Geophysical Union, December 3-7, 2012, San Francisco, CA.
734. Studying the space weather variability of the high-latitude ionosphere by using a physics-based data assimilation model (L. Zhu, R. W. Schunk, L. Scherliess, J. V. Eccles, and J. J. Sojka), presented at the 2012 Fall Meeting of the American Geophysical Union, December 3-7, 2012, San Francisco, CA.
735. Ionosphere/thermosphere morphology at low and mid-latitudes obtained from the GAIM-Physics-Based Data Assimilation Model (GAIM-FP) (L. Scherliess, L. Lomidze, and R. W. Schunk), presented at the 2012 Fall Meeting of the American Geophysical Union, December 3-7, 2012, San Francisco, CA.
736. A reassessment of the PRIMO recommendations for adjustments to mid-latitude ionospheric models (M. David, J. J. Sojka, and R. W. Schunk), presented at the 2012 Fall Meeting of the American Geophysical Union, December 3-7, 2012, San Francisco, CA.
737. 8/9 February 2012 SDO-EVE and Arecibo ISR ionospheric campaign (J. J. Sojka, M. David, J. Jensen, R. W. Schunk, T. N. Woods, F. Eparvier, M. P. Sulzer, and S. A. Gonzalez), presented at the 2012 Fall Meeting of the American Geophysical Union, December 3-7, 2012, San Francisco, CA.
738. Problems associated with overlaying empirical particle precipitation and plasma convection patterns (D. B. Hansen, W. Tobiska, R. W. Schunk, and L. Zhu), presented at the 2012 Fall Meeting of the American Geophysical Union, December 3-7, 2012, San Francisco, CA.
739. Global specification of the post-sunset equatorial ionization anomaly (C. Coker, P. B. Dandenault, K. Dymond, S. A. Budzien, A. C. Nicholas, D. H. Chua, S. E. McDonald, C. A. Metzler, P. W. Walker, L. Scherliess, R. W. Schunk, L. C. Gardner, and L. Zhu), presented at the 2012 Fall Meeting of the American Geophysical Union, December 3-7, 2012, San Francisco, CA.
740. Using SDO-EVE Satellite Data to Model for the First Time How large Solar Flares Influence the Earth's Ionosphere, (J. B. Jensen, J. J. Sojka, M. David, R. Schunk, To Woods, F. Eparvier), presented at the 7<sup>th</sup> Annual Utah Conference on Undergraduate Research (UCUR), February 22, 2013, Logan, Utah.
741. Resolving ionospheric E-region modeling challengers: The solar photon Flux dependence (J. B. Jensen, J. J. Sojka, M. David, W. K. Tobiska, R. W. Schunk, T. Woods, and F. Eparvier), presented at the American Physical Society April Meeting, April 13-16, 2013, Denver, Colorado.
742. Ensemble Modeling with Data Assimilation Models: A New Strategy for Space Weather Specifications and Forecasts (R W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, B. D. Wilson, A. Komjathy, C. Wang, and G. Rosen), presented at the Space Weather Workshop, April 16-19, 2013, Boulder, Colorado.
743. Automated Radiation Measurements for Aviation Safety (ARMAS) (W. K. Tobiska, W. Atwell, J. B. Blake, W. R. Crain, K. Cecil, C. Flynn, R. Fuschino, R. Wilkins, B. Gersey, M. Holland, K. Malone, B. Schunk, D. Rice, D. Bell, C. Mertens, G. Crowley, D. Bouwer, L. Didkovsky, J. Bailey, and H. Garrett), presented at the Space Weather Workshop, April 16-19, 2013, Boulder, Colorado.

744. Ensemble modeling with data assimilation models: A new strategy for space weather specifications and forecasts (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, B. D. Wilson, A. Komjathy, C. Wang, and G. Rosen), presented at the NASA-NSF Space Weather Modeling Collaborations Meeting, May 1, 2013, Greenbelt, Maryland.
745. Plasma redistribution in the M-I-T system during magnetic storms: Evidence from experiments and modeling (S. Basu, C. E. Valladares, S. Basu, E. M. MacKenzie, L. Scherliess, L. C. Gardner, A. J. Coster, and R. W. Schunk), presented at the AGU Meeting of the Americas, May 14-17, 2013, Cancun, Mexico.
746. Global modeling of polar wind and energetic ion outflow (R. W. Schunk and A. R. Barakat), presented at the GEM 2013 Summer Workshop, June 16-21, 2013, Snowmass, Colorado.
747. Neutral polar wind (R. W. Schunk and L. C. Gardner), presented at the GEM 2013 Summer Workshop, June 16-21, 2013, Snowmass, Colorado.
748. A Multimodel Ensemble Data Assimilation Approach to Specify Ionospheric Weather (X. Pi, A. J. Mannucci, B. D. Wilson, A. Komjathy, M. Butala, V. Akopian, R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, C. Wang, and G. Rosen), presented at the International Beacon Satellite Symposium, July 8-12, 2013, Bath, United Kingdom.
749. Sensitivity of ionospheric specifications to in situ plasma density observations obtained from a constellation of small satellites (R. Balthazor, M. G. McHarg, L. Scherliess, R. Schunk, C. L. Enloe, B. Mueller, L. Wilhelm, D. J. Barnhart, R. Brown, and Z. Hoeffner), presented at the International Beacon Satellite Symposium, July 8-12, 2013, Bath, United Kingdom.
750. E-region developments and E-region assimilation challenges (J. J. Sojka, J. B. Jensen, M. David, R. W. Schunk, T. Woods, F. Eparvier, M. Sulzer, and S. Gonzalez), presented at the International Beacon Satellite Symposium, July 8-12, 2013, Bath, United Kingdom.
751. The GAIM Physics-Based data assimilation model for the ionosphere (GAIM-FP) and its use to unravel the physical mechanisms behind the Weddell Sea Anomaly (L. Scherliess, L. Lomidze, and R. W. Schunk), presented at the International Beacon Satellite Symposium, July 8-12, 2013, Bath, United Kingdom.
752. EVE and the E-Layer (J. J. Sojka, J. B. Jensen, M. David, R. W. Schunk, T. N. Woods, and F. G. Eparvier), Presented at the 2013 LWS/SDO Science Workshop entitled "Exploring the Network of SDO Science, March 3-8, 2013, Cambridge, MD.
753. Modeling ionospheric outflow, *Invited Talk*, presented on my behalf by D. Welling at the ISSI Workshop on 'Plasma Sources for Solar System Magnetospheres', September 23-27, 2013; Bern, Switzerland.
754. Operational specification and forecasting advances for Dst, LEO thermospheric densities, and aviation radiation dose and dose rate (W. K. Tobiska, D. J. Knipp, W. J. Burke, D. Bouwer, J. J. Bailey, M. P. Hagan, L. V. Didkovsky, H. B. Garrett, B. R. Bowman, J. L. Gannon, W. Atwell, J. B. Blake, W. Crain, D. Rice, R. W. Schunk, J. Fulgham, D. Bell, B. Gersey, R. Wilkins, R. Fuschino, C. Flynn, F. Cecil, C. J. Mertens, X. Xu, G. Crowley, A. Reynolds, A. I. Azeem, S. Wiley, M. Holland, and K. Malone), poster presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.

755. Using a multimodel ensemble prediction system (MEPS) to study the ionosphere-thermosphere-electrodynamics system (R. W. Schunk, L. Scherliess, J. V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, B. D. Wilson, A. Komjathy, C. Wang and G. Rosen), poster presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.
756. Using multiple data types in the USU GAIM data assimilation models (L. C. Gardner, R. W. Schunk, L. Scherliess, D. D. Rice, J. J. Sojka, and L. Zhu), poster presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.
757. Reviewing the mechanisms underlying the pre-reversal enhancement of the vertical plasma drift in the low latitude ionosphere (J. V. Eccles, J. St-Maurice, and R. W. Schunk), poster presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.
758. A multimodel ensemble prediction system to specify ionospheric storms (X. Pi, A. J. Mannucci, B. D. Wilson, A. Komjathy, M. D. Butala, V. Akopian, C. Wang, G. Rosen, R. W. Schunk, L. Scherliess, J. V. Eccles, L. C. Gardner, J. J. Sojka, and L. Zhu), poster presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.
759. Ionosphere/thermosphere studies using the GAIM Physics-Based data assimilation models (L. Scherliess, R. W. Schunk, and L. Lomidze), *Invited Poster*, presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.
760. A low-cost CubeSat mission for space weather forecasting (R. L. Balthazor, M. G. McHarg, L. Scherliess, R. W. Schunk, Z. Hoeffner, D. Barnhart, and R. Brown), poster presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.
761. Comparisons of the low-cost in-situ MESA plasma sensor with C/NOFS and GAIM plasma density/temperature data (M. G. McHarg, R. L. Balthazor, L. Scherliess, R. W. Schunk, O. de la Beaujardiere, P. Roddy, Z. Hoeffner, B. Mueller, L. Wilhelm, L. Enloe), poster presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.
762. The neutral wind in ionospheric modeling: The month-long ISR campaign at Millstone Hill, October 2002 (M. David, J. J. Sojka, R. W. Schunk, and J. M. Holt), poster presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.
763. Improved hybrid Monte Carlo/n-moment transport equations model for the polar wind (A. R. Barakat, J. Ji, and R. W. Schunk), poster presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.
764. Building a coupled-ionosphere-plasmasphere-polar wind-superthermal electron system (Y. Omelchenko, H. Karamabadi, R. W. Schunk, A. R. Barakat, L. C. Gardner, G. V. Khazanov, A. Glocer, and L. M. Kistler), poster presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.
765. Kinetic framework for the magnetosphere-ionosphere-plasmasphere-polar wind system: A unified approach for studying hot and cold plasma interactions (H. Karamabadi, Y. Omelchenko, R. W. Schunk, A. R. Barakat, L. C. Gardner, G. V. Khazanov, A. Glocer, and L. M. Kistler), poster presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.

766. 3-D dynamic PIC model of the generalized polar wind as applied to a GEM focus group (J. B. Jensen, A. R. Barakat, and R. W. Schunk), poster presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.
767. Terminator field-aligned current system: A new finding from model-assimilated data set (MADS) (L. Zhu, R. W. Schunk, L. Scherliess, J. J. Sojka, L. C. Gardner, J. V. Eccles, and D. Rice), poster presented at the 2013 Fall Meeting of the American Geophysical Union, December 8-14, 2013, San Francisco, California.
768. Ionospheric reconstruction for various solar, seasonal, and geomagnetic conditions obtained from the Global Assimilation of Ionospheric Measurements – Gauss Markov (GAIM-GM) model, (L. C. Gardner, R. W. Schunk, L. Scherliess, L. Zhu, and J. J. Sojka), presented at the ION 2014 International Technical Meeting, January 27-29, 2014, San Diego, California.
769. Multimodel ensemble prediction system for space weather applications, (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, B. D. Wilson, A. Komjathy, C. Wang and G. Rosen), presented at the ION 2014 International Technical Meeting, January 27-29, 2014, San Diego, California.
770. Ensemble modeling with data assimilation models: A new strategy for space weather science, specifications and forecasts, *Invited Talk*, (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, B. D. Wilson, A. Komjathy, C. Wang, and G. Rosen), presented at the American Meteorological Society Meeting, February 2-5, 2014, Atlanta, Georgia.
771. Operational specification and forecasting advances for Dst, LEO thermospheric densities, and aviation radiation dose and dose rate (W. Kent Tobiska, Delores Knipp, W.J. Burke, D. Bouwer, J. Bailey, M.P. Hagan, Leonid Didkovsky, Henry Garrett, B.R. Bowman, J. Gannon, William Atwell, J. Bernard Blake, William R. Crain, Don Rice, Bob Schunk, Jared Fulgham, Duane Bell, Brad Gersey, Richard Wilkins, Robert Fuschino, Chris Flynn, Kurt Cecil, Chris Mertens, Xiaojing Xu, Geoff Crowley, Adam Reynolds, Irfan Azeem, Scott Wiley, Mike Holland, Kathleen Malone, and Lika Guhathakurta), presented at the American Meteorological Society Meeting, February 2-5, 2014, Atlanta, Georgia.
772. Magnetosphere-Ionosphere Coupling: Past, Present and Future, *Invited Talk*, presented at the AGU Chapman Conference on Magnetosphere-Ionosphere Coupling in the Solar System, February 9-14, 2014, Yosemite, California.
773. Ensemble modeling with data assimilation models: A new strategy for space weather specifications and forecasts, *Invited Talk*, (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, B. D. Wilson, A. Komjathy, C. Wang and G. Rosen), presented at the CCMC 2014 Workshop, April 1, 2014, Annapolis, Maryland.
774. Ensemble modeling with data assimilation models: A new strategy for space weather specifications and forecasts (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, M. Butala, B. D. Wilson, A. Komjathy, C. Wang and G. Rosen), presented at the LWS Heliophysics Science Technical Interchange Meeting, May 20-22, 2014, NASA Ames Research Center, California.
775. Ionosphere Tutorial, *Invited Talk*, presented at the Aerospace corporation, June 10, 2014, El Segundo, California.
776. Overview: Global Modeling of Ion Outflow, *Invited Talk*, (R. W. Schunk, A. R. Barakat and V. Eccles), presented at the GEM 2014 Summer Workshop, Norfolk, Virginia, June 15-20, 2014.

777. Ion Outflow Predicted by the Generalized Polar Wind Model During the GEM First Real Storm Period, *Invited Talk*, (A. R. Barakat, V. Eccles and R. W. Schunk), presented at the GEM 2014 Summer Workshop, Norfolk, Virginia, June 15-20, 2014.
778. Ionospheric Dynamics During the 8-day GEM First Real Storm Study Period, *Invited Talk*, (V. Eccles, R. W. Schunk and A. R. Barakat), presented at the GEM 2014 Summer Workshop, Norfolk, Virginia, June 15-20, 2014.
779. USU Space Weather Center, Presented at the USTAR Confluence Meeting, November 3-4, 2014; Salt Lake City, Utah.
780. Kinetic Framework for the Magnetosphere-Ionosphere-Plasmasphere-Polar Wind System: Modeling Ion Outflow (R. W. Schunk, A. R. Barakat, V. Eccles, H. Karimabadi, Y. Omelchenko, G. V. Khazanov, A. Glocer, and L. M. Kistler), *Invited Talk*, presented at the 2014 Fall Meeting of the American Geophysical Union, December 15-19, 2014, San Francisco, CA.
781. Using Multimodel Ensemble Prediction Systems (MEPS) for the Ionosphere-Thermosphere-Electrodynamics System (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, M. Butala, B. D. Wilson, A. Komjathy, C. Wang, and G. Rosen), *Invited Talk*, presented at the 2014 Fall Meeting of the American Geophysical Union, December 15-19, 2014, San Francisco, CA.
782. A Multimodel Ensemble Data Assimilation Approach to Specify Ionospheric Weather (L. Scherliess, R. W. Schunk, L. C. Gardner, L. Zhu, V. Eccles, J. J. Sojka, X. Pi, M. D. Butala, A. J. Mannucci, B. D. Wilson, A. Komjathy, C. Wang, and G. Rosen), presented at the 2014 Fall Meeting of the American Geophysical Union, December 15-19, 2014, San Francisco, CA.
783. How Uncertainties in the Neutral Wind Affect Ionospheric Modeling (M. David, J. J. Sojka, and R. W. Schunk), presented at the 2014 Fall Meeting of the American Geophysical Union, December 15-19, 2014, San Francisco, CA.
784. Impact of X-Class Flares on the Polar Ionosphere (J. J. Sojka, M. Lewis, M. David, R. W. Schunk, M. J. Nicolls, T. N. Wood, and F. Eparvier), presented at the 2014 Fall Meeting of the American Geophysical Union, December 15-19, 2014, San Francisco, CA.
785. The USU-GAIM Data Assimilation Models for Ionospheric Specifications and Forecasts (L. Scherliess, R. W. Schunk, L. C. Gardner, L. Zhu, and J. J. Sojka), presented at the 2014 Fall Meeting of the American Geophysical Union, December 15-19, 2014, San Francisco, CA.
786. Study of Ionospheric Storms Using Global Assimilative Ionospheric Models (X. Pi, M. Butala, A. J. Mannucci, B. D. Wilson, A. Komjathy, C. Wang, G. Rosen, R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, and L. Zhu), presented at the 2014 Fall Meeting of the American Geophysical Union, December 15-19, 2014, San Francisco, CA.
787. Data-Model Comparisons of the October 2002 Event Using the Space Weather Modeling Framework (D. T. Welling, C. R. Chappell, R. W. Schunk, A. R. Barakat, V. Eccles, A. Glocer, L. M. Kistler, S. Haaland, and T. E. Moore), presented at the 2014 Fall Meeting of the American Geophysical Union, December 15-19, 2014, San Francisco, CA.
788. Prototype Operational Advances for Atmospheric Radiation Dose Rate Specification (W. K. Tobiska, D. Bouwer, J. J. Bailey, L. V. Didkovsky, K. Judge, H. B. Garrett, W. Atwell, B. Gersey, R. Wilkins, D. Rice, R. W. Schunk, D. Bell, C. J. Mertens, X. Xu, G. Crowley, A. Reynolds, I. Azeem, M. J. Wiltberger, S. Wiley, S. Bacon, E. Teets, A. Sim, and L. Dominik), presented at the 2014 Fall Meeting of the American Geophysical Union, December 15-19, 2014, San Francisco, CA.

789. Flow Channel and Velocity Shear Impacts on the Thermospheric CUSP, with Associated Neutral Upwelling (L. C. Gardner, H. C. Carlson, and R. W. Schunk), presented at the 2014 Fall Meeting of the American Geophysical Union, December 15-19, 2014, San Francisco, CA.
790. Terminator Field-Aligned Current System: Its Dependencies on Solar, Seasonal, and Geomagnetic Conditions (L. Zhu, R. W. Schunk, V. Eccles, L. Scherliess, J. J. Sojka, and L. C. Gardner), presented at the 2014 Fall Meeting of the American Geophysical Union, December 15-19, 2014, San Francisco, CA.
791. Assessment of Modeling Capability for Reproducing Storm Impacts on TEC (J.-S. Shim, M. M. Kuznetsovs, L. Rastaetter, D. Bilitza, M. Codrescu, A. J. Coster, B. Emery, M. Foerster, B. Foster, T. J. Fuller-Rowell, J. D. Huba, L. P. Goncharenko, A. J. Mannucci, A. A. Namgaladze, X. Pi, B. E. Prokhorov, A. J. Ridley, L. Scherliess, R. W. Schunk, J. J. Sojka, and L. Zhu), presented at the 2014 Fall Meeting of the American Geophysical Union, December 15-19, 2014, San Francisco, CA.
792. Data Assimilation Models for Space Weather Specifications and Forecasts (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, and L. Zhu), presented at the 2015 American Meteorological Society Meeting, January 3-8, 2015, Phoenix, Arizona.
793. Lower Atmosphere Gravity Wave Coupling with a Traveling Atmospheric Disturbance in the Thermosphere (L. C. Gardner and R. W. Schunk), presented at the 2015 American Meteorological Society Meeting, January 3-8, 2015, Phoenix, Arizona.
794. Operational Advances for Atmospheric Radiation Dose Rate Specification (W. K. Tobiska, D. Bouwer, S. Bailey, L. Didkovsky, K. Judge, H. Garrett, W. Atwell, B. Gersey, R. Wilkins, D. Rice, R. W. Schunk, D. Bell, C. J. Mertens, X. Xu, G. Crowley, A. Reynolds, I. Azeem, M. Wiltberger, S. Wiley, S. Bacon, E. H. Teets, Jr., A. Sim, and J. Dominik), presented at the 2015 American Meteorological Society Meeting, January 3-8, 2015, Phoenix, Arizona.
795. Data Assimilation Models for Space Weather Specifications, Forecasts and Applications, presented at Space Dynamics Laboratory, *Invited*, February 6, 2015, Logan, Utah.
796. The USU-GAIM data assimilation models for ionospheric specifications and forecasts (L. Scherliess, R. W. Schunk, L. C. Gardner, L. Zhu, J.V. Eccles and J.J Sojka), Presented at the 2015 Ionospheric Effects Symposium, 12-14 May 2015, Alexandria, Virginia.
797. Space Weather Forecasting with a Multimodel Ensemble Prediction System (MEPS) of Data Assimilation Models (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, M. Butala, B. D. Wilson, A. Komjathy, C. Wang and G. Rosen), Presented at the 2015 Ionospheric Effects Symposium, 12-14 May 2015, Alexandria, Virginia.
798. Multimodel Ensemble Prediction System (MEPS): Ensemble Modeling with Data Assimilation Models for Space Weather Specifications and Forecasts, *Invited*, Overview talk presented at the LWS Heliophysics Science Technical Interchange Meeting, May 19-21, 2015, NASA Ames Research Park, Moffett Field, CA.
799. Ionospheric reconstructions with the Multi-model Ensemble Prediction System (MEPS), *Invited Talk*, (Schunk, R. W., L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, M. Butala, B. D. Wilson, A. Komjathy, C. Wang and G. Rosen), Presented at the CEDAR Meeting, June 21-25, 2015, Seattle, Washington.
800. Multi-Run Ionospheric Forecast Model results for geomagnetic storm periods, *Invited Talk*, (Eccles, V., R. W. Schunk and L. Gardner), Presented at the CEDAR Meeting, June 21-25, 2015, Seattle, Washington.
801. Ionosphere-Magnetosphere Coupling via Energized Ion Outflow, *Invited Talk*, Presented at

- the AGU Chapman Conference on Magnetospheric Dynamics, September 27 – October 2, 2015, Fairbanks, Alaska.
802. HF communications disruptions from a disturbed ionosphere, *Invited Talk*, (Rice, D., V. Eccles and R. W. Schunk), Presented at the Friends and Partners in Aviation Weather Forum, November 18-19, 2015, Las Vegas, Nevada.
  803. Modeling the Ionosphere-Thermosphere-Electrodynamics System for Space Weather Specifications, Forecasts and Applications, (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, M. Butala, B. D. Wilson, A. Komjathy, C. Wang, and G. Rosen), Presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2015, San Francisco, CA.
  804. Problems with Modeling Plasmasphere Refilling after Geomagnetic Storms, *Invited Talk*, (R. W. Schunk and K. Chatterjee), Presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2015, San Francisco, CA.
  805. Atmospheric radiation flight dose rates, (W. Kent Tobiska, D. Bouwer, D. Smart, P. Shea, J. Bailey, L. Didkovsky, K. Judge, H. Garrett, W. Atwell, B. Gersey, R. Wilkins, D. Rice, R. Schunk, D. Bell, C. Mertens, X. Xu, G. Crowley, I. Azeem, A. Reynolds, M. Wiltberger, S. Wiley, E. Teets, A. Sim, L. Dominik, B. Jones, S. Hong, and K. Yoon), Presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2015, San Francisco, CA.
  806. Comparing  $O^+$  and  $H^+$  Escape Fluxes from Fluid and Particle-in-Cell Solutions of the Polar Wind, (V. Eccles, R. W. Schunk and A. R. Barakat), Presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2015, San Francisco, CA.
  807. Diurnal Variations of Hemispheric Ion Outflow: Can the Ionosphere “wag” the Magnetospheric Tail?, (A. R. Barakat, V. Eccles and R. W. Schunk), Presented at the, December 14-18, 2015, San Francisco, CA.
  808. The missing solar irradiance spectrum: 1 to 7 nm, (J. J. Sojka, M. Lewis, M. David R. W. Schunk, T. Woods, F. Eparvier, and H. Warren), Presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2015, San Francisco, CA.
  809. Stormtime ionospheric outflow effects in global multi-fluid MHD, (K. Garcia-Sage, T. Moore, V. Eccles, V. Merkine, D. Welling, R. W. Schunk and A. R. Barakat), Presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2015, San Francisco, CA.
  810. Estimation of cold plasma outflow during geomagnetic storms, (S. Haaland, et al.), Presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2015, San Francisco, CA.
  811. The polar cap tongue of ionization: A survey of GPS TEC mapping from 2000 to 2014, (M. David, J. J. Sojka, R. W. Schunk and A. Coster), Presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2015, San Francisco, CA.
  812. Terminator field-aligned current system: Its dependencies on solar, seasonal, and geomagnetic conditions, (L. Zhu, R. W. Schunk, V. Eccles, L. Scherliess, J. J. Sojka, and L. Gardner), Presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2015, San Francisco, CA.
  813. Quantitative evaluation of ionospheric models for reproducing regional TEC during geomagnetic storms, (Ja-Soon Shim et al.), Presented at the Fall Meeting of the American Geophysical Union, December 14-18, 2015, San Francisco, CA.
  814. Multi-Scale Ionospheric Responses to the St. Patrick’s Day Storm (2015) Studied Using a Multimodel Ensemble Prediction System and GPS Data, (X. Pi, M. Butala, P. Vergadoes, A. J. Mannucci, A. Komjathy, R. Viereck, C. Wang, G. Rosen, R. W. Schunk, L.

- Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, and L. Zhu), AGU Fall Meeting, San Francisco, December 14-18, 2015.
815. *Advances in Modeling, Specifying and Predicting Space Weather*, (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, M. Butala, B. D. Wilson, A. Komjathy, C. Wang, and G. Rosen), Presented at the American Meteorological Society Meeting, January 11-14, 2016, New Orleans, LA.
  816. Atmospheric radiation flight dose rates, (Tobiska, W. K., D. Bouwer, J. Bailey, L. Didkovsky, K. Judge, W. Atwell, B. Gersey, R. Wilkins, D. Rice, R. W. Schunk, D. Bell, C. J. Mertens, X. Xu, M. Wiltberger, S. Wiley, and E. H. Teets Jr.), Presented at the American Meteorological Society Meeting, January 11-14, 2016, New Orleans, LA.
  817. An Ionospheric Multimodel Ensemble Prediction System, (Xiaoqing Pi, Anthony J. Mannucci, Attila Komjathy, Chunming Wang, Gary Rosen, Robert W. Schunk, Ludger Scherliess, Vince Eccles, Larry C. Gardner, Jan J. Sojka, and Lie Zhu), Presented at the International Beacon Satellite Symposium, 2016.
  818. Data Assimilation Models for Space Weather Specifications, Forecasts and Applications, *Invited Talk*, Presented at the Space Dynamics Laboratory, Utah State University, April 6, 2016, Logan, Utah.
  819. Space Weather Forecasting with a Multimodel Ensemble Prediction System (MEPS) of Data Assimilation Models, *Invited Talk*, (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, A. Komjathy, C. Wang and G. Rosen), Presented on my behalf by Jan Sojka at the CCMC Workshop, April 11-15, 2016, Annapolis, Maryland.
  820. Multimodel Ensemble Prediction System (MEPS): Ensemble Modeling with Data Assimilation Models for Space Weather Science, Specifications and Forecasts, *Invited Talk*, Overview talk presented at the LWS Heliophysics Science Technical Interchange Meeting, May 24-26, 2016, NASA Ames Research Park, Moffett Field, CA.
  821. Polar outflows and their sensitivity to O and H in the exosphere, *Invited Talk*, Presented at the CEDAR/GEM Meeting, June 19-24, 2016, Santa Fe, New Mexico.
  822. Auroral oval “images” in GPS TEC maps, (Michael David, J. J. Sojka, R. W. Schunk, A. J. Coster, and M. Nicolls), Presented at the Fall Meeting of the American Geophysical Union, December 12-16, 2016, San Francisco, CA.
  823. A multistream hydrodynamic model for the plasmasphere refilling problem following a geomagnetic storm, (Kausik Chatterjee and Robert W. Schunk), Presented at the Fall Meeting of the American Geophysical Union, December 12-16, 2016, San Francisco, CA.
  824. Ionospheric storm reconstructions with a Multimodel Ensemble Prediction System (MEPS) of data assimilation models: mid and low latitude dynamics, (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, A. Komjathy, C. Wang and G. Rosen), Presented at the Fall Meeting of the American Geophysical Union, December 12-16, 2016, San Francisco, CA.
  825. Electrodynamics of high-resolution waves in the ionosphere/thermosphere system – impacts on the ionospheric bottom-side profile, (L. C. Gardner, V. Eccles, R. W. Schunk, L. Scherliess, and L. Zhu), Presented at the Fall Meeting of the American Geophysical Union, December 12-16, 2016, San Francisco, CA.
  826. Ionospheric storm reconstruction with a Multimodel Ensemble Prediction System (MEPS) of data assimilation models: high latitude dynamics, (J. V. Eccles, R. W. Schunk, L. Scherliess, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, A. Komjathy, C.

- Wang, and G. Rosen), Presented at the Fall Meeting of the American Geophysical Union, December 12-16, 2016, San Francisco, CA.
827. Effects of the altitude variations of the equatorial vertical drifts on the ionospheric dynamics, (L. Zhu, R. W. Schunk, V. Eccles, L. Scherliess, J. J. Sojka, and L. Gardner), Presented at the Fall Meeting of the American Geophysical Union, December 12-16, 2016, San Francisco, CA.
  828. Data Assimilation Models for Space Weather Specifications, Forecasts and Applications, *Invited Talk*, Presented at the Space Dynamics Laboratory, Utah State University, March 17, 2017, Logan, Utah.
  829. Multimodel Ensemble Prediction System (MEPS): Ensemble Modeling with Data Assimilation Models for Space Weather Science, Specifications and Forecasts, *Invited Talk*, Overview talk presented at the LWS Heliophysics Science Technical Interchange Meeting, May 30 – June 2, 2017, NASA Ames Research Park, Moffett Field, CA.
  830. GNSS RO occultation data in the GAIM-FP model: Traditional occultation data ingest and extended slant TEC ingest with comparisons to GAIM-GM, (L. C. Gardner, R. W. Schunk, L. Scherliess and J. V. Eccles), Presented at the 32th URSI GASS Meeting, 19-26 August 2017, Montreal, Canada.
  831. The USU-GAIM-FP data assimilation model for ionospheric specifications and forecasts, (L. Scherliess, R. W. Schunk, L. C. Gardner, J. V. Eccles, L. Zhu and J. J. Sojka), Presented at the 32th URSI GASS Meeting, 19-26 August 2017, Montreal, Canada.
  832. Challenges in specifying and predicting space weather, (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, A. Komjathy, C. Wang and G. Rosen), Presented at the Fall Meeting of the American Geophysical Union, December 11-15, 2017, New Orleans, LA.
  833. Multimodel Ensemble Prediction System (MEPS) investigation of storm time variance characteristics across models and time, (L. C. Gardner, R. W. Schunk, L. Scherliess, and V. Eccles), Presented at the Fall Meeting of the American Geophysical Union, December 11-15, 2017, New Orleans, LA.
  834. Inferring polar ion outflows from topside ionograms, (J. J. Sojka, D. Rice, J. Vincent Eccles, R. W. Schunk, M. David, R. Benson, and G. James), Presented at the Fall Meeting of the American Geophysical Union, December 11-15, 2017, New Orleans, LA.
  835. A Flux-Corrected Transport Based Hydrodynamic Model for the Plasmasphere Refilling Problem following Geomagnetic Storms, (K. Chatterjee and R. W. Schunk), Presented at the Fall Meeting of the American Geophysical Union, December 11-15, 2017, New Orleans, LA.
  836. Data Assimilation Models for Space Weather, *Invited Talk*, Presented at the Space Dynamics Laboratory, Utah State University, March 16, 2018, Logan, Utah.
  837. USU GAIM data assimilation models for space weather specifications and forecasts, *Invited Talk*, (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, and L. Zhu), Space Weather Workshop, April 16-20, 2018, Westminster, CO.
  838. Ionosphere-Magnetosphere Coupling via Energized Ion Outflow, *Invited Talk*, Presented at the Southwest Research Institute, May 18, 2018, San Antonio, Texas.
  839. Challenge in specifying and predicting ionosphere disturbances, (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, A. Komjathy, C. Wang and G. Rosen), Talk given by L. C. Gardner, 42<sup>nd</sup> COSPAR Scientific Assembly, 14-22 July 2018, Pasadena, CA.
  840. Challenges in specifying and forecasting space weather, (R. W. Schunk, L. Scherliess, V. Eccles, L. C. Gardner, J. J. Sojka, L. Zhu, X. Pi, A. J. Mannucci, A. Komjathy, C. Wang

and G. Rosen), Presented at the Chapman Conference on Scientific Challenges Pertaining to Space Weather Forecasting Including Extremes, 11-15 February 2019, Pasadena, CA.

Thesis or Dissertation Advisor for the following students:

1. H. G. Demars; M.S., 1978  
*Transport Equations for Multispecies Plasmas Based on a bi-Maxwellian Distribution*
2. J. R. Conrad; M.S., 1981  
*A Study of Transport Processes in the Terrestrial Ionosphere and Atmosphere*
3. A. R. Barakat; Ph.D., 1982  
*On the Transport Equations for Anisotropic Plasmas*
4. H. G. Demars; Ph.D., 1986  
*On the Description of Space Plasmas Exhibiting Temperature Anisotropies for Subsonic Flow*
5. J. R. Conrad; Ph.D., 1987  
*A Study of Beam Driven Electrostatic Ion Cyclotron Instabilities in the Ionosphere*
6. M. Dwyer; M.S., 1987  
*Status of Spacecraft Charging at Low Earth Orbit Altitudes*
7. G. Wells; M.S., 1988  
*A Time-Dependent Model for the Low-Latitude Ionosphere*
8. D. R. Payne; M.S., 1991  
*Electron Heating and Ion Production Rates in Auroral and Sun-Aligned Arcs*
9. H. Bekerat; Ph.D., 2006  
*Evaluation of Plasma Convection Models and Their Effect on the High-Latitude Ionosphere*
10. G. Jee; Ph.D., 2006  
*Analysis and Interpretation of Total Electron Content Measurements*
11. L. Gardner; Ph.D., 2005  
*Neutral Atom Coupling of the High-Latitude Magnetosphere*
12. C. S. Wohlwend; Ph.D., 2008  
*Modeling the Electrodynamics of the Low-Latitude Ionosphere*
13. K. Chatterjee; Ph.D., 2019  
*The Development of Hydrodynamic and Kinetic Models for the Plasmasphere Refilling Problem Following a Geomagnetic Storm*

14. S. Thonnard, Ph.D., 2020

*Effects of the Radiation Belt on the Plasmasphere Distribution*

**Supervisory Committee Member for the Following Students:**

A. Acebal, Ph.D.  
M. Addae-Kagyah, Ph.D.  
R. Allen, M.S.  
T. Andriyas, Ph.D.  
I. Barghouthi, Ph.D.  
H. Bekerat, Ph.D.  
P.-L. Blelly, Ph.D.  
N. Chapagain, Ph.D.  
K. Chatterjee, Ph.D.  
D. Byers, Ph.D.  
T. Cade, Ph.D.  
J. Cahn, M.S.  
D. Della-Rose, Ph.D.  
W. F. Denig, Ph.D.  
V. Eccles, Ph.D.  
J. Emmert, Ph.D.  
C. Fish, Ph.D.  
S. A. González, Ph.D.  
C. Groves, Ph.D.  
D. Hansen, Ph.D.  
J. Herron, Ph.D.  
D. Hui, Ph.D.  
J. Jensen, Ph.D.  
E. B. Kluzek, M.S.  
L. Lomidze, Ph.D.  
J. Meehan, Ph.D.  
R. J. Mueller, M.S.  
J. R. Neilson, M.S.  
K. Nielsen, Ph.D.  
M. Olson, Ph.D.  
S. Patra, Ph.D.  
T. Pedersen, Ph.D.  
J. Pugmire, Ph.D.  
C. E. Rasmussen, Ph.D.  
H. J. Rhee, Ph.D.  
E. Saunders, M.D.  
S. Y. Sazykine, Ph.D.  
L. Scherliess, Ph.D.  
J. Shim, Ph.D.  
D. Siskind, M.S.  
T. Stark, M.S.  
D. Thompson, Ph.D.  
S. Thonnard, Ph.D.  
J. Trujillo, Ph.D.  
J. Ward, Ph.D.  
C. Wohlwend  
H.-Y. Wu, Ph.D.  
T. Wynn, Ph.D.  
L. Zhou, Ph.D.

## **Referee**

Dr. Schunk refereed papers for the following scientific journals:

- Journal of Geophysical Research – Space Physics
- Geophysical Research Letters
- Reviews of Geophysics
- Planetary and Space Science
- Annales of Geophysics
- Journal of Atmospheric and Terrestrial Physics
- Physica Scripta
- Physics of Fluids
- Plasma Physics
- Pure and Applied Geophysics
- Journal of Physics D – Applied Physics
- Advances in Space Research

Dr. Schunk also reviews proposals and projects for the following government agencies:

- National Aeronautics and Space Administration
- National Science Foundation
- Office of Naval Research
- Air Force Office of Scientific Research
- National Center for Atmospheric Research

## **CASS Director**

Dr. Schunk has been the Director of the Center for Atmospheric and Space Sciences at USU since 1983. The Center provides a strong interdisciplinary focus for applied and theoretical research related to basic processes present in the upper atmosphere, the ionosphere, and the magnetosphere of the earth. Currently, there are approximately 30 scientists, engineers, technicians and students working on space related projects in CASS. The support for research in CASS derives from Federal grants and contracts, with the funding level at about \$2,000,000 per year. CASS scientists use rockets, satellites, the Space Shuttle, radars, optical instruments and supercomputers to conduct their research. Dr. Schunk's role in CASS is to provide overall scientific direction, act as a liaison with upper administration at USU, assist individual Principal Investigators with proposal writing, attract new scientists, provide a contact point for funding agencies, and associated activities.

## **Federal Grant and Contract Activity Since 1976**

In recent years, Dr. Schunk has been the Principal Investigator on the following federal grants and contracts:

1. "Theoretical Investigations of Plasma and Neutral Gas Transport Processes in the Ionosphere"  
National Science Foundation  
9/1/76 - 8/31/78  
\$92,300
2. "Continuing Theoretical Investigations of Plasma and Neutral Gas Transport Processes in the Ionosphere"  
National Science Foundation  
9/1/78 - 8/31/80  
\$129,600
3. "Additional Theoretical Studies of Plasma and Neutral Gas Transport Processes in the Ionosphere"  
National Science Foundation  
9/1/80 - 8/31/82  
\$183,000
4. "The Flow of Plasma in the Solar-Terrestrial Environment"  
NASA  
7/1/80 - 6/30/83  
\$472,400
5. "Theoretical Studies of Dynamical Processes in the Ionosphere"  
National Science Foundation  
9/1/82 - 8/31/84  
\$232,000
6. "A Comparison of Ionospheric Model Predictions with MITHRAS Observations"  
AFOSR  
11/15/83 - 11/14/86  
\$160,000
7. "The Flow of Plasma in the Solar-Terrestrial Environment (Continued)"  
NASA  
7/1/83 - 10/31/86  
\$690,000

8. "Continuing Theoretical Studies of Dynamical Processes in the Ionosphere"  
National Science Foundation  
12/1/84 - 11/30/88  
\$437,000
9. "Space Science and Technology Program"  
Office of Naval Research  
8/15/85 - 12/31/86  
\$825,000
10. "The Flow of Plasma in the Solar-Terrestrial Environment (Continued)"  
NASA  
11/1/86 - 10/31/89  
\$715,000
11. "Center of Excellence in Theory and Analysis of the Geo-plasma Environment"  
AFOSR  
10/1/86 - 9/30/89  
\$1,200,000
12. "Continuing Theoretical Studies of Dynamical Processes in the Ionosphere (Continued)"  
National Science Foundation  
2/1/90 - 1/31/93  
\$405,000
13. "The Flow of Plasma in the Solar Terrestrial Environment (Continued)"  
NASA  
10/1/89 - 9/30/92  
\$750,000
14. "Center of Excellence in Theory and Analysis of the Geoplasma Environment"  
AFOSR  
10/1/89 - 9/30/92  
\$840,000
15. "Research on Orbital Plasma Electrodynamics (ROPE)"  
NASA  
5/4/87 - 12/31/93  
\$51,000
16. "The Flow of Plasma in the Solar Terrestrial Environment (continued)"  
NASA  
4/1/93 - 12/31/95  
\$835,000

17. "Continuing Theoretical Studies of Dynamical Processes in the Ionosphere (Continued)"  
National Science Foundation  
8/1/93 - 7/31/96  
\$445,437
18. "Research on Orbital Plasma Electrodynamics (ROPE) - Reflight"  
NASA  
1/1/94 - 2/28/97  
\$55,000
19. "Ionospheric and Thermospheric Weather: Simulations and Applications"  
Office of Naval Research (ONR)  
3/15/95 - 9/30/97  
\$310,000
20. "The Flow of Plasma in the Solar-Terrestrial Environment"  
NASA  
4/1/96 - 3/31/99  
\$810,000
21. "USU Participation in the Tethered Satellite Tether Separation Investigation"  
NASA  
10/1/96 - 6/30/97  
\$25,000 + \$5,000 = \$30,000
22. "Theoretical Studies of Dynamical Processes in the Ionosphere"  
National Science Foundation  
12/15/96 - 11/30/99  
\$465,000
23. "TSS-1R (ROPE) Additional Studies"  
NASA  
7/1/97 - 3/31/98  
\$70,000
24. "The Flow of Plasma in the Solar-Terrestrial Environment"  
NASA  
4/1/99 – 3/31/02  
\$840,000
25. "Global Assimilation of Ionospheric Measurements (GAIM)"  
ONR-MURI  
5/1/99 – 4/30/04  
\$3,490,000

26. "Continuing Theoretical Studies of Dynamical Processes in the Ionosphere"  
NSF  
4/1/00 – 3/31/05  
\$800,000
27. "The Flow of Plasma in the Solar Terrestrial Environment"  
NASA  
4/1/02 – 3/31/05  
\$915,000
28. "USU GAIM Data Assimilation Model: A Scientific Tool for the LWS Program"  
NASA  
6/15/04 – 6/14/07  
\$360,000
29. "Incorporation of UV Radiances Into the USU GAIM Models"  
Office of Naval Research (ONR)  
12/01/03 – 11/30/06  
\$465,000
30. "Improve and Transition the USU Gauss-Markov Kalman Filter Model for Operational Use"  
Office of Naval Research (ONR)  
6/15/04 – 9/30/04  
\$100,000
31. "Research and Development of the USU Full Physics Kalman Filter Model"  
Office of Naval Research (ONR)  
6/15/04 – 12/31/04  
\$100,000
32. "A Physics-Based Data Assimilation Facility for the Ionosphere-Plasmasphere-Polar Wind System"  
National Science Foundation  
8/1/04 – 7/31/07  
\$465,000
33. "The Flow of Plasma in the Solar Terrestrial Environment"  
NASA  
4/1/02 – 3/31/05  
\$930,000
34. "GAIM Source Code Implementation"  
Naval Research Laboratory  
9/1/03 – 1/31/04  
\$14,943

35. "USU Gauss-Markov Model: High Resolution Regional Capability and Support for AFWA"  
DoD/ONR  
3/1/05 – 2/28/06  
\$100,000
36. "Flow of Plasma in the Solar Terrestrial Environment"  
NASA  
5/1/05 – 4/30/09  
\$1,080,000
37. "Continuing Theoretical Studies of Dynamical Processes in the Ionosphere"  
National Science Foundation  
9/1/06 – 8/31/09  
\$499,999
38. "Space Environment Coupling in AF Systems Context"  
AFOSR  
9/1/06 – 12/31/06  
\$96,921
39. "Center for Space Weather"  
USURF/Space Dynamics Laboratory  
7/1/06 – 6/30/08  
\$50,000
40. "A thermosphere-ionosphere data assimilation model component for a seamless ocean-atmosphere model"  
ONR – DTRA  
10/1/06 – 9/30/09  
\$330,000
41. "SEMS/SWAFS Subcontract"  
Northrup Grumman  
1/24/07 – 12/31/08  
\$42,160
42. "Continued Development and Validation of the USU GAIM Models"  
ONR  
6/1/07 – 5/31/10  
\$495,000
43. "USU-GAIM: Maintenance and Upgrade of the Gauss-Markov Model"  
Naval Research Laboratory  
4/28/08 – 1/27/09  
\$186,000

44. "Studies to Improve GAIM Ionosphere Specifications and Forecasts"  
ONR  
7/1/08 – 9/30/08  
\$120,001
45. "USU Space Weather Initiative"  
State of Utah  
10/1/08 – 9/30/13  
\$4,000,000
46. "USU-SEMSII Space Weather Analysis and Forecast Systems CY09 Sustainment"  
Northrup Grumman  
1/1/09 – 12/31/09  
\$21,000
47. "Studies to Improve the Science in the GAIM-Full Physics Model  
Office of Naval Research  
1/1/09 – 12/31/12  
\$720,000
48. "SEMS II Space Weather Analysis and Forecast Systems (SWAFS)"  
Northrup Grumman  
11/5/09 – 09/30/10  
\$362,814
49. "SEMS II Space Weather Analysis and Forecast Systems (SWAFS)"  
Northrup Grumman  
9/16/10 – 3/31/11  
\$170,000
50. "SEMS II Space Weather Analysis and Forecast Systems (SWAFS)"  
Northrup Grumman  
4/27/11 – 5/7/12  
\$2,705.44
51. "Continuing Theoretical Studies of Dynamical Processes in the Ionosphere"  
National Science Foundation  
10/1/10 – 9/30/13  
\$300,000
52. "SEMS II Space Weather Analysis and Forecast Systems (SWAFS)"  
Northrup Grumman  
9/29/11 – 9/30/12  
\$675,932

53. “GEM Collaborative Proposal: The ionospheric source of magnetospheric plasma-measuring, modeling and merging in to the GEM Geospace General Circulation Model (GGCM)”  
National Science Foundation  
6/1/12 – 5/31/16  
\$266,660
54. “USU Support for ARMAS Phase II”  
Space Environment Technologies  
4/30/12 – 4/29/14  
\$91,000
55. “SEMS II (SWAFS)”  
Northrup Grumman  
10/31/12 – 1/29/14  
\$665,000
56. Scientific Studies of the High-Latitude Ionosphere with the Ionosphere Dynamics and ElectroDynamics – Data Assimilation (IDED-DA) Model”  
Office of Naval Research  
3/1/13 – 2/29/16  
\$285,001
56. “Physical Processes Governing Energy and Momentum Flows on Multiple Scales in Near-Earth Space Using a First-Principles-Based Data Assimilation System (DAS) for the Global Ionosphere”  
National Science Foundation  
5/1/13 – 4/30/18  
\$1,300,000
57. Collaborative Research: Investigations of the Mid-Latitude Ionosphere During Magnetic Disturbances: Observations, Modeling and Space Weather Impacts  
National Science Foundation, Award AGS-1242074  
8/15/13 – 7/31/16  
\$120,000
58. Magnetosphere-Ionosphere Coupling in the Solar System – A cross-Discipline Infrastructure Building Conference  
NASA, NNX14AE70G  
12/1/13 – 2/26/15  
\$35,391
59. “SEMS II (SWAFS)”  
Northrup Grumman  
3/10/14 – 4/6/15  
\$284,500

60. "SEMS II (SWAFS)"  
Northrup Grumman - Sustainment  
1/1/14 – 9/29/14  
\$2,056
61. "Continuing Theoretical Studies of Dynamical Processes in the Ionosphere"  
National Science Foundation  
06/1/15 – 5/31/18  
\$300,000
62. "SEMS III (SWAFS)"  
Northrup Grumman  
9/1/15 – 10/28/16  
\$459,000
63. "SEMS III (SWAFS)"  
Northrup Grumman  
9/1/16 – 4/30/17  
\$127,500
64. "Space weather-based Position error maps for TEC-On-line (SpoT-On)"  
Space Environment Technologies  
7/1/2018 – 6/30/2020  
\$200,000
65. "Physical Processes Governing Energy and Momentum Flows on Multiple Scales in Near-Earth Space Using a First-Principles-Based Data Assimilation System (DAS) for the Global Ionosphere"  
NASA  
2/28/19 – 2/27/20  
\$233,955
66. "GAIM-FP Tasks for Utah State University SEMS III Task Order WX32"  
Northrup Grumman  
10/1/19 – 9/30/20  
\$163,802

TOTAL FEDERAL FUNDING = \$32,469,077

## Research Interests and Accomplishments

Dr. Schunk's expertise lies in the general areas of plasma physics, fluid mechanics, atmospheric physics, ionospheric physics, magnetospheric physics, electricity and magnetism, and numerical analysis. During his career, Dr. Schunk has been involved in the development of numerous computer models of the solar-terrestrial environment, including the ionosphere, thermosphere, plasmasphere, polar wind, solar wind, as well as the Venusian and Jovian ionospheres. He has also been involved in the development of numerical models that describe active experiments and spacecraft-environment interaction problems. In addition, he has used particle-in-cell (PIC) numerical techniques to study plasma expansion phenomena, contact potentials, electron-beam plasma interactions, shock formation and propagation, plasma instabilities, nonlinear wave-particle and wave-wave coupling, and spacecraft charging problems. The following information pertains to the first 25 years of his 50-year career.

### 1. Mathematical Formulations for Space Plasmas

For more than 25 years, Dr. Schunk has been studying different mathematical approaches for modeling space plasmas. In the 1970's, he derived diffusion and heat conduction equations for collision-dominated gases and plasmas that included thermal diffusion, diffusion-thermal heat flow, and thermoelectric effects. These equations are now widely used to model planetary ionospheres and atmospheres. Subsequently, Dr. Schunk derived generalized transport equations that could be applied to plasmas that contained both collision-dominated and collisionless regimes as well as both subsonic and supersonic regimes. The first set of generalized transport equations was based on Grad's Maxwellian-based 13-moment system of equations, and these equations were used to study the polar wind, the solar wind, and subsonic flow on closed plasmaspheric field lines. For identical flow conditions, the results obtained from the 13-moment transport equations were compared to those obtained from the less rigorous, but widely used, Euler and Navier-Stokes systems of equations. The next set of generalized transport equations that Dr. Schunk used was the bi-Maxwellian based 16-moment set of equations. These equations were an improvement over the 13-moment set in that they could describe larger departures from a Maxwellian, i.e., larger temperature anisotropies and heat flow asymmetries. For both the supersonic polar wind and subsonic flow in the outer plasmasphere, the results from the 16-moment bi-Maxwellian equations were compared to those obtained from the Maxwellian-based 13-moment equations in order to understand their limits of applicability. The comparisons were done for both steady state and time-dependent situations, and the results were published in a series of papers.

Since the early 1980's, Dr. Schunk has not only used hydrodynamic and generalized transport models, but MHD, hydromagnetic, semikinetic, Monte Carlo, and macroscopic particle-in-cell models as well. Before the models were used for specific space physics applications, the different models were compared for similar flow conditions in order to elucidate the strengths and limitations of the different mathematical formulations. In one recent study, a *major breakthrough* was achieved with regard to comparing semikinetic and generalized transport formulations for steady state conditions. In this study, the solutions to the bi-Maxwellian based 16-moment set of transport equations were compared with those obtained from a semikinetic model for both supersonic and subsonic flow in the terrestrial polar wind as well as for supersonic flow in the solar wind. It was shown that for supersonic collisionless flow, the 16-moment transport theory and the semikinetic solutions were nearly identical over the whole spatial domain if care was exercised in making sure the boundary conditions were identical for the two models. Agreement was achieved for both the solar and polar winds. The nearly precise agreement between the 16-moment transport solutions and the semikinetic

solutions, which implicitly contain the full hierarchy of moment equations, indicates that moments higher than heat flow (flow of parallel and perpendicular thermal energies) are not needed to describe the steady-state solar and polar winds. Subsequent studies involved comparisons of Monte Carlo and 16-moment transport models, and it was shown that the generalized transport equations can describe weak conics on auroral field lines. For the polar wind, the macroscopic PIC and semi-kinetic models were compared and it was shown that the macroscopic PIC model could give acceptable results if a large number of simulation particles are used ( $\sim 2$  million for a 1-D polar wind simulation).

Within the generalized transport approach, Dr. Schunk compared the *Maxwellian-based* 5-moment, 8-moment, and 13-moment transport equations and the *bi-Maxwellian-based* 16-moment transport equations for the *same*, albeit simple, *time-dependent* polar wind scenario. It was found that the temporal evolution of the density and drift velocity profiles were the same for all transport levels that included heat flow (all agreed except the 5-moment level). This result is *significant* since it implies that a properly selected, relatively simple, set of transport equations can be used to describe the polar wind densities and velocities (i.e., it validates the 3-D polar wind model).

## 2. Ionosphere

During the last 25 years, Dr. Schunk conducted numerous studies of the effects that various magnetospheric and thermospheric processes have on the ionosphere, including convection electric fields, energetic particle precipitation, field-aligned currents, neutral winds, and gravity waves. In the early 1970's, Dr. Schunk concentrated on the study of various trough formation mechanisms, with the emphasis on the effect of convection electric fields. He was able to show, for the *first time*, that electric field ( $E_{\perp}$ ) heating leads to a significant  $O^+ \rightarrow NO^+$  composition change as well as an appreciable electron density depletion. It was shown that  $NO^+$  becomes an important ion in the F-region for  $E_{\perp} > 100$  mV/m and that it can be the dominant F-region ion for  $E_{\perp} > 150$  mV/m. This theoretical prediction was subsequently verified by both satellite and incoherent scatter radar measurements. At this time, Dr. Schunk also studied the effect that convection electric fields have on the ion velocity distributions in the E and F regions. In his first paper on this subject, he showed that, to lowest-order, the ion velocity distributions become bi-Maxwellian, with  $T_{\perp} > T_{\parallel}$ , as  $E_{\perp}$  increases. In a series of papers that followed, it was shown that at F-region altitudes the  $O^+$  velocity distribution evolves from a drifting Maxwellian, to a drifting bi-Maxwellian, and then to a drifting toroidal distribution as  $E_{\perp}$  increases from 10 to 150 mV/m. At E-region altitudes, the ion velocity distribution becomes bean-shaped for large  $E_{\perp}$ . These *new theoretical predictions* were later verified by both satellite and EISCAT radar measurements. The discovery of these non-Maxwellian features is significant because they affect chemical reaction rates, topside plasma scale heights, and the interpretation of both *in situ* satellite and ground-based radar measurements.

Dr. Schunk's ionospheric model started out as a single ion ( $O^+$ ) model of the mid-latitude ionosphere in 1970, evolved to a triple-ion ( $NO^+$ ,  $O_2^+$ ,  $O^+$ ) mid-latitude model in 1973, and then to a high-latitude model that incorporated the effects of particle precipitation and convection electric fields in 1975. Subsequently, with the help of colleagues, the model was extended to become the *first global ionospheric model*. In its current configuration, the model is a time-dependent, 3-dimensional, high-resolution, multi-ion model that covers the altitude range from 90 to 1000 km. With the model, the density distributions for six ions ( $NO^+$ ,  $O_2^+$ ,  $N_2^+$ ,  $O^+$ ,  $N^+$ ,  $He^+$ ) and  $T_e$  and  $T_i$  are obtained from a numerical solution of the appropriate continuity, momentum, and energy equations. Recently, this model has been selected to be the *official Air Force model* to be used for *Ionospheric Forecasts*. The model will provide 12-hour forecasts after it is installed at the Space Forecast Center at Falcon Air Force Base, Colorado Springs.

Over the years, the global ionospheric model has been used to study the *large-scale* climatology of the ionosphere, magnetic storm effects, and mesoscale ionosphere features. In addition to its use as a predictive tool, it has also been used in a large number of specific model-data comparisons in an effort to validate the underlying physics in the model. With regard to climatology modeling, about 120 simulations of the high-latitude ionosphere have been conducted (108 for one study) and numerous publications have resulted. The simulations showed how the tongue of ionization, polar hole, auroral enhancements, main electron density trough, ion composition, and temperature hot spots varied with solar cycle, season, geomagnetic activity (as expressed by Kp), universal time, and the IMF. The predicted variations were in favorable agreement with the existing measurements or were later shown to be in agreement with the measurements.

Some of the modeling concerning *mesoscale* ionospheric structures (100-1000 km) that Dr. Schunk has been involved in produced interesting new results. The studies include: (a) A theoretical study of the effect that '*structured precipitation*' has on the F-layer, and it was shown that F-region  $N_e$  enhancements can indeed form in just 10 minutes, as has been observed; (b) The *first study* of the effect that a distribution of '*electric field structures*' has on the ionosphere, and it was shown that it is effective in producing structured electron densities, ion temperatures, and ion compositions; (c) The *first study* of the '*lifetime and transport characteristics*' of already existing F-region density structures. It was found that the lifetime of an F-region density structure depends on several factors, including the initial location where it was formed, the magnitude of the density perturbation, season, solar cycle, and the IMF; (d) The *first study* that showed '*plasma patches*' can be created simply by varying the plasma convection pattern with time (i.e., by varying the IMF  $B_y$ ); (e) The *first study* of the effect that '*sun-aligned polar cap arcs*' have on the ionosphere. It was shown that the ionospheric response is nonlinear, with the largest effects occurring for intermediate arc widths and electric field strengths. It was also shown that as the ionospheric plasma convects across the arc, the  $O^+$  enhancement produced in the arc decays slowly and this yields a '*candle flame in the wind*' type of  $N_e$  distribution in the arc vicinity; and (f) The *first study* of the effect that '*traveling convection twin vortices*' have on the ionosphere. The vortices were shown to have an appreciable, albeit transient, effect on the ionosphere. The greatest effect occurs at altitudes between 140-300 km, where there is a significant increase in  $T_i$ , a substantial  $O^+ \rightarrow NO^+$  composition change, and a decreased electron density. The primary effect moves with the traveling twin vortices, but a smaller residual effect is left in their wake.

### 3. Thermosphere

Dr. Schunk has had a strong interest in elucidating the effect that mesoscale (100-1000 km) ionospheric structure has on the thermosphere. The ionospheric structure can appear in the form of propagating plasma patches, auroral and boundary blobs, and sun-aligned polar cap arcs. It can result from a variety of mechanisms including structured precipitation, sub-auroral convection channels (SAID events), and cusp plasma jets. Dr. Schunk's interest in this topic stems from the fact that ionospheric structure may not only affect the local thermosphere, but the cumulative effect of multiple ionospheric structures may affect the 'global mean' thermospheric circulation and temperature. In his early studies, Dr. Schunk used a 2-D, *steady state*, MHD model to study the momentum coupling between the ionosphere and thermosphere in the vicinity of sub-auroral convection channels and plasma troughs. It was found that convection channels have a pronounced effect on the thermosphere. An *important result* obtained was that in the lower thermosphere, the disturbance created by rapidly convection plasma in a latitudinally narrow channel (50-300 km) is confined to the channel, whereas in the upper thermosphere the convection channel acts to induce a thermospheric motion over a region that extends up to 1000

km on both sides of the channel owing to the effects of viscous dissipation in the horizontal direction.

More recently, Dr. Schunk was involved in the development of a *new time-dependent, global, thermospheric circulation model*. Although the model is fully global, it was specifically designed to handle mesoscale ionospheric structures. The model is based on a numerical solution of the continuity, momentum, and energy equations for a 'mean mass' neutral gas. It takes into account all of the processes contained in the NCAR and UCL/Sheffield TGCM's, including nonlinear advection, centrifugal and gravitational acceleration, the Coriolis force, pressure gradients, viscous dissipation, ion drag, thermal conduction, adiabatic expansion, and a host of heating and cooling processes. The equations are solved in a spherical coordinate system fixed to the Earth over the altitude range from 97 to 500 km using a flux-corrected-transport (FCT) numerical scheme. The FCT method has advantages over the numerical techniques used in the other TGCM's when one is interested in modeling discrete thermospheric features.

The new TGCM was used to study the effects that propagating plasma patches and sun-aligned polar cap arcs have on the thermosphere because their effects had not been previously studied. A *significant result* obtained from this study was that a propagating plasma patch acts as a *collisional snowplow*, creating a buildup of neutrals at the front of the patch and a decreased neutral density both in and behind the plasma patch. The neutral disturbance that is induced by, and moves along with, the plasma patch is characterized by a temperature enhancement, an increased wind speed, neutral gas upwelling, and O/N<sub>2</sub> composition changes. Sun-aligned polar cap arcs cause similar, but smaller, thermospheric perturbations.

#### 4. Plasmasphere

Dr. Schunk has developed new plasmaspheric models and has published several papers on plasmopause formation mechanisms, plasmasphere refilling characteristics during and after geomagnetic storms, the plasmaspheric wind, the annual plasmaspheric variation, and ionosphere-plasmasphere coupling along geomagnetic field lines in the vicinity of the plasmopause.

During the late 1970's, Dr. Schunk derived a set of diffusion and heat conduction equations for a collision-dominated multi-ion plasma that were applicable to the inner plasmasphere. These equations, which contained thermal diffusion and diffusion-thermal heat flow effects, are being used in all major models of the inner plasmasphere. In the late 1970's, Dr. Schunk was also the *first* to apply generalized transport equations to the plasma on magnetic field lines in the outer plasmasphere, where the plasma varies from collision-dominated to collisionless regimes as altitude increases. The generalized transport equations were based on the Maxwellian-based 13-moment system. A *significant result* obtained was that when the electron density becomes of the order of  $10^3 \text{ cm}^{-3}$  and/or the ion and electron temperatures become greater than about 5000 K, the plasma becomes collisionless and the standard Spitzer conductivities become invalid.

More recently, Dr. Schunk has been involved in the construction of the *first*, bi-Maxwellian based, 16-moment, multi-ion (H<sup>+</sup>, He<sup>+</sup>, O<sup>+</sup>) generalized transport model. The numerical model, which is steady state and 1-dimensional, calculates self-consistent densities, drift velocities, parallel and perpendicular temperatures, heat flows for parallel and perpendicular energies, and corresponding velocity distributions for H<sup>+</sup>, He<sup>+</sup>, O<sup>+</sup>, and electrons at altitudes between 1000-12,000 km. The model was used to study the transport of heat from high to low altitudes along plasmopause field lines connected to sub-auroral red arcs (SAR-arcs). The SAR-arcs occur because the interaction of the energetic ring current plasma with the upflowing cold ionospheric

plasma results in an energy transfer from the hot to cold plasmas. The heat then flows down along  $\mathbf{B}$  to F-region altitudes, raising  $T_e$  and exciting the atomic oxygen red line at 6300 Å. A *significant result* obtained from this study was that not only are the ion and electron heat flows collisionless, but the velocity distributions can become highly non-Maxwellian. For large downward heat flows in the Earth's converging geomagnetic field geometry, the electron velocity distribution develops an elongated tail in the downward direction which evolves into a secondary peak (*double-hump*) at about 6500 km. The double-hump distribution disappears at lower altitudes ( $\sim 1500$  km) due to the increasing importance of collisions. The appearance of the double-hump distribution is significant because if it is unstable, then all of the currently used models of the outer plasmasphere become invalid above 6500 km.

Dr. Schunk also helped develop the *first* 3-dimensional, time-dependent model of the *global plasmasphere* ( $L = 1.5$  to 4) in order to study time-dependent ionosphere-plasmasphere coupling phenomena. The model solves the nonlinear hydrodynamic continuity and momentum equations along closed magnetic flux tubes for *multiple  $H^+$  streams* arising from the conjugate hemispheres. This model takes account of production and loss of  $H^+$ , collisions of  $H^+$  and  $O^+$ , and the motion of plasmaspheric flux tubes in response to convection electric fields (cross-L drifts). The model includes the inertial terms in the momentum equations so that supersonic flow and low frequency wave phenomena can be studied. A *significant new result* obtained with the model concerned the early refilling characteristics of flux tubes depleted during geomagnetic storms. With the older, and widely-used, single-stream  $H^+$  models, the initial interaction of the counterstreaming  $H^+$  plasmas from the conjugate hemispheres led to a pair of shocks that formed at the equator and then propagated down to the conjugate ionospheres. However, this result was shown to be an artifact of the single fluid model, which requires a zero drift velocity at the equator when the equal and opposite  $H^+$  flows first meet at this location. When the multi-stream  $H^+$  model was used, the  $H^+$  streams from the conjugate hemispheres penetrated each other when they met at the equator and shocks did not form.

## 5. Polar Wind

The 'classical' polar wind is an ambipolar outflow of thermal plasma from the terrestrial ionosphere at high latitudes. The outflow, which consists primarily of  $H^+$ ,  $He^+$ , and  $O^+$ , begins at about 800 km. As the ions flow up and out of the topside ionosphere along diverging geomagnetic field lines, they are accelerated and eventually become supersonic (above 1300 km). Measurements have clearly shown that the polar wind is a significant source of plasma for the magnetosphere and that its interaction with the hot magnetospheric plasma is both complex and dynamic. Because of its importance, Dr. Schunk has been studying the polar wind for about 20 years.

In the course of studying the polar wind, Dr. Schunk has been involved in the development of a wide range of polar wind models, including the following:

- (a) Hydrodynamic model of the '*steady state*' polar wind. A solution to the continuity, momentum, and energy equations for  $O^+$ ,  $H^+$ , and electrons over the altitude range from 200-3000 km. Valid for both subsonic and supersonic  $H^+$  outflow.
- (b) Generalized multi-ion transport models of the '*steady-state*' polar wind (both 13-moment and 16-moment). The models are based on Gear's stiff differential equation solver. Valid for collision-dominated and collisionless flows and provides a continuous transition between the two regimes. Reduces to the hydrodynamic model in the collision-dominated limit, and takes account of temperature anisotropies and collisionless viscosity in the opposite limit.

- (c) Kinetic model of the ‘*steady-state*’ collisionless, polar wind. Takes account of temperature anisotropies, collisionless viscosity, and the effects of hot magnetospheric populations.
- (d) Generalized transport models for the ‘*time-dependent*’ polar wind. The models are based on the flux-corrected-transport (FCT) numerical technique. Separate models are available for the standard, 8- and 13-moment sets of transport equations, which are Maxwellian based systems, as well as for the 16-moment bi-Maxwellian based transport equations.
- (e) Macroscopic particle-in-cell (PIC) model for the ‘*time-dependent*’ polar wind. Solution is obtained along a diverging magnetic flux tube including the electrostatic, gravitational and magnetic mirror forces as well as Coulomb collisions.

Dr. Schunk studied numerous polar wind mechanisms, many of them for the first time, and was able to elucidate important processes. These studies include: (a) The *first* study of the effect that electric field heating has on the polar wind, and it was shown to have a pronounced effect on the  $H^+$ ,  $He^+$ , and  $O^+$  densities, drift velocities, and temperatures; (b) Showed, for the *first time*, that elevated ionospheric electron temperatures ( $\sim 8000$ - $10,000$  K) lead to significant escape fluxes of suprathermal  $O^+$  ions; (c) Showed that, contrary to previous claims, this is no charge exchange barrier in the polar wind; (d) Showed, for the *first time*, that the interaction of the cold polar wind electrons with the hot magnetospheric (polar rain) electrons can lead to a contact surface (double layer electric field) between the two populations. It was also shown that this outwardly-directed double layer electric field can energize the polar wind ions up to a few keV; (e) Conducted the *first* studies of the polar wind's stability. It was shown that even though the  $H^+$  velocity distribution becomes highly non-Maxwellian at high altitudes, it is still stable to electrostatic oscillations. However, it was also shown that auroral  $H^+$  and  $O^+$  beams passing through the classical polar wind can destabilize the flow; (f) Calculated the maximum (or limiting)  $H^+$  and  $O^+$  escape fluxes possible for a wide range of seasonal, solar cycle, and geomagnetic activity conditions; (g) Conducted a study of the multi-ion character of the polar wind that included both atomic ( $O^+$ ,  $H^+$ ,  $He^+$ ) and molecular ( $NO^+$ ,  $O_2^+$ ,  $N_2^+$ ) ions; (h) Was the *first* to show that a forward-reverse shock pair forms in the polar wind in response to the artificial injection of a plasma from either a rocket or satellite; (i) Was the *first* to show that shocks can occur naturally in the polar wind in response to an elevated  $T_e$  as the plasma convects into the auroral oval. This is significant because it means that the energy and momentum coupling between the ionospheric and magnetospheric plasmas is more complicated than previously thought. Specifically, the passage of a shock through a magnetospheric population could destabilize the magnetospheric plasma; (j) Was the *first* to show that as the polar wind passes through the transition region that separates the collision-dominated and collisionless regimes, the  $H^+$  velocity distribution becomes double-humped. This is significant because such a distribution might lead to plasma instabilities or enhanced thermal fluctuations; and (k) Conducted the *first* study of the effect that downward propagating electromagnetic waves have on the upflowing polar wind, and it was shown that these waves can heat the polar wind ions in a direction perpendicular to  $\mathbf{B}$ , thereby significantly increasing their escape fluxes and energies.

Dr. Schunk also constructed the *first* 3-dimensional, time-dependent, multi-ion model of the *global polar wind* in order to study the temporal evolution of ion outflow during magnetic storms and substorms. The model covers the altitude range from 120 to 9000 km. At low altitudes (120-800 km), 3-dimensional distributions for the  $NO^+$ ,  $O_2^+$ ,  $N_2^+$ ,  $N^+$ , and  $O^+$  densities and the ion and electron temperatures are obtained from a numerical solution of the appropriate continuity, momentum, and energy equations. At high altitudes (500-9000 km), the time-dependent nonlinear, hydrodynamic equations for  $O^+$  and  $H^+$  are solved self-consistently with the ionospheric equations taking into account collisions, charge exchange chemical reactions,  $\mathbf{B}$ -field divergence, and ion temperature anisotropies. The model can describe

supersonic ion outflow, shock formation, and ion energization during plasma expansion events. The model was subsequently used to study the temporal evolution and 3-D structure of the ionosphere-polar wind system during a magnetic storm for four geophysical cases (summer and winter solstices for solar maximum and minimum).

The global polar wind simulations produced some *very significant* and surprising results: (1) During increasing magnetic activity, there was an increase in the polar wind outflow rate over the entire polar region, but *localized holes* developed in the polar cap where the outflow rate was lower; (2) The polar wind displayed *more structure* than the underlying ionosphere because of both horizontal plasma convection and changing vertical propagation speeds due to spatially varying ionospheric temperatures. Upflows, downflows, and counterstreaming  $H^+O^+$  flows developed as the plasma convected into and out of sunlight, the cusp, the polar cap, the nocturnal oval, and the main plasma trough; (3) The time constant for moving from one high-latitude region to another was comparable to the time it takes the polar wind to flow from the topside ionosphere to 9000 km. Hence, it is *critical to take account* of changing ionospheric boundary conditions in polar wind modeling; and (4) During the storm, the temporal variation of the polar wind density at high altitudes *was opposite* to that at low altitudes for one of our geophysical cases. Specifically, at 9000 km there was a relative decrease in the  $H^+$  density during the storm, whereas at 500 km there was an increase in the  $H^+$  density. This opposite temporal variation indicates that, in general, it is not possible to relate *in situ* measurements made at high altitudes directly to stormtime changes in the underlying ionosphere.

## 6. Solar Wind

Dr. Schunk was involved in the development of several models of the solar wind, and he published several papers concerning the transport and energization of the solar wind plasma. Both 2-D and 3-D hydrodynamic models and a 2-D magnetohydrodynamic (MHD) model of steady corotating solar wind streams were constructed in order to study the latitudinal structure of the solar wind. Contrary to the predictions of the hydrodynamic models, the MHD model predicted that the latitudinal structure of the steady solar wind is determined by a dynamic balance between the magnetic and gas pressures. A proton number density maximum near the magnetic neutral line was found to exist regardless of whether there was a density maximum or minimum at the inner boundary of the calculation (0.15 AU). The drift motion of the magnetic field lines toward the magnetic neutral line enhances the magnetic field strength around the neutral sheet, which may explain the discrepancy between the measured IMF at 1 AU and that extrapolated from the photospheric  $\mathbf{B}$  by the current source-surface model.

A more rigorous, bi-Maxwellian based, 16-moment set of generalized transport equations was also used to study the evolution of the solar wind. The equations could describe electrons and multiple ion species, but were limited to steady state and 1-dimensional flows. A numerical solution of the 16-moment transport equations from 28 to 214 Rs yielded electron and proton densities, drift velocities, temperature anisotropies, heat flow asymmetries, and distribution functions at 1 AU that were in agreement with measurements. It was also shown that Coulomb collisions affect the different parameters differently, and correct temperature anisotropies and heat flow asymmetries can only be obtained if they are included in a rigorous manner. In another study, it was shown that the 16-moment expression for the distribution function can describe almost all of the proton distributions ( $\sim 80\%$ ) measured at both 28 Rs and 1 AU, including isotropic distributions, distributions for which only the core is isotropic, distributions elongated in the  $\mathbf{B}$  direction, distributions with cores elongated in a direction perpendicular to  $\mathbf{B}$  and with high-velocity tails parallel to  $\mathbf{B}$ , and distributions with two peaks (halo and core). This indicates that the generalized 16-moment transport equations can properly describe the solar wind most of the time. It also implies that the commonly used hydrodynamic equations, augmented with

parameterized conductivities, cannot properly describe the spatial evolution of temperature anisotropies and heat flow asymmetries in the solar wind.

## 7. Magnetosphere-Ionosphere Coupling

Dr. Schunk has studied the connection between the large-scale convection electric fields, field-aligned currents, and particle precipitation at high latitudes. The studies were conducted with a polar electrodynamic model, which was based on a numerical solution of Ohm's law and the current-continuity equation. Given a measured field-aligned current distribution and calculated ionospheric conductivities, the model calculates self-consistent convection electric fields and horizontal E-region currents. This electrodynamic model was used to conduct the *first* current-conductivity simulations for *northward IMF*. Measured field-aligned currents were used in an effort to determine whether 3-cell, 4-cell, or distorted 2-cell convection patterns occur during northward IMF and several papers were published on the subject. Unfortunately, because of a data gap on the dayside, the field-aligned currents had to be extrapolated and, depending on the extrapolation, different patterns could be obtained. To date, the form that the convection pattern takes for northward IMF is still controversial.

Dr. Schunk also participated in the development of an electrodynamic model for sun-aligned polar cap arcs. This model was based on a numerical solution of the time-dependent, 2-dimensional, magnetohydrodynamic (MHD) equations, and it was the *first model* in which the electrodynamics of the arcs is treated self-consistently in the frame of the coupled magnetosphere-ionosphere system. The model was used to study the effect of background convection and conductivity distributions on the arc dynamics as well as to study the occurrence and spacing of multiple polar cap arcs. A *significant result* obtained from recent simulations is that multiple polar cap arcs may not be due to multiple shears in the magnetosphere, but instead may result from the active role the ionosphere plays in the electrodynamic coupling between the ionosphere and magnetosphere. The edge-to-edge spacing between multiple arcs was predicted to vary from about 20 km to about 60 km when the ratio of the Hall-to-Pedersen conductances in the arc varies from 1 to 2. This prediction was subsequently verified with measurements from an All-Sky Intensified Photometer.

Dr. Schunk has also been involved in a series of studies concerning auroral energization processes. The studies were conducted with a 2.5-dimensional PIC simulation code. Both narrow and wide field-aligned current sheets were considered. The simulation results displayed electrostatic double layers, upflowing ion beams and conics, both downflowing and upflowing electron beams, several wave modes, and a variety of other nonlinear phenomena. The features seen in the simulations were similar to those observed in the auroral plasma.

## 8. Planetary Ionospheres/Comets

Dr. Schunk was involved in a few studies concerning planetary ionospheres and comets. He used a particle-in-cell simulation technique to study the charging characteristics of the ICE and Giotto spacecraft in cometary environments. He used a semikinetic model to study the polar wind outflow from the Jovian polar caps and found that the ionosphere may play an important role in populating the Jovian magnetosphere. Dr. Schunk also studied the extent to which thermal diffusion and diffusion-thermal heat flow can affect the Venus ionosphere. *One year before* the Pioneer Venus spacecraft went into orbit around Venus, Dr. Schunk *predicted that thermal diffusion* should have a dominating effect on the ionospheric densities if the ion temperature gradients are greater than about 2 K/km. Subsequent measurements by the Pioneer Venus Orbiter confirmed the importance of thermal diffusion. Dr. Schunk also noted that the

supersonic flow of the Venus ionosphere across the terminator could lead to appreciable ion temperature anisotropies, and he also co-authored a comprehensive review on ‘ionospheres of the terrestrial planets.’

## 9. Expanding Plasma Clouds

Dr. Schunk was involved in the development of several numerical models of expanding plasma clouds. The models were used in an effort to elucidate basic plasma expansion phenomena because of their relevance to certain solar-terrestrial flows (solar wind, polar wind, interhemispheric flow, etc.), and in an effort to study the expansion characteristics of artificial plasma clouds injected into the ionosphere via rockets, satellites, or the Space Shuttle. Studies were conducted with a 1-dimensional Vlasov-Poisson code and a 2.5-dimensional particle-in-cell (PIC) code in order to study plasma expansion phenomena on a small scale. Studies were also conducted with macroscopic 1-D, 2-D, and 3-D fluid models, and the results obtained from the various macroscopic and small-scale models were compared for similar expansion scenarios. The 3-D fluid model is the *most comprehensive model* developed to date. It is based on a numerical solution of the time-dependent fluid equations for both the expanding plasma cloud and background ionosphere. It is a multi-grid model that takes account of ion inertia, pressure gradients, collisions, chemical reactions, the large parallel-to-perpendicular ionospheric conductivity difference, and electrical coupling to the E-region and topside ionosphere. In his first study of small-scale plasma expansions in 1987, Dr. Schunk showed, *for the first time*, that an expanding plasma cloud acts as an *electrostatic snowplow*, creating a  $O^+$  hole in the ionosphere coincident with the cloud (factor of 10) as it pushes  $O^+$  density bumps (factor of 2) ahead of it along the geomagnetic field. It was also shown that if the cloud has a bulk velocity component along  $\mathbf{B}$ , which occurs for chemical releases from spacecraft, deep asymmetric ionospheric holes can be created as well as very large  $O^+$  density bumps. These predicted features were evident in all subsequent simulations involving progressively more rigorous mathematical formulations. The predictions were also later verified in barium cloud experiments.

## 10. High Voltage Spheres

Dr. Schunk published a series of papers concerning the interaction of a high-voltage sphere with the low-earth-orbit (LEO) plasma environment. The theoretical work was done in support of the SPEAR rocket experiments, laboratory experiments, and the TSS Space Shuttle mission (electrodynamic tether). The goal of the work was to elucidate the current collection characteristics of high voltage (10,000-50,000 V) elements exposed to the ionospheric plasma. The simulations were primarily based on a numerical solution of the time-dependent, 3-dimensional, nonlinear fluid equations for the plasma and the Poisson equation, although a 3-D PIC code was used in one study. Simulations were conducted for a wide range of conditions, including positive and negative potentials, different potential magnitudes and rise times, magnetized and unmagnetized plasmas, partially-ionized and fully-ionized plasmas, different background neutral densities and species ( $N_2$ , O, Ba, Ar), and different magnetic field strengths. Depending on the conditions, the plasma response to a high-voltage sphere involves a propagating spherical double layer, an electron ring, a stable rapidly-rotating electron density torus, as well as spherical and toroidal discharges. For a positive high-voltage (10-10,000 V) sphere in an unmagnetized plasma, the simulations showed, *for the first time*, that a spherical double layer forms around the sphere at early times and then propagates away, eventually slowing down and disappearing. This new feature was found to have a pronounced effect on the current collection. For a positive high-voltage sphere in a partially-ionized magnetized plasma, the simulations produced a stable rapidly-rotating electron density torus around the sphere in the

equatorial plane, a toroidal discharge, or a spherical discharge, depending on the density of the background neutrals. These results were able to explain previous laboratory experiments.

## 11. Solar Cells

Dr. Schunk published a series of studies concerning the interaction of solar arrays with the ionospheric plasma. The work was motivated by the fact that solar cell voltages will need to be elevated to 100-250 V on future space missions in order to minimize mass requirements and resistive losses of the solar arrays. However, as shown in laboratory experiments, these elevated voltages can yield hazardous conditions, including anomalous current surges, arcing, and continuous power drains. The goal of the theoretical work was to determine the electric field structure at the critical locations on the solar array where arcing is likely to occur. In general, it could occur at the interconnector-dielectric interface, solar cell edge, or gap regions. The simulations were conducted with a 2.5-dimensional particle-in-cell numerical technique, in which particles are followed in response to self-consistent electric fields. A range of conditions was considered, including both positive and negative voltages, different solar cell thicknesses, different materials, and different voltage turn-on times. For positive voltages, the simulations showed that arcing primarily occurs at the interconnector-dielectric interface, while for negative voltages it can occur at the gap region between adjacent solar cells and at the solar cell edge-substrate interface. The simulation results were in agreement with laboratory experiments concerning arcing characteristics, and they provided invaluable insight into the conditions leading to the buildup of large electric fields at certain locations.