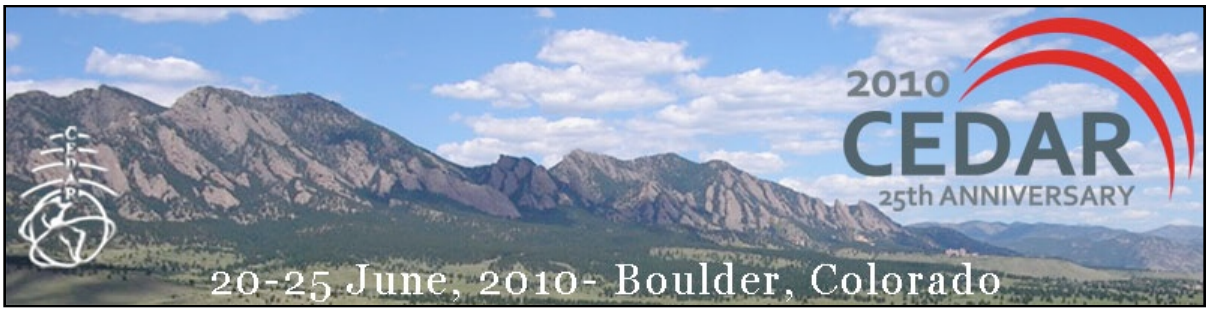
COUPLINGS, ENERGETICS AND DYNAMICS OF ATMOSPHERIC REGIONS

The Cedar Post

Spring 2010 | Issue #57 May 2010



Letter from the CSSC Chair

Welcome to the Spring 2010 issue of the CEDAR Post! This year marks the 25th anniversary of CEDAR Workshops and will be celebrated by holding an evening banquet on Monday (June 21) at the Millennium Hotel during the week of the CEDAR 2010 Workshop. The banquet will be open to all who have registered for the CEDAR workshop and will include an awards ceremony and anecdotal talks by longtime members of the CEDAR community – Michael Mendillo, Jerry Romick, and Joe Salah.

A detailed agenda of the CEDAR 2010 Workshop is included in this issue. The Poster Session will be held from 4-7pm on Tuesday and Wednesday night in the beautiful club level of the CU football stadium. I am pleased to announce that Dr. Paul Bernhardt was awarded the CEDAR Prize Lecture and Dr. Ray Roble will give the first CEDAR Distinguished Lecture. The Workshop will also highlight a future direction for CEDAR through talks and documents detailing its new strategic plan for the coming decade, called CEDAR: The New Dimension. This is an exciting time for CEDAR.

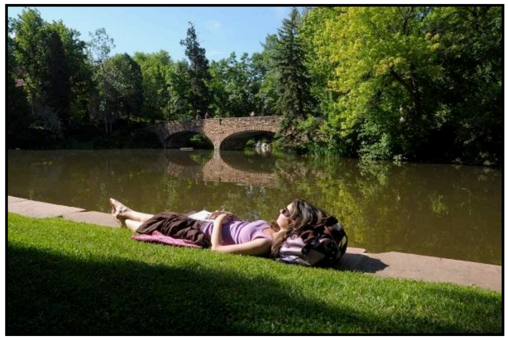
This is my last CEDAR Post issue as CSSC chair and I want to thank everyone for their support and guidance during my three year tenure. Dr. John Foster of MIT Haystack Observatory will take over the reins after the CEDAR 2010 workshop.

Jeff Thayer,
University of Colorado

Update from NSF

Outcome of the NSF CEDAR 2009 Competition

Proposal Title	Institution	PI Name
CEDAR: Quantitiative Assessment of Proton Aurora Using State-of-the-art Models	Trustees of Boston University	Chakrabarti, Supriya
CEDAR: Dynamics of the Neutral Upper Atmosphere and Coupling to the Topside Ionosphere	Scientific Solutions Incorporated	Kerr, Robert B.
Collaborative Research: CEDAR--Application of the RENOIR System in Brazil to Study the Gravity Wave Trigger Mechanism In the Production of Equatorial Spread F and Scintillations	University of Illinois at Urbana-Champaign	Makela, Jonathan J.
Collaborative Research: CEDAR--Application of the RENOIR System in Brazil to Study the Gravity Wave Trigger Mechanism In the Production of Equatorial Spread F and Scintillations	Clemson University	Meriwether, John W.
CEDAR: Physics of the Hydrogen Geocorona	University of Wisconsin-Madison	Mierkiewicz, Edwin J.
CEDAR: Natural and Rocket-Triggered Lightning in the Mesosphere-Lower Thermosphere-Ionosphere (MLTI) System	University of Florida	Moore, Robert C.
CEDAR: Investigating Atmospheric Effects of Energetic Particle Precipitation Using Whole Atmosphere Community Climate Model (WACCM)	University of Colorado at Boulder	Randall, Cora E.
CEDAR: Effects of Orographic Forcing on the Southern Mid-Latitude Mesosphere	Trustees of Boston University	Smith, Steven M.
CEDAR: Interactions of Short-Period Gravity Waves with the Horizontally-Inhomogeneous Structure of the MLT Region	Utah State University	Snively, Jonathan B.
CEDAR: Investigation of Baroclinic Disturbances in the Polar Wintertime Middle Atmosphere	University of Colorado at Boulder	Thayer, Jeffrey


CEDAR 2010 Workshop

We are looking forward to the CEDAR workshop's return to Boulder! The 2010 workshop will mark the 25th anniversary of CEDAR. As you can see from the following agenda, many activities are planned.

Agenda for 2010 CEDAR Workshop
20 June - 25 June 2010
University of Colorado
Boulder, Colorado

Sunday, 20 June 2010

	CEDAR Student Workshop (Non-students Welcome) **Theme – Equatorial Aeronomy: Phenomena and Outstanding Questions** **All sessions will be held in Math 100 unless otherwise noted**	**Co-Chairs:** **Elizabeth Bass (BU)** **Marco Milla (U IL)** **(CEDAR student reps)**
08:00-09:00	Registration, Sign Travel Vouchers	North Entrance to Math Bldg.
09:00-09:10	Student Welcome from NSF	F. Kamalabadi (NSF)
09:10-09:30	Student Welcome from CSSC	J. Thayer (CSSC chair)
09:30-09:40	Agenda Information and Organizational Details	E. Bass and M. Milla (CSSC student reps)
09:40-10:40	*Keynote Talk #1*: Equatorial Aeronomy from a Radar Perspective	D. Hysell (Cornell)
10:40-10:55	--- Break ---	
10:55-11:25	The Ionosphere in Motion: Winds, Waves and Electrodynamics	R. Varney (Cornell)
11:25-11:55	Meteors	J.Fentzke (CoRA)
11:55-12:00	URSI Student Opportunities	S. Briczinski (U WI)
12:00-13:30	Lunch on own at UMC or area restaurants	
13:30-14:00	Equatorial Electrojet	P. Alken (NOAA)
14:00-14:30	Equatorial Spread F	E. Miller (APL)
14:30-14:45	--- Break ---	
14:45-15:45	*Keynote Talk #2*: Modeling and Forecasting the Equatorial Ionospheric Density and Scintillation	O. de La Beaujardiere (AFRL)
15:45	Adjourn	
16:00-19:00	Free time for student recreation (Annual CEDAR Soccer Game, Ultimate Frisbee; etc)	Business Field
19:00-20:00	Pizza and Salad for Students and Soccer Players	Outside Darley Commons at Williams Village

Monday, 21 June 2010

All sessions will be held in Math 100 unless otherwise noted

07:15-08:00	Registration	North Entrance to Math Bldg.
08:00-08:15	Welcome from NSF/CSSC	R. Behnke (NSF) J. Thayer (CSSC)
08:15-08:20	Introduction of CEDAR Postdocs	F. Kamalabadi (NSF)
08:20-08:30	Introduction of Students by Institution	M. Milla (U IL)
08:30-08:40	Report of Student Workshop	E. Bass (BU)
08:40-09:10	NSF Aeronomy and Geospace Reviews	F. Kamalabadi (NSF) R. Behnke (NSF)
09:10-09:40	--- Break ---	
09:40-10:00	Inception of the New CEDAR Plan	R. Robinson (NSF)
10:00-10:40	CEDAR: The New Dimension	J. Thayer (CSSC chair)
10:40-11:00	Future NSF Initiatives of Relevance to CEDAR	F. Kamalabadi (NSF)
11:00-11:15	Execution of the CEDAR Plan	J Foster (CSSC chair-elect)
11:15-13:00	Lunch on own	
13:00-15:00	• W#1: Jicamarca and C/NOFS: The Beginning of Solar Cycle 24 **(Math 100)** • W#1: North American Regional DASI **(Benson 180)** • W#1: Calibration of Optical Data **(Engineering 265)** • W#1: Small-scale Dynamics in the MLT: A Tribute to Edmond Dewan, a valued colleague and friend **(Engineering 245)**	• D. Hysell, J. Chau, M. Milla, O. de La Beaujardiere, R. Stoneback • A. Coster, J. Ruohoniemi, J. Baker • S. Nossal, J. Baumgardner • D. Fritts, D. Picard, J. Winick
15:00-16:00	Networking Break (coffee only) ---Or--- Students Meet with NSF **(Benson 180 with special snacks outside)** ---Or--- W#1.5: CARE 2 Planning Workshop **(Engineering 151)**	• P. Bernhardt
16:00-18:00	• W#2: Jicamarca and C/NOFS: The Beginning of Solar Cycle 24 (continued)**(Math 100)** • W#2: Midlatitude Stratosphere, Mesosphere and Lower Thermosphere (SMLT) Science Enabled by Lidar and Other Ground-based Observations **(Benson 180)** • W#2: Calibration of Optical Data (continued)**(Engineering 265)** • W#2: Lightning Effects on the Upper Atmosphere **(Engineering 245)** • W#2: Probing the Physics of the Ionosphere with Active Experiments **(Engineering 151)**	• D. Hysell, J. Chau, M. Milla, O. de La Beaujardiere, R. Stoneback • T. Yuan, M. Taylor, J. She • S. Nossal, J. Baumgardner • N. Liu, M. Stanley, M. Taylor • P. Bernhardt, P. Erickson, A. Bhatt
18:30-21:30	CEDAR 25th Anniversary Banquet	Ballroom of Millennium Hotel
~19:45-20:45	CEDAR 25th Anniversary Anecdotal Talks	J. Romick (U AK), J. Salah (MIT) and M. Mendillo (BU)
~20:45-21:15	CEDAR 25th Anniversary Perfect Attendance and Past CSSC Chair Awards	J. Thayer (CSSC Chair)

Tuesday, 22 June 2010

All sessions will be held in Math 100 unless otherwise noted

08:00-10:00	• W#3: Atmospheric Coupling During Stratospheric Sudden Warmings **(Math 100)** • W#3: Arecibo Friends **(Benson 180)** • W#3: Cubesat, Constellation Mission Planning **(Engineering 265)** • W#3: Recent Advances in Mid-latitude Thermosphere-ionosphere Interaction Study **(Engineering 245)**	• L. Goncharenko, H. Liu, L. Harvey, J. Chau • P. Santos, C. Brum, S. Gonzalez • G. Swenson, D. Klumpar • Q. Wu, R. Kerr
09:00-10:30	Put all Posters up in Stadium Club	5th Floor
10:00-10:30	--- Break ---	
10:30-11:15	CEDAR Prize Lecture: Using Active Experiments to SEE and HEAR the Ionosphere	P. Bernhardt (NRL)
11:15-11:30	The New Arecibo Heater: Status and Future Plans	M. Sulzer (Arecibo) or A. Bhatt (MIT)
11:30-13:30	Lunch on own	
13:30-15:30	• W#4: Atmospheric Coupling During Stratospheric Sudden Warmings (continued) **(Math 100)** • W#4: Low-latitude Ionospheric Sensor Network (LISN): Scientific Results and Future Projects **(Benson 180)** • W#4: Mid-to-high Latitude Ionospheric Irregularities and Experimental Opportunities with the Radio Aurora Explorer Satellite Mission**(Engineering 265)** • W#4: Ionospheric Data Assimilation: Driver Estimation **(Engineering 245)**	• L. Goncharenko, H. Liu, L. Harvey, J. Chau • C. Valladares, T. Bullett, J. Chau, V. Eccles, J. Sojka, R. Woodman • H. Bahcivan and J. Cutler • G. Bust, X. Pi
15:30-16:00	--- Break (coffee only) ---	
16:00-19:00	MLT Poster Session #1 and Reception	Stadium Club 5th Floor
19:15-21:45	CSSC Dinner Meeting	Zolo Southwestern Grill

Wednesday, 23 June 2010

All sessions will be held in Math 100 unless otherwise noted

08:00-09:00	CEDAR Distinguished Lecture: The NCAR Themrospheric General Circulation Models (TGCMs): Past, Present and Future	R. Roble (NCAR)
09:00-09:15	CEDAR Post-Doc Final Report #1: Magnetospheric Energy Input Uncertainty and its Impact on the Thermosphere/Ionosphere	Y. Deng (UT Arlington)
09:15-09:30	CEDAR Post-Doc Final Report #2: Temporal Modulations of the Four-peaked Longitudinal Structure of the Equatorial Ionosphere by Planetary Waves from COSMIC-GPS Occultations	G. Liu (UCB)
09:30-10:00	--- Break ---	
10:00-10:20	Memorial Talk #1: Remembering Henry Rishbeth	M. Mendillo (BU)
10:20-10:40	Science Highlight #1: Stormtime Ionospheric Redistribution at Mid-Latitudes: A Coupled Geospace Phenomenon	P. Erickson (MIT)
10:40-11:10	Science Highlight #2: Modeling Efforts to Explain Observed Trends in Upper Atmosphere and Ionosphere	L. Qian (NCAR)
11:10-11:30	Some Highlights from the TRENDS 2010 Workshop	S. Solomon (NCAR)
11:30-13:30	Lunch on own	
13:30-15:30	• W#5: Meteoroids and Meteors: Impact Effects **(Math 100)** • W#5: Satellite-based Measurements of the Ionosphere and Plasmasphere Using the Global Positioning System **(Benson 180)** • W#5: Andes Lidar Observatory (ALO) Workshop **(Engineering 265)** • W#5: World Day Planning **(Engineering 245)**	• S. Close and L. Dyrud • A. Mannucci, W. Schreiner, X. Yue, X. Pi • G. Swenson and A. Liu • I. Haggstrom , M. McCready
15:30-16:00	--- Break (coffee only) ---	
16:00-19:00	IT Poster Session #2 and Reception (non-judged posters down between 19:00-20:30, judged posters down between 20:15-20:30)	Stadium Club 5th Floor

Thursday, 24 June 2010

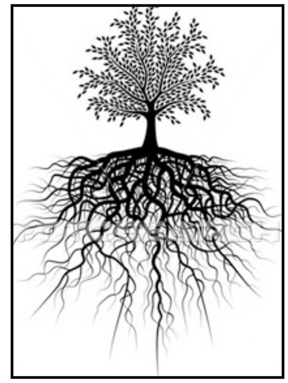
All sessions will be held in Math 100 unless otherwise noted

08:00-09:00	CEDAR Tutorial #1: The Earth's Hydrogen Corona	E. Mierkiewicz (U WI)
09:00-09:20	Science Highlight #3: CCMC Research and Education Resources for the CEDAR Community	J.S. Shim (CCMC)
09:20-09:30	Announcement of Poster Prize Winners	M. Conde and S. Skone (CSSC)
09:30-10:00	--- Break ---	
10:00-10:20	Memorial Talk #2: Remembering Bill Gordon	R. Behnke (NSF)
10:20-10:40	Science Highlight #4: PFISR Science: The First Three Years	J. Semeter (BU)
10:40-10:55	CEDAR Post-Doc Final Report #3: Nocturnal SHS observations of the 372.7nm O+doublet	S. Briczinski (U WI)
10:55-11:10	CEDAR Post-Doc Final Report #4: Airglow Signatures of Gravity Waves Near the Onset of Dissipation	J. Snively (USU)
11:10-11:15	Announcement of New CSSC Members	NSF
11:15-11:25	Announcement of the Transition of the CSSC Chair and Team	J. Thayer to J. Foster
11:25-13:30	Lunch on own ---Or--- CSSC Lunch (South Alcove of Stadium Club)	
13:30-15:30	• W#6: Magnetosphere-Ionosphere Coupling **(Math 100)** • W#6: Mini Lidar School for CEDAR Community **(Benson 180)** • W#6: Equatorial-PRIMO (Problems Related to Ionospheric Models and Observations) **(Engineering 265)** • W#6: Chemistry and Temperatures from the Upper Mesosphere to the Lower Thermosphere: Connecting Satellite Observations to Ground-based Measurement and Model Results **(Engineering 245)**	• J. Semeter, J. Sojka, B. Bristow, T. van Eyken, L. Zhu, M. Nicolls • X. Chu and C. She • T. Fang and D. Anderson • R. Bishop, S. Budzien, A. Stephan, S. Bailey, G. Crowley, S. Smith
15:30-16:00	--- Break (coffee only) ---	
15:45-17:45	W#7 Bus Field Trip to Table Mountain: Mini Lidar School for CEDAR Community	X. Chu and C. She
16:00-18:00	• W#7: High Latitude Plasma Structures (HLPS2) **(Math 100)** • W#7: Using WACCM for Studying the Atmosphere **(Benson 180)**	• J. Sojka, J. Semeter, B. Bristow, T. van Eyken, L. Zhu, M. Nicolls • A. Ridley, D. Marsh, H. Liu

Friday, 25 June 2010

All sessions will be held in Math 100 unless otherwise noted

08:00-10:00	• W#8: Recent Advances in Modeling the Ionosphere **(Benson 180)** • W#8: Turbopause: Measurements, Concepts and Implications **(Engineering 265)** • W#8: Equatorial Aeronomy Across South America **(Engineering 245)**	• J. Huba, R. Schunk, A. Ridley • G. Lehmacher, R. Collins, M. Larsen • J. Makela, A. Gerrard, J. Meriwether
10:00-10:30	--- Break ---	
10:30-12:30	• W#9: CEDAR Electrodynamics Thermosphere Ionosphere (ETI) Challenge **(Benson 180)** • W#9: Turbopause: Measurements, Concepts and Implications (continued) **(Engineering 265)** • W#9: Equatorial Aeronomy Across South America (continued) **(Engineering 245)**	• M. Kuznetsova, J.S. Shim, B. Emery, A. Ridley, J. Lei • G. Lehmacher, R. Collins, M. Larsen • J. Makela, A. Gerrard, J. Meriwether
12:30	ADJOURN	



CEDAR Roots

This section of the Post is to clarify terms or common concepts that are rooted in CEDAR science. The goal is that this material will help educate the community and the masses by also posting this material to Wikipedia. Through a culmination of material we hope the CEDAR science and program can be more visible to the general public through Wikipedia pages provided by experts in the field.

Penetration Electric Fields

Middle and low latitude radar and satellite observations show large electrodynamic (electric field and current) perturbations during periods of enhanced geomagnetic activity. These disturbances result from the interaction of solar wind electric fields and the coupled magnetosphere-ionosphere system. There are basically four main subauroral electrodynamic disturbance processes: extension of auroral zone electric fields and currents to lower geomagnetic latitudes, very large (up to about 100 mV/m) polarization electric fields at upper midlatitudes, penetration of electric fields of solar wind-magnetospheric origin down to equatorial latitudes, and storm time wind driven ionospheric disturbance dynamo electric fields. The first two processes are dominant at subauroral and upper midlatitudes (above about 50 degrees geomagnetic) during storms; the last two are most important at lower latitudes during moderate and strongly disturbed conditions.

Prompt penetration electric fields are characterized by relatively large (up to about 5 mV/m), short lived (typical time scales of 1-2 hours) global departures from the quiet time values resulting from nearly simultaneous solar wind/ magnetospheric electrodynamic disturbances.

Prompt penetration electric fields occur after solar wind driven changes in magnetospheric convection, when the inner edge of the plasma sheet and the region -2 magnetic field aligned (Birkeland) currents are configured to shield out a weaker or stronger cross-tail electric field. This solar wind/magnetosphere coupling process gives rise to nearly simultaneous middle and low latitude so-called undershielding and overshielding prompt penetration electric fields, respectively. During disturbed conditions, interplanetary southward (northward) magnetic field drives increased (decreased) high latitude convection and transient eastward (westward) prompt penetration electric fields during the day and westward (eastward) at night. Equatorial eastward electric fields drive upward F-region plasma drifts at the magnetic equator. On average, the ratio of the equatorial daytime eastward prompt penetration and the solar wind motional electric field (product of the solar wind speed and southward IMF Bz) is about 10%. Equatorial prompt penetration electric fields have their largest magnitudes near sunrise and sunset, and they reverse direction at about 06 and 22 local time. The time delay between the onset of equatorial prompt penetration electric fields and the driving solar wind electric field at the bow shock is about 20 min, and the delay between the high latitude and equatorial electric field perturbations is about 20 sec. It is generally believed that polar electric fields are transmitted to lower latitudes in the Earth's ionosphere waveguide and mapped upward along the magnetic field lines.

Zonal prompt penetration electric fields are the most important sources of ionospheric disturbances because their ExB plasma drift effects can strongly modify the distribution of the ionospheric plasma density up to geomagnetic latitudes of about 30 degrees, and can promote the generation and evolution of equatorial plasma instabilities and density structures, which can significantly degrade the performance of navigation systems.

Meridional prompt penetration electric fields, which drive zonal plasma drifts, have not been studied in as much detail at low latitudes. Undershielding meridional prompt penetration electric fields are equatorward (perpendicular to the magnetic field) between about 02 and 08 local times, corresponding to eastward plasma drifts, and northward at other times. They have opposite polarity during overshielding conditions.

The basic characteristics of prompt penetration electric fields are described in Kelley (2008). A brief discussion of middle and latitude prompt penetration zonal plasma drifts (meridional electric fields) is given in Fejer and Scherliess (1998).

References:

Fejer, B. G., and L. Scherliess (1998), Middle and low latitude prompt penetration ionospheric zonal plasma drifts, Geophys. Res. Lett., 25, 3071-3074.

Kelley, M. C., Earth's Ionosphere, Academic Press, pp 102-113, 2008.

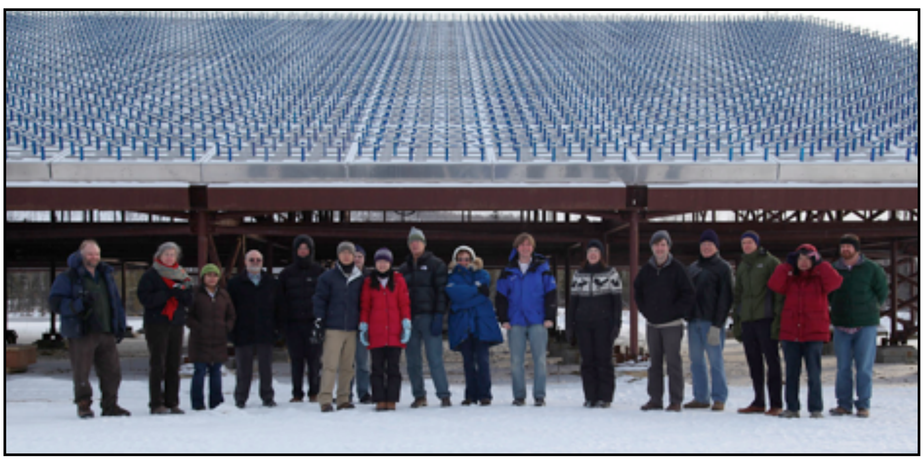
- *Bela Fejer, Utah State University*

A Community Workshop

PFISR: Science Results and Future Plans

Meeting held at the University of Alaska, March 10-12, 2010

In the fall of 2007, after 15 years of planning, 3 name changes, and countless late nights at SRI International, the Poker Flat Incoherent Scatter Radar (PFISR) was switched on. The event marked the return of ISR science to Alaska, and the return of the U.S. to a position of leadership in ISR technology. Funded by the NSF, PFISR is the first of two planned installations under the Advanced Modular ISR (AMISR) project.



Some of the workshop participants posing in front of PFISR

Unlike dish-based ISR's, the AMISR radars are steered electronically by controlling the phase of the signal delivered to each of its 4096 antenna elements. The result is a radar that may be repointed with each successive pulse, allowing the measurement of ionospheric state parameters simultaneously at multiple beam positions and ranges.

Almost from the moment PFISR was powerd on, it became clear that this was not just another auroral zone ISR. Pulse-to-pulse steering constitutes a new modality for ionospheric research, the full implications of which are still being explored. With three full years of operation completed, it was time to convene a workshop to evaluate what has been learned, and to discuss where we should go next. The meeting was held in the Syun-Ichi Akasofu building of the University of Alaska's Geophysical Institute. As its title suggests, the meeting was divided into two parts. The first part was dedicated to a review of new ISR-driven science from the first three years of operation. Although some contributions could be characterized as clarifications of known physics, others represented decidedly new entries into the pantheon of ionospheric science. (A complete list of PFISR publications can be found at http://isr.sri.com/iono/amisr). The second part of the meeting was dedicated to discussions of future plans, including the time table and destination for the first relocation of the facility. (The AMISR radars were designed to be relocated, with a nominal residency time of 5 years at any given location.)

The opening session concerned the use of PFISR to study auroral phenomena. Highlights of this session included (1) the first three-dimensional imagery of auroral ionization patterns during a substorm cycle (Semeter), (2) multi-beam studies of naturally enhanced ion-acoustic lines (NEIALs) and their relationship to the discrete aurora (Michell/ Samara), (3) production of F-region density patches via ELF-powered soft precipitation from the central plasma sheet (Liang), and (4) estimations of two-dimensional time-dependent ion flow fields in the vicinity of dynamic aurora (Butler). The session also highlighted some upcoming initiatives for PFISR in auroral research, including the use of coordinated radar and optical diagnostics to investigate the phenomenon of `enhanced aurora' (Bristow), and common volume measurements with coherent returns at HF frequency to understand Farley-Buneman wave development related produced by auroral electric fields (Hysell).

The second session concerned magnetosphere-ionosphere coupling during substorms and storms. A series of three talks demonstrated the unique capabilities of PFISR coupled with distributed ancillary diagnostics to establish the convective flow patterns leading to substorm onset, with focus on the dynamics of the Harang reversal (Nishimura, Zou, Lyons). Also highlighted was the use of PFISR to study the redistribution of plasma in the magnetosphere-ionosphere system, both horizontally (e.g., development of the tongue of ionization) and vertically (ion outflow) (Foster).

The third session focused on PFISR support of the NASA suborbital program. From its inception, PFISR has supported sounding rocket experiments at Poker Flat, serving as both a critical contextual diagnostic (Larsen, Burchill), but also as a monitor of geomagnetic conditions for making launch decisions (Lynch).

The fourth session focused on PFISR as a diagnostic of neutral atmosphere dynamics. PFISR has been used to validate Fabry-Perot Interferometer (FPI) measurements of ion drift and ion temperature in studies of ion-neutral coupling (Meriwether). A recently developed all-sky imaging FPI capability has enabled studies of the dynamic response of the neutral wind to changes in ion convection (Conde). At lower altitudes, PFISR has proven to be an effective tool for studies of gravity wave propagation and breaking (Nicolls). Continuing down in altitude, PFISR is being used in conjunction with a Rayleigh lidar and stereographic imaging to study noctilucent clouds (NLCs) and polar mesospheric summer echoes (PMSEs) (Taylor). At still lower altitudes, the first detections of meteor head echoes were reported. This study constituted the first use of PFISR in an interferometer mode (Sparks).

The fifth session focused on future ISR initiatives. The Resolute Bay face of AMISR (RISR) began operations in the winter of 2009/2010. First results have revealed a surprising degree of structure in the polar cap ionosphere (Heinselman). Several campaigns are underway at RISR, including studies of peculiarities in the convective flow produced by large-scale solar wind driven M-I coupling (Wilder). Other ISR initiatives include plans for a new NSF facility in Antarctica (van Eyken), as well as steady progress towards a new European facility, the EISCAT-3D project (Haggstrom).

Although much has been accomplished in the first three years of operation, much potential remains. Future plans were the focus of the second part of the meeting. One broad area of exploration is mode development. Every new technology is accompanied by a learning curve. PFISR has introduced a new dimension in experiment configuration. Not only does PFISR offer the rich choices associated with a multi-channel, multi-frequency ISR (vis-a-vis EISCAT), but also choices associated with number and distribution of beams. Optimal experiment design requires joint consideration of pulse pattern and beam selection.

A second broad area of exploration involves optimal coupling with ancillary diagnostics. The use of clustered diagnostics was a common theme in nearly all of the science highlights presented at this meeting. New optical diagnostics under development will add further capabilities, including an auroral lidar system (Collins), high-speed multi-spectral cameras (Michell/Samara), and coordinated studies using PFISR and HF radars has only recently begun in earnest. A third broad area concerns the coordinated studies using ground-based and space-borne diagnostics. Such studies will involve the extant THEMIS constellation, the forthcoming SWARM (Knudsen) and Rax (Bahcivan) missions, as well as the ongoing workhorse diagnostics provided by the DMSP program.

As with any fundamentally new diagnostic, there is a time constant associated with reaching its full potential. A clear conclusion from closing discussions was that activity at PFISR remains on a steep rise. The rich variety of physical phenomena that characterizes the current high-latitude location of PFISR provides an ideal testbed for learning how to exploit this new diagnostic capability.

- Josh Semeter, Boston University

Workshop Participants:

	Thomas Butler	Toshi Nishimura
	John Foster	Tony van Eyken
Bill Bristow (co-Chair)	Miguel Larsen	Robert Robinson
Joshua Semeter (co-Chair)	Jun Liang	Kristina Lynch
John Meriwether	Larry Lyons	Frederick Wilder
David Hysell	Kathryn McWilliams	Rich Behnke
David Knudsen	Robert Michell	Antonius Otto
Donald Hampton	Ingemar Haggstrom	Farzad Kamalabadi
Mark Conde	Johnathan Burchill	Syun-Ichi Akasofu
Shasha Zou	Michael Nicolls	Roger Smith
Jonathan Sparks	Richard Collins	Craig Heinselman

CEDAR Retirements

Joe She's Retirement

On the occasion of Chiao-Yao (Joe) She's retirement from full-time work at Colorado State University, it is appropriate for the CEDAR community to look back over his career and its impact on science. After receiving a Master's degree from North Dakota State University and his PhD in Electrical Engineering from Stanford, Joe went to the University of Minnesota before joining the Physics Department at CSU in 1968.

Joe has been a co-author of approximately 200 publications with a like number of collaborators from more than three dozen institutions over the world. His mastery of both theoretical ideas and experimental techniques is clear from looking at early papers which include "Quantum Description of an Infinite Lossless Transmission Line", "Simultaneous Measurement of Non-commuting Observables", Raman spectroscopy to study laser damage in crystals, use of laser photon correlation spectroscopy to measure flow and turbulence in a free jet, and "Seventh Harmonic Conversion of Mode Locked Pulses to 38.0 nm" (a world's record). Later papers encompassed "Measuring the Velocity of Individual Atoms in Real-Time", non-linear optics, a high-spectral-resolution Rayleigh-Mie lidar, night and day three-frequency Na lidar measurements of radial wind and temperature, and a proposed all-solid-state transportable narrowband sodium lidar.

Under Joe's leadership since first light in 1989, the CSU sodium lidar has introduced significant innovations enabling full-diurnal-cycle, simultaneous mesopause region temperature and zonal and meridional wind (TUV) measurements. Joe has played a central role in promoting comparisons of sodium lidar measurements with night glow, radar, Rayleigh lidar, rocket sonde, and satellite measurements. He has led the way in encouraging comparisons of sodium lidar measurements with results from modelers. Joe also provided leadership in the formation of the Consortium of Resonance and Rayleigh Lidars and in the transfer of the CSU sodium lidar system to Utah State University.

Joe's contributions to experimental aspects of science have been characterized by utilization of elegant, fundamental phenomena: narrow-band spectroscopy for temperature measurements in the mesosphere enabled by use of Doppler-free spectroscopy for laser locking, use of Faraday filters to permit daytime measurements, the use of iodine filters for chirp corrections to wind measurements, use of acoustic-optic modulator for wind measurements, and use of iodine filters in a high spectral resolution lidar for temperature and wind measurements in the troposphere.

Joe's collaborations on investigations in the mesopause region include gravity waves, tides, seasonal variations, the two-level mesopause, observed episodic warming ascribed to effects of Mount Pinatubo eruption, a mesopause region undular bore event, localized ripples, a gravity-wave breaking event, concentric gravity waves, momentum flux, bore formation from large-scale gravity wave perturbations, and sudden stratospheric warming impact on mid-latitude mesopause winds and temperatures. Some of these phenomena are mature areas of study and some only in the initial phases of scientific investigation, but all Joe's contributions have stimulated the community of middle atmosphere scientists.

Joe was recognized in 2003 by his selection to give the CEDAR Prize Lecture on winds and temperature measurements made by the CSU sodium lidar. In the same year, he received an AGU Editor's citation as an outstanding reviewer for GRL. Joe has been included in Marquis Who's Who in America and in the World.

Joe's retirement from CSU will give him more time for family, travel, and collaboration, and all his collaborators expect him to remain very active for a long time. Everyone with whom Joe has collaborated will, no doubt, agree that it has been a pleasure and privilege to have been exposed to Joe's productivity, insights, vision, enthusiasm, and initiative, and all look forward to this new phase of his career.

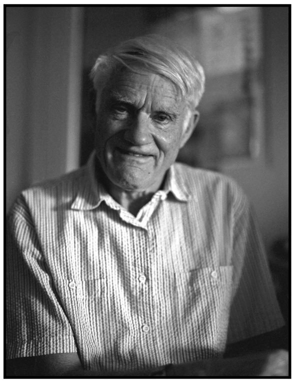
- *Dave Krueger, Colorado State University*

Announcements? Accolades? Accomplishments?

Please continue to submit information to the new Post editor at jcf@haystack.mit.edu

CEDAR Memorials

In Memory of Henry Rishbeth: Aeronomy Pioneer



Sidney Chapman published his theory on the formation of ionospheric layers in 1931. With remarkable foresight, the Rishbeth family of Southampton, England, arranged for their son Henry to be born in that very same year. In almost every way that the true ionosphere departs from simple Chapman Theory, Henry Rishbeth's name appears at the forefront of those contributing to the more robust understanding of the field that we now enjoy. His passing on 23 March 2010 was a deep loss to family, science colleagues and the broad spectrum of friends worldwide. In a very real sense, it also marked the end of the pioneer generation in terrestrial Aeronomy.

While still in his mid-thirties, Henry had literally "written the book" on the ionosphere (*Introduction to Ionospheric Physics*, with his friend and colleague Owen Garriott), a text that enlightened and molded future generations of space physicists A master teacher, his writing style conveyed an intuitive understanding of complex processes in a remarkably clear, concise and effective way. Henry's life-long scientific passion was the F-layer! Rishbethian concepts in photo-chemistry (his servo-model) and in electrodynamics (his F-layer dynamo) are standard components of instruction world-wide. Once when I suggested somewhat friskily that "layer" was just old-fashioned Chapman-esq terminology implying a stack of uncoupled pancakes, and that I preferred "regions" in place of D-E-F-layers, his eyes twinkled as he explained that it was the thermosphere and ionosphere that were regions, and that within a region there are layers. I never challenged his command of terminology again.

Henry earned his BA degree in Mathematic and Natural Science at Christ's College, Cambridge University, in 1954. He then went to Sydney, Australia, where he pursued studies and research in galactic radio astronomy, publishing his first paper in 1956. Radio emissions from Jupiter caught his attention and this led to his first publication on ionospheric physics, a paper that estimated jovian ionospheric processes. Returning to England, Henry completed his MA (1958) and Ph.D. (1960) in Physics at Cambridge, with none other that J. A. Ratcliffe as his advisor. His post-doctoral work was at the Radio Research Station in Slough, and its ionosonde became and remained his touchstone diagnostic for the next 50 years. From ionospheric storms to day-to-day variability of the F-layer, "Let's see what was observed at Slough" was always the entry point to a new project.

Henry moved to Boulder in 1962 to engage in research at the National Bureau of Standards. The call back to Slough came in 1964, and he remained at the Radio and Space Research Station for seventeen years, rising through the ranks of scientific and administrative leadership. From 1981 until his (so-called) retirement in 1996, Henry was back in his true home --- the academic setting in his native Southampton --- teaching, leading a research group, and championing solar-terrestrial physics throughout the UK and beyond. He was a strong advocate of incoherent scatter radar methods and was the UK Project Scientist for the European Incoherent Scatter (EISCAT) project. Henry remained deeply committed to its success in official capacities from 1974 to 1986.

Henry's many colleagues in the United States valued his visits and collaborations. His center of mass was always in Boulder, working with Tom van Zandt, Bill Wright and Ray Roble over the years, and delivering a tutorial lecture at the CEDAR meeting of 1997. Henry was not fond of giant meetings (due in part to his mobility problems from polio that appeared while serving in the Royal Air Force in 1950), but he was very pleased to attend the American Geophysical Union meeting in 1995 to deliver the prestigious Nicolet Lecture.

Henry always enjoyed his trips to Texas to work with Bill Hanson and Rod Heelis in Dallas and to visit with Owen Garriott in Houston. He delighted in time spent with Herb Carlson and the Basus during stop-overs in Washington, and with John Meriwether for research in Clemson. He worked with many other US colleagues, and especially so early in his career. [I am sure I have missed mentioning many in this brief list, for which I apologize.] Henry's trips to Boston University started in 1990 as part of his first faculty sabbatical from Southampton, and continued during most Springs and Falls until a few years ago (he referred to these trips as the Semi-Annual Rishbeth Mid-latitude Effect). Whether in Boston or elsewhere, Henry did not just visit; he worked each and every day, enriching the experience of graduate students, post-docs, staff and faculty.

Professional service was a centerpiece of Henry's work, with astonishing breadth within the UK and worldwide. He held leadership positions in virtually every organization linked to Solar-Terrestrial Physics, as well as proud membership in the International String Figure Association (his mother had published a book on the topic) and, to pursue his love of trains, membership in the Locomotive Society of Great Britain.

To have known Henry also provided the opportunity to know his remarkable wife Priscilla (lovingly called Pril), and his daughters Clare and Tessa. Now with three grandchildren, they collectively form a family of mutual support and individual accomplishment. On behalf of the CEDAR community, we extend our condolences to the Rishbeth family and to his colleagues and friends worldwide.

Photo Credit: Joei Wroten, Center for Space Physics, Boston University

- *Michael Mendillo, Boston University*

In Memory of William E. Gordon: ISR Pioneer

On February 16, 2010, the father of the Arecibo Observatory, Dr. William E. Gordon, died at the age of 92. With his passing, the CEDAR community lost a truly great creator, innovator, and friend.

William Edwin Gordon was born on Jan. 8, 1918, in Paterson, N.J. He earned his undergraduate degrees from Montclair State University and a PhD from Cornell University. Gordon was a professor of electrical engineering at Cornell, working with Henry Booker, when in 1958, he came up with the idea of using radio signals backscattered from individual electrons to measure the electron density of the ionosphere. This type of scatter, now called "incoherent scatter," is exceedingly weak, but Gordon did the math and showed that with existing 1958 radar technology using a 300-meter diameter antenna and several megawatts of pulsed transmitter power, it would be possible to detect– extremely difficult, but possible.

"We were taking a pretty big leap," Dr. Gordon said in an interview with The Houston

Chronicle in 2001. "They didn't know whether I was a crackpot or whether I really had something." In 2003, on the telescope's 40th anniversary, Dr. Gordon recalled being told that "it couldn't be done."

"We were in the position of trying to do something that was impossible, and it took a lot of guts," he said of his telescope team. "We were young enough that we didn't know we couldn't do it."

The observatory was completed in 1963; incredibly only five years after Dr. Gordon first had the idea, at a cost of $9.3 million. Dr. Gordon was director for the first two years after operations began.

There are few, if any projects, that are so shaped by one person. Dr. Gordon took an equation and envisioned a means of measuring things in the ionosphere never even dreamed of before. But he went beyond that. He raised the funds, found a natural bowl in the right place, and supervised construction. Upon completion, the Arecibo radar soon became the nation's premier ionospheric instrument. It worked far better than anyone had ever imagined. Over the years, the unrivaled sensitivity of the Arecibo Observatory has given rise to multiple firsts in studying ionosphere dynamics and composition. Incoherent scatter radars have become the single most powerful instrument in existence for probing the ionosphere.

The uses of the Arecibo telescope expanded far beyond what was originally planned, reaching into the solar system, the Milky Way and beyond. It was the first instrument to accurately measure the rotation of Mercury, where it also detected ice. It furnished detailed maps of the Moon, Venus and Mars. It provided the first solid evidence that neutron stars exist and made some of the most fundamental pulsar observations. The Observatory also discovered the first planets outside the solar system. Perhaps its most noteworthy use came from a series of observations that began in 1974 by Dr. Joseph Taylor of Princeton and his student Russell Hulse. Their work, for which they were awarded a Nobel Prize in 1993, was the first proof that gravity waves, never directly detected but predicted by Einstein's General Theory of Relativity, actually exist.

Dr. Gordon taught at Cornell from 1953 until 1965, when he moved to Rice as dean of science and engineering. He was a much-respected, longtime member of both the Space Science and Electrical Engineering departments and earned the rare distinction of being a member of both the National Academy of Sciences and National Academy of Engineering. He retired as provost and vice president of Rice in 1985.

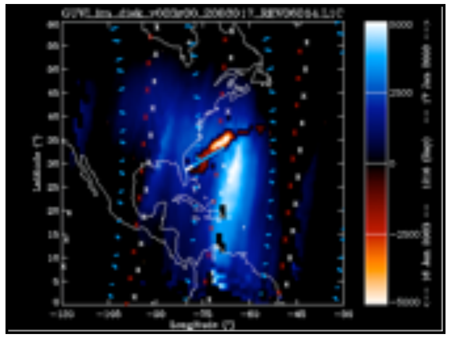
While at Rice, he guided 12 doctoral dissertations. I had the great good fortune to have been one of those as was Anthea Coster, another active CEDAR participant and a former member of CEDAR Science Steering Committee. Quite amazingly, Dr. Gordon always remained active in research, no matter what administrative positions he held. Long after he retired from Rice, Dr. Gordon made regular visits to the Arecibo Observatory to work on his research in HF heating of the ionosphere – often taking the midnight to 3:00 am shift!

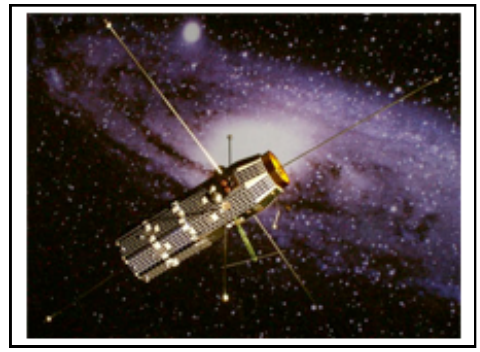
Dr. Gordon was a warm and kind man who, no matter how high he rose in the Rice administration, always had time for his students. We all admired him. In fact, we all loved him. He was a great advisor, mentor and personal friend.

On the 40th anniversary of the Arecibo Observatory, he gave this advice: "If you dream, have big dreams." And to graduate students he added: "May each of you experience the passion of creation as you discover something new as you do your doctoral research, and may you experience the same deep passion a few more times in your professional careers."

Good advice from a truly great man.

- Richard Behnke, NSF





Science Highlights

Can neutral winds transport a space shuttle plume to the Antarctic?

The launch of a shuttle releases ~300 tons of water vapour above 100 km during a period of about 4 minutes of near horizontal flight. During this time, a space shuttle travels ~1000 km north-eastwards from the Florida coast. About 80 hours after the launch of the ill-fated STS-107 Columbia mission on 16 January 2003, iron was observed above 100 km at Rothera Research Station in the Antarctic (67.6S, 68W). It has been concluded that the source of the iron is ablation from the STS-107 main engines [Stevens et al., 2005]. The distance traveled by the shuttle exhaust plume is roughly 100 degrees latitude, implying a mean southward meridional wind speed of nearly 40 m/s in the MLT, or about 1 degree of latitude per hour.

Additional evidence related to unusually intense NLC occurrence at high northern latitudes have also been connected to the injection of shuttle main engine exhaust, for example, the 7 August 1997 STS-85 mission [Stevens et al., 2003]. Again, rapid and sustained transport of engine exhaust is a necessity in order to transfer water vapour over exceptional distances.

Sounding rocket chemical releases, conceptually identical to the shuttle engine exhaust release, have for decades pointed to exceptionally strong horizontal neutral winds in the MLT. Larsen [2002] summarize the results from over 400 chemical tracer experiments. Though winds exceeding 100 m/s in the MLT exist in 60% of the chemical release profiles, the mean wind profile nearly matches the corresponding HWM profile. Essentially, a "textbook" altitude profile of the neutral winds in the MLT will never be able to support the hypothesis that a shuttle plume can be transported naturally across the equator to the Antarctic in 80 hours.

Recent improvements in the analysis of Doppler shifts of MLT airglow spectra from space-based platforms can now provide unambiguous confirmation of the existence of strong and sustained winds in the upper atmosphere. In addition, the amplitude and phasing of the winds confirm the premise that shuttle exhaust from STS-107 can traverse vast distances in a short time.

Figure 1 describes the evolution of the shuttle plume, observed in Lyman-alpha by TIMED-GUVI from injection (red) to one-day post injection (blue). A blue line indicates the ground track of the main engine firing during launch. Crosses (red, white) and lines (blue) indicate limb tangent intercepts for TIMED-TIDI and TIMED-SABER observations. Clearly, the plume has been sheared to the northwest and to the south of launch in one day. TIMED-SABER water observations indicate a peak altitude of 110 km following launch, while Figure 2 summarizes TIMED-TIDI data along the 64W meridian. The most northerly profile at 36.7N indicates poleward motion, while the two profiles at 34.7 and 24.9N indicate equatorward flow as strong as 75 m/s at plume altitudes.

TIMED-GUVI Lyman alpha imagery documents the plume's southward motion for 48 hours, at which point the plume extends over the latitude range 25S to 45S. TIMED-TIDI and UARS-HRDI meridional wind data above 100 km, shown in Figure 3 along the path of the plume, consistently indicate strong and sustained southward flow, similar to speeds inferred from the images. An intense two-day wave in the southern hemisphere MLT is in phase with sustained southward progress on 18 January 2003. Several hours prior to the first detection of Fe above 100 km at Rothera, UARS-HRDI continued to show strong southerly flow near Antarctica.

In conclusion, detailed examination of satellite based monitoring of the MLT have shown:

1. a strong two-day wave with a zonally averaged peak amplitude of 70 m/s existed in the southern hemisphere at the time of the STS-107 launch
2. the neutral horizontal wind just north of the plume supports a northwesterly motion to the northern plume tip
3. winds along and south of the plume support a sustained motion of the plume to the Antarctic continent in ~80 hours.

In contrast, our present theoretical knowledge of MLT dynamics, summarized in various models, cannot support these observations. We really don't yet fully understand our upper atmosphere.

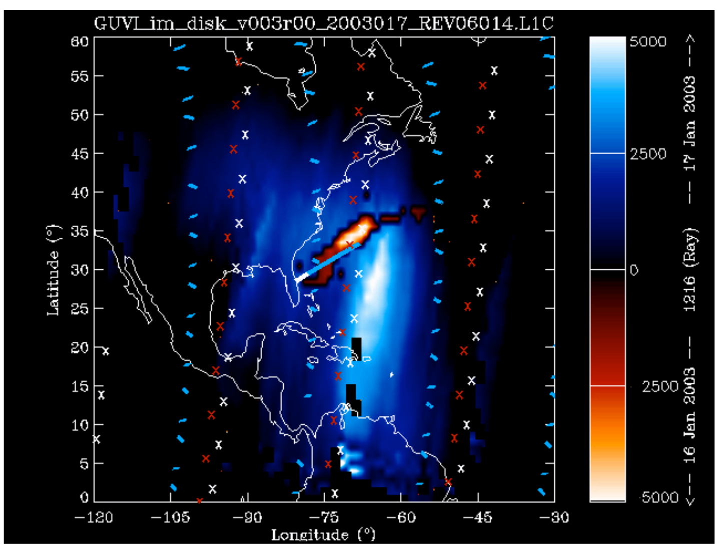


Figure 1. STS-107 plume, (red) on 16 January 2003, (blue) on 17 January 2003.

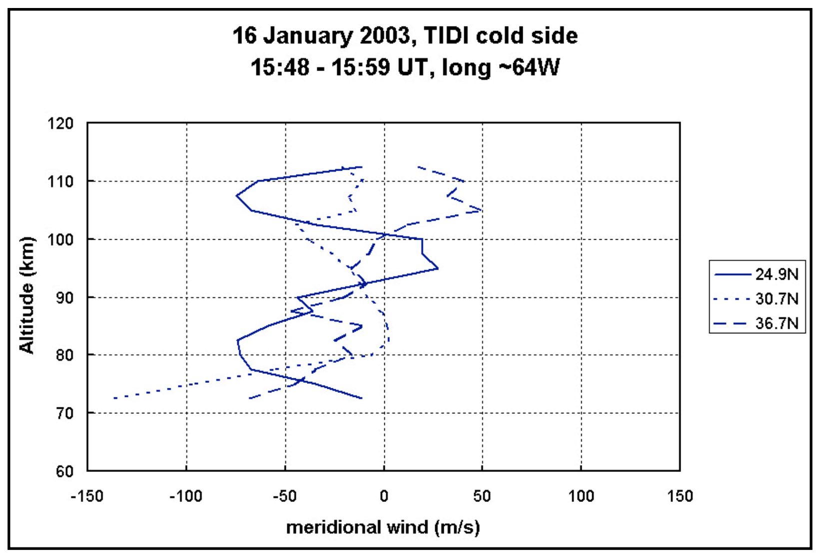


Figure 2. Meridional winds along the 64W longitude meridian, immediately following the launch of STS-107.

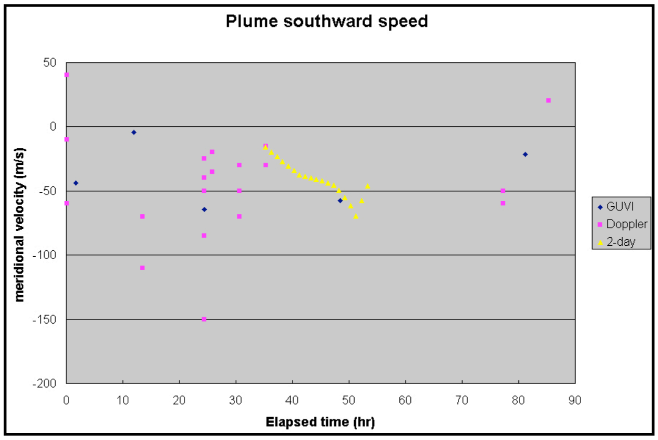


Figure 3. Meridional winds observed along the southward path of the plume.

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(UM-AOSS) R. Niciejewski, W. Skinner (NRL) M. Stevens

- *R. Niciejewski, W. Skinner, UM-AOSS; M. Stevens, NRL; and R. Meier, GMU*

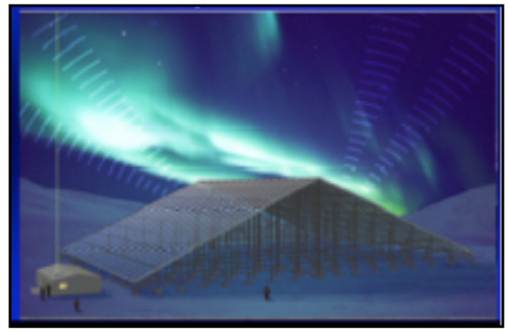
A Way Forward to CEDAR Observations and Modeling: A Tale of Two Workshops

The challenge of understanding the dynamics of the Ionosphere-Thermosphere system is a core activity of CEDAR. Progress in meeting this challenge can be evaluated by in-depth comparisons between observations and model simulations. During the 1990s, a mid-latitude CEDAR Workshop addressed this challenge/evaluation by meeting annually as the Problems Related to Ionospheric Modeling and Observations (PRIMO) Working Group. Similarly, during the 1990s high latitude CEDAR/HLPS and international STEP-GAPS working groups carried out model-observations comparisons. After almost a decade, a study was published on the status of the PRIMO team's findings (Anderson et al., 1998). The observations were from the ionosonde and incoherent scatter radar at the Millstone Hill, Massachusetts location, and restricted to "quiet" days. Five different model teams participated. These models covered the spectrum of physics-based modeling approaches; the fully coupled ionosphere-thermosphere, the ionospheric model, and the ionospheric-plasmasphere flux tube model. Were we successful? The answer at the time was that indeed the models were reasonably successful, however today, as our knowledge improves, a less positive answer would be forthcoming. As an example, when PRIMO was active, the I-T topside outstanding problem was referred to as the “Burnside Factor.” At that time, this parameter was set to 1.7. But today, the evidence suggests the factor is closer to 1.0. The physics and chemistry of the “Burnside Factor,” i.e., the interaction between [O] and O+ in the topside ionosphere is still to be fully resolved. It is crucial to all I-T models as it controls diffusion in the topside. Several other PRIMO community decisions were made and these also need to be reviewed.

The time is also right to review our aeronomy knowledge at locations other than mid-latitudes and under other conditions than geomagnetically quiet. In fact, it is often said that because aeronomy has been researched with “modern” methods for almost 100 years all the “low hanging” fruit has been harvested. The implication being that our knowledge of aeronomy is so mature that we have solved the problems! However, these statements and conclusions are a severe aberration of the true situation. If we use the ability of our models to predict the ionosphere or thermosphere, either their climate or their weather, we quickly find that our models, as representations of our knowledge, are surprisingly poor and primitive. We may claim that we understand the individual chemical and physical processes, but terrestrial aeronomy is a complex interplay between these two areas and in fact, a system that is poorly modeled.

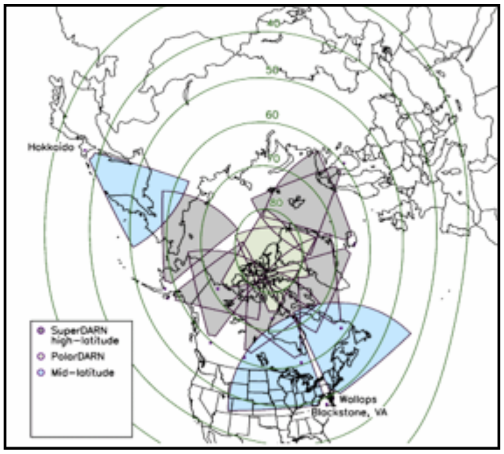
At high latitudes the recent extended solar minimum period has provided an ongoing challenge for the physical models of the high latitude ionosphere. These models include those that a decade ago were participating in the PRIMO CEDAR working groups studies. The recent availability of new observations has created a high-latitude observational data base far advanced from that available a decade ago. The SuperDARN network has extended into the polar regions as the PolarDARN system.

The Poker Flat Incoherent Scatter Radar (PFISR) located near Fairbanks, Alaska.



The Resolute Bay Incoherent Scatter Radar (PFISR) located at Resolute Bay, Canada.

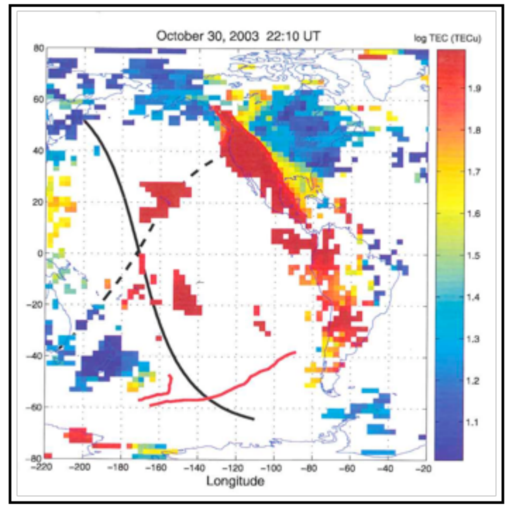
These new ISRs are for many outstanding high latitude questions “sweeping” fast enough to capture this illusive dynamics. For the first time these ISRs have 24/7 operation capability to enable data sets to be collected that adequately contains pre, during, and post event ionospheric and driver conditions. Optically the advent of 2-D mapping Fabry-Perot enables the mapping of the neutral wind in the thermosphere which is a long sought after measurement to complement the electric field distributions. Our models, hence, the application of our knowledge, perform poorly against these new observations.



A Northern Hemisphere map with superimposed fields of coverage of the SuperDARN, PolarDARN and new mid-latitude radars.

During the Super storms the situation is no better! For over a decade our CEDAR community together with colleagues from the other Solar Terrestrial Space Science and Space Weather communities have been meeting and working on solving this problem. The problem being that our models do not have realistic storm time responses. Classically we understand the basic ideas of how the ionosphere and thermosphere respond during the storm phases. Practically our weather modeling is primitive at best. In fact, the most obvious progress in modeling is the ability to assimilate observations into our models to reproduce the ionosphere, i.e., make better specifications. However, this does not answer the outstanding knowledge question of how the IT system responds during specific Super storms or storms in general.

The situation is no better as we go to low and equatorial latitudes! In the low latitude Ionospheric region, the vertical ExB drift velocity is the primary physical mechanism that determines the F region electron density distribution as a function of altitude, latitude and local time. Typical, daytime, vertical ExB drift velocities as measured by the Jicamarca Incoherent Scatter Radar (ISR) are 20 to 30 m/sec and these velocities produce crests in the peak F-region electron densities at +/- 15° to 18° dip latitude known as the equatorial anomaly. There exist climatological models that express ExB drift velocity as a function of local time, longitude, season and solar cycle. More recently, there are both ground-based and satellite observations of the low-latitude ExB drift velocities that provide the "drivers" for the "weather" modeling of the equatorial ionospheric electron density distributions.



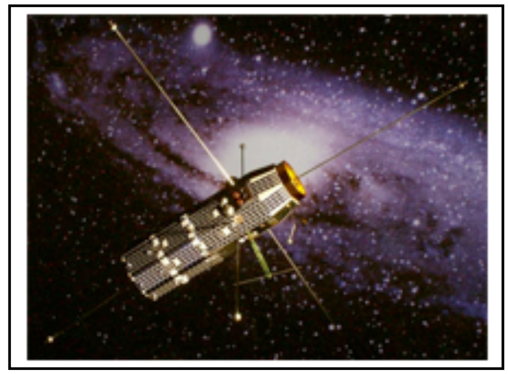
The inhomogeneous Total Electron Content (TEC) distribution over the American Continents during a Superstorm.

Just as there have been advances in the high latitude, ground-based observational techniques to measure electron density distributions and transport processes, significant advances in equatorial techniques to infer daytime, vertical ExB drift velocities from ground-based magnetometers have just now been realized. A new, Low-latitude Ionospheric Sensor Network (LISN) has been established, with NSF support, in the South American region that features a whole array of GPS receivers, ISRs, digital sounders and magnetometers. These 24/7 observations are exactly the observations needed to validate and point out the shortcomings of the current, theoretical I-T models in both a climatological and a "weather" sense. We do not fully understand all the relevant physics of the equatorial ionosphere, so that current models do not completely agree with each other and are not able to accurately reproduce observations. Comparisons between the LISN observations, for example, will help us to understand the strengths and the limitations of theoretical, time-dependent, low-latitude ionospheric models in representing observed ionospheric structure and variability.

Ever evolving map of the LISN sensor deployments in South America.

In April, 2008, the Air Force launched the Communication/Navigation Outage Forecast System (C/NOFS) satellite into a 13° Inclination orbit. The sensors on the C/NOFS satellite measure, among other quantities, the meridional and zonal ExB drift velocities, the AC and DC electric fields, the neutral wind velocity vector and in-situ electron densities. For the equatorial, theoretical ionospheric models that are not self-consistently coupled to the neutral atmospheric and electrodynamic models, the C/NOFS ExB drift velocities are important inputs so that calculated, low-latitude electron density distributions can realistically be compared with observations. For the self-consistent I-T models, the C/NOFS ExB drifts and neutral wind observations are fundamental to validating the realism of the coupled models under both climatological and "weather" conditions.

Given that in almost every aspect of I-T research the observation coverage and quality has recently increased markedly, the challenge to the modeling community is to model not just the "event" but rather the ongoing evolution of the I-T system through dynamics that are fast as gravity waves, TIDS, substorms to the longer time scales of climate, i.e., seasons. To begin this process the CEDAR instigators are initiating two new "round table" working groups to address the way forward in the upcoming CEDAR workshop. For the high latitude question a HLPS2 group will form while for the low latitudes an Equatorial-PRIMO group will form. These groups will be an open exchange between "observations" and "modeling" scientists seeking a way forward in understanding their aeronomy system.



The artist's rendering of the USAF C/NOFS satellite currently making low latitude measurements in the ionospheric topside.

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