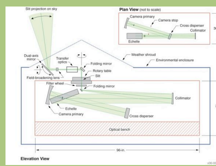
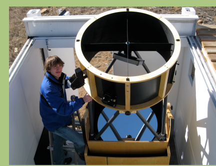
The CEDAR Post

Coupling, Energetics and Dynamics of Atmospheric Regions





http://cedarweb.hao.ucar.edu

Spring 2009 Issue 55

From the CSSC Chair

Welcome to the 2009 spring issue of the CEDAR Post. This issue provides an update from NSF's Upper Atmosphere Research Section, a CEDAR Roots description on the origins of the term Spread F, and highlights developing projects that are of interest to the CEDAR community. MRI projects funded in 2007 are nearing their completion and future use of these instruments will be driven by the science community. Three MRI projects relevant to CEDAR science are highlighted in this issue. New developments in HF radar deployments at midlatitudes, incoherent scatter radar community integration, and thermospheric winds from a balloon platform are also included in this issue. Continuing our interest in satellite collaborations, the GOLD team provides an article on its plans for future collaborations with the CEDAR community. In continuing support of common interests, the CSSC have provided letters of support to both the NICE and GOLD satellite teams as well as providing a letter of concern to the Danish ministry of science, technology and innovation regarding the possible shut down of the Greenland magnetometer chain. These letters are also included in this issue.

The 2009 CEDAR meeting is upon us. We return to the familiar grounds of the Eldorado Hotel, Santa Fe, NM. The student workshop will be held Sunday, June 28 followed by the general meeting starting on Monday, June 29 and going through Thursday, July 2. This year we have implemented a new CEDAR lecture series called the CEDAR Distinguished Lecture. This new lecture series is to recognize individuals within the CEDAR community that have sustained a body of work, beyond the past 10 years, that has helped shape the CEDAR program through research and service. I am pleased to announce that our first recipient of this award is Dr. Ray Roble of NCAR. His lecture will be given in a comfortable and collegial setting with a cash bar on the evening of Wednesday, July 1 from 8:30 - 9:30 p.m. We hope this setting will make for a long-standing tradition of recognizing those who have influenced us all in moving the field forward. I am also pleased to announce Dr. Michael Nicolls of SRI International as the 2009 recipient of the CEDAR Prize Lecture. His lecture will be given in the morning of Monday, June 29. These preeminent CEDAR lectures are complementary and will develop interesting perspectives on future research within CEDAR that will be of keen interest to the students as well as attending researchers.

I look forward to seeing you all in Santa Fe! Please take a look at the meeting agenda at http://cedarweb.hao.ucar.edu/wiki/index.php/2009_Workshop:Main.

Jeff Thayer, University of Colorado

INSIDE THIS ISSUE

An Update from NSF

Stimulus Funds

NSF received approximately $3 billion through the American Recovery and Reinvestment Act (ARRA); about $2 billion was allocated to Research and Related Activities which funds NSF grants. The decision was made to use these funds for proposals that are already in house and that will be reviewed and/or awarded prior to Sept. 30, 2009. All grants awarded with ARRA funds will be standard grants: the PI institution receives the entire award in one lump sum rather than through yearly increments. NSF also decided that ARRA funds will not be used for supplements to existing grants. More details on NSF's use of ARRA funds can be found at:

http://www.nsf.gov/publications/pub_summ.jsp?ods_key=in131
http://www.nsf.gov/pubs/2009/nsf09038/nsf09038.jsp
http://www.nsf.gov/news/news_summ.jsp?cntn_id=114483&org=NSF&from=news

CEDAR Postdoctoral Fellowship Competition

A record number of proposals were submitted to the Aeronomy Program for this year's CEDAR/GEM/SHINE Postdoc competition: 12. Decisions will be made by mid-July at the latest.

New/Temporary Manager for UAF

Dr. Paul Morris is the current Director for the Upper Atmospheric Facilities Program while Bob Robinson is on detail to NSF's Large Facilities Office. Paul's email address is pmorris@nsf.gov.

Update on the Arecibo heating facility

Design of the antenna system and the new building for the facility are nearly complete.

Update on the Resolute Bay ISR

First RISR operations commenced on April 24, 2009; testing and calibration are ongoing.

Update on the Cubesat Program

The two ongoing projects, RAX and Firefly, are both progressing very successfully. The STP-S26 launch that RAX is on has been delayed from December 2009 to February 2010 and RAX is on track for delivery to the launch site in October 2009. Firefly has been manifested on a launch by the National Reconnaissance Office as part of their ADAMsat cubesat launch currently scheduled for August 2010. The mission is on track for delivery in April 2010. The deadline for the next cubesat program solicitation is May 11, 2009. A review panel will be conducted over the summer. We expect to be able to fund two new projects from this competition.

Recompetition for operation of NAIC

NSF has distributed a Dear Colleague letter regarding competition for the next cooperative agreement for management and operation of the National Astronomy and Ionosphere Center following the expiration of the current cooperative agreement in 2010. The letter can be found at http://www.nsf.gov/pubs/2009/nsf09014/nsf09014.pdf.

NSF/ATM Administration Changes

NSF will be conducting national searches for Director of the Atmospheric Sciences Division, replacing Dr. Jarvis Moyers, and for Section Head of the Lower Atmospheric Facilities Oversight Section, replacing Dr. Clifford Jacobs. Beginning June 1, Dr. Stephan Nelson will serve as Section Head for ULAFOS until the search is completed.

~Cassandra Fesen, Therese Moretto Jorgensen and Robert Robinson, NSF Aeronomy, Cubesat and UAF Program Managers

Awards from the CEDAR 2008 Competition

PI Name	Institution	Proposal Title
Chu	CU- Boulder	CEDAR: Continuation to Daytime Potassium Doppler Lidar at Arecibo
Close	LANL	Collaborative Research: CEDAR: CEDAR Tomographic Array for Lightning and Ionospheric Studies (TALIS)
Eack	NM Inst. Mining and Tech	Collaborative Research: CEDAR: CEDAR Tomographic Array for Lightning and Ionospheric Studies (TALIS)
Bust	ASTRA	Collaborative Research: CEDAR: CEDAR Tomographic Array for Lightning and Ionospheric Studies (TALIS)
Michell	SWRI	Radar and Optical Observations of Enhanced Ion Acoustic Lines and Associated Auroral Fine Structure
Nossal	U Wisconsin	CEDAR: Solar Cyclic and Climatic Trends in Geocoronal Hydrogen
Oliver	Boston U	CEDAR: Comprehensive use of Incoherent Scatter Radar data to study the equatorial midnight plasma and neutral temperature maxima (MTM)
Palo	CU - Boulder	CEDAR: Nonlinear Wave-Wave Induced Diurnal Tidal Variability
Pasko	Penn State	CEDAR: Modeling Studies of Infrasonic Waves from Thunderstorms and Aurora
Richmond	UCAR	CEDAR: Whole-Atmosphere Modeling of Ionospheric Responses to Atmospheric Variability
Shepherd	Dartmouth	CEDAR: Characterizing the Variability in the High Latitude Ionospheric Electric Field
Vadas	NWRA	Collaborative Research: CEDAR: Investigation of the lower atmospheric source regions of medium-scale gravity waves
Nicolls	SRI	Collaborative Research: CEDAR: Investigation of the lower atmospheric source regions of medium-scale gravity waves
Waldrop	UIUC	Collaborative Research: CEDAR - A novel technique for estimating oxygen density in the mid-latitude thermosphere
Watchorn	SSI	Collaborative Research: CEDAR - A novel technique for estimating oxygen density in the mid-latitude thermosphere

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.

SPREAD F - The term Spread F refers to a F-region ionospheric phenomenon. The origin of the term comes from the early --- and only way--- scientists had at their disposal to observe the ionosphere: the ionosonde. The instrument was effectively a HF radar, which recorded the (virtual) altitude of the region where transmitted HF radio pulses were reflected. The altitude of reflection depends on the frequency used, and the instrument measured and recorded this altitude as a function of the frequency of the radio pulse. A typical output of an ionosonde consisted of a single trace (per propagation mode) displaying this altitude as a function of frequency. There were times where this trace “spread” into multiple traces, hence the name of the phenomenon. Since the early years of the observations, it was recognized that this behavior was due to the existence of irregularities in electron density. This was confirmed later by in situ probes on board satellites and rockets. They were also observed by the fluctuations they produce in the amplitude and phase of satellite radio signals (scintillations) observed on the ground. But, the most important and productive technique has been the use of radars at VHF and UHF frequencies. At these frequencies the irregularities are efficient scatterers and have permitted us to characterize their spatial and temporal morphology. Total electron content measured along satellite signal paths and air glow measurements have also permitted the observation of their behavior at their longest length scales. Irregularities exist at a large range of scale lengths, from centimeters to tens, or even hundreds of kilometers. The ionosondes, including modern digital ones, are sensitive to only a fraction of these scales. Nevertheless, whenever irregularities exist at F region heights in a large range of scale lengths the phenomenon is still referred to as “Spread F”, independent of the observing technique.

Of particular interest has been the existence of irregularities at F region heights in a band of 30-40 degrees of latitudinal extent, centered at the magnetic equator . They are referred to as “Equatorial Spread F”. Although it was discovered more than 70 years ago, in the records of an ionosonde deployed at Huancayo, Peru , it has not been until recently that we are starting to understand the physical processes responsible for its existence. Nevertheless, we are still not in the position to predict Spread F occurrence, or its day to day variability. Its manifestations and physical theories behind them continue to be a field of active research. I refer the reader to a recent review by Woodman* (2009), for historical and recent observations of the phenomenon and the current state of understanding.

*Woodman R. F., Spread F – an old equatorial aeronomy problem finally resolved?, Ann. Geophy., 27,1915-1934, 2009.

~Ron Woodman
Instituto Geofísico del Perú

Announcements? Accolades? Accomplishments?

Please continue to submit information to the Post editor at Jeffrey.thayer@colorado.edu

NSF Major Research Instrumentation Program (MRI)

The following three articles provide an update on MRI projects awarded from the 2007 competition that are coming to fruition and are of direct interest to the CEDAR community. MRI awards are for acquisition or instrument development and typically fund a two year effort. MRI projects result in new, available, state of the art instrumentation for scientific use by the community. Therefore, it is important the community be aware of these developments. Our community has been successful recently in winning proposals to the MRI program, as demonstrated by the three projects provided in this issue. The 2008 competition resulted in the selection of the Aeronomy proposal from Mark Conde of the University of Alaska-Fairbanks entitled: "MRI: Development of a Thermospheric Wind Imager." We hope this year's competition continues this trend of infusing new instrumentation into the field.

MRI: Compact Echelle Spectrograph for Aeronomical Research (CESAR)

The Compact Echelle Spectrograph for Aeronomical Research (CESAR) is a state-of-the-art instrument being constructed at SRI International under an MRI grant. The CESAR team is led by Tom Slanger, PI, and Elizabeth Kendall, Co-I. Conceptually, CESAR is an outgrowth of nightglow studies carried out over the last ten years utilizing the sky spectra of the 8–10 meter class optical telescopes – Keck I and Keck II on Mauna Kea, and the VLT (Very Large Telescope) in Chile. Such spectra are routinely recorded by ground-based astronomers, for the purpose of subtracting them from star spectra to remove the airglow contribution, but their characteristics are ideal for aeronomical studies. The HIRES echelle on Keck I and the UVES echelle on the VLT use a resolution around 40,000, with broad simultaneous spectral coverage.

A wide array of investigations have been carried out with the cooperation of astronomers, querying the nightglow in much greater detail than previous studies. Topics as diverse as the sodium D2/D1 intensity ratio, OH vibrational-level-dependent temperatures, radiative recombination, geomagnetic storm phenomena, and the identification of thousands of nightglow lines have all been made possible by utilizing these instruments. As a result of these studies, it became evident that if an echelle spectrograph of the quality used by the astronomers was available to the aeronomic community, new vistas would open up. The primary limitation of obtaining data from the astronomical instruments in such a parasitic manner is that the aeronomers have no control over the observations, the data becomes available at somewhat indeterminate times, and only equatorial studies are possible. These factors made it important to develop an instrument for the aeronomy community. With the MRI funding, CESAR will be able to implement new dimensions of operational control — including integration times and choice of siting. In addition to being re-locatable, the system is designed to be operated remotely.

Status

Currently, the camera, which has the longest lead time, has been contracted out, and a final design will soon be available. The detector system is also under design, and the two systems will be delivered in the fall of 2009.

System Capabilities

CESAR will operate at wavelengths between 310nm and 1000nm. Due to tradeoffs between commercially available CCDs and gratings, three exposures will be necessary to cover the complete range of wavelengths. CESAR will be able to observe strong features with short integration times and real-time interactive tracking capability on second timescales. Due to the use of a cryo-cooled CCD, integration times on the order of tens of seconds will be achievable for weak emission features. Maximum spectral resolution ($\lambda/\Delta\lambda$) will be 20,000.

Different fields of view, initially between approximately 7° and 20°, will be possible by remotely switching in different fore-optics. Operation in “exposed slit” mode for diffuse nightglow studies will also be supported. In addition to the standard filters required to block unwanted orders, scientists will be able to supply additional filters for specific applications if desired. The fore-optics allow the slit to be orientated freely, for example the slit can be aligned with a vertical auroral ray, or horizontally along the rim of an aurora.

CESAR will include an array of supportive environmental and diagnostic sensors, including an all-sky camera. Upon verification of clear-sky conditions, the operator will be able to remotely power up the spectrograph, open the fore-optics cover and start observing. The system will guide the user through necessary calibration steps, utilizing CESAR’s built-in calibration light sources as well as suitable calibration stars. Preview-quality spectra will be available in real-time, with the option of manually reducing the raw recorded CCD frames during post-processing where required. Existing data reduction pipelines will be utilized where possible. All recorded data will be archived for future reference. This includes all meta-data and data from all support instruments.

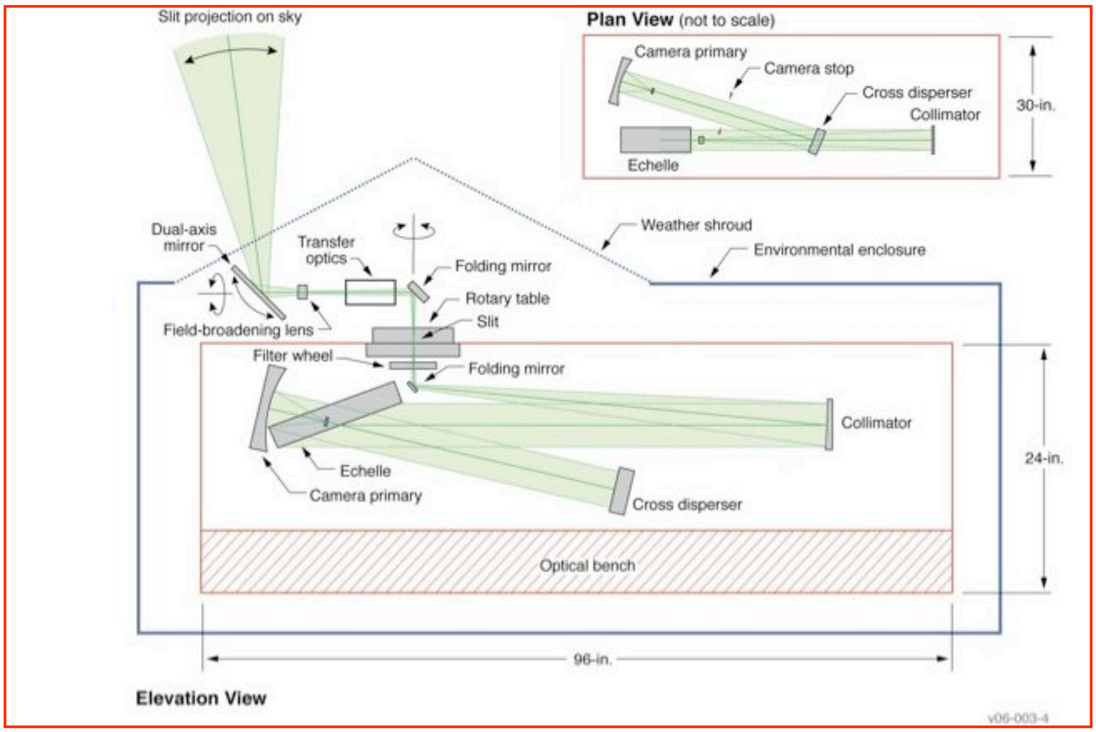
CESAR is designed to be re-locatable, meaning it can be shipped and re-deployed with minimum effort. All components that need regular adjustment can be remotely controlled; hence no operator is required on-site during normal operation.

Plans

Upon completion and testing of the instrument, it will initially be set up at the Poker Flat Rocket Range. There is a broad array of questions that will be addressed after the qualities of the instrument are demonstrated. Initially, many of these will be related to the observations and systems that we have investigated with the astronomical spectrographs, to establish that we can match and surpass the previous studies. By having CESAR located near the AMISR system, we will be making simultaneous high-resolution optical and radar observations of the same region of the sky.

We welcome enquiries about CESAR, and are particularly interested in finding researchers who want to use the system, either directly or in conjunction with their own nearby instruments. For further information, please email Tom Slanger at tom.slanger@sri.com.

~Tom Slanger
SRI International



CESAR optical design layout

MRI: Mobile Fe-Resonance/Rayleigh/Mie Doppler LIDAR

The mobile Fe-resonance/Rayleigh/Mie Doppler lidar is an instrument development project at the University of Colorado (CU), which was funded by the NSF Major Research Instrumentation (MRI) program in September 2007. The lidar team consists of the PI Dr. Xinzhao Chu, co-PI Dr. Jeff Thayer, CU Research Associate Dr. Wentao Huang, CU graduate students, and collaborations with Arecibo Observatory Dr. Jonathan Friedman, Colorado Research Associates Dr. Biff Williams, and several private companies. The MRI lidar system integrates the state-of-the-art technologies of lasers, laser spectroscopy, electro-optics, and sensors into a single system to produce a powerful and robust tool with unmatched measurement capabilities. The revolutionary lidar design (Fig. 1) and unique technologies make the MRI lidar superb in the following ways: simultaneous measurements of temperature (30-110 km), wind (80-110 km), Fe density (75-115 km), and aerosol (10-100 km) in both day and night with high accuracy, high precision, and high resolutions. Chirp-free lidar frequency locking and saturation-free Fe layer resonance results in a bias-free estimate of winds and temperatures.

Under the purview of the MRI program, we can only propose the development of the lidar system with no funds being directed towards deployment for scientific study. The lidar will be robust and compact for ground-based mobile deployment. It is containerized to move with a truck or ship to field locations of interest with extensive geographic coverage. However, we have received numerous inquiries from a cross section of the upper atmosphere science community expressing their excitement and interest to use such an instrument for breakthrough science endeavors. An attractive while very challenging measurement – the vertical drift associated with the meridional circulation (requiring a few cm/s accuracy), may be reachable with this lidar.

The design of the entire MRI lidar is revolutionary in calibrating and controlling the lidar pulse frequency, aiming for true bias-free measurements. This design, as described by Chu et al. [2008] in the Proceeding of the 24th International Laser Radar Conference, ensures the absolute frequency calibration and accuracy of the MRI lidar to be better than 1 MHz. An Fe Doppler-free saturation-absorption spectroscopy at 372 nm is the first key step to achieve high-accuracy (bias-free) MRI Doppler lidar, which has been accomplished by the PI and her team (Fig. 2). The Fe Doppler-free spectroscopy and the 372-nm cw laser provide an absolute frequency calibration to the entire lidar system – both the transmitter lidar pulse and the receiver calibration. Optical heterodyne detection technology will be used to measure the absolute frequency of each lidar pulse, which enables the stabilization of lidar pulse frequency onto the Fe absorption peak.

A Pulsed Alexandrite Ring Laser (PARL) is the heart of the entire lidar system. We chose an "Oscillator + Amplifier + Second-Harmonic-Generation" configuration as shown in Fig. 1. A proven "ramp-fire" laser technology is applied in this PARL system. Furthermore, the president of the laser manufacturer, Light Age., Inc. (private partner), Dr. John Walling takes extra steps to ensure a very stable laser system, including an Invar-cage design, stainless-steel pump chambers, and ~3 m long oscillator cavity, etc. Dr. Walling has spent tremendous efforts on this unique PARL system, in close collaboration with the PI and her associate Dr. Huang. The system is close to being delivered but Dr. Chu's recent injury will delay the process by a few months.

An 80-cm Newtonian telescope has been assembled by the co-PI and his student (Fig. 3), and the receiver is ready for a sky test. The PI's team has completed the lidar containers (Fig. 4), enabling mobile deployment of the entire MRI lidar. The first light of the MRI lidar is expected within 6 months, and the lidar will be ready for field deployment in summer 2010.

For further information, please contact Xinzhao Chu at Xinzhao.Chu@Colorado.edu.

~Xinzhao Chu
University of Colorado Boulder

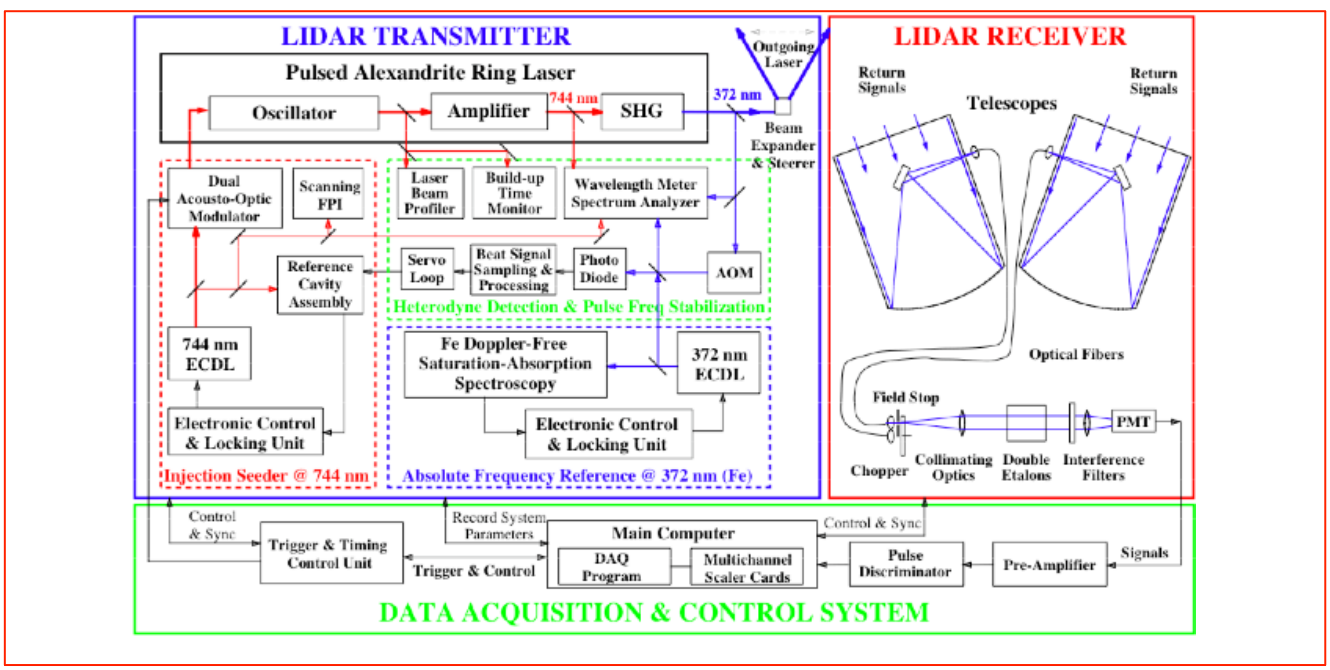


Fig. 1. Design of the MRI Mobile Fe-resonance/Rayleigh/Mie Doppler Lidar

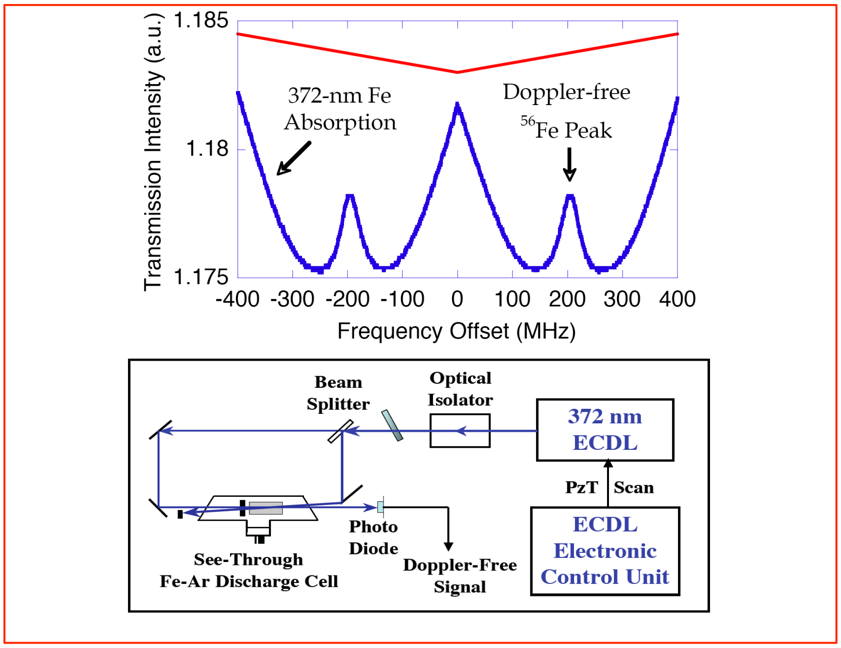


Fig. 2. Fe Doppler-free saturation-absorption spectroscopy at 372 nm obtained by the MRI Fe Doppler lidar (top) and the diagram of its experimental setup (bottom)

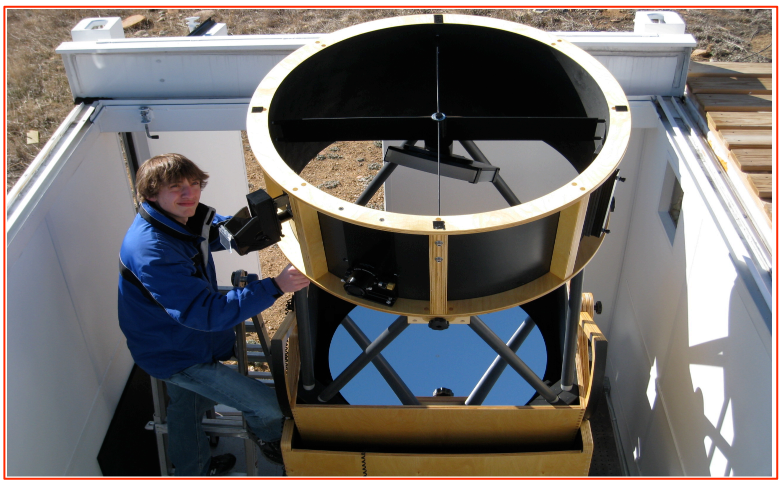


Fig. 3. CU Undergraduate Nick Bradley working on the 80-cm telescope for the MRI lidar

Fig. 4. Mobile containers for the MRI lidar in Boulder

MRI: Acquisition of a full-wave interferometric digital radio system: Status Report

An unexpected opportunity for improved implementation of phase synchronization, requiring an extension in the planned design period,combined with the more recent discovery of a fault in the 125-MHz 16-bit ADCchips necessitating their replacement and re-mounting, has resulted in a one-year delay in the delivery of our advanced MRI-funded radio receivers.

For these reasons NSF has granted a no-cost extension for the acquisition of the receivers. Laboratory and initial field testing are now planned during the fall and winter 2009, in time for delivery, installation, and field testing in advance of experiments to be proposed for the first campaign with the new Arecibo HF facility during the first half of 2010. We also have plans for testing and observations in fall 2009 or spring 2010 at EISCAT near Tromso, Norway.

New results are anticipated in the area of ionospheric radio emissions using high frequency and high time resolution observations, 3-D radio polarization and direction of arrival measurements, and 1-D imaging observations along the geomagnetic field. A reconstructed 1-D north-south image of three simulated radio emission regions is shown in figure 1. The model data-taking array consists of eight receivers situated at locations near Arecibo Observatory shown in figure 2. The potential field sites include local university campuses, high schools, middle schools, and grade schools, providing a unique opportunity for outreach.

Collaborators include Bo Thide, Jan Bergman, and Siavoush Mohammadi at the Swedish Institute of Space Physics in Uppsala, Lars Daldorff at the Finnish Meteorological Institute, Jim LaBelle at Dartmouth, Mike Rietveld at EISCAT, Vasyl Belyey at the University of Tromso, Koki Chau at the Jicamarca Radio Observatory, Dave Hysell at Cornell University, and others. Collaborations with anyone interested in the use of the instruments and/or the data from them are welcome.

~ Brett Isham

Interamerican University of Puerto Rico, Bayamón, PR

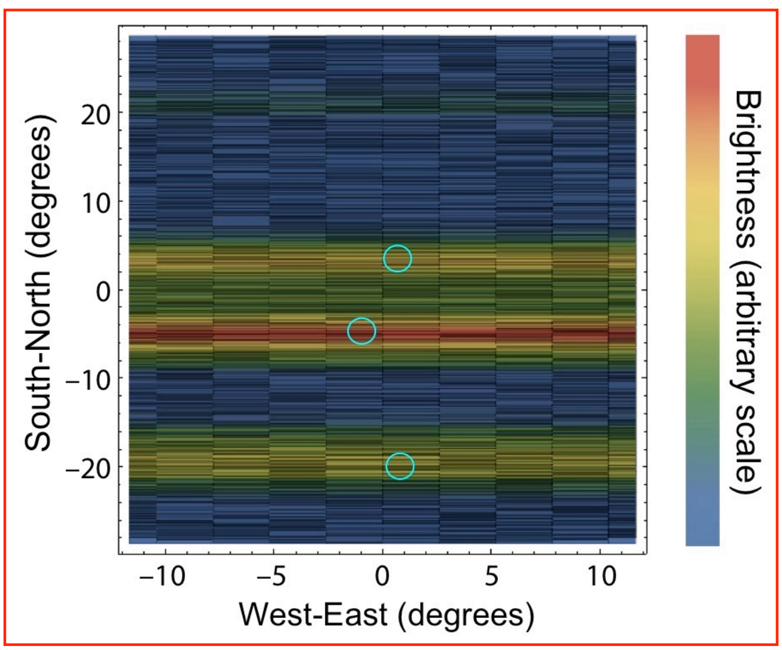


***Figure 1:** 1-D radio emission image showing the computed north-south (vertical axis) spacial variation of radio power vs. angle for three modeled emission regions at the locations indicated by the circles. The angular range of the north-south image is 30 degrees, and the three modeled radio emission regions are located at (2-deg E, 20-deg S), (2-deg W, 5-deg S), and (2-deg E, 3-deg N). The 1-sigma diameter of each Guassian emission region is 1.5 degrees. The color scale shows linear power intensity in arbitrary units. South and west are negative, north and east are positive. This plot was made by Vasyl Belyey of the University of Tromso using modeled receivers arranged as shown in figure 2.*

Figure 2: Google Earth image showing potential field sites (red dots) for eight receivers, in Puerto Rico near Arecibo Observatory, spread over a variety of linear north-south baselines ranging from 50 m to 6 km. These receiver locations were used to calculate the reconstructed image shown in figure 1.

CEDAR Satellite Collaboration

A GOLDen Opportunity for CEDAR Science

GOLD (Global-scale Observations of the Limb and Disk) is one of the two missions of opportunity selected by NASA's Small Explorer (SMEX) program in 2008. The far-ultraviolet imager to be constructed for the mission is currently scheduled to launch on a geostationary, communications satellite in 2014.

This imager will fly over the Americas and observe most of the hemisphere throughout the day. Due to its geostationary orbit, GOLD will unambiguously separate local time and longitude differences in the American sector. Consequently, GOLD can provide context for ground-based observations or other space-based observations, such as those from the Neutral-Ion Coupling Explorer (NICE), as well as providing the temperature, density and composition information needed for better understanding the space environment.

While the data may be used to address more questions than those proposed, the GOLD mission is designed to answer key elements of an overarching question: what is the global-scale response of the thermosphere and ionosphere to forcing in the integrated Sun-Earth system? Four key science questions, are addressed as part of this overarching question:

1. How do geomagnetic storms alter the thermosphere-ionosphere, and what is the dependence on the initial state?
2. What is the global-scale response of the thermosphere to solar EUV variability?
3. Do atmospheric waves and tides have a significant effect on the thermospheric temperature structure?
4. Do vertical ion drifts, as manifested in the structure of the equatorial anomaly, affect the occurrence of ionospheric irregularities?

GOLD's ability to provide, for the first time, both global-scale measurements of temperature and composition in the Earth's thermosphere is critical to answering most of these key science questions and to understanding these two major parameters respond to external and internal forcing. GOLD's images will cover the entire disk at a 30 minute cadence. The full, high resolution (~0.1 nm spectral) spectrum (132-162 nm) observed from each pixel (spatial resolution of 25 x 25 km^2 for daytime and 25 x 100 km^2 for nighttime imaging) is sent to the ground through a transponder dedicated to GOLD's data stream. From these data, disk temperatures and composition near 150 km can be obtained during the daytime and peak electron densities in the Appleton anomaly can be obtained at night. Observations of the limb provide exospheric temperatures in the daytime and O_2 density profiles throughout the day. All of these measurements can be performed by the single channel instrument studied during our recently completed Phase A study. One of the most significant benefits of a second channel, which was proposed but included in the selection, is an improved ability to conduct observing campaigns without interrupting the disk imaging. By concentrating the observations of a second channel on a specific location or local time, the temporal resolution and signal-to-noise in that region can be dramatically increased, allowing the observations to address a wider range of questions than originally envisioned. If a second channel is available, we anticipate inviting community input on the operations of that channel.

The CEDAR community's observations and capabilities in integrating ground-based and space-based observations will significantly enhance the understanding achieved from the GOLD mission. Since the GOLD imager will always observe from the same geographic location, it can separate spatial and temporal changes more readily than is possible from low Earth orbit and it will provide observations that are coincident with ground based observations throughout the Americas. Ground-based observations, such as Incoherent Scatter Radar measurements of temperature profiles or optical measurements of neutral winds, will provide information complementary to that from GOLD's observations. This combination of measurements will be even more useful for understanding the coupling of energy and momentum. Conversely, GOLD will be able to provide context and support for studies made from the ground. For example, a study of changing NmF_2 resulting from periodic variations of high latitude forcing can now be complemented by simultaneous observations of neutral temperatures and composition, which can also be put into a wider global context.

Thanks to the efforts of the geophysics community in general, and the CEDAR community in particular, it is clear that combining space and ground-based assets is an effective approach to achieving the system-level understanding necessary for advancing geophysical research and understanding the space environment. For achieving these objectives, data from both NICE, which is in competition to be selected as a stand-alone SMEX mission, and GOLD would be more valuable than data from a single mission.

The GOLD imager will be built by the Laboratory of Atmospheric and Space Physics at the University of Colorado. Data will be available online through the GOLD science data center at the University of Central Florida. More information about the GOLD mission is available at http://fsi.ucf.edu/GOLD/index.htm.

~Richard Eastes
University of Central Florida

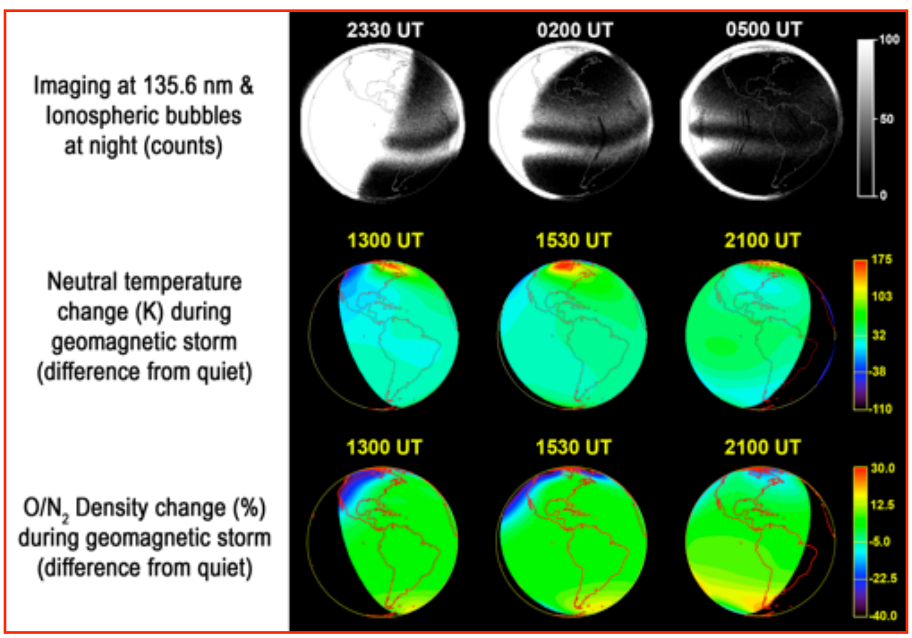


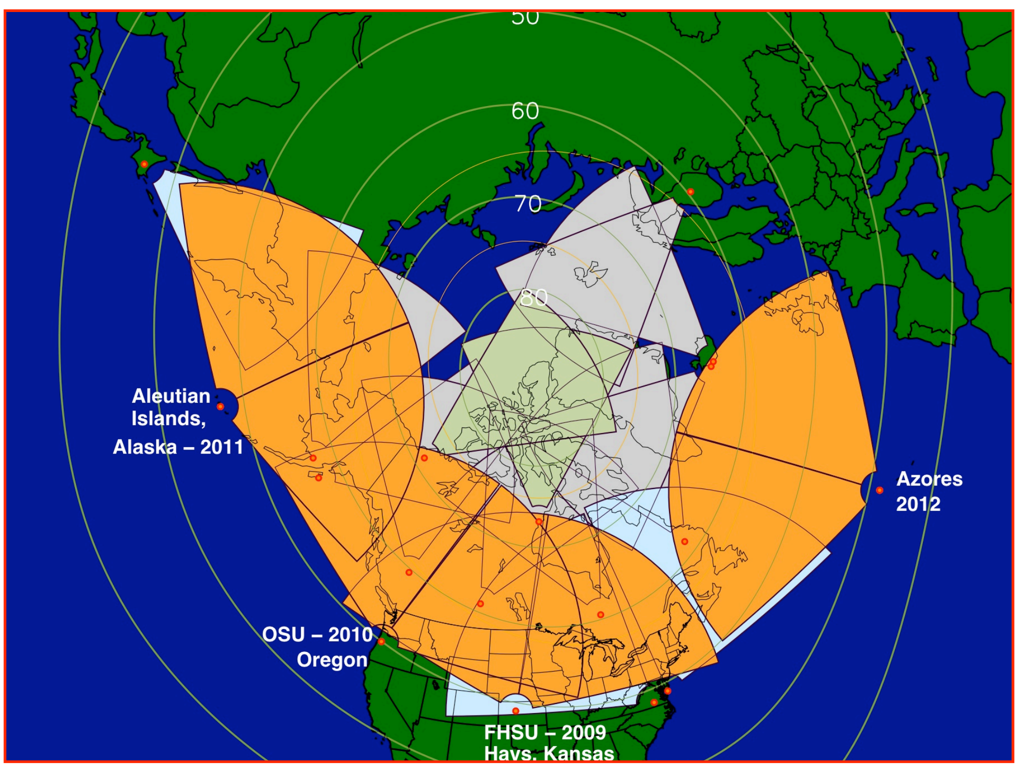
Figure caption: GOLD observes the same geographic locations throughout the day. The pictures above demonstrate potential observations of the nighttime ionosphere (top row) and daytime thermosphere (middle and bottom rows). Actual observations would be available at a higher (30 minute) cadence. Top row: simulation of nightside observations, counts at 135.6 nm, of equatorial ionosphere with "bubbles". This simulation used a 3-D ionosphere and integrated the emissions along the line of sight. Groups of three bubbles - with widths of 25, 50 and 100 km – are introduced just after sunset and allowed to propagate up through the ionosphere. Although the grayscale used saturates on the dayside, both dayside and nightside can be observed simultaneously. Bottom two rows: These pictures are derived from TIEGCM calculations temperature and composition changes from quiet to storm times at ~150 km, approximately the altitude sensed by the GOLD imager. These pictures are at the viewing geometry and approximately the spatial resolution expected from GOLD. Middle row: Neutral temperature change (K) between storm and quiet time. Bottom row: O/N_2 density ratio change (in percent) between storm and quiet time. GOLD observations will be able to distinguish changes of 15 K or 10%.

Community Research

Mid-Latitude SuperDARN Array

The National Science Foundation (NSF) is funding the construction of a new array of SuperDARN-style HF radars to be located in the northern hemisphere at latitudes near 50 geomagnetic. The new array will be comparable in extent to the existing SuperDARN array at high-latitudes and provide measurements of the ExB plasma drift in the ionosphere at lower latitudes. The mid-latitude array, scheduled for completion in 2012, will consist of three existing mid-latitude radars (Wallops Island, VA; Blackstone, VA; and Hokkaido, Japan) and eight new radars to be built in Kansas, Oregon, the Aleutian Islands in Alaska, and the Azores. Together with the existing high-latitude and polar radars, the combined network of SuperDARN-style radars will enable observation of the ionospheric electric field over a region that extends from Eastern Asia to Europe and from 50 degrees latitude to the geomagnetic pole. The new infrastructure will provide important measurements necessary for determining the electrodynamics of the ionosphere at sub-auroral latitudes as well as providing critical measurements of the ionospheric footprint of the plasmasphere boundary layer region. The expanded SuperDARN network will be capable of tracking plasma flow from the dayside cusp, over the polar cap, and into the nightside reconnection region, particularly during storm-time conditions when the convection region is expanded well equatorward of the quite-time auroral region.

The new radars are being funded by a grant from the NSF Division of Atmospheric Sciences (ATM) as part of the Mid-Size Infrastructure (MSI) opportunity. The ATM directorate created the MSI opportunity to provide equipment, costing between $4M and $25M, that has broad community support and will enable high-priority science consistent with community needs, ATM goals, and the NSF strategic vision. The SuperDARN network has been recognized as a model for international scientific cooperation and for practices that encourage data usage by a broad sector of the community.



Mid-latitude array of SuperDARN-style radars to be constructed over the next four years.

The MSI SuperDARN radars will be built over the next four years at a rate of two radars per year. The relatively rapid rate of construction is made possible, in part, by a unique collaboration between scientists at four institutions: Virginia Tech (VT), the University of Alaska Fairbanks (UAF), Dartmouth College, and the Johns Hopkins University Applied Physics Laboratory (JHU/APL). Principle scientists J. Michael Ruohoniemi (PI), Raymond Greenwald (Co-PI), and Joseph Baker from VT; William Bristow (Co-PI) from UAF; Simon Shepherd (Co-PI) from Dartmouth College; Elsayed Talaat (Co-PI) and Robin Barnes from JHU/APL; will combine resources and expertise to build the radars at each of the four identified sites.

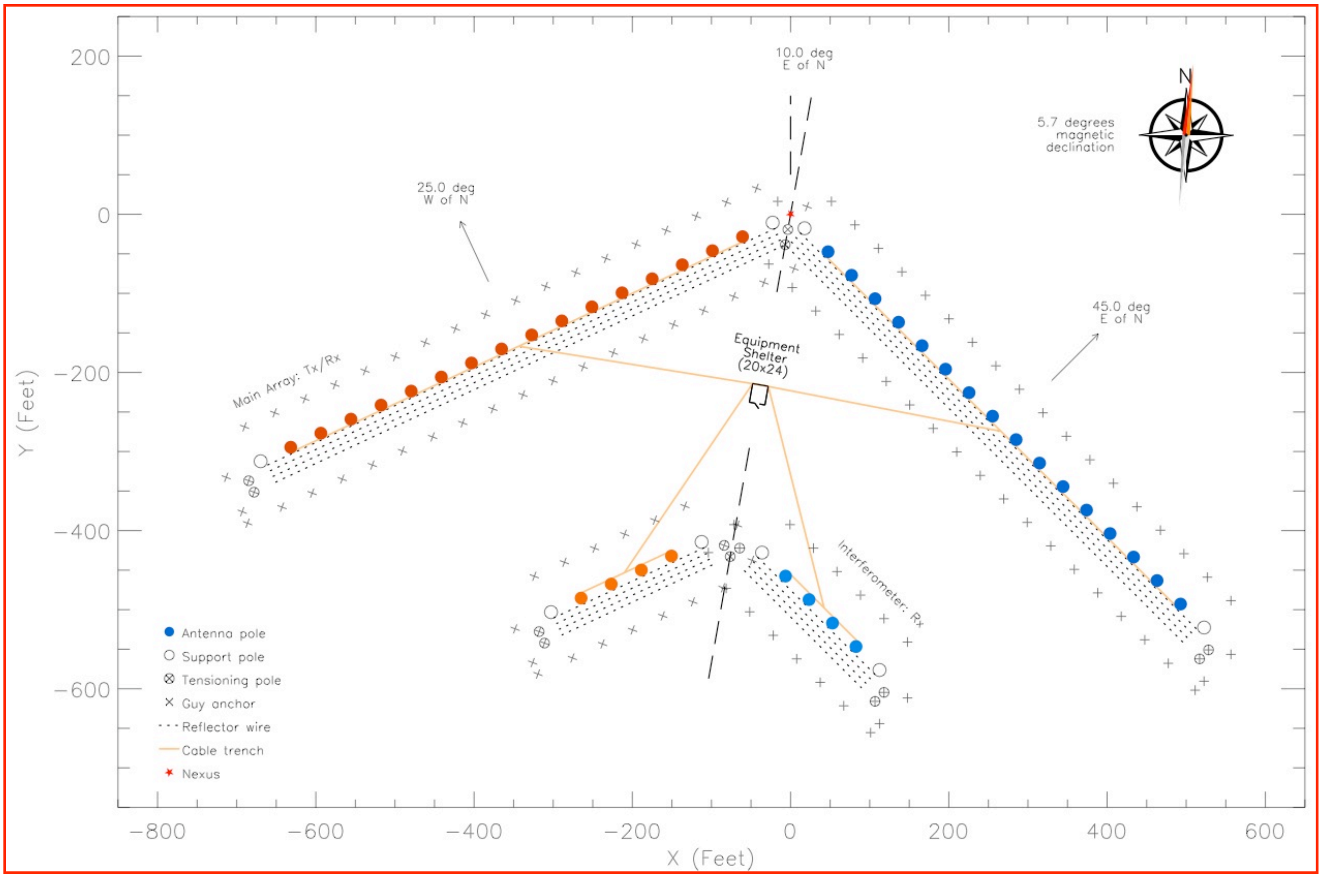
The new radars will resemble standard SuperDARN-style radars except for the addition of several recent advancements -- most notably in antenna design and the use of digital components throughout the radar electronics -- that significantly reduce the cost and increase the flexibility and reliability of each radar. Further cost-saving measures include co-locating a pair of eastward and westward looking radars at each site, minimizing construction costs and creating a single, synchronized radar pair that share integrated electronic and computer systems and cover a field-of-view that approaches 180 degrees of azimuth.

The new radars will be incorporated into the SuperDARN system as the construction and testing phases for each radar are completed. Real-time and archival data will be integrated into the standard SuperDARN processing stream and distributed through the SuperDARN website (superdarn.jhuapl.edu). Construction of the first pair of radars is scheduled for the summer of 2009 on land owned by the Fort Hays State University (FHSU) in Hays, Kansas. Data are currently available from the existing mid-latitude radars at Wallops Island, VA; Blackstone, VA; and Hokkaido, Japan through the SuperDARN website.

As an exciting new phase in ground-based remote sensing begins the international SuperDARN community, which has grown to include scientists from more than a dozen countries, is looking forward to the significant increase in infrastructure, which will ultimately enable new areas of research by scientists in the CEDAR and other ATM communities. Dr. Raymond Greenwald is one scientist that is no exception. In addition to being a pioneer in the technique of ionospheric remote sensing with HF radar, Dr. Greenwald is credited with many of the discoveries made with SuperDARN as well as many of the advancements that have resulted in the success of SuperDARN as a valuable scientific facility and a model for international scientific cooperation. Of special interest is that all of the principles on this project have trained under Dr. Greenwald at one time as either postdoctoral or research scientists.

~Simon Shepherd, Dartmouth College; J. Michael Ruohoniemi and Joesph Baker, Virginia Tech; and Bill Bristow, Geophysical Institute – University of Alaska Fairbanks.

Ray Greenwald pounds the honorary first stake into the ground at FHSU – site of the first pair of MSI SuperDARN-style radars.



Field layout of twin radar design to be used for new MSI-radars.

HIWIND a Balloon Borne Fabry-Perot Interferometer for Daytime Thermospheric Wind Observation

HIWIND (High altitude Interferometer WIND experiment) is a NASA funded stratospheric balloon mission to measure daytime thermospheric winds. For the first time, a balloon borne Fabry-Perot interferometer (FPI) will measure the thermospheric neutral winds by monitoring Doppler shift in the daytime thermosphere O 630 nm emission. The mission includes a test flight from Ft. Sumner, New Mexico in September, 2010 and a science flight from Kiruna, Sweden, in the summer of 2011. The planned scientific flight will last for about 5 - 7 days, during which the stratospheric balloon with the FPI will fly westward from Scandinavia across Atlantic Ocean over Greenland and land somewhere in northern Canada or Alaska. A possible flight path is shown in the figure. The main objective of the mission is to combine the daytime thermospheric winds from HIWIND with ground based incoherent scatter radars measurements from EISCAT, Sondrestrom, possibly Resolute AMISR southern beam, and PFISR to study high latitude thermosphere-ionosphere interaction. (All these radars are all on the possible balloon flight path as shown in the figure). More specifically, we will use the combined data set to calculate the Joule heating rate and compare the observational results with various model simulation results.

The significance of the HIWIND will go beyond the high latitude region. The system will be designed for nighttime measurements as well. A future flight of several days at mid- or low-latitudes can be very valuable. Thermospheric wind is the key to a better understanding of ionosphere from the equatorial to the polar region. In the equatorial region the thermospheric wind controls the occurrence rate of the equatorial ionospheric bubble. In the mid-latitude region, the meridional thermospheric wind determines the changes in the ionosphere by pushing it upward or downward along the field lines.

It is well known that daytime thermospheric wind measurement is a challenge for ground based optical observers using the O 630 nm dayglow emission. Usually a multi-etalon system is utilized to reduce the high solar scattering background.

The shifting Fraunhofer line feature in the solar scattering background requires frequent monitoring of the solar spectrum. Hence, operating such an instrument can be very labor intensive and the measurement results are much affected by the high solar background. Past and current satellite observations of the daytime thermospheric winds from DE and UARS have laid the foundation of our understanding of the thermosphere dynamics. Currently, only C/NOFS is ready to provide daytime equatorial thermospheric winds in the coming years. NICE is at early planning stage. No other satellites are offering thermospheric wind products at the moment. Hence, the basic fact remains that we have very scarce coverage of the thermospheric winds outside the equatorial region for years to come.

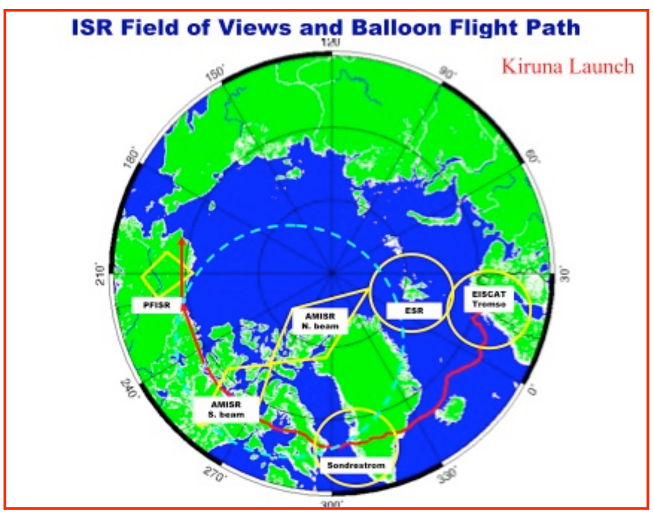
To meet the need of more thermospheric wind measurements, National Center for Atmospheric Research (NCAR) proposed to build a balloon borne FPI (HIWIND) to measure the thermospheric winds in the polar region during the summer season. Being at stratospheric height of 40km a balloon borne FPI will see only one thousandth of the solar scattering background as one would at sea level. The O 630 nm dayglow has only about 2 % of the intensity of the solar scattering background at sea level. At 40 km altitude, the dayglow intensity will be 20 times of that of the much reduced solar scattering background. Therefore, we no longer have to worry about the Fraunhofer line in the background. We can simplify the instrument from a multi-etalon system to a single etalon system. The main focus of the mission is the O 630 nm dayglow. Other emissions are also under consideration. The instrument will measure winds at four orthogonal directions with an elevation angle of 40 degrees. Our simulation shows that wind error for a 100-second exposure should be about 2 m/s. This accuracy should be sufficient for most of the ionosphere-thermosphere interaction study in the high latitude.

Even with the simplification of instrument design, flying an FPI on a balloon payload is an engineering challenge. The balloon FPI will be in a harsh environment with extreme temperatures. However, compare to other large balloon missions, the HIWIND mission is relatively small and simple. It does not have high pointing accuracy requirement as many astronomical balloon missions required.

From the beginning, we envision a great collaboration with CEDAR community for joint measurements. The HIWIND is predicted to fly over EISCAT, Sondrestrom, Resolute AMISR southern beam, and PFISR incoherent scattering radar field of views. Various ISR operators have been contacted for coordinated measurements. While HIWIND can provide the thermospheric wind and temperature, the ground based ISR can offer ion drift and other ionospheric information. Fortunately, the HIWIND mission will fly after the start of Resolute AMISR. We anticipate a strong collaboration between AMISR and HIWIND in the future. The combined measurements should allow us to address many unresolved issues related to the joule heating in the high latitudes. Moreover, the HIWIND will cover different magnetic latitudes from EISCAT (sub-auroral), Sondrestrom (auroral oval), Resolute (polar cap), and Poker Flat (auroral oval). Hence, the data set will also allow the study of the morphology of the high latitude thermospheric wind convection pattern.

The CEDAR community support will be crucial for the success of the project. The HIWIND mission will share data with the community for future analysis. The NCAR/HAO is leading the effort of building the payload with other possible collaborators.

~ Qian Wu
NCAR



The figure shows a past balloon mission flight path from Kiruna heading west. Additional possible flight sections were added. Flight over Russia may be possible in the future. The light blue dashed-circle roughly marks the polar cap boundary. Field of views of incoherent scatter radars are outlined by yellow lines. The AMISR and PFISR views are approximated.

Incoherent Scatter radars look towards the next phase of CEDAR

The next phase of CEDAR provides important scaffolding for the future development not only of the CEDAR program and community itself, but also for groups, disciplines, and even individual research projects related to the program.

The most recent UAF review-panel, chaired by Susan Avery, made a number of general recommendations about the future of the facilities as a group, which resonate with the ideas and goals of next phase of CEDAR, and encouraged the facilities to develop overarching scientific goals and drivers and to share resources and expertise more broadly across the community.

These ideas are timely and echo similar plans being developed at many levels in the wider community, both in the USA and elsewhere

Creating a more integrated program is hardly trivial because each of the upper atmosphere facilities is unique, with obvious differences in location and hardware and major differences in interests, applications, and science programs. Because of the different technology and international aspects of SuperDARN, early efforts are focusing on the incoherent scatter radars (ISRs).

Urged by the NSF, the community has already developed an outline program described in a major document: The National Science Foundation's Upper Atmospheric Facilities: Integrating Management, Operations, and Science (fall 2008). It contains detailed information on future plans at each facility as well as recommendations and proposals for more integrated activities. Guiding principals were developed describing the overall goals of the UAF program:

- To ensure that the science undertaken at the UAFs is of the highest quality and is coordinated with the university community to produce a synergistic effect in the advancement of upper atmospheric science

- To ensure that the facilities are maintained as state-of-the-art, cost-effective research tools available to all qualified scientists, and that the data and services provided by the facilities are adequate to meet the community's short- and long-range scientific objectives

- To educate future space scientists in the development, operation, and use of multiuser facilities, leading to the maintenance of a diverse, highly qualified user base for upper-atmospheric-research data

In parallel with the development of the Integrated Approach document, extensive discussions among facility staff have addressed the practical implementation of such ideas within the incoherent scatter community and led to the concept of a loosely constrained Consortium approach which strives to:

- Address the goals identified in the Integrated Approach document

- Apply the UAF ISRs more effectively to address the scientific drivers identified by our community

- Enable wider use of existing and new ISR data products

- Exploit capabilities of existing and future UAF ISRs

- Provide a new platform for effective 'World Day' co-ordination

- Provide foundations for effective discussion and prioritization of AMISR re-deployments

- Provide a foundation for effective planning and implementation of an Antarctic ISR

Another level of coordination, organization, or direction will not itself lead to either the adoption of such goals or the creation of an appropriate response to the original drivers and much care and further consultation is necessary. The differences between the facilities, their programs, and their approaches to current problems and opportunities are an important and valuable strength, but they necessitate proactive coordination efforts if the goals, and expected benefits, are to be achieved.

A dedicated session has been scheduled during the 2009 CEDAR meeting, and all those with interest in the development of the Upper Atmosphere Facilities, the ISRs, and the wider fields of atmospheric science (and beyond) are welcome to attend and participate. We need and value your inputs!

Initial planning has concentrated on achieving enhanced levels of coordination without adding additional loads at the facilities or impacting their research and development programs. Key elements are a small Integrated Facilities Office, a Science Committee, and multiple, distributed Skills Teams.

The Integrated Facilities Office will provide monitoring and awareness functions, support the Science Committee, and coordinate the formation and operation of the Distributed Skill Teams.

The Science Committee advises the Integrated Facilities Office and includes members with a broad range of scientific knowledge and expertise. It maintains an overall scientific

Jicamarca: the first phased array incoherent scatter radar observing the lowest magnetic latitude. Photo: Koki Chao

Resolute Bay (RISR-N): the latest phased array incoherent scatter radar observing the highest magnetic latitudes. Photo: Craig Heinselman

program and strategy, monitors and reacts to community and society drivers, and interacts with CEDAR, GEM, NASA, and other large programs. It identifies and prioritizes scientific opportunities. The scientific plan is a valuable shared community resource providing a living, developing framework for our work.

The Distributed Skills Teams provide a means for individuals and groups to extend their horizons. The number, composition, and goals of such teams will be fluid. Team members will generally remain embedded within their home facilities and an important side benefit is that a potential future dwindling supply of some essential skills can still be available across the community.

As the coordinated approach evolves, we can expect to see important and tangible benefits including:

- The Science Plan itself, jointly owned by the community, supporting effective application of resources to scientifically challenging and societally important issues
- Timely application of the best techniques and methods across the community
- Effective access to the whole available skill set
- Broadened horizons not only for facility scientists but also for technical, engineering, and other staff
- Streamlined access to data products within, and beyond, the community

We encourage you to attend and contribute to the workshop during the CEDAR meeting.

~Tony van Eyken
SRI International

2010 CEDAR Workshop

While you are busy preparing for the 2009 CEDAR Workshop in Santa Fe, please remember to plan ahead for the 2010 workshop at the University of Colorado in Boulder, CO. The workshop will be held June 21 through June 25. As details become available, they will be posted on the CEDAR wiki. We look forward to seeing you!

CSSC Letters

Letter of Concern for Greenland Magnetometer Chain

U.S. CEDAR Program – Coupling, Energetics and Dynamics of Atmospheric Regions

Chair of the CEDAR Science Steering Committee
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April 28, 2009

Minister Helge Sander
Danish Ministry of Science, Technology, and Innovation
Bredgade 43
DK-1260 Copenhagen,
DENMARK

Dear Minister Sander:

The members of the U.S. National Science Foundation's (NSF) Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) science steering committee express our deep concern regarding news of the Danish Meteorological Institute's plan to discontinue the operation of the Greenland magnetic measurement stations and to no longer maintain the data archive accumulated over the many years. This data resource is a critical asset for many researchers around the globe and is essential for continuing advancement of understanding solar-terrestrial interactions.

The CEDAR program funded by NSF is an element of the U.S. Global Change Program which started in 1986 to undertake coordinated collaborative studies of the Earth's upper atmosphere. Its primary objective is to understand the energetic and dynamic processes that determine the composition and structure of the atmosphere above 60 km, particularly how energy, momentum, and chemical processes from the magnetosphere, and those originating in the lower atmosphere, couple to and affect the mesosphere, thermosphere and ionosphere. CEDAR scientific efforts involve researchers, students and technicians, from many countries studying aspects of the upper atmosphere and ionosphere through modeling, data analysis and ground based observations. The CEDAR program has reached the level of icon status and is recognized around the world as the leading forum for upper atmosphere research.
In this role, the CEDAR community is gravely concerned with the potential loss of the Greenland magnetometer chain and its data. The Greenland array of magnetometers is uniquely located and provides

unmatched continuity and temporal resolution of currents flowing in the polar ionosphere and magnetosphere. Current flow in the ionosphere is a manifestation of energy transfer from the solar wind to the earth's upper atmosphere and is a major contributor to heating the upper atmosphere. This contribution is amplified during geomagnetic storms. The time-varying nature in the current leads to magnetic perturbations on the ground that can induce currents in conducting materials compromising power grids, cause corrosion of pipelines, and disrupt communications. These consequences constitute societal impacts of space weather. Though societal and economic impacts of space weather events are not well understood, estimates show that the economic cost of a severe geomagnetic storm could reach US $1-2 trillion during the first year alone, with recovery times of 4-10 years.

On behalf of the CEDAR community, we urge your ministry to consider alternatives to closing the Greenland magnetometer stations and urge the continuance to maintain the excellent data base that has been accumulated over several solar cycles. There is much research still to be accomplished and the Greenland magnetometer stations are among the most important ground-based resources needed to further develop our scientific understanding of the Sun-Earth system. The absence of the Greenland data will leave an enormous observational gap in a critical region of geospace. The Greenland infrastructure presently in place would also be difficult to reinstate once support is discontinued. The continued operation of the Greenland stations will directly contribute to the ongoing Danish satellite programs to investigate the Earth's magnetic field, whose remarkable results have earned strong international recognition.

Sincerely,

Jeffrey P. Thayer, Ph.D., Associate Professor, Aerospace Engineering Sciences Department
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Dr. Hanli Liu, NCAR; **Mr. Marco Milla,** Univ. Illinois Urbana-Champaign**; Dr. John Noto**, Scientific Solutions Incorporated; **Dr. Meers Oppenheim,** Boston University; **Dr. John Plane;** University of Leeds, England; **Dr. Mike Ruohoniemi,** Virginia Tech; **Dr. Susan Skone,** University of Calgary, Canada; **Dr. Lara Waldrop,** Univ. of Illinois Urbana-Champaign

Letter of Support for GOLD Mission

U.S. CEDAR Program – Coupling, Energetics and Dynamics of Atmospheric Regions

Chair of the CEDAR Science Steering Committee
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December 1, 2008

Dr. Hashima Hasan
Explorer Program Scientist, Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001 U.S.A.

Dear Dr. Hasan:

The members of the National Science Foundation's (NSF) Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) science steering committee express our enthusiastic support for the Global-scale Observations of the Limb and Disk (GOLD) mission. We strongly approve of NASA's selection of the mission. As will be demonstrated, the GOLD mission science goals complement those of the CEDAR program, adding unique value to resolving grand challenges within upper atmosphere physics.

The CEDAR program funded by NSF is an element of the U.S. Global Change Program which started in 1986 to undertake coordinated collaborative studies of the Earth's upper atmosphere. Its primary objective is to understand the energetic and dynamic processes that determine the composition and structure of the atmosphere above 60 km, particularly how energy, momentum, and chemical processes from the magnetosphere, and those originating in the lower atmosphere, couple to and affect the mesosphere, thermosphere and ionosphere. CEDAR scientific efforts involve researchers, students and technicians, studying aspects of the upper atmosphere and ionosphere through modeling, data analysis and ground based observations.

The CEDAR program has reached the level of icon status and is recognized around the world as the leading forum for upper atmosphere research. In this role, the CEDAR community is preparing its future research plan. The community recognizes the scientific advancements made and the rapidly changing research landscape. This has led the CEDAR community to take on a more holistic view of upper atmosphere processes. It is the vision of the CEDAR community that the physics and chemistry of the upper atmosphere be fully integrated with the response and evolution of the whole sun-earth system. Grand challenges within CEDAR are to address questions such as: What makes a planet habitable, variable and sustainable? and How does the sun-earth system influence our space-reliant society?

Resources on the ground and in space will be required to meet these challenges. The GOLD UV imager, with its global-scale measurements of daytime thermosphere temperature and composition and nighttime electron density from geostationary orbit, is precisely what is needed to advance the CEDAR mission and it will be greatly valued by the entire upper atmosphere community. The GOLD measurements will strongly complement the measurement suite of the ground-based CEDAR community and provide a new data set to constrain modeling efforts. The CEDAR program is an integral part of the National Space Weather Program (NSWP) and the unique vantage point afforded by the geostationary position of the GOLD UV imager over North America will enable continuous unprecedented study of geomagnetic storms and solar effects on the upper atmosphere. This mission will thus provide critical information on the large-scale context of observations made by the CEDAR community. GOLD will be the premier satellite mission for advancing our understanding of the fundamental drivers of the thermosphere and ionosphere and to advancing models of the space environment. It signifies the only thermosphere and ionosphere mission within NASA's missions of opportunity.

The GOLD mission's imager is expected to begin observations in 2014 from geostationary orbit. The NSF, through the CEDAR program and the facilities supported, anticipates performing a wide range of activities around the GOLD research program including provision of complementary data, analysis, and modeling efforts. Most of the ground based facilities and observatories supported by NSF are in the Americas (e.g., major facilities at Millstone Hill Observatory, Massachusetts, Arecibo Observatory, Puerto Rico, Jicamarca Observatory, Peru, and distributed instrumentation such as the Low-Latitude Ionospheric Sensor Network in South America) making them ideal for coincident observations with GOLD. The CEDAR program anticipates conducting observing campaigns in coordination with the GOLD mission with the aim of increasing the value of the science product and enabling a wider program of research on the global-scale response of the thermosphere and ionosphere to forcing in the integrated Sun-Earth system.

The CEDAR Science Steering Committee requests that the benefits of GOLD to the atmospheric and space science community worldwide be given substantial weight as decisions are made with regard to the future of this mission.

Sincerely,
Jeffrey P. Thayer, Ph.D., Associate Professor, Aerospace Engineering Sciences Department
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Letter of Support for NICE Mission

U.S. CEDAR Program – Coupling, Energetics and Dynamics of Atmospheric Regions

Chair of the CEDAR Science Steering Committee
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April 28, 2009

Dr. Hashima Hasan
Explorer Program Scientist
National Aeronautics and Space Administration
Washington, DC 20546-0001 U.S.A.

Dear Dr. Hasan:

The members of the National Science Foundation's (NSF) Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) science steering committee express our enthusiastic support for the Neutral-Ion Coupling Explorer (NICE) mission. As will be demonstrated, the NICE mission science goals complement those of the CEDAR program, adding unique value to resolving grand challenges within upper atmosphere physics. The lack of a dedicated aeronomic U.S. space mission to regions of the earth's ionosphere has severely limited progress in this field.

The CEDAR program funded by the NSF is an element of the U.S. Global Change Program which started in 1986 to undertake coordinated collaborative studies of the Earth's upper atmosphere. Its primary objective is to understand the energetic and dynamic processes that determine the composition and structure of the atmosphere above 60 km, particularly how energy, momentum, and chemical processes from the magnetosphere, and those originating in the lower atmosphere, couple to and affect the mesosphere, thermosphere and ionosphere. CEDAR scientific efforts involve researchers, students and technicians studying aspects of the upper atmosphere and ionosphere through modeling, data analysis and ground based observations.
The CEDAR program has reached the level of icon status and is recognized around the world as the leading forum for upper atmosphere research. CEDAR's outstanding track record has naturally served to facilitate the training and education of our current and future US space scientists and engineers. In this role, the CEDAR community is preparing its future research plan. The community recognizes the rapidly changing research landscape and the potential new opportunities to advance upper atmosphere research.

This has led the CEDAR community to take on a more holistic view of upper atmosphere processes. It is the vision of the CEDAR community that the physics and chemistry of the upper atmosphere be fully integrated with the response and evolution of the whole sun-earth system. Fundamental to this cause is understanding the interaction of the thermosphere gas with the ionosphere plasma.

In its low inclination (24º) 550-km circular orbit, NICE will often measure F-region ion drifts on magnetic field lines that map directly down to the location of the neutral wind and density measurements remotely sensed by NICE instruments. With thousands of such conjunctions, NICE will perform a very detailed study of the F-region effects of the dynamo electric fields produced by neutral winds in the lower ionosphere. Ground-based measurements will compliment the NICE mission, which will make repeated, daily passes over the well-instrumented Caribbean and South American regions familiar to CEDAR scientists. NICE hopes to boost this collaboration with the additional selection of a SMEX-"Science Enhancement Option" to select a site in Northern Brazil for new instrumentation to specifically study gravity waves that modify the neutral winds in the E region. The addition of NASA-supported, ground-based measurements has recent precedent with the successful deployment of 20 semi-autonomous all-sky camera and magnetometer observatories for the THEMIS mission. This effort clearly benefits from the existing network of facilities supported by NSF and international partners, and would allow NICE to expand its science investigation into more areas of current interest to CEDAR. The NICE mission signifies the only thermosphere and ionosphere mission within NASA's small explorer program.

The numerous interesting and surprising scientific discoveries made in the course of the past decade of aeronomical research, combining space- and ground-based assets to gain system-level understanding, make a strong case for the continuation of this successful approach to geophysical research. The CEDAR Science Steering Committee requests that the benefits of NICE to the atmospheric and space science community worldwide be given substantial weight as decisions are made with regard to the future of this mission.

Sincerely,

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