CEDAR

2013

Millennium Hotel

Boulder, Colorado

IT Poster Session

Tuesday June 25, 2013

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CEDAR Workshop – IT Poster Session Abstracts

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Data Assimilation or Management

DATA-01 Comparing quiet time standard deviation to error estimates of incoherent scatter radar measurements - by William Edward Archer

Status of First Author: Student IN poster competition, PhD

Authors: W. Archer, Knudsen, D., Burchill, J., Erickson, P.

Abstract: The ESA Swarm satellite mission has a current launch date of October 4th, 2013. The electric field instrument (EFI) aboard the Swarm satellites will be validated using coincident ISR measurements. In this study the standard deviation of quiet time ISR plasma measurements are compared to the error estimates of those plasma measurements. By characterizing the properties of ISR measurements made in unchanging conditions we improve the confidence and significance of comparative studies including ISR such as the validation of the Swarm EFI instrument.

DATA-02 Assimilation of FORMOSAT-3/COSMIC electron density profiles into a coupled Thermosphere/Ionosphere model - by I-Te Lee

Status of First Author: Student NOT in poster competition, PhD

Authors: Tomoko Matsuo, Arthur D. Richmond, Jann-Yenq Tiger Liu

Abstract: This paper presents our effort to assimilate FORMOSAT-3/COSMIC (F3/C) GPS Occultation Experiment observations into the National Center for Atmospheric Research (NCAR) Thermosphere Ionosphere Electrodynamics General Circulation Model (TIE-GCM) by means of ensemble Kalman filtering (EnKF). F3/C electron density profiles are combined with the TIE-GCM simulations by EnKF algorithms implemented in the NCAR Data Assimilation Research Testbed to estimate 'the best' states of the thermosphere and ionosphere. Initially, many of observations are not assimilated during nighttime due to a large model-observation discrepancy, and this issue has been resolved by adjusting the O+ flux at the TIE-GCM upper boundary using the EnKF observation rejection rate as guidance. Assimilation results during geomagnetically quiet and disturbed conditions exhibit some small-scale features that are typical under those geophysical conditions but absent in the TIE-GCM simulations. The results are further compared with independent ground-based observations and global Total Electron Content maps as well as F3/C profiles themselves, suggesting the overall improvement of the primary ionospheric parameter specification including NmF2 and hmF2.

DATA-03 Estimation of Thermospheric Winds Using a Kalman Filter Technique – by Levan Lomidze

Status of First Author: Student IN poster competition, PhD

Authors: Levan Lomidze and Ludger Scherliess

Abstract: Thermospheric neutral winds play an important role in the dynamics of the middle- and low-latitude F region ionosphere. Up to date their reliable estimation remains a challenge because of difficulties in both, measurement and modeling. The global sparseness and lack of continuous observations of global thermospheric wind often make empirical wind models to fall short in adequately reproducing even their observed climatology. We present a new method for the estimation of the global thermospheric neutral wind climatology using a Kalman filter technique combined with ionospheric observations. First, the magnetic meridional wind is obtained by assimilating

seasonally averaged COSMIC radio occultation data of F-region ionosphere peak parameters (NmF2 and hmF2) into the Global Assimilation of Ionospheric Measurements Full Physics (GAIM-FP) model. The model, which is based on Utah State University Ionosphere Plasmasphere Model (IPM), provides 3-D electron density throughout the ionosphere together with the magnetic meridional wind required to match the model density with the observed ionospheric parameters. Next, the estimation of global zonal and meridional winds is performed using a separate Kalman Filter, based on a semi-empirical 3-D thermospheric neutral wind model and on the GAIM-FP calculated magnetic meridional wind data. The ionospheric drag and ion diffusion velocities, needed for the wind calculation, are also taken from GAIM-FP. As an output the model provides the 3-D thermospheric neutral wind field at mid- and low-latitudes. The estimated climatology of neutral winds, when used in the IPM model, provide better agreement with the COSMIC ionospheric data than simulations performed using the empirical HWM93 and HWM07 wind models. We present the results of our wind decomposition and compare individual wind components to their corresponding empirical model values.

DATA-04 Preliminary results on a new plasmasphere data assimilation technique – by Romina Nikoukar

Status of First Author: Non-student

Authors: Romina Nikoukar, Gary Bust, David Murr

Abstract: This work presents preliminary results on a new state-of-the-art plasmasphere imaging and data assimilation technique. This technique will ingest data sets sensitive to plasmaspheric densities to produce time-evolving maps of electron density in the plasmasphere. Based on the Ionospheric Data Assimilation Four-Dimensional (IDA4D), the new method aims at further extending the capabilities of IDA4D to the plasmasphere and the top ionosphere. To this end, new grid descriptions and new background error covariance matrices suitable for the plasmasphere are developed. Two empirical plasmasphere models, international reference ionosphere with the Izmiran expansion and global core plasma model, are included in the assimilation. The technique is examined on actual data, and the results are presented and compared for these two different background models. The results of this study can be combined with ionospheric data assimilation results already developed or being developed to provide a unifying framework with the ability to forecast ionospheric and plasmaspheric states.

DATA-05 Assimilative Model Bias Correction Schemes for Global Ionospheric Modeling – by Yang-Yi Sun

Status of First Author: Student IN poster competition, PhD

Authors: Yang-Yi Sun, Tomoko Matsuo, Naomi Maruyama, Eduardo A. Araujo Pradere, and Jann-Yenq Liu

Abstract: The balance between plasma production, loss, and transport processes determines the distribution of the ionospheric plasma density, and thermospheric parameters such as neutral wind, temperature, and composition significantly influence these processes. The discrepancy between the modeled and observed ionospheric plasma density often results from inadequately specified thermospheric drivers. Global observations of the thermospheric parameters remain scarce, while plasma density measurements become relatively abundant thanks to radio occultation missions like the FORMOSAT-3/COMSIC (F3/C). The objective of this study is to infer relevant thermospheric parameters from plasma density observations for improving global plasma density distribution in a physics-based ionosphere and plasmasphere model. For example, in mid-latitudes, variations in the F2 layer peak height (hmF2) are almost exclusively controlled by neutral winds along a field line. We explore the usage of the hmF2 maps constructed from F3/C observations to infer global meridional neutral winds among other neutral parameters. The inferred winds are further used to drive the global ionosphere and plasmasphere model, and the longitudinal effects of magnetic declination/inclination angles on the inferred wind and plasma density are examined. Furthermore, the role of the neutral density and temperature is investigated in achieving reasonable agreement with observations, since F3/C is mainly operated during the extreme solar minimum of the cycle 23/24.

DATA-06 Latitudinal GRBR-TEC validated with TEC reconstructed from ionosonde and C/NOFS density data - by Kornyanat Watthanasangmechai

Status of First Author: Student NOT in poster competition, PhD

Authors: Kornyanat Watthanasangmechai, Mamoru Yamamoto and Akinori Saito

Abstract: To validate an effectiveness of latitudinal GNU Radio Beacon Receiver Total Electron Content (GRBR-TEC) estimation, the comparisons between GRBR-TEC and TEC reconstructed by using ionosondes and density data from Communications/Navigation Outage Forecasting System (C/NOFS) satellite were made. GRBR is a digital receiver, which is developed to measure the electron density from Low-Earth-Orbit (LEO) satellite, with a capability of capturing a small-scale ionospheric structure. The data used in this work are obtained from 5 GRBRs, 17 GPS receivers and 3 ionosondes, which are located in equatorial region, and C/NOFS satellite. GRBR-TEC was measured by GRBRs receiving signals from polar-orbit satellite. GPS-TEC and ionosonde height were used for helping the absolute-TEC determination. Then the absolute GRBR-TEC was compared with the TEC reconstructed by ionosonde and C/NOFS density data. The comparisons show that the GRBR-TEC and the reconstructed TEC normally agree, while they disagree at the Equatorial Spread F (ESF) event. In addition, two Equatorial Ionization Anomaly (EIA) enhancements and small-scale fluctuations at EIA region were captured by GRBR.

DATA-07 Boston University All-Sky Imager Data Archives - by Joei Wroten

Status of First Author: Non-student

Authors: Joei Wroten, Caity Sullivan, Michael Mendillo

Abstract: Boston University currently maintains an array of 8 all-sky imagers, each taking data at several wavelengths nearly every night. Within 48 hours these data are made available online at www.buimaging.com/data/ in the form of .gif images and .avi/mpeg time lapse animations. Here we present an overview of our online data archives, with image availability beginning in the year 2000 and records of sky-condition/event occurrence reaching back to 1985.

Equatorial Thermosphere or Ionosphere

EQIT-01 Solar Activity Dependence of Interhemispheric Transport – by Angeline Gail Burrell

Status of First Author: Non-student, PhD

Authors: Roderick A. Heelis, Aaron J. Ridley

Abstract: Dynamical changes in the upper atmosphere are principally governed by solar emissions. The intra-annual variation of interhemispheric transport, which is driven by changes in photoionization, ion loss, electric fields, and thermospheric forcing, is expected to depend strongly on the solar flux level. The solar activity dependence of interhemispheric transport is investigated for low and moderate solar flux levels using over four years of field-aligned ion drift observations taken near the geomagnetic equator by the Coupled Ion Neutral Dynamics Investigation (CINDI) onboard the Communications/Navigation Outage Forecasting System (C/NOFS) satellite. Changes in interhemispheric transport are all shown to be primarily dependent on the changes in ion density and composition that occur as the levels of extreme ultraviolet radiation increase.

EQIT-02 Study of gravity waves generated from strong tropospheric convection over Brazil by using multi-point GPS-TEC data - by Daisuke Fukushima

Status of First Author: Student IN poster competition, PhD

Authors: Daisuke Fukushima, Kazuo Shiokawa, Yuichi Otsuka, Sharon L. Vadas, Michi Nishioka, and Takuya Tsugawa

Abstract: It has been suggested that gravity waves causing the ionospheric disturbances were secondary waves generated by dissipation of primary gravity waves in the mesopause region or in the lower thermosphere. Vadas and Liu (JGR, 2013) simulated primary gravity waves generated from deep convection over Brazil after 18 UT on 1 October, 2005. They showed that the primary gravity waves generated secondary gravity waves through their dissipation in the thermosphere. The horizontal phase velocity, period, and horizontal wavelength of the secondary gravity waves were 500-600 m/s, 2-3 hours, and 4000-5000 km, respectively. They propagated away from Brazil, even to Antarctica, Africa, and Europe.

In this study, we investigated whether these simulated gravity waves were actually observed or not, by using the total electron content (TEC) data obtained by the multi-point GPS receivers in Central and South America. We extracted TEC perturbations by subtracting polynomial-fitting data from the original TEC. A sample analysis of the TEC data at Arecibo, Puerto Rico shows ~2-hour TEC perturbations seen at 19-24 UT on 1 October, 2005. The period of the observed TEC perturbation is slightly shorter than the original gravity-wave period, maybe because the observed period contains the effect of the GPS satellite motion which varies depending on satellites. Based on multi-satellite analysis, we infer that the phase velocity of the observed gravity wave has a northward component, consistent with the direction of simulated wave propagation. In the presentation, we report results of the multi-point multi-satellite TEC analysis and discuss the similarity and difference between the observed and simulated gravity waves in the thermosphere.

EQIT-03 **Another Fluid Simulation Results for Low-Latitude Irregularities in E-region –** by Ehab Hassan

Status of First Author: Student IN poster competition, PhD

Authors: Wendell Horton

Abstract: We show here another fluid simulation results as a continuation of our study of the ionosphere E-region irregularities. The simulation results this time based on data of the charged-carrier densities from IRI2012, neutral densities from NMSIS00, and electric field components from TIEGCM-1.94. In this model, which based on quasi-neutrality approximation, we study the perturbation in the electron carrier density, the electric field, and ion velocity. We explain the small- and large- structures of electron irregularities that might play a role on diffraction of the radiowaves propagating through the E-region. We will show the agreement of our results with the Kolmogorov's hypothesis.

EQIT-04 **A Mechanism for the Formation of the Equatorial Thermosphere Anomaly –** by Vicki W. Hsu

Status of First Author: Student IN poster competition, PhD

Authors: Jeffrey P. Thayer

Abstract: The equatorial thermosphere anomaly (ETA) is a feature in the equatorial thermosphere that has been identified in mass density and temperature observations by having two crests at ±20-30° magnetic latitude and a trough at the magnetic equator. Recent studies have begun to unravel the sequence of events that are responsible for the ETA formation. Maruyama et al., 2003 and Lei et al., 2012 demonstrated the importance of including field-aligned ion drag into global circulation models in order to simulate the ETA. In this study, we use the National Center for Atmospheric Research Thermosphere-Ionosphere Electrodynamics Global Circulation Model (TIE-GCM) with the inclusion of field-aligned ion drag to fully elucidate the processes involved in forming the ETA trough over the magnetic equator. In our simulations, the ETA coincides with a well-formed equatorial ionization anomaly (EIA). The EIA causes large poleward diffusive plasma fluxes, which leads to a field-aligned ion drag force. We analyze the hydrostatic processes that occur in the formation of the temperature trough of the ETA, and we also investigate the altitudinal structure of the ETA.

EQIT-05 **Quiet-Time Variability of Equatorial Plasma Drifts Near Dusk –**
by Debrup Hui

Status of First Author: Student IN poster competition, PhD

Authors: Debrup Hui, Bela G. Fejer, Brian D. Tracy

Abstract: Equatorial electrodynamics plasma drifts exhibit large spatial temporal variability particularly near dusk. These plasma drifts play important roles in the distribution of low latitude plasma density and on the occurrence of equatorial plasma structure and spread-F. We use extensive Jicamarca incoherent radar measurements to study the local time, season, solar cycle, and height-dependent climatology of equatorial F-region evening and early night vertical and zonal plasma drifts. We also examine their short-term (time scales from tens of minutes to a few days) variability. Our results indicate that this variability is largest during December solstice conditions.

EQIT-06 **Database of upper atmospheric winds and temperatures measured with the network of Fabry-Perot interferometers in Peru –**
by Luis Navarro Dominguez

Status of First Author: Student IN poster competition, Undergraduate

Authors: L. Navarro, R. Rojas, R. Alonso, M. Milla, J. Chau, J. Meriwether

Abstract: Some years ago, the construction of a scientific network of optical instruments began in Peru in order to study the wind velocities and the temperatures of the neutral component of the ionosphere over the Equator. Thus, two Fabry-Perot Interferometers were set up in Jicamarca (11°57'30.42"S, 76°51'32.28"W) and Nazca (14°58'21.17"S, 74°53'29.17"W), which together with the one already installed in Arequipa (16°27'56.60"S, 71°29'35.66"W), form the network of optical interferometers in Peru.
A processing routine based on the Fourier analysis of the spectral bins profile was applied to the everyday data of the three stations. Outliers were carried out by analyzing the estimates profiles of winds and temperatures obtained for each fringe along each night. Then, estimates and errors are weighted averaged to get a final estimate per image. Finally, daily winds, temperatures and intensities from the three stations are plotted together for quality control and then posted in the Jicamarca Radio Observatory's MADRIGAL database.

The whole process from the data taking to the database posting is present to the scientific community for the different experiments taken with this network.

EQIT-07 **On the variability of Low-latitude Thermospheric Winds, Temperatures, and Intensities observed by the Peruvian FPI network –**
by Luis Navarro Dominguez

Status of First Author: Student NOT in poster competition, Undergraduate

Authors: L. Navarro, R. Alonso, M. Milla, J. Meriwether, J. J. Makela, D. Fisher

Abstract: Optical observations of the low-latitude zonal and meridional thermospheric winds, temperatures, and intensities based upon measurements of Doppler shifts and Doppler widths of the OI-630nm nightglow emission have been made with the Fabry-Perot Interferometer network formed by three optical stations located in Jicamarca (11°57'30.42"S, 76°51'32.28"W),Nazca (14°58'21.17"S, 74°53'29.17"W) and Arequipa (16°27'56.60"S, 71°29'35.66"W). A comparative analysis of the 2012 wind and temperature results for the three stations shows generally good agreement indicating the consistency of the data. Inspection of the meridional winds did show occasional indication of a significant meridional wind gradient that might be positive or negative. Monthly plots are presented to illustrate the variability of the night-to-night data relative to the monthly climatological average for the months of May, June, July, and August, 2012. Comparison of the 630-nm intensities for the three stations showed some differences between the temporal behavior of the nightglow over MRH, which is at the geomagnetic equator,

and that of Arequipa, which is located ~500 km to the south. Preliminary wind and temperature results for the 557-nm emission obtained at MRH will also be presented.

EQIT-08 Forecasting Ionospheric Storms at the Magnetic Equator - by Ramin Jafari

Status of First Author: Student IN poster competition, PhD

Authors: David Hysell

Abstract: A number of forecast studies are conducted using numerical simulation of equatorial spread F (ESF) and the outcomes are compared with observations made using Jicamarca radar. The three-dimensional numerical simulation is developed at Cornell [Aveiro and Hysell, 2010] and advances plasma number density and electrostatic potential in time. To initialize the simulation, neutral winds are obtained from Horizontal Wind Model (HWM-07) and number density from Parametrized Ionospheric Model (PIM). To make forecast, we tune these parameters to match to observations made through campaigns in December 2012 and April 2013 at JRO. In addition, vertical drift measurements during the campaign are used to provide the background electric field. We compare ESF simulations with Jicamarca observations in two ways. The first way is to use the code to simulate RTI plots and compare it with backscattered power measured by JULIA (Jicamarca unattended long-term studies of the ionosphere and atmosphere) coherent scatter radar during the campaigns. The second is to compare the simulation results to Jicamarca data using the radar in imaging mode. This mode produces panoramic images of the coherent scatter intensity and Doppler shift versus altitude and zenith angle in the equatorial plane[Hysell and Chau, 2006]. By comparing the simulation under realistic background conditions and observations, we can evaluate the ability of the simulation to reproduce natural events in the equatorial ionosphere.

EQIT-09 Evidence for meridional wind gradients near the equatorial geomagnetic equator - by Samuel C. Sanders

Status of First Author: Student IN poster competition, Masters

Authors: Samuel Sanders, John Meriwether, Jonathan J. Makela, Daniel J. Fisher, Ricardo Buriti

Abstract: Equatorial measurements from Brazil of thermosphere zonal and meridional winds and temperature for two common volume (CV) locations separated in the meridional direction by about 300 km are examined to determine whether significant gradients exist, especially for meridional winds. The motivation for this research is the recent work reported by Huba and Krall [2013] suggesting that a positive gradient in the meridional thermosphere wind might be stabilizing retarding the development of the RT plasma instability that leads to the production of plasma bubbles. Two red-line Fabry-Perot interferometers (FPI) working in coordination in north-eastern Brazil (Cajazeiras and Cariri) were used in an observing strategy featuring two orthogonal line-of-sight measurements of the Doppler shift and Doppler broadening of the 630-nm nightglow emission for two CV locations. Included in this observing strategy was a third CV located where the two instrument lines-of-sight toward each other intersected. This inline position allows the measurements of vertical winds. Finally, zenith measurement overhead for each site and and a HeNe laser exposure completed the observing cycle with a cadence of about 25 minutes required for one cycle. Additionally, an all-sky imager acquired images of the 630-nm nightglow layer as a monitor of the plasma activity during the FPI observations. From these results, the horizontal wind vectors are calculated for the two CV locations north and south of the two FPI sites. In our study, we seek to examine the effect of a meridional wind gradient on the development of equatorial spread F (ESF). A number of examples of significant meridional wind gradient were found with the meridional wind at the site closer to the geomagnetic equator being 20-35 ms-1 faster in speed. Several examples of negative gradients were also noted. The statistics of these results will be examined in our review of the Brazil FPI database extending over three years. Our research also shows an interesting secondary peak feature of the meridional winds. Normally, a pre-midnight increase in the equatorward (northward) wind speed is observed that is typically associated with semidiurnal tides. An additional enhancement near 02-03 LT was often found that might be attributed to higher order tidal modes.

EQIT-10 **Jicamarca observations of the equatorial topside response to changes in solar flux conditions -** by Jessica Mae Smith

Status of First Author: Student IN poster competition, Masters

Authors: Fabiano S. Rodrigues, Robin Coley, David L. Hysell, Marco Milla

Abstract: Significant improvements in the analysis of topside ionosphere measurements made by the Jicamarca incoherent scatter radar (e.g. Hysell et al., 2008) have allowed the development of a new observing mode that can greatly contribute to our understanding of the short- and long-term variability of the equatorial thermal and ion composition structure.
We have used existing and new measurements made with this new mode, called hybrid2, to investigate changes in the topside ionosphere during the period of low solar flux observed between 2008 and 2013. In 2008, an abnormally low solar flux was observed and satellite measurements indicated an ionosphere that was colder and more contracted than expected. In particular, in-situ satellite measurements showed that the O+/H+ transition height reached heights that were as low as 450 km altitude during nighttime hours (e.g. Heelis et al., 2009). The satellite results, however, were based on average over several days and over all longitudes sectors.

Our analysis of the radar measurements made by Jicamarca between 2008 and 2013 confirm the contraction of the ionosphere during 2008 when F10.7 was about 68 SFU, and show that a relatively small change in solar flux (~ 60 SFU) can produce drastic changes in the topside equatorial ionosphere, particularly in electron density and ion composition.

EQIT-11 **First steps towards the implementation of a cognitive radar to study plasma instabilities near the Peruvian Andes -** by Robert Michael Sorbello

Status of First Author: Student IN poster competition, PhD

Authors: Robert Sorbello, Karim Kuyeng-Ruiz, Julio Urbina, Zach Stephens

Abstract: A cognitive radar system is composed of three key components: 1) intelligent signal processing, which builds on radar interactions from the surrounding environment, 2) receiver feedback which is utilized by the transmitter to facilitate an intelligent response to detected signals, and 3) preservation of radar echo information contents. We describe the implementation of a VHF coherent imaging radar in Huancayo, near the Peruvian Andes to initiate continuous monitoring of the plasma structuring in the equatorial ionosphere. The new radar system will utilize cognitive sensing techniques and complement the ionospheric observations conducted by the Jicamarca incoherent scatter radar (ISR), located about 170 km to the west of Huancayo along the geomagnetic equator. The main purpose of the new system will be to obtain uninterrupted images of ionospheric structuring and drifts from Huancayo, which are only probed and sampled intermittently from Jicamarca due to the operation costs and scheduling issues of the more powerful incoherent scatter system. The proposed system will work in two stages: 1.) Classifying the occurrences observed in the atmosphere, and 2.) transmitting an optimal waveform to illuminate and process areas of interest. In this paper, we present classification techniques to correctly indentify the following geophysical equatorial echoes: Spread-F, electrojet, 150 km echoes, and meteors. These events are each categorized by signal parameters with known distributions, e.g., signal-to-noise ratio, changes in range, instantaneous frequency, periodicity, etc. We will provide an overview of the classification algorithm used to distinguish returns from the various equatorial phenomena. A Gaussian Mixture Model (GMM) has already been implemented to classify meteor events at mid latitudes. The same algorithm has been extended to include the Spread F, 150 km echoes, and electrojet. Previously, classifying the meteors events involved capturing whole process because of the feature selection of the GMM. With the addition of these events however, new procedures are used because the duration of the phemonema sustains for multiple hours. Therefore, classification must be made with a small fraction of the entire event. The purpose of this approach is to formalize the first step towards the cognitive radar, which can then be further extended to adjusting the waveform parameters for optimal responses. In addition to the classification algorithm, results of a short campaign conducted at Jicamarca will be discussed. Implications of the results for the future system in Huancayo will be determined.

Irregularities of Ionosphere or Atmosphere

IRRI-01 **PFISR observations of thin turbulence layers in F-region auroral ionosphere –** by Hassanali Akbari

Status of First Author: Student IN poster competition, PhD

Authors: Hassanali Akbari, Joshua Semeter

Abstract: The recently discovered coherent echoes in the Poker Flat Incoherent Scatter Radar (PFISR) data is studied in more details. The echoes have distinct signatures, i.e. strongly enhanced flat ion line spectra and double-peaked plasma line spectra in both up- and down-shifted channels, identifying the underlying process as Langmuir turbulence. New results show that the background electron density profile plays an important role in development of the turbulence. While linear conversion of Langmuir waves to electromagnetic waves dominates in the presence of density gradient, non-linear processes dominates at the F-region peak resulting in a relatively thin layer.

IRRI-02 **Climatology of ionospheric Sporadic E Layer : Examination of Wind Shear Theory** - by Kuan-Ting Chen

Status of First Author: Student IN poster competition, Masters

Authors: Kuan-Ting Chen, Yen-Hsyang Chu, Kang-Hung Wu, Ching-Lun Su, Chien-Ya Wang

Abstract: On the basis of GPS radio occultation (RO) technique, we develop a method to extract ionospheric sporadic E (Es) layer from COSMIC-measured ionospheric data (e.g., GPS signal signal-to-noise ratio, L1 and L2 excess phases and RO-retrieved electron density) to to investigate the climatology of the Sporadic E layer. The results show that there is salient summer-winter asymmetry in the occurrence rate of the Es layer, namely, higher in summer hemisphere and lower in winter hemisphere. In addition, there is a strong tendency for the Es layer to descend with local time that is in harmony with the diurnal or semi-diurnal tidal motion, depending on season and latitude region. In order to realize the physical process responsible for the climatology of the COSMIC-measured Es layer, we simulate the temporal and global distribution of the occurrence of the Es layer in accordance with wind shear Theory. We calculate vertical ion drift velocity based on empirical models of the ionosphere, including HWM07, MSIS00, IGRF. The ferric ion (Fe+) density calculated from Whole Atmosphere Community Climate Model(WACCM) is used to obtain ferric ion vertical flux. The simulation results show that the seasonal asymmetry of of the Sporadic E layer occurrence rate between the summer and winter hemispheres is very likely caused by the neutral wind shear in the Es region.

IRRI-03 **Scintillation Hole Observed by FORMOSAT-3/COSMIC –** by Shih-Ping Chen

Status of First Author: Student IN poster competition, Masters

Authors: S. P Chen, Tiger J. Y. Liu, P. K. Rajesh

Abstract: Ionospheric scintillations can significantly disturb satellite positioning, navigation, and communication. FORMOSAT-3/COSMIC provides the first 3-D global observation by solo instrument (radio occultation experiment, GOX). The GPS L-band amplitude fluctuation from 50Hz signal is received and recorded by F3/C GOX to calculate S4-index from 50-800km altitude. The global F3/C S4 index are subdivided and examined in various latitudes, longitudes, altitudes, and seasons during 2007-2012. The F-region scintillations in the equatorial and low-latitude ionosphere start around post-sunset period and often persist till post-midnight hours (0300 MLT, magnetic local time) during the March and September equinox as well as December Solstice seasons. The E-region scintillations reveal a clear solar zenith effect and yield pronounced intensities in mid-latitudes during the Summer Solstice seasons, which are well correlated with occurrences of the sporadic E-layer. It is interesting to find there is no scintillation, which is termed “scintillation hole”, in the E region ranging from 80 to 130km altitude over the South Africa region, and become the most pronounced in November-January (December Solstice seasons or summer months). Other space-borne and ground based observations are use to confirm the existence of the scintillation hole.

IRRI-04 **Short-time Scale Ionospheric Oscillations In GPS Satellite Signal Observations –** by Pei-Yun Chiu

Status of First Author: Student IN poster competition, Undergraduate

Authors: Pei-Yun Chiu, Loren C. Chang, Chien-Hung Lin, Jann-Yenq Liu

Abstract: The structure of the ionosphere has important effects on radio propagation. By analyzing the GPS satellite signals from multiple ground-based receivers, we study the total electronic content (TEC) at middle to high magnetic latitudes in both hemispheres. We filter the TEC time series to isolate oscillations with periods shorter than 30 minutes, and analyze the local time and seasonal variation of these high frequency TEC disturbances in 2010.

From the data we analyzed, we find that the short-time scale oscillations show regular changes with local time and season in long term observations. We contrast this method with that of phase fluctuation indices (Fp), and compare our results with currently known phenomena in the E and F regions of the ionosphere, discussing possible sources for the oscillations.

IRRI-05 **Sensitivity study of a model of GPS scintillations used to characterize high latitude ionospheric irregularities -** by Kshitija Deshpande

Status of First Author: Student IN poster competition, PhD

Authors: Kshitija Deshpande, Gary Bust, C. Robert Clauer

Abstract: Complex magnetosphere--ionosphere coupling mechanisms result in high latitude irregularities that are difficult to characterize using only GPS scintillation measurements. GPS observations combined with physical parameters of the irregularity derived from modeling can be used to study the physics of these irregularities. We have developed a full 3D EM wave propagation model to simulate GPS scintillations in high latitude ionosphere. In order to be able to simulate the full 3D propagation through random media, several numerical techniques have been used to both speed up the code and to preserve accuracy over an arbitrary irregularity layer. In this work, we present a sensitivity study of the model for different input parameters such as the line of sight (LOS) angle of the satellite, the axial ratio of the irregularity and the optimum number of phase screens or layers that can be used to simulate the irregularity. With this sensitivity study, we can determine what geometrical combination of the irregularity alignment and the LOS signal gives stronger phase scintillations. As a following step, we will use our model and an inverse method for scintillation observations from GPS receivers from Northern and Southern polar and auroral regions in conjunction with ancillary observations from Incoherent Scatter Radars (ISRs), SuperDARN, All Sky Imagers etc. We believe that such inverse method can be used to derive certain characteristics of the irregularity causing the scintillations and further achieve an improved understanding of the physics of these high latitude irregularities.

IRRI-06 **Incoherent Scatter Radar observations of large scale electron density structures in the evening auroral zone –** by Krishna Prasad Gudivada

Status of First Author: Student IN poster competition, Masters

Authors: Krishna Prasad Gudivada, B.J.Watkins, C.T. Fallen

Abstract: The occurrence of large-scale F-region electron density structures in the evening auroral zone has been investigated with incoherent-scatter radar data from Poker Flat Alaska. These structures are potentially significant to applications such as SAR satellite imaging of the earth. The plasma velocity is approximately directed westward with speeds often up to several hundred meters per second. The time-dependent velocity and electron density data have been combined to derive the spectral distribution of irregularity scale sizes. Results show that for quiet geomagnetic conditions the structure sizes are mainly in the 10-50 km size range. For more active conditions the spectral distribution shifts to larger (50-200km) scale sizes. It is suggested that during the disturbed conditions when velocities are greater, that the structures are created in the polar cap and midnight region associated with auroral

electron precipitations and substorm events, and due to the long chemical recombination times convect horizontally into the observation regions in the evening.

IRRI-07 Monitoring mid-latitude scintillation and TEC at UT Dallas – by Matthew Alan Henderson

Status of First Author: Student IN poster competition, Undergraduate

Authors: Matthew Henderson, Fabiano Rodrigues

Abstract: We have been making nearly continuous observations of mid-latitude ionospheric scintillation and total electron content (TEC) using a CASES GPS receiver since September 2012. The CASES (Connected Autonomous Space Environment Sensors) GPS receiver was deployed at the University of Texas at Dallas (32.99°N, 96.76°W) as part of an educational and scientific space weather initiative within the William B. Hanson Center for Space Sciences. As part of this study, we have been performing data collection and transfer, and have developed tools for data visualization. We have also analyzed the measurements in search of cases of scintillation caused by mid-latitude irregularities. In this poster, we will present examples of our measurements, which include interesting cases of scintillation and TEC fluctuations.

IRRI-08 Plasma wave irregularities in the equatorial upper E region at twilight – by Ronald R. Ilma

Status of First Author: Student IN poster competition, PhD

Authors: Ronald R. Ilma, David L. Hysell, and Micheal C. Kelley

Abstract: A new class of plasma irregularities in the postsunset equatorial upper E region has been detected by radar experiments over Jicamarca, Peru [Chau and Hysell , 2004]. In comparison with daytime plasma irregularities, nighttime large-scale plasma waves are not well understood. These waves has been detected with the JULIA (Jicamarca Unattended Long-term Investigations of the Atmosphere) operation mode at Jicamarca. Despite the fact that observations of this new class of irregularities were made, there has been a lack of interest into the characterization of them. As stated by the work of Hysell and Chau [2002] and Chau and Hysell [2004], the source of these irregularities is related to gradient-drift (or interchange) instability process. This instability was firstly investigated for laboratory plasmas by Simon [1963]. It arises in the presence of an ionization gradient perpendicular to the current flow in a plasma [Sudan et al., 1973]. In the equatorial upper E region, the passage of the solar terminator generates an steep horizontal conductivity gradients which induce an upward current in the upper E region which is known to be present in the vicinity of the evening solar terminator and it is linked directly with the F-region overhead. We are going to show experimental evidence, numerical simulation results and a theoretical discussion which attempts to describe the origin of these irregularities.

IRRI-09 High Latitude Ionosphere Scintillation Characterization - by Yu Jiao

Status of First Author: Student IN poster competition, Masters

Authors: Yu Jiao, Jade Morton

Abstract: This poster presents analysis of high latitude scintillation data collected in Gakona Alaska from 2010 to 2012. Amplitude and phase scintillation indices are computed for scintillation events captured by a GSV 4004B ionosphere scintillation monitor. Distributions of the maximum index values and the number of amplitude and phase scintillation events are presented in the paper. Additionally, the spatial, temporal (diurnal, monthly, and seasonal), solar cycle, and event duration distributions are also established to characterize the climatology of high latitude ionosphere scintillation.

IRRI-10 **Thunderstorm-induced fluctuations detected in ionospheric plasma –** by Erin H. Lay

Status of First Author: Non-student

Authors: Erin H. Lay, Xuan-Min Shao, Charles S. Carrano, Abram R. Jacobson

Abstract: Recent studies on the D-layer ionosphere (~65-90 km altitude) have shown that AGWs originating from large mesoscale thunderstorms clearly perturb the electron distribution at the lower boundary of the ionosphere, and electrical activity within even a small storm affects the D-layer above by heating electrons and consequently reducing the density of the free electrons. Our most recent work extends the observations vertically through the entire ionosphere by analyzing total electron content (TEC) observations near a large mesoscale thunderstorm. TEC measured by GPS receivers in the United States Great Plains is examined for three nights with large thunderstorms and for one night with little thunderstorm activity. The GPS TEC data are fit with a polynomial and the variations are estimated by subtracting this fit from the data. We found that anomalous TEC variations are closely associated in time and space to the large underlying thunderstorms. The largest storm-related TEC variation is observed to be ~1.4 TECU over a typical nighttime background value of several TECUs. The variations near the storm appear to have more high frequency content than those away from the storm, with periods of minutes to tens of minutes. No detectable localized TEC variation is observed for the thunderstorm-quiet night.

IRRI-11 **A multi-instrument study of the Pre-midnight Brightness Wave and Brightness Wave signatures in the northeastern Brazil nightglow –** by Rafael Luiz Araujo de Mesquita

Status of First Author: Student NOT in poster competition, PhD

Authors: R. Mesquita, R. Buriti, J. Meriwether, J. Makela, D. Fisher, I. Paulino, A. Fragoso, H. Takahashi.

Abstract: In this work, we present two nights of all-sky images exhibiting the development of the pre-midnight brightness wave (PMBW) and brightness wave (BW) signatures of enhanced 630-nm equatorial nightglow over the Cajazeiras (6.89° S, 38.56° W) and Sao Joao do Cariri (7.38° S, 36.53° W) airglow observatories located in north-eastern Brazil. The 630-nm all-sky images were obtained with the simultaneous operation of the INPE/UFCG imager at Cariri and the U. of Illinois PICASSO/RENOIR imager at Cajazeiras. Signatures of the PMBW and BW were observed on the nights on 25 and 26 October, 2011. Coincident observations of the thermosphere wind and temperature were made with the RENOIR Fabry-Perot interferometers operating at both sites. CADI ionosonde measurements obtained at Cariri are also available and are used to establish the height of the F-layer plasma. These results demonstrate a strong correlation of the enhanced 630-nm nightglow intensity with the decrease of the F-layer's height during the PMBW and the BW events. These results also show that the 630-nm nightglow intensity exhibits a PWBW signature going northward before midnight and then, near midnight, a BW signature moving toward the southern pole. The conclusions reached from the examination of these results are that the PMBW signature is caused by the early-evening downward plasma motion along the flux tube from the southern Appleton anomaly toward the geomagnetic equator. In contrast, the BW signature is a result of the upward propagation of the lower thermosphere tidal wave that during the period of 21-23 LT reverses the normally-poleward meridional wind to the equatorward direction. Later, near midnight, the thermal part of the tidal wave causes the nighttime thermosphere temperature to be enhanced. This feature is identified as the midnight temperature maximum (MTM). The development of the northward flow and the MTM is followed by a reversal again of the meridional wind to the poleward direction causing a downward shift of the F-region plasma that increases the 630-nm nightglow emission to produce the BW signature. These results illustrate the complex nature of the equatorial thermospheric and ionospheric dynamics with upward coupling from the lower atmosphere combined with the downward coupling by the topside ionosphere.

IRRI-12 **A heuristic model of auroral Farley Buneman waves and comparison with PFISR and VHF coherent scatter radar data -** by Robert Miceli

Status of First Author: Student IN poster competition, PhD

Authors: R.J. Miceli, D.L. Hysell, J.D. Huba, M.J. Nicolls

Abstract: Intense Farley Buneman waves exist in the auroral electrojet and arise whenever the convection electric field is greater than about 20 mV/m, which is common during auroral substorms. VHF coherent scatter radar and Poker Flat Incoherent Scatter Radar (PFISR) observations of geomagnetic storms from November 2012 and March 2013 over Alaska are compared and quantified under the context of a global Farley Buneman wave model. The model combines the Farley Buneman wave model as implemented by Milikh and Dimant [2002] and the SAMI2 ionospheric model. It predicts E region altitude profiles of phase speeds, magnetic aspect widths, and heating caused by Farley Buneman waves for electron convection speeds ranging from 400 to 1000 m/s. An altitude averaging kernel is used to estimate the wave phase speed and magnetic aspect width of the waves in order to compare these profiles with the echoes from the coherent scatter radar. Temperature and plasma number density profiles measured by the PFISR are compared with the profiles computed by SAMI2 and are used to find periods of constant background convection speed. The accuracy of the model predictions are evaluated.

IRRI-13 **Wave activity in the Thermosphere-Ionosphere system as determined from Dynasonde data -** by Catalin Negrea

Status of First Author: Student IN poster competition, Masters

Authors: Catalin Negrea, Nikolay Zabotin, Terence Bullett

Abstract: Unique capabilities of the Dynasonde technique of ionospheric radio sounding allow measuring echo ranges and angles of arrival with high precision. The inversion algorithm NeXtYZ, which is a part of the Dynasonde data analysis package, uses this information to restore parameters of a three-dimensional plasma density distribution over the sounder location, including its vertical cross-section (vertical profile) and tilts of constant electron density surfaces as functions of the true altitude. With a month-long data series from a state-of-the-art Dynasonde installation at Wallops Island, VA, we demonstrate how results of this analysis can be used to study temporal spectral characteristics of the wave disturbances at a wide range of thermospheric altitudes. We discuss how different phenomena can produce similar signatures in our measurements and how we separate the effects of wave activity from the dominant background variability. The wave amplitudes and horizontal wavenumbers are determined directly from the data, along with signatures of tidal effects on the ionospheric plasma. High amplitude, low frequency activity is diagnosed using high resolution spectra computed over extended time periods. Also, the time evolution of high-frequency (up to 4 mHz) components is studied using a short (~2 hours) sliding window spectral calculation technique. The procedure has a relatively high sensitivity level and an estimate of it is provided. A transfer function incorporating gravity wave theory, chemistry and the electrodynamics of ionosphere-thermosphere coupling is implemented. It is used to infer characteristics of the original neutral atmosphere fluid waves from observed ionospheric perturbations.

IRRI-14 **50 MHz radar observations of E-region “sunset layer” and F-region plasma irregularities from Roi-Namur in 03/25 to 04/13, 2013 window in support of EVEX/MOSC NASA campaigns -** by Pablo M. Reyes

Status of First Author: Student IN poster competition, Masters

Authors: Erhan Kudeki

Abstract: Abstract The Illinois Radar Interferometer System (IRIS) was installed in the Reagan test site (RTS), Roi-Namur, Kwajalein atoll, in the Marshall Islands. The radar operated continuously from March 25 to May 13, 2013 as a part of the Equatorial Vortex Experiment --- EVEX --- NASA science mission. The main objective of IRIS was to study the E-region sunset layer and monitor the F-region 3-meter Bragg scattering irregularities as the spread-F structures crossed the radar beam. The antenna consists of two antenna arrays made of COCO (coaxial collinear)

antenna elements phased to point perpendicular to the geomagnetic field --- about 8 degrees off zenith --- forming an east-west interferometer that allows the measurement of east-west velocities of the field aligned irregularities structures. During the campaign, IRIS detected most of the time, E-region pre-sunset activity that started 1 or 2 hours before sunset. In the case of the sunset layer, interferometer velocities were obtained when the coherence of the backscatter signal between the two antennas was high enough. These velocities ranged from 25 up to 150 m/s westward direction. Some days, the velocities detected in the sunset layer were already reversed, moving eastwards. Strong E-region backscattering was observed consistently from midnight until sunrise throughout the campaign. In all pre-sunset, sunset, and post midnight the E-region showed single and/or multiple layers ranging from 90 km up to 120 km of altitude, upwards at sunset, and downwards after midnight.

IRRI-15 Particle-In-Cell simulation study of the Stimulated Electromagnetic Emission (SEE) observed during the second electron gyro-harmonic heating - by Alireza Samimi

Status of First Author: CANCELLED

Authors: Alireza Samimi, Wayne Scales, and Paul Bernhardt

Abstract: Experimental observations show new Stimulated Electromagnetic Emission (SEE) spectral features during the heating experiment near second electron gyro-harmonic. Structures ordered by ion gyro-frequency and a broadband structure that maximizes at around 500 Hz below the transmitter frequency are the two newly observed SEE characteristics. Parametric decay of the pump field into a high frequency electron wave and a low frequency ion wave is introduced as a potential generation mechanism. In this theory the high frequency decay mode is an upper hybrid/electron Bernstein (UH/EB) wave. The low frequency decay mode is either a group of the neutralized ion Bernstein waves or a highly oblique ion acoustic wave [Samimi et al., 2012, 2013].

In this presentation, by using the predictions of the analytical model about the wavelength of the decay modes, a two dimensional particle-in-cell (PIC) plasma computational model is developed. The generation mechanism of the aforementioned SEE characteristics is studied using the PIC model. The higher order nonlinear interactions of the plasma waves and the charged particles are investigated. The model shows how temperature of the electrons changes during heating. Also, by studying the wavenumber spectrum, the evolution of the plasma waves and the development of the parametric decay instability are investigated. The results of the simulation are compared with the experimental observations.

IRRI-16 Phase and coherence of longitudinally separated L-band scintillation – by Esayas B. Shume

Status of First Author: Non-student, PhD

Authors: E. B. Shume and A. J. Mannucci

Abstract: We present the first calculation of phase and coherence of cross-wavelet transform applied to longitudinally separated L-band equatorial ionospheric scintillation observations received from GEO satellites.

IRRI-17 Improvement of GPS Radio Occultation Retrieval of Ionospheric E region Electron Density - by Kai-Jia Tseng

Status of First Author: Student IN poster competition, Masters

Authors: Yen-Hsyang Chu,Kang-Hung Wu,Chien-Ya Wang,Ching-Lun Su

Abstract: The spherical symmetry approximation of the electron density distribution retrieved by Abel inversion is the main error source of GPS radio occultation (RO). In order to quantitatively estimate the retrieval error of RO, the calibrated total electron content (TEC) from empirical IRI model along GPS ray detected by COSMIC satellite is utilized to simulate the RO-retrieved electron density profile in the different season. The RO retrieval error is obtained by comparing IRI electron density profile with the retrieval one. The results show that retrieved electron

density in E region is overestimated in the equator (-10~10) and mid-latitude(±30~±50), and underestimates in the lower latitude (±10~±30). In order to eliminate the RO retrieval error, the retrieval error of the simulated electron density based on the IRI model is removed from the COSMIC-measured E region density profile for different latitudinal regions, and the results are compared with the ionosonde measurements for the data taken from July 2006 to Dec. 2010. Before the error removal, the mean deviation of the COSMIC-measured E region peak electron density is about 50~70%. After the error remocal, the mean deviation is reduced significantly, less than 5 % in spring and autumn and 30% in summer and winter. These results indicate that the much more reliable E region electron density can be obtained with this method and improve the reliability of COSMIC measurement in the lower ionosphere.

IRRI-18 **Evaluation the Wind Shear Effect on the Pronounced Summer Maximum Sporadic E Layers -** by Chien Ya Wang

Status of First Author: Non-student

Authors: Yen-Hsyang Chu, Kung-Ting Chen, and Chao-Tuan Cheng

Abstract: Analyzing the data of FORMOST-3/COSMIC, 1 Hz ionospheric sampled phase and amplitude variations during the interval from July 2006 to May 2011, striking fluctuations in GPS RO signals are used to identify Es layers on a global scale. The highlight of seasonal dependence of sporadic E, that is, the pronounced summer maximum is most interesting. In this study we focus on assessing the role of horizontal winds in the vertical ion convergence through their vertical shears action on the long-living metallic ions. By considering the preferably parameters from the HWM07, IGRF and MSIS models, also, Fe+ ion global distribution (WACCM) are combined to simulate the vertical flux of Fe+ ion through shears effect. The results show that sporadic E layers pronounced summer phenomenon is close relate to the Fe+ ion flux, and the flux due to zonal wind is the dominant.

Instruments or Techniques for Ionosphere or Thermosphere Observation

ITIT-01 **On The Measurement of Neutral Winds and Gradients in the Lower Thermosphere with Multi-Point, Chemical-Release Sounding Rocket Payloads -** by Carl Andersen

Status of First Author: Student IN poster competition, PhD

Authors: Carl Andersen, Mark Conde, Miguel Larsen

Abstract: Sounding rocket payloads capable of deploying multi-point chemical releases provide a unique tool for investigating the properties of the lower thermosphere. This type of payload consists of a collection of sub-payloads that are propelled laterally out of the rocket during flight. Each contains a canister of liquid tracer (such as tri-methyl aluminum) which, after separating from the main rocket, is dispersed by explosive detonation. The result is a luminous "puff" that can be tracked by triangulation using images taken from several ground stations, producing wind vector velocities with typical uncertainties of just 1-2 m/s. A deployment of puffs throughout a 3-dimensional volume spanning approximately 100x100 km horizontally and from 100 to 180 km altitude, vertically, makes it possible to measure the height profiles of all nine first-order spatial gradients of the neutral wind vector in the lower thermosphere.

ITIT-02 **Deriving Thermospheric Wind Fields from Distributed Arrays of Fabry-Perot Spectrometers -** by Mark G. Conde

Status of First Author: Non-student

Authors: Mark G. Conde, Callum E. Anderson

Abstract: Fabry-Perot spectrometers have been used since the 1960's for ground based remote sensing of thermospheric winds. However, because the technique only measures the wind's line of sight component, it is not

possible to infer even the 2-component horizontal wind field from observations recorded by a single instrument, unless substantial assumptions are made. The obvious way to overcome this limitation is to deploy an array of instruments at two or more geographic locations. It is then possible to derive unambiguous estimates of two or even all three wind components, for atmospheric regions that are viewed by the array along multiple non-colinear look directions. Here we use this approach to derive winds from an array of three all-sky Fabry-Perot spectrometers in Alaska. However, the geographic regions where the viewing geometry is favorable for this direct approach are surprisingly limited. As an alternative, we also present winds derived from least-squares fitting of 2-component polynomial basis functions to the line-of-sight wind data. Although this second technique is locally less accurate than the direct approach, it is also less sensitive to measurement noise, and it does provide a complete uninterrupted wind field throughout the geographic region spanned by the measurements. Results of both methods are compared.

ITIT-03 **Development of a mapping strategy for equatorial thermospheric winds using data from three Fabry-Perot interferometer observatories located in Central Peru –** by John W. Meriwether

Status of First Author: Non-student, PhD

Authors: J. Makela, D. Fisher, T. Duly, L. Navarro, J. Chau

Abstract: A new strategy for determining the equatorial thermospheric wind field has been developed that is based upon the combination of Fabry-Perot interferometer measurements obtained from three equatorial observatories located in central Peru (Jicamarca, Nazca, and Arequipa). Maps of the equatorial thermospheric wind field are prepared by using Fabry-Perot measurements that include 8 measurements obtained at nearly-equal azimuthal intervals at 45 degrees zenith angle. Observations to the zenith, used to establish the Doppler reference, are taken twice during the sequence through the 8 off-zenith measurements. The sequence of ten directions for each FPI site combined with a frequency-stabilized laser reference measurement takes ~25 minutes to complete. Six of the off-zenith measurements are common volume measurements, where two of the FPIs observe the same volume with a centroid height of ~250 km in the thermosphere at orthogonal angles, allowing the vector horizontal wind to be estimated. These common volume positions are located ~225 km north and south of the Nazca FPI observatory. The Doppler shifts from all of these measurements are used to produce a map of the neutral wind field. The process of producing this map is based upon the polynomial expansion of the neutral wind field relative to a central location. This expansion includes the first-order gradients of the zonal (u) and meridional (v) wind with respect to the zonal (x) and meridional (y) directions. The analysis is based upon producing the best fit in a linear least square sense of the model expansion parameters relative to the Doppler shift data. This approach is based upon the strategy developed in prior efforts undertaken by Burnside et al.[1980] at Arecibo, Greet et al.[1999] at Mawson, Antartica, and Meriwether et al.[2008] at Arequipa, Peru.

ITIT-04 **Dominant modes of variability in ionospheric plasma drifts –** by Ellen D. P. Cousins

Status of First Author: Non-student

Authors: E. D. P. Cousins (NCAR/HAO), A. D. Richmond (NCAR/HAO), T. Matsuo (CU/CIRES, NOAA/SWPC)

Abstract: Plasma drifts in the Earth's high-latitude ionosphere are one important component of the coupled magnetosphere-ionosphere-thermosphere system. These drifts are primarily driven by interactions between the magnetosphere and the solar wind, and they are an important energy source in the polar regions of the upper atmosphere. While the average or climatological behavior of these drifts is well studied and well characterized, variability in the drifts on various scales is less well understood. In this study, the dominant modes of large- and mid-scale variability in SuperDARN plasma drift data are investigated using the method of empirical orthogonal functions (EOFs). Possible drivers of the dominant modes of variability are investigated and moderate correlations with interplanetary and geophysical parameters are found. Based on the derived EOFs, the spatial and temporal coherence of electric field variability is characterized. Finally, the derived EOFs are used to represent realistic spatial coherence (i.e., covariance) information in a data assimilation procedure to improve estimates of the complete map of electrostatic potential in the high-latitude ionosphere.

ITIT-05 **Improving Millstone Hill electron density accuracy: Plasma-line profile developments -** by Juha Vierinen

Status of First Author: Non-student

Authors: Juha Vierinen, Philip J. Erickson, Frank D. Lind

Abstract: We present a new plasma-line profile capability being developed at Millstone Hill / MIT Haystack that allows improved, routine, precise measurements of sub-auroral electron density and electron temperature using measurements of the up and down shifted Langmuir or plasma line response. Both vertical and wide field measurements of plasma line properties are possible at UHF frequencies with relatively short time integrations using the 68 meter zenith and 46 meter fully steerable MISA antennas. We present RFI mitigation methods (essential due to strong interference) along with data acquisition hardware and processing software used to enable these measurements. We will also discuss the implications for future improvements in absolute electron density measurement errors.

ITIT-06 **Initial analysis of neutral winds and temperatures from the NATION FPIs –** by Daniel J. Fisher

Status of First Author: Student IN poster competition, Masters

Authors: D. J. Fisher, T. M. Duly, T. W. Gehrels, M. W. Castellez, M. Ciocca, J. J. Makela, J. W. Meriwether, A. J. Ridley

Abstract: Four Fabry-Perot interferometer (FPI) systems have been operating in the central-eastern region of the United States for the past year as part of the North American Thermosphere Ionosphere Observing Network (NATION). These observatories use interferometric measurements of the 630.0-nm redline emission to estimate thermospheric winds and temperatures at roughly 250 km. Thermospheric winds play a crucial role in driving and understanding the complex physics of the upper atmosphere. The four sites have been placed to provide ample latitudinal coverage of the thermosphere enabling studies of mid-latitude forcing from the polar region as well as the mid-latitude response to geomagnetic storms, and are close enough together to enable common volume measurements of the horizontal wind vector whenever possible. The NATION data from this past year have been analyzed to determine the monthly climatologies of the nighttime winds and temperatures in this region. These averages are then used in comparison with stormtime days to help understand the spatial and temporal thermospheric storm response.

ITIT-07 **Dynamic automated control of NATION FPIs -** by Thomas W. Gehrels

Status of First Author: Student IN poster competition, Masters

Authors: Thomas W. Gehrels, Jonathan. J Makela, Michael W. Castellez, Marco Ciocca, John W. Meriwether, Aaron J. Ridley

Abstract: The North American Thermosphere Ionosphere Observation Network (NATION) is a set of four Fabry-Perot Interferometers (FPI) in the United States arranged such that coordinated measurements can be performed of the same volume in the thermosphere from multiple FPIs. This coordination of measurement capabilities is not possible for a single FPI. Specifically, in-line measurements between two stations allow for the calculation of vertical winds, while common-volume measurements allow for the calculation of the meridonal and zonal components of the wind. In order to take advantage of these capabilities, the individual FPIs must be coordinated. Thus, a real-time control script running from a central control station has been designed that determines the optimal measurements to be made by each site, and communicates instructions to the remote FPI sites via internet connection. From the user-defined set of all possible measurements for each site as well as real-time observing conditions (e.g., cloud cover), the optimal choice is determined based on the evaluation of an exponential cost function, weighing delay until the measurement can be made versus time since the measurement has last been made, and a greedy decision tree is used to find the solution. Many of the parameters of the cost function are user-defined, including the weights for each measurement and how long to wait before a measurement can be repeated. These

parameters, as well as the selection of possible measurements for each site, can be adjusted while the program is running, so that real-time changes can be enacted.

ITIT-08 Multispectral Imaging of Aeronomical Features using Tunable Filters – by Chhavi Goenka

Status of First Author: Student IN poster competition, PhD

Authors: C.Goenka, J.L.Semeter, J.Noto, H.Dahlgren, R.Marshall, J.Baumgardner, J.Riccobono, M.Migliozzi

Abstract: Multipectral imaging of optical emissions in the Earth's upper atmosphere unravels vital information about dynamic phenomena in the Earth-space environment. Wavelength tunable filters allow us to accomplish this without using filter wheels or multiple imaging setups. We have carried out a feasibility study to evaluate one such filter, a liquid crystal Fabry-Perot etalon, as a potential candidate for the next generation of imagers for aeronomy. We will present the results of this feasibility study and discuss the use of such a filter in an optical instrument to image features such as the 7320-7330 Å multiplet, 6300-6364 Å oxygen emission doublet, or studying the rotational temperature of N2+ in the 4200-4300 Å range, observations which typically require multiple instruments. A low resolution prototype of the instrument was tested in Alaska in March 2013. Preliminary measurements from this test will be shown.

ITIT-09 Using Existing AMISR Modules To Create Multiple New ISR Facilities – by Mike Greffen

Status of First Author: Non-student

Authors: Mike Nicolls and Anja Stromme

Abstract: There are currently three Advanced Modular Incoherent Scatter Radars (AMISR) capable of making ISR measurements in operation (located in Resolute Bay, Canada and Poker Flat, AK). One of the fundamental building blocks of these AMISRs is a radar panel, which contains 32 Antenna Element Units, each capable of transmitting 500 W (peak) and receiving as part of a larger phased array. This modular design gives AMISR greater flexibility and mobility than traditional dish/klystron based ISRs. A proposal to utilize this functionality to create several new AMISR facilities was recently submitted to the NSF. The plan includes a 14 panel radar at Jicamarca, a 120 panel radar in Argentina, a 16 panel radar in Ethiopia and a 102 panel radar at McMurdo, utilizing currently deployed panels and 48 new panels. This presentation will elaborate on the plan and the unique logistical challenges associate with it will be discussed and community feedback will be encouraged.

ITIT-10 Calibration of EMCCD Imagers for Auroral Physics using Narrowband Filters – by Guy Alan Grubbs

Status of First Author: Student IN poster competition, PhD

Authors: G. Grubbs, M. Samara, R. Michell, J. Baumgardner, D. Hampton

Abstract: Ground-based data from several Electron Multiplying Charge Couple Device (EMCCD) imagers will be used in combination with narrowband filters in order to find the brightness of auroral emissions. Laboratory calibration data will be combined with star field data to quantify the imager response for different filters. These EMCCD imagers have high spatio-temporal resolution and dynamic range, enabling a variety of auroral structures to be quantified. Once the calibration factors are obtained for 427.8 nm, 630 nm, and 844.6 nm wavelengths, the ratios of auroral intensities will be used to derive the total and average energy of the incident electron flux. This work will be important in the future, when combining ground based auroral image data with in situ electron precipitation data. For example, the Ground-to-Rocket Electrodynamics-Electrons Correlative Experiment (GREECE) mission will launch a sounding rocket into an auroral event where electrons present in the ionosphere will be characterized and compared with ground-based imager data.

ITIT-11 **Development of a Reconfigurable Ionosonde Receiver Using a Software-defined Radio Hardware Platform -** by Alexander Hackett

Status of First Author: Student IN poster competition, Masters

Authors: Alexander Hackett, Julio Urbina, John Mathews

Abstract: Ionosonde systems provide diagnostic information about the ionosphere that is not only scientifically interesting on its own, but can also provide insight into the interpretation of other ionospheric measurements. Fortunately, the emergence of low-cost analog-to-digital converters has enabled high-performance analog circuitry of traditional systems to be replaced by digital signal processing techniques, with performance of the latter rivaling, if not exceeding, the that of the former. Through the use of a low-cost software-defined radio platform, signal and image processing techniques, and modern computing power, a reconfigurable digital ionosonde receiver has been developed. The system is currently installed and operating at Arecibo Observatory, in conjunction with a commercial ionosonde transceiver that has been utilized as a development testbed. Initial results have shown performance comparable to the commercial system. Although the system has been tailored for this specific application at Arecibo Observatory, the software reconfigurability welcomes and encourages deployment at other facilities. Additionally, work on an independent ionosonde transmitter using the same hardware platform and software tools has begun, with the goal of providing a low-cost, open-source ionosonde solution to the ionospheric sciences community for new and exciting scientific applications.

ITIT-12 **Development of an Advanced Digital Radar Network for Mid-latitude Ionospheric Studies -** by Alexander Hackett

Status of First Author: Student NOT in poster competition, Masters

Authors: Julio Urbina, Ryan Seal, Robert Sorbello, Pablo Reyes, Erhan Kudeki, Steven Franke

Abstract: Two 50-MHz digital radar (classical low power all-sky mode and narrow antenna beam and medium power) systems have been developed near Penn State main campus (Rock Springs Radio Space Observatory) to study ionospheric phenomena, which includes a prototype of the next generation of meteor radars with an improved ability for deriving neutral winds, temperatures, individual meteor properties, and a more accurate characterization of the global meteor flux and its effect on upper atmospheric physics, and space weather. These instruments use open source hardware and software tools, are fully-functional, and are in their initial operational phases. Additionally, a reconfigurable digital ionosonde system is currently under development, and is planned for deployment and operation at the same observatory. All of these instruments utilize a common software-defined hardware platform that facilitates rapid development of low-cost and highly configurable systems. This network of tools will help provide high temporal and spatial resolution to study ionospheric phenomena, demonstrating the value of software-defined systems for present and future atmospheric studies. In this poster, we describe the general approach taken into the implementation of these modern remote sensors. We also present the characteristics of continuous and routine measurements of radar meteors using these two modern radar systems and compare the meteor reflections detected by each radar. We discuss which part of the full spectrum of meteor sizes and speeds do these radar observe as well as sampling biases of different meteor observation techniques.

ITIT-13 **Radar Imaging with Compressed Sensing -** by Brian J. Harding

Status of First Author: Student IN poster competition, PhD

Authors: Brian J. Harding, Marco Milla

Abstract: Coherent radar imaging is a technique to image ionospheric irregularities in a direction transverse to propagation by combining signals from multiple antennas. In order to overcome the underdetermined nature of the radar imaging problem, various methods have been proposed. The two most popular are Capon's method and the Maximum Entropy method. However, the emerging field of compressed sensing offers a new perspective on this problem. This new method takes advantage of transform sparsity inherent in natural images in order to regularize the

inversion. We present simulations in which compressed sensing outperforms both Capon's method and MaxEnt in the context of radar imaging at the Jicamarca Radio Observatory. We also show an example using actual data.

ITIT-14 Sub-5km baseline tomography for fine-scale auroral measurements – by Michael Hirsch

Status of First Author: Student IN poster competition, PhD

Authors: Michael Hirsch, Joshua Semeter, Hanna Dahlgren, Chhavi Goenka, Hassanali Akbari, Donald Hampton

Abstract: We present measurements and initial characterization of a new high-speed auroral tomography system implemented for auroral arc measurements at the Poker Flat Research Range in Alaska. Auroral features are resolved with better than 1 millisecond timing precision between 2 sites with a 3km baseline using a 9 degree field of view at up to 53 frames/second. Building upon knowledge gained from multiscale auroral measurements in Greenland, we discuss the tradespace of SNR, frame rate and spatial resolution. We provide the first ever tomographic analysis of the structure and motion in the aurora at sub-100-m scales.

ITIT-15 Designs for an HF Imaging Antenna Array in Aguadilla, Puerto Rico – by Brett Isham

Status of First Author: Non-student

Authors: B. Isham (1) and T. Vega (2)
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Abstract: The Interamerican Radio Array, or Aguadilla array, is planned to be located at the Interamerican University campus in Aguadilla, Puerto Rico. It is intended for broad-band medium and high-frequency (roughly 2 to 25 MHz) radar observations of the ionosphere, in collaboration with the University of Colorado Versatile Interferometric Pulsed Ionospheric Radar (VIPIR) transmitter, located at the USGS San Juan Obsesrvatory in Cayey, Puerto Rico, and for observations of ionospheric radio emissions stimulated by the Arecibo Observatory high-power high-frequency transmitter. The array is currently in the design phase. The goals of the project include space and atmospheric research and the development of radio sounding, polarization, interferometry, and imaging techniques.

ITIT-16 High-Power Resonance Fluorescence Helium LIDAR - by Tony Mangognia

Status of First Author: Student IN poster competition, PhD

Authors: Tony Mangognia, Gary Swenson, and Peter Dragic

Abstract: The high-power helium resonance fluorescence LIDAR has the potential to measure helium density, temperature, and winds within the middle and upper thermosphere in the range of 250-750 km by resonantly scattering 1080 nm laser photons with metastable He(23S) atoms. The newly designed laser transmitter currently provides an intermediate output power of 42 Watts and can readily be scaled to higher powers.

ITIT-17 Indirect Estimates of High-Resolution Ionospheric-Thermospheric States During Stormtime - by Daniel S. Miladinovich

Status of First Author: Student IN poster competition, Undergraduate

Authors: Daniel Miladinovich, Seebany Datta-Barua, Gary Bust, Geoff Crowley

Abstract: The storm-time ionosphere remains an active area of interest for the scientific community. The storm enhanced density (SED) of plasma and associated poleward plume that stretches across mid-latitudes can have large

total electron content (TEC) and electron density gradients. The poleward plume is highly localized (only a few 100 km in width), and while its formation is attributed to a sub-auroral polarization stream (SAPS) field [Foster, 2005a, 2005b] the complex interactions between the ionosphere and thermosphere and electrodynamic processes are still not well understood. Also these highly localized high density regions cause abrupt spatial changes in GPS ranging errors which act to reduce differential-GPS navigation system services. Today's physical models cannot predict the SED's behavior. Thus, efforts have been focused on developing data-driven techniques for this purpose. To understand the behavior of the SED, the physical thermospheric and electrodynamic drivers that influence it must be understood. In addition, higher resolution is required for resolving the sharp electron density gradients and ion drift velocities at the boundaries of the plume.

We are developing and using techniques that allow for high resolution images, to resolve the features of the SED plume at 100 km scales and smaller. To do this, plasma densities of sub-degree grid resolution are estimated using Ionospheric Data Assimilation 4 Dimensional (IDA4D) software. IDA4D is a data assimilation tool that has a user customizable inversion grid, which allows for drastic improvements in computational efficiency by selecting regions of high resolution where it is necessary and regions with low resolutions where it is not [Bust et al., 2004]. The Estimating Model Parameters from Ionospheric Reverse Engineering (EMPIRE) software is used to estimate the ion drifts caused by thermospheric and electrodynamic forcing. IDA4D provides the time evolving 3D electron density maps as input "observations" to EMPIRE, which discretizes the ion-continuity equation in space and time. EMPIRE uses the Weimer model as a baseline electric potential from which field-perpendicular and field-parallel ion drift velocity corrections are estimated [Datta-Barua et al., 2011].

This study focuses on the comparison of the estimated physical drifts over the Midwest US region at half degree resolution, through comparison to direct ion velocity measurements from the Defense Meteorological Satellite Program (DMSP) satellites in that same region. The domain spans from about 35 to 50 degrees north geographic latitude, and 90 to 80 degrees west geographic longitude The DMSP satellite's Special Sensor-Ions, Electrons, and Scintillation (SSIES) package contains an Ion Drift Meter (IDM) which provides ion drift velocity measurements relative to the motion of the satellite. These measurements are rotated to a geographic East North Up coordinate system allowing for comparison with the EMPIRE estimated horizontal and vertical velocities. We present comparison plots of the EMPIRE drift estimates and DMSP measured drifts. The DMSP F13 and F15 satellites passed over the Midwest US before and after the passage of the SED and plume, at about 1530 UT and 2230 UT on November 20, 2003. The TEC plots, EMPIRE drift velocity profiles, and DMSP velocity profiles are shown side by side. The EMPIRE estimated drifts are comparable to the DMSP measurements in magnitude. Variations in direction and magnitude of the drift correction vectors to the Weimer-derived vectors are discussed.

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ITIT-18 Midnight Temperature Maximum Observations Over Millstone Hill – by Irfan Azeem

Status of First Author: Non-student

Authors: Irfan Azeem and Geoff Crowley (ASTRA LLC)
John Noto, R.B. Kerr, S. Kapali, J. Riccobono and M. Migliozzi (SSI)

Abstract: The thermospheric Midnight Temperature Maximum (MTM) is a large-scale neutral temperature anomaly usually observed at low latitudes. The magnitude of temperature enhancements during low-latitude MTM events is about 50-150 K and its occurrence is linked to poleward surges in an otherwise "quiescent" equatorward meridional flow. The MTM is also associated with the post-midnight brightness of 6300 Å emission and the downward descent of the F-region plasma (midnight collapse). Recent experimental and modeling studies have indicated that MTM anomalies extend into mid-latitudes, although observational evidence of the mid-latitude MTM in the literature is limited to a single site in the Southern Hemisphere. In this paper, we present observations of Northern Hemisphere mid-latitude MTM in Faby-Perot Interferometer (FPI) 6300Å (redline) data from Millstone Hill Observatory. The FPI at Millstone Hill has been operating since April, 2010 and providing F-region night-time neutral winds and temperatures. We present case studies of post-midnight red-line temperature enhancements and correlated poleward surges in the meridional neutral winds.

ITIT-19 Geospace and Space Weather Monitoring from Unmanned Marine Vehicles – by Irfan Azeem

Status of First Author: Non-student

Authors: Irfan Azeem, Geoff Crowley, Adam Reynolds, Julio Santana, ASTRA, Boulder CO
Gordon Wilson, Air Force Research Laboratory, Kirtland AFB, Albuquerque, NM

Abstract: Oceans cover about 70% of the Earth's surface. Our capability for monitoring the geospace environment from the vast stretches of the open ocean remains a technological challenge. Traditional ground-based ionospheric and upper atmospheric monitoring systems (e.g. ionosondes, imagers, interferometers) have been bulky, power intensive and have not been demonstrated to successfully operate from a platform in the open ocean. ASTRA is developing capabilities for hosting small size, weight, and power (SWaP) geospace instruments on unmanned marine vehicles. As part of this effort, ASTRA is leading the development of a GPS autonomous micro-monitor system that can be reliably operated in oceanic regions. This poster describes ASTRA's recent success in integrating its "CASES" GPS-based ionospheric TEC and scintillation monitor on a robotic marine vehicle. During a recent field test in Hawaii, ASTRA demonstrated the autonomous operation of its GPS receiver for TEC and scintillation monitoring from an oceanic buoy and the system's ability to send real-time data over an Iridium link. Future plans for extending the capabilities of the unmanned marine vehicle to support other instruments, such as imagers and interferometers, will be discussed.

ITIT-20 An initial test of a multi-frequency technique for SuperDARN derived electron density measurement during the PINOT 2012 campaign – by Ashton Seth Reimer

Status of First Author: Student IN poster competition, PhD

Authors: Ashton Seth Reimer (1), Glenn Hussey (1), William Bristow (2), Michael Nicolls (3)
Affiliation(s):
1. Institute of Space and Atmospheric Studies, University of Saskatchewan
2. Geophysical Institute, University of Alaska in Fairbanks
3. SRI International,

Abstract: The Advanced Modular Incoherent Scatter Radars (AMISR) make it possible to experimentally study three-dimensional electron density structures in the ionosphere. Using a multi-frequency technique similar to the two-frequency technique described in Gillies et al. (2010), electron density in the high frequency SuperDARN scattering volume may be calculated. A comparison of SuperDARN derived electron density co-located with the Poker Flats Incoherent Scatter Radar (PFISR) volumetric electron density is presented as obtained from data collected during the PFISR Ion-Neutral Observations in the Thermosphere (PINOT) 2012 experimental campaign at the Poker Flats Research Range.
Gillies, R. G., Hussey, G. C., Sofko, G. J., Wright, D. M., and Davies, J. A. (2010). A comparison of EISCAT and SuperDARN F-region measurements with consideration of the refractive index in the scattering volume. J. Geophys. Res., 115.

MidLatitude Ionosphere or Thermosphere

MDIT-01 Measurement Model of Ionospheric Electron Content with CYGNSS – by Jordi Xing

Status of First Author: Student IN poster competition, Masters

Authors: Jordi Xing, Seebany Datta-Barua, Boris Pervan and Aaron Ridley

Abstract: Society increasingly depends on communication and navigation satellites, which are vulnerable to operational errors by space weather effects. The ionosphere, while comprising only five percent of the Global Positioning System (GPS) signal path to a ground-based receiver, refracts the signal so that it becomes the largest error source for single frequency civilian users [Misra and Enge, 2011]. Understanding and predicting the complex dynamic environment of the upper atmosphere therefore grows more urgent. While GPS has emerged as a widespread tool for ionospheric investigation, coverage is typically limited to regions over land by using ground-based receivers. The upcoming Cyclone Global Navigation Satellite System (CYGNSS), coupled with the GPS constellation, brings a new opportunity to remotely sense the ionospheric state over the oceans. This improvement increases the availability of adequate ionospheric measurements making it possible to test and validate models and theories about fundamental properties of the space-atmosphere interaction region (SAIR).

CYGNSS is a new NASA micro-satellite constellation being designed primarily for extreme tropospheric weather predictions. The new constellation differs from other satellite missions such as COSMIC, MET or CHAMP, which have been used for ionospheric studies. CYGNSS is single-frequency, and its satellites have one zenith and two nadir antennas that allow the ability to receive simultaneous direct and reflected GPS signals coming from the ocean surface of the Earth. Consequently, CYGNSS provides ionospheric results from direct and reflected signal measurements; both can be applied in conjunction to study ionospheric behavior over certain strategic areas (i.e., the less well-sampled oceans) [Katzberg et al., 1996]. Each new micro-satellite will be equipped with a Delay Doppler Mapping Instrument (DDMI) capable of generating four Delay Doppler Maps (DDMs) simultaneously, processed from GPS signals scattered from the ocean surface [CYGNSS Mission, 2012]. We investigate the opportunity to perform ionospheric exploration by studying how the CYGNSS data can provide information about the physical properties of the ionosphere.

We are developing measurement models for both the direct and reflected signal measurements. We take as input the geometric configuration of the satellites at transmitting/receiving instants, and extract, as the output, ionospheric total electron content (TEC) from the radio signal measurements. In order to accomplish the development of the measurement models, a coverage analysis from CYGNSS over the ionosphere is required. We compute geometric configurations by validating the positioning algorithm with a simulation model. Consequently, we carry out a relative error analysis to perform data comparison. Finally, to test our algorithm, we input the desired initial time of study corresponding to an initial geometric configuration and validate by comparing our results on simulated data and actual data from another LEO satellite constellation.

First, we simulate satellite positions for CYGNSS and GPS for a day: 29th April 2013. Two different tools have been used for the same purpose: Satellite Tool Kit (STK) and MATLAB. STK consists of a physics-based software package from Analytical Graphics, Inc., which allows engineers and scientists to perform complex analyses of space assets. The software takes an almanac file as the input and produces satellite positions over time as the output. Both results are expressed in Earth-Centered, Earth-Fixed (ECEF) coordinate frames. Since the results from both tools are slightly different, an error variation analysis for satellite position has been set. Second, we calculate the raypath for both direct and reflected signals. The fact that portions of these raypaths' travel are not in the vacuum of space is attributed to several error sources on the corresponding measurement observables. We show the existence of an important difference in the ionospheric delay between the direct and the reflected signal due to the discrepancy between their raypath trajectories.

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Misra, P., and P. Enge (2011), Global Positioning System, revised 2nd ed., Ganga-Jamuna Press, Lincoln, Massachusetts.

MDIT-02 Mid and High Latitude Ionospheric Response to Geomagnetic Storms using the DICE CubeSat - by Geoff Crowley

Status of First Author: Non-student

Authors: Marcin Pilinski, Irfan Azeem, Charles Swenson, Chad Fish, Tim Neilsen, DICE Engineering Team and Aroh Barjatya

Abstract: The DICE mission consists of two identical 1.5U CubeSats deployed simultaneously from a single P-POD (Poly Picosatellite Orbital Deployer) into the same orbit. DICE was selected for flight under the NSF "CubeSat-based Science Mission for Space Weather and Atmospheric Research" program. The DICE twin satellites were launched on a Delta II rocket on October 28, 2011. The satellites are flying in a “leader-follower” formation in an elliptical orbit which ranges from 820 to 400 km in altitude. Each satellite carries a fixed-bias DC Langmuir Probe (DCP) to measure in-situ ionospheric plasma densities, a science grade magnetometer to measure DC and AC geomagnetic fields, and an Electric Field Probe (EFP) to measure DC and AC electric fields. These measurements will permit accurate identification of storm-time features such as the SED bulge and plume, together with simultaneous co-located electric field measurements which have previously been missing. The mission team combines expertise from ASTRA, Utah State University/Space Dynamics Laboratory (USU/SDL), Embry-Riddle Aeronautical University.
The DICE CubeSat mission has three scientific objectives: (1) Investigate the physical processes responsible for formation of the midlatitude ionospheric Storm Enhanced Density (SED) bulge in the noon to post-noon sector during magnetic storms; (2) Investigate the physical processes responsible for the formation of the SED plume at the base of the SED bulge and the transport of the high density SED plume across the magnetic pole; (3) Investigate the relationship between penetration electric fields and the formation and evolution of SED.

In this poster, the LP results during a geomagnetic storm event are compared with IDA4D assimilations of the polar and mid-latitude ionosphere. The presence and structure of an SED event is investigated.

MDIT-03 Modeling GPS TEC variations over North America using Empirical Orthogonal Function - by Ziwei Chen

Status of First Author: Student IN poster competition, PhD

Authors: Shunrong Zhang, Anthea Coster, Bill Rideout

Abstract: Midlatitude ionospheric variations have been an area of active research in recent years. New understanding on the midlatitude storm behavior, the Weddell Sea Anomaly and longitudinal variations are topics that have been advanced due to the use of high spatial-temporal resolution observations based on in situ and ground-based techniques. Ionospheric empirical models can provide an easy access to climatology of ionospheric variations. In this presentation, we report an effort to develop a GPS TEC-based ionospheric model during quiet geomagnetic activity conditions over North America, where a dense network of GPS receivers exists. GPS TEC data collected by the MIT Haystack Observatory over the region 20°N--60°N, 40°W--140°W during 2001-2012 are used. An empirical orthogonal function (EOF) analysis is performed to separate spatial and temporal variations in the month mean data. Because of the quick convergence of EOF decomposition, the first four orders of EOF series which can represent 98.9% of the overall variance of the original data set are utilized. The temporal variations are then expressed in terms of local time, season, and solar activity. An analysis of accuracy and quality of the model indicates that the model can reflect the majority of the monthly mean data during quiet geomagnetic activity, and represent characteristic temporal-spatial variations in the North American TEC.

MDIT-04 **A re-analysis of the role of the Temperature Gradient Drift Instability in mid-latitude quiet-time ionospheric scatter -** by Sebastien de Larquier

Status of First Author: Student NOT in poster competition, PhD

Authors: Sebastien de Larquier, A. Eltrass, A. Mahmoudian, J.M. Ruohoniemi, W.A. Scales, J.B.H. Baker, R.A. Greenwald, and P.J. Erickson

Abstract: The mid-latitude SuperDARN radars regularly observe low-velocity Sub-Auroral Ionospheric Scatter (SAIS) from decameter-scale ionospheric density irregularities during quiet geomagnetic conditions. Previous work has shown that this type of scatter is confined to local night, occurs on most nights, lacks significant seasonal variations, and is located equatorward of but otherwise uncorrelated with the positions of both the auroral region and the plasmapause boundary. Previous work also suggested that the Temperature Gradient Instability (TGI) could be responsible for the observed irregularities. We conduct a new analysis of electron density and temperature profiles accounting for the influence of the magnetic field dip-angle on mid-latitude irregularities. We distinguish between gradients along the meridional, vertical, and perpendicular to the magnetic field directions. A new kinetic model of the TGI is used to calculate irregularity growth rates. We find that the TGI can only develop in the top-side ionosphere, suggesting that a different or additional mechanism is required to account for the observed bottom-side SAIS.

MDIT-05 **Geomagnetic Dependence of Medium Scale Traveling Ionospheric Disturbances (MSTIDs) Observed by Mid- and High- Latitude SuperDARN Radars –** by Nathaniel A. Frissell

Status of First Author: Student IN poster competition, PhD

Authors: N.A. Frissell, J.B.H. Baker, J.M. Ruohoniemi, M.L. West, and W.A. Bristow

Abstract: Medium Scale Traveling Ionospheric Disturbances (MSTIDs) are wave-like perturbations of the F-region ionosphere with horizontal wavelengths on the order of 100-250 km and periods between ~15 - 60 min, and are generally thought to be the ionospheric manifestation of Atmospheric Gravity Waves (AGWs). High-latitude MSTIDs have been studied using SuperDARN radars since 1989, and are typically attributed to auroral sources and propagated by the Earth Reflected Wave (ERW) mode. Tropospheric sources and earthquakes are also known to be sources of MSTIDs. Observations of MSTIDs using both mid- and high- latitude SuperDARN radars are presented. North American radar data from November 2010 – November 2012 were searched for signatures of MSTIDs. Initial results suggest that MSTIDs are observed at high latitudes primarily in the fall/winter months, which is consistent with published results. During the fall/winter months, SuperDARN mid-latitude MSTIDs appear more often than high-latitude MSTIDs, likely due to calmer ionospheric conditions at mid-latitudes. In the springtime, SuperDARN-observed MSTIDs are less likely to be seen at high-latitudes, but still appear at mid-latitudes. Distributions of MSTID occurrence organized by geomagnetic parameters Kp, SYM-H, and AE are presented to investigate MSTID dependence on geomagnetic activity at both high and midlatitudes.

MDIT-06 **Thermosphere Winds from Champ Neutral and Plasma Density Measurements –** by Federico Gasperini

Status of First Author: Student IN poster competition, PhD

Authors: Federico Gasperini, Jeffrey M. Forbes, Eelco Doornbos and Sean Bruinsma

Abstract: Meridional winds in the thermosphere are key to understanding latitudinal coupling and thermosphere-ionosphere coupling, and yet global measurements of this wind component are scarce. In this work, neutral and plasma densities measured by the CHAMP satellite between about 350-425 km during 2002-2009 are used to derive a new wind product for thermosphere studies. Starting with measured neutral total mass densities and an empirical model of the thermosphere (e.g., NRLMSISE00), we iterate on a convenient parameter (i.e., F10.7 solar flux) to derive the model exosphere temperatures, pressures and pressure gradients consistent with the measured densities. [N.B. Although some net model bias may exist, we believe the horizontal pressure gradients reflect measured

gradients and not model gradients]. Using ion drag values derived from measured plasma densities along with the neutral pressure gradients, the 2-D momentum equations (neglecting viscosity) are used to solve for the zonal and meridional wind components. For validation purposes, the derived zonal winds are compared with winds measured by the cross-track accelerometer on CHAMP, as well as the HWM93 model. Climatological wind patterns in latitude vs. local time (longitude-averaged) and in latitude vs. longitude (at constant local times) formats will be presented and assessed. Future developments include solving the 3-D momentum equations to account for the viscous term, further investigating any dependences on the chosen empirical model, examination of the wind response to variations in geomagnetic activity, and comparisons with GOCE wind measurements near 250 km.

MDIT-07 Midnight temperature maximum observations using incoherent scatter radars: climatology and dual site comparisons - by Dustin A. Hickey

Status of First Author: Student IN poster competition, PhD

Authors: D. Hickey, C. Martinis, A. Wright, W. Oliver, P. Erickson, L. Goncharenko, N. Aponte, C.Brum, L. Condori

Abstract: We compare incoherent scatter radar (ISR) observations of the midnight temperature maximum (MTM) collected at three sites: the Jicamarca Radio Observatory, Peru (-11.95°, 283.13°), the Millstone Hill Observatory, USA (42.62°, 288.51°), and the Arecibo Observatory, Puerto Rico (18.35°, 293.25°). The MTM is a local maximum in the neutral temperature around midnight. Variations in the nighttime plasma temperatures Te and Ti, determined by ISR techniques, should reflect variations in the neutral temperature Tn. We characterize the MTM in terms of amplitude, time of occurrence and width. We present data on the seasonal dependence of the amplitude and time of occurrence of the MTM along with an analysis of the altitude dependence. These three sites allow us to exam the latitudinal extent of the MTM. Data from Millstone Hill are obtained using south pointing low elevation scans. This provides us with data between 30° and 34° N. We have observed the MTM at multiple altitudes, between 250 and 400 km at all three sites. Nights with simultaneous observations of the MTM using the Arecibo ISR and the Millstone Hill ISR are analyzed. Preliminary results indicate that the MTM occurs later at Millstone Hill and earlier at Jicamarca. It also appears that the amplitude is greater at higher latitudes. We are also investigating if the configuration of the Earth's magnetic at these sites might influence MTM characteristics.

MDIT-08 Longitudinal structures of He II radiation in the upper ionosphere observed from the International Space Station - by Yuta Hozumi

Status of First Author: Student NOT in poster competition, PhD

Authors: Yuta Hozumi, Akinori Saito, Atsushi Yamazaki, Go Murakami, and Ichiro Yoshikawa

Abstract: Horizontal distribution structure of He+ in the Earth's upper ionosphere was studied with He II image obtained by the Extreme Ultra Violet Imager (EUVI) of the ISS-IMAP (Ionosphere, Mesosphere, upper Atmosphere and Plasmasphere mapping) mission. EUVI has observed resonant scattering from He+ (30.4 nm) and O+ (83.4 nm) with backward limb FOV from the the International Space Station (ISS) since October 2012. A longitudinal enhancement of He II radiation was observed in the western pacific region and it seems to be due to the He+ distribution in the upper ionosphere. The available cause of this longitudinal structure will be also discussed in this presentation.

MDIT-09 TEC Perturbations near thunderstorms at Los Alamos GPS Receivers – by Alexander Kendrick

Status of First Author: Student IN poster competition Undergraduate

Authors: Alexander Kendrick, Erin Lay, Tim Hamlin

Abstract: Solar and geomagnetic activity are considered to be the main drivers of ionospheric variation, but recent findings have suggested that tropospheric weather could also have a significant effect in terms of tides, generation of

atmospheric gravity waves, and seeding of spread-F. A recent study has shown anomalous fluctuations nearby large mesoscale thunderstorms in the U.S. Great Plains [Lay et al., GRL 2013]. In this study, we examine GPS TEC data from a ground-based GPS receiver located at Los Alamos National Laboratory during the summer of 2012 to further clarify the connection between nearby thunderstorms and anomalous TEC variations. The LANL GPS TEC receiver uses a Kalman filter based program developed by Carrano et.al (2009) to determine the TEC by measuring the phase shift between the L1 and L2 GPS frequencies. We use the World Wide Lightning Location Network as an indicator of nearby thunderstorm activities.

MDIT-10 Statistical characterization of sub-auroral polarization stream using large scale observations by mid-latitude SuperDARN radars - by Bharat Kunduri

Status of First Author: Student IN poster competition, PhD

Authors: B. S. R. Kunduri, J. B. H. Baker, J. M. Ruohoniemi, E. G. Thomas, L. B. N. Clausen, K. T. Sterne, P. J. Erickson and J. C. Foster

Abstract: The Sub-Auroral Polarization Stream (SAPS) is a latitudinally narrow region of westward directed flows observed equatorward of the auroral oval. Recent studies have shown that the new mid-latitude chain of SuperDARN radars can be used to make measurements of velocities in a SAPS channel over an extended longitudinal sector, covering more than 6 hours in magnetic local time. Data from the mid-latitude SuperDARN radars between 2011 and 2012 was used to compile a database of such large scale SAPS events. In this study we present an analysis of the spatial variations in the occurrence of these events under different geomagnetic activity levels. Different aspects of the SAPS channel such as the latitudinal width of the channel, the strength and direction of the two dimensional velocities and potential drop across the channel are examined to estimate the average characteristics of the channel as a function of Dst index.

MDIT-11 Ionospheric Shock Waves Triggered by Rockets - by Charles Lin

Status of First Author: Non-student

Authors: C. H. Lin, J. T. Lin, C. H. Chen, J. Y. Liu, Y. Y. Sun, W. H. Chen, Y. Kakinami, H. Liu, and R. J. Rau1

Abstract: This paper presents two-dimensional structure of shock waves resulting from the rocket transit in the ionosphere using the time rate change of the total electron content (TEC) derived from networks of ground-based GPS receivers around Korea, Japan, and Taiwan. From the 2-D TEC maps constructed for the 2009 North Korea (NK) Taepodong-2 and 2013 South Korea (SK) KSLV-II rocket launches, the V-shape TEC shock wave fronts, with period of 100-600 sec, produced by the propulsive blasts of the rockets are seen immediately and then propagating perpendicular outward from the trajectory with velocities between 800-1200 m/s for both events. Along the trajectory, clear rocket exhaust depletions of TECs are seen and deflect by the background neutral wind. 20-mins after the rocket transits, wave signature with characteristic of bow/stern waves evolved from the blast shock wave fronts generated at earlier time stages are seen with velocities of 800-1200 m/s.

MDIT-12 Model Simulation of E-Region Electron Density and Sporadic E Layers – by Yen-Chieh Lin

Status of First Author: Student IN poster competition, PhD

Authors: Y. H. Chu

Abstract: In this study, electron density in E region ionosphere and the appearance of Sporadic E layers result of wind shear effect are simulated. In order to model the electron density of E region ,we simulate the ion densities of NO+、O2+、N2+、O+、Fe+ then sum all of them to get electron density that function of time and height at given latitude and longitude. Firstly, suppose that the background electron density only take account of photochemical reaction equilibrium. The process of simulation is: calculate each ion production rates that caused by

photoionization and photoelectron effect and substitute production rate ,loss rate coefficients and certain atmospheric parameters into each ion continuity equation then using Runge-Kutta Method to solve the first-order partial differential equation. In this work, the result is the variations in time and height of each ion density followed by photochemical equilibrium background electron density.
Besides, the tidal wind give rise to the appearance of Sporadic E layers is also simulated. In the ionosphere E region, the zonal neutral wind is primarily response for inducing vertical ion drifts, which result from a U×B dynamo as well as neutral characteristic of high collision frequency there. Hence, a reversal of the zonal neutral wind with altitude will result in ion convergence. According to these mechanisms, Sporadic E layers will occur at the regions where the ion converges. In terms of model simulation, the vertical ion drift velocity via tidal wind is the transport term in continuity equation. Once considering the transport term, using the Crank-Nicholson Method to solve these partial differential equations. The results of numerical simulation show that the sporadic E layers accurately occur at the region where ion vertical velocity converges.

MDIT-13 **Morphology of Ionospheric Storms during Different Solar Cycles –** by Clara Narvaez

Status of First Author: Non-student, Undergraduate

Authors: Clara Narvaez, Angela Marusiak, Michael Mendillo

Abstract: Ionospheric storms have been studied with groundbased data to understand the morphology patterns at all latitudes. Studies have examined the maximum electron density (Nmax) of the F-layer during different phases of the solar cycle, finding most differences for storms during the solar minimum and solar maximum. In this study, we compare ionospheric storm patterns during different solar cycles. We have chosen two mid-latitude stations with long data coverage: Wallops Island (Virginia) and Hobart (Tasmania), which have comparable geographic and geomagnetic coordinates. We have analyzed the average storm patterns produced by more than 200 moderate to strong geomagnetic storms during solar cycle #20 (October 1964 - June 1976) and solar cycle #23 (May 1996 – December 2008). The average patterns of ΔNmax(%) are measured with respect to the average monthly mean. We have looked at storm time patterns (hours from storm commencement) as well as local time ones (6-day storm period). We observed a remarkable consistency for the characteristic pattern, a short positive phase during daytime hours of the storm's first day, followed by a long negative phase. However, statistical differences were measured in the overall magnitude of these patterns, consistently showing that solar cycle #23 had less severe ionospheric storms. A geomagnetic indices comparison shows that solar activity was less geo-effective during solar cycle #23 than solar cycle #20.

MDIT-14 **TIME3D-IGGCAS: A New Three-Dimension Theoretical Ionospheric Model in realistic geomagnetic fields -** by Zhipeng Ren

Status of First Author: Non-student, PhD

Authors: Zhipeng Ren*, Hanli Liu, Weixing Wan, Libo Liu, and Huijun Le

Abstract: Based on the previous work, a new global three-dimension theoretical ionospheric model in realistic geomagnetic fields is developed, named Three-Dimension Theoretical Ionospheric Model of the Earth in the Institute of Geology and Geophysics, Chinese Academy of Sciences (TIME3D-IGGCAS). This new model covers the whole ionosphere and plasmasphere. It self-consistently solves the equations of mass continuity, motion and energy of electron and ions to give out the time-dependent three-dimensional structures of the main ionospheric and plasmaspheric parameters in realistic geomagnetic fields, including ion number densities of O+, H+, He+, NO+, O2+ , N2+ and electron; electron and ion temperature; and ion velocity vectors. TIME3D-IGGCAS can also self-consistently run as the module of ionosphere-plasmasphere of GCITEM-IGGCAS (Global Coupled Ionosphere-Thermosphere-Electrodynamics Model developed at Institute of Geology and Geophysics, Chinese Academy of Sciences). We carry out simulations in March Equinox and in June Solstice, and compare the simulated results with that from IRI empirical model. TIME3D-IGGCAS can well reproduce the main ionospheric features in all simulations. We also simulate the ionospheric differences between different kinds of geomagnetic fields. The results

suggest that the geomagnetic field configuration obviously affect the ionospheric plasma density, and the differences between NmF2 in realistic geomagnetic fields and that in tilted dipole fields can be larger than 40%.

MDIT-15 Sub-auroral ionospheric convection as observed by midlatitude SuperDARN Radars - by Alvaro J. Ribeiro

Status of First Author: Student IN poster competition, PhD

Authors: A.J. Ribeiro, J.M. Ruohoniemi, J.B.H Baker, S. de Larquier, R.A. Greenwald

Abstract: The midlatitude radars of the Super Dual Auroral Radar Network (SuperDARN) frequently observe backscatter subauroral ionospheric backscatter equatorward of the plasmapause boundary. This allows for derivation of subauroral convection patterns by fitting ionospheric flows to the line of sight velocities recorded at the radars. We have taken data from all of the North American midlatitude radars from the period of 2008-2012 and binned them into a geospatial grid. We have then binned the data based on season and geomagnetic activity level and present the resulting convection patterns.

MDIT-16 The new Remote Optical Facility of Arecibo Observatory in Culebra Island, Puerto Rico - by Pedrina Terra Santos

Status of First Author: Non-student, PhD

Authors: Robert Kerr and Eva Robles

Abstract: Optical instruments at AO have provided the neutral atmosphere context since the middle 1960s. Unfortunately, AO is a poor optical site, averaging 84 inches of rain annually, with overcast skies roughly 50% of the time. By placing optical instruments near AO, on the dry island of Culebra, east of Puerto Rico, the number of nights (annually) with simultaneous, high quality ISR and optical data can be tripled. Culebra averages less than 30 inches of rain annually, and received only seven inches of rain in calendar year 2012. Culebra is a dry, dark location with superior sky transparency, with more than three times the number of clear sky hours available at AO. Placed on Culebra, optical instruments can observe the same thermospheric volume over AO sampled by the ISR. This capability will become especially important when our ionospheric modification facility is commissioned this year. Small and large scale irregularities created by that facility can be readily observed and tracked from the Culebra site, and simultaneous observations from AO of the same atmospheric volume will permit direct vector measurements of dynamical evolution of the irregularities.

MDIT-17 High Accuracy Ionosphere Total Electron Content Map Based on Sparse Regional GNSS Networks - by Cheng Wang

Status of First Author: Student IN poster competition, PhD

Authors: Cheng Wang, Yu(Jade) Morton

Abstract: Ionosphere total electron content (TEC) is an important parameter for both satellite navigation and scientific studies of the ionosphere. There are a number of GNSS networks whose main task is to provide measurements to allow assimilation of TEC maps. However, global TEC maps have limited precision and resolution which are often inadequate to describe detailed features of local ionosphere. There is the need for regional ionosphere models to provide high precision ionosphere delay correction. Existing regional ionosphere model typically relies on modeling of measurements from a dense local GNSS network in order to achieve high precision. Various models, such as polynomial, grid model, and spherical harmonics model have been used in establishing regional models. These models lack sound physical and scientific support. This poster presents an innovative algorithm to generate regional ionosphere TEC map with improved precision using sparsely distributed sensors. The algorithm has been tested using a real GPS network consisting of only 7 receivers covering 46 to 53 degree latitude and 10 to 23 longitude areas in northern Europe. Our results show that there are less than 2 TEC units

average differences between our approach and the global TEC map over this area on a 0.5 degree latitude and 1 degree longitude grid during a 24 hour period.

Long Term Variations of the Ionosphere-Thermosphere

LTVI-01 Long-term trends on the F2 peak parameters over Arecibo based on over four decades of incoherent scatter radar and ionosonde measurements – by Edvier Cabassa-Miranda

Status of First Author: Non-student

Authors: Christiano G. M. Brum

Abstract: This work presents the results obtained from the analysis of 46 years of radar and ionosonde data (1966-2011). This study was performed using the Arecibo empirical model that describes the behavior of the ionospheric F2 region peak. The model was developed using nearly 25 years of incoherent scatter radar (ISR) measurements made at the Arecibo Observatory (AO) between 1985 and 2009. The model describes the variability of the F2 peak frequency (foF2) and F2 peak height (hmF2) as a function of local time, season, and solar activity for quiet-to-moderate geomagnetic activity conditions (Kp < 3+). The results described in this work are specifically for the12:00 LT (16:00 UT) profile. A yearly trend of –0.267km/year and –0.011Mhz/year was found for the hmF2 and foF2, respectively, and we have also found a strong seasonal long trend rate dependence as well.

LTVI-02 Climatology of nighttime medium-scale traveling ionospheric disturbances (MSTIDs) at middle and low geomagnetic latitudes in the Central Pacific and the South American sectors - by Timothy M. Duly

Status of First Author: Student IN poster competition, PhD

Authors: Duly, T. M., Chapagain, N. P., and Makela, J. J.

Abstract: We study the climatology of nighttime medium-scale traveling ionospheric disturbances (MSTIDs) within the recent solar minimum from two geographical sectors: Haleakala, Hawaii (20.71 N, 203.74 E) in the Central Pacific and Cerro Tololo, Chile (-30.17 N, 289.19 E) in the South American sector. The data are analyzed from OI 630.0-nm airglow imagers and range from September 2006 through December 2012. At Haleakala, an all-sky imager provides occurrence rates of MSTIDs at mid-latitudes, and a narrowfield imager with an equatorward field of view observes MSTIDs propagating toward low geomagnetic dip angles. At Cerro Tololo, a narrow field imager also observes MSTIDs at low geomagnetic dip angles, analogous to the narrowfield imager at Hawaii but for a different longitude sector. To establish seasonal trends, the occurrence rate statistics are binned according to season and solar flux and are compared with previous climatologies found in the literature. In addition, a statistical database of the latitudinal exent of observed MSTIDs is developed for the narrowfield imagers in Hawaii and Chile, providing a climatology of MSTIDs observed at low geomagnetic latitudes. These data could provide additional insight toward the role of MSTIDs as seeding mechanisms for equatorial spread F which have been observed and modeled in previous studies (Miller et al. 2009; Krall et al. 2011).

LTVI-03 Solar Cyclic and Climatic Influences on Upper Atmospheric Hydrogen Distributions - by Susan M. Nossal

Status of First Author: Non-student, PhD

Authors: S.M. Nossal, E.J. Mierkiewicz, F.L. Roesler, L. Qian, S. Solomon, A. Burns, and R.C. Woodward

Abstract: Geocoronal hydrogen forms the upper boundary of the Earth's atmospheric hydrogen distribution and is a byproduct of radiatively important methane and water vapor. We will discuss work in progress to improve the accuracy of the Wisconsin Northern hemisphere mid-latitude hydrogen emission data set to facilitate inter-comparison of observations by the high precision Wisconsin H-alpha Mapper Fabry-Perot with earlier observations.

We will also discuss sensitivity studies using the National Center for Atmospheric Research's single column global-average version of the Thermosphere Ionosphere Mesosphere Electrodynamics General Circulation Model to investigate solar cyclic and climatic influences on upper atmospheric hydrogen distributions. Results suggest a larger response of atmospheric hydrogen to greenhouse gas increases at solar minimum than at solar maximum. Carbon dioxide cooling appears to have a greater influence than methane increases in defining the change in the hydrogen distribution at thermospheric altitudes, especially at solar minimum.

LTVI-04 **A Long-Term Trend Study of the F-Region Peak Height Above Jicamarca –** by Enrique Rojas Villalba

Status of First Author: Student IN poster competition, Undergraduate

Authors: Enrique Rojas and Marco Milla

Abstract: About 30 years ago, some long-term trend studies based on numerical models predicted that an increment in the concentration of trace gases in the Earth's atmosphere can produce the cooling and shrinking of the F-region ionosphere [e.g., Roble and Dickinson, 1989].
We have carried out a long-term trend study of the F-region peak height (hmF2) based on measurements collected by an ionosonde system located at the Jicamarca Radio Observatory (Lima,Peru). The data set used in this study extends from 1994 to 2012. After the analysis, we found a trend of -0.105 km/year.
In this work, we first discuss the criteria used to classify and select the data, and then, we present the procedure applied to determine the F-region trend, approach that is similar to Ulich's method described in Lastovicka et al. [2006]. In addition, we discuss the accuracy of the estimated trend that has been determined following the technique proposed by Weatherhead et al. [1998], technique that considers possible correlations in the data time series.

Magnetosphere-Ionosphere-Thermosphere Coupling

MITC-01 **FDTD Modelling of Low-frequency Shear-Alfven-wave Propagation and its Interaction with Trapped Charge Particles in the Magnetosphere –** by Nithin Sivadas

Status of First Author: Student IN poster competition, Undergraduate

Authors: Nithin Sivadas, Dr. H. Ramachandran, Dr. T. M. Muruganandam

Abstract: This study presents test particle analysis of the scattering of high energy particles by shear alfven noise in the Van-Allen radiation belts. The alfven noise was generated by carrying out a Finite Difference Time Domain (FDTD) simulation of shear-Alfven-wave modes, using realistic values of plasma parameters and perfectly-reflecting ionosphere boundary conditions. The purpose of the study is to understand the statistics of high energy particle scattering into the near earth region of the ionosphere.

MITC-02 **Space-based Proton Electron Detector (SPEED) to Measure Fluctuations in the Energy Spectra of Protons and Electrons in the Upper Ionosphere –** by Nithin Sivadas

Status of First Author: Student NOT in poster competition, Undergraduate

Authors: Ananth Saran Yalamarthy, Ankit Dhiman, Athreya Shankar, Nitin Prasad, Nithin Sivadas, Dr. H. Ramachandran

Abstract: This poster presents the concept and design of SPEED; a space-based scintillator detector system for measuring the energy spectrum, background flux, and fluctuations in the flux of protons and electrons in the upper ionosphere. The detector is being developed as a payload for the small satellite by IIT Madras. The study made

using the detector will help verify and improve current trapped particle radiation models, and analyse the dynamic nature of radiation belts and its effects on the ionosphere.

Polar Aeronomy

POLA-01 Electron Energy Inversion from Auroral Optical Data – by Michael Jason Ahrns

Status of First Author: Student NOT in poster competition, PhD

Authors: M Jason Ahrns, Donald L Hampton, Hans Stenbaek-Nielsen, Robert Michell, Steven Powell, Kristina A Lynch, Philip A Fernandes, Marc Lessard

Abstract: The MICA (Magnetosphere-Ionosphere Coupling in the Alfvèn Resonator) sounding rocket was launched from Poker Flat, AK on Feb 19, 2012, into a series of discrete auroral arcs immediately following auroral breakup. We operated a set of ground-based optical imagers in support of the launch which captured the event, including more than an hour of auroral activity in the eventual rocket trajectory prior to launch at a variety of temporal (~1 second cadence to video frame rate) and spatial (all-sky to sub-kilometer) resolutions and in several spectral emission lines. Our imagers were located at Poker Flat, Fort Yukon, and Venetie AK (the last of which viewed the auroral conjugate of the rocket at magnetic zenith with sub-kilometer resolution) which allows a 3-dimensional reconstruction of certain auroral features from the optical data. We use this data, along with an electron transport model, to estimate the precipitating electron population and its effect on the background plasma to characterize the energy input prior to and during the rocket flight.

POLA-02 Dynamics of High-Latitude Ionospheric Upflow Processes – by Meghan Burleigh

Status of First Author: Student IN poster competition, Masters

Authors: Matthew Zettergren; Stephen Armstrong

Abstract: In an effort to quantify details of ionospheric upflow driving forces, we perform model simulations of the ionospheric response to frictional heating (type-1 upflow), soft particle precipitation (type-2 upflow), and high altitude density cavities. The model used for this study consists of fluid conservation equations for mass, momentum, and energy solved for all relevant E- and F-region species on a two-dimensional dipole mesh. These fluid equations are solved alongside an electrostatic treatment of the auroral currents. In addition to these model runs, Incoherent scatter radar data from multiple upflow events spanning 1998-2005, collected at Sondrestrom, are analyzed. Data including events with observed ion temperature enhancements, electron temperature enhancements, both enhancements simultaneously and upflows where neither signatures are present have been selected for comparison. The relationships between velocity and the temperature are explored for both the Sondrestrom data and the upflow models facilitating matching observed events to modeled upflow types. Through the use of force-balanced and steady state calculations, these upflow events and the model simulations show the correlations and limitations of steady state assumptions, illustrate the net acceleration of the plasma and also shed light on potential time dependencies that may be important for the ion outflow process.

POLA-03 Ionosphere-Thermosphere Coupling and Response to an Auroral Driver: An Analysis of Ionospheric Thermal Ions Using a SIMION-based Forward Instrument Model - by Philip Fernandes

Status of First Author: Student NOT in poster competition, PhD

Authors: Kristina Lynch, MICA Science Team

Abstract: The MICA sounding rocket launched on 19 Feb. 2012 into several discrete, localized arcs in the wake of a westward traveling surge. In situ and ground-based observations provide a measured response of the ionosphere to preflight and localized auroral drivers.

In the low-energy thermal plasma regime, instrument response to the measured thermal ion population is very sensitive to the presence of the instrument. Furthermore, the plasma is shifted and accelerated in the frame of the instrument due to flows, ram, and acceleration through the payload sheath. The energies associated with these processes are large compared to the thermal energy. Rigorous quantitative analysis of the instrument response is necessary to extract the plasma properties which describe the full 3D distribution function. First, we introduce a SIMION instrument model to characterize instrument response to measurements of thermal ions. Second, we will use the results from the instrument model to develop a forward model, from which we can extract anisotropic ion temperatures, flows, and density of the measured background thermal plasma. Only then can we use the the thermal plasma measurements to rigorously address questions of ionospheric-thermospheric coupling. These questions, for MICA, include the following: ss the state of the ionosphere during the rocket flight a remnant of the westward traveling surge, or is it a direct response to localized drivers? How do the calculated ion flows compare to the flows derived from the electric field data, and what do these flows tell us about the state of the ionosphere? How do these measurements compare to the nonlinear self-consistent Zettergren and Semeter (2012) ionospheric model specifying fields and currents? How do the calculated ion flows compare to the neutral wind measurements from the ground-based Fabry-Perot Interferometer, and what do these flows tell us about how the ionosphere couples to the thermosphere? In this poster we present our current progress toward these analysis goals.

POLA-04 Filling the void: Plans for a distributed array of ionospheric sensors in Alaska – by Donald L. Hampton

Status of First Author: Non-student

Authors: Donald Hampton, Mark Conde, Geoff Crowley, Irfan Azeem, Adam Reynolds and Julio Santana

Abstract: Significant insights into the structure and evolution of the ionosphere have been enabled by the increasing use of dual-frequency GPS receivers to probe the total electron content and GPS scintillation. In the US, this development has largely been concentrated in the contiguous states while the high latitude ionosphere has been poorly represented, due primarily to remoteness and lack of infrastructure. We are planning to remedy this by proposing to install 15 to 20 GPS receivers and fluxgate magnetometers across northern Alaska with the primary goal of significantly improving the temporal and spatial resolution of ionospheric remote sensing in a region of poor coverage but high geospace interest. We will describe the expected network, including station locations, improvement in coverage based on these locations and expected data products and latency. In a pilot program, ASTRA deployed four CASES dual-frequency GPS receivers in Alaska coincident with other instrumentation from the GI (see poster by Azeem). We will present preliminary results from this network of instruments, demonstrating the value of the data.

POLA-05 An Investigation of the Auroral Ionospheric Responses due to Atmospheric and Magnetospheric Forcing - by Yishi Lee

Status of First Author: Student IN poster competition, Masters

Authors: 1. Mr. Yishi Lee
2. Dr. Matthew D. Zettergren
3. Dr. Jonathan Snively

Abstract: We present the results of a new, local 3-D model of the auroral ionosphere perturbed from the topside by magnetospheric forcing, and from below by acoustic and gravity wave forcing. This model combines an electrostatic approximation for the fields/currents with a fluid moment equations describing the evolution of all of the major ionospheric constituents (O+, NO+, N2+, O2+, N+ and e-). Firstly, we examine various realistic boundary conditions (electric fields) based on the radar data during an auroral event. Results demonstrate the significance of using 3D treatments of the ionosphere, and also display some ionospheric processes that are not

easily observed using current remote sensing diagnostics. In particular, they shed some light on the correlations between the molecular ion densities (transitional altitude of O+) and the strength of the perpendicular electric field. In addition, the convection of the disturbed density and momentum may also play a key role in determining a large scale ionospheric structure over fairly long periods of time. Secondly, neutral density and wind perturbations, due to acoustic and gravity waves generated within a time-dependent nonlinear model, are coupled to the ionospheric model through source terms in the fluid and electrostatic equations. Results suggest that the neutral wind and density perturbations in the lower thermosphere, associated with waves generated by tropospheric forcing, can create a significant ionospheric response in ion and electron densities, velocities, and electric currents in the E-region and lower F-region of the auroral ionosphere.

POLA-06 Localized Swarm of Low-Resource CubeSat-Class Spacecraft – by Robert Clayton

Status of First Author: Student NOT in poster competition, PhD

Authors: Robert Clayton, Kristina Lynch

Abstract: In interesting and dynamic auroral ionospheric plasmas, a localized array of sensors deployed as a low-resource swarm from a main deployer can benefit from the low resource aspect of small satellites and resolve special and temporal differences. Thus a swarm of sensors can help understand the underlying truth of auroral dynamics more effectively than a single sensor. We consider two aspects of designing such a swarm: (a) maintaining the localization in a low-cost manner, and (b) creating an extremely low-resource spacecraft by taking advantage of commercially available technologies.

For a three month mission, STK (SatelliteToolKit) studies show that with proper deployment, an array of CubeSat-class spacecraft near 350 km altitude can regroup once per orbit over the auroral zone to form a sensor array spreading a few hundred km or less along the trajectory, and several 10's of km across the orbit trajectory. Kepler's laws and Hill's equations allow us to put constraints on the capability of the deployer needed, in order to deploy the array with a minimal component of the ejection velocity along the orbital track.

In order to keep the cost of each spacecraft low, we are exploring commercially available technologies such as Arduino controllers, video-game sensors, and wireless networks. For our developmental suborbital payloads, the Arduino on each sub-payload uses a local DNT 900 network to send the data to a main payload which will then relay the data from all sub payloads to the ground using more standard S band telemetry. We are investigating appropriate TM systems for an orbital swarm. In order to interpret the information gained from swarms, a Support Vector Regression algorithm is being developed to match the data collected from the swarm to ground observations (such as those from camera or radar array) and/or to model predictions.

POLA-07 Magnetic Field Observations from the Dynamic Ionosphere CubeSat Experiment (DICE) - by Marcin Palinski

Status of First Author: Non-student

Authors: Geoff Crowley, Irfan Azeem, Charles Swenson, Chad Fish, Tim Neilsen, DICE Engineering Team , Aroh Barjatya and Marcin Palinski

Abstract: The Dynamic Ionosphere CubeSat Experiment (DICE) was launched in October, 2011 with the primary mission objective to study and characterize ionospheric Storm Enhanced Density (SED) bulges and plumes. The mission consists of two spacecraft, each containing two Langmuir probes to measure ionospheric in-situ plasma densities, as well as electric field probes and a magnetometer to measure AC and DC electromagnetic fields. The Langmuir Probes are fully deployed, and data has been collected from them as well as from the science magnetometer. This work presents data from the on-board magnetometers. Background geomagnetic field values are subtracted to investigate magnetic perturbations at high latitudes due to Field Aligned Currents (FACs). These perturbations are compared to AMPERE fitted magnetic residuals, and AMIE assimilation results. This is the first time FAC observations have been demonstrated on a CubeSat body-mounted magnetometer.

POLA-08 **First Results from a Chain of GPS TEC and Scintillation Receivers in Alaska –** by Marcin Palinski

Status of First Author: Non-student

Authors: Marcin Palinski, Irfan Azeem, Geoff Crowley, Adam Reynolds, Julio Santana, ASTRA, Boulder, CO
Donald Hampton, Geophysical Institute, University of Alaska Fairbanks, AL

Abstract: We recently deployed several GPS scintillation receivers (ASTRA CASES model SM-211) in Alaska, for the purpose of documenting and understanding GPS scintillation at high latitudes, and to study the effects on operational GPS-dependent systems. These receivers were deployed in a longitudinal chain spanning the entire state, with sites in Kaktovik, Fort Yukon, Poker Flat, and Gakona. Scintillation statistics from November 9, 2012 and February 26, 2013 show phase scintillations to be largest at Kaktovik and smallest at Gakona. In this paper, we present GPS phase scintillation and auroral emission results from Alaska to characterize correspondence between scintillation and auroral features. Phase scintillation values from the longitudinal chain will be contrasted with quiet time scintillation values to investigate the role of high latitude auroral features in driving the phase scintillations. These software receivers provide the highest quality ionospheric TEC and scintillation data, while their low cost makes it feasible to deploy networks or arrays like the Alaska array demonstrated here in order to monitor effects on operational systems that depend on GPS, including navigation, communications and surveillance systems.

POLA-09 **Distortion in Thermospheric air masses by horizontal neutral winds over Poker-Flat (Alaska) measured using an All-Sky scanning Doppler imager –** by Manbharat Singh Dhadly

Status of First Author: Student IN poster competition, PhD

Authors: Manbharat Singh Dhadly, Mark Conde

Abstract: Thermospheric horizontal neutral wind vector fields have been mapped by measuring line-of-sight Doppler shift of thermospheric 630nm optical emission spectra recorded at 115 locations at approximately 240 km altitude over Poker Flat (Alaska) by an All-Sky wavelength scanning Fabry-Perot spectrometer. Any type of gradient present in the wind field can produce distortion of air masses. A parameter which we describe as the "Distortion gradient" was defined to capture non uniform transport caused by gradients in thermospheric neutral wind fields. It captures contributions from all gradients that are responsible for distorting or mixing of air masses. Climatological average behavior of the distortion gradient was studied. Distortion gradient is always positive so, averaging over time and/or space does not suppress small scale features. Conventional gradients, by contrast, are signed quantities that would often average to zero. Behavior of the distortion gradient algorithm was checked mathematically. On individual days it was compared with divergence, vorticity, and wind dial plots. Statistical analysis of distortion gradient for 2010, 2011, and 2012 revealed the diurnal and seasonal (annual) behavior of distortion in thermospheric wind over the Poker Flat observatory. Distortion in air masses was observed to be increase every year (2010 to 2012) and was higher before magnetic midnight than after magnetic midnight. Distortion was smaller in winter than summer. Diurnally, distortion was found to be high before magnetic midnight under quiet and active geomagnetic conditions, but no such feature was available in thermospheric neutral wind when geomagnetic conditions were active.

POLA-10 **Electron heat flux calculations associated with auroral precipitation events –** by Christopher T. Fallen

Status of First Author: Non-student

Authors: C. T. Fallen and B. J. Watkins

Abstract: Electron heat flux along the geomagnetic field is an important magnetosphere-ionosphere coupling mechanism. It can provide a significant source of heat in the nighttime mid- and high-latitude ionospheres. Generally this heat flux is assumed to be directed downward, when present at all. However, recent incoherent scatter radar (ISR) measurements made at Poker Flat, Alaska, indicate an occasional small persistent upward electron heat

flux above 300 km altitude in the spring and fall evenings. Is this upward heat flux simply an artifact of low radar signal-to-noise ratio during nighttime quiet geomagnetic conditions, or is it evidence of a small topside source (or sink) of electron heat? Soft (< 1keV) electron precipitation can deposit thermal energy in the F region and hence provides a potential heat source for thermal flows. In this paper, we present sample measurements from the Poker Flat ISR that show a typical case of apparent upward electron heat flux lasting throughout much of the night. The dependence of vertical electron heat flux on the characteristic energy of soft auroral electron precipitation is calculated with a one-dimensional physics-based ionosphere model. Airglow measurements from the Poker Flat meridian scanning photometer provide additional bounds on the electron precipitation flux and characteristic energy. Our calculations show that persistent topside upward electron heat flux does not result from the simulated soft auroral electron precipitation events.

POLA-11 High Latitude F-Region Ion Temperature Spikes and their Possible Origin – by Lindsay Victoria Goodwin

Status of First Author: Student IN poster competition, Masters

Authors: L. V. Goodwin, J.-P. St.-Maurice and P. G. Richards

Abstract: Daily ion temperature spikes and electron density depletions have been found in the F-region during the summer of 2007 using the Poker Flat Incoherent Scatter Radar (PFISR). The temperature change could have been due to either an increase in the neutral temperature or an increase in the ion temperature alone. A neutral temperature increase would have also explained the electron density depletion through an enhancement in molecular neutral density. The alternative to this scenario is a jump in the relative ion neutral drift resulting in an ion temperature spike. Using PFISR data in conjunction with SuperDARN convection maps, the location of these ion spikes and electron density troughs were found to be slightly north of the equatorward edge of the ionospheric convection pattern imposed by the solar wind. The implication is that the neutral wind was accelerated in the sunward direction, owing to ion drag. As well as explaining the spike in the ion temperature, this scenario associates the density troughs with plasma that recently emerged from the night side.

POLA-12 Pre-midnight, summer electron density depletions observed by the PFISR radar at Poker Flat, Alaska - by Phil G. Richards

Status of First Author: Non-student, PhD

Authors: Phil Richards, Mike Nicolls, Jean-Pierre St. Maurice

Abstract: This poster investigates unusual electron density and temperature behavior that have been observed in the Poker Flat (Alaska) Incoherent Scatter Radar (PFISR) data in summer 2007-2011. During periods of enhanced westward convection, there are deep depletions (troughs) in the electron density but there is usually no signature in the electron temperature (Te). High latitude electron density troughs are usually ascribed to either a long period in darkness due to convective flow stagnation or to increased O+ loss rates due to high ion temperatures. Neither of these processes appears to be operating in summer. This paper suggests that the summer troughs observed at Poker Flat are caused by convection of plasma from lower latitudes, which has been in darkness for a couple of hours post sunset. This is enabled by the magnetic declination of ~23 degrees east. On this trajectory, a westward convection velocity of 1 km/sec allows plasma to come from a location that is ~10 degrees south and ~30 degrees east of Poker Flat. This plasma has had extra time to decay because the sun sets earlier at lower latitudes and there is an extra ~2 hours of decay time due to the longitude difference. There is no need to invoke flow stagnation or increased O+ loss rates as causes of the density depletions.

POLA-13 An Investigation of Auroral Electrodynamics within the Auroral-Ionosphere: Observations and Modeling - by Stephen R. Kaeppler

Status of First Author: Non-student

Authors: S.R. Kaeppler, C. A. Kletzing, S. R. Bounds, M.J. Nicolls, J. W. Gjerloev, B. J. Anderson, H. Korth, J. W. LaBelle, M. P. Dombrowski, M. Lessard, R. F. Pfaff, D. E. Rowland, and S. Jones

Abstract: The Auroral Current and Electrodynamics Structure (ACES) mission consisted of two sounding rockets launched nearly simultaneously from Poker Flat Research Range, AK on January 29, 2009 into a dynamic multiple-arc aurora. The mission was designed to observe the three-dimensional nature of an auroral arc current system. The payloads were flown along nearly conjugate magnetic field footpoints, separated in altitude with small temporal separation. The high altitude payload (ACES High) took in situ measurements of plasma and electrodynamic parameters that map down from the magnetosphere and form the input signature into the lower ionosphere. The low-altitude payload (ACES Low) took similar observations within the region where perpendicular cross-field closure current can flow. Observations of the electric fields, magnetic fields, electron flux, and currents derived from magnetometer data are presented for the time frame when the payloads were nearly magnetically conjugate. ACES Low observed promising signatures in the magnetometer data that are consistent with cross-field closure current. Results are presented from a 2-D model of auroral electrodynamics that will be used to interpret the rocket-based observations. The precipitating auroral electron flux was modeled and fit to the electron flux data observed by the ACES Low payload. The electron density generated by the precipitating electron flux is compared with in situ and PFISR observations. Results are presented detailing the affect that enhanced ionospheric conductivity has on the 2-D electric field. For the condition that the divergence of the current is equal to zero, 2-D current densities are presented of solutions to Ohm's law using the electric fields and the height-dependent conductivities.

POLA-14 High Resolution Space-Based Magnetometer Comparisons--DMSP and AMPERE - by Delores Knipp

Status of First Author: Non-student

Authors: Tomoko Matsuo, Liam Kilcommons, Nathan Parish, Brian Anderson, Haje Korth, Fred Rich, and Art Richmond

Abstract: We show high-resolution comparisons of space-based magnetometer data from four Defense Meteorological Satellite Program (DMSP) spacecraft and the Iridium Active Magnetosphere and Planetary Electrodynamics Response Experiment (AMPERE) satellite constellation (~60 spacecraft) for 28-30 May 2010. We placed all data in the Modified APEX magnetic coordinate system [Richmond, 1995] and referred the data to a common altitude in order to find locations and times of magnetic conjunction. In a two-day comparison for 29-30 May 2010, we find minor discrepancies in the magnitude of the total vector perturbation in the polar cap and at low latitudes. We provide point-by-point comparisons as well as ensemble statistics. Spacecraft measurement differences and the differences in spacecraft location contribute to the variations.

Additionally, we provide animations of the 72-hour interval to show the response to passage of an interplanetary shock and magnetic cloud and the subsequent high-speed solar wind flow. The response is presented in terms of the IMF polar angle, the Borovsky et. al. [2013] Reconnection Control (Coupling) Function and the magnetic perturbations. Overall, the magnetic perturbations are in good agreement between DMSP and AMPERE.

POLA-15 Helium in the Recent Solar Minimum - by Xianjing Liu

Status of First Author: Student IN poster competition, PhD

Authors: Jeffrey P. Thayer, Wenbin Wang, Alan Burns, Eric Sutton

Abstract: Helium morphology during this recent solar minimum is investigated by using high-resolution mass density observations from CHAMP and GRACE satellites and simulations from the NCAR-TIEGCM model. During our case study of the 01-09 Dec 2008 period, the oxygen / helium transition region is determined to lie below the

GRACE altitude in the quiet time winter hemisphere. Estimates of the helium concentration at the GRACE altitude (~500 km) are retrieved from coplanar CHAMP and GRACE mass density observations. The estimated helium concentration at the GRACE altitude shows about 50% larger concentrations of helium in winter and a sharper gradient in latitude compared to estimates from the MSIS model. The depletion of helium during active geomagnetic conditions on 05-06 Dec 2008 is clearly illustrated in the estimated helium data. This depletion of helium number density during geomagnetic activity is more significant than estimated by the MSIS model. The composition change during geomagnetic active conditions leads to an altitude dependent response in mass density with the largest perturbation occurring near the oxygen / helium transition region. Helium is a great dynamic tracer of thermosphere circulation. The winter helium bulge is confirmed in the estimated helium number density with a winter to summer number density ratio approximately 5. A helium module has been implemented in the NCAR-TIEGCM model and simulations on winter helium bulge formation and behavior during the recent solar minimum will be presented.

POLA-16 Anti-correlated plasma density and ion temperature enhancements adjacent to a sun-aligned arc - by Gareth William Perry

Status of First Author: Student NOT in poster competition, PhD

Authors: G. W. Perry, H. Dahlgren, K. Hosokawa, M. J. Nicolls, C. Heinselman, J.-P. St.-Maurice, J. L. Semeter, and K. Shiokawa

Abstract: We report on a sun-aligned arc observed in the midnight sector of the polar cap on February 20, 2012. The arc is seen to detach from the poleward edge of the auroral oval during a period in which the z-component of the Interplanetary Magnetic Field (IMF) is transitioning from positive to negative polarity. The arc drifts eastward across the polar cap in conjunction with the polarity of the y-component of the IMF. Inaugural arc measurements from the Resolute Bay Incoherent Scatter Radar - North (RISR-N), combined with measurements from the Super Dual Auroral Radar Network (SuperDARN) and the Optical Mesosphere and Thermosphere Imagers (OMTI) imager at Resolute Bay, are used to investigate the characteristics of the arc. The multi-point plasma parameter measurements from RISR-N show strongly enhanced ion temperatures on the order of 3000 K colocated with a large plasma density depletion and strong electric fields, preceding the leading edge of the arc. Simultaneous measurements from SuperDARN indicate large plasma velocity shears in the vicinity of the arc. From these extensive data sets, we obtain a comprehensive depiction of the electrodynamics and energetics of the arc, and discuss its influence on the mesoscale polar-cap convection pattern.

POLA-17 An analysis of successive F-region ionization patches – by Gareth William Perry

Status of First Author: Student IN poster competition, PhD

Authors: G. W. Perry, K. Hosokawa, J.-P. St.-Maurice, and K. Shiokawa

Abstract: In the past decade, a large amount of scientific infrastructure has been installed in the North American Arctic region, enabling an unprecedented view of the high-latitude ionosphere. Of particular interest in this work are the Polar Dual Auroral Radar Network (PolarDARN), Optical Mesosphere and Thermosphere Imagers (OMTI) and the Resolute Bay Incoherent Scatter Radar - North (RISR-N) instruments, and their ability to provide complementary data sets. Over several hours on March 11, 2010, the Interplanetary Magnetic Field (IMF) orientation was predominately Southward. Throughout this time a steady stream of F-region ionization patches convected through the fields-of-view of all three instruments. This continuous period of observation presents an opportunity to address some outstanding questions regarding patches, including: when compared to each other, do the occurrence rates of patches identified by OMTI, PolarDARN and RISR-N agree? More specifically, for every patch that is detected with RISR-N and/or PolarDARN, is there a corresponding patch seen optically? Furthermore, during the period of time investigated here, is there any significant link between the occurrence rate of patches detected by the instruments, their plasma density or luminosity, and geomagnetic conditions? In this work, a detailed investigation into the characteristics of the patches is given with a particular focus on the proposed questions and any long term variation of their attributes.

POLA-18 Thermospheric winds around the cusp region - by Cheng Sheng

Status of First Author: Student IN poster competition, PhD

Authors: Cheng Sheng, Yue Deng, Qian Wu

Abstract: Due to the change of advection, the horizontal winds can be strongly influenced by the large vertical wind in the cusp. Indeed, the sunward wind has been observed by the balloon-borne FPI at the equatorward of the cusp on the dayside [Wu et al., 2012], which is caused by the heating added in the cusp and the corresponding changes of the horizontal pressure gradient. However, this phenomenon has not been reproduced by the TIEGCM simulation under low resolution (5×5 degrees). GITM will be run in different cases and different resolutions. First we will compare the simulations with and without the cusp energy inputs to identify the influence on the horizontal dynamics. Both runs will be done under high resolution in order to better resolve the cusp region. Then we will also compare the simulations with the same cusp energy inputs but different horizontal resolutions to identify the influence of the simulation resolution on the results. This work will significantly advance our understanding of the neutral dynamics and the relationship between winds and upper atmosphere storm time response.

POLA-19 Highlights of Initial Operation of a New High Latitude SuperDARN Radar at Amundsen-Scott South Pole Station, Antarctica - by Jeffrey D. Spaleta

Status of First Author: Non-student, PhD

Authors: Jeffrey Spaleta, William Bristow, Alex Morris

Abstract: A new SuperDARN radar installation was completed in January of 2013 at Amundsen-Scott South Pole Station, Antarctica. This poster provides highlights of the first 3 months of the South Pole radar operation including an operational comparison to the existing SuperDARN radar at McMurdo station over the same time period.

POLA-20 Efficiency of Energy Deposition Processes to the Creation and Destruction of Thermospheric Nitric Oxide - by Justin D. Yonker

Status of First Author: Student NOT in poster competition, PhD

Authors: Scott M. Bailey

Abstract: Most thermospheric energy deposition processes create as well as destroy nitric oxide (NO). That NO is a persistent thermospheric species suggests that NO must be more efficiently created by these processes than destroyed. Yet few detailed examinations have been provided of the chemical cascade that is initiated by photoabsorption or electron impact and, after the creation and destruction of several intermediate species, leads to the residue NO. Chemically tracing the NO production and loss to the energy deposition mechanisms is the goal of this talk.
It is shown that the validity of this method requires that the lifetime of each intermediate species be less than the timescale for changes in that species production rate. Discussion is provided of the many uncertainties in the basic rate coefficients and atmospheric parameters governing this cascade (e.g. N(^2D) chemistry and O/O_2 ratio). General conclusions are that ionization of N_2 is the primary process responsible for NO production, that ionization of O and O_2 generally lead to NO loss, and that although it contributes to NO production at high temperatures, the production of ground state atomic nitrogen (N^4S) is always more important as an NO loss.

POLA-21 Multi-instrument Observations of Storm Enhanced Density (SED) during Oct. 24-25 2011 Storm: Implications for SED Formation Processes – by Shasha Zou

Status of First Author: Non-student

Authors: Aaron Ridley, Mark Moldwin, Michael Nicolls, Anthea Coster, Evan Thomas, Mike Ruohoniemi

Abstract: We present multiple instrument observations of a storm-enhanced density (SED) during the Oct. 24-25, 2011 intense geomagnetic storm. Formation and the subsequent evolution of the SED and the mid-latitude trough are revealed by global GPS vertical total electron content (VTEC) maps. In addition, we present high time resolution Poker Flat Incoherent Scatter Radar (PFISR) observations of ionospheric profiles within the SED.

We divided the SED observed by PFISR into two parts. Both parts are characterized by elevated ionospheric peak height (HmF2) and TEC, compared to quiet time values. However, the two parts of the SED have different characteristics in the electron temperature (Te), the F-region peak density (NmF2) and convection flows. The first part of the SED is associated with enhanced Te in the lower F region and reduced Te in the upper F region, and is collocated with northward convection flows. The NmF2 was lower than quiet time values. The second part of the SED is associated with significantly increased NmF2, elevated Te at all altitudes, and is located near the equatorward boundary of a subauroral polarization stream (SAPS). Based on these observations, we suggest that the mechanisms responsible for the formation of the two parts of the SED may be different. The first part is due to equatorward expansion of the convection pattern and the projection of northward convection flows in the vertical direction, which lifts the ionospheric plasma to higher altitudes and thus reduces the loss rate of plasma recombination. The second part is more complicated. There is evidence of a combination of different mechanisms, including expansion of the convection pattern, horizontal advection due to SAPS flows, and enhanced thermospheric wind in the topside ionosphere. The thermospheric wind plays a secondary role in this case.

POLA-22 Polar cap flow channels and association with polar cap arcs, airglow patches and nightside auroral activity - by Ying Zou

Status of First Author: Student IN poster competition, PhD

Authors: Ying Zou; Toshi Nishimura; Larry Lyons; Eric Donovan; Michael Ruohoniemi; Nozomu Nishitani; George Sofko; Kazuo Shiokawa; Keisuke Hosokawa

Abstract: Previous studies have shown that polar cap flows are highly structured and that some of the localized flow channels lead to poleward boundary intensifications. While radar observations are limited to available echo regions, all-sky imagers (ASIs) allow detecting and tracing 2-d structure of polar cap emission. We utilize line-of-sight and merged vector velocities obtained from the Polar Dual Auroral Network (PolarDARN) located at Rankin Inlet and Inuvik in combination with the Resolute Bay ASI at 630.0 nm for studying polar cap flow structure and its relation to nightside auroral activity. We often find flow channels that exhibit large velocity enhancement with hundreds of meters per second difference from the large scale convection. The occurrence of these localized flows is found to be correlated with polar cap arcs and airglow patches. Near the polar cap arcs, strong flow shear is identified with the same orientation, while for airglow patches, one common type of distribution shows that fast flows are often observed on top of the patches. The longitudinal width of flows is comparable to that of arcs and patches. This correlation indicates that polar cap arcs and airglow patches can be used to locate fast flow channels in the polar cap region compensating the limited echo coverage by radar measurements. Propagating with arcs and patches, these flows may extend all the way across the polar cap region towards the nightside auroral oval. When reaching the auroral poleward boundary, polar cap flows are found to lead to PBIs, streamers, substorms and intensifications of diffuse auroras. Our results imply that meso-scale flow channels propagating from the open field line region can cross the separatrix into the plasma sheet and result in disturbances which are associated with bursty bulk flows.

Solar Terrestrial Interactions in the Upper Atmosphere

SOLA-01 Role of ionospheric boundary conditions on MI-coupling – by Tapas Bhattacharya

Status of First Author: Student IN poster competition, PhD

Authors: Antonius Otto, Dirk Lummerzheim

Abstract: Field-aligned current systems are of prime importance in the Magnetosphere-Ionosphere coupling, as they are believed to transfer energy and momentum from the solar wind or from the magnetotail current sheet to the ionosphere. Specifically, it is usually considered that they play a critical role in the evolution and morphology of active discrete auroral arcs. While the driver for the formation of field- aligned currents is usually considered to be of magnetospheric origin, properties such as the ionospheric conductances and density irregularities can have a significant effect on the formation and evolution of narrow field-aligned current curtains.

We use 3D MHD-neutral simulations to study the plasma dynamics with the introduction of Alfvenic perturbations, both homogeneous and inhomogeneous, in the velocity and magnetic field at the magnetospheric boundary. In this presentation we use homogeneous perturbations and examine the generation and modifications of field-aligned currents in response to the Alfven wave reflection at the ionospheric boundary with emphasis on the role of different ionospheric boundary conditions. Of particular interest are the effects of strong gradients of ionospheric conductance when the directions of perturbations are aligned with the direction of the conductance-gradient.

SOLA-02 Improving Storm-Time Ionospheric Forecasts - by Alex T. Chartier

Status of First Author: Student IN poster competition, PhD

Authors: A.T. Chartier, C.N. Mitchell, D.R. Jackson

Abstract: Data assimilation has been used successfully for real-time ionospheric specification, but it has not yet proved advantageous for forecasting. The most challenging and important ionospheric events to forecast are storms. The work presented here examines the effectiveness of data assimilation in a storm situation, where the initial conditions are known and the model is considered to be correct but the external solar and geomagnetic drivers are poorly specified. The aim is to determine whether data assimilation could be used to improve storm-time forecast accuracy. The results show that, in the case of the storm of Halloween 2003, changes made to the model's initial thermospheric conditions result in improved electron density forecasts for over 24 hours, whilst the effects of changes to the ionospheric fields are completely lost after 12 hours. Further examination shows that the neutral composition is especially important to the accuracy of ionospheric electron density forecasts. Updating the neutral composition gives almost all the benefits of updating the complete thermospheric state. A comparison with globally distributed observations of vertical total electron content confirms that an update of thermospheric composition can result in significantly improved forecast accuracy.

SOLA-03 Ionosphere response to CIR-induced recurrent geomagnetic activity during the declining phase of Solar Cycle 23 - by Yanhong Chen

Status of First Author: Non-student, PhD

Authors: Yanhong Chen, Wenbin Wang, Alan G. Burns, Siqing Liu, Xinan Yue, Guoying Jiang

Abstract: During the declining phase of solar cycle 23, corotating interaction regions (CIRs) occurred periodically and frequently when high solar wind speed streams originating from solar coronal holes interacted with the slow speed solar wind. These CIRs produced recurrent geomagnetic activity on Earth, which perturbed the ionosphere on a global scale as a result of energy and momentum deposition at high latitudes. Based on the GPS-TEC data from the madrigal database at the MIT Haystack Observatory and electron density data obtained by the CHAMP Planar Langmuir Probe (PLP) observations, we investigated the ionosphere response to recurrent geomagnetic activity during about 73 CIR events from 2005-2009. The results indicate that global ionosphere response to CIR events had some common features. The TEC and Ne data show significant positive response (increased electron densities) during the daytime. This response had a strong dependence on the south component (Bz) of the interplanetary magnetic field and solar weed speed. This means that penetration electric fields were an important process in causing the positive ionospheric response. During the recovery time of the CIR-produced geomagnetic activity, the TEC disturbance at low latitudes sometimes could last for 2-3 days, whereas that at middle to high latitudes occurred only for 1 day in most cases. A comparison of the ionospheric responses between the America, Europe and Asia sectors shows that the ionosphere response in Europe was relatively weaker than those in the other two regions. A

full understanding of these common features is helpful for forecasting the ionosphere weather during geomagnetic disturbed conditions.

SOLA-04 SuperDARN observations of structured flows associated with substorm auroral onset - by Bea Gallardo-Lacourt

Status of First Author: Student IN poster competition, Masters

Authors: Bea Gallardo-Lacourt, T. Nishimura, L. R. Lyons, Y. Zou, K. A. McWilliams, J. M. Ruohoniemi and N. Nishitani

Abstract: Identifying the instability responsible for substorm expansion phase onset is an important issue in space physics. Recent auroral observations have shown that brightening at substorm auroral onset consists of beads forming along a pre-existing arc and propagating azimuthally. However, ionospheric flow structure related to the wavy auroral structure has not been understood. We present two-dimensional line-of-sight flow observations and auroral images from the SuperDARN radar and the THEMIS ground-based-all sky-imager array to investigate the ionospheric flow pattern associated with the substorm onset. We also use the THEMIS mode of SuperDARN observations, and its high time resolution comparable to the imager resolution give us a unique tool to glimpse properties of flows associated with substorm onset instability. We found fast flows (~1000 m/s) that initiated simultaneously with onset arc beads propagating into the THEMIS-mode beam meridian. The flows show oscillations in ~9 mHz, and this periodicity corresponds to that of auroral beads propagating across the radar beam. 2-d snapshots of the radar data also show a wavy pattern in the azimuthal direction with a wavelength of ~74 km, which is close to the azimuthal separation of individual beads, although the flow pattern could change during 2 minutes of the radar scan period. These strong correlations (in time and space) between auroral beading and fast ionospheric flows suggest that the measured flows are associated with substorm onset. We will perform a further analysis to determine the flow structure relative to beads, which will help identify possible types of substorm instability in the plasma sheet.

SOLA-05 Vertical wavy structures triggered by Geomagnetic Disturbance – by Chih-Ting Hsu

Status of First Author: Student IN poster competition Masters

Authors: Chih-Ting Hsu and Jann-Yenq Liu

Abstract: This study for the first time reports wavy signatures in the vertical electron density profile observed by FORMOSAT-3/COSMIC (F3/ C) during 9 pronounced storm-level geomagnetic activity in 2008 to 2011. The profiles in the quiet time and disturbed periods are subdivided into four sectors, noon, dusk, midnight, and dawn to find wavy characteristics in three different latitude regions. Wavelet analyses are applied to examine profiles before and during the storm period. The density profile becomes very structured for the wavelength that shorter than 20 km and the amplitude of fluctuations significantly enhances during the storm period, especially in high latitude region.

SOLA-06 Classification of the Solar Aspect Monitor (SAM) Observations on Solar Dynamic Observatory's (SDO) Extreme ultraviolet Variability Experiment (EVE) – by Cissi Ying-tsen Lin

Status of First Author: Student IN poster competition, PhD

Authors: Cissi Ying-tsen LinScott BaileyAndrew JonesDon WoodraskaTom WoodsFrank Eparvier

Abstract: The Solar Aspect Monitor (SAM) is an imaging channel on Extreme ultraviolet Variability Experiment (EVE), which is one of the major instrument suites of NASA's Solar Dynamic Observatory (SDO). A pinhole places a solar image on an unused section of one EVE detector. As the image is used for individual photon detection to resolve the solar spectrum from 0.1 to 7 nm, contamination from out-of-band irradiance and the photon-like energetic particles is a crucial part of the data reduction. Techniques are developed to address these issues and

determine SAM irradiance in separated soft X-ray energy bands. In this study, combinations of different selecting 'filters' are performed and the results are compared with measurements from the other EVE instruments, including the shortest-wavelength portion of EVE/Multiple EUV Grating Spectrograph(MEGS)-A and the broadband irradiance of EUV SpectroPhotometer (ESP). As EUV is the major energy source to the ionosphere and the thermosphere, atmospheric models can benefit from the EVE data. The goal of the study is to pick an optimal filter-selection scheme for the SAM observation to maximize its scientific value.

SOLA-07 Signatures of the Russell-McPherron Effect in Thermospheric Density – by Ryan M. McGranaghan

Status of First Author: Student IN poster competition, PhD

Authors: Dr. Delores J. Knipp, Dr. Robert L. McPherron, Dr. Eric K. Sutton, Liam Kilcommons

Abstract: We examine thermospheric neutral density response to solar wind stream interaction regions (SIRs) and high-speed streams (HSSs) during the equinox seasons when the Russell-McPherron effect is known to increase geomagnetic response. The Russell-McPherron effect is an equinoctial phenomenon whereby the Earth's tilt causes in-the-ecliptic interplanetary magnetic field (IMF) to be projected onto the Earth's dipole as an out-of-ecliptic field. Differing IMF polarities cause this projection to be classified as either 'effective' or 'ineffective' based on whether conditions are conducive to magnetic reconnection in the Earth's magnetotail. An effective orientation results in enhanced energy deposition and subsequently thermospheric density variations. We examine four cases marked by conditions preceding and following SIRs and their attendant IMF polarity changes at Earth: 1) effective-effective (EE), 2) ineffective-ineffective (II), 3) ineffective-effective (IE), and 4) effective-ineffective (EI). Data are categorized into two forms: 1) driver and 2) response. Solar wind variations are the drivers in these events. We trace the intermediate responses in the DMSP Poynting flux and NOAA particle precipitation data, and find significant response in these, as well as in the thermospheric densities provided by the CHAMP and GRACE A and B satellites. Storms from 1996 until 2007 are analyzed using superposed epoch analysis. The superposed epoch analysis reveals the equinox and effective/ineffective responses in the thermospheric neutral density. The analysis shows that neutral density fluctuations between 30-100% of quiet-time values were experienced as a result of recurrent HSSs. We demonstrate that these fluctuations were a signature of the Earth's tilt throughout the day and year, and thus were representative of the Russell-McPherron effect.

SOLA-08 Impact of Small Scale E-field Variability and Lower Atmospheric Forcing on Thermospheric O/N2 Column Density Ratios - by Jack R. Olsen

Status of First Author: Student IN poster competition, Masters

Authors: Jack Olsen, Mariangel Fedrizzi, Mihail Codrescu, Tim Fuller-Rowell

Abstract: Over the past few decades, physical models have greatly enhanced the scientific knowledge of the complex Sun-Earth system. The creation of these models has been a steady process of developing numerical simulations and comparing their output with reliable observations of the real systems being modeled. The value of these physical models and the knowledge we gain from them is highly dependent on the validity of said models. This study aims to quantitatively assess the global, three-dimensional, time-dependent, non-linear coupled model of the thermosphere, ionosphere, plasmasphere, and electrodynamics (CTIPe). We explore the CTIPe model's calculations of the O/N2 ratios, using observations from the TIMED-GUVI satellite. A comparison-by-visualization tool contrasts the daily global averages and the monthly longitudinal cross-sections of the composition. The daily global averaging helps to gain a 'big picture' sense of seasonal variations. The month-by-month comparison across longitudes, with all latitudes averaged, displays the finer details of the distribution of the O/N2 composition. These visualizations are accompanied by statistical variation calculations and together are used on various simulations of the CTIPe model, with slight changes made to the small scale electric field variability and tidal forcing.

SOLA-09 **Thermosphere Temperature Response to Geomagnetic Storms –** by Padmashri Suresh

Status of First Author: Student IN poster competition, PhD

Authors: Charles M. Swenson

Abstract: We present a decadal study of thermosphere response to geomagnetic storms conducted using SABER temperature data. We present the magnitude of temperature response and the corresponding response time for storms of various intensities involving data from 2002-2010. We also present a quiet-time empirical thermosphere model which was formulated using SABER data in order to isolate storm time contributions from the SABER temperature measurements.

SOLA-10 **Subsolar thermosperic waves excited by the July-14-2000 solar flare –** by Jie Zhu

Status of First Author: Student IN poster competition, PhD

Authors: Jie Zhu and Aaron Ridley

Abstract: The thermospheric responses to the July-14-2000 solar flare has been simulated by the Global Ionosphere and Thermosphere Model (GITM). The subsolar point (i.e., local noon) was tracked with one-minute temporal resolution in order to study the vertical neutral wind behavior during the solar flare. Extensive acoustic-gravity waves were excited in the subsolar region during the solar flare. Acoustic waves, of frequencies higher than buoyancy frequency, propagate upward from E-region, with an increasing amplitude. The spectrum of the vertical neutral wind shows that the acoustic waves contain the majority of energy, with a peak at a period of 16 min. Also, gravity waves, with frequencies lower than the buoyancy frequency, were excited with horizontal-propagating components. During the flare, significant wave activity existed in the frequency-forbidden zone. Moreover, stationary waves at the buoyancy frequency were also intensified during the solar flare.