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Sprites

SPRT-01 Mechanism of infrasound radiation from sprites - by Victor Pasko

Status of First Author: Non-student

Authors: Victor P. Pasko (1) and Jonathan B. Snively (2)
(1) CSSL Laboratory, Penn State University
(2) Center for Atmospheric and Space Sciences, Utah State University

Abstract: The infrasonic waves correspond to the region of frequencies of acoustic waves in the range 0.02-10 Hz [e.g., Blanc, Ann. Geophys., 3, 673, 1985; Drob et al., JGR, 108, 4680, 2003]. The sprite phenomenon is one of several currently known forms of transient luminous events (TLEs) occurring at the mesospheric and lower ionospheric altitudes in the Earth's atmosphere, which are related to the lightning activity in underlying thunderstorms [Sentman et al., GRL, 22, 1205, 1995]. The history of research related to infrasound radiation from sprites is relatively short, with most of contributions and publications coming from several European research groups. The possibility of infrasound generation by sprite discharges has been discussed in a presentation at Fall AGU 1999 meeting by Bedard et al. [Eos Trans. AGU, 80 (46), Fall Meet. Suppl., F227, A51B-18, 1999]. Specific chirp-like infrasound signatures possibly related to sprite discharges have been identified by Liszka [J. Low Freq. Noise Vibr. Active Control, 23, 85, 2004], and their phenomenology further discussed by Liszka and Hobara [JASTP, 68, 1179, 2006]. Farges et al. [GRL, 32, L13824, 2005] provided first direct correlation of the chirp-like signatures in 0.1-9 Hz range with optical observations of sprites. The sprite correlated infrasound signatures are characterized by arrival of low frequencies before high frequencies and pressure amplitudes on the order 0.01-0.1 Pa at horizontal distances ~400 km. The total durations of sprite related infrasonic signals are several tens of seconds. These durations are well correlated with physical horizontal dimensions of sprites observed optically [Farges et al., 2005]. The analysis of total energy budget associated with sprite and causative lightning discharges indicates that the observed infrasonic signatures are most likely produced by direct Ohmic heating of air in sprite columns due to a passage of electric current. Adopting a hypothesis that the heating is the primary mechanism, the strength of observed infrasound emissions may appear to contradict available analysis of air heating in sprite streamers giving relatively small temperature changes $dT/T \sim 0.2\text{-}2\%$ [Pasko et al., GRL, 25, 2123, 1998], an accurate analysis of energy budget of sprite discharges indicating $dT <\sim 0.5$ K [Sentman et al., JASTP, 65, 537, 2003], and limited information on sprite rotational temperature indicating consistency of observed molecular nitrogen band emissions with rotational temperatures in the range 220-230 K (not exceeding 300 K) [Green et al., GRL, 23, 2161, 1996; Morrill et al., JASTP, 60, 811, 1998; Bucsela et al., 65, 583, 2003; Kanmae et al., GRL, 34, L07810, 2007]. In this talk a numerical modeling analysis utilizing equations of acoustics is presented, which demonstrates that observed sprite infrasound signatures are consistent with weak air heating in streamer channels in sprites on the order of several degrees K, and known atmospheric absorption properties of infrasound [Blanc, Ann. Geophys., 3, 673, 1985; Sutherland and Bass, J. Acoust. Soc. Am., 115, 1012, 2004, and references therein]. The modeling results demonstrate, in particular, that the angle of arrival of infrasound and the reflection at tropospheric altitudes significantly affect spectral properties of sprite infrasound signals observed on the ground.

SPRT-02 Quantifying Positive and Negative Sprite-Halo Characteristics over Northern Argentina - by Matthew A Bailey

Status of First Author: Student IN poster competition PhD

Authors: M.A. Bailey (mattbailey@cc.usu.edu), M.J. Taylor, and P-D. Pautet, Center for Atmospheric and Space Sciences, Utah State University, Logan, UT, USA., S.A. Cummer and N. Jaugey, Duke University, Department of Electrical and Computer Engineering, Duke University, Durham, NC, USA, J.N. Thomas and R.W. Holzworth, Department of Earth and Space Sciences, University of Washington, Seattle, WA, USA

Abstract: Sprites are part of a family of beautiful optical phenomenal known as Transient Luminous Events (TLEs), that occur over thunderstorms due to large lightning discharges. As part of a collaborative campaign, ground-based measurements were conducted from the Southern Space Observatory (SSO) near Santa Maria, Brazil (29.4 S, 53.8 W) during the spring of 2006. Remarkably, over 580 TLEs were imaged from two large thunderstorms located over north-eastern Argentina on February 22-23 and March 3- 4 2006. The optical observations were made using two intensified CCD cameras arranged to view the low elevation sky with overlapping fields of view to capture the TLE information from the extensive storm systems. This poster focuses on the optical characteristics of 150 TLEs with well defined and their associated polarity and charge moments as determined by an ELF-VLF lightning sensor also deployed at the SSO. Coincident data with the World Wide Lightning Location Network (WWLLN)

have enabled a detailed investigation of the polarities, altitude and apparent optical diameters of these events. Of special interest are rare observations of several sprite-halos associated with negative cloud to ground discharges.

SPRT-03 The Relationship of Sprite Streamer Velocities and Lightning-Driven Mesospheric Electric Fields - by Jingbo Li

Status of First Author: Student IN poster competition PhD

Authors: Jingbo Li, Steven A. Cummer, Electrical and Computer Engineering Department, Duke University

Abstract: Measurements of streamer velocity reflect the detailed internal microphysics of sprite development that is connected to the chemical effects streamers create in the mesosphere. However, the small temporal scale (in a few ms) of streamer development requires high time resolution imaging. In this work, we report intensified high speed video observations of streamer development acquired at 5,000 to 10,000 frames per second that include the entire altitude range of the sprite. This time resolution made it possible to examine the fine structure and the temporal development for both downward and upward streamers through their entire vertical extent. In our observations, downward streamers initiate at 70 - 80 km altitude and propagate almost vertically to a termination altitude of 45 km or above. They usually develop in an acceleration-deceleration process with a maximum velocity less than 1/10 of the speed of light and a maximum acceleration/deceleration rate in the order of $10^{10} m/s^2$. Upward streamers travel a much shorter distance in either an acceleration-deceleration or a simply deceleration process. The maximum velocity and acceleration/deceleration rate are in the same order as downward streamers but contain a significant horizontal component. We also extracted the sprite-producing lightning source current moment from remote measured magnetic field. By applying this lightning source current moment to a 2-D FDTD model, we are able to simulate the ambient background electric field during the entire process of streamer development. Both the observations and the simulation results indicate the dependence of streamer velocity and termination altitude on electric fields. Quantifying these relationships is a first step towards constraining detailed physical and chemical models that can predict the impact of sprites on the mesosphere.

SPRT-04 Modeling studies of atmospheric conductivity and thundercloud charge imbalance effects on development of blue jet and gigantic jet discharges - by Jeremy A Riousset

Status of First Author: Student IN poster competition PhD

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Abstract: Blue jets and gigantic jets are two distinct types of large scale electrical discharges between thundercloud tops and mesospheric and lower ionospheric regions [Wescott et al., GRL, 22, 1209, 1995; Boeck et al., JGR, 19, 1992, 1995; Pasko et al., Nature, 416, 152, 2002; Su et al., Nature, 423, 974, 2003]. The development of the various types of discharges produced by thunderstorms has been recently related to local and global charge imbalances in the thundercloud [Krehbiel et al., Nature Geoscience, 1, 233, 2008]. Depending on the locations and extents of these charge imbalances, a thunderstorm produces intracloud lightning [Rison et al., GRL, 26, 3573, 1999; Coleman et al., JGR, 108, 4298, 2003; Riousset et al., JGR, 112, D15203, 2007], cloud-to-ground discharges, which most commonly appear in the form of negative cloud-to-ground and bolt-from-the-blue discharges [Rison et al., 1999; Thomas et al., GRL, 28, 143, 2001] and upward electrical discharges, so-called blue jets [Wescott et al., 1995; Sentman et al., GRL, 93, 2857, 1995; Boeck et al., 1995] and gigantic jets [Pasko et al., 2002; Su et al., 2003]. In this work, particular attention is given to numerical modeling studies of the formation and role of the screening charges in the conducting atmosphere above thunderclouds in the development of lightning and jet discharges, first discussed in [Krehbiel et al., Eos Trans. AGU, 85(47), Fall. Meet. Suppl., AE23A-0848, 2004]. The present study is based on first principles time-dependent modeling of the screening charges utilizing realistic conductivity distributions in and around thunderclouds and provides further support of the ideas advanced recently in [Krehbiel et al., Eos Trans. AGU, 88(52), Fall. Meet. Suppl., AE23A-0891, 2007] that the mechanisms by which blue and gigantic jet discharges escape out of clouds are similar to those of downward cloud-to-ground lightning.

Stratosphere Studies and Below

STRT-01 Investigation of Positive Cloud-to-Ground Lightning Strikes - by Ildiko Beres

Status of First Author: Student NOT in poster competition Masters

Authors: Ildiko Beres, University of Western Ontario, Dr. W.K.Hocking, University Of Western Ontario, Dr. Ron Thomas New Mexico Institute of Mining and Technology

Abstract: A positive cloud to ground (CG) stroke consists of a bidirectional leader with a positive leader travelling into negative charge regions and a negative leader travelling into positive charge regions. The positive leader eventually makes its way out of the cloud and down to the ground. Since this positive breakdown does not radiate strongly at VHF, it is only possible to detect the radiation events from the negative leader that travel into the positive regions of the thundercloud. In this study, the sources of VHF radiation are detected using the New Mexico Tech Lightning Mapping Array (LMA), which is a three dimensional time-of-arrival lightning mapping system operating at 60-66 MHz. It has been noted that after the positive CG return stroke, the negative leader continues to propagate into the positive charge regions. The previous channels of the negative leader are extended and new channels are initiated. The velocities of the negative leaders before and after the positive CG are being investigated. The purpose of this is to determine if there is an increase or decrease in the velocity during this negative leader initiation and extension. Most positive CG's have a larger and longer duration continuing current component than negative CG's. A correlation between the velocity and this longer and larger continuing current is being investigated. To find the velocity of the negative leaders experimentally, smooth curves are independently fitted to the x,y, and z VHF source locations versus time and differentiated to give the Cartesian components of the propagation velocity. Attempts are also underway to relate the velocity of the negative leaders to other parameters in the cloud such as the potential, the electric field and the planar expansion of the negative leaders.

STRT-02 Turbulence Measurements by Wind Profiler Radar in Southwestern Ontario - by Armin Dehghan

Status of First Author: Student IN poster competition PhD

Authors: Armin Deghan

Abstract: In order to study turbulence in the atmosphere, the energy dissipation rate, has been measured for altitude of 1 to 8 km in the lower atmosphere using wind profiler radar at Walsingham, Southwestern Ontario, Canada. The spectral width method has been used to estimate during the period from November 2005 to October 2006. Seasonal studies of energy dissipation rates show that is larger during winter and smaller during summer at altitudes of 3 to 8 km. is also correlated positively with both 1 km scale wind shear and wind speed during winter, with maximum coefficients of 0.79 and 0.84 respectively. Correlation of wind shear and turbulence strength is specially strong during night time in winter. Hourly rates of energy dissipation rate are commonly maximum at about midday (local time) below 5 km, and around midnight (local time) from 5 to 8 km during summer and fall. We have also searched for dependences of on wind direction, and found good correlation between and southwesterly winds in October and November at altitudes of 1 to 8 km and 1 to 7 km respectively.

STRT-03 Detection of tides in the lower stratosphere using the Constellation Observing System for Meteorology Ionosphere & Climate radio occultation data - by Zhenhua Li

Status of First Author: Student IN poster competition PhD

Authors: Li, Zhenhua Department of Atmospheric Sciences, UIUC, zli2@uiuc.edu, Liu, Z. Alan Department of Electrical and Computer Engineering, UIUC, liuzr@uiuc.edu

Abstract: The atmospheric radio occultation technique utilizing radio signals transmitted by the Global Positioning System (GPS) has already proven to be a promising approach for global atmospheric measurements. We characterize the tidal activity in the lower stratosphere using the retrieved temperatures between 10 and 35 km globally from the Constellation Observing System for Meteorology Ionosphere & Climate (COSMIC) in 2007. With more than 1000 temperature profiles per day, the composited data for each month are analyzed using space-time spectrum analysis to isolate tidal waves. The monthly tidal structures are computed from the composite COSMIC occultation data, and the vertical, seasonal, and latitudinal structures of the diurnal, semidiurnal and terdiurnal tide are presented. The estimated diurnal amplitude generally increases with altitude, exhibiting a maximum of order 1 K

at 30 km in the tropics. Semidiurnal tides are prominent in high latitudes. In the polar regions, terdiurnal tides are significant with a maximum of order of 1K.

STRT-04 Radar Measurements of Turbulence Parameters on the Atmospheric Boundary Layer - by Danny Eddy Scipion

Status of First Author: Student IN poster competition PhD

Authors: Danny Scipion

Abstract: Retrievals of turbulence parameters in the atmosphere have been widely studied with radars for more than thirty years. However, a new approach is necessary to verify the accuracy of the techniques. The approach presented here combines large-eddy simulations and a virtual radar based on the LES. The LES estimates are considered as the "ground-truth", and the virtual radar estimates are compared with them.

Coupling of the Upper Atmosphere with Lower Altitudes

COUP-01 Short-term Variation of the s=1 Nonmigrating Semidiurnal Tide During the 2002 Sudden Stratospheric Warming - by Loren Chang

Status of First Author: Student IN poster competition PhD

Authors: Loren Chang, Department of Aerospace Engineering Sciences, University of Colorado, Scott Palo, Department of Aerospace Engineering Sciences, University of Colorado, Hanli Liu, National Center for Atmospheric Research

Abstract: In this study, the NCAR Thermosphere Ionosphere Mesosphere Electrodynamics General Circulation Model (TIME-GCM) is used to examine short-term changes in the global structure of the migrating and s=1 nonmigrating semidiurnal tides in a model run reproducing the 2002 Southern Hemisphere sudden stratospheric warming. TIME-GCM is found to resolve an s=1 nonmigrating semidiurnal tide with latitudinal structure similar to that of prior studies, with global structure in the MLT region strongly correlated with Southern Hemisphere stationary planetary wave 1 (SPW1) wave events. Correlation analysis of the s=1 semidiurnal tide structure suggests that the wave propagates from the source region in the Southern Hemisphere mesosphere across the Equator into the Northern Hemisphere lower thermosphere. The amplitude of the migrating semidiurnal tide in the Southern Hemisphere is also anti-correlated with the nonmigrating tide, suggesting an energy loss process due to nonlinear advection from the migrating to the nonmigrating tide. Changes to the global nonmigrating tidal structure at low latitudes are seen around the time of the mean wind reversals leading up to the major warming, suggesting changes in the propagation conditions imposed by the background atmosphere.

The amplitude of the s=1 nonmigrating semidiurnal tide from TIME-GCM is also compared with data from the South Pole meteor radar system. While the observations show bursts of nonmigrating tidal activity correlated to SPW1 activity with comparable amplitudes to the model results, these events do not always appear at the same times as those in the model. This suggests that while the processes generating the nonmigrating tide in TIME-GCM are realistic, the TIME-GCM run itself displays differences in time evolution compared to the observations during this time.

COUP-02 Millstone Hill ISR observations of variations in ion temperatures during stratospheric sudden warming by Larisa Goncharenko

Status of First Author: Non-student

Authors: Larisa Goncharenko, Shunrong Zhang, William Rideout, MIT Haystack Observatory

Abstract: Stratospheric sudden warming is a large-scale meteorological process in the winter hemisphere lasting several days or weeks. While extensive studies of SSW effects have been conducted using stratospheric and mesospheric data, very little is known about effects above ~100km. The ISR World Day campaign conducted on January 17-February 1, 2008 was arranged during a very large SSW event and focuses on studies of thermospheric and ionospheric response. We analyse temperature observations at 100-300 km height obtained at subauroral latitude by the Millstone Hill ISR (42.6N, 288.5E). Alternating areas of warming and

cooling are observed by the radar. We use NCEP zonally averaged temperature data at the 30hPa and 10hPa levels as well as the F10.7 and Ap indices to analyze cause-effect relationship between the observed variations in temperature and stratospheric warming event.

COUP-03 Variability of the mesosphere and lower thermosphere at high latitudes during suddent stratospheric warmings - by Peter Hoffmann

Status of First Author: Non-student

Authors: Hoffmann, P., E. Becker, W. Singer, A. Schöch, M. Rauthe , Leibniz-Institute of Atmospheric Physics, 18225 Kühlungsborn, Germany; (e-mail: hoffmann@iap-kborn.de; fax: +49 38293 6850; phone: +49 38293 680)
Hocking, W. K. University of Western Ontario, London, Ontario, N6A 3K7, Canada

Abstract: The mesosphere and lower thermosphere (MLT) is characterized by strong internal variability due to gravity waves, tides, and in-situ-generated planetary waves. During sudden stratospheric warmings (SSWs) in northern winter, planetary-scale Rossby-waves may propagate from the troposphere up to the mesopause. This study presents a combination and of observations and numerical simulation to illuminate the importance of Rossby waves in the MLT during a SSW.

We utilize MF radar wind measurements and temperature measurements using the ALOMAR RMR lidar at Andenes (69°N, 16°E), as well as meteor radar observations of winds and temperatures from Andenes (69°N, 16°E) and Resolute Bay (75°N, 95°W) during the winter months 2005/2006 and 2007/2008. Wind data cover the altitude range of the MLT, whereas meteor temperatures are daily means restricted to the mesopause region. In addition, energy dissipation rates are derived from spectral width measurements using a 3-MHz Doppler radar located near Andenes. The wind and temperature data indicate that a SSW is usually preceded by a reversal of upper mesospheric westerlies to easterlies and by mesospheric cooling several days before the SSW manifests in the lower stratosphere. Comparing data from the different locations indicates a clear zonal wavenumber one structure in the upper mesospheric meridional wind, whereas longitudinal variations of the zonal wind are weak. Further analysis of turbulence shows increased dissipation rates during the period of intense westerlies following the SSW. At the same time, gravity waves with periods between 3 and 9 hours are enhanced in the altitude range between 70 - 85 km.

To interpret these observations, we have analysed a SSW simulated with a simplified general circulation model extending form the bottom to 100 km. The model resolves the internal dynamics owing to synoptic and planetary-scale waves and includes a Lindzen-type gravity-wave parameterization. The simulated SSW exhibits the same characteristics as seen in the observations. The gravity-wave drag and dissipation are absent in the MLT during the SSW, confirming Holton's interpretation of the mesospheric cooling. Furthermore, there is a strong quasi-geostrophic Eliassen-Palm flux divergence in the mesopause region that propagates downward to the lower stratosphere synchronously with the wind reversal. This mechanism is consistent with the time lagged wind reversal seen in the observations, indicating that strong planetary-scale Rossby waves propagate up to the mesopause region and reverse the zonal circulation prior to a SSW, thereby filtering also most of the GWs. When the polar vortex is reestablished, the Rossby waves are rather weak and gravity waves can propagate up the mesopause where they are breaking in accordance with observed strong dissipation rates and gravity-wave amplitudes after a SSW.

COUP-04 Gravity Wave Activity during 2008 Stratospheric Sudden Warming from GPS Radio Occultations Wang Ling

Status of First Author: Non-student

Authors: Wang Ling

Abstract: Temperature retrievals from AURA/HIRDLS, COSMIC/CHAMP radio occultation, and TIMED/SABER will be compared in the context of a Northern Hemisphere 2008 minor stratospheric sudden warming event. The warming event occurred during late January 2008 and was accompanied by a mesospheric cooling and lowered stratopause height. We will compare adjacent temperature profiles (in both space and time) from these three types of instruments. The global scale zonal temperature structure and small-scale temperature perturbations right before, during, and after the warming event from the three different retrievals will also be compared and discussed in the altitude range where they overlap.

COUP-05 Lower atmosphere gravity wave responses to the 2002 stratospheric sudden warming and cooling effects in the mesosphere - by Chihoko Yamashita

Status of First Author: Student IN poster competition PhD

Authors: Chihoko Yamashita (University of Colorado/NCAR), Han-Li Liu (NCAR), and Xinzhao Chu (University of Colorado / CIRES)

Abstract: We employ a gravity wave parameterization scheme (the "Lindzen" scheme) to investigate the tropospheric mean wind and temperature effects on gravity wave forcing in the mesosphere during the 2002 stratospheric sudden warming (SSW) and lower stratospheric gravity wave responses to the 2002 SSW event. The gravity waves are launched at 10 hPa (~ 30 km) and 500 hPa (~ 5 km), respectively, and results of these two cases are compared to examine the lower atmospheric effects. Our results show that both cases present a similar trend of gravity wave forcing in the mesosphere, including strong eastward forcing during the major SSW. The gravity wave forcing exhibits a 10-day oscillation which may be associated with planetary wave 1. Calculated wind variances in the 20-30 km induced by gravity waves show a maximum just before the major warming, which is consistent with CHAMP observational results. These results imply that the lower atmospheric gravity waves are affected by the SSW, but the mean winds in the troposphere have less impact on gravity wave forcing in the mesosphere. The polar vortex effects on gravity wave during the warming are also investigated.

COUP-06 Nonmigrating tidal signals in the thermospheric zonal wind as observed by CHAMP - by Kathrin Haeusler

Status of First Author: Student IN poster competition PhD

Authors: Kathrin Haeusler, Hermann Luehr, GeoForschungsZentrum Potsdam

Abstract: The accelerometer onboard CHAMP located at the center of gravity enables us to derive the thermospheric zonal wind at orbit altitudes (~400km). Numerous equatorial overflights are used to investigate the influence of nonmigrating tides on the thermospheric zonal wind. In a previous study a wave-4 signal in the zonal delta wind (deviations from the zonal average) was identified during Equinox. The wave-4 pattern is a prevailing feature in the slowly precessing satellite frame. In the Mesosphere Lower Thermosphere (MLT) region the basic wave responsible for the wave-4 pattern is said to be the eastward propagating diurnal tide with zonal wavenumber 3 (DE3). This wave is primarily excited by latent heat release in the tropical troposphere. How the wave-4 structure is coupled to the upper thermospheric zonal wind is still not completely clarified. However, Oberheide and Forbes (2008) report that a significant part of the observed wave-4 structure in the zonal wind can be attributed to direct tidal upward propagation. The purpose of this study is to identify the annual variation of the wave-4 longitudinal structure in the zonal delta wind along equatorial latitudes using four years of data and to disclose the presence of other nonmigrating tides.

COUP-07 An Investigation of Planetary Wave Signatures in the equatorial ionosphere over the south American sector - by Amelia Naomi Onohara

Status of First Author: Student IN poster competition PhD

Authors: A. N. Onohara, H. Takahashi , I. S. Batista, C. M. Wrasse, L. M. Lima

Abstract: The main subject of this work is to investigate the planetary wave characteristics in the MLT region and ionosphere. For this purpose, it was used the temperature data from TIMED/SABER satellite and zonal and meridional winds data from the meteor radar operating at Sao Joao do Cariri (7.4°S, 36.5°W). Ionospheric parameters, h'F and foF2 are obtained from Fortaleza (3.9°S, 38.4°W, geomag. 5 S), Brazil. In order to find out periodic oscillation of these data, wavelet spectral analysis was carried out for the two observation periods, Nov/2004 – Apr/2005 and Nov/2005 – Apr/2006. The results show several wave packet structures with a period of ~2 days, ~4 days and 6-8 days. The planetary wave characteristics of period, phase and the vertical wavelength were calculated and compared in between the data time series. Simultaneous occurrence of wave-packet in the MLT region and ionosphere could suggest penetration of the planetary waves in the ionospheric height.

COUP-08 JOULE II Rocket-Based Measurements of Ion Velocity, Neutral Wind and Electric Field in the Collisional Transition Region of the Auroral Ionosphere - by Laureline Sangalli

Status of First Author: Student IN poster competition PhD

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Abstract: The JOULE-II sounding rocket salvo was launched from Poker Flat Rocket Range into weak pulsating aurora at 0345 LT on January 19, 2007. We present in-situ measurements of ion flow velocity, electric and magnetic fields and neutral wind velocity derived ground observations of trimethyl aluminate (TMA) trails. Ions flows between 150-198 km altitude are consistent with Ex B motion to within 23 m/s r.m.s. and with neutral wind velocity to within 21 m/s between 92-105 km. From these measurements we have calculated the ratio of ion cyclotron and ion collision frequencies, finding it to be equal to 1 at an altitude of 116 km. We estimated the neutral atmosphere scale height H = 5.1 km for that altitude. Although the ion flow vectors were measured at a rate of 125/s, no significant fluctuations were observed at spatial/temporal scales below ~1 km and 1 s.

COUP-09 Analysis of zonal structure in electron density, refractivity, and temperature using GPS radio occultation profiles - by Kerri Cahoy

Status of First Author: Non-student

Authors: Kerri Cahoy, kerri.cahoy@gmail.com

COSMIC/FORMOSAT-3 profiles of electron density from 150--500 km altitude and temperature from 0--60 km altitude are analyzed for zonal structure during the equinoxes and solstices of 2007. These time periods overlap with those during the CAWSES global tidal campaign. Refractivity profiles appear to contain information relevant to low-altitude (~5 km) tropospheric forcing. These refractivity structures will be considered with respect to their relationship to cloud formation, precipitation, and convection. Variability and zonal decomposition of the refractivity structures will also be presented as a function of altitude, season, and time of day during the equinoxes and solstices of 2007. The combination of the zonal analyses of electron density, temperature, and refractivity will address the relationship between tidal structure and forcing in the troposphere and zonal structures observed in the ionosphere.

Meteor Science other than Wind Observations

METR-01 The Effects of Meteor Radar Wavelength on the Retrieval of Atmospheric Parameters in the MLT - by Elias M. Lau

Status of First Author: Non-student PhD

Authors: Elias M. Lau, Santiago de la Peña, James P. Avery, Scott E. Palo

Abstract: Meteor radars have contributed immensely to our understanding of the dynamics of the mesosphere and lower thermosphere (MLT). They have been used to measure winds, tides, and planetary waves for over 50 years. In recent years they have also been used to measure temperatures by calculating the ambipolar diffusion coefficient derived from the decay time of underdense meteor echoes. Recent studies using two meteor radars operating at 50 and 40 MHz at Platteville, Colorado (40N, 105W) yielded different ambipolar diffusion coefficients at altitudes below 90 km. It is normally assumed that below 95 km ambipolar diffusion dominates the dissipation of meteor trails and effects such as diminished diffusion rates due to the Earth's magnetic field or anomalous diffusion are significant above 95 km. These recent results used only a limited number of echoes but raise questions about these assumptions and the validity of meteor radar results that depend on the knowledge of the ambipolar diffusion coefficient such as temperatures derived from it.

Given the vast amount of wind and temperature results derived from meteor data in the scientific literature a systematic study of the effects of wavelength is needed. We propose a long-term study the effects of meteor radar wavelength on the estimation of winds and temperatures in the MLT using three meteor radars operating at 50, 40, and 30 MHz at Platteville, Colorado. This systematic analysis will reveal if the observed differences are linked to other meteor parameters such as meteor height, initial power, electron line density, etc. Simultaneous lidar observations at Fort Collins, Colorado (27 miles away) will also be taken to quantify the biases caused by the meteor radar wavelengths.

METR-02 Characterizing Atmospheric Properties Using Meteor Observations - by Elizabeth Bass

Status of First Author: Student IN poster competition PhD

Authors: Meers Oppenheim, Boston University, Glenn Sugar, Boston University, Jorge Chau, Jicamarca Radio Observatory

Abstract: High-power, large-aperture (HPLA) radars such as the Jicamarca Radio Observatory (JRO) in Peru provide accurate measurements of meteoroid velocities and trajectories. These measurements allow researchers to calculate a number of meteoroid properties, such as mass. Meteoroid mass is typically inferred from the deceleration and, more recently, from the signal strength. The relationship between mass and deceleration is sensitive to atmospheric density, which we do not know with high precision. By fitting the velocities of a sample of head echoes within a short time period to a differential meteor ablation model, we find a best fit for the density and scale height of the neutral atmosphere. Small deviations in neutral density causes the fit between the model and data to lose accuracy. In this poster, we discuss how one applies this approach, its limitations and its usefulness.

METR-03 Seasonal and Diurnal variability of the meteor flux at high latitudes observed using PFISR - by Jonathan Sparks

Status of First Author: Student IN poster competition Undergraduate

Authors: Diego Janches, Jonathan Fentzke, Mike Nicolls, Craig Heiselman

Abstract: We report a complete seasonal study of the micrometeor input function (MIF) at high latitudes using meteor head-echo radar observations performed with the Poker Flat Incoherent Scatter Radar (PFISR). This flux is responsible for a number of atmospheric phenomena; for example, it could be the source of meteoric smoke that is thought to act as condensation nuclei in the formation of ice particles in the polar mesosphere. The observations presented here were performed for full 24-hour periods near the summer and winter solstices and spring and autumn equinoxes, times at which the seasonal variability of the MIF is predicted to be large at high latitudes (Janches et al, 2006). Precise altitude and radar instantaneous line-of-sight (radial) Doppler velocity information are obtained for each of the hundreds of events detected every day. We show that the number of meteors per day and the altitude and velocity distributions have a large seasonal dependence. This seasonal variability can be explained by a changing relative location of the meteoroid sources in the local sky with season. Our results show that the meteor flux into the upper atmosphere is strongly anisotropic and its characteristics must be accounted for when including this flux into models attempting to explain related aeronomical phenomena. In addition, the acceleration and received signal strength distribution do not seem to depend on season; which may suggest that these observed quantities do not have a strong dependence on entry angle.

METR-04 Meteor Input Function (MIF) Model Validation and Seasonal Study Using the Arecibo and Poker Flat HPLA Radars - by Jonathan Fentzke

Status of First Author: Student IN poster competition PhD

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Abstract: In this work we use a semi-empirical model of the Micrometeor Input Function (MIF) together with meteor head-echo observations obtained with two High Power and Large Aperture (HPLA) radars, one located at the Arecibo Observatory (AO) in Puerto Rico (18 N, 66 W) and another located in Alaska (65 N, 147 W) at the Poker Flat Incoherent Scatter Radar (PFISR), to study the seasonal and geographical dependence of the meteoric flux in the upper atmosphere as well as individual radar sensitivity to the MIF. The model, recently developed by Janches et al. (2006) and Fentzke and Janches (2008), includes an initial mass flux that is provided by the six known meteor sources (i.e. orbital families of dust) as well as detailed modeling of meteoroid atmospheric entry and ablation physics. In addition, we use a simple ionization model to treat radar sensitivity issues by defining minimum electron volume density production thresholds required in the meteor head-echo plasma for detection. This simplified

approach works well because we use observations from two radars with similar frequencies, but different sensitivities and locations. This methodology allows us the explore the initial input of particles and how it manifests in different parts of the MLT as observed by these instruments without the need to invoke more sophisticated plasma models, which are under current development. The comparisons between model predictions and radar observations show excellent agreement between diurnal, seasonal, and latitudinal variability of the detected meteor rate and radial velocity distributions, allowing us to understand how individual meteoroid populations contribute to the overall flux at a particular location and season.

METR-05 High Resolution Potassium Meteor Trail Observations at Arecibo: Preliminary Results - by Jonathan Fentzke

Status of First Author: Student NOT in poster competition PhD

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Abstract: We present new observations using a high resolution observing mode upgrade for the Potassium (K) resonance-fluorescence lidar at the Arecibo Observatory, Puerto Rico (180 N, 670 W). This mode is designed for pulse-to-pulse recording of the return signal from the atomic/ionic metal layers located in the Mesosphere and Lower Thermosphere (MLT) region with the goal of measuring meteor trails formed by the release of metallic atoms ablated from meteoroids entering earth's atmosphere. These new observations allow us to study properties of the meteoric input function (MIF) as described by Plane, 2003, Janches et al. 2006, Fentzke and Janches, 2008 using lidar.
We present for the first time K meteor trail observations at Arecibo associated with the sporadic meteoroid populations that are responsible for the MLT metal layers Plane, 2003. We use a newly-developed data processing algorithm to search for meteor trail enhancements in the presence of the persistent metal layer signals in the nominal range of 80 - 105 km. The purpose of this work is to improve our understanding of the MIF, and these preliminary results provide insight into its properties such as flux rates, altitude distribution, size distribution and composition. In addition, high-resolution lidar measurements of meteor trails can be used to compare with, and thus constrain, MLT chemistry models and MLT phenomena related to meteoric atmospheric entry.

METR-06 Day to Night Variability of Non-Specular Radar Meteor Trails - by Allen Kummer

Status of First Author: Student IN poster competition Undergraduate

Authors: Allen Kummer1, Julio Urbina1, Lars Dyrud2
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2Center for Remote Sensing, Fairfax VA USA

Abstract: We present day to night variability in non-specular radar meteor trails detected from Fort Macon, North Carolina during the summers of 1999 and 2001. These observations were made using the University of Illinois 50 MHz Interferometer Portable Radar System. The UI radar comprises three subsystems: the antenna array, the transmitter and receiver, and computer control and data collection. The antenna array of the UI radar is composed of two side-by-side identical arrays positioned to provide for zonal interferometric measurements and labeled east and west because of the generally northward point angle of the overall array. Phased beam steering was applied during this experiment to provide an elevation of 16° and an overall half power beam width in azimuth of 3.4° and in elevation of approximately 20°. We use radar observations that start 45 minutes before local sunrise and ends 45 minutes later. Our analysis shows that in general, non-specular meteor trails show strong day to night variability.

METR-07 Design of a Digital Pulsed Radar Receiver - by Matthew Sunderland, presented by Allen Kummer

Status of First Author: Student NOT in poster competition Undergraduate

Authors: Authors: Matthew Sunderland1, Julio Urbina1, Tamara Hall2, Sixto Gonzalez2, Mike Sulzer2, Allen Kummer1
1- The Pennsylvania State University
2- NAIC Arecibo Observatory

Abstract: Digital electronics have revolutionized communications and signal processing applications. The increased speed and capability of modern FPGAs and ADCs have enabled larger bandwidth signals to be processed in the digital domain. When applied to radar applications, this has resulted in better sensitivity combined with greater flexibility. We present a design of an

FPGA based pulsed radar receiver for ionospheric research. Optimization techniques of direct digital synthesizers are presented to improve performance and decrease resource usage. Methods such as look-up table compression, phase dithering, and Taylor series approximation can be used to increase the dynamic range of digital signal generators. Multi-rate filter designs are presented that map well to FPGA architectures. CIC and polyphase FIR filters combine performance with a filter structure that is inexpensive in terms of FPGA resources. The receiver will be first tested with a meteor radar system (independently developed) this summer at Penn State. The system will then be transported to the Arecibo Observatory for its final deployment.

Mesosphere or Lower Thermosphere General Studies

MLTS-01 Investigation of High Latitude D-Region Effects on RF Propagation - by Adam Escobar, presented by Allen Kummer

Status of First Author: Student NOT in poster competition Masters

Authors: Adam Escobar, Andrea Wyant, Perry Edwards, Sven Bilen, Julio Urbina, Allen Kummer, and Russell Philbrick
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Abstract: NittanySat is a nanosatellite designed by students at The Pennsylvania State University as participants in the University Nanosat-5 Program sponsored by the AFRL. The primary goal of NittanySat is the investigation of ionization variations in the D-region, particularly the effects of absorption and scintillation on radio waves caused by energetic particles at high latitudes. The satellite will function as a reverse riometer, taking measurements of signal strength and its fluctuations at multiple HF wavelengths transmitted from several ground stations to receivers onboard. Analysis of the amplitude fluctuations of the RF signals and correlating them to energetic particle flux and the local plasma environment will provide a mechanism for further understanding the absorption and scintillation properties in the D-region of the ionosphere.

The added knowledge of absorption and scintillation effects from the NittanySat experiment is expected to enhance our models of the D-region and improve understanding of satellite-earth communication links.

MLTS-02 Noctilucent Clouds from Above and Below - by Jodie Barker-Tvedtnes

Status of First Author: Student IN poster competition Undergraduate

Authors: Jodie Barker-Tvedtnes, USU, Michael Taylor, USU, C. Danial Burton, USU, Matthew DeLand, SSAI, Mark Zalcik, Edmonton, Canada,

Abstract: Noctilucent Clouds (NLCs) are tenuous ice clouds that form near the extremely cold (<150K) mesopause region (80-85 km) during the summer months at high-latitudes. NLC are seen during twilight hours when the sun is 6-16° below the horizon so the clouds are still illuminated while the observer is in darkness. Observations by the Solar Backscatter Ultraviolet (SBUV) instruments on the NOAA satellites have shown that the occurrence and brightness of NLCs have been increasing prompting serious speculation concerning their possible role in climate change. The Aeronomy of Ice in the Mesosphere (AIM) satellite, launched April 2007, has given us new quantitative measurements of the clouds from above extending over the polar cap region. Here we present the first detailed comparison of satellite and ground-based optical measurements of these tenuous clouds using SBUV and AIM observations with two-station optical image measurements collected during campaigns in Canada and Alaska during summer 2007.

MLTS-03 Calcium ion chemisty in the upper atmosphere - by Sarah Broadley

Status of First Author: Student IN poster competition PhD

Authors: Sarah Broadley, Tomas Vondrak, John M. C. Plane, University of Leeds

Abstract: Calcium atoms are produced in the mesosphere / lower thermosphere by the ablation of meteoroids and form a thin layer between 80 and 105 km. Above 85 km Ca+ ions are formed through photo-ionisation and charge transfer and these then go on to form molecular Ca ions by reaction with atmospheric constituents such as ozone and water. We have studied several reactions of relevance to calcium ion chemistry in the atmosphere using a pulsed laser photolysis / laser induced fluorescence (PLP-LIF) system and a fast flow tube system. Some atmospheric implications of these new studies will be discussed.

MLTS-04 Polar D-region Electron Temperatures Enhanced by Frictional Heating - by Laura Brower

Status of First Author: Student IN poster competition Masters

Authors: Jeffrey Thayer, Jiuhou Lei

Abstract: The Halloween storm of October 2003 produced significant electron density and electric field enhancements in the D-region. The densities were large enough to be detected by the Sondrestrom ISR, permitting rare observations of D-region density fluctuations during a substorm event. The small-scale density fluctuations indicate a correlation with the observed electric field strength. A 1-D physical model of electron energy and momentum equations was developed to determine if a physical correlation between the parameters is present. Results show frictional enhancement of D-region electron temperature (i.e., up to a factor of 2) in the presence of large electric fields (i.e., > 50 mV/m). Electron temperature directly affects the ISR backscatter (Thomson) crosssection, creating a positive correlation between measured Te and calculated Ne. The influence of Te on the Thomson crosssection is often ignored in the D-region, which may lead to erroneous analysis of observed D-region densities.

MLTS-05 Two Station Noctilucient Cloud Measurements Over Northern Canada - by Calvin Daniel Burton

Status of First Author: Student IN poster competition Undergraduate

Authors: C. D. Burton, M. J. Taylor, P-D. Pautet, Center for Atmospheric and Space Sciences, Utah State University, Logan, UT, USA, Mark S. Zalcik, NLC CAN AM Network, #7 14130 - 80 Street, Edmonton, AB, T5C 1L6,Canada

Abstract: Two station image measurements of noctilucient clouds (NLC) were taken from June 30 to June 18, 2007, in northern Canada. Coordinated digital photographs were taken at each of the sites using Canon EOS 30D cameras and Dell Inspiron notebook computers with automated camera software from Canon. Movies of NLC displays were also made using a Sony DCR-VX2000 NTSC digital camcorder.

The first site was located near Namao at 53º 43.14’ N, north of Edmonton, Alberta. The second site was located near Lamont at 53º 44.73’ N approximately 50 km to the east. Using this east-west baseline the cameras were oriented due north resulting in overlapping fields of view with star fields as common reference points.
This poster will summarize the campaign observations focusing on the night of July 4-5, which had a particularly good display of NLC, and will include initial height mapping and analysis.

MLTS-06 Preliminary results of the January 2008 campaign at Arecibo - MLT dynamics - by Eliana Nossa

Status of First Author: Student IN poster competition PhD

Authors: Eliana Nossa, - Cornell University, David Hysell -Cornell University, Miguel Larsen - Clemson University, John Munro - University of the Virgin Islands on St. Croix, Mike Sulzer - Arecibo Observatory, Sixto Gonzalez - Arecibo Observatory, Nestor Aponte - Arecibo Observatory.

Abstract: From January 12 to 15, 2008, the Arecibo 430MHz ISR was operated after sunset in a modified World-Day mode using a single beam. Barker coded, MRACF, and coded long pulse modes were interleaved with the intent of measuring plasma density, temperature, and neutral wind profiles in and around sporadic E layers. The objective of this project is to determine if patchy irregularities in the layers are associated with neutral convective and dynamical instability and, more generally, to study the interaction between the neutral atmosphere and ionosphere in the MLT region. The patchy layers in particular seem to be the cause of so-called "QP" echoes detected by coherent scatter radars. The methodology developed for this diagnostic is going to be used more comprehensively this summer to study QP echoes in conjunction with a 30 MHz imaging radar interferometer recently deployed in St. Croix, USVI.

MLTS-07 Noctilucent Clouds in the Mesophere - by Shelton O'Brien Simmons

Status of First Author: Student IN poster competition Masters

Authors: Shelton O"Brien Simmons, sheltos@clemson.edu, Dr. Gerd Baumgarten, baumgarten@iap-kborn.de
Dr. Gerald Lehmacher, glehmac@clemson.edu

Abstract: The goal of my research is to use images NLCs to determine parameters such as background wind, location, wavelength and period of any atmospheric waves or instabilities. I am working with Dr. Gerd Baumgarten's NLC data from various sites in Germany, particularly Rügen and Kühlungsborn, during June-July of 2006 and 2007. Currently I am analyzing the data to determine the celestial position of the stars that are in the background of the images. From the celestial positions of the stars I will be able to convert the image coordinates of the NLC features into a terrestrial, geocentric, coordinate frame.

Mesosphere and Lower Thermosphere Other Tidal or Planetary Waves

MLTT-01 Comparison of the Nonmigrating Semidiurnal Tide over Antarctica and Arctic from Wind Measurements by TIMED Doppler Interferometer - by Hiroyuki Iimura

Status of First Author: Student IN poster competition PhD

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Abstract: The nonmigrating components of the semidiurnal tide are likely to be important in understanding the global-scale dynamics of the Mesosphere and Lower Thermosphere (MLT) region, and have been observed as components of the high-latitude MLT wind fields for the past decade. Indeed, a meteor radar wind measurements at the South Pole have identified that the semidiurnal tidal component propagating westward with a zonal wavenumber 1 (W1) has a strong seasonal dependence and is mostly a summer phenomenon maximizing at approximately 90 km with a long vertical wavelength. The W1 semidiurnal tide has also been observed at latitudes from 75S to 78S. However, the nonmigrating semidiurnal tide is found to be a mixture of the W1 and standing (S0) components at 69S latitude. Despite these efforts, it has proven impossible to unambiguously extract the latitude and altitude variations of the nonmigrating semidiurnal tide because of the limited number of measurement locations in the Antarctic region. Furthermore, the tidal components in the wind fields over the Arctic region are not fully understood due to the lack of a network.

TIMED Doppler Interferometer (TIDI) on board the Thermosphere Ionosphere Mesosphere Energetics and Dynamics (TIMED) spacecraft can overcome these problems, and therefore, has the ability to determine the seasonal variation of the spatial structures of the tides at high latitudes.

We will present analysis results showing the spatial structure of the nonmigrating semidiurnal tide over the Antarctic and Arctic regions determined from horizontal wind measurements by TIDI. TIDI has observed a summer enhancement of the W1 component in both Antarctic and Arctic regions. However, the enhancement in the Arctic region is much weaker than that in the Antarctic region. Additionally, the W1 component maximizes at a higher altitude in the Arctic region than in the Antarctic region.

MLTT-02 Tidal Heating Rate Profiles Derived from Global ISCCP Radiative Fluxes - by Xiaoli Zhang

Status of First Author: Student IN poster competition PhD

Authors: Xiaoli Zhang and Jeffrey M. Forbes, University of Colorado at Boulder, xiaoli.zhang@colorado.edu
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Abstract: New and improved tidal heating rate profiles due to solar radiative absorption in the troposphere, and derived from radiative fluxes from the International Satellite Cloud Climatology Project (ISCCP) are presented. ISCCP radiative flux products come from the NASA Goddard Institute for Space Studies (GISS) radiative transfer model and improved ISCCP climatological cloud measurements and ancillary data sets. Among them, the radiative flux profile data set (ISCCP-FD) provides shortwave and longwave, upgoing and downgoing fluxes at five levels (SRF, 680 mbar, 440 mbar, 100 mbar, and TOA) with as many detailed cloud effects as possible (i.e. high-level ice clouds). The horizontal resolution of ISCCP-FD data set is 2.5 x 2.5 degrees globally

and its time resolution is 3-hour. So far, ISCCP is the most suitable data resource for specifying the troposphere heating sources of global scale waves, particularly tides. In this poster, we present the algorithm we have developed for converting the profiles of radiative fluxes to the profiles of radiative heating rates, and present a number of features of these heating rates, including their longitude dependence and their potential for exciting non-migrating tides. Differences and similarities with other previously developed heating rates are also addressed.

Mesosphere and Lower Thermosphere Gravity Waves

MLTG-01 Mesospheric momentum flux studies over Fort Collins, CO (41N, 105W) - by Phillip Edward Acott

Status of First Author: Student IN poster competition PhD

Authors: P.E. Acott, C.Y. She, S.C. Reising, T. Yuan, J. Yue, S. D.Harrell, Z.A. Yan, D.A. Krueger, Colorado State University, Department of Physics, Fort Collins CO 80523, phillip.acott@colostate.edu, joeshe@lamar.colostate.edu

Abstract: System upgrades to the Colorado State University Sodium Lidar in August 2006 have allowed over 300 hours of night-time, three-beam observations with a beam geometry of east-west, dual, co-planar beams 20o from zenith and the third beam north 30o from zenith. This geometry has allowed the determination of nighttime gravity wave zonal momentum flux with simultaneous 24-hour measurements of the mean and tidal fields of the mesopause region temperature and zonal and meridional winds. The data set has not only provided the vertical profile of nighttime zonal momentum flux, but also has shed some light on the accompanying gravity wave-tidal interactions. This poster introduces techniques used to explore gravity wave-tidal interactions and presents results from two days of a continuous 102 hour data set. Observations show a change in vertical flux of zonal momentum imparting a body force that reverses the direction of mean wind, consistent with the closure of the mesospheric jets. Further, the data show a correlation between large negative zonal momentum flux and changes in diurnal and semi-diurnal tidal amplitude at different altitudes. And finally, the data also show an accompanying sharp vertical gradient in diurnal tidal phase, correlated with a large negative zonal momentum flux. All of these observations are suggestive of gravity-wave tidal interaction.

MLTG-02 Gravity Waves Observation over Ferraz Station, Antarctica (62°S) - by Jose Valentin Bageston

Status of First Author: Student IN poster competition PhD

Authors: J. V. Bageston, C. M. Wrasse, D. Gobbi, H. Takahashi, R. E. Hibbins, D. C. Fritts

Abstract: During the winter 2007, an airglow all sky imager has been operated at Ferraz Station located at King George Island (62°S, 58°W) in the Antarctic Peninsula. Mesospheric gravity wave activities were observed by near infrared OH emissions (OHNIR). During the period with good weather condition it was observed forty five nights with a great variety of gravity waves pattern. The present work shows the statistic of the observed waves and wave characteristics (wavelength, period, phase velocity and direction of propagation). In order to calculate intrinsic gravity wave parameters, we used background winds observed by MF radar installed at Rothera Sation, Antarctica (67°S, 68°W).

MLTG-03 Gravity wave observations at the polar mesopause region from the CIPS Experiment on the AIM Spacecraft - by Amal Chandran

Status of First Author: Student IN poster competition PhD

Authors: Amal Chandran1, David Rusch2, Gary Thomas2, Scott Palo1
1Department of Aerospace Engineering, University of Colorado, Boulder
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Abstract: The Cloud Imaging and Particle Size (CIPS) experiment is one of the three instruments on board the Aeronomy of Ice in the Mesosphere (AIM) spacecraft that was launched into sun-synchronous orbit on April 25, 2007. CIPS is a 4 camera wide-field (120° x 80°) imager designed to measure PMC morphology and particle properties and has a spatial resolution of 1 x 2 km in the nadir. Structures observed in PMC's occurring near the cold summer mesopause have been attributed to various wave and instability processes and it has been suggested that PMC structures may be used to infer quantitative properties of gravity wave activity. One of the objectives of AIM is to investigate gravity wave effects on PMC formation and evolution. CIPS images show distinct wave patterns and structures in PMC's. In this work we present an analysis of gravity waves observed in PMC's near 80 –

85 km altitude in both Northern and Southern hemisphere summers of 2007–2008 season. Wavelengths of structures seen in PMC's range from 15 - 300 km, with smaller wavelength structures of less than 80 km being most common. We present maps of polar gravity wave activity in both hemispheres. The observed gravity waves will be analyzed for hemispherical similarities or differences. The wave scales will also be analyzed to detect the presence if any, of seasonal or latitudinal dependences.

MLTG-04 Simulations of wave-induced variations of minor species and OH airglow in the MLT region at north and south 18 degree latitude - by Nicholas Matthew Dzienis

Status of First Author: Student IN poster competition Undergraduate

Authors: N. M. Dzienis1, T.-Y. Huang1 and ,M. P. Hickey2
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2. College of Arts & Sciences, Embry-Riddle Aeronautical University, Daytona Beach, FL 32114, USA.

Abstract: A 2-dimensional, time-dependent, nonlinear OH chemistry-dynamics model is used to investigate wave-induced secular variations of species reacting in the OH chemistry and the associated OH airglow in the Mesosphere Lower Thermosphere region. A gravity wave packet with a forcing wave period of 20 min and a horizontal wavelength of 30 km is simulated to propagate from the troposphere to the OH airglow region. Atmospheric conditions at latitudes 18 N and 18 S were chosen for such an investigation. Our results reveal that a dissipative, transient wave packet could cause a substantial secular change in the number densities of the minor species and the OH airglow as well. Hemispheric differences and similarities in the simulated results will be presented and discussed.

MLTG-05 Quantitative evaluation of impact from momentum flux of mesospheric gravity wave on the background wind at a critical level - by Mitsumu K. Ejiri

Status of First Author: Non-student PhD

Authors: M. K. Ejiri[1,2], M. J. Taylor[1], T. Nakamura[2], P. D. Pautet[1],and S. J. Franke[3]
[1] Center for Atmospheric and Space Sciences, Utah State University, USA.
[2] Research Institute for Sustainable Humanosphere, Kyoto University, Japan.
[3] Department of Electric and Computer Engineering, University of Illinois at Urbana-Champaign, USA.

Abstract: Atmospheric gravity waves (GW) strongly influence middle atmosphere circulation and structure by vertically transporting horizontal momentum, heat, and constituents when they experience dissipation. To quantify there impact on the mean flow and temperature fields requires measurements of there momentum fluxes (FM) using detailed measurements of the wave events and background wind and temperature data and investigations of the detailed mechanism for GW's FM to influence the background fields. As a part of Maui-MALT program, the Utah State University Mesospheric Temperature Mapper (MTM) located at nearby Haleakala Crater, Maui (20.8N, 156.2W) can obtain propagation information of short-period GWs as well as temperature data in the mesosphere and lower thermosphere (MLT) region. Measurements were made in coordination with the University of Illinois Meteor Wind Radar (MWR) at Kihei, Maui (20.8N, 156.4W). On June 29, 2003, the MTM observed a short-period gravity wave (GW) event propagating through this region for most of the night from 6:00 to 15:00 UT. The GWs disappeared from the O2 band data (peak altitude: ~94 km) and the OH band data (~87 km) around 14:00 UT and 14:30 UT, respectively. Meanwhile, the meteor radar measured that wind around 90 km significantly accelerated from 13:00 UT to 14:00 UT. In this study, we discuss mechanism of GW dissipation at a critical level in detail. We also quantify strictly the impact from the GW on the background wind field by a quantitative comparison between GW's FM and wind acceleration using June 29 event.

MLTG-06 Middle Atmosphere Wave Extraction From Imager and Photomer Data - by Tony Mangognia

Status of First Author: Student NOT in poster competition Masters

Authors: David Scott Anderson , anders9@uiuc.edu, Gary Swenson, swenson1@uiuc.edu

Abstract:

MLTG-07 New Analysis Technique to Study Gravity Waves Structures in Noctilucent Clouds Images - by Pierre-Dominique Pautet

Status of First Author: Non-student

Authors: Pierre-Dominique Pautet, Cristiano-Max Wrasse, Hisao Takahashi, Joachim Fechine, Jacek Stegman, and Michael J. Taylor

Abstract: Noctilucent clouds (NLCs) are high-altitude bright cloud formations visible under twilight conditions at mid to high-latitudes (50 to 65°) during the summer months. The extreme conditions governing the formation of these clouds are still not understood. However, they are a visible tracer of the dynamic processes near the mesopause and are often characterized by the gravity waves propagating up from the troposphere. A mapping technique has been developed to analyze the structures visible in NLC images and is described in this poster. Example NLC data taken from Frescati, Sweden (59.3°N), between 2004 and 2007, have been processed in order to determine the characteristics of the short-period gravity wave events recorded every summer. The observed wave parameters have been compared to previous high-latitude MLT airglow observations.

MLTG-08 Observations of Mesopause Region Bores in OH and O2 Airglow Emissions over Maui, Hawaii - by Deepak B Simkhada

Status of First Author: Student IN poster competition PhD

Authors: Deepak B. Simkhada, dbsimkhada@gmail.com, Michael J. Taylor, mtaylor@cc.usu.edu, Center for Atmospheric and Space Sciences , Utah State University, Steven J. Franke, s-franke@uiuc.edu, Alan Z. Liu, liuzr@uiuc.edu, Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign

Abstract: We have investigated properties of sharp, front-like wave events observed in the mesospheric OH and O2 airglow emissions over Maui, Hawaii, during 2003-2004. A total of 61 (OH) and 62 (O2) bore events were observed during two years period. Typical wave parameters are horizontal wavelength of ~20 km, phase speed of ~46 m/s and observed period of ~7 min. The measurements were obtained as a part of the joint NSF/AFOSR Maui-MALT program using the Utah State University Mesospheric Temperature Mapper (MTM) sequentially sampling the OH and O2 airglow emissions centered at 87 and 94 km, respectively, and the University of Illinois meteor radar and Na lidar providing wind and temperature measurements over the altitude range of 80-100 km. Here we present results on two bore-like wave events, which were characterized by persistent, sharp bright and dark leading fronts with growing number of trailing waves. The measurements of the background wind, temperature inversion and intrinsic parameters of waves clearly show one event to be Doppler ducted and other event to be thermal ducted in nature. Our analyses of such small-scale, guided wave events provide important new information on the dynamics of wave ducting at mesopause region.

MLTG-09 Identifying Unusual Temperature and Intensity Perturbations in the Maui-MALT Airglow Data Set by Camille Briana Smith

Status of First Author: Student IN poster competition Undergraduate

Authors: Camille B. Smith and M. J. Taylor, Center for Atmospheric and Space Sciences, Utah State University, Logan, Utah

Abstract: Using the Utah State University Mesospheric Temperature Mapper (MTM) which sequentially measured the OH (at 87 km) and the O2 (at 94 km) airglow emissions over Maui, Hawaii; we have occasionally observed large perturbations in the temperature and the changing airglow emission intensity during a five year period (2002-2006). These measurements were acquired as part of the joint NSF/AFOSR Maui-MALT program. A disturbance in airglow depicted by large temperature perturbation and a significant change in airglow emission intensity suggests unusual gravity wave and/or tidal activity. We present examples of a variety of temperature and intensity perturbations that cause significant change in the mesospheric OH and O2 emissions over Maui, Hawaii.

MLTG-10 Influence of duct altitude and vertical wave structure on airglow layer perturbations - by Jonathan Snively
Status of First Author: Non-student

Authors: Jonathan B. Snively (1), Deepak Simkahada (1), Michael J. Taylor (1), Victor P. Pasko (2)
(1) Center for Atmospheric and Space Sciences, Utah State University
(2) Communications and Space Sciences Laboratory, Penn State University

Abstract: Atmospheric gravity waves with short periods and small spatial scales are frequently observed in airglow imaging experiments. Many of these waves propagate in ducts formed by the local temperature and wind fields [e.g., Walterscheid et al., JASTP, 61, 461, 1999; Isler et al., JGR, 102(D22), 26301, 1997]. Ducted waves contribute to strong airglow signatures, as a result of large vertical velocities, long vertical wavelengths, and standing wave structure [e.g., Hines and Tarasick, GRL, 21(24), 2729, 1994]. However, the vertical structure of ducted waves, and the altitude of trapping, is significantly determined by local temperature and wind conditions, and associated dynamics [e.g., Snively et al., JGR, 112, A03304, 2007; Fritts and Janches, JGR, 113, D05112, 2008].

For large-scale propagating waves, vertical wave structure may be assessed via comparisons of multiple airglow layer emissions [e.g., Vargas et al., JGR, 112, D14102, 2007, and references cited therein]. However, complications arise in the analysis of airglow signatures due to small-scale ducted waves. As a consequence of the limited vertical extent of ducted wave packets, and strong vertical velocities, the integrated airglow response is dependent both on the structure of the wave packet, and on the density profiles of minor species participating in photochemistry [e.g., Snively and Pasko, JGR, In Preparation, 2008].
Using numerical and analytical models, and comparing with observations, we investigate ducted gravity wave signatures within the OI (557.7 nm) and OH (Meinel band NIR) airglow layer emissions. First, we investigate cases where ideal ducted wave packets perturb the airglow layers from ducts at different altitudes near mesopause. Results suggest the altitude of the wave packet relative to the minor species profiles significantly affects the phase and magnitude of the integrated intensity response. Second, we investigate cases where Doppler-ducted wave parameters vary with altitude throughout the airglow region. Results suggest that these waves perturb the airglow layers strongest as they approach reflection, such that the altitudes of duct boundaries may determine the integrated signature. Observational implications are discussed.

MLTG-11 A study of OH imager observed concentric gravity waves - by Jia Yue

Status of First Author: Student IN poster competition PhD

Authors: Jia Yue, Sharon L. Vadas, Chiao-Yao She, Takuji Nakamura, Steven Reising, David Krueger, Hanli Liu, Pete Stamus, Denise Thorsen, Walter Lyons, Tao Li

Abstract: Expanding concentric rings of gravity waves were observed on the night of May 11, 2004 by the Kyoto University all-sky OH imager at Yucca Ridge Field Station (40.7ºN, 104.9ºW) near Fort Collins, Colorado. The pattern was observed for about 1.5 hours (0340 UT to 0510 UT) with the rings initially encompassing nearly 360º (0340 UT to 0410 UT). We use these observations of concentric rings to characterize the gravity waves by their horizontal wavelengths and periods as a function of radius and observation time; the observations compare favorably to predictions of internal gravity wave dispersion relations with the assumption of zero wind. The centers of the rings were located at the same geographic locations as convective plumes recorded by the NEXRAD radar. Using the OH imager at Yucca Ridge, concentric rings were observed on five nights out of approximately 750 nights of observation during the period 2004-2007. Since all of the observed concentric patterns occurred in May or late August/early September, we hypothesize that a weak mean background zonal wind in the stratosphere and mesosphere during the equinoctial periods, when the direction of the zonal wind reverses, is a necessary condition for observing gravity waves that are excited near the tropopause from convective plumes as concentric rings in the OH layer.

MLTG-12 Investigating Gravity Waves Measured by CIPS/AIM in the Summer Polar Mesosphere - by Yucheng Zhao

Status of First Author: Non-student

Authors: Yucheng Zhao, Mike J. Taylor, P-D. Pautet, Dave Rusch, Chris Jeppesen, James M. Russell III, Scott Bailey

Abstract: The Aeronomy of Ice in the Mesosphere (AIM) satellite was launched on April 25, 2007. Its primary goal is to explore Polar Mesospheric Clouds (PMC) near the mesopause region, and investigate their formation and evolution. One of the instruments onboard AIM is the Cloud Imaging and Particle Size (CIPS), which is a four camera, wide-field (120° x 80°) UV

imager designed to measure PMC morphology and particle sizes. CIPS imagery contains a variety of cloud and wave-like structures due primary to gravity waves. This provides the first look of gravity waves within the summer polar cap region (>70°). In this poster, we investigate some of the characteristics of the large-scale gravity waves imaged by CIPS during its first year seasonal observations.

Mesosphere and Lower Thermosphere Lidar Studies

MLTL-01 Characteristics of quasi-monochromatic gravity waves and wave saturation observed by Na lidar in the mesopause region - by Xian Lu

Status of First Author: Student IN poster competition PhD

Authors: Lu, Xian, Liu, Alan Z.

Abstract: By using the UIUC Na wind/temperature lidar measurements made at Maui, Hawaii (20.7N, 156.3W), quasi-monochromatic (QM) gravity waves (GWs) were identified with a new method. The new method takes into account the vertical variation of background wind and temperature and allows vertical variation of vertical wavenumber and intrinsic frequency. The QM GWs identified with this method are more consistent with GW theory than that from Hu et al. [2002], in which the vertical wavenumber and intrinsic frequency were assumed to be constant.

Statistical analyses are applied to the identified QM GWs to reveal the distribution of vertical wavelengths, horizontal wavelengths, intrinsic periods and horizontal propagation directions. The wave saturation process is investigated based on the "linear saturation theory" (LST). Comparisons are made between observed wave amplitude (|U '|) and the constraint of wave amplitude due to wave saturation (|C-mean(U)|) according to LST. It is shown that constraint of wave amplitudes imposed by the background temperature and wind predicted by LST is consistent with the actual wave amplitude. The conditions that LST may be not applicable are also identified. Possible effects of convective and dynamic instabilities on wave saturation are studied.

MLTL-02 Temperature structure and variability between 1 and 105 km altitude at 54°N from combined lidar soundings - by Michael Gerding

Status of First Author: Non-student

Authors: Michael Gerding, Josef Höffner, Jens Lautenbach, Monika Rauthe, and Franz-Josef Lübken, Leibniz-Institute of Atmospheric Physics, (gerding@iap-kborn.de)

Abstract: Temperature profiles between 1 and 105 km are measured at nighttime at the mid-latitude station of Kühlungsborn (Germany, 54°N) by combination of a Rayleigh-Mie-Raman lidar and a potassium resonance lidar. 266 observations of more than 3 hours duration have been performed between June 2002 and July 2007. The data are in good agreement e.g. with co-located radiosonde profiles and with simultaneously observed Noctilucent Clouds. Reference atmospheres differ from nightly mean profiles by ~20 K in winter during stratospheric warming events as well as in the summer mesopause region. We applied a harmonic filter to reveal the general temperature structure. A two-level mesopause structure was found with an altitude of about 86–87 km (~145 K) in summer and ~102 km (~170 K) during the rest of the year. The stratopause altitude is about 48 km with little variation throughout the year, and temperatures varying between 258 and 276 K. Beside the general temperature structure we will present examples of the temperature variability on different scales. Planetary wave activity can be described by the standard deviation of monthly mean profiles and is partly related with sudden stratospheric warmings occuring in winter even above our mid-latitude station. Additionally, the seasonal variation of gravity wave activity and wave parameters will be examined. A unique series of five consecutive nights (and days) allows to study the day-to-day variability in wave activity, including tides. In an outlook we will present the current state of daytime temperature soundings and planned developments.

MLTL-03 First daylight measurements of temperature and wind with the mobile scanning Fe-Doppler lidar - by Jens Lautenbach

Status of First Author: Non-student

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Abstract: Laser remote sensing is a powerful tool for ground-based atmospheric research. Because of the high solar background during the day, lidar operation is limited to the darkness. But a large number of dynamic processes in the Earth's atmosphere as well as long-period changes of atmospheric parameters can be only explored if the used lidar allows daylight operation with high data quality.

We report about the first continues daylight measurements of temperature and wind with the mobile scanning Fe-Doppler lidar of the IAP. Nearly background free daylight measurements have been accomplished due to an efficient narrowband spectral filtering and a small field of view (FOV). Initial night time measurements of Doppler temperatures and winds at the iron resonance line (386 nm) in 2002 have already shown the advantages of the scanning Fe-Doppler lidar over nowadays Doppler lidars. After initial daylight measurements in 2005 with a single etalon and FOV of 0.05 mrad we have achieved nearly background free measurements in 2007 with a 2 pm FWHM double etalon system. We have managed the common problem of determining the spectral filter function for an etalon system. The mobile scanning Fe-Doppler lidar determinates the filter functions of the double etalon during each measurement from the atmospheric measurement itself. Another key-feature for high precision daylight measurements is a small FOV which is achieved by fast beam stabilization and a diffraction limited laser with high pointing stability. Within the time from one pulse to the next pulse the beam stabilization detects the location of the beam in the sky and moves the beam into the centre of the FOV.

The mobile scanning Fe-Doppler lidar of the IAP is currently running as a two wavelength system with a FOV of 0.05 mrad. Altogether it has 8 detection channels, one double etalon system for temperature determination between 20 and 105 km altitude and a triple etalon system for background free aerosol measurements above 20 km altitude. All observed parameters such as laser power / spectrum, frequency of the pulse and count rate profile are measured pulse by pulse and stored on disk with 25 m altitude resolution. Similar to the former K-lidar the mobile scanning Fe-Doppler lidar needs no atomic reference at the observed wavelength. Hence this technique can be deployed to any wavelength within the wavelength range of the laser. With this setup we obtain high precision temperatures, Fe-densities, winds and aerosols with a high spatial and temporal resolution.

MLTL-04 Development of Resonance Fluorescence Lidar Methods for Studies of Aurorally Excited Molecular Nitrogen - by Agatha S. Light

Status of First Author: Student IN poster competition Masters

Authors: Agatha S. Light (alight@gi.alaska.edu), Richard L. Collins (rlc@gi.alaska.edu)

Abstract: Methods of using lidar to conduct measurements of aurorally excited molecules in the thermosphere have been developed. It has been determined that molecular nitrogen ions (N_2^+) are ideal for such a study due to their relatively large scattering cross section and short radiative lifetime. A prototype resonance lidar system for conducting N_2^+ studies exists at the Lidar Research Laboratory on the Poker Flat Research Range (PFRR). A series of measurements of mesospheric sodium and iron layers have been made to test the resonance system. The performance of various laser dyes is being explored and an engineering analysis of components of the lidar receiver, specifically bandpass filters is being conducted. N_2^+ measurements will be taken during auroral events in 2008-2009. The measurements of N_2^+ will be combined with simultaneous radar measurements of the auroral plasma taken by the Poker Flat Incoherent Scatter Radar (PFISR).

MLTL-05 The Role of Waves in the Arctic Middle Atmospheric Circulation: Rayleigh Lidar Observations and Analysis - by Brentha Thurairajah

Status of First Author: Student IN poster competition PhD

Authors: Brentha Thurairajah, Richard L. Collins, V. Lynn Harvey, David E. Atkinson, Caroline J. Larsen, Kohei Mizutani, John M. Livingston, Craig J. Heinselman, Mary A. McCready, Weilin Pan

Abstract: Analysis of observations by the Rayleigh lidar at Chatanika, Alaska (65o N, 147o W) and Kangerlussuaq, Greenland (67o N, 51o W) show that when the lidar samples the polar vortex the stratopause is warmer and higher than usual, and when the lidar samples the Aleutian High the stratopause is at relatively low altitudes and the mesosphere is colder than standard climatological values. In comparison, an 'elevated' stratopause is observed by the lidar at Chatanika in January 2004. The observed temperature structure is different from that observed due to the influence of the polar vortex and Aleutian high. The presence of the 'elevated' stratopause is attributed to modification of the gravity wave-driven middle atmospheric circulation. Wave activity will be quantified by gravity wave analysis of the observed temperature perturbations. This study is part of the International Polar Year (PASSMeC) project that includes high resolution temperature measurements of the stratosphere and mesosphere from a network of Rayleigh lidars across the western and eastern Arctic.

MLTL-06 Monthly-mean Tidal Perturbations of Na Density and Vertical Wind based on Full-Diurnal-Cycle Na Lidar Observations - by Tao Yuan

Status of First Author: Non-student

Authors: Tao Yuan, Takuya D. Kawahara*, Chiao-Yao She, David A. Krueger and Steven Reising, Colorado State University, Fort Collins, CO

Abstract: An unusually long data set was acquired at the sodium lidar facility at Colorado State University (40.6°N, 105.0°W), between September 18 and October 1, 2003, including a 9-day continuous observation. This period is long enough to remove the effect of gravity waves and short-period planetary waves by averaging. In fact, this data set has been used to deduce tidal-period perturbations in temperature and horizontal wind. The same data set can be used to determine the mean and tidal-period perturbations of Na density. These quantities can also be used to deduce the tidal perturbations of vertical wind. In this paper, we discuss the methodology for determining vertical wind tides, and we use the 9-day continuous full-diurnal-cycle observations to deduce not only mean Na density and its tidal perturbations, but also the vertical wind tides, which are also compared to predictions by the Global Scale Wave Model (GSWM00). Our future objective is to derive climatology and seasonal variations of these quantities using data from the full diurnal cycles observed at Fort Collins over a four-year period between May 2002 and April 2006.

Instruments or Instruments or Techniques for Middle Atmospheric Observation

ITMA-01 MRI: Development of a mobile mobile Fe-resonance/Rayleigh/Mie Doppler lidar - by Xinzhao Chu

Status of First Author: Non-student

Authors: Xinzhao Chu[1], Wentao Huang[1], Jonathan S. Friedman[2], Jeffrey P. Thayer[1], Archie T. Brown[3], Bifford P. Williams[4], Johannes Wiig[1], John A. Smith[1], Matthew Hayman[1]
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Abstract: Global temperature, wind, and aerosol profiling through the middle and upper atmosphere with high accuracy, precision, and resolution is crucial in atmosphere and climate study. Here we discuss the principle, design, and analysis of a NSF Major Research Instrumentation (MRI) mobile Fe-resonance/Rayleigh/Mie Doppler lidar that has compelling reasons to be attractive for these purposes. This lidar integrates the state-of-the-art technologies of lasers, laser spectroscopy, electro-optics, and sensors into a single system to produce a powerful and robust tool with unmatched capabilities. This lidar will provide simultaneous measurements of temperature (30-110 km), wind (75-110 km), Fe density (75-115 km), and aerosol (10-100 km) in both day and

night with high accuracy, high precision, and high spatial and temporal resolutions. Chirp-free lidar frequency locking and saturation-free Fe layer resonance result in a bias-free estimate of wind & temperature, which is revolutionary for Doppler lidar. The resulting breakthrough in lidar technology will push the atmospheric observations to a completely new level and the mobility of the system will enable new scientific endeavors. We will also present the first Fe absorption spectroscopy at 372 nm achieved in our laboratory with the MRI lidar system. Such Fe spectroscopy provides absolute frequency reference and calibration for the entire lidar system, marking a significant advancement in Fe Doppler lidar.

ITMA-02 LabVIEW-Based Laser Frequency Stabilization System Using Phase Sensitive Detection Techniques for LIDAR Applications - by John A. Smith

Status of First Author: Student IN poster competition Masters

Authors: John A. Smith[1], Xinzhao Chu[1], Wentao Huang[1], Johannes Wiig[1], Archie T. Brown[2]
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Abstract: Doppler lidars utilizing the Doppler shift and broadening effects are the major instruments that can measure wind and temperature simultaneously from the lower to upper atmosphere. Such lidars demand high accuracy, precision, and stability of the laser frequency. However, current resonance Doppler lidars suffer various problems in frequency stabilization that limit the locking precision to 5-10 MHz with low stability. We have addressed these issues by developing an innovative LabVIEW-based laser frequency locking system. This new system utilizes the wavelength-modulation and phase-sensitive-detection techniques in conjunction with a proportional-integral-derivative feedback servo loop. It achieves better than 1 MHz (±0.5 MHz) locking precision and stability. The system also stays locked throughout a series of abrupt disturbance tests. Owing to its high locking precision, immunity to electronic and laser noise, reliability, and flexibility in adapting for various systems, we believe that this new system represents a marked improvement in atmospheric Doppler lidar technology.

ITMA-03 Detectability of midlatitude D region variability driven by energetic particle precipitation - by Feng Han

Status of First Author: Student IN poster competition PhD

Authors: Feng Han

Abstract: Broadband VLF sensors located near Duke University and in Brazil have being operating with the aim of studying the midlatitude ionospheric D region variability driven by energetic particle precipitation through measuring the sferic signals launched by the lightning and propagating in the Earth-ionosphere waveguide. In this work, we analyzed the ability of our system to detect ionospheric D region variability by simulating VLF propagation under different particle precipitation conditions generated from a chemical model. Energetic electron precipitation spectra measured by the NOAA-18 satellite in the midlatitude northern hemisphere and computed theoretically from the radiation belt dynamics in the South Atlantic Anomaly region were used to generate expected steady state electron density profiles in the two regions. VLF signal propagation simulations under these electron density profiles were performed to determine how variable broadband VLF characteristics are expected to be and, consequently whether ionosphere variability driven by theses precipitations is detectable with our systems. Measured VLF variability in both regions was also analyzed in the context of these simulations.

ITMA-04 Theory and Applications of a Faraday Filter-Based Spectrometer to Measure Sodium Nightglow D2/D1 Intensity Ratios - by Sean Harrell

Status of First Author: Student IN poster competition PhD

Authors: Sean Harrell, Titus Yuan, Chiao-Yao She, David Krueger and Steven Reising, Colorado State University

Abstract: The Chapman mechanism (1939) offers the accepted chemical pathway for the production of excited states of mesospheric sodium, leading to nightglow at two wavelengths: D2 (589.158 nm) and D1 (589.756 nm). While the Chapman mechanism leaves open the possibility that the intensity ratio of the two transitions may vary due to the chemical reaction involving atomic oxygen, observations by Sipler and Biondi (1978) yielded the value of 2 within experimental error. Recent work by Slanger et al. (2005), however, showed that not only does the intensity ratio vary, but its value is related to the concentration ratio of atomic oxygen [O] to molecular oxygen [O2]. The same work proposed a modification of the Chapman mechanism involving two competing chemical pathways for sodium production. In this poster, we will describe the design, fabrication and

testing of a compact, Faraday filter-based spectrometer to measure the D2-to-D1 intensity ratio of the sodium nightglow from the upper mesosphere in order to infer information about [O]/[O2]. The novelty of this method will also permit determination of the fractional contributions of the two chemical pathways to test the validity of the modified Chapman mechanism for Na chemistry. Since the delineation between the two pathways requires spectral resolution of 0.0002 nm, this is not possible with any existing instrument. After this spectrometer is completed and deployed at the Colorado State University sodium lidar site, we expect to be able to measure short-term variations of the sodium nightglow intensity ratio, from which the related oxygen concentration ratio can be inferred. These observations may yield new insights into mesospheric chemistry, especially for atomic and molecular oxygen, which play a key role in upper atmospheric chemistry and dynamics.

ITMA-05 Description of a regularization technique for the analysis of photographic data used in chemical release wind measurements - by Justin Ingersoll

Status of First Author: Student IN poster competition Masters

Authors: J. Ingersoll, M. F. Larsen, and S. Birchfield, Clemson University

Abstract: The neutral winds are a key parameter in the electrodynamics of the ionosphere. The available techniques for measuring the neutral wind profiles, especially with good height resolution, are extremely limited. This is especially true with sounding rocket flights as it is not practical to take direct measurements of neutral winds with onboard instruments. Chemical releases from sounding rockets, however, can provide such measurements by providing a tracer of the motion of the neutral atmosphere at altitudes in the mesosphere and lower thermosphere (MLT). The resulting chemiluminescent trail is typically photographed from two or more locations to track neutral motions. Triangulation based on these photographs then yields position information at each instant when photographs are available simultaneously from different locations, which can be combined to obtain a neutral wind profile. A technique will be presented that improves the existing triangulation procedure by implementing computer vision-based automation techniques and an improved tracking algorithm that can accommodate non-simultaneous image data more easily and can provide better continuity in the motions inferred from consecutive images.

ITMA-06 Next generation meteor radar receiver based on an open-hardware, software radio platform - by Ryan Seal

Status of First Author: Student NOT in poster competition Masters

Authors: Ryan Seal, rlseal@gmail.com, The Pennsylvania State University, Julio Urbina, jurbina@engr.psu.edu, The Pennsylvania State University

Abstract: Interest in digital communication techniques has led to several recent open-hardware implementations; providing high performance hardware at very modest prices. The most popular of these implementations in use today is the Universal Software Radio Peripheral (USRP) board, which provides a complete digital receiver system compatible with the GNU Radio software platform. The system provides up to 4 input channels sampled at rates up to 64 MSPS with 12-bit precision. Data is transferred to a general purpose computer (GPC) using a USB 2.0 interface capable of continuous data collection at bandwidths up to 8 MHz. We present a technique to modify the existing USRP board to operate in a pulsed mode using an external trigger signal to control data collection; effectively increasing signal bandwidth. Additionally, software techniques used to improve system performance and provide the capability for real-time processing and data display will be given.

ITMA-07 Development of a falling sphere instrument for high-resolution neutral wind measurements in the mesosphere and lower thermosphere - by Arpan Shah

Status of First Author: Student IN poster competition Masters

Authors: A. Shah1, M. F. Larsen1, and C. Fish2, ArpanS@clemson.edu, Mlarsen@clemson.edu, Chad.Fish@sdl.usu.edu
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Abstract: Instrumented falling spheres launched from small rockets have been used extensively in the past to measure the winds and densities in the mesosphere. In principle, the same technique can be extended to higher altitudes that cover the lower thermosphere, in addition to the mesosphere. The main difficulties are that accelerations decrease rapidly with height due to the decreasing atmospheric density and rigid spheres are required at higher altitudes, which implies larger mass and smaller

accelerations. Accelerometers with broad dynamic range and high sensitivity are required for the measurements, but such devices are not available commercially. The instrument itself consists of a lightweight, hollow sphere fitted with a highly sensitive three-axis accelerometer in addition to other tracking and telemetry equipment. The sphere, along with an ejection system, is installed in the nose cone section of a sounding rocket. The sphere is ejected at an altitude near the base of the MLT region on the up-leg portion of the trajectory. The combination of the data from the up-leg and down-leg sections of the flight can be used to extract detailed density and neutral wind profiles. In addition, the temperature profile can be estimated by height integration of the density data. The instrument and the data analysis scheme will be described.

ITMA-08 A Multi-Channel FPGA Based High Speed Digital Receiver for Meteor Radar Applications - by Cody Vaudrin, presented by Scott Palo

Status of First Author: Student NOT in poster competition PhD

Authors: Cody Vaudrin (University of Colorado, Department of Aerospace Engineering Sciences, Cody.Vaudrin@Colorado.edu)
Scott Palo (University of Colorado, Department of Aerospace Engineering Sciences, Scott.Palo@Colorado.edu)

Abstract: In contrast to the fixed signal processing algorithms of conventional receivers built using discrete analog components, the signal processing algorithms of digital receivers are implemented in software defined digital logic. This software defined signal processing enables a digital receiver to process an incoming signal in a virtually limitless variety of ways. A digital receiver is defined by a minimal RF front-end followed by a high speed analog-to-digital (A/D) converter controlled by a reconfigurable logic device (FPGA). After processing by the FPGA the received data is transferred to a host general computing platform for storage and additional post-processing. This data transfer is accomplished using a standard USB communications protocol.
After numerous iterations the current receiver configuration consists of 8 high speed analog-to- digital converters integrated onto a single chip. Each 14 bit sample is serialized and interfaced to the FPGA via a high speed two wire low voltage differential serial (LVDS) interface. The use of the LVDS interface reduces the number of pins used on the FPGA from 112 to 16. A minimum of 6 independent channels are needed for meteor radar interferometry.

Inside the FPGA the LVDS data from each channel is parallelized and passed through a general purpose single process block. While the functionality of the signal processing block is programmable, currently for the meteor radar only sampling and decimation are implemented. After the signal processing block the data is packetized and passed to the Cypress USB chip for transfer to the host computer and additional processing.

In this poster receiver design details and the architecture of the system will be discussed. Data collected from initial system tests will also be presented.

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