DASP 2013

February 18-19 2013

Kingston, Ontario

Marriott Residence Inn, 7 Earl Street, Kingston, ON, K7L 0A4

Convenors:

K. Kabin, L. Sangalli, J. D. de Boer

	Monday morning February 18, 2013
8:00 – 8:45	Registration
	Session 1 chair: L. Sangalli
8:45-9:00	Kabin, K., *Magnetic conjugacy at high latitudes in global magnetohydrodynamic (MHD) and empirical models of the magnetosphere*
9:00-9:15	Wright, M. and W. Hocking, *Gravity waves in the Arctic and non-Arctic atmosphere: The "universality" of the universal spectrum*
9:15-9:30	Jayachandran, P. T., K. Hosokawa, K. Shiokawa, Y. Otsuka, S. C. Mushini, C. Watson, J. W. MacDougall, P. Prikryl, R. Chadwick, and T. D. Kelly, *GPS Amplitude and Phase Scintillation Associated with Poleward Moving Sun Aligned Arcs*
9:30-9:45	Haley, C. L. and D. J. Thomson, *Solar modal structure as observed by neutron monitors*
9:45-10:00	Lu, J. , *The IMF Dependence of the Magnetopause*
10:00-10:30	Coffee break
	Session 2 chair: E. Donovan
10:30 – 10:45	Sydorenko, D. and R Rankin, *Two-dimensional model of coupled ionosphere and magnetospher*
10:45-11:00	Urbancic, N. and K. Kabin, *Solar Wind variations between L1 and the Earth's magnetosphere: ACE, THEMIS, Geotail and OMNI*
11:00-11:15	Jackel, B. J., T. Cameron, and J. M. Weygand, *Orientation of solar wind dynamic pressure phase fronts*
11:15-11:30	Riegert, D., A. Springford and D. Thomson, *Modeling high impact low frequency geomagnetic disturbances using magnetic field data from solar-orbiting spacecraft*
11:30-11:45	Gillies, D. M., E. Donovan, D. Knudsen, E. Spanswick, C. Hansen, D. Keating, and S. Erion, *A survey of quiet arc morphologies and the effects of the interplanetary magnetic field on arc orientation*
11:45-12:00	Yau, A., A. Howarth, W. Peterson, T. Abe, *Quiet-time Transport of Ionospheric Oxygen Ions between the Ionosphere and the Inner Magnetosphere*
12:00-12:15	Hocking, W. K., *Radar Operation using real-time deconvolution*
12:00-13:30	lunch

	Monday afternoon, February 18, 2013
	Session 3 chair K. Kabin
13:30 – 13:45	Donovan, E., K. Rae, E. Spanswick, M. Gillies, D. Knudsen, S. Jones, A. Jaynes, and M. Lessard, *The motion and distortion of auroral patches*
13:45-14:00	Alrefay, T. Y., *Bow Shock Dynamics as observed by the Cluster satellites*
14:00-14:15	James, G., *Recent radio science research relevant to CASSIOPE/ePOP*
14:15-14:30	Garbanzo-Salas, M., and W. Hocking, *High resolution studies of wind and turbulence using MST radar in Costa Rica*
14:30-14:45	Damiano, P., and J. R. Johnson, *Electron energization and wave dispersion in a mirror kinetic Alfven wave*
14:45-15:00	Perron, P. J.G., J.-M. Noel, J.-P. St-Maurice, K. Kabin and J. De Boer, *Effects of ion temperature anisotropy and shears on PFISR theoretical incoherent scatter spectrum of stable CDEIA modes in the topside auroral region*
15:00-15:30	Coffee break
	Session 4 chair: K. McWilliams
15:30 – 15:45	St-Maurice, J.-P., A. Barjatya, and C. M. Swenson, *Electron heating in the lower ionosphere at low latitude: are parallel currents more common than we think?*
15:45-16:00	Miles, D. M., J.R. Bennest, I.R. Mann, and D.K. Millling, *A Radiation Hardened Digital Fluxgate Magnetometer for Space Applications*
16:00-16:15	Fiori, R.A.D., D. H. Boteler, and D. M. Gillies, *Superposed epoch study of geomagnetic storm sudden commencements: Understanding space weather effects on power systems*
16:15-16:30	Prikryl, P., R. Ghoddousi-Fard, B. S. R. Kunduri, E. G. Thomas, A. J. Coster, P. T. Jayachandran, E. Spanswick, D. W. Danskin, *GPS phase scintillation and proxy index at high latitudes: A case study*
16:30-16:45	Sukara, R. E. and W. K. Hocking, *Mesospheric Ozone Determination from the Radar Meteor Echo Duration*
16:45-17:00	Imtiaz, N., R. Marchand, and J. Burchill, *Impact of plasma sheath on rocket-based E-region ion measurements*

	Tuesday morning, February 19, 2013
	Session 1 chair: J. DeBoer
8:30 – 8:45	Mann, I. R., ULF *Wave Acceleration and Loss in the Radiation Belts: New Results from CARISMA and the Van Allen Probes Mission*
8:45-9:00	Martynenko, O. V., V. I. Fomichev, K. Semeniuk, S. R. Beagley, W. E. Ward, and J. C. McConnell, *Longitudinal structure of the 135.6 nm ionospheric emission: Preliminary results from the Canadian Ionosphere-Atmosphere Model*
9:00-9:15	Cushley, A., and J. M. Noel, *Computerized Ionosheric Tomography; Reconstruction of Ionosphere Electron Density Profiles Using Modelled TEC Measurements From ADS-B Model*
9:15-9:30	Archer, W., D. Knudsen and J. Burchill, *Comparison of reported uncertainty and measurement variability of Incoherent Scatter Radar measurements*
9:30-9:45	Spanswick, E., E. Donovan, C. Unick, J. Hackett, W. Liu, and J. S. Evans, *The Next Generation of UV Imaging - Modeling System Performance*
9:45-10:00	St-Maurice, J-P., *Upwelling from Joule heating at unusually high altitude.*
10:00-10:30	Coffee break
	Session 2 chair: J. McConnell
10:30 – 10:45	Ward, W., S. K. Kristoffersen, and C. Vail, *First simultaneous observations of gravity wave signatures in wind (vertical and hortizontal) and airglow*
10:45-11:00	Cully, C.M., *ABOVE: an Array for Broadband Observations of VLF/ELF Emissions*
11:00-11:15	Nikolic, L., and Larisa Trichtchenko, *Development and Validation of a Semi-empirical Code for Solar Wind Prediction*
11:15-11:30	Russell, A. T., K. Kabin, D. Burrell, and J.-M. Noel, *Density enhancements in the thermosphere and lower exosphere during the geomagnetic storms of October 2003 and November 2003*
11:30-11:45	Watson, C., P.T. Jayachandran and J.W. MacDougall, *Characteristics of GPS TEC variations in the polar cap ionosphere*
11:45-12:00	Knudsen D., J. Burchill, E. Donovan, R. Rankin, D. Sydorenko, J. McConnell, and V. Fomichev, *Advancing the State of the Art in Measurements and Models of I-T-M Coupling*
12:00-13:30	Lunch; DASP business meeting

	Tuesday afternoon, February 19, 2013
	Session 3 chair: P. Perron
13:30 – 13:45	Perry, G.W., K. Hosokawa, J.-P. St.-Maurice and K. Shiokawa, *An analysis of successive F-region ionization patches under prolonged Southward IMF conditions*
13:45-14:00	Kalugin G., and L. Trichtchenko*, Frequency parameters of the interplanetary magnetic field during large Forbush decrease events*
14:00-14:15	de Boer, J.D., J.-M. A. Noël, J.-P. St.-Maurice and K. Kabin, *Propagation of the scalar electric potential in the ionosphere*
14:15-14:30	Rehman, S., R. Marchand, L. E. Gayetsky, K. Lynch, *ELEPHANT experiment modelling with PTetra*
14:30-14:45	Martynenko, O. V. *Approach to the atmosphere and ionosphere models merging in application to the Canadian atmosphere and ionosphere model development*
14:45-15:00	McWilliams, K.A., M. Lockwood, and M.J. Owens, *Statistics of Solar Wind Strahl Electrons*
15:00-15:30	Coffee break
	Session 4 chair: W. Ward
15:30 – 15:45	Jackel, B. J., C. Unick, E. Davis, F. Creutzberg, C. Wilson, J. Little, *Field calibration of auroral meridian scanning photometers using Jupiter*
15:45-16:00	Gillies, R.G., A. W. Yau, G. C. Hussey, and G. J. Sofko, *HF radar measurements of scattering volume electron densities for various Interplanetary Magnetic Field (IMF) orientation*s
16:00-16:15	Shepherd, G. G. and Y-M. Cho, *WINDII observations of neutral wind perturbations originating in geomagnetic disturbances e*
16:15-16:30	Shepherd, M.G.,G. G. Shepherd, Y.-M. Cho, *Longitudinal perturbations in thermospheric temperatures from 100 km to 250 km*
16:30-16:45	Sangalli, L.R., *Comparison between triangulated auroral altitude and precipitating electron energy flux*
16:45-17:00	Donovan, E., E. Spanswick, T. Nishimura, M.Gkioulidou, and E. MacDonald, *Early results from RBSP and THEMIS-ASI/NORSTAR*

ABSTRACTS

Magnetic conjugacy at high latitudes in global magnetohydrodynamic (MHD) and empirical models of the magnetosphere.

Konstantin Kabin[1]

[1] Dept. of Physics, Royal Military College, Kingston, ON

Ionospheric manifestations of many magnetospheric phenomena are conjugate between the two hemispheres, meaning that they appear similarly and nearly simultaneously in the northern and southern hemispheres at approximately the same magnetic latitudes and longitudes. At high latitudes and especially in the cusp area this symmetry is, however, often broken implying complicated topology of the magnetic field lines in this region. Such magnetic field topology, in which the ionospheric foot points of a field line have substantially different magnetic longitudes appears naturally in null-separator models, the simplest analytical example of which is a superposition of a dipole and uniform field. Magnetic field topology consistent with the null-separator model has been recently identified in global MHD studies of the terrestrial magnetosphere and was found to be consistent with SuperDARN and DMSP observations. Similar behavior of magnetic field lines near the polar cap also appears in many empirical models, such as Tsyganenko T96. In this presentation we will focus on the field line geometry at high latitudes in numerical MHD and empirical models. We also discuss implications of the lack of magnetic conjugacy between the two hemispheres at high latitudes, in particular in the cusp region.

Gravity waves in the Arctic and non-Arctic atmosphere: The "universality" of the universal spectrum

Melanie Wright[1] and Wayne Hocking[2]

[1,2] Department of Physics and Astronomy, The University of Western Ontario, London, Ontario, Canada

In 1960, Hines suggested internal gravity waves (or buoyancy waves) as a major contributor to upper atmosphere motions; carrying energy and momentum large distances through the atmosphere. The literature fixated on singular waves until, in 1982, VanZandt proposed a "universal spectrum"—a shape to the intensity of gravity waves versus their wavenumber that is independent of geographic location, meteorological conditions, altitude, and time—based on the oceanographic work of Garrett and Munk (1972, 1975). The literature absorbed the concept of universality: many (e.g. Medvedev and Klassen 1995) produced power spectral density forms based on theories such as Weinstock's nonlinear wave diffusion, Hines' doppler shifted theory, and the inconsistent linear instability theory. Focus then shifted towards deviations from the spectrum (e.g. Eckermann 1995), which leaves us thinking, "How *'universal'* is the universal spectrum anyway?"

I investigate the form of the gravity wave spectra between geographic locations (Negrocreek, ON and Eureka, NU), altitudes (selected altitudes between 1-14 km), and times (particular months throughout 2009). The Negrocreek radar station belongs to the O-Q Net; a network of stratosphere-troposphere radars across Ontario and Quebec operating around 50 MHz; managed by Dr. Wayne Hocking. CANDAC gathered additional data at the Eureka radar station, SAFIRE. In addition to the location, altitude, and time, gravity wave spectra differ due to the spectra's method of computation. Different windowing techniques result in differences between spectra and I discuss their effects.

Monday AM, 9:15-9:30

GPS Amplitude and Phase Scintillation Associated with Poleward Moving Sun Aligned Arcs

P. T. Jayachandran[1], K. Hosokawa[2], K. Shiokawa[3], Y. Otsuka[3], S. C. Mushini[1], C. Watson[1], J. W. MacDougall[4], P. Prikryl[5], R. Chadwick[1], and T. D. Kelly[1]

[1]Physics Department, University of New Brunswick, Fredericton, NB, Canada

[2]Department of Information and Communication Engineering, University of Electro-Communications, Tokyo, Japan.

[3]Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya, Japan.

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An All-Sky imager at Resolute Bay, Canada observed many cases of Poleward Moving Sun Aligned Arcs (PMSAAs) during the Winter of 2010. Three Global Positioning System (GPS) receivers of the Canadian High Arctic Ionospheric Network (CHAIN), intersecting the field of view of the imager, showed rapid fluctuations of signal amplitude and phase (scintillation) associated with many of the PMSAAs. These fluctuations were intermittent (durations <10 min) and seen near simultaneously on many available ray-paths irrespective of the orientation of the ray-path with the arc and its motion. This observation is contrary to the well accepted hypothesis that scintillation producing irregularity is formed only in certain parts of the plasma structure. Spectral analysis of the amplitude and phase scintillation associated with PMSAAs showed different spectral slope compared to other forms of scintillations. These results along with the fact that scintillation is seen on all available ray-paths suggests a different mechanism for the generation of the scintillation. Implication of the results for the understanding of the scintillation producing irregularities will be discussed.

Solar modal structure as observed by neutron monitors

Charlotte L Haley[1] and David J Thomson[1]

[1]Department of Mathematics and Statistics, Queen's University

This study confirms the presence of solar modal structure in secondary cosmic rays. Secondarily, we consider coherence estimates between neutron monitor data and local atmospheric pressure. Spectra from data obtained from the Bartol neutron monitoring database sampled over ~50 days from South Pole, Thule, and Newark are presented. These spectra are shown to have significant peaks corresponding to pressure (p-) and gravity (g-) mode frequencies obtained experimentally and theoretically, and in some cases, p-modes are present with high significance, with quality factor exceeding that expected from various other known terrestrial sources. These results agree with previous investigations of solar modal structure presence on Earth in atmospheric pressure, undersea ocean cable variations, and communications systems as well as in data collected from space (SoHo, ACE, Ulysses). Additionally, pressure modes appear in these data above the 500microHz acoustic cutoff - indicating the presence of "pseudomodes".This discovery contributes to a growing understanding of the sources of variations in cosmic ray incidence on Earth and in space.

Monday AM, 9:45-10:00

The IMF Dependence of the Magnetopause

J. Y. Lu[1, 2]

[1]College of Math & Statistics, Nanjing University of Information Science & Technology, Nanjing 210044, China.

[2]National Center for Space Weather, China Meteorological Administration, Beijing 100081, China.

Numerical results from a physics-based global magnetohydrodynamic (MHD) model are used to investigate on the location and shape of the magnetopause and A new global magnetopause surface model with dipole tilt angle effects is constructed to describe the cusps as well as the asymmetries of the magnetopause. The subsolar magnetopause is identified by using the plasma velocity and density, the cusp by using the current density, and the other area by the streamline and the current density. These data are fitted with the new three dimensional magnetopause model, and a new parameter is introduced to describe the deviation of the stretch direction of the magnetopause. Effects of IMF B_Y and B_Z on the magnetopause configuration parameters are analyzed and a series of function about these parameters are obtained. It is found that the stretch direction of the magnetopause is near the IMF direction, and the deviation angle of the stretch direction from the meridional plane is a little smaller than the deviation angle of the IMF direction. With increasing B_Z or B_Y, the stretch ratio will increase, and this effect of the southward B_Z is larger than the northward BZ. Also, the stretch effect by B_Y is evidently smaller than by B_Z.

Monday AM, 10:30-10:45

Two-dimensional model of coupled ionosphere and magnetosphere

Dmytro Sydorenko[1] and Robert Rankin[1]

[1]University of Alberta, Edmonton

A two-dimensional multi-fluid model of an active ionosphere coupled with the magnetosphere has been developed. The model resolves directions parallel and perpendicular to the geomagnetic field in the meridional plane, the dipole coordinates are used. A typical simulation area stretches from about one hundred km altitude in the bottom end to a few thousand km altitude at the top end. The transverse size of the simulation area varies from a few km to a few hundreds km. Frictional heating of electrons and ions, as well as heat exchange between ions, electrons, and neutrals are included. The ionosphere is perturbed by Alfven waves and/or energetic electron precipitation injected through the top of the simulation area. The model reproduces formation of oxygen ion upflows in response to intense Alfven waves or electron precipitation. Recently, a work has started on including neutral wind effects into the model. This work is a part of the cluster capacity-building project “Advancing the State of the Art in Measurements and Models of Ionosphere-Thermosphere-Magnetosphere Coupling” involving teams from the University of Calgary, the University of Alberta, and the York University.

Monday AM, 10:45-11:00

Solar Wind variations between L1 and the Earth's magnetosphere: ACE, THEMIS, Geotail and OMNI

Tasha Urbancic,[1] and Konstantin Kabin[2]

[1] Dept. of Physics, Queen's University, Kingston, ON

[2] Dept. of Physics, Royal Military College, Kingston, ON

The vast majority of magnetospheric processes are controlled, at least to some extent, by the parameters of the solar wind that continuously impinges upon the terrestrial magnetosphere. Spacecraft located near the L1 Lagrangian point allow nearly continuous monitoring of the solar wind, thus providing a crucial dataset for magnetospheric studies. Various techniques are used to estimate propagation of solar wind from the L1 point ~200 R_E upstream to the subsolar point of the terrestrial magnetosphere. These techniques range from a simple ballistic time delay to much more refined algorithms based on the minimal variance method. In our work we study correlations between observations by spacecraft located near L1 and those in the solar wind just upstream of the Earth magnetosphere. Recent observations by the THEMIS mission provide excellent opportunity to significantly extend and improve similar studies done in the past. Similar to earlier studies we find that the correlations between solar wind and IMF parameters decrease as the azimuthal distance between the satellites increases and improve as the length of the time interval considered increases. Somewhat surprisingly, we find that OMNI algorithm which is very commonly used to shift L1 data to the Earth magnetosphere quite often provides lower correlations with the near-earth spacecraft than the original ACE or WIND measurements.

Monday AM, 11:00-11:15

Orientation of solar wind dynamic pressure phase fronts

Brian J. Jackel[1], Taylor Cameron[1], and James M. Weygand[2]

[1]Physics and Astronomy Department, University of Calgary

[2]University of California, Los Angeles

Orientation of structures in the solar wind plays an important role when attempting to use upstream observations at L1 for prediction of subsequent conditions near the Earth. In this study, the relationship between solar wind dynamic pressure forcing and geosynchronous magnetic field response is used to determine a very large set of lagged correlations between the ACE and GOES satellites. Effects due to tilted solar wind structures are explored using the dispersion of arrival times relative to a simple phase plane model.

Assuming that structure phase front normal vectors were located in the GSE-xy plane, we found a characteristic azimuth of 15^0. Similar analysis carried out with velocity scaling according to the Parker spiral model did not produce an improved fit. Binning by average IMF B orientation produced a clear pattern in characteristic azimuth, with phase front normals perpendicular to both the predominant Parker spiral orientation and the less common ortho-spiral configuration. An empirical relationship was found to predict phase front normal azimuth over the entire range of observed IMF azimuths. The effects of lateral displacement from the Sun-Earth line in the GSE-z direction are comparable to those for GSE-y, indicating that solar wind structures are often significantly inclined with respect to the ecliptic plane.

Monday AM, 11:15-11:30

Modeling high impact low frequency geomagnetic disturbances using magnetic field data from solar-orbiting spacecraft

Dave Riegert[1] and Aaron Springford[1] and David Thomson[1]

[1]Queen's University at Kingston

Solar geomagnetic disturbances are of primary concern for power transmission, especially at high latitudes where the Earth's magnetic field is less shielding to extreme solar events. Bonneville Power Administration (BPA) has identified the prediction of high-impact low frequency (HILF) geomagnetic disturbance / geomagnetically induced currency (GMD/GIC) events as a key research and development gap. Although various government agencies (e.g. NRCan, NOAA) provide short-term (hours to days) forecasts of space weather that can be used for more immediate management of power transmission, there is a need for longer-term space climate forecasts that can inform management and planning processes over an extended time horizon. In this talk we outline our proposed approach for tackling longer-term space climate forecasts using solar gravity modes and present work completed thus far.

Solar gravity modes (g-modes) are detectable from spacecraft measurements of the solar wind [Thomson et al, Nature: 376, 1995]. Solar g-modes are oscillations that originate inside the Sun that can persist over thousands of years. Solar surface events such as flares and coronal mass ejections (CMEs) are thought to be driven by subsurface mixing processes, which implies a link between gravity modes and surface events. Flares and CMEs can in turn cause HILF GMDs on Earth, depending on prevailing conditions. Therefore, the detection of g-modes in the solar wind thus suggests that associated GMDs might be forecast six months or further into the future using spacecraft measurements. A key unknown that could limit how far ahead prediction can occur is to what degree auxiliary characteristics of g-modes (e.g. polarization) are stationary or predictably varying.

Monday AM, 11:30-11:45

A survey of quiet arc morphologies and the effects of the interplanetary magnetic field on arc orientation.

D. Megan Gillies[1], Eric Donovan[1], David Knudsen, Emma Spanswick[1], Charles Hansen[1], Dylan Keating[1], and Stephanie Erion[1]

[1]Department of Physics and Astronomy University of Calgary 2500 University Drive NW Calgary, AB, Canada T2N 1N4

We present one of the first extensive studies of auroral arc morphology using the THEMIS ground-based all-sky camera array. Over 5,000 images of geomagnetically quiet auroral arcs at various geomagnetic latitudes and longitudes were identified. Their orientation and multiplicity were recorded and the results are presented in the following study. In particular, the degree of alignment of these arcs with lines of constant geomagnetic latitude was investigated. An extremely high degree of alignment was observed that strongly suggests the overall arc morphology is governed by the large-scale structure of the magnetosphere as opposed to localized processes within the ionosphere. We determined that both single and multiple arc systems tend to deflect a few degrees to the south-east prior to 23 MLT and to the north-east afterwards. This degree of deflection was more prominent at higher latitudes. In addition, we studied the effects of the interplanetary magnetic field (IMF) on the location (in magnetic local time) of the reversal of the auroral arc deflection. We found that negative IMF B_x and B_y conditions cause the auroral arc orientation reversal location to shift duskward. Alternately, a positive IMF $B_{x,}$ coupled with a negative $B_{y,}$ results in a shift in reversal location towards magnetic midnight. Finally, we quantified the occurrence rate and geomagnetic conditions of single and multiple arc systems and determined that they are comparable which indicates that arc theories need to account for the formation of multiple arcs.

Monday AM, 11:45-12:00

Quiet-time Transport of Ionospheric Oxygen Ions between the Ionosphere and the Inner Magnetosphere

Andrew Yau[1], Andrew Howarth[1], William Peterson[2], Takumi Abe[3],

[1]University of Calgary, Canada

[2]LASP, University of Colorado, USA

[3]JAXA/ISAS, Japan

The presence of energetic O^+ ions in the ring current at the onset of a magnetic storm prompts the question of the possible role of "in-transit" ionospheric O^+ ions between the ionosphere and the inner magnetosphere (plasma sheet and ring current) in the quiet periods immediately preceding the main phase of a magnetic storm. We use single-particle trajectory simulation to study the transport of polar wind O^+ ions from the high-altitude polar cap in the periods preceding a number of large magnetic storms. Due to centrifugal ion acceleration at higher altitudes, about 10-20% of low-energy O^+ ions reaches the plasma sheet during such periods; the actual percentage is a factor of ~3 larger in the dusk sector on average compared with the dawn sector and dependent on the IMF and the O^+ ion temperature. This provides a low but non-negligible flux of O^+ ions between the ionosphere and the inner magnetosphere, and a significant "in-transit" oxygen ion population preceding a magnetic storm, which could explain the presence of energetic O^+ ions at the onset of the main phase of the storm.

Monday AM, 12:00-12:15

Radar Operation using real-time deconvolution

Wayne.K. Hocking[1]

[1]University of Western Ontatio

Traditional radars using a sequence of steps to record data. Usually the RF signal is changed in frequency to an Intermediate Frequency, then beaten to baseband, whereupon the data are converted to inphase and quadrature components for subsequent Fourier analysis. This process is all performed in hardware, using splitters, amplifiers and mixers.

We have developed a new procedure that avoids almost all of this hardware, and allows data to be digitized at the incoming RF frequency and processed in real-time. In addition, real-time deconvolution is applied, allowing optimal height resolution at low cost. We are able to achieve resolutions of typically 50m and less using pulses several km long, allowing simultaneous high power and good resolution.

Resutlts obtained from several radars will be presented.

Monday PM, 13:30-13:45

The motion and distortion of auroral patches

Donovan[1], Eric, Kyle Rae[1], Emma Spanswick[1], Megan Gillies[1], David Knudsen[1], Sarah Jones[2], Allison Jaynes[3], and Marc Lessard[3]

[1]Department of Physics and Astronomy, University of Calgary

[2]NASA Goddard Space Flight Center

[3]Earth, Oceans and Atmospheres, University of New Hampshire

Patchy pulsating aurora occurs commonly in the post-midnight sector. Recent studies have moved us significantly closer to understanding exactly how specific plasma waves lead to the pitch angle scattering of the CPS electrons that in turn produce these aurora. We do not, however, have an adequate explanation for how these patches are formed, why their shapes are in general long-lived, and what causes their motion. These patches last for tens of minutes, with sizes that do not change significantly over their life time, and remain more or less stationary relative to the ground. Here we use THEMIS and NORSTAR ASI observations of these patches to explore the evolution of their shape and motion. Based on our results, we conclude that the patches are the ionospheric counterpart of structures in cold plasma near the magnetospheric equator.

Bow Shock Dynamics as observed by the Cluster satellites

Thamer Y Alrefay[1]

[1]Physics Department University of New Brunswick.

The location, shape and motion of the Earth's bow shock are investigated using observations based on measurements made by the cluster spacecraft quartet. Several bow shock crossings have been identified and carefully characterized according to several relevant plasma parameters; a collection of 133 shocks has been selected and analysed using a timing method. The results of this investigation are compared with both Gas Dynamics and Magnetophydrodynamics bow shock models.

We have found that, on a statistical basis, the shock standoff position derived from the timing method agrees well with the Gas Dynamics predictions for high Mach-number cases only. Statistical models provide a good overall agreement on bow shock shape only, for near ecliptic sections. Significant shock ripples are seen at relatively high ecliptic latitudes. Finally, we have found no evidence that the Mach number controls the shock velocity. However, interplanetary disturbances with significant changes in ram pressure cause high shock speeds larger than ~ 100 km/s that are consistent with Gas Dynamics models.

Recent radio science research relevant to CASSIOPE/ePOP

Gordon James[1]

[1]Communications Research Centre, 3701 Carling Avenue, Ottawa ON K2H 8S2

The CASSIOPE/ePOP launch is expected this year. An ePOP Principal Investigators' Meeting on 25-26 February and Fifteenth Science Team Meeting this coming March 11 will consolidate the planning of ePOP experiments and the roles of Science Team members in supporting spacecraft operations.

The current list of experiment concepts rests largely on agreements reached by the Team in the past, and has various members serving as promoters of specific techniques. Broadly, radio scientific topics continue to include studies of ionospheric structure with probing waves at various electromagnetic (EM) wavelengths, high-frequency heater experiments, and passive detection of spontaneous EM emissions of the ionosphere-magnetosphere system.

Recently published research has widened the possibilities of ePOP investigations. Results from satellite and ground programs have shed new light on EM phenomena observable in low earth orbit (LEO). The measurable levels of up-going very low frequency (VLF) transmissions in the low ionosphere have in some cases been found to be 20 dB below calculated values; an understanding of this disparity is needed by observers on the ground who wish to know and interpret the intensity of spontaneous magnetospheric sources. The LEO observation of VLF saucers has shed new light on the nature of that emission but leaves unanswered the pivotal question of how its broadband VLF source can remain apparently fixed for ~10 s in the top side ionosphere. Continuing observations of medium and high frequency auroral emissions on the ground from sources in the bottom side and the top side ionosphere have fed discussion about whether the same electrostatic to electromagnetic conversion processes (e.g., at $f_{uh} = \mathrm{n}f_{ce}$) proposed for the generation in the bottom side ionosphere could operate in the topside and thus be detectable by ePOP.

The increase in the number of ground HF sources of the SuperDARN or CADI types, or of the GPS receivers, deployed across N. America multiplies the opportunities for ePOP modelling of density structures available from these EM-wave probes

High resolution studies of wind and turbulence using MST radar in Costa Rica

Marcial Garbanzo-Salas[1] and Wayne Hocking[1]

[1]University of Western Ontario

A description of the radar in Costa Rica is given. The new design of this radar consisting of (i) state of the art receivers, (ii) improved digitization process, (iii) large bandwidth and (iv) the application of Fourier Theory for path information recovery, allows spatial resolution better than 50 m. Preliminary atmospheric structure information and other results are shown.

Electron energization and wave dispersion in a mirror kinetic Alfven wave

Peter Damiano[1] and Jay R. Johnson[1]

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Alfven waves in which mirror force effects dominate the parallel electric field generation can be termed mirror kinetic Alfven waves (Nakamura, JGR, 2000). Examples can be global scale Alfven waves (Field Line Resonances) that stand along the Earth's closed dipolar magnetic field lines and have been observationally linked to the formation of some auroral arcs. We use a hybrid MHD-kinetic model, that self-consistently couples the cold plasma MHD equations to a system of kinetic guiding center electrons, to explore the characteristics of these global modes. It is found that mirror force effects self-consistently result in parallel potential drops sufficient to accelerate electrons to keV energies (in order to carry the field aligned current) and the wave energy dissipated in this acceleration can damp the wave in a few Alfven cycles. In conjunction with the acceleration, there is also a structuring in the temporal evolution of the electron energization that scales with the electron bounce frequency and a cross-scale coupling from the global driver to kinetic scales that fragments the parallel current region. The perpendicular Poynting flux associated with the parallel electric field disperses wave energy perpendicular to the magnetic field leading to a broadening of the parallel current region as electrons are accelerated along adjacent field lines. For ambient plasmasheet electron temperatures, this mirror force induced dispersion dominates over that associated with electron inertial effects.

Monday PM, 14:45-15:00

EFFECTS OF ION TEMPERATURE ANISOTROPY AND SHEARS ON PFISR THEORETICAL INCOHERENT SCATTER SPECTRUM OF STABLE CDEIA MODES IN THE TOPSIDE AURORAL F REGION

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Temperature anisotropies may be encountered in space plasmas when there is a preferred direction, for instance, a strong magnetic or electric field. In the high-latitude ionosphere, the perpendicular temperature can be enhanced by low frequency waves or as a result of frictional heating due to the presence of a perpendicular electric field. For small values of electric field or when the ion convection velocity is smaller than the neutral thermal speed, a bi-Maxwellian can be useful to describe the ion velocity distribution. Moreover, perpendicular shears in FA ion velocities are expected to be present near auroral arc edges, coexisting with ion outflow processes and large parallel thermal drifts. In this study, a shear-modified CDEIA dispersion relation is generalized to include ion thermal anisotropy and collisions in order to make it most relevant to F region radar observations. A new fluid-like expression for the critical drift which depends explicitly on ion anisotropy is derived. Instability threshold conditions for different frequencies are computed. For realistic F-region conditions, ion temperature anisotropy may significantly lower the drift required for the onset of instability, especially for intermediate and large aspect angles and a broad range of frequencies. Then, the effects of ion shears and anisotropies on the theoretical PFISR spectrum for a topside F region stable and collisionless plasma have been studied when the radar is pointing 15^{o} away from the magnetic field. In some cases, it was found that one of the ion-acoustic shoulders can be significantly enhanced. Therefore, preliminary results indicates that shears and thermal anisotropies could play a role in the CDEIA generation mechanism of NEIAL's.

Electron heating in the lower ionosphere at low latitude: are parallel currents more common than we think?

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The E region night time ionosphere at low latitude is supposed to be free of heating from solar radiation or precipitation. However, the electron temperature in this region has on many occasions been seen to reach of the order of 1000 K at altitudes lower than 120 km. The temperature signatures are particularly clear in trough regions sandwiched between sporadic (Es) layers. It is argued that the only viable mechanism for the heating is the friction produced by parallel currents carried by electrons. Based on a recent rocket flight, the current generator appears to be the night-time F region dynamo. It is noted that the electron temperatures are also elevated in the Es layers and that the parallel currents there are likely the divergent Pedersen currents triggered by a combination of the meridional/vertical electric field and the sharp vertical plasma density gradients in the Es layer.

Monday PM, 15:45-16:00

A Radiation Hardened Digital Fluxgate Magnetometer for Space Applications

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Space-based measurements of the Earth's magnetic field are required to understand the plasma processes of the solar-terrestrial connection which energize the Van Allen radiation belts and cause space weather. This thesis describes a fluxgate magnetometer payload developed for the proposed Canadian Space Agency's Outer Radiation Belt Injection, Transport, Acceleration and Loss Satellite (ORBITALS) mission. The instrument can resolve 8 pT on a 65,000 nT field at 900 samples per second with a magnetic noise of less than 10 pT per square--root Hertz at 1 Hertz. The design can be manufactured from radiation tolerant (100 krad) space grade parts. A novel combination of analog temperature compensation and digital feedback simplifies and miniaturises the instrument while improving the measurement bandwidth and resolution. The prototype instrument was successfully validated at the Natural Resources Canada Geomagnetics Laboratory, and is being considered for future ground, satellite and sounding rocket applications.

Monday PM, 16:00-16:15

Superposed epoch study of geomagnetic storm sudden commencements: Understanding space weather effects on power systems

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During periods of enhanced geomagnetic activity, geomagnetically induced currents (GIC) flow in power systems potentially causing damage to system components or failure of the system. The largest GIC flow when there are large rates of change of the geomagnetic field (dB/dt). These conditions are present during periods of intense geomagnetic activity called geomagnetic storms and are caused by sudden strong variations in the solar wind. In this study, we investigate the risk posed by the sudden enhancement of the geomagnetic field that precedes a geomagnetic storm. For some events, we show that the amplitude of the enhancement and the dB/dt are largest at high magnetic latitudes over Canada. Using data from the Super Dual Auroral Radar Network (SuperDARN) we determine the source of this effect. We are also investigating the solar wind conditions that cause this enhanced risk for Canadian power systems.

GPS phase scintillation and proxy index at high latitudes: A case study

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Ionospheric phase scintillation was observed at high latitudes during a moderate geomagnetic storm (*Dst* = −61 nT) that was caused by a moderate solar wind plasma stream compounded with the impact of two coronal mass ejections. The most intense phase scintillation occurred in the cusp and the polar cap, where it was colocated with strong ionospheric convection and a tongue of ionization. In the auroral zone, moderate scintillation coincided with auroral breakups observed by an all-sky imager, a riometer and a magnetometer, all at Yellowknife. At subauroral latitudes, a subauroral polarization stream that was observed by mid-latitude SuperDARN radars produced only weak scintillation. The amplitude and phase scintillation indices were obtained as usual by specialized GPS Ionospheric Scintillation and TEC Monitors (GISTMs) from L1 signal recorded at the rate of 50 Hz. The scintillation indices S_4 and σ_Φ were stored in real time from an array of high-rate scintillation receivers of the Canadian High Arctic Ionospheric Network (CHAIN). To overcome limited geographic coverage by GISTMs other GNSS data sampled at 1 Hz were used to obtain scintillation proxy index (delta phase rate, *DPR*). The 50-Hz and 1-Hz phase scintillation indices are correlated and the percentage occurrences of σ_Φ and *DPR* exceeding given thresholds, mapped as a function of magnetic latitude and magnetic local time, are very similar.

Mesospheric Ozone Determination from the Radar Meteor Echo Duration

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Thousands of meteors enter Earth's atmosphere daily, with well understood diurnal and seasonal cycles. Collisions with upper atmospheric gases at altitudes between 80 – 100 km cause frictional heating and ablation which result in an ionized meteor trail containing electrons and positive ions. Radar detects electrons in the meteor trail, which can be classified in two distinct trail types; underdense with low electron density ($q<10^{14}$ el/m) and overdense where $q>10^{14}$ el/m. In the mesospheric region it is assumed that ambipolar diffusion is the dominant mechanism in radar echo decay time (Jones, 1975). Ambipolar diffusion has been used in the past to estimate mesospheric parameters such as temperature (Hocking et al, 1997). Overdense meteors and their radio echo durations are valuable tools for study of the upper atmosphere, especially of the secondary ozone layer between 80-100 km, where gradual ozone depletion had been observed in the past. Recent work however indicates additional mechanisms governing the meteor decay times (Dimant and Oppenheim, 2006). Maximum and minimum meteor decay times are observed at 83 and 96 km, respectively (Ballinger et al, 2008), which closely coincide with the beginning and the peak of the secondary ozone layer (Smith et al., 2008). Such observations of meteor decay times diverge from the predicted ones using the ambipolar diffusion only and should be scrutinized further by investigating the role of ozone chemistry (initial oxidation and dissociative recombination) in the process of meteor trail deionization and subsequent impact on decay times, expanding on previous work (eg. Baggaeley and Cummak, 1974). Moreover, the duration of overdense meteor echoes has been directly linked to the mesospheric ozone concentration in the past (Jones and Jones, 1990). In the light of more complete understanding of the mesospheric chemistry (Plane, 2012), we are developing the improved method of using meteor radar and meteor echo duration times along with experimentally derived diffusion coefficients to evaluate mesospheric ozone content with more accuracy. Our results will be validated by comparing data collected by OSIRIS.

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Impact of plasma sheath on rocket-based E-region ion measurements

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We model the particle velocity distribution functions around the entrance window of the Suprathermal Ion Imager (SII) to assess the impact of payload sheath ion measurements in the E-region ionosphere. The SII sensor is an electrostatic analyzer that measures two dimensional slices of the distribution of the kinetic energies and arrival-angles of low energy ions. The study is concerned with the interpretation of data obtained from an SII that was affixed to a 1-m NASA rocket 36.234 as part of the Joule II mission to investigate Joule heating in the E-region ionosphere. The rocket flew into quiet auroral conditions above Northern Alaska on 19 January 2007. The payload was spin-stabilitized with a period of 1.6 s, giving an apparent rotation of the ion flow velocity in the frame of reference of the SII. We numerically investigate the spinning effect on the ions velocity distributions in the vicinity of SII aperture at an altitudes of approximately 150 km. The electrostatic sheath potential profiles surrounding the sensor and payload are calculated numerically with PTetra. PTetra is based on a particle in cell approach by considering plasma species with physical masses and charges. The model is purely electrostatic but it accounts for a uniform background magnetic field. It is observed that the direction of the ion flow velocity vector modifies the plasma sheath potential profile. This in turn impacts the velocity distributions of NO+ and O+2 ions. The velocity distribution functions are calculated by using test-particle modeling. These particle distribution functions and corresponding particle fluxes on the microchannel plate (MCP) are also presented.

Acknowledgments

We thank D. Knudsen and R. Pfaff for providing data for this study. This work was supported by the Natural Sciences and Engineering Council of Canada. The simulations used in this work was made use of the westgrid computation infrastructure.

Tuesday AM, 8:30-8:45

ULF Wave Acceleration and Loss in the Radiation Belts: New Results from CARISMA and the Van Allen Probes Mission

I.R. Mann[1] and the CARISMA and NASA Van Allen Probes Mission Teams.

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Ultra-low frequency (ULF) waves in the Pc4-5 band can be excited in the magnetosphere by the solar wind. Much recent work has shown how ULF wave power is strongly correlated with solar wind speed. However, little attention has been paid the dynamics of ULF wave power penetration onto low L-shells in the inner magnetosphere, and their effect on radiation belt electrons. Similarly, recent research has revealed how electromagnetic ion-cyclotron (EMIC) waves can be excited for many hours, providing a potential pathway for loss of MeV electrons via scattering into the loss cone. Using historical statistical data sets, and case studies, we examine the role of long period Pc5 ULF and EMIC waves in radiation belt acceleration, transport, and loss. The combination of data from ground arrays such as CARISMA and the contemporaneous operation of the NASA Van Allen Probes mission offers an excellent basis for understanding this cross-energy plasma coupling which spans more than 6 orders of magnitude in energy. Explaining the casual connections between plasmas in the plasmasphere (eV), ring current (keV), and radiation belt (MeV), via the intermediaries of plasma waves, is key to understanding inner magnetosphere dynamics. Future high apogee Canadian missions such as Polar Communications and Weather offer further exciting opportunities for not only new scientific discoveries but also space radiation and space weather effects mitigation in this niche area of Canadian expertise.

This work has received funding from the European Union under the Seventh Framework Programme (FP7-Space) under grant agreement n 284520 for the MAARBLE (Monitoring, Analyzing and Assessing Radiation Belt Energization and Loss) collaborative research project.

Tuesday AM, 8:45-9:00

Longitudinal structure of the 135.6 nm ionospheric emission: Preliminary results from the Canadian Ionosphere-Atmosphere Model

Oleg V. Martynenko[1], Victor I. Fomichev[1], Kirill Semeniuk[1], Stephen R. Beagley[1], William E. Ward[2], and John C. McConnell[1]

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[2] Physics, University of New Brunswick, Fredericton, NB, Canada

The development of whole atmosphere models extending from the surface up to the ionosphere is a new field which is recently attracting more attention of the geophysical community. One of the primary goals of whole atmosphere modeling is to determine how lower atmosphere dynamical variability would propagate into and affect the upper atmosphere and ionosphere. As the first step toward developing a whole atmosphere model in Canada, termed the Canadian Ionosphere-Atmosphere Model (Canadian IAM or C-IAM), the extended Canadian Middle Atmosphere Model (CMAM) has been coupled with Murmansk's ionospheric Upper Atmosphere Model (UAM). To determine whether this model system is capable to capture the effect of the upward penetrating waves generated in the lower atmosphere on the ionospheric structure, it was used to reproduce the longitudinal structure of the 135.6 nm ionospheric emission observed by the IMAGE-FUV imager. These observations show four emission peaks in longitude in the equatorial region at 8 pm local time (and hence 4 peaks in electron/ion density), a pattern which cannot be obtained with the ionospheric model alone. Results obtained with the CMAM-UAM model system show good agreement with the observations. Analysis of the model results also suggests that the main mechanism for generating this longitudinal structure of the ionospheric emission is a modification of the ionospheric electric field in the E-region caused by differences in the diurnal evolution of the zonal wind in different longitudinal sectors due to waves penetrating from the lower atmosphere.

Tuesday AM, 9:00-9:15

Computerized Ionosheric Tomography; Reconstruction of Ionosphere Electron Density Profiles Using Modelled TEC Measurements From ADS-B Model

Alex Cushley[1] and Jean-Marc Noel[1]

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The proposed launch of a CubeSat carrying an ADS-B receiver by RMCC will create a unique opportunity to study the effect of the ionosphere as the signals propagate from the transmitting aircraft to the passive satellite receiver(s). The modification of a radio wave as it propagates through the ionosphere can be used to characterize the ionosphere and reveal a better understanding of magnetoionic wave propagation. A previously validated ray tracing program was used to determine characteristics of the wave, including the wave path and the full polarization state, at the satellite receiver. It has been shown that Faraday Rotation measurements from the received aircraft signals are detectable, and can be used to calculate the TEC along the ray paths. TEC measurements have been used previously from differential Navstar Global Positioning System (GPS) signals received at ground stations for ionospheric mapping, however are constrained in their geometry and deployment. The inverted ADS-B model involves a moving receiver, and multiple transmitting aircraft creating a spatially, and temporally dense basis for ionospheric computerized tomography as used for MRI scans in medical physics.

Tuesday AM, 9:15-9:30

Comparison of reported uncertainty and measurement variability of Incoherent Scatter Radar measurements

William Archer[1], David Knudsen[1] and Johnathan Burchill[1]

[1]University of Calgary

The uncertainty (error bars) distributed by ISR facilities along with their data represents the goodness-of-fit of measured spectra returned from the atmosphere compared to a theoretically derived ISR spectrum. This goodness-of-fit is inherently dependent on the variability of the ISR measurement over its integration period as well as system noise. The point-to-point variability between consecutive measurements also inherently depends on intra-measurement plasma variability and noise but also depends on inter-measurement plasma variability.

I will compare these two quantities (measurement variability and reported measurement uncertainty) and compare them under varying plasma conditions. This comparison allows us to characterize the relative importance of geophysical variability and system noise in characterizing the ionosphere and its dynamical behavior.

Tuesday AM, 9:30-9:45

The Next Generation of UV Imaging - Modeling System Performance

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[2]Computational Physics Inc.

Over the last 40 years, there have been great successes in auroral imaging from space. Still, we must acknowledge that there are shortcomings. For example, true daylight suppression has eluded us, and the dynamic range of past auroral imagers has not been sufficient to allow for reliable determination of the open-closed boundary (OCB) from auroral images. As well, the spatial resolution of satellite-borne imagers to date has not been sufficient to enable tracking of dynamic auroral features such as arcs. Technological advances over the last 10-20 years has made it possible to revisit the UV Imaging problem, and design new and innovative instruments capable of producing data to address most, if not all, of these previous shortcomings. In this paper we present an end-to-end system model of UV filter performance using recently obtained industry test results. We discuss how advances in thin film filter coatings, coupled with new efficient optical designs will allow for accurate specification of the auroral distribution at all local times, for near-perfect suppression of daylight and thus excellent dayside auroral imaging, and spatial resolution allowing for identification and tracking of arcs, patches, and other features that have never been imaged globally.

Tuesday AM, 9:45-10:00

Upwelling from Joule heating at unusually high altitudes.

Jean-Pierre St-Maurice[1]

[1]Institute of Space and Atmospheric Studies, University of Saskatchewan

Observations from the accelerometer on the CHAMP satellite have revealed unexpectedly high densities above 400 km in the cusp region. Another intriguing result is a second density enhancement around the same altitude near the equatorial anomaly, 10 degrees away from the magnetic equator. It is proposed here that in both cases there is a form of Joule heating involved, with for origin the zonal neutral wind near the equator and DC or AC electric fields near the cusp. The difference with normal situations is the altitude at which the heating is taking place. The altitude is so high that the work done by the heating goes mostly into upwelling. It is argued that the dominant factor in controlling the upwelling rate is the ion density and that the ambient neutral density is not involved, to first order, in a determination of the relative density changes in the ensuing convection cells.

Tuesday AM, 10:30-10:45

First simultaneous observations of gravity wave signatures in wind (vertical and hortizontal) and airglow

William Ward[1], Samuel K. Kristoffersen[1], and Chris Vail[1]

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Observations of wind and airglow radiance have been undertaken at the Polar Environment Atmospheric Research Laboratory (Eureka, Nunavut) for the past four years. Winds have been observed using a field widened Michelson interferometer, termed ERWIN II (E-Region Wind Interferometer II) and radiance measurements have been taken with ERWIN II and the PEARL all sky camera. Together these instruments provide a unique view of the dynamics of the Polar mesopause region. Vector winds from ERWIN II are obtained by determining Doppler shifts in airglow emission lines with a precision/accuracy of ~ 1 m/s in 45 s. These are the most precise and fastest wind measurements ever obtained from an optical instrument observing this region of the atmosphere and allow gravity wave signatures in horizontal and vertical winds to be determined. We report on several instances of short term variations in the wind measurements which are correlated with the airglow radiance variations seen with ERWIN II and the PEARL All Sky Imager. These are shown to be consistent with what is expected from gravity waves.

Tuesday AM, 10:45-11:00

ABOVE: an Array for Broadband Observations of VLF/ELF Emissions

Cully, C.M. [1]

[1]University of Calgary

Understanding particle acceleration and loss due to wave-particle interaction in the inner magnetosphere requires observations across a wide range of scales and from a variety of locations. High-altitude missions such as the Van Allen Probes provide extremely detailed in-situ observations at a very limited number of points. In contrast, ground-based arrays can simultaneously monitor a great volume of space, but are necessarily remote and less detailed. All of these scales are important to understanding this problem.

The University of Calgary is deploying a CFI-funded array of ground-based VLF/ELF receivers and riometers (ABOVE: an Array for Broadband Observations of VLF/ELF Emissions) to augment existing Canadian ground-based facilities such as CARISMA, Norstar and SuperDARN. The ABOVE instruments monitor electromagnetic waves in a frequency rage covering whistler-mode chorus and hiss emissions, and will also monitor high-energy electron precipitation into the atmosphere. The large physical scale monitored by these instruments will form an excellent complement to detailed but highly localized in-situ measurements (RBSP, THEMIS, etc.).

This presentation will cover the details and current status of the ABOVE project, complementarity with other space-based and ground-based resources, and how potential users can immediately access ABOVE data to use in their research.

Development and Validation of a Semi-empirical Code for Solar Wind Prediction

Ljubomir Nikolic and Larisa Trichtchenko

Geomagnetic Laboratory, Natural Resources Canada, Ottawa

The adverse effects of the Sun-to-Earth phenomena on modern technologies and human activities have spurred interest in the Space Weather (SW) research and products. There is a growing demand for the SW services from government agencies, power-grid companies, aviation, pipeline operators and GNSS users. The Canadian Space Weather Forecast Center is developing a number of numerical tools to enhance its prediction capabilities. Here, we report on the development of a numerical code that provides 1-4 day forecast of the solar wind speed. The code is based on the potential field source surface and Schatten current sheet models used to derive global magnetic field of the solar corona from observations of the photospheric fields. Using an empirical Wang-Sheeley-Arge relation, the solar wind is assigned to the open magnetic field lines and then propagated towards the Earth taking into account the overtaking between slow and fast solar wind streams. A good agreement between numerical results and observations of the solar wind speed by the ACE satellite has been found.

Tuesday AM, 11:15-11:30

Density enhancements in the thermosphere and lower exosphere during the geomagnetic storms of October 2003 and November 2003

A.T. Russell[1], K. Kabin[1], D. Burrell[1], and J.-M. Noel[1]

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The U. S. Space Surveillance Network routinely publishes Two Line Element sets (TLEs) for all unclassified objects orbiting the Earth. This extensive database allows satellite operators to predict the orbits of all unclassified objects into the near future, reducing the risk of a collision between satellites and/or orbiting debris. TLEs can also be used to infer neutral densities in the thermosphere, providing a very large database of neutral densities under a variety of geophysical conditions. Density enhancements inferred from polar orbiting objects in low Earth orbit during the geomagnetic storms of October and November 2003 indicate that neutral density enhancements associated with these storms persist to 1000 km altitude. Similarities and differences in the characteristics of the density enhancements will also be discussed.

Characteristics of GPS TEC variations in the polar cap ionosphere

Chris Watson[1], P.T. Jayachandran[1] and J.W. MacDougall[2]

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The highly dynamic polar cap ionosphere is problematic for ground and satellite communications, including GPS. Largely due to inadequate observational capabilities in this region, generation mechanisms and source regions of polar ionospheric irregularities are not well understood. We have used four high data rate GPS receivers in the Canadian Arctic to conduct a one year statistical study of low frequency (< 50 mHz) variations in GPS total electron content (TEC) in the polar cap. Characteristics (e.g. frequency, amplitude) of TEC variations were examined as a function of magnetic local time, latitude and solar wind condition in an attempt to link these variations to particular source regions. Co-located ionosonde radars were used to estimate altitudes of ionization structures associated with the variations in TEC. F region variations showed strong seasonal, diurnal and IMF dependence, with occurrence and amplitude peaks during the fall months, in the dayside ionosphere, and for high dayside IMF-magnetosphere merging rates. Occurrence of F region TEC variations was highly dependent on the dawn-dusk IMF orientation, with morning (afternoon) variations occurring more often for dusk-ward (dawn-ward) oriented IMF. Frequencies of these variations were typically less than 5 mHz. E layer variations in TEC showed little IMF or seasonal dependence, and were mainly confined to the dawn-dusk flanks of the magnetosphere. These variations occurred at a broad range of frequencies ranging from 0.4 – 40 mHz, with both broadband and harmonic spectral components observed in individual events. The frequency distribution for all TEC variations revealed peaks at 0.6, 2.0 and 4.0 mHz, with the 2.0 and 4.0 mHz peaks originating from dayside latitudes immediately poleward of the cusp. These results and their implications will be discussed.

Tuesday AM, 11:45-12:00

Advancing the State of the Art in Measurements and Models of I-T-M Coupling

David Knudsen[1] Johnathan Burchill, Eric Donovan[1], Robert Rankin[2], Dmytro Sydorenko[2], Jack McConnell[3], and Victor Fomichev[3]

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While the importance of energy coupling between the magnetosphere, ionosphere and thermosphere is widely recognized, there has to date been no coordinated effort to incorporate a realistic model of this coupling into thermospheric models, or conversely to monitor and characterize the effect of neutral atmosphere dynamics on the ionosphere and magnetosphere. The objective of this project is to address this situation by applying newly-available, state-of-the-art tools – both observational and numerical – to the study of the critically important ionosphere-thermosphere interface that spans altitudes of approximately 90-200 km. The project, the focus of a CSA Cluster Pilot grant, will involve trainees at the graduate and post-doctoral levels, and will prepare them to sustain and advance, well into the future, Canada's position as a world leader in observations and simulation of the geospace-atmosphere system.

An analysis of successive F-region ionization patches under prolonged Southward IMF conditions

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

Frequency parameters of the interplanetary magnetic field during large Forbush decrease events

G. Kalugin[1] and L. Trichtchenko[1]

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Extreme Space Weather (SW) events such as Coronal Mass Ejections (CMEs) can cause strong geomagnetic storms and have severe impacts on critical infrastructures. In particular, extreme SW effects can disrupt communications from satellites and produce geomagnetically induced currents in power systems. They also affect the cosmic radiation environment and change the radiation dose for aircrew on polar flights. Common-used tools to observe cosmic ray (CR) variations today are neutron monitors and muon telescopes. Canada has a long history of using CR detectors for monitoring the particles at ground level. For example, a neutron monitor located in the University of Calgary was running for decades. The monitor ceased operation in 2011 but now there are plans to bring it back into operational use. CR monitoring is also a potential source of information that can be used for SW monitoring and forecasting.

The main goal of this study is searching for the signatures of the interplanetary CMEs in CR intensities. Specifically, CRs often experience a rapid decrease in intensity associated with CMEs, which is called Forbush decrease. The hourly variations of the muon intensity for each year are obtained using data from the Nagoya muon telescope, and few large events in CRs are identified. A crucial factor in modulation of CR muon intensity is the interplanetary magnetic field (IMF). Many features of IMF are reflected in its power spectrum. The IMF-spectrograms produced by use of ACE level 2 data are analysed for the identified Forbush decrease events. A connection between the power spectrum of IMF and the diffusion coefficient in the transport equation for cosmic rays is considered.

Tuesday PM, 14:00-14:15

Propagation of the scalar electric potential in the ionosphere

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Numerical models of the coupled ionosphere and electrodynamics (I-E) in the polar oval, which may include thermospheric dynamics (I-T-E) as well, have produced many interesting results. Comparing these results to observations would generally require ionospheric parameters from ISR observations and simultaneous electrodynamic parameters from coincident satellite overflight, on spatial scales which match those under study. One of these inherent challenges is at least partially solved by the observation of drifting auroral arcs using ISR and optics, although the spatial resolution achieved does not provide a very strong test of model output. However it seems clear that in at least one parameter, the perpendicular electric field strength, the variation normal to the arc is greater than our model output would allow, enough so that either some missing physics or a wrong assumption is the cause.

In our recent AGU poster we enumerated four possible factors which might explain the differences. Here we shall focus on the electrodynamic propagation. Several models, including ours, have used time-independent solvers for the scalar electric potential. This approach is valid below about 1000 km, considering the relatively long time scales of typical interest compared to the propagation time for Alfvén waves. But some physical terms which may be relevant to the parallel thermal currents flowing in and out of the top of the domain are only significant above 1000 km. Moreover a thorough understanding of the ionosphere will ultimately require models which couple to inter-hemispheric magnetosphere models. Therefore we desire a better understanding of the time-dependent propagation of the electric potential in a magnetised plasma including, crucially, perpendicular propagation in the E-region.

ELEPHANT experiment modelling with PTetra

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An ELEPHANT experiment on probe-plasma interaction is modelled with the PIC code PTetra, and preliminary simulation results are compared with measurement. Experiments in the ELEPHANT facility are designed for simulating the interaction of material objects with plasma under well controlled experimental conditions. The experiment comprises of a small spherical body exposed to weakly ionized Argon plasma in the cylindrical vacuum chamber. A cylindrical Langmuir probe is used to measure IV characteristics at various positions in the near vicinity of the sphere. PTetra uses an adaptive unstructured tetrahedral grid capable of representing objects and boundaries with realistic shapes. It also uses this grid to solve for the electrostatic potential and associated electric fields from a finite element discretisation of Poisson's equation. PTetra describes all particle species fully kinetically with physical masses and charges. It can account for an arbitrary number of species with different densities, masses, charges, temperatures and drift velocities. Comparison of probe characteristics, potentials, plasma density, its temperature and flow velocity will be made.

Acknowledgements

This work is supported by the National Science and Engineering Research Council of Canada. The simulations used in this work made use of the Westgrid computing facility.

Tuesday PM, 14:30-14:45

Approach to the atmosphere and ionosphere models merging in application to the Canadian atmosphere and ionosphere model development

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The first version of the Canadian Ionosphere-Atmosphere Model (Canadian IAM or C-IAM) will be based on two well-established model: the extended Canadian Middle Atmosphere Model (CMAM), describing mostly the neutral atmosphere from the surface up to ~250 km, and an ionospheric part of Murmansk's Upper Atmosphere Model (UAM).

Merging these models will be based on the object oriented approach principles: representation of the models as independent self-sufficient objects which hide exact methods of their work from environment and accomplish all the external information exchange using a standardized interface. It allows to significantly reduce laboriousness of the model integration. Developer of every physical modeling block can know nothing about internal realization of any other parts of the merged model. All the external interaction of this block is explicitly described: what exactly it needs from the environment (input) and what it can provide to other blocks (output). On the other hand, the developer of all integrated system also do not need any details on how each particular block is working but have to only match their formal input-output requirements.

Details of the methodology will be described. On the current stage of the C-IAM development we implement this scheme in a simplified one-way mode. The CMAM data are passed to the UAM but not vice versa. Results obtained with this modeling system are discussed in our following presentation.

Tuesday PM, 14:45-15:00

Statistics of Solar Wind Strahl Electrons

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The orientation of the Parker Spiral angle of the interplanetary magnetic field is known to influence the distribution of polar rain in the Earth's polar caps. The strahl portion of solar wind electron distribution is responsible for forming the Earth's polar rain, and the particle distribution is strongly asymmetric in the northern and southern polar caps. This particle precipitation is believed to affect the state of the ionosphere, such that HF radio wave propagation and the amount of radar echoes can, at times, be directly correlated to the orientation of the Parker Spiral. Solar wind strahl observations from the ACE spacecraft from nearly one solar cycle will be examined, and statistical properties of the solar wind strahl will be presented. These will be linked to observations by HF radar data from SuperDARN.

Tuesday PM, 15:30-15:45

Field calibration of auroral meridian scanning photometers using Jupiter

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Optical aurora provides information which can be used for remote sensing of magnetospheric topology and dynamics. Ground-based observations from multiple locations can be combined to obtain a large-scale view of auroral processes. However, quantitative multi-site comparisons require that all instruments are properly calibrated, both geometrically and photometrically.

This is not straightforward given the variety of different instruments operated by researchers with different calibration procedures and standards. In the absence of ideal laboratory cross-calibration, it is desirable to develop methods for reliable field calibration that can be carried out using existing data. Astronomical objects such as stars or planets provide a useful set of sources with known locations and intensities.

We have used Jupiter as a reference for field cross-calibration of 4 auroral meridian scanning photometers during the 2011/12 and 2012/13 northern winters. Observed transit times are used to determine each instrument azimuth and tilt, along with estimates of optical beam shape. Peak count rates are used for relative cross-comparison of all instruments at several different wavelengths to compare sensitivity.

HF radar measurements of scattering volume electron densities for various Interplanetary Magnetic Field (IMF) orientations

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The Radio Receiver Instrument (RRI) on the enhanced Polar Outflow Probe (ePOP) will be used in conjunction with Super Dual Auroral Radar Network (SuperDARN) radars for detailed studies of the radar scattering volume. One area that will be supported by the SuperDARN-ePOP experiments will be the measurement of scattering volume electron densities using SuperDARN dual frequency modes. In preparation for such studies, an analysis of HF radar measurements of scattering volume electron densities has been undertaken. Due to the refractive index effect on ionospheric HF Doppler measurements, velocities measured using two different frequencies can be used to determine electron density. The scattering volume electron densities for the high-latitude region have been calculated for various parameters using this technique. This study fouses on the effect of the IMF orientation on the distribution of electron density in the high-latitude ionosphere. In particular, the orientations of both IMF Bz and IMF By have a noticeable effect on the ionospheric electron density. This paper will discuss the results of our analysis and our plan to confirm these results using the upcoming SuperDARN-ePOP measurements.

WINDII observations of neutral wind perturbations originating in geomagnetic disturbances

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Polar projections by WINDII of atomic oxygen $O(^1S)$ 557.7 nm daytime green line emission at 250 km altitude from the northern polar regions show spiral patterns extending out of the auroral region down to the equator. When plotted as latitude versus universal time these features become linear, consistent with southward propagation at velocities of around 500 m/s extending past the equator into the southern hemisphere. The measured meridional winds are smaller, and not in the same direction. Rather, they are northward in the northern hemisphere at about 100 m/s and also southward at around 50 m/s in the southern hemisphere. In other words, in the northern hemisphere what is seen are equatorward propagating poleward wind perturbations. The TIME-GCM model reproduces these results rather closely, and also indicates that the spirals arise from enhancements in the electron density and not the atomic oxygen concentration. This strongly suggests that the northern hemisphere northward winds drive the plasma down the magnetic field lines, enhancing the green line emission rate through the dissociative recombination of O_2^+ ions. These characteristics are similar to those observed in ground-based observations of Travelling Ionospheric Disturbances (TIDs), in which the electron density enhancements are clearly seen with ionosondes, TEC measurements, and incoherent scatter radars. They are also seen in nighttime optical observations of the atomic oxygen $O(^1D)$ red line emission, which is strongly produced by the dissociative recombination process, more strongly than for the green line which from the ground is masked by the recombination of oxygen atoms near 100 km. It is concluded that these features are most likely TIDs, but they have not been observed in this way before, over 24 hours from a spacecraft at fixed local time.

Tuesday PM, 16:15-16:30

Longitudinal perturbations in thermospheric temperatures from 100 km to 250 km

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A topic of great current interest in atmospheric dynamics is the developing recognition of the influence of the diurnal eastward-propagating non-migrating tide of wavenumber 3 (DE3) on the thermosphere. Longitudinal variations of the equatorial F-region ionospheric electron density show a zonal wavenumber 4 (wave 4) pattern expected for satellite observations at a fixed local time with respect to a rotating Earth. WINDII (Wind Imaging Interferometer) observations of airglow $O(^1S)$ volume emission rate (VER), excited by photoelectron impact on atomic oxygen at 250 km have previously been interpreted as neutral density observations; they have shown the wave 4 to be a common density perturbation in the equatorial thermosphere. The analysis has been extended further by examining daytime thermospheric neutral and Doppler temperatures from 100 to 250 km height over a period of 7 years, from December 1991 to April 1997. In the interpretation of the results obtained WINDII zonal and meridional wind observations, correlative in time and space with the temperatures are also considered.

Tuesday PM, 16:30-16:45

Comparison between triangulated auroral altitude and precipitating electron energy flux

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The MIRACLE network monitors auroral activity in the Fennoscandian sector of Europe. Network stations cover the range of 55° to 57° magnetic latitude North and span two hours in magnetic local time. Some of the MIRACLE network stations include digital all-sky cameras (ASC) with overlapping field-of-views at the latitude aurora occurs. The ASCs in this network operate at three different wavelengths: 427.8 nm (blue line), 557.7 nm (green line) and 630.0 nm (red line). These wavelengths are selected using narrow band filters. Red and blue lines images are recorded once per minute and green line images every 20 s. On January 31, 2001 multiple discrete arcs were observed at the zenith of the ASC located in Muonio (67.9° N, 23.6° E) and were visible in other stations. The peak auroral emission is estimated using triangulation between pairs of stations and compared with precipitating electron energy fluxes inverted from ASC images and measured in situ on the DMSP satellite.

Early results from RBSP and THEMIS-ASI/NORSTAR

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The NASA Van Allen (formerly Radiation Belt Storm) Probes were launched into low inclination orbits with apogee so that on the nightside the satellites will be in the inner CPS/radiation belt region. The two VAP satellites will undergo numerous long magnetic conjunctions with the Canadian sector which is increasingly well instrumented for observing the ionospheric effects of electron and proton precipitation. In this presentation, we will present satellite and ground-based data from the early phase of the mission in order to highlight the types of studies we anticipate the combined observations will enable. In one example, we will attempt to identify the satellite magnetic footpoint using simultaneous NORSTAR auroral and VAP wave observations. In a second, we will examine deep electron injections that are observed by the RBSPICE instruments and the riometers.