VERSIM 2010

Program
&
Book of Abstracts

Program:

Monday 13 September

11:00-11:55 registration
11:55-12:00 welcome announcements
12:00-13:10 lunch
13:10-15:15 Session I – Triggered emissions and wave-particle interactions
(1 invited + 4 contributed talks, 30’+4x20’+15’ buffer)
13:10 Yoshiharu Omura et al.:
Theory and Simulations of VLF Triggered Emissions
13:40 David R. Shklyar: Energy Constraints on Wave Excitation and Particle Acceleration in Self-Consistent Wave-Particle Interactions
14:00 Jay Albert: Diffusion-Advection Modeling of Quasilinear and Nonlinear Wave-Particle Interactions
14:20 Jacob Bortnik: Modeling and observation of plasmaspheric hiss
14:40 Sarah Dietrich et al.:Microburst Storm Characteristics: Combined Satellite and Ground-based Observations
15:15 coffee
15:45-17:40 Session II – Chorus and quasi-periodic emissions
(5 talks, 5x20’+15’ buffer)
15:45 Andrei G. Demekhov: Spectral Properties of ELF/VLF Chorus in the Earth's Magnetosphere: a Model and Numerical Simulations
16:05 Elena Titova et al.: Spectral Characteristics of VLF Chorus Elements Detected on Cluster Spacecraft and Their Explanation by the Backward Wave Oscillator Model
16:25 Eva Macúšová et al.: The Banded Structure of the Whistler-mode Chorus Emissions
16:45 O. Santolik et al.: Distributions of amplitudes and Poynting fluxes of whistler-mode chorus
17:05 Petr Bespalov: External Periodic Effects on VLF Noise Excitation

Tuesday 14 September

9:20 -12:00 Session III – Whistlers
(7 talks, 7x20'+20' buffer)
9:20 János Lichtenbergeret al.: Automatic Whistler Analyzer
9:40 János Lichtenberger et al.: Remote Sensing of the Plasmasphere: Lightnings and Whistler Propagation Paths
10:00 Dániel Hamar et al.: Comparison of Whistlers Recorded On-board and on the Ground
10:20 Péter Steinbach et al.: A Revised Classification of LEO Recorded Whistlers
10:40 Kaiti Wang et al.: Observations and Theory of Low-latitudinal ELF-whistlers
11:00 Marlie van Zyl and Andrew B. Collier: Whistlers as a Loss Mechanism in the Earth's Radiation Belts
11:20 Ilya Kuzichev and David Shklyar: Full Wave Solution for Whistler Wave Propagation Through the Ionosphere in Case of Small Angles of Incidence

12:00-13:10 lunch

13:10- 15:38 Session IV – VLF data sets and campaigns
(1 invited + 5 contributed talks, 30'+ 5x20'+ 18' buffer)
13:10 Andy J Smith: Extending Continuous Quantitative Measurements of ELF/VLF Noise at Halley, Antarctica, Towards Two Solar Cycles
13:40 Tauno Turunen and Jyrki Manninen: Features of Sferic Background during Quiet Period near the Equinox
14:00 Jyrki Manninen and Tauno Turunen: MLR Fine Structure - New Results
14:20 Jean-Pierre Raulin et al.: Overview of Solar-Terretrial, Ionospheric and Atmospheric Researches Performed Using the South America VLF Network SAVNET
14:40 Fernando C. P. Bertoni: Low ionosphere effects of long term solar and transient geomagnetic activity using VLF technique
15:00 Craig J. Rodger et al.: Improvements in the WWLLN: Increased Detection Efficiencies and new Lightning Power Measurements through more Stations and Smarter Algorithms

15:45 coffee

Tuesday 14 September — POSTERS

16:00 -17:30 Poster session

(9 posters)

1. Craig J. Rodger et al.: Long Distance Monitoring of the Lower Ionosphere using Subionospheric VLF Propagation: The Global AARDDVARK Sensor Array
2. Zuzana Hrbáčková et al.: Equatorial Noise Obtained from Measurements of the Cluster Spacecraft
3. Vida ŽIGMAN et al.: Similarities and Differences in Flare-Perturbed VLF Signals as Received in Erd and Belgrade
4. Jean Louis RAUCH et al.: Determination inside The Plasmasphere of the Ion Composition and Absolute Density from the ULF Wave Propagation Properties With WHISPER/CLUSTER and STAFF/CLUSTER Data.
5. Sahil Brijraj et al.: Ionospheric Anomalies Observed prior to Seismic Events
6. David Pisa et al.: Statistical Analysis of the Electromagnetic Waves Observed in the Upper Ionosphere by the DEMETER Spacecraft as Function of the Seismic Activity
7. Jaroslav Chum et al.: Obliquely propagating chorus and transverse motion of the source
8. Etienne J Koen et al.: Particle-in-cell simulations of chorus emissions
9. Stephen Guy Meyer and Andrew Blaine Collier: Effects of Ionospheric and Terrestrial Factors on VLF Propagation in the Earth-ionosphere Waveguide

Wednesday 15 September

9:30-11:48 **Session V – DEMETER**
(6 talks+ 18' buffer)

9:30 Michel Parrot: MF Waves Observed by DEMETER above the South Atlantic Anomaly

9:50 Brett Delport et al.: Satellite Observations of Whistlers near the Tihany Conjugate Point

10:10 Jiří Fišer et al: Sporadic E-layer and occurrence of subprotonospheric whistlers

10:30 L. Bankov and A. Vassileva: Large scale wave-like structures in the topside ionosphere as a manifestation of the vertical coupling processes at mid and low latitudes

10:50 L. Bankov and A. Vassileva: Seasonal behavior of the wave-number four (WN4) in the topside ionosphere at mid and low latitudes during declining 23 solar cycle

11:10 Craig J. Rodger: Radiation Belt Electron Precipitation from Plasmaspheric Hiss: Significance to Atmospheric Ozone Chemistry

12:00-13:00 lunch

14:00 excursion

19:00 workshop dinner

Thursday 16 September

9:40-11:45 Session VI – Subionospheric VLF propagation
(1 invited + 4 contributed talks, 30' + 4x20' + 15' buffer)

9:40 Umran S. Inan: TBD

10:10 Ernst Dieter Schmitter: Investigating the Impact of Solar Energetic Particle Events on the Lower Ionosphere using VLF/LF Propagation Conditions along a Midlatitude - Sub Polar Path

10:30 Desanka Sulic et al.: Study of the Observed Amplitude and Phase Perturbations on VLF Signals From Lighting Induced Electron Precipitation and Reconstruction of D-region Electron Density Height Profile

10:50 Mark A Clilverd et al.: Ground-based Estimates of Outer Radiation Belt Energetic Electron Precipitation Fluxes into the Atmosphere

11:10 Sandip Kumar Chakrabarti et al.: Results of VLF Campaigns During Summer, Winter and Total Solar Eclipse in Indian Subcontinent from Twelve Stations

12:00-13:10 lunch

13:10-14:42 Session VII – Ionoshere, Martian ionosphere, meteors
(4 contributed talks, 4x20' + 12' buffer)

13:10 Andrew Collier et al.: Multivariate Techniques for Constructing Quiet Day Curves

13:30 Jaroslav Chum and Vladimir Truhlik: Refractive Index in a Realistic Ionosphere

13:50 Frantisek Nemec: Martian Ionosphere Observed by the MARSIS Instrument

14:10 Colin Price et al.: The Connection between meteor showers and VLF atmospheric noise signals

14:45-15:15 VERSIM business meeting (1st part)

15:15 coffee

15:45 results of IAGA Student/young scientist competition,
VERSIM business meeting (2nd part)

Friday 17 September

Splinter meetings, discussions

Abstracts:

September 13, Monday 13:10–13:40 – ORAL (INVITED) – 30 minutes.

Theory and Simulations of VLF Triggered Emissions

Yoshiharu Omura (1), Mitsuru Hikishima (1), Danny Summers (2,3)

[1] Research Institute for Sustainable Humanosphere, Kyoto University,
[2] Department of Mathematics and Statistics, Memorial University of Newfoundland,
[3] School of Space Research, Kyung Hee University

Abstract. We develop a nonlinear wave growth theory of VLF whistler-mode emissions [1], taking into account the spatial inhomogeneity of the static magnetic field and the plasma density variation along the magnetic field line. We derive theoretical expressions for the nonlinear growth rate and the amplitude threshold for the generation of self-sustaining rising tone emissions like chorus emissions. We performed a self-consistent particle simulation, in which we inject triggering whistler-mode waves with a constant frequency. The resonant electrons are organized at the resonance velocity in the velocity phase space, and they are released from the triggering wave near the equator. Because of the organized phase structures, the electrons radiate a coherent wave with an increasing frequency that undergoes the nonlinear wave growth due to formation of an electromagnetic electron hole. Self-sustaining emissions become possible when the wave propagates away from the equator during which process the increasing gradients of the static magnetic field and electron density provide the conditions for nonlinear wave growth [2]. The self-sustaining mechanism can result in a rising tone emission covering the frequency range below the equatorial electron gyrofrequency. We obtain a pair of coupled differential equations for the wave amplitude and frequency. Solving the equations numerically, we reproduce a rising tone of VLF whistler-mode emissions that is continuous in frequency. Saturation of the nonlinear wave growth takes place because of formation of an electron bump in the velocity phase space. The bump is due to trapping and acceleration of the resonant electrons by the triggered emission. Natural chorus emissions, on the other hand, characteristically occur in two distinct frequency ranges, a lower band and an upper band, separated at half the electron gyrofrequency. We explain the gap by means of the nonlinear damping of the longitudinal component of a slightly oblique whistler mode wave packet propagating along the inhomogeneous static magnetic field [2].

References

[1] Y. Omura, Y. Katoh, and D. Summers, Theory and simulation of the generation of whistler-mode chorus, J. Geophys. Res., 113, A04223, doi:10.1029/2007JA012622 (2008)

[2] Y. Omura, M. Hikishima, Y. Katoh, D. Summers, and S. Yagitani, Nonlinear mechanisms of lower-band and upper-band VLF chorus emissions in the magnetosphere, J. Geophys. Res., 114, A07217, doi:10.1029/2009JA014206 (2009)

September 13, Monday 13:40–14:00 – ORAL – 20 minutes.

Energy Constraints on Wave Excitation and Particle Acceleration in Self-Consistent Wave-Particle Interactions

David R. Shklyar (1,2)

[1] Space Research Institute, Russian Academy of Sciences, Moscow, Russia,
[2] Moscow Institute of Physics and Technology, Russia

Abstract. Wave-particle interactions in plasma are described by nonlinear set of equations, which consists of Maxwell's equations and Boltzman-Vlasov equation with a self-consistent electromagnetic field. Two main analytical approaches to solution of this set consist in its linearization by either substituting an unperturbed distribution function into the nonlinear term (linear Vlasov-Landau approximation), or by substituting a given field ("nonlinear" approximation suggested by Mazitov, Al'tshul and Karpman, and O'Neil). Both approaches are not self-consistent, each having well known frames of validity though. At the same time, the initial nonlinear set of equations has an exact integral, which, in the case of a single wave, may be interpreted as energy conservation in the interacting system consisting of a wave and resonant particles. It is important that the wave energy includes the energy of electromagnetic field and kinetic energy of non-resonant particles, and that, in the case of oblique wave propagation, the resonant particles corresponding to different cyclotron resonances may have essentially different parallel velocities, thus belonging to different energetic particle populations. It means that, in this case, wave-particle interactions not only lead to energy exchange between wave and resonant particles, but also mediate the energy exchange between different particle populations. The energy conservation imposes certain constraints on wave amplitude and particle acceleration which may arise due to resonant wave-particle interactions. These contraints are discussed with reference to the conditions of upcoming RESONANCE project.

September 13, Monday 14:00–14:20 – ORAL – 20 minutes.

Diffusion-Advection Modeling of Quasilinear and Nonlinear Wave-Particle Interactions

Jay Albert (1)

[1] Air Force Research Lab

Abstract. Properly treating wave-particle interactions is crucial to understanding, modeling, and predicting the behavior of radiation belt electrons. The usual quasi-linear treatment alone cannot capture the specific effects that nonlinear interactions are known to cause. To avoid the inherent limitations of conventional quasi-linear theory, recently-developed analytical estimates of nonlinear particle behavior can be used to formulate and solve a combined diffusion-advection equation for the electron phase space density. For small amplitude waves, quasi-linear diffusion is recovered, but phase bunching and phase trapping, caused by larger amplitude waves, are also included.

September 13, Monday 14:20–14:40 – ORAL – 20 minutes.

Modeling and observation of plasmaspheric hiss

Jacob Bortnik (1)

[1] UCLA

Abstract. Plasmaspheric hiss has been observed on high-altitude spacecraft since the late 1960's and has long been known to be an important element in shaping the distribution and dynamics of Earth's radiation belts. It's origin, however, has been somewhat difficult to determine, although many models have been proposed over the last 4 decades. Recently, a new model has been proposed that traces the origin of plasmaspheric hiss to chorus waves, outside the plasmapause. This model has been able to reproduce the major statistical features of hiss, such as its frequency spectrum and its dependence on L-shell, its day/night asymmetry in intensity, and relation to geomagnetic activity. In this talk, we review details of the model, show new results and associated observations from the THEMIS spacecraft.

September 13, Monday 14:40–15:00 – ORAL – 20 minutes.

Microburst Storm Characteristics: Combined Satellite and Ground-based Observations

Sarah Dietrich (1), Craig J. Rodger (1), Mark A. Clilverd (2), Jacob Bortnik (3), Tero Raita (4)

[1] University of Otago, Dunedin, New Zealand,
[2] British Antarctic Survey, Cambridge, UK,
[3] Universityof California, Los Angeles, California, USA,
[4] Sodankylä Geophysical Observatory, University of Oulu, Finland

Abstract. Bursts of relativistic (>1MeV) electron precipitation from Earth's radiation belts are detected by the Solar Anomalous and Magnetospheric Particle Explorer (SAMPEX), a low Earth orbiting satellite. During periods of enhanced geomagnetic activity (Kp>6), burst-like perturbations can be found in very low frequency (VLF) signals received at Sodankyla, Finland, by the Antarctic-Arctic Radiation-belt (Dynamic) Deposition — VLF Atmospheric Research Konsortium (AARDDVARK). The VLF perturbations have been termed FAST events, which are characterised by their large perturbation amplitude, both positive and negative, their temporal brevity (t~<1s). These FAST events are observed to affect different locations of the D-region ionosphere during a series of events, and are therefore thought to be caused by a ?rainstorm? of spatially small (tens of kilometres or less) bursts of precipitation striking the atmosphere. It is seen that periods of FAST event activity coincide with periods of SAMPEX detected microbursts. In this talk we discuss the interplay between the two sets of observations, and provide some indication of the spatial extent of the microburst/FAST activity region.

September 13, Monday 15:45–16:05 – ORAL – 20 minutes.

Spectral Properties of ELF/VLF Chorus in the Earth's Magnetosphere: a Model and Numerical Simulations

Andrei G. Demekhov (1)

[1] Institute of Applied Physics of the Russian Academy of Sciences, Nizhny Novgorod, Russia

Abstract. We consider results of numerical study of a model of VLF chorus generation in the Earth's moagnetosphere based on the backward wave oscillator regime of the whistler-mode cyclotron instability. In particular, we study the spatial dependence of the whistler-mode dynamic frequency spectrum inside the generation region as obtained from the simulations. The simulation results confirm the role of the sideband instability in the formation of frequency drift in chorus elements which was suggested previously (V.Yu.Trakhtengerts et al., Phys. Plasmas, 11, 1345, 2004). The nonlinear distortion of the initial velocity distribution is accumulated during the energetic-particle passage through the wave generation region, and it can lead to significant differences in the spectrum of generated waves at different places in this region. Such differences are difficult to observe directly but they can be manifested in the statistical properties of recorded chorus elements. We also discuss possible mechanisms of formation of chorus elements with rising and falling frequency.

September 13, Monday 16:05–16:25 – ORAL – 20 minutes.

Spectral Characteristics of VLF Chorus Elements Detected on Cluster Spacecraft and Their Explanation by the Backward Wave Oscillator Model

Elena Titova (1,2), Boris Kozelov (1), Andrei G. Demekhov (3), Ondřej Santolík (4,5), Eva Macúšová (4,5), Jean Louis Rauch (6), Jean Gabriel Trotignon (6), Donald A. Gurnett (7), Jolene S. Pickett (7)

[1] Polar Geophysical Institute, Apatity, Russian Federation ,
[2] Space Research Institute of RAS, Moscow, Russia,
[3] Institute of Applied Physics, Nizhny Novgorod, Russia,,
[4] Charles University, Prague, Czech Republic,
[5] IAP/CAS, Prague, Czech Republic,
[6] LPCE/CNRS, Orleans, France,
[7] University of Iowa, Iowa City, IA, USA

Abstract. A generation mechanism for VLF chorus was suggested by V. Yu. Trakhtengerts (1995, 1999) on the basis of the backward wave oscillator (BWO) regime of magnetospheric cyclotron maser. In the BWO model a succession of whistler wave packets is generated in a small, near-equatorial region owing to the absolute instability of whistler-mode waves in the presence of a step-like distribution function of energetic electrons in parallel velocities with respect to the geomagnetic field. According to the BWO model, a sharp gradient (or step-like deformation) on the electron distribution function is the most important factor of chorus generation, but such a feature is very difficult to observe. In this report we study a dimensionless parameter q, which is related to the step feature and quantifies an excess of the electron flux over the absolute-instability threshold. Using the measured frequency sweep rate of chorus elements detected by the Wide-Band Data (WBD) instrument onboard the Cluster spacecraft and the electron density obtained from the WHISPER active sounder data we determined the values and variations of the q parameter in the generation region. A mean value of this parameter was obtained as q = 10, which is in agreement with results of numerical simulations of chorus elements based on the BWO model. Significant scatter of the q parameter values are observed during each Cluster passage of the generation region. The analysis of the q parameter shows that the q distribution depends on the plasma density. We use the values and the distributions of the q-parameter, obtained by the CLUSTER satellites as input parameters for a discrete BWO model describing generation of the VLF chorus in the on-off intermittency regime. The relationship between the parameters of the discrete BWO model and observations is discussed.

September 13, Monday 16:25–16:45 – student – ORAL – 20 minutes.

The Banded Structure of the Whistler-mode Chorus Emissions

Eva Macúšová (1,2), Ondřej Santolík (1,2), Jolene S. Pickett (3), Donald A. Gurnett (3), Nicole Cornilleau-Wehrlin (4,5)

[1] Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic,
[2] Institute of Atmospheric Physics, Prague, Czech Republic,
[3] University of Iowa, Iowa City, Iowa, USA,
[4] Station de Radioastronomie de Nançay, Observatoire de Paris/CNRS, Nançay, France,
[5] LPP-CNRS-Ecole Polytechnique, Velizy, France

Abstract. Whistler-mode chorus emissions are thought to be responsible for much of the acceleration of electrons in the outer Van Allen radiation belt to relativistic energies. Chorus emissions consist of individual wave packets exhibiting rising and falling tones or shapeless hiss divided into two frequency bands separated by a gap at 1/2 of the electron cyclotron frequency (1/2 fce) close to the source region. This configuration is called banded chorus and it is correlated with magnetic activity. Landau damping is one of the possible mechanisms for explaining the existence of the gap. On the other hand, the role of ducts in its formation was also discussed. In our study we present several events of chorus emissions with three frequency bands and two gaps mostly observed in a magnetic latitude range of 3 to 10 degrees on both sides of the equator. Some of them were situated in the chorus source region. We investigate the possible significance of MLT, Kp index, McIlwain parameter and plasma density in controlling the formation of the three frequency bands.

September 13, Monday 16:45–17:05 – ORAL – 20 minutes.

Distributions of amplitudes and Poynting fluxes of whistler-mode chorus

Ondřej Santolík (1,2), Donald A. Gurnett (3), Jolene S. Pickett (3)

[1] Institute of Atmospheric Physics, Prague, Czech Republic ,
[2] Charles University in Prague, Czech Republic ,
[3] University of Iowa, Iowa City, IA, USA

Abstract. Whistler mode chorus emissions have gained attention as a possible agent in acceleration of relativistic electrons in the outer Van Allen radiation belt. Theoretical and simulation studies show that sufficiently high amplitudes of chorus wave packets are needed to produce this acceleration. We present analysis of measurements of magnetic field waveforms recorded in the equatorial magnetosphere by the WBD instruments onboard the four Cluster spacecraft. The results show that chorus can reach amplitudes of several nT (approximately 1 percent of the terrestrial magnetic field at the Cluster orbit) but only for a very small fraction of wave packets. We also analyze multicomponent measurements of whistler-mode chorus by the Plasma Wave Instrument onboard the Polar spacecraft in order to to investigate the variations of their Poynting fluxes. We estimate that a few percent of the observed Poynting flux of chorus could be sufficient to accelerate electrons in the outer Van Allen radiation belt on the time scale of days.

September 13, Monday 17:05–17:25 – ORAL – 20 minutes.

External Periodic Effects on VLF Noise Excitation

Petr Bespalov (1)

[1] Institute of Applied Physics, Russian Academy of Sciences, 46 Ulyanov St, 603950 Nizhny Novgorod, Russia

Abstract. It is well known that VLF emissions are sensitive to external effects in the form of other signals. This is manifested both for the discrete and for the noise emissions. In this paper we will in detail considered as the background noise emissions hiss emissions and also comparatively wide-band quasi-periodic VLF emissions of the type QP-2. The excitation of these emissions occurs to the suitable value and angular dependence of the power of the energetic electron source power of in the plasma magnetosphere maser (PMM) which is characterized by known dispersion and nonlinearity. As the standard external effect we will examine monochromatic disturbance in the form of acoustics — gravity waves in the ionosphere and different types of MHD waves in the magnetosphere. These external effects modulate the rate of decay of whistler waves in the ionosphere, the energetic electron source power, and the increment of cyclotron instability. As a result can be formed the simple hiss with monochromatic modulation, the signals with complex modulation, and signals with stochastic modulation. The criteria of the realization of such processes are given. The obtained results are important both for understanding of nature of signals with complex modulation and for the development the new methods of resonance diagnostics of magnetosphere plasma.

September 14, Tuesday 09:20–09:40 – ORAL – 20 minutes.

Automatic Whistler Analyzer

János Lichtenberger (1), Csaba Ferencz (1), Dániel Hamar (1), Péter Steinbach (2), Craig J. Rodger (3), Mark A. Clilverd (4), Andrew B. Collier (5)

[1] Space Research Group, Eötvös University, Budapest, Hungary,
[2] Research Group for Geology, Geophysics and Space Sciences of HA S, Budapest, Hungary,
[3] Department of Physics, University of Otago, Dunedin, New Zealand,
[4] British Antarctic Survey, Cambridge, UK.,
[5] Hermanus Magnetic Observatory, Hermanus, South Africa

Abstract. There is an increasing 'demand' for plasmaspheric electron density data for plasmasphere models in Space Weather related investigations, particularly in modeling charged particle accelerations and losses in Radiation Belts. The global Automatic Whistler Detector and Analyzer system network (AWDANet, [1]) detects millions of whistlers in a year. But the analysis of the whistlers to extract the plasmaspheric electron density information has thus far proved to be slow and time consuming. A recently developed whistler inversion model [2] opened the way for an automated process of whistler analysis, not only for single whistler events but for complex analysis of multiple-path propagation whistler groups. Since then, our primary goal has been to develop an algorithm for practical implementation. In our definition, a practical implementation runs in quasi-realtime mode (real-time in long term), can be installed at remote locations like Antarctica, and its cost fits into the generally available funds for space research. In this paper we show the AWA algorithm and a practical implementation on a PC cluster with ~100 threads cost ~12000 EUR, where the analysis of a whistler group runs in a few minutes; as well as the results of test runs processing whistlers from our database. We are planning to install this algorithm on AWDANet nodes in the near future.

References
[1]J. Lichtenberger, Cs. Ferencz, L. Bodnár, D. Hamar, and P. Steinbach (2008):Automatic Whistler Detector and Analyzer system: Automatic Whistler Detector, J. Geophys. Res., 113, A12201, doi:10.1029/2008JA013467.
[2]Lichtenberger, J. (2009): A new whistler inversion method. Journal of Geophysical Research,114, A07222, doi: 10.1029/2008JA013799

September 14, Tuesday 09:40–10:00 – ORAL – 20 minutes.

Remote Sensing of the Plasmasphere: Lightnings and Whistler Propagation Paths

János Lichtenberger (1), Andrew B. Collier (2), Mark A. Clilverd (3), Craig J. Rodger (4), Csaba Ferencz (1), Dániel Hamar (1), Péter Steinbach (5), Daniel I. Golden (6), Umran S. Inan (6)

[1] Space Research Group, Eötvös University, Budapest, Hungary,
[2] Hermanus Magnetic Observatory, Hermanus, South Africa,
[3] British Antarctic Survey, Cambridge, UK,
[4] Department of Physics, University of Otago, Dunedin, New Zealand,
[5] Research Group for Geology, Geophysics and Space Sciences of HA S, Budapest, Hungary,
[6] Star Laboratory, Stanford University, Stanford, USA

Abstract. Space weather models to improve specification and prediction capabilities are in the front of the recent research studies. One of the key regions in space weather modeling is the Earth's plasmasphere. Whistlers have been regarded as a cheap and effective tool for monitoring the cold electron density variations in the plasmasphere since the early years of whistler research. The traditional interpretation of whistler data assumed that the sources of whistlers (lightnings) and the receiver are located on magnetic conjugate areas and the waves are propagating along the field line connecting them. Recent studies [1,2] show that this is not always the case, the source region and the receiver can be located not only at different magnetic latitudes (L-discrepancy), but at different magnetic meridians and even far away from the conjugate zones. The studies are based on a statistical/probability approach using lightning data from the World Wide Lightning Location Network (WWLLN, [3]) and whistler data from the Automatic Whistler Detector and Analyzer system network (AWDANet, [4]). In this study the enormous number of whistlers recorded from the Antarctic peninsula, at the British Antarctic base, Rothera (~6 million traces/year) and at the US base, Palmer ~9 million traces/year) made it possible to pair lightnings from WWLLN with whistler data from AWDANet using a more direct approach. In this paper we discuss the possible propagation scenarios and how the obtained electron density profiles can be incorporated into plasmasphere models.

References

[1] A.B. Collier., B. Delport, A.R.W. Hughes, J. Lichtenberger, P. Steinbach and J. Oster (2009): Correlation between Global Lightning and Whistlers observed at Tihany, J. Geophys. Res. doi: 10.1029/2008JA013863, 114, A07210 .

[2] A.B Collier, S. Bremner, J. Lichtenberger, J.R. Downs, C.J. Rodger, P. Steinbach and G. McDowell (2010): Global lightning distribution and whistlers observed at Dunedin, New Zealand, Ann. Geophys. 28, 499-513.

[3] R.L. Dowden, R.H. Holzworth, C.J. Rodger, J. Lichtenberger et al. (2008):World-Wide Lightning Location Using VLF Propagation in the Earth-Ionosphere Waveguide, IEEE Antennas and Propagation Mag., 50(5), 40.

[4] J. Lichtenberger, Cs. Ferencz, L. Bodnár, D. Hamar, and P. Steinbach (2008):Automatic Whistler Detector and Analyzer system: Automatic Whistler Detector, J. Geophys. Res., 113, A12201, doi:10.1029/2008JA013467.

September 14, Tuesday 10:00–10:20 – ORAL – 20 minutes.

Comparison of Whistlers Recorded On-board and on the Ground

Dániel Hamar (1), János Lichtenberger (1), Csaba Ferencz (1), Péter Steinbach (2), Orsolya E. Ferencz (1), Craig J. Rodger (3), Andrew B. Collier (4), Michel Parrot (5)

[1] Space Research Group, Eötvös University, Budapest, Hungary,
[2] Research Group for Geology, Geophysics and Space Sciences of HA S, Budapest, Hungary,
[3] Department of Physics, University of Otago, Dunedin, New Zealand,
[4] Hermanus Magnetic Observatory, Hermanus, South Africa ,
[5] LPCE/CNRS, Orléans, France

Abstract. The propagation of whistlers in the plasmasphere and the coupling through the ionosphere into the Earth-Ionosphere waveguide has several unknown processes. On the other hand the information acquired from whistler analysis is important to determine the plasma density as a function of L, therefore to determine the magnetic meridian of the path of the whistler is essential. Guided whistlers detected on-board the Demeter satellite should propagate in the vicinity of the magnetic meridian of the satellite. Comparison of whistlers measured simultaneously on-board a satellite and ground receivers can separate the whistlers arrived from the conjugate point or propagated in the Earth-Ionosphere waveguide from a long distance. Statistical investigations of whistlers and the possible causative lightnings proved that the location of the source of whistlers at Tihany, Hungary is at the conjugate area [1]. Opposite to this, the whistlers observed in Dunedin, New Zealand correlated with lightning activity of west coast of North America, remote from the conjugate point [2]. We analyzed several whistler signals measured simultaneously on-board the Demeter satellite and at two ground receivers (Tihany and Dunedin). Some of the signals were analyzed with high accuracy to compare the fine structure of the same signals detected on-board and ground stations.

References

[1] Collier A.B., B. Delport, A.R.W. Hughes, J. Lichtenberger, P. Steinbach and J. Oster (2009): Correlation between Global Lightning and Whistlers observed at Tihany, J. Geophys. Res. doi: 10.1029/2008JA013863, 114, A07210 .

[2] Collier, A.B., Bremner S., Lichtenberger, J., Downs, J.R., Rodger, C.J., Steinbach, P., Hughes, A.R.W., and McDowell, G. (2009) Global Lightning Distribution and Whistlers Observed at Dunedin, New Zealand. Ann. Geophys. 28, 499-513.

September 14, Tuesday 10:20–10:40 – ORAL – 20 minutes.

A Revised Classification of LEO Recorded Whistlers

Péter Steinbach (1,2), János Lichtenberger (2), Csaba Ferencz (2)

[1] MTA-ELTE Research Group for Geology, Geophysics and Space Sciences, Eötvös University, Budapest, Hungary,
[2] Space Research Group, Eötvös University, Budapest, Hungary

Abstract. Regular whistler analysis confirmed that characteristics of all type fractional hop whistlers, recorded at LEO altitudes exhibit clear geomagnetic latitude dependence. Furthermore, a well described class of these signals seem to fall out of classical whistler categories and/or source descriptions. Systematic incident angle analysis has been performed using numerous whistlers in the three component DEMETER ELF data, integrated with oblique propagation modelling to give explanation of observations. Next, automatic whistler detection (AWD) in mass archived satellite ELF and VLF recording has been applied, utilizing the knowledge of realistic whistler classes and properties at the current spacecraft position as additional input.

September 14, Tuesday 10:40–11:00 – ORAL – 20 minutes.

Observations and Theory of Low-latitudinal ELF-whistlers

Kaiti Wang (1,2), Yun-Ching Wang (3), Han-Tzong Su (3), Rue-Ron Hsu (3), Tzu-Yuan Lin (4)

[1] Plasma and Space Science Center, National Cheng Kung University, Tainan, Taiwan,
[2] Institute of Space, Astrophysical and Plasma Sciences, National Cheng Kung University, Tainan, Taiwan,
[3] Department of Physics, National Cheng Kung University, Tainan, Taiwan,
[4] Institute of Electro-Optical Science and Engineering, National Cheng Kung University, Tainan, Taiwan

Abstract. Whistler-like event at frequencies in the ELF band below 200Hz have been reported for four times for the past 35 years at Alaska, California, Taiwan, and South Pole, respectively. In this paper, observations of these events at low latitude with frequencies between about 60 and 100 Hz by the ELF station at the Lulin Observatory in Taiwan from August 26 of 2003 to July 13 of 2004 will be presented. The most distinguished feature for these events is the frequency descent in the frequency-time spectrograms, resembling terrestrial whistlers. Other two distinct features include (1) daytime occurrence from 5am to 9pm; (2) average event duration of two minutes. The wave modes responsible for these features are then examined in multi-ion ionospheric plasma with the composition inferred from the IRI model. The Class III right-hand ion-cyclotron wave mode between near the oxygen ion gyrofrequency and the helium ion gyrofrequency is found to be the most probable candidate to account for both features. The group time delay of these waves is found to increase with the electron density, consistent with observed NmF2 variations based on the radio occultation data from the CHAMP mission. Lightning activity examined from the WWLLN data also show that the conjugate area can be the high probable source region. The aforementioned wave mode can be also present at the respective local ionosphere environments of other locations with detections.

September 14, Tuesday 11:00–11:20 – student – ORAL – 20 minutes.

Whistlers as a Loss Mechanism in the Earth's Radiation Belts

Marlie van Zyl (1,2), Andrew B. Collier (1)

[1] University of KwaZulu-Natal
[2] Hermanus Magnetic Observatory

Abstract. Lightning induced whistler waves are one of the primary causes of energetic particle loss from the Earth's radiation belts. This is mainly due to pitch angle scattering of trapped particles. While the majority of lightning is focused in three equatorial chimney regions over South America, Africa and the Maritime Continent [Williams and G. Sátori, 2004], the bulk of precipitation occurs at magnetic latitudes around 45° to 60° [Rodger et al., 2005]. However, the detailed spatial and temporal influences of lightning on precipitation losses are not well known. World Wide Lightning Location Network (WWLLN) data is ideal for addressing this problem since WWLLN provides continuous global lightning observations and has excellent time resolution. The International Geomagnetic Reference Field (IGRF) model was used to transform WWLLN data from geographic to geomagnetic coordinates and create a global lightning distribution map as a function of geomagnetic latitude and local time. Statistical models of lightning polarity, stroke multiplicity and power were then incorporated to determine the incident whistler flux into the Earth's radiation belts.

September 14, Tuesday 11:20–11:40 – student – ORAL – 20 minutes.

Full Wave Solution for Whistler Wave Propagation Through the Ionosphere in Case of Small Angles of Incidence

Ilya Kuzichev (1), David R. Shklyar (1)

[1] Space Research Institute of RAS (IKI)

Abstract. Among many problems in whistler study, wave propagation through the ionosphere is one of the most arduous, and the most important at the same time. Both satellite and ground-based investigations of VLF waves include considerations of this problem, and it has been in the focus of research since the beginning of whistler study (Budden [1985]; Helliwell [1965]). The main difficulty in description of the problem arises from the fast variation of the lower ionosphere parameters as compared to typical VLF wave number. This makes irrelevant the consideration in the framework of geometrical optics, which, along with a smooth variation of parameters, is always based on a particular dispersion relation. Although the full wave analysis in the framework of cold plasma approximation does not require slow variations of plasma parameters, and does not assume any particular wave mode, the fact that the wave of a given frequency belongs to different modes in various regions makes numerical solution of the field equations not simple. More specifically, as is well known (e.g. Ginzburg and Rukhadze [1972]), in a cold magnetized plasma, there are, in general, two wave modes related to a given frequency. Both modes, however, do not necessarily correspond to propagating waves. In particular, in the frequency range related to whistler waves, the other mode is evanescent, i.e. it has a negative value of N2 (the refractive index squared). It means that one of solutions of the relevant differential equations is exponentially growing, which makes a straightforward numerical approach to these equations despairing. This well known difficulty in the problem under discussion is usually identified as numerical swamping (Budden [1985]; Nagano et al., [1975, 2003]). Resolving the problem of numerical swamping becomes, in fact, a key point in numerical study of wave passage through the ionosphere. As it is typical for work based on numerical simulations, its essential part remains virtually hidden. Then, every researcher, in order to get quantitative characteristics of the process, such as transmission and reflection coefficients, needs to go through the whole problem. That is why the number of publications dealing with VLF wave transmission through the ionosphere does not run short. The purpose of this work is to give a new approach to the problem, such that its basic equations are regularized analytically before numerical calculations, while the latter become accomplishable with the help of a routine program. Such formulation of the task allows presenting all equations and related formulae in an undisguised form, so that the problem may be solved in a straightforward way, once the ionospheric plasma parameters are given. In the framework of the developed method, full wave solution for the electromagnetic field was obtained, and the reflection coefficient was calculated as a function of frequency for various angles of incidence.

References

Budden, K. G. (1985), The Propagation of Radio Waves: The Theory of Radio Waves of Low Power in the Ionosphere and Magnetosphere, Cambridge Univ. Press, Cambridge, U.K.

Helliwell, R. A. (1965), Whistlers and Related Ionospheric Phenomena, Stanford University Press, Stanford, California

Nagano, I., M. Mambo, G. Hutatsuishi (1975), Numerical calculation of electromagnetic waves in an anisotropic multilayered medium, Radio Science, 10, 611–617.

Nagano, I., S. Yagitani, K. Miyamura, S. Makino (2003), Full-wave analysis of elves created by lightning-generated electromagnetic pulses, J. atmos. terr. Phys., 65, 615–625.

Ginzburg, V.L., and Rukhadze, A.A. (1972), Waves in Magnetoactive Plasma. In Handbuch der Physik (ed. S. Flűgge). Vol. 49, Part IV, p. 395, Springer Verlag, Berlin.

September 14, Tuesday 13:10–13:40 – ORAL (INVITED) – 30 minutes.

Extending Continuous Quantitative Measurements of ELF/VLF Noise at Halley, Antarctica, Towards Two Solar Cycles

Andy J. Smith (1)

[1] VLF/ELF Radio Research Institute, Bradwell, UK

Abstract. At the 2008 VERSIM Workshop, a unique set of continuous high-quality well-calibrated observations of ELF/VLF radio waves (0.3–10 kHz) made at Halley Research Station, Antarctica (75S, 27W, L=4.3) over one and a half solar cycles (1992–2007) was described, and a statistical analysis of the data was presented. Some of these results have since been published (J. Atmos. Solar-Terr. Phys. 72 463–475, 2010, doi:10.1016/j.jastp.2009.12.018). Below about 5 kHz the waves are predominantly natural whistler mode waves, notably chorus, which are generated near the equatorial plane of the magnetosphere and propagate on geomagnetic field-aligned (“ducted”) paths to both hemispheres. The magnetospheric source function is convolved with a propagation function which represents passage of the waves from the source region through and under the ionosphere to the receiver. At the top of the frequency range (~10 kHz) the observed waves are mostly subionospherically propagated atmospherics from tropical lightning. The Halley data were from the VELOX receiver which ceased operation on 1st October 2007. A new continuously operating receiver covering the same frequency band began operating on 5th February 2007 and has continued to the present day. The outputs from the two receivers during the overlap interval in 2007 have been compared and it is shown that, with certain caveats, the VELOX amplitude data can be extended using data from the new receiver, thus providing a 19-year long continuous run to date. In this paper, some key results from the extended data set will be presented. Assuming the current receiver continues to operate for a further three years, it will complete a 2-solar cycle interval.

September 14, Tuesday 13:40–14:00 – ORAL – 20 minutes.

Features of Sferic Background during Quiet Period near the Equinox

Tauno Turunen (1), Jyrki Manninen (1)

[1] Sodankyla Geophysical Observatory, Sodankyla, Finland

Abstract. Sferics are always present in ground-based VLF measurements. Sferics propagate in the Earth-ionosphere waveguide and part of the energy enters also to the magnetosphere causing well known whistlers under suitable conditions. We have studied some properties of the sferics background especially under quiet conditions in autumn conditions. The method used in this presentation is based on selection of whistlers propagating from a given direction within e.g. 10–30 degrees cone using minor axis direction of the polarization ellipse around 7–8 kHz and integrating then the power and polarization parameters over the whole band. Sferics from different directions show different behaviour. In general, the polarisation of mode 0 has the same orientation at polarisation ellipse as the other modes above 5 kHz. Between mode 1 cut-off frequency and about 5 kHz the polarisation behaviour is very variable. Also power level varies and shows peaks at systematically occurring intervals.

September 14, Tuesday 14:00–14:20 – ORAL – 20 minutes.

MLR Fine Structure — New Results

Jyrki Manninen (1), Tauno Turunen (1)

[1] Sodankyla Geophysical Observatory, Sodankyla, Finland

Abstract. As Manninen (2005) showed in his thesis, some MLR events (5 out of 31 events) had fine structure, which consisted of discrete narrow lines with spacing down to 5 Hz. One of the events showed both frequency drift and amplitude modulation.

There were at least two groups of MLR lines. One group consisted of the lines, which slowly decreased in time having about 72 Hz separations. Another group consisted of the lines, which kept almost constant frequency and they had quite exactly 50 Hz spacing. So, the frequency drifts could be different between neighbouring MLR lines. Strong lines of both groups had a pronounced common feature: periodic amplitude and frequency modulation. The modulation was in strong cases on-off modulation with a period of 4–6 s. Within every modulation period there was also a systematic frequency modulation, and the frequency swept upwards with a rate of 3 Hz/s.

In this presentation new results will be shown. They are based on new analysis package developed by T. Turunen.

September 14, Tuesday 14:20–14:40 – ORAL – 20 minutes.

Overview of Solar-Terretrial, Ionospheric and Atmospheric Researches Performed Using the South America VLF Network SAVNET

Jean-Pierre Raulin (1), Fernando C. P. Bertoni (1), Germán Fernandez (2)

[1] CRAAM/EE/UPM — São Paulo, Brazil, [2] CASLEO — San Juan, Argentina

Abstract. The South America VLF NETwork (SAVNET) has completed three years of operation in April 2010. In this work, we will review the results obtained so far in the context of the Sun-Earth relationships and the ionosphere. In particular the low ionospheric C-region has been monitored on a daily basis, using the well known post sunrise phase effect. The results show that the slow variations of this effect are well understood in terms of the solar illumination conditions, while transient and more intense variations are well correlated with "winter anomaly" times. We took advantage of the very low solar activity levels between 2006 and 2009 to study about 500 solar flares during this period, and their response in the D region. We find a new lower detection limit for such events of about 2.7 10^{-7} W/m^2, that is a soft X-ray power corresponding to very small solar events of GOES Class B 2.7. A comparison with earlier results nicely confirms the role of Lyman-alpha radiation in the formation and to maintain the diurnal D region. Finally, we used different VLF propagation paths to monitor the VLF wave amplitude at local noon. As we have found in the case of the C-region, the slow and long-term amplitude variations can be explained by the solar illumination. Interestingly, amplitude long-term variations do show the presence of both solar cycle and solar rotation signatures.

September 14, Tuesday 14:40–15:00 – ORAL – 20 minutes.

Low ionosphere effects of long term solar and transient geomagnetic activity using VLF technique

Fernando C. P. Bertoni (1), Jean-Pierre Raulin (1), Jorge E. Samanes (1)

[1] Centro de Radio-Astronomia e Astrofísica Mackenzie (CRAAM), Universidade Presbiteriana Mackenzie, São Paulo, Brazil

Abstract. The South America VLF NETwork (SAVNET) is an array of VLF receiver stations in Brazil, Peru and Argentina and is an international project dedicated to make solar monitoring of transient and quiescent activity, studying the effects of the South Atlantic Magnetic Anomaly, low ionosphere studies, among other subjects, including external and internal forcings of the low ionosphere. In this work, we present daily maximum diurnal amplitude time series that exhibited behavior patterns in different time scales, such as long term variations associated with the solar activity level control of the low ionosphere. Alternated periods of slow and faster variations were also observed, being the former related to solar illumination conditions, and the latter to the winter anomaly at high latitudes. A 27-days period related to the solar rotation, also associated to the solar Lyman-α radiation flux was identified, and will be discussed in the context of the formation of the D-region. In addition, we show that VLF data are suitable for analysis of geomagnetic disturbance events.

September 14, Tuesday 15:00–15:20 – ORAL – 20 minutes.

Improvements in the WWLLN: Increased Detection Efficiencies and new Lightning Power Measurements through more Stations and Smarter Algorithms

Craig J. Rodger (1), James B. Brundell (2), Michael Hutchins (3), Robert H. Holzworth (3), Rory J. Gamble (1)

[1] Department of Physics, University of Otago, Dunedin, New Zealand,
[2] UltraMSK.com, Dunedin, New Zealand,
[3] Dept. Earth and Space Sciences, University of Washington, Seattle, USA

Abstract. Powerful lightning flashes with large return stroke peak currents induce energetic and electrical coupling between the troposphere and the upper atmosphere via the quasi-electrostatic and/or the radiated electromagnetic pulse (EMP). Several researchers have suggested that the lightning EMP which drives ELVES may be a significant source of variation in the upper atmosphere at regional and global scales. In addition, "big" lightning is more loosely associated with other Transient Luminous Events (TLEs) and has been linked to Terrestrial Gamma-ray Flashes (TGFs). Global lightning provides context on the activity levels of thunderstorm systems, assisting studies into TLEs, TGFs, meteorology and atmospheric electricity in general. One of the few experiments which can currently provide such observations is the multi-station World Wide Lightning Location Network (WWLLN). The WWLLN-stations measure the very low frequency (VLF; 3–30 kHz) radiation from lightning discharges. Propagation at these very long electromagnetic wavelengths (up to 100 km) allows lightning strokes to be located in real time at up to 10,000 km from the receivers with a location accuracy that is estimated to be ≈10–20 km, and sometimes better than this. True global mapping of lightning from widely spaced (a few Mm) ground-based receivers requires the use of frequencies <30 kHz. Lightning impulses in this frequency range suffer low propagation attenuation, and hence propagation in the Earth-ionosphere waveguide is possible over global distances. In April 2009 we introduced a new algorithm for reprocessing WWLLN observations, leading to an increase in locations by a factor of 2.3. In this talk I hope to discuss our most recent efforts to produce new, smarter algorithms leading to Detection Efficiency improvements. Comparisons with commercial networks suggest that WWLLN triggers for 80–90% of strong cloud to ground lightning (>|50 kA|) and ≈30% of all cloud to ground lightning. Future improvements in algorithms could increase the number of locations extracted from the triggers by another factor of ≈3. In addition, I will briefly report on new work being under taken to use WWLLN measurements to report on the radiated power of global lightning discharges.

September 14, Tuesday 16:00–17:30 – student – POSTER

Ionospheric Anomalies Observed prior to Seismic Events

Sahil Brijraj (1), Brett Delport (1), Andrew B. Collier (1,2)

[1] University of KwaZulu-Natal, Westville Campus, Durban, South Africa, [2] Hermanus Magnetic Observatory

Abstract. Studies of anomalous ionospheric perturbations possibly due to seismic activity have been conducted as case studies on a single strong earthquake [Hobara 2005] or over several years in a specific region [Liu 2000]. Anomalous ionospheric phenomena possibly related to seismic activity include a decrease in the critical frequency of the F2 region, f0F2 [Liu 2000], increase in ionospheric electron and ion temperatures [Sharma 2006] and VLF signal distortion [Shvets 2004]. All the aforementioned phenomena were observed within a week of the associated seismic event. The observation of anomalies has been extensively proven to be associated with the strength of the corresponding seismic event, with earthquakes only of $M>5$ having associated anomalies [Pulinets 2003]. Liu 2000, stated that the strength of the earthquake not only determines whether there will be an associated anomaly but also the number of anomalies. Sharma 2006, concluded that electron temperatures increase by a factor of 1.2–1.5 prior to an earthquake. Shvets 2004, observed wave-like anomalies in the received VLF signals that correlated well with local seismicity at the time, again with an enhancement 2–3 days prior to an earthquake. The spectral density has an anomaly with a period of 3 hours. The nighttime fluctuations that deviate from average diurnal runs are considered as anomalous. Similar periodical variations between seismic and VLF signals of 4–14 days are observed. Using narrowband data from a Hungarian VLF receiver the behaviour of the signals will be monitored and compared to seismicity along the region covered by the propagation path for correlation, ultimately aiming to help use VLF perturbations as definitive precursors to seismic events. It is very difficult to isolate signatures in the ionosphere that are seismogenic and thus to classify any perturbation as purely seismically driven as the ionosphere is affected by numerous factors, predominantly solar activity.

September 14, Tuesday 16:00–17:30 – student – POSTER

Equatorial Noise Obtained from Measurements of the Cluster Spacecraft

Zuzana Hrbáčková (1,2), Ondřej Santolík (1,2), Nicole Cornilleau-Wehrlin (3)

[1] Charles University in Prague, Czech Republic,
[2] Institute of Atmospheric Physics, Prague, Czech Republic, [3] LPP/CNRS, Palaiseau, France

Abstract. We report results from systematic analysis of equatorial noise (EN) using eight years (2002–2009) of data from Cluster spacecraft. EN is an intense natural electromagnetic emission which propagates close to the geomagnetic equator between local proton cyclotron and local lower hybrid frequencies. The STAFF-SA instruments located onboard of four Cluster spacecraft provide us with a unique data set for wave analysis. In particular we have observed that EN is visible inside the plasmasphere as outside of the plasmapause.

September 14, Tuesday 16:00–17:30 – POSTER

Obliquely propagating chorus and transverse motion of the source

Jaroslav Chum (1), Ondřej Santolík (1,2), Jolene S. Pickett (3), Donald A. Gurnett (3)

[1] Institute of Atmospheric Physics, Prague, Czech Republic,
[2] Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic,
[3] University of Iowa, Iowa City, Iowa, USA

Abstract. We report observations and analysis of highly oblique lower band chorus recorded by WBD and STAFF instruments onboard CLUSTER spacecraft close to the geomagnetic equator. We observed falling elements in the analyzed cases. The Poynting flux measurements made by the STAFF instrument confirmed that the chorus source was located in the magnetic equatorial plane. Owing to the orbit, the spacecraft located closer to the equator were at lower L-shells during these observations. Surprisingly, the spacecraft located closer to the geomagnetic equator systematically received the corresponding chorus elements later than the spacecraft located at higher magnetic latitudes. The time shifts and frequency differences depended almost linearly on the perpendicular distance between the various spacecraft. We show that the sources moving across the magnetic field lines are reasonably well consistent with these observations. We consider that this motion of the chorus sources might be a consequence of a feedback between the oblique waves and counter streaming electrons during nonlinear cyclotron interaction, and provide a theoretical estimate of the transverse velocity of the source.

September 14, Tuesday 16:00–17:30 – student – POSTER

Particle-in-cell simulations of chorus emissions

Etienne J. Koen (1,2), Andrew B. Collier (2,3), Shimul K. Maharaj (2), Brett Delport (3)

[1] Royal Institute of Technology, Stockholm, Sweden.,
[2] Hermanus Magnetic Observatory, Hermanus, South Africa.,
[3] School of Physics, University of KwaZulu-Natal, Durban, South Africa.

Abstract. Chorus emissions are whistler mode waves propagating through the Earth's magnetosphere at frequencies typically in the range of 0.1–0.8 f_{ce}, where f_{ce} is the equatorial electron gyrofrequency. Chorus consists of discrete rising or falling tones, each of which lasts for a few tenths of a second. The emissions occur in two distinct frequency bands (lower and upper band) with a minimum wave power near 0.5 f_{ce}. The chorus source region is located outside the plasmapause near the geomagnetic equator. Chorus emissions are predominantly observed during geomagnetically disturbed conditions, in association with an enhanced flux of energetic electrons. Energetic electrons are injected into the inner magnetosphere during the onset of the substorm expansion phase. As they drift around towards noon, the distribution of the electrons becomes unstable for the amplification of whistler mode waves. Although the chorus generation mechanism is not well understood, it is thought that these unstable electrons interact with whistler mode waves via the Doppler-shifted cyclotron interaction. One approach to obtain some insight into chorus generation is through the use of particle-in-cell simulations. A region of plasma is simulated for a large population of particles with appropriate boundary and initial conditions. The trajectories of the individual particles are followed subject to their interaction with the macroscopic magnetic and electric fields. These fields, in turn, are calculated from the spatial distribution and motion of the particles. Small perturbations are then introduced into the system. If the conditions in the simulated plasma are suitable, then these perturbations will be amplified. The simulations are computationally intensive and require significant computer resources. Therefore the simulations were carried out on a high performance parallel computer cluster. Some of the results of these simulations will be presented and compared to observations.

September 14, Tuesday 16:00–17:30 – student – POSTER

Effects of Ionospheric and Terrestrial Factors on VLF Propagation in the Earth-ionosphere Waveguide

Stephen Guy Meyer (1,2), Andrew B. Collier (1,2)

[1] Hermanus Magnetic Observatory,
[2] University of KwaZulu-Natal

Abstract. Very Low Frequency (VLF) radio waves propagate with little attenuation within the Earth-ionosphere waveguide. Perturbations of the lower ionosphere produce a modification of the geometry of the waveguide, resulting in a disruption of the VLF propagation conditions. Ionospheric perturbations are caused by either an increased flux of energetic photons and particles, or periodic modifications due to the daily and seasonal cycles of the Earth. Whereas the latter occur with a regular periodicity, the former occur at random. In order to differentiate between the periodic and stochastic ionospheric perturbations it is important to understand the mechanisms which cause the diurnal and seasonal changes in VLF propagation conditions. Mode theory calculations are used to examine the effects of spatial and temporal changes in ionospheric conditions as characterised by Wait's parameters as well as the effect of different ground conductivities on the propagation of VLF waves.

September 14, Tuesday 16:00–17:30 – student – POSTER

Statistical Analysis of the Electromagnetic Waves Observed in the Upper Ionosphere by the DEMETER Spacecraft as Function of the Seismic Activity

David Pisa (1,2,3), Ondřej Santolík (1,2), Michel Parrot (3)

[1] Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic,
[2] Institute of Atmospheric Physics, Prague, Czech Republic,
[3] LPC2E/CNRS, Orléans, France

Abstract. Up to now many electromagnetic effects possibly related with earthquakes have been observed in the upper ionosphere. The payload of the DEMETER satellite (launched in 2004, orbiting at an altitude of about 660 km, still operating) is well suited to study these effects. With these spacecraft data a very small but statistically significant decrease of wave intensity has been already measured a few hours before the time of the main shocks at a frequency close to 1.7 kHz. The effect is observed in the vicinity (less than 330 km) of strong (M => 5.0) and shallow (depth < 40 km) earthquakes. In this paper, an extension of this statistical analysis is done until the end of July 2010. The results are shown as a function of different parameters. The data in other frequency ranges (ULF and HF) registered by DEMETER are also processed.

September 14, Tuesday 16:00–17:30 – POSTER

Determination inside The Plasmasphere of the Ion Composition and Absolute Density from the ULF Wave Propagation Properties With WHISPER/CLUSTER and STAFF/CLUSTER Data.

Jean Louis Rauch (1), Jean Gabriel Trotignon (1), Nicole Cornilleau-Wehrlin (2), Patrick Robert (2), Elena Titova (3,4), WHISPER Team (1), STAFF Team (2)

[1] LPC2E/CNRS, 3A av. de la Recherche Scientifique, 45071 Orleans Cedex 2, France,
[2] LPP/CNRS, Ecole Polytechnique, 91128 Palaiseau Cedex, France,
[3] Polar Geophysical Institute, Apatity, Russian Federation,
[4] Space Research Institute of RAS, Moscow, Russia

Abstract. The Wave of High frequency and Sounder for Probing of Electron density by Relaxation (WHISPER) performs the measurement of the electron density on the four satellites of the CLUSTER project. The two main purposes of the WHISPER experiment are to record the natural waves and to make a diagnostic of the electron density using the sounding technique. The various working modes and the fourier transforms calculated on board provide a good frequency resolution obtained in the bandwidth 2–83 kHz and a well instrumental adaptability to determine the electron density in various plasma. The Spatio Temporal Analysis of Field Fluctuations (STAFF) consists of a three-axis search coil magnetometer to measure magnetic fluctuations at frequencies up to 4 kHz, a waveform unit (up to either 10 Hz or 180 Hz) and a Spectrum Analyser (up to 4 kHz). In this work, we will use the data coming from the wave form unit. The aim of this presentation is to show the possibility to determine the ratio of the ion H^+, He^+, O^+ species using the propagation characteristic of the ULF waves inside the plasmasphere. In a multicomponents plasma, the wave dispersion relation is strongly modified. The propagation modes are spitted into several parts with various polarizations. Cut-off and resonance frequencies appear whose the values are a tracer of the ratio of the density species. Moreover, crossover frequencies happen where the polarization right-handed become left-handed which allow us to have another way to evaluate the rate of the different ion species. STAFF waveform measurements of the three magnetic components in the ULF bandwidth give us an access to the total wave energy, polarisation properties and wave propagation direction. A carefully analysis of the spectra allow us to determine these characteristic frequencies. An interpretation is proposed with the aim to determine a realistic estimation of the ion density background using, in addition, the absolute electron density deduced of the active WHISPER data with the assumption of global plasma neutrality.

September 14, Tuesday 16:00–17:30 – POSTER

Long Distance Monitoring of the Lower Ionosphere using Subionospheric VLF Propagation: The Global AARDDVARK Sensor Array

Craig J. Rodger (1), Mark A. Clilverd (2), the AARDDVARK Team (3)

[1] Department of Physics, University of Otago, Dunedin, New Zealand,
[2] British Antarctic Survey (NERC), Cambridge, United Kingdom,
[3] all over the world

Abstract. The Antarctic-Arctic Radiation-belt (Dynamic) Deposition — VLF Atmospheric Research Konsortium (AARDDVARK) provides continuous long-range observations of the lower-ionosphere. It is currently operating near-continuously in both hemispheres of the globe, and new stations will be added over the next few years. The Konsortia sensors detect changes in ionisation levels from ≈30–85 km altitude, with the goal of increasing the understanding of energy coupling between the Earth's atmosphere, Sun, and Space. We use the upper atmosphere as a gigantic energetic particle detector to observe and understand changing energy flows. The global-scale network of sensors monitors fixed-frequency very low frequency (VLF) communications transmitters; ionospheric modifications up to ≈85 km altitude lead to changes in the received amplitude and phase. Subionospheric VLF propagation allows us to undertake remote sensing of the upper atmosphere over large regions; these signals can be received thousands of kilometres from the source. The AARDDVARK sensor network is well suited to provide observations complementary to other ground based and space-based instruments, operating continuously or in high-resolution campaigns. AARDDVARK data is providing promising results on a number of active space weather science topics such as: Solar Proton Events, Relativistic Electron Precipitation, Microbursts, Substorm precipitation, Descent of NOx from Thermospheric Altitudes, and Solar Flares.

September 14, Tuesday 16:00–17:30 – POSTER

Similarities and Differences in Flare-Perturbed VLF Signals as Received in Erd and Belgrade

Vida Žigman (1), Davorka Grubor (2), Aleksandra Kolarski (3), Desanka Šulić (4)

[1] University of Nova Gorica, Nova Gorica, Slovenia,
[2] Milutina Milankovica 130, 11070 Belgrade, Serbia,
[3] Institute for Geophysics, Belgrade, Serbia ,
[4] Institute of Physics, Belgrade, Serbia

Abstract. The analysis of diurnal VLF signals NAA/24.0 kHz(Maine) and GQD/21.0 kHz (Skelton) as received in Belgrade and Erd has been performed for the period 10–20 August 2004, including both quiet days and a distinctly flare-disturbed sequence of days from 13 to 15 August 2004. The idea has been to compare the signal patterns at traces NAA-Bgd and NAA-Erd, on one hand and at GQD-Bgd and GQD-Erd on the other, with the goal to examine the respective VLF signatures of X-ray Solar flares and the accompanying electron density enhancements of the D-region. Along the GCP in the W-E direction the difference in the NAA-signal path amounts to 247 km, and in the NW-SE direction in the GQD-signal path to 264 km. In view of the rather close locations of the two receivers we expected that the respective amplitude and phase recordings should bear some similarities. It was found that, indeed, that the NAA-signal variations are highly similar as monitored by both receivers. This is particular so for quiet days (there is hardly any distinction between the modal extrema on the path) and also for moderate flares from class C to M. However, for flares exceeding class M1, whereas a clear amplitude peak lagging behind the X-ray irradiance peak was registered at Erd, amplitude distortion was monitored at Bgd, the latter being observed also at other higher-class flares events during the Solar cycle 23. On the GQD paths, there is a coincidence in VLF amplitude and phase response to flares, however, the amplitude and phase patterns, as recorded by the two receivers, resemble each other like 'mirror' reflections. To estimate the electron density enhancements induced by the sequence of flares (13–15 August) we have applied both the LWPC code yielding the height profile N(z) and the independent procedure N(t) to obtain the temporal evolution of N during flare duration. The results are found to be in fair mutual agreement, for all the cases analysed. All over the N values are of the same order of magnitude, only few cases include discrepancies up to 40%. Moreover, N enhancement deduced from the distorted NAA-Bgd amplitude, which was analyzed whithin the time interval of maximum waveguide perturbation, was found to be in good agreement with the N value resulting from the distinct amplitude peak revelead on the NAA-Erd trace. Apparently, the prediction of the flare induced density enhancements from VLF signal perturbations, depends on the magnitudes of the amplitude and phase perturbations and the relaxation of the ionospheric D-region, as given by the time delay. The redistribution of modal extrema due to flare occurrence is highly path-sensitive. Specific local amplitude/phase patterns (either minima or maxima), at least when the two close receivers are concerned, seem to be a second order effect. We wish to thank János Lichtenberger for providing the Erd VLF data, and thus enabling the present comparative research.

September 15, Wednesday 09:30–09:50 – ORAL – 20 minutes.

MF Waves Observed by DEMETER above the South Atlantic Anomaly

Michel Parrot (1)

[1] LPC2E/CNRS

Abstract. DEMETER is an ionospheric micro-satellite launched on a polar and circular orbit at an altitude of 710 km in June 2004. This altitude was decreased to 660 km in December 2005. Its main scientific objectives are to study the ionospheric perturbations in relation with seismic and anthropogenic activities. Therefore, its scientific payload allows to measure electromagnetic waves and plasma parameters all around the Earth except in the auroral zones. In the MF frequency range, the data of an electric field antenna are recorded up to 3 MHz. Global maps of an electric field component measured during night time have revealed a new emission around 670 kHz which fits the area of the SAMA (South Atlantic Magnetic Anomaly). This frequency is roughly less than or equal to the electron gyrofrequency fce below the satellite altitude, and the surface of observation is limited to an area where fce < 670 kHz. This emission is attributed to drifting energetic particles which continuously precipitate into the SAMA ionosphere. It is shown that this emission vanishes during summer in the southern hemisphere and in particular areas of the SAMA for some months. This observation is attributed to the larger ionospheric electron density at these times below the satellite and suggests that the source of the emission is below the F layer. A Z-mode emission, similar to the Z-mode which is observed in the auroral zone, is suggested as a possible explanation.

September 15, Wednesday 09:50–10:10 – student – ORAL – 20 minutes.

Satellite Observations of Whistlers near the Tihany Conjugate Point

Brett Delport (1), Andrew B. Collier (1,2), János Lichtenberger (3)

[1] University of KwaZulu Natal,
[2] Hermanus Magnetic Observatory,
[3] Eotvos University

Abstract. The classical production mechanism for whistlers predicts that a lightning stroke will result in a whistler being detected near the geomagnetic conjugate point. A recent study [Collier, 2009] has shown that, while the highest concentration of initiating strokes are near the conjugate point, there are also numerous initiating strokes located in isolated areas several thousand kilometers from the conjugate point. The present study aims to show what fraction of the conjugate lightning generates signals which penetrate the ionosphere by linking fractional hop whistlers detected onboard the DEMETER satellite to lightning strokes. This is done by enforcing the condition that the travel time of light must be equal to the delay between the whistler and the causative stroke. From this we develop a distribution of distance from the ionospheric penetration point, to the position of the causative stroke. The fractional hop whistlers will then, in turn, be associated with whistlers detected on the ground near the conjugate point, again using the travel time of the waves, and delay between detection. The study uses lightning data from the World Wide Lightning Location Network (WWLLN), burst mode VLF data from the DEMETER satellite and whistler data from the automatic detection station in Tihany, Hungary.

September 15, Wednesday 10:10–10:30 – student – ORAL – 20 minutes.

Sporadic E-layer and occurrence of subprotonospheric whistlers

Jiří Fišer (1), Jaroslav Chum (1), Michel Parrot (2), Gerhard Diendorfer (3), Ondřej Santolík (1,4)

[1] Institute of Atmospheric Physics, Prague, Czech Republic,
[2] LPC2E/CNRS, Orléans, France,
[3] Austrian Electrotechnical Association (OVE-ALDIS), Vienna, Austria,
[4] Charles University in Prague, Faculty of Mathematics and Physics, Prague, Czech Republic

Abstract. Subprotonospheric (SP) whistlers are characterized by repeated reflections between the base of the ionosphere and altitudes up to ~ 1000 km. Normally, the electromagnetic waves penetrate the ionosphere with vertically directed wave vectors. That is a consequence that the refractive index in the ionosphere is much larger than in the neutral atmosphere below it. The SP whistlers are formed if waves penetrating the ionosphere experience a spread of wave normal angles. Possible explanation of this spread of wave normal angles, reported in the literature, is based on scattering on small-scale irregularities in the sporadic E-layer. Here we present a statistical investigation that confirms that the occurrence of SP whistlers in the satellite VLF data is much larger if the sporadic E-layer is observed, than if it is not observed. Our analysis is based on the DEMETER VLF burst data recorded above European continent and data from European ionosondes. We also searched for causative lightning using EUCLID network.

September 15, Wednesday 10:30–10:50 – ORAL – 20 minutes.

Large scale wave-like structures in the topside ionosphere as a manifestation of the vertical coupling processes at mid and low latitudes

L. Bankov (1), A. Vassileva (1)

[1] Space Research Institute-Bulgarian Academy of sciences, 6 Moskovska str. Sofia 1000, Bulgaria

Abstract. In the present paper we study the seasonal climatology of wave-like structures in the ion density at mid and low latitudes. Ion density data concerning major H+, O+ ions obtained at ~840km altitude for DMSP-F13 and DMSP-F15 satellites and ~700km for DEMETER are used. We show statistically that peak amplitude of ion density wave-like structures in the topside ionosphere correspond to the geographic zones with expected minimum in F-region height due to the longitudinal asymmetries in the transequatorial plasma transport. We suggest that AGW disturbances in the bottom-side F-region caused by seismic activity could be accepted as one of relevant source of ionospheric wave-like structures in the topside ionosphere. It is shown that latitudinal extent the disturbed zone could vary significantly depending on the relative location of the earthquake epicenter in respect to the magnetic equator.

September 15, Wednesday 10:50–11:10 – ORAL – 20 minutes.

Seasonal behavior of the wave-number four (WN4) in the topside ionosphere at mid and low latitudes during declining 23 solar cycle

L. Bankov (1), A. Vassileva (1)

[1] Space Research Institute-Bulgarian Academy of sciences, 6 Moskovska str. Sofia 1000, Bulgaria

Abstract. We examine major peculiarities in the seasonal climatology of the so-called "wave-number four" (WN4) structures in the topside ionosphere at mid and low latitudes. For the period of declining solar activity 2002–2008, densities of major H+ and O+ ions as well as ion temperature Ti in situ satellite data obtained at ~840km altitude by DMSP-F13 and DMSP-F15 (2002–2005) and ≈700 km by DEMETER (2004–2008) are used. DMSP-F13, F15 and DEMETER satellites operate at almost circular sun-synchronous orbits since 1994,1999 and 2004, respectively. Seasonal climatology of the WN4 wave in the longitudinal distribution of O+, H and ion temperature Ti show remarkable seasonal stability in the longitudinal position of the wave crests within longitude sector with nearly zero magnetic declination (60–100 degrees). Reversely, throughout winter season and longitude zone with large magnetic declinations wave peaks merge to reduce a number of wave crests. Thus revealed magnetic declination effect on the WN4 wave in the topside ionosphere is referred as a major source of the seasonal behavior of the WN4 amplitude at these altitudes.

September 15, Wednesday 11:10–11:30 – ORAL – 20 minutes.

Radiation Belt Electron Precipitation from Plasmaspheric Hiss: Significance to Atmospheric Ozone Chemistry

Craig J. Rodger (1), Mark A. Clilverd (2), Annika Seppälä (2,3), Neil R. Thomson (1), Rory J. Gamble (1), Michel Parrot (4), Jean-André Sauvaud (5), Thomas Ulich (6)

[1] Department of Physics, University of Otago, Dunedin, New Zealand,
[2] British Antarctic Survey (NERC), Cambridge, United Kingdom,
[3] Earth Observation, Finnish Meteorological Institute, Helsinki, Finland,
[4] Laboratoire de Physique et Chimie de l'Environnement, Orleans, France,
[5] Centre d'Etude Spatiale des Rayonnements, Toulouse, France,
[6] Sodankylä Geophysical Observatory, University of Oulu, Sodankylä, Finland

Abstract. Geomagnetic storms triggered by coronal mass ejections and high-speed solar-wind streams can lead to enhanced losses of energetic electrons from the radiation belts into the atmosphere, both during the storm itself and also through the post-storm relaxation of enhanced radiation belt fluxes. In this study we have analyzed the impact of electron precipitation on atmospheric chemistry (30–90 km altitudes) as a result of a single geomagnetic storm. The study conditions were chosen such that there was no influence of solar proton precipitation, and thus we were able to determine the storm-induced electron precipitation fluxes from the outer radiation belt. We used ground-based subionospheric radio wave observations to infer the electron precipitation fluxes at L=3.2 during a geomagnetic disturbance which occurred in September 2005. Through application of the Sodankylä Ion and Neutral Chemistry (SIC) model, we examined the significance of this particular period of electron precipitation to neutral atmospheric chemistry. Building on an earlier study, we refined the quantification of the electron precipitation flux into the atmosphere by using a time-varying energy spectrum determined from the DEMETER satellite. We show that the large increases in odd nitrogen (NOx) caused by the electron precipitation did not lead to significant in-situ depletions in Ozone in September in the northern hemisphere, because of high levels of daytime photolysis. However, had the same precipitation fluxes deposited into the polar winter atmosphere, the production of NOx would have led to long-lived >20% in-situ decreases in ozone at 65–80 km altitudes.

September 16, Thursday 10:10–10:30 – ORAL – 20 minutes.

Investigating the Impact of Solar Energetic Particle Events on the Lower Ionosphere using VLF/LF Propagation Conditions along a Midlatitude — Sub Polar Path

Ernst Dieter Schmitter (1)

[1] University of Applied Sciences Osnabrueck, 49076 Osnabrueck, Germany

Abstract. We present observations of the VLF/LF transmitter (37.5 kHz) at Grindavik, Iceland, 64N 22.5W (L=5), from 2 receiver sites at 52N 8E (L=2.3), 40 km apart, great circle distance 2200 km. The path does not reach deeply into the polar cap but into the auroral zone. The continuously monitored propagation conditions prove as a sensitive and reliable proxy for the solar energetic particle (SEP) event intensity and impact area extension especially with regard to the night side auroral oval position which in turn is known to be closely related to IMF Bz and geomagnetic activity for example quantified by the AL index. Strong events also show up in the daytime signal strength leaving a fingerprint comparable to that of a solar flare (X-ray) induced SID. A multi wave hop + ground wave model validated by full wave 3D FEA calculations and fitted to the VLF data together with an auroral oval model calibrated with POES auroral activity data yields information about the lowering of the effective reflection heights along the propagation path during SEPs. Our data provide a useful complement to satellite data with regard to the continously monitored state of the lower ionosphere along the transmission path. Presented are results from this years events of the new solar cycle.

September 16, Thursday 10:30–10:50 – ORAL – 20 minutes.

Study of the Observed Amplitude and Phase Perturbations on VLF Signals From Lighting Induced Electron Precipitation and Reconstruction of D-region Electron Density Height Profile

Desanka Šulić (1), Vida Žigman (2), Aleksandra Nina (1)

[1] Institute of Physics, University of Belgrade, Belgrade, Serbia,
[2] University of Nova Gorica, Nova Gorica, Slovenia

Abstract. Measurements of the amplitude and/or phase of VLF transmissions have provided information on the variation of the D-region, both spatially and temporally. Subionospheric signals from VLF transmitters were recorded on AWESOME ELF/VLF receiver system at Belgrade station. Data are typically acquired everyday at 18 to 06 UT when the great circle paths between the transmitter and receiver are partially or whole in the nighttime sector. We analyze Lightning-induced Electron Precipitation (LEP) events during period 2008–2010 at Belgrade station on subionospheric VLF signals from five transmitters: NRK/37.5 kHz, Iceland; DHO/23.4 kHz, Germany; GQD/22.1 kHz, UK; NAA/24.0 kHz USA and ICV/20.9 kHz Italy.

In typical LEP events, the measurable perturbed magnitude ($\Delta\ A_{rec}$) of the VLF signal refers to the change in amplitude measured in dB, from the ambient levels prior to the event, to the maximum (or minimum) levels reached during the event. The associated phase change ($\Delta\varphi_{rec}$) is also measured. The observed VLF amplitude and phase perturbations are simulated by the computer program Long Wavelength Propagation Capability (LWPC), using Wait's model of the lower ionosphere, as determined by two parameters: the sharpness β and reflection height *h*'. By varying the values of β and *h*' so as to match the observed amplitude change $\Delta\ A_{rec}$ and phase ($\Delta\ \varphi_{rec}$, computer modeling yields information about electron density at reflection height, *h*', for ambient and perturbed D-region. In our calculations reflection height is between 87 and 84 km. The sharpness β during LEP events is found in range 0.50–0.46 km^{-1}. Calculated electron density at reflection height *Ne(h)* is a pointer for further modeling electron density height profile.

The altitude dependence of the electron density perturbation is assumed to be Gaussian, centered at a height h_0 ($h_0<h'$) with a variance σ in range from 10 to 7 km. The variation of the D-region electron density height profile *Ne(h)* in the altitude range 60–90 km was reconstructed, throughout LEP events which occurred over western and middle Europe.

September 16, Thursday 10:50–11:10 – ORAL – 20 minutes.

Ground-based Estimates of Outer Radiation Belt Energetic Electron Precipitation Fluxes into the Atmosphere

Mark A. Clilverd (1), Craig J. Rodger (2), Rory J. Gamble (2), Thomas Ulich (3), Tero Raita (3), Annika Seppälä (1), Janet C. Green (4), Neil R. Thomson (2), Jean-André Sauvaud (5), Michel Parrot (6)

[1] British Antarctic Survey (NERC), Cambridge, United Kingdom,
[2] Department of Physics, University of Otago, Dunedin, New Zealand,
[3] Sodankylä Geophysical Observatory, University of Oulu, Sodankylä, Finland,
[4] Space Weather Prediction Center, NOAA, Boulder, Colorado,
[5] Centre d'Etude Spatiale des Rayonnements, Toulouse, France,
[6] Laboratoire de Physique et Chimie de l'Environnement, Orleans, France

Abstract. AARDDVARK data from a radiowave receiver in Sodankylä, Finland have been used to monitor transmissions from the very low frequency communications transmitter, NAA, (24.0 kHz, 44^o N, 67^o W, L=2.9) in USA since 2004. The transmissions are influenced by outer radiation belt (L=3–7) energetic electron precipitation. In this study we have been able to show that the observed transmission amplitude variations can be used to routinely determine the flux of energetic electrons entering the atmosphere. Our analysis of the NAA observations shows that electron precipitation fluxes can vary by three orders of magnitude during geomagnetic storms. Comparison of the ground-based estimates of precipitation flux with satellite observations from DEMETER and POES indicates a broad agreement during geomagnetic storms, but some differences in the quiet-time levels, with the satellites observing higher fluxes than those observed from the ground. Typically when averaging over L=3–7 we find that the >100 keV POES "trapped" fluxes peak at about 10^6 el.cm^{-2}s^{-1}str^{-1} during geomagnetic storms, with the DEMETER >100 keV drift loss cone showing peak fluxes of 10^5 el.cm^{-2}s^{-1}str^{-1}, and both the POES >100 keV "loss" fluxes and the NAA ground-based >100 keV precipitation fluxes showing peaks of ~10^4 el.cm^{-2}s^{-1}str^{-1}. The analysis of NAA amplitude variability has the potential of providing a detailed, near real-time, picture of energetic electron precipitation fluxes from the outer radiation belts.

September 16, Thursday 11:10–11:30 – ORAL – 20 minutes.

Results of VLF Campaigns During Summer, Winter and Total Solar Eclipse in Indian Subcontinent from Twelve Stations

Sandip Kumar Chakrabarti (1,2), Sudipta Sasmal (2), Sushanta Mondal (2), Sujay Pal (1), Tamal Basak (1)

[1] S.N. Bose National Centre for Basic Sciences, JD Block, Salt Lake, Kolkata 700098, INDIA,
[2] Indian Centre for Space Physics, 43 Chalantika, Garia Station Road, Kolkata 700084 INDIA

Abstract. We conducted Multi-station VLF campaigns throughout the Indian subcontinent to understand the diurnal and seasonal behaviour of the propagation characteristics of Very Low Frequency (VLF) signal through the ionospheric. The campaigns were carried out in the Summer, Winter as well as during total solar eclipse in 2010. In each cases we have results from about twelve receiving stations spreaded throughout the Indian sub-continent and covered about 4million squared kilometer area, perhaps largest of this kind. In this paper we present the results of these campaigns. We clearly see the directional dependence of the propagation effects, especially the non-reciprocity of the east to west and west to east directions of the wave. We compare our results with the LWPC model predictions and find that the models require some improvements. We also discuss the results from wave hop and mode theories both of which use the earth-ionosphere waveguide model in predicting signal amplitude and phase.

September 16, Thursday 13:10–13:30 – ORAL – 20 minutes.

Multivariate Techniques for Constructing Quiet Day Curves

Andrew B. Collier (1,2), János Lichtenberger (3), Péter Steinbach (3)

[1] Hermanus Magnetic Observatory,
[2] University of KwaZulu-Natal,
[3] Eotvos University

Abstract. Time series data can generally be decomposed into three components: a linear trend, regular (sinusoidal) variations and anomalies. Whereas the first two components are generated by deterministic processes and are thus predictable, the anomalies arise from stochastic events. The identification of such anomalies depends on a knowledge of the expected “normal” variations in the data. Numerous techniques exist for deriving such Quiet Day Curves (QDCs). Most are based on averaging the regular variations from a number of periods during which the contributions from anomalies are negligible. This approach, however, does not cater for seasonal or secular variations in the form of the QDC. An alternative method based on multivariate analysis techniques has been developed which allows for these variations. This technique produces a unique QDC which is tailored to the conditions applicable on a specific day. Typical space physics applications arise in data from riometers, magnetometers and narrowband VLF receivers.

September 16, Thursday 13:30–13:50 – ORAL – 20 minutes.

Refractive Index in a Realistic Ionosphere

Jaroslav Chum (1), Vladimir Truhlik (1)

[1] Institute of Atmospheric Physics

Abstract. The refractive index is a basic parameter that describes properties and propagation of waves. In general, the refractive index N of electromagnetic waves in ionized medium or cold plasma, respectively, depends on plasma density, ion composition, magnetic field strength, wave frequency, electron and ion collision frequencies and angle between wave vector and magnetic field. Using the latest IRI2007 model of electron density and ion composition and MSIS model for neutral atmosphere we compute typical profiles of real and imaginary part of the refractive index in the ionosphere at various latitudes, longitudes and local times. We specially focus on the wave frequencies corresponding to whistler mode waves and to vertical wave vectors. Investigating the real part of the refractive index, we also show that the local Lower Hybrid Resonance (LHR) frequency changes into a cut-off frequency (real part of N goes to zero) at ionospheric heights where the neutral collision frequencies are sufficiently large. At the same time the imaginary part rapidly increases.

September 16, Thursday 13:50–14:10 – ORAL – 20 minutes.

Martian Ionosphere Observed by the MARSIS Instrument

Frantisek Nemec (1), David D. Morgan (1), Donald A. Gurnett (1), Firdevs Duru (1)

[1] Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa, USA

Abstract. MARSIS is an instrument designed for the topside ionospheric sounding placed on board the Mars Express spacecraft. The instrument is active since August 14, 2005 and still operational, providing us with the ionospheric traces of the Martian ionosphere. These can be used to evaluate the ionospheric electron density from the satellite altitude down to the altitude of peak electron density in the ionosphere. Two different topics are discussed: 1) Dayside ionosphere. It is shown that this region is on average well described by the Chapman theory with upward diffusion taken into account. 2) Nightside ionosphere. Although the basic Chapman theory predicts no ionization in this region, there are two ionization sources acting simultaneously: i) plasma transport from the dayside ii) ionization by precipitating electrons. Their relative importance and the general properties of the nightside ionosphere are discussed.

September 16, Thursday 14:10–14:30 – ORAL – 20 minutes.

The Connection between meteor showers and VLF atmospheric noise signals

Colin Price (1), Yuval Reuveni (1,2), Yoav Yair (3), Roy Yaniv (1)

[1] Dept. of Geophysics and Planetary Sciences, Tel Aviv University,
[2] Porter School of Environmental Sciences, Tel Aviv University,
[3] Dept. of Life and Natural Science, The Open University of Israel

Abstract. There have been two different interests in the past as related to meteors and very low frequency (VLF) radiation in the atmosphere. The first deals with VLF pulses being produced by meteors entering the atmosphere, while the other deals with changes in the properties of the ionosphere due to meteors. To revisit these ideas, continuous measurements of VLF electromagnetic waves were performed simultaneously with optical imaging of meteors. The measurements were obtained during the Perseids, Orionids, and Leonids meteor showers during August, October, and November, 2007 and 2009. While 75% of the optically imaged meteors can be associated with weak VLF pulses, we cannot objectively differentiate between these VLF pulses and weak/distant lightning sferics. However, the data analysis does indicate a distinct change in the background VLF atmospheric noise levels which were recorded on the nights of the meteor showers. The impact of meteor showers is investigated using the atmospheric noise parameter Vd. It is observed that enhancements in the Vd values relates to the collision parameter modification due to the attachment of ambient free electrons by the natural dust particles of meteoric origin. These ionospheric modifications cause more absorption or inferior reflection conditions for the main VLF noise which is produced by lightning.

Index of Authors:

Jay Albert	**Mon 14:00 (10)**
L. Bankov	**Wed 10:30 (43)** **Wed 10:50 (44)**
Tamal Basak	Thu 11:10 (50)
Fernando C. P. Bertoni	Tue 14:20 (28) **Tue 14:40 (29)**
Petr Bespalov	**Mon 17:05 (17)**
Jacob Bortnik	**Mon 14:20 (11)** Mon 14:40 (12)
Sahil Brijraj	**Tue 16:00 (31)**
James B. Brundell	Tue 15:00 (30)
Sandip Kumar Chakrabarti	**Thu 11:10 (50)**
Jaroslav Chum	**Tue 16:00 (33)** Wed 10:10 (42) **Thu 13:30 (52)**
Mark A. Clilverd	**Mon 14:40 (12)** Tue 09:20 (18) Tue 09:40 (19) Tue 16:00 (38) Wed 11:10 (45) **Thu 10:50 (49)**
Andrew B. Collier	Tue 09:20 (18) Tue 09:40 (19) Tue 10:00 (20) Tue 11:00 (23) Tue 16:00 (31) Tue 16:00 (34) Tue 16:00 (35) Wed 09:50 (41) **Thu 13:10 (51)**
Nicole Cornilleau-Wehrlin	Mon 16:25 (15) Tue 16:00 (32) Tue 16:00 (37)
Brett Delport	Tue 16:00 (31) Tue 16:00 (34) **Wed 09:50 (41)**
Andrei G. Demekhov	**Mon 15:45 (13)** Mon 16:05 (14)
Gerhard Diendorfer	Wed 10:10 (42)
Sarah Dietrich	Mon 14:40 (12)
Firdevs Duru	Thu 13:50 (53)
Orsolya E. Ferencz	Tue 10:00 (20)
Csaba Ferencz	Tue 09:20 (18) Tue 09:40 (19) Tue 10:00 (20) Tue 10:20 (21)
Germán Fernandez	Tue 14:20 (28)
Jiří Fišer	**Wed 10:10 (42)**
Rory J. Gamble	Tue 15:00 (30) Wed 11:10 (45) Thu 10:50 (49)
Daniel I. Golden	Tue 09:40 (19)
Janet C. Green	Thu 10:50 (49)
Davorka Grubor	Tue 16:00 (39)
Donald A. Gurnett	Mon 16:05 (14) Mon 16:25 (15) Mon 16:45 (16) Tue 16:00 (33) Thu 13:50 (53)
Dániel Hamar	Tue 09:20 (18) Tue 09:40 (19) **Tue 10:00 (20)**
Mitsuru Hikishima	Mon 13:10 (8)
Robert H. Holzworth	Tue 15:00 (30)
Zuzana Hrbáčková	**Tue 16:00 (32)**
Rue-Ron Hsu	Tue 10:40 (22)
Michael Hutchins	Tue 15:00 (30)
Umran S. Inan	Tue 09:40 (19) **Thu 09:40 (46)**
Etienne J. Koen	**Tue 16:00 (34)**
Aleksandra Kolarski	Tue 16:00 (39)
Boris Kozelov	Mon 16:05 (14)
Ilya Kuzichev	**Tue 11:20 (24)**
János Lichtenberger	**Tue 09:20 (18)** **Tue 09:40 (19)** Tue 10:00 (20) Tue 10:20 (21) Wed 09:50 (41) Thu 13:10 (51)
Tzu-Yuan Lin	Tue 10:40 (22)
Eva Macúšová	Mon 16:05 (14) **Mon 16:25 (15)**
Shimul K. Maharaj	Tue 16:00 (34)

Jyrki Manninen	Tue 13:40 (26)
	Tue 14:00 (27)
Stephen Guy Meyer	**Tue 16:00 (35)**
Sushanta Mondal	Thu 11:10 (50)
David D. Morgan	Thu 13:50 (53)
Frantisek Nemec	**Thu 13:50 (53)**
Aleksandra Nina	Thu 10:30 (48)
Yoshiharu Omura	**Mon 13:10 (8)**
Sujay Pal	Thu 11:10 (50)
Michel Parrot	Tue 10:00 (20)
	Tue 16:00 (36)
	Wed 09:30 (40)
	Wed 10:10 (42)
	Wed 11:10 (45)
	Thu 10:50 (49)
Jolene S. Pickett	Mon 16:05 (14)
	Mon 16:25 (15)
	Mon 16:45 (16)
	Tue 16:00 (33)
David Pisa	**Tue 16:00 (36)**
Colin Price	**Thu 14:10 (54)**
Tero Raita	Mon 14:40 (12)
	Thu 10:50 (49)
Jean Louis Rauch	Mon 16:05 (14)
	Tue 16:00 (37)
Jean-Pierre Raulin	**Tue 14:20 (28)**
	Tue 14:40 (29)
Yuval Reuveni	Thu 14:10 (54)
Patrick Robert	Tue 16:00 (37)
Craig J. Rodger	Mon 14:40 (12)
	Tue 09:20 (18)
	Tue 09:40 (19)
	Tue 10:00 (20)
	Tue 15:00 (30)
	Tue 16:00 (38)
	Wed 11:10 (45)
	Thu 10:50 (49)
Jorge E. Samanes	Tue 14:40 (29)
Ondřej Santolík	Mon 16:05 (14)
	Mon 16:25 (15)
	Mon 16:45 (16)
	Tue 16:00 (32)
	Tue 16:00 (33)
	Tue 16:00 (36)
	Wed 10:10 (42)

Sudipta Sasmal	Thu 11:10 (50)
Jean-André Sauvaud	Wed 11:10 (45)
	Thu 10:50 (49)
Ernst Dieter Schmitter	**Thu 10:10 (47)**
Annika Seppälä	Wed 11:10 (45)
	Thu 10:50 (49)
David R. Shklyar	**Mon 13:40 (9)**
	Tue 11:20 (24)
Andy J. Smith	**Tue 13:10 (25)**
Péter Steinbach	Tue 09:20 (18)
	Tue 09:40 (19)
	Tue 10:00 (20)
	Tue 10:20 (21)
	Thu 13:10 (51)
Han-Tzong Su	Tue 10:40 (22)
Desanka Šulić	Tue 16:00 (39)
	Thu 10:30 (48)
Danny Summers	Mon 13:10 (8)
WHISPER Team	Tue 16:00 (37)
STAFF Team	Tue 16:00 (37)
the AARDDVARK Team	Tue 16:00 (38)
Neil R. Thomson	Wed 11:10 (45)
	Thu 10:50 (49)
Elena Titova	**Mon 16:05 (14)**
	Tue 16:00 (37)
Jean Gabriel Trotignon	Mon 16:05 (14)
	Tue 16:00 (37)
Vladimir Truhlik	Thu 13:30 (52)
Tauno Turunen	**Tue 13:40 (26)**
	Tue 14:00 (27)
Thomas Ulich	Wed 11:10 (45)
	Thu 10:50 (49)
A. Vassileva	Wed 10:30 (43)
	Wed 10:50 (44)
Yun-Ching Wang	Tue 10:40 (22)
Kaiti Wang	**Tue 10:40 (22)**
Yoav Yair	Thu 14:10 (54)
Roy Yaniv	Thu 14:10 (54)
Marlie van Zyl	Tue 11:00 (23)
Vida Žigman	**Tue 16:00 (39)**
	Thu 10:30 (48)