IAGA/ URSI Joint Working Group on

VLF/ELF Remote Sensing of Ionospheres and Magnetospheres Newsletter

Editor: Craig J. Rodger No. 26, December 2011

Dear Colleagues,

As the year draws to a close the heat has begun in the Southern Hemisphere (well, at least in Dunedin), and I assume the cold now bites many of you in the Northern Hemisphere. This has been a significant year for the VERSIM community - in particular, our two parents bodies both met this year. I was very pleasantly surprised by how many of the VERSIM community I encountered at the IUGG conference in Melbourne, Australia - despite it having been a vast distance for most of the community (and expensive to boot), there was a lot of VERSIM-science presented at multiple sessions. For those of you who have read the report of the VERSIM Business Meeting at Melbourne you might have thought it was a "VERSIM-lite" conference - although the attendance at our business meeting was a bit weak (7 people), this was entirely due to the poor timing which was forced on us with many of community not having landed in Melbourne at that point! I can also report with pleasure that I was present to see Eva Macúšová (Czech Republic) presented with an IAGA Young Researcher Award; Eva had been put forward for this award by the scientific committee of the 4th VERSIM Workshop in 2010, and it was wonderful to see her confirmed and formally congratulated.

On another pleasurable not, I can report we made up for the low attendance at our Melbourne business meeting at the URSI General Assembly in Istanbul a few months later. With 18 scientists attending our VERSIM Business Meeting at URSI our community looked very strong indeed, in fact I don't think I have seen so may people at one of our business meetings (outside of those during the VERSIM workshops). And even then I know there were more active VERSIM scientists (and VERSIM students) present at the URSI meeting who didn't attend the business meeting - so as you might expect, the Istanbul URSI meeting was packing with material of interest to our community.

I also want to report on an event from the URSI General Assembly in Istanbul. I attended the Commission G & H joint business meeting, and was asked to give a brief report on our activities. I quickly mentioned our yearly newsletter, the regular VERSIM workshops, and our business meetings at IUGG and at URSI. My report was ended by spontaneous applause from the business meeting, with comments like "Now, that's what a working group should be like!". So I would like to congratulate you all for being the active and vibrant community you are - it turns out, this is noticed!

Following on from this, I am grateful for the all of the VERSIM researchers who took the time to prepare and send me material for the newsletter. The newsletter contains 22 reports from 20 different countries. We have a strong community!

2012 is already looking like a very full year, in terms of scientific meetings. The primary VERSIM-relevant meeting next year is of course the 5th VERSIM Workshop which is being organized by the Center for Radio Astronomy and Astrophysics Mackenzie (CRAAM), Mackenzie Presbyterian University, São Paulo, Brazil. Our Brazilian colleagues have requested funding support from IAGA and URSI, and URSI has already agreed. They have also arranged support from multiple Brazilian organisations! I am confident this will be an excellent VERSIM workshop, and continue the strong record to date. Please update your diaries!

Finally, let me say it has been a pleasure to meet and discuss our science with a large number of you this year. For me, the URSI General Assembly was not so good for this, as I was also the New Zealand national representative and missed most of the poster sessions to be at the URSI Council. I'm particularly disappointed to have missed so many student presentations - especially the large number of posters from Indian and South African students. But, I do look forward to seeing people at the many conferences of 2012. I hope the New Year finds you happy, and of course active in VERSIM too! Best wishes,

Craig J. Rodger
IAGA co-chair VERSIM working group

Upcoming meetings

- 39th COSPAR Scientific Assembly Mysore, India from 14-22 July 2012.
- AOGS 2012, 13 to 17 August 2012 in Singapore.
- 5th VERSIM Workshop, Sao Paulo, Brazil, 2-8 Sept. 2012.
- 4th HEPPA Workshop (High Altitude Particle Precipitation into the Atmosphere), 8-12th October 2012 in Boulder, USA.
- 2012 Fall Meeting of the American Geophysical Union, San Francisco, USA from 6–10 December 2012.

Reports from VERSIM research groups 2011

This based on information received by the IAGA co-chairman, Craig Rodger, by email from the VERSIM membership. Some reports have been slightly edited so the newsletter has consistent formatting. Hopefully this has not introduced any significant typos.

Belgium - Belgian Institute for Space Aeronomy (IASB-BIRA), Belgium, report by Fabien Darrouzet.

We continue our project to detect whistlers with VLF measurements. A VLF antenna has been installed in October 2010 in Humain, Belgium (Lat ~50.11°N, Long ~5.15°E), in order to detect whistlers and determine electron densities along propagation paths. The VLF antenna is made of two perpendicular magnetic loops, oriented N-S and E-W and with an area of approximately 50 m^2 each.

After some tests starting in April 2011, the antenna is now fully working since August 2011. First results and instrument capabilities have been presented at IAGA General Assembly in Melbourne in July 2011.

This antenna is part of AWDAnet, the Automatic Whistler Detector and Analyzer system's network. This network covers low, mid and high magnetic latitudes including conjugate locations. It has been initiated by J. Lichtenberger (Hungary). Worldwide, 10 antennas are in operation and 23 are planned/in construction.

Team: Fabien Darrouzet, Sylvain Ranvier, Hervé Lamy, Johan De Keyser.

Brazil - Mackenzie Presbyterian University, São Paulo, Brazil, report by Fernando Bertoni and Jean-Pierre Raulin.

Report on the 2012 workshop: VERSIM 2012, September 2nd - 7th, São Paulo, Brazil, Linear and non-Linear VLF/ELF wave phenomena: observations, theory and modeling.

The VERSIM Workshop 2012 edition will be hosted by the Center for Radio Astronomy and Astrophysics Mackenzie (CRAAM), Engineering School, Mackenzie Presbyterian University, São Paulo, Brazil, on September 2-7, 2012. The VLF and ELF techniques have proved to be versatile and applicable to diverse lines of research and development in the recent decades. The VERSIM community will have an excellent opportunity for discussing and exchanging ideas, information and new concepts related to subjects from the solar physics areas, the space and atmospheric physics, as well as the space weather, radio-sciences, and the computational modeling areas, and technological applications. With URSI partial sponsoring, this meeting is also a forum of debates for the new generation of students that are encouraged to submit their works. We are looking forward to see all the VERSIM community in VERSIM Workshop 2012.

Czech Republic - Report by Ondrej Santolik, Jaroslav Chum, Frantisek Nemec, and Ivana Kolmasova, representing the Institute of Atmospheric Physics and Charles University.

1. We have continued our investigation of propagation of lightning induced whistlers and their penetration through the ionosphere using the data of the DEMETER spacecraft. We have also started to study propagation of lightning induced ion cyclotron waves observed by DEMETER near the equatorial region.

2. We have also studied a detailed structure of magnetospheric line radiation events observed by the DEMETER spacecraft. Frequency drift and frequency spacing of more than 700 events have been analyzed.

3. We have continued our studies on a possible influence of earthquakes on the ionosphere using 6.5 years of data from the DEMETER spacecraft. We have confirmed a weak decrease of wave intensities (approximately 4 times below the level of natural fluctuations) occurring a few hours before the earthquakes.

4. We have investigated plasma waves in the Kronian magnetosphere using measurements of the Cassini mission. We have found intense plasma wave emissions (for example, whistler-mode waves) associated with Saturn's moon Rhea. Our analysis has shown that these emissions resulted from modifications of distributions functions of magnetospheric electrons.

5. We have started systematic ground-based measurements of broadband waveforms (up to 37 MHz) of electromagnetic radiation from lightning in preparation for the TARANIS mission. During summer 2010, this activity resulted in successful detection of high-resolution waveforms of several tens of lightning strokes at close distances from the measurement site.

Fiji - The University of the South Pacific, Suva, Fiji, report from Sushil Kumar.

We continue participating in the World Wide Lightning Location Network (WWLLN). Using the WWLLN, we continue recording the narrowband data of six transmitters with SoftPAL data acquisition system and waveforms of lightning generated sferics with high speed data recorder. The early VLF perturbation events on NWC, NPM, VTX, and NLK transmitter signals received at Suva were analysed for the daytime and long recovery events (5-10 min).WWLLN detected lightnings coincident with early VLF events and located within 500 km off the TRGCPs show that perturbations produced by wide-angle scattering are observed in our data. We also record the ELF-VLF data using the Atmospheric Weather Electromagnetic System for Observation Modeling and Education (AWESOME). The results obtained from the analysis of SoftPAL and AWESOME were presented in the Indo-US VLF workshop Workshop, Goa, India, 28 Nov-01 December 2011.

Sushil Kumar under the Ratu Sir Kamisese Mara Visiting Fellowship of University of Otago, New Zealand, to the USP academic, visited the Space Physics Group of the Department of Physics, Otago University. Kumar worked on the analysis of subionospheric VLF perturbations and LONG WAVE PROPAGATION CODE (LWPC) version 2.1 used in modelling of subionospheric VLF propagation. The LWPC tool can now be used by USP researchers, adding a new modeling ability to complement the existing VLF data gathering infrastructure. Kumar is grateful to Associate Professors Craig J. Rodger and Neil Thomson for useful discussions, support, and cooperation during his stay at the Otago University.

We also continue recording TEC and ionospheric scintillation measurements using GSV4004B receiver system. This system can locate up to 11 GPS signals at two frequencies of L1 and L2 signals (1575.42 MHz and 1227.6 MHz) and

measures phase and amplitude at 50-Hz rate and code/carrier divergence at 1-Hz rate for each satellite being tracked. It computes TEC from combined frequencies pseudorange and carrier phase measurements. This system along with the SoftPAL provides an opportunity to study both lower (D-region) and upper (F-region) ionosphere particularly under the strong space weather (geomagnetic storm and solar flare) conditions.

Finland - University of Oulu/Sodankylä Geophysical Observatory, Sodankylä report by Jyrki Manninen.

A Finnish VERSIM grand old man Prof. Tauno Turunen retired in June 2011. After that only a half of the original Finnish wide-band ELF-VLF researcher group is left. However, we hope that Tauno will be more active in science since his responsibility of administrative work is over.

Due to Tauno's retirement we had one of the longest ELF-VLF campaign starting on 28 March and ending on 18 April 2011. The campaign lasted without a single gap almost 3 weeks (2 weeks, 6 days, and 20 hours).

The most recent campaign has started on 8 December and it will end close to Christmas. This will be the 5th time at the same location Kannuslehto.

Our quick-look plots (1-min, 1-hour, 24-hour) since 2005 can be found at our server (http://data.sgo.fi/VLF/). Plots are 0-5 kHz or 0-10 kHz. However, our data covers the frequency range from 0 up to 39 kHz.

So, a wide frequency range is still mostly unknown. All colleagues are welcome to use our digital data. Unfortunately, the size of one-hour file is about 2.1 GB containing 24-bit data from two orthogonal components.

A huge amount of interesting natural events have been found. And some hints about other type of events at higher frequencies (20-39 kHz) have also been noticed.

Detailed instruction manual for analysis package is still under preparation.

Germany - University of Applied Sciences, Osnabrueck report by Ernst D. Schmitter.

This years focal point was research with regard to lower ionosphere forcing from below, especially by planetary waves. Several years of monitoring the propagation paths from northern (Iceland, NRK, 37.5 kHz) and southern directions (Sicily, NSY, 45.9 kHz) to our mid latitude site (52N 8E, NW Germany) show clear fingerprints of the quasi 16 day atmospheric wave. Key indicator is the day over absorption behaviour which we assess using the midnight/noon signal amplitude ratio. We believe that such investigations can be a good addition to more elaborate climate research methods. Ongoing research is also directed to propagation modelling using the LWPC code with externally provided electron density and collision frequency profiles as well as a day-night transition algorithm for the relevant parameters.

Results have been reported at the URSI-GASS in Istanbul (Aug. 13.-20., 2011, G02.10) and at the annual German URSI meeting (Miltenberg, Sep. 26.-28., 2011, KH2011-G-006).

At the moment we test possibilities providing us with long term phase recordings from VLF/LF MSK transmitters additionally to signal amplitude. First results are promising and in good agreement with LWPC propagation calculations.

Schmitter,E.D. 2011. Remote sensing planetary waves in the midlatitude mesosphere using low frequency transmitter signals, Annales Geophysicae, 29, pp. 1287-1293, 2011

Schmitter,E.D. 2011. Modeling Ionospheric Propagation of Low Frequency Signals for Remote Sensing Purposes using Charge Density Profiles, URSIGASS 2011, Istanbul, Aug. 13.-20., 2011, G02.10

Schmitter,E.D. 2011. Long term data analysis and propagation modelling of low frequency transmitter signals received at a midlatitude site with regard to planetary wave activity, Kleinheubacher Tagung, URSI Landesausschuss Deutschland, Miltenberg, Sep. 26.-28., 2011, KH2011-G-006

Greece - University of Crete report by Christos Haldoupis.

The Ionospheric Physics Laboratory, at the Physics Department, University of Crete continued this past year the continuous operation of an automated Stanford VLF receiver which performs routine narrow band, and occasionally broadband, VLF transmission measurements. The Crete VLF station was the first to be installed in Europe 8 years ago, in 2003, followed a few years later by a dense network of receivers deployed by the Stanford University VLF group, first in Europe and North Africa and then all over the world. This came to be known as the AWESOME VLF network (http://nova.stanford.edu/~vlf/awesome), of which the Crete station is one of its oldest members.

In 2011, we have continued participating in the EuroSprite campaigns and continued to research further the short-lived abrupt VLF signatures which are known to have an association with direct lightning effects on the upper atmosphere and D region ionosphere. In addition we investigated, by using Arecibo incoherent scatter radar measurements, the effects on D region electron densities caused by strong solar flares and how these densities compare with estimates observed by modeling VLF propagation during solar flares in the earth-ionosphere waveguide. Also we continued collaboration with colleagues from institutions in Denmark, Spain, Hungary, Israel and USA. For a summary of our activities, scientific contributions as well as paper reprints see webpage at: http://cal-crete.physics.uoc.gr/VLF-sprites/VLFmain.html

A highlight of our research is that we resolved a long going, and for some controversial, problem regarding the relationship between sprites and early VLF perturbations in the lower D region. More AWESOME VLF network and EuroSprite observations were obtained this year and analyzed to show unambiguously that visible sprites are accompanied always by early VLF perturbations and that a one to one correspondence exist between the two phenomena. The same was also shown to be true in the case of a gigantic jet, a rare type of transient luminous events (TLEs). These results imply that sprites and TLEs in general, lead in addition to light emission also to electron density perturbations in the nighttime D region ionosphere, produced through the combination of quasi electrostatic air breakdown and electromagnetic impact ionization processes.

International conferences/workshops presentations:

1). Early VLF events. A low ionosphere VLF propagation signature coincident with Sprites, C. Haldoupis, XXX URSI general Assembly and Scientific Symposium of International Union of Radio Science, 13-20 August, Istanbul, Turkey 2011.

2). Early VLF events coincident with TLEs. C. Haldoupis, The 3rd AWESOME VLF workshop, Goa, India, Nov 27- Dec. 2, 2011.

3). Solar flare radiation effects on D region ionization as measured by the Arecibo incoherent scatter radar, C. Haldoupis, Q. Zhou, and A. Bourdillon, The 3rd AWESOME VLF workshop, Goa, India, Nov 27- Dec. 2, 2011.

Hungary - Space Research Group, Eötvös University, Budapest report by János Lichtenberger.

The Space Research Group of Eötvös University continued the theoretical modeling and model-calculations of monochromatic and transient (Ultra Wide Band) electromagnetic signals and the evaluation and comparison of the results with the measured data-base registered at terrestrial stations and on board of satellites.

In the field of the theoretical model development of the full wave solutions of the Mawell's equations, beside the applications of the models developed earlier, several new results were achieved: 1) The general solution of the electromagnetic wave propagation in inhomogeneus moving media inside the validity of the special relativity was published in Radio Science (Cs. Ferencz, Radio Science, Vol.46). 2) The generalization of this solution method for the general relativistic cases was finished and the application of this new method is under way. 3) The application of the earlier UWB solutions is successful in the POP-DAT and PLASMON EU FP7 projects. 4) Application of the new, fully analytical inhomogeneous model of transient propagation in the ionosphere for simultaneous terrestrial and onboard recordings, more exact determination of the profile of the inhomogeneity of the traversed medium. 5) Application of the MIBM solving method of the Maxwell's equations for elastic problems (generalization of the transient solution for seismic problems). 6) Development of a new approach for numerical Laplace transformation for more complicated propagation problems (i.e. curved wave guides, curved geomagnetic field lines, etc.).

Detailed high accurate analysis of VLF signals were performed on simultaneous ground (Tihany, Hungary; Dunedin, New Zealand) and onboard (DEMETER) measurements. Model calculations using the full-wave solution of Maxwell equations in inhomogeneous plasma with realistic plasma parameters were performed. The obtained results with the possible explanations:

1) The ground station a single trace were detected while on board of Demeter three quasi-parallel whistlers occurred with ~20-30 ms distances. These are reflections and scatterings resulted by the inhomogeneity if the lower Ionosphere

2) Ground detected sferics and on board detected fractional-hop whistlers were identified. Several hundred ms wide dispersed noise followed the fractional-hop whistler, a part of this noise propagated downwards through the ionosphere and appeared in the ground measurements. The model calculations proved the occurrence of similar phenomena due to the inhomogeneity of the average plasmasphere.

We have extended the Automatic Whistler Detector and Analyzer Network with two new nodes, one at Eskdalemuir, UK in cooperation with British Antarctic Survey and another one at Nainital, India (Indian Institute of Geomagnetism). We analyzed the data acquired during 2009-2010 at Palmer (US, in Antarctic peninsula) to make a statistic of whistler rate. We found an extremely high, but asymmetric whistler activity: 3.8 million events, 11.3 million traces in 2009 and 2.2 million events, 6.3 million traces in 2010. We also made studies to locate the potential source area of these whistlers. For 2009, the most probable area is over the sea, east to the east-coast of US (200 km east to Charleston over the sea) over the Gulf-stream, but the Caribbean may contribute significantly. In 2010, the region south to the Great Lakes also contributes significantly. Similar analysis was performed on high-latitude data recorded at SANAE, Antarctica for years 2006-2007. The highest daily activity at SANAE occurs between 07-09UT, there were 256,148 events, 470,953 traces in 2006 and 165,864 events and 316,192 traces in 2007. Very interesting that in 2006, the source of these whistlers was the same region as for Palmer whistlers, while in 2007 the most probable source region was Central-America! We have implemented the Automatic Whistler Analyzer (AWA) algorithm on GPU and found significant speed increase compared to PCs and PC clusters.

India - Faculty of Engineering, R.B.S. College, Bichpuri, Agra, report by Birbal Singh.

Agra station has been consistently involved in research work in the fields of atmospheric science and seismo-electromagnetic studies. We have whistler recording set up, phase and amplitude measurements using softPal receiver, TEC measurement using a dual frequency receiver, ULF magnetic field measurement using a 3-component search coil magnetometer and subsurface VLF electric field measurement using a borehole antenna. The results of some of these equipments are utilized for studies in both the above fields

Our recent results in ground based observation of whistlers at a low latitude station Agra have been compared with DEMETER satellite observations which show that whistlers at law latitudes are mostly non-ducted which do not reach the ground. The satellite data show abundance of magnetically reflected (MR) whistlers. We have studied the effect of solar flares and lightening on the lower ionosphere by monitoring continuously the amplitude and phase of NWC (19.8 KHz) signals. The solar flares effect correlate positively with X-ray intensities and lightening induced perturbations are mostly early/low types. We have also utilized the TEC and VLF data to study the effect of solar eclipse occurred on 22 July, 2009 which was of longest duration ever seen in India after 1968 years and may re-occur after 123 years. The results show large scale depression in electron density in the ionosphere during total solar eclipse.

These results have been presented recently in the Indo-US Workshop on "Advance VLF science through the global AWESOME network" held at Goa, India during 28 Nov-01 Dec, 2011.

India - Department of Physics, University of Lucknow, report by Ashok K. Singh.

We have started a project to detect whistlers with VLF measurements including vlf emissions and other naturally occurring signals. A VLF antenna has been installed in December 2010 in the Physics Department, University of Lucknow, Lucknow (Geomag. Lat., 17.60 N, Geomag. Long., 154.50 E) in order to detect whistlers and to determine various medium parameters. The VLF antenna is made of two perpendicular magnetic loops, oriented N-S and E-W. This antenna will be part of AWDAnet, the Automatic Whistler Detector and Analyzer system's network. This network covers low, mid and high magnetic latitudes including conjugate locations. It has been initiated by Dr. J. Lichtenberger, Geophysical Department, Eotvos University, Budapest, Hungary.

Measurement of Amplitude and Phase fluctuations:

The amplitude and phase measurements of fixed frequency VLF signals transmitted from ground based transmitters are being carried out to study the D-region perturbation phenomena caused by solar flares, particle precipitation, transient luminous events (TLEs) and Earthquakes.

Israel - Report by Colin Price (Tel Aviv University)

Colin Price together with graduate student Israel Silber are investigating the long term changes of narrowband VLF signals from European transmitters. The reflection height of these VLF waves is close to the mesopause region, the coldest region of our atmosphere. For comparison with the VLF narrowband measurements, we have been using the satellite temperature measurements from the TIMED/SABER satellite along the same great circle path as the VLF data. We have now analysed close to 6 months of daily data, showing quite surprising agreement between the VLF amplitude changes, and the temperature changes in the upper atmosphere. We believe that the cooling/heating of the upper atmosphere will result in a lowering/rising of the D-region reflection height, and hence will influence the VLF narrowband signals detected in Israel. We are investigating the possibility to use narrowband VLF signals as a tool to study the long term variability of upper atmospheric temperatures.

To compliment this work, we have recently acquired a infrared spectrometer from DLR, Germany, in collaboration with Michael Bittner. This instrument supplies information about nighttime temperature of the mesopause region above Israel, with a temporal resolution of 1 minute, and an accuracy of 2 K. This will also be used to compare with our VLF measurements in the region.

New Zealand - University of Otago, Dunedin, report by Craig J. Rodger.

We continue to operate the following experimental measurements locally in Dunedin: 1) the VLF Doppler Experiment which monitors whistler-mode signals from VLF transmitters which have propagated through the plasmasphere predominantly inside whistler ducts. 2) several narrowband receivers (OmniPAL, AbsPAL, SoftPAL and Ultra MSK) which log changes in the phase and amplitude of powerful VLF communications transmitters (~13-30 kHz) to study subionospheric propagation. 3) an Automatic Whistler Detector and Analysis (AWDA) receiver operating in collaboration with Eötvös University. 4) a receiver and central processing computer of the World Wide Lightning Location Network (WWLLN). We also operate UltraMSK narrow-band loggers in Antarctica (near Scott Base, with support from Antarctica New Zealand), and Ministik Lake (near Edmonton, Canada, with support from the University of Alberta). Both of these instruments are part of AARDDVARK and also provide real-time observations to the WWLLN lightning consortia.

In 2011 we were fortunate to win funding support from both the New Zealand Marsden fund and the European Union FP7 programme (as part of the Eötvös University led PLASMON project, and due in large part to their efforts). This funding has supported two new PhD student scholarships, and we are about to advertise for a PLASMON-supported PostDoc position.

This year Neil Thomson travelled to Western Australia, Hawaii, Canada and Iceland to make near-field measurements of the powerful US Navy VLF transmitters. These campaigns were focused on understanding the typical electron number density profiles of the D-region, and specially to determine the profiles suitable to describe subionospheric VLF propagation. Combined with distant narrow-band AARDDVARK observations, plus the LWPC model, Neil Thomson has recently published two papers on updated mid-latitude daytime parameters [1, 2], complementing his earlier work in this area. In late November-December 2011 James Brundell and Peter McCabe travelled to Scott Base, Antarctica to undertake maintenance and repairs of our AARDDVARK receiver at Arrival Heights, and to investigate the local VLF noise. Finally, this week we celebrate the graduation of Dr Rory Gamble, who submitted his PhD thesis for examination early in 2011. Rory's thesis ("The 17-19 January 2005 Atmospheric Electron Precipitation Event") was placed on the list of Science Division Exceptional PhD Theses having being examined as "amongst the top 10% of theses examined.". For most of this year Rory has been working at the Sodankylä Geophysical Observatory, and next year we expect he will take up a new PostDoc position. Congratulations on a great year, Rory!

In 2011 Craig Rodger has been mostly focused on the detection and effects of energetic electron precipitation from the radiation belts. In particular, Craig has been working on some new modelling tools to help our modeling of narrowband VLF data, and also working with POES SEM-2 electron precipitation observations. The later work has led to some of the first evidence for "direct" neutral atmosphere changes due to storm-time electron precipitation [3, 4]. This year Craig has been supervising Aaron Hendry in an Honours research project looking at how solar wind stream interface-triggered storms lead to precipitation measured in satellite and AARDDVARK subionospheric data, on which we are preparing a paper. Our most recent paper focuses on precipitation during substorm-events, combining AARDDVARK observations from multiple Antarctic stations [5].

An up to date listing of our publications is available from the Space Physics Group's website: http://www.physics.otago.ac.nz/nx/space/space-physics-publications.html. This includes PDFs of our published work, where-ever possible.

1. Thomson, N R, M A Clilverd, and C J Rodger, Daytime Mid-Latitude D-region Parameters at Solar Minimum from Short Path VLF Phase and Amplitude, J. Geophys. Res., 116, A03310, doi:10.1029/2010JA016248, 2011.

2. Thomson, N R, C J Rodger, and M A Clilverd, Daytime D-region Parameters from Long Path VLF Phase and Amplitude, J. Geophys. Res., 116, A11305, doi:10.1029/2011JA016910, 2011.

3. Verronen, P T, C J Rodger, M A Clilverd, and S Wang, First evidence of mesospheric hydroxyl response to electron precipitation from the radiation belts, J. Geophys. Res., 116, D07307, doi:10.1029/2010JD014965, 2011.

4. Newnham, D A, P J Espy, M A Clilverd, C J Rodger, A Seppälä, D J Maxfield, P Hartogh, K Holmén, and R B Horne, Direct observations of nitric oxide produced by energetic electron precipitation in the Antarctic middle atmosphere, Geophys. Res. Lett., 38(20), L20104, doi:10.1029/2011GL049199, 2011.

5. Clilverd, M A, C J Rodger, I J Rae, J B Brundell, N R Thomson, N Cobbett, P T Verronen, and F W Menk, Combined THEMIS and ground-based observations of a pair of substorm associated electron precipitation events, J. Geophys. Res., doi:10.1029/2011ja016933, (in press), 2011.

Russia/France - Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation of RAS, Moscow, report by Boris Lundin
& Laboratoire de Physique des Plasmas, Paris South University, Orsay, France, report by Catherine Krafft

The appearance of negative ions and other heavy negatively charged particulates in multi-ion dusty space and laboratory plasmas can be the origin of drastic evolutions of the dispersive properties even of high frequency waves. The most non-conventional feature revealed in our previous papers was a manifold increase of the lower border of the transparency frequency domain of electron whistler waves associated with an essential diminishing of the free electron fraction. The reduced value of the free electron fraction can originate from the plasma contamination by electronegative gas molecules

and/or dust particulates highly adhesive to electrons (as during the rocket launches into the ionosphere). Under the same conditions, however, the total charge density in the background plasma as well as the value of the resultant ion plasma frequency can continue to be almost the same, if the inherent gyrofrequencies of newly formed heavy negative particulates will be very small compared to those ones of the primary ions' set of the background plasma before the contamination.

In our recent studies devoted to the analysis of moderate density plasmas with very small residual fractions of electrons, i.e. almost pure ion plasmas, the details of the collapse of the transparency frequency domain of electron whistler waves near the ion plasma frequency was first described. In addition, it was found that the appearance of light negative ionic charge carriers instead of most part of the electrons can be the origin of the high frequency crossover effect, i.e. when the polarization of plane waves of fixed plasma modes reverses from the "ion-type" to the "electron-type" at frequencies much above the ion gyrofrequency domain. The value of the residual fraction of free electrons corresponding to the revealed high frequency crossover effect is inversely proportional to the square of its frequency. It was also shown that the evolution with frequency of the wave magnetic field polarization ellipse can be used to determine the value of the ion plasma frequency in a moderate density plasma; the ellipse becomes a circle exactly when the wave frequency coincides with the background ion plasma frequency. An accurate registration of the ion cutoff frequency of electron whistler waves permits to estimate not only the relative density of the two lightest ion constituents but also the charge density associated with the almost Immobile Plasma Background (IPB, i.e. heavy ions and charged dust) and under favourable circumstances even the averaged value of the charge-to-mass ratio of the IPB without using onboard mass spectrometers.

The details can be found in the following recent publications:

B.Lundin, C.Krafft, On the dispersion features of whistler waves in almost pure ion plasmas, Physics of Plasmas. v.18, 102114(1-9), 2011.

C.Krafft, B.Lundin, Determination of the averaged charge-to-mass ratio of the heavy charged constituents of a magnetoplasma using whistler wave measurements, Ann. Geophys., v.28, 2237-2247, 2010.

Russia - Space Research Institute of RAS (IKI), Moscow, report by David Shklyar

Search for and understanding of mechanisms for particle energization is a key problem in physics of the Earth's radiation belts. A good deal of suggested mechanisms is related to resonant wave-particle interactions. These mechanisms may be divided roughly into two groups. The mechanisms of the first group deal with wave-particle interactions in the case of a wide wave spectrum, and are generally treated on the basis of quasi-linear theory as applied to magnetospheric conditions. Those mechanisms lead to particle diffusion in the phase space, and have characteristic times of the order of minutes or hours. The mechanisms of the second group involve resonant wave-particle interactions with quasi-monochromatic waves. In this case, the consideration is usually based on the analysis of particle motion in a given wave field, with a little concern about a back influence of resonant particles upon the wave. The characteristic time of the process is now determined by the duration of particle crossing of the wave packet, and, in the case of whistler-electron interactions, is of the order of seconds.

When a quasi-monochromatic wave propagating in an inhomogeneous magnetoplasma has sufficiently large amplitude, there exist phase-trapped resonant particles whose energy increases or decreases depending on the ``sign" of inhomogeneity. The variation of energy density of such particles can greatly exceed the wave energy density, which contradicts energy conservation under the prevalent assumption that the wave serves as the energy source or sink. It has been shown that, in fact, the energy increase (or decrease) of phase-trapped particles is related to energy transfer from (to) phase untrapped particles, while the wave basically mediates the energization process. Virtual importance of this comprehension consists in setting proper quantitative constraints on attainable particle energy. The results have immediate applications to at least two fundamental problems in the magnetospheric physics, i.e. particle dynamics in the radiation belts and whistler-triggered emissions.

The mechanism of particle energization discussed above is specific to inhomogeneous plasma, for both parallel and oblique wave propagation. Another mechanism of energy transfer between different populations of energetic particles is specific only to oblique wave propagation when all cyclotron resonances are involved in resonance wave-particle interaction, although, in many cases, only the first cyclotron and the Cerenkov resonances contribute mainly to resonance interaction. It turns out that in the case of plasma marginal instability, when the growth rate determined by the "competition" of two resonances is a small positive quantity, a slowly growing wave mediates an essential energy transfer between two particle populations that interact with the wave at the first cyclotron and the Cerenkov resonances. It is important that the state of plasma marginal stability is not unusual in the magnetosphere.

The results mentioned above were published in:

Shklyar, D.R., 2011. On the nature of particle energization via resonant wave-particle interaction in the inhomogeneous magnetospheric plasma. Ann. Geophys. 29, 1179-1188.

Shklyar, D.R., 2011. Wave-particle interactions in marginally unstable plasma as a means of energy transfer between energetic particle populations. Physics Letters A 375, 1583–1587.

Russia - Institute of Applied Physics of RAS, Nizhny Novgorod, report by Peter Bespalov

Several possibilities for diagnosing the magnetospheric plasma by studying the fine structure of a whistler were considered. The plasma magnetospheric maser (PMM) theory makes it possible to diagnose both local and less evident global characteristics of magnetospheric processes. The following diagnostic possibilities can be schematically distinguished:

- the upper frequency of the VLF hiss band characterizes anisotropy of the trapped particle distribution function;
- the upper frequency of the ELF hiss band characterizes the background plasma density;
- the period of QP VLF emissions characterizes the energetic particle source power;
- the damping time of the VLF emission level modulation after a short pulse of magnetospheric compression characterizes the lifetime of energetic particles in the magnetic trap;
- a phase difference between QP1 VLF emission modulation and a hydromagnetic wave makes it possible to additionally specify the eigenfrequency of the wave–particle interaction in the magnetic field tube;
- an analysis of quasiperiodic VLF emissions independent of geomagnetic pulsations (QP2) identifies anisotropy of the energetic particle source power;

• the degree of electromagnetic signal conjugacy in the Northern and Southern hemispheres characterizes the pitch-angle diffusion regime;

• the energy spectrum of energetic protons trapped into radiation belts can be used to find the frequency dependence of the magnetospheric resonator quality in the VLF range;

• quasiperiodic VLF emissions indicate that the regime of weak pitch-angle diffusion is implemented in the magnetic trap.

Additional useful results can be achieved by analyzing the data of absolute intensity measurements. For example, it is possible to find specific radiation belt parameters by comparing the electromagnetic pulse waveform with the theoretically found waveform.

We would like to pay attention to one more trend of experimental studies. To improve theoretical models, it seems important to distinguish the spectral structures that can (or cannot) smoothly change into one another. In such a way, it is possible to determine the number of different theoretical models that should be used to adequately describe experimental data.

Publication

Bespalov P.A. Some new possibilities for diagnosing the magnetosphere based on whistler characteristics. Geomagnetism and Aeronomy, 2011, v. 51, No. 2, p. 226-233.

Russia - Yu.G. Shafer Institute of Cosmophysical Research and Aeronomy SB of RAS, Yakutsk, report by Victor Mullayarov

1. Seismo-electromagnetics

Seismo-ionospheric perturbations have been monitored by the signal of atmospherics propagated above the epicenters. In particular, the variations of signal amplitude during the last large earthquakes near Japanese Islands on March 09 and March 11 have been considered. In these events precursor for each earthquake have been observed.

2. Thunderstorm electric fields

The study of generation of electric fields in the thunderstorm region is being continued. The phenomenon of significant increase in the flux of neutrons in the surface layer of the atmosphere during lightning discharges, when the electric field exceeds -15 kV/m has been established. It is indicative of the generation of MeV energy particles during negative lightning discharges.

Slovenia/Serbia joint report - University of Nova Gorica (Slovenia) and Institute of Physics, Belgrade (Serbia) report by V. Žigman (UNG), and by D. Šulić (IPB).

This is the second year that the long lasting collaboration between the Institute of Physics, Belgrade and the University of Nova Gorica has been strengthened by the approval of a new joint bilateral project: 'Solar forcing of the Earth's atmosphere - ionosphere system', which enabled several working visits of the two parties. Both the AbsPAL receiver and the AWESOME system, at IPB have been on continuous run, monitoring VLF phase and amplitude from a number of transmitters, e.g. NAA/24.0 kHz, NWC/19.8 kHz, ICV/20.3 kHz, GQD/22.1 kHz, DHO/23.4 kHz, NSC/45.9 kHz. Lightning-induced electron precipitation (LEP) events, which produced disturbances on subionospheric VLF signals over European paths have been analyzed from recordings in the period 2008-2011. The signals recorded at Belgrade station proved to be a good base for studying localized ionization enhancements in the nighttime D region over western and middle Europe. The statistical analysis of about 60 events of disturbed amplitude and phase induced by Solar flares, which occurred in the period 2010-2011 has been performed. As far as modelling is concerned, with the completed the extensive analysis of the compiled data we have carried out the task of extending the N(t)-model to the so called N(t,h)-model, which predicts both time and height variations of D-region electron density (N) enhancements during Solar flares. The model was presented (V. Žigman) at the Cost ES0803 Workshop on Assessment and validation of space weather models, Alcalá de Henares Spain, March 2011, and at the IUGG2011, Melbourne.

We continue to be active in the space weather society, participating in the Cost ES0803 Action: Developing space weather products and services in Europe (2008-2012) and at the European Space Weather Week 8, 28 .11- 2.12. 2011, Namur Belgium.

We have also taken part in the Indo-US Workshop on Advancing VLF Science through the Global AWESOME Network, 28 November -01 December, 2011 Goa India, where our VLF activity has been presented (D. Šulić) with two contributions: on VLF detection of Solar flares and LEP events.

Last year Slovenia officially joined the European Space Agency (ESA) and a PECS ESA project proposal submitted by the UNG has been approved this year, to start at the beginning of 2012; title: Study of the effects of the ionospheric plasma-density irregularities on satellite navigation and telecommunications services under adverse space weather conditions.

A PhD thesis on VLF detection of Solar flares is in progress in Belgrade and a diploma on space weather has been successfully concluded in Nova Gorica.

Publications:

A.Nina, V. Čadež, D. Šulić, V. Srećković and V. Žigman Effective electron recombination coefficient in ionospheric D-region during the relaxation regime after solar flare from February 18, 2011, NIBM, doi:10.1016/j.nimb.2011.10.026.

A.Nina, V. Čadež,V. Srećković and D. Šulić, Altitude distribution of electron concentration in ionospheric D-region in presence of time-varying solar radiation flux, NIMB, doi:10.1016/j.nimb.2011.10.019.

A. Nina, V. Čadež, V. Srećković and D. Šulić, The influence of solar spectral lines on electron concentration in terrestrial ionosphere, Baltic Astronomy, vol. 20, 609-612, 2011.

A. Kolarski, D. Grubor and D. Šulić, Diagnostics of the Solar X-flares impact on the lower ionosphere through seasons, based on VLF- NAA signal recordings, Baltic Astronomy, vol. 20, 591-595, 2011.

South Africa - University of KwaZulu-Natal (Durban) and SANSA Space Science (Hermanus), report by Andrew Collier.

In April 2011 the Hermanus Magnetic Observatory became part of the South African National Space Agency (SANSA). The operation of our experimental programme at SANAE IV (Antarctica) and Marion Island is now administered through SANSA.

The group is taking part in the PLASMON FP7 project. We have acquired two small supercomputers which will be installed at SANAE IV and Marion Island during the next year. These machines will perform the detection and analysis of whistlers on site. Whereas other nodes in the AWDA network will not perform on site analysis, the restricted bandwidth from SANAE IV and Marion Island prohibits the transmission of the raw VLF data files and therefore necessitates on site processing. Brett Delport worked at SGO (Finland) during October/November 2011 on a PLASMON related project. We

will be hosting a PLASMON meeting in Hermanus from 23 to 27 January 2012.

For three months around Christmas 2010 Andrew Collier worked with Nikolai Østgaard at the University of Bergen. This visit was funded by a YGGDRASIL scholarship. WWLLN lightning data was used to geolocate the lightning sources for TGFs observed on the RHESSI satellite. Two publications have resulted: 10.1029/2011JA016612 and 10.1029/2011JA016716.

Professor Steve Cummer sent a LF radio receiver to be installed at UKZN. We encountered some serious interference on campus but it seems that the data will still be usable. With the level of lightning activity now picking up, we are in the process of validating the data from this receiver. It is envisaged that the LF data will be complimentary to the FERMI satellite data gathered over Africa.

Professor Arthur Hughes continues to be involved in the work of the group although he is seldom in Durban. His presence in the department is sorely missed. He contributed significantly to a study of the average annual variation in lightning activity over Africa published as 10.1029/2010JD014455.

One component of the BARREL balloon campaign will be conducted from SANAE IV during January and February of 2013 and 2014. We are in the process of procuring half of the helium gas for this campaign, which will be shipped to Antarctica at the end of 2011. The remaining gas and the balance of the equipment will be taken down at the end of 2012.

Following the papers documenting the source regions of whistlers observed at Tihany, Hungary (10.1029/2008JA013863) and Dunedin, New Zealand (10.5194/angeo-28-499-2010), a third paper has been published detailing a similar analysis for whistlers observed at Rothera, Antarctica (10.1029/2010JA016197). The conclusions of this analysis were that the majority of the whistlers were generated by lightning along the east coast of the USA, but with a preference for oceanic lightning.

Four MSc students will be submitting their final theses at the end of 2011. Steven Meyer's thesis details the modelling of VLF waves in the EIWG using both mode theory and FDTD techniques. Marlie van Zyl has used LIS/OTD lightning data to attempt a time and space dependent normalisation of WWLLN data. Ola Ogunjobi used geosynchronous particle and riometer data to examine energetic electron dropouts. And Sahil Brijraj attempted to find signatures of earthquakes in subionospheric VLF data.

Taiwan - National Cheng Kung University, Tainan , report by Kaiti Wang, Alfred B. C. Chen, Han-Tzong Su, and Sung-Ming Huang.

The ELF magnetic field station continues being operated as well as an newly-installed VLF system. S. Huang et al has analyzed the effects from notch-filtering in our old setup by reconstructing the source signals and use lab-generated ELF-like signals to check the limitation of the reconstruction. The results may be useful for those have to operate a similar system with hardware filters to notch out the power-grid emissions. The results had been published in the following Radio Science paper:

Huang, S.-M., C.-L. Hsu, A. B. Chen, J. Li, L.-J. Lee, G.-L. Yang, Y.-C. Wang, R.-R. Hsu, and H.-T. Su (2011), Effects of notch□filtering on the ELF sferics and the physical parameters, Radio Sci., 46, RS5014, doi:10.1029/2010RS004519.

In addition, results from investigating the wave mode of low-latitudinal ELF-whistlers between 60 Hz to 100 Hz presented by K. Wang in the 4th VERSIM Workshop has been written into a paper and published. Right-hand ion-cyclotron mode between the lower cutoff frequency near f_cO^+ and f_cHe^+ is suggested to account for the observed waves. The reference is:

Wang, K., Y.-C. Wang, H.-T. Su, R.-R. Hsu, and T.-Y. Lin (2011), Wave mode of the low-latitudinal ELF-whistlers, J. Geophys. Res., 116, A09323, doi:10.1029/2011JA016832.

A Master student Shao-Ming Ho also finished his thesis with title "Characteristics of Magnetic Signals Observed at Lulin ELF Station and Their Association with Earthquakes in Taiwan" by analyzing the relation primarily between seismic activities and the ELF data below 10 Hz.

United Kingdom - British Antarctic Survey, Cambridge, report by Mark Clilverd.

BROADBAND RECORDINGS in Antarctica:

Whistler-detection and data collection has continued at Rothera (L=2.9) throughout 2011 using the Hungarian Automatic Whistler Detection (AWD) system. Typically ~9 million whistlers per year have been recorded. Halley (L=4.5) is expected to become an AWD site in February 2012.

The Stanford University AWESOME receiver has also operated throughout 2011, logging broadband and narrow-band data.

VELOX RECORDINGS at Halley, Antarctica:

Continuous (since 1992) recordings of VLF activity in 10 ELF/VLF bands, at 1-s resolution (VELOX and VELOXNET), including spheric counters, have continued at Halley in 2011. The VELOXNET data collection at Halley will continue indefinitely, despite closure of the rest of the VLF science during the 2008-2012 station rebuild period. The station is due to re-open in February 2012 with additional VLF instrumentation (AWD, Ultra, and WWLLN systems – see below).

NARROW-BAND RECORDINGS:

'Ultra' narrow-band recordings have continued at Rothera (Antarctica) the Australian Casey station (Antarctica), Sodankyla (Finland), Churchill (Canada), and Ny Alesund (Svalbard) throughout 2011. Significant data loss occurred at Churchill in the second half of the year due to Pc failure. A new Ultra system has been installed at Forks, Seattle since 05 October 2011, hosted by University of Washington, and a new Ultra system has been installed at Eskdalemuir, Scotland, since 01 December 2011, hosted by the British Geological Survey. Basic data collection at all sites is undertaken with 0.1-1 s resolution. Halley is expected to become an Ultra site in February 2012.

The software VLF Doppler system has continued at Rothera station, Antarctica (L=2.8) in 2011, receiving whistler mode and subionspheric signals primarily from NAA (24.0 kHz). An Upgraded Doppler system has been in operation at Marion Island, South Africa (L=2.9) during 2011, hosted by the University of Natal, Durban.

WWLLN sites:

British Antarctic Survey operated two World Wide Lightning Location Network systems in 2011. Rothera and Ascension Island have provided lighting location information all year. Some data loss has occurred at Ascension during the middle of the year due to instrument failure. Halley is expected to become a WWLLN site in February 2012.

Ukraine - Dept. of Remote Sensing, Usikov Institute for Radio-Physics and Electronics, Nat. Acad. of Sci. of the Ukraine, Kharkov, Ukraine, report by A. Nickolaenko.

1. We made a series of publications on the impact on Schumann resonance (SR) signals of the galactic gamma ray flare (December 27, 2004).

First of all, an abrupt modulation was detected [1] of the SR background spectrum caused by the reduction of the dayside ionosphere by approximately 20 km. The short-term effect of the gamma ray modification was disclosed by the direct comparison of experimental record with the model predictions, as the stochastic nature of SR signal hides the modulation.

The specific parametric Q–burst was experimentally detected in the ELF continuous records [2, 3] also caused by the gamma flare. The pulse was found at observatories Moshiri, Onagawa (Japan), and Esrange [1]. The record at Karymshino (Russia) also contains the parametric ELF transient associated with the gamma flare of Dec. 27, 2004 [3]. The advanced model was elaborated for explaining the origin of parametric Q–burst from an abrupt change of the leakage current in the global electric circuit [4].

2. We applied the ELF tomography technique based on the spherically symmetric model of the Earth-ionosphere cavity. The records were used of Schumann resonance at the stations West Greenwich, USA; Lekhta, Russia; Moshiri, Japan, which cover the one year period. Maps of the global lightning distributions were constructed by using the ELF inversion technique. They show that the most active regions drift zonally on the diurnal time scale and along the meridian during the year [5-7].

It is shown that angular patterns of the magnetic field sensors suggest additional information on the azimuthal distribution of the sources. Implementation of these data significantly increases the quality of the global lightning mapping when a limited number of ELF observatories conducts the record [7].

3. The "Kharkov' technique was improved of the sources distance finding from the transverse resonance [8]. The approach exploits the modal interference in the Earth-ionosphere waveguide observed in the amplitude spectra of a tweek-atmospheric.

By using this technique the source–observer distances were found ranging from 500 to 4000 km for an ensemble of experimental waveforms recorded in the Atlantic and Indian oceans. The ionosphere height variations were deduced from the experimental data being 5–6 km during the night and having 2–3 km changes on the seasonal time scale.

4. We applied the SR records from the West Greenwich, Lekhta, and Moshiri to separate the universal (UT) and the local time (LT) diurnal/seasonal variations [9]. The records used were the monthly averaged daily variations covering the period from August 1999 to December 2001. Tow techniques were applied. The first one was a further development of decomposition suggested by Sentman and Fraser, and the second implied the geometric averaging of the records. Results acquired with both techniques showed an outstanding similarity.

The UT variations are estimates for the diurnal variations of the global thunderstorm activity month after month. Patterns of a given months repeat year after year thus indicating that the space-time distribution of global thunderstorms is annually replicated with minor deviations.

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USA - University of California, Los Angeles, report by Richard M. Thorne and Jacob Bortnik.

Over the past year the Thorne group at UCLA studied the excitation and propagation of a variety of magnetospheric plasma waves, as well as their interaction with the energetic particles of the radiation belts, ring current and plasmasheet. These can be broadly divided by wave type:

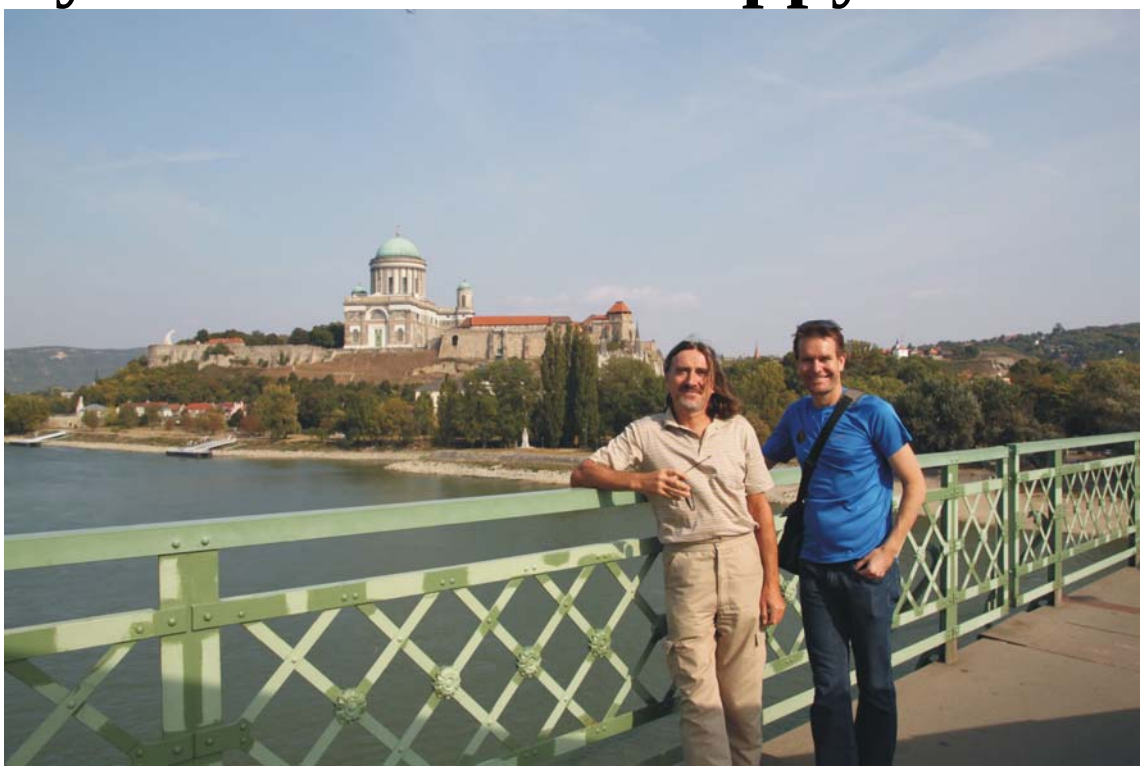
Chorus and ECH waves: In a study by Nishimura et al. [2011, JGR] it was shown that whistler-mode chorus waves were the driver of the pulsating aurora using conjunctions of ground-based all-sky imagers and the THEMIS spacecraft, and that the unique connection between near-equatorial chorus measurements and ionospheric footprint could be used to estimate the efficacy of magnetic field models in various phases of geomagnetic activity [Nishimura et al., 2011, GRL]. The pulsating nature of the chorus waves was shown to be intimately related to pulsations in the background electron density and magnetic field, or Pc5-type pulsations [Li et al., 2011a, 2011b, JGR]. The individual chorus elements making up these pulsations were examined in detail using THEMIS data, and an association was found between the rate of frequency sweep (df/dt) and wave normal characteristics [Li et al., 2011, GRL]. Modeling studies of chorus propagation showed its evolution into plasmaspheric hiss [Bortnik et al., 2011a, JGR], and the dependence of the hiss spectral and spatial characteristics upon the background plasma density distribution and chorus source characteristics were examined [Chen et al., 2011a; 2011b, JGR]. The chorus wave population was also found to be responsible for creating the (typically) subvisual diffuse aurora which was modeled in a series of studies that also examined the effects of Electrostatic Cyclotron Harmonic waves [Tao et al., 2011, JGR, Ni et al., 2011a, 2011b, JGR], non-dipolar magnetic fields [Ni et al., 2011c, JGR] and spectral characteristics [Ni et al., 2011d, JGR]. To

aid in the modeling, the global distribution of ECH waves was mapped [Ni et al., 2011e, JGR]. Finally, in an attempt to 'bridge the gap' between coherent, test-particle scattering of particles, versus incoherent, broadband quasilinear scattering, we developed a comprehensive model of test-particle scattering in a broadband field and showed the equivalence of the two approaches [Tao et al, 2011b, JGR].

EMIC and magnetosonic waves: The excitation and propagation of Electro-Magnetic Ion Cyclotron (EMIC) waves was recently modeled in a self-consistent, hybrid PIC code in a quasi-dipolar field, and the effects of the particle source population on the wave characteristics were examined [Omidi et al., 2011, JGR]. By comparing the saturation characteristics of these waves against the growth rates, it was found that a unique relationship exists that can predict saturation amplitudes within a few percent [Bortnik et al., 2011b, JGR]. In addition, when considering the scattering of relativistic electrons by EMIC waves, it was shown that including warm plasma effects in the EMIC dispersion relation was critical in controlling resonant accessibility below ~2 MeV, as well as growth in the stop bands [Chen et al., 2011c, JGR]. Using ~15 years of LANL geosynchronous proton data, the proton rings responsible for generating magnetosonic waves were examined [Thomsen et al., 2011, JGR], and the excited wave characteristics were carefully examined [Chen et al., 2011d, JGR] showing that wave could be generated up to the 35th harmonic of the proton gyrofrequency, in the range of 10-22 MLT.

In addition to the dominant theoretical and modeling aspects of our work, the Thorne group is involved in the JUNO mission which was launched in 2011, and in a few instruments on the Radiation Belt Storm Probes mission, due to be launched in the Autumn of 2012.

Merry Christmas and Happy New Year!



Dr. János Lichtenberger (Eötvös University, Hungary, the URSI co-chairy) and Dr Andrew Collier (University of KwaZulu-Natal & SANSA Space Science , South Africa). They are standing on a bridge connecting Esztergom and Parkany (now Hungary and Slovakia), which crosses the border of the two countries. In the background, the castle hill of Esztergom and the back facade of the Esztergom Basilica can be seen [early October 2011].

Dr. Craig Rodger (Otago University, New Zealand, the IAGA co-chair) in the cistern of the Hagia Sophia Basilica. This is a very large chamber (approx 139m × 70m) built in the 6th century AD, and contains 336 marble columns to hold up the roof. Craig was visiting Istanbul to attend the XXX General Assembly and Scientific Symposium of the International Union of Radio Science (URSI) [21 August 2011].