IAGA/ URSI Joint Working Group on

VLF/ELF Remote Sensing of Ionospheres and Magnetospheres Newsletter

Editor: Craig J. Rodger No. 27, December 2012

Dear Colleagues,

Once again we come to the end of another year, and I find myself reflecting that this is the 10th VERSIM newsletter which I have edited - and therefore taken the chance to write this forward. When I look back at the last decade I can say with all honesty that VERSIM is a much stronger and more vibrant community than it seemed back in 2003. The clearest example for me comes from our newsletters; in 2003 this was a mere 3 pages long, while this years newsletter is 11 pages!

A contributing factor to this new activity must surely be our regular series of VERSIM workshops. The first workshop (albeit not strictly named at that time as a VERSIM workshop) was organised by Jyrki Manninen in Finnish Lapland in 2004, and was advertised in the 18th VERSIM newsletter back in 2003. Of course, September this year saw the 5th VERSIM workshop organised by Fernando Bertoni and held in São Paulo, Brazil. This was our first VERSIM workshop outside of Europe. Because of the stunning levels of financial support sourced by our Brazilian hosts, many of the VERSIM community from across the world could participate. More than 50 participants attended, assisted by a special session on Radio Science, Natural Disasters and Space Weather on the last day of the workshop. All together researchers from 5 continents came come together to present and discuss. Our thanks to our Brazilian colleagues for hosting us in South America. I expect that the URSI Radio Science Bulletin will publish a report on the 5th VERSIM workshop soon.

During the workshop the Scientific Committee announced it recommended Ilya Kuzichev (Russia) was to be awarded an IAGA Young Researcher Award. A special mention was also given to Brett Delport (South Africa) for his excellent presentation – if we could present two prizes, Brett would certainly have received the second one for his clear presentation and high quality work. Previously the IAGA Young Researcher Award have assisted early career VERSIM members to attend the IAGA assemblies, so I hope we will see Ilya being formally awarded this in Mexico in 2013.

Hopefully you have noticed we already have plans for the next VERSIM workshop. After many years of people asking I have finally agreed to host this in New Zealand. I realise it will be a long way for most people to come, after all, I regularly fly those distances to see you! The flights are pretty draining. However, I really hope many of you can find the funding for the flights and attend. The plan is for this to take place from 20-23 January 2014 at the University of Otago, in Dunedin (New Zealand). So for most of you this will be a chance to escape winter and travel to the summer hemisphere. I should note that Andrew Collier (South Africa) has indicated he would like to host the 7th workshop, plus Jyrki would like us to return to Sodankylä for the 10th VERSIM workshop!

This year we have the 12th IAGA Scientific Assembly in Mérida, Mexico (26 - 31 August 2013). The draft programme is already out, and there is a lot of VERSIM-relevant sessions listed- as there should be, we suggested many of them through the VERSIM business meeting in Melbourne in 2010! We will have a VERSIM business meeting at Mérida, so please consider attending. As you know, I try and run these "short and sweet", but we have important things to discuss.

As you may have already seen from the minutes of VERSIM meetings I became the IAGA co-chair in 2003 and it is my intention is to step down from this role at IAGA in Mérida. I really think it is time for someone younger, smaller, and "less grumpy" too take over from me. I'm particularly worried that I am now just "doing what I did last year", rather than trying out new approaches. So please consider nominating someone at the IAGA meeting - and don't be shy, maybe the next chairperson should be you!

On that note, thanks to those of you have contributed to the VERSIM newsletters over the last 10 years, it has made it a real pleasure to put together each December. I hope the New Year finds you happy, and of scientific productive. Best wishes,

Craig J. Rodger
IAGA co-chair VERSIM working group

Upcoming meetings

http://www.physics.otago.ac.nz/versim/#meetings

- 12th IAGA Scientific Assembly in Mérida, Yucatán, México from 26 - 31 August 2013.
- URSI RASC in Taipei, Taiwan from 3 - 7 September 2013.
- SCOSTEP/CAWSES-II International Symposium in Nagoya, Japan from 18 - 22 November 2013.
- 2013 Fall Meeting of the American Geophysical Union, San Francisco, USA from 9 - 13 December 2013.
- 6th VERSIM Workshop, Dunedin, New Zealand from 20 - 23 January 2014.

Reports from VERSIM research groups 2012

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 m2 each. The antenna is fully working since August 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 Dr. J. Lichtenberger (Hungary). Worldwide; currently, 20 antennas are in operation and 9 are planned/in construction.

We are involved in the EXPRESSO proposal (FP7-2012 call) led by Dr. J. Lichtenberger (Hungary). This project aims to exploit European satellites and ground-based data to generate, visualize, qualify and validate series of high resolution 3D plasmasphere snapshots.

First results and instrument capabilities have been presented at the 5th VERSIM Workshop in São Paulo, Brazil, in September 2012.

We have published 2 papers in local journals in Belgium (1 in French and its translation in Dutch):

Darrouzet, F., Ranvier S., and De Keyser, J., Mesure des ondes sifflements pour l'étude de la plasmasphère de la Terre, Ciel et Terre, 128(2), 34-38, 2012.

Darrouzet, F., Ranvier S., and De Keyser, J., Het bestuderen van de plasmasfeer van de Aarde: Een meetstation voor whistler-golven, Heelal, 222-226, July 2012.

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

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

We continue participating in the *World Wide Lightning Location Network (*WWLLN*)* since our joining in 2003. Using the WWLLN setup we are recording the narrowband data on six transmitter signals using SoftPAL data acquisition system. The early VLF perturbation events on NWC, NPM, VTX, and NLK transmitter signals received at Suva were analysed. VTX signal was analysed to investigate VLF perturbations associated with earthquakes occurring in the Indonesian region within fifth Fresnel zone along the TRGCP. Out 5 earthquakes that occurred with their epicenter in the fifth Fresnel zone, only an earthquake of 18 December 2006 (M 5.8, depth 53 km) in the North Sumatra region has shown convincing evidence of lower ionospheric perturbations examined through terminator time, average night-time and day-time amplitude signal strength variations, and night-time fluctuation methods. The results are under review.

We also record ELF-VLF data using the Atmospheric Weather Electromagnetic System for Observation Modeling and Education (AWESOME) during specific campaigns. The results on broadband data analysis at some low latitudes stations under AWESOME network for tweeks, whistlers and unusually long recovery events have been published (JGR 117, A11308, doi:10.1029/2012JA017876, 2012; JGR 117, A08311, doi:10.1029/2012JA017567, 2012; JGR VOL. 117, A05301, 12 PP., 2012 doi:10.1029/2011JA016976; GRL 39, L23102, doi:10.1029/2012GL054122).

We also continue recording TEC and ionospheric scintillations using GSV4004B receiver system. This system can locate up to 11 GPS signals at two frequencies of L_1 and L_2 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. A student has completed his Masters thesis on morphological study of TEC and scintillations recoded during 2010. The Geomagnetic storm (Space Weather) effect of storms of different categories (moderate, intense and very intense) on TEC and scintillations recorded during 2010 and 2011 were also as part of this thesis.

The Research and International office of the University of the South Pacific (USP) has released its electronic research repository of the research (publications) generated during the staff affiliation with USP. For details please visit http://repository.usp.ac.fj/

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

Two ELF-VLF campaigns during last year were so encouraging that we actually continued our December 2011 campaign until 4 January 2012. It was again a new record in the length of our campaigns, almost 4 weeks. December was magnetically very quiet, but still it gave one of the most interesting data sets ever.

That campaign was also the first one when we were recording under polar night conditions. Especially days near the winter solstice were spectacular. We observed non-typical ground-based quasi-periodic VLF emissions (Manninen et al., JASTP, in press, but can be found as pdf) and new type of ensemble of quasi-periodic, long-lasting VLF emissions (Manninen et al., 2012, doi:10.5194/angeo-30-1655-2012). Last paper was published 11 Dec 2012.

The JASTP paper shows such observations, which should be possible to observe only during polar night according to theoretical explanation. In theory, these new QPs should show totally different nature on opposite hemisphere, which is under mid-night Sun. This was main reason why we had next campaign in May 2012. Mid-night Sun begins in Sodankylä in the end of May, but Kannuslehto is a few tens of kilometres further north, i.e. there mid-night Sun begins some days earlier. Furthermore, we do not need mid-night Sun on the ground, but at the altitude where QP emissions will be reflected back to the magnetosphere.

There is also one very practical reason why we do not want to record later during summer. In the end of 1990's we tried a mid-summer campaign. That was dramatically failed due to a single lightning discharge about 3 km far away from our receiver. All our amplifiers were destroyed… Nowadays our receiver contains much more expensive and unique parts, so we will not do our campaigns during summer or early autumn.

However, our May campaign begun on 7 May and ended on 6 June, i.e. it lasted almost 4 and half weeks. Data contains some interesting events, but so far we have not found any features of such QP emissions we observed in December 2011.

Our latest campaign started on 10 December 2012 and it may continue till mid January. Quick-look plots may appear in our server already during the campaign.

Just before December 2011 campaign Finnish VERSIM grand old man prof. Tauno Turunen was convinced to continue his activity in VLF analysis. After that he has made a new version of our analysis package. His new package is now used in current campaign. It contains better filtering for major sferics and totally new filters for PLHRs.

Some new results from Finnish campaigns have been presented in the 5th VERSIM Workshop. Most unique phenomenon seemed to be so called sudden enhancements of PLHRs. It is the PLHR event, which has a sudden (within a fraction of a second) start at frequency range of 0-5 kHz, and it contains every 50 Hz harmonics. This enhancement occurs simultaneously at all frequencies and duration of whole event is a few tens of seconds. One example is shown in Figure 1. Almost 100 events have been observed in 2011 and 2012 campaigns. This clearly requires more studying.

Another interesting observation is suppression of VLF hiss induced by whistler echo trains. The phenomenon was introduced by Gail and Carpenter (1984), but after that it was forgotten. A few cases have been observed in Finland. Main difference is that Finnish data is wide-band data and all detailed features can be studied. One example is shown in Figure 2.

Before current campaign we have altogether 3000 hours of digital 24-bit two-component ELF-VLF data recorded near Sodankylä since 2005. More than 2500 hours of data is wide-band data at 0-39 kHz, i.e. it covers also all VLF transmitter signals up to 39 kHz. Unfortunately, frequency band of 10-39 kHz is almost totally untouched and unknown in our recordings. So, any colleague who might be interested in these frequencies, is welcome to use our data.

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.

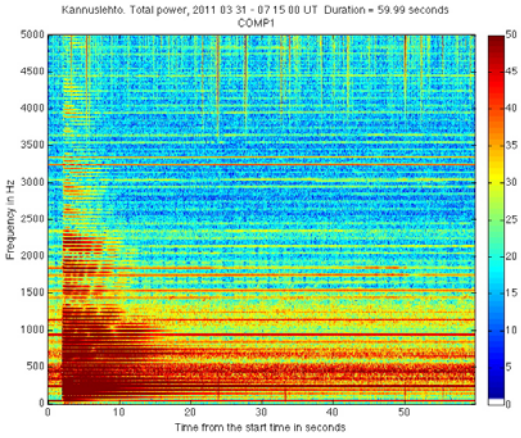


Fig. 1. An example of sudden enhancement of PLHR.

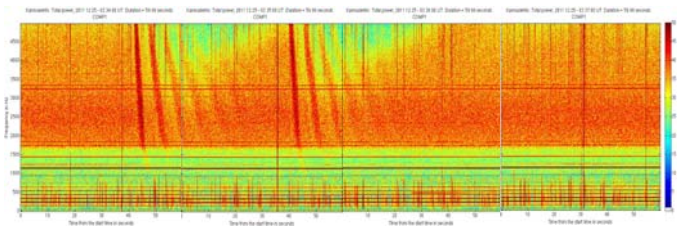


Fig. 2. An example of suppression of VLF hiss induced by whistler echo trains.

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

Last year's research with regard to planetary wave activity deduced from VLF/LF absorption phenomena led to another publication (see below, free to download).

Continuous amplitude and phase recordings from VLF/LF MSK transmitters again was the main topic of this year's activities at our mid latitude site (52°N, 8°E). Not all MSK transmitters provide stable phase. The radio signals from NRK (37.5 kHz, Iceland) and GBZ (19.58 kHz, UK) however could successfully be used to study quiet and disturbed situations continuously. During the increasing solar activity 2012 we especially looked for the effect of flares on the lower ionosphere and modeled our data with LWPC propagation calculations.

Some results have been reported at the 5th VERSIM Workshop, September 3-6, Sao Paulo, Brazil, and at the annual national URSI meeting (Miltenberg, Sep. 24-26).

Now with upcoming winter time in the northern hemisphere flare effects with propagation paths to our site are strongly suppressed because of the large Sun zenith angle. However the long nights together with ample CME activity open up new opportunities to record particle precipitation events in amplitude and phase. Most of the current data plots (and a few months back) are available at: http://electricterra.com/Ernst

Schmitter,E.D., Data analysis of low frequency transmitter signals received at a mid latitude site with regard to planetary wave activity, Advances in Radio Science, 10, 279-284, 2012

Schmitter,E.D., Monitoring And Modeling The Phase Behaviour Of VLK/LF MSK-Transmitters For Remote Sensing Purposes of the Lower Ionosphere, 5th VERSIM Workshop, September 3.-6., 2012, Sao Paulo, Brazil

Schmitter,E.D., Observations and model calculations of solar effects on lower ionosphere parameters using amplitude and phase monitoring of medium range VLF transmitters at a mid latitude site, Kleinheubacher Tagung, URSI national chapter Germany, Miltenberg, Sep. 24.-26., 2012,KH2012-GHJ.1-4

Greece - University of Crete report by Christos Haldoupis.

The Ionospheric Physics Laboratory, at the Physics Department, University of Crete continued during 2012 the operation of an automated Stanford VLF narrow-band receiver. The Crete VLF station is part of the AWESOME VLF network (http://nova.stanford.edu/~vlf/awesome), which is designed to investigate the Earth's VLF environment.

In 2012, we have continued participating and supporting the *EuroSprite* campaigns and continued to research open VLF topics, among them the impulsive VLF signatures, known as early VLF events. These are sudden nighttime VLF perturbations associating with direct lightning effects in the upper atmosphere D region ionosphere, which occur in close association with Transient Luminous Events (TLEs). Also we continued collaboration with colleagues from institutions in USA, Denmark, Spain, Italy, Israel and New Zealand. For a summary of our activities, scientific contributions as well as paper reprints see: http://cal-crete.physics.uoc.gr/VLF-sprites/VLFmain.html

The highlight of our 2012 research (published in Geophysical Research Letters) is a new finding showing that intense positive cloud-to-ground (+CG) lightning discharges which trigger both an elve and a sprite are associated with long-lasting conductivity modifications in the upper *D*-region ionosphere. The ionospheric disturbances can be observed as perturbations in the amplitude and phase of VLF signals propagating through or near the disturbed region. They are manifested as ***LO***ng ***R***ecovery early VLF ***E***vents (LOREs)

which can last up to 20 – 30 minutes. These same ionospheric modifications are responsible for abrupt step-like changes in VLF transmissions which offset signal levels for long times (>30 minutes). The evidence suggests that when a lightning stroke exhibits the properties both of elve production (high peak current) and sprite production (large positive total charge transfer), there may be a coupling effect between the elve and the sprite which produces extended and long lasting elevations in electron density at VLF ionospheric reflection heights. The results help identify a mechanism for, and thus clarify the nature of, the unexplained LORE phenomenon and confirm predictions and postulations that elves may be accompanied by significant and long-lasting electron density perturbations in the upper *D*– lower *E*– region ionosphere. More research, both observational and theoretical, is presently under way on the same topic, and new results have been obtained which are expected to be submitted for publication soon.

2012 Publications and conference presentations:

Long-lasting *D*-region ionospheric modifications, caused by intense lightning in association with elve and sprite pairs, Christos Haldoupis, Morris Cohen, Benjamin Cotts, Enrico Arnone, and Umran Inan, *Geophys. Res. Lett.,* 39, L16801, doi:10.1029/2012GL052765, 2012.

D-Region ionosphere sudden perturbations associated with lightning and TLEs, C. Haldoupis, 1st Thunderstorm Effects on the Atmosphere-Ionosphere system, 17-22 June 2012, Torremolinos, Malaga, Spain (*invited*).

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 Maxwell'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 general relativistic situations was published in Radio Science (Cs. Ferencz, Radio Science, Vol.47, RS1014). **2)** The application of this method for finding non-radiating, but propagating solutions which can affect the space-time structure is under way. **3)** The application of the earlier UWB solutions is successful in the POPDAT and PLASMON EU FP7 projects and in the Chibis-M satellite mission. **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) is also under way. **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.) continued also.

After the successful launch of the Chibis-M Russian-Hungarian-Ukrainian micro-satellite from the ISS to an ionospheric free orbit the data recording by the Hungarian SAS3 ULF-VLF wave experiment and the other onboard experiments started. The first results of the data collected by the SAS3-Chibis confirmed that the planned operation modes (monitoring, burst and event-detection) works well and these data sets are well usable in the Space Weather research and applications. The Chibis mission is in progress.

VLF signals measured simultaneously onboard (DEMETER) and ground stations (Tihany, Hungary; Dunedin, New Zealand) were analyzed with high accuracy to investigate the propagation in ionized plasma and decoupling to the Earth-Ionosphere waveguide. Complementing the results with model calculations it has been proved that the existence of closely spaced traces measured onboard can be explained by multiple reflections of the downer layers of the Ionosphere.

We have extended the Automatic Whistler Detector and Analyzer Network with a new node at Karymshyna, Kamchatka, Russia (L=2.13) in cooperation with Institute of Cosmophysical Researches and Radio Wave Propagation Far Eastern Branch of the Russian Academy of Sciences. The installation of the Automatic Whistler Analyzer (AWA) algorithm at 15 nodes of AWDANet is going on.

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

Employing a set of 3-component search coil magnetometer, Schumann (SR) studies have been carried out at Agra (geographic lat.27.2ºN, long.78ºE) and data for the period of 12 months between 01 March 2011 and 29 February 2012 are analysed. The average universal time variations of the intensity for the first mode corresponding to X-component (north-south) and Y-component (east-west) are studied for the three seasons of Summer (May-August), Winter (November-February) and Equinoxes (March, April and September, October), The results show significant variation in the three peaks corresponding to the major thunderstorm centres of, Asia, Africa, and, America as compared to optical transient detector (OTD) data. This is interpreted in terms of difference in weather, climate, and place of measurement. However, the monthly variation of the Y-component of the calculated intensity shows good correlation (correlation coefficient=0.67) with the OTD data.

Amplitude enhancements in the NWC (19.8 kHz) SoftPAL recorded VLF signals have been analyzed at Agra station which are produced by solar flares occurred during 01 January 2011 to 31 December 2011. In all 47 events have been recorded which are found to correlate positively with X-ray fluxes of varying intensity. The enhancements in the amplitude (ΔA) have been calculated which are found to range between 0.6 dB and 5.36 dB. Then we attempted to calculate the electron densities at three values of ΔA corresponding to a maximum (ΔA= 5.36 dB), moderate (ΔA= 2.80 dB) and minimum (ΔA= 0.6 dB) using initial unperturbed values of Wait parameters reflection height H'=71 km and β=0.43 km^{-1}. The D-region reflection height is found to be reduced to 66 km and β enhanced to 0.48 km^{-1} corresponding to ΔA=5.36 dB. The calculated electron density at this reflection height is found to be 801.61 cm^{-3} which is compared with IRI-2007 model electron density. The error between the two is ~10 %.

Ground based observations have been carried out for Ultra Low Frequency (ULF) precursors of earthquakes at four different stations in India namely Agra (Geograph.Lat 27^0 N, long. 78^0E), Guttu (lat 31.53^0N, long 78.75^0E), Shillong (lat. 25.92^0N, long. 91.88^0E) and Kolhapur (lat 16.40^0N, long 74.15^0E) using identical 3-component search coil magnetometers (f= 0.01-30 Hz) obtained from Lviv centre of space research Ukraine. An offline analysis of the combined data has been carried out in relation to a major earthquake of magnitude M=7.9 occurred in the neighbouring country China

(lat. 31^0N, long.103.32^0E, depth=19 km) under the National Program of Earthquakes Precursors (NPEP) launched in India since May 2009. The results of the analysis show occurrence of amplitude anomalies as precursors whose amplitudes decrease with distance. The precursory periods range between 2 and 5 days and are large for the stations nearer to epicenter. A graphical determination of location of the epicenter is found to be satisfactory with errors within about 20.5%. Further, the TEC data obtained from a dual frequency GPS receiver at Agra station and global ionospheric maps (GIMs) of TEC corresponding to the Wenchuan earthquake have also been analysed. The GIM TEC data are analysed for five different locations which lie between Agra and the epicenter of the earthquake. The anomalies in TEC data are investigated by using quartile based statistical process. It has been found that GPS and GIM TEC data show anomalous depletions 02 to 13 days before and anomalous enhancements 03 to 10 days prior to the occurrence of earthquake.

India - KSK Geomagnetic Research Laboratory, Indian Institute of Geomagnetism, Allahabad report by Rajesh Singh.

During the year 2007 three new VLF stations were setup in India at Allahabad (Geomag lat. ~160°N), Nainital (Geomag lat. ~200°N) and Varanasi (Geomag lat. ~160°N) by Indian Institute of Geomagnetism under scientific collaboration with Stanford VLF Group, Stanford University. These stations are among the lowest latitude locations stations. The setup of the stations was also supported by International Heliophysical Year (IHY) 2007 and United Nations Basic Space Sciences Initiative (UNBSSI) program. Since 2007 all the three Indian VLF stations are operating continuously particularly our main base station at Allahabad (Geomag lat. 16.08°N). All the three stations are located at the quiet sites and are generating the quality VLF data for the studies of D-region ionosphere and plasmasphere. In the recent years we have concentrated on the studies to understand 'Tweek' radio atmospherics morphology and study D-region ionosphere with these lightning generated signals in low latitudes (pl. refer to some relevant publications below). During past one year we have been concentrating on the low latitude 'Whistlers' with the observation of good number of whistlers on various nights during last two years. During 2010-2011 we also installed under collaboration with our Hungarian colleagues from Space Research Group, Eötvös University, Hungary an Automatic Whistler Detector (AWD) system for automatic detection of whistlers. In our recent publication in Geophysical Research Letters (Singh et al., doi:10.1029/2012GL054122, 2012) we were able to establish for the first time in Indian low latitude sector the "Ducted" propagation of low latitude whistlers by determining the location of the causative lightning strikes around the conjugate region of recording station in Indian ocean. Dependence of whistler occurrence on peak current radiated by causative lightning discharge was also studied. We from Indian Institute of Geomagnetism and Stanford University also jointly organized a workshop "Advancing VLF Science through global AWESOME network" at Goa, India during 28 Nov – 01 Dec 2011.

Expanding our research activity we had established two stations in India for the observation of 'Transient Luminous Events' (TLE's) during 2012. The TLE experiment is first in India region for the observation of "Sprites". Our collaborator in this experiment is DTU Space, Denmark.

1. Rajesh Singh, M.B Cohen, A.K. Maurya, B. Veenadhari, Sushil Kumar, P. Pant, Ryan K. Said, U.S. Inan, Very Low Latitude (L=1.08) Whistlers, Geophysical Research Letters, doi:10.1029/2012GL054122, 2012.

2. Ajeet K. Maurya, B. Veenadhari, Rajesh Singh, Sushil Kumar, M. B. Cohen, R. Selvakumaran, Sneha Goakani, P. Pant, A.K. Singh, U.S. Inan, Nighttime D region electron density measurements from ELF-VLF tweek radio atmospherics recorded at low latitudes, Journal of Geophysical Research, doi:10.1029/2012JA017876, 2012.

3. Ajeet K. Maurya, Rajesh Singh, B. Veenadhari, Sushil Kumar, M. B. Cohen, R. Selvakumaran, P. Pant, A.K. Singh, D. Siingh, U.S. Inan, Morphological features of tweeks and nighttime D-region ionosphere at tweek reflection height from the observations in the low latitude Indian Sector, Journal of Geophysical Research, doi:10.1029/2011JA016976, 2012.

4. Rajesh Singh, B. Veenadhari, A.K. Maurya, M.B Cohen, S. Kumar, R Selvakumaran, P. Pant, A. K Singh, U.S. Inan, D-region ionosphere response to the Total Solar Eclipse of 22 July 2009 deduced from ELF-VLF tweek observations in the Indian sector, Journal of Geophysical Research, doi:10.1029/2011JA016641, 2011.

5. Rajesh Singh, B. Veenadhari, M.B. Cohen, P. Pant, A.K. Singh, A.K. Maurya, P. Vohat, and U.S. Inan; Initial results from AWESOME VLF receivers: Setup in low latitude Indian region under IHY2007/UNBSSI program, Current Science, 98, No. 3, 398-405, 2010

6. As. K. Singh, R. P. Patel, Rajesh Singh, K. K. Singh, and A. K. Singh; Characteristics of discrete VLF falling-tone chorus emissions observed at low latitude ground station, Earth Planets Space, 61, 1179–1183, 2009.

7. D. Siingh, A.K. Singh, R.P. Patel, Rajesh Singh, R.P. Singh, B. Veenadhari and M. Mukherjee, Thunderstorms, Lightning, Sprites and Magnetospheric Whistler-mode Radio Waves, Surveys in Geophysics, 29: 499-551, DOI 10.1007/s10712-008-9053-z, 2008.

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

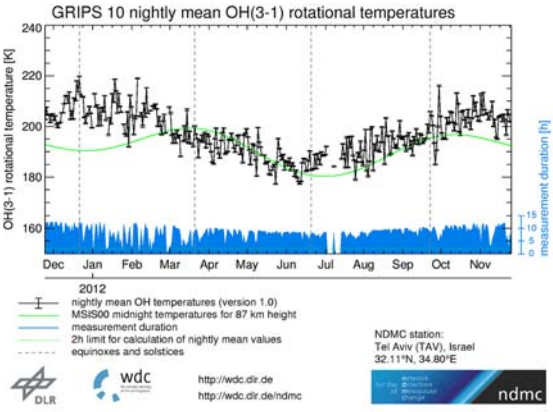
The recording and analysis of whistler waves and the VLF emissions at Physics Department, University of Lucknow, Lucknow (Geomag. Lat., 17.60° N, Geomag. Long., 154.50° E) are continuing in order to detect whistlers and to determine various medium parameters. The VLF antenna is made of two perpendicular magnetic loops, oriented N-S and E-W. This antenna will be part of AWDAnet, the Automatic Whistler Detector and Analyzer system's network. 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. Apart from it some work on Atmospheric-Ionospheric coupling is also being carried out.

Israel - Report by Colin Price (Tel Aviv University)

At Tel Aviv University we are presently working on studying the link between narrowband (NB) VLF signal amplitudes, and the temperature of the mesopause region of the atmosphere along the same great circle path (GCP). This work is being carried out by graduate student Israel Silber, together with Colin Price, and collaborations with Craig Rodger (NZ) and Christos Haldoupis (GR). The findings show an intriguing strong negative correlation between mesopause temperatures and VLF amplitudes detected on the ground. It is believed that changes in the temperature of the upper atmosphere impact the altitude of the D-region reflection height, and hence the amplitudes of the GCP VLF signals. Numerous GCPs have been analysed, for different periods.

In relation to this work, we have also started to work with mesopause temperature data obtained from ground-based airglow measurements in Tel Aviv, as part of the Network for Detection of Mesopause Change (NDMC: http://wdc.dlr.de/ndmc/).

Temperature data for the last year are shown in the image below.



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 that 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 (~16-30 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 the latter instruments are part of the AARDDVARK global network of subionospheric VLF monitors; they both also provide real-time observations to the WWLLN lightning consortia.

The Ministik Lake VLF receiver has had a hard time since it was installed in late 2010; some sort of sharp toothed locals have twice damaged the main data cable, and near-by lightning discharges have destroyed the pre-amp this year. Who would have thought Alberta would be a tougher environment to operate in than Antarctica! Mid-way through this year Craig Rodger and James Brundell travelled to Canada to repair and upgrade the experiment, although we would not have data if it were not for the support of Dr. David Milling from the University of Alberta. In late November-December 2012 James Brundell and Ian Whittaker travelled to Scott Base, Antarctica to undertake maintenance and repairs of our AARDDVARK receiver at Arrival Heights, and to investigate the local VLF noise.

In 2012 the group was joined by Dr. Ian Whittaker, who has come to us from the UK. His PostDoc funding comes via our workpackage in the European Union FP7 PLASMON project (led by Eötvös University). This funding has also supported a new PhD student (Mr. Aaron Hendry), who attended the 5th VERSIM workshop in Brazil. The group is also supported by the New Zealand Marsden fund, and two new MSc students will be starting next year (Kathy Cresswell-Moorcock and Jason Neal) supported by that project. Kathy and Jason undertook research in our group in 2012, looking at satellite data during substorms and solar proton events, respectively. Craig is preparing papers for submission based on their project work.

This year Neil Thomson travelled to Western Australia, and Hawaii to make near-field measurements of the powerful US Navy VLF transmitters. These campaigns are focused on understanding the typical electron number density profiles of the D-region, and particularly 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 a paper looking at the solar cycle dependence of D-region daytime parameters appropriate for VLF propagation in the tropics [1], complementing his earlier work in this area.

In 2012 Craig Rodger has again 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 analysis of narrowband VLF, riometers and vTEC observations [2]. He has also continued his work with POES SEM-2 electron precipitation observations, which has produced a paper on substorm-driven precipitation [3,4], including evidence of a geostationary satellite being "zombified" by a substorm [4]. Two student-lead papers building on POES (and in one case AARDDVARK) data have been accepted for publication [doi:10.1029/2012BK001299, doi:10.1029/2012JA017998]. The continuing POES-focused work has led to additional evidence for significant "direct" neutral atmosphere chemical changes due to storm-time electron precipitation [5]. Finally, the group has continued to work on understanding the operation of WWLLN data, supporting research led from the University of Washington [6,7].

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., C. J. Rodger, and M. A. Clilverd, Tropical Daytime Lower D-region Dependence on Sunspot Number, J. Geophys. Res., 117(A10), A10306, doi:10.1029/2012JA018077, 2012.

2. Rodger, C. J., M. A. Clilverd, A. J. Kavanagh, C. E. J. Watt, P. T. Verronen, and T. Raita, Contrasting the responses of three different ground-based instruments to energetic electron precipitation, Radio Sci., 47(2), RS2021, doi:10.1029/2011RS004971, 2012.

3. 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., 117, A02313, doi:10.1029/2011ja016933, 2012.

4. Clilverd, M. A., C. J. Rodger, D. Danskin, M. E. Usanova, T. Raita, Th. Ulich, and E. L. Spanswick, Energetic Particle injection, acceleration, and loss during the geomagnetic disturbances which upset Galaxy 15, J. Geophys. Res., 117, A12213, doi:10.1029/2012JA018175, 2012.

5. Andersson, M., P. T. Verronen, S. Wang, C. J. Rodger, M. A. Clilverd, and B. R. Carson, Precipitating radiation belt electrons and the production of mesospheric hydroxyl during 2004–2009, J. Geophys. Res., 117(D9), D09304, doi:10.1029/2011JD01724, 2012.

6. Hutchins, M. L., R. H. Holzworth, C. J. Rodger, and J. B. Brundell, Far-field power of lightning strokes as measured by the World Wide Lightning Location Network, J. Atmos. Ocean. Tech., 29, 1102–1110, doi:10.1175/JTECH-D-11-00174.1, 2012.

7. Hutchins, M. L., R. H. Holzworth, J. B. Brundell, and C. J. Rodger, Relative Detection Efficiency of the World Wide Lightning Location Network, Radio Sci., 47, RS6005, doi:10.1029/2012RS005049, 2012.

Russia - Space Research Institute of RAS (IKI), Moscow, report by David Shklyar, Elena Titova, and Ilya Kuzichev

A comprehensive analysis of 6-component ELF wave data from the DEMETER satellite has been used to study proton whistlers, placing emphasis on low-latitude events originating from lightning strokes in the hemisphere opposite to the

hemisphere of observation. In this case, the formation of proton whistlers does not involve mode conversion caused by a strong mode coupling at a crossover frequency, although a polarization reversal remains an important element in formation of the phenomenon. DEMETER measurements of the six electromagnetic field components in the frequency band below 1000 Hz make it possible to determine not only the dynamic spectrum, but also the wave polarization, the wave normal angle, and the normalized parallel component of the Poynting vector. This has permitted us to address fine features of proton whistlers; in particular, we have shown that the deviation of the upper cutoff frequency from the equatorial cyclotron frequency is related to the Doppler shift. Experimental study of proton whistlers has been supplemented by an investigation of ion cyclotron wave propagation in a multicomponent magnetoplasma and by numerical modeling of spectrograms, both in the frame of geometrical optics.

Shklyar, D. R., L. R. O. Storey, J. Chum, F. Jiříček, F. Němec, M. Parrot, O. Santolik, and E. E. Titova (2012), Spectral features of lightning-induced ion cyclotron waves at low latitudes: DEMETER observations and simulation, *J. Geophys. Res.*, 117, A12206, doi:10.1029/2012JA018016.

In relation to the problem of whistler mode wave exit to the ground, a detailed study of whistler wave scattering on small-scale density irregularities has been performed. The problem consists in that, after propagation in the magnetosphere, a whistler wave, in general, falls on the ionosphere with the angle of incidence outside the transmission cone. Such waves do not reach the Earth experiencing total internal reflection at the atmosphere-ionosphere boundary. To explain wave exit to the ground, the idea of wave scattering on small-scale irregularities in the ionosphere has been followed up. Interaction with these irregularities excites harmonics inside the transmission cone. Using the Green function method, an integral equation for the wave field containing all modes possible for a given frequency has been derived and solved in the Born approximation. This permitted to obtain an expression for the energy flux of the waves which are scattered into the transmission cone.

Kuzichev, I. V. (2012), On whistler mode wave scattering from density irregularities in the upper ionosphere, J. Geophys. Res., 117, A06325, doi:10.1029/2011JA017130.

Another VERSIM related activity at IKI has been the full-wave description of the lower hybrid resonance (LHR) reflection. As it is known, when a quasi-resonance whistler-mode wave propagates in the direction of increasing LHR frequency, it is reflected from the region where the wave frequency is below the LHR frequency. This effect is usually described in the frame of geometrical optics. However, the LHR reflection often takes place in the region of the ionosphere where electron-neutral collisions are significant and lead to the wave attenuation. In this case, a full wave description is required for a correct explanation of the phenomenon. Using this approach, wave reflection coefficients have been calculated for various ionosphere plasma parameters. The relation of the LHR reflection with the problem of whistler wave exit to the ground has also been discussed. The results of this research are being prepared for publication.

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

Through the 2011 we have mainly analyzed the VLF data monitored by the Stanford University ELF/VLF Receiver Atmospheric Weather Electromagnetic System for Observation Modeling and Education (AWESOME) installed in Belgrade (44.85°N, 20.38°E), We have focussed on solar X-ray flare signatures on relatively short paths from transmitters DHO/23.4 kHz at Rhauderfehn (53.10°N, 7.60°E), Germany and ICV/20.27 kHz from Isola di Tavolara (40.92°N, 9.73°E), Italy, evaluating electron density enhancements pertaining to flares in the period 2010-2012.

Versim worked at its best in establishing a collaboration with the Otago University VLF group. Thanks to Craig Rodger and Mark Clilverd we have gained access to the Antarctica data of the stations Casey and Scott Base, with the aim to elucidate the VLF effects of the early March 2012 flares, which have received much attention in the space weather community. The results of this investigation have been reported at the Versim 2012 workshop (São Paulo) and at the ESWW9 (Brussels).

We have advanced the newly promoted N(t,h) model that gives the time-height profile of the D-region electron density during solar flares, confirming the height dependence of the local ionization efficiency. In relating the VLF amplitude and phase perturbations to the flare increased solar radiation we have run the N(t,h) model with the irradiance as measured on Proba2 by the LYRA radiometer (channel 2-4: 6-20 nm +X ray) and compared the results for the D-region ceiling with the ones obtained by the traditionally used GOES(15) irradiance measurements in the 0.1-0.8 nm band. Good agreement between the enhanced electron densities at 90 km height indicates that in producing ionization the lower local ionization efficiency of the EUV and soft X ray spectrum my be compensated by the increased spectral irradiance (http://proba2.oma.be/community/meetings/SWT6).

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

The PLASMON supercomputers were installed at SANAE IV (during December 2011) and Marion Island (during April 2012). Both of these systems have been commissioned but the parallel automatic whistler analyser code is not yet running.

A further AWDA node will be installed in South Africa as part of PLASMON. This node will be located at Weston Agricultural College in the Natal Midlands. Its operation will be supervised by Struan Cockcroft who was a MSc student in our group some years ago. Weston provides an electromagnetically quiet location and has an internet connection, so fulfils the requirements for an AWDA site.

The first PLASMON progress meeting was hosted at SANSA Space Science in Hermanus 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.

Our group is still actively involved in TGF research. Two publications have resulted from the collaboration with the University of Bergen, Norway: 10.1029/2012GL050899 and 10.1029/2011JA017365. Although we have been granted funding to employ both a PhD student and a postdoctoral researcher on this programme, no suitable candidates have yet been found and these positions are still open.

Professor Steve Cummer's LF radio receiver is still being operated from the Westville campus of UKZN. The quality of

the data has stabilised and preliminary analysis indicates that it will be fruitful.

One component of the BARREL balloon campaign will be conducted from SANAE IV during January and February of 2013 and 2014. BARREL is a ground campaign complimentary to RBSP. Two scientists from the USA will travel on the new SA Agulhas II to Antarctica to coordinate this campaign. They will be assisted by members of the South African Antarctic programme.

Etienne Koen is making excellent progress using Particle in Cell (PIC) techniques to model electrostatic wave growth. He has published two papers this year (10.1063/1.3695402 and 10.1063/1.3695404) and will be defending his Licentiate thesis in Stockholm in December 2012.

Brett Delport is about to submit his PhD thesis entitled. Marlie van Zyl, Olakunle Ogunjobi and Sahil Brijraj received their MSc degrees this year. Acceptance of Stephen Meyer's thesis is still pending.

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 2012 using the Hungarian Automatic Whistler Detection (AWD) system. Halley (L=4.5) became an AWD site in February 2012. BAS now operates a third AWD site, at Eskdalemuir in Southern Scotland (L=2.7), beginning recordings in January 2012.

The Stamford University AWESOME receiver has also operated at Rothera throughout 2012, 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) have been maintained at Halley in 2012. The new Halley station is now open (as of February 2012) meaning that the VELOX recordings relocated in February to a point about 16 km upstream on the glacier which forms the Brunt Ice shelf. Movement of the Halley antenna location is typically 0.5 km/year.

NARROW-BAND RECORDINGS:

'Ultra' narrow-band recordings have continued at Rothera (Antarctica) the Australian Casey station (Antarctica), Forks, Seattle (USA), Sodankyla (Finland), Churchill (Canada), Eskdalemuir (Scotland), and Ny-Ålesund (Svalbard) throughout 2012. Basic data collection at all sites is undertaken with 0.1-1 s resolution. Halley became an Ultra site in February 2012, and new Ultra systems were installed at Ottawa (L~3) and St. John's (L~3) in Canada in September and October 2012 respectively. The Canadian sites are operated in collaboration with the Natural Resources Canada, hosted by the Space Weather group.

The software VLF Doppler system has continued at Rothera station, Antarctica (L=2.8) in 2012, receiving whistler mode and sub-ionospheric signals primarily from NAA (24.0 kHz). An Upgraded Doppler system has been in operation at Marion Island, South Africa (L=2.9) during 2012, hosted by the University of Natal, Durban.

WWLLN sites:

British Antarctic Survey has operated three World Wide Lightning Location Network systems in 2012. Rothera and Halley have successfully provided lighting location information all year. Ascension is expected to become an operational WWLLN site again in 2013, after a fault throughout most of 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.

Studies were continued of LF radio propagation during the year 2012. The following results were obtained.

- The diurnal – seasonal dynamics of the global thunderstorm activity was evaluated in traditional way from the simultaneous Schumann resonance records (about two years long) at three widely separated observatories (Moshiri – Japan, West Greenwich – USA, Lehta – Russia). The same data were used for resolving the rigorously formulated inverse problem by using Tikhonov's technique. The global maps of lightning distribution were obtained for particular hour of the given day.
- The analysis was concluded of the parametric Q-burst associated with the galactic gamma flare of Dec. 27, 2004.
- An advanced technique was elaborated for processing the tweek atmospheric signals, which allows for obtaining temporal variations of effective height of the night ionosphere with accuracy of a few hundred meters.

The results obtained were published, submitted for publication, and reported at the First International EMES'12 conference dedicated to P.V. Bliokh, Kharkov, Ukraine, September 25–27, 2012. Program, Abstracts, and Presentations of this conference might be found at the web-site: http://ri.kharkov.ua/emes/materials.html

Modeling was made of the scattering and diffraction of the plane microwave by a metallic cylinder with the dielectric coating. The "left-hand" meta-material medium was treated among the other types of coating. Computations show that the wave back-scatter remains highly variable against the frequency. The coating itself cannot reduce the reflection coefficient in a considerable microwave frequency band, so the cylinder cannot be made "invisible" by mere coating. The results were sent for publication and reported at the local conference.

USA - University of Washington, Seattle, report by Bob Holzworth (with some input from James Brundell & Craig Rodger (University of Otago, New Zealand)).

The World Wide Lightning Location Network (WWLLN) is continuing to grow, with new receiving stations being added in locations as diverse as India, Puerto Rico, Egypt, Australia, Venezuela and Holland. There have been several recent examples of WWLLN featured in scientific news stories, including:

New Observations of Terrestrial Gamma Flashes
NASA press release
http://www.nasa.gov/mission_pages/GLAST/news/vision-improve.html

WWLLN and Tornado prediction
story in Washington Post
http://www.washingtonpost.com/blogs/capital-weather-gang/post/can-lightning-help-predict-tornadoes-a-dc-area-case-may-shed-some-light/2012/12/07/12cce3f0-400a-11e2-bca3-aadc9b7e29c5_blog.html

There is a growing list of scientific publications which make use of WWLLN data, as recorded at the WWLLN Publication webpage http://wwlln.net/publications/
This includes work lead by University of Washington PhD student Michael Hutchins, who has developed an approach to

determine the energy for each WWLLN-detected lightning stroke. This was published in Radio Science this year. An effort is currently underway to apply it to the real-time WWLLN processing such that stroke energy will be reported along with the lightning location and time.

Hutchins, M. L., R. H. Holzworth, J. B. Brundell, and C. J. Rodger, Relative Detection Efficiency of the World Wide Lightning Location Network, Radio Sci., 47, RS6005, doi:10.1029/2012RS005049, 2012.

To check out the latest WWLLN global lightning maps and movies, visit the WWLLN webpage at http://wwlln.net

USA - University of Stanford, report by Morris Cohen.

We have spent some considerable effort to address the trans-ionospheric propagation of VLF transmitter signals. It has long been believed that these beacons may play a significant role in determining the lifetimes of radiation belt electrons, particularly in mid and low latitudes (Abel and Thorne, 1999). But some recent studies of VLF transmitter signals observed by the DEMETER satellite found that the early models to predict the power injected into the magnetosphere overestimated the power by at least 20 dB (Starks et al., 2008), leading to the so-called "20 dB problem". In particular, the Helliwell absorption curves had been used as the basis of the radiation belt impacts of VLF transmitters, but that model was known to be based on several simplifying assumptions. It was subsequently suggested that there may be ionospheric irregularities that scatter the VLF transmitter signal, that are not taken into account properly in not only the Helliwell model, but in all `smooth' ionosphere models. Our most recent work is intended to clarify this question, and finds that while the Helliwell absorption curves were overestimating the power, a more complete model that still does not include irregularities does match the data much more closely.

We used 6.5 years of averaged DEMETER survey mode data first to form the first detailed pictures of VLF transmitter injection into the magnetosphere. With so much data you could see the radiation pattern of the transmitter at 700 km altitude, including the waveguide interference pattern mapped upward, for both daytime and nighttime. The signal strength does not appear to be a function of kp index but does have 5-10 dB of variability from night to night. The conjugate signal is also observable and has two distinct regions. With this data, we calculated empirically the total power injected by a dozen transmitters for both daytime and nighttime. For instance, we find that 1 MegaWatt 19.8 kHz NWC transmitter in Australia injects about 125 kW of power at night, and ~900 W at daytime.

We then compared to the full wave model of VLF propagation developed by Nikolai Lehtinen, recalculating the total power injected for all transmitters in the study, for both day and night, and found that the more advanced model correctly reproduced the total power within 5-6 dB. This close match indicates that the effect of ionospheric irregularities may not have been the cause of the "20 dB problem" as much as the simplifying assumptions that were made to derive the Helliwell absorption curves (which in our view were never intended to be used as a broad and complete measure of trans-ionospheric propagation).

The results were presented (by proxy) at the 2012 VERSIM workshop in Brazil, and have been published in two papers, one in review:
http://vlf.stanford.edu/sites/default/files/publications/2012-09.pdf
http://www.agu.org/journals/pip/gl/2012GL054437-pip.pdf

More detailed work is forthcoming. We welcome discussion or feedback from our colleagues, and send our best regards for happy VLF'ing.

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

The past year has been a big one for the UCLA Thorne group, with the launch of the Radiation Belt Storm Probes (now renamed to Van Allen Probes) in which we are heavily involved, and awarding of the prestigious AGU Fred L. Scarf to Lunjin Chen for an "outstanding dissertation that contributes directly to solar-planetary science". We have continued our research into a number of key magnetospheric plasma waves and their various types of interactions with radiation belt and ring current particles. The ensuing publications can be roughly grouped as follows:

Chorus characteristics: various characteristics of whistler-mode chorus (or chorus-like) waves have been examined. For instance, Li et al. [2012, JGR] studied the association of chorus with CIR storms, Li et al. [2012, GRL] looked at spectral properties of hiss-like versus discrete chorus waves, and Tao et al. [2012, GRL] compared the chorus sweep-rate (df/dt) to a few current models. A large database of wave observations from several satellites was compiled by Meredith et al. [2012, JGR] who used this to study the distribution and dependencies of chorus waves, and Keika et al. [2012, JGR] studied a particular chorus event on the dayside, showing that it is produced in a region of uniform magnetic field lines, dubbed the dayside uniform zone (DUZ).

Plasmaspheric hiss: with the basic connection between chorus waves and plasmaspheric hiss having been established a few years ago, Chen et al. [2012a, 2012b, JGR] studied the characteristics of plasmaspheric hiss as a function of the (a) source chorus wave model, and (b) distribution of cold plasma density. In a follow-up study, first order cyclotron growth inside the plasmasphere was included in the model [Chen et al., 2012a, GRL], showing excellent agreement between modeled and observed hiss intensities, and Chen et al. [2012b, GRL] studied the modulation of hiss intensity by cold plasma density (also receiving an editor's highlight for this paper).

EMIC and ELF waves: Electromagnetic Ion Cyclotron wave distributions were obtained by Usanova et al. [2012, JGR] showing their dependence on AE, SymH, and solar wind dynamic pressure. A fortuitous fast flow event observed on THEMIS and reported by Lee et al. [2012, JGR] was able to infer the cold ion species and relate these to the vanishingly small stop band observed coincidentally in EMIC waves. In a statistical examination of such fast flow events, Liang et al. [2012, AnnGeo] showed a clear a clear trend of increasing wave intensity over a broad frequency range spanning from below LHR to f_{ce}. Chen and Thorne [2012, GRL] performed an analytical study of fast magnetosonic waves and showed that such waves can be trapped within the plasmapause and travel of substantial MLT regions.

Particle dynamics and scattering: The dynamics of electrons and protons drifting in a storm-time magneotsphere with a self-consistent magnetic field have been studied by Jordanova et al. [2012, JGR], showing the development of significant anisotropies that lead to wave growth. The effects of non-dipolar magnetic fields were further seen in the evaluation of diffusion coefficients [Ni et al., 2012, AnnGeo] and scattering of plasmasheet particles [Ma et al., 2012, AnnGeo].

A detailed event study by Ni et al. [2012, JGR] showed that ECH waves can be responsible, or even dominant, in producing the diffuse aurora in the outer magnetosphere, complementing earlier work that established chorus waves as the dominant driver of the diffuse aurora in the inner magnetoshere. In a separate series of papers [Tao et al., 2012 JGR, 2012, GRL], detailed test particle tracing in whistler mode wave fields was performed to assess the validity of the often-used quasilinear theory (QLT), showing that QLT worked very well for low intensity waves but reached a saturation amplitude near a few 100 pT, and additionally that single-wave scattering studies tend to overestimate the effect of nonlinearity when realistic wave amplitude modulation (i.e., subpacket structure) is included in chorus wave models.

Our current focus has shifted heavily towards the analysis of the Van Allen Probe data, which is now arriving in large quantities. Initial results have already been written up and submitted for publication by the various instrument PI's.

Merry Christmas and Happy New Year!

Dr. János Lichtenberger (Eötvös University, Hungary, the URSI co-chair) at the top of the crater of the Gorely volcano in Kamchatka. This trip was undertaken during the setup of the new AWDANet node at Karymshina, Kamchatka, Russia [18 August 2012].

Dr. Craig Rodger (Otago University, New Zealand, the IAGA co-chair) wine tasting at the Fairview winery, near Paarl, South Africa in January 2012. Craig was visiting SANSA Space Science in Hermanus as part of a business meeting for the EU FP7 PLASMON project [image courtesy of Dr Andrew Collier, SANSA Space Science].