IAGA/ URSI Joint Working Group on

VLF/ELF Remote Sensing of Ionospheres and Magnetospheres Newsletter

Editor: Craig J. Rodger No. 22, December 2007

Dear Colleagues,

In 2007 the "primary" meeting for our community was the IUGG XXIV General Assembly held in Perugia, Italy from 2-13 July 2007. There was a VERSIM business meeting on 3 July 2007, and I was re-elected as the IAGA co-chair of the VERSIM working group. Thanks for this vote of confidence, although part of me is looking forward to a contested vote, or even a new IAGA co-chair one day! At this business meeting I gave a brief discussion on the yearly VERSIM newsletter, which is well supported by the community through a large number of reports made from many countries. Our email list had 133 members on that date, and 3 new members requested to join during the business meeting. I should also note that our yearly newsletter was described as one of the most positive and interesting of all the material produced by the working groups inside Division II of IAGA. I certainly enjoy reading what our community has been engaged in, especially in the years outside those of the VERSIM workshops were we now really get a chance to meet properly.

While our business meeting was very early in the General Assembly, the nature of the Perugia meeting had already become clear. As IAGA co-chair I was asked to pass on to "higher levels" the displeasure of the working group members with the organisation levels of the Perugia IUGG Assembly. Many issues were raised at the VERSIM Business Meeting, but the poor programme "book", the incoherent programme organisation, and the lack of any abstract availability (whether through a printed booklet or a CD) were all noted as particularly unacceptable. Some participants noted that the registration fee was not low by international standards, but that this was not reflected by the support the meeting has received. Several participants indicated that they are re-considering attending IAGA/IUGG meetings in the future. I can report that I took those observations to the IAGA Division II Business Meeting, and to the outgoing President of IAGA, both of whom largely agreed with our observations. Since then, a rather disappointing comment has come out from the IUGG President in the October 2007 IUGG newsletter, and a frankly ridiculous response from the head of the Perugia Local Organizing Committee in the following IUGG newsletter. I can only say that I have a lot of confidence in the scientists and professionals behind the IAGA in Sopron (Hungary) in 2009 and IUGG in Melbourne (Australia) in 2011. Hopefully, I will see many of you there!

Next year we have several important and core VERSIM gatherings to add to our agenda. The first is the XXIX General Assembly of URSI in Chicago (USA) in August 2008, shortly followed by the 3rd VERSIM Workshop in Tihany (Hungary) in September 2008. You may recall that after the successes of the 2nd VERSIM Workshop in Finland in 2006 our community agreed to the 3rd meeting being in the same year as the URSI GA to maintain the momentum the VERSIM workshops are bringing to our community. Looking back I am convinced that the previous two workshops have provided a strong opportunity for our community to interact, and was very important for linking researchers together, helping to identify the major scientific of the day, and establishing new collaborations. Without VERSIM Workshops our techniques, approaches and science can be somewhat isolated and fragmented at the large international conferences.

In this sense 2008 is a perfect year for our community. A large meeting in which we can link our activities with the wider scientific questions of the day, as well as our internal highly focused workshop!

As in previous year, I have enjoyed the chance to meet our community at various meetings this year. Please come along to the VERSIM Business Meeting during the URSI assembly in Chicago (time to be announced), and of course I hope to see many of our community at the 3rd VERSIM workshop. I hope the New Year finds you prosperous, productive, and well. Best wishes to you all! Have a great summer or winter, depending on your hemisphere!

Craig J. Rodger
IAGA co-chair VERSIM working group

Forthcoming meetings

- *High Energy Energetic Particle Precipitation into the Atmosphere (HEPPA) Workshop, Helsinki, Finland, 28-31 May 2008*
- *XXIX General Assembly of URSI, Chicago, USA, 7-16 August 2008.*
- *3rd VERSIM Workshop, Tihany, Hungary, 15th - 20th September 2008.*

Reports from VERSIM research groups 2007

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.

Czech Republic - Report by Ondrej Santolik and Jaroslav Chum.

VLF phenomena are traditionally studied at two institutions in the Czech Republic: at the Institute of Atmospheric Physics and at Charles University in Prague, Faculty of Mathematics and Physics. Both institutions closely cooperate. Our VLF research is mainly based on spacecraft data (DEMETER, MAGION5, CLUSTER, Double-Star, Polar, Freja and Cassini). We very often collaborate with our colleagues abroad. We are interested in various types of VLF waves: chorus emissions, equatorial noise, auroral hiss, lion roars, lightning induced whistlers, magnetospheric line radiation, power line harmonic radiation, and in wave phenomena associated with possible seismo-ionospheric coupling.

For example, our investigation of chorus emissions has been based on multipoint observations by the CLUSTER spacecraft and ray tracing simulations of chorus propagation. In a close collaboration with our colleagues from the University of Iowa, USA, we have investigated possible chorus source properties that may lead to frequency and time shifts between corresponding chorus elements which were observed on different CLUSTER spacecraft [1]. Another example of our research: Together with our French colleagues from LPCE Orleans and CETP Saint-Maur des Fosses, we have published a systematic survey of data records of magnetospheric line radiation and power line harmonic radiation obtained by the DEMETER spacecraft [2].

[1] Chum, J., O. Santolik, A.W. Breneman, C. A. Kletzing, D. A. Gurnett, and J. S. Pickett (2007), Chorus source properties that produce time shifts and frequency range differences observed on different Cluster spacecraft, J. Geophys. Res., 112, A06206, doi:10.1029/2006JA012061.

[2] Nemec, F. O. Santolik, M. Parrot, and J. J. Berthelier, Comparison of magnetospheric line radiation and power line harmonic radiation: A systematic survey using the DEMETER spacecraft, J. Geophys. Res., 112, A04301, doi:10.1029/2006JA012134, 2007

Fiji - The University of the South Pacific, Suva, Fiji, report from Dr. Sushil Kumar and Dr. V. Ramachandran.

The waveforms of lightning generated sferics are recorded since September 2006 using the WWLLN system and high sampling rate data logger. Analyses based on the recording of oscillatory waveforms of the electric fields of sferics was utilised to estimate the distance of the lightning strikes d with a single VLF electromagnetic wave receiver at a single station (Suva). The deviations in d calculated from the field pattern and from the arrival time of the sferic were 3.2 % and 1.5 % respectively compared to *d* calculated from WWLLN system. The broadband VLF data were recorded for 5 min. duration at every hour in the nighttime and were analysed for tweeks and whistlers. The tweeks are utilised to estimate the nighttime reflection heights and the electron density at the reflection heights. The propagation features of nighttime whistlers to low latitude station, Suva (-18.2º, 178.3º, geomag. lat. - 21.1º, geomag. long. 253.5º, L = 1.15), Fiji, from preliminary observations made during the period from September 2003-2005, were studied. The results on above studies have been published (Ramachandran et al., Annales Geophysicae, 25, 1509-1517, 2007 and Kumar et al., J. Atmos. Sol.- Terr. Phys., 69, 1366-1376, 2007).

First observations of early VLF perturbations on signals from NWC (19.8 kHz) and NPM (21.4 kHz) transmitters monitored at Suva were studied. The early/fast, early/slow, early/short (RORD), and step-like early VLF perturbations are observed on signals from both the transmitters. This study is being carried out in collaboration with Radio and Space Physics research group at University of Otago, Dunedin, New Zealand. The important results have been sent for publication. The daytime early/fast VLF perturbations with faster recovery and step-like early VLF perturbations initiated and ended by the lightnings which are most likely associated with red sprites and/or elves occurring in the day-time are reported. We thank Prof. Richard Dowden for his valuable help and suggestions in support of our research activities in the area of ELF/VLF at The University of the South Pacific, Suva, Fiji.

France - LPCE/CNRS report by Michel Parrot.

Operations with the satellite DEMETER will continue at least until the end of 2008. Main problems are only related to the old computers of the mission center. More than 30 scientific papers have been published and their references can be found on http://demeter.cnrs-orleans.fr. In 2008 two special meetings related to the DEMETER results will be organized:

- concerning non-seismic topics:
  A dedicated session will occur during the next EGU in Vienna (13-18 April 2008). All necessary information can be found under http://meetings.copernicus.org/egu2008. The name of the session is ST16 (Results from the DEMETER satellite). The deadline for the receipt of abstracts is 14 January 2008.
- concerning seismic topics:
  The Annual EMSEV Meeting and Second DEMETER meeting in Romania will be held between 7-12 September 2008 at a resort centre (Sinaia) in the Romanian mountains. Information can be found on http://www.geodin.ro/~prezentare

LPCE is preparing the payload of the new micro-satellite TARANIS dedicated to the study of the Transient Luminous Events occurring between the top of the clouds and the lower ionosphere during thunderstorm activity. This project is funded since last April for a launch at the end of 2011.

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

We started regular monitoring of VLF transmitter signals with respect to D-layer variation studies about a year ago. Uploads daily go to http://www.electricterra.com/Ernst/.

An Appleton-Hartree equation based signal strength model has been developed. Additionally since August 2007 we operate a fluxgate magnetometer at a sample rate of 10 Hz. The 24 hour B_y-field component together with a 0-5 Hz waterfall is uploaded daily to the same site. As we are situated in a noisy environment (traffic regularly distorting the magnetic field) we have to implement data processing algorithms to 'clean up' the situation as good as possible.

Looking forward to increasing solar activity.

Greece - University of Crete report by Christos Haldoupis.

During 2007, we have continued our research on studying the physics of subionospheric VLF events observed in association with active thunderstorms in the troposphere and transient luminous events (TLEs, particularly sprites) in the upper atmosphere. We continued the operation of an automated narrow band receiver which is located on the roof of the Physics Department, University of Crete. The Crete VLF receiver station, which is a project in collaboration with Prof. Umran Inan and his group at Stanford University, participated in the latest EuroSprite 2007 campaign by providing VLF observations on a continuous basis. Also we have continued our collaborations with colleagues and institutions from USA, Denmark, Israel, Hungary, Finland and Russia.

An important development in our group was the graduation of Agnes Mika, who completed her PhD thesis in May 2007, and started in June a new job as research scientist in ARGOSS, a Dutch company that specializes on applied environmental research. The title of Agnes PhD thesis is: "Very low Frequency wave studies of Transient Luminous Events in the lower Thermosphere" Physics Department, University of Crete, May 2007, and it can be accessed and downloaded in pdf form at: http://cal-crete.physics.uoc.gr/VLF-sprites/files/Mika-thesis-2007.pdf

Space does not permit here to provide details on our recent scientific results. We chose to refer briefly only on some new findings in relation with the levels of ionization produced in the lower ionosphere during sprite occurrences. Such estimates, which are rather sparse, were obtained by using a D-region model and observations of sprite-related early VLF recovery signatures. The model, which has been developed and used before for Lightning induced Electron Precipitation (LEP) studies, can account for charge exchanges between four types of charged particles and for various electron loss mechanisms in the lower ionosphere (upper D region). By fitting the model results to measured sprite-related early VLF event recoveries, we inferred ionization levels and the altitudes of their occurrence. The model accounted reasonably well for the observed recovery times from about 20 s to more than 250 s, if electron density increases of ~ 102 to 104 times the ambient values were taken to occur in the altitude range from about 75 to 85 km. This endorses the notion of VLF scattering from relatively large diffuse regions of electron ionization enhancements located below the nighttime VLF reflection heights, in line also with existing simulations and observations of sprite halos. We are presently finishing a paper on these findings that is to be submitted for publication in JGR.

2007 papers and presentations:

Haldoupis, C., Á. Mika, T. Neubert, U. Inan, R. J. Steiner, and S. Shalimov: "Early" type VLF perturbations observed in relation with sprites and elves during the Eurosprite campaigns, European Geosciences Union General Assembly, Vienna, Austria, 16–20 April 2007.

A. Mika, and C. Haldoupis, Ionization production in relation with Sprites and elves, International Space Science Institute, Europlanet workshop on Planetary Atmospheric Electricity, Bern, Switzerland, July 23-17, 2007.

A. Mika, and C. Haldoupis, VLF studies during TLE occurrences in Europe: A summary of new findings, paper submitted for ublication in Space Science reviews, November 2007.

E. Greenberg, C. Price, Y. Yair, C. Haldoupis, O. Chanrion and T. Neubert, On the ELF charge moment change, VLF bursts and subionospheric perturbations associated with sprites, paper submitted for publication in J. Geophys. Res. Atmospheres, November 2007.

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

The Russian COMPASS-2 satellite was successfully launched on the 26th May 2006 on board with the Hungarian SAS2 experiment. One magnetic and one electric component of the ELF-VLF electromagnetic field were measured. Although the measurements lasted for less than a year, some interesting and exciting phenomena were observed. The highly accurate analysis of these signals are in progress.

Systematic survey of whistlers recorded on board of the French LEO DEMETER satellite continued. Current research topics aim to support better description of e.m. impulse propagation between the lower plasmasphere and mesosphere. Occurrences, spatial distribution and signal structure of one-hop whistlers, appeared both in satellite (DEMETER orbit data above Europe) and ground wide band recordings (provided by the Hungarian VLF network) were simultaneously analyzed. Statistical study of regional lightning data (Safir system in the Carpathian-basin), spherics in VLF data in Hungary and AWDA-detected short-path fractional-hop whistlers (DEMETER) has been started.

The theoretical model development of the electromagnetic wave propagation phenomena around the Earth and in the interplanetary space environment has been going on. We have developed a real full-wave model for UWB (Ultra Wide Band) short impulse signals and applied it for the whole propagation path of electron and ion whistlers from including EIWG. The solution was used to model the short impulse propagation in rectangular-shape waveguides and a waveguide confined by two planes and filled with plasma. These models have been applied successfully to interpret DEMETER and COMPASS-2 data.

The development of the Automatic Whistler Detector and Analyzer (AWDA) system was continued and now it is capable to analyze both mid-latitude traces and multiple-path whistler groups (the latter one is still in test phase). In 2007, an AWDA system was running at SANAE (Antarctica) and at Sutherland and Marion Island (South Africa) in collaboration with University of KwaZulu-Natal, Durban; at Dunedin, New Zealand in collaboration with University of Otago, where the statistical analysis on diurnal and seasonal variations was extended to date; at Halley, Antarctica in collaboration with British Antarctic Survey (due to Halley closer, the experiment is transferred to Rothera, Antarctica); and at four locations in Carpathian Basin (Budapest, Gyergyo, Nagycenk, Tihany), where UltraMSK narrow-band phase and amplitude loggers were also setup as part of AARDDVARK.

Additional information on the 3rd VERSIM workshop was described in the beginning of the newsletter. Note we have approached both URSI and IAGA for financial support.

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

(i) Whistler data analysis

Several whistlers of varying dispersions have been recorded at Agra station using the recently developed new experiment setup for recording and analysis of whistlers. The whistler data recorded using modified digital recording system is being stored on the computer disk and then analyzed using DSP technique. Most of the time data analysis is done offline. The analysis can be divided into two parts, pre-event data analysis and post-event data analysis. The pre-event data analysis is done to investigate the event like whistler or any other phenomena of interest from whole data set. Pre-event data

analysis consists of filtering 50 Hz noise, calculating FFT and making movie of whole data set. To make the lower portion of the frequency spectrum clear, 50 Hz and its harmonics are removed by a digital 6 point IIR filter. Thereafter a 250 point FFT is calculated for each 6 seconds data and plotted against time. Each of this kind of spectrum is saved as a frame of movie. Finally at the end of data set all the frames are saved as AVI movie file which can be played and watched at the desired rate of frames per second (unlike the earlier system in which one had to listen the sound in real time to identify the whistler). The system processes data offline at any time of convenience. Once the event is discovered in the movie, post event data analysis can be applied for that particular frame. The post-event data analysis is done to sharpen the features of discovered events. Depending upon the noise background the data quality may be improved either by increasing the frequency resolution by increasing FFT points or shrinking window from 6 seconds to the duration of event.

(ii) Automation of whistler

Measurement of dispersion of a whistler is an important task to determine the path of propagation, electron density distribution, and temperature etc. along the propagation path in the ionosphere and magnetosphere. This exercise has been done earlier manually which took a lot of time. In order to solve this problem a software has been designed by which the dispersion and arriving latitude etc. can be determined directly from the spectrogram of the whistler on the computer. The main task while designing the software was to automate essential theoretical procedures for which an algorithm has been developed and implemented using JAVA codes. The software has been tested on some previously recorded whistlers and it has been found that results obtained from this technique are much better and accurate in comparison with manually calculated results.

(iii) Study of Trimpi/TLE events

Eight cases of sudden amplitude and phase changes similar to trimpi events have been recorded at our low latitude ground station Agra (Geomag. Lat. 17.1, L=1.1) while monitoring the amplitude and phase of fixed frequency VLF transmitter signals at frequencies of 19.8 kHz (NWC), 21.4 (NPM) and 24 kHz (NAA) using AbsPAL receiver for a period of 3 years between 1 September, 2002 and 30 August, 2005. The characteristics of the phase and amplitude variation so obtained are compared with the data obtained from a mid latitude station Budapest (Hungary) corresponding to the frequencies of 22.1 kHz and 45.9 kHz. The data show average amplitude enhancement of about 3-7 dB and phase decrease ~8.6 μs in almost all cases. Although, there is no direct evidence of the phenomena, it is possible that these rare trimpi/TLE events are caused by lightning generated whistlers in the low latitude ionosphere. The simple calculations show that during such events the ionosphere height was lowered by 0.97 to 4.5 km and the number of particles precipitated were around 100.

(iv) Satellite data analysis

The satellite DEMETER was launched by CNRS, France on 29 June, 2004 in circular orbit at 710 km for measurements of electromagnetic emissions in ELF/VLF range, energetic electron and ions, and temperature etc. besides it's main objective to verify electromagnetic emissions generated from seismic zones and their penetration in the ionosphere and magnetosphere. The Agra station has been actively engaged in these research areas for a long time and keeping this in view it has been given user-1 category for analysis of the DEMETER data in India. Recently, satellite data for the study of ELF/VLF emissions and electron density distribution in the low latitude ionosphere have been analysed and considerable evidences of existence of ELF emissions in the frequency range 300 to 1200 Hz has been found around the equator at the satellite height. The analysis of the ELF data has been carried out in the light of magnetic storms and the earthquakes in the Indonesian region and it has been found that the emissions are possibly due to earthquakes. The data have also been analysed for the electron density anomalies in the low latitude ionosphere along with the TEC and it has also been found that such anomalies are created during earthquakes.

(v) New experimental set up for TEC measurement

The equipments related to TEC measurements have been imported from USA and include an L1/L2 GPS antenna (Novatel's Model GPS 702), a GPS receiver (Novatel's Euro Pak 3-M), relevant softwares and connecting cables. The GPS receiver can locate upto 11 GPS signals at two frequencies of 1575.42 MHz and 1227.6 MHz. It measures phase and amplitude at 50-Hz rate and code/carrier divergence at 1-Hz rate for each satellite being tracked and computes TEC from combined frequencies pseudorange and carrier phase measurements. The primary purpose of the GPS receiver is to collect ionospheric scintillation and TEC data for all visible satellites. The output data contains 4-pairs of TEC and TEC rate values computed every 15 seconds along with real time values of amplitude scintillation index S4 and the phase scintillation index computed over 1-minute. The initial data for a period of 15 months have been analysed and considerable evidences have been found for the TEC anomalies prior to some major earthquakes occurring in the North-West region across India.

Israel - Department of Geophysics and Planetary Sciences, Tel Aviv University, report by Colin Price.

Colin Price and graduate student Yuval Reuveni are operating two VLF antenna in both broadband (BB) and narrowband (NB) modes. The data are being used to study sprites in the eastern Mediterranean winter thunderstorms, and more recently, the possibility of VLF pulses being produced by meteors. There has been anecdotal evidence for hundreds of years related to sounds being heard simultaneously with the visible observations of meteors (especially fireballs or bolides). While these accounts were brushed off as being people's imagination, recently the idea of VLF pulses being generated with the optical light, and being transformed into sound close the observer, has been proposed. We have collected GPS stamped optical and VLF data during the Perseids meteor shower of 2007. Our initial analysis does indicate short (10 ms) pulses of VLF radiation associated with some of the meteors. This research continues.

Colin Price and graduate student Eran Greenberg have analysed the VLF BB and NB data in Israel related to 15 sprites observed in France. It appears that intracloud lightning may play a more significant role in sprite generation and lifetime than previously thought. This winter 2007/8 we have already imaged ~30 sprites and elves, and possibly a blue starter, above winter thunderstorms in Israel (together with Yoav Yair of the Open University of Israel, and students Roy Yaniv and Naama Reicher).

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

Experimental Measurements

We have been running the following experimental measurements locally: 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 which log small changes in the phase and amplitude of powerful VLF communications transmitters (~13-30 kHz) to study subionospheric propagation. We operate OmniPAL, AbsPAL, SoftPAL and Ultra MSK receivers. 3) an Automatic Whistler Dector 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 have also collaborated with French researchers who together operate the DEMETER spacecraft.

Summary of Recent Results

Our subionospheric measurements are made inside the Antarctic-Arctic Radiation-belt (Dynamic) Deposition - VLF Atmospheric Research Konsortium (AARDDVARK) network, jointly lead by Otago and the British Antarctic Survey, but including other researchers from Hungary, South Africa and Finland. AARDDVARK activities are include examining the ionospheric and atmospheric effects of relativistic electron precipitation, solar flares, solar proton events, whistler induced electron precipitation, and NO_X production and descent towards the stratosphere. These are summarised at the network webpage http://www.physics.otago.ac.nz/space/AARDDVARK_homepage.htm
In addition, Neil Thomson from Otago has used subionospheric measurements from multiple locations to determine "typical" Wait ionosphere parameters appropriate for nighttime propagation. This is described in Thomson et al.(J. Geophys. Res., 112, A07304, doi:10.1029/2007JA012271, 2007).

DEMETER data has been an invaluable assistance in interpreting other observations. Recent results include looking at the precipitation of relativistic electrons into the atmosphere over ~2-3 weeks after a geomagnetic storm, the relative importance of whistler ducts to the propagation of VLF radiation from ground-based sources through the magnetosphere, and the effects of powerful communications transmitters on the radiation belts.

The Eötvös whistler detector system has now operated from Dunedin nearly continuously since May 2005. In the first 846days of operation nearly 100,000 whistler-containing files have been recorded and stored by the system. The high whistler rate is not consistent with lightning rates in our conjugate region. Several conference presentations have been prepared on this topic area, and a publication is in preparation.

An up to date listing of our publications is available from the Groups website: www.physics.otago.ac.nz/research/space/spacehome.html
We have recently started including PDFs of our published work

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

VLF recordings of the Belgrade Absolute Phase and Amplitude Logger (AbsPAL), continuously operating throughout the year, have been the subject of the team's strenghtened research efforts. Data at five, out of six frequencies that can be logged simultaneously, have been used in connection with Solar X-ray flare and LEP observations. At the end of 2006, after three years of stable operation, we have repeated the calibration of the AbsPAL facility to check the reliabitily and quality of the data for physical modelling. Upon successfully completing the task, improvements in the automation of the recording procedure were performed (Prof. M. Popović, Faculty of Electrical Engineering, Belgrade).

In continuing the research of the lower ionosphere, in terms of D-region electron density enhancements during Solar X- ray flares, we have focussed on the signals from the transmitters: NAA/24.0 kHz, NWC/19.8 kHz and GQD/22.1 kHz. By combining ground and space-based measurements: the VLF amplitude perturbance, recorded by the (AbsPAL) has been related to the X-ray irradiance measured by the GOES -12 satellite, for 120 flare induced events, registered through May-August 2004-2007. On the two database sets, a new physics - based model for determining electron density time profiles during Solar flares has been proposed. The results arrived at are found in good agreement with measurements by different techniques and independent estimates of the Wait ionosphere model, as incorporated in the LWPC code (V. Žigman, D. Grubor and D. Šulić, J. Atmos. Solar-Terr. Phys., 2007, 69, 775-792).

Activities have carried out within the European COST Action 724, (2004-2007) by contributing two review papers to the Final COST-724 Report, and in constructing the European Spaceweather Portal (http://www.spaceweather.eu).

Another line of research has focussed on the ground observation and analysis of Lightning-induced Electron Precipitation (LEP). Simultaneous LEP events signatures recorded during December 2004 on the signals: GQD/22,1 kHz, NAA/24 kHz, HWV/18,3 kHz and IDC/20,27 kHz, have been analyzed in particular. By using the LWPCv21 program and by adapting, in successive approximations, the disturbed ionospheric profiles the regions of enhanced ionization along the GCP have been identified Comparison of geographical locations of enhanced ionization for the five traces mentioned, has led to the mapping of LEP events over middle and west Europe. A research paper is presently under preparation.

Two oral papers were presented at the IUGG General Assembly, in Perugia (July 2-13 2007) and a contribution to the Fourth European Spaceweather Week, Brussels (5-9 November 2007) was given as well. We are confident to continue our joint research work under a new Slovenian-Serbian bilateral project that we have presently applied for.

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.

A simple two-component model is developed for the global thunderstorm activity based on the long term Schumann resonance monitoring (5.5 years). The source consists of a compact "hot spot" circling the globe along the equator and place at ~17 hr LT and of a "belt" embracing the Earth along the equator where the "background" stable thunderstorm activity is concentrated. We called it "diamond ring model", its predictions correspond to measurements as good way (or as poor), as do the computations based on the OTD maps.

Two papers were "pushed" into the Radio Science #2 special section on Schumann resonance, both related to the ionosphere non-uniformity and anisotropy.

At present, the work is underway in the transverse and Schumann resonance bands. The first is devoted to temporal variations of the night ionosphere height, which is evaluated from the peak frequencies of transverse resonance (~1.6,

3.2 kHz, etc.) In the Schumann resonance band, a comparison is made between Q-bursts waveforms detected by Ogawa and Komatsu (Rad. Sci. #2, 2007) and these computed by using the direct time domain solution with accelerated convergence. A striking similarity was found owing to a very wide band of receiver and the 16 kHz sampling frequency. Probably, there will be a joint paper.

A paper was published in Russian on the detection of the man-made signal from Kola Peninsula Source at the "Bellinshausen" Antarctic station in February of 1989. Diurnal variations of amplitude are presented discussed from the positions of existing ELF propagation models.

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

BROADBAND RECORDINGS:

Synoptic broadband VLF recordings at Halley station, Antarctica (L=4.3), using Digital Audio Tape, have continued on a 1-minute-in-15 synoptic schedule, with occasional recordings at 1-minute-in-15 or continuous. Note: These recordings stopped indefinitely on 1 October 2007 following the closure of Halley science activities, as a result of the 2008-2010 station rebuild.

The Hungarian Automatic Whistler Detection system was trailed at Halley in 2007. Data collection has now stopped indefinitely at Halley, but a similar system is scheduled for deployment at Rothera in 2008.

VELOX RECORDINGS:

Continuous (since 1992) recordings of VLF activity in 10 ELF/VLF bands, at 1-s resolution (VELOX), including spheric counters, have continued at Halley. Note: The VELOX at Halley will continue indefinitely, despite closure of the rest of the VLF science during the 2008-2010 period.

AGOs (Automatic Geophysical Observatories) programme: No AGO systems are operating now.

1-s resolution data are available on the Web using the BAS Data Access & Browsing System (DABS) http://dabs.nerc-bas.ac.uk/. A new data access system will come on-line during 2008, replacing DABS – further details to follow.

NARROW-BAND RECORDINGS:

The narrow band receiver `OmniPAL' has operated through 2007 at Halley, and Rothera bases, Antarctica, Sodankyla, Finland, and Ny Alesund, Spitzbergen. Northern hemisphere transmitters in Europe and USA are being received at 0.1-0.2 sec resolution. In May 2007 BAS installed an 'Ultra' narrow-band system at Churchill, Canada. Northern hemisphere transmitters in Europe and USA are being received at 0.2 sec resolution. The Australian Casey station (Antarctica) has continued to operate as an amplitude-only narrow-band receiver throughout 2007. Southern hemisphere transmitters are being received with ~2 sec resolution, although a long-term problem has affected data quality since March 2007. Note: Halley narrow-band recordings stopped indefinitely on 1 October 2007.

A VLF Doppler receiver has continued to operate at Rothera station, Antarctica (L=2.8), receiving whistler mode and subionspheric signals primarily from NAA (24.0 kHz).

WWLLN sites:

British Antarctic Survey operated two World Wide Lightning Location Network systems in 2007. Rothera, Antarctica, and Ascension Island have provided lighting location information all year.

United Kingdom - VERRI, Derbyshire, report by Andy Smith.

A new institute for research in the VERSIM field has recently been set up in the UK. The VLF/ELF Radio Research Institute is based at Bradwell, Derbyshire, England. Research is carried out into VLF and ELF radio waves, particularly naturally generated waves in the Earth's magnetosphere and ionosphere, such as whistlers and chorus. For more information, see: http://www.verri.org.uk/

Please could colleagues note that, now I have retired from the British Antarctic Survey, my bas.ac.uk address no longer works. I may now be contacted at: a.j.smith@verri.org.uk

USA - University of California, Los Angeles, report by Jacob Bortnik.

In 2007, Jacob worked on modeling the global propagation characteristics of ELF/VLF chorus waves, and comparing to observations from CRRES. He has shown that waves initiated at the magnetic equator with small wave normal angles, combined with Landau damping, can explain the observed chorus distributions, but that small amount of power that leaked into large wave normal angles could propagate all the way to the ground. He has also demonstrated that chorus from a range of L-shells and wave normals could propagate into the plasmasphere and merge into an incoherent noise band that was remarkably consistent with plasmaspheric hiss.

Jacob has also worked on the characteristics of Pc1 magnetic pulsations at low-latitudes, their statistical relation to geomagnetic storms, the automatic identification of such waves, and case studies of Pc1 pulsations associated with 'superstorms'. The association of Pc1 pulsations to Earthquake occurrence has also been examined, showing a possible correlation.

USA - Stanford University, California, report by Don Carpenter.

Recent and current projects: A paper on Proton Cyclotron Echo phenomena observed in records of the RPI instrument on IMAGE has been published in JGR in 2007. One of the most important PC effects is seen near 10 kHz in the whistler-mode frequency range.

At the leading edge of each successive rf pulse, spatial bunching of accelerated protons is believed to occur during the formation of an electron sheath around the RPI positive-voltage antenna element. The gyrating protons then produce a series of electrostatic pulses at multiples of the proton cyclotron period. These proton echoes occur following each of a series of sounder pulses at frequencies near 10 kHz, but because of the transient nature of their excitation, do not replicate the rf of the originating sounder pulses. However, they do appear to depend upon the transmitter pulse frequency in the sense that excitation is favored for operations near the proton plasma frequency, which is near 10 kHz in the plasmasphere regions of observation below ~5000 km.

Also of great interest is a new resonance observed during RPI soundings above ~7,000 km altitude. The resonance appears ~15% above the local electron gyrofrequency, in the same frequency range within which another class of discrete proton cyclotron echoes is seen. These latter echoes are a high altitude version of PC echoes reported from the ISIS series satellites. Such echoes, unlike those observed near 10 kHz, do replicate the transmitter pulse frequency, but show evidence of increasing delay beyond the local cyclotron period as the electron gyrofrequency is approached from above.

One of our student projects involves recovery and digital archiving of magnetic tape recorded data from Siple station and from VLF experiments on the DE and ISEE satellites. New insights have been obtained into the phenomenon of saturation of signals transmitted from the Siple experimental transmitter and amplified in the magnetosphere. Simulation of the saturation process is being investigated as a PhD project.

Another student project involves review of VLF emission activity at Palmer Station, Antarctica (L~2.3) and determination of the geomagnetic and other conditions under which there appear at Palmer certain classes of emission events that are most common at locations near and above L=4.

Students working with Umran Inan continue to develop and conduct projects in connection with the HAARP ionospheric heater in Alaska. They are concerned with the generation of ELF and VLF signals in the ionosphere and signal reception at ground locations near HAARP and in the conjugate region (ocean buoys), as well as on satellites such as Cluster and Demeter. Other projects include further study of ionospheric and subionospheric perturbations associated with lightning. Ongoing work in Antarctica includes upgrading of automatic observatories and preparations for new work with a VLF beacon located at South Pole Station.

Merry Christmas and Happy New Year!

Dr. János Lichtenberger (Eötvös University, Hungary) at Shag Point, north of Dunedin, during János's visit to New Zealand (early-November 2007). János came to the Otago Space Physics group to upgrade the Automatic Whistler Detector and Analysis experiment.

Dr. Craig Rodger (Otago University, New Zealand) at Luosto in the north of Finland, during a CHAMOS workshop (late November 2007)