IAGA/ URSI Joint Working Group on

VLF/ELF Remote Sensing of Ionospheres and Magnetospheres Newsletter

Editor: Craig J. Rodger No. 20, December 2005

Dear Colleagues,

2005 was a particularly busy years for VERSIM members, with both the IAGA Scientific Assembly and the URSI General Assembly taking place. There were VERSIM Business Meetings at both of these conferences, along with a great deal of relevant Science presented! Thankyou for all of those who attended the VERSIM Business Meetings in Toulouse and New Delhi, particularly for those few strong souls who were at both! Reports on the business meetings at both conferences can be found on the VERSIM website (*www.physics.otago.ac.nz/versim*). The community might be interested to know that planning has already started for the future IAGA/URSI meetings: IUGG (which includes) IAGA in 2007 in Perugia (Italy), URSI in 2008 in Chicago (USA) and IAGA in Sopron (Hungary).

At the URSI Meeting in New Delhi Michel Parrot (*Laboratoire de Physique et Chimie de L'Environnement*, France), the URSI co-chairman, indicated that he would stand down from his role. I would like to point out to the community that Michel acted as the URSI co-chair of VERSIM from 1996-2005, serving our community throughout this time period. One behalf of the entire VERSIM community, I would like to express our sincere thanks to Michel for his long-term efforts, much of which has been behind the scenes. While Michel has stepped down from the VERSIM co-chair position, I am sure he will remain an active member of our research community! Thankyou Michel! At the same meeting Janos Lichtenberger (*Eötvös University*, Hungary) was nominated and elected unopposed at the meeting. Congratulations to Janos, we are grateful to him for taking on this role!

Normally one might expect 2006 to be a quieter year for VERSIM, what with neither IAGA or URSI scheduled to have major meetings. However, late next year we have the 2nd VERSIM Workshop, following up on the first workshop in 2004. The 2nd VERSIM Workshop will again take place in September at the Sodankylä Geophysical Observatory, Lapland, Finland. The first workshop was a big success, and attracted a large part of the VERSIM community. A report on this meeting can be found on the VERSIM website (*www.physics.otago.ac.nz/versim*). At the end of the 2004 Workshop it was felt that the meeting had been a large success, providing a fresh venue for the VERSIM community to gather and exchange information. After discussions amongst the participants, it was decided to run the second workshop in 2006. I am hopeful that the VERSIM Workshops will become a standard feature of our scientific community. So, travel funding willing, please plan to attend the 2nd Workshop and support this gathering of our community! More information on the 2nd Workshop is already available from the Workshop webpage at:

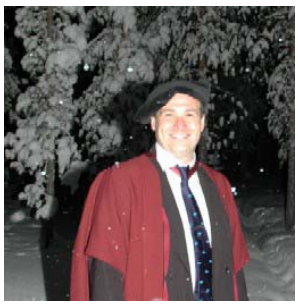
http://www.sgo.fi/Events/versim-2006/versim-2006.php

The 2nd Workshop will be supported by IAGA and, we hope, URSI. IAGA support includes a prize for the best presentation by a young scientist at our Workshop. This award will provide support to participate in the next IAGA Assembly: a low-cost air ticket, waiving of the registration fee, and hotel and subsistence costs for one day. So think if some young scientist in your group should be coming to Sodankylä!

Again in 2005 there has been a significant problem with spam-email being sent to the mailing list. I need to again apologise for the IT problems which have delayed the VERSIM email list becoming moderated (which continue). The only high-point is that I discovered that mid-way through the year the spam-filtering on the VERSIM emailing list had been disabled. When I switched it back on the quantity of junk being sent on to you should have strongly decreased. I hope!

I hope the New Year finds you prosperous, productive, and well. Looking forward to seeing you in Lapland in 2006! Best wishes to you all.

Craig J. Rodger
IAGA co-chair VERSIM working group



Forthcoming meetings

- ***2nd VERSIM Workshop*, Sodankylä, Finland, 18-22 September 2006.**
- *36th COSPAR Scientific Assembly*; Beijing, China, 16-26 July 2006.
- *2006 Western Pacific Geophysics Meeting*. Beijing China, 24-27 July 2006.
- *AGU Fall Meeting*, San Francisco, USA, 11-15 December 2006.

Reports from VERSIM research groups 2005

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)and Center for Space Radiations (CSR) report by F. Darrouzet:

Within the RABEM/SEVEM (Radiation Belts Models/Statistical ELF and VLF Environment Models) project at CSR (Center for Space Radiations, Belgium) the data from the wave experiment IMSC (Instrument Magnétomètre Search Coil) and ICE (Instrument Champ Electrique) onboard of DEMETER as well as from the particle experiment IDP (Instrument Détecteur de Particules) are analyzed. The modeling of the electromagnetic environment in the magnetosphere for VLF and ELF waves started with the creation of a database for the distribution of wave intensities. That means: Power Spectral Densities of E and/or B as a function of time, space, geomagnetic indices, solar wind parameters, ... The wave spectra base is now the major input for the drawing of global maps of the wave intensities distributions in the magnetosphere and for the development of a statistical ELF and VLF environment model at LEO (Low Earth Orbit). The determination of the propagation direction and polarization of the wave is important while analyzing particle-wave interactions. In this context, in a second phase of this project, the waveforms will be analyzed and correlations between particle flux and wave characteristics will be studied. (http://csrsrv1.fynu.ucl.ac.be/csr_web/demeter/)

Concerning CLUSTER data analysis, the electric field spectrograms (2-80 kHz) measured by the resonance sounder and wave analyzer WHISPER are analyzed at IASB-BIRA (Belgian Institute for Space Aeronomy, Belgium) in order to determine the electron plasma frequency, and then the electron density during plasmasphere crossings. A multipoint tool (the spatial gradient of a scalar quantity, applied to electron density and magnetic field strength) is used to assess the relation between the electron density distribution and the magnetic field inside the plasmasphere. (http://www.magnet.oma.be/cluster/)

Czech Republic Institute of Atmospheric Physics report by J. Chum:

We have investigated the ray trajectories of nonductedly propagating lower-band chorus waves with respect to their initial angle θ_0, between the wave vector and ambient magnetic field. We have paid special attention to the intervals of initial angles θ_0, for which the waves propagate along the field lines in the source region. That means we have mainly focused on waves generated with θ_0 within an interval close to 0^o (Chum et al., 2005a) and on waves generated within an interval close to Gendrin angle.

The ray tracing analysis shows that the trajectories of obliquely propagating chorus waves may exhibit a divergent behaviour accompanied by the divergence/bifurcation of the evolution of wave normal angle θ along these trajectories. The initial angles θ_0 at the equator for which the divergence occurs depends on the initial f/f_c ratio, plasma density distribution and magnetic field. For an initial angle θ_B, which we call the bifurcation angle, the wave reach topside ionosphere having $\theta=0$. These waves should have due to the divergence rather character of structured hiss, than of discrete elements, when observed at low altitudes.

The value of bifurcation angle is usually not too far from the value of Gendrin angle, provided that the wave vector is directed towards the lower L-shells. The waves generated very close to the bifurcation angle may arrive to the ground especially at higher latitudes where the field lines have a nearly vertical direction. The waves generated with different initial angles are reflected. A small variation of initial wave normal angle thus very dramatically changes the behaviour of the resulting ray (Chum and Santolik, 2005b).

Chum J., Jiříček F., Šmilauer J.: Nonducted propagation of chorus emissions and their observation, Planetary and Space Science, 53, 1-3: 307-315, doi: 10.1016/j.pss.2004.09.057, 2005a,

Chum J., Santolík O.: Propagation of whistler-mode chorus to low altitudes: divergent ray trajectories and ground accessibility, Annales Geophysicae, Sref-ID:1432-0567/ag/2005-23-1, 2005b, (in press)

Charles University report by O. Santolik:

Our main activities were related to analysis of VLF measurements on board spacecraft. We have closely cooperated with the VLF group at the department of upper atmosphere at the Institute of Atmospheric physics. We have also closely cooperated with our colleagues from other institutions in Europe and United States, for example from LPCE Orleans (France) and from the University of Iowa (USA). Our efforts were directed toward analysis of natural VLF emissions of whistler-mode chorus, auroral hiss and equatorial noise. We have also contributed to the development of analysis methods for multi-component wave measurements and antenna theory. These results were published in international refereed journals, for example in Geophysical Research Letters, Annales Geophysicae, Journal of Geophysical Research and Planetary and Space Science.

An example of this research is a paper in Planetary and Space Science where we describe analysis of measurements of whistler-mode chorus by the four spacecraft of the Cluster mission close to their perigee at a radial distance of 4 Earth radii. The data were recorded on the nightside during two disturbed periods. We have estimated the central position of the source region of chorus using simultaneous measurements of the Poynting flux in several points in space. The derived central position of the chorus source region is close to the geomagnetic equator, as it has been shown by previous studies. This global central position of the source region is defined by the equilibrium of the Poynting flux parallel and antiparallel to the field line. The central position is found to randomly move back and forth with an amplitude of a few thousands of kilometers on time scales of minutes. The typical order of magnitude of the speed of this motion is 100 km/s.

Santolik, O., D. A. Gurnett, J. S. Pickett, M. Parrot, and N. Cornilleau-Wehrlin, Central position of the source region of storm-time chorus, Planetary and Space Sci. 53, 299-305, 2005.

Fiji University of the South Pacific report by S. Kumar:

Research activities in the area of ELF/VLF started recently in 2003 through participating in Prof. Richard Dowden's lightning detection network known as *World Wide Lightning Location Network (WWLLN)*. The system was extended to record lightning generated sferics and whistlers in the year 2004. The data were recorded for 2 min. duration at every hour.

The tweeks are analysed to estimate the nighttime reflection heights and the electron density at the reflection heights. The results were presented in COSPAR 04 and URSI 2005. The lighting data obtained with *WWLLN* and LIS onboard TRMM satellite were analysed for the lighting occurrence over Fiji (Viti Levu) during 2003, which have been published (*V. Ramachandran, S. Kumar and A. Kishore, Atmos. Sci. Letts. ,**6**, 128-132, 2005)*.

A wide variety of plasma waves are generated in the magnetosphere under different plasma conditions, particularly in the auroral region. The existence of parallel electric fields and field-aligned electron beams (currents) is well established in the auroral magnetosphere. The theoretical study on the effects of energetic electron beams flowing upwards/downwards on whistler mode waves observed by ground and satellite based facilities has been undertaken.

A narrow band receiver "OmniPAL" has been installed in October 2005. The recording of amplitude and phase of the signals from six VLF transmitters is being carried out simultaneously. A collaborative study on this with the research group at University of Otago, NZ, will be carried out in future. We thank Prof. Richard Dowden, Dr. N. R. Thomson and Dr. C. J. Rodger for their 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 M. Parrot:

If there is no major problem with the satellite and the experiments (up to now everything is nominal) DEMETER will record data until the end of 2006. Discussions will occur in May 2006 to know if we continue one year more.

An international workshop open to all scientists and related to the scientific objectives of DEMETER (seismic activity, anthropic activity, EM environment of the Earth at mid and low latitudes) will be held in Toulouse on June 14-16 2006. Please consult the symposium website at *http://www.cnes.fr/colloques*.

Meanwhile LPCE prepare a new micro-satellite project named TARANIS (expected launch in 2009) to study the phenomena which occur between the top of the clouds and the lower ionosphere during thunderstorm activity.

Greece University of Crete report by C. Haldoupis:

During 2005, we have continued our participation in the "Coupling of Atmospheric Layers" (CAL) Research Training Network (RTN), that is a 4-year project supported by the European Union. In this frame, we have continued our research efforts and studies on subionospheric VLF perturbations observed in association with Transient Luminous Events (TLEs) in the upper atmosphere. The research activities and scientific progress are summarized as follows:

Agnes Mika, a CAL PhD student at the University of Crete finished successfully her 2nd year of research training and completed her class requirements. We organized and hosted the CAL midterm review and science meeting which took place in Elounda, Crete from June 20 to 24, 2005 and was attended by 50 participants (http://cal-crete.physics.uoc.gr/). The Crete multi-channel, narrow-band VLF station, which was set up during the summer of 2003 in collaboration with the Stanford University, has been kept since on continuous operation, while in June 2005 it was upgraded to run also in broadband mode for the purpose of supporting the EuroSprite 2005 experimental campaign. In addition and in collaboration with the Universtity of Eötvos in Budapest, Hungary, a second VLF receiver of different origin (made at the University of Otago, New Zealand) was also installed in Crete next to the Stanford receiver, for the purpose of comparing their responses during sub-ionospheric perturbations and for evaluating their observational performances. Also, we have actively participated and supported the EuroSprite 2005 campaign, which lasted for about 3 months, from July 15 to October 15, 2005. This campaign, which deployed a broad range of ground based instruments in Europe and beyond for studying TLEs and related phenomena, involved most of the CAL members and was run remotely via Internet by the CAL young scientists. Finally, Dr. Rene Steiner from Austria has joined our UoC CAL group as postdoctorate fellow on September 1, 2005, and started research work on the broadband VLF signatures and characteristics in relation with sprites.

Our research has focused on the analysis and interpretation of narrow- and broad-band VLF recordings in relation with sprite occurrences detected during EuroSprite-2003, and with elves observed either from the ground or from space by imagers of TLEs and atmospheric lightning. In November 2004, Mika et al. submitted a research paper to the Journal of Atmospheric-Solar Terrestrial Physics (JASTP), which was just published in the November 2005 Issue of JASTP. In this study, VLF observations during *EuroSprite-2003* were analyzed in connection with many sprites observed above thunderstorms in central France. The receiver in Crete observed early VLF perturbations in nearly one-to-one association with the sprites, which endorses the findings of an earlier CAL work by Haldoupis et al., published in the Journal of Geophysical Research, 2004, that was based on a limited number of observations from a single storm. While part of the sprite-related VLF perturbations were of the early/fast type, several classified as "early/slow" having onset durations up to ~2 s and thus suggesting a new mechanism at work which may cause a slow build up of ionization after a sprite. The only elve in the data set was found to associate also with an early/fast VLF perturbation. Bandpass filtering of broadband VLF signals near the storm revealed that only about 5% of the sprites were escorted by early VLF perturbations, possibly due to backscatter. Also, by using all 130 sprites captured during *EuroSprite-2003,* the time lags of the sprites to the preceding +CG discharges were analyzed. The time-lag distribution had a well defined tail suggesting that at least one third of the sprites observed were lagging the +CG discharges by more than 30 ms up to 300 ms. In addition these "long-delayed" sprites were not accompanied by any strong radio-sferics during the sprite observation period, in sharp contrast to the short-delayed sprites which were escorted nearly always by enhanced sferic activity. These observations endorse the notion of long delayed sprites reported in past studies, but also show that their occurrence is much more frequent than it was thought before.

Hungary Space Research Group of Department of Geophysics, Eötvös University, Budapest report by J. Lichtenberger:

The two automatic whistler detectors in Hunary (Tihany and Nagycenk) continue the non-stop operation. The Tihany's one has been enhanced with a very high accuracy sampling unit capable to sample the data with ~100 ns accuracy, and opens a new class for simultaneous measurements. A copy of the detector system was setup in Dunedin as a joint experiment with University of Otago this May and operates well since then

collecting unexpectedly high number of whistlers, largely high L-value multipath groups. A whistler detector was operating between June and November 2005 in Grahamstown (South Africa) close to the magnetic conjugate of Tihany in cooperation with University Of KwaZulu-Natal (Durban). Another one will be installed at South African base Sanae during 2005-2006 Antarctic Summer. A couple of study on lightning- whistler relationship have been done based on the whistler data collected by the automatic detector system.

We started the analysis of DEMETER data as guest investigators concentrating on strange shape VLF signals because that might have relation to seismic event. Until now we found four wave propagation new phenomena, two of them can be explained by our theoretical UWB wave propagation models that includes a new, exact inhomogeneous propagation model for transmission line for monochromatic waves. We have not find seismic-related events until now.

The SAS2-KOMPAS VLF wave experiment is waiting for the launch on KOMPASS-2 satellite. The launch is expected in the very near future. THA SAS-3 experiment as a part of OBSTANOVKA (Environment) experiment on board the International Space Station is about to be carried to ISS on the 1st half of 2006.

India R.B.S.College report by B. Singh:

1.. Monitoring of amplitude and phase of fixed frequency VLF transmitter signals

i) Using AbsPAL receiver, phase and amplitude monitoring of 19.8 kHz NWC signal propagating between Australia and Agra has been carried out since September, 2002. The great circle path (GCP) of this signal passes just over Sumatra region of Indonesia and this has given an unique opportunity to study the effect of two major earthquakes on the lower ionosphere, one occurring on 26 December, 2004 (M=9.1, tsunami) and the other on 28 March, 2005 (M= 8.5) nearly at the same place in the region. We find that the termination times corresponding to both the sunrise and sunset hours show significant deviations from their normal values under the influence of both the earthquakes. The statistical significance of these results have also been tested and found satisfactory. These results are not influenced by other geophysical events like solar flares, magnetic storms, precipitation of energetic particles etc.

ii) A collaborative research program with Space Research Group of Eotvos University, Budapest (Hungary) to monitor the phase and amplitude of 24 kHz NAA signals transmitted from Cutler, Maine at both of our stations (Agra in India and Budapest in Hungary) has been going on for the last two years. We have examined the day/night, seismic, and solar flare effects on propagation paths of the signals recorded at the two stations. The data for a period of three months from July to September, 2002 have been examined on a test basis and anomalous enhancements and reductions in the amplitude variation are studied. We find that the occasional amplitude reductions are caused by earthquakes (M>5) which occurred near the GCP, and occasional enhancements are caused by solar flares. The amplitude falls by 3 dB after midnight at Budapest and increases by 5 dB during sunrise hours at Agra. The magnetic storms do not seem to influence the data except in the case when associated with large solar flares.

2. Study of ULF magnetic field emissions

A 3-component search coil magnetometer (f=0.01 – 30 Hz) has been employed by us at our Agra station since February, 2002 to monitor micropulsations, Schumann resonances, and seismic effect. Recently, we have found from the analysis of September - October, 2005 data that the Z- component of the magnetic field amplitude is enhanced considerably almost 10 days before the occurrence of main shock of Muzaffarabad (Pakistan) earthquake (M= 7.4) between 27 and 29 September, 2005. Another enhancement occurred on 3rd October, 5 days before the main shock. There was no solar flare or magnetic storms during these days and hence the anomalies are attributed to the above mentioned earthquake.

Comparing the amplitude anomalies observed during Muzaffarabad earthquake with those observed during Indonesian (tsunami) earthquake we find that the former anomaly occurred in the Z-component whereas the later occurred in Y- component. It may be noted that the Z-component of the magnetometer points vertically whereas the Y-components is directed East- West. This shows that we may assess the direction of arrival of emissions also, a result verified from the bulk of data obtained earlier.

The simultaneous operation of ULF and VLF equipments as mentioned above has shown simultaneous ULF/VLF amplitude perturbations corresponding to moderate magnitude earthquakes (6<M>5) that occurred along the Agra- NWC great circle path.

3. Ionospheric perturbations during some major Indian earthquakes

The variation in nighttime ionospheric E and F layer critical frequencies (foes and foF2) has been examined for the months of August, 1988, September, 1993, and May, 1997 in which major earthquakes (6<M>6.6) occurred in Indian seismic zones of Bihar-Nepal border, Latur in West India, and Jabalpur in central India. The results show that foF2 are reduced prior to the occurrence of the earthquakes. In pre-midnight sector the reduction is between 24% and 30%, 0 to 4 days before the main shock and in the post-midnight sector it is between 18% and 26%, 1 to 15 days before the main shock. The foes shows enhancements between 100 % and 155% during the same period. These results are interpreted in terms of electromagnetic coupling between the lithosphere and ionosphere during earthquake preparation processes.

4. Observations with the newly developed whistler recorder and analyzer.

The ground based observations of low latitude whistlers, VLF emissions, and spherics have been started from 1st October, 2005 and will be continued till 30th April, 2006. During this period we expect large number of whistlers and emissions due to lightning activity in the opposite hemisphere. The initial results have shown the observation of large number of high latitude whistlers and emissions which propagated to our station via earth- ionosphere waveguide.

Israel Tel Aviv University report by C. Price:

The group of Colin Price at Tel Aviv University (Dept. of Geophysics and Planetary Sciences) carries out research in the ULF, ELF and VLF range. In the ULF range we have continuous measurements at 6 Hz sampling frequency from summer of 2003 (3 magnetic components). These data are being used to study both ULF pulsations, geomagnetic storms, while also searching for seismic precursors along the Dead Sea rift valley in southern Israel.

Our VLF measurements are performed primarily in campaign mode in support of sprite campaigns in Europe, USA, Brazil and Japan. We sample the broadband data at 100 kHz during

nighttime hours only. We have also started synoptic measurements of the broadband VLF data (1 minute every 15) for comparisons with our colleagues at Stanford University. In addition, we host one of the VLF antenna in the WWLN array to detect real time lightning around the globe. We are starting to use the archived WWLN as input for theoretical models of VLF/ELF propagation in the atmosphere.

Our ELF station is our longest running (~8 years) station and is used for studying Schumann resonances and ELF transients in the atmosphere. These data are presently being used to study lightning discharges related to sprites, the statistics of ELF transients, as well as studying the influence of the day-night asymmetry on the Schumann resonance parameters.

Japan Kanazawa University by I. Nagano:

A small workshop "2nd Kanazawa Workshop on Waves in Plasmas and Electromagnetic Applications" will be held on March 23-24, 2006, at Kanazawa University, Kanazawa, Japan. It will deal with the theory, observation, and simulation of space plasma waves, and some related topics of electromagnetic applications such as EMC/EMI, antennas, and hyperthermia. For further information, please visit our web site (*http://reg.is.t.kanazawa-u.ac.jp/Kanazawa-WS/)*.

In order to estimate the dynamic motion of ionospheric exit points of natural ELF/VLF waves, such as polar chorus and auroral hiss, we have plan ground-based multipoint observations at three bases by using loop antenna systems in Antarctica for a year from February 2006. These systems consist of two crossed vertical loop antenna and multi channel analyzer where measures continuously at 6 seconds resolution the mean power and polarization in 4 spaced frequency bands (500, 1 k, 2 k and 6 kHz). The observation will be conducted with the aid of the imaging riometer observation at Syowa Station, which tells the area of small absorption in the ionosphere, possible candidate of exit points of ELF/VLF waves, and also with the ELF/VLF wave observations onboard Akebono satellite (Ozaki, Nagano (Kanazawa Univ.) and Yamagishi,Sato (NIPR)).

New Zealand University of Otago report by C.J. Rodger and N.R. Thomson :

AbsPAL VLF phase and amplitude observations have been used to extend the solar flare response of D-region electron densities up to the level of the great X45 flare of 4 November 2003. The VLF signals used at Dunedin were NLK (Seattle, 24.8 kHz), NPM (Hawaii, 21.4 kHz), NDK (25.2 kHz, North Dakota), and 'Omega Australia' (13.0 kHz, Sale). Also used were NPM signals recorded at Ny Alesund, Spitzbergen. The size of the Great Flare was determined by extrapolating the GOES X-rays fluxes (which saturated at X17.4) using the VLF phase changes (which did not saturate!) using the VLF phase changes which tracked the GOES fluxes very well. In addition (and independent of VLF measurements) the XL/XS ratio (i.e., the flux ratio of the long, 0.1-0.8 nm, and the short, 0.05-0.4 nm, X-ray bands) during big flares also gives X45 for the Great Flare. AbsPAL VLF phase and amplitude recordings are continuing in Dunedin and (on Study Leave) in Cambridge.

In the last year we have undertaken significant studies in collaboration with the British Antarctic Survey, focused on particle precipitation into the ionosphere. This includes increasing our understanding of whistler induced particle precipitation (WEP), both in terms of the ionospheric effects and the significance as a loss process in the inner radiation belt and slot region. Together with our collaborators, we are building a network of subionospheric VLF monitors to study energy inputs into the lower ionosphere. These monitors form the Antarctic-Arctic Radiation-belt Dynamic Deposition VLF Atmospheric Research Konsortia (AARDDVARK). Recently we have used the data from our AARDDVARK monitors to examine effects of Solar Proton Events (SPE) on the high-latitude ionosphere, and the importance of Relativistic Electron Precipitation to the radiation belts. Working with the University of Oulu and Finnish Meteorological institute, we have examined the importance of SPE to atmospheric chemistry, particularly the production of ozone destroying chemicals.

The groups studies have also focused on the growing World Wide Lightning Location Network (WWLLN), which now has ~22 receiving locations spread across the world. This VLF based lightning detection and location network sends lightning observations back across the internet to central processing computers in Seattle, USA (University of Washington) and Dunedin, NZ (LF*EM Research). The WWLLN is unlike any other global scientific lightning detection system in that it operates in real-time, with only a few seconds delay before a lightning location is registered. Working with the PIs of the network Professors Dowden (LF*EM Research) and Holzworth (University of Washington), we have a growing understanding of the capabilities of the WWLLN. Both cloud to ground and cloud lightning are detected, although the WWLLN is strongly biased to high peak current discharges. The University of Otago group is now focused on working on the detection efficiency of the WWLLN, with the intention of developing methods to describe the peak currents of detected lightning. Historic data access is available to the hosts, and other institutions should discuss data access with the Prof. Bob Holzworth of the University of Seattle. Real-time lightning maps are available on the web (*http://webflash.ess.washington.edu/*) in multiple formats, including lightning locations over-plotted onto satellite observed weather images.

Finally, this year we hosted Janos Lichtenberger of Eötvös University (Hungary), who installed one of his automatic whistler detection systems. This has operated almost continuously since May 2005. A 4th year Honours student analysed the data from the first ~4 months of operation, which included 25,974 whistler groupings (where a single trace or a multi-trace whistler is described as a group), leading to an average whistler rate of 0.5 min^{-1}. Further observations are continuing.

An up to date listing of our publications is available from the Groups website:

www.physics.otago.ac.nz/research/space/spacehome.html

UK British Antarctic Survey report M.A. Clilverd

Dr Andy J. Smith retired from BAS at the end of October 2005, after 35 years of Antarctic service. Much of the instrumentation that Andy developed will continue to operate for the foreseeable future. Andy will remain contactable by email, but the first point of contact for VERSIM matters at BAS is now Dr Mark A. Clilverd (macl@bas.ac.uk).

1. 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.

2. 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. More than a whole solar cycle of data (1992-2003) is now available. A latitudinal chain of VELOX receivers (VELOXnet), aimed at substorm research using SCEs (substorm chorus events), was officially closed down in April 2005. The VELOX at Halley will continue indefinitely.

AGOs (Automatic Geophysical Observatories) programme: the VELOX receiver on A84 (L=8.1) continued to operate through 2005. A84 will be decommissioned in December 2005.

1-s resolution data are available on the Web using the BAS Data Access & Browsing System (DABS) http://dabs.nerc-bas.ac.uk/

Daily summary plots 1992--2003 are on the Web at http://www.nerc-bas.ac.uk/uasd/data/dataserv.html

3. Narrow-band Recordings:

A narrow-band tunable receiver at Halley has been tuned to 19.4 kHz to receive the transmissions from the South Pole beacon. The South Pole Beacon has been off-air since October 2005, and is expected to remain off until 2007.

The narrow band receiver `OmniPAL' is operating at Sodankyla, Finland (Oct 2002 – June 2003, Oct 2004 - present), and Ny Alesund, Spitzbergen (since June 2003). Northern hemisphere transmitters in Europe and USA are being received at 0.1-1.25 sec resolution. The Australian Casey station (Antarctica) began operation as an amplitude-only narrow-band receiver in May 2005. Southern hemisphere transmitters are being received with ~2 sec resolution.

A VLF Doppler receiver has continued to operate at Rothera station, Antarctica (L=2.8), receiving whistler mode and subionospheric signals from NAA (24.0 kHz). In 2005 the same system has also been used to monitor the South Pole Beacon transmissions at 19.4 kHz with 1 second resolution.

Merry Christmas and Happy New Year!

Craig in mid-talk during a presentation on the use of VLF to remote sense ionospheric disturbances.
CAL mid-term review and science meeting , June 20-24, 2005 - Elounda, Crete, Greece