IAGA URSI

IAGA/URSI
Joint Working Group on

VLF/ELF Remote Sensing of the Ionosphere and Magnetosphere

Editor: A J Smith — Newsletter — No. 4 — September 1992

Dear colleagues,

There will be no General Assembly this year of either IAGA or URSI — the two parent bodies of our working group. Thus we will not have the opportunity to hold one of our regular meetings and this newsletter therefore assumes increased importance as a medium for communications between members of the working group. This issue contains information about forthcoming meetings and about current and planned experiments in our field. It is noticeable that VLF receiver networks for studying LEP (lightning-induced electron precipitation) by means of the trimpi effect, continue to be deployed and developed. Descriptions of various such developments are contained in the newsletter. There is also an article by Dr Bob Estes of the Smithsonian Astrophysical Observatory about the Tethered Satellite System and wave generation, which should be of interest to VERSIM people. I would like to thank all those who have sent me contributions for the newsletter. For anyone reading this who is unfamiliar with the aims and role of the VERSIM working group, some background information is provided at the end.

Forthcoming meetings

AGARD, Brussels, September, 1992

AGARD, NATO's Advisory Group for Aerospace Research and Development, is sponsoring a meeting on *ELF/VLF/LF Radio Propagation and System Aspects.* It will be held in Brussels, 28 September – 2 October 1992. The sessions on VLF/ELF propagation, and on ELF/VLF radio noise, are most relevant to VERSIM.

IAGA, Buenos Aires, August 1993

The 7th Scientific Assembly of IAGA will be held 8–20 August 1993 in Buenos Aires. For more information contact the local organisation: Asociación Argentina de Geofisicos y Geodestas, CC 106 Suc 28, (1428) Buenos Aires, Argentina; Phone: 54 1 781 1253; Fax: 54 1 791 2658; Telex: 18052/CICYT AR. A list of the scientific sessions to be held can be found in *IAGA News* No. 30 (December 1991). A meeting of the VERSIM working group is scheduled for the evening of 14 August 1993; further details will be circulated later.

Radio Propagation, Beijing, August 1993

An International Symposium on Radio Propagation (ISRP'93) is to be held in Beijing, 18–21 August 1993. The programme includes a session on ELF/VLF/LF propagation. More information from Professor Sha Zong, China Research Institute of Radiowave Propagation, PO Box 138/93, Xinxiang, Henan 453003, China.

URSI, Kyoto, August 1993

The XXIVth General Assembly of URSI will be held in Kyoto, Japan, 25 August – 2 September 1993. Session H6 is a VERSIM sponsored session on *Whistlers and Particle Precipitation*. The conveners are **U S Inan** and **H J Strangeways**, and the deadline for abstracts is 15 January 1993. For more information about the Assembly, contact Professor I Kimura, Secretariat, URSI-GA Kyoto, *c/o* Center for Academic Societies, Osaka, 14th floor, Senri Life Science Center Bldg., 1-4-2 Shinsenri Higashi-machi, Toyonaka, Osaka 565, Japan; Phone: +81-6-873-2301; Fax: +81-6-873-2300.

EM phenomena and Earthquake Prediction, Tokyo, September 1993

There will be an international workshop on Electromagnetic Phenomena related to Earthquake prediction, held after the URSI General Assembly. That part of the meeting dealing with the possible ELF/VLF precursor signatures of seismic events may be of interest to some members of the VERSIM community. For more details, contact Professor M Hayakawa, University of Electro-Communications, 1-5-1 Chofugaoka, Chofu, Tokyo 182, Japan.

IUGG Boulder, 1995

IAGA will be meeting during the 21st General Assembly of IUGG to be held in Boulder, Colorado. A VERSIM session on *Whistler Mode Waves and Particle Precipitation* has been proposed for the meeting.

Meeting Reports

If you have been to an interesting meeting relevant to VERSIM, why not share it with your colleagues by writing a brief report for the VERSIM Newsletter?

VLF Doppler meeting, Sheffield, November 1991

A meeting was held on 7–8 November 1991 in Sheffield, England, to mark five years of operation of the VLF Doppler experiment at Faraday, Antarctica. Although most of the 20 or so scientists who attended were from the UK, there were also participants from USA and New Zealand. It was a successful meeting which reviewed the achievements of the experiment (in which one-hop group time delays and Doppler shifts of fixed-frequency whistler-mode signals from VLF transmitters are measured), including the new insights which the technique has provided into plasma phenomena in the inner magnetosphere. Examples are the annual variation in plasmaspheric densities (up to 3 times greater in December than in June), the response of the plasmasphere to magnetic storms, and the effect of horizontal density gradients on whistler mode waves traversing the ionosphere. The meeting also discussed current scientific problems which could be addressed with the technique, as well as potential enhancements made possible by new technology.

The Tethered Satellite System and Wave Generation Experiments

by **Bob Estes** (EMET PI) *Smithsonian Astrophysical Observatory*, 60 Garden St., MS 80, Cambridge, MA 02138. Phone: 617-495-7261; Fax: 617-496-7670; cfa::estes, estes@cfa.harvard.edus

On July 31, 1992 the Space Shuttle Atlantis carried into orbit the first Tethered Satellite System (TSS-1), a joint project of NASA and the Italian Space Agency. The orbit was circular with an inclination of 28.5° and an altitude of 300 km. On the fifth day of the mission the Shuttle crew began to deploy the satellite, which was connected to the Shuttle by a long, electrically conducting cable (the tether) consisting of an insulating kevlar jacket over a copper core. The satellite was to have been reeled out vertically upward to a maximum distance of 20 km for a series of active electromagnetic experiments utilizing the electric field experienced by the system as it moved through the terrestrial magnetic field. Unfortunately, a mechanical problem caused the tether to jam, and a maximum length of 256 m was reached before the satellite had to be reeled back in.

It now appears that the malfunction was not due to any fundamental flaw in the tether reel's design or engineering. A bolt that had been added for structural reasons after the tether's final installation and testing at Kennedy Space Center evidently interfered with the reel mechanism. After the great disappointment of the aborted mission, TSS scientists are now hoping to get an early re-flight of the tethered system. In the most optimistic scenario this might take place as early as next spring.

The TSS re-flight, whenever it takes place, should be of more than passing interest to readers of this newsletter. TSS may generate electromagnetic signals in the ULF-ELF-VLF bands that could be detected by sensors on the Earth's surface. In order to motivate the participation of VERSIM working group members in making measurements during TSS I will provide a brief outline of the experiments with emphasis on wave excitation.

TSS was conceived as a unique, re-usable platform for carrying out active space plasma experiments. The TSS scientists have designed experiments to obtain data on the behaviour of plasma around highly charged conductors (high-voltage sheaths, etc.) and on the mechanisms by which large conductors excite currents and waves by their motion through a magnetoplasma. Our aim is also to characterize and understand the system and its complex interaction with the ionosphere with an eye to developing future experiments and tether applications.

The conducting tether has electrical contact with conducting surfaces exposed to the ionosphere on the satellite and with the cathode of an electron gun (optionally conducting surfaces on the Shuttle) at the lower end. By virtue of the 4–5 kV emf induced between the ends of the system by the orbital motion through the Earth's magnetic field, a current can be made to flow through the tether. At the upper end of the system, the motion-induced potential attracts electrons from the ionosphere to the conducting surface of the satellite, while the electron gun at the Shuttle end expels electrons, and while conducting surfaces of the Shuttle collect positive ions.

There are two basic modes in which the tethered system, as presently configured, operates. In one, the lower end of the tether is connected to the cathode of an electron gun (one of the two "core equipment" guns), whose anode is connected to the Shuttle frame. Thus the beam voltage of these electron guns is supplied by the motion-induced emf of the system. Each gun has its own power supply for filament heating and current control. These novel electron guns were developed by the Italian Space Agency for use with TSS-1.

Only one gun operates at a time. We can set the current to a given level by controlling the filament temperature, assuming that sufficient voltage is available for the gun to operate in the flat region of its IV curve for the selected current value. The gun is expected to reach a maximum current of 750 mA.

This is well below the resistive limit set by the tether. The tether voltages range from 3 kV to 5 kV, and the tether resistance is 2 kΩ. For much of the time, low electron densities at the satellite and experimental design will keep the current below 100 mA.

In the other mode of operating the system, the core electron guns are switched out of the circuit. One of three selectable resistors connects the tether with the Shuttle surface. One or two electron guns (fast pulse electron guns or FPEGs), distinct from the core guns and having their own power supplies for beam acceleration, can be operated to keep the Shuttle potential from going negative. Currents are below 120 mA in this mode.

Tether current modulation capabilities are limited. The core gun can pulse (on/off) at a maximum frequency of 1 Hz. The FPEGs pulse in the VLF range. However, because they are not directly in the tether circuit, the FPEGs will not control the tether current. It is possible to open and close the circuit in the resistor mode at up to 10 Hz. Since there is 2 km of tether left on the reel at 'full' deployment, the consequent inductance causes a resonance at 6 kHz, which we expect to show up in the current during switching.

Current modulation is not the only potential source of wave generation, however. The very operation of the electrodynamic tether depends upon its exciting ionospheric waves with an electrostatic component. The tethered system presents the plasma with a time-varying source of net charge at each end as it passes through the ionosphere. Locally, the ionosphere sees a pulse as the system passes by. It responds as a transmission line to complete the circuit.

Io generates Alfvén wave packets (Alfvén wings) in Jupiter's ionosphere by this mechanism, and TSS may do the same. Some theorists feel that whistler waves are likely to be the dominant mode excited. In either of these cases, we expect the energy of the waves to be guided along the magnetic field lines. The power into waves is likely to be low, but the concentration along field lines should increase the likelihood of detection for optimally positioned instruments on the ground.

Calculations with simple models indicate that only the longest wavelength components of the Alfven wave packets excited will leak through to the Earth's surface at appreciable amplitudes. A wave mode with frequencies above the lower hybrid frequency may also be excited, but calculations are lacking on propagation of this wave. We will also attempt to excite a resonance of the ionospheric waveguide for isotropic Alfven waves by pulsing the core electron gun at 1 Hz.

Various instruments on the satellite; on a 2.5 m extendible, retractable boom on the satellite; and in the Shuttle payload bay will record tether and plasma diagnostic data. These include tether current monitors, voltmeters, accelerometer, magnetometers, Langmuir probes, and charged particle detectors. Since the source of tether-excited waves will be well documented, the experiment provides an unusual opportunity to correlate ground measurements with a known ionospheric source.

Our NASA-sponsored investigation (EMET) will maintain two dedicated ground stations at remote sites (islands off Puerto Rico and Australia) near the ground track of the "hot spot" obtained by tracking magnetic field lines from the tethered system down to the atmosphere. We will operate two sets of sensitive triaxial magnetometers at each site to cover a frequency range of 0.1 Hz to 30 kHz. A similar station limited to ULF will be operated by an Italian team (OESEE) under Professor **Giorgio Tacconi** of Genoa University using SQUID magnetometers in the Canary Islands. The tether current will be at the maximum attainable (less than 750 mA) during overflights of these stations. A concurrent experiment using the 430 MHz incoherent scatter radar at Arecibo Observatory will attempt to observe the perturbation to the ionosphere caused by TSS in its current-exciting operation. Co-operating stations at various points of the globe (the more the better) will also collect data during the mission.

Although the tether lengths attained during the TSS-1 mission were so short as to preclude the achievement of our primary experimental objectives, there were some positive results. First and foremost, the tether proved to be very stable—and at the very short lengths for which there had been the greatest worry about dynamical stability. Secondly, the core electron guns were able to operate very well even at the low voltages (less than 50 V) attained. Almost all of the instruments on the satellite and orbiter functioned flawlessly.

I would like to encourage those who have instruments capable of monitoring ELF/VLF field variations to get on the TSS ground observation mailing list for future co-ordination plans. Also, anyone wanting the NASA brochure on TSS can get one from me. It gives a good overview but contains some inaccuracies on the wave measurement experiments.

"Trimpi" networks

USA

From Dr **U S Inan** *Stanford University*

Narrowband VLF observations (to monitor lightning-induced ionospheric disturbances, or Trimpi effects) are currently ongoing at College Park/Maryland, Houston, Huntsville, and at Stanford. Observations are typically carried out nightly during 0000–1200 UT. Both narrowband and continuous (6-hour) broadband observations are also carried out at Palmer Station, Antarctica. The broadband data are typically acquired during 0400–1000 UT.

South Africa

From Dr **A R W Hughes** *Space Physics Research Institute, University of Natal, Durban.*

In 1993 we will be operating an OMSKI

(Omega and MSK Instrument) receiver at Sanae tuned to NAA, NSS, Omega Liberia and Omega Argentina. During the year we will be recording approximately 420 M-bytes of phase and amplitude data, and using the same recording schedule as that being used at Halley (see below). We are planning to analyse much of the data at Sanae using programs provided for us by **Dr C D D Adams** (University of Otago, New Zealand).

France

From Dr **Y Corcuff** *Signals and Communications Laboratory, University of Poitiers.*

The "WIPP-trimpi" programme, which began at Kerguelen ($L = 3.7$) in March 1991, continued during 1992. Trimpi events were observed in the amplitude of signals received from NWC, and in the amplitude and phase of signals received from the Omega transmitters located at La Reunion, Liberia and Argentina. The data were recorded on to optical disc together with VLF noise levels observed in the frequency bands 1.25–2.5 kHz and 2.5–5.0 kHz. The broad band VLF waveform was also recorded for 1 minute every 20 minutes.

The programme will become fully operational from June 1993 when it is planned to begin similar observations at Poitiers ($L = 1.9$). At Poitiers it is planned to install a 3-channel amplitude and phase receiving system built at Stanford University.

New Zealand

From **R L Dowden**, **C D D Adams** and **J Brundell** *University of Otago, Dunedin*

A 30-element array of VLF receivers for Trimpi reception, covering the full length of New Zealand ($\sim$ 1000 km, approximately north–south) is planned for completion in 1993. Analysis of Trimpis from the present 5-element array shows that lightning-induced electron precipitation (LEP) sometimes shows fine structure in the north–south direction with dimensions as small as 10 km.

Germany

From Prof. **R L Dowden** and Dr **C D D Adams** *University of Otago, Dunedin* but based at *Max-Planck-Institut, Lindau* until October 1992

Europe array. The establishment of a multi-element (20 are planned) VLF receiver array similar to that in New Zealand (see preceding paragraph) is under way. Unlike the New Zealand one, this will be used for several VLF transmitters simultaneously. Most of the elements will be within 100 km of Katlenburg-Lindau in Germany with outliers at Eötvös University, Budapest, and at British Antarctic Survey, Cambridge.

Hungary

Dr **Gy Tarcsai** *Eötvös University, Budapest*

An Otago-pattern OMSK (Omega and MSK) receiver was run in Budapest January–March 1992, and several trimpi events were observed on signals from the NAA transmitter. Budapest is now part of the European array of receivers (see preceding paragraph).

Brazil

Dr **L R Piazza**
Centro de Radio-Astronomica e Aplicações Espaciais, São Paulo

A 6-channel tunable VLF receiver, dedicated to receiving trimpi events at the Brazilian Antarctic station Cmte. Ferraz (60° S; 58° W; $L = 2.2$), will be constructed at Stanford University. After testing in Brazil, at Itapetinga Radio Observatory, São Paulo (23° S; 46° W; $L = 1.2$), observations are planned to begin in Antarctica in 1994.

These observations at Ferraz will be a crucial element of a joint Brazil-UK-USA experiment to establish a north-south chain of trimpi receivers in the Antarctic Peninsula region to operate throughout 1994. The other stations in the chain are Palmer (US; 64°46′ S; 64°04′ W), Faraday (UK; 65°15′ S; 64°15′ W), and Rothera (UK; 67°34′ S; 68°07′ W).

UK

A J Smith, *British Antarctic Survey, Cambridge*

OMSK receivers, designed to study Lightning-induced Electron Precipitation through the study of trimpi events, are currently being operated at Halley and Faraday stations, Antarctica. This is planned to continue through 1994. Each receiver can record simultaneously the amplitude and phase of two Omega signals and two MSK signals. At Halley we currently receive Omega Argentina, Omega Liberia, NAA (Maine) and NSS (Maryland). At Faraday the selections are Omega Argentina, Omega Hawaii, NAA and NPM (Hawaii). The current recording schedule at both stations is SHL mode for 0630–0230 UT and FHL mode for 0230–0630 UT. SHL and FHL refer to the recording format for the MSK data. The 'S' and 'F' indicate slow and fast, meaning a time resolution (averaging time) of 1.25 s and 0.04 s respectively. 'HL' indicates that the high and low frequencies present in the MSK signals (50 Hz above and below the nominal transmitter frequency) are both recorded, permitting the detection of "group trimpis".

For 1994, an additional receiver is planned to be set up at Rothera as part of an international experiment (see description under 'Brazil').

Automatic Geophysical Observatories

Work is proceeding with the plan to place a network of automatic geophysical observatories (AGOs) on the Antarctic ice sheet for studying high latitude phenomena. The SCAR international steering group on AGOs, chaired by **Dr J R Dudeney** (British Antarctic Survey) met in Bariloche, Argentina, in June 1992 to coordinate the various national efforts.

UK

Two AGOs were deployed in Antarctica during the 1991/92 season. The first was located at Halley and the second at site 'A1' (77.5° S, 23.4° W). These each carry a three-axis magnetometer and a riometer. More details were given in *VERSIM Newsletter* No. 3. Some problems have been experienced with the wind generators over the winter, but otherwise the AGO systems appear to have worked well. It is planned to deploy the first AGO VLF/ELF instrument in the 1993/94 or 1994/95 summer season.

USA

From Dr **U S Inan** *Stanford University*

New ELF/VLF Receiver systems for the Automatic Geophysical Observatories are now complete and are being shipped to the Antarctic for deployment in November/December 1992. Four ELF/VLF systems involving narrowband (6-channel) amplitude as well as fully digital broadband (snapshot mode) measurements have been completed after intensive work during the past summer. Three AGO systems are planned to be deployed this year, with the fourth system being deployed next year. The previously chosen sites will facilitate measurements on a meridional chain of stations including South Pole, as well as spaced measurements along the auroral oval.

Ionospheric Heating Experiments

From Dr **U S Inan** *Stanford University*

Stanford VLF observations have now started at Kotzebue and Fort Yukon, Alaska, as part of the HF heating campaign (CAMPAIGN'92) with the HIPAS facility. The two Stanford systems were installed at Kotzebue and Fort Yukon in early September and will continue to acquire data for the next 6 months. Narrowband amplitude and phase measurements are carried out on three signals at each site, typically NPM, NLK and 48.5 kHz transmitters. At present, no broadband observations are made; however, plans are to make such measurements on at least one site in Alaska.

VLF observations at Arecibo, Puerto Rico have been terminated as of March 1992. The equipment at Arecibo is currently at Stanford for refurbishment and installation of a new digital data acquisition system (using 8-mm high density tapes). Current plans are to deploy this system in Gander, Newfoundland to conduct continuous measurements starting in late October 1992. Within the following six months, an active experiment involving the NAA transmitter in Cutler, Maine will be carried out, for the purpose of heating the ionosphere and possibly generating ELF waves.

VELOX

VELOX (VLF/ELF Logger Experiment) is a new facility set up by British Antarctic Survey for systematically studying the characteristics of ELF/VLF radio noise received at a high latitude ground station. Wideband signals from two perpendicular vertical loop aerials are processed in real time to give the power (peak, mean, and minimum), arrival azimuth, and polarisation ellipticity in 10 frequency bands. The system uses DSP (Digital Signal Processing) hardware and firmware developed by High Greave Associates, Sheffield, together with an IBM compatible host computer, and data are recorded on optical disc (800 M-byte capacity/ disc).

The wideband signals are digitised to 12 bits at a 25.6 kHz sampling rate. The dynamic range is 60 dB (or 100 dB with AGC). Two complex 256-point spectra are computed every 10 ms. The record interval (time resolution) is selectable in the range 1 s to 1 min.

The frequency channels have been chosen for comparability with other multichannel ELF/VLF receiver systems, past and present; their centre frequencies and bandwidths are:

f_0 (kHz)	Δf (kHz)	f_0 (kHz)	Δf (kHz)
0.5	0.5	4.25	1.5
1.0	1.0	6.0	2.0
1.5	1.0	9.3	1.0
2.0	1.0	10.2	0.1
3.0	1.0	10–30	0.1

The first eight channels receive predominantly natural noise below 10 kHz. Most is of magnetospheric origin (hiss, chorus etc), though the peak channels are sensitive to atmospherics. The top two narrow-band channels (the second is tunable) are for receiving VLF transmissions above 10 kHz.

The facility was installed at Halley-5, the newly constructed BAS Antarctic research station (76°S, 27°W, $L = 4.2$), in January 1992, and has been producing good quality data since 14 January 1992. Key parameters (1 kHz and 3 kHz mean power channels only, 1 minute integration time) for each day are extracted and transferred via the Halley Local Area Network and InMarSat to BAS HQ in Cambridge, and thence via the SPAN/NSI network, to the NASA GGS (Global Geospace Study) CDHF (Central Data Handling Facility) shortly after midnight UT. This transfer is done automatically and has been routine since 24 July 1992, the date on which the first of the three GGS satellites, Geotail, was launched into the magnetospheric tail. The other two GGS satellites are to be launched into polar and solar wind orbits in the near future. GGS is a component of the International Solar Terrestrial Physics programme (ISTP).

Simultaneous data taken from other sensors at Halley, and from other components of the GGS mission, should permit a better understanding of magnetospheric wave generation and propagation and associated phenomena. Future plans envisage the deployment of VELOX-like systems on a network of Automatic Geophysical Observatories extending to higher latitudes (south of Halley); this will give a detailed picture of the spatial distribution and temporal development of ELF/VLF emissions arising from wave-particle interactions in the magnetosphere. It is envisaged that VELOX will run for several years and will be well suited for studying long-term secular changes in VLF/ELF noise characteristics, including possible anthropogenic effects.

ELBBO

From **R L Dowden**, **C D D Adams** and **J Brundell** *University of Otago, Dunedin*

Five extended life, balloon-borne observatories (ELBBOs) will be launched a few days apart beginning in early November, 1992. Each will carry a Sferics, Hiss, Omega and MSK Instrument (SHOMSKI) built by the Otago University group for recording phase and amplitude

Trimpis received on board. Each of the ELBBOs is expected to remain aloft (26 km) for several weeks, during which some may complete one or more full trips around the world at around 45°S latitude.

Antarctic News

As will be seen from some of the above items, Antarctica is a region of great activity and importance for VERSIM work. Below are a few further items of news which may be of interest.

UK

The new station at Halley-5, 16 km from the old Halley-4, was fully commissioned during the 1991/92 season, and all the scientific experiments were moved across. Unlike the old station which was many metres below the ice surface, the new base is designed to be kept above the surface. It is built on platforms supported by steel legs sunk in the ice. Snow drift passes under the platforms which are jacked up at regular intervals. There are three main platforms, spaced about 500 m apart. The largest platform houses all the living accommodation, radio room, computer room, library, main generators, etc. One of the two smaller science platforms is dedicated to meteorology and neutral atmosphere science, including ozone studies; the second is for space science and ionised atmosphere science.

The VLF aerials are now sited in an electromagnetically quiet location about 1.8 km away from the main station, linked by a multicore cable. Digital data are stored on optical disc, and data files may be moved around the site by means of the local area network, which also links through to BAS HQ in Cambridge. Currently, routine broadband VLF recordings are made on analogue magnetic audio tape, but it is planned to change to DAT (digital audio tape) in 1994.

At Faraday the VLF Doppler receiver experiment, designed to study plasmaspheric drifts and densities by looking at whistler mode signals from VLF transmitters in the conjugate region, is being modernised by replacing two PDP-11 computers by an Apple Macintosh II. The new system will be operated on the BAS supply ship RRS Bransfield, on the voyage south to Faraday, which should provide evidence on the distribution of whistler ducts as a function of latitude, and complement what is already known from natural whistlers.

South Africa

From Dr **A R W Hughes** *Space Physics Research Institute, University of Natal, Durban.*

The start of construction of the new South African Antarctic base has been delayed, but it is expected to be operational by the end of 1994. This base will be approximately 160 km south of the existing base at Sanae.

Russia/Australia

From Dr **V Papitashvili** *IZMIRAN, Moscow*

As part of a Russian-Australian collaboration, a new experiment has been deployed at Davis station and is operating through 1992. The equipment has been developed at IZMIRAN and consists of a digital magnetometer and data collection system based on a laptop PC with an ADC card. A VLF receiver is also included. At Davis we have now regular digital recordings with 1 s time resolution of magnetic fields and of VLF amplitudes at three frequencies near 1 kHz. The main goal of the experiment at Davis is to collect data from the magnetometer and VLF receiver and try to interpret them in terms of the strength and direction of the IMF (Interplanetary Magnetic Field).

Synoptic VLF Observations

This note is to remind VERSIM experimenters of the working group's recommendations regarding the timing of broadband synoptic VLF recordings, in order to facilitate detailed comparisons of data from different observing sites. For 1-minute-in-5 synoptic sampling, the minutes recorded should whenever possible be 00–01, 05-06, ... 55–56 past the hour; for 1-minute-in-15 sampling, the minutes recorded should be 05–06, 20–21, 35–36 and 50–51.

Whistlers: 1953–1993

Next year is the 40th anniversary of the publication of **L R O Storey**'s classic observational and theoretical study of whistlers, inferring them to be signals originating in lightning and travelling along geomagnetically field-aligned paths between opposite hemispheres (*Phil. Trans. R. Soc. Lond.* **A246**, 113–141, 1953). Although whistlers had been observed for many years previously, and it was well known that they often followed atmospherics after a time t proportional to $f^{-1/2}$ (the Eckersley law), Storey was the first to advance a theory which explained this law. Furthermore he was able to estimate plasma densities at very high altitudes which had not previously been possible. Professor **R A Helliwell** will give a lecture at the URSI Assembly in Kyoto entitled *40 Years of Whistler Research.*

The role of the VERSIM Working Group

The working group serves as a forum for workers studying the behaviour of the magnetosphere and ionosphere by means of ELF and VLF radio waves, both naturally and artificially generated. Originally the emphasis was on probing of the magnetosphere by whistlers, but recently the scope has become somewhat broader. The group aims to promote research in this field by facilitating the exchange of ideas, information and experience between active research workers and other interested scientists. This is done through regular meetings at IAGA and URSI Assemblies, and via the circulation of a newsletter. The group has also been active in sponsoring scientific symposia at IAGA and URSI Assemblies, in areas relevant to its field of interest, and in coordinating observational campaigns. There are currently 92 scientists from 22 different countries on the VERSIM mailing list. If you are not on the mailing list, and would like to be, please contact one of the co-chairmen (addresses etc. given below).

Please send any information of interest to other members of the working group, for publication in the next newsletter, to the editor, **A J Smith**, at the address given below; electronic mail preferred, otherwise mail or fax.

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