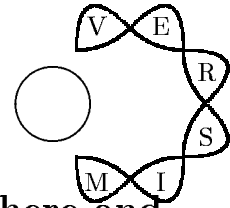


IAGA/URSI
Joint Working Group on



VLF/ELF Remote Sensing of the Ionosphere and Magnetosphere

Editor: A J Smith

Newsletter

No. 8 — October 1995

Dear colleagues,

It was good to see many of you at the successful IUGG Assembly held in Boulder, Colorado, USA this summer, and to attend the many lively and interesting sessions. In this issue of the *VERSIM Newsletter* are included some reports from the Assembly as well as news from the VERSIM community and details of forthcoming meetings. Of particular interest next August is the 25th General Assembly of URSI (International Union of Radio Science), one of the working group's two parent bodies, which will be held in Lille, France. This issue of the Newsletter contains some information about the Assembly and a call for papers (note the deadline for submission of abstracts is **8 January 1996!**). I hope to see many of you in Lille. Thanks to those who have contributed news to this issue.

VERSIM activities 1993–95

The following is a précis of a report presented to IAGA at Boulder.

The working group serves as a forum for researchers 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 in-

terested 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. At present the main subjects of interest include *Plasma structures and boundaries — morphology and dynamics, Wave-particle and wave-wave interactions, Wave-induced precipitation, and Wave propagation in magnetosphere and ionosphere.*

Meetings of the VERSIM group in 1993, both at the IAGA Assembly in Buenos Aires and at the URSI Assembly in Kyoto, Japan, recommended that the working group continue in existence.

The Buenos Aires meeting proposed a half-day session for the 1995 Boulder Assembly, on *Whistler-mode waves and Particle Precipitation* (convenors A.J. Smith and U.S. Inan); this was held on 8 July 1995 [see following item]. The session was well-supported with 24 papers submitted, although some were later withdrawn because the authors (mainly from Russia) failed to obtain travel funds. One contributor, from Belgrade, withdrew her paper when, regrettably, she was denied a US entry visa.

The Kyoto meeting elected U.S. Inan (USA) to serve another 3-year term as URSI co-chairman of the working group, and proposed a session on *Whistler-mode waves and their effects on the radiation belts* (convenors, A.J. Smith, U.S. Inan and J. Lemaire (Belgium)) for the 1996 URSI Assembly in Lille,

France. This was later approved by URSI Commission H and the URSI executive.

A successful session was held at the Kyoto URSI General Assembly, on *Whistlers and Particle Precipitation*. A report on this session was published in the *VERSIM Newsletter*, No. 6.

A meeting of the VERSIM working group was held at Boulder on 8 July 1995 [see report below].

There are currently about 100 scientists from 23 different countries (Australia, Austria, Belgium, Brazil, China, Czech Republic, Denmark, Finland, France, Germany, Hungary, India, Japan, New Zealand, Norway, Russia, South Africa, Sweden, Turkey, Ukraine, UK, USA, and Yugoslavia) on the VERSIM mailing list.

Two newsletters (No. 6 and No. 7) have been issued since the 1993 IAGA Assembly in Buenos Aires, Argentina.

The working group now has a World-Wide-Web page [see below for more details].

XXI General Assembly of IUGG

The Assembly was held on the campus of the University of Colorado, Boulder Colorado, and began with a spectacular firework display to mark the Fourth of July. The weather was considerably hotter than usual; fortunately free ice-cold beer was available each evening at the integrated poster sessions.

Whistler-Mode Waves and Particle Precipitation

A VERSIM half-day session on this subject was held on Saturday 8 July 1995. 24 papers were submitted but several authors were unable to attend the meeting and in the event only 11 papers were presented; nevertheless this session was a valuable and interesting one. The following report is by M.A. Clilverd (UK).

L. Rizzo Piazza (Brazil) gave a talk on the preliminary results from an experiment to study the Trimpf effect which was installed at King George Island, Antarctica on 5 January

1995. Six transmitters are monitored including NAA/NPM/NSS/NAU/NLK between 00–12 UT each day. R. Yeo (UK) presented a report on modelling the Trimpf effect using a Born weak scattering approximation. Complex structure of the precipitation region is allowed in the model and all subionospheric propagation of the VLF signals is calculated using LWPC. M. Parrot (France) gave a talk on the determination of TEC using data from the TOPEX/POSEIDON satellite. The technique described in the talk uses the apparent height of the satellite to deduce the total ionospheric electron content. The data covered August 1992 – March 1994 and showed a peak in ionospheric correction near some of the powerful VLF transmitters (NSS and NPM). Large ionospheric corrections were also observed when passing over earthquake regions just prior to seismic activity.

M. Clilverd gave a paper on the observation of whistler-mode signals at Faraday, Antarctica, and Dunedin, New Zealand, which have originated from the same plasmaspheric duct. Small differences in group delay can be explained by different subionospheric propagation paths and can be used to estimate the location of the duct. Y. Nakamura (Japan) talked on a 2-D ray tracing technique using wave-normal distributions of a whistler that could be used to estimate the exit region dimensions of low latitude whistlers. It was shown that the width of the ionospheric exit regions were of similar size to the width of the duct. J.L. Alford (USA) presented work with co-workers on magnetic pulsations and QP emissions at Pc3–4 frequencies observed at South Pole station near the cusp and explained in terms of a model of generation at high latitudes in the outer magnetosphere. V.N. Oraevsky (Russia) reported observations of VLF-triggered emissions observed aboard the Intercosmos-25 satellite. A.R.W. Hughes (South Africa) discussed hiss ramps observed on the ground and low latitude whistlers observed on the ISIS-2 satellite.

Report on VERSIM meeting — 8 July 1995

A business meeting of the VERSIM working group was held during the IUGG Assembly at Boulder, on the above date. Af-

ter the Chairman's report on VERSIM activities 1993–95 [see above], there was a discussion on the role and future of the working group. It was resolved that the group constituted a valuable forum for workers in the VERSIM field, and to recommend that the group should continue in existence at least until the next IUGG in 1999. Reports on research activities were presented by A.J. Smith (UK), S. Reising (USA), R.L. Dowden (New Zealand), M. Parrot (France) and L.R. Pizazza (Brazil); for more details, see later sections in this newsletter. A half-day session on *Localised ionospheric perturbations related to lightning* had been proposed for the 1997 IAGA Assembly by D. Nunn (UK). This was broadened to include VLF transmitters as well as lightning [and later approved by the Division 2 business meeting for inclusion in its 1997 programme]. In the absence of any other nominations, A.J. Smith was elected to serve as VERSIM co-chairman (for IAGA) for a further 4 year term.

XXV General Assembly of URSI

The next URSI General Assembly will be held in Lille, France, 28 August to 5 September 1996. Details about the Assembly were published the *First Announcement*. To obtain this, or further information, contact AG URSI, Université de Lille 1, F-59655 Villeneuve d'Ascq Cedex, France; phone: +33-20-33-72-06; fax: +33-20-33-72-07; email: agursi@univ-lille1.fr. See also the WWW page <http://www.univ-lille1.fr/ursi>.

Session H1—Call for papers

A VERSIM half-day session on *Whistler-mode waves and their effects on the radiation belts* (convenors A.J. Smith, U.S. Inan and J. Lemaire) is open to oral or poster papers, and contributions are invited. The oral session is scheduled for the morning of Thursday 29 August, and the posters for the afternoon of 3 Tuesday 3 September.

It is well known that whistler-mode waves propagating in the magnetosphere interact strongly through transverse cyclotron reso-

nance with energetic electrons trapped in the radiation belts; this causes pitch angle scattering, and precipitation into the ionosphere. It is still not clear, however, how important this is as a loss process for the radiation belts compared with other loss processes. The whistler mode waves involved may either be naturally generated in space (e.g. hiss) or may come from powerful ground sources (e.g. transmitters, power lines or lightning). It is particularly important to quantify the effect of lightning in view of an expected increase in global lightning activity associated with global warming. Papers reporting experimental and theoretical results on this and related topics are invited.

The abstract deadline is: **8 January 1996**. Abstract submission instructions were published with the *First Announcement*; a copy is appended and additional copies may be obtained from the Local Organizing Committee (contact details given above). Abstracts (original plus one copy) should be sent to AG URSI, Dr Martine LIÉNARD, Université de Lille 1, F-59655 VILLENEUVE D'ASCQ Cedex, France, with a further copy to me.

Other relevant sessions

Some of the proposed sessions for this Assembly, of relevance to VERSIM, are:

E2.1 *The terrestrial electromagnetic environment* (convenors: M. Hayakawa, A.P. Nickolaenko)

H4 *Nonlinear theory and computer simulation of waves and particles in geospace plasma* (convenors: H. Matsumoto, M. Ashour-Abdalla)

HG2 *Effects of lightning and VLF waves on the ionosphere* (convenors: D. Nunn, M.J. Rycroft)

HEG1 *Electromagnetic coupling between the ground (including seismic activity) the upper ionosphere and magnetosphere* (convenors: M. Parrot, O.A. Molchanov, T. Yoshino, A.C. Fraser-Smith)

VERSIM business meeting

There will be a meeting of the VERSIM working group during the Lille Assembly; details to be announced later.

Other forthcoming meetings

IAGA, Uppsala, 1997

The 8th Scientific Assembly of IAGA will be held in Uppsala, Sweden, 3–15 August 1997. There will be a VERSIM session on *Localised ionospheric perturbations related to lightning and VLF transmitters*.

COSPAR, Birmingham, 1996

The 31st COSPAR Scientific Assembly will be held in Birmingham, UK, 14–21 July 1996. The abstract deadline is: **15 January 1995**. For more information, TELNET to LINAX1.MPAE.GWDG.DE or check the WWW page <http://www.mpaе.gwdg.de/COSPAR/COSPAR.html>.

News from the VERSIM Community

South Africa

Two VLF Doppler receivers are planned to be run on Marion Island (46°S 38°E) in May 1996, a collaboration between the University of Natal (A.R.W. Hughes) and British Antarctic Survey (M.A. Clilverd). The purpose of the experiment is study the interaction of whistler-mode signals from powerful VLF transmitters (e.g. the 200 kW HWU, Rosnay, France at 18.3 kHz) with plasmaspheric electrons at higher L -shells than has been possible to date.

British Antarctic Survey

(A.J. Smith and M.A. Clilverd)

Rothera (67.6°S 68.1°W)

VLF observations at Rothera were discontinued on 25 October 1994 after operating continuously since March 1994. Broadband (0.1–10 kHz) and narrowband (OMSK) recordings resumed on a campaign basis during the austral winter 1995, with recordings being made during 24 March – 23 May and 8 Sept – 8 October. The broadband recording was run on a 1-in-5 minute sampling schedule, 16 hours a day starting at 23 UT. The narrowband OMSK recordings were made during the same period at 0.4 s time resolution in phase and amplitude.

Faraday (65.3°S 64.3°W)

The 2 narrow-band experiments (OMSK and DOPPLER) and the VLF broadband receiver have continued to operate through 1995, with the latter run synoptically on a 1-in-15 minute schedule for the most of the time. The programme will continue to run until December 1995 when it will be closed prior to the station being handed over to the Ukraine in February 1996.

Halley (75.6°S 27.3°W)

VLF broadband (recording to DAT tape), OMSK narrowband ('trimpi'), and VELOX (filterbank) observations continued through 1995. In addition, 2 of the 4 VLF Doppler receivers previously at Faraday were moved to Halley in February 1995, allowing triangulation of whistler mode signal exit regions on a regular basis, with the added interest of receiving signals from European transmitters. To date good whistler mode signals have been received. The OMSK programme will close in December 1995, at the same time as the Faraday experiment. VELOX will continue as a long-running well-calibrated instrument useful for investigating long term variations in ELF/VLF noise levels as well as for case studies. Key parameters from VELOX and other experiments at Halley are routinely transferred into the ISTEP database as part of the SESAME investigation of GGS (Global Geospace Study). It is planned to enhance the VELOX with an additional tunable narrow-band channel ca-

pable of receiving signals from the proposed South Pole VLF beacon. For more information, consult the World Wide Web page <http://www.nerc-bas.ac.uk/public/uasd/>.

Since January 1995 the north-south and east-west components of the broadband VLF horizontal wave magnetic field have been recorded on to separate channels of a DAT recorder, with the IRIG-B 1 kHz time code being multiplexed up to the top of the frequency band where there are few signals of interest. This new scheme renders the old VLF goniometer obsolete, since arrival directions can be computed from the two separate channels (this was not possible until DAT recorders had replaced the old analogue tapes recorders, because of “wow and flutter” and poor relative phase stability between the two channels).

AGO A80 (80.9°S 22.3°W)

This AGO (Automatic Geophysical Observatory), the second of the BAS network of four AGOs south of Halley, was deployed on the Recovery Glacier in January 1995. As well as a magnetometer and riometer, the instrument complement included an ELF/VLF receiver similar to the VELOX at Halley except that, because of data storage limitations, there were only 5 frequency bands instead of 8 (centre frequencies 0.5, 1, 2, 3, 6 kHz; bandwidths 0.5, 1, 1, 1, 2 kHz respectively) and the time resolution was lower (10 s for all parameters except the mean log power which still has 1 s resolution. In addition there was a “snapshot mode” which records a 2 s long 0–6 kHz spectrogram every 15 minutes. During the 1995–96 Antarctic summer it is planned to add two additional experiments supplied by US collaborators: a LF/MF/HF receiver to study auroral radio noise (J. LaBelle, Dartmouth College) and a pulsation magnetometer (M. Engebretson, Augsburg College). Data from the BAS AGOs has been contributed to the AGONet database in Italy (M. Candidi) and the associated ADAF (AGONet Data Analysis Facility).

AGO A81 (81.5°S 3.0°E)

It is planned to deploy the third of the BAS AGOs during the 1995–96 Antarctic summer; it will have the same instrument payload as

A80.

New Zealand

(as reported by R.L. Dowden, to the VERSIM meeting held at Boulder)

Projects in progress at University of Otago, Dunedin (R.L. Dowden and N.R. Thomson).

- Monitoring of “absolute” phase and amplitude of VLF transmitters to look for long term variations (hours to years). GPS is used to keep the phase standard fixed with respect to UT even in the event of power outage.
- Monitoring of whistler duct drift, growth and (possibly) creation.
- VLF holography of scattering sources (electron precipitation plasma and cloud-ionosphere discharge (CID) plasma) over Australia and the Tasman Sea using the ANZ antenna array.
- Verification that the RORD (Rapid Onset, Rapid Decay) component of “fast” or “early” trimpis are produced by CID plasma coincident with “red sprites”. This is being done at Yucca Ridge (near Fort Collins, Colorado) in cooperation with the ASTeR group. Several coincidences have been found so far. Some “super bolts” (cloud-ground lightning of currents > 200 kA) have been found to produce sprites, and separately identifiable RORDs and “classic” (electron precipitation) trimpis. VLF scattering by CID plasma can be as much as 180°.

Brazil

(as reported by L.R. Piazza, to the VERSIM meeting held at Boulder)

Since 5 January 1995 the VLF experiment to study Trimpis events was installed on King George Island at Commandante Ferraz, the Brazilian Antarctic station. The equipment consists of a 6-channel amplitude receiver and the experiment is an international one together with BAS and Stanford University, USA. During this period we lost only two days of data. The stations tracked are NAA (24.0 kHz),

NPM (23.4 kHz), NSS (21.4 kHz), NAU (28.5 kHz), NLK (22.3 kHz). The observation schedule is 12 hours per day (00–12 UT). The first results were presented at the symposium at IUGG Boulder.

France

LPCE

(as reported by M. Parrot, to the VERSIM meeting held at Boulder)

Data from a number of sources are currently being studied, i.e. TEC data of TOPEX-POSEIDON, for looking at the signals from VLF transmitters and from earthquakes; FREJA data (waves between ~ 1 Hz and 16 kHz); and AUREOL-3 (signals from the ELF US Navy transmitter at 72 Hz).

New wave analysis techniques being developed are WDF (Wave Distribution Function) with hot plasma, and the application of Neural Networks to recognise different classes of events.

Future space projects in which the group is involved are INTERBOL (Tail, August 1995; Auroral, 1996?); CLUSTER (early 1996?); IBIZA (2000?), investigation of the auroral zones with 2 satellites; DEMETER (?).

Three useful publications have recently been or are about to be published: *Handbook of Atmospheric* (ed. Volland, CRC Press); *Electromagnetic phenomena related to earthquakes* (ed. Hayakawa and Fujinawa, Terra Publishing Company); and *Mechanisms of man-made influences on the ionosphere* (a review by M. Parrot in *Surveys of Geophysics*).

Université de Poitiers

(from Y. Corcuff)

The Signals and Communications Laboratory is about to be merged into a new Signal Image Communications Laboratory (SIC) and will be moving to the 'Futuroscope' site from the beginning of November 1995.

Observations of wave-induced perturbations of subionospheric VLF signals (in particular Trimpi events) have now ceased at Kerguelen. Instead, from January 1994 a chain of receivers has been established at Poitiers to

measure amplitude and phase of signals from three VLF transmitters. Each channel of the Stanford University pattern receivers used has a passband of 300 Hz and a centre frequency adjustable in the range 10–90 kHz. The data are recorded on magneto-optic discs with a 10 Hz sampling frequency. The main transmitters, selected for their stability and geographical location, are NAA (24.0 kHz), GQD (19.02 kHz), and HWU (18.3 kHz), the latter situated at Rosnay, only ~ 60 km from Poitiers. Some observations have also been made of the 23.4 kHz transmitter at Ramsloh near Bremen, Germany, but its transmissions are very irregular.

From January 1994 to June 1995 we have made recordings every night from 17 UT to 07 UT. Trimpi activity has been observed on these VLF paths but is clearly weaker than that observed in June–July 1991 on the NWC–Kerguelen path. The latter occurred during the rapidly decreasing phase of the solar cycle (and thus of geomagnetic activity) between 1991 and 1994–95. Taken together, the Poitiers and Kerguelen data indicate that the occurrence of geomagnetic storms has an important influence on Trimpi activity.

Hungary

Trimpi recordings are continuing at Budapest (Gy. Tarcsai and Cs. Ferencz). Perturbations are seen on the NAA (and sometimes NSS) signals.

VERSIM on WWW

The VERSIM working group now has a page on the World Wide Web. This can be found at the following URL:

<http://www.nerc-bas.ac.uk/public/uasd/versim.html>.

Y.I. Likhter, 1914–1995

We note with sadness the death of Yakov Likhter, a pioneer of radio wave science in Russia and one of the founders of satellite VLF wave research. He was a member of the working group for many years. An obituary can

be found in *Radio Science Bulletin*, **273**, 6 (1995).

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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