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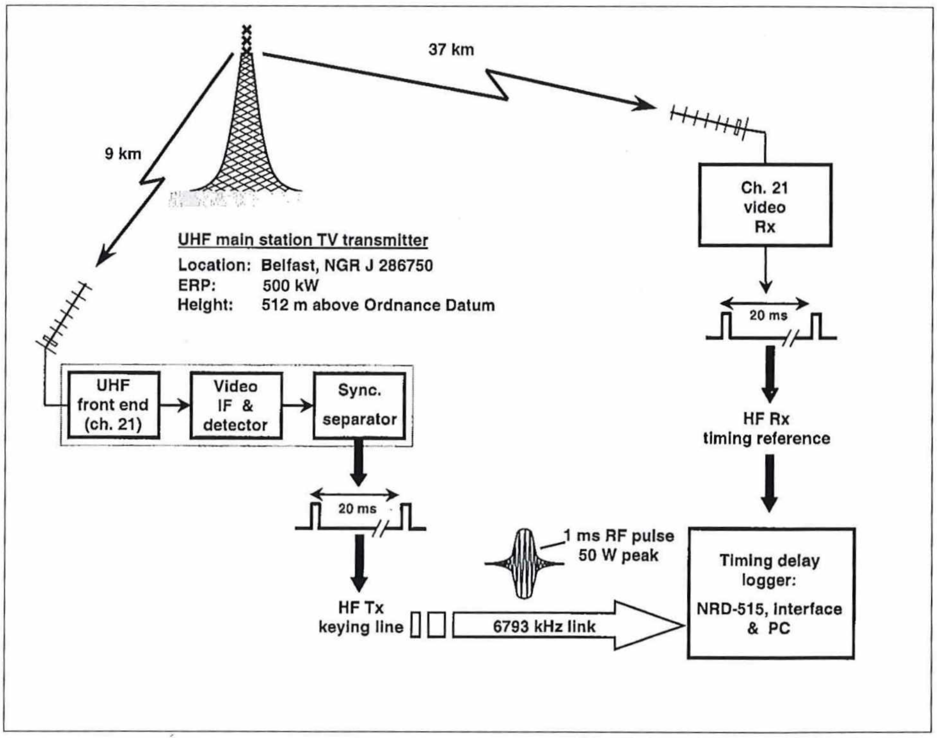


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*Front cover: The probing system layout, illustrating timing synchronisation (more on pp. 7 - 12)*

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# Editorial

## The General Assembly Deadline is Near!

By the time you receive this issue, the 15 January 2002 deadline for submitting abstracts of papers to be considered for presentation at the XXVIIth General Assembly of URSI will be close. The General Assembly will be held in Maastricht, The Netherlands, 17-24 August 2002. Abstracts must be submitted online: see the Web site at http://www.URSI-GA2002.nl/ for details. You really should plan on attending and participating in this General Assembly!

## What's in this Issue

HF (3-30 MHz) radio has been the basis of a tremendous amount of radio communications for decades. For HF communication over ranges of from a few tens to a few hundreds of kilometers, the radio waves are reflected off of the ionosphere at nearly vertical incidence. The variation in the time delay of a pulsed HF signal after it reflects from the ionosphere is a useful measure for studying the channel properties for such communication. In their paper in this issue, S. J. Burgess, N. E. Evans, and J. B. Burns describe a simple method of making such measurements. What is particularly clever about their method is the use of a portion of a television broadcast signal, capable of being received at both ends of the HF propagation path, for timing synchronization between the HF transmitter and receiver. The result is an inexpensive ionospheric pulse-probing system. The authors describe how the system operates, and provide examples of the data obtained.

Electromagnetic terrorism, or intentional electromagnetic interference (EMI) – the "intentional malicious generation of electromagnetic energy introducing noise or signals into electric and electronic systems, thus disrupting, confusing or damaging these systems for terrorist or criminal purposes" – is an area of growing concern. In this issue, Manuel Wik and Bill Radasky describe what is being done by the International Electrotechnical Commission (IEC) in the area of standards related to intentional EMI. They discuss the types of potential threats, and summarize the available open-literature information regarding equipment susceptibility. They then detail the standards work being undertaken by the IEC. The intention is to provide standards that manufacturers can use to protect equipment from such disturbances. I think you'll find this a most interesting and timely paper.

In his column on Radio-Frequency Radiation Safety and Health, Jim Lin reports on a new long-term study being undertaken to investigate the whether cellular-telephone radiation causes cancer. This leads him to a related discussion of recent research on the effects of electromagnetic radiation on the blood-brain barrier (BBB). The BBB is a fascinating physiological system, which acts as a filter, controlling how certain substances are transferred from the blood to the brain. As he explains, it turns out that electromagnetic radiation could have both detrimental and beneficial effects on this important system. Indeed, EM radiation effects on this system could enable new treatments for brain tumors – or they could compromise the filtering effects of this system, leading to brain-cell damage.

This issue also contains reports from a half-dozen scientific conferences of interest to radio scientists. We greatly appreciate receiving these reports, and strongly encourage those who organize and attend conferences of interest to share what goes on with our readers in these pages.

We also have news from the Egyptian Member Committee in this issue. Again, we strongly encourage the Member Committees and the Commissions to use the *Radio Science Bulletin* as a way of communicating with radio scientists around the world. Finally, this issue of the *Bulletin* is the one you have to keep readily at hand for the coming year: it contains the annual directory of those involved in URSI. If you are listed in this section, please be sure to let the URSI Secretariat know if your contact information changes during the year.

## A Call for Papers

You will note that we have two quite interesting technical articles in this issue of the *Bulletin*. I'm grateful to the authors for having submitted them, and for the reviewers (and the authors) for working in such a timely manner to complete the review process. I'm pleased to report that we are starting to see an increase in the number of authors who are submitting work to the *Bulletin*. We're also being proactive about trying to increase the technical content of the *Bulletin*. Special thanks go to Prof. Ken'ichi Okamoto, Dr. Yoji Furuhama, and the other organizers of the Asia-Pacific Radio Science Conference (AP-RASC'01) for recommending appropriate papers. Most of the authors of the recommended papers have kindly accepted invitations to publish their papers in the *Bulletin*. You should be seeing these in our pages over the next year or so.

I hope you will consider the *Bulletin* for publishing papers of broader, general interest to radio scientists. If you have such a paper, please send it in. If you hear such a paper at a conference, please encourage the author to submit it to the *Bulletin*, and let me know about it.

It is perhaps worth summarizing the process we are now using to review papers for the *Bulletin* (all technical papers published in the *Bulletin* are subject to the same review process, including invited papers; the only exceptions will be the General and Tutorial Lectures from the General Assembly, which are reviewed by the respective Commissions). When a paper is first received, an acknowledgement is sent back to the author. The paper is then sent out to at least two reviewers who are knowledgeable in the field of the paper. Agreement is sought from the reviewers that they will do the review promptly, before the paper is sent to them. The reviewers are also sent a review form that basically has four options: "accept," "accept with minor revisions," "revise substantially and re-review," or "reject." Of course, there are several questions regarding correctness and suitability, and the reviewer has to justify each recommendation (and is asked to provide substantial comments to the author for anything other than a recommendation to "accept as is"). I then make a decision based on the reviewers' comments, and send the reviewers' comments along with my decision and recommendations to the author. Except for the "accept as is" and "reject" situations, this usually means that the author will have to make revisions. When the revised manuscript is returned, I decide either that it satisfies the reviewers' requirements or that it needs to be re-reviewed, and take the appropriate action. Once it is finally accepted, the author is asked for a final version in both hard copy and electronic form. I then edit the final version, and send it to the URSI Secretariat. Under the direction of Paul Lagasse, Inge Lievens and Inge Heleu edit and put together each issue of the *Bulletin* in its final form.

## Terror

I was attending the International Conference on Electromagnetics and Advanced Applications (ICEAA'01) in Torino, Italy – representing URSI, along with Frank Olyslager – when the September 11 terrorist attacks occurred. Shortly thereafter, I wrote comments similar to what follow. I think they are still relevant.

URSI is an international organization of radio scientists. It is, by definition, non-political. However, our science and technology play a major role in the world-wide communication of ideas. We are also a world-wide group of intelligent people. As such, we can – and I believe, should – play a role in how the societies in which we live react to what has occurred. The terrorist attacks of September 11 and subsequent weeks have affected not just the US, but the world, and that most certainly includes all of us. I hope I will be forgiven if I share some personal thoughts. These aren't intended as political comments: they are simply one radio scientist's poor attempts to grapple with what has happened, and what should perhaps happen from here.

Part of the reason the effects of the attacks go far beyond the US is that they were not made just against the US: it is estimated that over one-third of those killed or missing in the World Trade Center were non-US citizens, from perhaps 65 other countries. That number alone is far greater than the total number of people killed in the world's 10 worst prior terrorist attacks. It has also become apparent that it is likely that these terrorists were not acting simply as groups of individuals, but have had at least some support from one or more nations. It is for these reasons, and others, that the war that the US and the many countries that have joined it have declared against the terrorists is, and will continue to be, a war involving much of our world.

Terrorism is irrational: trying to force a country to change its political views by killing innocent citizens simply doesn't work. In fact, the recent attacks have had exactly the opposite effect: there is now a degree of unity of belief and purpose, both in the US and around the world, that probably hasn't existed since World War II. Given modern communications and the degree to which countries' economies are intertwined, this may prove to be the greatest unity the world has yet known. In the case of the US, terrorism involves even an additional irrationality. The US was founded on the belief that *all* people "...are created equal, that they are endowed by their creator with certain unalienable rights, that among these are life, liberty, and the pursuit of happiness" (those words are from the US Declaration of Independence, the founding document of the country). That belief transcends politics. It's even in common with *some* of what the terrorists *claim* they want.

But beliefs are at the core of this terrorism, too. Unfortunately, those beliefs have been twisted and molded into hatred and prejudice. People aren't born with hatred and prejudice: they are taught it. That is, perhaps, where we can make a difference. We have to educate people that racial, ethnic, religious, and political hatred are fundamentally wrong. We have to stop the teaching of such hatred in the guise of education. And where we are ourselves guilty of such hatred, we need to find the strength to learn otherwise. We must also recognize that people lacking the necessities for survival are perhaps easier prey for those who teach hatred. It's hard to hate someone who feeds you.

Terrorism is irrational: that's why you can't negotiate with terrorists. It is also probably impossible to re-educate a terrorist away from hatred. But through education, we might be able to prevent the creation of a future generation of terrorists.

The greatest weapon of terrorism is fear. I pray that you will feel safe, and be safe.

Ross

# Erratum

## Correction

[Note: A section of the paper by K. Schlegel, "The Strongest Geomagnetic Storms of the Last Century" (*Radio Science Bulletin*, No. 298, pp. 5-11, September, 2001) was omitted. The omitted section, plus the material immediately before and after it, is reprinted below. Table 1 is also reprinted, with new labels for some of the entries. The *RSB* regrets the omission. WRS]

## The Strongest Storms

Table 1 lists all of the geomagnetic storms between January 1, 1900, and December 31, 1999, with AA* > 250 nT (this is a subset of all storms listed in [14]). Slightly different from AA, the index AA* characterises the most strongly disturbed 24-hour interval, which does not necessarily coincide with a full day. Strong storms generally last longer than one day. The listed events are really "super storms," which can be realised from the following comparison. The average AA of all days of the above 100-year interval amounts to 20.4 nT as the average magnetic activity. Usually, events with AA* > 60 nT are counted as magnetic storms; in the past century, 1172 of these occurred (see the list cited above). Storms with AA* > 250 nT are therefore truly exceptional. Also included in this table are the maximal Kp and the minimal Dst index of the corresponding 24-hour interval, if available. The last column contains auroral observations that will be described in more detail in Section 5.

A magnetogram, recorded during the strongest storm of March, 1989, in Tromsø (northern Norway), is shown in Figure 3 (from [15]). The excursion of the three components from the quiet-time mean are extraordinary. The horizontal component, $B_H$, varied by 3400 nT between 7:30 and 8:30 UT, which is about 30% of the constant $B_H$ component. The declination jumped during the same interval by about 6.5°. Such large changes can be visually observed as a flutter of the compass needle, and led Alexander von Humboldt (1769-1859) to use the expression "*magnetisches Ungewitter*" (i.e., "magnetic storm").

| *Date* | *AA* [nT]* | *max. Kp* | *min. Dst [nT]* | *Auroral Observation nearest to the Equator (geogr. Latitude)* |
|---|---|---|---|---|
| *1989 13./14. March* | *441* | *9o* | *-589* | *A: Florida Keys, (φ ≈ 24°N)* |
| *1941 18./19. Sept.* | *429* | *9-* | - | *Si: Florida, (φ ≈ 29°N)* |
| *1940 24./25. March* | *377* | *9o* | - | *Si: Korfu, (φ = 39°N)* |
| *1960 12./13. Nov.* | *372* | *9o* | *-339* | *A: Atlantic, (φ = 28°N)* |
| *1959 15./16. July* | *357* | *9o* | *-429* | *Sch: φ ≈ 48°N* |
| *1921 14./15. May* | *356* | - | - | *Si: Samoa, (φ = 14°S)* |
| *1909 25./26. Sept.* | *333* | - | - | *Si: Mallorca, (φ = 39°N)* |
| *1946 28./29. March* | *329* | *9o* | - | *Si: Queensland, (φ ≈ 27°S)* |
| *1928 7./8. July* | *325* | - | - | *Si: Atlantic, (φ = 24°N)* |
| *1903 31.10./1.11.* | *324* | - | - | *Si: Bamberg, (φ = 50°N)* |
| *1958 8./9. July* | *314* | *9o* | *-330* | *Sch: φ ≈ 38°N* |
| *1960 31.3./1.4* | *312* | *9-* | *-327* | *Sch: φ ≈ 36°N* |
| *1941 5./6. July* | *302* | *9o* | - | *Si: New England, (φ ≈ 42°N)* |
| *1958 11./12. Feb.* | *298* | *9o* | *-426* | *Sch: φ ≈ 25°N* |
| *1946 22./23. Sept.* | *295* | *9o* | - | *Si: New Zealand, (φ ≈ 40°S)* |
| *1972 4./5. Aug.* | *290* | *9o* | *-125* | *Sch: φ ≈ 48°N* |
| *1986 8./9. Feb.* | *287* | *9o* | *-307* | *Sch: φ ≈ 48-50°N* |
| *1967 25./26. May* | *279* | *9o* | *-387* | *Sch: φ ≈ 50°N* |
| *1982 13./14. July* | *268* | *9o* | *-325* | *Sch: φ ≈ 49-50°N* |
| *1946 7./8. Feb.* | *256* | *9-* | - | *Si: England, (φ ≈ 55°N)* |
| *1941 1./2. March* | *254* | *9o* | - | *Si: Tasmania, (φ ≈ 43°S)* |
| *1960 6./7. Oct.* | *253* | *9o* | *-287* | *Sch: φ ≈ 49°N* |

*Table 1. Geomagnetic storms in the past century with AA* > 250 nT in descending order. The third column gives the maximal Kp (since 1932) and the fourth the minimal Dst (since 1957) in the corresponding interval. The last column shows the location of auroral observations most near to the equator during the storms. Si refers to a list of auroral observations compiled by Silverman [34] ranging from 686 BC to 1951 AD, Sch to W. Schröder (private communication), A to other sources.*

### Ionospheric and Thermospheric Changes

Magnetic storms strongly influence the ionosphere. The so-called "negative storm effect" is particularly important. It is characterised by a strong decrease of the F-region electron density during and immediately after a magnetic storm [16]. This effect has been studied since the 1930s by ionosondes. Figure 4 shows an example for storm No. 4 in our list. Simplified, it can be explained as follows: the currents in the lower ionosphere heat the atmosphere, which consequently expands. Molecular constituents ($N_2$, $O_2$) are thereby transported from lower heights (150-250 km), where they are abundant, into regions around 250-450 km altitude. At this height, atomic oxygen is normally dominant, and its photo-ionisation usually yields high electron densities. The molecular constituents cause a strong increase in recombination through several reaction chains, which leads to a decrease in the electron density. Several hours after a geomagnetic storm, a "positive storm effect" often occurs. This increase in the electron density results from a combination of chemical and dynamical processes, as well [16]. The irregular changes in the ionosphere cause disturbances in short-wave radio-wave propagation [17], and also deteriorate the accuracy of navigation systems such as GPS [18].

### Aurora

Auroral displays in the sky are a visible sign of magnetic storms [19]. They occur when energetic particles precipitate into the upper atmosphere, and excite the atmospheric constituents (O, $O_2$, $N_2$) between 100 and 500 km altitude by collisions. The excitation energy is then released as radiation (UV, visible, and IR), which we observe as the aurora. During quiet and weakly disturbed conditions, the aurora occurs only in an oval-shaped ring around the magnetic poles. However, during strongly disturbed conditions, this oval expands towards the equator [20]. In such events, the aurora can be observed at mid-latitudes or even at low latitudes.

For storm No. 4 of Table 1, Figure 5 shows a map with locations marked where ships and other observers have reported aurora. These show that the aurora was visible down to a geographic latitude of 28° N (about 40° geomagnetic). The last column in Table 1 lists the most-southerly-observed auroral displays during the storms, together with the corresponding geographic latitude. From this compilation, it follows that the aurora most near to the equator was observed on 14/15 May, 1921, from Samoa (an alleged sighting from Singapore during storm No. 7, in 1909, was disputed by Silverman [21]). Today, auroral activity and the extension of the auroral oval is monitored by polar-orbiting satellites, and can be viewed on the Web [22]. An interesting review of auroral activity over the last 500 years has been published by Silverman [23].

# CSIRO Bolton Post-Doctoral Fellowship

Applications are invited for the Bolton Fellowship, a three-year post-doctoral appointment tenable at the major Australia Telescope National Facility locations. Bolton Fellows are encouraged to undertake research and/or development in any area relevant to ATNF observational capabilities. The ATNF facilities provide unique opportunities to observe the Southern sky including the Magellanic Clouds and the richest part of our Galaxy.

The ATNF, a Division of CSIRO and Australia's premier radio astronomical facility, has its Sydney Headquarters at the Radiophysics Laboratory, and operates the Parkes 64m telescope, the Narrabri Compact Array and the Mopra 22m telescope near Coonabarabran. The Compact Array has six 22m antennas on a 6km east-west baseline with a 220m north-south spur and operates in six bands between 20cm and 3mm. Among other receivers, the Parkes telescope has a 13-beam focal-plane-array receiver system operating in the 20cm band, primarily for HI and pulsar surveys. With other Australian and overseas antennas, the ATNF telescopes operate as a VLBI array which uses the broad-band S2 recording system. The Headquarters site is shared with CSIRO Telecommunications and Industrial Physics (formerly CSIRO Radiophysics) and the Anglo-Australian Observatory, which operates the 4m Anglo-Australian and Schmidt optical telescopes near Coonabarabran.

The Fellowship is named in honour of John Bolton FRS, a pioneer of radio astronomy who made the first identifications of extragalactic radio sources and who worked at the CSIRO Radiophysics Laboratory between 1947 and 1981.

Applicants must have (or will shortly satisfy the requirements for) a PhD degree in astronomy, astrophysics or related disciplines. The commencement annual salary is in the range $A50K to $A55K plus benefits. A relocation allowance is payable. Bolton Fellows also receive a discretionary research allowance of $A24K over the three-year term.

Applications should include a curriculum vitae, list of publications, statement of proposed research or development ideas, and the names and addresses (preferably email) of

*(continued on the bottom of page18)*

# The Measurement of Pulse Arrival Variation in a Short Range HF Channel using TV-Broadcast Time Referencing

S.J. Burgess
N.E. Evans
J.B. Burns

## Abstract

Radio systems operating in the HF band are enjoying a resurgence as spectrally efficient digital transmission equipment becomes available that is capable of offering moderate data transfer speed in hostile channels, whilst coincidentally providing good security and low user error rates. The historical HF radio problem, of implementing reliable operation just beyond the ground-wave limit, can be alleviated by using near-vertical-incidence skywave (NVIS) propagation. This paper discusses how variations in pulse arrival time were investigated in an experimental, 6793 kHz NVIS link with a 42 km map range, using an off-air television waveform for timing synchronisation. The result was a low-cost, oblique ionospheric sounder, giving 20 ms timing resolution. To illustrate the potential of the technique, a comparison is provided between the arrival times measured in a summer daytime link and those found as nightfall approached.

## Introduction

One of the main factors governing the success of line-of-sight (LOS) communication systems within any frequency band is the type of terrain over which the radiowave has to travel. For VHF/UHF systems, the limitations imposed by high ground can be alleviated by the insertion of "active" repeaters to relay the signal, but only where a power supply (usually "AC-mains" derived) is readily available and equipment can be made secure. Ground effects can also be mitigated by use of satellite communication, with its inherently high data transfer rate capability. However, this mode also has limitations in terms of equipment/channel cost and critical antenna alignment. A satellite is, in essence, a repeater; as such, it can suffer from "down time" and has a finite operational lifetime.

An alternative to achieving short-to-medium-range radio coverage (10s to a few 100s of km), unaffected by terrain, is by the use of HF techniques with antennas having high take-off angles. Typically, the ionosphere is irradiated by low-profile, horizontally polarised antennas, driven by transmitters delivering 15-50 W of RF output power. This results in radio waves striking the ionosphere at extremely low angles of incidence: this mode is termed near-vertical-incidence skywave (NVIS) propagation [1, 2], and yields omni-directional ground coverage, similar to the effect seen when directing a garden hose vertically upwards. The repeater is the "passive" ionosphere, and the technique can be used for "one-to-many" or "one-to-one" types of coverage.

In the past, this method of communication has been regarded as somewhat specialist in nature, [1, 3] but, as advances in system integration and digital signal processing techniques enable low-cost, portable HF radios to be built, wider applications are becoming increasingly viable. These include environmental monitoring in geographical regions not easily served by VHF/UHF repeater networks, and the transmission of digitised vital-sign files in the provision of telemedicine for remote areas.

Advances in radio hardware, and associated software, have brought about a change in HF signalling modes. Wideband methods and spread-spectrum techniques are gaining in popularity, given their inherent advantages in terms of low probability of intercept and interference rejection. There have been several investigations into ionospheric effects on wideband signals. Results from Hausman et al. [4] show how it is possible to model wideband HF channels from narrowband observations. It is also known that observations of a swept-frequency signal at HF will reveal nulls at various points on a frequency ($x$ axis) versus amplitude ($y$ axis) plot.

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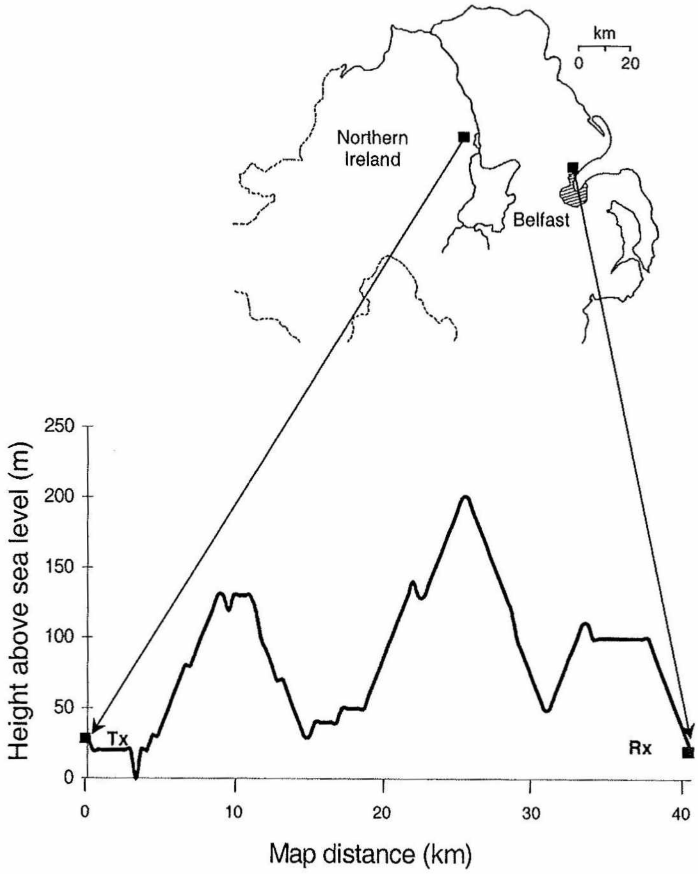


*Figure 1. The map profile of the NVIS link. The groundwave signals dropped below the receiver's noise floor some 30 km from the transmitter.*

The nulls are set by the interference between the ionospheric O and X modes, and give an indication as to the coherent bandwidth available. Salous [5] discusses how the width of received pulses depends upon the relationship between the bandwidth needed by the signal and the coherent bandwidth readily provided by the channel. She also explains how the pulse width and degree of distortion is essentially related to the slope of the group time delay in μs/MHz: several mathematical relationships are presented to illustrate this.

We have recently been examining the variation in pulse arrival times found in a single-frequency, mid-latitude NVIS link operated over a short map-range (42 km). In essence, the results display the variation of a "fixed point" on the group time delay curve and, as such, give an indication of the pulse deviation that might be suffered by a frequency-hopping system on a single hop. This paper describes a cost-effective ionospheric pulse-probing system, developed at the University of Ulster, and introduces the nature and analysis of the experimental data obtained.

## Test Link Characteristics

The experimental NVIS link was established over the non-LOS path shown in Figure 1. The receiver was sited 10 km north of Belfast, with the 6793 kHz transmitter located a further 42 km to the northwest. Initially, this oblique-sounder system was configured for channel-availability and CW-fading investigations [6]. A commercial ICOM 706 transceiver was used at the out-station, and an NRD-515 receiver was used at the University (logging station). To achieve maximum vertical polar-pattern response, inverted-V antennas were used, mounted 6 m above ground level.

To permit the timed transmission and accurate recovery of probing pulses, the original CW system was modified so that it could be triggered from an external synchronisation signal capable of being received at both ends of the HF link: see Figure 2. The common timing reference was extracted from the 50 Hz frame-flyback waveform of a 471.25 MHz television signal, broadcast from the 500 kW UHF transmitter at Divis, near Belfast. The logging station was 24.8 km closer to the TV transmitter than the NVIS source, yielding a differential trigger delay of 82.7 μs between HF transmitter and receiver; for the measurement of arrival time variation in ionospherically propagated pulses, this offset had no significant effect. Inspection of the frame-flyback waveform revealed its jitter to be no more than 2 μs. The driver stage in the power amplifier of the ICOM 706 was directly keyed (to avoid processor-induced jitter), resulting in 1 ms-wide, 50 W peak-power RF output pulses. This pulse width was not narrow enough to fully resolve both O and X modes [4], but was adequate to allow the investigation of arrival times. Propagation in the path was firstly investigated by extracting the detected IF output of the NRD-515 link receiver. The resulting base-band output, after amplification and filtering, was sampled by a 12 bit analogue-to-digital converter as part of a custom logging system, also timed from the same UHF broadcast source as the ICOM 706 transmitter.

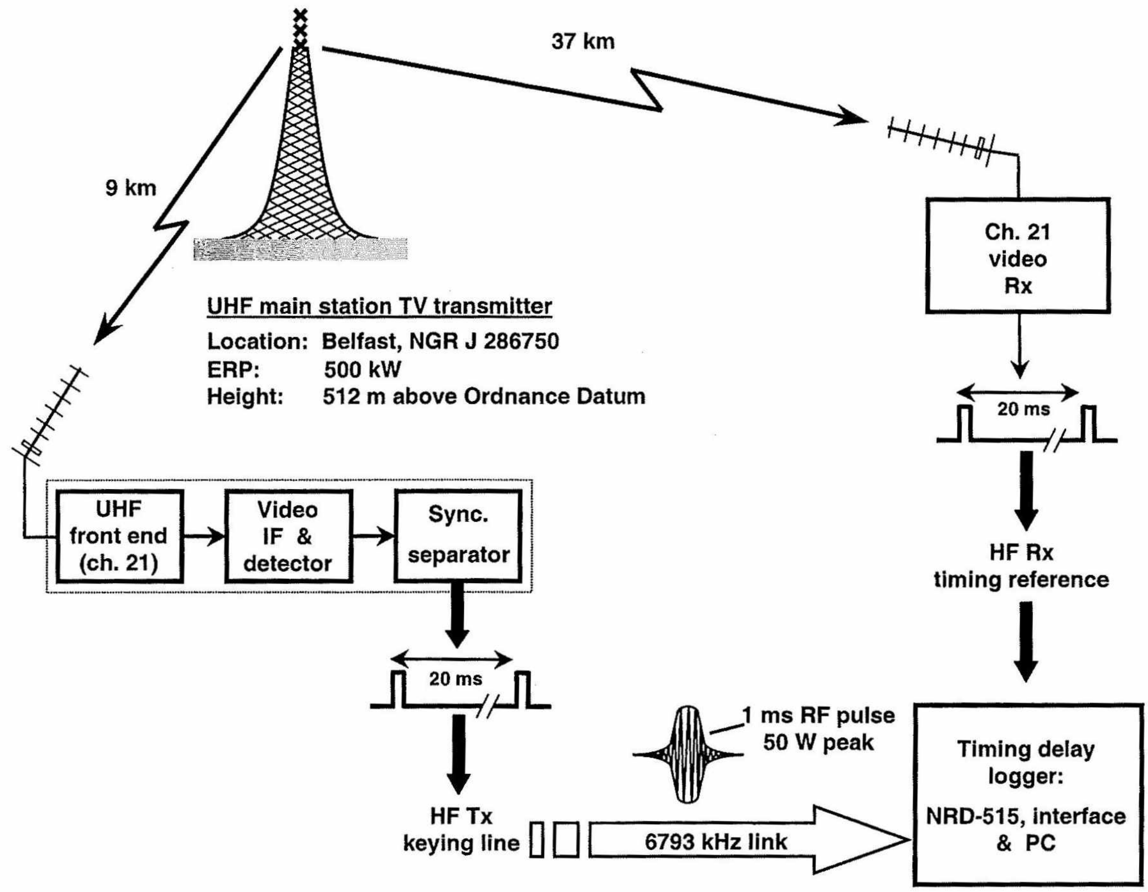


*Figure 2. The probing system layout, illustrating timing synchronisation.*

## Experimental Data

Pulse capture at the logging site was achieved by opening a 5 ms data window, initiated from the 50 Hz trigger signal. The sampling rate for the data window was 100 kHz, yielding 500 samples per window with 10 μs resolution. Given that the UHF television transmitter sent 50 pulses per second, it was decided to store one ionospheric probing pulse in every ten at the logging station. This kept the amount of data to a manageable level, and permitted long-term (tens of minutes) investigations. Therefore, five data windows were taken every second, giving 150,000 samples stored per minute.

Figure 3 shows a single 5 ms data window, encompassing two pulses: a reference pulse at the start, and the received probing pulse seen in the middle. The reference pulse was the falling edge of a delayed version of the television trigger signal. This storage method eliminated significant measurement errors due to logger start-cycle variations. The variation in pulse arrival times was obtained by measuring the number of samples from the reference point to the received pulse centre. It was also possible to use the system to investigate the virtual height [2] of the foF2 layer responsible for NVIS propagation. The time taken from the arrival of the TV trigger pulse to the centre of the HF pulse, minus quantifiable system delays, revealed the time-of-flight of the skywave signal. Extensive comparison of single-frequency results from this system with 30-minute observations from the wideband vertical sounder at the World Data Centre (Slough, England) revealed a maximum "difference" error of 2.7% in foF2 effective height. Slough is 550 km southeast of the NVIS test area.

## Data Analysis

Measuring the variation in pulse arrival times on a window-by-window basis was achieved in *C* code by detecting the falling edge of the reference pulse, and subsequently counting the number of samples out to the peak of the HF pulse. Before any data processing took place, the raw data samples within each 5 ms window had to pass an algorithm test that checked if:

- A reference pulse was present
- The channel noise was minimum
- That the received probing pulse existed, and
- The maximum "tip" value on the HF probe pulse occurred only once.

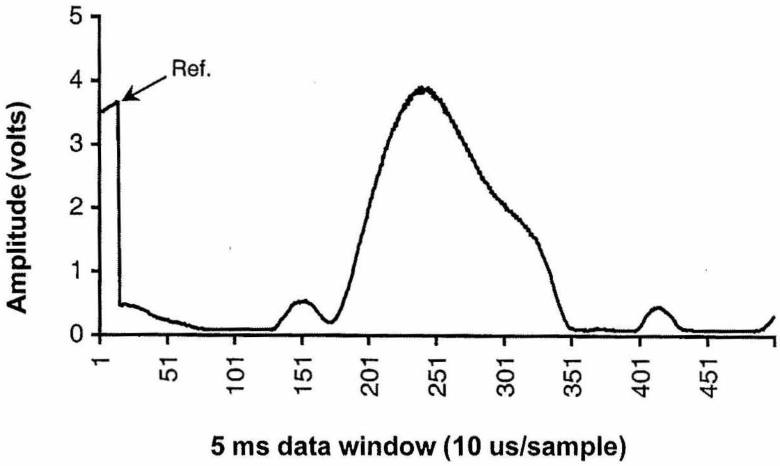


*Figure 3. A single 5 ms data window, showing the reference point at the window's start, and a "captured" probing pulse around its centre.*

The algorithm removed any "outstandingly" early arrival pulses that were refracted from lower layers (for example, sporadic E); only pulses from the F layer were investigated in this phase of the work. Due to ripple on the pulse tip, the samples were smoothed by sliding a three-point averaging window across the data. The time count was then taken from the reference point to the centre of the three-point window. For example, if averaging across sample locations 220, 221, and 222 yielded the pulse maximum, then the count was taken from the reference edge to 221. Unfortunately, 10 μs of uncertainty was introduced into the count, as the actual pulse maximum could be on either side of location 221. Due to a variation in opening times of the data window, it was noted that the falling edge of the reference pulse spanned between one and two samples, hence introducing a further 10 μs potential error. Overall, the measured pulse arrival times can be taken as accurate to the nearest 20 μs.

Figure 4 shows the results obtained from a 20-minute pulse test, conducted at 13:30 on 28 July, 1999. Passing the raw samples through the algorithm screen resulted in 18.3% of the 6000 possible data windows being disregarded. A visual examination revealed the absence or reduced amplitude of probing pulses due to channel fading. The rate of change of the time delay – useful in the estimation of Doppler shift [7]–varied between $1.7\times10^{-8}$ and $5\times10^{-8}$ in this experiment.

Further analysis showed that the variations in arrival times ranged from ±10 μs to ±500 μs, with a standard deviation of 158.1 ms. In the absence of data from any other short-range HF path, these values were compared with results obtained from investigations made in long-haul links, as discussed by LaBahn and Rose [8]. In general, the lower variation figure of ±10 μs is well below that observed on any long-haul link. The upper figure of ± 500 μs compared well with long-haul paths. An interesting point is that the standard deviation was lower than those for long-haul observations,

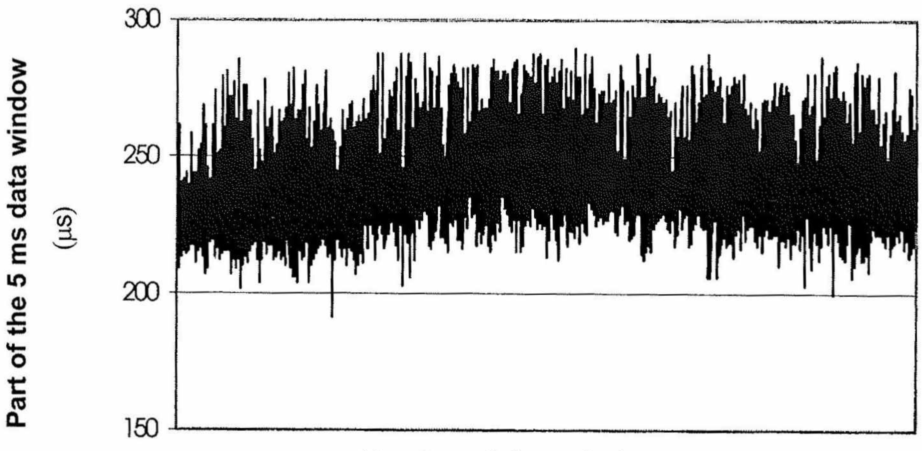


*Figure 4. The variation in pulse arrival times over 20 minutes, recorded from the 6.793 MHz NVIS test link during a mid-summer day, with an overhead foF2 value of 8.02 MHz.*

which have been found to range between 190 μs and 1400 μs (values around 300 μs appeared most often). This suggests that, on average, a short-range NVIS link experiences less variation than long-haul paths: this is a beneficial feature in parallel modem design.

An investigation of the variation in arrival times about the mean revealed the plot shown in Figure 5. A best fit through the data points showed that the spread about the mean was Gaussian, given by

$$y = ae^{-\frac{(x-b)^2}{2c^2}} .$$

Here, $a = 2.5$, $b = 12.7$, and $c = 149.1$.

This result does correspond well with arrival variations on long-haul HF paths that have also been found, to a good approximation, to be distributed normally [8].

Two more twenty-minute pulse samples were taken at 20:58 and 23:04 on the same day, when the foF2 values were 9.43 MHz and 7.69 MHz, respectively. Both data sets were passed through the screening algorithm, giving a total sample loss of 14.1% for the first investigation and 15.4% for the second. The variation in arrival times were found to range from ±20 μs to ±660 μs for the 20:58 test, and ±10 μs to ±830 μs for the 23:04 test. The standard deviations for each were 141.7 μs and 179.8 μs, respectively.

As nighttime approached (sunset was at 21:32 local time), the results suggested a spread in the variation of pulse arrival times. However, the standard deviation figures did remain fairly close to the daytime value, and were still well below those observed on long-haul links. Plotting the spread in variation times about the mean for each test resulted in the plots of Figures 6 and 7. These curves are no longer Gaussian, but follow an exponential "best fit" given by

$$y = ae^{bx} ,$$

where $a = 3.9$, $b = -0.007$ for Figure 6, and $a = 3.0$, $b = -0.006$ for Figure 7.

An overall observation is that the error between the actual arrival time and the best-fit curve got smaller as the foF2 value rose. The standard deviation was smallest for the 20:58 test, when foF2 was at its maximum. This suggests that HF schemes susceptible to error as a result of pulse-arrival variations might function better in an NVIS role at frequencies well below the overhead foF2 value.

## Conclusions

This paper has illustrated some initial findings, taken from pulse transmissions made over a short-range NVIS link, using a low-cost sounder. The path investigated was truly non-line-of-sight, and just beyond the ground-wave limit. The measurement system described can be used to monitor multiple echoes resulting from earth reflections, transient phenomena such as sporadic-E propagation, and the narrowband variability that occurs at the onset of channel closure. The latter is particularly apparent in winter, as conditions change from the relative stability experienced in daytime to those found at dusk. Software control of the radios and broadband antennas will allow a wider section of the spectrum to be covered in future work.

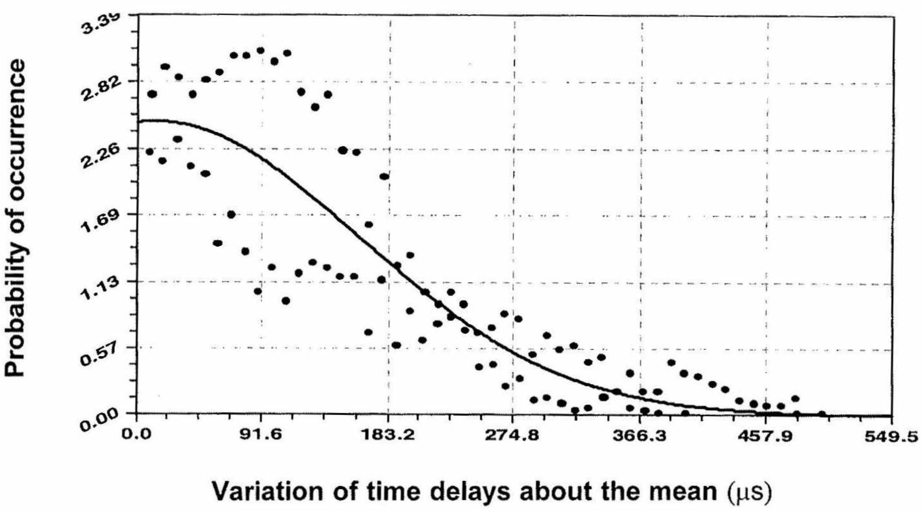


*Figure 5. The spread in time variations about the mean pulse arrival time, obtained from the values in Figure 4. Note that all variations are taken as being positive.*

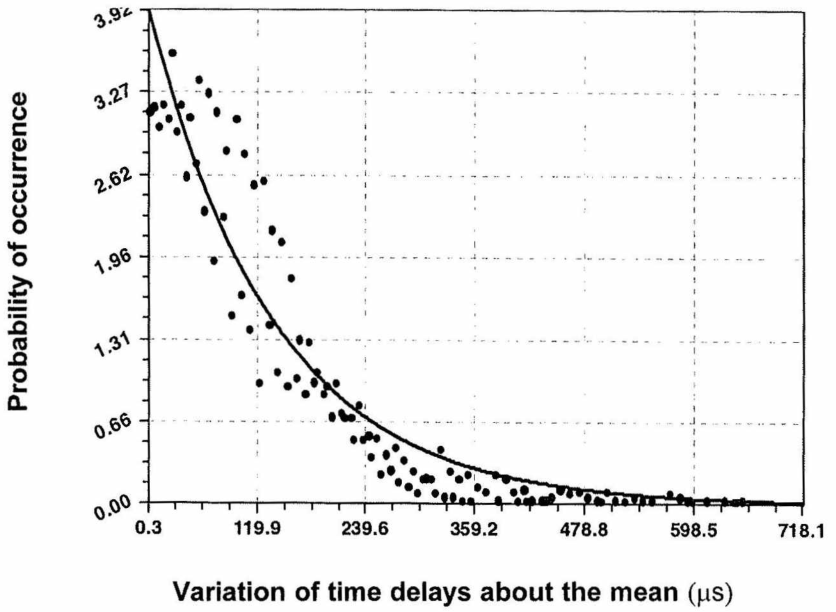


*Figure 6. The variation in arrival times about the mean for the 20:58 test, with an foF2 value of 9.43 MHz.*

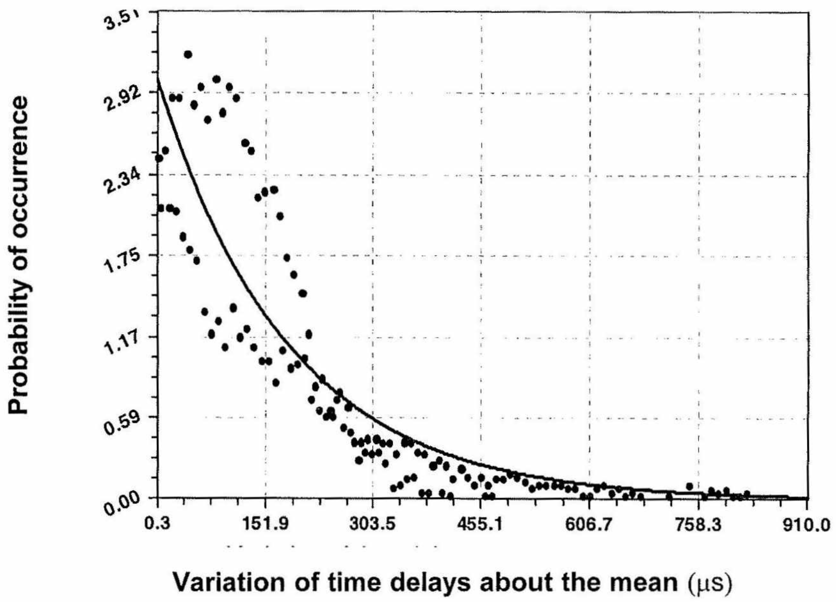


*Figure 7. The variation in arrival times about the mean for the 23:04 test, with an foF2 value of 7.69 MHz.*

## Acknowledgements

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# Intentional Electromagnetic Interference (IEMI): Background and Status of the Standardization Work in the International Electrotechnical Commission (IEC)

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## Abstract

Intentional EMI, or, as it is sometimes known, "EM terrorism," is a new area of concern for public and commercial interests. This paper will review the different categories of EM threats, and will also summarize available information concerning the susceptibility levels for commercial equipment. This paper will conclude with a presentation of the standardization work being accomplished by the International Electrotechnical Commission (IEC) in the area of high-power transient phenomena.

## 1. What is Intentional EMI ?

At the XXVIth General Assembly of URSI in Toronto, August, 1999, a resolution was adopted on "Criminal Activities using Electromagnetic Tools" [1]. According to this, intentional EMI is defined as the "Intentional malicious generation of electromagnetic energy introducing noise or signals into electric and electronic systems, thus disrupting, confusing or damaging these systems for terrorist or criminal purposes."

Over the past two years, there has been increasing activity in the area of intentional electromagnetic interference (EMI), which is sometimes referred to as EM terrorism. In particular, at the International Zurich Symposium and Technical Exhibition on EMC in February, 1999, there was a well-attended session on EM terrorism that resulted in the publication of five important papers. These dealt with the overall problem [2], presented an approach to protecting systems from the threat [3], provided HPM test data on automobiles [4], reviewed modeling and simulation methods [5], and described the use of large-scale simulators to evaluate EM threats [6].

In the summer of 2000, there were two important conferences that provided additional information on this subject. At the EUROEM2000 Conference in Edinburgh in May, there was a special session on intentional EMI that attracted 15 presented papers, although no papers were published. Later, in June at Wroclaw, Poland, the URSI Commission E session resulted in three published papers, dealing with the nature of the threat [7], testing strategies [8], and the approach of the International Electrotechnical Commission (IEC) Subcommittee 77C toward developing environmental and protection standards to deal with the problem [9].

The objective of the IEC is to produce civilian standards. This is of interest worldwide for the electronics and power industries, in order to harmonize methods of protection and the development of protection devices. All information used and developed is unclassified. Today, there is more interest within military organizations in several countries to benefit from civilian standards wherever possible, in order to save money. However, military organizations should have no direct control over the IEC work, although contributions from open military documents (with appropriate background) are welcome. Among other matters, the URSI resolution [1] recommended providing reasonable data regarding the formulation of standards of protection and supporting the standardization work that is in progress.

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This paper reviews the different types of intentional EMI threats, the susceptibility of some common types of equipment, and closes with a review of the standardization work underway in the IEC.

## 2. Types of IEMI Threats

In the simplest of terms, there are two basic types of IEMI waveforms: narrowband and wideband. However, the meaning of narrowband and wideband, concerning pulses, needs to be discussed further, and this is planned to be included in the IEC work. The narrowband category describes a nearly single frequency that may be transmitted in a pulse on the order of microseconds in length. This type of threat is often referred to as HPM (high-powered microwave). The frequency range for HPM is typically higher than 1 GHz, although from an IEMI point of view, frequencies between 0.2 and 5 GHz seem to be the most important to consider as narrowband threats.

Of course, the "single" frequency may vary with time, and the signal can be modulated. It is generally fairly easy to create fairly high power and energy levels with this type of waveform. Examples of this type of waveform are those generated in a microwave oven or by radar tubes. The disadvantage of this type of waveform is that systems are affected by the currents and voltages coupled by the incident field, and many systems have resonances that create significant susceptibilities to particular frequencies. However, different systems will likely have different resonances, thereby limiting the effectiveness of a single-frequency IEMI generator.

For the wideband category, a pulse produces frequency content over a wide range of frequencies. One type of wideband waveform is UWB (ultra-wideband). These pulses typically have a rise time of less than 100 picoseconds, and a pulse width of a few nanoseconds. The main frequency content of the UWB pulse ranges from 0.3-3 GHz. It should be noted that the HEMP waveform described by the IEC [10] has a 2.5 ns risetime and a 25 ns pulse width. This qualifies as a wideband waveform, but it is not considered to be an ultra-wideband pulse.

The advantage of the wideband pulse is that the resonances of different-sized systems can be stimulated simultaneously. The disadvantage is that the energy produced in a single pulse is spread over many frequencies. In addition, the peak electric-field value of the pulse is limited by the breakdown field value of air. For these reasons, wideband pulses are often repetitively pulsed, and therefore pose mainly an interference threat to systems, as opposed to a permanent-damage threat, as provided by narrowband waveforms.

In addition to the waveform type, there is the issue of how the disturbing waveform is delivered to the system. The two general categories described in the electromagnetic compatibility discipline are radiated and conducted. In the case of radiated waveforms, an antenna is used to produce electromagnetic fields that propagate to the vicinity of a "target" system. These radiated fields will propagate through the air and through apertures in buildings, automobiles, or aircraft. The electromagnetic fields will either couple directly to the cables attached to a piece of equipment, or will penetrate directly inside of the equipment, where damage or upset to system operations will occur.

Conducted disturbances can be injected directly, capacitively, or inductively onto power or telecommunication cables. These disturbances will then propagate along the cables until they reach equipment connected to the cables.

**Telecom/CWG Pulse Test Summary**

- Power cord (telecom pulse test only):
  - No reproducible damage or computer upsets up to max voltage capability.
  - Arcs heard from power supply area.
  - Typical maximum stresses at load (4.5 kV generator open circuit voltage):
    1.2 kV peak voltage spike (4 ms wide) followed by 200-300 V slow decay (300 ms width).
    300 A peak current (limited by generator).
- 10Base-2 Ethernet (coax)
  - Port destroyed by both CWG and telecom pulses.
    500 V pulse (minimum generator voltage).
    50 VDC (100-200 V/s ramp).
  - No damage to computer beyond Ethernet card.
- 10Base-T Ethernet (twisted pair)
  - Damage occurred at 4 kV for telecom pulse.
    About 4 joules required for damage.
    Arcs began at 3 kV for both CWG and telecom pulses.
  - No damage to computer beyond Ethernet card.

*Table 1. A summary of the results of testing power and data ports with the telecom and CWG pulse generators.*

As in the case of radiated disturbances, both narrowband and wideband waveforms can be injected; however, often, the cables' transfer functions will limit the frequency content of conducted disturbances to below 1 MHz, particularly on power lines.

## 3. Susceptibility Levels of Commercial Equipment

*3.1 PC Cable Experiments*

A recent paper by Radasky, et al., at the Zurich EMC conference surveyed equipment-failure data from a series of laboratory experiments [11]. Four sets of data – two conducted and two radiated – provided valuable information. Power cords and Ethernet cables connected to personal computers were tested and surveyed in this paper. Two types of conducted pulse waveforms were reviewed there: the CWG (combination wave generator) waveform (1.2/50 microsecond pulse) and the telecom waveform (10/700 microsecond pulse). The results are provided in Table 1. The results indicated that the power ports were not affected for delivered voltages as high as 1.2 kV, although higher levels have been reported to cause damage. For the Ethernet cables, the 10Base-2 cards were damaged at 500 volts, which was the lowest test level. The 10Base-T interface was not damaged until a level of 4 kV was reached, using the telecom waveform. It is interesting to note that the 10Base-2 port uses a coaxial cable; however, the shield is not connected at the card, thereby creating an easy damage path.

*3.2 Building Power-Cable Experiments*

An experiment was performed by Fortov et al. [12], by injecting both narrowband and wideband waveforms onto the power lines entering a five-story office building, and by making measurements at various power plugs within the building. The measurements indicated that voltages injected on external wiring could propagate well through the internal wiring of a building, even when considering multiple switchboards inside the building. It is clear from their work that frequencies less than 1 MHz propagate with low attenuation, as do pulses with widths greater than 1 microsecond. Although this study did not directly address the issue of wiring breakdown, it is felt that, for the types of pulses considered, normal building wiring should be able to support peak voltages in the range of 10 kV.

In terms of the vulnerability of computers, both the analyses and limited testing revealed that computer power supplies – and, in particular, the input filters – appear to be vulnerable to levels of 6 kV for a 50-microsecond pulse. Analyses indicate that levels of 1-2 kV would create damage for a 1 ms wide pulse.

By considering both aspects of this work, it appears possible to inject significant levels of voltage into the power wiring system of a building, and it appears that voltage can propagate easily and cause damage to computer power supplies. Of course, it is possible that other types of equipment connected to the power system will be vulnerable to injected pulses, although other types of equipment have not yet been considered.

*3.3 Radiated-Field Effects on PCs*

Three types of PCs were tested by LoVetri, et al. [13], by irradiating them with different frequencies, modulation types, and field-strength levels. A summary of the results is provided in Table 2. An effort was made to determine the lowest field levels at various frequencies using narrowband waveforms. Angles of incidence and polarization variations were minimal, so the results should not be considered to be the lowest levels at which effects could occur. The authors concluded in their study that relatively weak fields – as low as 30 V/m – reaching the inside of a personal computer could disrupt its operation. In addition, they noted that the effects were observed only at particular frequencies, due to resonances present inside each computer.

*3.4 Automobile Test Results and Conclusions*

Another experiment was performed in Sweden by Bäckström [4], by irradiating an automobile with narrowband waveforms at high power and field levels (HPM). The frequencies of illumination varied between 1.3 and 15 GHz. Two angles of incidence to the automobile were considered. The authors of this study noted that effects were more prominent at the lower test frequencies, with automobile upsets (including the stoppage of the engine) noted at the lowest test value of 500 V/m. Permanent damage occurred at 15 kV/m at 1.3 GHz, and 24 kV/m at 2.86 GHz. They also noted that permanent damage occurred when the automobile was not operating. The types components to which damage was observed included engine control units, relays, speedometer, revolution counter, burglar alarm, and a video camera.

It is clear that an unprotected (from HPM) electronics system such as an automobile can be vulnerable to HPM fields at relatively low levels. A field level of 500 V/m or lower has the capability to stop the vehicle. Based on this test data, and the capability today of building a van with an HPM power source of 10 MW and a directional antenna, it would be possible to damage an automobile at a range of 15 meters, and to stop its operation at 500 meters.

*3.5 Susceptibility Conclusions*

It is apparent from the data summarized here that both conducted and radiated disturbances are a threat to commercial systems. Clearly, it is possible to generate conducted wideband waveforms similar to those used for EMC testing of equipment, but with somewhat higher peak levels than those specified for normal home or commercial usage. For radiated waveforms, it is possible to apply microwave oven parts and those from surplus military radars to generate threatening electromagnetic field levels. Of course, generators can be built in laboratories with higher-level capabilities; however, source size is an important factor to be considered when creating threat-level criteria.

The next section describes efforts that are underway to establish environmental threat levels and protection methods in a standardized fashion.

| PC Type | Description of Incident Field | | | Observed Effects |
|---|---|---|---|---|
| | Carrier Frequency (GHz) | Field Strength and Modulation | | |
| | | E (V/m) | Modulation | |
| 133 MHz Pentium | 2.713 | 30 | CW | loss of data |
| | 2.770 | 50 | AM | loss of data |
| | 1.133 | 50 | AM, RP | reset |
| | 2.675 | 50, 75 | AM, RP | loss of access |
| | 2.887 | 75 | AM | loss of access |
| 233 MHz Pentium II | 1.070 | 100 | RP | write error |
| | 1.460 | 100 | CW,AM,RP | power down |
| | 1.480 | 100 | CW | power down |
| 300 MHz Pentium II | 1.040 | 45 | RP | power down |
| | 1.400 | 100 | CW | power down |
| | 1.510 | 100 | AM | power down |
| | 1.515 | 100 | AM | reset |
| | 1.510 | 75 | RP | power down |
| | 1.750 | 75 | RP | power down |
| | 1.430-1.550 | 50 | RP | power down |
| | 1.690 | 85 | RP | power down |

*Table 2: A description of the PCs tested, the incident field properties, and the observed effects [13].*

## 4. Introduction to the IEC

The objective of the International Electrotechnical Commission (IEC) is to produce international standards for electrical and electronic equipment and systems. In particular, the electromagnetic compatibility (EMC) aspects are of interest worldwide for the electronics and power industries, in order to harmonize methods of testing and to develop protection methods and devices. The main part of the EMC immunity work is centered in IEC Technical Committee 77, which has three subcommittees, dealing with different aspects of EMC (77A, 77B, 77C). The work described below is part of the approved program of IEC SC77C, "EMC: High Power Transient Phenomena." The intention of the subcommittee is to apply openly published information and to reference existing IEC EMC standards wherever possible, so that there is no duplication of effort. Those working in the SC77C subcommittee and on particular project teams represent their countries, and not particular organizations (civilian or military). Subcommittee 77C currently has eighteen participating member nations: Austria, Bulgaria, China, Czech Republic, Finland, France, Germany, Italy, Japan, Mexico, Romania, Russia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and USA. In addition, there are fourteen observing member nations: Belgium, Canada, Croatia, Denmark, Ireland, Israel, Republic of Korea, Netherlands, Norway, Poland, Portugal, Slovakia, Thailand, and Ukraine. The Chairman is Dr. W. A. Radasky (USA), and the Secretariat has been undertaken by Sweden (Messrs. M. W. Wik, J-O. Sjödin).

The preparation of SC77C standards is consistent with the development of EMC standards within other parts of TC77 (EMC), and is thus structured according to "IEC Publication 61000," which is divided into seven major parts. Only Parts 1, 2, 4, 5, and 6 are utilized by SC77C, at present. The current development of standards and reports includes seventeen active projects and/or publications, which are summarized below.

## 5. Progress of Work and Highlights

### *5.1 61000-1-X*

Part 1, "General," of the IEC 61000 series includes terminology, definitions, and other general aspects. "The Effects of High-Altitude EMP (HEMP) on Civil Equipment and Systems" (61000-1-3, W. A. Radasky, USA) will provide information concerning the effects of high-altitude EMP (HEMP) on electrical and electronic equipment and systems. This information is based on effects observed during high-altitude nuclear testing, and from tests performed in HEMP simulators in several countries. The project, when complete, will produce an IEC Technical Report, and is in preparation as a Committee Draft for Vote (CDV).

"High-Power Electromagnetic (HPEM) Effects on Civil Systems" (61000-1-5, F. M. Tesche, USA) will result in an IEC Technical Report that discusses the effects of HPEM fields on civilian systems, and illustrates the general protection principles that can be applied to protect systems from this newly emerging threat. The next stage is Committee Draft (CD).

*5.2 61000-2-X*

Part 2, "Environment," gives a description of the high-power electromagnetic environment, and is divided by SC77C into radiated and conducted parts. "Description of HEMP Environment – Radiated Disturbance" (61000-2-9, G. Champiot, France) is published as an IEC International Standard. It contains a number of definitions and the radiated parameters for the early-time, intermediate-time, and late-time HEMP waveforms. This includes electric- and magnetic-field time waveforms, HEMP frequency amplitude and energy, and weighting of the early, intermediate, and late-time HEMP. The standard also deals with reflection and transmission of the HEMP from and through the Earth's surface.

"Description of HEMP Environment – Conducted Disturbance" (61000-2-10, W. A. Radasky, USA) is based on the radiated waveforms in standard 61000-2-9, and is published as an IEC International Standard. It describes the conducted environment applicable for categories of conductors, for different positions and illumination cases taken into account statistically. The specified environments are based on extensive theoretical calculations and experimental measurements.

Part 2 also includes "Classification of HEMP Environment" (61000-2-11, W. A. Radasky, USA), and groups HEMP environments present at various locations outside and inside of civilian systems. The project is published as an IEC International Standard. One reason for classification is to provide guidance for equipment manufacturers, to help them decide on the proper immunity test levels appropriate for their equipment. Another reason is to provide system designers with guidance regarding construction methods and protective measures needed to achieve defined EM classes.

Another, new, Part 2 project, entitled, "High Power Electromagnetic (HPEM) Environments – Radiated and Conducted" (61000-2-13, D. V. Giri, USA) defines the current and near-future high-power electromagnetic (HPEM) environments that are a potential threat to civilian systems, including both the radiated and conducted environments. It is expected that this standard will become the basis for defining appropriate protection methods in the future. The next stage is Committee Draft (CD).

*5.3 61000-4-X*

Part 4, "Testing and Measurement Techniques," presently includes five projects. "Test Methods for Protective Devices for HEMP and Other Radiated Disturbances" (61000-4-23, F. M. Tesche, USA) is published as an IEC International Standard. The document contains definitions; shielding-effectiveness measurement methods for shielding materials, gaskets, and shielded enclosures; and transfer-impedance measurement methods for coaxial cables.

"Test Methods for Protective Devices for HEMP Conducted Disturbance" (61000-4-24, W. K. Büchler, Switzerland) is published as an IEC International Standard. It describes methods to measure the residual voltage on protective devices under HEMP conditions, i.e., for the case of very fast changes of voltage and current as a function of time. This standard complements the standard 61000-5-5, "Specification of Protective Devices for Conducted Disturbance."

"HEMP Immunity Test Methods for Equipment and Systems" (61000-4-25, P. R. Barnes, USA) is in the stage of Final Draft International Standard (FDIS). The document includes a list of immunity tests and environmental conditions, and guidance for the selection of particular immunity tests, test levels, test methods, test equipment, test setups, and test procedures. Efforts have been made to employ as many existing EMC test techniques as possible, and to avoid more-costly special HEMP tests.

"HEMP Simulator Compendium" (61000-4-32, J. C. Giles, USA) is in the stage of Committee Draft for Vote (CDV). The specific aim of this project is to produce an IEC Technical Report that provides information on the various types of existing large HEMP simulators and their uses, performance parameters, limitations, and availability. This will allow all potential simulator users to evaluate the adequacy of available simulators for testing large systems.

"Measurement Methods for High-Power Transients," (61000-4-33, A. Kaelin, Switzerland) is presently planned for Committee Draft (CD). This project provides information on the techniques applicable to the measurement of high-power transient waveforms. It is important for sensor performance to be standardized, so that errors are not made during high field and current testing. Very often, normal sensor design and qualification methods are not applicable when high-intensity fields and currents are present, often with rise times on the order of one nanosecond.

The intention of this work is to identify appropriate sensor calibrations and measurement methods to be used for the measurement of high-power transient electromagnetic disturbances. The project is planning to circulate its first Committee Draft (1CD) in mid-2001.

*5.4 61000-5-X*

Part 5, "Installation and Mitigation Guidelines," presently includes five projects. "HEMP Protection Concepts" (61000-5-3, M. Ianoz, Switzerland) is published as an IEC Technical Report. The concepts presented are based on general principles, such as zoning, grounding, component selection, and circuit and equipment design.

"Specification of Protective Devices for HEMP Radiated Disturbance" (61000-5-4, J. Delaballe, France) is published as an IEC Technical Report. This document identifies the parameters required to accurately specify protection from HEMP-radiated fields.

"Specification of Protective Devices for HEMP Conducted Disturbance" (61000-5-5, W. K. Büchler, Switzerland) is published as an IEC International Standard. This standard identifies the parameters required to accurately specify protection from HEMP-conducted environments.

A project originally started by SC77B, "Mitigation of External EM Influences" (61000-5-6, W. A. Radasky, USA) was transferred to SC77C several years ago. The project is in the stage of Committee Draft for Vote (CDV). The document contains specific information on installation practices for shielding and other types of electromagnetic protection. As indicated by the title, this publication will cover both HEMP and other external EM disturbances, such as lightning and radiated high-power EM threats.

"Degrees of Protection Against Electromagnetic Disturbances Provided by Enclosures (EM Code)" (61000-5-7, C. W. Jones, USA) describes protection properties with respect to electromagnetic fields offered by different types of equipment enclosures. In addition, standardized test methods are identified, along with a codification system that is consistent with the IP code previously established by the IEC. This project has been published as an IEC International Standard.

*5.5 61000-6-X*

Part 6, "Generic Standards," includes "HEMP Immunity for Indoor Equipment" (61000-6-6, P. R. Barnes, USA), presently in the stage of Committee Draft (CD). This work identifies a generic set of environments and test levels to be applied to electronic equipment located inside of buildings, to survive the effects of HEMP.

## 6. Conclusions

This paper has defined the meaning of intentional EMI, and has briefly described the basic categories of the disturbances. In addition, past experiments have been reviewed to indicate the relatively low levels of radiated and conducted environments that have been shown to affect commercial equipment, ranging from PCs to automobiles. Since it is clear that the levels of fields and voltages that can be created using current technology are sufficient to upset and/or damage equipment, there is a standardization effort in the IEC to develop a solution. IEC Subcommittee 77C is in the process of developing a family of HEMP and high-power EM transient standards and reports that will help manufacturers and facility owners protect their equipment from the effects of these disturbances.

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**CSIRO Bolton Post-Doctoral Fellowship** *Continued from page 6*

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# Radio-Frequency Radiation Safety and Health

James C. Lin

## *Blood-Brain Barrier, Cancer, and Mobile Phones*

An important announcement was made on May 22, 2001. A five-year study, by the US National Toxicology Program (NTP), located at Research Triangle Park, North Carolina, will focus on whether microwave radiation from cellular mobile telephones causes cancer. "With over one billion cell phones in use worldwide, it is critical to obtain scientifically rigorous laboratory studies of the potential for health effects from long-term use of these products," said Kenneth Olden, head of the National Institute of Environmental Health Sciences (NIEHS) and Director of the NTP. NIEHS is an arm of the US National Institutes of Health (NIH), based in Washington, DC.

The NTP will be doing the studies at the request of the US Food and Drug Administration (FDA), which had asked for these studies in 1999. The cost is estimated to be approximately $10 million, but most of the funding will be derived from the cellular telephone industry. It will be a major animal study on cell-phone radiation.

Note that major research efforts are underway, also, in several European countries. The most comprehensive appears to be the one coordinated through the European Cooperation in the Field of Scientific and Technical Research (COST), to help provide more definitive information.

A series of recent epidemiological studies has provided some optimism, in that they imply that the use of cellular mobile telephones does not cause brain tumors in the short term [1, 2]. It is also recognized that these investigations do not measure risks – in the long run – for cancers such as brain tumors with longer latency periods of induction, or for slow-growing tumors that could take decades for symptoms to emerge in humans. Therefore, life-span-long research, using animal models, is crucial.

The scientific evidence on cellular-telephone safety or harm remains inconclusive. Many users and nonusers alike are somewhat wary because an effect from wireless radiation, even small, could have a considerable impact on the total population in terms of public health. Indeed, the FDA has offered advice to people who are worried about their cell phones but don't want to give them up, including keeping conversations short, and switching to models with headsets, rather than using hand-held devices.

While cancer – in particular, central-nervous-system cancers – continues to occupy the focal spot of research interest in linking exposure of human cells to cell phones, a series of reports from Sweden [3-5] on the microwave-induced blood-brain barrier (BBB) permeability changes at an extremely low level of microwave exposure (below 1.6 W/kg) has captured increasing attention.

The blood-brain barrier is an anatomic/physiologic complex associated with the cerebral vascular system. It is composed of a network of astrocytic pseudopodia, which envelopes the tight junctions of the vascular endothelium. It is a natural defense system that maintains the physiochemical environment of the brain within certain narrow limits that are essential for life. It functions as a differential filter that permits the selective passage of biological substances from blood to brain. For instance, amino acids, anesthetics, and glucose may gain access to brain cells, while carbohydrates, proteins, and most microorganisms and antibiotics are excluded from brain tissues by the blood-brain barrier. This selective passage is a mixed blessing, because while it prohibits harmful toxins from infiltrating the brain, agents and drugs that are effective in treating diseases in other parts of the body may not be able to gain entree into the brain to combat infection. On the other hand, unintentional opening of the blood-brain barrier may subject the central nervous system to assault from extraneous microorganisms. Also, the ability to selectively open the blood-brain barrier suggests the possibility of using microwave regional hyperthermia to combat infection, or to facilitate chemotherapy for brain tumors.

Since the first report from Ukraine [6], many investigators have reported studies on the effect of microwave radiation on the blood-brain barrier of experimental animals, with varied results. To date, there are approximately 30 reported investigations on the effect of

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microwave radiation on blood-brain barrier permeability [7]. The assay methods employed include (a) visual dye markers, such as Evan's blue, sodium fluorescein, and rhodamine-ferritin; (b) radioactive tracers; (c) horse radish peroxidase (HRP) and electron microscopy; and (d) endogenous albumin.

The visual marker, Evan's blue dye, is normally excluded from the brain, and is very easy to use. Staining of brain tissue provides a clear indication of any dye penetration into the brain. However, like other visual dye markers, it is a qualitative method. Radioactive tracer methods offer a quantitative analysis to assess breaching of the blood-brain barrier.

At high and low specific absorption rates (SARs), studies showing increased blood-brain barrier permeability in experimental animals, and those that did not find microwave-induced disruption of the blood-brain barrier, were about equal in number. Thus, the effect of microwave radiation on blood-brain barrier permeability has remained controversial. Some of the apparent discrepancies undoubtedly stemmed from the complexity of the blood-brain barrier; from differences in microwave exposure conditions, such as frequency, power level, and SAR distribution; and from differences in the use of a variety of assays and procedures to detect changes in blood-brain barrier permeability. Clearly, the highly complex physical and biological phenomena involved requires the development of new experimental, measuring, and observation procedures: these were not always completely controlled in the early research projects.

Until recently, it had been accepted that changes in blood-brain barrier permeability can occur where higher SARs are induced by microwave exposure [8]. In particular, a series of studies from our laboratory, using assays such as visual dye markers, sodium fluorescein, and radioactive tracers, had indicated that when the absorbed microwave power is high enough (165 W/kg or more) to elevate the temperature of the rat brain to about 42° C, blood-brain barrier permeability increases for substances normally excluded [9, 10]. Moreover, microwave-hyperthermia-induced blood-brain barrier disruption has been shown to be reversible within 30 to 45 minutes after exposure. It is interesting to note that intravenous injection of ethanol, prior to microwave irradiation, resulted in cooling of the brain, thereby mitigating against an excessive temperature increase, and this can attenuate or eliminate the observed changes in BBB permeability [11].

A recent series of reports, using the leakage of serum albumin, suggests that repeated exposure to cellular-phone-like microwave radiation can alter BBB permeability at SARs that are well below the maximum permissible level for cellular telephones (1.6 W/kg) [3-5]. A particularly vexing problem with this series of studies is that barrier permeation appears to have been observed at all levels of microwave exposure investigated, including those at an extremely low level (0.016 W/kg). Since this SAR is 100 times lower than that allowed for cell phones, these results could raise serious questions about repeated exposures of the human brain to microwaves from cellular mobile telephones, if independently confirmed. A plausible question might be, "Could albumin and other toxic molecules leak into and accumulate around and in the brain cells?"

On the positive side, a trustworthy opening and closing of the BBB means the possibility of using microwave selective hyperthermia to facilitate chemotherapy of brain tumors. As a natural defense system, not present in other organs of the body, the BBB protects the brain from foreign substances by blocking their passage from the blood. For an intravascularly administered drug to be effective in treating brain tumors, a sufficient quantity must either pass through the BBB, or bypass it entirely.

The incidence rate for brain tumors is currently 12.8 per 100,000 people [12]. This suggests an expected incidence of 36,290 primary brain tumors, based on a 2001 United States population of 283,517,000 people. About 13,000 people in the US die of malignant brain tumors each year.

Slow-growing primary brain tumors (tumors that start in the brain) are often benign or the least malignant, and could take decades for symptoms to emerge in humans. They are usually associated with long-term survival.

The most malignant brain tumors are astrocytoma and glioblastoma multiforme. They lack distinct borders, reproduce rapidly, invade and infiltrate widely. These tumors also induce the formation of new blood vessels, so they can maintain their aggressive growth. They have a necrotic core, areas of dead cells in their center that are hypoxic, deficient in oxygen. At present, the prognosis or prediction about the future course of most aggressive brain tumors is not very encouraging. The survival rate is about one month for watchful waiting, about one year with surgery and radiation therapy, and is improved when combined with some form of chemotherapy.

Many useful antineoplastic agents are not lipid soluble and are excluded by the intact, normal blood-brain barrier. If one could safely and transiently disrupt the blood-brain barrier, water-soluble chemotherapeutic agents could reach the brain tumor and surrounding brain. For example, methotrexate (MTX) is an antifolate widely prescribed in chemotherapy for a variety of neoplasms. It is the drug most often used for high-dose chemotherapy. However, the blood-brain barrier permeability of MTX is among the lowest of the agents currently used clinically.

The effect of selective microwave hyperthermia in the brain of anesthetized rats has been investigated for the transport of MTX across the blood-brain barrier [13]. Standard high-pressure liquid chromatography (HPLC) analysis was performed to determine the drug concentration in various brain regions. The concentration of MTX in brain tissue with or without microwave hyperthermia was compared. The quantity of MTX uptake by the brain after microwave hyperthermia treatment was tested as a function of time after microwave hyperthermia treatment. Results indicated that MTX uptake was significantly increased (about 20 fold) in rat brains subjected to the opening of the blood-brain barrier by selective microwave hyperthermia treatment. Furthermore, the increase is reversible within 45 minutes, post-irradiation. Thus, microwave-hyperthermia-induced permeation of the blood-brain barrier significantly facilitates the delivery of anticancer drugs such as MTX, which is normally excluded from the brain.

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# Conferences

## CONFERENCE REPORTS

## ASTRONOMICAL SITE EVALUATION IN THE VISIBLE AND RADIO RANGE (SITE 2000)

Marrakech, Morocco, 13 - 17 November 2000

Co-sponsored by URSI, a technical workshop on Astronomical Site Evaluation in the Visible and Radio Range, took place 2000 November 13-17 in Marrakech, Morocco. The conference, attended by over 125 scientists from more than 20 countries, was dedicated to Rodney Marks, a young Australian astronomer who died on 2000 May 12 while stationed at the South Pole. Marks had written his thesis on determination of the astronomical seeing at the South Pole from microthermal measurements of the atmosphere.

Over the last 10-15 years, our understanding of the Earth's atmosphere and its influence on astronomical observations has dramatically improved. A sound physical basis for the measurement and interpretation of the key atmospheric parameters for astronomical research at all wavelengths has been established and translated into working field equipment. This development has occurred in increasingly close collaboration with the atmospheric sciences, drawing on atmospheric modeling and a better knowledge of turbulence parametrization. As a result, the evaluation and intercomparison of existing and potential observing sites has reached a level of sophistication, detail, and reliability hardly imagined only 25 years ago. The experience over this period has led to dramatic improvements in the delivered image quality at existing observatories, both with conventional telescopes in suitable mountings and enclosures and through the development of adaptive optics and optical interferometry to the operational stage. At the same time, the wavelength range covered from a single observatory has increased dramatically; at observatories initially established for optical astronomy, infrared and (sub)mm astronomy have become of increasing importance.

These advances greatly increase the demands on the atmospheric qualityof potential future observatory sites. Because of multi-year cycles of climate variation, measurements must extend over long periods. Furthermore, diagnostics of the rapid rise in man-made perturbation of the environment must also be included, such as potential airborne pollution from (natural and) artificial sources, interference from urban development and airline traffic, and radio noise from ground and space based radar or communications installations. Together, these developments greatly expand the range of atmospheric and other environmental parameters to be quantified and considered in the selection of future observatory sites. On the one hand, this implies greater complication and more rational planning of the equipment and analysis techniques to be deployed in future site testing campaigns. On the other hand, the more detailed understanding of the atmosphere resulting from these measurements is itself of scientific value that transcends the narrow borders of astronomy into the environmental sciences. Finally, the recent commissioning of several very large telescopes on a very small number of sites has highlighted the need to prepare an inventory of the - presumably few - remaining sites on Earth where adequate conditions still exist for future major observatories, so the options are known and, if necessary, protective measures can be taken in time.

The aim of the Site 2000 workshop was to assess the state of the art with regard to astronomical site testing methods and instruments across the entire ground-based optical, infrared, and (sub)mm wavelength ranges. Eight sessions were spread over five days, each with an invited review followed by several contributed talks: Physical Mechanisms of Atmospheric Turbulence, Measuring Instruments in the Visible, Site Characterization and Atmospheric Transparency in the mm/submm Range, Tropospheric Phase Stability and Compensation Schemes, Forecasting, Site Surveys (in two parts), Astroclimatic Stations, and Phase Correction: Adaptive Optics and Interferometry. In total, about 85 talks and poster were presented. The proceedings will be published in the Astronomical Society of the Pacific Conference Series.

An emphasis was placed on the physical mechanisms governing the propagation of waves in the atmosphere, their origin and consequences. Special mention was made of all the techniques that allow evaluation of the perturbation along the beam path: remote sensing, in situ probing,and atmospheric modeling. A detailed survey of the major astronomical sites was presented, as well as the requirements of ground based astronomy for the next decades. Although this meeting was devoted to gaining a better insight into the physical phenomena, related fields of astronomy were included, such as interferometry and adaptive optics. Special attention was given to Moroccan sites.

In addition to the scientific sessions, three public lectures were givenin conjunction with the conference. A. Labeyrie (College de France) spoke on Hypertelescopes and Extraterrestrial Life, R. Giovanelli (Cornell U.) spoke on The Expanding Universe: Observational Foundations of Modern Cosmology, and J. M. Robillot (U. Bordeaux) spoke on Astronomy and the Exploration of the Universe. The conference concluded with an overnight visit to the observing station at Oukaimeden in the high Atlas mountains.

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# INTERNATIONAL REFERENCE IONOSPHERE 2001 WORKSHOP ON THE LOW LATITUDE IONOSPHERE (IRI 2001)

São José dos Campos, Brazil, 25 - 29 June 2001

The 2001 IRI Workshop was held at the Instituto Nacional de Pesquisas Espaciais in São José dos Campos, Brazil in the week from June 25 to 29. It was attend by about 60 scientists including representatives from USA, Russia, India, Peru, South Africa, Japan, Spain, Argentina, U.K., Czech Republic, Chile, and Brazil. The 75 papers were presented in 8 oral sessions and in 1 poster session. The titles of the oral sessions were: The Equatorial Anomaly Region, Total Electron Content and Topside, Description of Ionospheric Variability, Modeling the Low Latitude Ionosphere, Ion composition, Scintillation and Spread-F, Representation of F Peak and Bottomside Parameters, New Data and Model Inputs and Applications. The workshop opened with a welcome address by the INPE Director, V.W.J.H. Kirchhoff and was followed by an overview talk by D. Bilitza (USA) describing the new version of the IRI model, IRI-2001. The meeting was well prepared and organized thanks to the excellent efforts of the Local Organizers: J. H. A. Sobral, M.A. Abdu, and I.S. Batista. Financial support was provided by the Committee on Space Research (COSPAR), the International Union of Radio Science (URSI), the International Center for Theoretical Physics (ICTP), the Instituto Nacional de Pesquisas Espaciais/ Ministério da Ciência e Tecnologia (INPE/MCT), the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), the Sociedade Brasileira de Geofísica (SBGf), and the Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superios (CAPES). The papers and posters from this workshop will be considered for a special issue of Advances of Space Research.

## Electron Density: D and E Region

Two new D-region options have been introduced with IRI-2001 and now await testing by the user community. The standard IRI D-region model remains in effect as before. A few first comparisons have shown good agreement between the three model options as pointed by Bilitza (USA) in his IRI-2001 overview talk. Pulinets (Russia) pointed out the existence of a large data base of absorption measurements in Russia that could be of help in modeling long-term trends of D-region densities. He will contact the responsible scientists. McKinnell (South Africa) presented a Neural Network (NN) model for E region parameters based on ionosonde data from Grahamstown, South Africa.

The E region in general is well represented by IRI. But some areas of improvement remain: (1) The correct representation of the depth of the nighttime E valley. Incoherent scatter measurements and theoretical studies have shown that the current IRI E-valley is too deep. (2) The enhanced E region ionization due to particle precipitation at auroral latitudes. Bradley (U.K.) reviewed models for sporadic-E as a starting point for the future inclusion of a sporadic-E model in IRI.

## Electron Density: F1 Region and F2 Bottomside

IRI-2001 provides considerably improved profiles in this region and includes the F1 probability as a new parameter. These improvements are a result of the annual IRI Task Force Activity that is organized by Radicella (Italy) at the Abdus Salam International Center for Theoretical Physics (ICTP) in Trieste, Italy. Presentations by Reinisch (USA), Mosert (Argentina), Ezquer (Argentina), Adeniyi (Nigeria; presented by Bilitza), and Mahajan (India) discussed these efforts and pointed out areas for future improvements. The IRI group strongly pursues and encourages the establishment of a data base of F1 and bottomside parameters from a large number of globally distributed ionosondes. Especially at high solar activities the current IRI bottomside thickness parameter B0 underestimates Jicamarca incoherent scatter data. The great potential of Jicamarca incoherent scatter data for IRI modelling was reviewed by Chau (Peru). Comparisons of Brazilian rocket data with IRI were presented by Sobral (Brazil) and Muralikrishna (Brazil).

## Electron Density: F2 Peak Parameters

With the 2001 version IRI now includes a model for the description of storm effects. The storm-time updating model of Fuller-Rowell et al. (USA) describes the changes in F2 peak density in terms of the of the 3-hourly ap index (13 values prior to observation time). First comparison with ionosonde and Total Electron Content (TEC) data were presented by Radicella (Italy). The model predicts the observed trends but the study also underlines the importance of the next step in storm effects modeling, namely the description of the storm-induced changes in the F2 peak height hmF2.

Another prominent feature still missing in the IRI hmF2 model, is the characteristic peak shortly after sunset at equatorial latitudes. With the introduction of the Scherliess-Fejer equatorial ion drift model in IRI-2001, one could now try to include this feature by exploiting the strong correlation between hmF2 and vertical ion drift at the equator especially during nighttime. Obrou (Ivory Coast) and Bilitza (USA) studied this correlation with ionosonde data from Korhogo (Ivory Coast). Batista (Brazil) plans to investigate this aspect further with South American data. The current hmF2 model in IRI is based on the CCIR model for the propagation factor M(3000)F2. Adeniyi (Nigeria) and Bilitza (USA) showed that by using measured values of M(3000)F2, instead of the CCIR model, the evening peak in hmF2 could quite often be reproduced. Their study is based on ionosonde data from Ougadougou, Burkina Faso, an African station close to the magnetic equator. A better representation of hmF2 during quiet as well as storm time will be an important future goal of the IRI group.

Intercosmos 19 topside sounder data were used to study the equator anomaly region and the longitudinal distribution of F peak and topside parameters (Deminova and Karpachev (Russia). Torres (Chile presented a systematic comparative study of ionosonde data from Brazil and Chile and found in general good agreement between the foF2 and hmF2 measurements and the IRI predictions for low solar activity and discrepancies during high solar activity especially during nighttime. Lazo and Calzadilla (Cuba; presented by Radicella) showed how spherical harmonic analysis can be used for regional foF2 mapping for the European and American sector. Ways to fully access the large amount of ionosonde data stored on microfilm were discussed by Wright (USA)

## Electron Density: Topside, Plasmasphere and TEC

The times and frequency of occurrence of an additional layer (the so-called F3 layer) above the F2 peak were discussed by Batista (Brazil) based on data from ionosondes and topside sounders. Such a layer develops when the equatorial vertical drift pushes the F2 peak upward while simultaneously a new F2 peak develops at lower altitudes due to the standard F layer forming processes. This equatorial phenomenon is most often found during daytime summer and high solar activity. More statistical studies are needed before this feature can be included in IRI.

Shortcomings of the current IRI topside model were discussed by Ezquer (Argentina) based on comparisons with in situ data from the Japanese Taiyo satellite. Efforts to improve the IRI topside model continue with topside sounder data from Alouette and ISIS (Bilitza, USA), and Intercosmos 19 (Pulinets, Russia). Bilitza (USA) proposed a correction factor to better represent the upper topside. Iwamoto (Japan) discussed ways of correcting the current IRI topside formulas to better represent ISS-b measurements.

Argentine IRI studies with topside and TEC data were discussed by Ezquer Argentina) and Mosert (Argentina). A TEC model for the Brazilian region was compared with IRI and discrepancies were found during sunrise (1-hour shift) and midnight (IRI does not include the observed peak near midnight) (Souza, Brazil). An effort was initiated during the workshop to develop a TEC model for the whole South American continent. The validation of GPS deduced TEC maps from several groups with TOPEX data revealed shortcomings of several of the map algorithms (Orus and Garcia-Fernandez, Spain). An overview of the activities of the International GPS Service (IGS) Ionosphere Working Group was provided by Feltens (Germany; presented by Bilitza). The Barcelona, Spain UPC group will continue to pursue the updating of IRI with GPS data as a promising way to get better IRI predictions.

Efforts to combine IRI with a plasmaspheric model continue. Gallagher's GCPM and Chasovitin's SIM have been proposed as candidate models. Triskova (Czech Republic) pointed out Magion satellite data as potential data source and Oyama (Japan) the Akebono data.

## Electron Density: Spread-F and Variability

A model describing the occurrence probability of Spread-F in the American longitude sector was presented by Abdu (Brazil). The model describes the probability in terms of local time, season, solar flux, and latitude (dip=+/- 25). The dominant features of spread-F occurrence in the Indian sector were discussed by Chandra (India) highlighting the strong correlation with solar activity. Combining the Brazilian and Indian efforts should produce a first global spread-F model for IRI. Ezquer (Argentina) reported about first GPS scintillation measurements at Tucuman, Argentina. Iyer (India) compared the scintillation indices (SI, S4) derived from data of the anomaly crest station Rajkot with the models of Aerons and Secan. Wright (USA) discussed the monitoring of Spread-F with digital ionosondes and pointed to the IGY-era "f-plots" as a data source.

Quantitative description of ionopsheric variability (i.e. standard deviation from a monthly mean) are now the primary goal of the IRI Task Force Activity at ICTP. At this workshop first results were presented by Mosert (Argentina) regarding the variability of TEC based on data from two Argentine stations.

## Electron and Ion Temperatures

IRI now includes the Truhlik-Triskova-Smilauer model as a new option for the electron temperature. This new model includes the early morning peak in temperature that is currently represented by the standard IRI model only in the F region not in the topside. An important next step is now a correct representation of solar cycle variations. The effect of geomagnetic inclination of electron density and temperature was discussed by Oyama (Japan) based on his Hinotori satellite data. Truhlik (Czech Republic) intends to use the formalism developed for his electron temperature model to also produce a global ion temperature model. Incoherent scatter data could play an important role in improving the IRI plasma temperature models, especially the variation with season and solar activity as was pointed out by Mahajan (India) and Chau (Peru).

## Ion Composition and Drift

Triskova and Truhlik (Czech Republic) presented a new model for the ion composition ($O^+$, $H^+$, $He^+$, and $N^+$) in the altitude range 500 to 3000 km based on data from Intercosmos 24 (ACTIVE) and from the Atmosphere Explorer satellites. The model describes the ion densities in terms of local time and a specially introduced magnetic field coordinate. The authors plan to also use ion composition data from ISIS 1, ISS-b, AE-B and AEROS to extend their model particularly in terms of the description of solar cycle variations. An effort at the National Space Science Data Center (NSSDC) to make older ionospheric satellite data (like ISIS 1, AEROS and AE) available online was described by Bilitza (USA). Truhlik (Czech Republic) introduced a new model for the light ion density ratio based on ISIS 2, ISS-b, and Intercosmos 24 data. Currently IRI use a constant value of 0.1 for this ratio. It was decided to include the new model in the next version of IRI.

Anderson and Reinisch (USA) pointed to the potential for deducing the daytime electrojet current and vertical ExB ion drift from equatorial magnetometer measurements.

## Applications, New Members, and Future Meetings

A 3-D visualization of the Earth globe with surrounding IRI ionosphere nicely illustrated the great educational capabilities of IRI in conjunction with graphics tools (Watari and Iwamoto, Japan).

Lee-Anne McKinnell (Rhodes University, Grahamstown, South Africa), Vladimir Truhlik (Institute of Atmospheric Physics, Prague, Czech Republic), and V. K. Depuev (IZMIRAN, Moscow, Russia) were elected as new members of the IRI Working Group.

In 2002 there will be a number of meetings with IRI involvement. Most importantly the next IRI workshop will be held as a session C4.3, entitled "The Path toward Improved Ionosphere Specification and Forecast Models", during the World Space Congress 2002 (34th COSPAR Scientific Assembly) in Houston, Texas (10-19 October, 2002). Session C0.1 (Standard Space Environment Models for ISO) during the same congress will discuss models that are proposed to the International Standardization Organization (ISO) including the IRI model for the ionosphere. During the URSI General Assembly in Maastricht, Netherlands (18-24 August 2002) session G2, entitled "Operational Ionospheric Models Including Data Ingest" is of special interest for the IRI group.

For the 2003 IRI Workshop the IRI Working Group has been presented with two proposals: (1) Rhodes University, Grahamstown, South Africa; (2) Polytechnical University of Catalonia, Barcelona, Spain. The local organizers were tasked with exploring local funding possibilities to support the workshop logistics and maybe also local travel for participants from the region.

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# ISSSE 2001

Tokyo, Japan, 24 - 27 July 2001

The International Symposium on Signals, Systems and Electronics was held this year in Tokyo, Japan, July 24-27. Its motto was "Questing more significant harmony and integration: Systems/Devices and Software/Hardware". The organisers had taken great efforts to put together an interesting program and a nice, hospitable surrounding (and a grand dinner). The fashionable venue, a large hotel in Tokyo, made attendants forget how hot is was outside in the street -even the local residents said it had been unusually hot.

Altogether there were 114 papers, about half of them invited. The bulk came from Asia (58), 39 were authored by Europeans and 12 by North Americans, with the rest divided among South America, Africa, and Oceania. Registration turned out to be disappointing: only 120 persons attended,which was a shame given the fine program offered and the hard work put into the organisation. The reason for this limited attendance is not very clear. It is to be feared that it will be hard to find organisers for ISSSE in 2004.

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# ATELIER "REMOTE SENSING BY LOW-FREQUENCY RADARS"

Naples, Italie, 20 - 21 septembre 2001

Cet atelier était organisé conjointement par : CO.RI.S.T.A. (Consortium of Research on Advanced Remote Sensing Systems) et-EARSeL (European Association of Remote Sensing Laboratories, avec le concours de l'ESA et d'ALENIA-Spazio et sous le patronage du Ministère italien des Universités et de la Recherche Scientifique et Technique ainsi que de la Région de Campanie.

L'atelier était organisé en quatre sessions :

- Spaceborne low-frequency radar systems : technological aspects and applications of new satellite systems
- Airborne low-frequency radar systems : technological aspects and applications of new airborne systems
- Ground based low-frequency radars : technological aspects and applications of new ground based systems»
- data processing numerical modelling,inverse problems and tomography

Plus de cinquante participants (Treize nationalités représentées) se sont réunis pour écouter et commenter quarante exposés traitant de l'intérêt scientifique de divers radars fonctionnant en fréquences basses ou multibandes.

La technique de l'antenne synthétique (SAR : Synthetic Aperture Radar) est largement utilisée; il est vrai qu'elle présente l'avantage d'obtenir des résolutions spatiales qu'il serait impossible d'avoir à ces fréquences au moyen d'antennes de dimensions acceptables; les conditions de mises en œuvre de cette technique ,notamment la durée d'observation, ne sont pas la plupart du temps un obstacle ce qui la rend indispensable pour les projets aéroportés ou spatiaux.

Il ressort aussi que l'association des bandes de fréquences basses avec les diversités de polarisation et d'incidence (en particulier en observation spatiale) accroît considérablement la qualité des données de cartographie.

De nombreux projets (EARTH WATCH, MARISIS, Radar Sail, CARABAS III...) ont été présentés à des étapes de développements divers : tous intéressants ils illustrent la grande activité créatrice en ce domaine.

L'analyse des résultats de quelques expérimentations a été l'occasion de suggérer des modèles plus perfectionnés de réflectivité, mais il reste, à l'évidence ,encore beaucoup de travail systématique et critique à faire tant les expériences sont diverses et partielles. Il est regrettable que ces travaux n'aient pas mentionné l'impact des brouillages inévitables dans ces bandes, soit sur les conditions de mesure, soit sur les biais éventuels des résultats soit encore sur les traitements à mettre en œuvre a posteriori pour garantir l'intégrité des données utiles.

De nombreuses applications des radars de sondage du sous-sol (GPR:Ground Penetrating Radar) ont été exposées. A défaut de découverte importante, les expériences très diverses rapportées sont très utiles pour faire progresser ce sujet difficile (A noter The Ninth International Conference on GPR, GPR 2002, April 29-May 2, 2002 at Santa Barbara CA, USA).

Les fréquences centrales de fonctionnement proposées pour tous ces radars étant entre 100MHz et 1500MHz environ et les bandes passantes des signaux émis étant étendues on s'étonne du peu d'attention porté , en général, à la possibilité d'obtenir l'autorisation d'émettre dans cette partie du spectre déjà très occupée!

On s'attendait à ce qu'à défaut de solutions établies cette difficulté ne soit pas oubliée mises à part quelques allusions vagues. Des projets en V/UHF à large bande requérant des puissances de plusieurs centaines de watts ne sont pas réalistes si les conditions de leur accès au spectre ne sont pas examinées de manière approfondie dès le début du projet.

De même on aurait aimé bénéficier d'au moins un exposé sur l'état de l'art des modèles de propagation en fréquences V/UHF tant prisées par ailleurs.

Comme d'habitude nos hôtes italiens ont su créer l'atmosphère sympathique propice aux échanges techniques: qu'ils soient ici vivement remercier.

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# School on Analysis Techniques for Space Plasma Data

La Londe-Les Maures, France, 8 - 13 October 2001

The school on analysis techniques for space plasma data was held in La Londe-Les Maures (southern France) from 8 to 13 October 2001. The sponsors of this school were: Centre National de la Recherche Scientifique (CNRS, France), host, Centre National d'Etudes Spatiales (CNES, France), Committee for Space Research (COSPAR), European Space Agency (ESA), International Space Science Institute (ISSI, Switzerland), Programme National Soleil-Terre (PNST, France), Research Systems Inc. (RSI, UK), International Union of Radio Science (URSI).

The objective of this school was to review the basic and more advanced techniques for analyzing plasma data as gathered by spacecraft. A central issue was the interpretation of the techniques, their validation and the understanding of their limitations. The programme included topics such as basic statistics (probability distributions, covariance), higher order statistics (structure functions), spectral analysis (Fourier and wavelet techniques), higher order spectra, phase space methods and nonlinear dynamics, prediction, and multipoint techniques for CLUSTER. The school mainly consisted of tutorial lectures, with some short talks dedicated to specific applications, and informal computer sessions in the afternoon.

The attendance of this school was limited to 70 participants, but the large number of applications we received, suggests that there is today a considerable demand for this kind of meeting. Most of the participants came either from european countries or from the U.S., with about 50% of PhD students.

A key issue in such a school is a proper matching between the material that is presented, and the expectations of the participants. The latter came from different communties and showed a broad spectrum of expectations and rather different prior knowledge in data analysis. The tutorial lectures were widely appreciated and the diversity of concepts provided an excellent opportunity for cross-fertilization between different disciplines. There was a strong demand, however, for more examples of applications to space plasma data. The participants also expressed their need for formal computer sessions with hands-on exercices, rather than informal meetings.

A final round-table discussion provided valuable feedback about the expectations with regard to a future edition of this school. The following points clearly came out:

1) there is a clear need for tutorials addressing either specific problems (e.g. how to analyse transients, how to deal wit data gaps) or providing physical understanding on data analysis techniques. This need is expressed both by young and by senior scientists.
2) in a school, the presentations should be tutorial and definitely depart from the usual conference style, which was often considered as a major obstacle to efficient learning. We also noted, however, that the barriers for turning a conference presentation into a good tutorial are very high !
3) the programme should offer a multilevel approach, with a balance between the following:
   - tutorials that first clarify the basic concepts, and then provide the appropriate material for understanding how the technique works;
   - applications to space plasmas, with examples on how the technique is applied and what its limitations are;
   - computer sessions, both informal (free access) and formal (the lecturers provide some test examples and exercices).
4) a large fraction of the space plasma community is today involved in the analysis of CLUSTER II data, which require several specific concepts and techniques. A good understanding of univariate (in contrast to multivariate or multipoint) techniques, however, is still essential for properly exploiting multipoint data.
5) finally, there is a demand for a repository where one could upload software for basic techniques and find links to sites of interest. Preferred languages for software are by far IDL and Matlab, and thereafter C/C++ and Fortran.

For more information and feedback about the school, inluding copies of the presentations, see http://www.tu-bs.de/institute/geophysik/la-londe/

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# 2001 CIE INTERNATIONAL CONFERENCE ON RADAR

Pekin, Chine, 15 - 18 octobre 2001

La grande Conférence Internationale annuelle sur le radar s'est tenu à Pékin du 15 au 18 octobre; elle était organisée par l'Institut Chinois d' Electronique (CIE) avec le concours de l'IEEE-AESS (USA), de l'IEE Electro. Div. (UK), de la SEE (F) et de l'IEICE (Japan). Les prochaines conférences internationales auront lieu en Grande-Bretagne en 2002 et en France en 2004, celle de 2003 n'étant pas encore fixée.

Vingt-quatre pays étaient représentés parmi les plus de trois cents participants qui ont eu à examiner 270 exposés groupés en 18 sessions de présentation orale et 5 de présentation affichée.

Les attentats du 11 septembre aux Etats Unis d'Amérique ont eu pour conséquence une moindre participation étrangère; néanmoins les communications ont, grosso modo, couvert l'ensemble des thèmes d'actualité radar.

La confidentialité des caractéristiques et des performances inhérentes aux matériels a eu pour effet, aussi bien du côté République Populaire de Chine que du côté étranger, de mettre l'accent sur les aspects scientifiques et techniques.

En ce qui concerne les systèmes, la plupart des principes mis en œuvre dans les développements les plus récents ont été exposés et comparés.

Le principe **SAR** (Radar à ouverture synthétique) a fait l'objet de nombreux exposés, en particulier sur les deux thèmes suivants: effets des résidus de compensation des mouvements du porteur et dispositifs de détection des cibles mobiles. Relativement à ce deuxième thème, nous avons relevé trois conférences:

- Spaceborne Synthetic Aperture Radar raw data simultion of three dimensional natural terrain par CHEN Jie, ZHOU Yin-qing, LI Chun-sheng
- Wideband coherent airborne radar systems: performances for moving target detection par A. BECKER et F. LE CHEVALIER
- Moving target detection in wide band SAR par M. PETTERSSON.

Le principe **DBF** (Formation de faisceau par le calcul) a fait l'objet d'un exposé général par E. BROOKNER et de nombreux autres

Les radars fonctionnant à basses fréquences en général, notamment **OTH** (Radars trans-horizons), et **UWB** ( Radar à très large bande ) ont fait l'objet de très nombreuses communications; plusieurs projets combinent même les deux principes. A ce propos on remarque qu'il est explicable que l'accès au spectre ne soit pas la préoccupation principale des chercheurs en télédétection, mais il est étonnant que des industriels qui investissent leur avenir dans le développement de nouveaux équipements ne soient pas plus préoccupés des conditions strictes de cet accès (Cf. supra l'exposé de M. Pettersson dont le projet devrait fonctionner avec la bande 200-800 MHz. ).

En ce qui concerne les techniques, les plus fréquemment traitées ont été:

- le couplage GPS/INS (Navigation à l'aide de satellites et dispositifs inertiels ) afin d'améliorer la précision et la résistance aux brouillages,
- la haute résolution,
- l'anti-brouillage,
- l'imagerie, notamment la technique STAP (Traitement adaptatif temps-fréquence ) à laquelle une session entière a été consacrée,
- les CFAR (Dispositifs à taux de fausse alarme constant),
- la polarimétrie ( A noter la conférence théorique du Professeur KE Youan «Notes on invariant characters of radar cross sections» ),etc....

En ce qui concerne l'environnement, quelques conférences sur le fouillis de mer ( Conférence de S. WATTS sur les modèles de mer et leur adéquation à comparer les performances des radars ) et de végétation (Polarimetric classification of trees par Yosho YAMAGUCHI ).

Compte tenu du nombre élevé d'exposés - quatre sessions à présentation orale simultanées- il eut été intéressant de synchroniser les présentations de manière à pouvoir bénéficier du plus possible d'entre elles suivant les pôles d'intérêts de chacun ;ça n'a malheureusement pas été le cas; il est vrai que cela aurait demandé une grande discipline de la part des Présidents de sessions. A l'avenir, pour des conférences de cet ampleur, il faudrait peut-être bien en arriver là.

Enfin nous avons noté la participation de plusieurs membres du Comité National Chinois Radio Scientifique de l'URSI dont son Président le Professeur SHA Zong, également Président-Adjoint de l'Institut Chinois d'Electronique (CIE).

La Conférence s'est achevé par plusieurs visites techniques et culturelles, notamment celle d'une exposition sur les radars organisée dans le Musée Militaire tout proche.

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# CONFERENCE ANNOUNCEMENT

## Open Symposium on Propagation and Remote Sensing

Garmisch-Partenkirchen, Germany, 12 - 15 February 2002

### General

The Triennium Open Symposium of URSI Commission F is an established international conference with a focus on the latest research in Propagation and Remote Sensing. The Open Symposium in 2002 will build on the success of previous years in providing a premier forum for the scientific community to discuss the latest results and to identify developing trends. The conference programme will include a number of keynote presentations by leading researchers, intended to review recent progress in each field and define the current "state of the art". The high degree of interaction between the two areas represented by URSI Commission-F is a particular strength and will continue to be encouraged.

The Symposium will take place in the attractive Alpine resort of Garmisch-Partenkirchen in Bavaria, Southern Germany, between the 12th and 15th of February, 2002 and is sponsored by DLR (Deutsche Zentrum für Luft- und Raumfahrt e.V., Institut für Hochfrequenztechnik und Radarsysteme) and URSI.

### Topics

**Propagation**

- Terrestrial and slant path millimetre wave propagation
- Propagation for indoor (wireless local loop) and transport Systems
- Tropospheric, ionospheric and trans-ionospheric propagation
- Propagation aspects of frequency management
- Propagation modelling and tools for system design
- Propagation in subsurface and biological media
- Radar application in propagation research
- Radio meteorology and climatology, including clear air and precipitation effects

**Remote Sensing**

- Radar and radiometer remote sensing of land, sea, ice and atmosphere
- Applications in environmental and disaster management
- Forestry, agriculture and surface topography
- Radar meteorology
- Polarimetric and Doppler radars
- Polarimetric interferometry and tomography
- Remote sensing of buried objects
- Radar and radiometer design
- Propagation aspects of radar
- Oceanographic remote sensing

### Contact

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## World Space Congress 2002
## 34th COSPAR Scientific Assembly

Houston, Texas, USA, 10 - 19 October 2002

### General

The Second World Space Congress will be a joint meeting between the Committee on Space Research (COSPAR) and the organizations which meet during the International Astronautical Congress, i.e., the International Astronautical Federation (IAF), the International Academy of Astronautics (IAA), and the International Institute of Space Law (IISL).

### Topics

Approximately 80 events covering the fields of COSPAR Scientific Commissions and Panels:

- Commission A: The Earth's Surface, Meteorology and Climate
- Commission B: The Earth-Moon System, Planets, and Small Bodies of the Solar System
- Commission C: The Upper Atmospheres of the Earth and Planets Including Reference Atmospheres
- Commission D: Space Plasmas in the Solar System, Including Planetary Magnetospheres
- Commission E: Research in Astrophysics from Space
- Commission F: Life Sciences as Related to Space
- Commission G: Materials Sciences in Space
- Commission H: Fundamental Physics in Space
- Panel on Satellite Dynamics (PSD)
- Panel on Scientific Ballooning (PSB)
- Panel on Potentially Environmentally Detrimental Activities in Space (PEDAS)

- Panel on Standard Radiation Belts (PSRB)
- Panel on Space Weather (PSW)
- Panel on Planetary Protection (PPP)
- Panel on Space Research in Developing Countries (PSRDC)
- The Public Understanding of Space Science
- Space Science Education and Outreach

## Scientific Program

A0.1: Properties of the Earth-Atmosphere-Ocean System as Inferred from the New Generation of Earth Science Satellites

A0.2/C0.3: Calibration, Characterization of Satellite Sensors, Physical Parameters Derived from Satellite Data

A0.3: Natural and Manmade Hazards Management Using Space Technology

A0.4: Trends in Earth Research Satellite Missions

A0.5: Assimilation of Satellite Observations

A1.1/C2.7: Climate Change Processes in the Stratosphere and at the Tropopause

A1.2: Trace Constituents in the Troposphere and Lower Stratosphere

A2.1: Biological and Physical Oceanographic Processes from Satellite Data

A3.1: Characterization of Land Surfaces with Satellite-borne Sensors

B0.1/D3.7: Mercury: Knowledge and Plans for Exploration

B0.2/C1.3: NEO Impact Hazards on Earth and Other Solar System Bodies

B0.3/F3.3: The Moon: Science, Exploration, and Utilisation

B0.4/C3.4: Mars Exploration: Latest Results and Current Status of International Cooperation

B0.5/D3.5: Outer Planets Scientific Exploration

B0.8/C3.2/D3.6: Saturn Two Years Before the Beginning of the Cassini Tour

B1.1: Exploration of Small Solar System Objects: Past, Present and Future

B1.2: Interpretation of the Remote and In-situ Observations of Small Bodies

B1.3: Science, Strategies, and Techniques for Sample Return and Curation

C0.1: Standard Space Environment Models for ISO

C1.1: Coordinated Space and Ground-Based Observations of the Ionosphere-Thermospheric Structure and its Response to Energy Inputs

C1.2/B1.5: Meteor Induced Chemistry, Ablation Products and Dust in the Middle and Upper Atmosphere

C2.1: Middle Atmosphere Structure and Dynamics

C2.2: Structures Around the Polar Summer Mesopause

C2.3: Long-Term Trends in the Thermosphere-Mesosphere-Stratosphere Coupling

C2.4: The Non-Zonal Structures in the Middle Atmosphere and Lower Ionosphere

## Deadline

1 May 2002, but the deadline for abstracts submitted to the IAC is 1 February 2002.

## Contact

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# 12TH INTERNATIONAL SYMPOSIUM ON ANTENNAS
# JINA 2002

Nice, France, 12 - 14 November 2002

## General

The twelfth edition of the biennial "Journées Internationales de Nice sur les Antennes" will be held at "Palais des Congrès Acropolis" in Nice, France, from 12 to 14 November 2002. As in previous editions, presentations will include invited conferences and convivial posters selected among submitted proposals.

## Topics

- Theorical electromagnetism
- Analytic and numerical techniques
- Scattering and inverse scattering problems
- Integration, coupling and interaction, EMC
- Synthesis and optimization
- Design and expert systems
- Reflector antennas and lenses
- Radiating elements and associated circuits
- Frequency selective surfaces
- Multifrequency and/or wideband antennas
- Millimetre and sub-millimetre wave antennas
- Array antennas
- Beamforming, MEMS
- Adaptive and signal processing antennas
- Active and integrated antennas

- Printed antennas
- Conformal antennas
- New materials
- Photonic bandgap structures
- Antennas for space applications
- Antennas for mobile communications
- Industrial and medical applications
- Measurements and instrumentation
- Power handling
- Radar cross section
- Discrete targets

## Deadlines

May 15, 2002: Deadline for submission of complete papers
July 15, 2002: Notification of accepted papers

## Contact

Secrétariat JINA 2002, France Télécom R&D
Fort de la Tête de Chien
06320 La Turbie, France
Fax : +33 4 92 10 65 19
E-mail : jina.cnet@wanadoo.fr
Web site : www.jina2002.com

# 2002 Asia-Pacific Microwave Conference (APMC 2002)

Kyoto, Japan, 19 – 22 November 2002

## General

The 2002 Asia-Pacific Microwave Conference (APMC 2002) will be held at the Kyoto International Conference Hall, Kyoto, Japan, on November 19-22, 2002. This conference is organized and sponsored by the Institute of Electronics, Information and Communication Engineers (IEICE) of Japan, and will be cooperatively sponsored by IEEE MTT-S, URSI, IEEE MTT-S Japan Chapter and IEEE EDS Kansai Chapter.

## Topics

**Active Devices and Circuits**

- Low-Noise Devices and Circuits
- High-Power Devices and Circuits
- Control Circuits (MIX, Osc., SW, etc.)
- MMICs and HMICs (Receivers, Transmitters, etc.)
- Silicon RF Devices

**Passive Components**

- Filters and Resonators
- Ferrite and Surface Wave Components
- Packaging Techniques
- Passive Devices and Circuits
- Waveguides and Striplines

**Systems**

- Communication Systems
- Microwave Applications (ITS, SPS, etc.)
- Microwave Medical & Biological Applications/EMC/EMI
- Phased Array Antenna Systems

**Basic Theory and Techniques**

- Scattering and Propagation
- Electromagnetic Field Theory and CAD
- Antenna Theory
- Microwave Antennas
- MicrowavePhotonics
- Microwave Superconductivity
- Measurement Techniques

**Emerging Technologies**

- RF MEMS
- Active Antennas
- Photonic Bandgap
- Software Defined Radio
- Wireless LAN and Bluetooth

## Deadline

May 15, 2002: Deadline for submission of papers

## Workshops and Short Courses

The APMC 2002 will provide exciting workshops and short courses conducted by a group of specialists in a wide range of interesting and timely subjects.

## APMC Prize

Papers presented at APMC 2002 will be judged by the APMC 2002 Prize Award Committee, and the authors of selected papers will be awarded the APMC 2002 Prize for outstanding contributions to the microwave field.

## Contact

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# URSI CONFERENCE CALENDAR

*URSI cannot be held responsible for any errors contained in this list of meetings.*
*Do you wish to announce your meeting in this Calendar? More information about URSI-sponsored meetings can be found on our Homepage at : http://www.intec.rug.ac.be/ursi/Rules.html*

## February 2002

**Commission F Open Symposium - URSI-F-2002**
*Garmisch-Partenkirchen, Germany, 12-15 February 2002*
Contact: Dr. M. Chandra, URSI-F-2002 Office, DLR, Institut für Hochfrequenztechnik, D-82230 Wessling, Germany, Tel: +49 8153-28-2313, Fax: +49 8153-28-1149, E-mail: URSI-F-2002@dlr.de or Madhu.chandra@dlr.de

## May 2002

**Third URSI International Commission G High Latitude Ionosphere Symposium**
*Fairbanks, Alaska, USA, 15-19 May 2002*
Contact : Dr. Robert Hunsucker, Oregon Institute of Technology, Electronic Engineering Technology, 3201 Campus Drive, Purvine Building, Room PV282, Klamath Falls, OR 97601, USA, Tel: +1 541-885-1515, Fax:+1 541-885-1666, E-mail: hunsuckr@oit.edu@aol.com

**EMC 2002**
*Beijing, China, 21-24 May 2002*
Contact: Prof. L. Dayong, EMC 2002 Secretary, Chinese Institute of Electronics, P.O. Box 165, Beijing 100036, China, Tel: +8610 68283463, Fax: +861068283458, E-mail: dyliu@public.bta.net.cn, http://www.cie-china.org/emc2002

## June 2002

**EUSAR 2002**
*Cologne, Germany, 4-6 June 2002*
Contact: Dr. Richard Klemm, FFM-FGAN, Neuenahrer Strasse 20, D-53343 Wachtberg, Germany, Fax: +49 229 9435 618, Email: r.klemm@fgan.de, http://www.fhr.fgan.de/eusar/

**EMC Wroclaw 2002**
*Wroclaw, Poland, 27-30 June 2002*
Contact: Mr. W. Moron, EMC Symposium, Box 2141, 51-645, Wroclaw 12, Poland, Tel: +4871-348-3051, Fax: +4871-372-8878, Email: emc@il.wroc.pl

## August 2002

**URSI General Assembly 2002**
*Maastricht, The Netherlands, 17-24 August 2002*
Contact: Dr. Leon P.J. Kamp, Eindhoven University of Technology, Department of Applied Physics, P.O. Box 513, NL-5600 MB Eindhoven, The Netherlands, Tel: +31 40-2474292, Fax: +31 40-2445253, Email: URSI2002@tue.nl

## September 2002

**EMC Europe 2002 - International Symposium on Electromagnetic Compatibility**
*Sorrentino, Italy, 9-13 September 2002*
Contact: EMC Europe 2002 Secretariat, AEI Ufficio Centrale, Piazzale R. Morandi 2, 20121 Milano, Italy, Phone: +39-02-77790-205/218, Fax: +39-02-798817, E-mail: emceurope2002@aei.it, http://www.aei.it/emceurope2002.html

## October 2002

**World Space Congress 2002, 34th COPSPAR Scientific Assembly**
*Houston, Texas, USA, 10-19 October 2002*
Contact: COSPAR Secretariat, 51 bd de Montmorency, 75016 Paris, France, Tel: +33 1 4525 0679, Fax: +33 1 4050 9827, E-mail: cospar@cosparhq.org, Internet: http://www.copernicus.org/COSPAR/COSPAR.html

## November 2002

**12th International Symposium on Antennas (JINA 2002)**
*Nice, France, 12-14 November 2002*
Contact: Secrétariat JINA 2002, France Télécom R&D, Fort de la Tête de Chien, 06320 La Turbie, France, Fax: +33 4 9210 6519, E-mail: jina.cnet@wanadoo.fr, Internet: http://www.jina2002.com

**APMC2002, Asia-Pacific microwave Conference**
*Kyoto, Japan, 19-22 November 2002*
Contact: Prof. Shozo Komaki, Chair, Steering Committee, c/o Realize Inc., 4-1-4 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, Tel: +81-3-3815-8590, Fax: +81-3-3815-8529, Email: mweap mc@bleu.ocn.ne.jp, http://www.apmc-mwe.org

**ISAP-i02, 2002 Intermediate International Symposium on Antennas and Propagation**
*Yokosuka, Japan, 26-28 November 2002*
Contact: Prof. Kenichi Kagoshima, Chairperson, ISAP i-02, Ibaraki University, 4-12-1 Nakanarusawa, Hitachi, 316-8511 Japan, Internet: http://www.ieice.org/cs/ap/ISAP2002/

# News from the URSI Community

## NEWS FROM A MEMBER COMMITTEE

# EGYPT

## Nineteenth National Radio Science Conference (NRSC'2002)

This is to announce the 19th National Radio Science Conference, NRSC'2002, to be held in Alexandria, Egypt. The Faculty of Engineering, Alexandria University will host the conference over the period 19 - 21 March 2002.

The conference will provide a valuable opportunity to exchange and update information and stimulate discussions on current and future research activities in the fields of the committee.

### Program

The technical program will consist of invited and submitted papers covered by the URSI commissions A-K:

A) Electromagnetic metrology
B) Fields and waves
C) Signals and Systems
D) Electronics and photonics
E) Electromagnetic noise and interference
F) Wave propagation and remote sensing
G) Ionospheric radio and propagation
H) Waves in plasma.
J) Radio astronomy
K) Electromagnetics in biology and medicine.

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### Submission of Papers

Prospective authors are invited to submit 4 copies of the complete manuscript of a maximum of 8 A4 pages (typed single column and single spaced) to:

NRSC'2002
Academy of Scientific Research and Technology
Department of Scientific Societies
& International Unions 101
Kasr El-Eini Street
Cairo, Egypt.

The papers should be original and not published elsewhere. A one page Arabic Summary is required. Manuscripts and correspondences can also be submitted directly to the conference chairman, vice chairman or general Secretary.

Invited papers will be solicited from leading international and national experts in the listed topics. Papers should review in a tutorial manner the state of the art and developments in the field.

### Deadlines

Submission of manuscript : October 15, 2001.
Notification of acceptance and authors kits: December 1, 2001.
Submission of camera-ready mats: January 1, 2002.

### Contact

Prof. Dr. Ibrahim Salem
Chairman of Egyptian NRS Committee
Tel: +202 2580256
Fax: +202 7921270
Email: ia.salem@ieee.org
http://conf.mans.eun.eg, http://ursi-egypt.org

# International Geophysical Calendar 2002

| | S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|---|
| JANUARY | | | 1 | 2 | 3 | 4 | 5 |
| | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| | 13N | 14 | (15)* | [16]* | (17) | 18 | 19 |
| | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| | 27 | 28F | 29 | 30 | 31 | 1 | 2 |
| FEBRUARY | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | 10 | 11 | (12)*N | {13}* | (14) | 15 | 16 |
| | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| | 24 | 25 | 26 | 27F | 28 | 1 | 2 |
| MARCH | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | 10 | 11+ | (12)+ | {13}*+ | (14)*N+ | 15+ | 16 |
| | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| | 24 | 25 | 26 | 27 | 28F | 29 | 30 |
| | 31 | 1 | 2 | 3 | 4 | 5 | 6 |
| APRIL | 7 | 8 | 9+ | 10+ | 11+ | 12N+ | 13 |
| | 14 | 15 | (16)* | [17]* | (18) | 19 | 20 |
| | 21 | 22 | 23 | 24 | 25 | 26 | 27F |
| | 28 | 29 | 30 | 1 | 2 | 3 | 4 |
| MAY | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | 12N | 13 | (14)* | {15}* | (16) | 17 | 18 |
| | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| | 26F | 27 | 28 | 29 | 30 | 31 | 1 |
| JUNE | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | 9 | 10*N | (11)*+ | {12}*+ | (13) | 14 | 15 |
| | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| | 23 | 24F | 25 | 26 | 27 | 28 | 29 |
| | 30 | | | | | | |
| | S | M | T | W | T | F | S |

| S | M | T | W | T | F | S | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | JULY |
| 7 | 8 | (9)* | [10]*N | (11)* | 12 | 13 | |
| 14 | 15 | 16 | 17 | 18 | 19 | 20 | |
| 21 | 22 | 23 | 24F | 25 | 26 | 27 | |
| 28 | 29 | 30 | 31 | 1 | 2 | 3 | AUGUST |
| 4 | 5 | 6 | 7* | 8*N | 9 | 10 | |
| 11 | 12 | (13)+ | {14}+ | (15) | 16 | 17 | |
| 18 | 19 | 20 | 21 | 22F | 23 | 24 | |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 | |
| 1 | 2 | 3 | 4* | 5* | 6 | 7N | SEPTEMBER |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 | |
| 15 | 16 | (17) | {18} | (19) | 20 | 21F | |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 | |
| 29 | 30 | 1 | 2 | 3 | 4 | 5+ | OCTOBER |
| 6N+ | 7+ | 8*+ | 9*+ | 10+ | 11+ | 12 | |
| 13 | 14 | (15) | [16] | (17) | 18 | 19 | |
| 20 | 21F | 22 | 23 | 24 | 25 | 26 | |
| 27 | 28 | 29 | 30 | 31 | 1 | 2 | NOVEMBER |
| 3 | 4N | 5* | 6* | 7 | 8 | 9 | |
| 10 | 11+ | 12+ | 13+ | 14+ | 15+ | 16 | |
| 17 | 18 | (19) | {20}F | (21) | 22 | 23 | |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 | |
| 1 | 2 | 3+ | 4*N+ | 5*+ | 6 | 7 | DECEMBER |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 | |
| 15 | 16 | (17) | {18} | (19)F | 20 | 21 | |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 | |
| 29 | 30 | 31 | 1* | 2*N | 3 | 4 | 2003 |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 | JANUARY |
| 12 | 13 | 14 | 15 | 16 | 17 | 18F | |
| 19 | 20 | (21) | {22} | (23) | 24 | 25 | |
| 26 | 27 | 28 | 29 | 30 | 31 | | |
| S | M | T | W | T | F | S | |

(15) Regular World Day (RWD)

{13} Priority Regular World Day (PRWD)

[16] Quarterly World Day (QWD) also a PRWD and RWD

2 Regular Geophysical Day (RGD)

7 8 World Geophysical Interval (WGI)

11 + Incoherent Scatter Coordinated Observation Day

N NEW MOON F FULL MOON

4 Day of Solar Eclipse: Jun 10-11 and Dec 4

10 11 Airglow and Aurora Period

15* Dark Moon Geophysical Day (DMGD)

## Explanation

This Calendar continues the series begun for the IGY years 1957-58, and is issued annually to recommend dates for solar and geophysical observations, which cannot be carried out continuously. Thus, the amount of observational data in existence tends to be larger on Calendar days. The recommendations on data reduction and especially the flow of data to World Data Centers (WDCs) in many instances emphasize Calendar days. The Calendar is prepared by the International Space Environment Service (ISES) with the advice of spokesmen for the various scientific disciplines. For some programs, greater detail concerning recommendations appears from time to time published in IAGA News, IUGG Chronicle, URSI Information Bulletin and other scientific journals or newsletters. For on-line information, see **http://ises-spaceweather.org.**

The definitions of the designated days remain as described on previous Calendars. Universal Time (UT) is the standard time for all world days. Regular Geophysical Days (RGD) are each Wednesday. Regular World Days (RWD) are three consecutive days each month (always Tuesday, Wednesday and Thursday near the middle of the month). Priority Regular World Days (PRWD) are the RWD which fall on Wednesdays. Quarterly World Days (QWD) are one day each quarter and are the PRWD which fall in the World Geophysical Intervals (WGI). The WGI are fourteen consecutive days in each season, beginning on Monday of the selected month, and normally shift from year to year. In 2002 the WGI are January, April, July and October.

The **Solar Eclipses** are:

- **10-11 June 2002 (annular) eclipse** with annularity visible only over the Pacific Ocean, passing about 50 km south of Baja California, Mexico, near its end just before sunset and touching Mexico west of Guadalajara at sunset; partial phases visible in Eastern Asia, Japan, Indonesia, northern Australia, Pacific Ocean, northwestern Mexico, western U.S.A. (60%-80% in California, for example), and western Canada. The annularity has 0.996 eclipse magnitude, with duration only 23 s in a narrow, 13 km path width. See http://sunearth.gsfc.nasa.gov/eclipse/SEplot/SEplot2001/SE2002Jun10A.gif
- **4 December 2002 (total) eclipse** with totality visible only in Angola, northeastern Botswana, southwestern Zimbabwe, the northeastern border region of South Africa near Zimbabwe, and southern Madagascar and, near sunset, low in the sky in south-central Australia about 800 km west of Adelaide. A partial eclipse is visible in Africa except the north, southeastern Atlantic Ocean, central Indian Ocean, much of Antarctica, eastern Indonesia, East Timor, and western Australia. Maximum duration is 2 min 4 s in an 87 km path width, though accessible durations are 1 min in Angola, 1 1/2 min in Mozambique, and about 30 s in Australia.

Description by Dr. Jay Pasachoff, Williams College, Chair of IAU WG on Solar Eclipses, jmp@williams.edu with input from Fred Espenak, NASA GSFC.

**Web Sites:** http://sunearth.gsfc.nasa.gov/eclipse/SEcat/SEdecade2001.html, International Astronomical Union Working Group on Eclipses: http://www.williams.edu/Astronomy/IAU_eclipses

**References:**

Fred Espenak, Fifty Year Canon of Solar Eclipses: 1986-2035, NASA Reference Publication 1178 Revised, July 1987.

Leon Golub and Jay M. Pasachoff, The Solar Corona, Cambridge University Press, 1998. http://www.williams.edu/Astronomy/corona

Jay M. Pasachoff, Astronomy: From the Earth to the Universe, 5th ed., Saunders College Publishing, 1998. http://www.williams.edu/Astronomy/jay

**Meteor Showers** (selected by R. Hawkes, Mount Allison Univ, Canada, rhawkes@mta.ca) include the most prominent regular showers. The dates (based on UT) for Northern Hemisphere meteor showers are: Jan 3 (Quadrantid); Apr 21-23 (Lyrid); May 4-6 (Eta-Aquarid); Jun 6-11 (Arietid, Zeta-Perseid); Jun 27-29 (Beta-Taurid); Aug 12-14 (Perseid); Oct 21-23 (Orionid); Nov 18-19 (Leonid); Dec 13-15 (Geminid); Dec 21-23, 2002 (Ursid); and Jan 3-4, 2003 (Quadrantid). The dates for Southern Hemisphere meteor showers are: May 4-6 (Eta-Aquarid); Jun 6-11 (Arietid, Zeta-Perseid); Jun 27-29 (Beta-Taurid); Jul 27-Aug 2 (S. Delta-Aquarid, Alpha-Aurigid); Oct 21-23 (Orionid); Nov 18-19 (Leonid); and Dec 13-15, 2002 (Geminid).

The occurrence of **unusual solar or geophysical conditions** is announced or forecast by the ISES through various types of geophysical **"Alerts"** (which are widely distributed by telegram and radio broadcast on a current schedule). Stratospheric warmings (STRATWARM) are also designated. The meteorological telecommunications network coordinated by WMO carries these worldwide Alerts once daily soon after 0400 UT. For definitions of Alerts see ISES "Synoptic Codes for Solar and Geophysical Data", March 1990 and its amendments (http://ises-spaceweather.org). Retrospective World Intervals are selected and announced by MONSEE and elsewhere to provide additional analyzed data for particular events studied in the ICSU Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) programs.

## Recommended Scientific Programs Operational Edition

(The following material was reviewed in 2001 by spokesmen of IAGA, WMO and URSI as suitable for coordinated geophysical programs in 2002.)

**Airglow and Aurora Phenomena**. Airglow and auroral observatories operate with their full capacity around the New Moon periods. However, for progress in understanding the mechanism of many phenomena, such as low latitude aurora, the coordinated use of all available techniques, optical and radio, from the ground and in space is required. Thus, for the airglow and aurora 7-day periods on the Calendar, ionosonde, incoherent scatter, special satellite or balloon observations, etc., are especially encouraged. Periods of approximately one weeks' duration centered on the New Moon are proposed for high resolution of ionospheric, auroral and magnetospheric observations at high latitudes during northern winter.

**Atmospheric Electricity.** Non-continuous measurements and data reduction for continuous measurements of atmospheric electric current density, field, conductivities, space charges, ion number densities, ionosphere potentials, condensation nuclei, etc.; both at ground as well as with radiosondes, aircraft, rockets; should be done with first priority on the RGD each Wednesday, beginning on 2 January 2002 at 0000 UT, 9 January at 0600 UT, 16 January at 1200 UT, 23 January at 1800 UT, etc. (beginning hour shifts six hours each week, but is always on Wednesday). Minimum program is at the same time on PRWD beginning with 24 January at 1800 UT. Data reduction for continuous measurements should be extended, if possible, to cover at least the full RGD including, in addition, at least 6 hours prior to indicated beginning time. Measurements prohibited by bad weather should be done 24 hours later. Results on sferics and ELF are wanted with first priority for the same hours, short-period measurements centered around the minutes 35-50 of the hours indicated. Priority Weeks are the weeks that contain a PRWD; minimum priority weeks are the ones with a QWD. The World Data Centre for Atmospheric Electricity, 7 Karbysheva, St. Petersburg 194018, USSR, is the collection point for data and information on measurements.

**Geomagnetic Phenomena.** It has always been a leading principle for geomagnetic observatories that operations should be as continuous as possible and the great majority of stations undertake the same program without regard to the Calendar.

Stations equipped for making magnetic observations, but which cannot carry out such observations and reductions on a continuous schedule are encouraged to carry out such work at least on RWD (and during times of MAGSTORM Alert).

**Ionospheric Phenomena.** Special attention is continuing on particular events that cannot be forecast in advance with reasonable certainty. These will be identified by Retrospective World Intervals. The importance of obtaining full observational coverage is therefore stressed even if it is possible to analyze the detailed data only for the chosen events. In the case of vertical incidence sounding, the need to obtain quarter-hourly ionograms at as many stations as possible is particularly stressed and takes priority over recommendation (a) below when both are not practical.

For the **vertical incidence (VI) sounding program**, the summary recommendations are:

(a) All stations should make soundings on the hour and every quarter hour;
(b) On RWDs, ionogram soundings should be made at least every quarter hour and preferably every five minutes or more frequently, particularly at high latitudes;
(c) All stations are encouraged to make f-plots on RWDs; f-plots should be made for high latitude stations, and for so-called "representative" stations at lower latitudes for all days (i.e., including RWDs and WGIs) (Continuous records of ionospheric parameters are acceptable in place of f-plots at temperate and low latitude stations);
(d) Copies of all ionogram scaled parameters, in digital form if possible, be sent to WDCs;
(e) Stations in the eclipse zone and its conjugate area should take continuous observations on solar eclipse days and special observations on adjacent days. See also recommendations under Airglow and Aurora Phenomena.

For the **incoherent scatter observation program**, every effort should be made to obtain measurements at least on the Incoherent Scatter Coordinated Observation Days, and intensive series should be attempted whenever possible in WGIs, on Dark Moon Geophysical Days (DMGD) or the Airglow and Aurora Periods. The need for collateral VI observations with not more than quarter-hourly spacing at least during all observation periods is stressed.

Special programs include:

**CSSP** – Coordinated Storm Study Period (John Foster – jcf@haystack.mit.edu);

**DATABASE** — Incoherent Scatter Database — emphasis on broad latitudinal coverage of the F region (Anthony van Eyken – Tony.van.Eyken@eiscat.com);

**LTCS** — Lower Thermosphere Coupling Study (C. Fesen - fesen@tides.utdallas.edu);

**Millennium Polar Max** – Santimay Basu (santimay@aol.com) and Cesar Valladares (cesar@dl5000.bc.edu);

**POLITE** — Plasmaspheric Observations of Light Ions in the Topside Exosphere — global coordinated measurements of topside light ions. Simultaneous optical observations of neutral hydrogen and helium are highly desirable where possible (Phillip Erickson - pje@hyperion.haystack.edu);

**SELT** – Storm Effects in the Lower Thermosphere (Joe Salah – jsalah@haystack.mit.edu);

**Special programs**: Dr. Anthony P. van Eyken, EISCAT Scientific Association, Ramfjordmoen, N-9027 Ramfjordbotn, Norway. Tel. +47 77692166; Fax +47 77692380; e-mail: tony@eiscat.no; URSI Working Group G.5.

See http://www.eiscat.uit.no/URSI_ISWG/2002_schedule.html for complete definitions.

For the ionospheric drift or wind measurement by the various radio techniques, observations are recommended to be concentrated on the weeks including RWDs.

For traveling ionosphere disturbances, propose special periods for coordinated measurements of gravity waves induced by magnetospheric activity, probably on selected PRWD and RWD.

For the ionospheric absorption program half-hourly observations are made at least on all RWDs and half-hourly tabulations sent to WDCs. Observations should be continuous on solar eclipse days for stations in eclipse zone and in its conjugate area. Special efforts should be made to obtain daily absorption measurements at temperate latitude stations during the period of Absorption Winter Anomaly, particularly on days of abnormally high or abnormally low absorption (approximately October-March, Northern Hemisphere; April-September, Southern Hemisphere).

For back-scatter and forward scatter programs, observations should be made and analyzed at least on all RWDs.

For synoptic observations of mesospheric (D region) electron densities, several groups have agreed on using the RGD for the hours around noon.

For ELF noise measurements involving the earth-ionosphere cavity resonances any special effort should be concentrated during the WGIs.

It is recommended that more intensive observations in all programs be considered on days of unusual meteor activity.

**Meteorology.** Particular efforts should be made to carry out an intensified program on the RGD — each Wednesday, UT. A desirable goal would be the scheduling of meteorological rocketsondes, ozone sondes and radiometer sondes on these days, together with maximum-altitude rawinsonde ascents at both 0000 and 1200 UT.

During **WGI and STRATWARM Alert Intervals**, intensified programs are also desirable, preferably by the implementation of RGD-type programs (see above) on Mondays and Fridays, as well as on Wednesdays.

**Global Atmosphere Watch (GAW)** The World Meteorological Organizations (WMO) GAW integrates many monitoring and research activities involving measurement of atmospheric composition. Serves as an early warning system to detect further changes in atmospheric concentrations of greenhouse gases, changes in the ozone layer and in the long range transport of pollutants, including acidity and toxicity of rain as well as of atmospheric burden of aerosols (dirt and dust particles). Contact WMO, 7 bis avenue de la Paix, P.O. Box 2300, 1211 Geneva, Switzerland.

**Solar Phenomena.** Observatories making specialized studies of solar phenomena, particularly using new or complex techniques, such that continuous observation or reporting is impractical, are requested to make special efforts to provide to WDCs data for solar eclipse days, RWDs and during PROTON/FLARE ALERTS. The attention of those recording solar noise spectra, solar magnetic fields and doing specialized optical studies is particularly drawn to this recommendation.

**ISCS (International Solar Cycle Studies).** Program within the SCOSTEP (Scientific Committee on Solar-Terrestrial Physics): 1998-2002. Its focus is on observations and basic research directed toward understanding the underlying and resulting processes associated with the rising and maximum phase of a solar cycle. Contacts are S.T. Wu, Univ of Alabama, Huntsville Dept. Mech. Eng. & Ctr. for Space Plasma & Aeron. Res., Huntsville, AL 35899 USA, (205)895-6413, Fax (205)895-6328, wu@cspar.uah.edu, and V. Obridko, IZMIRAN, Solar Physics Department, 142092 Troitsk, Moscow, Russia, 095-344-0926, Fax 095-334-0124, obridko@lars.izmiran.troitsk.su.

**Solar Terrestrial Energy Program (STEP) Results, Applications, and Modeling Phase (RAMP) [S-RAMP].** Global coordinated ground-based and space-borne observations of space weather phenomena covering the entire space weather chain from the surface of the Sun to the effects on the near-Earth space and ground-based technological systems.

Contacts: Dr. David Boteler (Boteler@Geolab.nrcan.gc.ca) and Dr. Phil Wilkinson, IPS Radio and Space Services, P.O. Box 1386, Haymarket, NSW 1240, Australia, +61 2 9213 8003, Fax +61 2 9213 8060 (Phil@ips.gov.au). See http://www.ngdc.noaa.gov/stp/SRAMP/sramp.html.

**Space Research, Interplanetary Phenomena, Cosmic Rays, Aeronomy.** Experimenters should take into account that observational effort in other disciplines tends to be intensified on the days marked on the Calendar, and schedule balloon and rocket experiments accordingly if there are no other geophysical reasons for choice. In particular it is desirable to make rocket measurements of ionospheric characteristics on the same day at as many locations as possible; where feasible, experimenters should endeavor to launch rockets to monitor at least normal conditions on the Quarterly World Days (QWD) or on RWDs, since these are also days when there will be maximum support from ground observations. Also, special efforts should be made to assure recording of telemetry on QWD and Airglow and Aurora Periods of experiments on satellites and of experiments on spacecraft in orbit around the Sun.

The **International Space Environment Service (ISES)** is a permanent scientific service of the International Union of Radio Science (URSI), with the participation of the International Astronomical Union and the International Union Geodesy and Geophysics. ISES adheres to the Federation of Astronomical and Geophysical Data Analysis Services (FAGS) of the International Council of Scientific Unions (ICSU). The ISES coordinates the international aspects of the world days program and rapid data interchange.

This Calendar for 2002 has been drawn up by H.E. Coffey, of the ISES Steering Committee, in association with spokesmen for the various scientific disciplines in SCOSTEP, IAGA and URSI and other ICSU organizations. Similar Calendars are issued annually beginning with the IGY, 1957-58, and are published in various widely available scientific publications.

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Additional copies are available upon request to ISES Chairman, Dr. Katsuhide Marubashi, Space Science Division, Communications Research Laboratory, 4-2-1 Nukui-kita, Koganei-shi, Tokyo 184-8795, Japan (FAX number +81-42-327-6677; e-mail kmaru@crl.go.jp), or ISES Secretary for World Days, Miss H.E. Coffey, WDC-A for Solar-Terrestrial Physics, NOAA E/GC2, 325 Broadway, Boulder, Colorado 80303, USA (FAX number (303)497-6513; e-mail Helen.E.Coffey@noaa.gov).

The calendar is available on-line at http://ises-spaceweather.org.

## NOTES on other dates and programs of interest:

1. Days with **significant meteor shower activity** are: Northern Hemisphere 3 Jan; 21-23 Apr; 4-6 May; 6-11, 27-29 Jun; 12-14 Aug; 21-23 Oct; 18-19 Nov; 13-15, 21-23 Dec 2002; 3-4 Jan 2003. Southern Hemisphere 4-6 May; 6-11, 27-29 Jun; 27 Jul-2 Aug; 21-23 Oct; 18-19 Nov; 13-15 Dec 2002. These can be studied for their own geophysical effects or may be "geophysical noise" to other experiments.
2. **Global Atmosphere Watch (GAW)** — early warning system for changes in greenhouse gases, ozone layer, and long range transport of pollutants. (See Explanations.)
3. **ISCS (International Solar Cycle Studies)** Observing Program 1998-2002: SCOSTEP Study of processes associated with the maximum phase of the solar cycle. (See Explanations.)
4. **S-RAMP — SCOSTEP Project.** Solar Terrestrial Energy Program (S) - Results, Applications, and Modeling Phase (RAMP). (See Explanations.)
5. + **Incoherent Scatter Coordinated Observations Days** (see Explanations) starting at 1300 UT on the first day of the intervals indicated, and ending at 1600 UT on the last day of the intervals: 4-29 Mar SELT month long alert (11-15 Mar default); 2-17 Apr CSSP two week alert (9-12 Apr default); 11-12 Jun Database; 13-14 Aug Database; 5-7 Oct POLITE; 1-29 Oct SELT month long alert (7-11 Oct default); 11-15 Nov LTCS; 3-5 Dec Millennium Polar Max — see http://www.eiscat.uit.no/URSI_ISWG/2002_schedule.html. where

**CSSP** = Coordinated Storm Study Period (John Foster - jcf@haystack.mit.edu);
**Database** = Emphasis on broad latitutdinal coverage of the F region (Tony van Eyken — Tony.van.Eyken@eiscat.com);
**LTCS**= Lower Thermosphere Coupling Study (C. Fessen - fesen@tides.utdallas.edu);
**Millennium Polar Max** = Santimay Basu (santimay@aol.com) and Cesar Valladares (cesar@dl5000.bc.edu);
**POLITE** =Plasmaspheric Observations of Light Ions in the Topside Exosphere (P. Erickson — pje@haystack.mit.edu);
**SELT**= Storm Effects in the Lower Thermosphere (Joe Salah – jsalah@haystack.mit.edu).

# UTC Time Step

On n'introduira pas de seconde intercalaire à la fin de décembre 2001.
La différence entre UTI et le Temps Atomique International TAI est :
du 1er janvier 1999, 0h UTC, jusqu'à nouvel avis : UTC - TAI = -32 s
Des secondes intercalaires peuvent être introduites à la fin des mois de décembre ou de juin, selon l'évolution de UT1-TAI. Le Bulletin C est diffusé deux fois par an, soit pour annoncer un saut de seconde, soit pour confirmer qu'il n'y aura pas de saut de seconde à la prochaine date possible.

No positive leap second will be introduced at the end of December 2001.
The difference between UTC and the International Atomic Time TAI is :
from 1999 January 1, 0 h UTC, until further notice : UTC - TAI = -32 s
Leap seconds can be introduced in UTC at the end of the months of December and June, depending on the evolution of UT1-TAI. Bulletin C is mailed every six months, either to announce a time step in UTC, or to confirm that there is no time step at the next possible date.

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## Modern Radio Science 1999

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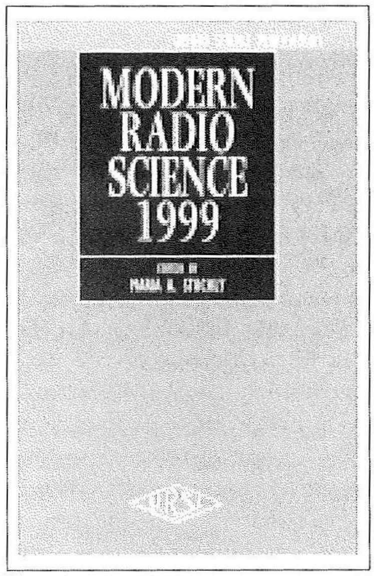


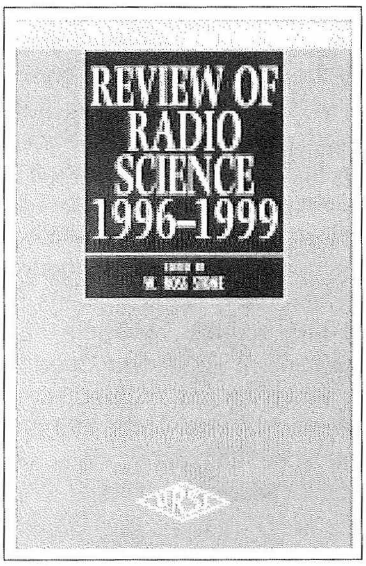


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S. Feng, S.M. Radicella, B.M. Reddy

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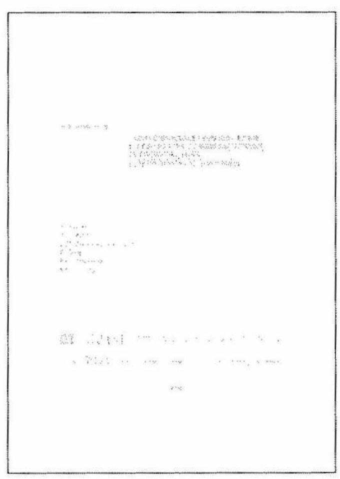

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