# The Radio Science Bulletin

ISSN 1024-4530

INTERNATIONAL
UNION OF
RADIO SCIENCE

UNION
RADIO-SCIENTIFIQUE
INTERNATIONALE


**No 282**
**September 1997**

Publié avec l'aide financière de l'UNESCO

URSI, c/o University of Gent (INTEC)
St.-Pietersnieuwstraat 41, B-9000 Gent (Belgium)

# Contents

# Editorial

Dear URSI Correspondent,

Summer is almost over and you'll find in your hand the autumn issue of our Bulletin. Its scientific part concerns electromagnetic wave propagation. More specifically an interesting technique based on parabolic wave equations that provides accurate and fast numerical solutions for many problems in radio science is presented.

In the administrative sections, reports about activities of members of our Union are gathered and concern several Commissions. I also suggest you carefully review future conference annoucements in order to prepare your plans for next year. Your participation to some of them is needed, as you are the prime actor of these events through your scientific contributions. The exchanges this allows are essential for the life of our Union. However, we should be aware that some new legal developments concerning the free exchange of data are facing us. A report covering this topic, which is so important for the scientific community, is proposed in this issue of the Bulletin.

I wish you a pleasant reading.

Piotr Sobieski, Editor

# Letter to the Editor

Subject : Review by John S. Belrose of the **Handbook of Electromagnetic Compatibility** by Reinaldo Perez Editor, in the March 1997 issue of the *Radio Science Bulletin*, pp. 41-42.

*Comment concerning chapters 19.20 written by me*

I don't agree with the comment of the Reviewer : "The Author's References to CCIR now ITU-R only go as far as 1982", as I am up to date with the important contributions of ITU-R.

From the first page of chapter 19, I have mentioned twice the important contribution of CCIR and mentioned that the name has shifted to ITU-R. I have also used numerous new references which are included in pp. 754-758 Chapter 19 see numbers of references :

4 CCIR (1990), 6 Struzak R.G. (1990) from Telecom J which was an ITU Journal

22 CCIR (1978 and 1990) Kyoto and Dusseldorf Assemblies

48 CISPR (1986)

73 CCIR (1986)

78 CCIR (1986) ITU-TS

108 ITU General Secretariat (1990) Radio Regulations Vol. 1, 2, 3 ITU

111 CCIR (1990) Dusseldorf Annex to Volume 5

130 ITU-CCIR Handbook on Spectrum Management (1987). In the next editons, I shall use references from 1984 and maybe (1998).

Intentionally I have not treated extensively the antenna problems to avoid duplication.

Dr. M. Kanda, an eminent specialist in the field of antennas and measurements, has dedicated in this handbook chapters 15 and 16 on this subject as well as chapter 3, 4, 6, 13 treated partly on antennas radiation.

About the absence of references dealing with "Corona and gap noise from EHV powerlines" I apologise because I am not an expert in this domain and I relied on former chapters 4 to 7 authors dealing with "radiated and conducted emissions". I shall add these references in the next editions.

The next editions will also include recent work on propagation computation methods frequency spectrum management considerations and novel methods to mitigate interference in radio systems.

Professor J. Gavan
Head of Communications Engineering Department
Center for Technological Education, Holon, Israel

*Reply :*

We thank Professor Gavan for his clarifications concerning this book review published in our spring issue.

the Editor

# Thanks to Jim Wait

*A few months ago Dr. James R. (Jim) Wait informed the Editor of the Radio Science Bulletin that he wishes to retire from the Editorial Advisory Board of the Radio Science Bulletin. We would like to thank Jim for his many contributions to this magazine. Professor R.L. Dowden wrote the following tribute....*

Jim Wait first appeared on the editor list (as Review Editor) of Vol 2, No 4, of The Radioscientist (October, 1991). Bearing in mind that there was only one issue of Vol 1 (that distributed at the Prague GA), this was really the first year of The Radioscientist. Jim rapidly became the most prolific of my editors, either by getting reviews and other articles or by writing them himself. Prolific writing has been his life — he has published around 1000 papers in learned journals and 10 books.

I came to know Jim over a paper (my first) on HF sea echoes I received on an ionosonde at Macquarie Island in 1956. Correspondence eventually lead to an invitation to a Visiting Fellowship at CIRES (Cooperative Institute for Research in the Environmental Sciences), a joint institute between Colorado University and the National Bureau of Standards. Jim was a member of the latter and a permanent Fellow of CIRES. Jim was almost as well known internationally then (some 40 years ago) as now. I certainly thought of him as a boffin, perhaps as dictating papers to four secretaries simultaneously. I was greatly surprised on arriving at Boulder to take up my Visiting Fellowship just before Christmas that he was not like that at all. He was a most gracious host, inviting me, my wife and family (6 children under 9!) to Christmas dinner. On the Christmas tree there were presents for every one of us. Far from meeting my boffin image, I found he skied most week nights up in the Rockies some 30 km distant.

Jim thinks faster than anyone else I know. He wrote several papers during the 6-week Prestige Fellowship he had with us at Otago. He writes them all by hand and adds the references from memory, page numbers and all. One of my PhD students had submitted his thesis some months previously and we were still waiting for the examiner's report. Jim asked if he could take a copy to his hostel one night. Next morning Jim returned the copy and said: "I've made some notes." This turned out to be a far longer and deeper analysis of my student's work than the external examiner's when it eventually arrived.

More recently I again visited Jim just before Christmas, this time in Tucson but on my own. He again asked me to Christmas dinner, this time with his relatives some 200 km to the south east. During the long drive I put a problem to him on scattering by a bunch of conducting cylinders (VLF scattering from the ionised columns of red sprites). The cylinder spacing is neither small nor large compared with a wavelength (some 10-15 km at VLF) and each cylinder is in the field of waves scattered from all the other cylinders as well as that (barely stronger) from the VLF transmitter direct. I had no idea how to start. Next morning (Boxing Day), Jim handed me a piece of paper about the size of two of his famous post cards with the problem solved in his hand writing, adding: "You may have a student who could work this up on a computer." As I happened, I had the best PhD student in some 30 years who did just that when I returned home to New Zealand. However, I still have that piece of paper which I regard like the back of the envelope on which Ernest Rutherford worked out the alpha scattering from gold foil.

R.L. Dowden

# Rectification

In No 280 (March 1997) of the Radio Science Bulletin on page 30 we printed the report of the First meeting (August 29, 1996) of the Commission H on Waves and Plasmas. It read as follows : "The chairman (Dr. F. Lefeuvre) started the meeting by a thought to Professors Alpert (Russia) and Woolliscroft (UK) who passed away during last triennium."

Professor Yakov Alpert let us know that is alive and well and quite active. He quoted the words of Mark Twain: "The rumours of my death are exaggerated".

We sincerely apologise for the inconvenience this error caused to Professor Alpert. Dr. Lefeuvre is trying to figure out who provided him with this information.

# Copyright of Databases

Henry Rishbeth

In the last year, steps have been taken in Europe, the USA and other countries, and also through international treaties, to protect computer-based material. While this is right and proper, the legislation may severely restrict the use of data for scientific research. A critical stage has now been reached in this process. The UK Patent Office has published new regulations, for the purpose of implementing EC Database Directive 96/9 which introduces copyright for databases. There is a public consultation period, ending on 30 September 1997 and the law takes effect on 1 January 1998. Similar procedures must take place in other member countries of the European Union. For information on the UK regulations, see the Web site, http://www.patent.gov.uk/snews/datacopy.html. (reproduced under * below)

The European regulations introduce a "database right" (called "sui generis") which seems open-ended and all-embracing, and might be applicable to almost any kind of data — past, present or future. The definition of "database" is very wide and applies to paper-based data as well as electronic material. It seems quite possible that, in the UK and maybe elsewhere, there will be NO "fair use" exceptions at all for scientific and educational use of data (such as are allowed by the Berne Convention for printed matter). This might be the policy of the European Commission itself, so it would be useful to know whether the Commission's scientific staff have had any part in the legislation, and whether they are aware that the legislation may conflict with the European Commission's own policy of full and open access to environmental data (Directive 90/313/EEC).

The legislation (and similar measures proposed in the USA and elsewhere) could pose a threat to research, especially in the astronomical, solar-terrestrial and environmental sciences which are of interest to URSI. The "copyright philosophy" is totally different from the scientific tradition of "full and open access", and raises the threat of a "data market" with endless access charges, copyright fees and accompanying paperwork. From the point of view of "the authorities", this may not sound too serious, but the situation will look very different to the working scientists who will have to bear the burdens. The new laws, however, may be welcomed by scientists whose data is commercially valuable.

To resolve the problem, I suggest that:

[a] scientists should press for reasonable "fair use" provisions for teaching and research;

[b] research organizations and agencies, that operate a policy of full and open access to their data, should consider what steps may be necessary to ensure that their data stay in the "public domain" for the benefit of the scientific community.

URSI has a distinguished record of supporting the long-standing scientific principle of "full and open access to data at minimum cost". The resolutions made at the Lille General Assembly were very helpful in this respect. Information on statements by ICSU and other bodies on the subject of access to data may be found via the Web site http://www.codata.org.

* Consultation on EC Database Directive (96/9/EC)

A consultative document on changes to the legal protection of databases has been published by the Department of Trade and Industry. The document seeks views on regulations to implement the EC Database Directive, which limits copyright protection to databases of which the selection and arrangement of the contents are the author's own intellectual creation, and introduces a new right against unauthorised extraction or reuse of their contents.
Protection of databases will be significantly enhanced by the new measures in some EU member states, but some databases which at present qualify for copyright protection in the United Kingdom may no longer do so. However, all databases will be eligible for the newly created "database right", whether or not they qualify for copyright protection.
The intention of the new right is to protect the investment of money, time and effort that goes into compiling databases, even if they do not qualify for copyright as the "intellectual creation" of the maker. The new right will last for fifteen years from the completion or publication of the database, and will give the maker the ability to control extraction and re-utilisation of all, or a substantial part, of the contents. Existing databases up to 15 years old will qualify for the new right. Databases currently protected by copyright will retain that protection for the remainder of the copyright term.
Exceptions which currently operate in the copyright field - for example research, education and library use - will continue to apply except where the Directive specifically requires otherwise (the research exception is limited to non-commercial research). Certain similar exceptions will apply to database right.

*Professor Henry Rishbeth is with the*
*Department of Physics & Astronomy*
*University of Southampton*
*SOUTHAMPTON S017 1BJ, UNITED KINGDOM*
*Phone: +44 1703 592073 Fax: +44 1703 593910*
*Email: hr@phys.soton.ac.uk*
*http://www.phys.soton.ac.uk/atmos/uagrp.html*

# Parabolic wave equation techniques for radiowave propagation

M.F. Levy

## Introduction

Parabolic wave equation (PWE) techniques provide accurate and fast numerical solutions for many electromagnetic wave propagation problems. The basic idea of parabolic approximation techniques is to factor the wave equation into two terms representing respectively the forward and backward propagating energy. Here "backward" and "forward" refer to a preferred direction, the paraxial direction, which is usually range $x$. The resulting partial differential equations have very good numerical properties which lead to efficient computer codes. The parabolic approximation of the wave equation was introduced by Fock [1] in the 1940's to solve spherical diffraction problems. In the 1970's, acousticians developed computer implementations of the PWE for application to long-range underwater propagation problems [2]. In subsequent years PWE techniques became increasingly popular for solving radiowave propagation problems, and they are now the dominant tool for computing electromagnetic fields in complex tropospheric environments [3,4,5,6]. More recently they have been applied to scattering problems, and in particular to radar-cross section calculations [7,8].

## PWE framework

*Fundamental equations*

To give the flavour of the method, we derive the PWE for the scalar wave equation in cartesian coordinates

$$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}+\frac{\partial^2\psi}{\partial z^2}+k^2n^2(x,y,z)\psi=0 \qquad (1)$$

where $k$ is the free-space wavelength and $n$ is the refractive index of the air. The field component represents the electric field for horizontal polarisation and the magnetic field for vertical polarisation. First the fast phase variation in $x$ is factored out by using a reduced field function $u$ defined by

$$u(x,y,z)=\exp(-ikx)\psi(x,y,z) \qquad (2)$$

The $x$-direction is the paraxial direction: in a ray picture, forward propagation corresponds to rays propagating with increasing $x$, and backward propagation to rays propagating with decreasing $x$. The scalar wave equation in terms of $u$ can be formally factored as

$$\left\{\frac{\partial}{\partial x}+ik(1-Q)\right\}\left\{\frac{\partial}{\partial x}+ik(1+Q)\right\}u=0 \qquad (3)$$

where the pseudo-differential operator $Q$ is defined by

$$\left\{\frac{\partial}{\partial x}+ik(1-Q)\right\}\left\{\frac{\partial}{\partial x}+ik(1+Q)\right\}u=0 \qquad (4)$$

The two terms correspond respectively to forward and back propagating waves. The resulting partial differential equations are parabolic in nature, meaning that they are of first order in $x$ and of second order in the transverse directions $y$ and $z$. It follows that they can be marched in range, getting the solution at successive range steps from the solution at the previous range.

For example in a range-independent medium the forward parabolic equation has the formal solution

$$u(x+\Delta x,y,z)=e^{ik\Delta x(-1+Q)}u(x,y,z) \qquad (5)$$

To march the solution forward, all that is needed is the field at a given range and appropriate boundary conditions. This results in considerable computational gain, reducing for example a two-dimensional scattering problem to a sequence of one-dimensional problems. Figure 1 illustrates forward integration of the PWE for the two-dimensional case.

*Dr. Mireille Levy is with the*
*Radio Communications Research Unit*
*Rutherford Appleton Laboratory*
*Chilton, Didcot, Oxon OX11 0QXX, United Kingdom*
*Tel. : (44) 1235-446522 Fax : (44) 1235-446140*
E-mail : m.levy@rl.ac.uk

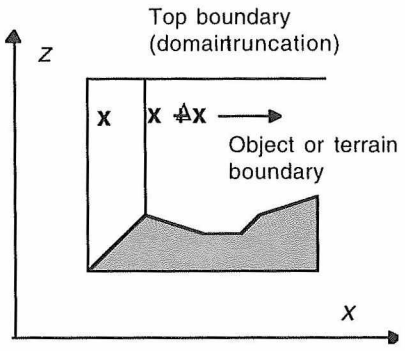



*Fig. 1 - Forward integration with the PWE*

The PWE is a full-wave method which calculates the field at all points of the computational grid. It works equally well at any distance from the source, from a few wavelengths to very long ranges.

Errors are of course introduced by the factorization: first of all it is only approximate in a non-homogeneous medium because multiplication by $n$ does not then commute with the partial derivatives. More importantly, the introduction of the square root operator means that energy propagating along the transverse plane $(y,z)$ is not represented accurately. This is not a problem for tropospheric applications, where directions of interest are usually well within 90 degrees of the horizontal paraxial direction, but it does restrict the applicability of the PWE method to discrete-object scattering calculations.

For tropospheric applications, it is often convenient to make the problem two-dimensional by using cylindrical coordinates and assuming that the problem does not depend on azimuthal angle. A slightly different reduced field function which takes cylindrical spreading into account is then used [3,4].

*Narrow and wide-angle PWEs*

For numerical implementation, we must find a suitable approximation of the square root operator. The simplest approximation of Eq. 5 is obtained by using the first order Taylor expansion of the square-root. This yields the Standard Parabolic Equation (SPE):

$$u(x+\Delta x,y,z)=e^{\frac{ik}{2}(n^2-1)\Delta x}\,e^{\frac{i\Delta x}{2k}\left(\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)}u(x,y,z) \qquad (6)$$

This simple form of the parabolic equation is extremely useful for solving long-range tropospheric radiowave propagation problems. The refractive index of the air is very close to unity and does not cause significant accuracy problems. The limitations of the standard PWE approximation are due to its bad behaviour at large propagation angles: for a plane wave propagating at angle from the horizontal, we have

$$\left|\frac{\partial^2 u}{k^2\partial z^2}\right|=\sin^2\alpha \qquad (7)$$

Hence the first discarded term in the Taylor expansion is proportional to , going from about 0.00001% for an angle of 1 degree to 0.1% for an angle of 10 degrees and over 1% for an angle of 20 degrees. As propagation angles of interest in tropospheric problems are usually less than a few degrees, accuracy is very good for long-range calculations.

For problems involving large propagation angles, it is necessary to use more sophisticated techniques. The obvious idea of using higher order expansions of the square root does not help because it involves high order derivatives which are more difficult to approximate in numerical schemes. A very successful approach which does not have this drawback is the split-step Padé parabolic equation method [9].

The idea here is to approximate the exponential operator as a sum of simple fractional expressions in the form

$$e^{ik\Delta x\left(-1+\sqrt{1+Z}\right)}\cong 1+\sum_{j=1}^{N}\frac{a_jZ}{1+b_jZ} \qquad (8)$$

where . The $2N$ complex coefficients are determined by Taylor expansion constraints and by stability conditions. One important feature is their dependence on the range-step: the accuracy of the solution is improved by tailoring the Padé expansion to the discretization. The Padé approximation yields the split-step Padé solution, which only involves second order derivatives:

$$u(x+\Delta x,y,z)=u(x,y,z)+\sum_{j=1}^{N}\left(1+b_jZ\right)^{-1}a_jZu(x,y,z) \qquad (9)$$

This equation is marched in range by solving separately for each term in the sum. Since there is no interaction between the terms, the method lends itself quite well to parallel computing. As the number $N$ of terms increases, so does the angular cone of validity. For example with $N$=8, propagation angles of up to 70 degrees can be modelled. The method is very stable, and allows the use of large range steps.

Here we have briefly described the SPE and split-step Padé methods in order to give the reader an idea of the possibilities. Many other approximations of the square-root operator are available, the optimal choice depending on the angular sector of interest and on the type of boundary conditions to be modelled.

*Modelling boundaries*

In order to march the solution forward, PWE methods need the specification of boundary conditions at the edges of the integration domain and on scattering objects. On an air/ground or air/object interface, boundary conditions are specified by surface impedance expressions, which are adequate for smooth reasonably well conducting materials. At the "sky" boundary, the domain has to be truncated in such a way that energy radiates outwards to infinity, avoiding parasitic reflections as much as possible. Several techniques

are available to do this: the simplest is to add an absorbing layer to the domain of interest. This is easy to implement and is the preferred method for long-range problems. It can be computationally expensive: for large propagation angles, an absorbing layer several orders of magnitude larger than the domain of interest may be required in order to dampen spurious reflections. The recent Perfectly Matched Layer (PML) method [10,11] is more suitable for scattering problems. The PML is a special medium put around the domain of interest, with the property that all outgoing waves are fully transmitted at the interface without generating any reflections. A very thin PML is adequate for most scattering problems.

Non-local boundary conditions [12,13,14] provide a very different type of domain truncation: they are derived by matching the field inside the domain of interest to the outgoing solution outside it. The usual boundary conditions are local, for example linking the normal derivative of the field and the field itself at a boundary point. The non-local conditions involve the field at all previous boundary points.

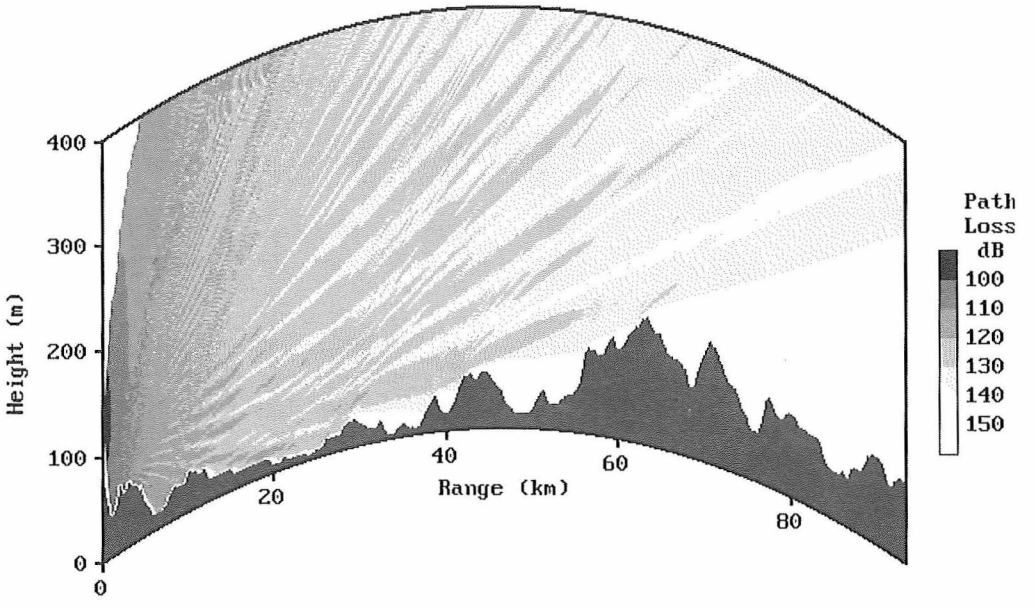



*Fig. 2 - Path loss contours for 2 GHz source radiating over hilly terrain under standard atmospheric conditions, plotted in 4/3 Earth coordinates. The PWE simulation copes accurately with terrain reflections and multiple diffraction effects.*

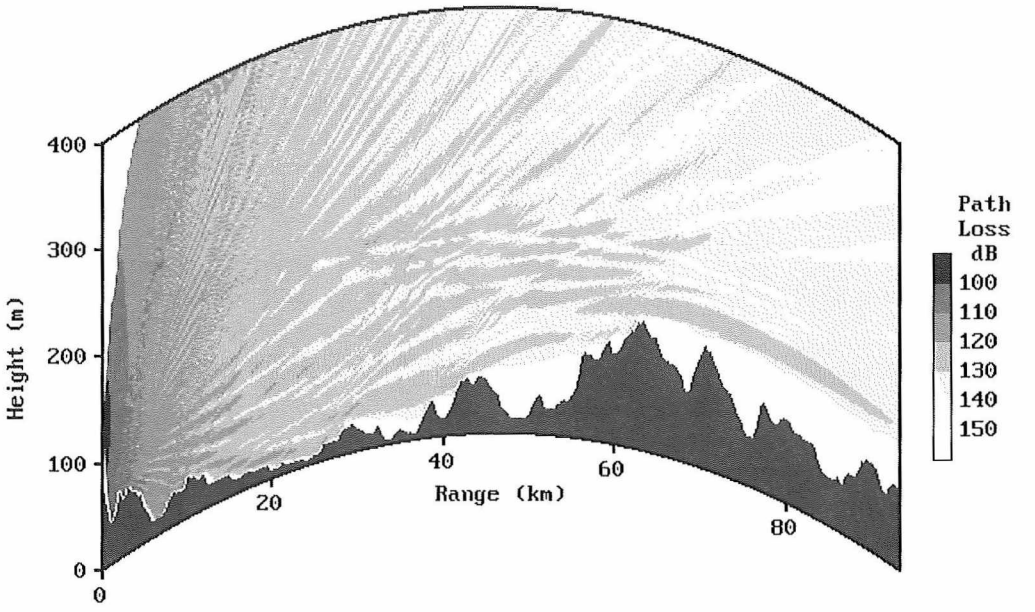



*Fig. 3 - Same as Figure 2 with an elevated ducting layer at a fixed height of 200 m, showing interaction of trapping effects with terrain.*

Because they take into account the global properties of the solution, they are perfectly transparent at all angles of incidence. Non-local boundary conditions are particularly useful for problems involving plane-wave incidence.

*Source modelling*

The incident PWE field must be determined at the initial range. Many scattering problems involve plane wave incidence which presents no difficulty. Alternatively, sources can be modelled if the beam pattern is known by starting integration at the antenna aperture, using the far-field/near-field transformation. More difficult problems (for example ground wave propagation where the ground is part of the antenna) have to be initialized by using other numerical methods.

*Numerical solutions*

There are two main families of PWE algorithms, based on either Fourier transform methods or finite-difference schemes. The Fourier transform algorithms, first introduced in [15], compute the second order derivatives in the Fourier domain. This requires the splitting of the term involving the refractive index from the rest, hence the "split-step Fourier" terminology for that type of algorithm. The SPE is already in split form and is particularly suitable for that treatment, but this is not the case for the split-step Padé equation. It is not straightforward to model complicated boundaries with split-step Fourier algorithms. Special mixed transforms which correctly propagate impedance boundary conditions have recently been introduced [16]. These provide accurate and fast solutions for many two-dimensional problems. We should also mention the existence of split-step/Fourier wide angle codes [17,18], which are often used instead of the SPE.

Finite difference schemes replace the second order derivatives with finite-difference approximations. They are suitable for both the standard and split-step/Padé equations and also lend themselves quite well to 3D generalizations. Their great flexibility for boundary modelling makes them very useful for scattering studies [5,7,8,11,12].

## Tropospheric propagation

*Ducting and terrain effects*

PWE models are routinely used to calculate field strength on tropospheric links. A great advantage is their ability to incorporate environmental data directly, without resorting to predefined templates for refractive index profiles or terrain shapes. Modern radiometeorological tools (state-of-the-art radiosondes or mesoscale numerical weather models) can feed their data straight into the PWE model, and similarly the PWE models can make direct use of terrain profiles extracted from digital terrain databases.
Figures 2 and 3 show contour plots of path loss in dB for a 2 GHz source radiating over a hilly path. Curved Earth coordinates with an effective Earth radius of 8500 km are used for easier comparison with standard propagation conditions: in this coordinate system, radio-rays are straight lines under average atmospheric conditions. A standard refractive index profile has been used for the simulation plotted in Figure 2, which emphasizes the complex patterns that are obtained with irregular terrain reflections, and shows that the PWE has no difficulty modelling diffraction effects. An elevated ducting layer is present in the simulation shown in Figure 3. The resulting duct is strong enough to trap some of the radiated energy and carry it at large distances. The signal beyond the main hilly obstacle is far larger than under standard diffraction conditions.

The PWE can deal with range-dependent variations of the refractive index profile. Here the limitations are not caused by the PWE model, but by the lack of adequate meteorological data. In some detailed case studies where good meteorological measurements were available, it has been shown that range-dependent information improves the quality of the PWE forecasts [19].

Here we have stressed the microwave applications, but there is no inherent frequency limitation: for example the PWE can be used to compute the surface wave at HF [16] or for millimetre wave modelling by including range and height dependent atmospheric absorption [3].

*Rough surface modelling*

The modelling of propagation over a rough surface is one of the remaining challenges in PWE research. One possibility is to treat the rough surface in a deterministic way, representing all the rough features of interest. This is however uneconomical for long-range problems, and other solutions have beeen sought. For propagation over the rough sea surface, effective reflection coefficients depending on the rms waveheight can be computed for a given angle of incidence [20]. These can then be used to calibrate the mixed transform at each range [16]. Local angles of incidence can be computed with geometrical optics or spectral algorithms like MUSIC.

Roughness effects can be severe, as shown in Figures 4 and 5. A vertically polarized 10 GHz source is located inside a strong surface duct. Figure 4 shows path loss contours for a smooth sea surface: the energy is carried forward with negligible loss by the multiple bounces at the sea surface.

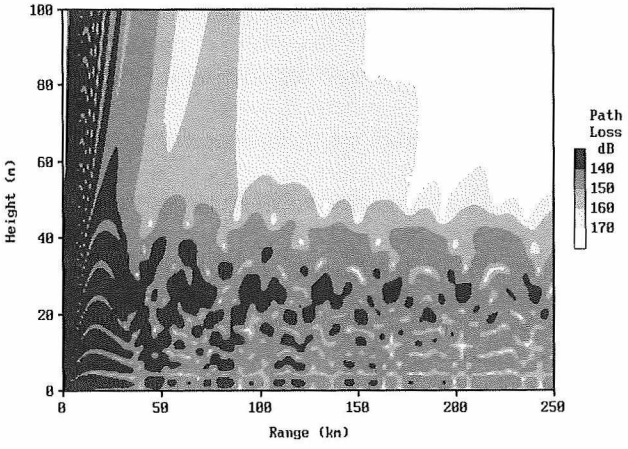



*Fig. 4 - Vertically polarized 10 GHz antenna in strong bilinear surface duct with smooth sea surface. The source is at a height of 25 m and the duct extends from 0 to 50 m above sea level.*

In Figure 5, a wind speed of 14 m/s has roughened the sea surface. The corresponding rms waveheight is 1 m. A large part of the energy is now lost through diffuse scatter at each bounce, preventing long-range ducting.

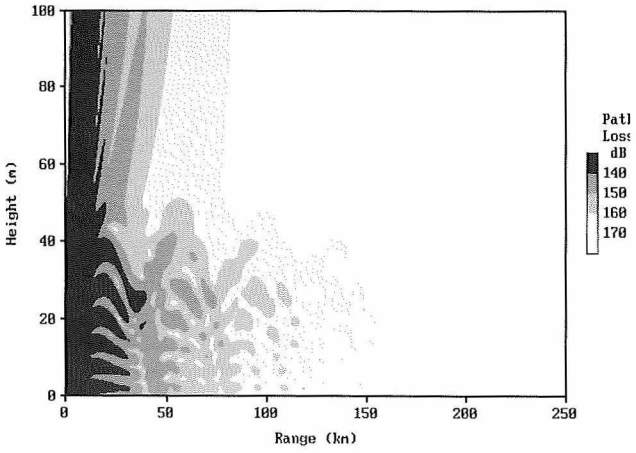



*Fig. 5 - 10 GHz antenna in strong surface duct with rough sea surface corresponding to 14 m/s wind speed. A range-dependent mixed transform model has been used, with ray-optics to calculate local incidence angles on the sea surface.*

### *Hybrid models*

Some applications involve high propagation angles and require field strength calculations at large ranges and heights: this is the case for the computation of radar coverage diagrams. For this type of problem the memory requirements and execution times of PWE solutions can become prohibitively large. Fortunately in most tropospheric environments, the full power of the PWE is unnecessary for large angles and heights: severe atmospheric refraction effects are normally limited to a few hundred metres above sea level, and even with very strong refractive index gradients, effects on energy propagating at more than a degree or so from the horizontal are relatively easy to model. The idea of using faster techniques in regions of the coverage diagram where the PWE is not needed was pioneered in [21] with the Radio Physical Optics model (RPO). Further developments have extended these hybrid techniques to deal with terrain and speed up calculations involving high transmitters [22].

Hybrid models restrict the PWE to low altitudes and energy propagating at small angles from the horizontal. Ray optics are used for rays that remain in the line-of-sight region and carry no risk of being trapped in ducts or approaching diffraction shadow zones. The limiting ray beyond which ray optics could become unsound is determined by the environment and the frequency. Two techniques are available for extending the PWE solution to higher altitudes. The extended optics method is used in RPO. This very efficient method has the drawback that it requires launching angles at the upper boundary of the PWE region. This is not necessary with the second option, the horizontal parabolic wave equation (HPWE) method [23]. HPWE is a rigorous full-wave solution to the wave equation which calculates the field above a certain height from known values at that height. Terrain and range-dependent refractivity features below the threshold height can be handled without difficulty. The numerical HPWE solution is based on Fast Fourier Transforms in the range variable.

Figure 6 shows the regions of the coverage diagram where the different models are used. The PWE region includes trapping layers and terrain. The resulting hybrid algorithms are extremely fast, with typical integration times of a few seconds on modern desktop computers. An interesting development is the use of hybrid models to assess the effects of tropospheric ducting on Earth-space links [24].

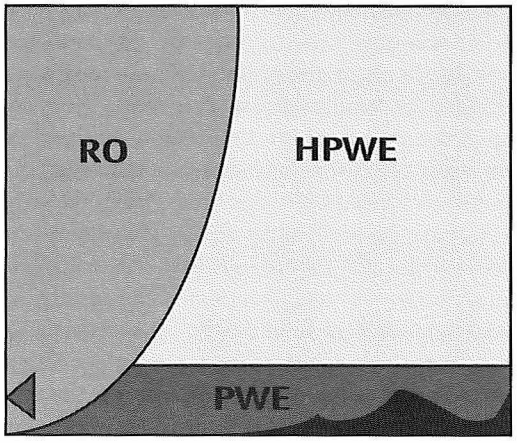



*Fig. 6 - Hybrid model regions. A limiting ray is traced to separate the ray-optics (RO) region from the parabolic wave equation domain.*

### *High antenna modelling*

With conventional modelling, the PWE region must include the source, and hence integration times and memory requirements can become prohibitive when computing coverage diagrams for airborne systems. Recent work on non-local boundary conditions [14] demonstrated that with finite-difference implementations, the PWE domain can in fact be truncated cleanly at any height above which the propagation medium becomes fully upwards transmitting, i.e. no energy coming from below is bent back downwards. Incoming energy is represented by an integral term which is added at the boundary at each range.

These ideas have been taken further with the development of a split-step/Fourier version of the rigorous non-local boundary condition approach [22]. The basic idea is to feed in the incoming energy at each range through a special kernel. The incoming field can be calculated with a ray-trace. With this technique, the PWE domain does not depend on source height, but only on environmental constraints. The angular domain for the PWE region is kept to the minimum required for accurate treatment of ducting layers and terrain, and ray-optics are used for larger angles.

A matching generalized HPWE technique is available to extend the solution upwards if required.

Figure 7 shows the coverage diagram of a 10 GHz vertically polarized source at an altitude of 1000 m, with an elevated ducting layer between 300 and 400 m. The PWE domain was truncated at 400 m with incoming energy boundary conditions. The results are in excellent agreement with conventional PWE techniques. The hybrid high antenna model gives a computational gain of over an order of magnitude in both time and memory.

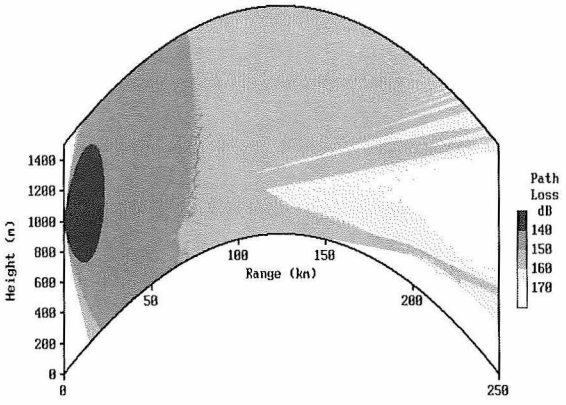



*Fig. 7 - High 10 GHz source in elevated duct environment. The duct traps part of the energy and creates an area of weaker field strength (the "radar hole") just above the layer. Incoming energy hybrid models have been used, with the PWE boundary at 400 m, HPWE to extend the field upwards and ray-optics for high angle propagation.*

## Scattering by obstacles

In recent years it became clear that PWE techniques could become a powerful tool for diffraction and scattering studies. Indeed the PWE is at the core of Fresnel-Kirchhoff diffraction theory: for example closed-form formulae for half-plane or planar aperture diffraction can be shown to be exactly equivalent to the integrals obtained using the PWE framework. The power of the PWE is that it does away with the need for closed form results since it calculates the scattered field directly. PWE techniques model both reflection and diffraction accurately, and can deal directly with objects specified numerically, without resorting to decomposition into canonical shapes. For many applications the propagation medium is vacuum, but if necessary the scattering objects can be embedded in a non-homogeneous atmosphere.

### *Urban diffraction and scatter*

An important application is the modelling of diffraction by buildings, to assist in the planning of urban communications [25]. Figure 8 shows path loss contours for a 900 MHz source in an urban environment, showing the effects of multiple diffraction.

Generalization to three-dimensional modelling is relatively straightforward for simple building geometries for which the scalar wave equation is still adequate [11,26].

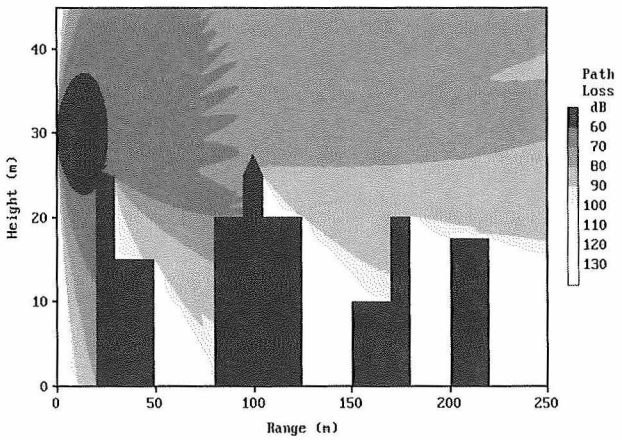



*Fig. 8 - Horizontally polarized 900 MHz source in urban environment. This is a 2-dimensional simulation which neglects the effects of diffraction around buildings.*

A great advantage of the method is that it can model detailed features of the buildings like doors and windows by using suitable boundary conditions on each feature. Rough brick walls can be modelled in a deterministic way by representing the wall as a composite of the individual bricks. The resulting models are sufficiently realistic for comparison with experimental results.

Building scatter measurements at a frequency of 38 GHz were recently made at Rutherford Appleton Laboratory [27]. Three-dimensional PWE techniques were used to compute the scattered field. Figure 9 shows the normalized reflected field on the building when the wall is modelled as a smooth surface. The scattered field was measured with a receiver kept at a fixed height of 1.7 m and moved along a horizontal circular arc of 30 m radius centered on the illuminated spot on the building. The measured results presented high scatter levels away from the specular direction which could not be explained by the smooth wall PWE results, but were in good agreement with rough wall results using the actual brick dimensions. The comparison of predicted and measured results is shown is Figure 10.

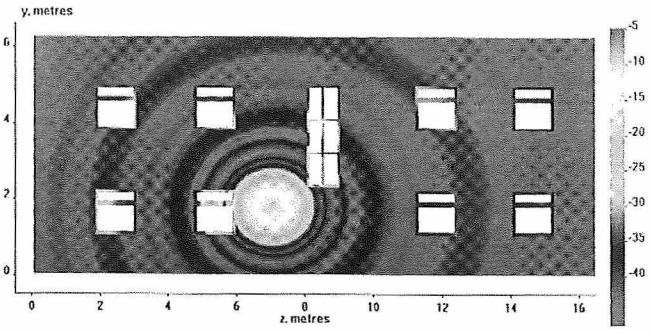



*Fig. 9. - Normalized field of a 38 GHz source obliquely incident on a building. The windows are modelled as perfectly transparent and the window frames as perfectly conducting. The reflection coefficient of the smooth brick wall is 0.35.*

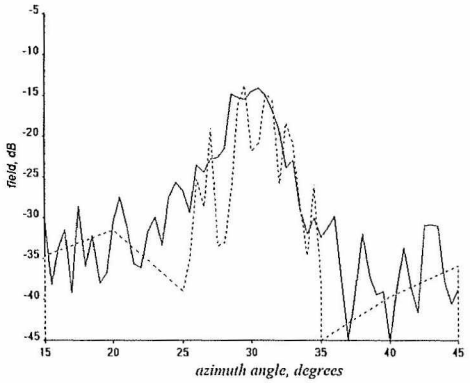



*Fig. 10 - Comparison of PWE results(continous line) to bistatic measurements (dashed line) on a horizontal circular arc of radius 30 m centered on illuminated spot on the building wall. Diffuse scatter due to the roughness of the wall is quite well simulated with a realistic brick model.*

*Bistatic scattering studies*

PWE methods provide a robust and fast solution for target scattering problems. A single pass produces forward bistatic scattering results for a given incidence angle, and a second pass is needed for backscattering results. Bistatic radar-cross section results are obtained via a Fast Fourier Transform of the near field. Objects ranging from a size of few wavelengths to many hundreds of wavelengths can be treated. Two-dimensional codes are very efficient and have been validated against other numerical methods [7,8].
Figure 11 shows the real part of the scattered field for a 57 MHz plane wave incident from below. A split-step Padé PWE code was used, dealing with scattering angles up to 70 degrees from the paraxial direction, here the vertical. The distortions due to the paraxial approximation are clearly visible on Figure 11 in scattering directions close to the horizontal. This limitation can be removed by rotating the paraxial direction, producing full angle coverage with a small number of runs.

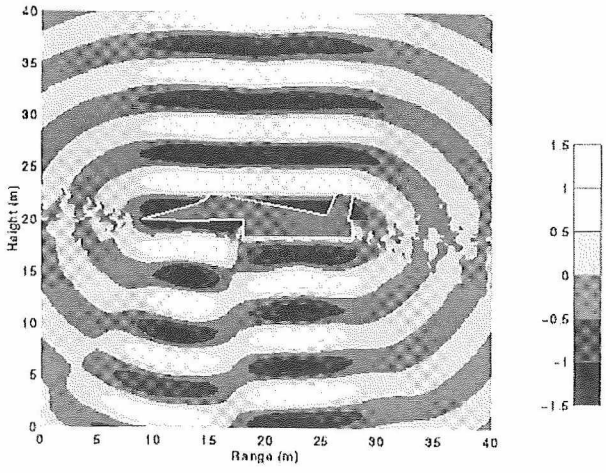



*Fig. 11 - Real part of field scattered by idealized aircraft shape for a horizontally polarized 57 MHz plane wave incident from below.*

Extension to scalar three-dimensional problems is straightforward, and the method has been successfully applied to acoustic scattering [8]. General three-dimensional electromagnetic scattering is a more difficult problem, as the boundary conditions on the scattering object couple the field components which can no longer be solved for separately. A vector version of the PWE incorporating the divergence condition of Maxwell's equations as well as polarisation effects has recently been developed and tested on canonical shapes.

## Conclusions

Parabolic wave equation techniques are now a well-established tool for tropospheric propagation modelling, with several efficient models to compute the combined effects of terrain and ducting at frequencies ranging from HF to millimetre wave. Work in this area now focuses on the modelling of rough surface effects and on the development of more accurate techniques for representing irregular terrain. It is quite an exciting development that PWE methods should prove so useful for scattering studies, with excellent results in two-dimensional problems and a very promising start in three-dimensions.

## Acknowledgments

This work is supported by the Radiocommunications Agency of the Department of Trade and Industry and by the Engineering and Physical Sciences Research Council of the United Kingdom.

## References

V.A. Fock, "*Electromagnetic diffraction and propagation problems*", Pergamon Press, 1965.

D. Lee and A. Pierce, "Parabolic equation development in recent decade", *J. Comput. Acous.*, Vol. 3, pp. 95-173, 1995.

K.H. Craig and M.F. Levy, "Parabolic equation modelling of the effects of multipath and ducting on radar systems", *IEE Proc.-F*, Vol. 138, pp. 153-162, 1991.

J.R. Kuttler and G.D. Dockery, "Theoretical description of the PE/Fourier split-step method of representing electromagnetic propagation in the troposphere", *Radio Sci.*, Vol. 26, pp. 381-303, 1991.

M.F. Levy, "Parabolic equation modelling of propagation over irregular terrain", *Electron. Lett.*, Vol. 26, pp. 1153-1555, 1990.

A.E. Barrios: "A terrain parabolic equation model for propagation in the troposphere", *IEEE Trans. Antennas Propag.*, Vol 42, pp 90-98, 1994.

M.F. Levy and P-P. Borsboom, "Radar cross-section computations using the parabolic equation method", *Electron. Lett.*, Vol. 32, pp. 1234-1236, 1996.

M.F. Levy, P-P. Borsboom, A.A. Zaporozhets and A. Zebic-Le Hyaric, "RCS calculations with the parabolic wave equation", *AGARD Conf. Pub.*, No 583, Paper 5, 1996.

M.D. Collins, "A Split-Step Padé solution for the Parabolic equation Method", *J.Acoust.Soc.Am.*, Vol. 94, pp. 1736-1742, 1993.

J.-P. Bérenger, "A perfectly matched layer for the absorption of electromagnetic waves", *J.Comp.Phys.*, Vol. 114, pp. 185-200, 1994.

A.A. Zaporozhets and M.F. Levy, "Modelling of radiowave propagation in urban environment with parabolic equation method", *Electron. Lett.*, Vol. 32, pp. 1615-1616, 1996.

S.H. Marcus, "A hybrid (finite difference—surface Green's function) method for computing transmission losses in an inhomogeneous atmosphere over irregular terrain", *IEEE Trans. Antennas Propag.*, vol. 40, pp. 1451-1458, 1992.

A.V. Popov, "Accurate modeling of transparent boundaries in quasioptics", *Radio Sci.*, Vol. 31, pp. 1781-1790, Nov-Dec. 1996.

M.F. Levy, "Transparent boundary conditions for parabolic equation solutions of radiowave propagation problems", *IEEE Trans. Antennas Propag.*, Vol 45, pp 66-72, 1997.

R.H. Hardin and F.D. Tappert, "Applications of the split-step Fourier method to the numerical solution of nonlinear and variable coefficient wave equations", *SIAM Rev.*, Vol. 15, pp. 423, 1973.

G.D. Dockery and J.R. Kuttler, "An improved impedance boundary algorithm for Fourier split-step solutions of the parabolic wave equation", *IEEE Trans. Antennas Propagat.*, Vol 44, pp. 1592-1599, 1996.

M.D. Feit and J.A. Fleck, "Light propagation in graded-index fibers", *Appl. Optics*, Vol 17, pp. 3990-3998, 1978.

D.J. Thomson and N.R. Chapman, "A wide-angle split-step algorithm for the parabolic equation", *J. Acoust. Soc. Am.*, Vol. 74, pp. 1848-1854, 1983.

A.E. Barrios: "Parabolic equation modeling in horizontally inhomogeneous environments", *IEEE Trans. Antennas Propag.*, Vol 40, pp 191-797, 1992.

A.R. Miller, R.M. Brown and E. Vegh, "New derivation for the rough-surface reflection coefficient and for the distribution of sea-wave elevations", *IEE Proc.*, Vol. 131, Pt H, pp. 114-116, 1984.

H.V. Hitney: "Hybrid ray-optics and parabolic equation methods for radar propagation modeling", Proceedings of Radar 92, *IEE Conf. Pub No 365*, pp 58-61, 1992.

M.F. Levy and K.H. Craig, "Hybrid models for operational forecasting with EEMS", *IEE Digest* No 96/055, 1996.

M.F. Levy: "Horizontal parabolic equation solution of radiowave propagation problems on large domains", *IEEE Trans. Antennas Propag.*, Vol. 43, p. 137-144, 1995.

H.V. Hitney, "Modelling tropospheric ducting effects on satellite to ground paths", *AGARD Conf. Proc.*, No 543, paper 16, 1994.

M.F. Levy, "Diffraction studies in urban environment with parabolic equation method", *Electron. Lett.*, Vol. 28, pp. 1491-1492, July 1992.

A.A. Zaporozhets, "Modelling of radiowave diffraction and scattering in urban environment", ICAP 97, *IEE Conf. Pub.*, No 436, Vol. 2, pp. 83-89, 1997.

A. Seville, U. Yilmaz, P.R.V. Charrière, N. Powell, K.H. Craig, "Building scatter and vegetation attenuation measurements at 38 GHz, ICAP 95, *IEE Conf. Pub.*, No 407, Vol. 2, pp. 46-50, 1995.

# URSI

## The URSI Board of Officers

| | |
|---|---|
| President: | Prof. Thomas B. A. Senior (U.S.A.) |
| Past President: | Dr. Pierre Bauer (France) |
| Vice-Presidents: | Prof. Peter J. B. Clarricoats (UK) |
| | Prof. Hiroshi Matsumoto (Japan) |
| | Dr. Joseph Shapira (Israel) |
| | Prof. Maria A. Stuchly (Canada) |
| Secretary-General: | Prof. Paul Lagasse (Belgium) |

## The URSI Commissions

*Commission A : Electromagnetic Metrology*
Chair: Dr. M. Kanda (U.S.A.)
Vice-Chair : Prof. E. Bava (Italy)

*Commission B : Fields and Waves*
Chair: Prof. C.M. Butler (U.S.A.)
Vice-Chair : Prof. S.E.G. Ström (Sweden)

*Commission C: Signals and Systems*
Chair: Prof. J.G. Lucas (Australia)
Vice-Chair : Prof. E. Bonek (Austria)

*Commission D: Electronics and Photonics*
Chair: Prof. R. Sorrentino (Italy)
Vice-Chair : Prof. A. Seeds (U.K.)

*Commission E: Electromagnetic Noise and Interference*
Chair: Prof. M. Hayakawa (Japan)
Vice-Chair : Dr. R.L. Gardner (U.S.A.)

*Commission F: Wave Propagation and Remote sensing*
Chair: Mr. M.P.M. Hall (UK)
Vice-Chair : Dr. Y. Furuhama (Japan)

*Commission G : Ionospheric Radio and Propagation*
Chair: Prof. B.W. Reinisch (U.S.A.)
Vice-Chair : Dr. P. Wilkinson (Australia)

*Commission H : Waves in Plasmas*
Chair: Dr. V. Fiala (Czech rep.)
Vice-Chair : Dr. H.G. James (Canada)

*Commission J: Radio Astronomy*
Chair: Prof. R.S. Booth (Sweden)
Vice-Chair : Prof. J. Hewitt (U.S.A.)

*Commission K: Electromagnetics in Biology and Medicine*
Chair: Prof. J.C. Lin (U.S.A.)
Vice-Chair : Prof. S. Ueno (Japan)

# Conferences

## CONFERENCE REPORTS

# ISAP'96

Chiba, Japan, 24-27 September 1996

ISAP'96 was held on September 24-27, 1996, at Makuhari Messe International Conference Hall, Chiba, Japan, sponsored by IEICE (The Institute of Electronics, Information and Communication Engineers), in cooperation with URSI (International Union of Radio Science), IEEE Antennas and Propagation Society, IEE Electronics Division, with the support of Foundation for the Promotion of Electrical Electronics and Information Sciences.

ISAP is an international conference held in Japan on antennas, propagation, electromagnetic wave theory and related fields. The ISAP'96 was the 6th Symposium since the first one in Sendai in 1971. In recent years, the Symposium has been held with increasing frequency, and is convened approximately once every four years.

The 480 participants were welcomed from 26 different countries. The number of Japanese participants was the largest with 351, followed by the United States with 19, the United Kingdom and Korea with 7, Hong Kong with 6, and France with 5. A total of 360 research papers from 32 different countries were submitted to the conference, of which 321 were published in the symposium record (including four which were presented by special invited speakers). Totally 281 papers were presented during the conference, including 198 from Japan, 19 from the United States, 6 from Taiwan, and 6 from Australia.

A feature of the conference was the high number of sessions, 65 in all. These comprised special-invitation presentations, special sessions, and regular presentations (oral and poster). The regular presentations included 23 sessions on antennas, 17 on electromagnetic wave theory, and six on propagation. Thirteen special sessions were also held.

Another feature of the conference was the inclusion of Poster sessions and Technical Demonstrations for the first time in ISAP. In addition to 40 conventional poster session papers using posters only, there were four poster session papers for which additional visual information was provided with the aid of personal computers. As for Technical Demonstrations, explanatory panels and devices were on hand in all booths offering technical demonstrations, as well as personal computers for demonstration purposes. Attendees at the conference had the opportunity to witness 17 different technical demonstrations, 15 of them by courtesy of participants from Japan. In addition, Young Scientist Awards (YSA) were presented to youthful researchers who had distinguished themselves with the quality of their work. Four participants received the YSA in recognition of their achievements.

The opening session of the conference was held on September 24. Formal greetings were addressed by Prof. Kiyohiko Itoh (Organizing/Steering Committee Chairperson), Prof. Naohisa Goto (former Vice-Chairperson of IEICE), and Mr. Shimazaki (Vice-Gov. of Chiba Pref., on behalf of Mr. Numata, Gov. of Chiba Pref.). These were followed in turn by words of greeting from Mr. M.P.M. Hall (as the Representative of URSI), Dr. W. R. Stone (on behalf of Prof.S.A. Long who was the Representative of IEEE Antennas and Propagation Society) and Prof. P.S. Hall (as the Representative of IEE Electronics Division).

The technical sessions followed the opening addresses, beginning with informative and thought-provoking presentations given by the following four special invited speakers : Prof. A. Ishimaru (University of Washington, U.S.A.), on "Imaging in Biological and Environmental Random Media" ; Dr. A.G. Roederer (European Space Agency, Netherlands), on "Recent European Antenna Technology for Space Systems" ; Mr. M.P.M. Hall (Rutherford Appleton Laboratory, UK), on "Radiowave Propagation Research Activities in Europe" ; and Prof.S.A. Long(University of Houston, U.S.A.), on "Application of High Temperature Superconductors in Antenna Systems".

Special sessions were organized and conducted to deal with topics which have become particular items of focus in recent years. These encompassed seven major areas of study : (1) Propagation for wideband digital mobile/ indoor communication systems, (2) Microwave power transmission technology, (3) Emerging technologies in remote sensing, (4) Recent developments in computational electromagnetics, (5) Integrated and millimeter-wave antennas, (6) Antennas and propagation for mobile satellite communication systems, and (7) Bioeffects and biomedical use. The organizers of special sessions received a great deal of help and cooperation from researchers outside of Japan in arranging these sessions, and this cooperation was reflected in the significant increase in the number of non-Japanese participants at the conference. With the timely range of topics and the large number of excellent papers submitted from abroad, this part of the conference had very high attendance figures and generated a great amount of energetic and active discussions.

In the general presentations, antenna-related topics covered microstrip antennas, small antennas, reflector and lens antennas, array antennas and phase arrays, adaptive and signal processing antennas, mobile communication antennas, satellite communication antennas, remote sensing, and antenna measurement methods. In the area of propagation and related topics, reports were presented on such subjects as tropospheric and terrestrial propagation, ionospheric propagation, earth-space propagation, and propagation for mobile communications. Finally, presentations on electromagnetic theory covered such items as scattering and diffraction, transients and time domain methods, inverse problems and inverse scattering, canonical problems, numerical techniques, high frequency techniques, waveguides, and wavelets in electromagnetics.

The ISAP continue to develop and expand in the fullness of their coverage of antenna- and propagation-related topics. With the success of ISAP '96 behind us, we are now making preparations for ISAP 2000, which will be expected to be bigger and better than any of its predecessors.

Prof. Kiyohiko Itoh, Chairperson of ISAP'96

Dr. Yoji Furuhama, President Japanese Committee

# COMMSPHERE 97

Lausanne, Switzerland, 11-14 February 1997

The conference was held during February 11-14, 1997, in the campus of EPFL in Lausanne, Switzerland - very nice facilities. The participation was low (about 65 registrants), which may be attributed to many reasons, that we will review in a later report. Prof. Ianoz, the chairman of the Swiss URSI committee, was the organizer, and did all the work by himself, assisted by a part time secretary only. I admire his courage, but it had its costs.

The participation was characterized by a high number of senior scientists and administration experts, which account for the quality of the presentations and discussions. URSI was represented across the scientific commissions, including J.B. Andersen (past VP, Comm. B), G. Lucas (chair, comm. C), M. Ianoz, R. Struzak (comm. E), W. Baan, J. Cohen, J. Ponsonby (comm. J), J. Lin (chair), P. Bernardi (comm. K), G. Swarup, S. Radicella (Committee on developing countries, and comm. J, G, respectively). ITU was represented by R. Jones (first day) , K. Hughes (last day) and others. The industry was also fairly well represented by senior delegates, though we had a couple of no-shows.

## Developments in Spectrum Management Policies and Techniques

Organized and Summary by R Struzak

The session consisted of discussions around the following six invited contributions:

Robert McCaughern and Gerry Chan (Canada), in their paper "Convergence of services and technologies and the impact on RF spectrum management" discussed consequences of current convergence of the informatics, communications and entertainment industries and a merging of telecommunications, computer, television and radio technologies into one entity. It leads to congestion and increased demand for spectrum/orbit resources that cannot be satisfied. A redefinition of the radio services and review of the existing allocation of the spectrum/orbit resources is needed.

The paper "ITU-R studies on spectrum management" by Albert Nalbandian (ITU) offered a review of recent international studies aimed at more rational use of the radio frequency and geostationary orbit resources. The ITU has played a central role in the management of the radio frequency spectrum and the geostationary satellite orbit and in assurance of the equitable access to these resources. The author included also a survey of preparations to the World Radiocommunication Conference to be held later this year.

Darius Breau (Canada) in his paper "Spectrum market issues - a public policy perspective" analysed relative benefits and disadvantages of two approaches to the spectrum management: one based on administrative regulations and another one based on economic incentives. The issue was illustrated by a case study (Canada). The main conclusion is that the application of economic techniques unleashes the market dynamic that will work to bring about more societally optimal assignments, system designs and frequency allocations.

The paper "Congestion of the geostationary satellite orbit- Means to solve the problems" by Erhard Hauck (Switzerland) presented current problems faced by international community in connection with the unconstrained demand for the spectrum/orbit resources. He reviewed the current studies and regulatory- procedural initiatives undertaken in the framework of ITU in response to the request of ITU Plenipotentiary Conference.

Ryszard Struzak (Poland) in his paper "Spectrum management system for the 21st century" discussed some inefficiencies in current spectrum management practices, national and international, and suggested possible improvements. Among others, integration of the existing fragmented national spectrum management systems can bring substantial benefits.

The paper "Reflections on frequency management from the past to the future", by Henry Kieffer (Switzerland), offered comments drawn from the author's experience first national and then international, as chair of the ITU Radio Regulations Board.

The session generated great interest. It was attended by the Vice-President of URSI, the past Chair of ITU-RRB, the Director of the ITU-R, by Chairs of URSI Commissions and by almost all registrants of Commsphere 97.

The subsequent discussions raised the following major issues: A spectrum management definition was agreed: it embraces planning, allocation, use and monitoring of the spectrum - orbit resources aimed at rational use of these resources, with environmental - ecological and EMC aspects as key elements.

It was stressed that the spectrum management is vital for all applications of radio. It was commented that the existing Radio Regulations need to be reviewed in view of their better adaptation to current needs. First, the "service" concept needs to be reviewed in view of developments in digital techniques, multi-service systems and new spatial, stratospheric and terrestrial communication technologies. Moreover: (1) frequency allocations should be grouped in wider frequency bands, (2) the passive applications and active applications should be re - allocated to non - adjacent frequency bands, (3) the admissible levels of unwanted emissions should be reduced.

Opinions were expressed that the regulations, recommendations, data, software tools and other material concerning spectrum management that have been gathered in the framework of ITU and converted into electronic format should be made accessible via Internet free of charge. That material has been produced using public money and consequently it should remain in public domain. The current ITU copyright and pricing policy creates additional obstacles in promoting the rational use of spectrum - orbit resources especially in developing countries, where more and more universities are connected to Internet. The current ITU pricing policy is incompatible with the purposes of that organization.

## Radio Astronomy and the EM environment - people to Nature communications issues

Organized and Summary by R. J. Cohen

The impact of global telecommunications on the passive users of the radio spectrum was considered in the session on "Radio astronomy and the EM environment - People to Nature Communication Issues" chaired by Dr. R. J. Cohen (NRAL Jodrell Bank). The following papers were presented:

- "The Radio Astronomer's experience of Communications Systems", R. J. Cohen (NRAL Jodrell Bank, UK)
- "Global cooperation - VLBI and space VLBI", R. T. Schilizzi (Joint Institute for VLBI in Europe, Dwingleoo, The Netherlands)
- "Sharing the spectrum - what is the problem?", J. E. B. Ponsonby (NRAL Jodrell Bank, UK)
- "Doing Radio Astronomy alongside Communications in a Developing Country", G. Swarup (Director, Giant Metrewave Radio Telescope, Pune, India)
- "Working Together to keep the Radio Window open", W. A. Baan (Arecibo Observatory, USA)

Prof. Schilizzi's paper was presented by Dr. H. J. van Langevelde just hours after the launch of the first space-VLBI mission, the Japanese Haruka project. Dr. Ponsonby's paper was presented by the chairman.

The session was well attended and each talk generated lively discussions. One of the key problems facing radio astronomy is how to protect new and existing instruments from interference, in the face of rapidly increased use of the radio spectrum. One of the recurring themes was the threat posed by spurious and out-of-band emissions from satellite transmitters, particularly those operating in bands adjacent to radio astronomy bands. The majority of radio astronomy's allocated bands stand to be affected in this way, because of the unfortunate way the satellite bands have been allocated. The generic limits on spurious emissions adopted by Task Group 1-3 of ITU-R fall far short of what is needed. At millimetre-wavelengths the problem can be even more acute because of inadequate filter-technology:- it is difficult to filter transmitters, and on the other hand receivers cannot adequately protect themselves against transmitters in bands well removed in frequency. Issues such as these are of general concern for all system designers, and will become more urgent as spectrum use expands into the mm-wave region.

The launch of the space-VLBI mission heralds a new dimension to radio astronomy and a new interference environment, one in which geographical sharing is no longer feasible. It is the satellite problem in reverse! For the future we need to find ways of improving access to unallocated parts of the spectrum at particular observatory sites. The concept of protection zones or quiet zones around mm-wave observatories was raised again. Some such arrangement will certainly be necessary for the large 21st-century project to build a radio array with one square kilometer collecting area. The instrument is currently in the design study phase (URSI Large Telescope Working Group). Although it will be optimized for interference rejection there will still need to be special regional arrangements to ensure that the instrument can access much more than the 2% of the spectrum allocated to radio astronomy at metre and centimetre wavelengths.

Outside the meeting a small working group considered ways to improve the interaction between URSI and the ITU-R. The group also discussed the role URSI could play in coordinating joint studies of technical issues, such as filter technology at mm-wavelengths, modulation schemes, linearization of amplifiers, propagation, time-transfer, and automated spectrum management techniques and algorithms.

## Satellite personal communications / network integration issues

Organized by B. Evans
Summary by G. Maral

In the field of satellite personal communications integration can be looked upon at different levels : - service area : of

relevance here is the integration of terrestrial and satellite systems. The latter are anticipated to complement the former in two ways, either by expanding the service to regions where the terrestrial infrastructure would be too costly to develop, or by overcoming the incompatibility of different terrestrial standards implemented in various geographical regions. - user categories : future satellite personal communications will be used by mobile users as well as fixed ones. Indeed, many operators will offer satellite services as a means to obviate the lack of service to fixed users from terrestrial networks. An integration issue then is the ability of the network to accommodate categories of users with different demands. Usually, a fixed user is more sensitive to forced call termination than a mobile user. With non-geostationary satellite systems, a cause of forced call termination is satellite handover, which applies to both fixed and mobile users, as it results from satellite motion and not from user motion. - service types : up till now, services have been either circuit-switching or packet-switching oriented. Also, services have been either narrow-band or wide-band oriented. An integration issue therefore resides in setting up networks able to accommodate simultaneously such very different service types.

- applications : integration deals with the ability of the network to support both professional and general public applications.
- multiple operators : integration also means having different operators using networks to build up their business over a common infrastructure as a result of the disappearance of monopolies.
- frequency band utilization : frequency bands must be shared between different systems of the same kind, and also of different kinds. For instance, a given frequency band can be used by several satellite systems, but also it may happen that the frequency band is used both by satellite and terrestrial systems. Interference must be kept under control, and this implies interference co-ordination. A new situation arises with the co-existence of geostationary satellite systems and non-geostationary satellite systems : the co-ordination procedures that have prevailed up till now for co-ordinating geostationary satellites systems have to be adapted to integrate non-geostationary satellite systems. The use of reverse band sharing is an example of the necessary adaptation.

The major factors against integration are the distinct radiofrequency channels whose characteristics are strongly dependent upon frequency. Terrestrial systems and satellite systems may be allocated very different frequency bands, and therefore the service will be delivered differently depending on which system delivers the service. Also uncoordinated development of systems in the world is a strong impediment to graceful integration.

Fortunately, there are also favorable forces towards integration. First ranking is the user's pressure : indeed the user perceives integration as a premium convenience. Also, in a satellite system, the nodal position of the satellite in the network gives the satellite a strong potential for service integration : an on-board processing satellite equipped with an ATM switch would make it suitable for offering a large variety of services over large areas with easy access from any parts of the world within the satellite coverage.

## Session on Communications development in Developing Countries / Workshop on Wireless alternatives for Telecommunications in Developing Countries.

Organized and Summary by S. M. Radicella

At the session three papers were presented addressing: information and telecommunications, telecommunication development in Africa and training for telecommunications development. Two more papers presented the use of wireless solutions for telecommunication development in Nigeria and the background approaches to FM broadcasting spectrum management as defined in Argentina.

At the workshop some telecommunication needs in developing countries where wireless alternatives appear to give possible leap-frog solutions were indicated. Typical examples presented are: communications for rural development, environmental monitoring and disaster prevention and access to the Global Information Infrastructure for: education, health care, agricultural development, and economic development.

During the discussions the following problem areas were identified: regulation matters and standardization, spectrum management, equipment environmental and power supply constrains and technological and managerial capacity building.

The action points stressed were:

- Political and administrative will and decision taking are essential ingredients in order to provide the necessary improvements of the telecommunication and information infrastructure in developing countries. To address this problem the organisation of regional discussion fora like COMMSPHERE are suggested. Such fora should bring together international experts and telecommunication regulators/operators and policy makers to present developments in wireless technologies and their potential use and the spectrum management issues needed for such use.
- Capacity building is urgently needed for decision makers down to the level of technical operators on wireless technologies and spectrum management. Specific capacity building projects should be identified with institutions like, UNU, ICTP and others. Such capacity building should include studies on the quantitative social and economic impact of telecommunications and radiocommunications in particular.
- The establishment of technological observatories in specific areas of wireless technologies to provide advise to developing countries willing to use such technologies for the advancement of the telecommunication and information infrastructure is suggested. The identification of specific plans in this direction is encouraged.
- The need for free access to the important technical information available in ITU has been underlined and possible solutions will be analyzed at ITU level.
- The need to identify industrial and financing agencies willing to collaborate in capacity building for specific projects or programs is stressed.

In order to obtain the best possible results from the actions indicated above, it is considered essential to collaborate with ITU/BDT existing projects that address similar problem areas.

## Global Information Superhighway - the wireless arm

Organized and Summary by J. Shapira

The session included two papers, one on wireless multimedia networks, and the other on integrated multiservice wireless access networks. Two other presentations were cancelled at the last moment, intended to cover integrated satellite broadband multiservice network, and the enabling technologies for wireless multiple access communications. The issues illuminated, and discussed were the wired/ wireline transport trade-off and their integration, the integration of services in a single (CDMA) communications system, and the distribution of the cellular nodes. A detailed network of such nodes ("micorcells") Is necessary both for the undisturbed transmisison of high frequency, broadband multiple access network, and for minimizing the interference to other cells and other services. The trade-off of such detailed distribution of cellular nodes, backed by wireline (e.g. fibers) or another layer of wireless transmission, vs. Larger cells - is an economical issue at the system level, and at the national level, as much as a broader issue of interaction with other services.

## Wave-oriented space-time signal processing

Organised by L.B.Felsen
Summary by J.B.Andersen

Unfortunately, professor Felsen could not be present, and the workshop was chaired by J.B.Andersen. The idea behind the workshop was an attempt to categorise the various electromagnetic problems, discuss the connection between the physics anÈ the computational models, and hopefully reach at a syståmatic approach encompassing fields, networks, computations, and signal processing. There were two other contributions. T. Zwick (Germany)discussed a 3D ray optical approach for modelling urban and indoor radio channels, using primarily UTD techniques. Vaughan (New Zealand) and Andersen (Denmark) gave an overview of the stochastic radio channel and its relation to the physical environment of distributed effective scatterers.

The discussion focused on the concept of spatial averaging, the local averaging over the rapid fading, and the more global averaging of the local means.

## Smart Antennas in Wireless Communications

Organised by J.B.Andersen and A. Paulraj
Summary by J.B.Andersen

The well attended workshop encompassed various aspects of the topic. The idea behind the workshop was to discuss the possibilities of adaptive antennas for improving cellular systems. J B Andersen (Denmark) gave an overview of the connection between the environmental spreading and the correlation coefficients between array elements, both at the base and at the mobile, and showed the various possibilities offered by decorrelation. A wider overview of signal processing algorithms was given by Paulraj (USA) and Lindskog(Sweden)in a context of architecture and classifications of single and multiple antennas at each end. The various channel spreading parameters, Doppler, angle, and delay were discussed as a source of effects to be mitigated.

The implications and possibilities for practical systems like GSM and IS-95 were discussed by J.H.Winters (USA), and some experimental results were presented by Forssen (Sweden), who showed some field- trial results carried out in Germany with Mannesmann. It is clear that significant improvements in the number of simultaneous users in a cellular system can be achieved with adaptive antennas, but that it is still too early to quantify the economic aspects.

For a higher frequency range around 60 GHz some antenna results for indoor use in wideband wireless local area networks was discussed by Bernardi et al (Italy).

## Mobile and personal communications and the health and safety of radiofrequency radiation

James C. Lin

The summary of the workshop, organized by P. Bernardi, was unavailable at the time of submitting this report. The following announcement by the chairman of the commission, represents the discussion.

The advent of wireless communication service has delivered mobile and personal telecommunication to vast segments of the world's population. The wide spread impact of this new technology has raised concerns about the safety of human exposure to radiofrequency (RF) energy emitted by these telecommunication devices. A better understanding of the biological effects of RF electromagnetic field is needed to safeguard the general population against possible harm. Within the last few years there has been a resurgence of research interest in achieving a quantitative understanding of the relationships between the biological effects of RF radiation and the physical variables that may cause them.

At sufficiently high power levels RF radiation can produce deleterious thermal effects. Wireless telecommunication systems use low power modulated forms of RF radiation that was not investigated extensively in the past. Specific questions must be answered before any consistent, dependable and scientific conclusions can be drawn for the biological effects and safety of wireless mobile and personal telecommunication systems. Nevertheless, it is noteworthy that available data do not suggest any immediate cause for concern of a impending threat to public health from acute or short term exposure to low level RF radiation. A critical need is the investigation of effects of long term or prolonged exposure over extended periods of time.

URSI and its Commission (K) on Electromagnetics in Biology and Medicine recognize the problem, the scientific uncertainty, and that there is public concern about health effects of all RF systems have adopted resolutions. The objectives of the resolutions are to stimulate domestic research, encourage international cooperation, and to provide coordination, if necessary.

Accordingly, it is recommended that broadly based research programs be established nationally and internationally to address the following key questions:

What are the interaction mechanisms, with living systems, especially weak electromagnetic fields of various characteristics;

What biological effects - and particularly potentially harmful effects - are caused, and under what exposure conditions;

How to evaluate the exposures through proper measurements and dosimetric modeling.

Furthermore, it is noted that there is now increasing evidence that electromagnetic fields from wireless communication devices may affect the operation of some medical devices - either implanted or connected to the human body - and as a result may pose a problem to the operation and health; URSI and Commission K recommend accelerated scientific and industrial research to ensure the safety of medical devices in the presence of electromagnetic fields. Specifically, studies are to be aimed at clarifying (a) the specific behavior of implanted equipment; (b) the characteristic of connected medical equipment; (c) modeling methods; (d) specific measurements; and (e) influence of the person on electromagnetic interference (EMI).

## URSI business meeting

The discussions in COMMSPHERE, and the action items proposed, were reviewed by an URSI business meeting that took place during the symposium, and is summarized bellow.

Participating: W. Baan, G. Swarup, J.B. Andersen, R. Struzak, S. Radicella, G. Lucas, J. Cohen, J. Shapira

Protection of the spectrum for scientific observations. It was agreed that in order to be effective we have to bring our message to many members that vote in the ITU WRC, and in particular - to developing countries. We agreed on three elements:

- Acting with the national committees of URSI
- Supporting them by providing explanatory material, suitable for decision makers, and visiting selected regions.
- Providing other benefits to their support of the science cause, including the URSI activities for developing countries.

The ITU questions. It was agreed that URSI should respond to these questions, in a timely fashion, to the best of our ability. The questions are listed in the ITU home page

*Study group 1:*

Spurious emissions - comm C, E, J.

Spectrum management aspects of short range communications systems - comm C, E

Interference to digital communications systems - comm C

Methods and algorithms for frequency planning - comm E

Network planning and frequency assignment techniques - comm E

*Study group 3:*

Ionosphere comm G

Atmosphere - comm F

Radio noise - comm E

*Study group 7:*

Frequency standards and time signals - comm A

radio Astronomy - comm J

Antenna radiation pattern - comm B

Purpose - to respond to the questions within 2-3 months, by referring to accumulated knowledge already in existence, and to plans for pursuing further research where applicable. This in order the show visibility and start a creative interaction with the ITU. Each response will be reviewed and approved by the respective commission chair, and sent to Dr. Hughes in the ITU-R and to the URSI secretariat. National submissions (in addition to the URSI submission) of the responses is preferred, as it has a stronger status in the study groups.

Reference information. URSI cannot have free access to the ITU library. (Information that may be required in order to process the questions may be available with national administrations that have it free).

Intercommission working group on spectral congestion.

Recognizing the spectral congestion is a main obstacle in the development of communications alongside sciences and other uses of the EM spectrum, and

Recognizing that a considerable effort is being dedicated to competitive development of new services, and much less - to the coexistence of these services, and

Recognizing that URSI has both the scientific knowledge and the objectives of research and scientific development,

An intercommission working group, with the participation of all URSI commissions, and in collaboration with ITU, can be a leader in scientific research into the congestion issues. It is proposed that a working group be established now.

Proposed terms of reference:

Generate and coordinate studies

Generate symposia and sessions in symposia

Generate contributions to the ITU study groups and other ITU bodies

Action items:

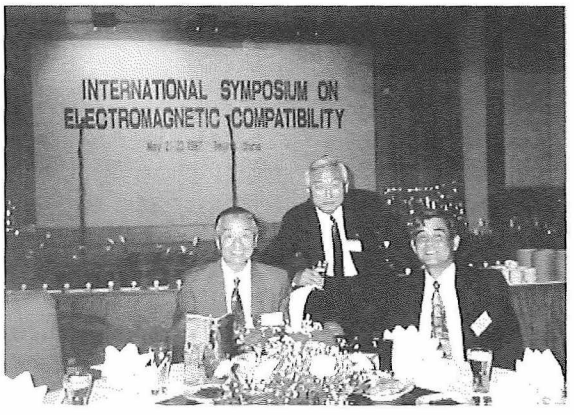
- Generate the response to the ITU questions
- Propose that the 1999 GA will have a theme - spectral congestion.
- Generate sessions for the GA and other symposia
- Generate its own agenda.
- Organize COMMSPHERE 98 at a time that suits the preparations to WRC 99. Optional - 14-17 December 1998.

Joseph Shapira
Vice President, URSI
Chairman, COMMSPHERE Program committee

# EMC'97/BEIJING

Beijing, China, 21-23 May, 1997

The 1997 International Symposium on Electromagnetic Compatibility was organised by IEEE Beijing Section, URSI Committee E, CIE Committee for URSI, IEE Beijing Centre, and technical co-sponsored by IEEE EMC Society. Prof. Gao Yougang acted as Symposium general chairman. The chairman of the technical program committee was Prof. Zhang Linchang (China) and the co-chairmen of the technical program committee were Prof. Masashi Hayakawa (Japan), and Prof. F. Vance (USA). The Chairman of the local organising committee was Prof. Sha Zhong.




*from left to right : G. Yougang, J.-G. Rhee and S. Nitta*

Roughly 300 participants from 23 countries attended the meeting. The exhibition included 30 exhibitor booths. The symposium was highly evaluated by the participants and the exhibitors. The symposium programme committee of EMC'97/Beijing received over 170 technical papers. After carefully selection by the technical programme committee, a total of 132 technical papers were presented in 16 sessions. The papers were devoted to: EMC Measurement, EMC in communication systems, standards, seismo-EM phenomena, shielding & grounding, EM sensor, probe, antenna, EMI prediction/analysis/reduction, EMI coupling/cross-talk, biological effects, EMC in microelectronics, EMC in computer and PCB'S, EMC in power engineering, spectrum management & education, EM calculation, lightning & ESD, EMP, and filter/absorbing material. The sessions cover almost all the EMC topics in which people are interested today. The representatives reviewed the current research results as well as the future trends of EMC technology.

The full text of the presentations has been made available in the symposium proceedings which has 533 pages. A strong response by the audiences earned the presentations on lightning electromagnetic effects, on EMC standards, on the EMC Measurement, on biological effects, on EMC in computer and PCB'S, and on EM calculation. It is difficult to point out the general trends in the field of EMC, but with the growing interest in the networking, people pay more attention also on the EMC problems in communication network and the protection of computers. The attendees clearly showed the inquiry of exchange experience and technology in EMC. The symposium really set-up a platform for personal contact and direct information exchange. More than 80% of the participants said that they found the solutions or the clue of the solutions to their practical EMC problem.

The next International Beijing symposium on EMC will be held in China in 2002.

Gao Yougang

# BIANISOTROPICS'97

Glasgow, Great Britain, 5 — 7 June 1997

## Introduction

Bianisotropics'97, the International Conference and Workshop on Electromagnetics of Complex Media, was held at the University of Glasgow, Great Britain, from 5 to 7 June 1997. It was the sixth in a series of loosely connected international conferences and workshops and concerned with all aspects of electromagnetics relating to novel materials. Its predecessors were Bi—isotropics'93, (Helsinki University of Technology, Finland), Bianisotropics'93 (Gomel, Belarus), Chiral'94 (Périgueux, France), Chiral'95 (Pennsylvania State University, USA) and Chiral'96 (St. Petersburg/Moscow, Russia). Since their inception in 1993 these events have proved highly successful meetings for scientists actively working in this particular area of research. They have provided a stimulating setting for the exchange of research results, the development of new directions of theoretical and experimental research and the fostering of new research collaborations. Equally importantly, they have provided a platform for vital mutual interaction between the FSU and the West.

## Background

During much of the 19th century and until quite recently in this century, electromagnetics researchers focused on either vacuum, metals or dielectric media such as crystals, powders, epoxies and plasmas. Some attention was paid to magnetic materials as well, chiefly at low frequencies. During the 1960s, however, attention began to be sporadically focused on general electromagnetic media. Although non-linear dielectric media quickly became very important in optics owing to their technological significance, advances in materials sciences were very slow so that general (i.e., bianisotropic) media were considered important only by a few theorists.

This picture began to dramatically alter during the mid—1980s. Chiral media arrived on the scene, with the possibility of being technologically significant at microwave frequencies. This became possible owing to huge advances in polymer sciences: biomimetic materials as well as extremely long—chain polymers with chiral conformations make chiral media attractive for electromagneticists. The study of the optical properties of enantiomers has been boosted by the recognition of enantioselectivity by the pharmaceutical industry. The chirality of ocular media has been targeted for noninvasive monitoring of blood glucose in diabetics. More recent advances in thin film technology are yielding new forms of smart composites and functional gradient materials. Helicoidal bianisotropic mediums have been proposed and fabricated, and have given rise to the sculptured thin film concept for use in solid optics, optoelectronics, bio—ultrasonics, transduction, micro-catalysis, and many other areas.

A major new thrust area is in combining the fast electromagnetic responses of most materials with their relatively slower mechanical responses, giving rise to electromagnetically controllable smart materials for transduction and actuation. Typically, these are composites so that their electromagnetic as well as mechanical responses have desirable attributes. Moreover, they may be inhomogeneous in order to possess functional gradients.

Complex media require the attentions of scientists from a wide spectrum of disciplines: from Applied Mathematics and Physics to Electrical and Electronic Engineering, from Chemistry to Materials Science, and even Biophysics. Thus, the electromagnetics of complex media is indeed a truly multidisciplinary research area spanning the bridge from basic theoretical and experimental research at universities to industrial production of a diverse array of electrical, microwave, infrared and optical materials and devices.

All of this means that the study of electromagnetic fields in bianisotropic media is no longer merely the province of ivory—tower theorists, but a vibrant area of technological research as well with great promise for societal benefits.

## The event

Bianisotropics'97 was attended by 62 scientists representing institutions from 22 nations. The scientific program was spread over three days comprising 11 sessions: Introduction to complex materials; complex composite materials: experimental research, theoretical research; rotationally inhomogeneous thin films and materials; linear complex materials: theory 1, 2, 3 and applications; non-linear complex materials; a poster session and round table discussion.

Key developments in each of these areas were introduced by 9 invited talks:

- Non-linear electromagnetics and complex media (J M Arnold, Glasgow);
- Fundamental symmetry aspects of chirality}V (L D Barron, Glasgow);
- Measurement techniques for characterizing handed microwave media (G Busse and A F Jacob, Braunschweig);
- The status of experimental research on chiral composites (J H Cloete, Stellenbosch);
- Time—domain methods for complex media (G Kristensson, Lund);
- Dali's dalliances: Sculptured thin films (A Lakhtakia, State College);
- Image theory of complex media and structures (I V Lindell, Helsinki);
- Pulse propagation in linear and non-linear chiral media (S A Maksimenko and G Y Slepyan, Minsk)
- Progress in the homogenization theories of the Maxwell equations for inhomogeneous media (review of Russian works) (A P Vinogradov, Moscow).

The program contained a further 33 regular oral presentations whereas 26 posters were on display. The manuscripts of all oral and poster presentations were printed in the Conference Proceedings {Copies of the Conference Proceedings (318 pages) can be obtained by writing to: Mrs A B Anderson, Department of Mathematics, University of Glasgow, Glasgow G12 8QW, Great Britain. Payment of GBP 15 (or, alternatively, USD 25) must be made in advance in cash or cheque (made payable to The University of Glasgow ) which were issued at the start of the meeting. After the conference, the authors of some of the key talks at Bianisotropics'97 were invited to submit full papers based on their presentations. Following a normal review procedure, the collection of these papers will appear in a special issue of the International Journal of Applied Electromagnetics and Mechanics (guest editor: W S Weiglhofer) with a publication date scheduled for mid—1998.

Presentations were generally of high quality and special mention should be made of excellent talks by speakers who are either still working towards their PhDs or who are at the post—doctoral level. A vibrant atmosphere permeated the round table discussion. First, in the experimental part, participants focused on chiral media — not surprisingly if one considers that the vast majority of experimental investigations into composite materials deals with such media. A decade after chiral media had first caught the imagination of electromagneticists, it was a good opportunity to take stock of the situation. There seemed to be a general consensus, certainly as far as technological significance is concerned, that chirality has not delivered the superior radar absorption capabilities that some researchers had promised. Yet, at the same time, one must recognize that the number of research groups involved in experimental research on chiral composites is comparatively small so that many avenues that can lead to the proverbial "pot of gold at the end of the rainbow" still need to be explored. Increasingly, and that is a very welcome development for theorists to whom anisotropy and bianisotropy is just an increase in parameters, experimental research goes beyond isotropy (such as in chiral composites): recent work on uniaxial bianisotropic composites as well as on helicoidal bianisotropic mediums and other sculptured thin films is proof of that.

Theoretical discussion centred mostly on the role of the constitutive relations. These are the equations between the electromagnetic fields which must be formulated to supplement Maxwell's (differential) equations in any given medium. As such they provide information about the material under consideration; and as they are largely phenomenological, much discussion, disagreement and even controversy surrounds their proper formulation. Indeed, it was at Chiral'94 that theoretical work was first presented which, in its most important application, negates the recognizability of certain materials, commonly known as NRBI (nonreciprocal bi—isotropic) materials. Despite an intensive three year search, materials that violate the so-called Post Constraint remain elusive. Yet, despite many articles/comments/replies in research journals no clear consensus has emerged. While the proponents of the Post Constraint are convinced of the soundness of the theoretical apparatus, others disagree. Clearly, especially targeted experimental research could go a long way towards clarifying the situation, as unique experimental characterization of an NRBI material would immediately point to a flaw in the Post Constraint. At this point discussion concentrated on the Tellegen medium (a special case of an NRBI medium) for which a (handwaving, but nevertheless) recipe for construction has existed for almost half a century. The hope was expressed that experimentalists who do have the facilities to taylor composites in their laboratories will focus their efforts onto this problem.

Another issue centred on the temporal delay that material media must evince in responding to externally applied electromagnetic fields. Whereas certain researchers ignore this non—zero delay born out of microscopic causality and make complex materials exhibit purely instantaneous responses so that analysis is greatly simplified, others argued against such a facile approximation because it "throws out the baby with the bath water." The so-called optical response was identified as being purely instantaneous response, which was deemed unphysical by some because microscopic causality is neglected thereby.

One of the most successful organizational features of Bianisotropics'97 was the electronic dissemination of information via the world wide web. All conference materials were published at http://www.maths.gla.ac.uk/~tropics/ were they will remain available for future reference. Files are available in various formats and the large majority of all manuscripts contributed to the Proceedings can be either read on-line (by using a dvi-viewer) or downloaded for printing (in postscript format).

Social highlights were the conference dinner and a civic reception in Glasgow City Chambers.

## Acknowledgement of sponsorship

The support of various institutions and organizations is gratefully acknowledged. Direct financial support was obtained from the European Commission (Brussels), the London Mathematical Society (London), the Office of Naval Research Europe (London), the University of Glasgow (Glasgow), the Royal Society (London) and the Edinburgh Mathematical Society (Edinburgh). Technical co—sponsorship support was provided by IEEE—EDS (Electron Devices Society) whereas URSI (International Union of Radio Science) supported the event through "Mode A" sponsorship. Acknowledgement is also made to the local business community for support and the organizer is particularly grateful to the members of the Organization as well as the Scientific Advisory Committees.

Werner S Weiglhofer

# INTERNATIONAL CONFERENCE ON MARINE ELECTROMAGNETICS

London, United Kingdom, 23-26 June 1997

An international conference on Marine Electromagnetics was held at Imperial College, London from 23-26 June 1997. The co-chairmen of the meeting were E.M. Freeman of Imperial College and P. Loach of the Defence Evaluation Research Agency (Winfrith, Dorset). Sponsorship was by the IEE, IOP, IEEE EMC Society and the IEEE Geoscience and Remote Sensing Society.

The subject matter is of interest to many URSI scientists, as it embraced the terms of reference of Commissions E, F and, to a lesser extent, Commission H. The underlying theme of the meeting was ELFE (extremely low frequency electromagnetic 96 3Hz to 3kHz), magnetohydrodynamic and seismic phenomena. Sub-surface (mostly oceanic) effects were of predominate interest.

The sessions included papers on the following topics 97 ELFE generation, propagation, scattering and communication; ELFE measurements; ELFE signature reduction, seismic phenomena; environmental noise and magnetohydrodynamic induction and submarine propulsion. Four keynote addresses were presented to set the scene 97 Review of electromagnetic research in an ocean environment (J.B. Peddell and G.W. Garnett). Review of marine electromagnetic research in USSR and Russia 1936-1996 (V.S. Shneyer, M.S. Zhdanov and C.S. Gillmor) A global ELFE atmospheric noise model (D.Ll. Jones). Excitation of sub-surface electromagnetic waves - a review (J.R. Wait). Some 135 participants from Europe (including Russia), Australia, Japan and North and South America attended the conference. About 70 papers were formally presented together with 16 posters. The presentations and posters depicted a good mixture of work involving experimental measurements, theoretical modelling and computational techniques. The papers reflected both geophysical and defence-related interests.

A list of the papers which were presented is available on the World-Wide Web (address http://www.ee.ic.ac.uk/conferences/marelec/textprog.html). The proceedings of the meeting are scheduled to be published in September 1997. Inquiries should be addressed to Ms. K. Hancox, E.E. Dept, Imperial College, Exhibition Rd., London, SW7 2BT, UK.

D. Llanwyn Jones

## CONFERENCE ANNOUNCEMENTS

# TELECOM'97

Fes, Maroc, 15-17 Octobre 1997

### 1 - Organisation

Le Colloque TELECOM'97 sera organisé par le Laboratoire de Transmission et de Traitement d'Images de l'Ecole Supérieure de Technologie de Fès (Maroc) et le Laboratoire de Radiopropagation et Electronique de l'Université des Sciences et Technologies de Lille (France) avec la contribution de l'Office National des Postes et Télécommunications de Lille (France) et de l'URSI.

### 2 - Lieu du Colloque

Le Colloque se tiendra les 15-17 Octobre 1997 à l'Université Sidi Mohamed Ben Abdellah - Ecole Supérieure de Technologie - FES - Maroc. Aux habituelles sessions orales sera jointe une session affiches ainsi qu'une exposition technique et des visites culturelles.

### 3 - Thèmes couverts par le Colloque

Les thèmes couverts par TELECOM'97 concernent les Télécommunications, la Compatibilité Electromagnétique, les Techniques Micro Ondes et le Traitement d'images et plus particulièrement :

- Télécommunications : Systèmes de télécommunications Réseaux de télécommunications Radars Antennes Liaisons optiques Traitement du signal appliqué aux télécommunications
- Compatibilité Electromagnétique : Théorie et mesures des couplages électromagnétiques Méthodes d'essai et de mesures Simulation numérique en CEM Susceptibilité électromagnétique Normes en CEM
- Techniques Micro Ondes : Instrumentation et mesures Capteurs Applications médicales Applications des microondes pour les procédés industriels
- Traitement d'images: Compression et transmission d'images Reconstitution d'images Applications aux multimédias

### 4 - Langue officielle du Colloque

Le français sera la langue officielle, mais les articles rédigés et les conférences faites en anglais seront aussi acceptées.

### Information

- Au Maroc : Mr Mounir RIFI, LTTI - Ecole Supérieure de Technologie de Fès, BP 2427 - Route d'Imouzer 30000 FES - MAROC
  Tel. (212) 5 60 05 85/86, Fax (212) 5 60 05 88
- En France : Mr Bernard DEMOULIN, LRPE - Univ. des Sciences et Technologies de LILLE, Bâtiment P3 59655 VILLENEUVE D'ASCQ Cedex, FRANCE
  Tel. (33) 3 20 43 48 56, Fax (33) 3 20 43 65 23
  Email : Bernard.Demoulin@univ-lille1.fr

# CLIMPARA'98

Ottawa, Canada, 27-29 April 1998

The CLIMPARA conferences have been a series of special-interest URSI Commission F meetings designed to analyze the role of different climatic and geographic parameters on radiowave propagation and the development of prediction techniques and models. Earlier conferences in this series were held in Rio de Janeiro (1990), Moscow (1994) and Oslo (1996).

An important goal of these conferences is to merge the diverse knowledge and activities existing within the aegis of URSI Commission F, ITU-R Study Group 3 and the meteorological community. In order to enhance this interaction, CLIMPARA'98 will be held immediately prior to concurrent meetings of ITU-R Working Parties 3J (Propagation Fundamentals) and 3M (Point-to-point and Earth-space propagation) to be held 30 April - 7 May 1998 at the same venue. Participants in CLIMPARA'98 who do not normally participate in ITU-R meetings are invited to remain for the subsequent activities of these Working Parties. It is expected that the conference will include invited presentations as well as submitted research papers, poster sessions and workshops.

## Topics

Presentations, workshops and poster session are expected to be in two main areas:

1. Clear-air effects on propagation:
   - 1.1 modelling of climatic and associated geographic variations
   - 1.2 mapping procedures
   - 1.3 measurements and data available or still needed
   - 1.4 instruments.
2. Precipitation effects on propagation:
   - 2.1 modelling of climatic and associated geographic variations
   - 2.2 mapping procedures
   - 2.3 measurements and data available or still needed
   - 2.4 instruments.

## Deadlines

Synopses: 1 December 1997.
Camera ready papers: 28 February 1998

## Contact

Dr. Roderic L. Olsen, CLIMPARA '98
Communications Research Centre
P.O. Box 11490, Station H,
Ottawa, ON K2H 8S2, Canada
Tel: +1 613-998-2564, Fax: +1 613-998-4077
E-mail: rod.olsen@crc.doc.ca
http://www.crc.doc.ca/climpara98/climpara.html

# MMET'98

June 2 - 5, 1998, Kharkov, Ukraine

The 7th International Conference on Mathematical Methods in Electromagnetic Theory will be organized in Kharkov, Ukraine on June 2 - 5, 1998. MMET series of conferences was started in 1988 and since 1990 it has been the only regular symposium in the Former Soviet Union (FSU) in electromagnetics, that has English as a medium of presentation and discussion.

## Young Scientist Travel Grants

A number of travel grants will be given to help young scientists from FSU and developing countries attend Kharkov meeting.

## Topics

antenna theory; - asymptotic methods; - beam electronics; - complex media; - computational techniques; - electromagnetic theory; - fiber optics; - function-theoretic methods; - gratings and FSS; - inverse problems; - linear accelerator models; - nonlinear phenomena; - plasma science; - propagation; - RCS; - radomes; - random media; - regularization techniques; - remote sensing models; - rough surfaces; - scattering and diffraction; - time-domain methods; - waveguide circuits,and others.

## Deadlines

Deadline for submission : February 15, 1998
Camera-ready papers : March 25, 1998

## Organizers

• IEEE AP/MTT/ED/AES-SS East Ukraine Joint Chapter • Ukrainian URSI Commission "B"• Kharkov State University• Institute of Radiophysics and Electronics of the National Academy of Sciences (IRE NAS)• Institute of Radio Astronomy of NAS (IRA NAS)• Co-sponsorship of IEEE Societies and URSI Commission "B" is expected

Chairman Organizing Committee :
Prof. Eldar I. Veliev, IRE NAS, Ukraine

Co-Chairmen Technical Program Committee :
Dr. W. Ross Stone, IEEE APS & URSI
Prof. Alexander I. Nosich, IRE NAS, Ukraine

## Contact

MMET'98 c/o Dept. Computational Electromagnetics
IRE NAS, Ulitsa Proskury 12
Kharkov 310085, Ukraine
Tel: +380-(572)-448595, -377380
Fax: +380-(572)-441105, -377380, -365968
E-mail: veliev@dut.kharkov.ua, alex@emt.kharkov.ua

# 32ND COSPAR SCIENTIFIC ASSEMBLY

Nagoya, Japan, 12-19 July 1998

The 32nd edition of the COSPAR Scientific Assembly and Associated Events will be held in Nagoya, Japan from 12 to 19 July 1998.

## Organisation

The Scientific Programme Committee is chaired by Prof. Y. Kamide of the Solar Terrestrial Environemnt Laboratory, Nagoya University, Japan.
The Local Organising Committee is chaired by Prof. A. Nishida of ISAS, Kanagawa, Japan

## Topics

The approximately 80 meetings and symposia will cover the following areas :

- the Earth's Surface, Meteorology and Climate
- the Earth-Moon System, Planets, and Small Bodies of the Solar System
- the Upper Atmospheres of the Earth and Planets incl. Reference Atmospheres
- Space Plasmas in the Solar System, including Planetary Magnetospheres
- Research in Astrophysics
- Life Sciences as Related to Space
- Materials Sciences in Space
- Fundamental Physics in Space
- Satellite Dynamics
- Scientific Ballooning
- Space Borne Geophysical Sata for Global Change Studies

The papers will be published in *Advances in Space Research.*

## Deadline

Abstract deadline : 9 January 1998

## Contact

Prof. S. Grzedzielski
Executive Director of COSPAR
COSPAR Secretariat
51, bd de Montmorency
F-75016 Paris, France
Fax +33 1-4050 9827
E-mail cospar@paris7.jussieu.fr

# VTH INTERNATIONAL SUZDAL SYMPOSIUM

Moscow, Russia, 26-29 August 1998

The Vth International Suzdal URSI Symposium on "Modification of the Ionosphere by Powerful Radio Waves" will be devoted to the recent theoretical and experimental results on interaction of high power radio waves with ionospheric plasma.

## Topics

1. Interaction of high power HF radio waves with ionospheric plasma
2. Excitation of ELF-VLF waves in the ionosphere and magnetosphere
3. Action of powerful microwaves on the Earth's atmosphere

These main topics fall within the scope of interest of URSI Commissions E, G, H and J.

## Organisation

The Chairman of the Organising and Programme Committee is Professor V.V. Migulin. The symposium is organised by the Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation of the Russian Academy of Sciences.

## Contact

Professor V.V. Migulin
Institute of Terrestrial Magnetism,
Ionosphere and Radio Wave Propagation
Russian Academy of Sciences
Mokhovaya 11, 103907 Moscow Center, Russia
Fax +7 095 203 8414

# Wave Propagation and Remote Sensing

Aveiro, Portugal, 22-25 September 1998

The Commission F Triennial Open Symposium will be held in Aveiro, Portugal from 22 to 25 September 1998.
**Scientific Programme Committee:** Y Furuhama, M P M Hall, J P V Poiares Baptista, A Fiúza, M Hallikainen, Richard K Moore, J C S Neves, K Okamoto, R L Olsen, W J Vogel
**Organising Committee:** A C D Rocha (Chairman), Y Furuhama, J P V Poiares Baptista, J C S Neves, T Maranhão, A Marques

## Topics

Papers on any topic of interest to Commission F are welcome. However papers are particularly encouraged in the following areas:

- Application of radiowave propagation studies to telecommunications and remote sensing
- Remote sensing of the lower and middle atmospheres, emphasising physical models
- Studies of scattering from the Earth's surface, oceans, land and ice
- Characterisation of radio propagation for terrestrial and satellite communication systems
- Radiowave propagation studies for mobile communications
- Radar meteorology
- Climatic parameters in radiowave propagation

Synopses (no more than one side of A4 paper, or E-mail equivalent) should give sufficient information to enable an objective assessment to be made by referees.

## Deadlines

Abstracts : 1 January 1998
Notification of acceptance : 1 March 1998
Camera-ready accepted papers : 1 June 1998

## Contact

Dr. Armando C.D. Rocha
Instituto de Telecunicaçoes
Universidade de Aveiro
3810 Aveiro, Portugal
Tel. +351 34-370324
Fax +351 34-381128
E-mail : arocha@av.it.pt

Other meetings brought to our attention :

# PIERS Workshop on Advances in Radar Methods

Baveno, Italy, 20 - 22 July 1998

A Topical PIERS Workshop on Advances in Radar Methods will be organized by the Joint Research Centre of the European Commission. The workshop will be held at the Hotel Dino in Baveno, Lake Maggiore, Italy, on July 20-22, 1998, i.e. Monday through Wednesday following the PIERS 1998 in Nantes. The workshop will provide the opportunity for extended presentations and in depth discussions within the selected theme: *Advances in Radar Methods*

## Main topics

Polarimetric interferometry Delta k interferometer Wide band interferometry Noise radar 3D radar imaging Bistatic imaging Bistatic polarimetry Passive SAR imaging Adaptive SAR processing

## Workshop Organization

General Chairman: R. Winter
Technical Committee: W.M. Boerner, J.Ch. Bolomey, A. Broquetas, S. Cloude, G. Franceschetti, A. Franchois, M. Hallikainen, H. Hellsten, W. Keydel, K. Langenberg, D. Lesselier, K. Lukin, D. Mensa, P. Pampaloni, Ch. Pichot, A. Priou, S. Quegan, F. Rocca, K. Sarabandi, T.K. Sarkar, A.J. Sieber (Chairman), D. Solimini, J.D. Taylor, J. van Zyl, W. Wiesbeck, Y. Yamaguchi.
Local Arrangements: D. Schlittenhardt

## Deadlines

The abstract deadline is January 31, 1998.
Acceptance Notification by March 15, 1998
Registration deadline for presenting authors : April 15 1998.
Advance Program will be mailed by March 31, 1998

## Contact:

Dr. Ann Franchois
Space Applications Institute
Joint Research Centre of the European Commission
I-21020 Ispra (VA), Italy
phone:+39 332 789131, fax:+39 332 785772
e-mail: piers.aviram@jrc.it
WWW:http://www.sai.jrc.it/piers.aviram

# IX European Signal Processing Conference

Island of Rhodes, Greece, 8 - 11 September 1998

The 1998 European Signal Processing Conference is the 9th biennial conference promoted and organized by the European Association for Signal Processing in cooperation with the Computer Technology Institute and the University of Athens. Its aim is to cover all aspects of Signal Processing theory and applications. Sessions will include tutorials in addition to presentations on new research results. An extensive technical exhibition will also be organised in parallel with an industrial vendors session. Papers describing original work are invited in any of the areas listed below.

## Topics

1. Digital Signal Processing 1.1 Filter design and structures 1.2 Fast algorithms 1.3 Multirate filtering and filter banks 1.4 Signal reconstruction 1.5 Adaptive filters 1.6 Nonlinear Signals and Systems 1.7 Time-frequency analysis 1.8 Other (specify)
2. Statistical Signal and Array Processing 2.1 Spectral estimation 2.2 Higher order spectrum analysis 2.3 Array signal processing 2.4 Statistical signal analysis 2.5 Parameter estimation 2.6 Detection 2.7 Signal and system modeling 2.8 System identification 2.9 Cyclostationary signal analysis 2.10 Other (specify)
3. Speech processing 3.1 Speech production and perception 3.2 Speech analysis 3.3 Speech synthesis 3.4 Speech coding 3.5 Speech enhancement and noise reduction 3.6 Isolated word recognition 3.7 Word spotting 3.8 Continuous speech recognition 3.9 Other (specify)
4. Audio and Electroacoustics 4.1 Active noise control 4.2 Active noise reduction 4.3 Echo cancellation 4.4 Psychoacoustics 4.5 Aids for the handicapped 4.6 Broadband audio coding 4.7 Signal processing for music 4.8 Binaural systems 4.9 Room acoustics 4.10 Other (specify)
5. Image and Multidimensional Signal Processing 5.1 Image coding 5.2 Image motion / sequence / video 5.3 Computed imaging (SAR, CAT, MRI, ultrasound) 5.4 Geophysical and seismic processing 5.5 Image analysis and segmentation 5.6 Image filtering, restoration and enhancement 5.7 Image representation and modeling 5.8 Digital transforms 5.9 HDTV 5.10 Multidimensional systems 5.11 Machine vision 5.12 Other (specify)
6. Knowledge Engineering and Signal Processing 6.1 Pattern recognition 6.2 Expert systems 6.3 Neural networks 6.4 Fuzzy systems 6.5 Signal interpretation 6.6 Multisensor Data Fusion 6.7 Other (specify)
7. Implementations 7.1 Architectures and VLSI hardware 7.2 Programmable signal processors 7.3 Algorithms and applications mappings 7.4 Design methodology and CAD tools 7.5 Languages and real time software 7.6 Other (specify)
8. Applications 8.1 Radar 8.2 Sonar 8.3 Communications 8.4 Biomedical processing 8.5 Geophysical signal processing 8.6 Underwater signal processing 8.7 Sensing 8.8 Robotics 8.9 Astronomy 8.10 Other (specify)

## Deadlines

Submission of proposal: October 31, 1997
Notification of acceptance: February 28, 1998
Submission of camera-ready paper: April 30, 1998.

## Contact

EUSIPCO - 98
Dept. of Informatics, University of Athens
Panepistimioupolis, TYPA, Athens 15784, Greece
Tel.: +301 7211119, Fax : +301 7219561
E-mail: eusipco@di.uoa.gr

# URSI CONFERENCE CALENDAR

*URSI cannot be held responsible for any errors contained in this list of meetings.*

## September 1997

**URPS'97**
**Urban Radiowave Propagation Symposium**
*Tomsk, Russia, 2 - 4 September 1997*
Contact : Prof. German S Sharygin, Tomsk State Academy of Control Systems and Radioelectronics, 40 Lenin Ave., Tomsk 634050, Russia, Tel. : +7 3822-224 302, E-mail: gssh@tiasur.tomsk.su and gssh@cp.tomsk.su

## October 1997

**Telecom'97**
*Fès, Morocco, 15-17 October, 1997*
Contact in Morocco : Dr. Mounir Rifi, Ecole Supérieure de Technologie, Université Sidi Mohammed Ben Abdellah, BP 27 Route d'Imùouzer, 30 000 Fes, Maroc, Tel. +212 5-60 0585/86, Fax +212 5-60 0588
Contact in France : Prof. B. Demoulin, Université des Sciences et Technologies de Lille, Bâtiment 1e étage, F-59655 Villeneuve d'Ascq, France, Tel. +33 3-2043 4856, Fax +33 3-2043 6523, E-mail : Bernard.Demoulin@univ-Lille1.fr

**International Symposium devoted to Galileo Ferraris**
*Torino, Italy, 27-29 October 1997*
Contact : Professor S. Leschiutta, IEN Galileo Ferraris, Corso Massimo d'Azeglio 4242, I-10125 Torino, Italy, Fax +39 11-650 7611, E-mail pres@amm.ien.it

## November 1997

**EM-Med 97: International Scientific Meeting on Electromagnetics in Medicine**
*Chicago, Illinois, 3-5 November, 1997*
Contact : EM-Med, M/C 154, University of Illinois at Chicago, 851 South Morgan Street, Chicago, IL 60607-7053, U.S.A., Fax : +1 312 413-0024, E-mail : emmed@eecs.uic.edu, web site : http://www.eecs.uic.edu/~emmed"

## December 1997

**ISDRS'97 : 1997 International Semiconductor Device Research Symposium**
*Charlottesville, VA, USA, 11-13 December 1997*
Contact : Prof. William C. B. Peatman, Program Chair, Department of Electrical Engineering, Thornton Hall, University of Virginia, Charlottesville, VA 22903-2442, USA, Phone: +1 (804) 979-4103, Fax: +1 (804) 924-8818, E-mail: wcp4b@virginia.edu

**MST8 : Eight International Workshop on Technical nd Scientific Aspects of MST Radar**
*Bangalore, India, 15-20 December 1997*
Contact : Dr. S.C. Chakravarty, Indian Space Research Organisation, ISRO Headquarters, Antariksh Bhavan, New BEL Road, Bangalore 560 094, India, Tel. +91 80-341 6271, Fax +91 80-341 9190, E-mail scc@isro.ernet.in

## March 1998

**Microwave Signatures in Remote Sensing**
*Moscow, Russia, 11-13 March 1998*
Contact : Dr. Eugeny Petrov, URSI Commission F Specialist meeting, Institute of Radioengineering and Electronics, Russian Academy of Sciences, Mokhovaya Street 11, 103907 Moscow, Russia, Tel. +7-095 203-4793, Fax : +7-095 203-8414, e-mail: petrov@web.cplire.ru

**ESGAP 2**
*Lviv, Ukraine, 30 March - 2 April 1998*
Contact : Dr. O. Ivankiv, Institute for Condensed Matter Physics I, Svientsitsky Str., 290011 Lviv, Ukraine, Fax : +380 322-761978 and +380 322-761158, E-mail : esgap2@icmp.lviv.ua

## April 1998

**CLIMPARA'98**
*Ottawa, Ontario, Canada, 27-29 April 1998*
Contact : Dr. Roderic L. Olsen, Communications Research Centre, P.O. Box 11490, Station H, Ottawa, Ontario K2H 8S2, Canada, Tel: +1-613-998-2564, Fax: +1-613-998-4077, E-mail: rod.olsen@crc.doc.ca, http://www.crc.doc.ca/climpara98/climpara.html

## May 1998

**1998 International Symposium on Electromagnetic Theory (Commission B Triennial Open Symposium)**
*Thessaloniki, Greece, 25 - 28 May 1998*
Contact : Prof. Chalmers M. Butler, Chair, 1998 URSI Electromagnetic Theory Symposium, Department of Electrical and Computer Engineering, 102 Riggs Hall Box 340915, Clemson University, Clemson, SC 29634-0915, USA, Tel. +1-864 656-5922, Fax +1-864 656-7220, e-mail: cbutler@eng.clemson.edu

**EUSAR'98 : European Conference on Synthetic Aperture Radar**
*Friedrichshafen, Germany, 25-27 May 1998*
Contact : Dr. Richard Klemm, FGAN-FFM, Neuenahrer Str. 20, D-53343 Wachtberg, Germany, Tel. +49 228-9435 377, Fax : +49 228-348 953, e-mail: r.klemm@fgan.de

## June 1998

**MMET'98**
**1998 International Conference on Mathematical Methods in Electromagnetic Theory**
*Kharkov, Ukraine, 2-5 June 1998*
Contact : MMET'98 c/o Dept. Computational Electromagnetics, IRE NAS, Ulitsa Proskury 12, Kharkov 310085, Ukraine. Tel: +380-572-448595 Fax: +380-572-441105, E-mail:veliev@dut.kharkov.ua alex@emt.kharkov.ua

**International Conference on Telecommunications (ICT'98)**
*Chalkidiki, Greece, 22-25 June 1998*
Contact : Dr. I. Gragopoulos, Aristotle University of Thessaloniki, Greece, E-mail : itse@egnatia.ee.auth.gr

**EMC Wroclaw'98 : 14th International Wroclaw Symposium on Electromagnetic Compatibility**
*Wroclaw, Poland, 23 - 26 June 1998*
Contact : EMC Symposium, Box 2141, 51-645 Wroclaw 12, Poland, Fax : +48 71-728878, e-mail: emc@ita.pwr.wroc.pl

## July 1998

**CPEM98 : Conference on Precision Electromagnetic Measurements**
*Washington, DC, U.S.A., 6 - 10 July 1998*
Contact : Katherine H. Magruder, Conference Secretary, NIST, Bldg. 220, Room B162, Gaithersburg, MD 20899-0001, USA, Tel. +1-301 975-4223; FAX +1-301 926-3972; email katherine.magruder@nist.gov., WWW site : http://www.eeel.nist.gov/cpem98/

**32nd COSPAR Scientific Assembly**
*Nagoya, Japan, 12-19 July 1998*
Contact : COSPAR Secretariat, 51? Bd de Montmorency, F-75016 Paris, France, Tel. +33 1-4525 0679, Fax +33 1-4050 9827, E-mail : COSPAR@paris7.jussieu.fr

## August 1998

**Vth International Suzdal Symposium on Modification of the Ionosphere by Powerful Radio Waves**
*Moscow, Russia, 26-29 August 1998*
Contact : Prof. V.V. Migulin, Vth International Suzdal Symposium, Russian URSI Committee, Russian Academy of Sciences, Mokhovaja St. 11, 103907 Moscow, Russia, Fax +7-095 334-0124

## September 1998

**Physics and Engineering of Millimeter and Submillimeter Waves**
*Kharkov, Ukraine, 15-17 September 1998*
Contact : Dr. A.A. Kostenko, Institute of Radiophysics and Electronics, National Academy of Science of Ukraine, 12 Acad. Proskura St. Kharkov, 310085 Ukraine, Tel. & Fax +380 572-44 1105, E-mail : symposium@ire.kharkov.ua

**URSI Commission F Triennial Open Symposium Wave Propagation and Remote Sensing**
*Aveiro, Portugal, 22-25 September 1998*
Contact : Dr. Armando C.D. Rocha, Instituto de Telecunicaçoes, Universidade de Aveiro, 3810 Aveiro, Portugal, Tel. +351 34-370324, Fax +351 34-381128, E-mail : arocha@av.it.pt

## December 1998

**Asia-Pacific Microwave Conference**
*Yokohama, Japan, 8-11 December 1998*
Contact : Prof. Yoshio Kobayashi, Faculty of Engineering, Saitama University, Urawa, Saitama 338, Japan, Fax +81 48-857 2529, E-mail : yoshio@reso.ees.saitama-u.ac.jp

## February 1999

**EMC Zurich '99**
**13th International Zurich Symposium and Technical Exhibition on Electromagnetic Compatibility**
*Zurich, Switzerland, 16-18 February 1999*
Contact : Dr. Gabriël Meyer, Communication Technology Laboratory, Sternwartstraße 7, CH-8092 Zurich, Switzerland, Tel. +41 1-632 2790, Fax +41 1-632 1209, E-mail : gmeyer@nari.ee.ethz.ch

# UTC Time Step

On n'introduira pas de seconde intercalaire à la fin de décembre 1997. La différence entre UTC et le Temps Atomique International TAI est:
de 1997 juillet 1, 0h UTC , jusqu'à nouvel avis : UTC-TAI = -31 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.

Martine FEISSEL
Directeur, Bureau Central de l'IERS
Service International de la Rotation Terrestre

No positive leap second will be introduced at the end of December 1997. The difference between UTC and the International Atomic Time TAI is:
from 1997 July 1, 0h UTC , until further notice : UTC-TAI = -31 s

Leap seconds can be introduced in UTC at the end of the months of December or 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 will be no time step at the next possible date.

Martine FEISSEL
Director, Central Bureau of IERS
International Earth Rotation Service
Observatoire de Paris, 61, Av. de l'Observatoire
F-75014 Paris (France)
tel +33 1-40 51 22 26, fax +33 1-40 51 22 91
Internet : services@obspm.fr

# News from the IUGG

## IDNDR INTERNATIONAL CONFERENCE ON MODERN PREPARATION AND RESPONSE SYSTEMS FOR EARTHQUAKE, TSUNAMI AND VOLCANIC HAZARDS

27 - 30 April 1998 Santiago - Chile

On the occasion of the XXI General Assembly of the International Union of Geodesy and Geophysics (IUGG) in Boulder, Colorado in June of 1995, Chile was proposed as host of a major IDNDR conference to highlight the ability of modern technology to lessen the risk in large urban and industrial areas from earthquakes, volcanoes and tsunamis.

The co-sponsors are the International Association of Seismology and Physics of the Earth s Interior (IASPEI) and the International Association of Volcanology and Chemistry of the Earth s Interior (IAVCEI). The 1998 Conference is planned to respond to the United Nations call for all governments, universities and private organizations to strengthen their IDNDR activities on natural disaster reduction.

With the participation of governmental, university and private organizations. With the endorsement of the United Nations Secretariat for the International Decade for Natural Disaster Reduction.

Organized by the I.U.G.G. Chile National Committee and the IASPEI Commission for the INDNR, IASPEI Commission for the IDNAR

### Objectives

Recent rapid advances in the relevant technological systems can now be implemented in a practical way that is relatively inespensive and robust. Particularly, modems connected to telephone, radio and satellite links with monitoring digital instruments (e.g., earthquake accelerographs) in and around critical structures in densely populated areas allow easy access to fast low-cost PC computers. These can be networked to historical data bases of population, lifelines, governmental response plans, etc. Preliminary experience with such smart systems gained in Los Angeles, Mexico City and Japan, for example, will be discussed at the 1998 Chile Conference.

To be effective, natural hazard mitigation policies and practices must be integrated into the mainstream of community and governmental activities. Thus major technical upgrades for preparation and response to natural hazards must involve responsible local government, utilities and national Emergency Services Organizations.

The Conference wil be organized to ensure working interaction between scientific, engineering, government, business and emergency service professionals. The emphasis will be on information, dissemination and risk reduction.

### Topics

Instrumental Recording System Status (volcanoes, earthquakes, tsunamis) . Data Acquisition State-of-the Art Technology. . Explosive Volcanic Eruptions: Air Navigation Problems. . Rapid Assessment of Hazards in Urban Areas (strong ground shaking, tephra falls, ocean run-up) . Rapid Failure Evaluation for Critical Structures and Lifelines. . Near Real-Time Emergency Response: lifelines, utilities, hospitals. . Early-Warning Satellite Systems for Monitoring Seismic, Volcanic and Tsunami Hazards . Integration of Dissemination Technology and Disaster Mitigation Plans. Interaction between Scientists, Engineeers and Emergency Organizations: Case Histories . Role of the News Media . Educational aspects.

### Organisation

*INTERNATIONAL PROGRAM COMMITTEE*

B.A. Bolt & W. Johnson, Co-Chairmen

*LOCAL ORGANIZING COMMITTEE*

BGL. Enrique Gillmore C. (President)
CRL. Juan E. Gutierrez (Secretary)

### Programme

Lectures on each major topic will be by selected distinguished experts. Short Papers for oral or poster presentation are also invited. Discussion groups of attendees wil be organized on the present status and future directions of practical implementation of instrumental monitoring systems for risk mitigation. A volume of abstracts will be published. There wil be pre-and post-conference excursions. The official languages will be English and Spanish.

### Registration fees

| | before 1st. Oct. 97 | after 1st. Oct. 97 |
|---|---|---|
| Active participants : | US$ 300,00 | US$ 350,00 |
| Students : | US$ 80,00 | US$ 100,00 |

### Contact

International IDNDR Conference
c/o I.U.G.G. Chile National Committee
Instituto Geografico Militar Chile
NVA. STA. ISABEL 16040 SANTIAGO, CHILE
Tel.: 56-2-26962188, Fax: 56-2-698-8278
email: igm@reuna.cl

# News from the URSI Community

## AWARDS PRESENTED TO URSI COLLEAGUES

### 1997 Distinguished Achievement Award presented to Prof. Dr. Ir. Jean Van Bladel

The Antennas and Propagation Society AdCom has accepted the recommendation of the Awards Committee that the **1997 Distinguished Achievement Award** be presented to **Jean Van Bladel,** *for outstanding contributions to electromagnetic theory and education.* The award presentation was made at the 1997 AP-S International Symposium and URSI Radio Science Meeting in Montreal, Canada.

Jean G. Van Bladel was born in Antwerp, Belgium, on July 24, 1922. He received the Electromechanical Engineer degree in 1947 and the Radio Engineer degree in 1948, both from Brussels University, Belgium, and the Ph. D. degree in Electrical Engineering in 1950 from the University of Wisconsin, Madison.

From 1950 to 1954 he was Head of the Radar Department of the Manufacture Belge de Lampes et de Matériel Electronique, Brussels, and from 1954 to 1956 he was Associate Professor of Electrical Engineering at Washington University, St. Louis. In 1956 Van Bladel joined the faculty of the University of Wisconsin as Associate Professor of Electrical Engineering and in 1960 he was elevated to Professor. In 1964 he returned to his native Belgium to become Professor of Electrical Engineering and Director of the Laboratory for Electromagnetism and Acoustics, the University of Ghent, which position he held until retirement in 1987. From 1976 through 1978, Professor Van Bladel also served as Dean of the University's Faculty of Applied Science.

Professor Van Bladel was Secretary General of URSI from 1979 to 1993. He is a Foreign Member of the Real Academia de Ciencias of Spain, and a Member of the Royal Belgian Academy of Sciences, Letters and Fine Arts, of which he was President in 1995. Professor Van Bladel received the Heinrich Hertz Medal of the IEEE in 1994.

Professor Van Bladel is the author of the textbooks *Electromagnetic Fields* (1984, 1985), *Relativity and Engineering* (1984) and *Singular Electromagnetic Fields and Sources* (1991).

## NEWS FROM THE MEMBER COMMITTEES

### Thailand

The National Communications Day was celebrated, on 4th August 1997, which is the 114th anniversary of the Post and Telegraph Department. The following activities were organised from 1 to 4 August :

- The Thai Telecomm'97 : Thailand's 8th Exhibition on International Telecommunications Information Technology and Multimedia, held at the Queen Sirikit National Convention Centre. The products put on display were newly developed technological systems and services in telecommunications, office automation & computers and broadcasting.
- The Seminar on "Telecommunications in Great Pace : Thailand Moves Forwards" was attended by experts with long experience in education, distant learning and telemedicine.
- The commemorative stamps and envelopes were issued and sold to the general public on 4th August.
- The commemorative proceedings on the National Communications Day incorporate all interesting articles relevant to the theme.
- Radio Thailand, the TV Pool Network and the cable television network broadcasted special documentary programmes and the Minister of Transport and Communications addressed the public on the significance of the National Communications Day.

Kitti Yupho, President, Thai Committee

# COMMISSION K

## Report on Commission K Activities at the 1997 URSI North American Radio Science Meeting held jointly with IEEE AP-S International Symposium

Montreal, Quebec, Canada, July 13 - 18, 1997

Two sessions were devoted to Commission K, and one joint session of commissions A, F, and K. Additionally, several papers within Commission K areas were presented at the AP-S , and Commission B sessions.

The attendance at the sessions was excellent with "standing room only" at papers devoted to interactions of handheld telephones and other PCS devices with the human body.

The following papers were presented at the two Commission K sessions:

*Hazard Evaluation and Prevention*, Co-chairs: O. P. Gandhi, USA and A. Thansandote, Canada

"A System for calibration of microwave antennae and radiation survey meters", A. Thansandote, S. Wasoontarajaroen, G. Gajda, D. Lecuyer, Radiation Protection Bureau, Ottawa, ON., Canada.

"Radio frequency fields from cellular transmitter towers and roof-top antennas", A. Thansandote, G. Gajda, D. Lecuyer, Radiation Protection Bureau, Ottawa, ON., Canada.

"Microwave fields as control of complex formation time in hemoglobin binding site", M. Zago, A. Palombo, G. D'Inzeo, Univ. "La Sapienza", Rome, Italy.

"Voltage-gated membrane channels under GSM and DECT exposure: A Global Analysis", F. Apollonio1, G. D'Inzeo1, L. Tarricone2, 1Univ. "La Sapienza", Rome, and 2Univ. of Perugia, Perugia, Italy.

"Simulation of radio frequency coils for super high rield magnetic resonance imaging", T. S. Ibrahim, R. Lee, Ohio State Univ., Columbus, OH., USA.

"Molecular simulation to study thermal variations at microscopic scale in bioelectromagnetics", M. Zago1, L. Tarricone2, A. Palombo1, G. D'Inzeo1, 1Univ. "La Sapienza", Rome, and 2Univ. of Perugia, Perugia, Italy.

"Compact low coupling, higher efficiency, broadband stacked-patch antennas for cellular telephones", S. S. Pattnaik, G. Lazzi, O. P. Gandhi, Univ. of Utah, Salt Lake City, UT., USA.

"Potential effects of 60 Hz magnetic fields on cell-cell communications In Vitro ", E. J. Rothwell, K. M. Chen, G. S. Wallinga, F. Nan, C.C. Chang, J. E. Trosko, B.L. Upham, Michigan State University, East Lansing, MI, USA.

"Frequency response of transmembrane potential in gap junction connected biological cells", E. C. Fear, Univ. of Victoria, Victoria, BC, Canada.

"Comparison of calculated and measured near-fields, radiation patterns, and SAR distributions for model of the human head for some typical cellular telephone antennas", G. Lazzi, O.P. Gandhi, Univ. of Utah, Salt Lake City, UT, USA.

*Electromagnetic Engineering in Medicine and Biology* , Co-chairs: M. Stuchly, Canada and T. J. F. Pavlasek, Canada

"Flexible microwave applicator for superficial heating of large contoured surfaces", P. R. Stauffer1, D. Deardorf1, F. Rossetto1, G. B. Gentil2, M. Leoncini2, 1Univ. of California, San Francisco, CA., USA, and 2Univ. of Florence, Italy,

"EM Analysis of the feeding network of DCC planar applicators for superficial microwave hyperthermia", G. Biffi Gentili1, C. Salvador1, M. Leoncini1, P. Stauffer2, F. Rossetto2, 1Univ. of Florence, Italy, and 2Univ. of California, San Francisco, CA.

"The input impedance of inhomogeneous cylindrical tissue layers excited with axial and circumferential polarization waves", R.M. Najafabadi1, A. F. Peterson2, 1Atlanta, GA. and 2Georgia Institute of Technology, Atlanta, GA, USA.

"Temperature imaging by non-contacting microwave radiometry", E. Di Giampaolo1, F. Bardati2, 1Univ. of Aquila and 2Univ. of Rome, Italy.

"Calculation of the power absorbed by the head using a non uniform FDTD", J. Wiart, S. Chaillou, S. Drago, France Telecom CNET, Issy Moulineaux, France.

"Comparison of 60 Hz uniform electric and magnetic induction in human organs using high-resolution modelling", T. W. Dawson, M. A. Stuchly and K. Caputa, Univ. of Victoria, BC., Canada.

"A small sensor to measure the electric and the magnetic field component simultaneously in biological material", A. Gille, J. L. Ter Haseborge, Tech. Univ. of Hamburg-Harburg, Hamburg, Germany.

"Biological-tissue-equivalent phantom material for EM modeling of human body at microwave frequency", L. Hamada1, R. Wang1, K. Ito2, 1Grad. School of Science and Technology, and 2Chiba Univ., Chiba, Japan.

"EM interaction between a head and antennas: Exact scattering solution of a double-layered lossy spherical head", K. W. Kim, Y. Rahmat-Samii, Univ. of California, Los Angeles, CA., USA.

"EM-energy absorption in human heads depending on the age, size and shape", M. Burkhardt, F. Schonborn, N. Kuster, Swiss Federal Inst. of Techology (ETH), Zurich, Switzerland.

There was also an AP-S session dedicated to EM Interaction with Biological Structures, co-chaired by A. Khebir, Canada and M. Popovic, USA. The following papers were presented:
"Diversity performance of personal communications handset antennas near operator tissue", B. M. Green, M. A. Jensen, Brigham Young Univ., Provo, UT, USA.
"Numerical computation of EM interaction between human body and loop antennas with arbitrary orientation", H-R. Chuang, W-T. Chen, National Cheng Kung Univ., Tainan, Taiwan, China.
"Human body coupling effects on radiation characteristics of superquadric loop antennas for pagers' application", W-T., Chen, H-R. Chuang, National Cheng Kung Univ., Tainan, Taiwan, China.
"A printed microwave antenna for the treatment of heart rhythm disorders", A. Khebir, P-A. Chapelon, P. Savard, Ecole Polytech. de Montreal, QU., Canada.
"Detecting fractures in artifical heart valves", E.S.A.M. Lepelaars1, W.D.R. Van Ooijen2, A. G. Tijhuis1, B.A.J.M. De Mol3, 1Eindhoven Univ. of Techn., Eindhoven, 2TNO Physics and Electronics Laboratory, Gravenhage and 3Academic Medical Center, Amsterdam, The Netherlands.
"A comparison of BCG-FFT and FD-TD Methods for the 3-D human head absorption problem", E.A. Forgy, J.Chen, W.C. Chew, J.M. Jin, Univ. of Illinois at Urbana-Champaign, Urbana, IL, USA.
"Thermal noise, motional electromotive force and electric fields in the human body", R.W.P. King, Harvard Univ., Cambridge, MA., USA.
"Calculation of SAR and B1 field within human head excited by MRI birdcage coils", J.Chen, J.M. Jin, Univ. of Illinois at Urbana-Champaign, Urbana, IL, USA.
"Phase alignment of multiple surface coil data for reduced bandwidth and reconstruction requirements in volumetric MRI applications", J.P. Debbins, J/P. Felmlee, S.J. Riederer, Mayo Clinic, Rochester, MN., USA.
"Nonuniform exposures of petri dish cultures within a TEM cell identified by FDTD modeling", M. Popovic, S.C. Hagness, A. Taflove, Northwestern Univ., Evanston, IL, USA.

Some other papers associated with Commission K field were:
"Computationally efficient algorithms for multi-term dielectric dispersion in FDTD", M. Okoniewski1, M. Mrozowski2 and M. A. Stuchly1, 1Univ. of Victoria, Victoria, BC., Canada and 2Technical Univ. of Gdansk, Belgium, presented in an AP-S session.
"Estimating the error of the FDTD method for complex inhomogeneous models" M. Sumetskii, J. C. Tully, S. S Patel, and I. A. Korisch, Lucent Technologies, Murray Hill, NJ., USA, presented in an AP-S session.
"Analysis of handset antenna in a multipath environment", I. A. Korisch, M. Sumetskii, S.S. Patel, Lucent Technologies, Murray Hill, N.J., USA., presented in an AP-S session.
"Currents induced in human body by incident 50-60 Hz or 10-30 kHz electric field when the arms are raised", R.W.P. King, Harvard University, Cambridge, MASS, USA, presented in a Commission B session.
"Limitations of precise simulations of handheld mobile phones with FDTD", Q. Voles, K. Popovic, M. Burkhardt and N. Kuster, Swiss Federal Institute of Technology, Zurich, Switzerland, presented in a Commission B session.

Maria A.Stuchly
Canadian Chair Commission K

# JOURNAL OF ATMOSPHERIC AND SOLAR-TERRRESTRIAL PHYSICS

Special Offer to URSI Correspondents

## AIMS AND SCOPE

The *Journal of Atmospheric and Solar-Terrestrial Physics* is an international journal concerned with the interdisciplinary science of the Earth's atmospheric and space environment. Papers are published on the results of experiments and their interpretations, and on theoretical or modelling studies. Papers dealing with remote sensing carried out from the ground or with *in situ* studies made from rockets or from satellites orbiting the Earth are particularly suitable. Plans for future research, often carried out as an international programme, are also discussed. Besides original research papers, discussion papers and short reports, the journal includes commissioned review papers on topical subjects and special issues arising from chosen scientific symposia or workshops. The journal covers the physical processes operating in the troposphere, stratosphere, mesosphere, thermosphere, ionosphere, magnetosphere and heliosphere. Phenomena occurring in other "spheres" and supporting laboratory measurements are also considered. The journal deals especially with the coupling between the different regions. Regarding the upper atmosphere, the subjects of aeronomy, geomagnetism, auroral phenomena, radio wave propagation and plasma instabilities are examples within the broad field of solar-terrestrial physics which emphasise the energy exchange between the solar wind, the magnetospheric and ionospheric plasmas, and the neutral gas. In the middle and lower atmosphere, the topics covered include dynamics, radiation and chemistry, atmospheric electricity and electrodynamic effects, including lightning and its effects, and anthropogenic changes. Helpful, novel schematic diagrams are encouraged as is the use of colour.

**ABSTRACTED/INDEXED IN:**
*Cam Sci Abstr, Curr Cont SCISEARCH Data, Curr Cont Sci Cit Ind, Curr Cont/Phys Chem & Sci, INSPEC Data, Meteoro & Geoastrophys Abstr, Res Alert.*

**Audience:**
Atmospheric physicists, geophysicists and astrophysicists




Special Rate for URSI Correspondents 199
NLG 224.00 (US$138.00)

Subscription Information
1997: Volume 59 (18 issues)
Subscription price: **NLG 3263.00 (US$2014.00)**
ISSN 1364-6826 (00211)
Associated Personal Price: NLG 224.00/US$138.00



The table of contents for this journal is now available pre-publication, via mail, as part of the free ContentsDirect service from Elsevier Science. Please send an e-mail message to cdhelp@elsevier.co.uk for further information about this service.


US Dollar price(s) quoted are definitive to customers outside Europe and Japan. For price(s) within Europe and Japan contact your nearest Elsevier Science office.
Prices include postage and insurance.

**Elsevier Science Offices**
**For customers in the Americas**
**(North, South and Central America):**
Elsevier Science
Regional Sales Office
Customer Support Department
655 Ave of the Americas
New York, NY 10010, USA
Telephone: +1-212-633-3730
Toll-free for customers in the USA and Canada:
1-888-437-4636 (1-888-4ES-INFO)
Fax: +1-212-633-3680
E-mail: usinfo-f@elsevier.com
**For customers elsewhere:**
Elsevier Science Ltd
The Boulevard
Langford Lane
Kidlington
Oxford OX5 1GB, UK
Fax: +44 (0) 1865 843952
E-mail: freesamples@elsevier.co.uk

EA6A59//9/96

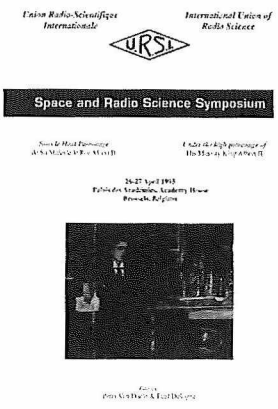
**Pergamon**
An imprint of Elsevier Science


Complementary information about this journal can be found at http://www.sprl.umich.edu/JATP

# URSI Publications

## Proceedings of the "Space and Radio Science Symposium"

Editors: Peter Van Daele and Paul Delogne
ISBN 90-9008628-5




**This "Space and Radio Science Symposium" was held on 26-27 April 1995, at the occasion of the 75th Anniversary of our Union.**

Copies of these Proceedings are available at the URSI Secretariat for 500 Belgian francs per copy (for countries outside Europe we charge an extra 140 Belgian francs per copy for mailing costs).

**Table of Contents :**

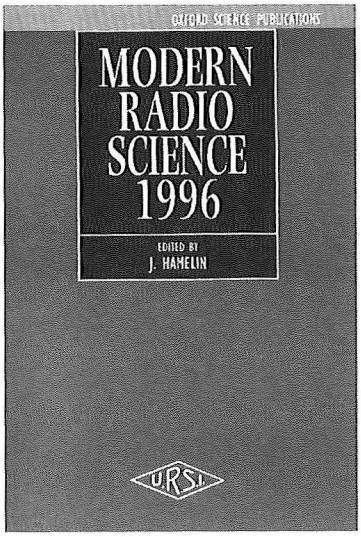


## Modern Radio Science 1996

Editor: Joël Hamelin
ISBN 0-19-856530-5
Price : £ 35

For further information, please contact :

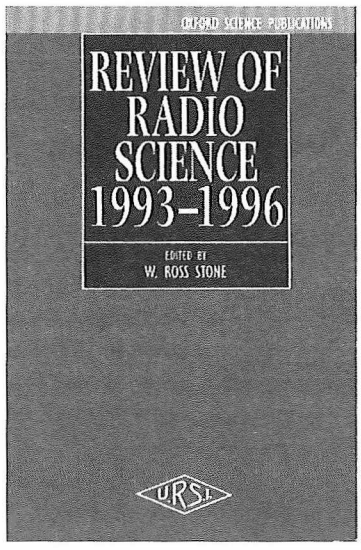
CWO Department
Oxford University Press
Saxon Way West, Corby
NORTHANTS NN18 9ES
UNITED KINGDOM
tel. +44 1-536-746-337
fax +44 1-536-744-964



## Review of Radio Science 1993-1996

Editor: W. Ross Stone
ISBN 0-19-856532-1
Price : £ 95

For further information, please contact :
CWO Department
Oxford University Press
Saxon Way West, Corby
NORTHANTS NN18 9ES
UNITED KINGDOM
tel. +44 1-536-746-337
fax +44 1-536-744-964

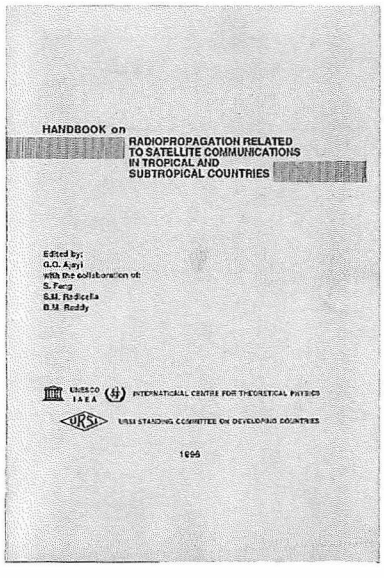



## Handbook on Radiopropagation Related to Satellite Communications in Tropical and Subtropical Countries

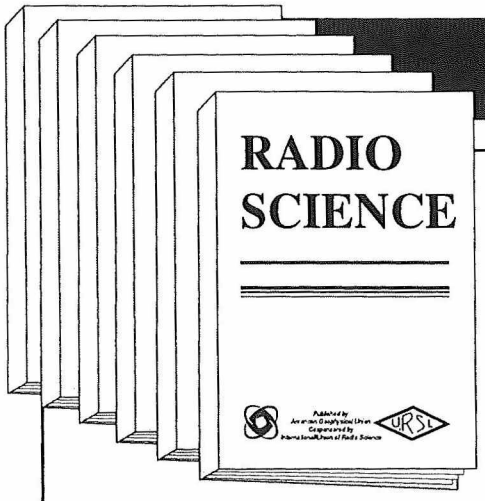
Editor: G.O. Ajayi
with the collaboration of :
S. Feng
S.M. Radicella
B.M. Reddy

**Table of Contents :**

* Chapter 1 : Attenuation by Rain and Clouds and Rain Rate Statistics
* Chapter 2 : Absorption by Atmospheric Gases including Prediction Models
* Chapter 3 : Ionospheric Effects on Space Communications Systems
* Chapter 4 : Attenuation Prediction Models for Design of Satellite Systems
* Chapter 5 : System Design for Point-to-Point Satellite Services
* Chapter 6 : System Design for Broadcasting Satellite Services




For further information, please contact :
The URSI Secretariat
c/o University of Gent (INTEC)
Sint-Pietersnieuwstraat 41
B-9000 GENT, BELGIUM
tel. +32 9-264-33-20
fax +32 9-264-42-88
e-mail : heleu@intec.rug.ac.be




# SUBSCRIBE

# Radio Science

*Robert Hunsucker, Editor, Electronic Engineering Institute, Oregon Institute of Technology*

**See a Recent Table of Contents with Abstracts on the AGU Web Site. http://www.agu.org**

**Ranked #1 in the telecommunications category of the *1995 Journal Citation Reports,* published by the Institute for Scientific Information.**

***Radio Science*** contains original scientific contributions on all aspects of electromagnetic phenomena related to physical problems. Covers the propagation through and interaction of electromagnetic waves with geophysical media, biological media, plasmas, and man-made structures. Also included, but not limited to, are papers on the application of electromagnetic techniques to remote sensing of the Earth and its environment, telecommunications, signals and systems, the ionosphere, and radio astronomy. All frequencies, including optical, are considered.

Cosponsored by U.R.S.I. International

Published bimonthly by AGU

Volume 32. ISSN 0048-6604. Print or microfiche.

**1997 Subscription Rates**

| | |
|---|---|
| U.R.S.I. Correspondents & AGU Members | $57.00 |
| AGU Student Members | $29.00 |
| Surface Postage outside the USA | $20.00 |
| Air Freight Postage | $52.00 |
| Air Mail Postage | $81.00 |

AGU encourages contributions to ***Radio Science*** from authors throughout the world. Contact AGU Publication Office, Washington DC, for submission instructions.

**To order:** Subscription must be prepaid by check, money order, or credit card. AGU accepts American Express, VISA, and Master Card. Credit card payments may be placed over the phone Monday through Friday, 8:30 am to 6:00 pm Eastern time. **Please reference AGU code URSI when ordering.**

**WRITE:** AGU — Orders
2000 Florida Avenue NW
Washington DC 20009 USA

**CALL:** 1-800-966-2481 (toll-free in North America)
+1-202-462-6900
Fax +1-202-328-0566
E-Mail: orders@kosmos.agu.org

**Or send orders to AGU's European office:**
AGU — Orders, Max-Planck-Str. 1, 37191 Katlenburg-Lindau, GERMANY, Tel: (49)5556-1440.
Fax: (49)5556-4709. E-Mail: agu@linax1.mpae.gwdg.de

URSI

# Information for authors

### Content

The Radio Science Bulletin is published 4 times a year by Radio Science Press on behalf of URSI, the International Union of Radio Science. Besides general and administrative information issued by the URSI Secretariat, the Bulletin includes a scientific section containing articles and correspondence items (short notes, letters to the editor and book reviews). Contributed papers are preferably of a tutorial nature and should be of interest to a wide range of persons belonging to the Radio Science Community. The subject matter should relate to the analysis and applications of Radio Science in areas of principal or broad interest.

Articles are subject to peer-reviewing. The content should be original and must not duplicate descriptions or derivations available elsewhere. Submission of a manuscript manifests the fact that it has been neither copyrighted, published, nor submitted or accepted for publication elsewhere, unless otherwise so stated by the author. The manuscript text should not contain any commercial references, such as company names, university names, trademarks, commercial acronyms, or part numbers. All material not accepted will be returned. Accepted material will not be returned unless asked by the authors on submission.

### Length

Articles can vary in length but are preferably 7 to 15 double-spaced typewritten pages (A4 size) in length, plus up to 10 pages of figures. Correspondence items are of less than 3 double-spaced typewritten pages, plus not more than 1 page of figures.

### Submissions

All material submitted for publication in the scientific section of the Bulletin should be addressed to the Editor, whereas administrative matters are to be handled directly with the URSI Secretariat. Submission in electronic format according to the instructions below is preferred. In addition, a paper copy of your manuscript should be sent to the Editor, accompanied by a separate sheet containing the address to which correspondence can be sent. Also enclose original illustrations in case the electronic format yields problems of quality or compatibility.

### Styles

No specific style for the manuscript is required as the final layout of the paper is done at the URSI Secretariat. Name, affiliation, address and telephone/fax numbers for all authors is required. Figure captions should be on a separate sheet in proper style for typesetting. See this issue for examples.

Originals of drawings and glossy print black-and-white photographs should be sharp and of good contrast. Line drawings should be in black ink on a white background. Prefer A4 size sheets to simplify handling of the manuscript. Template lettering is recommended; typing on figures is not acceptable. Lettering should be large enough to permit legible reduction of the figure to column width, perhaps as much as 4:1. Identify each illustration on the back or at the bottom of the sheet with the figure number and name of author(s). Indicate the top of a photograph. Captions lettered on figures will be blocked out in reproduction in favor of typeset captions. If possible also provide the figures in electronic format. MacDrawPro, CricketGraph, Microsoft Excell, Adobe Illustrator are possible as well as postscript files (PS) and EPS formats.

### Electronic Submission

As the final editing will be done using Aldus Pagemaker 5.0 on Macintosh, the paper can be submitted in Microsoft Word (for Macintosh or IBM Compatible) version 6.0 or any earlier version. Wordperfect is also acceptable. The files can be send to the Editor in three ways:

1) By sending a floppy diskette. Both Macintosh (low and high density) and IBM-PC, 3.5 inch, 720 kb or 1.44 Mb disk formats are acceptable. The following information is needed:
   * The operating system and word processing software used to produce your document should be noted on your disk (e.g. DOS/WordPerfect).
   * The disk should be labeled with the file name(s) relating to the manuscript.
   * No program files should be included on the disk.
   * Package floppy disks in such a way as to minimize possible damage in transit.
   * Include a flat ASCII version on the disk with the word-processed version, if possible.
2) By sending an e-mail message to the Editor.
3) By putting your submission on a ftp site. For this purpose:
   * Open the ftp site at address *ftp.tele.ucl.ac.be* ,
   * Login as *anonymous* ,
   * Password: *your e-mail address* ,
   * In the directory */pub/URSI,* create your own directory,
   * Change to this directory and put your text and/or figures there,
   * Send an e-mail message to the Editor (Sobieski@tele.ucl.ac.be) to draw his attention on the fact that the files have been transferred.

### Review Process

The review process usually requires about three months. The author is then notified of the acceptance/rejection decision of the Editor or Associate Editor based on reviewer recommendations. The authors may be asked to modify the manuscript if it is not accepted in its original form. The elapsed time between receipt of a manuscript and publication is usually less than twelve months.

### Page Charges

No page charges are applied for any contribution following the above mentioned guidelines. No free reprints will be issued.

### Copyright

Publication of papers in the Radio Science Bulletin is subject to copyright transfer to Radio Science Press acting as agent and trustee for URSI. Submission of a paper for publication implicitely indicates the author(s) agreement with such transfer and his certification that publication does not violate copyrights granted elsewhere

# APPLICATION FOR AN URSI CORRESPONDENT

I wish to become an URSI Correspondent for the 1997-1999 triennium.
Subscription to "The Radio Science Bulletin" is included in the fee.
(please type or print in BLOCK LETTERS)

Name: Prof./Dr./Mr./Mrs./Ms. _____
*Family Name* *First Name* *Middle Initials*

Present job title: _____

Years of professional experience: _____

Professional affiliation: _____

Company name: _____

Department: _____

Street address: _____

City and postal / zip code: _____

Province / State: _____ Country: _____

This is my ☐ home ☐ business address

Phone: _____ ext: _____ Fax: _____

E-mail: _____

**Areas of interest (please tick)**

☐ A Electromagnetic Metrology
☐ B Fields and Waves
☐ C Signals and Systems
☐ D Electronics and Photonics
☐ E Electromagnetic Noise & Interference
☐ F Wave Propagation & Remote Sensing
☐ G Ionospheric Radio and Propagation
☐ H Waves in Plasmas
☐ J Radio Astronomy
☐ K Electromagnetics in Biology & Medicine

The fee is US$ 40.
(The URSI Board of Officers will consider waiving of the fee if the case is made to them in writing)

Method of payment: VISA / MASTERCARD

Credit Card No ☐☐☐☐ ☐☐☐☐ ☐☐☐☐ ☐☐☐☐ Exp. date: _____

Date: _____ Signed _____

Return this form to:

The URSI Secretariat
c /o University of Gent / INTEC
Sint-Pietersnieuwstraat 41
B-9000 GENT, BELGIUM
fax (32) 9-264.42.88