Editorial

There should be something for everyone in this Spring Newsletter, containing details of exciting events and ongoing research. We are pleased to advertise our second Members' Day event, including a wide variety of presentations across environmental physics. Events organised by the Group are becoming ever more innovative; this issue contains details of a summer visit to Eskdalemuir Geophysical Observatory in Scotland with a lecture by the eminent environmental physicist and former Director General of the Met Office, Lord Hunt. For those who would prefer to go somewhere warmer than Scotland this summer, the newsletter contains details of three summer schools, all to be held in Italy. Research news includes a description of a new method to remotely estimate soil parameters from satellite and micrometeorological measurements, and the latest on the thermohaline circulation. This issue contains a provocative review of the Radio 4 "Document" programme, broadcast last year and mentioned in the previous issue of the Newsletter. Finally, an article celebrates the contribution of Dr Doug Peirson to Environmental Physics. Doug was one of the founder members of the Group, who sadly died last year.

General interest articles about work in environmental physics are always welcomed. Contributors do not have to be members of the group, and the Newsletter may be a useful forum for relatively informal research articles, so please encourage your students and colleagues to contribute. Additional copies of the Newsletter are available on request for coffee rooms and to pass on.

Karen Aplin

NOTICE

13TH Annual General Meeting of the Environmental Physics Group

The 13th Annual General Meeting of the Environmental Physics Group will be held on **Wednesday 19th May 2004. at 1:40pm**. The meeting will be held in the Phillips Room at the Institute of Physics' headquarters at 76 Portland Place, London.

This year's AGM will be held during the EPG Member's Day meeting, at which attendees will get the chance to hear talks on a wide range of environmental physics topics and celebrate the diversity of the Environmental Physics Group.

I look forward to seeing you at the AGM.

Peter Hodgson (Vice-Chair)

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Forthcoming Events

Environmental Physics Group Members' Day: A Broad Spectrum of Activities

Wednesday 19th May 2004
Phillips Room, Institute of Physics, 76 Portland Place, London.

The Members' Day meeting promises a varied collection of presentations on environmental physics topics, as well as being an opportunity for the community to get together to discuss common interests.

Speakers include:

Dr Jeff Polton, University of Reading, "Ocean Circulation"
Professor Edward Youngs, Cranfield University, "Maintaining fresh-water aquifers in coastal regions"
Dr Pat Goodman, Dublin Institute of Technology, "Air pollution and delayed health effects"
Dr Paul Williams, University of Reading, "Can weather forecasts be improved by adding random noise?"
David Cooper, Centre for Ecology & Hydrology, "Soil water measurements"
Dr Ian Marshall, University of Kent, "Networks of smart sensors for environmental applications"
Dr Jamie Taylor, University of Edinburgh, "Wave Energy - a critical moment"

As well as a full programme of talks, a selection of posters will also be presented at the meeting. The meeting will commence at 10:00am with coffee, with the first talk scheduled for 10:30am.

We would welcome further contributions to the photography exhibition. If you have a photograph(s) to offer, contact Peter Hughes, Westminster Kingsway College, Sidmouth Street, London, WC1H 8JB (0207 306 5958; peter.hughes@westking.ac.uk).

All members are welcome to attend the meeting. There will be no charge to members and a free buffet lunch will be provided. A limited number of places may be available to non-members (a fee will be charged). A number of EPG bursaries are available to assist members with travel costs incurred in attending the meeting. Please contact the Vice-Chair for further details.

If you have not already done so, please indicate your intention to attend the meeting. The EPG AGM will also be held during the meeting. I look forward to seeing you there.

Contact Details
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Weather and Disease Forecasting

8 June 2004, 2.00 to 5.20 pm.
Institute of Physics, 76 Portland Place, London W1N 3DH.

The weather has major impacts on human health and crop productivity, and prediction can save lives and crops by enabling effective application of resources. This meeting will explore three current developments in this important, dynamic field.

In the UK, each winter brings 40,000 extra deaths, mostly through respiratory and cardiovascular disease. These diseases respond to the weather, impacting rapidly on the workload of the NHS. The Met Office has been exploring the effect of weather on health for over four years, developing a tool to provide timely forecasts and facilitate efficient use of NHS resources.

Malaria may respond on the much longer timescale of climate change. Recent progress in combining new technologies such as remote sensing, climate modelling and spatial modelling has improved understanding of the dynamics of this parasite-vector-host system. Developing these approaches may provide a means for prediction, mitigation and possibly control of this terrible disease.

Predicting crop disease follows two broad approaches. Statistical mining of data for empirical relationships often reveals only spurious correlations, but a new statistic can overcome this problem, as shown by encouraging progress on predicting Septoria triticii epidemics in winter wheat. Mechanistic models also reveal the dependence of plant disease epidemics on environmental variables (mainly weather) and examples of both approaches show their power.

Speakers
William Bird, Met Office
Noel Nelson, Met Office
Mark Cresswell, Manchester Metropolitan University
Frank van den Bosch, Rothamsted Research

Provisional programme
1400 Opening remarks –chairman
1405 Noel Nelson: Weather and disease
1445 William Bird: Forecasting disease outbreaks
1525 Tea
1545 Frank van den Bosch: Risk prediction algorithms for plant disease
1625 Mark Cresswell: The Geography and dynamics of malaria – causes and possible solutions
1705 General discussion
1720 Close

If you wish to attend, please contact John Garland by 3 June, so that expected numbers can be estimated.
48 Priory Orchard, Wantage, Oxon OX12 9EL
email: john_garland@online.rednet.co.uk

Visit to Eskdalemuir Geophysical Observatory

Saturday 17th July 2004

In the early 1900s, electrical interference from trams caused difficulties with geomagnetic measurements at the long-established Kew Observatory, near London. A more suitable rural site was found by the Royal Society at Eskdalemuir, Dumfriesshire, and construction of the new Observatory began on 19th July 1904. Since it opened in 1908, Eskdalemuir Observatory has made seismic, geomagnetic, meteorological and atmospheric electrical measurements (for further information, see Harrison R.G., Long term measurements of the global atmospheric electric circuit at Eskdalemuir, Scotland, 1911-1981 *Atmospheric Research* **70** (1), 1-19, 10.1016/j.atmosres.2003.09.007). It is still an operating geophysical Observatory, run by the British Geological Survey. There is also a long history of meteorological measurements at Eskdalemuir, and the eminent dynamical meteorologist and developer of the first numerical weather forecast, L. F. Richardson FRS, was Superintendent there before the First World War.

As part of the Centenary celebrations, the Environmental Physics Group of the Institute of Physics is arranging a summer visit to Eskdalemuir Observatory. This visit will include a tour of the Observatory site and museum, and will include lectures on the scientific history of the observatory. Prof Julian Hunt CB FRS, formerly Chief Executive of the Met Office, will give a talk on the contributions of L. F. Richardson while at Eskdalemuir.

Transport

Eskdalemuir Observatory is relatively remote. A coach will be arranged from Carlisle railway station to the Observatory. The coach times allow the visit to be possible by train in one day from London and Edinburgh, although detailed rail enquiries will need to be made by those coming. Numbers at the Observatory are limited, and it is necessary to book a place on the coach in advance.

Contact Details

Booking information is available at: http://conferences.iop.org/EGO/index.html

Optical Environmental Sensing

Thursday 9th September, 2004
Photon 04, Glasgow

The Optical Physics and Environmental Physics Groups are jointly organising a meeting on Optical Environmental Sensing to be held within the Photon 04 conference (6th – 9th September) at Glasgow Caledonian University. Speakers will cover topics including gas analysis, satellite imaging, combustion measurements and atmospheric dispersion.

Further details may be obtained from the conference web-site: www.Photon04.org

A number of EPG bursaries may be available to assist members with travel costs incurred in attending the meeting. Please contact the Vice-Chair for further details.

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Summer Schools

Summer School on Mountain Meteorology, Trento, Italy, 25 - 30 July 2004

This is a reminder that deadline for applications to the Summer School on Mountain Meteorology, to be held in Trento, Italy, 25 - 30 July 2004 is Friday 7 May 2004.

Online registration form can be found on our web page:
http://www.unitn.it/ssmm

ESA summer school "Earth System Monitoring & Modelling", Frascati, Italy, 16-26 August 2004

This is a reminder that deadline for applications to the ESA Summer School on "Earth System Monitoring & Modelling" to be held in ESRIN (Frascati, Italy) is Mon 10th May 2004

Online registration at http://envisat.esa.int/envschool/

Environmental Stratified Flows, Udine, Italy 12-16 July 2004

A course on "Environmental Stratified Flows", coordinated by professsors V.Armenio e S.Sarkar, will be given on July 12-16, 2004.
In http://www.cism.it/cism/p2004/annC0406.pdf you will find information about the contents of the school and the procedures for admission.

Environmental Physics Research News

Remote estimation of thermal inertia and soil heat flux for bare soil

The surface soil heat flux, G, is an important term of the surface energy balance (SEB) equation:

$$R_n = H + LE + G \qquad (1)$$

particularly for (semi)-arid regions, areas with low or no vegetation cover, and over a diurnal time scale. The SEB describes how the net radiation received at the Earth's surface, R_n, is partitioned between sensible heat flux, H, evaporation, LE, and G. Accurate quantification of the SEB fluxes is important in understanding a surface's (whether bare or vegetated) energy and water use. Field-averages of H and LE are relatively easy to obtain using current micrometeorological techniques. However, most existing methods used to determine G can only provide *in-situ* values that are valid for an area of much less than 1 m^2. A possible solution for finding area-average values, $\overline{G}$, is to use remotely sensed data. However, this requires knowledge of the thermal soil properties (soil heat capacity, C_h, and the soil thermal diffusivity, D_h). Ideally, we would derive both the soil thermal properties and G from time series of surface temperature and/or any other variables that can be obtained from remote sensing. Some examples of this can be found in the literature and these methods involve the use of a lumped variable, the thermal inertia, $C_h\sqrt{D_h}$. This parameter describes the impedance to variations of soil surface temperature. However, these models still require *in-situ* information, such as wind speed, which has to be obtained by ground measurements. Furthermore, most of them are only satisfactorily accurate for dry ground surfaces, as a result of the fact that the upper boundary condition for the majority of these models is given by Eq. (1).

Here, a method has been derived which allows bare soil thermal inertia, for any soil moisture content, to be estimated remotely from micrometeorological observations. The method uses the drop in surface temperature, ΔT_s, between sunset and sunrise, and the average night-time net radiation, R_n, during that period, for clear, still nights.

$$\left(C_h\sqrt{D_h}\right) = 2\left|\overline{R_n}\right|\sqrt{\Delta t}\,/\,\Delta T_s\sqrt{\pi} \qquad (2)$$

Here, Δt is the time between sunset and sunrise. A Fourier Series analysis is applied to analyse the time series of T_s. The Fourier series constants, together with the remote estimate of thermal inertia, are used in an analytical expression to calculate diurnal area-average estimates of the (remote) soil heat flux, G (see Verhoef, 2004).

Remote estimates of $C_h\sqrt{D_h}$ and G were compared with values derived from *in-situ* sensors, as employed at a 200 by 60 m bare soil field (sandy loam, overlying plateau gravel on a terrace of the River Thames) at the University of Reading's Crop Research Unit, located at Sonning Farm, Sonning, Berkshire, UK (51°27' N, 0°58' E, altitude: 36 m ASL). The soil physical instrumentation comprised 5 pairs of thermistors (at nominal depths of 0.05 and 0.10 m), to measure soil temperatures, $T_{soil,1}$ and $T_{soil,2}$, respectively. In addition, at each point a Thetaprobe (Delta-T Devices, Cambridge, UK) was installed at a nominal depth of 0.05 m to measure soil moisture content, θ, of the topsoil. These measurements, and estimates of dry bulk density, allowed *in-situ* $C_h\sqrt{D_h}$ and G to be calculated. T_s (°C) and R_n, as required

for the calculation of remote thermal inertia, were obtained from a 4-component radiometer (Kipp and Zonen, Delft, the Netherlands).

Eq. 2 gives thermal inertia values that are similar to thermal inertia values derived from *in-situ* measurements of volumetric heat capacity and thermal diffusivity. Furthermore, both types of thermal inertia exhibit a comparable dependence on soil moisture content.

The *in-situ* and remote estimates of soil heat flux, G, also compare well ($r^2 = 0.83$, see Fig. 1). Especially when we take into account that *in-situ* G, and hence the goodness of fit between *in-situ* and remote G, is very dependent on the sensor depths used in equations to calculate thermal diffusivity and G (see Verhoef, 2004). This illustrates that Eq. 2 can be a powerful tool in determining thermal inertia, remotely, and possibly can be used to estimate soil moisture content indirectly. Importantly, this method can be used for soils under varying degrees of wetness. Furthermore, this method will provide an area-average estimate of G, depending on the height at which the (4-component) radiometer is installed, possibly leading to better energy balance closure. In addition, this method will not disturb the soil or interact with the flow of heat, liquid water and water vapour (as do soil heat flux plates, which may lead to unreliable estimates of *in-situ* estimates of soil heat flux).

This method potentially allows area-average estimates of thermal inertia and soil heat flux to be derived from remote sensing, e.g. METEOSAT Second Generation, where the area is determined by the sensor's height and viewing angle. At the moment, the method is being adapted to allow calculation of $C_h\sqrt{D_h}$ and G for vegetated surfaces.

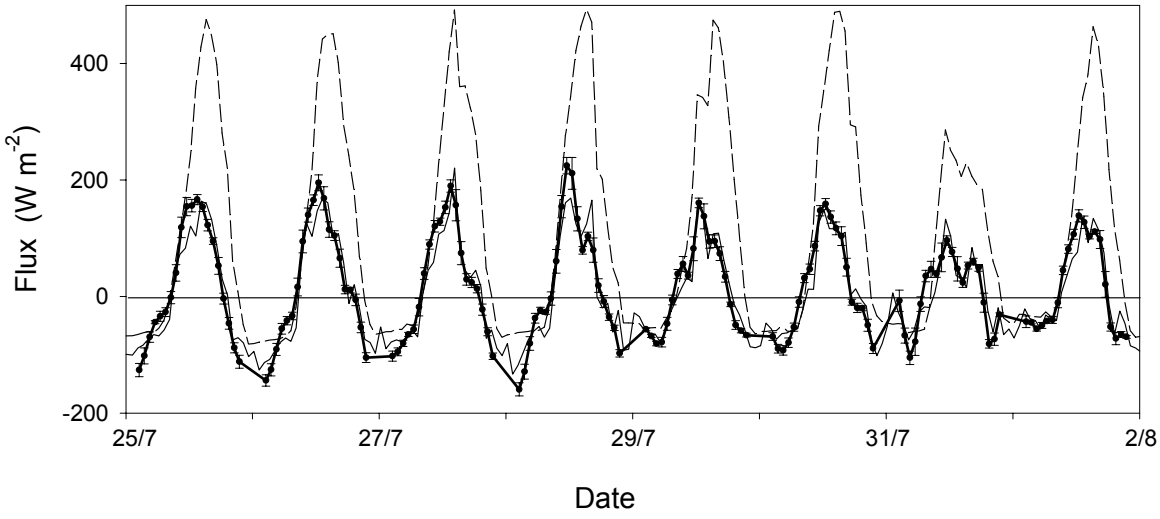

Fig. 1. Diurnal variation of net radiation, R_n (dashed line), remote soil heat flux, G_r (continuous line), and the average in-situ soil heat flux, $G_{i\text{-}s}$ (bold continuous line, including error bars) during 8 consecutive days of the experimental campaign.

This research was funded by a UK Natural Environment Research Council small research grant (NER/M/S/2000/00268). Further reading can be found in Verhoef, A., Remote estimation of thermal inertia and soil heat flux for bare soil, *Agricultural and Forest Meteorology*. In press (already available on ScienceDirect).

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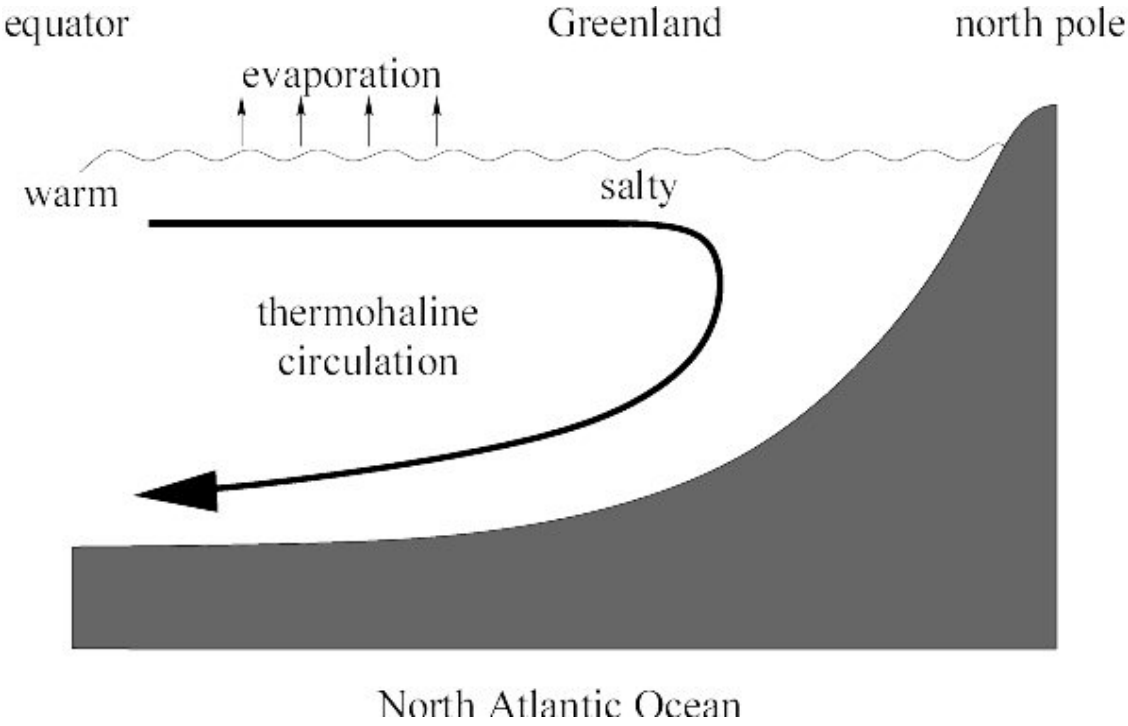
The Department of Soil Science, School of Human and Environmental Sciences, The University of Reading, Reading RG6 6DW

Climate change and the thermohaline circulation

As every physicist knows, objects do not accelerate unless they are acted upon by an external force. Water in the ocean is no exception to this rule - parcels of sea water are constantly in motion around the globe, constrained by the continents. For ocean water, the two most important forces are atmospheric winds blowing across the sea surface, and internal pressure gradient forces which result from variations in the density of the water. The component of the global ocean circulation due to the latter is known as the thermohaline circulation (THC), since the density of sea water depends upon both its temperature ("thermo") and density ("haline").



In the Atlantic Ocean, the THC brings warm, equatorial surface waters northwards along the east coast of the american continent. This forms the famous Gulf Stream. Due to the relatively high temperature, evaporation of water molecules to the atmosphere is large. Salty, and therefore dense, surface waters are left behind by the evaporation. The waters eventually become so heavy that they sink near Greenland, and return southwards along the ocean floor. The sinking water is replaced by yet more warm surface water from the tropics.

The Atlantic THC therefore seems to be maintained by a self-sustaining cycle of events: water sinks near Greenland because it is dense; it is dense because it is salty; it is salty because evaporation is high; evaporation is high because it is warm; it is warm because it it comes northwards from the tropics; and it comes northwards from the tropics because it replaces water which sinks near Greenland!

The existence of the THC therefore depends upon a potentially delicate chain of feedbacks. One current concern of climate scientists and oceanographers is that anthropogenic climate change due to greenhouse gas emissions is likely to give changes to rainfall patterns in the North Atlantic, plus an influx of freshwater due to melting of Arctic ice. This would modify some of the links in the feedback chain

discussed above, which could dramatically modify the THC. Some computer models have even predicted that the THC could shut down completely, which would have profound implications for the climate of Europe. Though the chances of a complete shutdown are small, the impacts would be severe. The possibility therefore needs to be taken seriously, and research into the mechanisms and timescales is on-going.

Paul Williams (williams@met.rdg.ac.uk)
Centre for Global Atmospheric Modelling, University of Reading

Radio Programme Review

The Bunker

Radio programme in the series Document, broadcast on BBC Radio 4 at 20.00 on 6th October 2003 (Presenter, Mike Thomson; Producer, Neil George)

Ray Fox is not a well man. He has deserted his house in Earley, a suburb of Reading, and now lives a few miles away. He is convinced that his home is contaminated with radioactive material and that this has made him seriously ill. Ray's plight was the subject of the BBC Radio 4 programme "The Bunker", part of the investigative series "Document" presented by Mike Thomson.

But what exactly is wrong with Ray Fox and is it a condition that is linked to radiation exposure? Dr Josef Kees, a German physician "who specialises in treating victims of chemical and radioactive poisoning", has examined him. Dr Kees told Mike Thomson that he had found "a lot of toxins like slightly raised dioxins ... like Lindane" in fatty tissue, and "uranium in his bloodstream double as high as the accepted normal value". According to Dr Kees, this seemed to have caused "Multiple Chemical Sensitivity" syndrome, an ill-defined syndrome supposedly produced by environmental exposure to chemicals rather than radiation. We were to hear nothing further of the nature of Mr Fox's "mystery illness". A web-search reveals that Dr Kees runs a private clinic in Bad Homburg, Germany, specialising in "detoxification, induced self tissue repair and restorative medicine", which probably speaks for itself.

What evidence is there that Ray Fox's property is highly contaminated? Concerned that he could not grow any plants in his garden and the presence there of "white worms", Ray contacted his insurance company, Sun Alliance, who sent "consultant toxicologist" Dr Kartar Badsha to investigate. A "shocked" Dr Badsha found "very high levels of uranium and plutonium, some 55 times background levels". He advised Ray Fox to abandon his home ("the worst house I [Dr Badsha] have ever been to") and that young people should be prevented from entering the house until remediation has been carried out. No details of the measurements that had been conducted to allow Dr Badsha to arrive at this startling conclusion were presented on the programme. A web-search shows that Dr Badsha runs the Environmental Law Centre (`specialising in protecting your human rights on issues that concern health and the environment') and MCS (Multiple Chemical Sensitivity) International, both based in Southport.

Retired GP Dr Dick van Steenis, "who has dedicated himself to investigating various chemical and radioactive anomalies" then informed us that the $^{238}U/^{235}U$ ratio of the uranium found in the house was 24.5, i.e. 4% ^{235}U enrichment, "and this proves that the uranium is actually weapons grade and the plutonium is reactor grade". How this isotopic ratio was determined and how Dr van Steenis managed to arrive at this staggering conclusion remained a mystery for listeners, but he went on to infer that this indicated the presence of an underground reactor nearby. Dr van Steenis appears to be a campaigner against general industrial pollution, but, as far as I can gather, has no expertise in radiological protection.

The story then developed of a covert underground nuclear reactor at the former Shell site behind Ray Fox's house. Professor Asef Durakovic, "a colonel in the US Army" and "a key speaker at a conference in London on the effects of low level radiation", briefly told us of his experiences with military reactors and underground bunkers in the USA. Professor Durakovic is now the Medical Research Director of the Uranium Medical Research Centre, an organisation based in North America that specialises in conducting research on depleted uranium. It may be relevant that Drs Kees, van Steenis and Durakovic have all been speakers at London conferences (the most recent being this September) on Multiple Chemical Sensitivity and environmental illness organised by none other than Dr Kartar Badsha.

Enter Dr Christopher Charles Busby, this time in the guise of an "environmental physicist". Dr Busby carried out radiation measurements down a drain in Ray Fox's garden, and also collected samples for analysis. He was uncharacteristically restrained in his interpretation of the results: the levels were not especially high, but higher than they should be for the outskirts of Reading. Undeterred, Dr Busby returned to the matter raised by Dr van Steenis, "The earlier samples showed uranium ratios which contained enriched uranium from a reactor or from a bomb, and that's it in a nutshell really." Again, no details of this surprising isotopic ratio measurement were given.

The presenter, Mike Thomson, seemed to have some difficulty in distinguishing between a nuclear bunker, designed to keep radiation and radioactivity out, and a nuclear reactor, with containment designed to keep them in. (Indeed, the programme might have been better entitled "The Reactor".) Mr Thomson became increasingly more confused about this distinction and why Shell should have secretly operated an underground reactor at their Earley site. Unfortunately, Shell did not make anyone available for interview, a questionable decision under the circumstances. Surely someone who used to work at Earley could have been found to speak about operations at the site? However, in a statement the company "categorically and absolutely" denied that there ever was an underground research facility at the Earley site.

Dr Mike Clark of NRPB explained that the Board had advised that the reported levels of radioactivity in samples originally taken from Ray Fox's garden were unusual, although not remarkably so, but that permission to take further samples for analysis had, rather surprisingly, been refused. However, surveys in the vicinity of the Fox residence found nothing anomalous. Dr Clark was highly dubious about the inference that the monitoring results indicated the presence of a covert nuclear reactor.

The only piece of real evidence presented by the programme for the existence of a reactor at Earley was from an anonymous "medical physicist" who said that he had

visited the Shell site regularly and seen the reactor. However, he recalled that bedrooms were situated “adjacent to the actual reactor chamber”, which seems a rather odd layout for a nuclear facility. The programme-makers had failed to find anyone to verify this account, and one can only wonder whether this man was mistaken in his understanding of what he had seen at Earley.

Despite the less than persuasive evidence for contamination by a secret nuclear reactor, Green MEP Dr Caroline Lucas suggested that the European Commission should investigate. Let us hope that the results of any investigation by the Commission are given as much publicity as the somewhat diaphanous material that formed the basis of this radio programme. If a nuclear reactor did operate covertly at Earley and caused contamination of Ray Fox's home it is a very serious matter indeed; but it is not a trivial issue that 30 minutes can be devoted to on national radio to claims of radiation-induced illness based upon information that can only be described as exceptionally thin.

What is to be made of this programme? That the programme-makers were gullible in allowing a band of zealots with little relevant expertise to speak to the central issue of radioactive contamination making Ray Fox ill probably goes without saying. I suspect, however, that laziness played a large part in the programme. Here was a topic that would attract attention without undue effort being expended, and a number of `experts' were conveniently on hand to build the story. Provided no one created problems by asking them any searching questions it was not difficult to fill half an hour with suitably superficial material - an easy way to produce the last programme of the Document series. Disappointing journalism, though.

Richard Wakeford
British Nuclear Fuels Ltd.

This review is kindly reproduced with permission from the *Journal of Radiological Protection*. Full citation: Wakeford R.P., *J. Radiol. Prot*., **23**, 2003 (469-471)

Doug Peirson and Environmental Physics

Doug Peirson, a founder member of the Environmental Physics Group, died on 5 June last year. He made a leading contribution to developing the group's activities right from the start and was vice-chairman or chairman for many years, hardly missing any of the group's meetings for more than a decade. He made an important contribution to the work of the Institute in advising government, by commenting on consultative papers on environmental aspects of energy generation and the relative merits of different energy sources.

He had spent most of his career in what is now recognised as environmental physics. He graduated in 1940 and, in wartime, joined the Royal Aircraft Establishment, Farnborough, and transferred to the Atomic Energy Research Establishment, Harwell, after the war. His early work was in developing electronic devices for use in aircraft. At Harwell he worked on counting systems for nuclear radiation and became interested in their application to prospecting for uranium ores by aerial survey. This experience equipped him to observe the environmental effects of nuclear weapon tests in Australia. He returned to Harwell to join the Health Physics Division, later renamed the Environmental and Medical Sciences Division. As a group leader, his responsibilities spanned a range of instrument developments for monitoring the exposure of people to radiation and also the operation of an expanding global network for monitoring radioactive isotopes in rain and later in the air. He used data from the network to gain early information on atmospheric mixing, the deposition of particulate tracers and the exchange of air between the stratosphere and troposphere, helping to evaluate international pollution issues of following decades, such as acid rain and ozone depletion. During the remainder of his career he continued to contribute to programmes on the consequences of the emissions of a variety of pollutants to the environment as well as the measurement and health risks of radiation exposure. He retired from full time employment in 1986. As he had been a member of the Institute of Physics since 1942 and a fellow since 1951, it is not surprising that he chose to continue his scientific interest by helping establish the environmental Physics Group.

Always a keen sportsman, he captained teams at school and university and later played football for Oxford City. He also enjoyed cricket, tennis and squash. In retirement he supported local groups and contributed to the work of the Citizens Advice Bureau in his home town of Abingdon.

John Garland

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