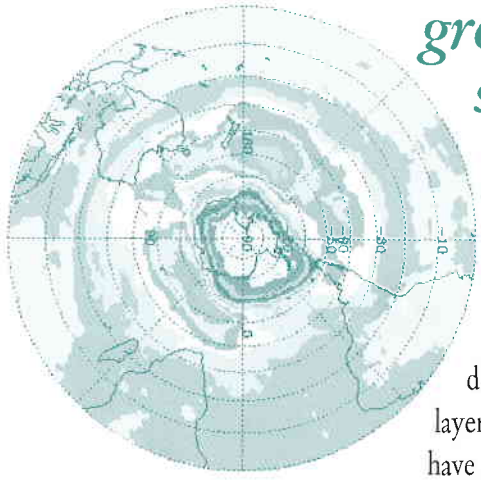
atmosphere
Newsletter of the CSIRO Division of Atmospheric Research
Issue 1 February, 1996
CSIRO AUSTRALIA

Air archive reveals growth of CFC substitutes



The latest measurements of HCFCs offer further evidence that the Montreal Protocol, the international agreement designed to protect the ozone layer, is working. HCFCs, which have a short atmosphere lifetime, are interim replacement chemicals for ozone-depleting CFCs.

Since 1978, the Division has set aside samples of pristine air collected at the Cape Grim Baseline Air Pollution Station in Tasmania. Dr Paul Fraser reports that analysis of these samples shows that concentrations of HCFC-142b increased from 0.2 ppt to 3 ppt during the past 15 years. Most of the HCFC increase has occurred since 1989, reflecting phase-out of CFCs. The plastics industry uses HCFC-142b as a replacement for CFC-12 in foam blowing.

Under the Montreal Protocol, HCFC emissions are to be successively reduced until virtual phaseout by the year 2020.

"Chlorine concentrations in the troposphere peaked more than two years ago and are about to peak in the stratosphere," said Dr Fraser. "During the next 20 or 30 years we should see stratospheric ozone damage declining."

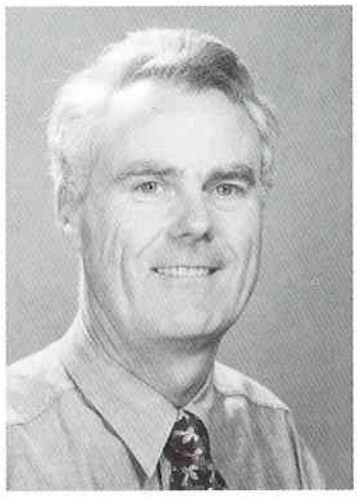
The Cape Grim air archive is a unique resource, allowing high precision measurements to be made of recent changes in atmospheric composition. Without the archive, there would be no record of HCFC concentrations before 1992.

The Division's HCFC measurement program has been conducted in collaboration with the University of East Anglia in the United Kingdom.

Paul Fraser, pictured here with Nada Derek, has won the 1995 Australian Museum POL Eureka Prize for environmental science. He has been recognised for his contributions to the science of ozone depletion, in particular his contributions linking science with government policy, industry responses and community information.

from the chief

This is the first issue of Atmosphere, our new Divisional newsletter. It replaces the DAR Bulletin which many of you will have been receiving for up to 10 years. The name change coincides with a new design that complements the Division's other key publications. We trust that you will find Atmosphere informative, interesting and appealing.



In the last issue of the DAR Bulletin I wrote briefly about the resurgence of field work in the Division. This first issue of Atmosphere illustrates the breadth of our work. The cover story describes some new measurements of hydrochlorofluorocarbons (HCFCs) in the atmosphere. These are new chemicals introduced as replacements for the chlorofluorocarbons, which are responsible for the ozone hole. A marvellous piece of foresight nearly 20 years ago when our scientists started to archive air samples means that we are able to go back to this stored air and measure new chemicals or repeat measurements using vastly improved techniques.

Last winter saw us involved in a very innovative project with VicRoads to measure road surface temperatures along one of Victoria's major highways using an airborne radiometer. The project is helping to define the potential for the formation of black ice, a serious hazard in winter, and will lead to safer driving conditions.

In collaboration with our colleagues in the Division of Coal and Energy Technology we have been measuring the emission rates of toxic hydrocarbons from cars for the Commonwealth Environmental Protection Agency.

Our involvement in major field projects continues through the OASIS project in southern New South Wales and through the measurement of acid deposition both in Australia and in South-East Asia.

We have just released a report detailing 43 research projects in which our climate change scenarios have been applied to a wide range of Australian activities and industries.

These are just a few of the research activities you will find described in Atmosphere. At an organisational level, many of you will have heard that CSIRO has a new CEO, Dr Malcolm McIntosh, who will take up his position shortly and that some fairly major structural and operational changes are in train. I hope you will agree with me when I say that this Division, with its broad and exciting research portfolio and its service to the nation through the provision of advice and through problem solving, is well placed to continue its important contributions no matter what form the new CSIRO eventually takes.

Once again, I hope that you will enjoy reading about our work and sharing in its excitement. Please contact us if you have any comments or would like more information.

Dr Brian Sawford
Acting Chief

Atmosphere

Atmosphere replaces the *DAR Bulletin* as the six-monthly newsletter from the CSIRO Division of Atmospheric Research.

ISSN 1325-0299

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Flying kites in an open air laboratory

More than 40 scientists gathered in Wagga Wagga late last year for an ambitious experiment to measure greenhouse gas emissions from typical Australia landscapes. Greenhouse gases, such as carbon dioxide and methane, are likely to contribute to global warming.

The scientists used a plane, a 4-km high kite, satellites, and instruments on the ground to monitor gas release from farm land. They also studied the way in which water vapour and energy are exchanged between the land and the air.

The experiment, known as OASIS, began with a month-long preliminary program in 1994.

"OASIS is the most comprehensive program of its type ever carried out in Australia," said Coordinator Mike Raupach, from the CSIRO Centre for Environmental Mechanics.

"OASIS is the most comprehensive program of its type ever carried out in Australia"

"The challenge is to obtain agreement between measurements made at small scales, such as a one-square metre chamber, and larger scales, such as a region 100 km across," Dr Raupach said.

More than $5 million worth of sophisticated equipment was set up at three sites in the Wagga Wagga region, at Urana, at Charles Sturt University campus and at a site near Lockhart. The sites span a distance of 100 kilometres.

This intensive measurement stage of the experiment charted the interaction between land and air from spring through to early summer.

"OASIS is yet another example of the practical application of long-term fundamental scientific studies," said Dr Raupach. "We are applying our knowledge to a very real environmental problem confronting Australians."

Results from OASIS will also help improve computer climate models that are assessing the likely impact of global warming.

OASIS involved researchers from the CSIRO Climate Change Research Program; Flinders University; the Australian National University; the University of Wollongong; and two New Zealand agencies: the Horticultural Research Institute and the National Institute of Water and Atmospheric Research.

Mick Meyer monitors gas release and uptake in a wheatfield during OASIS.

news

Climate change studies to aid economy

CSIRO is making a major contribution to our economic future by providing advice to help plan for the impact of global warming, according to Dr Roy Green, CSIRO's Chief Executive. Dr Green recently launched a report detailing 43 research projects in which Divisional climate change scenarios are being applied to a wide range of Australian activities and industries.

Working on the projects are 60 scientists from 9 CSIRO Divisions, 10 Australian universities, 5 overseas universities, 10 Commonwealth or State government organisations, 3 non-government organisations, and 13 overseas government organisations.

Topics examined include water resources, irrigation, ecosystems, agriculture, horticulture and human health.

"After years of research it is extremely gratifying to see once again CSIRO's work being used in the national interest," said Dr Green.

"There is so much exciting research being done which will enable us to better manage Australia's environment and infrastructure," said Dr Green.

CSIRO's climate change scenarios identify the range of possible changes to Australia's future climate. The scenarios examine elements of climate including temperature, rainfall and evaporation.

Copies of the report are available from the Division.

AIRWATCH

Margot Finn

AIRWATCH is an educational package on air pollution for schools and community groups. The Department of Environmental Protection in Western Australia and the Division have developed the package.

CSIRO's role has been to prepare, trial, and document suitable experimental activities. We have supplied a number of kits to undergo trials this year in pilot schools in Western Australia, Victoria, and Queensland.

The kits cover three related measurement topics: pollutants in the atmosphere; meteorology controlling pollutant concentrations; and where pollutants come from. We have chosen activities that are fun to do, give insight into air pollution processes, and generate good quality data that could be useful for researchers.

Contact Margot at the Division for more information.

Consultancy projects

Recent and current projects include:

Adelaide airshed study
EPA, South Australia

Aerosol and rainwater chemistry
Tenaga National Berhad, Malaysia

Aerosol and rainwater chemistry
WMO, Indonesia

Auckland regional air quality study
NIWA, Auckland Regional Authority

Climate change assessment
EPA, New South Wales

Climate change assessment for northern Australia
QDPI/ DLPE NT / DEPWA

Climate change impact on runoff and water availability
RIRDC

Computerised environmental impact assessment system
ESSA, Canada for Asian Development Bank

Corrosion study
Klang Valley, Malaysia, BHP

Dry deposition modelling study
Tenaga National Berhad, Malaysia

Greenhouse gas emissions from bitumen
AusRoads

Greenhouse gas inventory for industrial processes and waste
Department of the Environment Sport and Territories (DEST)

Impacts of climate change on grain production
DEST

Kurri-Kurri Highway smog study
Road Traffic Authority, New South Wales

Methodology workbook for greenhouse gases from waste
DEST

Multi-seasonal predictions
Land and Water Resources Research Corporation

Pacific Atmospheric Chemistry Experiment
MRI, Japan

Performance indicators for the National Greenhouse Response Strategy
DEST

Perth haze study
DEP, Western Australia

Perth photochemical smog study
DEP and SEC , Western Australia

Pinjar power station study
SEC , Western Australia

Precipitation enhancement workshop
Department of Foreign Affairs

Risk assessment of national environmental priorities
EPA

Sea-breeze fumigation study, Kwinana
DEP, Western Australia

Smog impact from a co-generation project
BHP, Appin Power Partnership

Sydney, Newcastle and Wollongong Metropolitan Air Quality Study (MAQS)
EPA, New south Wales

Wet and dry deposition study, Hunter Valley
Pacific Power

Wet deposition study, Western Coalfields
Pacific Power

Low flying Lear jet to make driving safer

Divisional scientists have taken to the skies in a Lear jet to advise VicRoads on how to minimise the risks of black ice on new bypasses of the Calder Highway. Black ice on roads is invisible and can make driving very hazardous.

The scientists have built up thermal maps of the 50-kilometre highway route between Macedon and Kyneton, north-east of Melbourne. The scanner on board their Lear jet showed temperatures on the ground to within 0.1°C.

"We advised VicRoads where the terrain is below freezing point," said Dr Fred Prata.

"It is these sections where black ice is likely to be the greatest problem. VicRoads can then design road surfaces that are resistant to black ice or undertake other management strategies," said Dr Prata.

Black ice forms from rain that has frozen, from surface water released by the road surface and from drips falling from overhanging trees. It makes roads very slippery, making cars difficult to steer.

To get precise data on temperatures and to check the accuracy of the airborne scanner, the Divisional team made additional measurements from a four-wheel drive vehicle. The vehicle has the advantage of being able to make measurements inaccessible to the jet, such as beneath tree canopies.

"We anticipate that the project will help us make scientific advances in the understanding of the type of terrain in which sub-zero temperatures occur," said Dr Prata.

Climate change network

Kevin Hennessy

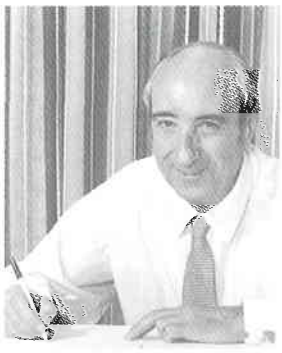
To improve communication between those interested in potential climate change impacts, we have created the Australia and New Zealand Climate Change Impacts Network (CCIN). This electronic mail network has over 100 subscribers from CSIRO, and from Australian and New Zealand universities, government departments, and non-government organisations. There are also overseas universities represented.

The aim of the network is to foster improved scientific and socio-economic scenario development, better dissemination of this information, improved assessment of potential impacts, and increased understanding of the use of scenario-derived information. Exchange of information via the network has included press releases, new publications, workshop and conference information, and a wide range of other relevant research information.

For any queries regarding subscribing to CCIN, please e-mail *ccin_man@dar.csiro.au*

Inaugural Priestley Lecture

To commemorate the 80th birthday of Dr Bill Priestley, our founding Chief, the Division has established the annual Priestley Lecture. The inaugural Priestley Lecturer for 1995 was Professor Akiva Yaglom, an eminent Russian-born scientist, based at Massachusetts Institute of Technology. Professor Yaglom is highly respected for his achievements in boundary-layer meteorology. His theme was turbulence, and he presented a fascinating review of international developments in the field to which both he and Dr Priestley contributed so much.



The event was a resounding success, with our theatre packed with staff and visitors.

The Priestley lecture will be an important annual event in the life of the Division, and in Australian atmospheric science.

Frances Philip and Professor Akiva Yaglom. Mrs Philip generously donated to the Division her portrait of Dr Bill Priestley.

Longer-term visiting scientists	Host scientist
Dr Clara Finkele CSIRO Centre for Environmental Mechanics	**John McGregor**
Mr Denis Gauthier McGill University, Canada	**John Bennett**
Dr David Lowe NIWA, New Zealand	**David Etheridge**
Mr Sharan Majumdar Jesus College, Cambridge, United Kingdom	**Peter Baines**
Dr Mezak Indonesia	**Barrie Hunt**
Dr Elisabeth Michel Centre des Faibles Radioactivities, CEA CNRS, France	**David Etheridge**
Mr Paul Monks University of East Anglia, United Kingdom	**Greg Ayers**
Dr Duong Ngoc Hai Institute of Mechanics, Vietnam	**Peter Manins**
Mr John Tabraham Cambridge University, United Kingdom	**Mark Hibberd**
Dr Shoichi Taguchi National Institute of Resources and Environment, Japan	**Ian Enting**
Prof Ill-Hee Yoon Kyungpook National University, South Korea	**Peter Manins**

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http://www.dar.csiro.au/

in brief

Searching for signs of climate change

Rainfall in tropical Australia is becoming heavier, according to a study of measurements collected since 1910.

Daily rainfall data from 53 stations, supplied by the Bureau of Meteorology, have been analysed by Ramasamy Suppiah and Kevin Hennessy. They have discovered statistically significant increasing trends in heavy rainfall events at 46 of the stations during the past 85 years.

At the 11 wettest stations, the annual number of days of heavy rainfall has risen by up to 20 per cent.

The trend is still present once the influence of the El Niño cycle is removed. The researchers suggest that whilst climate change is a possible cause of the increased rainfall intensity, changes to cloud cover, biomass burning, land-use changes and natural variability cannot be dismissed.

Taking the air at 8000 metres

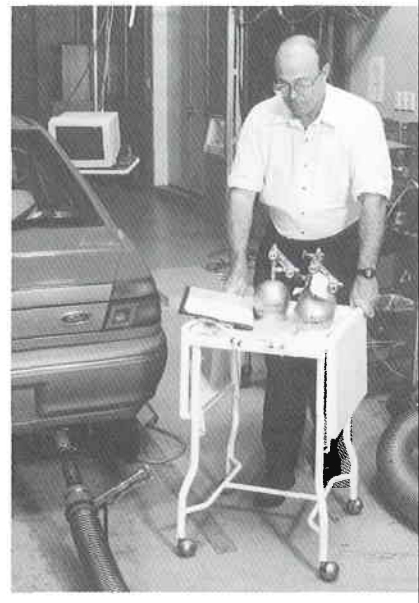
Since the early 1970s the Division has regularly sampled and analysed air over southern Australia to assess variations in carbon dioxide concentrations. In the past this was a time consuming, expensive exercise, involving a staff member travelling on a plane, opening and closing flasks according to a schedule.

Now, thanks to the skill of technician Marco Lucarelli and his NOAA counterparts, the whole process is computer controlled. A global positioning sensor on-board the plane determines height and location by comparing signals from polar orbiting satellites. The sensor's signal is fed to the computer, which controls air collection according to a programmed plan.

Air flask analysis takes place in the Division's sophisticated Global Atmospheric Sampling Laboratory.

Drive to identify emissions

The Division is using its new gas chromatograph – mass spectrometer to monitor emission rates of specific hydrocarbons from cars in a project for the Commonwealth Environment Protection Agency.



The focus of this work is on toxic hydrocarbons. Past emission standards have been based on the total mass of hydrocarbons released by vehicles. However, there is a growing awareness that individual hydrocarbons can have very different toxicities and contributions to smog formation.

Ian Weeks, Rose Ye and Ian Galbally are working on the project with scientists from CSIRO's Division of Coal and Energy Technology. An important outcome will be comparisons of emissions from modern cars with those from cars built before catalytic convertors were introduced in 1986.

Cloud seeding workshop

A Divisional team, led by Brian Ryan, has conducted a cloud seeding workshop in Terrigal, New South Wales for delegates from six Middle Eastern countries. The scientific workshop included presentations on the history of seeding in Australia, descriptions of overseas projects, and recommendations for planning and assessing experiments.

Overseas countries represented were Egypt, Israel, Jordan, Morocco, Oman, and Palestine.

The workshop was funded by the Department of Foreign Affairs as part of Australia's contribution to the Middle East peace process.

Greg Ayers has just been awarded the Australian Meteorological and Oceanographic Society's highest award, the 1995 Priestley Medal. The award is in recognition of Greg's contributions to the science of precipitation chemistry and acid deposition, with significant applications to Australia's atmospheric environment.

Acidification in Australia and Asia

During the past 15 years, CSIRO's Dr Greg Ayers has been investigating the impact on rainwater of our sprawling cities and growing industrialisation. Recognised as Australia's pre-eminent expert on atmospheric acidification, Greg's research and monitoring work are helping government and industry safeguard our environment.

"If we don't understand the problem or know its extent, there's little chance we can prevent damage," he says.

During the early 1980s, Greg and fellow chemist Rob Gillett monitored rainwater at 12 sites in Sydney. In metropolitan areas they found that rainwater was more acidic than in less polluted parts of the city.

'Industry and motor vehicles were clearly making rainwater acidic,' Greg says.

Shortly afterwards, Greg and Rob headed south to make similar measurements in Melbourne. They found little evidence of acidity. 'It didn't surprise us greatly. Melbourne is well ventilated. The strong prevailing westerly winds on rainy days clear the air. In Sydney, the pollution often accumulates for longer.'

'Industry and motor vehicles were clearly making rainwater acidic'

Deposition, not rain

Greg points out that rainwater is just one way in which acidic pollutants reach the ground. Atmospheric scientists believe that just as much acid-causing material is directly deposited from the air. They prefer the term 'acid deposition' to 'acid rain'.

One-quarter of the sulfur in the atmosphere is natural, the rest is caused by human activity. Nature releases sulfur through decomposing marine algae and erupting volcanoes. Industry releases sulfur dioxide when fossil fuels are burnt and sulfide ores smelted.

Sulfur dioxide readily forms sulfuric acid in the air or when it reaches the ground. In the year 1900, global sulfur dioxide emissions were approximately 15 million tonnes. Annual emissions are now close to six times that amount.

Nitrogen oxides are generated by lightning and microbes, and by burning of fossil fuel and biomass. In the atmosphere the oxides are often transformed into nitric acid.

Throughout the late 1980s and the early '90s, Greg Ayers and his team completed studies in three of Australia's largest power generating regions: Victoria's Latrobe Valley, and the Hunter Valley and Western Coalfields of New South Wales.

Greg's team needed some way of reliably monitoring and collecting daily rainfall at each site. After some thought, they came up with an automatic sampler containing eight polyethylene

bottles mounted on a carousel. Each morning the carousel automatically rotated to position the next bottle beneath the funnel. The sampler logged rainfall to within 0.2 millimetres as well as measuring the rate of rainfall in each shower.
So successful were the samplers that they are now being manufactured and sold internationally under licence by Ecotech Ltd, a Melbourne-based environmental equipment company.

Soils ain't soils

Environmental response to pollutants depends on many factors. Some regions cope with acidification better than others, having larger 'critical loads'. Critical load refers to the greatest assault that an ecological system can withstand before showing measurable degradation.
Scientists determine critical load by examining rock and soil type, land use and rainfall.
If soil is fertile with a pH greater than 4.5, and rainfall is relatively low, the critical load will be high. The terrain can withstand moderately large additions of acidity without undue suffering.
Conversely, in low pH soils, acidification mobilises toxic aluminium ions. If coniferous forests predominate, or if land is devoted to rough grazing, the result is a low critical load. Even minor acid deposition is undesirable.
In the Hunter Valley, Greg concludes, the greatest determinant of critical load is land use. The combined effect of farming and industry may be a problem in some areas.

Acidification in Asia

In 1991, the Australian International Development Assistance Bureau (now AusAID) financed the first ever survey of acid deposition in Indonesia. Rob Gillett and Paul Selleck, a technical officer in Greg's team, measured rainwater chemistry for a year at four locations on the main island, Java.
'The levels of acid deposition we found in Indonesia are comparable with those occurring in the worst affected parts of Europe and North America,' Greg says.
Since the Indonesian work, the CSIRO team has travelled extensively, initiating studies and providing advice to local authorities. They've worked in Malaysia, New Guinea, Fiji and Brazil. The Melbourne laboratories have seen a steady stream of overseas scientists completing training programs.

Future plans ...

'We're aiming to establish a network of tropical sites for rainwater and atmospheric measurements,' Greg says. 'We will include five "hot spots" in Indonesia and Malaysia. The baseline station at Charles Point near Darwin will give us relatively unpolluted rainwater and air samples for comparison.'
Greg is also keen to build up the complete picture of Australian sources and sinks of atmospheric sulfur, showing how the chemical reaches the atmosphere and where it is consumed.

Unpolluted rainwater is not neutral. It is slightly acidic, with a pH between five and six. (On the pH scale, seven is neutral. Anything less is considered acidic.) The atmosphere is full of acidic particles released from natural processes. These acids dissolve in the tiny cloud droplets that ultimately fall to earth as rain.

publications

The following items have been published since the last Divisional newsletter. Divisional authors are shown in bold typeface. This list does not include the following types of publications: abstracts of conference papers, book reviews, Divisional information publications and non-technical internal, Divisional reports.

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Ill-Hee Yoon: Visiting scientist

Dr Ill-Hee Yoon, an Assistant Professor from South Korea's Kyungpook National University, spent 1995 at the Division as a visiting scientist, working with Peter Manins.

Within days of arriving in Australia with his wife Young-Hee and two daughters, Yesie and Susie, Ill-Hee flew to Perth with the air pollution group to measure plume dispersion in an industrial region near the coast. Ill-Hee's main interest during the experiment was lidar tracking of pollutants, in which laser beams are reflected by the plume back into a detector, providing information on concentration and makeup.

"There are no lidars in Korea, so this is one of the reasons I chose to come to Australia. A lidar is a very effective tool for measuring air pollution and cloud physics. Besides, I like your country!" explains Ill-Hee.

"We face severe air pollution problems in Korean cities. My research work focuses on these problems."

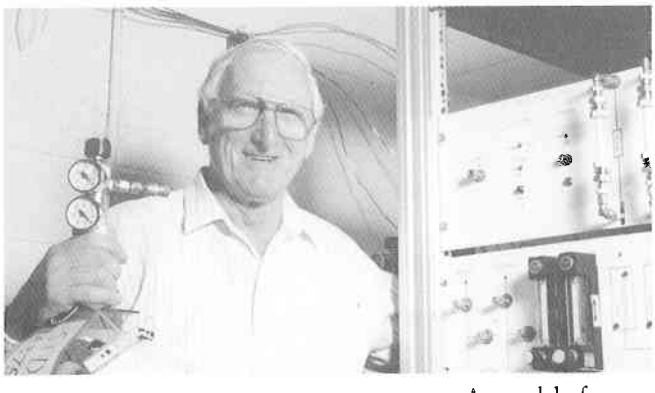
Ill-Hee has spent much of his time at the Division analysing lidar data from the Perth experiment.

"I have also read many journal articles and made lots of friends," he adds.

Ill-Hee plans to incorporate into his research and teaching much that he has learnt during his stay. He is also looking forward to showing family and friends photos from his family's recent holiday to Uluru (Ayers Rock), a trip, he says, that he will always treasure.

David Beardsmore retires after 45 years with the Division

Two-thirds of CSIRO's current staff members were yet to be born on the first working day in 1950 when David Beardsmore nervously entered the army hut that housed the CSIRO Section of Meteorological Physics in Highett, a southern suburb of Melbourne.



It was the then 16-year-old's first day at his new job, and just weeks since he had finished Form 6 at Frankston High.

Forty-five years later, David has retired from CSIRO, having been an integral part of scientific research into the behaviour and make-up of the atmosphere.

David began his career with the Micrometeorology Group, making numerous visits to the paddocks of Edithvale and Aspendale for experimental studies of lower atmospheric phenomena. The latter suburb became permanent home to the Division in 1953.

Hobbies such as lapidary and more prosaic activities such as home maintenance will occupy David's retirement days. He and his wife Loris are also keen to explore some of the more remote parts of Australia.

This newsletter presents general information about the activities of the CSIRO Division of Atmospheric Research.
If you would like advice or information on particular issues, or would like to receive this publication, please contact the Division.