

# Getting physical

A paradigm shift in the location, structure and scientific emphasis of our Antarctic atmospheric and space physics research has occurred since the Australian Antarctic Division's (AAD) relocation from Melbourne to Kingston.

Prior to the move, research was conducted through two groups: Upper Atmosphere Physics, which later became Auroral and Space Physics, and Cosmic Ray Physics (Cosray). After the move these two groups merged to form Atmospheric and Space Physics – later renamed Space and Atmospheric Sciences – which forms part of today's Ice, Ocean, Atmosphere and Climate programme. The title changes reflect how the research has adapted to address Australian Government goals and evolving policy initiatives.

In the 1970s, staff of Upper Atmosphere Physics (based in Melbourne) and Cosray (based at the University of Tasmania) conducted a winter-over programme at all four stations. This enabled year-round scientific activity in Antarctica. The main objectives were to investigate the upper atmosphere, in particular the Aurora Australis or 'southern lights', and associated variations in the geomagnetic field, ionosphere and the radiation environment in near-Earth space. In many respects it was an era of discovery using basic geophysics instrumentation such as all sky cameras, photometers, magnetometers, ionosondes, cosmic ray telescopes and neutron monitors. Physicists and electronic engineers operated and maintained these instruments, and expedition physicists also conducted research projects. Significant contributions to the scientific literature on the upper atmosphere and cosmic rays were made.

Following the relocation to Kingston, joint research with universities and other government agencies led to the deployment of more sophisticated instrumentation, to investigate the temperature of the mesopause region (near 85 km altitude) and the thermosphere (above 100 km altitude). Expeditioners wintered at all four stations, with enhanced activities at one or two stations. During this time the important projects included atmospheric dynamics studies at Mawson, studies of the ionosphere at Casey, and measurements at Davis (beginning in the early 1990s) to establish a long-term temperature record for the mesopause region.

The cosmic ray programme continued at the University of Tasmania, making observations in Tasmania and at Mawson. By the late 1980s, the cosmic ray measurements at Mawson had been automated.

After the 1993 Antarctic Science Advisory Committee review of the Australian Antarctic programme, physics research was realigned and focussed on the middle atmosphere region (15–100 km) – the stratosphere – where the ozone layer occurs, and the mesosphere, where 'noctilucent' (night shining) clouds are a sensitive indicator of climate.

As a result of the new direction scientific instruments were relocated to a new physics laboratory at Davis, and basic



KAREN FRENCH AND JOHN FRENCH

geophysical measurements were automated. The change came at the time of heightening national and international awareness of the Antarctic ozone hole (discovered in 1985) and global climate change. Atmospheric modelling in the early 1990s had shown that a significant cooling of the middle and upper atmosphere, particularly in the polar regions, was likely to accompany human-induced greenhouse warming at the surface. The discovery provided an opportunity for Australian researchers to contribute to the detection and understanding of this effect.

In 1996 the AAD, in partnership with the University of Adelaide, developed a sophisticated LIDAR (Light Detection and Ranging) system (commissioned at Davis in 2001) which probes the atmosphere with a laser beam to measure aerosol density, temperature and wind speed. This work is examining long-term trends in the Antarctic atmosphere and includes investigation of the ozone hole through collaborative measurements with the Bureau of Meteorology. Complementing the LIDAR measurements are atmospheric radar systems which investigate winds in the lower and middle atmosphere.

Davis now houses some 19 instruments that provide a unique perspective on the atmosphere by probing conditions on a variety of scales with complementary techniques. The geographic location of Davis and the type of measurements being made there make it an important site for comparison with other ground-based and satellite research programmes.

The measurements provided by the LIDAR, radars, and other instruments at Davis, have enabled novel research to be undertaken on polar mesosphere summer echoes (*Australian Antarctic Magazine* 7: 33), clouds in the mesosphere and stratosphere, the Antarctic stratospheric vortex, ozone

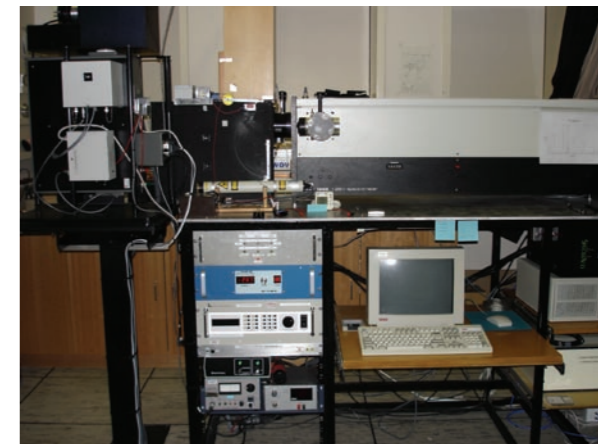
depletion, and atmospheric energy flow and circulation. In addition, the influence of the sun on the global electric circuit and weather is now being investigated through measurements at Vostok, in collaboration with Russian scientists. Apart from their intrinsic scientific value, all of these studies are relevant to international efforts to understand and predict trends in Earth's climate.

In the last few years the cosmic ray links with the University of Tasmania have ended. However, cosmic ray research continues at Kingston and Mawson and now includes investigations into the radiation dose to crew and passengers flying in jets at high latitudes. This has increasing relevance to our Antarctic operations as we develop inter-continental air transport.

Australia's Antarctic research has come a long way in the past 25 years. The atmospheric research in the Ice, Ocean, Atmosphere and Climate programme includes important collaborations with Australian universities (Adelaide, La Trobe, Newcastle and Tasmania) and government agencies (Ionospheric Prediction Service Radio and Space Services, Bureau of Meteorology), as well as several international research groups and programmes. It is now positioned to make an important contribution to the International Polar Year in 2007–09.

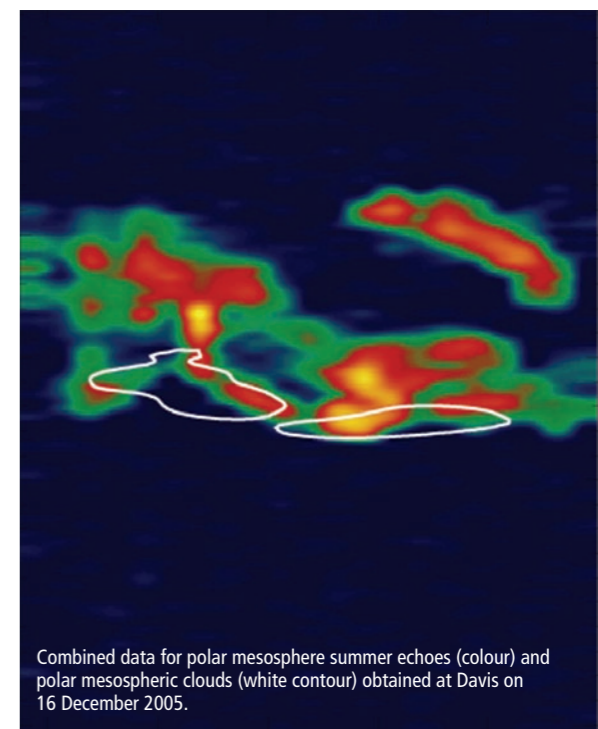
—RAY MORRIS, ANDREW KLEKOCIUK and MARC DULDIG  
*Ice, Ocean, Atmosphere and Climate programme, AAD*

Left: Noctilucent (night shining) clouds.



JOHN FRENCH

Hydroxyl spectrometer in the Davis Space and Atmospheric Sciences laboratory, used to investigate the temperature of the mesopause region (near 85 km altitude).



J.WHELAN, A.KLEKOCIUK, R.MORRIS

Davis Space and Atmospheric Sciences laboratory and LIDAR Observatory



D. MARCLIFFE