

*Final preparations before releasing sounding balloons. Free-flying balloons are released to provide profiles of wind, pressure, air temperature and humidity during case study days.*



The programme has also been well supported by several support staff from the Geography Department, while assistance has been provided by Physics and Astronomy staff at the Mount John Observatory. Our research strategy is to build on current knowledge of the individual local wind components, such as the lake/land breeze and mountain/valley wind circulations. The role of prevailing weather systems are also evaluated using data collected over the South Island by the Meteorological Service, as well as high resolution meteorological satellite data obtained with our own receiving equipment.

An initial field investigation was undertaken last summer between 16 November and 12 December 1997, with a network of seven automatic weather stations deployed in the lake basin at the beginning of this period. These surface observations were supplemented by vertical soundings of atmospheric pressure, air temperature and humidity obtained from the instrumented aircraft, which also obtained transects of surface temperature using a downward-looking thermal radiometer. Regular pilot balloon

ascents provided information on wind speed and direction throughout the atmospheric boundary layer at two sites on case study days. Measurements of surface energy exchange were also made using micrometeorological equipment. The field period was not ideal because of strong, persistent west-northwesterly conditions throughout. However, approximately seven case study events were documented, in addition to a continuous record obtained from the automatic weather station network. This network will continue to collect data until the end of our second major field programme, which is planned for January/February 1999. Researchers from the University of British Columbia and Lawrence Livermore National Laboratory (California) hope to join us during this second period at Lake Tekapo. Collaboration is also planned with Landcare Research – Manaaki Whenua ecologists who are running an experiment to relate surface  $\text{CO}_2$  exchange in the study area to the extent of degradation of high country pastures.

Three-dimensional numerical modelling is currently underway in parallel with the field data collection programme, with the aim of developing tools which can be applied to understanding local airflow patterns observed in this and other regions of complex terrain. The downstream implications include the ability to more accurately assess the dispersion of wind-blown dust, air pollution and spray drift from aircraft, as well as the siting of tourist facilities in alpine regions.

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## Air movement in the middle atmosphere

**T**he middle atmosphere is the layer of air from about 10–100 km in height that contains the stratosphere and mesosphere. For most of us, the stratosphere is a remote region important only because we know it contains most of the ozone that protects us from ultraviolet (UV) radiation. The UV radiation heats up the stratosphere and causes large global-scale movement of air, which moves the ozone around, causing some regions to have better protection from UV than others. Therefore, the air movement in the stratosphere is a critical part of the Earth's climate system. The stratospheric air flow is

controlled not only by UV heating but also by disturbances rising up from the troposphere.

Research being carried out in the Atmospheric Physics group in the Department of Physics and Astronomy aims to help us understand the movement of air in the stratosphere and how it might influence climate. The work is being carried out in a number of projects.

One of the research projects is a Marsden-funded programme called "The Impact of Gravity Waves on Climate." Gravity waves are oscillations in the atmosphere which arise as weather fronts are formed,

as air flows over mountains, and as large-scale clouds form. These waves do very little to the atmosphere in the region where they are formed but, like Tsunami, can have a large effect at long distances. (The analogy is imperfect – in the atmosphere it is the propagation in height which is important).

In "The Impact of Gravity Waves on Climate" project, Dr Bryan Lawrence and two research students are examining how these waves, which are insignificant in the troposphere, can control large scale movement of air in the stratosphere. Their study uses large computers to run complex mathematical models of the atmosphere. Initial results show how the temperature of the air in the dark winter stratosphere may be affected by the way gravity waves interact with each other and with the rest of the atmosphere.

Another of the programmes being carried out by the Atmospheric Physics Group involves the measurement of wind motions in the mesosphere (the layer above the stratosphere) at two sites: one in the Antarctic, and one near Christchurch. These wind measurements are carried out by bouncing radar waves off free electrons in the mesosphere. The data collected by these radars is the focus of international collaborative studies aimed at understanding air movements in the upper atmosphere.

As well as measuring air movement, the Physics Department radars can measure the number of electrons involved in returning the radar signals.



These measurements are being used to study the "Winter Anomaly", which is a strange change in the properties of radio propagation that occurs in the high latitudes during winter.

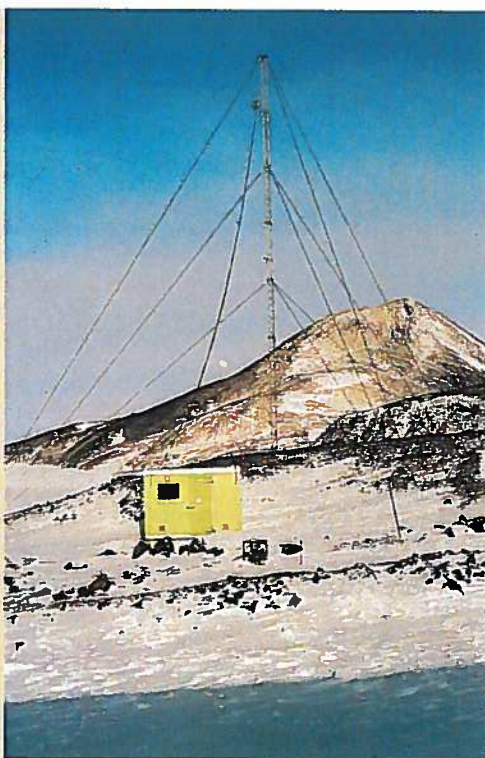
Work in the Atmospheric Physics Group has also concentrated on the predictability of air movement in the lower stratosphere. This work aims to forecast ozone movement, particularly for the period when the ozone hole breaks up in the Southern Hemisphere spring. This work is mainly being done by students, and it will eventually lead to improvements in how well we can estimate the amount of UV reaching the Earth's surface. Such forecasts are already available in summer (on TV and radio), and this work will make such predictions more reliable.

Two new projects in climate physics began in 1998. A former student, Adam Dunford, has begun working part-time on the development of a new radar to measure the meteorology of the troposphere. This work is being assisted by two of our Research Associates, Dr Grahame Fraser and Dr Bob Bennett. With the new radar the Atmospheric Physics Group will be able to measure the climatic impact of gravity waves that arise from air flow over the Southern Alps.

The other new project started in 1998 involves a new staff member, Dr Don Grainger, who has begun a programme to study the properties of stratospheric aerosols ('dust' particles whose diameters are less than one-thousandth of a millimetre). These aerosols are implicated both in global ozone depletion and in shielding the influence of global climate change. They can also directly affect the Earth's climate when large amounts of sulphuric acid are injected into the stratosphere from a volcanic eruption. The aerosols investigations include use of NASA satellite data and a University of Canterbury designed balloon-borne particle counter.

*Above: Stormy polar conditions mean the aerial connections need to be checked regularly.*

*Right: The transmitter aerial and the hut containing the 2.9MHz radar, as viewed from the science laboratory at Scott Base.*



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