Atmospheric measurements at Reunion Island

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At an ideal location in the southern subtropics, an atmospheric station hosts a suite of specialized instruments, producing data for many applications.

It is now well-known that the climate is changing, but the effects of climate change vary at different atmospheric levels. For example, climate models predict up to a 7K cooling of the stratosphere, but a warming of the troposphere of about 2K.¹ Thus, it is of primary importance to detect and quantify such changes, and to identify and measure exchanges between atmospheric levels.

Achieving this goal requires long-term data records documenting the atmosphere's vertical temperature profile and chemical composition. Ideally, this data should reflect varying types of instruments and approaches (i.e., ground based observations, satellite data, and models). At an atmospheric station on Reunion Island, scientists are contributing to this data set (see Figure 1) using the systems at their disposal.

There have been five main instruments available at the island in recent years. First, the *système d'analyse par observation zénitale* (SAOZ)² is a UV-visible spectrometer providing total ozone (O₃) and NO₂ columns twice a day, at sunrise and sunset. This instrument has worked to this schedule since 1993. SAOZ data is being extensively used for the validation of satellite data. The multi-axis differential optical absorption spectroscopy instrument (MAXDOAS) is another UV-visible spectrometer designed to measure stratospheric and/or tropospheric columns of atmospheric trace gases NO₂, BrO, HCHO, O₃, SO₂, IO, and O₄. This was installed in July 2004 and operated continuously for a period of one year. In 2007, it is expected to resume operations.

Third is a high-spectral-resolution Fourier-transform infrared spectrometer (FTIR) that provides quasi-simultaneous total column and/or vertical profiles of about 20 atmospheric species, including O₃, CO, N₂O, OCS, HF, HCl, and HNO₃. So far, this instrument has been operated as needed, rather than on a routine basis, with longer-term operation expected to begin in 2007. Next, a light detection and ranging (lidar) system based on the active emission of laser pulses into the atmosphere is

Figure 1. Atmospheric parameters are measured at a variety of altitudes by an instrumental set developed at Reunion Island. Hatched rectangles and lines represent total column measurements and profiles, respectively. Radiometers are in blue, sondes in red, and lidar in green.

used on a daily basis. The return signals are processed to derive atmospheric profiles of aerosols,³ temperature,⁴ and ozone.⁵

Finally, the radiosounding program, started in 1992, uses balloon-mounted electrochemical concentration cells to provide temperature, pressure, and humidity profiles from the ground to the altitude at which the balloon bursts, typically between 30 and 35km. Regular measurements are taken weekly, and additionally as needed.

Continuous data, such as that collected by the instruments we have just described, can be used to improve our knowledge of atmospheric processes. For example, measurements provided by ozone soundings have allowed the characterization of the seasonal variability of tropospheric ozone.⁶ In addition, the photochemical influence of biomass burning of South Africa and Madagascar, the ozone diurnal cycle in the boundary layer, and the ozone destruction inside cirrus clouds have been characterized. Of particular interest are the exchange between the stratosphere and the troposphere, and the related roles of important

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meteorological phenomena like tropopause fold, Rossby wave breaking, tropical cut-off lows,⁷ and tropical convection. Recent studies have improved our knowledge of stratospheric dynamics in the southern subtropics, with an observation of large scale meridional transports of stratospheric ozone,⁸ the characterization of atmospheric tides and gravity waves, and the survey of the tropical tropopause characteristics. The location of Reunion Island also makes it an ideal venue for the observation of cyclones during austral summer.

The data produced at the Reunion Island station is included in the database of the Network for the Detection of Atmospheric Composition Change, a consortium of more than 70 research stations worldwide. Studies involving this data have been used to help define and support international agreements: these include the Montreal protocol on the production of CFCs and halogenated species and the Kyoto protocol on the emission of greenhouse gases.

In the near future, some additional instruments will be implemented at the atmospheric station on Reunion Island, including a Doppler lidar and a water-vapor radiometer. Finally, plans are underway to build an altitude station at Maïdo Mount (2200m above sea level). Planned for 2010, this new station will be a platform for other instruments on a temporary basis, and will be available for international use.

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Figure 2. A radiosounding device is launched.

Figure 3. A lidar beam rises above Reunion Island.

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