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Data Set Description:
PI: Valentin Duflot
Instrument: Tropospheric ozone DIAL
Site(s): Reunion island (21.1S, 55.4E)
Measurement Quantities: ozone profiles (6-19 km)

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Reference Articles:
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Vérèmes, H., et al.: Observational, Lagrangian, and Eulerian numerical modeling approaches, J. Geophys. Res., 121, 14414–14432, 2016.

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Instrument Description:
Ozone measurements are performed using the DIAL (Differential Absorption Lidar) technique which requires the simultaneous emission of two laser beams characterised by a different ozone absorption cross-section. The emission part of this system consists of a wavelength pair (289 and 316 nm) obtained by Raman shifting of the fourth harmonic of the Nd:Yag laser in a high pressure deuterium cell. The energy at 266 nm is 40 mJ pulse-1. The laser frequency is 30 Hz and the beam diameter 10 mm. The length and diameter in/out of the Raman cell are respectively 1500, 20 and 55 mm. The beam is expanded in a divergence optimizer system located after the Raman cell. The output diameter and divergence of the emitted beam are 30mm and 0.25 mrad. Regarding the reception system, we use a 4x500mm telescope mosaic. The signal collected is transmitted with 1.5mm diameter optical fibers. The spectral separation of 289 and 316 nm beams is obtained with a spectrometer formed by a Czerny–Turner holographic grating. Hamamatsu R9880-110 and R7400P-03 photomultiplier tubes are used for 289 and 316 nm channels, respectively.

Algorithm Description:
The algorithm has been developed in Matlab language by Guillaume Payen. In the routine mode, the lidar signals are time averaged over the whole measurement period (2 to 3 hours in general) in order to increase the signal-to-noise ratio. Each averaged signal is then corrected from the background light which is estimated using a linear regression or a mean in the altitude range where the lidar signal is negligible (>60 km).
The ozone number density is corrected from the Rayleigh extinction using composite pressure-temperature profiles computed from daily radiosoundings performed at Gillot Airport and the Arletty model (above Gillot profile).

Expected Precision/Accuracy of Instrument:
The accuracy of the ozone lidar measurement depends on the correction of the differential molecular and aerosol scattering, the differential absorption by other constituents and on the temperature dependence of the ozone absorption cross-sections (Godin et al., 1989). The precision of the measurement corresponds to the statistical error of the signal due to the random character of the detection process which follows basically the Poisson statistics. Among other parameters such as the power of the lasers and the telescope detection area, it depends on the duration of the measurements and the vertical resolution chosen to process the data. The total accuracy varies from about 4 % to 10 % in the 6-19 km altitude range, for a corresponding vertical resolution ranging from 0.3 to 1.2 km and a typical temporal resolution of 3 hours.

Instrument History:
A Rayleigh–Mie scattering lidar was first installed at the Université de la Réunion campus site in 1993 to monitor stratospheric and mesospheric aerosols in the southern tropics. From 1993 to 1998, the lidar system evolved both in terms of emission and reception (Nd:YAG laser replacement, mosaic telescopes addition, polarization channels installation, infrared channel reception set up) to improve aerosol detection and characterization and to allow stratospheric–mesospheric temperature measurement.
In 1998, an extension was installed on the existing system to perform O3 measurements in the free troposphere, including the upper troposphere. Note that the first "home-made" acquisition chain was

exchanged for a LICEL one in 2007, but this exchange did not cause significant differences in the profiles acquired.
In late 2012, the Maïdo Observatory new facility was complete and the fixed lidar systems were moved from the Université de la Réunion campus site and installed in the Observatory.
Since temperature measurements are now performed with the LI1200 system – also dedicated to water vapour measurement (Dionisi et al., 2015; Vérèmes et al., 2017) – the previous lidar was modified into a system dedicated to the measurement of tropospheric O3 (and aerosols).

In addition, ozone measurements are weekly performed by radiosondes at Reunion island since 1992.

Other lidar instrumentations are also operational on the same site: Rayleigh Temperature and aerosols since 1994, tropospheric ozone since 1998, Raman Temperature since 1999, tropospheric water vapor since 2012.