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Data Set Description:

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Instrument: Water Vapor lidar
Site(s): Reunion island (21.1S, 55.4E)
Measurement Quantities: water vapor profiles (2-15 km)

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Instrument Description:

Laser pulses are generated by two Quanta Ray Nd:Yag lasers with a repetition rate of 30 Hz, an energy of 375 mJ.pulse-1 and a duration of 9 ns. The two lasers are synchronized with a pulse generator with an uncertainty of less than 20 ns. The geometry for transmitter and receiver is coaxial for three reasons: i) to avoid parallax effects, ii) to extend the measurements down to few meters from the ground and iii) to facilitate the alignment. The overlap of the laser beam with the field of view of the telescope is partial from the ground (i.e. 2.2 km asl) to 4 km asl. The backscattered signal is collected by a Newtonian telescope with a primary mirror of 1200 mm diameter (which gives its name to the lidar: "Lidar1200").
No optical fiber is employed: an optical box unit is used directly after the telescope to separate the Raman and Rayleigh signals. The field of view (FOV) of the system is adjustable (from 3.0 to 0.5 mrad) thanks to a diaphragm field stop at the entrance of the separation unit. A 2 mm FOV (0.5 mrad) allows the background light to be reduced and limits photon counting saturation from low altitude scattering. The separation unit is composed of dichroic beam splitters and interference filters, which separate the backscattered light. Hamamatsu miniature PMT (photomultipliers tubes) and Licel transient recorders are used for the photon detection and data acquisition (in photon counting only). The raw data corresponds to the integration of the signal over 1 minute.

Algorithm Description:

We use the 387 nm (N_2) and 407 nm (H_2O) Raman shifted wavelengths to retrieve the water vapor mixing ratio.
The Lidar1200 being able to start measurement at ground level, the lidar profiles are calibrated with integrated water vapor columns obtained from collocated GNSS measurements of integrated water vapor columns.
With hindsight on the dataset, a manual identification of the periods' change of calibration coefficient can be made by checking the results of the lamp measurements and the logbook overview. The average nightly coefficient between two instrumental changes detected as described above is considered as the "calibration coefficient" of each measurement performed during this period. There is only one calibration

coefficient for all the data belonging to a same period, regardless of the integration time of the lidar measurement. This means that the measurement is re-calibrated only after an instrumental change.

Expected Precision/Accuracy of Instrument:

The different sources of the statistical uncertainty are associated with the counting of the number of photons collected by the detector for the water vapor and nitrogen channels (depending on the altitude). The main sources of systematic uncertainties are the determination of the calibration coefficient, the temperature-dependence of Raman backscattering, overlap function ratios and the differential transmission in the atmosphere at the wavelengths of the water vapor and nitrogen Raman channels. Each of these uncertainties has been calculated or estimated. The uncertainties on saturation correction, fluorescence and differential transmission due to aerosols are neglected. The uncertainty depends strongly on the integration time and the filtering of the signal. Thus, it is important to use a suitable digital filter regarding the vertical resolution and the order of magnitude of the total uncertainty.
The total uncertainty is <20% (<30%) up to 12km (15km).

Instrument History:

The first Raman water vapoor lidar system at La Reunion was deployed at the Reunion Island university at 80m above sea level. This initial Raman lidar system was based on a Nd:Yag laser source with a repetition rate of 30 Hz and the second harmonic was used. The pulse energy at 532.1 nm was 800mJ/pulse (9 ns pulse length). The radiation backscattered by the atmosphere was collected by optical fibres mounted on the focal plane of a 4-telescope mosaic (0.53m diameter each) of Newtonian type with a field-of-view of 1mrad and transferred to the optical ensemble. Regular water vapoor measurements have been realized with this configuration over the period 2002–2005. Before being transferred to the Maïdo Observatory in 2012, critical points have been handled (fluorescence, power and parallax effects) in order to optimize the new configuration of the system. When moved to the Maïdo Observatory, the emitted wavelength was changed to 355 nm, more efficient than 532 nm.

In addition, water vapor measurements are daily performed by radiosondes at Reunion Island since 1992.

Other lidar instrumentations are also operational at La Réunion : Rayleigh Temperature and aerosols since 1994, tropospheric ozone since 1998, stratospheric ozone since 2000, Raman Temperature since 1999, and wind since 2014.