File Revision Date:
October 2, 2019

Data Set Description:

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Instrument: Rayleigh LIDAR

Site(s): RÈunion Island (21.0S, 55.5E, 2158 m)

Measurement Quantities: Temperature (30 - 90 km)

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Instrument Description:

The same lidar is operated for NDACC temperature and water vapor measurements. Laser pulses are generated by two Quanta Ray Nd:Yag lasers with a repetition rate of 30 Hz, an energy of 375 mJ. per pulse- 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 (0.3 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.
In order to reduce saturation effects of the photomultiplier, each channel is equipped with an electronic gating.

Algorithm Description:

The method used to retrieve temperature profiles from molecular backscattered signal and the associated errors has been described in detail by Hauchecorne and Chanin (1980). A description of the instrumental errors sources and bias has been reported by Keckhut et al. (1993).
Since 1987, the two existing channels have been mixed together to provide a single signal for the entire height range. This is achieved in comparing the both channels in the common altitude range (30-50 km) and in calculating the ratio between the both channels and the high-flux non linearity of the high-gain

channel considering the low-gain channel as a reference. The signal-induced noise (SIN) is considerably reduced using electronic gating, but still can be identified from the very low mean background noise. It is estimated by fitting with a parabolic function the background signal between 10 km above the top of the temperature profile and 153 km. The residual atmospheric signal at high altitude is estimated using the MSIS model.
Computation of temperature profiles requires a pressure initialisation. Instead of assuming that the pressure at the top of the profile is equal to the value given by the standard atmosphere model, the scale height of the pressure (which is directly related to the temperature) is adjusting on the MSIS model. Part of the actual algorithm can be found in Keckhut et al. (1993) and in Singh et al. (1996).
Data are processed using the V6 version of the Temper code developed by LATMOS. Since the version V4 in 1998 the processing is improved in including in the version V4 an automatic data selection/rejection of data files with too high background signal or too low atmospheric signal (Keckhut et al., 2001).

Expected Precision/Accuracy of Instrument:
The accuracy in determining density and temperature is directly related to photon noise and is associated to temporal and vertical resolution. Statistical noise increases with the altitude and becomes suddenly very large as the signal amplitude reaches the noise level. Relative and absolute uncertainties have been identified and quantified using simulated data (Leblanc et al., 1998).
Error calculation can be found in Hauchecorne and Chanin (1980). For NDSC purposes a 2-km vertical resolution constant with altitude is obtained using a Hanning filter. The integration time is about 4 hours, depending on weather conditions. The amplitude of the correction of the non-linearity of the counting is determined with an accuracy of 1 K. The error due to the initialisation was estimated to be equal to 15 % at the initialisation level. The calculation of uncertainty shows that this error becomes negligible 15 km below as opposed to the noise statistic. The sum of these uncertainties is reported on the NDSC archive. Comparison and data analyses have revealed that the possible bias occurs mainly at the bottom part of the profile induced by miss-alignement problems or by the presence of aerosols.

Instrument History:
A first temperature lidar was operated at Saint-Denis de la RŽunion from 1994 to 2009. The new lidar was installed in 2012 in the Ma•do Observatory and the operations started in 2013. In May 2015 a validation campaign took place with the venue of the NASA-GSFC mobile lidar.

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