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Data Set Description:

PI: Alain HAUCHECORNE
Instrument: ALOMAR Rayleigh/Mie/Raman Lidar
Site(s): Andoya (69°N, 16°E, 379 m)
Measurement Quantities: Temperature (10-90 km)

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Reference Articles:

DENSITY AND TEMPERATURE PROFILES OBTAINED BY LIDAR BETWEEN 35 AND 70 KM, Hauchecorne A., and M.L. Chanin, Geophys. Res. Lett., 7, 565-568, 1980.

LIDAR MONITORING OF THE TEMPERATURE IN THE MIDDLE AND LOWER ATMOSPHERE, Hauchecorne A., M.L. Chanin, P. Keckhut, and D. Nedeljkovic, Applied Physics, B 54, 2573-2579, 1992.

A CRITICAL REVIEW ON THE DATA BASE ACQUIRED FOR THE LONG TERM SURVEILLANCE OF THE MIDDLE ATMOSPHERE BY FRENCH RAYLEIGH LIDARS, Keckhut P., A. Hauchecorne and M.L. Chanin, J. Atmos. Oceanic Technol., 10, 850-867, 1993.

EVALUATION AND OPTIMIZATION OF LIDAR TEMPERATURE ANALYSIS ALGORITHMS USING SIMULATED DATA, Leblanc T., I.S. McDermid, A. Hauchecorne, and P. Keckhut, J. Geophys. Res., 103, 6177-6187, 1998.

von Zahn U et al., 1995, The ALOMAR facility: Status and Outlook, in Proccedings 12th ESA Symposium on European Rocket and Balloon Programmes & Related Research, pp379-385, Lillehammer, Norway, 29 May-1 June 1995.

Fiedler J. et al., Stratospheric/mesospheric temperature profiles obtained by the ALOMAR Rayleigh/Mie/Raman Lidar over Andoya, in Proccedings 14th ESA Symposium on European Rocket and Balloon Programmes & Related Research, edited by B. Kaldeich-Schurmann, ESA SP-437, in press, 1999.

vonCossart G et al., 1995,Modern Technologies employed in the ALOMAR Rayleigh/Mie/Raman Lidar, in Proccedings 12th ESA Symposium on European Rocket and Balloon Programmes & Related Research, pp387-393, Lillehammer, Norway, 29 May-1 June 1995.

Instrument Description:

This lidar uses the second harmonic of two ND:Yag pulse Laser (532.2 nm). The laser provides an energy of 600 mJ per pulse at 30 Hz. The beam divergence is reduced using an afocal system to 0.04 mrad. The receiving area is composed by two 1.8 meter diameter telescopes. Light collected by the telescopes is fed by optical fibers to the 11 photomultipliers working photon counting mode for Rayleigh, Mie and Raman channels and to 24 channel ring anode detectors for Doppler wind and Temperature system. Counting gating is 0.5 microsecond providing a 75 meters vertical resolution. Electronic gates is used on each channel, in an effort to reduce the effects of the large initial burst of light and the resulting signal induced noise. Reasons for the choice of this instrumental configuration have been detailed in Keckhut et al. (1993).

Algorithm Description:
The method used to retrieve temperature profiles from molecular backscattered signal and the associated errors have been given in detail by Hauchecorne and Chanin (1980). More recently a description of the instrumental errors sources and biais have 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. Simultaneously, the channel providing the highest sensitivity (upper altitude range) is corrected for non-linearity effects in assuming an exponential function of the number of shots and in considering the channel for low altitudes 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. To estimate the background noise and the SIN, a model backscattered signal is constructed by normalising the MSIS model to the experimental data at 40 km. By subtracting this model signal from the real bacscattered signal, a first estimate of the SIN is obtained. For the altitude range where the backscattered signal is small compare to the noise, a quadratic fit of the estimated noise is calculated. This noise function is then extrapolated back to lower altitudes and subtracted from the data. 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 ajusting on the atmospheric model. Part of the actual algorithm can be found in Keckhut et al. (1993).

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 reach 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 vertical resolution is constant with altitude and equal to around 3 km. The integration time changes from night to night as it depend on weather conditions. The amplitude of the correction of the non-linearities of the counting is around 1-2 K that is determined with an accuracy of 0.1 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 rapidly negligible as opposed to the noise statistic. The sum of these uncertainties have been reported on the NDSC archive. Comparison and data analyses at OHP with similar lidar have reveal that the possible biais occur mainly at the bottom part of the profile induced by miss-alignement problem or by the presence

of aerosols. Improvments on signal and noise may have induced some spurious trend in the data series in the upper mesosphere. Comparison with the mobile GSFC/NASA lidar in summer 1992 reveals bias smaller than 2K between both instruments while variability of the differences between the both instruments is larger than estimated error between 35 to 45 km. A very good agreement on analysis software are obtained at that time.

Instrument History:
The main evolution of the lidar have been described in J. Fiedler et al. (1999). The lidar started to collect data in June 1994 and is in routine operations since January 1995. Since the end of 1995, 1064 nm, 532 nm and 355 nn are emited simultaneously by the Nd:YAG laser. A 0.6 m telescope have been used up to spring 1997 folowed by twin 1.8m steerable telescope used until now. A 0.5 m telescope have been used temporary in winter 1996/1997 for depolarisation measurements.