File Revision Date:
December 8. 2009

Data Set Description:

PI: Hassan BENCHERIF & Philippe KECKHUT
Instrument: Rayleigh LIDAR
Site(s): RÈunion Island (21.0ƒS, 55.5ƒE)
Measurement Quantities: Temperature (30 - 75 km)

Contact Information:

Name: Hassan BENCHERIF
Address: 15, av. RenÈ Cassin, BP 7151
97715, St-Denis cedex 9
Reunion Island, France
Phone / Fax: (262) 93 82 55 / (262) 93 86 65
e-mail: hassan@univ-reunion.fr

Reference Articles:

LIDAR DEVELOPMENTS AND OBSERVATIONS OVER REUNION ISLAND (20.8 S, 55.5 E), Bencherif H., J. Leveau, J. Porteneuve, P. Keckhut, A. Hauchecorne, G. MÈgie, F. Fassina and M. Bessafi, Advances in Atmospheric. Remote Sensing with lidar, Springer-verlag, Eds. : A. Ansmann, R. Neuber, P. Rairoux, and U. Wandinger, 1996.

PLANETARY WAVES AS OBSERVED BY LIDAR OVER REUNION ISLAND, Bencherif H., J. Leveau, A. Hauchecorne, and P. Keckhut, Proceeding of the 1st SPARC General Assembly, Melbourne, December 2-6, 1996.

STRATOSPHERIC TEMPERATURE MEASUREMENTS BY TWO COLLOCATED NDSC LIDARS AT OHP DURING UARS VALIDATION CAMPAIGN, Singh U.N., P. Keckhut, T.J. McGee, Gross, A. Hauchecorne, E.F. Fishbein, J.W. Waters, J.C. Gille, A.E. Roche, and J.M. Russel III, J. Geophys. Res., special issue on UARS Data Validation, 101, 10287-10298, 1996.

MID-LATITUDE LONG-TERM VARIABILITY OF THE MIDDLE ATMOSPHERE TRENDS, AND CYCLIC AND EPISODIC CHANGES, Keckhut P., A. Hauchecorne, and M.L. Chanin, J. Geophys. Res., 100, 18887-18897, 1995.

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 and A. Hauchecorne, applied Optics, 29, 5182 5186, 1990.

STRATOSPHERE TEMPERATURE MEASUREMENT USING RAMAN LIDAR, Keckhut P., M.L. Chanin and A. Hauchecorne, Applied Optics, 29, 5182-5186, 1990.

DESCRIPTION AND EVALUATION OF A TROPOSPHERIC OZONE LIDAR IMPLEMENTED ON AN EXISTING LIDAR IN THE SOUTHERN SUBTROPICS, Baray J-L., J. Leveau, J. Porteneuve, G. Ancellet, P. Keckhut, F. Posny et S. Baldy, Appl. Opt., 38, 6808-6817, 1999.

ANALYSIS OF GRAVITY WAVE IN THE TROPICAL MIDDLE ATMOSPHERE OVER LA REUNION ISLAND (21¡S, 55¡E) WITH LIDAR USING WAVELET TECHNIQUES, Chane-Ming F., F. Molinaro, J. Leveau, P. Keckhut et A. Hauchecorne, Ann. Geophys., 18, 485-498, 2000

EVIDENCE OF TIDAL PERTURBATIONS IN THE MIDDLE ATMOSPHEREOVER SOUTHERN TROPICS AS OBSERVED BY RAYLEIGH LIDAR. Morel B., H. Bencherif, P. Keckhut, S. Baldy, A. Hauchecorne J. Atmos. Sol. Terr. Phys., 64, 1979-1988, 2002.

REVIEW OF OZONE AND TEMPERATURE LIDAR VALIDATIONS PERFORMED WITHIN THE FRAMEWORK OF THE NETWORK FOR THE DETECTION OF STRATOSPHERIC CHANGE, P. Keckhut, S. McDermid, D. Swart, T. McGee, S. Godin-Beekmann, A. Adriani, J. Barnes, J-L. Baray, H. Bencherif, H. Claude, G. Fiocco, G. Hansen, A. Hauchecorne, T. Leblanc, C.H. Lee, S. Pal, G. Megie, H. Nakane, R. Neuber, W. Steinbrecht, and J. Thayer, J. Environ. Monit., 6, 721-733, 2004.

STRATOSPHERIC TEMPERATURE MONITORING USING A VIBRATIONAL RAMAN LIDAR. Part 1: AEROSOLS AND OZONE INTERFERENCES, Faduilhe D., P. Keckhut, H. Bencherif, L. Robert and S. Baldy, J. Environ. Monit., 7,357-364, doi:10.1039/B415299a, 2005.

AN INSTRUMENTED STATION FOR THE SURVEY OF OZONE AND CLIMATE CHANGE IN THE SOUTHERN TROPICS, JL Baray, J. Leveau, S. Baldy, J. Jouzel, P. Keckhut, G. Bergametti, G. Ancellet, H. Bencherif, B. Cadet, M. Carleer, C. David, M. de Mazi□re, D. Fadhuilhe, S. Godin Beekmann, P. Goloub, F. Goutail, J-M. Metzger, B. Morel, J-P. Pommereau, J. Porteneuve, T. Portafaix, F. Posny, L. Robert and M. Van Roozendael, J. Environ. Monit., DOI :10.1039/b607762e, 2006.

RAYLEIGH LIDAR OBSERVATIONS OF DOUBLE STRATOPAUSE STRUCTURE OVER THREE DIFFERENT NORTHERN HEMISPHERE STATIONS, Sivakumar V., H. Bencherif, A. Hauchecorne, P. Keckhut, D.N. Rao, S. Sharma, H. Chandra, A. Jayaraman and P.B. Rao, Atmos. Chem. Phys. Discuss., 6, 6933-6956, 2007.

SEASONAL OSCILLATIONS OF MIDDLE ATMOSPHERE TEMPERATURE OBSERVED BY RAYLEIGH LIDARS AND THEIR COMPARISONS WITH TIMED/SABER OBSERVATIONS, X. Dou, T. Li, J. Xu, H. Liu, X. Xue, S. Wang, T. Leblanc, I.S. McDermid, A. Hauchecorne, P. Keckhut, H. Bencherif, G. Heinselman, W. Steinbrecht, M.G. Mlynczak, and J.M. Russell III, J. Geophys. Res., 2009.

Instrument Description:

This lidar is very similar to the one operating at OHP. It uses the second harmonic of a Nd:YAG pulsed laser (532 nm) with a repetition rate of 30 Hz. Each laser pulse provides an energy of 500 mJ. The beam divergence is reduced to 0.04 mrad using an afocal system. The reception system consist of two channels:

- channel-A composed of a mosaic of four 0.530 meter diameter mirrors,

- channel-B is a small receiver (0.20 meter diameter mirror) and have a lower sensitivity in order to cover the lower altitude range (30-45 km).

Light is collected using optical fibres located at the focus of each mirror. The optical fibres drive the photons to two receiver boxes where filtering is ensured using an interference filter of 1 nanometer of bandwidth. Detection is made by Hamamatsu photomultiplier tubes which are water-cooled. The photon-counting mode is used with a vertical resolution of 150 meters. In order to reduce saturation effects of the photomultiplier, each channel is equipped with an electronic shutter.

Algorithm Description:

The software used to retrieve temperature profiles from molecular backscattered signal is the one developed by the Service d'AÈronomie. The method and the associated errors have been described in detail by Hauchecorne and Chanin (1980). More recently a description of the instrumental errors sources and bias have been reported by Keckhut et al. (1993).

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 CIRA model to the experimental data at 40 km. By subtracting this model signal from the real backscattered 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 adjusting on the atmospheric model. Part of the actual algorithm can be found in Keckhut et al. (1993) and in Singh et al. (1996). Up to now temperature processing has used version 5 of the algorithm which is a MATHLAB version of the version V4 used at OHP (for detailed see OHP metafile)

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 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.

Instrument History:

Reunion lidar has been in operation since May 1994. Following the first validation campaign including comparisons with NMC and radiosonde data, an electronic shutter was implemented by Oct. 1994, while the laser emission rate was at 10 Hz (350 mJ / pulse) and the receiver was made of only one mirror (500 mm of diameter). By April 1995 the laser and the receiver havebeen improved, leading to the system described above. New channels have been added to the initial lidar version including a replacement of the electronic acquisition system and the computer in December 1997. Comparisons with the mobile GSFC/NASA lidar are expected in 2010.