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Data Set Description:

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Instrument: Lidar

Site(s): McMurdo Station, Antarctica

Measurement Quantities: Aerosol profiles (NDSC)
Temperature profiles (no NDSC)

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Instrument Description:

The lidar, installed in 1990 in McMurdo Station (78S, 167E), Antarctica, is based on a Nd:YAG laser with a second harmonic generator, emitting pulses of 10 ns at 532 nm. The energy is typically 150 mJ/pulse with a pulse repetition frequency of 10 Hz. The beam is sent through a beam expander, thus reducing the laser divergence below 0.2 mrad. The receiving telescope is a 0.4 diameter, vertically pointing Cassegrain, with a FOV < 0.5mrad.

Parallel and cross polarized signals are detected by two photomultipliers and acquired in A/D mode for aerosol measurements, and in photon counting mode (<125 Mhz) for the temperature measurements. A rotating shutter inserted in the optical path of the receiver prevents saturation from short range echoes. An interference filter of 0.15nm reduces the sky noise, allowing daylight measurements up to 30 Km of altitude. The data acquisition and storage are controlled by PC.

The aerosol analysis is generally based on two or more integrated profiles of 5 minutes each, with a vertical resolution of 75 m. For temperature measurements (not yet in NDSC), the signal is recorded at a height resolution of 300 m with 30 minute of integration.

Since 1993 the Italian Lidar is operated by ASA personnel during the entire polar winter. The aerosol observations are carried out during nighttime and daylight on a schedule depending on the season (1run/4days before 1st June; 1run/day after 1st June; 2-3runs/day during PSCs events).

A new lidar system was installed in 2004. It is based on a compact sealed off Nd:YAG laser with a second harmonic generator. The energy is typically 150 mJ per pulse @ 532 nm and about 70 mJ/pulse @ 1064 nm, with a repetition rate of 10 Hz. The laser beam is expanded 5 times, and has a resulting divergence of about 0.3 mrad. The receiving telescope is a commercial 14" diameter Schmidt- Cassegrain type with a FOV of < 0.7 mrad. Signals are detected at 532 nm (low, high and depolarized) and 607.3 nm (Raman signal) with miniaturized photomultipliers (Hamamatsu) and at 1064 nm with a APD. All signals are fed in photoncounting data acquisition cards. The vertical resolution is typically 30 m and vertical profiles are typically 55 km for the 532 high channel, 40 km for the depolarized 532 nm channel and 20-30 km for the 1064 nm channel. The Raman channel is operational but not used for the moment.

Aerosol Algorithm Description:

The inversion algorithm for aerosol needs molecular density profiles routinely obtained with radiosondes launched by the McMurdo Weather Station, and, occasionally, by sondes launched by the University of Wyoming (Dr. T. Deshler). The sondes typically reach 15-20 km. Above such altitude, NCEP analysis is used (obtained by Automailer). When high altitude data are not available, CIRA88 model is used. The data analysis proceeds by successive approximations. A molecular echo intensity profile is calculated on the basis of the molecular density, taking into account molecular extinction and range attenuation. The lidar signal is fitted to the molecular profile in the aerosol-free regions expected to exist above the stratospheric aerosol layer (at bout 28-30 Km); a normalization factor is then obtained and used to calculate the first guess of aerosol optical depth.

The Backscattering Ratio [(Baer+Bmol)/Bmol] where

Baer = backscattering from aerosols

Bmol = pure molecular atmosphere

the backscattering coefficient, beta, and the extinction-to-backscatter ratio, c, are determined by an iterative method, in which c is assumed to be function of beta.

The ratio between main and cross polarized signals gives the Volume depolarization {[Baer+Bmol]s/[Baer+Bmol]p}*Dmol where

S = orthogonal polarization

P = parallel

Dmol = Depolarization ratio for molecules (0.0144)

The error related to the extinction to backscattering ratio (EXT/BACK)' is a function of the backscattering. For backscattering values lower than 10-3[km-1 sr-1] errors as large as 40% are possible for the retrieved values of ratio. For higher backscattering values errors of the order of 15% or smaller can be expected.

The errors related to the backscattering coefficient and to the backscattering ratio depend mainly on the lidar to radiosonde calibration error and only slightly on the calculated EXT/BACK ratio.

In strong PSCs events they are as large as 25% for the data below the clouds and smaller (10%) elsewhere; in volcanic background situation the errors are of the order of 10%.

The error related to depolarization ratio depends on the quality of the lidar signal and is usually in the range of 10%-40%.

Expected Precision/Accuracy of Instrument:

An error estimate (one sigma) is listed in the files.

Instrument History:

August 1990: The lidar is installed in a building of McMurdo Station. Analog acquisition mode only.

August 1991: Photon counting mode is introduced for temperature measurements.

March 1993: ASA starts aerosol measurements on a regular basis during the polar night.

January 2004: The old lidar system is substituted with a completely new system.

The new lidar system, uses photon counting at three different wavelengths, 532 nm (2 different polarizations), 1064 nm and 608 nm (Raman signal of nitrogen).

August 2004: The new lidar becomes fully operative.
August 2006: A lower tropospheric channel has been added (532 nm, 1-30 km)