AMALi processed data in PANGAEA

The data files contain aerosol attenuated backscatter at 532nm and 355, volume depolarization at 532 nm and attenuated total color ratio (532 nm/355 nm) profiles derived from measurements of the Airborne Mobile Aerosol Lidar (AMALi). The lidar was installed on board the aircraft Polar 5 in nadir pointing mode. The measurements were obtained on flights over the Arctic Ocean during the PAMARCMIP 2012 campaign.

The variables are calculated assuming as boundary condition a median backscatter ratio ((molecular + aerosol) / molecular) between 1800 m and 2300 m altitude with a value of 1.2 at 532 nm, 1.07 at 355 nm and 1.0028 for the perpendicular polarized channel at 532 nm. This is based on the assumption of moderate background aerosol concentrations at this altitude range.

Coordinates and flight altitude are obtained from the aircrafts GPS1 module. The altitude vector of the lidar profiles is calculated from the GPS flight altitude minus the range vector of the lidar profiles with a resolution of 7.5 m and is based on the assumption of level flight. For flight maneuvers where the aircraft is inclined around a horizontal axis (e.g. during curves or ascent), the profiles appear 'stretched' against the height scale. The deviation scales with the cosine of the inclination angle and is e.g. around 0.4% of the distance from the aircraft for an inclination of 5 degrees and 1.6% for 10 degrees. The horizontal aircraft attitude angles are provided as variables 'roll' and 'pitch' where they are available from the aircrafts inertial navigation system (INS).

The AMALi variables refer to attenuated backscatter in order to only contain a minimal amount of additional assumptions. This means that they are not corrected for the two-way attenuation of the light beam by aerosols or clouds between aircraft and measurement altitude. The attenuation under typical Arctic aerosol conditions and a flight altitude of 3000 m is estimated to be on the order of 5% close to the ground. Since the attenuation resulting from clouds is much stronger, backscatter from below clouds is attenuated significantly. Aerosol attenuated backscatter can have negative, un-physical values there.

Additionally, within clouds multiple scattering can become significant and lead to an overestimation of backscatter and depolarization signals within and shortly below the cloud. Due to the extension of the geometrical length of the path travelled by the light beam, multiple scattering also influences the range information of the signal where it occurs. This can lead to an “after-glow” effect within or below clouds that may not represent the actual vertical extent of the cloud. Since sideward scattering adds a perpendicular polarized component to the scattered beam, multiple scattering can cause high values of depolarization even for spherical cloud droplets.

Uncertainties given for the variables are estimated taking into account three influences:

- Signal noise, optical and electronic (statistical, depends on temporal and spatial averaging)
- Estimated error due to electronic baseline drift of transient recorders (systematic, determined after linear baseline correction)
- Estimated error due to backscatter boundary condition (systematic, +-50% of assumed aerosol contribution)

The error sources are combined to derive a maximum and a minimum expected value for each data point.

A quality flag is provided for each variable, with 1 indicating valid and 0 invalid data points. The flag takes into account a minimum signal-to-noise ratio of 2 (1 at 532nm perpendicular) and the region of incomplete overlap of laser beam and telescope field of view below the aircraft. For the depolarization variable, a threshold optical thickness is taken into account additionally that excludes areas of penetration into cloud layers, where considerable multiple scattering is expected.

The quality flags as well as the given uncertainties are meant to provide a quick estimate on the reliability of the data, but can not replace individual examination of the data from case to case by an experienced user.