# Intercomparison of Aerosol Lidar Systems

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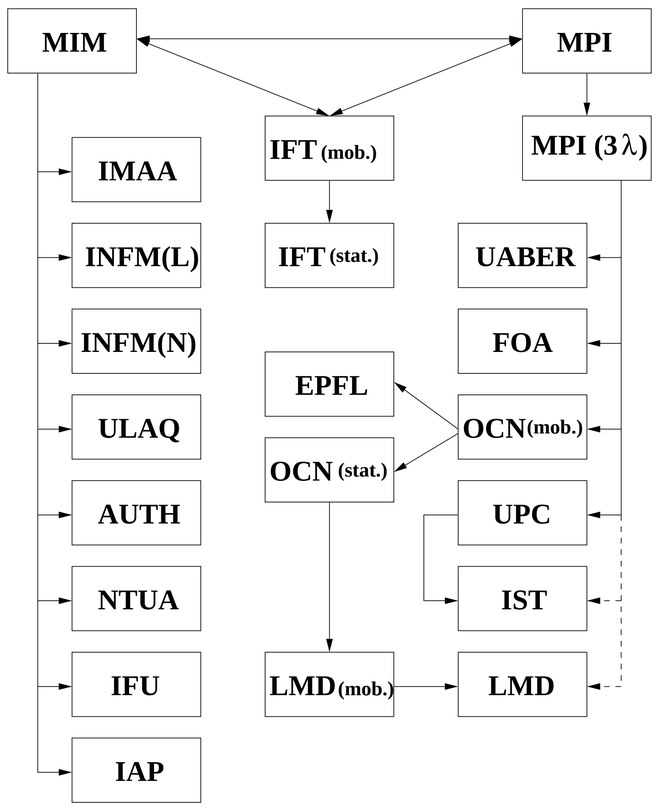
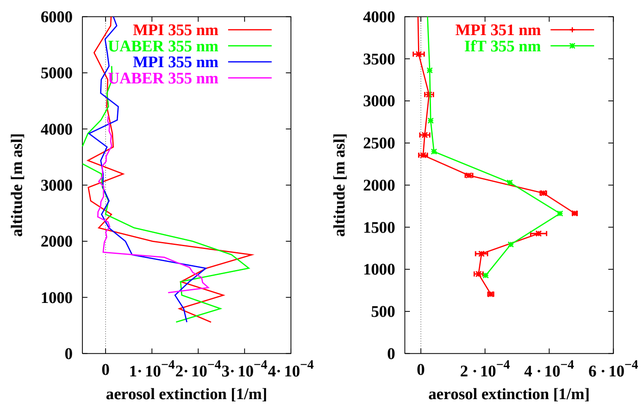
A key requirement for data produced in an observation network is homogeneous and well established data quality. Therefore within EARLINET specific attention is given to quality assurance, both at system and evaluation level. At system level the basic approach was to compare each system to either one of the transportable “standards” or to another quality controlled system. The required level of agreement was defined before the intercomparison excercise.

## Approach




The transportable lidar systems from Hamburg, Munich and Leipzig have been compared already in 1998, during the Lindenberg Aerosol Characterization Experiment (LACE 98). Therefore these systems served as “standards” for the EARLINET intercomparison procedure. They performed most of the intercomparisons. In some cases, those lidar systems which passed the quality assurance served as standards themselves. The OCN mobile system served as standard in two cases. Two groups did not pass the quality assurance from the beginning. They had to repeat the intercomparisons.

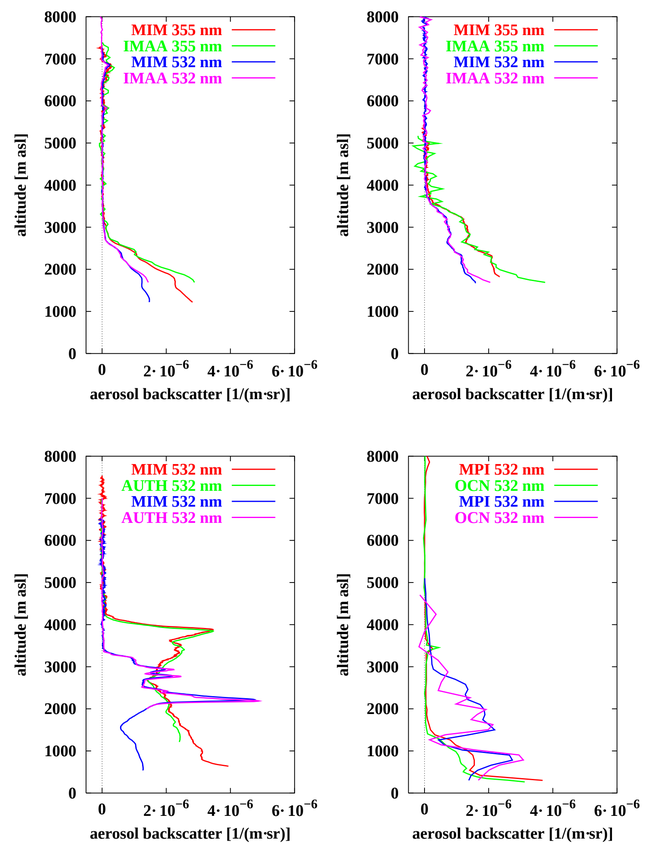
## Aerosol Extinction Measurements




**Maximum allowed deviations**

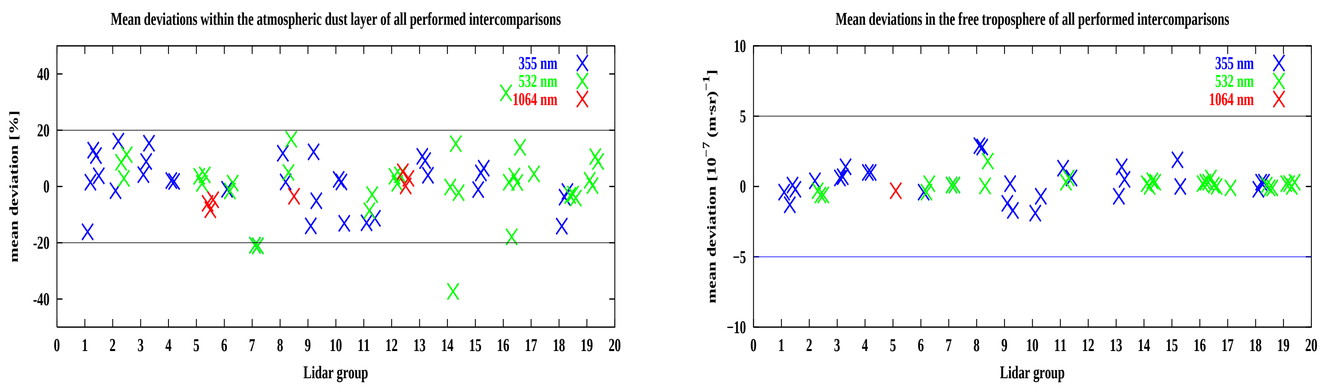
| Wavelength | Mean Deviation | Std. Deviation |
|---|---|---|
| Aerosol extinction (dust layer) | | |
| 355 nm | $< 20\%$ | $< 25\%$ |
| 532 nm | $< 20\%$ | $< 30\%$ |
| Aerosol backscatter (dust layer) | | |
| 355 nm | $< 20\%$ | $< 25\%$ |
| 532 nm | $< 20\%$ | $< 25\%$ |
| 1064 nm | $< 20\%$ | $< 30\%$ |
| Aerosol extinction (free trop.) | | |
| 355 nm | $< 5 \cdot 10^{-5} m^{-1}$ | $< 1 \cdot 10^{-4} m^{-1}$ |
| 532 nm | $< 5 \cdot 10^{-5} m^{-1}$ | $< 1 \cdot 10^{-4} m^{-1}$ |
| Aerosol backscatter (free trop.) | | |
| 355 nm | $< 5 \cdot 10^{-7} (m \cdot sr)^{-1}$ | $< 5 \cdot 10^{-7} (m \cdot sr)^{-1}$ |
| 532 nm | $< 5 \cdot 10^{-7} (m \cdot sr)^{-1}$ | $< 5 \cdot 10^{-7} (m \cdot sr)^{-1}$ |
| 1064 nm | $< 5 \cdot 10^{-7} (m \cdot sr)^{-1}$ | $< 5 \cdot 10^{-7} (m \cdot sr)^{-1}$ |
| Aerosol optical depth | | |
| 355 nm | $< 30\%$ / 0.1 | $< 30\%$ / 0.1 |

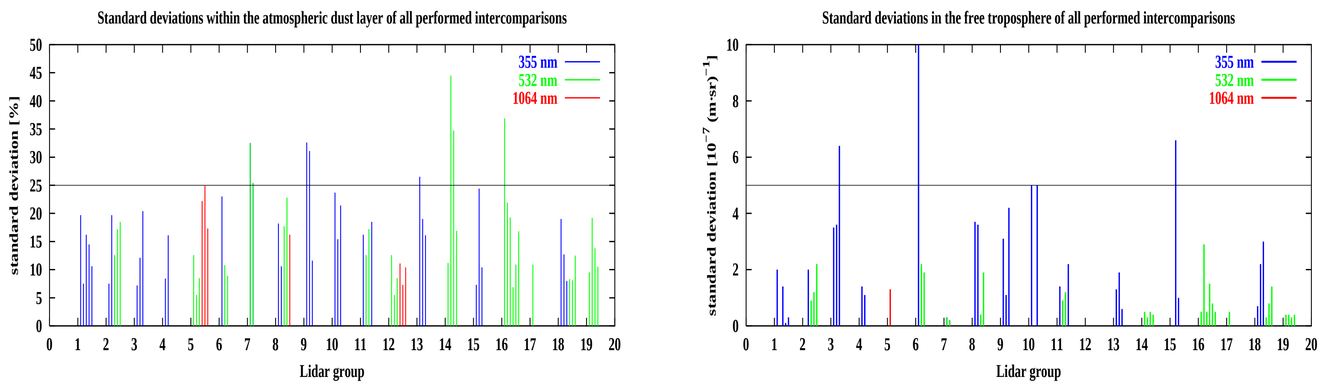
## Aerosol Backscatter Measurements




The examples of the measurements show mostly good agreement. However, some of the systems showed problems in the near range. Incomplete overlap between laser beam and receiving telescope, detector saturation or thermal instabilities were the most common problems that could be detected during the intercomparison measurements. The problems have been solved by the groups after the experiments or the altitude region with reliable data has been redefined.

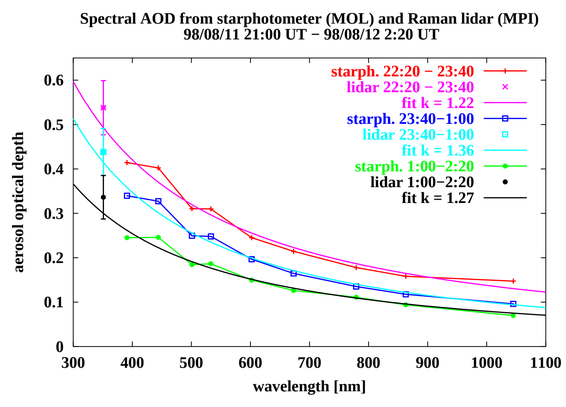
## Summary of Lidar Intercomparisons

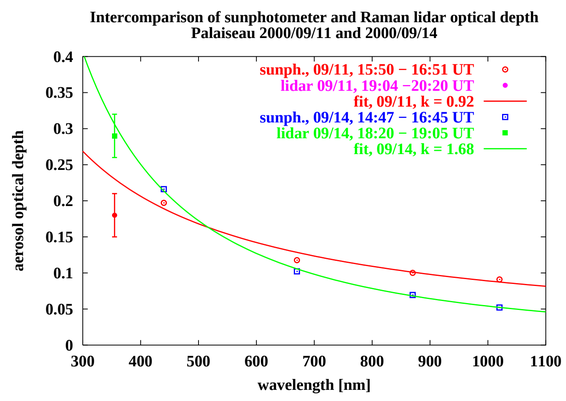



With only few exceptions, the mean deviations of the considered intercomparison measurements stayed within the given 20 % limits, most of them were even within 10 %. All cases with higher deviations were connected with low aerosol load and the maximum allowed deviations in absolute values were not exceeded.
In regions with low aerosol which is usually the free troposphere, in some cases the standard deviation was higher than the allowed values. This was mainly due to poor signal statistics in the upper height range and could be reduced by further spatial averaging. Additionally, some of the profiles represent only short time periods which also leads to higher statistical fluctuations.

## Comparison with Photometers




The aerosol optical depth comparisons between lidar and photometer show good agreement. The starphotometer is better suited for such comparisons because the lidar data is taken at nighttime. The sunphotometer additionally suffers from the low number of wavelengths, the shortest wavelength is at 440 nm, while the lidar measures at 355 nm. For many aerosols the spectral behaviour in the UV is different from the region of longer wavelengths which could explain some of the differences.