Reconciling aerosol light extinction from ground-based in-situ measurements and active satellite remote sensing

M. Tesche[1], N. Rastak[1], P. Glantz[1], H.–C. Hansson[1], I. Riipinen[1], and R. Charlson[2]

[1]Department for Applied Environmental Science, Stockholm University, Stockholm, Sweden
[2]Department of Atmospheric Sciences, University of Washington, Seattle, WA 98195, USA
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Presenting author email: matthias.tesche@itm.su.se

Aerosols play an important role in the Earth's climate system. This is especially relevant for the vulnerable and clean Arctic, where even slight changes in aerosol size or concentration can have large effects on cloudiness and the radiative budget. To assess aerosol microphysical and optical properties, in–situ measurements are performed at Mt. Zeppelin, Svalbard, since the early 1990s (Ström *et al.*, 2001). However, in–situ measurements are usually performed with dried aerosol samples whose particle size distribution, refractive index, or extinction coefficient can vary significantly during different ambient (i.e., humid) conditions. Arctic aerosols were also found to be highly sensitive to relative humidity (Zieger *et al.*, 2010). Microphysical models are used to transform the measured properties of the dried aerosol sample to values that are representative for ambient conditions. Such numbers are needed for a reliable assessment of aerosol optical properties.

In this study we try to reconcile particle light extinction coefficients derived from humidifying dry in–situ measurements at Zeppelin station and ambient observations with the lidar aboard the Cloud–Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite (Winker *et al.*, 2009). The high overpass rate of polar–orbiting satellites over the Svalbard region favors a systematic comparison of continuous ground–based in–situ measurements and spaceborne lidar observations. Previous studies revealed that high correlation in aerosol properties can be expected for distances of up to 500 km over water (Kovacs 2006). However, for this study we only considered overpasses at distances of less than 360 km from the ground site at Svalbard.

The present study focuses on measurements performed in 2008. A comparison of ambient extinction coefficients measured by CALIPSO with humidified extinction coefficients from the in-situ measurements could be performed for 57 suitable cases — mostly during winter and spring. Clouds, low aerosol load, and a strong solar background (i.e., low signal–to–noise ratio in the spaceborne lidar measurements) inhibit comparisons during summer.

Figure 1 summarizes the findings of this study. On the whole, humidified extinction coefficients from ground-based in–situ measurements and ambient extinction coefficients from spaceborne lidar measurements were found to agree within a factor of one to five with a majority of the values not exceeding a factor of two. This is a surprisingly good finding when considering the efforts necessary to come up with comparable quantities. CALIPSO extinction coefficients are generally larger than the ones derived from the humidification of in–situ measurements. Is has been observed previously, that extinction coefficients measured with lidar are larger than the ones obtained from in–situ measurements (e.g., Masonis *et al.*, 2002).

In the future we will expand this study to the entire CALIPSO data set that currently spans six years.

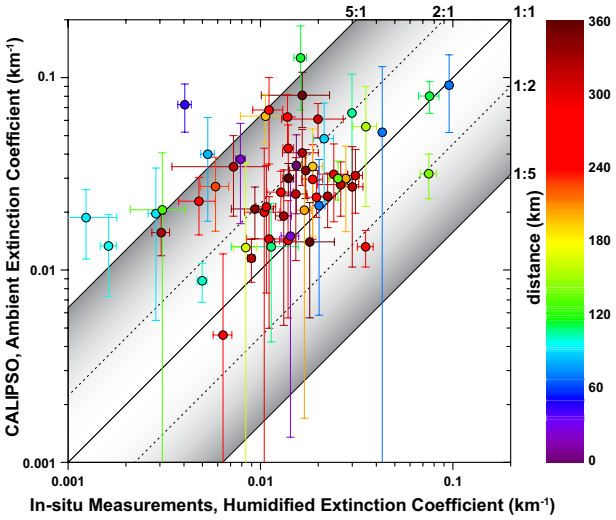

Figure 1: Comparison of the humidified extinction coefficient calculated from in–situ measurements at Zeppelin station with the ambient extinction coefficient extracted from CALIPSO overpasses for 57 suitable cases. The color coding describes the distance of the CALIPSO observation from the ground site. Error bars represent the standard deviation from averaging over 5 hourly nephelometer data points and 9 30–m CALIPSO height bins between 250 and 760 m, respectively. Ratios of 1:1, 1:2, and 1:5 are marked by solid and dashed lines as well as the shaded area.

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