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Comparison of Fennec airborne in-situ dust measurements with CALIOP spaceborne lidar retrievals of extinction and AOD

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Dust originating from the Sahara desert in northern Africa is transported across the Atlantic Ocean to North and South America throughout the year, enriching the Atlantic Ocean and Amazon basin with mineral ingredients. Saharan dust has also an impact on atmospheric radiation and dynamics. Of particular importance is the vertical distribution of dust particles, knowledge of which is important in our attempt to simulate global dust transport. Despite this importance, consistent monitoring of Saharan dust is challenging, particularly over the remote Sahara. Satellite data are therefore a valuable source of measurements in desert regions, though it is important to compare these with other measurements where possible.

In this study, vertical profiles of extinction coefficient and columnar aerosol optical depth (AOD) values from the space-borne Cloud-Aerosol Lidar with Orthogonal Polarisation (CALIOP) L2-Version 3.01 Profile data have been compared against aircraft in-situ measurements made during the Fennec campaign over West Africa in June 2011. The study presents measurements in remote locations – close to dust sources - and over Atlantic Ocean. The direct comparison between CALIOP and aircraft measurements close to regions where dust is uplifted is challenging due to the large spatial and temporal variability of dust load. However, the lack of vertically resolved in-situ measurements close to dust sources makes the Fennec aircraft observations particularly valuable. Values of extinction coefficient measured by the aircraft were larger by up to 250% than those measured by CALIOP. AOD had a smaller difference, of up to 70%. When compared to AERONET ground-based data, CALIOP AOD was lower by 46%.

A number of factors are explored that can partially explain the discrepancies. In particular for the CALIOP retrievals a) the dust extinction-to-backscatter (lidar) ratio and scattering properties assumed in CALIOP retrieval algorithm might not be suitable for dust particles close to their source, b) daytime low signal-to-noise ratio might lead to misclassification of aerosols as clouds, c) attenuation of the lidar beam makes retrieval of the lowest aerosol layers from space challenging. For the aircraft measurements, uncertainties stem from aircraft inlets excluding measurement of the coarse mode, and instrumental errors.