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Remote sensing of aerosols over snow using infrared AATSR observations

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Infrared (IR) retrievals of aerosol optical thickness (AOT) are challenging because of the low reflectance of aerosol layer at longer wavelengths. In this work we present a closer analysis of this problem, performed with radiative transfer (RT) simulations for coarse and accumulation mode of four main aerosol components. It shows the strong angular dependence of aerosol IR reflectance at low solar elevations resulting from significant asymmetry of aerosol phase function at these wavelengths. This results in detectable values of aerosol IR reflectance at certain non-nadir observation angles providing the advantage of multiangle remote sensing instruments for a retrieval of AOT at longer wavelengths. Such retrievals can be of importance e.g. in case of a very strong effect of the surface on the top of atmosphere (TOA) reflectance in the visible range of spectrum. In current work, a simple method to retrieve AOT over snow has been developed using the measurements of Advanced Along Track Scanning Radiometer (AATSR) on board the ENVISAT satellite. The algorithm uses AATSR channel at 3.7 μm and utilizes its dual-viewing observation technique implying the forward view with an observation zenith angle around 55 degrees and the nadir view. It includes cloud/snow discrimination, extraction of the atmospheric reflectance out of measured brightness temperature (BT) at 3.7 μm, interpolation of look-up tables (LUTs) for a given aerosol reflectance. The algorithm uses LUTs, separately simulated with RT forward calculations. The resulting AOT at 500 nm is estimated from the value at 3.7 μm using a fixed Angström parameter.
The presented method has been validated against ground-based Aerosol Robotic Network (AERONET) data for 4 high Arctic stations and shows good agreement. A case study has been performed at W-Greenland on 5 July 2008. The day before was characterized by a noticeable dust event. The retrieved AOT maps of the region show a clear increase of AOT in the Kangerlussuaq area. The area of increased AOT was detected on 5 July on the ice sheet east of Kangelussuaq opposite to the observed north easterly wind at ground level. This position can be explained by a small scale atmospheric circulation transporting the mobilized mineral dust upslope, after its intrusion into the upper branch of the circulation.
The performed study of atmospheric reflectance at 3.7 μm also shows possibilities of detection and retrievals of cloud properties over snow surface.