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Aerosol retrieval over the Arctic: prerequisites and case studies

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The challenging task of Aerosol Optical Thickness (AOT) retrieval over the Arctic regions has led to a coverage gap in global AOT datasets. The lack of aerosol information over those regions contributes to the uncertainties in understanding the direct/indirect aerosol impacts on global climate change. In fact, a typical/classical AOT retrieval using satellite observation over snow/ice covered regions requires two crucial prerequisites: 1) a mature cloud identification algorithm to separate cloud-free scenes from cloudy ones for further AOT retrieval; 2) accurate knowledge of snow/ice bidirectional reflectance to decouple surface from atmosphere contribution observed in the Top Of Atmosphere (TOA) reflectance in cloud-free scenarios.

In this study, a new cloud identification method is developed and applied on observations of Advanced Along-Track Scanning Radiometer (AATSR) on European Space Agency's (ESA)-Envisat and Sea and Land Surface Temperature Radiometer (SLSTR) onboard ESA's Sentinel-3A and -3B. The main idea of this method named AATSR/SLSTR Cloud Identification Algorithm (ASCIA) is analyzing stability/variability of TOA reflectance within time series measurements with the assumption that clouds indicate larger spatial variability compared to cloud free ground scenarios [1]. The results of this method are validated against 1) ESA standard cloud product from AATSR L2 nadir cloud flag, 2) One of existing methods based on clear-snow spectral shape, 3) Surface synoptic observations (SYNOP), 4) AERONET.

Furthermore, to improve the current assumptions of snow/ice surface reflectance in AOT retrieval, we calculated snow Bidirectional Reflectance Factor (BRF) values utilizing airborne Cloud Absorption Radiometer (CAR) data. CAR data were acquired during Arctic Research of the Composition of the Troposphere from Aircraft and Satellite (ARCTAS) campaign conducted by NASA at Barrow, Alaska in spring 2008. The derived snow BRF is compared with model simulations using the Radiative Transfer Model (RTM) SCIATRAN [2]. The accuracy of SCIATRAN RTM simulated snow/ice reflectance properties has been investigated with respect to wavelength (from UV to shortwave infrared region), sun-satellite geometry and physical properties of snow (such as snow grain size and shape). The results indicate in general very good agreements between airborne observation and SCIATRAN simulations. Some discrepancies are also analyzed.

In addition to above-mentioned prerequisites for aerosol retrieval over snow and ice, including the newly developed ASCIA and investigation of snow surface bidirectional reflectance properties, some preliminary results of AOT retrieval over the Arctic region with the new knowledge from a better cloud identification and surface properties characterization will be presented.

References

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