Estimation of Cloud Radiative Effects from Ground-based Observations in the Western Arctic.

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Clouds are a driving element in the Arctic climate system due to their interaction with solar and thermal infrared radiation, yet their contribution to the Arctic amplification is still uncertain. As part of the (AC)³ Arctic Amplification project (TRR 172, www.ac3-tr.de), we are studying the influence of specific sea ice conditions on micro- and macrophysical cloud properties such as cloud fraction, altitude, thickness, thermodynamic phase, and their surface radiative effects.

The present contribution exploits long-term measurements at the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) at the North Slope of Alaska (NSA) site in Utqiagvik, Alaska to derive cloud radiative effects (CRE) in the Western Arctic.

Cloud radiative effects are estimated using up- and downward ground-based observations of broadband solar and thermal infrared sensors in cloudy conditions which are provided in a quality-controlled version by the ARM data repository. For this study two ARM products are mainly being analyzed: the surface energy balance system (SEBS) with availability from 2011 on, and the Surface Radiation measurement QCRAD product with availability from July 2013 on. To determine the cloud radiative effects, the observed surface solar and thermal infrared measurements under cloudy conditions are compared to modeled clear-sky values for the same atmospheric states. This method has already been successfully utilized in Arctic conditions by Ebell et al. (2019) for observations of more than two years from Ny Ålesund, Svalbard, Norway.

To characterize CRE, broadband radiative transfer modeling is performed using the Rapid Radiative Transfer Model for GCM (RRTMG). Surface albedo and atmospheric states are used as input for the RRTMG. Surface albedo information is obtained either by estimation from upward- and downward facing pyranometers or from the SEBS product. Microphysical cloud properties are obtained via the CloudNet (Illingworth et al., 2007; Tukiainen et al., 2020) cloud target classification algorithm that the authors have already applied to the atmospheric remote-sensing instrumentation suite at the NSA site in Utqiagvik (Saavedra Garfias et al. 2021).

Microphysical cloud properties, which are crucial for the estimation of CRE, can be affected by sea ice conditions in the Arctic. Statistics of CRE and possible linkage to sea ice will be discussed.

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