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Investigation of cloud radiative effects and closure in the Central Arctic based on ship-borne remote sensing observations

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The surface in the Arctic is warming at double the rate than the global average. This phenomenon, named Arctic amplification, makes the Arctic a sensitive and important location to investigate climate change. The principal mechanisms contributing to Arctic Amplification are still under debate due to lack of observations and comprehension of different mechanisms.

With the aim to collect additional observations for the investigation of several processes related to Arctic amplification, the project (AC)³ (Arctic Amplification: Climate Relevant Atmospheric and SurfaCe Processes and Feedback Mechanisms) established two major field campaigns in summer of 2017. Both performed in situ and remote sensing observations over the ocean with PASCAL and in the air with ALOUD (Macke and Flores, 2018, Wendisch et al., 2019).

The PASCAL expedition took place on board of the German research vessel Polarstern which was equipped with active and passive remote sensing instrumentation. The synergistic operation of this instrumentation was used to derive macro and microphysical properties of clouds by applying the Cloudnet algorithm. These retrievals together with vertical profiles of temperature and relative humidity are used as input to the Rapid Radiative Transfer Model for GCM applications (RRTMG). We used the RRTMG outputs of solar and terrestrial broadband irradiances and compare them to observations to assess the radiative closure.

In the scope of this study, the difference in radiative fluxes arriving at the surface by using model profiles instead of radiosonde data as thermodynamic driver is quantified, focusing on the representation of temperature and humidity inversions. Furthermore, a sensitivity study is given of the variation of cloud optical properties and their radiative effects at the surface. To test the radiative closure performance at different scales, an inter-comparison is made among airborne, tethered balloon-borne and ship-borne broadband solar and terrestrial radiation in different case studies.

The methodology described is also applicable to the current Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAIC) expedition which started in September 2019. First results will be presented for the first leg which will allow a direct comparison of the contrasting properties of cloud radiative effects during summer and winter.

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