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Impact of clouds on atmospheric heating rate profiles at Ny-Ålesund, Svalbard

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Clouds strongly impact the available energy at the surface and at the top of the atmosphere as well as its vertical distribution within the atmosphere by modifying the shortwave (SW) and longwave (LW) fluxes and heating rates. The so-called cloud radiative effect (CRE) and the cloud radiative forcing (CRF), i.e. the difference between the all-sky and clear-sky fluxes and heating rates, respectively, strongly depend on the cloud macrophysical (e.g. frequency of occurrence, cloud vertical distribution) and microphysical (e.g. phase, water content, hydrometeor size distribution) properties.

In the Arctic, the cloud–radiative interactions are even more complex due to low temperatures, frequently occurring temperature inversions, the dryness of the atmosphere, large solar zenith angles and a high surface albedo. In particular (supercooled) liquid containing clouds, which frequently occur in the Arctic and often have very low amounts of liquid water, exhibit a strong impact on the radiative fluxes.

Recently, Ebell et al. (2020) have analysed for the first time the radiative effect of clouds for the Arctic site Ny-Ålesund exploiting more than 2 years (06/2016 -10/2018) of continuous vertical cloud measurements at the French-German research station AWIPEV. They showed that at Ny-Ålesund, the monthly net surface CRE is positive from September to April/May and negative in summer. The annual surface warming effect by clouds is 11.1 W m^{-2}.

Based on the same data set, we will now investigate in more detail how clouds modify the LW and SW heating rates in the atmospheric profile. First results show that the net CRF is dominated by the LW CRF with warming taking place in principal below the height of the maximum frequency of occurrence of liquid around 1 km, and cooling above. The strength of this cooling and warming is closely related to the amount of liquid. We will also analyze heating rates for different cloud types similar to the study by Turner et al. (2017) who found characteristic heating rate profiles for the Arctic site Barrow. In this way, we will gain insight into the representastiveness of these heating rate profiles throughout the Arctic.

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