Assessing cloud representation of two global atmospheric models using multiple overpasses of CloudSat-CALIPSO over the same Arctic cyclone

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Mixed-phase clouds are common in Arctic cyclones, but their representation in global atmospheric models is still challenging. The aim of the study is to evaluate and improve the ratio of ice and liquid water within mixed-phase clouds simulated by two general circulation models (GCM): ARPEGE (operational at Météo-France) and LMDZ (the atmospheric component of the IPSL-CM Earth System Model). For that evaluation, we consider ERA5 reanalysis for the overall dynamics and for the cloud representation, DARDAR satellite products which provide the ice water content (IWC) as well as categorization masks along CloudSat-CALIPSO tracks. This work focuses on an Arctic cyclone that occurred in May 2019 near Svalbard and has been sampled several times by CloudSat-CALIPSO.

Compared to satellite observations, LMDZ simulations provide quite realistic IWC while ARPEGE underestimates this quantity. However, by comparing liquid and ice occurrences between models and observations, both GCMs clearly miss occurrences of liquid phase at temperature lower than -30°C but they all overestimate the liquid occurrence in the whole negative temperature range between 0°C and -30°C.

In order to improve such liquid and ice occurrences, different liquid/ice partition functions are tested in the two models. In particular, different shapes and extensions to lower temperatures are considered. This helps to improve the occurrence of liquid water at the lowest temperatures but does not correct the overestimation between 0°C and -30°C. As temperature does not discriminate liquid-ice partition properly, different other predictors are tested and distance from the cloud top appears to be the most relevant.