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Arctic mixed-phase clouds simulated by the WRF model: Comparisons with ACLOUD radar and in situ airborne observations and sensitivity of microphysics properties

Abstract

Mixed-phase clouds (MPCs)' unique microphysical properties significantly influence energy budget and hydrological cycle in the atmospheric boundary layer (ABL). However, their maintenance mechanisms remain poorly understood and are often oversimplified in forecast models . Additionally, the impact of surface types on MPC properties remains controversial. To know more about the characteristics of MPCs, this study utilizes data from ACLOUD airborne campaign west of Svalbard on 17 June 2017. Using in-situ measurements and cloud radar data, the study evaluates the performance of the Weather Research and Forecasting (WRF) model in reproducing these cloud systems in different surface types.

The results show that the model greatly underestimates the vertical profile of ice crystal concentrations for both cases. This discrepancy is primarily attributed to a warmer temperature in simulation. The sensitivity analysis was also conducted to investigate the impact of model configurations. The results indicate that increasing the vertical resolution will improve the simulation of liquid water content (LWC) and cloud altitude. Furthermore, modifying the ABL or microphysics schemes notably influences cloud top and base altitudes also the IWC and LWC. Finally, increasing the Cloud Condensation Nuclei (CCN) concentration leads to deeper clouds and higher LWC. This occurs because higher droplet numbers reduce the effective radius, thereby lowering the auto-conversion rate and suppressing precipitation .

Keyword

Mixed-Phase Cloud (MPC)

Reference

Arteaga, D., Planche, C., Tridon, F., Dupuy, R., Baudoux, A., Banson, S., Baray, J.-L., Mioche, G., Ehrlich, A., Mech, M., Mertes, S., Wendisch, M., Wobrock, W., & Jourdan, O. (2024). Arctic mixed-phase clouds simulated by the WRF model: Comparisons with ACLOUD radar and in situ airborne observations and sensitivity of microphysics properties. *Atmospheric Research*, **307**, 107471. https://doi.org/10.1016/j.atmosres.2024.107471