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Modelling mixed-phase summertime Antarctic clouds with aerosol-aware double-moment microphysics

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Clouds contribute towards strong shortwave surface radiation biases across the Southern Ocean and coastal Antarctic regions in global climate models (Hyder et al., 2018). Our poor understanding of microphysical processes driving their small-scale structure limits our ability to accurately represent them in atmospheric and coupled models across spatial scales. To improve our cloud modelling capability, we must develop the subgrid-scale parametrizations controlling cloud microphysics in cloud-resolving models with comparison to in-situ measurements. However, bulk microphysics schemes in such models traditionally offer a single-moment or simplistic double-moment representation of hydrometeor mass and number concentrations, with prescribed droplet number concentrations often used, and rarely consider the role of aerosol-cloud interactions.

Here, we show how the aerosol-aware Thompson-Eidhammer microphysics scheme (Thompson and Eidhammer, 2014) in the Weather Research and Forecasting model performs at modelling coastal Antarctic clouds by comparing with airborne observations made during the Microphysics of Antarctic Clouds campaign. This state-of-the-art microphysics scheme utilises an externally-calculated climatology of global aerosol concentrations to provide spatially-dependent estimates of the number of aerosol particles which may facilitate the formation of ice crystals or cloud droplets. By including this link to aerosol particles, we show that spatially-dependent aerosol concentrations can strongly influence the optical properties and precipitation production from these polar clouds.

References:
Hyder et al., (2018): Critical Southern Ocean climate model biases traced to atmospheric model cloud errors, Nature Communications, doi:10.1038/s41467-018-05634-2
Thompson and Eidhammer (2014): A Study of Aerosol Impacts on Clouds and Precipitation Development in a Large Winter Cyclone, J. Atmos. Science, doi:10.1175/JAS-D-13-0305.1