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An evaluation of kilometre scale ICON simulations of mixed-phase stratocumulus over the Southern Ocean during CAPRICORN

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Stratocumulus (Sc) clouds cover between 25% to 40% of the mid-latitude oceans, where they substantially cool the ocean surface. Many climate models poorly represent these marine boundary layer clouds in the lee of cold fronts in the Southern Ocean (SO), which yields a substantial underestimation of the reflection of short wave radiation. This results in a positive mean bias of 2K in the SO. The representation of stratocumulus clouds, cloud variability, precipitation statistics, and boundary layer dynamics within the ICON-NWP (Icosahedral Nonhydrostatic – Numerical Weather Prediction) model at the km-scale is evaluated in this study over the SO.

Real case simulations forced by ERA5 are performed with a two-way nesting strategy down to a resolution of 1.2 km. The model is evaluated using the soundings, remote sensing and in-situ observations obtained during the CAPRICORN (Clouds, Aerosols, Precipitation, Radiation, and Atmospheric Composition over the Southern Ocean) field campaign that took place during March and April 2016. During two days (26^{th} to 27^{th} of March 2016), open-cell stratocumuli were continuously observed by the shipborne radars and lidars between 47°S 144°E and 45°S 146°E (South of Tasmania). Our simulations are evaluated against the remote sensing retrievals using the forward simulated radar signatures from PAMTRA (Passive and Active Microwave TRAnsfer).

The initial results show that the observed variability of various cloud fields is best captured in simulations where only shallow convection is parameterised at this scale. Furthermore, ICON-NWP captures the observed intermittency of precipitation, yet the precipitation amount is overestimated. We further analyse the sensitivity of the cloud and precipitation statistics with respect to primary and secondary ice-phase processes (such as Hallett–Mossop and collisional breakup) in ICON-NWP. Both processes have previously been shown to improve ice properties of simulated shallow mixed-phase clouds over the Southern Ocean in other models.