1. Objective
To evaluate the representation of mixed-phase stratocumulus clouds, cloud variability, precipitation statistics, and boundary layer dynamics in ICON-NWP model at the km scale resolution.
To analyse the sensitivity of the clouds and precipitation statistics with respect to primary and secondary ice-phase processes (such as Hallett-Mossop and collisional breakup) in ICON-NWP.

2. Motivation
Boundary layer/low-level Mixed-Phase Clouds (MPCs) - a major source of uncertainty in climate models with significant implications to cloud feedback and climate sensitivity.
Error due to the deficit of reflected shortwave radiation (SW) at the top-of-atmosphere (TOA) in the current climate models is largest over the Southern Ocean (SO) (Trenberth et al., 2010).
Climate models poorly simulate the clouds with supercooled liquid tops, where they contribute between 27% and 38% of the total reflected solar radiation between 40°S and 70°S (A. Bodas-Salcedo, 2016).
This results in a positive mean bias of 2 K in the annual mean SST over the SO averaged across several climate models (Wang et al., 2014).
Clouds during frontal passage are represented to a significant level in WRF, however, they are poorly represented in the postfrontal environment (Huang et al., 2014).

3. Model configuration
ICON-NWP - Limited area model with two-way nesting strategy.
Radiation - RRTM (Mlawer et al., 1997; Barker et al., 2003).
Cloud microphysics and precipitation - Two-moment microphysics scheme (Seifert et al., 2006).
ERAS - Initial conditions; lateral boundary conditions (1 hr interval).
Time period: 26-03-2016T00:00:00Z to 28-03-2016T00:00:00Z.
Initialized twice for better numerical accuracy (first 12 hours as spin-up period):
25-03-2016T12:00:00Z to 27-03-2016T00:00:00Z.
26-03-2016T00:00:00Z to 28-03-2016T00:00:00Z.
Vertical levels in boundary layer & Model top: 30 & 23 km.
Model output: 1 minute interval.

5. Preliminary analysis
5.1 Cloud vertical structure

5.2 Cloud base phase statistics

6. Conclusion
Observation: CAPRICORN: Clouds, Aerosols, Precipitation, Radiation, and Atmospheric Composition over the Southern Ocean (CSIRO, IN2016_V02, Mace et al., 2018).
Characterize: Cloud and precipitation properties, boundary layer structure. Open-cell stratocumulus were continuously observed by the shipborne radars and lidars between 47°S 144°E and 45°S 146°E (South of Tasmania).

References
Mace et al., AMS (2018).
Mech et al., Geosci. Model Dev (2020).
Mlawer et al., J Geophys Res-Atmos (1997).
Trenberth et al., J. Climate (2010).