

EarthCARE observations for evaluating and improving polar clouds in the regional climate model RACMO2.4



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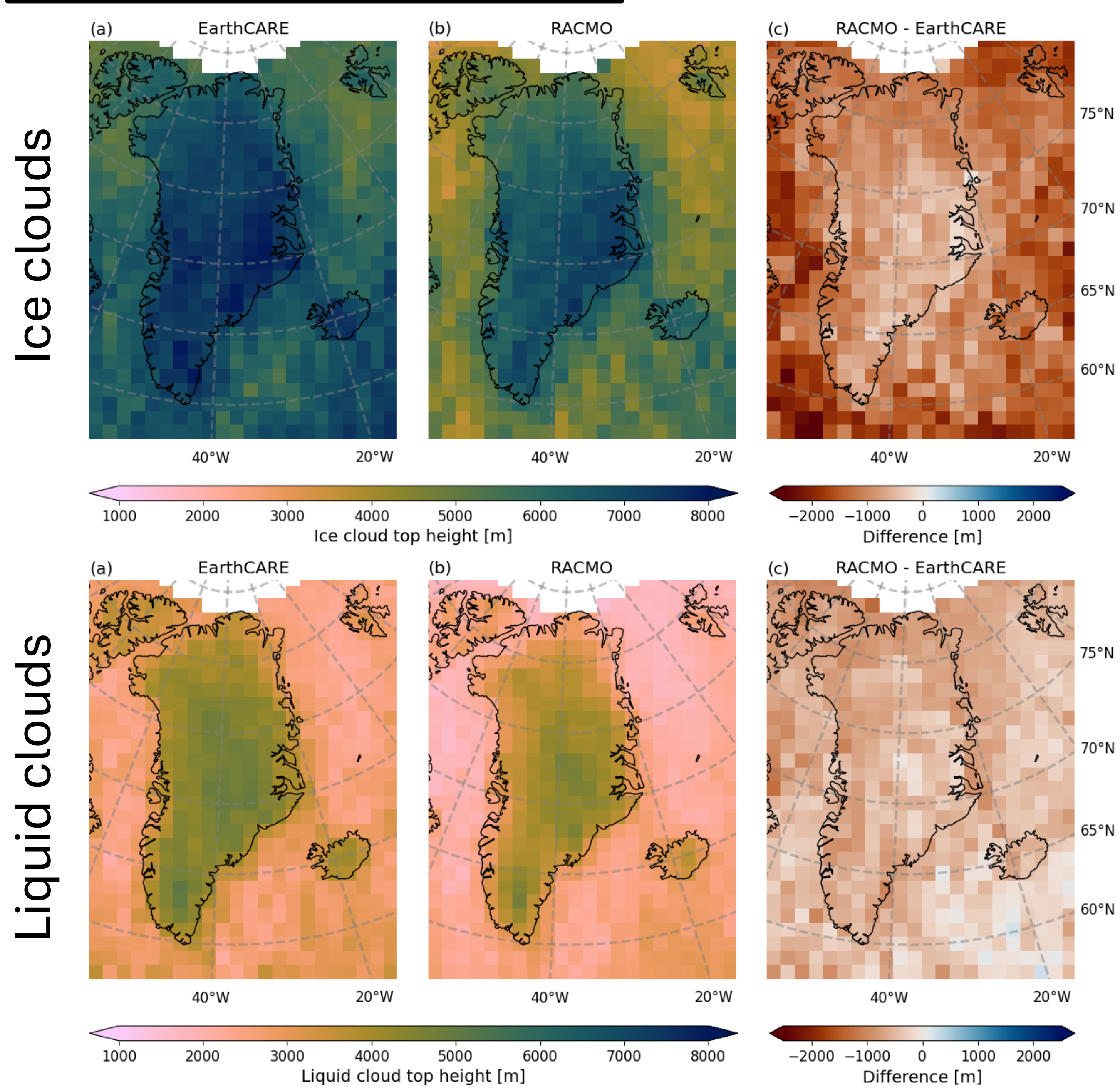
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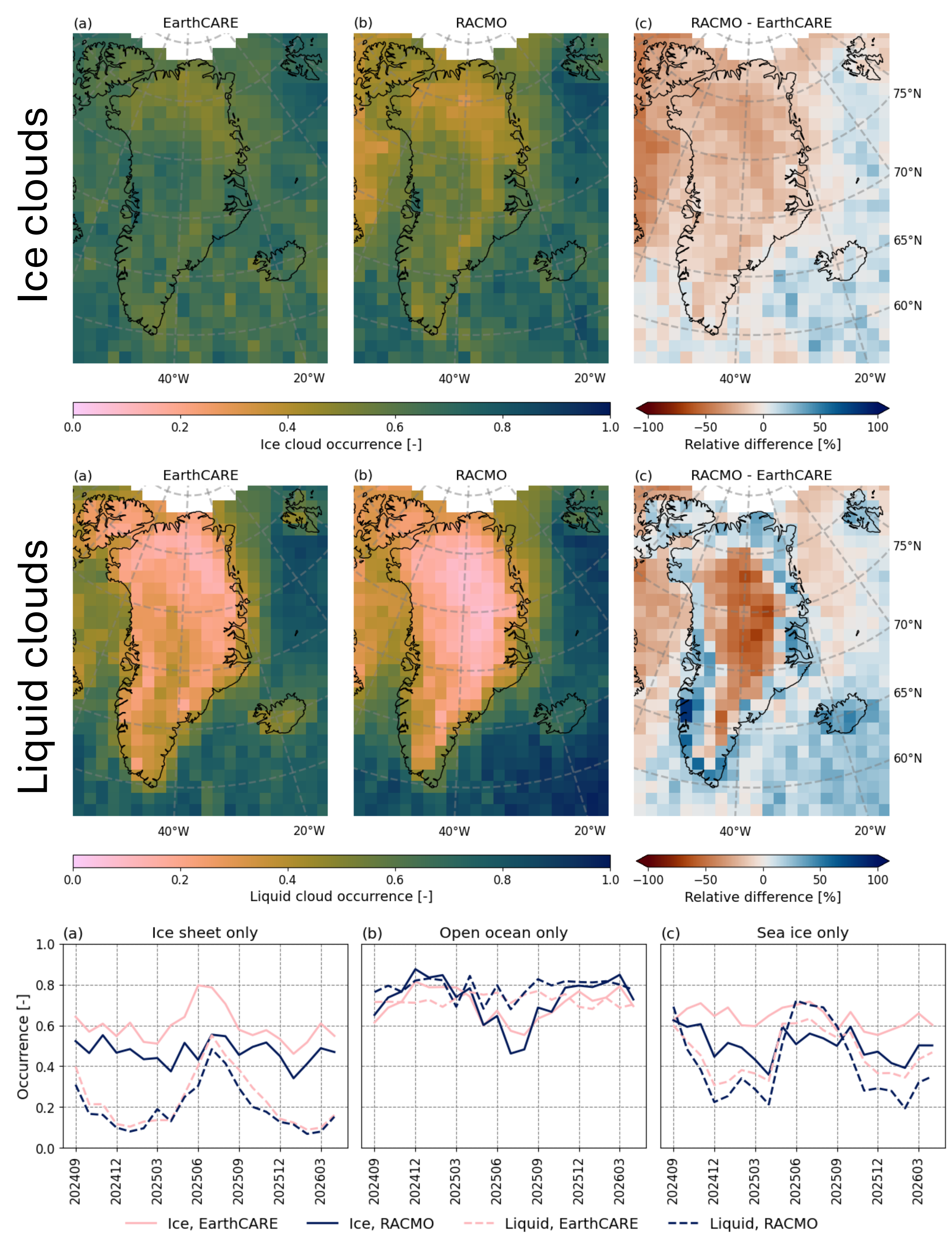
Evaluating clouds in RACMO2.4

Clouds strongly influence surface melt on ice sheets by blocking shortwave radiation, trapping longwave radiation, and modulating the surface albedo through snow- and rainfall. Their representation introduces large uncertainties in regional climate models, used to estimate ice sheet surface melt. We use **EarthCARE (ACM-CAP) observations to evaluate clouds in the polar regional climate model RACMO (v2.4p1)**. Using a **co-location approach**, we compare EarthCARE observations with RACMO model output for September 2024 – April 2026. The RACMO simulations cover the Greenland region at 5.5 km resolution and are forced with ERA5. RACMO uses ECMWF Integrated Forecasting System (cy47r1) physics, with prognostic ice, liquid, snow, and rain and single-moment microphysics.

Too low cloud tops



Contrasting cloud patterns



Conclusions

- Over the Greenland region, there are **contrasting patterns** in cloud occurrence, where cloud occurrence is generally overestimated over the open ocean and underestimated over ice sheets and sea ice, with **seasonal differences**.
- Ice and liquid **top height is strongly underestimated**. In the ice phase, thin high clouds are missed, while in the liquid phase, supercooled liquid water cannot persist long enough under low temperatures.
- The average **IWP is strongly underestimated**, mainly because RACMO does not capture the thickest ice clouds and heavy snowfall events.

Open questions

- What is the best way to constrain liquid cloud properties using EarthCARE?
- How uncertain are EarthCARE's retrieved ice cloud mixing ratios?

Next steps

- Evaluate cloud representation over Antarctica for the same period
- Improve RACMO's cloud microphysical scheme for use in the polar regions
 - Cloud formation processes (e.g., homogeneous nucleation)
 - Mixed-phase processes (e.g., Wegener-Bergeron-Findeisen process)
 - Precipitation processes (e.g., fall speed, droplet number, convection)
 - Cloud – radiation interaction

Missing thin and thick clouds

