Fast Change of Phase Partitioning in the Mixed-Phase Stratiform Clouds was observed at McMurdo Station (77°51'S, 166°40'E) on Ross Island, Antarctica, on 31 March 2016 during the ARM West Antarctic Radiation Experiment (AWARE).

Evaluating the effect of coupled-to-decoupled transition of the atmospheric boundary layer on the phase partitioning in the mixed-phase stratiform clouds

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Model setup

The simulation is similar to ISDAC case (Ovchinnikov et al., 2014) with some modifications.

Model: SAM 6.11.2

Resolution: 50 m x 50 m x 10 m

Domain: 3.2 km x 3.2 km x 1.5 km

Total time: 12 hours

Initial profiles: Sounding at 10:14 UTC

Radiation: longwave from NCAR CAM3 model

Microphysics: Morrison et al. (2009)

Forcing: large-scale subsidence

Nudging: u, v

Surface:

1. Control run: no surface flux
2. Three ways to generate surface inversion:
   - * nudging
   - * negative sensible heat flux
   - * Monin-Obukhov + surface T forcing

Effect of boundary layer structure on the phase partitioning

For all cases, we do not see fast change of phase partitioning. Increasing the thickness of surface inversion layer will decrease the thickness of the mixing layer, thus weaken the turbulent strength in the mixing layer, and lose the ability to recycle large ice particles, which compensates the thermodynamic benefit of IWP enhancement for a decoupled boundary layer as proposed in Yang et al. (2015). The coupled-to-decoupled transition of the atmospheric boundary layer is unlikely to be the main cause of the observed fast change of phase partitioning.

Possible mechanisms

Yang et al. (2015) suggested that IWP in a decoupled field is larger than that in a coupled field with the same mixed-phase cloud thickness and ice nucleation rate.

Motivation:

Is the coupled-to-decoupled transition of the atmospheric boundary layer the cause or the result of the fast change of phase partitioning in the mixed-phase stratiform clouds?

Important effect of ice number concentration

Ice number concentration effect without surface flux

Ice number concentration effect with surface flux