Effects of decoupling boundary layer on the change of phase partitioning in the mixed-phase stratiform clouds

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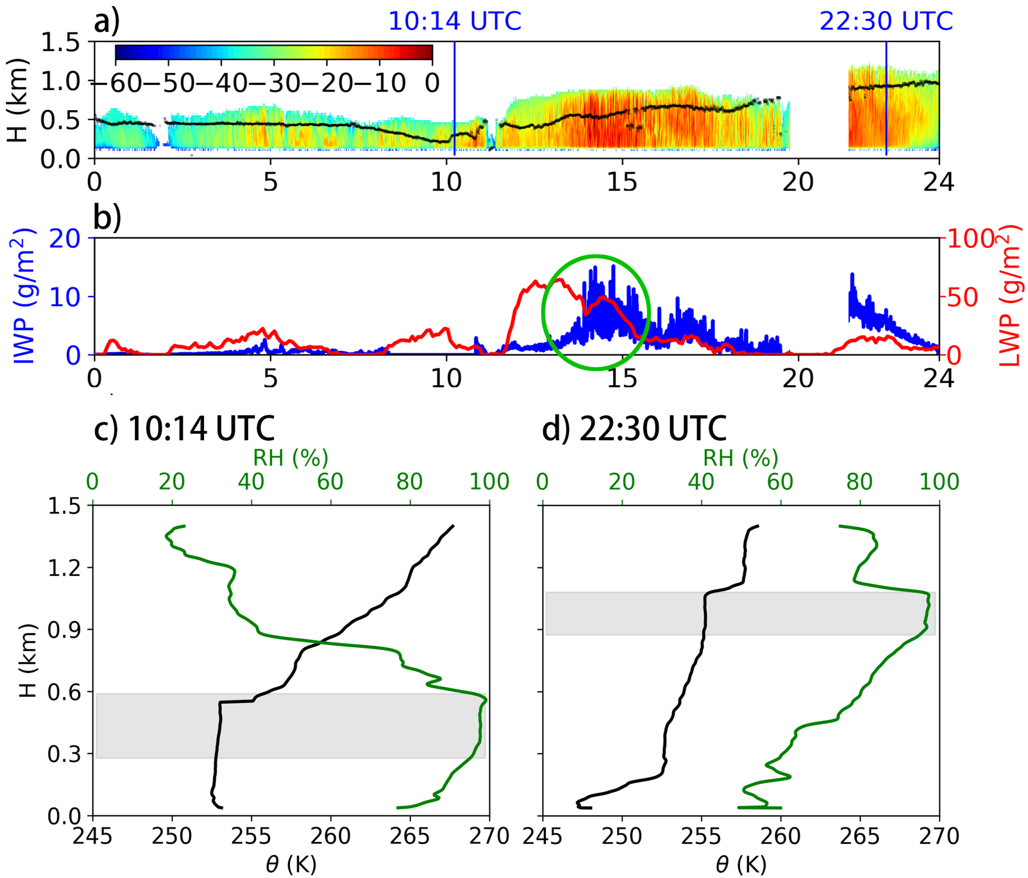
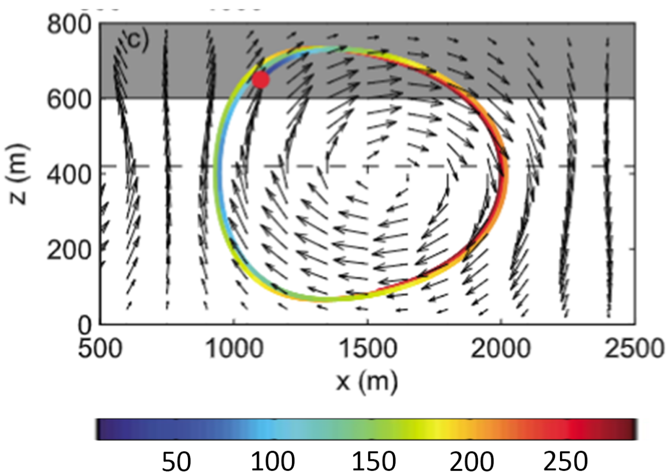
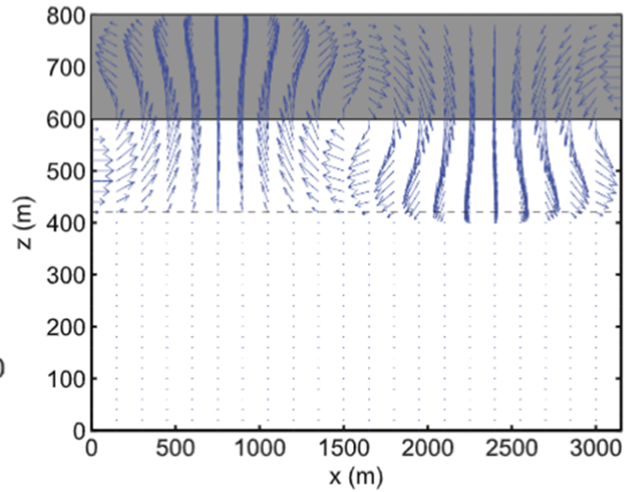


Effect of decoupled PBL on phase partitioning



coupled

low IWP



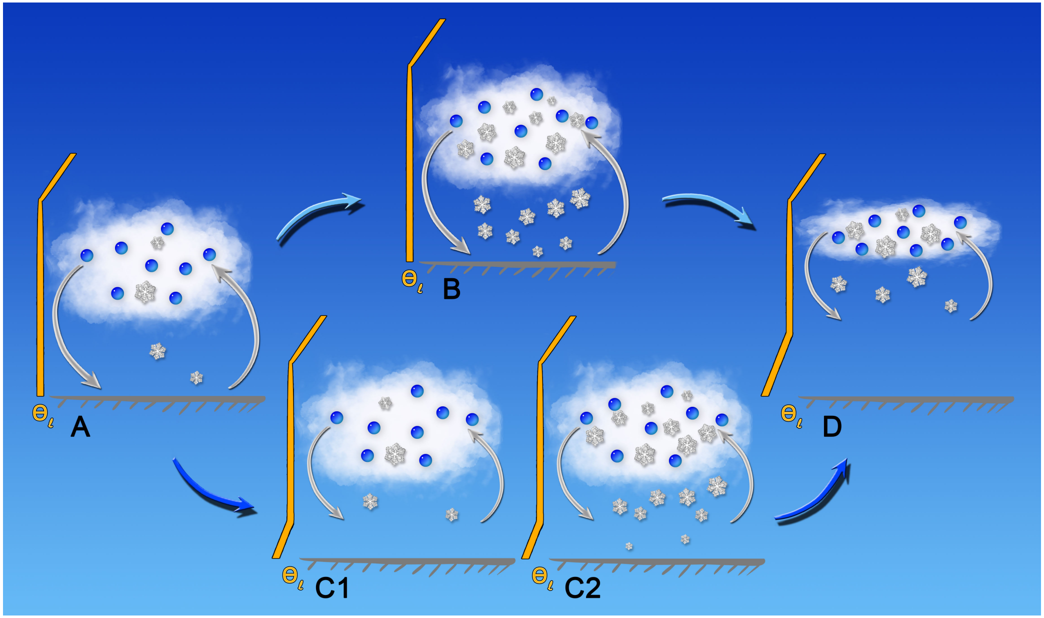
decoupled

high IWP

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[1].

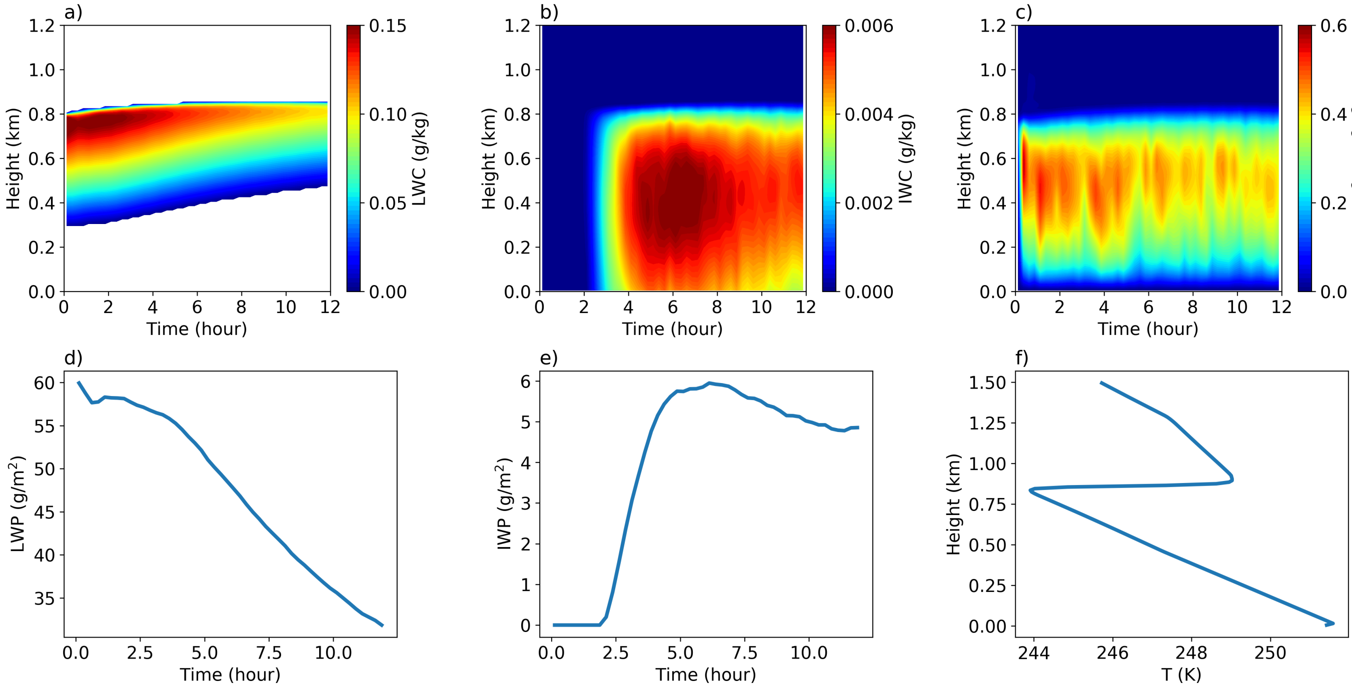
1. Yang et al., JGR, 2015

Working hypothesis



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?

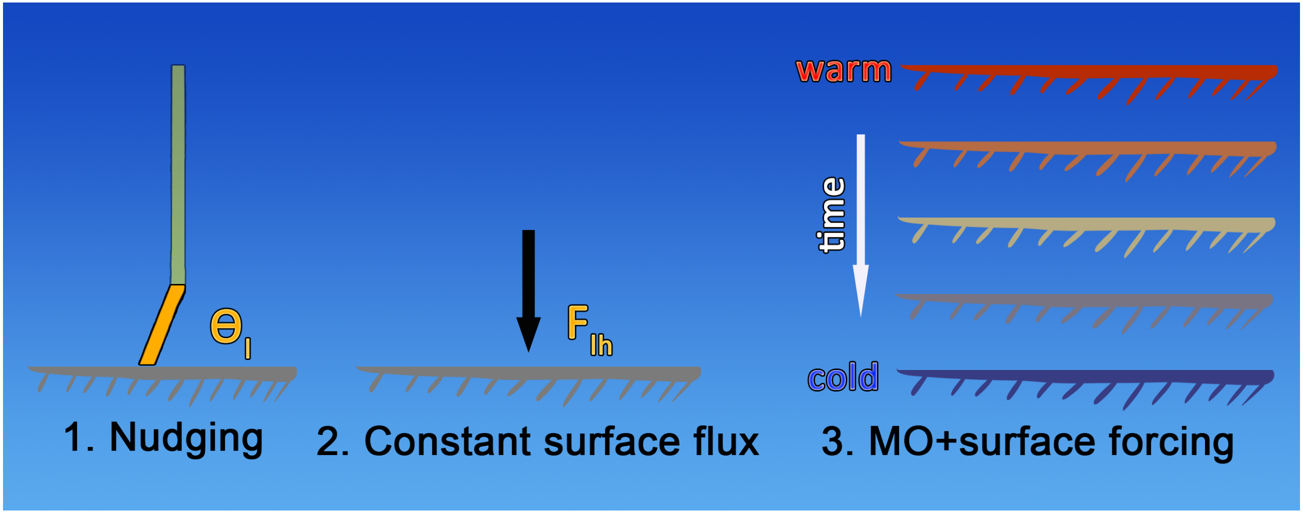
Control run



This simulation is similar to the ISDAC[1] case.

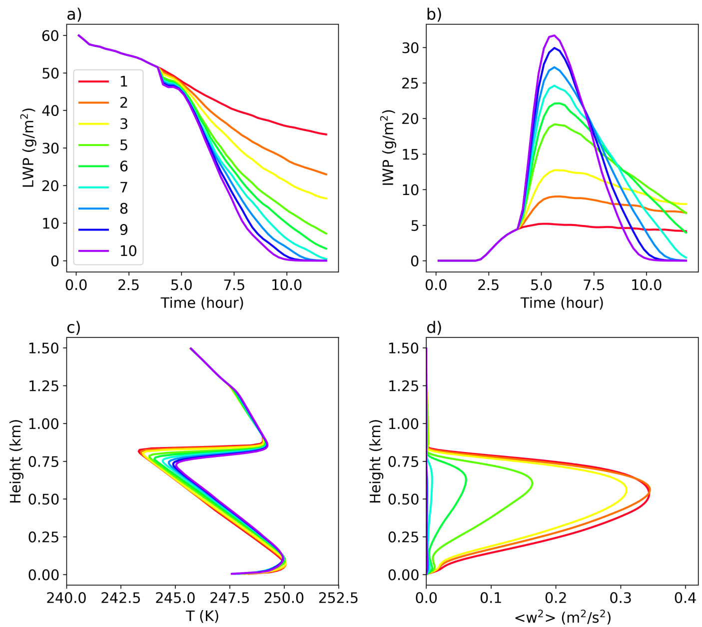
1. Ovchinnikov et al., JAMES, 2014

Ways to generate surface inversion



Conclusion I: Decoupled PBL has **minor** effect in LWP and IWP. For details, please come to see our poster **B2-99**.

Important effect of ice number concentration



Conclusion II: The "only" way that I can mimic the observation is considering both **the change of ice number concentration** (fast change of phase partitioning) and **land-atmosphere interaction** (surface inversion).

Lines in the figure represent different values of ice number concentration (L^{-1}) in the mixed-phase clouds.

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Conclusion and discussion

- Changing ice number concentration significantly alter the LWP and IWP time evolution.
- Addition of surface flux/inversion reduces the intensity of BL turbulence ($< w^2 >$) and introduces **minor** quantitative changes in LWP and IWP.
- 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.

Please come to see our poster **B2-99**.

Backup Slides

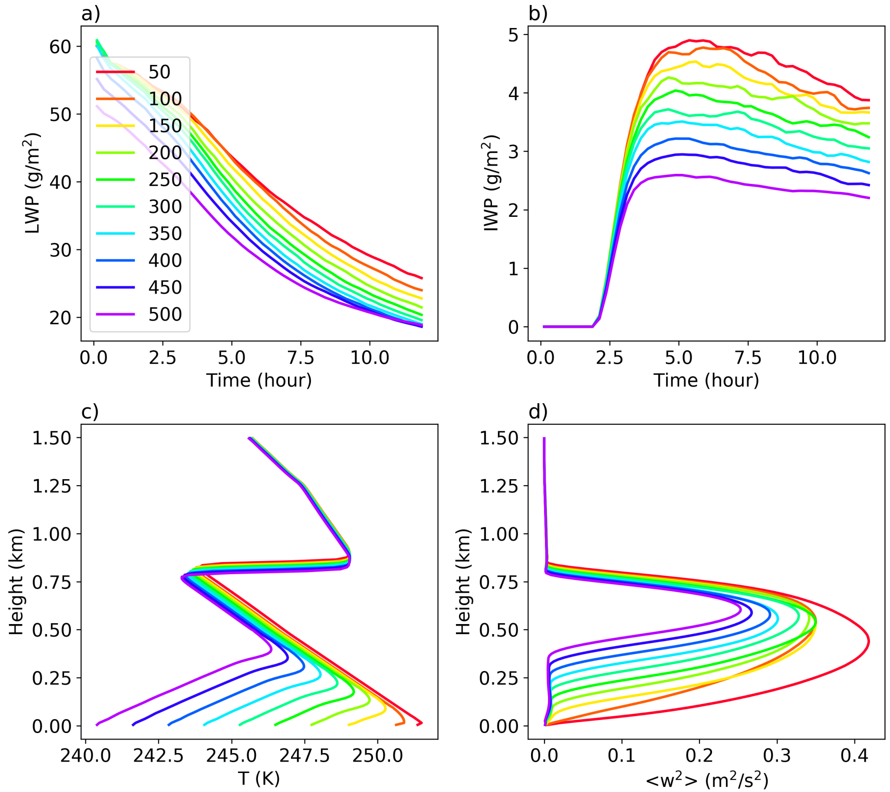
Model setup

The simulation is similar to ISDAC[1] case with some modifications.

Model	:	System for Atmospheric Modeling[2] (SAM 6.11.2)
Resolution	:	50 m $\times$ 50 m $\times$ 10 m
Domain	:	3.2 km $\times$ 3.2 km $\times$ 1.5 km
Total Time	:	12 hours
Profiles	:	Sounding at 10:14 UTC
Radiation	:	longwave radiation from NCAR CAM3 model
Microphysics	:	Morrison (2009) two-moment μphysical scheme[3]
Forcing	:	w_{ls}
Nudging	:	u, v, θ_l, q_t
Surface	:	no flux, MO+surface forcing, constant flux

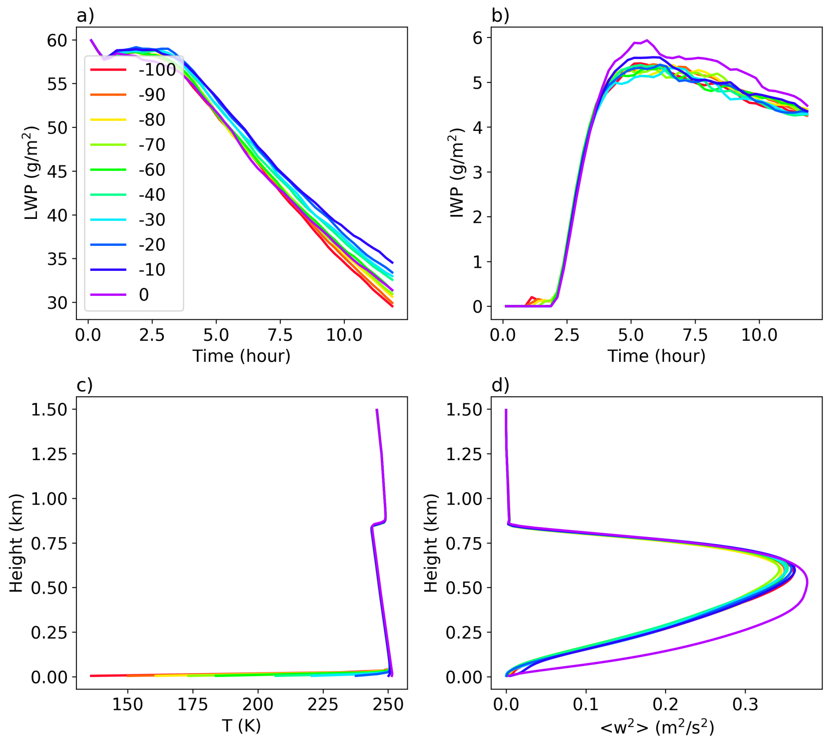
1. Ovchinnikov et al., JAMES, 2014 2. SAM
3. Morrison et al., MWR, 2009

(1) Nudging-induced inversion layer



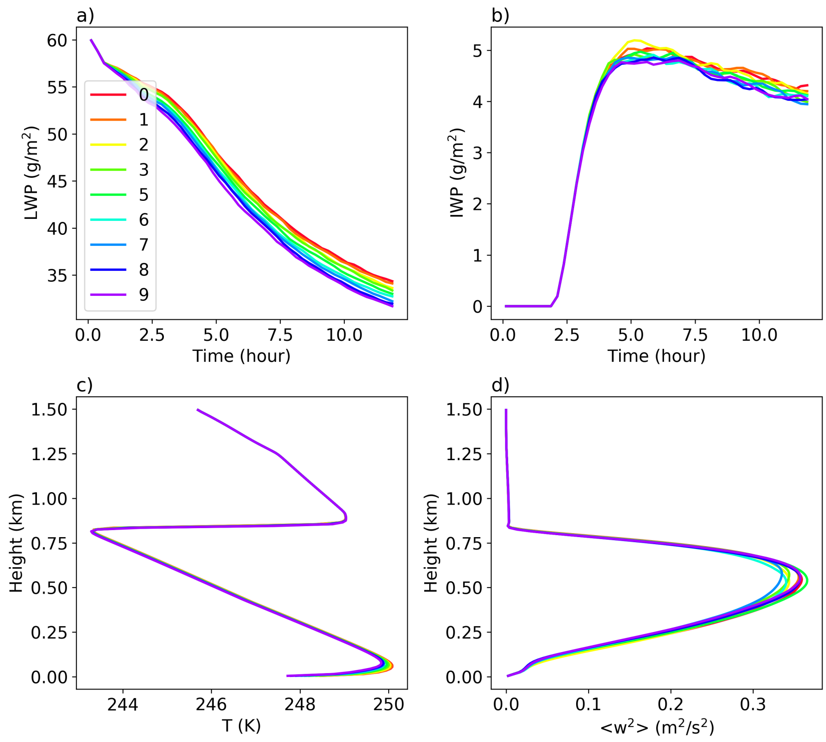
Lines in the figure represent different thicknesses of the nudged-inversion layers above the surface.

(2) F_{lh}-induced inversion layer



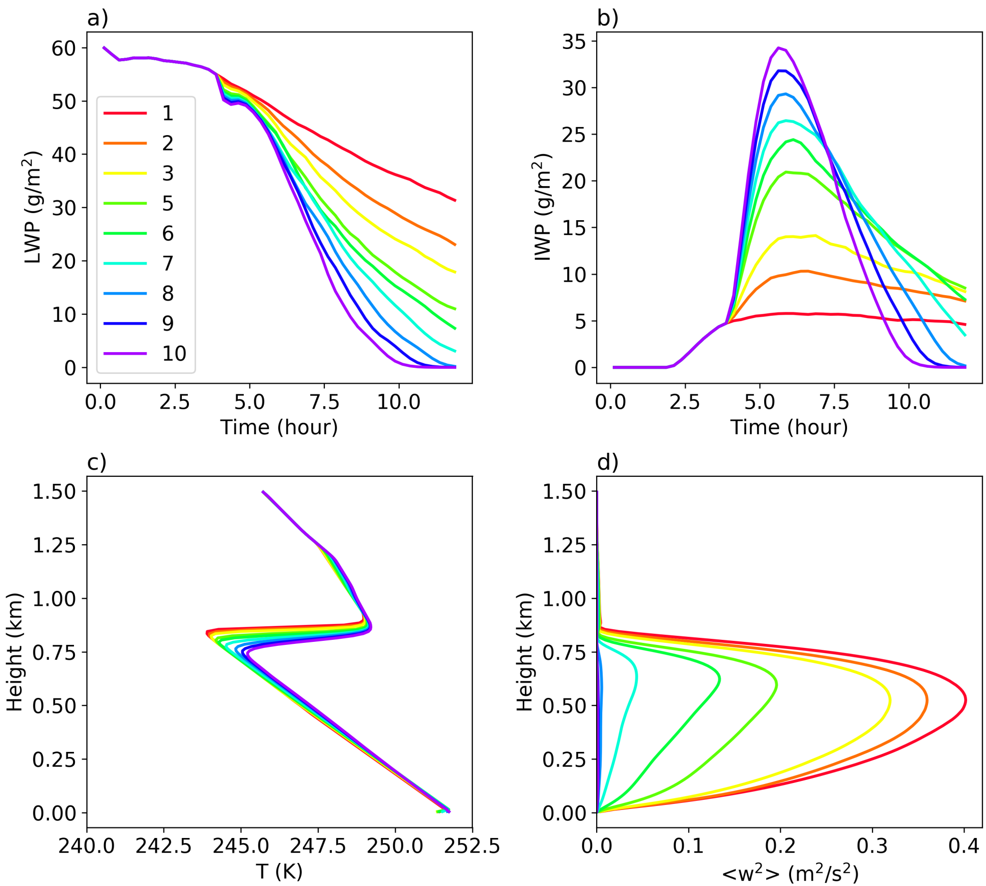
Lines in the figure represent different values of F_{lh} at the surface.

(3) T_s-induced inversion layer



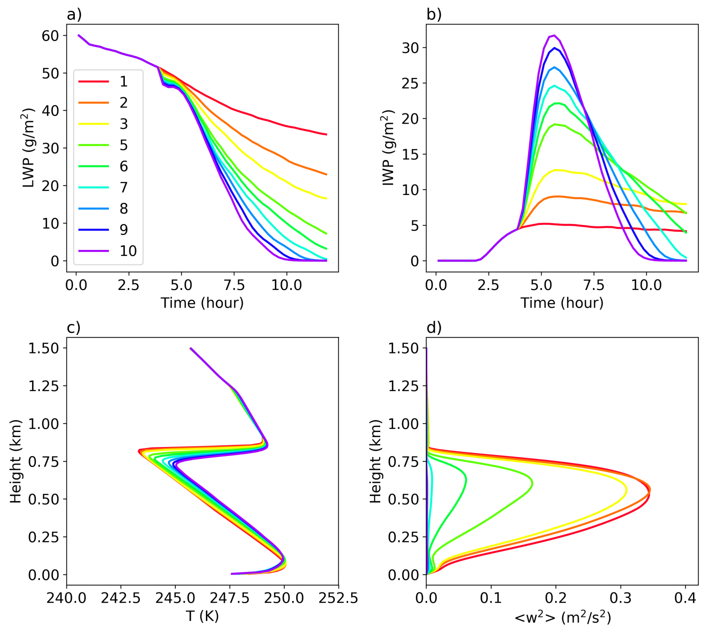
Lines in the figure represent different values of $z_0 = 2^n \times 10^{-4}$ at the surface.

Effect of change of ice number concentration



Lines in the figure represent different values of ice number concentration (L^{-1}) in the mixed-phase clouds.

Important effect of ice number concentration



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