



Supplement of

Intercomparison of the weather and climate physics suites of a unified forecast–climate model system (GRIST-A22.7.28) based on single-column modeling

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Text S1. Sensitivity experiment of PBL turbulence schemes for PhysW

The YSU PBL turbulence scheme for PhysW is a nonlocal diffusivity (K)-profile scheme, optimized for simulation of dry convective and nocturnal boundary layers. The UW scheme for PhysC is a second-order turbulence closure scheme based on moist-conserved variables and diagnosed TKE. In this section, the UW moist turbulence scheme is coupled to the PhysW suite and replaces the YSU scheme. The CGILS experiment is conducted and compared with the default configuration of PhysW. Figure S1 shows the time-averaged cloud fraction and cloud liquid water mixing ratio simulated by PhysW (UW) and PhysW (YSU), respectively. Compared with PhysW (YSU), PhysW (UW) increases stratocumulus at CGILS-S11 and better resembles the observation. The water vapor budget shows that moist turbulence for PhysW (UW) increases the moisture transport, reducing the ventilation of shallow convection (Figure S2). This leads to condensation instead of evaporation occurring in the microphysics.

Comparing Figure 7b and Figure S2, shallow convection in PhysW (UW) is still more active than that in PhysC. It confirms that the generation of stratocumulus come from different interactions of sub physical processes between PhysC and PhysW. The collaborative effect of shallow convection and PBL turbulence is the key difference of PhysW to PhysC for the stratiform cloud process. In addition, changes in the PBL turbulence scheme can notably impact this collaborative effect, leading to improved stratocumulus for PhysW.

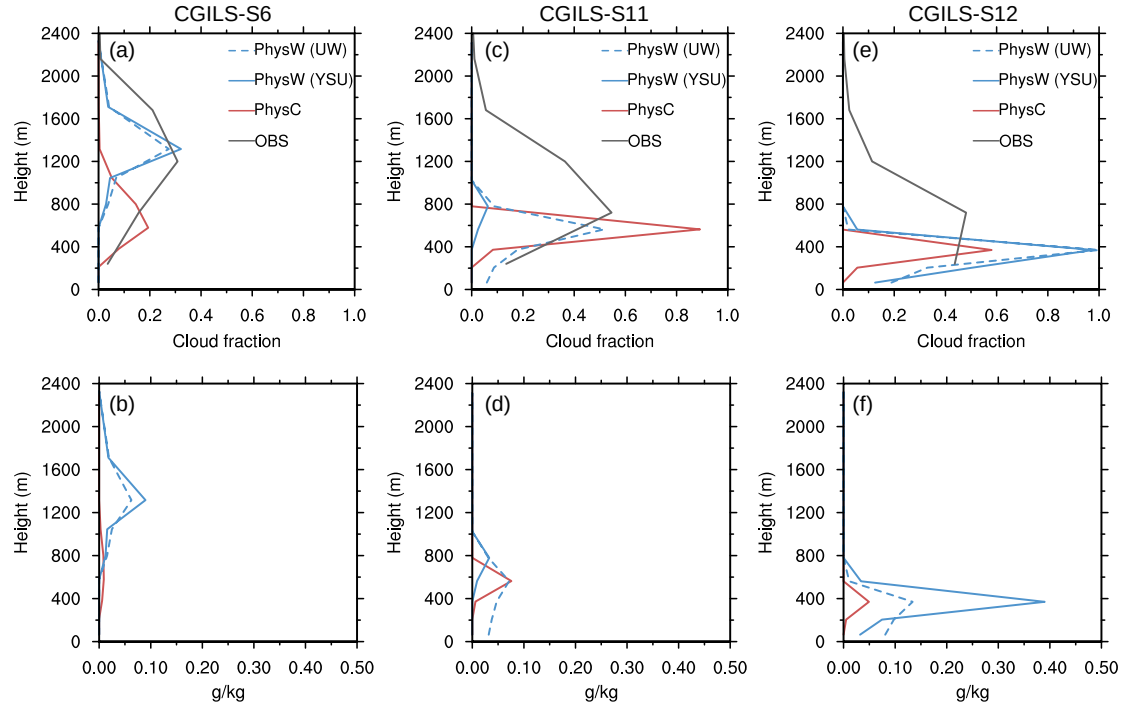


Figure S1: Time-averaged (a) cloud fraction and (b) cloud liquid water mixing ratio (units: g kg^{-1}) for CGILS-S6. Shown are the simulations for PhysC (red solid) and PhysW using YSU scheme (blue solid) and UW scheme (blue dashed), respectively. (c-d) and (e-f) The same as (a-b) but for CGILS-S11 and CGILS-S12. The gray lines in (a-c) show the observation.

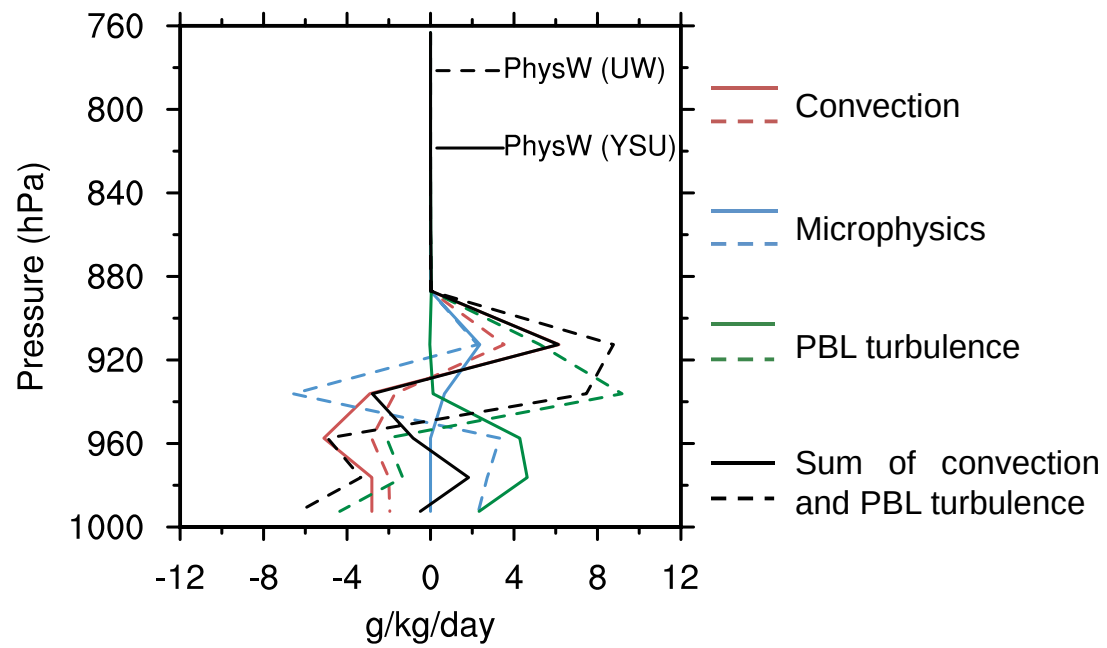


Figure S2: Water vapor budget for PhysW using YSU scheme (solid) and UW scheme (dashed) at CGILS-S11 (units: $\text{g kg}^{-1} \text{ day}^{-1}$). Shown are water vapor tendencies of microphysics (blue), convection (red), PBL turbulence (green), and the sum effect of convection and PBL turbulence (black).