Impacts of Secondary Ice Production on the Microphysics and Dynamics of Deep Convective Clouds in Different Environments

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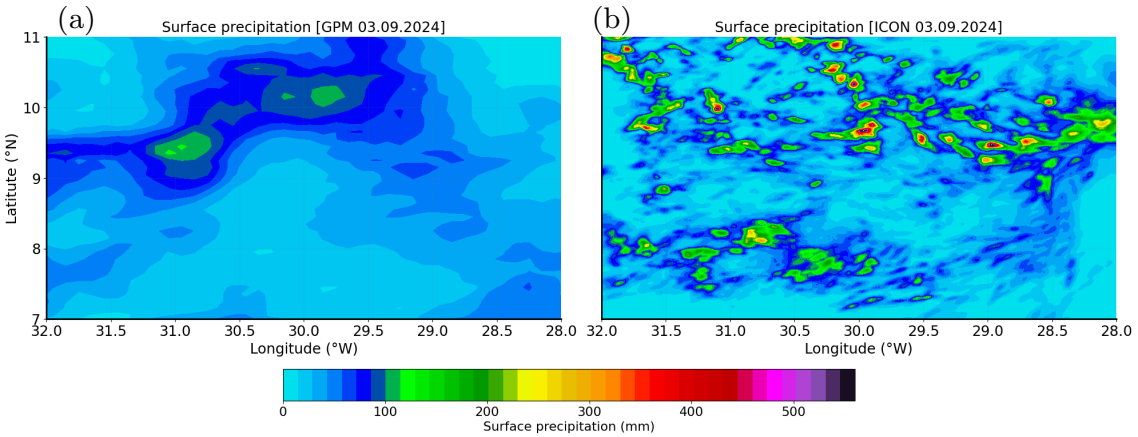

Figure S1: *ICON simulates localized, intense convective cells that are not observed by the GPM*. Spatial distribution of the (a) GPM observed, and (b) ICON simulated (control run) surface accumulated precipitation for 24 h on 3 September 2024 for the ORCESTRA case.

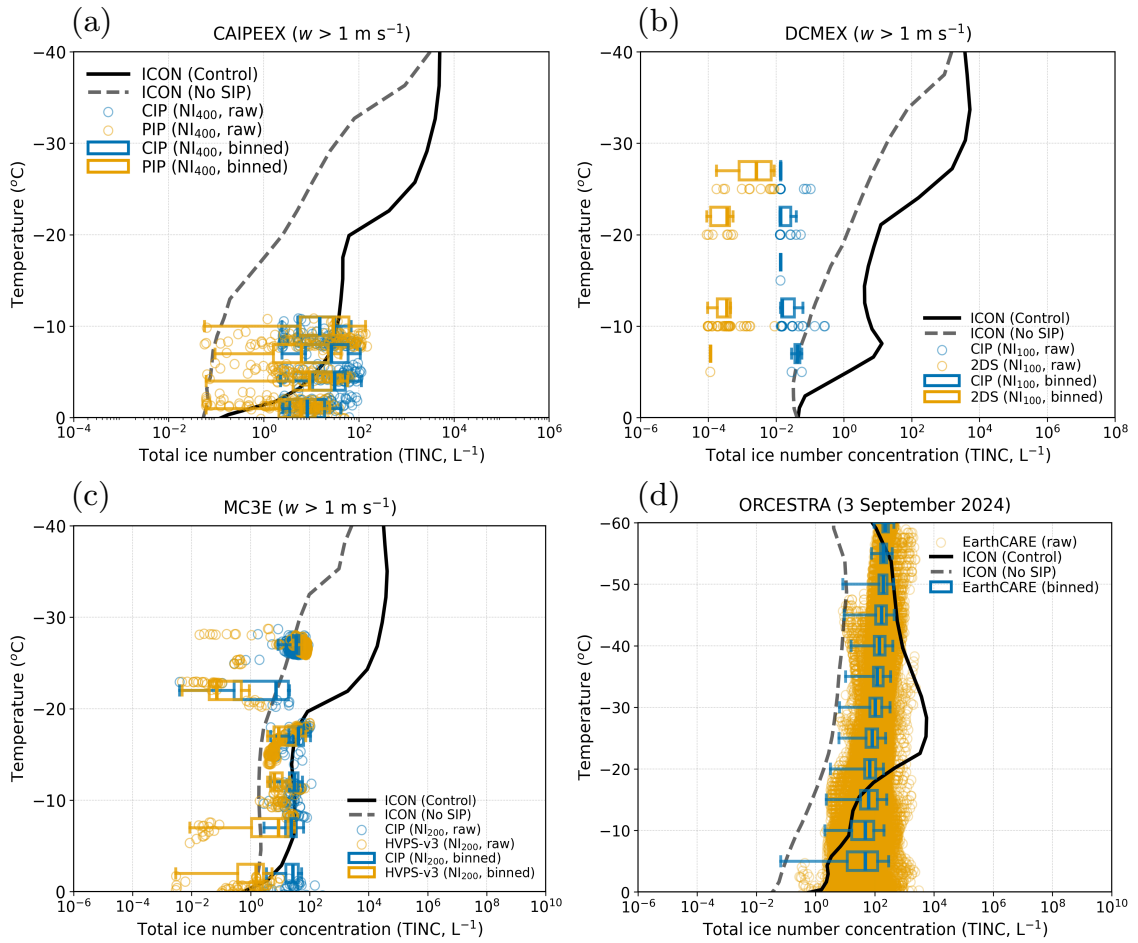

Figure S2: *SIP form the observed ice particle number concentrations in the simulated DCCs*. Total ice number concentrations from the control (solid black line) and No SIP (dashed black line) for the simulated (a) CAIPEEX, (b) DCMEX, (c) MC3E, and (d) ORCESTRA DCCs. These profiles are averaged over cloudy convective updrafts ($w > 1$ m s^{-1}) from the control simulation of line of convection observed on (a) 30 September 2019 during CAIPEEX, (b) 02 August 2022 during DCMEX, (c) 11 May 2011 during MC3E, and (d) 03 September 2024 in ORCESTRA. These profiles are compared with the corresponding NI_{400} observations from CIP and PIP for CAIPEEX, NI_{100} from CIP and 2-DS in DCMEX, NI_{200} from CIP and HVPS-v3 in MC3E, and CPR observations in ORCESTRA.

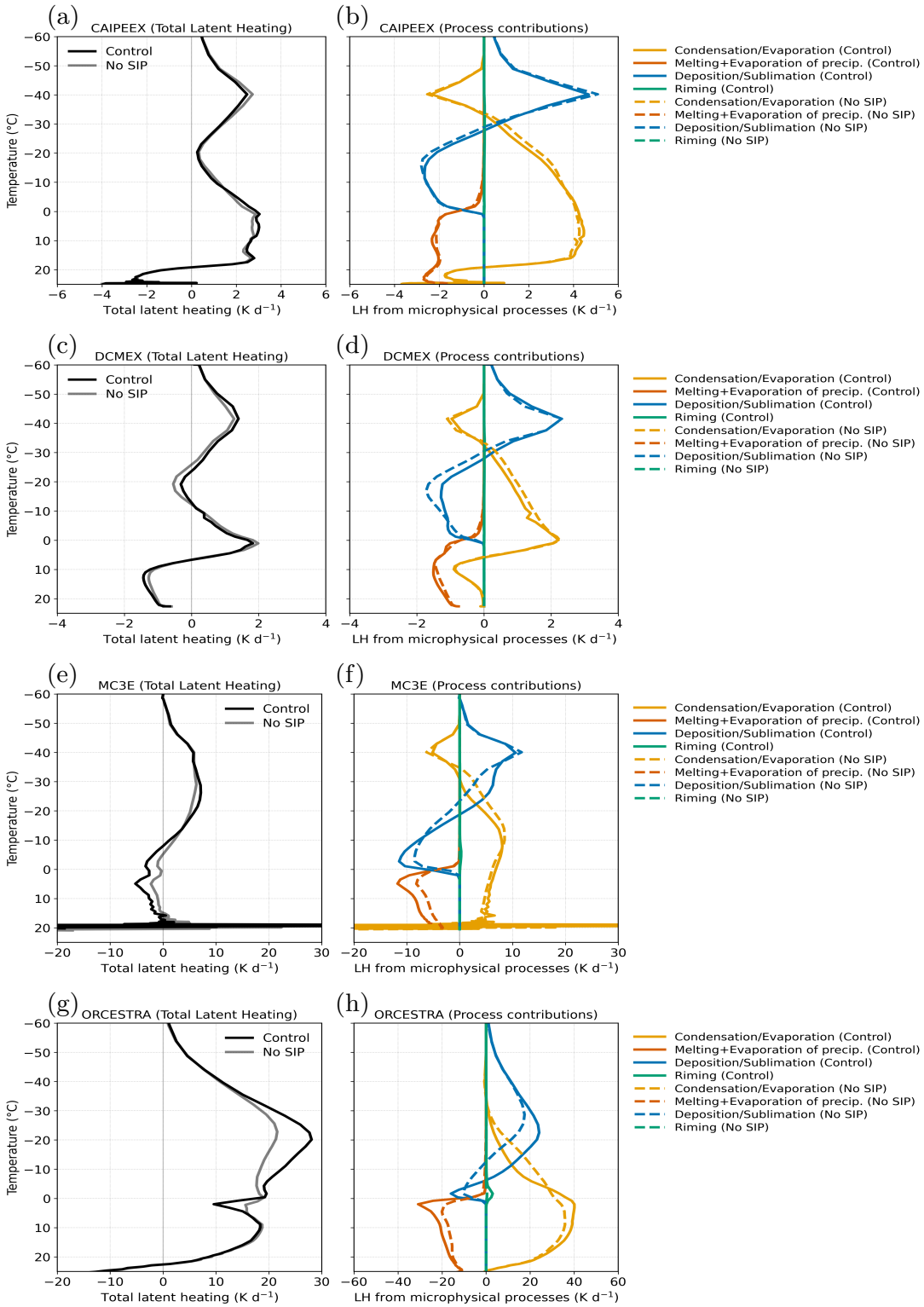

Figure S3: *In the mixed-phase region, SIP enhances diabatic heating through ice-crystal processes.* Domain-averaged latent heating (K d^{-1}) from the control (black lines) and No SIP (gray lines) simulations of (a) CAIPEEX, (c) DCMEX, (e) MC3E, and (g) ORCESTRA clouds. In (b, d, f, h), also shown is the contribution to the total latent heat release from major microphysical processes, such as Deposition/Sublimation (positive/negative values shown with cyan lines), Condensation/Evaporation (positive/negative values shown with orange lines), Riming (green lines), and Melting and Evaporation (pink lines) from the respective control (solid lines) and No SIP (dashed lines) simulations.

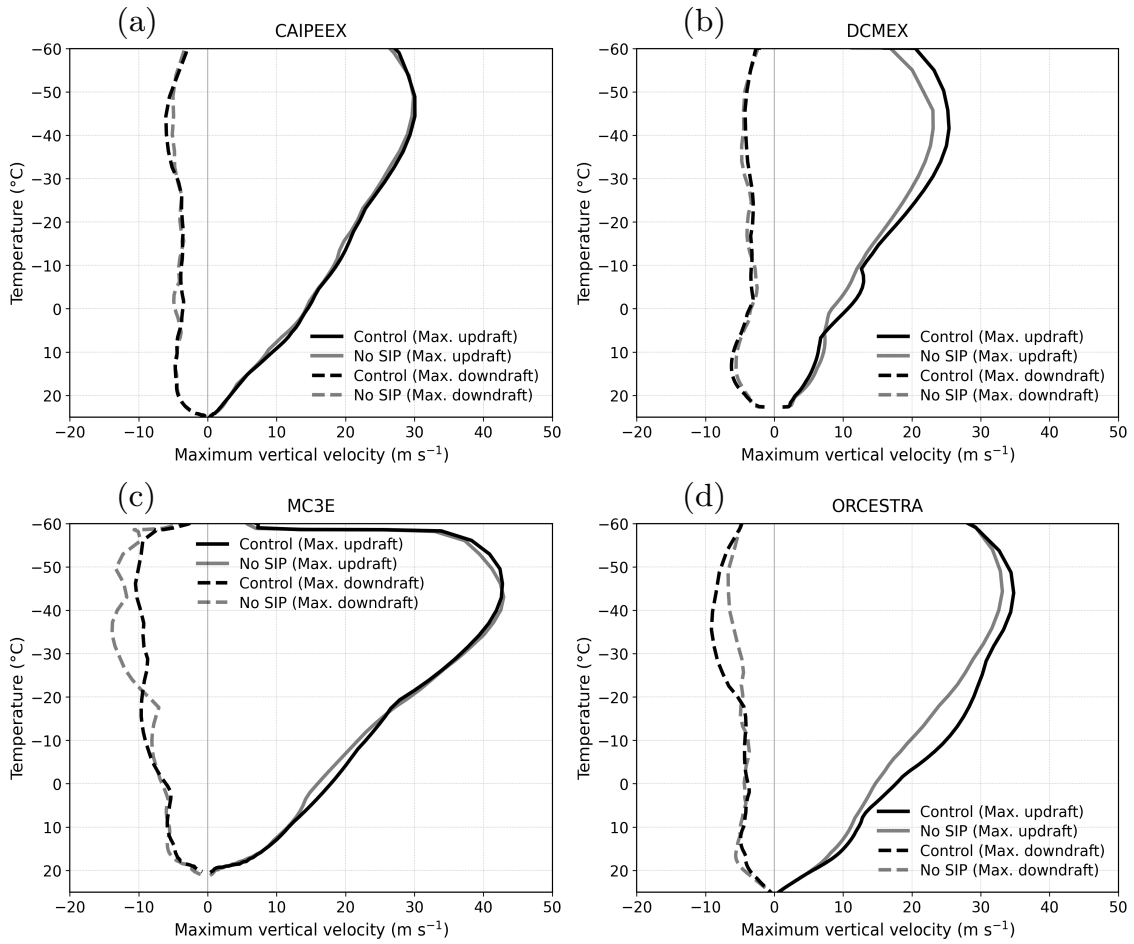

Figure S4: *Through enhanced diabatic heating, SIP increases convective vigor in the simulated DCCs.* The maximum updrafts (black lines) and downdrafts (dashed lines) in the simulated (a) CAIPEEX, (b) DCMEX, (c) MC3E, and (d) ORCESTRA DCCs in their control (black lines) and No SIP (grey lines) simulations.