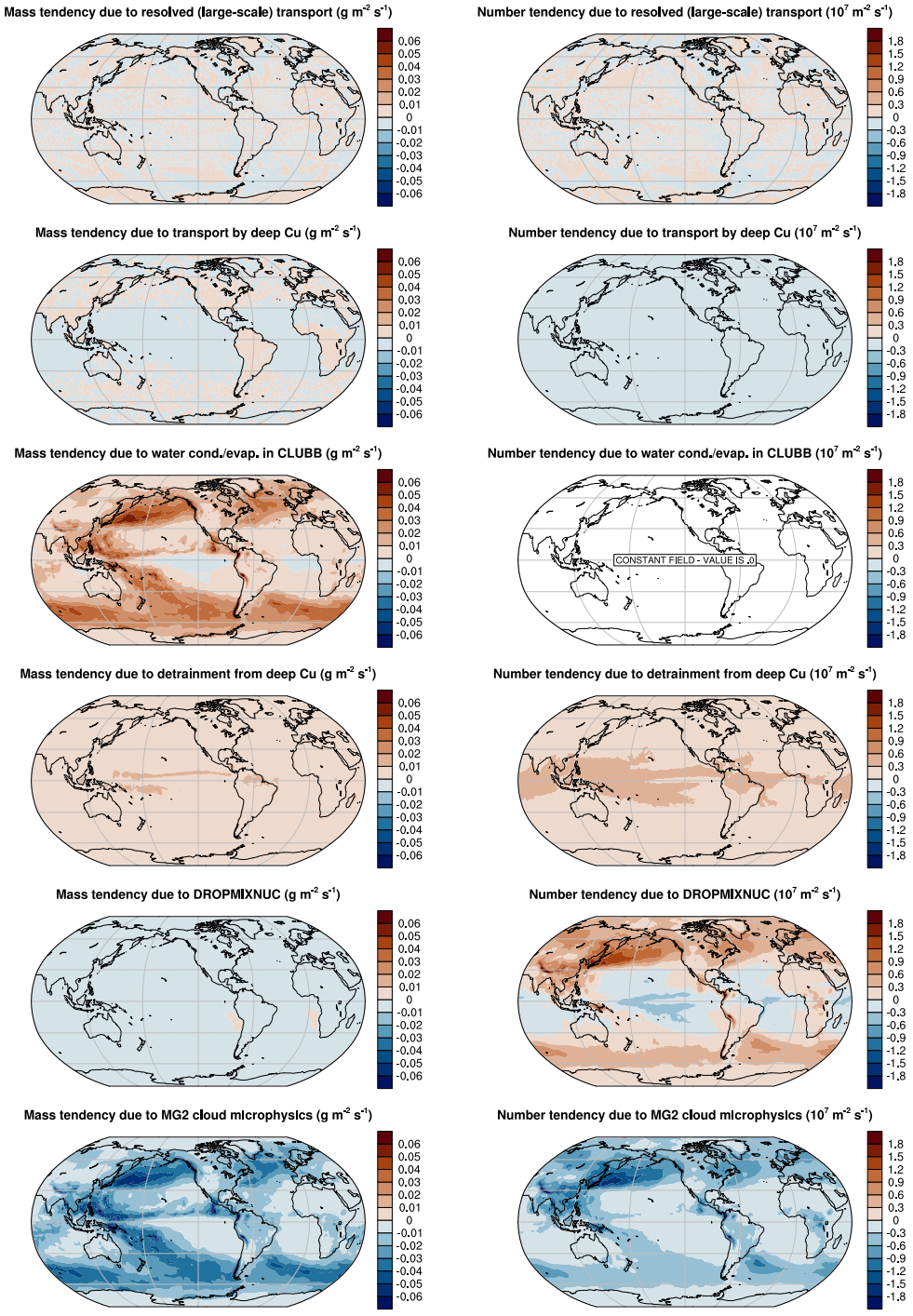

Figure S1. Annual mean tendency of the vertically integrated grid box mean cloud droplet mass (left column, unit: g m^{-2} s^{-1}) and cloud droplet number (right column, unit: 10^7 m^{-2} s^{-1}) in stratiform and shallow convective clouds simulated by EAMv2. The different rows correspond to different physical processes, as indicated in the panel titles.

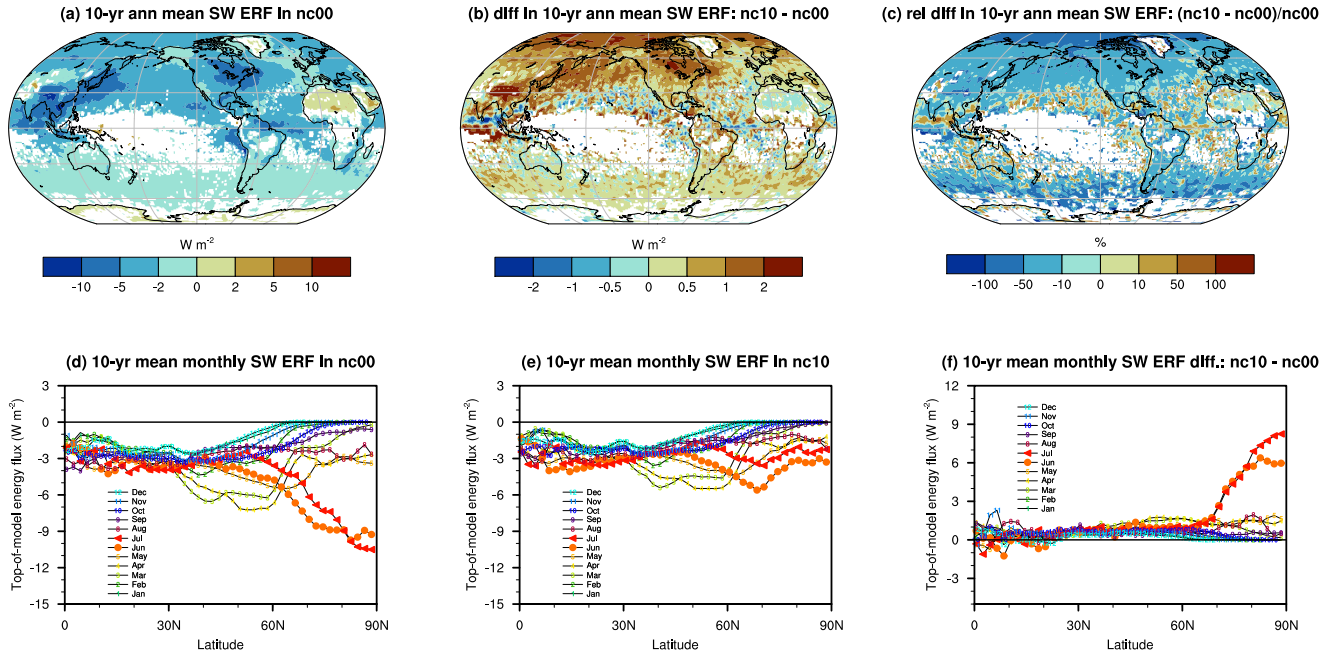

Figure S2. As in Fig. 4 of the paper but showing the shortwave (SW) component of ERF_{aer}.

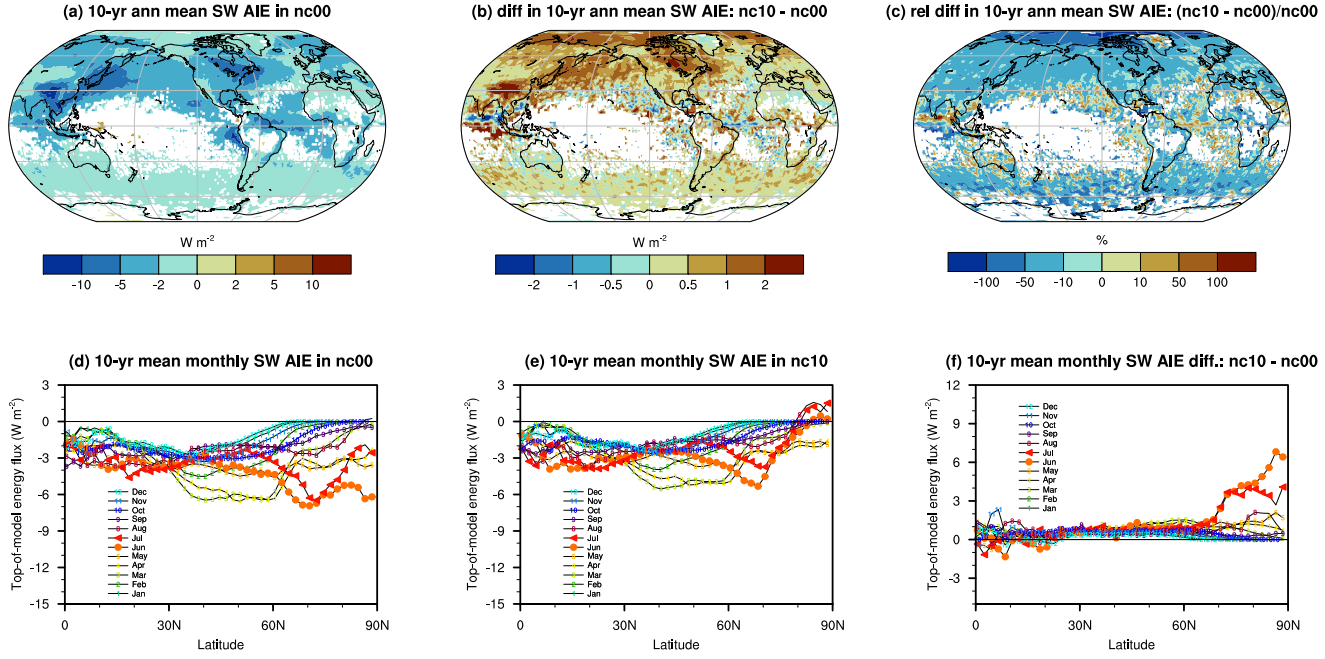

Figure S3. As in Fig. 4 of the paper and Fig. S2 above, but showing the SW component of the aerosol indirect effect (AIE).

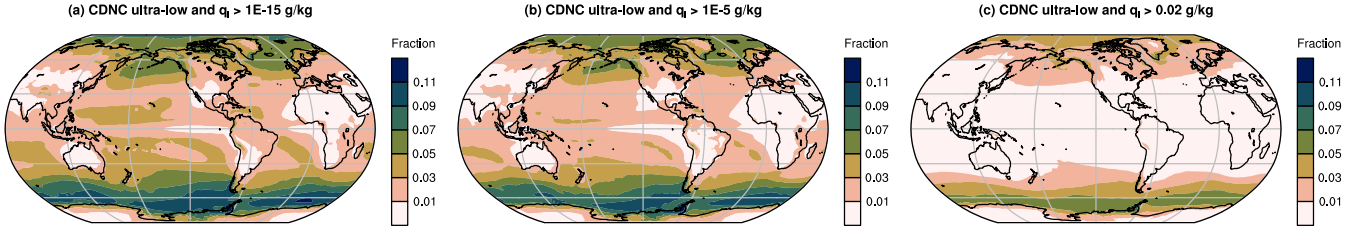

Figure S4. Geographical distributions of the joint probability $P\,(\text{CDNC ultra-low} \cap \overline{q_l} \geqslant q_{l,\min})$ in the 10-year free-running nc00 simulation explained in Table 1 of the paper, i.e., EAMv2 with no lower bound for CDNC. All model time steps in the 10 years and all vertical layers in EAMv2 were included in the calculation of the joint probability. The three panels correspond to three different choices of $q_{l,\min}$ used in conditional sampling: **(a)** $q_{l,\min} = 10^{-15}$ g kg^{-1}, **(b)** $q_{l,\min} = 10^{-5}$ g kg^{-1}, and **(c)** $q_{l,\min} = 0.02$ g kg^{-1}.

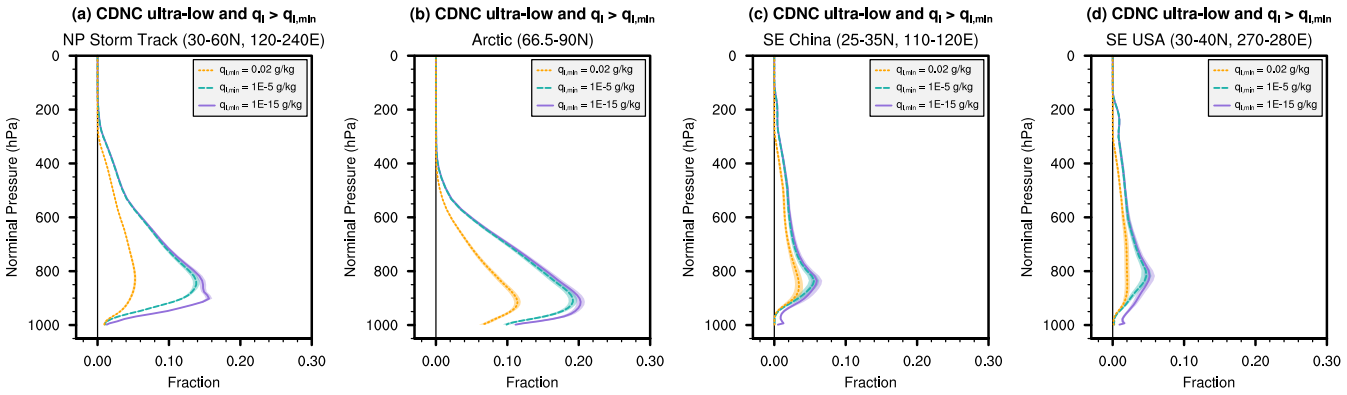

Figure S5. Regionally averaged vertical profiles of the joint probability $P\,(\text{CDNC ultra-low} \cap \overline{q_l} \geqslant q_{l,\min})$. The four columns correspond to different regions; from left to right are the North Pacific storm track, the Arctic region, SE China, and SE United States, respectively. The solid, dashed, and dotted lines are 10-year averages corresponding to different $q_{l,\min}$ values used in conditional sampling. Color shading indicates two standard deviations of the 1-year averages.

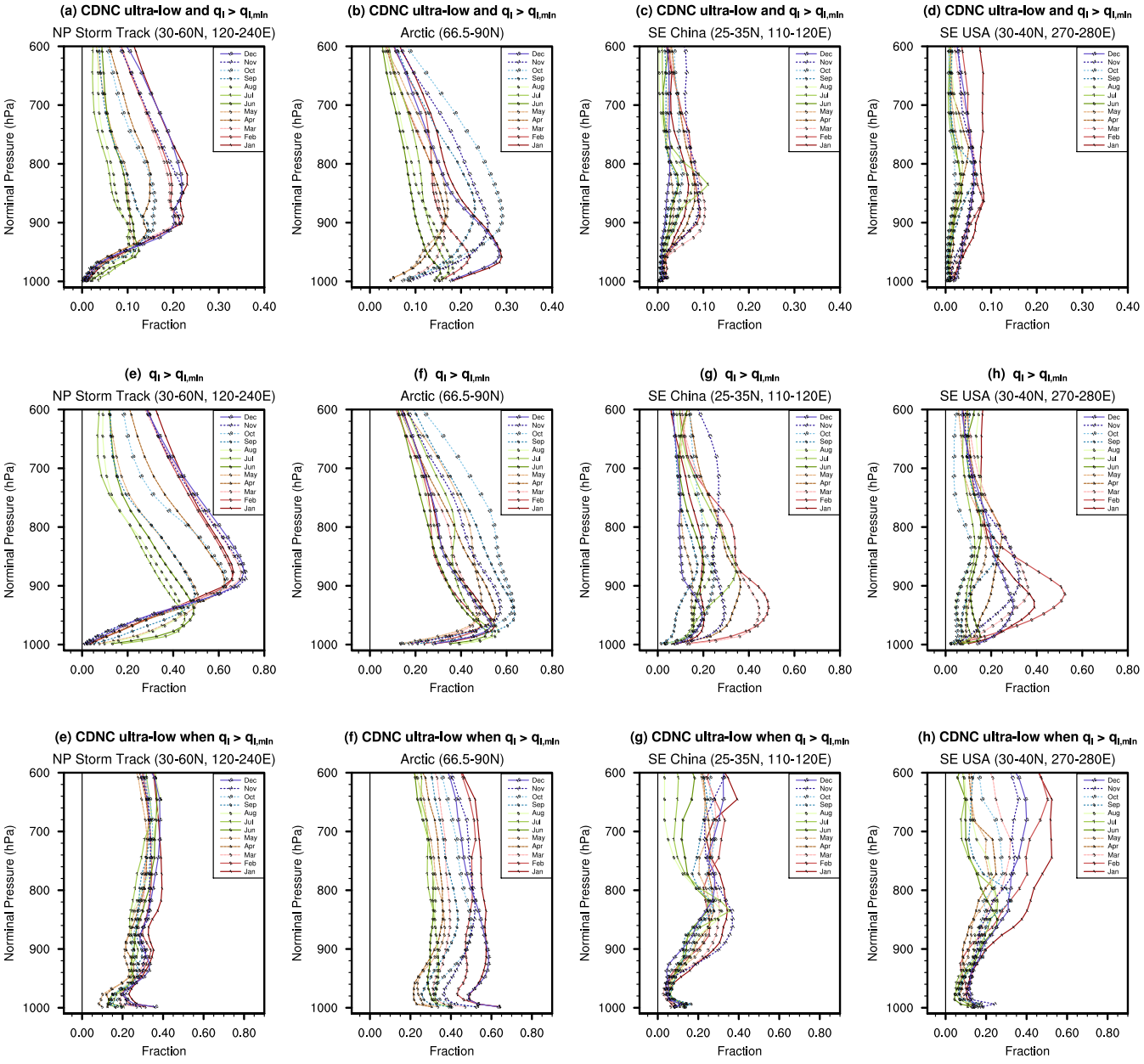

Figure S6. Monthly and regional mean vertical profiles of the joint probability $P\left(\text{CDNC ultra-low} \cap \overline{q_l} \geqslant q_{l,\min}\right)$ (upper row), the probability $P\left(\overline{q_l} \geqslant q_{l,\min}\right)$ (middle row), and the conditional probability $P\left(\text{CDNC ultra-low} \middle| \overline{q_l} \geqslant q_{l,\min}\right)$ (bottom row). The four columns correspond to different geographical regions, as indicated above the plot panels. All results shown in this figure correspond to $q_{l,\min} = 10^{-15}$ g kg^{-1}. The fractions (probabilities) were diagnosed from the free-running nc00 simulation (i.e., EAMv2 with no lower bound for CDNC) using output from the first simulation year after spin-up.

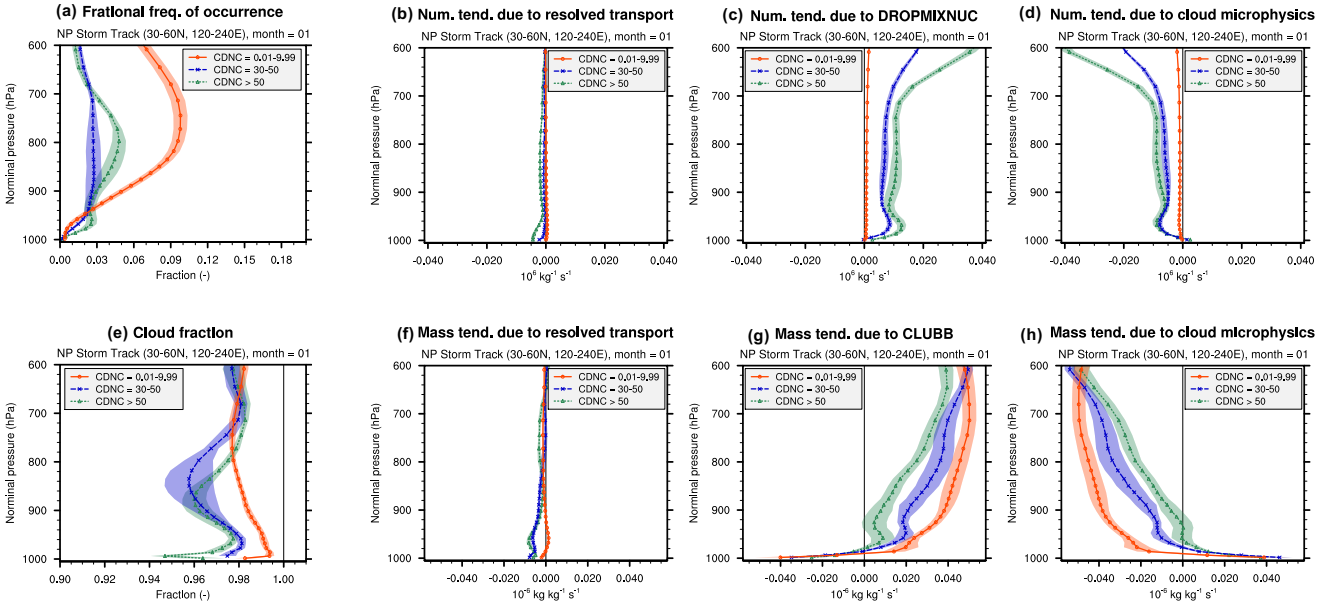

Figure S7. As in Fig. 10 of the paper but showing results for the January average over the North Pacific storm track. **(a)** Regionally averaged monthly mean frequency of occurrence of grid boxes and model time steps with cloud fraction larger than 0.9 and CDNC (unit: cm^{-3}) in three different ranges. **(b)–(d)** Composite mean grid box mean cloud droplet number tendencies caused by the resolved (large-scale) transport, DROPMIXNUC, and cloud microphysics, respectively. **(e)** Composite mean cloud fraction. **(f)–(h)** Composite mean grid box mean cloud droplet mass tendencies caused by the resolved (large-scale) transport, CLUBB, and cloud microphysics, respectively. Different marks and colors correspond to different CDNC ranges. The marks and lines show the averages of 10 Januaries. Color shading indicates two standard deviations of 10 January averages.

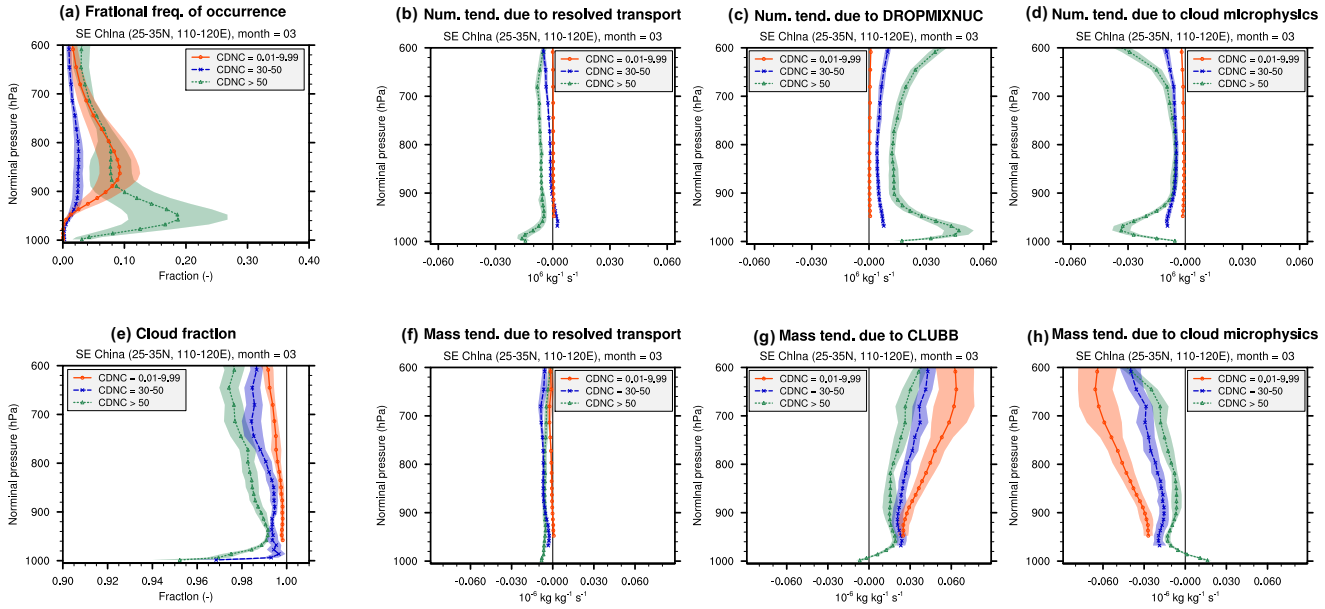

Figure S8. As in Fig. 10 of the paper and in Fig. S7 above but showing results for the March average over southeast (SE) China. CDNC unit: cm^{-3}. Some of the curves are not showing results in the near-surface layers because the fractional frequency of occurrence of the respective condition is lower than 0.1% in the focus month in one or more of the 10 model years used in the analysis.

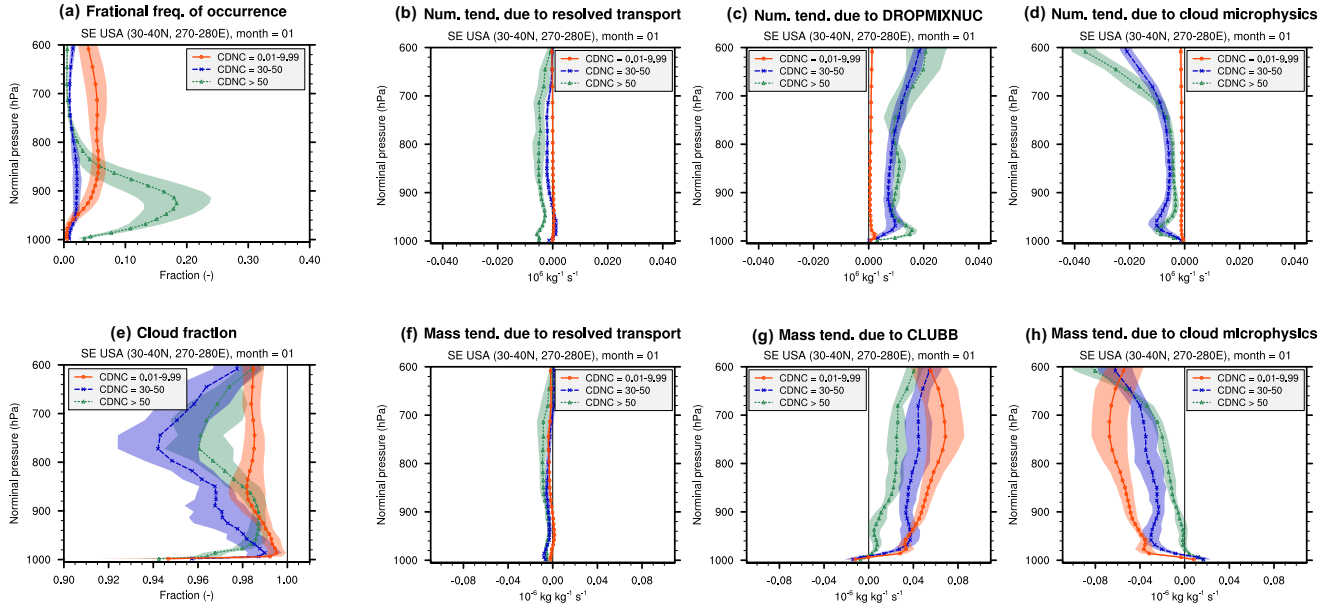

Figure S9. As in Fig. 10 of the paper and in Figs. S7 and S8 above but showing results for the January average over SE United States. CDNC unit: cm^{-3}.

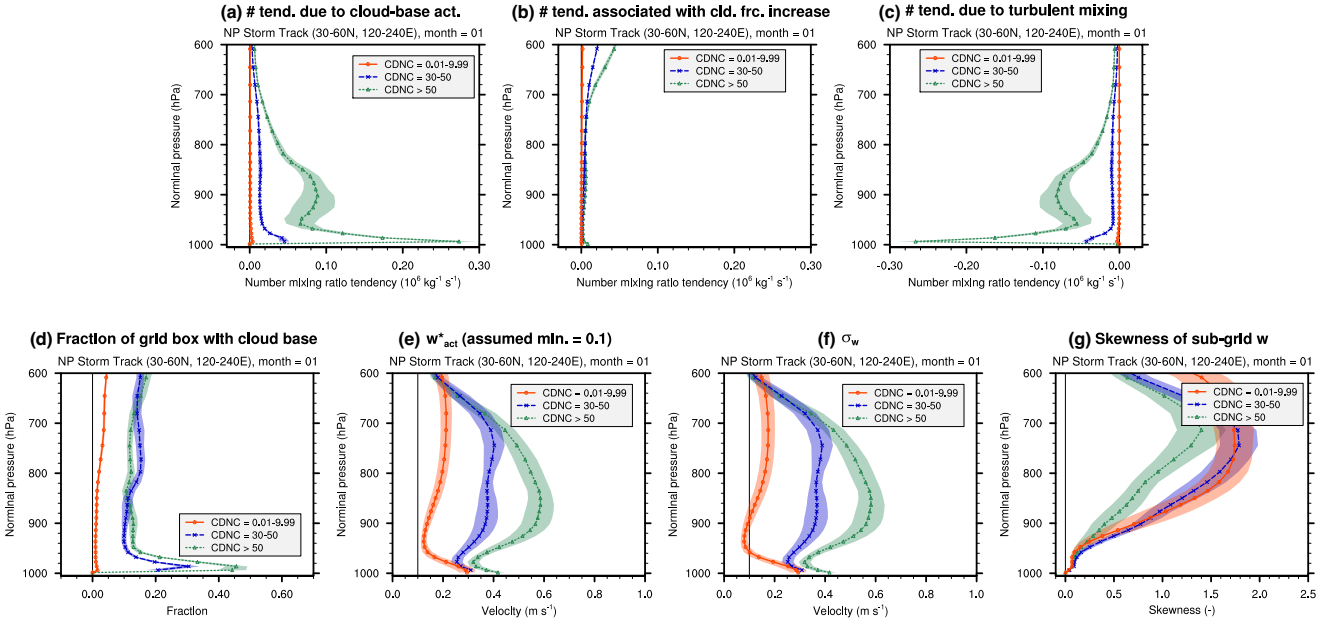

Figure S10. As in Fig. 11 of the paper but showing results for the January average over the North Pacific storm track. CDNC unit: cm^{-3}.

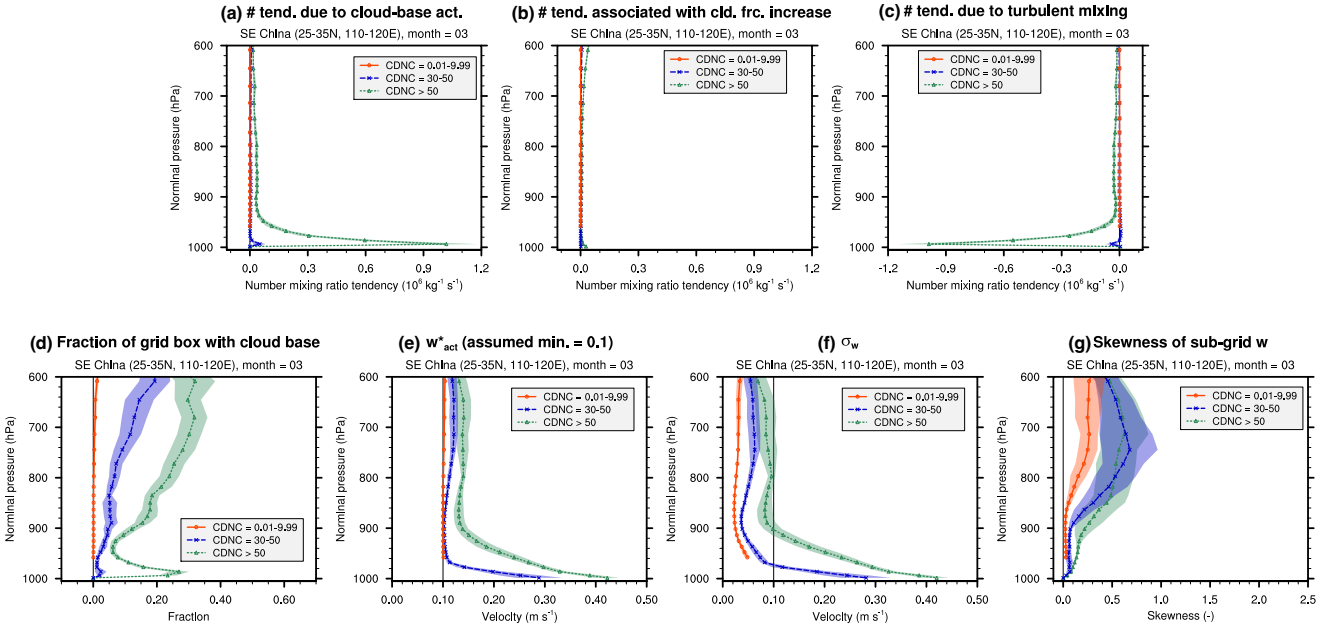

Figure S11. As in Fig. 11 of the paper and in Fig. S10 above but showing results for the March average over SE China. CDNC unit: cm^{-3}. Some of the curves are not showing results in the near-surface layers because the fractional frequency of occurrence of the respective condition is lower than 0.1% in the focus month in one or more of the 10 model years used in the analysis.

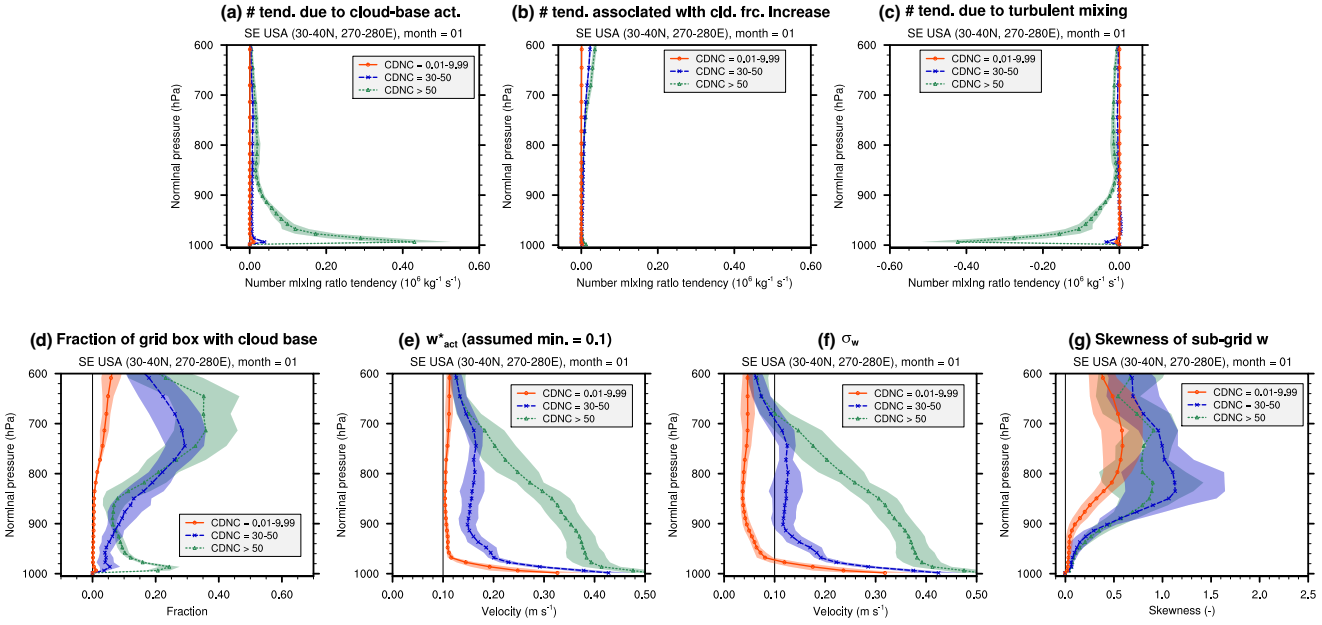

Figure S12. As in Fig. 11 of the paper and in Figs. S10 and S11 above but showing results for the January average over SE United States. CDNC unit: cm^{-3}.