Extreme supersaturation in CESM2 and E3SMv1 simulations: sensitivity to step time-stepping and impact on model climate

Ross D. Dixon, Shixuan Zhang, Xubin Zeng, Hui Wan

Supersaturated regions, where relative humidity (RH) with respect to ice or liquid water is greater than 100%, are observed in ice and mixed-phase clouds. Regions of strong supersaturation can impact the upper troposphere through latent heat release and interaction with radiation. It is therefore desirable that our global climate models are able to produce values of RH greater than 100%, but important that they do so for the correct reasons and that they do not produce values of RH much greater than seen in observations.

Simulations performed with the default configuration of NCAR's Single Column Atmospheric Model (SCAM6) produce RH values greater than 110% with respect to liquid water and greater than 200% with respect to ice. Extreme values of supersaturation are also seen when running the full CESM2 with CAM6 physics. When the time step for the model microphysics is decreased from its default value, the extreme values of RH are decreased.

We explore the sensitivity of model RH to choices in model microphysical and macrophysical time step. Following previous studies, we look at the process level to understand how decreasing the microphysical time step decreases extreme values of supersaturation. We also explore the impact of reducing these extreme supersaturations on the model climate, especially in terms of radiative transfer.

To assess the robustness of these results, we will also repeat these experiments using the SCM and full model of the DOE Earth System Model (E3SMv1). Results from both CESM2 and E3SMv1 will be presented.