

Understanding When Modeled Clouds Form Too Few Droplets

Objective

- Understand when, where, and why unrealistic, ultra-low cloud droplet number concentrations occur in the atmospheric component of the Energy Exascale Earth System Model version 2 (E3SMv2), focusing on the cases that significantly affect the simulated atmospheric energy balance.

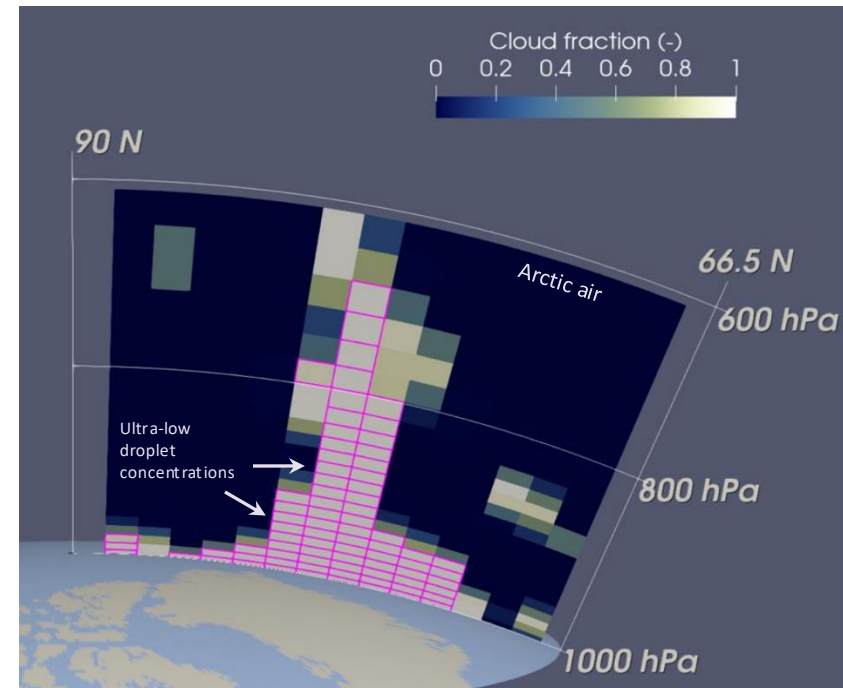
Approach

- Use interactive data exploration and 3D visualization to provide clues and guide composite analysis and sensitivity experiments.
- Perform process-level analysis of cloud droplet formation and removal to gain insights into the E3SM-simulated cloud life cycle.

Impact

- Unrealistic yet impactful ultra-low cloud droplet number concentrations are found to occur mainly in mid- and high-latitude stratus clouds in the lower troposphere, when turbulence is weak and aerosol activation is effectively absent.
- These findings provide important clues for efforts toward better understanding and improvements to aerosol-cloud interactions in the Earth system model.

Wan, H., Yenpure, A., Geveci, B., Easter, R. C., Rasch, P. J., Zhang, K., and Zeng, X.: Features of mid- and high-latitude low-level clouds and their relation to strong aerosol effects in the Energy Exascale Earth System Model version 2 (E3SMv2), *Geosci. Model Dev.*, 18, 5655–5680 (2025). DOI: 10.5194/gmd-18-5655-2025



A snapshot of clouds in an 2D slice of the Earth's atmosphere within the Arctic Circle. Color shading shows cloud fraction. Magenta boxes indicate where ultra-low droplet number concentrations are found in the simulation. Snapshots like this produced by an interactive visualization tool reveal that unrealistic results may prevail large core areas of low-altitude stratus clouds, suggesting that more research is needed to understand the life cycle of such clouds and their representation in numerical models like E3SM.