Evaluation of Subgrid-Scale Hydrometeor Transport Using a High-Resolution CRM

Research Highlight

Clouds moderate the climate system through direct impact on surface hydrology, as gatekeepers for the sun's energy-in/energy-out flux, and by stabilizing the atmosphere through vertical redistribution of heat and moisture. Turbulent convective clouds and storms are especially efficient at moving moisture and heat in the atmosphere. But because the structure of these clouds is not explicitly resolved by global climate models, the convective (subgrid-scale) vertical transport of hydrometeors (i.e., cloud and precipitation particles) needs to be parameterized.

Using high-resolution simulations of continental deep convection, a research team led by scientists at the U.S. Department of Energy's Pacific Northwest National Laboratory first demonstrated the important role of hydrometeor transport in the development of convective clouds. They showed that suppressing rain or graupel transport drastically alters vertical cloud ice and snow profiles through changes in the distribution of cloud water, which in turn governs the production of cloud ice and snow aloft. The team then examined the potential ways of representing vertical turbulent fluxes of hydrometeors in coarse-resolution models. They found that the commonly used eddy-diffusion approximation enforces transport away from the layer of peak concentrations, whereas the benchmark simulations show that hydrometeors are often moved across that layer. They show that a newly proposed transport parameterization, which takes into account the previously ignored correlation between vertical motions and precipitating hydrometeors, significantly improves the diagnosed vertical fluxes of these hydrometeors.

The study demonstrates the importance of convective transport of hydrometeors in convection and proposes a new way to include this aspect of the dynamics-microphysics interaction in large-scale models.

Reference(s)

Wong M, M Ovchinnikov, and M Wang. 2015. "Evaluation of subgrid-scale hydrometeor transport schemes using a high-resolution cloud-resolving model." Journal of the Atmospheric Sciences, 72(9), doi:10.1175/JAS-D-15-0060.1.

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Cloud Life Cycle