# Advanced design to represent cloud turbulence improves simulations in a multi-scale model

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Stratocumulus clouds blanket large expanses of the subtropical oceans. They have a strong regulating influence on the amount of solar energy absorbed by the oceans. Therein lies their large influence over Earth's energy budget. Scientists are working to understand the characteristics of these clouds, such as the turbulence that can organize them into the distinctive "clumps" shown in this photo taken from an aircraft. Credit: Roger Edwards/SkyPix

Low and wispy clouds have escaped climate model detection until now. A new modeling system captures their most difficult-to-picture side: turbulence. Researchers from Pacific Northwest National Laboratory led implementation of a new system to represent turbulence in a multi-scale atmosphere model that improves the simulated distribution of low clouds. The research tackles a key weakness of atmospheric models that use grid sizes too coarse to solve for turbulence. With the new formula, researchers now capture low clouds that have a big impact on Earth's energy budget.

Call them the climate gatekeepers. Covering vast areas of Earth, low clouds are critical regulators of Earth's climate. Because they are thin and small in scale, many climate models crudely represent these clouds and their ability to block and filter sunlight. With new model formulas that solve these cloud details, researchers can deliver better understanding of clouds' control over Earth's energy balance.

PNNL researchers and their collaborators from the University of Wisconsin - Milwaukee coupled the Cloud Layers Unified By Binormals (CLUBB) turbulence treatment with a multi-scale atmosphere model, Superparameterized Community Atmosphere Model (SPCAM), in which a reduced-dimension cloud-resolving model is embedded within each grid cell of a global model. (See sidebar, Multi-Scale Climate Modeling). They tested this modeling system in configurations using both simple, single-moment cloud microphysics and advanced, double-moment cloud microphysics coupled with aerosols. They compared the simulations in those configurations with previous methods; that is, simulations without the CLUBB formula and with estimated clouds rather than reduced-dimension, cloud-resolving models. They compared simulated low clouds with CloudSat low cloud distribution satellite data.

The SPCAM multi-scale model has advantages. It uses a much more realistic treatment of cloud processes, and simulates more realistic estimates of aerosol effects on clouds and climate. But until now, its simulation of clouds near the surface was poor. The CLUBB improvement permits even more reliable estimates of aerosol effects on clouds, especially important for the transition regions between overcast and scattered clouds.

The new CLUBB modeling system will be used to improve estimates of the effects of aerosols on climate through their impact on clouds.

**More information:** "A Multi-scale Modeling

Framework Model (Superparameterized CAM5) with a Higher-Order Turbulence Closure: Model Description and Low Cloud Simulations." *Journal of Advances in Modeling Earth Systems* 7. DOI: 10.1002/2014MS000375

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