Cloud Effects on Climate

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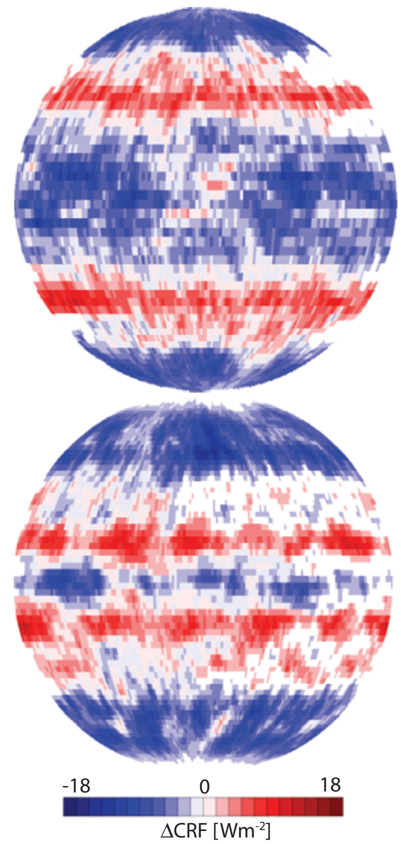
As recently restated by the Intergovernmental Panel on Climate Change "cloud feedbacks remain the largest source of uncertainty" in projections of cloud feedbacks. The sensitivity of climate projections to the representation of clouds was identified from the very earliest attempts to systematically investigate and quantify climate change. And while the intervening years have seen little progress in our ability to constrain representations of clouds at the level of climate prediction; we have made progress in more definitively establishing the role of clouds in the climate system, articulating ways in which they may respond to perturbations, and most recently, attributing uncertainty to broad classes of cloud.



Cloud effects on climate from the NCAR CAM3 (above) and GFDL AM2 (below) general circulation models. Red indicates a positive cloud effect wherein clouds change to enhance climate warming, blue indicates a negative cloud effect.
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Credit Brian Medeiros, UCLA

Work at UCLA in collaboration with scientists at the University of Washington and Colorado State University and modeling centers at the National Center for Atmospheric Research and the Geophysical Fluid Dynamics Laboratory, has helped identify the principle cloud type responsible for discrepancies in climate projections by the two centers. Using idealized climate model configurations, called "aqua-planets," wherein the surface of the earth is rendered zonally symmetric with specified sea-surface temperatures and no topography, the UCLA team and its collaborators showed that the cloud effects responsible for discrepancies between the GFDL and NCAR representation of the climate could be reproduced by the aqua-planet configurations and were not sensitive to the details of the surface temperature specification.

This result, shown on the right, indicates that: (i) cloud effects are ultimate rather than proximate causes of inter-model differences in the representation of climate change; (ii) these effects are associated with the zonally symmetric component of the tropical low-cloud response, which physically correspond to shallow cumulus in the trade-wind regime; and (iii) climate simulations in which one dimension (latitude) is rendered statistically homogeneous, are useful predictors of the model behavior for more earth-like configurations. Such findings opens new vistas for better understanding and constraining how clouds may change in a future climate and are being actively pursued with support by the NSF CMMAP Science and Technology Center.