ATS/CIRA Colloquium

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Visiting from NCAR

The role of shallow cumulus in the climate system, and asking how bad is "good enough" for climate models

Hosted by Russ Schumacher

Friday, October 21, 2016

ATS room 101; Discussion will begin at 11:15am
Refreshments will be served at 10:45am in the weather lab

Shallow cumulus clouds predominate in the trade-wind regions, and the response of this widespread regime has been directly linked to the spread in climate model estimates of cloud feedback and climate sensitivity. These findings will be reviewed using CMIP5 climate model simulations. Observations and process-model simulations show that trade-wind regions foster multi-layered cloud structures with complicated relationships to their environment that manifest as different cloud variability near the cloud base versus cloud top as well as inhomogeneous horizontal distributions of cloud. The climate models show a disturbing spread in their boundary layer structure, but much less spread in the cloud radiative effect signaling compensating biases. The models also fail to capture the observed correlations between clouds and environmental parameters, often showing the opposite sign compared to observations. Based on such errors, one hypothesis is that climate models lack the proper parameterized physics to represent shallow convection. An alternate hypothesis is that models do not capture observed mesoscale variability, leading to erroneous cloud statistics. Of course, the hypotheses are not mutually exclusive. Hindcasts are performed with the Community Atmosphere Model to test these hypotheses. I will show that the hindcasts produce clouds that are similar to long-term, free-running simulations. A set of hindcasts with a refined 0.25-degree mesh over the northern Atlantic trade-wind region compares the model's clouds with and without resolved mesoscale variability. Two more sets of hindcasts are run with the same grid configurations but using updated parameterized physics that change the representation of clouds, turbulence, and shallow convection. The updated physics are nominally less sensitive to horizontal resolution, which is tested by comparing the coarse and fine resolution, and the impact of the physics package is described by comparing the different model versions. In all configurations, significant errors are apparent, raising questions about the prospects for accurately parameterizing shallow convection and how much it matters for climate model applications.

Link to colloquium videos and announcement page: http://www.atmos.colostate.edu/dept/colloquia.php