CPT to improve cloud and boundary layer processes in GFS/CFS

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A Climate Process Team (CPT) is proposed to improve cloud and boundary layer processes in NCEP's Global Forecast System (GFS) and Climate Forecast System (CFS) models. **The intended CPO program/competition is MAPP (Research to Advance Climate and Earth System Models)**. The CPT will be a multi-institution collaboration between the University of Washington (CPT lead PI: Christopher Bretherton), the Jet Propulsion Laboratory (PI: Joao Teixeira), NCEP's Environmental Modeling Center (PI: Hualu Pan), and GFDL (PI: Chris Golaz; Co-PI: Ming Zhao). It is a sequel to a current MAPP-funded CPT on the subtropical stratocumulus to cumulus transition that builds on progress already made by this CPT and addresses MAPP's goal of leveraging the involvement of multiple NOAA climate modeling centers within a limited budget. The primary goal is to simultaneously improve the cloud climatology, energy budget, and operational forecast skill of the GFS and the next-generation CFS. A secondary goal is to identify weather regimes where clouds are either forecast much better or much worse by GFDL global climate models vs. GFS, as a step toward improving cloud-related parameterizations in both models.

Our current CPT found that both the operational GFS and CFS severely under-predict cloud amount, water content, and cloud radiative impact over most of the globe, producing unacceptably large global and regional biases in the net top-of-atmosphere and surface energy budgets. Reducing these biases would provide a strong foundation for reducing systematic errors in extended-range and seasonal forecasts. Our current CPT developed a portable single-column version of the operational GFS, which was used to improve the boundary-layer and shallow cumulus parameterizations, modestly improving global cloud distributions. We also developed a new cloud fraction parameterization that somewhat increases GFS-simulated global cloudiness, and a new eddy-diffusivity mass-flux scheme for GFS that combines the simulation of turbulence and shallow cumulus convection. The proposed CPT will try to advance these first steps into a GFS version which has clouds whose radiative properties are simulated as skillfully as in leading climate models, while at the same time maintaining or improving conventional measures of weather forecast skill. Our strategy involves careful testing and improvement of the microphysics and precipitation parameterizations, single-column and global analysis of the fidelity of parameterized cloud-turbulence-precipitation interactions in the revised GFS, and detailed comparisons of cloud simulations in hindcasts by GFS and two GFDL models, AM3 and HiRAM.

Relevance to NOAA Next-Generation Strategic Plan and targeted competition: The targeted MAPP competition requests CPTs of the type we propose in our focal area of clouds and cloudradiative processes, involving multiple NOAA climate modeling centers and external experts. Our goal of improving clouds in the NCEP and GFDL climate models supports NOAA's NGSP goals of 1) improving scientific understanding of the changing climate and 2) providing better assessments of climate system change, variability and impacts, both of which require reliable, comprehensive climate models.