Advances in Lake-Effect Process Prediction within NOAA's Climate Forecast System for North America

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Abstract

This proposal intends to incorporate a numerically efficient, physically based lake model into NCEP's operational Climate Forecast System (CFS) version 2 in order to advance climate prediction at intraseasonal to interannual (ISI) time scales in North America. The proposed work is in response to the request for proposals by the Modeling, Analysis, Predictions, and Projections (MAPP) Program, which is partnering with the Climate Test Bed (CTB) to foster stronger operational practices for climate prediction at NCEP. The project will be completed under collaboration between Utah State University (USU) and the Land-Hydrology Team at NCEP's Environmental Modeling Center (EMC). North America has the largest total lake volume and surface area of any continent on Earth. Lakes in this continent alter precipitation and temperature patterns at various spatial and temporal scales because they have smaller surface roughness, lower surface reflectance, and higher heat capacity than the nearby land; some of them also trigger severe storms during early winter and spring (e.g., the Great Lakes). However, in the current version of the operational CFS, running at approximately 100-km resolution, lake processes and their interactions with the atmosphere are largely neglected, potentially degrading climate forecasting skill.

For this project, we propose to couple an existing physically based lake model into the CFS to dynamically predict lake processes and their effects on climate in North America at ISI time scales. The lake model selected is the freshwater lake (FLake) model, which is a one-dimensional, two-layer energy and mass balance model. It includes the parameterizations of lake thermocline, lake ice and snow, and surface momentum, water, and heat fluxes. FLake has been implemented in several operational and research climate models across the world, resulting in improved predictions of lake-atmosphere interactions and thermal conditions for different-sized lakes at hourly to interannual time scales. During this project, retrospective forecasts with the coupled CFS-FLake model will be performed for historical periods and will be quantitatively evaluated using standard NCEP metrics for model evaluation with a focus on lake-related processes. The coupling work will provide a framework for the next CFS (version 3). The tasks proposed above fully comply with the operational activities for climate prediction at NCEP and are supported by the CTB, EMC, and Climate Prediction Center. The proposed studies are also consistent with the mission of MAPP, that is, to "*enhance the Nation's capability to predict variability and changes in the Earth's climate system,*" and will augment the current capacity of MAPP's Climate Prediction Task Force to better understand and predict climate variability at ISI time scales.