Evaluating the Fidelity of a Community Coupled Ocean-Atmosphere Data Assimilation System

Abhishek Chatterjee\textsuperscript{a}, Alicia R. Karspeck\textsuperscript{b}, Jeffrey L. Anderson\textsuperscript{c}, Nancy Collins\textsuperscript{d}, Gokhan Danabasoglu\textsuperscript{b}, Timothy J. Hoar\textsuperscript{c}, Kevin D. Raeder\textsuperscript{e}, Joseph J. Tribbia\textsuperscript{b}

\textsuperscript{a} CGD/IMAGe, National Center for Atmospheric Research, USA, Email: abhishek@ucar.edu, \textsuperscript{b} CGD, NESL, National Center for Atmospheric Research, USA, \textsuperscript{c} IMAGe, CISL, National Center for Atmospheric Research, USA

Several prototypes of coupled ocean-atmosphere data assimilation (DA) frameworks have been developed or are under development by different groups worldwide [e.g. 1, 2, 3, 4]. Almost all of these systems, however, tend to analyze the atmosphere and the ocean separately, i.e., coupled single-component DA, thereby limiting the impact of observations across the air-sea interface. While such a framework serves as a valuable ‘intermediate’ step for operational centers such as the NCEP [3], several fundamental questions remain unanswered. For example, it is not yet clear what will be the potential benefit of using near surface observations (SST, for example) to correct both the ocean and the atmospheric states simultaneously within a coupled framework. At a more fundamental level, the relative differences in accuracy between different coupled frameworks, which can include assimilation of data either within a single-component, within multiple components or allow cross-component interactions, remain to be established.

Recently, the Community Earth System Model (CESM; previously known as the Community Climate System Model -CCSM) [5] has been interfaced to a community facility for ensemble data assimilation (Data Assimilation Research Testbed – DART) [6], which allows us to answer such questions critically by examining a suite of coupled system configurations. First a coupled multi-component DA system is being run in which data is assimilated into each of the respective ocean/atmosphere model components during the assimilation step, and information is exchanged between the model components during the forecast step. Secondly, two coupled single-component DA systems are being run in which observations are assimilated into only one of the ocean/atmosphere components during the assimilation step. Work is ongoing to expand the coupled multi-component DA framework to allow for cross-component DA, in which the data will be assimilated into each of the ocean and the atmosphere components but the information immediately transferred to the other component through the ensemble filter, and both components updated simultaneously at each assimilation step. Initial runs are being conducted to evaluate the differences between these coupled system configurations after assimilation experiments of length one year. In this presentation, specific analyses (e.g., development of tropical storms, sea-ice formation around the Arctic) as well as correlations of states with observations across model components will be discussed. Details of the air-sea fluxes (heat, momentum and moisture) and corresponding ocean-atmosphere dynamical feedbacks will also be presented. The knowledge gained through this study is expected to improve our understanding of the fidelity and applicability of coupled ocean-atmosphere DA systems, and potentially their long-term climate prediction capabilities.

References