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An atmosphere-ocean partially coupled data assimilation and prediction system developed within the NCEP GFS/CFS

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Abstract
An atmosphere-ocean partially coupled data assimilation and prediction system has been developed within the NCEP Global Forecasting System (GFS).
In the new scheme, the ocean has been extended from Sea Surface Temperature (SST) to NSST (Near-Surface Sea Temperature) to resolve the thermal vertical structure due to two physics processes, diurnal warming and sub-layer cooling.
At the analysis step, an oceanic analysis variable, foundation or mixed layer temperature, Tf, has been added to atmospheric assimilation system, Gridded Statistical Interpolation (GSI), of GFS, and is analyzed together with the atmospheric ones by minimizing a single cost function.
At the prediction step, the NSST model, including a diurnal warming model and a sub-layer parameterization, has been built into the atmospheric prediction model, Global Spectral Model (GSM), of GFS, to include the time evolution of the ocean.
It is still a partially coupled system since only the part of the SST evolution due to diurnal warming and sub-layer cooling is accounted for in the prediction mode and the error covariance between the ocean and atmosphere variables is not addressed yet in the analysis mode.
The new system is also improved by using more observations and more effective use of satellite radiance for the oceanic variable analysis.
The cycling runs with this partially coupled system have been performed.
For GFS with 3DVAR GSI, it has shown improved SST analysis, the better use of satellite data and positive weather prediction skill in tropics. The impact on weather prediction at higher latitude areas is not significant statistically.
For GFS with 3D Hybrid ENKF GSI, with the simplified NSST for the ENKF part where the NSST model is on but the Tf analysis is off, the preliminary results show the same results for oceanic analysis and satellite radiance simulation, as expected. For weather prediction, the tropics wind is improved, but the air temperature is slightly degraded, which seems related to its predicted cold bias.
The future plan includes the extension of the analysis variables to include an oceanic one (Tf) for the EnKF as well, which will address the air-sea error covariance in the coupled analysis and the incorporation of the NSST into NCEP Climate Forecasting System (CFS), which will address the fully atmosphere-ocean interaction in the prediction.