Surface heat flux corrections for Global Ocean Forecasts

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Introduction

RTOFS (Real Time Ocean Forecast System)-Global is the first global eddy resolving ocean forecast system implemented operationally at National Centers for Environmental Prediction (NCEP) in close collaboration with US Navy. It will soon be upgraded to Version 1.1. The core model and configuration were developed and validated at National Research Laboratory (NRL), using the Hybrid Coordinates Ocean Model (HYCOM) at 1/12° horizontal resolution coupled with Los Alamos Community sea ICE model (CICE). The RTOFS forecast system runs once a day and produces forecasts from the daily initialization fields produced at NAVOCEANO (NAVal OCEANographic Office) obtained using NCODA (Navy Coupled Ocean Data Assimilation), a 3DVAR data assimilation methodology (Cummings and Smedstad, 2013).

The RTOFS forecasts were developed and validated at Environmental Modeling Center (EMC). Each day, a 2-day spin up starts with the analysis of 2 days before the present, using the ocean model in forecast mode forced with hourly NCEP's Global Data Assimilation System (GDAS) atmospheric fluxes. This is continued from the present with an 8-day forecast cycle forced with 3-hourly momentum, radiation, and precipitation fluxes from NCEP's Global Forecast System (GFS) fields for the next eight days.

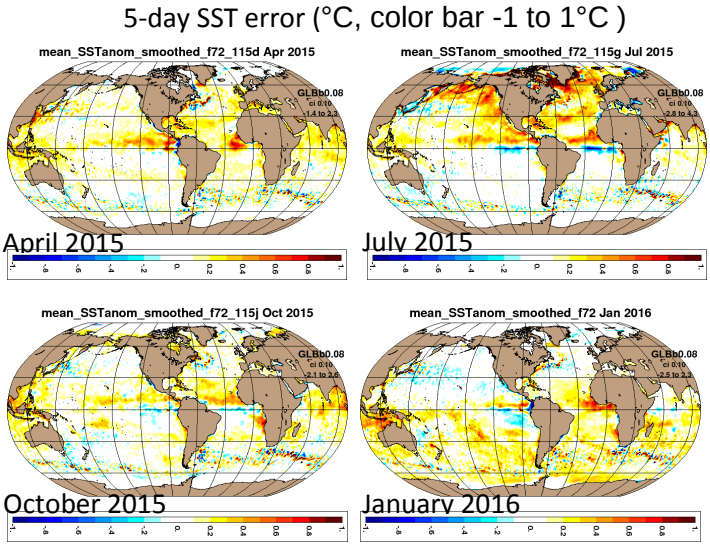
Following flux-corrections efforts at NRL (Metzger et al., 2013; Hogan et al., 2016), heat flux corrections are computed for the RTOFS v1.1 configuration.

SST errors and Net heat flux corrections

Net heat corrections are computed to minimize the 5 day SST forecast error (Metzger et al., 2013; Hogan et al., 2016).

The SST error for the first 5 days of the forecast - which starts 2 days before the present - was taken as the difference between the 5 day forecast and the analysis at the date of the 5 day forecast.

SST error= SST (day 5 of forecast) – SST (analysis for day 5)

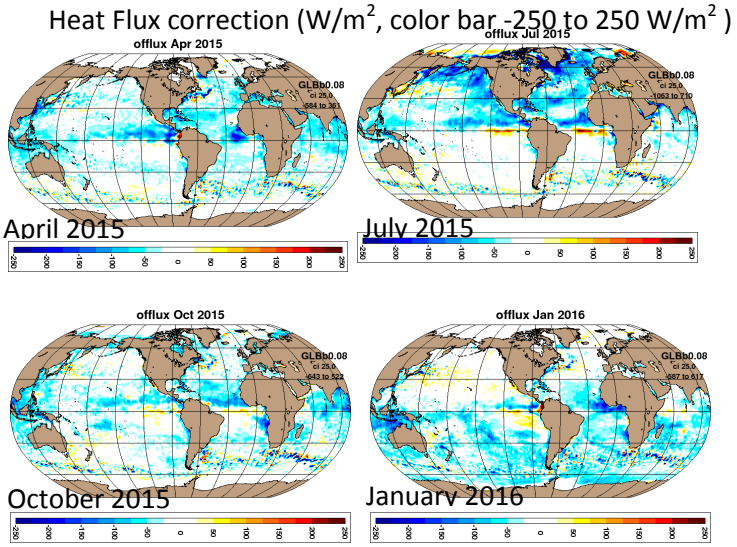


The monthly mean space smoothed SST 5 day error (SST error) is converted to a surface heat flux applying a factor of -250 to the SST error to obtain the heat flux ((Metzger et al, 2013)

Net Heat Flux correction = -250W/(° m^2) * SST error

This amount of heat would, for example, cool the upper near-surface ocean by 1°C till a depth of 26m.

Since this analysis was done with forecasts during March 2015 to Feb 2016, effects of the 2015-2016 El Niño and others can be present in the correction fields. Flux correction estimates when applied will be based in SST errors from previous years/months; therefore, this method does not minimize the error for a particular year/month.



The correction should compensate for a warm SST error in the summer hemisphere (Southern hemisphere for January and Northern hemisphere for July), which was found to be present in several years. The warm narrow band north of the equator and cool band south of it was seen in other years, but its details may vary.

The following comparisons with other years/products were done:

a) Hogan et al. (2016)'s 5-day SST errors with GDAS for 2014 show generally consistent patterns.
b) Forecasts done with next future upgrades for GDAS/GFS (available as a parallel GDAS/GFS run) result in small differences for flux corrections.

Simulations with flux corrections are being performed. Metzger et al. (2013) demonstrate an improvement in the SST error when the same simulations from which the flux corrections were obtained are redone with flux correction. When the flux correction obtained in a year is applied to simulations from other years it is to be expected that the improvement will be diminished. In addition to flux corrections, residual flux corrections will be computed and applied if necessary.

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