

Operational Ocean Reanalysis for S2S at NCEP: P-A6-05-Xue

Upgrading from 1° MOM3 GODAS to 1/4° MOM6 Hybrid-GODAS



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Abstract

The global ocean data assimilation system (GODAS) is an important tool at the Climate Prediction Center for monitoring ocean/ENSO variability in real-time. However, the current system has not been upgraded since 2003. A Hybrid LETKF/3DVar, referred to as Hybrid-GODAS, has been developed (Penny et al. 2015), which shows significant advantage over the 3DVar GODAS. NCEP is implementing the Hybrid-GODAS as a replacement for the GODAS. We use the recently released GFDL Modular Ocean Model version 6 (MOM6) at 1/4°x1/4° horizontal resolution and Sea-Ice Simulator (SIS2). The upgrade, without a relaxation to the OI SST, allows the model SST to interact with surface fluxes through the bulk formula and reanalysis flux variables from the bias-corrected CFSR with perturbations from the 20CRv2c ensembles. The proposed upgrades will produce an ocean reanalysis from 1979 to present, and also contribute to the marine data assimilation development under the Joint Effort for Data assimilation Integration (JEDI) for ocean initialization of the coupled FV3GFS-MOM6-CICE5 model.

Surface Forcings

- **CFSR forcings at T382**
T/Q@2m, U/V@10m, SLP (6hr)
DSW and DLW, Prec. (daily)
Large and Yeager bulk formula
- **Bias correction of CFSR**
Monthly clim. bias correction
against DRAKKAR forcing sets (DFS5.2)
Two clim. periods (1980-1998, 1999-2015)
- **Ensemble perturbations**
from 20th Century Reanalysis v2c
- **River runoff**
Dai and Trenberth monthly clim.
- **No SST relaxation**
- **SSS is relaxed to WOA clim.**

Data Assimilation

The Hybrid-GODAS is based on a hybrid LETKF/3DVar (Penny et al. 2015). **A 5 day centered data assimilation cycle is used.**

LETKF

- 20 ensemble members
- Flow-dependent and multivariate background error covariance
- Latitudinally dependent localization (for in situ profiles, 600km at eq. to 100km in high-latitudes, for satellite SST, 200km at eq. to 50km at high-latitudes)

3DVar

- Observation-space 3DVar modeled after the Navy Coupled Ocean Data Assimilation System (NCODA)
- T / S univariate, static background-error covariance

GODAS:

- Univariate T/S, based on Derber and Rosati, 1989

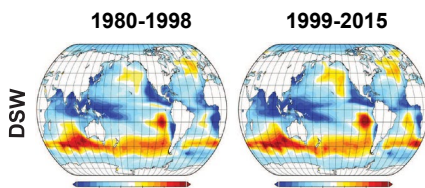


Fig 2: The multiplicative bias corrections are applied to the downward shortwave (DSW), downward longwave, and precipitation rate. Monthly bias corrections are generated, but only the annual average is shown here.

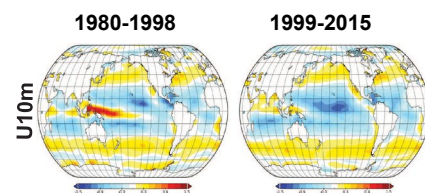


Fig 3: The additive bias corrections are applied to 10 meter winds. Monthly bias corrections are generated, but only the annual average is shown here.

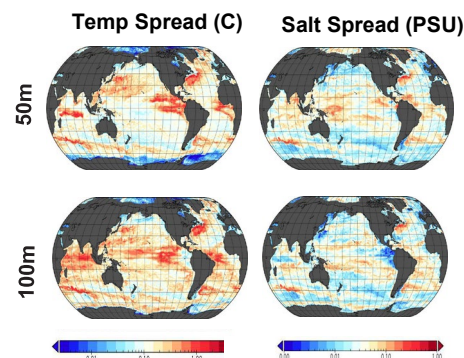


Fig 4: Hybrid-GODAS ensemble spread in June 2004 for temperature and salinity at 50m (1st row) and 100m (2nd row).

Current Status

- Tuning and evaluation of the system
- A historical ocean reanalysis from 1979
- Operational implementation in FY19

Fig 1: Overview of Hybrid-GODAS

Ocean Model

- GFDL MOM6/SIS2
- 1/4° horizontal, 75 vertical levels
- GFDL OM4_025 configuration

GODAS:

- GFDL MOM3 ocean only (no sea ice)
- 1° horizontal, 40 vertical levels
- Domain limited to 75S - 65N

Reference

Behringer, D., & Xue, Y. (2004). Evaluation of the Global Ocean Data Assimilation System at NCEP: The Pacific Ocean. Eighth Symposium on Integrated Observing and Assimilation Systems for Atmosphere, Oceans, and Land Surface, AMS 84th Annual Meeting, (January), 11-15.

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Ignatov, A., X. Zhou, B. Petrenko, X. Liang, Y. Kihai, P. Dash, J. Stroup, J. Sapper, & P. DiGiacomo, 2016: AVHRR GAC SST Reanalysis Version 1 (RAN1). Remote Sens., 8(4), 315, doi: 10.3390/rs8040315, www.mdpi.com/2072-4292/8/4/315

Penny, S. G., Behringer, D. W., Carton, J., & Kalnay, E. (2015). A Hybrid Global Ocean Data Assimilation System at NCEP. Monthly Weather Review, 143(11), 4660-4677. <https://doi.org/10.1175/MWR-D-14-00376.1>

Observations

In situ T/S

- In situ temperature and salinity profiles from world ocean database (XBT, CTD, PFL), daily mean

Satellite SST

- L2 along-track SST from ACSPO (Advanced Clear Sky Processor for Ocean) AVHRR (Ignatov, et al. 2016)
- Night-time only tracks are used.
- Thinning into one observation per grid-box per day

GODAS:

- In situ temperature profiles
- Synthetic salinity profiles derived from climatological T/S relationship
- SST relaxed to weekly OI SST

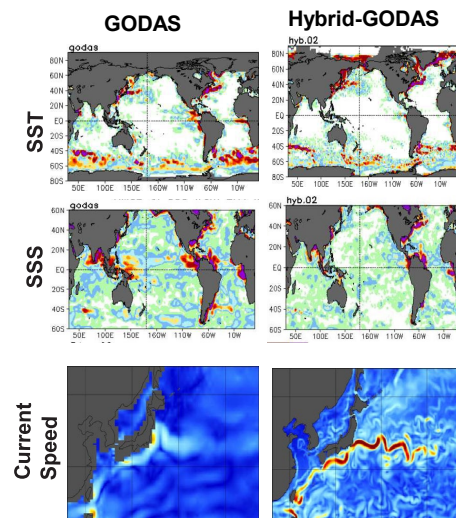


Fig 5: RMSE compared to weekly OISST (1st row), SSS from EN4 (2nd row). Surface current speed.