



Ocean Color in Operational Ocean Forecast Systems

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- Background
- Overall objectives
- Interesting results
- Operational Plans
- Ongoing Work



Real-Time Ocean Forecast System (RTOFS)





Operational configuration of RTOFS

Hybrid Coordinate Ocean Model (HYCOM) with 1/12° horizontal resolution and 41 hybrid layers
 Iso-pycnal (deep ocean), z-levels (surface), σ (coasts)
 NAVOCEANO daily initialization with MVOI (now 3DVAR) data assimilation from NCODA (Navy's Coupled Ocean Data Assimilation)
 Daily 2-day nowcast (GDAS) and 8-day forecasts (GFS)





Current Ocean Color Projects (funded by JPSS-PGRR program)



Titles :

- Using Neural Networks for gap-filling and preliminary short-range (1-2 weeks) to medium-range (3-4 weeks) predictions of satellite-derived ocean color fields (Chl-a, Kd₄₉₀ and Kd_{PAR})
- Initial biogeochemical modeling at NOAA/NCEP: Using VIIRS ocean color data for validation and data assimilation

Main priorities:

- Update OC fields for Ocean Data Assimilation (NCODA)
- Predict OC fields for feedback during forecast cycle



Ocean Color & NN/BGC





FEEDBACK FROM OCEAN BIOLOGY (COLOR) TO UPPER-OCEAN HEATING IS IMPORTANT FOR OCEAN/COUPLED FORECASTING



Overall Objectives



- 1. Ocean Color (OC) integration in operational ocean and coupled modeling
 - Ingest NRT and Science quality data: OC data in ocean models for physical and biological processes

Application: Improve short-term Operational Ocean Forecasts

Consistent Gap-Filled OC values across multiple satellite missions for use in long ocean reanalysis efforts

Application: Neural Network (NN)-based consistent gap-filled Ocean Color

2. Make Short-Term (1-2 weeks) to Medium-Term (3-4 weeks) Ocean Color Predictions <u>Application:</u> Short-term to Medium-term Operational Ocean Forecasts

3. Bio-Geo-Chemical Modeling with Ocean Color inputs

<u>Application:</u> Use Ocean Color Fields for estimating 3D Ocean BGC ocean states <u>Application:</u> Boundary and initial conditions for Coastal OFS (inputs for NOS, NMFS)



OCEAN COLOR IN OCEAN MODELING





NESDIS Science-quality Chlorophyll-a significantly outperforms NRT and BASE in ocean model simulations; GODAS analyses used as observations;

BASE is model run with SeaWiFS 4-yr monthly climatology; SCI is run with VIIRS science-quality OC; NRT is run with VIIRS NRT OC (all based on 4 year experiments 2012-2015)



SST Verification against GODAS for NINO 3.4 (170W-120W; 5S-5N)







- Algorithmic impact (Chl vs Kpar) is not as big as expected (e.g., SeaWiFS case) when daily-averaged forcings were used
- When diurnal variation is resolved (hourly forcings used) both Kpar and Chl algorithm yielded different results from the others



(www.climate.gov/)



NEURAL NETWORK PERFORMANCE





NN is able to capture OC variability reasonably well over most of the global oceans for training period > 2 years.



Operational Plans with Ocean Color



Integrating Ocean Color in RTOFS:

(1) Use Statistical (NN) Model

Blend of mean, low-frequency variability, high-frequency variability Advantage: Being tested for next operational RTOFS upgrade/impacts

(2) Use Biogeochemical Model

Use BGC model with NCODA/RTOFS. Advantage: Provides full 3-d ocean biological state







BLEND: MIXES MEAN (VSCI_CLIM), LOW-FREQUENCY (NN_INTER) AND HIGH-FREQUENCY (ENRT_MESO) OC VARIABILITY

















Objective: Ocean Color for Operational Ocean Forecast Systems:

(1): Preliminary assessment of NESDIS NRT and science-quality OC in ocean models (completed).(2): Testing NN model for coupling to RTOFS (on-going).

FY 18 Targets:

- (1): Testing for operational upgrade of RTOFS with embedded NN (on-target)
- (2): Role of ocean color in SST predictions over weather time scales (on-going).





Objective: Ocean Color for Operational Ocean Forecast Systems:

(1): Science quality VIIRS products and thermal structure effects on BGC variables (completed)(2): In-line coupling of NPZD-type ecosystem model in HYCOM/RTOFS (completed)

FY 18 Targets:

(1): Ocean color (VIIRS science quality) data assimilation (2DVAR) in RTOFS-BGC-NCODA (on-going)
(2): Implementation of physical/biogeochemical variables (3DVAR) in RTOFS-BGC-NCODA (on-target)
(3): Exploring added complexities (e.g., 9-component BGC model which includes carbon and dissolved oxygen sub-modules) (TBD)





Thank You !