Marine Modeling *Working Group*

Presented by
Avichal Mehra, NWS/NCEP/EMC
Pat Burke, NOS/CO-OPS

Presented at SIP Coordination Meeting
May 15, 2019; College Park, MD

Marine Modeling WG
Membership

- Alistair Adcroft (NOAA/GFDL)
- Clarissa Anderson (UCSD)
- Brian Arbic (U. of Michigan)
- Robert Banks (Delta Airlines)
- Eric Bayler (NOAA/NESDIS)
- *Patrick Burke (NOAA/NOS) ***
- *Eric Chassignet (FSU) ***
- Arun Chawla (NWS/NCEP)
- Gokhan Danabasoglu (UCAR)
- Bob Grumbine (NWS/NCEP)
- *Bob Hallberg (NOAA/GFDL) ***
- *Pat Hogan (NRL) ***
- Derrick Snowden (NOS/IOOS)

- Changshen Chen (U. Mass)
- Elizabeth Hunke (LANL)
- Rick Luettich (UNC)
- *Avichal Mehra (NWS/NCEP) ***
- Andy Moore (UCSC)
- Shastri Paturi (NWS/NCEP)
- Steve Penny (UMD/ESSIC)
- Todd Ringler (LANL)
- Shan Sun (NOAA/ESRL)
- Sergey Vinogradov (NOAA/NOS)
- Alan Wallcraft (FSU)
- John Wilkin (Rutgers U.)
- Yan Xue (NWS/NCEP)

- *Co-Chairs ***

Marine Models WG
Project Milestone Accomplishments

- **Project 1: Ocean Data Assimilation to support RTOFS (based on NCODA)**
  - Daily cycling of Global HYCOM + RTOFS-DA with NCEP data sets

    - ❖ MODAS synthetic profiles for downward projection of altimeter SSH anomalies (SSHA)
    - ❖ SSH, SST, profiles, sea ice
    - ❖ Modified Cooper Haines method for limited 3-month run: Oct-Dec 2017
    - ❖ Assimilate NESDIS ADT altimeter data

  - Build automated QC procedures using HYCOM forecasts (completed)
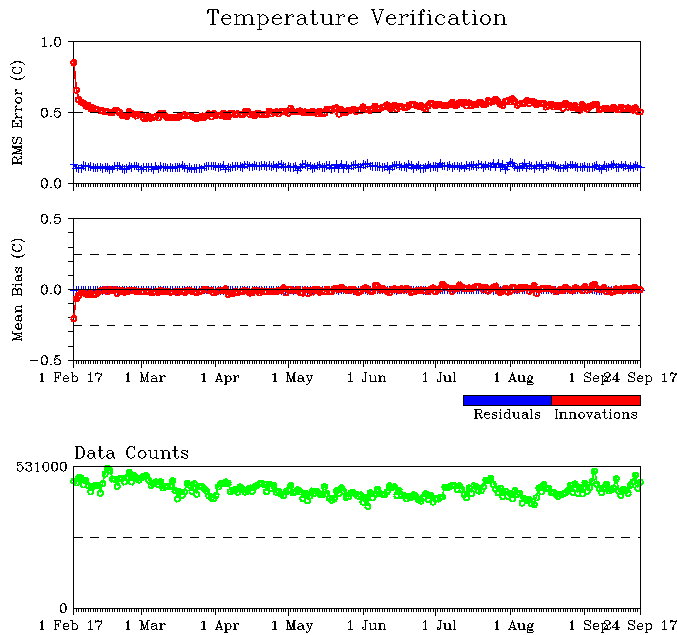 - Build diagnostics for evaluation & monitoring (ongoing)

Marine Models WG
Project Milestone Accomplishments

Global HYCOM+CICE+RTOFS-DA 1/12°, with external data sets

Total temperatures
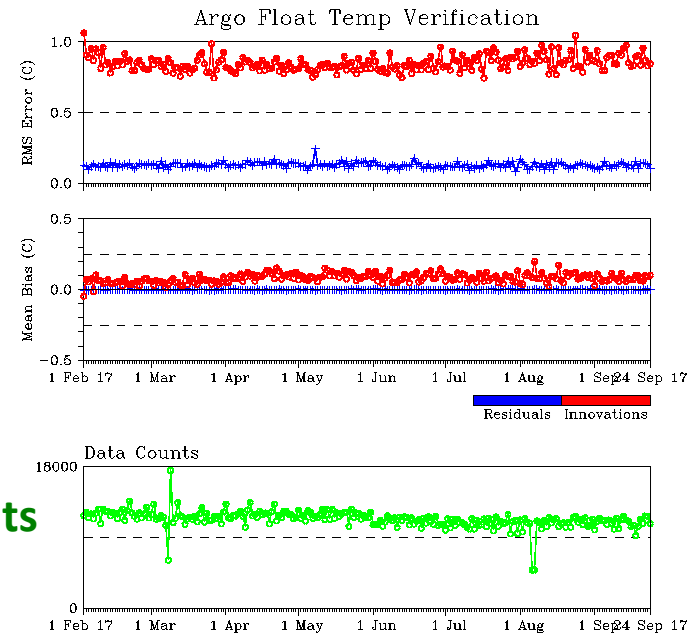
Argo float temperatures

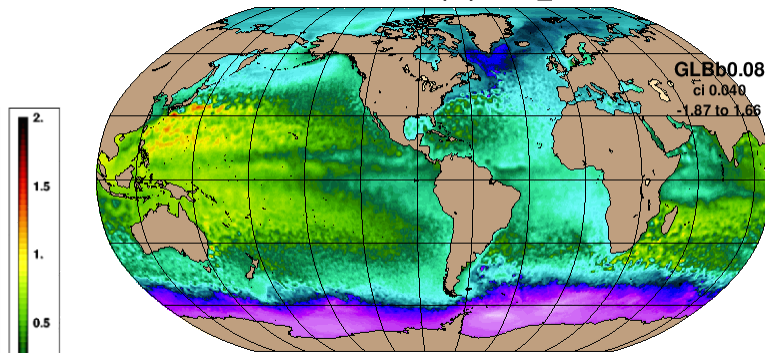RMS

Bias

Data counts

Red: innovations
Blue: residuals

Global 24-hr forecast temperatures are unbiased

Marine Models WG
Project Milestone Accomplishments
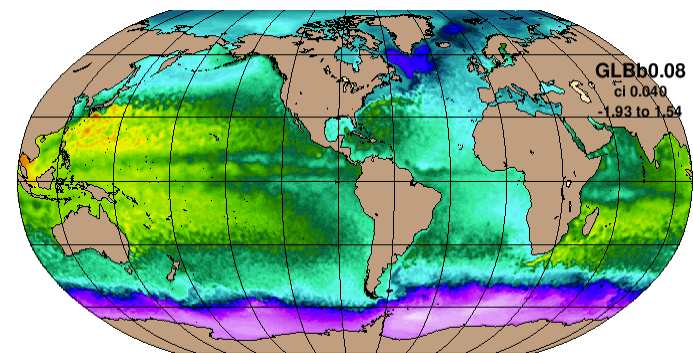
Global mean SSH fields
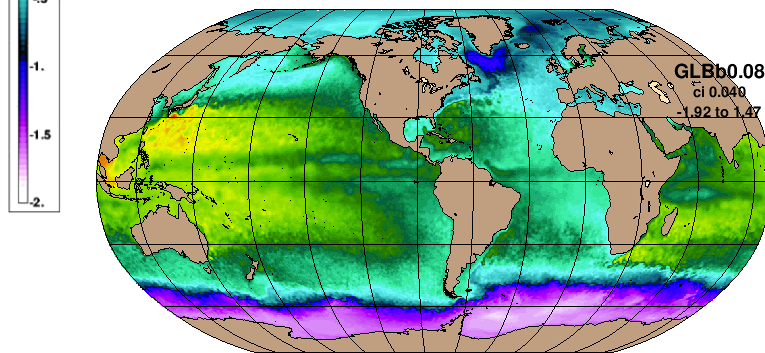
NAVO (RTOFS initialization)

GLBb0.08
ci 0.040
-1.87 to 1.66

DIRECT Method with ADT SSH

GLBb0.08
ci 0.040
-1.93 to 1.54

MODAS with SSHA

GLBb0.08
ci 0.040
-1.92 to 1.47

- Direct assimilation of ADT SSH shows a more active eddy field (similar to NAVO RTOFS eddy field) than MODAS synthetic profile SSHA assimilation eddy field
- ADT SSH observations are more accurate than SSHA observations because the data incorporate geoid information instead of a model-based SSH mean field

- **Project 1: Ocean Data Assimilation to support RTOFS (based on NCODA)**
  - RTOFS-DA observation processing and assimilation options:
    - ❖ SST, SSH, and Sea Ice data averaged to form super-observations
      - uses local correlation length scales, removes data redundancies
    - ❖ Background error variances computed from forecast differences
    - ❖ 3DVAR runs on global grid using hybrid coordinates
    - ❖ Flow dependent error correlations

- **SIP project issues:**
  - Availability, processing and evaluation of marine/ocean observations in NCEP data tanks
  - Gaps in Coastal Ocean DA (Tiger Team ?)
  - Main developer is leaving

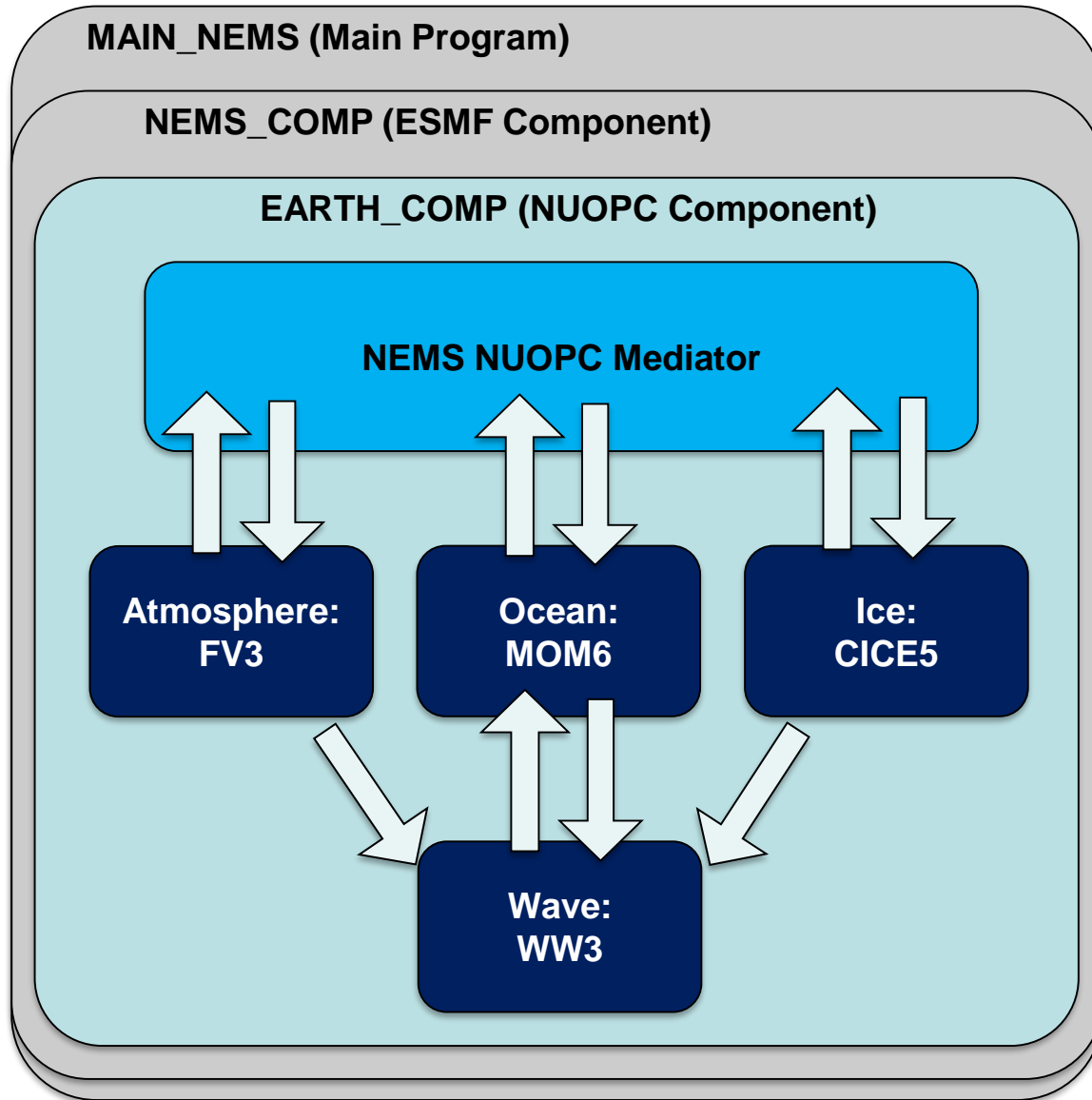# Marine Models WG
Project Milestone Accomplishments

- **Project 2(a): Hurricane Coupling/Nesting developments**
  - (briefed as part of **Dynamics and Nesting WG**)

- **Project 2(b): Development of a Global Coupled Unified Model**
  - (briefed as part of **NGGPS Global Model Suites**)

  - Coupling efforts are being leveraged with other related projects (e.g. COASTAL Act, COMT, TWI) which provide an opportunity to bring in other marine/coastal model components within the NEMS/UFS Framework (ADCIRC, WW3, NWM, other coastal models etc.)

MAIN_NEMS (Main Program)

NEMS_COMP (ESMF Component)

EARTH_COMP (NUOPC Component)

NEMS NUOPC Mediator

Atmosphere: FV3

Ocean: MOM6

Ice: CICE5

Wave: WW3

Project 2(c): Coupling wave models to Atmosphere-Ocean systems

Atmosphere ➔ Wave
- 10m Winds (u,v)

Ocean ➔ Wave
- Currents (u,v)

Ice ➔ Wave
- Ice concentration

Wave ➔ Ocean
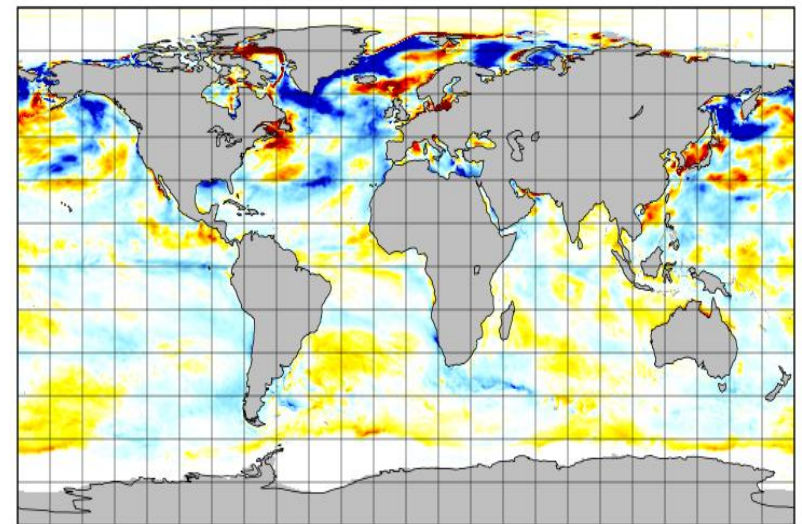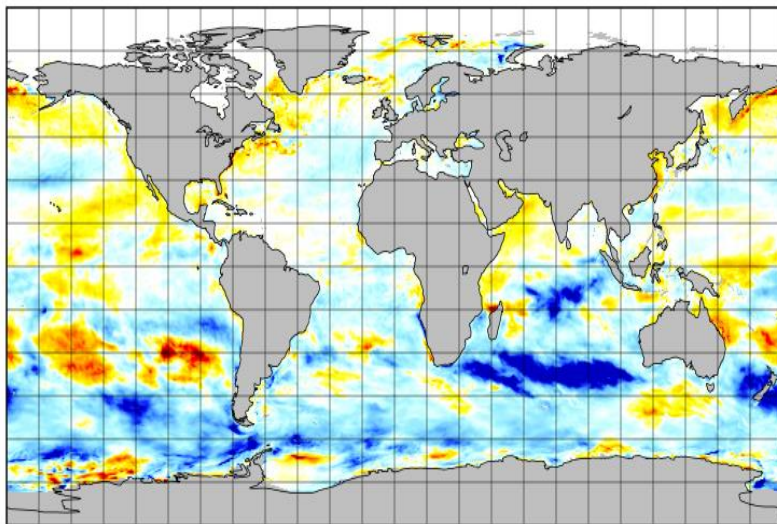- Stokes Drift (u,v)

Project 2(c): Coupling wave models to Atmosphere-Ocean systems

Effect of Langmuir Turbulence on SST

January 2016   June 2016

[deg C]

9
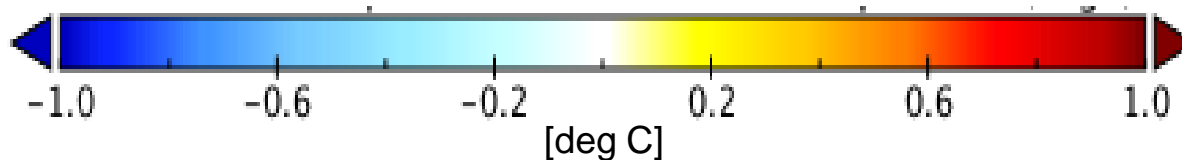
Marine Models WG
Project Milestone Accomplishments

- **Project 2(c): Coupling wave models to Atmosphere-Ocean systems**
  - physics changes in FV3GFS and FV3GEFS to accept sea-state dependent drag formulation (work ongoing)
  - impact limited to surface physics

- **SIP project issue:**
  - If two-way coupling degrades skill scores, revert to one-way
  - Efficiency in speed and memory usage in coupled FV3-WW3 and FV3-MOM6-WW3 systems.

- **Project 3: Integrated Water Prediction (IWP):**

  - Ongoing investigation of NWM coupling to coastal models
    - Demonstrated coupled model capability for single river system (NWM and 2-D ADCIRC in Delaware River) - completed by end of FY
    - Other marine-related accomplishments briefed by **Hydrology WG**
  - Funded multiple development projects to investigate 2-D and 3-D estuarine model coupling with NWM (Ongoing)
  - Successful transition of DA capabilities for West Coast OFS for operational testing and evaluation (Ongoing)

- **SIP project issues:**
  - Limited access to NWM output (ongoing discussion with NWC and Big Data Project)

  - Leverage knowledge and resources with Marine JEDI WG.

- **Project 4: NextGen Ocean Modeling and Marine Data Assimilation:**
  - Extending MOM6 collaborations with GFDL
  - Marine JEDI project ongoing which will leverage sub-projects 6.1 -- 6.4 from the DA WG plans.
    - 6.1: Assimilation of Observations
    - 6.2: Data Assimilation Algorithms
    - 6.3: Coupled Data Assimilation
    - 6.4: JEDI Data Assimilation Framework

- **SIP project issue:**
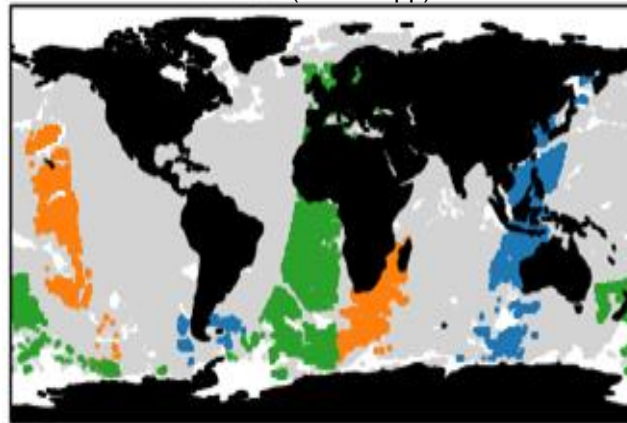 - Funding/resources for GFDL collaborations secured recently
  - Strong dependence on JEDI framework developments

Marine Models WG
Project Milestone·Accomplishments

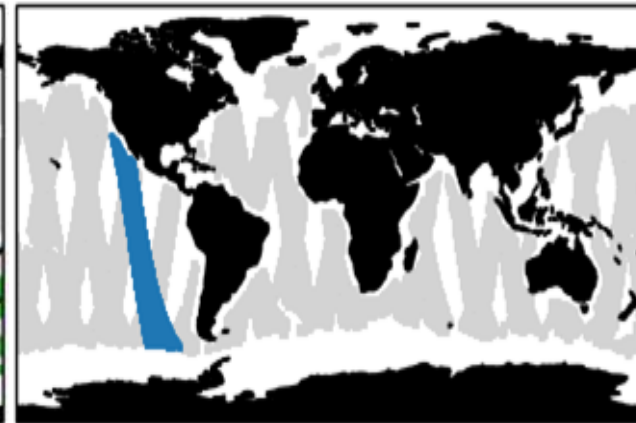Example: 30 days cycling

**1 day of observations
(2018-04-15)**

sea surface temperature (IR)
AVHRR (metopa, noaa19)
VIIRS (suomi-npp)

sea surface salinity
SMAP

Insitu T/S

sea surface temperature (MW)
GMI, AMSR2, WindSat

Altimetry
Jason-2, Jason-3, Sentinel-3a,
Cryosat-2, SARAL

Unified DA Effort-JEDI

1 day of observations
(2018-04-15)

Assimilating satellite SST (NESDIS/ACSPO AVHRR L2P) and altimetry (Jason-2, Jason-3, Sentinel-3a, Cryosat-2, SARAL)
24 hour window, MOM6 1 degree model…. after 30 days.
Kuroshio large meander correctly placed

Time average sea surface height (meter)
Data Min = -2.0, Max = 1.0

Time average sea surface height (meter)
Data Min = -2.1, Max = 1.1
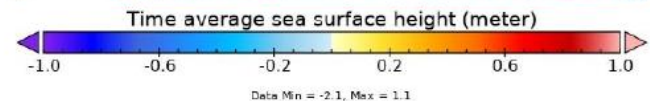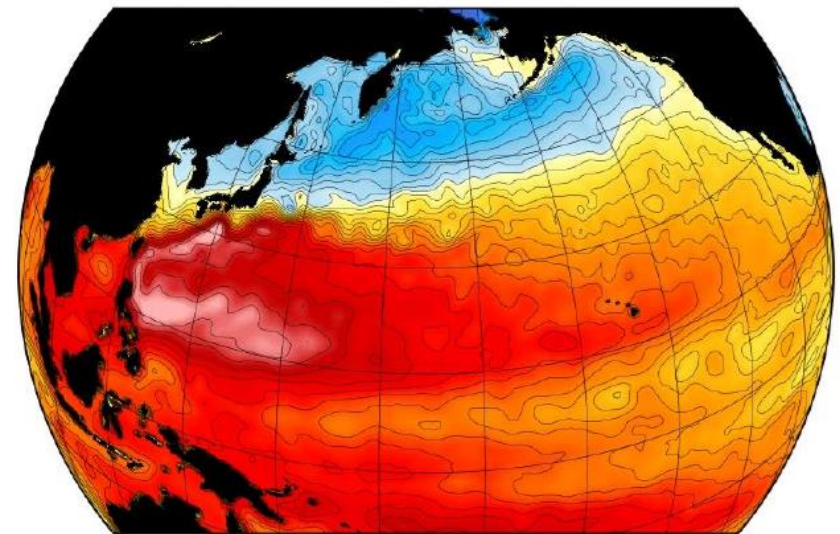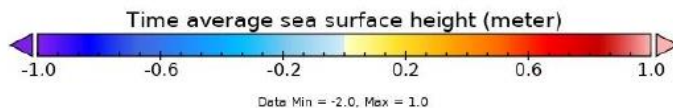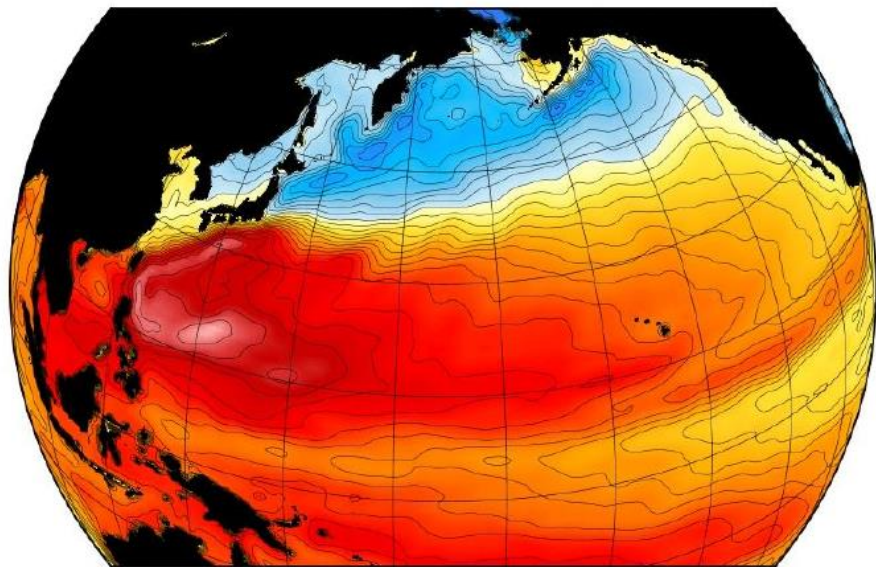
- **Project 5: Ecosystems and Eco-Forecasting**
  - Development of BGC modules in HYCOM/RTOFS, leveraged with NESDIS/JPSS funding (ongoing)
  - NOAA's Eco Forecasting Roadmap (EFR) undergoing update this FY

- **SIP project issue:**
  - Identification of requirements and resources

Marine Models WG
Team Coordination and Dependencies

- List major team coordination/dependency issues
  - Primary Issue: **the mandate for the Marine WG is too broad**

  Solution: Float new projects with support from sub-project teams or Tiger Teams. Some potential example sub-projects:

  - ➢ Marine JEDI for coastal oceans
  - ➢ MOM6 developments for weather scale applications
  - ➢ Marine coupling (oceans, waves, surge, hydrology) for Hurricanes (HAFS development)
  - ➢ Coastal Coupling Community of Practice