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* **
• 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
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
• 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.)
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Project Milestone Accomplishments

**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

[Color-coded map showing SST changes from January 2016 to June 2016]
• **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.
Marine Models WG
Project Milestone Accomplishments

• 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
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Project Milestone Accomplishments

Unified DA Effort-JEDI

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

- Sea surface salinity
  SMAP

Example: 30 days cycling

1 day of observations
(2018-04-15)

Insitu T/S

- Sea surface temperature (MW)
  GMI, AMSR2, WindSat

Altimetry
  Jason-2, Jason-3, Sentinel-3a,
  Cryosat-2, SARAL
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Project Milestone Accomplishments

Unified DA Effort-JEDI

1 day of observations
(2018-04-15)

Assimilating satellite SST (NESDIS/ACSP-O 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
• **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
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