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14. ABSTRACT
Modeling component of a coordinated 6.1-6.4 effort on the "Grand Challenge" problem of eddy-resolving global and basin-scale ocean modeling and prediction. This includes increased understanding of ocean dynamics, model development, model validation, naval applications, oceanic data assimilation, ocean predictability studies, observing system simulation studies, and nested models.

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Title: Eddy-Resolving Global/Basin-SOM

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CTA: CWO

Computer Resources: Cray XE6 [ERDC, MS]; Cray XC30, Cray XC40, IBM iDataPlex [NAVY, MS]

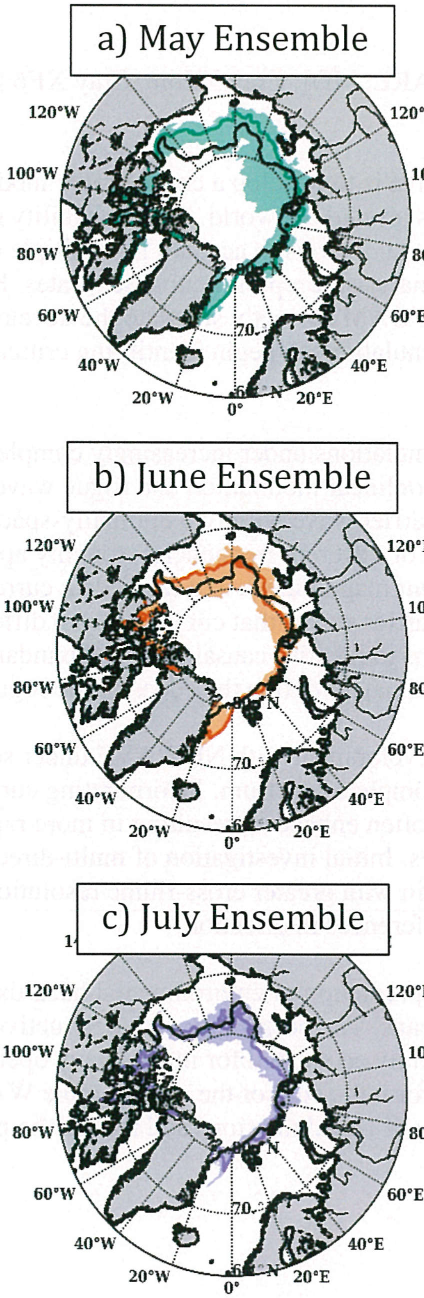
Research Objectives: Modeling component of a coordinated 6.1-6.4 effort on the "Grand Challenge" problem of eddy-resolving global and basin-scale ocean modeling and prediction. This includes increased understanding of ocean dynamics, model development, model validation, naval applications, oceanic data assimilation, ocean predictability studies, observing system simulation studies, and nested models.

Methodology: The appropriate choice of vertical coordinate is a key factor in ocean model design. Traditional ocean models use a single coordinate type to represent the vertical, but no single approach is optimal for the global ocean. Isopycnal (density tracking) layers are best in the deep stratified ocean, Z-levels (constant depths) provide high vertical resolution in the mixed layer, and terrain-following levels are often the best choice in coastal regions. The HYbrid Coordinate Ocean Model (HYCOM) has a completely general vertical coordinate (isopycnal, terrain-following, and Z-level) via the layered continuity equation that allows for an accurate transition from the deep to shallow water.

Results: 7 refereed articles, 8 non-refereed articles published or in press in FY17.
Global modeling: The Global Ocean Forecast System (GOFS) 3.1 was transitioned to the Naval Oceanographic Office (NAVOCEANO). It is comprised of 0.08° HYCOM that is two way coupled to the Community Ice CodE (CICE) and employs the Navy Coupled Ocean Data Assimilation (NCODA) to ingest all available real-time surface and subsurface ocean observations. A year-long reanalysis was integrated and error analyses computed and compared against operational GOFS 3.0. A newly developed ocean scorecard indicated superior performance of GOFS 3.1 vs. 3.0. Error analyses for ice metrics also indicated superior predictive skill of GOFS 3.1 compared to the operational Arctic Cap Nowcast/Forecast System (ACNFS).
Arctic modeling: ACNFS, a pan-Arctic coupled HYCOM/CICE system similar to GOFS 3.1, generates ice products for the Northern Hemisphere. In FY17, the Navy developed a new capability to produce "in-house" derived ice concentration for AMSR2 (passive microwave) and higher resolution VIIRS (a visible microwave) products. A year-long hindcast simulation for both ACNFS and GOFS 3.1 was run to evaluate the model skill assimilating these new data streams. Ice error analyses using these new data streams showed improvement over the systems not using these new data streams. Also, an 18-month ACNFS hindcast simulation was performed and results showed a signification improvement when initialized using a satellite-derived ice thickness product over the existing ACNFS.
Earth System Prediction Capability (ESPC): ESPC is a national, multi-agency, collaborative effort to develop the next generation whole Earth prediction system. The Navy's ESPC presently includes atmosphere, ocean, and sea ice components in fully coupled mode. We participated in the 2017 Sea Ice Prediction Network Sea Ice Outlook using a 10+ member time-lagged ESPC ensemble using initial conditions from early May, June and July 2017 to make three predictions of the September 2017 mean ice extent. The accompanying figure shows the ensemble mean and spread of the forecasts along with the observed September mean sea ice extent. Skill increases as the forecast lead time decreases.

DoD Impact/Significance: Data assimilative eddy resolving models are important components of global ocean and sea ice monitoring and prediction systems. Military and civilian applications include ship routing, search and rescue, antisubmarine warfare, coastal and mine warfare, fisheries forecasts, pollutant spill risks, El Niño forecasting, ocean observing system simulation, and global change studies.

2017 September Mean Sea Ice Extent
ESPC Forecasts



The 2017 mean September sea ice extent from the Navy ESPC forecasts started from initial conditions in early May 2017 (top), June 2017 (middle) and July 2017 (bottom). The black line is the observed September sea ice extent from NASA, the bold colored line is the ESPC ensemble mean and the light colored area represents the ESPC ensemble spread.