OceanPredict '19
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Theme 5: Ocean Prediction Systems and Services

Session 3: Global and Regional Prediction Systems I

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Evaluating the extended range ocean forecast in the Navy Earth System Model

Richman, James[1], Shriver, Jay[2], Metzger, E. Joseph[2], Dykes, James[2], Hogan, Patrick[2], Zamudio, Luis[3]
[1]Florida State University, CORVALLIS, OR, USA [2]Naval Research Laboratory, Stennis Space Center, MS, USA [3]Florida State University, Stennis Space Center, MS, USA jrichman@coaps.fsu.edu

The Naval Research Laboratory is developing a high-resolution coupled atmosphere-ocean-sea ice-surface gravity waves extended-range forecast system to transition into operations in the next few years. The system will have two configurations: a high-resolution ensemble 30-60 day forecast and a very high resolution 16 day deterministic forecast. The initial resolution of the deterministic forecast system is 19 km (T861 with 60 levels) for the atmosphere based upon the NAVy Global Environmental Model (NAVGEM), 4 km (1/25 with 41 layers)for the ocean based upon the HYbrid Coordinate Ocean Model (HYCOM) and 2 km for sea ice based upon the Community Ice CodE (CICE). In the current configuration, the atmosphere is blended with observations using a 4D variational data assimilation scheme (NAVy Data Assimilation System Advanced Representer, NAVDAS-AR) every 6 hours with a 3 hour Incremental Analysis Update (IAU), while the ocean and sea ice use a 3D variational scheme (Navy Coupled Ocean Data Assimilation, NCODA) once a day with 3 hour IAU for the ocean and direct insertion for sea ice. The test period for this evaluation spans the entire year, 2017, with analyses every day and 16 day forecasts launched once a week. Preliminary evaluation of the ocean at the valid time of the data assimilation analysis (nowcast time) shows similar results for the ocean only forecast system (Global Ocean Forecast System, GOFS), forced by the operational atmospheric model analysis, and the ocean component of the fully coupled system. The ocean forecasts have been evaluated against temperature and salinity profiles. The weekly forecasts perform similar to the analyses for about 7 days with a slow performance degradation over the remainder of the forecast. The rms error in temperature and isotherm depth increases by about 20% over the first two weeks of the forecast and nearly doubles over 60 days. The entire forecast performs better than climatology. Further evaluation is needed to identify the performance across all observed state variables of the model as well as calculated variables for mixed layer depth and acoustic characteristics and for new metrics appropriate for extended forecasts.

Keywords: Systems - Prediction system performance & evaluation, Systems - Implementation of Ocean Prediction Systems, Models - Coupled modelling, ,

Presenter:
James Richman
Florida State University
CORVALLIS, OR, USA
jrichman@coaps.fsu.edu

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Ensemble Ocean and Sea Ice Prediction in GEPS

Peterson, Andrew[1], Smith, Greg[1], Lin, Hai[1], Muncaster, Ryan[1], Gagnon, Normand[1] [1]Environment and Climate Change Canada, Dorval, Canada andrew.peterson@canada.ca

Environment and Climate Change Canadas (ECCCs) Global Ensemble Prediction System (GEPS) offers ensemble weather forecasts out to both 16 days (twice daily) and 1 month (weekly). A coupled version of this system (GEPS6) will go operational in 2019 offering ensemble ocean and sea ice forecasts at these lead times. Here, using prototypes of the system used to test operational suitability of system upgrade, we show the skill of the system for ocean and sea ice prediction. Ensemble forecasting offers up the ability to perform probabilistic forecasting, but to skillfully do this, the spread of the ensemble must adequately sample the forecast system error. Since this is first implementation of this system in a coupled forecast, we will pay particular attention to the spread/error relationship in forecasts of ocean and sea ice states, exploring work on stochastic ocean and sea ice parametrizations to improve this.

Keywords: Systems - Probabilistic forecasting, Systems - Prediction system performance & evaluation, Systems - Coupled systems, Models - Model assessments and verification, Systems - Coupled systems

Presenter:
Andrew Peterson
Environment and Climate Change Canada
Dorval, Canada
andrew.peterson@canada.ca

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The current Copernicus Marine Service global ocean monitoring and forecasting real-time system and the updates planned for the future system

Lellouche, Jean-Michel[1], Greiner, Eric[2], Le Galloudec, Olivier[1], Garric, Gilles[1], Bourdalle-Badie, Romain[1], Regnier, Charly[1], Drevillon, Marie[1], Benkiran, Mounir[1], Drillet, Yann[1], Le Traon, Pierre-Yves[1]
[1]Mercator Ocean, Ramonville Saint Agne, France [2]CLS, Ramonville Saint Agne, France
jlellouche@mercator-ocean.fr

Since October 19, 2016, and in the framework of Copernicus Marine Environment Monitoring Service (CMEMS), Mercator Ocean delivers in real-time daily services (weekly analyses and daily 10-day forecasts) with a new global 1/12 high resolution (eddy-resolving) system. The model component is the NEMO platform driven at the surface by the IFS ECMWF atmospheric analyses and forecasts. Observations are assimilated by means of a reduced-order Kalman filter with a 3D multivariate modal decomposition of the forecast error. Along track altimeter data, satellite Sea Surface Temperature and in situ temperature and salinity vertical profiles are jointly assimilated to estimate the initial conditions for numerical ocean forecasting. A 3D-VAR scheme provides a correction for the slowly-evolving large-scale biases in temperature and salinity.

An assessment of the current system has been conducted and has highlighted improvements compared to the previous system thanks to the following updates: large-scale and objective correction of atmospheric quantities with satellite data, new freshwater runoff from ice sheets melting, global steric effect added to the model sea level, new Mean Dynamic Topography taking into account the last version of GOCE geoid, new adaptive tuning of some observational errors, new Quality Control on the assimilated temperature and salinity vertical profiles based on dynamic height criteria, assimilation of satellite sea-ice concentration, week constraint imposed on temperature and salinity in the deep ocean (below 2000 m) to prevent drift.

However, some weaknesses of the current system have been identified as for instance the equatorial vertical velocity in the physical simulations with data assimilation and the interaction with the biogeochemistry. To improve our simulations, we are working on the following components: correction of the Mean Dynamic Topography, assimilation of a higher resolution SST L3S data, use of a 4D version of the analysis including a smoother capability, update of the NEMO model with the possibility to activate new numerical schemes, update of sea-ice model (from LIM2 to LIM3) and activation of a multivariate sea-ice analysis.

This presentation will focus on the impact of some of these changes in order to quantify the expected improvements on ocean analyses and forecasts for the future system.

Keywords: DA - Background and observation error covariances, Systems - General ocean monitoring (including those based on ocean DA and prediction systems), Systems - Ocean Prediction Systems types (forecasting, analysis, scales, assessment, regions, ecosystem, ice, wave, etc.), Systems - Implementation of Ocean Prediction Systems, Observations - Observation operators

Presenter:
Jean-Michel Lellouche
Mercator Ocean
Ramonville Saint Agne, France
jlellouche@mercator-ocean.fr

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An Overview of the Current and Future Operational Ocean Forecast Systems at NWS/NCEP and their Applications

MEHRA, AVICHAL[1], CHAWLA, ARUN[1] [1]NWS/NCEP/EMC, College Park, US avichal.mehra@noaa.gov

Operational ocean forecast systems at NWS/NCEP cover a gamut of temporal scales from short-term weather to seasonal/annual scales at apt spatial grid resolutions to provide real-time numerical guidance to NWS forecasters at national service centers as well as weather forecast offices across the country and the public at large.

At weather time scales, global Real Time Ocean Forecast System (RTOFS) which is based on an eddy resolving 1/12 global HYCOM (HYbrid Coordinates Ocean Model) (Chassignet et al., 2009) runs once a day and produces 2 days of nowcasts and up to 8 days of forecasts. The dynamic ocean model is coupled to the Community ICE (CICE v4) model for Sea Ice predictions. It also provides initial and boundary conditions for the coupled ocean components of the operational Hurricane models HWRF and HMON. For sub-seasonal-to-seasonal scales, Climate Forecast System Version 2 (CFS v2), a coupled Atmosphere-Ocean-Sea Ice-Land system is run daily and has 4 control runs (00Z, 06Z, 12Z and 18Z) up to 90 days and three additional runs at 00Z for one season for a total of 7 daily members of seasonal forecasts. For medium-range (sub-seasonal) forecasts, there are 9 daily runs which go out to 45 days (3 each at 06Z, 12Z and 18Z). All these members are coupled to a global MOM4 ocean model with a horizontal resolution of 0.25 degree from 10 North to 10 South latitudes. Northwards and southwards to the poles, the resolution decreases to 0.5 degree globally.

In the future, NCEP is transitioning from a stand alone modeling framework, with different components only interacting through boundary conditions, to fully coupled systems with full two-way interactions. Design and development of this framework for coupled systems for both weather and seasonal scales will be discussed along with developments of associated ocean data assimilation methods for these future coupled forecast systems.

Keywords: Evolution - End to end operational oceanography systems, Evolution - Enhancing community collaboration (observations, modelling, operations, users), Evolution - Future perspective and new frontiers in Operational Oceanography, Systems - Coupled systems, Systems - Earth-system models

Presenter:
AVICHAL MEHRA
NWS/NCEP/EMC
College Park, US
avichal.mehra@noaa.gov

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Recent developments to the Met Office operational global ocean forecast system FOAM

Aguiar, Ana[1], Harris, Chris[1], Martin, Matthew[1], Price, Martin[1] [1]UK Met Office, EXETER, United Kingdom ana.aguiar@metoffice.gov.uk

The Met Office global ocean forecasting model is FOAMv14.1, to become operational in early 2019. This version combines NEMOv3.6, CICE5.1 and NEMOVAR5 at 1/4 degree resolution and 75 vertical levels. FOAMv14.0 was implemented in late September 2018, running NEMOVAR4. The FOAM system runs daily and produces 7-day forecasts after a 48-hour analysis window, assimilating sea-ice concentration, sea surface temperature (SST) and along-track altimetry (SSH) satellite observations plus in situ temperature and salinity observations from surface drifters, ships, moorings, marine mammals and Argo floats. The ocean state is forced at the surface boundary by 3-hourly heat fluxes and precipitation fields, plus hourly winds output from the Met Office Unified Model.

We will highlight the main developments to the operational system and show how the results of the new version of our system compare against FOAMv13. Global observations minus background statistics look similar, with moderate changes on SST and SSH analysis time-series and slightly more significant improvements for temperature and salinity profiles in the North Atlantic, Tropical Pacific and Southern Ocean.

FOAMv14 was implemented partly to enable future capability. The next major upgrade,planned for 2020, will increase the resolution of our global ocean forecasting system to 1/12 degree (orca12).

Keywords: Systems - Ocean Prediction Systems types (forecasting, analysis, scales, assessment, regions, ecosystem, ice, wave, etc.), Systems - Prediction system performance & evaluation, , ,

Presenter:
Ana Aguiar
UK Met Office
EXETER, United Kingdom
ana.aguiar@metoffice.gov.uk

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Updates to the coupled ocean-atmosphere forecasting system at the Met Office

Roberts-Jones, Jonah[1] [1]Met Office, Exeter , U.K.

The Met Office has been running a coupled ocean-atmosphere forecasting system operationally since October 2016 which assimilates data following a weakly-coupled approach. Oceanic and atmospheric data are assimilated in a shortened assimilation window of 6 hours relative to the 24-hour window used by the ocean-only models run at the Met Office. The system produces daily short-range 10-day forecasts for both components. Ocean forecasts are available to users via the Copernicus Marine Environment Monitoring Service (CMEMS).

Recent updates to the CMEMS coupled system will be presented, with a focus on the performance of the ocean component. The impact ofassimilatingSLSTR SST data will be demonstrated and results from trials into using these data as a reference against which to bias correct the other satellite SST data will be shown.

The impact of running ocean only models with a shortened assimilation window and the impact of this on error covariance parameters will also be demonstrated. This is crucial in decomposing the effect of coupling from the effect of the shortened window when interpreting system results.

The nextgeneration of the coupled ocean-atmosphere forecasting system is currently under development. This is intended to replace the current atmosphere-only numerical weather prediction system by 2020/2021. A brief outline of major updates and results from initial validation of the ocean component of this system will be given.

Keywords: Systems - Coupled systems, DA - Coupled data assimilation for various earth system components, DA - Assimilation of new observation types, DA - Background and observation error covariances,

Presenter:
Jonah Roberts-Jones
Met Office
Exeter, U.K.
Jonah Roberts-Jones