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Theme 5: Ocean Prediction Systems and Services

Session 6: Verification

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High Resolution Surface Current From The Synergetic Use Of Altimetry, Sea Surface Temperature, Wind And In Situ Measurements

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Accurate estimate of ocean surface currents is both a challenging issue and a growing end-users requirement. The most exploited system for the monitoring of ocean surface currents at global scale is so far spaceborne altimetry observations, the flow in the ocean interior and away from the equator being at first order in geostrophic balance. Three complementary observations-based approaches have been developed to correct the altimeter-derived geostrophic currents and to obtain more realistic upper ocean surface circulation fields in terms of physical content and spatial and temporal resolution. These developments have been carried out through CNES/CLS projects as well as during the Globcurrent project (funded by the ESA User Element Program). Operational products are now available through CMEMS MULTIOBS component and experimental products are available through AVISO and Globcurrent portals.

The first approach combines the geostrophic and Ekman components of the circulation. The geostrophic component is derived from altimeter multimission fields (SSALTO-DUACS component, distribution by CMEMS Sea Level Thematic Assembly Center) and the CNES-CLS13 Mean Dynamic Topography. The Ekman component is available at two depths (surface and 15m) and is computed using an empirical model forced by wind-stress fields. The empirical model parameters (amplitude and angle) are derived using wind-stress fields and collocated in-situ velocities (Argo floats at the surface and SVP drifters at 15m depth) from which the geostrophic component and high frequency motion has been extracted. The surface and 15m Ekman currents show a spiral-like response to wind stress in good qualitative agreement with the theory.

The second approach uses the synergy between spaceborne altimetry and Sea Surface Temperature observations. The method is based on the inversion for the velocity of the heat conservation equation using the altimeter-derived geostrophic currents as background. By accurately prescribing the error both on the background velocities and on the forcing term (heat fluxes), the surface velocities are successfully improved in areas characterized by strong SST gradients and remain unchanged in low SST gradient regions, where by construction no additional information is brought by the SST field. Both the spatial and temporal resolutions of the altimeter derived velocities are enhanced by the SST information.

The third approach uses the synergy between spaceborne altimetry and in situ velocities observations which provide essential and complementary information on the position and displacement of mesoscale structures. The method is based on a multivariate optimal interpolation mapping method using both observations of height and velocities and prior statistical knowledge of

the field to be estimated. It allows both to improve the ocean surface currents and height where the density of the the in situ observations is sufficient.

Keywords: Systems - General ocean monitoring (including those based on ocean DA and prediction systems), Observations - Ocean monitoring based on observing systems, Observations - Satellite ocean observing systems, Observations - In-situ ocean observing systems,

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Six years class4 intercomparison with IV-TT dataset

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Mercator Ocean, the French operational oceanography service provider is in charge of implementing the Copernicus Marine Environment Monitoring Service CMEMS under a delegation agreement from the European Commission (2014-2021). As part of this service, Mercator Ocean develops and operates ocean analysis and forecasting systems based on state-of-the-art Ocean General Circulation Models assimilating observations of the Global Ocean Observing System.

Mercator Ocean runs several global (1/4 eddy permitting and 1/12 eddy resolving) ocean forecasting systems and delivers daily model equivalents for a common set of observations, called class4 metrics. In the context of the Intercomparison and Validation Task Team (IV-TT) the Mercator validation team has also developed intercomparison tools (physical diagnostics for mixed layer depth or water masses characterization, skill scores) based on CLASS4 metrics which are routinely used for the evaluation of the global Mercator configurations. These tools were also utilized to build a yearly validation report which keeps track of the performance of the global monitoring and forecasting system (MFC) in order to identify possible improvements. The accuracy and forecast capabilities of the different GODAE systems were computed over a six-year period using all the data provided by the GODAE IV-TT partners. The following set of observations was used: SLA from satellite altimetry, SST from drifting buoys, in-situ Argo profiles and satellite sea-ice concentrations.

In this presentation, we will illustrate the recent improvements of the different GODAE systems over the last six years using Mercator Oceans intercomparison tools

Keywords: Systems - Prediction system validation/ intercomparisons, Models - Model assessments and verification, Observations - Ocean monitoring based on observing systems, Systems - Ocean product and data formats,

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2-D Class-1 and Class-4 Verification Metrics and Methods for the Global Real Time Ocean Prediction System

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As Global Ocean Circulation models increase in size and complexity, the need for metrics to verify model results against independent observations and analyses continues to grow. This is of particular importance as ocean models are coupled to atmospheric and ice models, and as models undergo upgrades in resolution, parameterizations and physics algorithms. Synoptic analyses as well as longer-term (sub-seasonal to seasonal and beyond) tracking of the comparisons between model results and external observations are important both in terms of operational model diagnostics as well as measuring improvements gained by upgrades to operational models.

The challenges presented in designing the metrics can be summarized in three categories: Are the model results consistent with our knowledge of ocean processes? How much do the model results differ from observations? What is the forecasting skill of the model? A well-designed suite of metrics needs to address these questions in terms of both regional and global processes and parameters, preferably using observations that are independent of and not assimilated into the model.
Here we review the suite of 2-D surface metrics currently in use and under development at the NCEP Environmental Modeling Center to verify our operational Global Real Time Ocean Prediction System (Global RTOFS). Model nowcasts (Class-1) and forecasts (Class-4) are compared with satellite surface observations of temperature, salinity, and sea surface height, as well as polar ice concentrations, areas and extents.

Keywords: Systems - Prediction system validation/ intercomparisons, Models - Model assessments and verification, Systems - Ocean Prediction Systems types (forecasting, analysis, scales, assessment, regions, ecosystem, ice, wave, etc.), Systems - Visualisation,

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Regional Class 4 verification of the Canadian operational ice-ocean prediction systems

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Ice-ocean analysis and forecasting systems have been developed and operationally implemented under the Canadian Operational Network of Coupled Environmental Prediction Systems (CONCEPTS), an inter-departmental initiative involving Environment and Climate Change Canada (ECCC), Fisheries and Oceans Canada (DFO) and the Department of National Defense (DND). A DFO Service Desk for Operational Oceanography (SeDOO) was recently established at the ECCC Canadian Centre for Meteorological and Environmental Prediction (Dorval, Qubec) to be the DFO hub for the application of operational ice-ocean prediction systems. One of its missions is to support real-time monitoring and analysis. SeDOO has notably undertaken the management and the update of the verification and evaluation tools based on the Class 4 metrics defined by GODAE OceanView (GOV) for Sea Surface Temperature (SST), Sea Level Anomaly (SLA), temperature and salinity profiles and sea ice concentration. The analysis and forecasts of the Global Ice-Ocean Prediction System (GIOPS) are near real-time evaluated against observations and compared with other models that participate in the GOV international benchmarking. The Class 4 metrics are also calculated for the new Regional Ice-Ocean Prediction Systems (RIOPS), whose the geographical domain covers the North Atlantic, the Arctic and the North-East Pacific. Statistics of the difference between the observations and the model equivalents are calculated into various sub-areas allowing to better assess the quality of the GIOPS and RIOPS forecasts and their skills in key regions of interest for Canada, such as the North-East Pacific, the North-West Atlantic or the Canadian Arctic. This is necessary to guide and enhance operational model uses in those areas. This presentation will focus on those regional comparisons of the Class 4 verifications of the CONCEPTS systems.

Keywords: Systems - Prediction system validation/ intercomparisons, Systems - Prediction system performance & evaluation, Systems - Ocean Prediction Systems types (forecasting, analysis, scales, assessment, regions, ecosystem, ice, wave, etc.), Systems - Coupled systems, Evolution - International and intergovernmental collaboration

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Ocean drift projection verifications against drogued drifters in the North West Atlantic

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We deployed 50 iSVP MetOcean drogued surface drifters in 2016 and 2017 to help evaluate the performance of new and current prediction systems in the northwest atlantic stretching from the west Greenland Coast, to Baffin Bay, to Hudson Straight to the Newfoundland Shelf. These drifters contributed to the overall DBCP network, and included surface pressure, high accuracy surface temperature (for verification of GHRSST satellite data) and surface salinity measurements.
Herein we present drift projection verification against the Canadian Global and Regional Ocean Prediction Systems (GIOPS, RIOPS). This verification is done with a python suite that automatically compares available observation tracks against available prediction output. We evaluate differences between the Ariane Drift Projection system and the Environment and Climate Change Canada MLDP drift projection system. Additionally we explore various shelf circulation features contributing to cross shelf exchange on the Labrador Shelf outlined by the drifter tracks and compare these to the prediction system output. We analyze prediction observation misfit along the drifter tracks for temperature, salinity and velocity to map out along track spatial gradient differences between the drifter observations and the prediction system output. Overall this work contributes tools and results that are in part intended to increase meaningful dialogue/exchange between the ocean prediction community, the drifter community and ocean information end users.

Keywords: Systems - Prediction system performance & evaluation, Applications - Marine pollution, Applications - Search and rescue, Models - Ocean processes and parameterisation, Observations - Ocean monitoring based on observing systems

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Evaluating the performance of the CONCEPTS Global Ice Ocean Prediction System over the Grand Banks using ship based Doppler sonar velocity measurements

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Within GODAE OceanView, there has been over the last 5 years, a strong increase in verification of Ocean Prediction Systems against observations, known as the class 4 metrics. This well established approach within GODAE, compares Ocean Prediction Output against observed variables for a given day from a variety of observation platforms. Here we look at verification of an ocean prediction system through comparisons against direct velocity observations. Ship mounted Doppler sonar (ADCP) surface velocity measurements were collected over a ~2 month period and compared with equivalent interpolated velocity values from the CONCEPTS Global Ice-Ocean Prediction System (GIOPS) over a 30,000 km2 region of the Grand Banks. The ADCP data were made available from the Chevron 2011 North East Grand Banks seismic survey. Water depths included in the comparison range from O(100 m) to depths of about 1500 m and critically, the observation region includes the offshore branch of the Labrador Current. ADCP data and model output agree qualitatively with the model reproducing the long term fluctuations seen in the data. At higher frequencies between 0.3 and 2.0 cycles/day, the model tends to underrepresent the current velocities by about 20% but the spectral peak associated with inertial oscillations is well resolved. Comparisons of drift track predictions based on the ADCP observations and model output show rms displacement differences of 8 km after 24 hours and ~10 km separations for drift tracks with length under 50 km. This comparison demonstrates the predictive ability of the GIOPS system and highlights how collaboration with industry can be used to evaluate, and in time improve, ocean predictive model capabilities.

Keywords: Systems - Prediction system validation/ intercomparisons, Systems - Prediction system performance & evaluation, Models - Model assessments and verification, Observations - New observation types, Applications - Oil & gas industries

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