OceanPredict '19
GODAE OceanView Symposium | 6-10 May 2019 Halifax, Canada
Advancing the science and application of ocean predictions

Theme 3: Numerical Modelling

Session 1: Forecasts and nowcasts from models of ocean, atmosphere, and ice I

Abstract ID: 3586934

Flow-induced variations of sea surface temperature on Scotian Shelf

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Sea surface temperature (SST) on Scotian Shelf has strong variations on both seasonal and interannual time scales. The seasonal cycle of SST is mainly controlled by local air-ocean heat fluxes (solar radiation, longwave radiation, sensible and latent heat fluxes), with modulation by other oceanic processes, e.g., horizontal advection, horizontal/vertical mixing and upwelling. The contributions of these factors have been investigated by early studies based on limited observations, however, further quantification is still needed, particularly the horizontal advection term, to better understand the physics driving the SST.

In this study, a 4-km resolution regional configuration based on NEMO 3.6 with LIM2 sea-ice module is set up and used to conduct a hindcast simulation from 2007 to 2016 over the Canadian Maritimes seas (including the Gulf of Saint Lawrence, Scotian Shelf and Gulf of Maine). With the daily model output, we are going to 1) show the spatial distribution of SST horizontal advection and its seasonal amplitude and phase; 2) quantify the contribution of horizontal advection on eastern Scotian Shelf to its seasonal SST evolution, especially during the ocean warming and cooling periods; 3) discuss the interannual variability of SST horizontal advection on Scotian Shelf and the implications for future SST prediction in this area.

Presentation Format: Oral Session

Keywords: Models - Ocean processes and parameterisation, Models - Model assessments and verification, Models - Coupled modelling, Models - Ocean model boundary conditions and forcings,

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The Mediterranean analysis and forecasting physical system for the Copernicus Marine Service: description and skill assessment

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The Mediterranean Analysis and Forecasting System is a numerical ocean prediction system that operationally produces analyses and 10 days forecasts of the main physical parameters for the entire Mediterranean Sea and its Atlantic Ocean adjacent areas.

The system is composed by the hydrodynamic model NEMO (Nucleus for European Modelling of the Ocean) 2-way coupled with the third-generation wave model WW3 (WaveWatchIII) and forced by ECMWF (European Centre for Medium-range Weather Forecasts) atmospheric fields. The forecast initial conditions are produced by a 3D variational data assimilation system which considers a daily assimilation cycle of Sea Level Anomaly, vertical profiles of Temperature and Salinity from ARGO and ship CTDs and heat flux corrections with satellite SST.

The system has been recently upgraded in the framework of the Copernicus Marine Environment Monitoring Service (CMEMS) by increasing the grid resolution from 1/16 to 1/24 degree in the horizontal, thus becoming fully mesoscale resolving and from 72 to 141 vertical levels, by increasing the number of fresh water river inputs and by updating the data assimilation scheme. The model has a non-linear explicit free surface and the forecast is forced by surface pressure, interactive heat, momentum and water fluxes at the air-sea interface.

The focus of this work is to present the latest modeling system upgrades and the related improvements achieved by showing the model skill assessment including comparison with independent (insitu coastal moorings) and quasi-independent (insitu vertical profiles and satellite) datasets.

Presentation Format: Oral Session

Keywords: Models - Ocean model configurations, Models - Model assessments and verification, , ,

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CIOPS-W: An operational forecasting model for oceans off Canada's West Coast to support the Ocean Protection Plan

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In order to provide Canada with short-term ice-ocean predictions and oil spill trajectory forecasts for the Ocean Protection Plan, the Government of Canada CONCEPTS initiative (Canadian Operational Network of Coupled Environmental Prediction Systems) is developing new coastal ice-ocean prediction systems. This presentation introduces the Coastal Ice Ocean Prediction System for the West Coast of Canada (CIOPS-W). The system uses a 1/36 resolution (2km) configuration of the NEMO model covering the North East Pacific (NEP36). The CIOPS-W system has been setup using a spectral nudging approach to downscale the ocean analysis from the updated Regional Ice Ocean Prediction System (RIOPSv2), which now includes a full multivariate data assimilation system and an extension over the North Pacific Ocean.

The main aim is to present an evaluation of the CIOPS-W with a focus on the evaluation of the processes that influence the surface drift and the fate and behaviour of oil spills such as (i) the representation of tidal amplitude, phase and currents, (ii) the evolution of sub-tidal elevation and currents and (iii) the evolution of water masses. Drift characterization and evaluation of simulated drift using surface and drogued drifters is also presented for the pseudo-analysis and forecasts. Finally, case studies of observed oil spills are presented to compare trajectories obtained with the Canadian Oil Spill Modeling System (COSMoS) with input ocean currents CIOPS-W.

Presentation Format: Oral Session

Keywords: Applications - Coastal protection, Models - Model assessments and verification, Systems - Prediction system performance & evaluation, Systems - Implementation of Ocean Prediction Systems, Applications - Disaster & risk management

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Evaluation of nowcast and decade-long hindcasts of ocean variations on Canada's Scotian Shelf based on high-resolution ocean regional models

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Variability on the Scotian Shelf (SS) is influenced by multiple factors, including local atmospheric forcing and mixing, coastal and on-shelf currents that advect upstream variations from the Gulf of Saint Lawrence and Newfoundland Shelf on to the SS, and eddy intrusions of Scotian-Slope water, formed through the mixing of Gulf Stream and Labrador Sea waters. Recently, high-resolution models have been developed to produce both real-time nowcasts and decade-long hindcasts for the SS and adjacent regions. In this study, the accuracy of the model nowcasts and forecasts are evaluated using a variety of in-situ and remote-sensing observations. Overall, the models possess significant skill in predicting the complicated space and time variations of temperature, salinity, sea level and circulation on the SS. We also identify and explain some important model biases. Finally, we present examples of how the model results are applied to better understand changes in the SS ecosystem and the associated fisheries.

Presentation Format: Oral Session

Keywords: Models - Model assessments and verification, Applications - Fisheries, , ,

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GCOAST Model System: coupling of ocean and atmosphere through a dynamic wave interface

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The coupling of models is a commonly used approach when addressing the complex interactions between different components of earth system. Here we present the development of a new, high -resolution, coupled ocean (NEMO), wave(WAM) and atmosphere (COSMO-CLM), model system for the North Sea and the Baltic Sea, which is part of the Geestacht COAstal model SysTem GCOAST. We focus on the nonlinear feedback between strong tidal currents and wind -waves, which can no longer be ignored, in particular in the coastal zone where its role seems to be dominant. In NEMO stand-alone model, the momentum flux from the atmosphere, which is related to the wind speed, is passed directly to the ocean and this is controlled by the drag coefficient. However, in the real ocean, the waves also play the role of a reservoir for momentum and energy because different amounts of the momentum flux from the atmosphere is taken up by the waves. In the coupled model system the momentum transferred into the ocean model is estimated as the fraction of the total flux that goes directly to the currents plus the momentum lost from wave dissipation. Additionally, we demonstrate that the wave -induced Stokes Coriolis force leads to a deflection of the current. During extreme events the Stokes velocity is comparable in magnitude to the current velocity. The resulting wave -induced drift is crucial for the transport of particles in the upper ocean. The Stokes drift impact on mass and tracer advection on the simulation of the Baltic Sea upwelling is demonstrated. The performance of the coupled modelling system is also illustrated for the cases of several extreme events. The model comparisons with data from satellite altimeter and in-situ observations showed that the implementation of wave model component into the coupled systems reduces the errors, especially under severe storm conditions. However, the performed sensitivity analyses demonstrate that the model skill depends on the chosen processes. This justifies these further developments in the frame of both operational activities and climate studies.

Presentation Format: Oral Session

Keywords: Models - Coupled modelling, Systems - Coupled systems, Models - Wave and tide modelling, Models - Future trends in ocean modelling, Models - Downscaling

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Improvements to the Yellow Sea and East China Sea Operational Forecasting System

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The Yellow sea and East China Sea Operational Forecasting System (YEOFS) has been developed based on the state-of-the-art Regional Ocean Modeling System and operated since January 1, 2013 in NMEFC of China. Daily updated 120-hour forecasting products for the 3D ocean temperature, salinity and currents are used for: open boundary conditions for high resolution coastal ocean models, oil spill forecasting, marine search and rescue, red/green tide, navigation, fisheries management, and marine environmental protection. During recently couple years, in order to increase YEOFS forecasting skill, we have improve the system from a few aspects as follow. Firstly, we have fixed a small bug of bathymetry in the middle of Yellow Sea to represent the Yellow Sea Warm Current better during winter time. Secondly, we have changed the surfacing forcing method from direct forcing to an atmosphere-ocean coupling by employing bulk formula COARE 3.0, and the forecasting skill of sea surface temperature have been improved about 18%. At the same time, one method of correcting the Climate Forecast System Reanalysis (CFSR) surface heat flux forcing data has been developed by employing the EOF analysis, and 6-hourly correction datasets to the CFSR surface heat flux forcing data have been generated for a year round, according to a series of surfacing forcing experiments. Thirdly, two kinds of vertical mixing schemes of GLS and MY-2.5 have been tested and compared in order to improve the forecasting skill of the surfacing mixing, thermocline and the vertical structures of temperature and salinity. The MY-2.5 scheme has been improved by considering the surface wave affection.

Presentation Format: Oral Session

Keywords: Models - Ocean model boundary conditions and forcings, Models - Ocean processes and parameterisation, Systems - Prediction system performance & evaluation, Models - Ocean model configurations,

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A three-dimensional circulation prediction system around the Korean peninsula

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Current systems in the south coast of Korea are complex and relatively strong owing to a combination of geological features and tidal effects. Athough it is not a very wide area, the flow patterns of the eastern side and western side are quite different. In the western part of the south coast of Korea, there are strong tidal currents with speeds of more than 3 m/s during spring tides. On the other hand, the southeast coast has relatively weak tidal current although the Tsushima Current, a branch of the Kuroshio that flows toward the northeast, affects it constantly. Thus, it is very difficult to predict the currents in the south coast of Korea. The Korea Institute of Ocean Science and Technology has been conducting the KOOS (Korea Operational Oceanographic System) project since 2009, which includes a three-dimensional circulation prediction system that calculates tidal and oceanic effects around the Korean peninsula. Since 2016, a three-dimensional circulation prediction system with a spatial resolution of 300 m has been constructed for coastal waters around the Korean peninsula. The MOHID model is used as the circulation model in this system. The results of FES2014 are used as harmonic constants at open boundary conditions while the results of KOOS-OPEM (Ocean Predictability Experiment for Marine environment) are used as the initial conditions in the system. The Weather Research and Forecasting model is used for atmospheric prediction. Since the circulation prediction system has high resolution, the number of grids is more than 1600 in the x and y axes, and the time step is calculated as 10 s.
This presentation will provide an overview of the costal KOOS. The study results indicated very good agreement with observed data in a high resolution grid in the eastern and western sides of the south coast of the Korean peninsula.

Presentation Format: Poster Session

Keywords: Models - Downscaling, Models - Ocean model configurations, Models - Wave and tide modelling, Systems - Integration of coastal systems in large-scale systems, Systems - Ocean Prediction Systems types (forecasting, analysis, scales, assessment, regions, ecosystem, ice, wave, etc.)

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