OceanPredict '19
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Advancing the science and application of ocean predictions

Theme 6: User Applications and Societal Benefit

Session 2a: Oil Spill and Drift Modeling

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A wealth of free ocean data for all market sectors: The Copernicus Marine Service

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The oceanic component of the Copernicus programme - The Copernicus Marine Service (http://marine.copernicus.eu) - offers all visitors, freely and openly, simply and instantaneously, qualified and regularly updated information on the physical and biogeochemical state of the global ocean and the six regional seas in Europe. Ocean products are derived from satellite and in situ observations, forecasts, real-time analyses and long time series over several decades. The Copernicus Marine Service meets user needs in research, industry, public and commercial services in four areas of benefit:

Maritime safety: For example, the Copernicus Marine Service supports ship routing activities and provides shipping companies with ocean currents and waves conditions for ship routing software for safer navigation routes including ice covered areas. It also supports Search and Rescue Coast Guards with ocean currents and waves products used as input for search and rescue software and met-ocean dashboards to reduce risk at sea. The Copernicus Marine Service also help combatting offshore marine oil spill with the provision of ocean current to forecast the oil spill drift and plan for the emergency response.

Marine resources: For example, the Copernicus Marine Service supports sustainable fishery management with products used as inputs for modelling of fish habitats. It also helps aquaculture farms with products on the water quality monitoring and potential harmful algae blooms.

Coastal and marine environment: For example, the Copernicus Marine Service supports the European Marine Strategy Framework Directive (MSFD) and its agenda for clean marine waters in Europe by 2020 and provides products to monitor sea water eutrophication to each European Member. The Copernicus Marine Service is also used for coastal management where harbor authorities develop high resolution coastal models using the Copernicus Marine Service products as initial and boundary conditions. The Copernicus Marine Service ocean models also provide key input in the offshore energy sector to estimate the ocean energy resources, minimize the risks and help with the mandatory environmental monitoring of offshore sites.

Weather, seasonal and climate forecasting: The Copernicus Marine Service Ocean State Report synthetizes the Global Ocean and European Seas state and health for the preceding 20 years. It furthers knowledge for the Intergovernmental Panel on Climate Change (IPCC), the ocean

scientific community as well as for policy and decision makers. The Copernicus Marine Service provides data for the seasonal prediction of events such as El Nio/La Nia.

This presentation will first briefly introduce the Copernicus Marine Service and its free and open marine data and information for the benefit of all sectors. Then, it will mainly provide with examples of use of the Copernicus Marine Service products. Future evolution of Copernicus Marine Service will also be highlighted.

Keywords: Applications - Ship navigation, Applications - Marine pollution, Applications - Renewable energies, Applications - Water quality, Applications - Sustainable use of ocean resources for economic growth (blue economy)

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Application of HF radar currents to improve accuracy of particle-tracking model

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The accuracy of drift prediction for missing persons in the event of a marine accident is influenced by various factors such as wind and current in the accident area, drift type, location information, and time of occurrence. Among these, surface current information affecting the drift object movement is an important factor in determining drift prediction accuracy. Because the accuracy of the particle tracking model (PTM) depends on the accuracy of initial conditions, to improve the accuracy of PTM, drift prediction simulation was performed using surface current data observed by high-frequency radar (HFR) as input data.

We used the data obtained by the 13 MHz HFR installed in Jeju Island by the Korea Institute of Ocean Science Technology (KIOST). The observation range of the HFR is the Jeju Strait in the southern part of the Korean Peninsula; and the resolution of current field is 3 km. The PTM was based on the Modelo Hidrodin?mico (MOHID) Lagrangian module, and uses Monte Carlo ensemble technology. The input data of the numerical model used for the PTM are 300 m resolution current field of the coastal circulation forecasting system (MOHID) and 4 km resolution of the weather forecasting system (Weather Research and Forecasting model) of the Korea Operational Oceanographic System. In order to verify the PTM results, a field experiment using the surface drift buoy was conducted in April 2018 near Chuja Island in northern Jeju Island.

We applied MOHID currents and HFR currents to the PTM. The results of the PTM show improved accuracy when using HFR current. In order to apply HFR to the PTM for search and rescue, it is necessary to use high-quality HFR data on a wide area. In addition, it is important to transmit HFR data as soon as possible by improving the real-time transmission rate of HFR in order to utilize these data for predictions in cases of real marine accidents.

Keywords: Applications - Search and rescue, Applications - Navy applications, Models - Model assessments and verification, Observations - In-situ ocean observing systems, Applications - Disaster & risk management

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Forward and Backward Lagrangian Particle Tracking in Ensemble Flow Fields

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Ocean ensemble data assimilation systems generate ensembles of independent velocity field realizations after every assimilation cycle. Lagrangian tracking of passive tracers within such a framework is challenging due to the exponential growth in the number of particles that arises from describing the behavior of velocity over time as a set of possible combinations of the different realizations. This contribution addresses the problem of efficiently advecting particles, forward and backward in time, in ensemble flow fields, whose statistics are prescribed by an underlying assimilated ensemble. To this end, a parallel adaptive binning procedure that conserves the zeroth, first and second moments of probability is introduced to control the growth in the number of particles. The adaptive binning process offers a tradeoff between speed and accuracy by limiting the number of particles to a desired maximum. To validate the proposed method, we conducted various forward and backward particle tracking experiments within a realistic high-resolution ensemble assimilation setting of the Red Sea, focusing on the effect of the maximum number of particles, the time step, the variance of the ensemble, the travel time, the source location and history of transport. We also demonstrate the efficiency of the method for possibly identifying the location of a moving source from observed released materials.

Keywords: Applications - Marine pollution, Applications - Environmental assessment, Applications - Coastal protection, Applications - Disaster & risk management, Applications - Oil & gas industries

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Wind driven response of different surface drifters

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The near surface drift in the ocean is of paramount importance for many operational oceanography activities. These include search and rescue, oil spill modelling, and the dispersion of other marine biological and chemical tracers. There are many types of surface drifters used in operational oceanography, each having its own unique response to the wind, wave and oceanic forcing. In particular, the vertical position of the drifter - whether it be drogued or floating at the surface - can strongly affect the drifter response even within the upper metre of the ocean. Presented is an experiment using six different types of surface drifters deployed off of western Norway during June 2018. Results show that the various drifters have very different responses to wind and wave forcing. These results are presented in relation to improving trajectory forecasts of surface objects and understanding the near-surface structure of surface currents.

Keywords: Models - Ocean processes and parameterisation, Systems - Prediction system performance & evaluation, Applications - Oil & gas industries, Applications - Search and rescue,

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Ocean surface drift and the search for MH370

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Malaysian Airlines Flight MH370 disappeared in March 2014. Five years on, neither the crash site nor the reason for the loss of 239 people is known. Clues to where the crash occurred are few and very imprecise. Drift modelling was used in three ways during the investigation: 1) during the initial six-week search of the sea surface for floating debris, 2) once debris items were located on African shores, and 3) when objects were identified in high-resolution satellite optical imagery. A huge area of sea floor has now been searched unsuccessfully and there is no consensus on where any future search should be directed. Was the search unsuccessful because our models of ocean surface currents were not good enough, or not used well enough? In this talk we look into this question, focussing on what we believe are the key uncertainties, and what could possibly be done to reduce them, not just for the sake of this search but for any future similar application of Operational Oceanography.

Keywords: Applications - Search and rescue, Applications - Marine pollution, DA - Model and observation systematic errors, Systems - Ocean reanalysis, Systems - Prediction system validation/ intercomparisons

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Combined evaluation of surface drifters trajectories and oil spill modeling results as support to offshore Oil & Gas emergencies

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Ocean monitoring based on observing systems such as surface drifters trajectories analysis, combined with oil spill modeling results is of fundamental importance to decision making during offshore Oil Gas emergencies. In this context, a project to monitor surface oceanic drift in the Santos Basin - a region of high OG activity in Southeastern Brazil - is described. The drifters used are equipped with satellite telemetry and GPS and designed to simulate sea surface oil drift, as their buoyancy and spherical shape provide a drift influenced by both surface currents and winds. So far, six campaigns with 3 drifters each were performed over two years in different seasonal scenarios and allowed to evaluate the stochastic oil spill modeling results produced for the environmental permitting of an exploratory oil block in the region. The simulations considered an oil drift of 31 days, in the two main seasonal scenarios: the first comprising September to February (spring/summer), and the second from March to August (autumn/winter). Drifters trajectories were mainly southwestward, following the average pattern of the Brazil Current. We discuss the influence of the wind drift factor used in the model versus the wind influence over the drifters and the fitness of the hydrodynamic and atmospheric databases used in the numerical simulations. The maps of the probability of oil presence and time of arrival from the stochastic modeling showed a good agreement with the drifters trajectories in general, with a better attachment during the autumn/winter scenario.

Keywords: Applications - Oil & gas industries, Observations - Ocean monitoring based on observing systems, Models - Model assessments and verification, Applications - Environmental assessment, Applications - Marine pollution

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