ACCESS NUMBER: M12PG00030

STUDY TITLE: A Study to Improve Oil-Spill Risk Analysis in the Gulf of Mexico: a Multi-Model Approach

REPORT TITLE: Intra-Americas Sea Nowcast/Forecast System Ocean Reanalysis to Support Improvement of Oil-Spill Risk Analysis in the Gulf of Mexico by Multi-Model Approach

CONTRACT NUMBER(S): M12PG00030

SPONSORING OCS REGION: Headquarters

APPLICABLE PLANNING AREA(S): Gulf of Mexico

FISCAL YEAR(S) OF PROJECT FUNDING: 2013, 2014

COMPLETION DATE OF REPORT: October, 2014

COST(S): (BY FISCAL YEAR); CUMULATIVE PROJECT COST: FY 2013: $60,000.00; FY2014: $60,000.00

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KEY WORDS: Ocean reanalysis; Intra-Americas Sea Nowcast/Forecast System (IASNFS); Navy Operational Global Atmospheric Prediction System (NOGAPS) surface wind; Correlation and model efficiency (skill); Gulf of Mexico, OSRA, Oil Spill Risk Analysis, surface currents

BACKGROUND: The Bureau of Ocean Energy Management (BOEM) is responsible for analysis of potential oil-spill impact to the environmental resources prior to a lease sale for oil and gas exploration in the Gulf of Mexico Outer Continental Shelf (OCS). To estimate the probability of potential oil spill contacts with environmental resources in the Gulf of Mexico OCS, the high-resolution gridded surface current and wind products in the Gulf of Mexico are needed to drive the oil-spill trajectory model. Currently, the Bureau's Oil Spill Risk Analysis (OSRA) model relies on the surface currents generated by one of the Gulf of Mexico circulation model. The deterministic approach with one set of surface current and wind input to the OSRA model could be improved by incorporating several sets of input from different proven ocean models to run the OSRA model, as the ocean model output might be subject to uncertainty in surface winds from various atmospheric re-analysis products.

This study proposes a multi-model approach by conducting ensemble OSRA model runs that include different sets of surface currents simulated by other well-validated Gulf of Mexico ocean circulation

models, and their corresponding wind forcings. The outcome of this study will improve the accuracy of the oil spill risk analysis in projected areas of OCS operations. The method developed for this study could be employed in other OCS Regions.

OBJECTIVES: The objective of this study is to provide more accurate information for the BOEM on oil spill risk management and contingency planning in the GOM. To achieve this objective, several different sets of model-simulated surface currents and their corresponding surface winds in the GOM are needed to drive the OSRA model. This study will generate an ensemble of model solutions that will be statistically analyzed in order to understand the uncertainty in the probability of the potential oil-spill contacts with environmental resources.

DESCRIPTION: The Naval Research Laboratory (NRL) and the BOEM are entering into this Interagency Agreement to work on improving oil-spill risk analysis in the Gulf of Mexico. This study will last 24 months from award to submission and acceptance of all deliverables. BOEM estimates $120,000.00 will be approximately available for this project. During this period the NRL is expected to successfully complete the tasks described below.

a. Use an existing state-of-the-art, high resolution ocean model in the Gulf of Mexico with advanced data assimilation techniques to perform the hindcast run from 2003 to 2012. Data assimilation should include the available space-borne observations and in-situ measurements.
b. Validate model results with in-situ observations in the Gulf of Mexico. BOEM scientists will provide a set of metrics for the Recipients to perform comparisons between model results and observations.
c. Provide the model output for the period 2003-2012 to BOEM. BOEM is interested in the gridded surface winds and currents fields at 3-hourly or less intervals, and maybe other model fields, such as sea surface heights, 3D temperature, salinity and velocity fields. The final model output should be gridded products in a netcdf format using Cooperative Ocean/Atmosphere Research Data Service (COARDS) and Climate and Forecast (CF) conventions (i.e. standard definition of names, units, and etc).

d. Write a report to describe the model setup (i.e., parameterization, forcing functions, data assimilation techniques), validation of model results, and etc. Publication in a peer-reviewed journal is encouraged.

SIGNIFICANT CONCLUSIONS: Ten years of IASNFS reanalysis was evaluated extensively by applying in-situ and satellite measurements. The reanalysis was evaluated against satellite altimeter sea surface height, National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) tide gauge data, NOAA National Data Buoy Center (NDBC) buoy surface temperature, satellite Multi-Channel Sea Surface Temperature (MCSST) and current measurement at BOEM-supported moorings. The evaluations show overall high correlations and very good model skills for the IASNFS reanalysis indicating the reanalysis is very well produced.

STUDY RESULTS: A multi-model approach was proposed by BOEM to better assess the potential impact of oil spill on the environment of Gulf of Mexico by conducting ensemble OSRA model runs. Different sets of model-simulated surface currents and their corresponding surface winds in the Gulf are needed to drive the OSRA model. A 10-year ocean re-analysis for the Gulf of Mexico based on NRL IASNFS has been produced to support this effort.

The reanalysis was derived with NOGAPS atmospheric forcing and assimilation of satellite altimeter sea surface height and MCSST. The open boundary conditions were taken from Navy's Global NCOM. Details of the ocean model, the NOGAPS forcing the data, and data assimilation were described. The output of reanalysis was examined that includes evaluations against satellite altimeter measurements, coastal sea levels from tide gauges, sea surface temperatures from buoys and satellite, and ocean currents from moorings. Overall, it shows that the IASNFS reanalysis is well produced.
Ten-years-long monthly data sets in netCDF format at 3-hourly interval from 2003 to 2012 within the Gulf of Mexico and Straits of Florida have been prepared and provided to BOEM for the ensemble OSRA model run.

STUDY PRODUCT(S):

- Final report for the U.S. Department of the Interior, Bureau of Ocean Energy Management: Intra-Americas Sea Nowcast/Forecast System Ocean Reanalysis to Support Improvement of Oil-Spill Risk Analysis in the Gulf of Mexico by Multi-Model Approach. Contract no M12PG00030. 64 pp. BOEM 2014-1003.
- Scientific conference presentation of "A Decadal Ocean Reanalysis for the Gulf of Mexico" at Gulf of Mexico Oil Spill & Ecosystem Science Conference, January 2013, New Orleans, Louisiana.
- Data set of a ten-year-long ocean re-analysis that includes sea surface elevation, 3D temperature, salinity and current, and surface wind at 3-hourly interval from 2003 to 2012 within the Gulf of Mexico and Straits of Florida. 1.7 TB.