Analysis of Uncertainty in Simulations of Surface Oil Drift in the Gulf of Mexico

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Numerical predictions of the evolution of an oil spill played a crucial role in coordination of the emergency response activities during The Deepwater Horizon catastrophe of 2010 in the Gulf of Mexico. Oil spill models vary in the level of complexity from surface drift models simulating only the movement of oil on the surface to the three-dimensional models simulating the full life cycle of hydrocarbons from a subsurface source through a buoyant plume to the surface. Different models have different parameterizations and approximations of the hydrocarbon modifications due to chemical and biological processes often termed “weathering”. The efficiency of the oil spill mitigation efforts relies heavily on the accuracy of numerical forecasts of oil pathways. However, several studies revealed substantial uncertainties in oil drift forecasts of the Deepwater Horizon spill. The presentation discusses several sources of uncertainty in surface oil drift modeling such as wind forcing, ocean currents, and weathering. A particular focus is given to the uncertainties in the dynamical aspects of the oil drift simulation. Most surface oil drift models combine the effects of wind and ocean surface currents to estimate drift of oil particles in the ocean. The surface ocean currents are typically derived from hydrodynamic models. While oil surface drift occurs at the very surface of the ocean, ocean surface currents in a hydrodynamic model is approximated by the upper vertical layer, which may be several meters thick. Thus, the so-called “surface current” usually represents the mean velocity of the upper layer in the model. This layer-averaged velocity may diverge substantially from the true surface current depending on the vertical shear in the upper ocean currents and model vertical resolution. The study analyzes the sensitivity of the oil drift forecasts to the representation of the ocean surface currents.