CARTHE-II Project Summary

Building on results from RFP-I, *The Consortium for Advanced Research on Transport of Hydrocarbon in the Environment*, *(CARTHE)* remain focused on advancing fundamental understanding and modeling of the diverse physical mechanisms responsible for hydrocarbon transport in the Gulf of Mexico environment. An integral part of any informed response to a future event like the Deepwater Horizon incident requires knowledge of the distribution of pollutants in the water column and the ability to predict where and how fast the pollutants will spread. This information is also crucial for estimating the pollutants' impact on the local ecosystem and coastal communities. The overall goal of CARTHE is accurate predictive modeling of pollutant transport from ocean-bottom release to landfall on the beach.

This project specifically identifies two topics, whose understanding is critical for oil spill dispersion prediction; namely (i) the dynamics of transport in the near-surface ocean and lower atmosphere, and (ii) transport in deep-ocean plumes.

Synergies within CARTHE are designed to produce a number of leaps in understanding transport in the Gulf. Two large coordinated oceanic experiments are proposed to investigate the dynamic processes controlling advection and dispersion in the upper ocean. The experimental goals are to understand the dynamics driving transport across and along small-scale, highly-intermittent convergence zones. The proposed field programs would be the first major observing programs specifically targeting upper ocean dynamics at these scales. The multiple-sensor approach integrates aircraft surveillance, remote sensing, real-time data-assimilating models, and advanced Lagrangian transport analysis methods to guide unprecedented levels of Lagrangian sampling in the upper ocean. The experiments are specifically designed to: (i) quantify variability due to seasonality and geographic location in the DeSoto Canyon region and the continental shelf, (ii) to provide unique measurements for modeling and understanding flows in the top 1m of the ocean, (iii) to directly measure vertical velocities, and (iv) to guide the development of robust parameterizations of upper ocean transport and mixing processes.

Directly interacting with the field experiments, a hierarchy of highly-resolved process models, predictive regional models, coastal models, and diagnostic models will operate in concert to address transport questions over an unprecedented range of spatial and temporal scales. Cross comparisons of varying model outputs, field observations, and dedicated air-sea interaction experiments in a state-of-the-art seawater wave tank will allow advances in model parameterization of unresolved processes such as Stokes drift, high resolution wave-ocean coupling, and multi-scale Lagrangian data assimilation techniques.

In a similar vein, transport in the deep-sea plume will be approached by integrating turbulence-resolving near-field computations, modern experimental facilities, and larger-scale hydrostatic and non-hydrostatic ocean models. Turbulence-resolving three-phase plume computations, complemented by laboratory experiments will delineate the anatomy of multi-phase plumes, with implications for dispersant application in the near-field, mixing parameterization in lateral intrusions, and parameterization of the vertical effluent distribution for up-scaling to coarser models.

Dedicated outreach efforts will lead to enhanced communications and collaborations with government response agencies (US Coast Guard and NOAA), industry (American Petroleum Institute), and local Gulf State constituents.

Beyond enabling a more efficient and more effective response to a future undersea oil release, broader impacts of this project include education and training of graduate students and postdocs, as well as far-reaching applications of the new scientific insight for navigation using local currents, potential off-shore green energy production, the influence of upper-ocean flows on the ocean's carbon intake in the climate system, a better representation of ocean and atmosphere heat exchanges for hurricane predictions, and finally for public beach safety and welfare.