A COORDINATED MODELING APPROACH IN SUPPORT OF OIL SPILL TRACKING

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and

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SCIENCE ACTIVITIES

1) General Summary

Narrative (1 pages maximum): Please provide a brief overview of the project and goals supported during the conduct of this project. Be sure to highlight any 'lessons learned' that could be applied to the conduct of RFP-I and RFP-II projects (e.g., management, data support, logistics, etc.). Listing accomplishments against project activities, objectives and milestones in bulleted form is acceptable.

Ocean circulation modeling groups at FSU, UM and USF individually and collectively assisted with tracking oil spilled from the Deepwater Horizon well. These activities started at crisis onset, when after exploding on 4/20 the Deepwater Horizon rig sank on 4/22. Our groups were positioned to respond with existing models because we had all been a part of the NOPP funded, HYCOM consortium. Subsequently, our individual work continued along separate lines based on individual research awards. Our primary goals for this GRI project were to provide oil spill tracking guidance for federal and state agencies and the general public and to improve upon the tools available for providing such guidance.

By institution, the following were our objectives and accomplishments.

FSU

The objectives were threefold:

1. Implement a coupled ocean – atmosphere modeling system for the region.
2. Develop metrics for objectively evaluating oil spill model performance using SAR data.
3. Apply this modeling system and the model evaluation metrics in an oil spill forecasting system to understand the sensitivity to different oil spill algorithms, forcing, and parameterizations.

Synthetic Aperture Radar (SAR) – derived maps of surface oil produced by FSU collaborators MacDonald and Garcia using a Texture Classifying Neural Net Algorithm (TCNNA) were used to calibrate and validate oil spill models. The key "lessons learned" from this research were the utility of utilizing time composites of these data, and the development of methods for objectively comparing these maps to oil spill model results. The objective metrics developed in this work can be applied for both model validation as well as to create cost functions for variational parameter estimation procedures. These methods were developed and tested with simple surface oil transport models using ocean and atmospheric model velocity and wind fields. These results are being applied in ongoing oil spill research activities.

The research with this simplified surface oil transport model and satellite-derived validation metrics highlighted the model sensitivity to selection of surface current and wind products, and inclusion of model physics (for example, inclusion of Stokes drift and improved simulation of wind drift). This has led to initiation of a coupled ocean-atmospheric modeling system, whose development will continue through current GRI-funded efforts.

UM

The objectives were as follows. Using the Hybrid Coordinate Ocean Model (HYCOM):

1. Model a regional domain over the entire Gulf of Mexico (GoM)
2. Model a nested domain over Florida Straits, South Florida and Florida Keys (FKEYS)
3. Model a nested domain over the Northern Gulf of Mexico (NGoM).

Simulations on the GoM-HYCOM 1/25 deg. domain were performed in collaboration with the Naval Research Lab at the Stennis Space Center (NRL-SSC). The oil spill period was evaluated. The impact of P-3 aircraft observations in the assimilation was studied, in collaboration with NRL-SSC and NOAA-AOML. Progress was made on a new GoM-HYCOM simulation with double resolution (1/50 deg.), both with free-runs and data assimilation.

A new system was developed with real time capabilities. This system replaced the hindcast-only SFFS-HYCOM. A major effort was to develop the real time system and sustain bi-weekly 6-day forecasts.

A nested high resolution (1/50 deg.) Northern Gulf of Mexico modeling (NGoM-HYCOM) domain was implemented. NGoM-HYCOM was previously run until 2008. For this project, the simulation continued for 2009 and is in progress for the oil spill period with daily discharges from the Mississippi River.

USF

The objectives were threefold.

1. Use the USF eastern Gulf of Mexico ROMS nested in global HYCOM, plus surface velocity fields from an ensemble of other models (Global HYCOM, GOM HYCOM, NCOM, RTOFS, SABGOM) to track oil and provide these 3.5 day forecasts to agencies and the general public.
2. Using observations of surface oil from satellite interpretations (supplied by USF professor, C, Hu) and USF deployed drifters, develop performance metrics for some of these models.

3. Recognizing the limitations of the large-scale ocean models, develop a new regional model for downscaling from the deep ocean, across the continental shelf and into the estuaries

Surface oil trajectories were tracked throughout the spill using the ensemble of models and these were provided daily to the agencies (see acknowledgments on all of the NOAA trice daily forecasts) and also the general public.

Subsurface trajectory analyses originating from nine depths were continued until such time as simulated particles passed outside of the analysis domain.

Trajectories from model simulations were compared against satellite tracked surface drifters and a new metric was introduced to better account for errors found in deep versus shallow water.

A new model code development was accelerated by nesting the unstructured grid, FVCOM into the Global HYCOM, and this was tested against observations for a calendar year 2007 hindcast simulation. The new model, including tides, provides daily automated nowcasts/forecasts for the WFS from west of DeSoto Canyon to south of the Florida Keys. Resolution varies from that of HYCOM along the nesting zone to 150 m in the estuaries. It thereby resolves the conveyances of mass between the shelf and the major estuaries and also across the Florida Keys.

As a measure of our accomplishments the USF team published six papers in refereed professional journals and co-edited a book in which we published four additional papers, plus preface and introduction.

Some lessons learned are that:

- Satellite oil location products remain in need of improvements due to cloudiness and varying coverage by other means. Combining all information into daily, unified products would be an advancement in the event of future spills.
- Models themselves all have errors; hence ensemble modeling is a fruitful strategy.
- Models must be subjected to rigorous testing by observations. Modeling without adequate observations remains a shortcoming.
- Failure to aggressively monitor for subsurface hydrocarbons (beyond the limited emphasis given to the southwestward deep plume or immediate vicinity of the well) was unfortunate. This left the modeling of subsurface hydrocarbons subject to too much uncertainty and limited what may have been learned in the short term. Perhaps what may be written in the sediments will offer additional lessons; perhaps not, depending on how and when these are sampled.
- Modeling tools for the coastal ocean are inadequate to deal with major spills impacting major estuaries.
- Oil spill fate and effects is fully multidisciplinary topic. Breaking out separate themes is less than conducive to such multidisciplinary requirements.
- Movements of oil or any materials in the eastern GOM are critically dependent on the Loop Current; yet the scientific community remains ill equipped to predict Loop Current behaviors. How we study the Gulf of Mexico requires reconsideration.
- Whereas the Gulf of Mexico harbors major risks from hydrocarbon exploration and production it remains under financed for ocean observing, both in deep water and on the continental shelf.

2) Results and scientific highlights

Narrative (2 pages maximum): This should be a summary of significant results (positive and negative) and conclusions during the conduct of this project. Listing science results and highlights in bulleted form is acceptable. In each case, please explain the impact of the result.

FSU

Oil slick maps produced from the SAR data can be readily compared against oil spill model results when the entire slick is contained in a useful satellite overpass, although intersection of the satellite swath with the oil slick present complications. To address this issue, SAR TCNNA-derived oil slick maps were collected for the period from 22 April, 1200UTC, to 14 July, 0000UTC and a temporal compositing method was developed as follows: For each cell in a spatial grid consisting of 0.05° x 0.05° bins, the total number of times the cell was observed by an overpass with useful data from the Envisat satellite is counted. Next, for each cell, the number of these observations that had oil present is computed, multiplied by the fractional areal coverage of oil. Dividing this array by the number of overpasses produces a map approximating the percent of time oil was detected at each location in the northern Gulf (Figure 3).

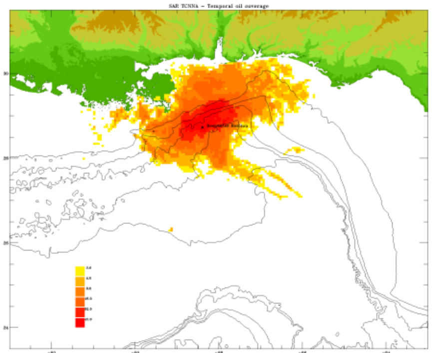

Figure 3. Normalized detection rate of oil by the SAR TCNNA algorithm over the period 22 April, 1200UTC, to 14 July, 0000UTC. The fractional coverage of each grid cell is summed for all satellite observation times, and normalized by the total number of observation times for each cell.

The time-composing technique described above can provide a host of objective metrics for evaluating an oil spill model over a given time period. Shape-descriptive quantities, such as eccentricity, area, and bulk dispersion must be modified to account for the varying scalar quantity, the normalized detection rate. As an illustration, a quantity related to the bulk dispersion is the *Weighted Time-Averaged Mean Displacement*, calculated as

$$\overline{D} = \frac{1}{T}\int_0^T \sigma\, dt$$

where

$$\sigma = \frac{1}{n}\sum_{i=1}^{n} f_i\sqrt{(x_i - x_0)^2 + (y_i - y_0)^2}$$

is the mean displacement of each bin location (x_i, y_i) with normalized oil detection f_i from the source (x_0, y_0).

To illustrate this model evaluation metric, a reduced-physics oil spill model was run from the beginning of the oil spill (22 April, 1200UTC) to 14 July, 0000UTC. The model consists of a particle tracking algorithm in which discrete particles representing a set volume of oil are advected in a velocity field constructed from surface currents from the HYbrid Coordinate Ocean Model (HYCOM) 1/25° Gulf of Mexico data assimilative hindcast. To the surface current is added a commonly-used wind drift parameterization: 3.5% of the wind speed directed 20° to the right of the wind vector. Here, winds are taken from the Rapid Update Cycle (RUC) forecast.

New oil particles are added at a rate of 1200 per day (given estimates of 4,000 m^3 / day of oil reaching the surface, each particle would be representative of approximately 3.3 m^3 of oil). As the oil is advected, a random walk algorithm is applied, increased near source to account for gravitational spreading. Particles are removed from the computation randomly based on a prescribed half-life to parameterize weathering processes. Oil positions are saved each hour, and the results are time-composited in the same manner as the SAR imagery. As an example application of the metric, weighted time-averaged mean displacement metric are computed for several experiments with varying half-life parameter (Figure 4).

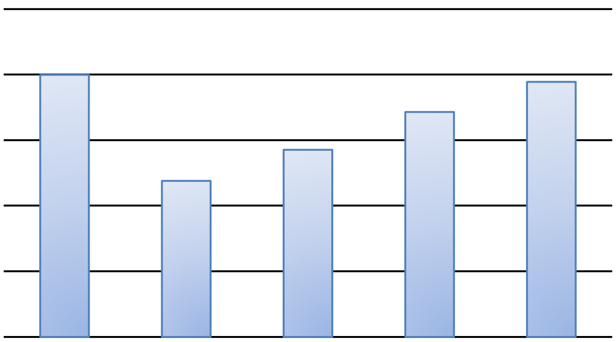

Figure 4. Weighted time-averaged mean displacement computed from the SAR-derived gridded map (Figure 1) and model experiments with half-lives of 72, 96, 120, and 144 hours. The results suggest that for this particular model, a half-life of 6 days produces the best match for the spread of the oil. The metric can be applied both for tuning the model, and for a variational parameter estimation technique.

To improve consistency in surface currents, winds, and boundary layer physics, development was begun on a coupled ocean-atmosphere-wave modeling system. The oceanic component of the coupled modeling system (COAWST) was developed to run over a a high resolution (1/50° ≈ 2000 m) domain applied on the entire Gulf of Mexico and the northwestern Caribbean region. The resulting numerical grid conforms to the 1/25° (≈ 3500 m) and 1/50° Gulf of Mexico HYCOM computational domains that are run at NRL, as the grids have been made available for transition to those modeling systems. Special attention was paid so that the newly developed grid matches very well with a high resolution shoreline definition so that this modeling system can be used in the future to study deep ocean to coast transport, and to provide boundary conditions for coastal and estuarine model nests. The atmospheric modeling component of this system was developed collaboratively by R. Hart (FSU) and these components of the coupled modeling system are now being fused into the earth-system coupled modeling system to be utilized for future GRI-funded research.

UM

The Univ. of Miami/RSMAS contribution has focused on using high resolution, nested regional and shelf models to better understand the processes that influence circulation in the Gulf of Mexico (GoM) in general and during the Deepwater Horizon (DwH) accident in particular. Data have been used for model forcing and model evaluation. The regions of interest (and respective model domains) are: the full GoM, the Northern GoM and the region around South Florida, including the Straits of Florida. Major results are as follows:

- The eddy field plays a significant role in the evolution of the Loop Current (LC), influencing the formation and detachment of anticyclonic rings. The resulting evolution of the northward LC extension has strong implications in the connectivity between the Northern and Southern GoM.

During the DwH period, the formation of Eddie Franklin effectively interrupted the possibility of oil pathways toward the Florida Straits, and beyond.

- The eddy field also plays a significant role in the meandering of the Florida Current (FC) in the Straits of Florida. Topography plays an important role in eddy dissipation or growth. A mechanism of local cyclogenesis was revealed in the Dry Tortugas. The results revealed, for the first time, a close synergy was shown between FC modulations and eddy evolution. Implications include the transport and fate of particles entering the Straits, including fish larvae from the Dry Tortugas spawning grounds.
- The near surface transport and fate of the DwH oil substances was influenced by both offshore and shelf circulation processes.
- In addition to wind-driven circulation, the wind induced Stokes drift played a significant role on oil transport. Twin model simulations with a three-dimensional oil spill model (with and without Stokes drift) showed that oil particles would be erroneously advected southward, reaching the Straits of Florida, when the Stokes drift was neglected.
- During certain periods of the 2010 oil spill, Northern GoM circulation associated with the Mississippi River plume had a significant impact on the evolution of the oil patch. Dissolved oxygen measurements, in tandem with model results, revealed that both the presence of the oil patch and the riverine waters had implications for Northern GoM hypoxia.

USF

In keeping with the objectives previously discussed, the following were achieved.

- An ensemble of six surface oil spill trajectory forecasts were provided throughout the duration of the spill and until the dissipation of surface oil. We used the USF ROMS nested in Global HYCOM, Global HYCOM, GOM HYCOM, NCOM, SABGOM, and RTOFS and provided these on a public internet site (http://ocgweb.marine.usf.edu). Oil locations were from ocean color interpretations (C. Hu, USF), and these were advected forward in time using 3.5 day forecasts of currents. Our surface oil trajectory forecasts were used by NOAA in all of their thrice daily advisories. We successfully accounted for small amounts of surface oil entering the Loop current system and with limited amounts as seen in satellite imagery even being advected to the Florida Straits.
- The veracity of these forecasts were addressed in Liu et al., 2011a,b,f.g.
- Using the USF ROMS nested in global HYCOM, we tracked subsurface hydrocarbons assuming that some of these were equilibrated at depths of 1400m, 1200m, 100m, 800m, 600m, 400m, 200m, 100m, 50m. This strategy was adopted immediately upon the sinking of the rig because without a priori knowledge of properties such arbitrary initializations seemed as good as any set of assumptions. Prospectively our results were found to be consistent with the deep plume observed by several studies, and we advised USF seagoing investigators where to look for hydrocarbons at mid-depths. Their determinations at 400 m depth were consistent with our projections. Such tracking continued until such time as all proxy particles were advected out of the analysis domain. These projections will remain useful as sediment samples begin to establish the domain of subsurface hydrocarbon impacts. Differences between the sediment record and the model trajectory projections may form a useful basis for bracketing rates of decay through biological and chemical processes which we did not consider.

- While not funded to do observations, we did supply all of our available data (funded separately) for use during the oil spill. Our recommendation is that models without adequate observations are themselves inadequate. A discussion, for instance, is given by Weisberg (2011). Detailed comparisons between modeled and observed surface drifters are given by Liu and Weisberg (2011).
- It was recognized from the outset that models of the coastal ocean were woefully inadequate to account for surface (or subsurface) oil reaching sensitive estuaries. This is because the extant models, geared toward the deep sea, have limited resolution and generally omit tides. For most of west Florida this limitation was not problematic during the Deepwater Horizon event because surface oil (for reasons we explained in several of our publications) did not advance far enough eastward to impact Apalachicola Bay or estuaries along Florida's west coast. Nevertheless, a glaring need existed which we advanced toward filling by nesting the unstructured grid FVCOM into the Global HYCOM (Zheng and Weisberg, 2012) to downscale from the deep ocean, across the continental shelf and into the estuaries. By doing this we resolve scales of motion from that of HYCOM along in the nesting regions (~12 km) to 150 m in the estuaries. Such high resolution is essential to account for the inlet conveyances of mass, which separate the estuaries from the coastal ocean. We also included tides by adding these along the FVCOM open boundary, which is also an essential element because, unlike the deep ocean, tidal currents are very large within the inlets and estuaries. Our new model construct also accounts for conveyances of mass between Florida Bay and the Gulf Stream through the Florida Keys.

3) Cruises & field expeditions

Ship or Platform Name	**Class** (if applicable)	**Chief Scientist**	**Objectives**	**Dates**

4) Peer-reviewed publications, if planned (Note: a special section will focus on student and post-doctoral publications)
   a. Published, peer-reviewed bibliography (Copies of the papers are requested)

UM

Kourafalou, V.H. and H. Kang, 2012. Florida Current meandering and evolution of cyclonic eddies along the Florida Keys Reef Tract: are they inter-connected? *J. Geophys. Res., doi:10.1029/2011JC007383* (In Press).

USF

Liu, Y., R.H. Weisberg, C. Hu, and L. Zheng (2011a), Tracking the Deepwater Horizon oil spill: A modeling perspective, *EOS Transactions, American Geophysical Union,* 92(6), 45-46, doi: 10.1029/2010ES003187.

Weisberg, R.H. (2011) Coastal Ocean Pollution, Water Quality and Ecology: A Commentary, *MTS Journal*, Vol. 45, No. 2, 35-42.

Hu, C., R.H. Weisberg, Y. Liu, L. Zheng, K.L. Daly, D.C. English, J. Zhao, and G.A. Vargo (2011), Did the northeastern Gulf of Mexico become greener after the Deepwater Horizon oil spill?, *Geophys. Res. Lett.*, 38, L09601, doi:10.1029/2011GL047184.

Liu, Y., R.H. Weisberg, C. Hu, and L. Zheng (2011b), Satellites, models combine to track Deepwater Horizon oil spill. SPIE Newsroom, doi:10.1117/2.1201104.003575.

Liu, Y., and R. H. Weisberg (2011), Evaluation of trajectory modeling in different dynamic regions using normalized cumulative Lagrangian separation, *J. Geophys. Res.*, 116, C09013, doi:10.1029/2010JC006837.

Liu, Y., A. MacFadyen, Z.-G. Ji, and R.H. Weisberg (Editors), (2011c), *Monitoring and Modeling the Deepwater Horizon Oil Spill: A Record-Breaking Enterprise*, *Geophysical Monograph Series*, Vol. 195, 271 PP., ISSN: 0065-8448, ISBN 978-0-87590-485-6. AGU/geopress, Washington D.C.

Liu, Y., A. MacFadyen, Z.-G. Ji, and R.H. Weisberg, (2011d), Preface, in *Monitoring and Modeling the Deepwater Horizon Oil Spill: A Record-Breaking Enterprise, Geophysical Monograph Series*, 195, doi:10.1029/2011GM001146.

Weisberg, R.H., L. Zheng, and Y. Liu, (2011), Tracking subsurface oil in the aftermath of the Deepwater Horizon well blowout, in *Monitoring and Modeling the Deepwater Horizon Oil Spill: A Record-Breaking Enterprise, Geophysical Monograph Series*, 195, 205-215, doi:10.1029/2011GM001131.

Liu, Y., A. MacFadyen, Z.-G. Ji, and R.H. Weisberg (2011e), Introduction to Monitoring and Modeling the Deepwater Horizon Oil Spill, in *Monitoring and Modeling the Deepwater Horizon Oil Spill: A Record-Breaking Enterprise, Geophysical Monograph Series*, 195, 1-7, doi:10.1029/2011GM001147.

Liu, Y., R.H. Weisberg, C. Hu, and L. Zheng (2011f), Trajectory forecast as a rapid response to the Deepwater Horizon oil spill, in *Monitoring and Modeling the Deepwater Horizon Oil Spill: A Record-Breaking Enterprise, Geophysical Monograph Series*, 195, 153-165, doi:10.1029/2011GM001121.

Liu, Y., R.H. Weisberg, C. Hu, C. Kovach, and R. Riethmüller (2011g), Evolution of the Loop Current system during the Deepwater Horizon oil spill event as observed with drifters and satellites, in *Monitoring and Modeling the Deepwater Horizon Oil Spill: A Record-Breaking Enterprise, Geophysical Monograph Series*, 195, 91-101, doi:10.1029/2011GM001127.

Zheng, L. and R.H. Weisberg (2012), Modeling the West Florida Coastal Ocean by Downscaling from the Deep Ocean, Across the Continental Shelf and into the Estuaries, *Ocean Modeling*, 48 (2012), 10-29, doi:10.1016/j.ocemod.2012.02.002.

b. Manuscripts submitted or in preparation (Please note target journal, and anticipated date of publication or submission)

UM

Le Hénaff M., V.H. Kourafalou, C.B. Paris, J. Helgers, P.J. Hogan, A. Srinivasan, 2012. Surface evolution of the Deepwater Horizon oil spill: combined effects of circulation and wind induced drift. *Environmental Science and Technology* (In Revision).

Kourafalou, V.H. and I. Androulidakis, 2012. Evolution of the Deepwater Horizon oil spill patch: influence of the Mississippi River plume circulation. *Nature Geoscience* (Submitted).

Le Hénaff M., V.H. Kourafalou, R. Dussurget, and R. Lumpkin, 2012. Intensification of the Loop Current Frontal Eddies in the Northern Gulf of Mexico : characterization from in-situ and remote observations" (In Preparation, to be Submitted to *J. Phys. Ocean*ogr., June 2012).

USF

Weisberg, R.H., L. Zheng, Y. Liu, C. Lembke, J.M. Lenes and J.J. Walsh (2013). Why a Red Tide was not Observed on the West Florida Continental Shelf in 2010., *Harmful Algae*, in press.

5) Presentations and posters, if planned (Please provide copies of each) (Note: a special section will focus on student presentations)

FSU

Title	Presenter	Authors	Meeting or Audience	Abstract published (Y/N)	Date
Objective evaluation of oil spill models using SAR imagery	Steve Morey	Steve Morey Dmitry Dukhovskoy Eric Chassignet Ian MacDonald Oscar Garcia	American Society of Limnology and Oceanography	Y	Feb, 2011
Oil Spill Model Validation and Parameter Estimation using Remotely Sensed	Steve Morey	Steve Morey Dmitry Dukhovskoy Eric Chassignet	Gordon Research Institute Conference on Coastal Oceanography	N	June, 2011

Data		Ian MacDonald Oscar Garcia-Pineda			
Natural and Unnatural Oil Layers on the Surface of the Gulf of Mexico Detected and Quantified in Synthetic Aperture RADAR Images with Texture Classifying Neural Network Algorithms.	Ian MacDonald	Ian MacDonald Oscar Garcia-Pineda Steve Morey	American Geophysical Union Fall Meeting	Y	Dec, 2011
Remote Sensing Overview of BP Oil Discharge from Satellite SAR Data.	Oscar Garcia-Pinea	Oscar Garcia-Pineda Ian MacDonald Steve Morey	2012 Ocean Sciences Meeting	Y	Feb, 2012

UM

Title	Presenter	Authors	Meeting or Audience	Abstract published (Y/N)	Date
On the role of Loop Current eddies in altering the oil pathways during the Deepwater Horizon oil spill	V. Kourafalou	V. Kourafalou, H. Kang, P. Hogan, O.M. Smedstad	AGU/TOS/ASLO Ocean Sciences 2012 Meeting	Y	Jan. 2012

USF

Title	Presenter	Authors	Meeting or Audience	Abstract published (Y/N)	Date
The Oil Trajectory: How it behaved in the Gulf of Mexico and why, and where might residual oil be heading?	Y. Liu	R.H. Weisberg, Y. Liu, L. Zheng, C. Hu	CSDMS Meeting, San Antonio, Texas, USA, *(Invited Keynote Talk)*	Y	October 14-17, 2010

Trajectory Forecasts Based on Numerical Ocean Circulation Models and Satellite Observations: A Rapid Response to Deepwater Horizon Oil Spill	Y. Liu	Y. Liu, R.H. Weisberg, L. Zheng, C. Hu	AGU Fall Meeting, San Francisco, California, USA,	Y	Dec. 13-17, 2010
Rapid Response to Deepwater Horizon Oil Spill from University of South Florida: Numerical Models, Remote Sensing, and In-situ Observations	R.H. Weisberg	Weisberg, R.H., Y. Liu, L. Zheng, C. Hu, C. Lembke	AGU Fall Meeting, San Francisco, California, USA,	Y	Dec. 13-17, 2010
Commentary on Ocean pollution, water quality and ecology	R. H. Weisberg	R.H. Weisberg	Marine Technical Society TECHSURGE Meeting, 2011 Ocean Pollution: From Technology to Management and Policy, Sarasota, FL	Y	April 13-14, 2011
Response to the Deepwater Horizon oil spill by the USF Ocean Circulation Group: A review, Deepwater Horizon Oil Spill Principal Investigator Conference	R.H. Weisberg	R.H. Weisberg and Y. Liu	NSTC Subcommittee on Ocean Science and Technology, St. Petersburg, FL	N	October 25-26, 2011
Combining numerical ocean circulation models with satellite observations in a trajectory forecast system: a rapid response to the Deepwater Horizon oil spill	Y. Liu	Y. Liu and R.H. Weisberg	SPIE Conference 8030 - Ocean Sensing and Monitoring, Orlando, Florida	Y	April 25-29, 2011
Invited briefing of Florida Century Committee on oil spill	R.H. Weisberg	R.H. Weisberg	St. Petersburg, FL	N	August 16, 2010
Invited presentation on Deepwater	R.H. Weisberg	R.H. Weisberg	Homosassa Springs, FL	N	August 19, 2010

Horizon oil spill given to Withlacoochee Area Residents, Inc					
Invited presentation on Deepwater Horizon oil spill given to Florida Bar Association	R.H. Weisberg	R.H. Weisberg	Tampa, FL	Y	August 26, 2010
A coordinated modeling approach in support of oil spill tracking.	L. Zheng	Weisberg, R.H., L.Y. Zheng, V.H. Kourafalou, E.P. Chassignet.	FIO PI Coordination Workshop, Orlando, FL.	N	Sept. 16, 2010
Invited participant, JSOST oil spill workshop	R.H. Weisberg	R.H. Weisberg	St. Pete Be, FL.	N	Oct. 5, 2010
Where did the oil go and why?	R.H. Weisberg	R.H. Weisberg	Invited presentation (by USACE-Jacksonville Office) at the Western Dredging Assoc. Mtg, Tampa, FL.	N	Oct. 6, 2010
Modeling the location of the Gulf oil spill.	R.H. Weisberg	R.H. Weisberg	USF Research I invited presentation, Tampa, FL	N	Oct. 11, 2010
Invited oil spill presentation	R.H. Weisberg	R.H. Weisberg	Sierra Club sponsored public forum on the Gulf of Mexico oil spill, St. Petersburg, FL.	N	Oct. !6, 2010
Invited presentation on Deepwater Horizon oil spill	R.H. Weisberg	R.H. Weisberg	Invited presentation given to Town and Gown, St. Petersburg, FL	N	Jan. 21, 2011
Invited seminar on oil spill restoration	R.H. Weisberg	R.H. Weisberg	Invited seminar at USF FIO workshop on oil spill Restoration, St. Petersburg, FL	N	April 8, 2011
4/10, Tampa, FL. Invited seminar at Phi Kappa Phi honor society induction.	R.H. Weisberg	R.H. Weisberg	Invited seminar at Phi Kappa Phi honor society induction, Tampa, FL.	N	April 10, 2011
Presentation at FIO BP PI meeting	R.H. Weisberg	R.H. Weisberg	Presentation at FIO BP PI meeting, Orlando, FL	N	May 25-26, 2011
10/24, Xiamen, PRC, Invited lecture	R.H. Weisberg	R.H. Weisberg	10/24, Invited lecture at Third Institute for Oceanography,	N	Oct. 24, 2011

at Third Institute for Oceanography.			Xiamen, PRC,		

6) Other products or deliverables
Please list (for example: maps, models, tools) and indicate where they can be located/obtained.

7) Data
Reporting on data is done separately through communications with Harte Research Institute; however, please provide a spreadsheet indicating the metadata and ancillary information on the location and status of the archived samples. Also, indicate if there are any issues with respect to data archiving schedule and plan.

PARTICIPANTS AND COLLABORATORS

8) Project participants
Please list the participants of your project, their role(s) and contact information. This includes some personal information that we will hold closely and for limited purposes. We ask for demographic data – relating to gender, race, and citizenship – so that we can: gauge whether the GoMRI program is fairly reaching and benefiting everyone regardless of demographic category; ensure that those in under-represented groups have the same knowledge of and access to programs, meetings, vacancies, and other research and educational opportunities as everyone else; and we can monitor involvement of international investigators. We will use the demographic data for statistical purposes only. Submission of demographic data is voluntary, but basic data such as name, contact information, and role in the project is required. No personal information will be released.* ***Note: Student/educational information will be collected elsewhere in this report****.*

** We understand one person may fulfill more than one role; please list all applicable roles using the following standardized titles: Principal Investigator, Co-Principal Investigator, Scientific Participant, Technician, Lab Assistant, Administrative Support.*

FSU

First Name	Last Name	Role in Project	Institution	Email	Gender	Race	Citizenship
Eric	Chassignet	PI	FSU	echassignet@coaps.fsu.edu	M	Caucasian	
Steve	Morey	Co-PI	FSU	smorey@coaps.fsu.edu	M	Caucasian	US
Dmitry	Dukhovskoy	Co-PI	FSU	ddmitry@coaps.fsu.edu	M	Caucasian	Russia
Jordan	Yao	Technician	FSU	yao@coaps.fsu.edu	M	Asian	
Panagiotis	Velissariou	Scientific Participant	FSU	Pvelissariou@coaps.fsu.edu	M	Caucasian	Greek
Oscar	Garcia	Scientific Participant	FSU	ogarcia@fsu.edu	M	Hispanic	

UM

First Name	Last Name	Role in Project	Institution	Email	Gender	Race	Citizenship
Vassiliki	Kourafalou	Co-PI	Univ. of Miami/RSMAS	vkourafalou@rsmas.miami.edu	F	White	USA
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USF

First Name	Last Name	Role in Project	Institution	Email	Gender	Race	Citizenship
Robert	Weisberg	P.I.	University of South Florida	Weisberg@marine.usf.edu	M	C	USA
Yonggang	Liu	Associate	University of South Florida	yliu@marine.usf.edu	M	Asian	China
Lianyuan	Zheng	Associate	University of South Florida	LZheng@marine.usf.edu	M	Asian	China
Jeff	Donovan	Technician	University of South Florida	jdonovan@usf.edu	M	C	USA
Chuanmin	Hu	Collaborator	University of South Florida	chu@usf.edu	M	Asian	China

MENTORING AND TRAINING

9) Student and post-doctoral participants

Please list the student participants of your project, their educational role, and other information. This includes some personal information that we will hold closely and for limited purposes. We ask for demographic data – relating to gender, race, and citizenship – so that we can: gauge whether the GoMRI program is fairly reaching and benefiting everyone regardless of demographic category; ensure that those in under-represented groups have the same knowledge of and access to programs, meetings, vacancies, and other research and educational opportunities as everyone else; and we can monitor involvement of international investigators and students. We will use the demographic data for statistical purposes only. Submission of demographic data is voluntary, but basic data such as name, contact information, and research area is required. No personal information will be released.

FSU

First Name	Last Name	Post-doc / PhD / MS / BS	Thesis or research topic	Institution	Supervisor	Expected Completion year	Gender	Race	Citizenship
Ekaterina	Maksimova	PhD	Physical Oceanography of the Big Bend Coastal Area	FSU	Allan Clarke	2012	F	Caucasian	Russia

UM

First Name	Last Name	Post-doc / PhD / MS / BS	Thesis or research topic	Institution	Supervisor	Expected Completion year	Gender	Race	Citizenship
Matthieu	Le Hénaff	Post-doc	Mesoscale eddy dynamics	Univ. of Miami/RSMAS	V. Kourafalou	2012	M	White	France
Ioannis	Androulidakis	Post-doc	River plume dynamics	Univ. of Miami/RSMAS	V. Kourafalou	2012	M	White	Greece
Andrew	Kough	MS	Florida Keys coral reefs	Univ. of Miami/RSMAS	C. Paris	2013	M	White	

First Name	Last Name	Post-doc / PhD / MS / BS	Thesis or research topic	Institution	Supervisor	Expected Completion year	Gender	Race	Citizenship

10) Student and post-doctoral publications, if planned

a. Published, peer-reviewed bibliography (Copies of the papers are requested)
b. Manuscripts submitted or in preparation (Please note target journal, and anticipated date of submission or publication)

FSU

In Preparation (these papers will form the basis of Ekaterina's thesis which she plans to defend sometime this summer.):

1. Synoptic Eulerian Current Observations Near the Florida Big Bend Coast by Maksimova E. V. and A. J. Clarke
2. Seasonal Eulerian Current Observations Near the Florida Big Bend Coast by Clarke A. J. and E.V. Maksimova

11) Student and post-doctoral presentations and posters, if planned (Please provide copies of each)

FSU

Title	Presenter	Authors	Meeting or Audience	Abstract published	Date

				(Y/N)	
Multiyear Current Observations Near Florida's Big Bend Coast	Ekaterina Maksimova	E.V. Maksimova and Allan J. Clarke	NGI meeting 2011	N	May 2011

UM

Title	Presenter	Authors	Meeting or Audience	Abstract published (Y/N)	Date
Intensification of the Loop Current frontal eddies in the Northern Gulf of Mexico: role of the topography	M. Le Hénaff	M. Le Hénaff, V. Kourafalou, Y. Morel, A. Srinivasan	AGU/TOS/ASLO Ocean Sciences 2012 Meeting	Y	Jan. 2012

Title	Presenter	Authors	Meeting or Audience	Abstract published (Y/N)	Date

12) Images

Please attach high-resolution image and provide details including a description of the image, location, credit, date, etc. Of note: Image may be used in GoMRI promotions, make sure you have rights to use the image. Note: GoMRI will establish a Flicker site to share these images through the GoMRI website and with media and the public.

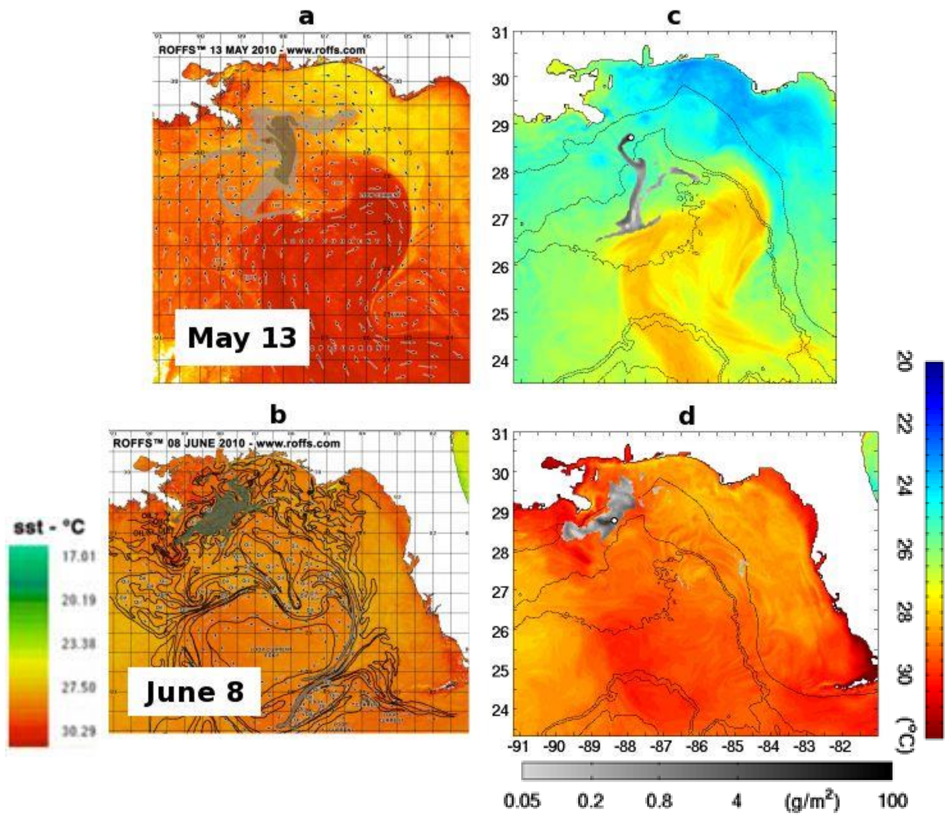

Fig. UM1: Oil presence and concentration from data (left) and a three-dimensional hydrodynamic and oil spill model (right). Data are adapted from remotely sensed oil composites by Roffer's Ocean Fishing Forecasting System (www.roffs.com/deepwaterhorizon.html) for May 13 (a) and June 8 (B). The modeled patches (c), (d) are for the same dates, representing the surface oil patch of the full three-dimensional oil plume starting at the well head. Oil concentration at the surface is in g/m^2 (gray scale). Surface colors indicate sea surface temperature, with yellow to red colors for low to high temperatures. Color bars are different for model (right bar) and data (left bar, valid for June 8 only; no color bar was available for data of May 13). Black lines at (c), (d) are the 200, 2000 and 3000 m isobaths. *CREDIT: V. Kourafalou and M. Le Hénaff, Univ. of Miami/RSMAS.*

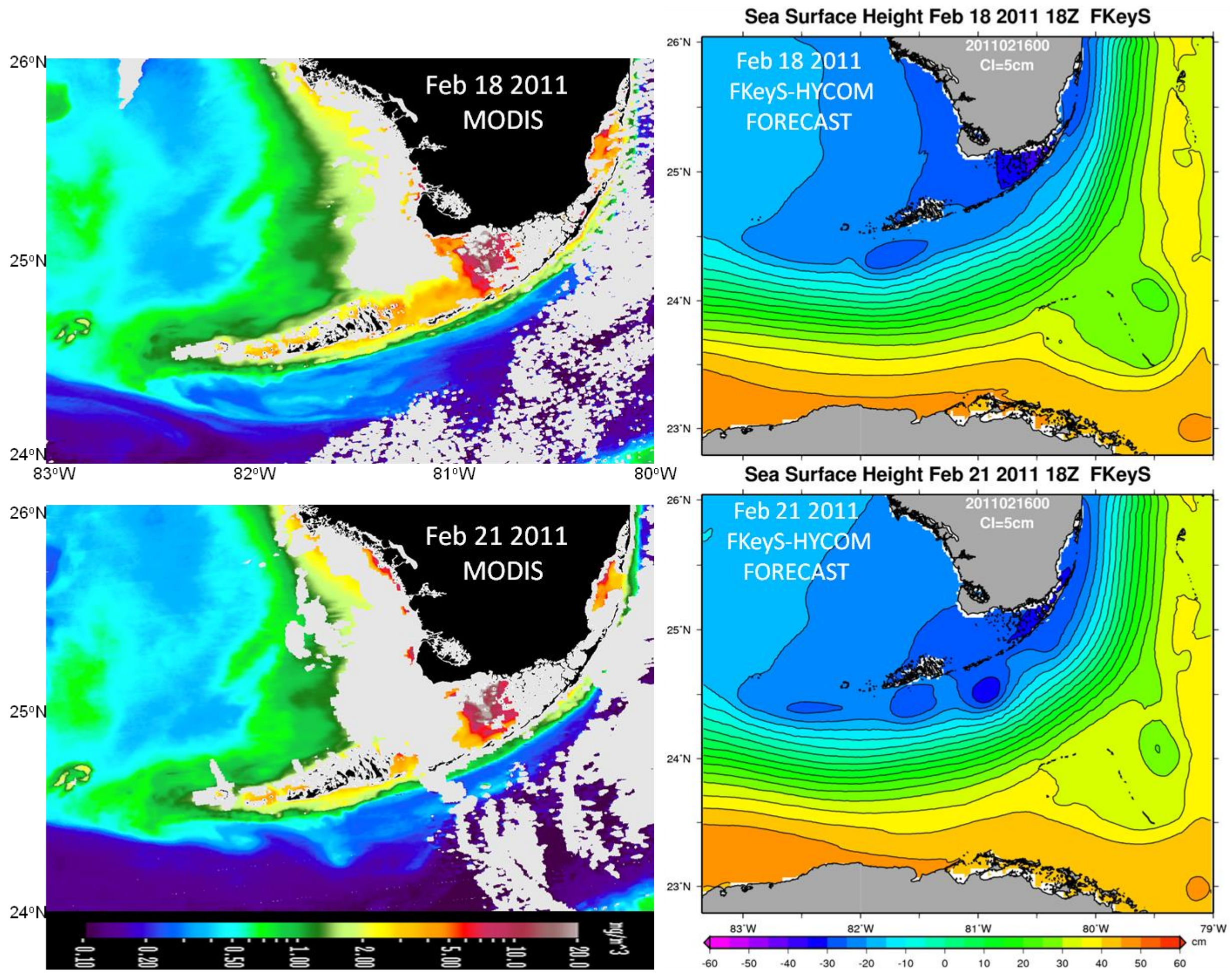

Fig. UM2: Example of forecast from the high resolution (~900m horizontal grid) FKeyS-HYCOM (FLorida Straits, South Florida and Florida Keys Hybrid Coordinate Ocean Model, http://coastalmodeling.rsmas.miami.edu/Models/View/Florida_Keys), nested in the regional Gulf of Mexico (GoM) HYCOM model (resolution ~3.5 km). Model forecast for Feb. 18, 2011 and Feb. 21, 2011 (right), starting from Feb. 16, 2011; Sea Surface Height fields shown, revealing a series of mesoscale eddies. MODIS ocean color imagery (left) for the same dates, showing eddy evolution in agreement with the model forecast (imagery from the USF Optical Oceanography Laboratory). *CREDIT: V. Kourafalou and H. Kang, Univ. of Miami/RSMAS; C. Hu, USF.*

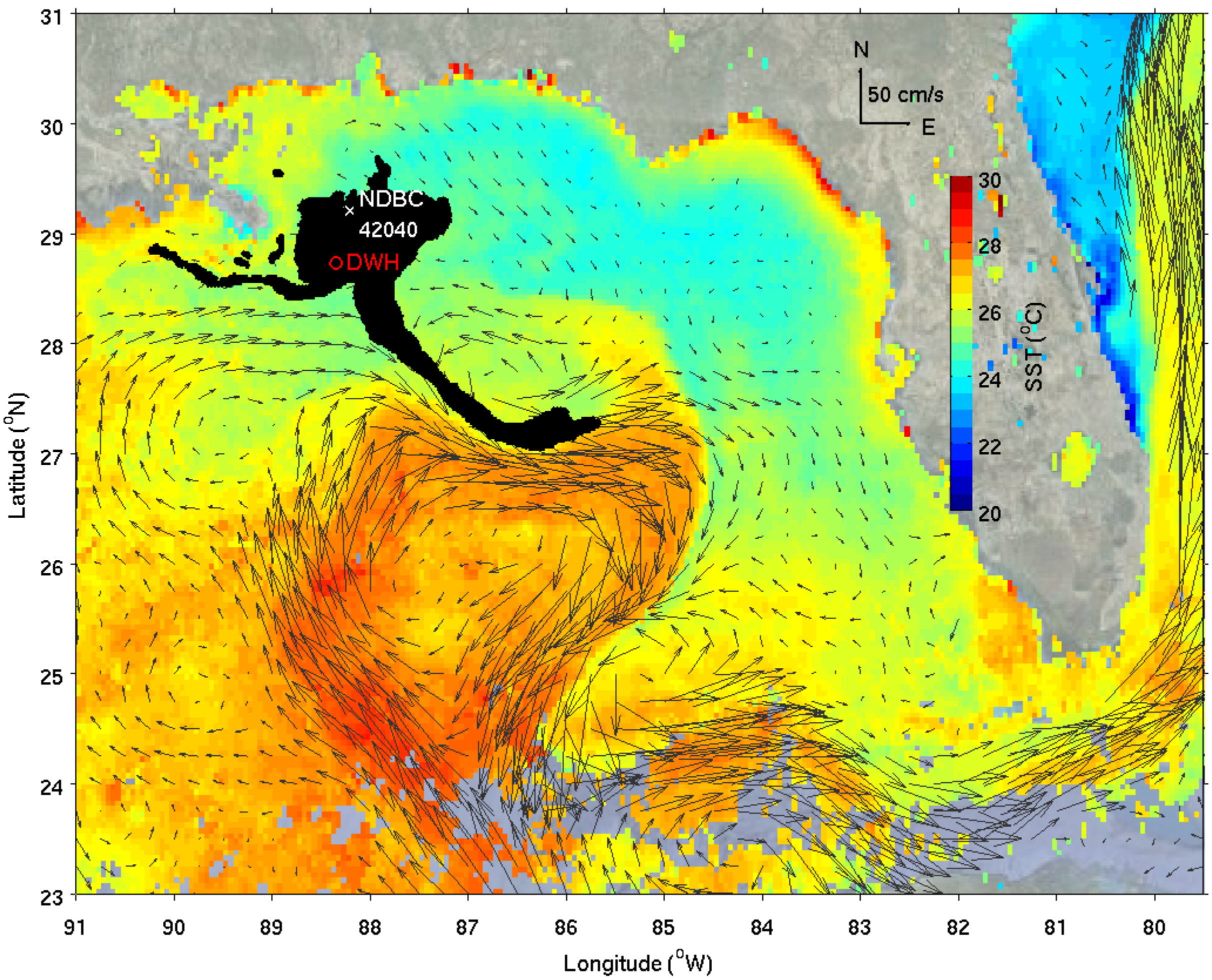

Fig. USF1. Satellite determined surface oil distribution superimposed on surface geostrophic currents (from Liu et al., 2011)

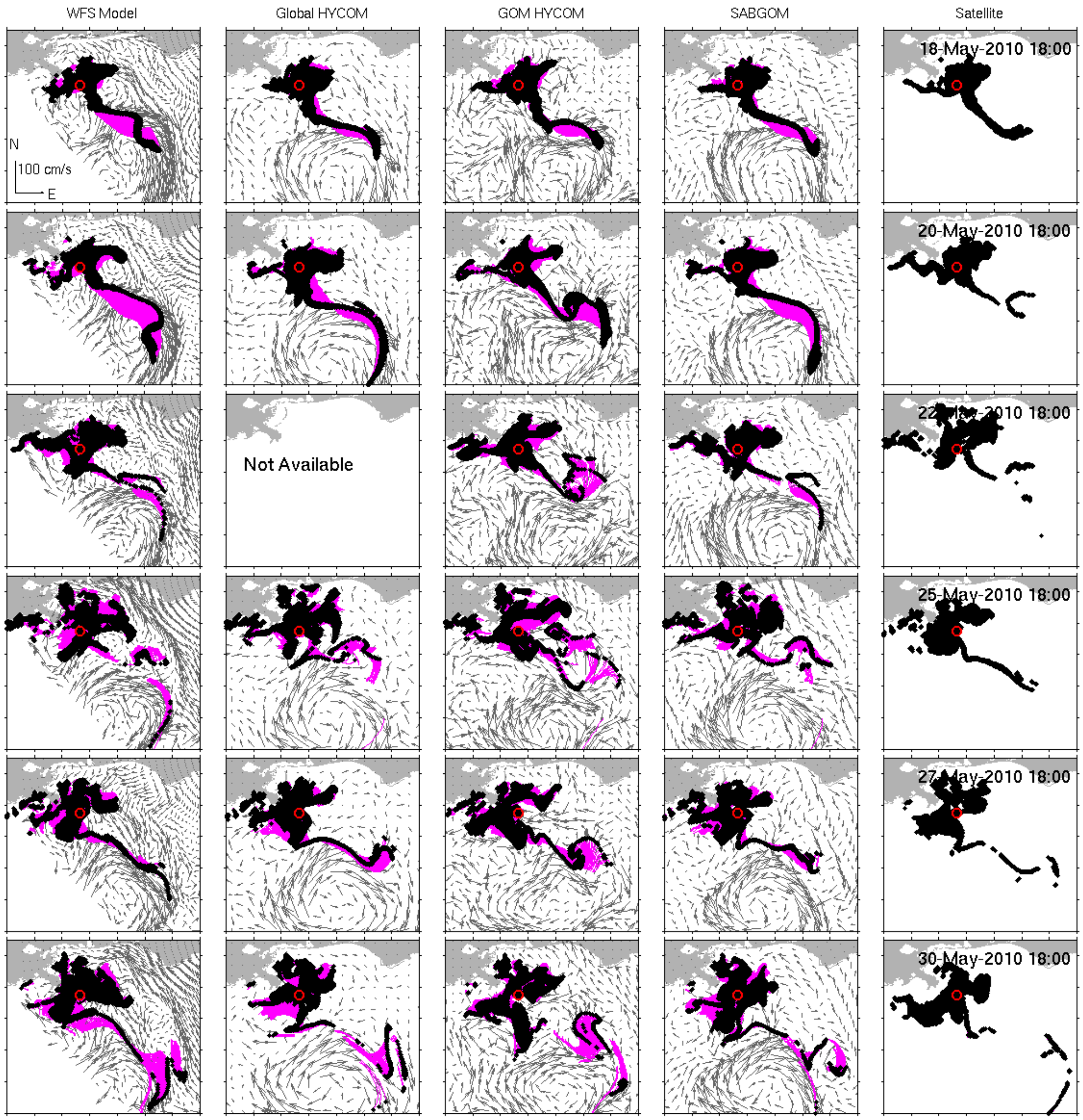

Fig. USF2. Comparisons between USF ensemble forecasts from four of the models diagnosed shown against observed oil distributions at the end of the particular forecast cycle (from Liu et al., 2011).

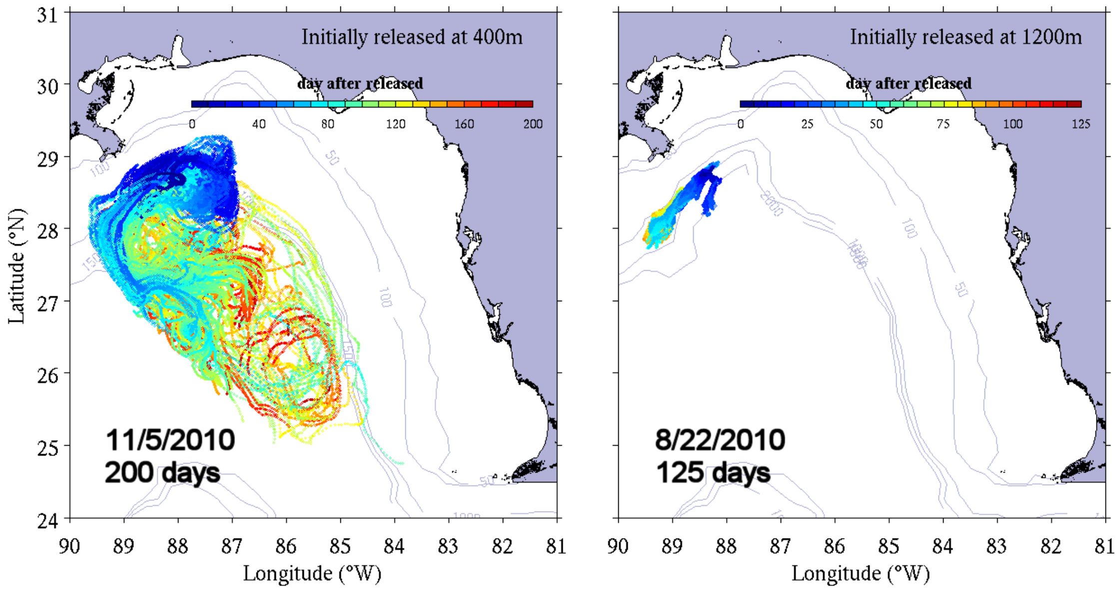

Fig. USF3. Examples of subsurface trajectories and ages for virtual particles released at 1200m and 400m depths at times past rig sinking when most of these virtual particles had exited the model domain (from Weisberg et al., 2011). By keeping track of age we can reassess once realistic (biological and chemical) decay times are identified. We note that the 1200 m results are consistent with numerous investigators' findings there and that the 400 m results were used by USF scientists to inform their sampling decisions to the northeast of the well.

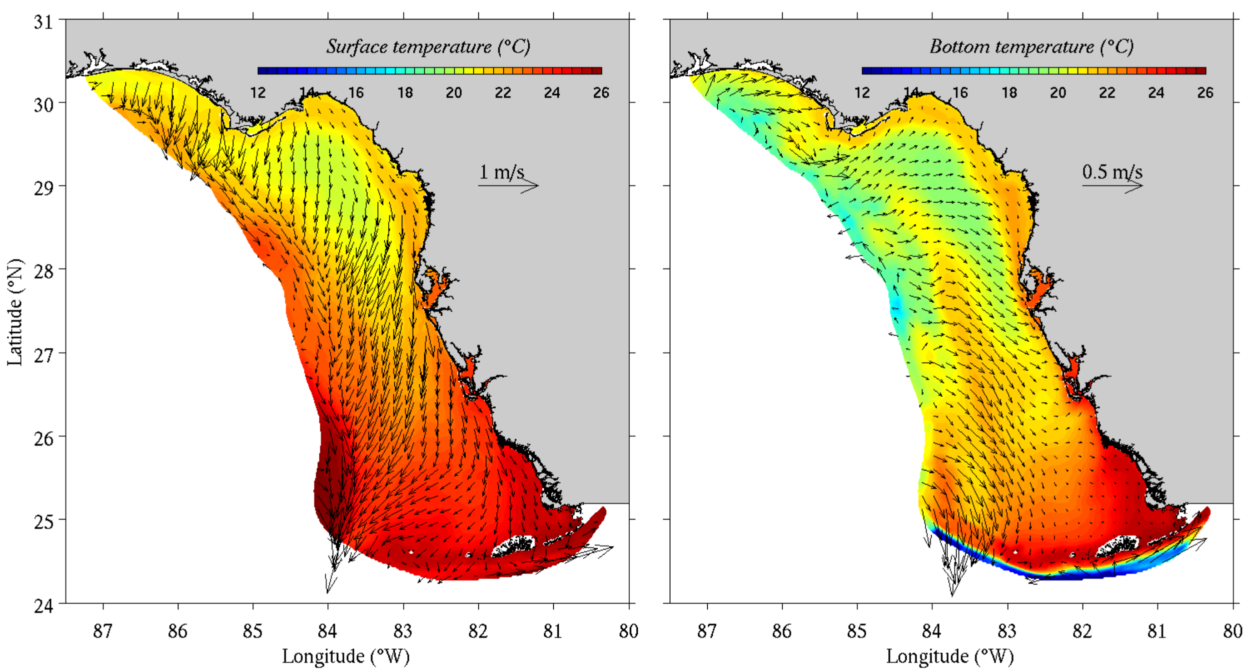

Fig. USF4. Surface currents (left) and bottom currents (right) superimposed on temperature for an upwelling event, using our new WFS (FVCOM nested in HYCOM) model (from Zheng and Weisberg 2012). Note the inclusions of the Apalachicola Bay, Tampa Bay, Charlotte Harbor and Florida Bay estuaries, plus the conveyances of mass across the Florida Keys.