

National Aeronautics and Space Administration



NASA Earth Science Division Applied Sciences Program

DEVELOP National Program



Gulf of Mexico Oil Spill Monitoring
Oil Spill and Wetlands Impact Assessment using Polarimetric Synthetic Aperture Radar (PolSAR) Data
Jet Propulsion Laboratory – March 24, 2011

JPL Team Members: Spring 2011

Current team members

- Katrina Laygo (Center Lead) - UCLA
- Briton Voorhees – CSULB
- Stephen LaPointe – American Public University

Advisors

- Dr. Cathleen Jones – NASA JPL Advisor
- Benjamin Holt – NASA JPL Advisor

Gulf of Mexico Oil Spill Wetlands Impact Assessment

Community Concerns

- Oil from the Deepwater Horizon Oil Spill is likely to become distributed widely in the waters of the Gulf of Mexico and along adjoining coastlines and wetland regions.
- Ground-based tracking of the extent and impact of the oil is costly and resource intensive and therefore is unlikely to be both comprehensive and timely.
- A number of sensitive ecosystems along the Gulf coast could be threatened if oil reaches them, as is likely if tropical storms push water inland from the coast.
- Mitigation of the impact will be most effective if assets can be targeted to areas with known oil contamination as quickly as possible following exposure.

Project Partner(s)

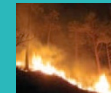
- US Department of Homeland Security
- United States Coast Guard

Decision Making Process / Partner Needs

- The DHS is interested in defining types of remote sensing assets that can quickly, reliably, and accurately identify and track oil dispersion following a spill.
- The DHS has a particular interest in data regarding oil dispersion past the Gulf coastline, especially due to the difficulty of tracking oil diffusion in wetlands.
- Furthermore, the DHS is interested in facilitating information transfer between scientists, who can analyze remote sensing data, and the state and federal agencies that can provide ground truth information needed for validation.

Decision Support Tools

- The UAVSAR data will be analyzed to determine whether future L-band satellite-based radar assets can provide data of use to the response and recovery efforts for future oil spills in the open ocean or within wetland areas.
- The UAVSAR data will be analyzed in conjunction with NASA's hyperspectral AVIRIS data, as well as Galileo Imaging Group's hyperspectral data in order to locate oil in wetlands and identify vegetation stress.



Natural
Disasters



Public
Health



Ecological
Forecasting

Advisors

Dr. Cathleen Jones - JPL
Benjamin Holt - JPL

Gulf of Mexico Oil Spill Wetlands Impact Assessment

Project Objectives

1. Correlate ground, aerial, and satellite observations from any available source with UAVSAR 2010 images of the area to validate oil detection on the waters.
2. Track when oil entered the area to see when the vegetation was impacted.
3. Find other observations during same week as UAVSAR deployment to serve as “truth.”
4. Compare other observations to UAVSAR data.
5. Compare 2009/2010 UAVSAR data, when available.

Study Area & Period

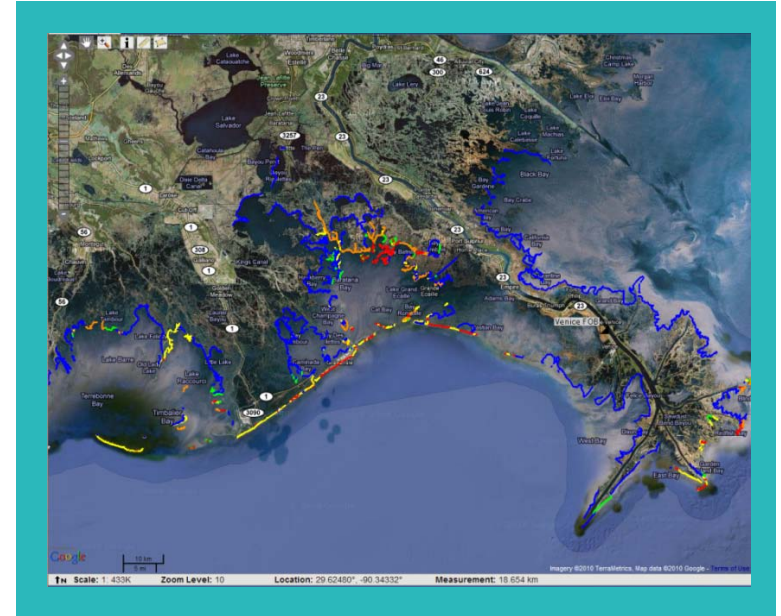
- Louisiana Barataria Bay
- Study period (April 2010 – August 2010)

Benefits to Partners

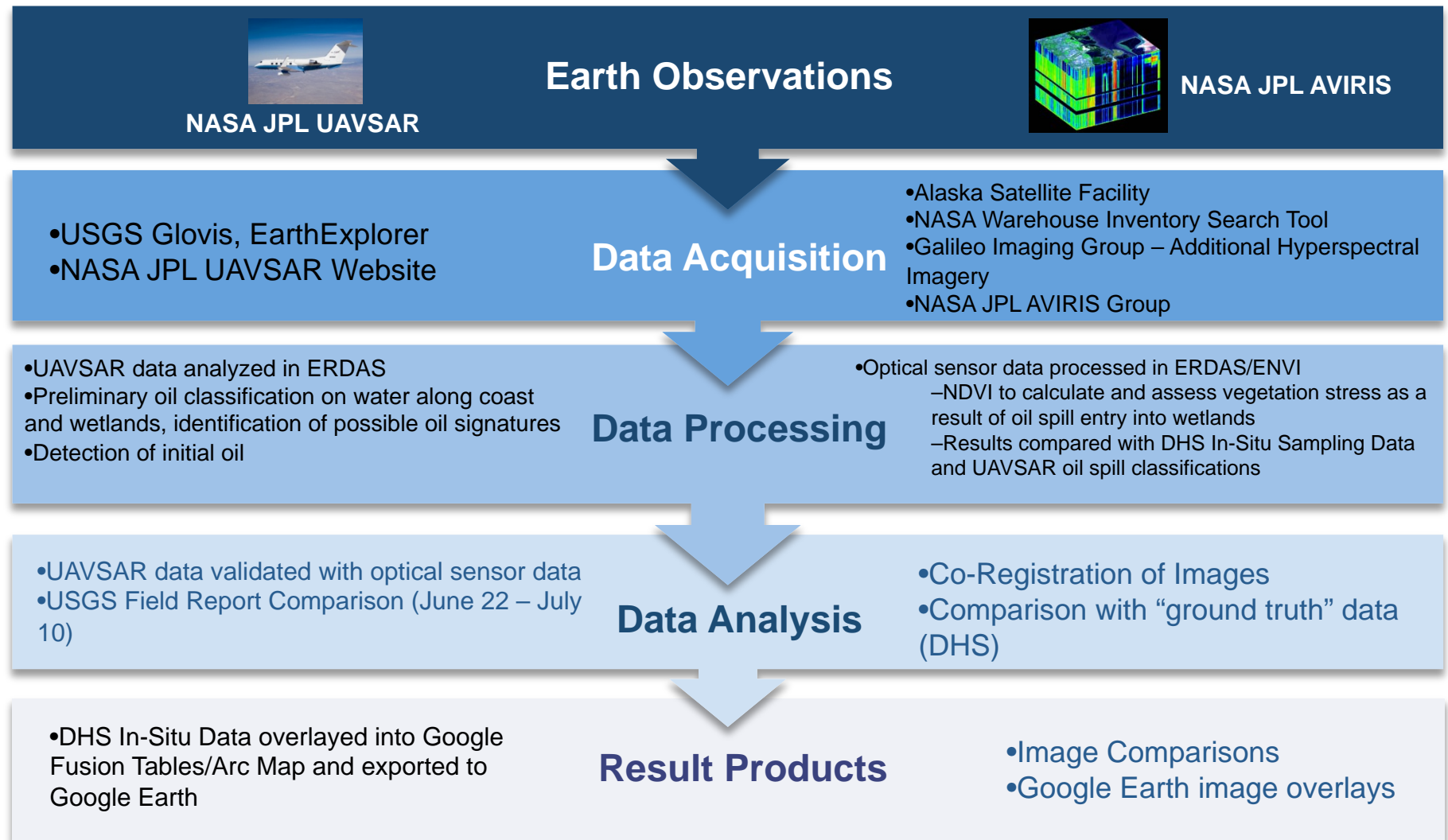
- This study will provide an innovative analysis through a combination of satellite, airborne sensors, and in situ field surveys to validate oil detection, particularly on vegetation and in small water channels, and is needed to substantiate results in order to characterize oil from the spill.
- The research results will be utilized for disaster management, monitoring, and mitigation.

Oil on Water

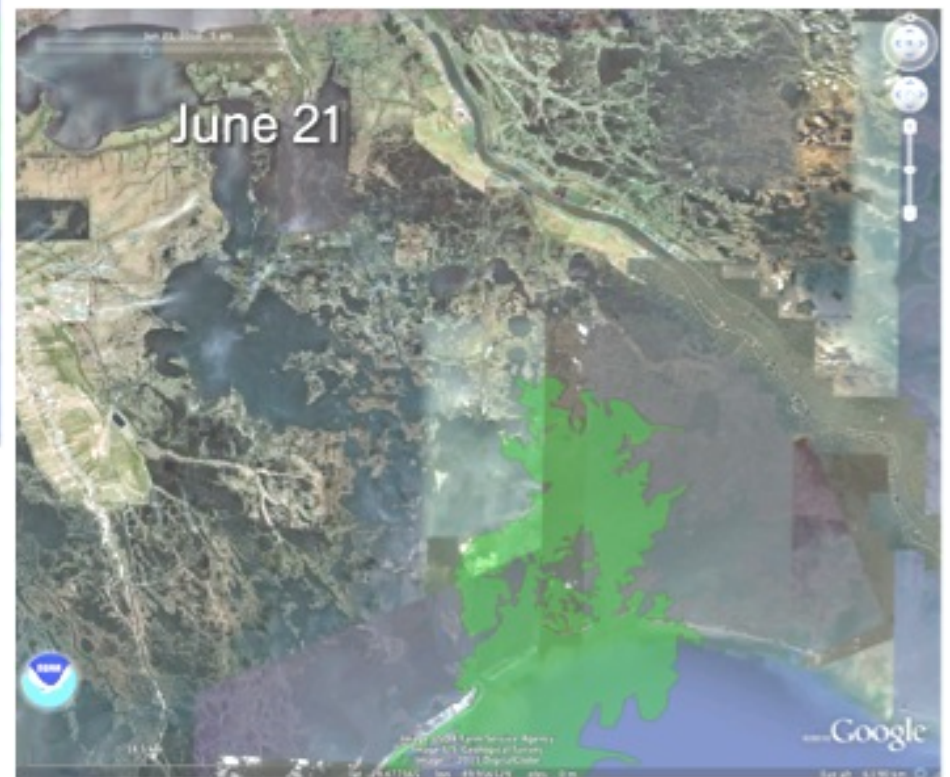
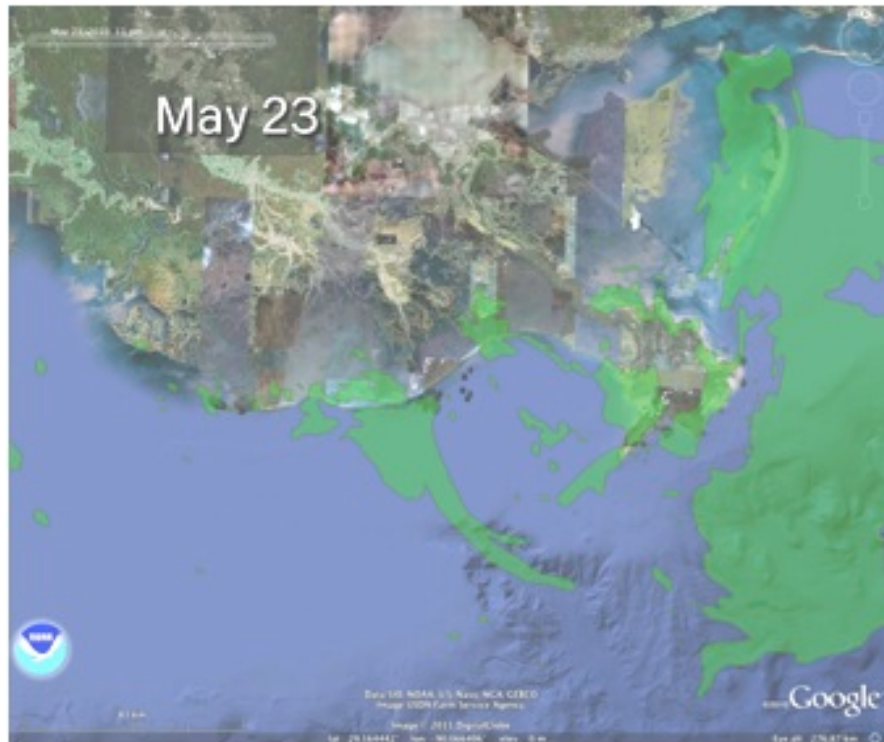
- Extent of oil on the water along the coast and wetlands
- Location of oil so that USCG can respond with assets
- Stagnant water classification – algae
- Classification of vegetation on the island, proximity to the vegetation
- Identification of thicker oil/non-oil



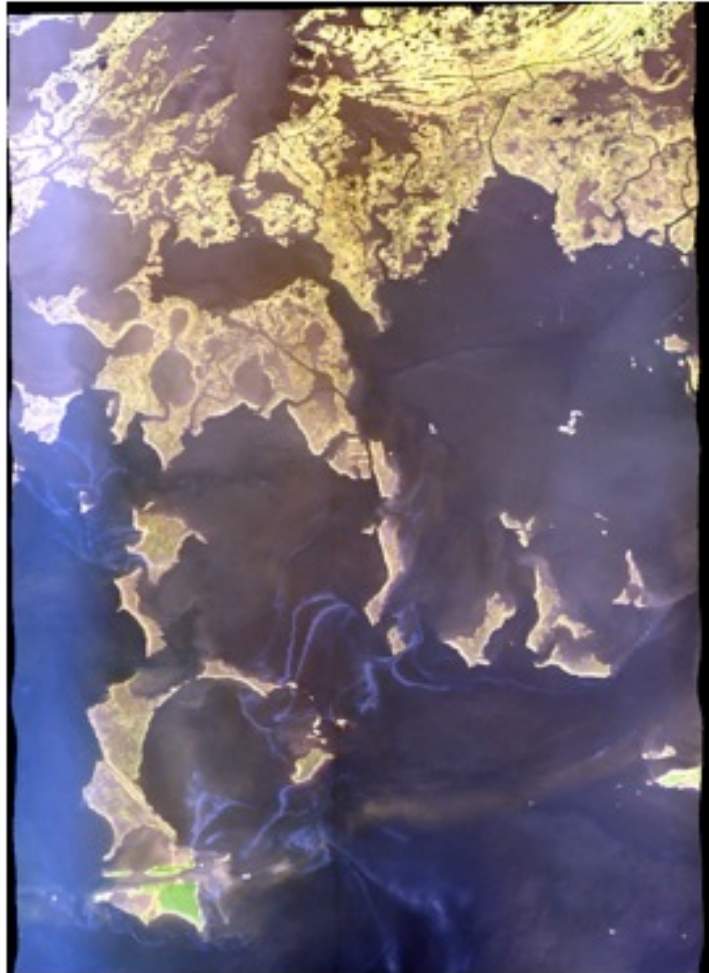
Methods



Oil Spill Wetlands Entry Timeline



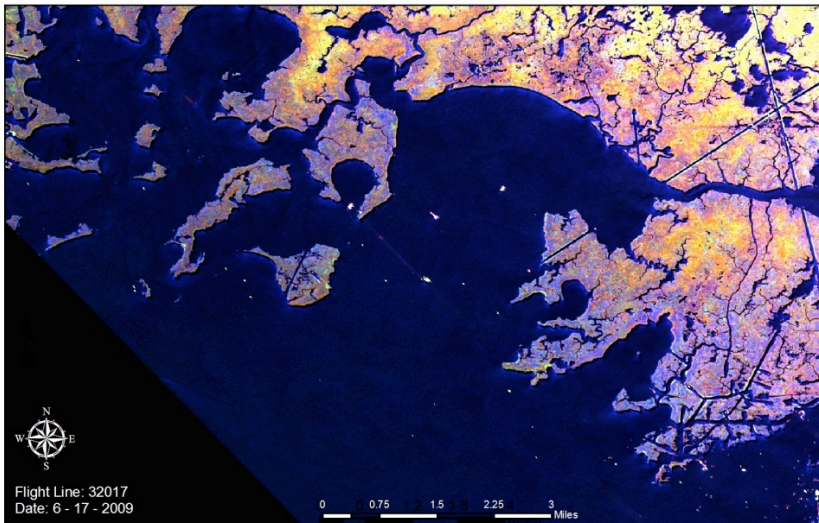
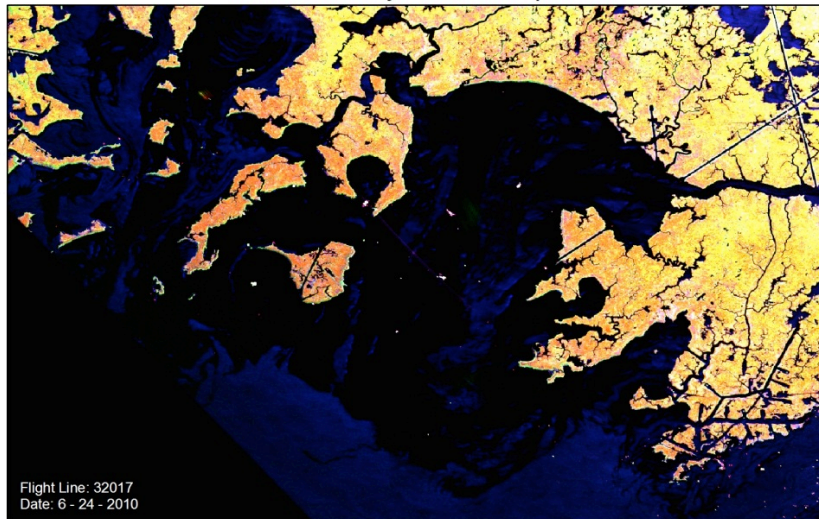
AVIRIS Flight Line Data



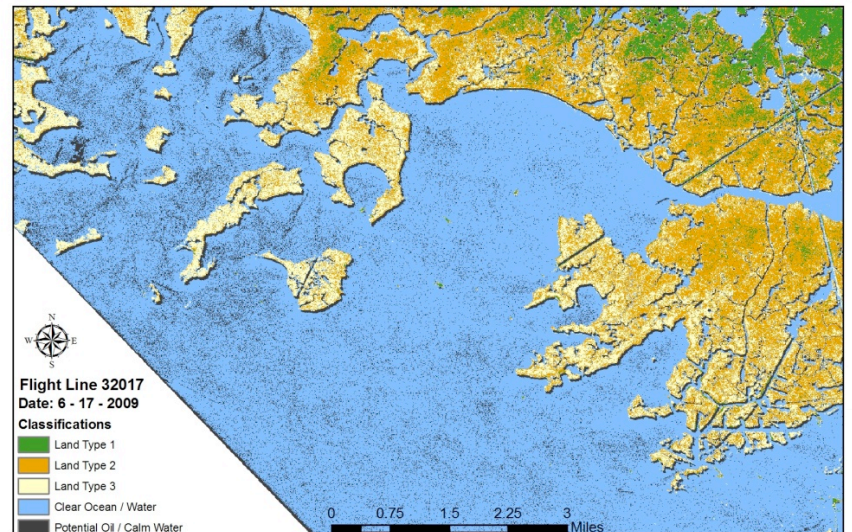
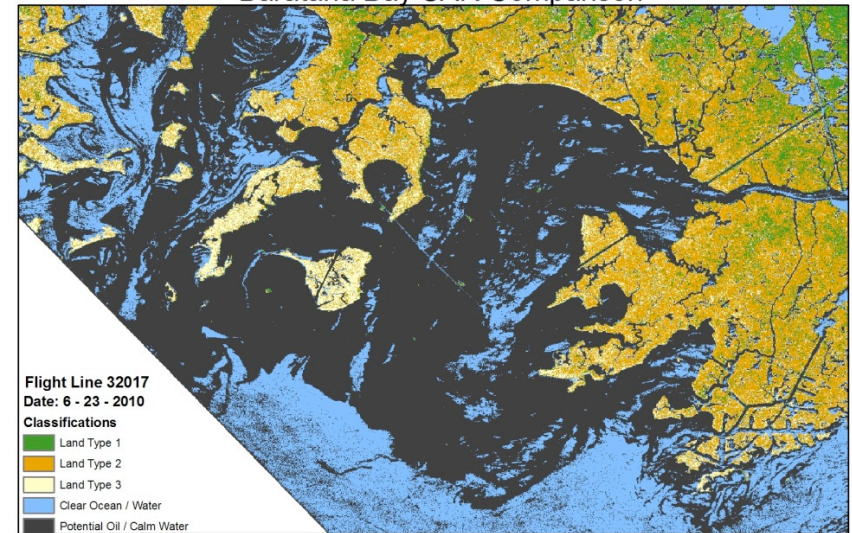
AVIRIS Flight: f100525t01
Image Center: 29.361 N, 90.038 W
Acquired from NASA JPL AVIRIS Group.
Include link to processed images in Google Fusion Tables

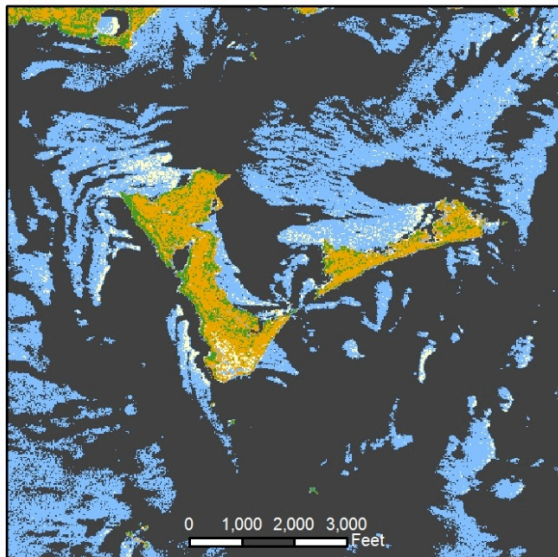
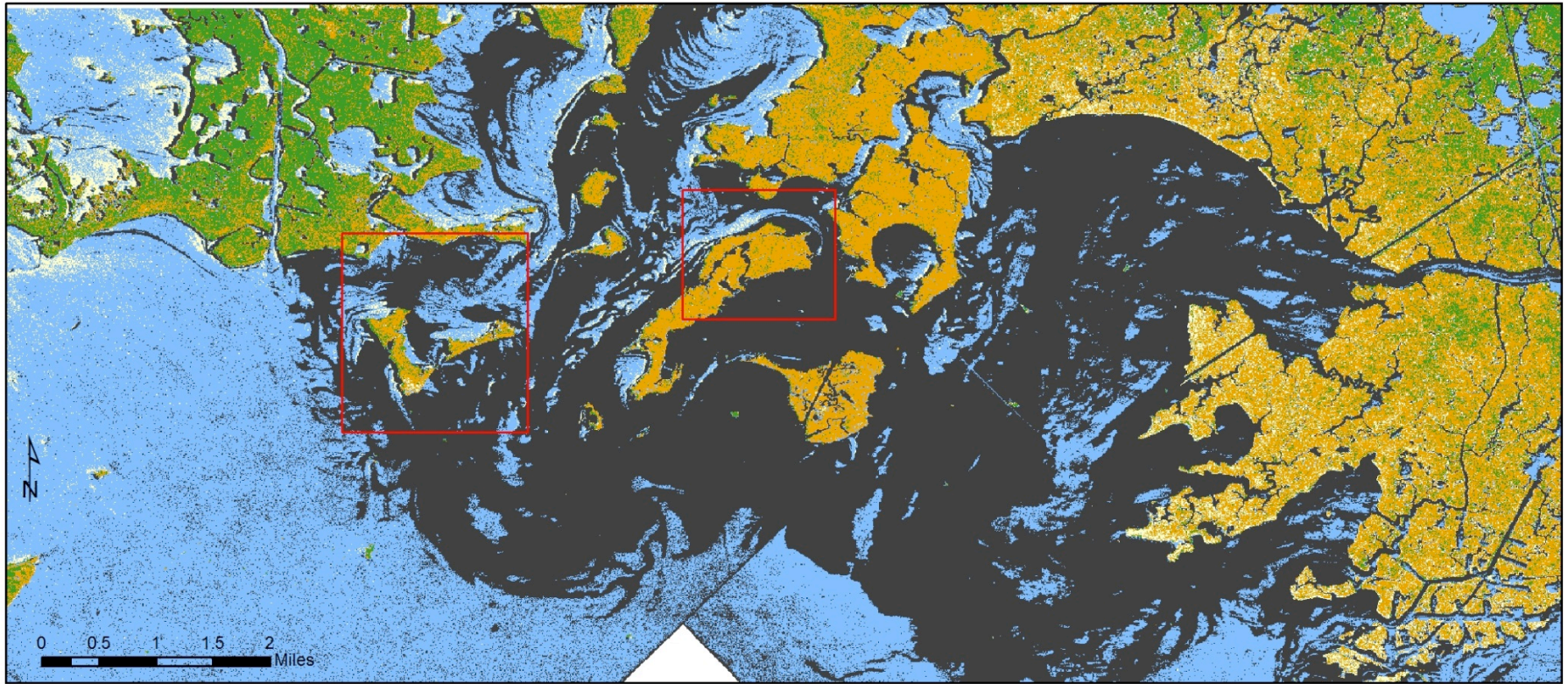
Results – UAVSAR Oil Spill Classification

Barataria Bay SAR Comparison



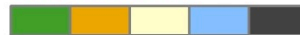
Barataria Bay SAR Comparison





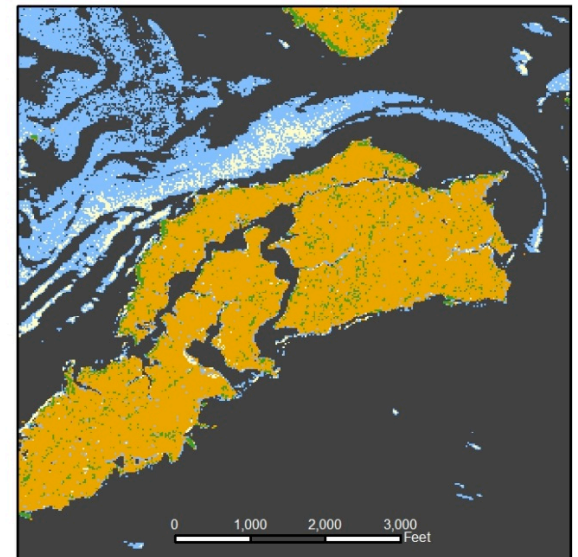
Barataria Bay Area of Impact

Classifications



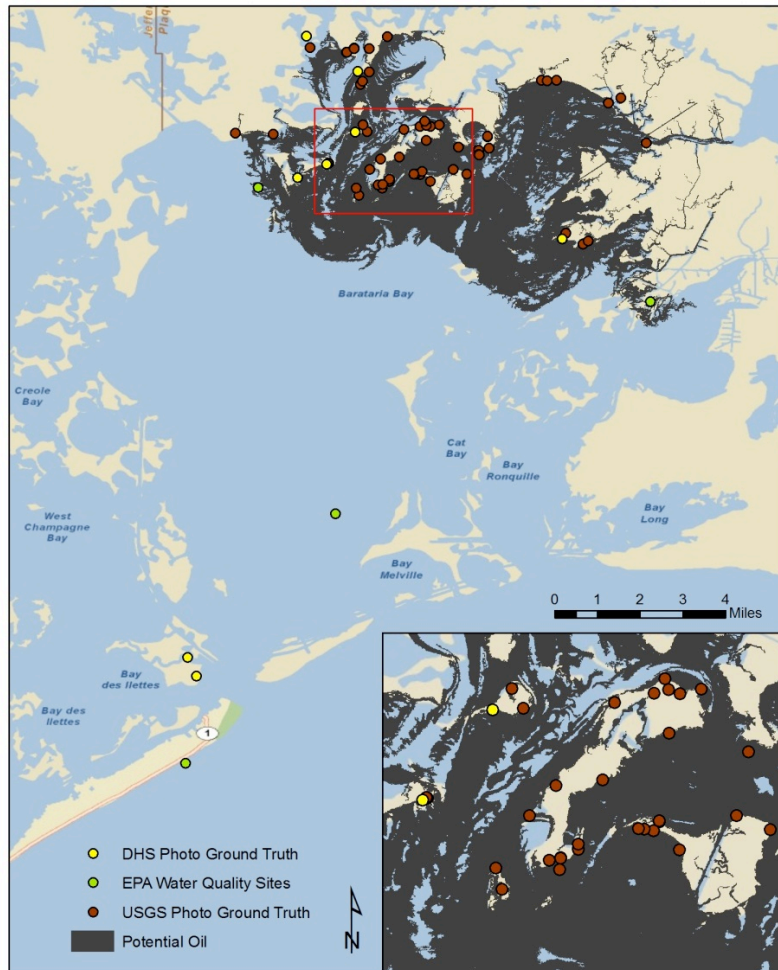
Land Type 1
Land Type 2
Marsh / Water Land Mix
Clean Ocean / Water
Potential Oil / Calm Water

Flight Line: 22202 / 32017 Mosaic
Date: 6 - 23 - 2010



Results

Barataria Bay Potential Oil Coverage



Ground truth photo points and EPA water sampling points. Notice the correlation between in-situ data and potential oil coverage extent.



Left: DHS in-situ data shows similar characteristics all along Jimmy Island's shoreline. These in-situ photos show oil along the shoreline, with this point containing a 4 meter penetration. Once again classified potential oil within this study match up well with the in-situ findings by the DHS. We also see that NDVI results show areas of dead vegetation along the same areas as these photos.



Left: Oil covered vegetation along the water's edge. This DHS photo shows the penetration of oil onto the edge of the land on Jimmy Island. We can also see where the oil boom failed and washed ashore. Oil vegetation is distinctively different than surrounding areas and thus easy to see in these photos as well as on aerial imagery. The penetration depth of oil onto land was measured at 2-4 meters by the DHS. Oil was described as weathered oil. The percentage of living vegetation at this point was estimated at 20%.



Above: Water along the shoreline can be seen in contrast to the oil boom. A slight sheen can be seen in the photo and was also recorded by DHS data. Even areas where the oil booms held intact we can see oil upon the shoreline to about 4 meters.

Left: This area had 40% of the vegetation living along the fringe according to DHS reports.



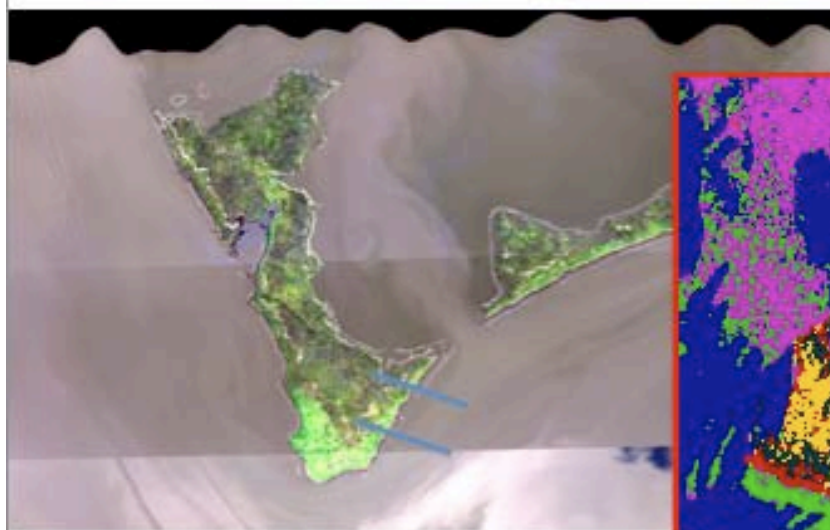
Above: A wider view of the shoreline that gives perspective to the extent of oil coverage. DHS oil occurrence along this shoreline corresponds well with area of impact determined by this classification study. Oil boom location inland is due to high tide according to DHS reports.

Left: Water at this site held a moderate sheen with previous weathered oil seen in the water. Vegetation along the shoreline was reported as 100% oil coverage.

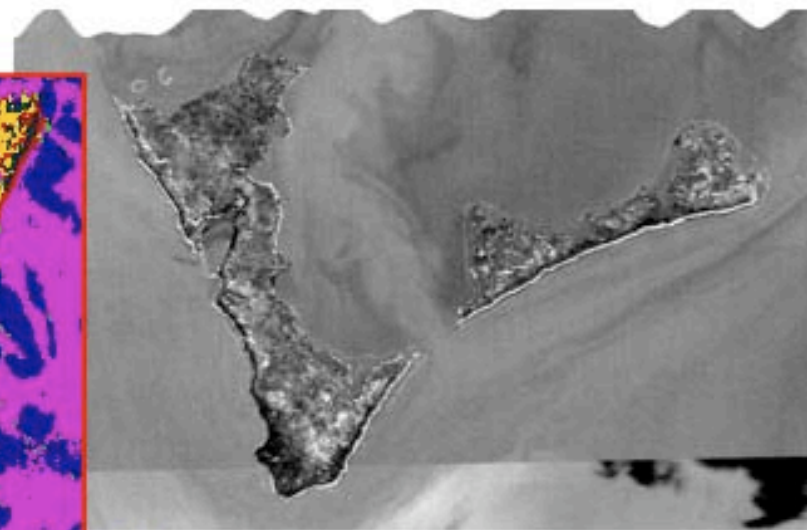
NDVI and Classification Comparisons

Galileo Group: Alpha 3.0 Island Latitude: 29.4434 Longitude: -89.9315

Bands 50/35/15 - RGB



NDVI Results



- Water
- Water + Open Marsh + Mud
- Possibly different density oil + Edges water or marsh
- Marsh (Double-bounce)
- Possible oil large patch + along leeward edge
- Marsh + Oil along edges



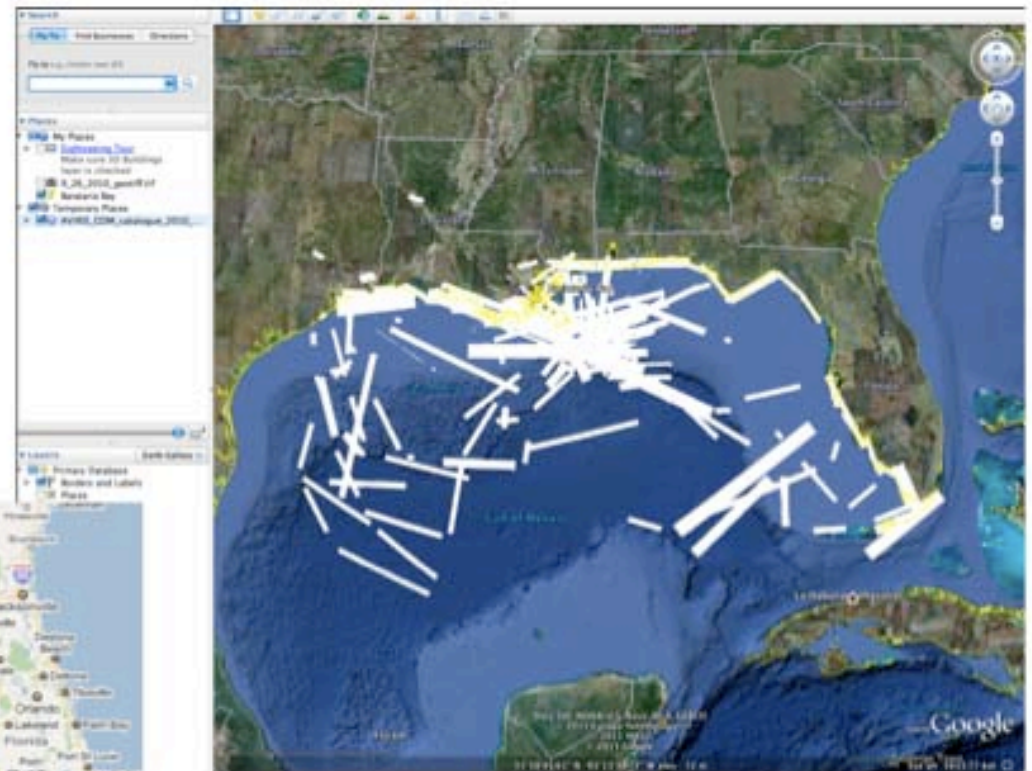
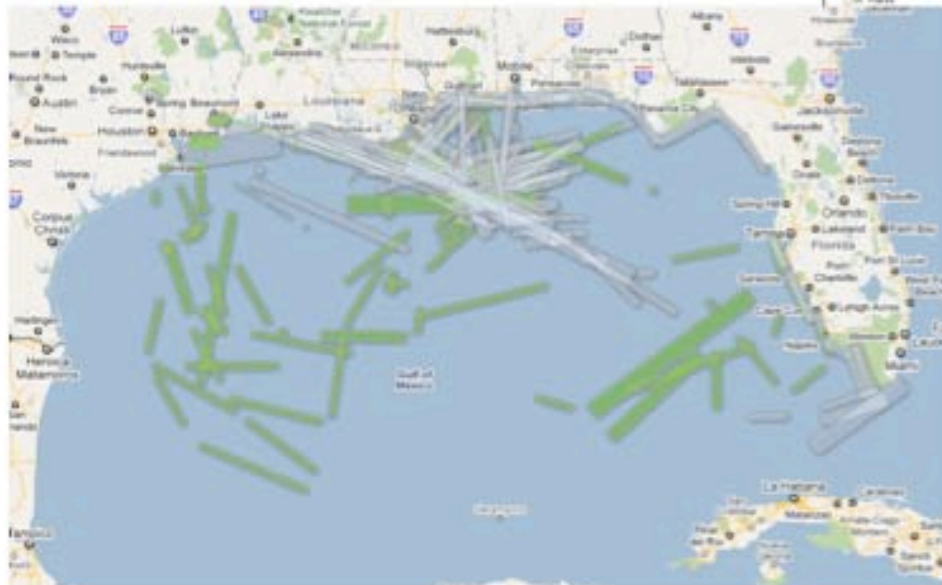
Unsupervised Wishart Classification –
Dr. Elijah Ramsey, USGS, National
Wetlands Research Center

Dr. Bruce Davis, DHS – Jimmy V2 Island In situ photographs of oil spill extent
Shoreline Impact Assessment Site Summary Date: 6/23/10 Bay: Jimmy Area:
V-2 Latitude: 29.4434 Longitude: -89.9315 Time: 9:54 Site Width: Site
Length: 30-m

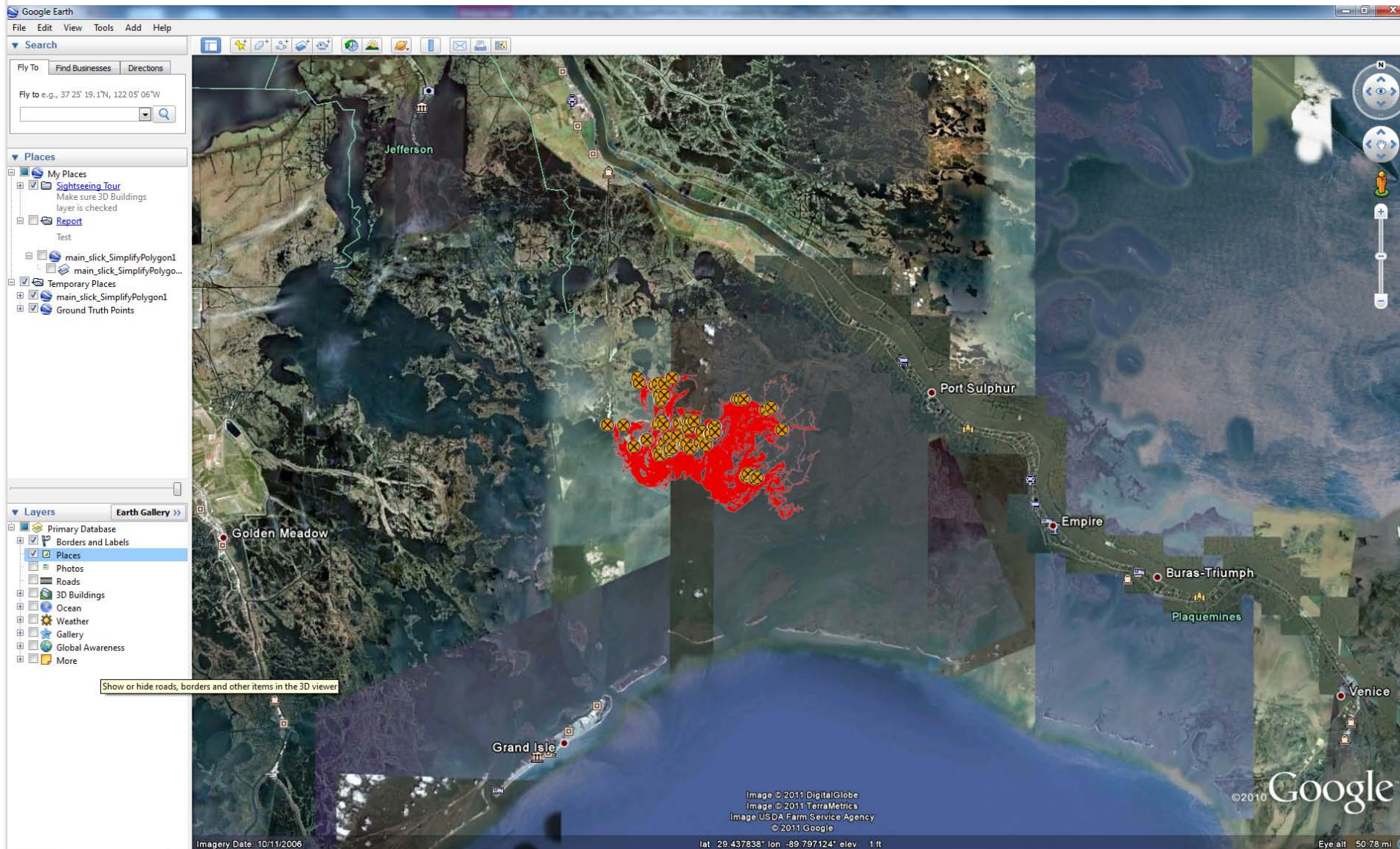
Source: Dr. Zhihong Pan, Galileo Group, Inc.

Enduser Products

AVIRIS Flight Line data in Google
Fusion Tables



Google Earth Layered Product



Conclusion

Conclusions

- Radar and SAR imagery, hyperspectral satellite and airborne imagery prove to be more effective as compliments to NASA JPL UAVSAR oil spill detection and validation studies as opposed to multispectral satellite sensors like Landsat 5 –In consultation with Dr. Bruce Davis, DHS
- Best method for bioremediation and oil spill tracking on coastal waters is through a combination of in-situ surveying, ground validation, Radar, UAVSAR tracking, and hyperspectral earth observations.

Partner Transition

Rapidly transferable Google Earth images with processed, overlaid UAVSAR and optical airborne (and for additional studies, satellite) sensor data.

Timeline: End products will be utilized for the duration of the oil spill cleanup (no end date). Our end products will be easily accessible to our endusers through Google Earth and Google Fusion Tables.

The use of Google Earth in conjunction with processed and analyzed NASA EOS and ancillary data will allow DHS and USGS with oil spill recovery efforts. DHS is primarily interested in utilizing our end products for natural disasters, while USGS is primarily interested in utilizing it for the ecological forecasting societal benefit area. DHS is requesting that we research the regulations on redistributing data so that they can easily email our end product within the organization and to their partner organizations.