Current Capabilities and Proposed Enhancements to the Airborne Spectral Photometric Environmental Collection Technology
-Remote Oil Detection System-

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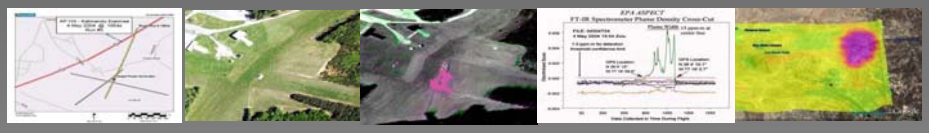
Remote-Sensing & Imagery- Chemical, Radiological & Situational Awareness

- Provide a readiness level on a 24/7 basis
- Provide a simple, one phone call activation of the aircraft
- Wheels up in under 1 hour from the time of activation
- Once onsite and data is collected it takes about….

~ 5 minutes to process and turn around data to first responders



- **Deployment Simplified:**
  - Once on-scene collect chemical, radiological, or situational data (imagery) using established collection procedures
  - Process all data within the aircraft using tested automated algorithms
  - Extract the near real time data from the aircraft using a broadband satellite system and rapidly QA/QC the data by a dedicated scientific reach back team
  - Provide the qualified data to the first responder enabling them to make informed decisions in minimal time

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Platform: N9738B

- N9738B: Full FAA DER/STC for all systems and components
- 1987 Cessna 208B Caravan
- TT6A Turbo Prop
- Useful Weight: 4180 lbs
- Typical Cruise Speed and Duration: 160 Kts at 6 Hours
- Full IRF Avionics with weather radar, live weather feeds and terrain/obstacle avoidance
- Broadband Satellite Communication/Data System
- Enhancements:
  - Exhaust modifications
  - Heavy lift modifications
  - Certified for ice landing and takeoff

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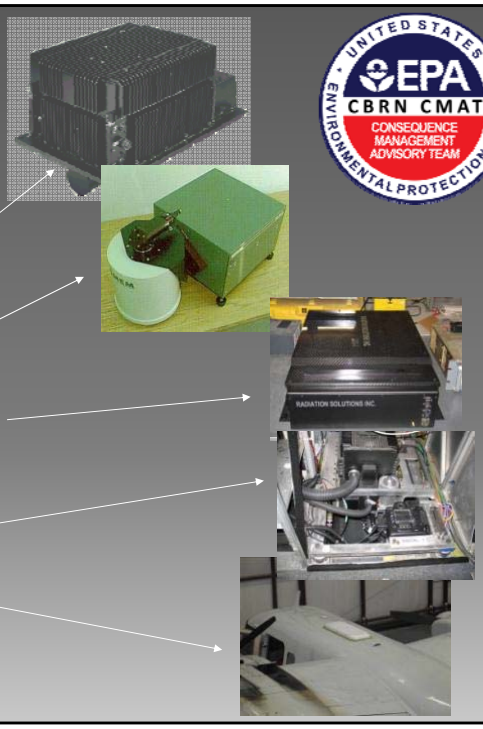
CURRENT SYSTEMS

- ASPECT Uses Six Primary Sensors/Systems:
  - ✓ An Infrared Line Scanner* to image the plume
  - ✓ A High Speed Infrared Spectrometer* to identify and quantify the composition of the plume
  - ✓ Gamma-Ray Spectrometer Packs for Radiological Detection NaI and LaBr and Neutron Detector
  - ✓ High Resolution Digital Aerial Cameras* with ability to rectify for inclusion into GIS
  - ✓ Broadband Satellite Data System (SatCom)



*Scheduled for replacement in FY16

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ASPECT Oil Detection Program

- Specificity – Detection is accomplished using a pattern recognition method to attenuate false alarms
- Due to the design of the imaging system, ASPECT can image a swath 1 mile wide with a pixel level spatial resolution of 3 feet. This permits the system to see both large oil masses and smaller isolated patches
- Each pixel of the image is geo-registered
- ASPECT can image about 2 square miles per minute or about 750 to 1000 square miles per patrol
- Oil location, relative thickness, and location can be relayed to the response team in about 5 minutes.

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ASPECT Products

(Secured, Google Earth, Google Maps, ESRI)

Google Earth: 3D Infrared Line Scanning Image

www.epaaspect3.net/googleearth/BSA_Jamboree_July2013/web/main/web_main_BSA_Jamboree_July2013_link.html

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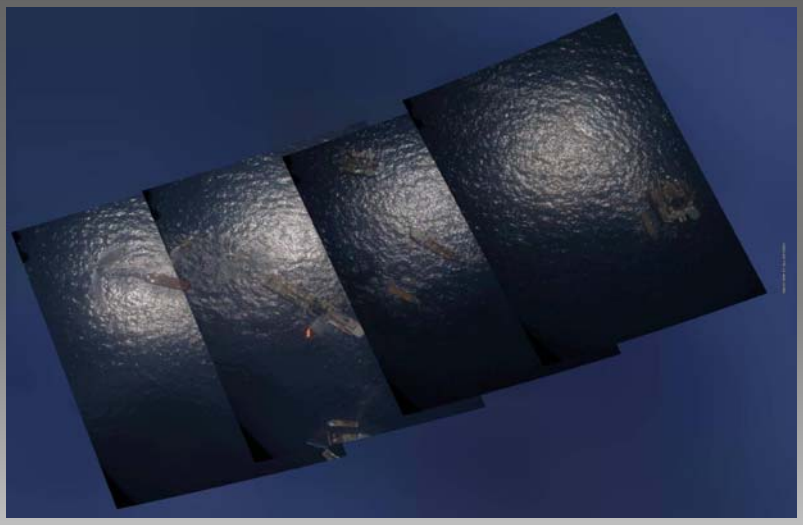
Deep Water Oil Detection

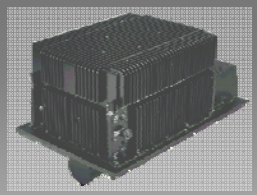
Aerial Photography



- Standard still frame photography is often used for Oil Detection
- While the method is simple to implement several complication exist:
  - Low target (oil) contrast to water
  - High glare and glint contamination
  - Day light dependent
  - Difficult to interpret

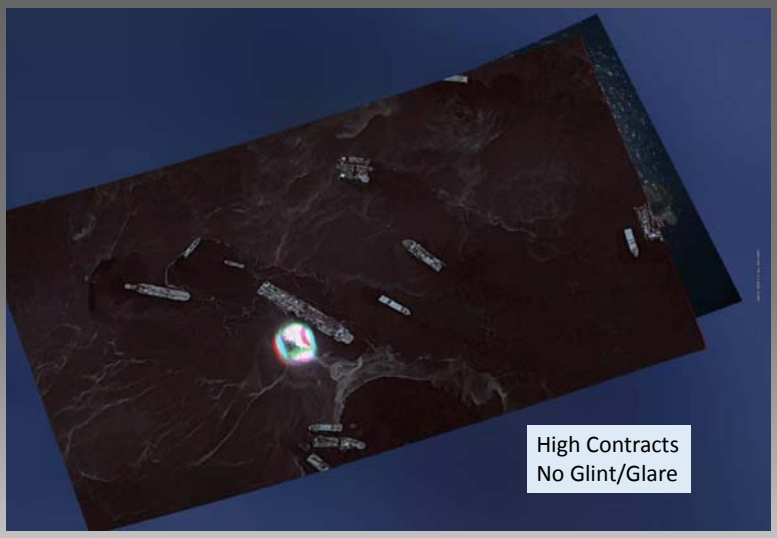
Open Ocean Oil Detection

- Based on the difficulties of traditional aerial photography, the EPA ASPECT program has developed several methods to use data collected with the programs RS800 multispectral infrared imaging systems to quantify and locate surface oil in deep, open ocean waters
- A number of open ocean oil-on-water detection algorithms have been developed and successfully demonstrated including
  - ✓ Multi Spectral Infrared
  - ✓ ISO Data (Unsupervised Classification)
  - ✓ Spectral Pattern Recognition (Supervised Pattern Recognition)
- Trend analysis
  - ✓ Quantitative amounts (thickness of oils)
  - ✓ Dispersant effectiveness
  - ✓ Oil migration monitoring



Open Ocean Oil Detection

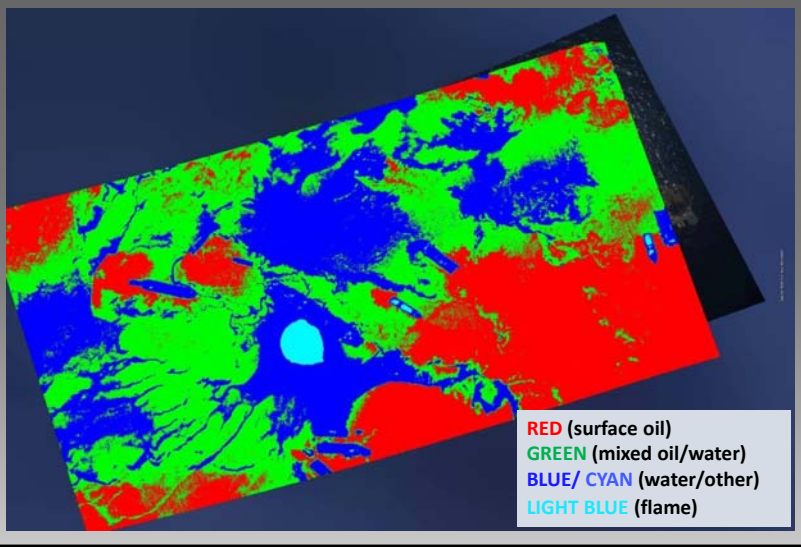
Multi Spectral Infrared Image – Deep Water Horizon Rig Location



- Multispectral infrared imagery permits physical properties of the water and oil (such as emissivity) to be exploited to show contrast.
- Since this method is driven by temperature and emissivity, day/night time operations are both possible.
- While contrast is outstanding, additional methods are needed to extract type and quantity of surface oils.

Open Ocean Oil Detection

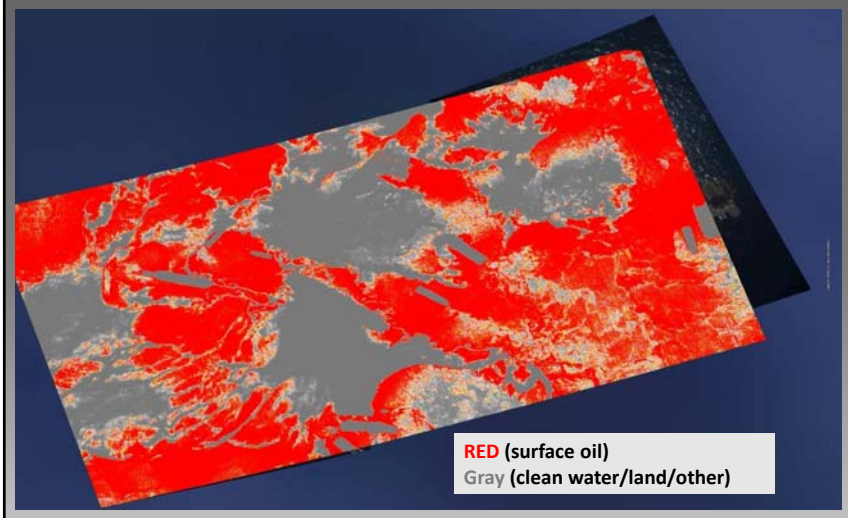
Unsupervised Classification Infrared Image



- Due to the fairly uniform surface temperature of the open ocean, simple classification methods can be employed
- An ISOData technique was found to be useful and permitted various levels of oil content/water content to be contoured.
- Since this method is unsupervised, caution must be used in interpretation since all data field are classified (Note the ships are classified as water)

Open Ocean Oil Detection

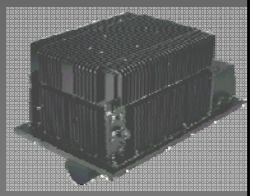
Supervised Pattern Recognition of IR Image



- By using several channels from the RS800 imager, a multi-variant pattern recognition method can be developed showing very strong oil to water discrimination
- By using several spectral channels, the software is trained to recognize oil and classify all other instances as non-oil

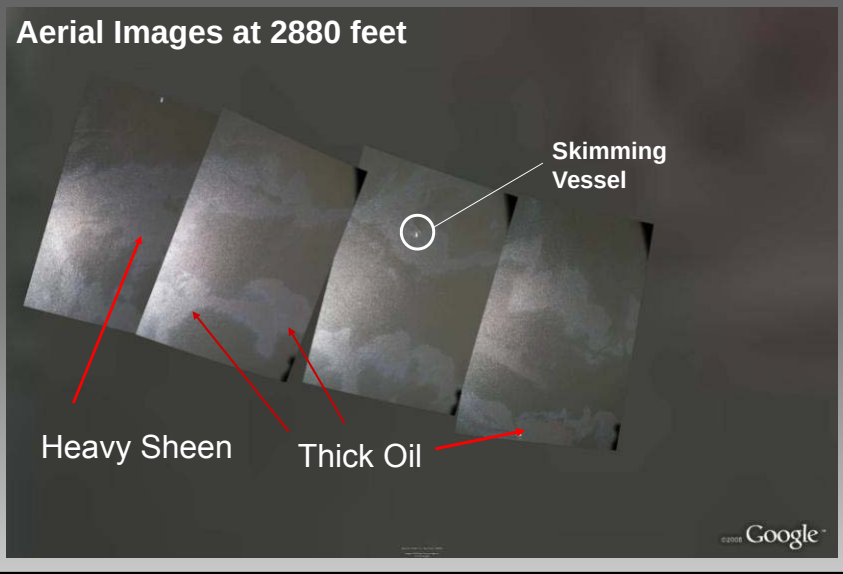
Shallow Water Oil Detection

- Shallow water oil detection is complicated by the thermal environment of near shore waters
  - Water can and does show high temperature gradients within the environment
  - These gradients complicate emissivity extraction giving rise to false oil detection and or detection clutter.
  - The shallow environment is often “contaminated” with natural substances which can be false identified as oil
- Shallow water detection requires the use multispectral multivariate methods. The program has found that spectral pattern recognition (Supervised Pattern Recognition) is most effective:
  - ✓ The thermal gradient environment is part of the training set and does not significantly drive false alarms
  - ✓ Vegetation and other natural features (land mass) are spectrally different than the oil and are placed correctly into the background training set.



Near Shore Oil Detection

Aerial Imagery – Barataria Bay



Low Contrast
High Glint Contamination
Difficult to Interpret

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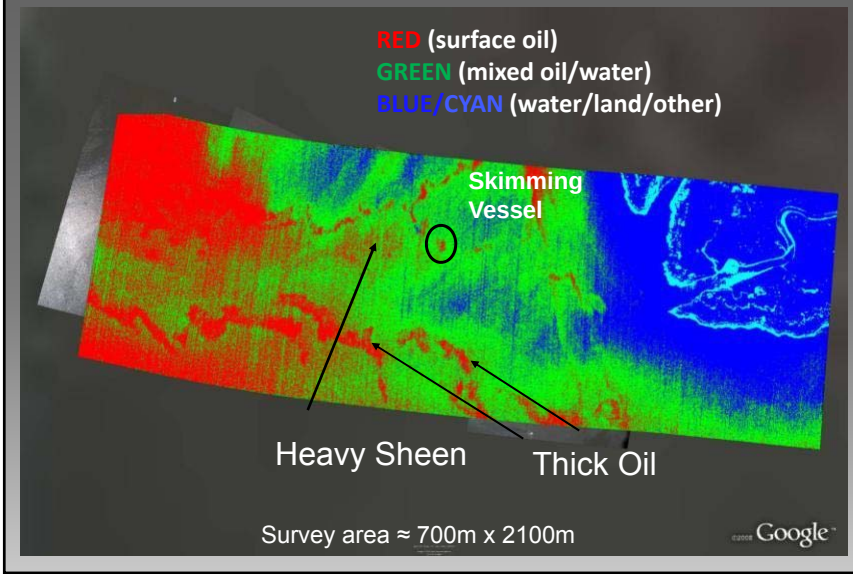
Near Shore Oil Detection

Unsupervised Classification Infrared Image



- The ISOData method becomes unstable when the surface temperature of the water begins to show a high gradient as present in show waters.
- Land masses also significantly impact the method and make interpretation difficult.

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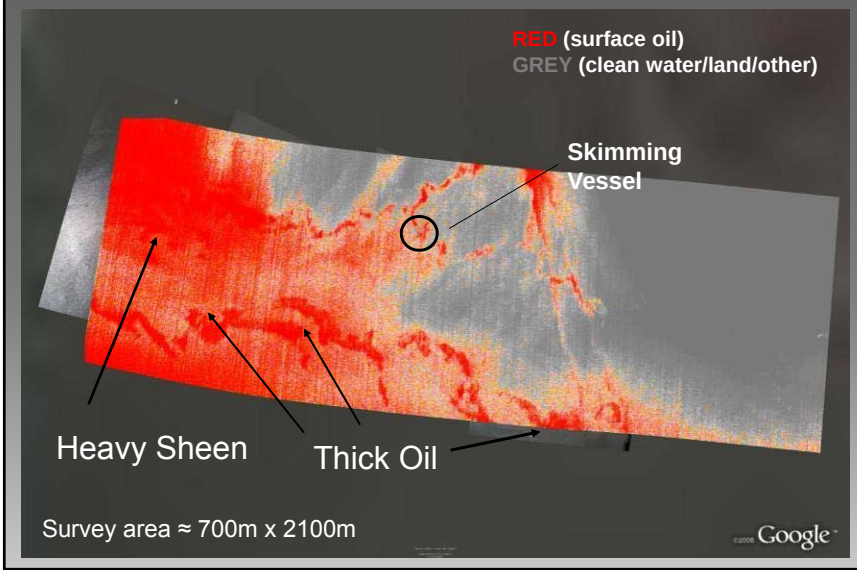
Near Shore Oil Detection

Supervised Pattern Recognition of IR Image



- The Supervised Pattern Recognition methods show strong performance in the high thermal gradient environments.
- The density of the detection effectively provides information on the amount of oil present on the surface.
- Land masses, structures, natural vegetation and other non oil targets are correctly identified as non oil and make interpretation much easier.

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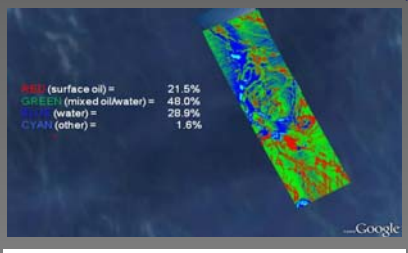
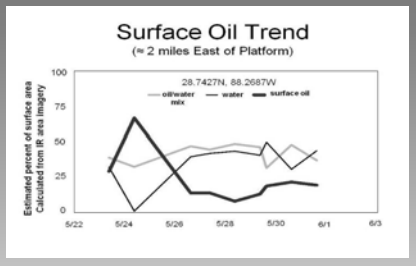
Spectral Analysis of Oil

Determining the Effectiveness of Dispersants

- During Deep Water Horizon ASPECT collected data approximately 2 miles east of the recovery site for a period of one month. Spectral analysis of the surface oil allowed a trend analysis to be conducted.
- Indicated that between 24 May and 26 May the surface characteristic of the oil changed.
- This observation is consistent with the application of dispersants to the area
- The features measured by ASPECT include the transition of oil from predominately surface oil to an oil/water mixture, consistent with dispersant physics.





Imaging Sensor Upgrade Status

- The ASPECT program is replacing the current RS800 Infrared imaging systems with the LS1600 imager. This unit will have:
  - A 16 channel long wave detector providing higher resolution IR discrimination
  - Higher spectral throughput for the system to provide better noise equivalent temperature sensitivity
  - Enhanced data handling and onboard data processing to permit continuous data collection and continuous coverage selection areas of ocean
  - It is estimated that 2 square miles of ocean will be imaged and assessed per minute. A typical sortie will screen 750 to 1000 square miles of water.
- Anticipated delivery of the first modified unit – March 2016

- This up-grade/replacement includes the develop of additional software and training data to support the LS1600 sensor.

Planned Development Work Software

- Using experience developed by the ASPECT program and existing software tools to develop:
  - A fully automated detection algorithm using both unsupervised and supervised detection methods which will detection, locate and quantify oil on water and provide these results to response management in near real time.
  - Spatial resolution of the system will be approximately 1 square meter.
  - The software will support both day and night time operations
  - Through proper data training, the software will be trained to support oil responses ranging from tropical waters to arctic frozen ice.

- It is anticipated that the basic software package will be completed in 12 months.