The NOAA/NESDIS Satellite Monitoring of Marine Oil Program

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Workshop Sargassum and Oil Spills Monitoring Pilot Project for the Caribbean and Adjacent Regions
The Satellite Analysis Branch (SAB)

- Part of the U.S. National Oceanic and Atmospheric Administration (NOAA) Satellite and Information Service (NESDIS)
- Based on the outskirts of Washington D.C. in College Park, MD
- Staffed 24 hours a day, 7 days a week
- **Mission:** Operate new proof of concept satellite analysis techniques needed to support disaster mitigation and warning services for U.S. federal agencies and the international community.
- 5 operational desks: Tropical cyclones, volcanic ash, heavy precipitation, wildfires, and **oil spills**
NOAA’s Oil Spill Monitoring Program

• In 2009 a formal request was made by NOAA’s Office of Response and Restoration (specifically, the Emergency Response Division) for satellite support of oil spill emergencies and for assistance in monitoring intentional and accidental crude oil discharges in U.S. waters
• Oil Spill desk became fully operational in 2011.
• Customers/users include the U.S. Coast Guard, NOAA/ National Ocean Service, the Bureau of Safety and Environmental Enforcement, the Environmental Protection Agency, and State Agencies (e.g. Florida Fish and Wildlife, Texas General Land Office)
• As of 1 March 2018, Marine Pollution Surveillance Reports (MPSRs) are published to the web and publicly available.
Operational Regions

U.S. water within the Exclusive Economic Zone (EEZ) and their approaches, and internationally when requested.
Possible oil discharge was observed in the Gulf of Mexico just offshore from the birds foot delta in Louisiana. This ongoing oil release is the result of a Taylor Energy platform that was damaged by Hurricane Ivan in 2004. Litigation remains ongoing, and each satellite report generated by SAB serves as documentation.

Possible oil discharge was observed south of Long Island, NY. This ongoing oil release is the result of the Coimbra Tanker, which was torpedoed by a U-boat and sank in January 1942. This wreck is part of NOAA’s Remediation of Underwater Legacy Environmental Threats (RULET) project, and SAB satellite reports serve as documentation of the ongoing discharge.
Routine Satellite Acquisitions

**Manmade crude oil slicks occur for two reasons:**
1. Accidental discharges. Examples – Exxon Valdez, Deepwater Horizon, platform equipment failure, pinhole leaks in pipelines, damage to platforms/rigs from natural disasters, sunken vessels.
2. Intentional discharges. Examples – Pumping bilge waste at sea instead of paying to properly dispose of the waste in port.

**Synthetic Aperture Radar**
- Radarsat-2
- Sentinel-1A
- Sentinel-1B

**Optical**
- Landsat-7
- Landsat-8
- NPP-VIIRS
- Sentinel-2A
- MODIS Terra
- MODIS Aqua

**Software Used to Analyze Satellite Imagery and Create Reports**
- **ENVI**
  - Geospatial image analysis program that features spectral interrogation, enhancements and stretches, and target detection, among other tools.
- **ARC GIS**
  - Geospatial map interface that also allows for imagery analysis as well as the creation of shapefiles that depict the boundaries of the oil.
Routine Satellite Revisit Times

- Landsat7/8 – 30m optical - 16 days
- Sentinel-1 – 5 to 40m SAR - 12 days
- Sentinel-2 – 10m optical - 10 days
- MODIS Terra/Aqua – 250m optical Everyday
Operational Workflow

Marine analysts download and *manually* analyze satellite imagery for possible oil anomalies based on a *visual inspection*, but also consult a wide array of ancillary information to help rule out false positives.

If believed to be the result of man made discharge, a Marine Pollution Surveillance Report is created and disseminated.
Observing Oil in Synthetic Aperture Radar

Visual Characteristics of Accidental Discharges

- Good contrast
- Stands out from any other feature in the image
- Has a point source
- Well defined edges
On Sunday morning December 24th, 2017 a three mile long possible oil sheen was detected in the Gulf of Mexico using a 0001Z Sentinel-1A satellite image. The USCG Sector New Orleans determined that the discharge was ongoing and originating from a decommissioned oil production platform. The Coast Guard’s Incident Management Division (IMD) opened a Federal Project and contracted OMI Environmental Solutions to assess the incident and install a containment boom on December 25th.
Identifying Oil in Synthetic Aperture Radar

Visual Characteristics of Bilge Dumping

- Feathering signature
- Widening with distance
- Discontinuous

- Unnatural turns
- Widening with distance
Possible oil discharge was reported by SAB in British Virgin Islands waters from a vessel departing Puerto Rico bound for St. Maarten. The MPSR was picked up by the USCG Sector San Juan and the USCG Maritime Intelligence Fusion Center – Atlantic (MIFCLANT) in Virginia Beach. A cutter investigated and found a light remnant sheen. Coordination was established with the British CG as this is a MARPOL violation (The International Convention for the Prevention of Pollution from Ships).
Possible oil discharge was observed in the Gulf of Mexico from a vessel cruising approximately 150 NMI south of the U.S. EEZ. Report was picked up by the USCG Maritime Intelligence Fusion Center – Atlantic (MIFCLANT) in Virginia Beach. The vessel was boarded when it reached port in Savannah, GA on 3 March 2018. We are awaiting feedback on the results of the investigation.
Automated Oil Spill Mapping - TCNNA

Texture Classifier Neural Network Algorithm (TCNNA), is an automated oil spill identification tool that our branch has been evaluating since Fall 2017. It performs best in satellite scenes that have a homogenous background, but that typically isn’t the case. We continue to investigate of and how we can rely on this tool to semi replace manual inspection.
Common Pitfalls for Oil Detection in Synthetic Aperture Radar

- Low wind conditions
- Ship wakes
- Sheltering
- Upwelling
- Biogenic slicks or organic material
- Fishing Activity
- Convective Outflow
- Grease Ice

Despite exhibiting good contrast, the anomalies trailing the vessels neither show feathering nor widening with distance and are retroactively assessed to be wakes.
Identifying Oil in Optical Imagery

Can appear white and shimmery in sun illumination

Dark anomaly with well defined edges and good contrast against the ocean background

Unnatural turns

Feathering signature

Does not emit in the Near IR portion of the electromagnetic spectrum, as this would be indicative of vegetation (e.g. algal bloom)
Vegetation vs. Oil

1.5 meter resolution WV2

Vegetation band enhancement (NearIR-Red-Green)

1.5 meter resolution WV2

True Color image (Red-Green-Blue)
On the evening of February 15th, the marine pollution analyst in the Satellite Analysis Branch (SAB) detected a 3.8 NMI long possible oil sheen in the Gulf of Mexico using a 1632Z Landsat-8 satellite image. In the morning on February 16th the Bureau of Safety and Environmental Enforcement (BSEE) Sector Houma overflew the area and discovered an oil sheen measuring 1 NMI by 200 yards. The oil slick was in the vicinity of numerous pipelines, but its source remains unknown at this time.
Common Pitfalls for Oil Detection in Optical Imagery

- Bathymetric or “bottom” features
- Fishing activity
- Ship wakes
- Cleaning agents
- Shadows

Similar anomaly 1 year earlier →
Thank you!

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Marine Pollution Webpage
http://www.ospo.noaa.gov/Products/ocean/marinepollution/