Oil Spill Program at Satellite Analysis Branch & How our knowledge can help wider Caribbean area

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SAB| NESDIS|NOAA **June 25th, 2020**

https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills

Bottom Line Up Front (BLUF)

- NOAA Satellite Analysis Branch(SAB) issues man-in-the-mix interpretive satellite products for intentional oil discharge, accidental oil spill and oil spill related to disasters.

- Particularly, One of our key monitoring capability is monitoring for MARPOL violations which is intentional oil dumpling by the ships. Cognizant of the need for a unified regional response, we are eager to help other nations especially in the neighboring areas, to stand up similar capabilities.

- SAB has experiences helping other nations developing oil spill monitoring capabilities through training, personnel exchanges, and guidance on procedures. SAB can upscale or downscale its guidance depending on resources available for oil spill monitoring.

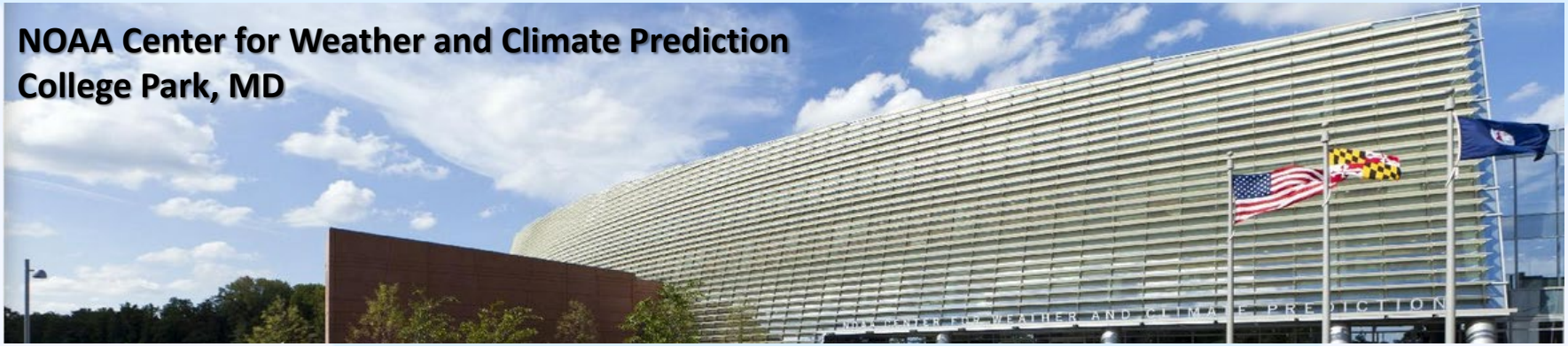
- Freely available satellite imagery for wider Caribbean region include VIIRS, MODIS, Sentinel 1, Sentinel 2 and Landsat.

- An automated tool named TCNNA for detecting oil spill is available to help.

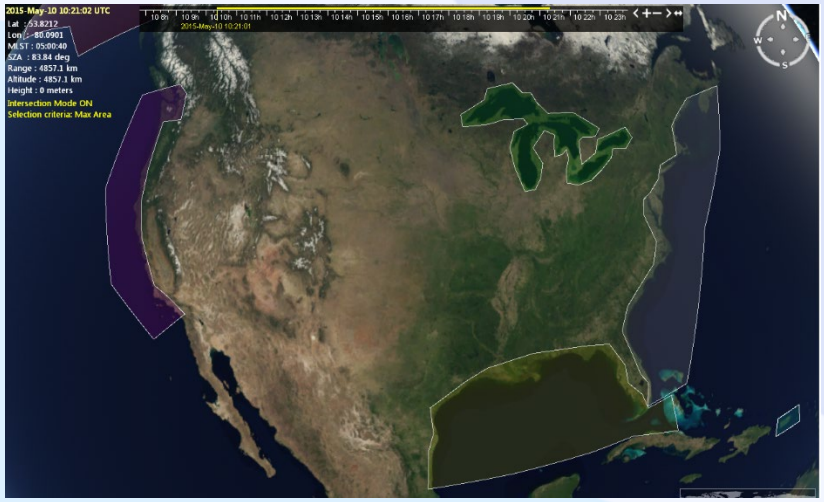
- Examples will be shown on the oil spill cases captured in satellite imagery and some special requests we have supported in the wider Caribbean region.

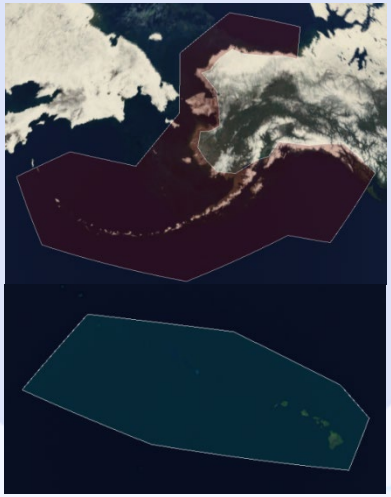
Satellite Analysis Branch (SAB)

- Part of the NOAA | National Environmental Satellite Data and Information Service (NESDIS).
- **Oil Desk Mission:** To analyze satellite imagery for accidental and intentional oil discharges, create the Marine Pollution Surveillance Report (MPSR), notify Federal and State Agencies
- The oil spill monitoring desk became fully operational in 2011.
- Stakeholders include the **U.S. Coast Guard, NOAA's Ocean Service, the Bureau of Safety and Environmental Enforcement (BSEE), the Environmental Protection Agency, and State Agencies (e.g. Florida Fish and Wildlife, Texas General Land Office, Louisiana Oil Spill Coordinator's Office)**
- As of 1 March 2018 MPSRs are published to the web and publicly available
  - https://www.ospo.noaa.gov/Products/ocean/marinepollution/



Area of Responsibility





U.S. waters within the Exclusive Economic Zone (EEZ) and their approaches, and internationally when requested.

Manmade crude oil slicks occur for two reasons:

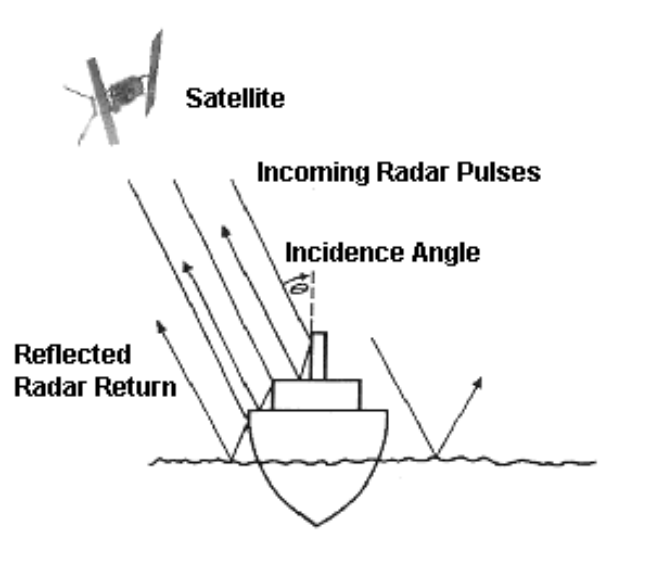
1. Accidental discharges. Examples – Exxon Valdez, Deepwater Horizon, platform equipment failure, pinhole leaks in pipelines, damage to platforms/rigs from natural disasters, shipwrecks.

2. Intentional discharges. Examples – Pumping bilge waste at sea instead of paying to properly dispose of the waste in port, which is a MARPOL violation (The International Convention for the Prevention of Pollution from Ships).

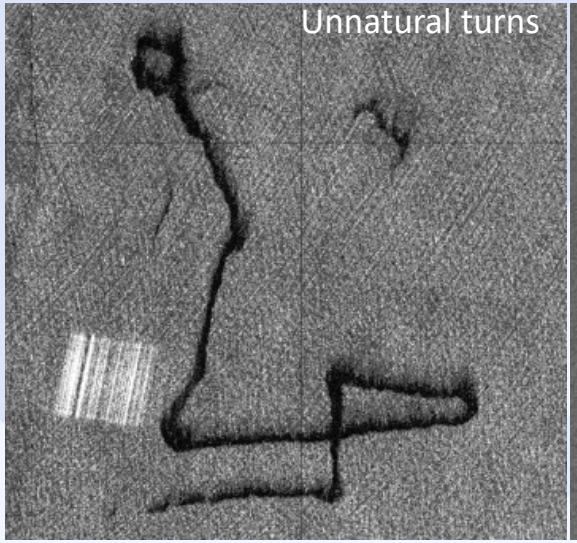
Imagery Type I: Synthetic Aperture Radar (SAR)

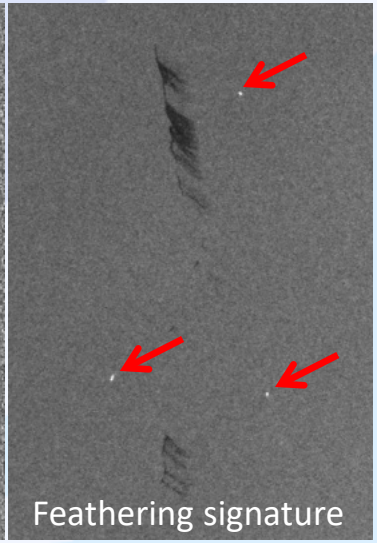
SYNTHETIC APERTURE RADAR

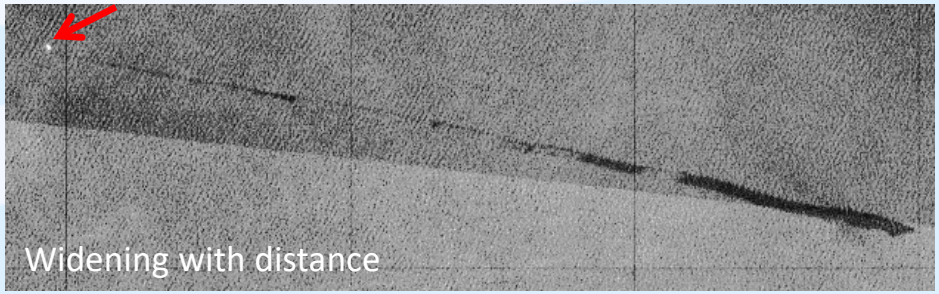
- Sentinel-1A and B (Europe, 5-40m, free)
- Radarsat-2 (Canada, 25-50m)

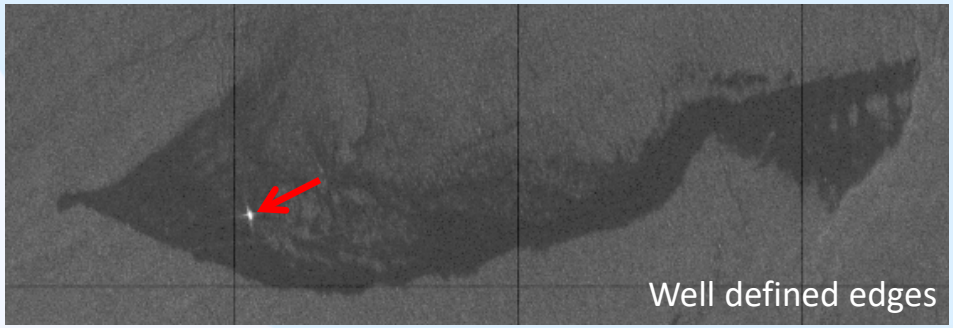


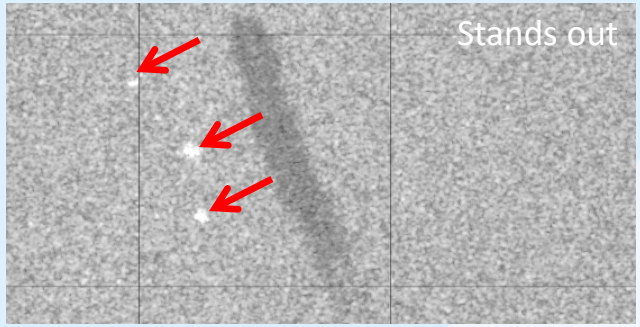
Structures



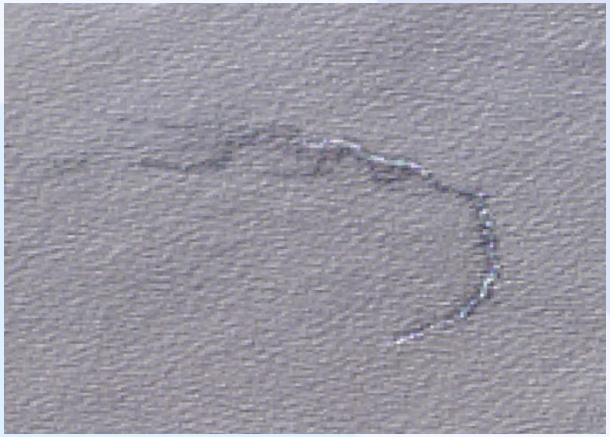




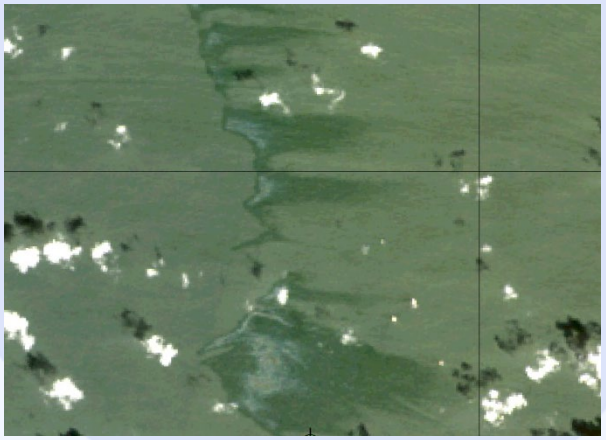




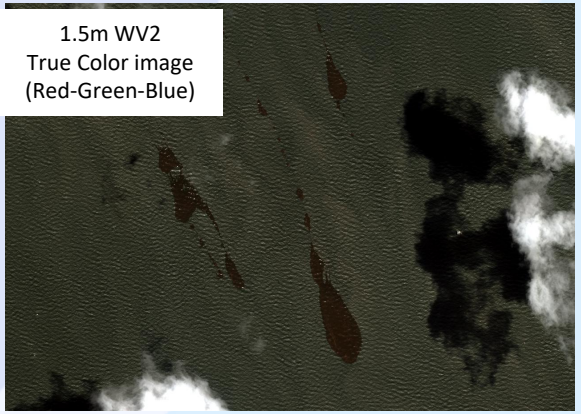
Imagery Type II: Multispectral Optical

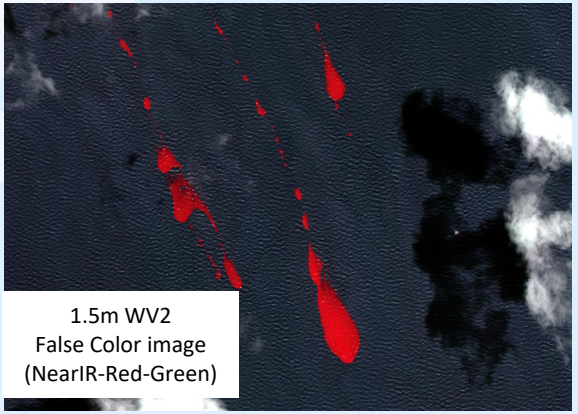


Can appear white and shimmery in sun illumination



Feathering signature





Multispectral OPTICAL

<u>Free</u>

- Sentinel-2A/B (Europe,10m)
- Landsat-7/8 (USGS, 30m)
- MODIS Terra/Aqua (NASA, 250m)
- NPP-VIIRS (NOAA, 375m)

<u>Upon request, free</u>

- ASTER (15m, upon request)

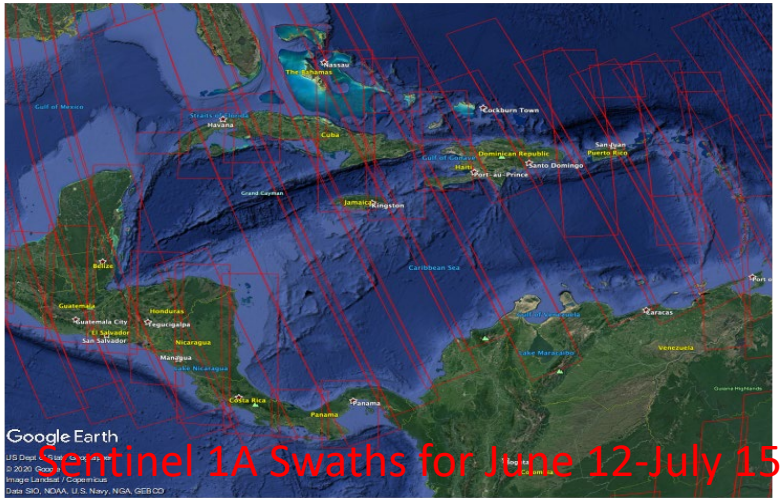
<u>Commercial imagery</u>

Planet Scope (3m)

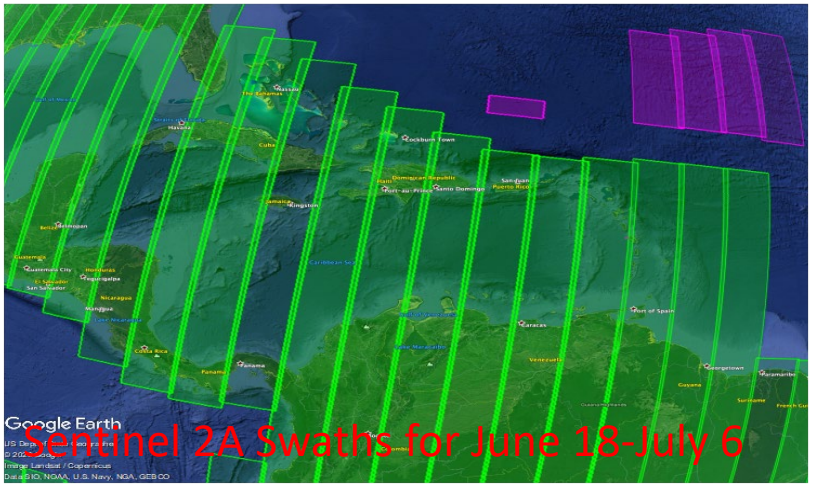
Worldview (2m)

Free sensors with routine coverage for wider Caribbean

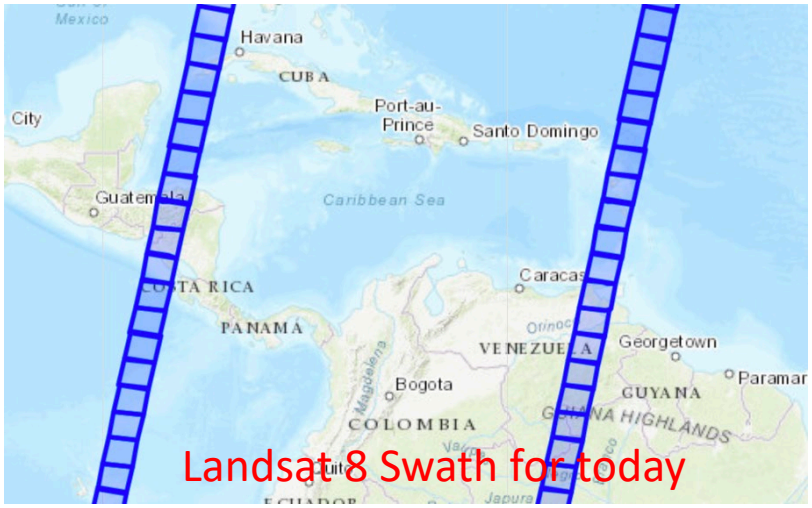
Sentinel 1A and 1B (5-40m res,12 days revisit time)



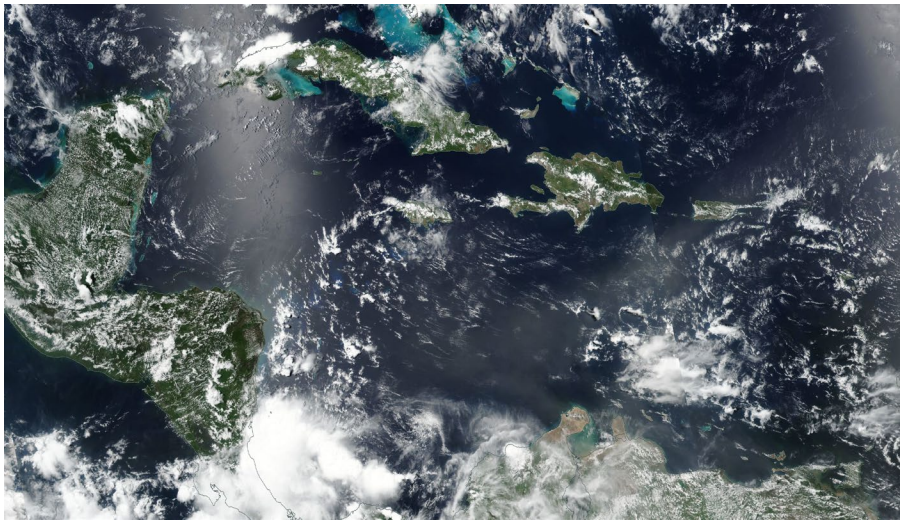
Sentinel 2A/2B (10m res, 10 day revisit time)



Landsat 7/8 (10m res, 16 days revisit time)



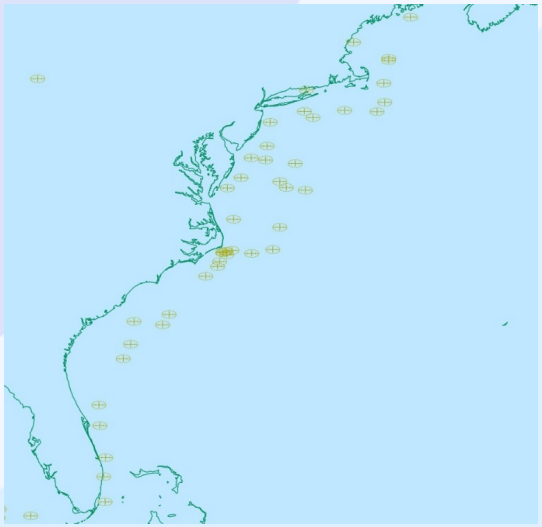
MODIS and VIIRS (250-375m res, daily)

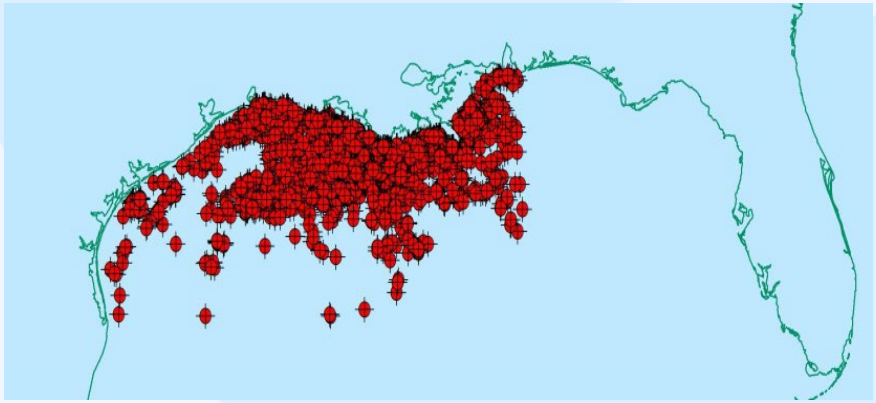


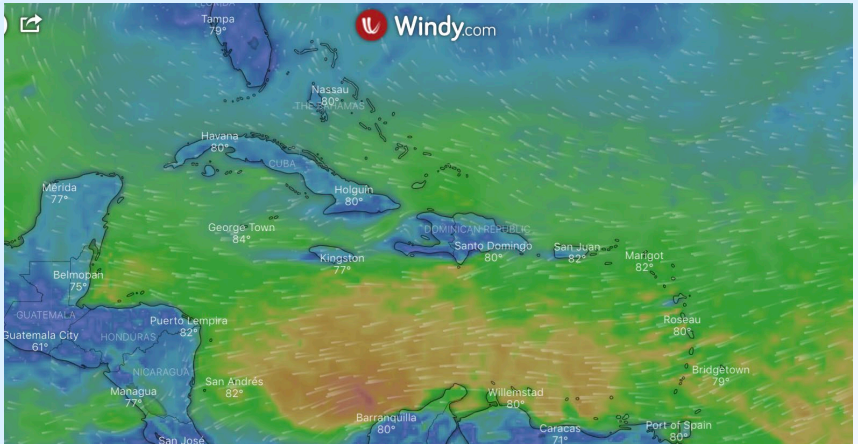
Ancillary Data needed for oil spill monitoring

In addition to satellite images, satellite assessed anomalies are compared against a wide array of ancillary information, including but not limited to

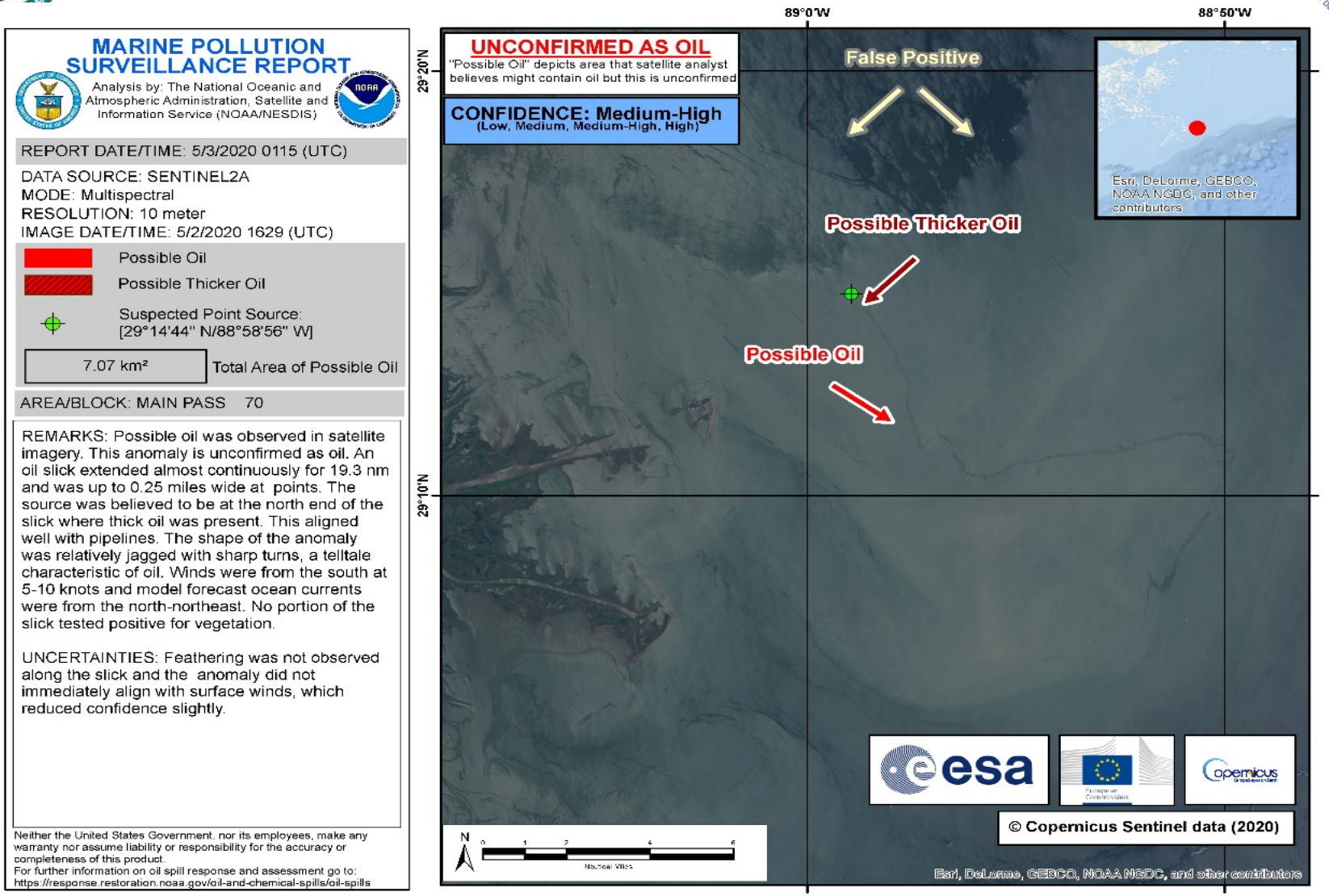
- platforms,
- pipelines,
- Wellheads and boreholes,
- natural oil seeps,
- Shipwreck locations,
- Bathymetry,
- ocean currents and surface winds.







The Marine Pollution Surveillance Report (MPSR)



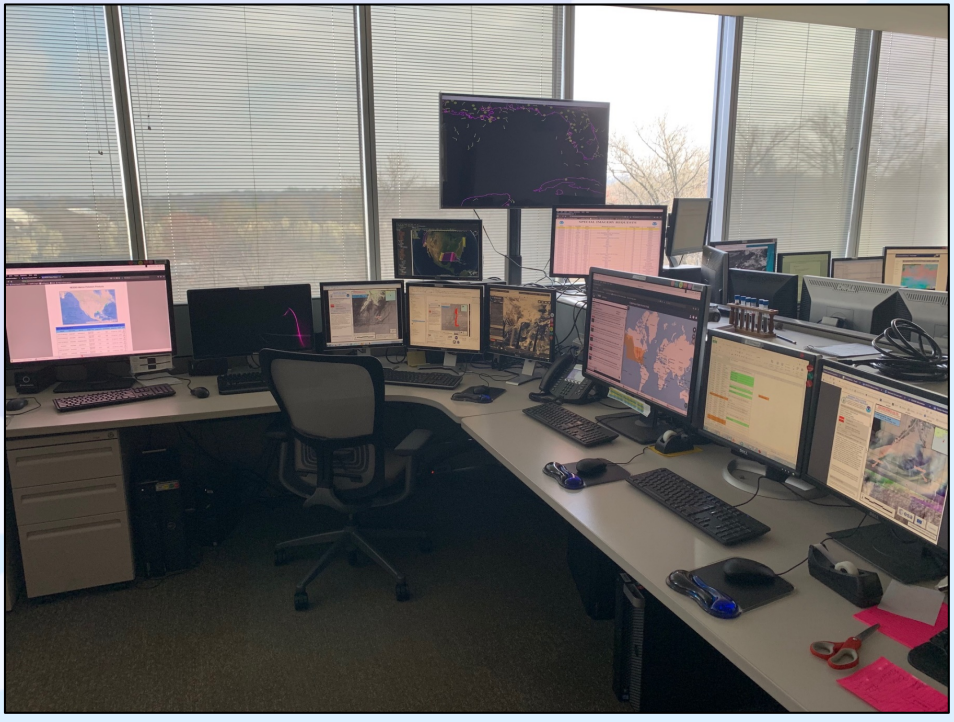
Check the MPSR webpage for latest product and archives

https://www.ospo.noaa.gov/Products/ocean/marinepollution/

Oil Spill Monitoring Set Up @ SAB

Hardware:
3 PC + 3 Linux workstation (2 each minimum considering backup)

Software:
ArcGIS – imagery analysis and MPSR generation
ENVI- imagery analysis
Savoir- satellite swath planner (optional)
SAB-developed product generation toolbox and dissemination scripts (perl and python)
Google earth



Imagery Access (free):
Copernicus Sentinel Hub
USGS Earth Explorer
NASA worldview

Manpower: 3 analyst per day for 24/7 operations. Afternoon (from 1pm-11pm) shift is the busiest.

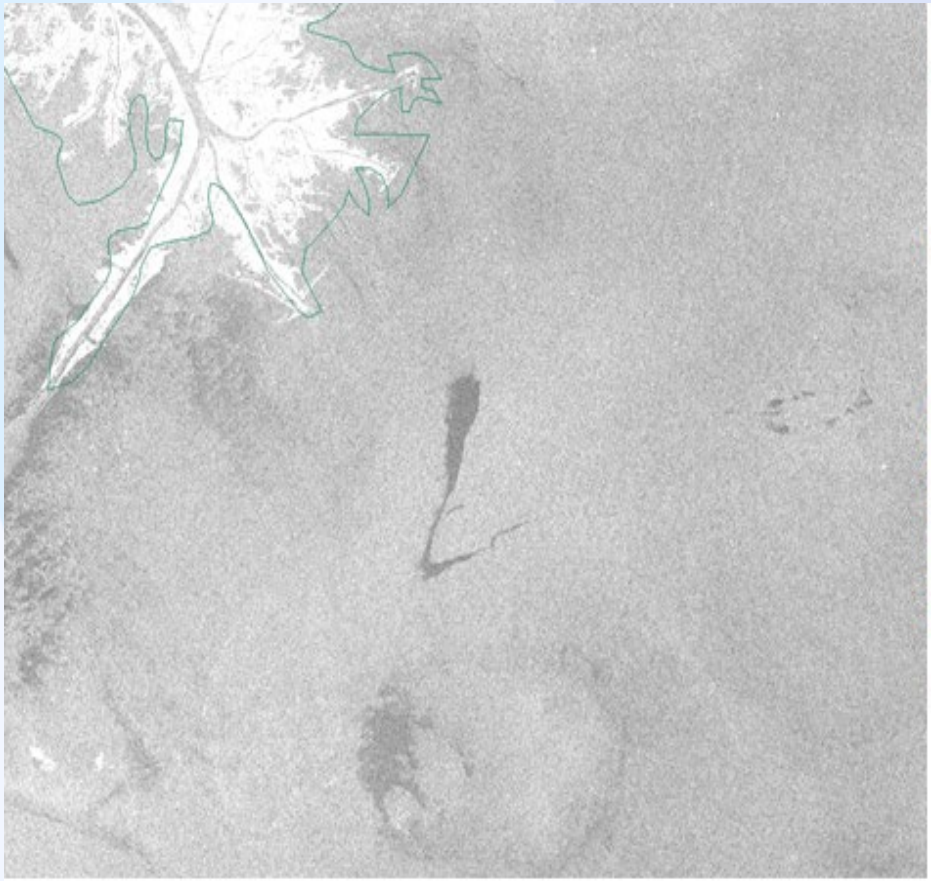
Similar Oil Spill Monitoring Initial Set Up and Budget Estimate for Wide Caribbean

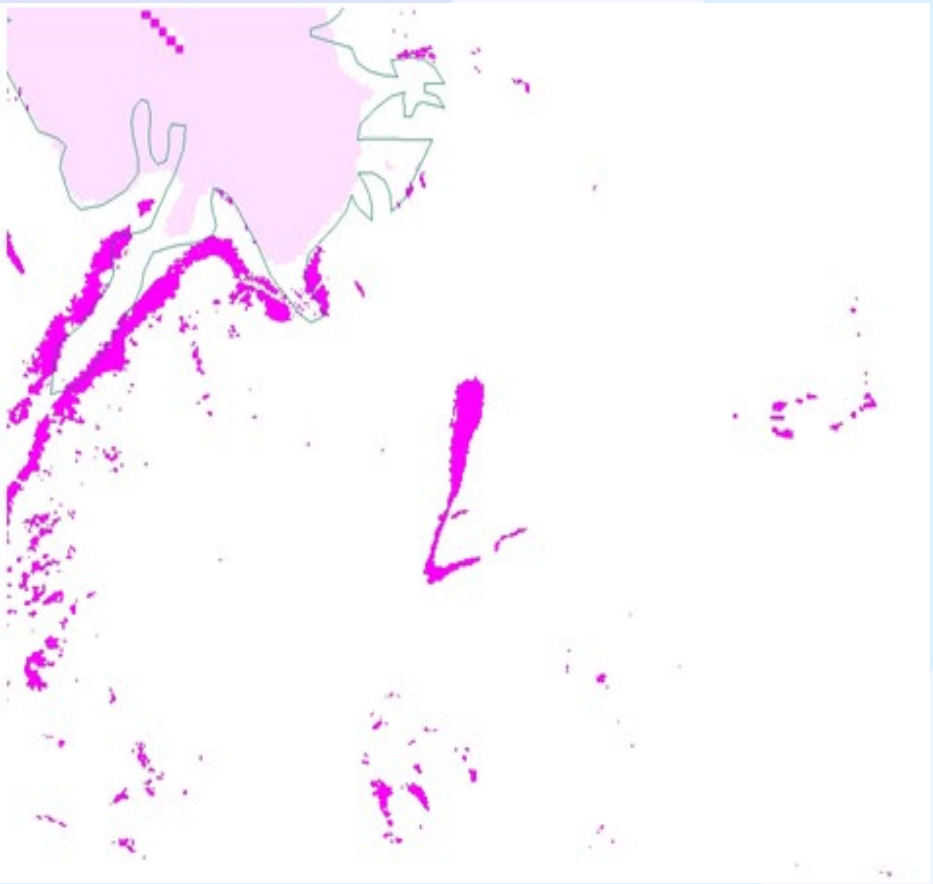
Budget Cost Category	Funding needed
Hardware: Windows PC and Linux workstation (x3) minimum(x2)	$24,000-$35,000
Software 1. ArcGIS license (x3) 2. ENVI/IDL License (x3) minimum(x2)	$30,000-$45,000
Travel 1. SAB to travel to regional host office to set up equipment 2. Travel and housing for Caribbean oil spill monitoring staff to train at SAB for 6 weeks	$50, 000 Utilize virtualization tools, especially during the pandemic?
Regional Staff 1. Satellite Analyst for the Caribbean Sea (1) 2. Satellite Analyst for Central America (1) 3. Satellite Analysts for South America (2)	Benefit and salary for 4 FTE Can we combine some of the regions? 24/7 or only daytime?

TCNNA: An Automated SAR Oil Spill Product

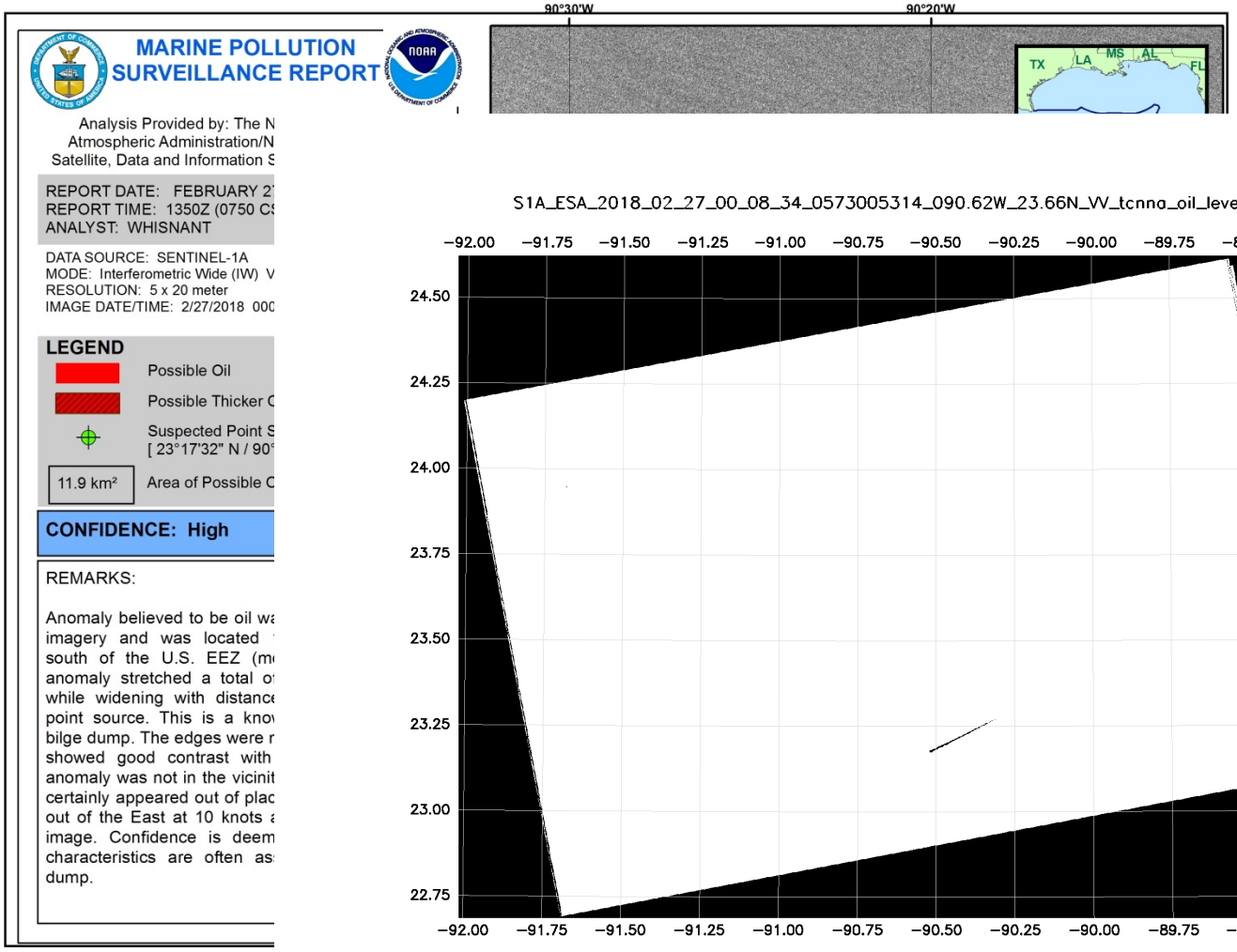
- TCNNA (Texture-Classifying Neural Network Algorithm)
- Product was developed in NESDIS Center for Satellite Applications and Research (STAR) based on the work of Oscar Garcia-Pineda.
- One of the final product is a binary oil mask, where no oil is set to 1 and oil is set to is 0.
- Product has been evaluated at SAB, we found that
  - for oil spill with simpler background (far away from coastline and its sheltering effect, no natural oil seep), the TCNNA works the best.
  - In the Gulf of Mexico where we were evaluating, we see a lot of false positives which still needs manual check from an analyst.

Discharge from MC20 repeat leak source near the coast line



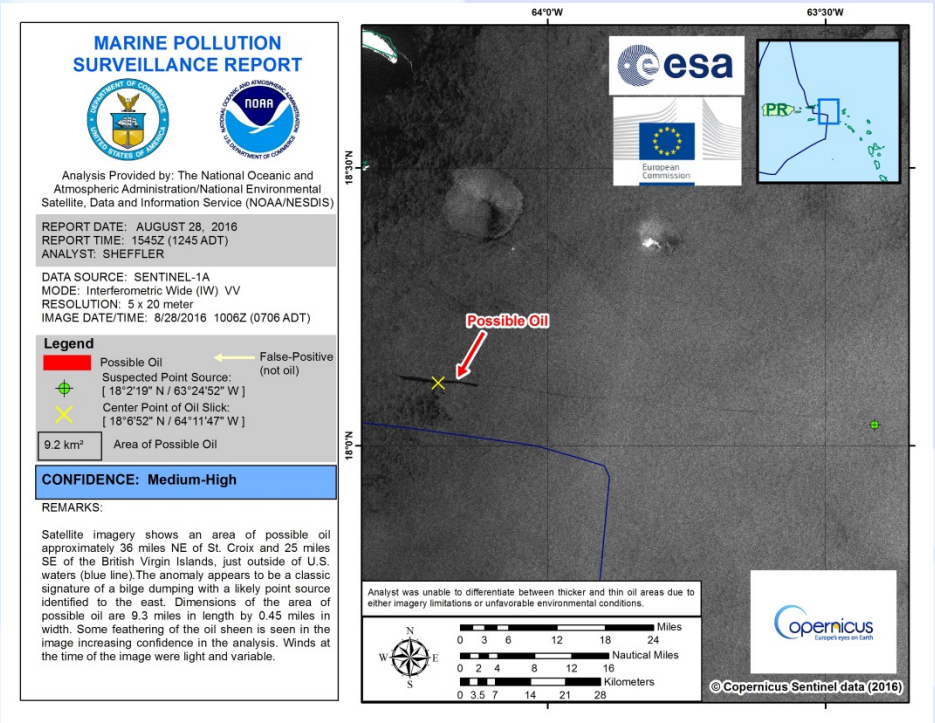


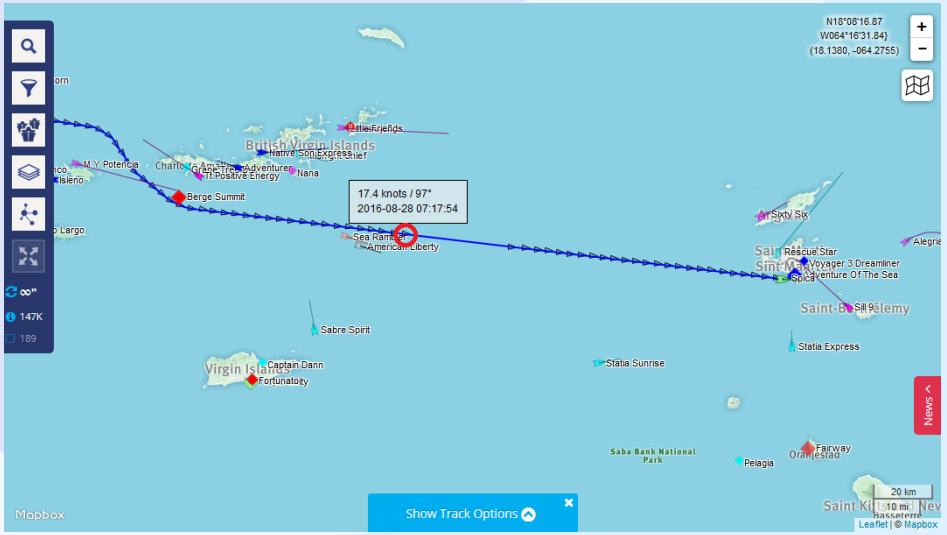
Possible Vessel Discharge Observed in SAR



Possible Oil Spill we have Observed or Assisted for the wider Caribbean region

Possible Bilge Dumping in the region - MARPOL Violations

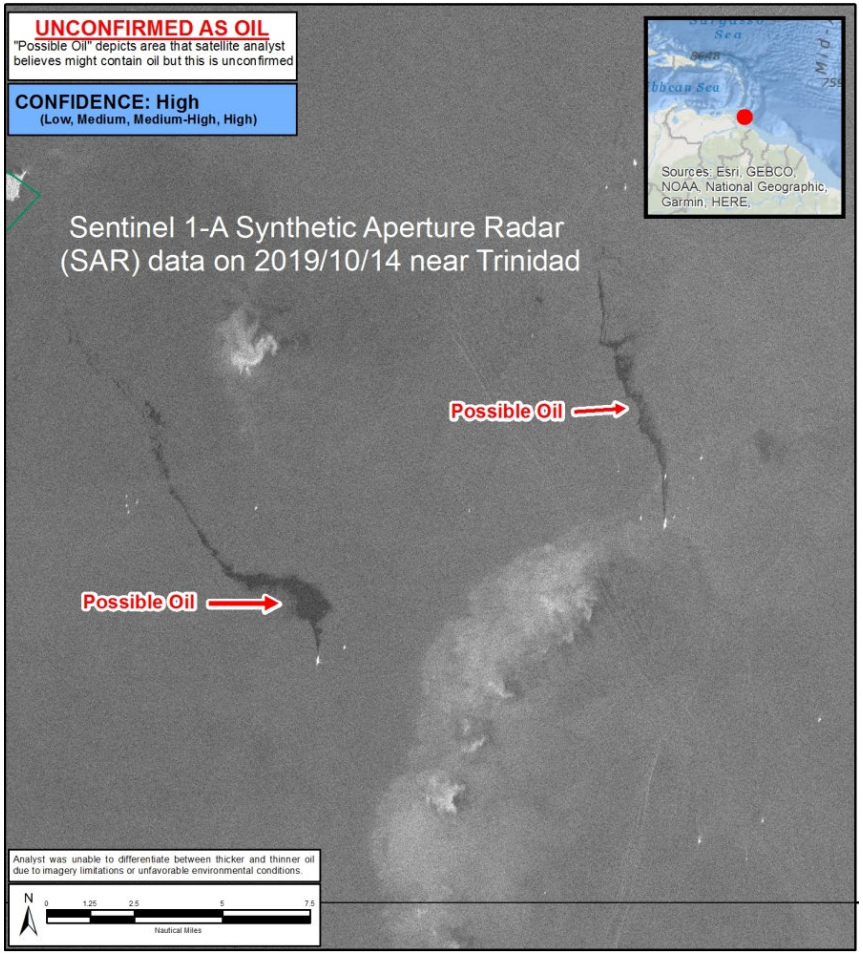




AIS data revealed the beacon was turned off between 0717Z – 0822Z. Sentinel-1A imaged the area at 1006Z.

Possible oil discharge was reported by SAB in the British Virgin Island's waters from a vessel departing Puerto Rico. A cutter investigated and found a light remnant sheen. Coordination was established with the British CG. This discharge is a MARPOL violation (The International Convention for the Prevention of Pollution from Ships).

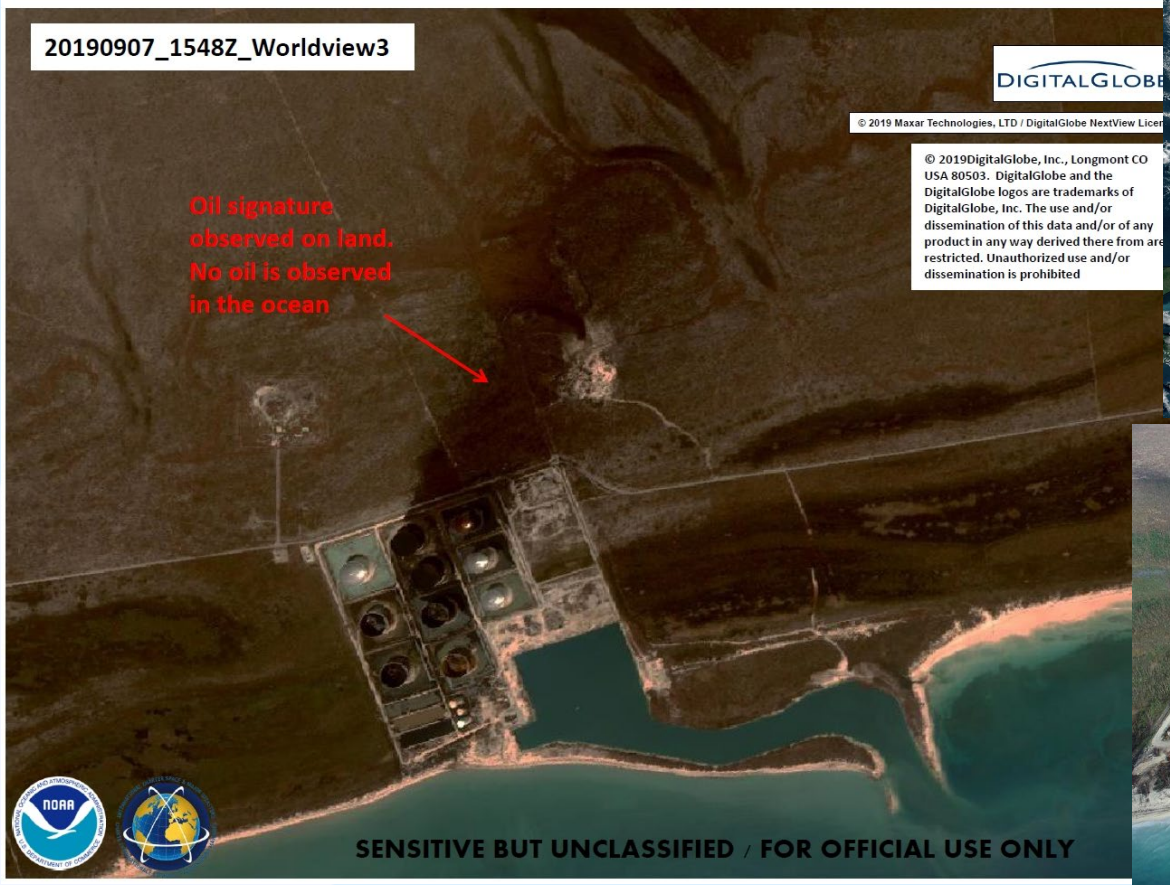
Platform Discharge near Trinidad and Tobago

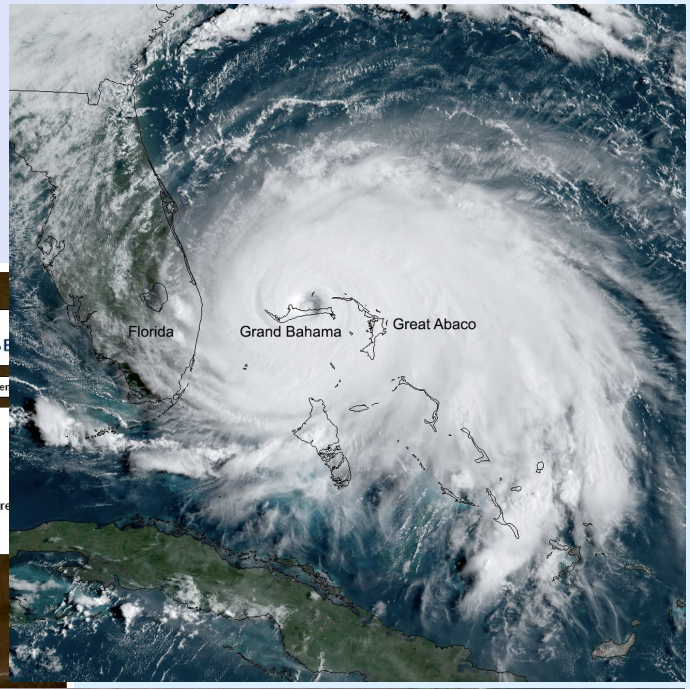


Oil discharge are seen from two nearby platforms at the same time on Oct 14, 2019

Hurricane Dorian's impact on Grand Bahama

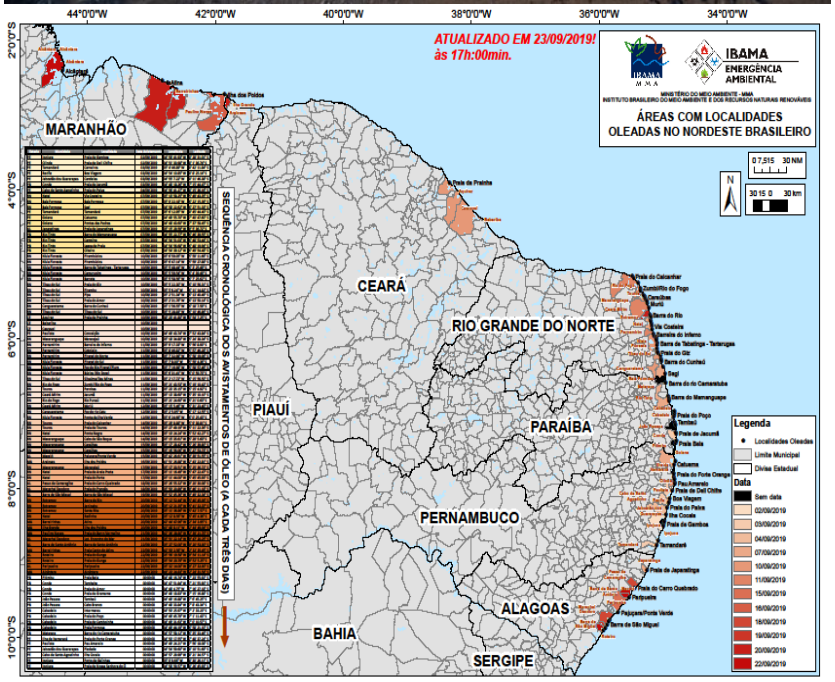
- SAB satellite support for the Equinor Facility's 55000 barrels of oil spill on Grand Bahamas, and conducted surveillance of other open ocean areas for potential spills after Hurricane Dorian in September 2019.



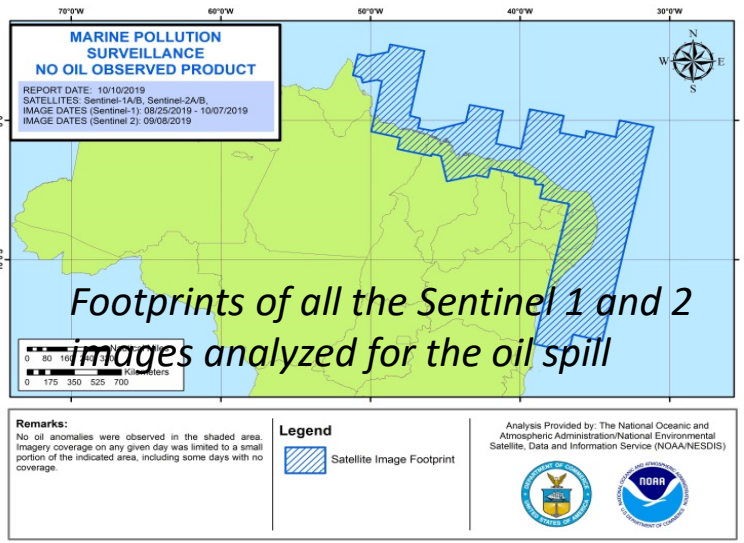


Mystery Brazilian Oil Spill

- On 7 October 2019, a request was received by NOAA via the EPA from the Brazilian Minister of Environment, Ricardo Salles, for support in determining the source of a high impact oil spill spanning across 61 municipalities in 9 states in Brazil, first reported on September 2nd.
- SAB analysts have analyzed Sentinel-1 SAR images and Sentinel-2 high resolution multispectral images for impacted ocean area from late August to early October , no oil signatures were found.



Oil spill found along Brazil's NE beaches



Footprints of all the Sentinel 1 and 2 images analyzed for the oil spill

Questions?
Thank you

Possible Intentional Bilge Dump in the region - MARPOL Violations

MARINE POLLUTION SURVEILLANCE REPORT

Analysis by: The National Oceanic and Atmospheric Administration, Satellite and Information Service (NOAA/NESDIS)

REPORT DATE/TIME: 5/9/2019 1102 (UTC)

DATA SOURCE: SENTINEL1A
MODE: Interferometric Wide (IW) VV
RESOLUTION: 20 meter
IMAGE DATE/TIME: 5/08/2019 1102 (UTC)

Possible Oil

Possible Thicker Oil

Suspected Point Source: [24°45'38" N/75°55'11" W]

3.15 km² Total Area of Possible Oil

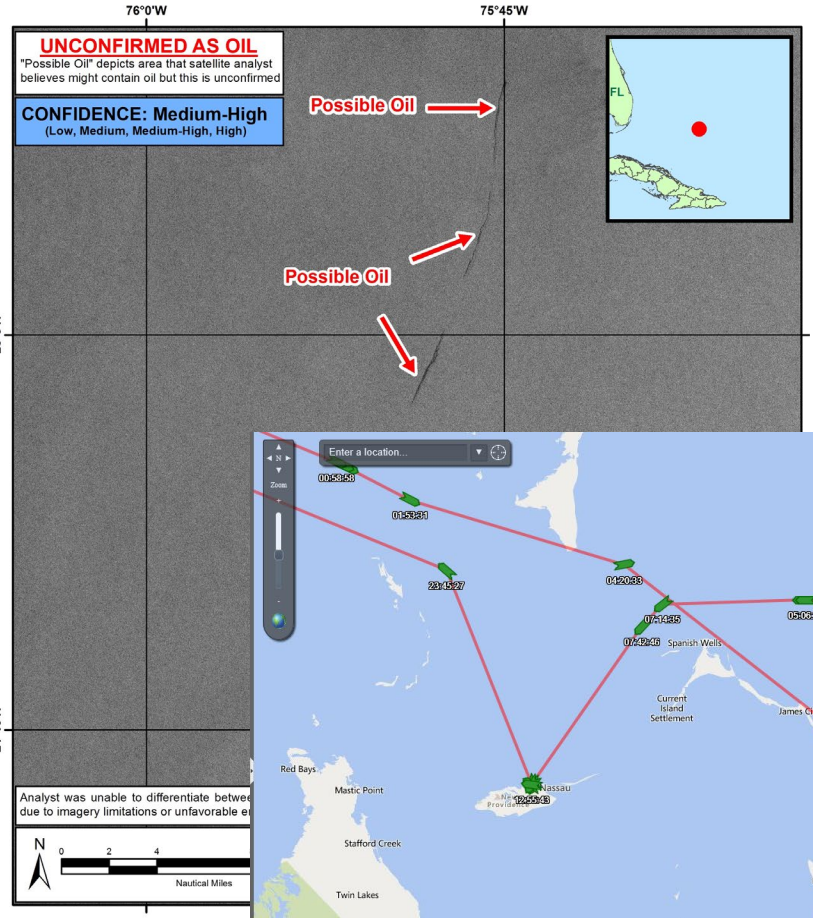
AREA/BLOCK: N/A

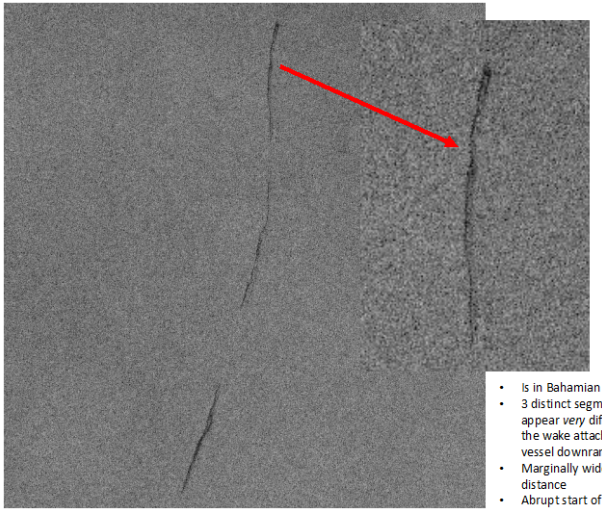
REMARKS: Possible oil was observed in satellite imagery. This anomaly is unconfirmed as oil. Please note this image is greater than 24hrs old. A possible vessel discharge was identified in Bahamian waters that measured 14 miles in total length, but was separated into 3 distinct segments. The anomaly marginally widened with distance, exhibited good contrast against the ocean background, and was removed from natural phenomena. It did not appear consistent with a vessel wake. Winds were from the east at 10 knots.

UNCERTAINTIES: The feature was not directly connected to the suspected source, it did not appreciably widen with distance, and it did not exhibit feathering (wind direction might not have been conducive)

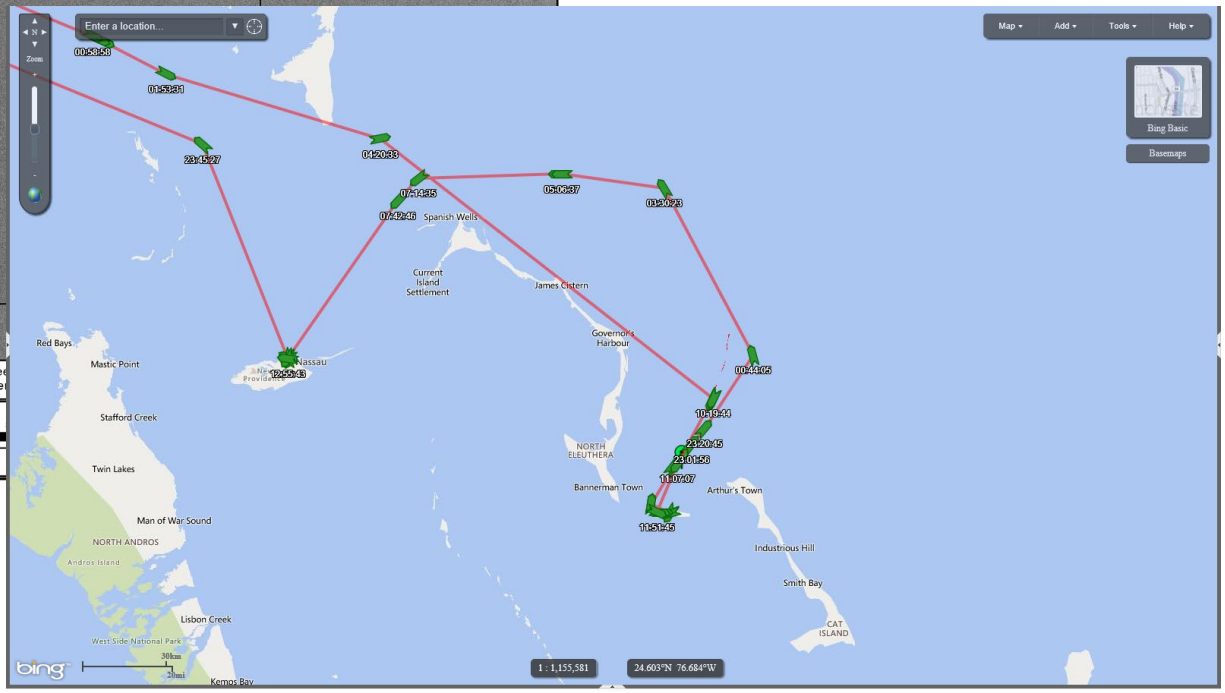
ANALYST: RAMIREZ

For further information on oil spill response and assessment go to: https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills





- Is in Bahamian waters
- 3 distinct segments, which appear *very* different from the wake attached to the vessel downrange
- Marginally widens with distance
- Abrupt start of the feature



Illegal Vessel Discharges….MARPOL violations

- **Background**: Satellite analysis groups (EMSA, ISTOP, SAB, etc) are experienced and effective with this. A few high profile cases deter illegal dumping by others.
- **Way forward?:** SAB would be happy to provide training and advice about how to most effectively monitor; for example, much ship dumping occurs shortly after sunset, in the hopes that they will escape detection since the oil will disperse before sunrise.
- **Essential component**: Satellite analysts need to immediately contact Coast Guard (or in some nations Navy) personnel and those personnel need to have awareness of the satellite analysis oil product.
- **Follow-through**: Coast Guard personnel can either intervene while the ship is at sea (e.g., boarding, overflights) or identify the vessel and when it arrives in port, board and inspect it for MARPOL violations (sometimes, dramatically, with the satellite image in hand).