Supporting Trinidad and Tobago's Creation of a Satellite Oil Spill Monitoring Program

Training, transitions to operations and future plans

IGM19/COP16
July 28th, 2021

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Presentation Highlights

- Several US and Caribbean regional partners have collaborated with Trinidad and Tobago government to establish a pilot program to use satellite remote sensing to monitor oil spills.
- 18 people from three Trinidad and Tobago government agencies have completed a US NOAA-led satellite oil spill monitoring virtual training course, during the period of May 17th to July 9th 2021.
- On July 1st 2021, Trinidad and Tobago has started monitoring near real time oil spill incidents and issuing reports for their Exclusive Economic Zone.

Background

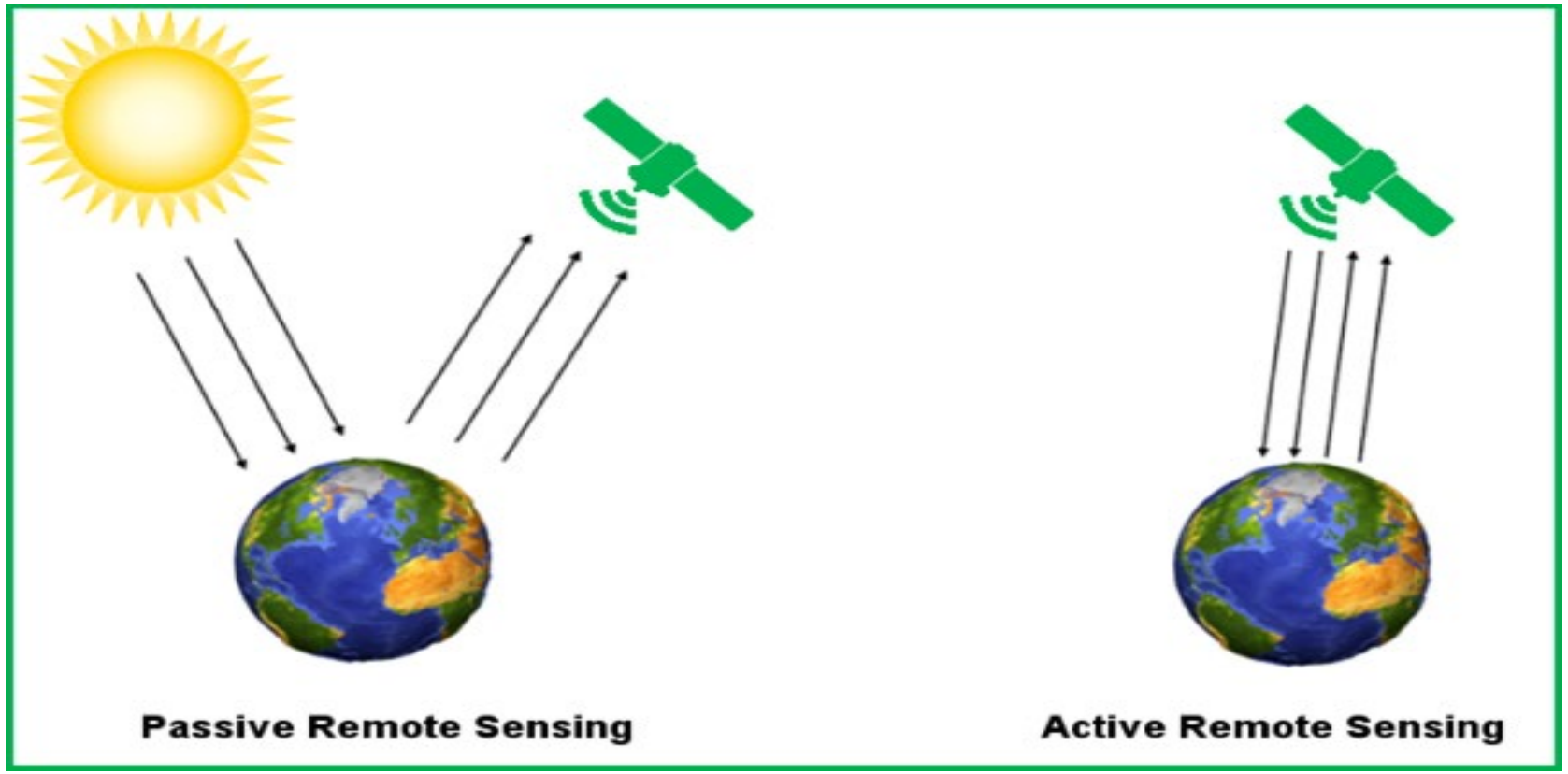
Oil Spill Incidences in the region

- Like many other parts of the world, the Wider Caribbean Region, while renowned for its pristine beaches, blue ocean and robust tourism, has faced the challenges of many oil spill incidents or near misses in recent years. Examples include large oil spills in Trinidad and Tobago in 2014, the mysterious oil spill off the Brazilian coast in 2019, Equinor storage facility spill after Hurricane Dorian in Grand Bahamas and the stranded oil tanker Nabarima.
- Illegal dumping of oil-contaminated waste by ships operating in the region is also a common occurrence.
- The ecosystem impact and economic cost of the marine oil spill is vast and can be long-term.

Satellite monitoring, a proven, timely and cost-effective way to monitor oil spills

- With the ability to image large areas with ever increasing spatial resolutions and shorter revisit times, satellite remote sensing of oil spills is a proven and effective way to monitor.
- Publicly available free satellite imagery with high enough spatial resolution (~10 meter) to monitor the spill is available.
- Various government agencies and institutions in the US, Canada, Europe and central America (Mexico) are leveraging the imagery as part of monitoring programs for their respective regions, including the Satellite Analysis Branch from US National Oceanic and Atmospheric Administration (NOAA).

Imaging Types for Oil Spill Monitoring



https://grindgis.com/remote-sensing/active-and-passive-remote-sensing

Optical Sensor
Need cloud free condition, day time imaging, more color/thickness information

Synthetic Aperture Radar (SAR)
24/7 day/night, can see through clouds, grayscale imagery

Routine Satellite Data

Free, openly-available data

Passive sensor data (Optical)

- Landsat 7 & 8 (US Geologic Survey)
- Sentinel-2A & 2B (ESA/Copernicus)
- MODIS on Aqua & Terra(US NASA)
- VIIRS on S-NPP/NOAA-20 (US NOAA)
- ASTER on Terra (US NASA/JAL)

Active sensor data (SAR)

- Sentinel-1A & 1B (ESA/Copernicus)

Commercial data

Passive sensor data (Optical)

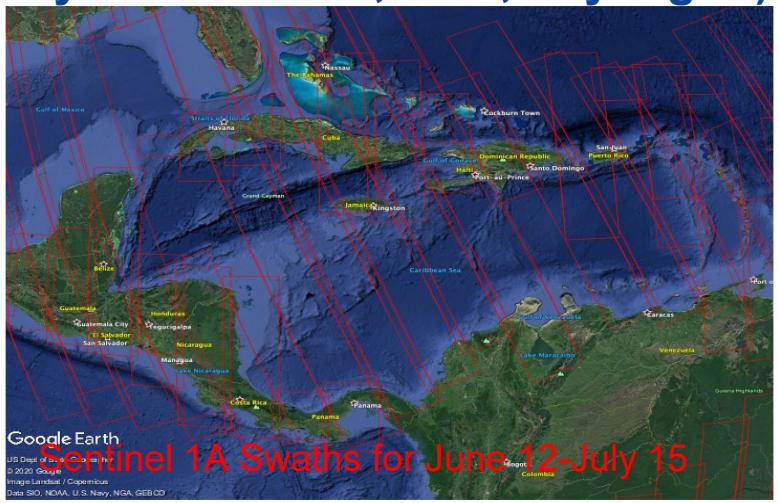
- PlanetScope (Planet Labs, US.)
- Worldview-2,3 (MAXAR, US)
- Pleiades(CNES, France) & others

Active sensor data (SAR)

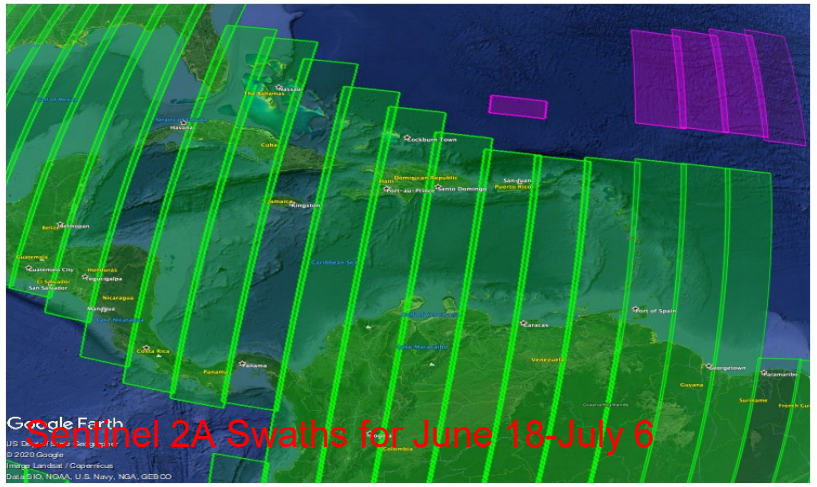
- Radarsat-2 (MDA, Canana)
- TerraSAR-X (DLR, Gemany)
- COSMO-SkyMed (ASI, Italy)
- ALOS-2, Kompsat-5 & others

Free sensors with routine coverage for wider Caribbean

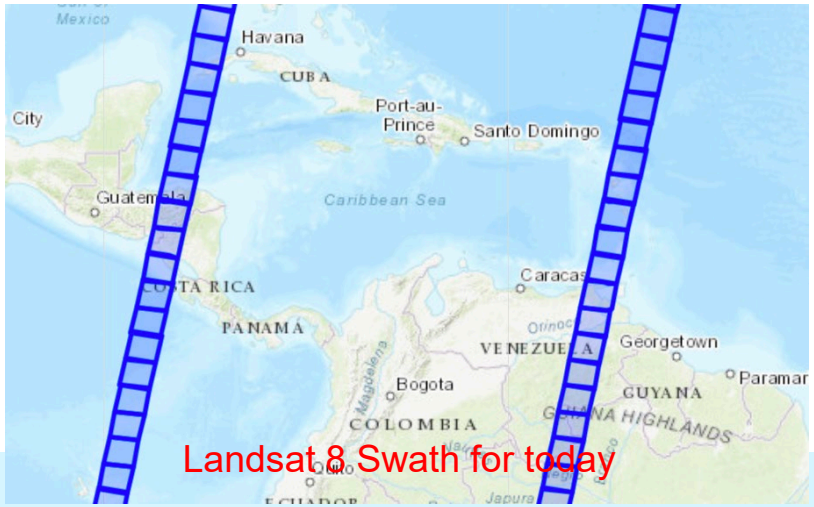
Sentinel 1A and 1B (5-40m res,12 days revisit time, SAR, day/night)



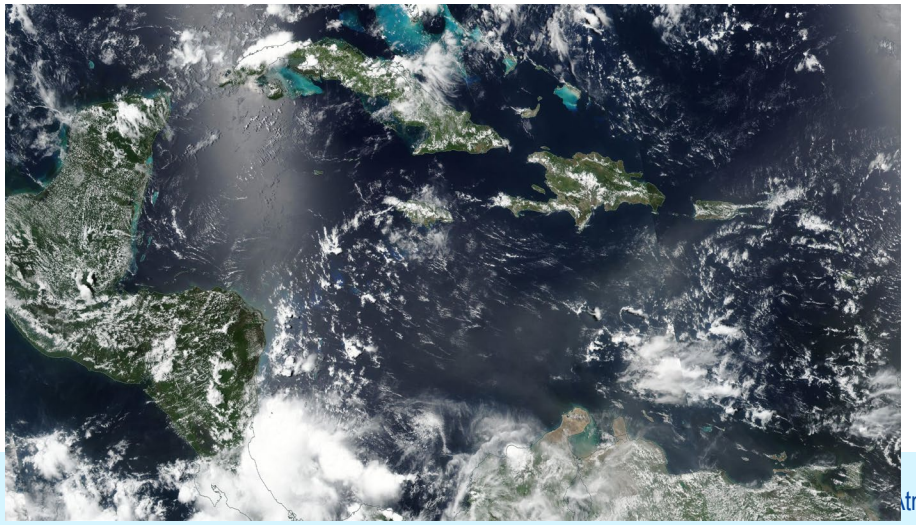
Sentinel 2A/2B (10m res, 10 day revisit time, optical, cloud free day)



Landsat 7/8 (30m res, 16 days revisit time, optical, cloud free day)



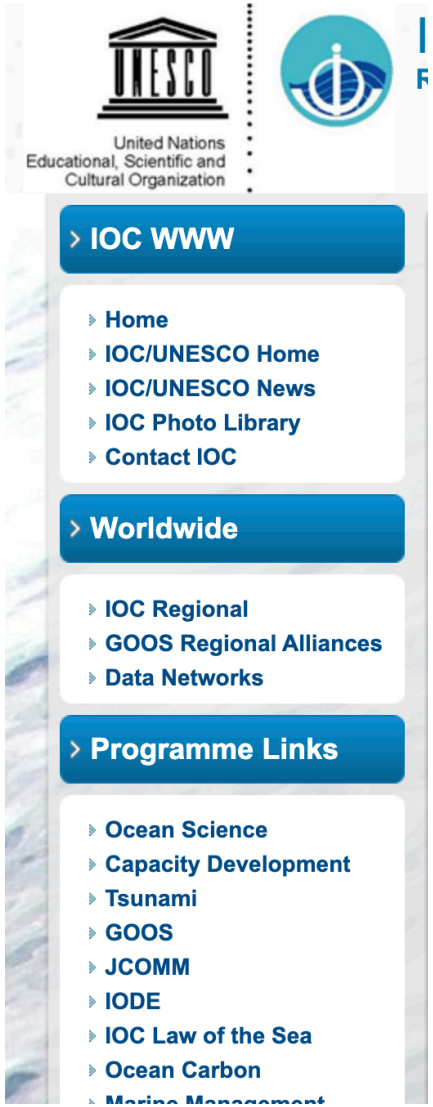
MODIS and VIIRS (250-375m res, sun glint area)



Project Partners

The 2018 workshop on Caribbean oil spill and sargassum monitoring

- The meeting was organized by GEO Blue Planet and IOC UNESCO
- During the meeting, the participants from many Caribbean countries expressed a strong interest in setting up a regional Caribbean-wide oil spill monitoring system



Presentations

Agenda #	Code	Title	Author	Upd. On
		The NOAA-NESDIS Satellite Monitoring of Marine Oil Program	Alexandra Rodriguez	16/08/18
		Summary of Presentations	Cesar Toro	16/08/18
		Management of oil spill in OECS and Wider Caribbean	Christopher Williams	15/08/18
		Sargassum Watch from Space	Chuanmin Hu	16/08/18
		Sargassum Group Report	Doug Wilson	16/08/18
		Project Introduction	Doug Wilson	15/08/18
		Marine Environmental Emergencies Response – International Context of Coordination	Edgard Cabrera	15/08/18
		Oil Spill Breakout Summary	Emily Smail	16/08/18
		Ocean and Coastal Observations for Societal Benefit - The GEO Blue Planet Initiative	Emily Smail	15/08/18
		Data Downstream Services in Support of Decision Making Operational Spill. Emergency Response and marine Resource Management	Eric Comerma	15/08/18
		The Marine Biodiversity Observation Network (MBON)	Frank Muller-Karger	15/08/18
		Smart Response Systems Architecture	Gianluca Luraschi	16/08/18
		Overview of the GOOS Regional Alliances (GRAs)	Glenn Nolan	15/08/18
		Oil Spill Impacts and Management in the Caribbean and Adjacent Regions	Ileana Lopez	15/08/18
		Environmental Response Data Visualization and Modeling of Oil Spills	Jay Coady	16/08/18
		Sargassum related products from Atlantic OceanWatchat NOAA-AOML	Joaquin Trinanes	15/08/18
		An Introduction to NOAA - AOML Sargassum Tracking Experiments	Joaquin Trinnanes and Gustavo Goni	16/08/18
		Numerical Modelling at Centro de Ciencias de la Atmosfera - UNAM	Jorge Zavala Hidalgo	16/08/18
		Oceanographic Observational Platforms, Baseline Studies, Model Simultaions and Scenarios of the Natural Response to Large-Scale Oil Spills in the Gulf of Mexico	Julio Sheinbaum	15/08/18
		Regional Marine Pollution Emergency Information and Training Center	Keith Donough	16/08/18

Regional Caribbean and International partners

- GEO Blue Planet Initiative
- IOCARIBE IOC UNESCO
- RAC-REMPEITC Caribe

Project role:

- Regional coordination and networking
- Help the group identify and connect to regional stakeholders and users to establish oil spill monitoring and aid in dissemination of the product

Why Trinidad and Tobago?

- Trinidad and Tobago is the leading Caribbean producer of oil and gas. Oil and gas account for about 40% of GDP and 80% of exports.
- There are extensive oil infrastructures(platforms, pipelines) in the Gulf of Paria and also to the east of the Trinidad Island. Oil spill incidences from oil facilities and vessels are not uncommon occurrences. Larger oil spills occurred in 2013, 2014, 2017 and there is also the latest 2020 Nabarima scare.
- Satellite oil spill monitoring capability is something Trinidad and Tobago agencies have for a long time wanted to develop.

Trinidad and Tobago (TT) Project Partners

- Institute of Marine Affairs (IMA)
- Ministry of Energy and Energy Industries (MEEI)
- Environmental Management Authority (EMA)

Project role:

- Provide personnel, computers and software for the training.
- Coordinate between three agencies to perform near real time oil spill monitoring and issuing reports.

Main US Partner to provide training and support

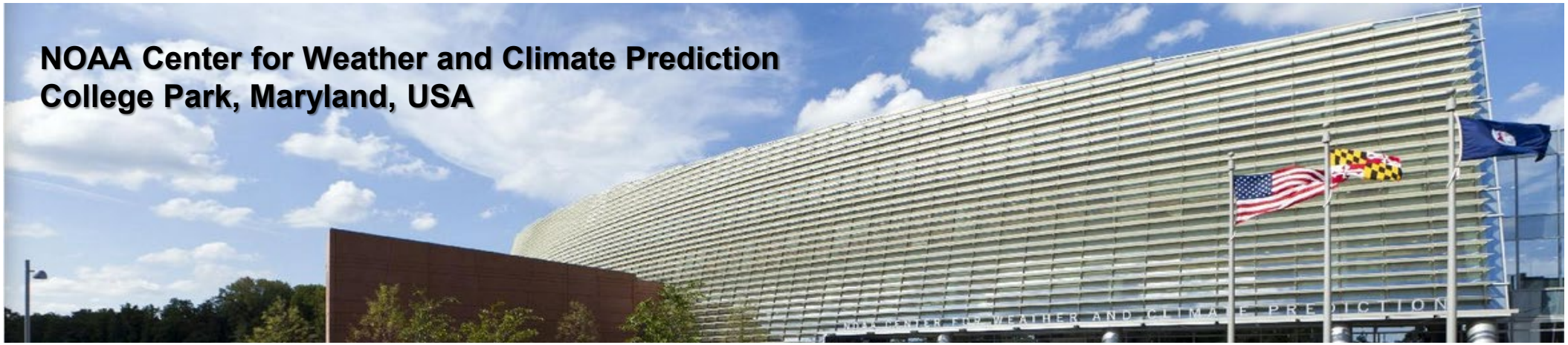
- Satellite Analysis Branch (SAB) from National Oceanic and Atmospheric Administration (NOAA)

Project Role:

- Guidance about hardware, software and procedures setup tailored to the budget and needs of the pilot project agency
- Provide comprehensive training to local staff members to produce satellite oil spill analysis reports.
- Expert guidance and support on satellite detection of oil spills.

NOAA Satellite Analysis Branch (SAB)

- Oil Spill 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.
- As of 1 March 2018, MPSRs are published to the web and publicly available
  - https://www.ospo.noaa.gov/Products/ocean/marinepollution/



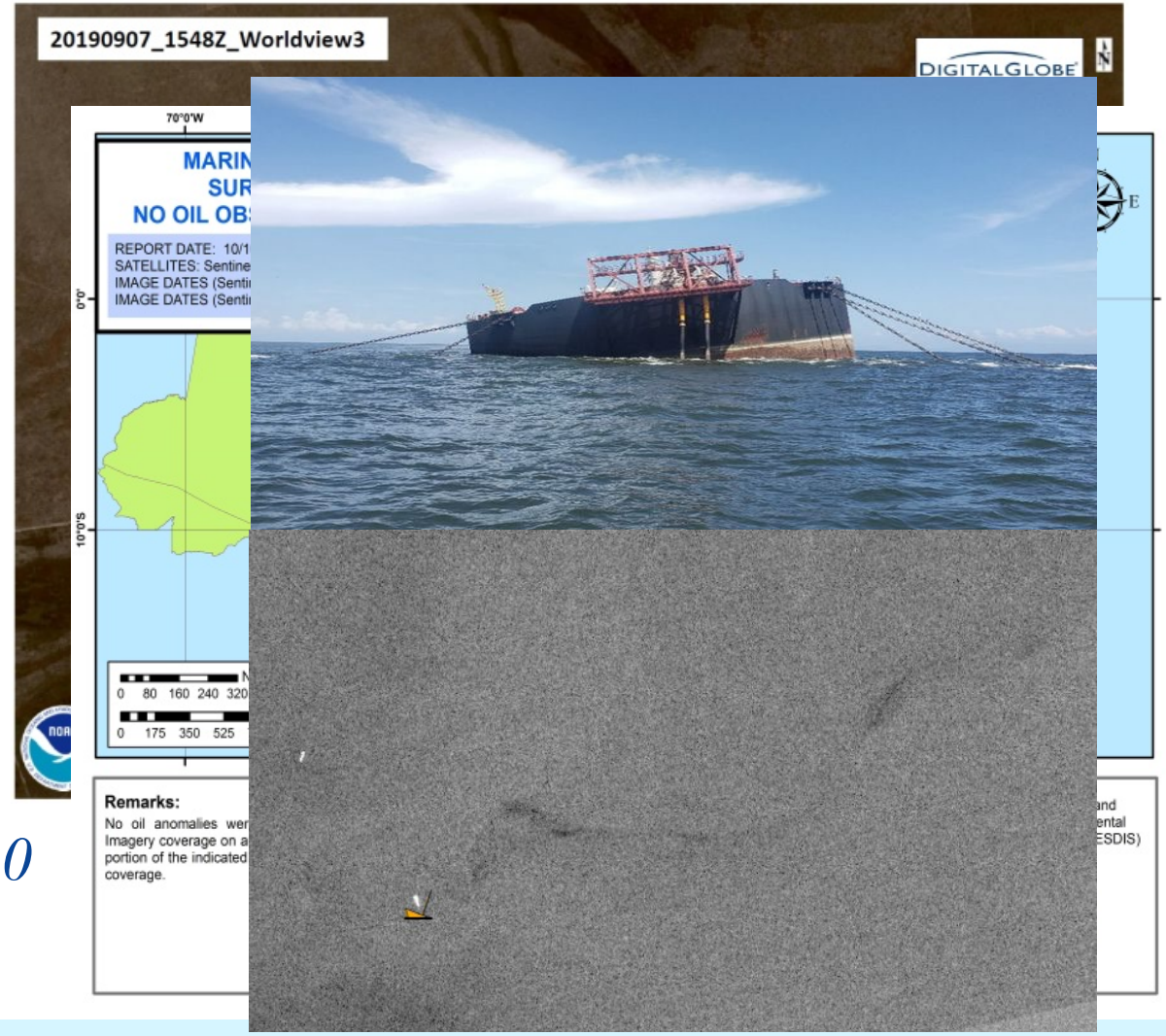
Previous event based oil spill support for wider Caribbean

- When formal requests via US State Dept and NOAA/NOS are received, SAB can provide event based satellite oil spill support in areas outside the US EEZ including the Wider Caribbean region.
- SAB has supported the following recent events in the region for the last few years

➢ *Grand Bahamas Equinor facility oil spill after Hurricane Dorian, 2019*

➢ *Mystery Oil Spill off Brazil, 2019*

➢ *FSO Nabarima scare,late 2019- early 2020*



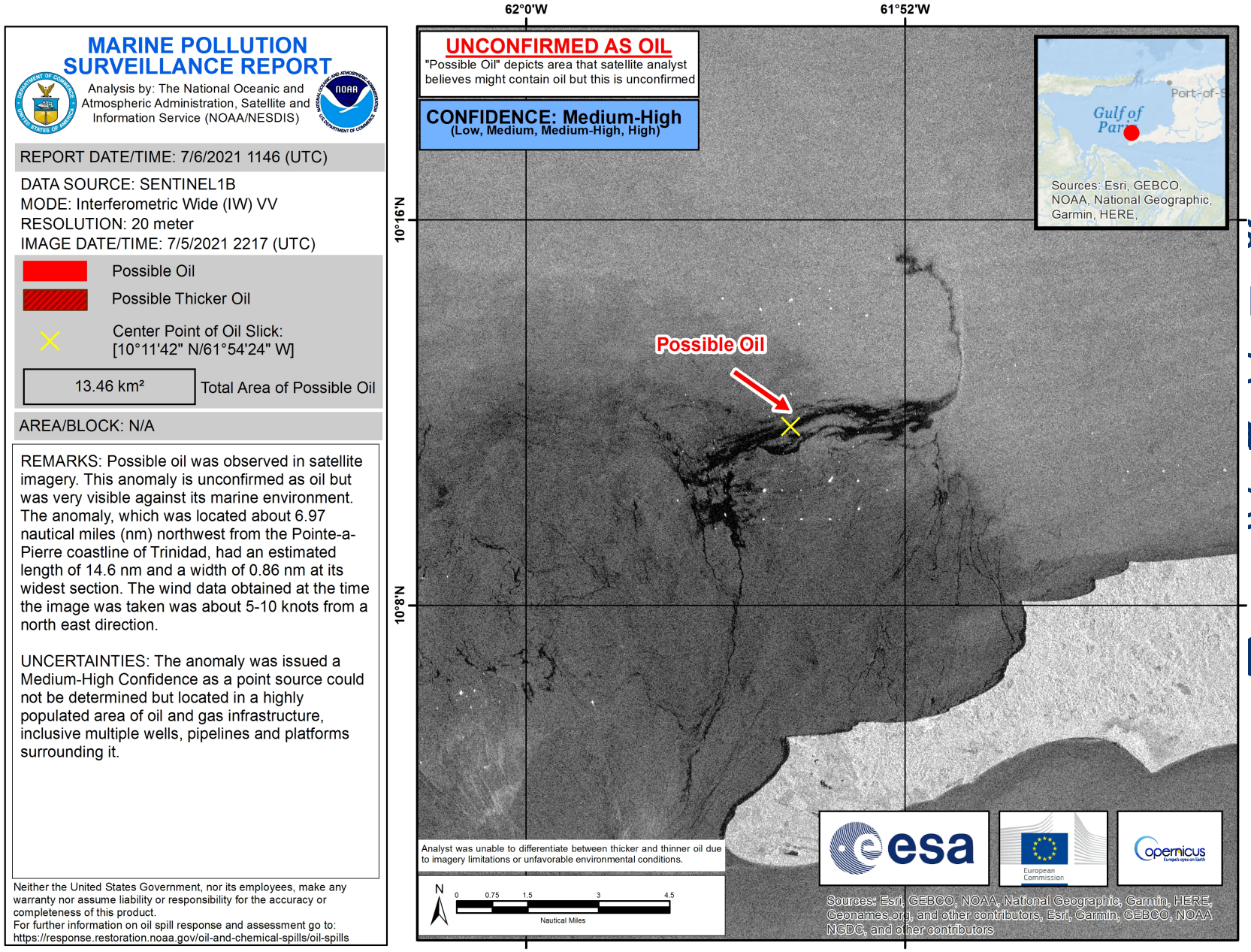
Satellite Oil Spill Virtual training

2021/05/17-2021/07/09

Training schedule, groups and format

- 5 trainers from SAB, and 18 trainees divided into 3 groups from IMA, MEEI and EMA participated in the virtual Webex training.

Group 1	Group 2	Group 3	Friday Group1,2,3 Q&A plenary for the week
Monday Morning 8:30-12:30 (trainer A)	Monday afternoon 1:00-5:00 (trainer A)	Tuesday Morning 8:30-12:30 (trainer A)	Trainer A + Trainer B will be present to answer questions
Wednesday morning (Trainer B) 8:30-12:30	Wednesday afternoon (Trainer B) 1:00pm-5:00pm	Thursday morning (TrainerB) 8:30-12:30	



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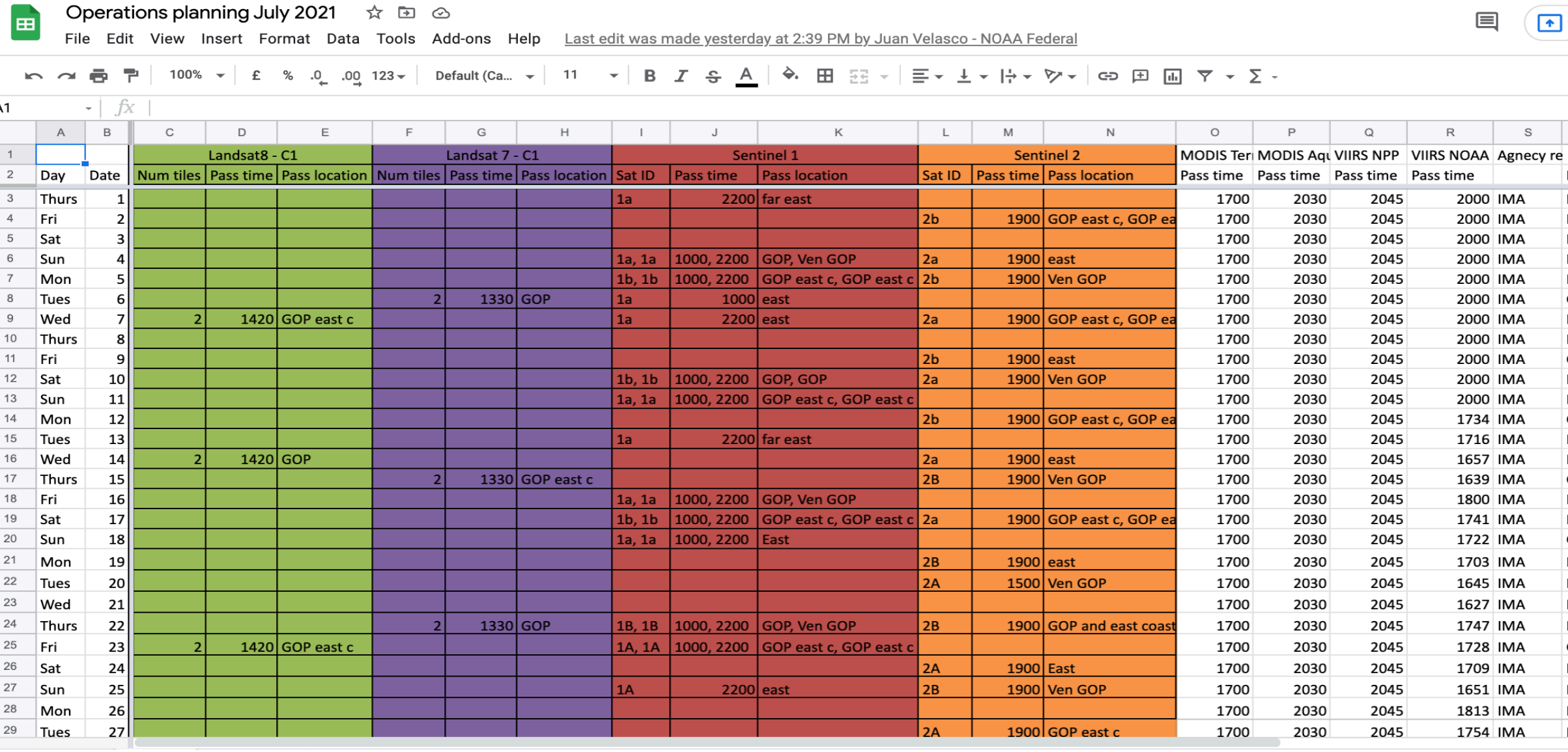
Near Real Time monitoring and support

TT Oil Spill Monitoring has Started!

- IMA has started the near real time oil spill monitoring on July 1st, one week before the training ended.
- The plan is that after IMA has done the initial set up and has accumulated some experience with real time monitoring, the three Trinidad and Tobago agencies will coordinate and rotate monitoring on a weekly basis.
- NOAA SAB is providing support for the dates where TT EEZ has imagery. TT analysts consult with SAB analysts through email, phone and Webex meetings. The oil spill report, imagery log and operational logs are shared.

Satellite imagery covering TT EEZ in July



Operations planning July 2021

File Edit View Insert Format Data Tools Add-ons Help Last edit was made yesterday at 2:39 PM by Juan Velasco - NOAA Federal

			Landsat8 - C1			Landsat 7 - C1			Sentinel 1			Sentinel 2			MODIS Ter	MODIS Aqu	VIIRS NPP	VIIRS NOAA	Agnecy re
	Day	Date	Num tiles	Pass time	Pass location	Num tiles	Pass time	Pass location	Sat ID	Pass time	Pass location	Sat ID	Pass time	Pass location	Pass time	Pass time	Pass time	Pass time	
3	Thurs	1							1a	2200	far east				1700	2030	2045	2000	IMA
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24	Thurs	22				2	1330	GOP	1B, 1B	1000, 2200	GOP, Ven GOP	2B	1900	GOP and east coast	1700	2030	2045	1747	IMA
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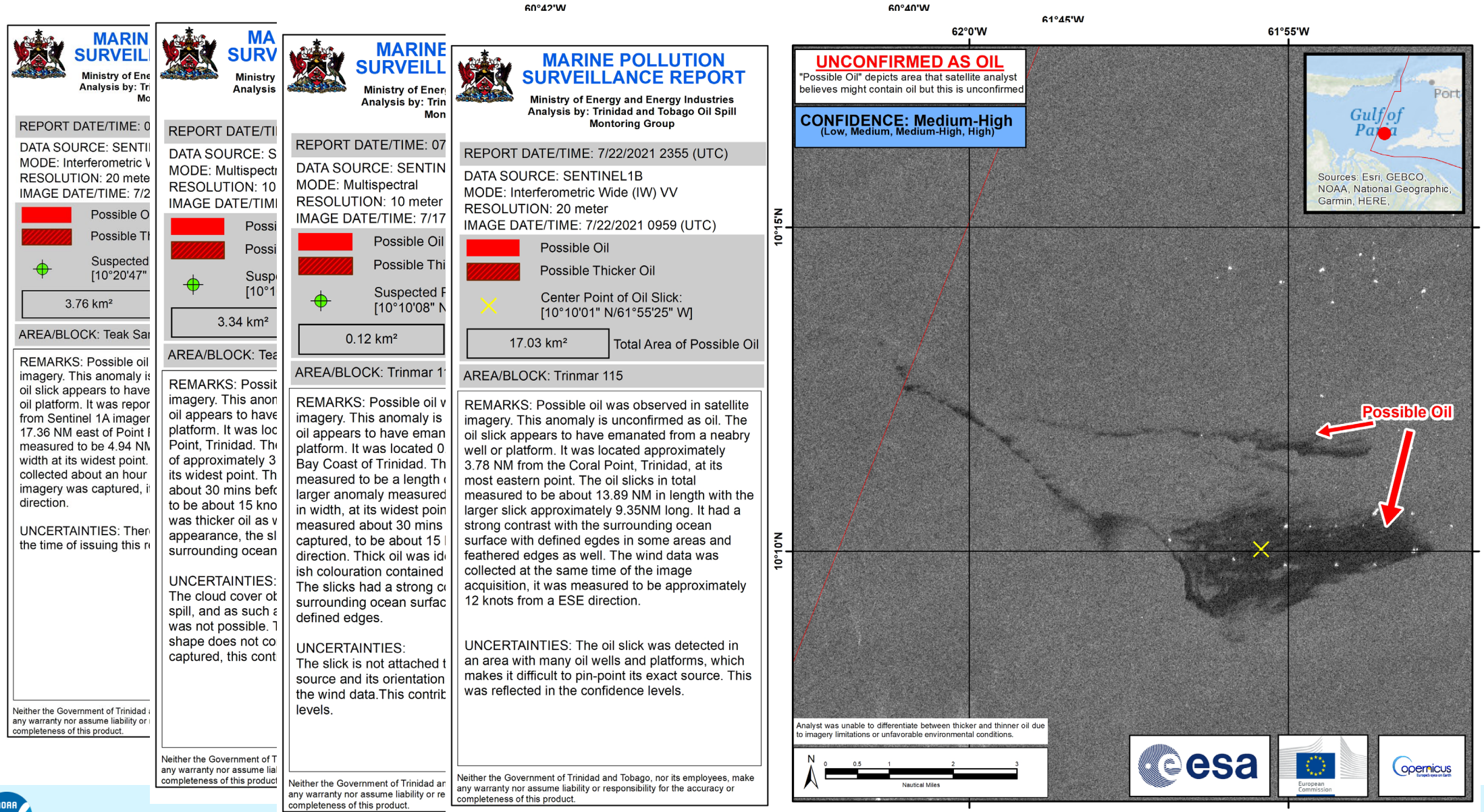
26	Sat	24										2A	1900	East	1700	2030	2045	1709	IMA
27	Sun	25							1A	2200	east	2B	1900	Ven GOP	1700	2030	2045	1651	IMA
28	Mon	26													1700	2030	2045	1813	IMA
29	Tues	27										2A	1900	GOP east c	1700	2030	2045	1754	IMA

TT Oil Spill Monitoring Reports Examples



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Analysis by: Tr
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DATA SOURCE: SENTI
MODE: Interferometric V
RESOLUTION: 20 mete
IMAGE DATE/TIME: 7/2

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AREA/BLOCK: Teak Sa

REMARKS: Possible oil
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from Sentinel 1A imager
17.36 NM east of Point
measured to be 4.94 NM
width at its widest point.
collected about an hour
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UNCERTAINTIES: Ther
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Neither the Government of Trinidad
any warranty nor assume liability or
completeness of this product.

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RESOLUTION: 10
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AREA/BLOCK: Tea

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60°42'W

MARINE
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DATA SOURCE: SENTIN
MODE: Multispectral
RESOLUTION: 10 meter
IMAGE DATE/TIME: 7/17

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Possible Thi
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in width, at its widest poin
measured about 30 mins
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direction. Thick oil was id
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The slicks had a strong c
surrounding ocean surfac
defined edges.

UNCERTAINTIES:
The slick is not attached t
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the wind data.This contrib
levels.

Neither the Government of Trinidad ar
any warranty nor assume liability or re
completeness of this product.

60°40'W

MARINE POLLUTION
SURVEILLANCE REPORT
Ministry of Energy and Energy Industries
Analysis by: Trinidad and Tobago Oil Spill
Montoring Group

REPORT DATE/TIME: 7/22/2021 2355 (UTC)

DATA SOURCE: SENTINEL1B
MODE: Interferometric Wide (IW) VV
RESOLUTION: 20 meter
IMAGE DATE/TIME: 7/22/2021 0959 (UTC)

Possible Oil
Possible Thicker Oil
Center Point of Oil Slick:
[10°10'01" N/61°55'25" W]

17.03 km² Total Area of Possible Oil

AREA/BLOCK: Trinmar 115

REMARKS: Possible oil was observed in satellite imagery. This anomaly is unconfirmed as oil. The oil slick appears to have emanated from a neabry well or platform. It was located approximately 3.78 NM from the Coral Point, Trinidad, at its most eastern point. The oil slicks in total measured to be about 13.89 NM in length with the larger slick approximately 9.35NM long. It had a strong contrast with the surrounding ocean surface with defined egdes in some areas and feathered edges as well. The wind data was collected at the same time of the image acquisition, it was measured to be approximately 12 knots from a ESE direction.

UNCERTAINTIES: The oil slick was detected in an area with many oil wells and platforms, which makes it difficult to pin-point its exact source. This was reflected in the confidence levels.

Neither the Government of Trinidad and Tobago, nor its employees, make any warranty nor assume liability or responsibility for the accuracy or completeness of this product.

61°45'W
62°0'W
61°55'W

UNCONFIRMED AS OIL
"Possible Oil" depicts area that satellite analyst believes might contain oil but this is unconfirmed

CONFIDENCE: Medium-High
(Low, Medium, Medium-High, High)

Gulf of Paria
Port
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE,

10°15'N
10°10'N

Possible Oil

Analyst was unable to differentiate between thicker and thinner oil due to imagery limitations or unfavorable environmental conditions.

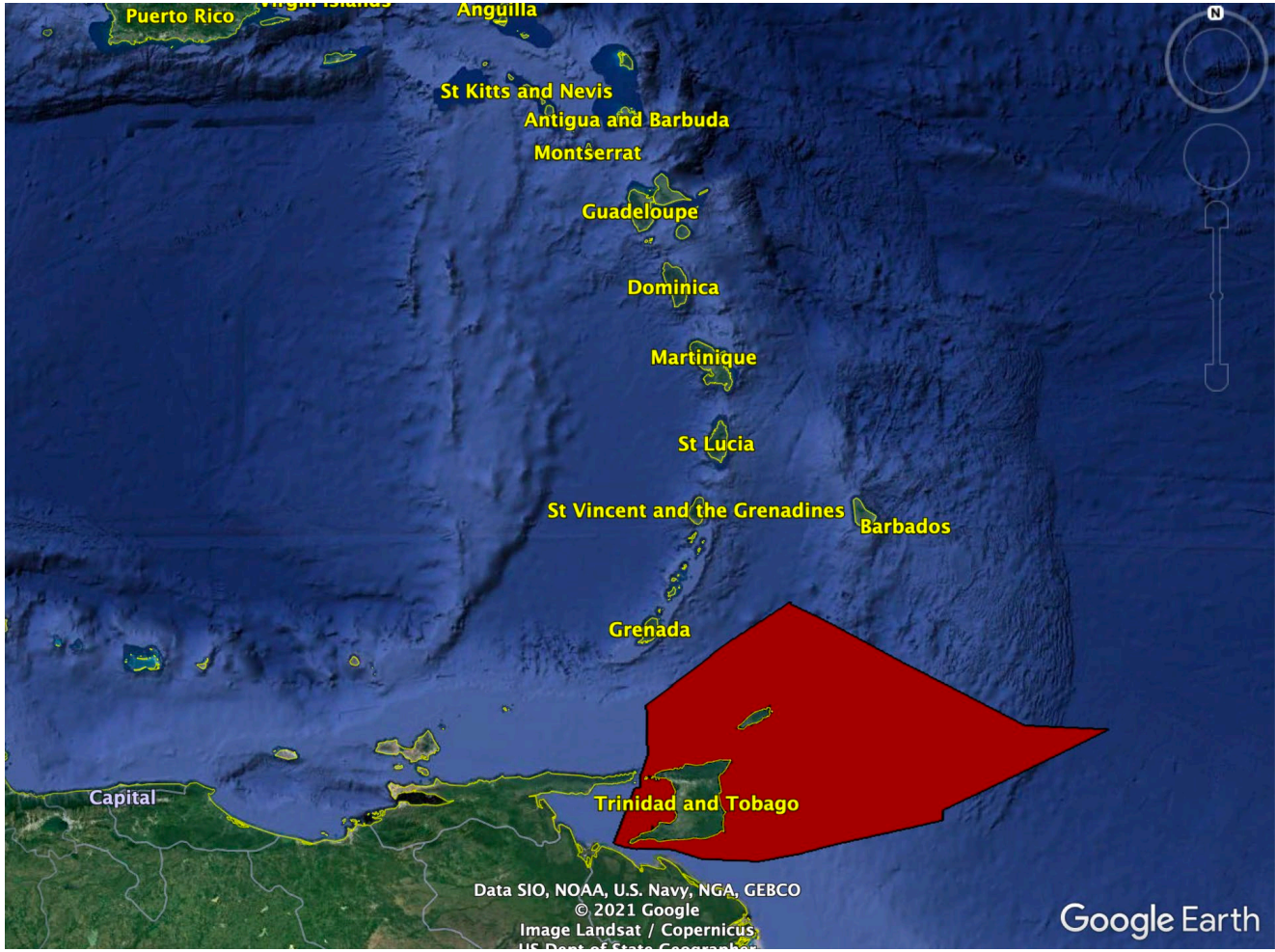
N
0 0.5 1 2 3
Nautical Miles

esa
European Commission
Copernicus

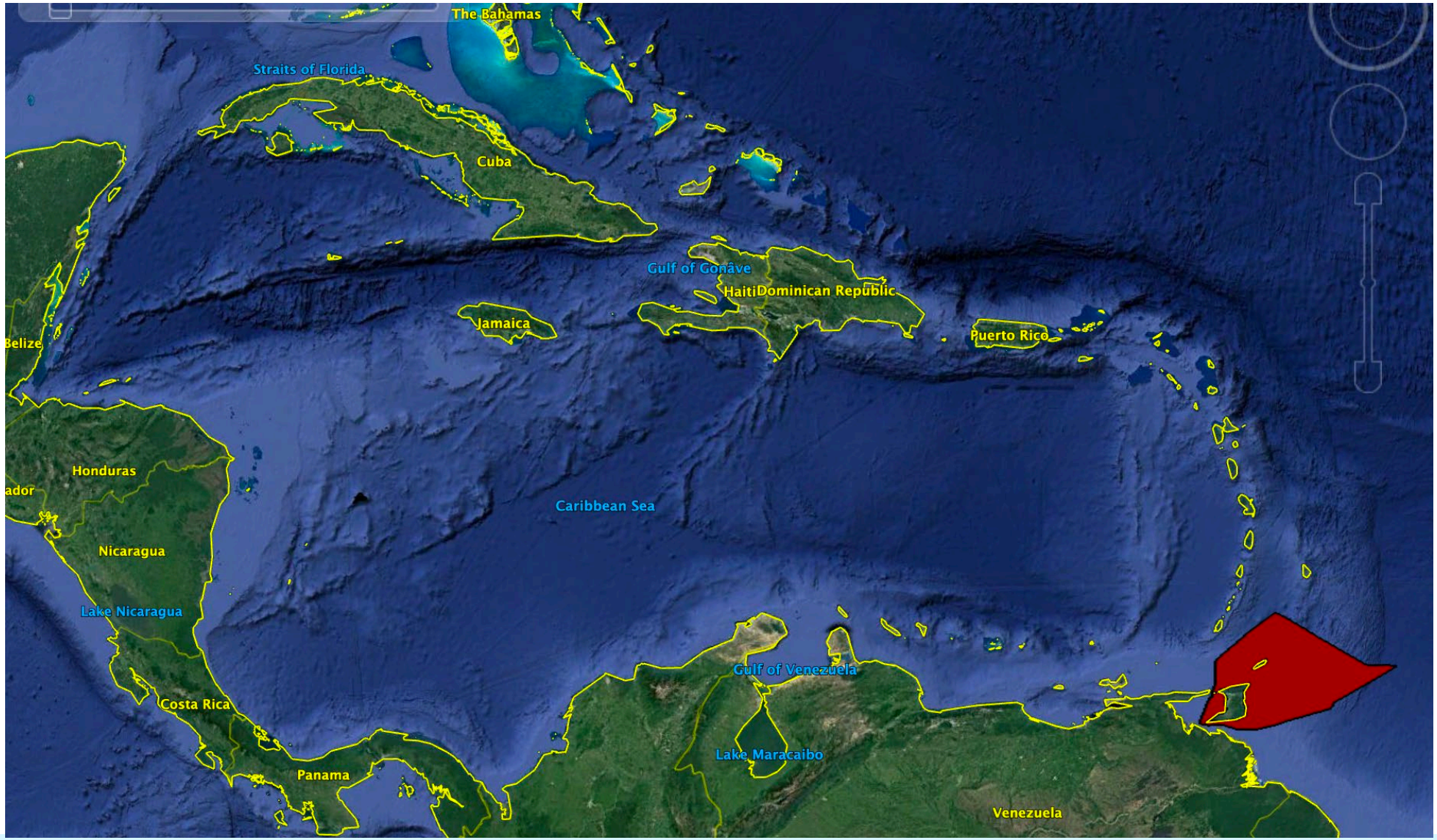
What’s next?

For Trinidad and Tobago

- Accumulate more experience of the region such as the repeat leak sources and natural seep areas.
- Make sure the transition to operations can proceed smoothly to three agencies
- Potentially IMA can monitor larger area around TT such as the lesser Antilles later



The Caribbean Sea is Large…



More regional partners needed…

- If you are interested or know someone or some agency is interested in

✓ *learning more about the satellite oil spill monitoring*

✓ *becoming users of the oil spill report*

✓ *participate in satellite oil spill monitoring training*

✓ *develop similar oil spill monitoring capabilities*

- Please Contact

Bonnie Zhu (xiaofang.zhu@noaa.gov) from NOAA

Hamish Asmath (hasmath@ima.gov.tt) from IMA

Questions?

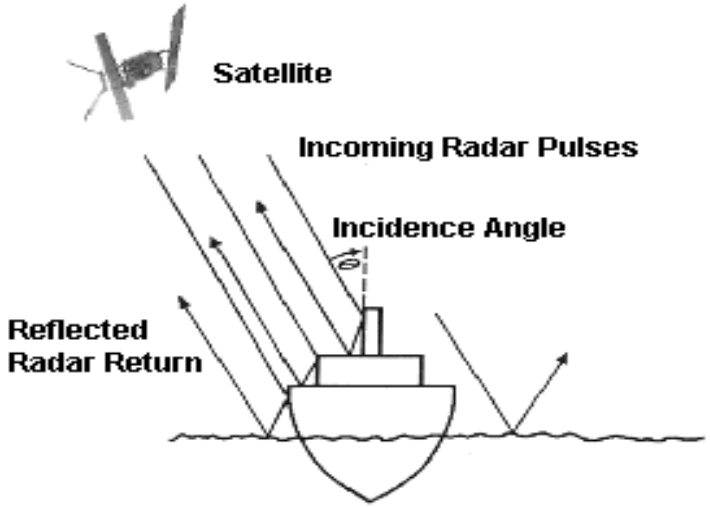
Thank you!

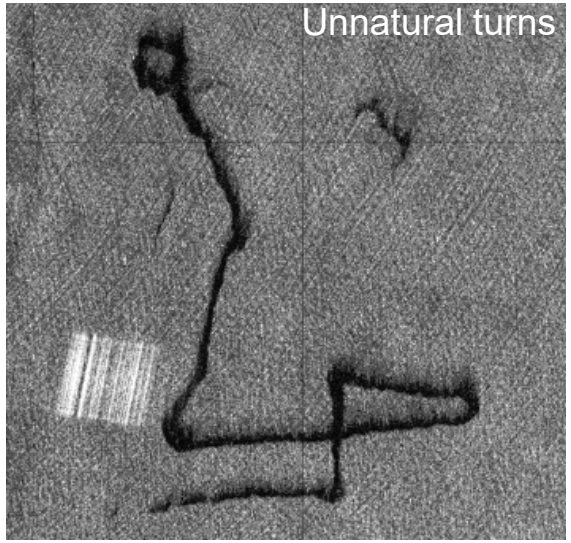
Additional Slides

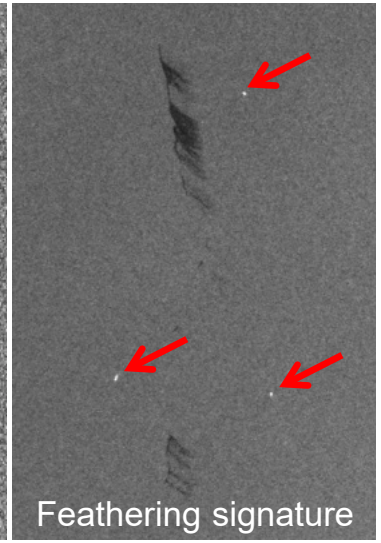
Imagery Type I: Synthetic Aperture Radar (SAR)

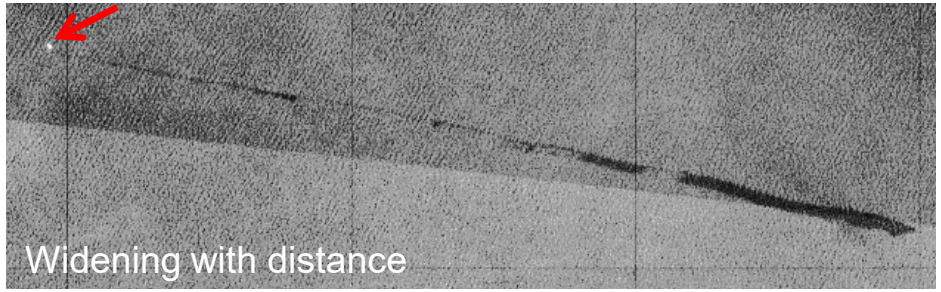
SYNTHETIC APERTURE RADAR

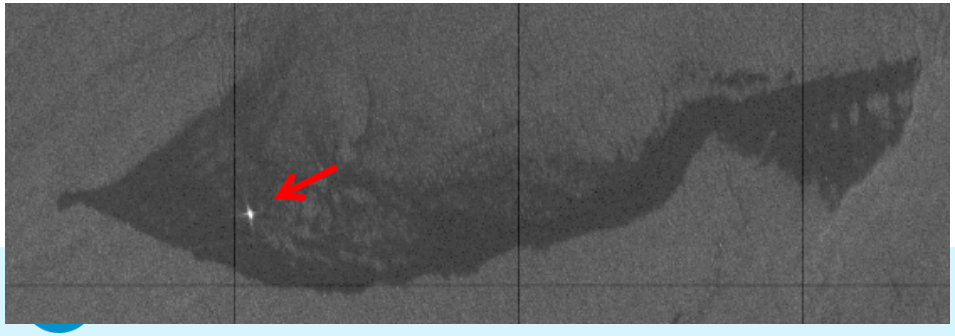
- Sentinel-1A and B (Europe, 5-40m, free)
- Radarsat-2 (Canada, 25-50m)

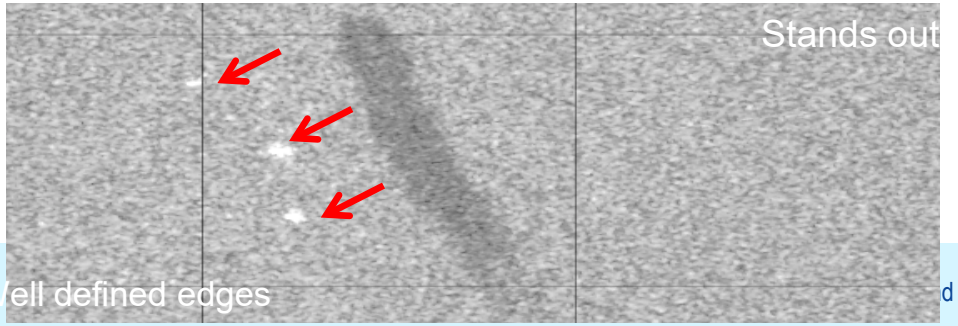




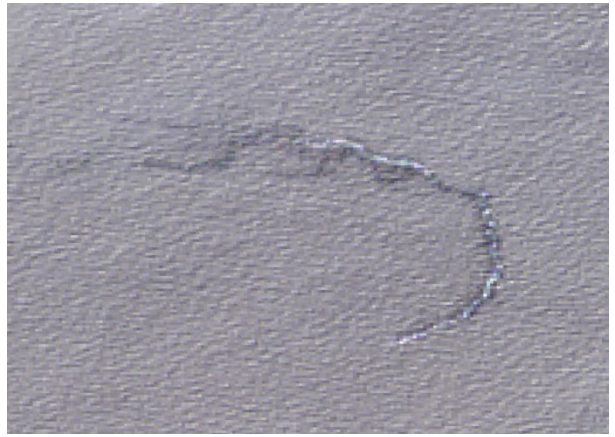




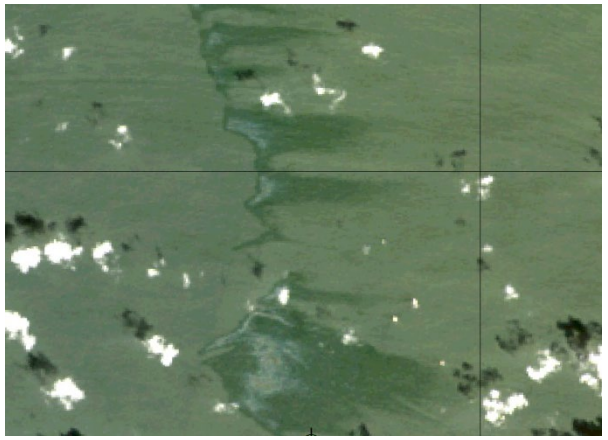




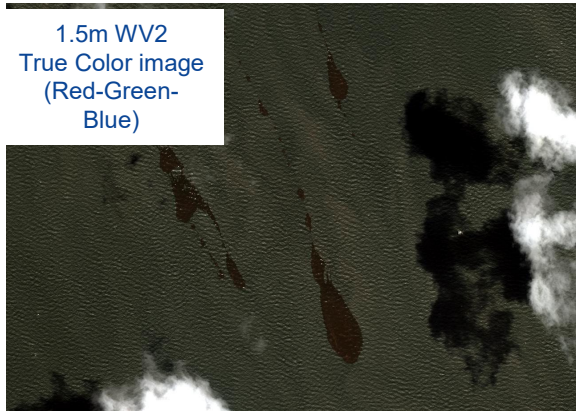
Imagery Type II: Multispectral Optical



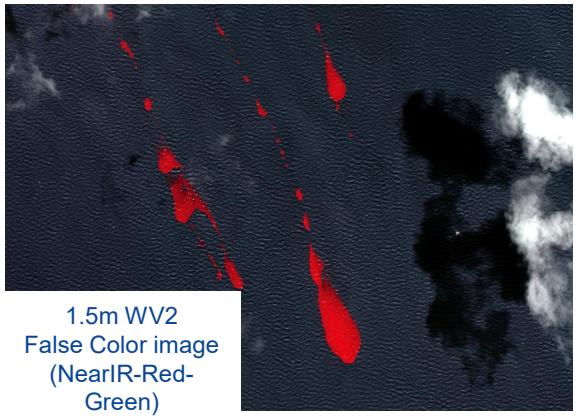
Can appear white and shimmery in sun illumination



Feathering signature



1.5m WV2 True Color image (Red-Green-Blue)



1.5m WV2 False Color image (NearIR-Red-Green)

Multispectral OPTICAL

Free

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

Upon request, free

- ASTER (15m, upon request)

Commercial imagery

Planet Scope (3m)

Worldview (2m)