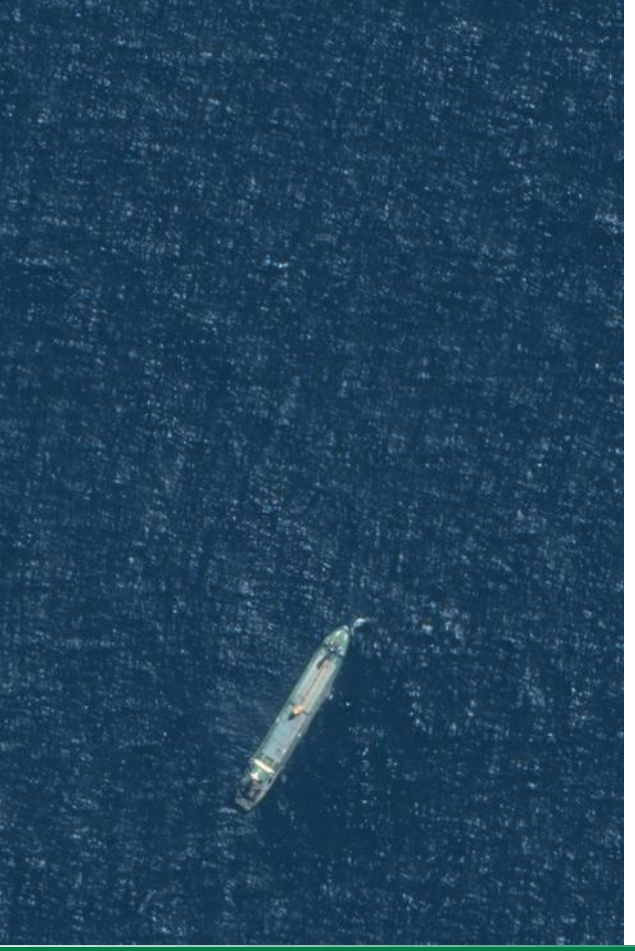
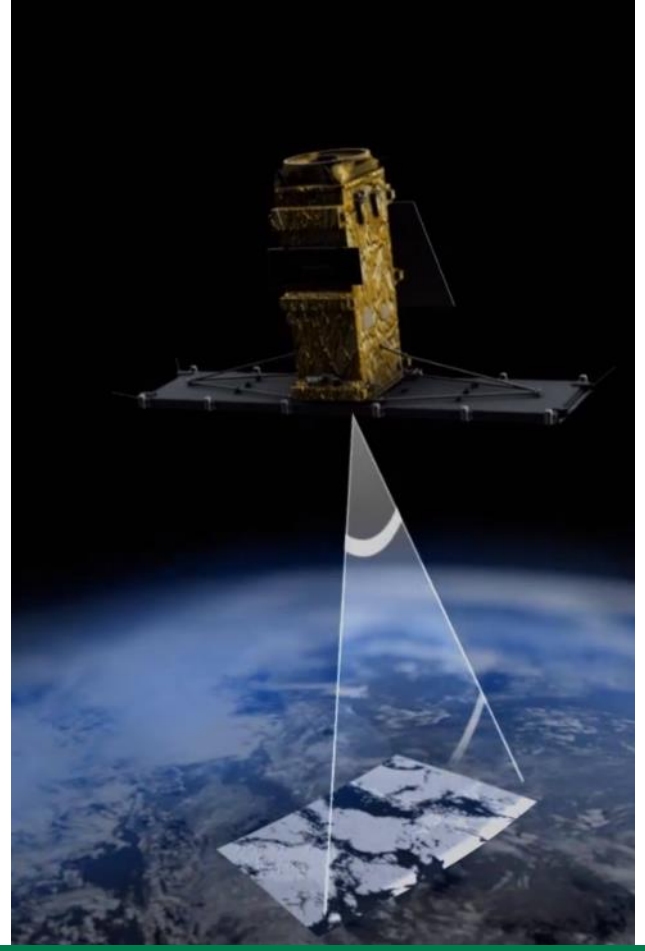





DFO'S *DARK VESSEL DETECTION* PROGRAM

LEVERAGING SATELLITE TECHNOLOGY TO IMPROVE ENFORCEMENT EFFORTS AT SEA AND AT PORT

May 2, 2023

What is IUU Fishing?

Illegal Fishing

- *In violation of international & domestic laws/obligations.*

Unreported Fishing

- Unreported and misreported catch

Unregulated Fishing

- Areas outside application of RFMOs / flag state not party to fora / fish stocks not covered by CMMs
- **Costs the global economy up to $23B annually**
- **Accounts for up to 30% of all fishing activity worldwide**
- **10 – 26 million tonnes of fish annually**
- ***"Dark" Vessels: Those vessels which extinguish their location transmitters in order to evade detection, a practice most frequently conducted by perpetrators of illegal fishing and other illicit activities.***

C&P FASE Dash-8 actively engaged in counter-IUU-F Operations in 2021

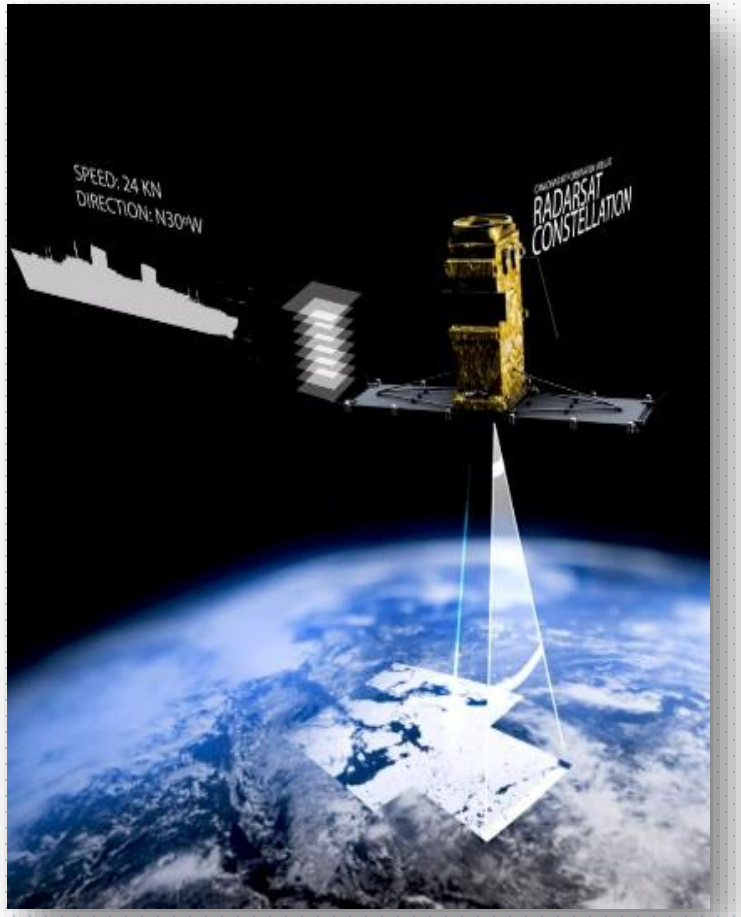
Fisheries and Oceans Canada | Pêches et Océans Canada

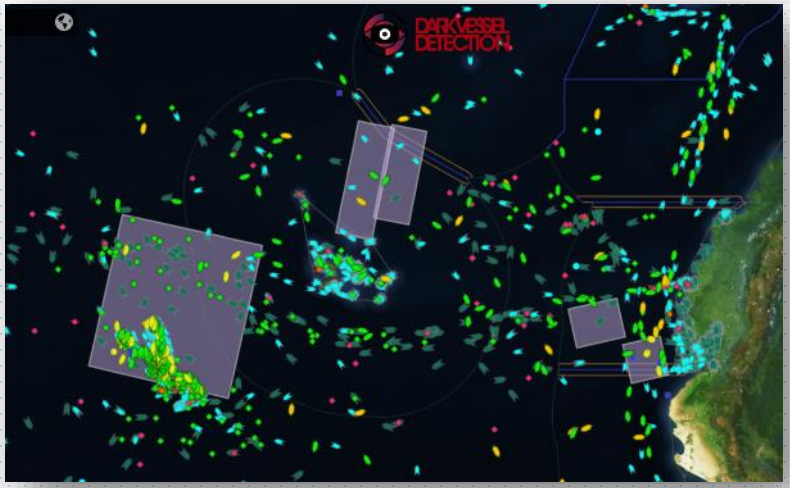
Stemming the Flow of Illegal Shark Catch into International Trade through Heightened Efforts to Combat IUU Fishing at Sea and at Port

- *Internationally, DFO has deployed fishery officers to support ship-based inspections during multilateral operations in the Pacific and Atlantic, and conduct aerial surveillance operations on the high seas to detect shark finning practices.*
- *DFO's Dark Vessel Detection platform permits heightened surveillance of illegal fishing activities at sea, thereby enabling partner countries to more efficiently deploy patrol assets and improve in-port targeting of vessels which may be illegally fishing and landing shark.*

Canada's Dark Vessel Detection (DVD) Program

- **Government of Canada program**, developed in partnership with **contractor MDA Ltd.**, that uses **satellite data** to identify vessels that extinguish location transponders (AIS/VMS) – **'Dark Vessels'**
- **Layered approach** to **near real-time surveillance** – leverages Canada's RadarSat Constellation Mission (RCM) and various commercial satellite data sources.
- DFO C&P International Enforcement Program is supporting international partners with access to DVD to **support counter illegal, unreported and unregulated fishing (IUU) operations.**



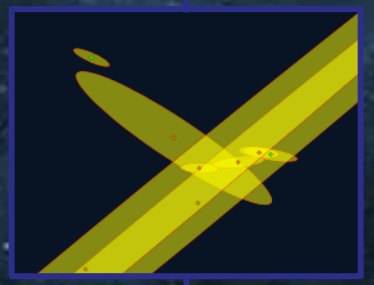


DARKVESSEL DETECTION

Data Types

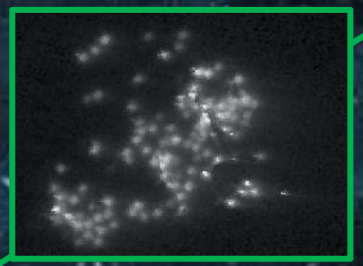
RF

Sources:
- UnseenLabs
- Hawkeye360
- KLEOS



VIIRs

Sources:
- NASA/NOAA



SAR

Sources:
- RADARSAT Constellation Mission (RCM)
- RADARSAT 2
- ICEYE

Voluntary Signals

S-AIS

VMS

Sources (AIS):
- Spire Maritime (formerly exactEarth)

Sources (VMS):
- Various

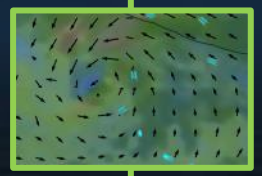
Optical

Sources:
- MAXAR
- Blacksky
- Satellogic

MMSI	548946000
IMO	9761231
Call Sign	DUIN
Type	Cargo Vessel
Length	180 meters
Width	30 meters

Sources:
- IHS Fairplay

Vessel details



Environmental Data

Sources:
- Openweathermap.org

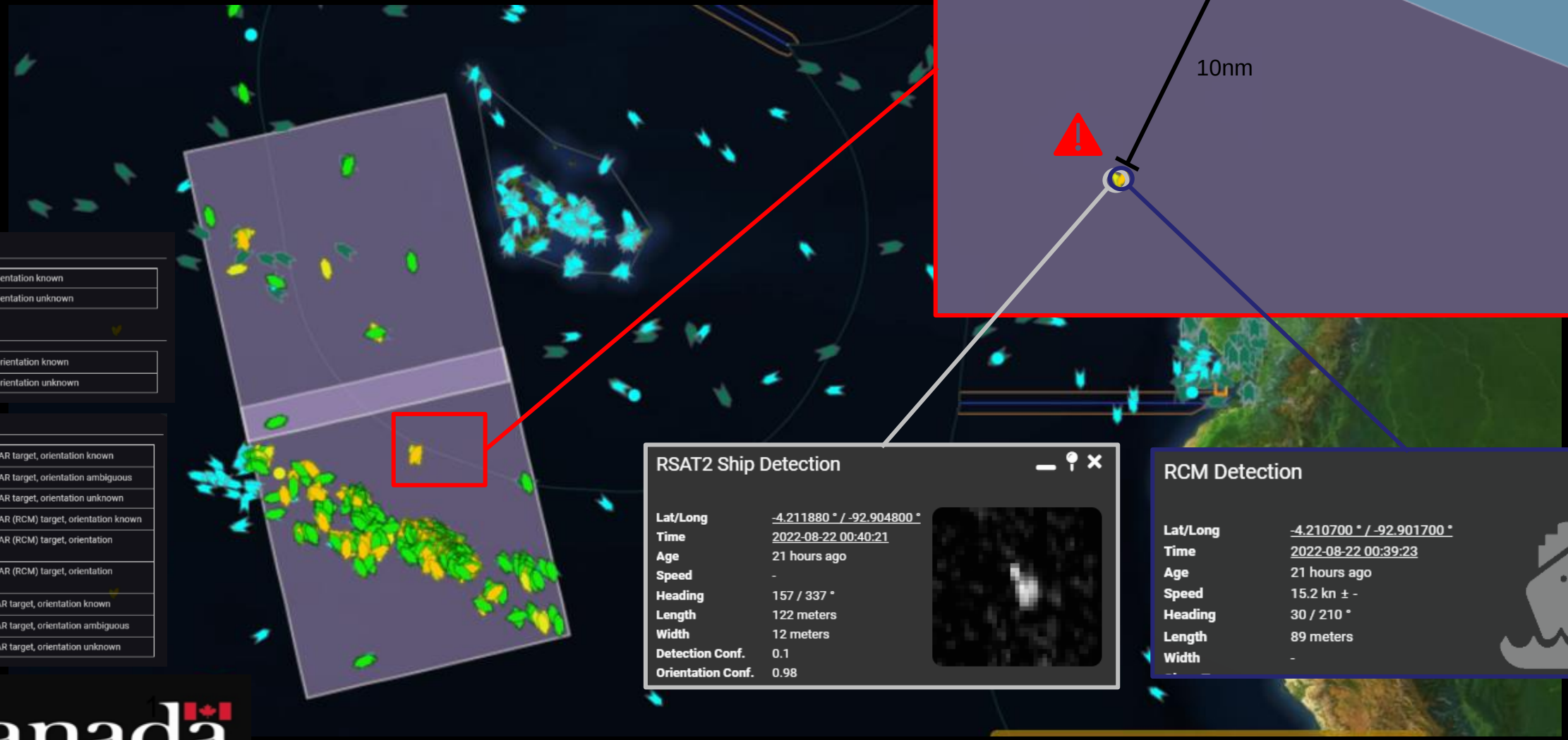
(Wind Speed and Direction, Cloud Cover, Precipitation, Sea surface temp)

MDA

Government of Canada / Gouvernement du Canada

DARKVESSEL DETECTION

Radarsat 2 / RCM - Use Case



AIS

	AIS vessel, orientation known
	AIS vessel, orientation unknown

VMS

	VMS vessel, orientation known
	VMS vessel, orientation unknown

SAR

	Unidentified SAR target, orientation known
	Unidentified SAR target, orientation ambiguous
	Unidentified SAR target, orientation unknown
	Unidentified SAR (RCM) target, orientation known
	Unidentified SAR (RCM) target, orientation ambiguous
	Unidentified SAR (RCM) target, orientation unknown
	Associated SAR target, orientation known
	Associated SAR target, orientation ambiguous
	Associated SAR target, orientation unknown

RSAT2 Ship Detection

Lat/Long	-4.211880 ° / -92.904800 °
Time	2022-08-22 00:40:21
Age	21 hours ago
Speed	-
Heading	157 / 337 °
Length	122 meters
Width	12 meters
Detection Conf.	0.1
Orientation Conf.	0.98

RCM Detection

Lat/Long	-4.210700 ° / -92.901700 °
Time	2022-08-22 00:39:23
Age	21 hours ago
Speed	15.2 kn ± -
Heading	30 / 210 °
Length	89 meters
Width	-

Canada

Radio Frequency (RF) signal mapping

- Used to identify and geolocate RF signals of interest (SOIs), within an error ellipse / circle.
- Offers broad area detection – day/night coverage – cloud penetration

VHF (HE360 only) 30MHz-300MHz
49 VHF Marine Communications Channels, includes AIS

S-Band (Both providers) 3GHz
Marine Navigation Radars, used especially when in rain or fog as well as for identification and tracking

X-Band (Both providers) 8GHz-12GHz
Marine Navigation Radars used for a sharper image and better resolution (and smaller antenna).

L-Band (HE360 only) 1GHz-2GHz
L-Band Mobile Satellite devices (phones, data), FADs
Can not detect Iridium devices (US GovOnly)

Data Providers:

unseenlabs — THE BRIGHT SIGHT

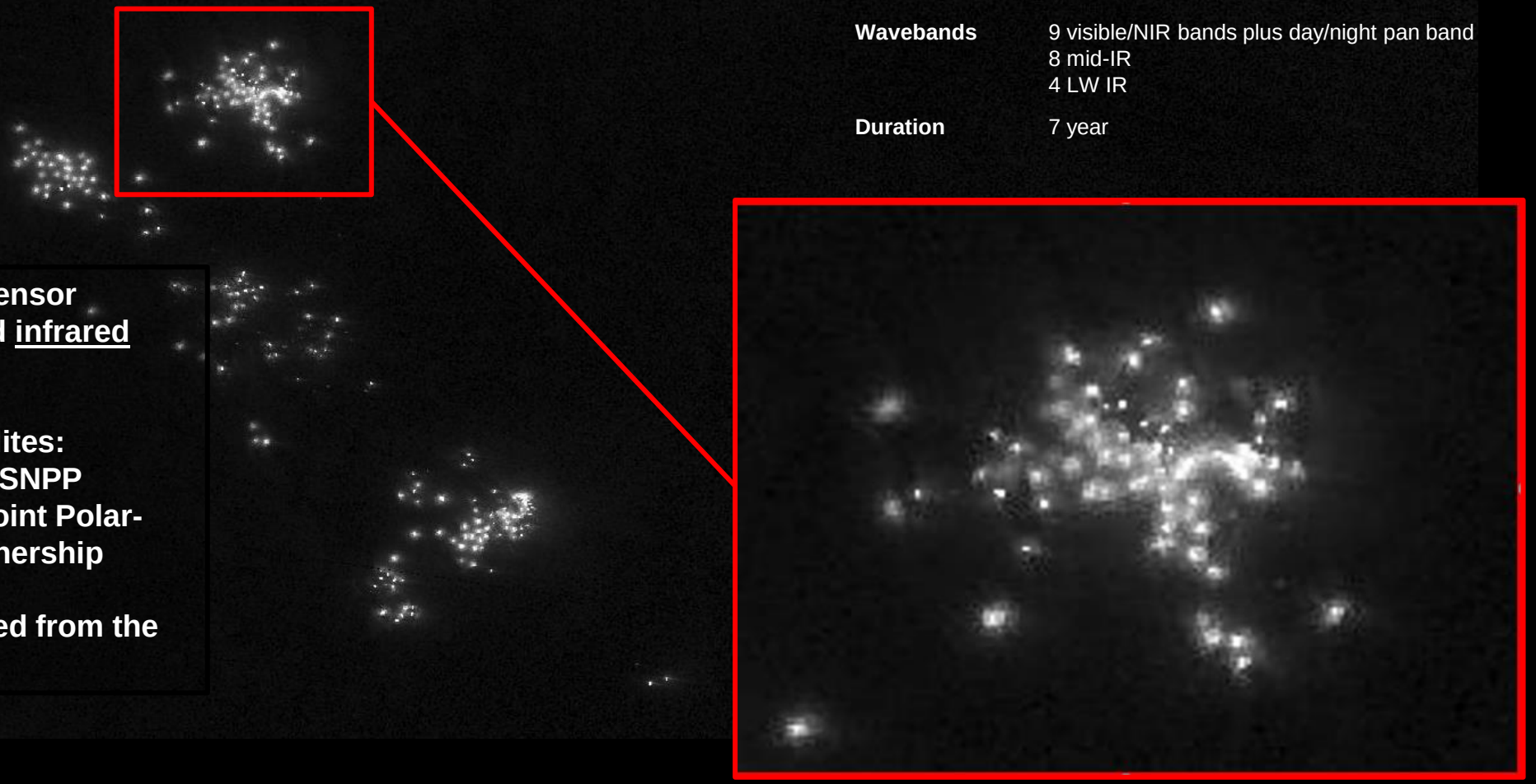
HawkEye 360

DARK VESSEL DETECTION

Visible Infrared Imaging Radiometer Suite (VIIRS)

Technical Specifications:

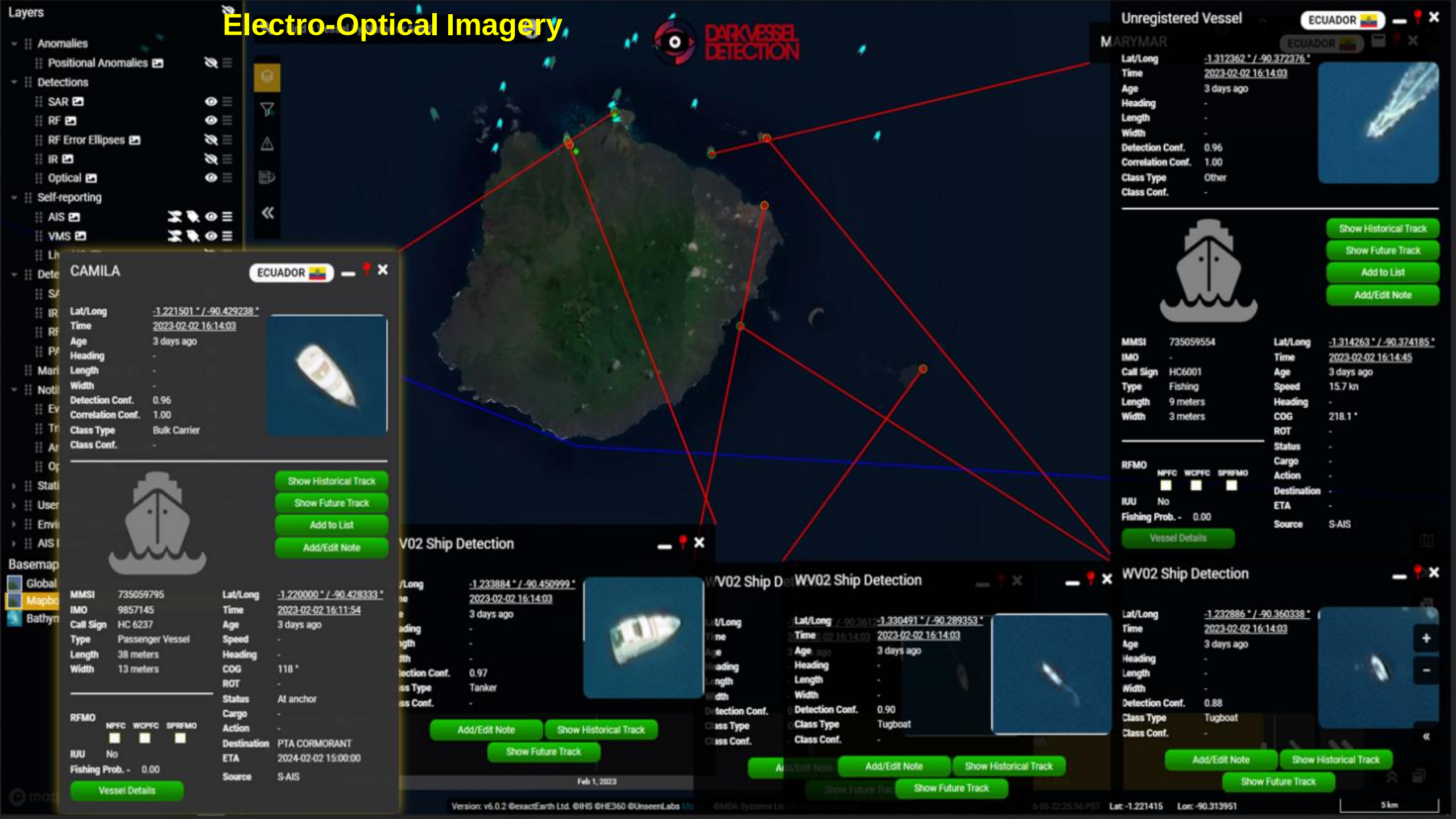
Orbit	830km, 1:30pm mean local solar time. sun-synchronous, polar
Repeat Cycle	16 days
Swath Dimensions	3000km, nearly global coverage every day
Spatial Resolution	750m
Wavebands	9 visible/NIR bands plus day/night pan band 8 mid-IR 4 LW IR
Duration	7 year



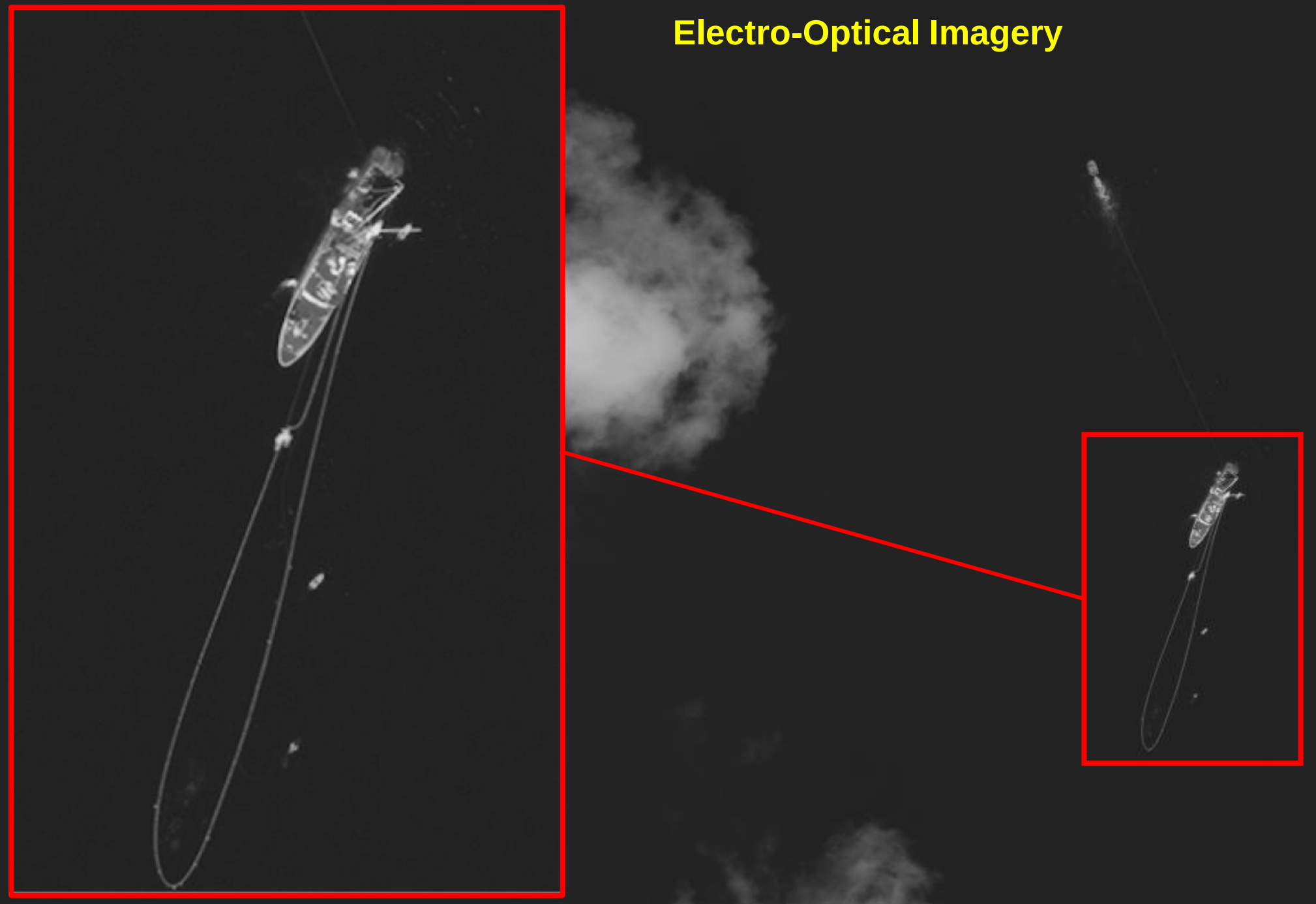
- **Sensitive optical sensor collects visible and infrared images**
- **Onboard two satellites:**
  - **NASA/NOAA SNPP**
  - **NOAA-20 / Joint Polar-Orbiting Partnership**
- **Detects light emitted from the water at night**

Canada

Electro-Optical Imagery



Electro-Optical Imagery



Electro-Optical Imagery

Lat/Long	2.641374 ° / -90.245347 °
Time	2023-01-18 16:32:08
Age	29 days ago
Heading	-
Length	-
Width	-
Detection Conf.	1.00
Class Type	Barge
Class Conf.	-

Lat/Long	2.641233 ° / -90.245145 °
Time	2023-01-18 16:32:08
Age	29 days ago
Heading	-
Length	-
Width	-
Detection Conf.	1.00
Class Type	Barge
Class Conf.	-

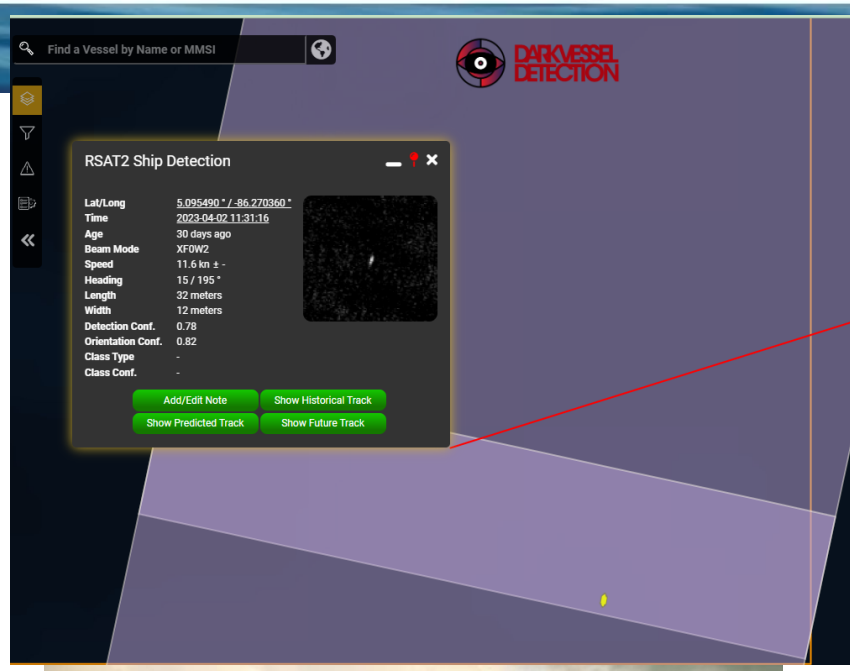
Lat/Long	2.641041 ° / -90.244954 °
Time	2023-01-18 16:32:08
Age	29 days ago
Heading	-
Length	-
Width	-
Detection Conf.	0.64
Class Type	Barge
Class Conf.	-

Lat/Long	2.640854 ° / -90.244812 °
Time	2023-01-18 16:32:08
Age	29 days ago
Heading	-
Length	-
Width	-
Detection Conf.	0.82
Correlation Conf.	1.00
Class Type	Barge
Class Conf.	-

Satellite SAR for Maritime Surveillance

Key Missions:

- **Large Area Maritime Domain Awareness**
  - Fill intelligence gaps in remote regions where other assets are scarce
- **Efficient Tasking or Cueing of Patrol Assets**
- **Specific Area of Interest Monitoring**
  - Use higher resolution modes over distinct areas to get more detailed picture of ship activity

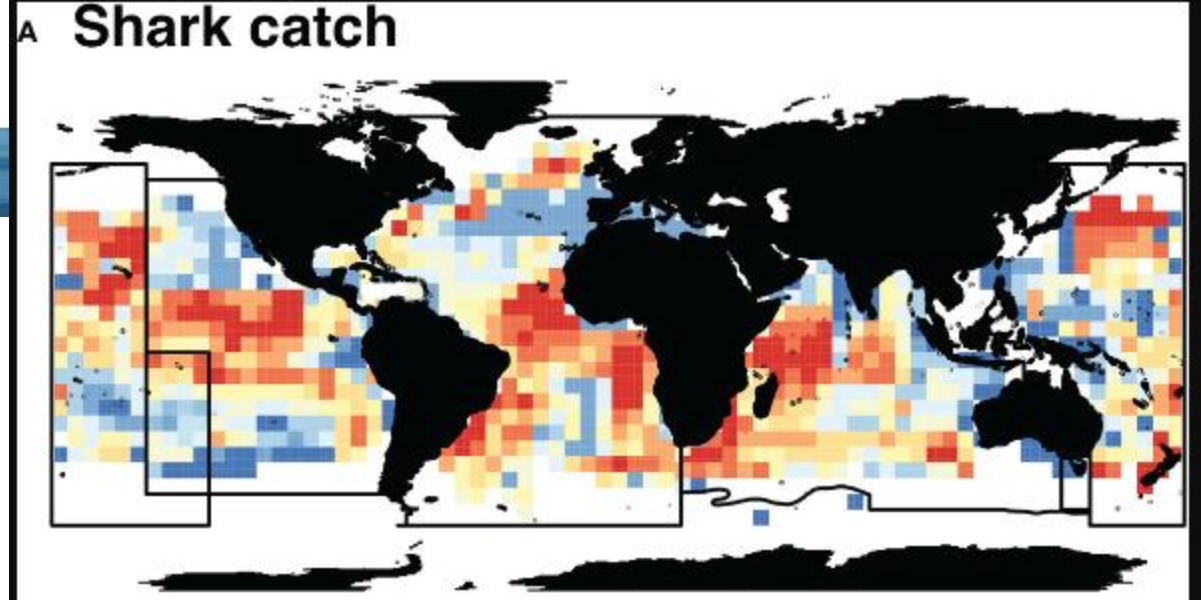


Strengths:

- Find all vessels, including non-emitting ships (“**Dark targets**”)
- **Weather** / Lighting independent imaging
- **Unclassified** sources allow sharing of data with coalition/partners
- Regular access to denied or **remote** territories

Benefits of Remote Satellite Surveillance Towards Combatting Illegal Fishing Practices of Shark

- *Provides maritime and fisheries authorities with heightened maritime domain awareness in order to identify and monitor illegal fishing activities.*
- *Certain modalities, such as EO, are delivering higher resolution images that may enable prosecutions of illegal fishing based on satellite imagery.*
- *Permits monitoring of higher-risk shark corridors and fisheries most at risk to catch shark, and can support risk-based and targeted deployment of enforcement assets, as well as contribute to vessel targeting to improve port state inspection activities during catch offload.*
- Delivers a capability to monitor “dark” fishing and transshipment activities.



Sources: Burns et al. 2023 (above)/Oliver et al. 2015 (below)