

# CleanSeaNet

## Introduction to CleanSeaNet Service

Earth Observation Services  
Unit Surveillance

Lisbon / September / October 2020



- Overview EO Services
- Overview CleanSeaNet
- CSN Products

- **AOI: Area of Interest**
- CMS: Copernicus Maritime Surveillance (EMSA Service)
- CSN: CleanSeaNet (EMSA Service)
- EMSA: European Maritime Safety Agency
- ENP: European Neighbourhood Policy
- EOS: Earth Observation Services
- EODC: Earth Observation Data Centre
- EU: European Union
- KML: Keyhole Markup Language
- LP: License Provider
- MS: Member State
- MR: Medium Resolution
- N/A: Not Applicable
- NCA: National Competent Authority
- **NRT: Near Real Time , for EMSA services , all deliveries above 30 minutes are considered NRT.**
- **QRT: Quasi real time, For EMSA, all deliveries in less or equal than 30 minutes are considered QRT.**
- **RPAS: Remotely Piloted Aircraft Systems (RPAS)**
- RS-2: Radarsat-2
- **SAR: Synthetic Aperture Radar**
- SEG: SSN Ecosystem GUI (EMSA application)
- TSX: TerraSAR-X
- VAP: Value Added Products

## USERS



## SATELITE MISSIONS



### SAR

PAZ  
RADARSAT-2,  
SENTINEL-1A,  
SENTINEL-1B,  
TERRASAR-X,  
TANDEM-X

### OPTICAL

DEIMOS-2,  
EROS-B  
GEOEYE-1,  
PLEIADES-1A/1B,  
SPOT 6/7,  
WORLDVIEW-1/2/3,  
SUPERVIEW-1/2/3/4

## SERVICE PROVIDERS



### SAR

CLS  
EGEOS,  
KSAT  
EDISOFT

### OPTICAL

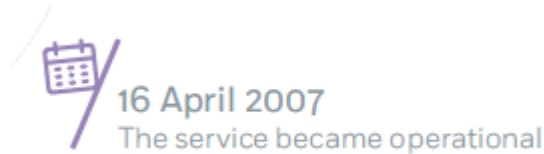
EUSI  
AIRBUS  
KSAT

## EO DATA CENTRE



DELIVERY TO USERS VIA:  
WEB PORTAL  
MOBILE APP  
SYSTEM TO SYSTEM  
ALERTS AND NOTIFICATIONS

## CleanSeaNet service



CleanSeaNet is the European satellite-based oil spill monitoring and vessel detection service. It analyses images, mainly from synthetic aperture radar (SAR) but also from optical missions, to:

- detect possible oil on the sea surface, including illegal discharges of mineral oil
- identify potential polluters, and
- monitor the spread of oil during maritime emergencies.

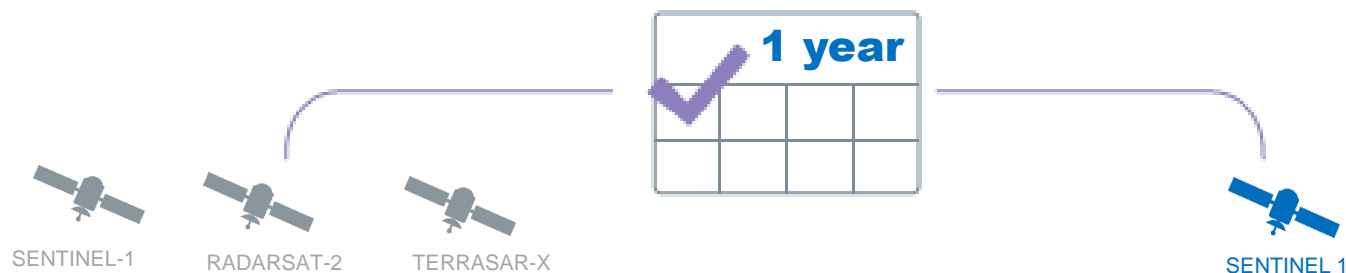
The service was developed and is operated by EMSA, and is available to all EU member states, EFTA/EEA member states, candidate countries and ENP participating countries



## 2019

EMSA EARTH OBSERVATION  
(SAR) CLEANSEANET DATA

### Activities Covering



**1 313 MILLION KM<sup>2</sup>** MONITORED IN QRT/NRT

**7153** SAR IMAGES

**7755** POSSIBLE OIL SPILLS DETECTED

(APPROX. 6 SPILLS PER MILLION KM<sup>2</sup> MONITORED)

**1 132 MILLION KM<sup>2</sup>** MONITORED IN QRT/NRT




**6113** SENTINEL-1 IMAGES (85% OF OVERALL CSN IMAGES)

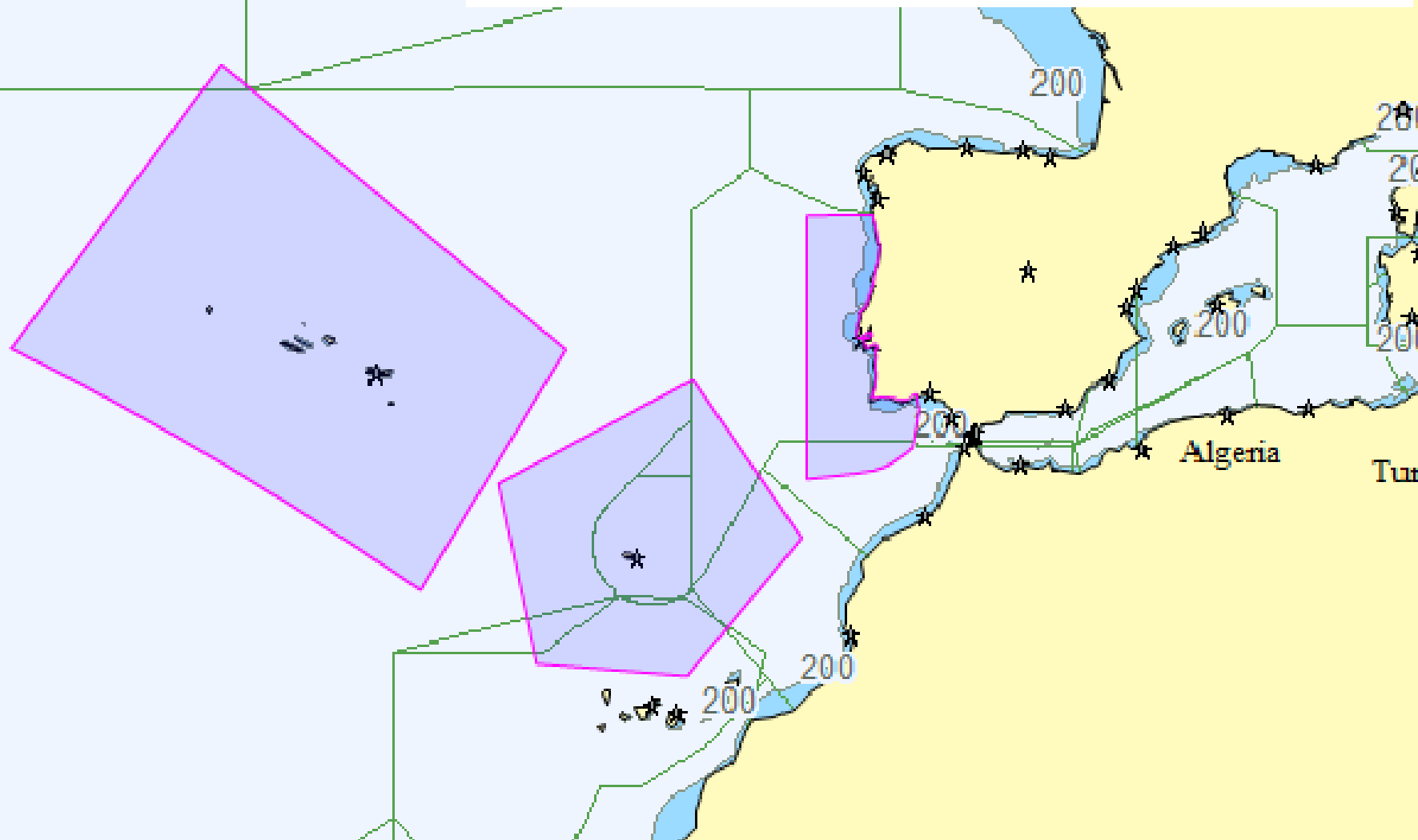
**95%** OF DELIVERY RELIABILITY FOR SENTINEL-1 IMAGES

(95% FOR RADASART-2 AND 80% FOR TERRASAR-X)

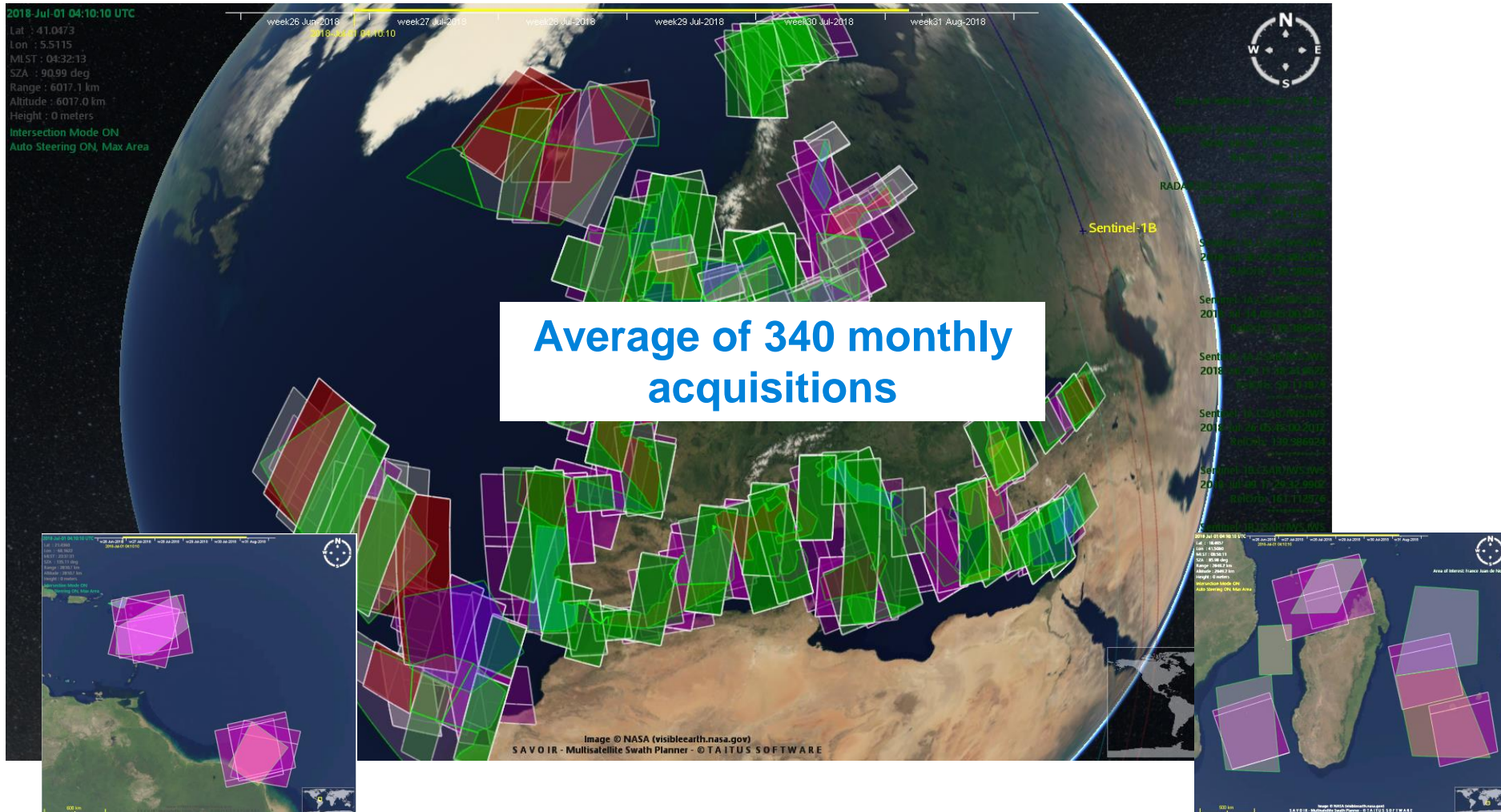
(1) 35 coastal states : 23 coastal European Union (EU) , 2 European Free Trade Association (EFTA), 3 candidate countries, 7 countries in the context of the European Neighbourhood Policy (ENP) SAFEMED IV and BCSEA projects

# CleanSeaNet : Coverage requirements

Portugal			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<input checked="" type="checkbox"/>	 Portugal		10	10	10	10	10	10	10	10	10	10	10	10
<input checked="" type="checkbox"/>	 Portugal_Azores		10	10	10	10	10	10	10	10	10	10	10	10
<input checked="" type="checkbox"/>	 Portugal_Madeira		10	10	10	10	10	10	10	10	10	10	10	10

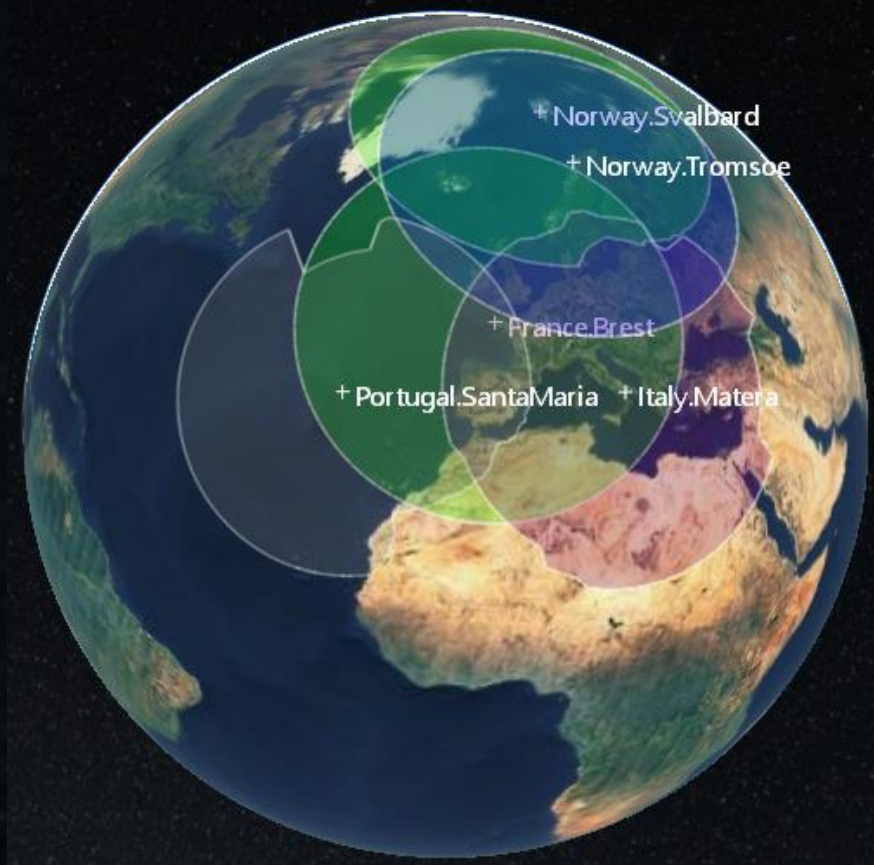


2018-Jul-01 04:10:10 UTC  
Lat : 41.0473  
Lon : 5.5115  
MLST : 04:32:13  
SZA : 90.99 deg  
Range : 6017.1 km  
Altitude : 6017.0 km  
Height : 0 meters  
Intersection Mode ON  
Auto Steering ON, Max Area

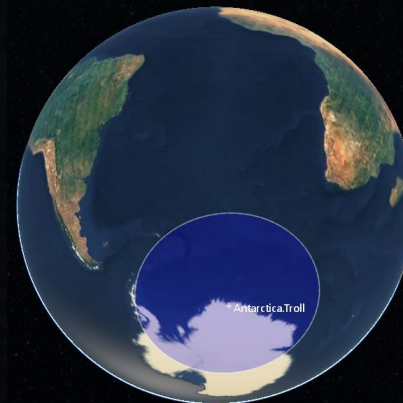


# EO Products NRT delivery Time

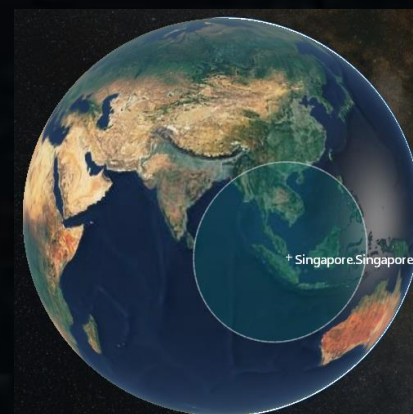
## Med / North seas / Baltic / Arctic / North Atlantic



## Antarctica



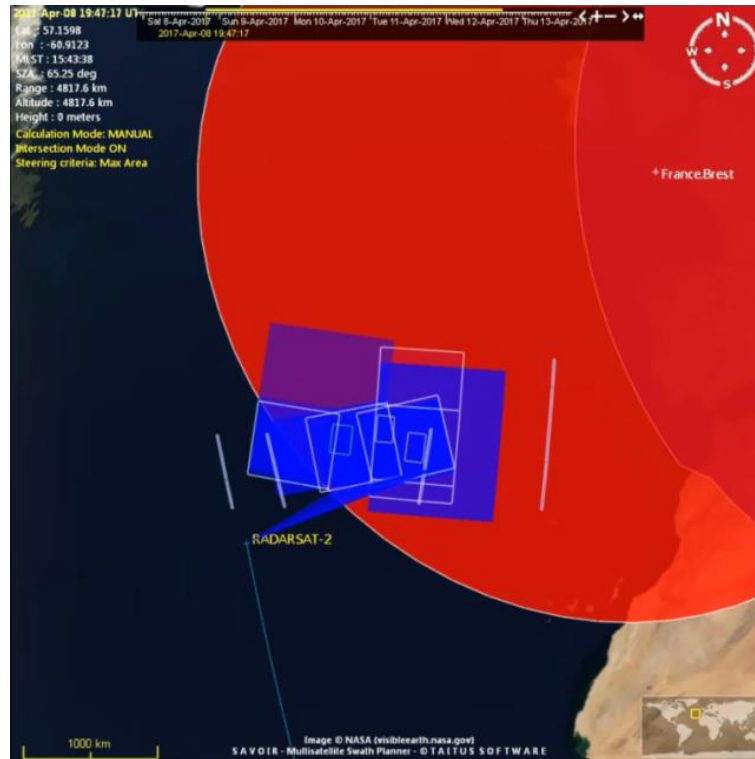
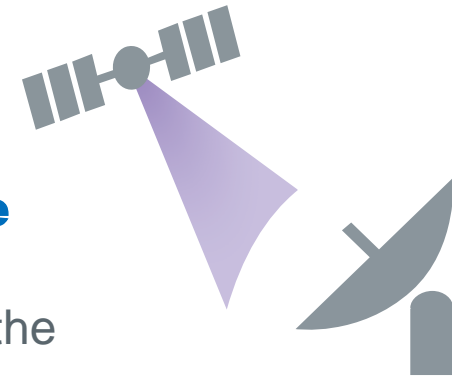
## Singapore

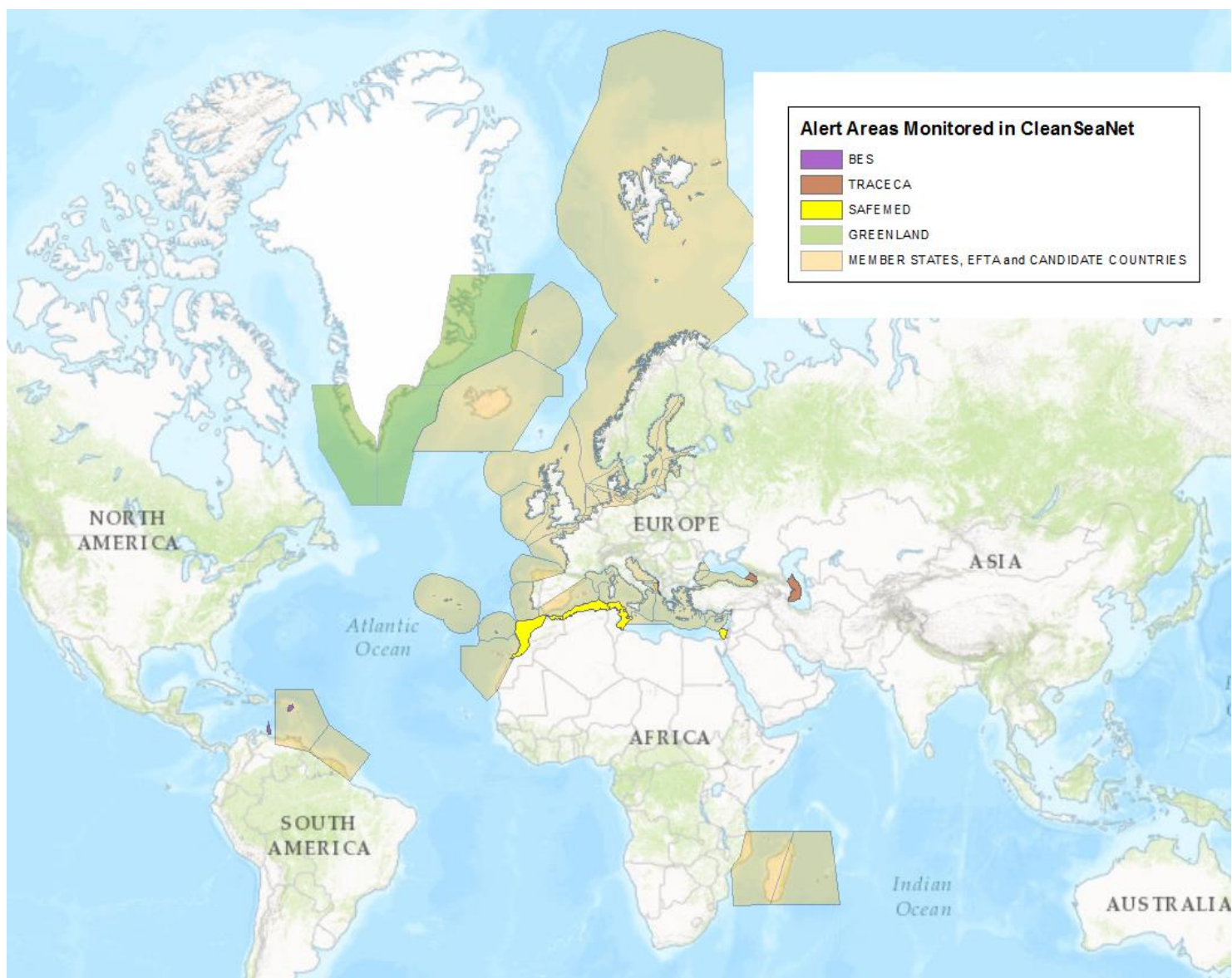


## Delivery time

### Delivery time outside the ground station coverage

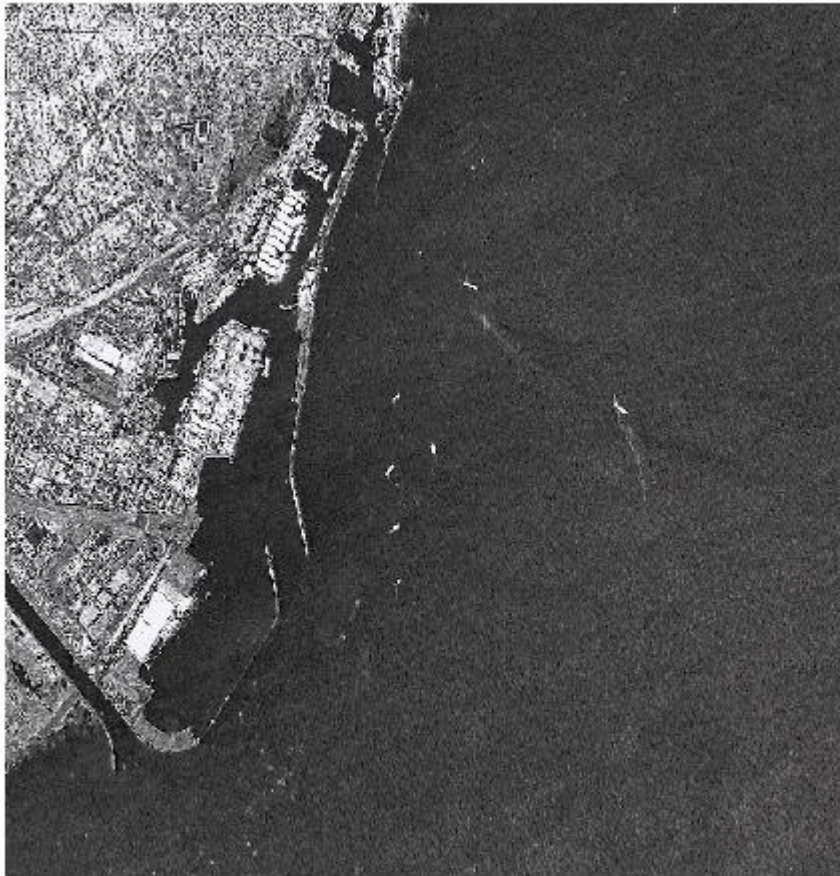
- Satellite flight time to ground station visibility is added to the delay:





## SAR DATA

QUASI REAL TIME\* DELIVERY (20') TO USERS



Barcelona, Spain - TSX ST © DLR e.V. 2019, Distribution Airbus Defence and Space GmbH

## OPTICAL DATA

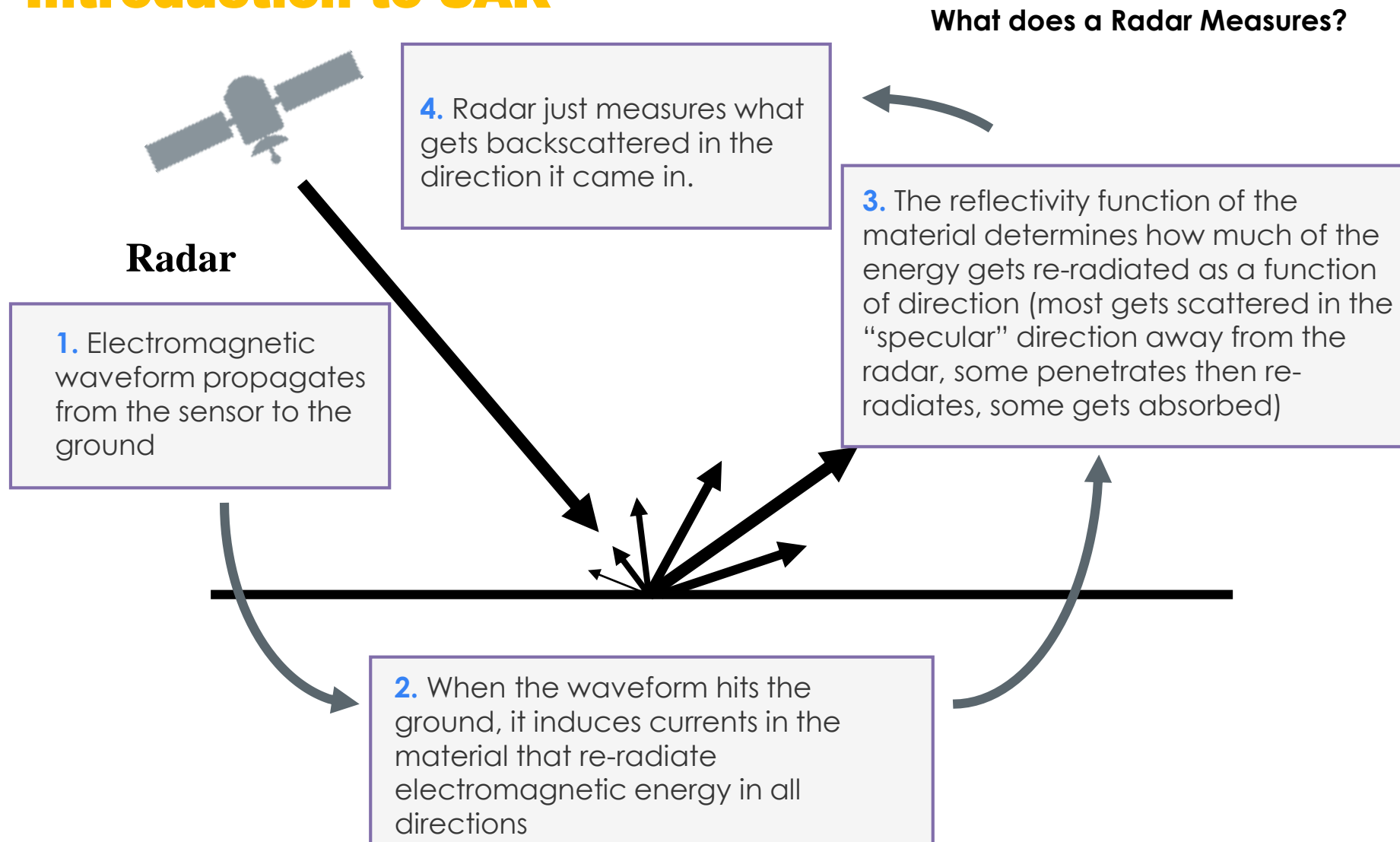
NEAR REAL TIME\* DELIVERY (30') TO USERS



Ponta Delgada - Azores, Portugal - WV2 © 2018 European Space Imaging/DigitalGlobe, a MAXAR company

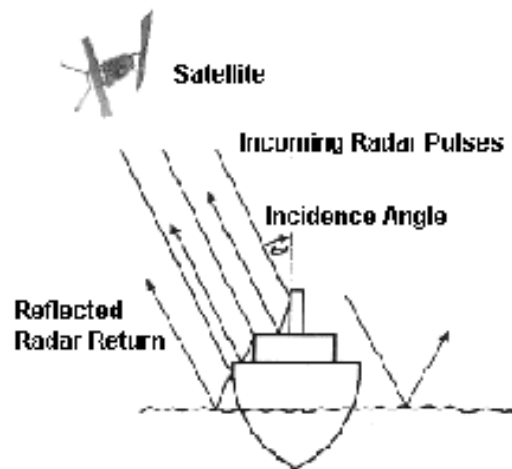
(\*) Depending on acquisition size and value added products

## Introduction to SAR



## Detection Principle in CSN

- Vessels are visible as bright spots due to the metallic structure, which is a strong reflector, and corner structure that bounces back radiation. Non-Metalic targets might be missed!

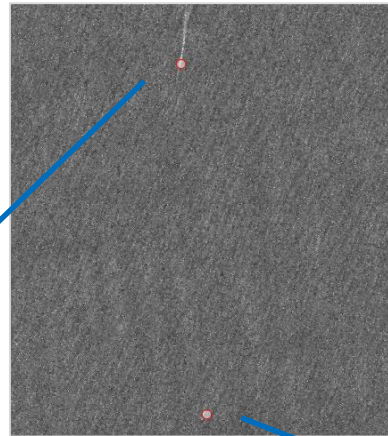
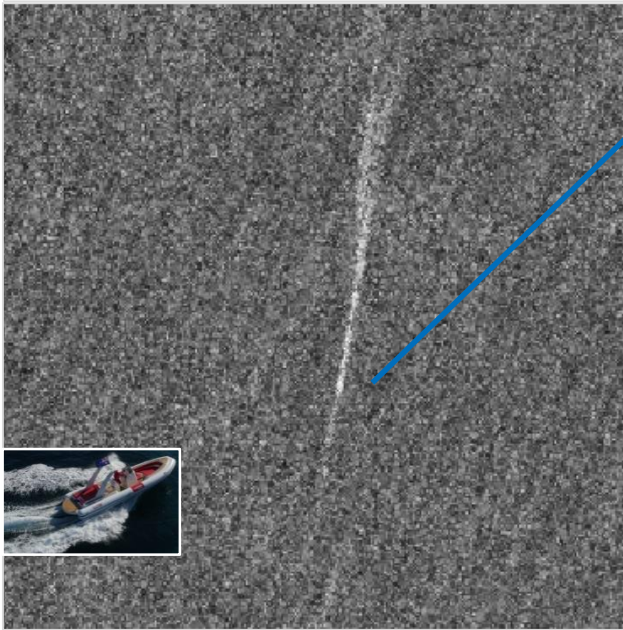


Sensor: **Strong signal => Bright Pixel**

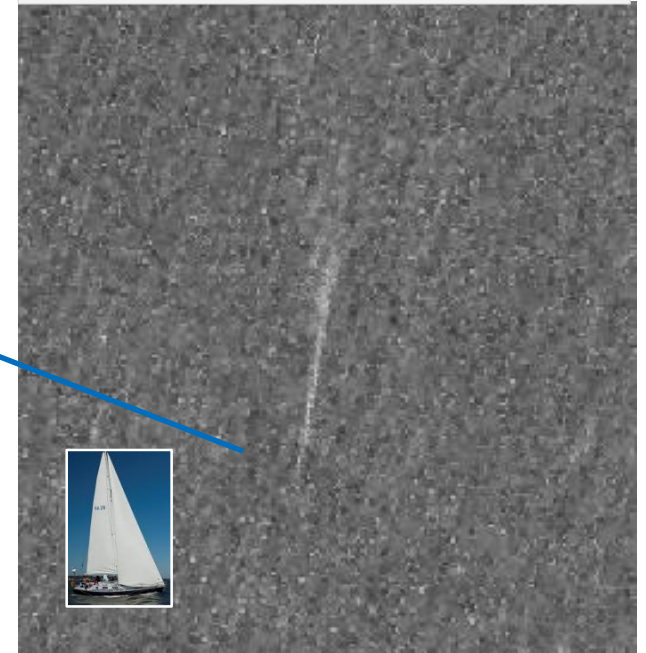
## Detection Principle in CSN

Vessels can also be detected, and heading estimated, through the wake

Go fast rib – 12m

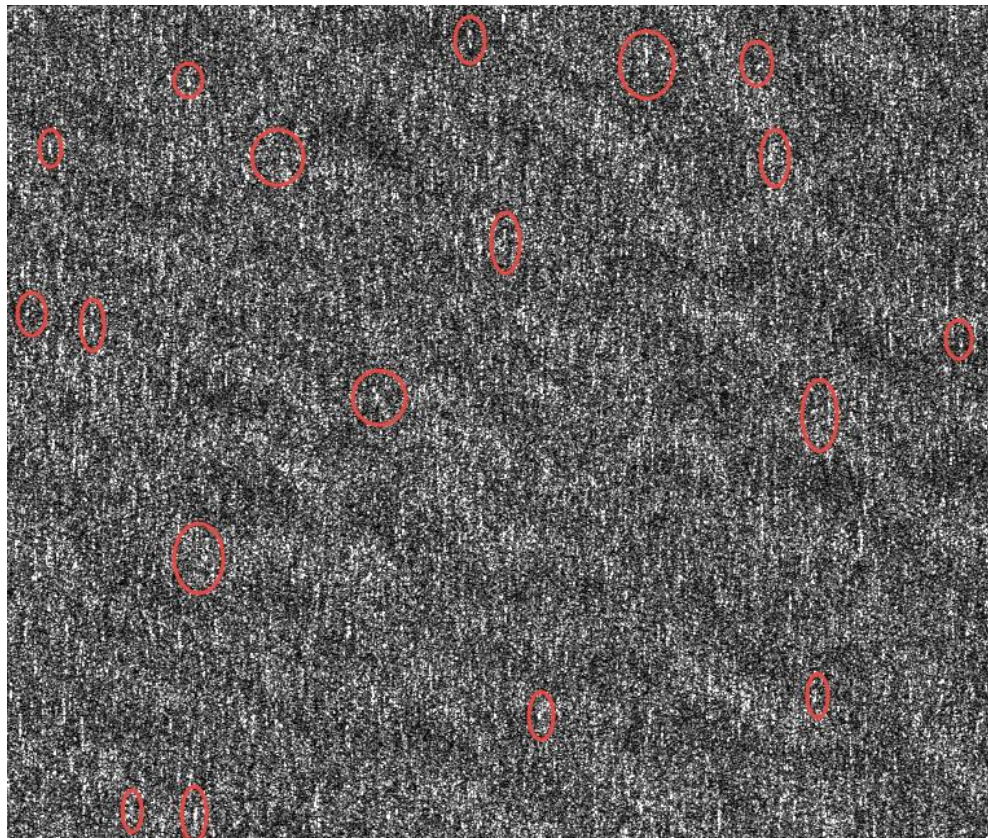


Sailing vessel – 14m



## SAR images dependency – Wind

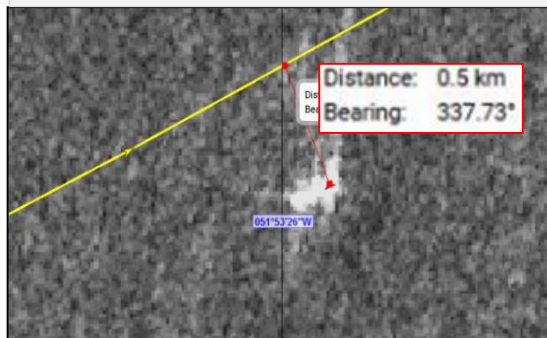
- High wind speed may mask existing targets or generate false positive results



© DLR e.V. [2016], Distribution Airbus DS Geo GmbH

## SAR images dependency – Artefacts and Ambiguities

**Doppler shift – created by sensor and target motions**

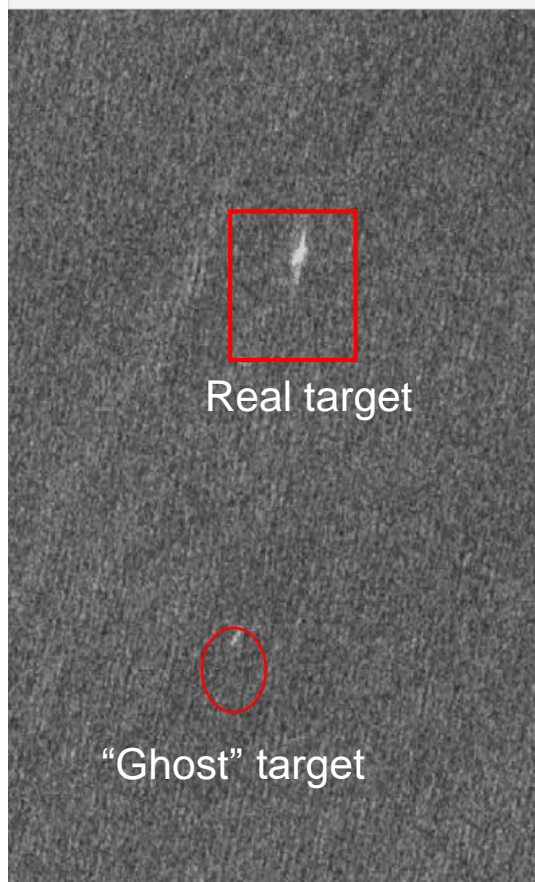


RADARSAT-2 Data and Products © MacDONALD, DETTWILER AND ASSOCIATES LTD [2016] – All Rights Reserved" and "RADARSAT is an official mark of the Canadian Space Agency

**Major reflector – might mask surrounding targets**

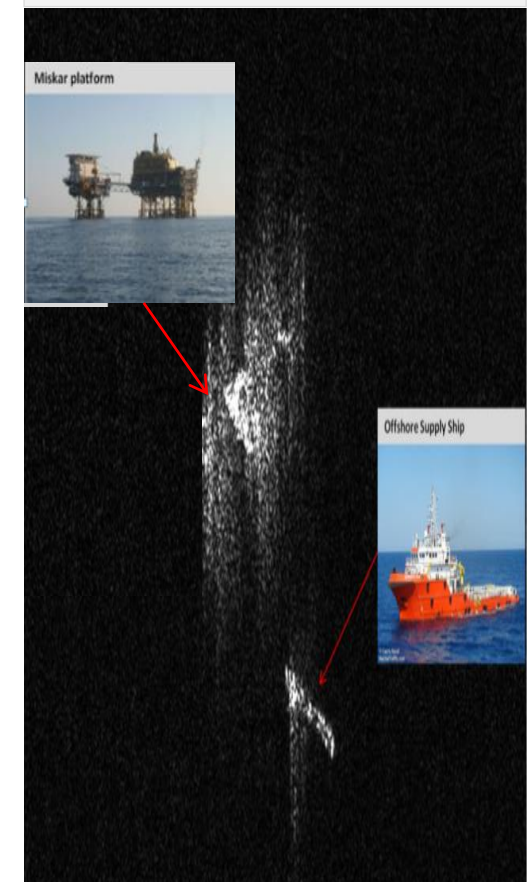


**Azimuth Ambiguity – replicas of strong scatterers**



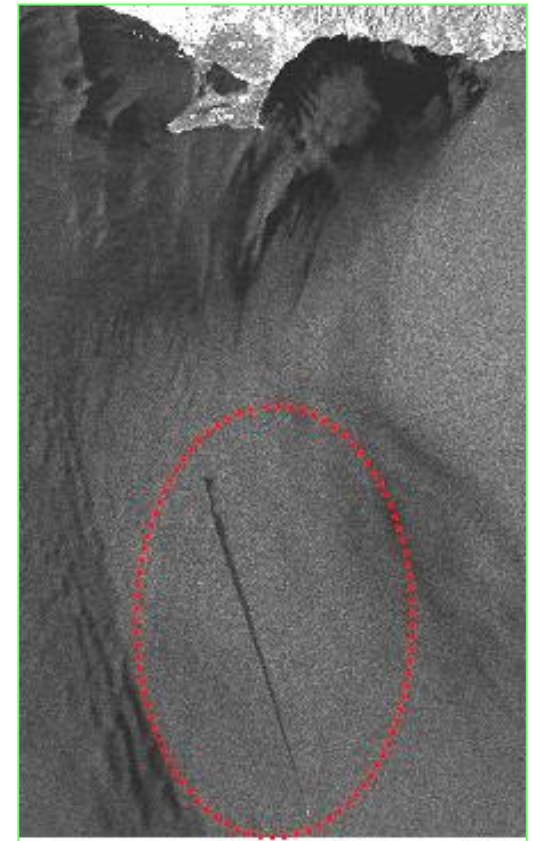
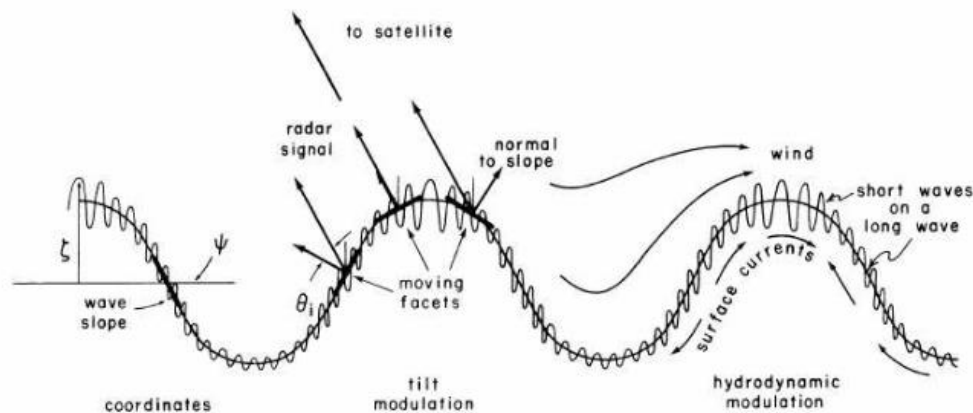
RADARSAT-2 Data and Products © MacDONALD, DETTWILER AND ASSOCIATES LTD [2016] – All Rights Reserved" and "RADARSAT is an official mark of the Canadian Space Agency

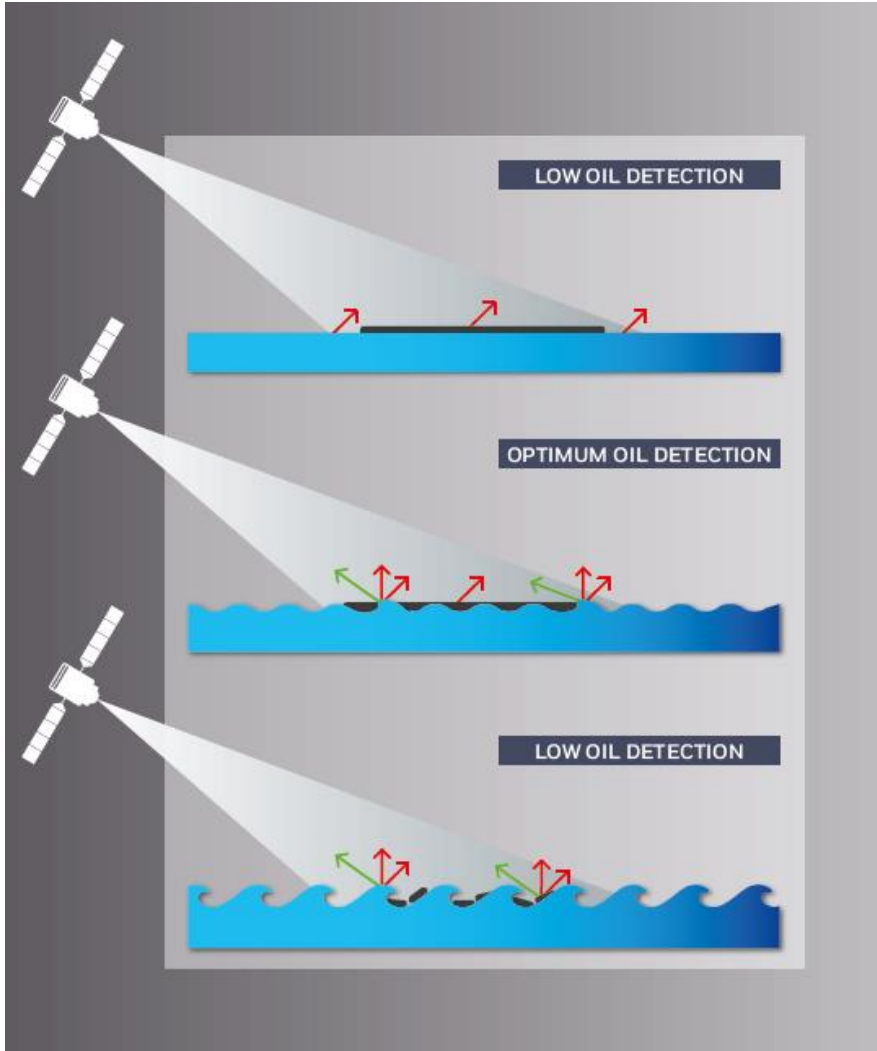
**Lookalikes for vessels**



## Detection Principle in CSN

- Oily films are visible as dark patches
  - sea surface is 'rough' due to small scale waves
  - waves are caused by wind
  - oil smooths the sea surface
  - reduce the backscattered signal





## SAR images dependency Wind

$2-3 \text{ m/s} < \text{WIND} < 12-15 \text{ m/s}$

Moderate winds: strong contrast between oil slick and surrounding waters

## Lookalikes

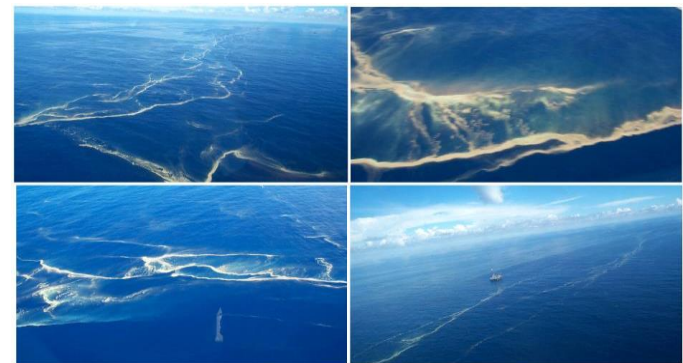
- Examples of lookalikes: low wind area, algae, current front, upwelling area
- Fish or vegetable oil cannot be discriminated in SAR from mineral oil → not considered lookalikes. For validation, they are considered as true detections.



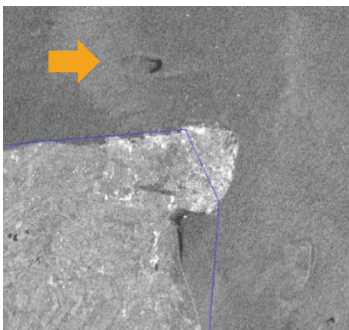
Current fronts



Low wind, rain cells and  
oil seepage



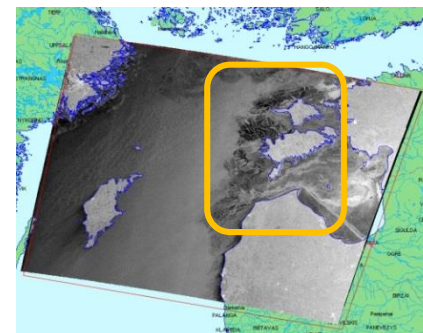
Algae



Sandbank



Land breeze



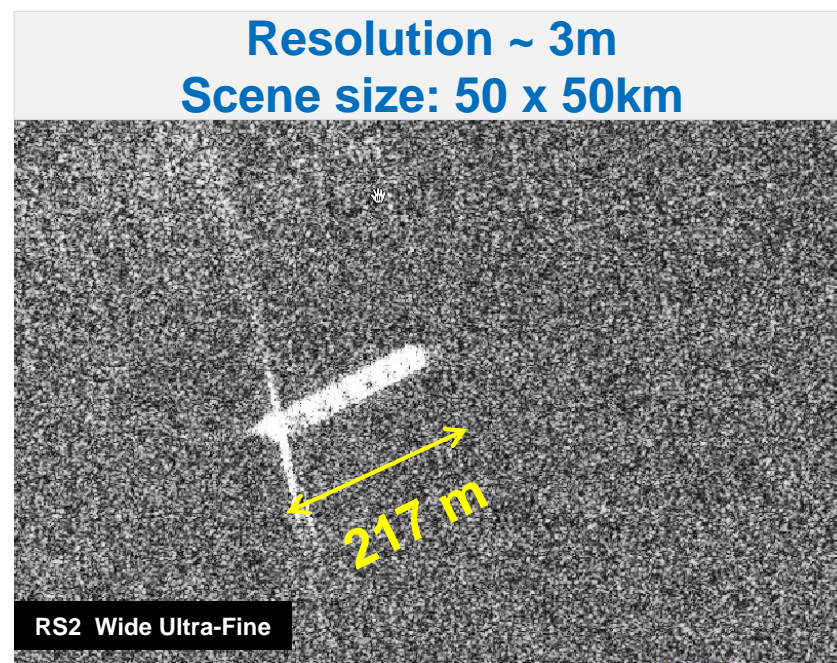
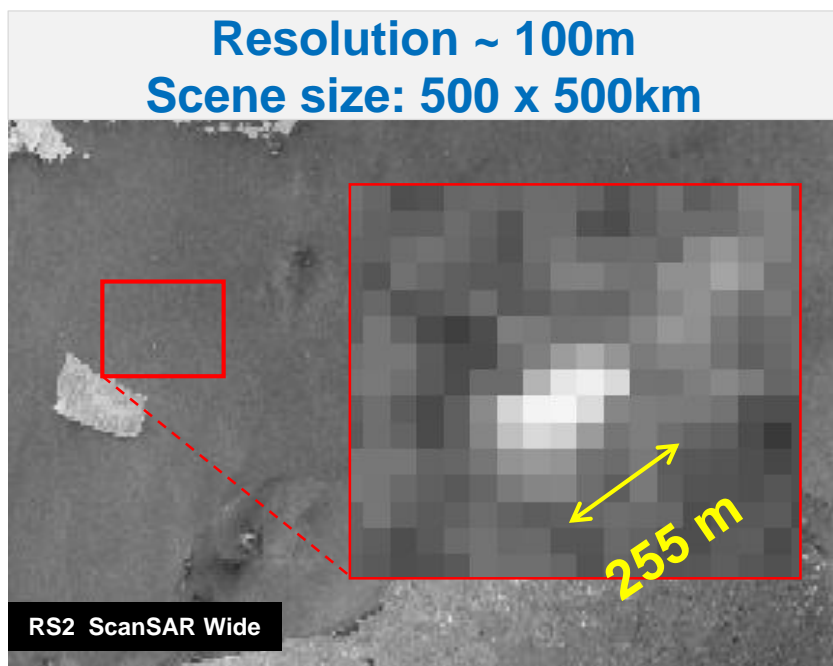
Ice

## **SAR Analysis – due to artifacts, wind dependence lookalikes**

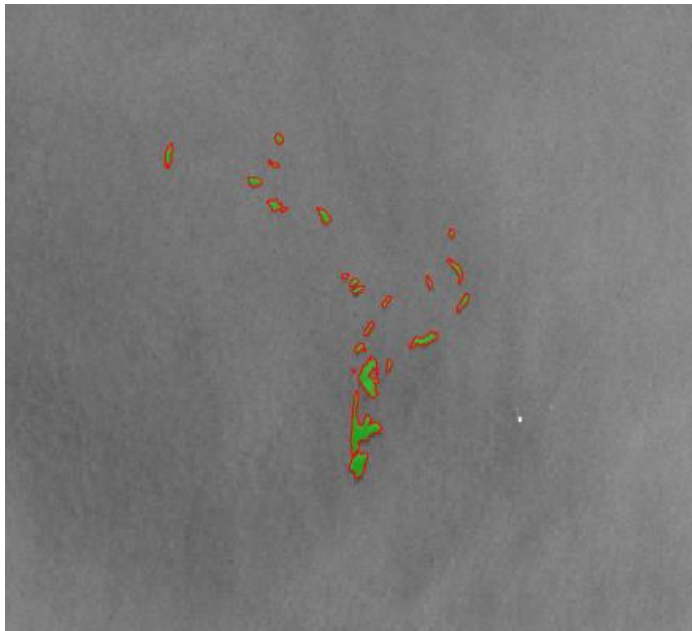
- Oil Spill Detections are “Potential Oil Spills”, and have an associated confidence level: **Class A/Class B**.
- Vessel Detections also have an associated **confidence level** (value from 0 to 100%)
- Oil Spills and Vessel detections might be ‘missed’!
- Polluters are potential polluters: more than one can be indicated

## Trade-off: Resolution vs Coverage

- There are different image products for each satellite
- They differ for example in spatial resolution/swath width
- Trade-off of 2 parameters impacts the size of object detected and the area covered
- High resolution images have a narrower swath and vice-versa



## Value Adding: Oil Spill Detection Service (OSD)



### OSD information

Position\*: Lat/long

TimeStamp: *UTC time*

Class: Class A/Class B

Alert Level: Green Yellow Red

Impacted Areas: list of affected Countries

Feedback Type: list of possible verification values

Origin: SAR detection or drift model

Wind Speed: m/s, from SAR and meteo

Wind Direction: [0-360] °, from SAR and meteo

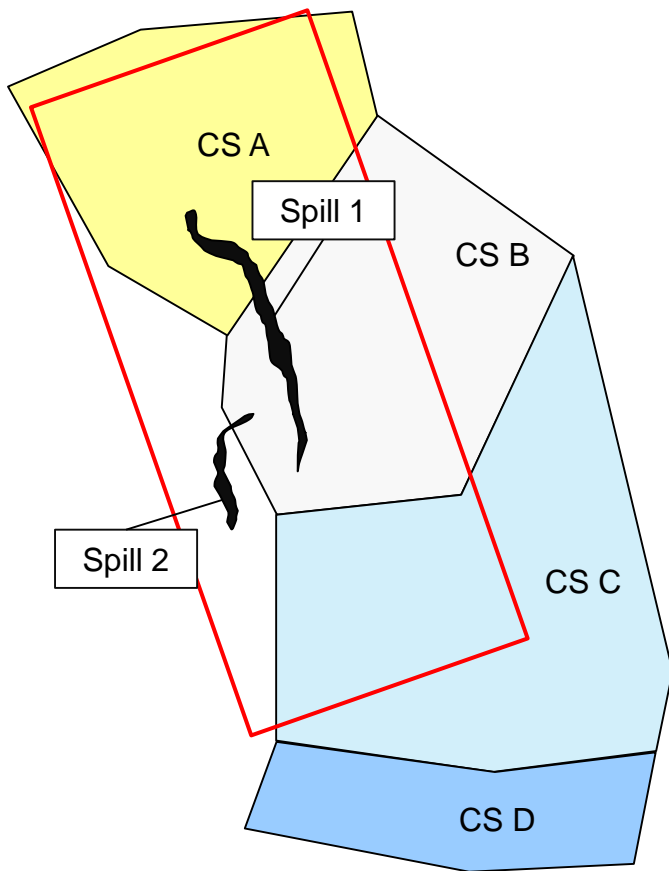
Polygon and List of Slicks

Estimated Length: in meters (per slick)

Estimated Area: in meters (per slick)

Estimated Width: in meters (per slick)

Potential Polluter: one or more of: possible source detected; possible source identified; possible source type

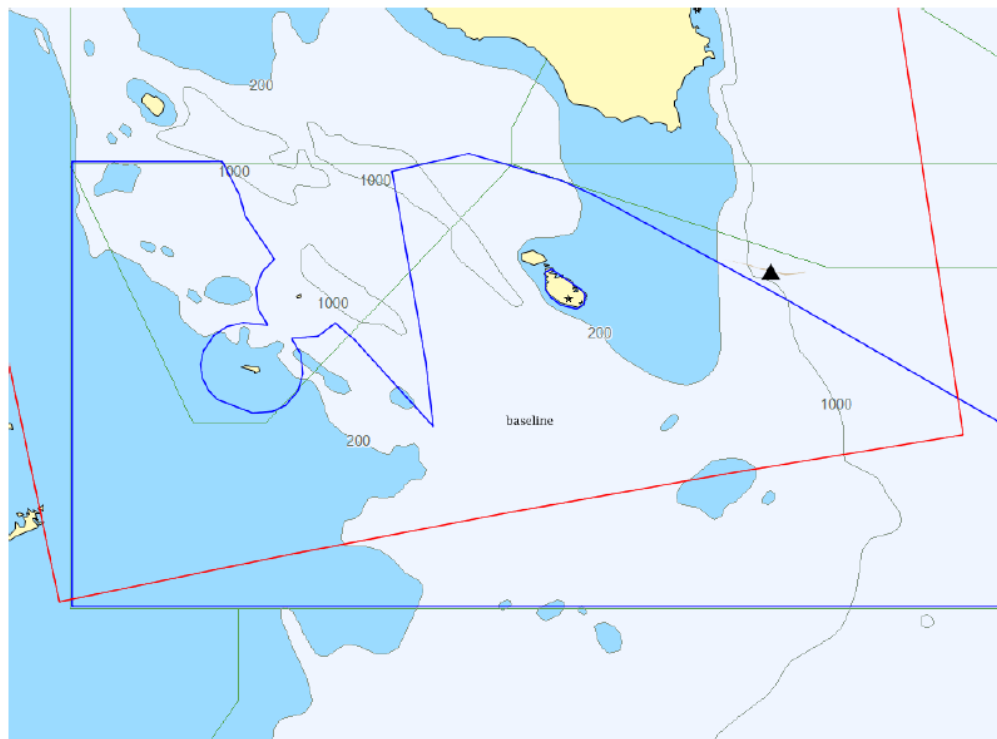


Every time a satellite image is intersecting one national Alert Area, the Coastal State will receive:

- ❑ a “CleanSeaNet Alert Report” if at least one spill polygon intersects the area
- ❑ a “CleanSeaNet Notification” of Clean Sea if no spill intersects the area
- ❑ Additionally, a ‘CleanSeaNet Oil Spill Warning’ if the spill is on-going (to promote catch of polluter red-handed )

CS A and CS B will receive an Alert Report  
CS C will receive a CleanSeaNet Notification  
CS D will not be alerted


# EO Products for CSN



### Comments

### Clean sea

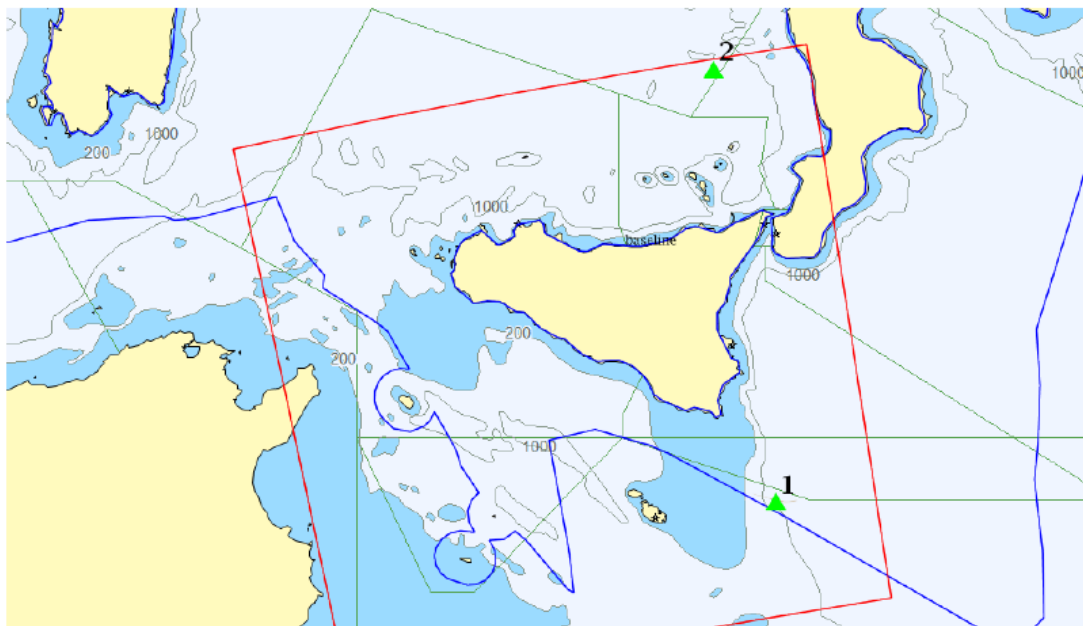
No possible spills have been detected in the alert area

Note: Possible spills outside alert area are presented on map as  - Additional spills may also have been reported outside the map - Please consult GIS Viewer

# EO Products for CSN



Comments



List of possible spills

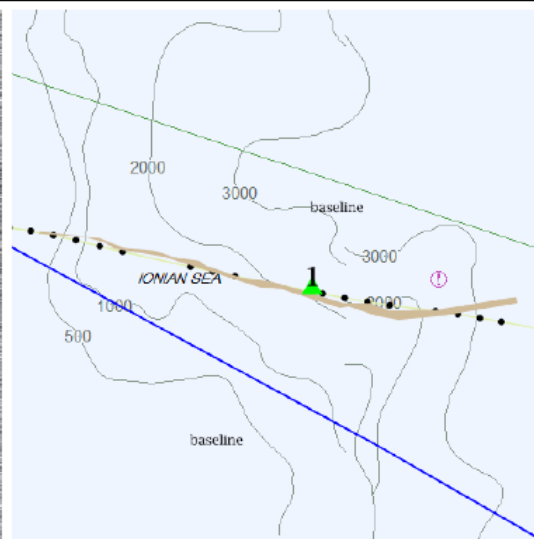
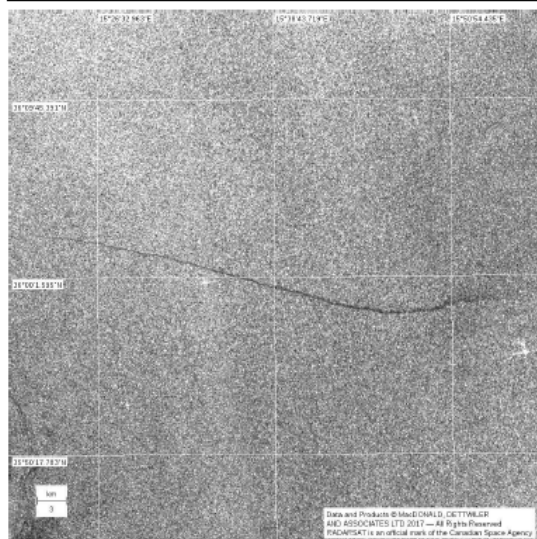
Spill # on map	Spill Identifier	Centre Position		Area (km <sup>2</sup> )	Length (km)	Width (km)	Alert	Oil Spill Warning Issued	Possible Source	
		Latitude	Longitude						Detected	Identified
1	OS_1708150001_1	35° 59' 52" N	015° 38' 44" E	21.74	46.05	3.54	Green	YES	Yes	Yes
2	OS_1708150001_2	39° 25' 13" N	015° 03' 34" E	1.00	2.40	0.69	Green	NO	No	Yes

Note: Possible spills outside alert area are presented on map

▲ - Additional spills may also have been reported outside the map - Please consult GIS Viewer

### Details of possible Spill n°1 - OS\_1708150001\_1

Centre Position		SAR Wind at Center		Area (km²)	Length (km)	Width (km)	Class (A/B)	Alert Level	Number of slicks	Oilspill Warning Issued
Latitude	Longitude	Direction (From)	Speed (m/s)							
35° 59' 52" N	015° 38' 44" E	118.00	2.70	21.74	46.05	3.54	A	Green	1	YES



### Meteorological and Ocean Data

Sea State	N/A	Wave Height (m)	N/A
Met.Wind	Direction (from)		90
	Speed (m/s)		0
Current	Direction (from)		N/A
	Speed (m/s)		N/A

Note: Grey fields are parameters set as "invisible" in the Print Parameters matrix or not available

### Comments from Service Provider

### Possible source information

N.	Detected	Dist.(Km)	Identified	Type	IMO	Name	MMSI	C/S	Latitude	Longitude	Time (UTC)	Track
1	Yes	13	Yes	VESSEL	N/A	N/A	677021400	N/A	36° 03' 33" N	015° 14' 49" E	17:03:05Z	No

### Additional Information

Distance (km) to					Traffic Density
Sensitive Areas	Shoreline	TSS/Shipping Lanes	Rigs/Offshore	Known Wrecks	
1964.4	73.9	687.2		N/A	

Note: Grey fields are parameters set as "invisible" in the Print Parameters matrix

### Alert rules parameters

Classification	A
----------------	---

Note: Classification level is set by the operator analysing the satellite image

Impact and Culprit values ("High", "Medium" or "Low") are the result of alert level rules defined by the Coastal State.

Grey fields are parameters selected as "invisible" in the Print Parameters matrix or parameters for which the alert rules

### List of slicks composing the spill

Slick ref. on Map	Centre position		Area (km <sup>2</sup> )	Length (km)	Width (km)
	Latitude	Longitude			
A	35° 59' 52" N	015° 38' 44" E	21.74	46.05	3.54

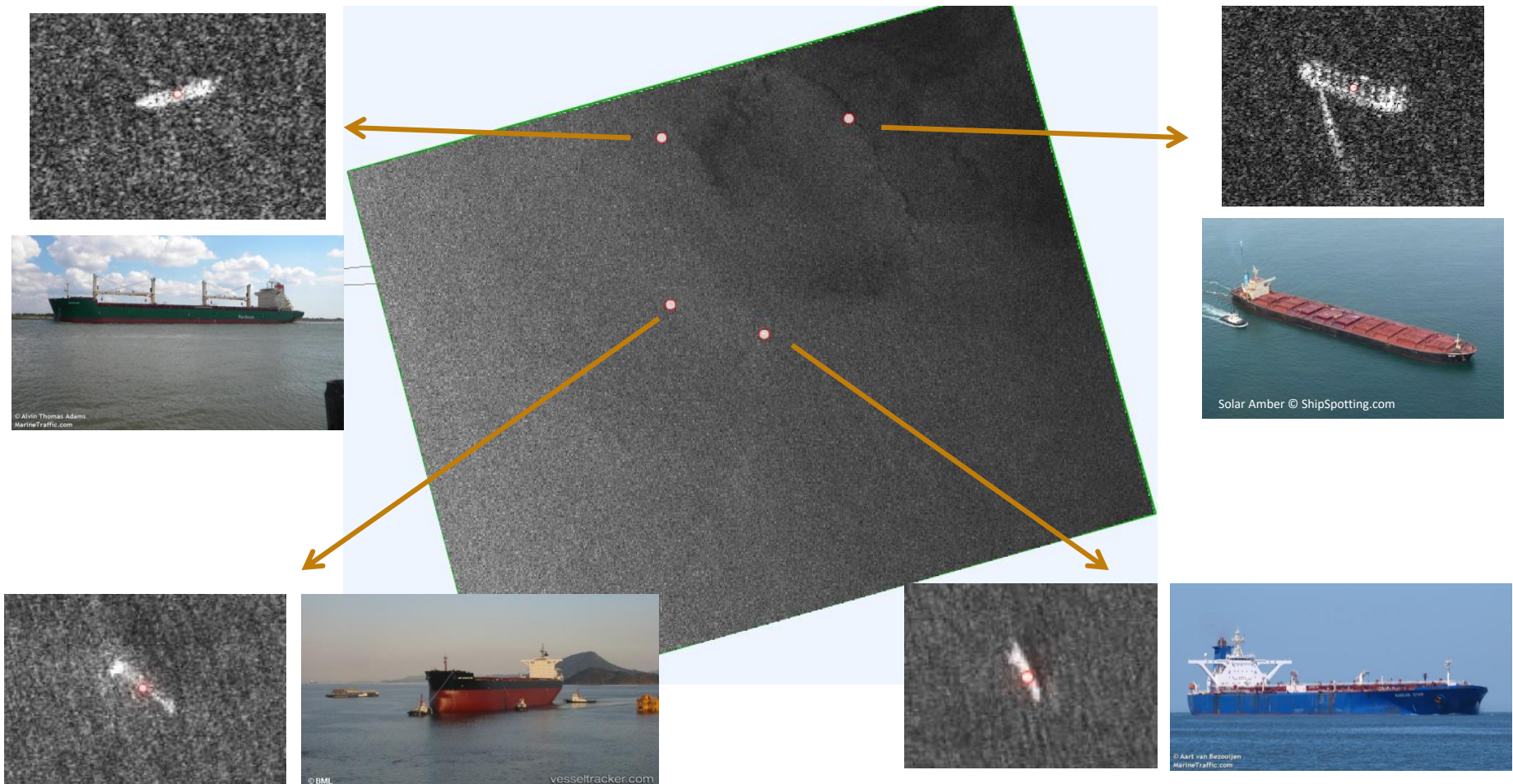
### List of affected areas

Country	Zone	Impact	Culprit
Italy	baseline	Low	Low

Alert level can be **Red**, **Yellow** or **Green**, based on combination of 3 factors:

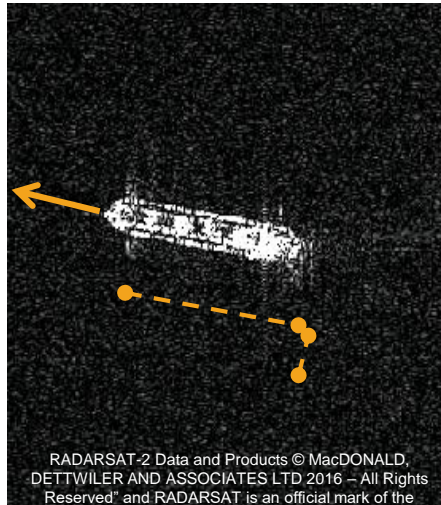
- **Likelihood**
  - Likelihood of the reported spill being oil
  - 2 values: Class A or Class B
  - Information provided by CleanSeaNet service providers
- **Culprit**
  - Probability that a clear culprit can be identified
  - Information calculated by CleanSeaNet data centre based on culprit rules defined by Coastal States for each alert area
- **Impact**
  - Level of potential damage to the environment
  - Information calculated by CleanSeaNet data centre based on impact rules defined by Coastal States for each alert area

## Value Adding: Vessel Detection Service (VDS)



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## Extracted Both from SAR and Optical Images



### VDS information

Position\*: Lat/long

TimeStamp\*: *UTC time*

Confidence level: [0-100]



\* – Mandatory information

## SAR versus Optical

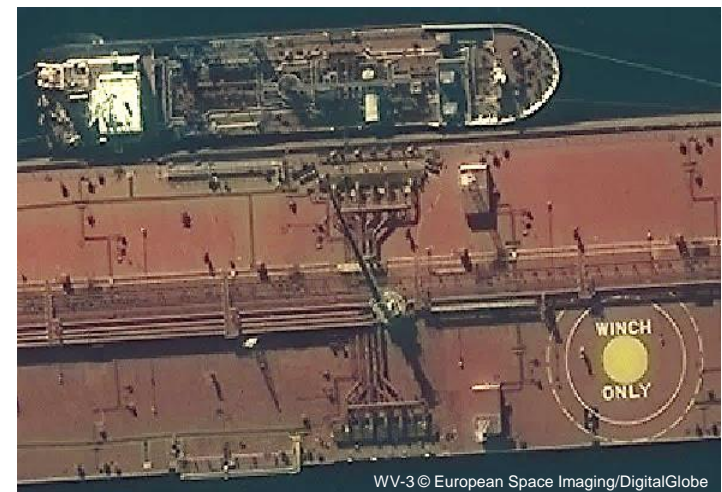
CSN uses mainly **SAR data**.

From: Sentinel-1, Radarsat-2, TerraSAR-X

- In spite of:
  - Sensitivity to wind
  - Subject to many artifacts
  - Analysis difficult!
  - Not useful close to the coast

**Optical data** used only under very specific situations (ex: Emergencies) because:

- Needs sun light and has small area coverage
- Although it contains more info, has higher resolution and is of easier analysis for smaller AOI

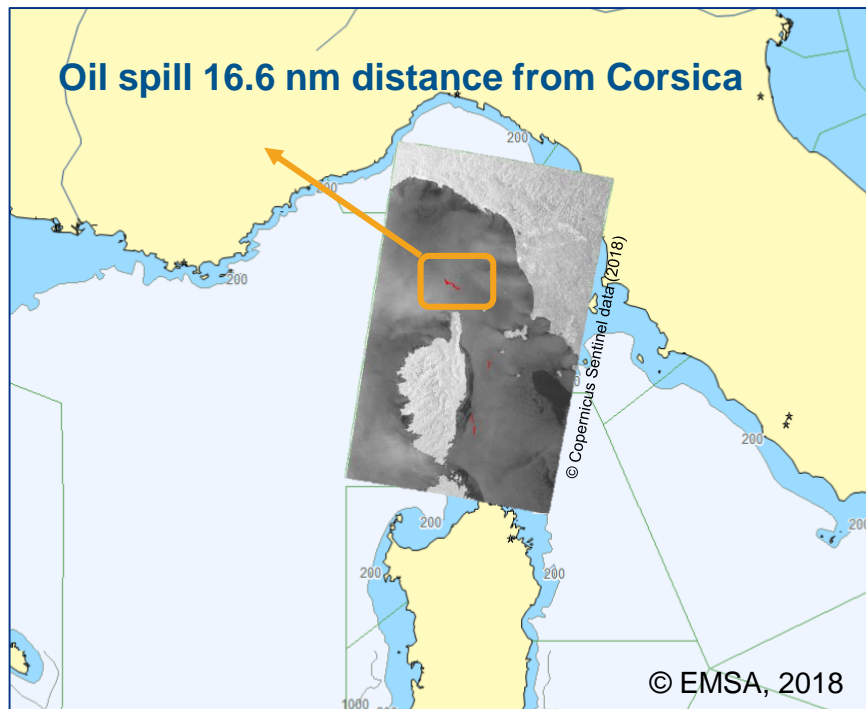


### Corsica incident in 2018

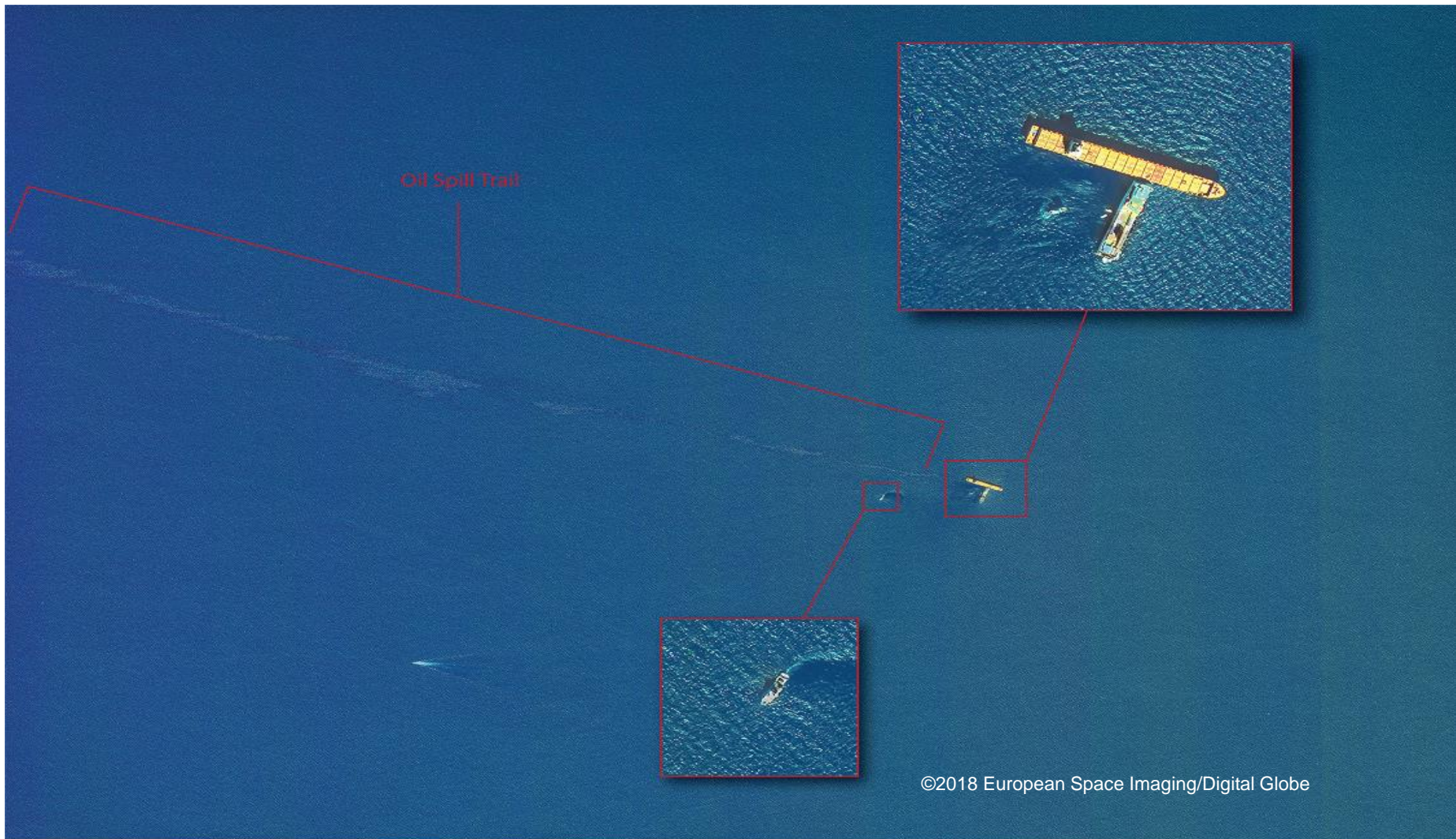
- Oil spill detection in SAR and optical images
- Support pollution response on site



© Prefecture Maritime de la Méditerranée, 2018



# CleanSeaNet Support to Emergencies



Corsica incident October 2018



 [twitter.com/emsa\\_lisbon](https://twitter.com/emsa_lisbon)  
 [facebook.com/emsa.lisbon](https://facebook.com/emsa.lisbon)

