European Maritime Safety Agency

CleanSeaNet

Introduction to CleanSeaNet Service

Earth Observation Services
Unit Surveillance

Lisbon / March 2021

EMSA

Contents

- Overview Earth Observation Services
- Overview CleanSeaNet service
- CleanSeaNet Products

Acronyms

- 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

EMSA Earth Observation Services

USERS

CleanSeaNet

Copernicus Europe's eyes on Earth
Maritime Surveillance

FRONTEX

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

EO DATA CENTRE

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

CleanSeaNet service

16 April 2007
The service became operational

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.

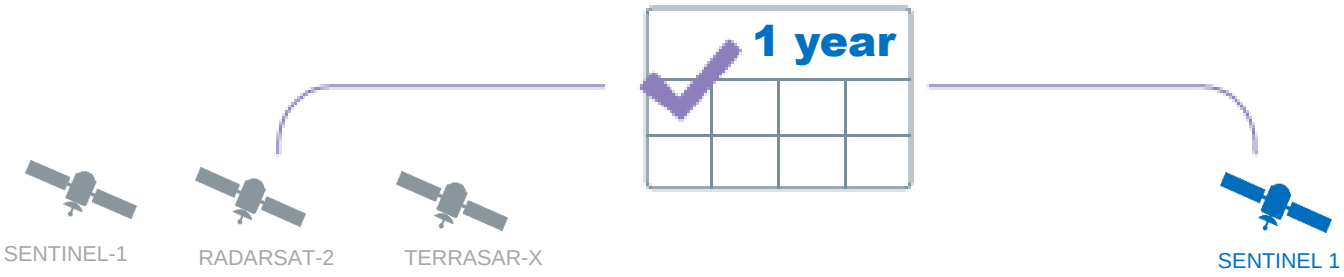
The service was developed and is operated by EMSA, and is available to all EU member states, EFTA/EEA member states, candidate countries and ENP participating countries

CleanSeaNet Key Facts and Figures(1)

2020

EMSA EARTH OBSERVATION
(SAR) CLEANSEANET DATA

Activities Covering



1 584 MILLION KM² MONITORED IN QRT/NRT

8276 SAR IMAGES

8158 POSSIBLE OIL SPILLS DETECTED

(APPROX. 5 SPILLS PER MILLION KM² MONITORED)

1 439 MILLION KM² MONITORED IN QRT/NRT (91% OF OVERALL MONITORED AREA)

7300 SENTINEL-1 IMAGES (88% OF OVERALL CSN IMAGES)

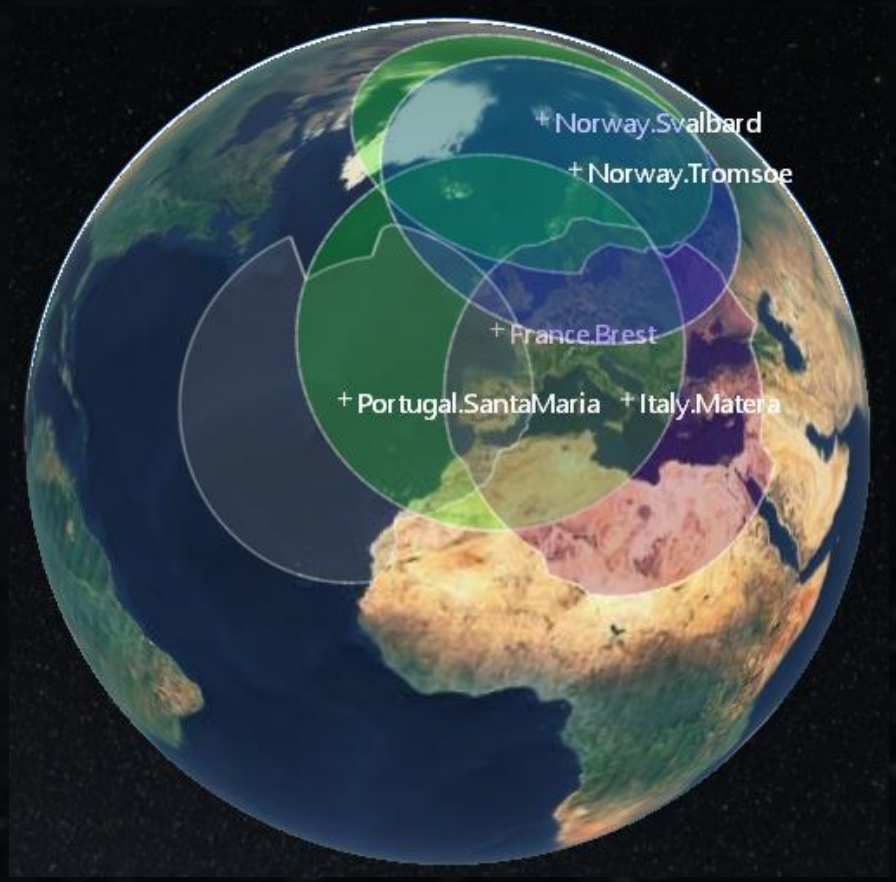
97% OF DELIVERY RELIABILITY FOR SENTINEL-1 IMAGES

(93% FOR RADASART-2 AND 93% 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

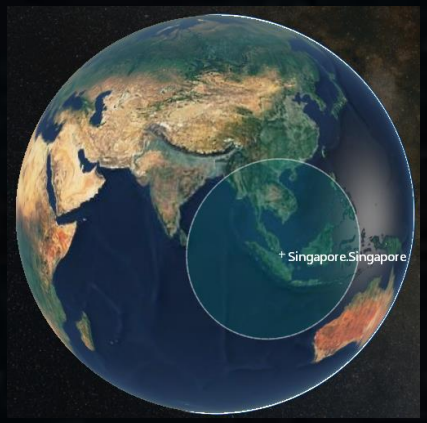
EO Products NRT delivery Time

Med / North seas /
Baltic / Arctic / North Atlantic



Antarctica

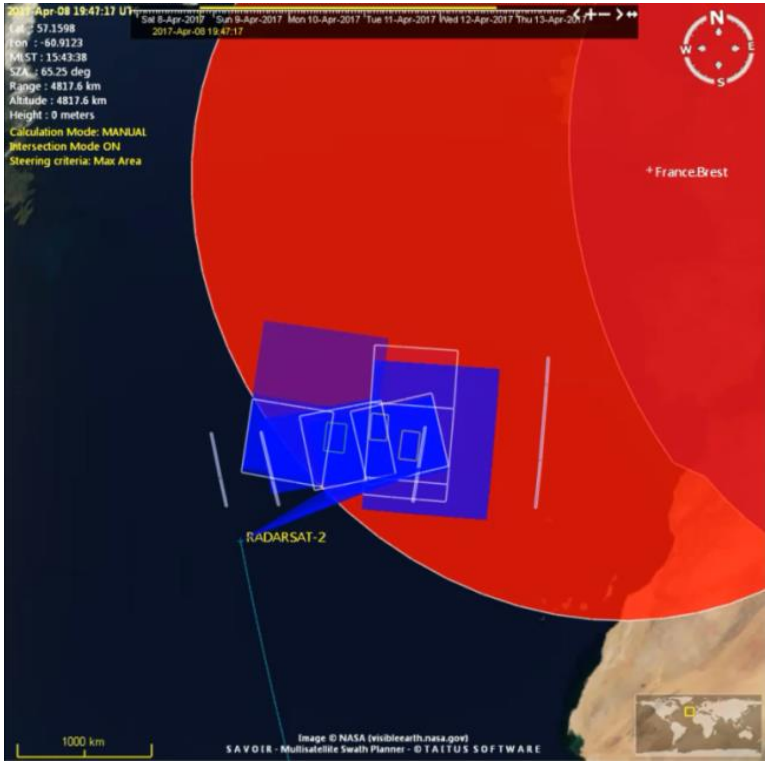
Singapore



Delivery time

Delivery time outside the ground station coverage

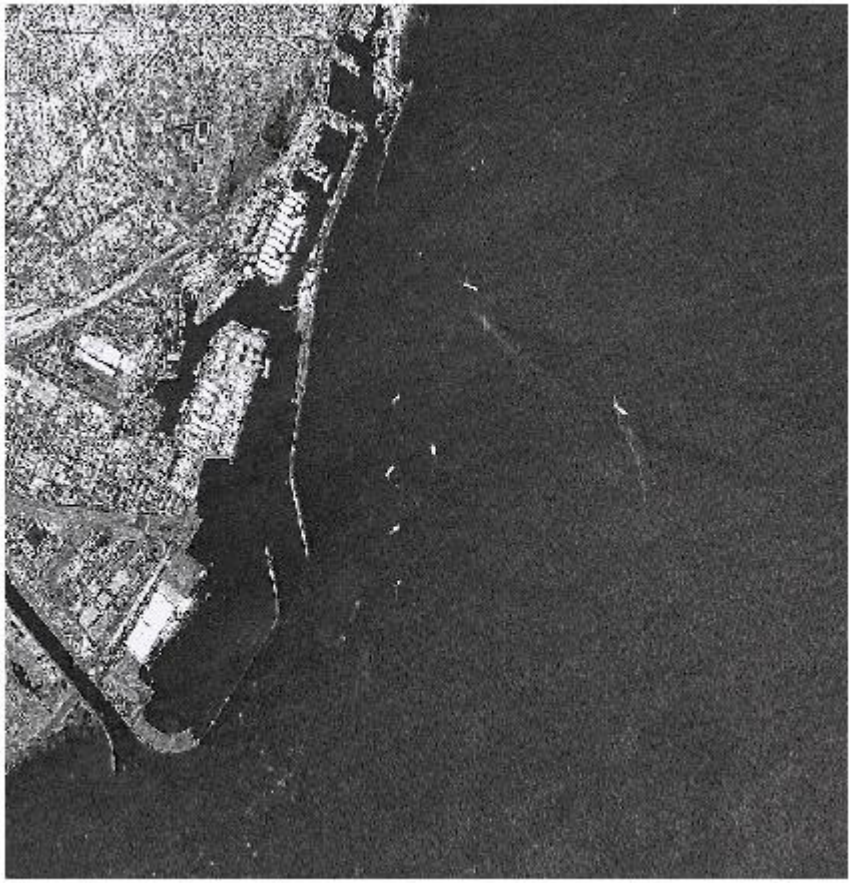
- Satellite flight time to ground station visibility is added to the delay:



CleanSeaNet image products

SAR DATA

QUASI REAL TIME* DELIVERY (20‘) TO USERS



Barcelona, Spain - TSX ST © DLR eV. 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

What does a Radar Measures?

Radar

1. Electromagnetic waveform propagates from the sensor to the ground

2. When the waveform hits the ground, it induces currents in the material that re-radiate electromagnetic energy in all directions

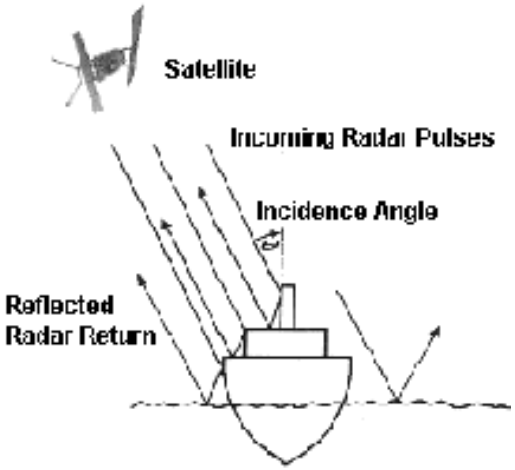
3. The reflectivity function of the material determines how much of the energy gets re-radiated as a function of direction (most gets scattered in the "specular" direction away from the radar, some penetrates then re-radiates, some gets absorbed)

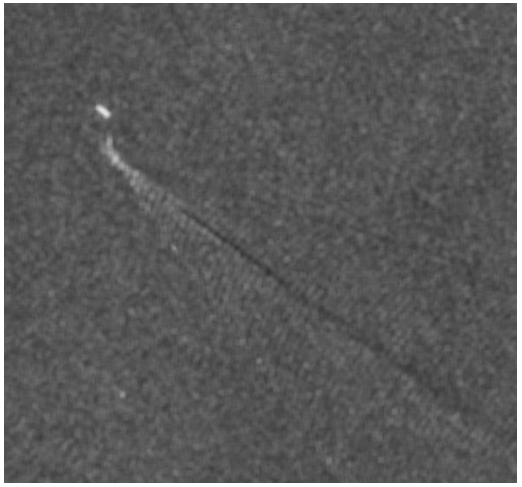
4. Radar just measures what gets backscattered in the direction it came in.

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!

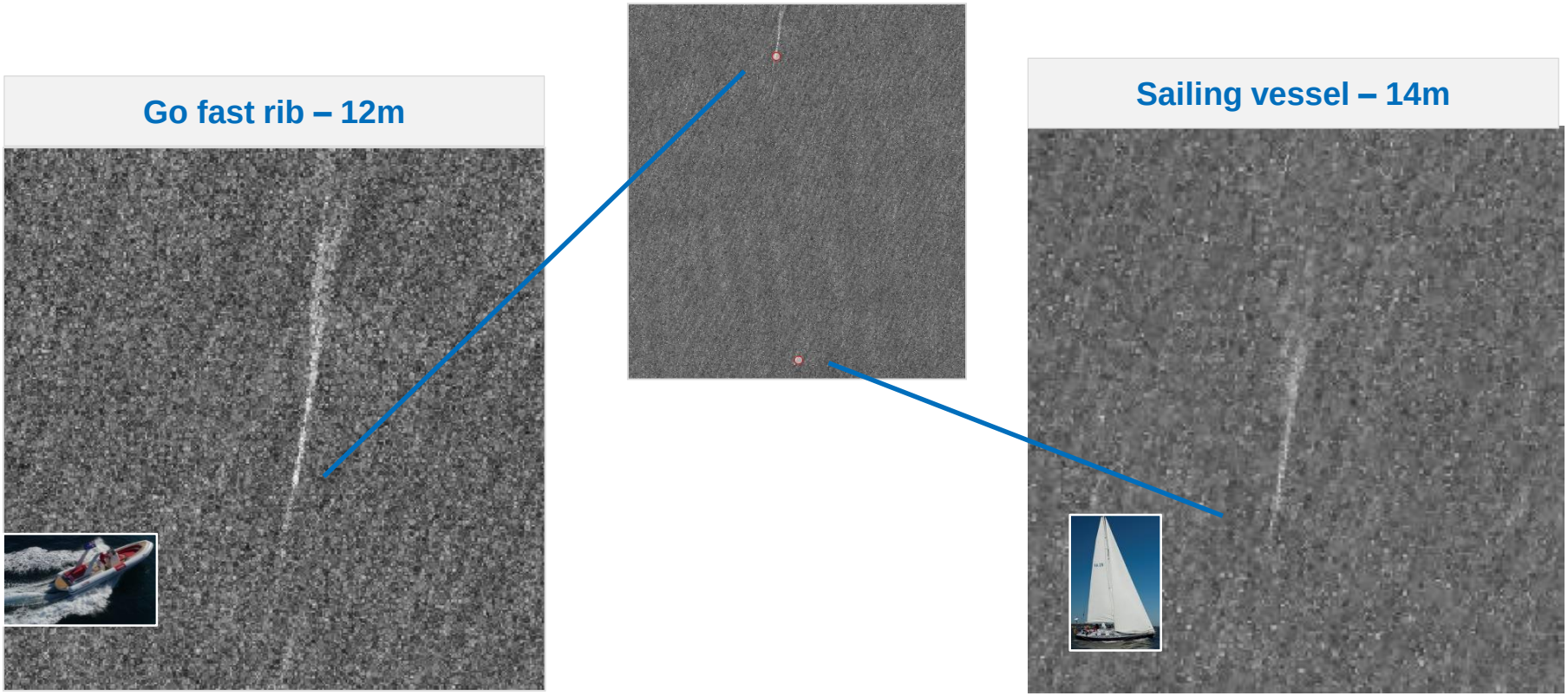




Sensor: **Strong signal => Bright Pixel**

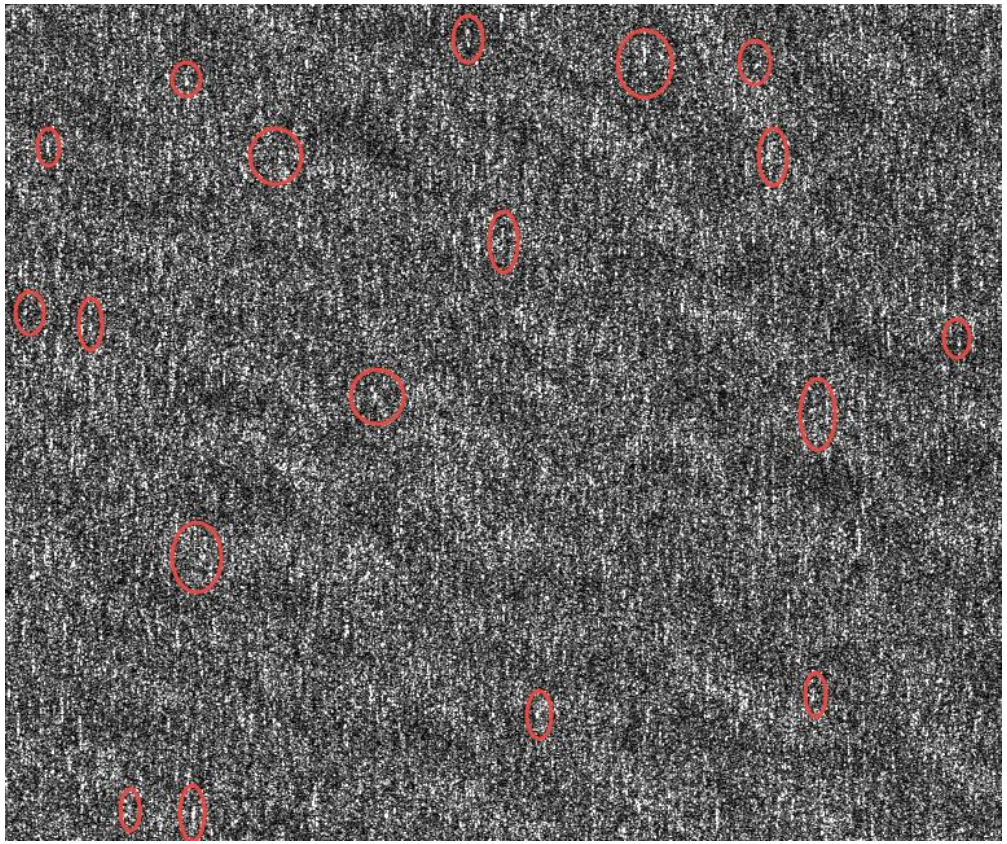
Detection Principle in CSN

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



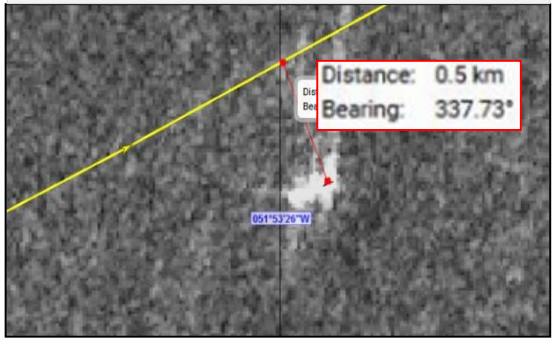
SAR images dependency – Wind

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



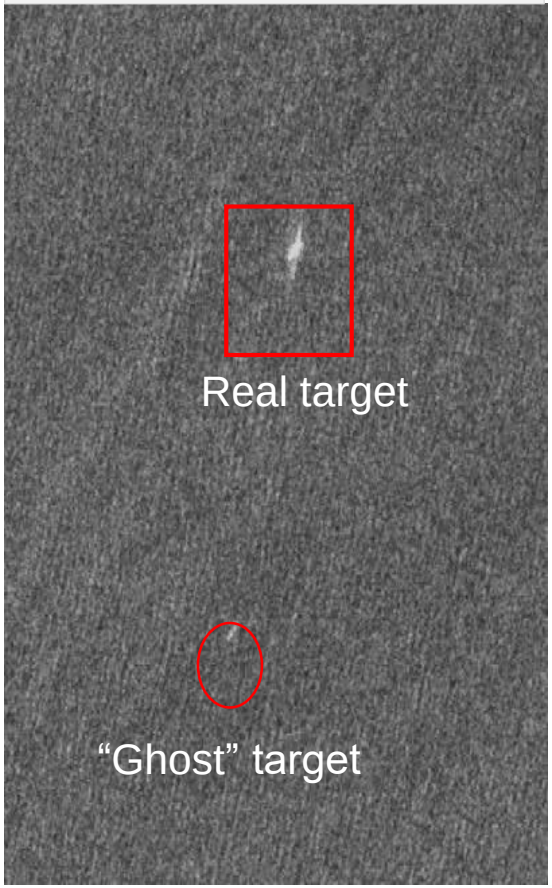
SAR images dependency – Artefacts and Ambiguities

Doppler shift – created by sensor and target motions

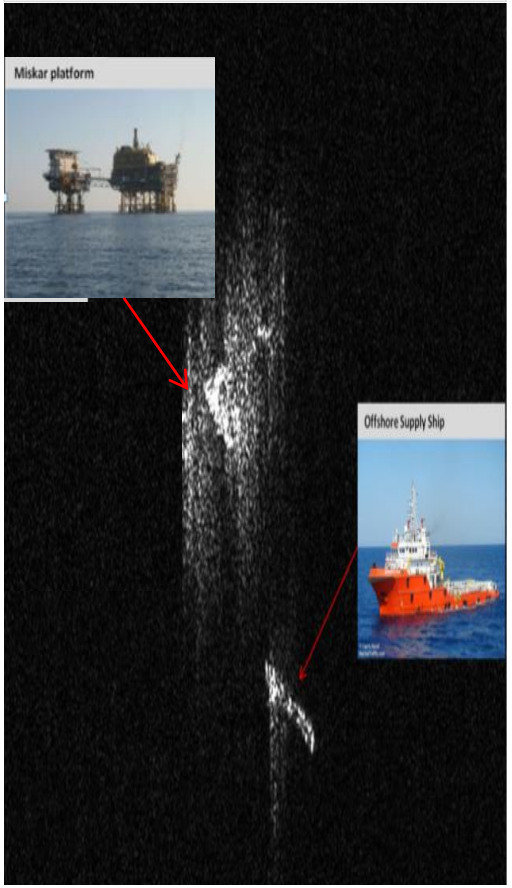


Major reflector – might mask surrounding targets

Azimuth Ambiguity – replicas of strong scatterers

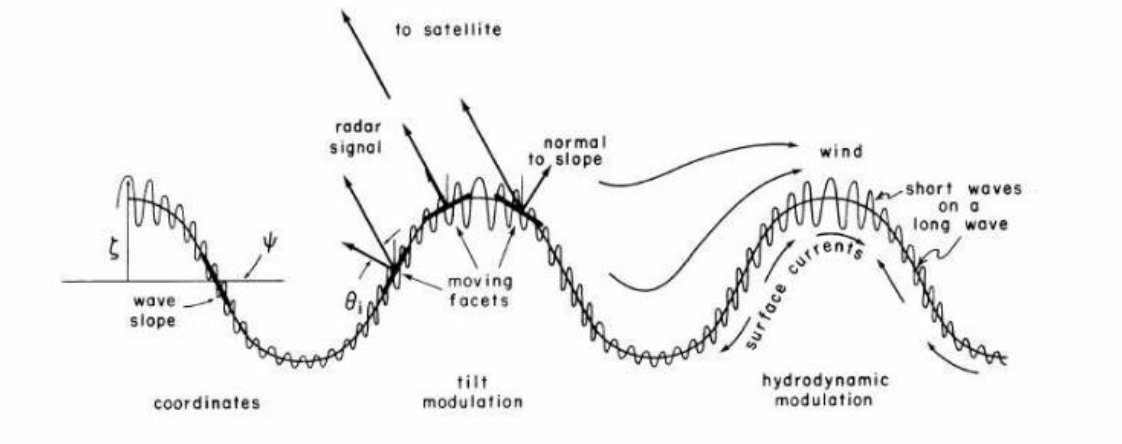


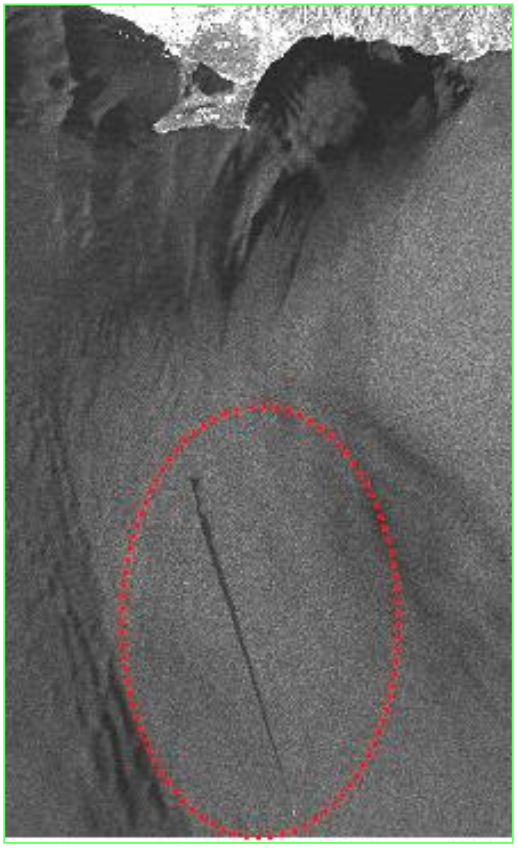
Lookalikes for vessels



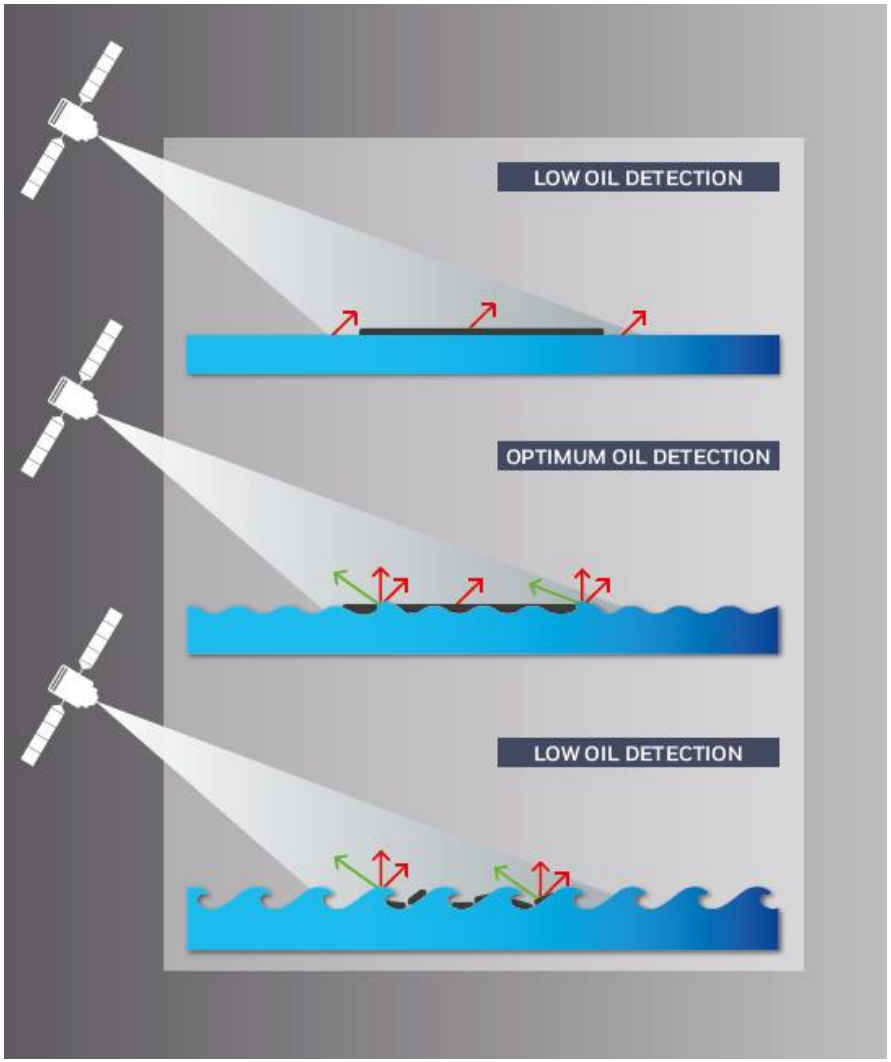
Detection Principle in CSN

- 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





EO Products



SAR images dependency Wind

2-3 m/s < WIND < 12-15 m/s

Moderate winds: strong contrast between oil slick and surrounding waters

EO Products

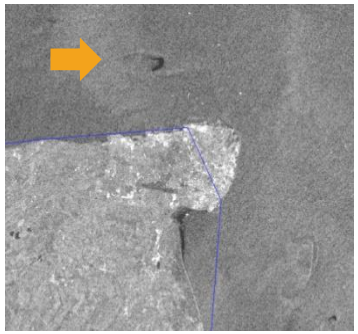
Lookalikes

- 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

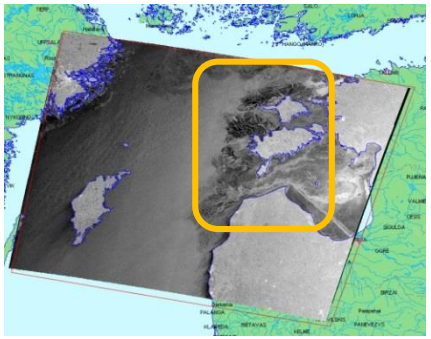
Low wind, rain cells and oil seepage

Algae



Sandbank

Land breeze



Ice

EO Products

SAR Analysis – due to artifacts, wind dependence lookalikes

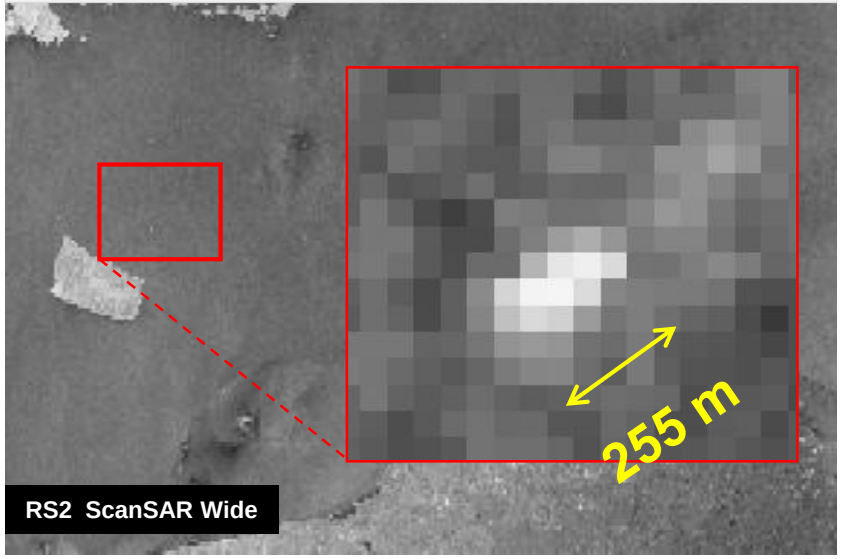
- Oil Spill Detections are “Potential Oil Spills”, and have an associated confidence level: **Class A**/**Class B**.
- Vessel Detections also have an associated **confidence level** (value from 0 to 100%)
- Oil Spills and Vessel detections might be ‘missed’!
- Polluters are potential polluters: more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

EO Products

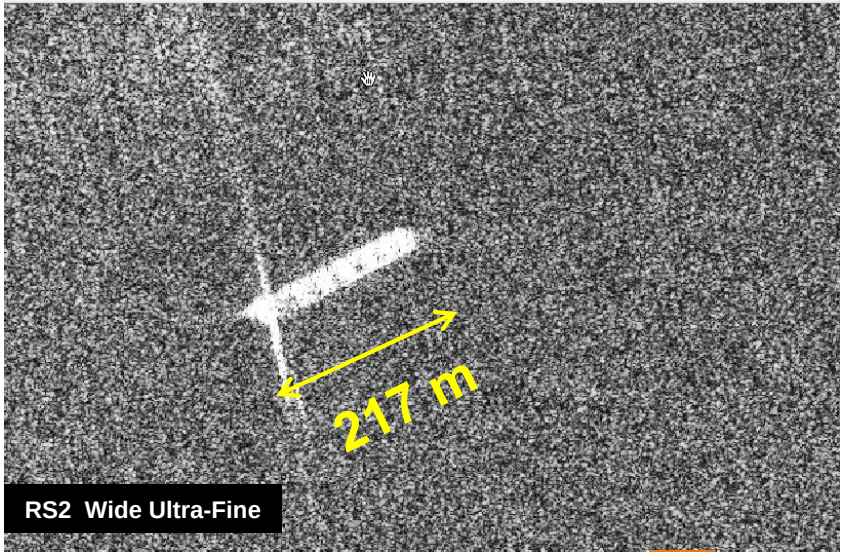
Trade-off: Resolution vs Coverage

- 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

Resolution ~ 100m
Scene size: 500 x 500km

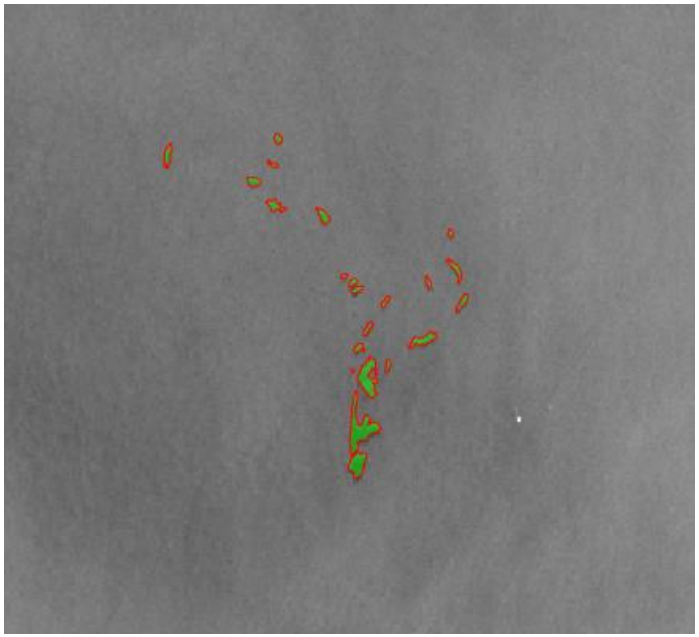


Resolution ~ 3m
Scene size: 50 x 50km



EO Products for CSN

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] º, 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

EO Products for CSN

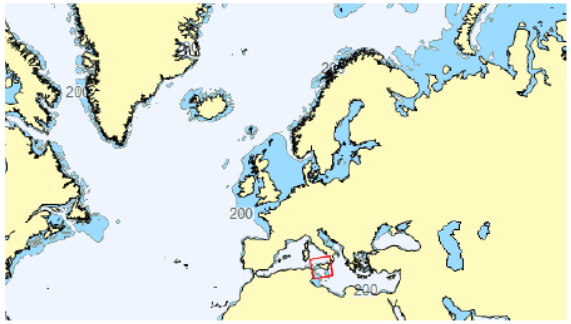
EMSA
European Maritime Safety Agency

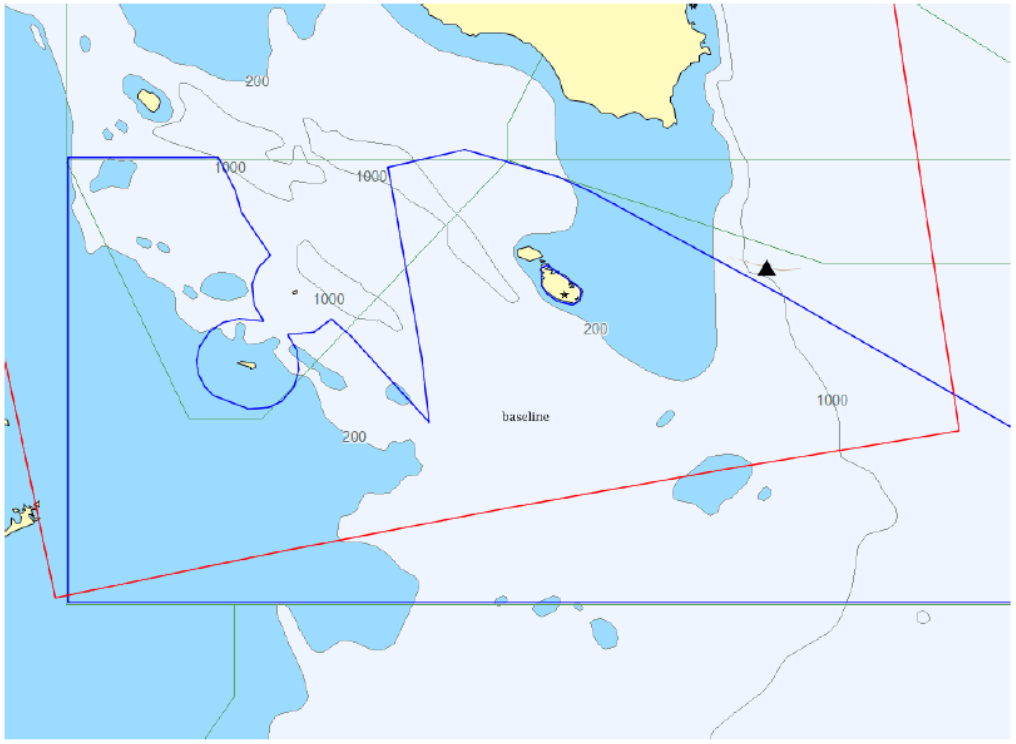
CleanSeaNet Notification **MALTA**

Acquisition Start Time: **2017-08-15 17:03:18 UTC**

Service Identifier: **1708150001** **RADARSAT-2 - SAR - SCW**

GIS Viewer





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

EMSA Maritime Support Services 24/7 - Tel.: +351 21 1209 415 - Fax: +351 21 1209 480 Mail: MaritimeSupportServices@emsa.europa.eu

EO Products for CSN

EMSA

European Maritime Safety Agency

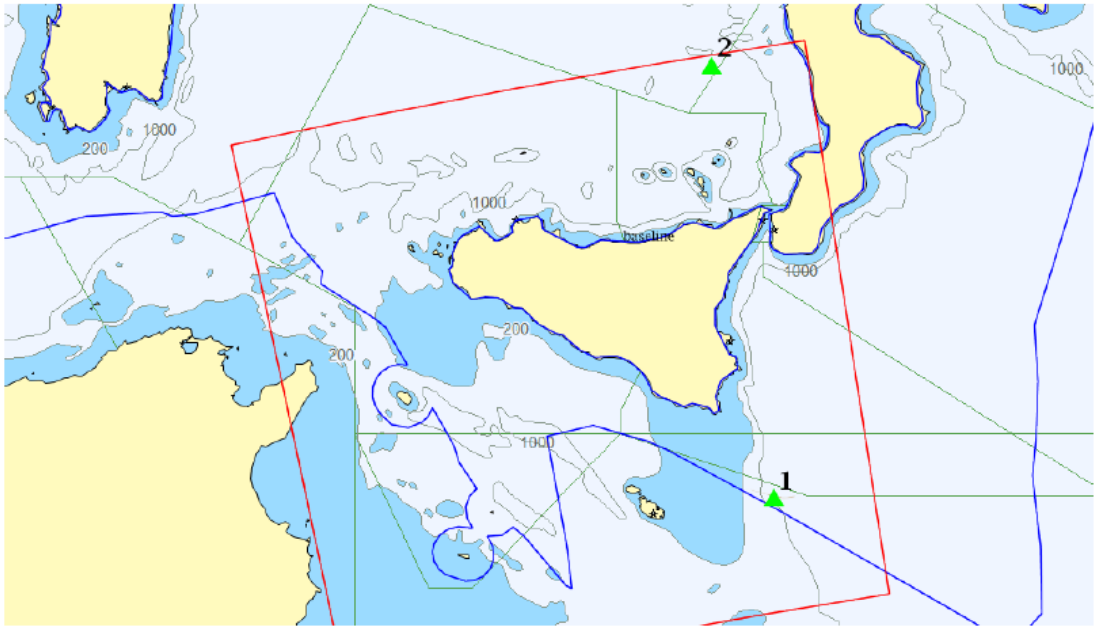
CleanSeaNet Alert Report

ITALY

Acquisition Start Time: **2017-08-15 17:03:18 UTC**

Service Identifier: **1708150001** **RADARSAT-2 - SAR - SCW**

GIS Viewer



Comments

List of possible spills

Spill # on map	Spill Identifier	Centre Position		Area	Length	Width	Alert	Oil Spill Warning Issued	Possible Source	
		Latitude	Longitude	(km²)	(km)	(km)			Detected	Identified
1	OS_1708150001_1			21.74	46.05	3.54	Green	YES	Yes	Yes
2	OS_1708150001_2			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

EO Products for CSN

EMSA
European Maritime Safety Agency

CleanSeaNet Alert Report

ITALY

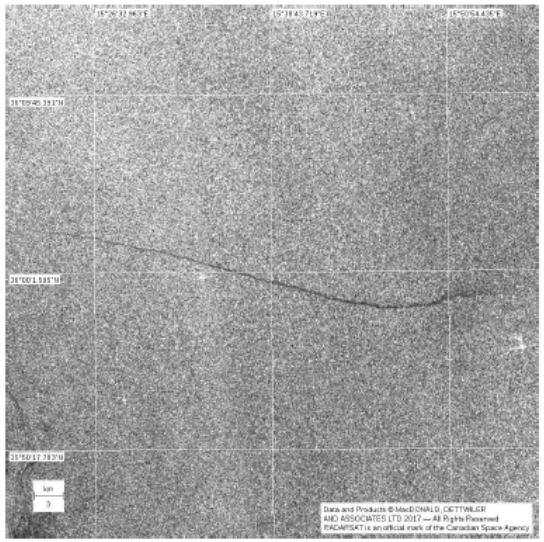
Acquisition Start Time: **2017-08-15 17:03:18 UTC**

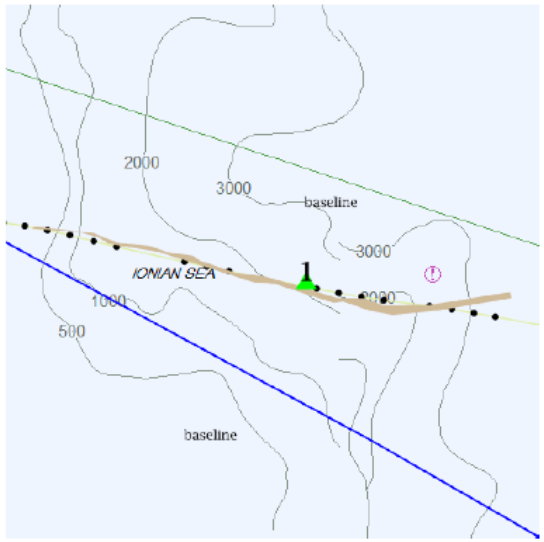
Service Identifier: **1708150001** **RADARSAT-2 - SAR - SCW**

List of Spills | GIS Viewer

Details of possible Spill n°1 - OS_1708150001_1

Centre Position		SAR Wind at Center		Area	Length	Width	Class	Alert Level	Number of slicks	Oilspill Warning Issued
Latitude	Longitude	Direction (From)	Speed (m/s)	(km²)	(km)	(km)	(A/B)			
[redacted]	0[redacted]	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	[redacted]	N/A	36° 03' 33" N	015° 14' 49" E	17:03:05Z	No

EO Products for CSN

EMSA

European Maritime Safety Agency

CleanSeaNet Alert Report

ITALY

Acquisition Start Time: **2017-08-15 17:03:18 UTC**

Service Identifier: **1708150001** **RADARSAT-2 - SAR - SCW**

List of Spills | GIS Viewer

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	Length	Width
	Latitude	Longitude	(km²)	(km)	(km)
A	[redacted]	[redacted]	21.74	46.05	3.54

List of affected areas

Country	Zone	Impact	Culprit
[redacted]	baseline	Low	Low

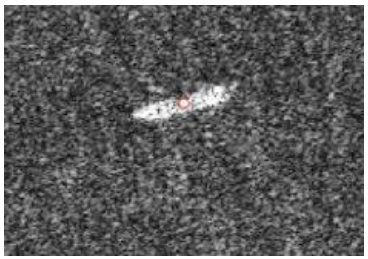
EO Products for CSN

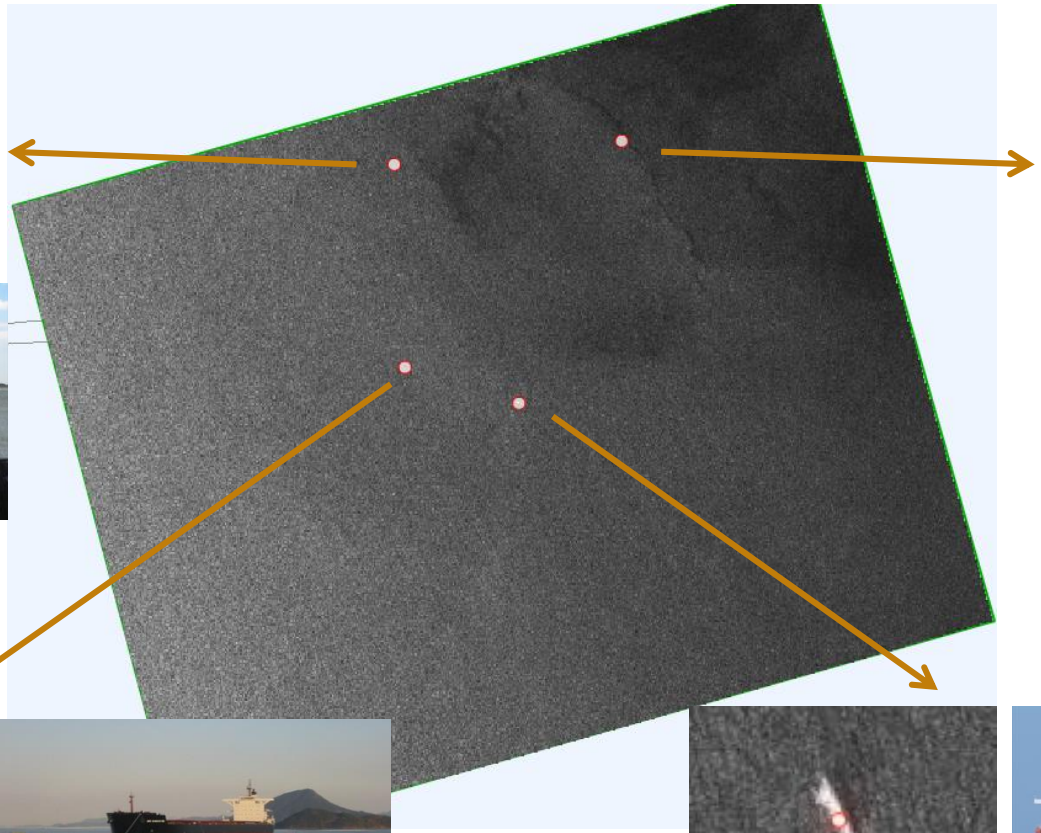
Alert level can be Red, Yellow or Green, based on combination of 3 factors:

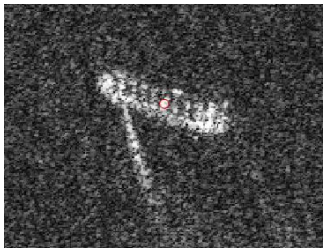
- **Likelihood**
  - Likelihood of the reported spill being oil
  - 2 values: Class A or Class B
  - Information provided by CleanSeaNet service providers
- **Culprit**
  - Probability that a clear culprit can be identified
  - Information calculated by CleanSeaNet data centre based on culprit rules 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

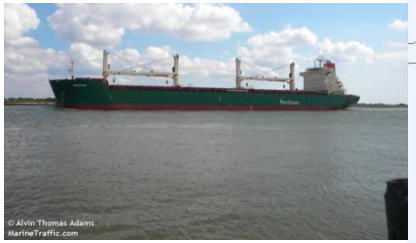
EO Products for CSN

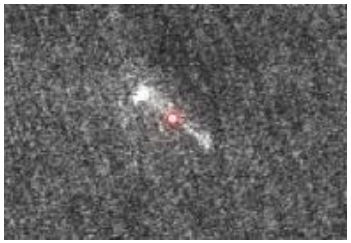
Value Adding: Vessel Detection Service (VDS)





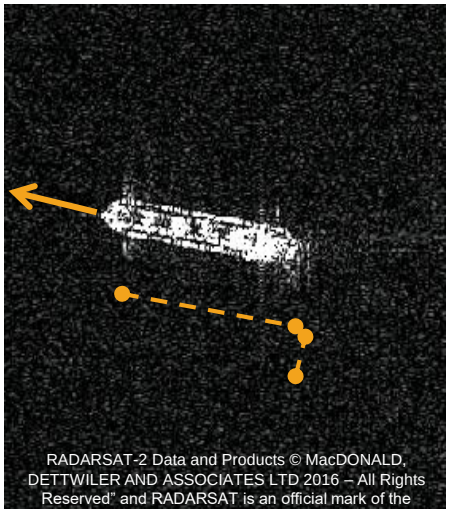






EO Products for CSN

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

twitter.com/emsa_lisbon

facebook.com/emsa.lisbon

EMSA

European Maritime Safety Agency