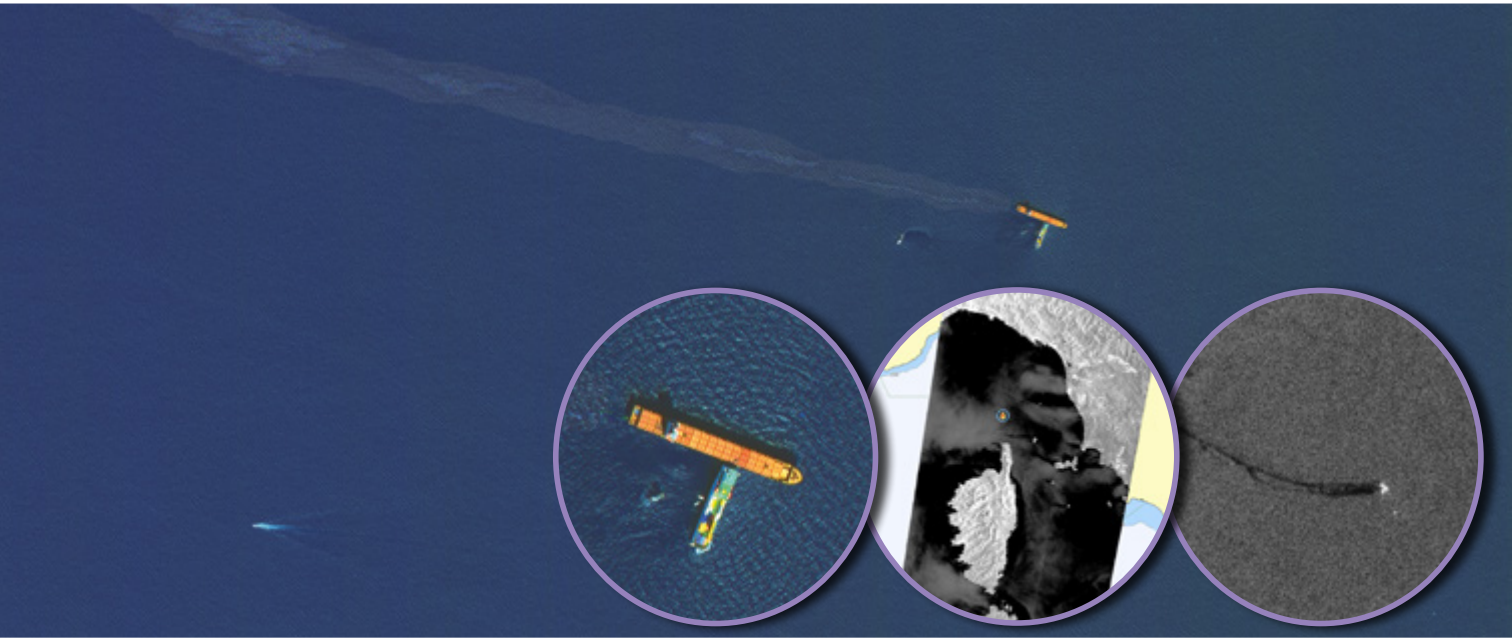
European Maritime Safety Agency



COPERNICUS MARITIME SURVEILLANCE PRODUCT CATALOGUE

European Commission

Copernicus
Europe's eyes on Earth

EMSA

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COPERNICUS MARITIME SURVEILLANCE PRODUCT CATALOGUE

Version 2019

CONTENTS

INTRODUCTION

Copernicus is a European Union Programme aimed at developing European information services based on satellite Earth Observation (EO) and in-situ (non-space) data. The European Maritime Safety Agency (EMSA) is the Entrusted Entity responsible for implementing the Copernicus Maritime Surveillance (CMS) service under a Delegation Agreement signed with the European Commission.

The CMS service provides satellite image and value-added products to support monitoring of human activity at sea for a range of functions, including amongst others: fisheries control, maritime safety and security, customs, law enforcement, marine environment pollution monitoring, and support to international organisations and other functions. The CMS service can be accessed by European Union (EU) and European Free Trade Association (EFTA) national administrations with responsibilities at sea, as well as relevant EU bodies and institutions.

The CMS service forms one component of the broader Integrated Maritime Services (IMS) approach offered by EMSA. This allows users to access other complementary data sets, such as vessel position reports, enabling them to combine data selectively to obtain information in the most useful way possible.

CMS offers users an extended geographical scope and enhanced range of high-quality earth observation and related information. Coverage can be

provided in areas of European interest across the globe, with a variety of different resolutions and sensor types. In addition to image products, the service provides value-added products, including detection and classification of vessels, and activity detection.

The catalogue is divided into six chapters:

- The first chapter of the catalogue describes the service scope and data policy.
- The second chapter explains how to access the service, describes the types of service requests that can be made and provides an overview of service delivery.
- The third chapter of the catalogue presents the EO image products available, both from synthetic aperture radar (SAR) and optical satellites.
- The fourth chapter of the catalogue describes the value-added products. This type of information is extracted from the images using algorithms developed for that specific purpose and is tailored to the end-users' needs.
- The fifth chapter provides information on the higher-level fusion products available.
- The sixth chapter addresses some of the frequently asked questions posed by users.

The products listed in the Product Catalogue and provided by the CMS service are only for distribution to, and for the official use of, authorised users.

CHAPTER 1

GETTING STARTED

1.1 SERVICE SCOPE

The Copernicus Maritime Surveillance (CMS) service provides Earth Observation (EO) products (satellite images and value-added products) to support a better understanding and improved monitoring of human activities at sea. The products available through the CMS service are combined with other data sources as an integral part of the Integrated Maritime Services (IMS) offered by the European Maritime Safety Agency (EMSA).

The CMS service is available to interested European Union (EU) and European Free Trade Association (EFTA) national administrations with responsibilities at sea, as well as relevant EU bodies and institutions. On request, CMS can also provide support to relevant international organisations, in consultation with and based on the approval of DG-GROW and the European External Action Service (EEAS).

The six function areas served by CMS are listed below.

- Fisheries control

  Support is provided to the European Fisheries Control Agency (EFCA) and relevant Member State Administrations through satellite monitoring in EU, third country and international waters. EO data can provide valuable additional information for combatting Illegal, Unreported and Unregulated (IUU) fishing, including detecting fishing vessels inside and outside designated fishing grounds, identifying targets for inspection, and providing information on fish farm and aquaculture activity.

- Maritime safety and security

  Maritime safety and security operations support the safe transit of vessels, people and goods; and ensure that when necessary, assistance can be provided in the most timely and effective way possible. CMS provides authorities with additional means to ensure safety of navigation, monitor locations of interest, follow the development of accidents and incidents, track objects at sea, and locate and identify vessels.

- Law enforcement

  Maritime law enforcement encompasses a wide range of activities involving the detection and monitoring of potentially unlawful activities. Perpetrators often will not wish to be identified, and so illegal activities may take place in remote locations or involve vessels with their reporting systems switched off. Without traditional means of surveillance nearby, the role of satellite EO data is particularly important. A combination of high-resolution radar for wide area monitoring with very high resolution optical for target identification brings significant value to operations, particularly in areas where other assets cannot be used.

- Customs

  Customs authorities ensure that legitimate trade can flow freely, whilst preventing trafficking and smuggling of illegal or dangerous goods (including drugs, counterfeit goods, firearms, explosives, cash or even protected wildlife species). Satellite image and value-added products reinforce authorities' capacity to maintain oversight of goods transported at sea, to monitor ports and beaches for departure of specific ships, and to detect abnormal behaviour that may indicate transhipment of goods between vessels.

- Marine environment pollution monitoring

  To detect pollution discharges at sea, wide areas must be monitored at regular intervals. Synthetic aperture radar (SAR) sensors can detect very thin films of oil and similar substances on the sea surface and combining this with other data available through the EMSA systems can also support the identification of potential polluters. Pollution monitoring is provided in areas of European interest outside European waters (e.g. overseas territories).

- Support to international organisations and other activities

  The CMS service provides maritime surveillance support to international organisations promoting the European Union's Common Foreign and Security Policy (CFSP) and related policies and strategies. Activities in the maritime domain are often inherently transboundary, and successful operations rely on cooperation and the exchange of data – including EO data – and intelligence to address issues of regional or global concern. Use of the service by international organisations is dependent on coordination with the European Commission (DG-GROW).

1.2 DATA POLICY

- Handling of Sensitive Information

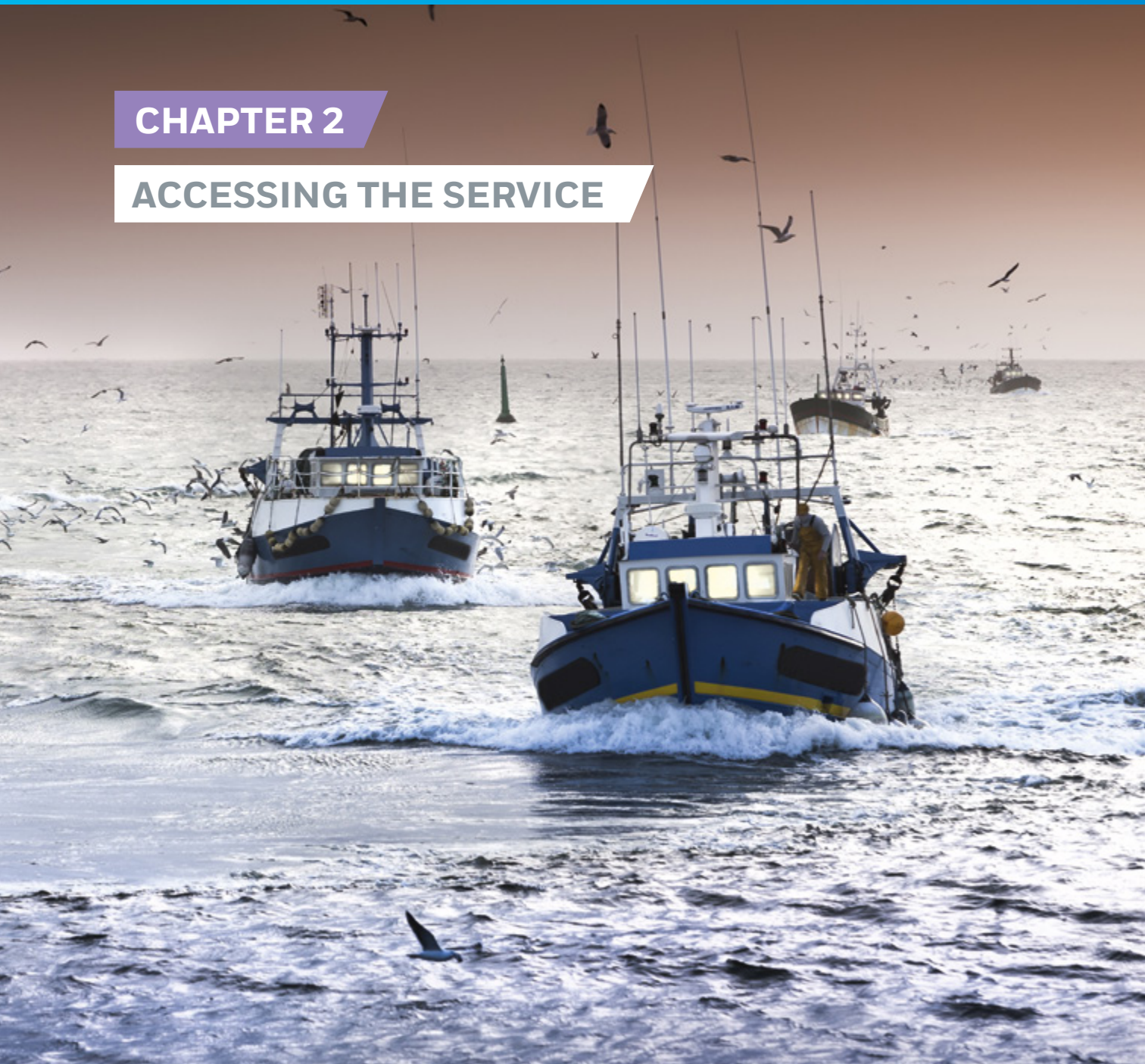
  Given the types of operations, information exchanged within the context of requesting and receiving CMS services[1] may be considered sensitive. Although information exchanged in this context is not considered to be EU Classified Information, the sensitive nature of the information is nonetheless addressed by controlled procedures which have been put in place internally.

  Information from users is provided to the CMS team through request forms which are sent via email. Once the request has been received, the request forms are then accessible only to the CMS team and are not shared with third parties. Discreet data elements from the request forms are shared with satellite service providers only to the extent that is necessary to provide the requested service (e.g. definition of the area of interest and period of acquisition). The satellite data and value-added products are transferred from the satellite ground receiving station to EMSA, and subsequently to the end-user, via encrypted connections.

- Data Sharing

  CMS is one of the Security services of the Copernicus Programme, and as such does not have an open data policy. When services are delivered they will normally be visible in the restricted EMSA portal to other authorised users, all of which are governmental authorities or EU institutions and bodies with functions in the maritime domain. For particularly sensitive operational activities, EMSA can restrict the visibility of and access to the products delivered. This option can only be implemented in justified cases as it entails additional technical steps.

[1] An EO service is considered to be one satellite image product, along with any relevant additional data such as vessel detection or value-added products which may be combined with the image.



CHAPTER 2

ACCESSING THE SERVICE

2.1 SETTING UP THE CMS SERVICE

To set up the CMS service users must:

- obtain access, if they do not already have it, to the EMSA portal, and
- complete the User Registration Form (one should be completed per organisation activating the service).

The initial contacts for setting up the CMS service will depend on the functions being exercised.

FISHERIES CONTROL USERS:

- If you are interested in CMS for the purposes of fisheries control, and your country is a member of the European Fisheries Control Agency (EFCA), please contact EFCA, which coordinates user access for this service component, at: copernicus@efca.europa.eu.

ALL OTHER USERS:

- Please contact the EMSA Copernicus team directly at copernicus@emsa.europa.eu to discuss your specific needs in terms of earth observation information and products. If you are interested in using the CMS service as an international organisation, coordination with the European Commission (DG-GROW) may be necessary.

Please contact the EMSA Copernicus team at copernicus@emsa.europa.eu at any time with questions, comments, suggestions, or additional requirements.

2.2 SERVICE REQUEST

Once a user has contacted the EMSA CMS team to request access to the CMS service, an iterative process of further defining the exact user requirements will be initiated.

REQUEST TYPE

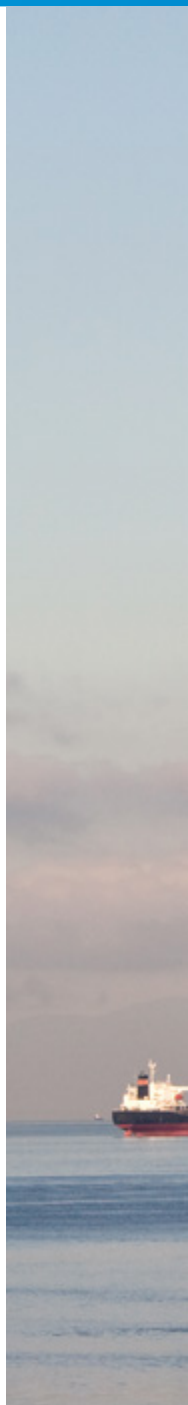
There are two different options, based on the operational context of the user's activities, for requesting CMS services.

- Routine request is the standard tasking mode. All requests to support routine activities fit in this category, i.e. monitoring or surveillance operations. Ordering can take place several weeks or months before satellite acquisition.
- Short-notice request shall be issued when the CMS user requests EO-based services for supporting unforeseen or unscheduled operations, including support to live operations involving national assets, and intelligence-driven operations. Ordering can take place 72-48 hours before satellite acquisition.

PLANNING

In addition to the standard planning done by the CMS team, there are some advanced planning options available for optical missions. The advanced planning options, which can be used separately or in combination, are: cloud cover, data take opportunity (DTO) and cross-cueing.

- Cloud cover protection activation guarantees that an acquisition over an area of interest (AOI) is done only if a minimum of cloud-free area can be guaranteed. If an image has more clouds than the maximum defined this will not be acquired. This prevents the acquisition of images filled with clouds that have limited operational value.
- Data take acquisition (DTO) planning aims to maximise the reliability of a successful delivery and minimise the impact of last-minute cancellations or satellite unavailability. This can be achieved by allowing flexible dates, times of acquisition and different missions. Several images are tasked, over the same area, maximizing the probability of delivery. As soon as a successful delivery takes place, the remaining data takes are cancelled.



- Cross-cueing enables geographical adjustment of the footprint of the satellite image to a specific location within a pre-defined AOI in the hours before the image is acquired*. This planning mode exploits the agility of the optical satellites, which have sensors with steering capability. Usually this scenario includes: first, one acquisition with wide area monitoring capabilities (radar) over the generic area of interest, and then a specific adjustment of the optical image to focus on targets detected by the radar.

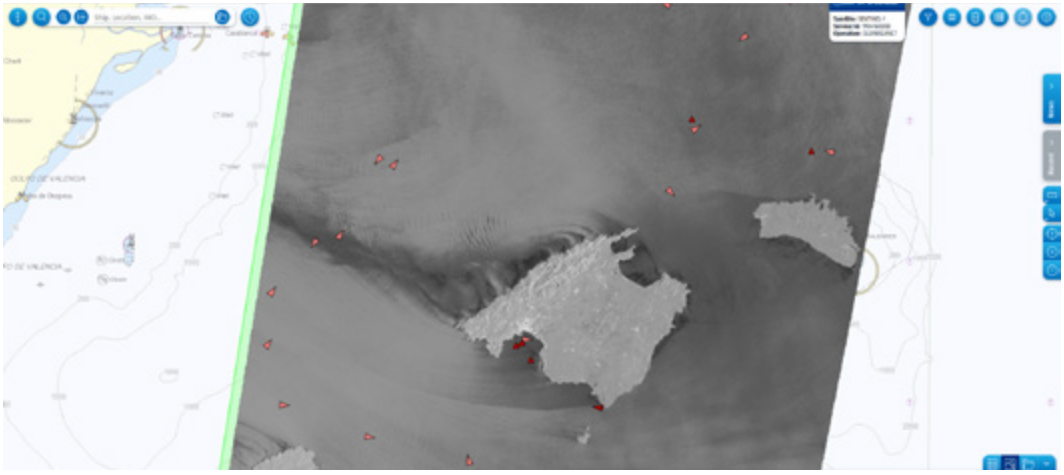
* the cut-off time, expressed in hours before the acquisition start time, is variable and depends on the satellite mission and the location of the acquisition. Consult the CMS team for more information.

2.3 SERVICE DELIVERY

Access to CMS and other related data hosted by EMSA is normally provided through the EMSA portal, accessible only to authorised users. Maritime administrations that are already users of other EMSA IMS services will be familiar with the portal. New users should contact EMSA to set up access.

IMS integrates and combines different types of data - including EO data, as well as vessel traffic reports, additional value-added products and data provided by the end user, for example - to produce customised services tailored to user requirements.[2]

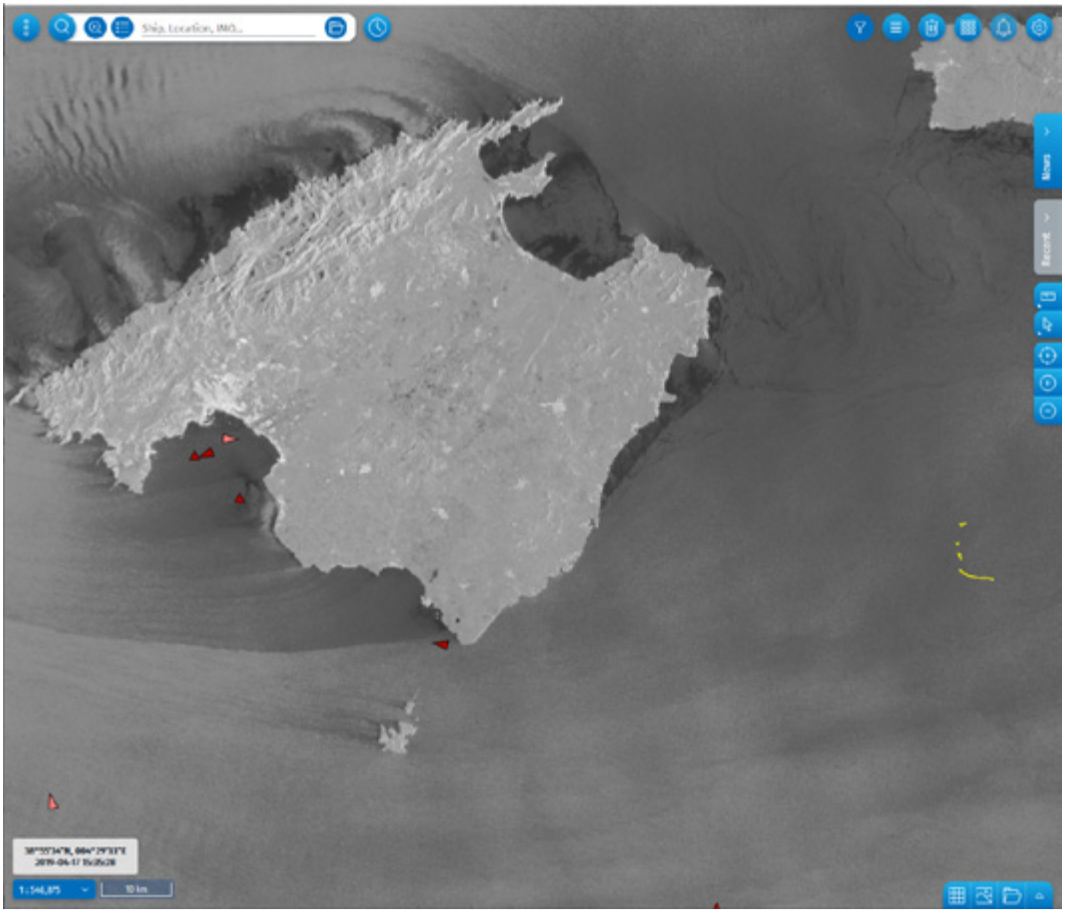
Users also have full technical support, 24 hours a day, 7 days a week, through EMSA's Maritime Support Services (MSS).[3] The MSS helpdesk is available to respond to users, assist them with issues related to the performance of the maritime applications and access-related.



EMSA portal © EMSA, contains modified Copernicus Sentinel data, 2019

[2] Existing access rights continue to apply with regard to other data sources such as vessel position information.

[3] The MSS also coordinates EMSA's assistance in the event of an emergency at sea.



EO product delivered in EMSA portal © EMSA, contains modified Copernicus Sentinel data, 2019

DELIVERY TIME

Delivery time is the time between the acquisition of the information by the satellite and the EO product reaching the end user. This time is a function of a) the satellite flight time between the acquisition site to the Ground Station (GS) where the image will be downloaded, b) the image size, and, c) the product complexity. Products based on images acquired outside GS coverage will be delivered with an additional delay.

Most CMS products are delivered in Near Real Time (NRT). Table 1 summarises the NRT delivery in minutes for both SAR and optical-based products.

TABLE 1 – DELIVERY TIMES FOR SAR AND OPTICAL EO PRODUCTS

STANDARD PRODUCT		VALUE-ADDED PRODUCT	
EO Image		• Vessel Detection Service (VDS) • Feature Detection Service (FDS) • Oil Spill Detection	• Enriched Vessel Service (EVS) • Enriched Feature Service (EFS) • Wake Detection Service (WDS) • Activity Detection Service (ADS)
SAR*	25 min	20 min	30 min
Optical*	30 min	40 min	50 min

Notes*:

- For images acquired outside GS coverage using on-board recorders, between 10 and 90 minutes may be added to the delivery time
- These delivery times refer to the standard image size presented in this catalogue. Specifics on the delivery time for non-standard-size images can be provided by the CMS team
- For monitoring and surveillance operations in which NRT is not needed, the delivery times can be extended to: delivery in less than 3h; less than 6h or less than 24h.

CONFIDENCE LEVEL

The confidence level expresses a quantitative measurement - on a scale 1 to 100% - of the certainty associated with the detection or identification of a vessel, oil spill, feature, vessel wake or activity.

- 100% - Confirmed, i.e. validated by ancillary data
- 75 – 99% - Very high confidence
- 50 – 74% - High confidence
- 1 - 49% - Low confidence

2.4 ARCHIVE DATA ACCESS

There are two types of archive data which may be of interest to CMS users:

1. EMSA archive data which has been previously ordered by EMSA is accessible to authorized users directly through the EMSA portal for up to six months after acquisition. Archive data that is older than six months can be retrieved manually by EMSA; interested users should contact copernicus@emsa.europa.eu

2. Other satellite date not available at EMSA, which may have been acquired by the satellite missions which EMSA has contracts with, but which was not ordered directly by EMSA at any point in time and is not archived in EMSA. If users are interested in this type of data, e.g. to confirm whether a suspected activity took place, it may be possible to acquire it. If users are interested in historic data not available in the EMSA archive, they should contact copernicus@emsa.europa.eu. The EMSA Copernicus team will then evaluate whether there is data available from any source to fulfil the request.

CHAPTER 3

EARTH OBSERVATION PRODUCTS

3.1 OVERVIEW

The products described in Chapter 3 constitute the core of the EO data being delivered by the CMS service. The CMS service offers image products, value-added products and fusion products based on two types of EO data: SAR data and optical data.

SAR sensors use microwave frequencies to retrieve backscatter measurements from the detected surface below (sea or land). The images can be acquired regardless of cloud cover conditions and at any time of day or night. SAR images of the ocean greatly depend on surface roughness caused by wind stress at the sea surface. By measuring the roughness of the sea surface, resulting images display features which stand out against the background; for example, vessels and other man-made structures appear as bright spots, while oil spills or areas with very low wind appear as dark shapes.

Optical images can provide a wealth of information in different spectral bands. They provide easier image interpretation and object identification due to the combination of Red-Green-Blue (RGB) frequencies and higher contrast, albeit with very high dependency on sunlight and weather conditions. Optical sensors cannot capture images during the night or in cloud cover conditions.

3.2 RESOLUTION CLASSES AND PRODUCTS

The resolution classes presented here are aligned with the European Space Agency (ESA) Data Access Portfolio[4]. All missions of the space component are classified primarily by sensor type (SAR or optical) but also by resolution classes. The classifications are very high resolution (VHR), high resolution (HR) and medium resolution (MR). Table 2 summarises these classes for the SAR products and table 3 summarises them for the optical products available through the CMS service.

TABLE 2 - RESOLUTION CLASSES FOR EO SAR IMAGE PRODUCTS

CLASS	RESOLUTION (x)	EO SAR IMAGES
VHR1	x ≤ 1m	TerraSAR-X/PAZ Staring Spotlight
		RADARSAT-2 Spotlight
VHR2	1m < x ≤ 4m	RADARSAT-2 Wide Ultra-Fine
		TerraSAR-X/PAZ StripMap
		RADARSAT-2 Ultra-Fine
HR1	4m < x ≤ 10m	RADARSAT-2 Extra Fine
		TerraSAR-X/PAZ StripMapRE
		RADARSAT-2 Multi-Look Fine
HR2	10m < x ≤ 30m	TerraSAR-X/PAZ ScanSAR
		RADARSAT-2 Wide
		RADARSAT-2 Standard
MR1	30m < x ≤ 100m	TerraSAR-X/PAZ Wide ScanSAR
		RADARSAT-2 ScanSAR Narrow
		RADARSAT-2 Ship Detection
		Sentinel-1 Interferometric Wide Swath
		RADARSAT-2 Ocean Surveillance
		RADARSAT-2 ScanSAR wide
		Sentinel-1 Extra Wide Swath

[4] Copernicus Space Component Data Access Portfolio: Data Warehouse 2014 - 2020.

TABLE 3 - RESOLUTION CLASSES FOR EO OPTICAL IMAGE PRODUCTS

CLASS	RESOLUTION (x)	EO OPTICAL SATELLITE
VHR1	x ≤ 1m	WorldView-3
		WorldView-2
		WorldView-1
		Superview-1
		Superview-2
		Superview-3
		Superview-4
		GeoEye-1
		Pleiades 1A
		Pleiades 1B
		EROS-B
		Deimos 2
VHR2	1m < x ≤ 4m	Spot 6
		Spot 7

The products in sections 3.3 and 3.4 are categorised by the best spatial resolution available for each image. For the optical images, the highest resolution refers to the spatial resolution at the nadir of the panchromatic band. For the SAR products, the highest resolution presented is the azimuth spatial resolution defined by the satellite provider.

Generically, spatial resolution, given in metres or centimetres, indicates the order of magnitude of the smallest object that can be depicted in an image.

3.3 EO SAR IMAGE PRODUCTS

3.3.1 SAR VERY HIGH RESOLUTION 1 (SAR VHR1)

PRODUCT CHARACTERISTICS

SAR VHR1 Images	Highest resolution	Coverage (width x length)
TerraSAR-X Staring Spotlight (TSX ST)	0.25m	4km x 3.7km or 2.5km x 7.5km
PAZ Staring Spotlight (PAZ ST)	0.25m	4km x 3.7km or 2.5km x 7.5km
RADARSAT-2 Spotlight (RS2 ST)	0.8m	18km x 8km

DESCRIPTION

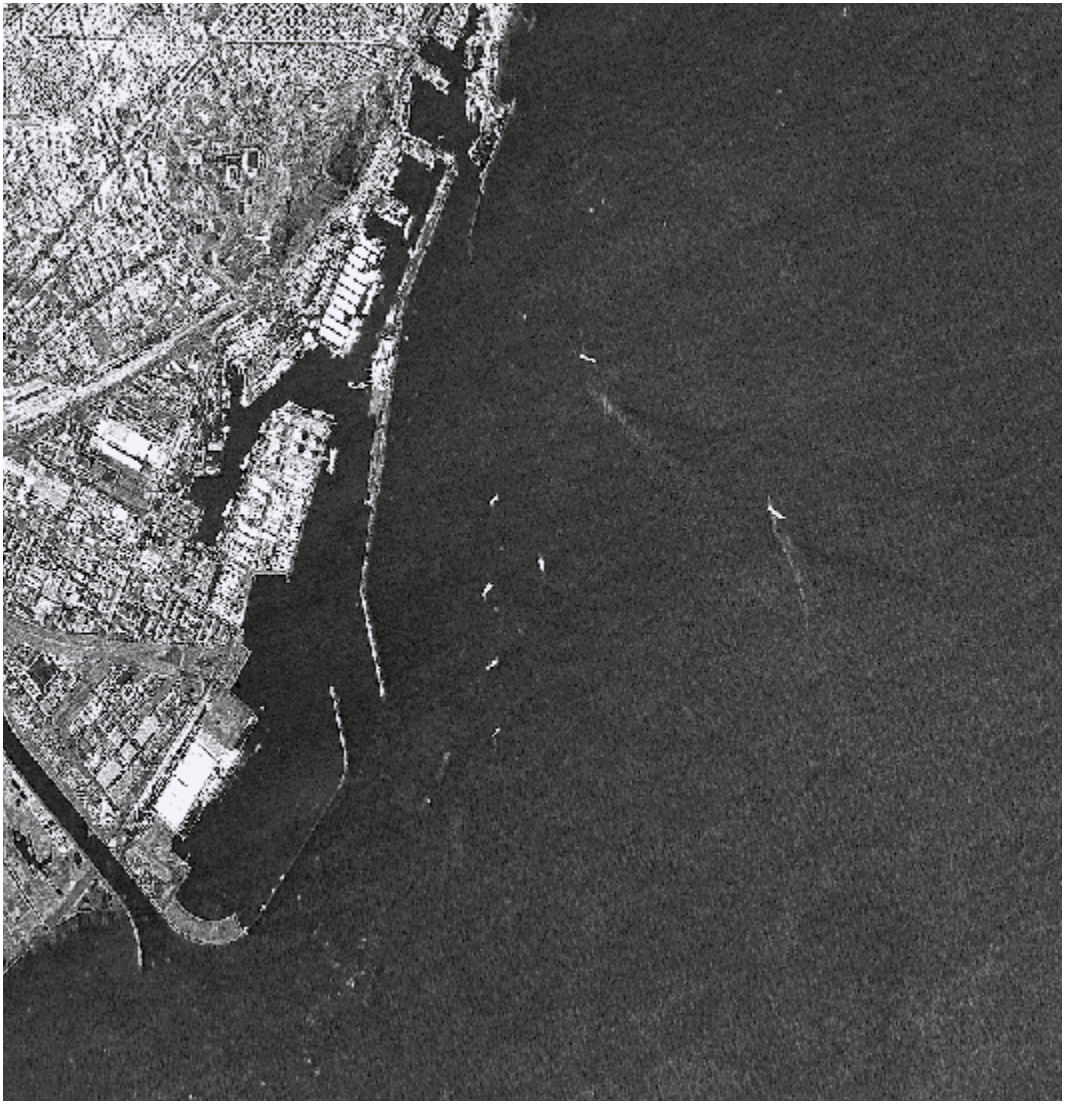
Very high resolution SAR images, delivered in NRT 25 minutes, with spatial resolution x ≤ 1m

HOW TO CITE THIS PRODUCT

TerraSAR-X: "© DLR e.V. [year], Distribution Airbus DS Geo GmbH"

PAZ: "© Hisdesat Servicios Estratégicos S.A. [year]"

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



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

3.3.2 SAR VERY HIGH RESOLUTION 2 (SAR VHR2)

PRODUCT CHARACTERISTICS

SAR VHR2 Images	Highest resolution	Coverage (width x length)
RADARSAT-2 Wide Ultra-Fine (RS2 UFW)	3m	50km x 50km
TerraSAR-X StripMap (TSX SM)	3m	30km x 50km
PAZ StripMap (PAZ SM)	3m	30km x 50km
RADARSAT-2 Ultra-Fine (RS2 UF)	3m	20km x 20km

DESCRIPTION

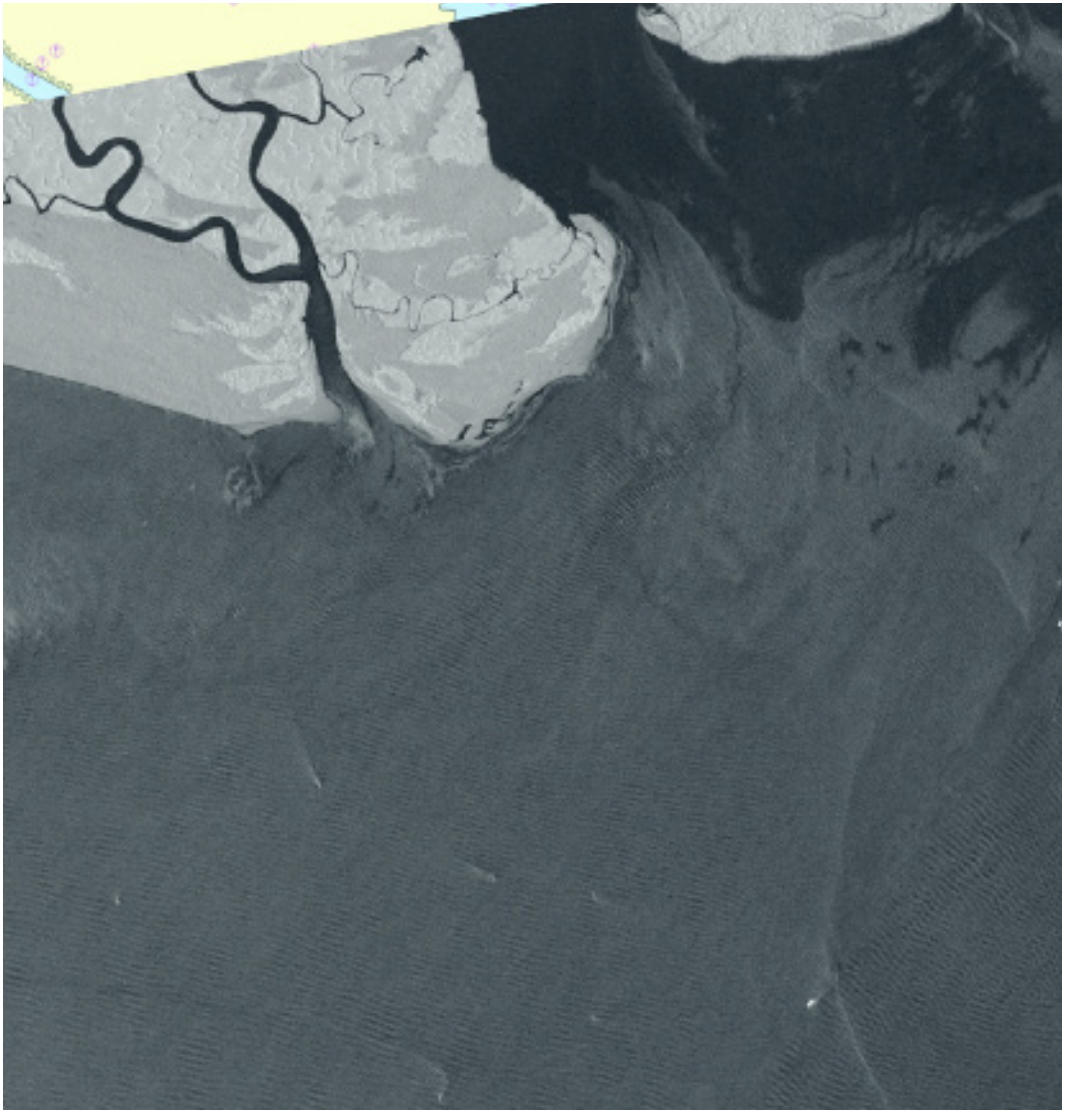
Very high resolution SAR images, delivered in NRT 25 minutes, with spatial resolution $1m < x \leq 4m$

HOW TO CITE THIS PRODUCT

TerraSAR-X: "© DLR e.V. [year], Distribution Airbus DS Geo GmbH"

PAZ: "© Hisdesat Servicios Estratégicos S.A. [year]"

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



Gulf of Guinea - TSX SM © DLR e.V. 2019, Distribution Airbus DS Geo GmbH

3.3.3 SAR HIGH RESOLUTION 1 (SAR HR1)

PRODUCT CHARACTERISTICS

SAR HR1 Images	Highest resolution	Coverage (width x length)
RADARSAT-2 Extra Fine (RS2 XF)	6m	125km x 125km
TerraSAR-X StripMapRE (TSX SMRE)	7m	30km x 50km
PAZ StripMapRE (PAZ SMRE)	7m	30km x 50km
RADARSAT-2 Multi-Look Fine (RS2 MF)	8m	50km x 50km

DESCRIPTION

High resolution SAR images, delivered in NRT 25 minutes, with spatial resolution $4m < x \leq 10m$

HOW TO CITE THIS PRODUCT

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PAZ: "© Hisdesat Servicios Estratégicos S.A. [year]"

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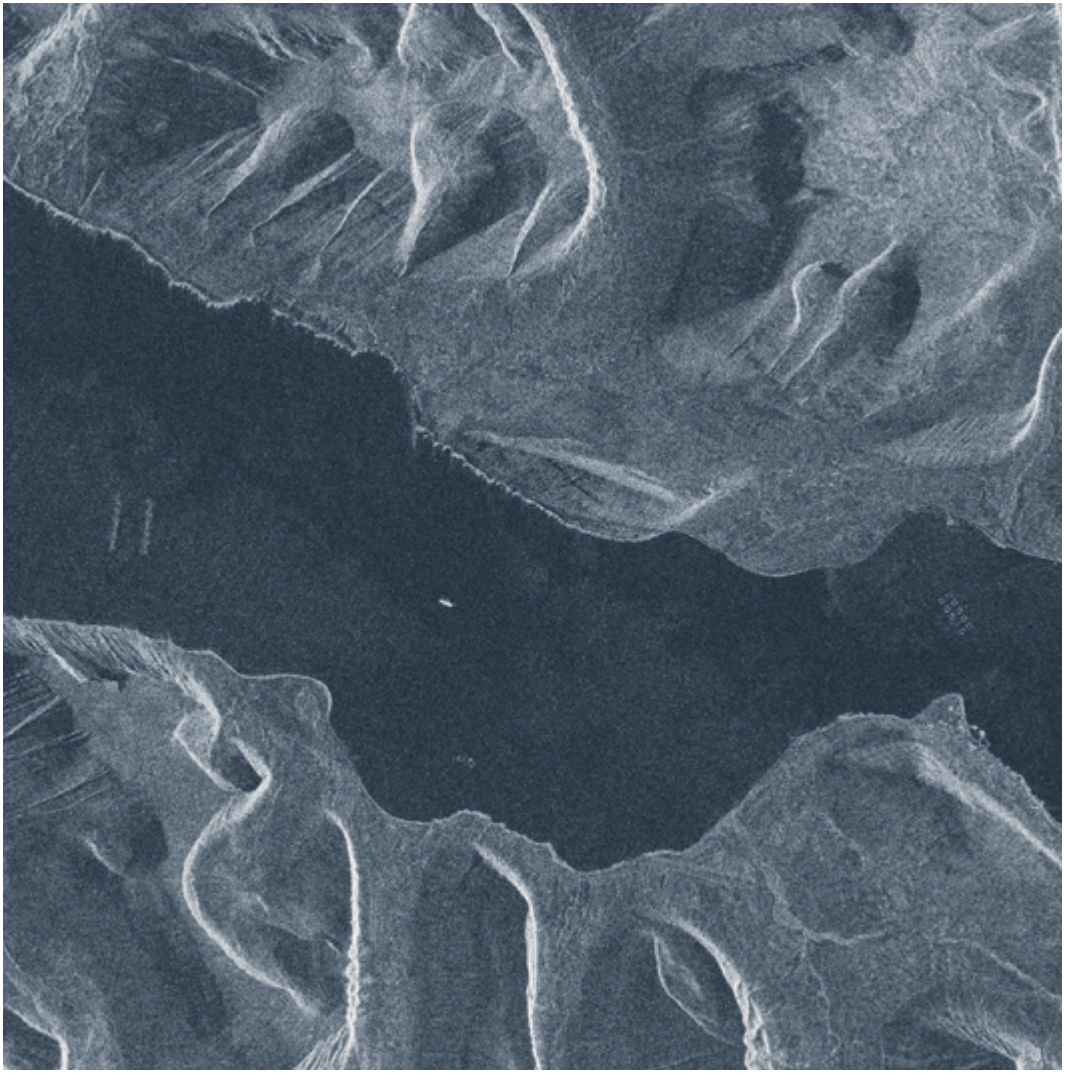

Iceland – RS2 XF - RADARSAT-2 Data and Products © MacDONALD, DETTWILER AND ASSOCIATES LTD - 2019 – All Rights Reserved; RADARSAT is an official mark of the Canadian Space Agency

3.3.4 SAR HIGH RESOLUTION 2 (SAR HR2)

PRODUCT CHARACTERISTICS

SAR HR2 Images	Highest resolution	Coverage (width x length)
TerraSAR-X ScanSAR (TSX SC)	18.5m	100km x 150km
PAZ ScanSAR (PAZ SC)	18.5m	100km x 150km
RADARSAT-2 Wide (RS2 W)	25m	150km x 150km
RADARSAT-2 Standard (RS2 S)	25m	100km x 100km

DESCRIPTION

High resolution SAR images, delivered in NRT 25 minutes, with spatial resolution $10m < x \leq 30m$

HOW TO CITE THIS PRODUCT

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PAZ: "© Hisdesat Servicios Estratégicos S.A. [year]"

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Hurd Peninsula, Antarctic - TSX SC © DLR e.V. 2019, Distribution Airbus DS Geo GmbH

3.3.5 SAR MEDIUM RESOLUTION 1 (SAR MR1)

PRODUCT CHARACTERISTICS

SAR MR1 Images	Highest resolution	Coverage (width x length)
TerraSAR-X Wide ScanSAR (TSX WS)	40m	270km x 200km
PAZ Wide ScanSAR (PAZ WS)	40m	270km x 200km
RADARSAT-2 ScanSAR Narrow (RS2 SCN)	60m	300km x 300km
RADARSAT-2 Ship Detection (RS2 DVWF)	80m	450km x 500km
Sentinel 1 Interferometric Wide Swath (S1 IWS)	90m	250km x variable length
RADARSAT-2 Ocean Surveillance (RS2 OSVN)	100m	500km x 500km
RADARSAT-2 ScanSAR Wide (RS2 SCW)	100m	500km x 500km
Sentinel 1 Extra-Wide Swath (S1 EWS)	100m	400km x variable length

DESCRIPTION

Medium resolution SAR images, delivered in NRT 25 minutes, with spatial resolution 30m < x ≤ 100m.

Products optimised for particular tasks:

- RS2 DVWF is optimised for ship detection. It can detect ships larger than 25m with high confidence level.
- RS2 OSVN is optimized for ocean surveillance: ship detection, oil on water, ice analysis and wake detection. It can detect ships larger than 50m in length.

HOW TO CITE THIS PRODUCT

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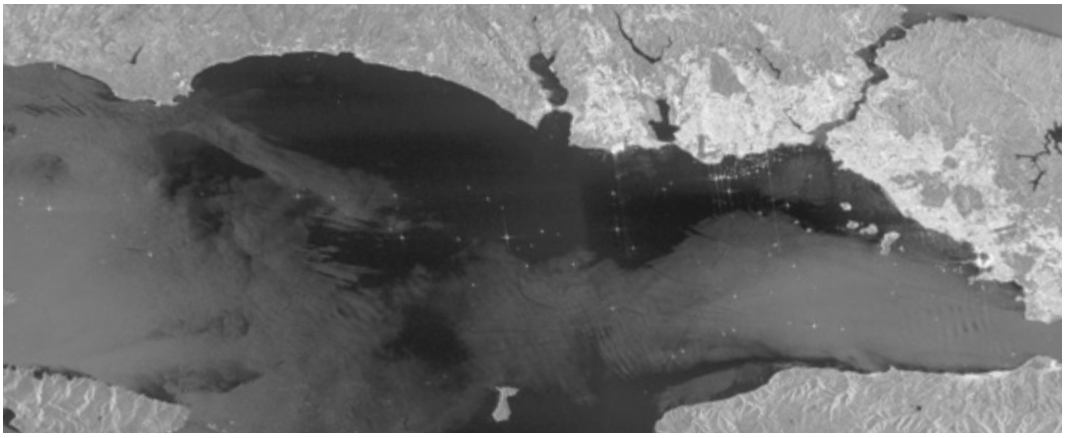
Sentinel-1 (data obtained via Copernicus): "© Copernicus Sentinel data [Year]"



Sea of Marmara – S1 IWS © EMSA, contains modified Copernicus Sentinel-1 data, 2019

3.4 EO OPTICAL IMAGE PRODUCTS

3.4.1 OPTICAL VERY HIGH RESOLUTION 1 (OPTICAL VHR1)

PRODUCT CHARACTERISTICS

Optical VHR1 satellites	Highest resolution	Recommended size
WorldView 3 (WV3)	30cm	50 - 250km^2
WorldView 2 (WV2)	50cm	
WorldView 1 (WV1)		
Superview 1 (SV1)		
Superview 2 (SV2)		
Superview 3 (SV3)		
Superview 4 (SV4)		
GeoEye-1 (GE1)		
Pleiades 1A (PHR1A)*		
Pleiades 1B (PHR1B)*		
EROS-B	70cm	
Deimos 2 (DE2)	75cm	

DESCRIPTION

Very high resolution optical images, delivered in NRT 30 minutes, with spatial resolution x ≤ 1m and different band combinations: Panchromatic, Multispectral, Pansharpened.
The recommended size of a VHR1 optical product varies from 50km^2 to 250km^2

HOW TO CITE THIS PRODUCT

WorldView: "© [year] European Space Imaging/DigitalGlobe, a MAXAR company"

SuperView "© SIWEI [year]"

GeoEye: "© [year] European Space Imaging/DigitalGlobe a MAXAR company"

PLEIADES: "© CNES [year], Distribution Airbus DS"

EROS-B: "© ImageSat International N.V. [year]"

DEIMOS-2: "© Deimos Imaging [year], Distribution Airbus DS"/"© Deimos Imaging [year]"

Note*: Pleiades optical sensor has a 70 cm Ground Sampling Distance at nadir for the panchromatic band. A product resolution of 50 cm is offered after post-processing resampling. For more information refer to the Pleiades User Guide.

Marseille, France - WV 3 © 2018 European Space Imaging/DigitalGlobe, a MAXAR company

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

3.4.2 OPTICAL VERY HIGH RESOLUTION 2 (OPTICAL VHR2)

PRODUCT CHARACTERISTICS

Optical VHR2 satellites	Highest resolution	Recommended size
SPOT 6	1.5m	50 - 500km^2
SPOT 7		

DESCRIPTION

Very high resolution optical images, delivered in NRT 30 minutes, with spatial resolution 1m < x ≤ 4m and different band combinations: Panchromatic, Multispectral, Pansharpened. The recommended size of a VHR2 optical product varies from 50km^2 to 500km^2.

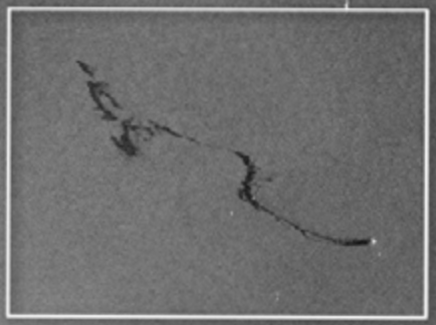
HOW TO CITE THIS PRODUCT

Spot: "© Airbus DS [year]"

Black Sea, Sozopol, Bulgaria - Spot 6 © Airbus DS 2018

CHAPTER 4

EARTH OBSERVATION VALUE-ADDED PRODUCTS



4.1 OVERVIEW

For maritime surveillance purposes, the benefits to be derived from EO data do not lie solely in the volume of data available, but rather in the intelligent use of data in a targeted manner. The value-added products offered by the CMS service aid users by extracting particularly valuable information from the basic image products, allowing authorities to undertake higher level analysis of objects, features or activities at sea more quickly and efficiently.

The value-added products can be provided either as a layer on top of the original satellite image product or as a separate layer of information, for example a vector layer. This enables users to select which individual product or particular combination of products is relevant to them. For example, a user requesting high resolution optical data to support the search for an individual vessel may want a vessel detection layer to quickly identify the location of all vessels in the area, but also the original image product layer to see the details of the vessels to narrow down the search; however, a pollution response team using SAR imagery might prefer to receive just the vector coordinates of a suspected oil spill rapidly, and not wait for a download of the full original image product, in order to send assets to the area as quickly as possible.

The factsheets in this chapter contain a brief description of the value-added products and their relevant attributes. The value-added products currently being offered to users include:

- vessel detection
- feature detection
- activity detection
- oil spill detection
- wind and wave information

4.2 VESSEL DETECTION

PRODUCT NAME

Vessel Detection Service (VDS)
Enriched Vessel Service (EVS)
Wake Detection Service (WDS)

DESCRIPTION

This service entails the delivery of value-added products, mainly using high and very high resolution images, focusing on vessel detection. The Vessel Detection Service (VDS) refers to the extraction of vessel positions based on echoes or detectable objects in the satellite image that may be vessels.

The VDS has nominal delivery times of 20 minutes for SAR-based and 40 minutes for optical-based products and it includes the following attributes:

- Position – latitude/longitude coordinates
- Time stamp – date/time of acquisition
- Confidence level of vessel detection - quantitative measurement of the certainty associated with the detection of a vessel, on a scale 1 to 100%

The Enriched Vessel Service (EVS) includes the vessel detection and classification. It entails further analysis of the satellite images and contains elements which were not included in the VDS.

DESCRIPTION (CONT.)

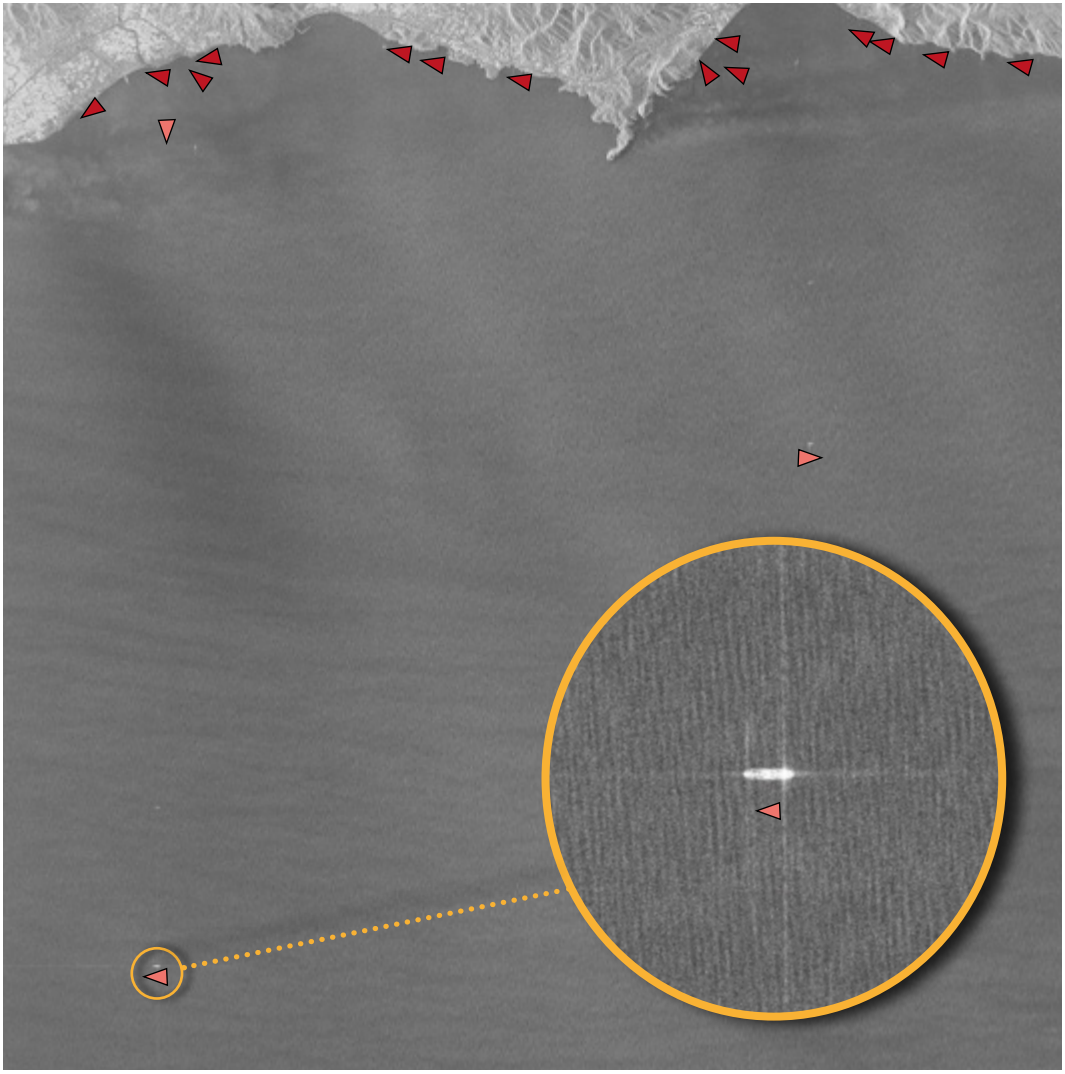
The EVS has nominal delivery times of 30 minutes for SAR-based and 50 minutes for optical-based products and it includes the VDS parameters abovementioned plus the following attributes:

- Length and width - expressed in meters (when possible)
- Heading – route direction (when possible)
- Speed - expressed in m/s (when possible)
- Vessel classification – category of the vessel e.g. fishing vessel, sailing vessel, merchant vessel (when possible)

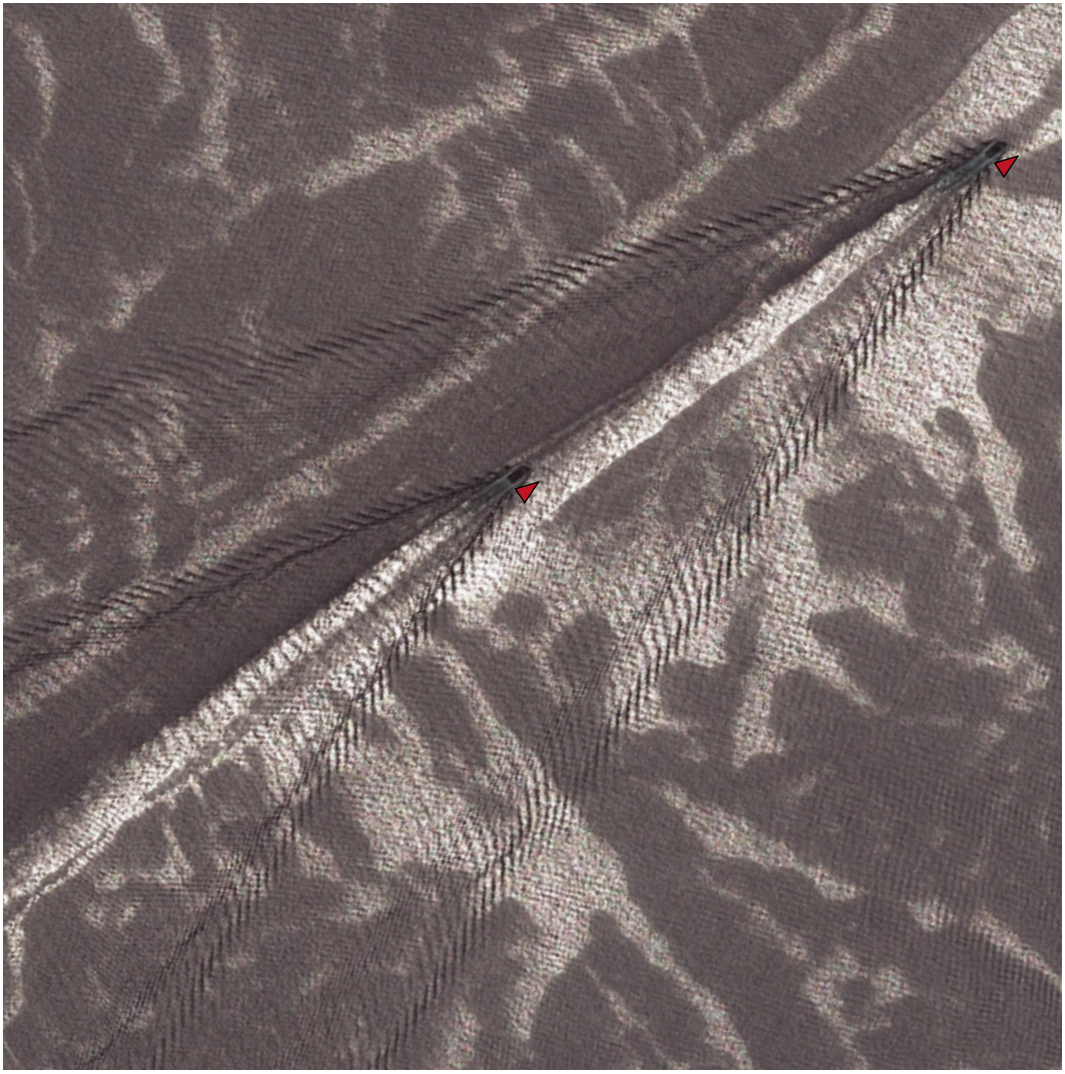
The Wake Detection Service (WDS) aims to identify potential vessel wakes and, when possible, to detect the vessel associated with the detected wake. The WDS product has nominal delivery times of 30 minutes for SAR-based and 50 minutes for optical-based products and it includes the following attributes:

- Position – latitude/longitude coordinates
- Time stamp – date/time of acquisition
- Wake geometry – polygon contouring the wake geometry
- Length and width - expressed in meters (when possible)
- Heading – route direction (when possible)
- Confidence level of wake detection - quantitative measurement of the uncertainty associated with the detection of a vessel wake, on a scale 1 to 100%

HOW TO CITE THIS PRODUCT



Vessel detection and detail of correlated vessel © EMSA, contains modified RADARSAT-2 data, 2018. RADARSAT-2 Data and Products © MacDONALD, DETTWILER AND ASSOCIATES LTD, 2018 – All Rights Reserved; RADARSAT is an official mark of the Canadian Space Agency



Uncorrelated vessels and corresponding vessels wake – PHR1B © CNES 2019, Distribution Airbus DS

4.3 FEATURE DETECTION

PRODUCT NAME

Feature Detection Service (FDS)
Enriched Feature Service (EFS)

DESCRIPTION

This service entails the delivery of value-added products, mainly using high and very high resolution images, focusing on feature detection. The Feature Detection Service (FDS) aims to detect features of interest at sea, in the shoreline and in harbour areas which are not covered by other EO products (oil spill detection, vessel detection or activity detection). Consult section 4.7 for examples of FDS.

The FDS has nominal delivery times of 20 minutes for SAR-based and 40 minutes for optical-based products and it includes the following attributes:

- Feature description – high level description of the detected feature
- Position – latitude/longitude coordinates
- Time stamp – date/time of acquisition
- Confidence level of feature detection- quantitative measurement of the certainty associated with the detection of a feature, on a scale 1 to 100%

The Enriched Feature Service (EFS) includes the feature detection and classification. It entails further analysis of the satellite images and contains elements which were not included in the FDS.

The EFS has nominal delivery times of 30 minutes for SAR-based and 50 minutes for optical-based products and it includes the FDS attributes abovementioned plus the following:

- Length and width - expressed in meters (when possible)
- Heading – route direction (when possible)
- Feature classification – more detailed description of the detected feature (when possible)

HOW TO CITE THIS PRODUCT

© EMSA, contains modified [insert satellite mission and credit as relevant] data, [year]

Fish cages - WV2 © 2018 European Space Imaging/DigitalGlobe, a MAXAR company

4.4 ACTIVITY DETECTION

PRODUCT NAME

Activity Detection Service (ADS)

DESCRIPTION

This service entails the delivery of value added products, mainly using very high resolution images, focusing on activity detection. The purpose of the Activity Detection Service (ADS) is to report information about activities of interest detected in the satellite images, over a defined area at a given time. For example, when the user requests an ADS for at-sea-encounter only at-sea-encounters shall be included in the delivered product and not other activities such as oil pollution.

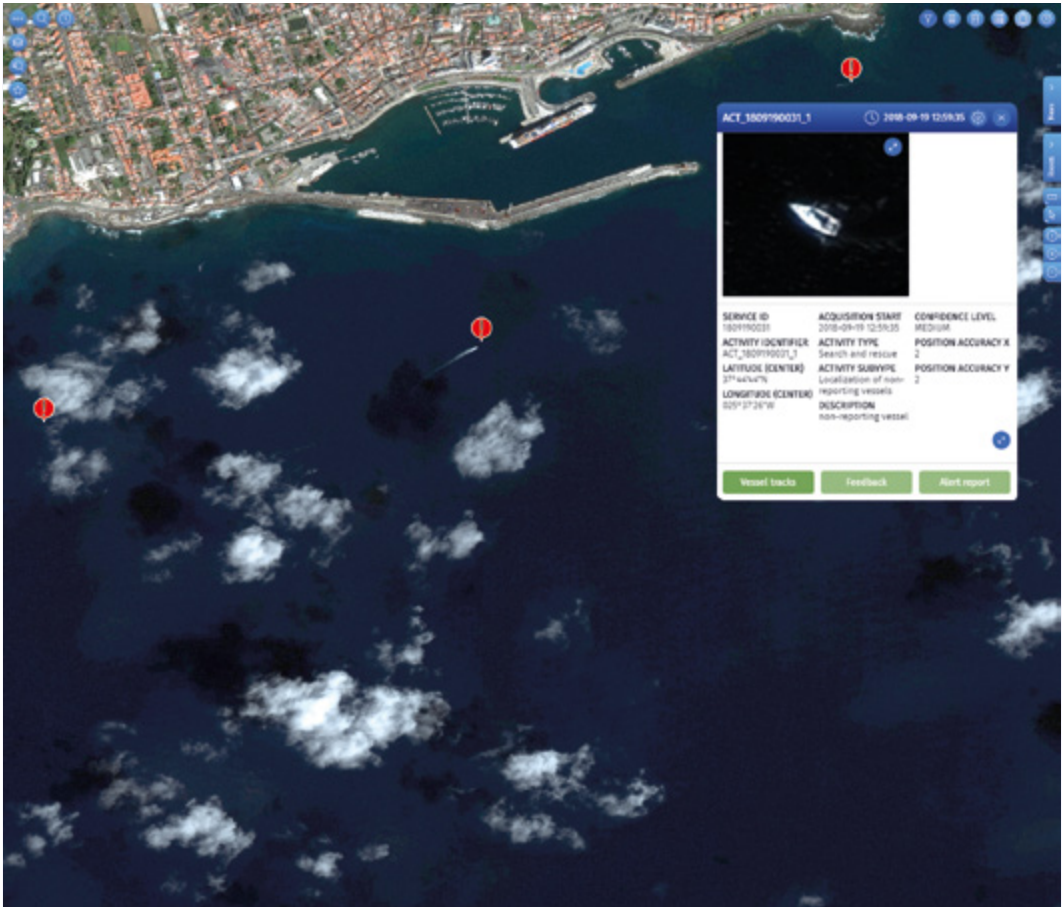
Consult section 4.7 for examples of ADS.

The ADS has nominal delivery times of 30 minutes for SAR-based and 50 minutes for optical-based products and the following attributes are included:

- Activity description – type of activity detected on an EO scene
- Area – latitude/longitude coordinates
- Time stamp – date/time of acquisition
- Confidence level of activity detection - quantitative measurement of the uncertainty associated with the identified activity, on a scale 1 to 100%
- Associated vessels or features – attributes described in the vessel and feature detection factsheets (when possible)

HOW TO CITE THIS PRODUCT

© EMSA, contains modified [insert satellite mission and credit as relevant] data, [year]



Activity Detection –WV2 © EMSA, contains modified WV2 data. 2018 European Space Imaging/DigitalGlobe data, a MAXAR company

4.5 OIL SPILL DETECTION

PRODUCT NAME

Oil Spill Detection

DESCRIPTION

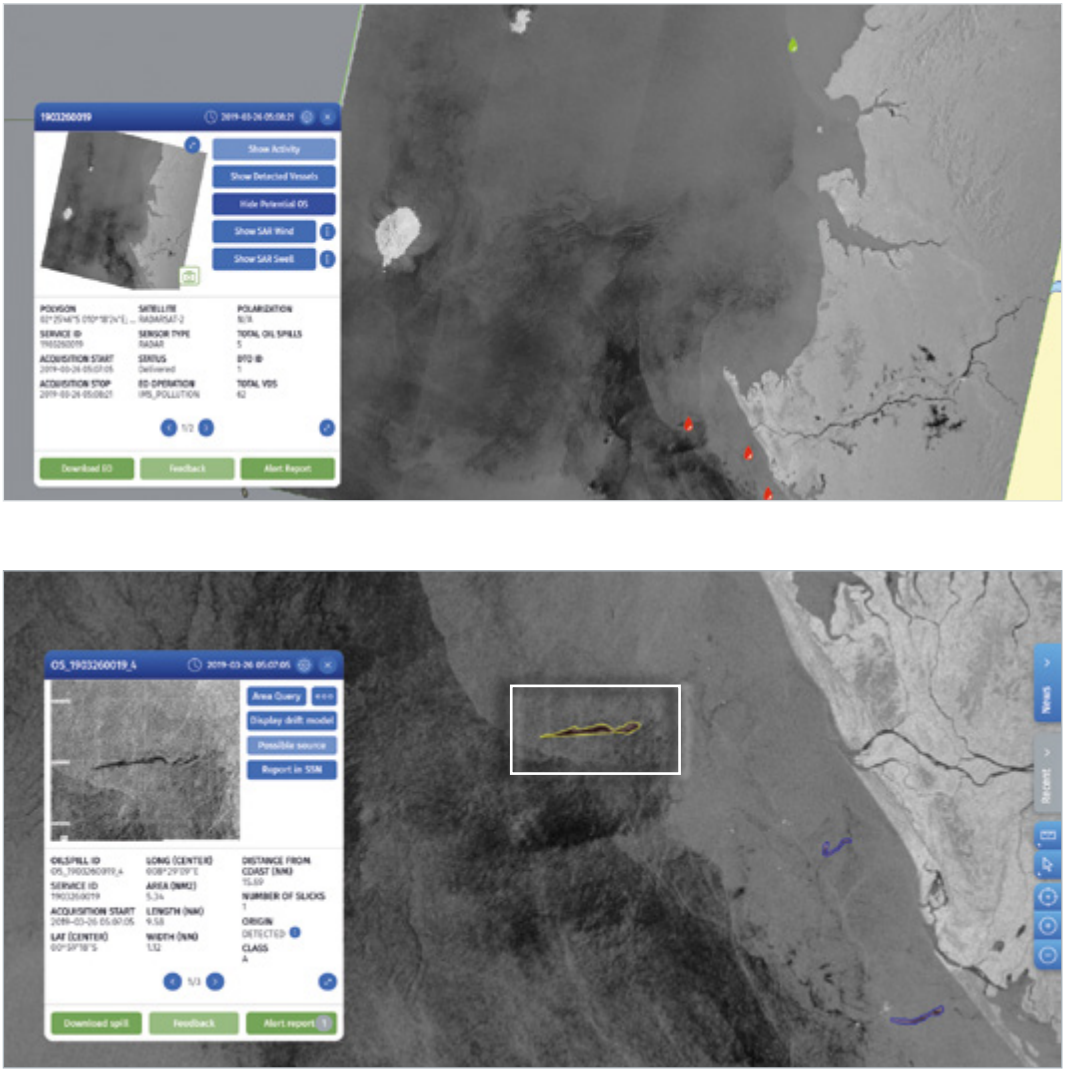
This service entails the delivery of value-added products, mainly using medium resolution SAR images and very high resolution optical images, focusing on oil spill detection and associated pollution source. The Oil Spill Detection delivered by CMS extends the European CleanSeaNet service to other areas of interest beyond European waters. This service is complemented by the fusion product oil spill notification described in section 5.3.

The oil spill detection has nominal delivery times of 20 minutes for SAR-based and 40 minutes for optical-based products and the following attributes are included:

- Centre - latitude/longitude coordinates
- Geometry - polygon(s) describing oil spill and associated slicks boundaries
- Area - expressed in m^2
- Time stamp - date/time of the observation
- Distance from coast - expressed in NM
- Meteo-oceanographic conditions
- Possible pollution source: detected or identified (when possible)

HOW TO CITE THIS PRODUCT

© EMSA, contains modified [insert satellite mission and credit as relevant] data, [year]



Oil spill detection product showing four slicks and details of one of the slicks © EMSA, contains modified RADARSAT-2 data, 2019. RADARSAT-2 Data and Products © MacDONALD, DETTWILER AND ASSOCIATES LTD, 2019 – All Rights Reserved; RADARSAT is an official mark of the Canadian Space Agency

4.6 WIND AND WAVE INFORMATION

PRODUCT NAME

SAR Wind
SAR Wave

DESCRIPTION

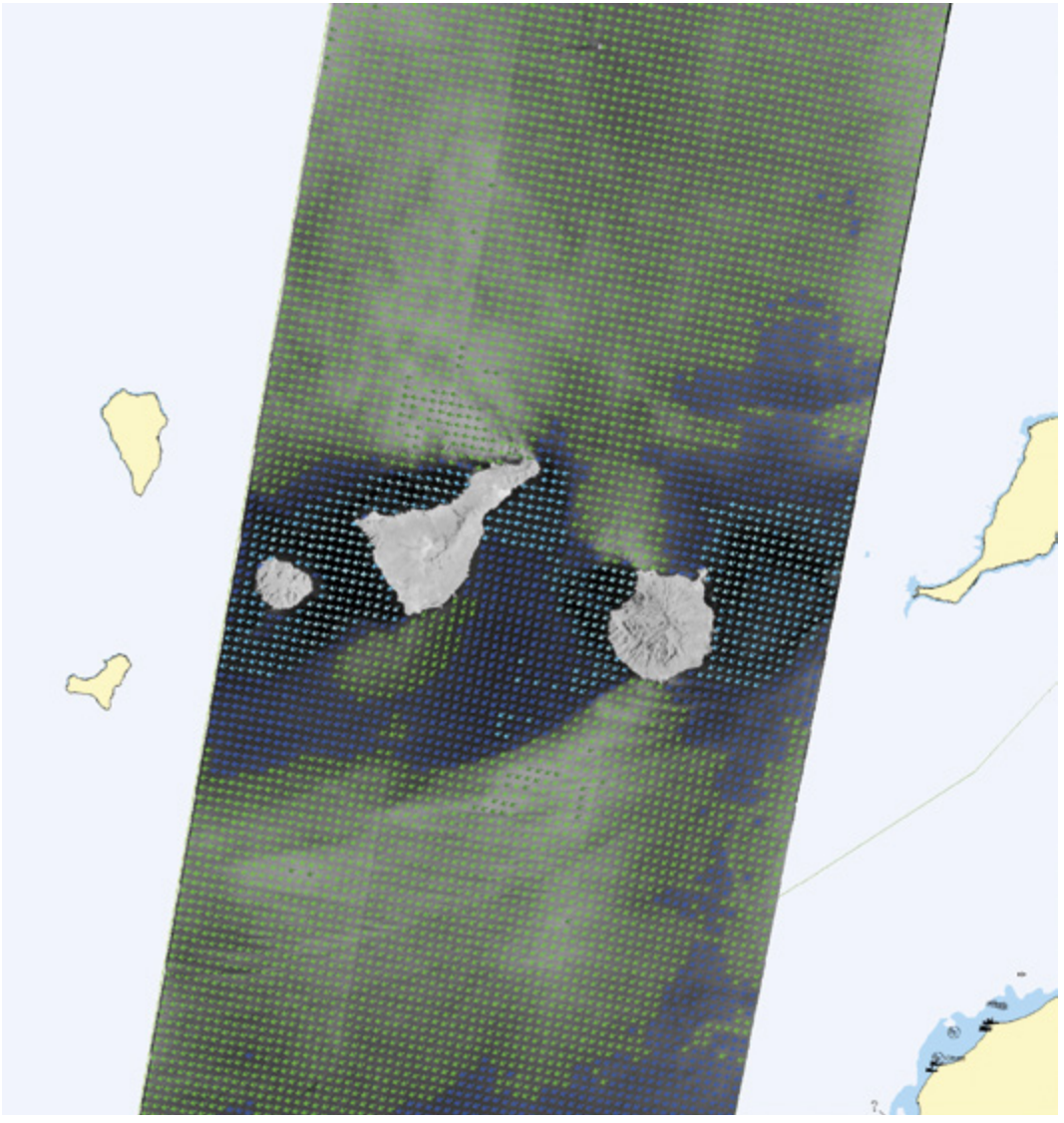
This service entails the delivery of a package containing ocean surface wind and wave (swell) derived from SAR imagery. The SAR Wind and SAR Wave have nominal delivery times of 25 minutes for SAR-based products and the following attributes are included:

- Wind speed – expressed in m/s
- Wind direction – wind from direction
- Wave height – sea surface swell wave significant height, expressed in meters
- Wave direction – sea surface swell wave to direction

SAR wave products are not available for all radar satellite modes. Please contact the Copernicus team for additional details.

HOW TO CITE THIS PRODUCT

© EMSA, contains modified [insert satellite mission and credit as relevant] data, [year]



SAR Wind © EMSA, contains modified Copernicus Sentinel Data, 2019

4.7 VALUE-ADDED PRODUCTS: APPLICATIONS AND USES

Table 4 provides an overview of the value-added products available through the Copernicus Maritime Surveillance service, along with some potential use cases.

TABLE 4 VALUE-ADDED PRODUCTS OVERVIEW

VALUE-ADDED PRODUCTS	USE CASES
Vessel detection	Detection and tracking of vessels of interest
	Detection of non-reporting, missing vessels or vessels in distress
	Vessel type classification, e.g. fishing vessel, reefer, sailing vessel, etc
	Monitoring of vessel movements inside restricted areas
Feature detection	Fish cages and fish traps
	Fish farms
	Oil and gas installations
	Detection of lost containers
	Detection of aircraft debris
	Iceberg detection
	Skiffs on beach

TABLE 4 VALUE-ADDED PRODUCTS OVERVIEW (CONT.)

VALUE-ADDED PRODUCTS	USE CASES
Activity detection	Fishing grounds monitoring
	Fishing activity pattern
	Vessels towing cages
	Rendezvous at sea and transhipment operations
	At-sea refuelling
	Remote port and coastal monitoring
	Detection of potential aggregation points for illegal embarkation
	Detection of illegal discards
	Hijacked ship
	Skiffs/speed boats approaching vessel
	Monitoring of activities/change detection along the coastline
	Ice monitoring
Oil spill detection	Oil spill and potential polluter detection
Wind and wave information	SAR Wind
	SAR Wave

CHAPTER 5

FUSION PRODUCTS

5.1 OVERVIEW

Copernicus Earth Observation images can be integrated with other data both from EMSA's maritime information applications and from external data sources. This additional data may include information such as vessel location, identification and tracking data (for example Automatic Identification System [AIS], Long Range Identification and Tracking [LRIT], and Vessel Monitoring System [VMS]), intelligence data provided by users, and external meteorological data. Combining data makes the overall information provided to Member States users more valuable operationally. Vessel position and track information, for example, overlaid on satellite images with a vessel detection layer, provides a very powerful tool for checking on vessel activity at sea – including verifying those vessels that are reporting, and locating vessels that are not reporting their whereabouts. EMSA provides these fusion products to CMS service users according to their needs and to their access rights to the data.

5.2 CORRELATION WITH VESSEL REPORTING INFORMATION

PRODUCT NAME

VESSEL CORRELATION

DESCRIPTION

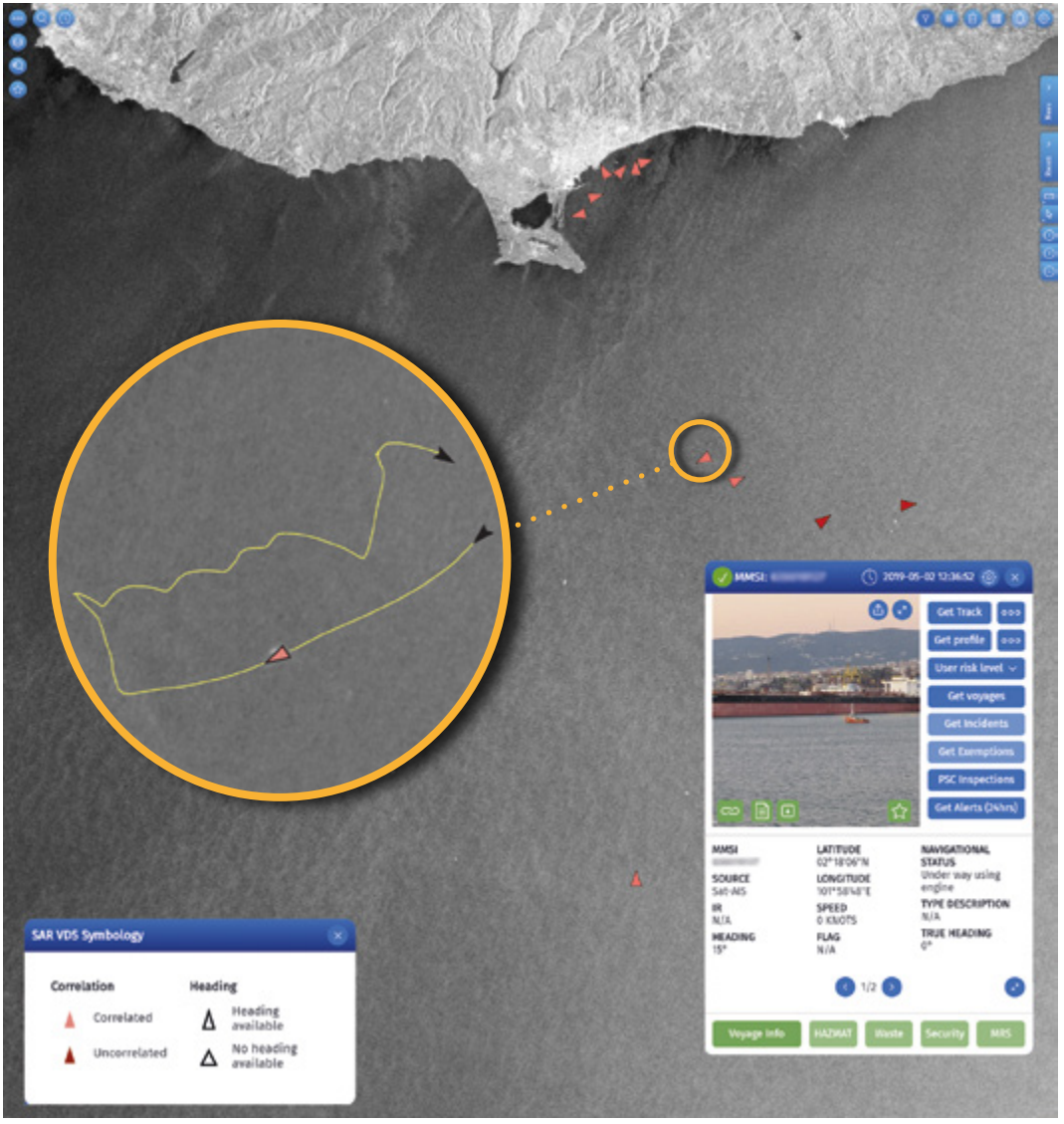
Vessel detections derived from SAR and optical images are correlated against vessel data, such as: AIS reported positions from terrestrial and satellite AIS system data; LRIT reported positions; and VMS data. This integration can provide an overview of which vessels are reporting in a given area, and which are not. This information is shown in two categories:

- VDS correlated with vessel reporting information (vessel detected by the satellite can be matched with vessel reporting information and therefore identified)
- VDS not correlated with vessel reporting information (vessel detected by the satellite cannot be matched with vessel information and therefore no identification of the vessel is possible)

It should be noted that a user will only receive correlations of vessel reporting information for which that user has been granted the relevant access rights.

The correlation layer is provided through the EMSA portal or via system-to-system connection.

HOW TO CITE THIS PRODUCT



Circled vessel correlated with vessel reporting information © EMSA, 2019

5.3 OIL SPILL NOTIFICATION

PRODUCT NAME

OIL SPILL NOTIFICATION

DESCRIPTION

This product is based on the NRT analysis of satellite images in order to detect possible oil spills on the sea surface. When a possible spill is detected within the alert area of a coastal state, an oil spill notification is sent to the relevant authorities.

This notification consists of a report comprising a complete analysis of the known details of all spills detected in the area, including possible polluter(s) if detected.

HOW TO CITE THIS PRODUCT

EMSA
European Maritime Safety Agency

Alert Report **EUROPEAN UNION** Acquisition Start Time: 2019-03-26 05:07:54 UTC

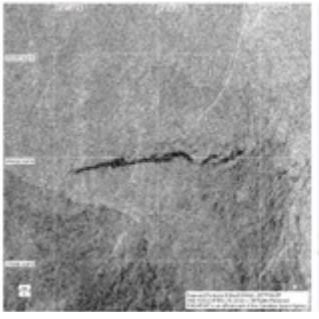
Service Identifier: 1903260019 RADARSAT-2 - SCWA - SCWA GIS Viewer

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_1903260019_1	02° 04' 16" S	009° 09' 14" E	5.57	5.03	2.03	Red	YES	Yes	No
2	OS_1903260019_2	01° 10' 32" S	008° 51' 25" E	4.09	5.57	2.20	Red	YES	Yes	No
3	OS_1903260019_3	01° 26' 40" S	008° 59' 28" E	7.23	9.49	1.99	Red	YES	Yes	No
4	OS_1903260019_4	00° 59' 19" S	008° 29' 09" E	18.33	17.73	2.08	Red	NO	No	No
5	OS_1903260019_5	01° 28' 15" N	009° 08' 31" E	18.82	10.53	3.12	Red	NO	No	No

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



Meteorological and Ocean Data			
Sea State	N/A	Wave Height (m)	N/A
Met.Wind		Direction (from)	320
		Speed (m/s)	0.9
Current		Direction (from)	N/A
		Speed (m/s)	N/A

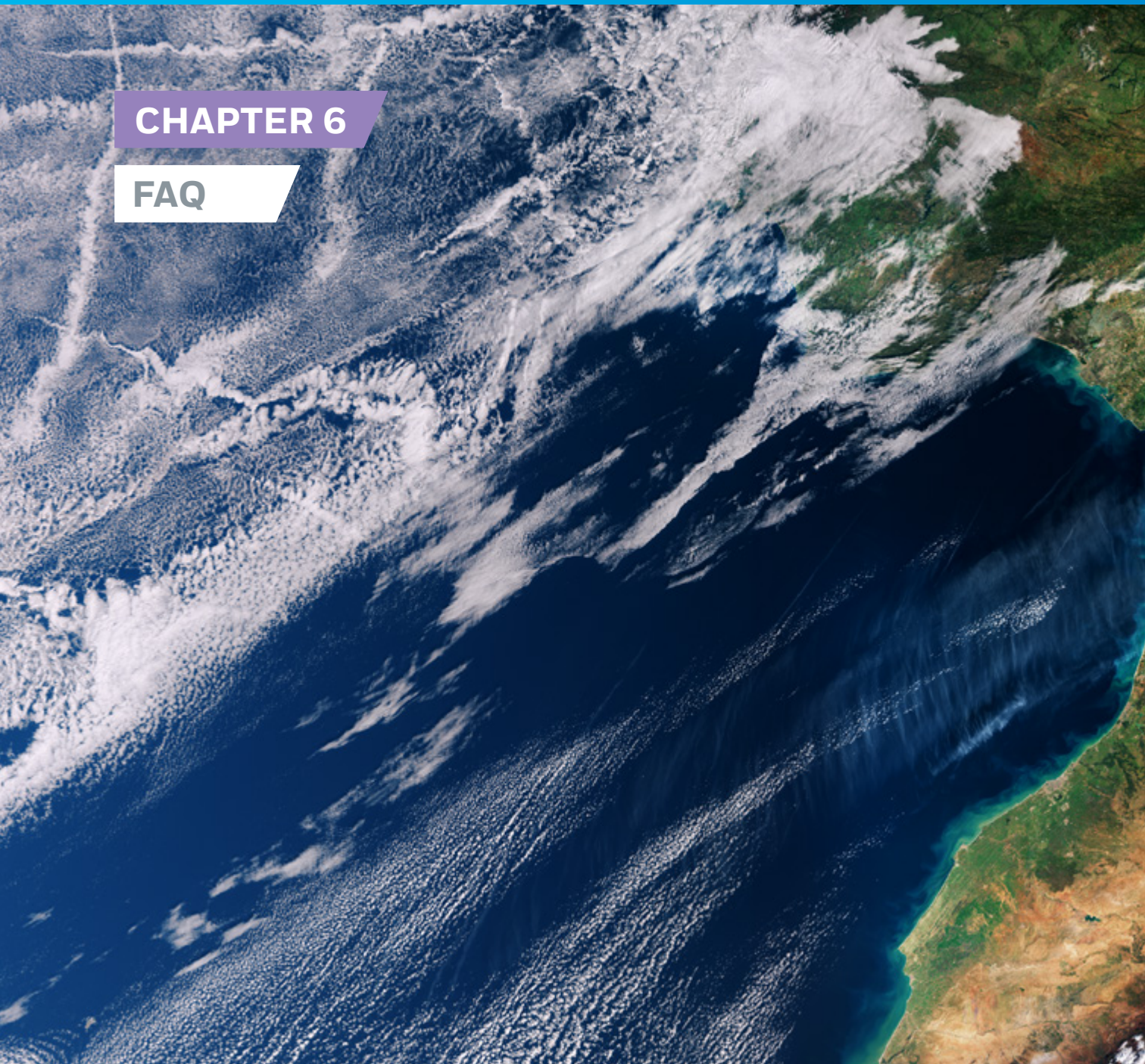
Note: Grey fields are parameters set as "invisible" in the Print Parameters matrix or not available

Comments from Service Provider

Oil spill notification report showing five slicks and additional details of one of the slicks © EMSA, 2019

CHAPTER 6

FAQ



Q: CAN CMS MONITOR ANY LOCATION IN THE WORLD?

Yes. The satellites can provide coverage around the world. However, the 'revisit time' (the amount of time that elapses before the satellites passes over the same location again) varies considerably depending on the location, with more frequent passes near the poles and less frequent near the equator. The time at which the satellite passes is fixed.

Q: HOW ARE REQUESTS FROM DIFFERENT USERS ADDRESSED IF THEY REQUEST IMAGES IN THE SAME AREA?

EMSA tries to manage these conflicts between users' requests to minimize the impact to the user. If requirements from all users cannot be accommodated then priority is given to the user that requested the products first, in order of the request submission.

Q: IS THERE A NOTIFICATION WHEN THE IMAGE IS DELIVERED?

No. The image is automatically uploaded to the EMSA portal as soon as it is available. When images are requested, the user receives the times of planned images and an identifier that can be used to find the image in the EMSA portal. For oil spill detections, as soon as the oil spill information is received an alert report is triggered to the user.

Q: HOW ACCURATE IS THE VESSEL DETECTION SERVICE (VDS)?

Although in general terms the VDS returns very good results, the accuracy depends on several factors such as size of the vessel versus image resolution, vessel shape and material, quality of the acquisition and conditions of the sea surface (i.e. wind and waves). Vessel detection is performed using automatic algorithms and, in some cases, it is supervised by a human and therefore misdetections can occur.

Q: THE SYSTEM REPORTS AN UNCORRELATED VESSEL, BUT WHEN THE AIS LAYER IS SUPERIMPOSED THERE IS A REPORTING VESSEL NEXT TO IT. IS THIS THE SAME VESSEL?

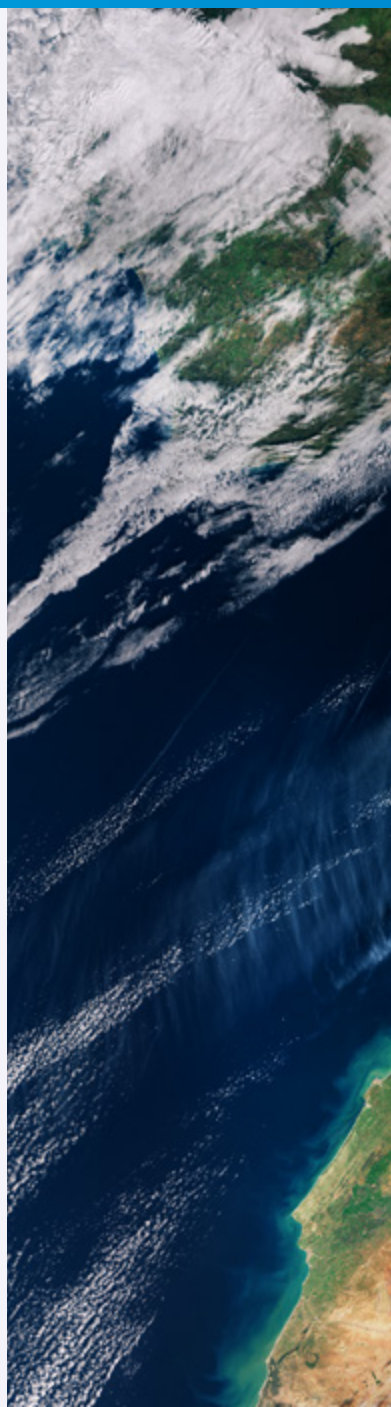
Probably. The CMS service uses algorithms to decide if a vessel detected in an image is correlated with a vessel report. However, if the vessel report is too far from the detected vessel it might fail to correlate properly. This is more likely to happen with satellite AIS reports, as the frequency of reports is lower than for terrestrial AIS.

Q: WHAT IS THE RELATIONSHIP BETWEEN THE COVERAGE AND SPATIAL RESOLUTION OF THE IMAGE?

There is always a trade-off to consider between the satellite spatial resolution (level of detail that can be seen) and the area covered by the satellite, i.e. large images are good for monitoring wide areas, but cannot detect smaller features; higher resolution images deliver much more detail but cover a much smaller area. The CMS team can provide additional information in accordance with the users' specific operational needs.

Q: WHAT IS THE SMALLEST OBJECT THAT CAN BE SEEN IN AN IMAGE?

The smallest object in the image is determined by the image resolution. For example, a vessel of 6m length detected in a 3m resolution SAR image will show as two bright pixels. The same vessel in a 30cm resolution image will be much more detailed.



Q: CAN CMS DATA BE USED IN A COURT OF LAW?

Yes. Depending on the case, type of data and national law, EO data can be used as single proof or as supporting evidence. In some cases (i.e. oil spill detection products) EO data requires complementary validation by other sources (i.e. aerial surveillance verification, sample, etc.).

Q: IS IT POSSIBLE TO USE THE CMS SERVICE FOR RESEARCH OR OTHER PROJECTS WITHOUT BEING A REGISTERED USER?

No. The CMS can be accessed by EU and EFTA national administrations with responsibility at sea, as well as relevant EU bodies and institutions.

On request and where there is clear alignment with the EU's Common Foreign and Security Policy, CMS may provide support to relevant international organisations, with the approval of the European External Action Service and DG GROW. The aim of CMS is to provide a service (i.e. added value information from EO satellites fused with additional non–EO information for specific user purposes) and not to act as raw data provider.

For more FAQ please see the EMSA webpage:
www.emsa.europa.eu/copernicus

ANNEX I

SATELLITE LICENCE CONDITIONS

SATELLITE LICENCE CONDITIONS

States are responsible under international law for regulating their space activities and ensuring that national activities, even if conducted by non-State actors such as corporations, respect international law. Authorisation is given by the State in the form of a licence to parties conducting space-related activities.

National regulations, which differ between States, supplement this international framework. At a national level, States have the prerogative – within the constraints set by International Law – to regulate, authorise, licence and supervise space activity. States exercise this power with two main objectives: 1) to protect national security and safeguard national interest; and 2) to gain priority access for government purposes.

There are two main types of restrictions imposed on satellite owners and operators: on data collection, and/or on data dissemination. This means that, depending on the licence conditions imposed and on national security legislation in the data provider's country, there may be restrictions applied to end-users from certain countries and/or restrictions regarding the area over which an image is taken depending on the resolution of the image. For end-users of the Copernicus Maritime Surveillance service, who comprise European Union bodies and institutions and EU and EFTA Member State national authorities, few such restrictions apply. End-users or potential end-users are encouraged to contact EMSA to discuss whether restrictions will apply to their requests.

The satellite licence conditions of products provided under the CMS service are visible to users when the products are downloaded from the EMSA portal.

ANNEX II

IMAGE CREDITS

OPTICAL SATELLITE DATA

EMSA has a contract with Airbus DS GEO SA for licences and services for PLEIADES 1A/1B, Spot 6/7, and DEIMOS-2 missions. When acquired via Airbus DS GEO SA, the Product, when displayed, distributed, made available and/or printed shall include the following credit conspicuously displayed:

- PLEIADES 1A and 1B: "© CNES (year of acquisition), Distribution Airbus DS"
- Spot 6 and 7: "© Airbus DS (year of acquisition)"
- DEIMOS-2: "© Deimos Imaging (year of acquisition), Distribution Airbus DS"

EMSA has a contract with European Space Imaging GmbH for licences and services for WorldView 1-3, GeoEye-1, DEIMOS-2 and EROS-B missions. When acquired via European Space Imaging GmbH, the following credits should be applied when the product is displayed:

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- GeoEye: "© (year of acquisition) European Space Imaging/DigitalGlobe, a Maxar Company"
- DEIMOS-2: "© Deimos Imaging (year of acquisition)"
- EROS-B: "© ImageSat International N.V. (year of acquisition)"

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- SuperView: "©SIWEI (year of acquisition)"

SYNTHETIC APERTURE RADAR DATA

For the SAR missions available through the Copernicus Maritime Surveillance service, the copyright notices/credits are determined by the satellite owner/operator and licence provider:

- For Copernicus Sentinel data: "© Copernicus Sentinel data (year of acquisition)"
- For RADARSAT-2 data: "RADARSAT-2 Data and Products © MacDONALD, DETTWILER AND ASSOCIATES LTD (year of acquisition) – All Rights Reserved" and "RADARSAT is an official mark of the Canadian Space Agency"
- For TerraSAR-X data: "© DLR e.V. (year of acquisition), Distribution Airbus Defence and Space GmbH"
- For PAZ data: "© Hisdesat Servicios Estratégicos S.A. (year of acquisition).

EMSA DERIVED PRODUCTS AND VALUE-ADDED PRODUCTS

If an end-user wishes to display an EO image product which has subsequently been overlaid with other information (e.g. value-adding products) or is provided through the means of a fusion product, or is conspicuously displayed in the context of the EMSA web interface, EMSA should be credited as follows:

- Image credit: © EMSA, [year], contains modified [insert satellite mission and credit as relevant] data. All rights reserved. Certain parts are licenced under conditions to EMSA.

If an end-user wishes to display only the value-added product or fusion product and/or if the EO image product has been further processed to such an extent that the original image product cannot be specifically identified, EMSA should be credited as follows:

- Image credit: © EMSA, [year]. All rights reserved. Certain parts are licenced under conditions to EMSA.

ANNEX III

ACRONYMS AND ABBREVIATIONS

ACRONYMS AND ABBREVIATIONS	
ADS	Activity Detection Service
AIS	Automatic Identification System
AOI	Area of Interest
CMS	Copernicus Maritime Surveillance
DE	Deimos
DTO	Data Take Opportunities
EEAS	European Extenal Action Service
EEZ	Exclusive Economic Zone
EFCA	European Fisheries Control Agency
EFS	Enriched Feature Service
EFTA	European Free Trade Association
EMSA	European Maritime Safety Agency
EO	Earth Observation
ESA	European Space Agency
EU	European Union
EUSI	European Space Imaging
EVS	Enriched Vessel Service
GE	GeoEye-1
GS	Ground Station
HR	High Resolution

ACRONYMS AND ABBREVIATIONS - CONT.	
IMS	Integrated Maritime Services
IUU	Illegal, Unreported and Unregulated
LRIT	Long Range Identification and Tracking
MR	Medium Resolution
MSS	Maritime Support Services
NRT	Near Real Time
PHR	PLEIADES
RGB	Red-Green-Blue
RS2	RADARSAT-2
SAR	Synthetic Aperture Radar
SEG	SafeSeaNet Ecosystem GUI
TSX	TerraSAR-X
VAP	Value Added Product
VDS	Vessel Detection Service
VHR	Very High Resolution
VMS	Vessel Monitoring System
WDS	Wake Detection Service
WV	WorldView




ABOUT THE EUROPEAN MARITIME SAFETY AGENCY

The European Maritime Safety Agency is one of the European Union's decentralised agencies. Based in Lisbon, the Agency's mission is to ensure a high level of maritime safety, maritime security, prevention of and response to pollution from ships, as well as response to marine pollution from oil and gas installations. The overall purpose is to promote a safe, clean and economically viable maritime sector in the EU.

ABOUT COPERNICUS

Copernicus is a European Union Programme aimed at developing European information services based on satellite Earth Observation and in-situ (non-space) data analyses. The Programme is coordinated and managed by the European Commission. It is implemented in partnership with the Member States, the European Space Agency (ESA), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the European Centre for medium-range Weather Forecasts (ECMWF), EU Agencies and Mercator Océan.

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