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Impact of Sentinel in Earth Observation Based Maritime Applications

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Santa Maria Ground Station(s)

Context of existing activities at Santa Maria Island in the Azorean archipelago

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Santa Maria Ground Station(s) Site

Tracking Station – Dual use station

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Tracking Launchers

- Belongs to the ESA ESTRACK Stations Network
- SMA Tracking Station is part of the Ariane Tracking Stations Network used to support launcher vehicles, like Ariane 5 and the new generation of small **Launchers, Vega and Soyuz**. First Station mission was in 2008 during the ATV (Jules Verne) launching support.

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- Certified to receive Radarsat Satellites data and is prepared to receive Sentinels Satellites (ongoing)
- Part of the receiving Stations for the CleanSeaNet service for EMSA. Daily operations provides near real time maritime pollution information (less than 20 minutes) to EMSA.
- Part of Sat-AIS receiving stations

Maritime Surveillance Needs

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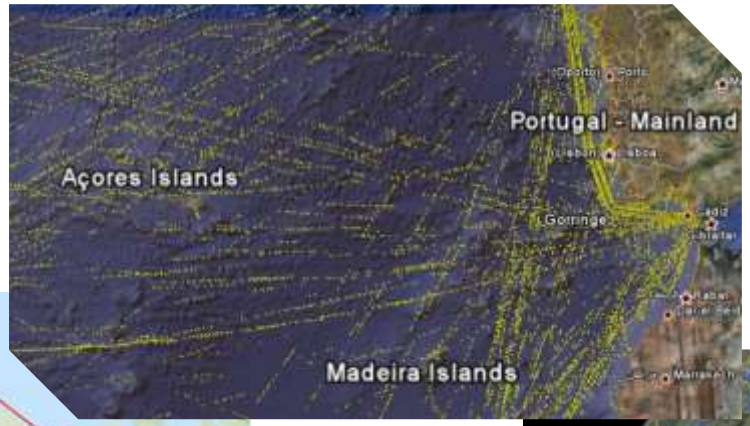

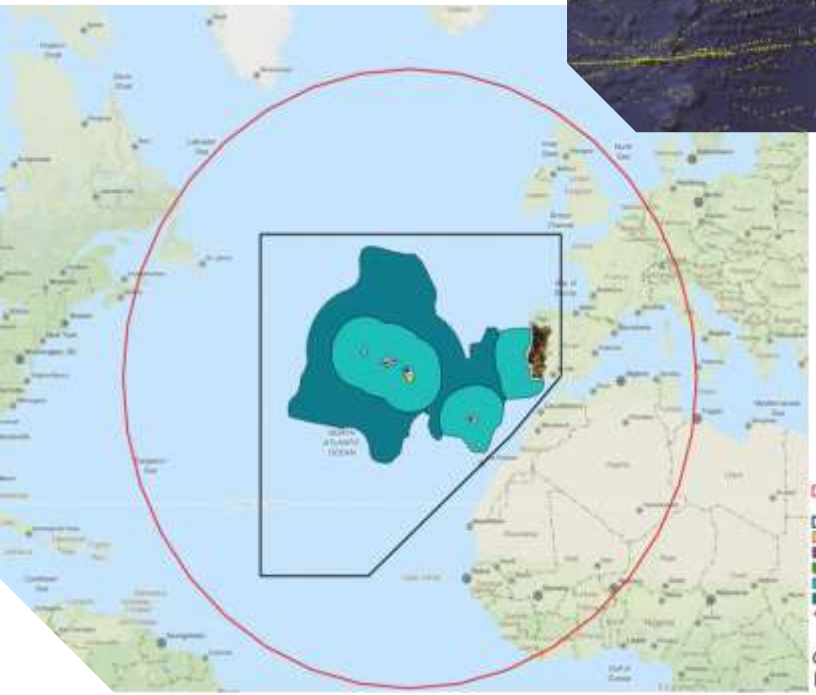

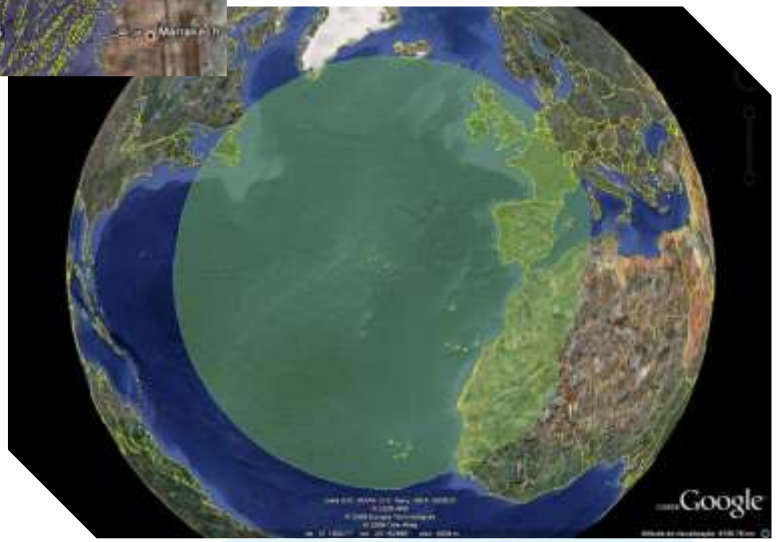

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Maritime Surveillance Services

Quick Overview of existing activities

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Operational Services

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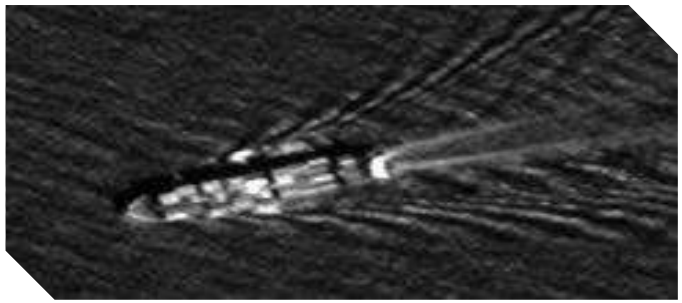


Existing Services being upgraded to Sentinel-1

- CleanSeaNet: Oil Spill Detection (Safety)
- Vessel Detection (Security)

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Oil Spill Detection examples (1/3)

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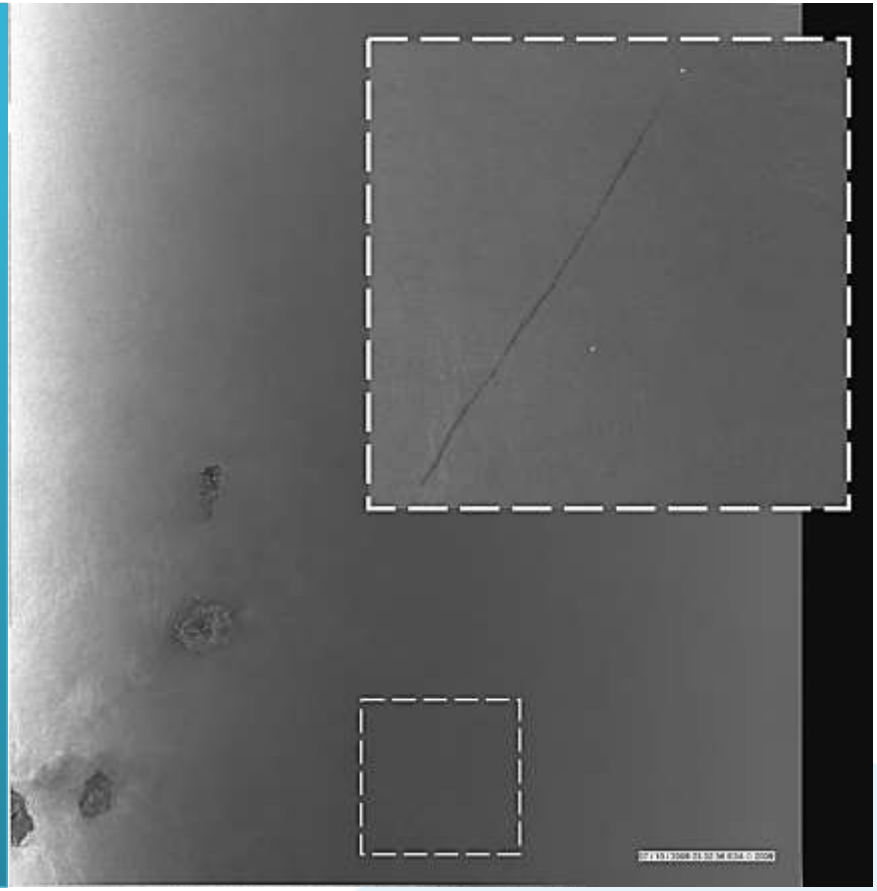
Date: 7 Out 2008, 23:32 UTC

Satellite: ENVISAT

Location: Cabo Verde

Observations:

- **Length of 80 km**
- Polluter was detected but not identified



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Oil Spill Detection examples (2/3)

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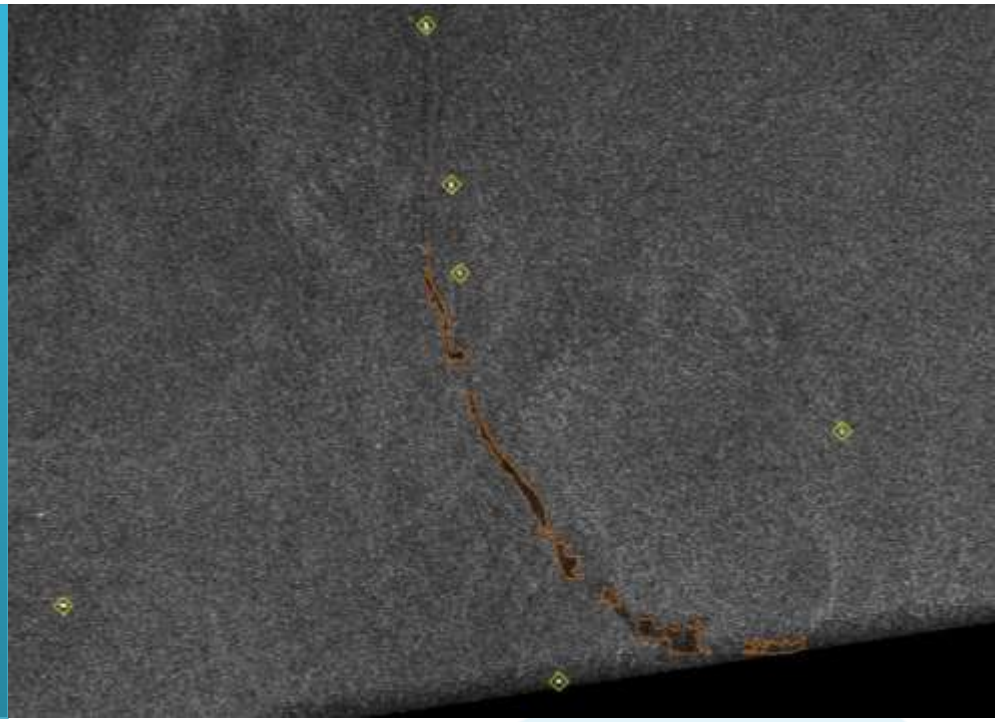
Date: 5 May 2013, 18:33 UTC

Satellite: RADARSAT-2

Location: 36 Km / 19 mni
west of city of Lisbon



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Oil Spill Detection examples (3/3)

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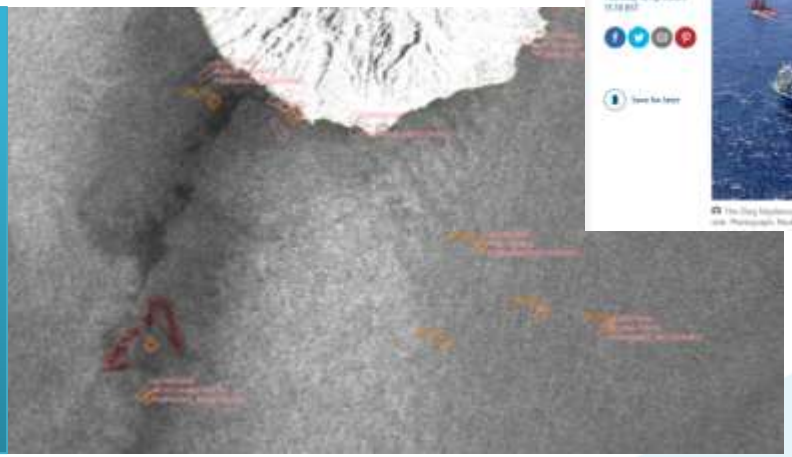
Date:	17 Apr 2015
Satellite:	RADARSAT-2
Location:	Canary Islands
Observations:	**2 days after sunking**

Date:	19 Apr 2015
Satellite:	RADARSAT-2
Location:	Canary Islands
Observations:	**4 days after sunking**



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Fishing Vessel Detection Example

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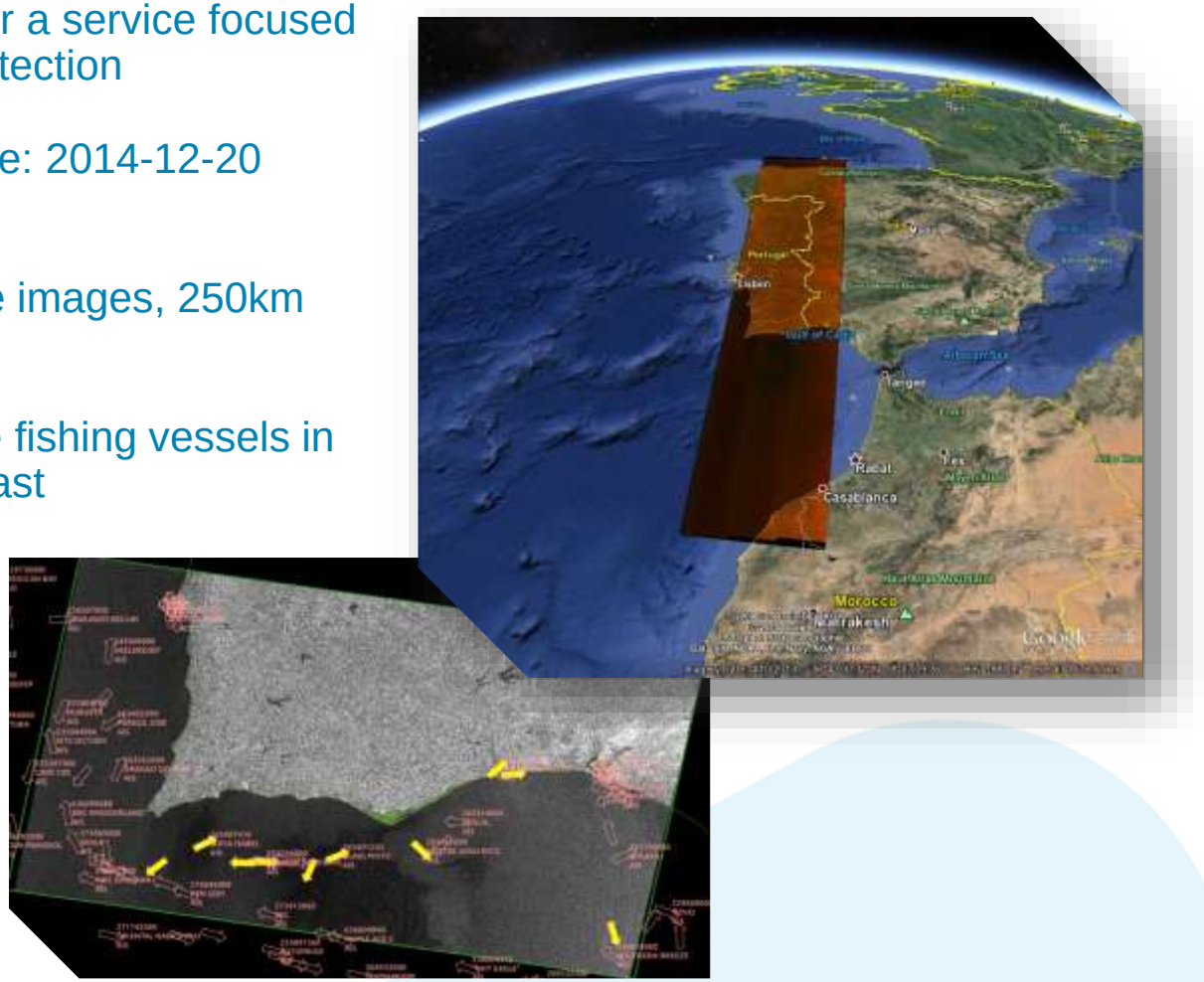
- This is an example scene using Sentinel-1 imagery for a service focused on Fishing Activity detection
- Sentinel-1A strip. Date: 2014-12-20 06:34:55
- Strip of 6 consecutive images, 250km width
- AIS data: Portuguese fishing vessels in Portuguese south coast



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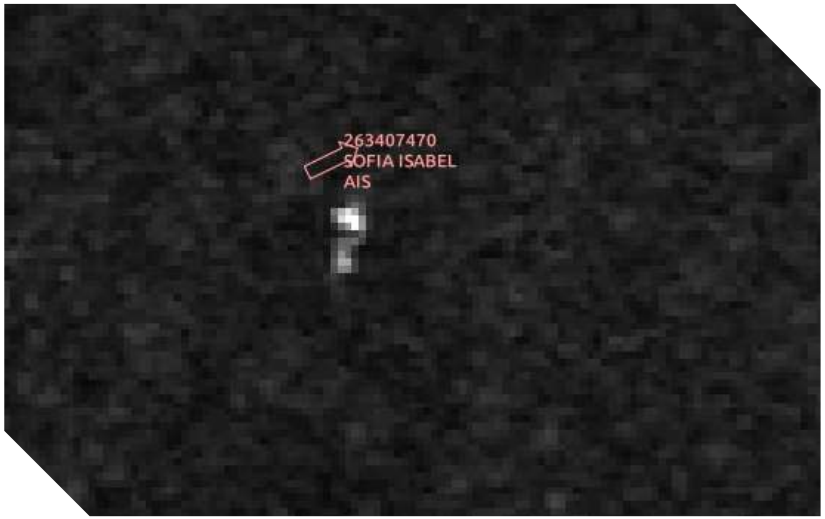
Fishing Vessel Detection

- This is a typical fishing vessel on Portuguese waters
- Image shows potencial for correlation between **Cooperative** (AIS, VMS) with **Non Cooperative** (SAR) data
- Without Sentinel, this detection was only possible with expensive satellites/modes

IMO: -	Gross Tonnage: -
MMSI: **263407470**	Deadweight: -
Call Sign: **CULJ7**	Length × Breadth: **24m × 7m**
Flag: **Portugal (PT)**	Year Built: -
AIS Type: **Fishing**	Status: **Active**



SAR Satellite based Sea Surveillance

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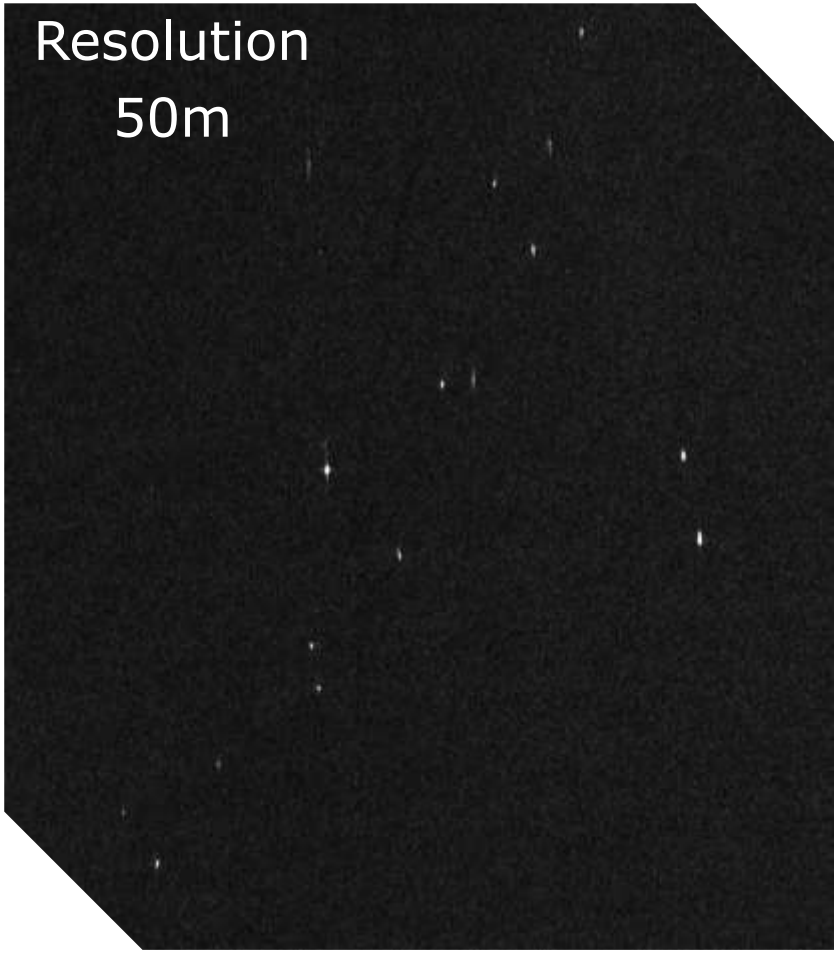

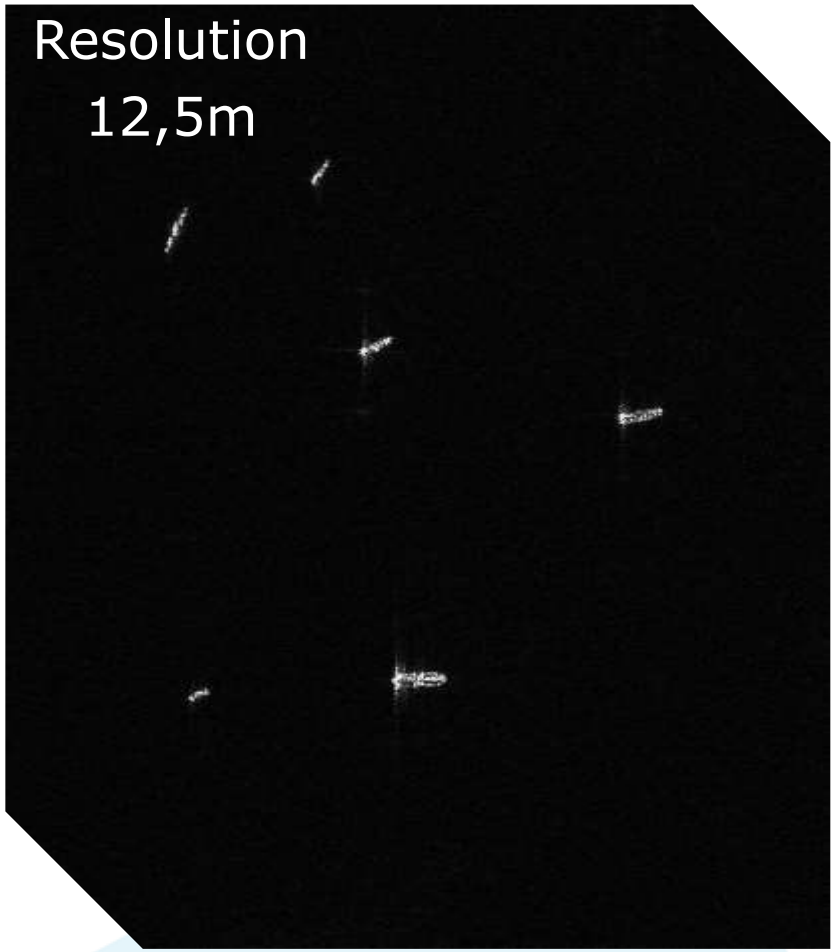

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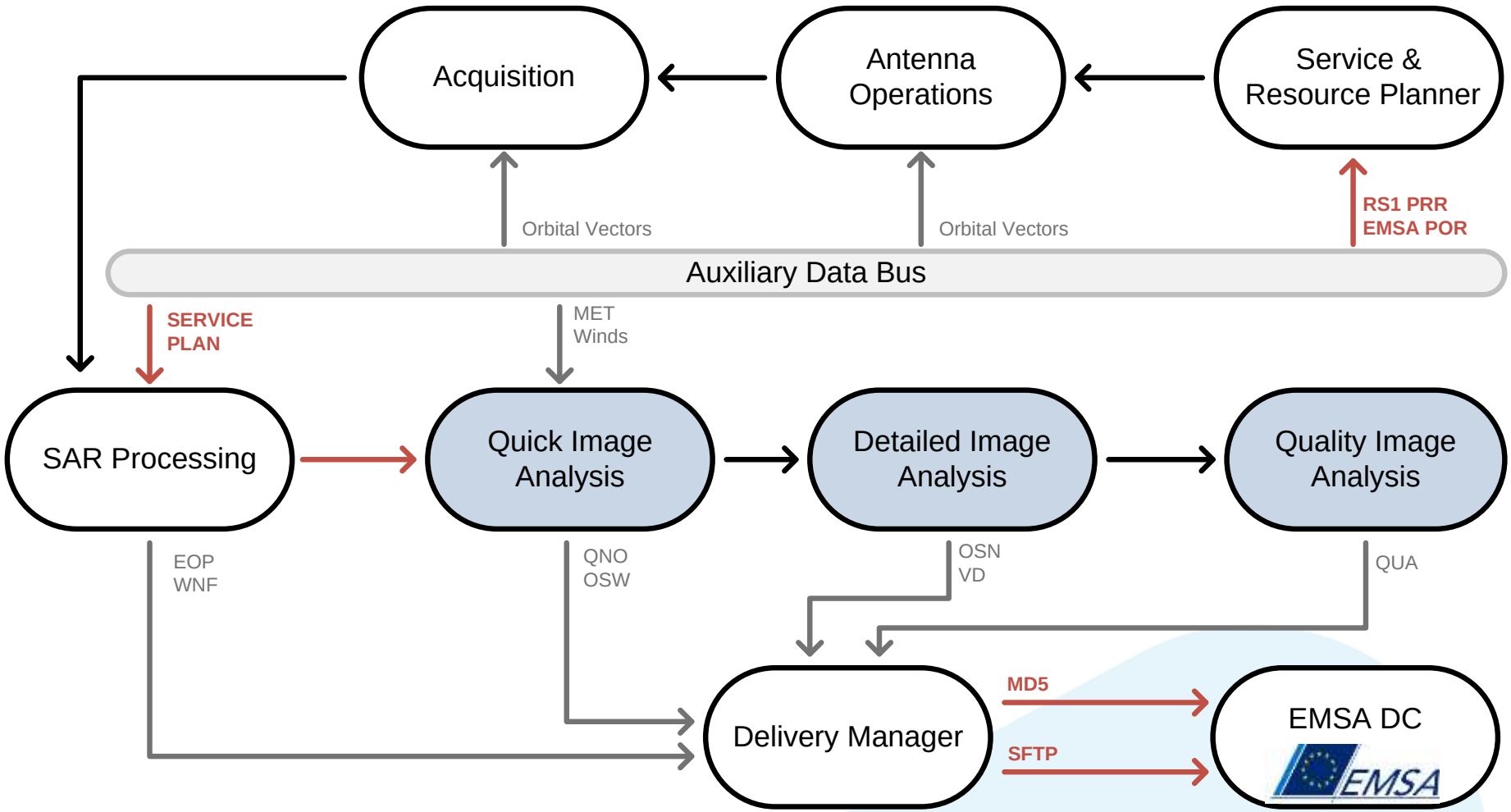
CleanSeaNet Edisoft Processing Chain



Vessel Detection

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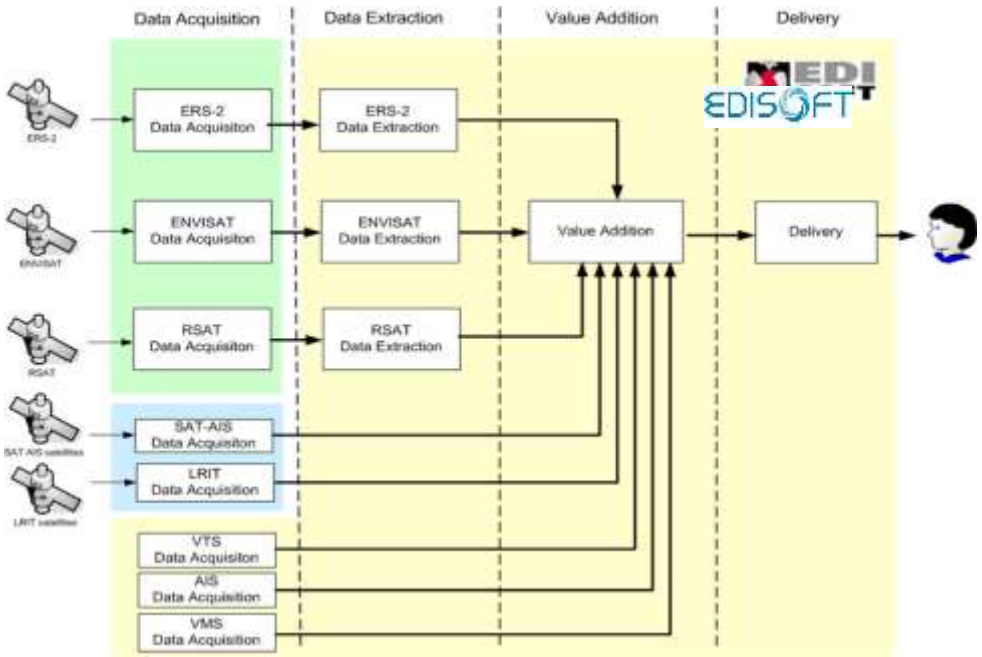

Vessel detection service in the Atlantic

- Acquisition and pre-processing (L1) of SAR data at Santa Maria Ground Station
- Processing and product generation at Edisoft Remote Sensing Operations Center
- Correlation with other vessel detection and identification systems: AIS, VTS, VMS, LRIT and Satellite AIS
- The system was already successfully tested in several campaigns both in national and international waters and in cooperation with the Portuguese Navy.
- Users with SLA: Portuguese Navy, Ports Administration, National Guard, Portuguese Investigation Police

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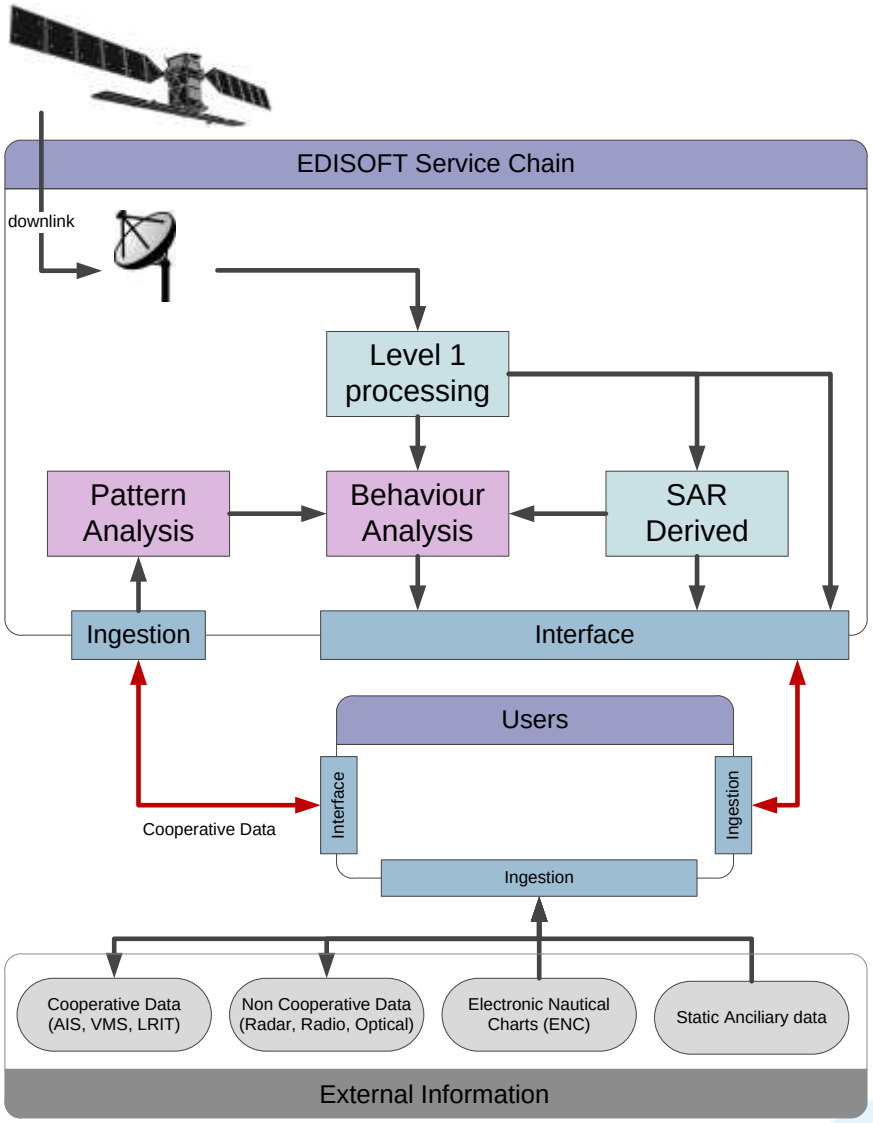
Towards Behaviour Detection…



- Complex, not-straight tracks, in contrast with an expected more linear track
- Possible disconnection of AIS, when the vessel has “visibility” to a given AIS station
- Detection of an extended stop in a vessel travel
- Travelling in forbidden areas – backtrack may be needed when just a few AIS tracks exist
- Deviation from typical route to the announced arrival port
- Proximity between ships in Open Seas
- Non-cooperative detections of big vessels without correspondent AIS signal
- Multiple vessels transmitting with the same MMSI

Other activities

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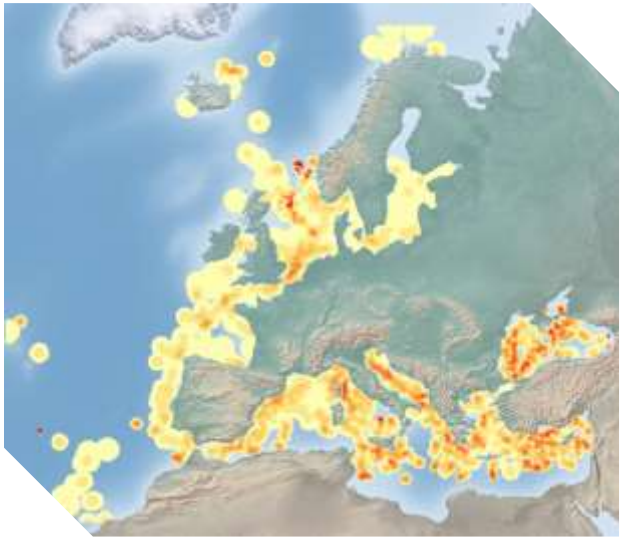
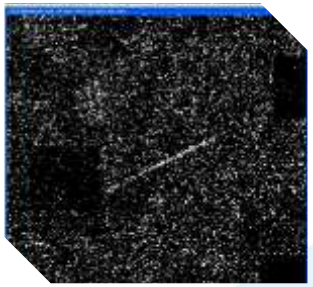
- **OPSA** – Oil Pollution Statistical Analyser
- **Automatic OSD**: Development and validation with ESA and EMSA of an Oil Spill Detection automatic algorithm.
- Several international R&D projects:
  - **MARISS**
  - **MARCOAST,**
  - **SEABILLA**
  - **SEA-U**
  - **DOLPHIN**





First processing phase: Identification of suspect pixels.

Second processing phase: aggregation of pixels and correspondent classification

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Impact of Sentinel

Sentinel-1 Observation Scenario
Data volume and how to address it
Impact on Azores Region
Applications
Recommendations

SMA Sentinel-1 Upgrade is being sponsored by EEA Grants

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Sentinel-1 prime mission objectives

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- Land monitoring of forests, water, soil and agriculture
- **Emergency mapping support in the event of natural disasters**
- **Marine monitoring of the maritime environment**
- Sea ice observations and iceberg monitoring
- Production of high resolution ice charts
- Forecasting ice conditions at sea
- **Mapping oil spills**
- **Sea vessel detection**
- Climate change monitoring

S1A Observation Scenario

Before and after commissioning phase

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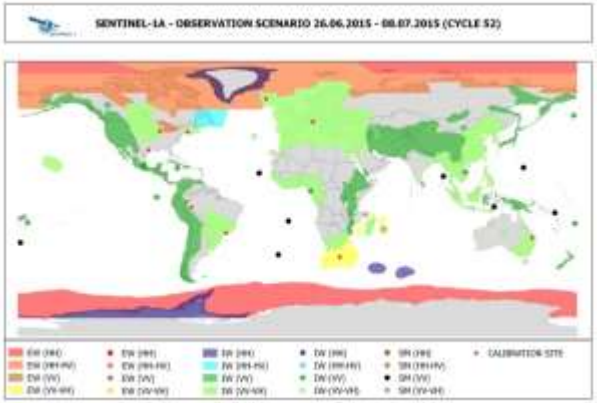

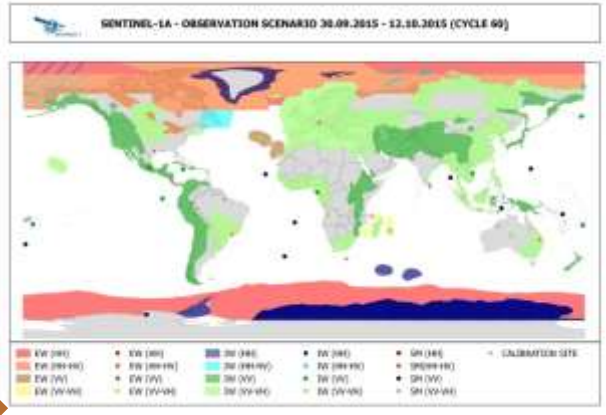

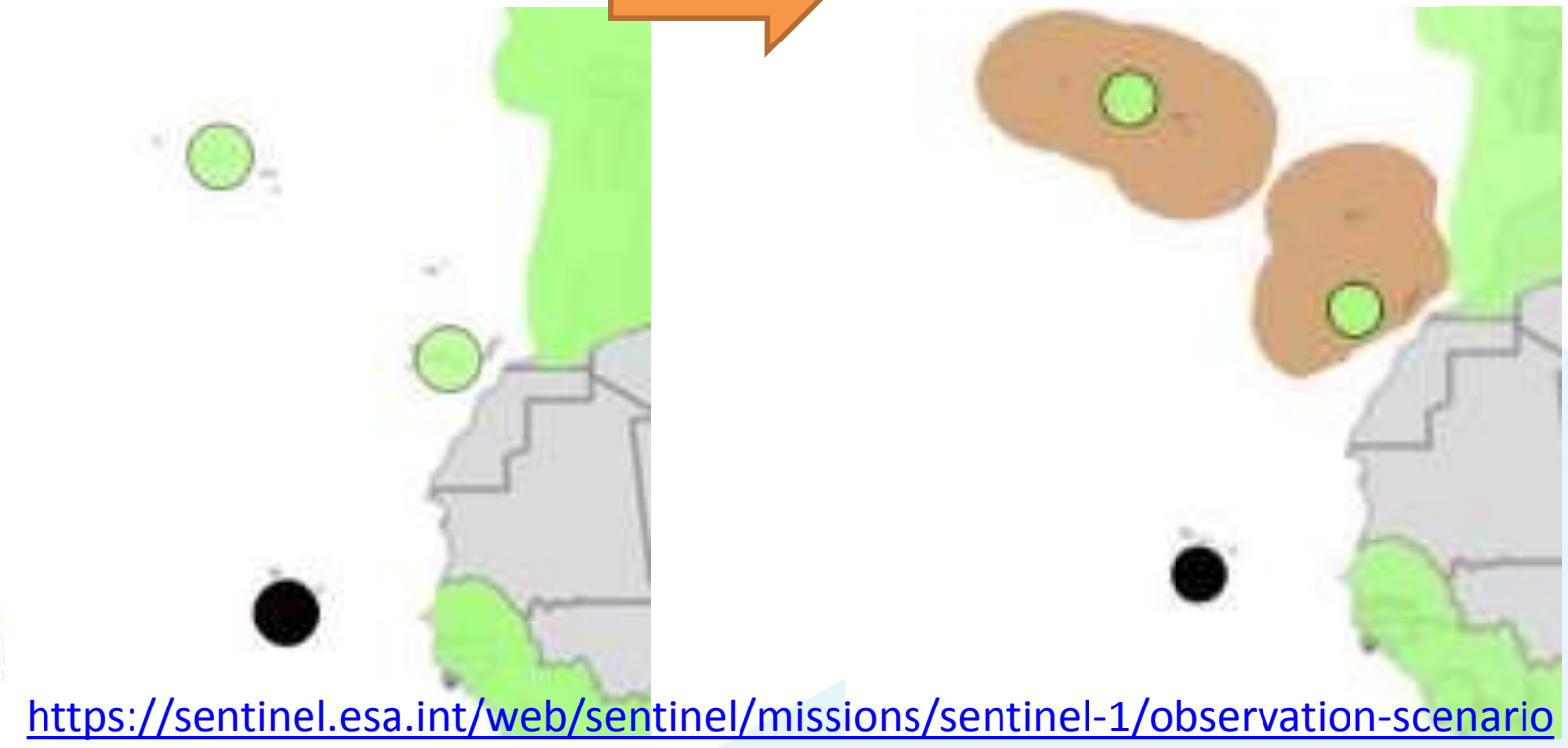

https://sentinel.esa.int/web/sentinel/missions/sentinel-1/observation-scenario

Expected Data Volume (global)

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Global Coverage	Daily data rates	Yearly product archive
Sentinel 1A/1B	1.8 TB/day raw data	2.0 PB/year
Sentinel 2A	1.6 TB/day raw data	2.5 PB/year
Sentinel 3A	0.6 TB/day raw data	2.0 PB/year

Expected Data Volume (PT EEZ)

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Portuguese EEZ	Daily data rates	Yearly product archive
Sentinel 1A/1B	70 GB/day raw data	76 TB/year
Sentinel 2A	60 GB/day raw data	68 TB/year
Sentinel 3A	25 GB/day raw data	25 TB/year

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Sentinel-1 Impact on Technologies, Products & Services

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Types	Sub-types	Data Requirements
Enhanced Vessel Detection	SLC based vessel detection	SLC **(10x larger)**
	Small vessel detection	SLC **(10x larger)**
	Vessel speed estimation	SLC **(10x larger)**
	Vessel classification	SLC **(10x larger)**
Enhanced Oil Spill Detection	Automatic Oil Slick Detection	Multi look **(10x larger)**
	Oil Slick thickness	Multi look **(10x larger)**

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How to Address this data volume?

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- **Virtualization**
  - High availability
  - Risk mitigation
  - Data/Processing preservation
- **Cloud Computing**
  - Shared environment
  - Flexibility, Scalability, Elasticity, Reliability
  - Easy private / public cloud provisioning
- **Recent Experience**
  - ESA DAS-LT

How to Address this data volume?

- **In summary**
  - Core products are free, reducing the cost of added value services
  - Move processing closer to the input data
  - Don’t over-invest in private infrastructure
  - Use public cloud services for peak processing needs
  - End Users should ingest the added value products and avoid storing the bigger core products
    - The idea is to use information extracted from the core product, which is smaller

Impact on Azores Region

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- **Satellite Monitoring is now feasible for Azores**
  - Other assets (naval, air force) are expensive to operate
  - As a background mission, Sentinel facilitates change detection over time
  - Improves performance of existing assets
- **Research opportunities**
  - Improved knowledge of Marine and land areas
- **Improve export capability**
  - Other regions face the same challenges
- **Promotes regional resilience to menaces and independence**
  - by using state-of-the-art technology

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Applications for Azorean Archipelago

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- **Existing, improved with Sentinel-1**
  - Oil Spill and Vessel Detection
- **Potential, now financially possible**
  - Fishing activities
  - Behaviour Analysis (for civilian use)
- **Other important applications**
  - InSAR (Landslides, Volcanic Activities)
  - Change detection (farming/urban areas)
  - Monitoring Marine Protected Areas
  - Search and Rescue

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Recommendations

- **Interfaces (where and how)**
  - Clear from Core to Collaborative
  - Not clear from Collaborative to PT End Users
  - Clear for Core products, but not for user's exploitation
- **Regional users**
  - Embrace the "XaaS" trend, even for research
  - Deploy your models closer to the core products
- **Sentinel Observation Scenario**
  - Does not cover all areas of interest

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THANK YOU

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