ARGOS

Argos satellite system for animal tracking

CMS/Sharks MOU MOS3
Monaco, 10-14th December 2018

CLS
COLLECTE LOCALISATION SATELLITES

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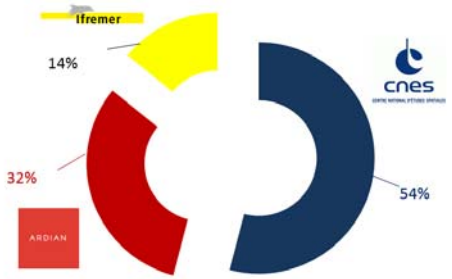
CLS – Collecte Localisation Satellites



- ✓ Subsidiary of CNES, the French Space Agency and IFREMER, the French Research Insitute for the Exploitation of the Sea
- ✓ Worldwide company with around 650 people and 25 subsidiaries and offices
- ✓ **Exclusive operator of the Argos satellite system since 1986**
- ✓ 2 redundant operational centers 24/7 located in Toulouse, France

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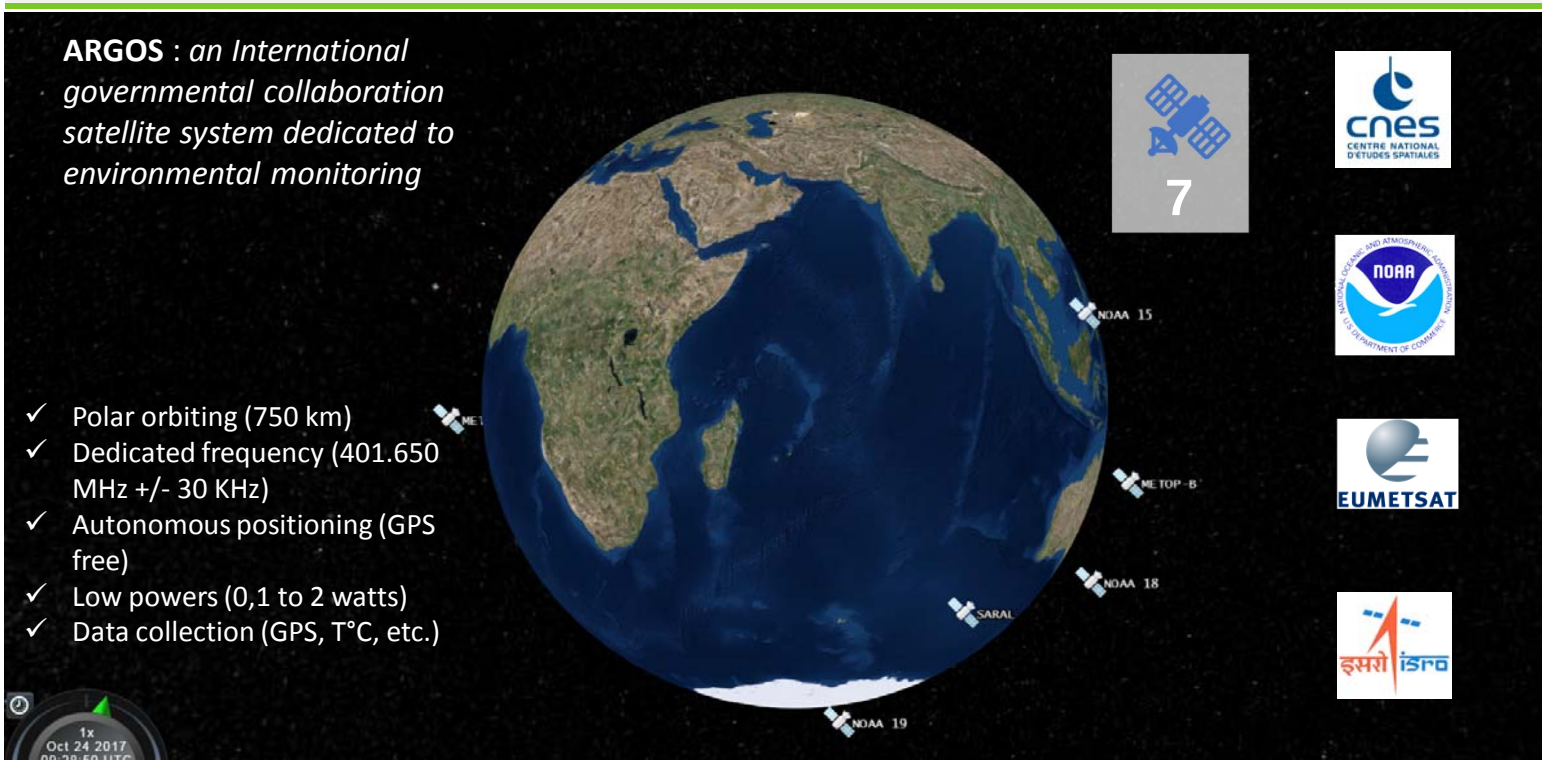
Outline

- The Argos satellite system
- Migratory species tracking with Argos
- Fish tracking with Argos
- Argos related and other services
- Field tools
- The future of Argos

The Argos satellite system

ARGOS : *an International governmental collaboration satellite system dedicated to environmental monitoring*



- ✓ Polar orbiting (750 km)
- ✓ Dedicated frequency (401.650 MHz +/- 30 KHz)
- ✓ Autonomous positioning (GPS free)
- ✓ Low powers (0,1 to 2 watts)
- ✓ Data collection (GPS, T°C, etc.)

Argos usage

16 000 active transmitters

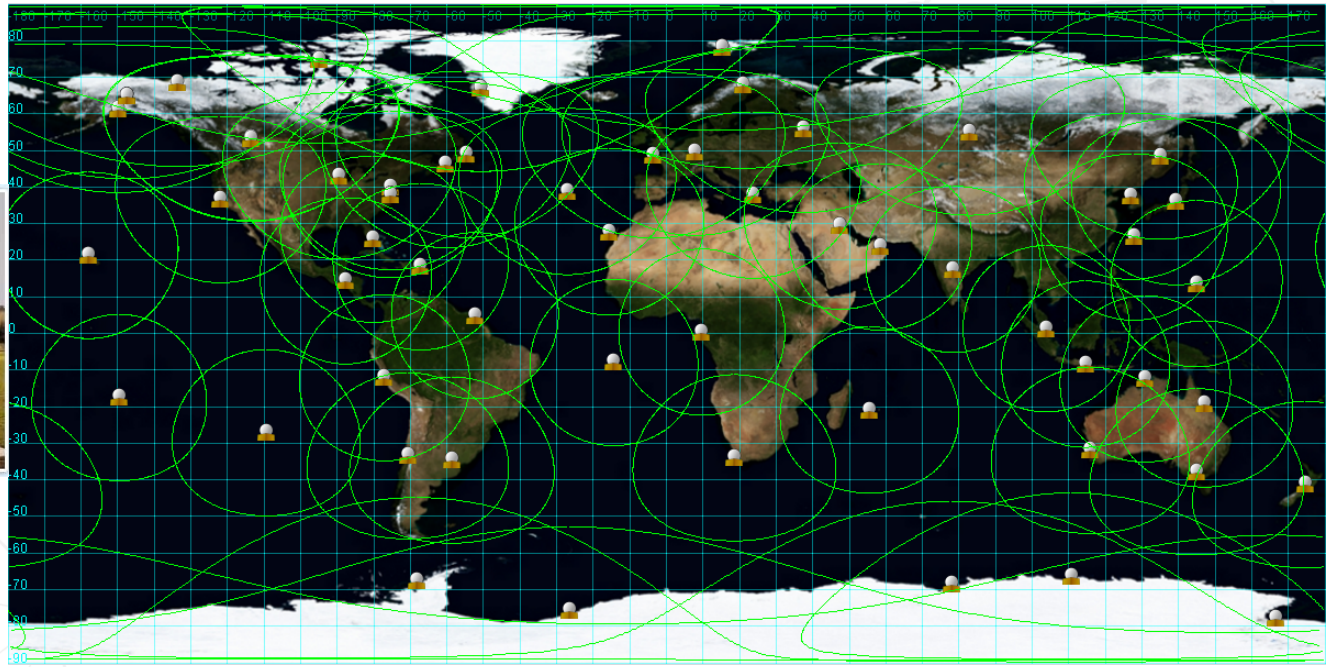
4 000 fishing vessels

1 000 other ships & uses

11 000 scientific platforms

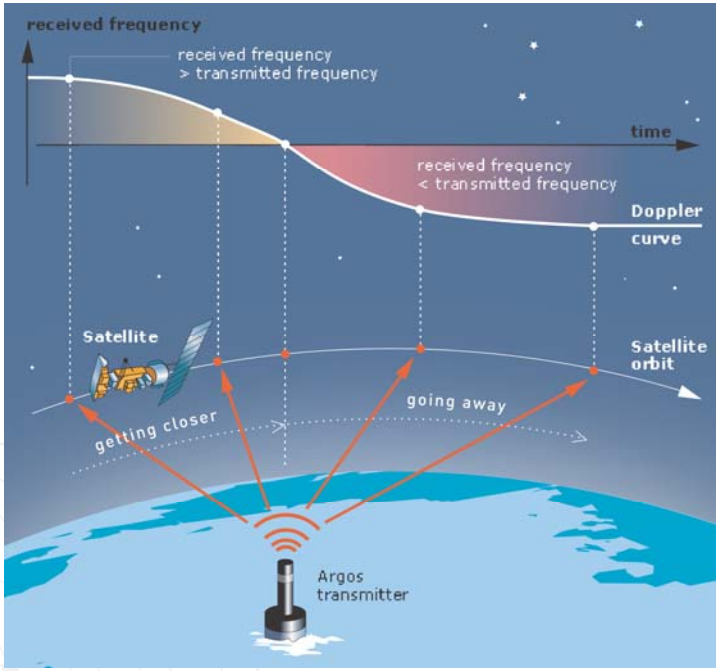
Ground antennas network

~65 Stations (April 2018)

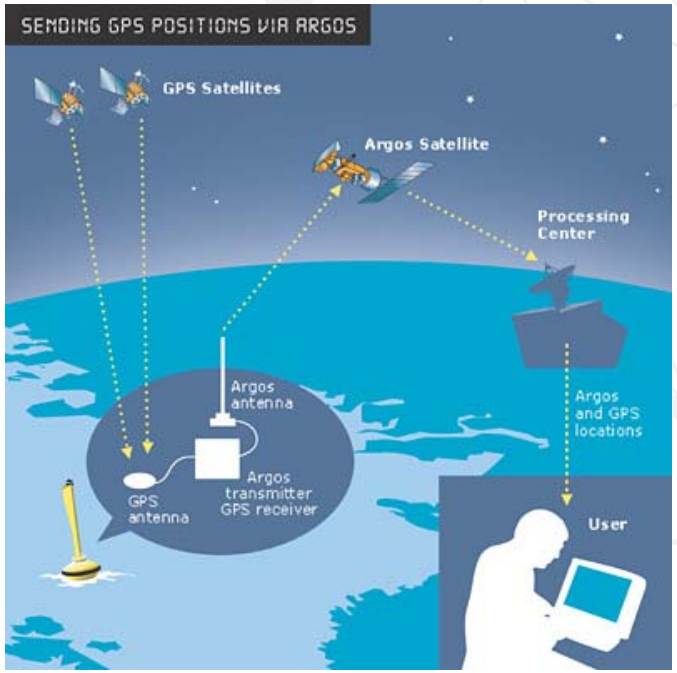


Localisation and Data Collection

Autonomous positioning by Doppler effect



And Data Collection of GPS (if any) and other data



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Migratory species tracking with Argos

- ❑ The Argos satellite system
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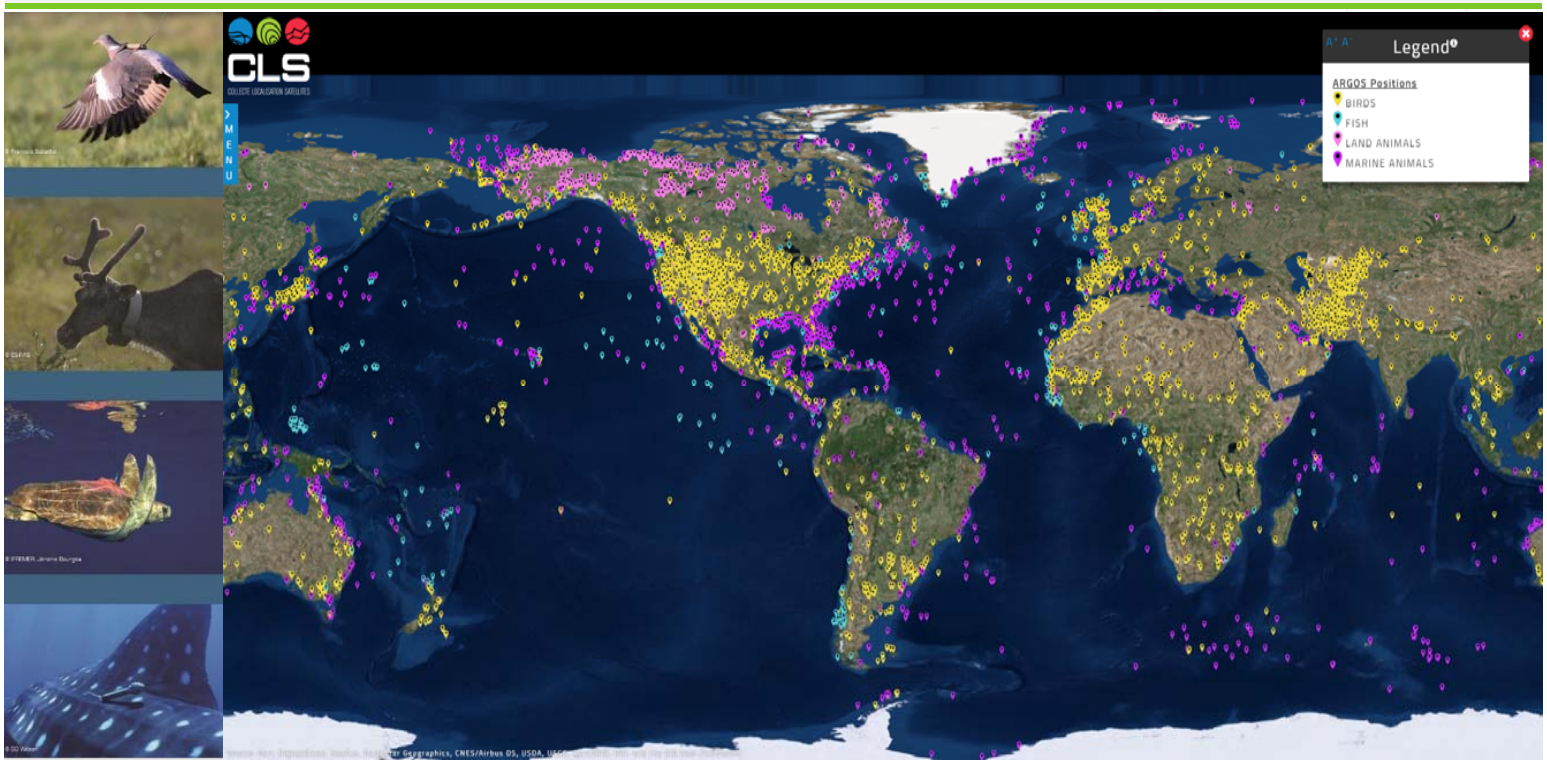
8167 animals tracked last month



Argos wildlife: some key figures

✓ 11 years of data and metadata from October 2007 to now

 # Argos Programs
3 010

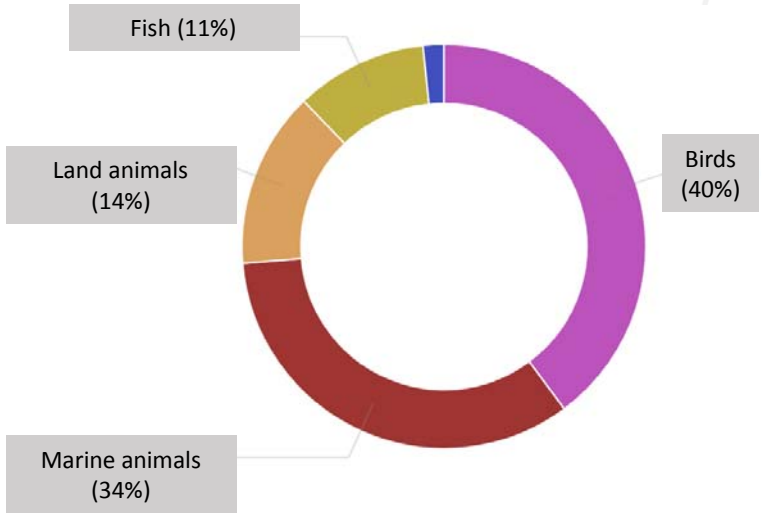
 # Platforms
76 600

 # Positions
77 500 000

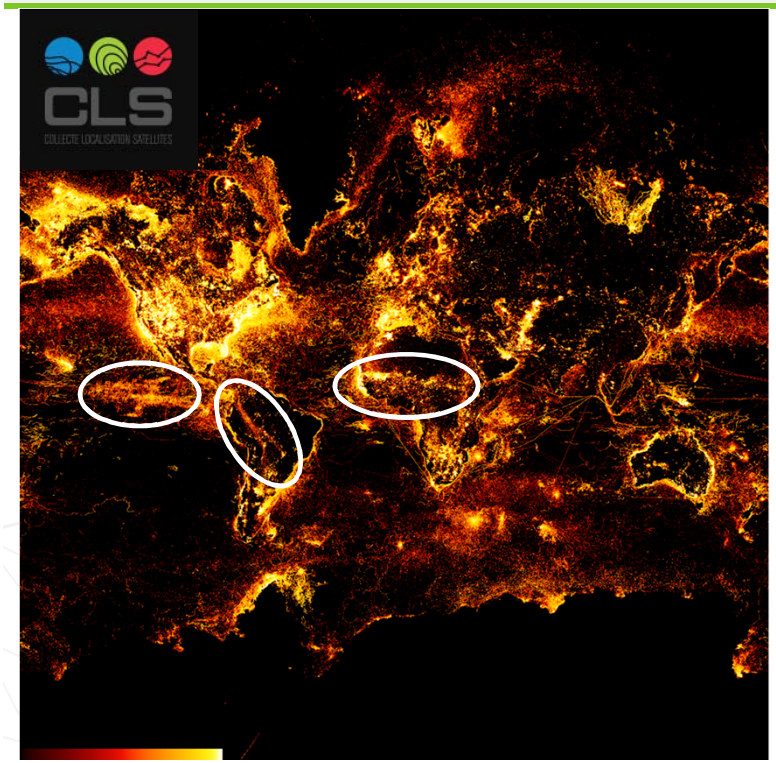
 # Platforms by program
Min: 1, Max: 450
Average: 25, Median: 10

Programs : a lot of small: 630 prog < 10 PTTs, 470 prog between 10 and 30 PTTs

The Big 4 wildlife groups by number of programs



Argos density map



- ✓ Argos density map is drawing the continents
- ✓ Indeed there is a bias due to the location of tagging
- ✓ Nevertheless, we can see a rich biodiversity information and migration corridors:
  - ✓ Fishes (pop-up surfacing) along the equator in the Eastern Pacific
  - ✓ Birds corridors in South America
  - ✓ And across Sub-Saharian Africa

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Tracking fish with Argos

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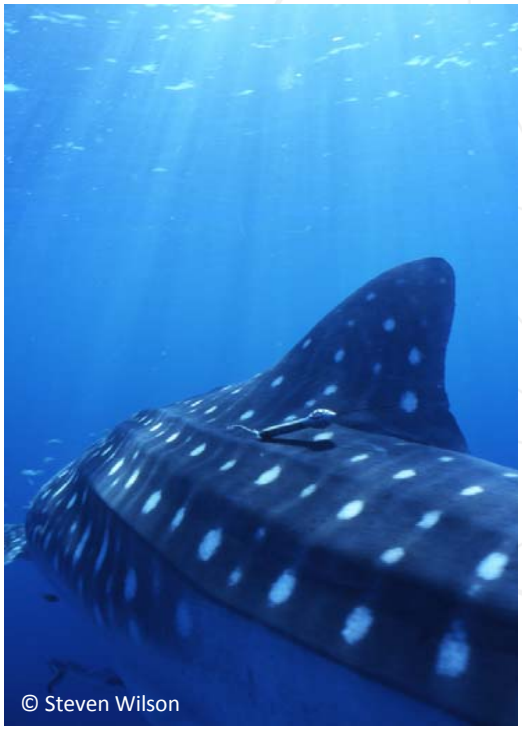
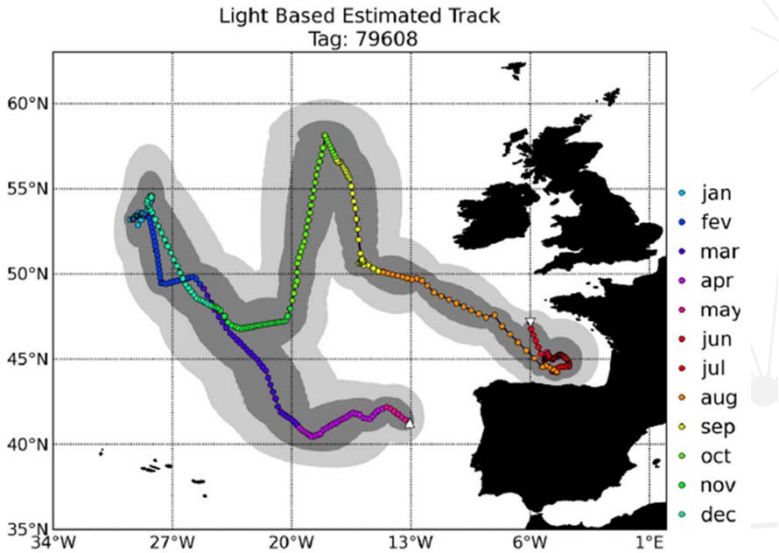
Argos Pop-up Satellite Archival Tag (PSAT)

- ✓ Data-logging module (Light, T°C, Pressure) + Argos transmitter + antenna + float
- ✓ Automatic detachment on a preset date or after a specified period of time
- ✓ Then the data are transmitted to Argos satellites
- ✓ Geolocation based on Light + Temperature and Pressure
- ✓ 4 main manufacturers



« Track & Loc » service by CLS

- ✓ Porbeagle shark
- ✓ Deployed in July 2013, Bay of Biscay shelf break
- ✓ Surfaced in May 2014 (> 10 months)
- ✓ Estimation of one location per day that best explains the daily observed light intensity, depth and temperature data
- ✓ State-space formulation of the tracking problem



Return migration patterns of porbeagle shark (Lamna nasus) in the Northeast Atlantic: implications for stock range and structure, Gérard Biais et al. ICES Journal of Marine Science, 2017, doi:10.1093/icesjms/fsw233

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Argos related and other services

- ❑ The Argos satellite system
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- ❑ Tracking fish with Argos
- ❑ Argos related and other services
- ❑ Field tools
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Argos related and other services

- ✓ **“Basic” telemetry service :**
  - ➢ **positioning and data collection, Argos web, one year online, data mapping & download**
- ✓ **ArgosDirect (email, sms, ftp) & Alarms**
- ✓ **Track Reprocessing after end of transmission (smoother)**
- ✓ **Additional satellite data:**
  - ➢ **Oceanographic data**
  - ➢ **Fishing Vessel traffic monitoring (VMS, AIS/SAT AIS data)**
  - ➢ **Oil spill monitoring (radar satellite)**

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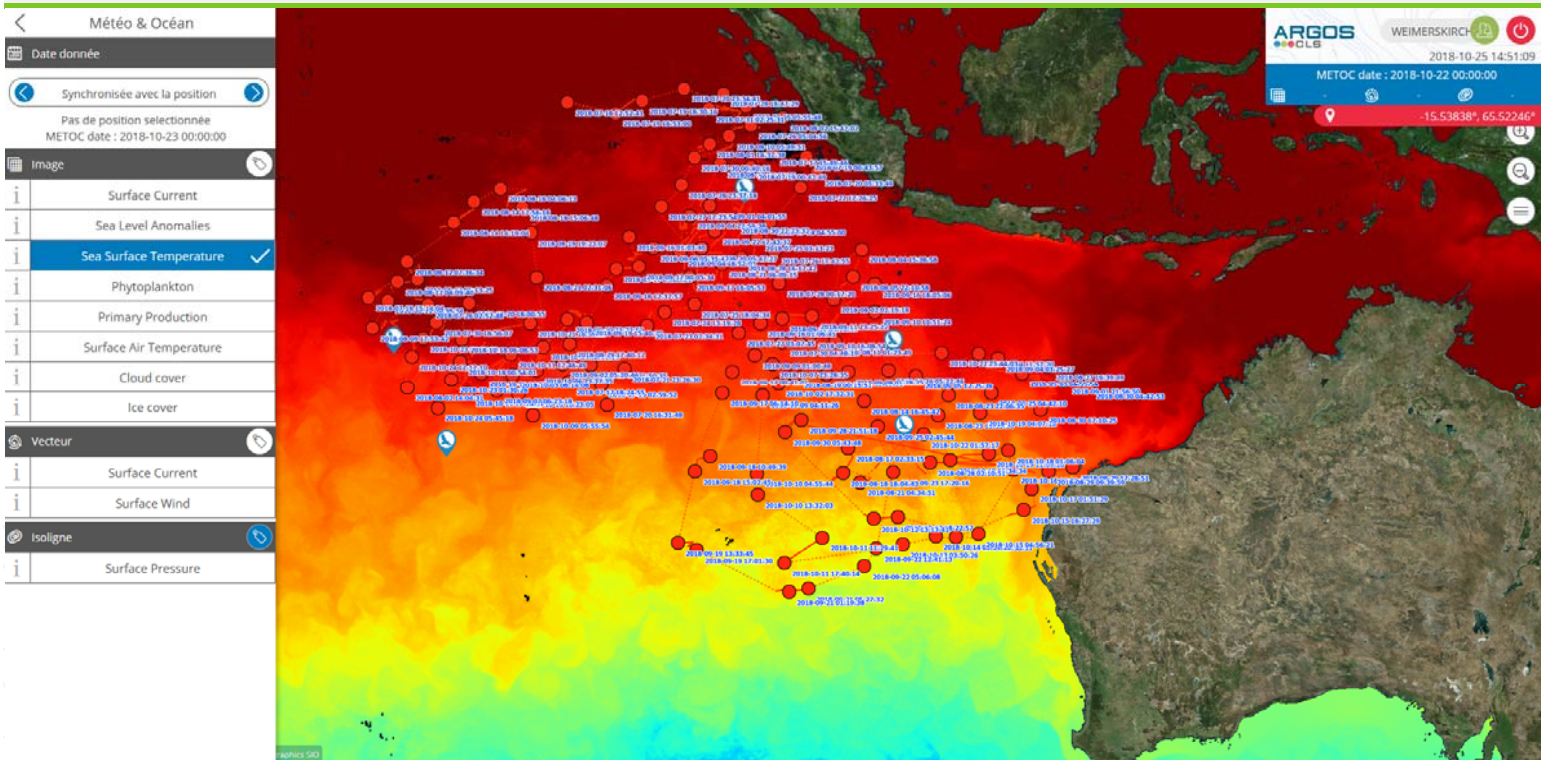
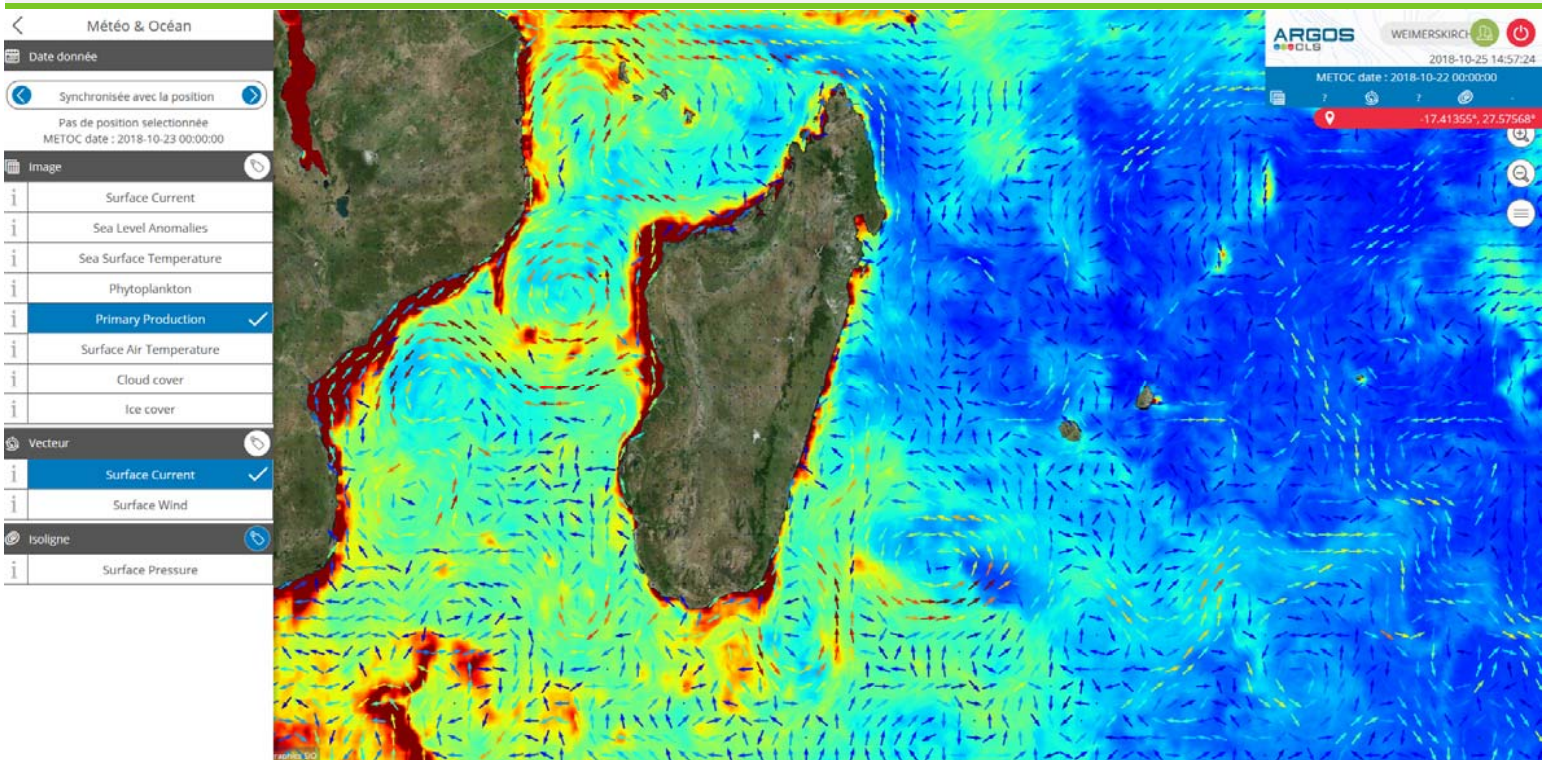
Real-time oceanographic data Viewing and downloading

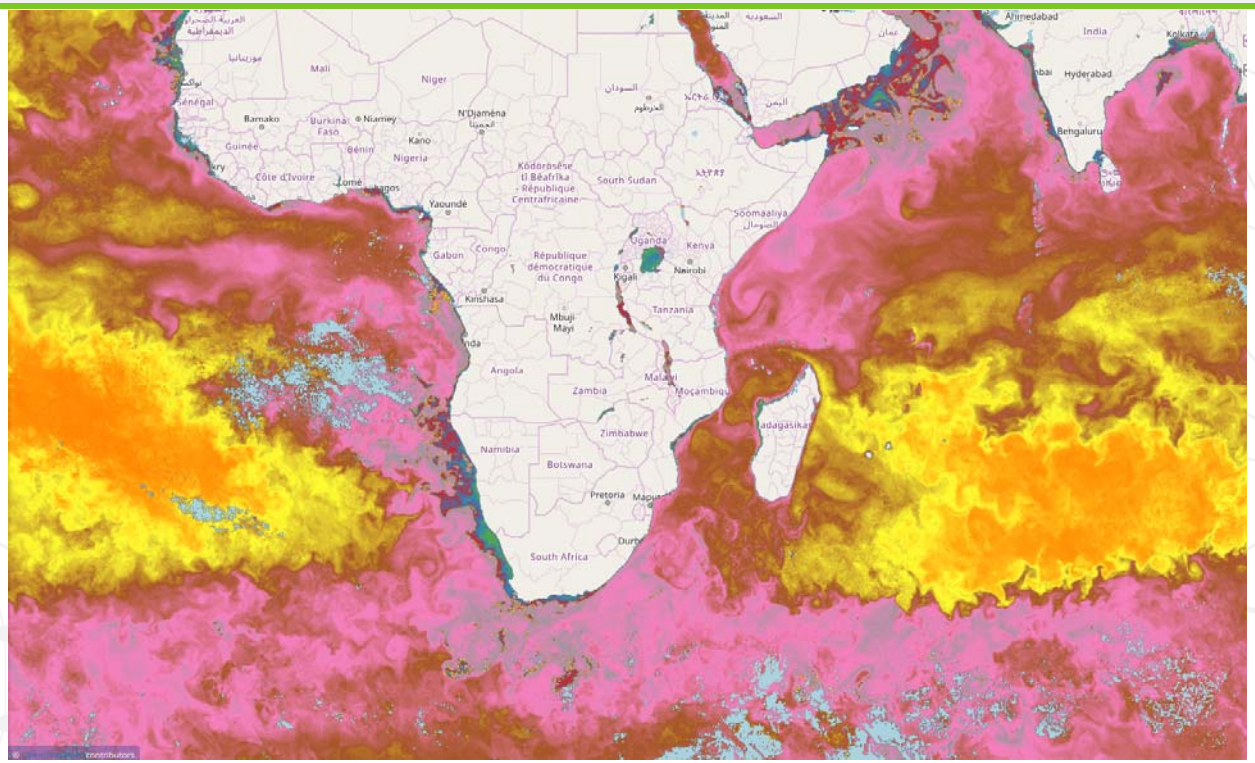
Surface temperature & Argos (frigates) tracks



Primary productivity



Surface Chlorophylle



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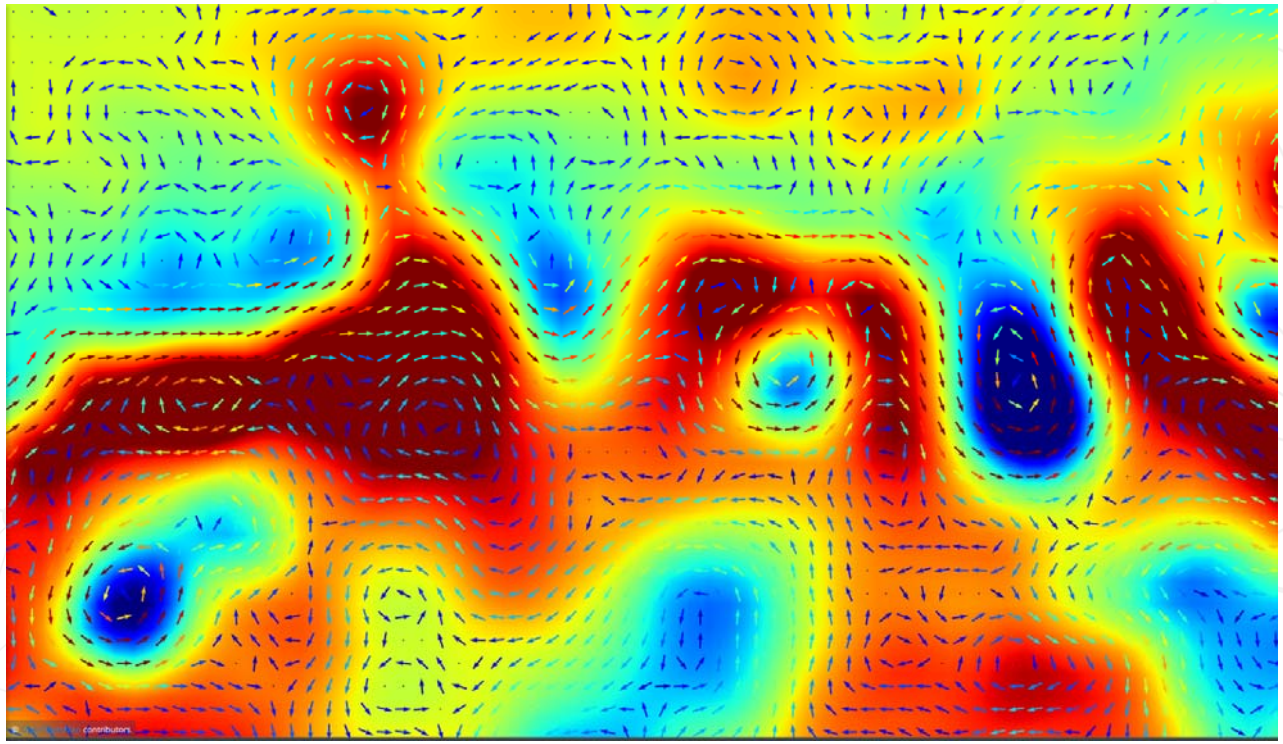
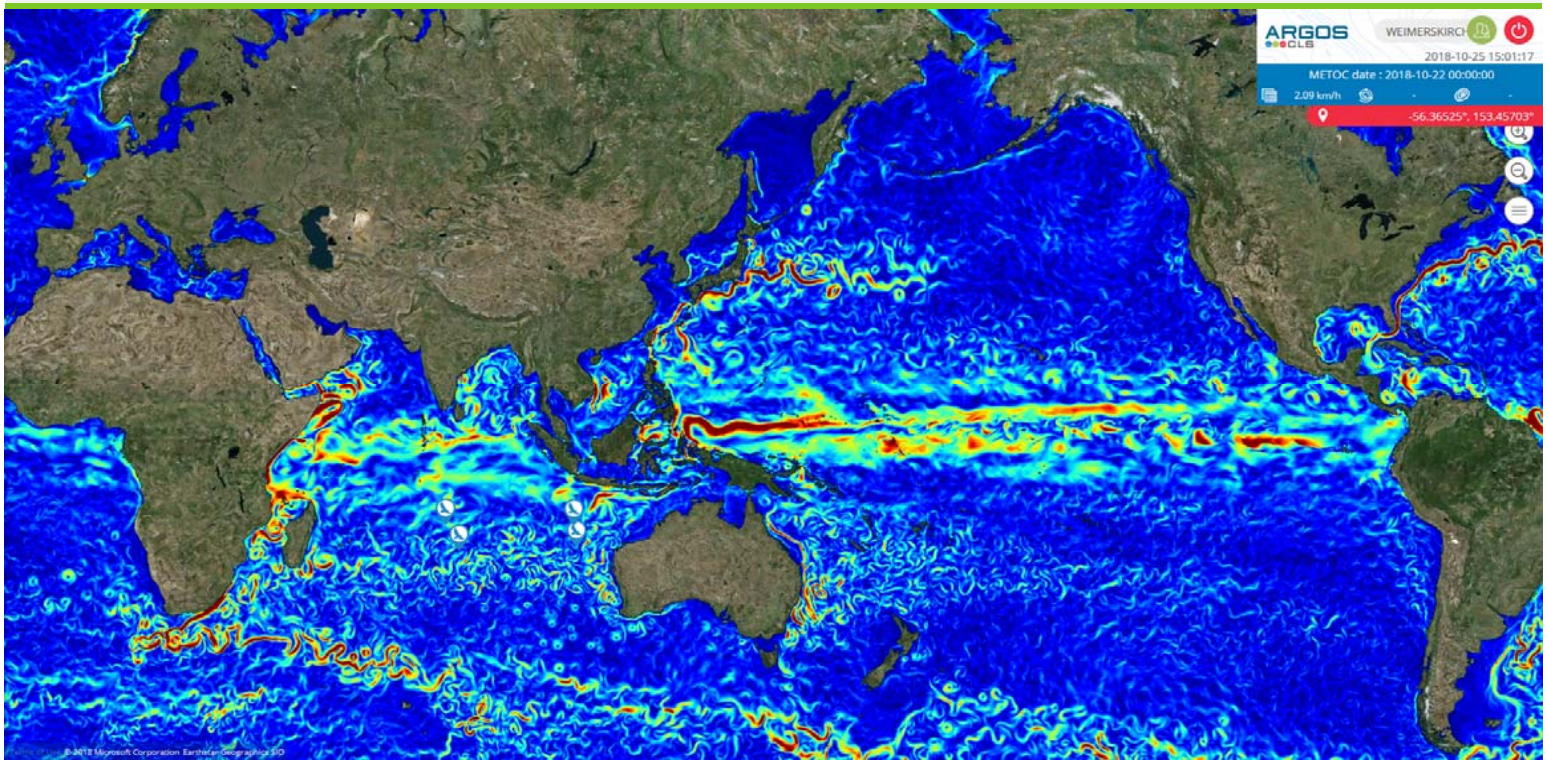
Sea level anomaly and associated current

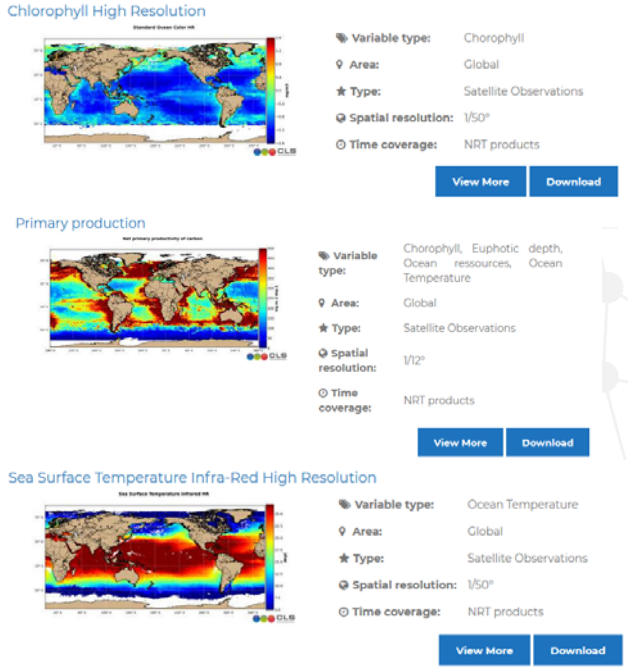


Surface current intensity



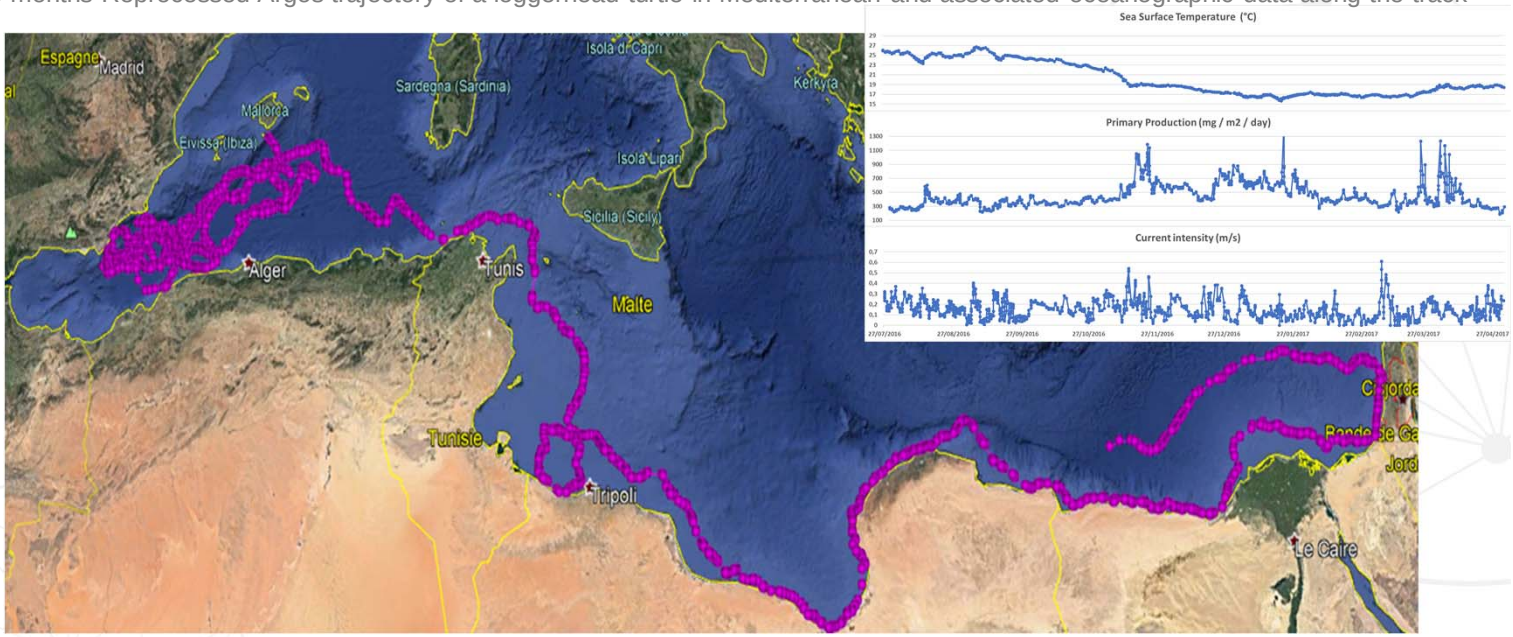
CLS Data Catalogue https://datastore.cls.fr/catalogue

- ✓ Satellite data:
  - Surface temperature
  - Chlorophyll concentration
  - Primary productivity
  - Euphotic depth
  - Sea level & surface current
  - …
- ✓ Model data:
  - 3D current
  - 3D temperature
  - 3D salinity
  - Surface wind
  - Surface pressure
  - …



Oceanographic data along track

9 months Reprocessed Argos trajectory of a loggerhead turtle in Mediterranean and associated oceanographic data along the track



Data Courtesy of: David March, SOCIB, Oceanographic Turtles Project (March et al., unpubl.).

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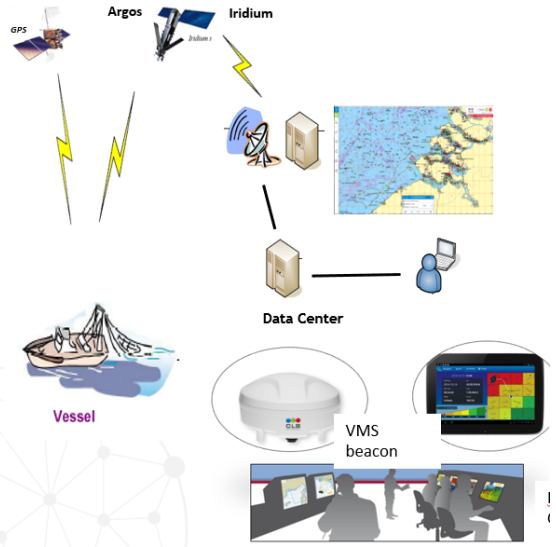
Legal & Illegal Fisheries Monitoring

Vessel Monitoring System (VMS) data centers equipped by CLS

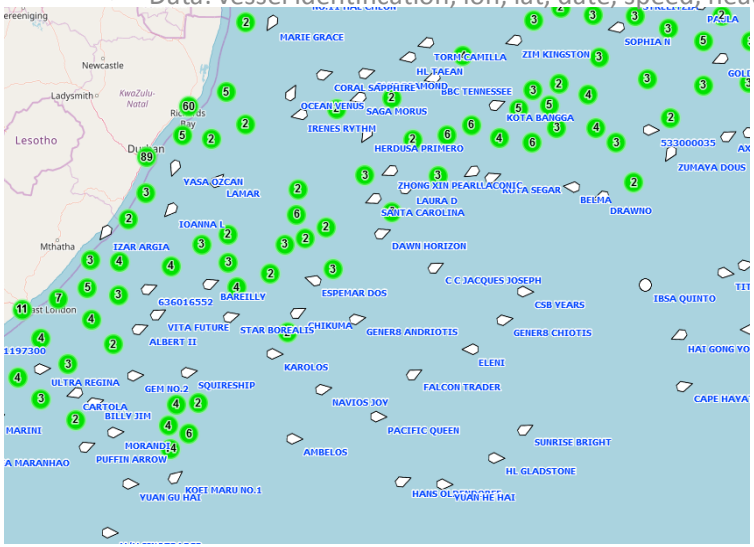


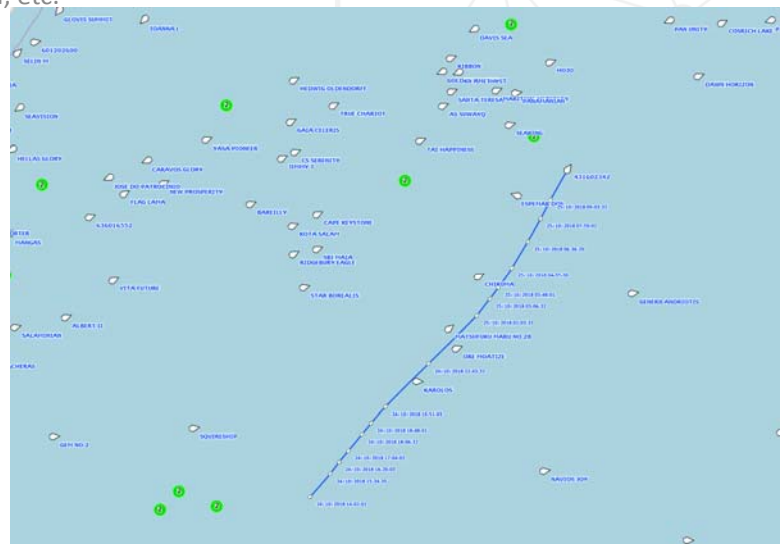
Satellite Vessel Monitoring System & Electronic reporting system under national regulation:

- Monitors fishing and vessel activities
- Monitors vessel positions anywhere in the world.
- Real-time data
- Reporting to national fishing administrations and RFMO's.

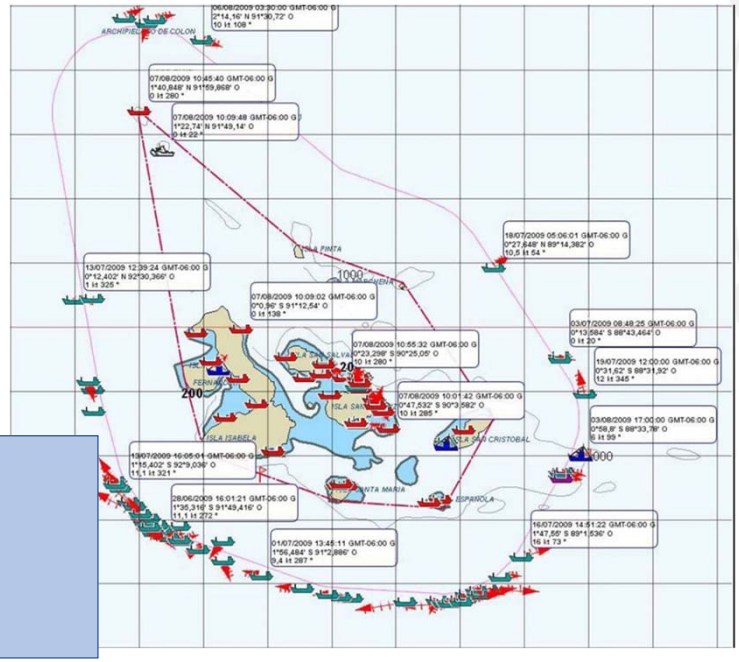
Vessel traffic Monitoring with AIS

- ✓ IMOS SOLAS convention > 300 gros tons (GT) passengers and shipping + EU fishing vessels > 15 m
- ✓ Anti-collision system
  - ✓ From boat to boat
  - ✓ From boat to ground antennas
  - ✓ From boat to satellites (global coverage)
- ✓ Data: vessel identification, lon, lat, date, speed, head, etc.





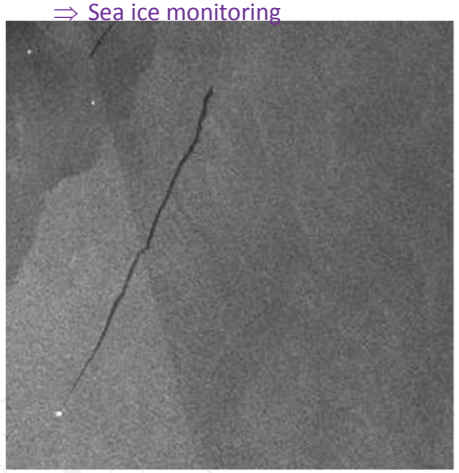
Example: Galapagos Marine Protected Area (AIS + VMS)



Industrial fishing boats
Local fishing boats
Tour boats
Cargo boats
Park enforcement boats

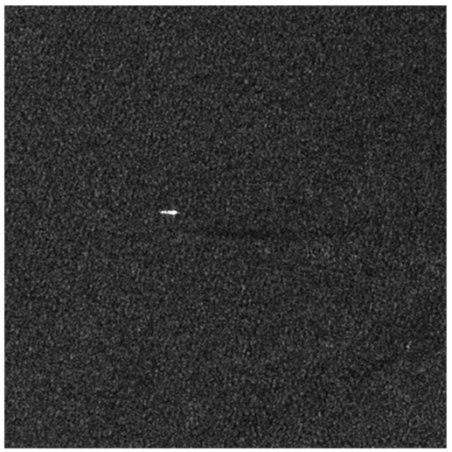
solution satellite (Synthetic Aperture Radar)

Routine large scale surveillance
⇒ Oil pollution monitoring
⇒ Sea ice monitoring



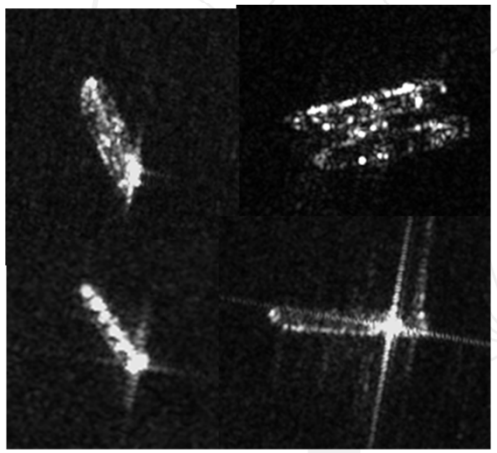
Spatial resolution > 50 m
Swath coverage 250 to 500 km
(Sentinel-1, Radarsat-1&2 ScanSAR)

Surveillance of large vessels & wakes
⇒ Detection of IUU fishing activities
⇒ Detection of illegal traffics



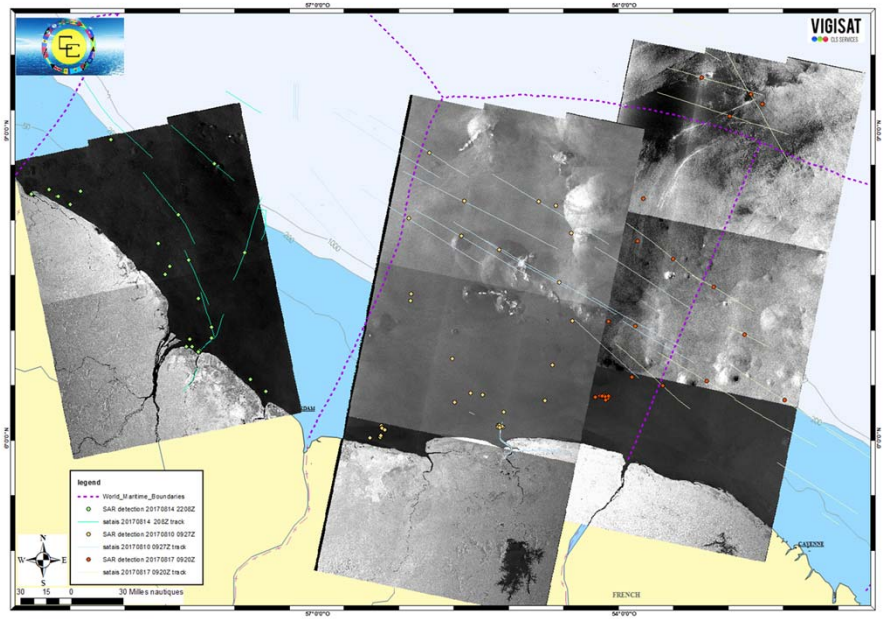
Spatial resolution 25 m
Swath Coverage 50 to 150 km
(Sentinel-1, Radarsat, TerraSAR-X, COSMO SkyMed)

Zoom on Area of Interest – Details
⇒ Behaviour
⇒ Trans-shipment

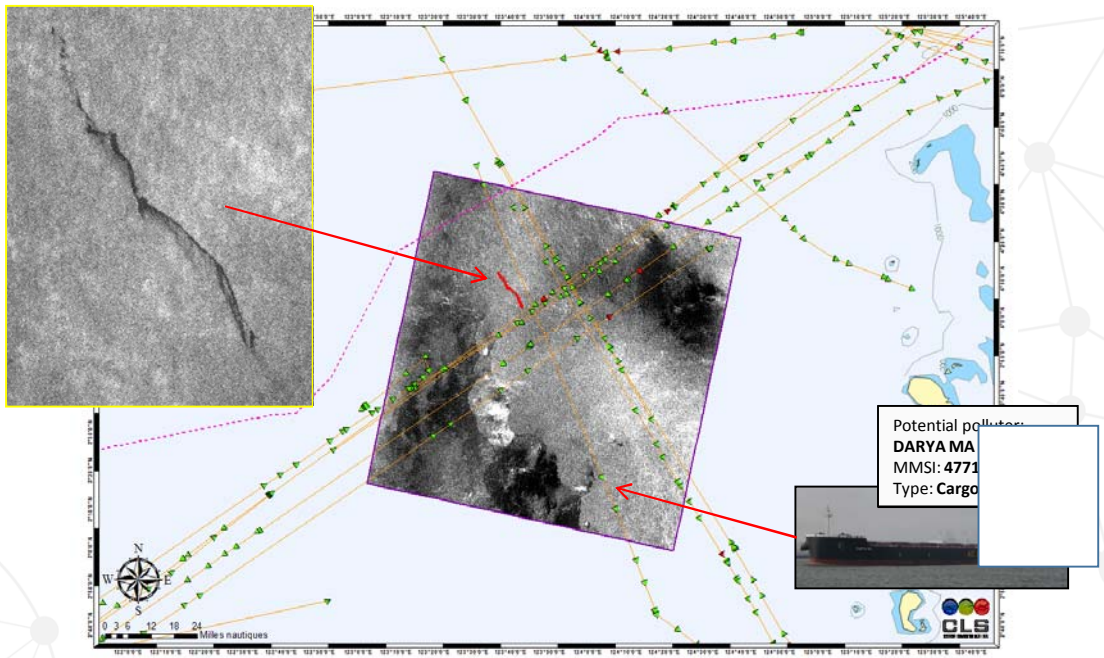


Spatial resolution < 5 m
Swath coverage < 20 km
(TerraSAR –X, Cosmo SkyMed, Radarsat-2)

Radar satellite detection & SAT AIS



Oil Spill detection and polluter identification



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Field tools

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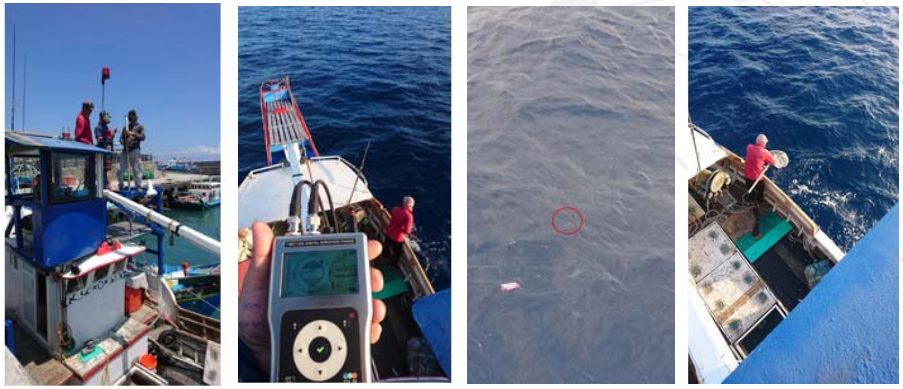
Argos Goniometer

CLS RXG-134 GONIOMETER

http://www.argos-system.org/using-argos/goniometer-cls-argos/

- ✓ For Argos beacons/tags recovery on land / at sea
- ✓ GPS & internal compass
- ✓ Goniometry mode : gives the direction
- ✓ Direct mode (if GPS receiver in the tag/beacon): direction + distance
- ✓ Range: depends on antenna height (several tens of Km)
- ✓ Autonomy > 50h



Reporting Tablet

- ✓ Marinized Android tablet
- ✓ Camera, video
- ✓ Telecom:
- ✓ Iridium SBD
- ✓ GPS
- ✓ Wifi/Bluetooth
- ✓ 4G option

- ✓ Use cases:
  - ✓ Fising catch books
  - ✓ Environmental reporting
  - ✓ Argos mapping on ground
  - ✓ Field reporting

Let’s talk about the FUTURE

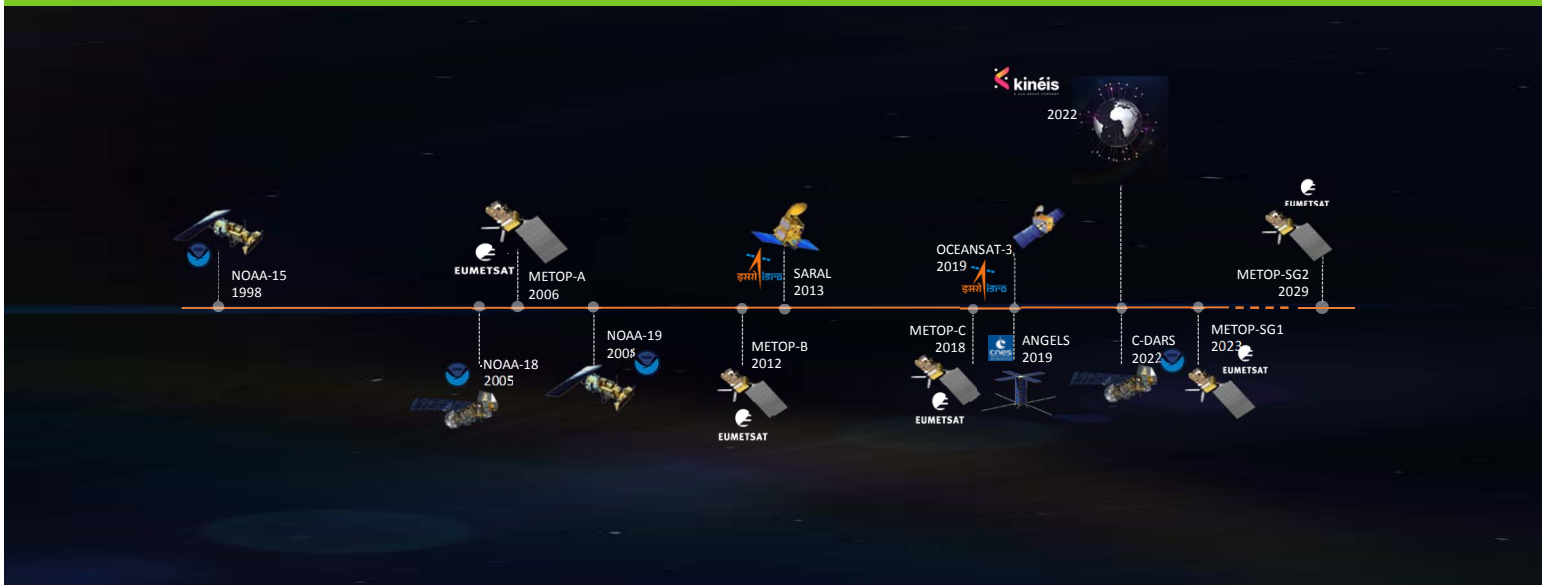
ARGOS

The Argos constellation

New generation of Argos-4 payload will be launched in 2019 on ISRO/OceanSat-3 and in 2021 on NOAA/CDARS

CNES is launching the Argos ANGELS project with the launch of the 1st Argos nanosat in 2019

EUMETSAT committed to Argos until 2036

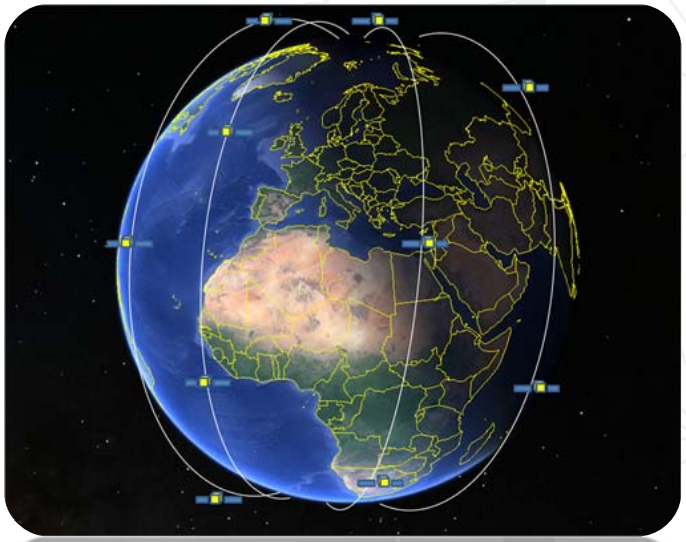


2022 – 20 nanosatellites

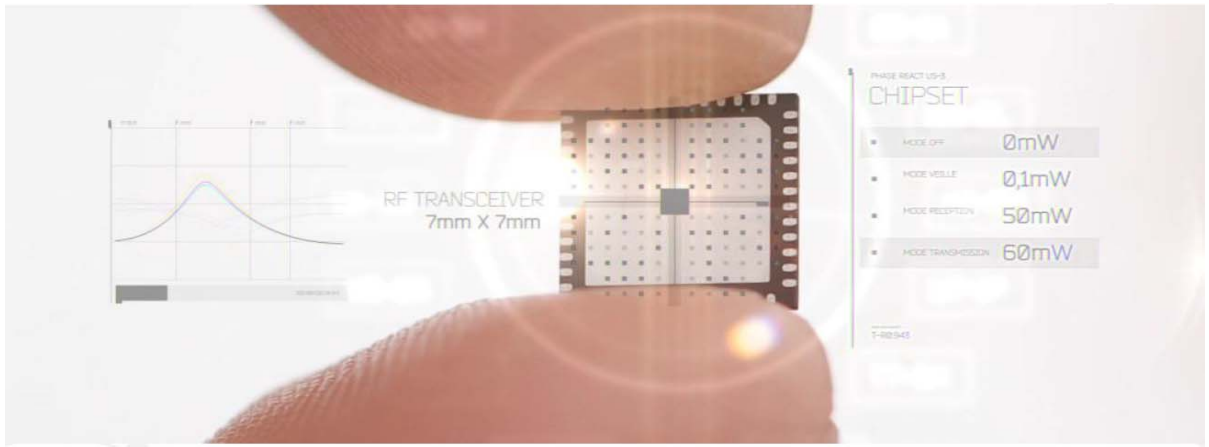
- Operational in 2022
- Target is **20 operational nano-satellites**
- With an improved revisit time: **10 to 30 minutes max** between 2 satellite passes

Argos-4 for next generations

- Transmitter output power:
  - **down to 100 mWatt** (animal tracking)
- High data rate performance (oceanographic applications, …)
- New downlink capability
  - transmit only over satellite passes
  - Send data with Acknowledgement
  - Manage remotely by commands
- Much bigger system capacity:
  - **More than 50 000 beacons** processed (16 000 today)



Argos 4 chipset



- CHEAPER AND SMALLER
- NEW APPLICATIONS (epidemiology, herd monitoring, …)
- HYBRID TERMINALS : /ARGOS, /GSM, /Sigfox, /LORA

On-going partnerships with manufacurers to integrate the Argos chipset

With Kinéis, ARGOS becomes IoT Everywhere

20
NANOSATELLITES
INTEGRATED PROPULSION

25
GROUND STATIONS

3
STRATEGIC PARTNERS

cnes
CENTRE NATIONAL D'ETUDES SPATIALES
NEXEYA
LET'S MERGE OUR TALENTS
ThalesAlenia Space

2021
PUT INTO ORBIT

2022
OPERATIONAL SYTEM