

Copernicus and the Sentinels – New Advances, satellite sensors and opportunities

Craig Donlon
ESA/ESTEC, Noordwijk, The Netherlands

STSE OceanFlux Evolution Workshop, IFREMER, France, September
2016



- ESA and OceanFlux
- What is Copernicus?
- Mission overviews
- Data access



Purpose of ESA



“To provide for and promote, for exclusively peaceful purposes, cooperation among European states in **space research** and **technology** and their **space applications**.”

Article 2 of ESA Convention





ESA STSE OceanFlux GHG: New Climatology of CO₂ Gas flux

<http://www.oceanflux-ghg.org/>



Oceanflux Greenhouse Gases

Site map | Contact

Ifremer | eri | NOC | HERIOT WATT | PML

oceanflux-ghg
support to science element

stse
ESA

The Project | Science | Products | Documents | Meetings & Events | Blog | News | Links | Workshop | Contacts

Latest news



Published on the 15/04/2013
Science workshop registration

The registration for the science workshop is open.

[Read the news](#) +



Published on the 01/02/2013
Brochure

The brochure of the project is available

[Read the news](#) +

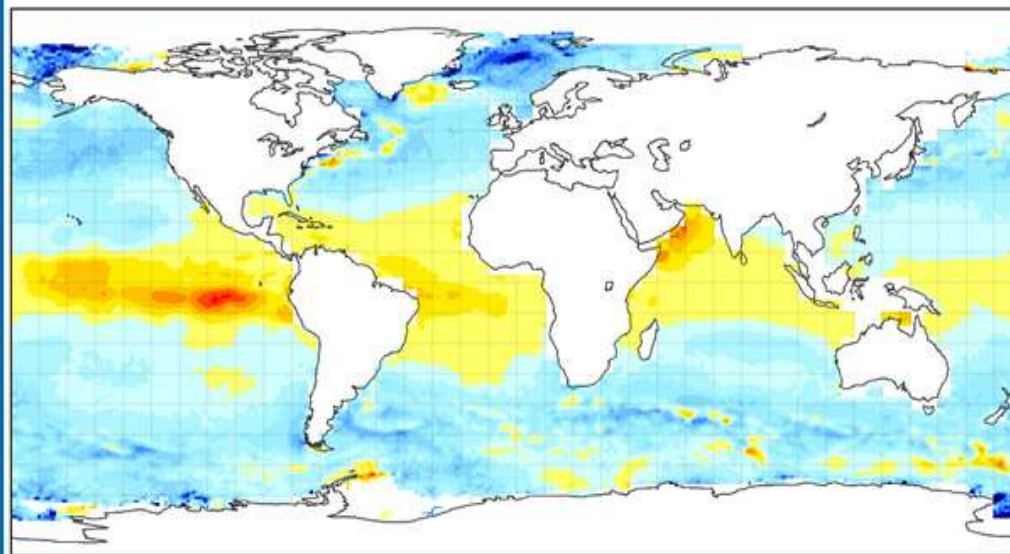


Published on the 22/11/2012
Observing gas transfer between ocean and atmosphere from space

Short wind waves in the order of centimeters can be observed by satellite altimeters; their relation with gas transfer velocity through the sea surface is used to develop gas transfer algorithms for the world's oceans.

[Read the news](#) +

Zoom



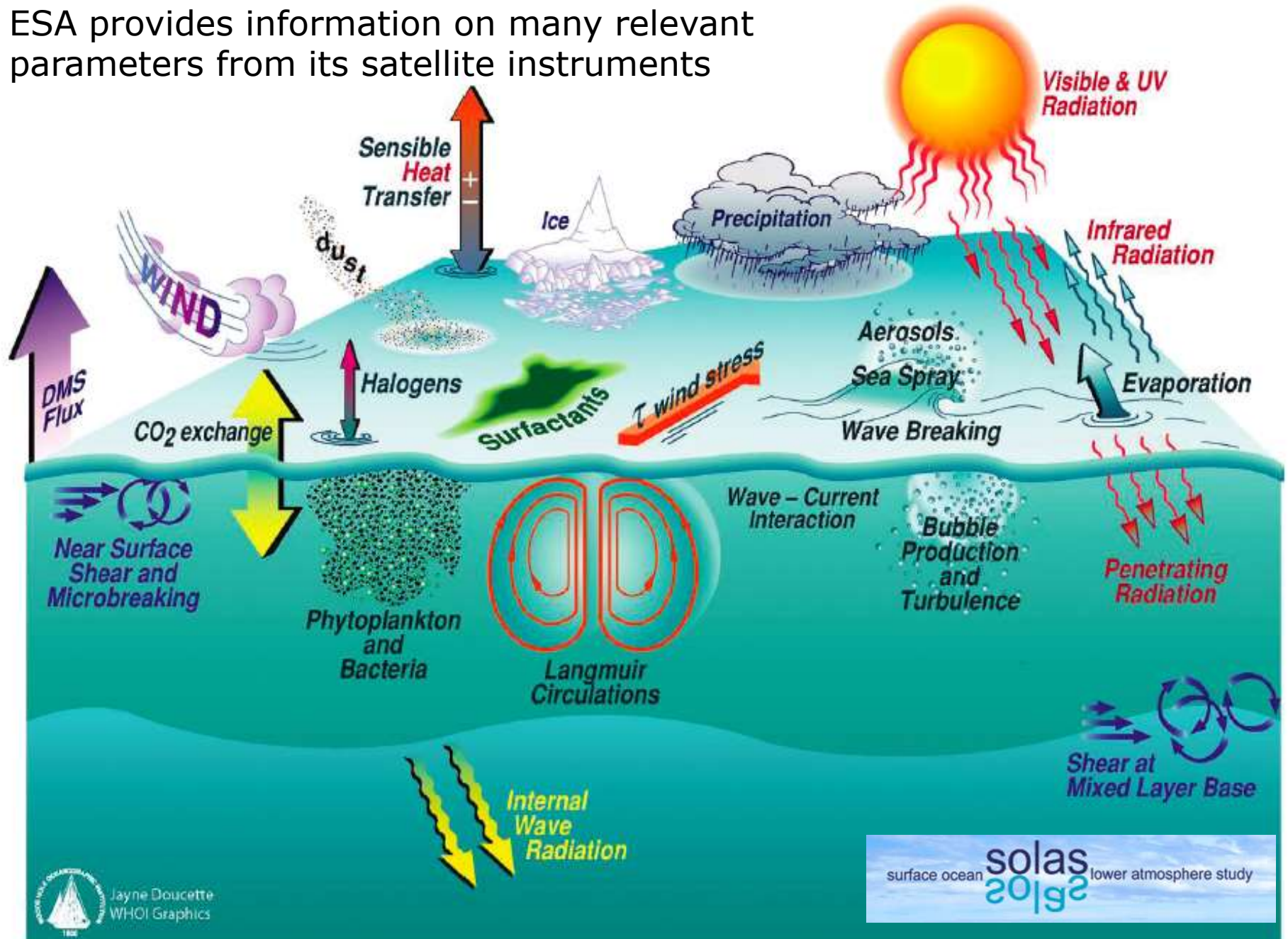
The Project

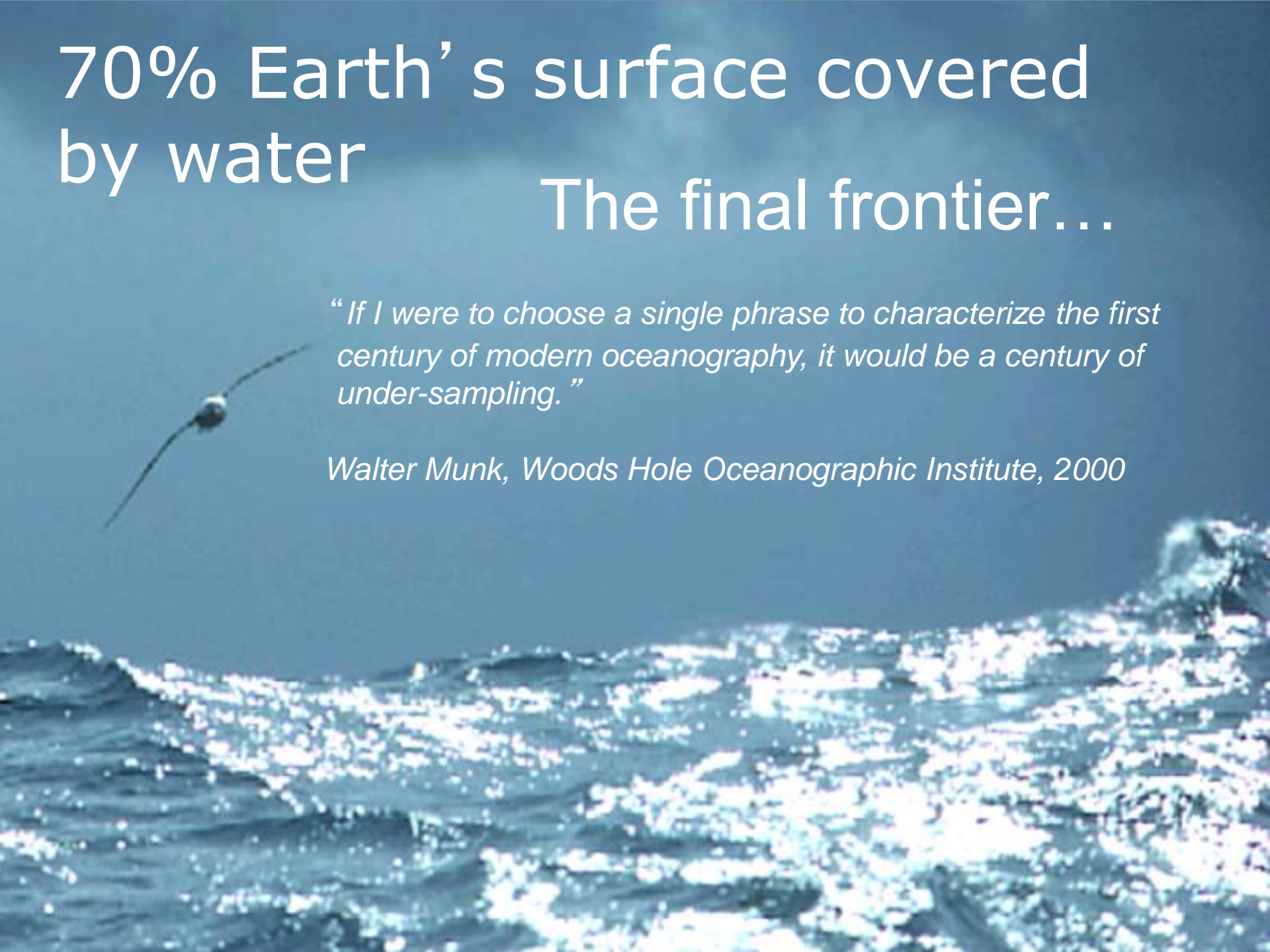


Partners

Ifremer

ESA provides information on many relevant parameters from its satellite instruments



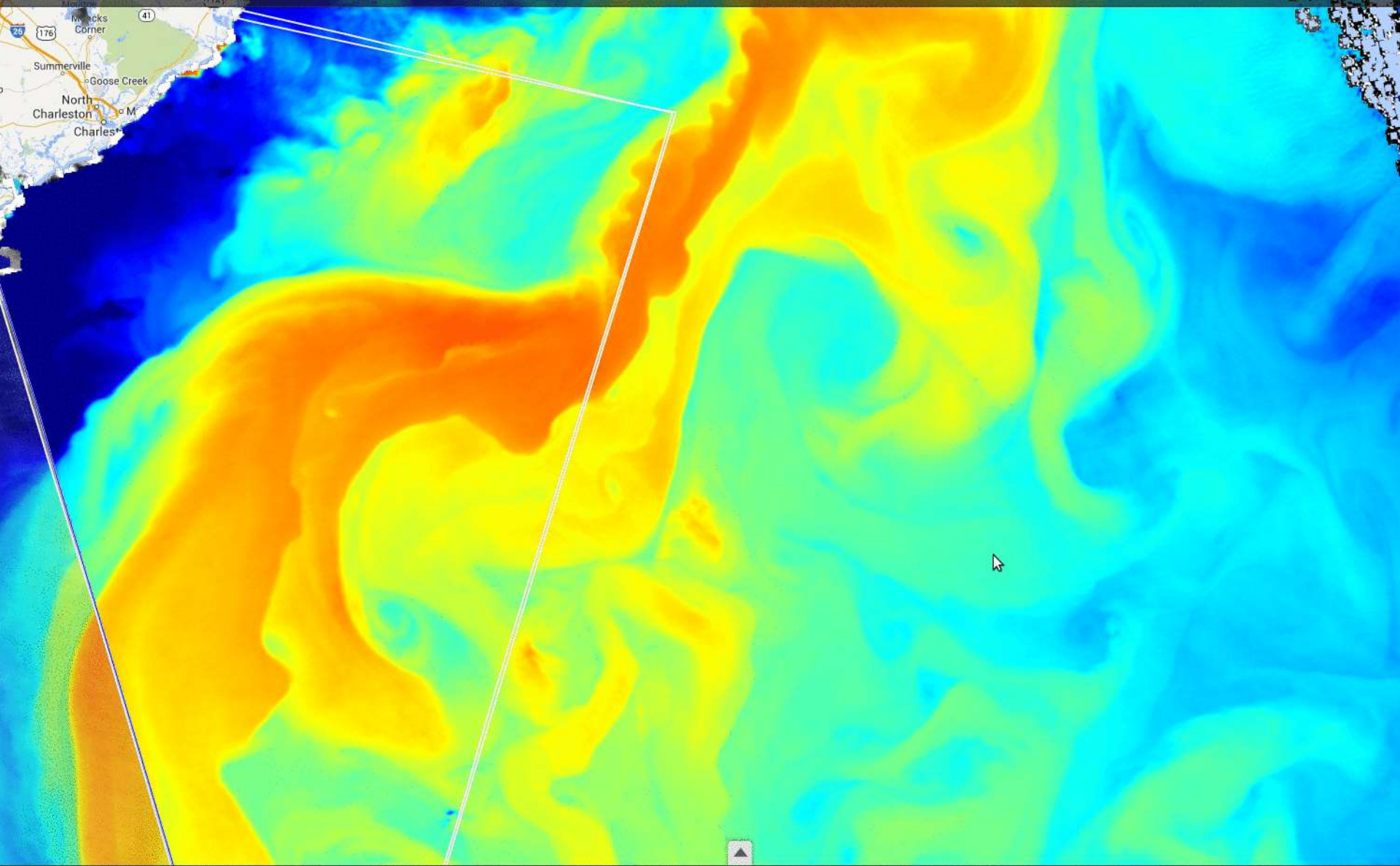
A blue-toned photograph of a seagull in flight over a body of water. The seagull is positioned on the left side of the frame, with its wings spread and its tail visible. The water below is textured with small waves and white foam, suggesting movement or a current. The sky is a clear, deep blue.

70% Earth's surface covered
by water

The final frontier...

“If I were to choose a single phrase to characterize the first century of modern oceanography, it would be a century of under-sampling.”

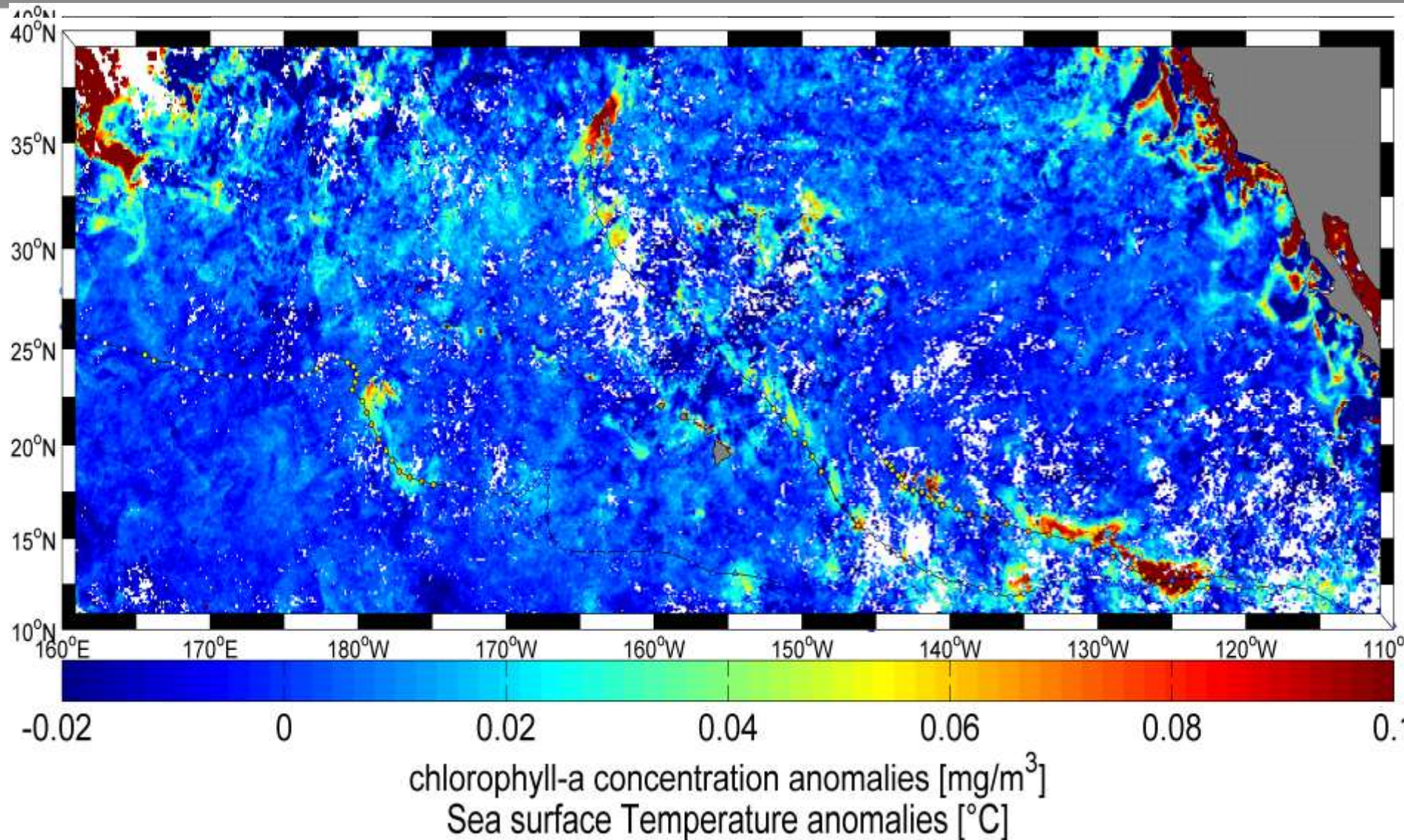
Walter Munk, Woods Hole Oceanographic Institute, 2000



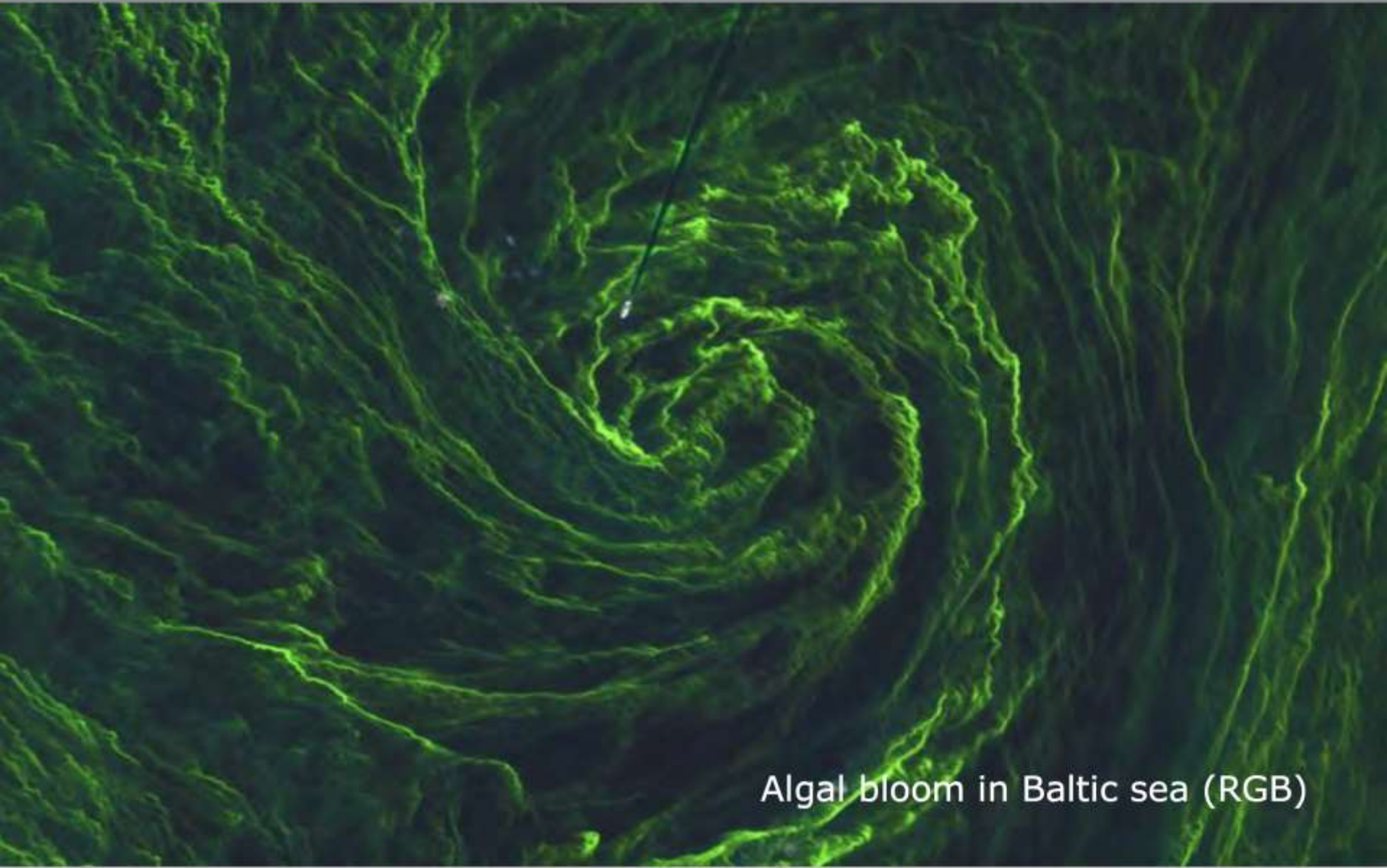
3-Day Weekly 100.0% datasets shown (4/4) MYD02QKM.A2010091.1805 from SST MODIS denoised (NASA, OceanDataLab)



SMOS+ STORMS: Air-sea interaction from space



S2 MSI Baltic Bloom (Aug 2015)



Algal bloom in Baltic sea (RGB)



Ocean Virtual Laboratory



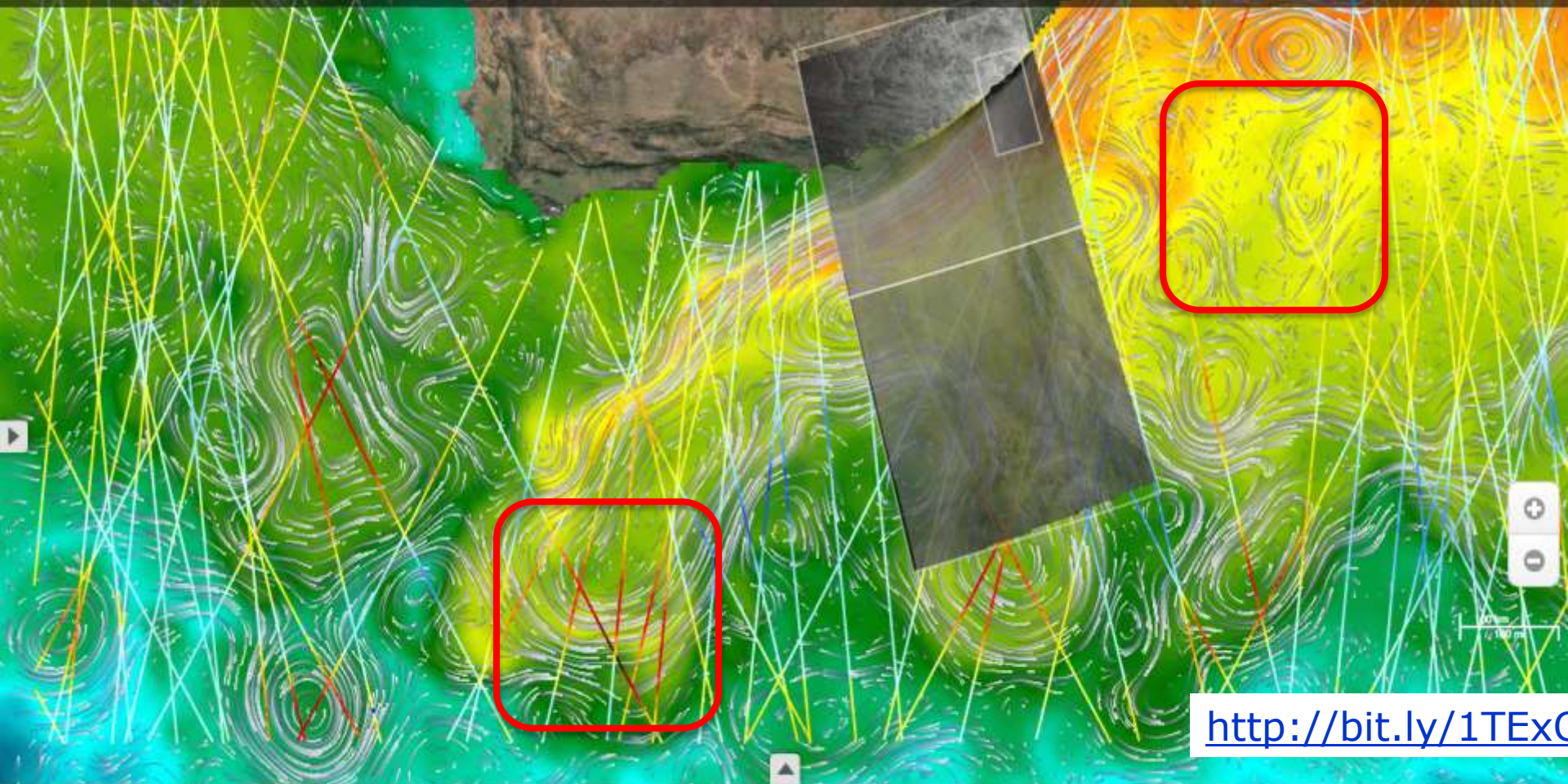
oceandatalab
making sense of the deep blue sea

seom
scientific exploitation
of operational missions

<https://www.oceandatalab.org>

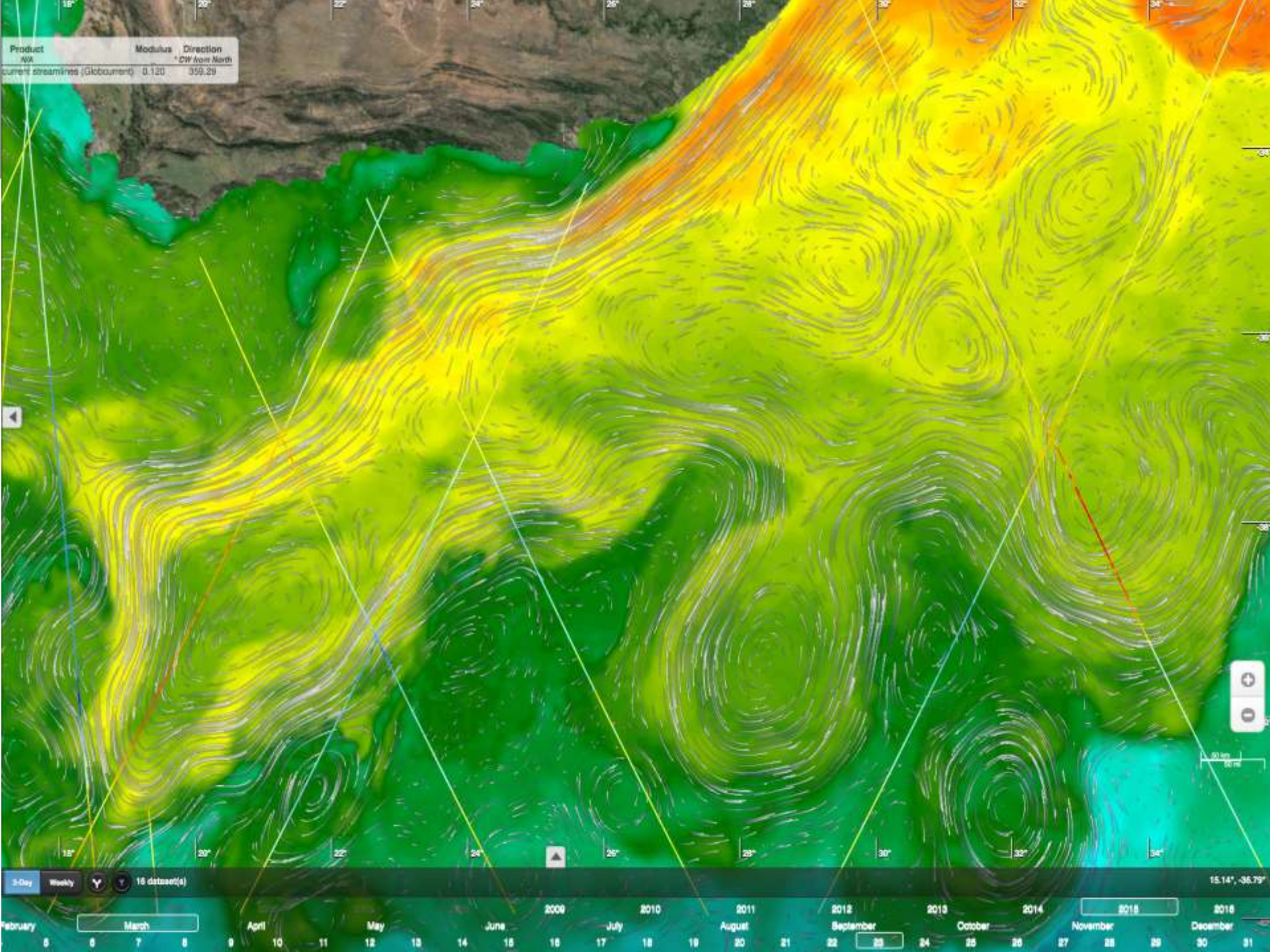
Ocean Virtual Laboratory

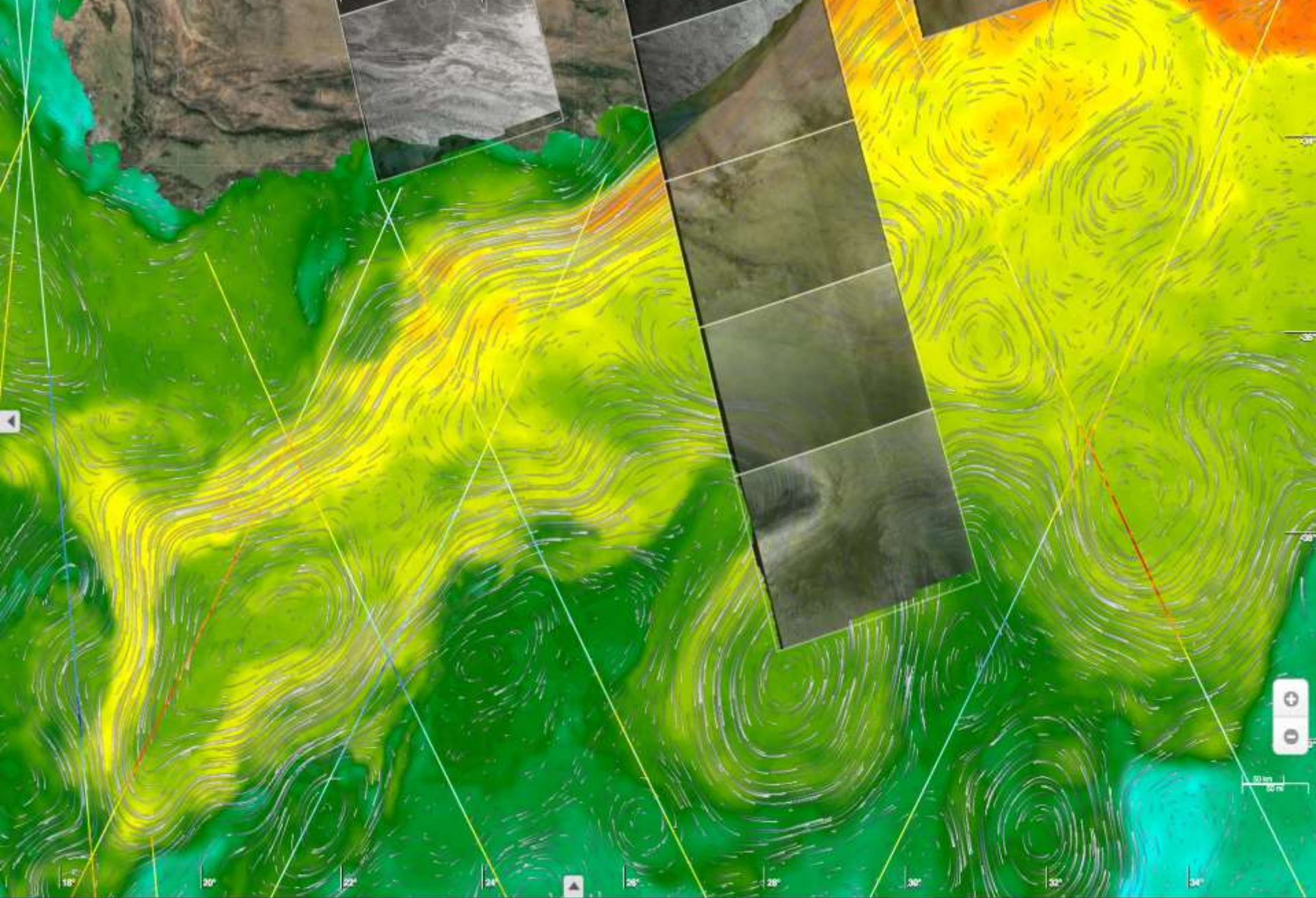
Products Hotspots Share Settings About Help Feedback

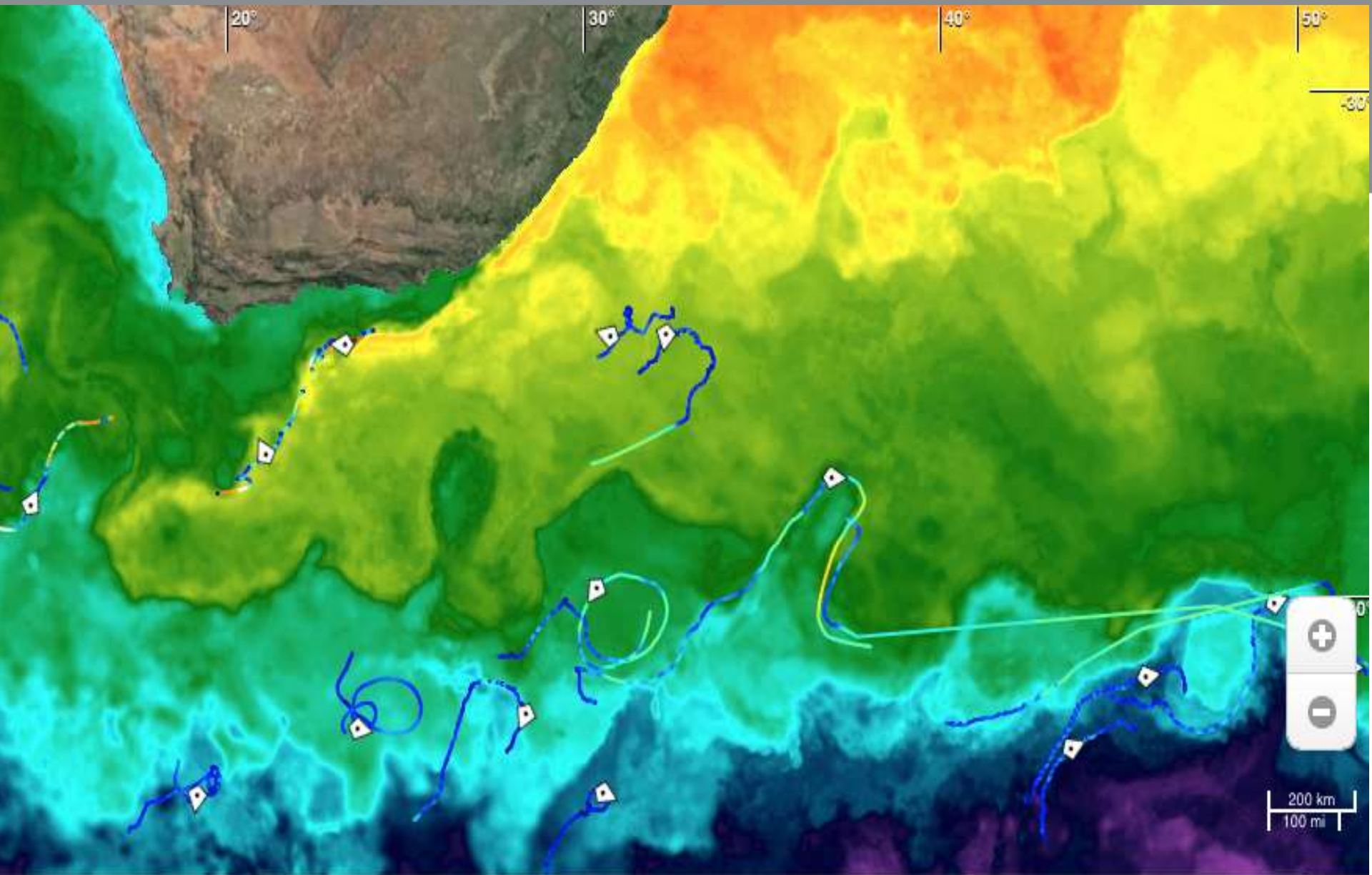




<http://bit.ly/1TExC>









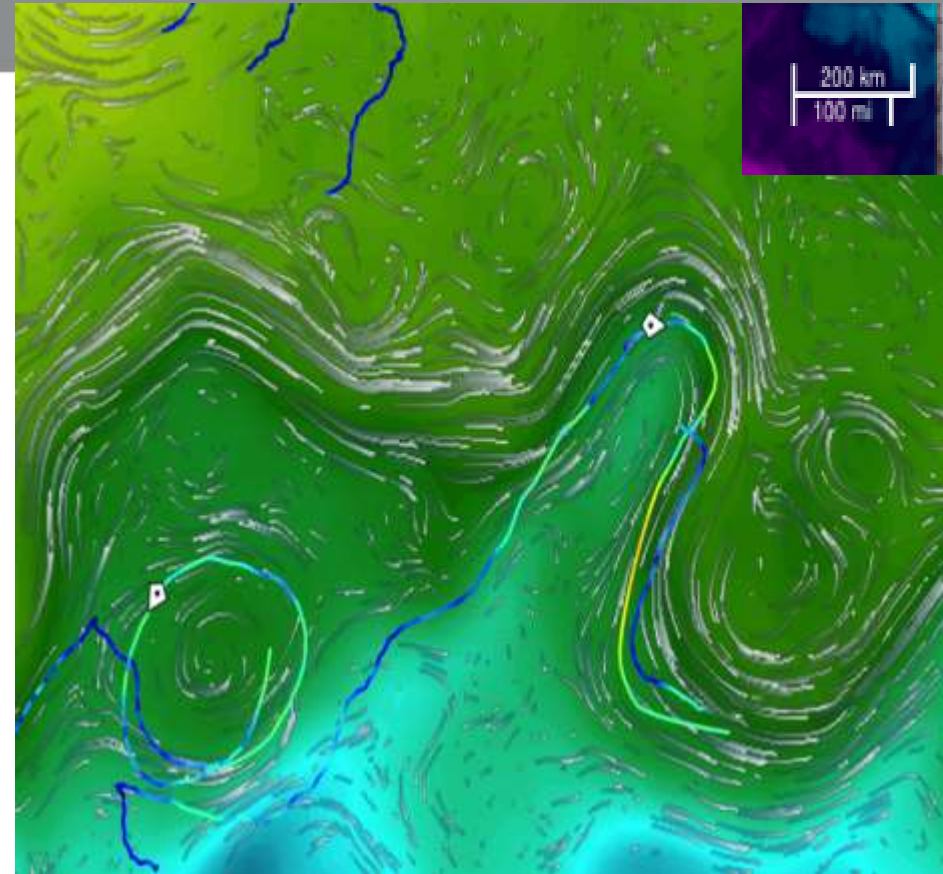
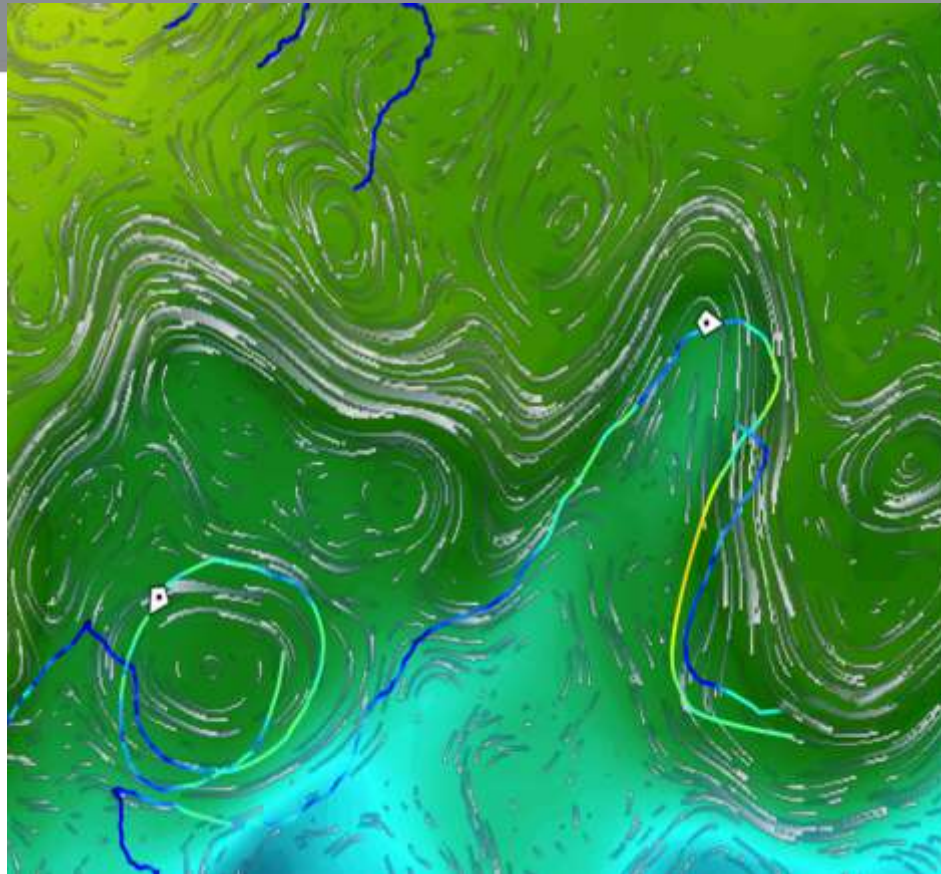
Day Weekly   1 dataset(s) 38.88°, -37.94°

2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015		2016	
April		May		June		July		August		September		October		November		December							
8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	

Image © 2015 NASA, TerraMetrics Terms of Use

24 April 2015, Uncorrected
velocity field

24 April 2015, Corrected
velocity field

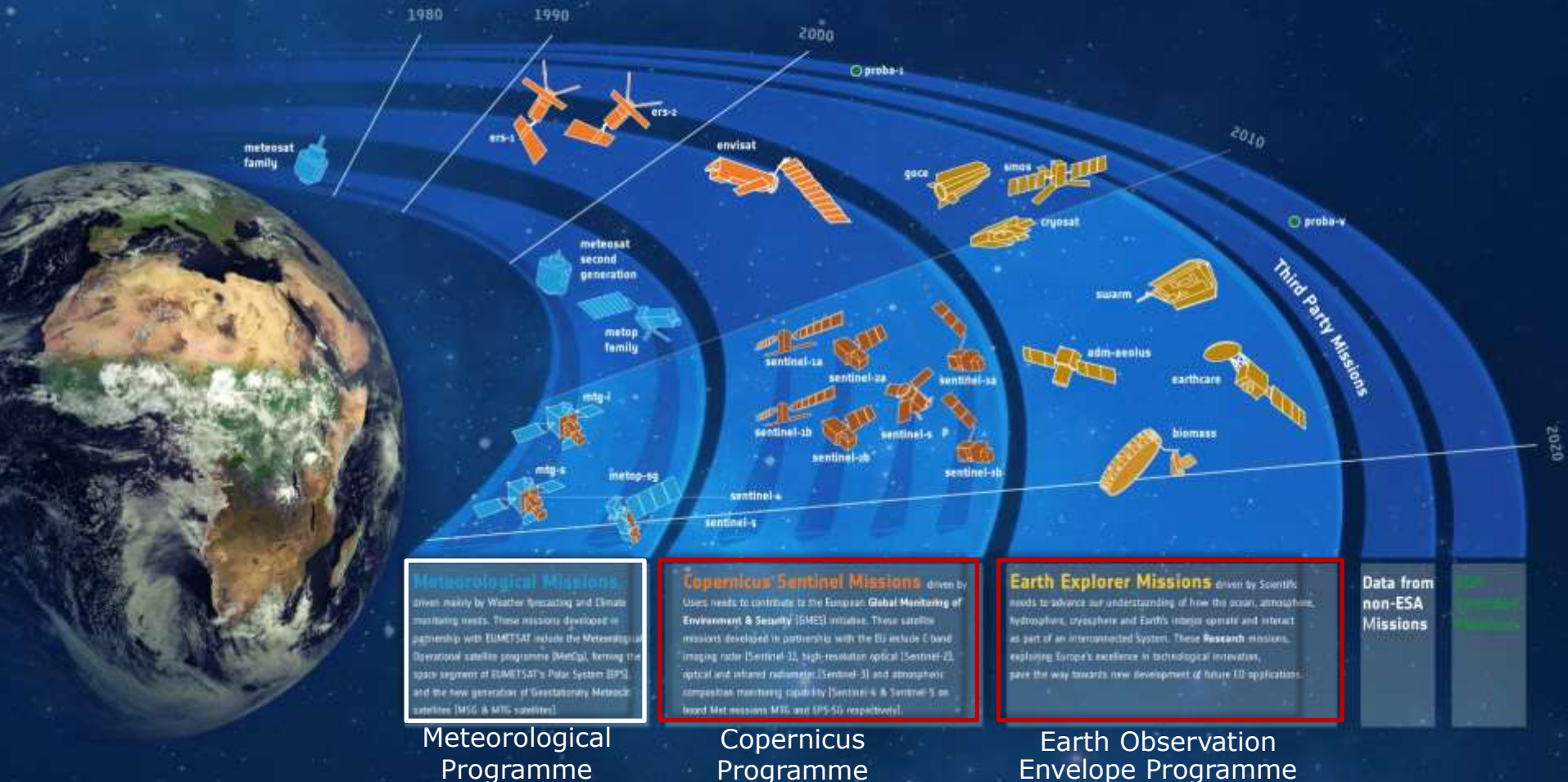


Streamlines of altimeter derived
velocities overlaid microwave SST
and drifters.

Streamlines of corrected velocities
using SST plotted with microwave
SST and drifters.

Courtesy Lucille Gaultier, OceanDataLab

THE ESA EARTH OBSERVATION PROGRAMME



What is Copernicus? – Space in Action for You!



- A source of information for **policymakers, industry, scientists, business and the public**
- A European response to **global issues**:
 - manage the environment;
 - understand and to mitigate the effects of climate change;
 - ensure civil security
- A **user-driven** programme of services for environment and security
- An **integrated** Earth Observation system (combining space-based and in-situ data with Earth System Models)



Copernicus Overview



A Programme of the European Union

www.copernicus.eu



- Overall Programme Management
- Coordination of the Services Component
- Cross-cutting user-uptake activities



EUMETSAT

- Operations of S3 (marine part), S4, S5, S6 and Jason-3



- Technical coordination of the Space Component
- Development and procurement of Copernicus Sentinel missions
- Coordination and procurement of Contributing Missions data
- Operations of S1, S2, S3 (land part), S5P

In-situ component not represented here

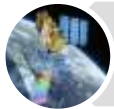
...plus other partners...

Copernicus Sentinel Satellites...

Coordinated by ESA



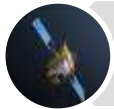
S1A/B/C/D: Radar Mission



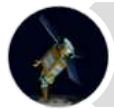
S2A/B/C/D: High Resolution Optical Mission



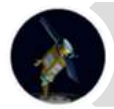
S3A/B/C/D: Medium Resolution Imaging and Altimetry Mission



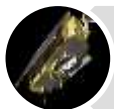
S4A/B: Geostationary Atmospheric Chemistry Mission



S5P: Low Earth Orbit Atmospheric Chemistry Precursor Mission

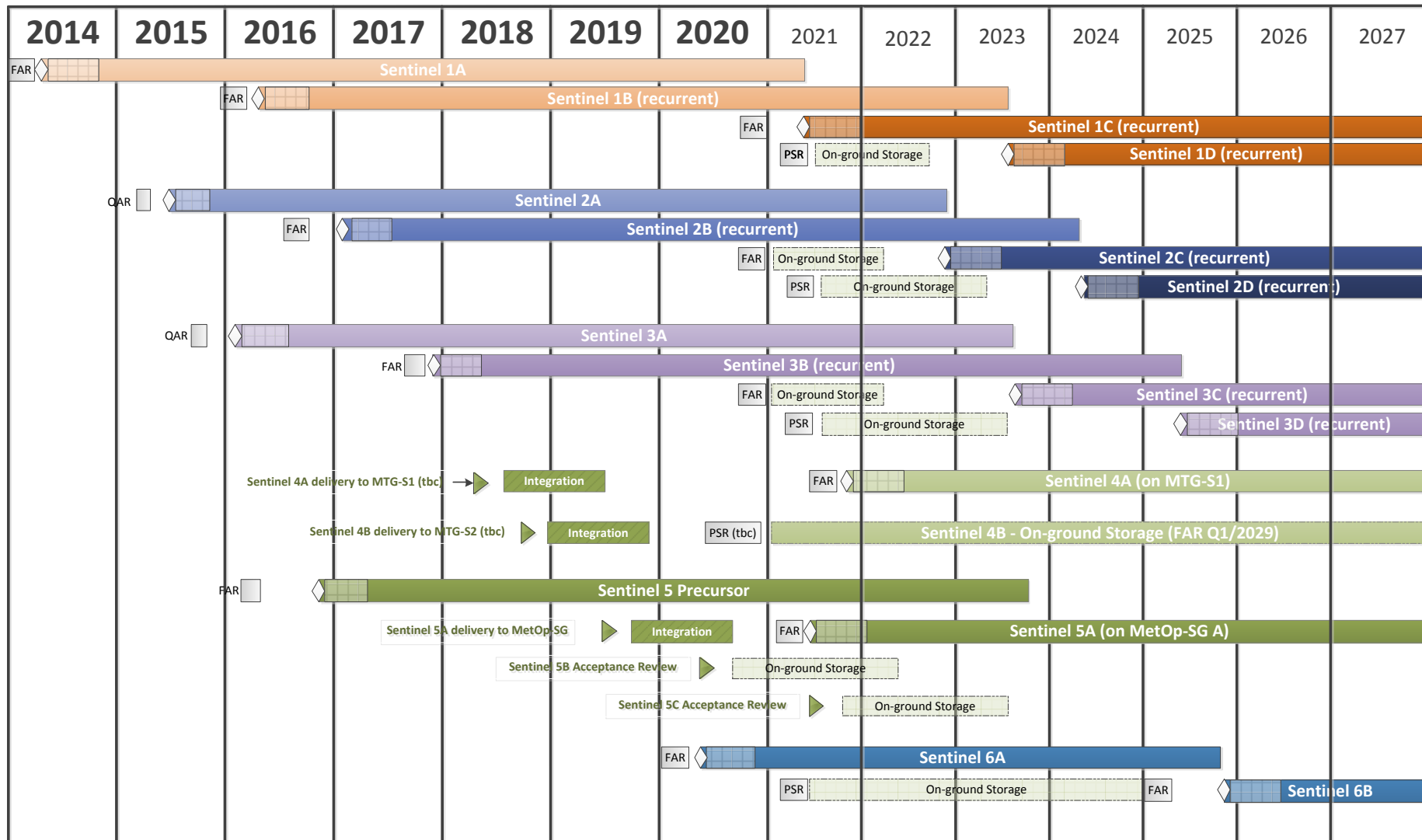


S5A/B/C: Low Earth Orbit Atmospheric Chemistry Mission



S6/Jason-CS A/B: Reference Altimetry Mission

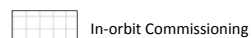
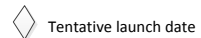
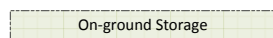
Planned Sentinel Schedule



Legend:



Qualification Acceptance Review (QAR)
Flight Acceptance Review (FAR) or
PreStorage Review (PSR)



Status: 22 March 2016



Sentinel-1

→ RADAR VISION FOR COPERNICUS

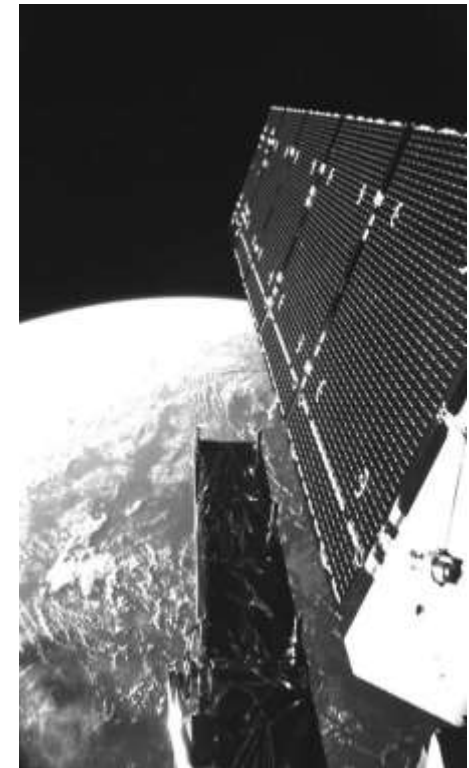
Sentinel-1 C-band SAR mission

S1A launched on 3 April 2014
S1B launched on 22 April 2016



Mission profile:

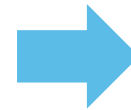
- 🚀 **C-Band SAR** at 5.4 GHz, multi-polarisation
- 🚀 Sun synchronous orbit at **693 km** mean altitude
- 🚀 **250 km** swath width (Interferometric Wide-swath mode)
- 🚀 **6 days** repeat cycle at Equator with 2 satellites
- 🚀 **7 years** design life time, consumables for 12 years
- 🚀 **4** nominal mutually exclusive operation modes



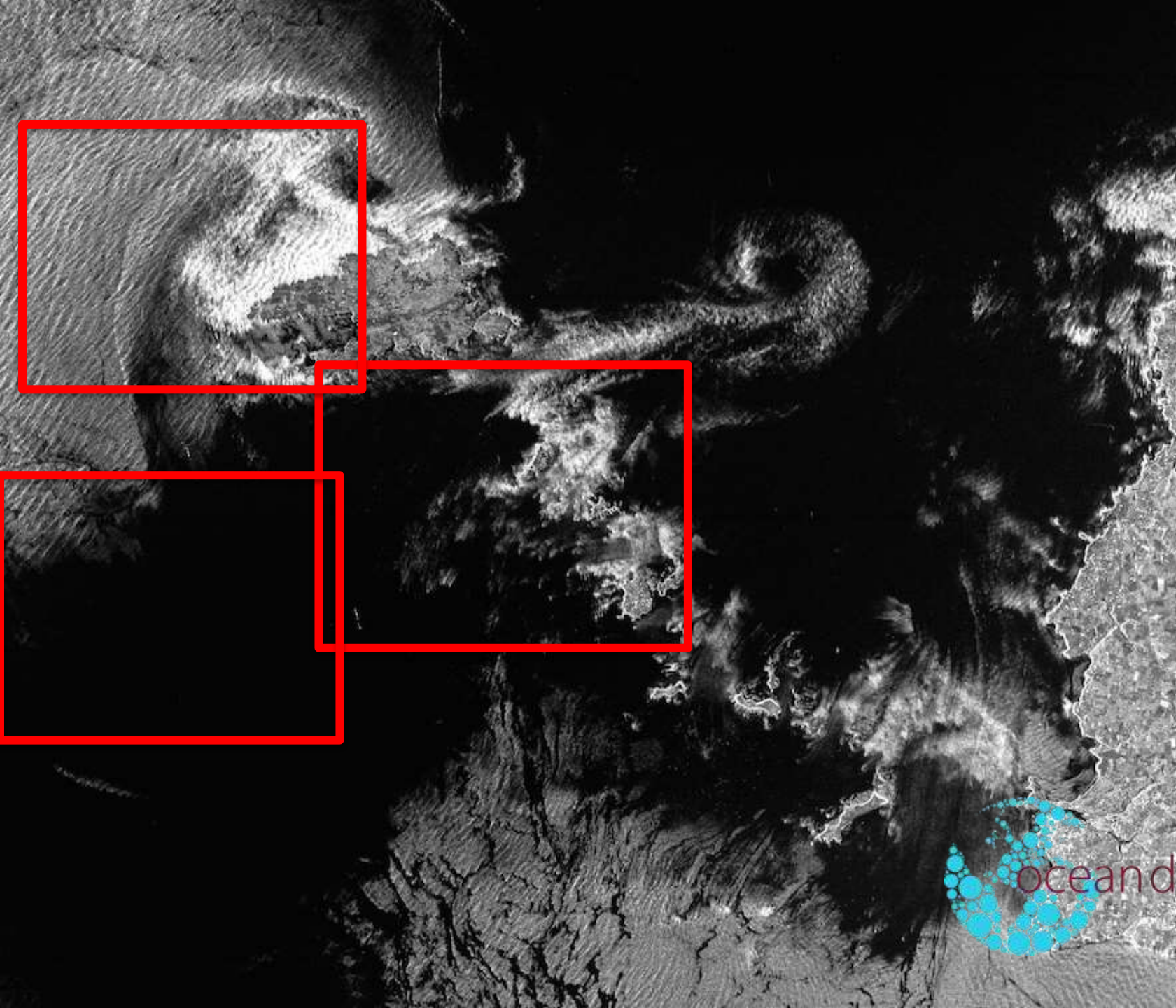
'Selfie' April 4th 2014

Sentinel-1 Operational Modes

Operational Modes



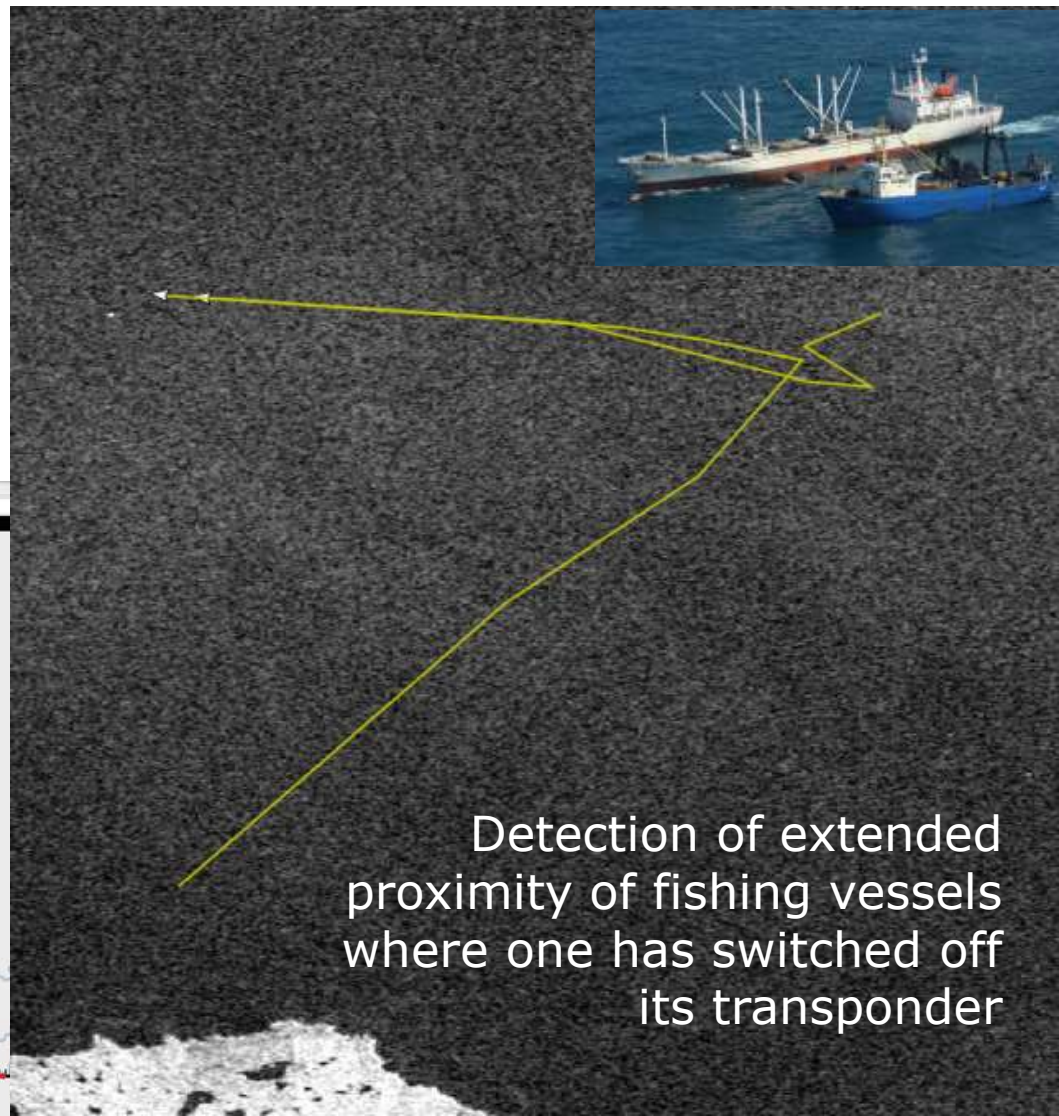
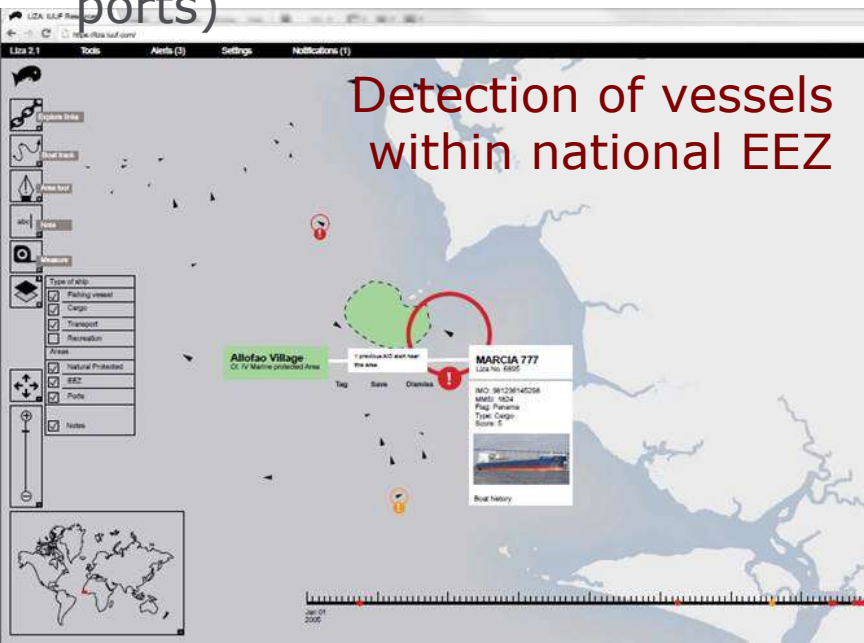
Resolution (1 look)	Swath Width	Polarisation
20 x 40 m ²	> 400 km	HH+HV or VV+VH
5 x 20 m ²	> 250 km	HH+HV or VV+VH
5 x 5 m ²	> 80 km	HH+HV or VV+VH
5 x 5 m ²	20 x 20 km ² at 100 km spacing	HH or VV



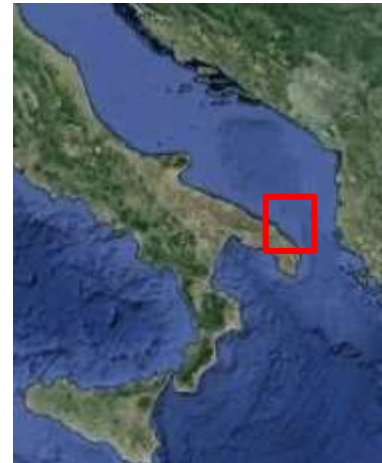
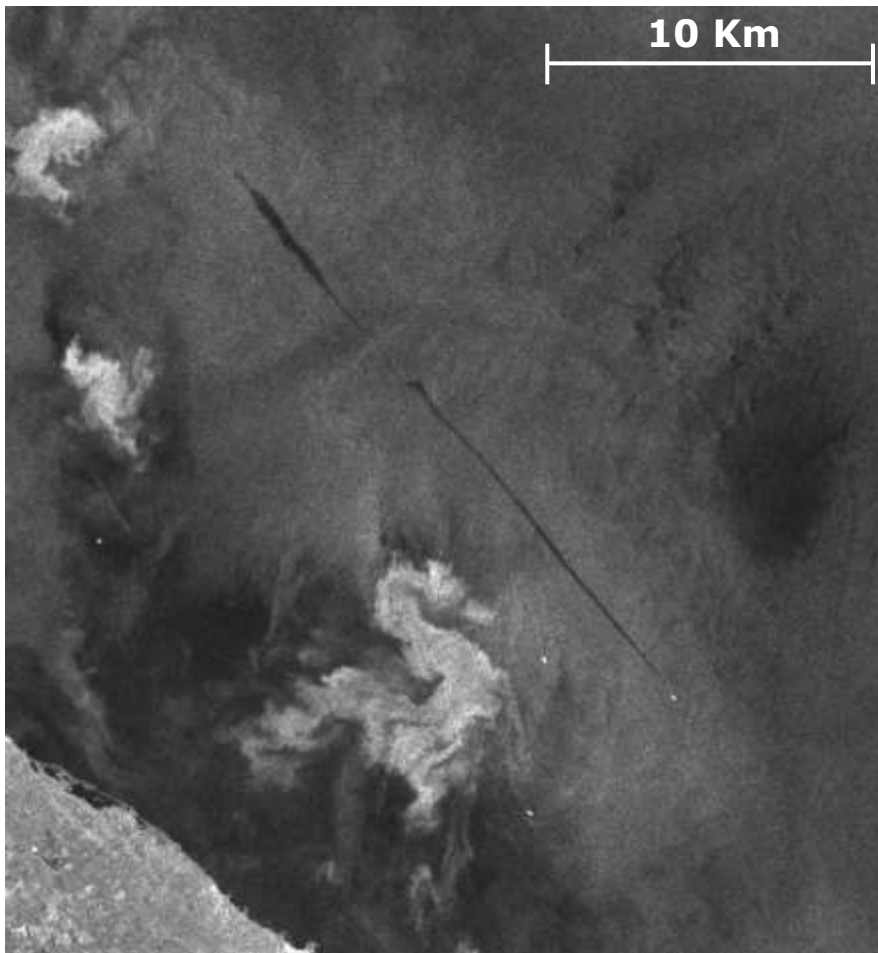
Illegal, Unregulated Unreported (IUU) Fisheries



- Detection of Vessels operating in national EEZs
- Detection of support to IUU fishing (eg catch transfer, refuelling etc)
- Detection of anomalous behaviour by fishing vessels (eg presence in third party ports)



Oil discharge



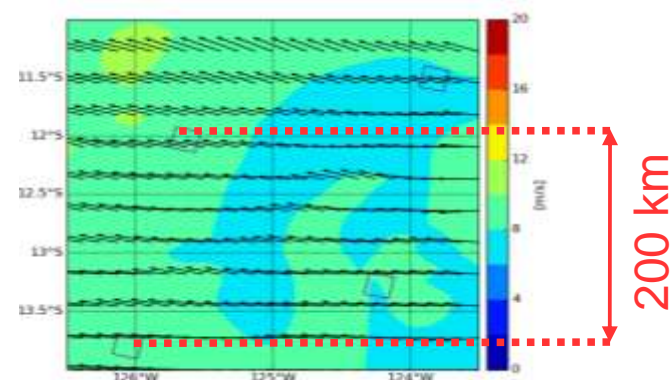
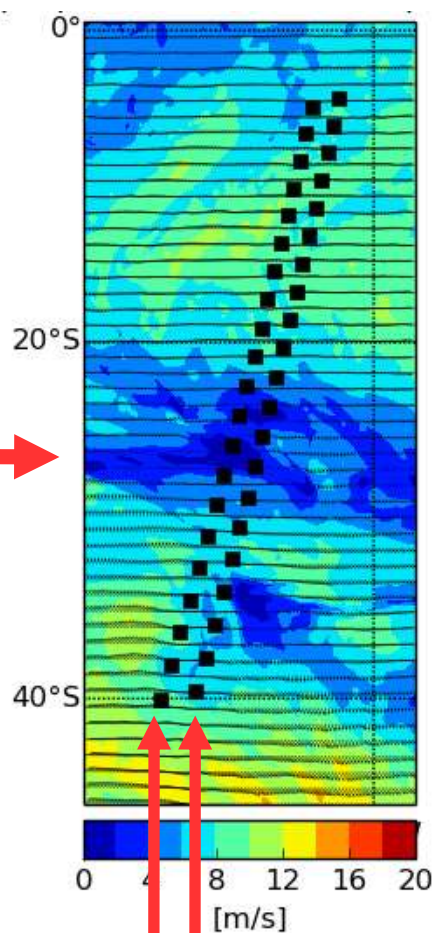
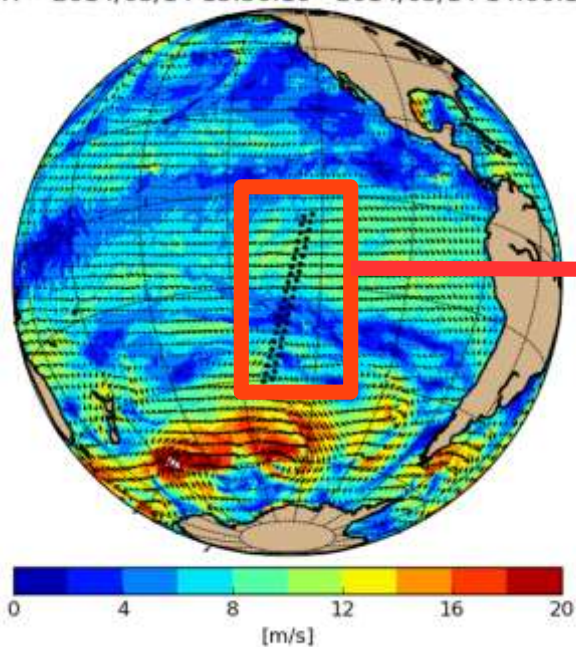
(H. Greidanus and C. Santamaria, EC-JRC)

S1A_IW_GRDH_1SDV_20140903T045517_20140903T045542_002223_002459_3497
Lat: 40.340 Lon : 18.554

Sentinel-1 Wave-mode



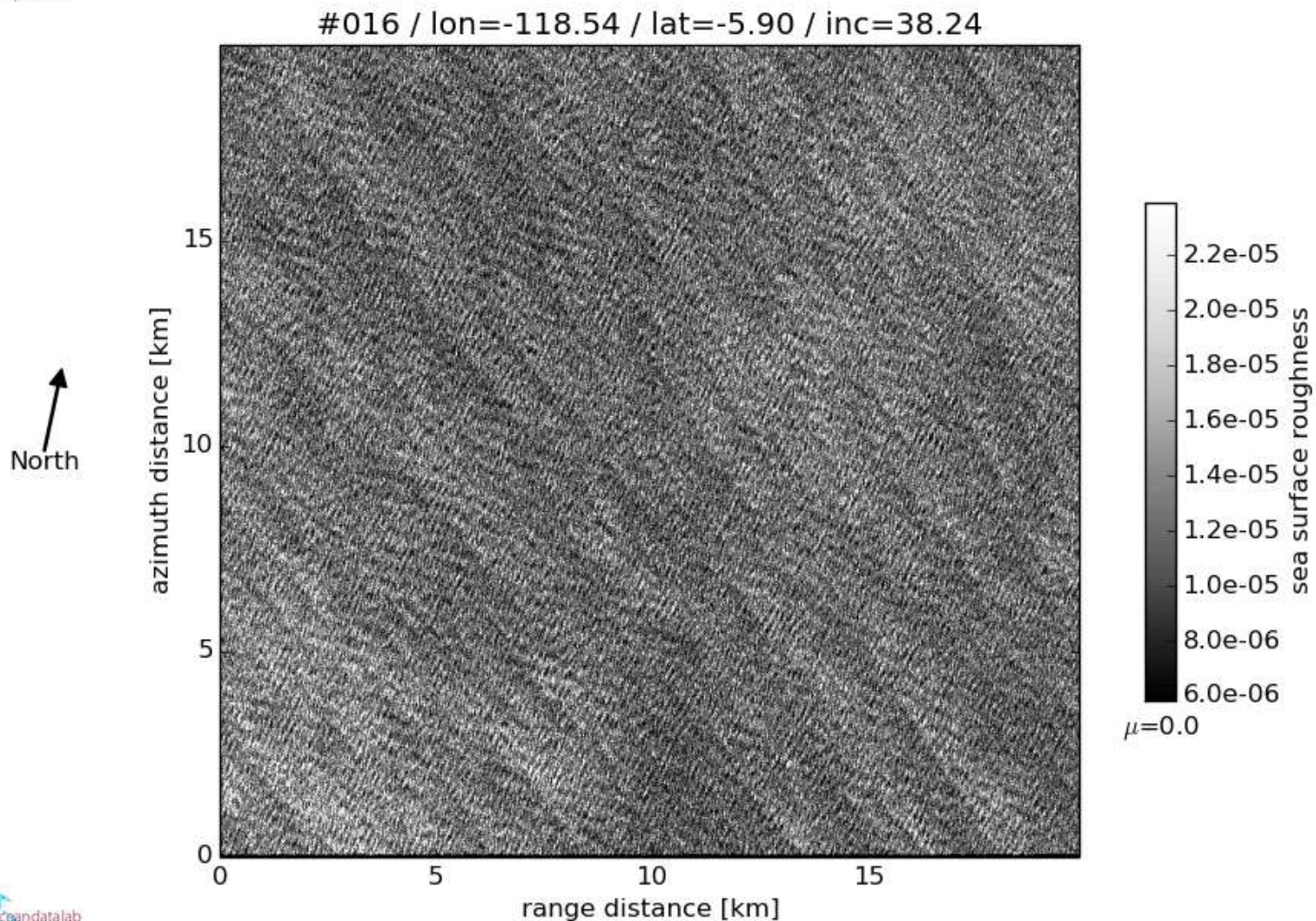
HH - 2014/05/14 13:56:10 - 2014/05/14 14:06:13



WV2 WV1

(A. Mouche)

Wave Mode : Imagette (20 x 20 km)



Forerunners

Mid Pacific ocean : WV, VV pol, Sept 12

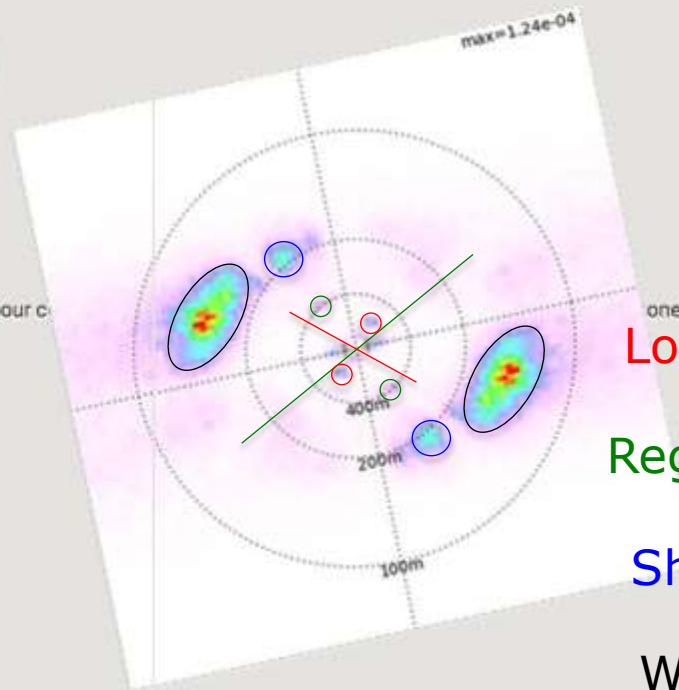


MPC Sentinel-1 portal

Products Hotspots Share Settings About

Products

- ☐ SAR roughness (ESA, OceanDataLab)
- ☐ SAR cross-spectrum imaginary (ESA, OceanDataLab)
- ☒ SAR cross-spectrum real (ESA, OceanDataLab)



Long swell 800m

Regular swell 400m

Short swell 200m

Wind sea 150m

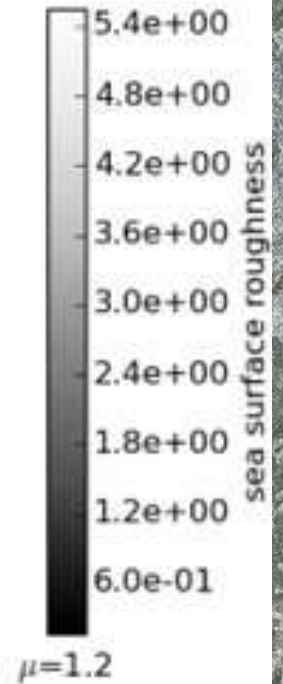
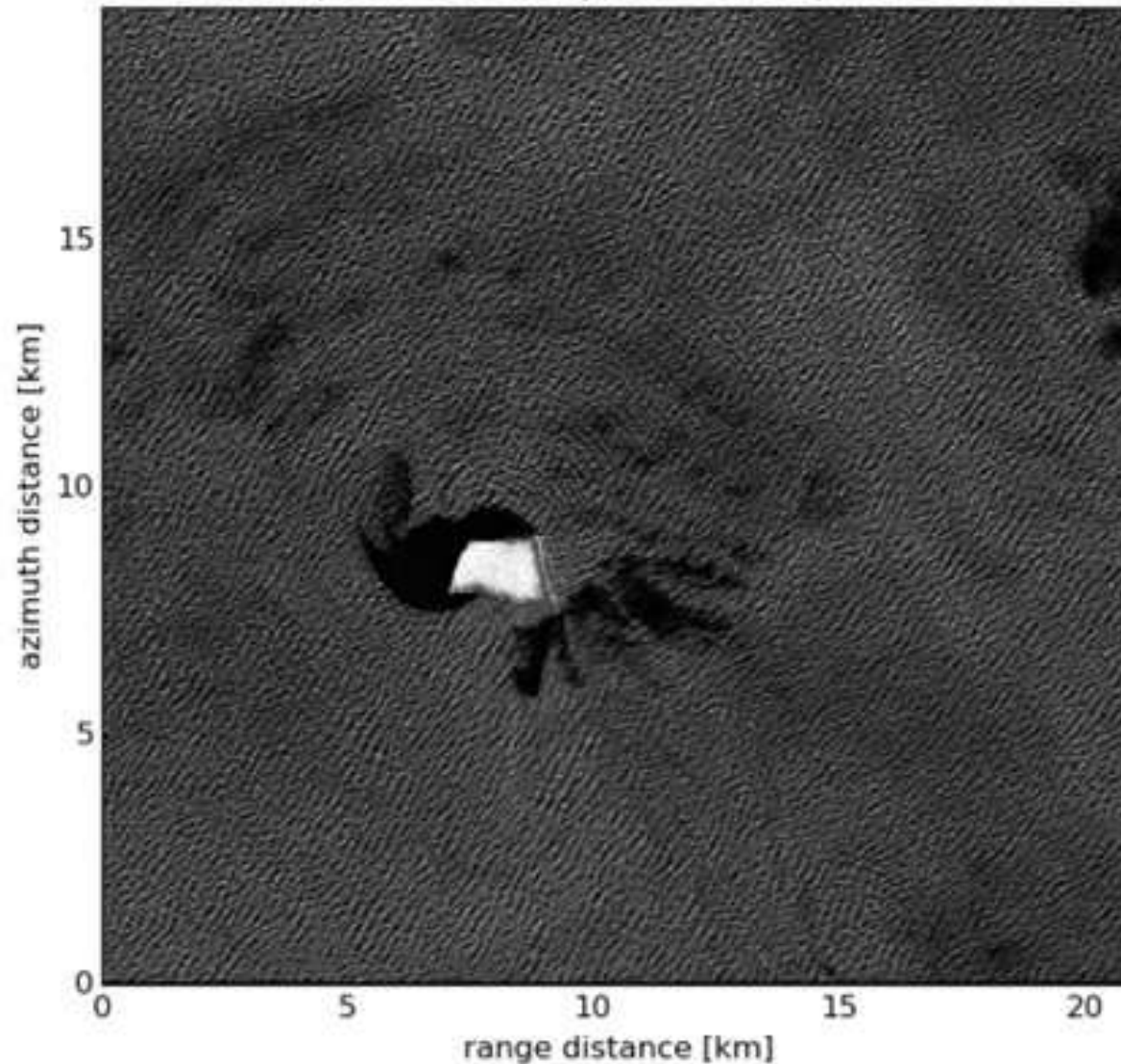
100.0% datasets shown (582/582)



2006 2007 2008 2009 2010 2011 2012 2013 2014
March April May June July August September October November December
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

Examples...each one a PhD topic...

#038 / lon=-101.73 / lat=-67.51 / inc=35.77



Sentinel-2

→ COLOUR VISION FOR COPERNICUS

Sentinel-2 Mission Overview

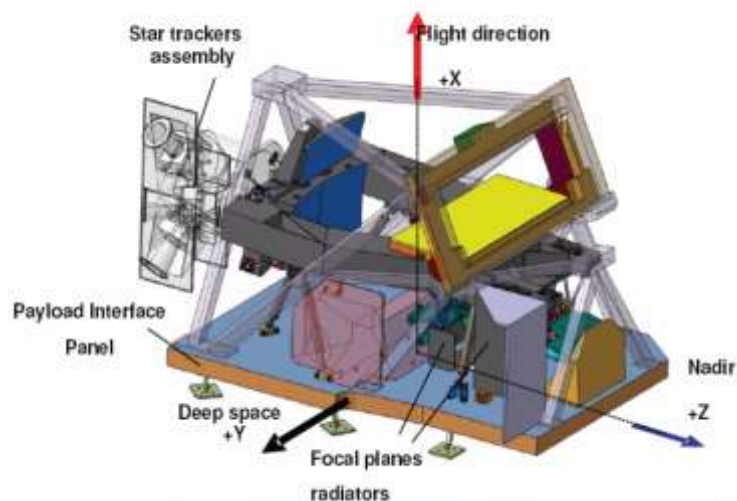
Sentinel-2A Launch June 23 2015

Sentinel-2B Launch planned Feb/March 2017



- **Spacecraft**: 2 operating in twin configuration
- **Orbit**: Sun-synchronous at 786 km (14+3/10 revs per day), with LTDN 10:30 AM
- **MultiSpectral Instrument (MSI)**: operating in pushbroom principle, filter based optical system
- **Spectral bands**: 13 (VIS–NIR–SWIR spectral domains)
- **Spatial resolution**: 10m / 20m / 60m
- **Swath**: 290 km

MultiSpectral instrument (MSI)



- Filter based push broom imager (280 kg, 1 m³)
- Three mirrors silicon carbide telescope, with dichroic beam splitter
- Focal plane arrays: Si CMOS VNIR detectors, HgCdTe SWIR detectors.
- Onboard wavelet compression (divided by 3)
- Integrated video & compression electronics (state of the art wavelet compression)
- Radiometric resolution 12bits
- Daily generated telemetry: 1.4 TB

Sentinel-2 Mission Highlights



Table 6.1. Spectral bands and signal-to-noise ratio requirements for the Sentinel-2 mission.

Band number	Central wavelength (nm)	Bandwidth (nm)	Spatial resolution (m)	L_{ref} ($W m^{-2} sr^{-1} \mu m^{-1}$)	SNR @ L_{ref}
1	443	20	60	129	129
2	490	65	10	128	154
3	560	35	10	128	168
4	665	30	10	108	142
5	705	15	20	74.5	117
6	740	15	20	68	89
7	783	20	20	67	105
8	842	115	10	103	174
8b	865	20	20	52.5	72
9	945	20	60	9	114
10	1380	30	60	6	50
11	1610	90	20	4	100
12	2190	180	20	1.5	100

- **2 Satellites** in twin formation,
- Sun-synchronous orbit at 786 km (14+3/10 revs/day), with **LTDN** 10:30 AM
- **Revisit**: 5 days at equator (with 2 satellites) under same viewing conditions;
- **Multispectral Instrument**: pushbroom with 13 bands in the VNIR and SWIR
- High **spatial resolution**: 10m, 20m and 60m;
- Wide **field of view**: 290 km
- **Duty cycle**: average 17 min/orbit, maximum 32 min/orbit
- **Lifetime**: 7.25 years, extendable to 12 years

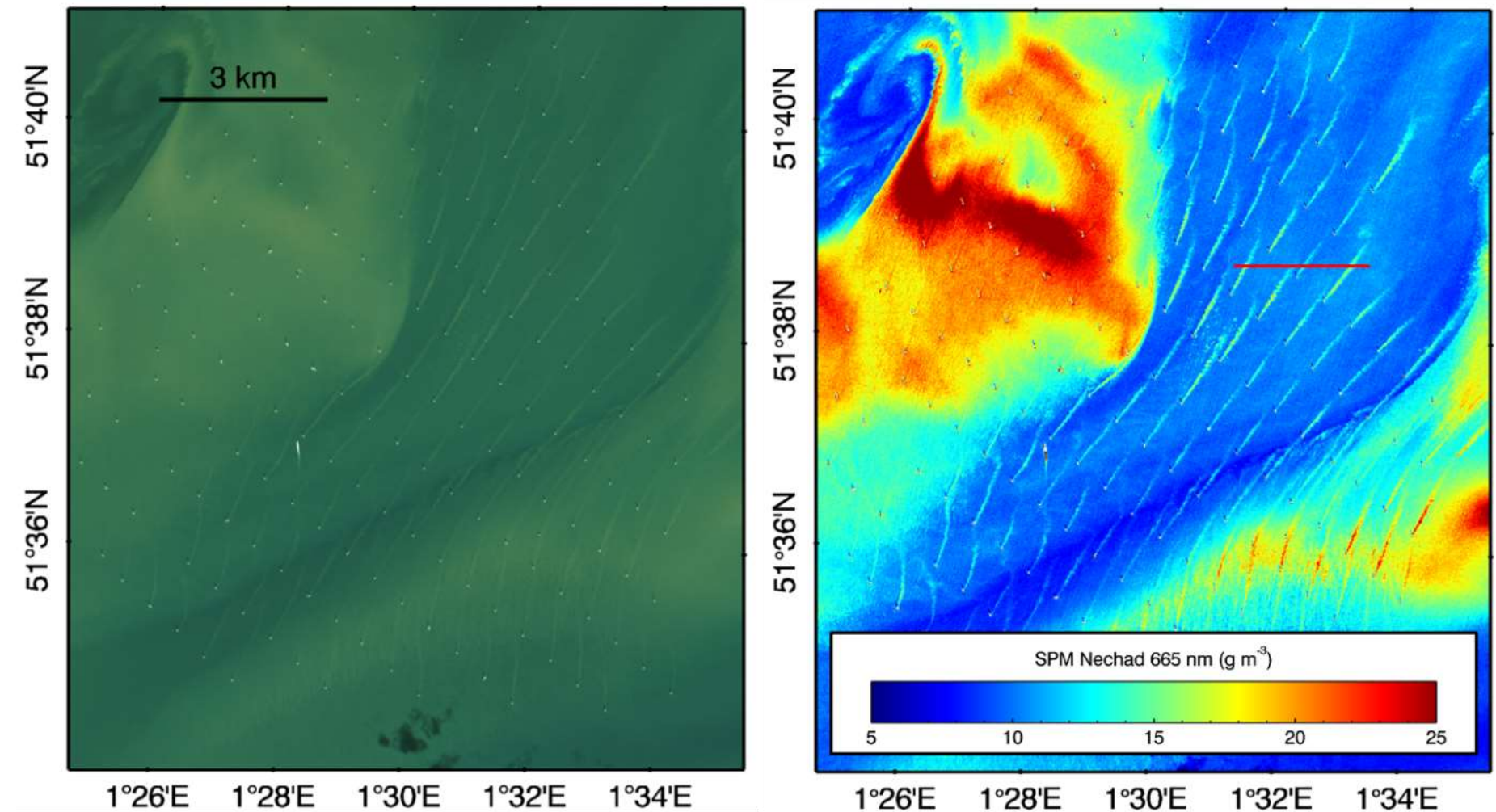
San Francisco Bay



Coral Reef Monitoring



London Wind Turbine Array (E. Channel)



(Quinten Vanhellemont & Kevin Ruddick, RBINS)

S2 MSI



S2 assumption on coastal acquisitions 20 km offshore 280 km swath – lots of data.



The screenshot shows the Sentinel Online website interface. At the top is a blue header with the ESA logo, 'Sentinel Online' text, and several satellite icons. Below the header is a navigation bar with links like 'Need Help?', 'Contact Us', and 'About sentinel online'. A search bar with 'Google Custom Search' is on the right. A main navigation menu includes 'Missions', 'User Guides', 'Technical Guides', 'Thematic Areas', 'Data Access', and 'Toolboxes'. A breadcrumb trail reads 'You are here Home > Missions > Sentinel-2 > S2A Acquisition Plans'. The main content area has a dark blue header for '- Acquisition Plans' and text explaining Sentinel-2 mission planning. A list of dates is provided at the bottom left. On the right, a 'Missions' sidebar lists various mission-related links, with 'S2A Acquisition Plans' highlighted. A large black box with yellow text is overlaid at the bottom right.

- Acquisition Plans

Sentinel-2 Mission Planning activities are routinely carried out on a weekly basis covering a planning period of 10 days.

Every week, an outlook over the planning period will be provided in a Google Earth KML file with detailed information on the image segments. As this KML file is a result of the Mission Planning activities done prior to the actual execution, operational constraints may lead to deviations between what is reported in the KML file and the actual products then resulting in the catalogue.

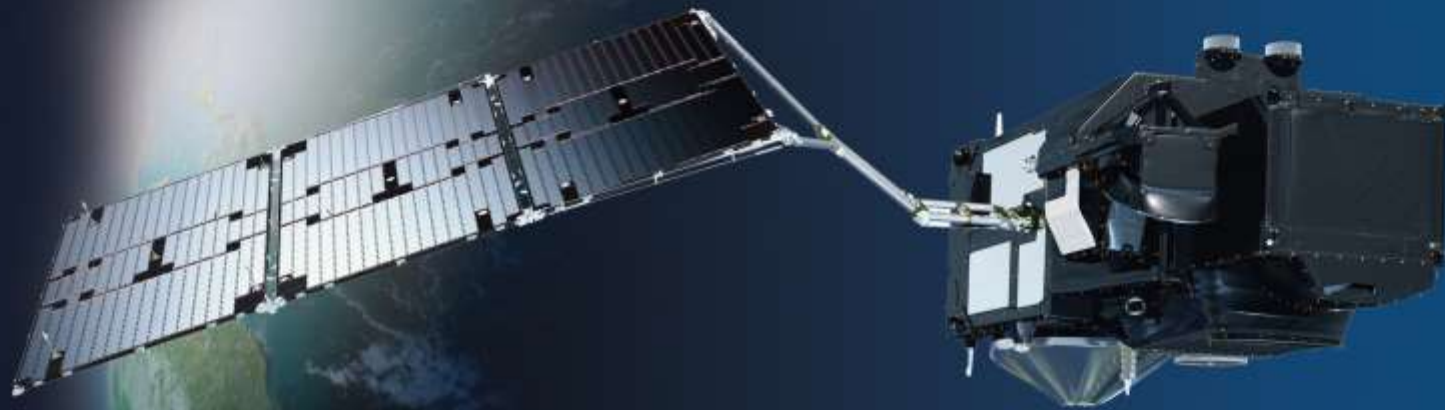
It is further highlighted that the KML display in the Google Earth client will show the Sentinel-2 acquisitions along a simplified swath (constructed by simply linking the 4 corners of the image acquisition strip) that does not match precisely the actual swath in the corresponding products.

- [26 February - 08 March 2016](#)
- [19 February - 01 March 2016](#)
- [12 - 23 February 2016](#)
- [05 - 16 February 2016](#)
- [29 January - 09 February 2016](#)
- [22 January - 02 February 2016](#)
- [15 - 26 January 2016](#)
- [08 - 19 January 2016](#)

Missions

- Missions Home
- Sentinel-1
- Sentinel-2
 - Overview
 - Mission Objectives
 - Satellite Description
 - Ground Segment
 - Observation Scenario
 - Operations Ramp-Up Phase
 - S2A Acquisition Plans**
 - Mission Status

<https://sentinels.copernicus.eu/web/sentinel/missions/sentinel-2/acquisition-plans>



Sentinel-3

→ A BIGGER PICTURE FOR COPERNICUS

Sentinel-3 Mission Overview

Sentinel-3A launched 16th February 2016

Sentinel-3B launch planned in 2017



- Operational mission in high-inclination, low Earth orbit
- Full performance achieved with 2 satellites in orbit (S-3A,-3B)

Optical Mission Payload providing

- ❑ Sea and land color data, through **OLCI (Ocean and Land Color Instrument)**
- ❑ Sea and land surface temperature, through the **SLSTR (Sea and Land Surface Temperature Radiometer)**

Topography Mission Payload providing

- ❑ Sea surface topography data, through a Topo P/L including a **Ku-/C-band Synthetic Aperture Radar Altimeter (SRAL)**, a bi-frequency **MicroWave Radiometer (MWR)**, and a **Precise Orbit Determination (POD)** including
 - **GNSS Receiver**
 - **DORIS**
 - **Laser Retro-Reflector**

In addition, the payload design will allow

- ❑ Data continuity of the Vegetation instrument (on SPOT4/5),
- ❑ Enhanced fire monitoring capabilities



Sentinel-3a launch from Plesetsk Cosmodrome 16th February 2016

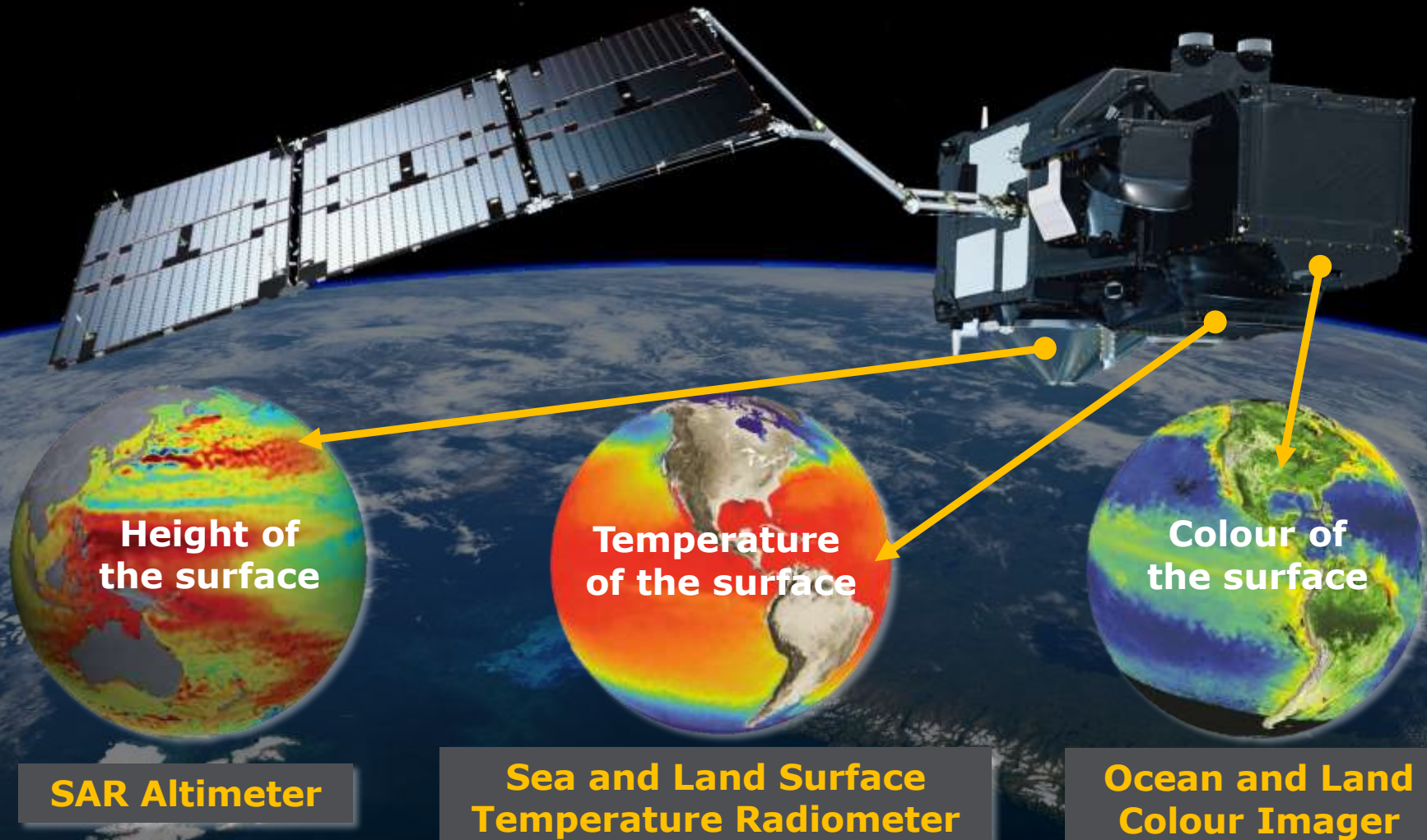


Sentinel-3a launch from Plesetsk Cosmodrome 16th February 2016



(Credit: Antero Isola)

Sentinel-3A: The Bigger Picture



Sentinel-3: Satellite Orbit details



S3B has a 180° phase separation on the same orbital plane

Instrument Swath Patterns

SRAL tracks at the equator:
S3A = 104 km track separation
S3A+B = 52 km separation

SRAL (>2 km) and MWR (20 km nadir track)

1400 km SLSTR (nadir)

740 km SLSTR (oblique)

1270 km OLCI

Orbit type	Repeating frozen SSO
Repeat cycle	27 days (14 + 7/27 orbits/day)
LTDN	10:00
Average altitude	815 km
Inclination	98.65°

Ground Track Patterns

S3-A

KML of ground tracks for S3A and S3B are available at sentinel.esa.int

1 Repeat Cycle
(27 days)

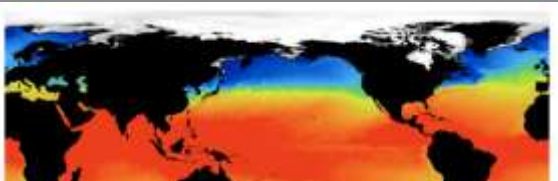
SRAL orbit drivers:

- Ground track repeatability,
- Dense spatial sampling


Orbit control requirement:

- Ground track dead-band ± 1 km

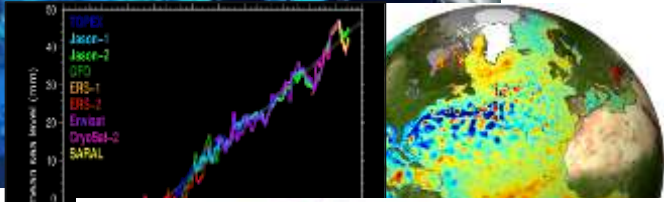
A huge number of applications...



Sea surface temperature for climate monitoring, numerical modelling and mesoscale analysis



Harmful algal bloom/water quality/marine biology/global ocean primary production



Mean sea level/sea level anomalies/ large and mesoscale ocean circulation, currents, tides

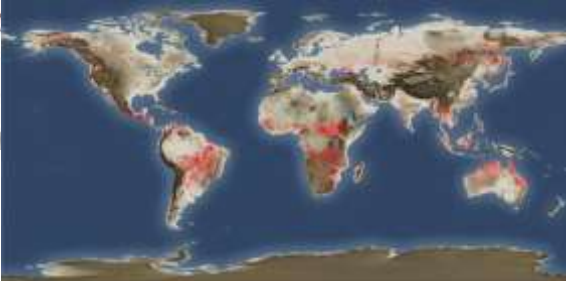


Land surface temperatures for weather forecasting, climate research, agriculture, water resources management



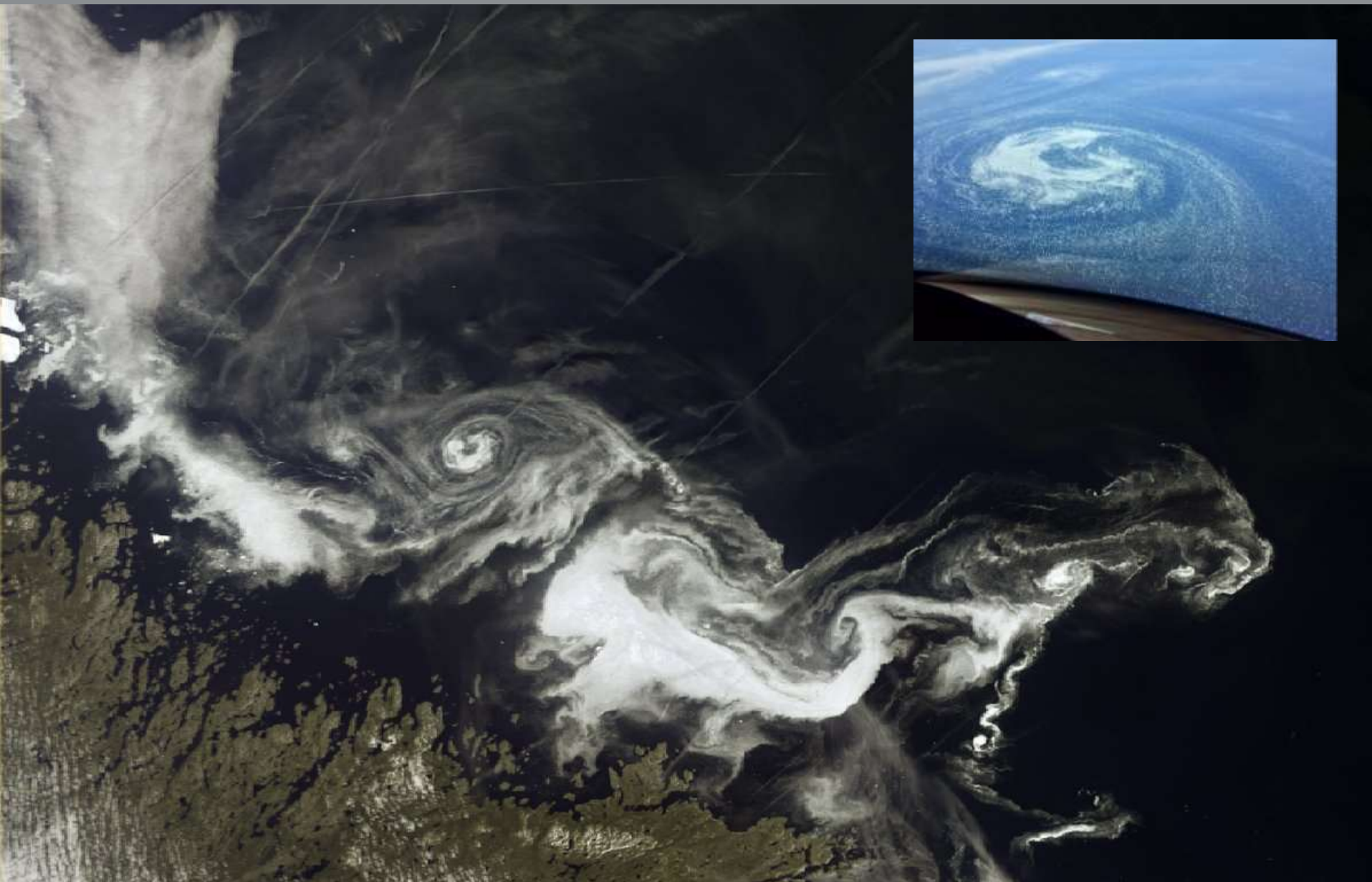
Vegetation/ plant status/agriculture

River and lake height/fresh water resource management



Fire location and radiative power monitoring

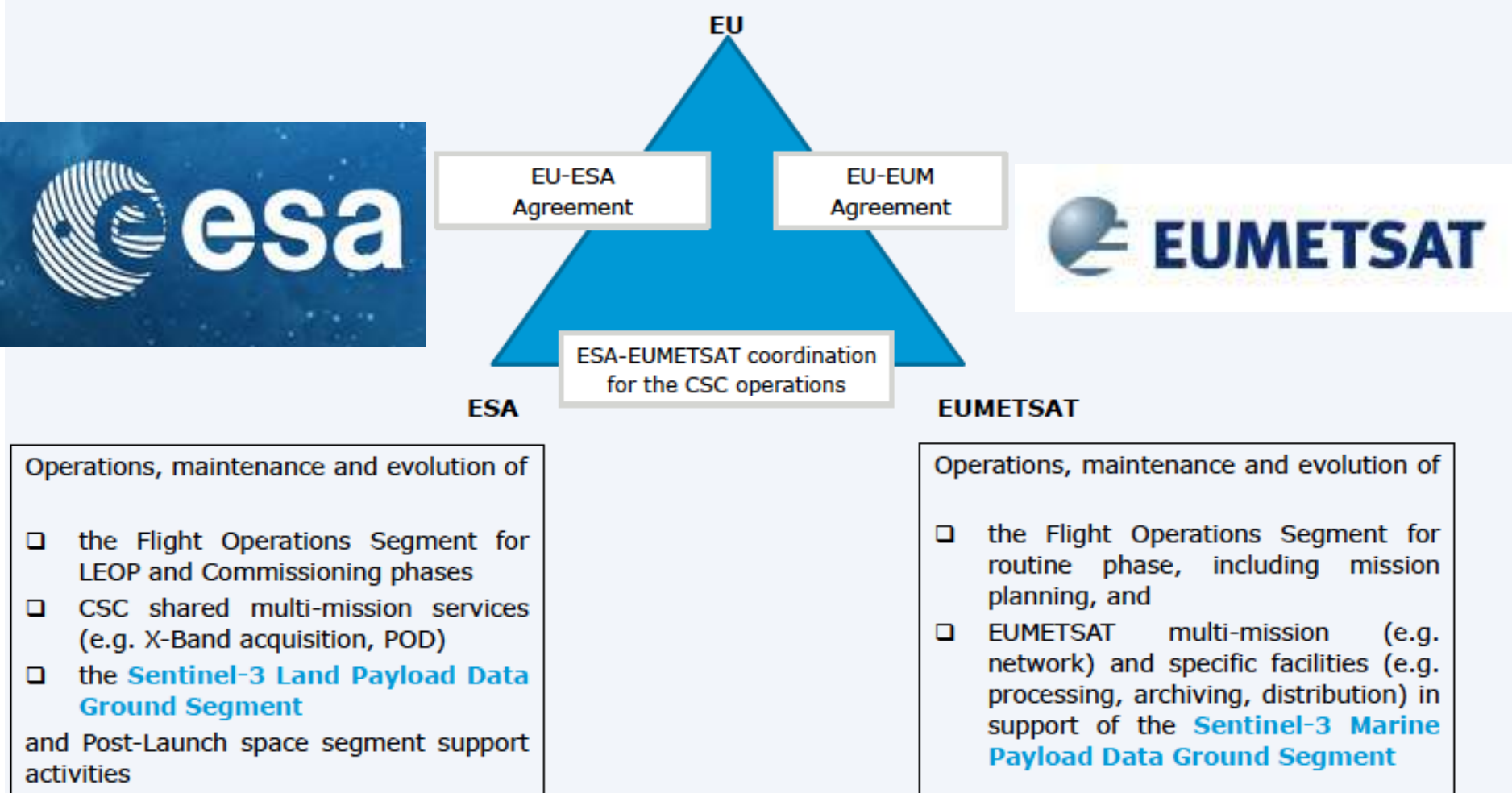
Examples...



ESA & EUMETSAT SHARE OPERATIONS



- ❑ **EU Copernicus Regulation:** full, open and free data policy, defining responsibilities for ESA and EUMETSAT and overall financial envelope
- ❑ **Dedicated EU-ESA and EU-EUMETSAT Copernicus agreements**



What happened since launch



Sentinel-3A successfully launched from Plesetsk Cosmodrome (Russia) on 16 February 2016



Spacecraft and all instruments in nominal operational mode and functioning well.

16 Feb	Successful Launch
18 Feb	LEOP phase concluded successfully <ul style="list-style-type: none">✓ Perfect orbit injection from the launcher✓ Rapid and smooth Solar Array deployment✓ Only one minor anomaly encountered (Star Tracker depointing due to incorrect quaternion data), rapidly identified and corrected
26 Feb	Platform In-Orbit Verification completed
4 March	Payload In-Orbit Verification completed <ul style="list-style-type: none">✓ All instrument ON and operating (except SLSTR in decontamination mode, as planned)✓ Level-0 products being generated
7 March	Cal/Val Phase of S3 commences
April/May	Mid-Term-Reviews for OLCI, SLSTR and SRAL
End-May	Sample products to all users for familiarisation
28-30 June	Expert users meeting – first feedback from S3 validation teams
11/12-July	In-Orbit Commissioning Review – successful completion of commissioning phase, start of ramp-up phase (initial operational)

Released sample data products so far

All L1 (OLCI, SLSTR SRAL/ also L2)

planned for early October.



Data available from

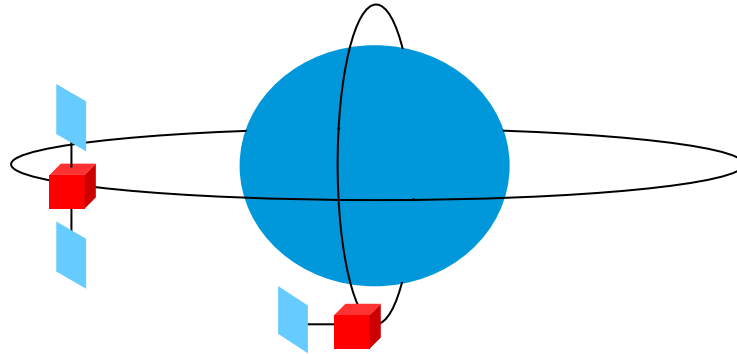
- ❑ *ESA's Sentinel Data Hub for expert users (*)*
- ❑ *EUMETSAT's ODA, Data Centre, EUMETCast*

Data product (*)	Released on	Available data
OLCI L1 (FR)	11 May	9 May - today
OLCI L2 over land (ESA)	20 June	20 June - today
OLCI L2 over ocean (EUMETSAT)	22 June	22 June - today
SLSTR L1	13 June	8 June – today
SLSTR L2 - LST (ESA)	20 June	9 June - today
SLSTR L2 - SST (EUMETSAT)	21 June	21 June – today
SRAL L1B (**)	15 June	6 April – 6 May (SAR), 9-12 April (LRM); 18 June- today
SRAL L2 over land (ESA)	15 June	6 April – 6 May (SAR), 9-12 April (LRM) 18 June- today
SRAL L2 over ocean (EUMETSAT)	15 June	6 April – 6 May (SAR), 9-12 April (LRM) 12 July - today

SYN, AOD, FRP products to be released in ramp-up phase

* In addition: some sample products on General Sentinel Data Hub for familiarisation for data users

Dedicated Atmospheric Missions: Sentinels-4, -5 and -5p



GEOstationary (GEO)

- Hourly revisit time over Europe
- Mainly air quality
- Diurnal cycle of tropospheric composition

→ Sentinel-4 (S4)

Low Earth Orbit (LEO)

- Daily revisit time global coverage
- Climate, air quality, ozone & UV
- Tropospheric & stratospheric composition

→ Sentinel-5 Precursor (S5p)

→ Sentinel-5 (S5)

Meteosat Third Generation – Sounder Satellite



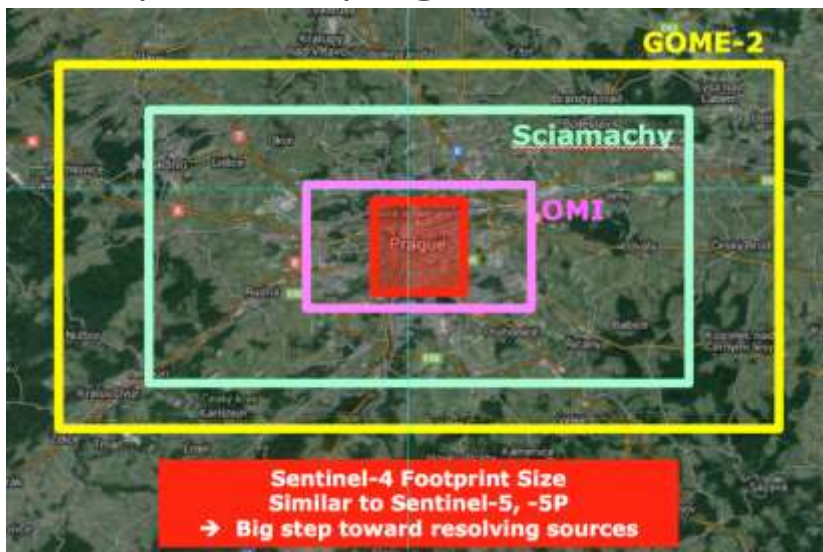
Sentinel-4
UVN Instrument

- Tropospheric composition
- With fast revisit time (<1 hour)
- At high spatial resolution over Europe
- Operational over 15 years (2 satellites)

Sentinel-4/UVN: Key Requirements

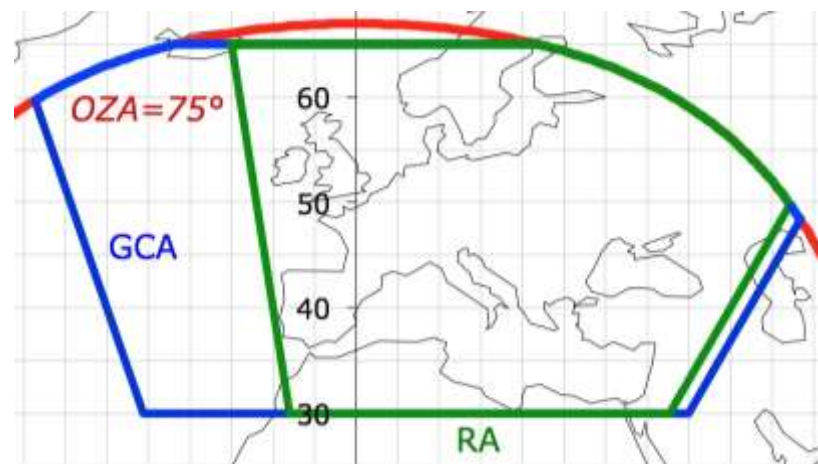


Spatial Sampling: 8 km at



Coverage

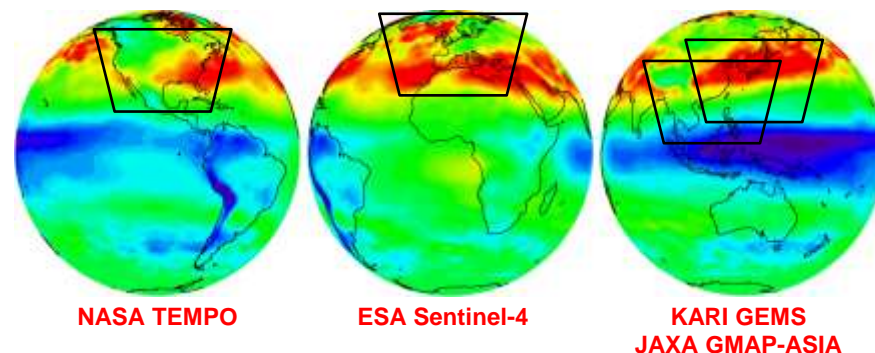
Geographic Coverage Area, Observation Zenith Angle, Reference Area



Spectral range and resolution (UVN)

Band ID	Wavelength range [nm]	Spectral resolution [nm]	Spectral sampling ratio
UV	305 - 400	0.5	3
VIS	400 - 500	0.5	3
NIR	750 - 775	0.12	3

Global Cooperation



Sentinel-4 Level-2 Product Overview



Species	Relevance	
	Air quality	Other
Ozone (O ₃)	Toxic, irritates lung and soft tissue, regulated(*)	Reduces plant growth, greenhouse gas, controls oxidising capacity of atmosphere, controls surface UV
Nitrogen Dioxide (NO ₂)	Toxic, production of O ₃ and nitrate aerosol, regulated(*)	Acid rain
Sulfur Dioxide (SO ₂)	Toxic, production of sulphate aerosol, regulated(*)	Acid rain, tracer for volcanic emissions
Formaldehyde (HCHO)	Influences production of O ₃ and CO	Volatile Organic Compounds emission estimates
Glyoxal (CHOCHO)	Influences production of O ₃ and CO	Volatile Organic Compounds emission estimates
Aerosol or Particulate Matter (PM)	Pulmonary and cardiovascular diseases, regulated(*)	Direct and indirect climate effect, controls cloud formation, aviation control (volcanic ash)
Cloud characteristics		Auxiliary for other products
Surface characteristics		Auxiliary for other products

*) by European Standards: <http://ec.europa.eu/environment/air/quality/standards.htm>

Sentinel-5 Mission



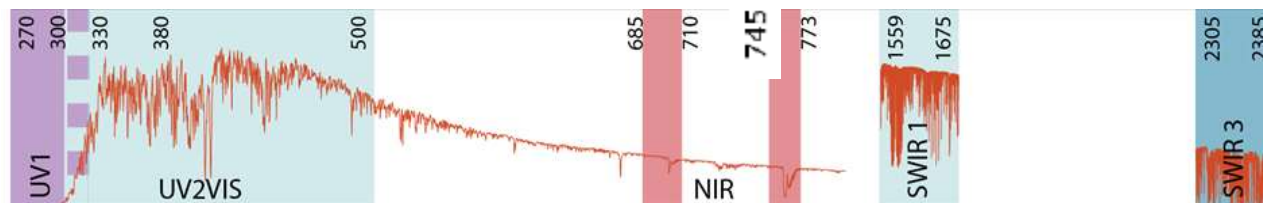
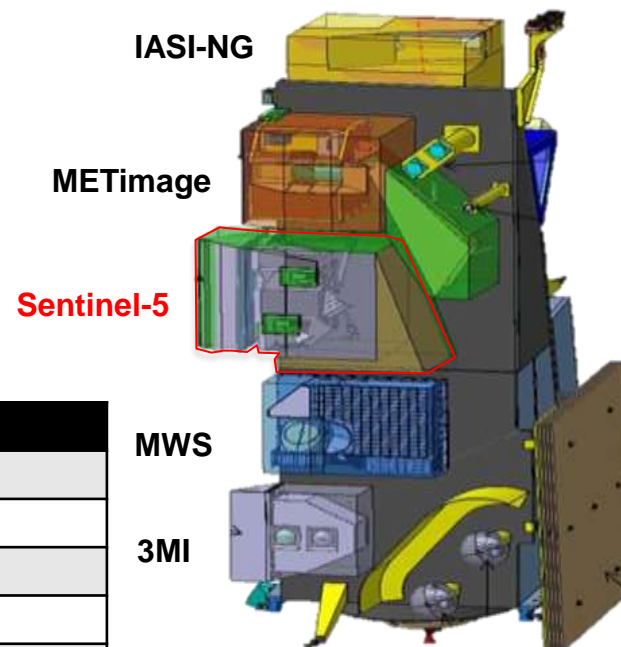
Sentinel-5 consists of

- a **UVNS spectrometer** to be embarked on the **MetOp-SG A** platforms;
- will utilise the **IR sounder (IASI-NG)**, the **imager (MetImage)** and the **polarisation imager (3MI)**, all onboard the same platform

Satellite A	
IASI-NG	CNES via EUMETSAT
METImage	DLR via EUMETSAT
Sentinel-5	ESA - Copernicus
MWS	ESA - MetOp-SG
3MI	ESA - MetOp-SG
RO	ESA - MetOp-SG

Satellite B	
Argos-4	CNES via EUMETSAT
MWI	ESA - MetOp-SG
ICI	ESA - MetOp-SG
SCA	ESA - MetOp-SG
RO	ESA - MetOp-SG

MetOp-SG Satellite A



Sentinel-5: Implementation Status



- UVNS instrument & Level-1b Prototype Processor developed by ESA
with Airbus Defence & Space as prime
 - Preliminary Design Review completed in December 2015
 - Critical Design Review mid 2017
 - Flight Acceptance Review early 2021
- Level-1 **Operational** Processor developed by **EUMETSAT** kick-off in 2017
- Level-2 **Prototype** Processor developed by ESA, kick-off mid 2016
- Level-2 **Operational** Processor developed by **EUMETSAT** kick-off in 2018
- EUMETSAT will operate the instruments and process the mission data up to Level-2

Sentinel-5 Precursor (S5P): Mission Launch in 2016

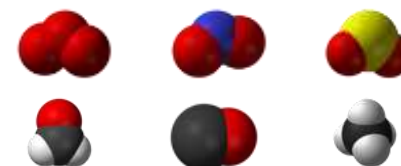


Sentinel-5 Precursor: Product Overview



S5P Data Products		
Product	Description	Remarks
Level 0	Raw measurement & engineering data	internal use only
Level 1B	Calibrated, geo-located Earth radiance & solar irradiance spectra	Systematic processing
Level 2	<p>Geophysical data (column densities/profiles) of S5P:</p> <p><i>UVN channel products</i></p> <p>O₃ total & tropospheric columns, profiles</p> <p>NO₂ total & tropospheric columns</p> <p>SO₂, HCHO total columns</p> <p>aerosols aerosol index & aerosol layer height</p> <p>clouds cloud fraction, top height, optical thickness</p> <p><i>SWIR channel products</i></p> <p>CO, CH₄ total columns</p>	<p>Near Real-Time: All species except CH₄ & tropospheric O₃</p> <p>Non Time Critical delivery: All products</p>

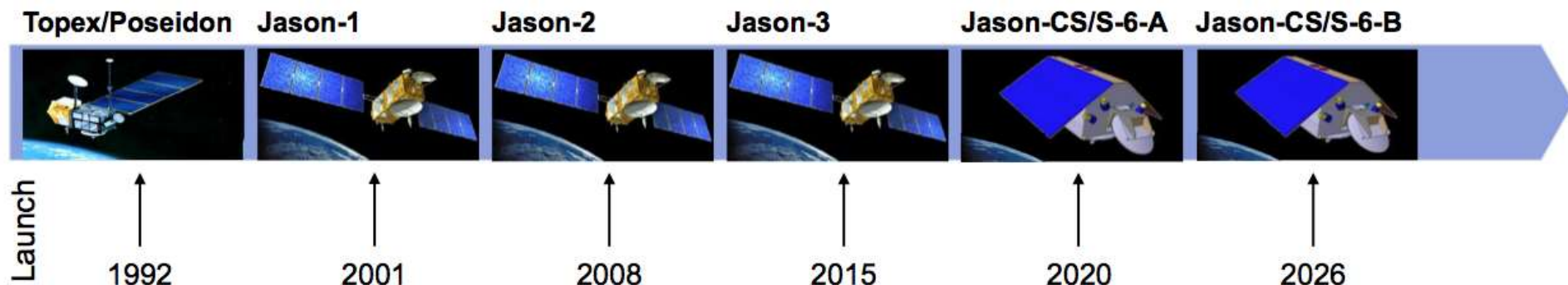
Near real-time (NRT): 3 hours after sensing
 Non time critical (NTC): 14 days after sensing
 Level 1b and Level 2 will be provided to the users



Sentinel-6 / JASON-CS

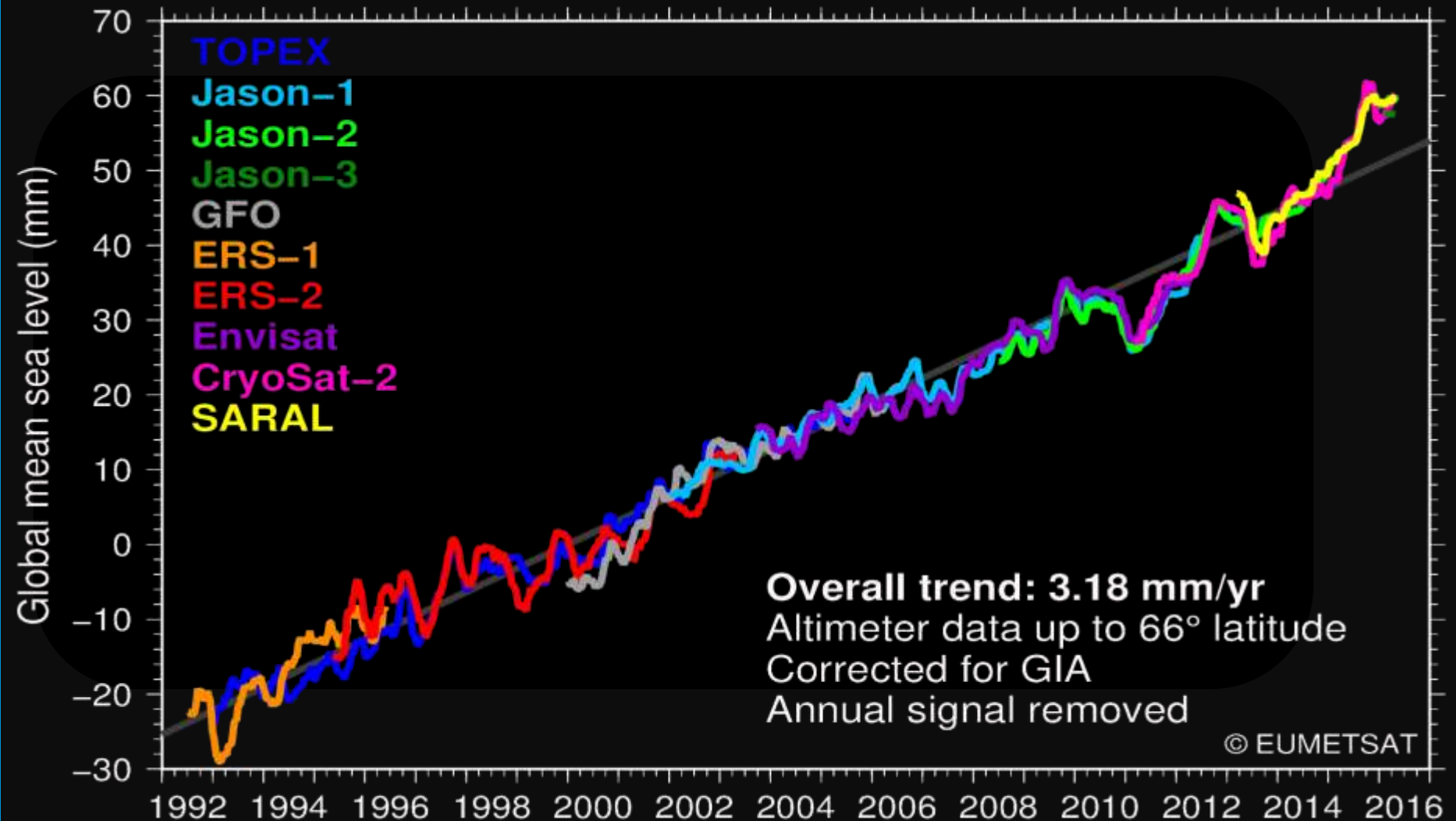


Sentinel-6/Jason-CS mission

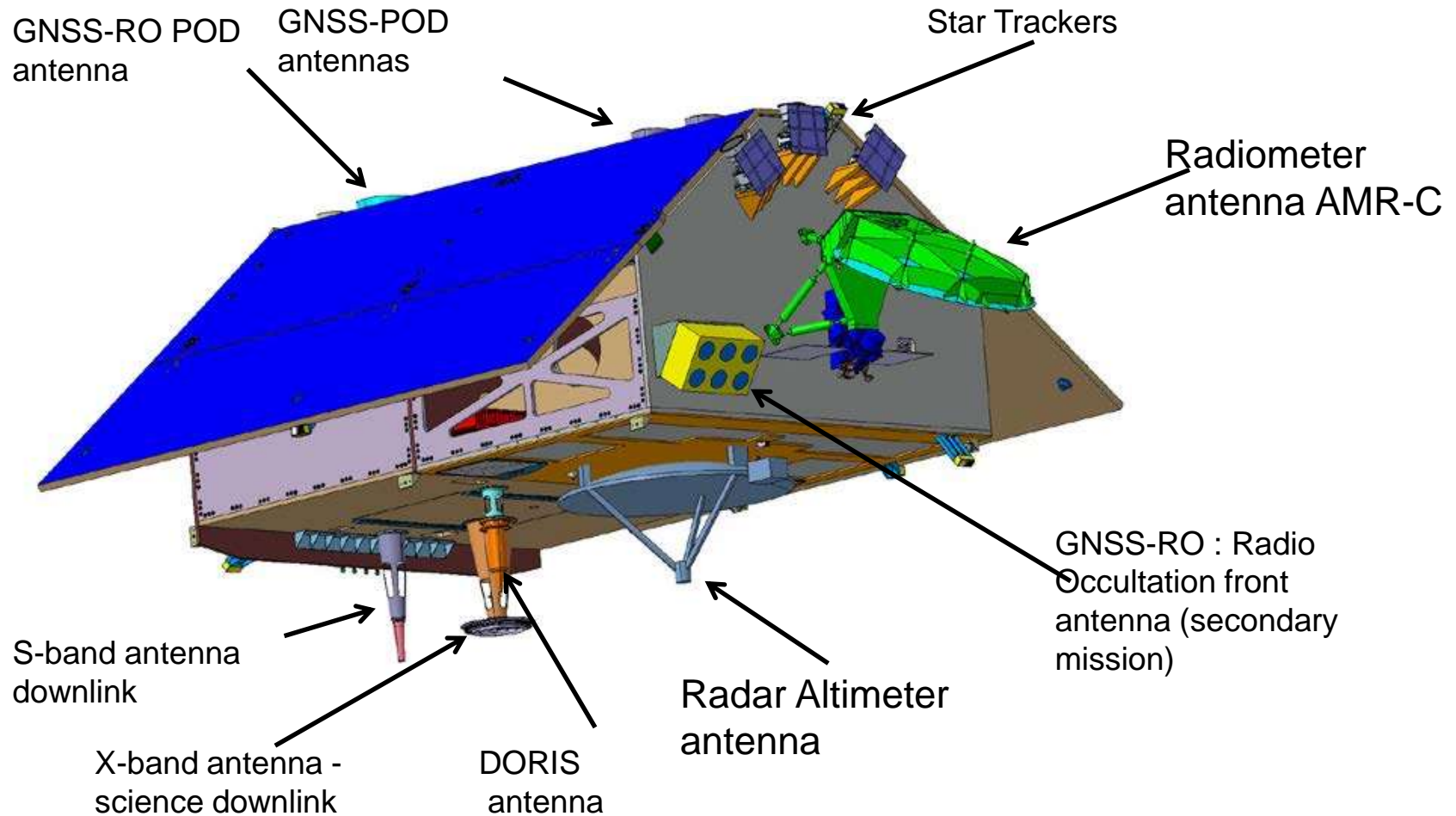


- **Forms the Copernicus Altimetry Constellation together with Sentinel-3 SRAL**
- Maintains the **reference-orbit topography mission** - started in 1992 with Topex-Poseidon and subsequent Jason missions (Jason-3 launch in 2015).
- Carries a **new Posiedon-4 Open Burst interleaved-mode altimeter**
 - Allows **simultaneous measurement of SAR and LRM modes**.
 - Implements Range Migration Compression (RMC) on board

Sentinel-6/Jason-CS mission



- The Platform Structure end Phase B2



Open and Free data access policy

<https://sentinels.copernicus.eu>

<https://scihub.copernicus.eu/>



Sentinels Scientific Data Hub

Sentinel Online

Need Help? | [Contact Us](#) | [About sentinel online](#)

Missions | [User Guides](#) | [Technical Guides](#) | [Thematic Areas](#) | [Data Access](#) | [Toolboxes](#)

You are here: [Home](#)

Welcome to the Sentinels Scientific/Other use Data Hub

The [Sentinels](#) Scientific Data Hub provides free and open access to a rolling repository of [Sentinel-1](#) and [Sentinel-2](#) from the In-Orbit Commissioning Review (IOCR).
Start of rolling activity will be announced to users before activation.

Scientific Hub | API Hub | S-2 PreOpsHub | User Guide

Welcome to Sentinel Online

THIRD SENTINEL SATELLITE LAUNCHED
The third ESA-developed satellite carrying four Earth-observing instruments was launched on 18 February, and first surface cover with high accuracy.

[Read more](#)

Sentinel News

- [Sentinel-3A dances with northern lights](#)
- [Third Sentinel satellite launched for](#)
- [Sentinel-3A launch rehearsal complete](#)

Events

- [Big Data from Space 2016](#)
- [EO Open Science and ESA SEOM sessions at EGU 2016](#)
- [Living Planet Symposium 2016](#)
- [1st ESA Advanced Training Course on Remote Sensing of the Cryosphere](#)
- [See all Sentinel Events](#)

Access Points

Scientific Hub : access point for all sentinel mission with access to the interactive graphical user interface.
API Hub : access point for API users with no graphical interface. All API users regularly downloading the latest S-1 data on point for a better performance.
Sentinel-2 Pre-operational Hub : pre-operational access point for all users to Sentinel-2 data. Login credentials are `guest:guest`

Due to the massive increase of requests on the Scientific Data Hub that have been creating performance issues in the recent API Hub, is now being operated in parallel to the Scientific Data Hub. This API Hub is dedicated to users of the scripting interface.

The API Hub Access is currently available only for users registered on SciHub before the 21st of December 16:46 UTC. The SA access this site.

The API Hub may be accessed through the URL <https://scihub.copernicus.eu/apihub/>. This implies that the OpenData API is published at <https://scihub.copernicus.eu/apihub/odata/v1>. The API Hub is managed with the same quota restrictions, i.e. a limit of two parallel downloads per user. The site is publishing as the Scientific Data Hub, with all new data as of the 16th November. A rolling policy for the Hub will be established following operations.

Sentinel Missions

Learn more about the Sentinel missions here, with comprehensive information about mission objectives, spacecraft design, instrument payloads and data products, as well as the latest mission news.

[Read more](#)

Thematic Areas

There are many applications for the data acquired from the Sentinel missions. The Thematic Areas expand on six main categories: land management, marine environment, atmosphere, emergency response, security and climate change.

[Read more](#)

Collaborative Ground Segment

Sentinel Data Products

Browse to Other Sites

- [EU Copernicus](#)
- [ESA Copernicus](#)
- [Observing the Earth](#)
- [Earth Online](#)
- [CSCDA](#)
- [Copernicus Data Quick Look Portal](#)
- [Disasters Charter](#)
- [ESA Climate Change Initiative](#)
- [Ground Segment Coordination Body \(GSCB\)](#)
- [eoPortal](#)
- [Find us on Facebook](#)
- [Follow us on Twitter](#)
- [Get the Sentinel App for iOS](#)

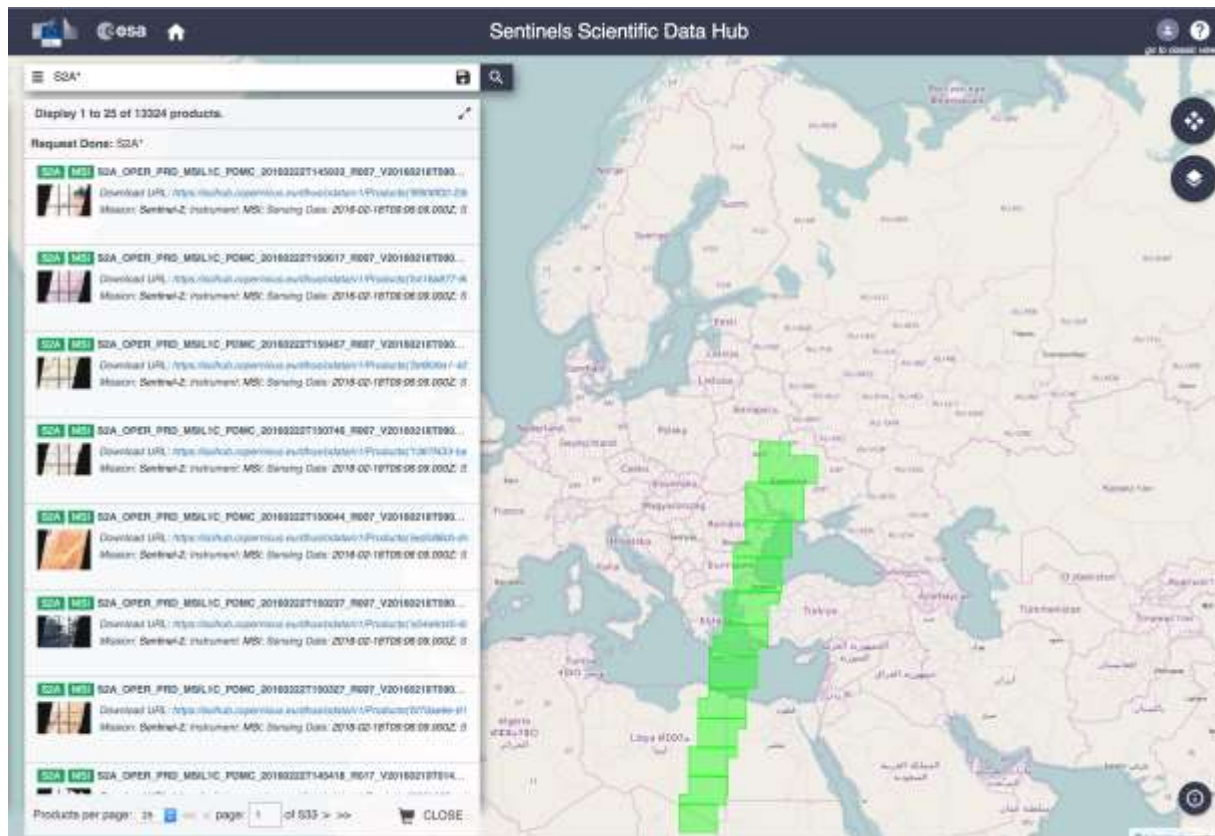
Latest Results

- [ERS and Envisat multitemporal interferometric analysis to characterize](#)

Sentinel Data – Online Access

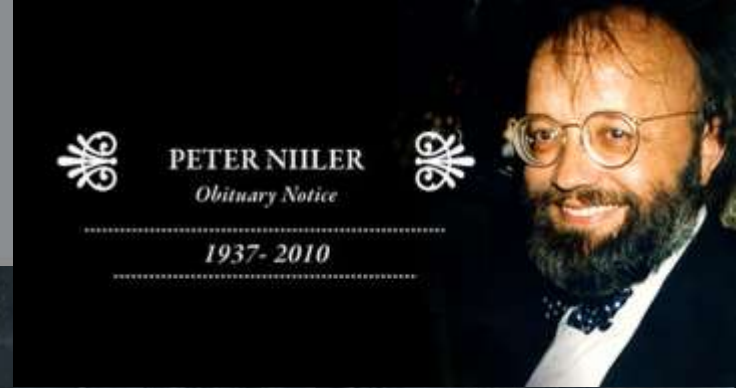


Online data access at: scihub.copernicus.eu



- ESA Data Hub Software (DHuS) provides an **open source** Web Interface
- Users can set scripts to **automatically download data**

Oceanographic Priorities for 2025 (Peter Niiler 2009)



- ***"The oceanography of 2025 will require observations and realistic modelling of the circulation patterns that contain the vertical motion of the upper 200m.***
- ***Models will be compared not by how well they assimilate or replicate the sea-level or reproduce the geostrophic velocity, but rather by how their internal vorticity, thermal energy and fresh water balances maintain ageostrophic velocity structures and the associated vertical circulations.***
- ***This task calls for development and implementation of new methods and instruments for direct velocity observations of the oceans"***



Thank You –
any Questions

Contact: Craig.Donlon@esa.int