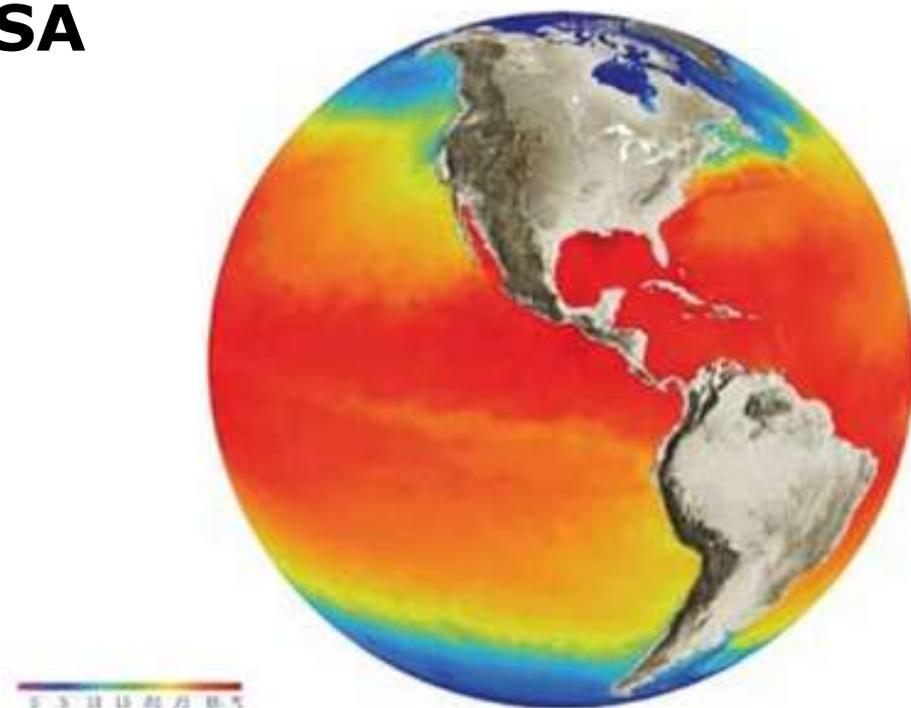


# Sea Surface Temperature Developments at ESA

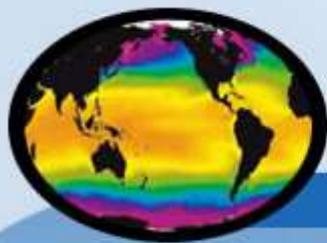


Craig Donlon (plus many more contributors)  
European Space Agency, ESTEC, The Netherlands

GHRSSST XVII Science Team Meeting, Tysons Corner, VA, USA, 6-12<sup>th</sup> June 2016

# Overview





# GHRSSST



## Group for High Resolution Sea Surface Temperature

Search:

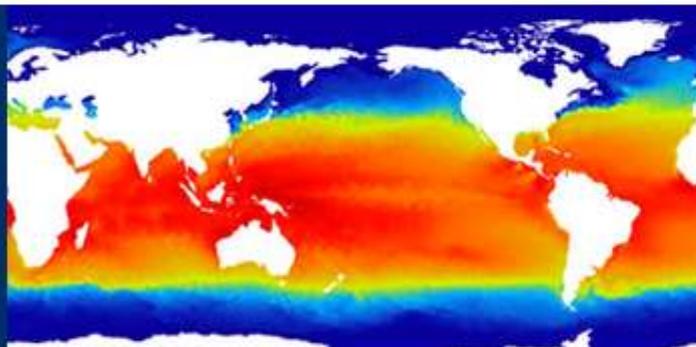
[Home](#) | [Data](#) | [GHRSSST Science](#) | [Users & Partners](#) | [Documents](#) | [News](#) | [Contact](#) | [Calendar](#) | [Login](#)

Location: [Home](#) /

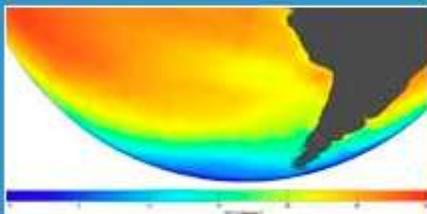
## Integrated SST Data Products

The Group for High-Resolution Sea Surface Temperature (SST) (GHRSSST) provides a new generation of global high-resolution (<10km) SST products to the operational oceanographic, meteorological, climate and general scientific community.

## In a hurry to use SST?



## Data



- Latest SST map
- Real-time
- Historical data
- RDAC Data Servers
- Data Descriptions
- GHRSSST Data Tools
- Operational Announcements

## GHRSSST Science



- SST definitions
- What is GHRSSST?
- Organisation
- Science Team Members 2012/2013
- Science Team & Groups
- Product Validation
- GHRSSST Publications
- Documents
- Meetings and workshops

## Users & Partners



- Applications
- CEOS SST VC
- GHRSSST related projects
- Sponsors
- Community links
- New Satellite Programs
- Input data streams
- User Requirements
- Education

## Login

Email:

Password:

## News

### Ocean Flux Science Workshop

Added: 12-Jun-2013

### GOV Symposium – Abstracts & Registration

Added: 12-Jun-2013

### Final agenda for G-XIV

Added: 11-Jun-2013

### Release of Turbulent Flux analyses by Ifremer

Added: 08-Jun-2013

### Links to recordings of GHRSSST Webinar

Added: 06-Jun-2013

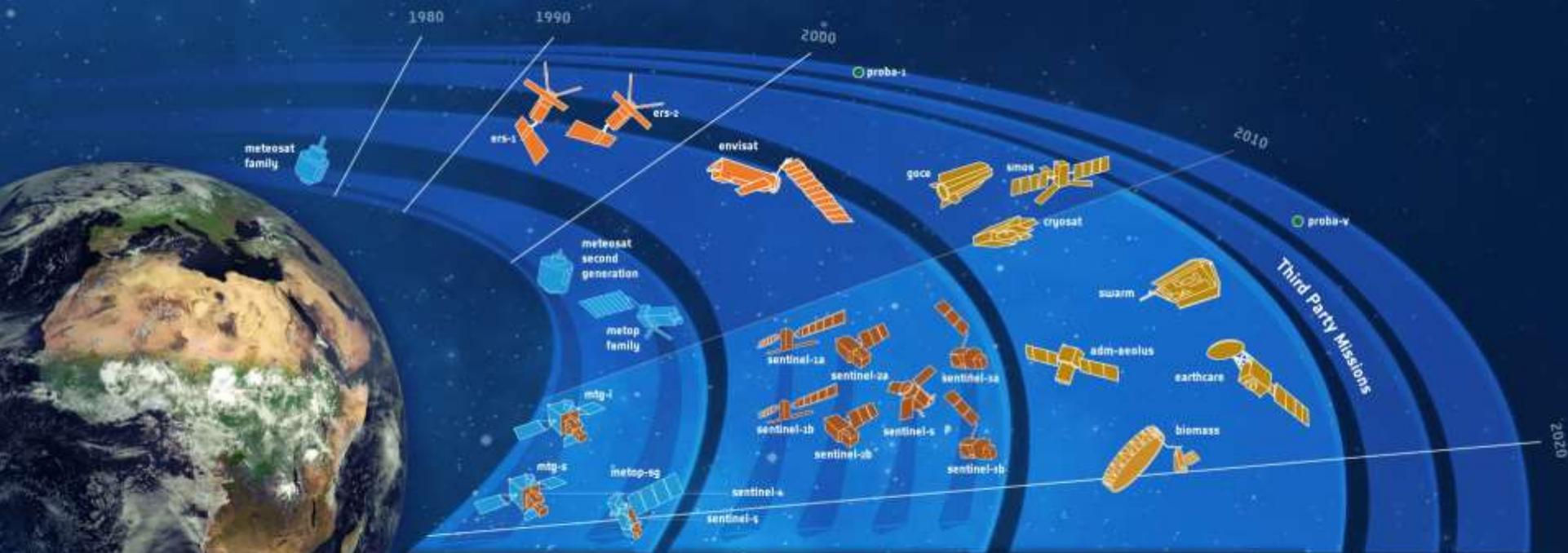
### GHRSSST XIV - Latest draft agenda (4th June 2013)

Added: 04-Jun-2013

### OSISAF - LEO SST format change from GDS V1 to GDS V2

Added: 30-May-2013

## THE ESA EARTH OBSERVATION PROGRAMME



**Meteorological Missions**  
 Driven mainly by Weather forecasting and Climate monitoring needs. These missions developed in partnership with EUMETSAT include the Meteorological Operational satellite programme (MetOp), forming the space segment of EUMETSAT's Polar System (PS), and the new generation of Generation Meteosat satellites (MSG & MTG satellites).

Meteorological Programme

**Copernicus Sentinel Missions** driven by Users needs to contribute to the European **Global Monitoring of Environment & Security (GMES)** initiative. These satellite missions developed in partnership with the EU include C-band imaging radar (Sentinel-1), high-resolution optical (Sentinel-2), optical and infrared radiometer (Sentinel-3) and atmospheric composition monitoring capability (Sentinel-4 & Sentinel-5 on-board Met missions MTG and PS-SG respectively).

Copernicus Programme

**Earth Explorer Missions** driven by Scientific needs to advance our understanding of how the ocean, atmosphere, hydrosphere, cryosphere and Earth's interior operate and interact as part of an interconnected system. These **Research** missions, exploring Europe's excellence in technological innovation, pave the way towards new development of future EO applications.

Earth Observation Envelope Programme

**Data from non-ESA Missions**

Open Access Data

# Copernicus Overview



A Programme of the European Union

[www.copernicus.eu](http://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



European Space Agency

- 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

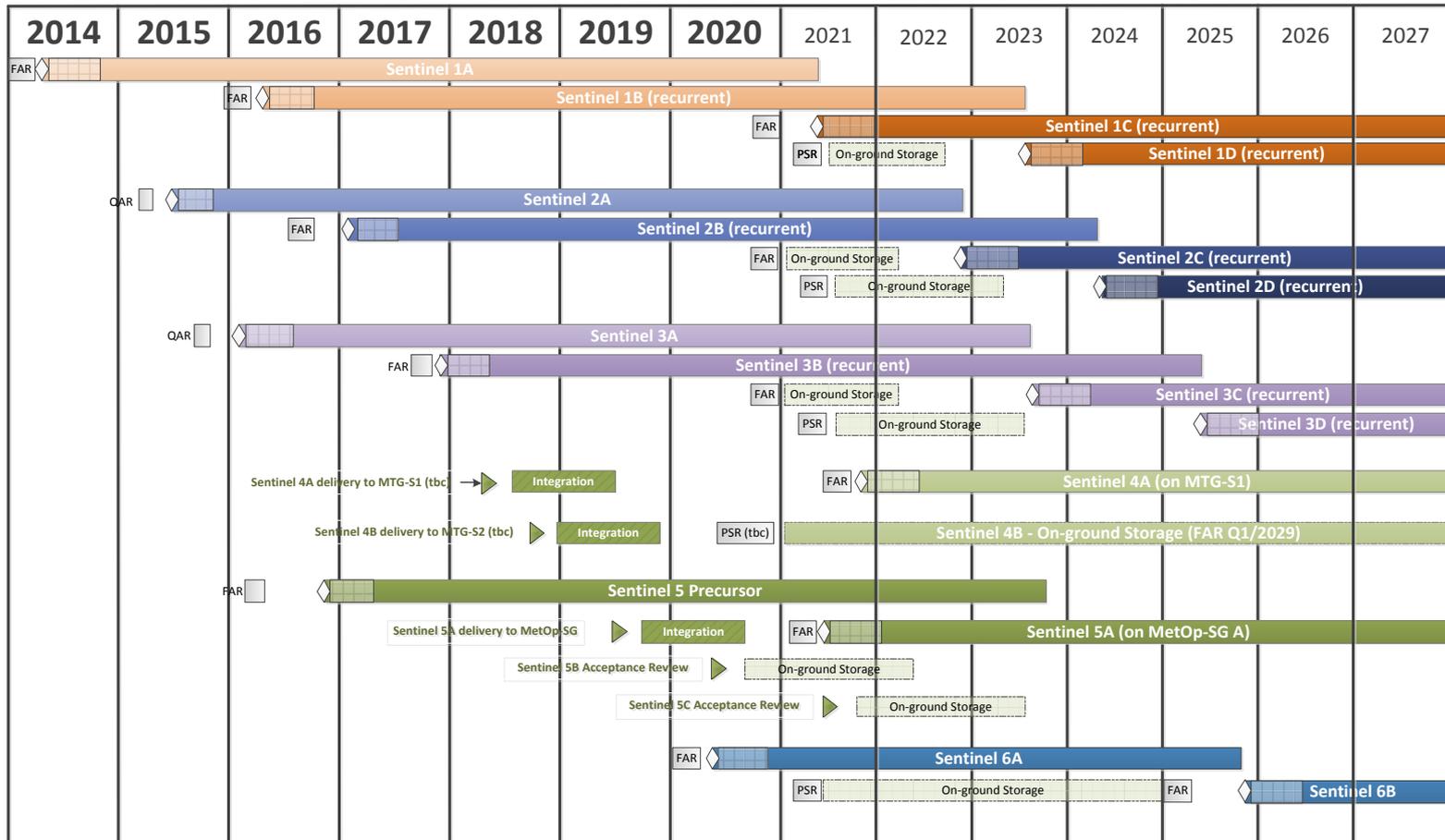
*...plus other partners...*

*In-situ component not represented here*

# Sentinels constellation deployment schedule



## Copernicus Constellation Deployment Schedule



**Legend:**   
 Qualification Acceptance Review (QAR)   
 Flight Acceptance Review (FAR) or PreStorage Review (PSR)   
 On-ground Storage   
 Tentative launch date   
 In-orbit Commissioning

Status: 22 March 2016



## Papers on SST uncertainties

Submitted by SCL webmaster on Thu, 2016-03-31 10:42

The SST CCI project has produced three papers on various aspects of SST uncertainties, published in *Remote Sensing of the Environment*.

Estimating background error covariance parameters and assessing their impact in the SST CCI analysis

## Updated SST CCI Analysis

Submitted by SCL webmaster on Thu, 2015-06-29 11:53

The SST CCI Analysis product has been updated. Compared to v1.0, it is now based on a new SST input and directly using the sea ice concentration data.

the SST inputs as analysis v1.0. The analysis has been corrected. For users not using the analysis v1.0, the analysis v2.0 is recommended.

## SST CCI User Tools

Submitted by SCL webmaster on Thu, 2015-06-29 11:53

The ESA SST CCI project provides a set of user tools to generate an additional uncertainty product from the SST data products to a coarser raster and the regional SST data products.

of the SST data products to a coarser raster and the regional SST data products. The uncertainty information and the regional SST data products are available in the user tools.

## SST video for COP21

Submitted by SCL webmaster on Thu, 2015-06-29 11:53

To coincide with COP21 in Paris, the ESA SST CCI project has produced a video about sea surface temperature.

climate variables, including [this one](#) about sea surface temperature.

## Very easy download of SST CCI data

Submitted by SCL webmaster on Mon, 2015-06-29 11:53

If you want some of our data in the simplest possible form, head to our new [Read more](#) »

**See Poster 40: REQUIREMENTS FOR SEA SURFACE TEMPERATURE DATA SETS FOR CLIMATE RESEARCH AND SERVICES**

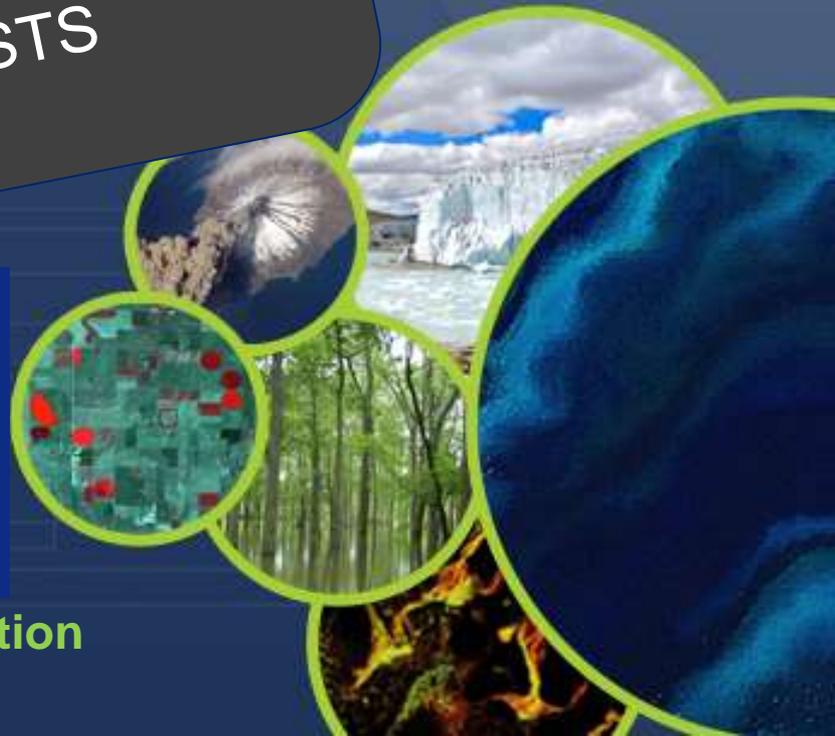
<http://www.esa-sst-cci.org/>



# FRM4STS: Fiducial Reference Measurements for validation of Surface Temperature Satellites (ceos)

Aim to improve global satellite validation and harmonization for sustainable

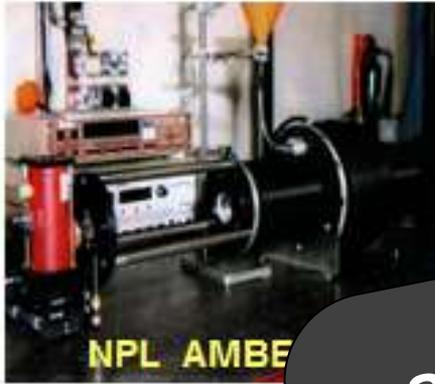
**See Poster 10: AN ESA INITIATIVE TO ESTABLISH AN IN SITU REFERENCE FRAMEWORK FOR SATELLITE SST VALIDATION: FRM4STS**



**Working Group on Calibration and Validation**

# SI traceability: LCE (June 2016)

Necessary for all participants to assess biases to SI under  
Laboratory conditions **18 participants inc 2 from Australia**



NPL AMBER

ITS-90

50 – 325 K  
vacuum  
for sky  
e

See Poster 29: DRIFTING BUOYS  
WITHIN THE ESA INITIATIVE  
TO ESTABLISH AN IN SITU  
REFERENCE FRAMEWORK FOR  
SATELLITE SST VALIDATION: FRM4STS

NPL Rad  
(AMBER)

Rad 4

Rad n

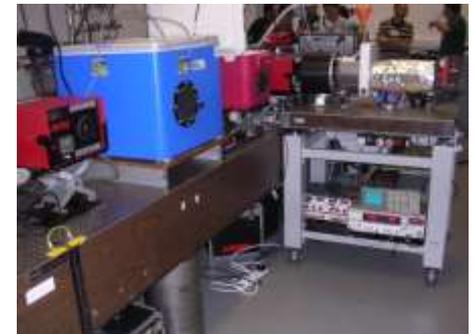
BB1

BB 2

BB 3

BB 4

BB n



Room Environment with variable T

# Water Surface Temp (near NPL) (Jun/Jul 2016)

The floating platform from which WST measurements are due to take place is in the middle of the Wraysbury reservoir. The depth of the reservoir is 20 m.





# Ocean Virtual Laboratory



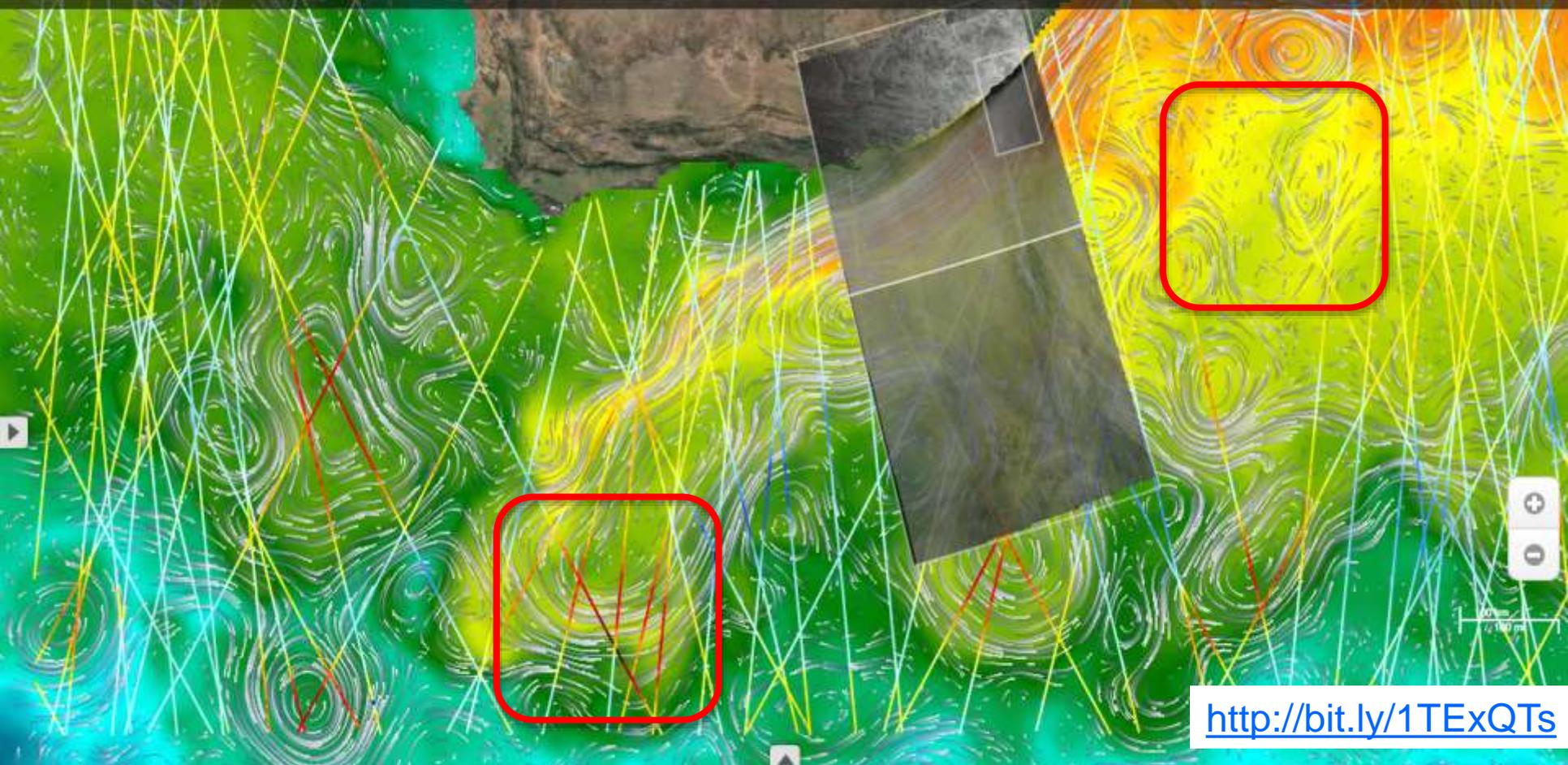
**ocean data lab**  
making sense of the deep blue sea

**seom**  
scientific exploitation  
of operational missions

<https://www.oceandatalab.com>

Ocean Virtual Laboratory

Products Hotspots Share Settings About Help Feedback



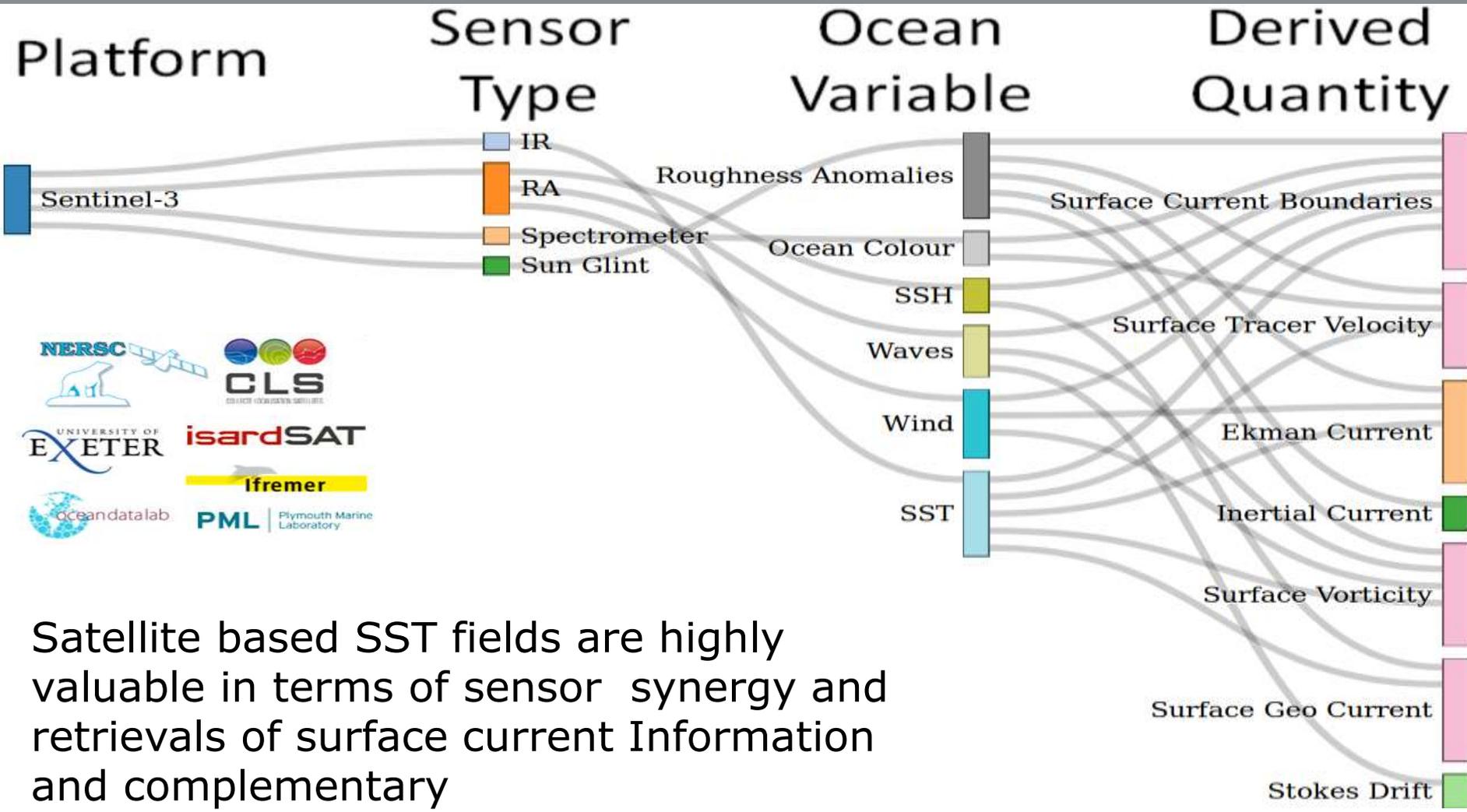
<http://bit.ly/1TExQTs>

1x Daily 3-Day Weekly 79 dataset(s) 22.42°, -35.24°

2009 2010 2011 2012 2013 2014 2015

January February March April May

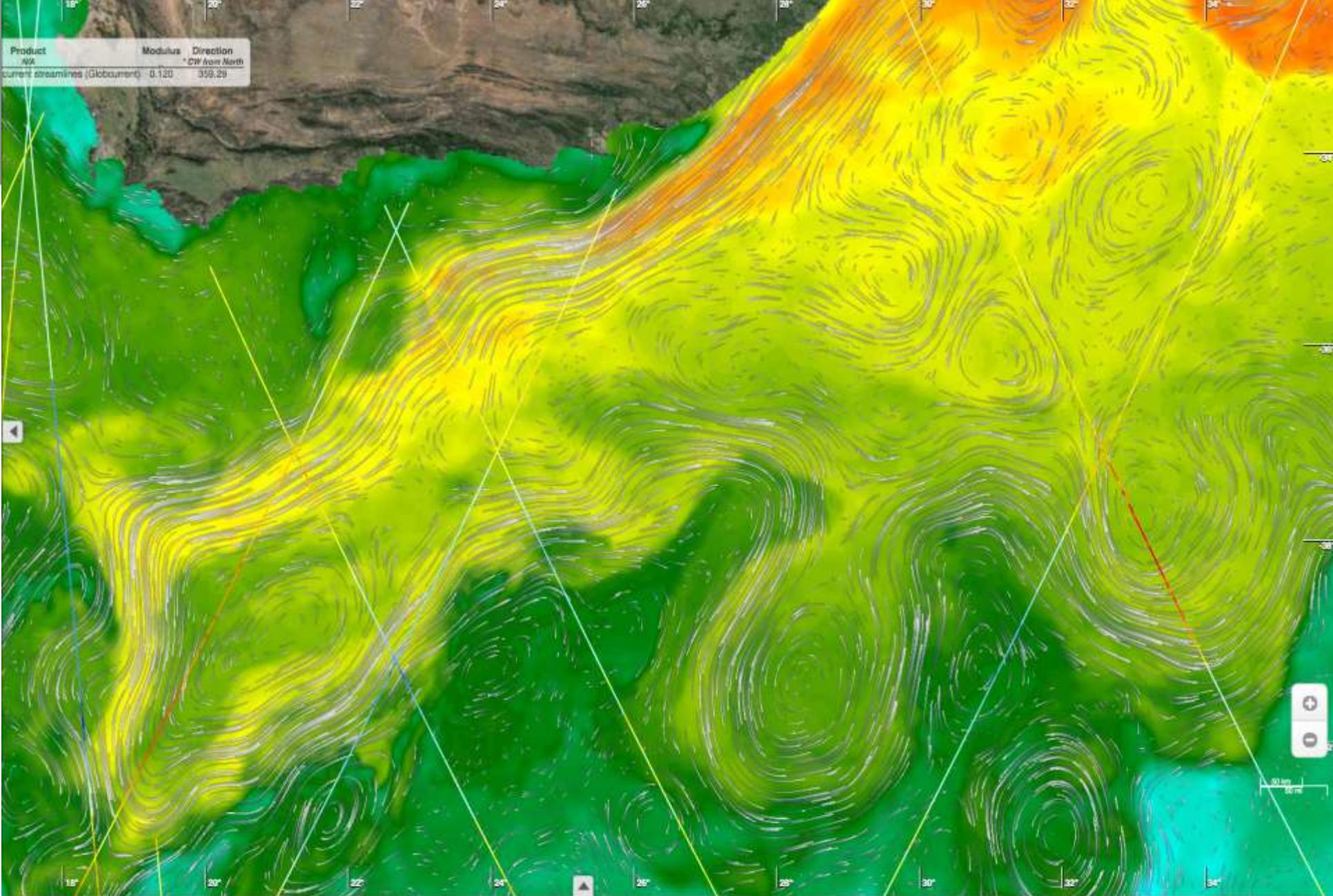
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31



Satellite based SST fields are highly valuable in terms of sensor synergy and retrievals of surface current information and complementary derived quantities.



Product	Modulus	Direction
WA		° CW from North
current streamlines (Gibbounet)	0.120	359.39



3-Day Weekly 16 dataset(s) 15.14°, -36.79°

2009 2010 2011 2012 2013 2014 2015 2016

February 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

March 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

April 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

May 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

June 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

July 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

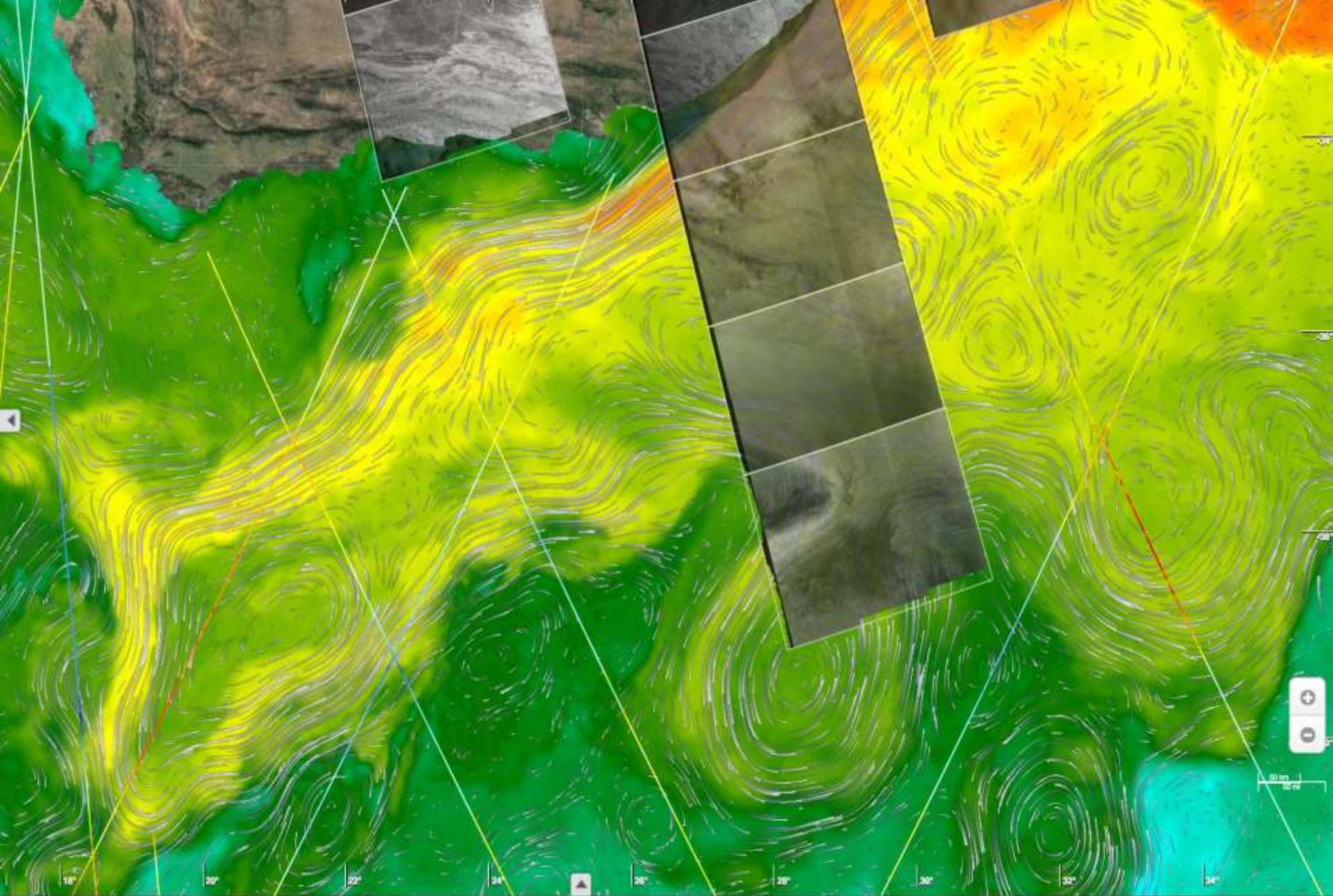
August 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

September 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

October 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

November 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

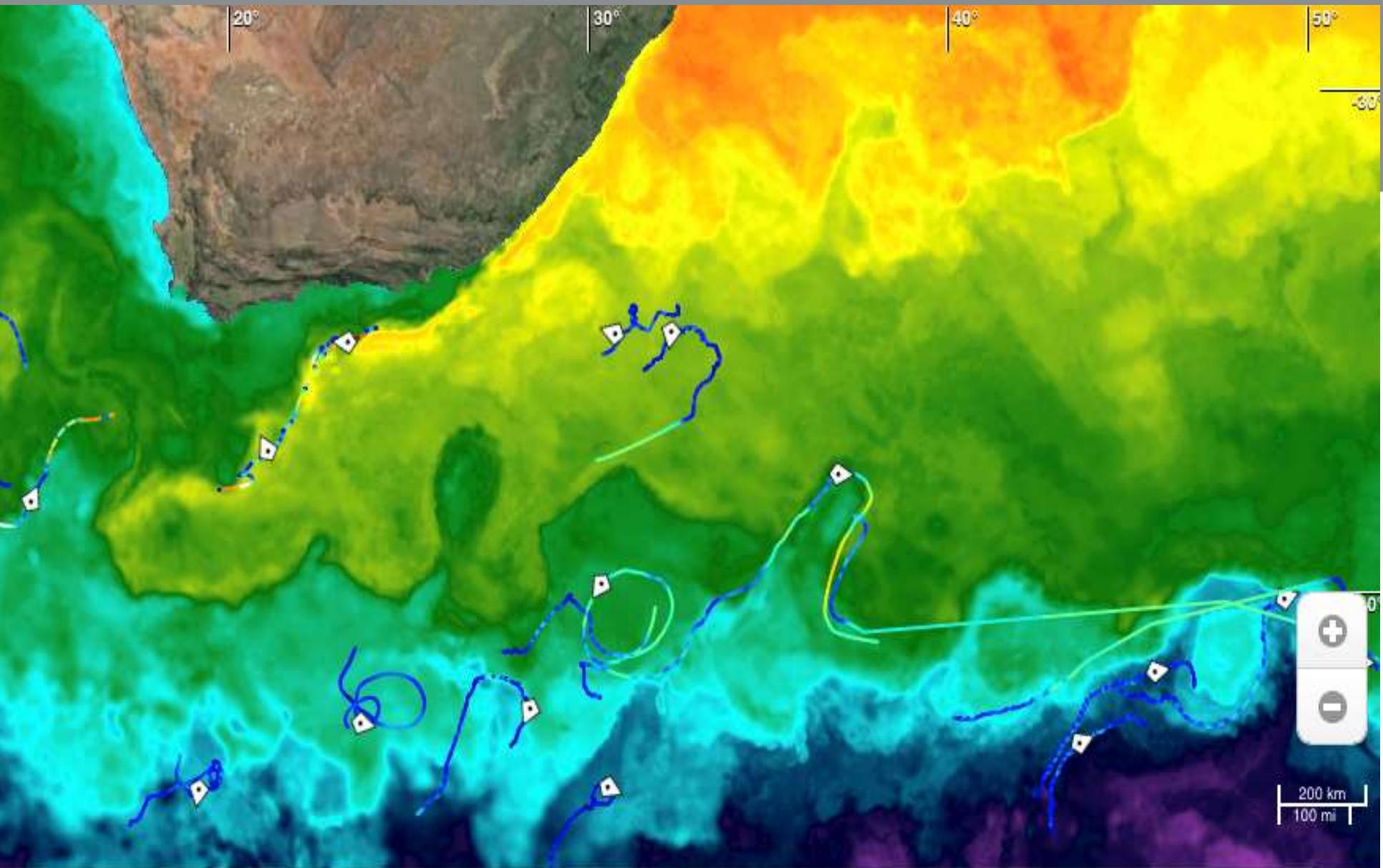
December 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31



9-Day Weekly 34 dataset(s) 20.32° -34.30°

2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019

February 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



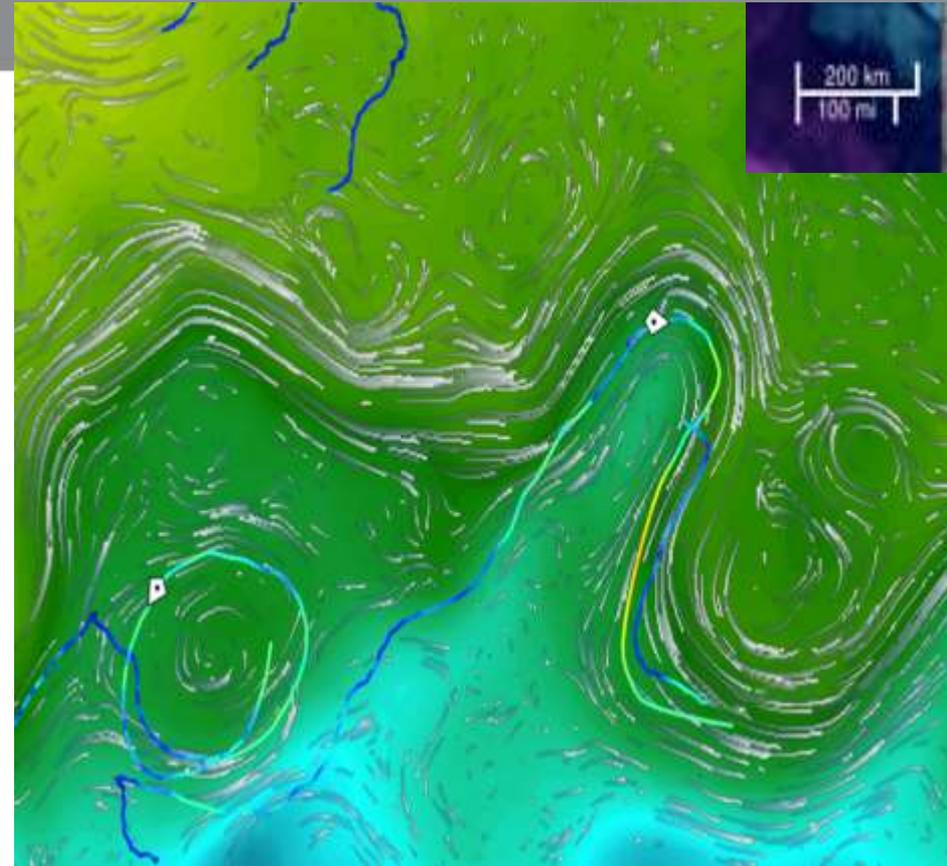
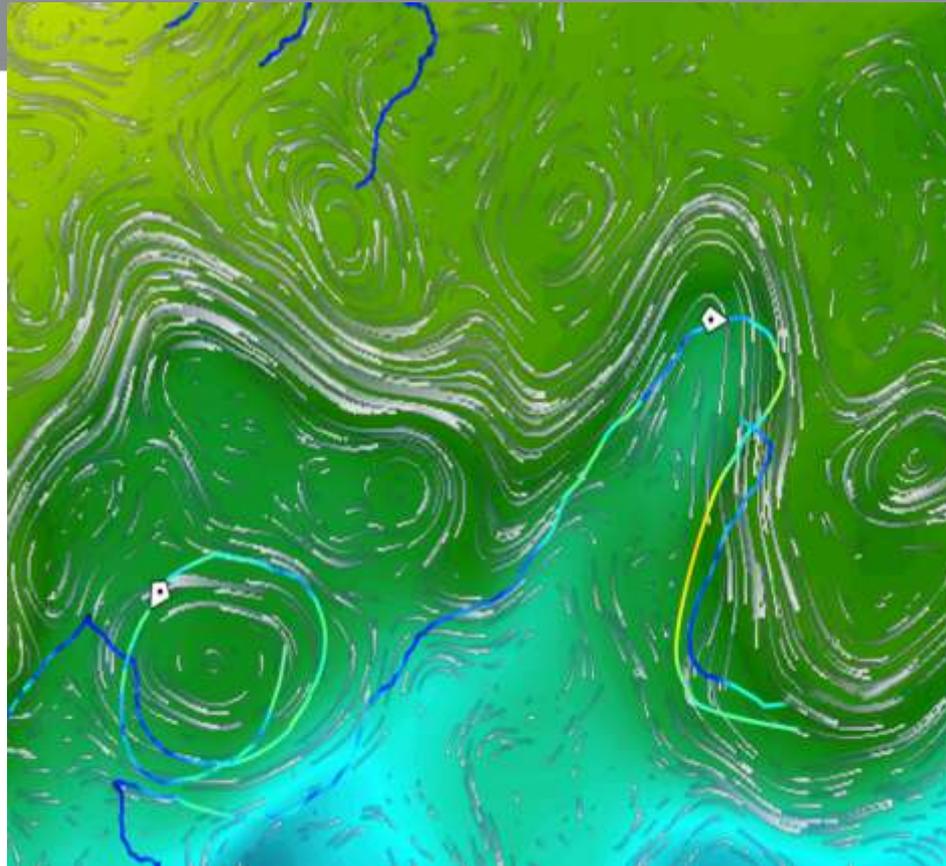
Day Weekly 1 dataset(s) 38.88°, -37.94°

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 © 2011 NASA, TerraMetrics Terms of Use

24 April 2015, Uncorrected  
velocity field

24 April 2015, Corrected  
velocity field

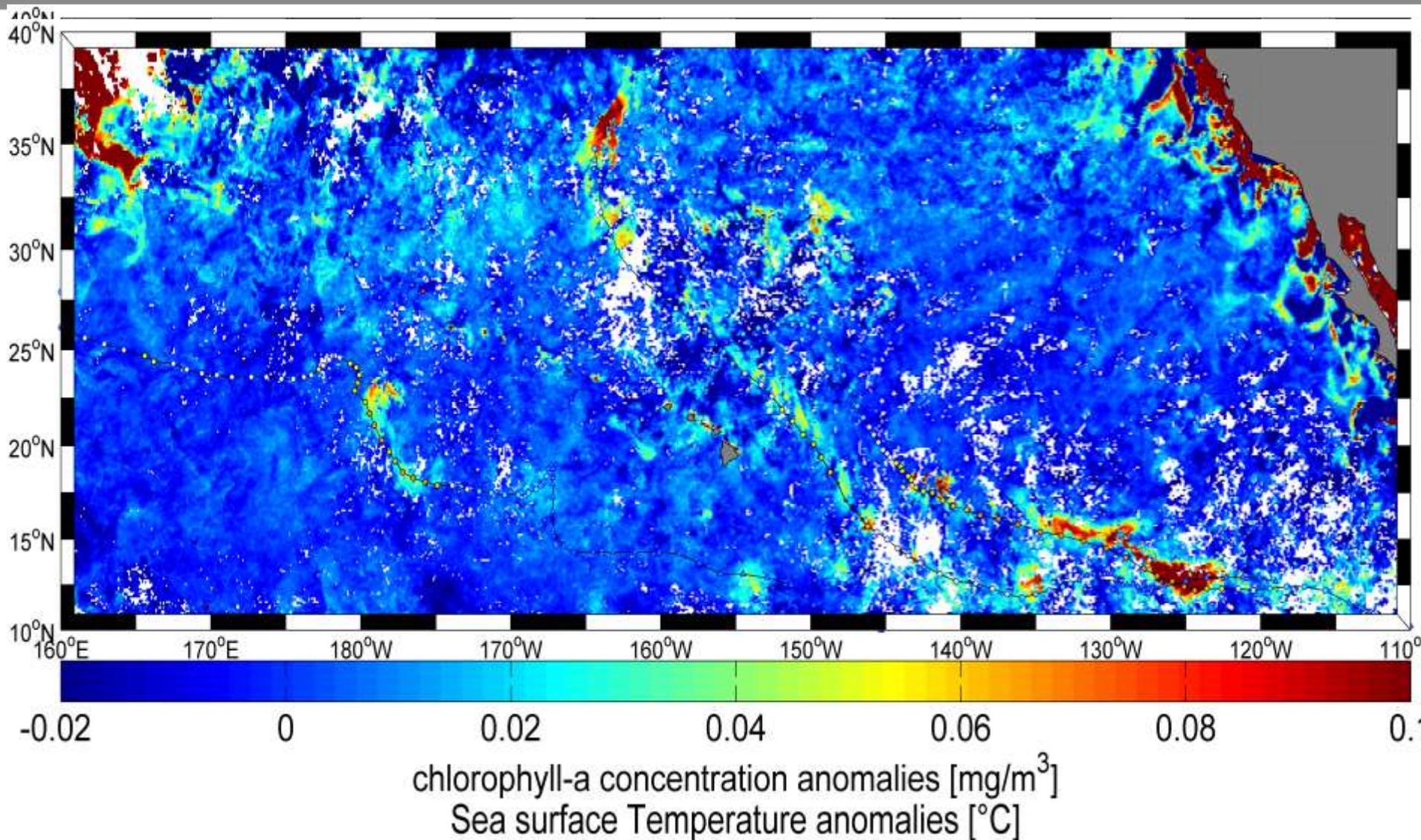


Streamlines of altimeter derived  
velocities overlaid microwave SST  
and drifters.

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

Courtesy Lucille Gaultier, OceanDataLab

# SMOS+ STORMS: Air-sea interaction from space



# → 4472 FISH CAGES IN THE WESTERN MEDITERRANEAN SEA



Seabass & seabream cages, Cannes (France).  
Pleiades image on 24/12/2011, CNES.



Example of mussels aquaculture on racks, Spain



Sentinel-1 on 05/09/2015

Sentinel-2 on 06/02/2016



Seabass & seabream cages, St Paul's Bay (Malta).  
By Frank Vincentz, via Wikimedia Commons.

SST Medspratlon 01/09/2015 (deg.C)

< 17.0	20.6	29.0
17.0	22.4	31
18.8	26.0	
19.5	27.8	

● Cages detected, Sentinel 1



**innovators**  
smart



BLUEFARM

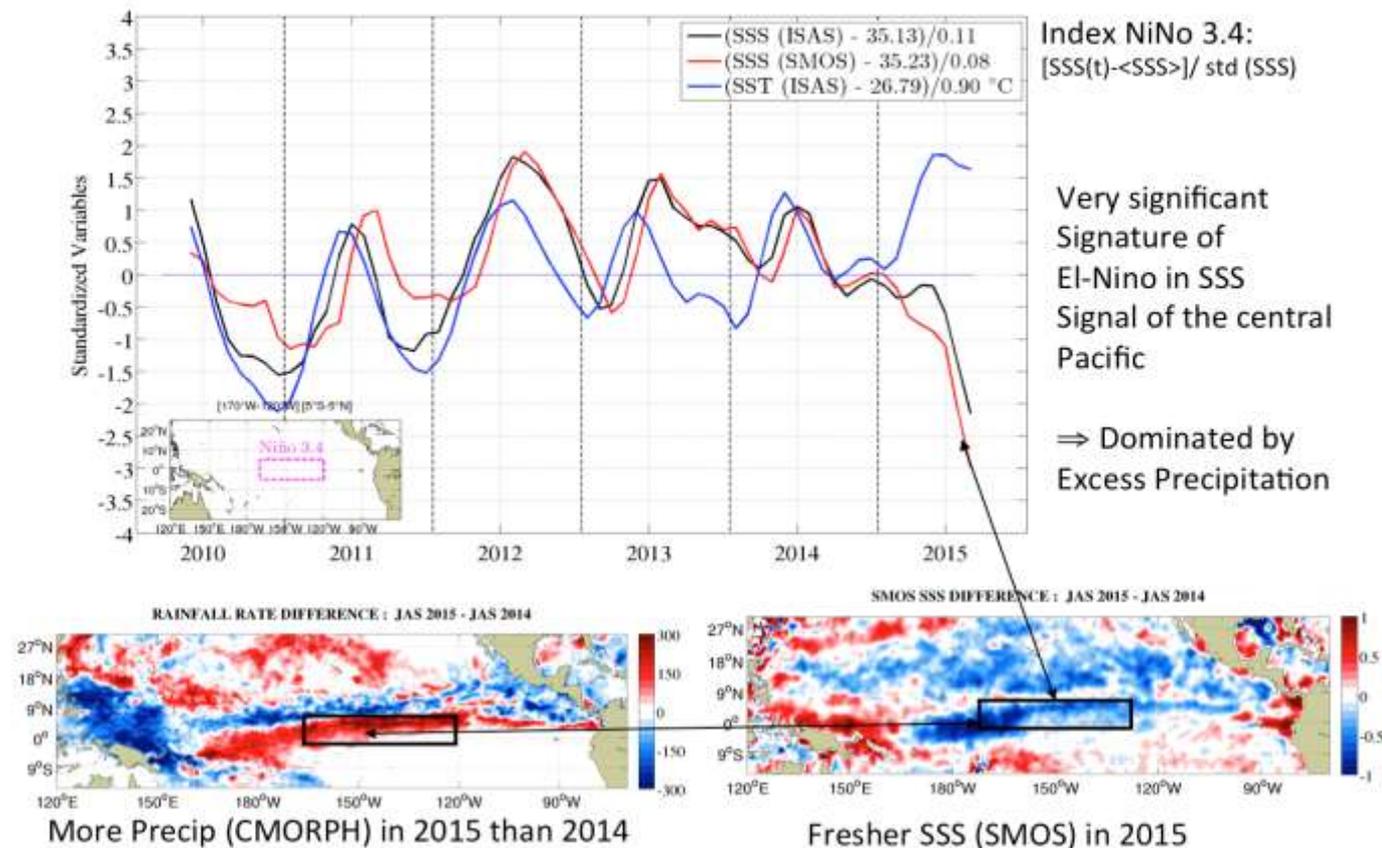
[www.smart-ee.eu](http://www.smart-ee.eu)

# New Project: STSE SMOS Nino15 250KEuro



- ESA Support to GODAE OceanView Task Team for Observing System simulation Experiments (OSEVal-TT)
- **Conduct an Observing System Experiment to assess the impact of satellite Sea Surface Salinity for the El Niño 2015/16 event.**
- **KO in Q3 2016**

## SMOS « sees » an intense freshening in the Tropical Pacific during El-Nino 2014-2015



(credit: N. Reul, IFREMER)

# OceanFlux and Workshop



- Global CO<sub>2</sub> air-sea flux Climatology
- Paper accepted on how to handle temperature for pCO<sub>2</sub> fluxes
- FluxEngine is still active
- Final Workshop
- 75 abstracts submitted,
- 110 people have already registered!

**SCIENCE WORKSHOP**  
20-23 Sept. 2016  
BREST | FRANCE

Scientists and engineers are invited to attend the Science Workshop which will allow the project and other international teams to present their recent advances. It will also provide a forum for the community to plan future aims and collaborations.

**oceanflux evolution**  
support to science element

[www.oceanflux-ghg.org](http://www.oceanflux-ghg.org)  
The website presents the project and provides easy access to data, publications, the project climatology and the open-source FluxEngine tool.

[twitter.com/OceanFluxweb](https://twitter.com/OceanFluxweb)  
Please find here news about recent developments of the project, including scientific results.

**The OceanFlux Greenhouse Gases project**  
Aims to improve the quantification of air-sea exchanges of greenhouse gases, of prime importance in the climate system.

Logos: erc, PML, the ocean, EXETER, esa, stse

profiles in the water column and changes in the aqueous concentration act primarily through the partitioning of the carbonate system. Climatological calculations of flux require attention to variability in the upper ocean and to the limited validity of assuming “constant chemistry” in transforming measurements to climatological values. Contrary to some recent analysis, it is shown that the effect on CO<sub>2</sub> fluxes of a cool skin on the sea surface is large and ubiquitous. An opposing effect on calculated fluxes is related to the occurrence of warm layers near the surface; this effect can be locally large but will usually coincide with periods of low exchange. A salty skin and salinity anomalies in the upper ocean also affect CO<sub>2</sub> flux calculations, though these haline effects are generally weaker than the thermal effects.

# Sentinel-3



# Sentinel-3a launch from Plesetsk Cosmodrome 16<sup>th</sup> February 2016



(Credit: Antero Isola)

# Current status of Commissioning

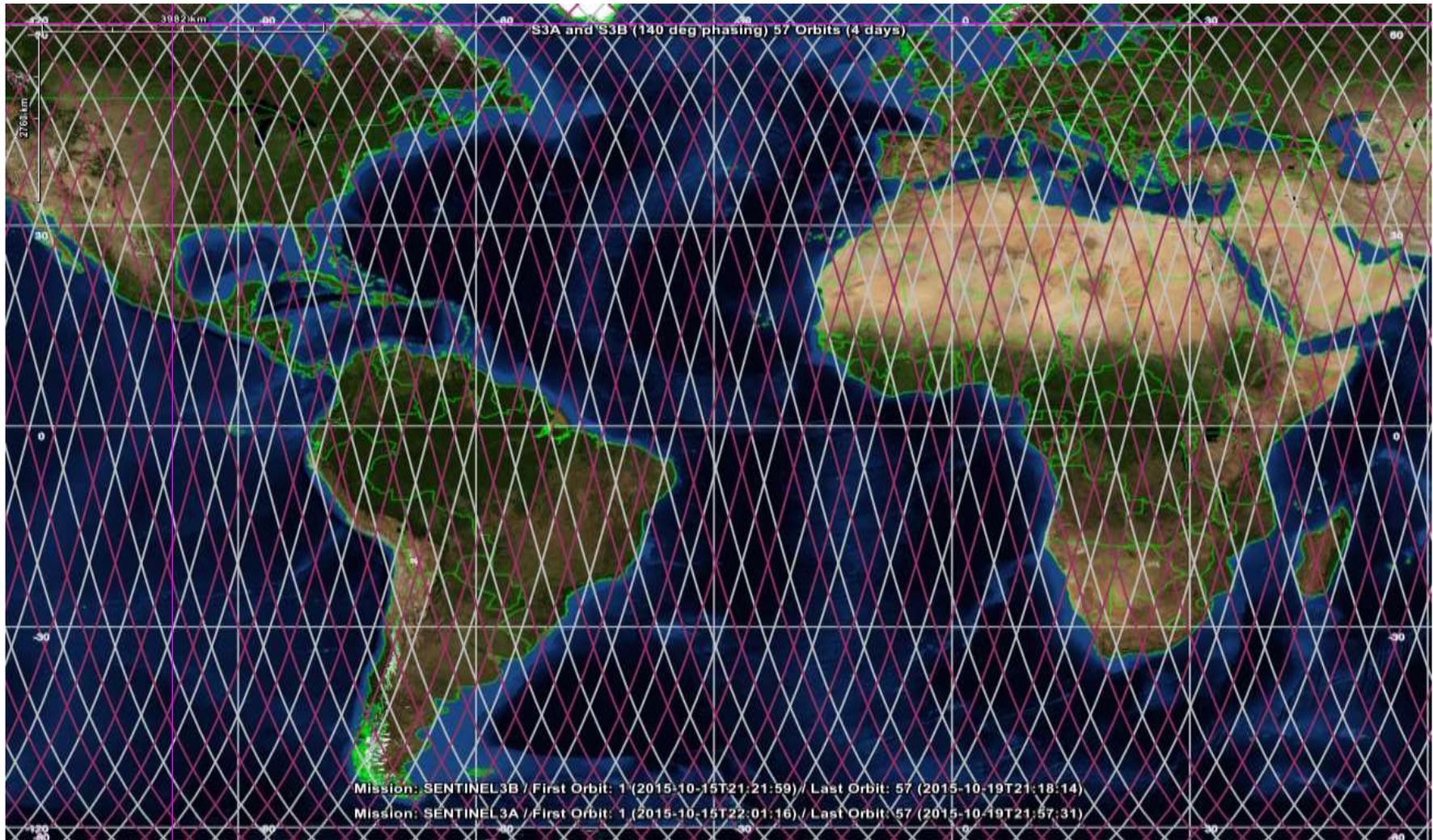


**Spacecraft and all instruments in nominal operational mode and functioning well.**

**Weekly mission status on <https://sentinel.esa.int/web/sentinel/missions/sentinel-3/mission-status>**

<b>16 Feb</b>	Successful Launch
<b>18 Feb</b>	LEOP phase concluded successfully in 47 hrs, thanks to <ul style="list-style-type: none"><li>✓ Perfect orbit injection from the launcher</li><li>✓ Rapid and smooth Solar Array deployment</li><li>✓ No need for collision avoidance manoeuvre</li><li>✓ Only one minor anomaly encountered (Star Tracker depointing due to incorrect quaternion data), rapidly identified and corrected</li></ul>
<b>26 Feb</b>	Platform In-Orbit Verification completed
<b>4 March</b>	Payload In-Orbit Verification completed <ul style="list-style-type: none"><li>✓ Sentinel-3A already flying in its reference orbit</li><li>✓ All instrument ON and operating (except SLSTR in decontamination mode, as planned)</li><li>✓ Level-0 products being generated</li></ul>
<b>7 March</b>	Cal/Val Phase of S3 commences
<b>April/May</b>	<b>Mid-Term-Reviews for OLCI, SLSTR and SRAL,</b> <ul style="list-style-type: none"><li>✓ Confirming functionalities and key performance of all Instrument</li><li>✓ Authorising release of first data/products to expert users</li></ul>

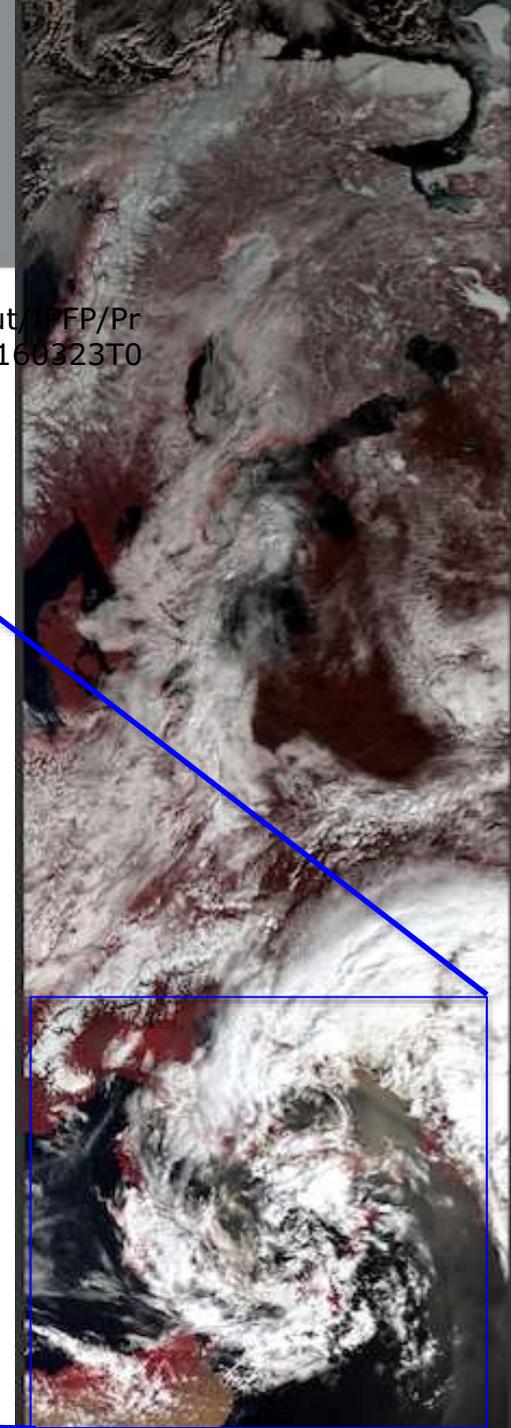
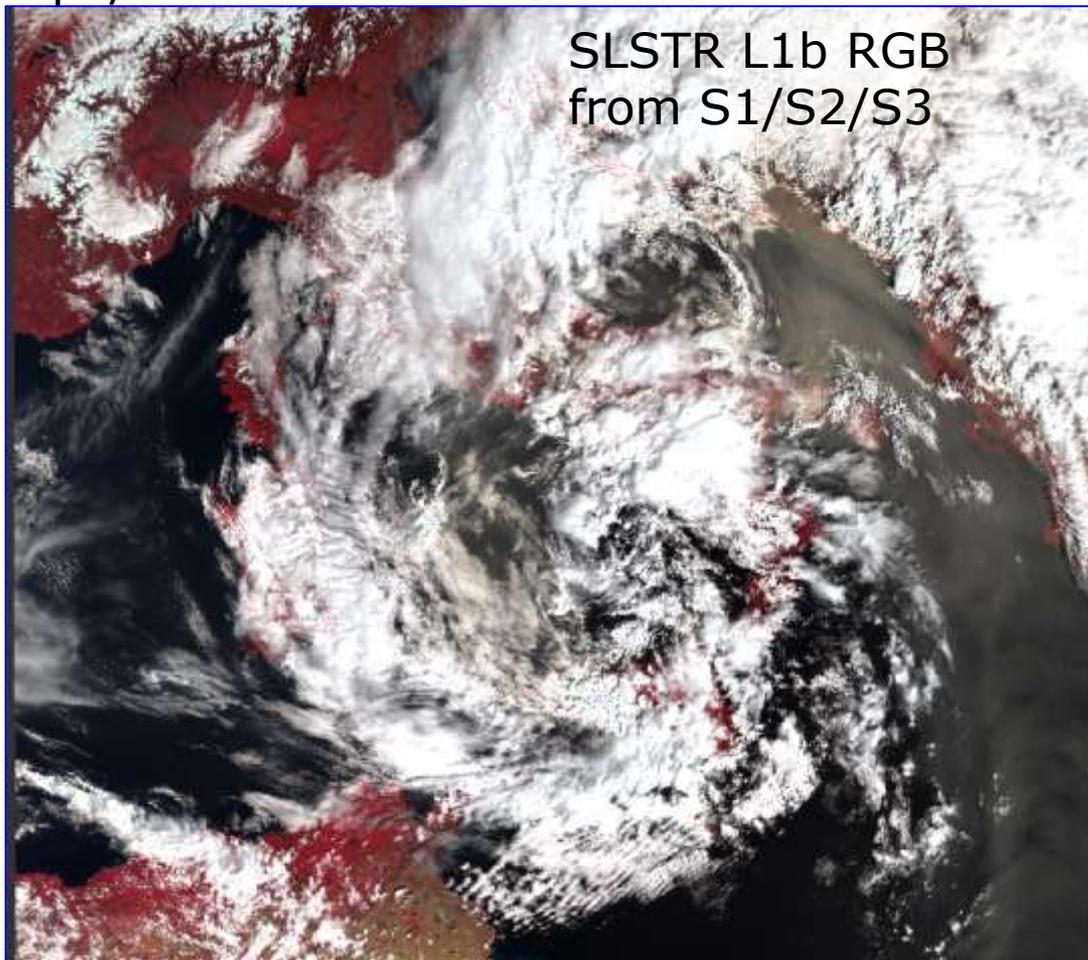
# Optimising the Constellation: Sentinel-3B phasing to 140° (instead of 180° ) after 4 days



# SLSTR IR channels switch on 23-Mar-2016

Sentinel-3 SLSTR First  
IR Image over  
Europe/North Africa

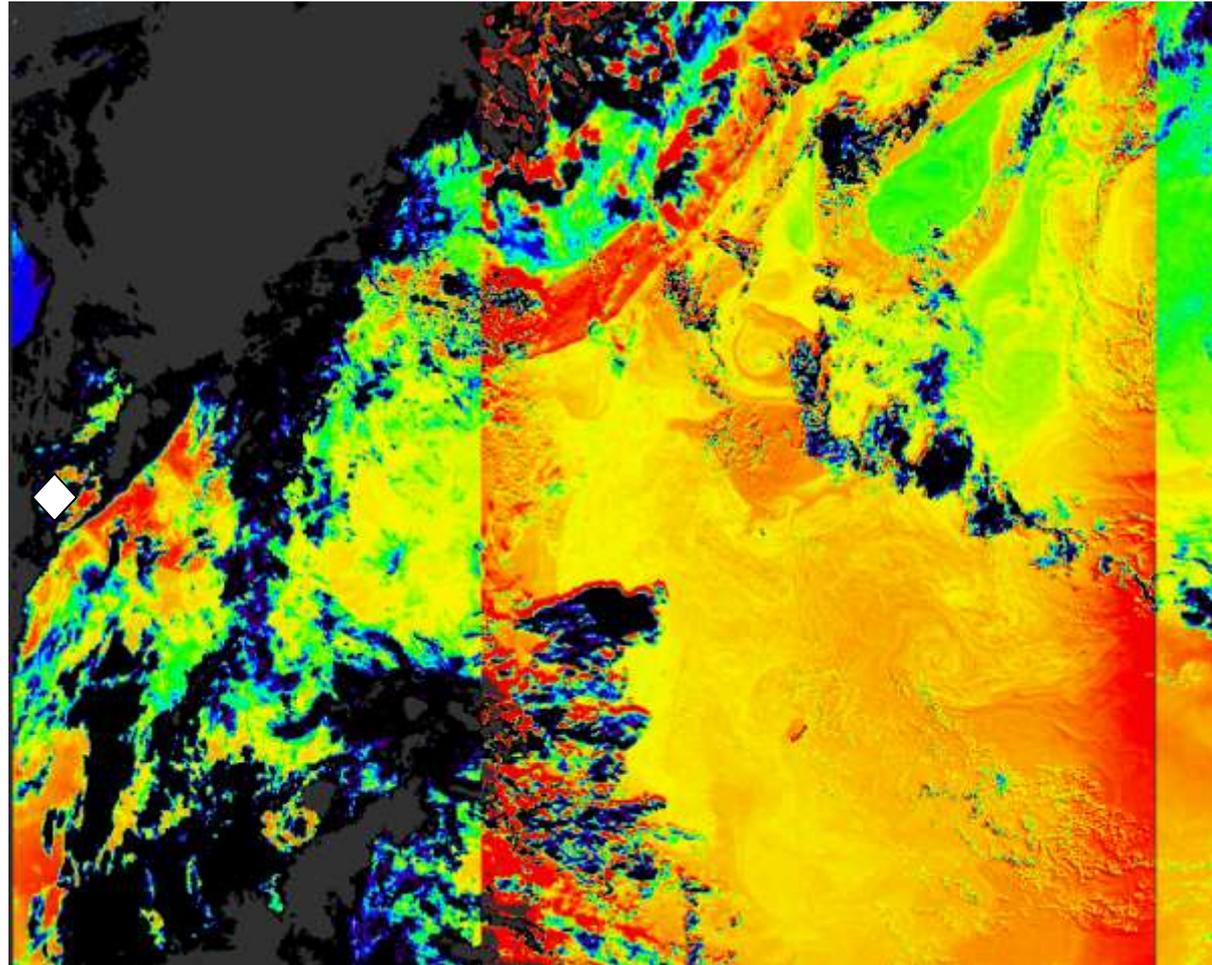
[ftp://s3a-commteam@commissioning.sentinel3.esa.int/Output/FP/Products/LI\\_005\\_ROI\\_Europe/20160323T091429\\_20160323T092523](ftp://s3a-commteam@commissioning.sentinel3.esa.int/Output/FP/Products/LI_005_ROI_Europe/20160323T091429_20160323T092523)



# Sentinel-3 L2P SST



- SLSTR data are provided in GHRSSST L2P format
- “Best” available SSTs so uses dual-view and Nadir only SST’s in the same product
- Ground Segment and product verification progress with full operational capability in ~8 months
- **See ESA and EUMETSAT posters on early performance of SLSTR on orbit and initial L1 and L2**



# Sentinel data



## Sentinel data are available:

- Open and free
- Over very long term
- Systematically, in an operational fashion



# Open and Free data access policy

<https://sentinels.copernicus.eu>

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



The screenshot displays the Sentinel Scientific Data Hub website. The top navigation bar includes the Copernicus and ESA logos, the text 'Sentinels Scientific Data Hub', and 'Sentinel Online'. A search bar is located in the top right. Below the navigation, there are several menu items: 'Missions', 'User Guides', 'Technical Guides', 'Thematic Areas', 'Data Access', and 'Toolboxes'. A main content area features a video titled 'Welcome to Sentinel Online' with a 'Read more' button. To the right, there are sections for 'Sentinel News' and 'Events'. Below the main content, there are sections for 'Sentinel Missions' and 'Thematic Areas'. At the bottom, there are sections for 'Collaborative Ground Segment' and 'Sentinel Data Products'. On the left side, there are sections for 'Access Points' and 'Welcome to the Sentinels Scientific/Other use Data Hub'.

## 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 data 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

### 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 are 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 : gue**

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 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, ie. 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.

## 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 colour with high accuracy.

[Read more](#)

### 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](#)

### 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

### 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

### Collaborative Ground Segment

### Sentinel Data Products

### Latest Results

- ERS and Envisat multitemporal interferometric analysis to characterize

# Sentinel data access tools @ ESA



**Data Hub Web graphic Interface**  
<http://scihub.copernicus>

**Open Data Protocol (OData)**

The Open Data Protocol (OData) enables the creation of REST-based data services, which allow resources, identified using Uniform Resource Identifiers (URIs) and defined in a data model, to be published and consumed by Web clients using simple HTTP messages.

The OData protocol provides easy access to the Data Hub and can be used for building GUIs for performing search queries and product downloads offering to the user the capability to remotely run scripts in batch mode.

**URI Components**

OData uses an OData service URI to identify the location of REST-based data services, which allow resources, identified using Uniform Resource Identifiers (URIs) and defined in a data model, to be published and consumed by Web clients using simple HTTP messages.

**URI Components**

OData uses an OData service URI to identify the location of REST-based data services, which allow resources, identified using Uniform Resource Identifiers (URIs) and defined in a data model, to be published and consumed by Web clients using simple HTTP messages.

APIs scripting automatic interface: for data

## SNAP Sentinel toolbox

**Data Hub Server available as open source software**

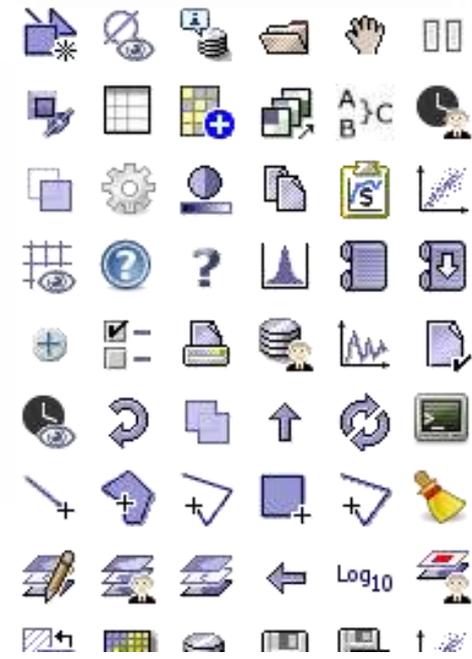
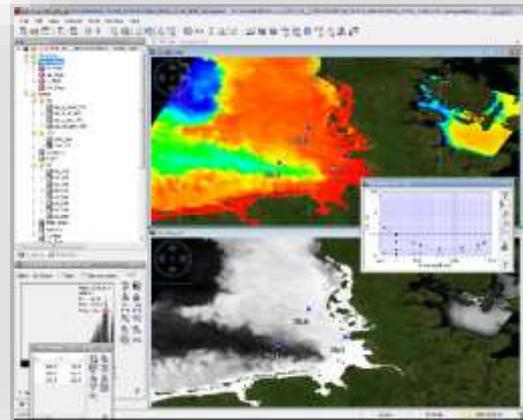
**Sentinel Toolbox available as open source software**  
<https://github.com/senbox-org>

<https://github.com/SentinelDataHub/DataHubSystem>

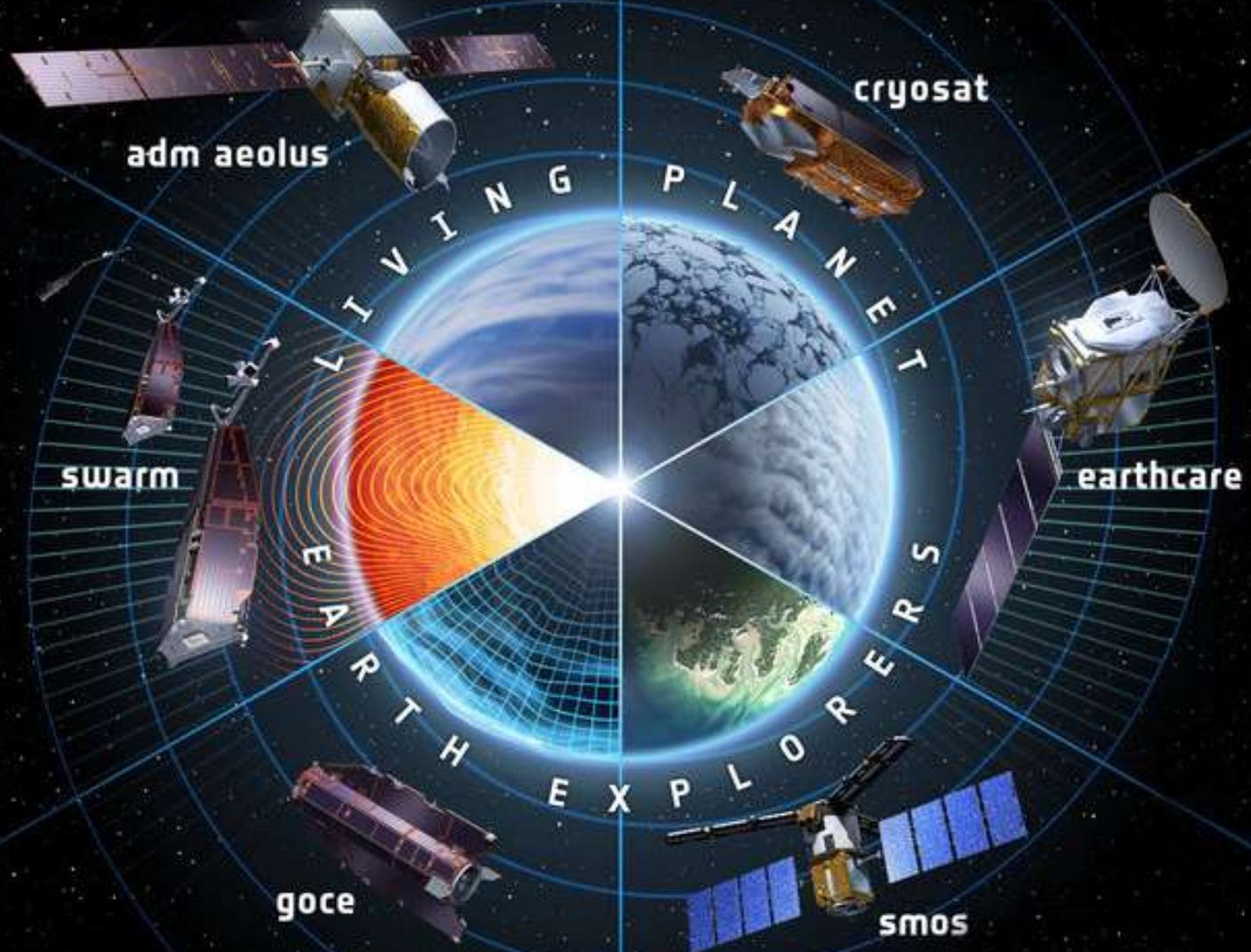
## Sentinel-3 Toolbox:

- Visualisation & processing of **Sentinel-3 OLCI and SLSTR data** and other optical data
- Uncertainty visualization and exploitation
- Remote in-situ database access
- Synergistic use of OLCI and SLSTR
- Various OLCI and SLSTR data processors

<http://step.esa.int/>



# Earth Explorer 9 Call for new Missions



# Earth Explorer 9 Call for new Missions: Now open at <http://explorercall.esa.int>



- Respond with new missions that scientifically address ESA's new Earth Observation Science Strategy, its key elements and strategic science goals
- Maximum industrial cost of 120M€ (at 2016 ec.) for the space segment and mission specific ground segment excluding launcher, operations, generic ground segment, level 2 processor and ESA internal costs.
- 31 Letters of intent and proposals due by 24<sup>th</sup> June 2016
- C-band Passive microwave radiometers are competing.

## The Earth Observation Envelope Programme



Call for Proposals for Earth Explorer Mission EE-9

# GHRSSST Project Office (GPO)



University of  
**Leicester**



- The GPO remains a cornerstone of the GHRSSST activity
- It is the glue that keeps GHRSSST together on a day-to-day basis
- Challenging job!
- ESA maintains funding at this moment
- Will be shared by EUM next year
- **A Director Role is required**



A new Statement of Work is being developed now – **please talk to Gary, Anne and Craig if you have specific comments to help the GPO provide the best support to your GHRSSST activities.**

# GHRSSST and the Science Team is an ambassador for SST in applications

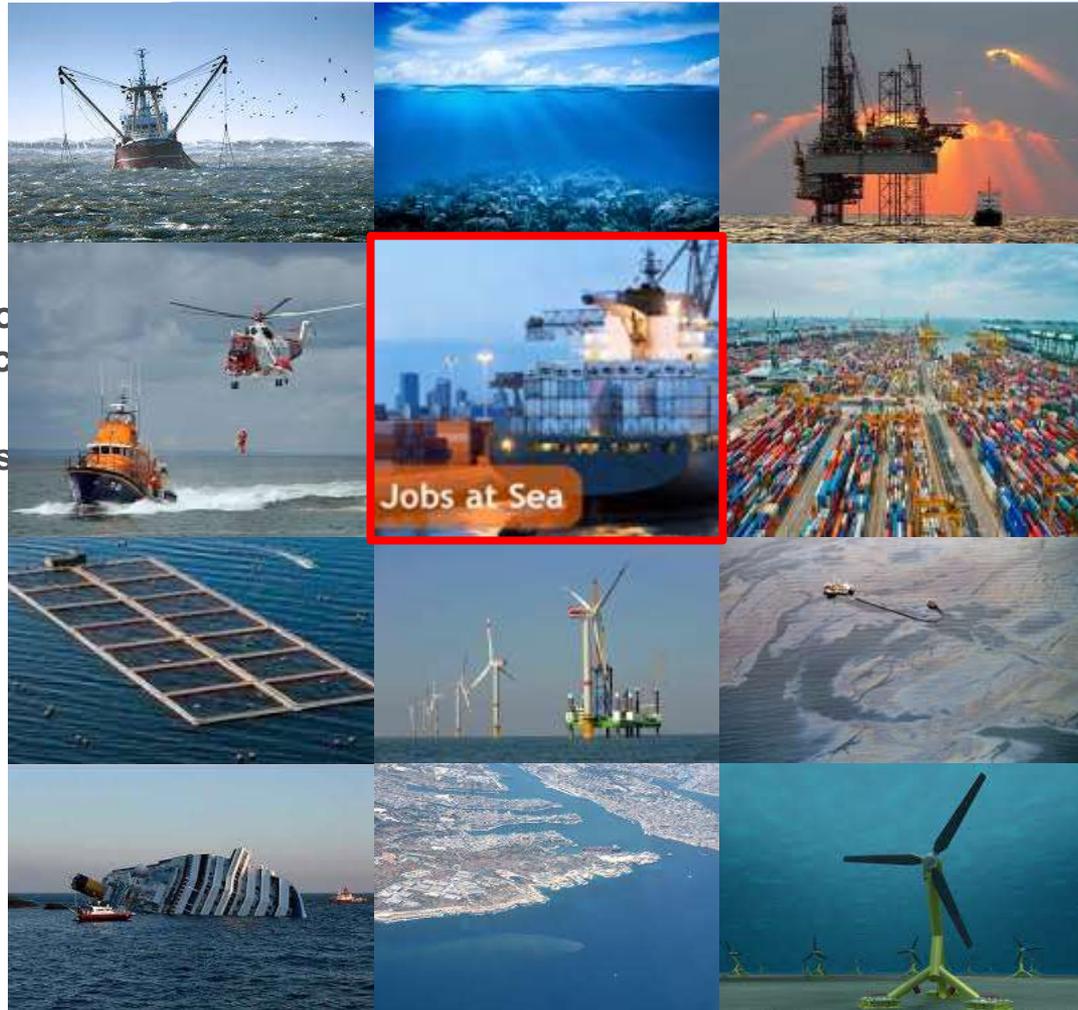


**We** need to demonstrate the impacts of our SST products  
**With** the end -user communities  
Suggest a GHRSSST User Applications Workshop in 2017?

# User Communities...



- Shipping
- Aquaculture and fisheries
- Offshore energy
- MetOcean Services
- Oil and Gas Industries
- Numerical Weather Prediction and Numerical Ocean Prediction (NWP/NOP)
- Coastguard, Search and Rescue (GMDSS)
- Maritime Pollution services
- Ports and Harbours
- Hydrographic survey
- Insurance Industry
- Offshore sailing
- Ice Services
- Local authorities
- Government
- Space Agencies
- Defence agencies



# Sentinel-3a launch from Plesetsk Cosmodrome 16<sup>th</sup> February 2016





# Thank you - any questions?

For more information <http://www.esa.int>

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