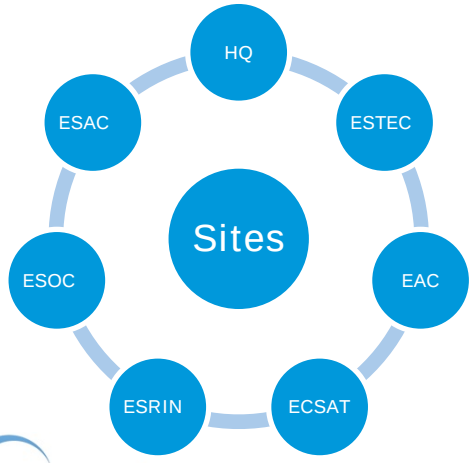
Copernicus – Sentinel-1

Y.-L. Desnos, P. Potin, M. Foumelis,
N. Miranda, B. Rosich-Tell M. Engdahl

What is ESA?

"To provide for and promote, for exclusively peaceful purposes, cooperation among European states in **space research** and **technology** and their **space applications.**" (Art. 2 ESA Convention)



Copernicus

Copernicus
Components & Competences

Coordinators:

Partners:

European Commission

Overall Programme Coordination

Space Component

Services Component

In-Situ Component

esa

European Commission

EEA

Industries

Private companies

National Space Agencies

Eumetsat

Service operators

National environmental agencies

Copernicus Space Component
Role of ESA

- **Coordinator of overall Copernicus Space Component**
  - Definition of overall architecture and plan for future evolutions
  - Coordinating access to Copernicus missions from national, EUMETSAT and third party satellite owners
- **Development and procurement Agency for dedicated space infrastructure**
  - Development of first spacecraft and Ground Segment
  - Procurement of recurrent elements
- **Operator of Sentinel-1, Sentinel-2 and Sentinel-3 (land)**
  - EUMETSAT is operator of Sentinel-3 (marine), Sentinel-4, Sentinel-5 and Sentinel 6 (Jason)

Copernicus Services Component

Atmosphere

Climate Change

Emergency Management

Land

Marine

Security

Services Component

Copernicus Sentinel Data Policy

Sentinel Data Policy = FREE and OPEN access

- Joint COM/ESA **Sentinel Data Policy Principles** have been prepared in 2009 - adopted by ESA MSs in Sep 2009
- **EU Delegated Act** on Copernicus Data and Information Policy has been published on 12 July 2013 (C(2013)4311, final)
- ESA will table a **Sentinel Data Policy** for approval by PB-EO in Sep 2013. Main principles of Sentinel data policy:
  - **Open** access to Sentinel data by anybody and for any use
  - **Free** of charge data licenses
  - Restrictions possible due to technical limitations or security constraints

Copernicus Sentinels

S1A/B: Radar Mission  2014/ 2016

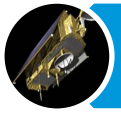
S2A/B: High Resolution Optical Mission 2015/2016

S3A/B: Medium Resolution Imaging and Altimetry Mission 2015/2017

S4A/B: Geostationary Atmospheric Chemistry Mission 2019/2027

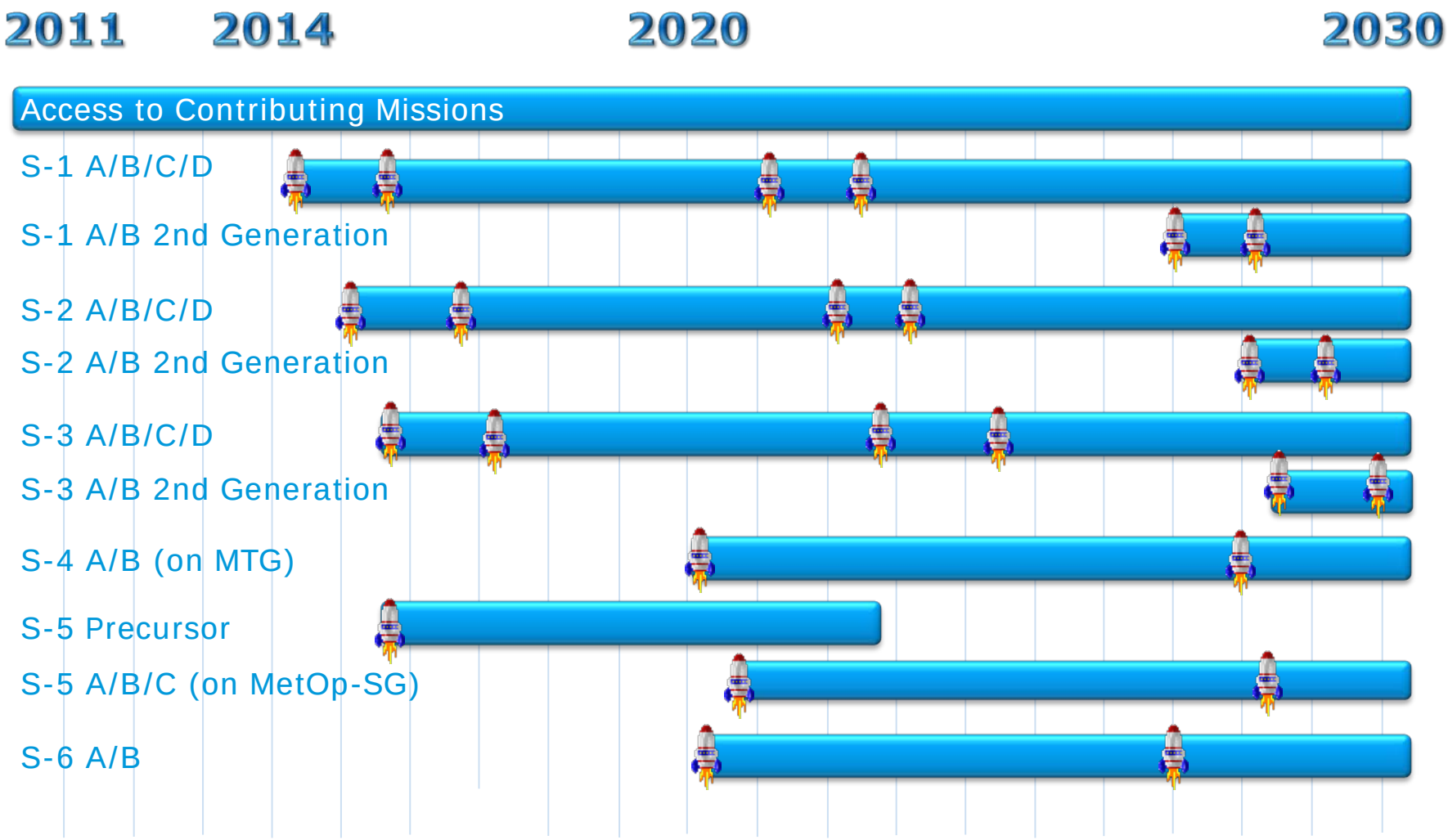
S5P: Low Earth Orbit Atmospheric Chemistry Mission 2016

S5A/B/C: Low Earth Orbit Atmospheric Chemistry Mission 2020/2027



S6-(Jason-CS) **A/B:** Altimetry Mission 2019/2025

… with a long-term operational perspective



Launch Sentinel-1A

- 3 April 2014
- Kourou spaceport
- Soyuz-2 rocket
- New era of Earth observation

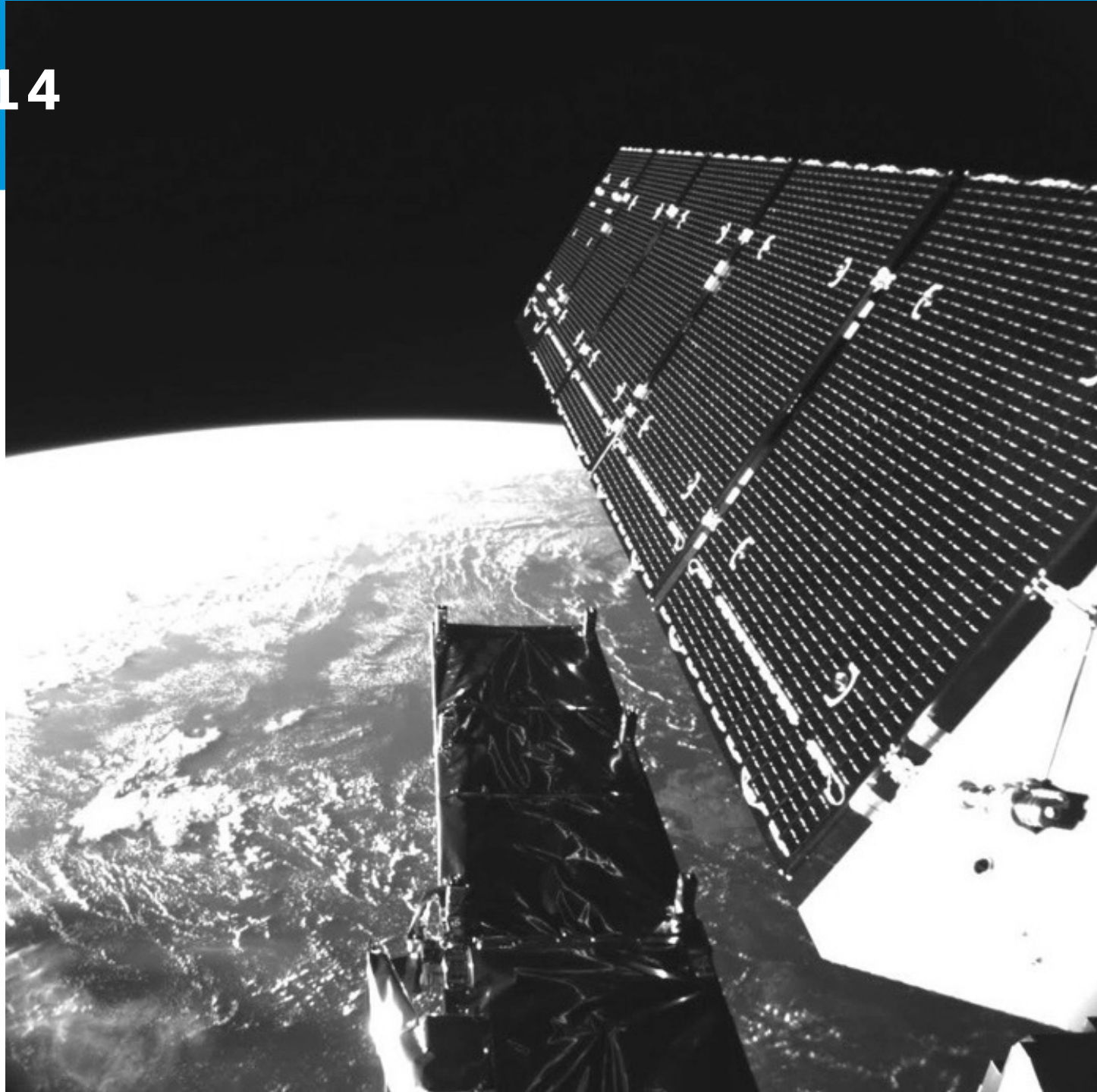
Launch - 3 April 2014


FOD
Flight Operations Director
Pier Paolo Emanuelli
Sentinel-1A Flight Operations Director

First Hours in Orbit

4 April 2014

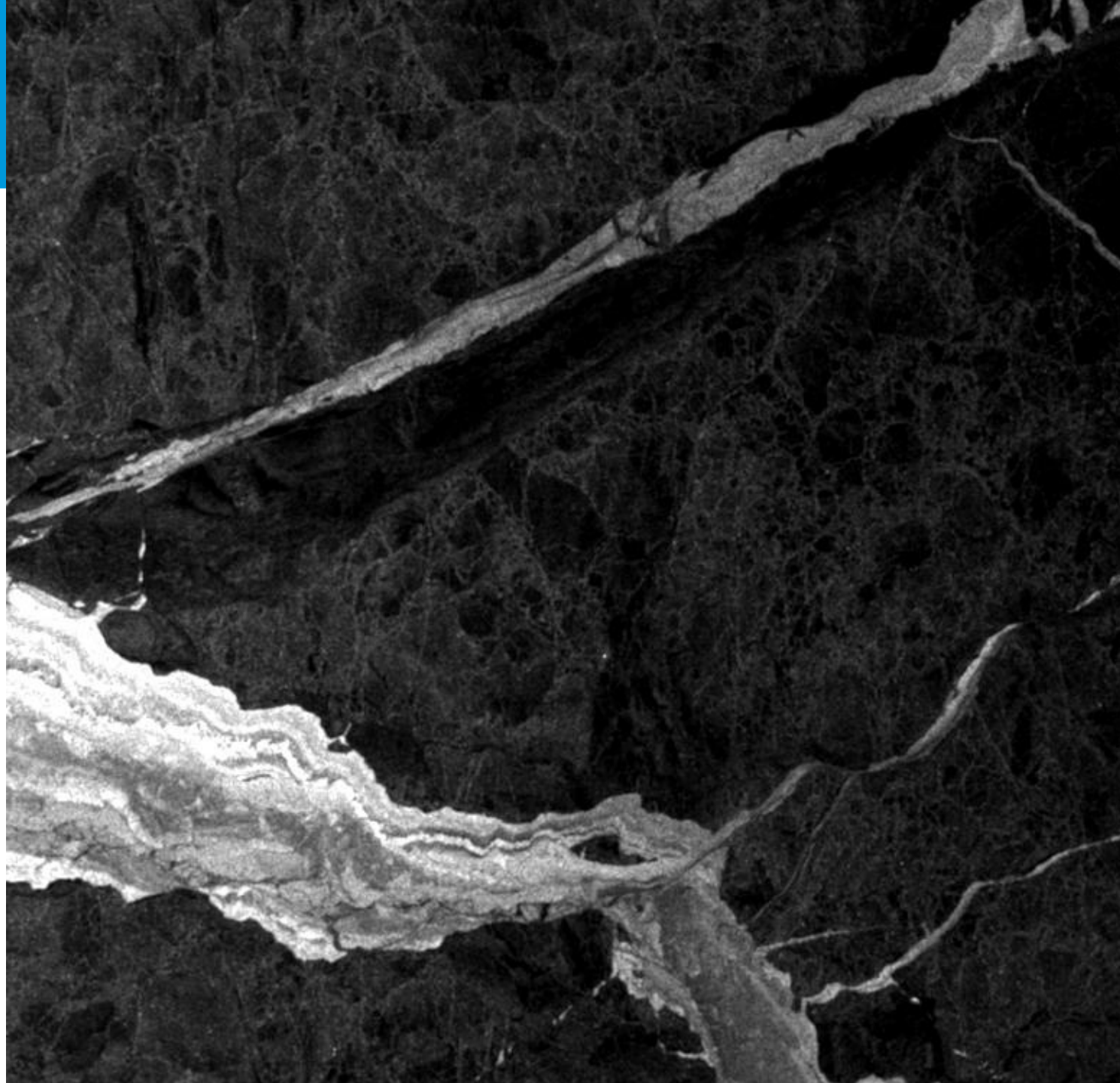
Sentinel-1A offers the world the first ever EO ‘selfie’



Copernicus

LEOP

1. Completed in three days as planned
2. All s/s were switched on
3. First X-band downlink in Matera (I)
4. First SAR acquisition occurred on 6 April at L+62h33’ (WM over Svalbard)

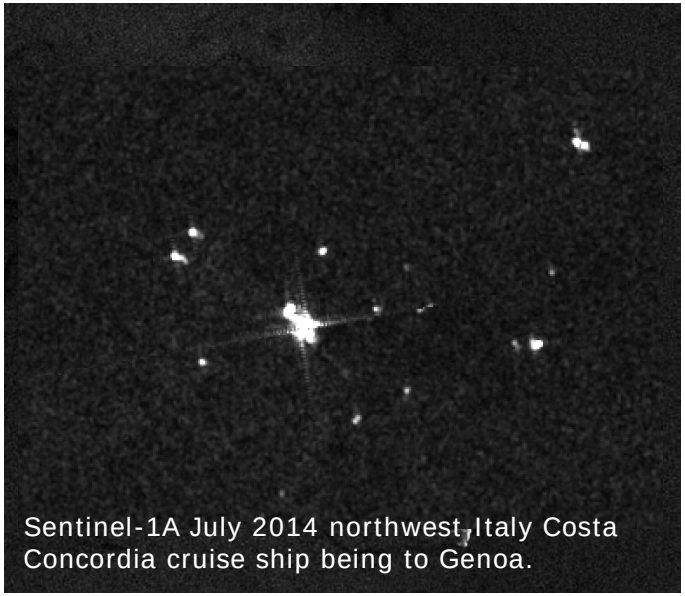


Sentinel-1 mission objectives

✓**Data continuity of ERS and ENVISAT missions**

✓ **Copernicus imaging radar mission for ocean, land, emergency applications:**

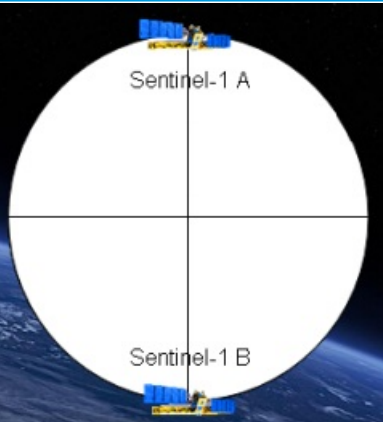
- monitoring sea ice zones and the arctic environment
- surveillance of marine environment (oil spill monitoring)
- maritime security (e.g. ship detection)
- wind, wave, current monitoring
- monitoring of land surface motion (subsidence, tectonics, volcanoes)
- support to emergency / risk management and humanitarian aid in crisis situations
- mapping of land surfaces: forest, water and soil, agriculture, etc.



Sentinel-1A July 2014 northwest Italy Costa Concordia cruise ship being to Genoa.

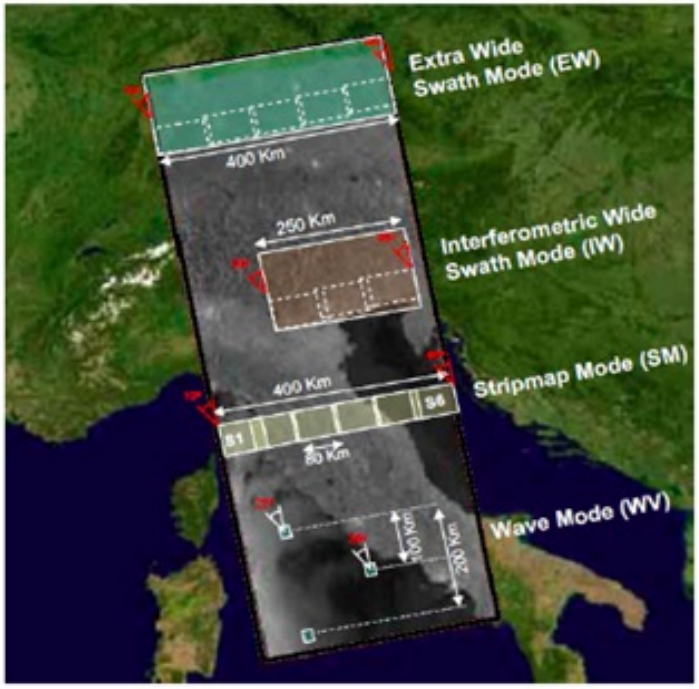
Sentinel-1
Mission Overview

- Two satellites
- C-band Radar instrument
- Sun-synchronous orbit at 693 km altitude
- Inclination: 98.18°
- 7 years lifetime
- Consumables for 12 years
- Mean LST: 18:00h at ascending node
- 12-day repeat cycle at Equator (with 1 satellite)
- 96h operative autonomy



Sentinel-1
SAR Operational Modes

Operational Modes

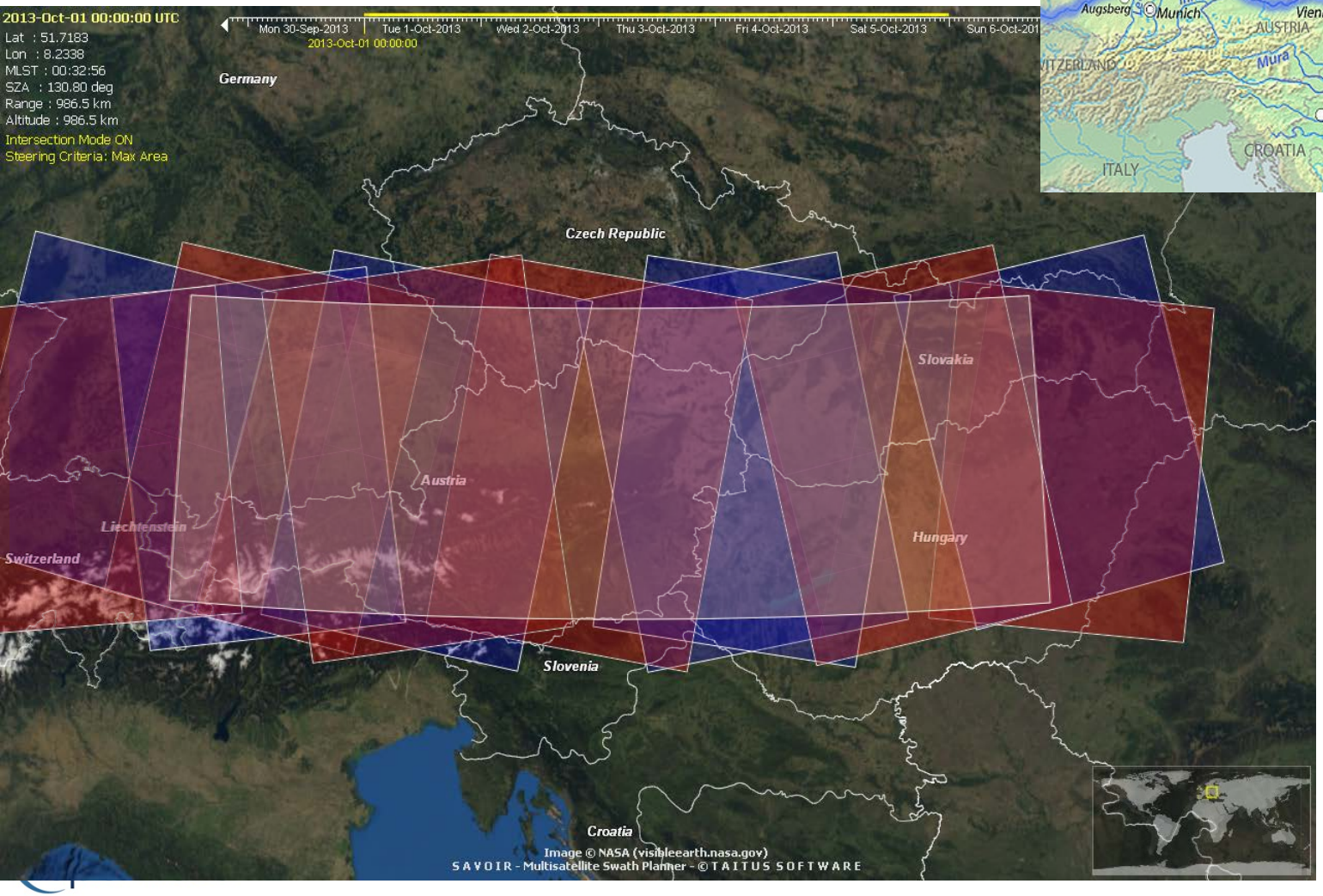


Resolution	Swath Width	Polarisation
20 x 40 m²	> 400 km	HH+HV or VV+VH
5 x 20 m²	> 250 km	HH+HV or VV+VH
5 x 5 m²	> 80 km	HH+HV or VV+VH
5 x 5 m²	20 x 20 km² at 100 km spacing	HH or VV

- **Daily coverage of high priority areas, e.g. Europe, Canada, shipping routes**

Sentinel-1
Improved spatial coverage

Sentinel-1 vs. ENVISAT 5-day coverage

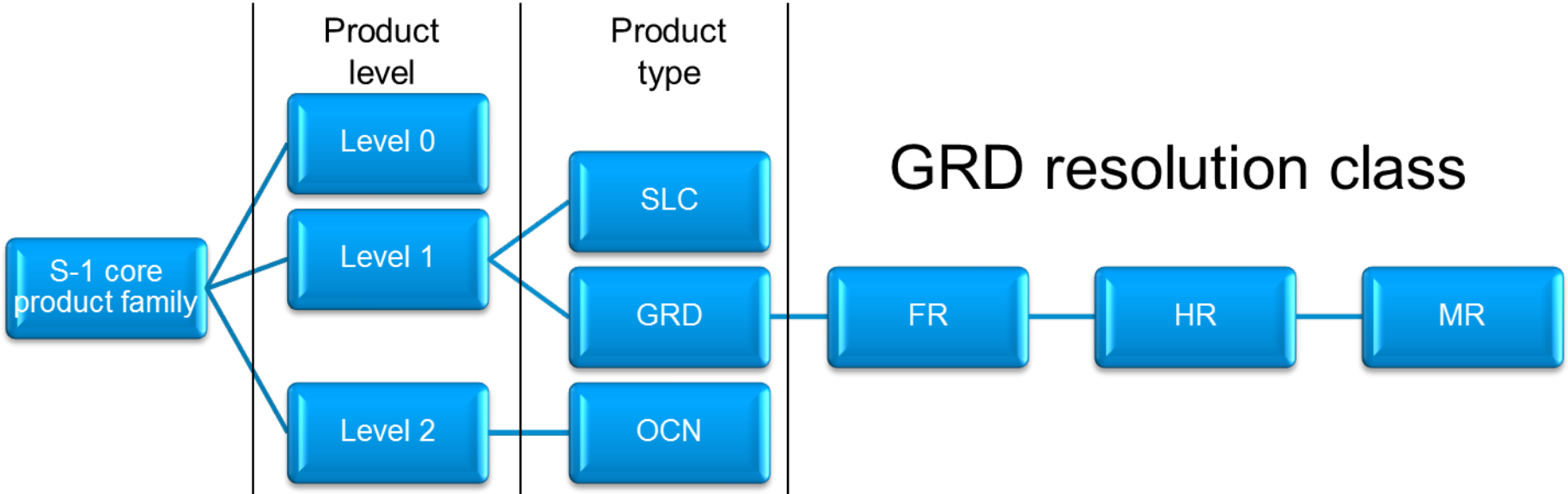


Until 2012:
ENVISAT

2014+:
Sentinel1A

2015+:
Sentinel1A/B

S-1 Product Family



Acquisition Mode	L0/1/2	Product type	GRD_FR	GRD_HR	GRD_MR
SM	✔	✔	✔	✔	✔
IW	✔	✔		✔	✔
EW	✔	✔		✔	✔
WV	✔	✔			

Sentinel-1 Systematic acquisition & production concept

Visibility of observation scenario through Discovery Service

Observation Scenario
(implementation of observation scenario within the available spacecraft and GS resource)

S1 Ground Segment

Regular Satellite tasking

Regular Instrument sensing

Regular Data acquisition

DAP/ HLOP

Observation needs

COPERNICUS Users

Sentinel-1 Systematic acquisition & production concept

Regular access to operational S1 PDGS products for predefined data sets through Discovery and Download services

COPERNICUS Users

DAP/ HLOP

Systematic production needs

S1 Ground Segment

S1 systematic L0/L1/L2 production rules

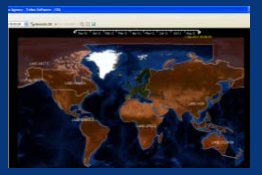
S1 data acquisition

S1 data downlink

GRD-MR NRT-1h (Data Set A)

GRD-MR NRT-3h (Data Set B)

WV L2-OCN NRT-3h (Data Set C)



GRD-MR Fast24 (Data Set D)

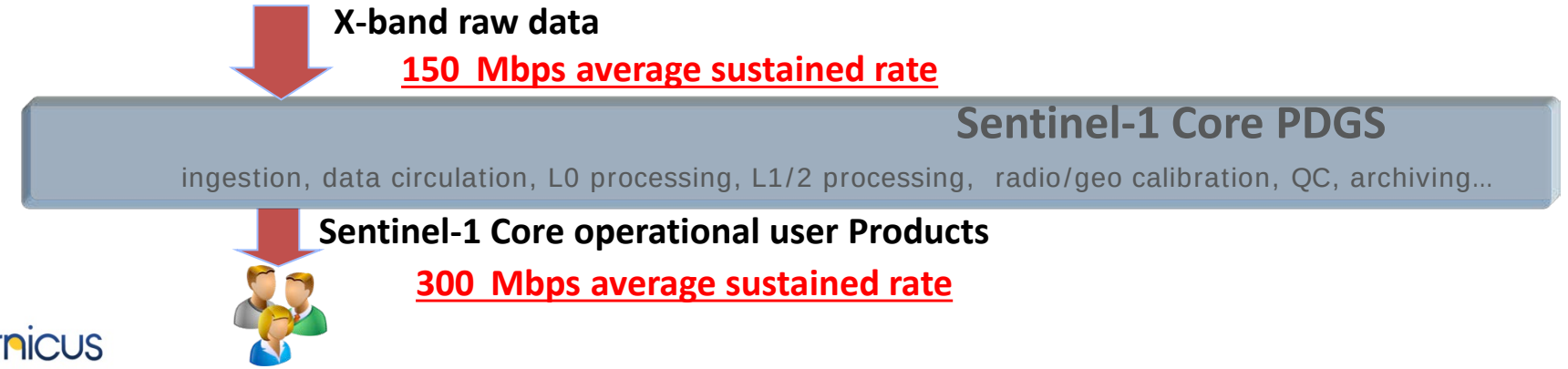
SLC Fast24 (Data Set E)

. . . .

Sentinel-1: un-precedent data volume

With the Sentinel-1 instrument characteristics and mission operations concept, data volume handling is a major challenge both for Ground Segment operations and also for user data access and management

- Systematic generation of **Level-0 products: about 1.5 TB per day** (both satellites) to be generated, real time quality checked and archived
- Systematic processing to **Level-1 products: about 1.7 TB per day** (both satellites) to be generated, real time quality checked and archived
- **To be disseminated to users with an on-line data access**



Sentinel-1 Observation Scenario

Observation scenario candidates (subsets of the requirements database)

SIMULATOR

Technical mission constraints:

- SAR duty cycle
- Inter-SAR-mode transition times
- Downlink constraints
- (...)

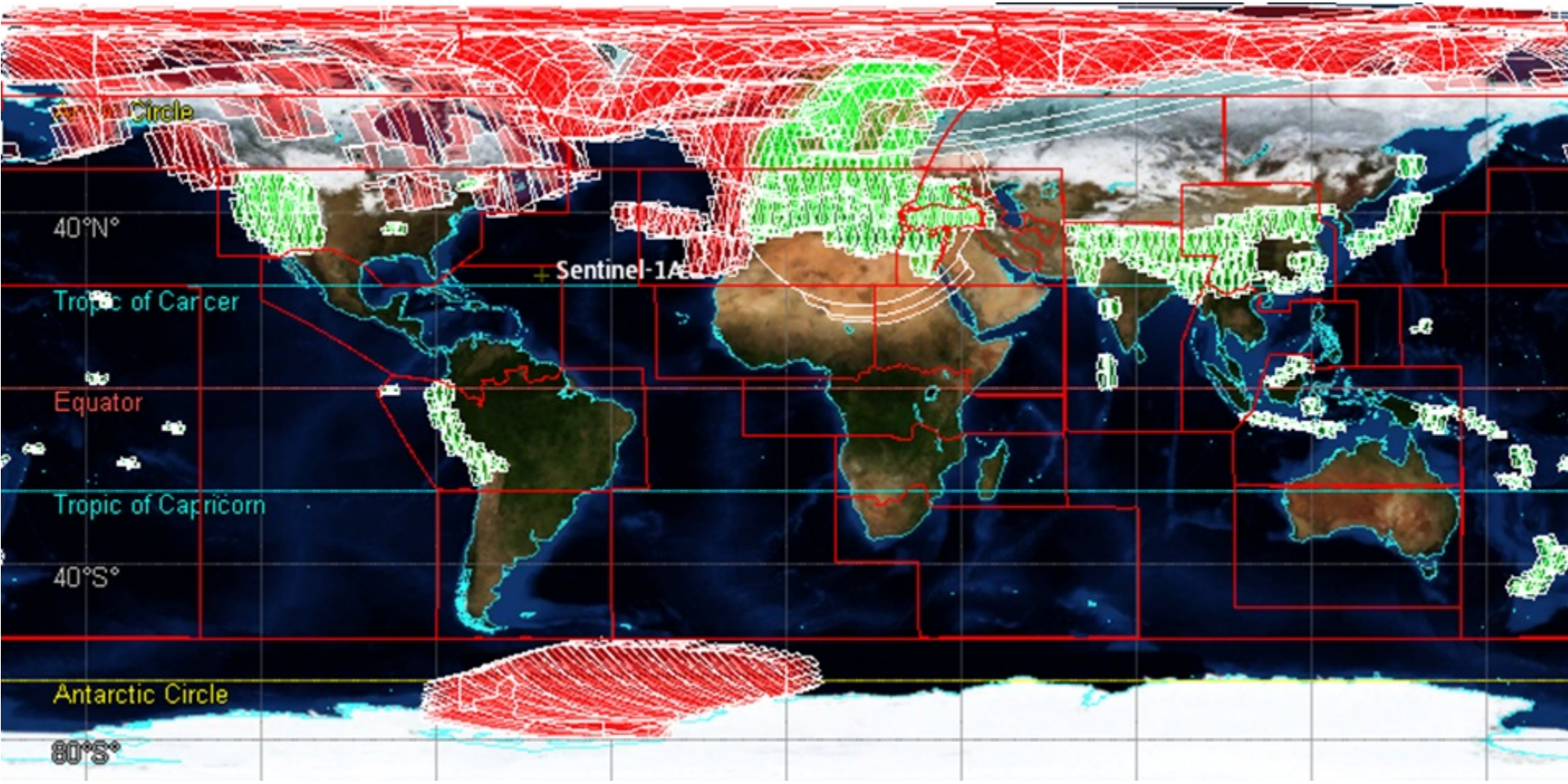
SIMULATOR

Consolidated observation scenarios on a cycle basis

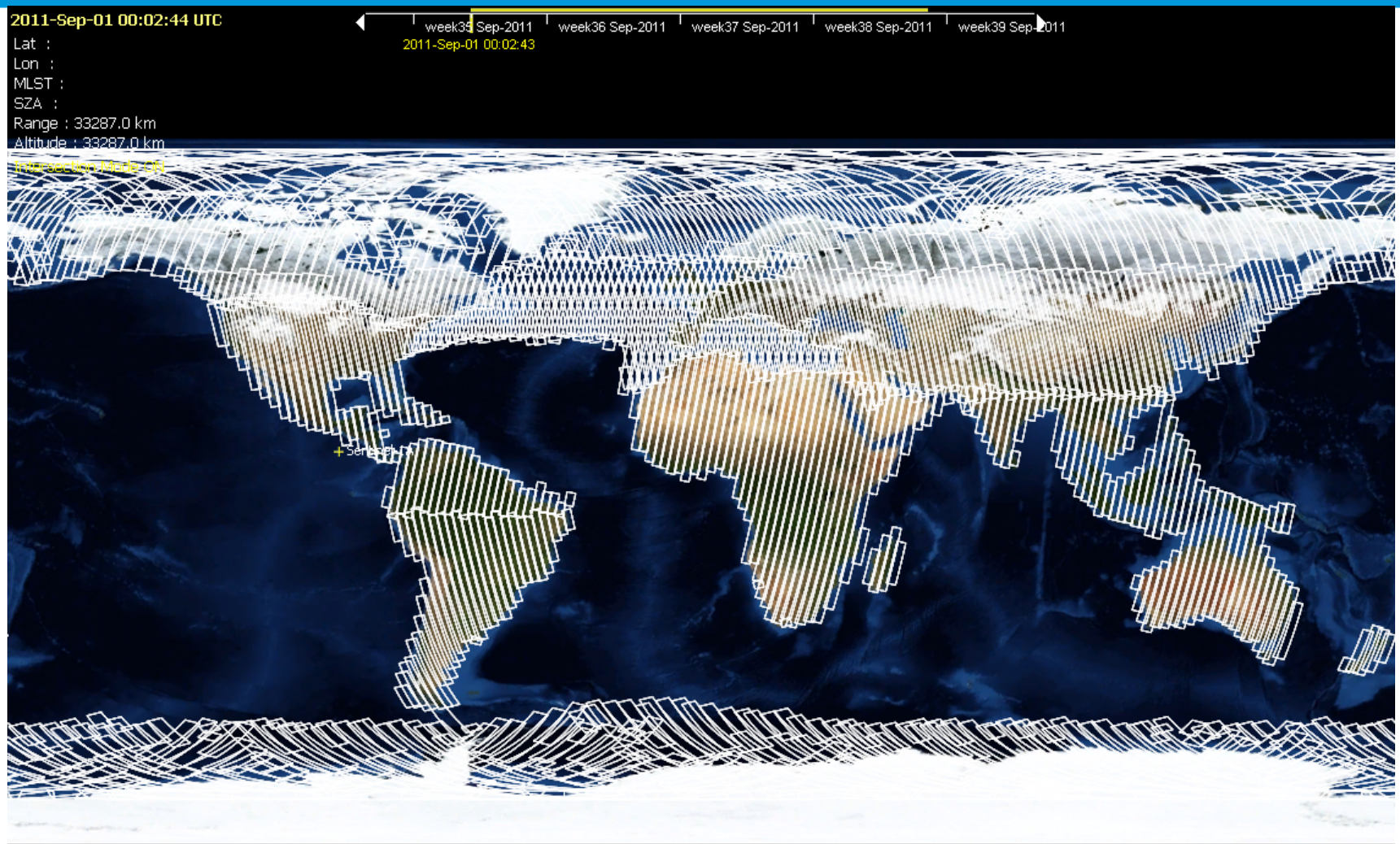
Sentinel-1

Observations plan for cycles 1 & 2 after IOCR

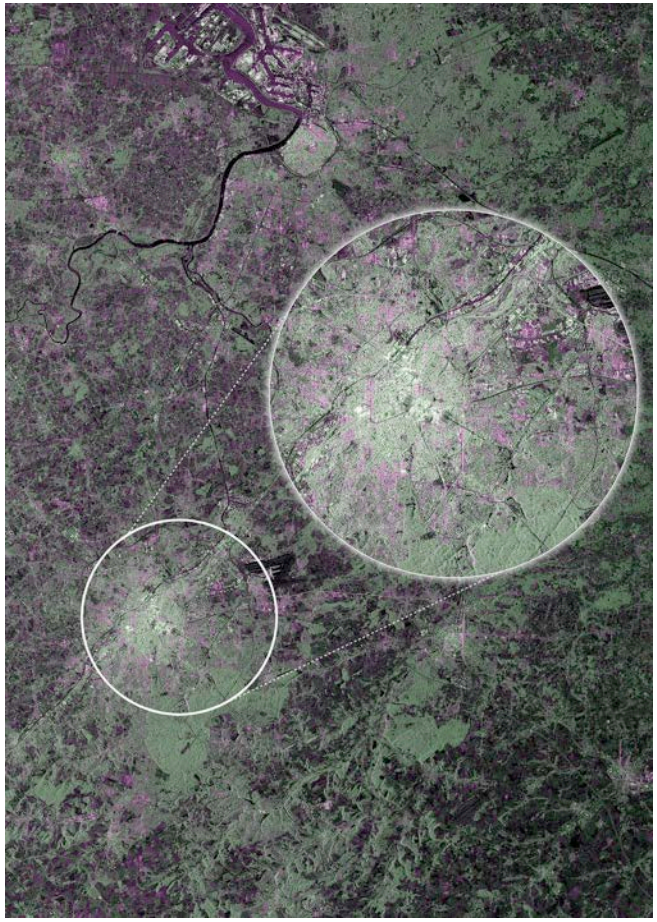
Indicative observations plan for cycles 1 & 2 after IOCR (acquisitions over 1 repeat cycle)

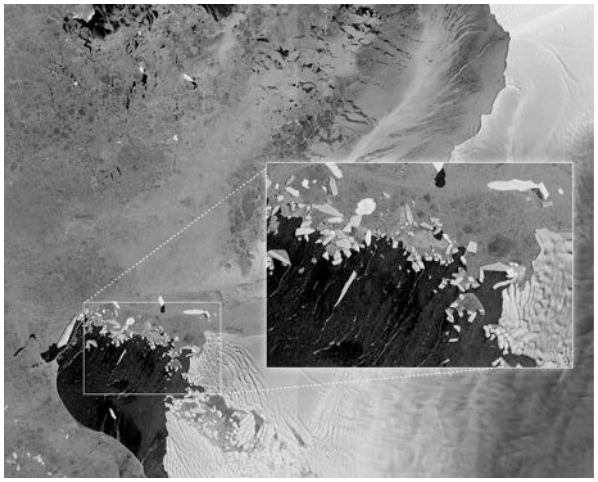


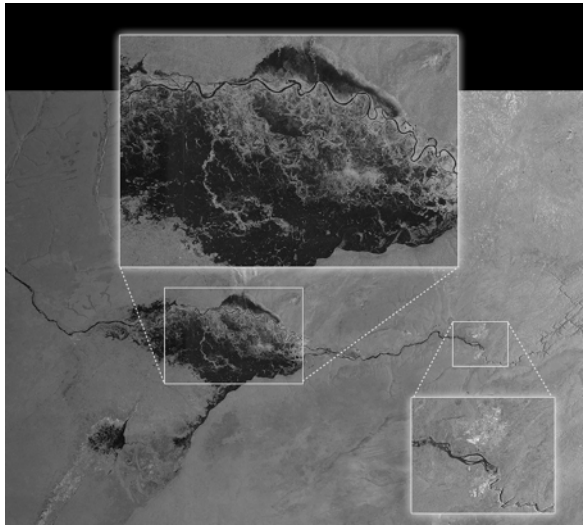
Sentinel-1
Observation plan during Full Operations



SENTINEL-1A FIRST IMAGES





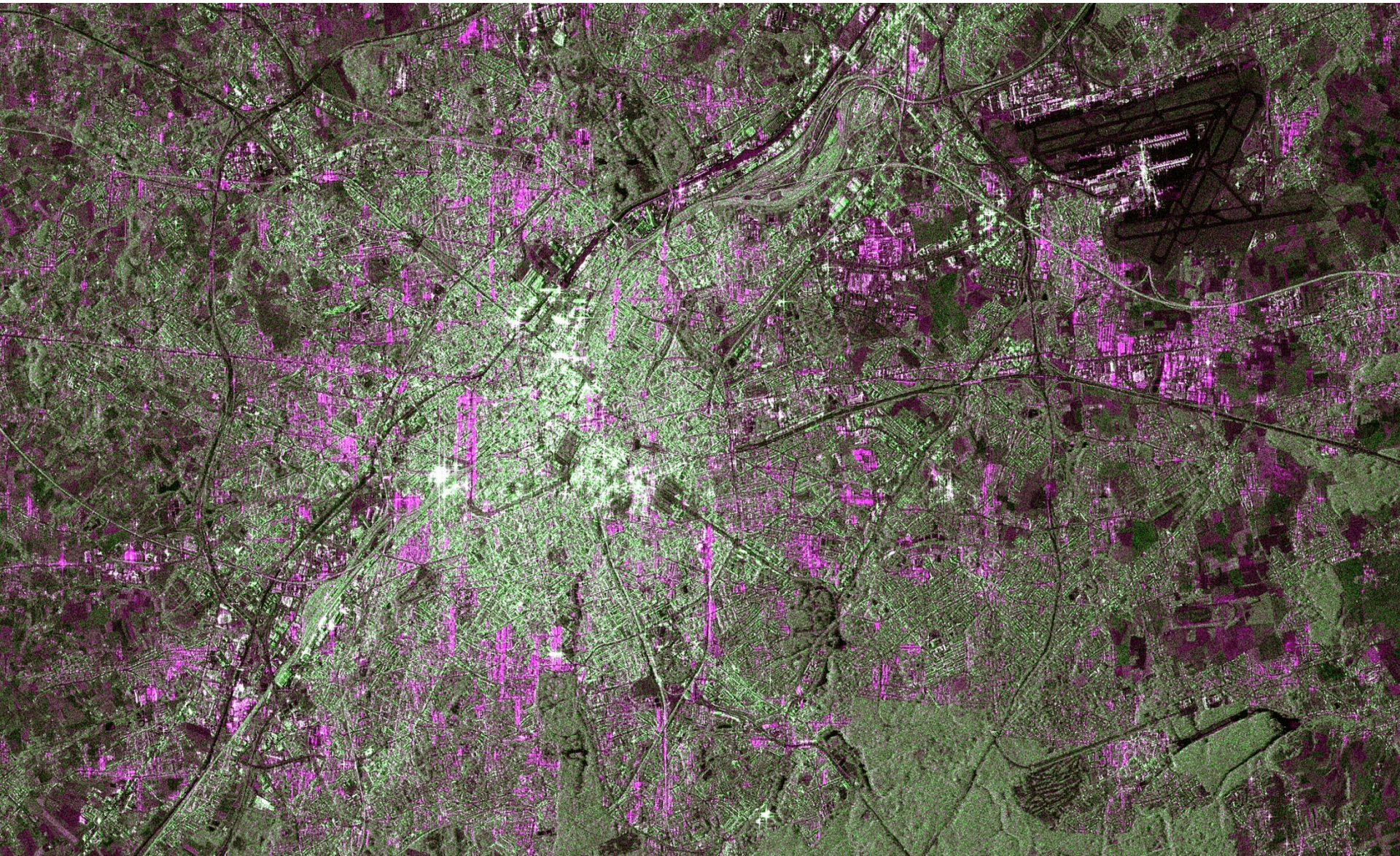


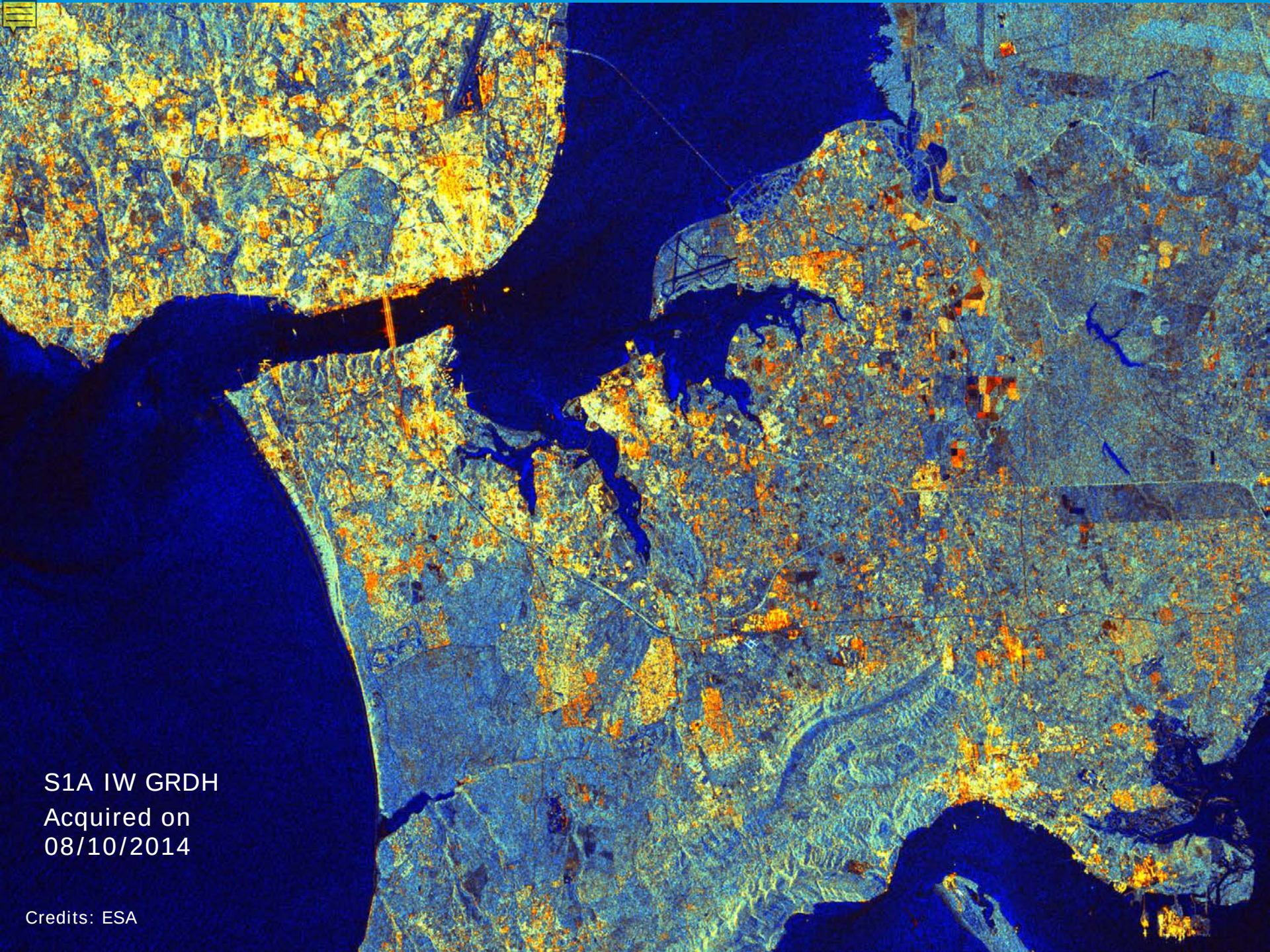
Land

Land Cover
Crop monitoring, Forest, Food Security
… and New Promising Land Applications …

Harbour of Antwerp, Belgium

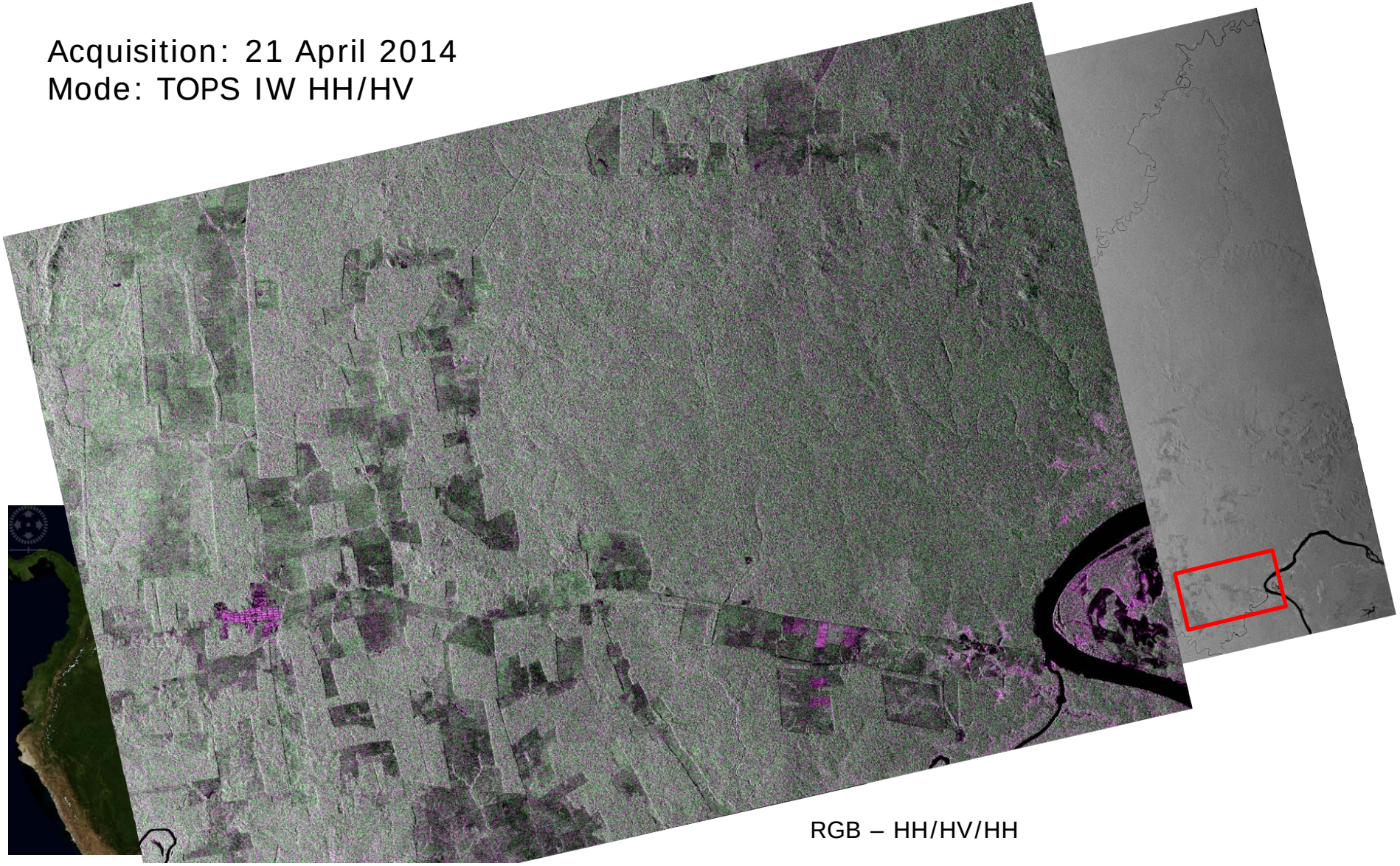
Brussels and Surroundings




S1A IW GRDH
Acquired on
08/10/2014
Credits: ESA

Sentinel-1A Deforestation over Brazil

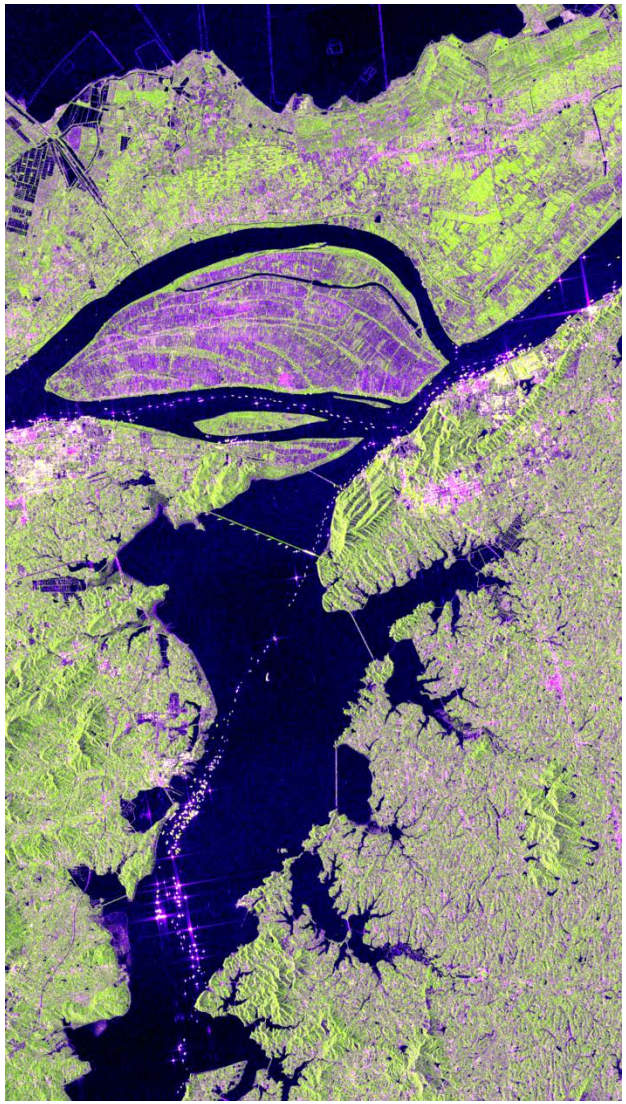
Acquisition: 21 April 2014
Mode: TOPS IW HH/HV

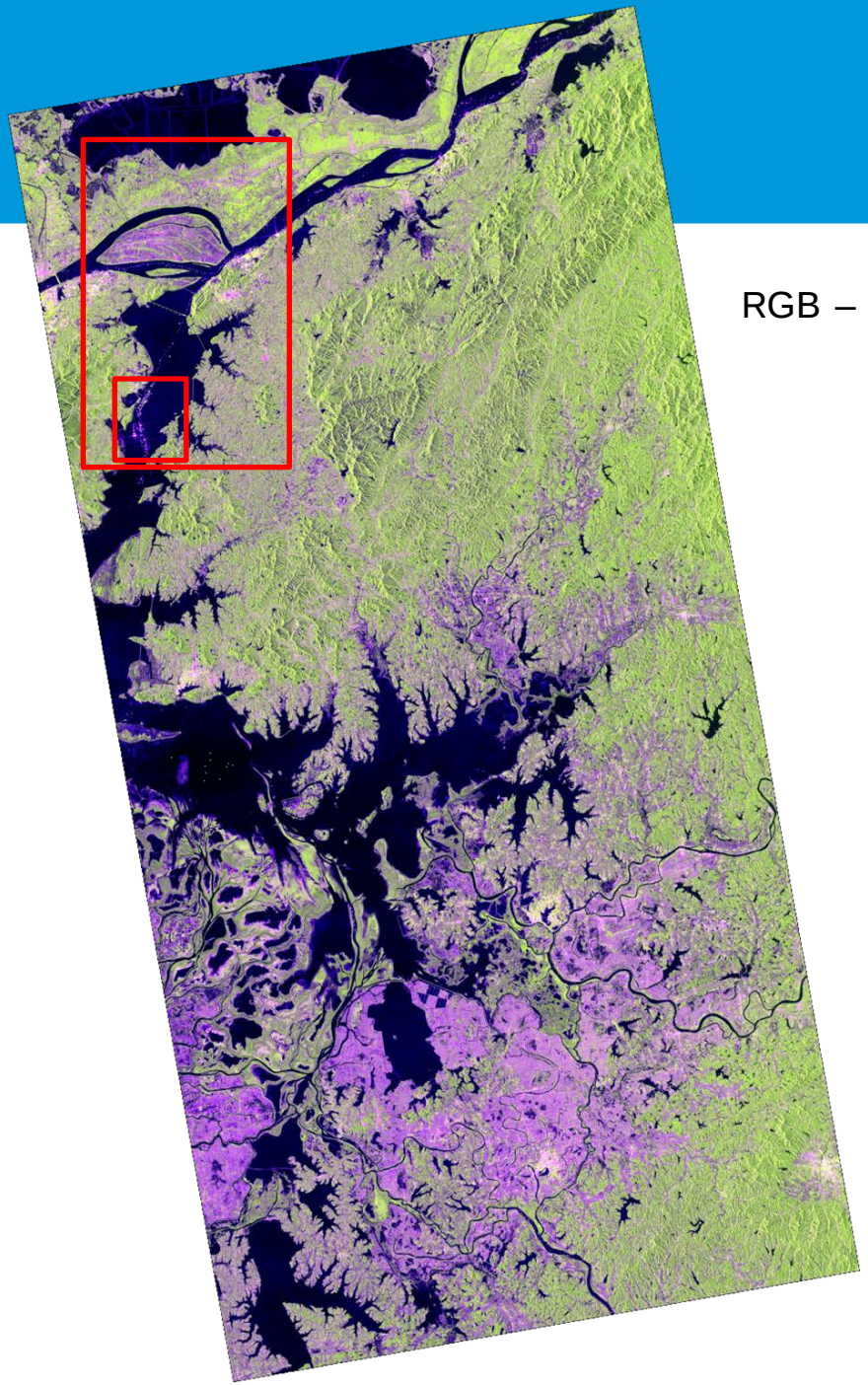


RGB – HH/HV/HH

S1A Polarimetric Composition

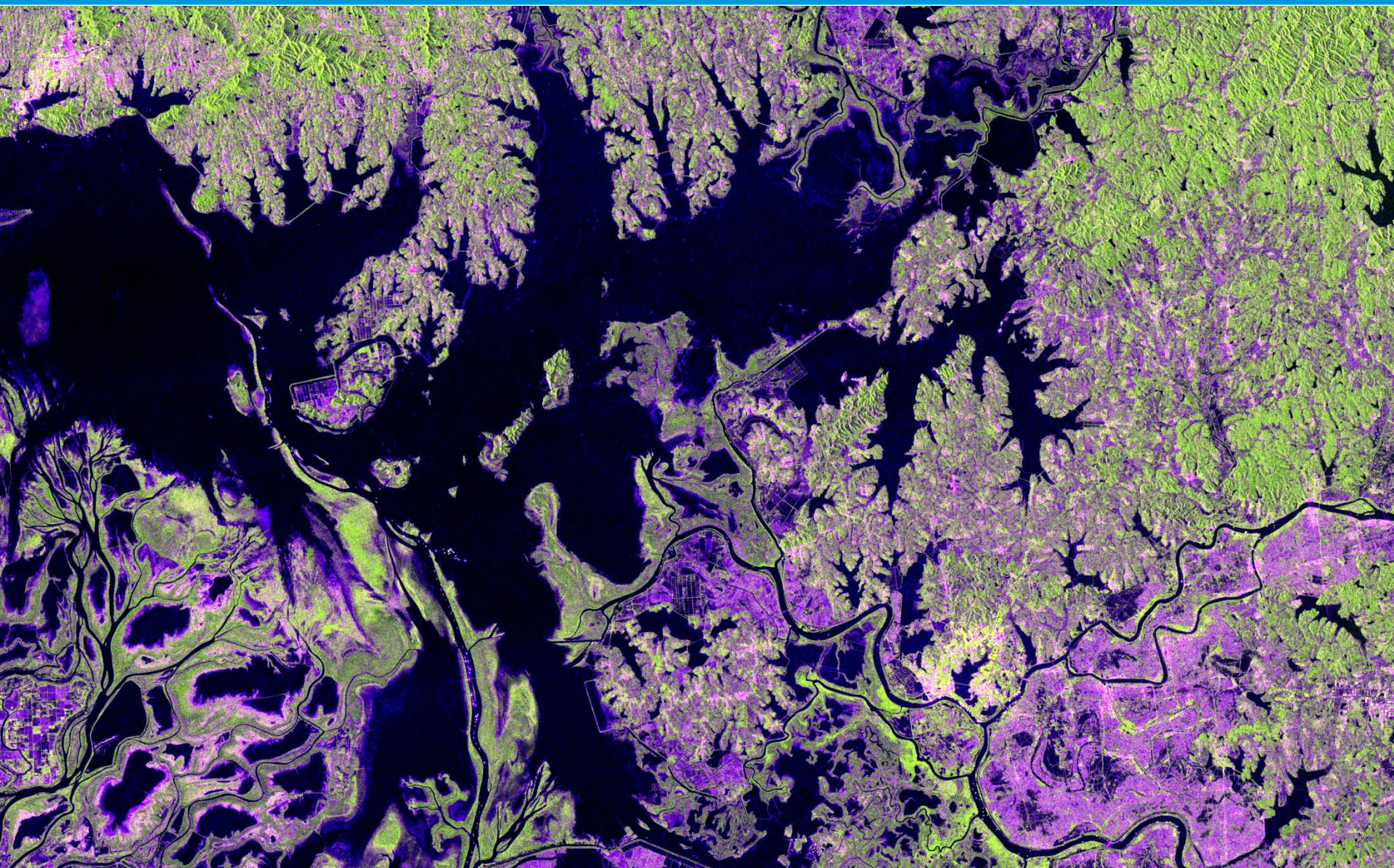
Poyang Lake



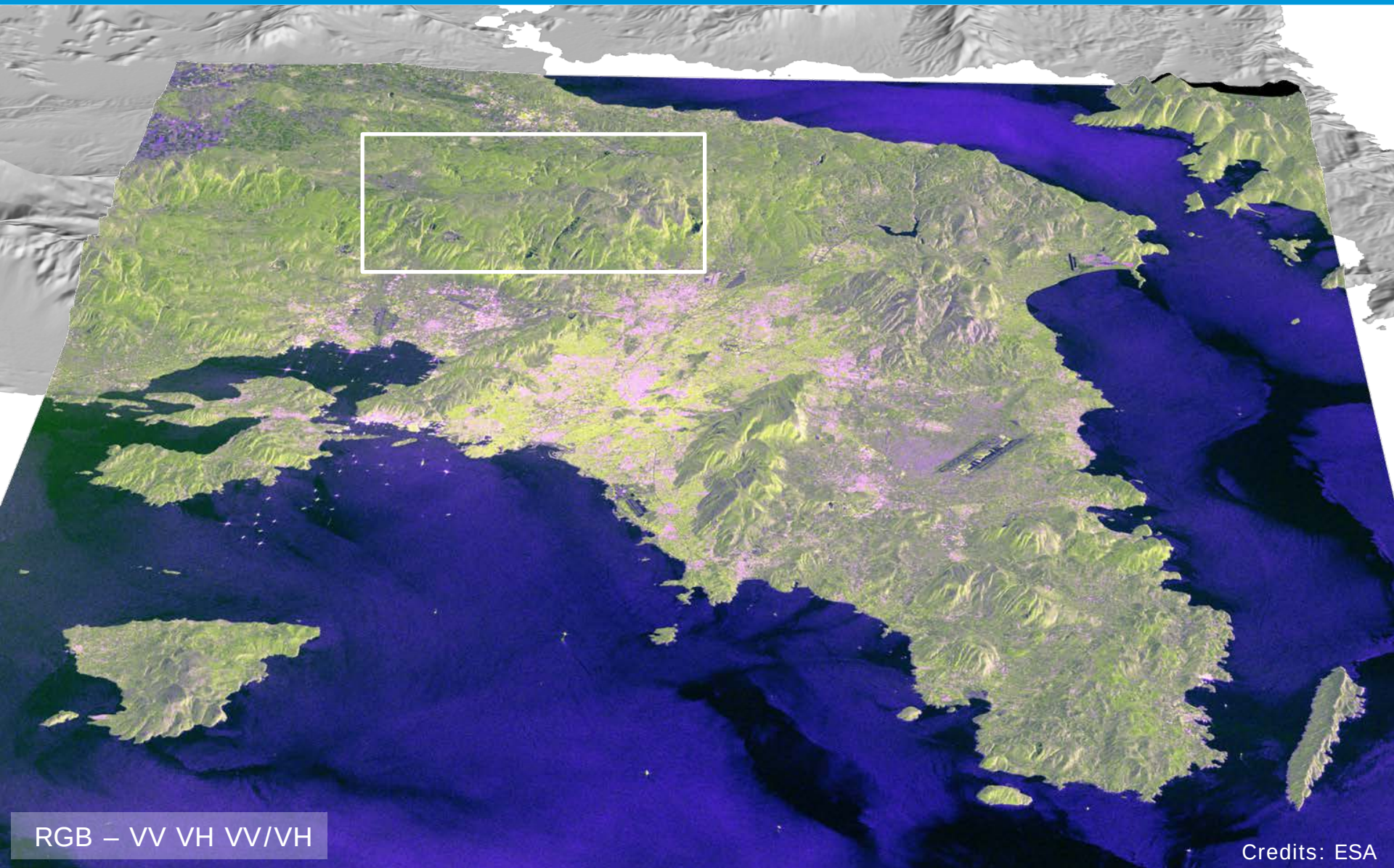


RGB – VV VH VV/VH

S1A Polarimetric Composition – Poyang Lake



Sentinel-1 TOPS Polarimetric Composite

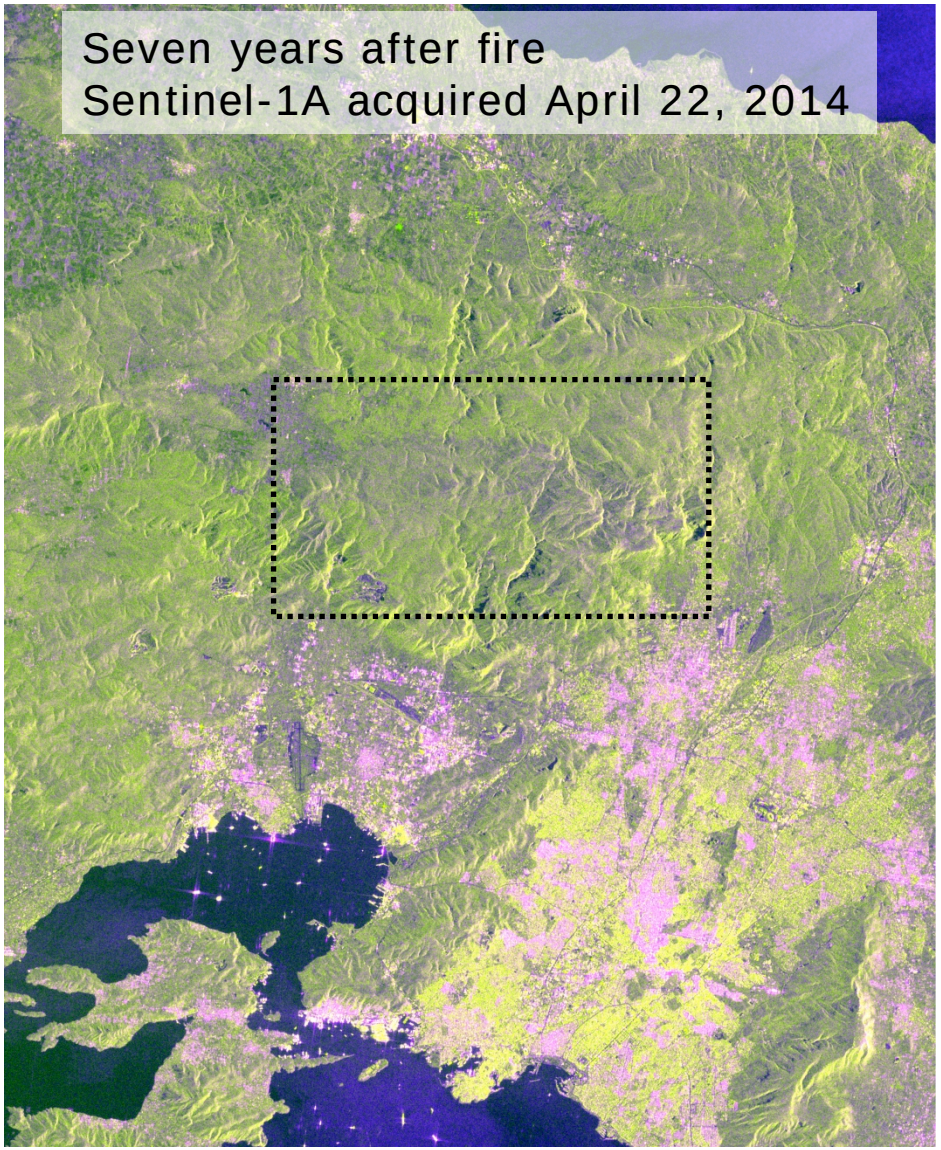


RGB – VV VH VV/VH

Credits: ESA

Vegetation Regeneration

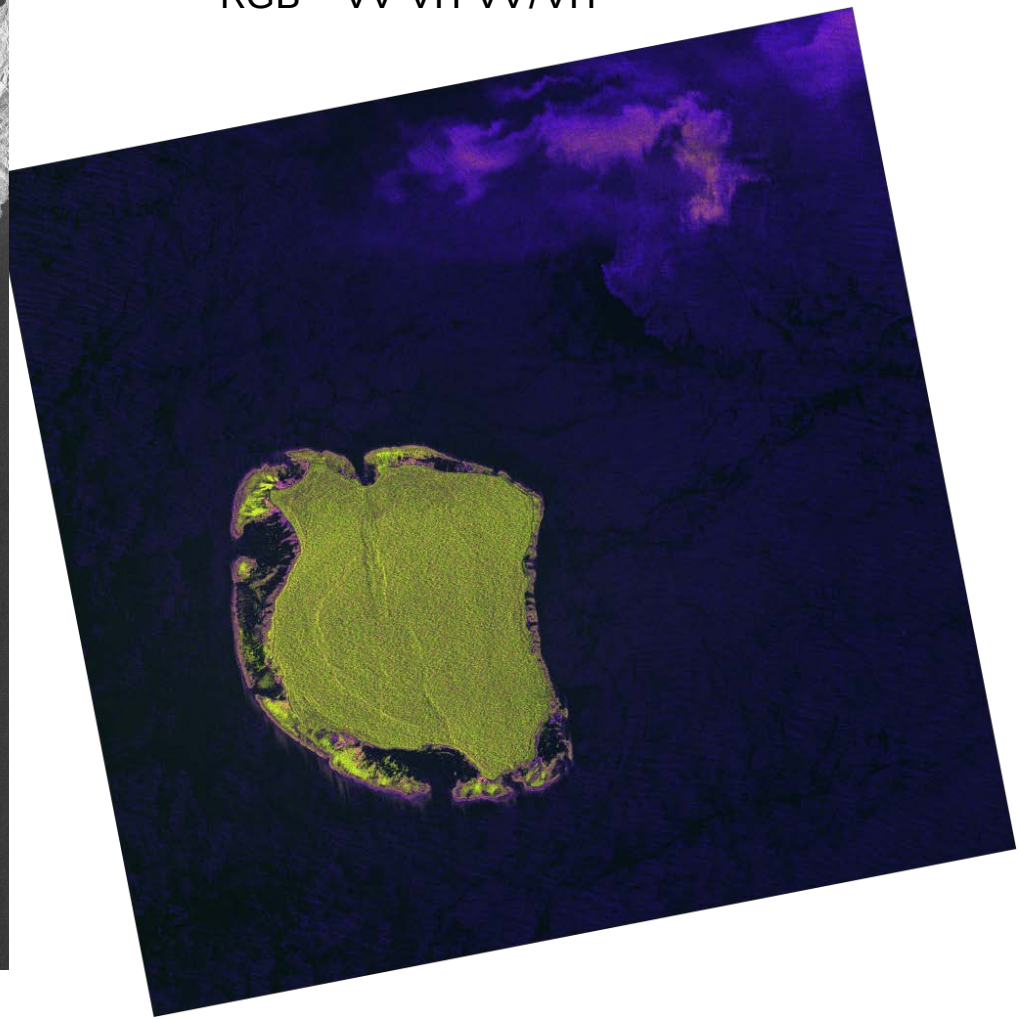
Burn Scar over Parnitha Mt. (Greece)

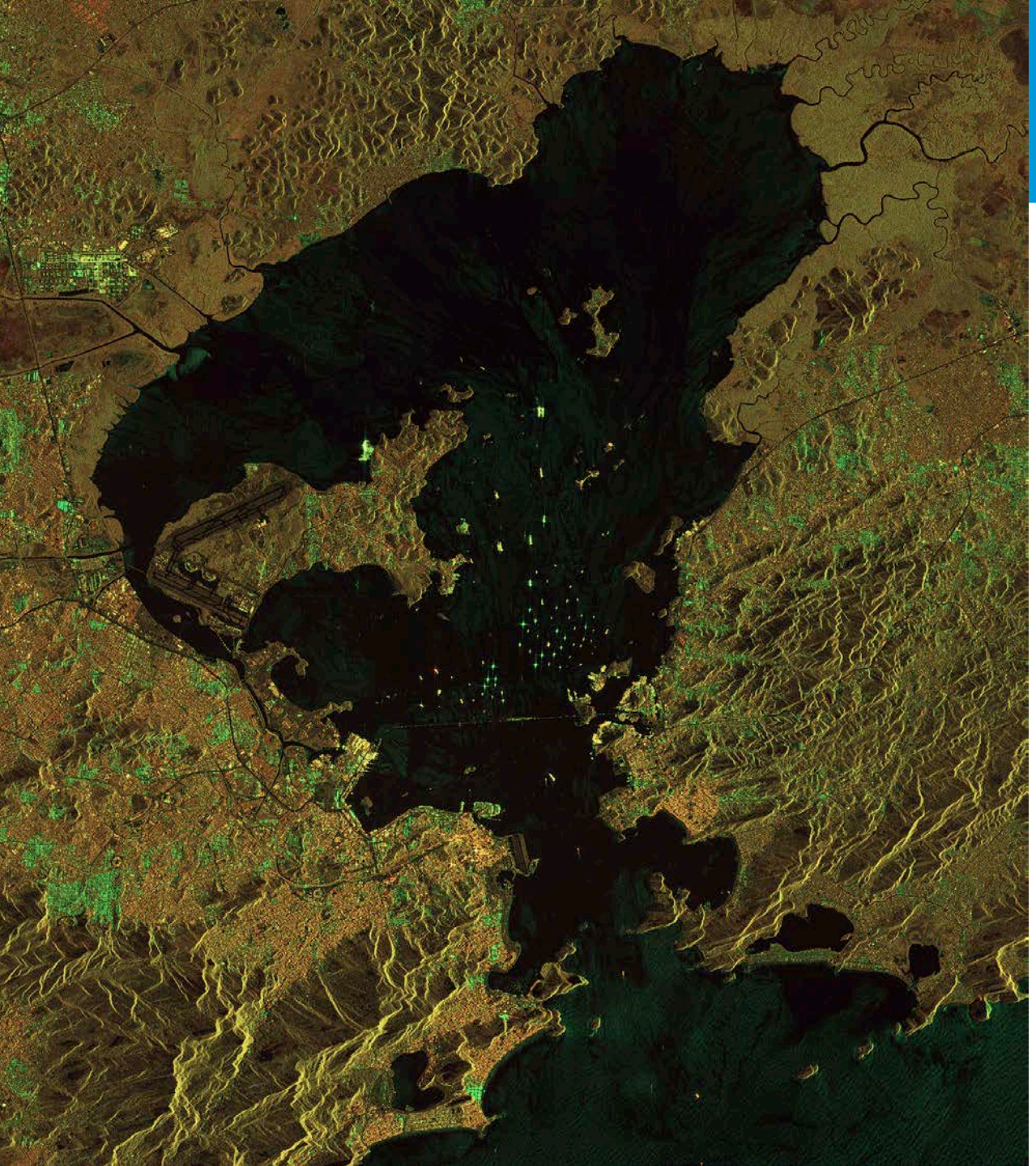


Sentinel-1A Island

S-1A Stripmap VV/VH

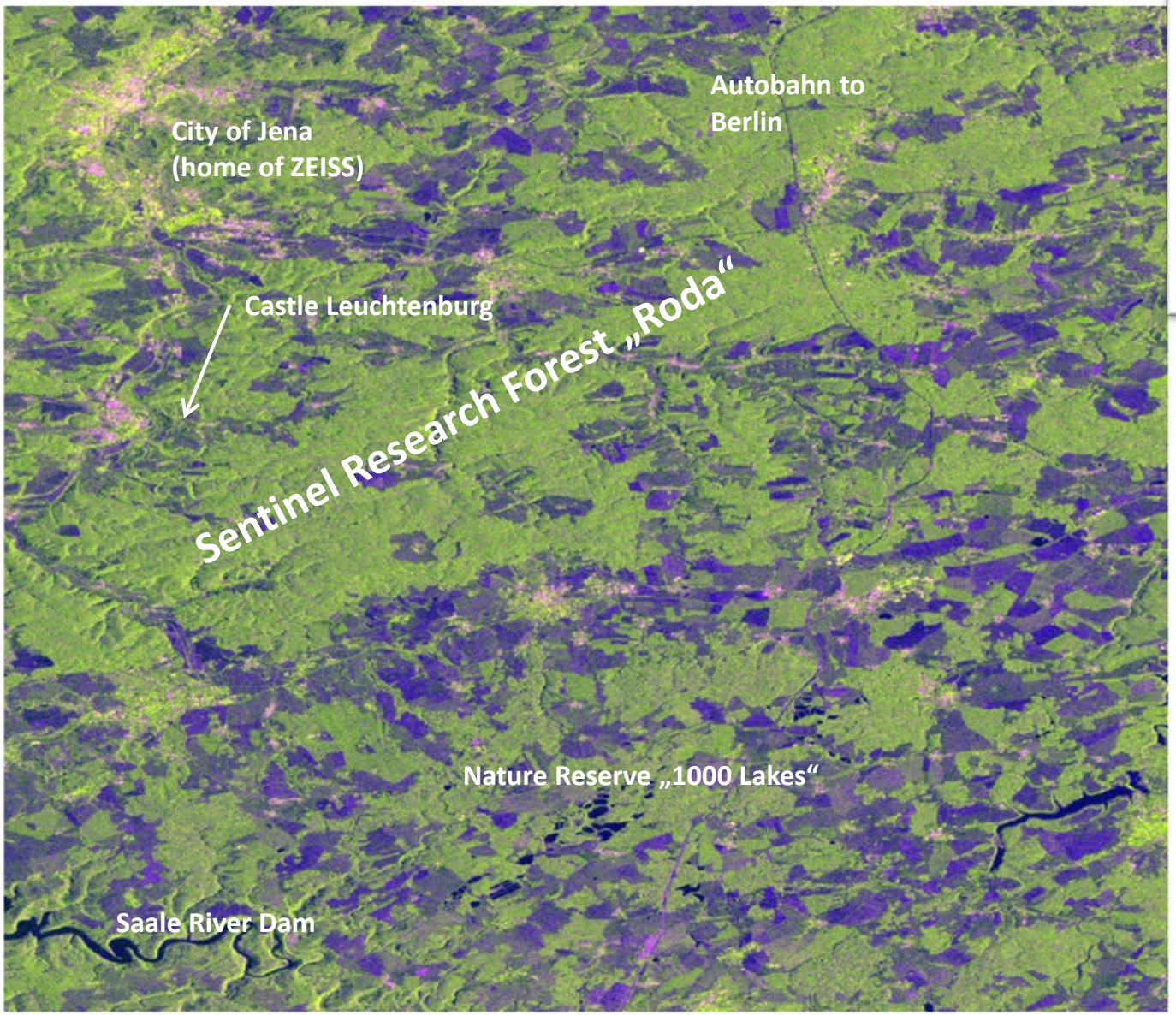
Polarimetric Composite
RGB - VV VH VV/VH





Guanabara Bay, Rio de Janeiro, Brazil

FIRST DEMONSTRATION OF LAND APPLICATIONS



Castle Leuchtenburg
(http://burgerbe.files.wordpress.com/)

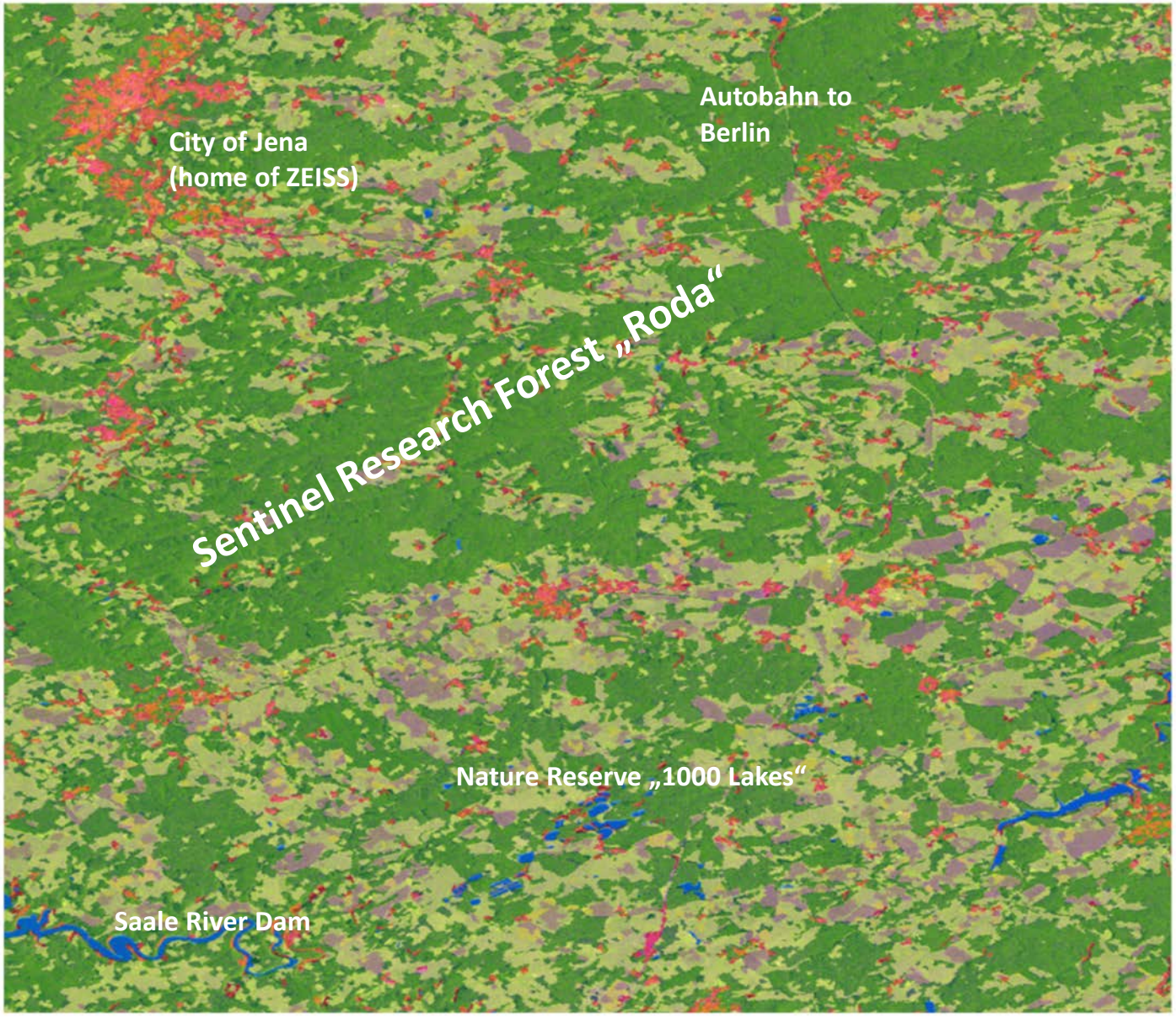
Location: Thuringia, Central Germany

Colour Composite
HH – **HV** – **HH/HV**

Acquisition Date:
26-April-2014

Courtesy University of Jena

FIRST DEMONSTRATION OF LAND APPLICATIONS

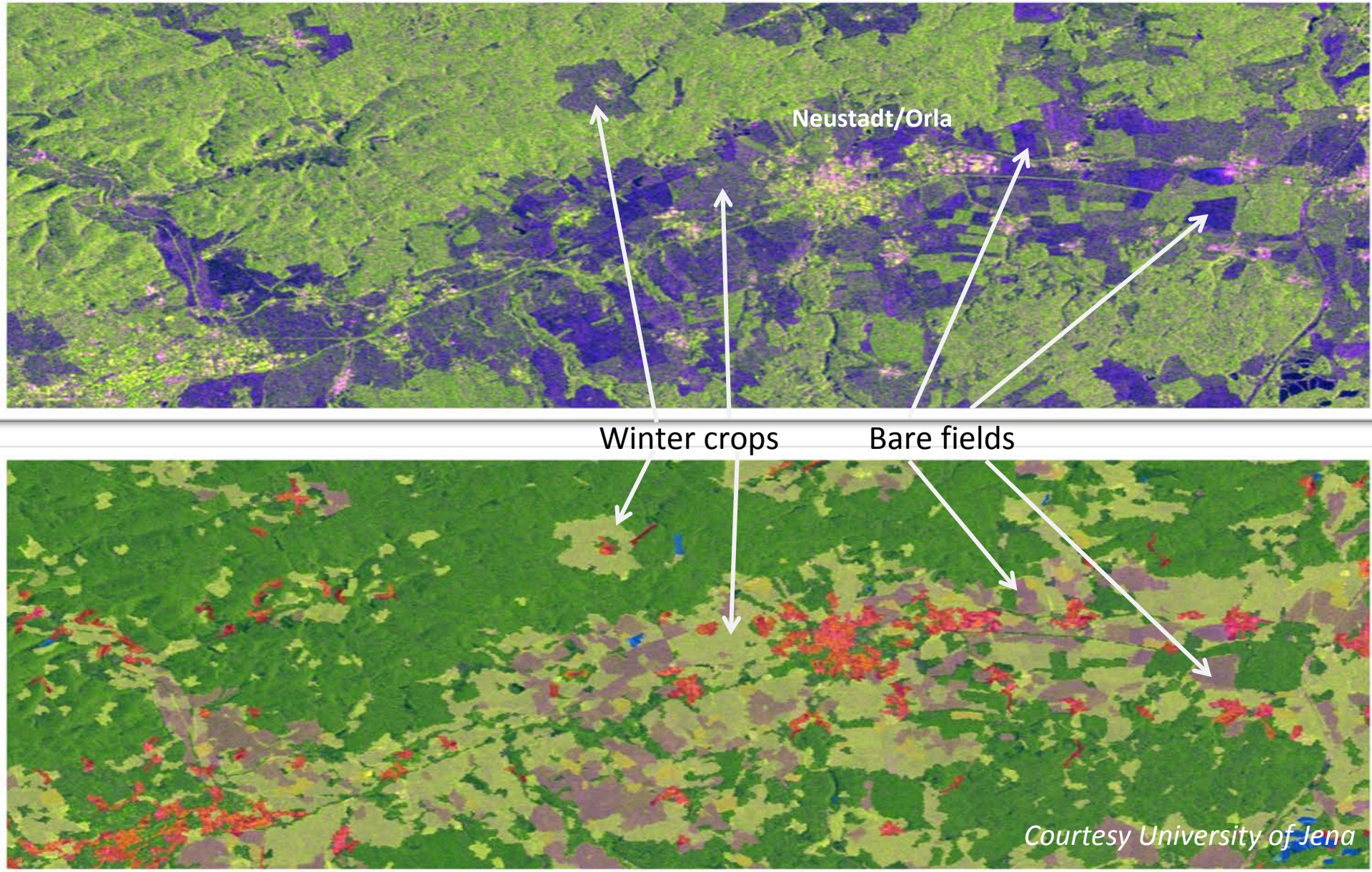


Class. Method:
Random Forest

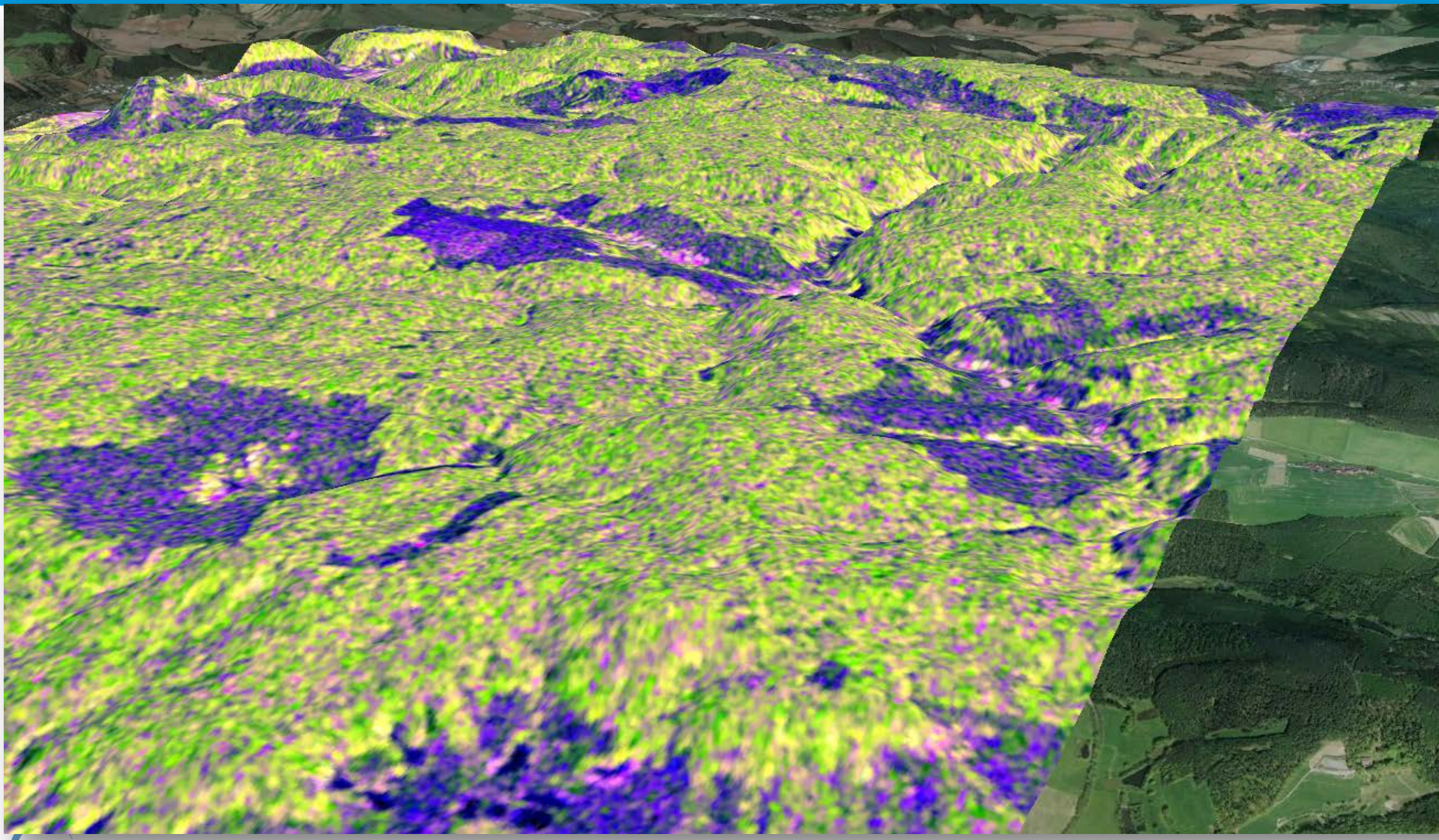
Classes:
Forest
Water
Urban
Winter crops
Bare fields

Courtesy University of Jena

FIRST DEMONSTRATION OF LAND APPLICATIONS



FIRST DEMONSTRATION OF FOREST APPLICATIONS



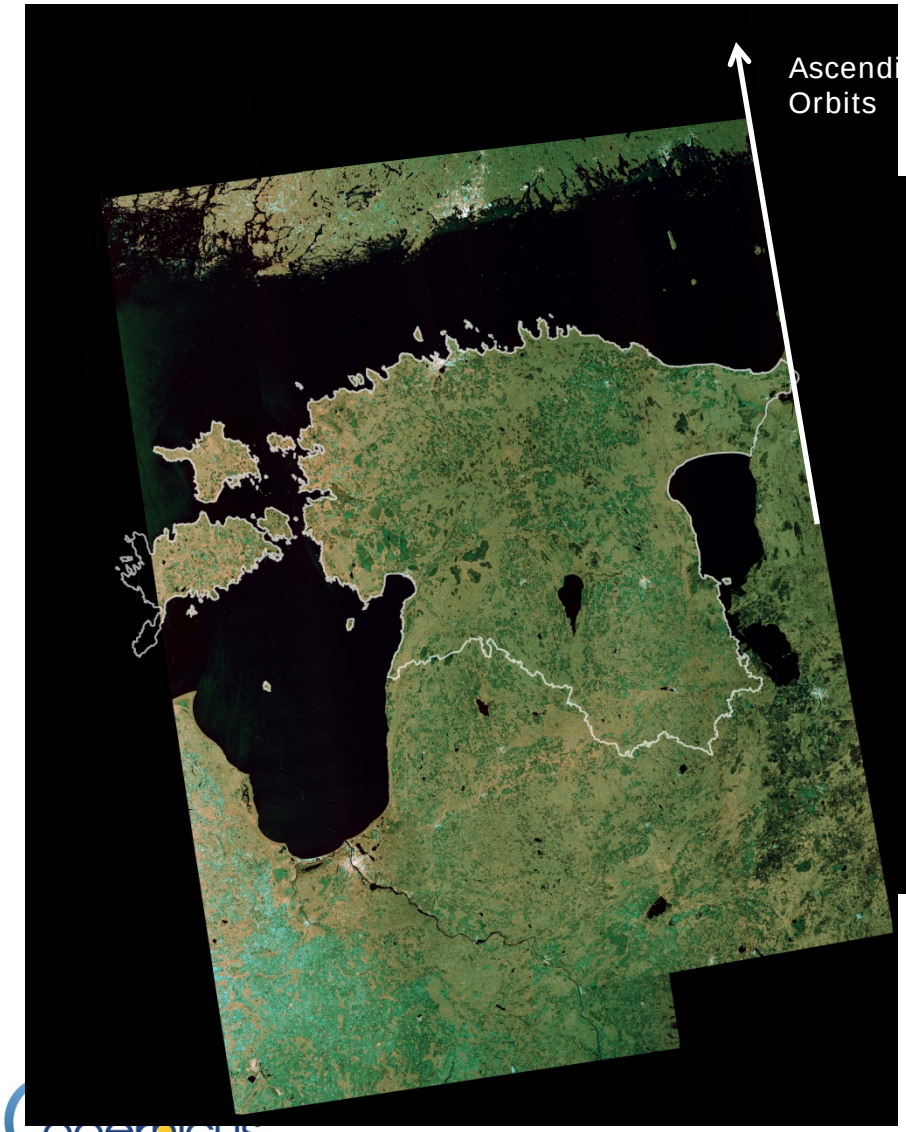
Courtesy University of Jena

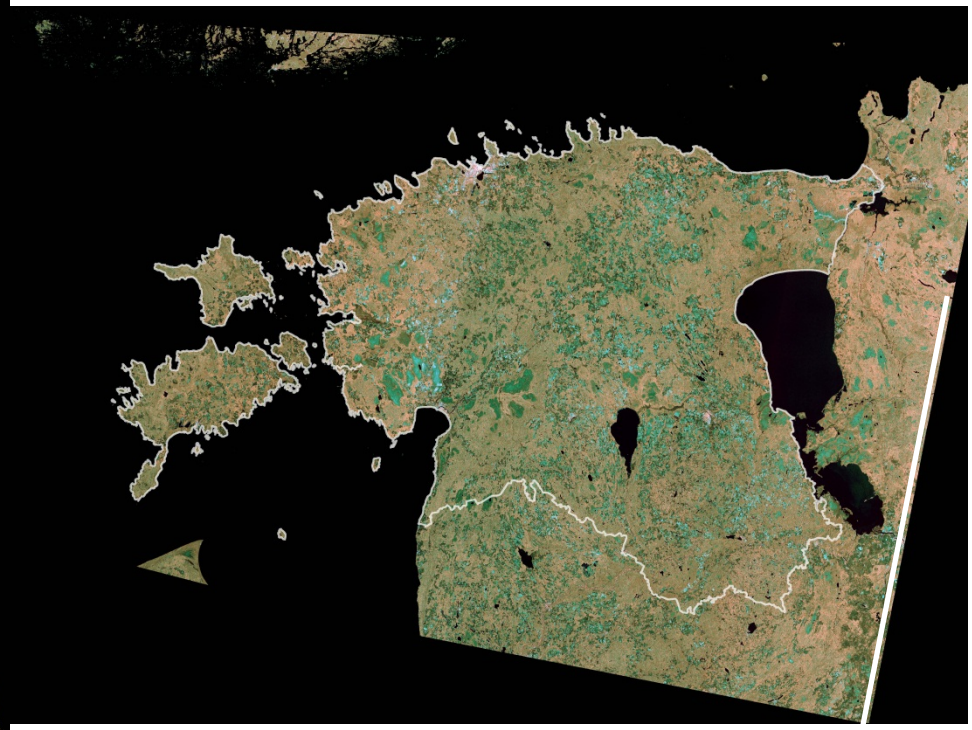
S1A Country Mosaic of Romania

d Novem

S1A Mosaic - Hungary

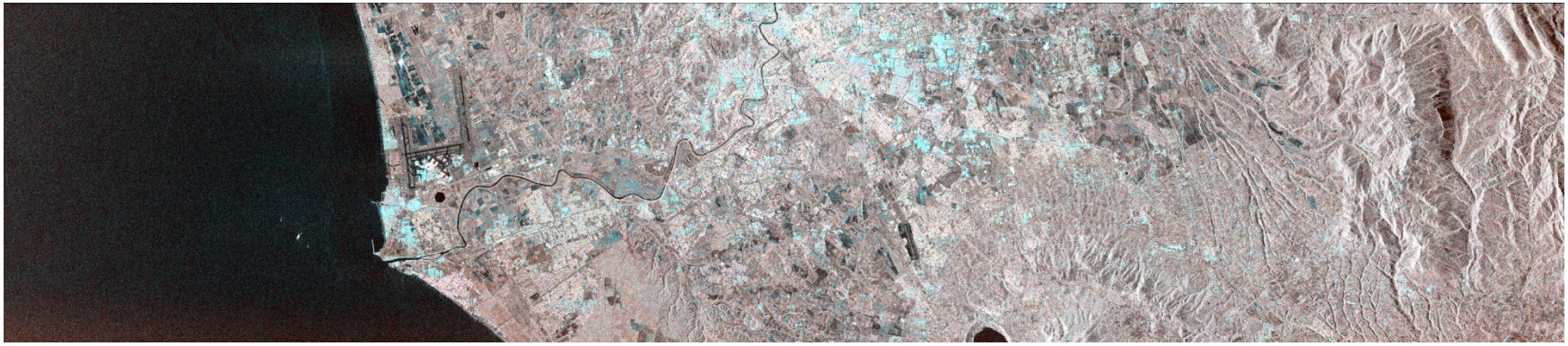
S1A Country Mosaics - Estonia





PRELIMINARY RESULTS

SLC - IW : Swath 2 – Burst 4



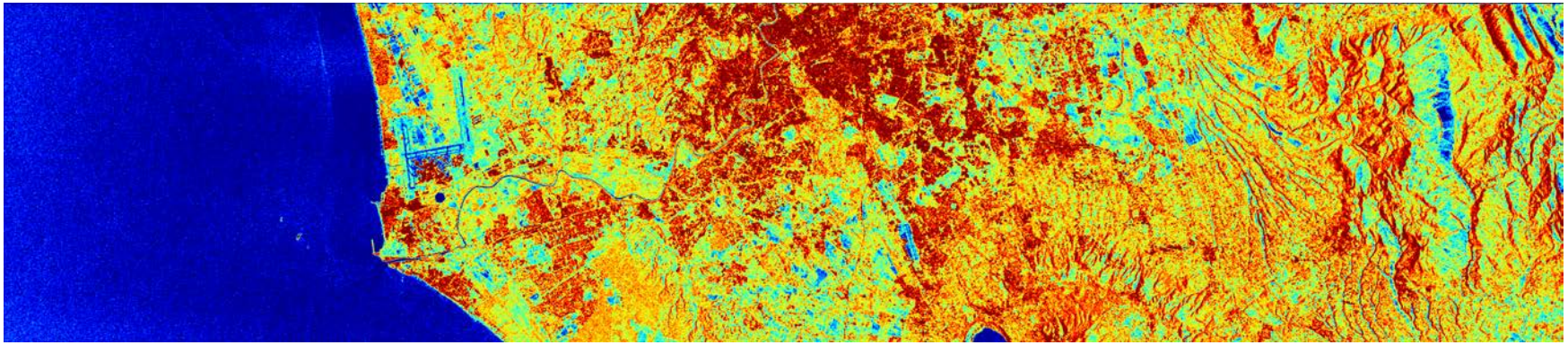
|VH| |VV| / |VH| |VV|

Slant range (no geocoding)

Prof. Eric POTTIER IETR – CNRS 6164
University of Rennes 1 - France

PRELIMINARY RESULTS

SLC - IW : Swath 2 – Burst 4

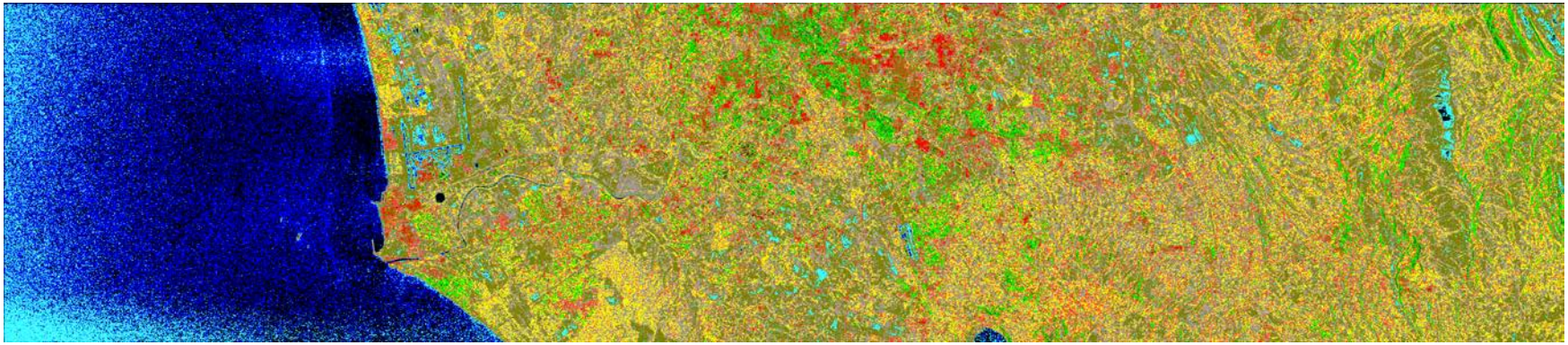


Shannon Entropy (wave and not scattering !)

Prof. Eric POTTIER IETR – CNRS 6164
University of Rennes 1 - France

PRELIMINARY RESULTS

SLC - IW : Swath 2 – Burst 4



Wishart – H/A/alpha unsupervised segmentation (J.S. Lee – E Pottier 2000)

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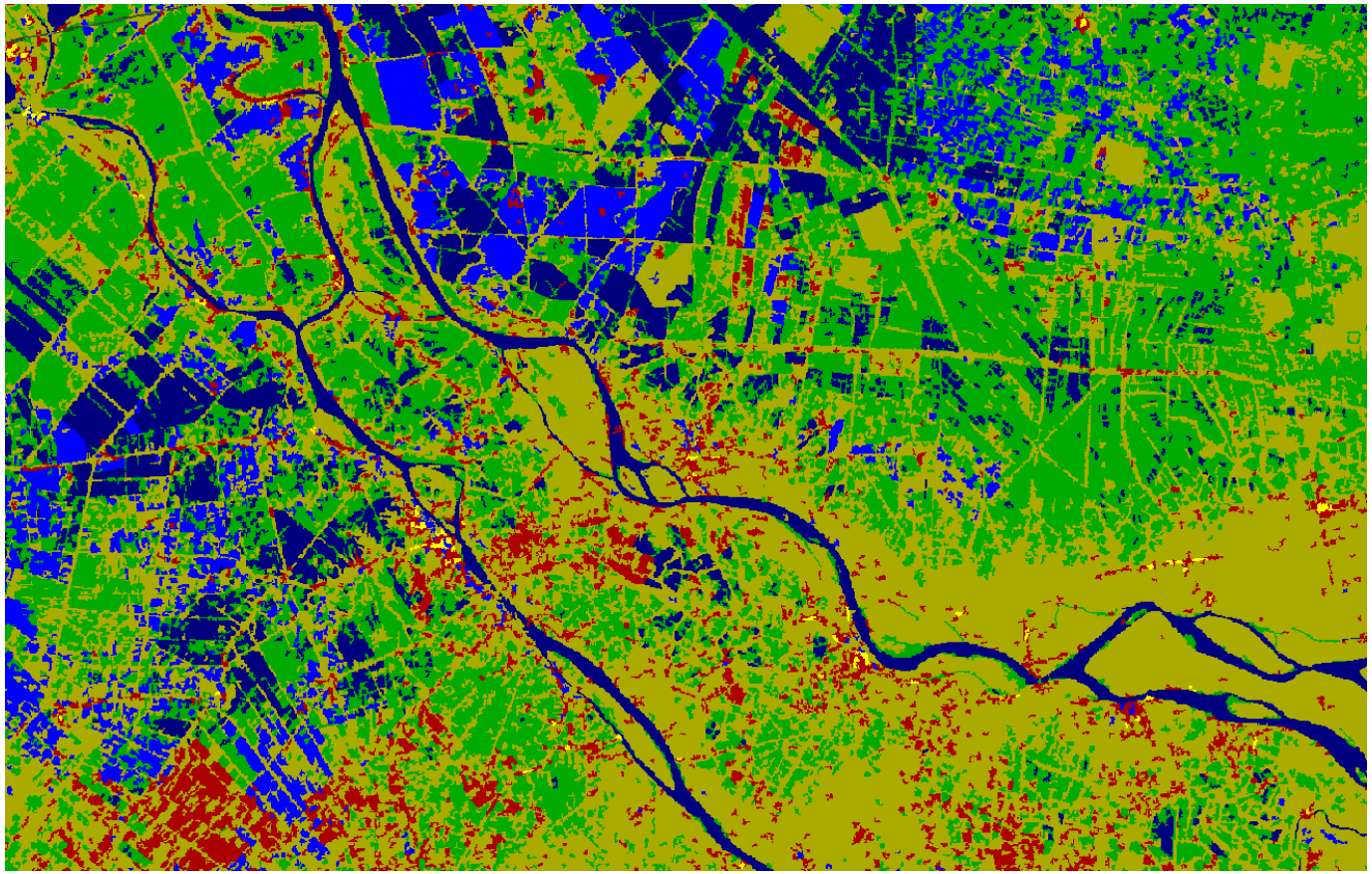
University of Rennes 1 - France

PRELIMINAY RESULTS RICE MONITORING

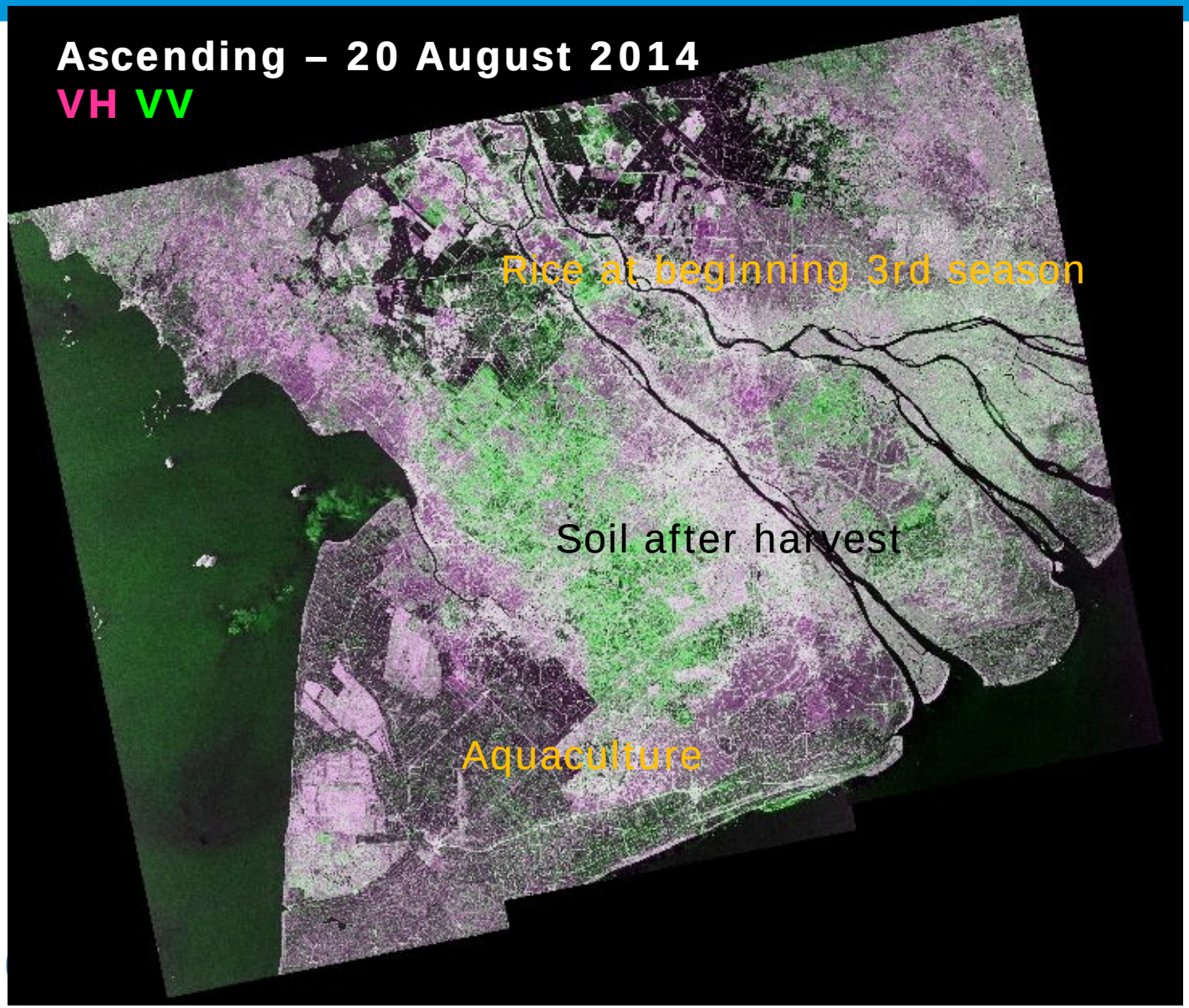
S-1A geocoded – 8 & 20 Aug, 80m (detail) – Vietnam



rice stage 1
rice stage 2
rice stage 3
non-rice

Courtesy SARMAP

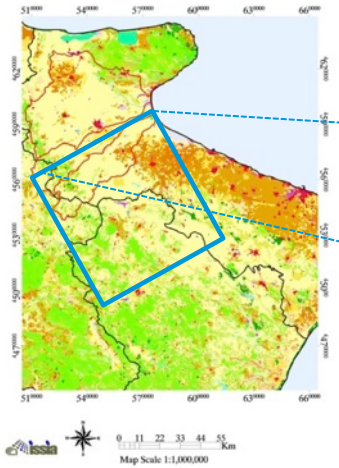
PRELIMINAY RESULTS: CROP MONITORING



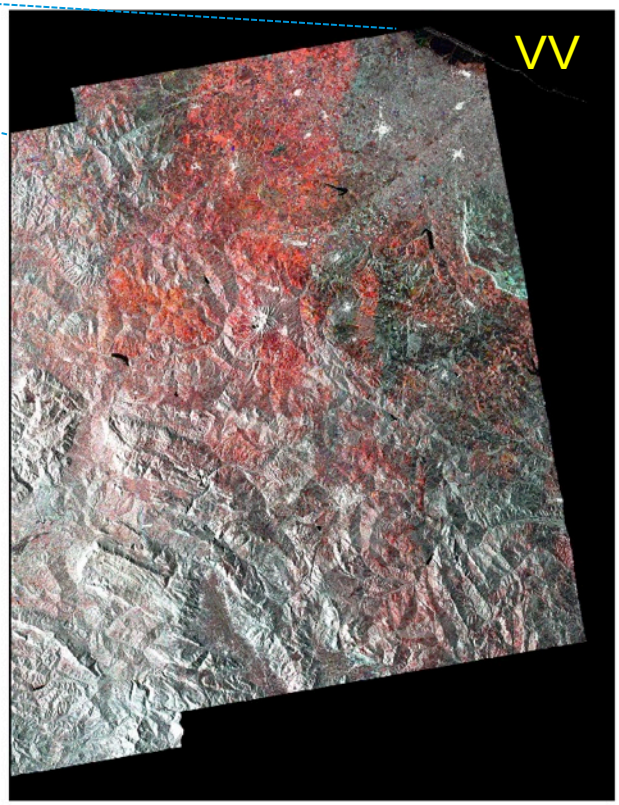
Courtesy CESBIO

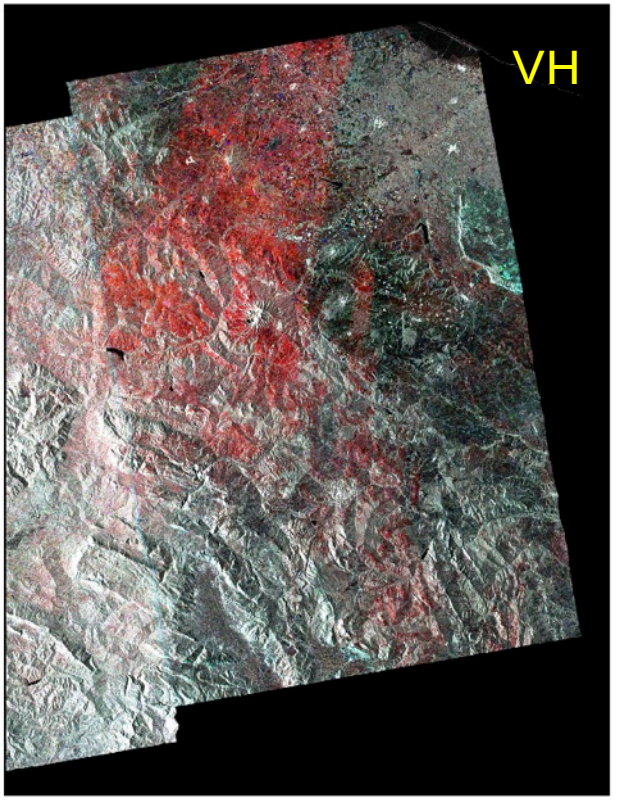
PRELIMINAY RESULTS
Soil Moisture
(with SLC Geocoded products)

CORINE



Multi temporal
RGB Composition





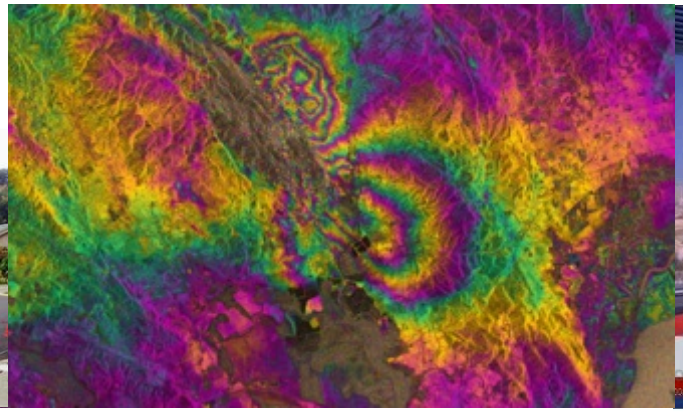
- 09/02
- 08/21
- 08/09

Courtesy
CNR ISSIA

Soil moisture change due to precipitation fields on September 2nd

FIRST SENTINEL-1A RESULTS

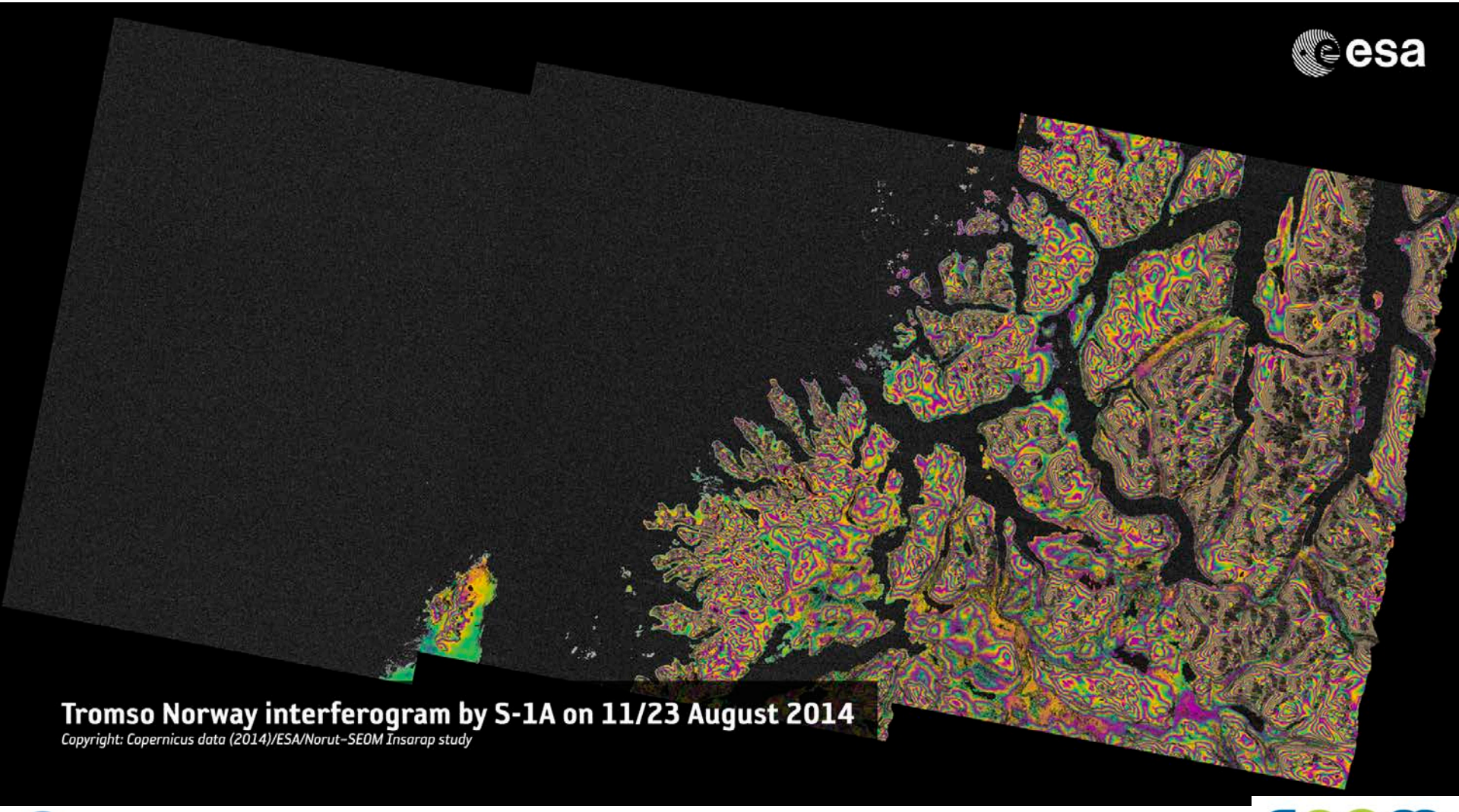
Land



InSAR Applications
Ground Motion ...

Sentinel-1

Interferometry INSARAP (NORUT)

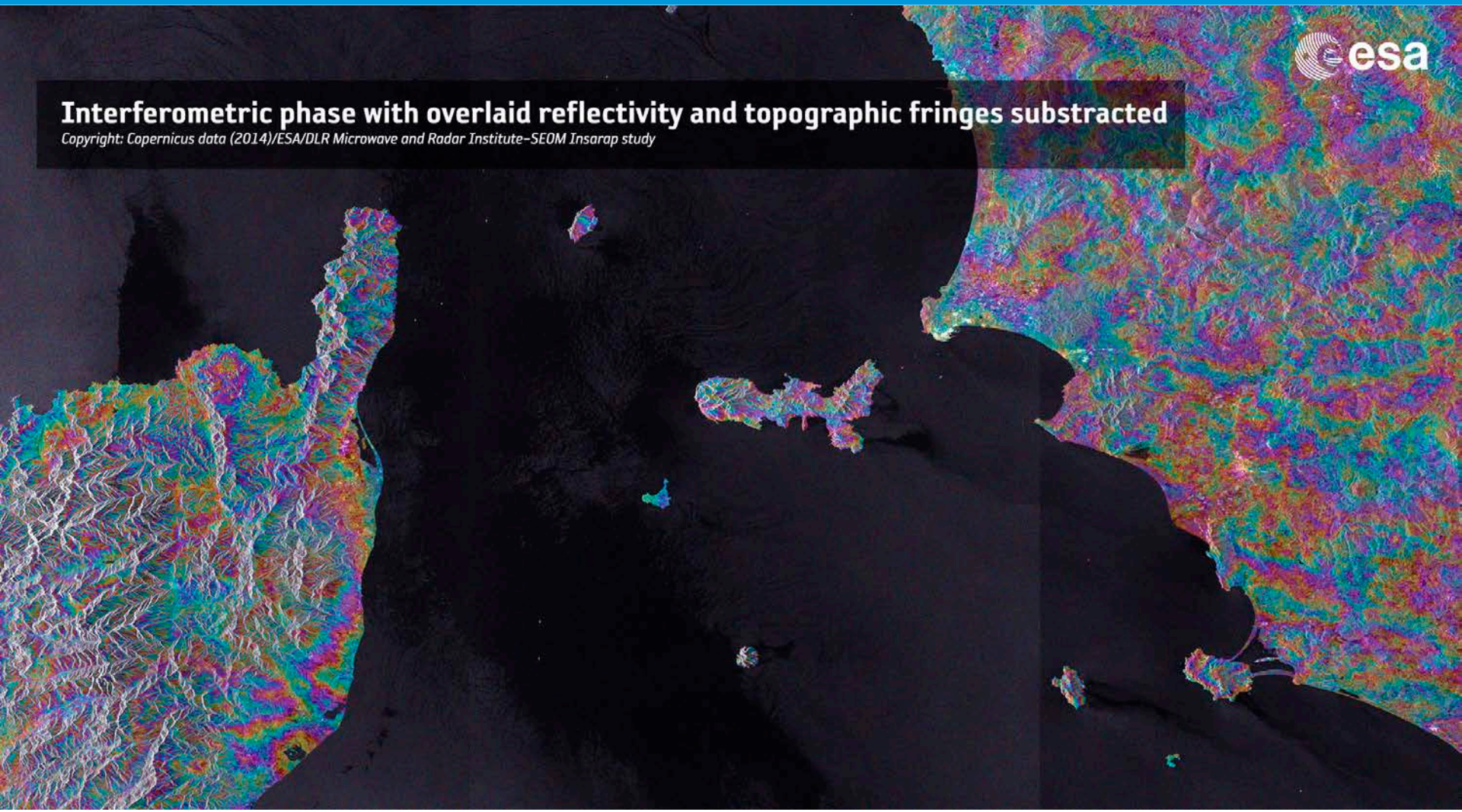


Copernicus

seom
scientific exploitation of operational missions

Sentinel-1

Interferometry INSARAP (DLR - HR)

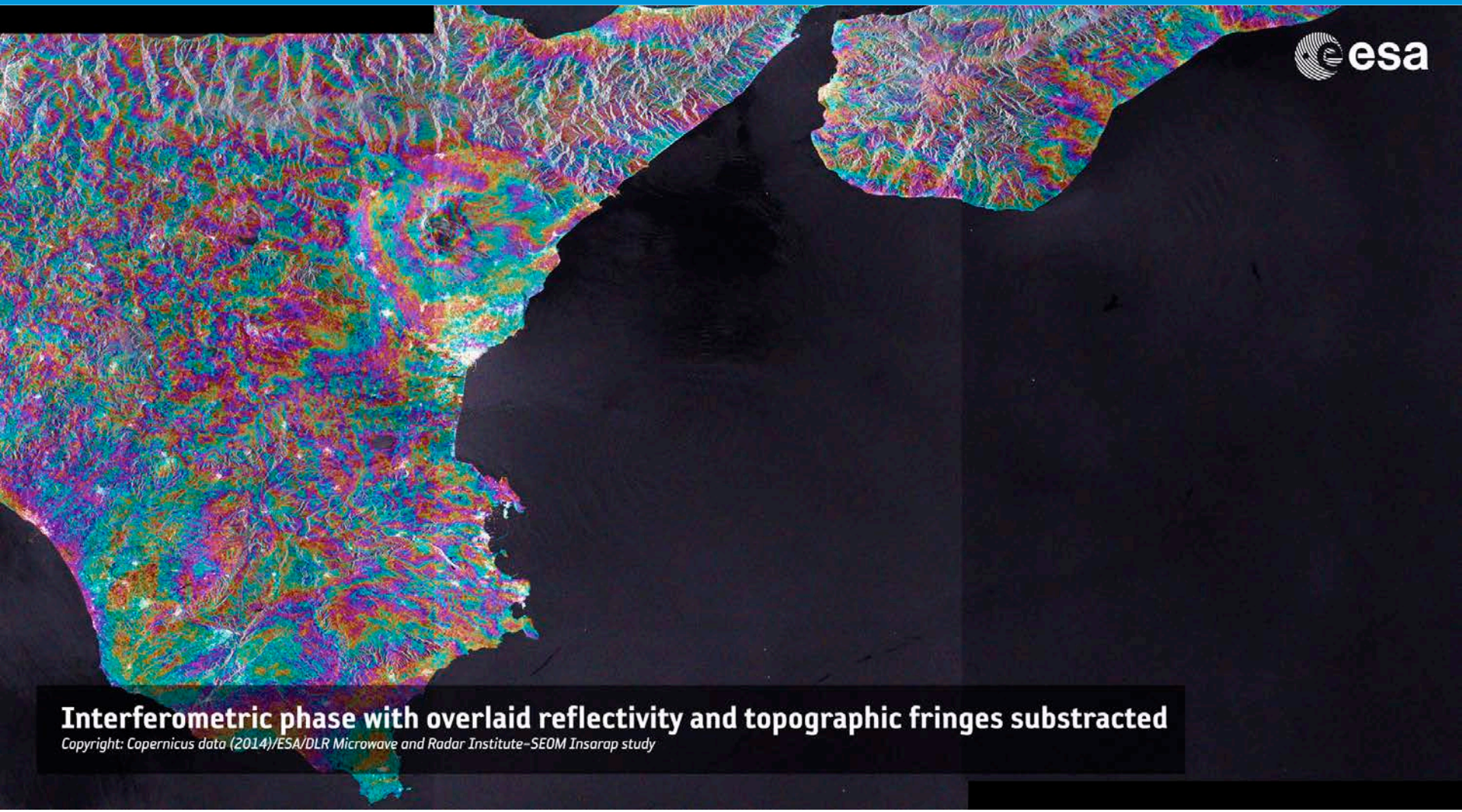


Copernicus

seom
scientific exploitation of operational missions

Sentinel-1

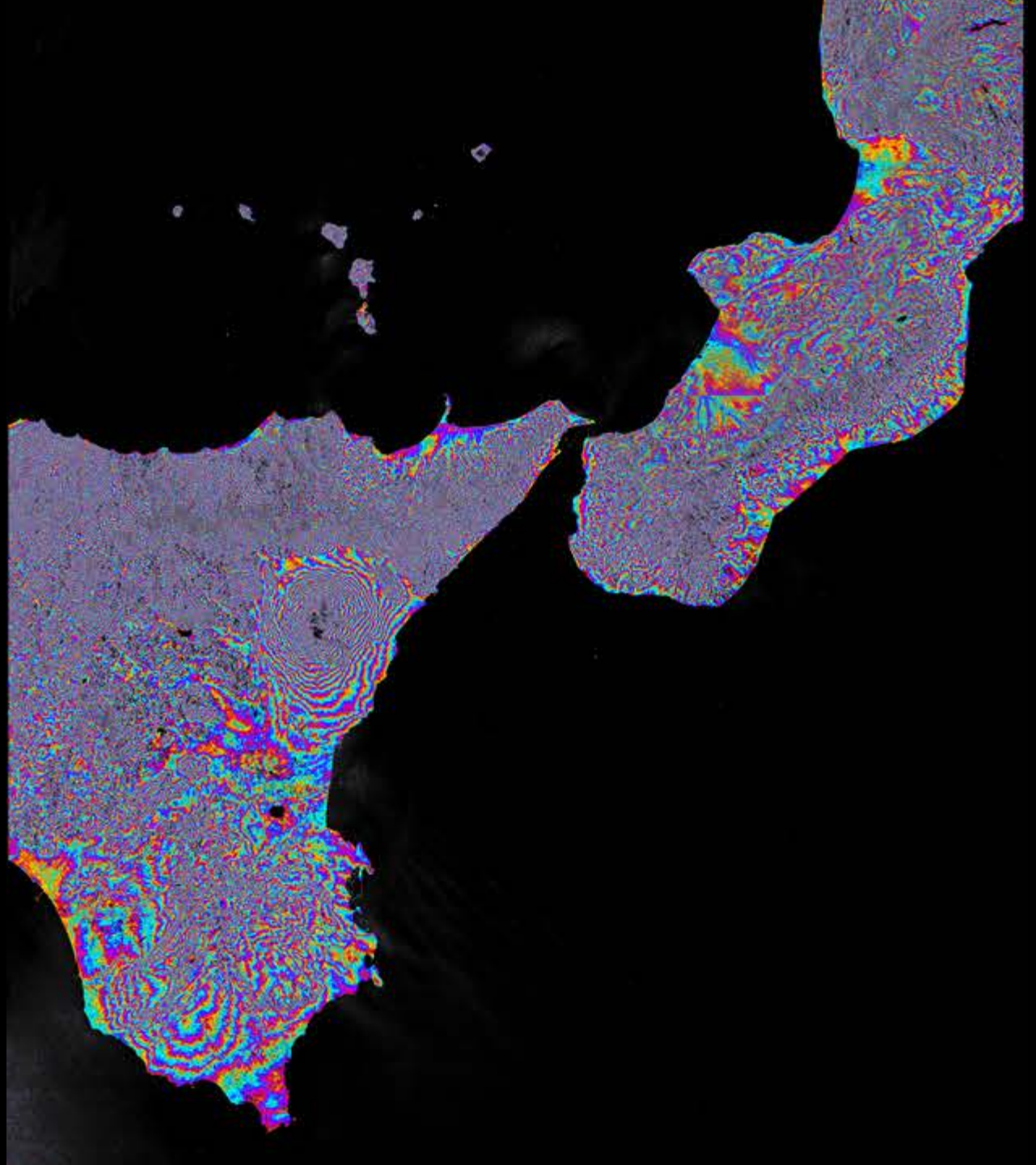
Interferometry INSARAP (DLR - HR)



Copernicus

seom
scientific exploitation of operational missions

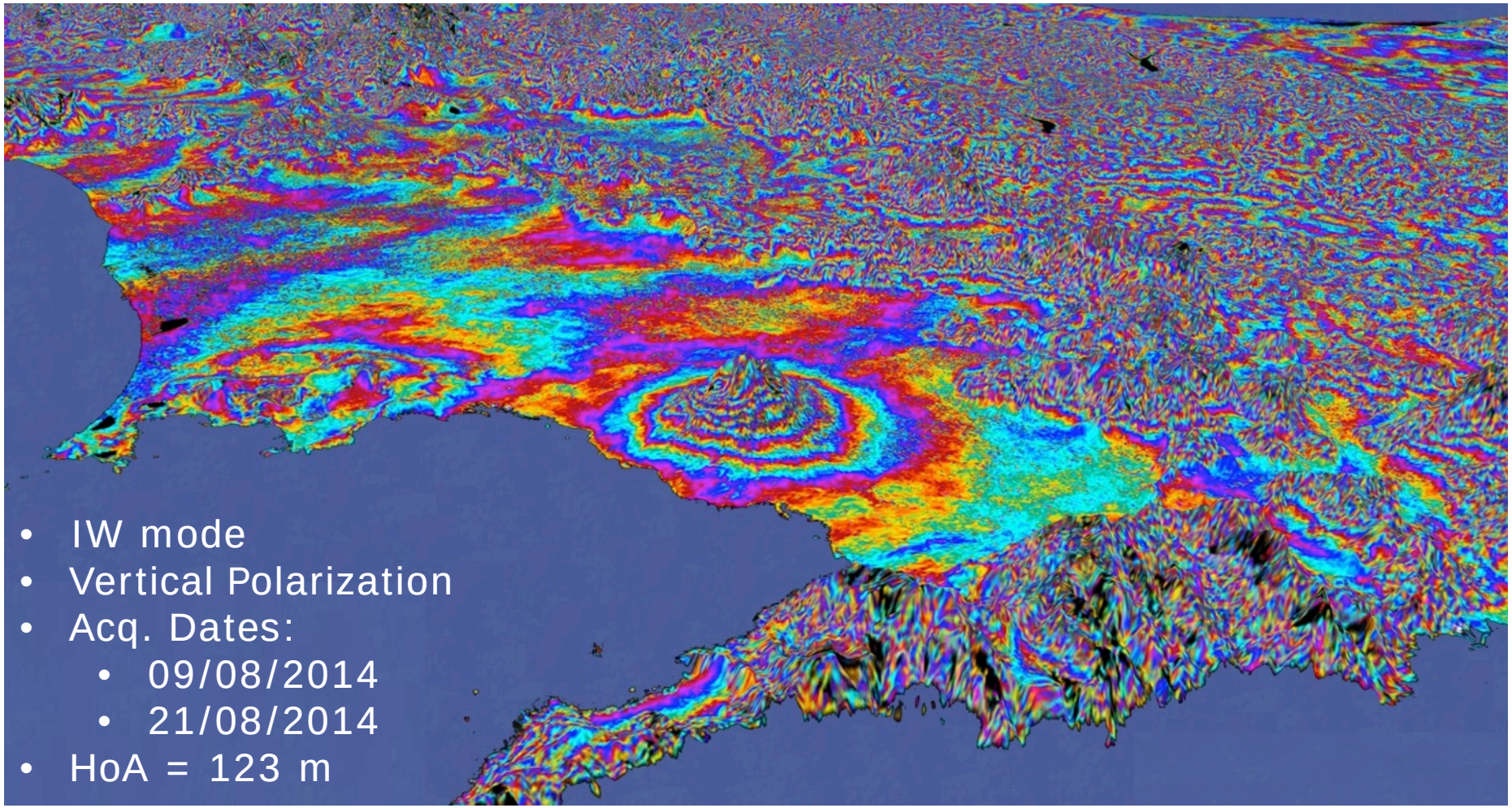
Italy
1200 Km



Datatake (7 slices):

- IW mode
- Vertical Polarization
- Acq. Dates:
  - 09/08/2014
  - 21/08/2014

Mount Vesuvius

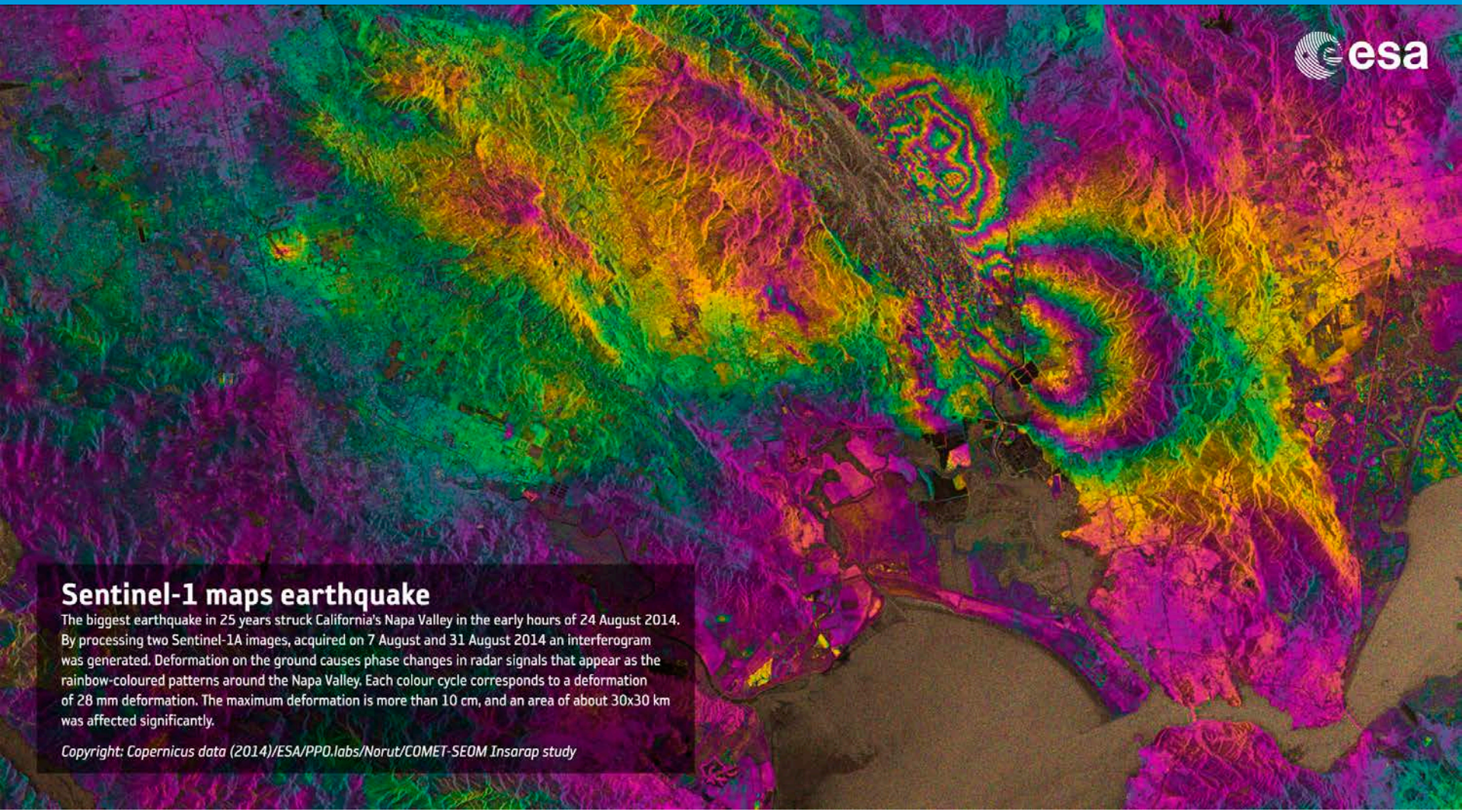


- IW mode
- Vertical Polarization
- Acq. Dates:
  - 09/08/2014
  - 21/08/2014
- HoA = 123 m

Sentinel-1 Napa Valley Earthquake

INSARAP (NORUT-PPO.labs-Univ. Leeds-COMET)

esa



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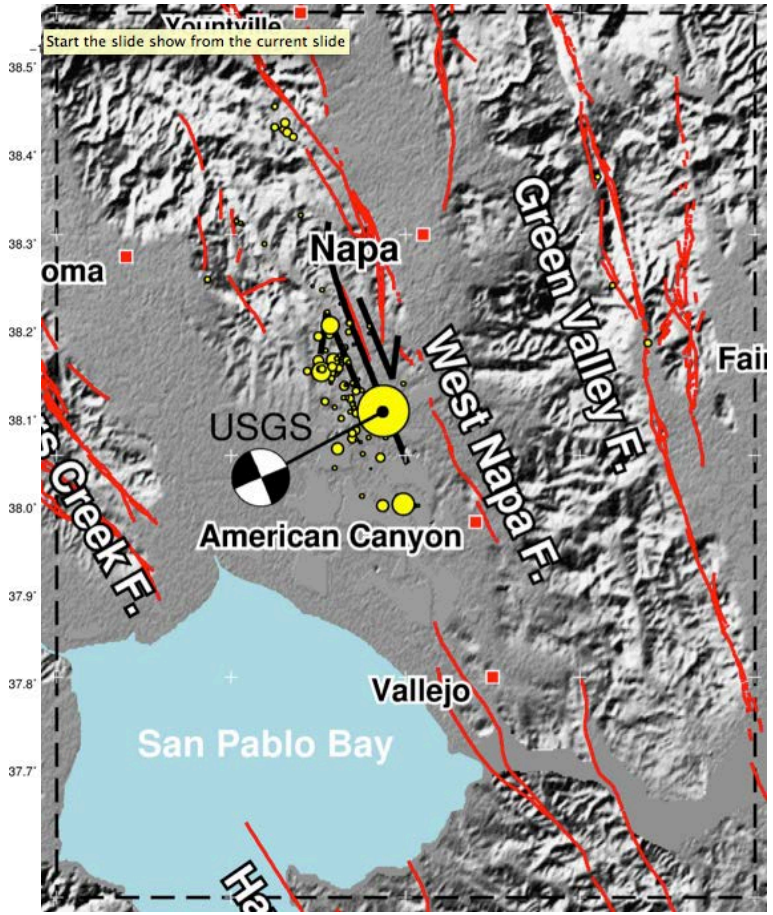
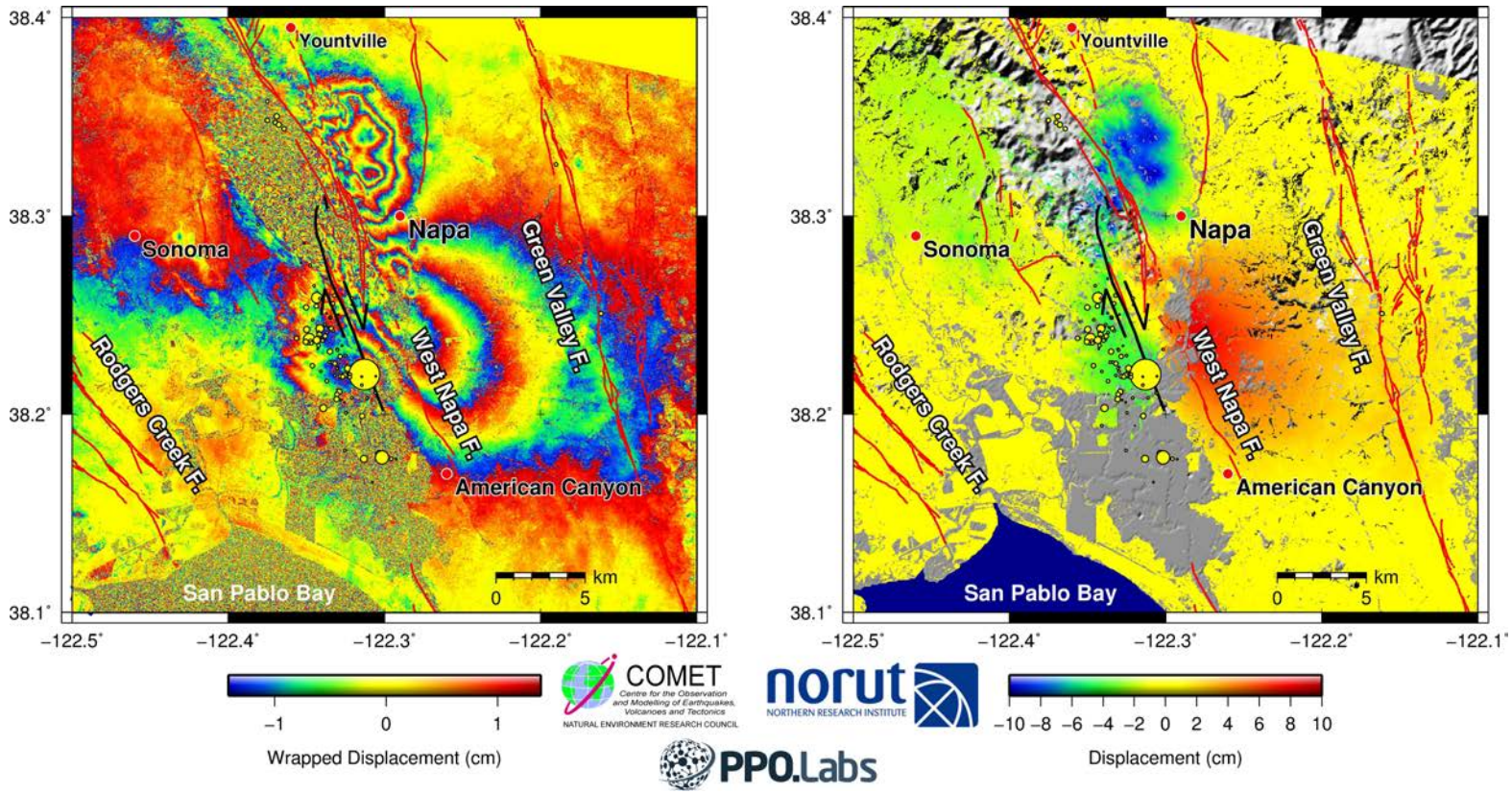
Sentinel-1 Napa Valley Earthquake
INSARAP (Univ. Leeds-COMET-NORUT-PPO.labs)

Fault damage in the suburbs west of Napa, California from the August 24th magnitude 6 earthquake. The fault rupture ran through homes and across roads, buckling the tarmac surface and pavements.
Photo credit: Austin Elliott, UC Davis.



Fault map (red lines) of the region around the Napa Valley earthquake, California. The fault rupture (mapped by UC Davis scientists) resulting from the August 24 earthquake is shown by the black line, south-west of Napa. The mainshock and smaller aftershocks are denoted by the yellow circles. Earthquake locations and existing fault locations sourced from USGS. The dashed line denotes the regions shown in the other figures.

Sentinel-1 *Napa Valley Earthquake*
INSARAP (Univ. Leeds-COMET- NORUT-PPO.labs)



(left) Sentinel-1A (European Space Agency) interferogram of the ground deformation from the Napa earthquake. The contours show the ground motion towards and away from the satellite. The black line denotes the surface rupture mapped in the field by scientists from UC Davis.

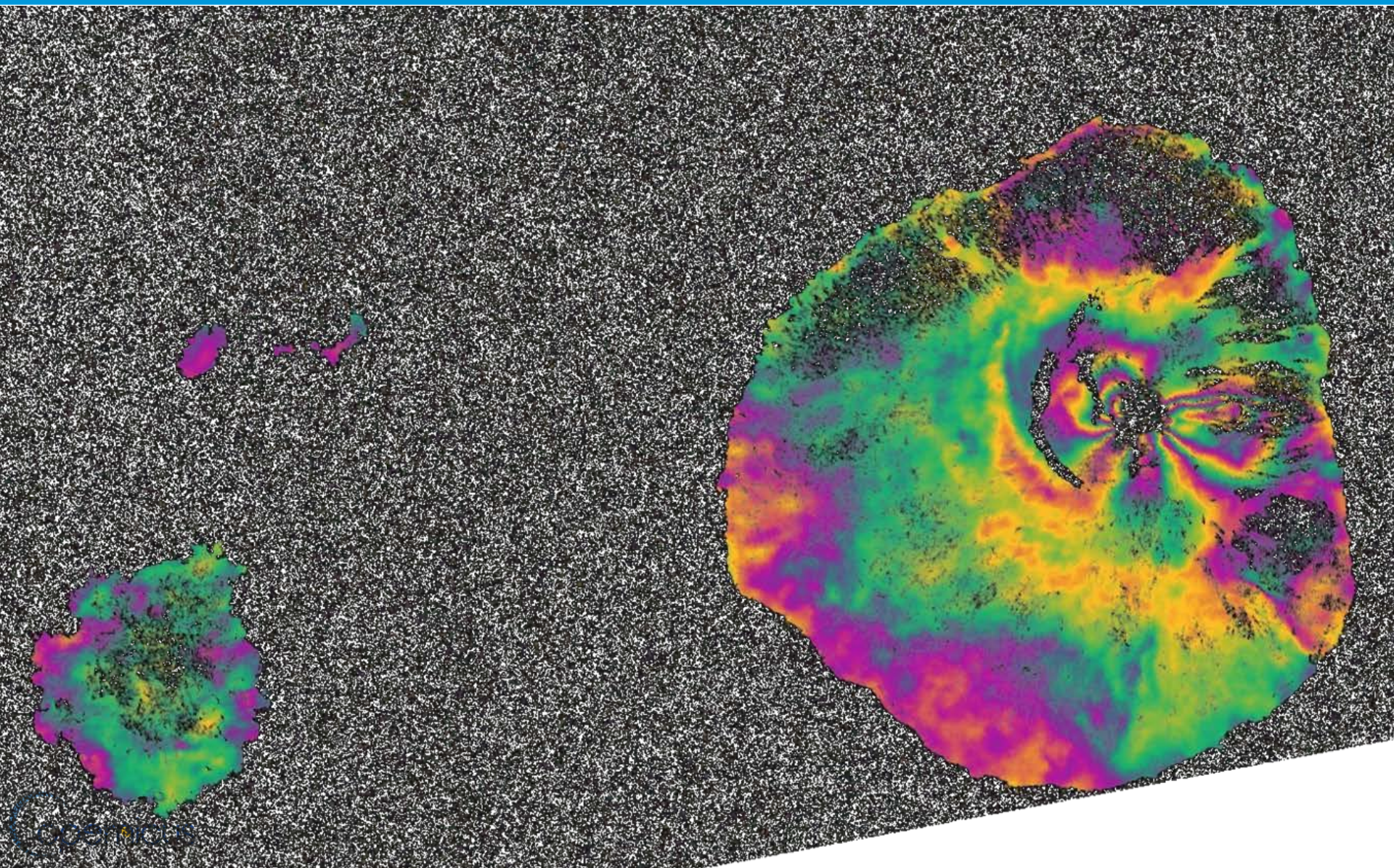
(right) The same interferogram processed to show the total motion towards and away from the satellite. South of the town of Napa, the ground has moved towards the satellite by up to 10 cm (red colours), whereas to the north it has moved away by 10 cm (blue colors).

Despite being a strike-slip earthquake in which most motion is horizontal, the satellite measures mainly vertical and east-west motion and sees the ends of the rupture bulge up (and eastwards) at one end (towards the satellite in the south) and down (and west) at the other. The mainshock and smaller aftershocks are denoted by the yellow circles.

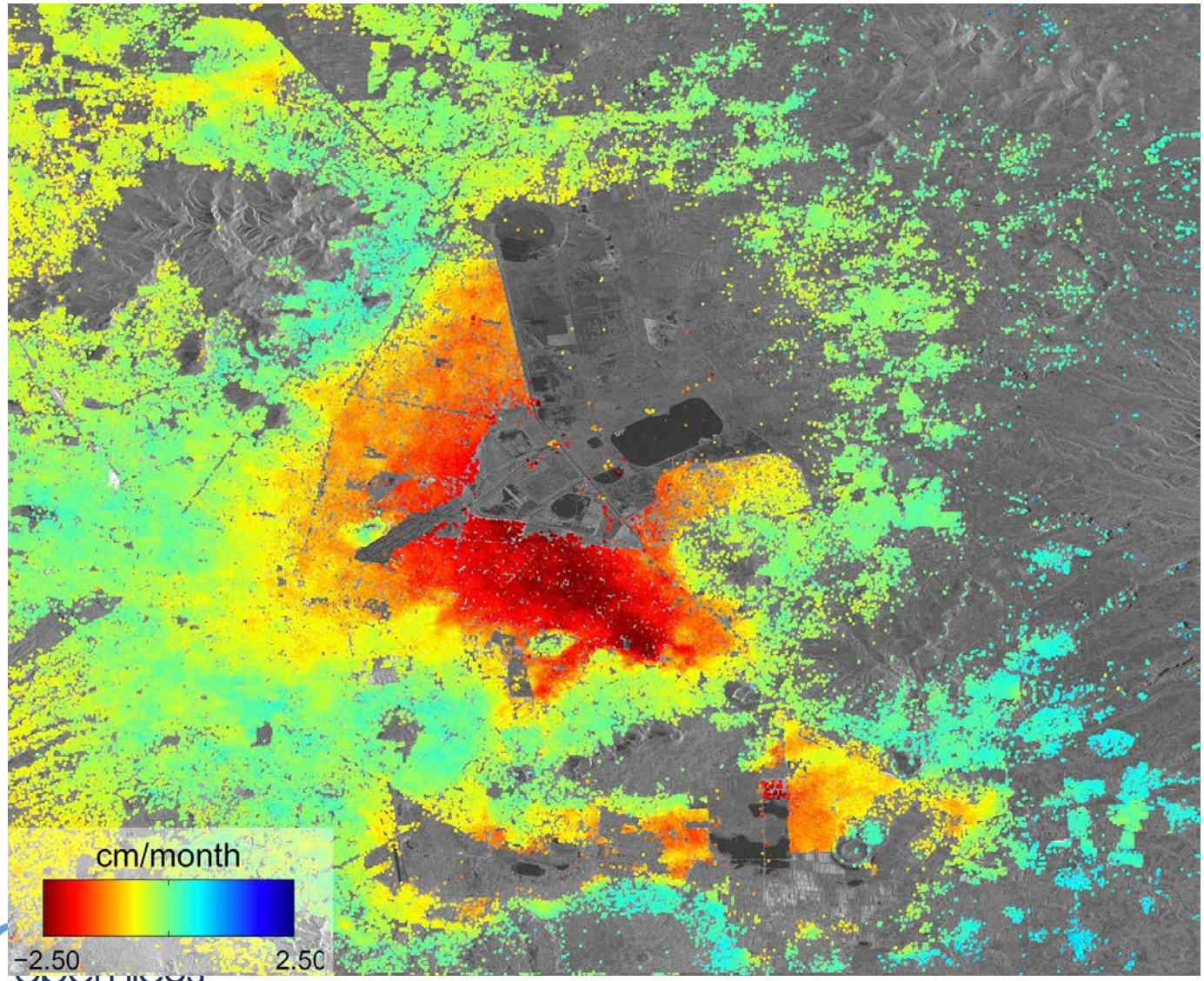
Earthquake locations and existing fault locations (red lines) are sourced from the USGS.

scientific exploitation of operational missions

Sentinel-1 Maps Fogo Eruption



Sentinel-1A *First subsidence monitoring with PS - INSARAP (DLR-HR))*

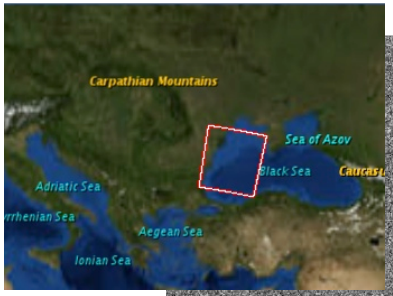


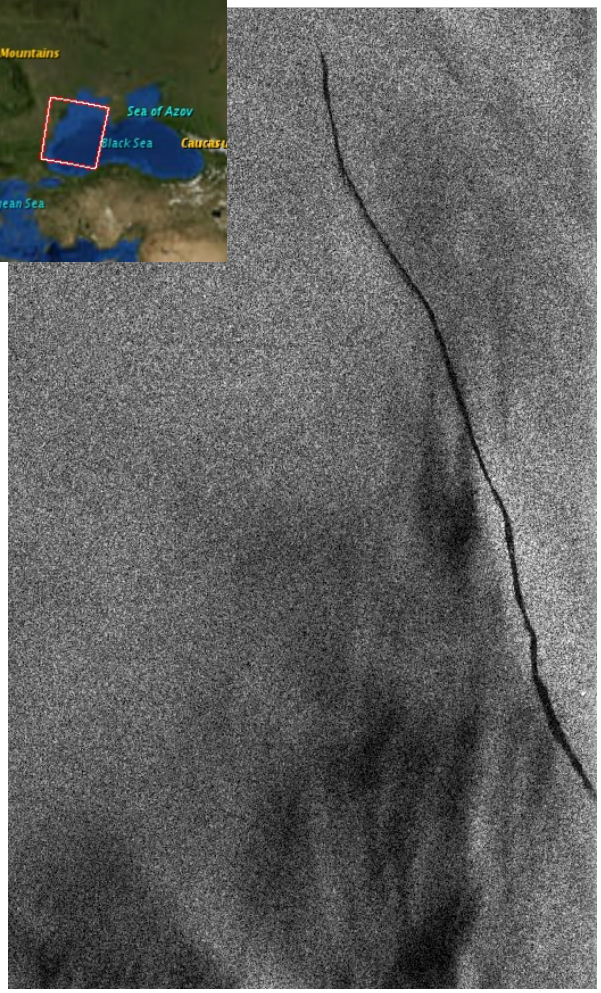
Five Sentinel-1A radar TOPS scans acquired between 3 October and 2 December 2014 were combined to create this image of ground deformation in Mexico City.
The deformation is caused by ground water extraction, with some areas of the city subsiding at up to 2.5 cm/month (red).

Marine / Oceans

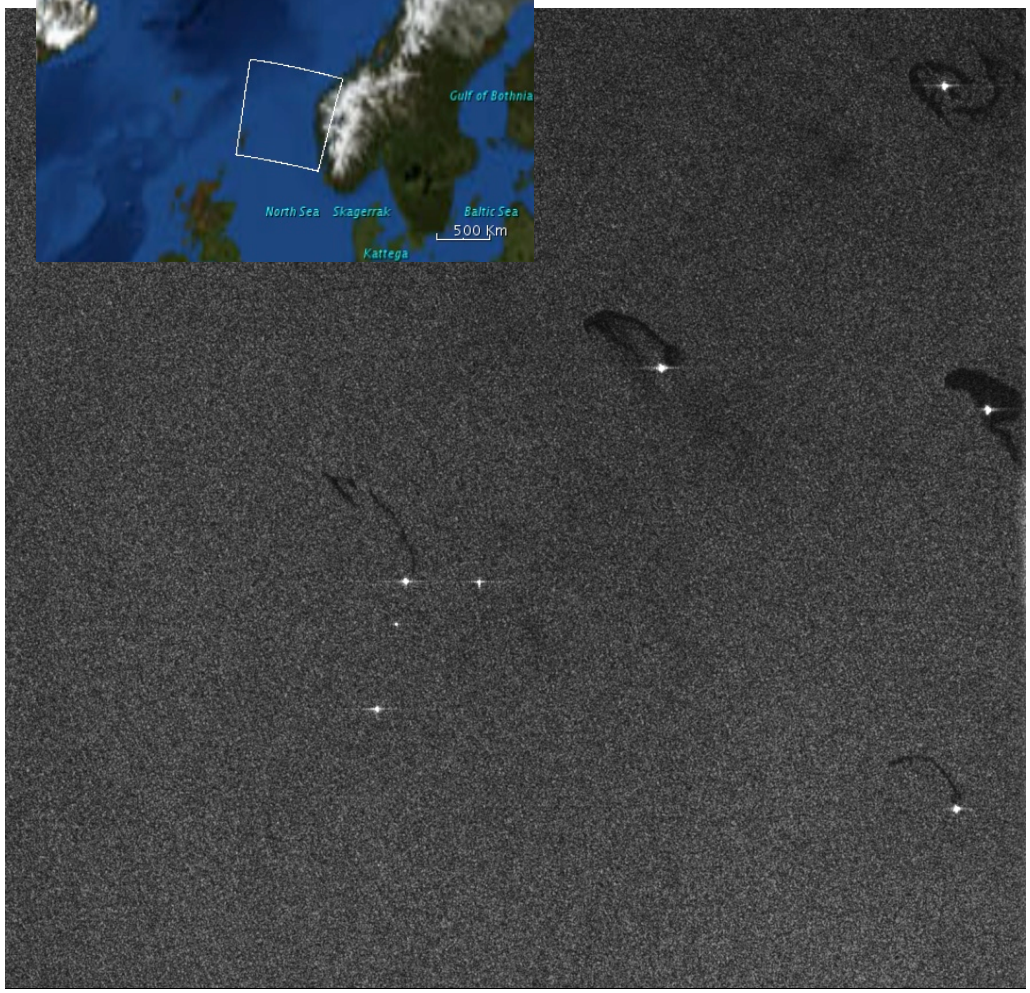
Maritime Surveillance
(Oil Spill Detection, Ship Detection, Illegal Fisheries, etc.)
Wind / Wave / Current

First Oil Spills Detected by Sentinel-1



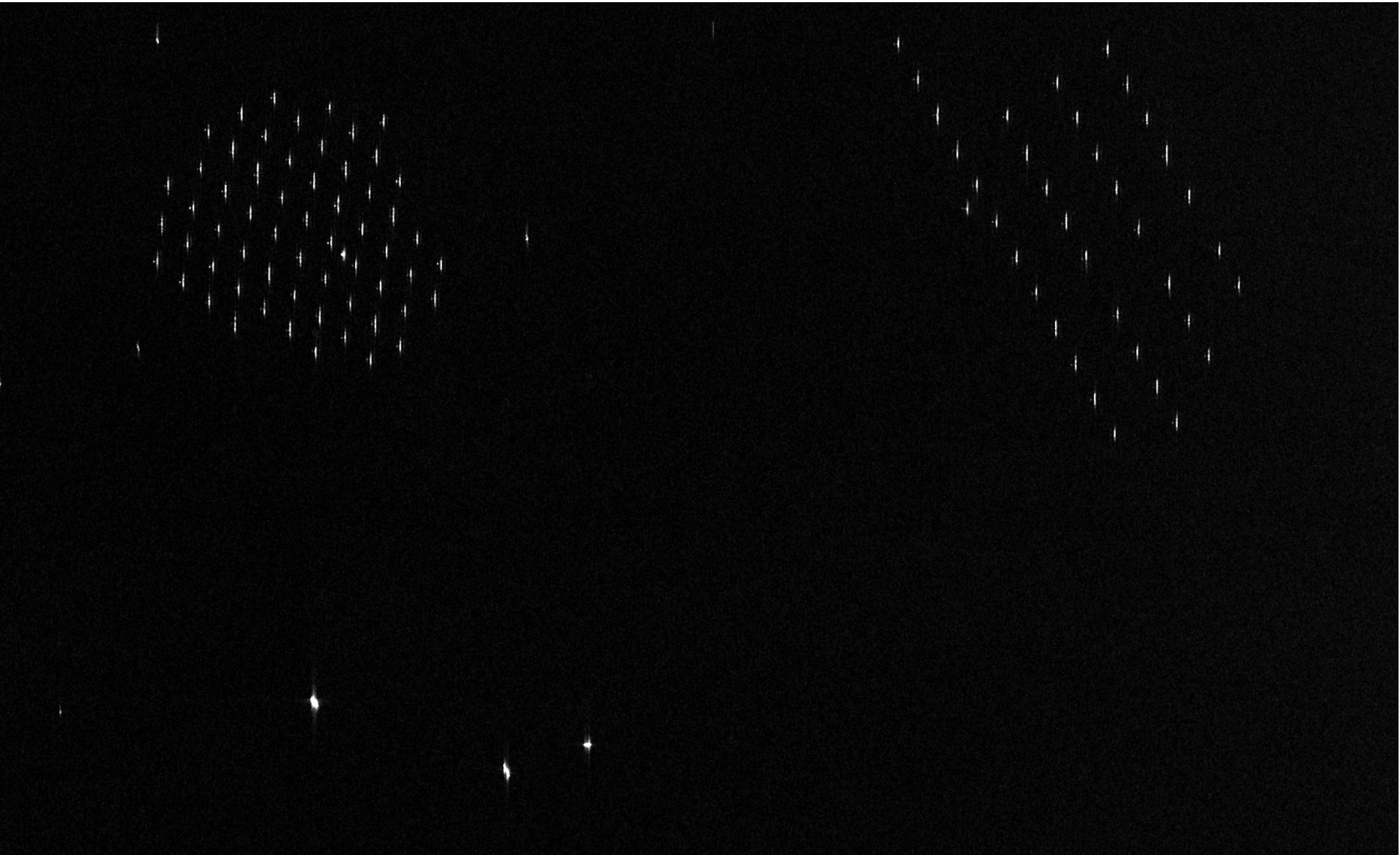


Sentinel-1A TOPS EW VV/VH
acquired on 19 April 2014



Sentinel-1A TOPS EW HH/HV
acquired on 25 April 2014

Windfarms off the Dutch Coast

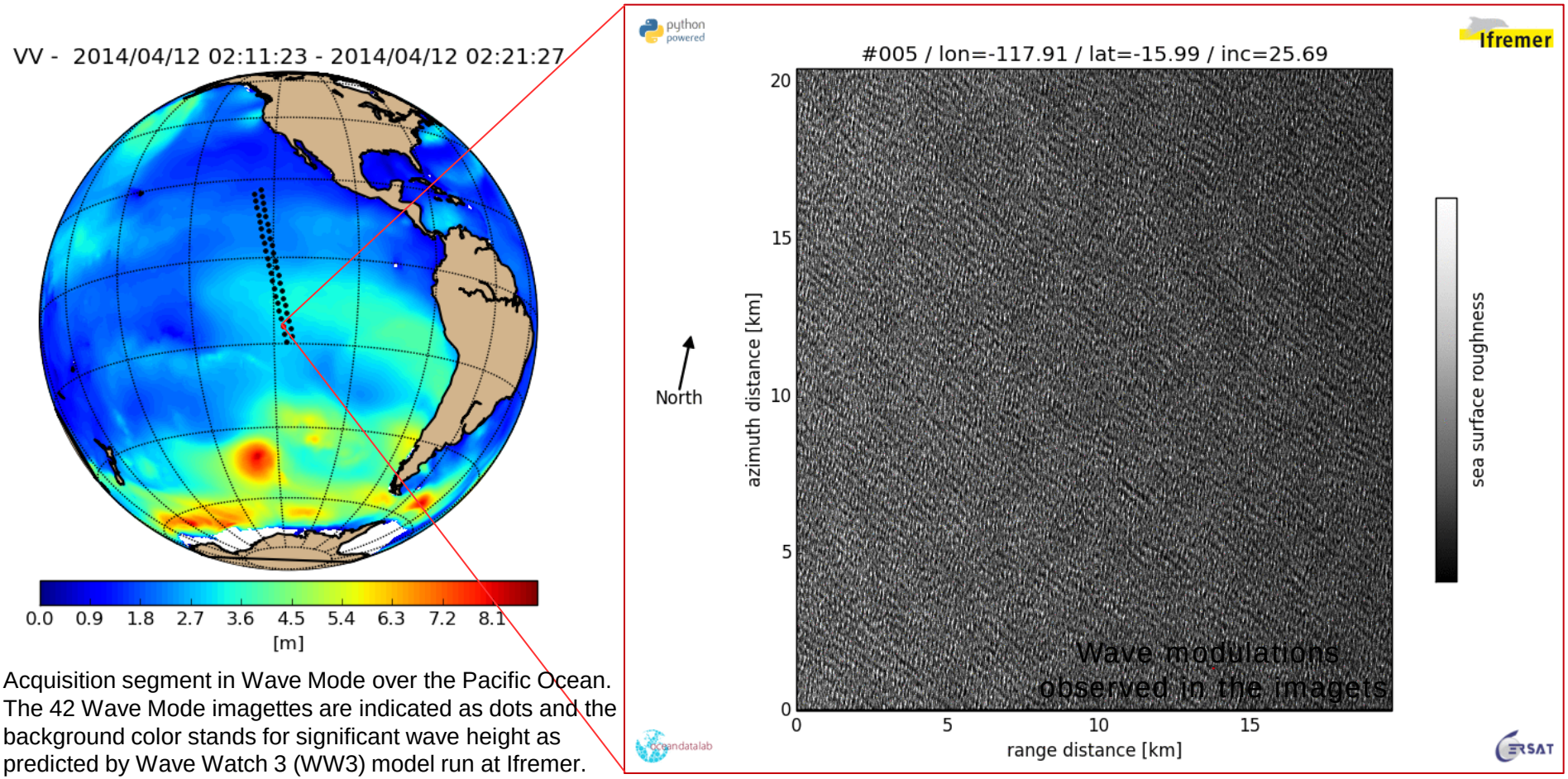


Sentinel-1A TOPS over Greece

Credits: ESA

FIRST DEMONSTRATION FOR SEA STATE APPLICATIONS

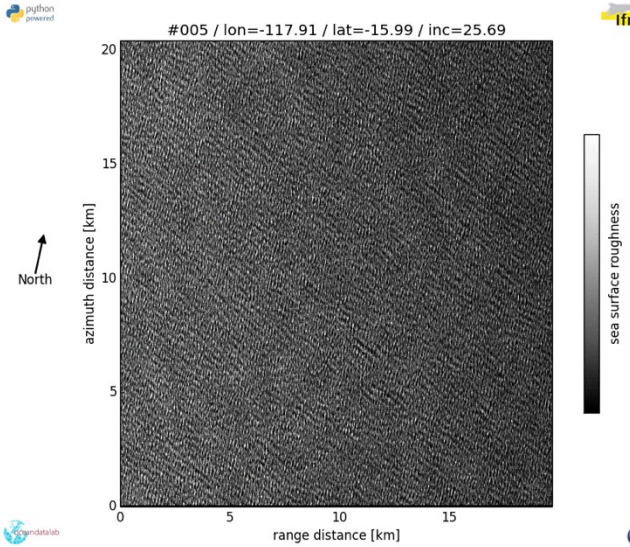
First Analysis of WM acquisition segment (1/2)

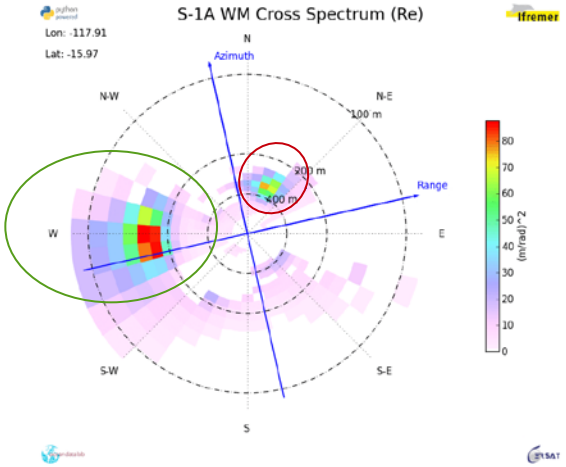


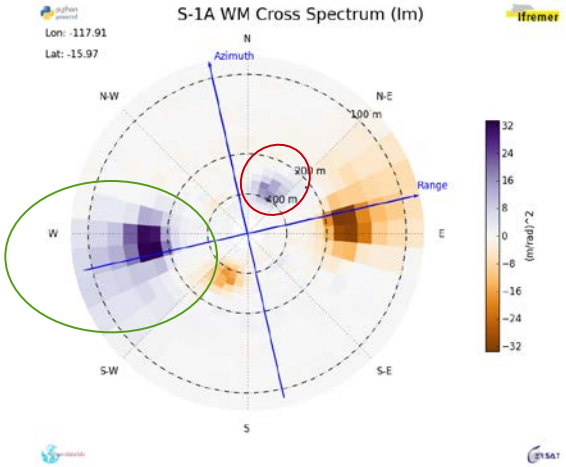
Acquisition segment in Wave Mode over the Pacific Ocean. The 42 Wave Mode imagettes are indicated as dots and the background color stands for significant wave height as predicted by Wave Watch 3 (WW3) model run at Ifremer.

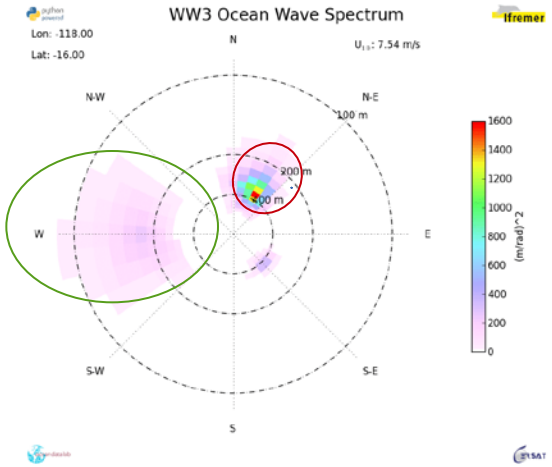
FIRST DEMONSTRATION FOR SEA STATE APPLICATIONS

First Analysis of WM acquisition segment (2/2)







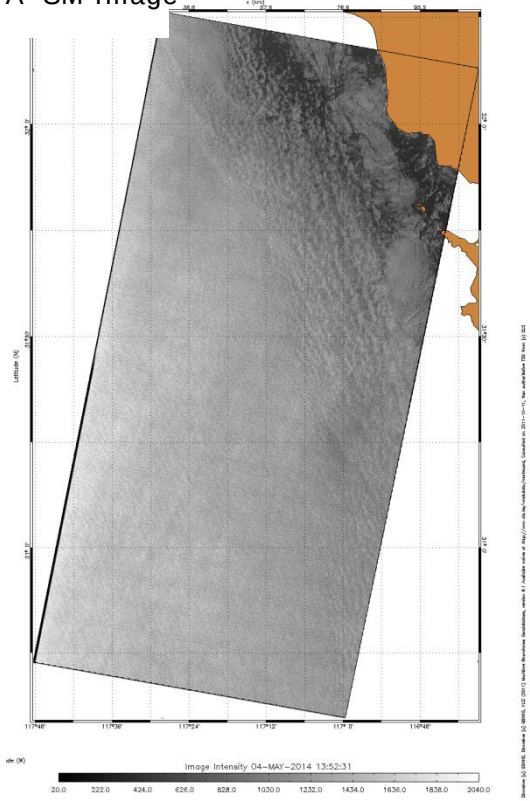


- S-1 A is able to detect the 3 waves sytems (up to 5 in certain cases)
- S-1 A is able to remove the ambiguity direction of wave propagation
- The very good consistency between S-1 A measurement and WW3 model ouput is very promising

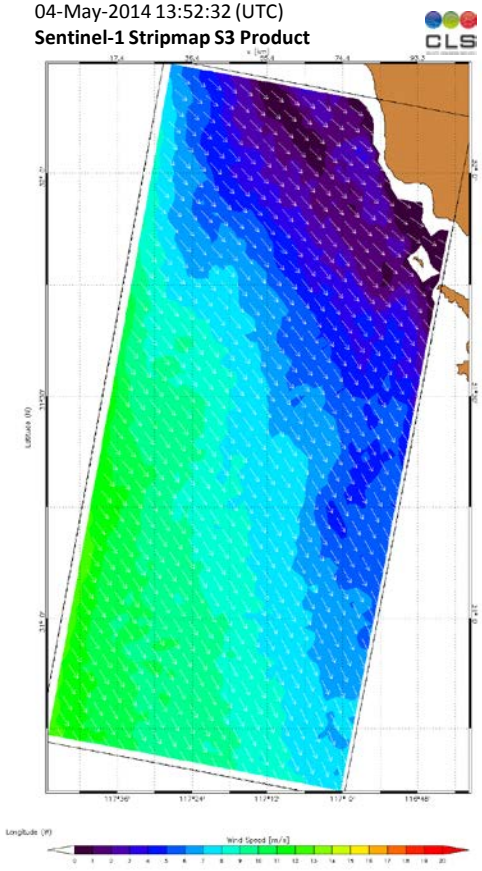
FIRST DEMONSTRATION FOR SEA STATE APPLICATIONS

First Wind measurement with S-1 A

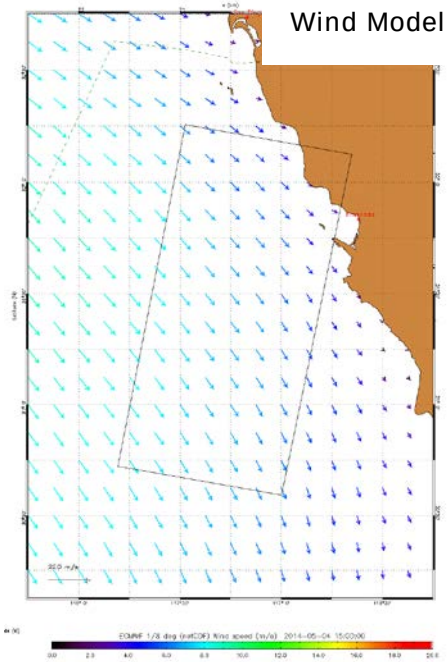
S-1 A SM Image



04-May-2014 13:52:32 (UTC)
Sentinel-1 Stripmap S3 Product



Wind Model

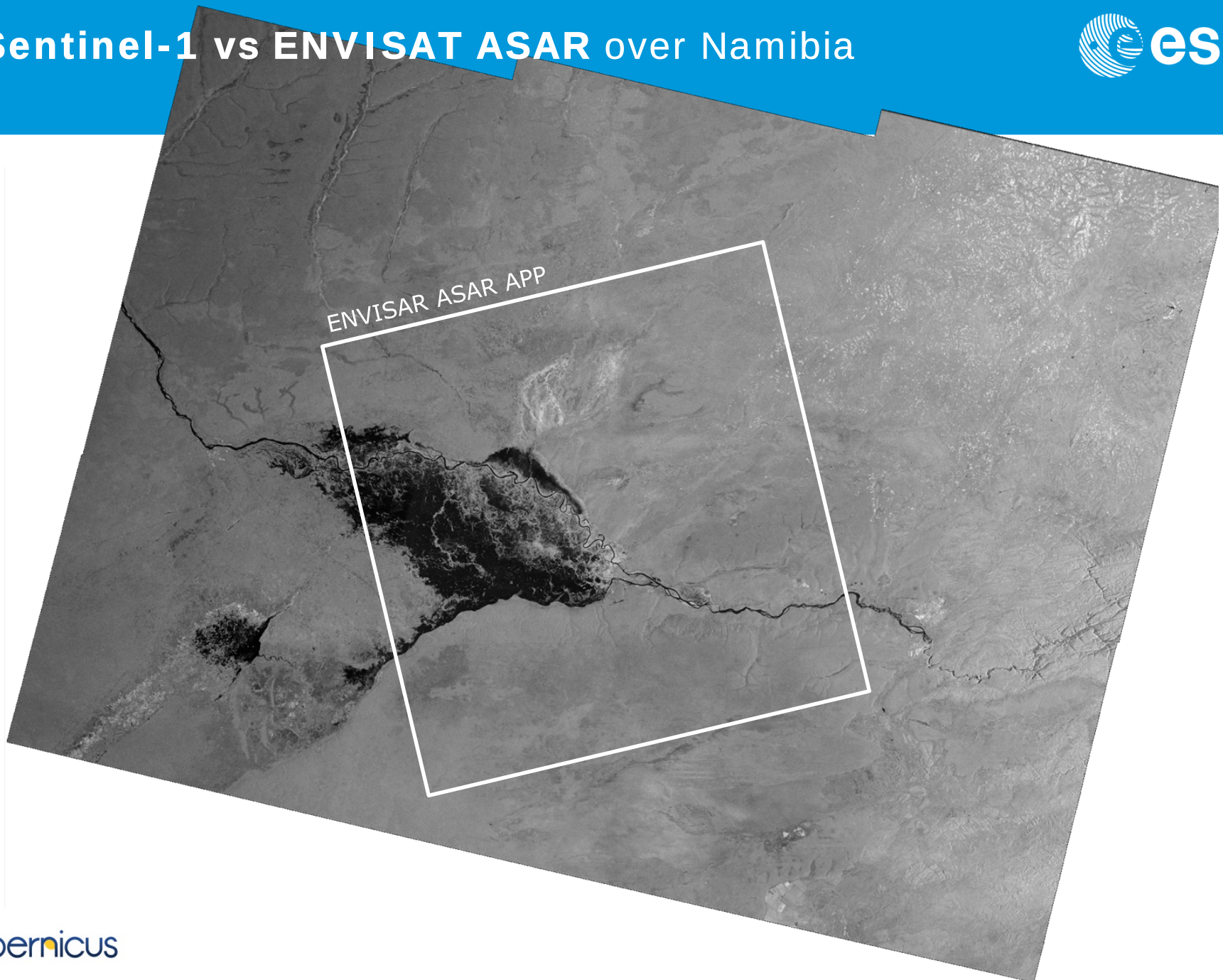


- S-1 A is able to measure relative wind variations at very high resolution (1 km here)
- Wind fields estimates will benefit from dual polarization for extreme events such as hurricanes.

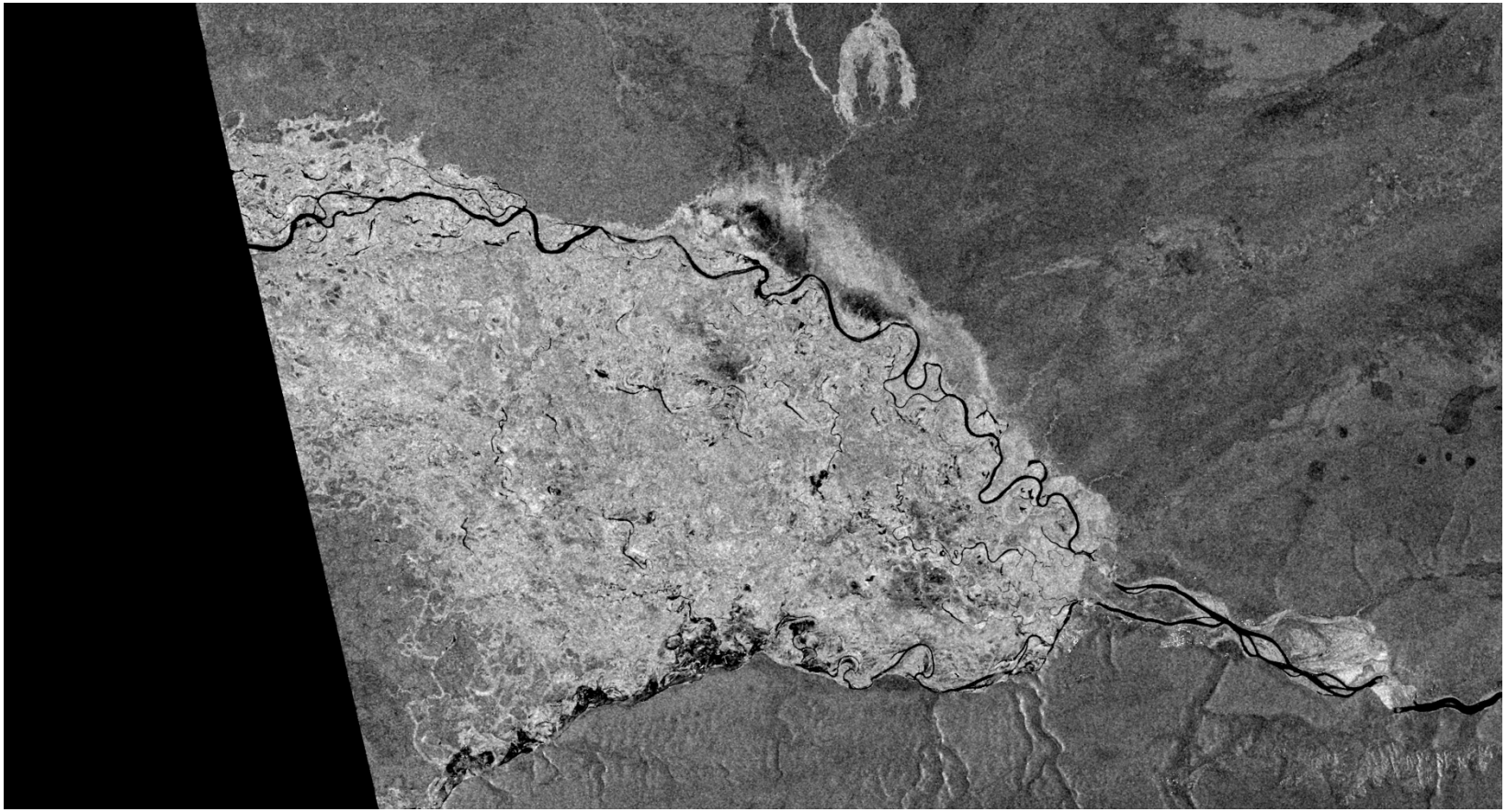
Emergency Disaster Management

Flooding
Geohazards
Natural / Man-made Disasters
etc

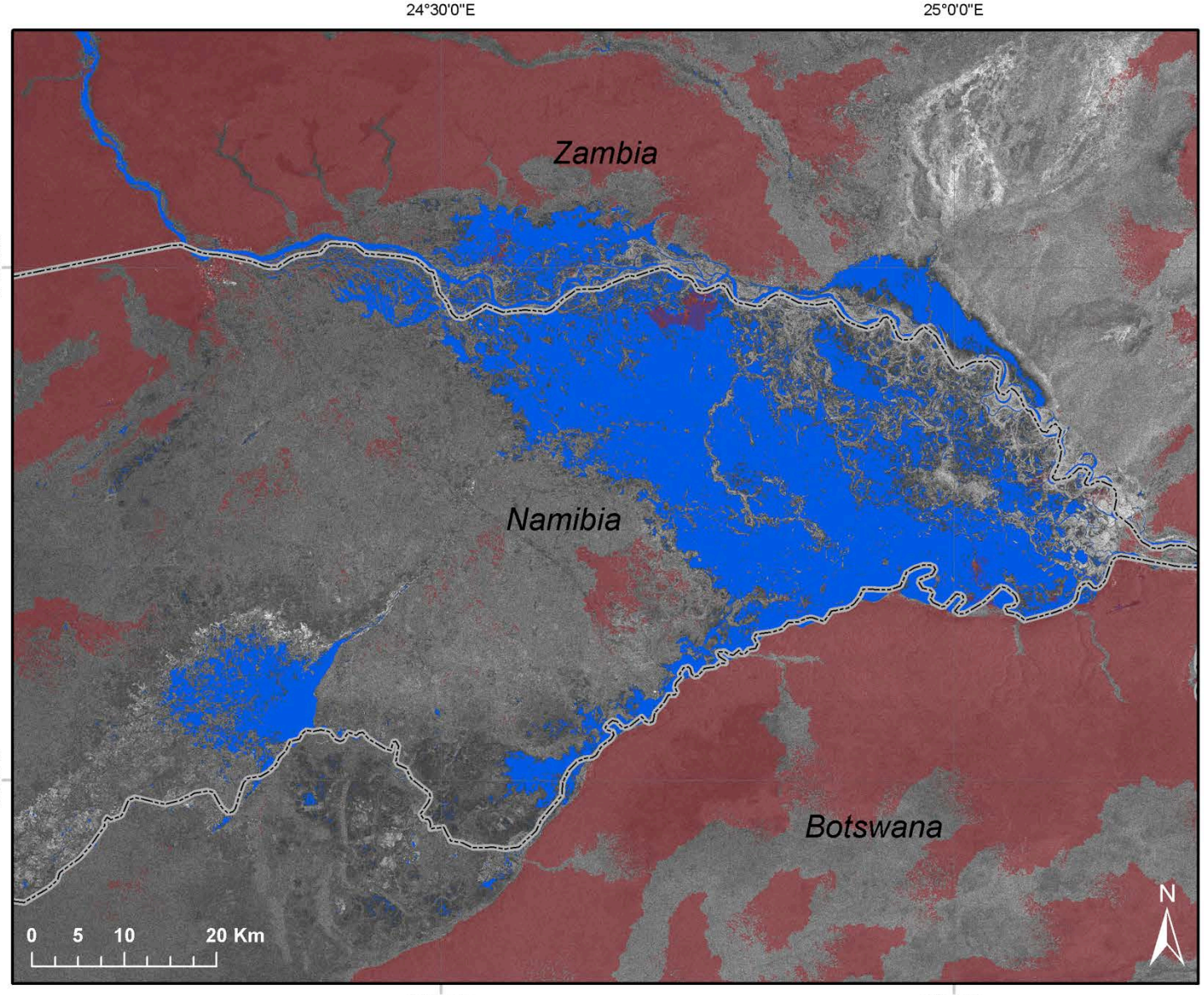
Sentinel-1 vs ENVISAT ASAR over Namibia



Flooding event captured by Sentinel-1 (Namibia)



Sentinel-1 Flood Monitoring of Caprivi Flood Plain, Namibia



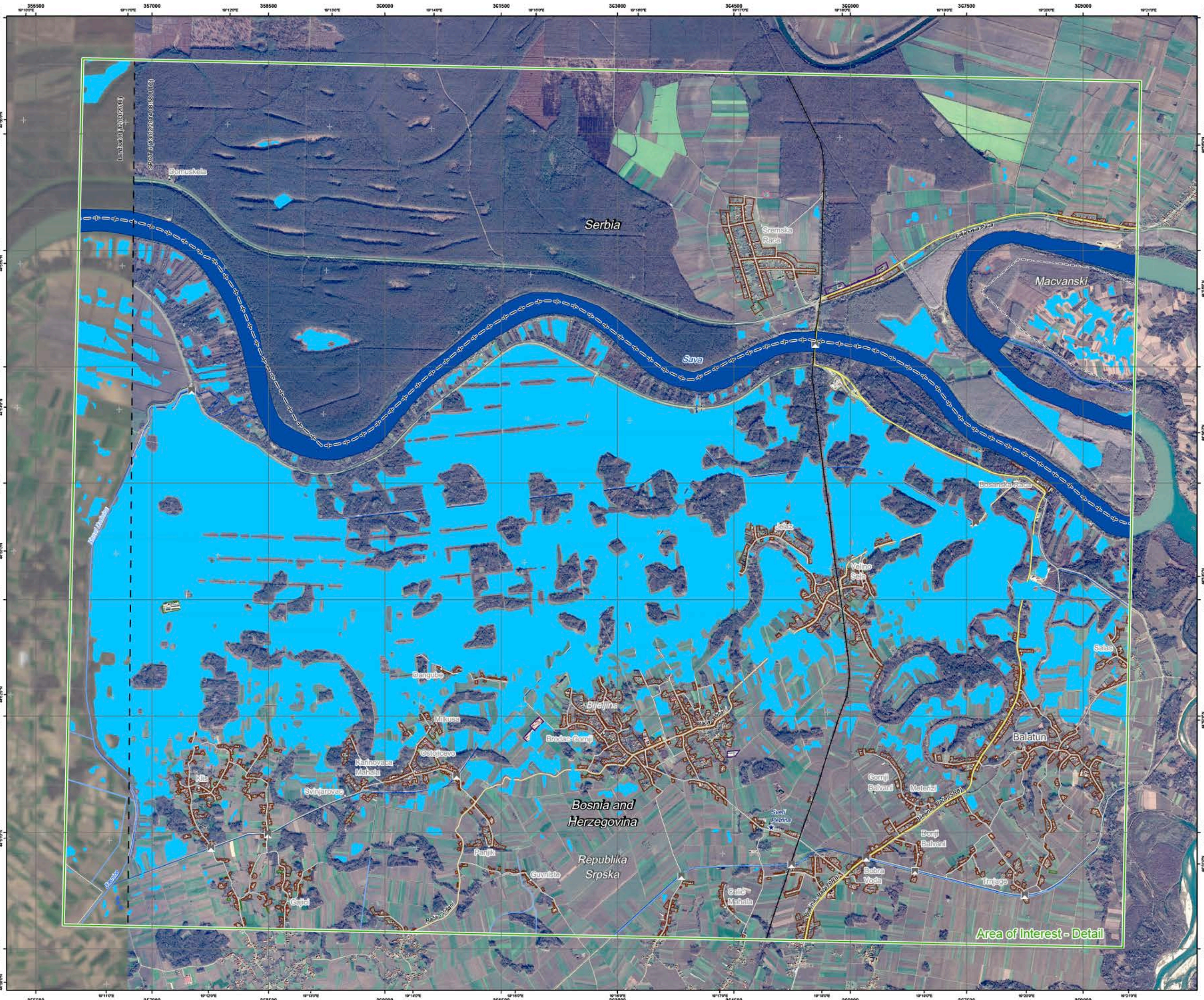
Legend

- Country border
- Derived HAND Index > 10 m
- Flooded areas

Description:
This map shows the flooding situation in the Caprivi flood plain of Zambezi River on 13th of April, 2014. The flood was delineated with the Water Observation and Information System (WOIS) based on SENTINEL-1A satellite data.

Source data:
SENTINEL-1A IW mode, 20 m resolution, acquired on 13th of April, 2014 at 03:50 GMT.
SENTINEL-1 image was provided by the European Space Agency.

Cartographic Reference
Projection: EPSG:4326
Datum: WGS 84



GLIDE number: FF-2014-000059-BIH
Activation ID: EMSR-087
Product N.: 07Balatun, v1

Balatun - BOSNIA AND HERZEGOVINA
Flood - 13/05/2014
Delineation Map - Detail

Production date: 27/05/2014

Cartographic Information

1:22500

Full color ISO A1, high resolution (300 dpi)

0 0.5 1 2 km

Grid: WGS 1984 UTM Zone 34N map coordinate system

Tick marks: WGS 84 geographical coordinate system

Legend

Crisis Information: Flooded Area (24/05/2014 16:31 UTC)

General Information: Area of Interest; Sensor Footprint

Administrative boundaries: International Boundary; Region

Settlements: Populated Place; Residential; Agricultural; Cemetery; Industrial; Religious; Transportation

Hydrology: River; Stream; Canal; River; Lake; Reservoir

Point of Interest: Religious

Transportation: Bridge; Railway; Primary Road; Secondary Road; Local Road

Consequences within the detail AOI on 24/05/2014

			Affected	Total in AOI
Flooded area		ha	3622.1	
Estimated population		inhabitants	1090	9140
Settlements	Residential	ha	1.1	472.9
	Agricultural	ha	0.7	3.7
	Cemetery	ha	0	0.8
	Industrial	ha	1.2	9.3
	Transportation	ha	0	4.4
	Religious	ha	0	0.5
Transportation	Primary roads	km	0.3	16.5
	Secondary roads	km	1.5	11.6
	Local Roads	km	7.6	80.5
	Railways	km	0	11.5
	Bridges	No.	1	13

Map Information

On 13 May 2014, heavy rainfalls and widespread flooding hit large parts of Bosnia and Herzegovina. Heavy rainfall continued to affect large parts, in particular the region of Doboj and Zenica. The core users of the maps are Disaster Response Authorities involved in operations.

Data Sources

Inset maps based on: Administrative boundaries (JRC 2013, GISCO 2010, ©EuroGeographics), Hydrology, Transportation (Natural Earth, 2012, CCM River DB © EUJRC 2007), Settlements (Geonames, 2013).

Sentinel-1A (acquired on 24/05/2014 16:31 UTC, GSD 10 m) provided by the European Space Agency.

Pre-event: SPOT6 © Airbus Defence and Space (acquired on 13/02/2014 08:58 UTC, GSD 2.6 m, 0% cloud coverage), all rights reserved, Landsat © U.S. Geological Survey (acquired on 12/03/2014, GSD 15 m, approx. 0% cloud coverage).

Base vector layers based on OpenStreetMap © OpenStreetMap contributors, GeoNames (approx. 1:10.000, extracted on 21/05/2014), refined by ITHACA. Source information is included in vector data.

Population data: Landscan 2010 © UT BATTELLE, LLC.

Elevation data: EU-DEM (25 m posting). Height in meters above mean sea level.

All Data sources are complete and with no gaps.

Dissemination/Publication

No restrictions on the publication of the mapping apply.

Delivery formats are GeoTIFF, GeoPDF, GeoJPEG and vectors (shapefile and KML formats).

Framework

The products elaborated in the framework of current mapping in rush mode activation are realized to the best of our ability, within a very short time frame during a crisis, optimising the available data and information. All geographic information has limitations due to scale, resolution, date and interpretation of the original data sources. The products are compliant with GIO-EMS RUSH Product Portfolio specifications.

Map Production

The present map shows the flood delineation in the area of Balatun (BOSNIA AND HERZEGOVINA).

The basic topographic features are derived from public datasets, refined by means of visual interpretation of pre-event orthoimagery from SPOT6 © Airbus Defence and Space (acquired on 13/02/2014 08:58 UTC, GSD 2.6 m, 0% cloud coverage).

Thematic layers, assessing the delineation of the event have been derived from post-event image Sentinel-1A (acquired on 24/05/2014 16:31 UTC, GSD 10 m) provided by the European Space Agency.

All satellite images have been radiometrically enhanced and coregistered to the pre-event image.

The estimated geometric accuracy of this product is 6.6 m CE90 or better, from native positional accuracy of the background satellite image.

The estimated thematic accuracy of this product is 85% or better, based on previous experience in using high-resolution SAR for flood extent delineation. Please be aware that the thematic accuracy might be lower in urban and forested areas due to known limitations of the analysis technique.

Map produced on 27/05/2014 by ITHACA under contract 257219 with the European Commission. All products are © of the European Commission.

Name of the release inspector (quality control): GAF AG (ODO).

E-mail: rush@ems-gmes.eu

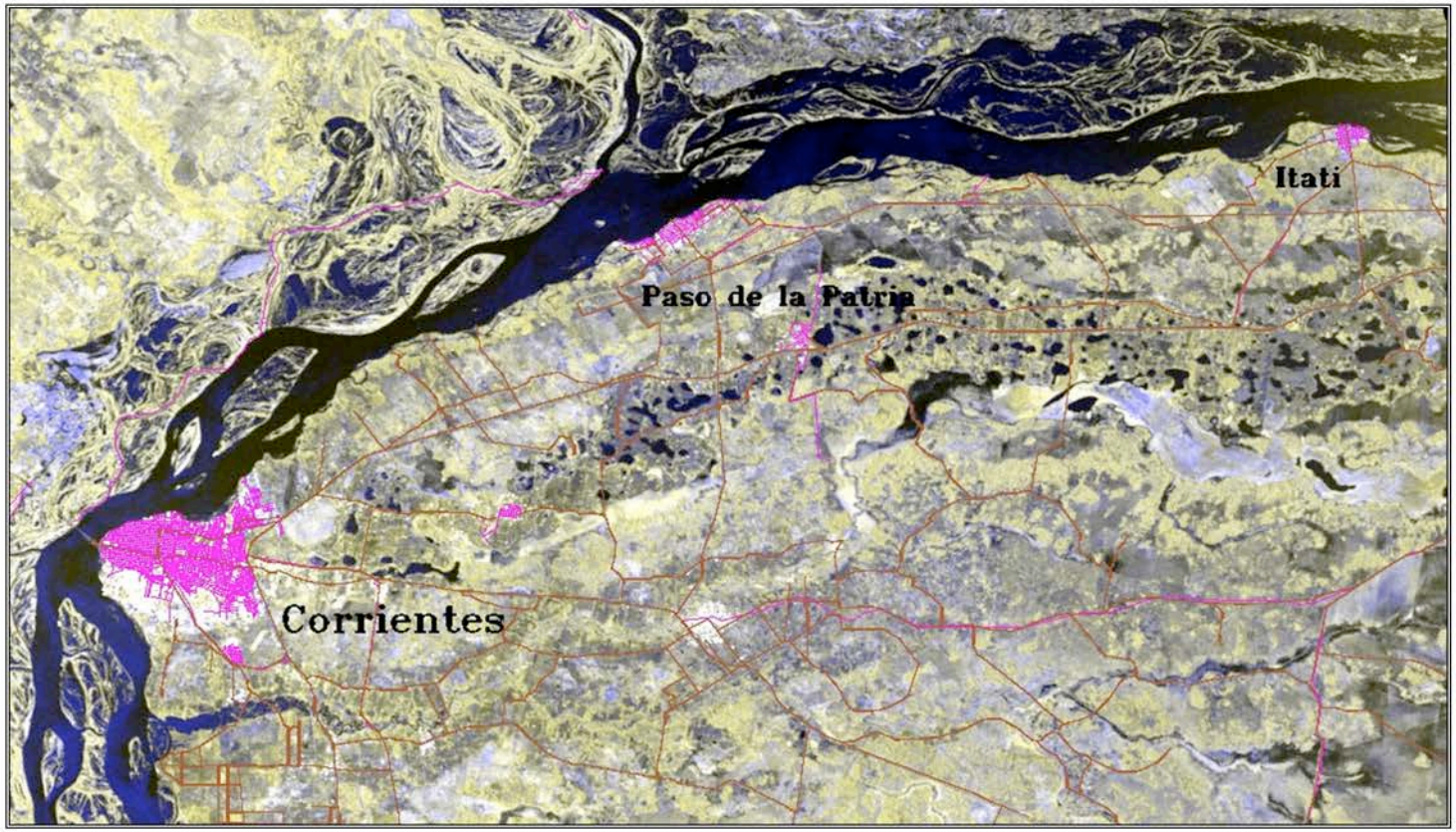
Map products available at http://emergency.copernicus.eu/mapping/list-of-components/EMSR087

Flood

- Civil Protection
- Response
- Delineation Map - Detail
- Planning
- Sentinel-1A (c) European Space Agency
- 13-05-2014

Copernicus

Paraná River's Flood Valley - June, 15 2014



Area Location

Argentinean northeast

DESCRIPTION

Sentinel-1 image acquired on June 15, 2014. Paraná River's Flood Valley in the north of the Province of Corrientes on its border with Paraguay is observed. Cities of Corrientes, Paso de la Patria and Itatí are identified . Paraná River and water bodies of the surrounding wetlands can be seen in a blue levels.

Road are drawn in brown.

Satellite Data: SENTINEL-1

Imagery Date: June, 15 2014

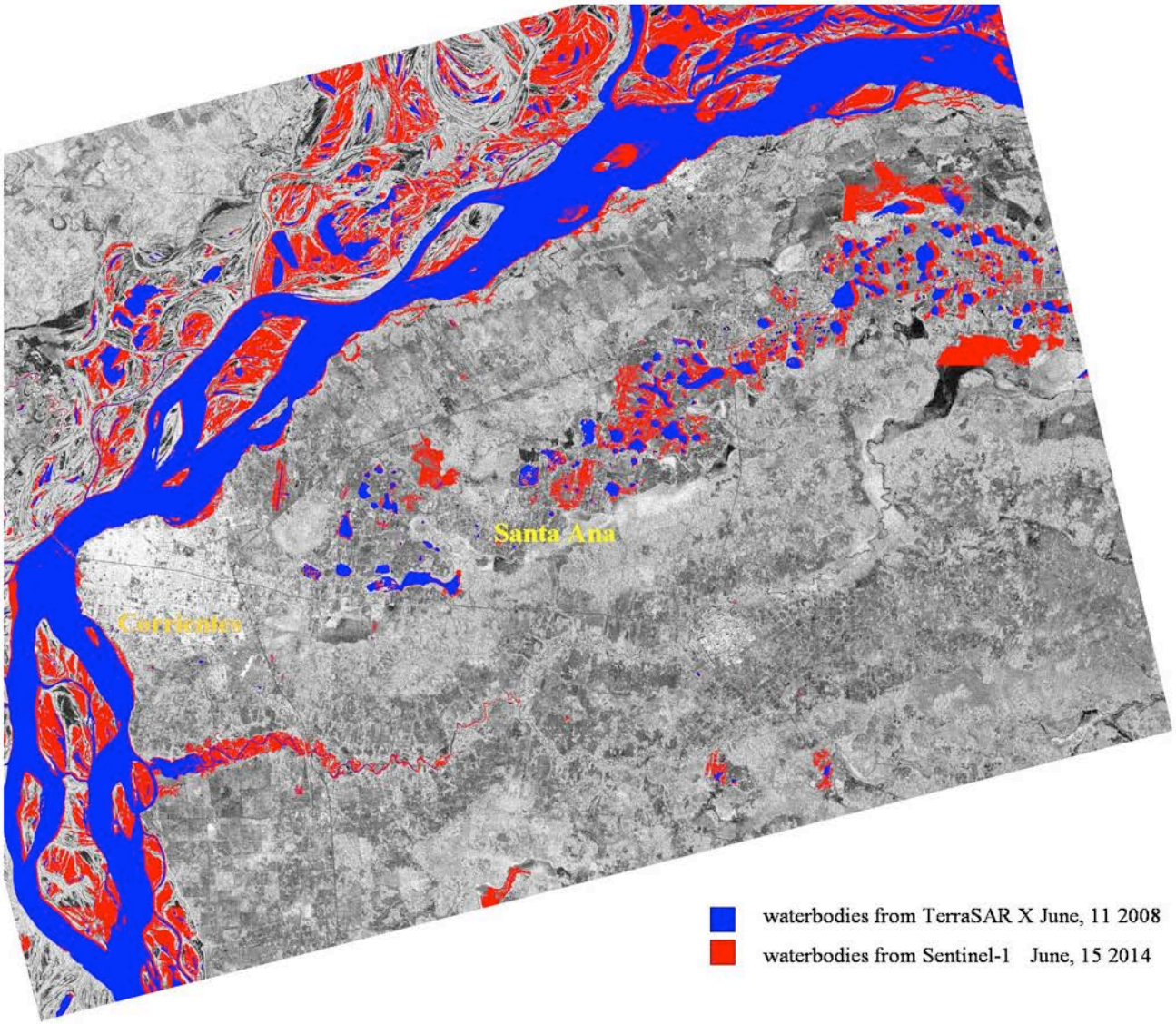
Color Composition RGB=[HV,HV,HH]

Production: CAEARTE/CONAE ML

Acknowledgement to Francesca Cecinati who exploited the data.

Charter CALL # 491

Paraná River's Flood Valley - June, 15 2014



Area Location

Argentinean northeast

DESCRIPTION

Sentinel 1 image acquired on June 15, 2014. Paraná River's Flood Valley in the north of the Province of Corrientes on its border with Paraguay is observed. Cities of Corrientes, Santa Ana are identified in yellow. Paraná River and water bodies of the surrounding wetlands at June, 11 2008 can be seen in blue, whereas flooded areas at June, 15 2014 can be seen in red.

Satellite Data: Sentinel -1, TerraSAR X.

Imagery Date: June, 15 2014 (Sentinel 1), June, 11 2008 (TerraSAR X).

Production: CAEARTE/CONAE ML

CAEARTE

CONAE

International Charter Space & Major Disasters

Charte Internationale Espace et Catastrophes Majeures

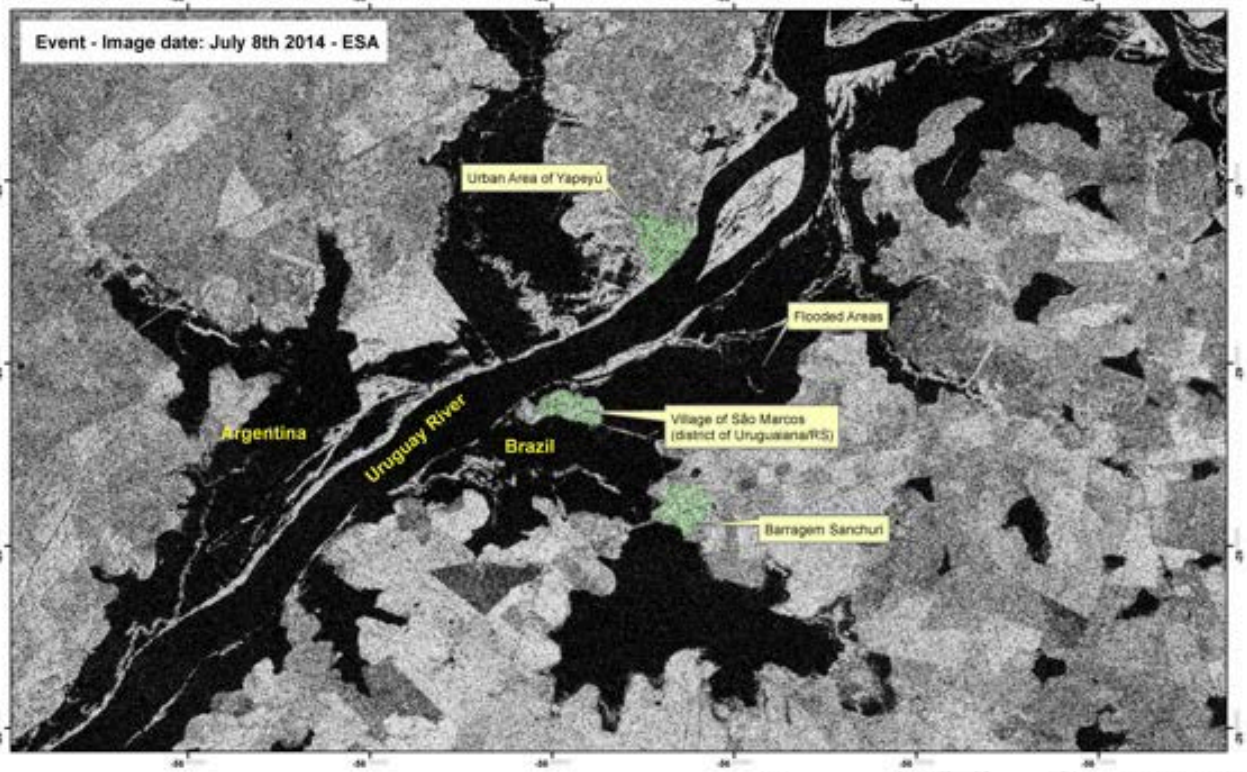
Charter CALL # 491

esa

Copernicus

DLR

BRAZIL - FLOOD - São Marcos (Uruguaiana) - Rio Grande do Sul / RS - JULY 8th 2014



N

0 1,25 2,5 5 km

1:100.000

Pre event - Image date: November 6th 2013 - Google Earth (CNES/Astrium)

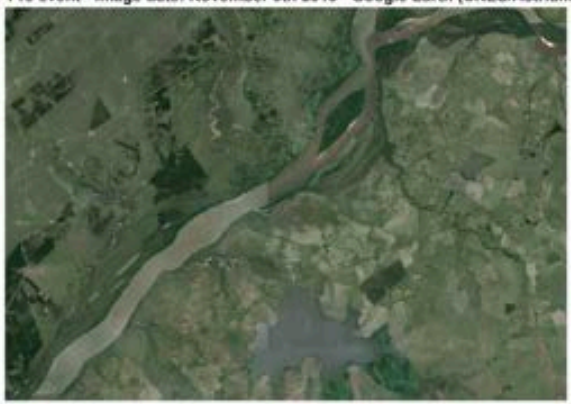


IMAGE INFORMATION:

Pre Event:
©2014 Google Earth, Image ©2014 CNES/Astrium.

Event:
Source: ESA – Sentinel-1
Acquired: July 8th 2014
Acquisition Mode: IW
Resolution: 20 m
Polarisation: HV
Copyright: © ESA 2014

Product ID: generated by CENAD (Brazilian National Risk and Disaster Menagement Center), through the agreement International Charter "Space and Major Disasters" Charter Activation ID 425, with images provided by ESA - European Space Agency

This product was generated using digital techniques and requires field verification. There is no precision mapping in this product

STANDING WATERS IN TARIND MUHAMMED PANAH AREA, PUNJAB PROVINCE, PAKISTAN

Analysis with SENTINEL-1 data 16 September 2014

This map illustrates satellite-detected areas with waters as detected by SENTINEL-1 imagery acquired the 16 September 2014 in Tarind Muhammad Panah area. The Indus and the Panjnad rivers expanded and seem to have inundated some agricultural fields along the Indus River and the Panjnad River in the Punjab Province (Pakistan). This analysis has not yet been validated in the field. Please send ground feedback to UNITAR /UNOSAT.

Disaster coverage by the International Charter 'Space and Major Disasters'. For more information on the Charter, which is about

Flood

Production Date: 9/17/2014

Version 1.0

Activation Number: FL20140910PAK

LEGEND

- City/Town
- Populated Place
- Primary Road
- Secondary Road
- Local/Urban Road
- District Boundary

WATER EXTENT ANALYSIS

- Observed Waters / Flood Affected Lands Sentinel-1 16 September 2014
- Pre-Crisis Water Extent Google Map Maker

Map Scale for A3: 1:175,000

0 1.5 3 6 9 Km

Satellite Data (1): SENTINEL-1
Imagery Dates: 16 September 2014
Resolution: 10m
Copyright: ESA
Source: ESA
Road Data : Google Map Maker / OSM / ESRI
Other Data: USGS, UNCS, NASA, NGA
Analysis : UNITAR / UNOSAT
Production: UNITAR / UNOSAT
Analysis conducted with ArcGIS v10.2

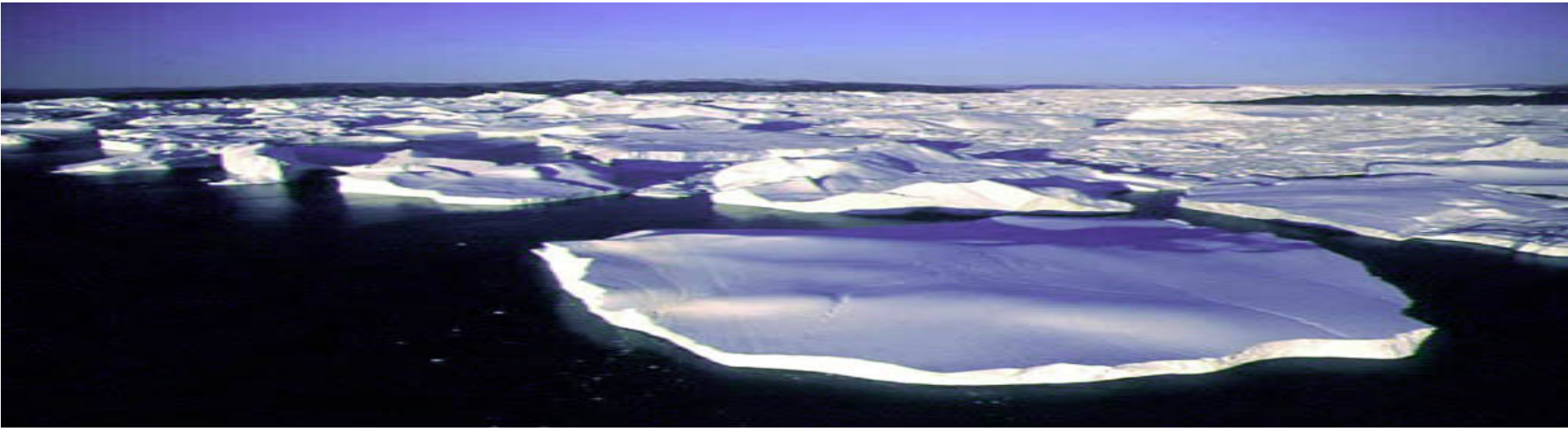
Coordinate System: WGS 1984 UTM Zone 42N
Projection: Transverse Mercator
Datum: WGS 1984
Units: Meter

unitar

UNOSAT

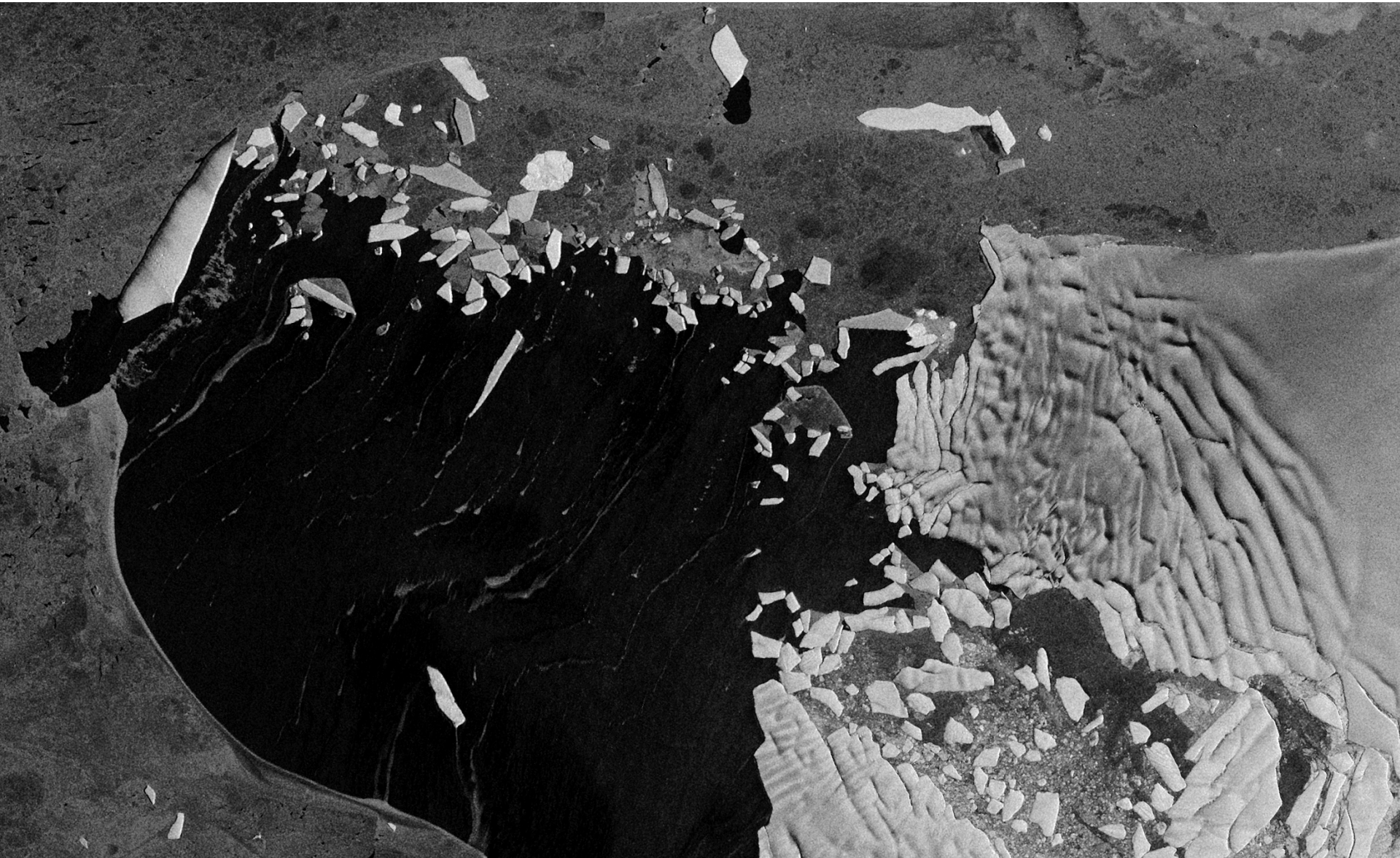
Contact Information: unosat@unitar.org
24/7 Hotline: +41 76 487 4998
www.unitar.org/unosat

Ice / Cryosphere / Climate



Sea Ice / Iceberg
Ice Sheets
Polar Monitoring
Snow

Thwaites Glacier, Antarctica

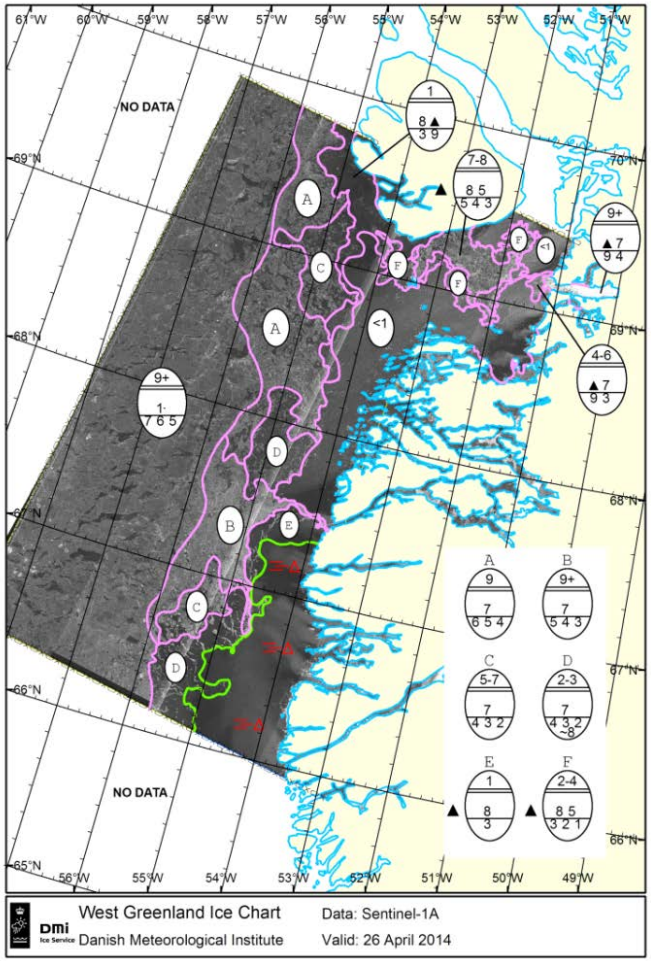


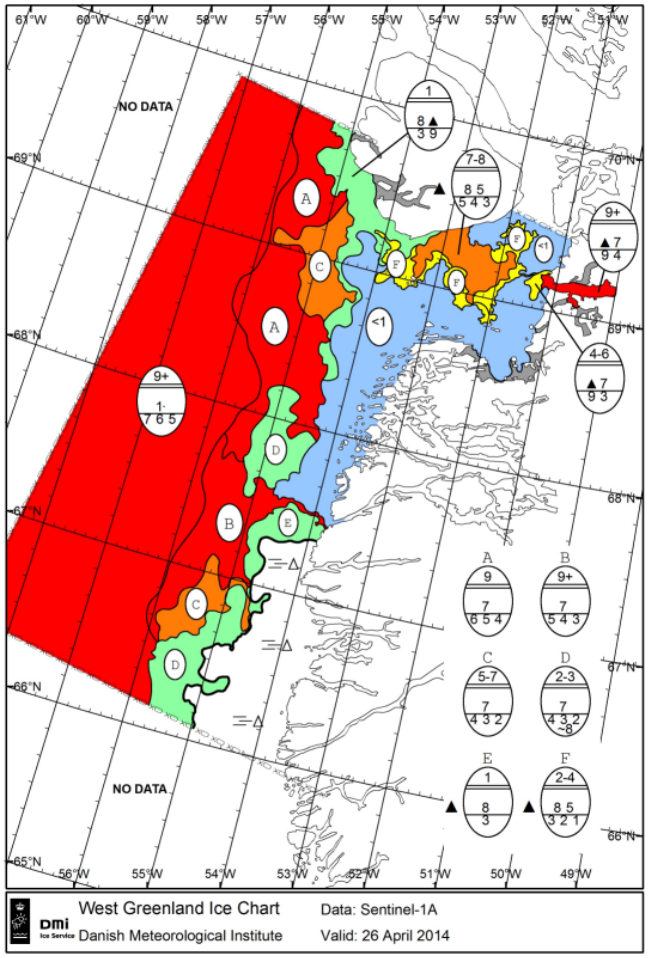
Icebergs Antarctica Peninsula from Sentinel-1A (RGB HV-HH-HH)

Post processing with Sentinel 1 Toolbox

FIRST DEMONSTRATION OF SEA-ICE APPLICATIONS WITH SENTINEL-1A DATA

The first Sentinel-1 sea-ice chart





S1A image20140426 10:10 UTC, EWS, HH

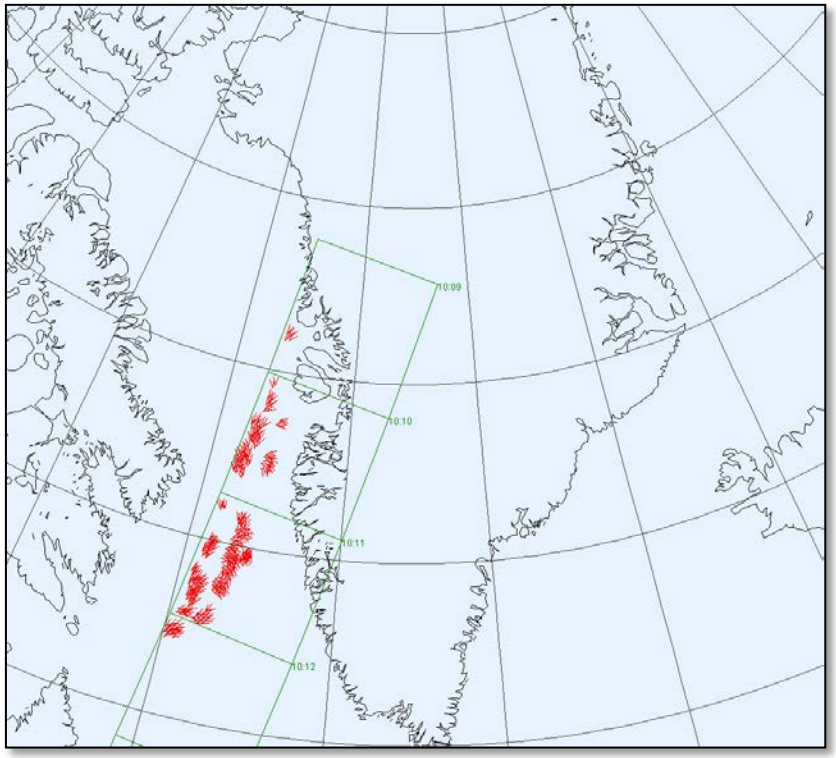
Courtesy of DMI, MyOcean

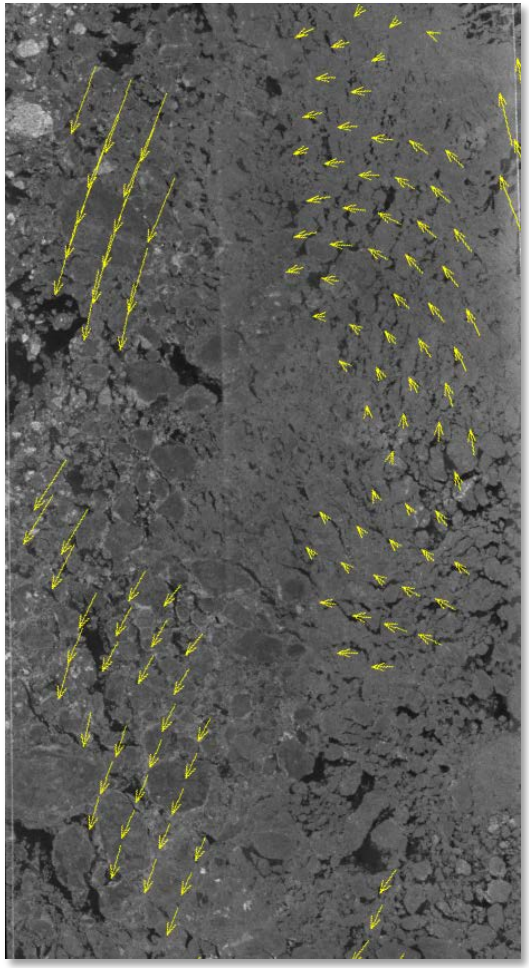
FIRST DEMONSTRATION OF SEA-ICE APPLICATIONS WITH SENTINEL-1A DATA

Arctic Sea Ice drift between April 26 and April 27, observed by Sentinel-1 and Radarsat-2

Sentinel-1A HH scenes on April 26 and

partly overlapping Radarsat-2 HH scenes from April 27





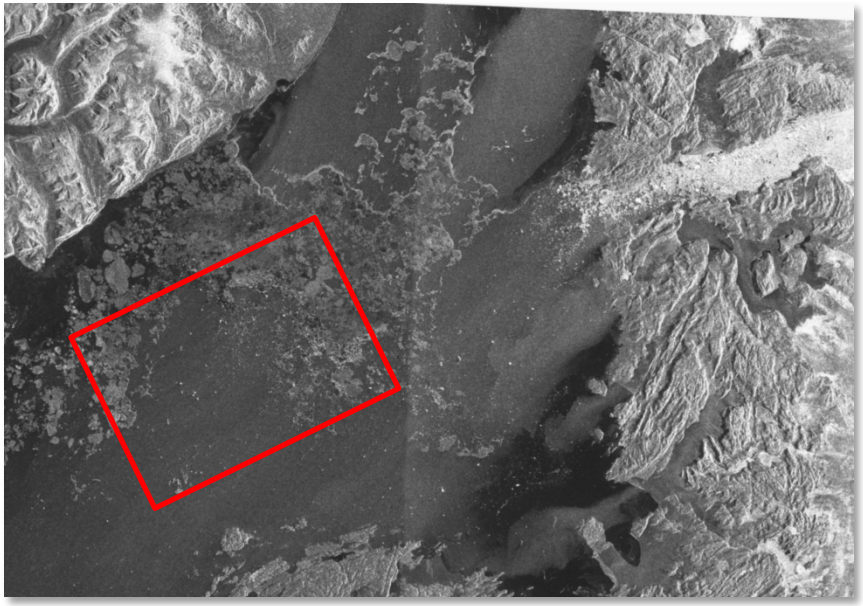
Courtesy of DMI, MyOcean

FIRST DEMONSTRATION OF SEA-ICE APPLICATIONS WITH SENTINEL-1A DATA

Icebergs in Disko Bay, Sentinel 1A, 20140426 10:10 UTC, EWS, HH+HV

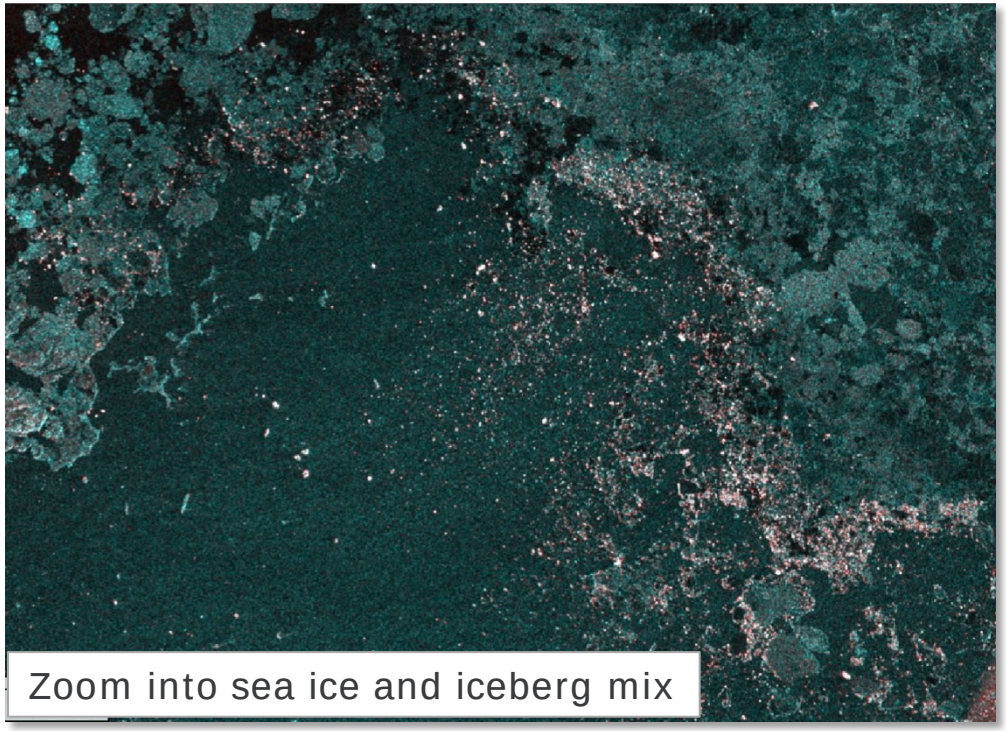
Icebergs show up pink, sea-ice in bluish colors when using dual polarisation

Single pol HH



Jakobshavn glacier pouring icebergs into Disko Bay

Dual pol HH+HV

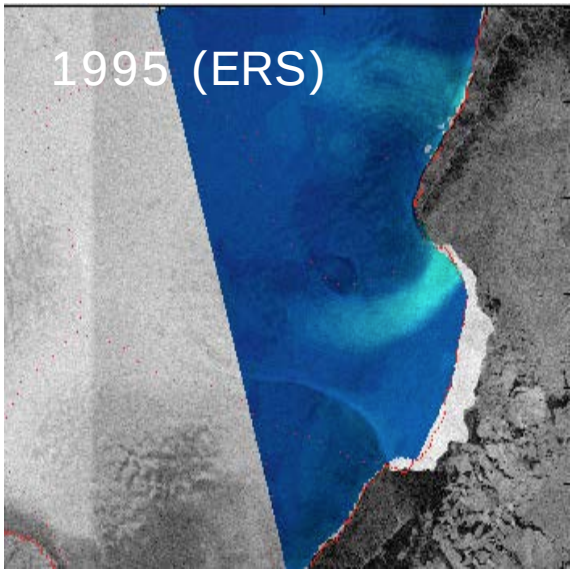


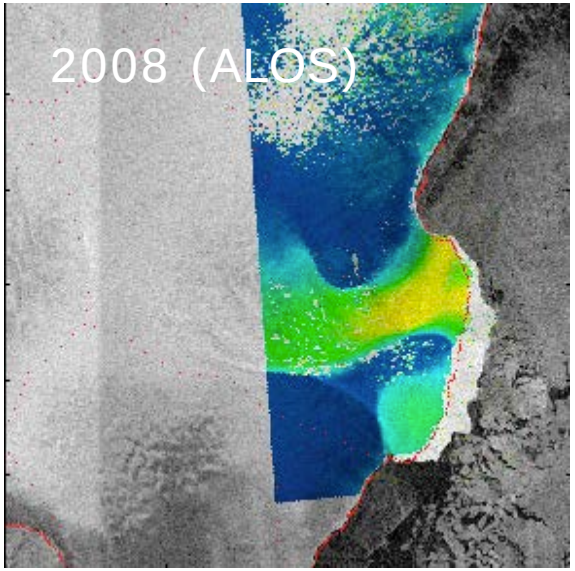
Zoom into sea ice and iceberg mix

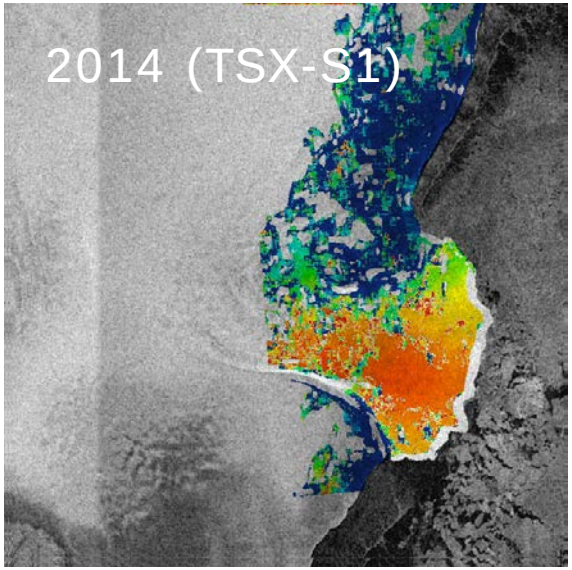
Courtesy of DMI, MyOcean

FIRST DEMONSTRATION OF ICE SPEED Measurement

- *Unique (first ever) combination of S1A stripmap and TerraSAR-X SAR data provides first map of Austfonna ice speed in 2014*
- *Data show that glacier at Cap Mohn has experienced a rapid acceleration*







Ice Speed (kilometres per year)

0 **4**

Credit: N. Gourmelen, University of Edinburgh

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Welcome to Sentinel Online, the ESA Sentinel website.

The site is constructed in such a way as to enable you to navigate easily through a variety of topics related to each Mission, Instrument, and their associated Data, as well as highlighting the Copernicus Thematic Areas served by the Missions. For more information see About sentinel online.

The GMES (Global Monitoring for Environment and Security) program has been recently renamed by the European Union to 'Copernicus'. It shall be noted that currently the content of this Website refers to the terms GMES and Copernicus alongside.

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- Greece's ups and downs
- Securing operational EU funding for GMES
- ESA-NASA collaboration fosters comparable

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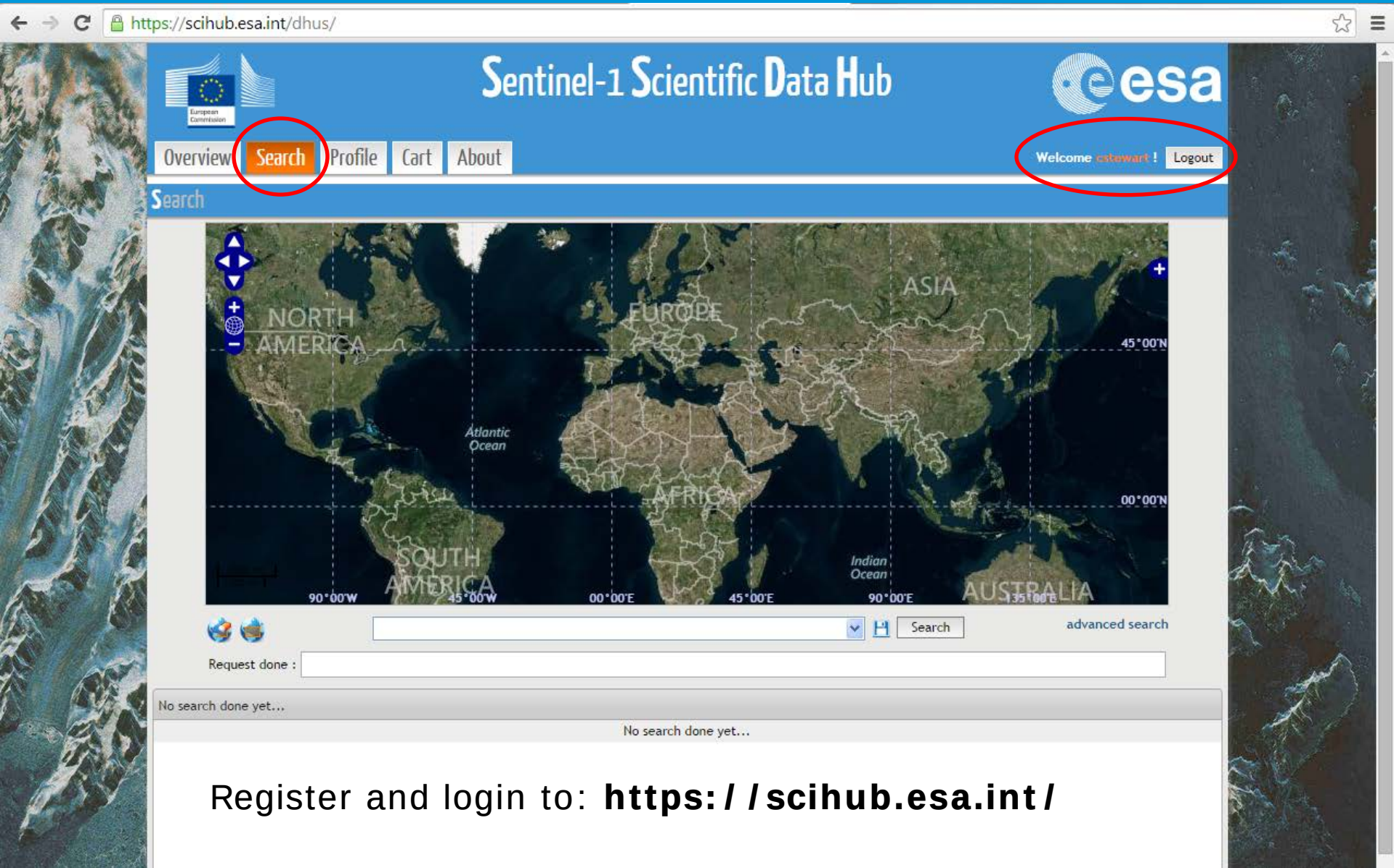
- ESA EO Image Gallery

http://sentinel.esa.int

Copernicus

Scientific Access to Sentinel-1



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Display 1 to 23 of 23 products

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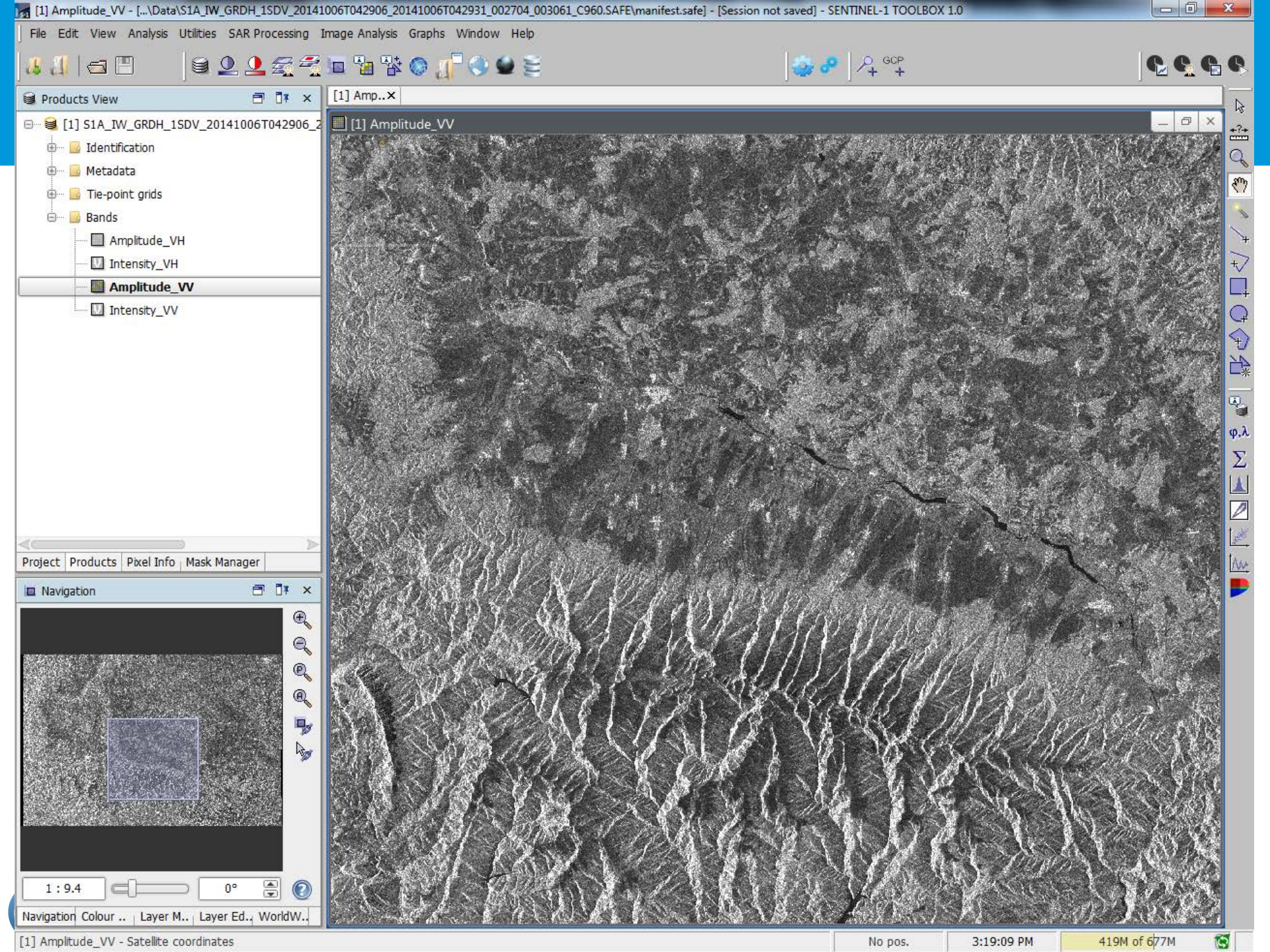
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Identification
Metadata
Tie-point grids
Bands
Amplitude_VH
Intensity_VH
Amplitude_VV
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