Live-link to ESA big data

A study to enhance the access to ESA and TPM EO products

	name *function* *company*	*date* *signature*
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1 INTRODUCTION

1.1 Purpose of this document

This document describes the results of the study accomplished by VisioTerra on behalf the European Space Agency in the framework of the purchase order n°5401001970 dated 23/09/2014 under the technical supervision of Mr. Philippe MOUGNAUD (ESRIN/EOP-GSR).

Scope of this study is threefold:

- **ESA archives** - analyse the ESA repositories storing ESA and Third-Party-Missions (TPM) Earth Observation (EO) products in term of volumes, access capabilities, available services…
- **Proofs of concept** - develop prototypes enabling to access, enhance and display ESA and TPM data on the VtWeb platform.
- **Demonstration** - demonstrate the proof of concepts through a meeting and/or in the "Big data conference" (http://congrexprojects.com/2014-events/BigDatafromSpace) at ESRIN premises.

fig. 1 - Artist view of ERS, Envisat and Sentinel-1 satellites.

1.2 Document overview

- Chapter 1 is the present section applicable to the overall document.
- Chapter 2 describes the results of the study applied to ESA+TPM archives.
- Chapter 3 describes the prototypes demonstrating the proofs of concept.
- Annex A gives statistics relative to "VtCatalog / Envisat" archive.
- Annex B gives statistics relative to "DHuS / Sentinel-1" archive.

1.3 Applicable documents

A-1 PO 5401001970
Purchase order - Study to enhance the access to ESA and TPM EO products - Live-Link to ESA big data
23/09/2014
ESA - ESRIN
..\management\20140925_Ungherese_visioterra 5401001970.pdf

A-2 VT/SR/PR/233
Live-Link to ESA big data - Study to enhance the access to ESA and TPM EO products
30/07/2014
VisioTerra
..\..\..\propositions_commerciales\P233_ESRIN_Live-link_to_ESA_big_data.pdf

1.4 Reference documents

This section describes the related documents and applied conventions to be considered within the present document.

1.4.1 EO data portals

R-1 G-POD
grid processing on demand
ESA
https://gpod.eo.esa.int/

1.4.2 Sentinel-1

R-2 Web S1 UG
SENTINEL-1 SAR User Guide Introduction
2014
ESA
https://sentinel.esa.int/web/sentinel/user-guides/sentinel-1-sar

R-3 Web DHuS
Sentinel-1 Scientific Data Hub -
Welcome to the Sentinel-1 Scientific/Other use Data Hub
2014
ESA - SERCO / GAEL Consultant
https://scihub.esa.int/

R-4 Web DHuS API
Sentinel-1 Scientific Data Hub -
The Data Hub Application Programming Interfaces (APIs)
Rev. 57 - 08 Dec. 2014
ESA - SERCO / GAEL Consultant
https://scihub.esa.int/userguide/BatchScripting

R-5 Web Obs. Plan
SENTINEL-1 Observation Scenario
2014
ESA
https://sentinel.esa.int/web/sentinel/missions/sentinel-1/observation-scenario

1.4.3 Big Data

R-6 ISBN 978-0-9825442-0-4
The Fourth Paradigm - Data-Intensive Scientific Discovery
Second printing, version 1.1, October 2009
Edited by Tony Hey, Stewart Tansley, and Kristin Tolle - Microsoft Research
http://research.microsoft.com/en-us/collaboration/fourthparadigm/4th_paradigm_book_complete_lr.pdf
..\reference_documents\4th_paradigm_book_complete_lr.pdf

R-7
A model for the scientific exploitation of Earth observation missions: The ESA research and service support
P/G. Marchetti & al. - March 2012
IEEE Geoscience and remote sensing newsletter
..\reference_documents\ngrs_NL_0312.indd - ngrs_NL_0312-Webv2.pdf

R-8
Proceedings of the 2014 conference on Big Data from Space (BIDS'14)
Edited by P. Soille and P.G. Marchetti
12th - 14th November 2014, Frascati (Italy)
..\reference_documents\20141112-14_Proceedings_of_Big_Data_from_space.pdf

R-9
On the preservation and application of climate data records in a ig data world
Ed. Kearns, NOAA's National Climatic Data Center
BIDS'14, 12 November 2014
..\reference_documents\20141112_Kearns_On_the_preservation_and_application_of_climate_data_records_in_a_big_data_world.pdf

R-10 Web
fedeo - Federated EO missions support environment.
http://www.opengeospatial.org/projects/initiatives/fedeo
http://geo.spacebel.be/opensearch/readme.html

R-11 Web
GeoViQua - QUAlity aware VIsualisation for the Global Earth Observation System of systems.
http://www.geoviqua.org/

R-12
Towards Data Management Principles
GEO XI - 13-14 November 2014
..\reference_documents\GEO-XI_07_Towards GEO Data Management Principles-Report of the Data Management Principals Task Force.pdf

1.4.4 OGC

R-13 OGC 07-118r8 — *User Management Interfaces for Earth Observation Services*
Version 1.0, 2010-09-08
Open Geospatial Consortium Inc.
..\reference_documents\07-118r8_User_Management_Interfaces_for_Earth_Observation_Services.pdf

1.5 Abbreviations and Acronyms

This section controls the definition of all abbreviations and acronyms used within this document. Special attention has been paid to adopt abbreviations, acronyms and their definitions from international standards as ISO, ANSI or ECSS.

ANSI	American National Standards Institute
AOCS	Attitude and Orbit Control System
AOI	Area Of Interest
AOT	Aerosol Optical Thickness
ASAR	Advanced Synthetic Aperture Radar (Instrument of Envisat)
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
BOA	Bottom Of Atmosphere
CAL	Calibration
CAL/VAL	Calibration and Validation
CCA	Cloud Cover Assessment
CCN	Cloud Cover Notation
CCSDS	Consultative Committee for Space Data Systems
CRS	Coordinates Reference System
CryoSat	Cryogenic Satellite (mission of ESA to study the cryosphere)
DEM	Digital Elevation Model
DHuS	Data Huh Services
DN	Digital Number
DS	Data Set
ECMWF	European Centre for Medium-Range Weather Forecasts
ECSS	European Cooperation for Space Standardization
Envisat	ESA polar SATellite for ENVIronment monitoring
EO	Earth Observation
EOP	Earth Observation Product
ERS	European Remote Sensing satellite (ESA)
ESA	European Space Agency
ESRIN	European Space Research Institute
ETM+	Enhanced Thematic Mapper (instrument of Landsat 7)
EUMETSAT	European Organisation for the Exploitation of Meteorological satellites

FR	Full Resolution
FTP	File Transfer Protocol
GB	Giga Bytes (=10^9 bytes)
GeoTIFF	Geocoded Tagged Image File Format
GIS	Geographical Information System
GM	Global Monitoring (observation mode of Envisat ASAR)
GMES	Global Monitoring for Environment and Security
GOCE	Gravity field and steady-state Ocean Circulation Explorer
GOME	Global Ozone Monitoring Experiment
G-POD	Grid Processing on demand
HDF	Hierarchical Data Format
HTTP	Hyper-text transfer protocol
JERS-1	First Japanese Earth Resource Satellite
KML	Keyhole Markup Language
KMZ	Keyhole Markup Language document compressed in a ZIP file
KNMI	Königlich-Niederländisches Meteorologisches Institut
MB	Mega Bytes (=10^6 bytes)
MERIS	Medium Resolution Imaging Spectrometer (instrument of Envisat)
NASA	National Aeronautics and Space Administration
OGC	Open Geospatial Consortium
OLI	Optical Land Imager (instrument of Landsat-8)
RADAR	RAdio Detection And Ranging
SAR	Synthetic Aperture Radar
Swarm	Constellation of three satellites (ESA) to study the magnetosphere and ionosphere
SWIR	Short Wave Infrared
TB	Tera Bytes (=10^{12} bytes)
TBC	To Be Confirmed
TBD	To Be Defined
TIFF	Tagged Image File Format
TM	Thematic Mapper (instrument of Landsat-4 and Landsat-5)
TOA	Top Of Atmosphere
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VIS	Visible
VNIR	Visible and Near Infrared
W3C	World Wide Web consortium
WGS84	World Geodetic System 1984

WMO	World Meteorological Organization
WMS	Web Map Service
WSM	Wide Swath Mode (observation mode of Envisat ASAR)
WWW	World Wide Web
XML	eXtensible Markup Language
XSL	eXtensible Stylesheet Language
XSL-FO	eXtensible Stylesheet Language – Formatting Object
XSLT	eXtensible Stylesheet Language Transformation
CNES	Centre National d'Etudes Spatiales
HRG	Haute Résolution Géométrique (instrument de SPOT-5)
HRS	Haute Résolution Stéréoscopique (instrument de SPOT-5)
HRV	Haute Résolution Visible (instrument de SPOT-123)
HRVIR	Haute Résolution Visible et Infrarouge (instrument de SPOT-4)
SPOT	Satellite Pour l'Observation de la Terre

1.6 Definitions

This section provides the definition of all common terms used within this document. Special attention has been paid to adopt definitions from international standards as ISO, ANSI or ECSS.

geocoded	An image (or more generally any EO data) is geocoded if a simple relation exists giving the geodetic coordinates (λ,φ) or (X,Y) of the attached geodetic system, from the coordinates of any point (i,j) of the image.

2 TECHNICAL STUDY

2.1 Introduction

2.1.1 Scope of the study

Scope of this study is to analyse the features of some of the biggest archives of ESA and to suggest a modern way for users to browse and watch these data. The selected archives are analysed in depth and the ESA staff in charge of managing these various archives may also find interesting figures in the present report.

The in-depth analysis concerns the:

- data inventory - in order to efficiently manage "remote databases" to enable presenting users to find the products matching spatial and temporal criteria,
- data volume and availability - in order to enable users to navigate inside the products of interest seeking for particular details,
- data dissemination - in order to make know the potential of the EO products to reveal an exception, to catch a particular event, to share views of the EO products with the least possible data transfer.

2.1.2 New paradigms

2.1.2.1 Big data

More missions for… more data

As shown in the figures below and just mentioning the two main spatial agencies, the number of missions and the volume of the EO data have dramatically increased leading to a huge amount of data.

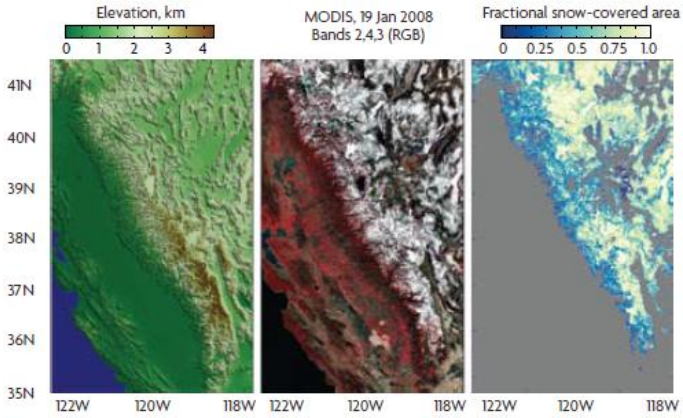
fig. 2 NASA (left) and ESA (right) Earth observation fleets.

More data processing for… more data

For many data providers, enhancements in the algorithms or refinements of the exogenous data leads to a "data reprocessing" of the long term archive to produce a dataset version (n+1). In many cases, the previous versions are kept because they have been disseminated and the data provider wants to keep a trace of them. These numerous versions multiplies the size of the archives.

More data for… more merged data

In *The Fourth Paradigm* (R-6), chapter "*The emerging science of environmental applications*", Jeff Dozier shows that large volumes of observed data (here SRTM elevation data and MODIS scenes on the left and middle of the attached figure) enable to produce new data like the "fractional snow-covered area" (see the rightmost image of the attached figure).



More data for… more temporal data

In the same way, the growing interest to the climate change leads to consider always growing time series. Improvements of the algorithms and of the data lead to a growing number of data reanalysis.

More data for… more workshops

Regarding the Earth observation in Europa, the growing interest to big data has motivated at least three workshops gathering each time a large number of scientists and EO data users :

- BIG DATA FROM SPACE, 5-7 June 2013, ESA-ESRIN, Frascati, Italy http://www.congrexprojects.com/2013-events/13c10/announcement
- Copernicus Big Data workshop, 13-14 March 2014, EC, Brussels, Belgium - http://www.copernicus.eu/pages-secondaires/events/event-detail/?tx_julleevents_pi1%5BshowUid%5D=533&cHash=6b72b992422ee703f83e7c6de4c7e697
- BiDS'14, 12-14 November 2014, ESA-ESRIN, Frascati, Italy - http://congrexprojects.com/2014-events/BigDatafromSpace/introduction

2.1.2.2 Data policy

The free data policy is becoming the norm except for very-high resolution data. In many case, users are invited to register providing with various information regarding their profile, their domains of interest, the expected use of the data…

This uncontrolled data dissemination is not always in relation with the capabilities of massive distributions requested from the infrastructures.

2.1.2.3 Bandwidth

The speed of exchanged data across the Web has dramatically increased, but certainly not in the same proportions of the increase of data volumes to be managed by the infrastructures.

In the same time, the numerical divide between developed countries and emerging countries is going always sharper. As an example, the ERAIFT School attached to the University of Kinshasa (DRC) VisioTerra is working with will not be able to download the new Sentinel products.

2.1.2.4 From data self-consistency to the cross-fertilisation of datasets

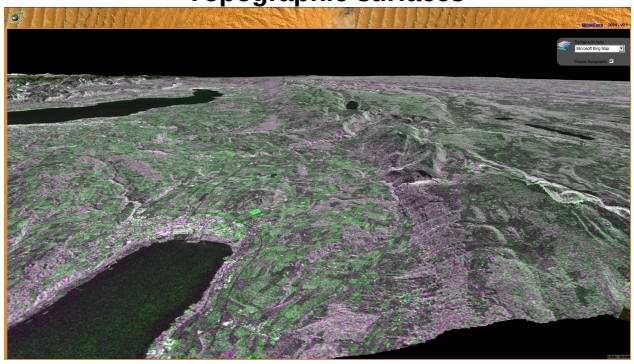
Images distributed by agencies bring answers to many questions (what is the location of the cyclone, the extents of the oil spill, the height of the subsidence…) and many users only wants to know if this information is given by the EO data or not.

But many users are not fully satisfied by the information given by the image alone. To achieve a better understanding of the context, they would like to get immediately some extra information like:

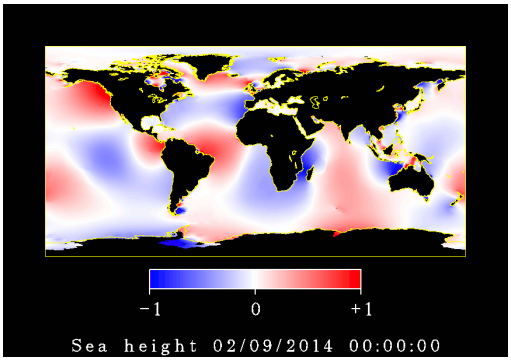
- questions addressed to Earth Observation agencies and scientists
  - what were the colours of the landscape at the time of this radar acquisition??
  - what was the tide height at the time of the acquisition?
  - what were the direction and strength of the wind at the time of this acquisition?
  - what were the moisture level and possible precipitations at the time of this acquisition?
  - what it the land cover / land use in this zone of the image?
  - what is the topography in this zone?
  - …
- questions addressed to Earth sciences experts:
  - what are the underlying lithology, fracturing, stratigraphy dips…?
  - …
- questions addressed to the civil protection:
  - how was dispatched the population at the time of this storm surge approach?
  - what is the state of the circulation network?
  - what was the level of the population information / warning?
  - …

These requests from our end-user customers have lead VisioTerra to develop modules to access a large variety of datasets like:

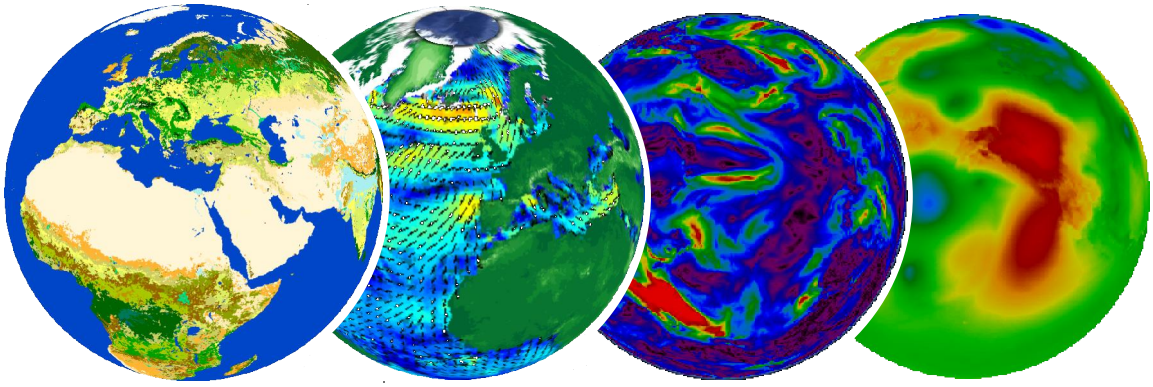
Topographic surfaces



tidal models



Land use / land cover (KML) **winds** **temperature** **pressure**



2.1.2.5 Technics of data access

Modern fluxes of data (see fig. 32) requires sophisticated modes to access the part of data of interest. When user wants for example to access only certain bands of certain lines of an image, the data provider should offer such a possibility. The "Data Request Broker (DRB)" developed by GAEL Systems (see http://www.gael.fr/drb/) gives this possibility. Unfortunately, this solution is not offered by most of the data providers.

For the developers having a good knowledge of the organisation (format) of the EO products and if the "data provider" has enabled this access, OpenDAP (http://www.opendap.org/) gives the possibility to seek a defined location in the target file and to download the part of interest.

2.1.2.6 Interoperability

Many standards have been published to enable exchange of data and services. Most of them are endorsed by the **Open Geospatial Consortium (OGC)**. See for example one of these standards in R-13.

2.1.3 New requirements

2.1.3.1 Bringing users to EO data

In the recent period, one may hear many political declarations inviting to manage the **access of European citizen to data**. These data shall be immediately available, free, easy to access, enhanced, matching the user domain.

During the "Copernicus Big Data Workshop" held on 13-14 March 2014 in Brussels, (see http://gmes.gov.cz/sites/default/files/documents/POSTER%20BIG%20DATA.pdf) organisers of the European Commission have presented two dissemination models:

- Dissemination models Part 1 – Bringing the data to the users
- Dissemination models Part 2 – Bringing the users to the data

Ed. Kears (R-9) during the BIDS'14 organized by ESA defines the ""**End User Computing" Platform (EUC)** is one of many IT industry buzzwords, defined as: data services delivered in such a way that the user need not be aware of how or where these services are provisioned."

More data requiring… more education

Ambition to bring "citizen to data" implies a strong effort of education. As an example, everybody who would like to assess the vegetation cover in the place of their future holidays should be enabled and trained to activate a colour composition of optical bands involving the near infrared or better displaying a pseudo-colour NDVI. Such a possibility is for example not offered by the most popular virtual globe: Google Earth.

2.1.3.2 More information and fewer downloads

Users browse and watch the EO data where they are. If the information he/she is interesting in is found, only a small subset of the enhanced EO data is download. In most of the cases, the amount of downloads will dramatically decrease.

2.1.3.3 Sharing the information

User shall be enable to share the view of the EO data. He/she must be allowed to add comments, metadata, collocated documents… to this "EO view".

2.1.3.4 Enhancement from scientists

Scientists (like whatever other citizen) shall be allowed to easily submit and control a processing unit to the "data access infrastructure" hosting the EO data.

A particular concern of many people in ESRIN to keep the possibility for scientists to access raw data despite the fears to see the GSE (former GMES Service Elements) to monopolize the access to data.

2.2 Analysis of the ESA archives

2.2.1 "Earthnet / G-POD" to VtCatalog archive

2.2.1.1 Introduction

Envisat / ASAR data of the G-POD archive (see fig. 3) have been copied on the VtWeb infrastructure hosted in VisioTerra premises.

In the same way, Envisat / MERIS / FRS data (see fig. 4) have been copied from the "mercifrs" FTP portal.

These downloads have been supplemented by successive EOLI orders (see fig. 5) in the framework of CAT-1 projects of VisioTerra.

fig. 3 - G-POD portal (http://gpod.eo.esa.int/).

fig. 4 - MERIS / FRS portal (http://merisfrs-merci-ds.eo.esa.int/merci/welcome.d).

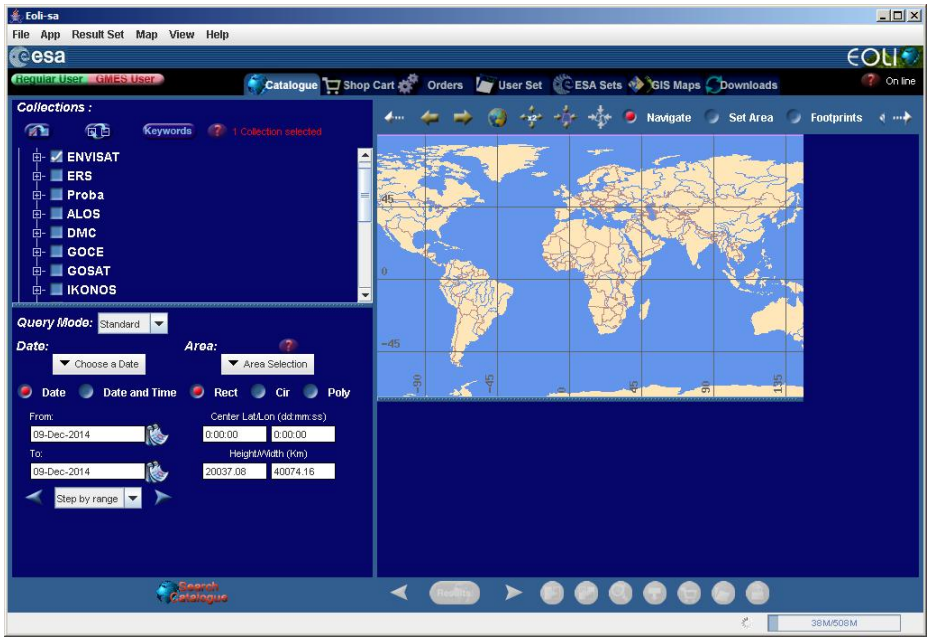


fig. 5 - EOLI Stand Alone application.

2.2.1.2 Data inventory

Inventory has been performed for each one of the beam modes and processing modes. Statistical results and figures are given in ANNEX A.

2.2.2 "Sentinel" missions

2.2.2.1 Introduction

DHuS data access

On **6 October 2014**, a newsletter has been sent by ESA informing that Sentinel-1A become available (https://sentinel.esa.int/web/sentinel/news/-/article/sentinel-1-data-now-available)

Access to Sentinel-1 (S1) data via the Scientific Data Hub (DHuS) is granted to users in two ways:

- DHuS portal - A classical EO data portal (see fig. 6) enables users to define spatial, temporal and other technical criteria (https://scihub.esa.int/dhus/)
- DHuS API - A set of services are available to programmers to automatically get S1 lists, metadata and/or products through a dedicated API (R-4). This API has been used to produce the report of this section.

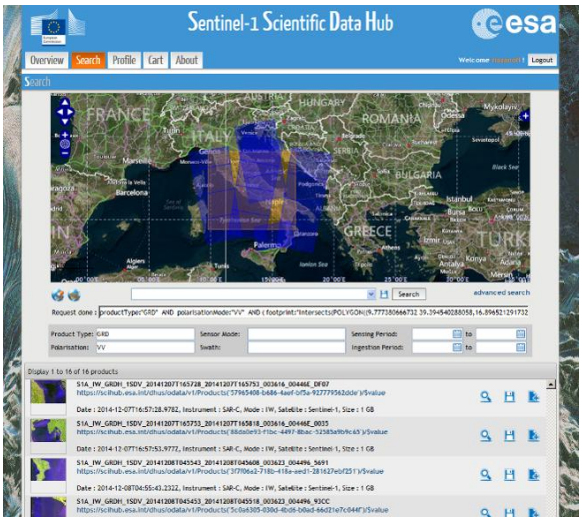


fig. 6 - DHuS "Search" portal.

Product naming

The names of S1 products complies with the syntax summarized here after.

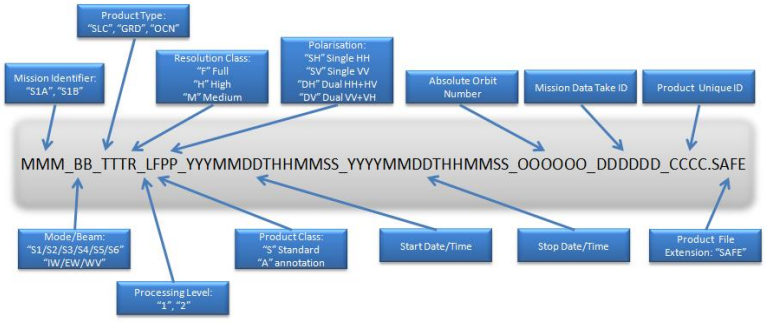


fig. 7 - S1 naming conventions (https://sentinel.esa.int/web/sentinel/user-guides/sentinel-1-sar/naming-conventions).

Acquisition scenarii

The occurrence maps of this section 2.2.1.2 may be compared to the acquisition scenarii given in R-5. Figures below show two successive acquisition scenario matching the start of the period object of the present study.

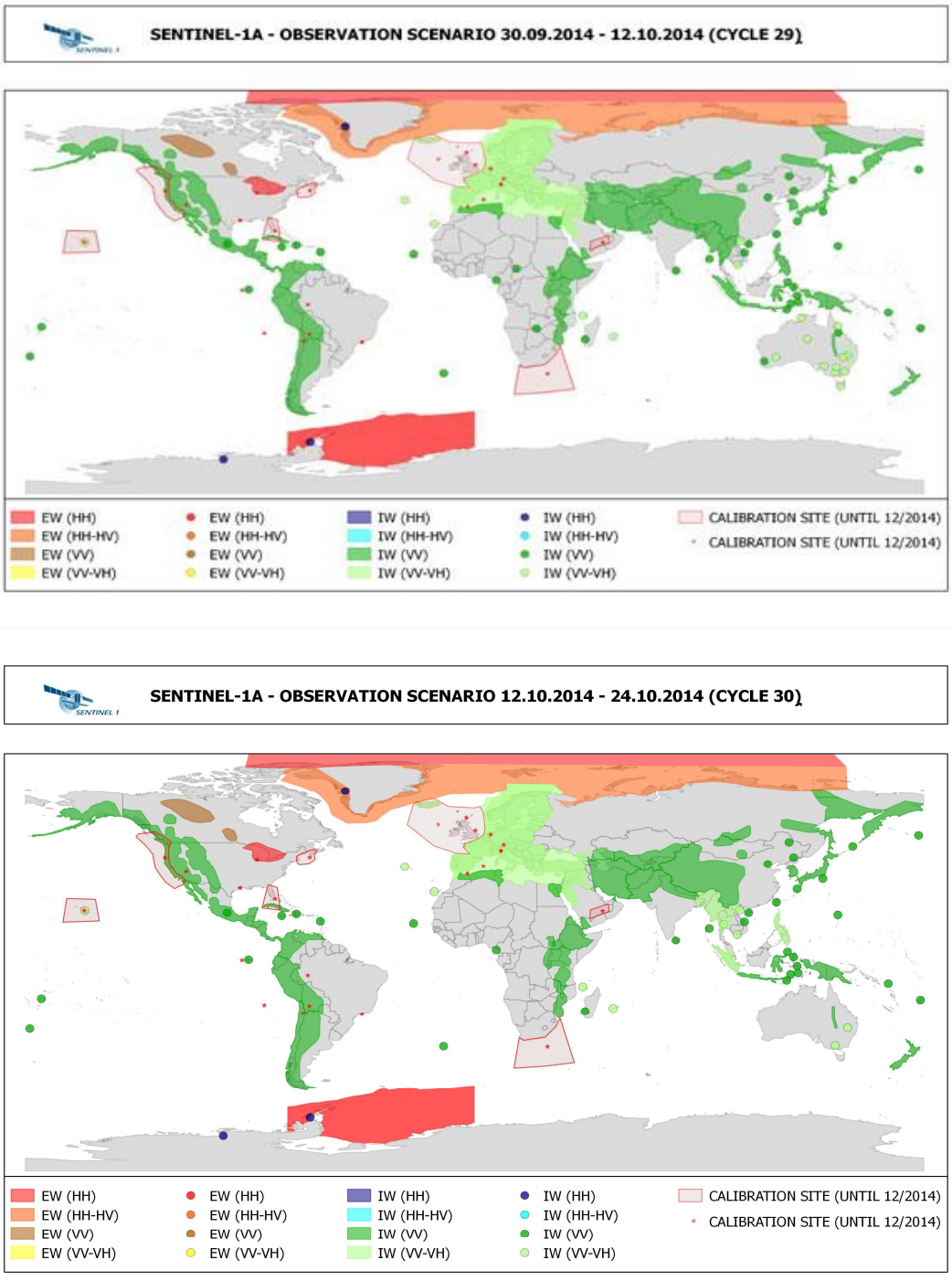


fig. 8 - Two of the Sentinel-1 observation scenarii.

2.2.2.2 Data inventory

Inventory has been performed for each one of the beam modes and processing modes. Detailed statistical results and figures are given in ANNEX B.

The overall acquisitions shown in fig. 84 are repeated in fig. 9 to underline the compliance with the observation scenario schown in fig. 8.

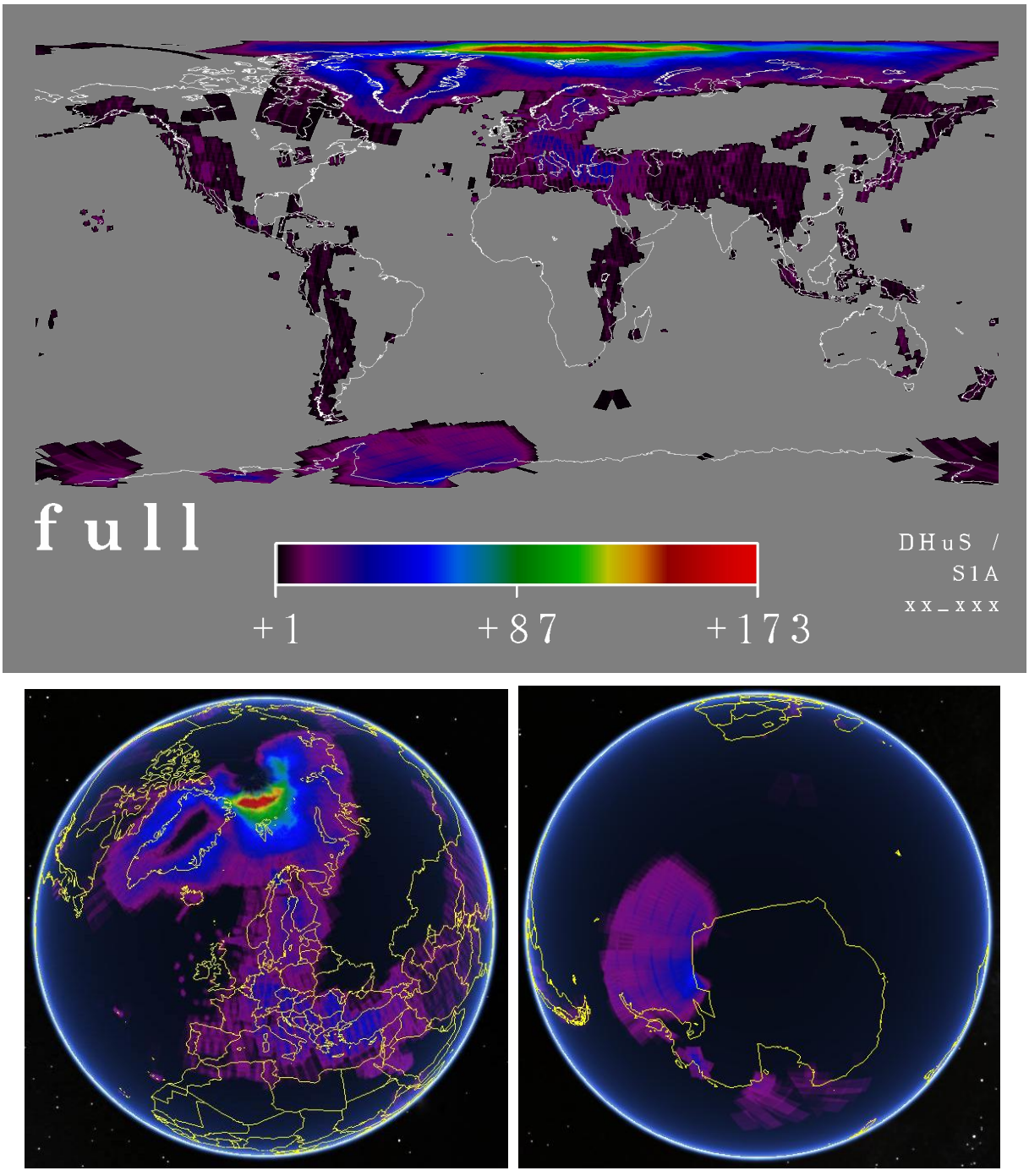


fig. 9 - ESA / DHuS / S1A / C-SAR / xx_xxx (overall) occurrences map
(..\data\DHuS\S1A\xx_xxx\jpg_full\xx_xxx.occ.cal.card.gra.tit.tif
..\data\DHuS\S1A\xx_xxx\jpg_full\xx_xxx.occ.cal.card.gra.kmz).

2.2.2.3 DHuS / S1A / C-SAR - Distribution of. RAW, SLC, GRD

RAW, SLC and GRD vs. TOTAL

Curves of fig. 11 show the distribution of RAW, SLC and GRD processing levels in the overall (TOTAL) item number and content length. Table here below summarizes this distribution.

processing levels	RAW	SLC	GRD
item number vs. TOTAL of **14 472** items.	**3 774** items **26.1 %**	**2 054** items **14.2 %**	**8 644** items **59.7 %**
content length vs. TOTAL of **26 894** GB.	**3 905** GB **14.5 %**	**15 461** GB **57.5 %**	**7 529** GB **28.0 %**

table 1 - Item number and content length of RAW, SLC and GRD products vs. the overall products in DHuS.

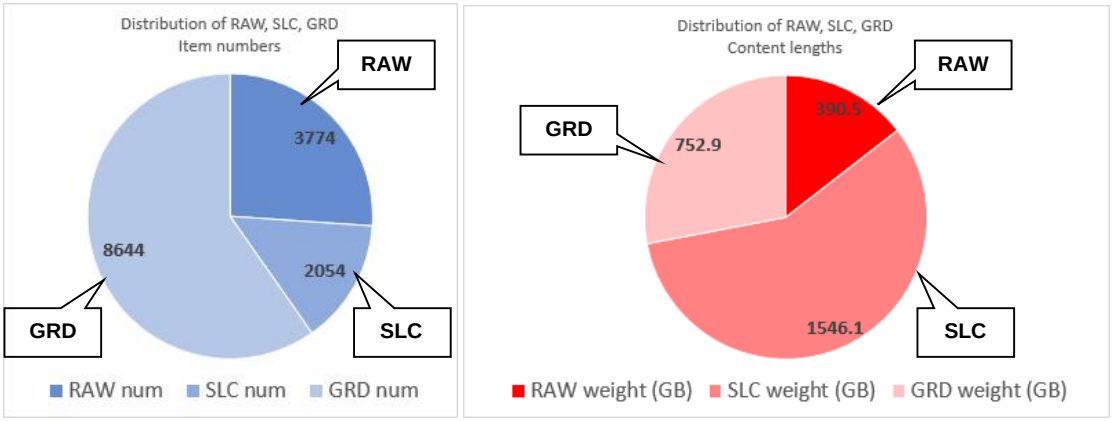
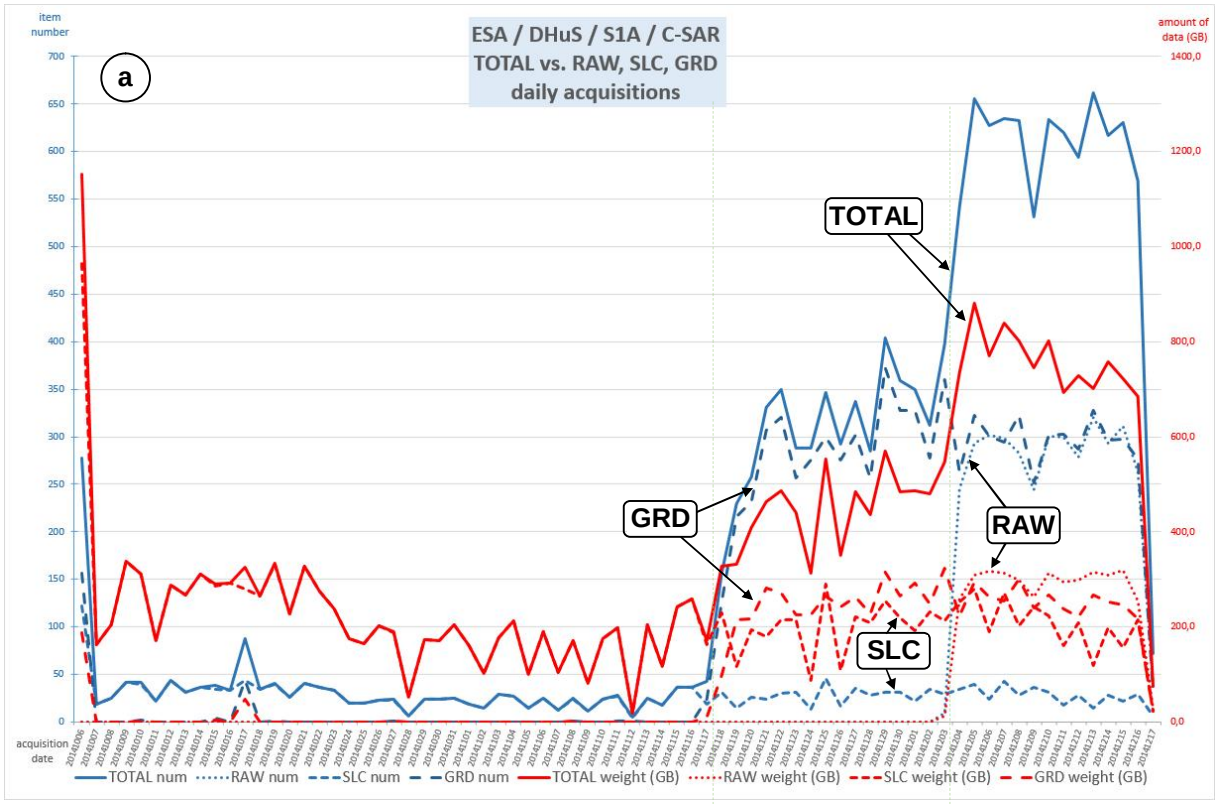


fig. 10 - Item number (left) and content length (right) of RAW, SLC and GRD products vs. overall products in DHuS

Main events

Curves of fig. 11 enables to distinguish at least the three events set in evidence in diagram b:

- 06/10/2014 - Official start of the public access to DHuS - A total of 278 products were already available for a total amount of 1 152 GB: 122 SLC (964 GB) and 156 GRD (188 GB).
- 17/11/2014 - Regular GRD delivery - Since this date around 320 S1A GRD products are regularly delivered per day.
- 03/12/2014 - Regular RAW delivery - Since this date around 290 S1A RAW products are regularly delivered per day.



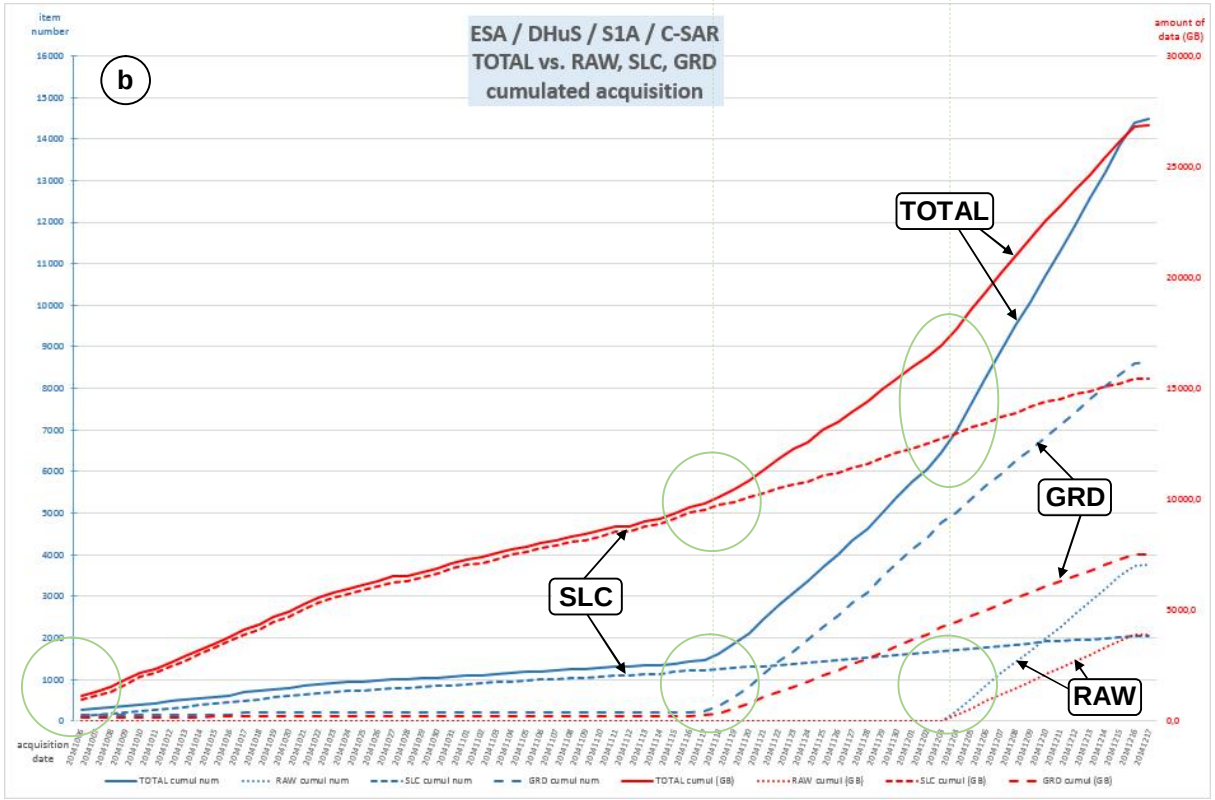


fig. 11 - Daily acquisition of S1A/C-SAR instrument in all the modes and for all (TOTAL) versus the RAW, SLC and GRD processing levels.

Mean product length

These statistics computed along the two first months of activity of DHuS enable to assess a mean content length for each product.

processing levels	RAW	SLC	GRD
Mean content length	**1.03 GB**	**7.53 GB**	**0.87 GB**

table 1 - Mean content length for RAW, SLC and GRD processing levels.

Figures fig. 12 and fig. 13 clearly show this non-linearity between the number of items and the memory space required for the various processing levels (RAW, SLC and GRD). The SLC processing level requires 8 to 10 times the size of RAW or GRD data.

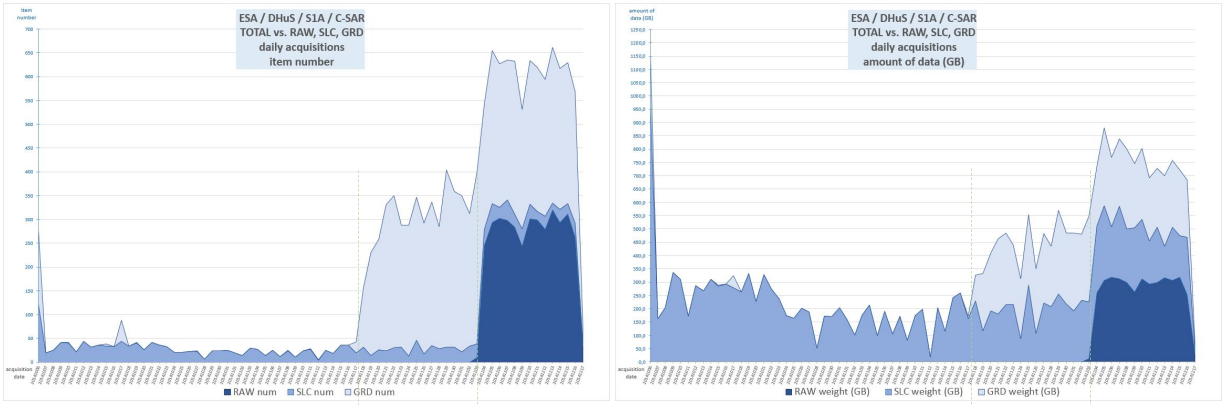


fig. 12 - Daily acquisition of S1A/C-SAR - Comparison of RAW, SLC and GRD processing levels in terms of item numbers and amount of data.

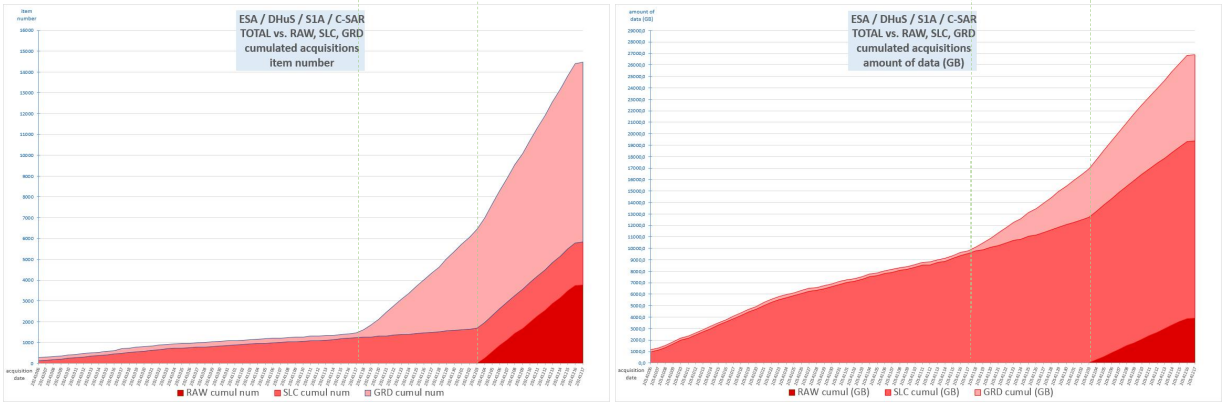
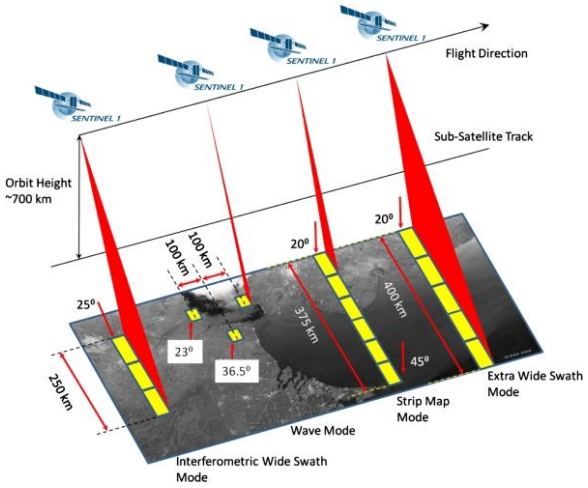


fig. 13 - Cumulated acquisitions of S1A/C-SAR - Comparison of RAW, SLC and GRD processing levels in terms of item numbers and amount of data.

2.2.2.4 DHuS / S1A / C-SAR - Distribution of. EW, IW, SM

As shown in the Sentinel-1 user's guide (R-2) at page https://sentinel.esa.int/web/sentinel/user-guides/sentinel-1-sar/acquisition-modes from which the attached figure has been extracted, C-SAR instrument of Sentinel-1 is operating in one of the four modes:



- **EW - Extra-Wide swath** - Acquisition through 5 sub-swaths of a 400 km swath, with a spatial resolution of 20mx40m in dual polarisation (HH+HV or VV+VH) or single polarisation (HH or VV).
- **IW - Interferometric Wide swath** - Acquisition through 3 sub-swaths of a 250 km swath, with a spatial resolution of 5mx20m in dual polarisation (HH+HV or VV+VH) or single polarisation (HH or VV).
- **SM - Stripmap** - Acquisition of a 80 km swath with 6 possible beam elevations (S1, S2, S3, S4, S5 or S6), with a spatial resolution of 5mx5m (single look) in dual polarisation (HH+HV or VV+VH) or single polarisation (HH or VV).
- **WV - Wave** - No WV product has been found in DHuS archive when the present report has been written.

EW, IW and SM vs. TOTAL

Curves of fig. 15 show the distribution of EW, IW and SM acquisition modes in the overall (TOTAL) item number and content length. Table here below summarizes this distribution.

acquisition modes	EW	IW	SM
item number vs. TOTAL of **14 472** items.	**3 904** items **27.0 %**	**9 631** items **66.5 %**	**937** items **6.5 %**
content length vs. TOTAL of **26 894** GB.	**2 094** GB **7.8 %**	**24 029** GB **89.3 %**	**771** GB **2.9 %**

table 2 - Item number and content length of EW, IW and SM products vs. overall products in DHuS.

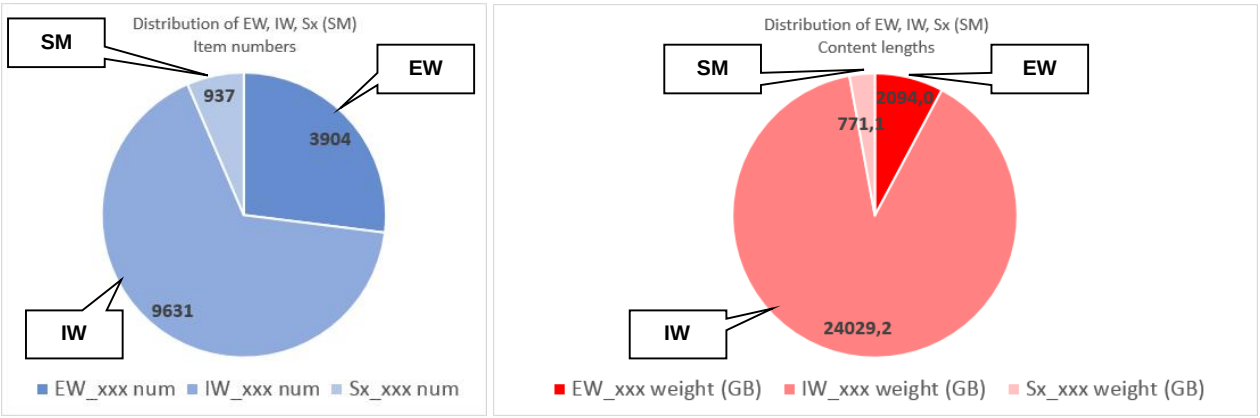


fig. 14 - Item number (left) and content length (right) of EW, IW and SM products vs. overall products in DHuS

Main events

Like for the RAW, SLC and GRD distribution analysis (see previous section 2.2.2.3) the three events identified in fig. 11 are also distinguishable in diagrams a and b of fig. 15:

- 06/10/2014 - Official start of the public access to DHuS - A total of 278 products were already available for a total amount of 1 152 GB: 194 IW (1 091 GB) and 84 SM (61 GB).
- 17/11/2014 - First increase - Since this date around 90 EW + 190 IW + 25 SM products are regularly delivered per day.
- 03/12/2014 - Second increase - Since this date the number of products delivered per day has approximately doubled.

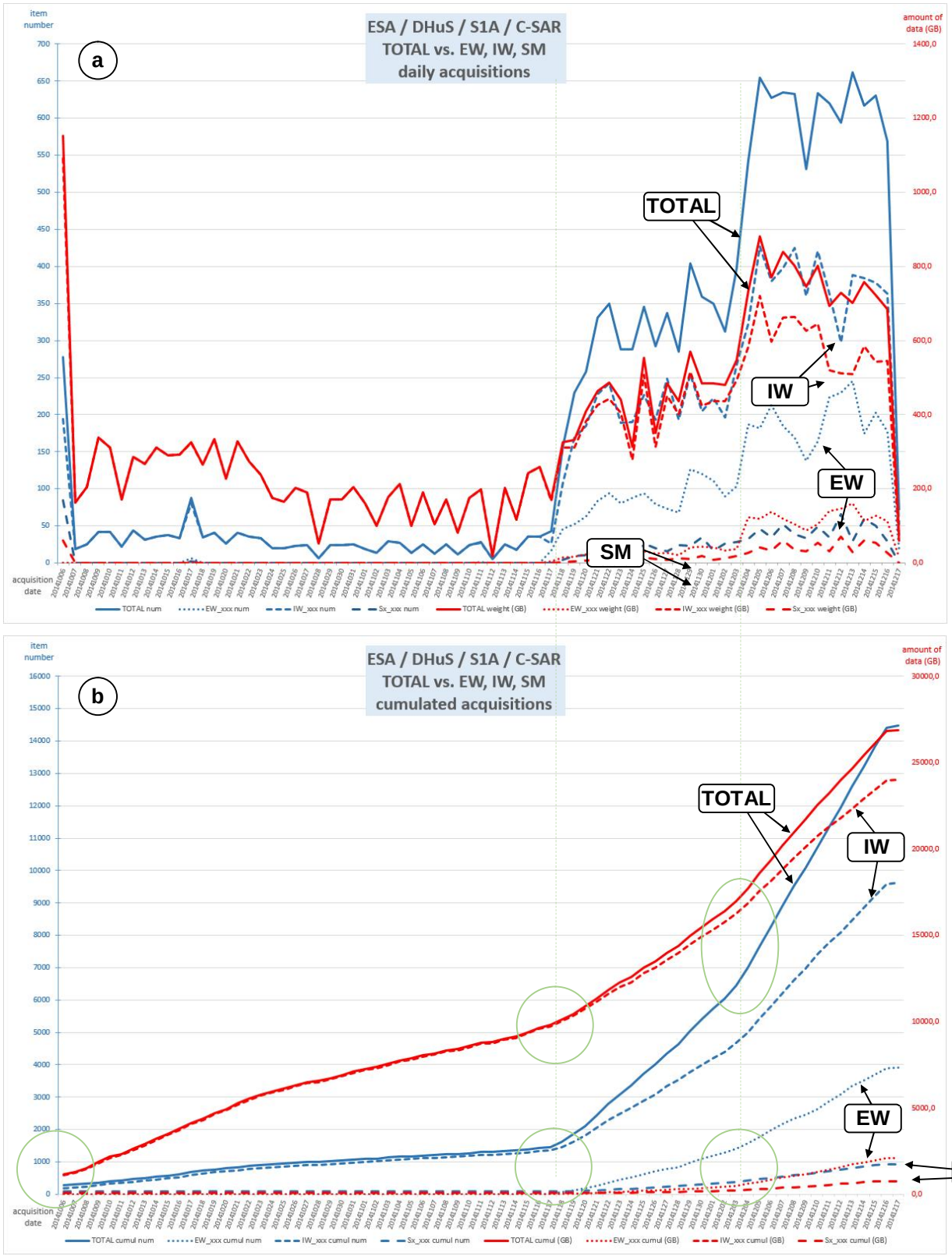


fig. 15 - Daily acquisition of S1A/C-SAR instrument in all the modes and for all (TOTAL) versus the EW, IW and SM acquisition modes.

Mean product length

These statistics computed along the two first months of activity of DHuS enable to assess a mean content length for each product according to their acquisition modes and processing levels.

	acquisition mode	EW	IW	SM	ALL
processing levels	RAW	**0.92 GB**	**1.04 GB**	**1.49 GB**	**1.03 GB**
	SLC	**-**	**7.53 GB**	**-**	**7.53 GB**
	GRD	**0.35 GB**	**1.17 GB**	**0.53 GB**	**0.87 GB**
	ALL	**0.54 GB**	**2.49 GB**	**0.82 GB**	**1.86 GB**

table 3 - Mean content length for EW, IW and SM depending on RAW, SLC and GRD processing levels.

Figures fig. 16 and fig. 17 clearly show the predominance of the IW products in terms of number of items but also in a sharper way in term of memory size.

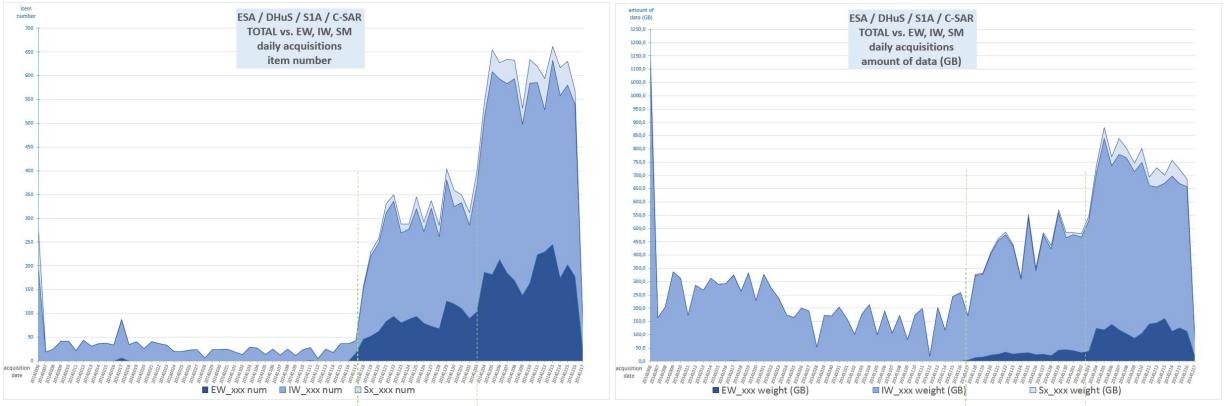


fig. 16 - Daily acquisition of S1A/C-SAR - Comparison of EW, IW and SM acquisition modes in terms of item numbers and amount of data.

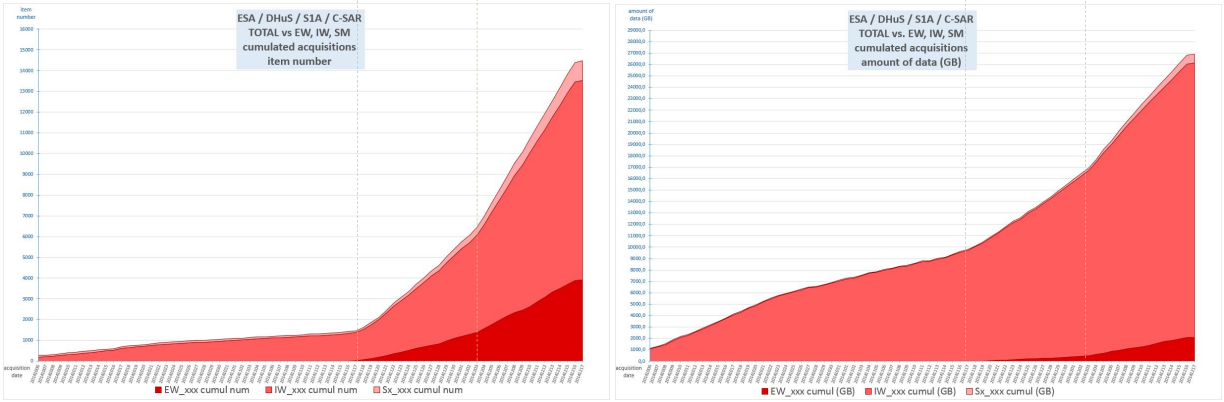


fig. 17 - Cumulated acquisitions of S1A/C-SAR - Comparison of EW, IW and SM acquisition modes in terms of item numbers and amount of data.

2.2.2.5 DHuS / S1A / C-SAR - Stripmap (SM) mode

Analysis of the sub-swath acquisitions

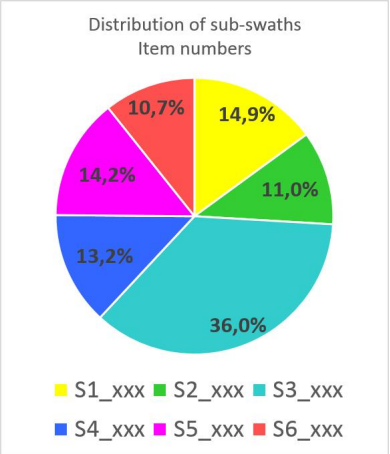
As shown in the Sentinel-1 user's guide (R-2), the Stripmap (SM) mode is operating with 6 elevation of the beam called S1 to S6 leading to different footprints called "sub-swaths" in this section.

Beam	S1	S2	S3	S4	S5	S6
Off-nadir angles at min orbit altitude	17.93-23.53	21.00-26.33	26.18-30.99	30.87-35.15	35.07-38.85	37.53-41.01
Incidence angles at min orbit altitude	19.99-26.31	23.45-29.50	29.33-34.85	34.71-39.72	39.62-44.12	42.53-46.73
Off-nadir angles at max orbit altitude	16.45-21.96	19.51-24.77	24.67-29.45	29.34-33.63	33.53-37.34	35.98-39.51
Incidence angles at max orbit altitude	18.32-24.55	21.78-27.76	27.64-33.13	33.00-38.02	37.89-42.43	40.79-45.04

table 4 - Observation geometry in Stripmap mode for the various sub-swaths.

As shown in fig. 18, one may observe that few S1, S4 and S5 were already acquired at the launch of the DHuS portal on 06/10/2014.

A clear take-off of the Stripmap production is observed on 17/11/2014. Since this date the provision of SM data is continuously growing with a clear predominance of the S3 sub-swath as shown in the attached chart.



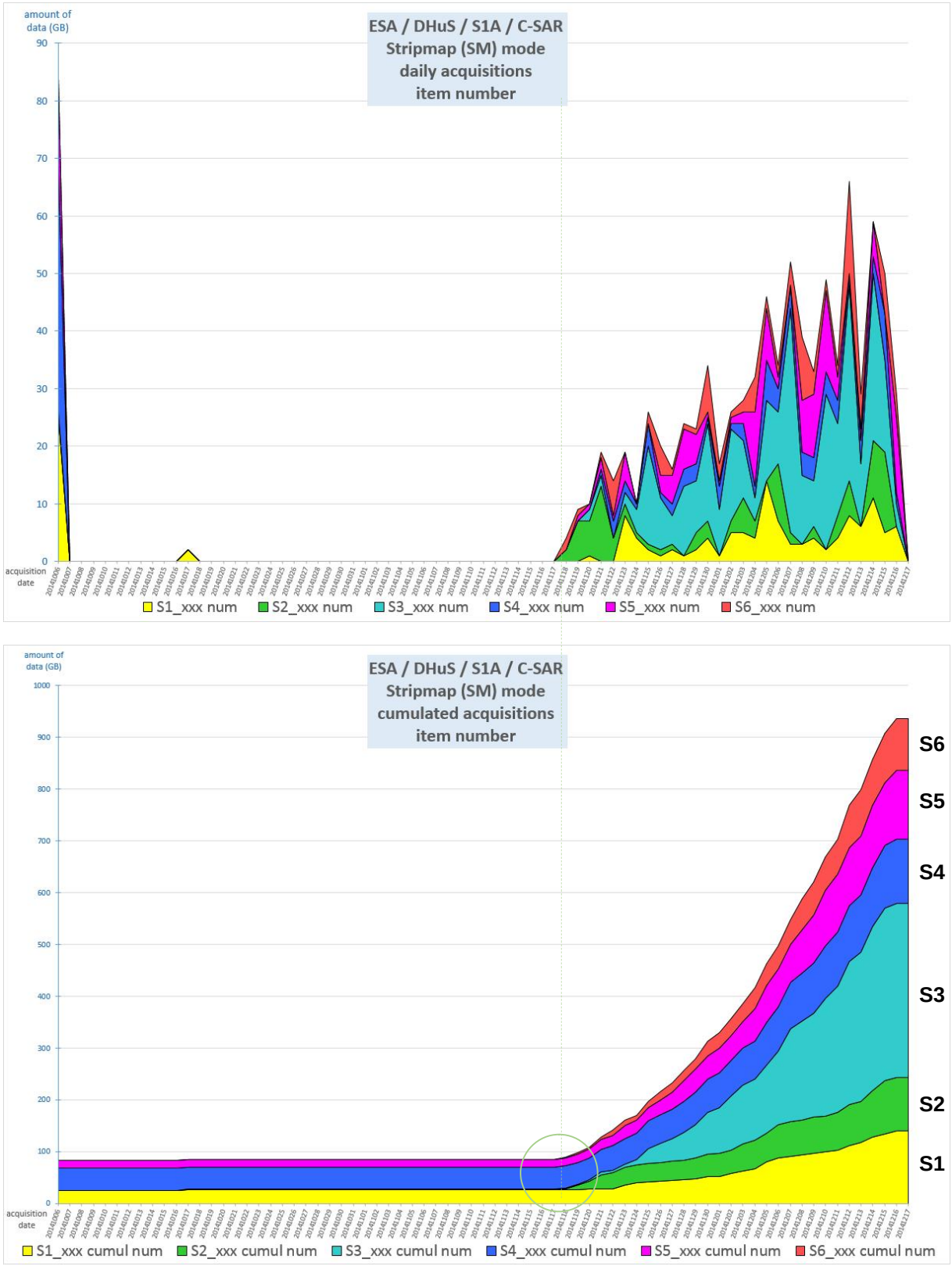


fig. 18 - ESA / DHuS / S1A / C-SAR - Stripmap mode (SM) - Distribution of S1,S2,S3,S4,S5,S6 sub-swaths.

2.2.3 Third-party missions (TPM)

2.2.3.1 TPM / Landsat-4/5 / TM

For registered users, Landsat data are available at the URL https://landsat-ds.eo.esa.int/app/. One may navigate across the path/row up to display HTML pages enabling to download the "Browse" image, the "Metadata" file or the "Product".

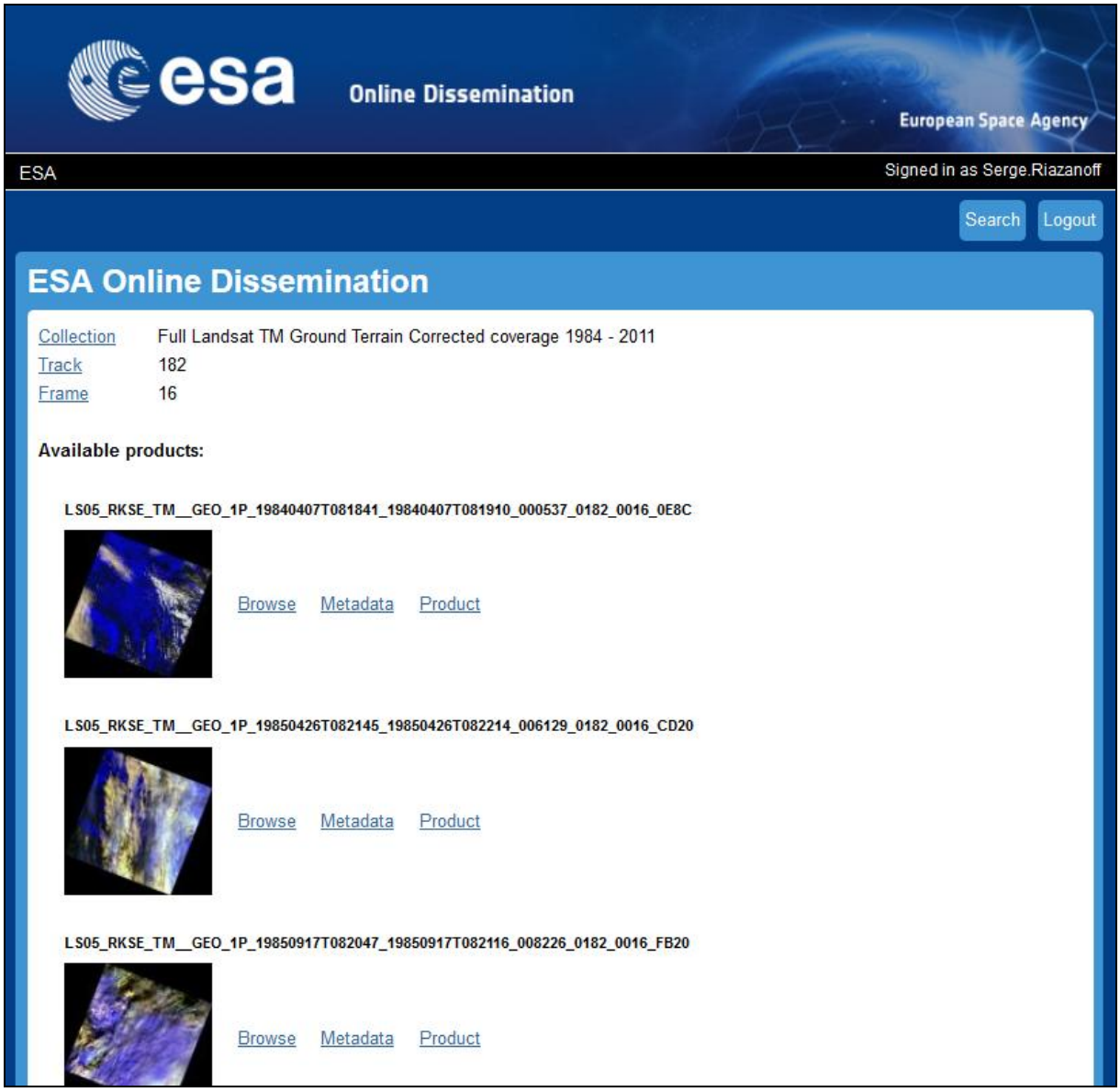


fig. 19 - ESA / TPM / LANDSAT / TM - Archive browse page.

No Landsat-4 data have been found in the archive.

The ESA / TPM / LANDSAT / TM archives contains a total of **319 055 scenes**.

From the first acquisitions of Landsat-5 in 1984 to November 1998, acquisitions were regular. As shown in fig. 21, the acquisition volume varies along the seasons with a maximum reached in September.

Monthly and yearly occurrence maps are available in the directories ..\data\TPM\LANDSAT\TM\jpg_months and ..\data\TPM\LANDSAT\TM\jpg_years respectively. These images enable to monitor the monthly activities in the Kiruna and Mas Palomas receiving stations.

In the Google Earth globe on bottom right, the unbalance between the acquisition volume of Kiruna with regard to the one of Mas Palomas has been compensated applying a square root to the occurrence map.

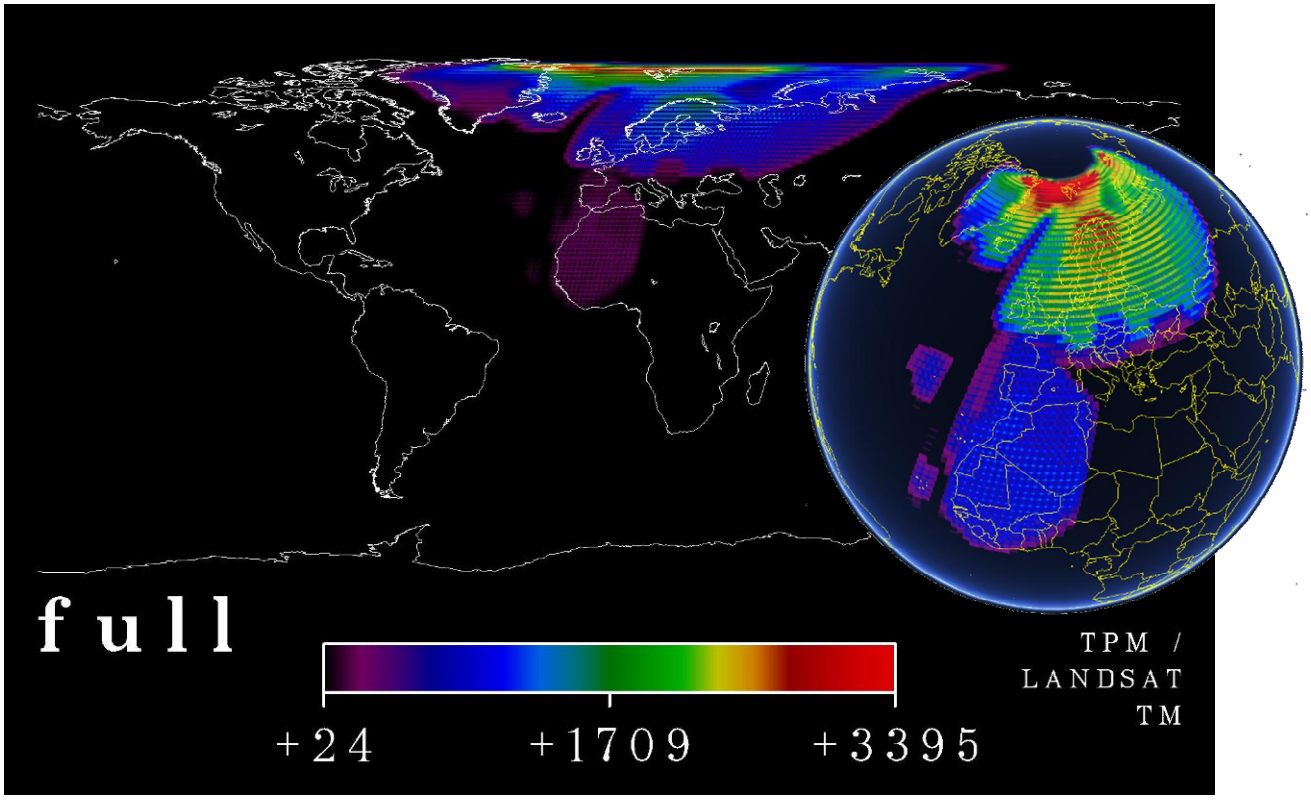


fig. 20 - ESA / TPM / LANDSAT / TM occurrences map (..\data\TPM\LANDSAT\TM\jpg_full\TM.occ.cal.card.gra.tit.jpg).

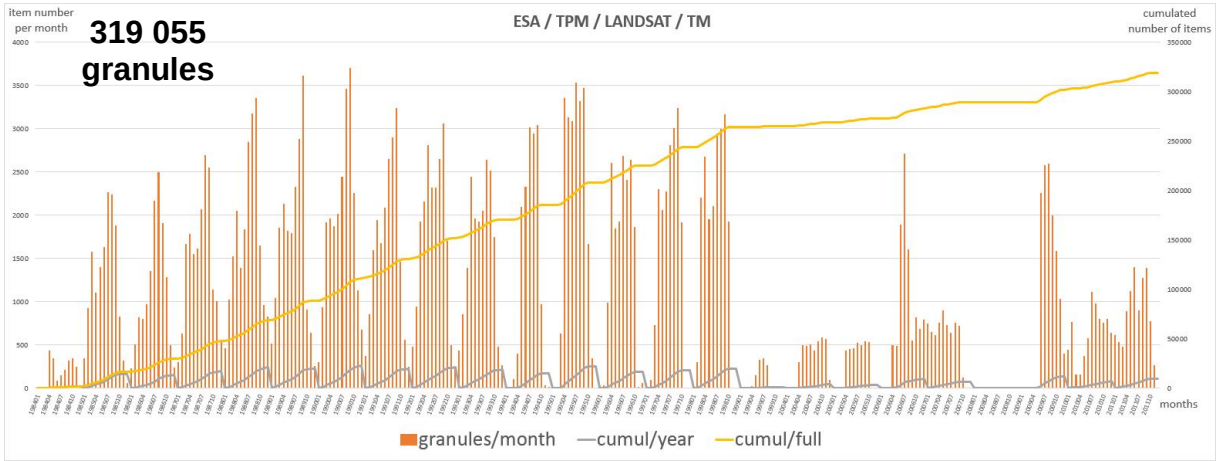


fig. 21 - ESA / TPM / LANDSAT / TM acquisition statistics (..\data\TPM\LANDSAT\TM\LANDSAT_TM_v02.xlsx).

2.2.3.2 TPM / Landsat-7 / ETM+

Access to Landsat-7 ETM+ data is performed in the same way as for Landsat-5 TM data (see previous section 2.2.3.1.

The ESA / TPM / LANDSAT / ETM archives contains a total of **28 577 scenes**.

As shown in fig. 23, acquisitions span from June 1999 to November 2003 with some monthly interruptions.

Monthly and yearly occurrence maps are available in the directories ..\data\TPM\LANDSAT\ETM\jpg_months and ..\data\TPM\LANDSAT\ETM\jpg_years respectively. These images enable to monitor the monthly activities in the Kiruna and Mas Palomas receiving stations.

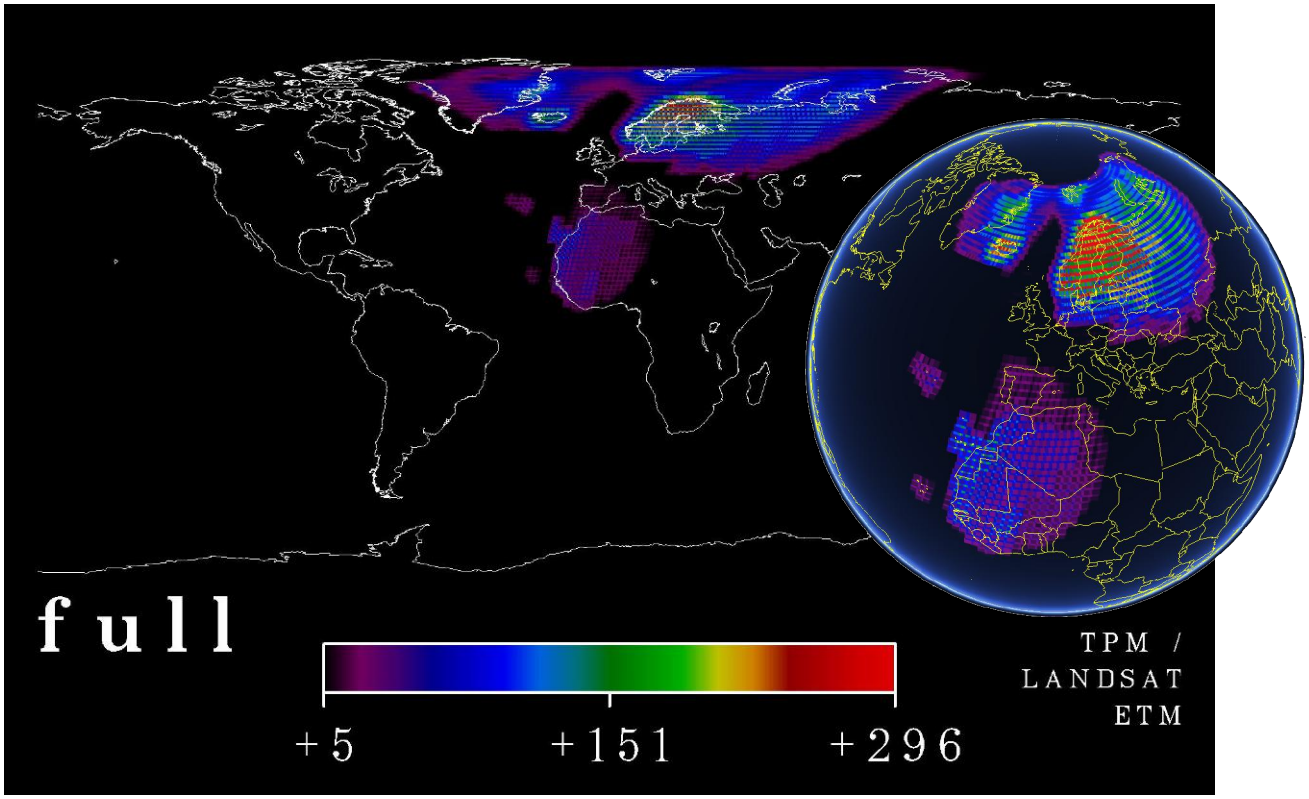


fig. 22 - ESA / TPM / LANDSAT / ETM occurrences map (..\data\TPM\LANDSAT\ETM\jpg_full\ETM.occ.cal.card.gra.tit.jpg).

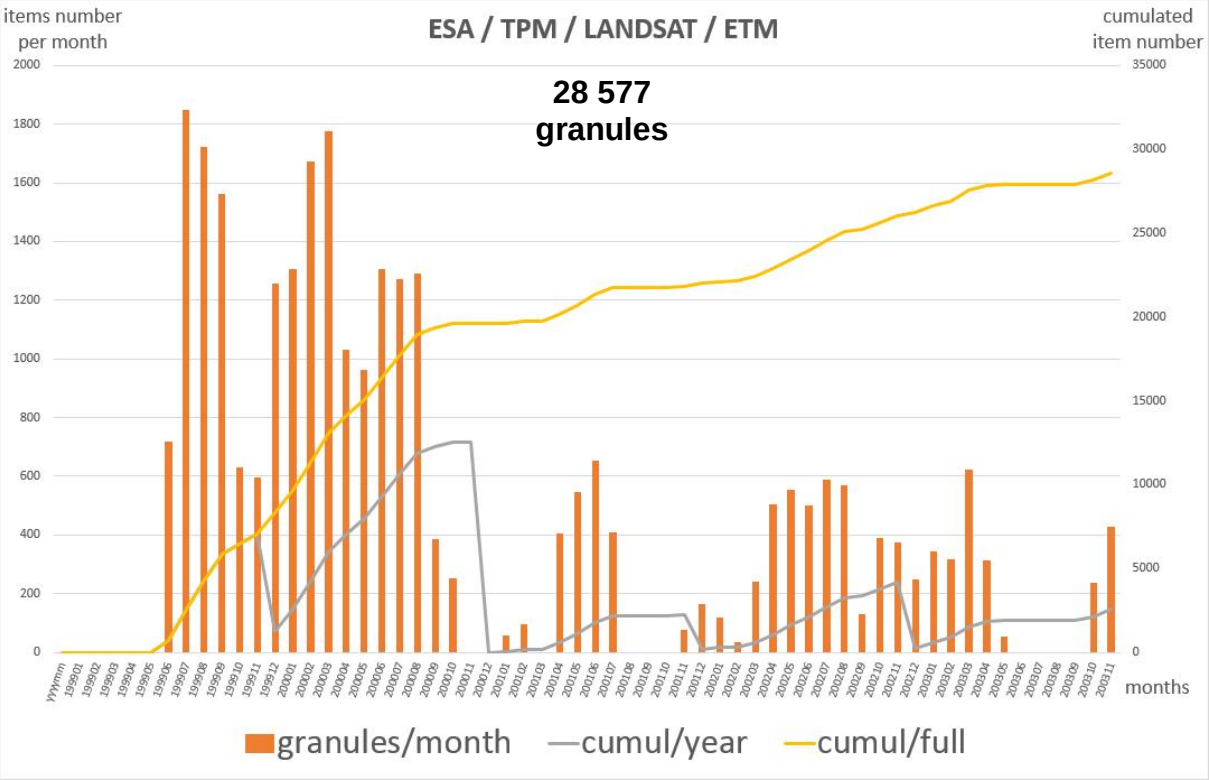


fig. 23 - ESA / TPM / LANDSAT / ETM acquisition statistics (..\data\TPM\LANDSAT\ETM\LANDSAT_ETM_v02.xlsx).

2.2.3.3 TPM / Landsat-8 / OLI/TIRS

ESA TPM archive managing the Landsat-8 OLI/TIRS dataset is accessible through a more sophisticated human-machine interface on the portal https://landsat8portal.eo.esa.int/portal/. The latest Landsat scenes are listed, quick-looks and metadata may be viewed. Products may be selected in the user's basket and registered users may download the product.

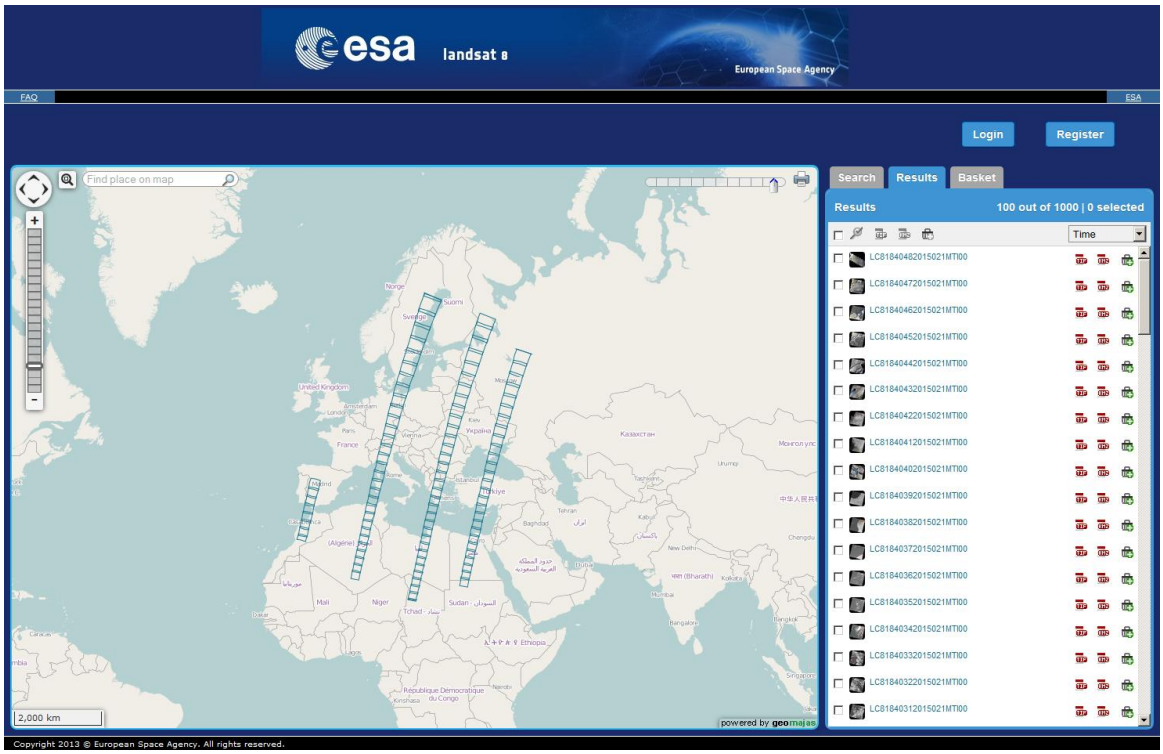


fig. 24 - ESA TPM Landsat-8 portal.

Landsat-8 products not being on-line but interactively ordered, VisioTerra has no simple ways to analyse the Landsat-8 archive neither to build up a prototype accessing the Landsat-8 dataset through a « processing relay » scheme (see explanations in section 3.1.3.2).

2.3 Recommendations

2.3.1 Data access

2.3.2 Use cases and user profiles

2.3.2.1 Use case 1 - Browsing data in an area of interest

User should have the possibility to check for the presence of Landsat products matching basic criteria: -identifier of the mission, -spatial area of interest, -time interval, -cloud coverage.

In the case the "cloud coverage" would not be accessible, an analysis of the whole archive could be performed using one of the latest algorithms like the "Automatic Cloud Cover Assessment (ACCA)".

2.3.2.2 Use case 2 - Checking for the visibility of a particular event - NRT monitoring

The prototype has demonstrated the potential of the on-the-fly processing to promote the ESA EO products. A VtWeb is to be implemented as proof of concept in the DHuS infrastructure.

The same could be performed in the TPM infrastructure or at least a “processing relay” operating on these datasets.

2.3.2.3 Use case 4 - Checking the radiometry

Predefined styles may be tuned to enhance the human detection of radiometry defects. Such a function may be used by the archive managers to periodically control products by a visual inspection.

VtWeb prototype to detect periodic noise along the azimuth

Example below (see fig. 25) show a periodic noise along the azimuth lines of a SM product acquired on 2014-11-25 on 14:08:13.

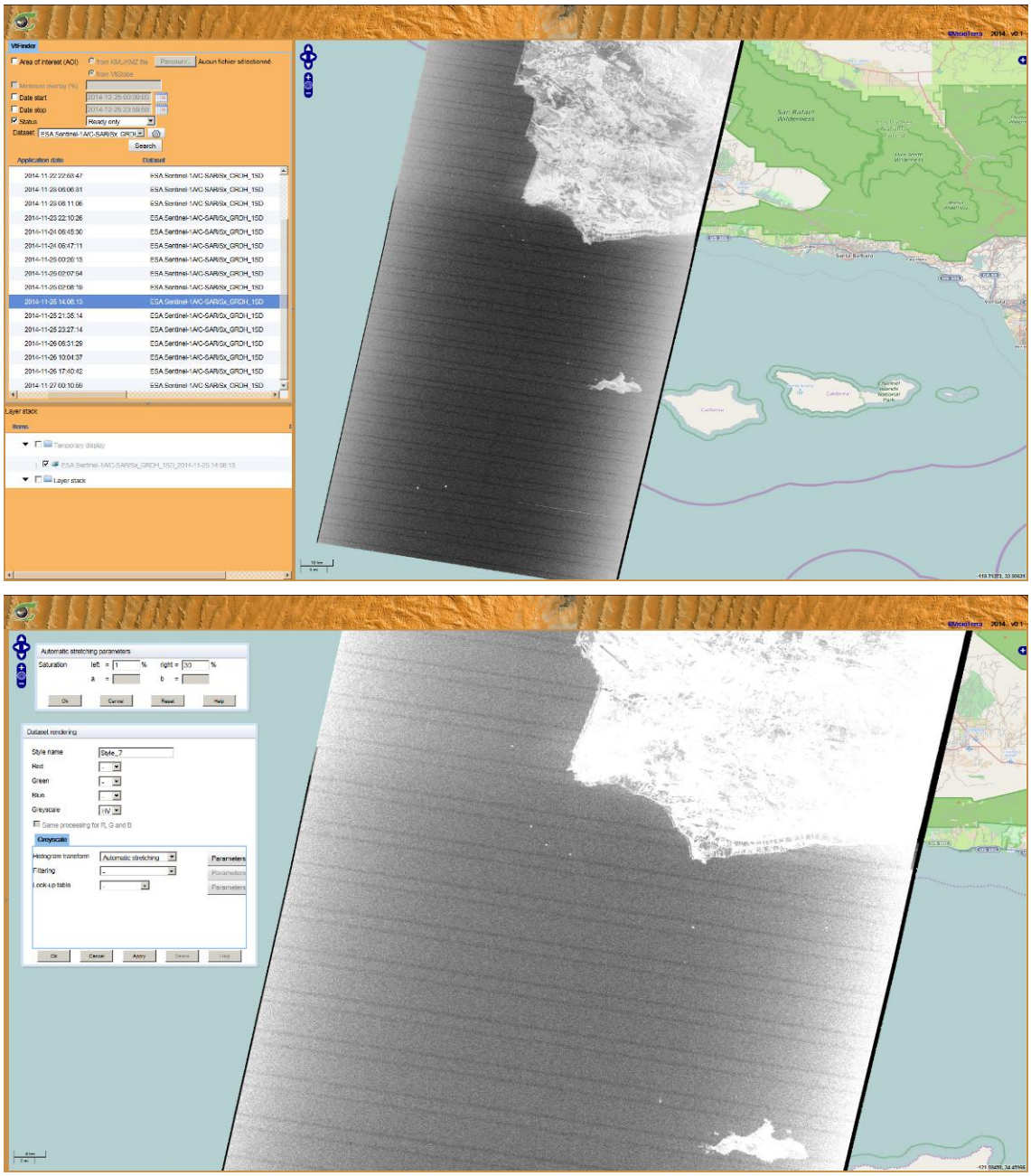


fig. 25 - Display in VtWeb of a SM product along the coast of Santa Barbara (California) - Automatic histogram equalization (a) and automatic 1%-30% saturation linear stretching (b).

More sophisticated image processing to detect sub-swath calibration discontinuities

This other example set in evidence:

- the differences of the sub-swath calibrations (shown in the red boxes) and
- a periodic noise pointed by the green arrows

by processing the land and sea parts in a differentiated way:

- land - IHS (intensity-hue-saturation) transform applied to a VH-VV-VH colour composition
- sea - colour composition of the VV, PCA1 and PCA2 (RGB) applying a principal component analysis.

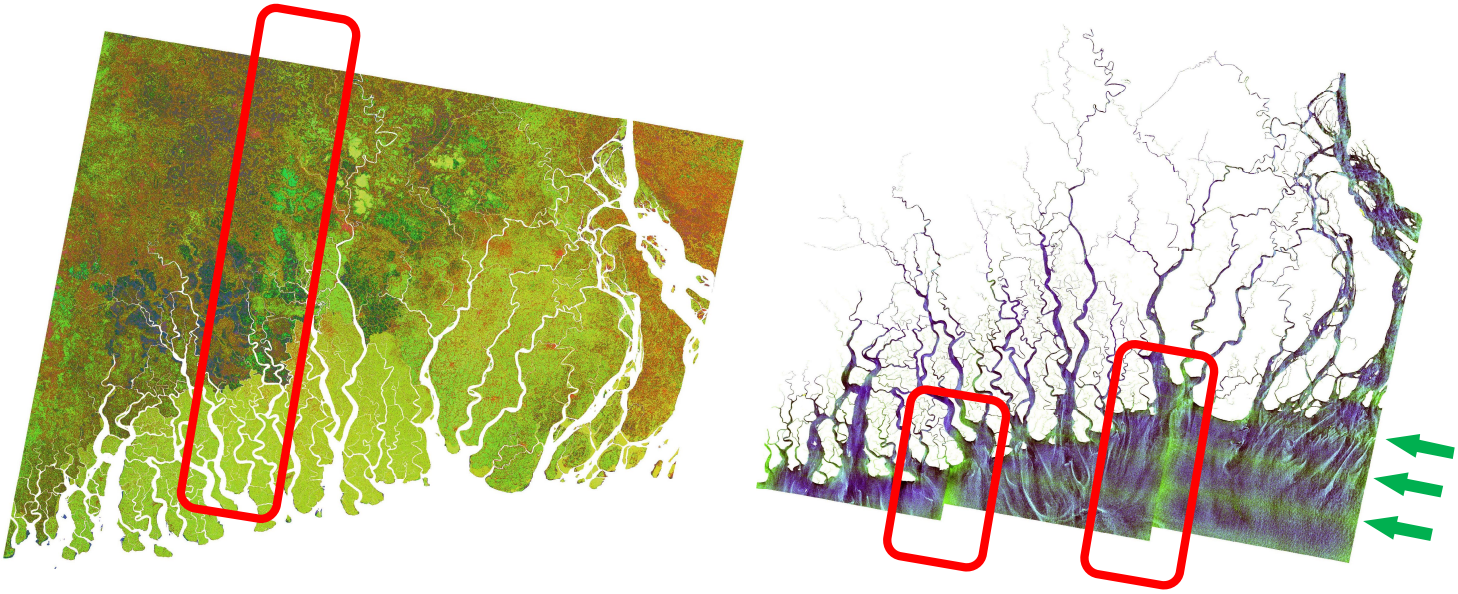


fig. 26 - S1A IW_GRDH_1SDV acquired on 2014-12-26 over the Ganges Delta - land processing (left) and sea processing (right).

2.3.2.4 Use case 5 - Checking the georeferencing

Qualitative assessment

On-the-fly processing geocode tiles using the tie points provided as metadata of the product. In the present version no orthorectification is offered and tiles are simply mapped “on-the-fly” on the WGS 1984 ellipsoid. Such a capability enables archive managers to immediately check the correctness of the product georeferencing. Experience has shown (for example as far as Envisat ASAR products are concerned) that one may observe up to 0.1% to 0.5% of erroneous tie-point locations. In most of the case, these errors are due to a inaccurate acquisition time leading to mislocation along the track up to 5000 metres while the RMSE using star trackers is expected less than 60 metres.

Figure fig. 28 shows for example a SM product acquired on 2014-11-25 at 02:07:54 start time. The global view (a) shows a good registration of the coast in the radar image with the Open-Street-Map background layer.

A rough geolocation quality control (see fig. 27 below) of the SM scene versus the Google Earth high scale reference exhibits aa error eastward in the range [180m ; 300m]. Results of this quality control are available in ..\data\DHuS\S1A_S3_GRDH_1SDH_20141125T020754_20141125T020819_003432_004026_FDA3.QC.kmz.

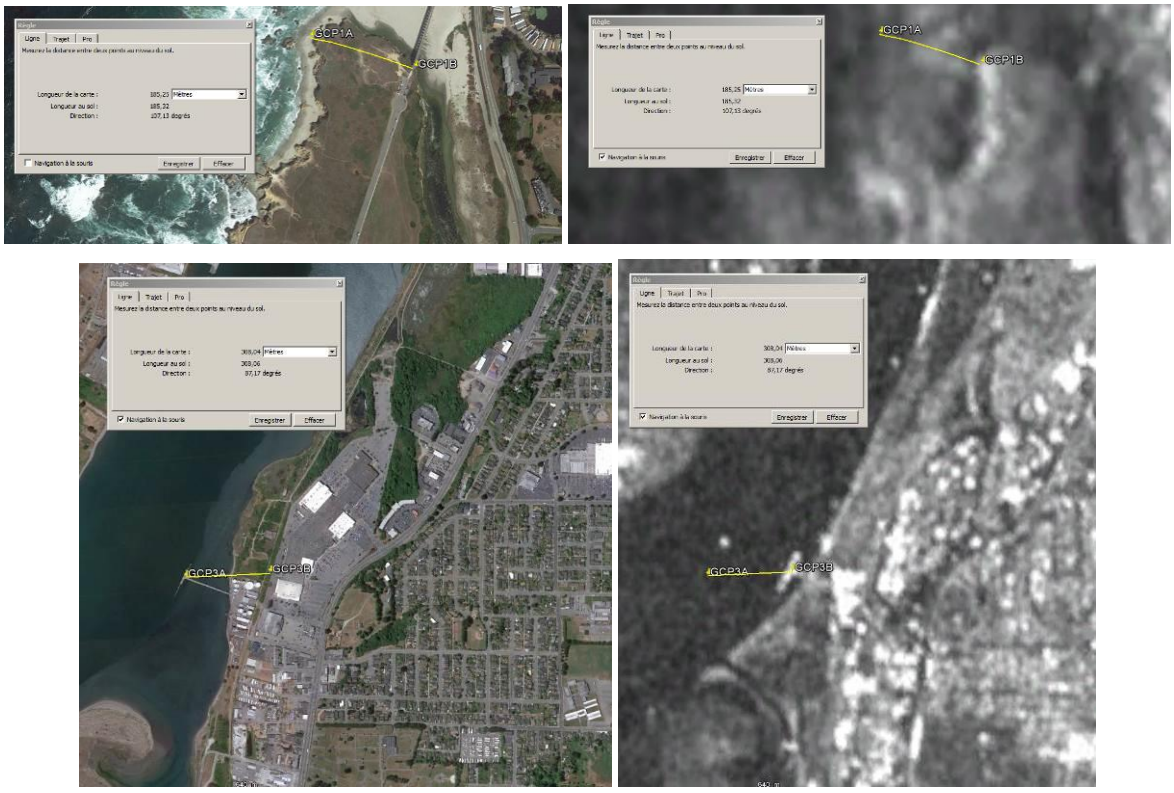


fig. 27 - Geolocation quality control of a SM product.

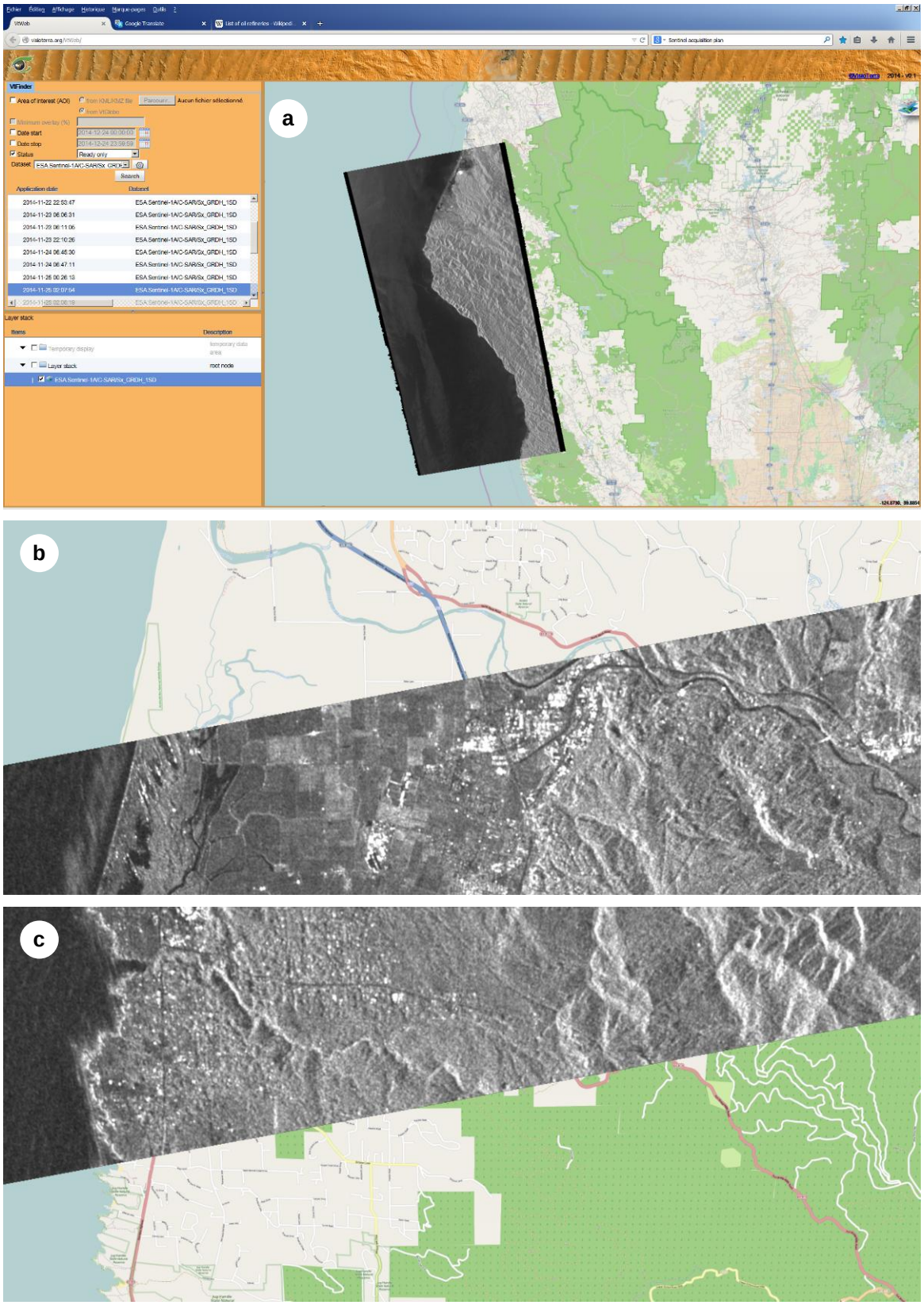
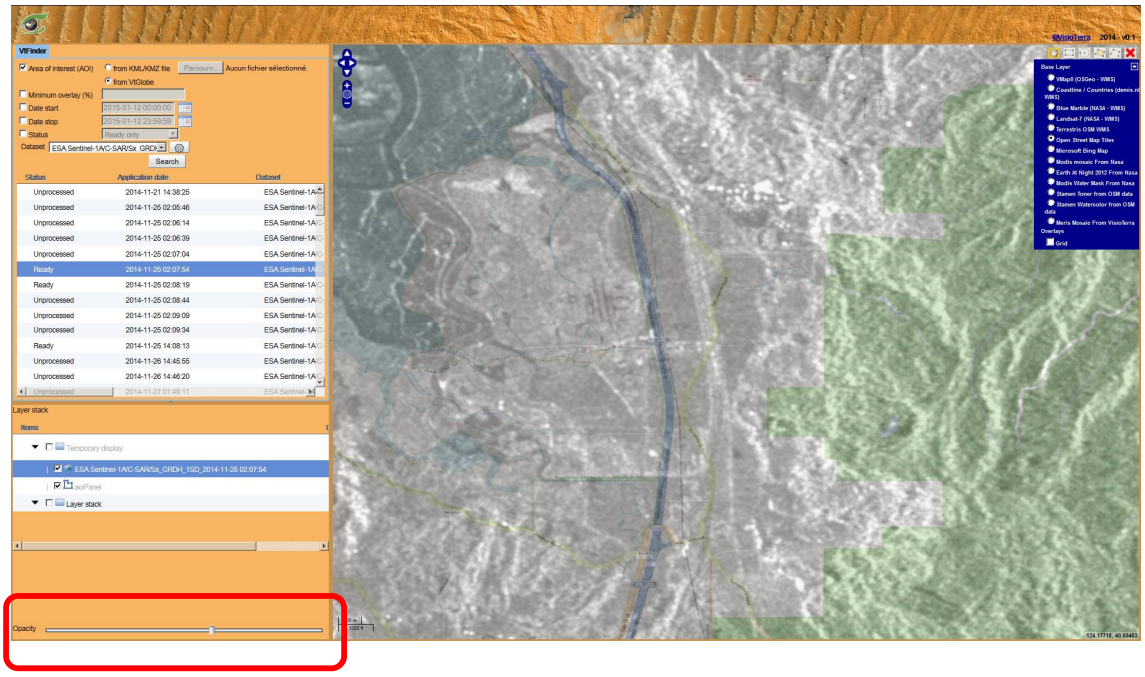


fig. 28 - Display in VtWeb of a SM product over the West coast at the North of San-Francisco (California) - Global view (a), top edge (b) and bottom edge (c) along the coast.

Superimposition of the EO product with the background layer may also be simply checked adjusting the "Opacity" scale of the product. In the figure below, the opacity of the S1A SM scene has been decreased to around 65%.



Quantitative assessment

A more accurate geolocation control has been performed on the North part (along the coast) of the IW product S1A_IW_GRDH_1SSV_20141003T054552_20141003T054621_002661_002F67_5EA4.SAFE located over Algeria between Alger and Aokas.

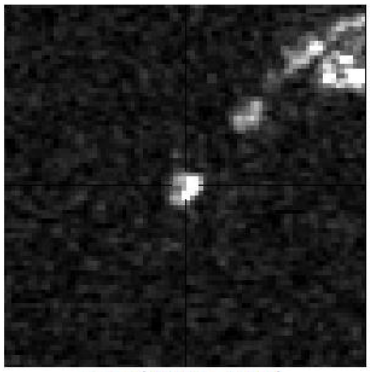
The quality control report exhibits a geolocation error of 714 metres (see fig. 29 extracted from the HTML quality control report available at the address ..\data\DHuS\S1A_IW_GRDH_1SSV_20141003T054552_20141003T054621_002661_002F67_5EA4.SAFE_Algeria\georef.rep\index.htm.

5	**717.5 m**	-710.6 m	99.3 m	Any altitude
6	**714.4 m**	-710.6 m	72.8 m	Any altitude
7	**797.5 m**	-785.3 m	139.2 m	Any altitude
8	**583.2 m**	-572.2 m	112.5 m	Any altitude
9	**777.7 m**	-765.1 m	139.2 m	Any altitude

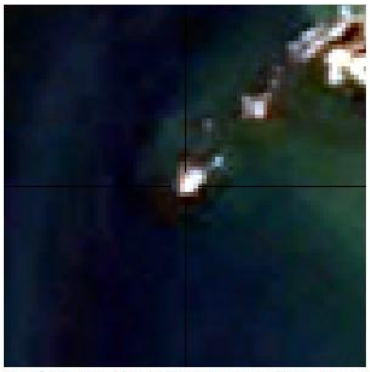
GCP
Global statistics

Algebraic mean ðX	-698.680 m
Algebraic mean ðY	130.319 m
Error modulus arithmetic mean	711.445 m
Standard deviation ðX	60.383 m
Standard deviation ðY	31.919 m
Error modulus standard deviation	60.334 m
Quadratic mean (RMS) ðX	701.285 m
Quadratic mean (RMS) ðY	134.171 m
Error modulus quadratic mean (RMS)	**713.999 m**
Number of points inside limit	0 (0.0 %)

POINT 1

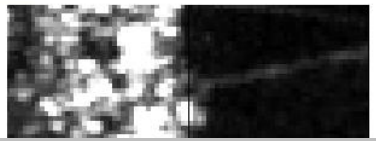


GCP - (1973.6 , 967.8)



map_Plate_Carree_2.721747_37.004652_12.5m.1

POINT 2



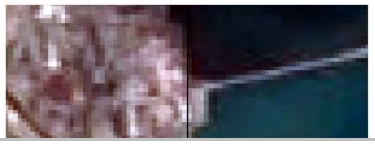


fig. 29 - Extract of the quality control report performed on IW product acquired on 2014-10-03 at 05:45:52.

2.3.2.5 Use case 6 - Image of the day / Best of the week

Earth observation Image of the Week

ESA has set-up a service "Earth observation Image of the Week" that regularly displays the most striking images among the ESA and TPM collections. As a summary, subscribers of the ESA newsletter have received on 19/12/2014 a link giving access to the whole collection of 500 images (see fig. 30): http://www.esa.int/spaceinimages/Sets/Earth_observation_image_of_the_week.

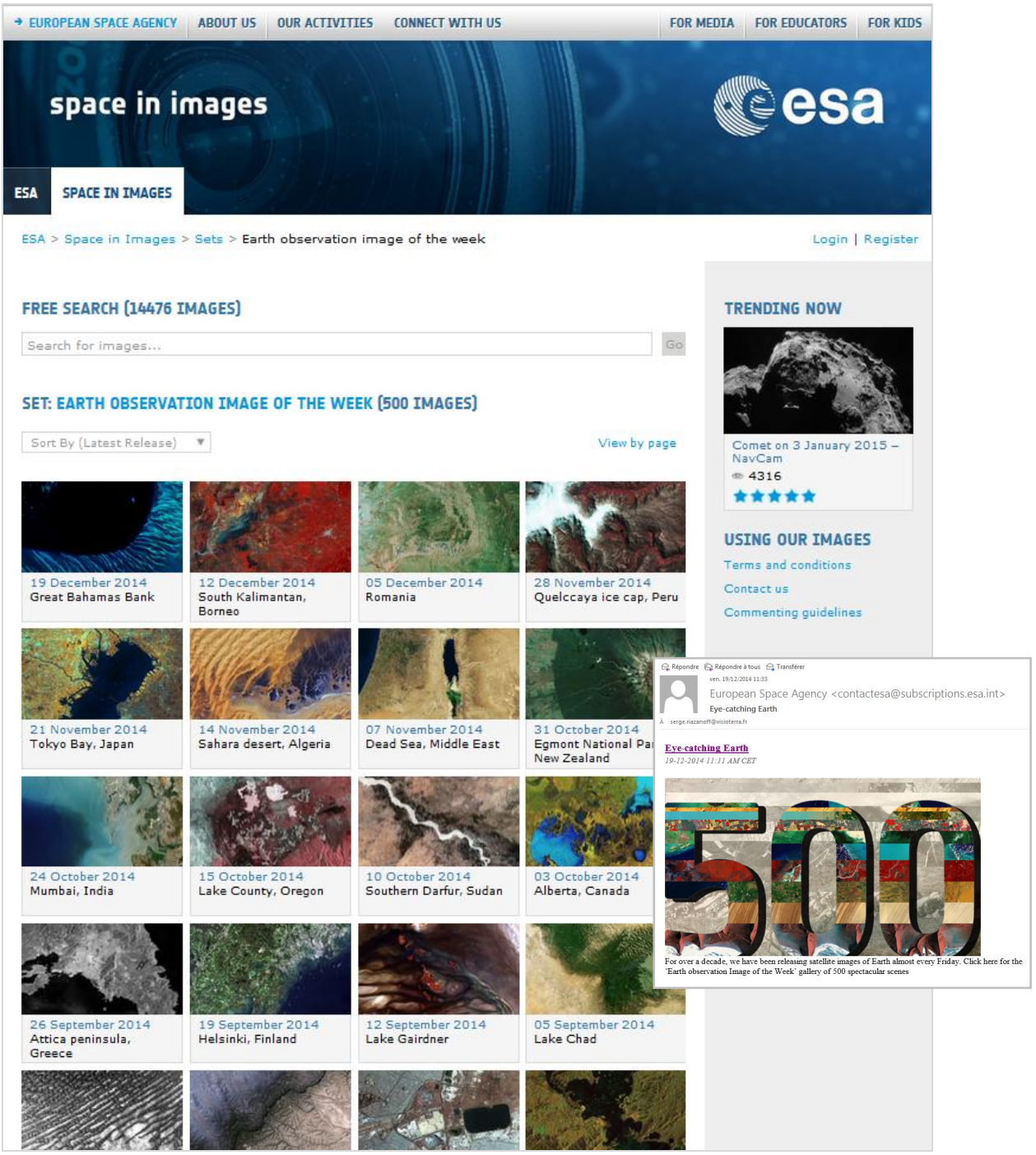
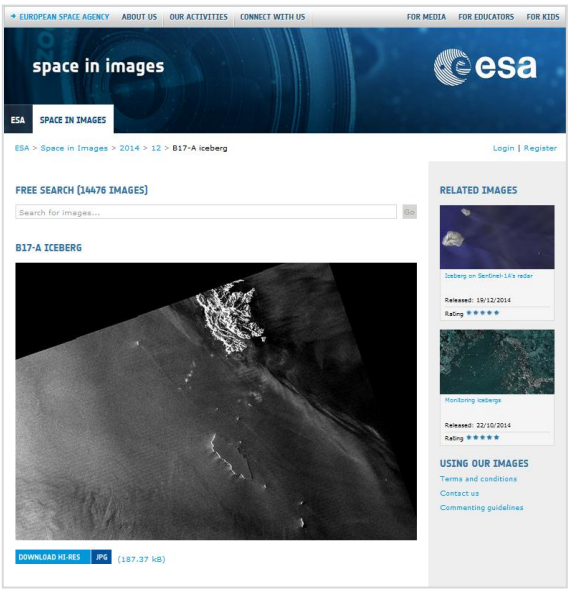


fig. 30 - ESA "Image of the week.

Enabling subscribers to handle this "Image of the Week"

The VtWeb on-the-fly processing could provide an extra source of data promotion sending to the subscribers not only a static image but an URL enabling users to navigate across the product changing the background layer and enabling more skilled users to change the processing parameters to match their particular field of interest.

The Manager of the EO Image of the Week" may also provide for a same EO product two or more URLs matching different points of view or processing styles.



Examples here attached and here below compares a static view of a Cosmo-Skymed product released on 19/12/2014 in the "Space in images" collection (http://www.esa.int/spaceinimages/Images/2014/12/B17-A_iceberg) and an interactive display of a Sentinel-1A product acquired on XXX over the East coast of Antarctica.

The explicit published URL would be http://visioterra.org/VtWeb/?MODULEID=VtSentinel&DATASETID=Sentinel-1A/C-SAR/IW_GRDH_1SD&GRANULEID=e066f5e5-6b3c-4d06-b3f1-c7c761a3a0d6&STYLE=rgb%28sha%28gau%28QT_hh,HT_hh,128,80%29,1.0%29,sha%28gau%28QT_hv,HT_hv,128,80%29,1.0%29,sha%28gau%28QT_hh,HT_hh,128,80%29,1.0%29%29&lookat={%22view%22:%223D%22,%22Longitude%22:71.059,%22Latitude%22:-68.124,%22Range%22:200796,%22Heading%22:-25.9,%22Tilt%22:39.3,%22backgroundLayer%22:%22modis%22}&sidePanel=false. This long URL could be replaced by a shortcut recognised by the VtWeb server that could also include more than one image at time.

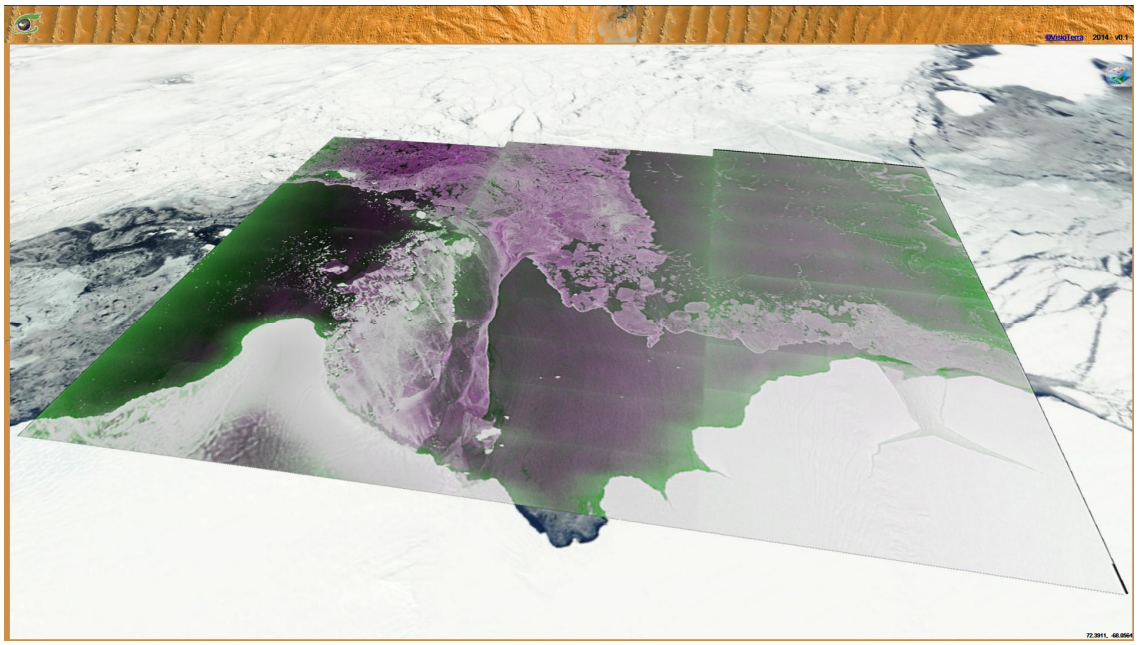


fig. 31 - S1A IW GRDH 1SD acquired on 2014-11-30 at 22 :59 :06.

Towards a collaborative best-of the Week

One may imagine the involvement of scientists and citizen to suggest the publication of the interesting EO products only sending the URL of the product they have browsed on the ESA archives.

These scientists or citizen could also join to this URL:

- a text explaining the interest of this view,
- any on-ground image / map / GPS…,
- a photo-interpretation processed by the scientist or citizen,
- a hyperlinks on
  - other data of other missions,
  - same region observed at another date,
  - extract of news paper
  - …

Towards an education framework

These URLs are easy to disseminate and they provide the education community with immediate example of EO data in relation with various teaching domains.

The teachers may regularly watch with their students in the rolling archive or a newsletter could be addressed enabling teachers to immediately addressed the given URLs.

2.3.3 New products

2.3.3.1 SMOS

Many Earth Explorer missions like SMOS have produced new datasets (see for example http://www.esa.int/Our_Activities/Observing_the_Earth/SMOS/Salinity_matters) that could be accessed through rich URLs.

2.3.3.2 ESA TPM - Landsat-8

At the time of the present study, Landsat-8 scenes were not directly accessible. VtWeb is able to access the Landsat-8 scenes produced by USGS and some styles have revealed wonderful colour compositions.

2.3.4 Processing time series - Aggregated data

2.3.4.1 Systematic processing

We suggest to automatically prepare the data for a multi-scale visualisation.

For further anomaly detection, we also suggest to perform a systematic slicing mean of radar images or cloud-free synthesis of optical data.

2.3.4.2 Computing the trends - Aggregated products

The short period mean could be aggregated to produce long term mean from which trends could be computed.

2.3.4.3 Detecting the anomaly - Difference to the “median product”

In front of the huge amount of data, it is suggested to notice the interest users the anomaly detected in the just acquired scene with regard to the slicing mean.

2.3.4.4 Multi-instrument synthesis - Coupling / referencing with exogenous products

Meteorological products

Meteorological data interpolated at the time of the acquisition could be always available for users enabling to superimpose them interactively.

Essential Climate Variables (ECV)

Some of the meteorological data are part of the "Essential Climate Variables (ECV)" (see http://gosic.org/ios/MATRICES/ECV/ECV-matrix.htm). Other ECV like for example the Land Use / Land Cover should be also available to be superimposed to the EO product being viewed by the user.

Elevation data

A 3D view and the derived products like the slopes, roughness, exposure… could also be available under the footprint of the EO product being viewed. User should be enabled to superimpose adjusting the opacity of these associated data.

3 PROOFS OF CONCEPT

3.1 Introduction

3.1.1 Stand-alone applications versus client / server application

3.1.1.1 Definitions

Stand-alone application

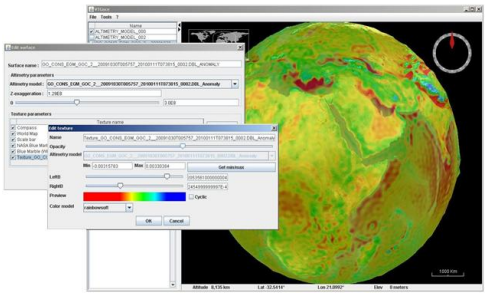
A “stand-alone application” runs a code that has been installed on a particular machine. A “stand-alone application” may be launched without any Web connection and, in most of the case, doesn’t need a Web connection to run processing data that may be stored locally.

Client / server application

A “client / server application” involves two processing units: -one or more “client(s)” interpreting a code (HTML, JavaScript…) dynamically downloaded from the server when addressing request expressed in defined protocols (HTTP, HTTPS… and possibly OGC standards), and -one “server” responding to these requests.

A “client / server” application is running only when the Web connection is alive. The client is run in whatever “Web browser” (Chrome, Mozilla Firefox, Internet Explorer, Safari…).

3.1.1.2 VtGoce - an example of “stand-alone application”

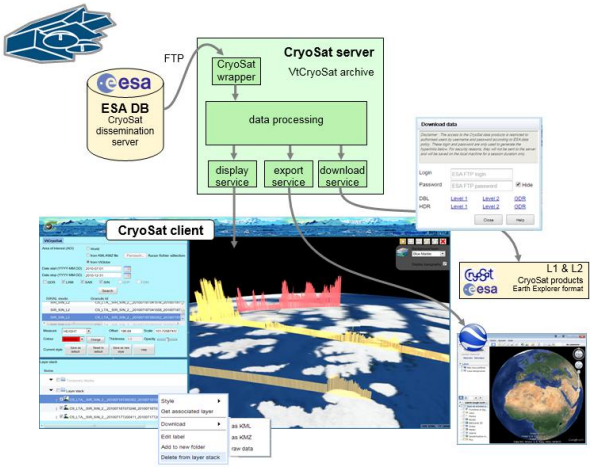


VtGoce is for example a “stand-alone application” developed by VisioTerra in Java language to access COCE products, display the geoid solutions, perform arithmetic operations between surfaces, compare surfaces, analyse the topographic serial profiles of a surface.

VtGoce is distributed together with the GOCE data from the ESA portal at URL https://earth.esa.int/web/guest/software-tools/content/-/article/vtgoce.

3.1.1.3 VtCryoSat - an example of “client / server application”

VtCryoSat is an application designed to filter CryoSat data, display them on a virtual globe, easily download them as a KML file and download products directly from the CryoSat dissemination server. VtCryoSat is intended to work with the use of a recent web browser and doesn’t require any software or plug-in installation.



In order to search data, the user needs to specify an Area Of Interest (AOI), a time interval, and one or more datasets.

Once CryoSat products have been listed, they can be displayed on the layer stack. The physical measure, its scale and the display colour of the selected data can be set according to the user’s needs and will then appear on the VtWeb virtual globe. Following the same criteria, a KML export of the same measure can also be downloaded.

Afterwards, ESA-allowed users can download the product data in the L2 and L1B product levels by using their login password which will give VtCryoSat access to the ESA CryoSat dissemination server ftp://science-pds.cryosat.esa.int.

3.1.1.4 Pros and cons

The pros and cons of a "client / server application" with respect to a "stand-alone application" are summarized in the table below.

	stand-alone application	client-server application
pro	Able to run without a Web connection.	Immediately available through a simple URL. Unique code for the navigators applying HTML5. Able to dynamically access selected data. Easy maintenance and deployment. A new version may simply be pointed by a new URL. 3D WebGL client API always more powerful.
cons	Requires to download and install the application code. Difficulties to manage the 32 bits / 64 bits architecture and the three operating systems (Windows, LINUX, Mac OS). Requires to embed the data. Heavy maintenance and deployment. The 3D "NASA World Wind" virtual globe is evolving slowly.	Requires a Web connection.

table 5 - Pro / cons of the "stand-alone application" vs. "client / server" application.

Stronger of its pro, the "Client / server applications" are preferred for modern developments.

3.1.2 Data providers and processing relays

3.1.2.1 Definitions

Data providers

"Data providers" match here infrastructures managed by organisations disseminating datasets. These organisations are often those having produced the datasets and who want to make know these datasets to other parties who are the "end users" in most of the cases.

ESA is one data provider.

Processing relay

A "processing relay" is an engine that ingest data provided by one or more data provider(s) and that process the data according to algorithms to produce a flux of data in output. In most of the case, the "processing relay" is a processing pipe fully automatic.

VtWeb has been designed as a processing relay that should don't store data except as memory cache for optimisation reasons.

End users

"End users" are here those who receive data from data providers through processing relays or not. The present study aims to satisfy these end users making more secure and comfortable the access to enhanced data.

3.1.2.2 Data flux schemes

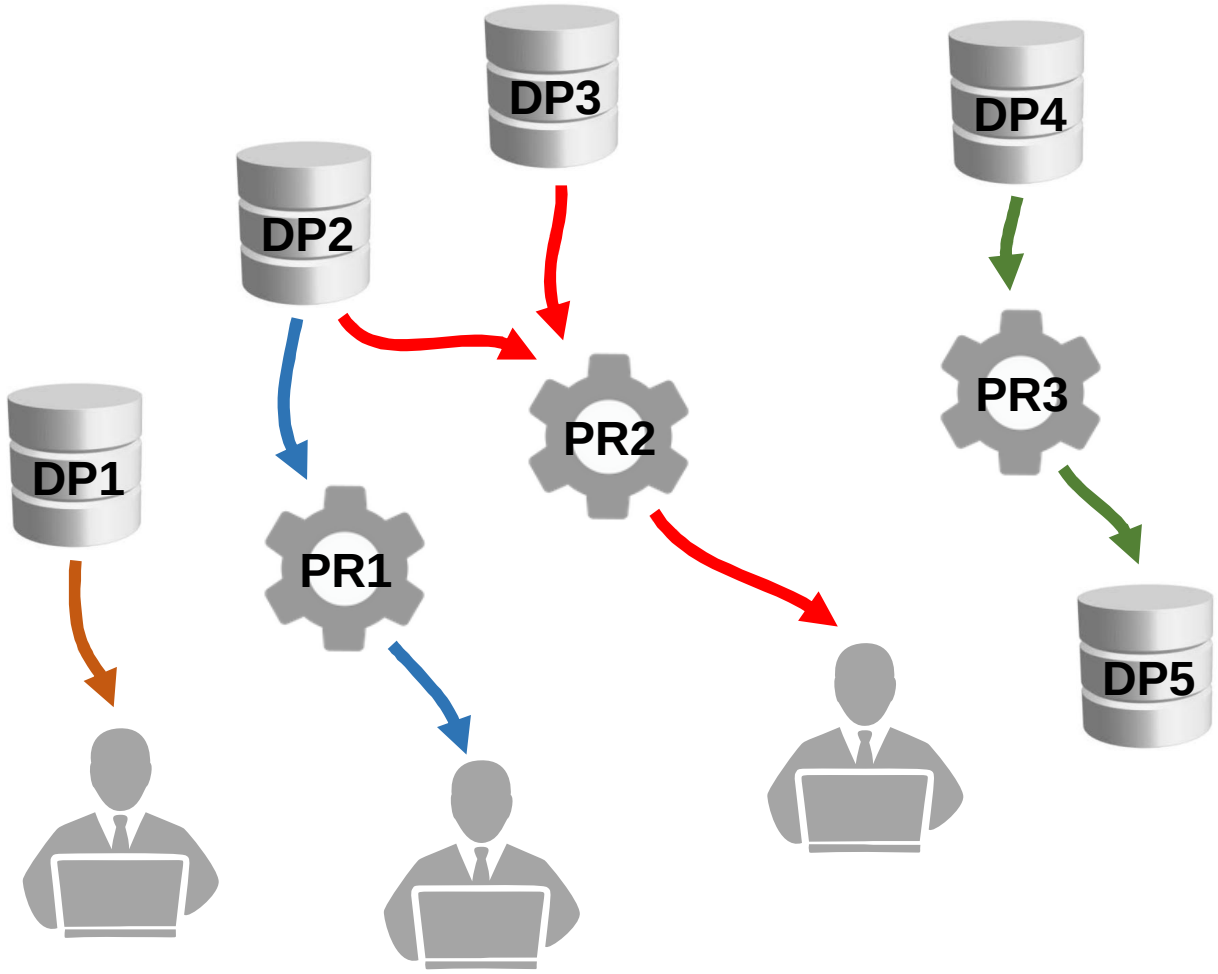


fig. 32 - Data flux schemes between "Data Providers" (DP) "Processing Relays" (PR) and "End Users".

As shown in fig. 32 above, the data fluxes falls into four schemes at least.

Data download

This is the most classical interaction between the "Data provider" and the "End user". Due to the amount of data generated by the Sentinel missions, this is the scheme we try to avoid.

Single data processing

The "processing relay" ingest data from only one "data provider". These data are processed on-the-fly to be presented to the end user. The prototype developed in the framework of the present study complies with this scheme (see next section 3.1.3).

Multi-source data processing

This scheme is the most promising solution to enhance the data + added value delivered to end users. A typical example could be the on-the-fly atmospheric correction of optical data provided by one data provider but getting the composition (ozone, water vapour, aerosols…) of the atmosphere at the time of acquisition from another data provider.

From one data provider to another

A “processing relay” may be thought as a (virtual) “data provider”. Storing the outputs of the “processing relay” leads to stock the data of a data provider. For example ESA introduces ECMWF data in its Sentinel metadata running a daemon that get the atmosphere data for each one of the Sentinel product generated.

3.1.3 Three schemes of ESA data access

As shown in fig. 33, data of the ESA archives are handled in different level of integrations with the VisioTerra applications enabling in particular to manage a modern processing on-the-fly (P.O.F.).

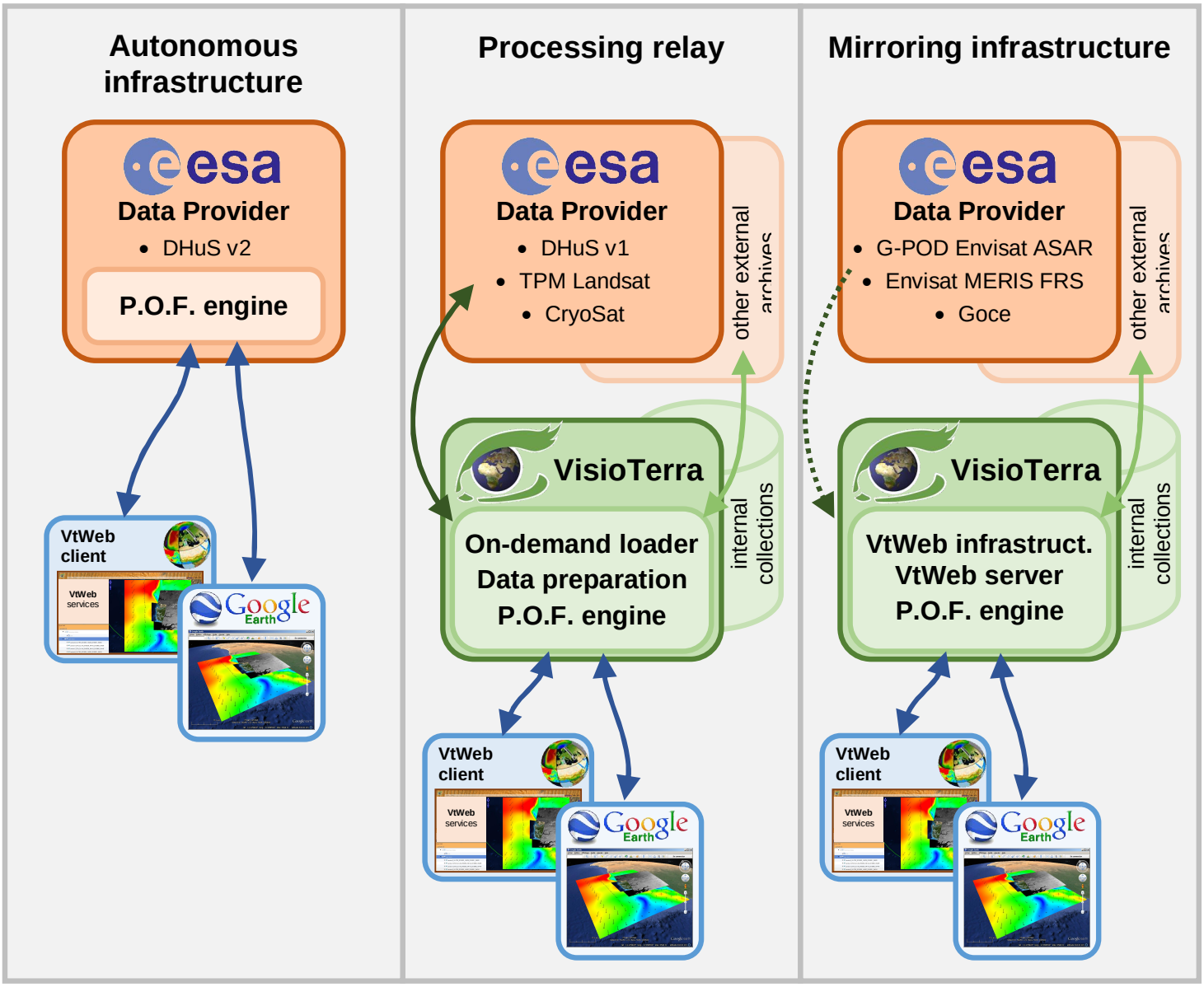


fig. 33 - Schemes of collaborations between ESA archives and the VisioTerra infrastructure.

3.1.3.1 Autonomous infrastructure

In its future versions, the DHuS infrastructure disseminating the Sentinel data will be equipped with a VtWeb "Processing-On-the-Fly (POF) engine" enabling users to process and display products of the rolling archive.

3.1.3.2 Processing relay

People connecting to the VisioTerra infrastructure have the possibility to:

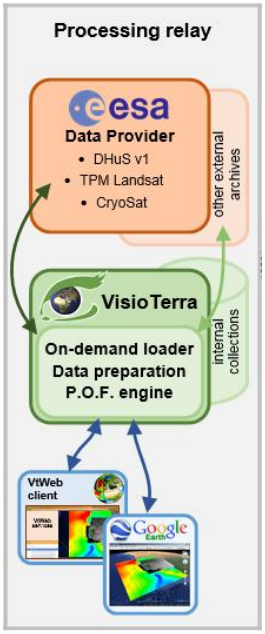
- know which ESA products (Sentinel, TPM Landsat and CryoSat) are available in an area of interest and/or for a time interval defined by the user,
- display the product in 2D/3D in their usual browser querying tiles elaborated by the VtWeb server in VisioTerra premises in Champs-sur-Marne,
- export the viewed images in a reduced representation (limited number of bands, 8-bits per pixel, no metadata) in a standard format (KML, GeoTIFF),
- download the original product if authorized by the data provider.

Due to bandwidth limitations and/or in absence of possibilities for the “processing relay” engine to directly extract a part only of the data (for example specific bands of specific lines of specific rows of an image), the “processing relay” infrastructure may be obliged to copy the original product in whole or in part in its local disks. Such a copy is not intended to be durable but shall be seen as a “memory cache” only.

3.1.3.3 Mirroring infrastructure

When the data are not interactively accessible from the “data provider” side, the dataset in whole or in part is copied from the “data provider” to another infrastructure acting as a “mirroring infrastructure”. This mechanism is proposed by “Google Earth Engine”.

3.2 DHuS / VtWeb / Sentinel-1 / C-BAND



3.2.1 Prototype implementation

In this version (see http://visioterra.org/VtWeb/), the mechanism to access and display Sentinel-1 data is a "Processing relay" (see the attached figure explained in section 3.1.3 above).

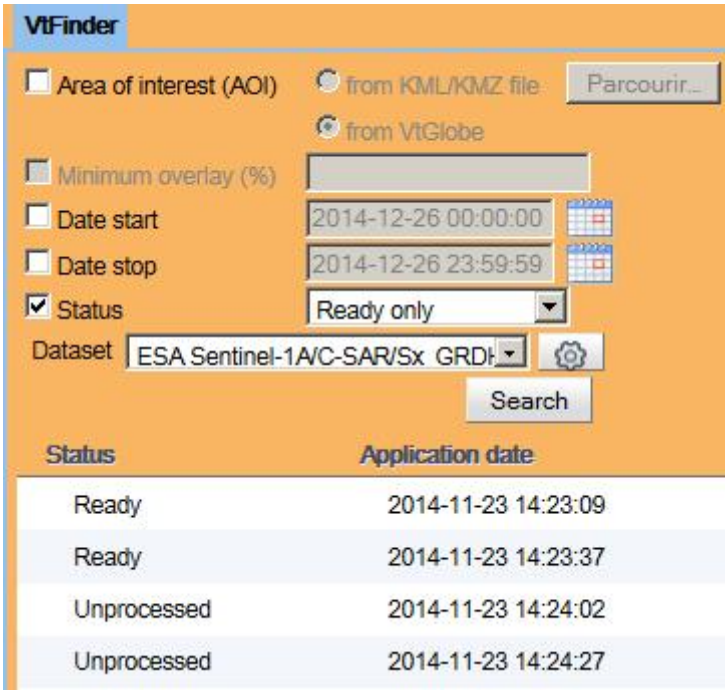
To support the multi-scale interactive display, VtWeb has to prepare the data by building a hierarchical pyramid. Because, VisioTerra is not granted the right to remotely store any data on the DHuS infrastructure, the target product shall be previously downloaded and prepared in the VtWeb infrastructure at VisioTerra premises over disks playing the role of "cache of DHuS".

Downloading and data preparation may require up to 20 minutes depending of the size of the product (see table 3). This is one of the reason this first version of the prototype is limited to GRD products.

When a product has been prepared (downloaded and its pyramid computed), its status is set to "Ready"; in the other case its status is "Unprocessed".

3.2.2 User interface

The first service of VtWeb is called "VtFinder" that enables to interactively retrieve and display a wide range of data types.



The implementation of VtFinder for this prototype has been limited to the datasets of the three ESA archives: DHuS, TPM and Envisat.

The upper-left service panel containing VtFinder is composed of:

- a part containing the search criteria,
- a "Search" button and
- a list of returned items that have been found matching the criteria.

3.2.2.1 Search criteria

To restrict searching according to particular criteria, one shall check the box prefixing this criteria on the left. In the attached figure only the "Status" criteria has been selected; all the other criteria will therefore get the default value that will be detailed here after.

Area of interest (AOI)

The geographic region that EO products are expected to overlay is defined by user in three different ways:

- **World (default)** - when the criteria checkbox is not selected, no spatial selection is performed.
- **from KML/KMZ file** - if the criteria checkbox and this option are selected, the "Browse" button will enable user to select the KML or KMZ file containing a closed polygon.
- **from VtGlobe** - if the checkbox and this option are selected, user may define a bounding box, a disk, a closed polygon or a corridor from the icons located at the upper-right of the display area.

Date start

When the checkbox of this criteria is not selected, no inferior temporal limit will be considered and the returned items are collected from the start of the mission. At the opposite, an inferior limit may be set as a text or using the calendar.

Date stop

When the checkbox of this criteria is not selected, no superior temporal limit will be considered and the returned items are collected up to the more recent ones. At the opposite, a superior limit may be set as a text or using the calendar.

Status

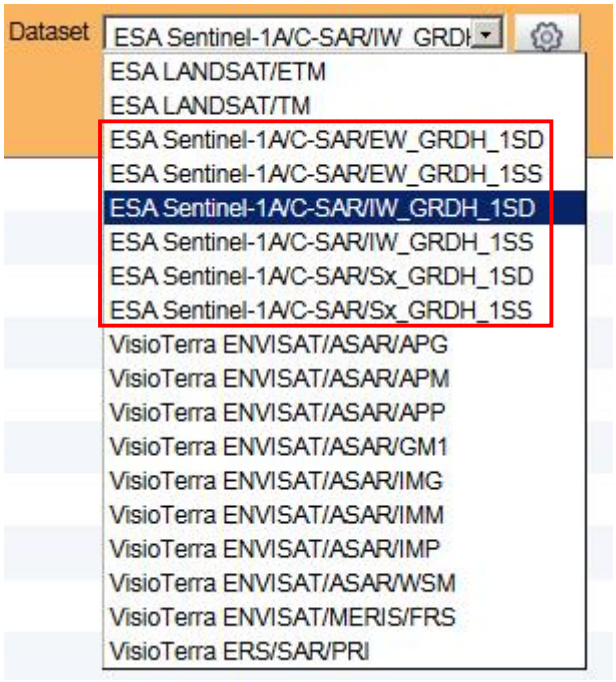
By default when this criteria checkbox is not selected, all the products disregarding their status ("Unprocessed" or "Ready") will be returned. At the opposite, if the user wants to immediately watch the products, the checkbox may be selected and the option of the pulldown menu set to "Ready only".

Datasets

Scope of the prototype was just to demonstrate the feasibility and advantages of an "on-the-fly processing relay". The developers of the prototype have captured once the list of metadata of 7079 S1A products acquired between 2014-10-26 and 2014-12-15.

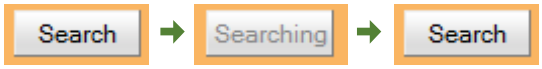
At the time of this report, the six datasets highlighted in the attached figure contain products that have been acquired before 2014-12-15 in the EW, IW and SM modes with a single or dual polarisation and processed "Ground Range Detected" (GRD):

- EW 2184 granules
- IW 4322 granules
- Sx 573 granules



3.2.2.2 Searching

To get granules for the selected dataset, one shall activate the "Search". As shown here below, the "Search" button is set in grey (inactive state) when the search is on-going.

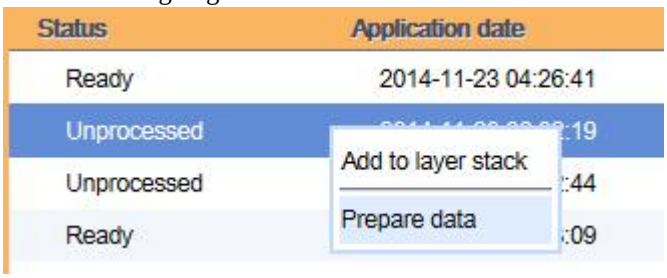


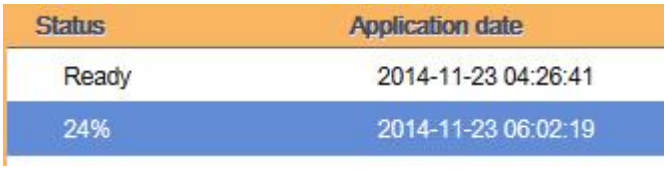
3.2.2.3 Asking for the "preparation of data"

When a product is "Unprocessed", one may ask for its data preparation right-clicking on the item and selecting the "Prepare data" option.

The progress of preparation is given by a percentage in place of the label.

Data preparation are processed sequentially and requests of users are queued by the VtWeb server.





3.2.3 Example of session - Getting an image on the Sundarbans oil spill

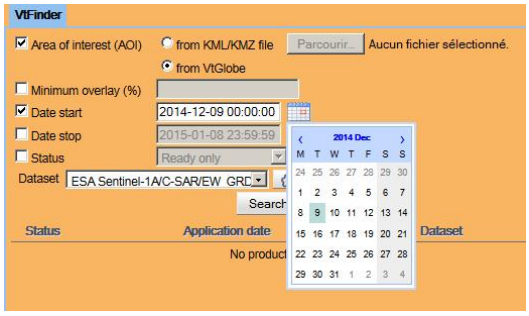
On 9 December 2014 an oil spill occurred at the Sela river of Sundarbans (Bangladesh), a UNESCO World Heritage site when an oil-tanker named “Southern Star VII” carrying 350,000 litres of furnace oil was sunk in the river (see http://en.wikipedia.org/wiki/2014_Sundarbans_oil_spill).

3.2.3.1 Defining the search criteria

Area of interest

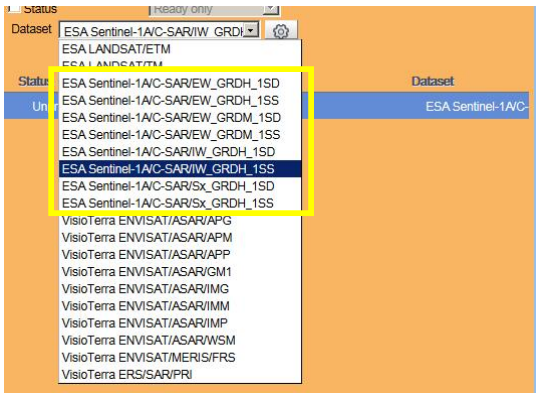
Time interval

Only products acquired after 4th December 2014 are of interest but the stop date is not defined.



Datasets

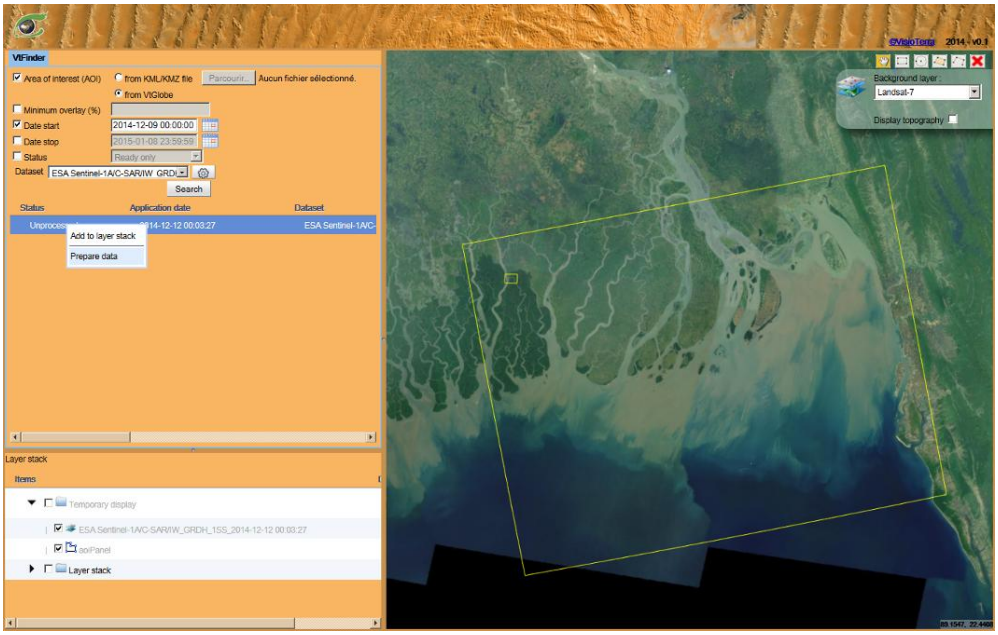
Browse the datasets pressing the “Search” button.



3.2.3.2 Requesting the product

Asking for the data preparation

In the dataset “IW GRDH” a product has been found acquired on 2014-12-12 at 00:03:27. This product being “Unprocessed”, one shall ask the server to “Prepare data”, an option of the pop-up menu appearing on a right-click over the product.

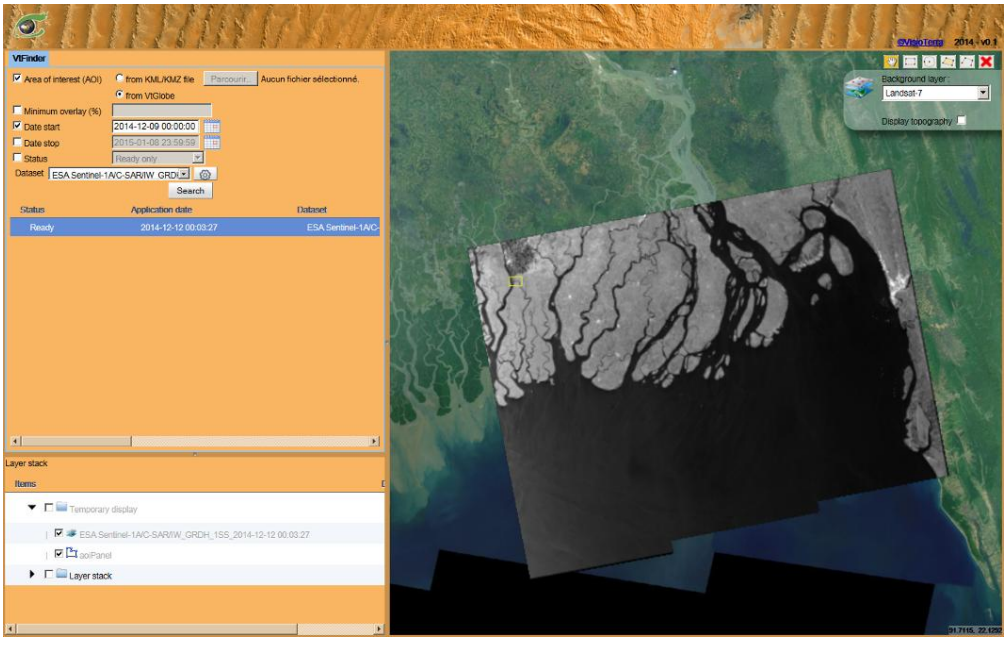


Waiting for the data preparation

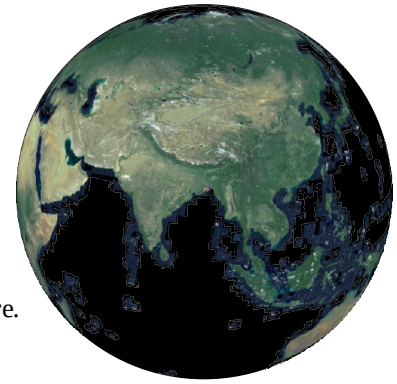
The status displays the progress in the data preparation.

…

When the preparation is completed, the « Status » becomes « Ready » and the image is displayed using the default style.



3.2.3.3 Interactive display enhancement



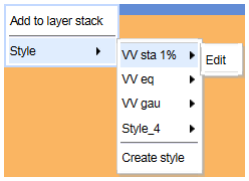
Navigating across the globe and the product

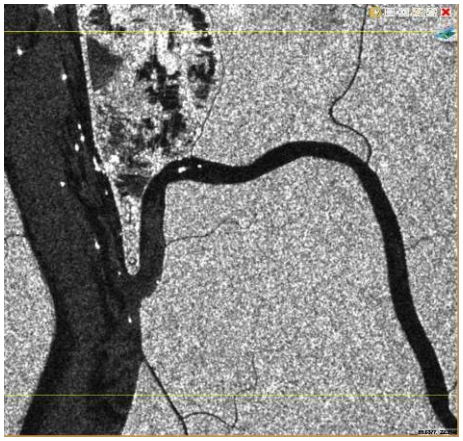
User may use :

- the mouse and the **central wheel** to pan and zoom,
- **CTL+m** - to switch between 2D and 3D,
- "**r**" - to reset the azimuth and inclination of the globe,
- **SHFT+R** - to reset the globe at the default location
-  to change the background layer (Landsat-7) in the attached figure.

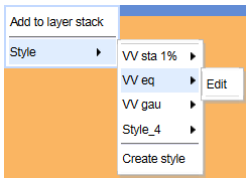
Using predefined styles

linear stretching

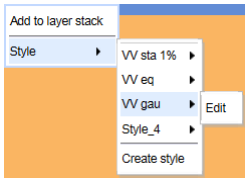


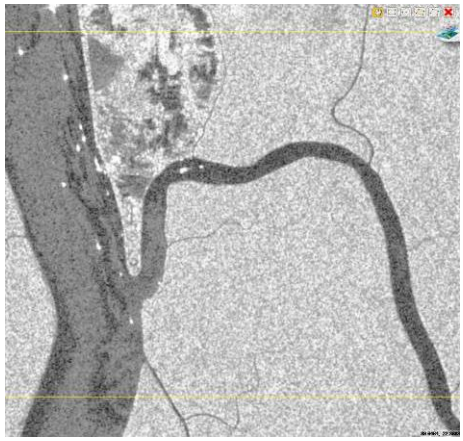


histogram equalisation



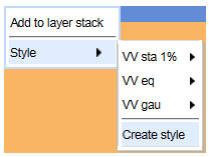
Gaussian equalisation



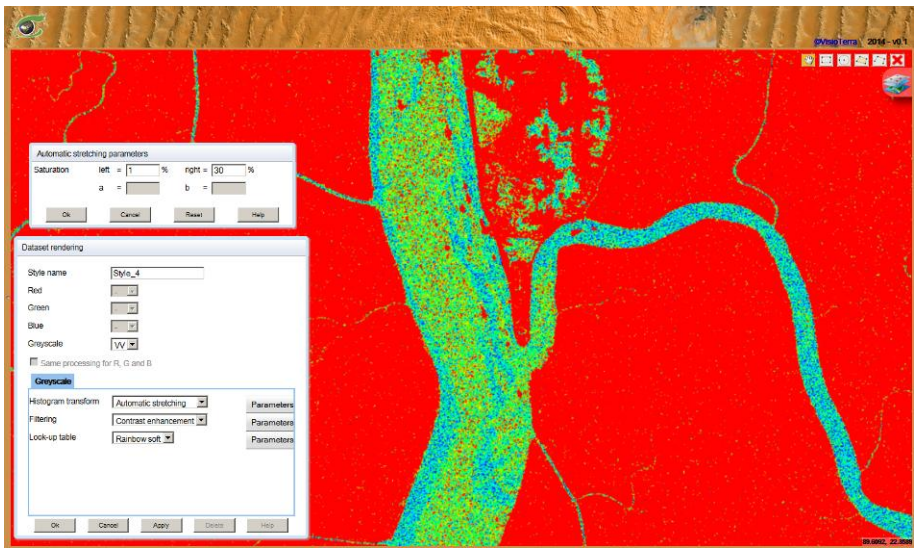


Creating a new style

User may create his/her proper style using the "Create style" option of the "Style" menu.



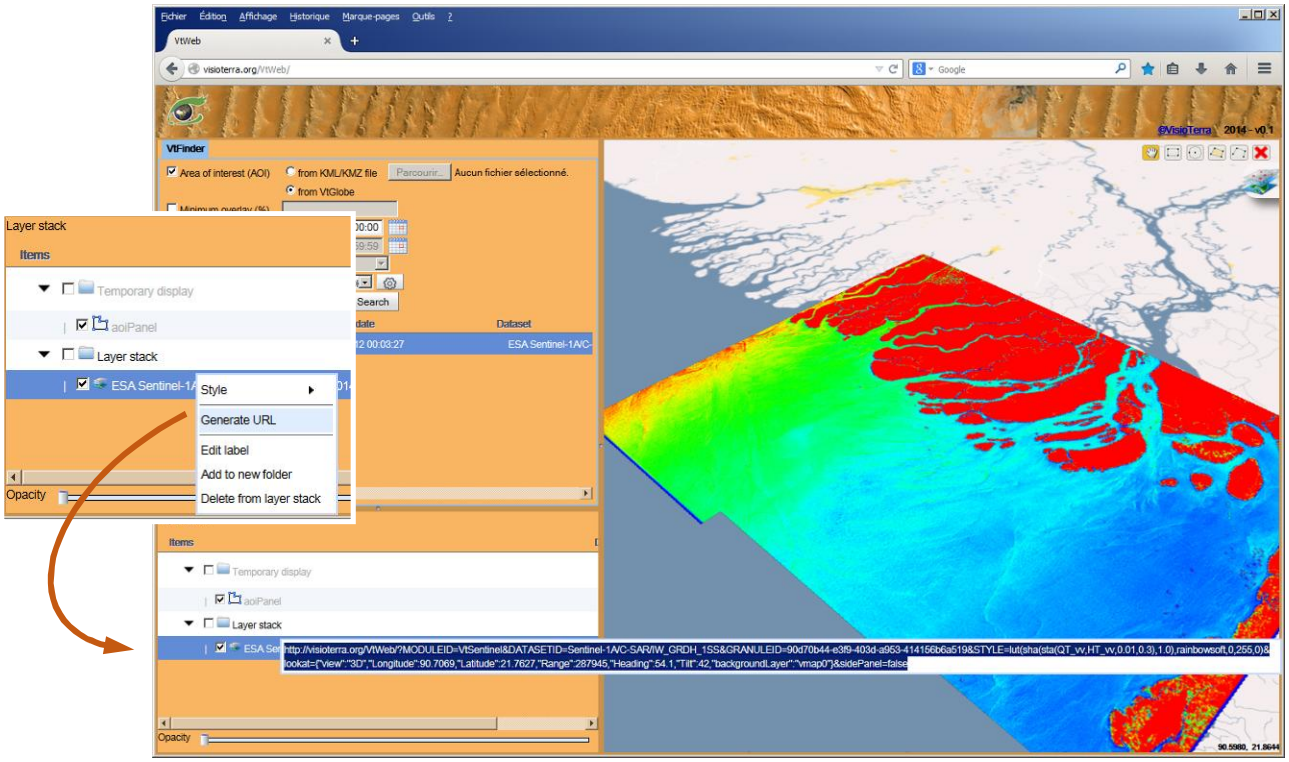
The attached figure shows for example a linear stretching with 35% saturation on the right followed by a contrast enhancement and a pseudo-colour rendering to highlight possible oil spills.



Sharing a view

User may share its view by (see the figure below) :

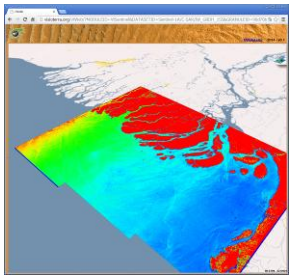
- setting the "viewing geometry" (location of the central target, distance to the target, azimuth and inclination of the globe),
- selecting the "Generate URL" option of the pop-up menu over the selected product,
- copying the URL that can be sent to anyone.



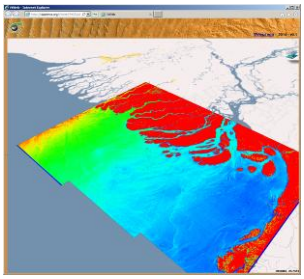
This complex URL identifies the VtWeb server, the dataset and its granule, the on-the-fly processing parameters and the viewing geometry parameters.

In our example : http://visioterra.org/VtWeb/?MODULEID=VtSentinel&DATASETID=Sentinel-1A/C-SAR/IW_GRDH_1SS&GRANULEID=90d70b44-e3f9-403d-a953-414156b6a519&STYLE=lut(sha(sta(QT_vv,HT_vv,0.01,0.3),1.0),rainbowsoft,0,255,0)&lookat={"view":"3D","Longitude":90.7069,"Latitude":21.7627,"Range":287945,"Heading":54.1,"Tilt":42,"backgroundLayer":"vmap0"}&sidePanel=false

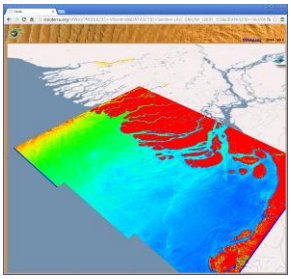
Recipient of this URL will look at your product in their usual navigator:



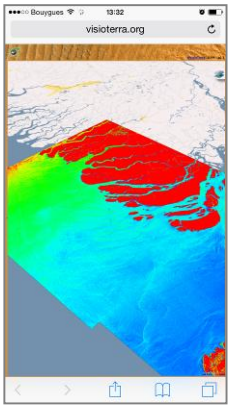
Mozilla Firefox



Internet Explorer



Chrome



Safari

3.2.4 Gallery of DHuS images and on-the-fly automatic processing

3.2.4.1 Display of one or more products at time

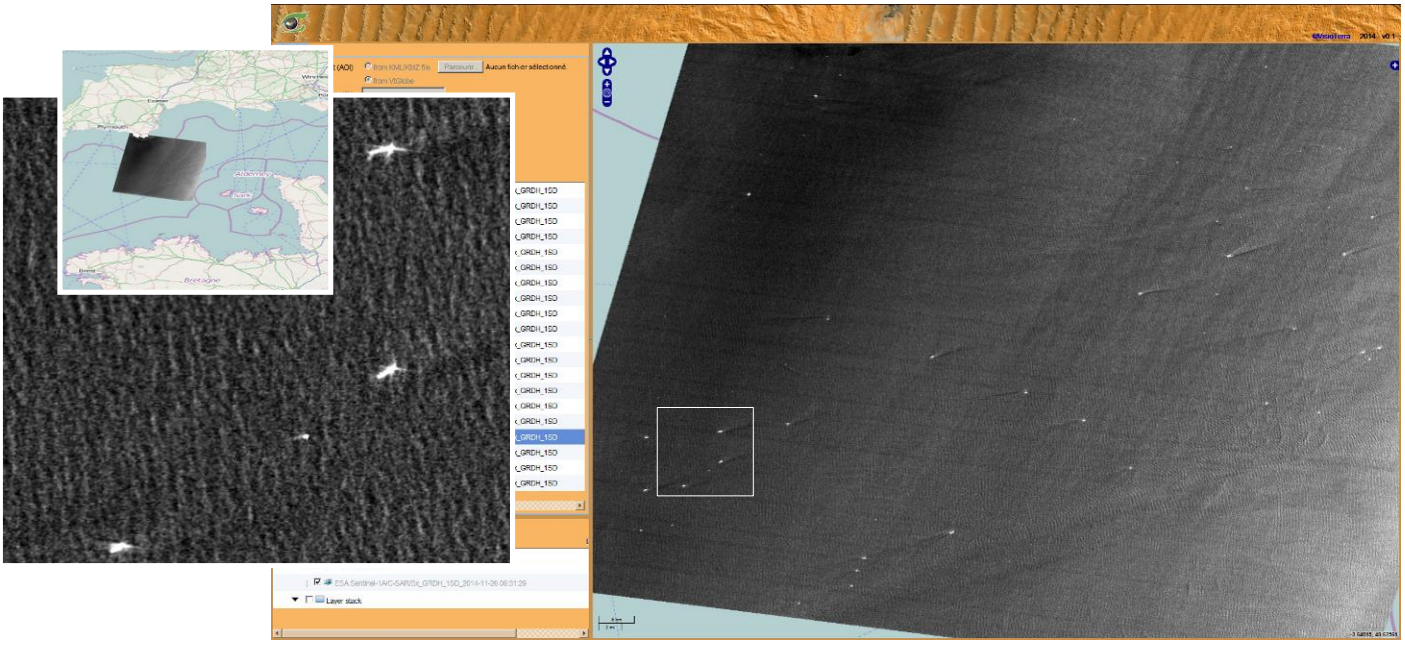


fig. 34 - Display in VtWeb of Sx_GRDH_1SD acquired on 2014-11-26 at 06:31:29 over Channel (UK-France).

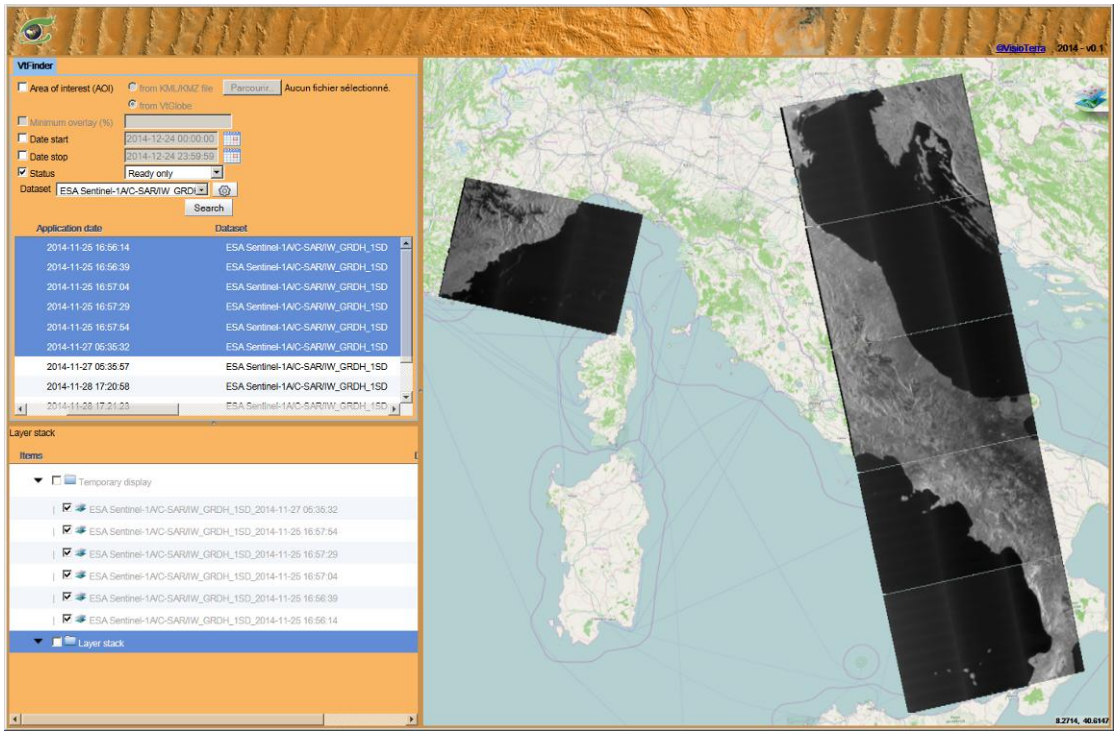


fig. 35 - Display in VtWeb of 5+1 IW-S products over Italy with on-the-fly geocoding and automatic radiometry processing.

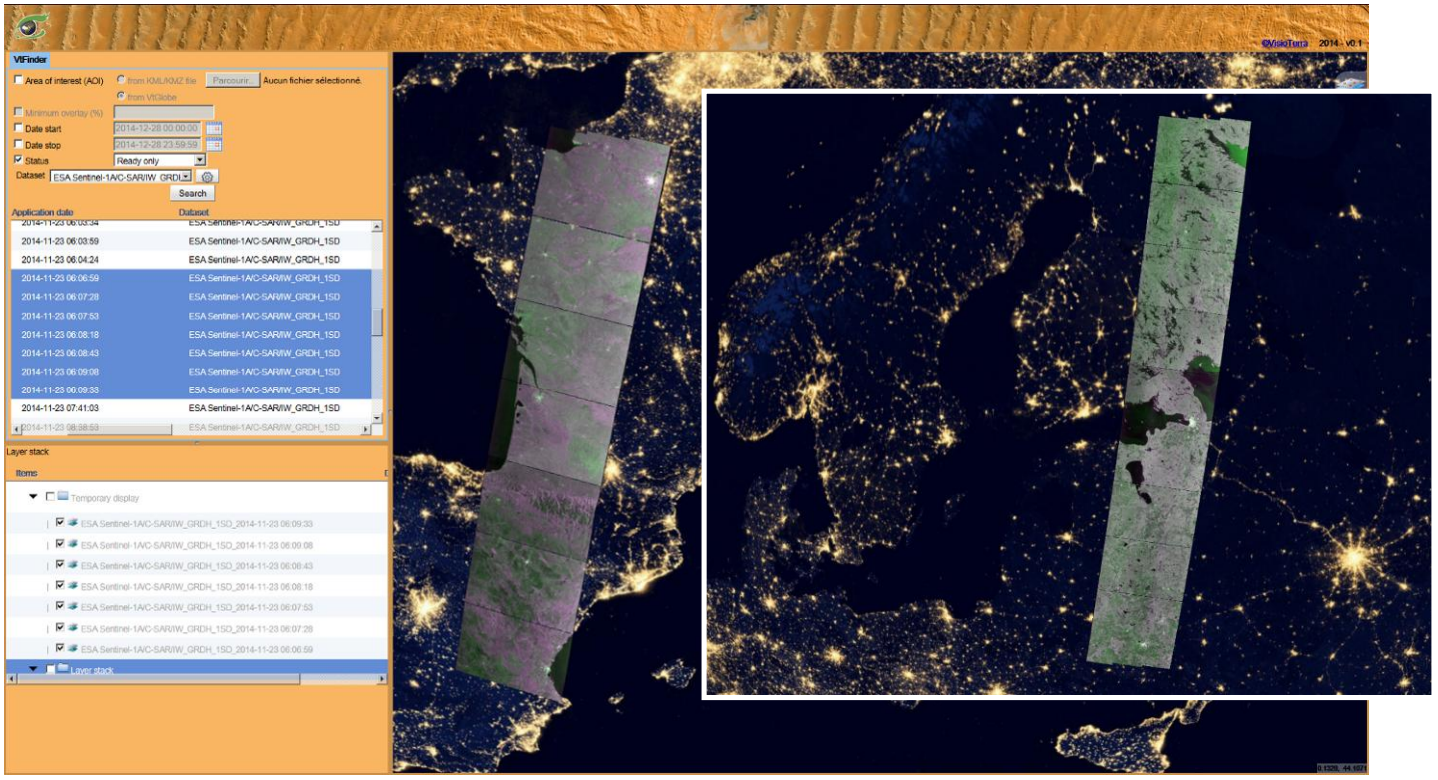


fig. 36 - Display in VtWeb of 7 IW products over France-Spain and 9 IW over Russia.

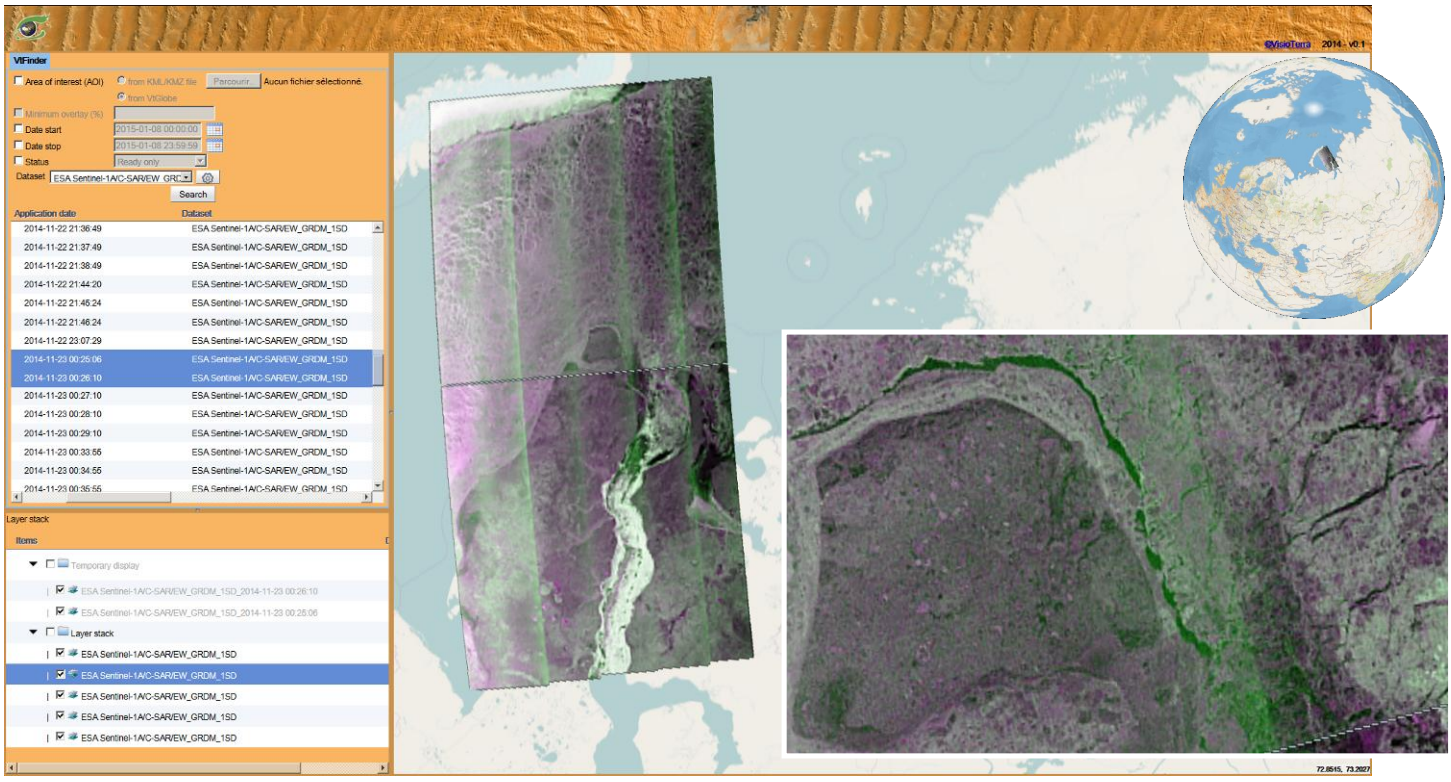


fig. 37 - Display in VtWeb of 2 EW products over Yamal (Russia) - Colour composition, histogram equalization and contrast enhancement.

3.2.4.2 On-the-fly geocoding - Multiscale display

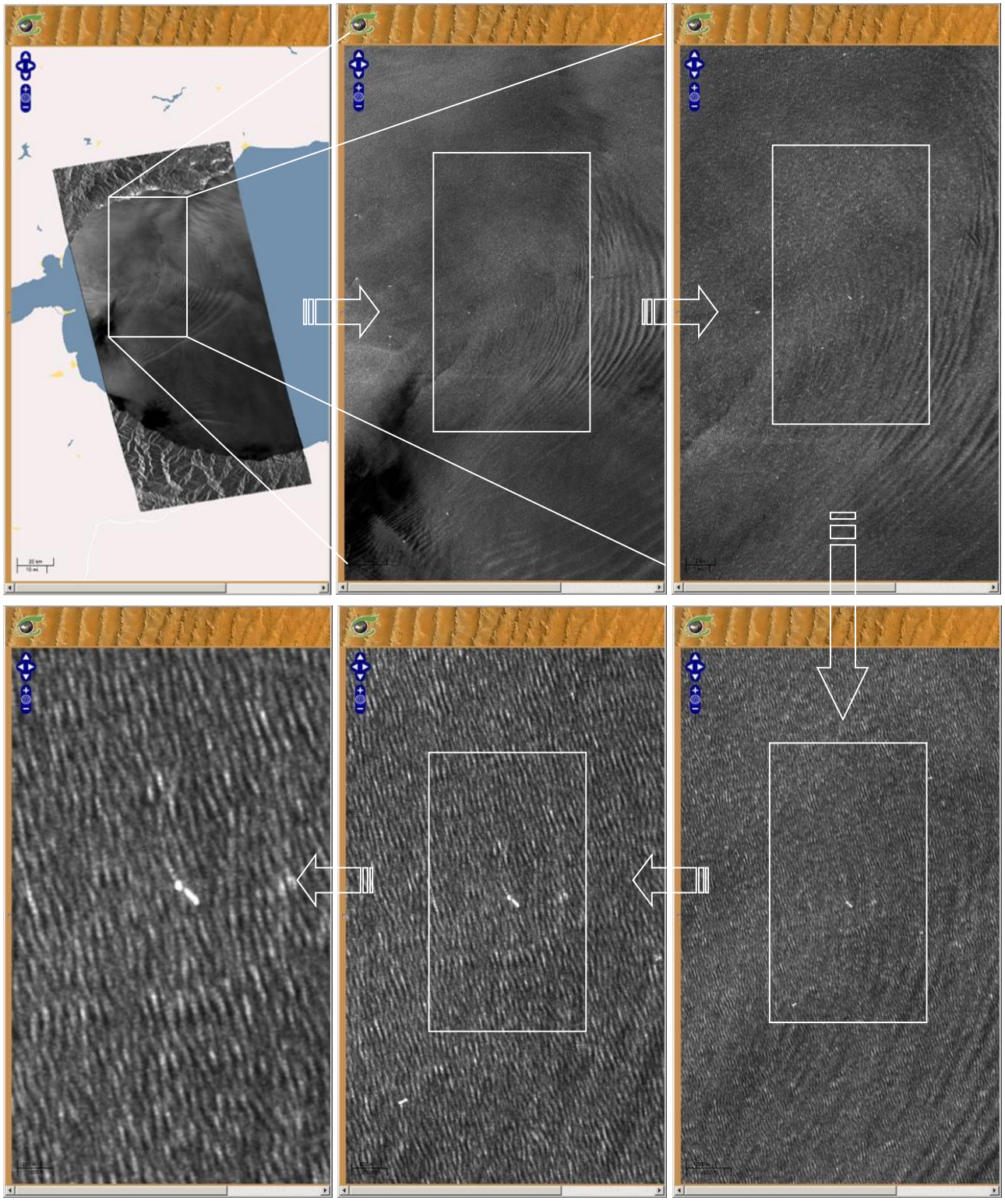


fig. 38 - Display in VtWeb of a SM product at different scales.

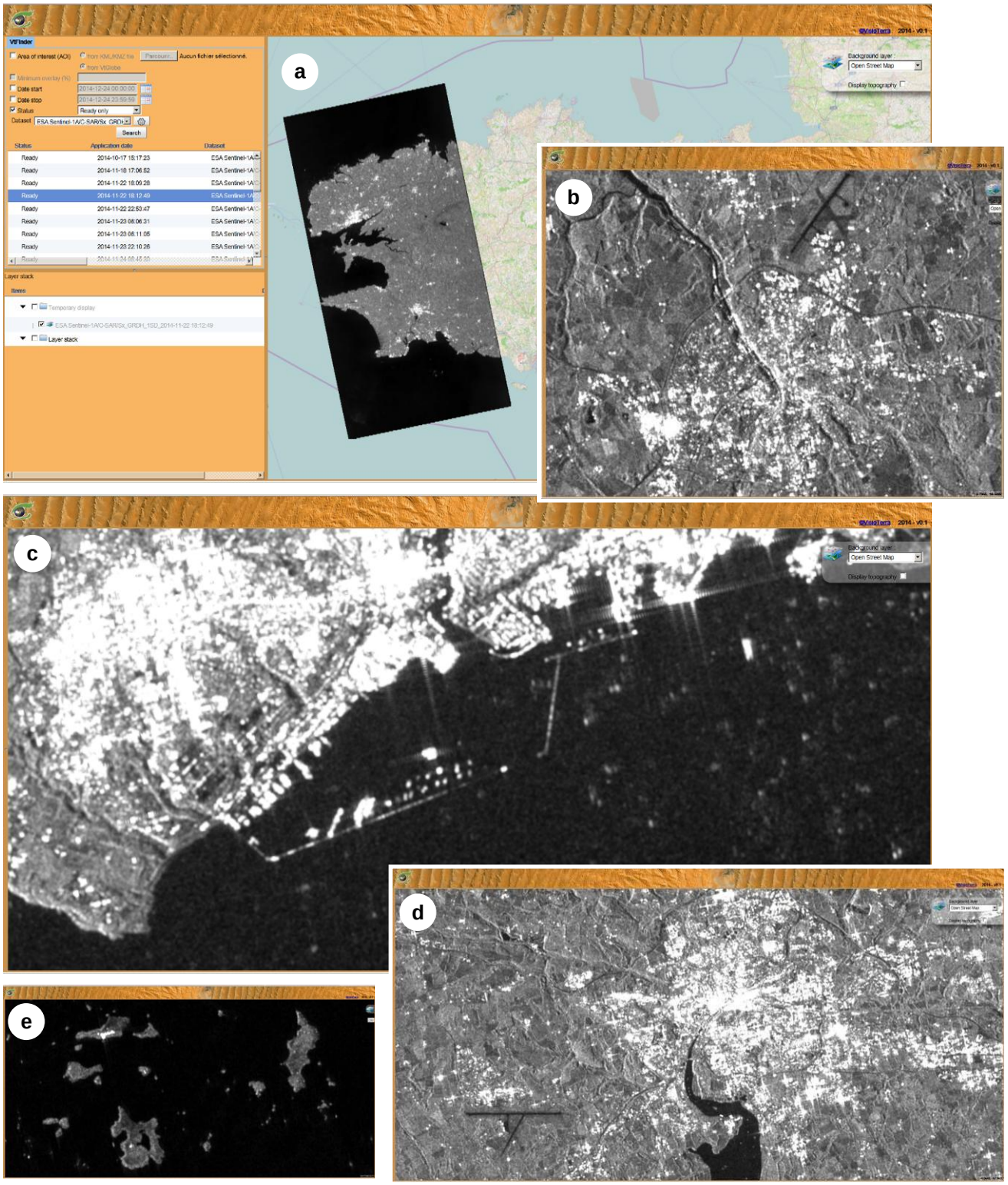


fig. 39 - Display in VtWeb of a SM product on French Bretagne. Full scene (a) and full resolution on Morlaix (b) Brest harbor (c), Quimper (d) and Glénan archipelago (e)

3.2.4.3 On-the-fly RGB combination - Greyscale or colour composition

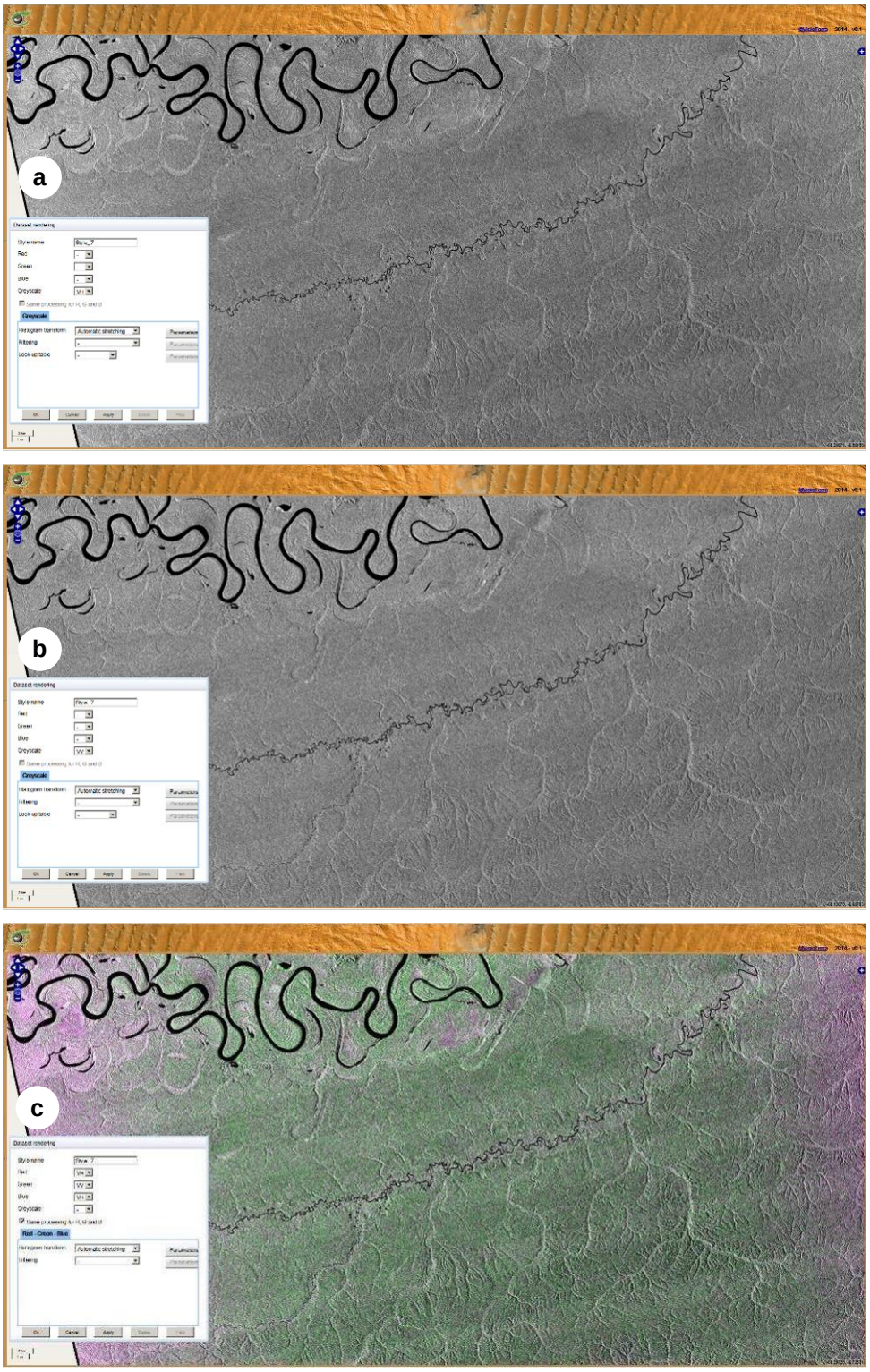


fig. 40 - Display in VtWeb of a SM product over the Amazonia rainforest - Automatic linear stretching on VH component (a) idem on VV (b) histogram equalization on VH-VV-VH RGB colour composition (c).

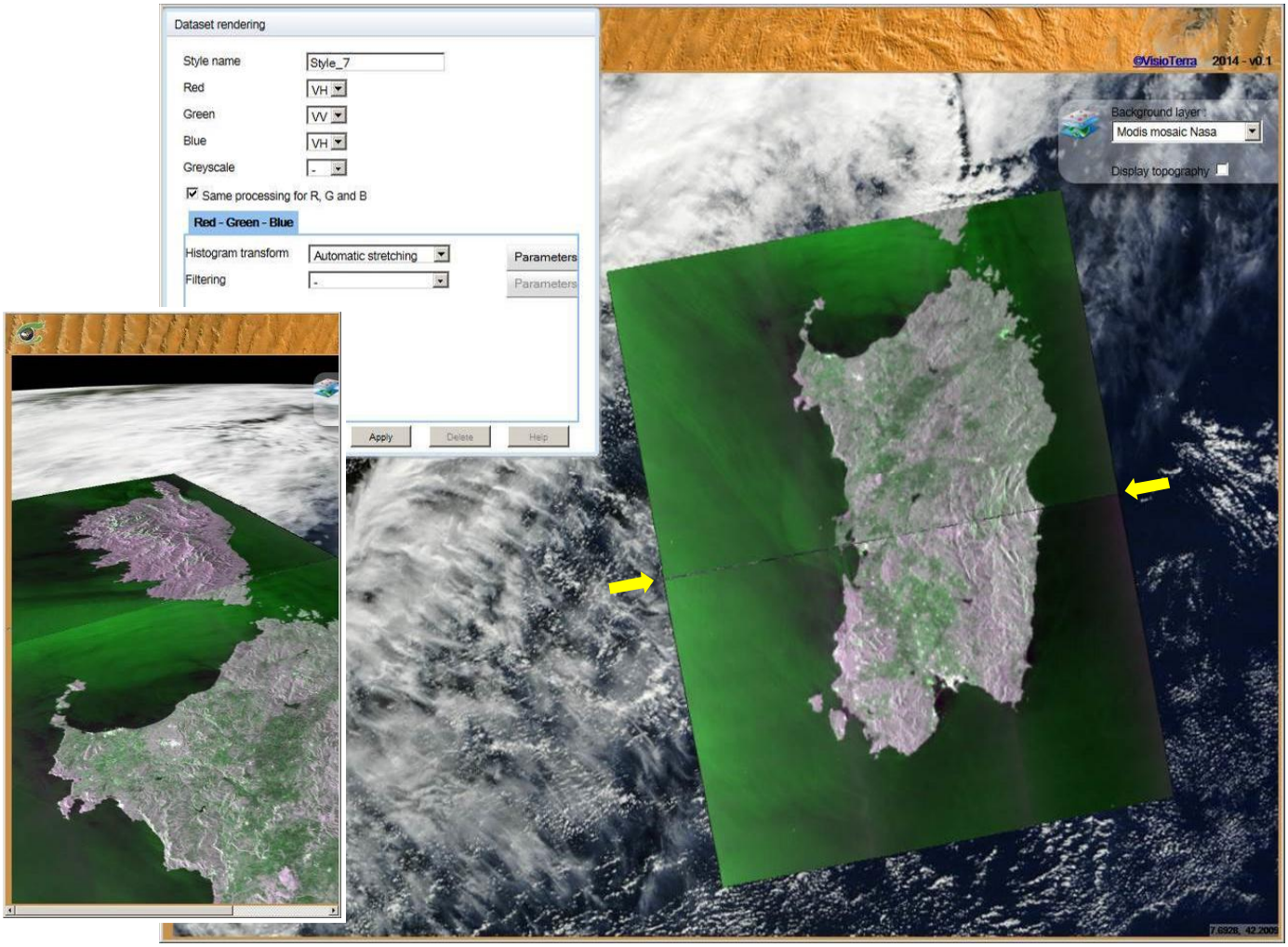


fig. 41 - Display in VtWeb of a IW VH/VV colour composition over Sardinia (Italy). No overlay between scenes.

fig. 42 - Display in VtWeb of a SM product over South of Melilla (Algeria) - Possible trouble of gains in the NRCS correction (TBC).

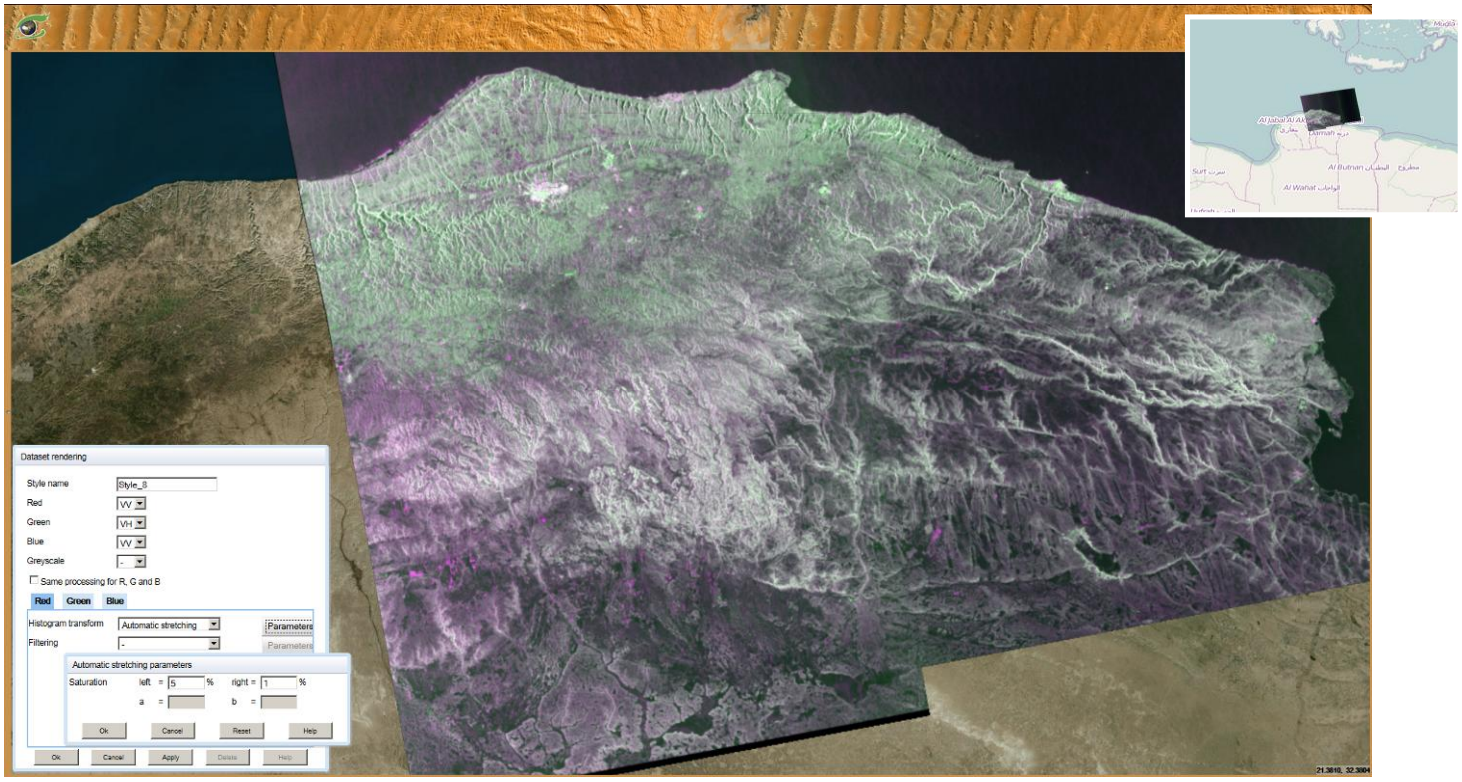


fig. 43 - Display in VtWeb of a IW product over East of Libya - Original VV:VH-VV colour combination showing unrevealed structures.

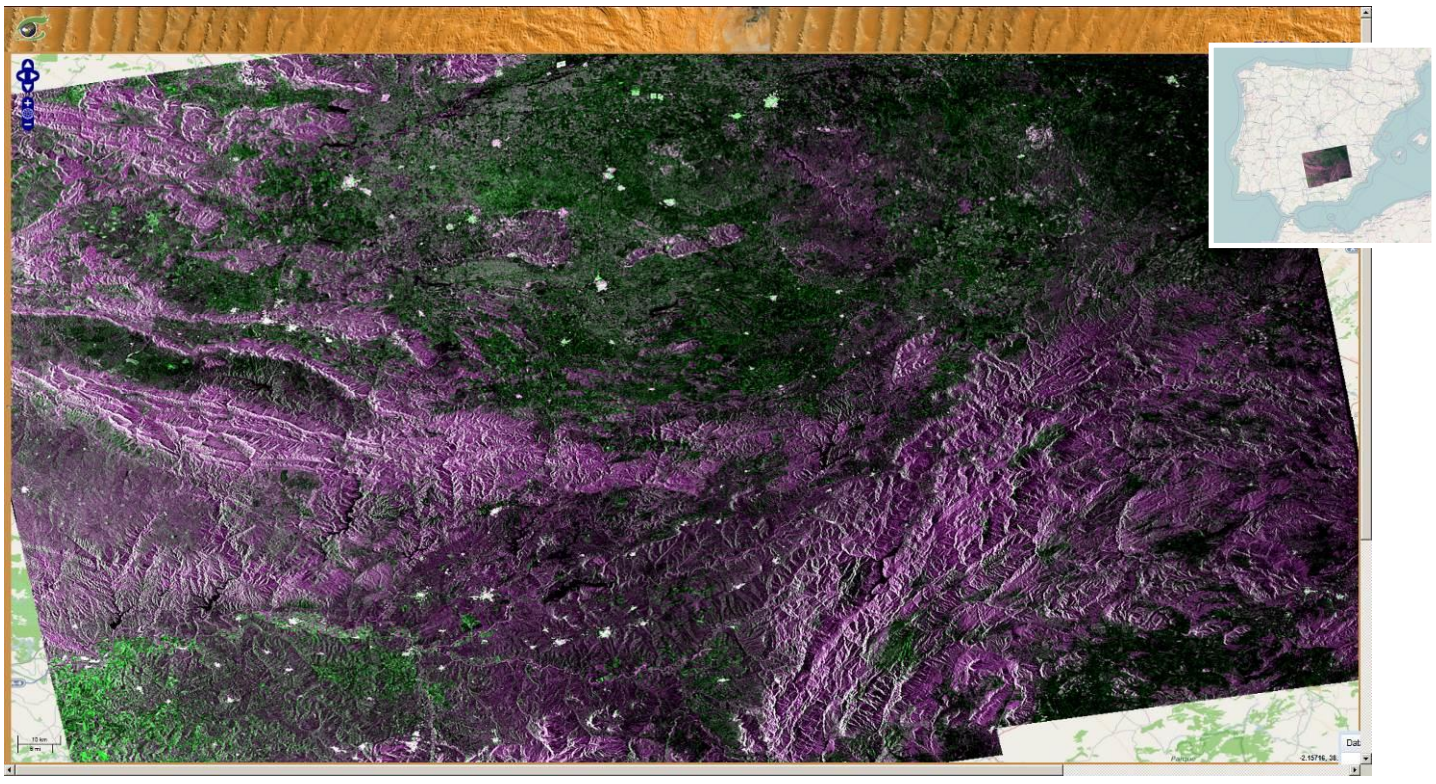


fig. 44 - Display in VtWeb of a IW product over the region of Ciudad Real (Spain) - 10%-1% automatic stretching followed by a contrast enhancement of the classical VH-VV-VH colour composition.

3.2.4.4 On-the-fly radiometry processing - Detection of structures

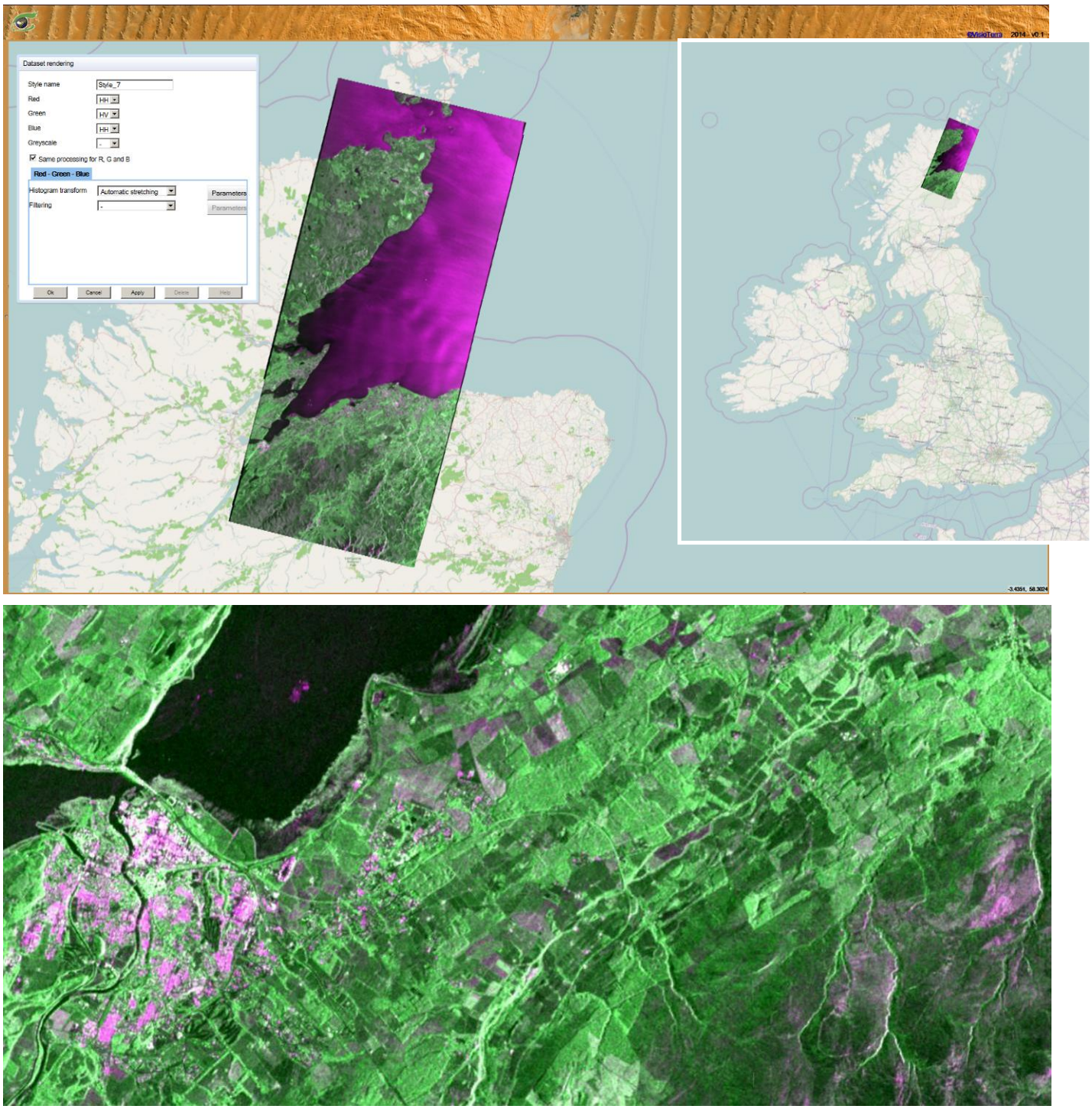


fig. 45 - Display in VtWeb of a SM product over North of Scotland - Full resolution over the city of Inverness.

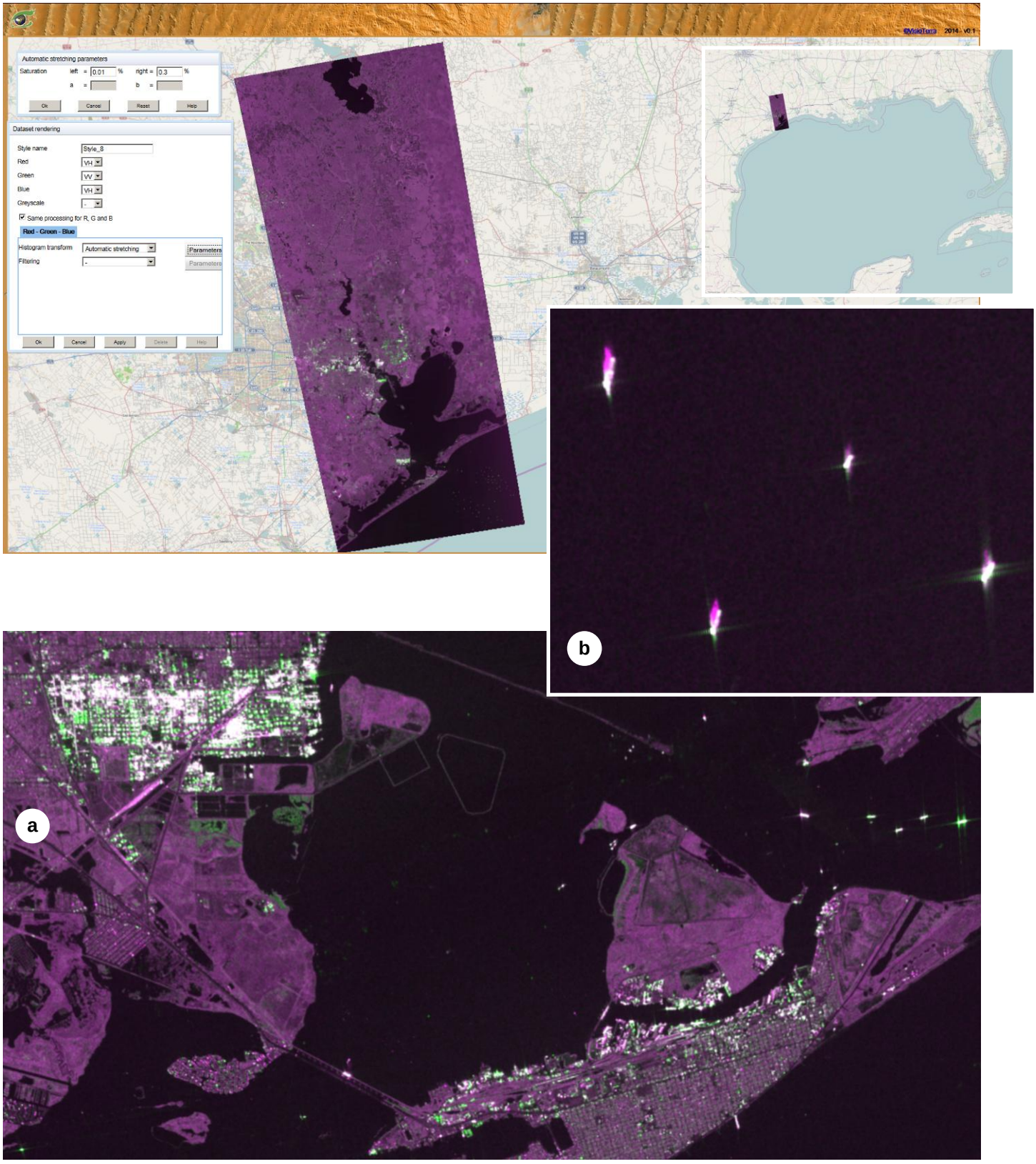


fig. 46 - Display in VtWeb of a SM product over Houston (Texas) - Simple 0.01-0.3 automatic stretching highlighting buildings with metallic structures like the Texas City oil refinery (a) and ships waiting at the entry of Galveston Bay (b).

fig. 47 - Display in VtWeb of Sx_GRDH_1SD acquired on 2014-11-25 at 21:35:14 over SaoPaulo (Brazil).

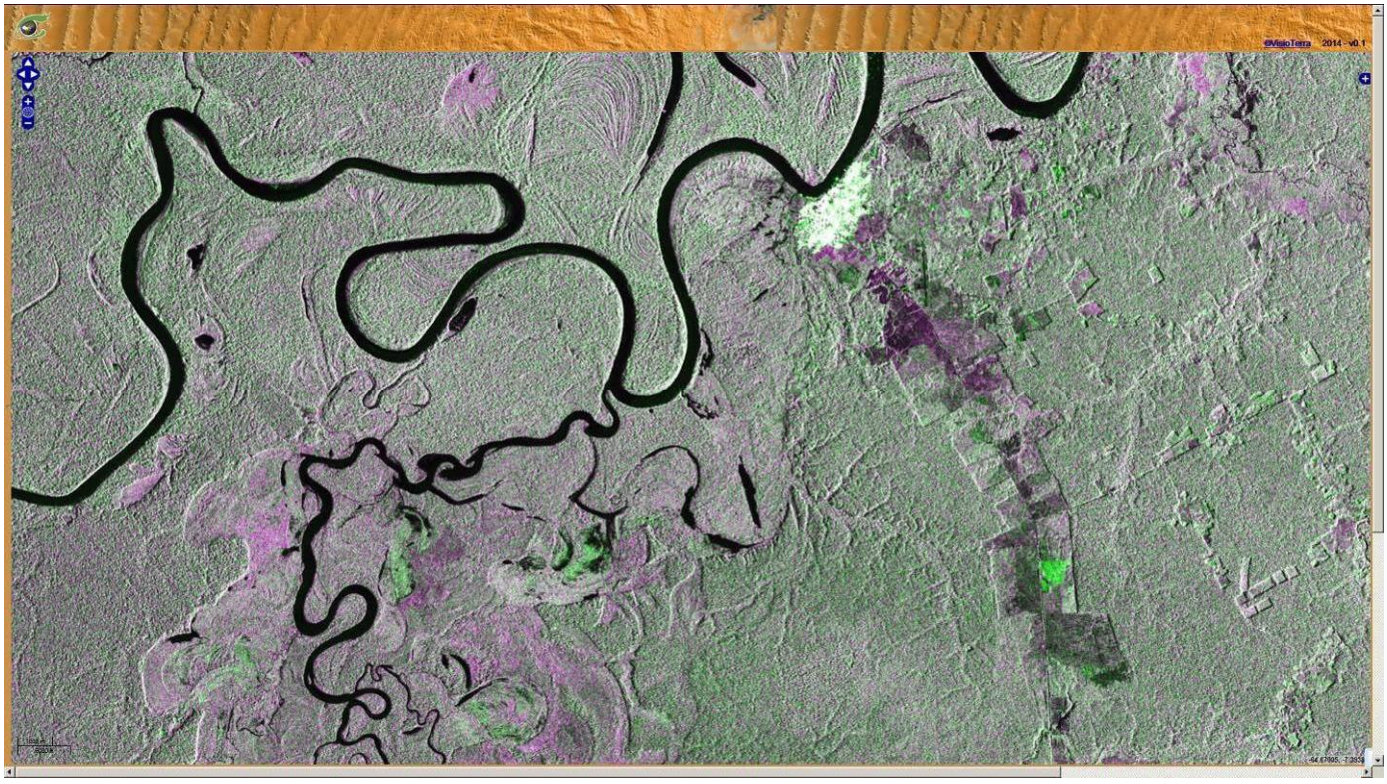


fig. 48 - Display in VtWeb of Sx_GRDH_1SD acquired on 2014-11-26 at 10:04:37 over Amazonia (Brazil).

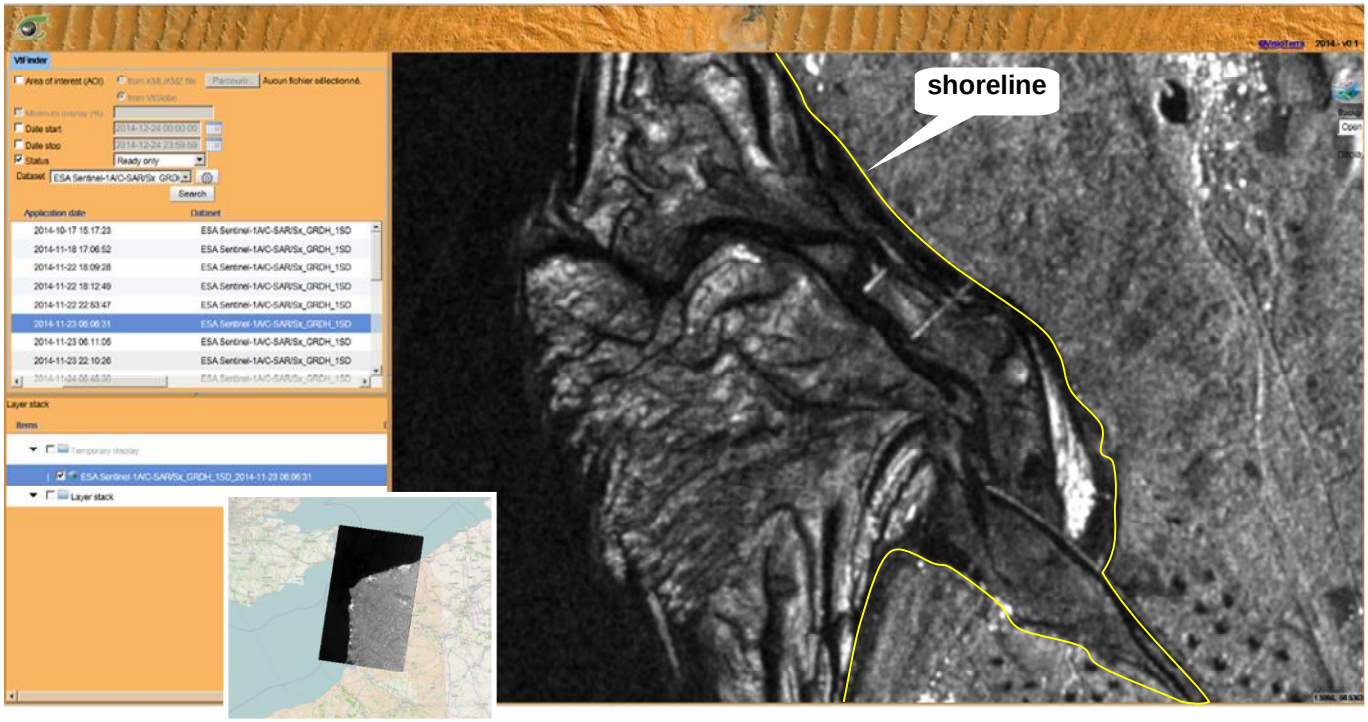


fig. 49 - Display in VtWeb of a SM product over Pas-de-Calais (France) - Foreshore at low tide (South of Boulogne-sur-Mer).

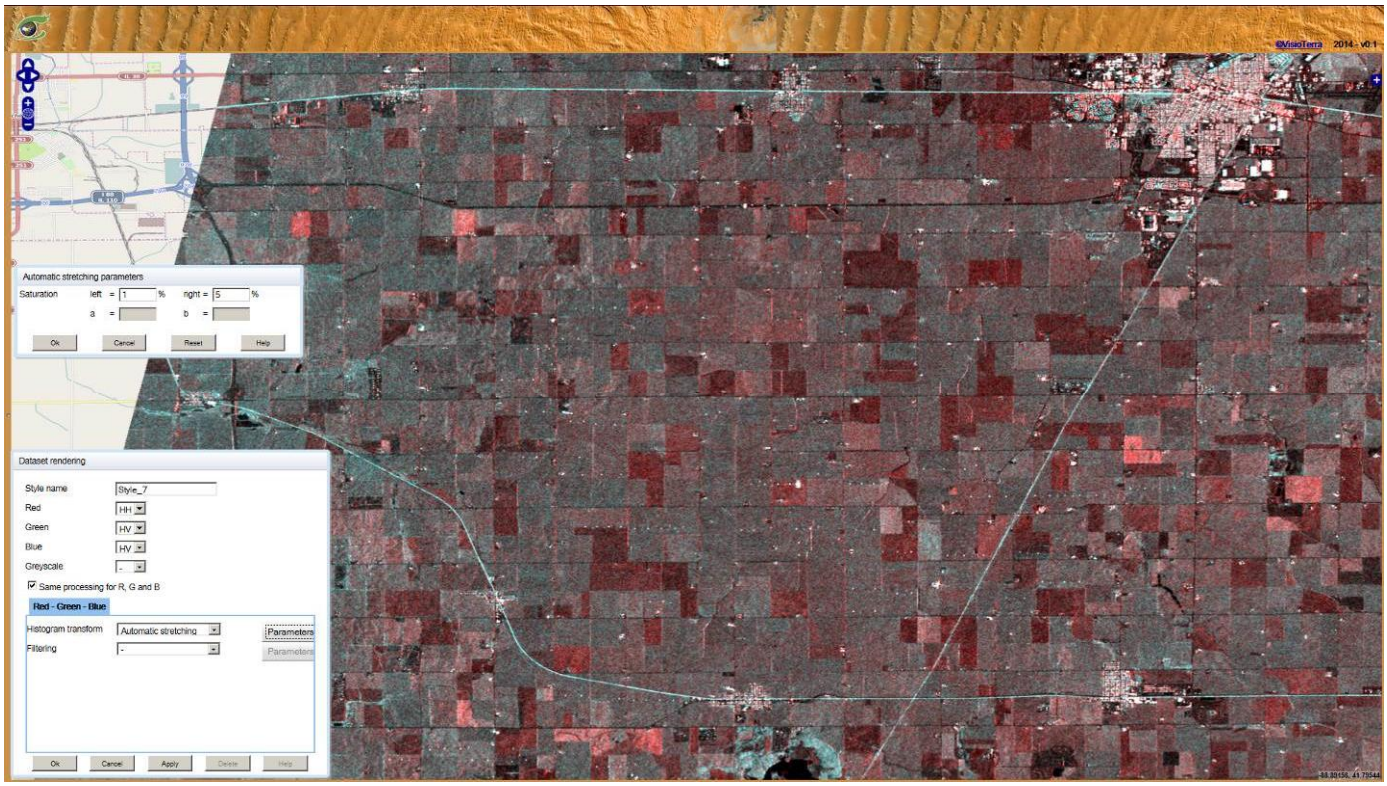


fig. 50 - Display in VtWeb of Sx_GRDH_1SD acquired on 2014-11-27 at 00:10:59 over West of Chicago (USA). Highlighting the rail ways with 1%-5% automatic stretching on the HH-HV-HV colour composition.

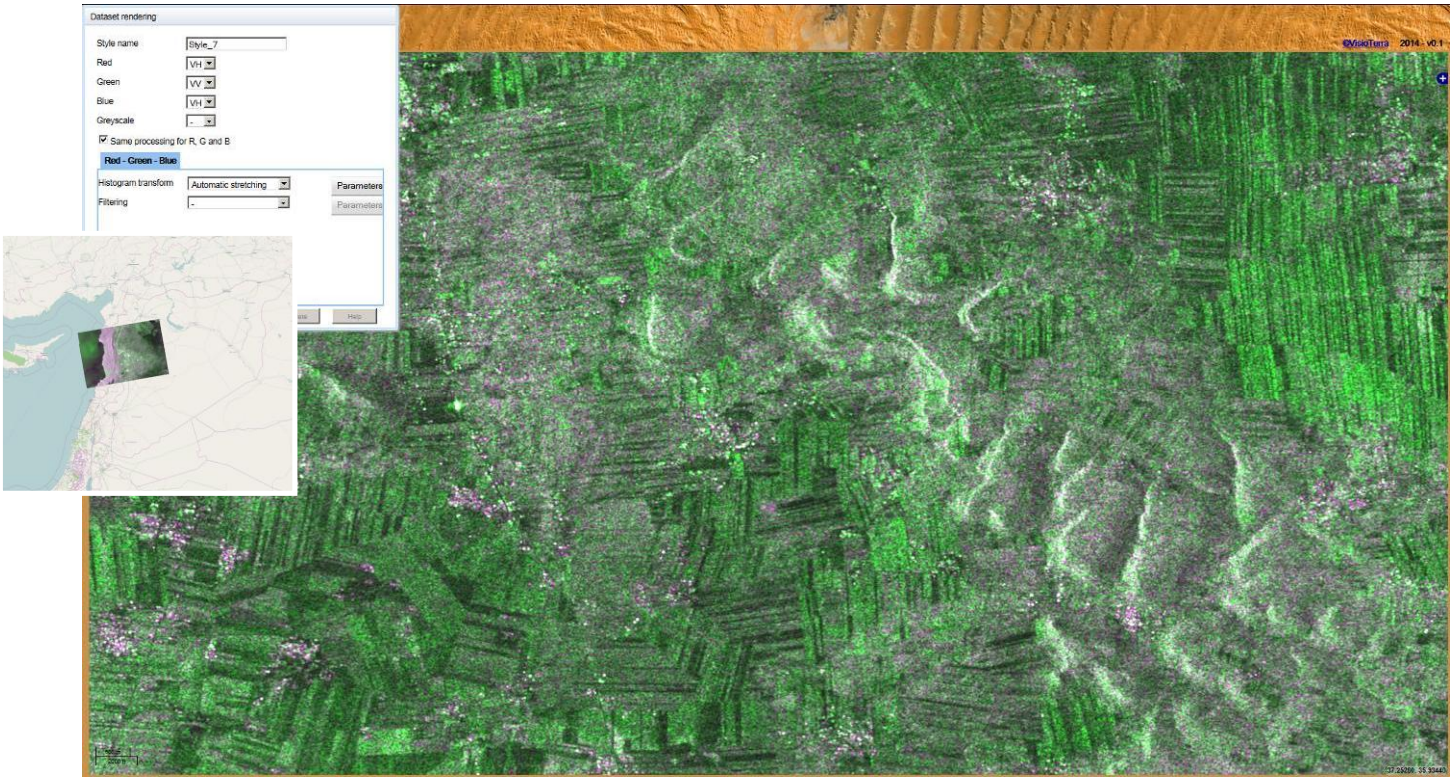


fig. 51 - Display in VtWeb of Sx_GRDH_1SD acquired on 2014-11-23 at 15:32:54 over South of Alep (Syria).

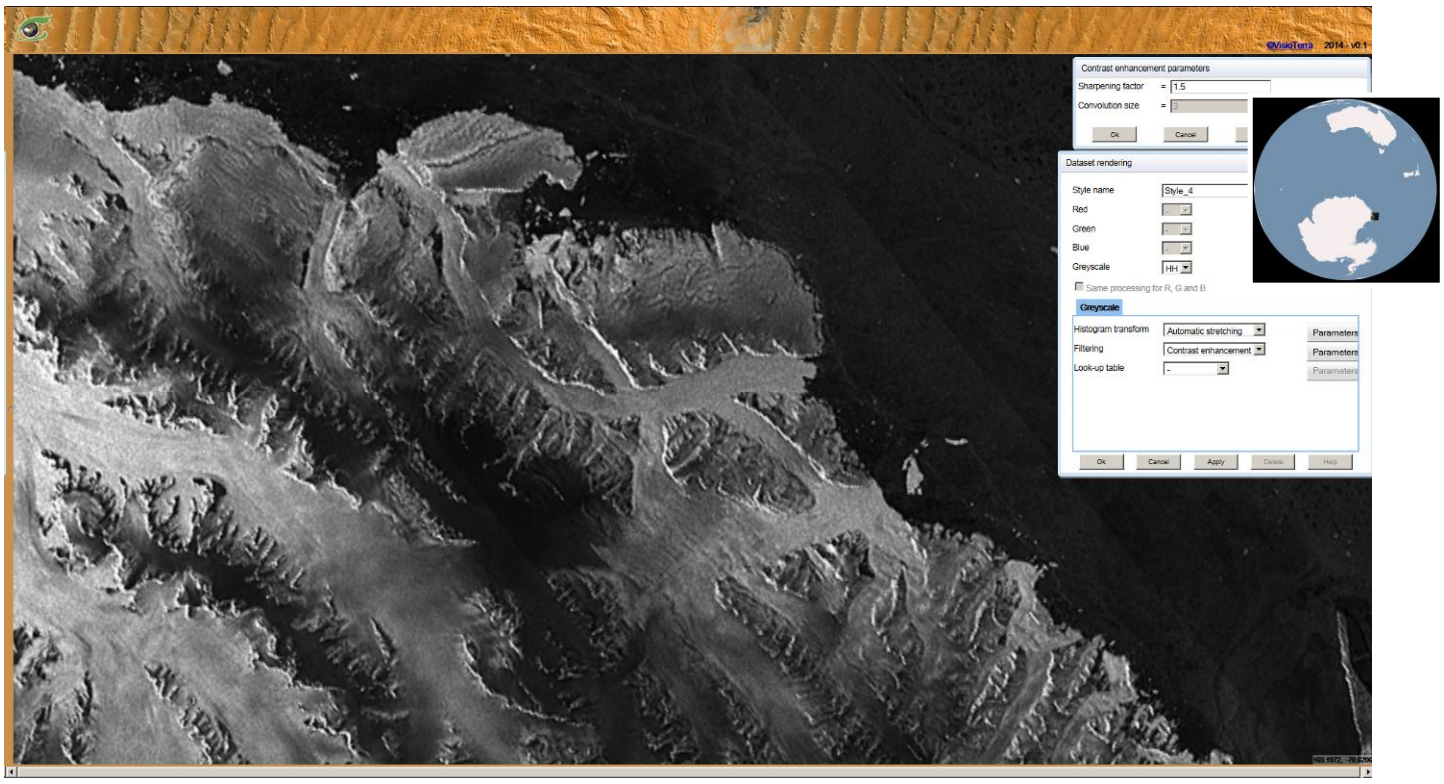


fig. 52 - Display in VtWeb of EW_GRDM_1SS acquired on 2014-11-17 at 09:17:02 over Antarctica with 1.2 contrast enhancement.

3.2.5 Possible extensions

3.2.5.1 Synchronous inventory

DHuS server would be periodically requested to get the metadata of the latest products being assimilated by the rolling archive and to get the list (TBC) of the products having been cancelled from the DHuS archive.

3.2.5.2 VtWeb server embedded in DHuS infrastructure

A project is on-going under the supervision of Eric MONJOUX to implement basic image processing functions of VtWeb server in the DHuS server. When the work packages of this project will be completed (scheduled mid-2015), DHuS server will systematically prepare the data for GRD products of S1A and access for users will be immediate.

3.2.5.3 Scene aggregation

Interest of time-series aggregation

VisioTerra suggests to enable citizen and scientists to quickly focus on the exceptions (see section 2.3.4.3 Detecting the anomaly - Difference to the "median product").

Experience has shown that the multi-date aggregation is one of the best way to suppress the speckle in the radar images. In addition the very short repeat cycle of 12 days of Sentinel-1 coupled with the stability of the trajectory control ("orbital tube" with a radius inferior to 50 metres) will lead to successive scenes of a same track will be viewed in almost the same geometry. As a result, a simple geocoding (not requiring orthorectification) will lead to perfectly superimposable scenes.

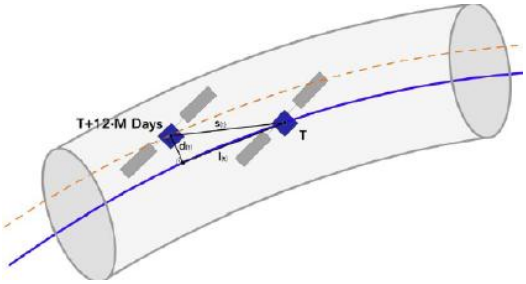


Figure here below show for example the difference between a single Envisat ASAR WSM scene (left) and the mean of 25 scenes (right) on the west coast of the Caspian Sea.

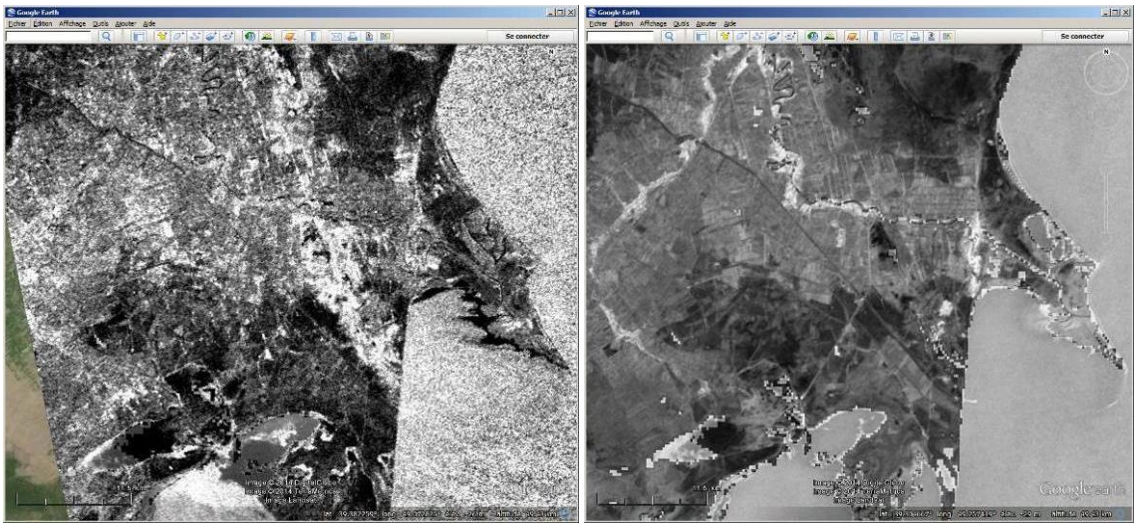


fig. 53 - Envisat ASAR WSM - Single image (left) and mean aggregation (right).

Multi-date aggregation

Multi-date aggregation is a way to monitor how the landscapes are varying across the time. The aggregation operators that will be implemented are: -mean, -standard deviation, -variation coefficient (mean divided by the standard deviation), -minimum and -maximum.

Users will have the possibility to define a time range and/or a seasonal range like for example all the scenes acquired on a particular zone between the 1st March and the 18th May between 2014 and 2017.

These requests are time-consuming. The server may refuse a request that would involve too many resources or the server may make use of intermediate calculations (like for example monthly mean) to speed up the requested aggregation.

Figure fig. 54 here below shows some aggregation operators (mean, standard deviation and variation coefficient) performed on Envisat ASAR WSM segments in Santa Barbara (California, US). The zoomed images show oil platforms that, for some of them, are not identified in Google Earth.

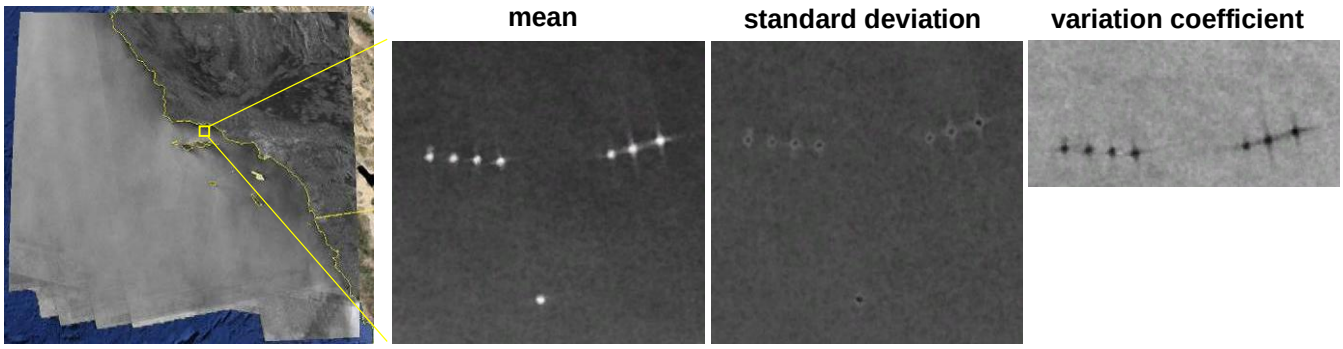
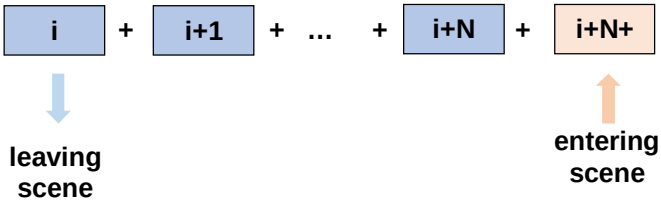


fig. 54 - Envisat ASAR WSM - Mean of a set of scenes (left) and zoom on various aggregation operators.

Change analysis

Rolling statistics

Making a systematic "rolling mean" of the latest scenes in the DHuS rolling archive will enable to compute for whatever arriving Sentinel-1 scene its difference with the "rolling mean".



As said above, the "rolling mean" is computed for each one of the tracks geocoding systematically the level 1B product.

Assuming a period of rolling archive of 3 months, a 12 days repeat cycle and for regions systematically observed, one may assume that the "rolling mean" will involve about 7 scenes. Keeping an "occurrence image" attached to the "rolling mean", one may subtract a scene leaving the rolling archive and add a scene entering in the rolling archive.

Annual statistics

We also suggest to keep an "annual mean" of the qualified scenes, i.e. those that do not show a out of range difference with the "rolling mean" (see here after).

One may also extend the computation to the "standard deviation" and to the "variation coefficient" (TBC). Six products will therefore be available: "rolling mean", "rolling standard deviation", "rolling variation coefficient", "annual mean", "annual standard deviation", "annual variation coefficient".

Rolling difference

For each new scene entering in the rolling archive, a "difference to mean" is computed for each scene. Basic statistics (mean and standard deviation) are computed on this "difference to mean" image in order to:

- help users to detect changes in the new image with regard to the usual mean,
- warn the DHuS system manager (QA officer) if an out of range difference is detected (such a measurement may be the sign of a calibration defect or a mislocation),
- keep the history for each track/frame of the mean showing cyclic changes in the Radar backscattering over the this region.

3.2.5.4 Extension to SLC datasets

SLC products could be processed on the fly to produce coherence maps, detected processing levels (if not already done), merged products towards derived products like the subsidence maps, wind field or ocean current maps… developed by cooperative entities (see a development toolbox outlined in 3.2.5.7).

3.2.5.5 Simple extra on-the-fly processing

Figure below shows a colour composition of layers derived from the two VV and VH polarisation images of the S1A IW GRDH scene acquired on the 26/12/2014 over the Ganges delta. The RGB components are results of the simple processing that could be added to the toolbox:

- IntensityHue-Saturation (HIS) transform,
- Principal Component Analysis (PCA),
- Normalized Difference Index (NDI).

..\data\DHuS\S1A_IW_GRDH_1SDV_20141226T235545_20141226T235619_003897_004AD2_CAEB.SAFE.bangladesh\ganges_delta_20141226_v3.kml\ganges_delta_20141226_v3.kml

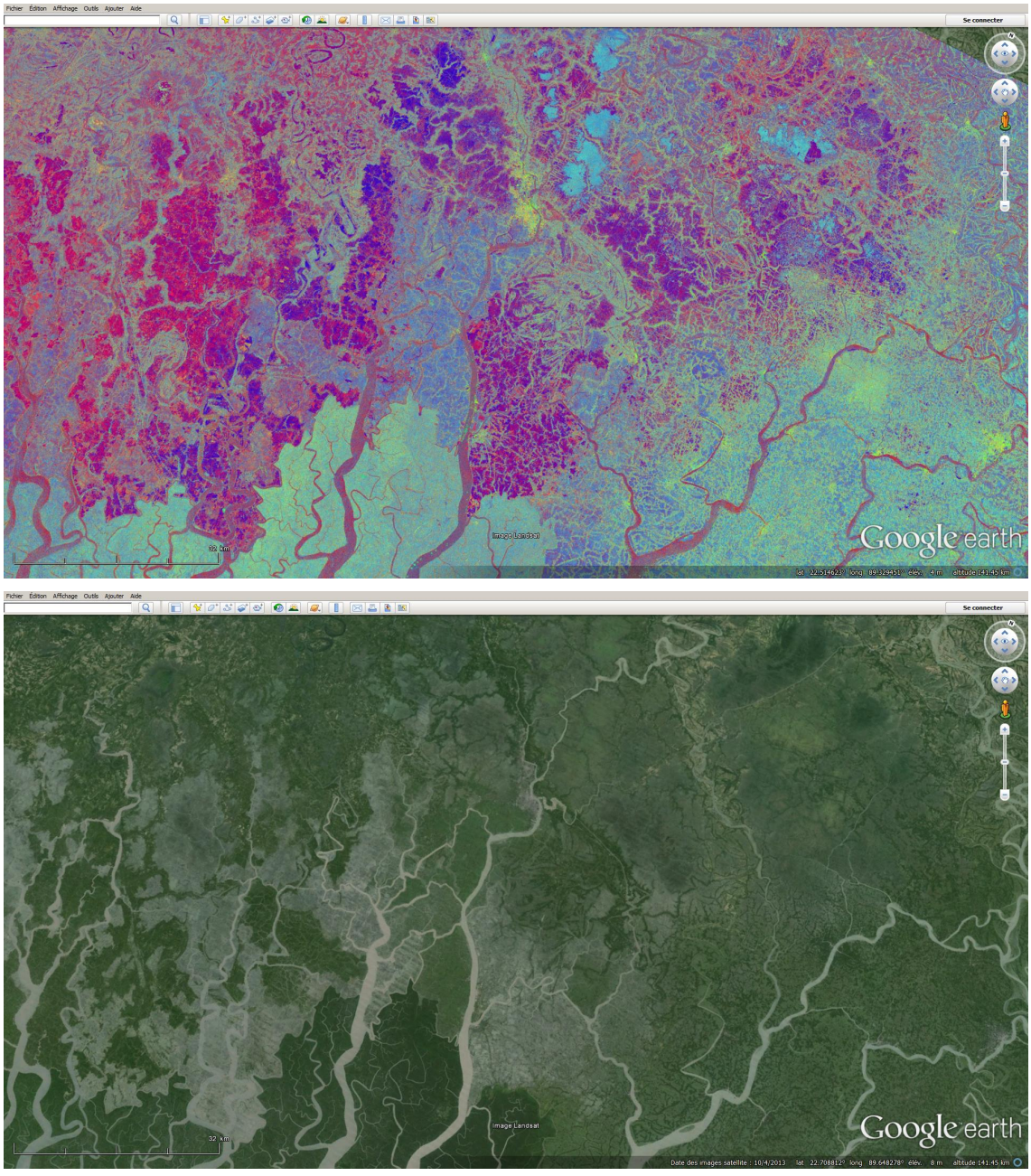


fig. 55 - Potential of Sentinel-1 C-SAR (top) to bring complementary information of the optical data (bottom).

3.2.5.6 On-the-fly orthorectification

Experience has shown that the on-the-fly geocoding from the level 1B S1 geometry to the Geographic Coordinates Reference System may be processed interactively with the user. In the same way, engineers of VisioTerra assumes that the on-the-fly orthorectification could be processed interactively meanwhile an adequate metadata preparation.

3.2.5.7 On-the-fly processing toolbox - PoF-TB

Processing data on-the-fly (PoF) is full in line with the objectives of the G-POD ("Grid Processing on Demand") that were launched in 2005 to process Envisat data. This project gave the possibility for scientists to implement their algorithms, ESA providing them with the power of an infrastructure able to systematically compute these new products.

A "Processing on-the-fly toolbox" would enable scientists to:

- adjust parameters of canonical formulae like:
  - the normalized difference index (X - Y) / (X + Y)
  - linear combinations of the bands (or polarisations) $\sum \alpha_i . X_i$
  - handle correlation coefficients…
- implement their proper plug-in compliant with standard calling patterns.

Main difference with G-POD would be that the system would enable scientists to interactively monitor their processes and that the system would not necessarily produce extra amount of data even if they are not used. Added value products are generated on demand and on-the-fly.

In addition, the generic VtWeb platform could manage a back-office providing scientists with statistics relative to the frequency of use of their algorithms, the class of data users have tested with their algorithms,

3.2.5.8 Collaborative platform

Sharing simple URLs for data views and styles

As shown in the gallery, the "4-parts URL" containing the -address of the server, -the data showing interesting details, -the process description and -the geometry of view may be very easily exchanged across social networks / dissemination portals / newsletters / competitions…

In the same way, the styles that process a class of data to underlines a particular aspects (oil spill, moisture indicator, land / sea thresholding…) may be exchanged across communities.

FedEO - Providing with rich URLS

The FedEO (Federated Earth Observation Missions) is an initiative of ESA to set-up a standard platform providing users with links to data from a broad set of data providers.

The "rich URLs" including on-the-fly processing may provide novice user with an immediate response to their requests.

Web camp

In a way similar to the "App camp" managed by ESA (see for example the 3rd one in September 2014 http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Bringing_Earth_observation_to_the_everyday_user), "Web camp" could be managed to find during a given period the best data in connection with the latest news.

Scope would be also to adjust on-the-fly process sequences and parameters giving the best rendering to underline the event of the news.

Citizen laboratory

Principles of access to citizen is also recommended by the GEO organisation (see R-12).

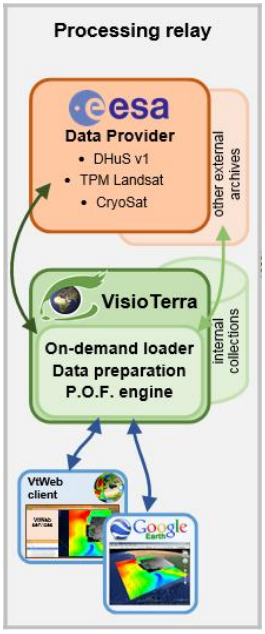
At EARSC Research Workshop held in Brussels on 26.09.2014, Gilles OLLIER, Head of Sector EO, Directorate Environment, presented a paper on "**Demonstrating the concept of citizen observatories"**: "*The specific challenge is to demonstrate the concept of citizen observatories using innovative Earth Observation technologies to generate new and original applications, thereby strengthening in-situ environmental monitoring capabilities.*

The focus of this topic is to conduct suitable prototyping and pilot phase activities to test and validate the concept of 'next-generation' in-situ community observatories and the direct transfer of environmental knowledge for policy, industrial, research and societal use."

Civil protection repository

The rich URLs combined to the NRT deliveries are a powerful tool that could be taken into account for disaster management.

3.3 TPM / VtWeb / Landsat-4/5 / TM and TPM / VtWeb / Landsat-7 / ETM+



Prototype implementation

In this version (see http://visioterra.org/VtWeb/), the mechanism to access and display Sentinel-1 data is a "Processing relay" (see the attached figure explained in section 3.1.3 above).

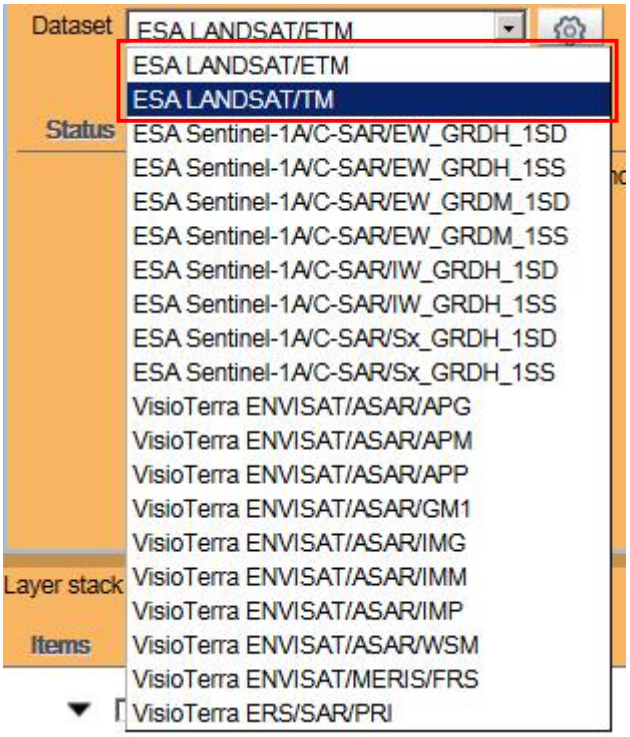
To support the multi-scale interactive display, VtWeb has to prepare the data by building a hierarchical pyramid. Because, VisioTerra is not granted the right to remotely store any data on the ESA infrastructures, the target product shall be previously downloaded and prepared in the VtWeb infrastructure at VisioTerra premises over disks playing the role of "cache of ESA archives".

Downloading and data preparation may require up to 2 minutes depending of the size of the product.

When a product has been prepared (downloaded and its pyramid computed), its status is set to "Ready"; in the other case its status is "Unprocessed".

3.3.1 User interface

The man-machine interface of VtWeb client is detailed in section 3.2.2. Only differs the dataset list that is detailed below.



Datasets

Landsat-8 OLI/TIRS data not being directly accessible on the ESA Third Party Missions (TPM) archive (see section 2.2.3), only the Landsat-5 TM and the Landsat-7 ETM+ data are available.

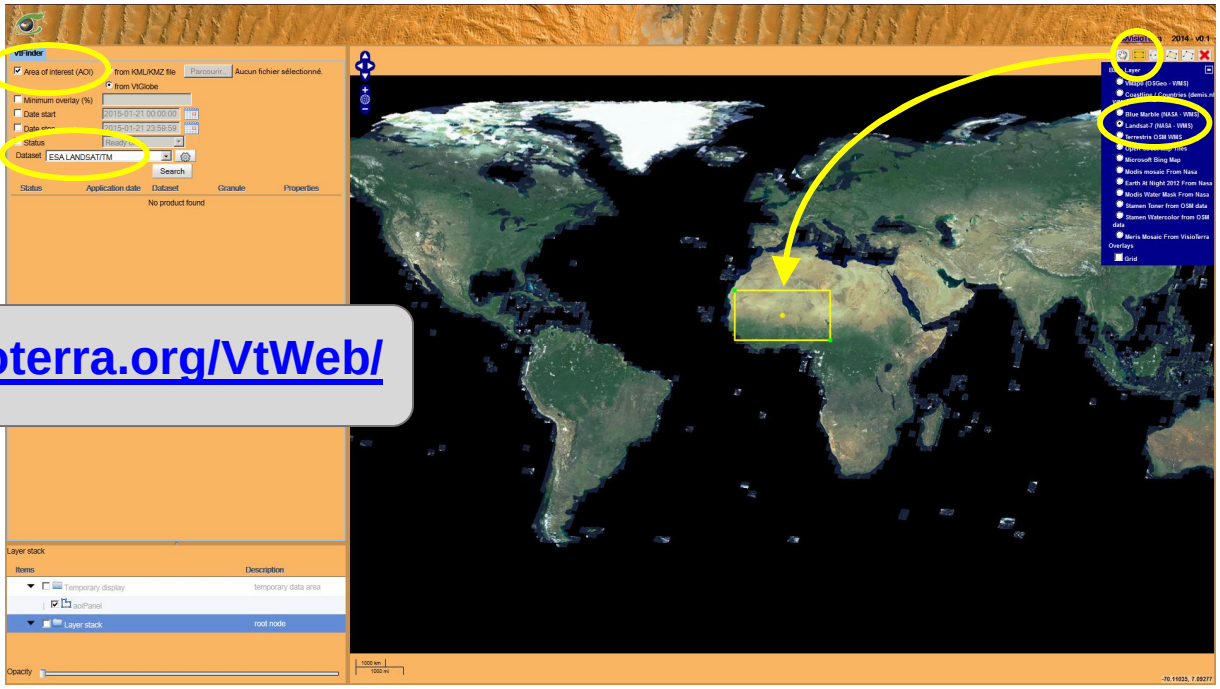
- Landsat-5 / TM 319 055 granules
- Landsat-7 ETM+ 28 577 granules

3.3.2 Example of session - Getting one of the first Landsat-5 image acquired by ESA over the South of Algeria

3.3.2.1 Defining the search criteria

Area of interest

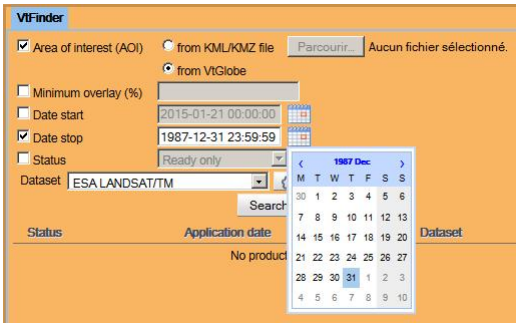
After having selected the "Landsat-7 (NASA - WSM)" dataset as background layer, user checks the "Area of interest (AOI)" box, select the  bounding box icon and design this bounding box over the 2D globe pressing on the upper-left corner location and releasing the mouse button on the lower-right location.



http://visioterra.org/VtWeb/

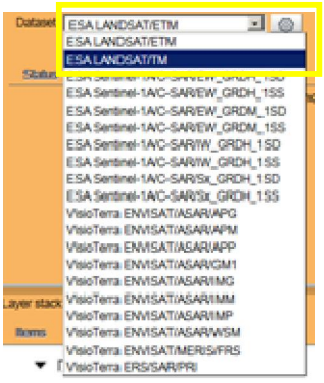
Time interval

To get one of the first images the "Date stop" could be selected (leftmost checkbox) and set to the value 1987-12-31 23:59:59.

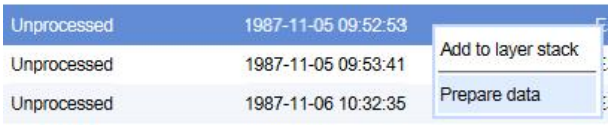


Datasets

Select the "ESA LANDSAT / TM" dataset.



3.3.2.2 Asking for the data preparation



3.3.2.3 Choosing one of the predefined styles

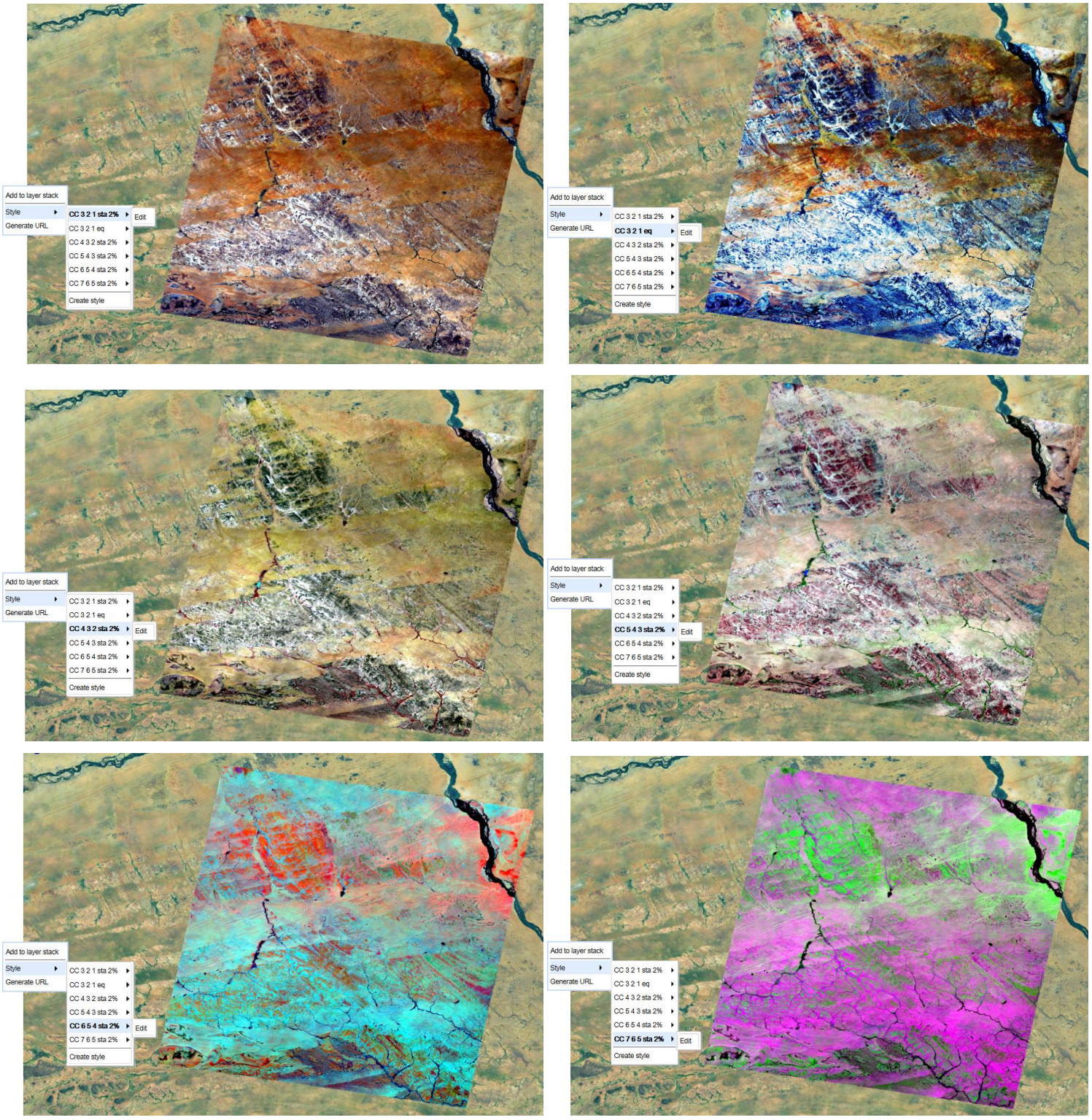
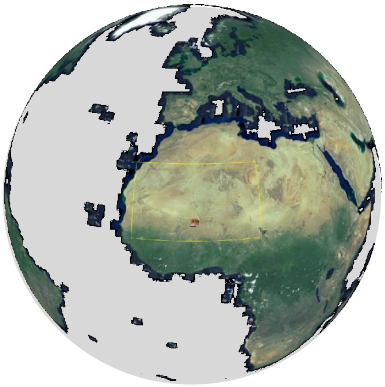


fig. 56 - Landsat-5 acquired on 1987-11-05 at 09:52:53 - Predefined styles.

3.3.2.4 Interactive display enhancement



Navigating across the globe and the product

User may use :

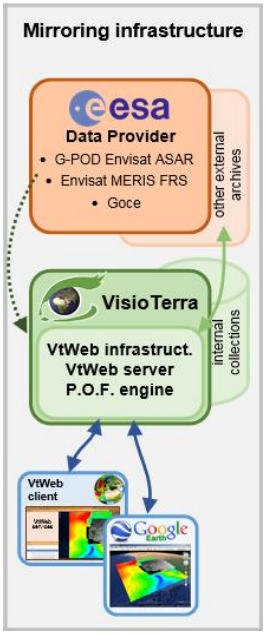
- the mouse and the **central wheel** to pan and zoom,
- **CTL+m** - to switch between 2D and 3D,
- "r" - to reset the azimuth and inclination of the globe,
- **SHFT+R** - to reset the globe at the default location
-  to change the background layer (Landsat-7) in the attached figure.

Sharing a view

TPM / Landsat-5 TM (one of the first images acquired by ESA on 05/11/1987):
http://visioterra.org/VtWeb/?MODULEID=VtEsaTpm&DATASETID=LANDSAT/TM&GRANULEID=LS05_RMPS_TM__GTC_1P_19871105T095253_19871105T095322_019571_0195_0049_1E28&STYLE=rgb(sta(QT_TM3,HT_TM3,0.02,0.02),sta(QT_TM2,HT_TM2,0.02,0.02),sta(QT_TM1,HT_TM1,0.02,0.02))&lookat={%22view%22:%223D%22,%22Longitude%22:-0.8323,%22Latitude%22:15.6514,%22Range%22:209773,%22Heading%22:5.6,%22Tilt%22:51.7,%22backgroundLayer%22:%22landsat%22}&sidePanel=false

3.4 VtCatalog / Envisat / ASAR and MERIS

3.4.1 Prototype implementation



In this version (see http://visioterra.org/VtWeb/), the mechanism to access and display Envisat ASAR and MERIS data is a "Mirroring infrastructure" (see the attached figure explained in section 3.1.3).

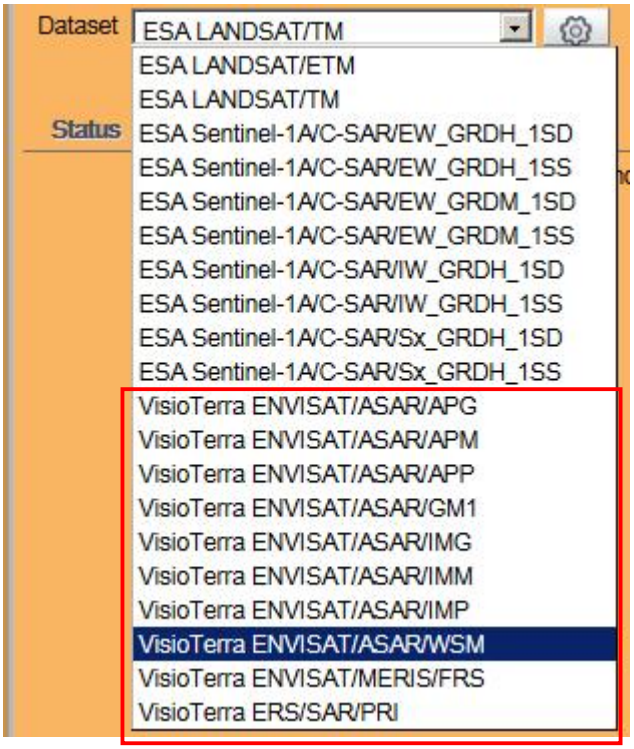
The ESA archives storing the Envisat data (ASAR on G-POD and MERIS FRS on XXX) do not enable a direct access to reach an interactive full-resolution display. As a consequence, the whole archives (G-POD ASAR for 40 TB and MERIS FRS for 150 TB) have been integrally copied onto the VisioTerra infrastructure acting as a "mirror" of the ESA collections.

A local database enables users to browse the local products. When a user wants to display the contents of a product, he/she has to ask for the computation of the hierarchical tree that will enable the multi-scale navigation.

When a product has been prepared, i.e. when its pyramid has been computed, its status is set to "Ready"; in the other case its status is "Unprocessed".

3.4.2 User interface

The man-machine interface of VtWeb client is detailed in section 3.2.2. Only differs the dataset list that is detailed below.



Datasets

Envisat ASAT, MERIS and some ERS SAR data have been copied on the VisioTerra infrastructure and are available through the following datasets (see section 2.2:

- Envisat ASAR APG 318 granules
- Envisat ASAR APM 15 149 granules
- Envisat ASAR APP 4 005 granules
- Envisat ASAR APS 40 granules
- Envisat ASAR GM1 214 825 granules
- Envisat ASAR IMG 15 granules
- Envisat ASAR IMM 72 967 granules
- Envisat ASAR IMP 6 941 granules
- Envisat ASAR WSM 150 167 granules
- Envisat MERIS FRS 137 791 granules

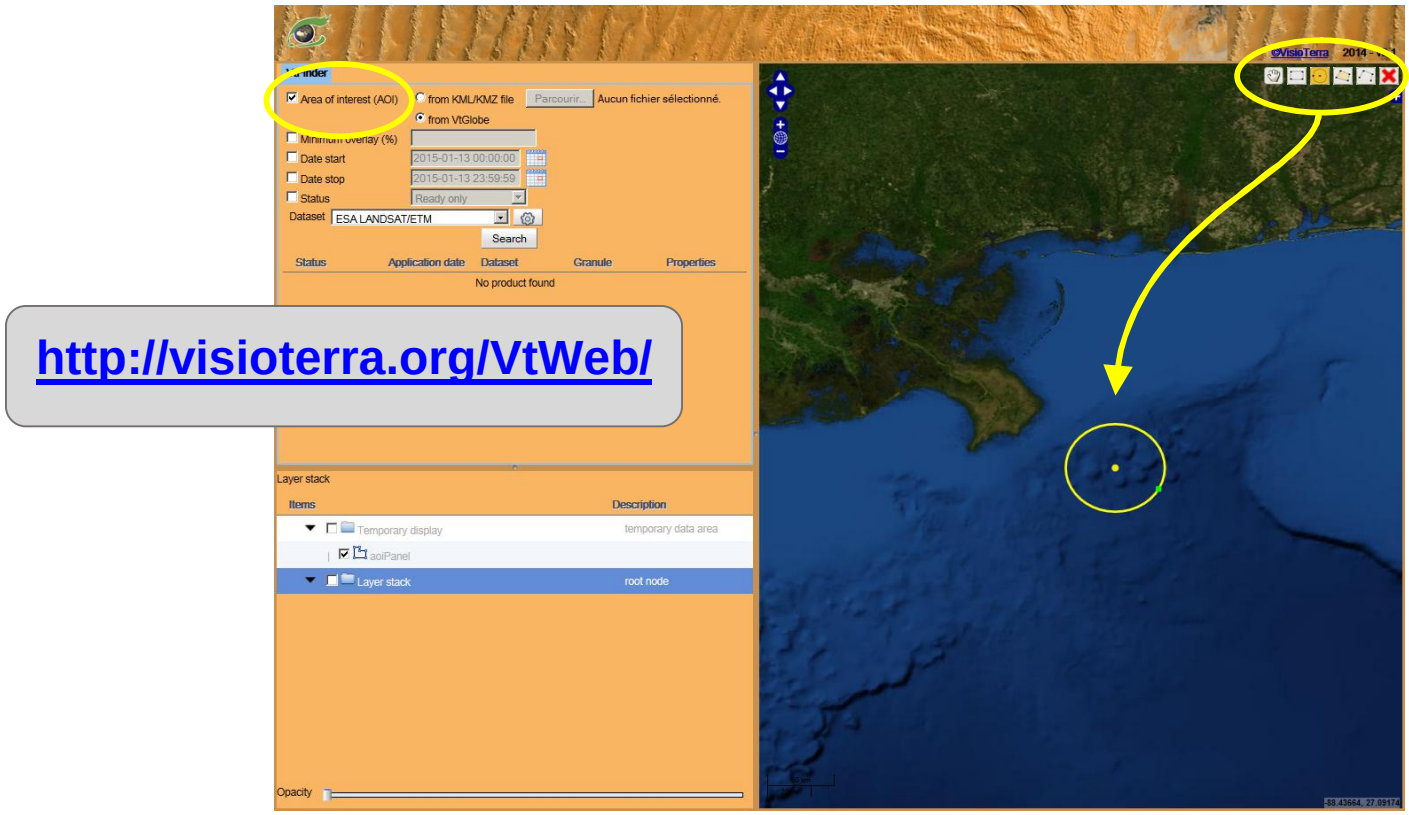
3.4.3 Example of session - Getting a (radar , optical) Envisat couple

On April 20, 2010 occurred an explosion and subsequent fire on the Deepwater Horizon semi-submersible Mobile Offshore Drilling Unit (MODU), which was owned and operated by Transocean and drilling for BP in the Macondo Prospect oil field about 40 miles (60 km) southeast of the Louisiana coast.

The explosion killed 11 workers and injured 16 others. The explosion caused the Deepwater Horizon to burn and sink, resulting in a massive offshore oil spill in the Gulf of Mexico, considered the largest accidental marine oil spill in the world, and the largest environmental disaster in U.S. history (http://en.wikipedia.org/wiki/Deepwater_Horizon_explosion and http://en.wikipedia.org/wiki/Deepwater_Horizon_oil_spill).

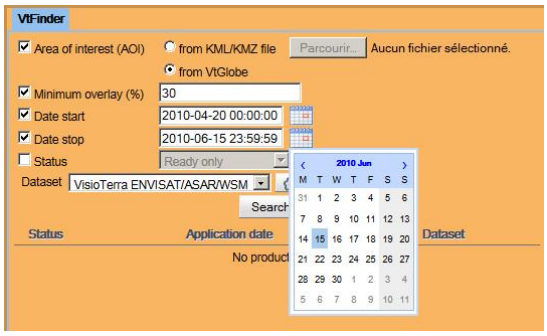
3.4.3.1 Defining the search criteria

Area of interest



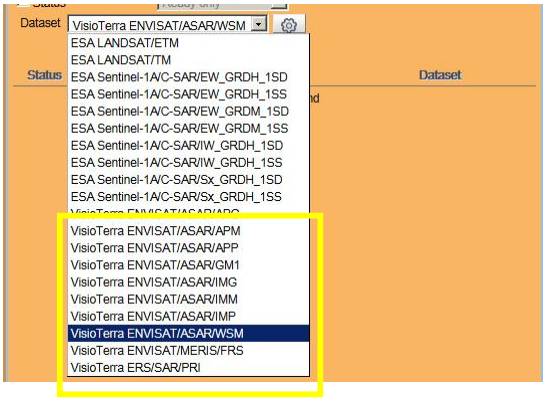
Time interval

The time interval is defined by the "Date start" and "Date stop" that shall be both selected (leftmost checkbox) and set here with the YYYY-MM-DD HH:mm:SS values 2010-04-20 00:00:00 and 2010-06-15 23:59:59 respectively.



Datasets

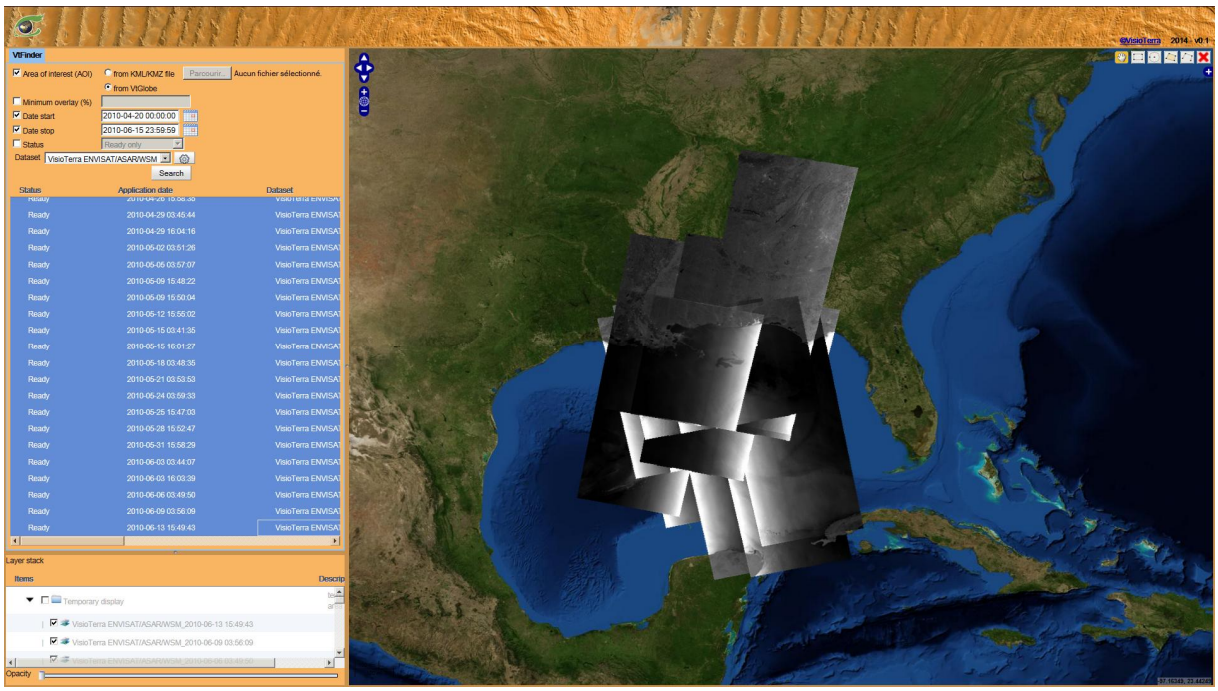
To monitor oil spills over large areas, one prefer use the Envisat ASAR data acquired in Wide Swath Mode (WSM).



3.4.3.2 Selecting the products

Envisat ASAR WSM

As shown in the figures below, all the products falling in this area of interest have been already prepared and are immediately displayable.



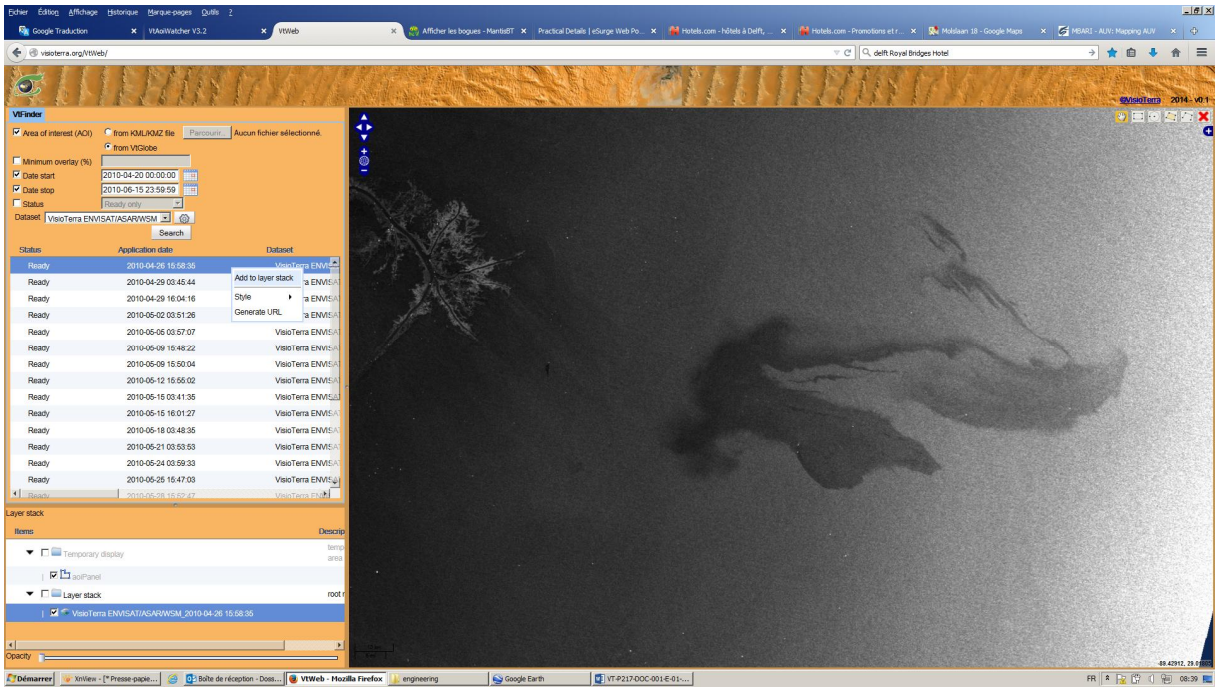


fig. 57 - Selecting the Envisat ASAR WSM acquired on 2010-04-26 at 15:58:35.

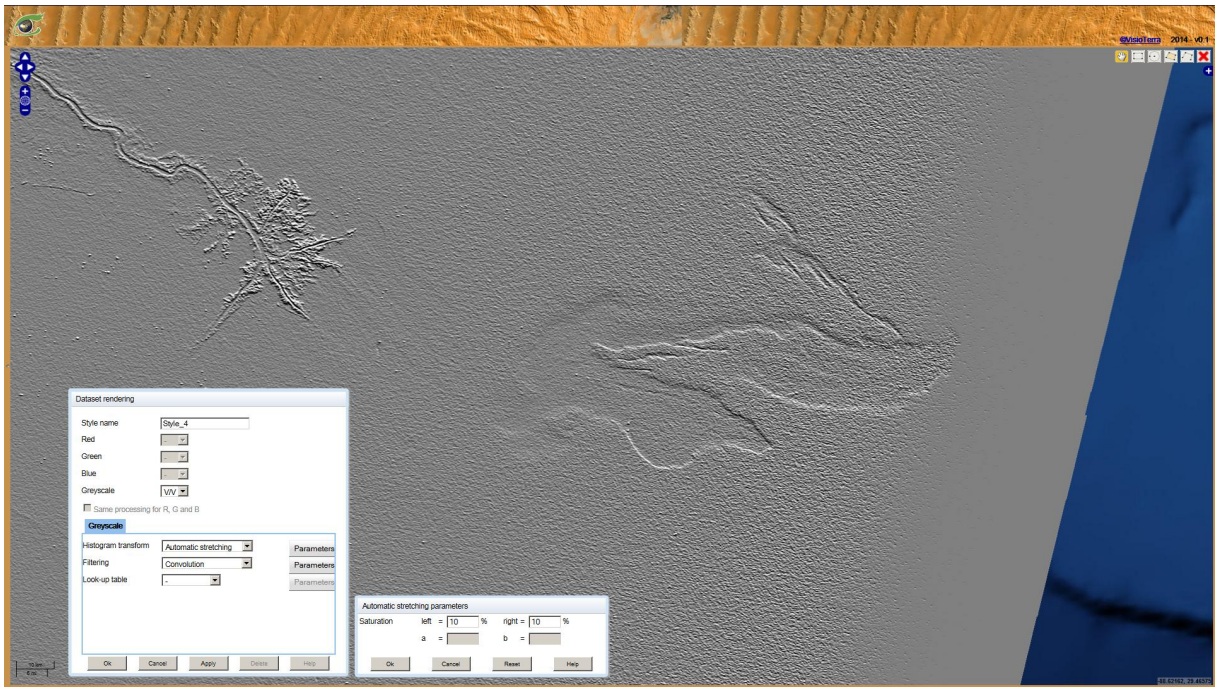


fig. 58 - Envisat ASAR WSM acquired on 2010-04-26 at 15:58:35 - 10% automatic linear stretching followed by a high-pass N-S filtering.

Envisat MERIS FRS

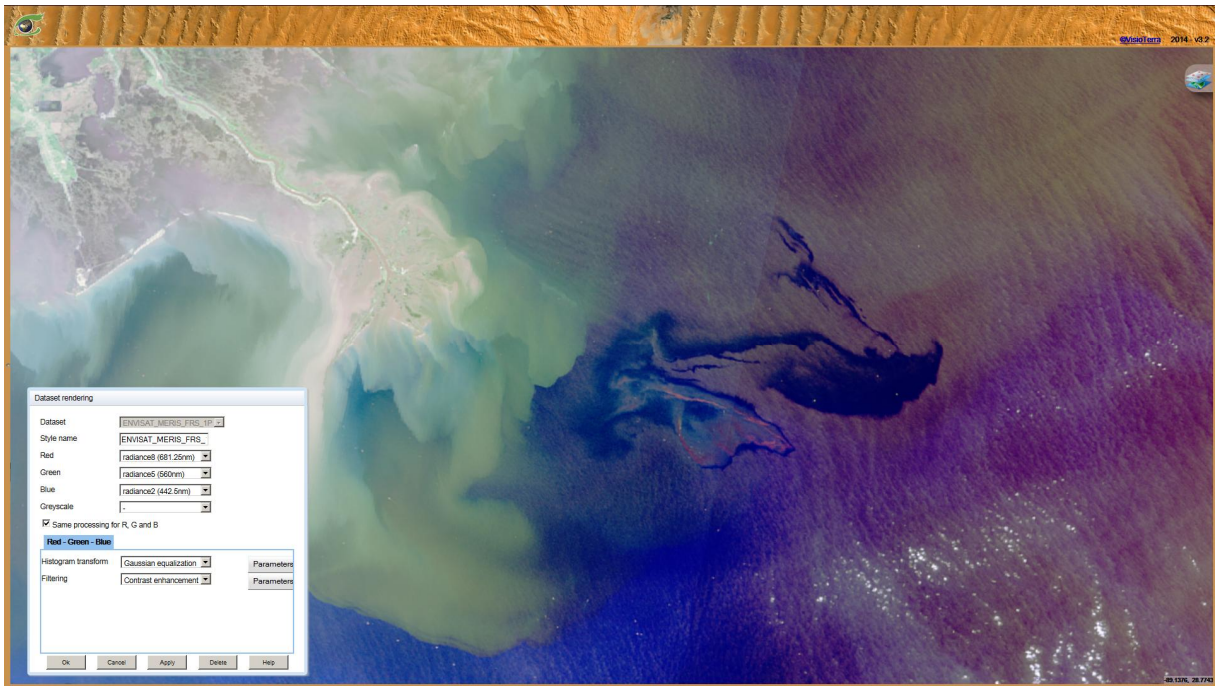


fig. 59 - Envisat ASAR MERIS acquired on 2010-04-26 at 15:58:35 - Gaussian equalisation followed by a contrast enhancement.

3.4.3.3 Interactive display enhancement

Navigating across the globe and the product

User may use :

- the mouse and the **central wheel** to pan and zoom,
- **CTL+m** - to switch between 2D and 3D,
- "r" - to reset the azimuth and inclination of the globe,
- **SHFT+R** - to reset the globe at the default location
-  to change the background layer (Landsat-7) in the attached figure.

Sharing a view

Envisat ASAR WSM acquired on 2010-04-26 at 15:58:35 :
http://visioterra.org/VTAOIWatcher/?DATASETID=ENVISAT_ASAR_WSM&GRANULEID=ENVISAT_ASAR_WSM_1P_20100426_155835_20100426_155835&GROUPID=RADAR&STYLE=gra(sta(band1%2C0.1%2C0.1)%2CN%2C1%2C128)&lookat={%22view%22:%223D%22,%22Longitude%22:-88.3914,%22Latitude%22:28.9144,%22Range%22:158597,%22Heading%22:0.3,%22Tilt%22:44.4,%22backgroundLayer%22:%22bing%22}&sidePanel=false

Envisat MERIS FRS acquired on 2010-04-26 at 15:58:35 :
http://visioterra.org/VTAOIWatcher/?DATASETID=ENVISAT_MERIS_FRS_1P&GRANULEID=ENVISAT_MERIS_FRS_1P_20100426_155832_20100426_155832&GROUPID=VNIRSWIR&STYLE=rgb(sha(gau(band8%2C128%2C60)%2C0.15)%2Csha(gau(band5%2C128%2C60)%2C0.15)%2Csha(gau(band2%2C128%2C60)%2C0.15))&lookat={%22view%22:%223D%22,%22Longitude%22:-88.3914,%22Latitude%22:28.9144,%22Range%22:158597,%22Heading%22:0.3,%22Tilt%22:44.4,%22backgroundLayer%22:%22bing%22}&sidePanel=false

3.4.4 Gallery of VtCatalog / Envisat images and on-the-fly automatic processing

3.4.4.1 Nargis cyclone in Myanmar (Burma) - 28 April to 5 May 2008

http://visioterra.org/VtWeb/?MODULEID=VtEnvisat&DATASETID=ENVISAT/MERIS/FRS&GRANULEID=MER_FRS_1PPEPA20080501_040328_000002952068_00133_32251_7570.N1&STYLE=rgb(sha(sta(QT_radiance8,HT_radiance8,0.02,0.02),1.0),sha(sta(QT_radiance5,HT_radiance5,0.02,0.02),1.0),sha(sta(QT_radiance2,HT_radiance2,0.02,0.02),1.0))&lookat={%22view%22:%223D%22,%22Longitude%22:90.8965,%22Latitude%22:10.6934,%22Range%22:2916675,%22Heading%22:0,%22Tilt%22:90,%22backgroundLayer%22:%22bluemarble%221&sidePanel=false

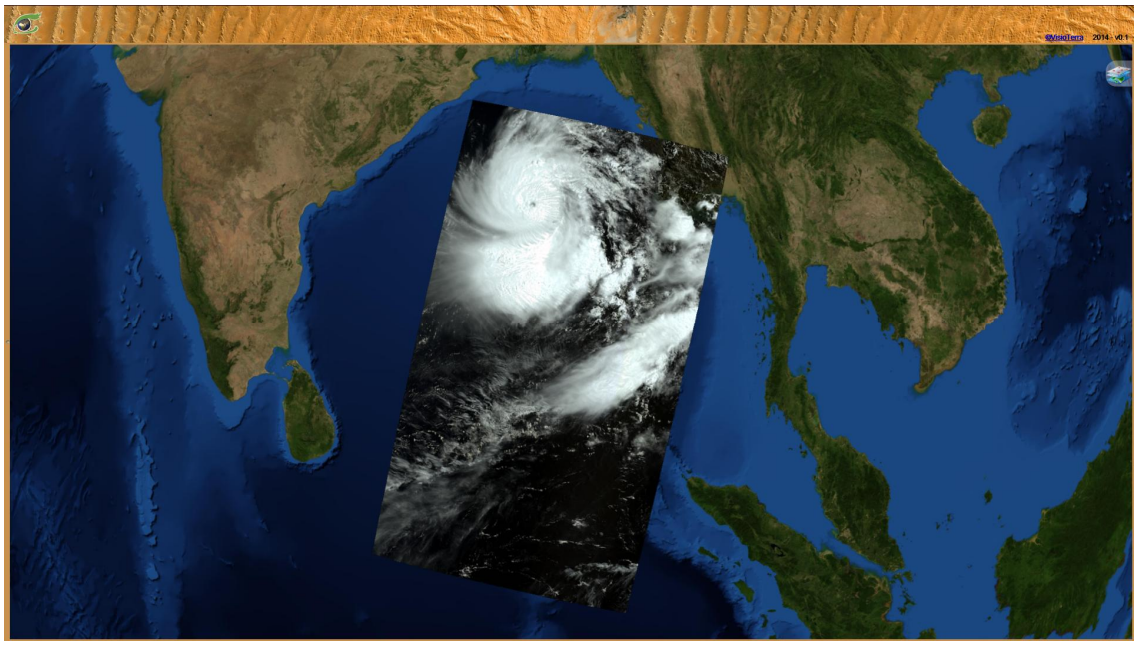


fig. 60 - MERIS FRS acquired on 2008-05-05 04:03:28 showing Nargis cyclone approaching the Myanmar's shoreline.

http://visioterra.org/VtWeb/?MODULEID=VtEnvisat&DATASETID=ENVISAT/MERIS/FRS&GRANULEID=MER_FRS_1PPEPA20080505_033507_000005122068_00190_32308_7748.N1&STYLE=rgb(sha(sta(QT_radiance8,HT_radiance8,0.02,0.49),1.0),sha(sta(QT_radiance5,HT_radiance5,0.02,0.49),1.0),sha(sta(QT_radiance2,HT_radiance2,0.02,0.49),1.0))&lookat={%22view%22:%223D%22,%22Longitude%22:94.9071,%22Latitude%22:15.832,%22Range%22:337741,%22Heading%22:-30.6,%22Tilt%22:39.7,%22backgroundLayer%22:%22osm%221&sidePanel=false

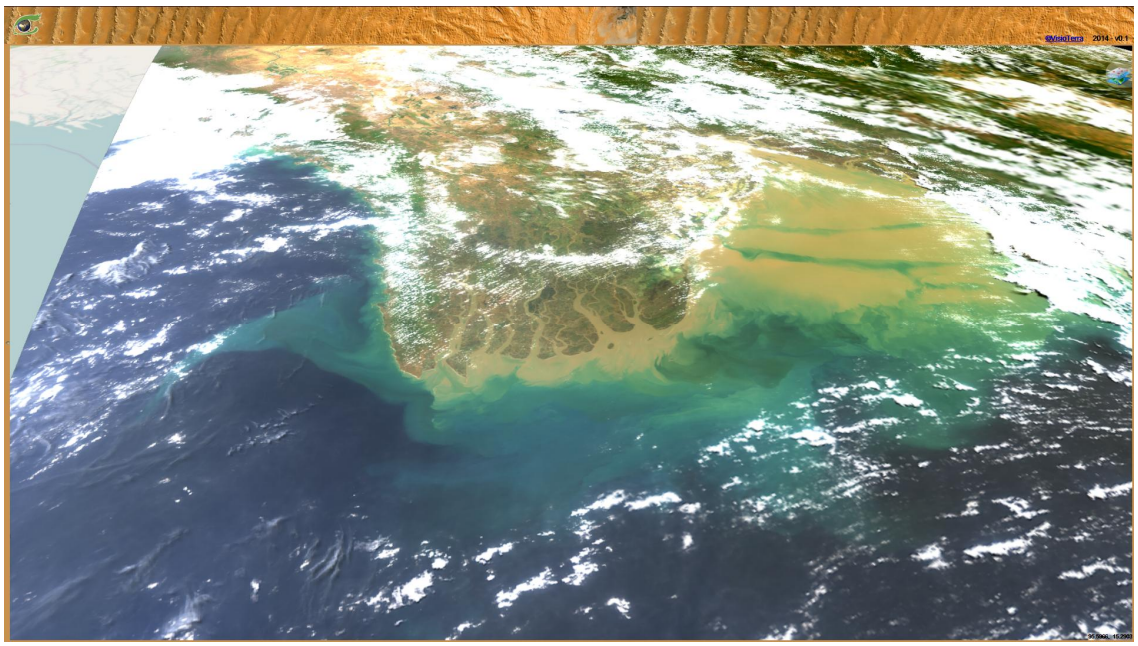
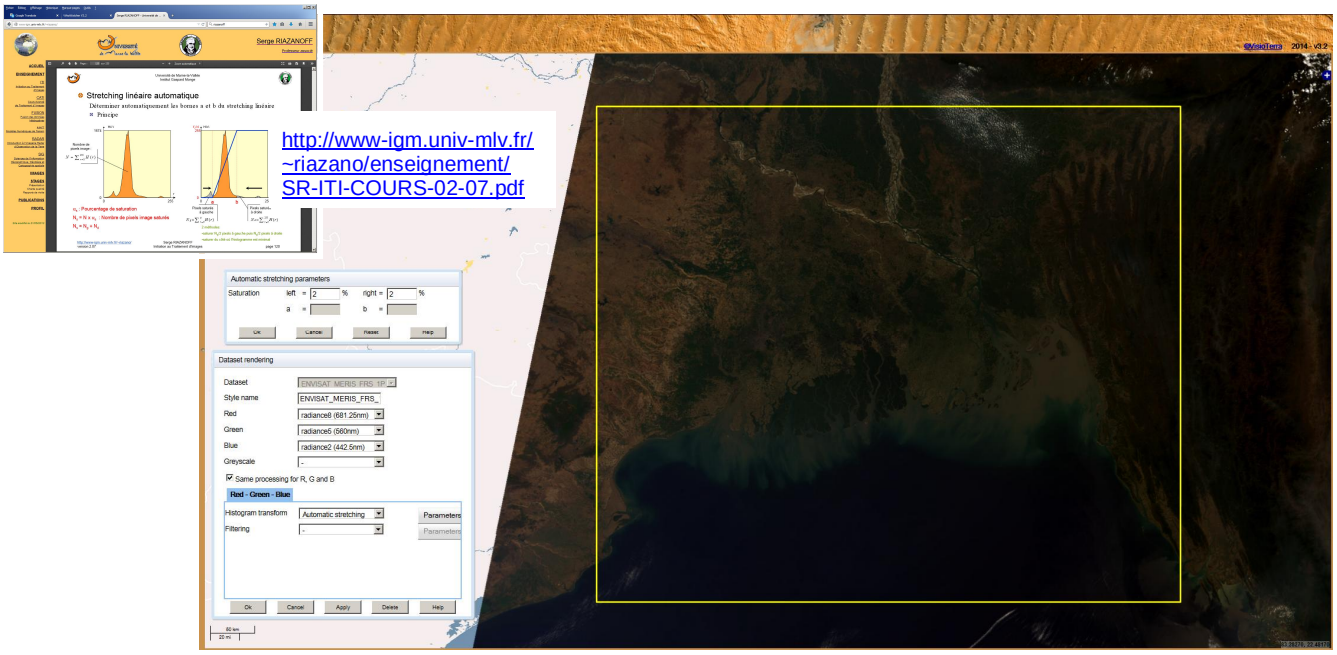


fig. 61 - MERIS FRS acquired on 2008-05-05 03:35:07 and the increase of suspended matter after the event.

3.4.4.2 Enhancing the display of Envisat MERIS over the Ganges Delta

http://visioterra.org/VTAOIWatcher/?DATASETID=ENVISAT_MERIS_FRS_1P&GRANULEID=ENVISAT_MERIS_FRS_1P_20060326_040659_20060326_040659&GROUPID=VNIRSWIR&STYLE=rgb(sta(band8()%2C0.02%2C0.02)%2Csta(band5()%2C0.02%2C0.02)%2Csta(band2()%2C0.02%2C0.02))&lookat={%22view%22:%222D%22,%22BoundingBox%22:%2283.4165,19.7469,93.4635,25.1907%22,%22backgroundLayer%22:%22vmap0%22}&sidePanel=false



http://visioterra.org/VTAOIWatcher/?DATASETID=ENVISAT_MERIS_FRS_1P&GRANULEID=ENVISAT_MERIS_FRS_1P_20060326_040659_20060326_040659&GROUPID=VNIRSWIR&STYLE=rgb(sta(band8%2C0.02%2C0.2)%2Csta(band5%2C0.02%2C0.2)%2Csta(band2%2C0.02%2C0.2))&lookat={%22view%22:%222D%22,%22BoundingBox%22:%2283.4165,19.7469,93.4635,25.1907%22,%22backgroundLayer%22:%22vmap0%22}&sidePanel=false

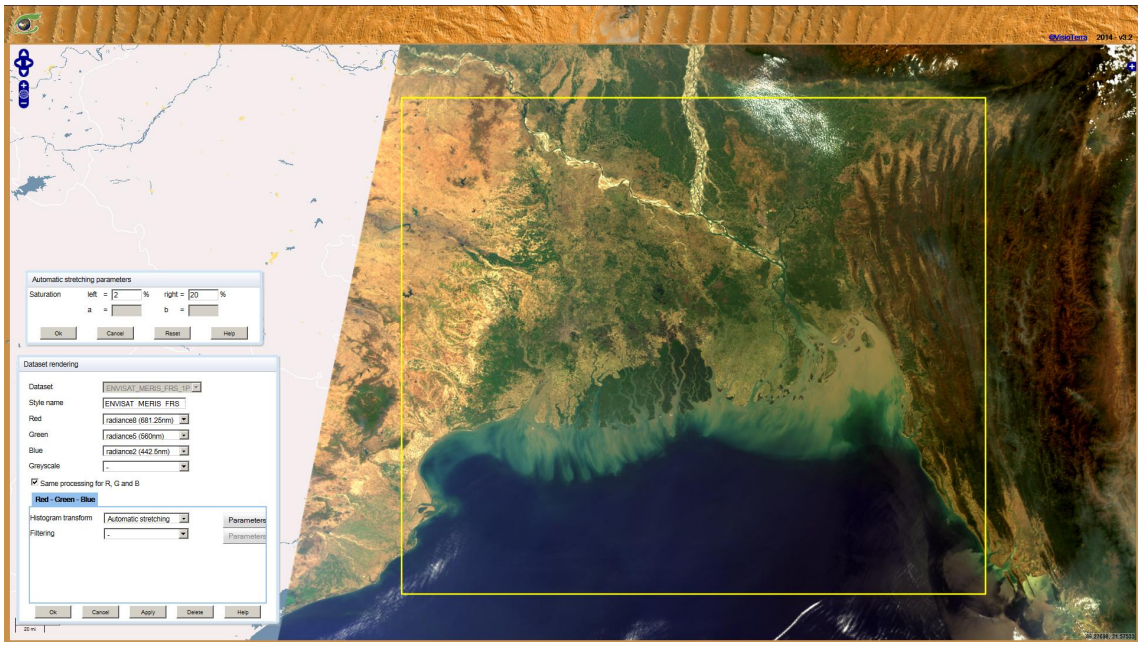


fig. 62 - MERIS FRS acquired on 2006-03-26 04:06:59 - (2%,2%) automatic stretching (top and see also the course of Serge RIAZANOFF at UPEM) and a (2%,20%) automatic stretching (bottom).

3.4.5 Possible extensions

3.4.5.1 Mixing data with meteorological datasets

An other service called VtAoiWatcher has been developed by VisioTerra that enables to superimpose the ECMWF meteorological data and the Earth observation datasets. These meteorological datasets could be also mixed with the ESA archives datasets. Such a possibility would for example enable users to forecast the drift of oil spills as shown in the figure below.

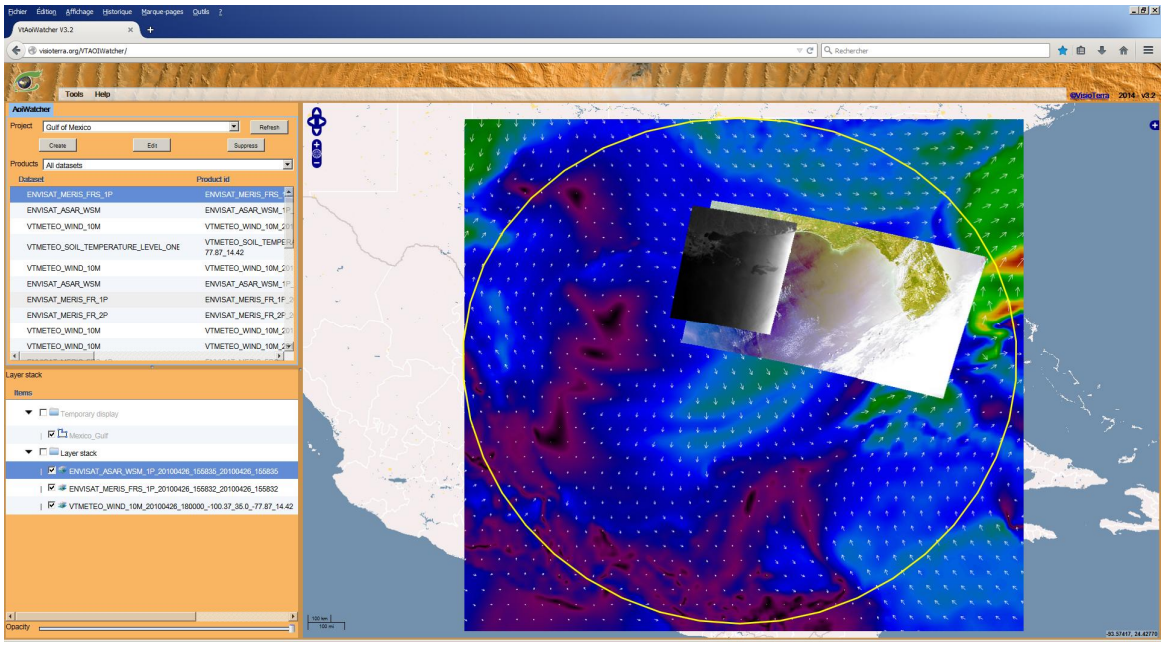


fig. 63 - VtAoiWatcher - Envisat MERIS FRS and ASAR WSM acquired on 2010-04-26 at 15:58:35 over a wind field acquired the same day at 18:00:00.

ANNEX A - VTCATALOG / ENVISAT - STATISTICS

A.1 VtCatalog / Envisat / ASAR / APG

total number of granules: **318**
monthly animation ..\data\VtCatalog\Envisat\ASAR_APG\jpg_months
yearly animation ..\data\VtCatalog\Envisat\ASAR_APG\jpg_years

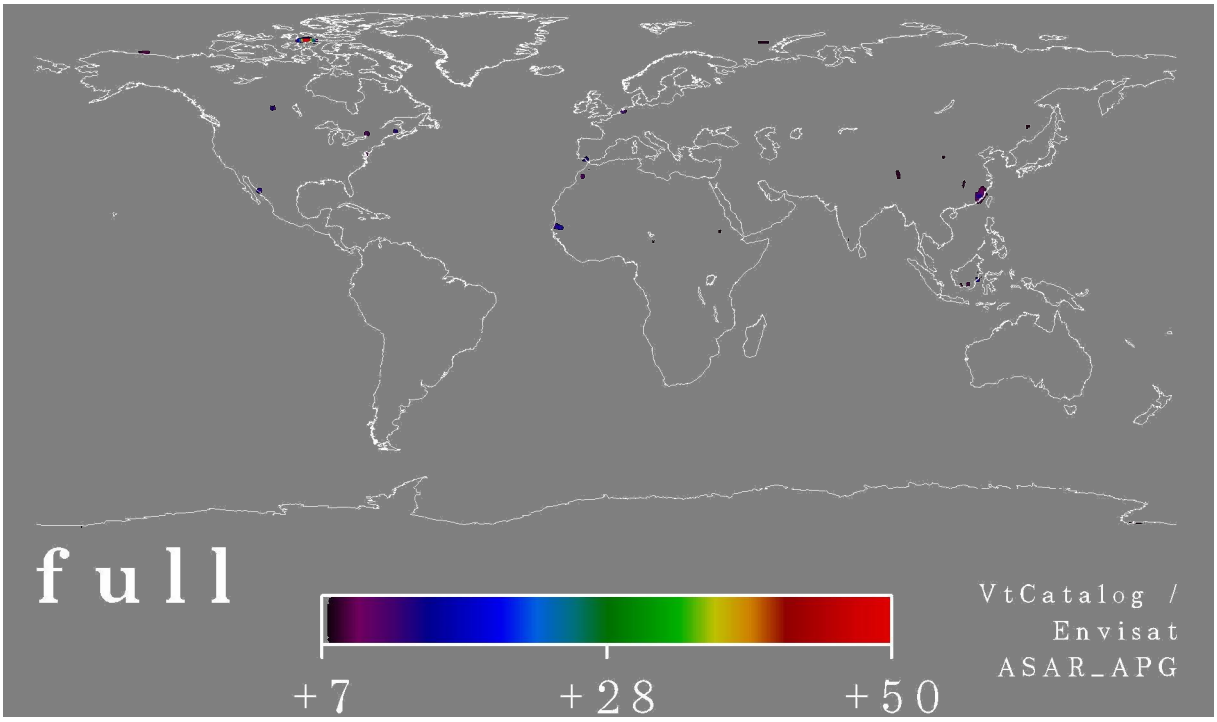


fig. 64 - VtCatalog / Envisat / ASAR / APG occurrences map
(..\data\VtCatalog\Envisat\ASAR_APG\jpg_full\ASAR_APG.occ.cal.card.gra.tit.jpg).

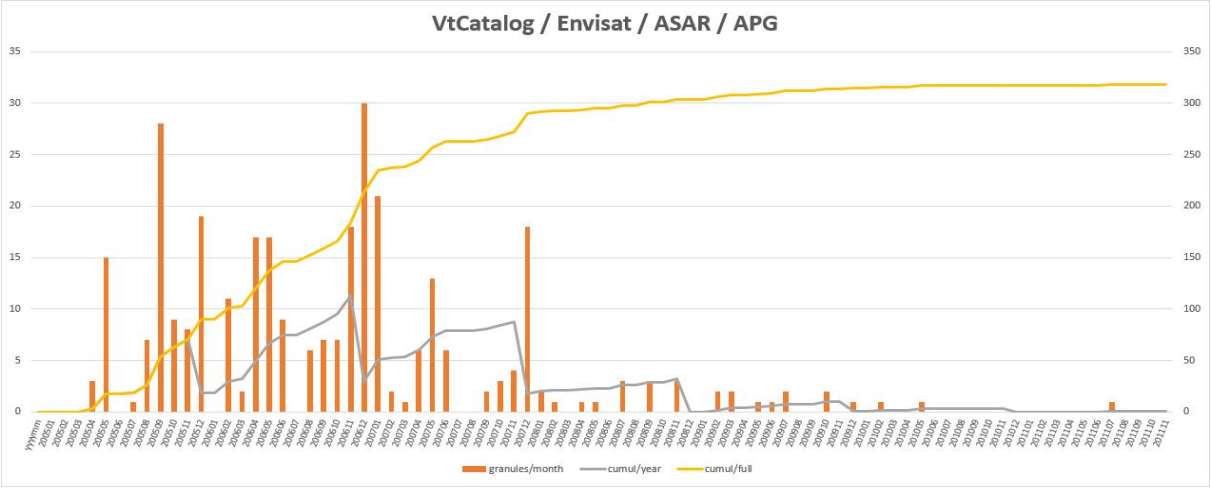


fig. 65 - VtCatalog / Envisat / ASAR / APG acquisition statistics
(..\data\VtCatalog\Envisat\ASAR_APG\VtCatalog_Envisat_ASAR_APG.xlsx).

A.2 VtCatalog / Envisat / ASAR / APM

total number of granules: **15 149**
monthly animation ..\data\VtCatalog\Envisat\ASAR_APM\jpg_months
yearly animation ../data/VtCatalog/Envisat/ASAR_APM/jpg_years

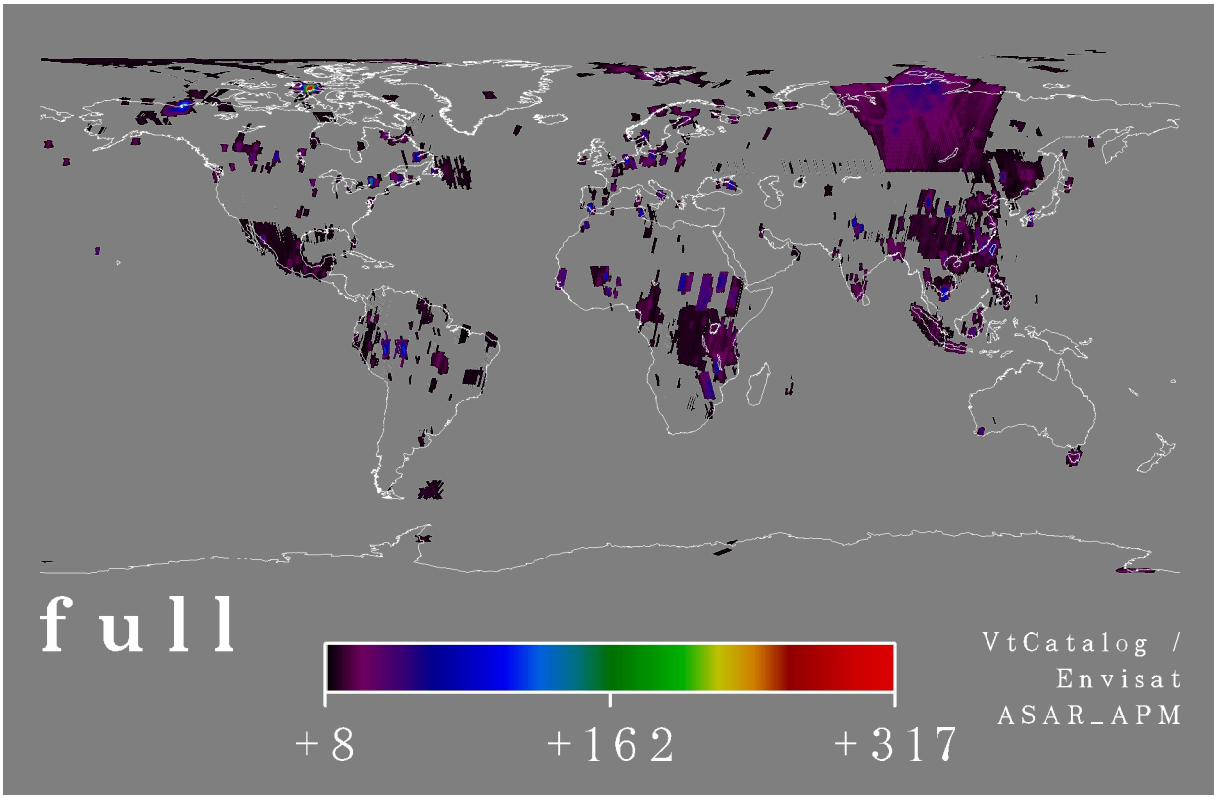


fig. 66 - VtCatalog / Envisat / ASAR / APM occurrences map
(..\data\VtCatalog\Envisat\ASAR_APM\jpg_full\ASAR_APM.occ.cal.card.gra.tit.jpg).

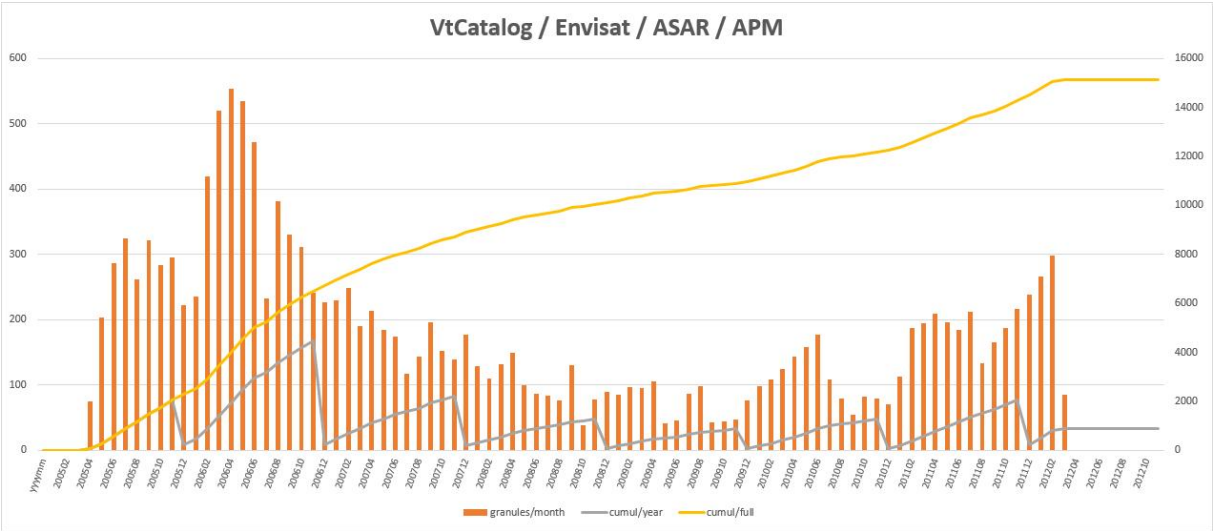


fig. 67 - VtCatalog / Envisat / ASAR / APM acquisition statistics
(..\data\VtCatalog\Envisat\ASAR_APM\VtCatalog_Envisat_ASAR_APM.xlsx).

A.3 VtCatalog / Envisat / ASAR / APP

total number of granules: **4 005**
monthly animation ..\data\VtCatalog\Envisat\ASAR_APP\jpg_months
yearly animation ../data/VtCatalog/Envisat/ASAR_APP/jpg_years

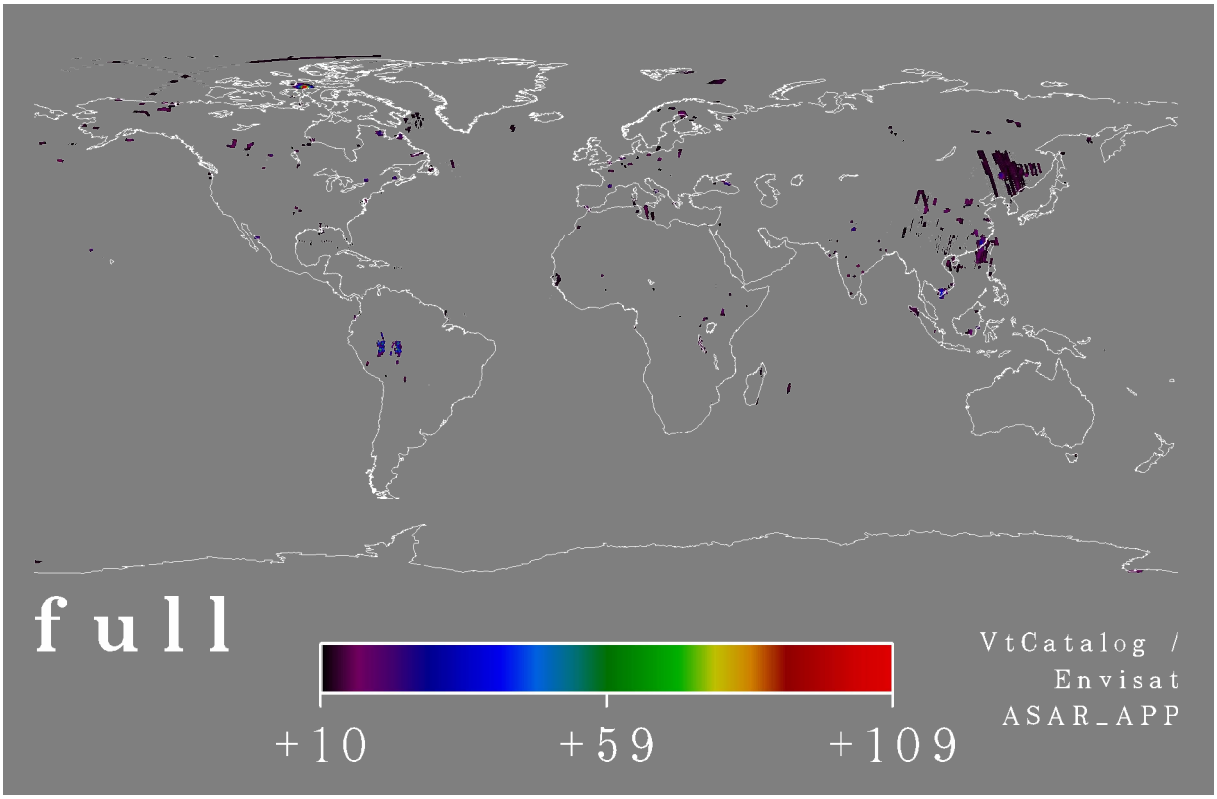


fig. 68 - VtCatalog / Envisat / ASAR / APP occurrences map (..\data\VtCatalog\Envisat\ASAR_APP\jpg_full\ASAR_APP.occ.cal.card.gra.tit.jpg).

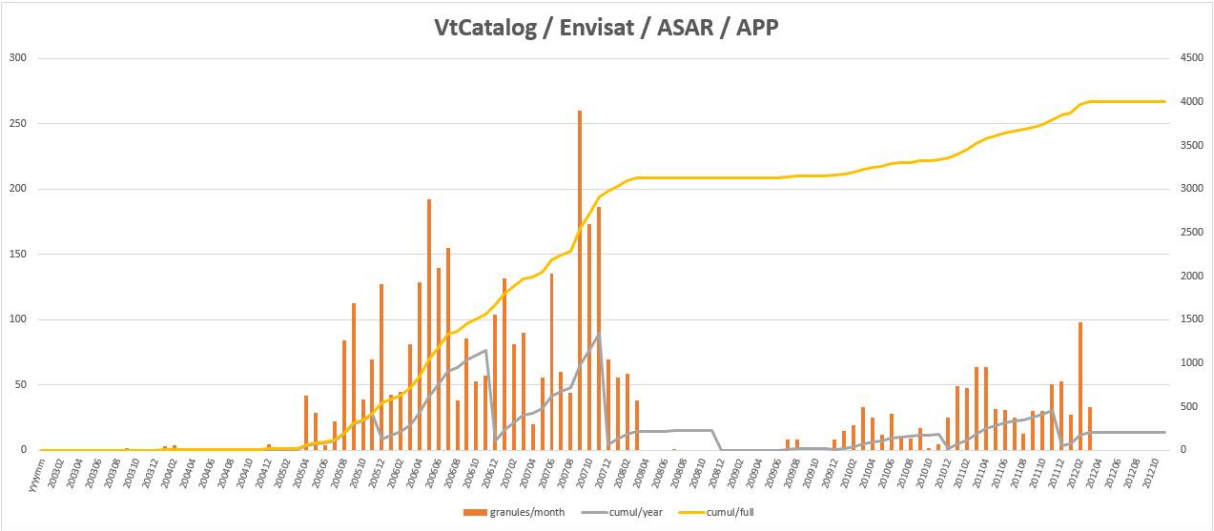


fig. 69 - VtCatalog / Envisat / ASAR / APP acquisition statistics (..\data\VtCatalog\Envisat\ASAR_APP\VtCatalog_Envisat_ASAR_APP.xlsx).

A.4 VtCatalog / Envisat / ASAR / APS

total number of granules: **40**
monthly animation ..\data\VtCatalog\Envisat\ASAR_APS\jpg_months
yearly animation ..\data\VtCatalog\Envisat\ASAR_APS\jpg_years

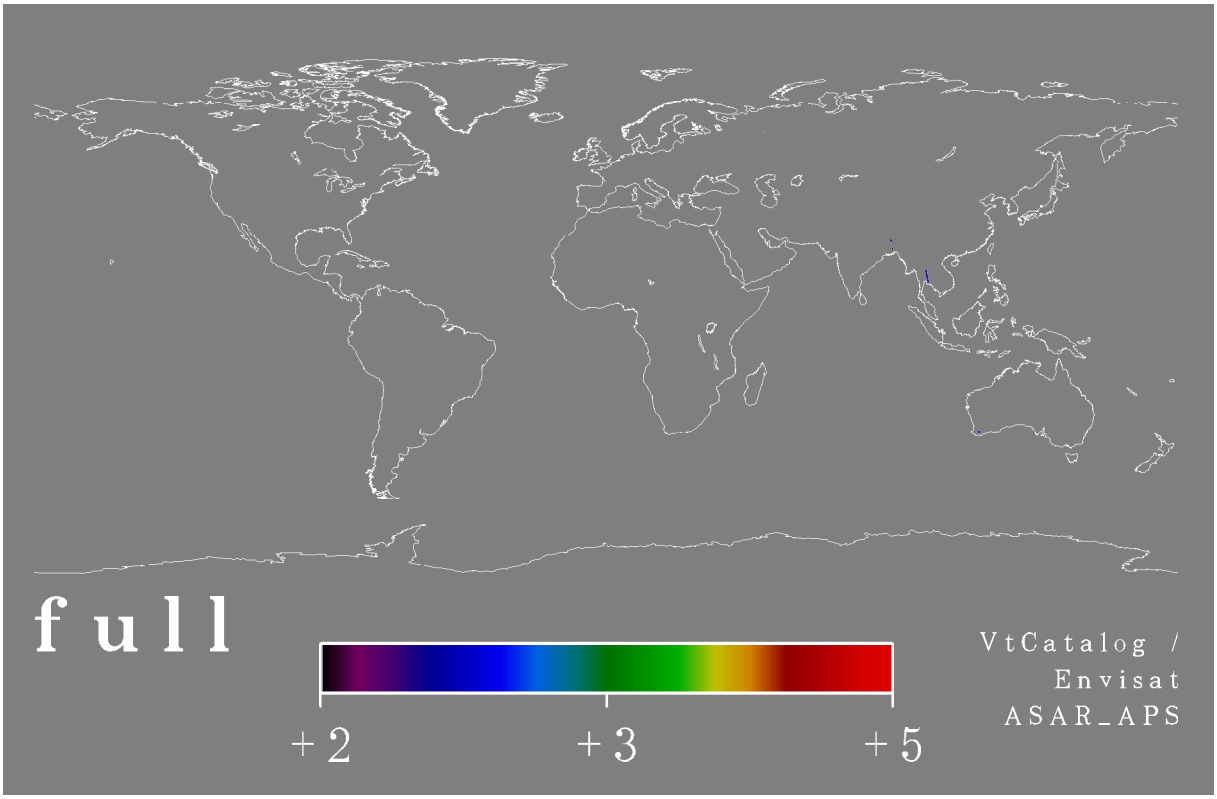


fig. 70 - VtCatalog / Envisat / ASAR / APS occurrences map (..\data\VtCatalog\Envisat\ASAR_APS\jpg_full\ASAR_APS.occ.cal.card.gra.tit.jpg).

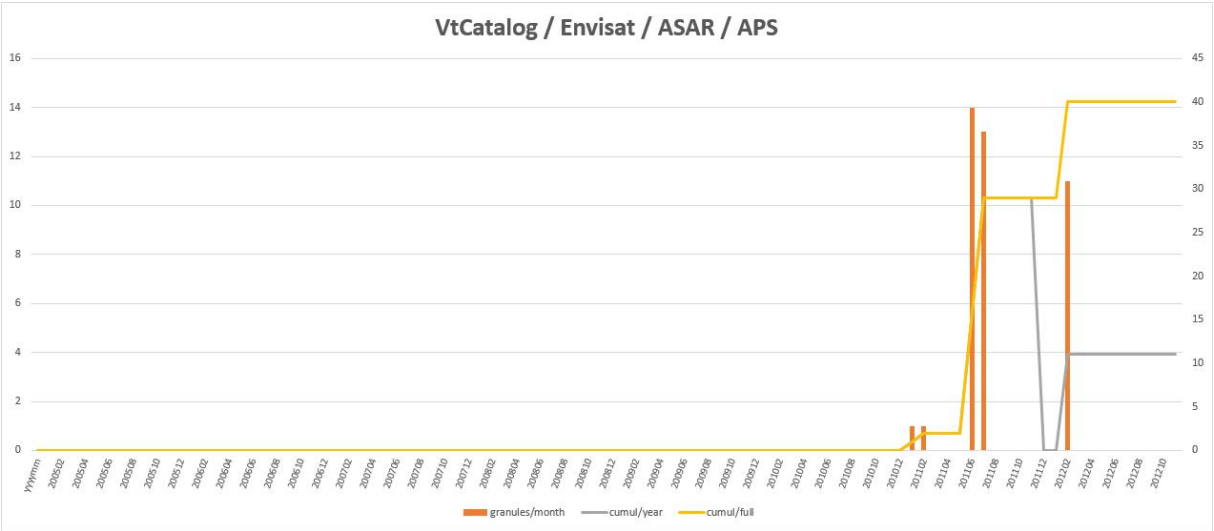


fig. 71 - VtCatalog / Envisat / ASAR / APS acquisition statistics (..\data\VtCatalog\Envisat\ASAR_APS\VtCatalog_Envisat_ASAR_APS.xlsx).

A.5 VtCatalog / Envisat / ASAR / GM1

total number of granules: **214 825**
monthly animation ..\data\VtCatalog\Envisat\ASAR_GM1\jpg_months
yearly animation ..\data\VtCatalog\Envisat\ASAR_GM1\jpg_years

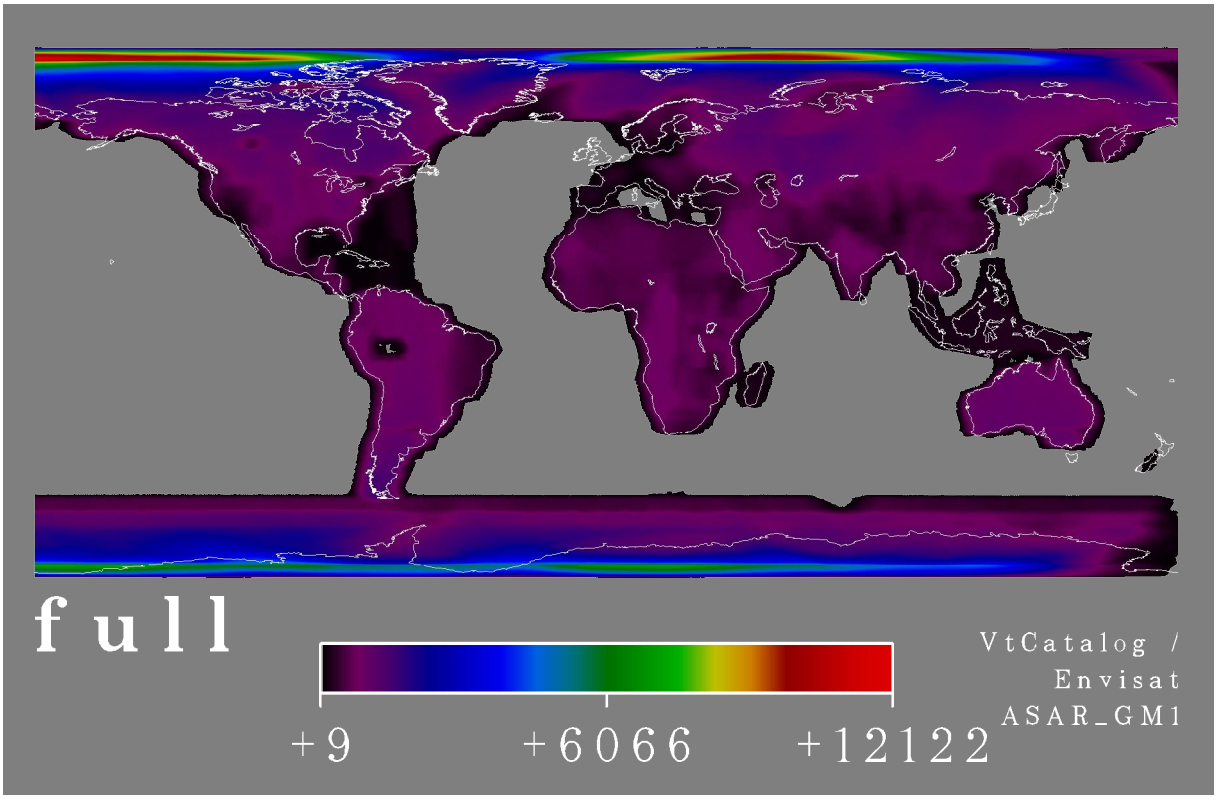


fig. 72 - VtCatalog / Envisat / ASAR / GM1 occurrences map (..\data\VtCatalog\Envisat\ASAR_GM1\jpg_full\ASAR_GM1.occ.cal.card.gra.tit.jpg).

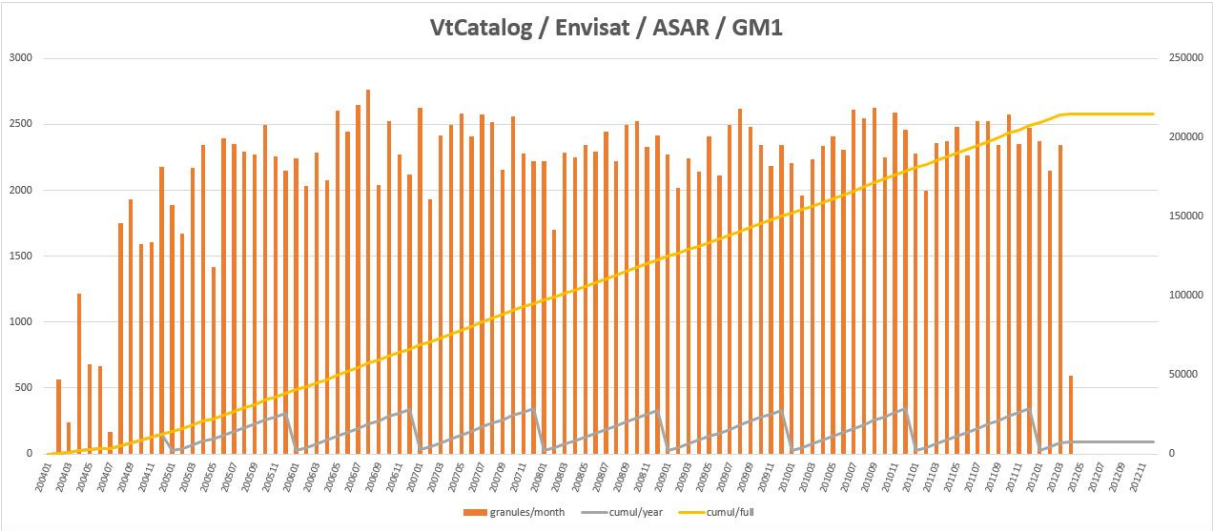


fig. 73 - VtCatalog / Envisat / ASAR / GM1 acquisition statistics (../data/VtCatalog/Envisat/ASAR_GM1/VtCatalog_Envisat_ASAR_GM1.xlsx).

A.6 VtCatalog / Envisat / ASAR / IMG

total number of granules: **15**
monthly animation ..\data\VtCatalog\Envisat\ASAR_IMG\jpg_months
yearly animation ..\data\VtCatalog\Envisat\ASAR_IMG\jpg_years

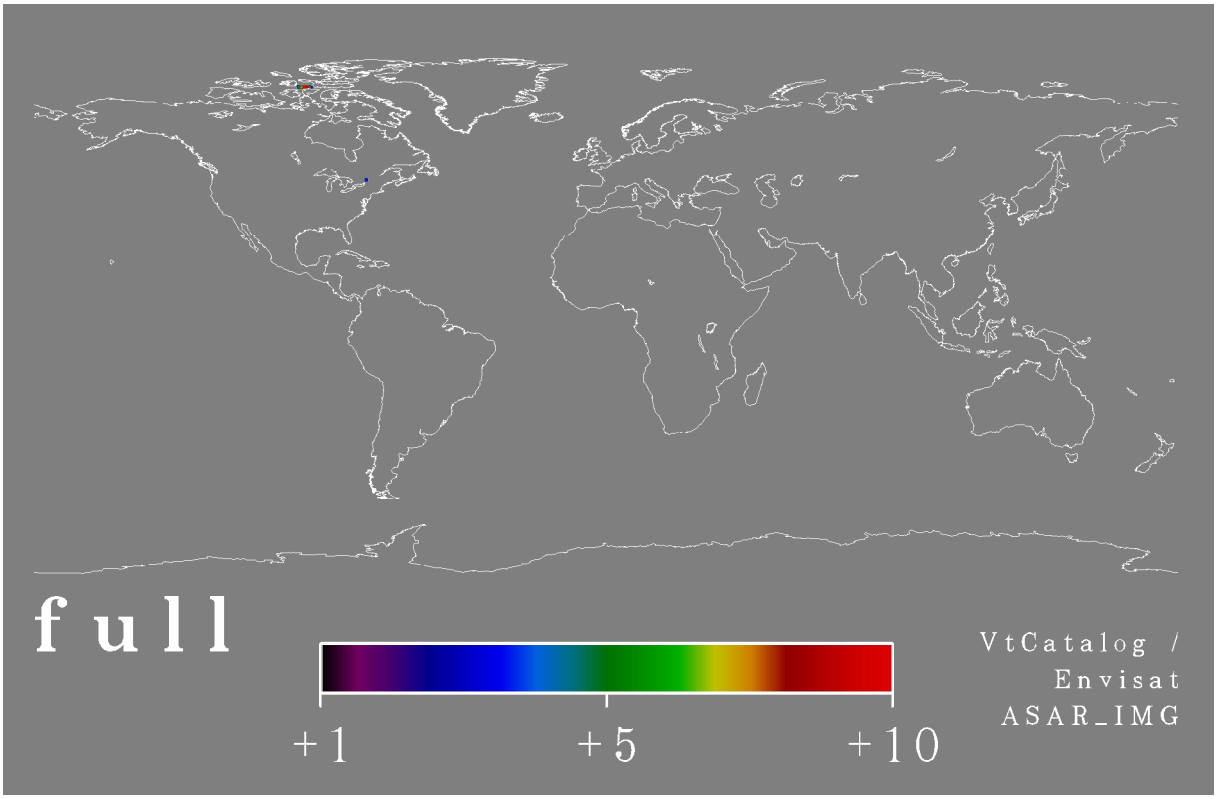


fig. 74 - VtCatalog / Envisat / ASAR / IMG occurrences map (..\data\VtCatalog\Envisat\ASAR_IMG\jpg_full\ASAR_IMG.occ.cal.card.gra.tit.jpg).

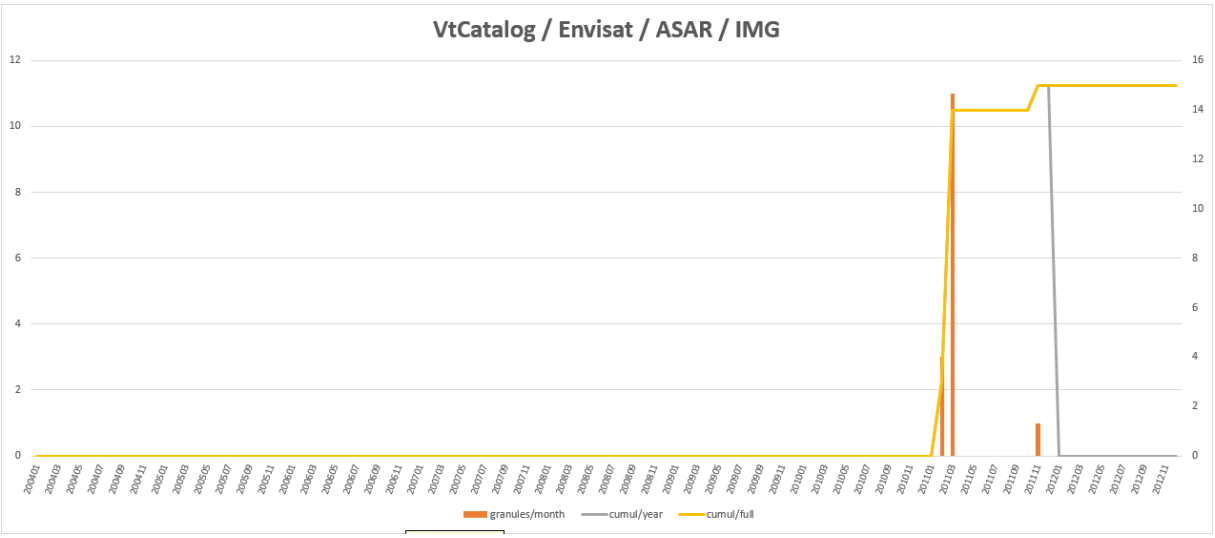


fig. 75 - VtCatalog / Envisat / ASAR / IMG acquisition statistics (..\data\VtCatalog\Envisat\ASAR_IMG\VtCatalog_Envisat_ASAR_IMG.xlsx).

A.7 VtCatalog / Envisat / ASAR / IMM

total number of granules: **72 967**
monthly animation ..\data\VtCatalog\Envisat\ASAR_IMM\jpg_months
yearly animation ..\data\VtCatalog\Envisat\ASAR_IMM\jpg_years

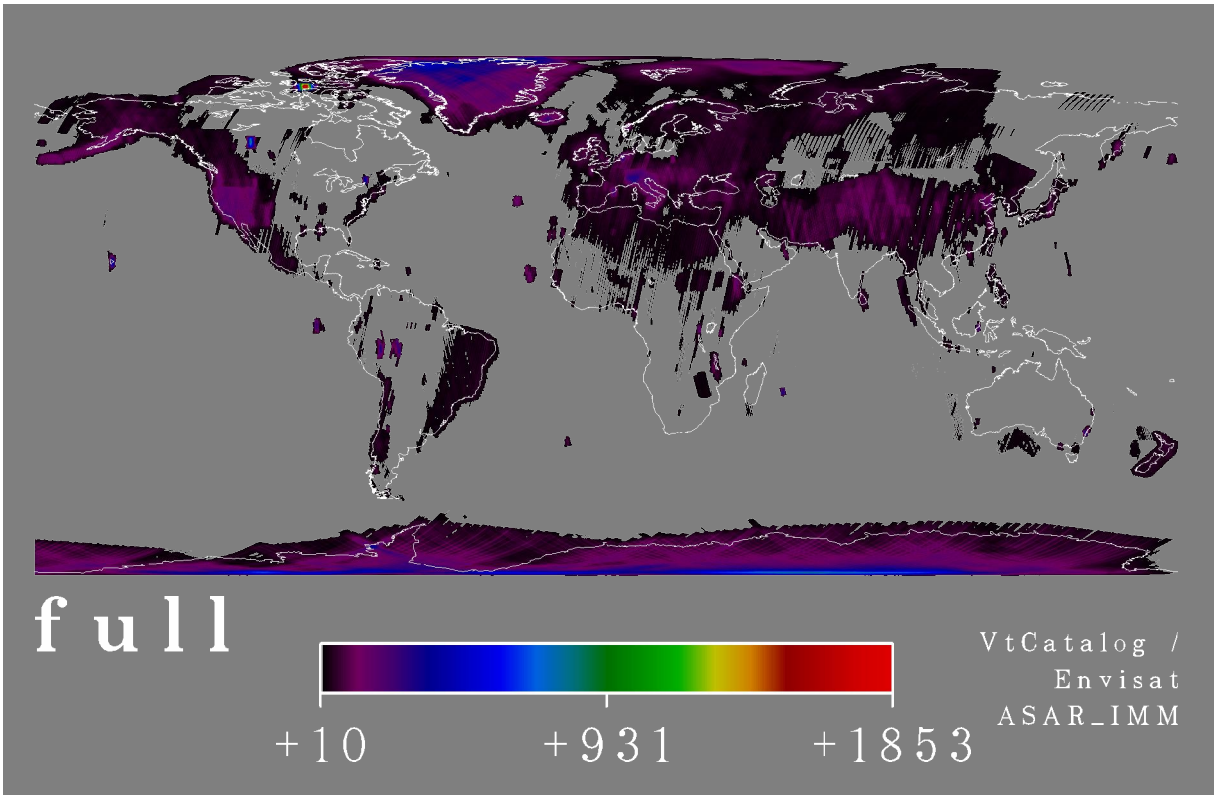


fig. 76 - VtCatalog / Envisat / ASAR / IMM occurrences map (..\data\VtCatalog\Envisat\ASAR_IMM\jpg_full\ASAR_IMM.occ.cal.card.gra.tit.jpg).

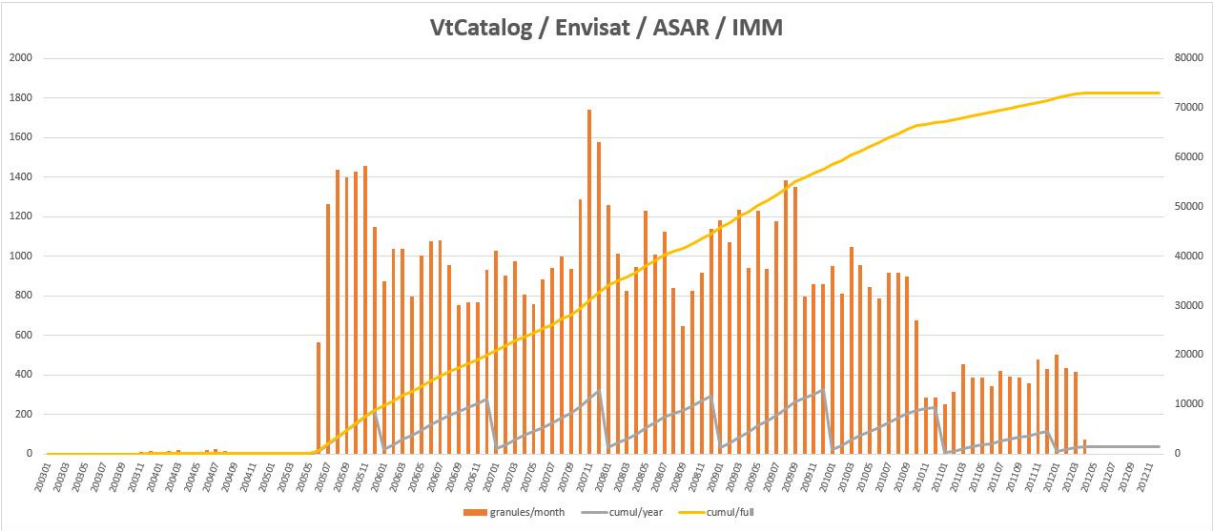


fig. 77 - VtCatalog / Envisat / ASAR / IMM acquisition statistics (..\data\VtCatalog\Envisat\ASAR_IMM\VtCatalog_Envisat_ASAR_IMM.xlsx).

A.8 VtCatalog / Envisat / ASAR / IMP

total number of granules: **6 941**
monthly animation ..\data\VtCatalog\Envisat\ASAR_IMP\jpg_months
yearly animation ..\data\VtCatalog\Envisat\ASAR_IMP\jpg_years

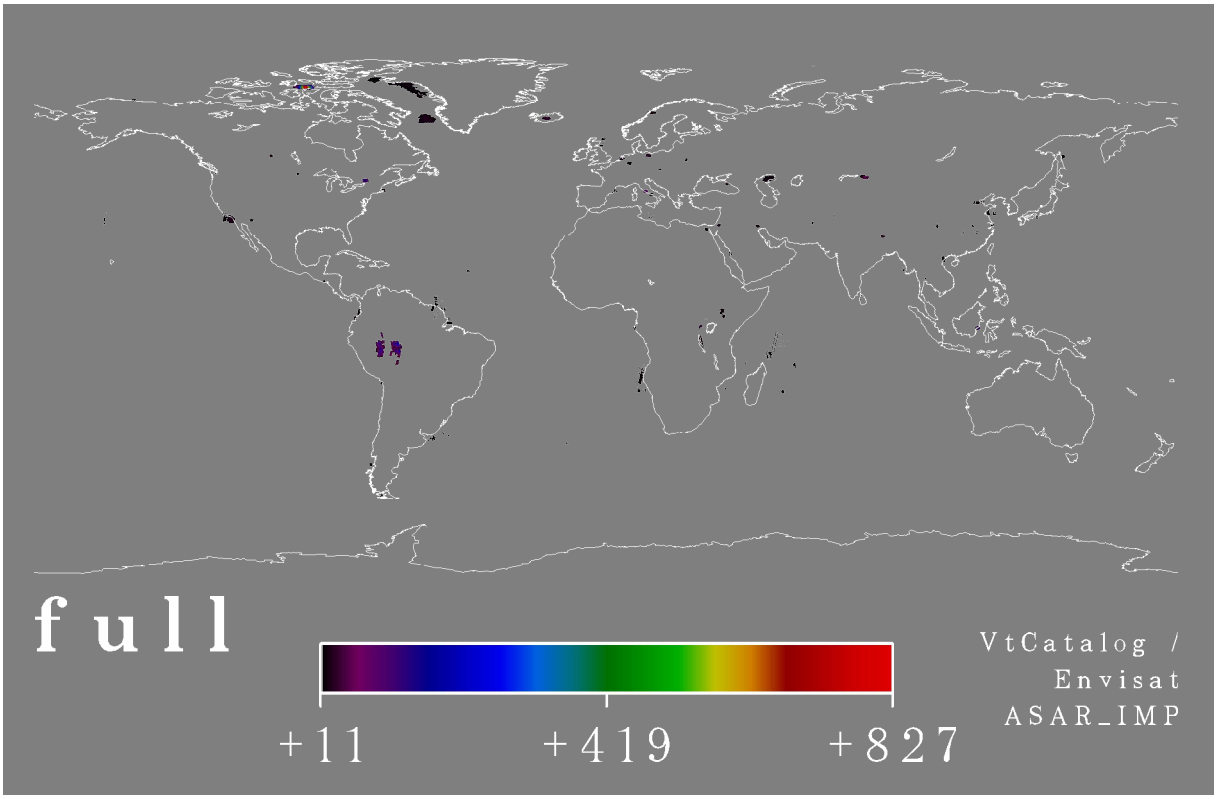


fig. 78 - VtCatalog / Envisat / ASAR / IMP occurrences map (..\data\VtCatalog\Envisat\ASAR_IMP\jpg_full\ASAR_IMP.occ.cal.card.gra.tit.jpg).

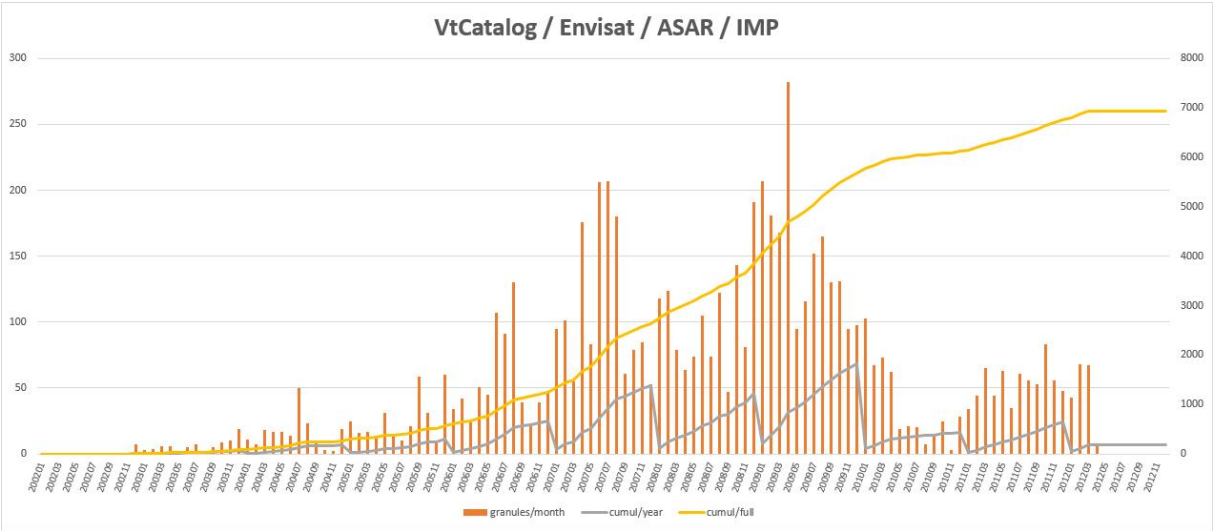


fig. 79 - VtCatalog / Envisat / ASAR / IMP acquisition statistics (..\data\VtCatalog\Envisat\ASAR_IMP\VtCatalog_Envisat_ASAR_IMP.xlsx).

A.9 VtCatalog / Envisat / ASAR / WSM

total number of granules: **150 167**
monthly animation ..\data\VtCatalog\Envisat\ASAR_WSM\jpg_months
yearly animation ..\data\VtCatalog\Envisat\ASAR_WSM\jpg_years

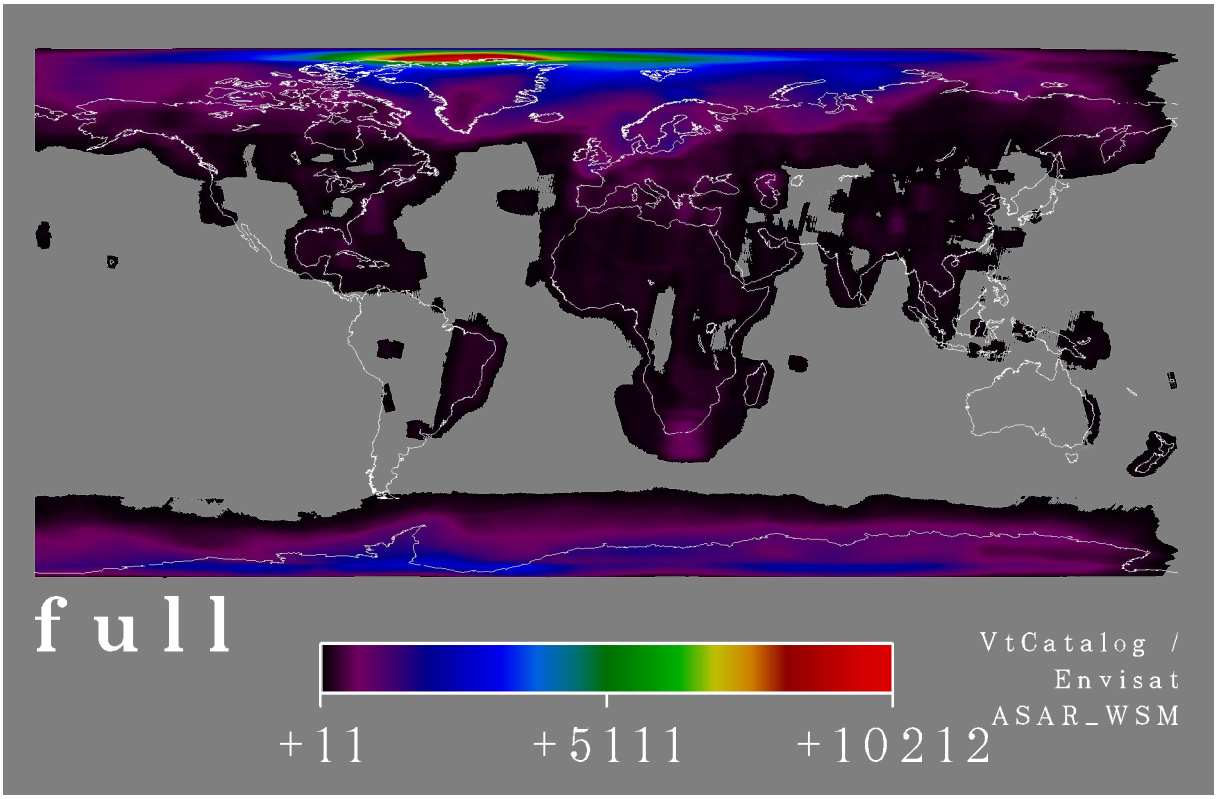


fig. 80 - VtCatalog / Envisat / ASAR / WSM occurrences map (..\data\VtCatalog\Envisat\ASAR_WSM\jpg_full\ASAR_WSM.occ.cal.card.gra.tit.jpg).

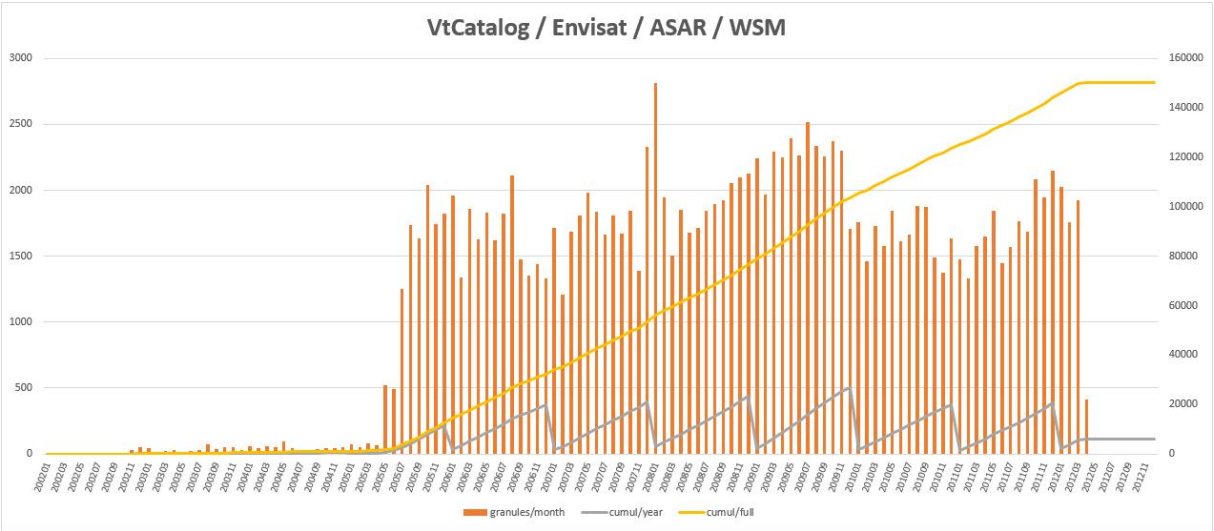


fig. 81 - VtCatalog / Envisat / ASAR / WSM acquisition statistics (..\data\VtCatalog\Envisat\ASAR_WSM\VtCatalog_Envisat_ASAR_WSM.xlsx).

A.10 VtCatalog / Envisat / MERIS / FRS

total number of granules: **137 791**
monthly animation ..\data\VtCatalog\Envisat\MERIS_FRS\jpg_months
yearly animation ..\data\VtCatalog\Envisat\MERIS_FRS\jpg_years

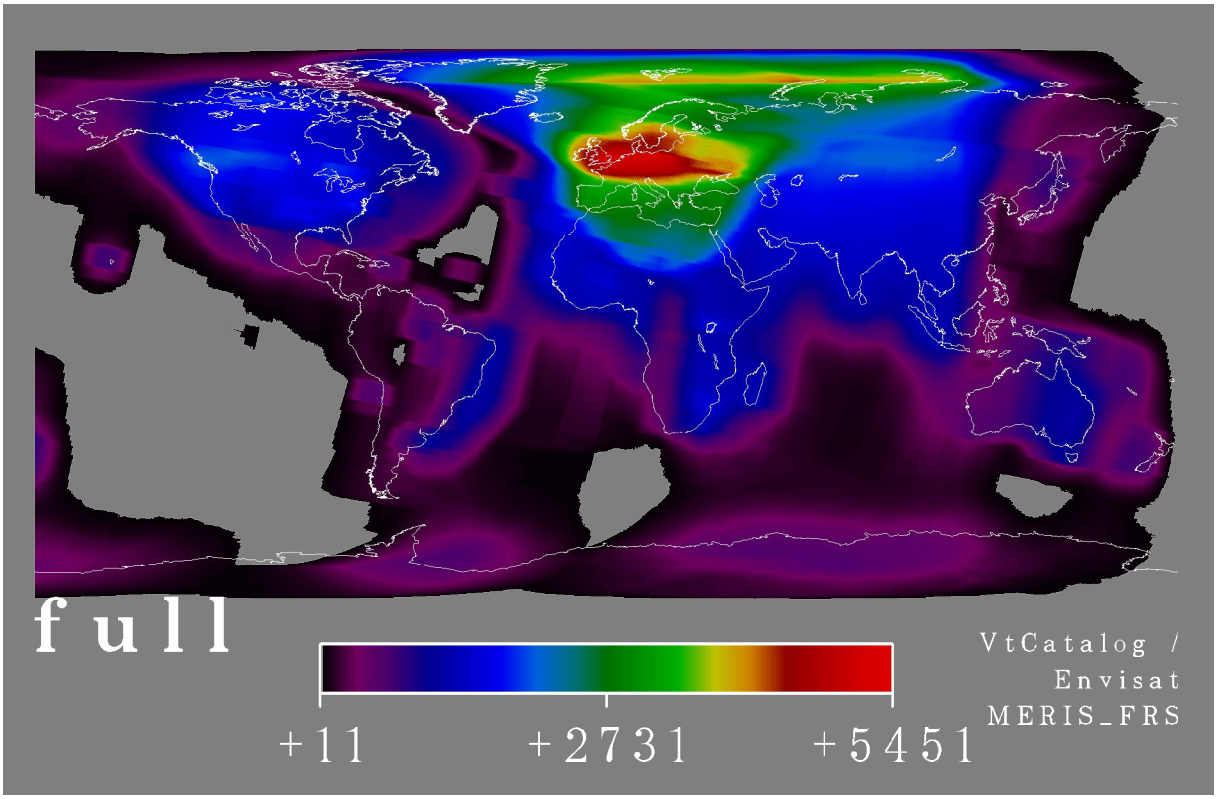
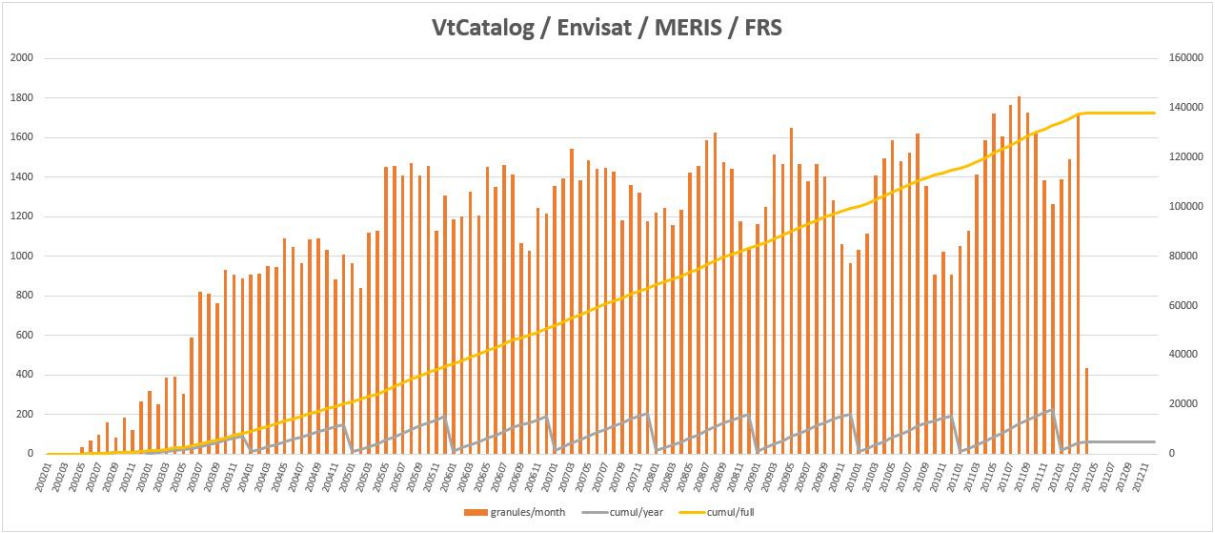


fig. 82 - VtCatalog / Envisat / MERIS / FRS occurrences map (..\data\VtCatalog\Envisat\MERIS_FRS\jpg_full\MERIS_FRS.occ.cal.card.gra.tit.jpg).

fig. 83 - VtCatalog / Envisat / MERIS / FRS acquisition statistics (..\data\VtCatalog\Envisat\MERIS_FRS\VtCatalog_Envisat_MERIS_FRS.xlsx).



ANNEX B - ESA / DHuS / S1A / C-SAR

B.1 ESA / DHuS / S1A / C-SAR - Overall acquisitions

total number of granules: **14 472** (on 17 December 2014 10AM)

total content length of granules: **26 894 GB**

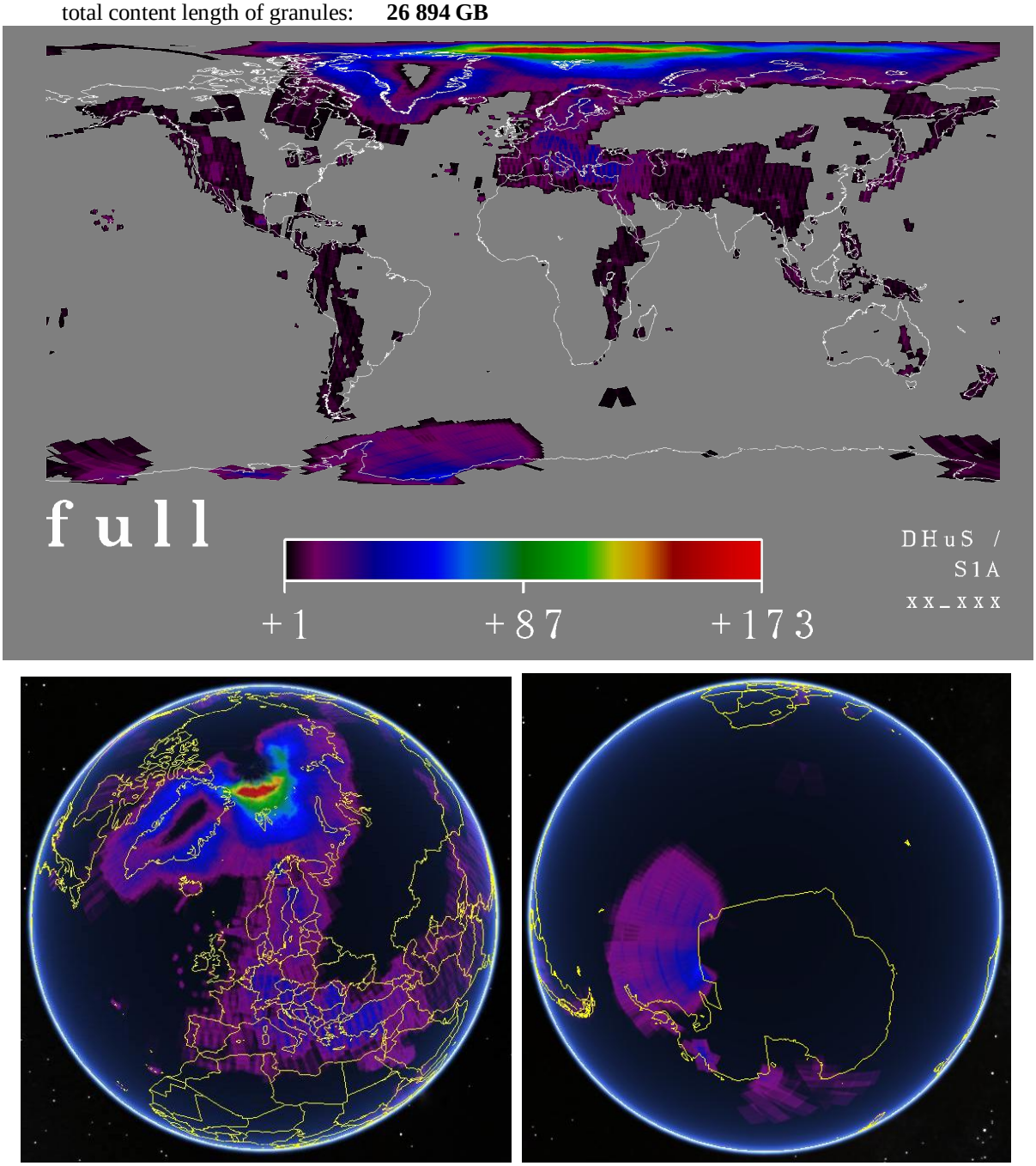


fig. 84 - ESA / DHuS / S1A / C-SAR / xx_xxx (overall) occurrences map
(..\data\DHuS\S1A\xx_xxx\jpg_full\xx_xxx.occ.cal.card.gra.tit.tif
..\data\DHuS\S1A\xx_xxx\jpg_full\xx_xxx.occ.cal.card.gra.kmz).

B.2 DHuS / S1A / C-SAR - Distribution of. RAW, SLC, GRD

B.2.1 Location of products delivered in RAW processing level

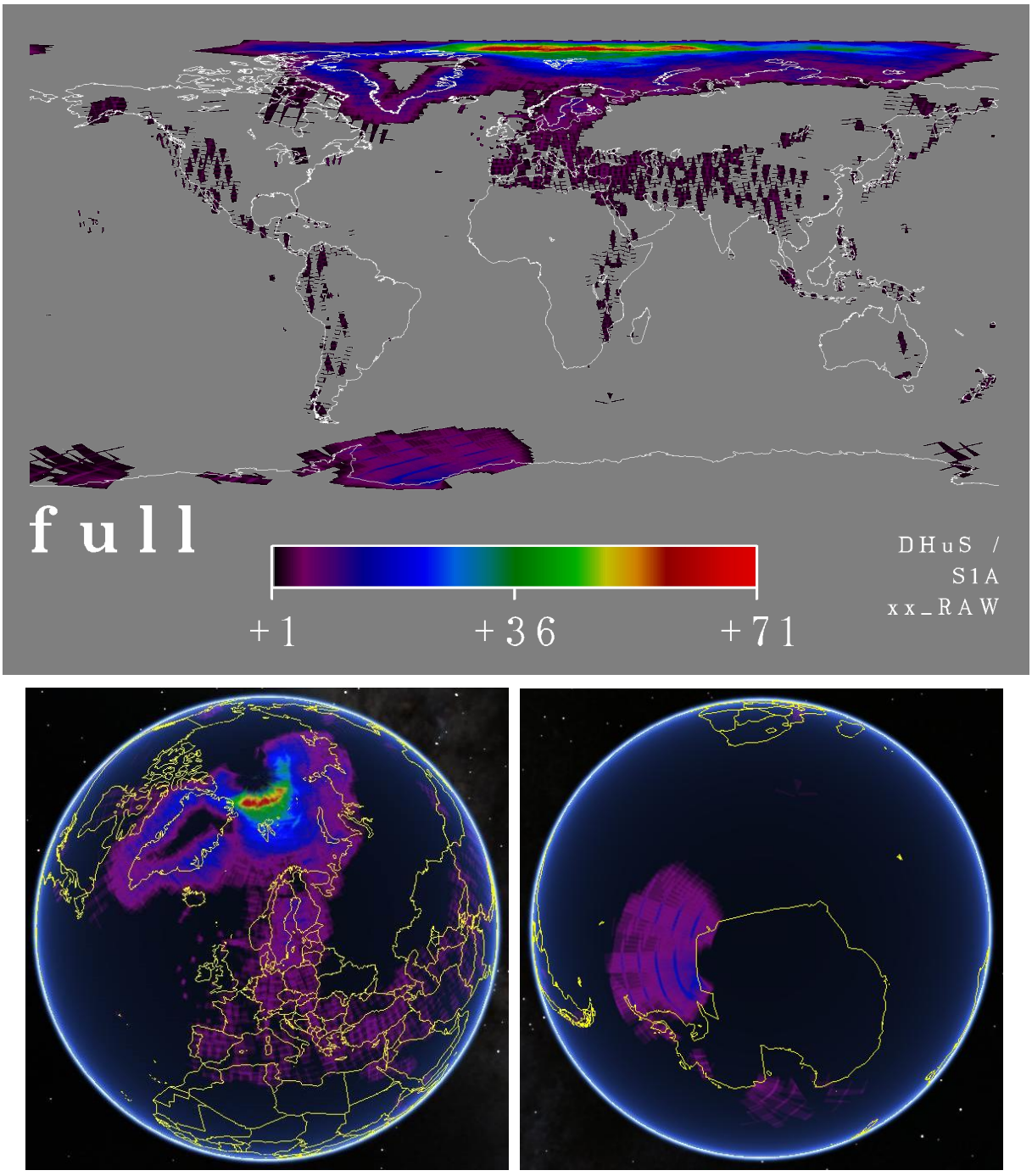
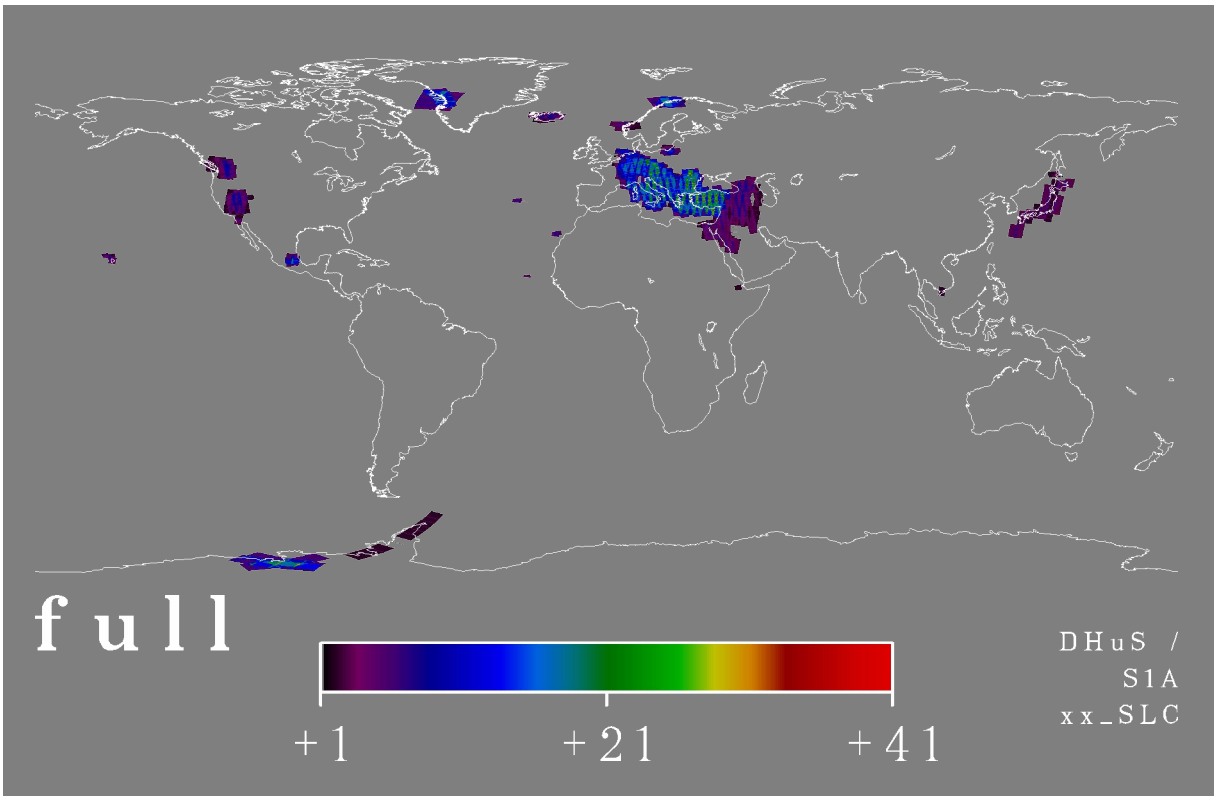


fig. 85 - ESA / DHuS / S1A / C-SAR / xx_RAW (all RAW) occurrences map (..\data\DHuS\S1A\xx_RAW\jpg_full\xx_RAW.occ.cal.card.gra.tit.tif ..\data\DHuS\S1A\xx_RAW\jpg_full\xx_RAW.occ.cal.card.gra.kmz).

B.2.2 Location of products delivered in SLC processing level

As shown here below, the distribution of SLC products is less distributed and much more concentrated in sparse sites.



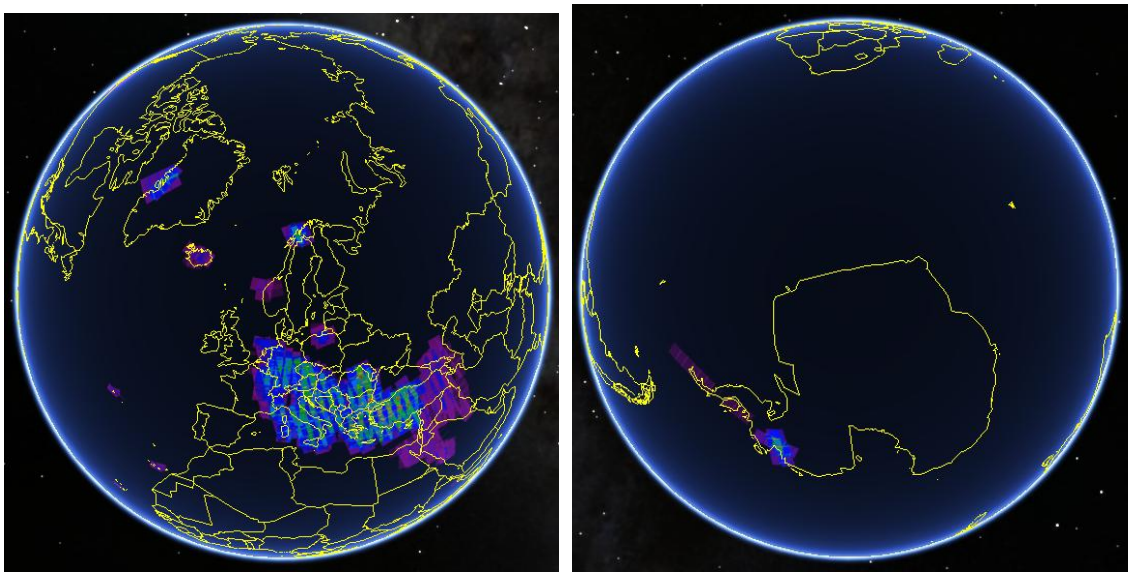


fig. 86 - ESA / DHuS / S1A / C-SAR / xx_SLC (all SLC) occurrences map (..\data\DHuS\S1A\xx_SLC\jpg_full\xx_SLC.occ.cal.card.gra.tit.tif ..\data\DHuS\S1A\xx_SLC\jpg_full\xx_SLC.occ.cal.card.gra.kmz).

B.2.3 Location of products delivered in GRD processing level

With 2.5 times more products available, the distribution of GRD products looks very close the one of RAW products (see **Erreur ! Source du renvoi introuvable.**).

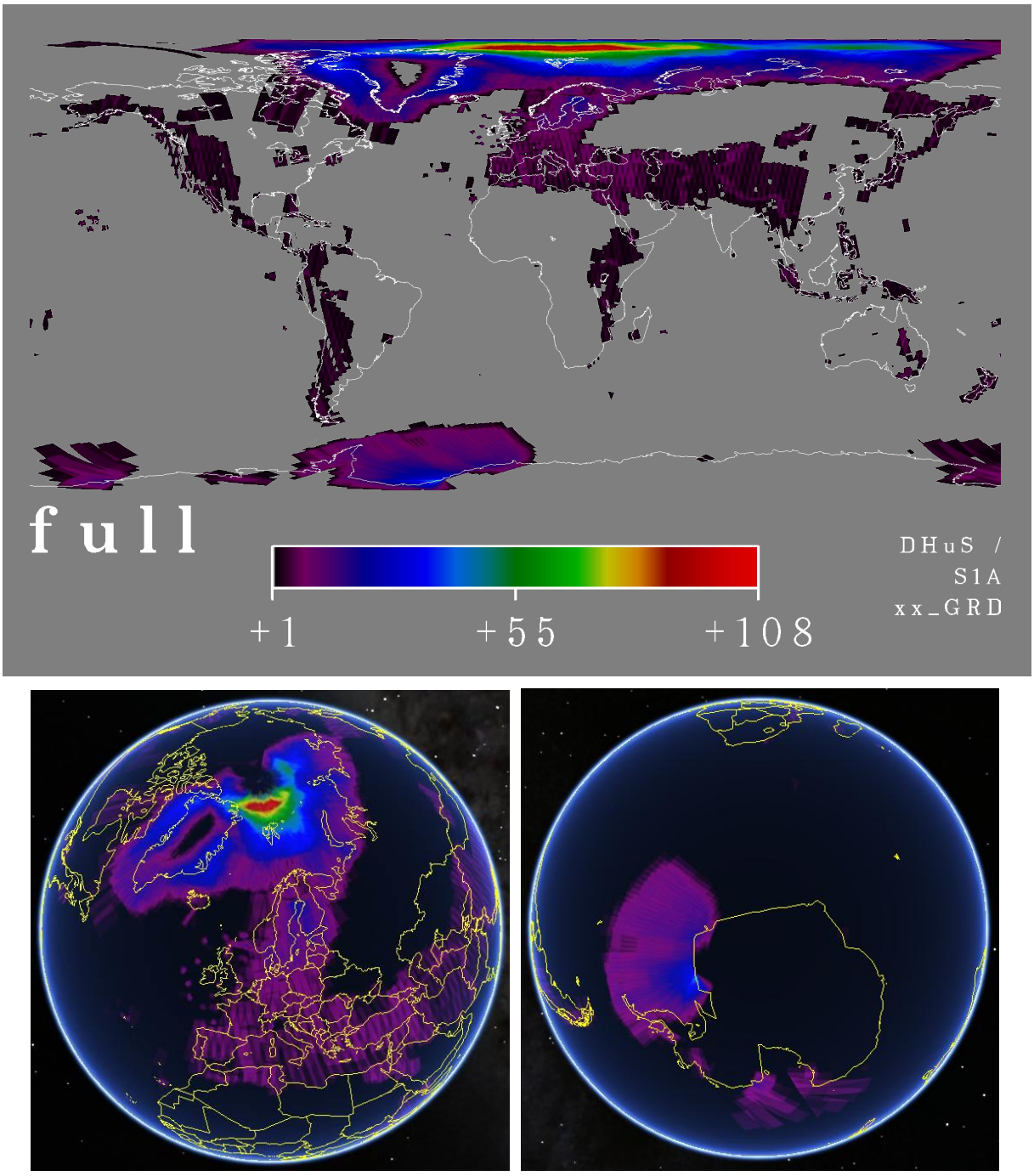


fig. 87 - ESA / DHuS / S1A / C-SAR / xx_GRD (all GRD) occurrences map (..\data\DHuS\S1A\xx_GRD\jpg_full\xx_GRD.occ.cal.card.gra.tit.tif ..\data\DHuS\S1A\xx_GRD\jpg_full\xx_GRD.occ.cal.card.gra.kmz).

B.3 DHuS / S1A / C-SAR - Distribution of EW, IW, SM

B.3.1 Location of EW products

Most of the acquisitions are located at high latitudes and seem to be involved in the characterisation of sea ices.

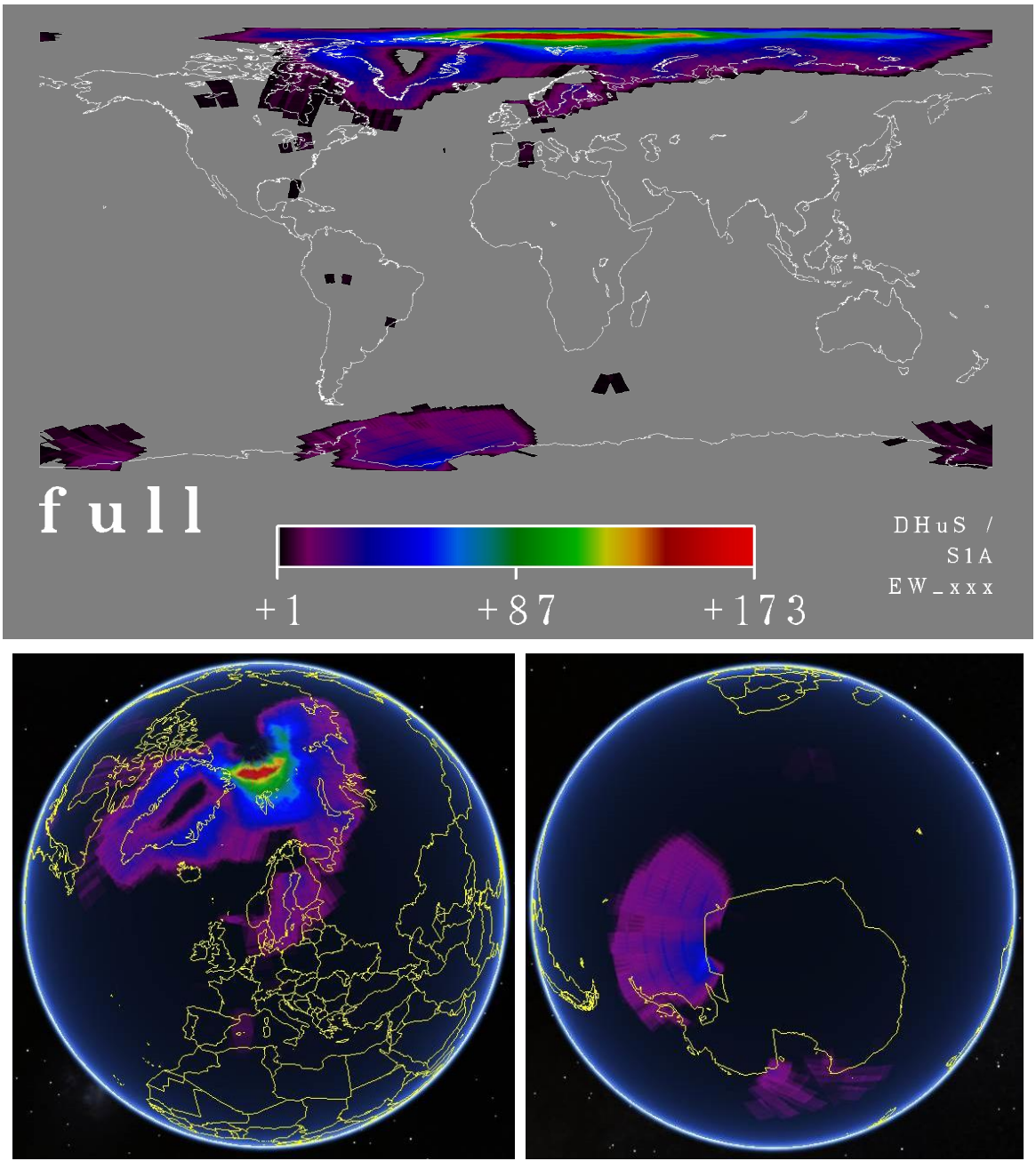


fig. 88 - ESA / DHuS / S1A / C-SAR / EW_xxx (all EW) occurrences map
(..\data\DHuS\S1A\EW_xxx\jpg_full\EW_xxx.occ.cal.card.gra.tit.tif ..\data\DHuS\S1A\EW_xxx\jpg_full\EW_xxx.occ.cal.card.gra.kmz).

B.3.2 Location of IW products

Most of the IW acquisitions are located along active faults, limits of tectonic plates and more generally in regions of large seismicity.

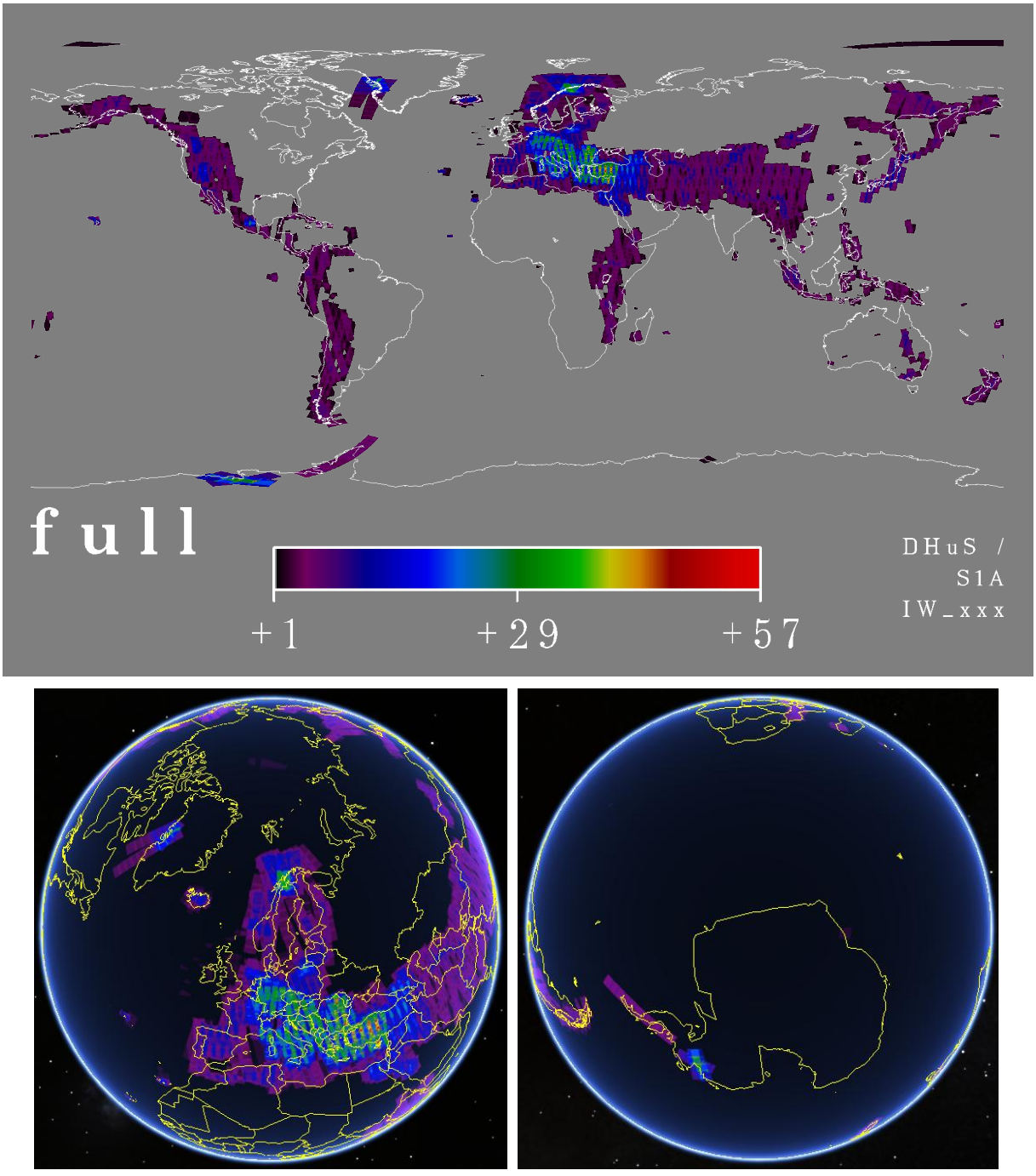


fig. 89 - ESA / DHuS / S1A / C-SAR / IW_xxx (all IW) occurrences map
(..\data\DHuS\S1A\IW_xxx\jpg_full\IW_xxx.occ.cal.card.gra.tit.tif
..\data\DHuS\S1A\IW_xxx\jpg_full\IW_xxx.occ.cal.card.gra.kmz).

B.3.3 Location of SM products

These high resolution acquisitions have been performed in very localised sites along the West coast of USA and Canada, South of Island, across the North Sea.

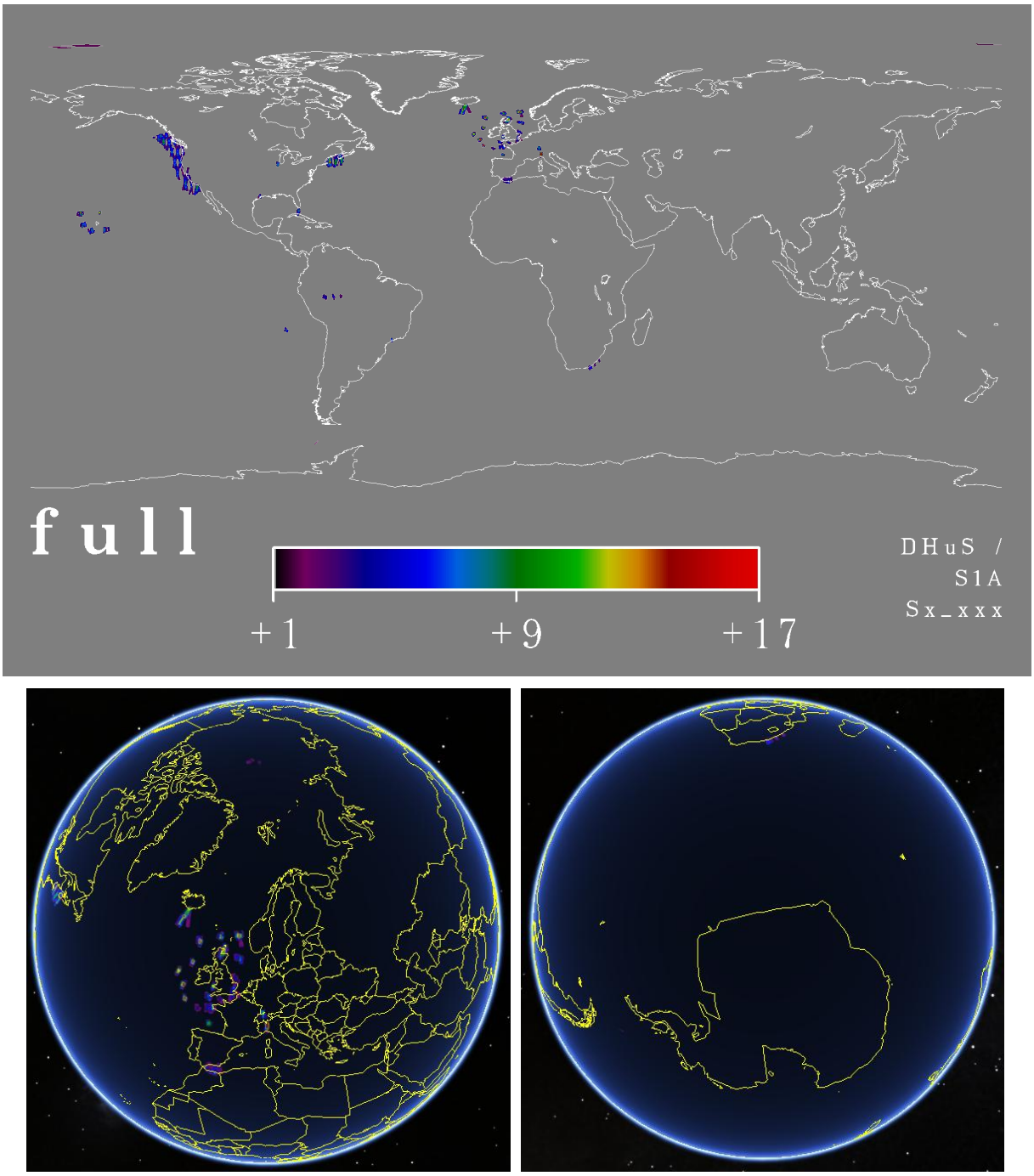


fig. 90 - ESA / DHuS / S1A / C-SAR / Sx_xxx (all SM) occurrences map
(..\data\DHuS\S1A\Sx_xxx\jpg_full\Sx_xxx.occ.cal.card.gra.tit.tif
..\data\DHuS\S1A\Sx_xxx\jpg_full\Sx_xxx.occ.cal.card.gra.kmz).