Bulk-processing of ESA's Unique Landsat Archive

Landsat MSS, TM and ETM+ archive (1974 – 2011)

Biasutti, Roberto - Gascon, Ferran - Fischer, Peggy - Hoersch, Bianca (1)

Pinori, Sabrina - Paciucci, Alessandra (2)

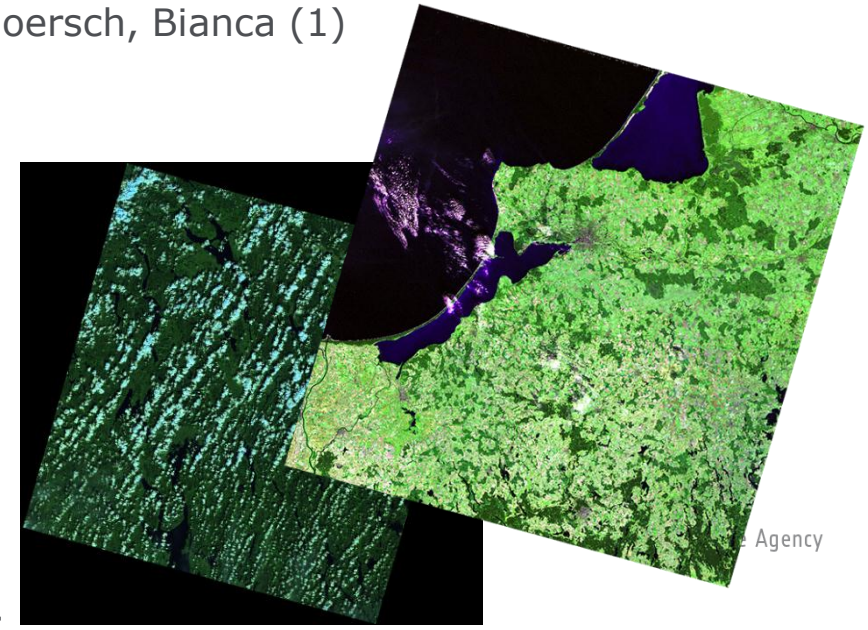
Ferrara, Riccardo - Galli, Luca - Mica, Stefano (3)

Hopkins, Stacey - Jackson, Jan (4)

Lavender, Samantha (5); Northrop, Amy (5);
Paul, Fredric (6); Saunier, Sebastien (7)

Organisations:
1: ESA-ESRIN (I)
2: SERCO S.p.A. (I)
3: ACS (I)
4: ARGANS Ltd (UK)
5: VEGA UK (UK)
6: IFREMER (F)
7: Magellium (F)

Presented by: R.Biasutti – Landsat PDGS ops manager

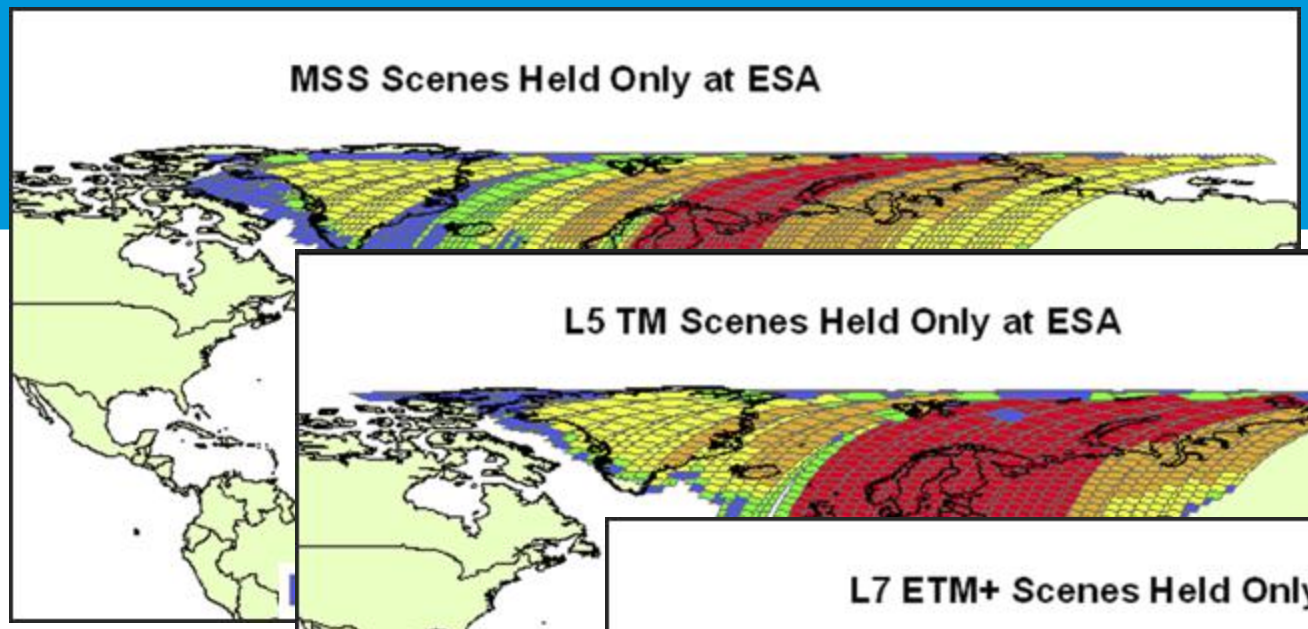


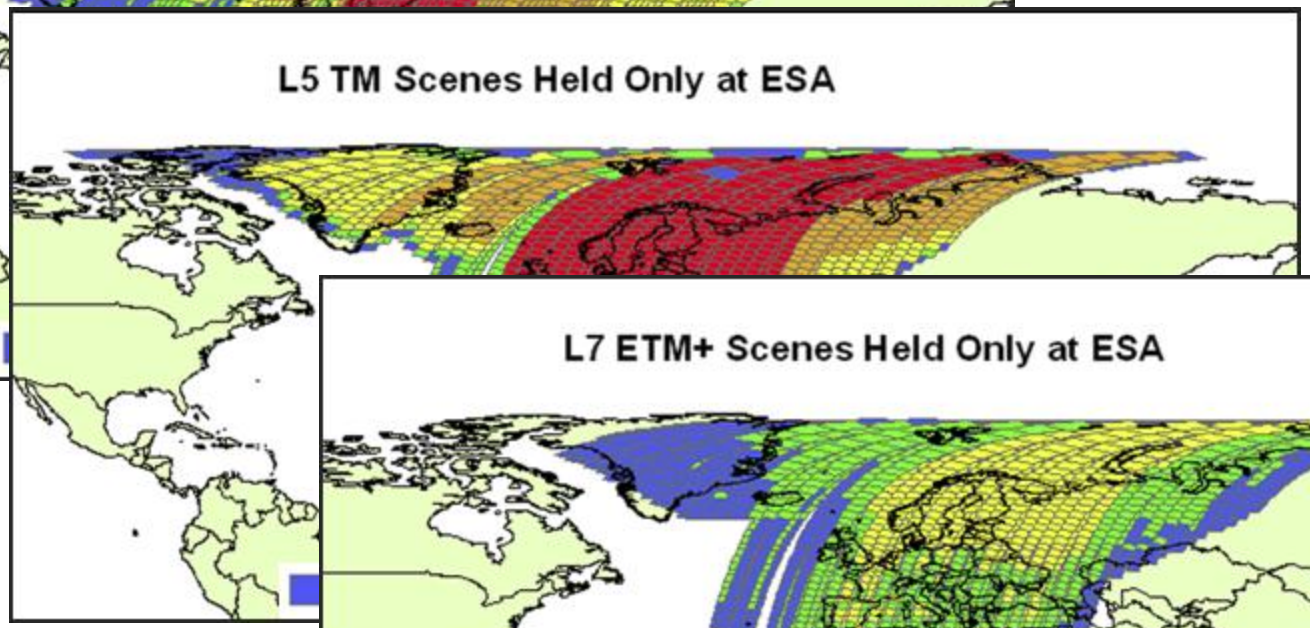
Content

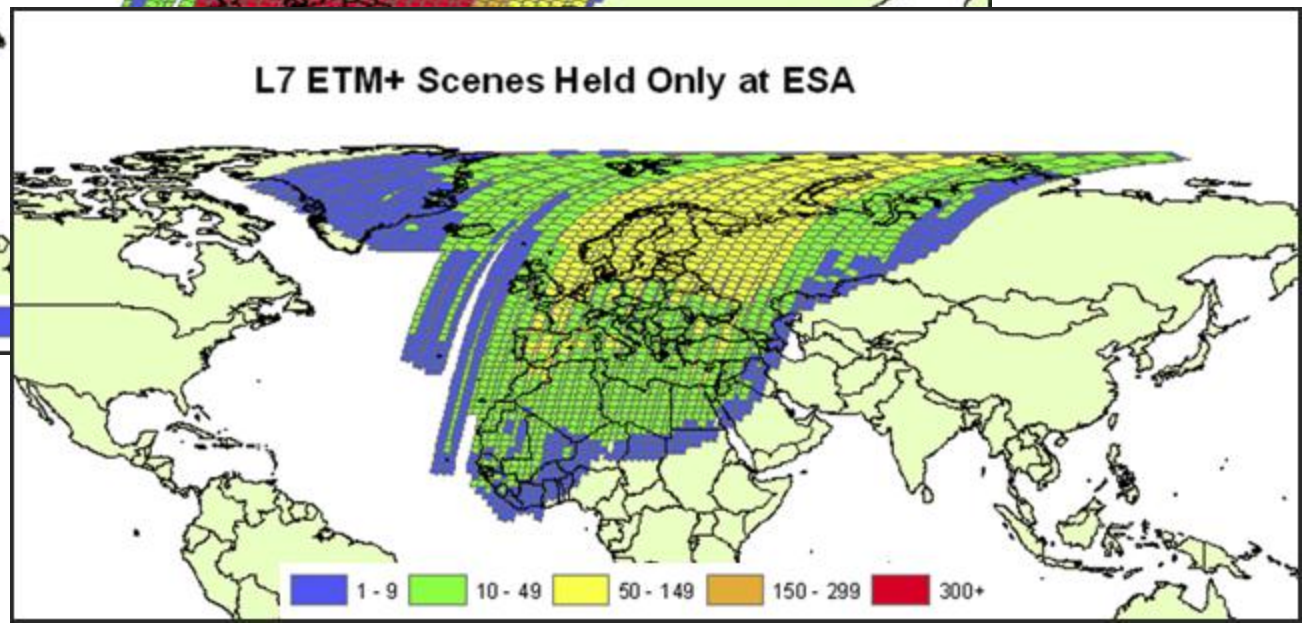
1) ESA Landsat archive bulk-processing Project purpose
2) Phase 1 and Phase 1 follow-on
3) Results
4) Data Access
5) On-going activities
6) Landsat-8

Context

1. Within the Third Party Mission scheme, ESA provides to Earth Observation users data from non-ESA Third Party Missions, to complement the data from ESA EO missions and to support and build up the scientific user community for those data in Europe.
2. Landsat has with its history over the last 40 years been one of the longest existing Third Party Missions. Fucino performed the first Landsat acquisition for ESA in April 1975
3. ESA has acquired data and kept a Landsat archive at the Kiruna, Maspalomas, Neustrelitz and Matera facilities.







MSS => 585,000 scenes (95% unique scenes)

TM => 1,325,000 scenes (90% unique scenes)

ETM+ => 125,000 scenes (70% unique scenes)

Landsat Bulk-Processing Project Requirements

- **Data Collection of input data** from ESA and **Data Consolidation**
- **Systematic production** of all Landsat archives
  - Landsat 4, 5 TM
  - Landsat 7 ETM+
  - Landsat 1-5 MSS
- Into the highest possible processing level, orthorectified **L1T (GTC)**, otherwise to **L1Gt (GEC),** starting from Wilma Lv.0
- All products **systematically quality** assessed
- All products shall be available online for **direct user download**
- Directly or through a **search tool** (geographic search, time search, cloud cover filtering, etc..)
- Density Maps of produced scenes as part of reporting
- Support Lv.0 **data repatriation to USGS** (after online access is implemented)

Landsat Bulk-Processing
Phased approach

In order to have a quick start of data delivery on-line and data repatriation, the project was divided in 2 slices:

Phase 1: bulk-processing and on-line dissemination of an initial set all Landsat 5 TM data of Kiruna **-> COMPLETED**

- *Duration: 8 months*
- *Includes also: processors and QC tool update, metadata/browse compatible with ESA browsing tools, IDEAS scientific QC, data extraction from ESA facilities, data access configurations, proof of concept*

Phase 2: bulk-processing and on-line dissemination of the full archive of all Landsat missions (MSS, TM and ETM+) **-> ON-GOING**

- *Duration: 10 months*
- *Includes also: processors and QC tool update, IDEAS scientific QC, data access configurations*

Industrial Consortia involved

X-PReSS

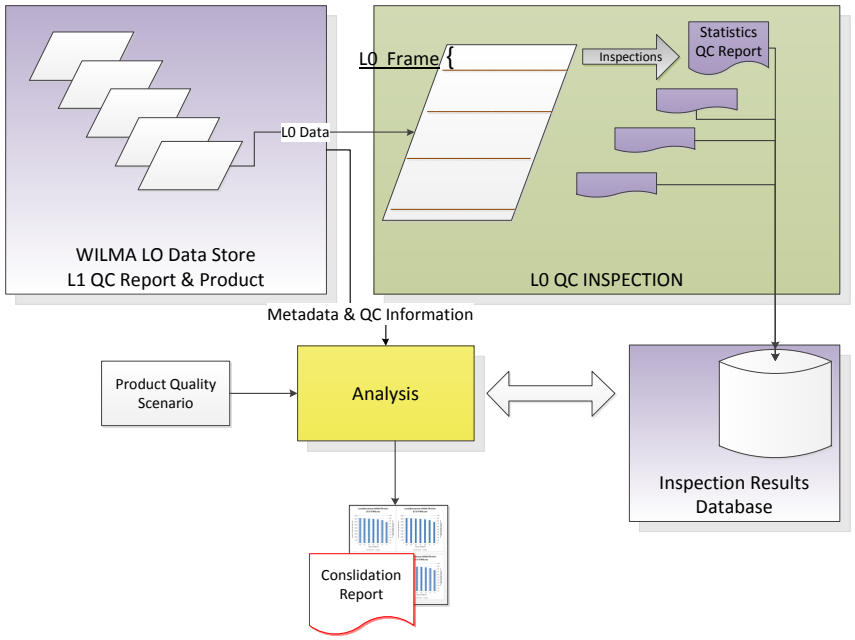
- Data Collection
- Data Consolidation
- Processor and QC tool integration and orchestration
- Systematic processing
- Data repatriation to ESA and USGS
- Data Configuration Management

- Processor evolution
- QC tool evolution
- Systematic Scientific Data Quality Control of processed data

Data Consolidation approach

- Data Consolidation. The dataset resulting from the Collection phase is:
  - Purged of corrupted or duplicated data.
  - Gap filled (Any additional data sources are added to address gaps and the dataset)
  - Updated recent ancillary information
  - Harmonised file-naming, format, packaging and metadata
  - Detection of anomalies within L0 and integrity and consistency verification

- All steps of this process are recorded in the CCM (including Level 0 QC results)

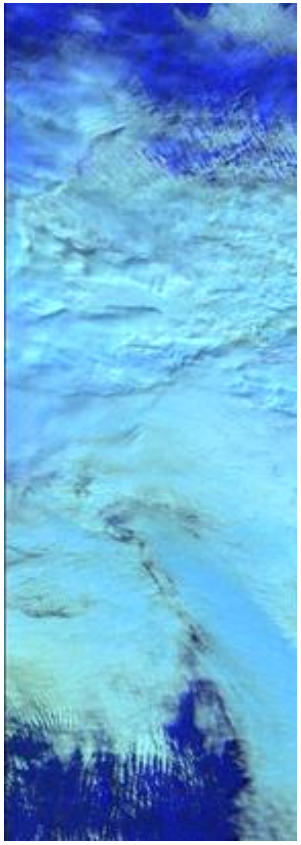


1. Inspection of L0 WILMA Data
2. Analysis tool

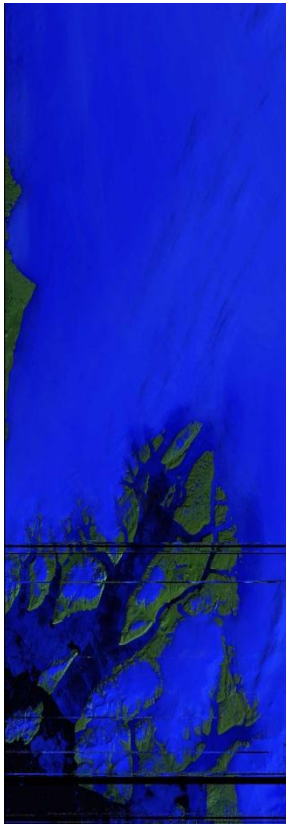
Data Consolidation - Inspectors

- The following inspectors have been defined

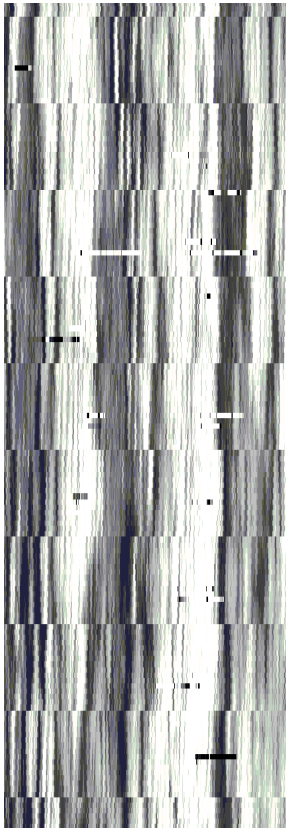
Corrupted and Missing Scan



Saturated Pixels



Scan Line Artifacts



OverSaturation

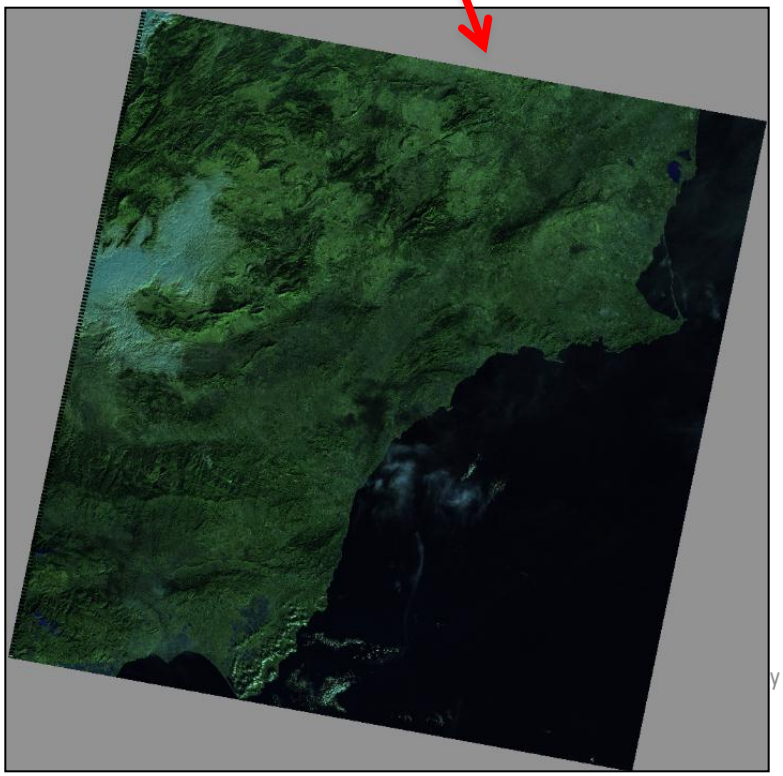
Landsat Bulk Processing Processor

1. Generation of L1T product
2. List of main improvement of the Landsat processor (versions 2.2 and 2.3):
    a. Multi-Scene Refinement (using full pass);
    b. Bias Correction;
    c. Residual Striping Correction;
    d. Thermal Band Calibration;
    e. Memory Effect Correction;
    f. Scan Correlated Shift Correction;
    g. Metadata and Quick Look compliant to ngEO requirements;
    h. Quick Look generated from the Lv.1 product
3. List of the main improvement of the Landsat processor (version 3.0.1):
    a. Introduction of MSS L1T processor;
    b. Correction of saturation and stripping issues;
    c. ngEO metadata fields fixing;
    d. Single processor version for all MSS, TM and ETM+.

Landsat Bulk Processing Processor Output

ESA Ground Terrain Corrected (GTC) product supplied as:

|-- LS05_TM__GTC_1P_*.ZIP (ESA Standard Naming Convention)
| |-- **LS05_TM__GTC_1P_*.BP.PNG (Quicklook Image in Portable Native Graphic format)**
| |-- LS05_TM__GTC_1P_*.BP.XML (Quicklook Image metadata in XML format)
| |-- LS05_TM__GTC_1P_*.MTR.XML (Report Metadata in XML format)
| |-- LS05_TM__GTC_1P_*.TIFF (Product Folder)
| |-- LT5*_Bn.TIF (Band 1 to 7 product files)
| |-- LT5*_GCP.txt (Ground Control Points file, not when Multiscene Refinement usage occurs)
| |-- LT5*_MTL.txt (Metadata file)
|-- **LS05_TM__GTC_1P_*.PDF (Amalfi On-Line QC Report)**



Amalfi

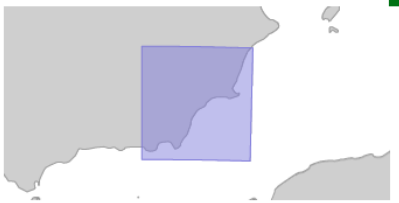
Quality Control Report

2013-06-12T11:35:50

Landsat L1 GeoTIFF Product
LT51990342007008ESA00

Passed

Elapsed time: 19.266s



Spacecraft:	LANDSAT_5
Sensor:	TM (BUMPER)
Acquisition Date:	2007-01-08
Acquisition Time:	10:38:50.7090000Z
Path / Row:	199 / 34
Product Level:	L1T
Map Projection:	UTM (WGS84 / WGS84)
Elevation Source:	GLS2000
Processing Date:	2013-05-17T10:13:40Z
Software Version:	SLAP_02.03

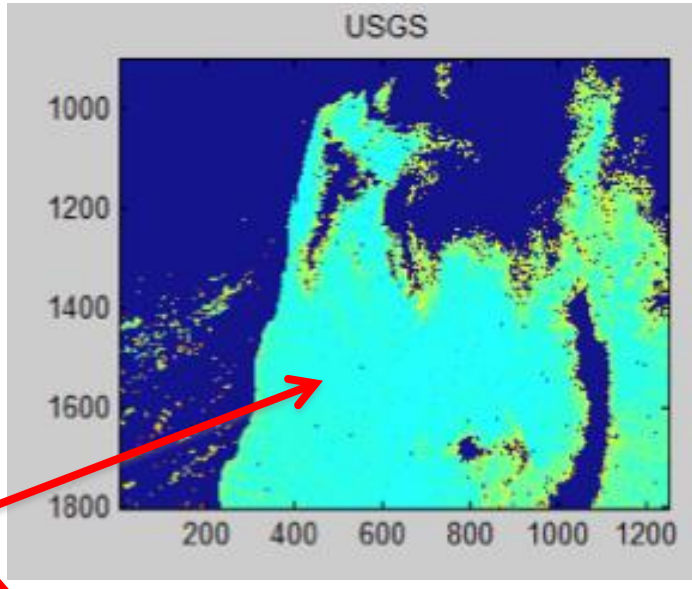
Landsat TM/ETM+ GeoTIFF Inspection Plan

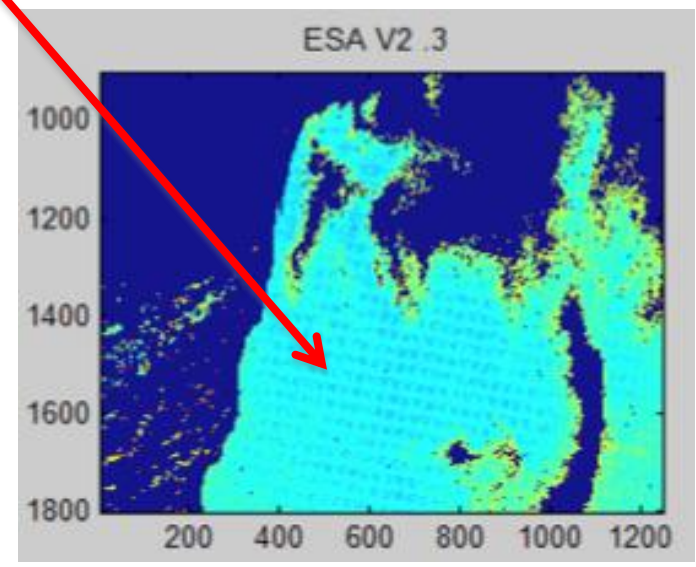
1	**LT51990342007008ESA00_MTL** (Landsat TM L1 Metadata File) *All 6 inspection(s) passed successfully [More at p. 2]*	2.692s	Passed
2	**LT51990342007008ESA00_GCP** (Landsat L1 GCP File) *All 2 inspection(s) passed successfully [More at p. 4]*	0.038s	Passed

Landsat Bulk Processing Processor Validation

1. On-line Quality Control (using Amalfi 2)
2. Off line Quality Control (by ARGANS and VEGA)
3. Scientific validation (by Magellium)

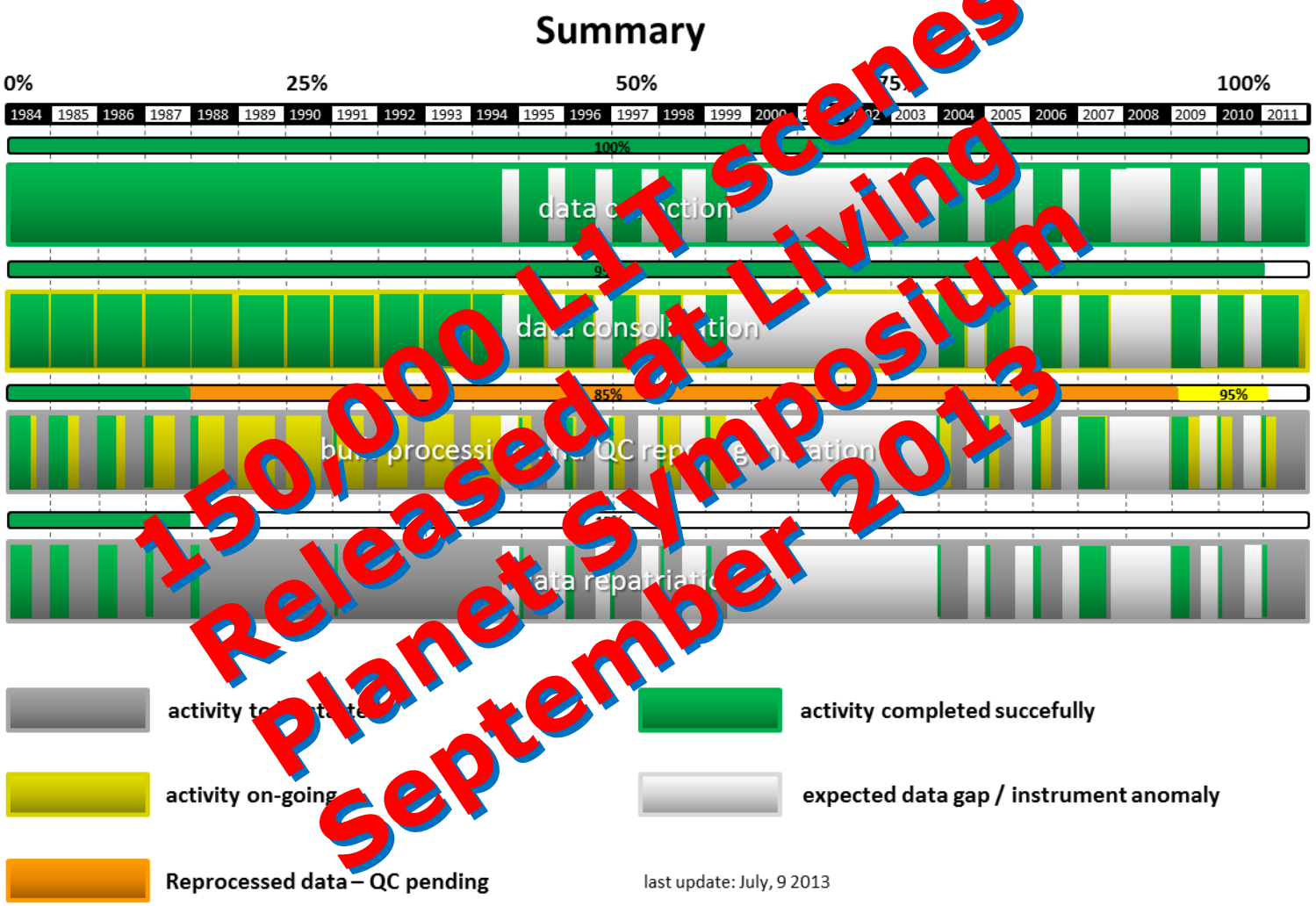
Validation Item	Comment
Metadata format, correctness and completeness	The format is in conformance with the format specification [LS DFCB 20, Version 4.0].
Quick Look quality,	The quick look quality is correct and within expectation
Image quality, Comparison with the USGS products.	The overall image quality has been improved along with successive SLAP update. The band 4 is still contaminated with noise after the ME / SCS correction is applied. The magnitude of the noise is very small (less than 1 DN).
Radiometric match up, Comparison with the USGS products.	The radiometric agreement between ESA and USGS products is 1 within 0.6 % for bands 1, 2, 2 within 0.4 % for bands 4, 5, 6, 7. A lost in accuracy is observed for band 7 when passing from SLAP V2.2 to SLAP V2.3 of only 0.1 %.
Geometry, interband registration	The interband registration is within 1/2 a pixel.
Geometry, multi temporal geolocation accuracy	The multi temportal accuracy is within the pixel.
Geometry, planimetric accuracy of L1T.	The planimetric accuracy is about 33 m (RMSE 2D – 1 sigma). And Circular Error @ 90 th percentile; 50 m





4. Validation by 5 ESA PIs

Landsat Bulk-Processing – phase 1



150,000 L1T scenes Released at Living Planet Symposium September 2013

European Space Agency

Landsat Bulk-Processing – phase 1
Challenges, and consequences

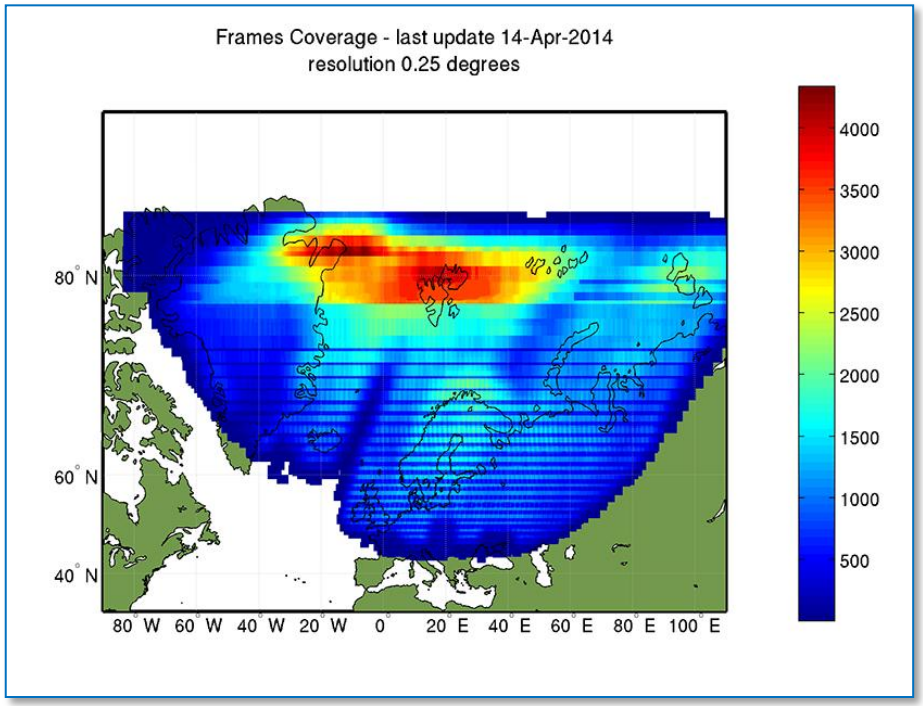
Challenge	Consequence	Strategy
New Landsat-8 format definition • USGS delivered in Nov 2012 a new file format common to Landsat-8	Products with obsolete format	• Processor upgrade in order to align format with USGS one • QC tool upgrade to handle the new format
Costal Areas • Scenes with large water portions cannot be processed to L1GTC	Lower L1GTC production over coastal area	• Processor upgrade to allow process to L1GTC • Re-run processing
Climate conditions • Large presence of Ice /snow coverage • High CC (~50% of the Kiruna scenes have a CC > 50	25% less L1GTC production over land area (vs to total available 'Land' scenes) due to lack of GCP	• Processor tuning allowing use of fewer GCPs for L1GTC generation • Produce also lower level products (L1GT, L1G) • Re-run processing
Large areas over sea: • ~40% of the overall scenes acquired over Kiruna visibility are over Ocean	No production of fully water and sea/ice scenes*	• Produce also lower level products (L1G) • Re-run processing

Phase 1 → Phase 1 follow-on

Therefore a Phase-1 follow on was defined in order to:

a. Improve the processor to generate also L1GT (GEO) products
b. Generate L1T in the costal areas
c. Improve browse quality
d. Fix minor bugs
e. Update QC tools accordingly

All data had been process again and



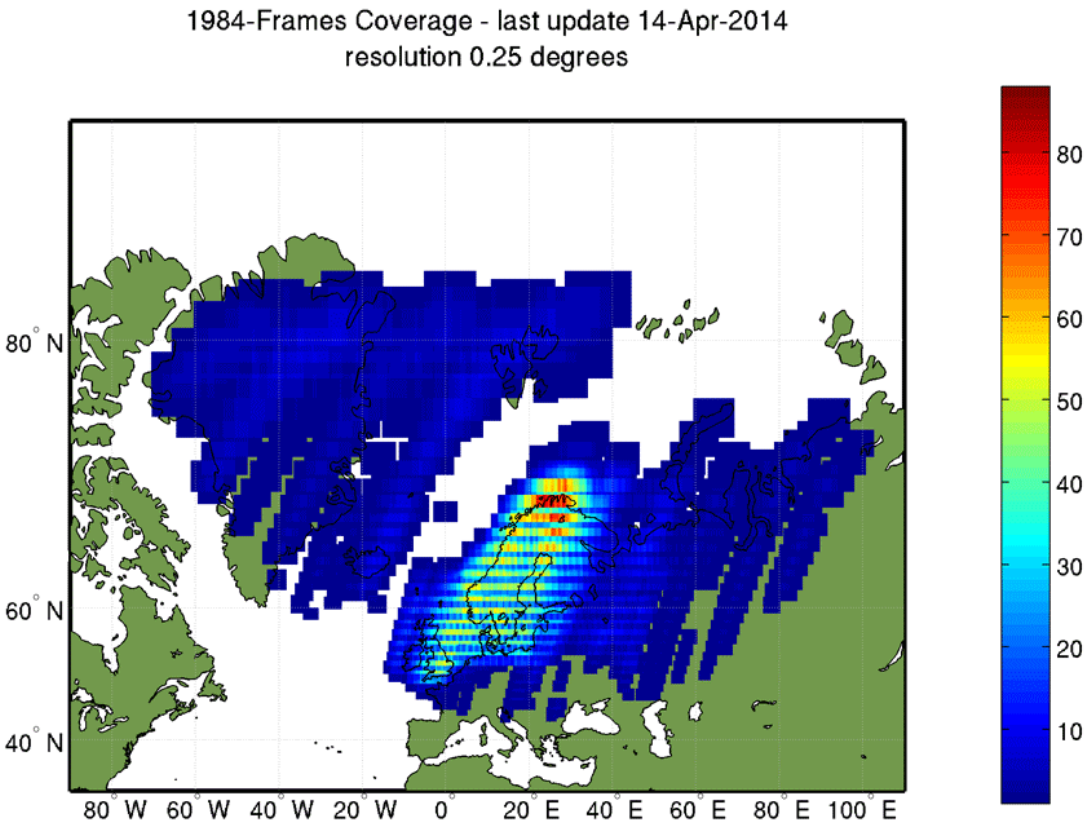
~~150,000~~ **305,000**

L1T+L1Gt scenes released

Landsat Bulk Processing
ESA Processor Achievements

1. ESA products are equivalent to USGS products, and in some cases better thanks to the "Multi-Scene Refinement " which exploits the Ground Control Points (GCPs) from neighbouring scenes allowing to:
    a. Improve geolocation accuracy;
    b. Produce scenes not generable by USGS processor or by the on-request ESA chain.
2. Aligned with the new USGS Landsat-8 product format
3. Quality Report included in each product package
4. Improved radiometric quality

End of phase 1 follow-on:
KIS Landsat TM L1 data availability per year



Data access: EARTH.ESA.INT portal

esa

Data Access | Missions

You are here Home › Missions › 3r

Overview

ESA uses its multi-mission ground
so called Third Party Missions. The
owners or operators of the mission
supported by ESA are found below.

Third Party Miss

Current Missions | Historical Mi

ALOS
The Advan
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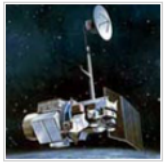
(ADEOS).
payload wi
observatio
European



Landsat
The MSS s
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the first glo
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Read more

Landsat
Landsat T
on board L
from July 1982 to present. The Landsat Enhanced Thematic Mapper (ETM) was introduced with Landsat 7. ETM data cover the visible, near-infrared, shortwave, and thermal infrared spectral bands of the electromagnetic spectrum.

Read more

esa Earth Online

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Landsat TM/ETM

Landsat Thematic Mapper (TM) is a multispectral scanning radiometer that was carried on board Landsats 4 and 5. The TM sensors have provided nearly continuous coverage from July 1982 to present. The Landsat Enhanced Thematic Mapper (ETM) was introduced with Landsat 7. ETM data cover the visible, near-infrared, shortwave, and thermal infrared spectral bands of the electromagnetic spectrum. The Landsat Project is a joint initiative of the U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA). Landsat's Global Survey Mission is to establish and execute a data acquisition strategy that ensures repetitive acquisition of observations over the Earth's land mass, coastal boundaries, and coral reefs.

Mission News

Landsat on-demand processing
24 January 2014
ESA is currently aiming at providing users with an immediate access to the Landsat higher level products as an easier and quicker alternative to the regular on-demand ordering.

Read more

New Landsat data just a few clicks away
05 September 2013
Thousands of never-before-seen data products from the US Landsat satellites acquired over 30 years have been released for online access. In addition, the newest data over Europe from the latest satellite in the series, Landsat-8, are now accessible in near-real time through a new portal hosted by ESA.
About 150,000 new products from the Landsat-5 satellite are available for direct download, free of charge. The products from the satellite's Thematic Mapper instrument were acquired by the Kiruna ground station in northern Sweden between 1983 and 2011.

Read more

Next

Data Information and Updates

Data updates:

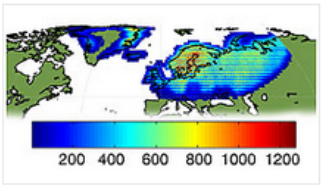
- Category-1 access to data is available. More information can be obtained at EOPI.
- The data are in CEOS format, and are of type LANDSAT.TM.SCPRNN for Landsat 7 and LANDSAT.TM.SCPRCC for Landsat 5.
- Landsat ETM+ acquisition is suspended since May 2003.
- LANDSAT.TM.SCPRNN for Landsat 7 and LANDSAT.TM.SCPRCC for Landsat 5 may be seen and downloaded from EOLI web.
- LANDSAT.TM.GTC for Landsat 5 may be seen from EOLI-SA or online dissemination portal.

Landsat 5 TM GTC product description

Landsat TM

LANDSAT 5 Thematic Mapper Geolocated Terrain Corrected Systematic processing over Kiruna (LANDSAT.TM.GTC)

This dataset contains all the Landsat 5 Thematic Mapper high-quality ortho-rectified L1T dataset over Kiruna visibility mask:



Landsat TM GTC density map

The acquired Landsat TM scene covers approximately 183 x 172.8 km. A standard full scene is nominally centred on the intersection between a path and row (the actual image centre can vary by up to 100m). A full image is composed of 6920 pixels x 5760 lines and each band requires 40 Mbytes of storage space (uncompressed).

Product Availability

Data may be viewed via the EOLI Catalogue without registration.
Data may be downloaded after fast registration via EOLI Catalogue or via the online dissemination portal.

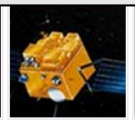
Get Data [LANDSAT.TM.GTC (archive) - Registration]

Data Set Specifications

Temporal Coverage:	April 1984 to October 2011
Spatial Coverage:	
Current Processor Version:	2.3
Data Type:	Optical/Multi Spectral Radiometry High Resolution
Processing Level:	Level 1

More Data Types On Landsat , TM , Land , Snow and Ice , Solid Earth , Water

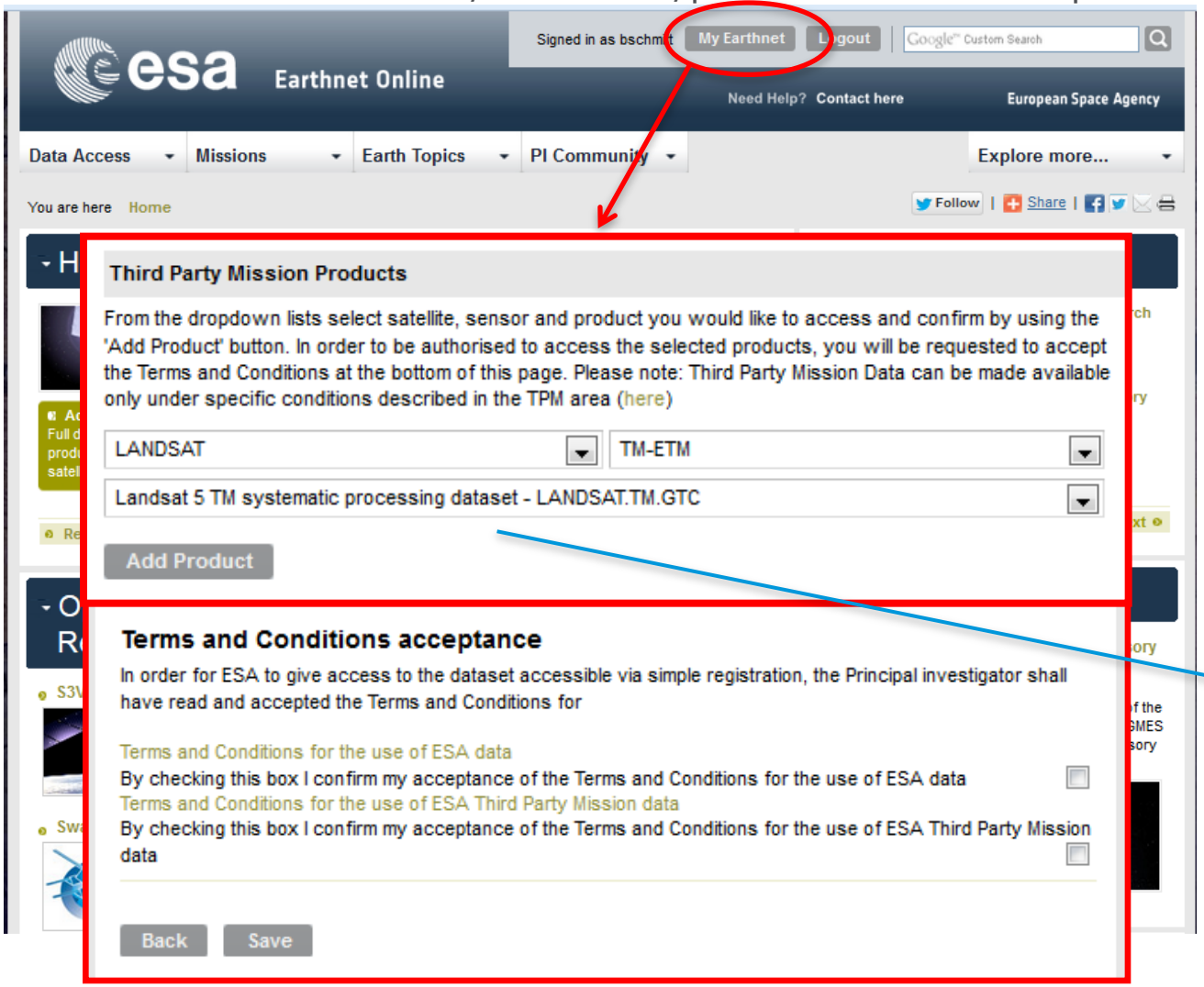
Related links


European Space Agency

Data access:
FAST Registration

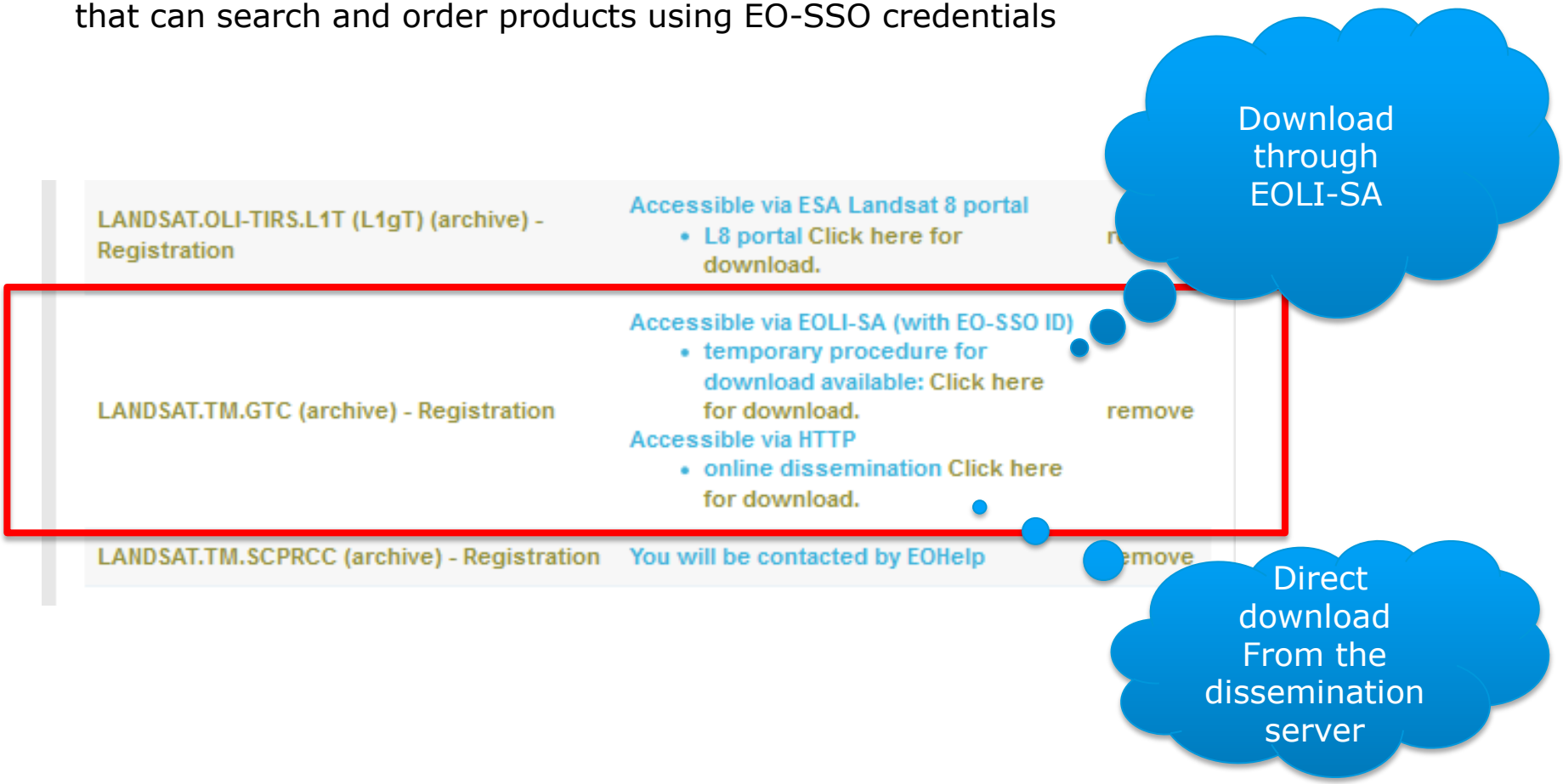
3. Through Earthnet online (**My Earthnet** or from Browse Data Products), the user requests the access to satellite/instrument/product. He shall accept the T&C.



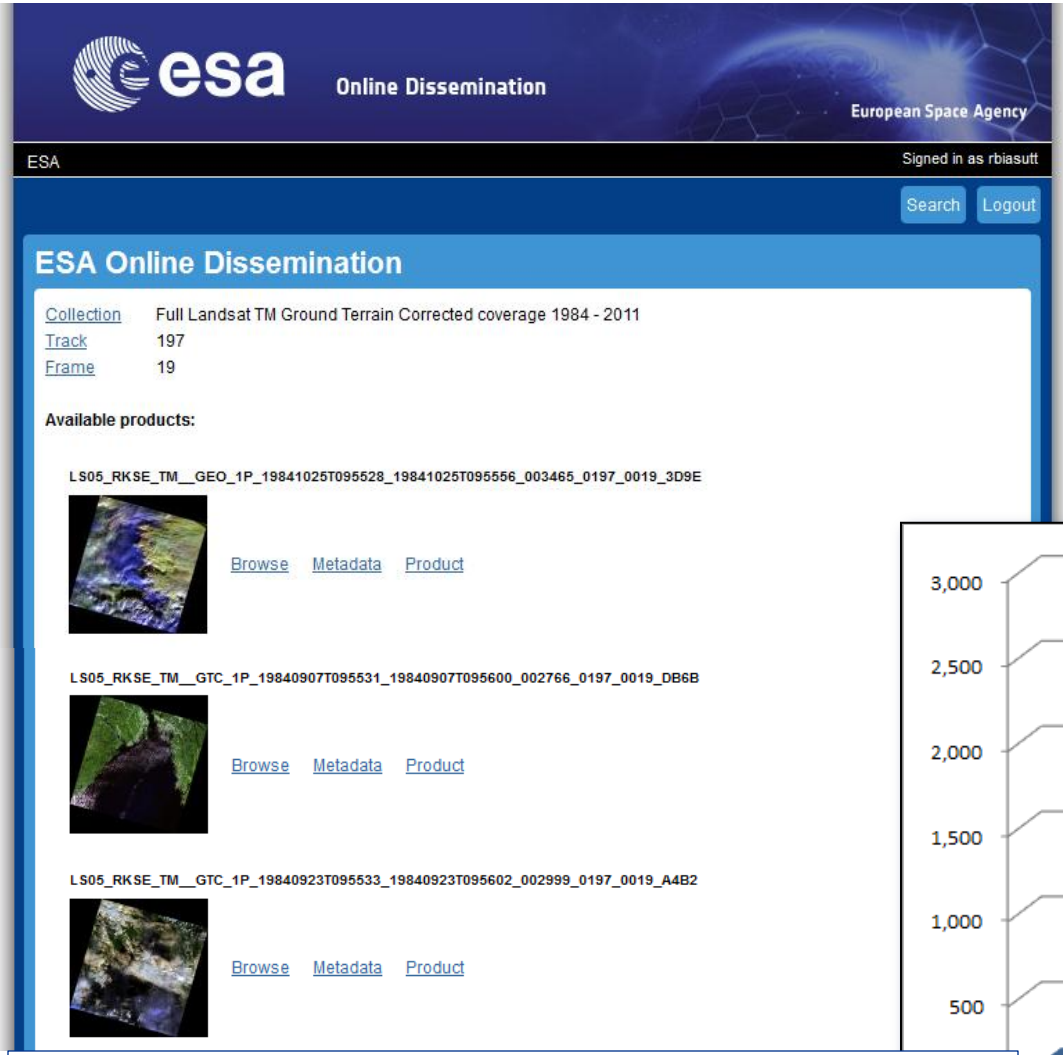
New LANDSAT.TM.GTC dataset

Data access: 2 options

4. Immediately, in the My EarthNet list, the links to access the dataset is provided to the user that can search and order products using EO-SSO credentials



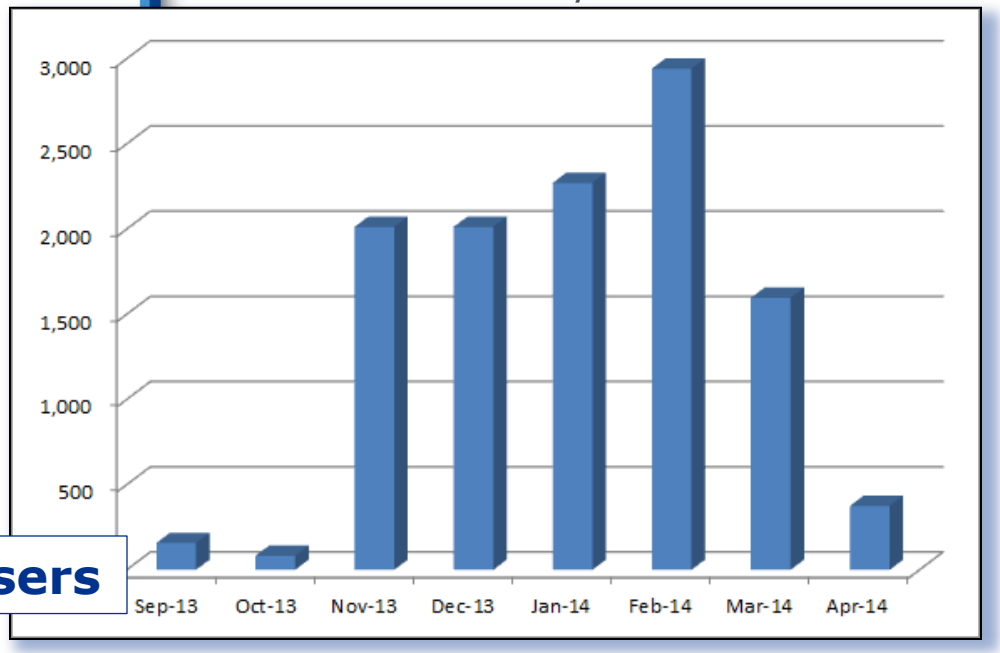
Landsat Online Dissemination: Lite Dissemination Precursor



45 TB of data

305,000 products

- Simple Navigation
  - Mission
  - Product Type
  - Sensing Date
  - Path / Row



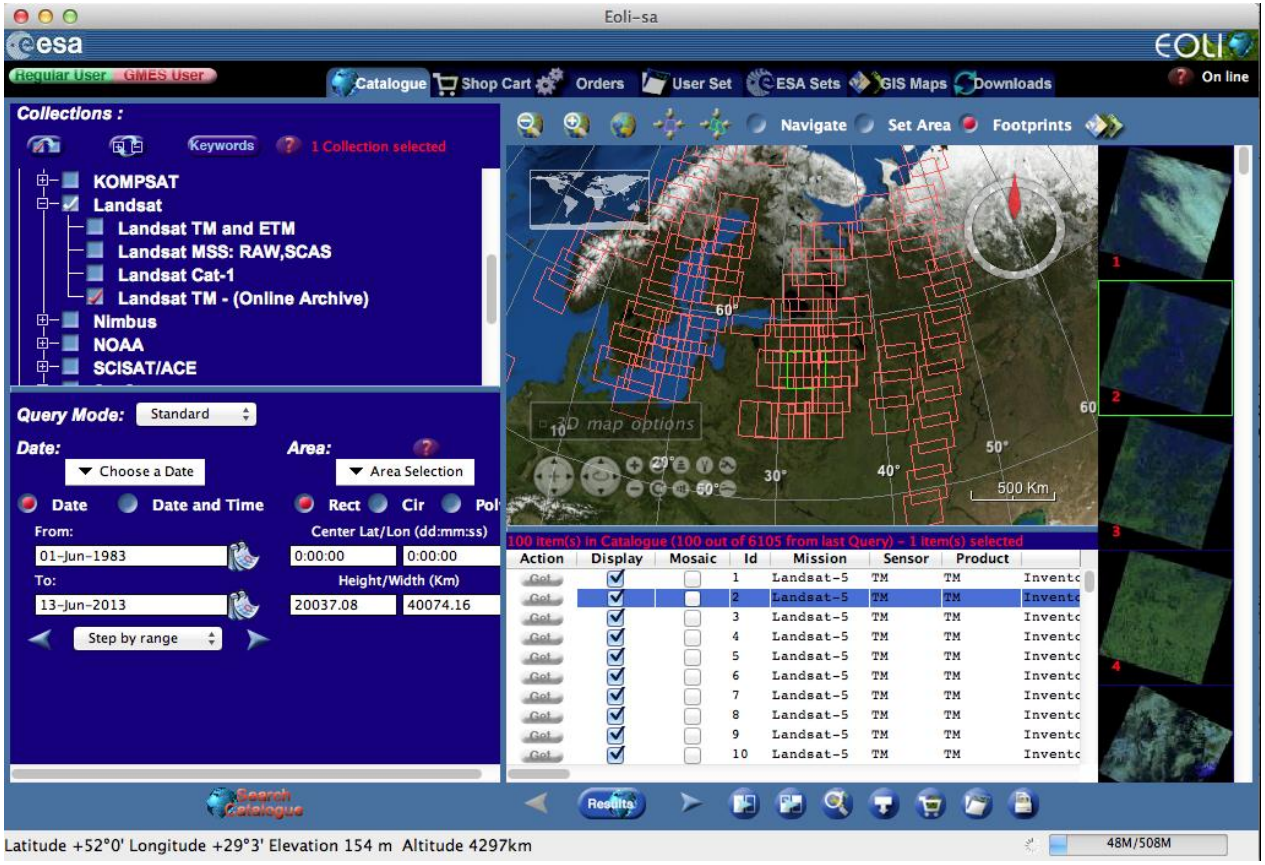
11.5 TB downloaded so far by users

Landsat Online Dissemination - EOLI

Automatic generation of index files for EOLI at data upload on the web server

EOLI

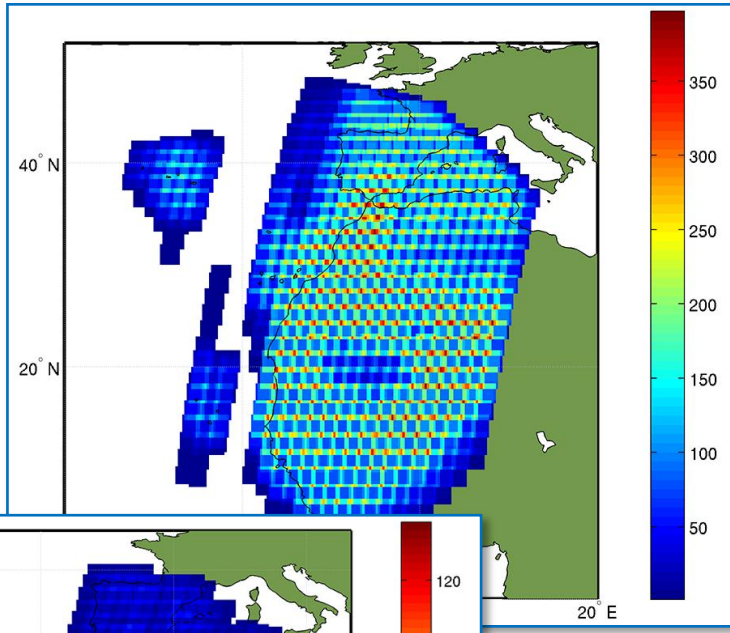
- Catalogue Search
  - Mission
  - Sensing Time
  - Geographical area (AOI)
  - Path / Row
  - Cloud Cover
- Map Navigation
  - Zoom In/Out
  - Pan Left/Right, Bottom Up
- Direct Download

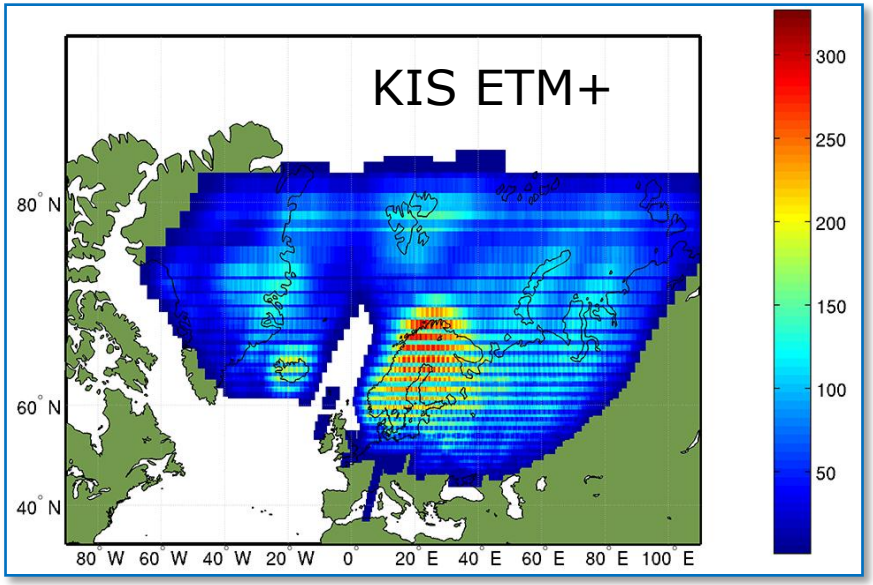


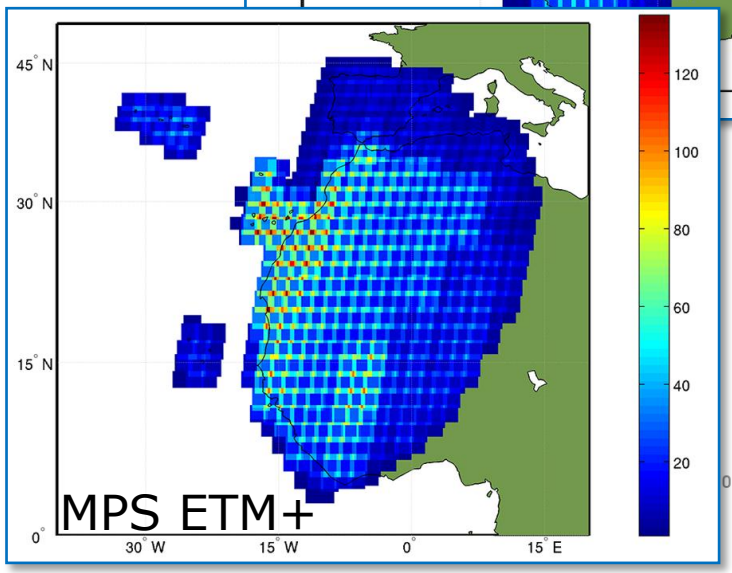
On-going activities – phase 2

Gradual availability of the full dataset (1975-2011) during 2014 as following:

- Maspalomas TM archive (on-line in **MAY**)
- Maspalomas ETM+ archive (on-line in **JUNE**)
- Kiruna ETM+ archive (on-line in **JUNE**)
- Matera TM, ETM+ archive (under consolidation)
- Kiruna, Matera, Maspalomas MSS archives (under consolidation)





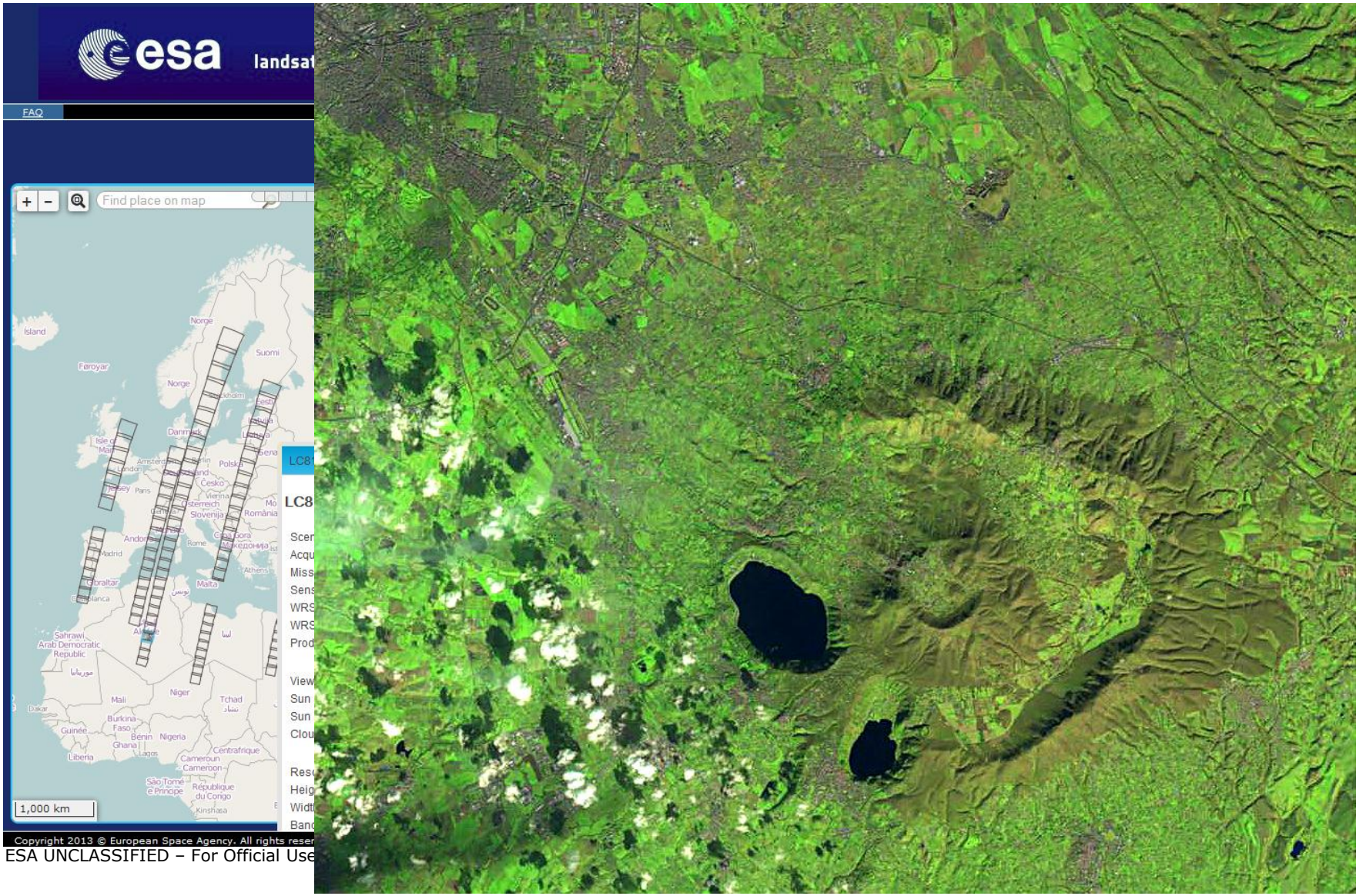


opean Space Agency

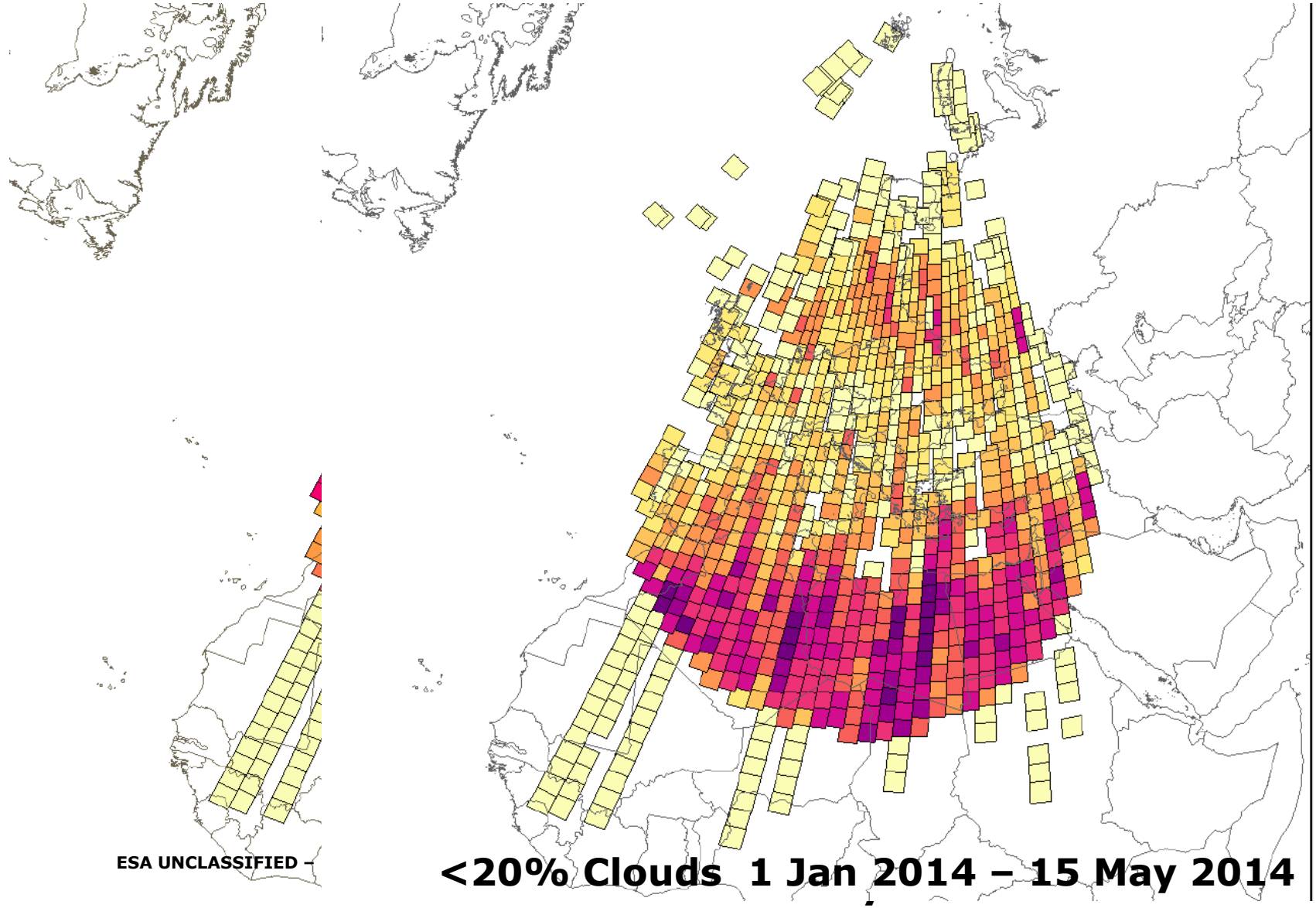
Landsat-8 at ESA

1. ESA started to acquire Landsat-8 data on August 2013 as temporary service in Neustrelitz station
2. From January 2014 Landsat-8 data are daily acquired by Matera station and, from the 1st April also from Kiruna.
3. All the data are systematically processed in NRT (~3hours) and available on-line
4. More than 4,000 scenes are available on-line at: https://landsat8portal.eo.esa.int/portal
5. In order to access to the data, only a simple fast-registration is required

Landsat-8 portal



Landsat-8 Archives



<20% Clouds 1 Jan 2014 – 15 May 2014