

mundialis

Processing Copernicus Sentinel data with GRASS GIS

Markus Neteler and Carmen Tawalika

mundialis GmbH & Co. KG

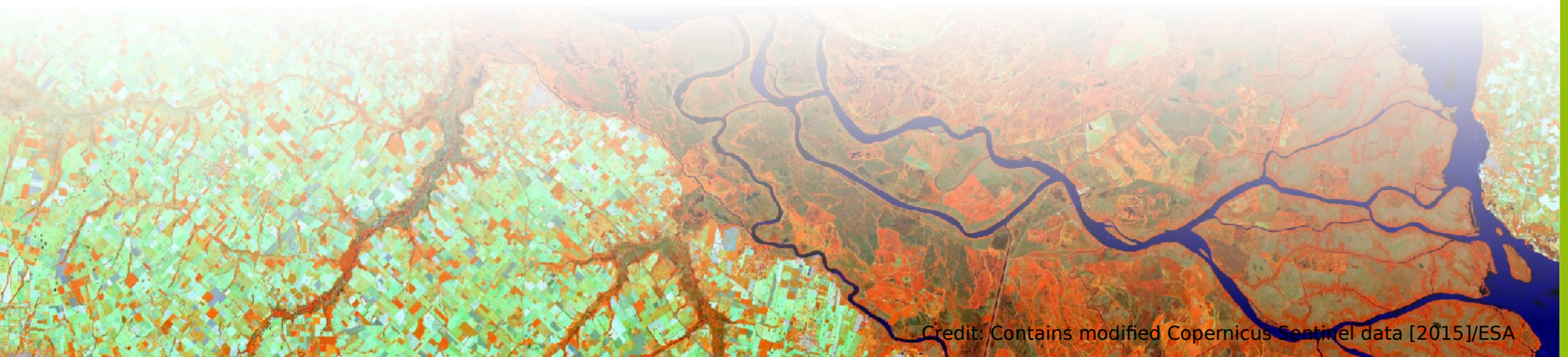
www.mundialis.de

FOSS4G 2016, Bonn, Germany

Who we are

mundialis GmbH & Co. KG

- founded in 2015 in Bonn by T. Adams, H. Paulsen and M. Neteler
- at time 6 staff
- massive GIS data processing and Earth Observation
- offers decades of experience in Open Source GIS (especially GRASS GIS development)
- gained HPC experience through processing of MODIS Land Surface Temperature : “EuroLST”
 - 15 years of gap free daily data at 250m resolution



Why frontend, backend and such for Sentinel-2?

<https://sentinel.esa.int/web/sentinel/missions/sentinel-2/mission-status>



sentinel-2

→ COLOUR VISION FOR COPERNICUS

Mission Status Report 49

Reference Period: 6-12 Aug 2016

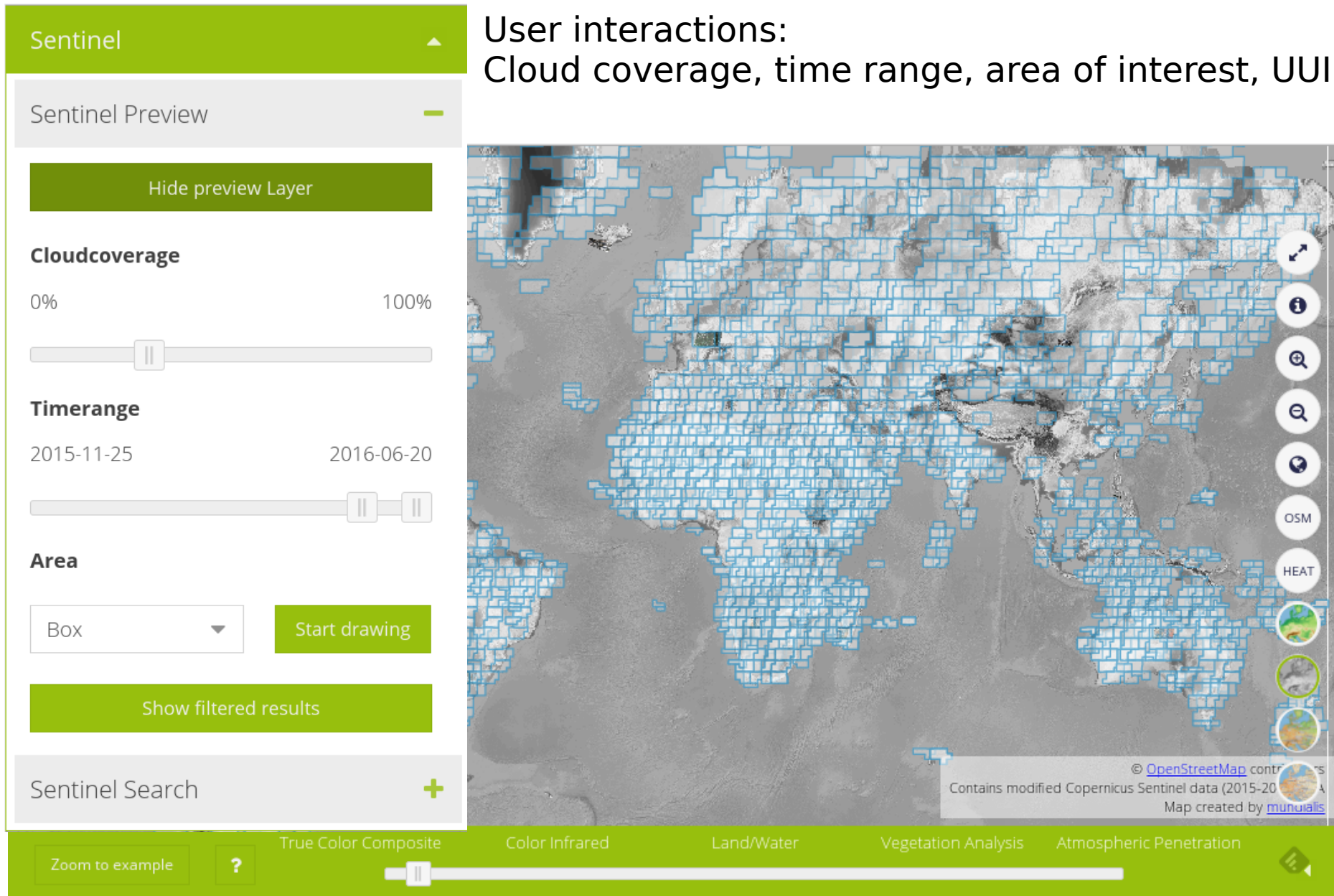
Mission Status

- Access to the routine production of Sentinel-2A ortho-rectified Level-1C products is available at <https://scihub.copernicus.eu>. The availability of products falling between the 3rd and 5th August that was only partial is almost restored, with few remaining products under recovery.
- To date, about 62 thousand Level-1C products are available for download, cumulating a total volume of 310 TB. Overall, a total volume of at least 1.21 Petabyte has been downloaded by the user community.

62,000 Sentinel-2A scenes...
each of 5GB size (in average)

The frontend: Web interface

User interactions:
Cloud coverage, time range, area of interest, UUID



The screenshot displays the web interface for monitoring Sentinel satellite data. On the left, a sidebar contains several control panels:

- Sentinel**: A green header with an upward arrow.
- Sentinel Preview**: A grey header with a green minus sign.
- Hide preview Layer**: A green button.
- Cloudcoverage**: A slider ranging from 0% to 100%.
- Timerange**: A date range from 2015-11-25 to 2016-06-20 with a slider.
- Area**: A dropdown menu set to 'Box' and a green 'Start drawing' button.
- Show filtered results**: A green button.
- Sentinel Search**: A grey header with a green plus sign.

The main map area shows a satellite image of Africa with a grid of blue-outlined polygons representing cloud coverage. On the right side of the map, there is a vertical toolbar with icons for zooming, panning, and switching between different data layers (OSM, HEAT, and various Sentinel data visualizations).

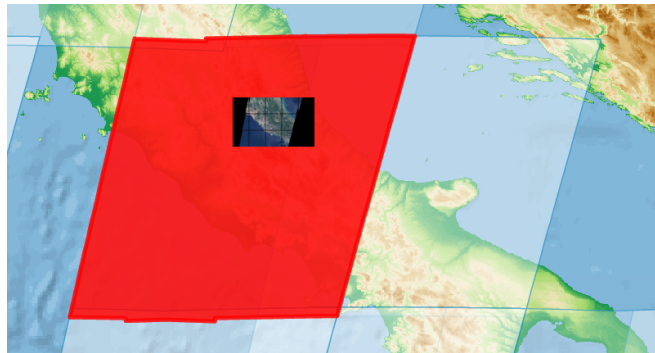
At the bottom, there is a green bar with a 'Zoom to example' button, a help icon (?), and a series of tabs for different data visualizations: 'True Color Composite', 'Color Infrared', 'Land/Water', 'Vegetation Analysis', and 'Atmospheric Penetration'. A slider is positioned below these tabs.

Text at the bottom right of the map area reads: "© OpenStreetMap contributors Contains modified Copernicus Sentinel data (2015-2016) Map created by mundialis".

Online available at: <http://maps.mundialis.de/>

The frontend: Preview and ordering of processed Sentinel-2 scenes (atmospherically corrected)

Color composites, Land/Water layer, Vegetation Indices,... more to come!



Cloudcoverage

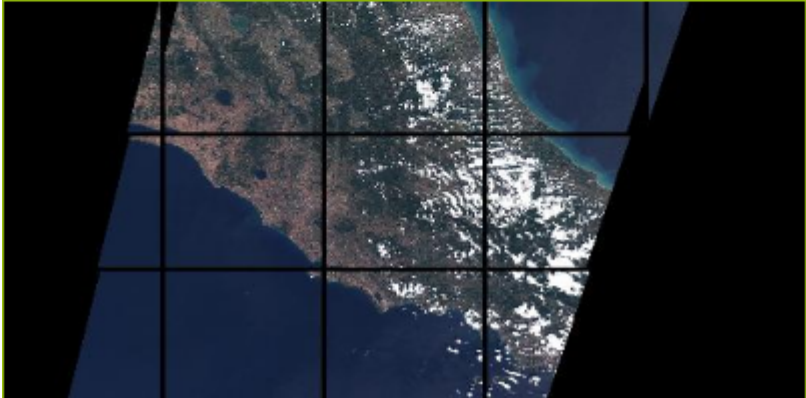
0.1%

3.92%

Name	Value
Name	S2A_OPER_PRD_MSIL1C_PDMC_20160825T1...
UUID	9b0bf47c-b6ff-4be1-abf5-71439d9e1016
Size	6.30 GB
Date	2016-08-24T08:06:07Z

Download raw data

Order processed scene



Order processed scene

Here you can order one processed scene. This will be the scene you selected before. Choose the type of processing below. If you want more scenes processed or different types of processing, please contact us at info@mundialis.de

Check data availability

Your Name*:

Nicolaus Copernicus

Your Email*:

nicolaus@mundialis.de

Your Company:

mundialis

Process*:

Composite

Subprocess*:

True Color Composite

Color Infrared Composite

Land/Water Composite

Vegetation Analysis Composite

Atmospheric Penetration Composite

Info

job successfully sent.

This will take a few hours.

You will receive an email when processing is done.

OK

Pre- and postearthquake overpass

The software behind our Sentinel-2 processing chain



Bringing advanced geospatial technologies to the world



Full Open Source software stack





- “Bare Metal” system in Frankfurt
- Google + Amazon Cloud Platform
- CloudSigma IaaS

SUSE Cloud Openstack

Testproject12

Project

Compute

Overview

Instances

Volumes

Images

Access & Security

Network

Overview

Limit Summary

Instances

Used 367 of No Limit

Volumes

Used 0 of No Limit

Usage Summary

Select a period of time to query its usage:

From: 2016-04-01 To: 2016-04-20 Submit

The date should be

Active Instances: 2 Active RAM: 8GB This Period's VCPU-Hours:

Usage

Instance Name	VCPUus
RUViewTEST	2
TestInstance001	2

Displaying 2 items

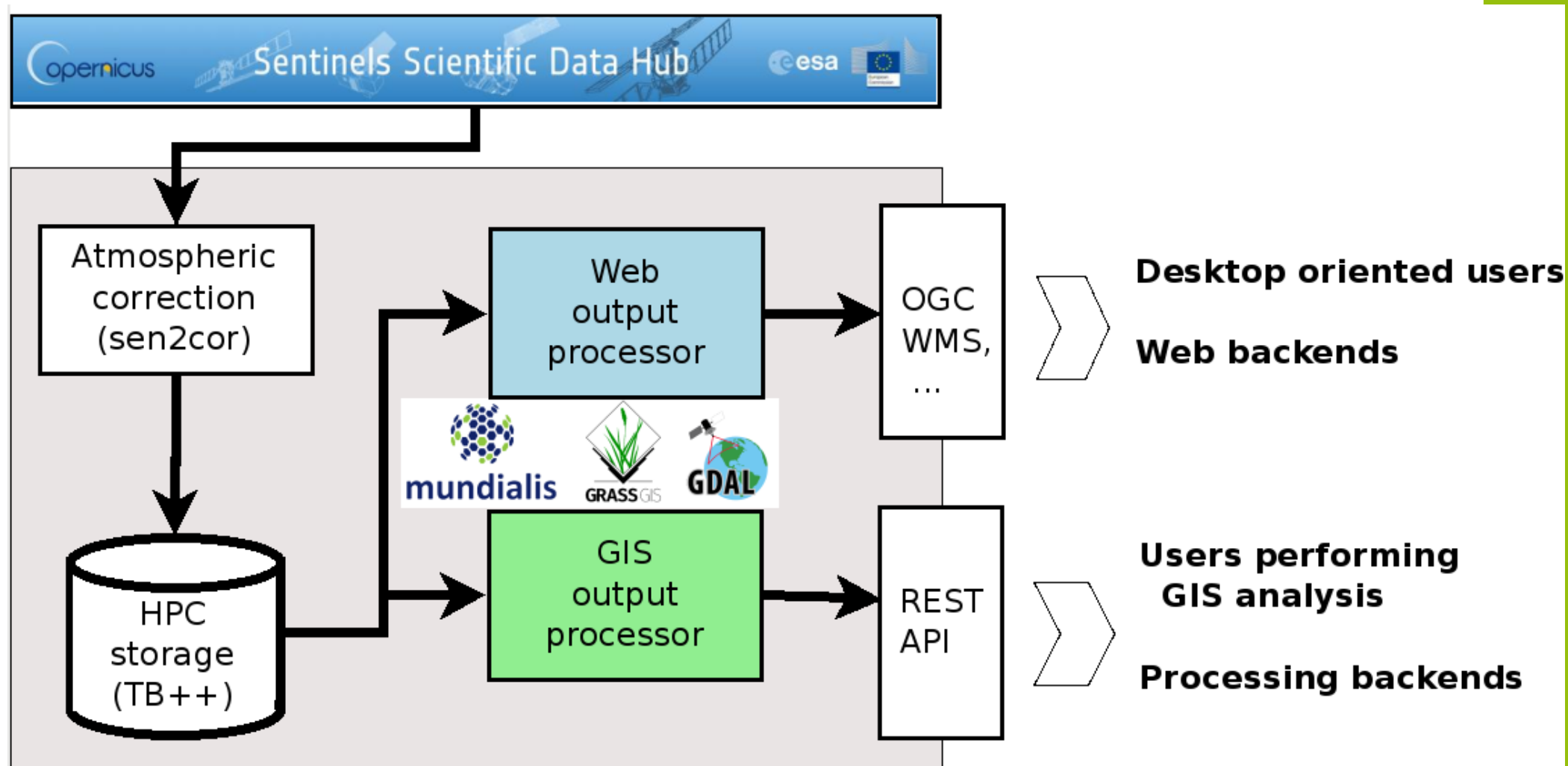
• C

Take

he data!

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The backend: cloud computing



Data size:

Input data: S2 scene = 5-7 GB compressed

Prepare for up to 250GB of temporary data per scene

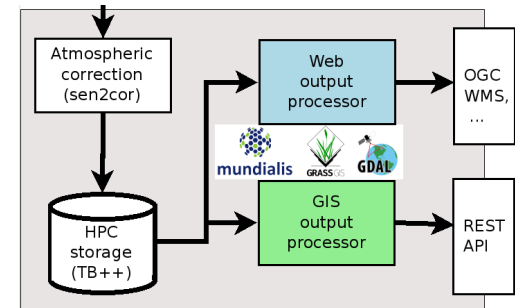
GRASS GIS processing of Sentinel-2 data

Processing steps 1/2

- **atmospheric correction** step with “sen2cor”
 - Issues: sen2cor sometimes fails
 - Solution: sit & wait (next sen2cor version?)
- **Mosaic** of tiles with highest resolution using GDAL VRT
 - Issues: different UTM zones may be mixed in one S2 scene
 - Solution: use r.import with reprojection on the fly
- **Import** into GRASS GIS
- Next: Web or GIS processor...

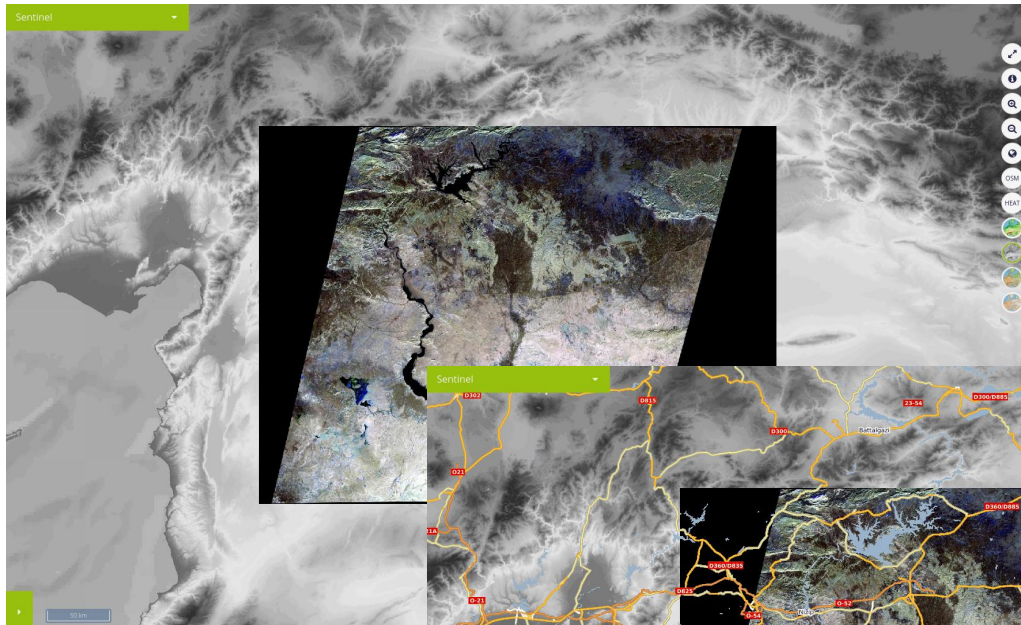
GRASS GIS processing of Sentinel-2 data

Processing steps 2/2

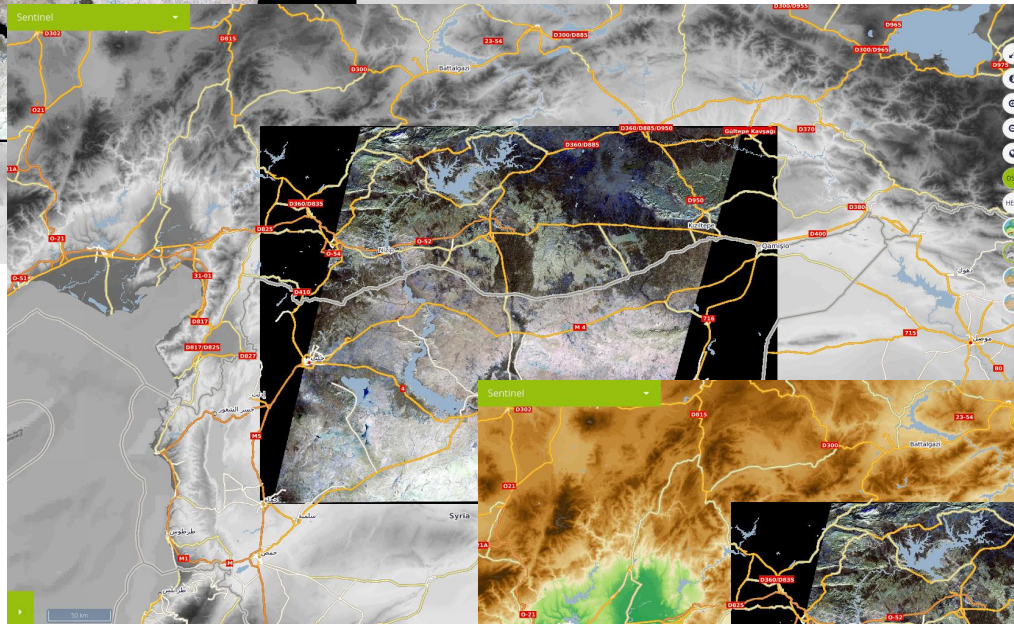


- **Web processor:** target is optimal data reduction
 - rescale to 8 bits with # operator of r.mapcalc
 - Remove black border with MASK
 - Generate color composites or vegetation indices
 - Export to compressed GeoTIFF
- **GIS processor:** target is best quality, no reduction
 - Process scene classification layer
 - Export to multilayer GeoTIFF
- **Placename identification** with OSM nominatim

The frontend: Visualising the results

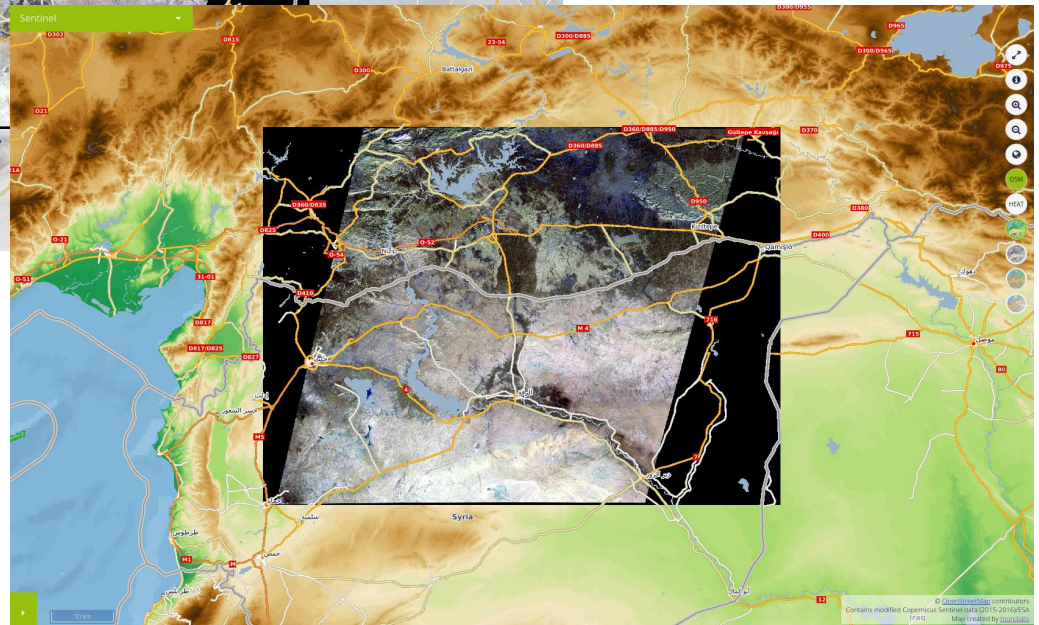


Sentinel-2 scene over shaded terrain

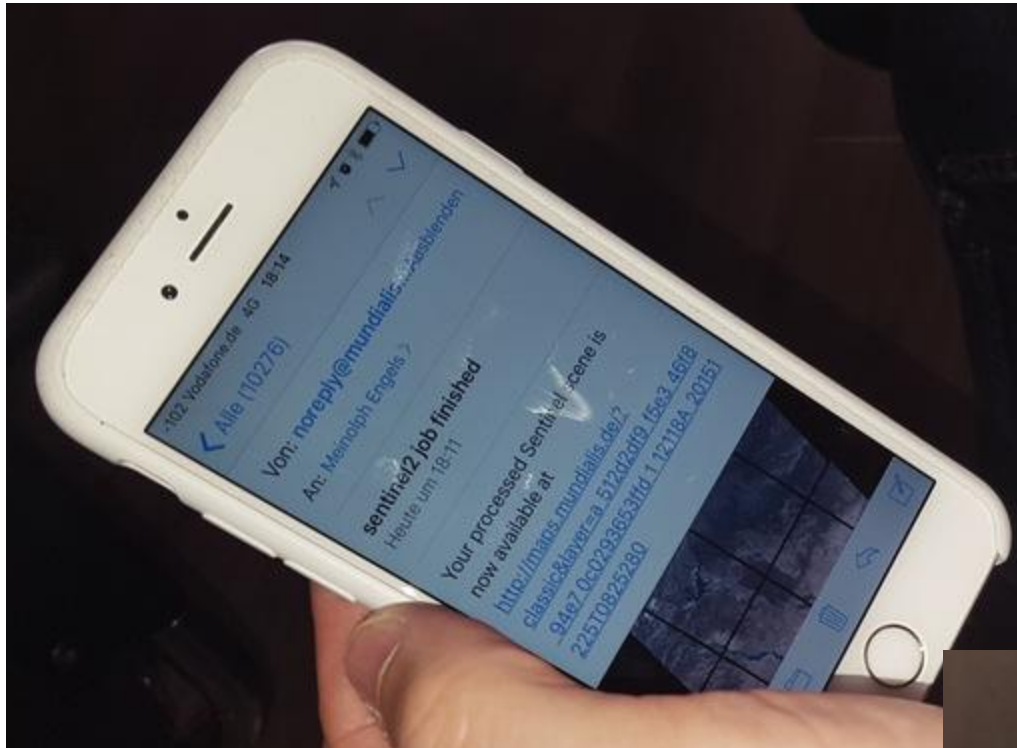


Sentinel-2 scene with OSM streets

Sentinel-2 scene over elevation model etc.



Web client on mobile devices via Web



Visualization of the ordered Sentinel scene on the mobile device via Web

Responsive design
= mobile ready

User notification: “Your processed Sentinel scene is now available at ... URL ...”



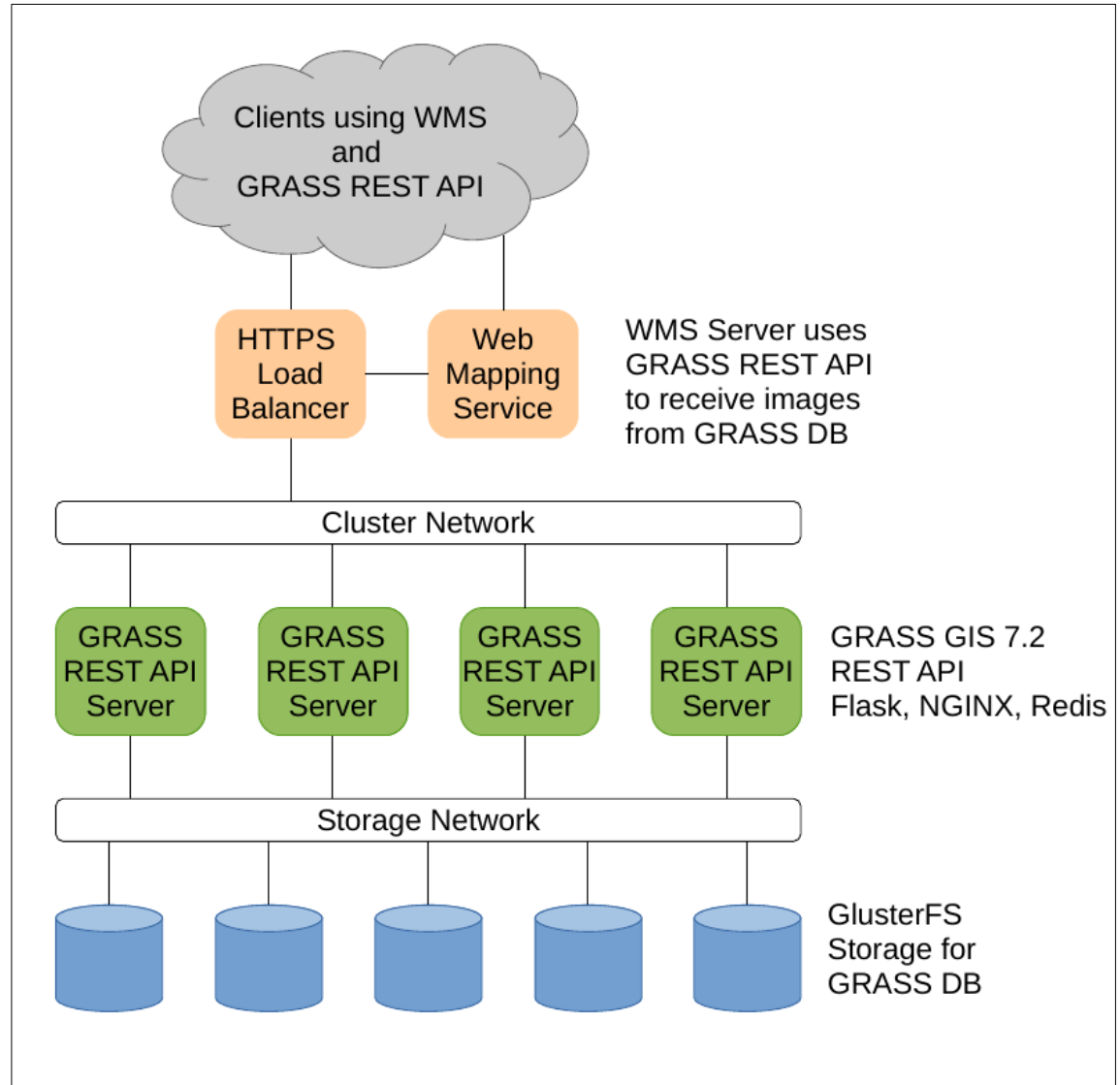
New: GRaaS - REST API implementation for easy deployment of processing jobs

Purpose

- Horizontally **scalable** processing, analysis and visualization service
- **REST API** to perform
 - Massive parallel processing
 - Resources and user management

Deployment:

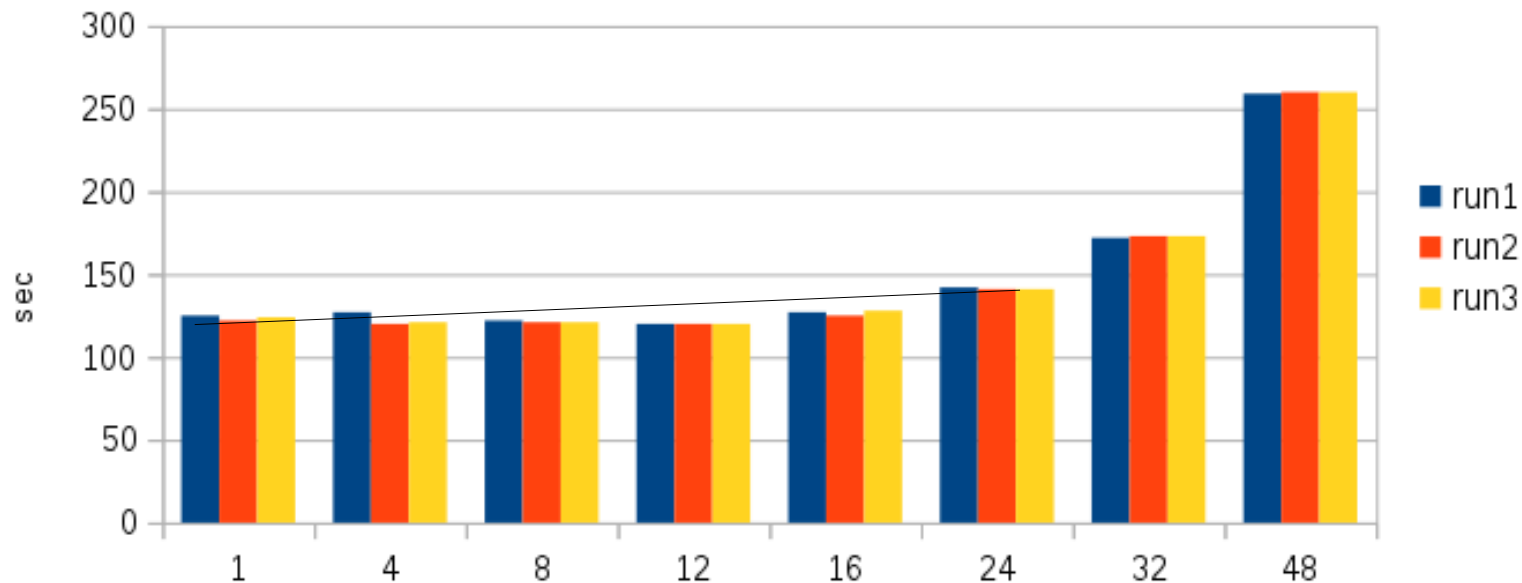
currently on AWS + CloudSigma
Scope: **European Cloud**



New: GRaaS - REST API implementation for easy deployment of processing jobs

GRaaS Scalability

Number of CPUs versus seconds



Tests on Google cloud

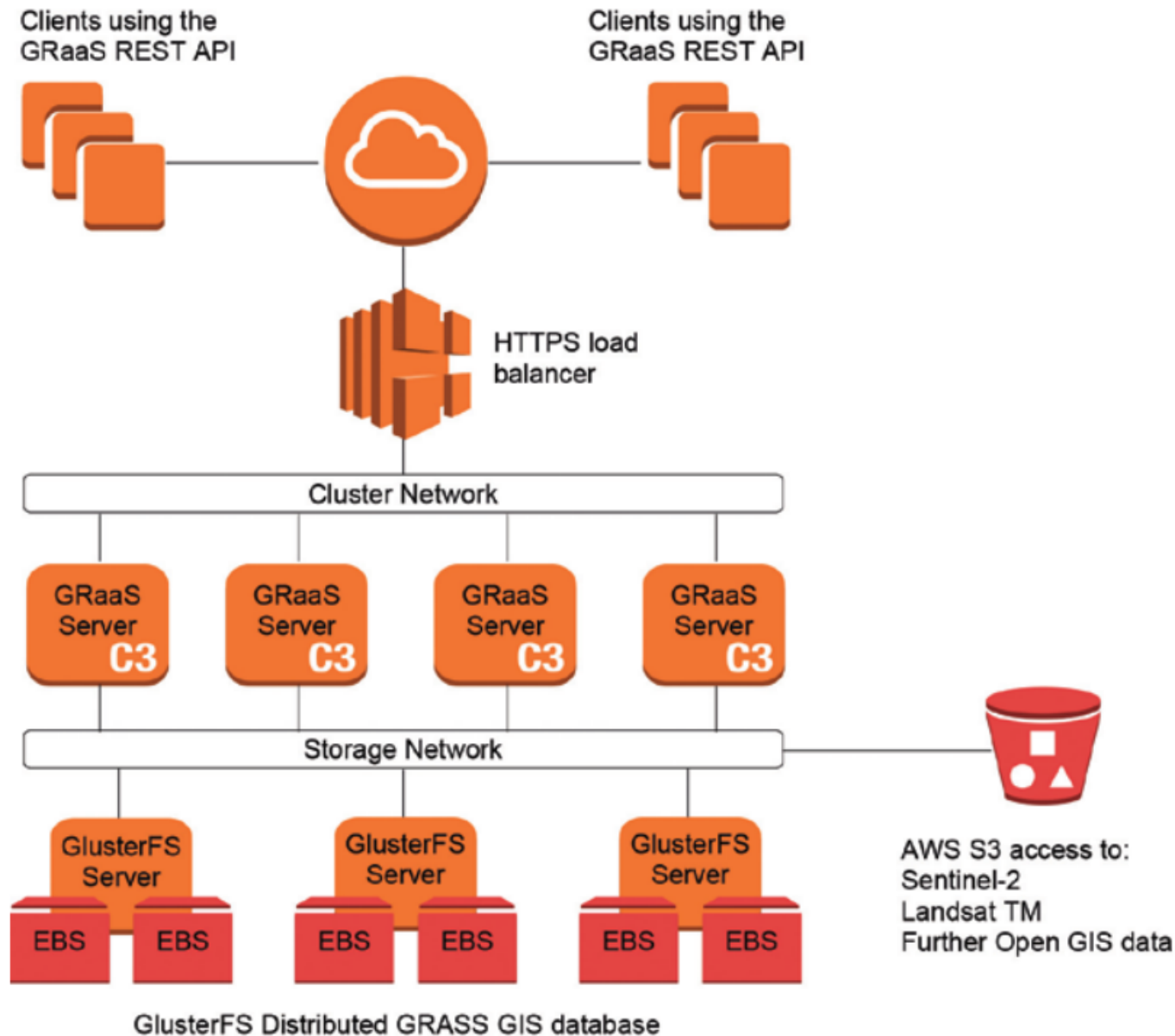
↑ CPUs
Caching effects
(faster)

↑
I/O saturation
(... add more
Nodes = \$\$)

Developed by Sören Gebbert

GRaaS - REST API implementation

Amazon AWS cloud solution example



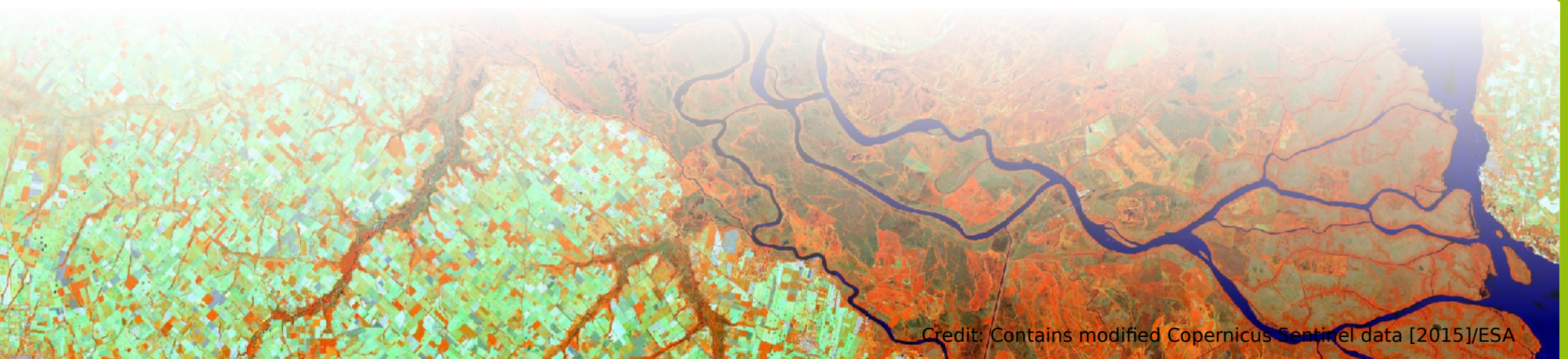
Use cases

- Time series analysis e.g. in agriculture: **trends and anomalies**
- Using the new temporal algebra implemented in GRASS GIS **data along trajectories** can be extracted (e.g. GPS track over a time series)
- Generating input for **predictive models**



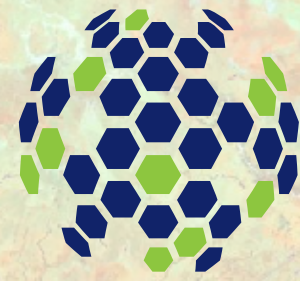
Conclusions

- For us GIS & Earth Observation belong together!
- Thanks to GDAL, using Sentinel-2 data in GRASS GIS is easy
- Thanks to the efficient memory management in GRASS GIS the processing of massive data is very efficient
- New REST API: huge potential for distributed computing with clear interface, user and resources management



Credit: Contains modified Copernicus Sentinel data [2015]/ESA

Earth as art...



mundialis

...thank you

Dr. Markus Neteler
mundialis GmbH & Co. KG
Kölnstraße 99
53111 Bonn, Germany

Email: neteler@mundialis.de
Web: <http://www.mundialis.de>

