



Copernicus Sentinel-2 Global Mosaic

Copernicus Global Land User Conference

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GeoVille



SINERGISE


BROCKMANN
CONSULT GMBH

 Copernicus
Europe's eyes on Earth



Objective and scope

- Generating composites of Sentinel-2 L2A surface reflectance data on global scale
- Analysis-ready data for direct and convenient usage
- Use cases include but are not limited to REDD+ activities, i.e. monitoring land use and deforestation
- Expert support
- State-of-the art service provision



Positioning within CLMS

Copernicus is a European system for monitoring the Earth. Data is collected by different sources, including Earth observation satellites and in-situ sensors. The data is processed and provides reliable and up-to-date information in six thematic areas: land, marine, atmosphere, climate change, emergency management and security. The land theme is divided into four main components:

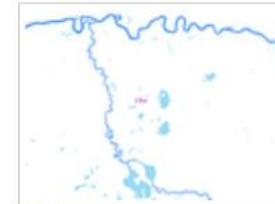
- Global**
provides a series of bio-geophysical products on the status and evolution of the land surface at global scale at mid and low spatial resolution
- Pan-European**
provides information about the land cover and land use (LC/LU), land cover and land use changes and land cover characteristics
- Local**
focuses on different hotspots, i.e. areas that are prone to specific environmental challenges and problems
- Imagery and reference data**
Satellite imagery forms the input for the creation of Copernicus land products. In order to ensure an efficient and effective use of satellite data the Copernicus land monitoring service needs access to in-situ data

You are here: [Home](#) / Imagery and reference data

Imagery and reference data



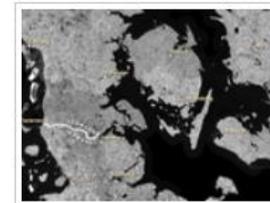
EU-DEM



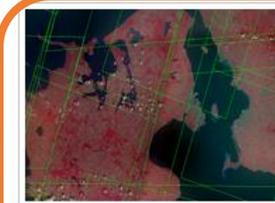
EU-Hydro



LUCAS



European Image Mosaics



Global Image Mosaics

<https://land.copernicus.eu/imagery-in-situ/global-image-mosaics>

www.s2gm.eu Copernicus Sentinel-2 Global Mosaic

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Copernicus Europe's eyes on Earth



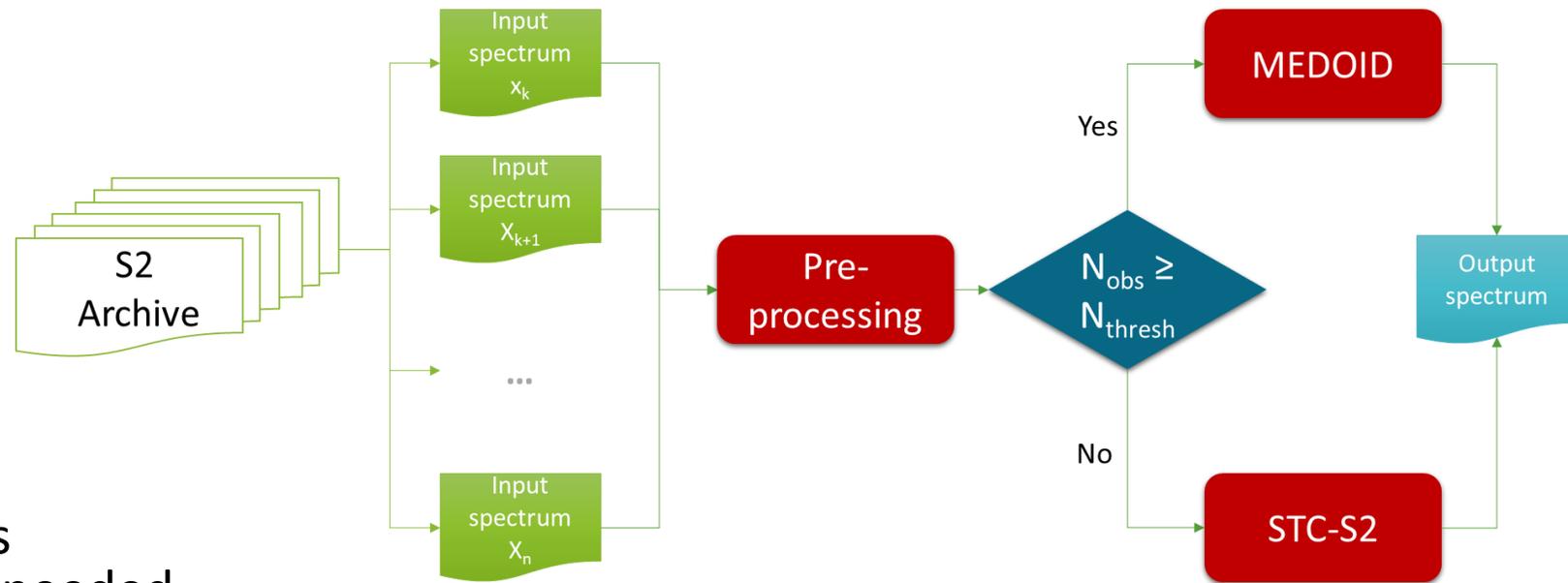
Offer in a nutshell

- **User-tailored mosaics and composites** of Sentinel-2 L2A, best representative pixel
- **European coverage**, global coverage expected in the coming months, conditional to availability of Sentinel-2 L2A
- Temporal coverage, currently **since April 2017**
- **Different compositing periods** comprising 1-day, 10-day, month, quarter, year
- 3 Sentinel-2 **native spatial resolutions** 10, 20, and 60m, resampling applied if required
- **Near real-time** product availability, typically few days after observation



Two Compositing Algorithms

- **Short-term composite < 4 valid observations:**
Decision-tree approach evaluating scene classification, similar to Landsat WELD
- **MEDOID ≥ 4 observations:**
Multidimensional median on the entire spectrum, statistical approach
- **Rigid pre-processing**
to eliminate invalid observations
- Generating mosaics pixel by pixel from **original observations, no spectrum averaging or other image blending** is applied
- **Spatial resampling** of bands to non-native resolutions if needed

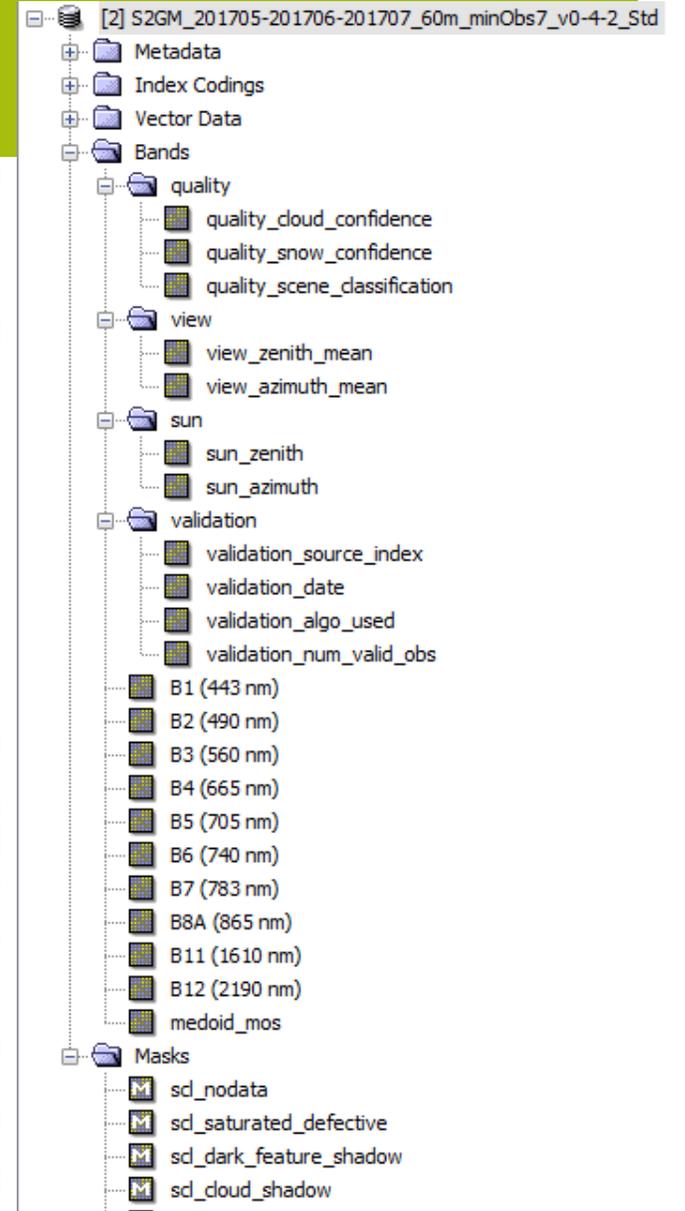
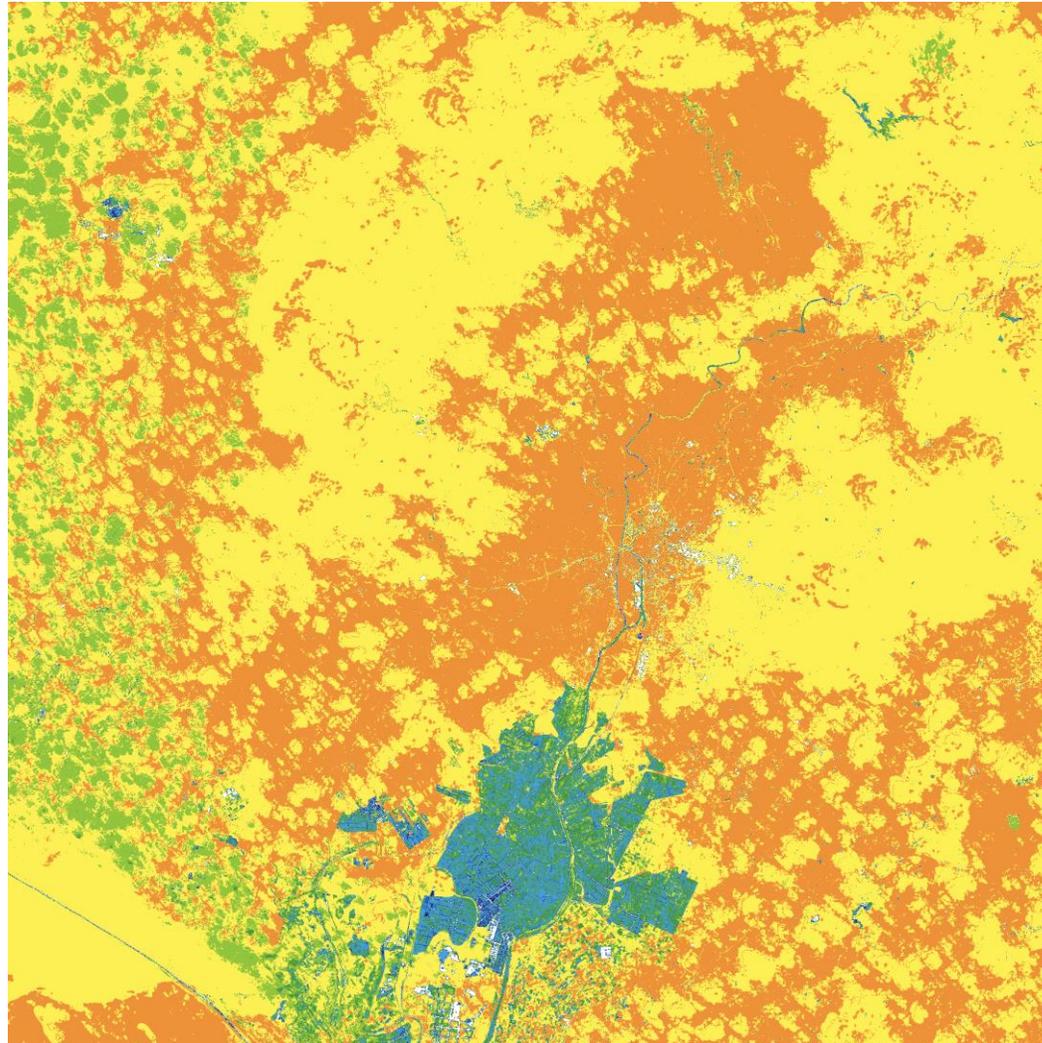
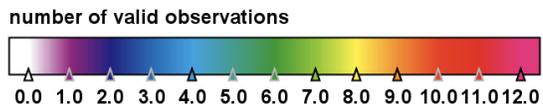




60m, Annual mosaic 2017

Composite Algorithm - Sevilla

- 1) Sevilla
3-monthly composite
May/ June/ July 2017
60m spatial resolution
- 2) Mask – Medoid
Algorithm
- 3) Number of valid
observations



Mosaic generation and distribution approach

- Sentinel-2 Global Mosaic allows users to **tailor products** with respect to
 - Compositing period (day, 10-day, month, quarter, year)
 - Area of interest
 - File format (GeoTIFF, JP2, NetCDF)
 - Spatial resolution (10, 20, 60m)
 - Coordinate system (WGS84, UTM)
 - Bands to be included
 - Auxiliary information (AOT, geometry, scene classification, etc.)
- Sentinel-2 data volumes and permutations of options make **traditional approach** of full-archive processing, storage, and distribution **prohibitive**

Mosaic Hub

- **On-request** generation of tailored mosaics leveraging on cloud resources and free availability of S-2 L2A
- **Time-series** feature
- Mosaic Hub as **interactive user interface**
- Website and desktop application with convenient **download manager**

Tailoring & Requesting

- Mosaic specification is dialogue-based

Order panel

Data format Choose data format options

Band selection Choose bands for your mosaic

Order Enter order information

Confirm order Confirm order details

Image Format

GeoTiff JP2 NetCDF

Resolution

10 20 60

Coordinate System

WGS 84 UTM

Next →

✕ Cancel

Mosaic Hub

Compositing Period 8 - 2018

Year Quarter **Month** Ten days Day

2018 1 2 3 4 5 6 7 8 9 10 11 12

2017 1 2 3 4 5 6 7 8 9 10 11 12

Area Selection Area of Interest Selected

Manual draw File upload Country selection Continent selection WKT

Area Of Interest selected ✓

PREPARE DOWNLOAD

Download

- User area lists all requests
- Download manager ensures convenient and robust distribution

Navigation: Mosaic Downloader | User Manual | About S2GM

Mosaic downloader

Waiting for downloads

Mosaics download directory: G:\EOData\related\S2GM\s2gm_hub

▶ SLOVENIA_DEMO

▼ ISPRA_DEMO

1/1 tiles generated

Open mosaic in file explorer

Mosaic ordered on 25 September 2018 14:44

Something wrong?

Mosaic tiles

1 Date of creation: 25 September 2018 13:44

100%

Navigation: Home | Mosaic Hub | Time Series | User Area | Mosaic Downloader | User Manual | About S2GM | Marco Peters

< To Mosaic Hub

Orders

Refresh Orders

Showing 1 - 10 of 27 Orders

Search...

Name	Image Format	Resolution	Coordinate System	Created	Mosaic Start Date	Compositing Period	Status	More
SLOVENIA_DEMO	NetCDF	60	UTM	25 September 2018 14:53	01 April 2017	Quarter	Processing	
ISPRA_DEMO	GeoTiff	10	UTM	25 September 2018 14:44	01 August 2018	Month	Processing	

Analysis Ready products

- **Three file formats:** jp2, GeoTIFF, NetCDF
- **INSPIRE-compliant**
- Accompanied by extensive **metadata** (xml, json, NetCDF Metadata)
- **SNAP reader** about to be released
- **Example:**
Exploit stack of S2GM products with Python's xarray

```
localhost:8888/notebooks/S2GM_read_NetCDF.ipynb 120% ... Suchen
jupyter S2GM_read_NetCDF Last Checkpoint: 15.10.2018 (unsaved changes)
File Edit View Insert Cell Kernel Widgets Help
Code
In [7]: import xarray as xr
import glob
import cartopy.crs as ccrs
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings('ignore')

In [8]: data = xr.open_mfdataset(glob.glob("S2GM*/test*/*.nc"))

In [9]: data

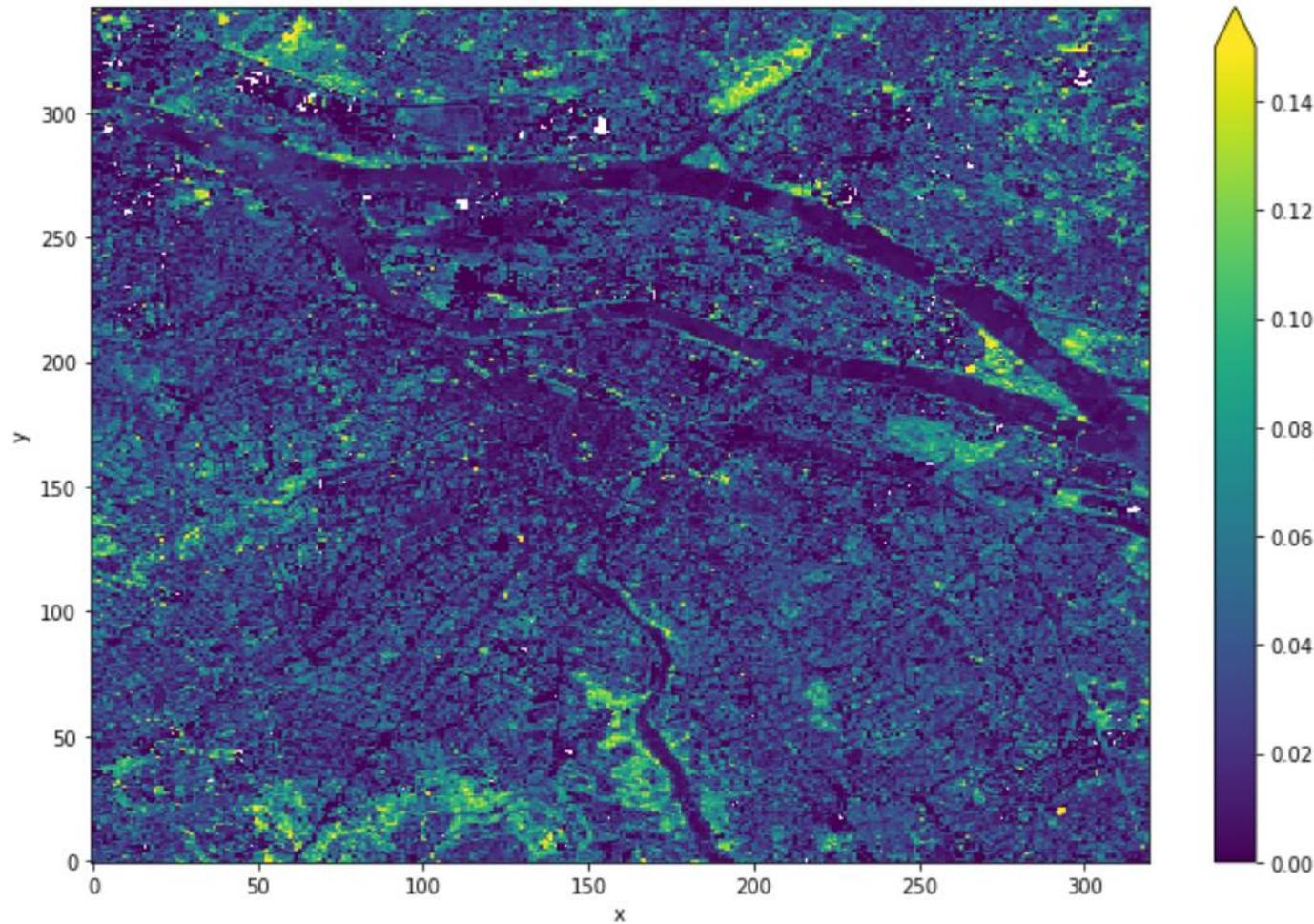
Out[9]: <xarray.Dataset>
Dimensions: (bnds: 2, time: 3, x: 320, y: 343)
Coordinates:
  lat      (y, x) float32 47.1861 47.1861 47.1861 47.1861 47.1861 ...
  lon      (y, x) float32 -1.59392 -1.59365 -1.59339 -1.59312 -1.59286 ...
  * time    (time) datetime64[ns] 2018-03-16T12:00:00 2018-04-16 ...
Dimensions without coordinates: bnds, x, y
Data variables:
  B02      (time, y, x) float32 dask.array<shape=(3, 343, 320), chunksize=(1, 343, 320)>
  B03      (time, y, x) float32 dask.array<shape=(3, 343, 320), chunksize=(1, 343, 320)>
  B08      (time, y, x) float32 dask.array<shape=(3, 343, 320), chunksize=(1, 343, 320)>
  B04      (time, y, x) float32 dask.array<shape=(3, 343, 320), chunksize=(1, 343, 320)>
  time_bnds (time, bnds) datetime64[ns] dask.array<shape=(3, 2), chunksize=(1, 2)>
Attributes:
  id:          S2GM_M20_20180301_20180331_Test_20m_03201...
  title:       Copernicus Sentinel-2 Mosaic
```

Analysis Ready products

- Readily exploit image time-series of monthly composites

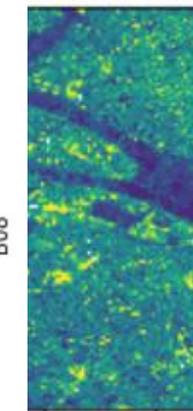
```
In [16]: std = data.B08.std(dim="time").plot(figsize=(12,8),vmax = 0.15)
```

In
Out

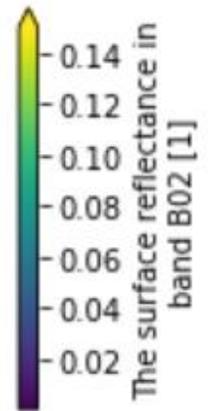


```
time")
```

6T12:00:00



1.54 -1.52
longitude [east]



Time-series tool

- Generation of time-series at arbitrary locations
- Single pixels or 3x3
- Direct inspection of data in the Mosaic Hub
- Download as csv for further analysis

Timeseries data

01-01-2018 29-08-2018

Data for time period: 11.04.2018 - 21.04.2018

Longitude: -3.925038090199315

Latitude: 39.90578625467069

Source tile Identifier

S2A_OPER_MSI_L2A_TL_MPS_20180414T112338_A014677_T30TVK_N02.07

Bands	Quality bands
B01: 0.022600000000000002	medoid_mos: 6.553500000000000005
B02: 0.023200000000000002	quality_aot: 0.135
B03: 0.0606	quality_cloud_confidence: 0
B04: 0.023	quality_scene_classification: 4
B05: 0.1109	quality_snow_confidence: 0
B06: 0.4292	sun_azimuth: 149.84
B07: 0.5	sun_zenith: 33.78
B08: 0.51450000000000001	valid_obs: 3
B11: 0.19440000000000002	view_azimuth_mean: 113.17
B12: 0.0882	view_zenith_mean: 7.66
B8A: 0.52670000000000001	

Close Export as CSV

Timeseries data

01-01-2018 01-08-2018

Data for time period: 01.01.2018 - 01.02.2018

Longitude: -3.925450534583247

Latitude: 39.90600820718234

Source tile Identifier

S2B_USER_MSI_L2A_TL_MPS_20180119T131401_A004553_T30TVK_N02.06

Bands	Quality bands
B01: 0.0013000000000000002	medoid_mos: 0.061700000000000005
B02: 0.029500000000000002	quality_aot: 0.135
B03: 0.0632	quality_cloud_confidence: 0
B04: 0.0589	quality_scene_classification: 4
B05: 0.1217	quality_snow_confidence: 0
B06: 0.24250000000000002	sun_azimuth: 159.81
B07: 0.26680000000000004	sun_zenith: 62.79
B08: 0.2842	valid_obs: 6
B11: 0.2142	view_azimuth_mean: 113.91
B12: 0.132	view_zenith_mean: 7.71
B8A: 0.2876	

Close Export as CSV

Time Series

Compositing Period

Year Quarter Month Ten days Day

Resolution

10 20 60

Area of Interest

Latitude Longitude

Select pixel center

Time period

Start Date End Date

October 2018 November 2018

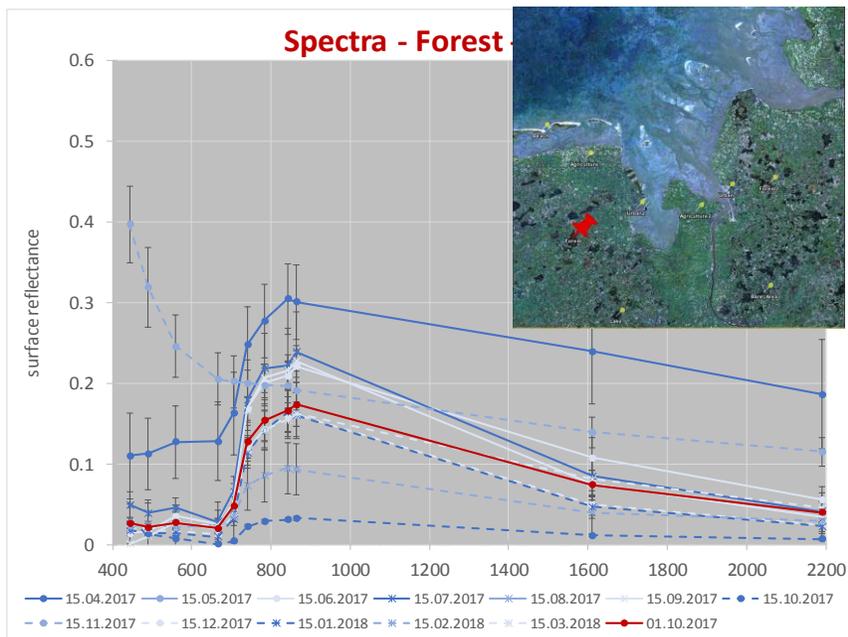
Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

Close Export as CSV

Quality control and validation

- Internal QC in production process to
 - Eliminate corrupt input files
 - Ensure integrity of output files
- Expert validation independent of production process
- Independent reference implementation
- External validation by independently contracted expert team
- Scientific validation of products and service provision
- Consortium led by IGN FI



S2GM website

- Central entry point to all service components:
 - Mosaic Hub
 - Documentation
 - User support
 - News

<https://land.copernicus.eu/imagery-in-situ/global-image-mosaics/>
www.s2gm.eu



The screenshot shows the Copernicus Land Monitoring Service website. The header includes the Copernicus logo and the Land Monitoring Service logo. The navigation menu contains: Home, Mosaic Hub, Documentation, News, Contact & Support, and About. The main content area features a breadcrumb trail 'Home » Home', the title 'The Sentinel-2 Global Mosaic service', and a descriptive paragraph: 'The Sentinel-2 Global Mosaic (S2GM) service is a component of the Copernicus Land Monitoring Service providing composites from time-series of Sentinel-2 surface reflectance observations. S2GM comprises best representative pixels in three spatial resolutions and from different compositing periods ranging from one day to one year on a European scale. It primarily seeks to support the sustainable management of natural resources by offering Analysis Ready Data (ARD) through the interactive Mosaic Hub. Users can tailor mosaics to their specific requirements in terms of area of interest, compositing period, included bands, file format, and metadata content and conveniently manage product requests via the S2GM Hub or App.' Below this is a 'Global Mosaic' section with a large satellite image of a coastal area. A 'FOLLOW US ON twitter' button is located to the right of the image.

Documentation and support

- Algorithm Theoretical Basis Document (ATBD)
- Online User Manual
- Expert support via CLMS service desk

https://land.copernicus.eu/contact-form

Global Pan-European Local

You are here: Home / Service desk contact form

Service desk contact form

Welcome to the Copernicus land service desk!

Have you checked our FAQ section? If you have not found an answer to your problem or question, please fill in this form to contact the Copernicus land service desk. We will try to respond as soon as possible within office working hours from Monday to Friday. Please note, that support is provided in English only.

Your e-mail address ■

Subject ■

A short indication of the problem, question or issue, i.e. login, download, errors in the product, thematic question etc.

Your message ■

A short description of the problem, question or issue. Please don't forget to specify which product(s) you are referring to in your message.

Prevent spam ■

https://usermanual.readthedocs.io/en/latest/pages/MosaickingAlgorithms.html

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3. Mosaicking Algorithms

Input to the mosaicking process are surface reflectance values, from the so-called Level 2A (L2A) product. This product is operationally produced by the Copernicus (ESA) ground segment. Currently, ESA is using the Sen2Cor atmospheric correction processor for the generation of L2A products.

The L2A product contains directional surface reflectances in 10 spectral bands (i.e. not BRDF corrected), a scene classification layer (SCL) providing information on cloudiness, snow and other pixel classification information, as well as aerosol and water vapour used during the atmospheric correction process. The S2GM mosaicking algorithm relies on this information for the processing. The S2GM processing chain to calculate the mosaic products is fully automated and is based on a modular design - see Fig. 3.1. The three following main modules form the basis of the chain.

1. Quality assurance/ quality check (QA/QC) of the input products
2. Composite/Mosaic algorithm
3. Quality assurance/ quality check (QA/QC) of the input products

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 - 3.2. Input Data - Sentinel-2 L2A processed with Sen2Cor
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 - 3.2.2. Temporal Resampling
 - 3.2.2.1. Short Term Composite - STC - adaption of the WELD algorithm regarding Sentinel-2
 - 3.2.2.2. Medoid Composite
 - 3.2.2.3. Spatial resampling

```
graph LR
    L2A[L2A tile stack] --> InputQC((Input tile QC))
    InputQC -- reject --> Record1[record]
    InputQC -- pass --> Filtered[L2A filtered tile stack]
    Filtered --> Mosaic((Mosaicking pixel-level I/O QC))
    Mosaic --> L3[L3 mosaic tile with per-pixel QC]
    L3 --> OutputQC((Output tile QC))
    OutputQC -- reject --> Record2[record]
    OutputQC -- pass --> Product[L3 mosaic tile product]
    OutputQC --> Meta[QC meta-data]
    
    InputQC --- QC1[tile-level QC rules]
    Mosaic --- QC2[pixel-level QC rules]
    OutputQC --- QC3[tile-level QC rules]
```

Consortium

- Three European SMEs with complementary expertise in Earth Observation since many years.
- Clearly defined roles in S2GM service



- Maintaining S2 L2A archive
- Mosaic Hub technology
- Distribution of products



- Managing contract and consortium
- Mosaicking algorithms
- Sentinel-2 (pre-) processing expertise



- Internal quality control
- Thematic expertise land

Summary

Copernicus Sentinel-2 Global Mosaic service

- provides scientifically sound mosaics of Sentinel-2 surface reflectance data on a global scale
- is fit for various applications
- is free to use by everyone
- is accessible via www.s2gm.eu and via CLMS
- is operated by a team of dedicated experts ready to support users



Contact info@s2gm.eu
Or the Service desk of CLMS at
<https://land.copernicus.eu/contact-form> for more information!

