10TH ADVANCED TRAINING COURSE ON
LAND REMOTE SENSING

Sentinel-2 Composites for the Tropics

Dario Simonetti - Joint Research Centre (JRC)

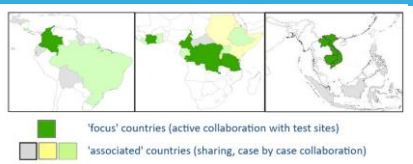
Context

- **Challenges**
  - Difficulty to handle large set EO data
  - Automated preprocessing chains
  - Complexity to mask clouds/ shadows, haze, correct sensor artefacts and registration inaccuracies
- **Purpose**
  - Provision of analysis-ready satellite image as input for Activity Data for REDD+ reporting
- **Sentinel-2 (S2) is ideally suited**
  - High resolution (10m), high revisit frequency (5 days), spectral bands, freely available
- **Identification of the products for REDD+**
  - S2GM: existing Copernicus Service for S2 composite
  - JRC-L1C-S2: improved cloud-free S2 composites

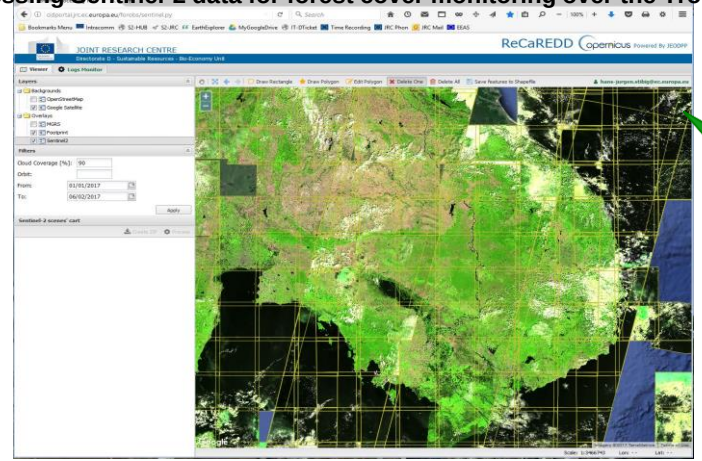
Since January 2016 ….

Why ?

JRC support to ReCaREDD (2013-2018)



Sentinel-2 web platform for REDD+ monitoring. Online web platform for browsing and processing Sentinel-2 data for forest cover monitoring over the Tropics



- Filter by AOI, time, Cloud %
- Full resolution custom visualization
- Download only what you see / need

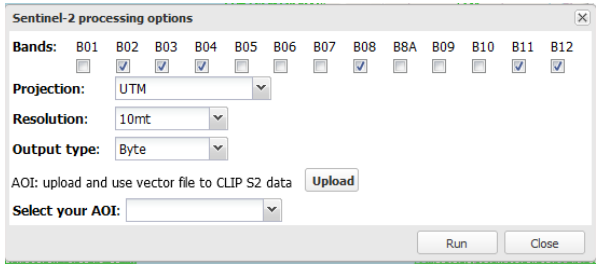
From GB to Mb

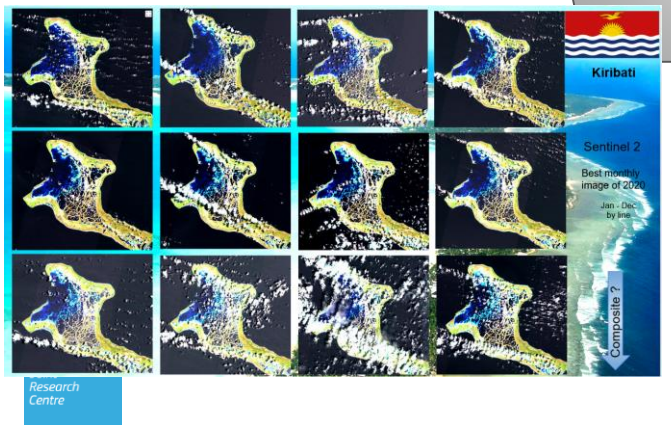
REGIONAL CENTRE FOR MAPPING OF RESOURCES FOR DEVELOPMENT

RCMRD becomes the 1st Organization in Africa to Provide Sentinel 2 Data for 10 Countries

Sentinel 2 images of Sudan being processing in the JRC IMPACT tool.

2016





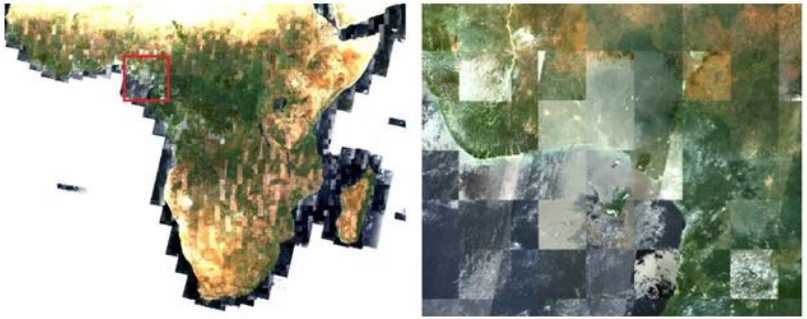
But ...

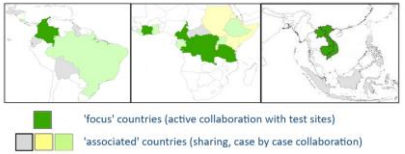
Still single image

What about Clouds ?

Why ?

"Provide Remote Sensing Tools and Methods for Monitoring Forest Change in the Context of REDD+"



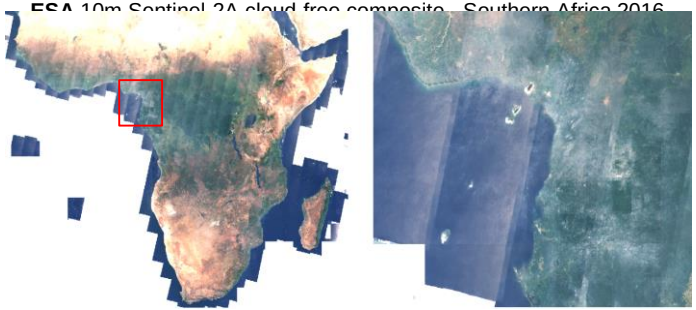


JRC Africa Sentinel-2 L1C 2017 annual composite as proposed by Kempeneers P.

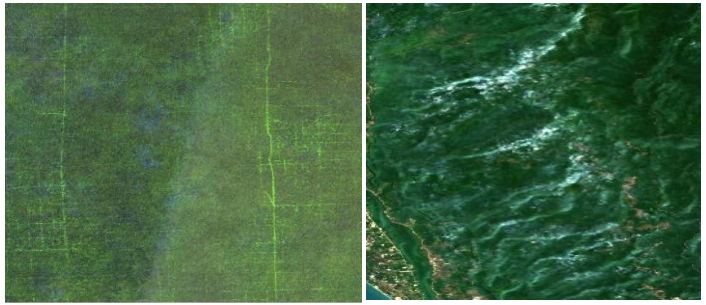
JRC support to

- ReCaREDD,
- REDDCopernicus
- ClimSA

ESA 10m Sentinel-2A cloud free composite - Southern Africa 2016



JRC Global Sentinel-2 L1C 2017-2018 composite as proposed by Corbane C.



S2GM Sentinel-2 L2A composite pics over Central African Republic, forest in Ko Chang island (Thailand)

But ...

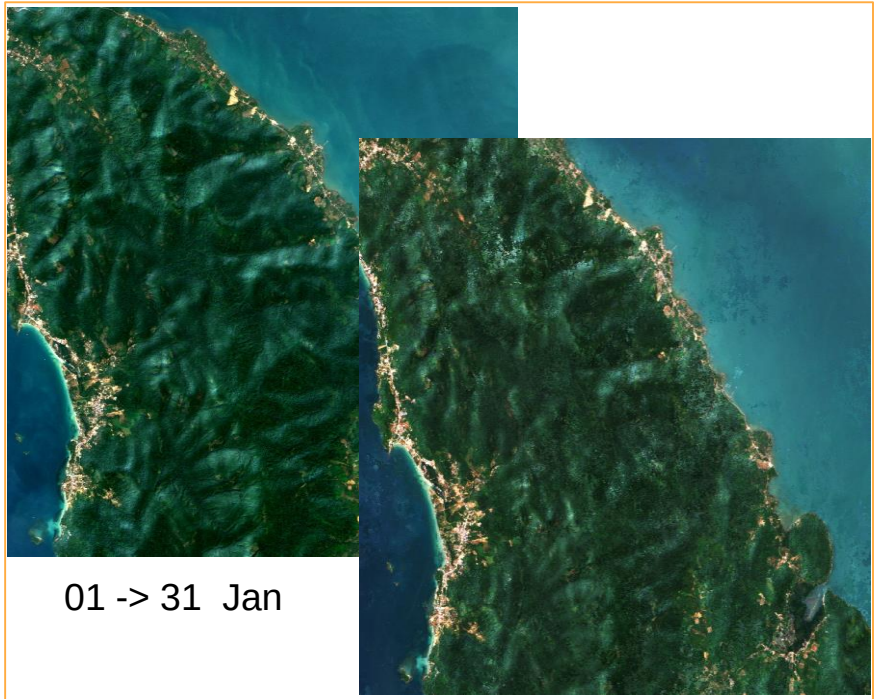
Available composites are affected by:

- Tiling
- Residual clouds
- L2A overcorrection

Why L1C level?

Examples of L2A composites for 2019

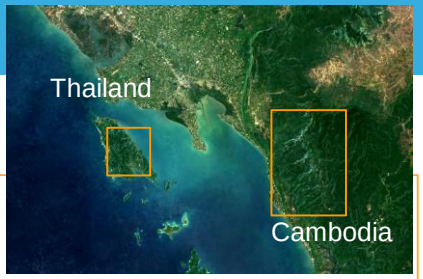
- overcorrection of north facing slopes
- S2GM / any other L2A composite are affected

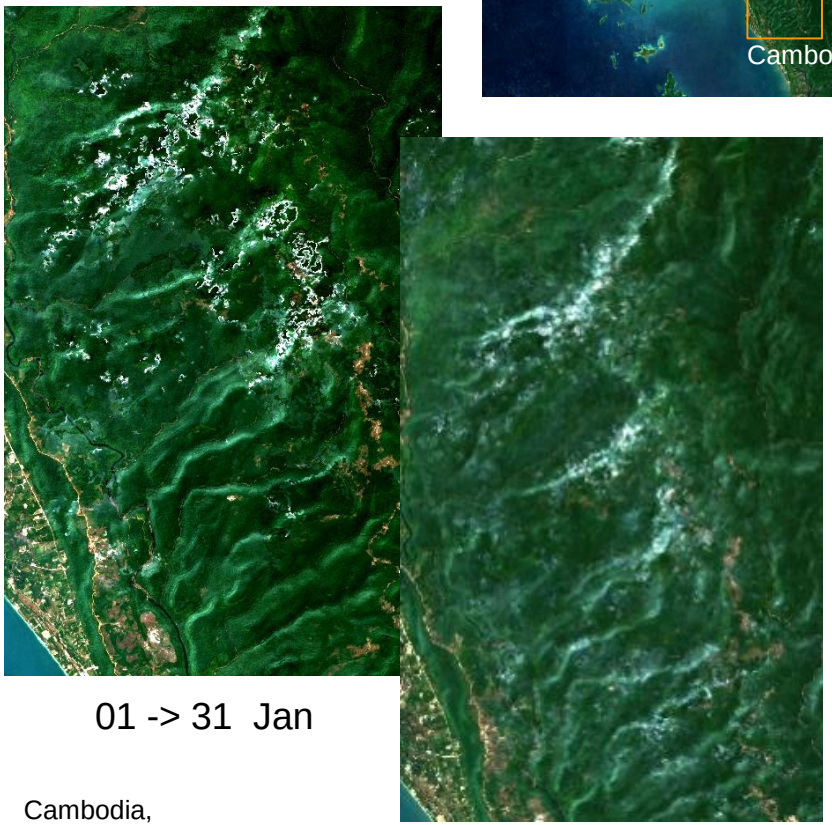


01 -> 31 Jan

Jan / May

Ko Chang Island, Thailand



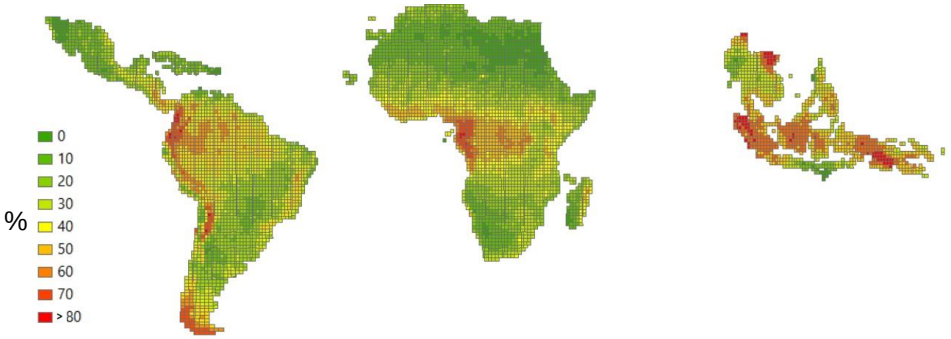


01 -> 31 Jan

Jan / May

Cambodia,
Phnum Samkos Wildlife Sanctuary

Cloud coverage issues



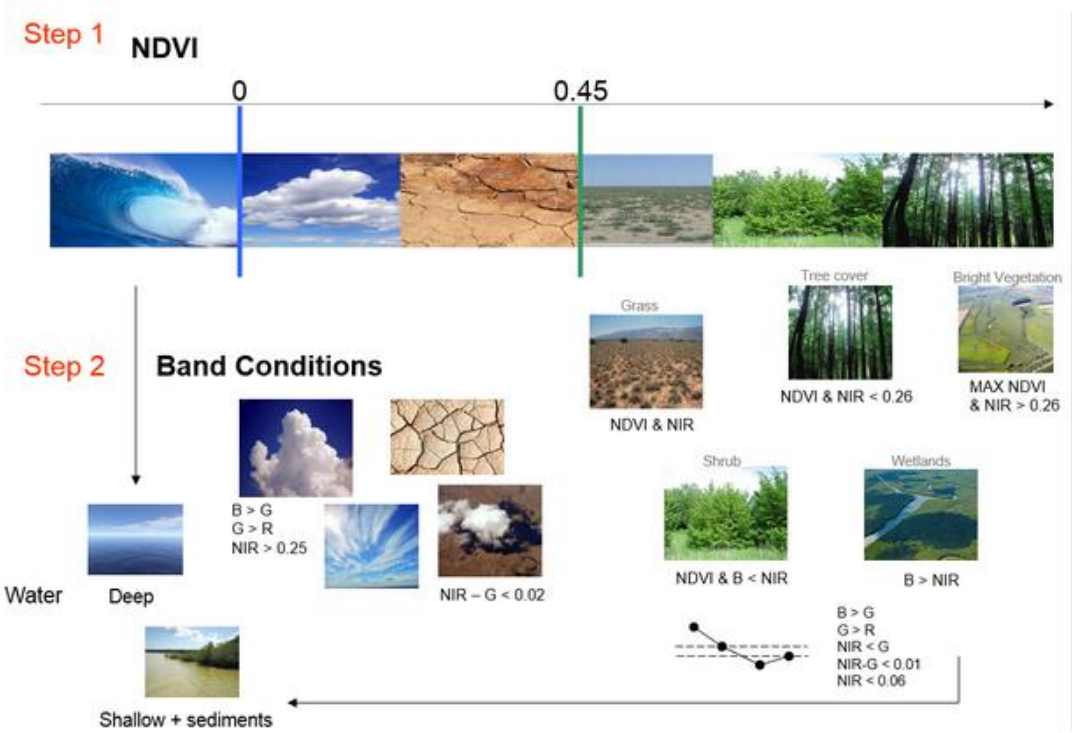
Average cloud cover distribution per S2 MGRS tiles in year 2020 as computed from image metadata

The proposed PINO cloud & shadow mask algorithm has been applied to cloud-prone countries (yellow) while a simple mask based on ESA QA60 band (>=1024) was sufficient in areas with abundance of cloud free images (green).

The former approach is resource (CPU, RAM) demanding hence almost two times slower; however, the average execution time (per orbit, per country) remains within the 2 hours

Cloud-prone (yellow) and non cloud-prone (green) countries

Cloud/Shadow mask based on pre-defined thresholds based on individual pixel



Class ID	Thematic Classes
WAT (DWAT/SWAT)	Water
CL	Clouds
TCD	Tree Cover Dark
TCL	Tree Cover Light
SHR	Shrub
GRS	Grassland
SPV	Sparse vegetation
OLL	Other Land Light
OLD	Other Land Dark
SV	Shadowed Vegetation
SS	Bare or Shadowed Soil

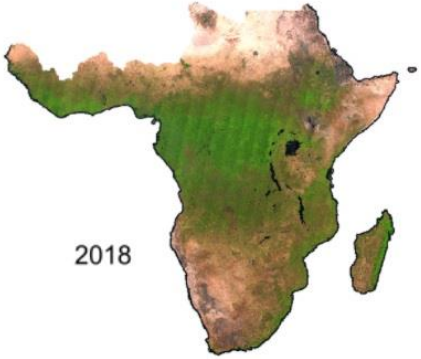
~~Solving~~ Mitigating radiometric issue

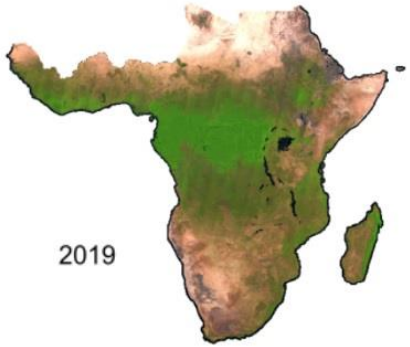
From Raw L1C (2018) & Forest Normalization per MGRS Tile (2019) to Orbit Equalization (2020)

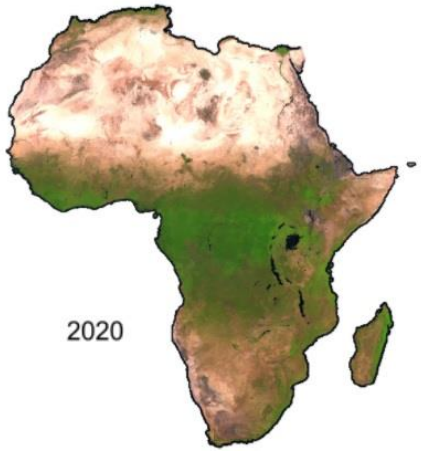
L1C Top of Atmosphere reflectance

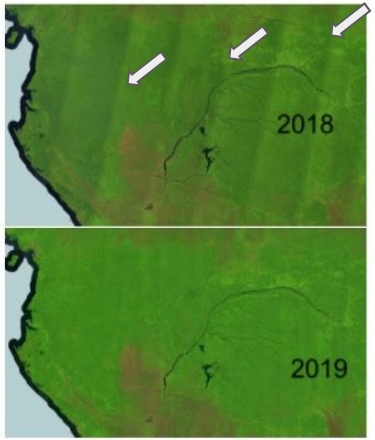
dark object subtraction using evergreen forest as pseudo invariant feature

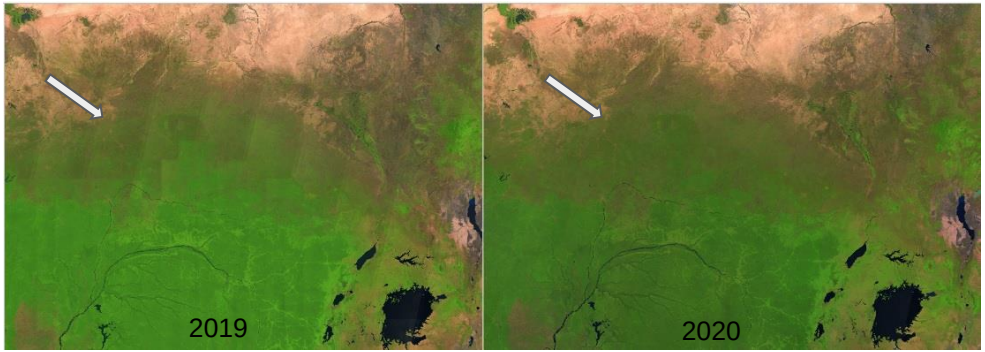
multiplicative gradient ranging, over humid forest, from -12% to 0% (west-east)



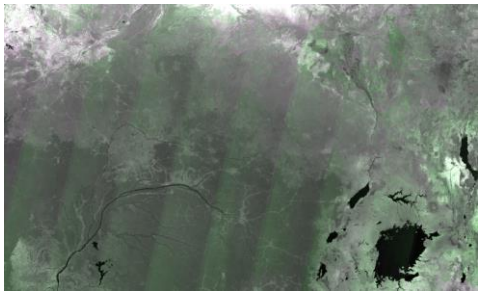








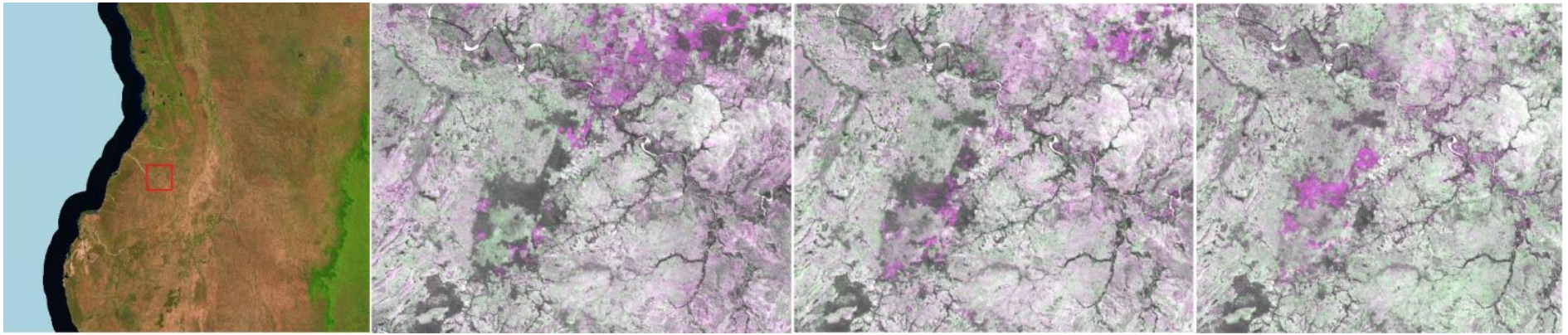
Visible tiling effect on the transition between dense forest and savanna (2019, left) and a smooth correction with the orbit normalization approach (2020, right)



Effect of the orbit correction by subtracting 2018 and 2020. The green gradient shows where correction is more intense (west of each orbits) and where original values are preserved (east)

Spotting annual changes

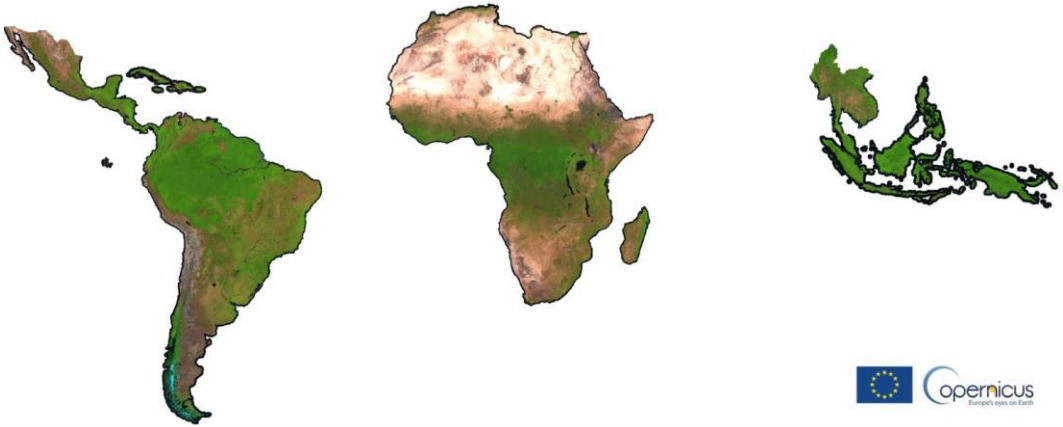
Malaysia: map, change in 2018, 2019 and 2020. Vegetation loss (violet), gain (green). Vast deforestation propagating from the edge into the forest



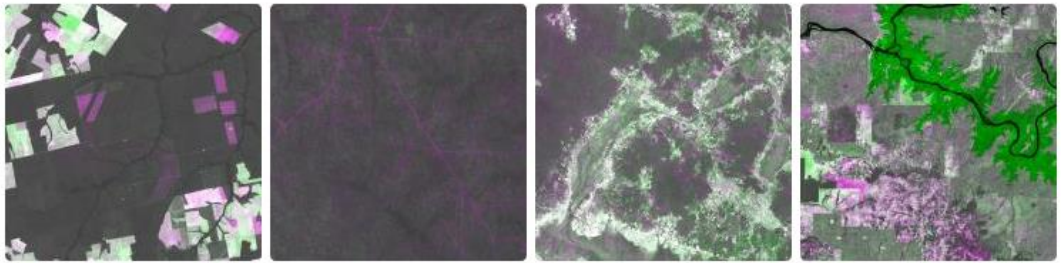
Madagascar: map, change in 2018, 2019 and 2020. Vegetation loss (violet), gain (green). Scattered, small scale deforestation

Sentinel-2 L1C cloud-free composites for the Tropics

2015-2017, 2018, 2019, 2020



Indication for potential annual change

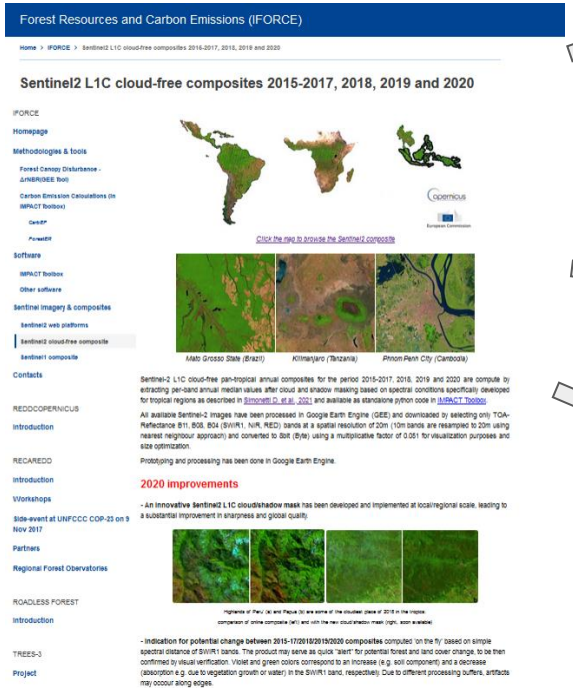


From left: Mato Groso (Brazil), Sanga (Congo), Manyoni (Tanzania), Stung Trene (Cambodia)

- L1C Sentinel-2 A/B
- 20m resolution (pre-computed)
- B11 B8 B4 (SWIR, NIR, RED)
- 4 composites of ~500 GB each
- Pre-computed and ready to use
- Fast web browsing and WMS service
- GeoTiff Download

Available on
https://forobs.jrc.ec.europa.eu/recaredd/map/

Data Access and References

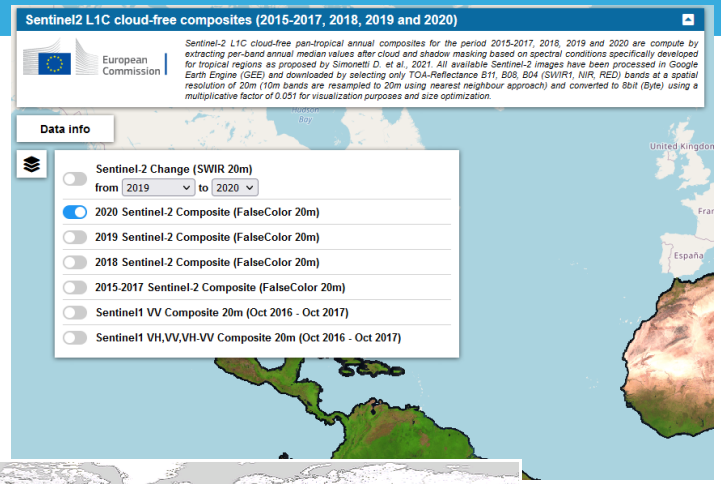


Ref.

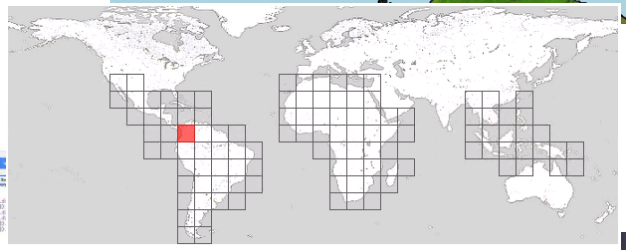
ELSEVIER

Data in Brief
under review

Browse

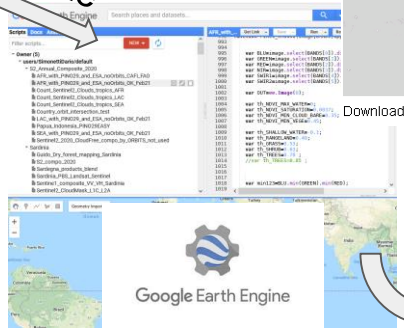


Download



Download tile **N05_W075**: 2015-2017 2018 2019 2020

Customize



Porting

https://forobs.jrc.ec.europa.eu/recaredd/S2_composite.php

Joint Research Centre

Direct Integration into IMPACT Toolbox (Open Source)

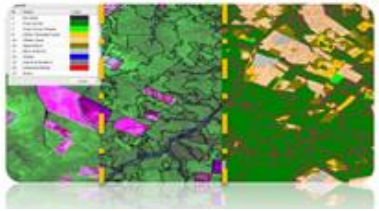
IMPACT TOOLBOX

- ✓ Portable GIS
- ✓ Free & Open Source
- ✓ Online / Offline
- ✓ Easy to Use

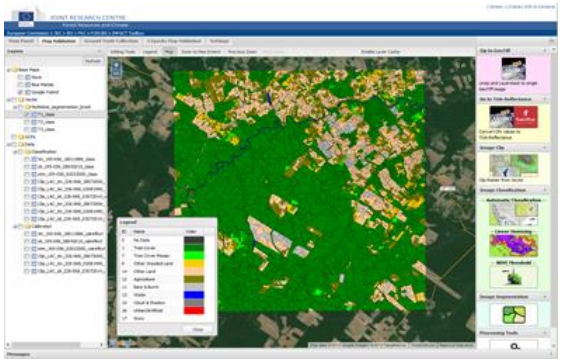
Quick Data Visualization

- Raster and vector visualization
- Adjustable bands and stretch
- Fast rendering with tiling approach
- Data auto-load and refresh
- Processing buttons for easy access

Map Visualization & Editing



- Easy and efficient editing environment
- Selection and recoding by :
  - class or cluster
  - single or multi polygon
- 1 click edit
- Class masking / showing
- Customizable legend
- On the fly .dbf file editing



Ground Truth Collection

Collection of ground truth data at local, national or global scale is now faster with a built-it feature editor supporting either systematic samples collection or wall-to-wall feature labeling.

- Built-it degradation menu with identification of location, causes and intensity
- Customizable legend

http://forobs.jrc.ec.europa.eu/products/software

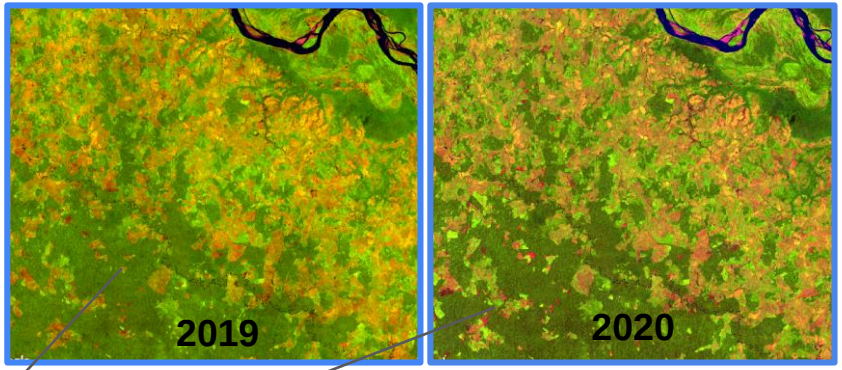
Joint Research Centre

IMPACT TOOLBOX

N05_W075

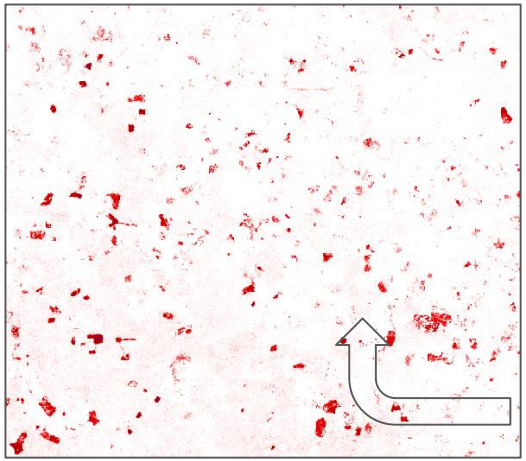
Colombia

Lon: -75.882 Lat: 0.800

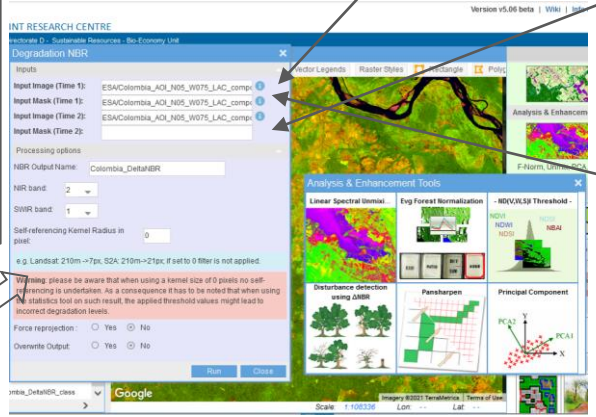


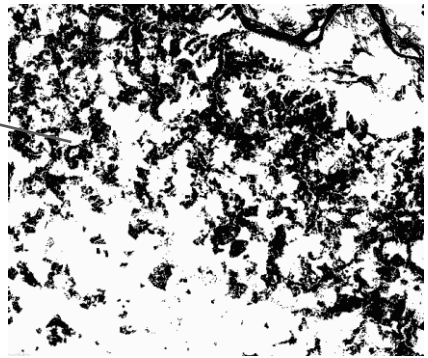
Sentinel-2 Composite

Delta NBR: potential forest loss



Download
&
Clip to AOI





2019
Forest Mask
(Optional)

Automatic NBR index extraction from 2 epochs and calculation of difference layer

Joint Research Centre

Conclusions and Perspectives

- JRC-S2-L1C fills the gap of cloud-free S2 composites production over the Tropics
- Compositing production includes several advanced processing
  - Dedicated Cloud/Shadow mask
  - Specific Radiometric Normalization
  - Compositing by Orbits
- Analysis-Ready Satellite Image Data can facilitate REDD+ reporting process by
  - Reducing/ avoiding image pre-processing time and resource
  - Providing satellite images directly ready-to-use for mapping and monitoring
  - Providing relevant reference data for visual interpretation
- Perspectives: Integration of the GEE code within the FAO SEPAL Platform

Thank you for your attention

Available on https://forobs.jrc.ec.europa.eu/recaredd/map/