University of Zurich[UZH]

Department of Geography

NPOC

Google Earth Engine: A cloud infrastructure for Earth observation applications

Swisstopo Colloquium, Wabern

23 March 2018

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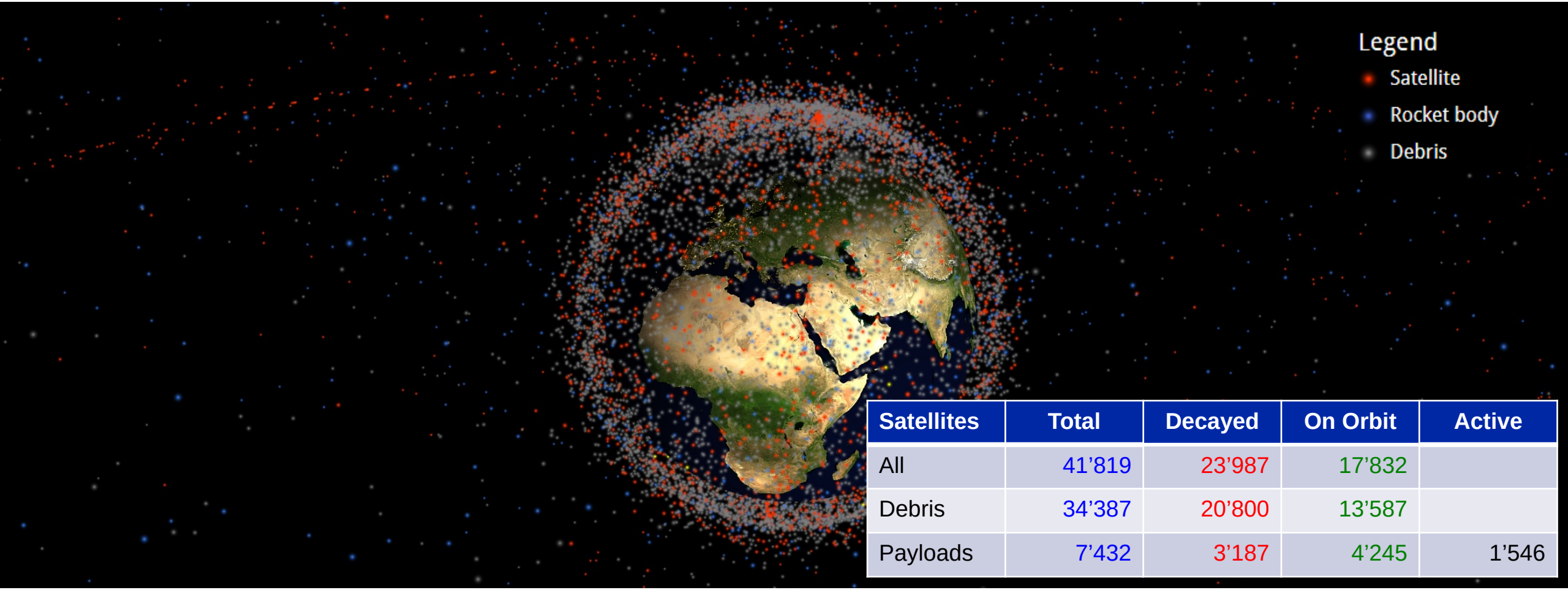
Changing focus: from single satellites & scenes to...

ESA

...collecting “big data” – from space!



Satellites	Total	Decayed	On Orbit	Active
All	41’819	23’987	17’832	
Debris	34’387	20’800	13’587	
Payloads	7’432	3’187	4’245	1’546

Stuffin.space http://celestrak.com/satcat/boxscore.asp

Content

- Introduction Google Earth Engine (GEE)
- The power of cloud computing
- Some application cases with examples and demonstrations:
    1. Hydrology
    2. Forestry
    3. Agriculture
    4. Climate
- Limitations/criticism

Working with big data: Remote sensing and cloud computing

- The **Google Earth Engine** (GEE) is a multi-petabyte **geospatial data archive and parallel processing infrastructure** allowing planetary-scale analysis.
- It combines **freely available EO and other geospatial data sets**: all of Landsat, Sentinels, MODIS, DEMs, land cover maps, demographic maps, and you may upload own raster or vector data sets.
- GEE provides a data explorer and a JavaScript or Python based **application programming interface** (API). It is intended for scientists, not software engineers – which is good news!

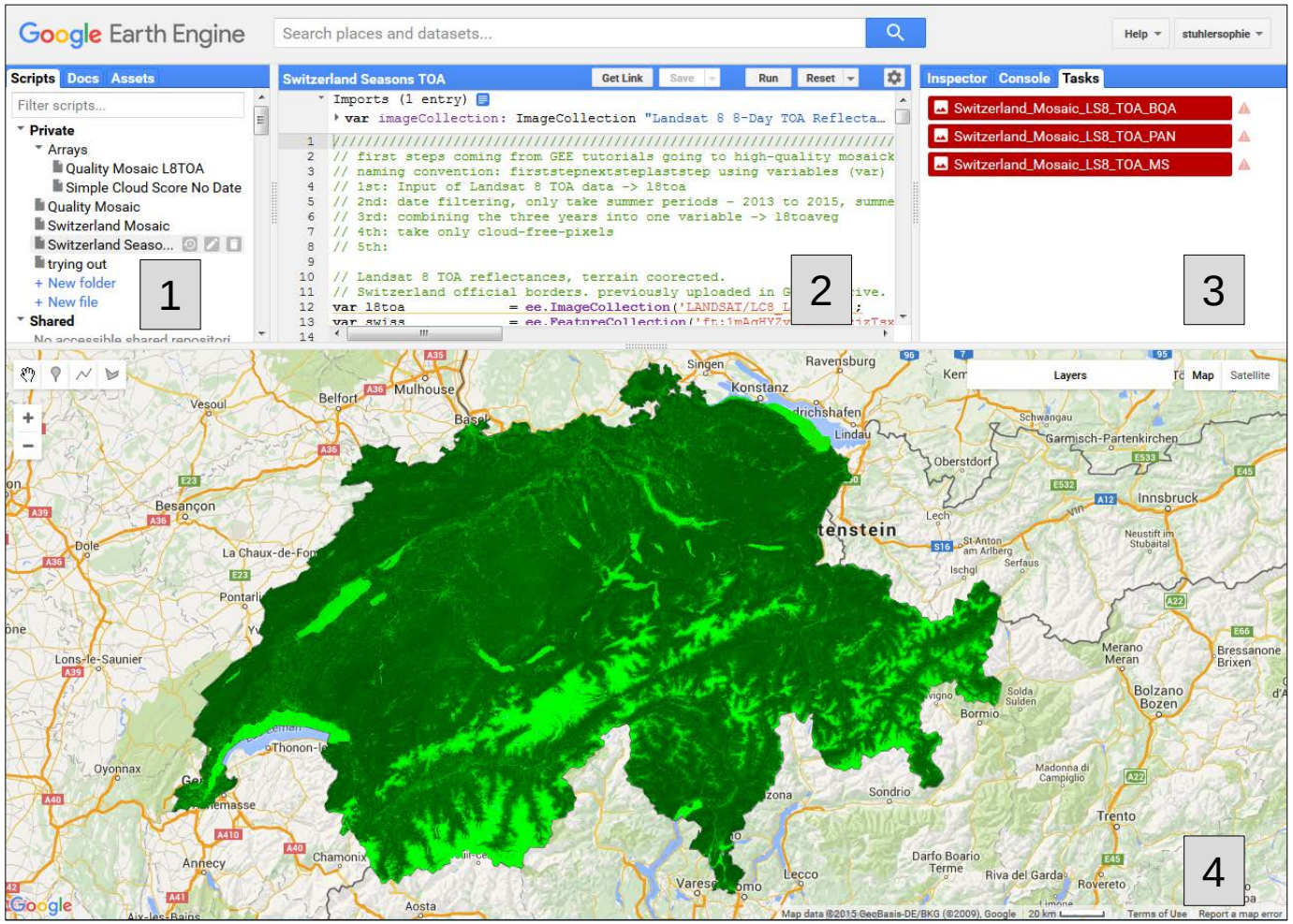
→ No more downloading tons of data sets and processing locally! Only export the results.

→ It's fast & relatively easy to master with guidance provided by the GEE.

→ **Very high potential in the future of remote sensing** (also with Amazon AWS and similar).

Sign up for free: signup.earthengine.google.com

Remote sensing cloud computing: Google Earth Engine API



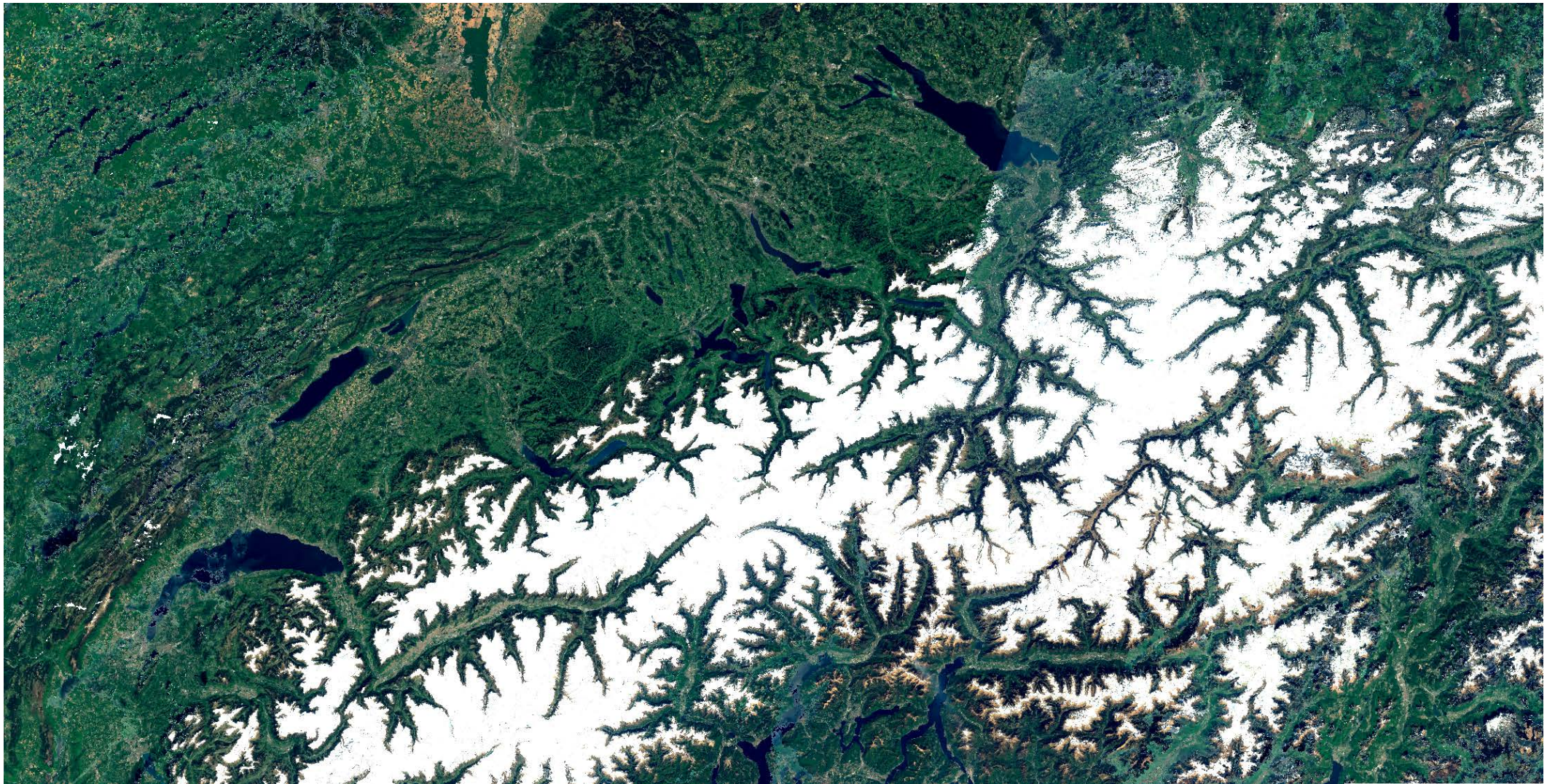
1) Algorithms, Assets

2) Code: JavaScript (Python)

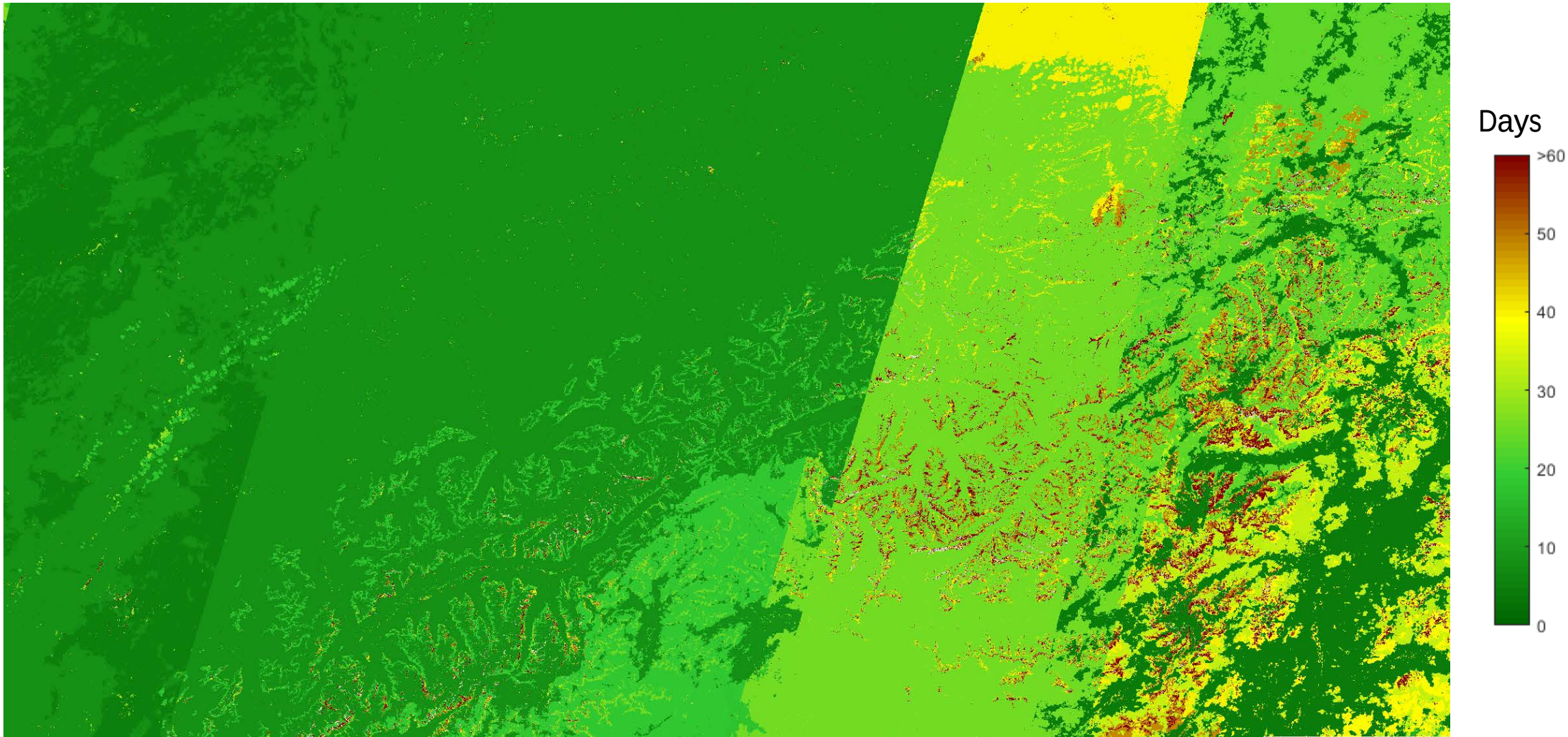
3) Metadata, Inspector

4) Live Visualisition

This is not a satellite image!

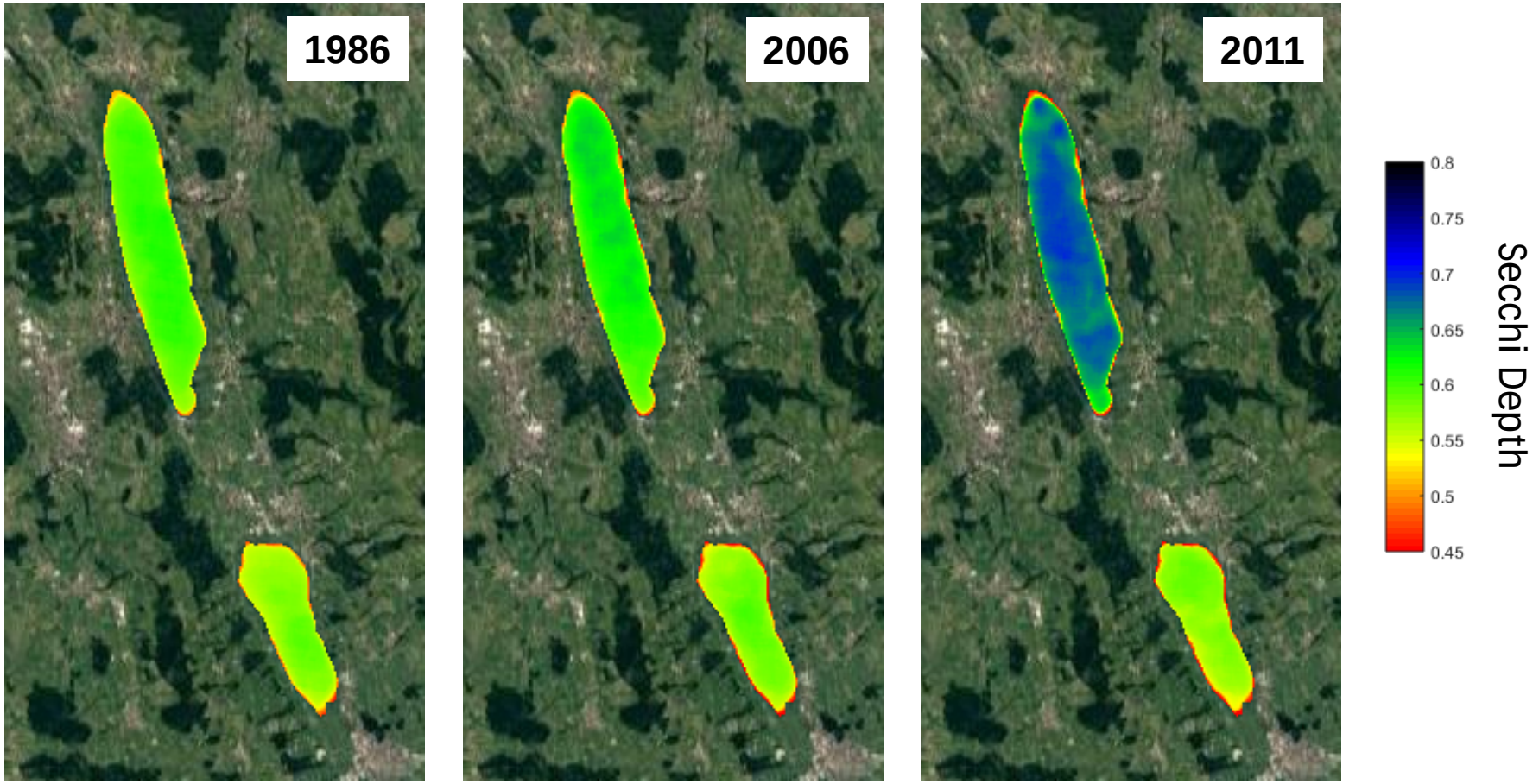


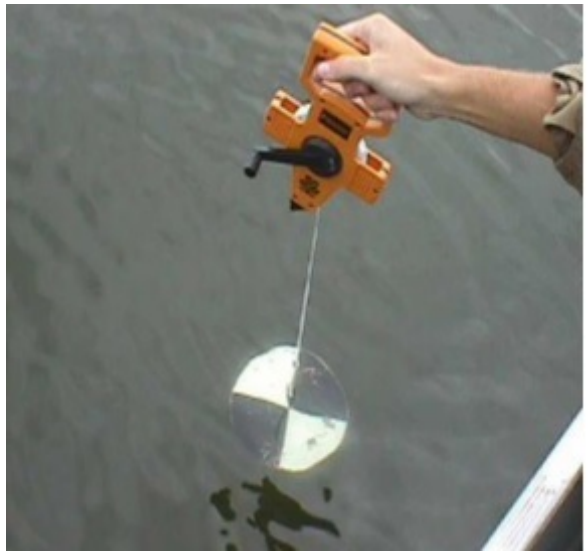
...the data stems from different “pixel ages”

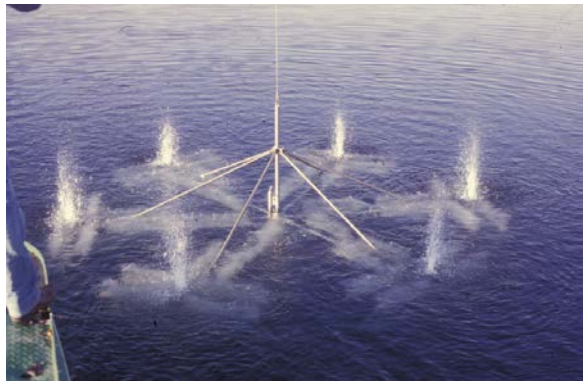


Examples: Hydrology

Secchi depth – water quality indicator



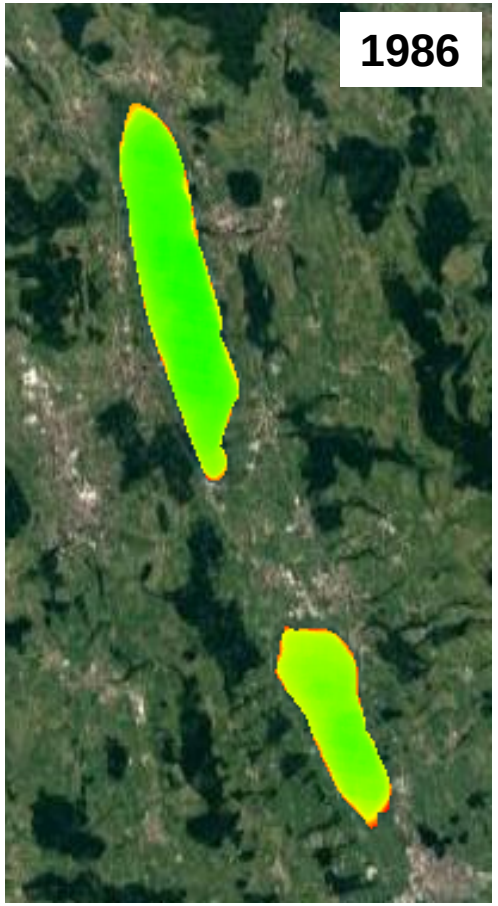


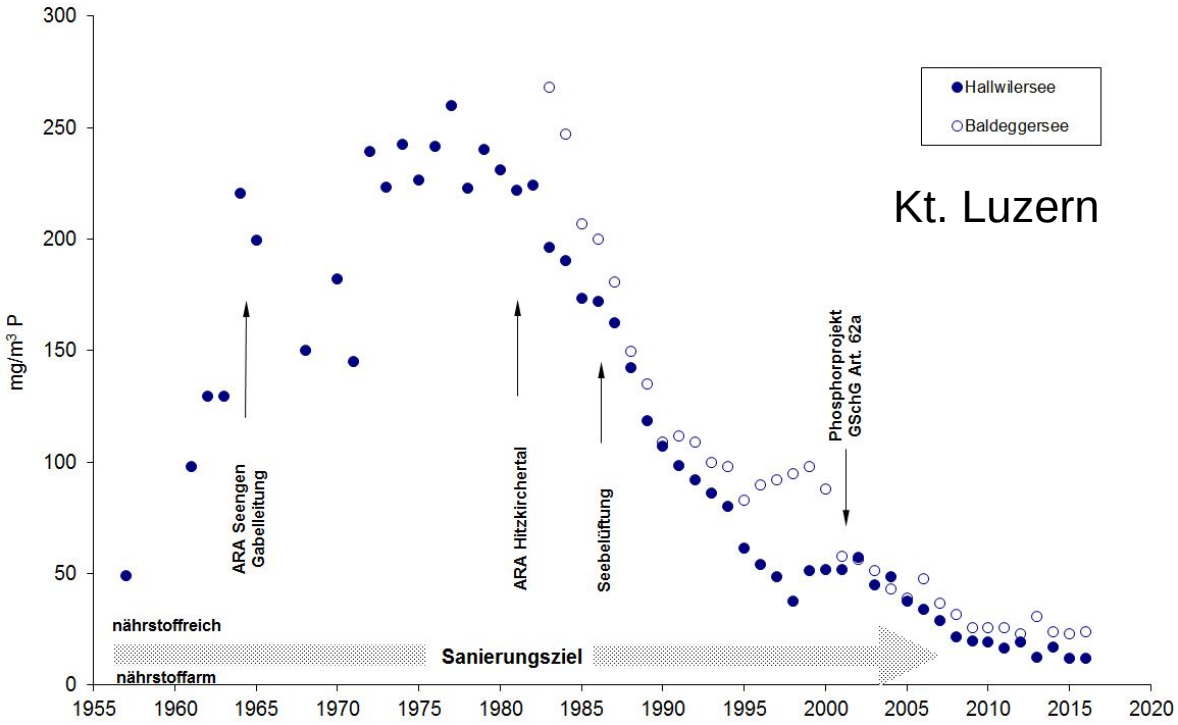


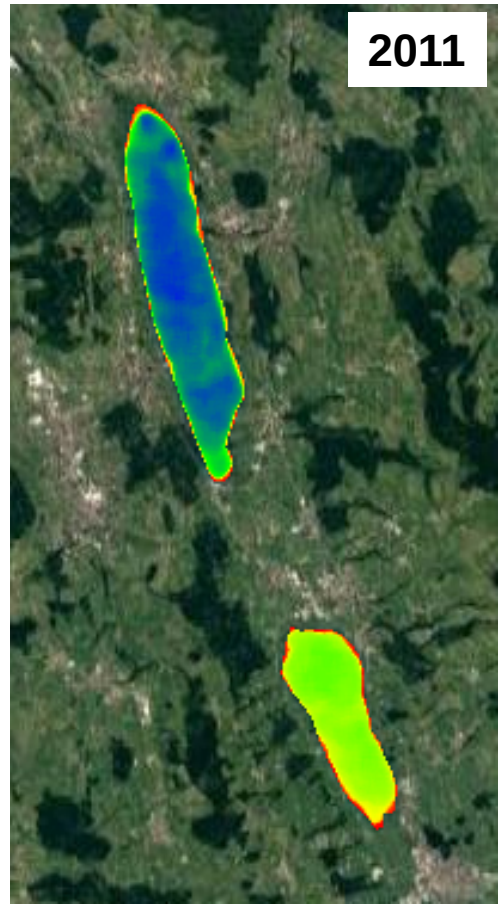
Kt. Luzern

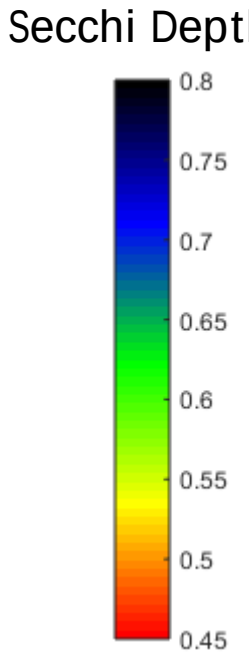
Data: Landsat 5 Surface Reflectance. Summer 1986, 2006, 2011

Secchi depth – water quality indicator





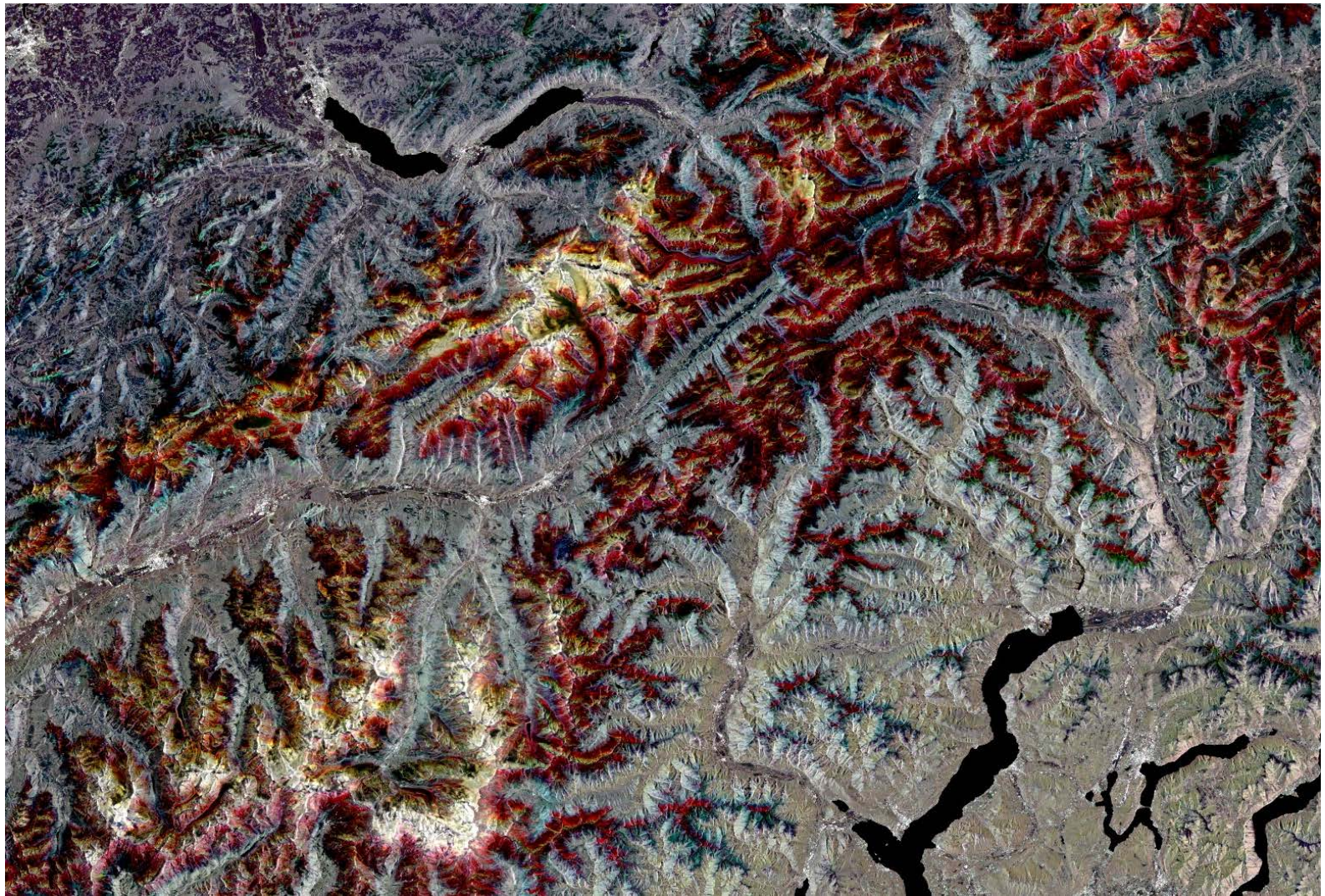




→ Both lakes are artificially ventilated, but only Hallwilersee shows an increased transparency!

→ Remote sensing data should always be verified with independent data!

Water applications: Snow melt and agriculture



Copernicus Sentinel-1 RADAR data product

→ Mosaics of ascending and descending node data

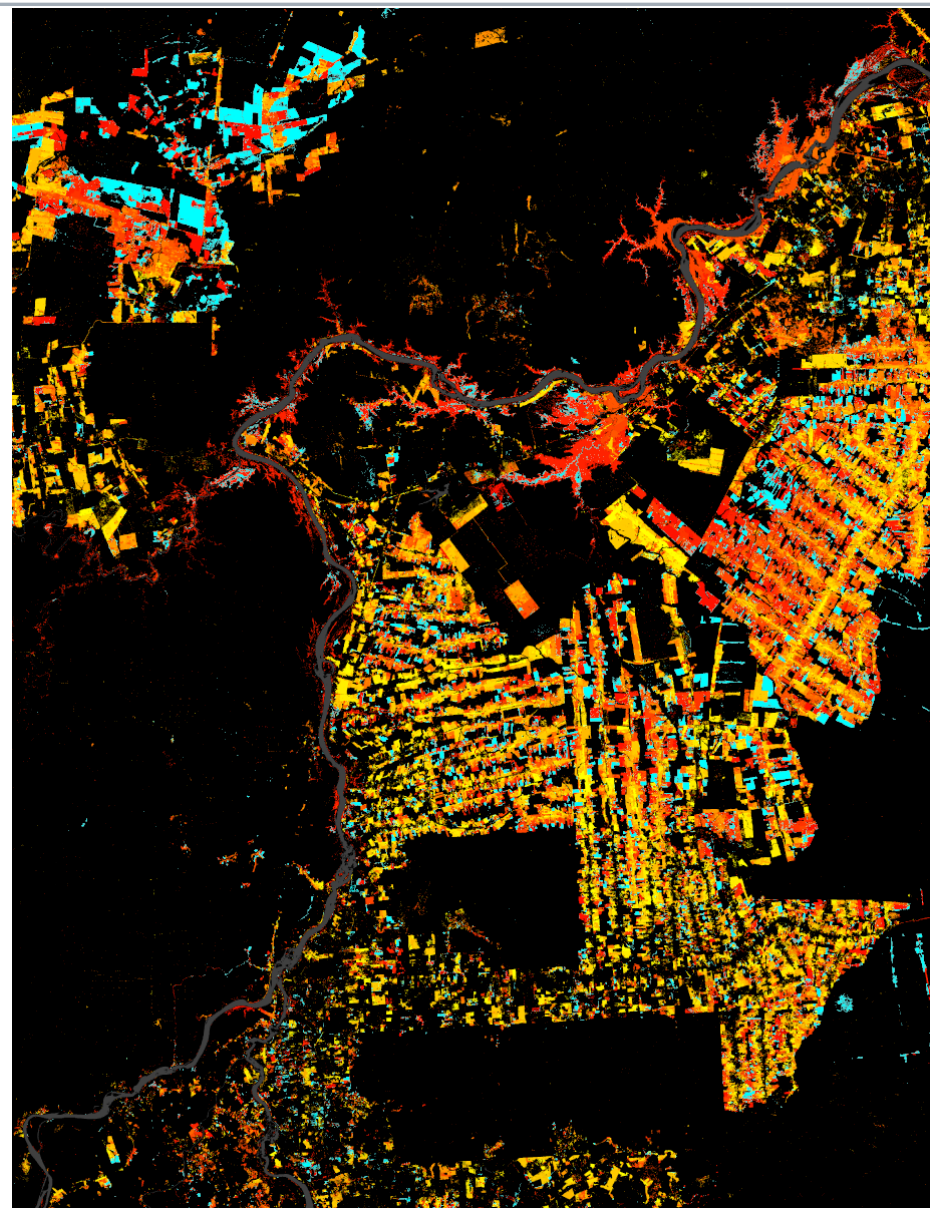
→ Each mosaic shows amplitudes, averaged over 18 days

→ Amplitude is mostly a product of surface roughness and moisture

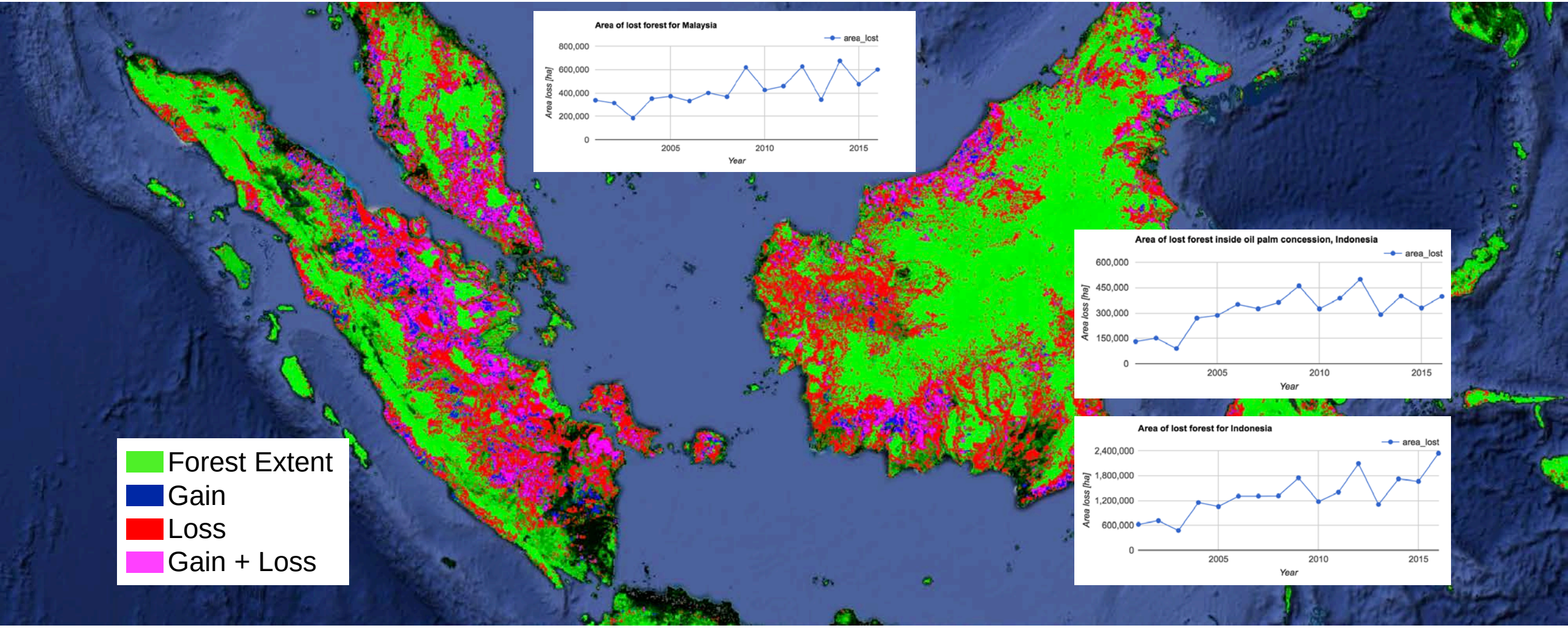
→ Colours are provided by combining three periods of time:

RED: March 2017
GREEN: April 2017
BLUE: May 2017

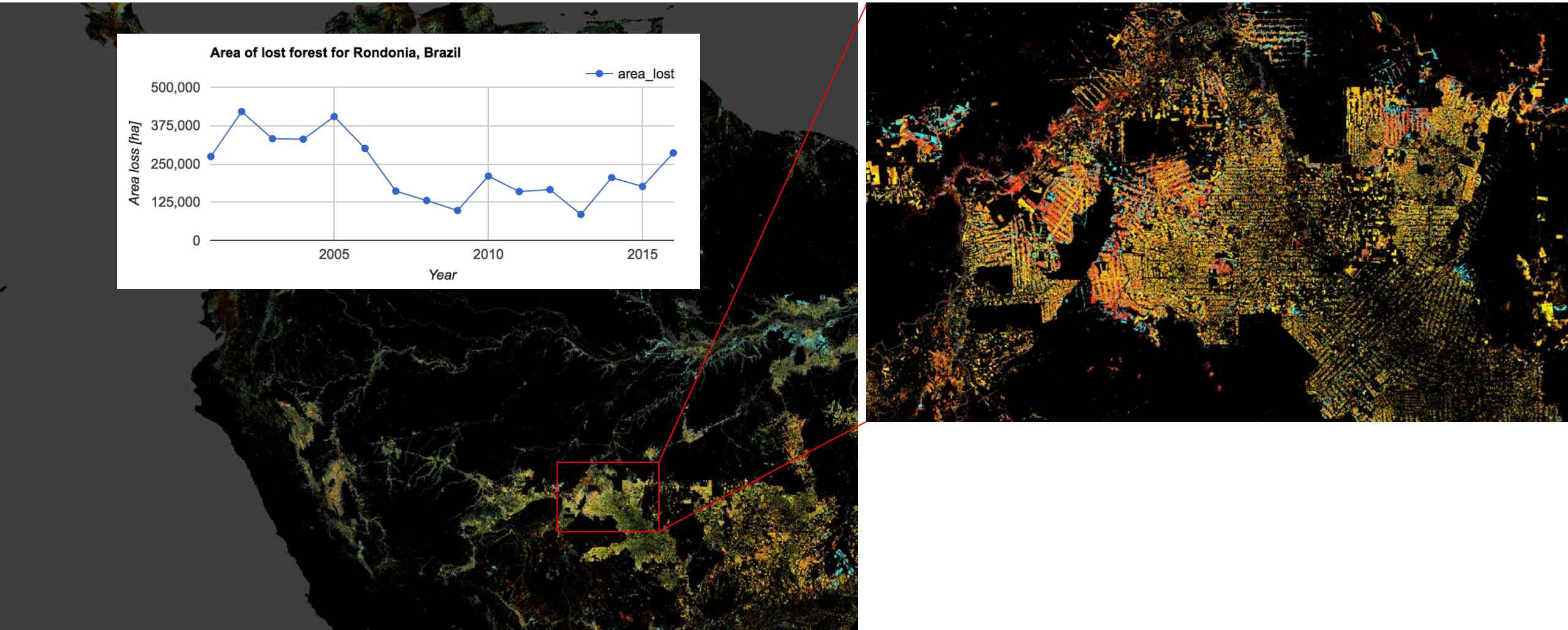
Examples: Forestry



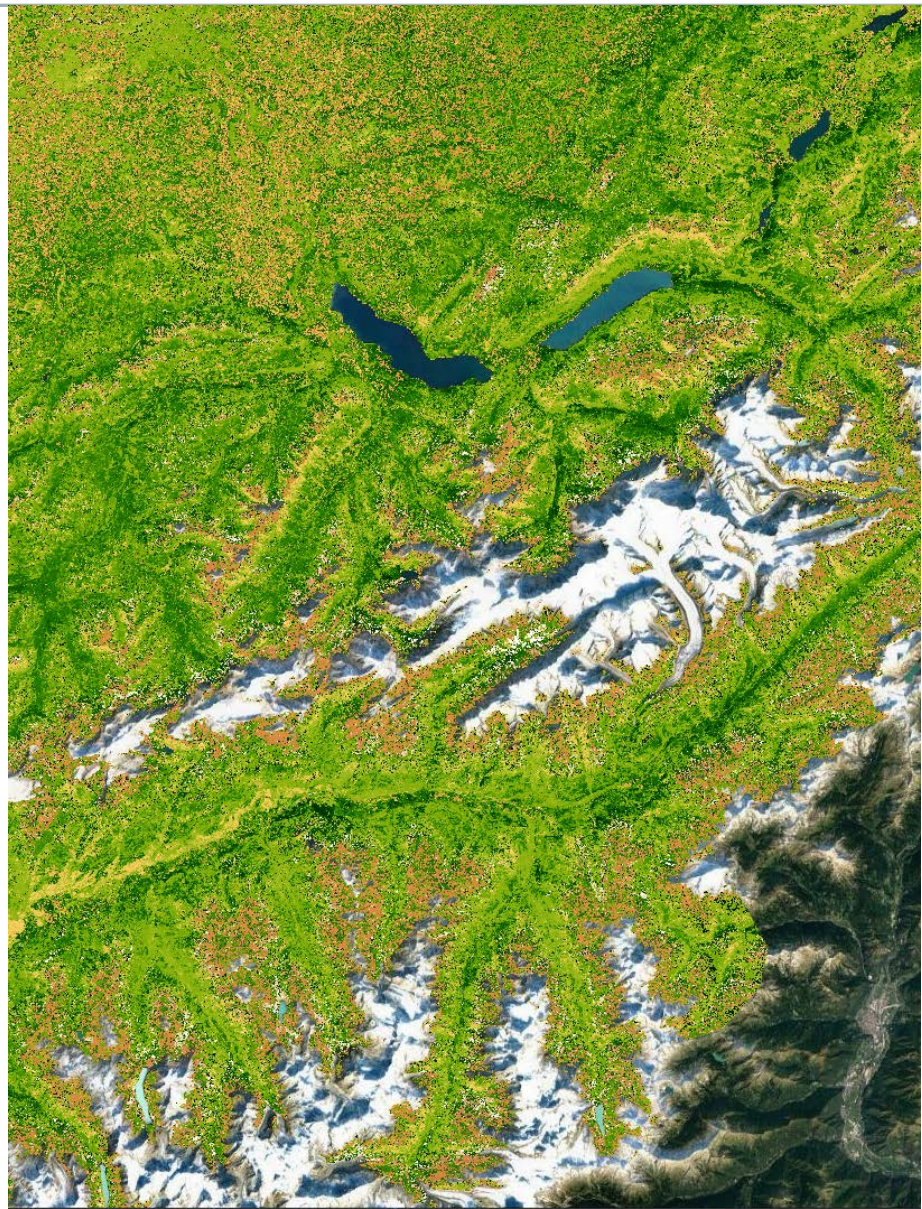
Deforestation/palm oil plantations in Indonesia & Malaysia



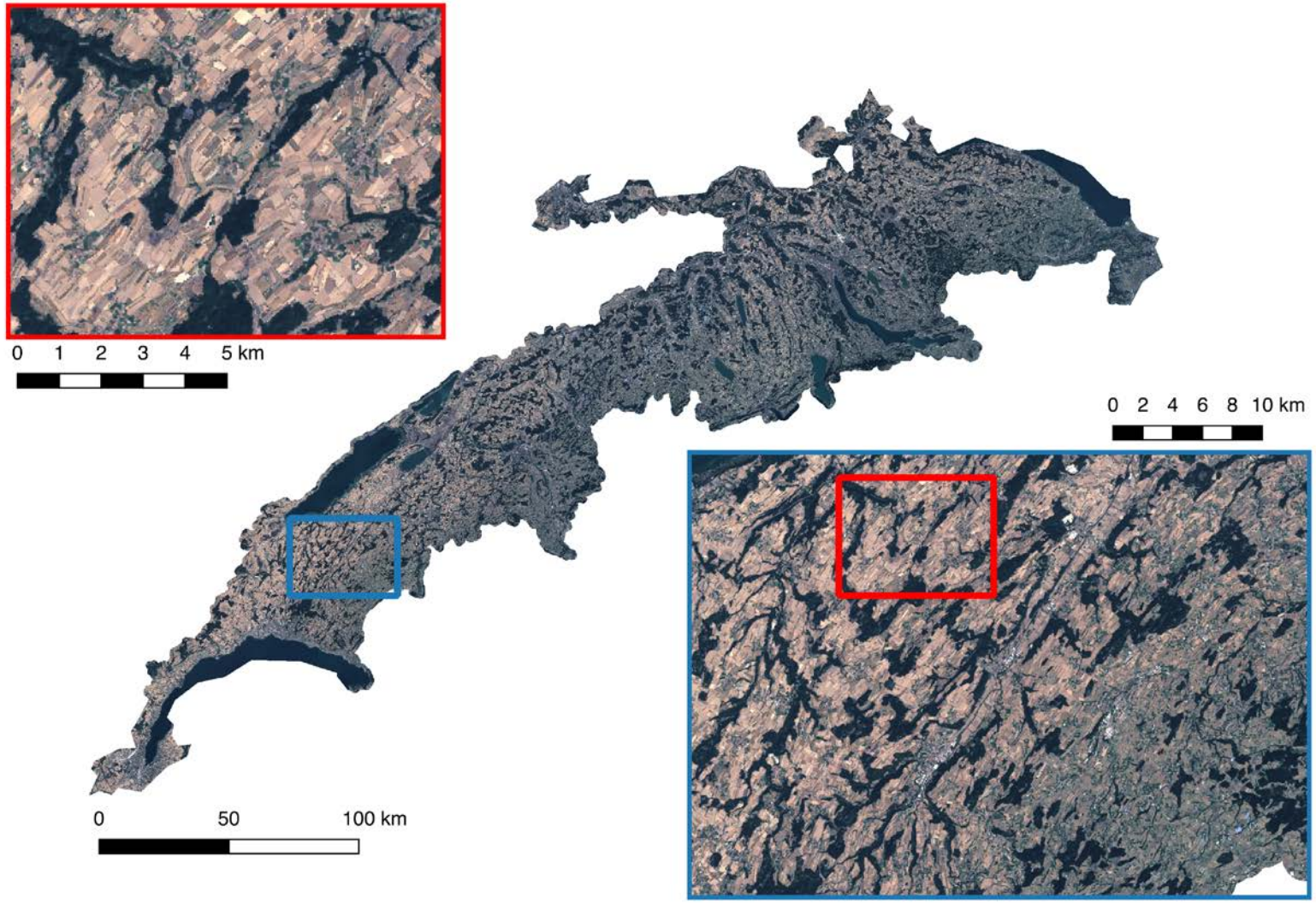
Deforestation Rondonia, Brazil



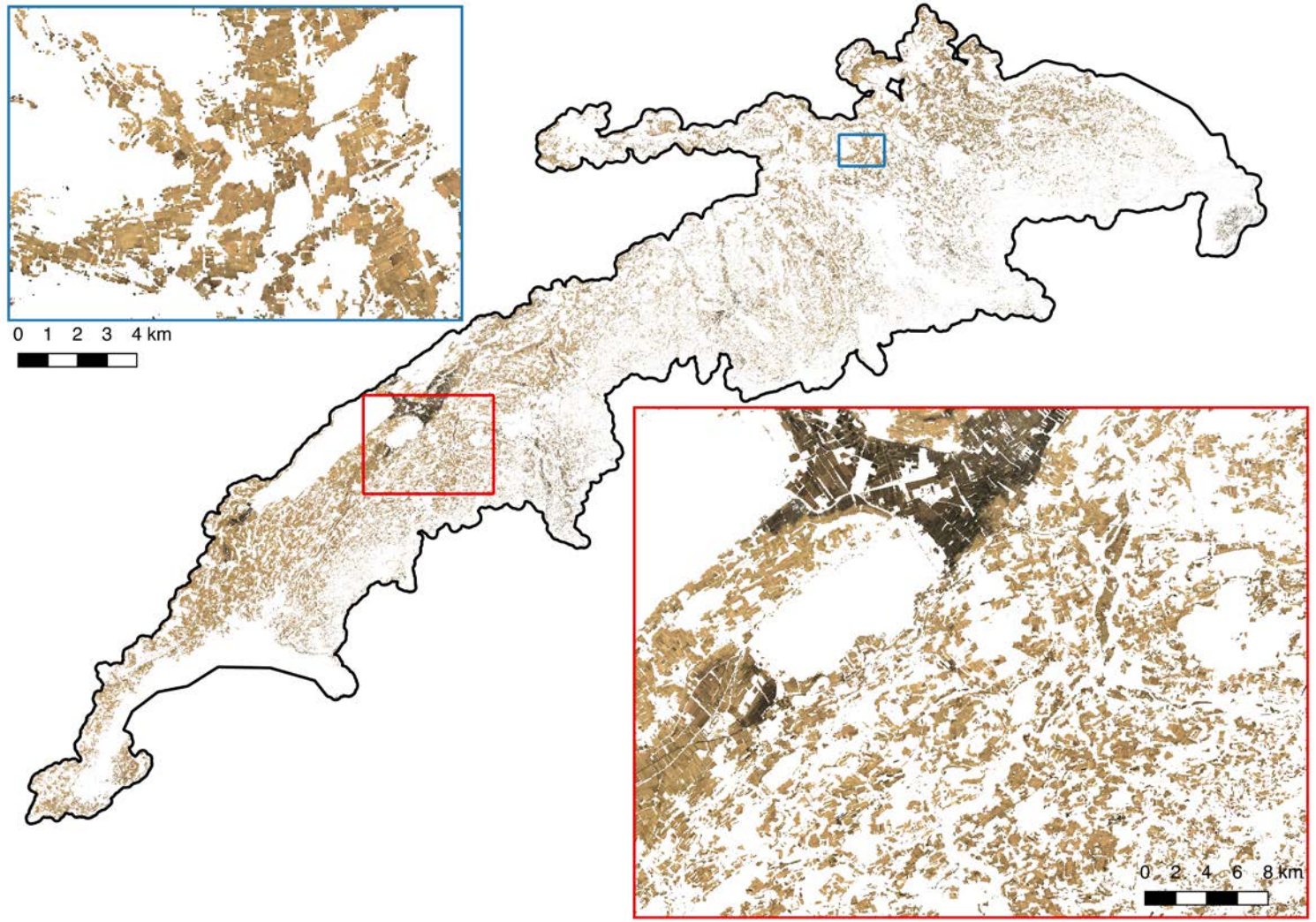
Examples: Agriculture



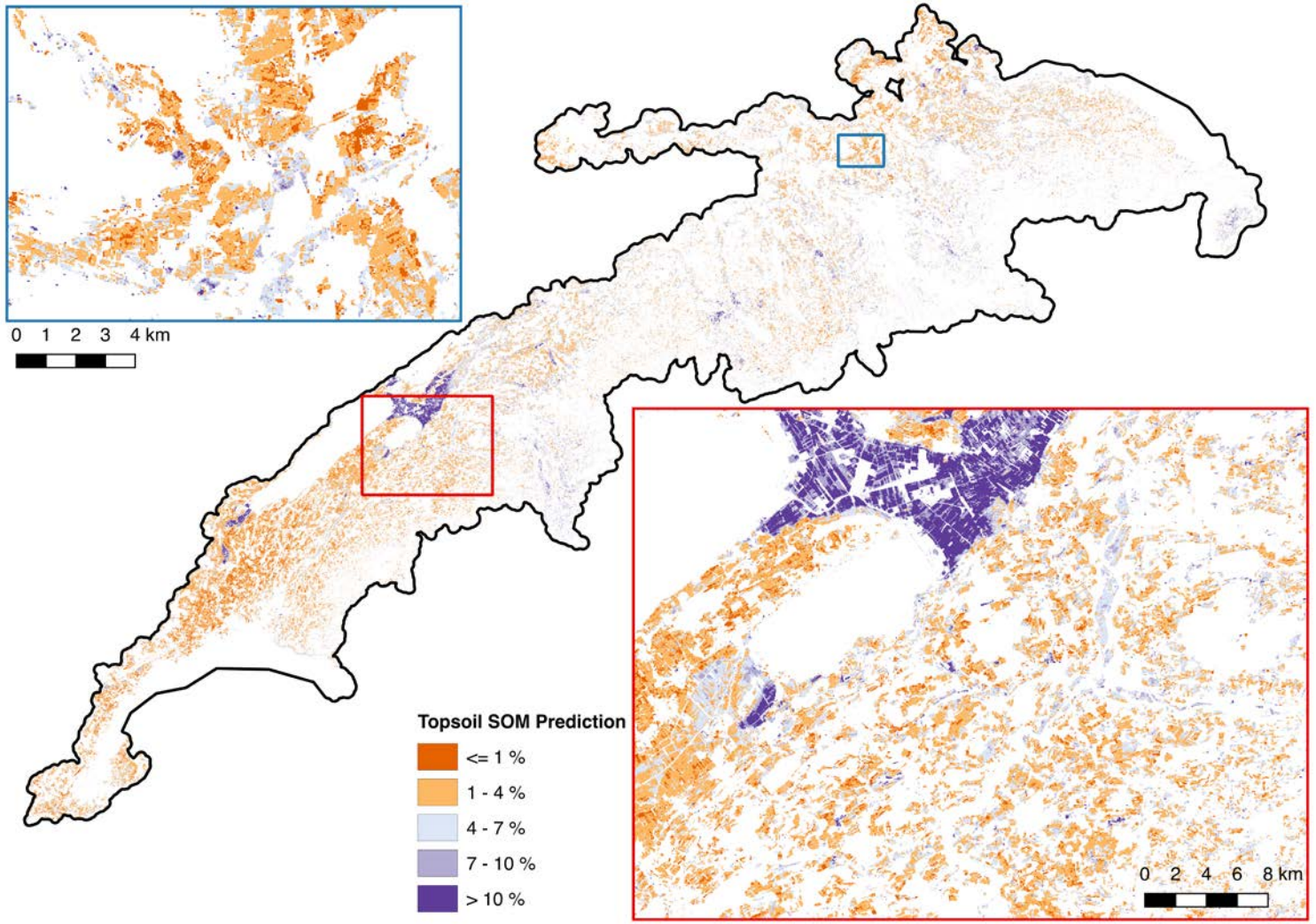
Best Pixel Mosaic: Bare Soil



Best Pixel Mosaic: Bare Soil

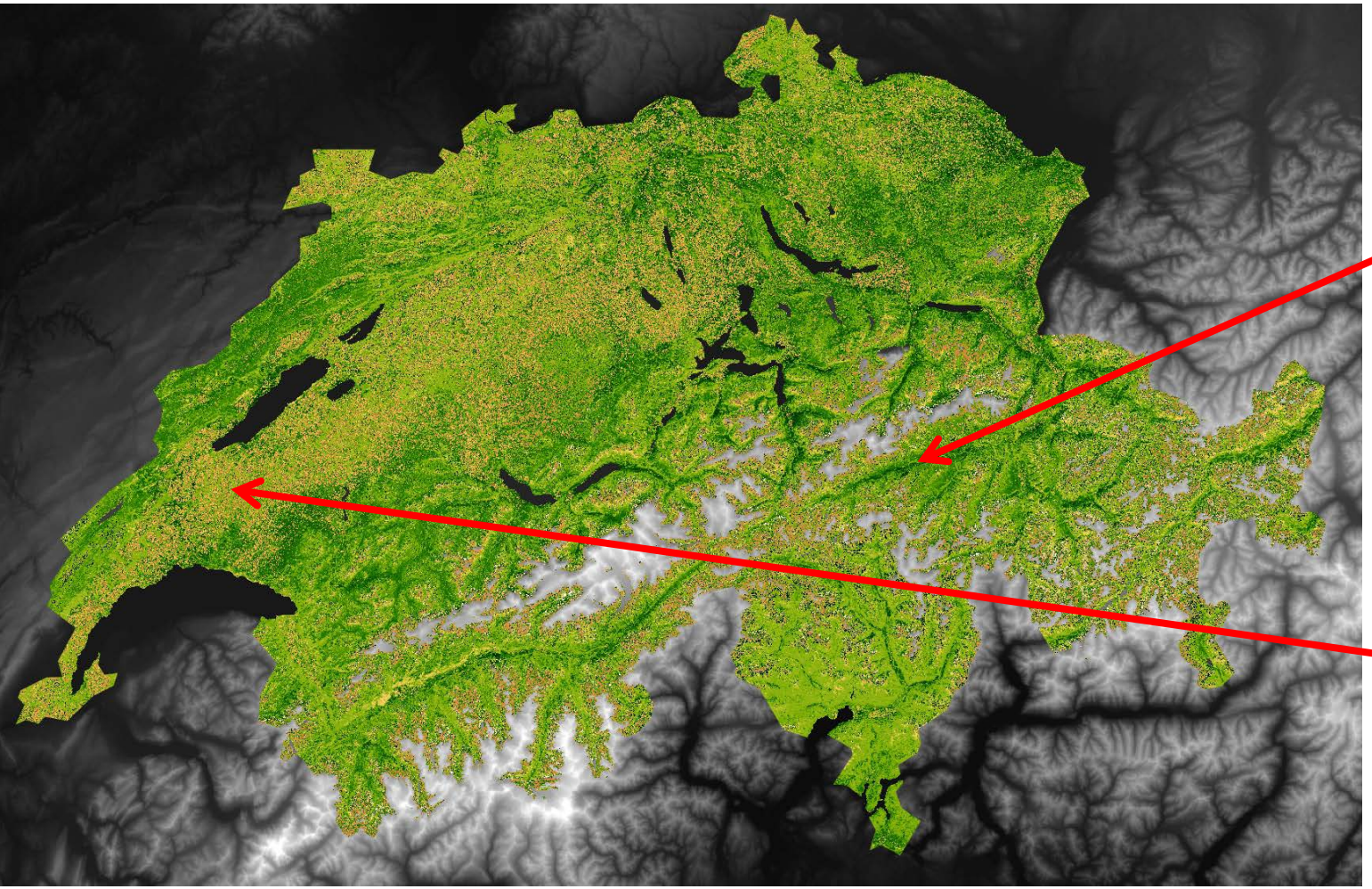


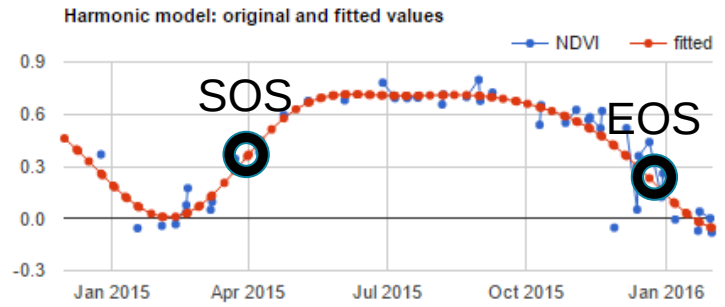
Product from bare soil mosaic: Soil organic matter (SOM) content

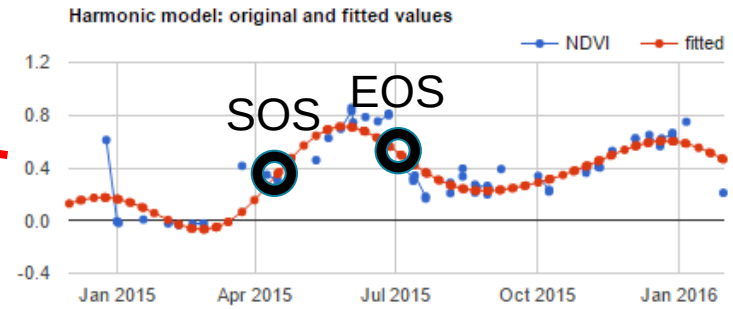


MSc Thesis
Fabio Fornallaz

Measuring Switzerland's productivity: Growing season length

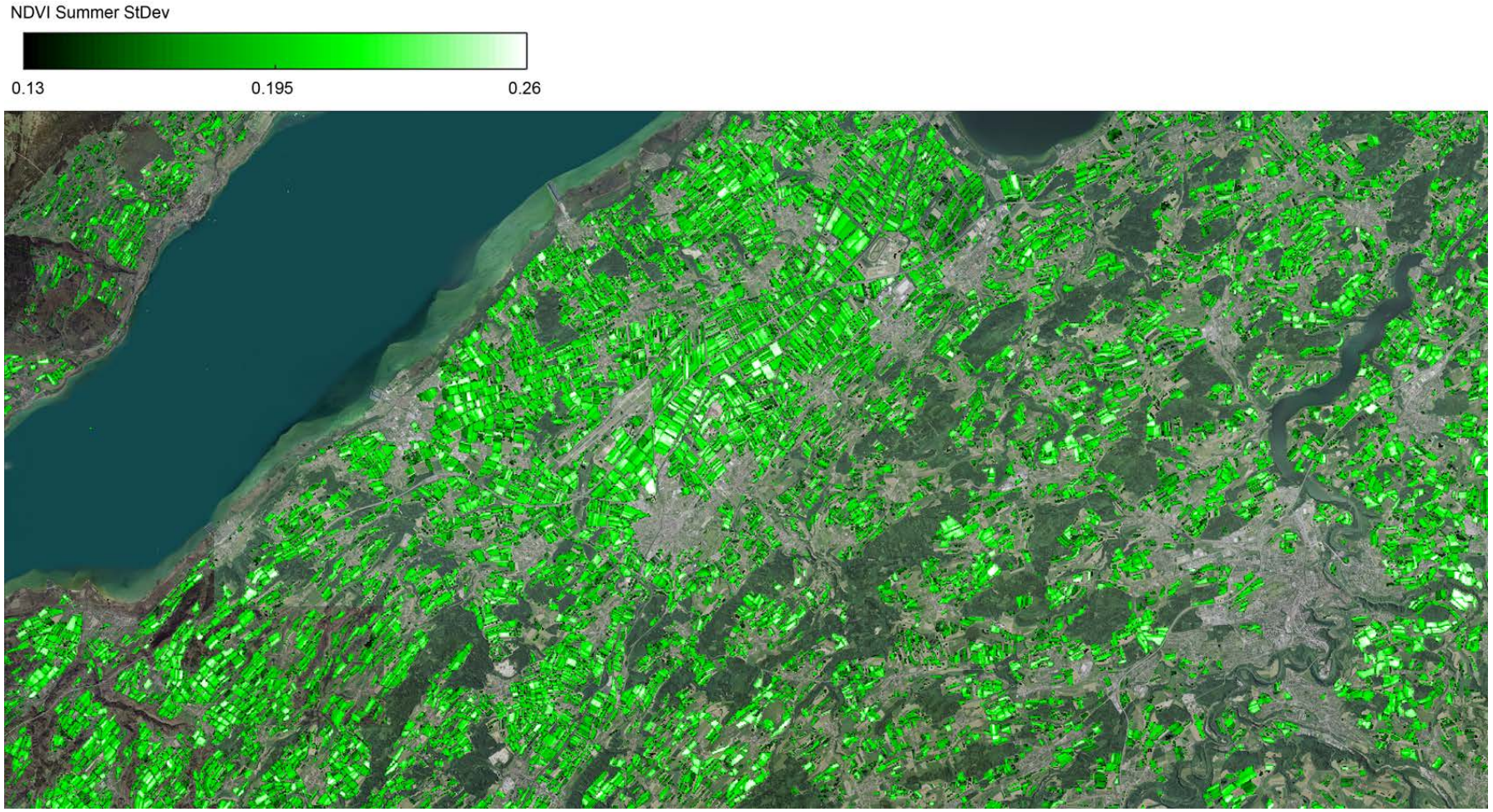






Data: Landsat 7 + 8 Surface Reflectance derived NDVI, time frame: 2015

Detecting agricultural fields by measuring vegetation change



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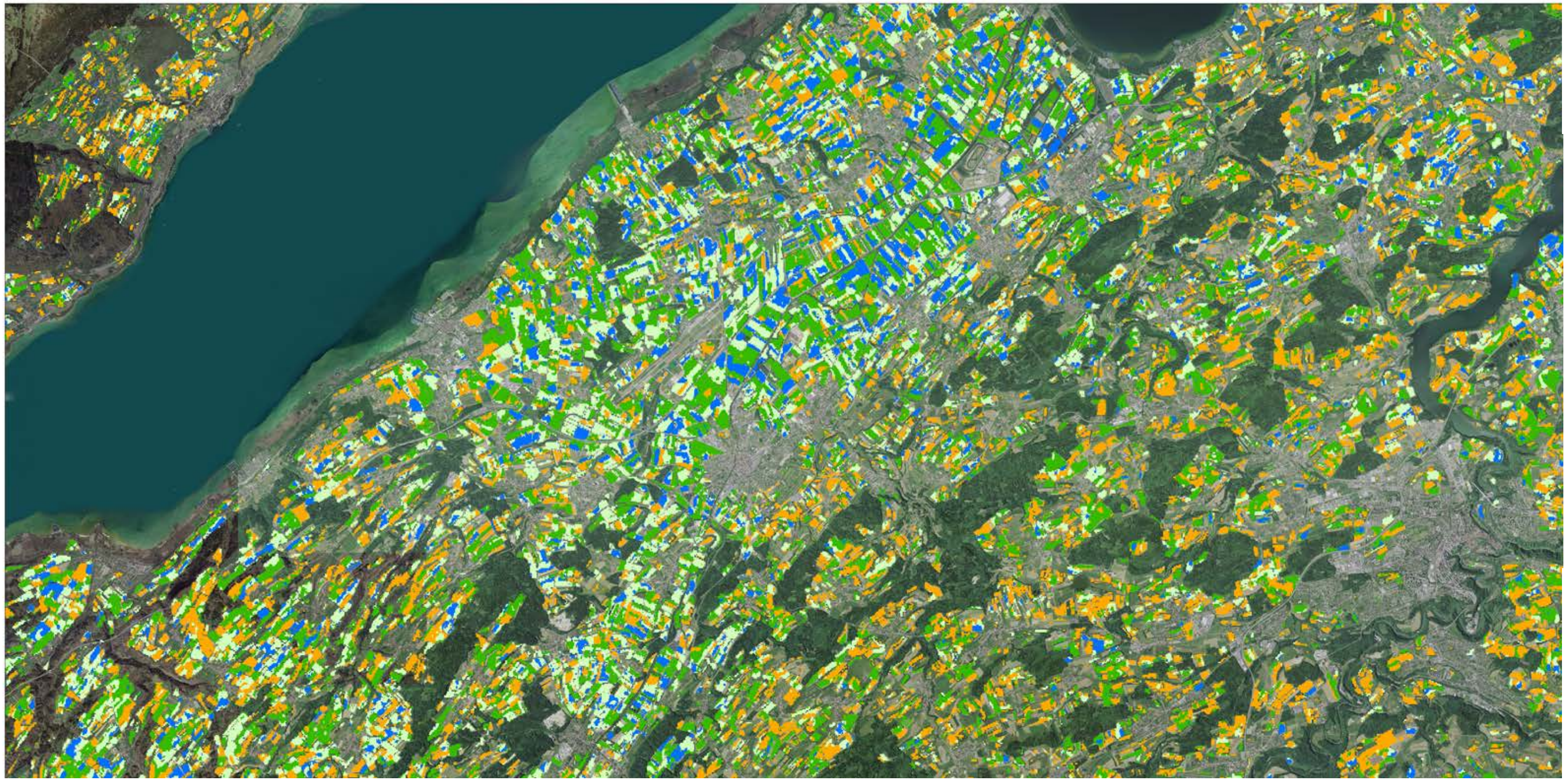
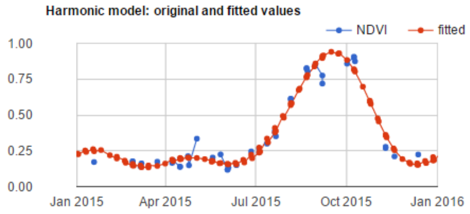
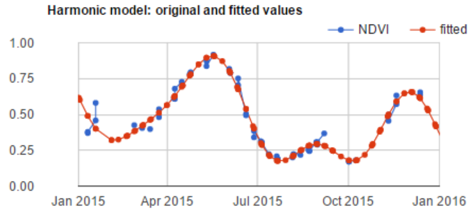
Classifying different field and crop types

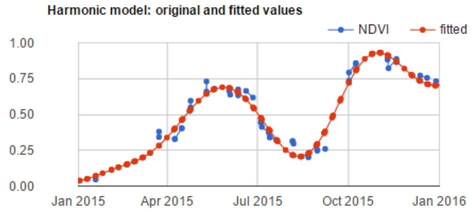
Classes

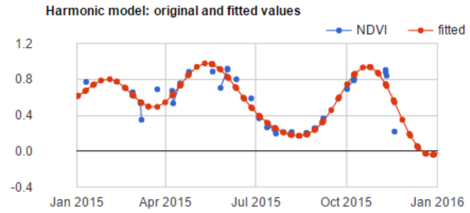
(blue)	1: Fields with one phase of crop growth	(light green)	2.2: Fields with two phases of crop growth (dominant phase in autumn)
(green)	2.1: Fields with two phases of crop growth (dominant phase in summer)	(orange)	3: Fields with multiple (<= 3) or inseparable phases of crop growth



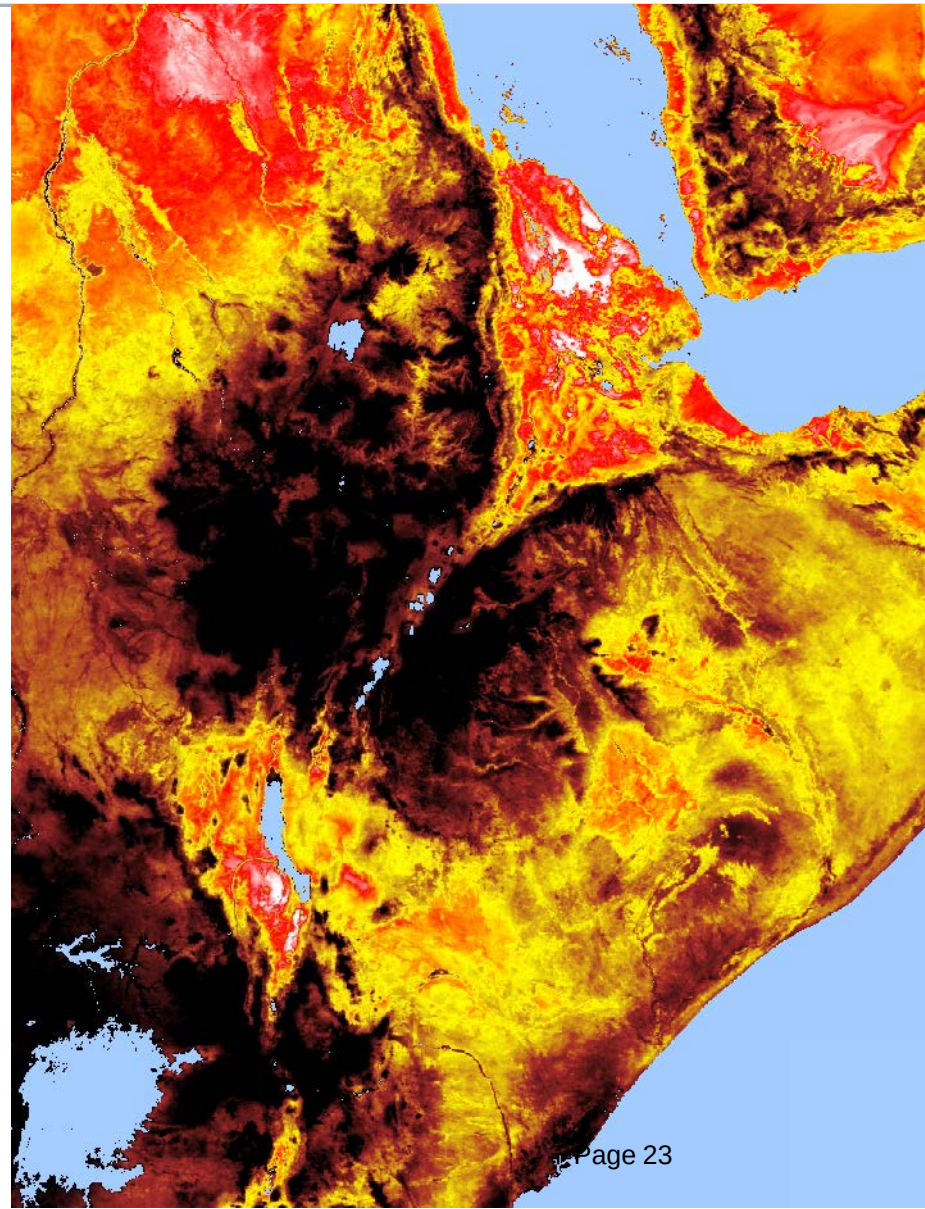








Examples: Climate



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Global summer fractional cloud cover

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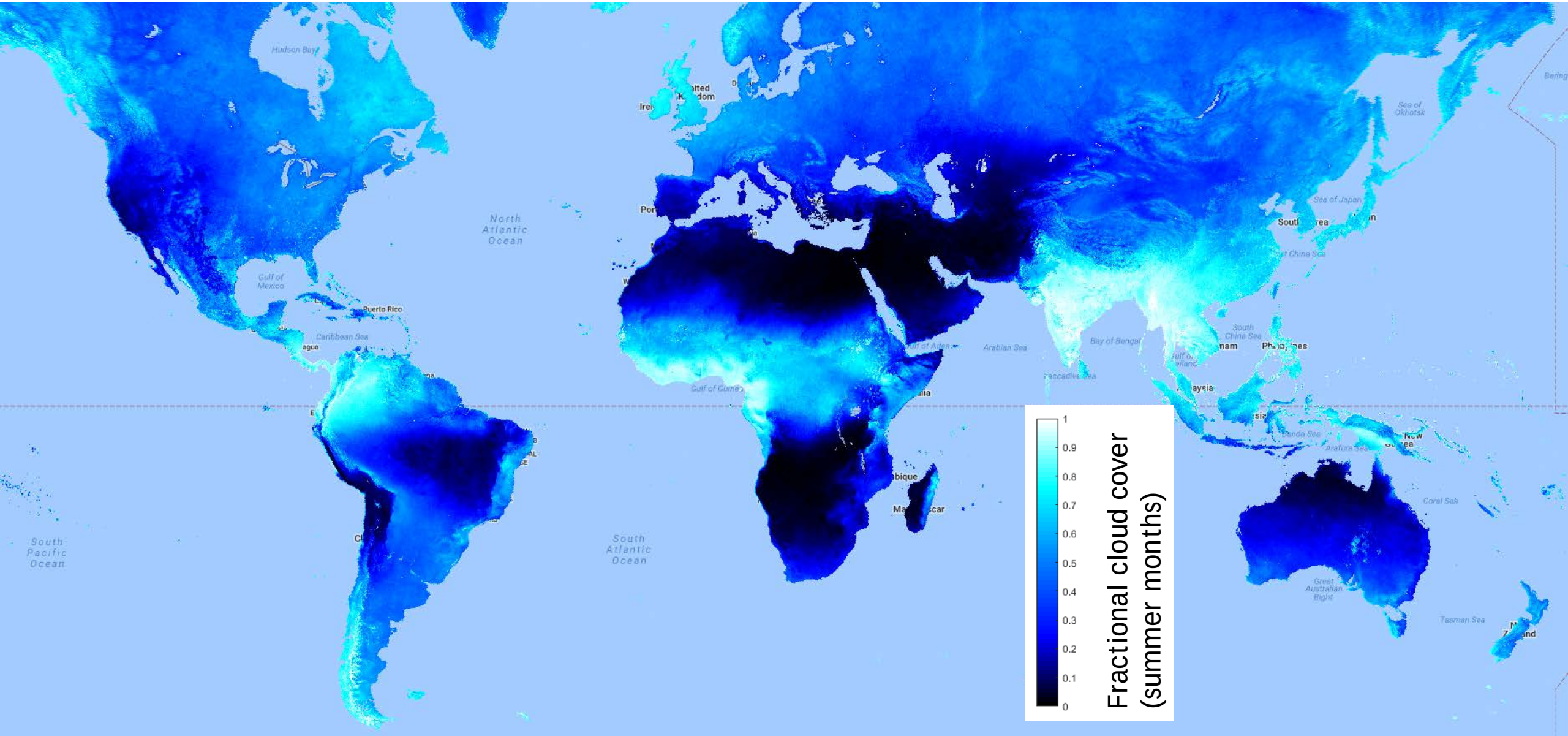
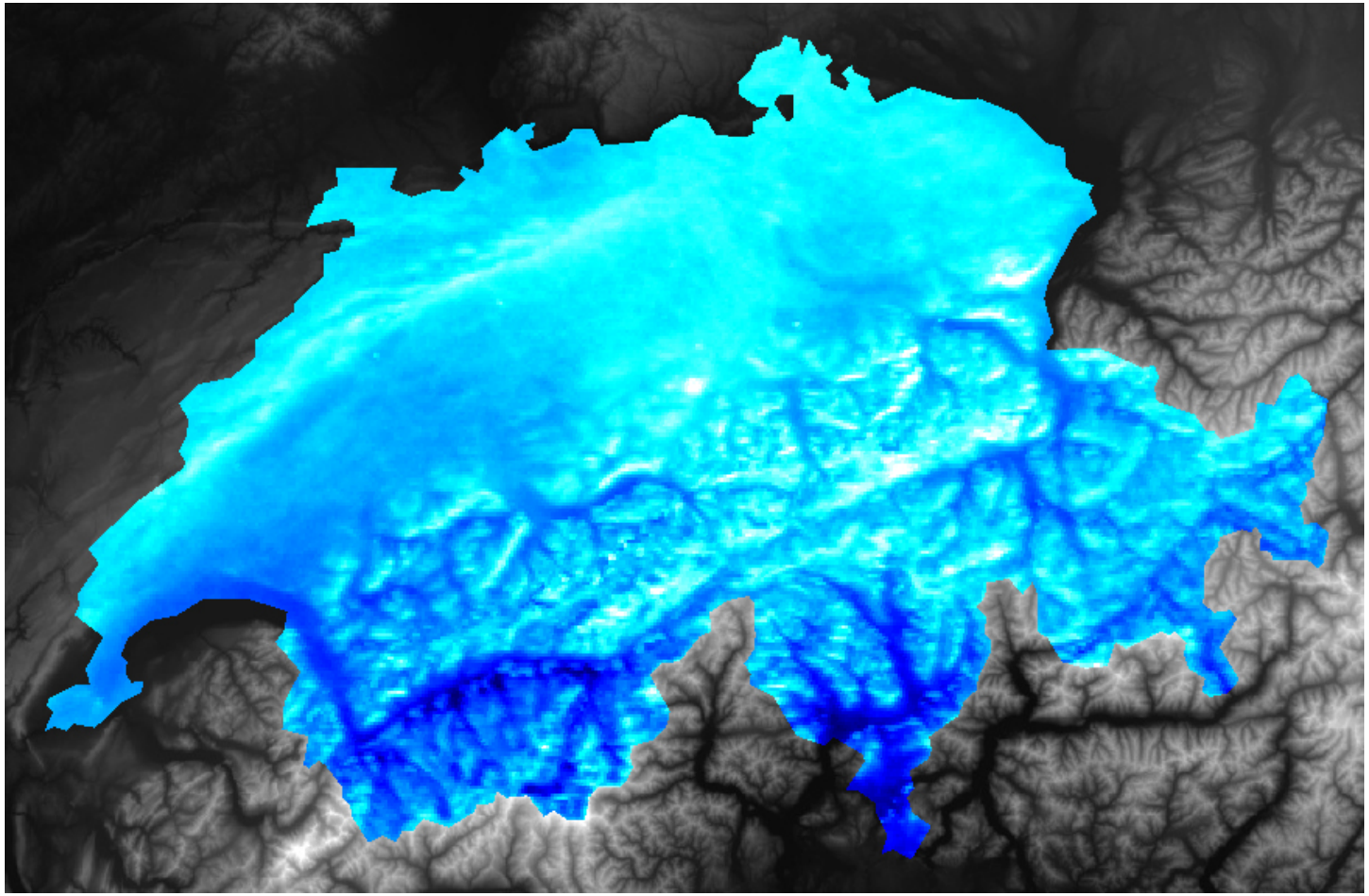
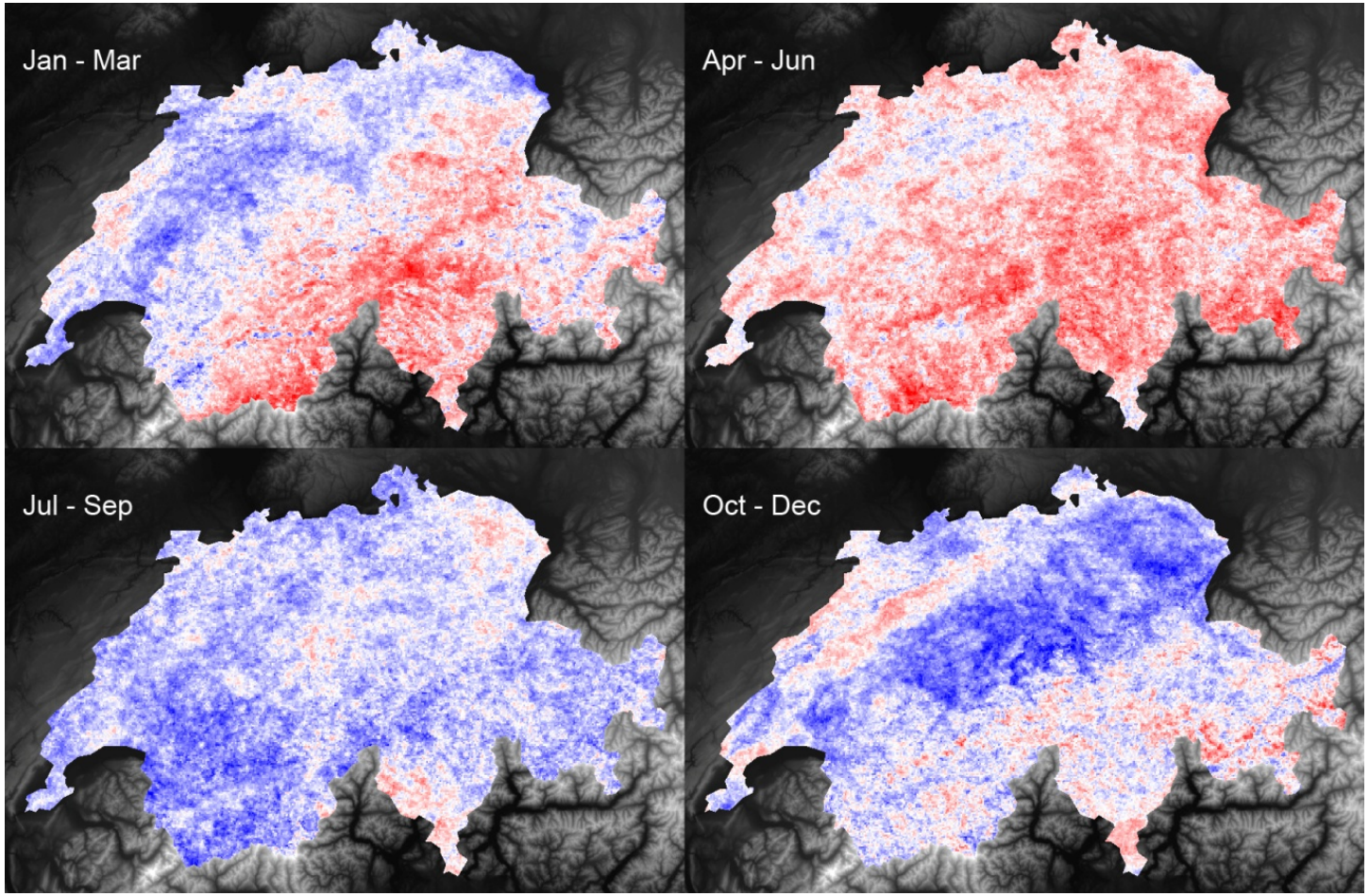


Fractional cloud cover for Switzerland, daily data averaged

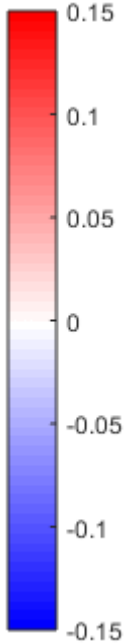


Data: MODIS surface reflectance MOD09GA, duration: 2001-2015

Linearly extrapolated change in Switzerland's cloud cover

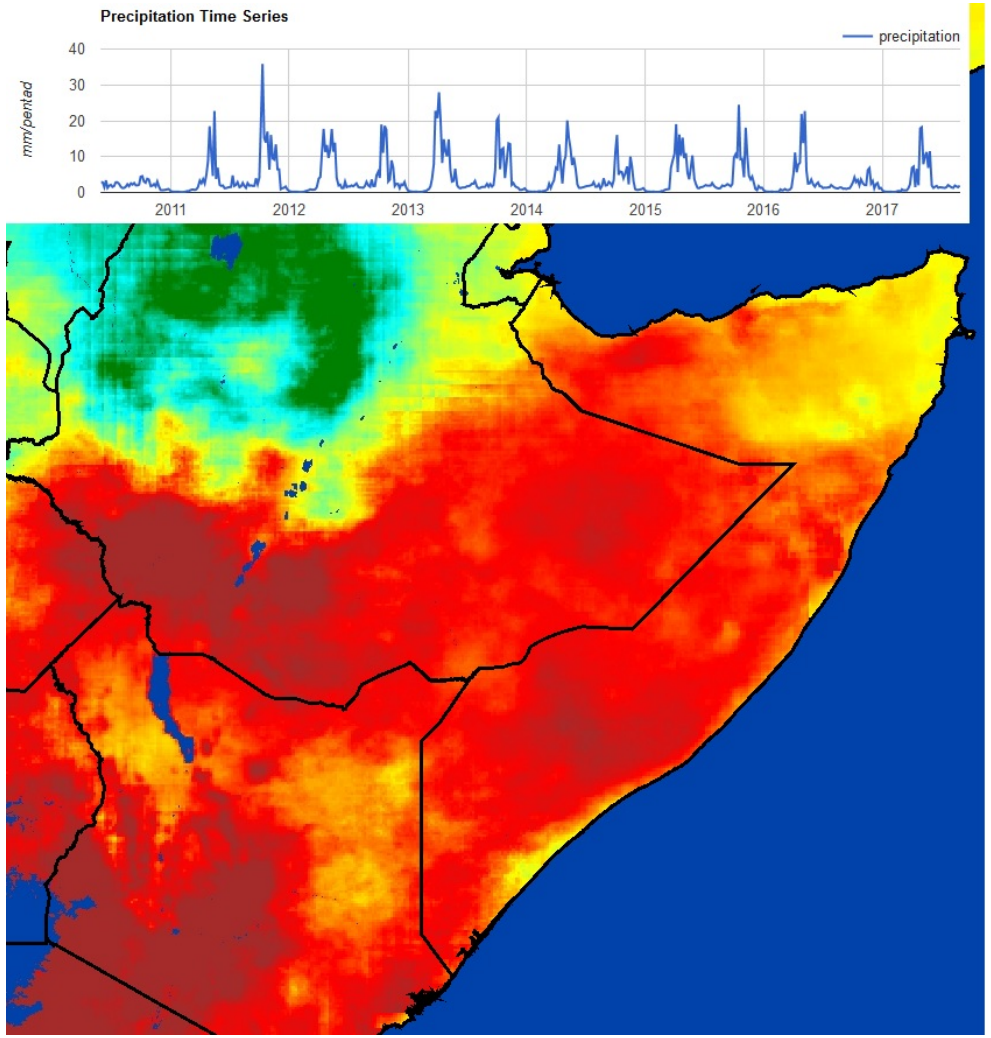


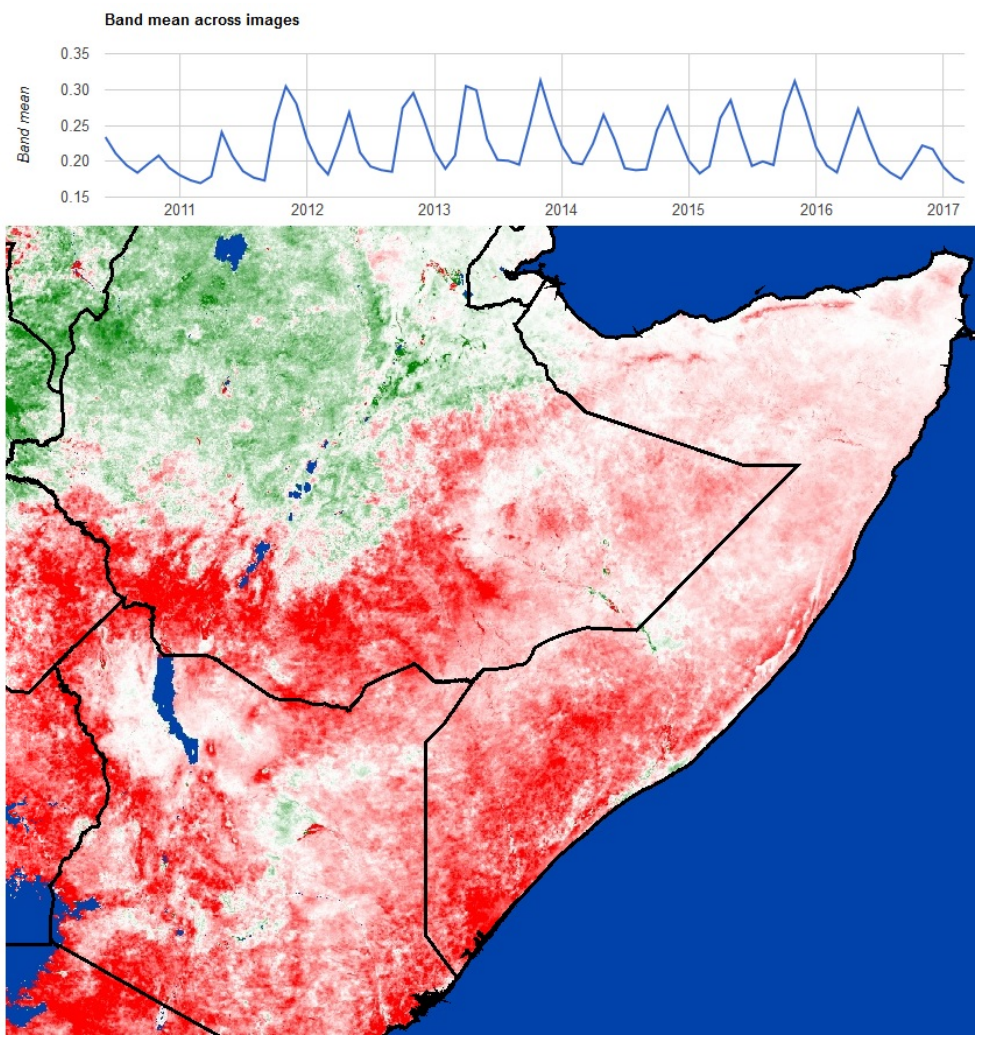
Cloud cover trend



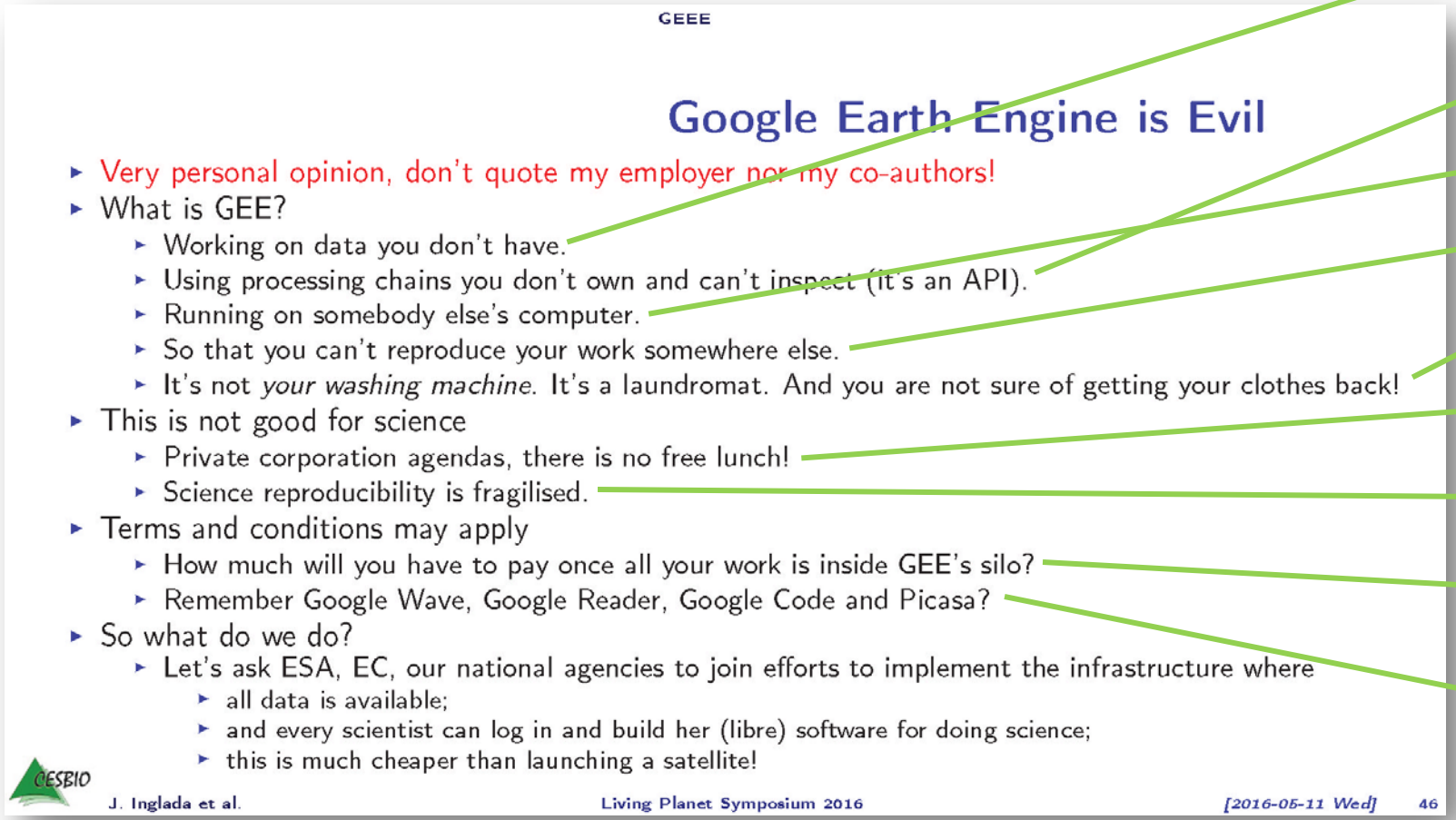
Data: MODIS surface reflectance MOD09GA, duration: 2001-2015

Drought in Somalia: Precipitation and vegetation health over time





Limitations/criticism



True for every cloud… and actually the benefit of it.

True, but documentation is very good.

True, that is a plus!

Not true, sharing code is easy

???

Could be true, however, free for edu/R&D since years

Much worse today! Matlab…

Work = code; not visible to Google (would kill it…)

True; however, internal use by Google dominating

Thank you for your attention!

Dr. Philip Jörg

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Remote Sensing Laboratories

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