

THE ARRIVAL OF A GAME CHANGER: SENTINEL-2 AND POSSIBLE APPLICATIONS FOR VEGETATION MONITORING IN FORESTRY & AGRICULTURE

Anja KLISCH & Clement ATZBERGER
(56th Photogrammetric Week ,17, Stuttgart, Germany)

... STRUCTURE...

Copernicus program of EC

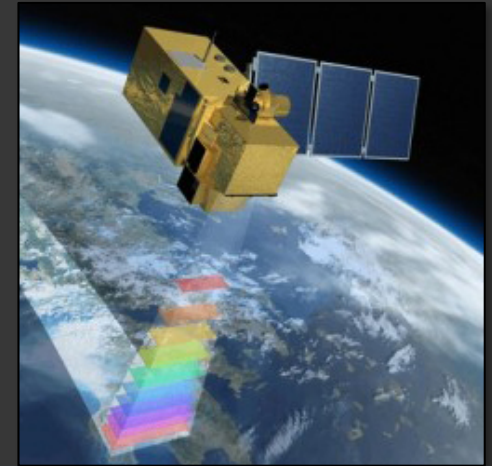
Key characteristics of S2 (and S1) game changers

Big data challenges

Example applications

... THE ARRIVAL OF A GAME CHANGER ...

- Two identical satellites (plus L8)
- 10m/20m spatial resolution
- 13 spectral channels
- Global coverage every 5 days
- Data is free and open

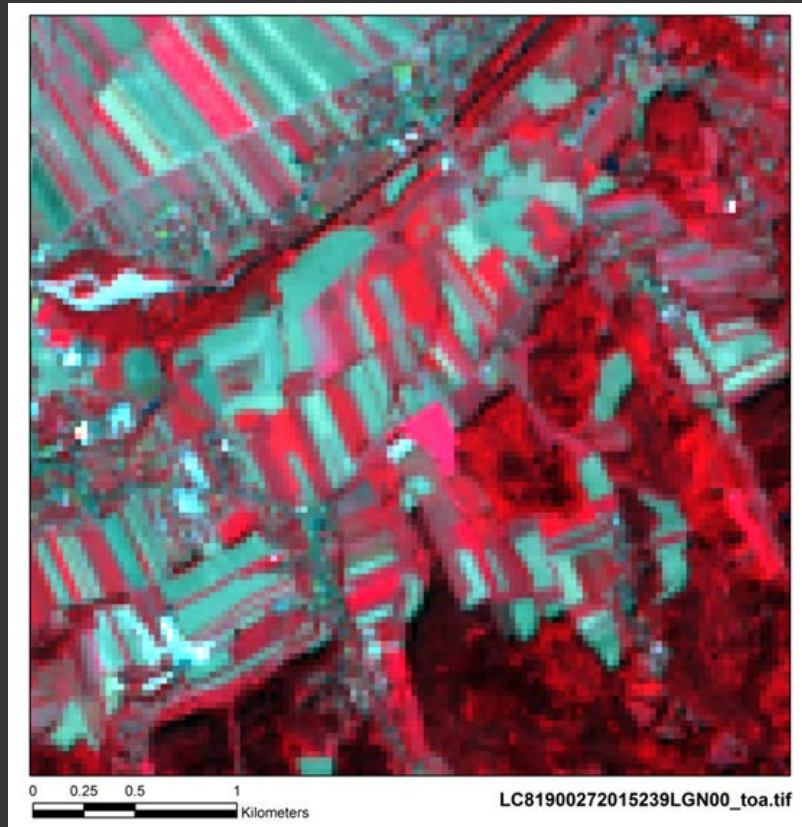


The Sentinel-2 mission is a land monitoring constellation of two identical satellites providing high resolution optical imagery. It ensures continuity for the current SPOT and Landsat missions for the next ~20 years.

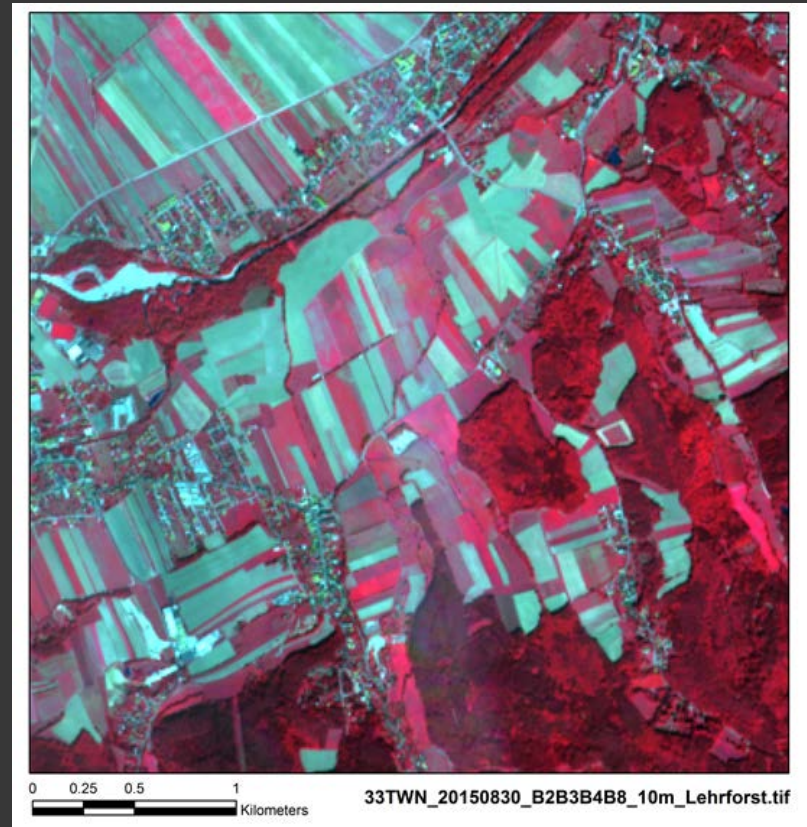
The mission provides a global coverage of the Earth's land surface every 5 days (with twin satellites), making the data of great use for humanitarian organizations such as WFP.

The satellites are equipped with the state-of-the-art MSI (Multispectral Imager) instrument, that offers high-resolution optical imagery. All data are for free to everyone.

... THE ARRIVAL OF A GAME CHANGER ...
SPATIAL RESOLUTION 10 METER



Landsat-8



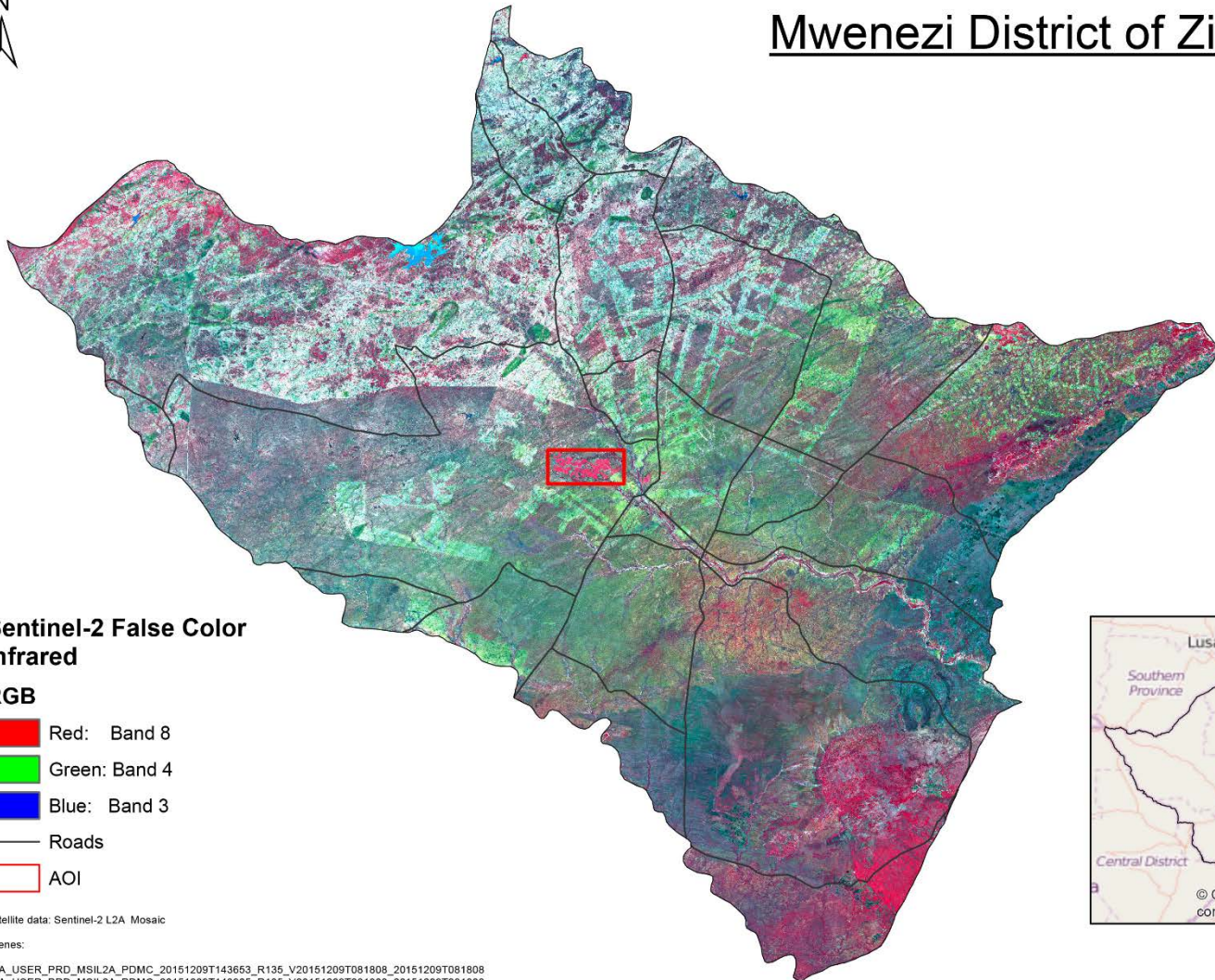
Sentinel-2

... THE ARRIVAL OF A GAME CHANGER ...

SPATIAL COVERAGE 290 KM



Mwenezi District of Zimbabwe



Sentinel-2 False Color Infrared

RGB

-  Red: Band 8
-  Green: Band 4
-  Blue: Band 3
-  Roads
-  AOI

Satellite data: Sentinel-2 L2A Mosaic

Scenes:

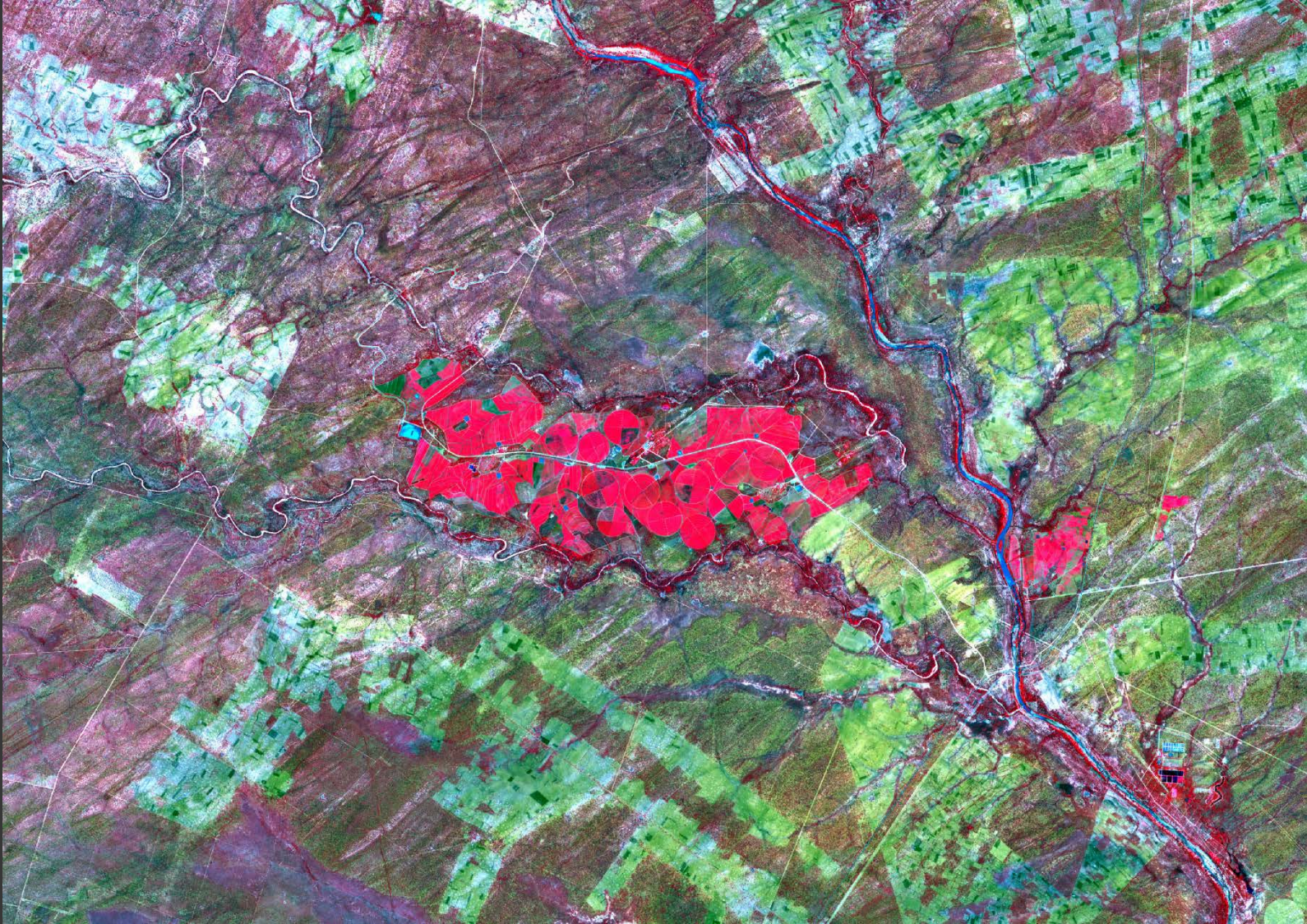
S2A_USER_PRD_MSIL2A_PDMC_20151209T143653_R135_V20151209T081808_20151209T081808
S2A_USER_PRD_MSIL2A_PDMC_20151209T143905_R135_V20151209T081808_20151209T081808

Vector data: www.diva-gis.org

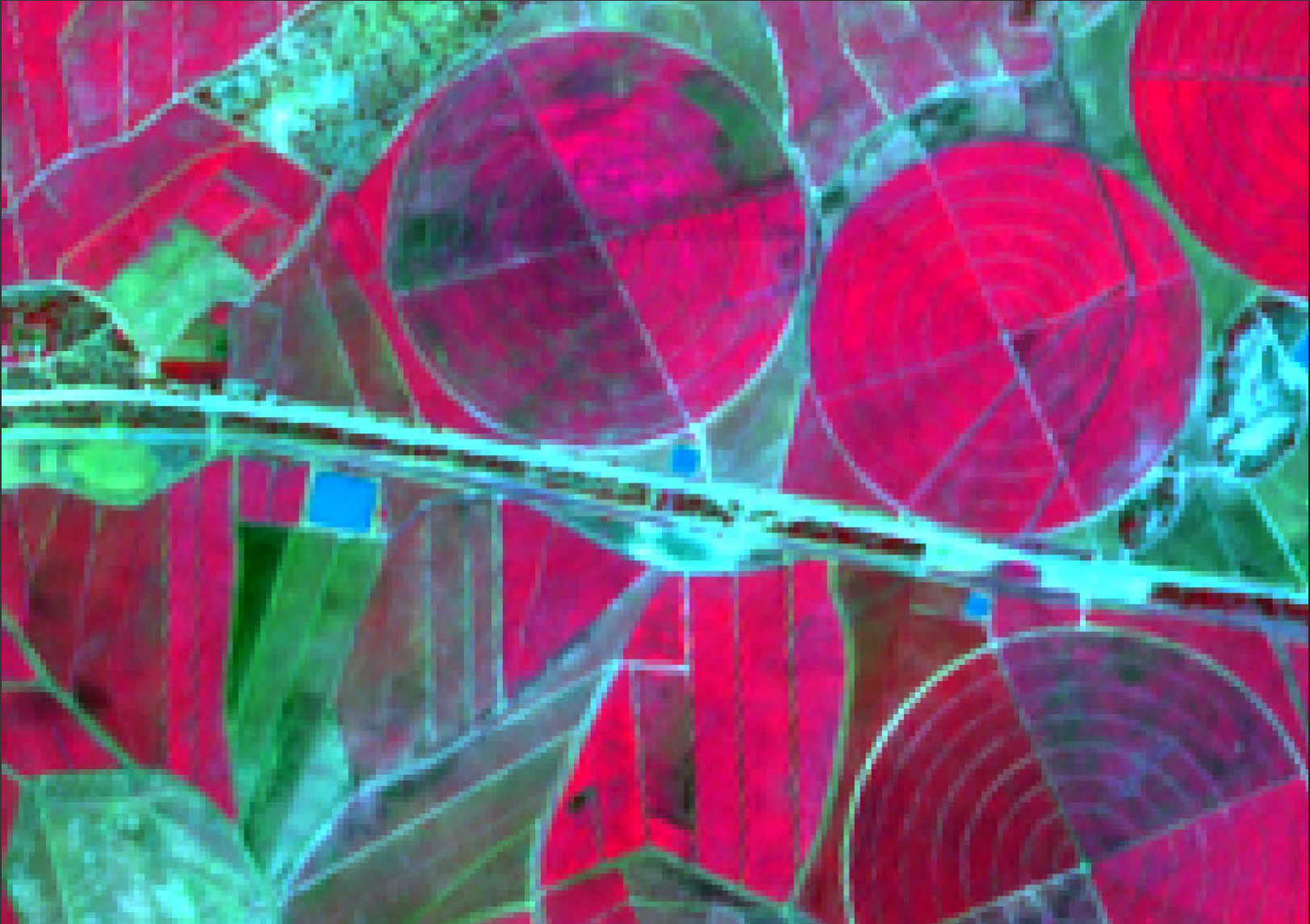


© OpenStreetMap (and)
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... THE ARRIVAL OF A GAME CHANGER ...
ZOOM-IN

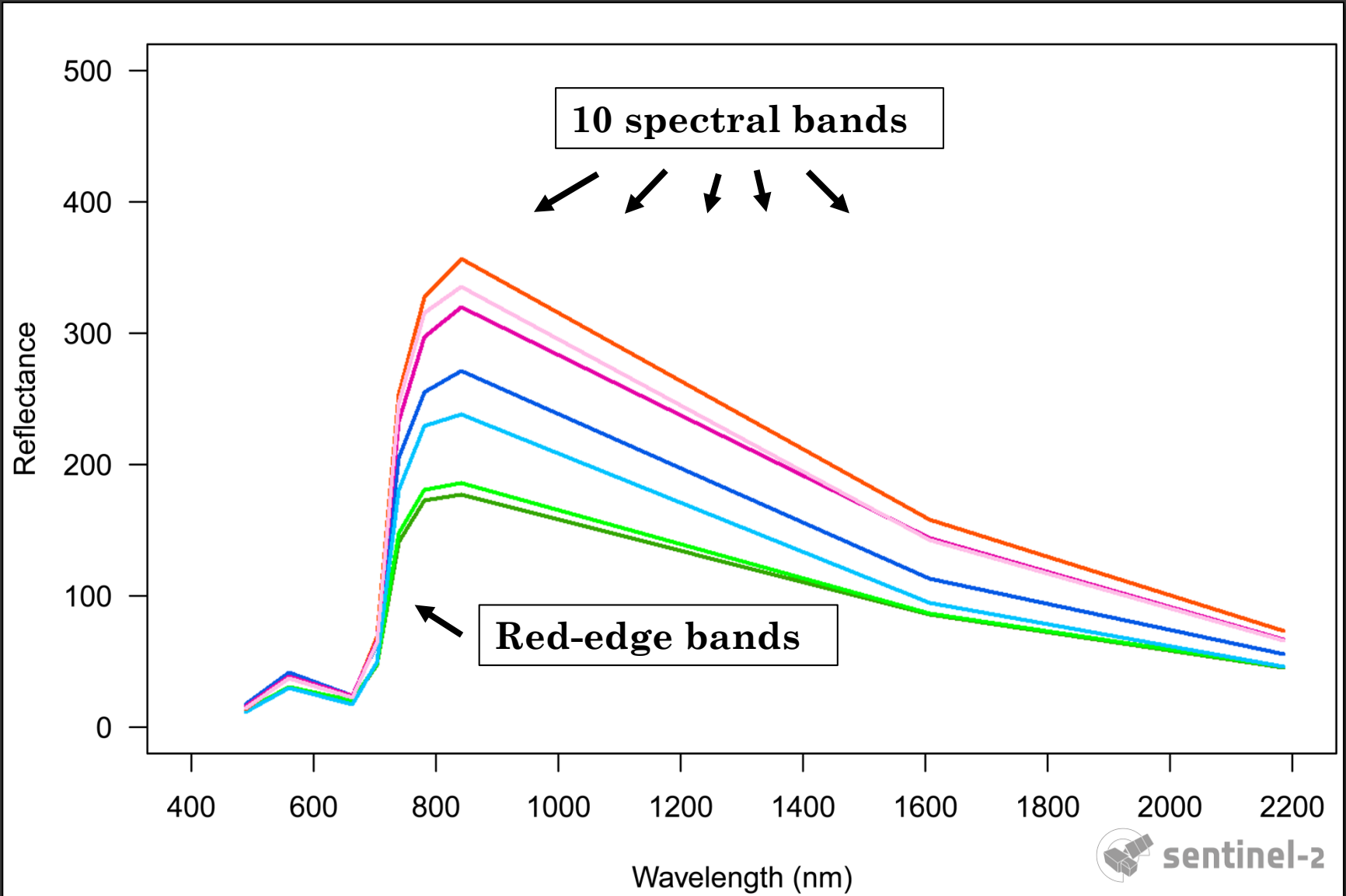


... THE ARRIVAL OF A GAME CHANGER ...
ZOOM-IN



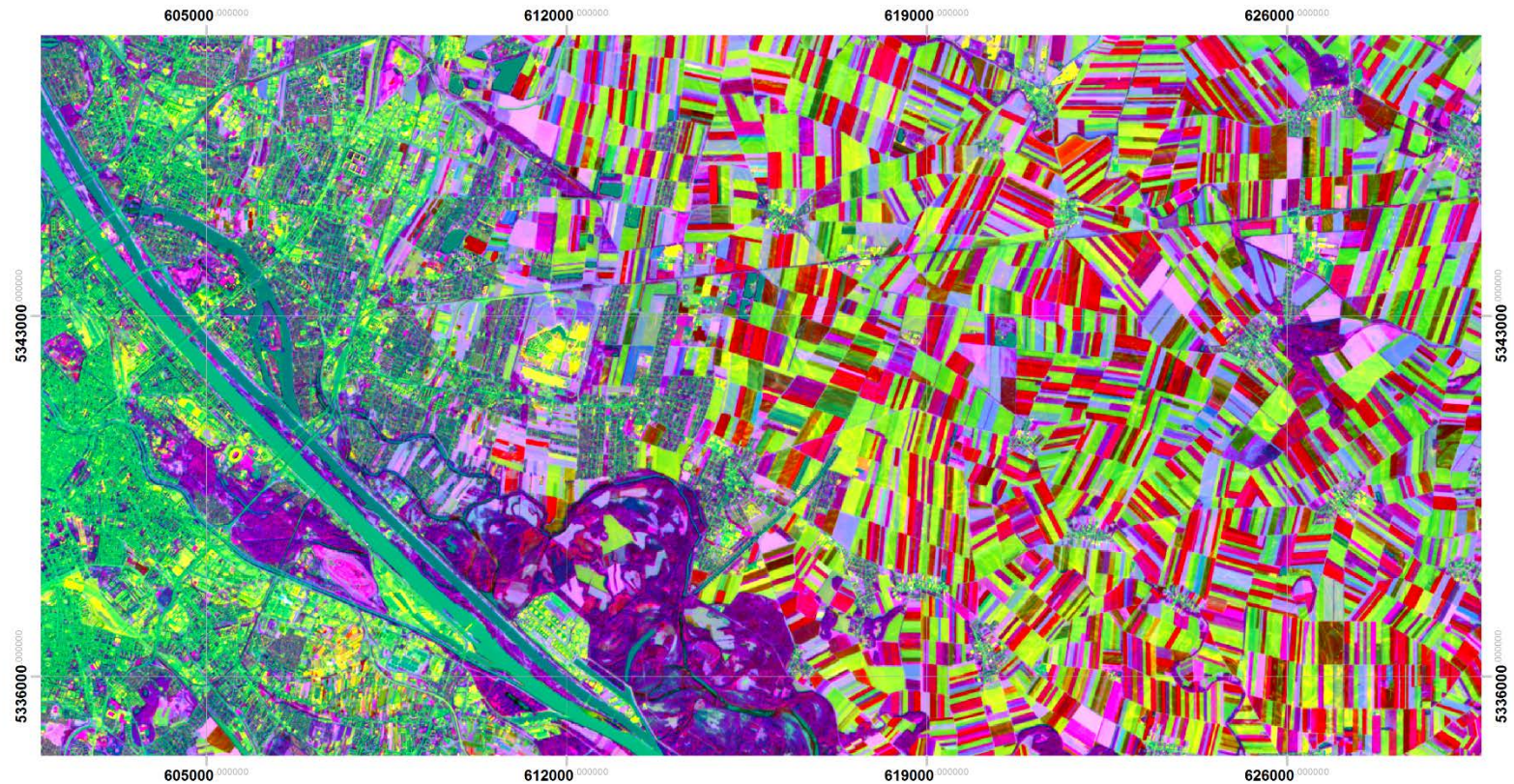
... THE ARRIVAL OF A GAME CHANGER ...

SPECTRAL SETTING

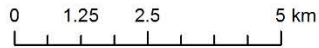


... THE ARRIVAL OF A GAME CHANGER ...




RICH & DETAILED INFORMATION



SENTINEL2



RGB

-  PC 1
-  PC 2
-  PC 3

Data:

S2A_USER_PRD_MSIL2A_PDMC_20160319T120048_R079_V20150807T095007_20150807T095007
S2A_USER_PRD_MSIL2A_PDMC_20160206T202544_R122_V20160206T100203_20160206T100203
S2A_USER_PRD_MSIL2A_PDMC_20160506T205958_R122_V20160506T100527_20160506T100527

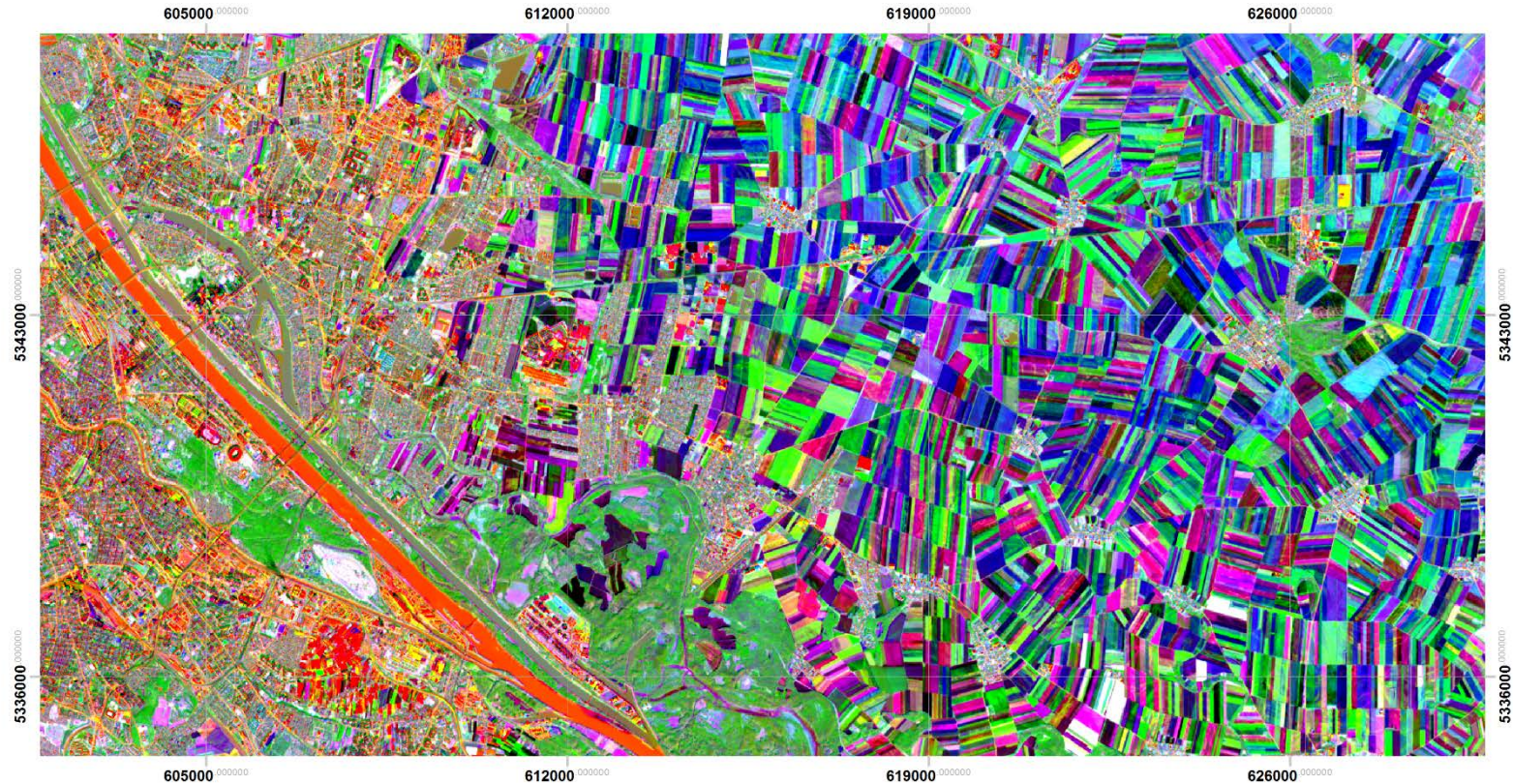


PCs: 1-2-3: Information from three S2 images



... THE ARRIVAL OF A GAME CHANGER ...

RICH & DETAILED INFORMATION

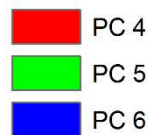


SENTINEL2



0 1.25 2.5 5 km

RGB



Data:

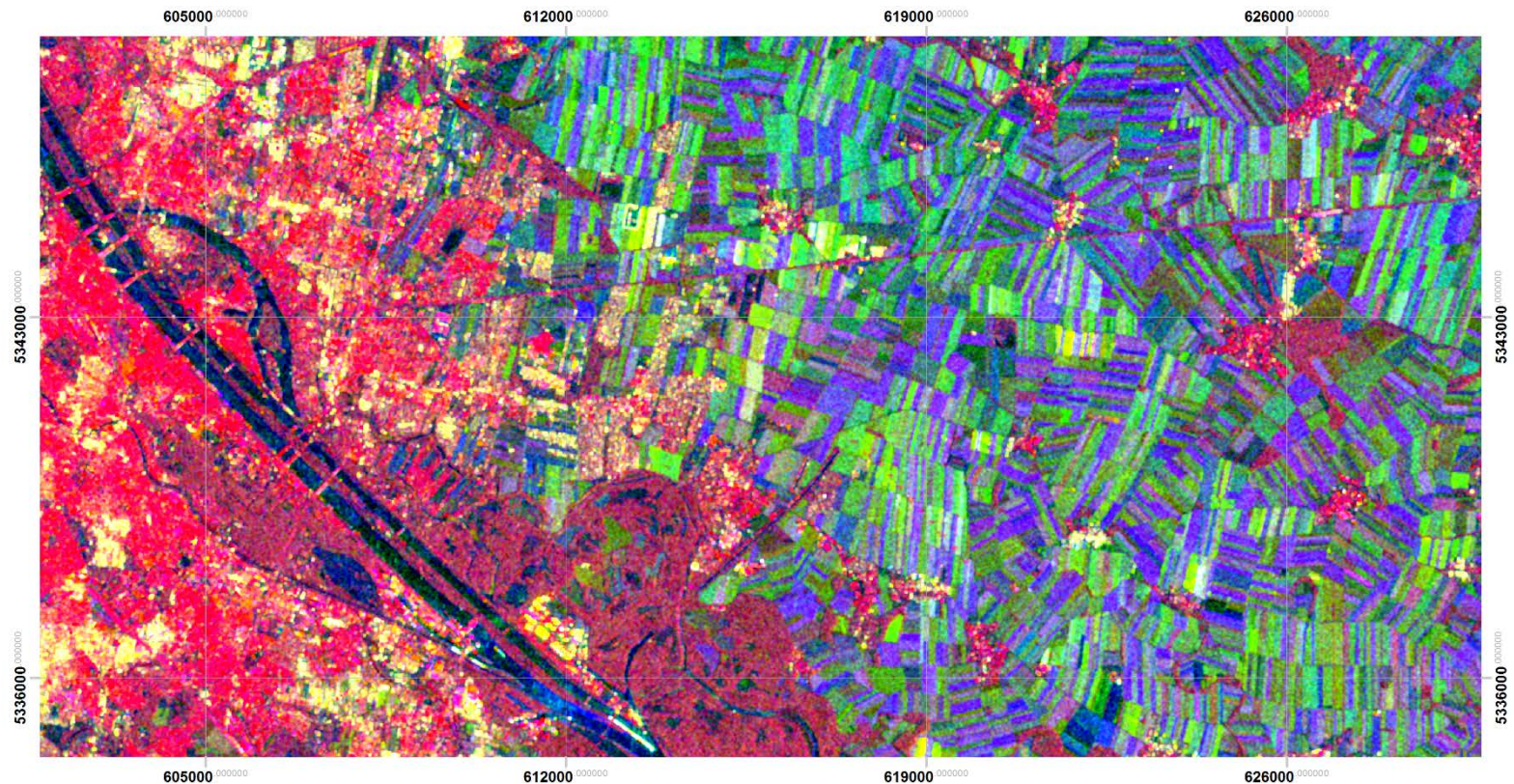
S2A_USER_PRD_MSIL2A_PDMC_20160319T120048_R079_V20150807T095007_20150807T095007
S2A_USER_PRD_MSIL2A_PDMC_20160206T202544_R122_V20160206T100203_20160206T100203
S2A_USER_PRD_MSIL2A_PDMC_20160506T205958_R122_V20160506T100527_20160506T100527



PCs: 4-5-6: Information from three S2 images



... ANOTHER GAME CHANGER ... MICROWAVE SENSING THROUGH CLOUDS

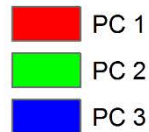


SENTINEL1



0 1.25 2.5 5 km

RGB



Data:

S1A_IW_GRDH_1SDV_20150815T050946_20150815T051011_007269_009F59_D543
S1A_IW_GRDH_1SDV_20160206T050130_20160206T050155_009821_00E5FD_7538
S1A_IW_GRDH_1SDV_20160505T050948_20160505T051013_011119_010C29_EC90

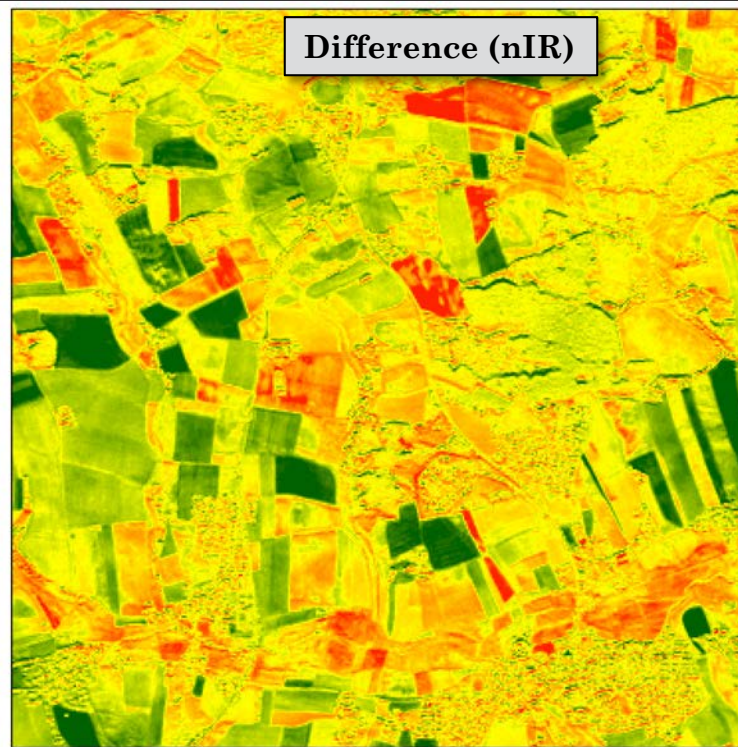
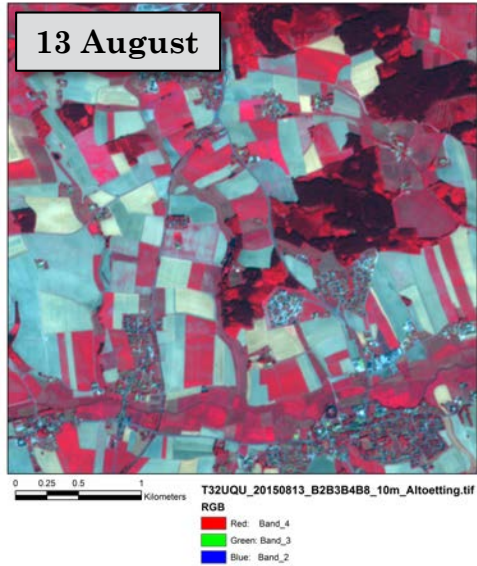


PCs: 1-2-3: Information from three S1 (RADAR) images

... THE ARRIVAL OF A GAME CHANGER ...

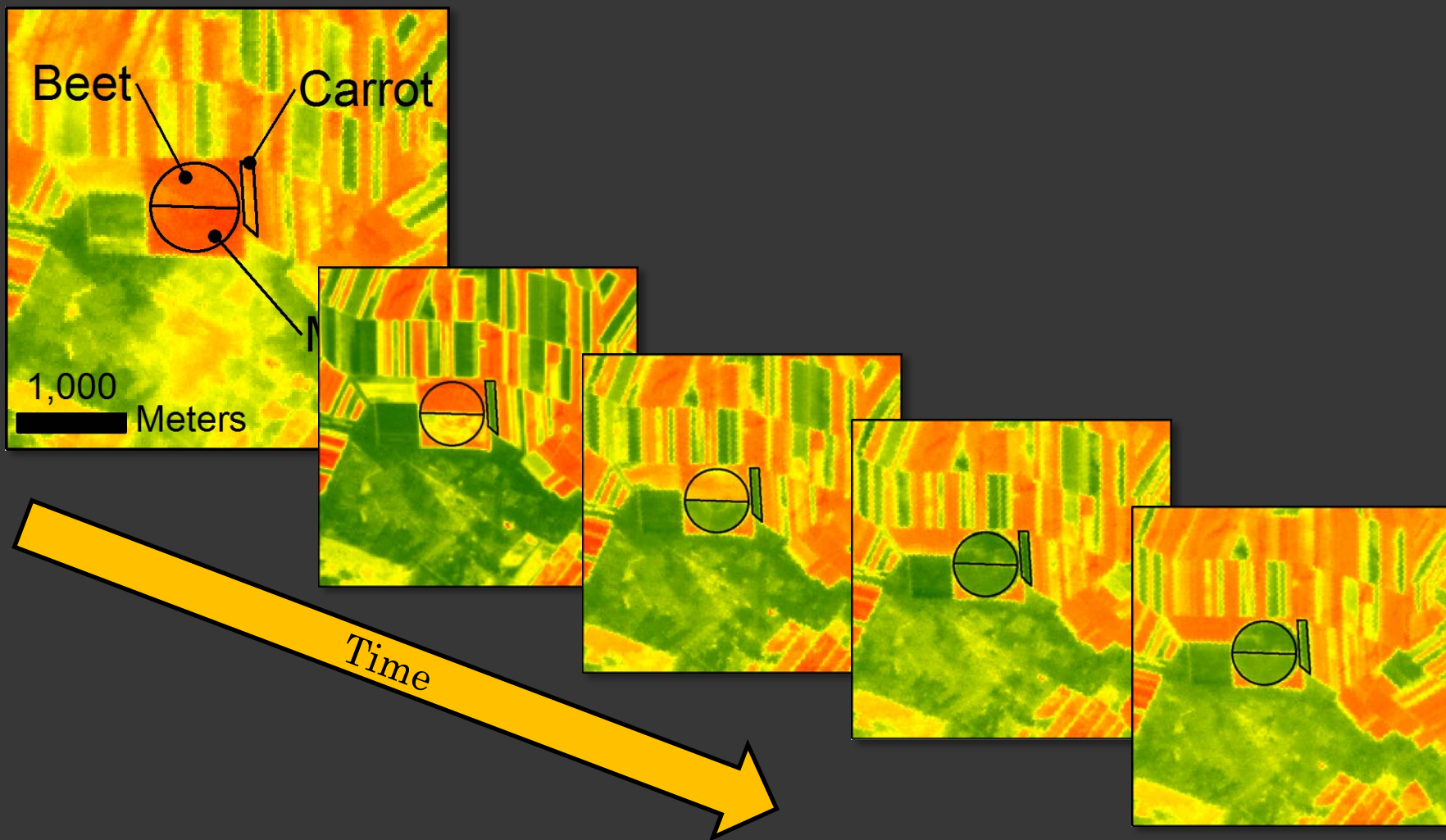
SHORT REVISIT TIME

← 10 days →



... THE ARRIVAL OF A GAME CHANGER ...

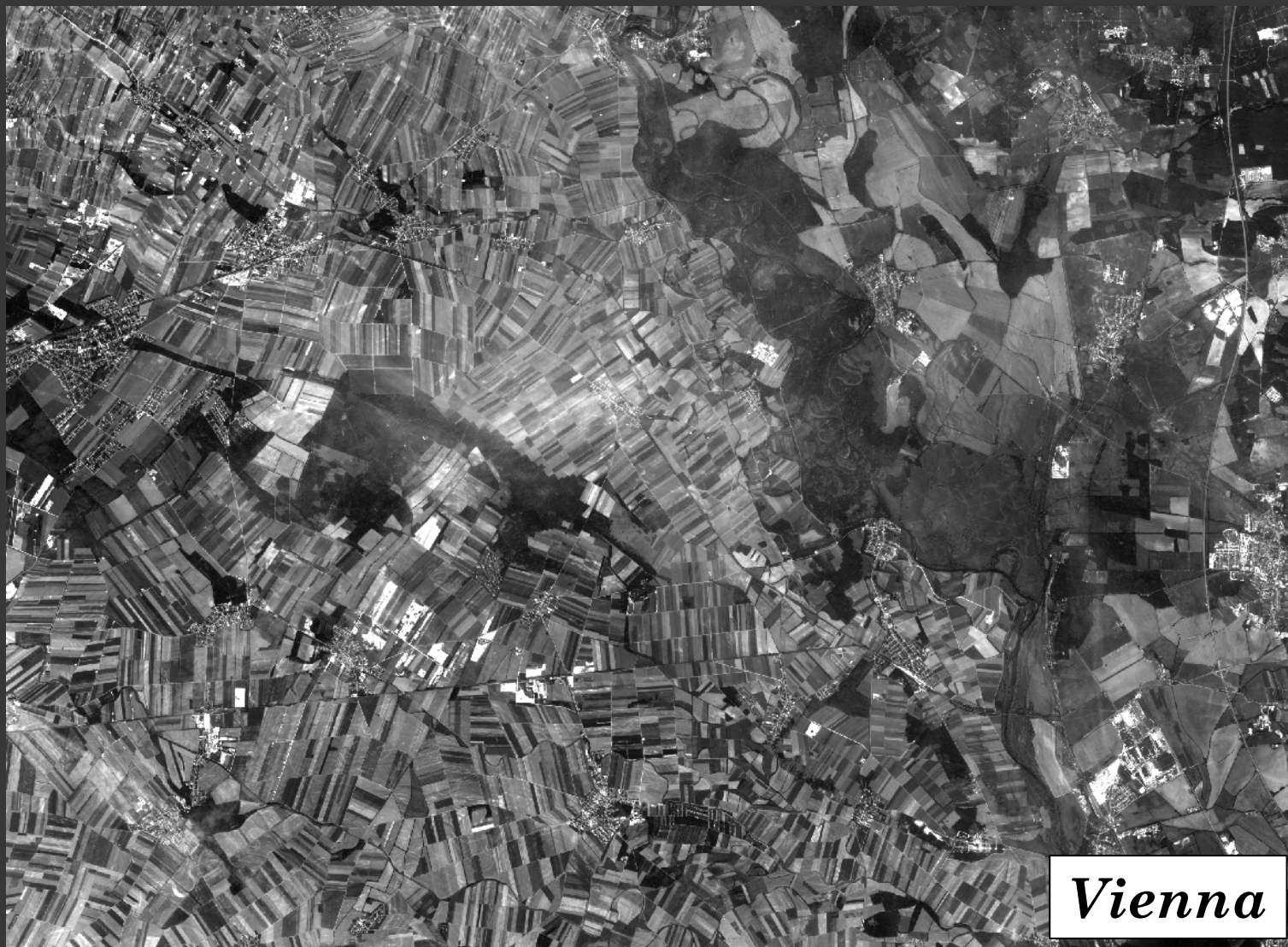
SHORT REVISIT TIME



... THE ARRIVAL OF A GAME CHANGER ...

ATMOSPHERIC CORRECTION

B02: 30/08/2015



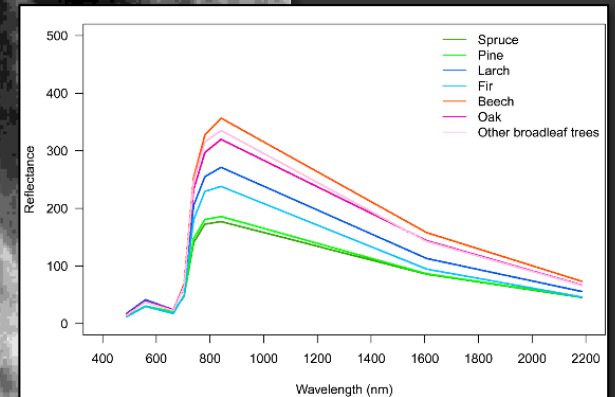
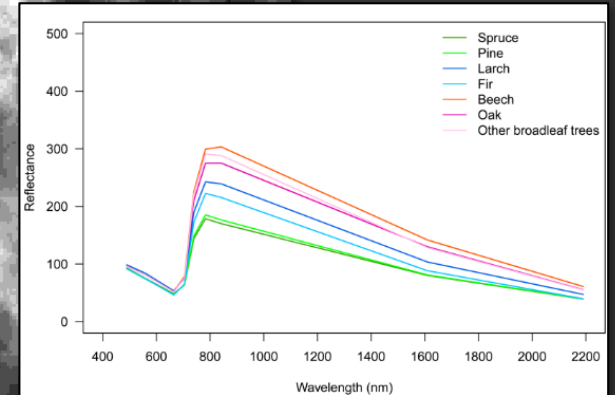
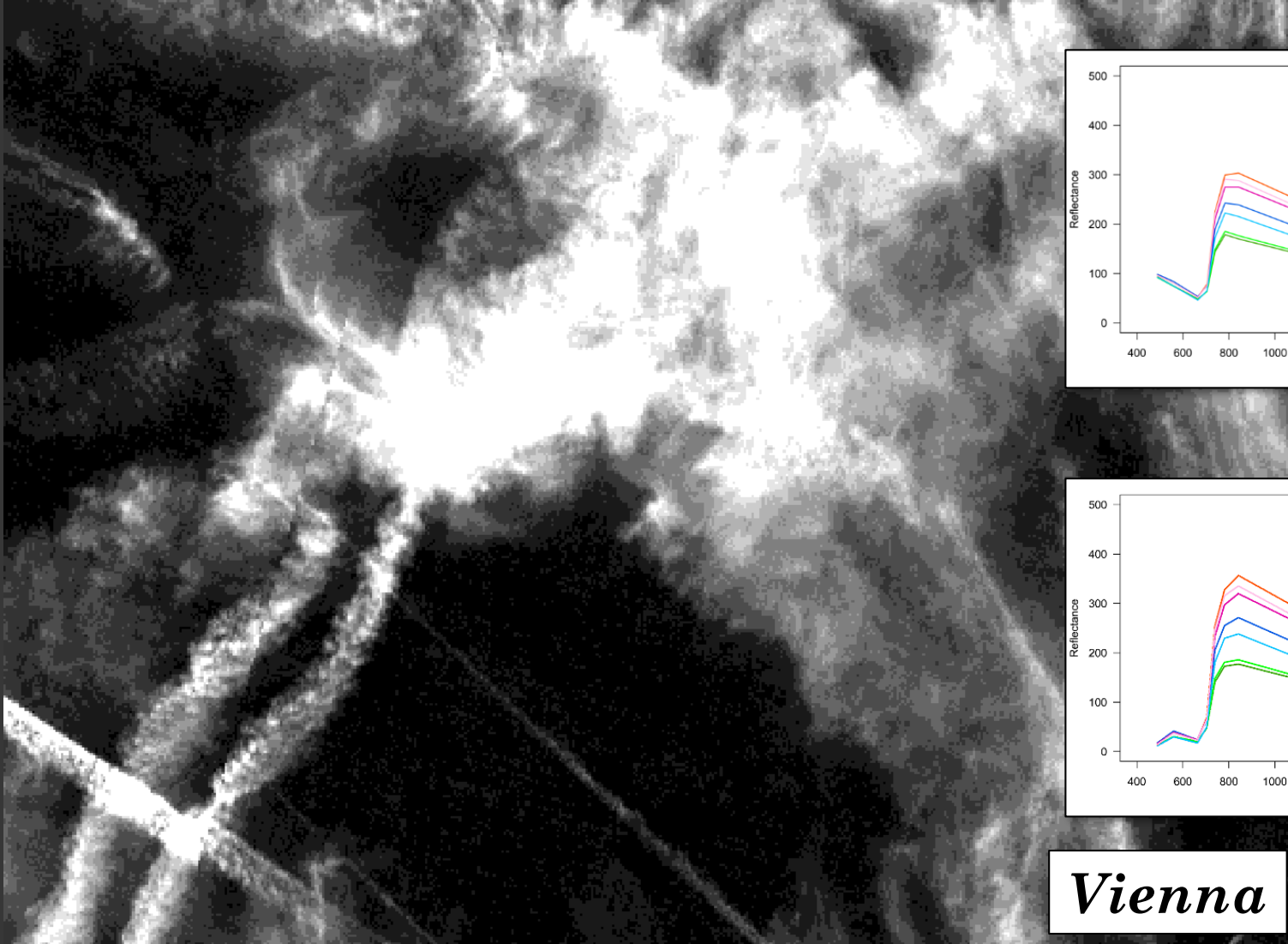
Vienna



... THE ARRIVAL OF A GAME CHANGER ...

ATMOSPHERIC CORRECTION

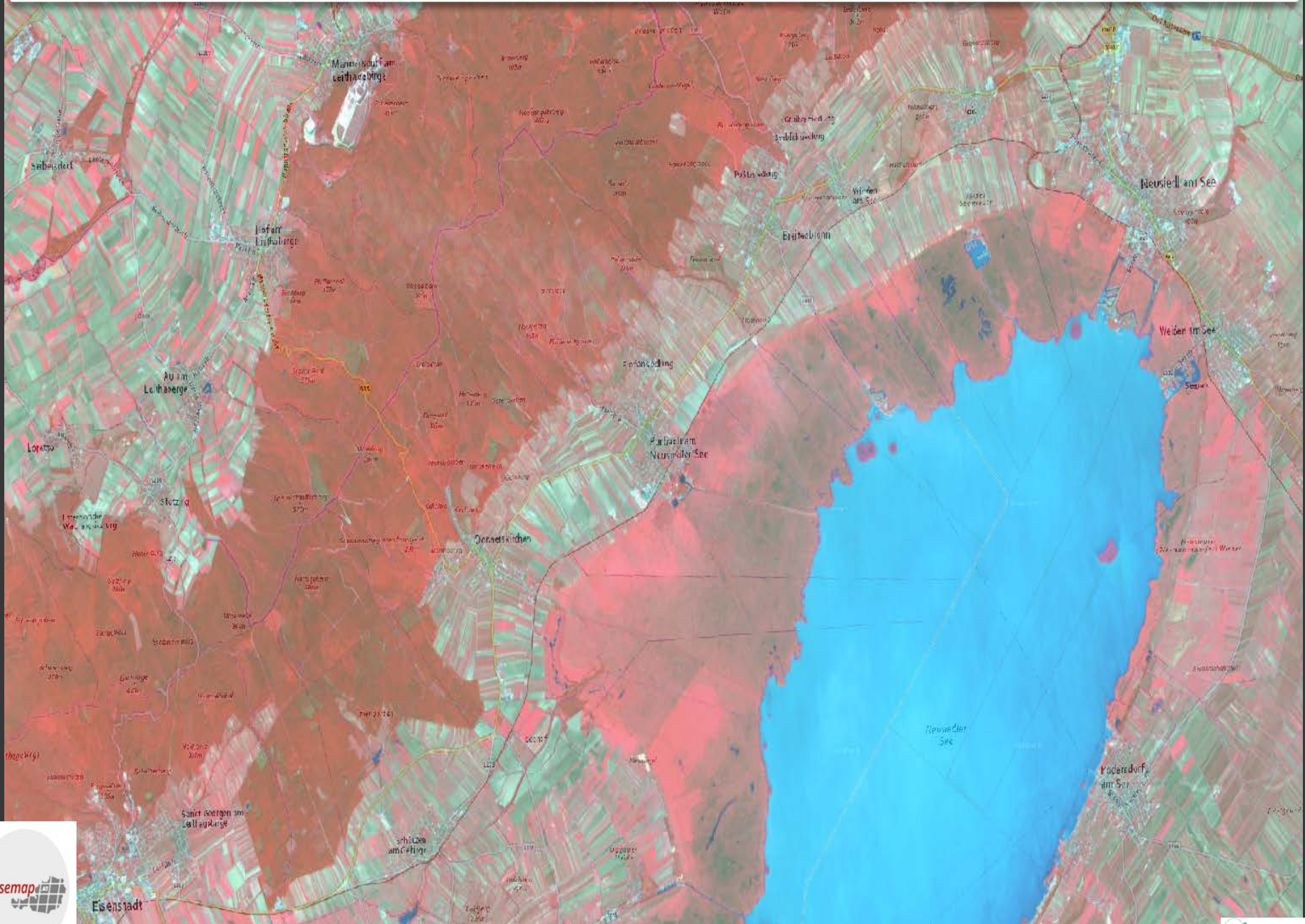
B10: 30/08/2015



Vienna

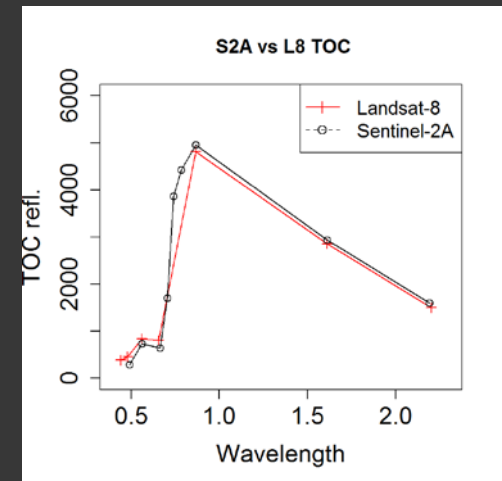
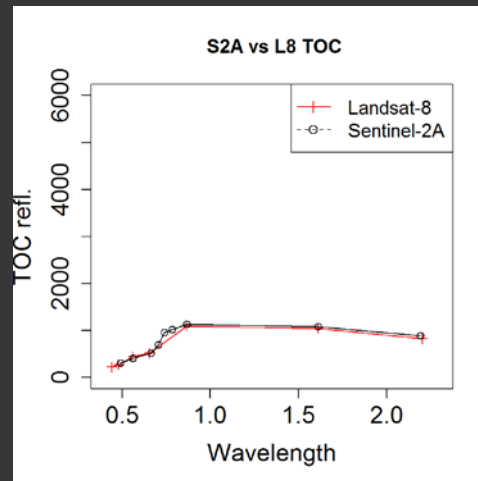
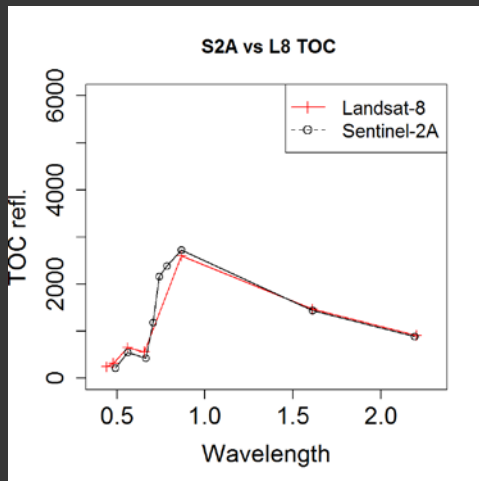
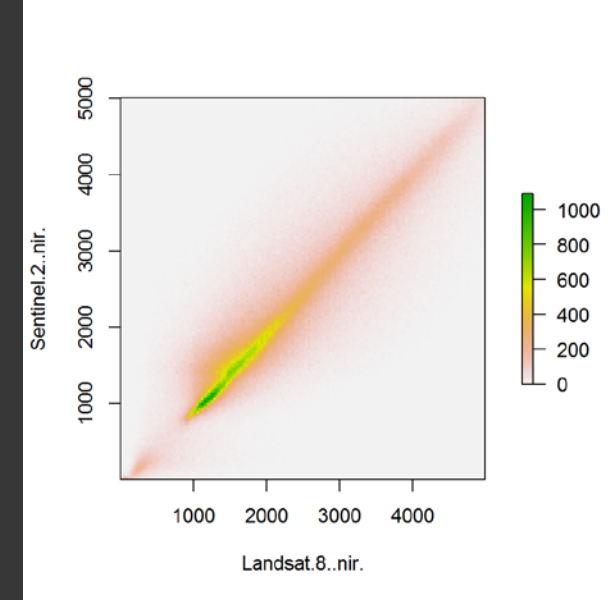
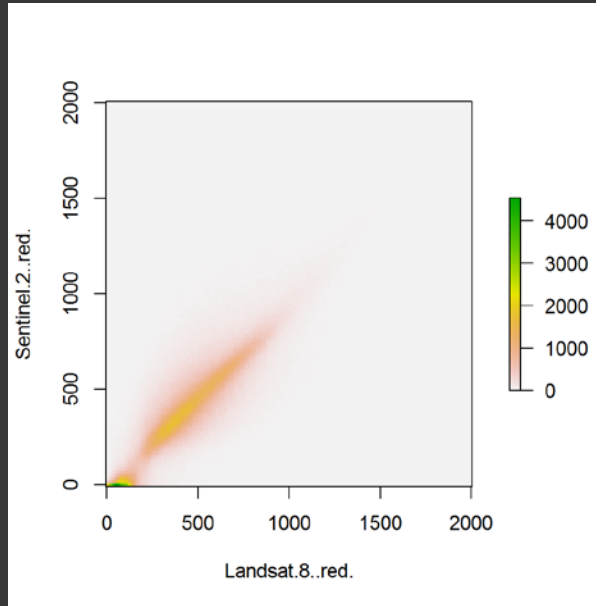
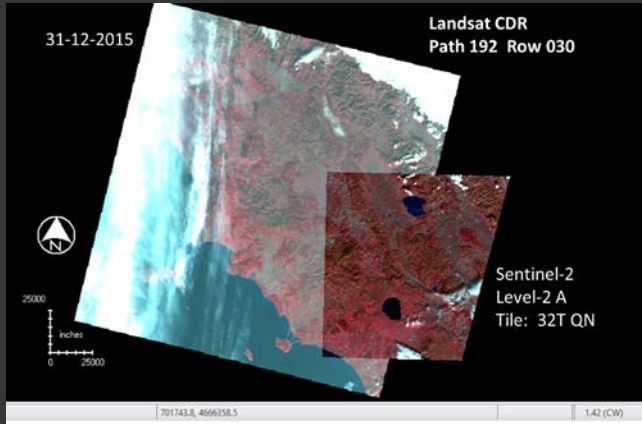


Basemap High DPI + S2 2015/08/30 B3-4-8 @10m (50% transparency)



... THE ARRIVAL OF A GAME CHANGER ...

VIRTUAL CONSTELLATION WITH L8



... THE ARRIVAL OF A GAME CHANGER ...

SOME CHALLENGES

BIG DATA from Sentinel-2

Data is recorded and coded in 12 bits globally at up to 10 m spatial resolution and with 5-days revisit time.

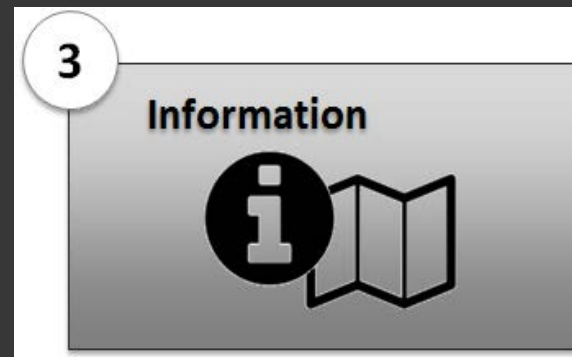
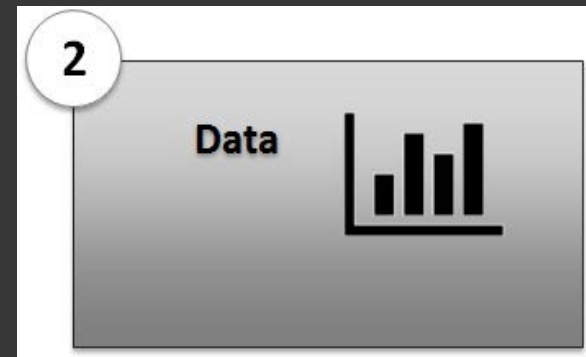
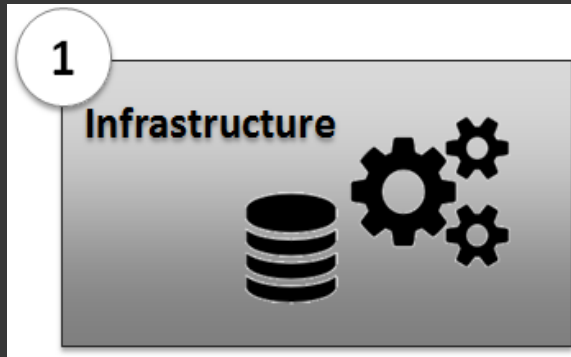
At **each orbit** (90 min) up to **0.7 TB** of data are recorded (16 orbits per day).

Fully operational (e.g. both sensors in orbit), this means that **every year, several PB's** of data have to be stored/processed in particular if one considers **Level-2 and other added-value products**.

Processing without latency has to handle these amounts of data while providing services in near real-time.

... CLOUDS FOR HANDLING BIG DATA ...

EXAMPLE EODC



Earth Observation Data Center,
Vienna, Austria

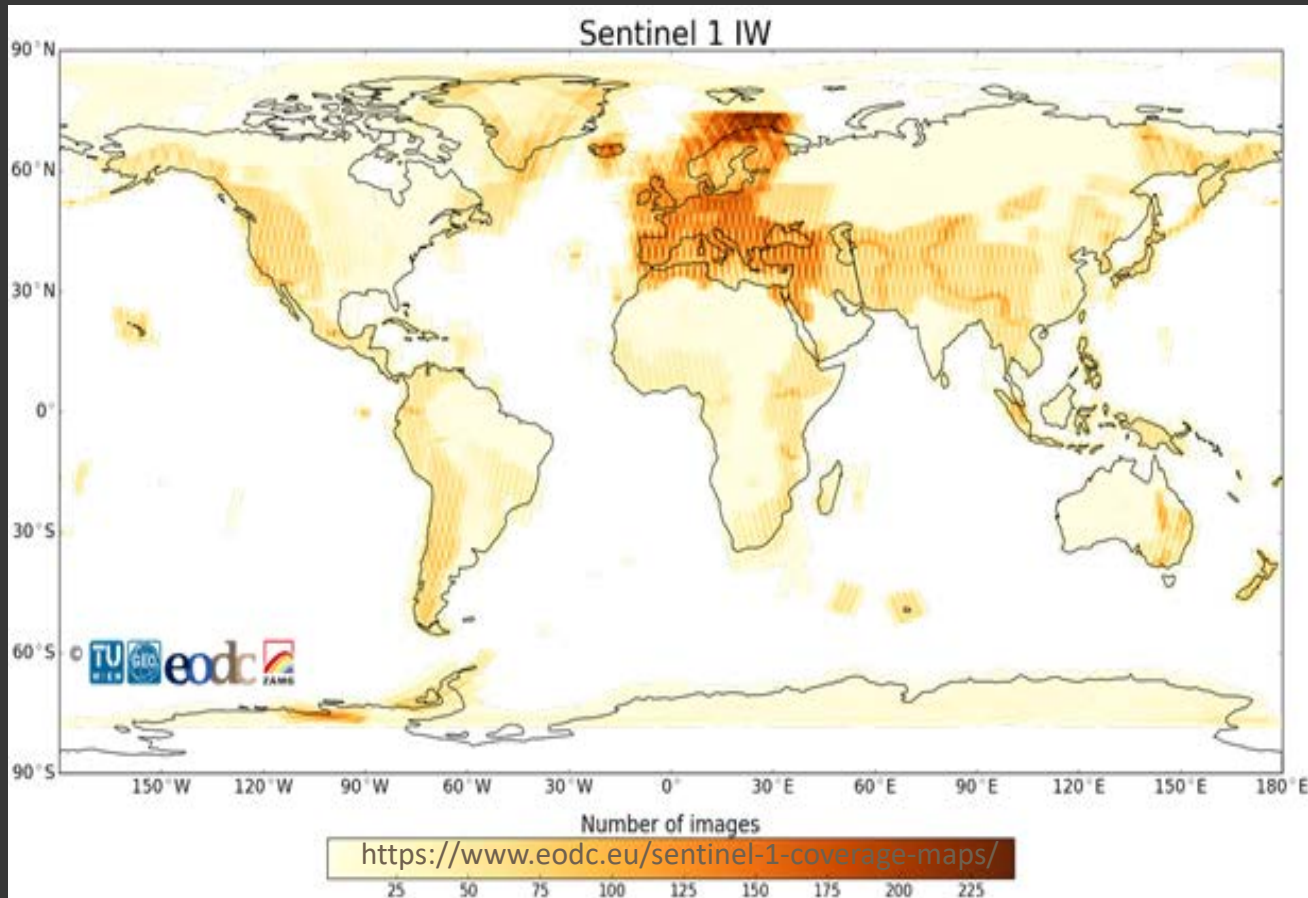
KEY FACTS ON EODC

- EODC is a **public-private partnership** founded in 2014
- EODC serves as **community facilitator** for **collaboration between public and private partners** with the aim to
 - Establish, manage and operate a joint IT infrastructure offering Big EO Data storage and high performance computing (HPC)
 - Provide data, processing chains and value-added products
 - To offer a virtual research, development and operation environment
- EODC was initiated by Austria but international partners are essential for achieving its scientific and technical goals (Costs: ~1 KEUR/month)

... CLOUDS FOR HANDLING BIG DATA ...

EODC: DATA ACCESS

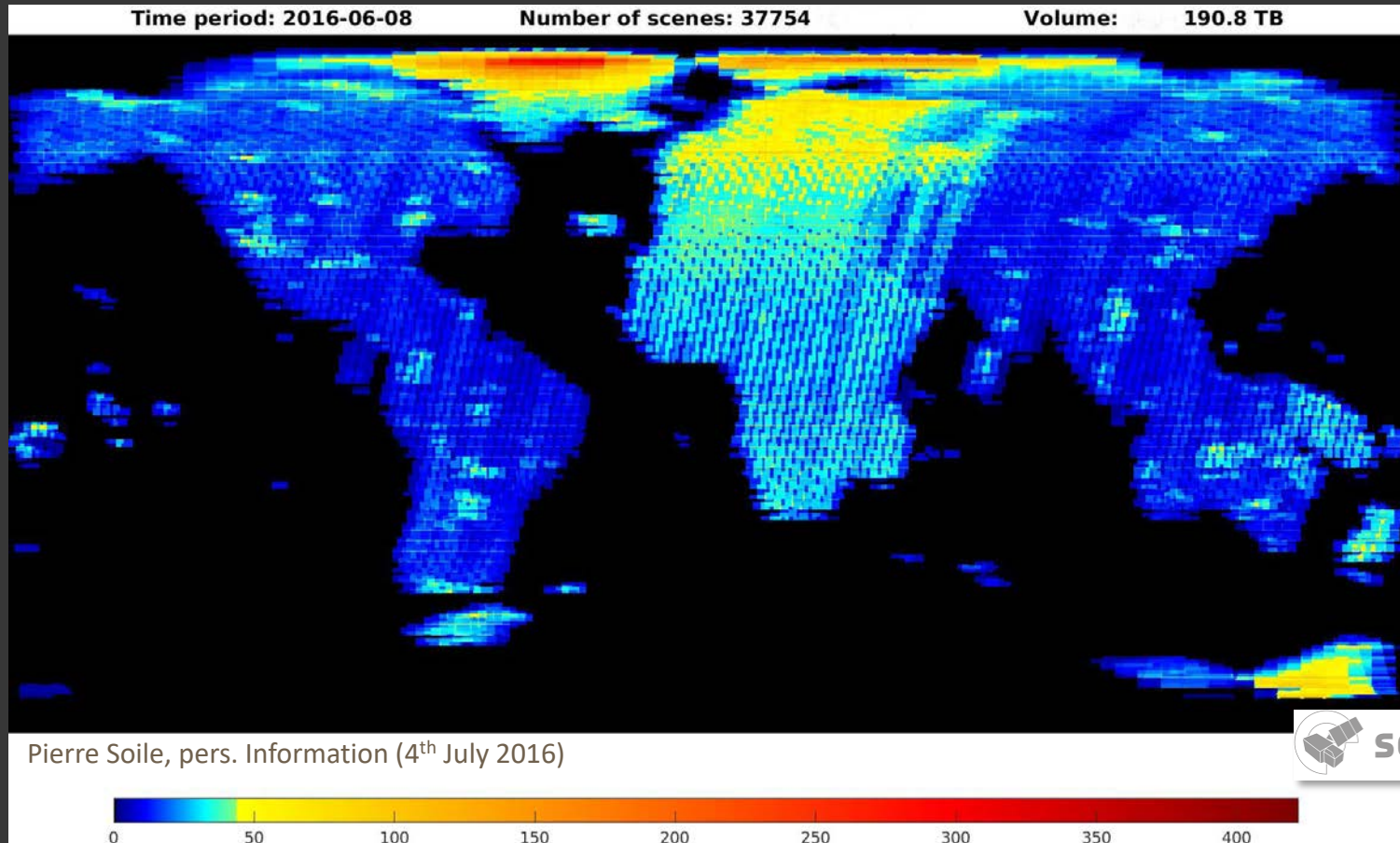
- Sentinel-1a data: 190.831 acquisitions (31th May 2016)
- Sentinel-2a data: 37.754 acquisitions (8th June 2016)
- Landsat 8 (Europe)



... CLOUDS FOR HANDLING BIG DATA ...

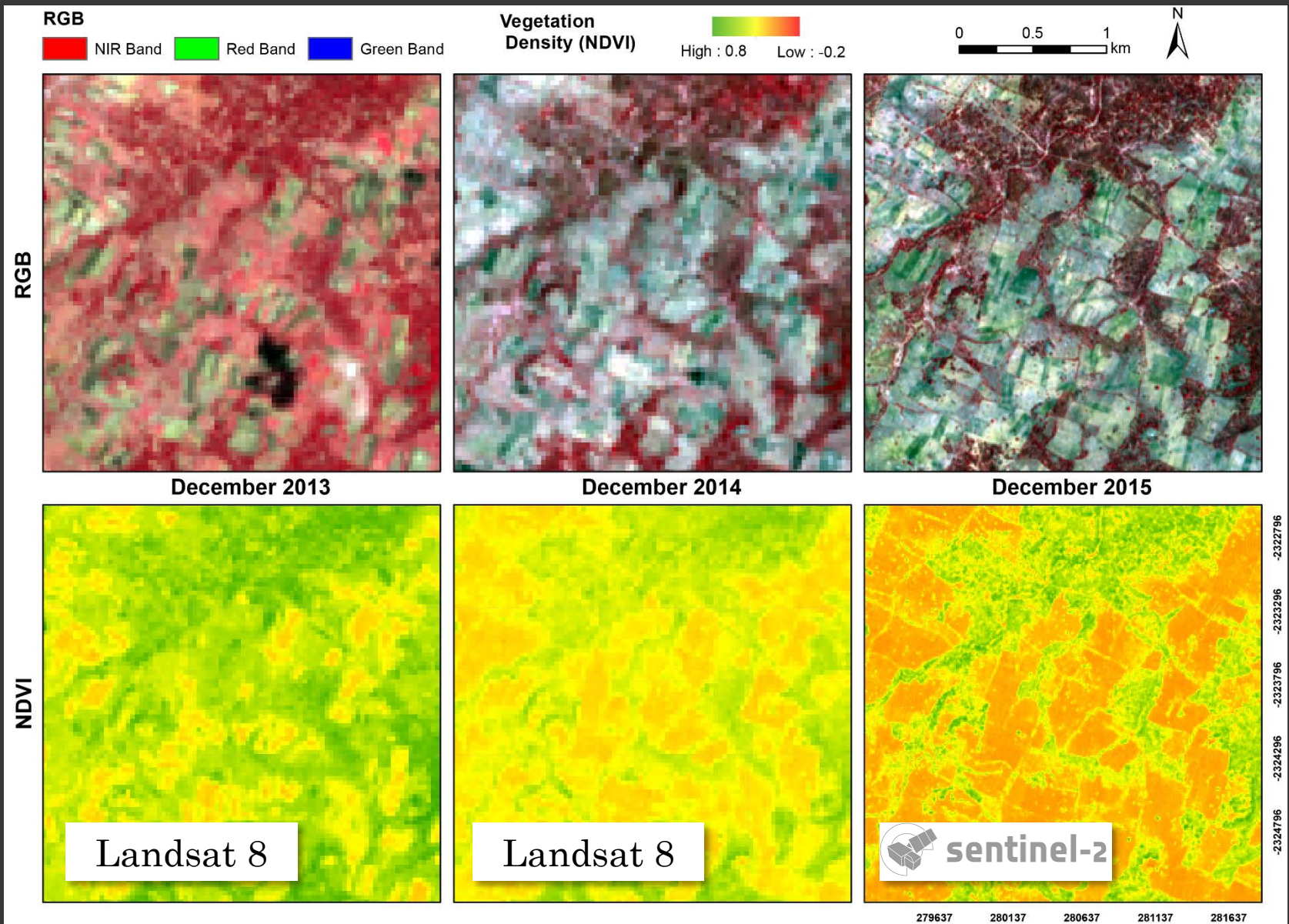
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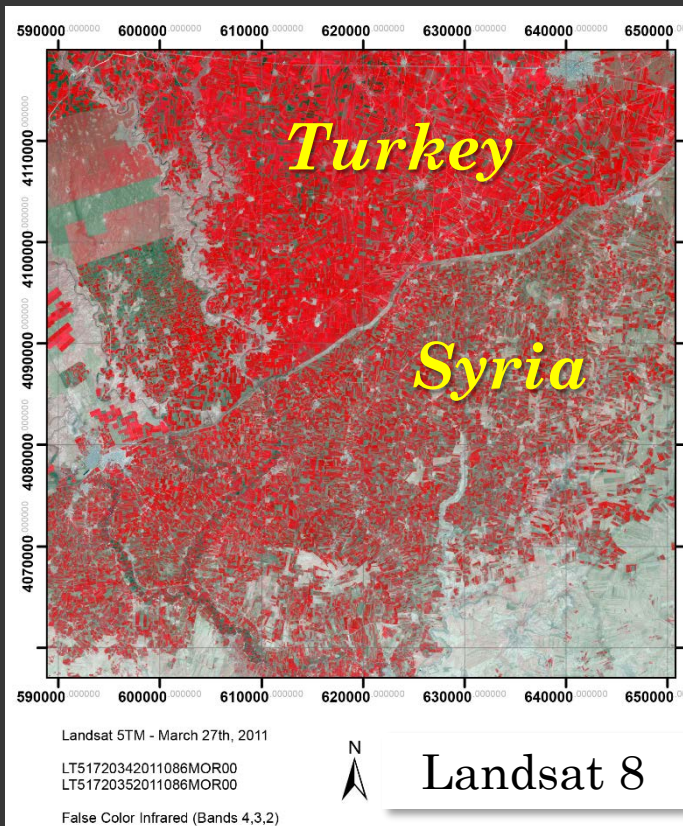
... EXAMPLE APPLICATIONS ...

CROP FAILURE ZIMBABABWE



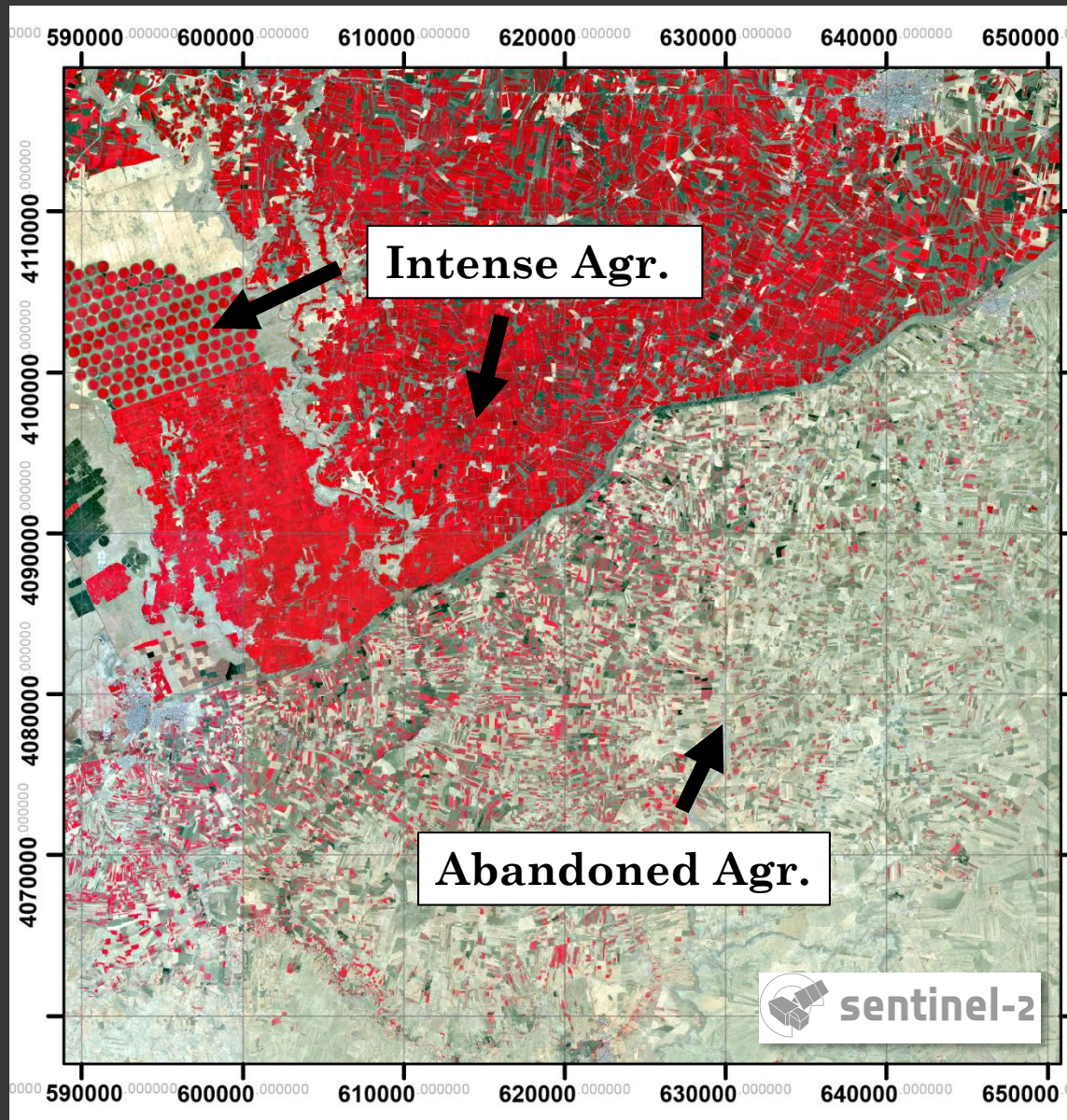
... EXAMPLE APPLICATIONS ...

CROPPING INTENSITY SYRIAN BORDER



Before conflict
(March 2011)

Current situation
(April 2016)



... EXAMPLE APPLICATIONS ...

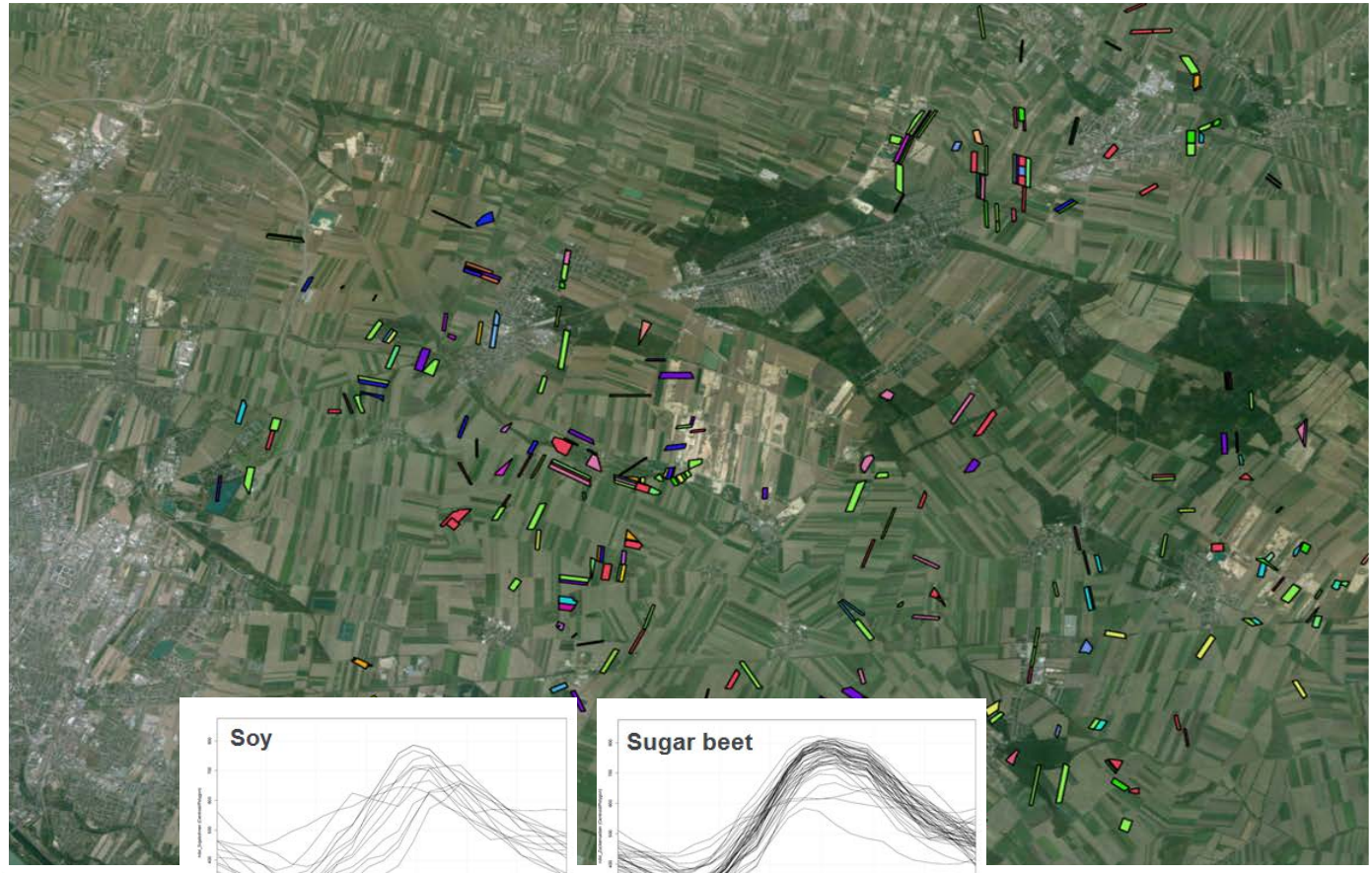
YIELD & PRODUCTION FORECASTS

Legend

Crop Type 2013

- Grünerbse
- Käferbohnen
- Karotten
- Kartoffeln - f*
- Kartoffeln - s
- Klee - Klee gras
- Klee - Luzerne
- Körnermais
- Kürbis
- Kurzumtrieb
- Miscanthus
- Not classified
- Ölkürbis
- Raps
- Roggen
- Saatmais
- Sellerie
- Sojabohnen
- Sommergerste
- Sonnenblumen
- Sonstige Hülsen
- Sonstige Ölfr
- Speiseerbsen
- Spinat
- Weizen - Hartw*
- Weizen - Somme*
- Weizen - Winte*
- Wintergerste
- Zuckerrüben
-

In-situ data collection

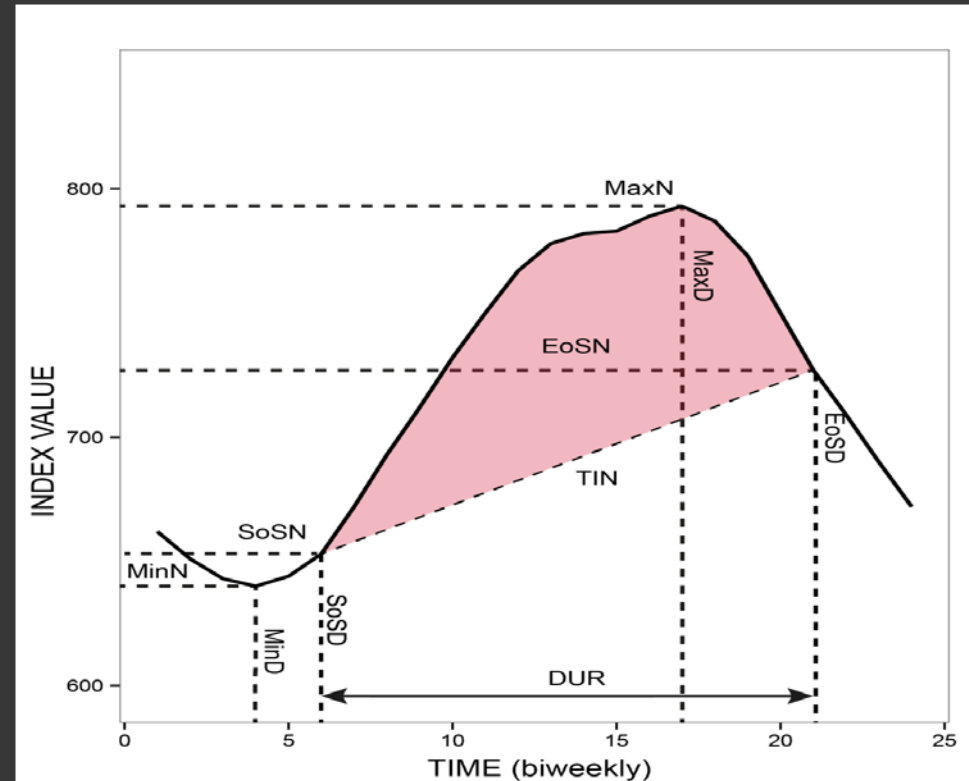


... EXAMPLE APPLICATIONS ...

YIELD & PRODUCTION FORECASTS

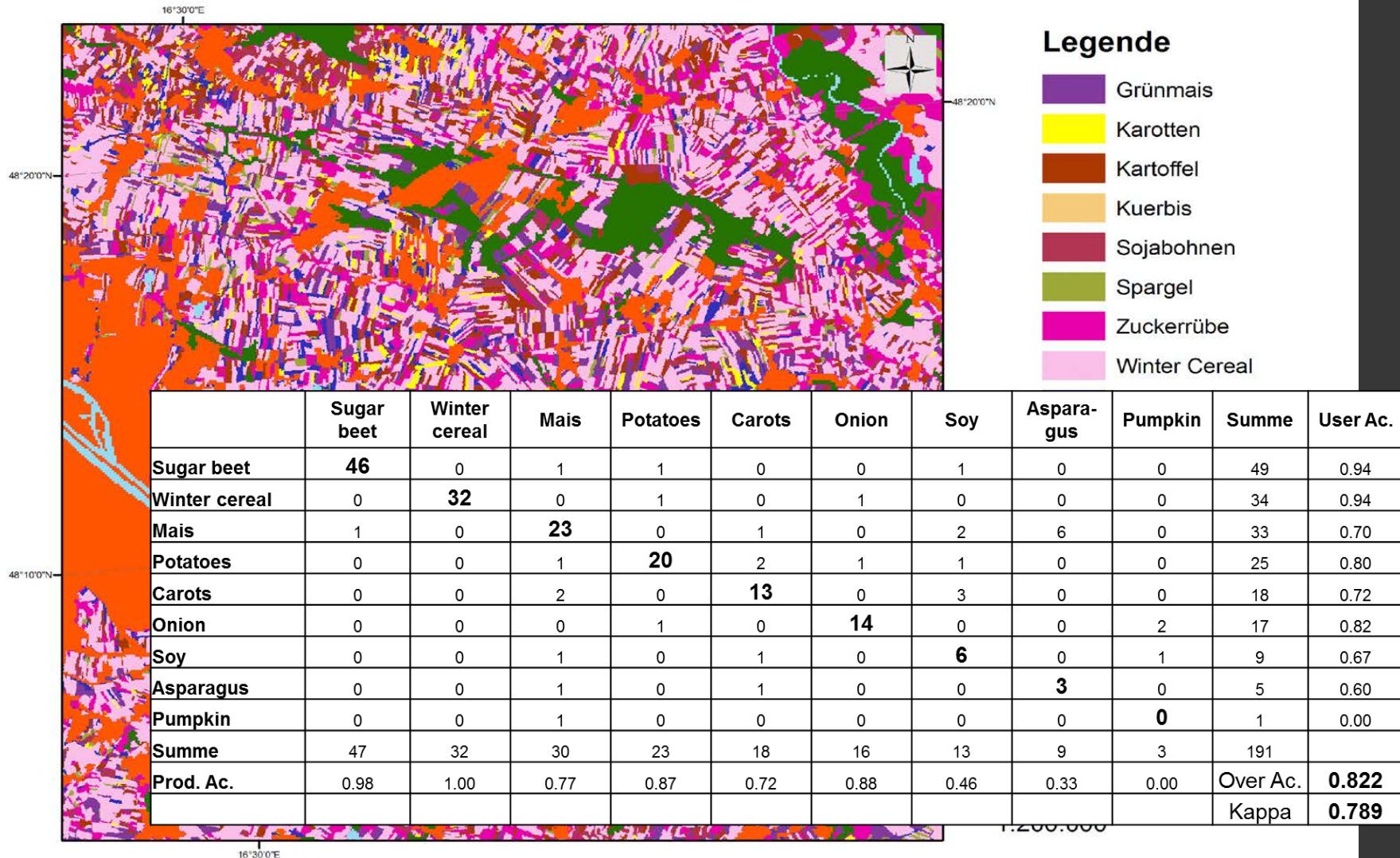
Data compression through phenological indices:

- Start of Season
- Baseline
- Maximum and minimum
- Time of maximum
- Length of growing season
- Integral of cyclic fraction
 - until maximum
 - full growing season



... EXAMPLE APPLICATIONS ...

YIELD & PRODUCTION FORECASTS



... EXAMPLE APPLICATIONS ...

YIELD & PRODUCTION FORECASTS

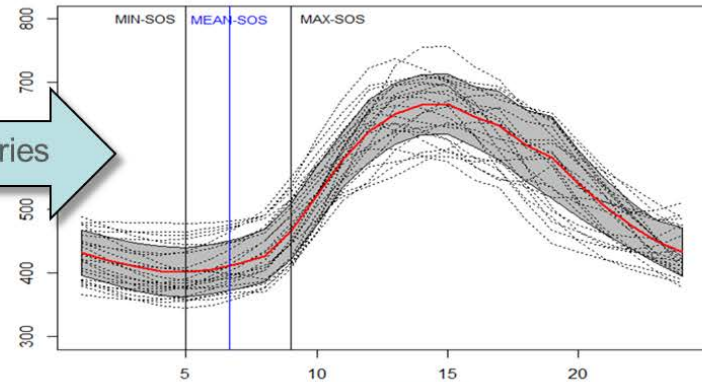
Per-field growth conditions

Mapping results



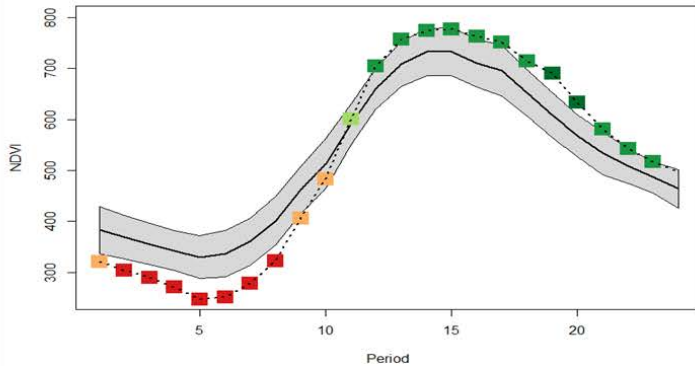
Crop time series

Sugar beet fields

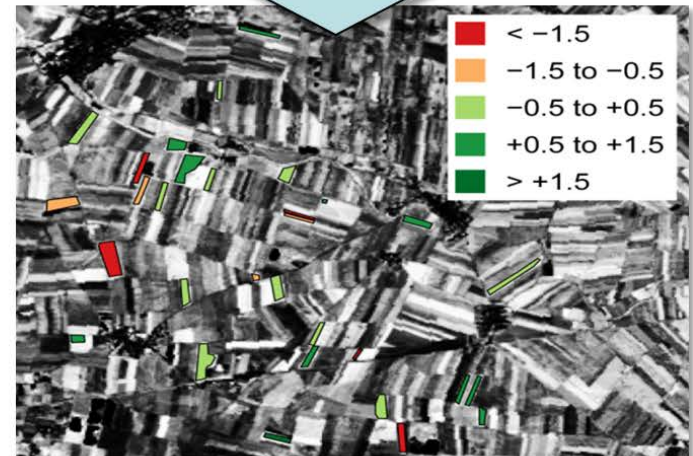


Z-scores

Specific sugar beet field

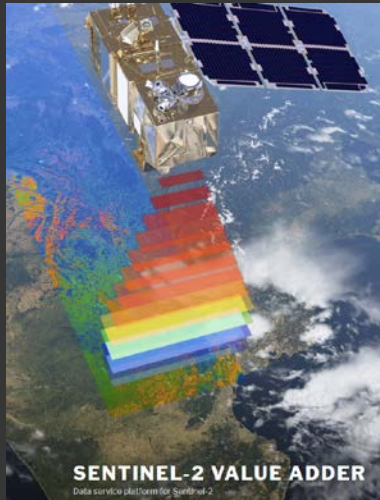


Particular field



... ACCESS ...

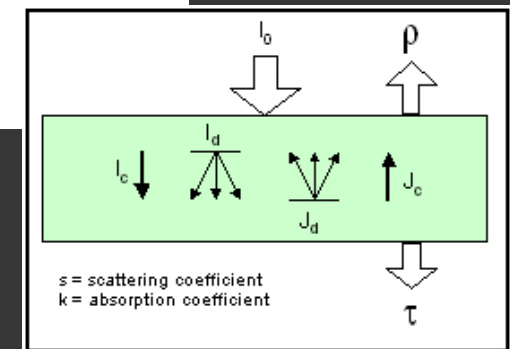
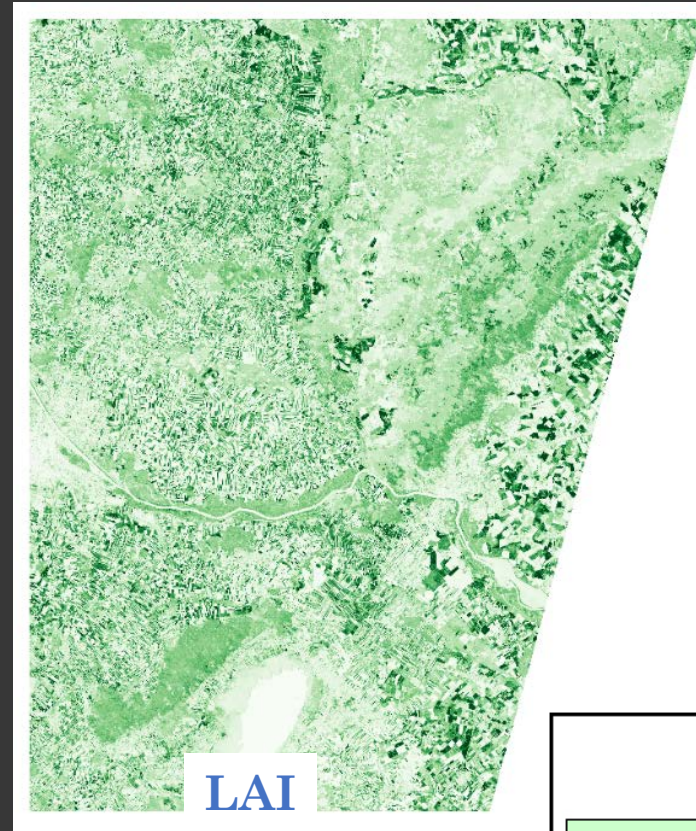
STANDARD & ADDED-VALUE PRODUCTS (LAI)



<https://ivfl-arc.boku.ac.at/eodc/>
<http://s2.boku.eodc.eu/>

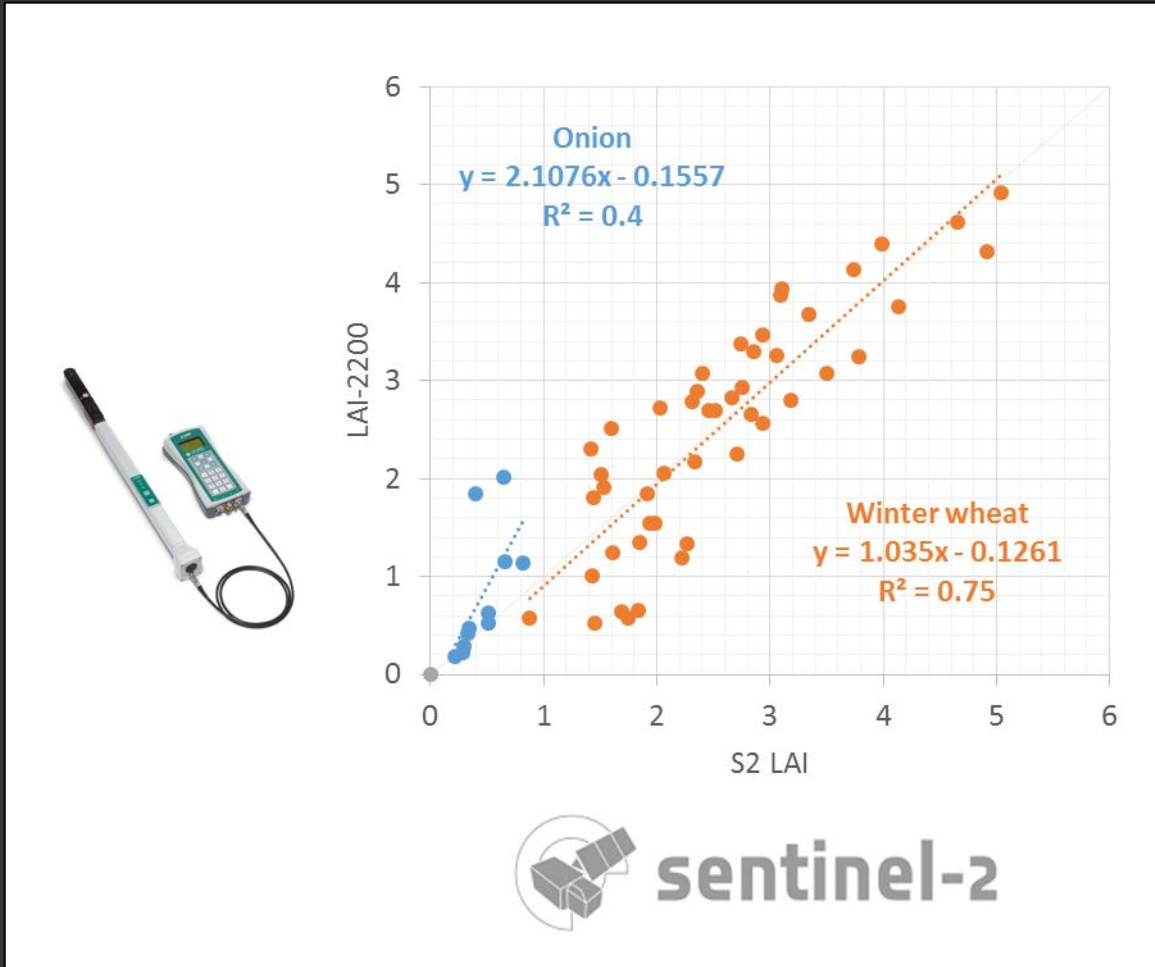
We process:

- Sentinel-2 Level-1C images into Level-2A data using the ESA's Sen2Cor algorithm
- value added products, e.g. LAI, fCOVER, fAPAR

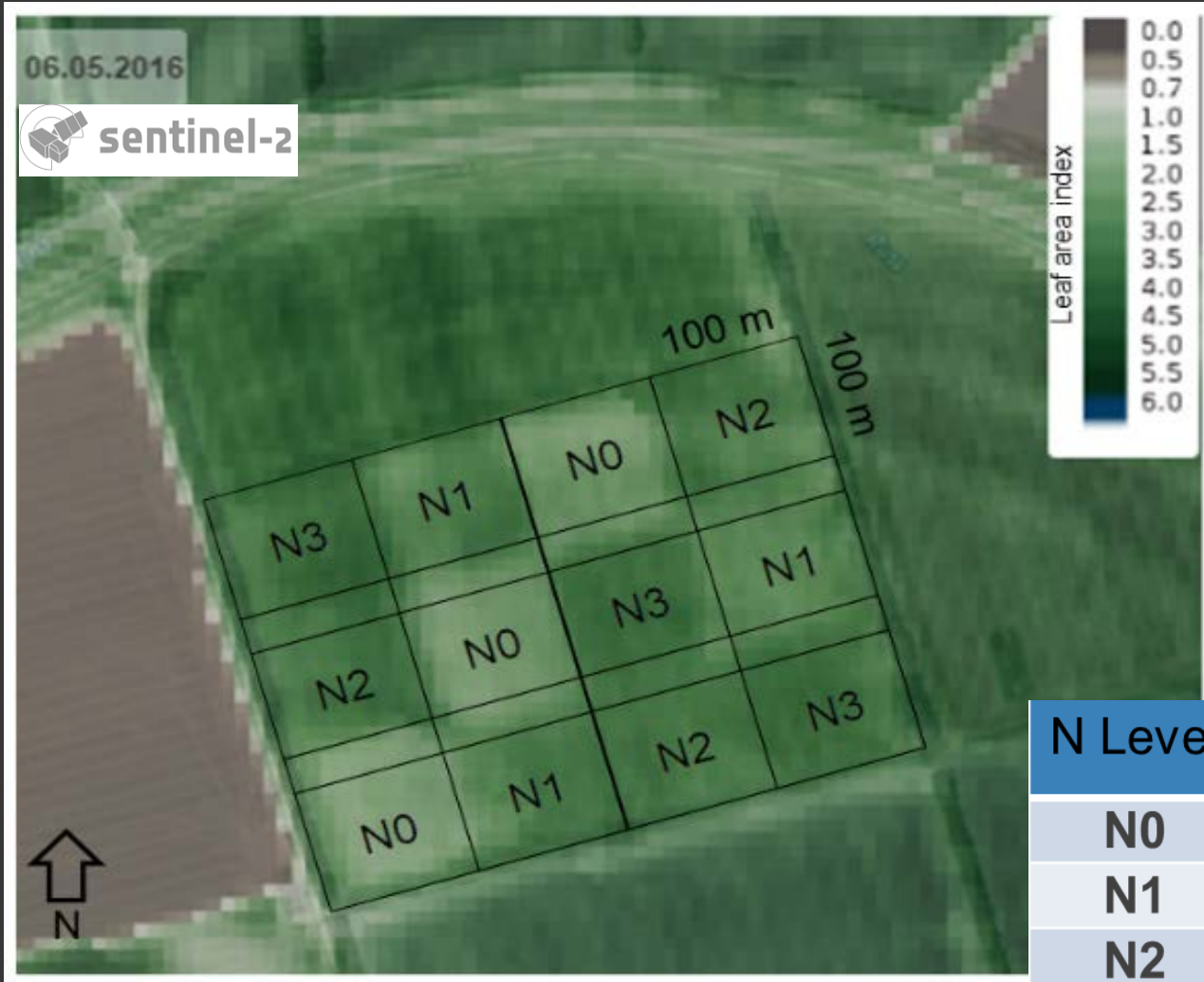


... ACCESS ...

STANDARD & ADDED-VALUE PRODUCTS



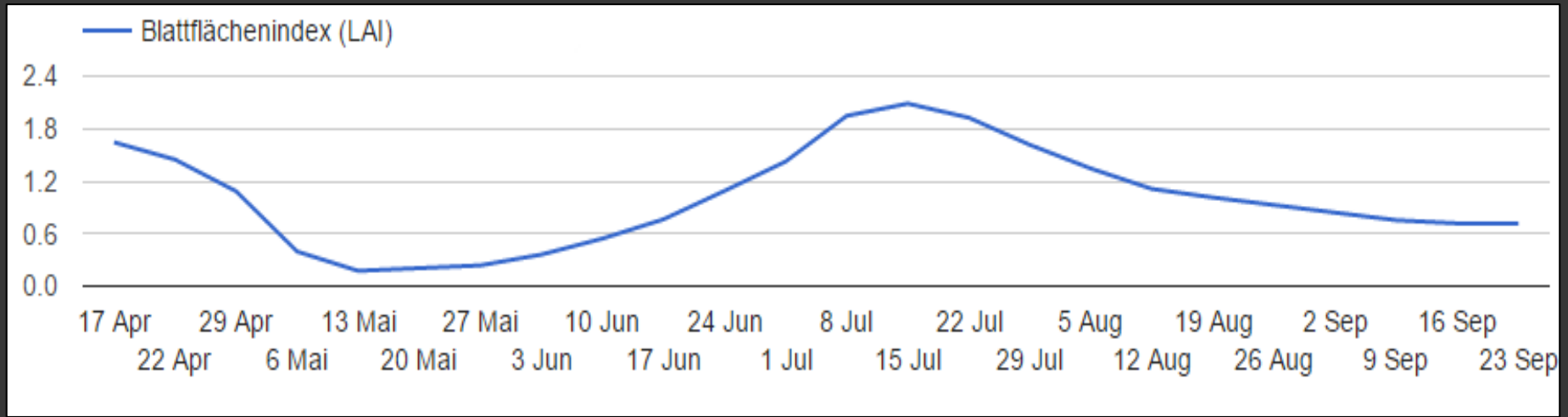
... PRECISION FARMING... *N-MANAGEMENT*



N Level	kg N ha ⁻¹
N0	0
N1	60
N2	120
N3	180

... ACCESS ...

STANDARD & ADDED-VALUE PRODUCTS



... CONCLUSIONS ...

Huge potential of Sentinel-2 (& S-1 & L8) ...

spatial, spectral and temporal resolutions, data policy, ...

Challenges in terms of data storage and processing ...

BIG DATA, need for cloud solution (plus supercomputing)

EODC (Earth Observation Data Center) ...

handling of data volumes & cooperation ... at fair price ...

Many applications for agriculture and forestry...

services for standard & value added products ...

scientific expertise in data mining, pattern recognition,

image classification ...

CONTACT

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and Land Information

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