

New Capabilities in Earth Observation supporting Drought Risk Assessment

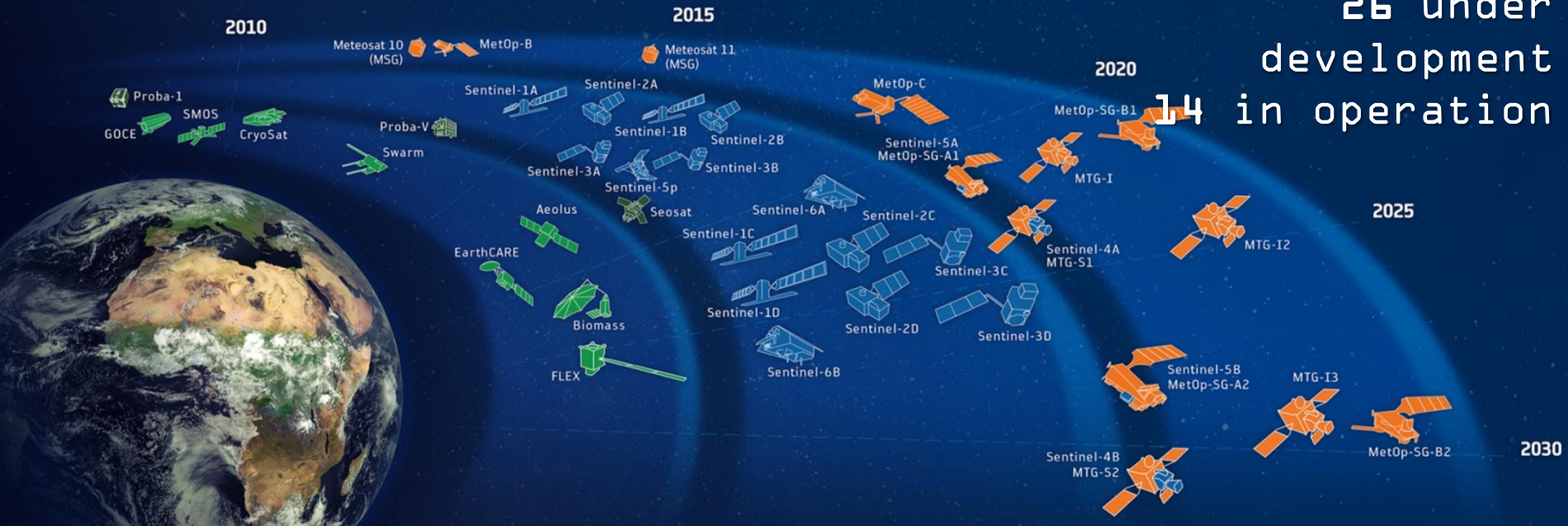
Espen Volden
Earth Observation Data Applications Division

Thanks to: Diego Fernandez, Ben Koetz (ESA)

ESA-DEVELOPED EARTH OBSERVATION MISSIONS



Satellites
26 under
development
14 in operation



Science

Copernicus

Meteorology



Launch of MetOp-C this morning ...



Copernicus – a new Phase in EO



European Earth Observation System

- Led by the EU
- EU-ESA Collaboration

European response to global needs:

- to manage the environment
- to mitigate the effects of climate change
- to ensure civil security

European independence, contribution to global system (GEOSS)



FULL, FREE AND OPEN
ACCESS TO DATA

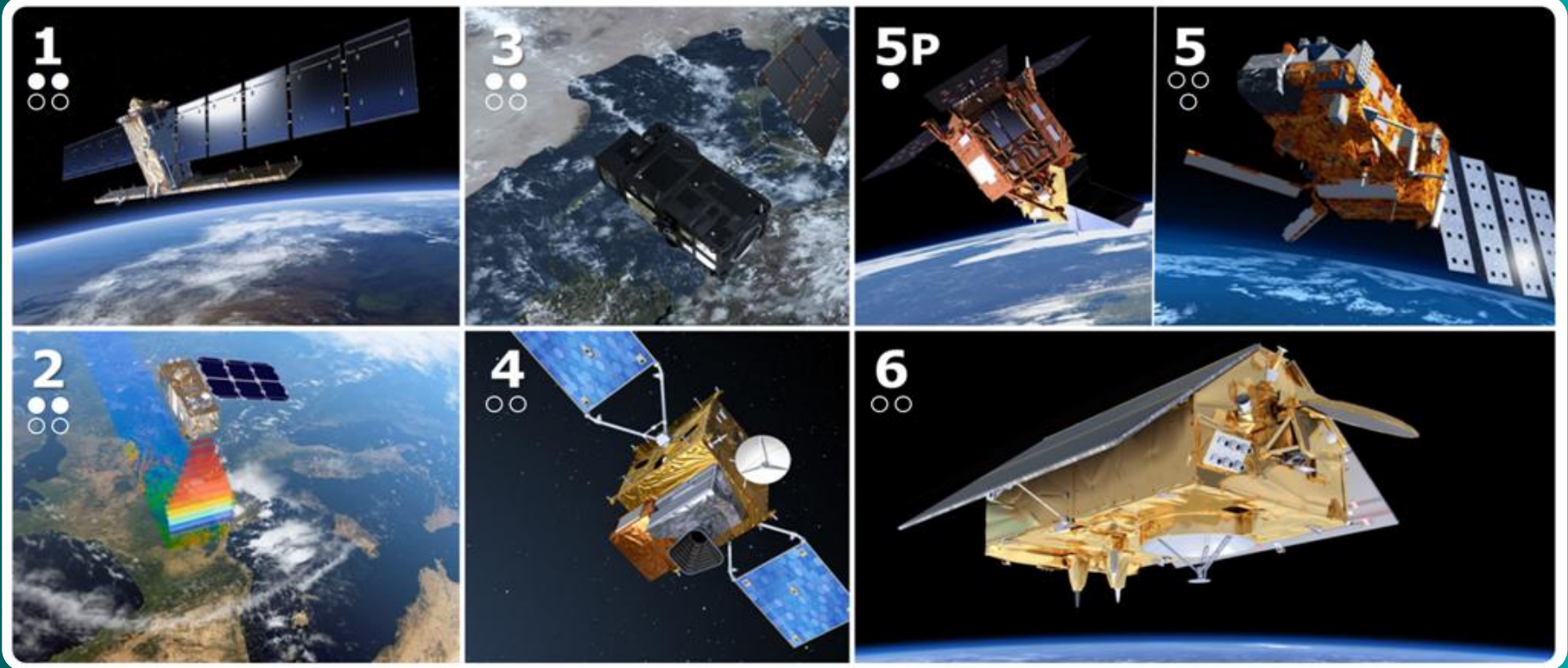


- ATMOSPHERE MONITORING
- MARINE ENVIRONMENT MONITORING
- LAND MONITORING
- CLIMATE CHANGE
- EMERGENCY MANAGEMENT
- SECURITY



The Big Data Revolution

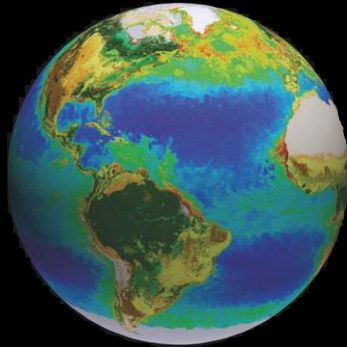
Copernicus is the largest producer of EO data in the world



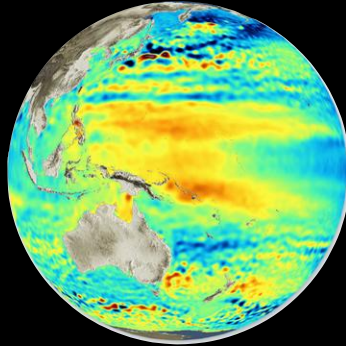
Global & System View by Copernicus



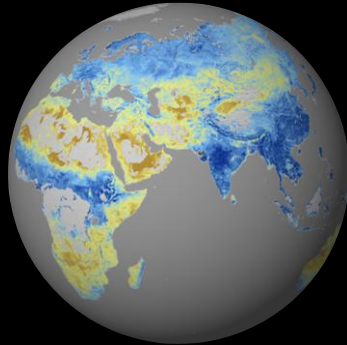
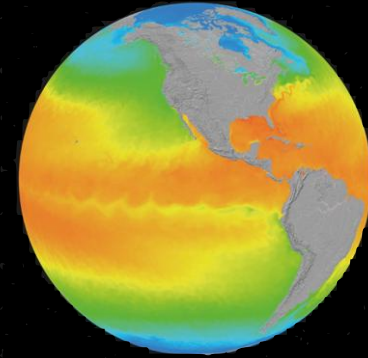
Chlorophyll



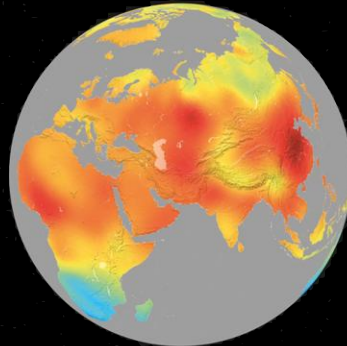
Sea Level Height



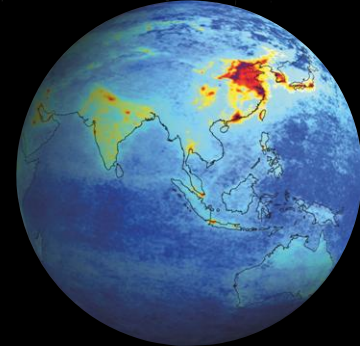
Sea Surface Temperature



Soil Moisture



Carbon Dioxide



Nitrous Oxide



Copernicus Sentinel Satellites



Sentinel 1 (A/B/C/D)
SAR Imaging

All weather, day/night applications,
interferometry



Sentinel 2 (A/B/C/D)
Multispectral Imaging

Land applications: urban, forest, agriculture, ...
Continuity of Landsat, SPOT



Sentinel 3 (A/B/C/D)
Ocean & Global Land Monitoring

Wide-swath ocean colour, vegetation, sea/land
surface temperature, altimetry



Sentinel 4 (A/B)
Geostationary Atmospheric

Atmospheric composition monitoring, pollution;
instrument on MTG satellites



Sentinel 5 (A/B/C) & Precursor
Low-Orbit Atmospheric

Atmospheric composition monitoring;
instrument on MetOp-SG satellites

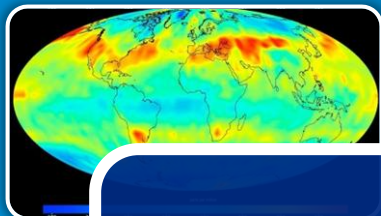


Sentinel 6
Jason CS (A/B)

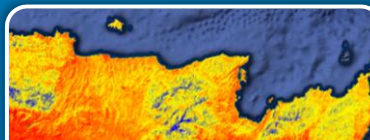
Altimetry reference mission



6 High Priority Candidate Missions



Anthropogenic CO₂ Emissions
Monitor causes of Climate Change



High Resolution Agriculture & Water Surface Temp.

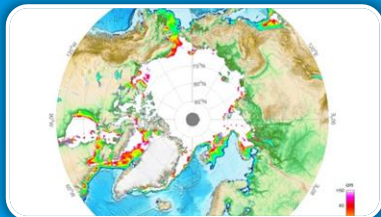
Studies for new Sentinels ongoing



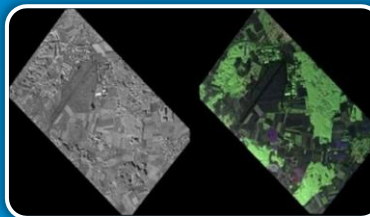
(volume)



Biodiversity



Passive Microwave & SST (Arctic situational awareness)



Soil Moisture, Vegetation & Ground Motion

• esa

30 June 2018



July 2017



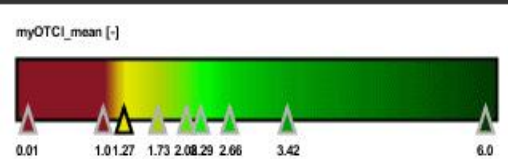
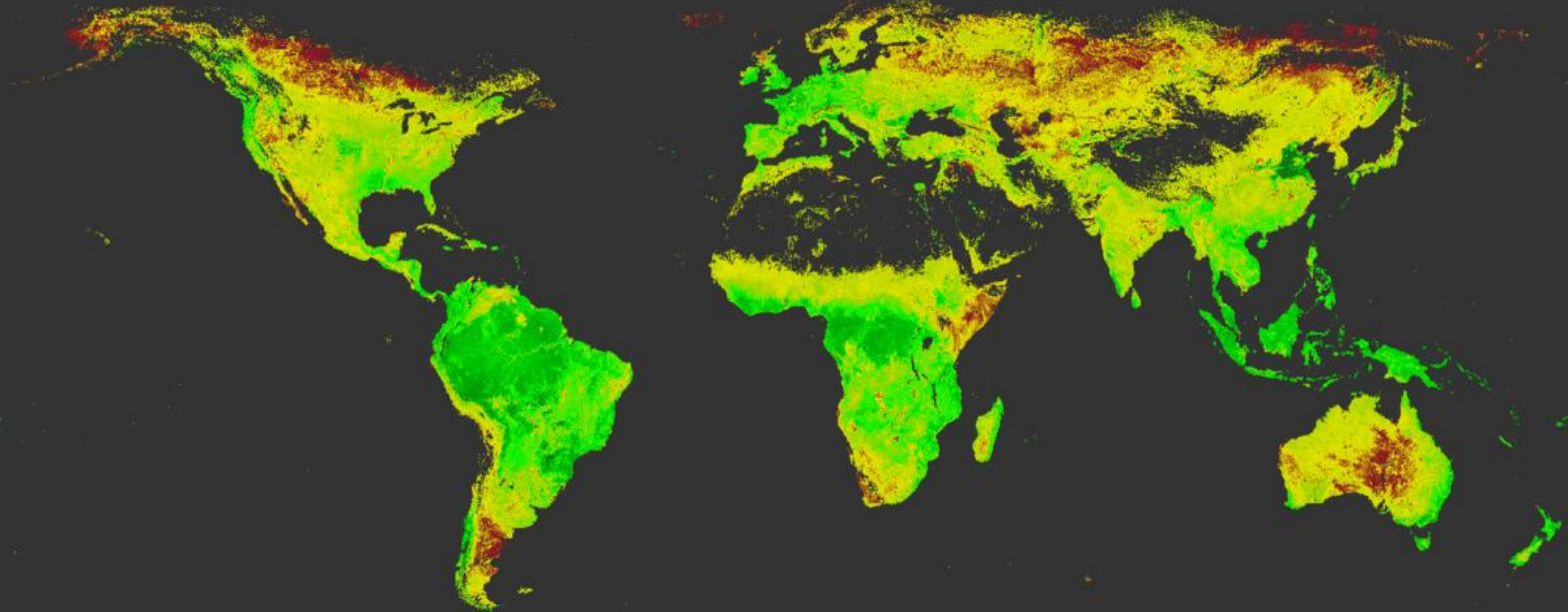
Slagelse

Tystrup Lake

5 km



Plant Growth in Spring

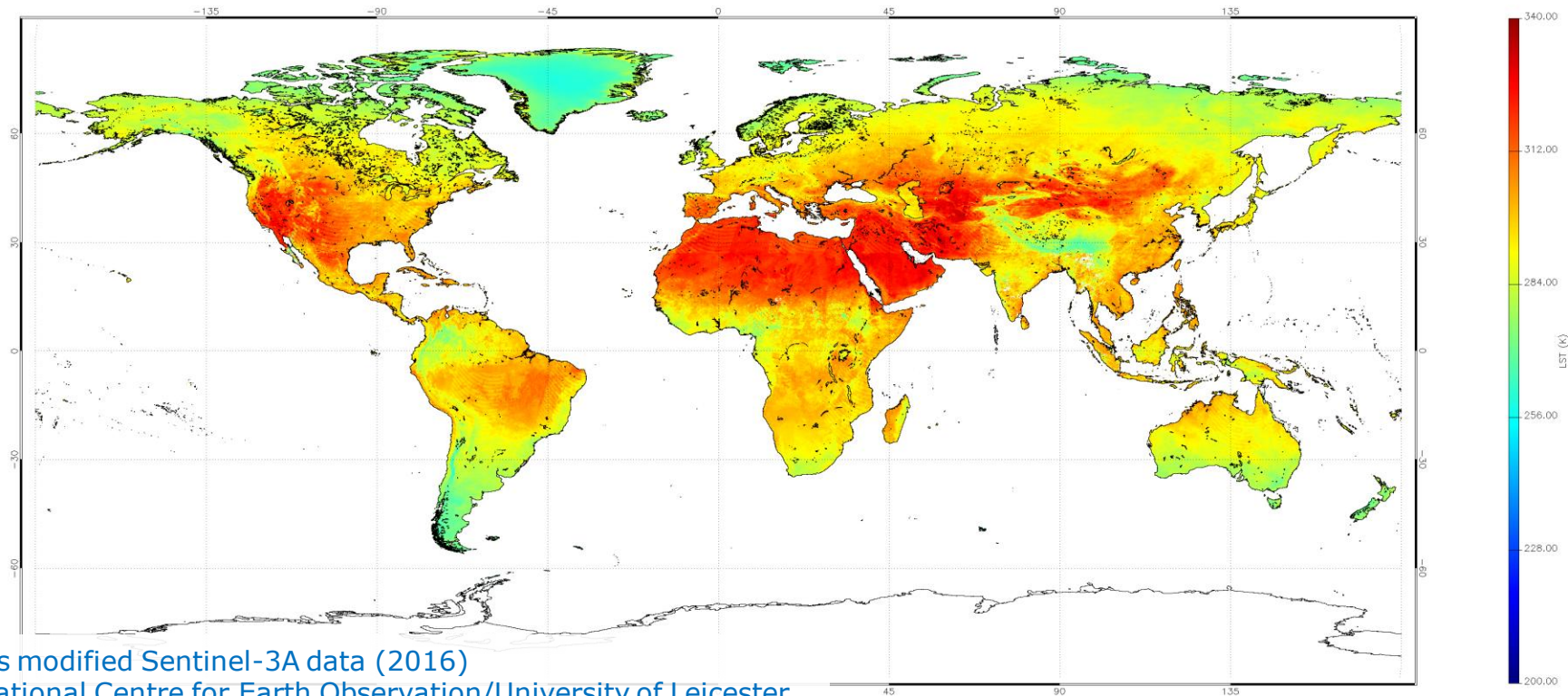


Vegetation Index

Based upon Copernicus Sentinel-3A data (2017)

© University of Southampton–J. Dash/Brockman Consult (S3-MPC)

Earth Surface Heat



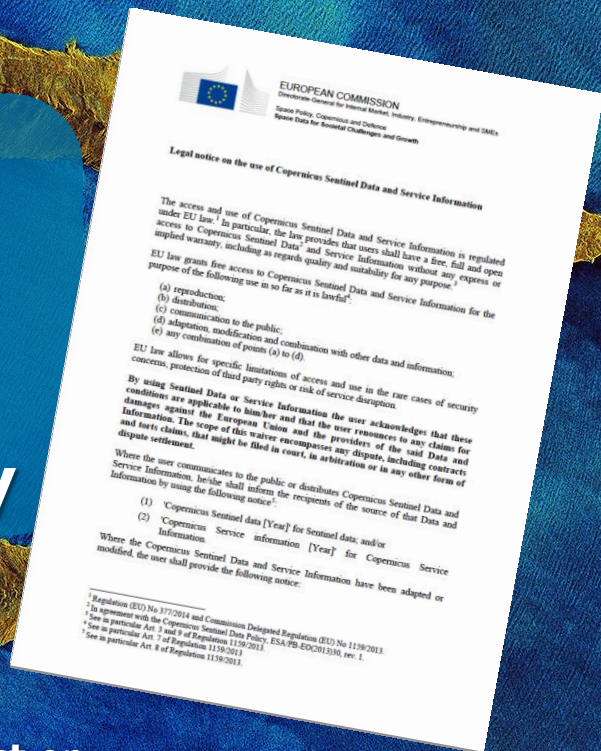
Contains modified Sentinel-3A data (2016)
© UK National Centre for Earth Observation/University of Leicester

Copernicus Sentinel Data Policy



Sentinel data are available:

- ✓ Free, Full and Open*
- ✓ Over very long term
- ✓ Systematically, Operationally



* **ESA Sentinel Data Policy** (Sep 2013) and **EU Delegated Act on Copernicus Data and Information Policy** (Dec 2013)



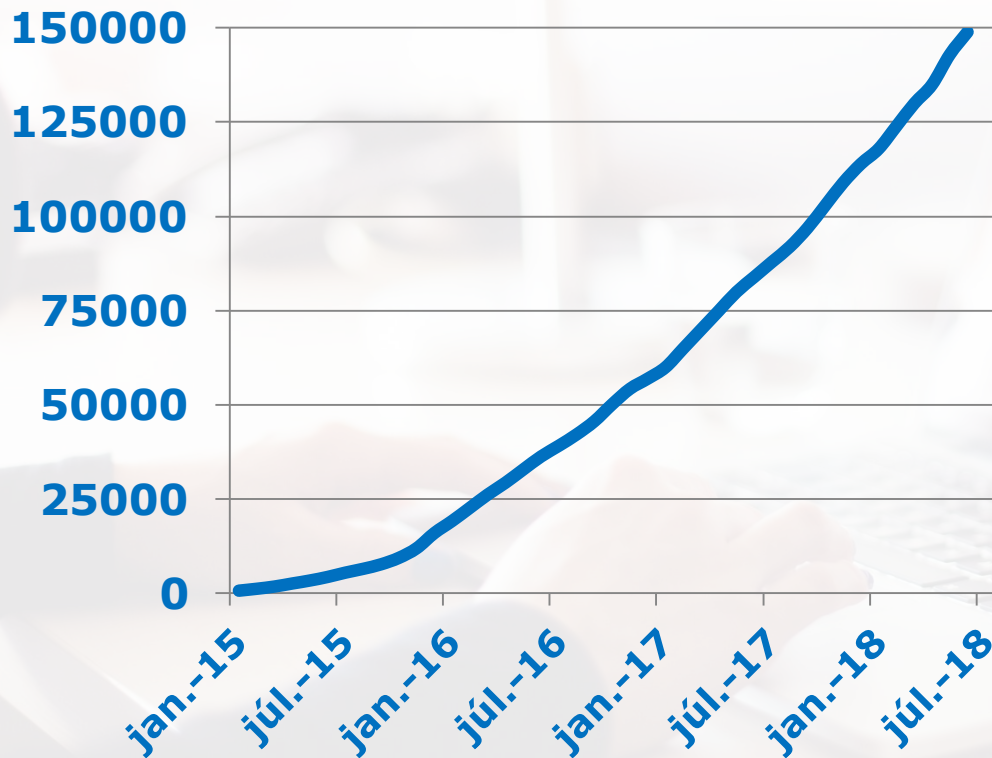
DIAS – Creating an EO Data Ecosystem



- Copernicus **D**ata and **I**nformation **A**ccess **S**ervices
- Common DG-GROW-ESA approach to EO data exploitation with Copernicus at its core
- Create & enable European EO Data ecosystem for research & business
- Started in June 2018



Registered Copernicus Sentinel Users



Data access through

- EU/ESA Copernicus Open Access Hub
- 5 DIAS
- 6 Copernicus services
- Thematic Exploitation Platforms (TEPs)
- 18 ESA Member State hubs
- NASA, NOAA, USGS, Geoscience Australia
- Commercial hubs

Copernicus Services

Land

Atmosphere

Marine Environment

Climate Change

Emergency Management

Security



Security

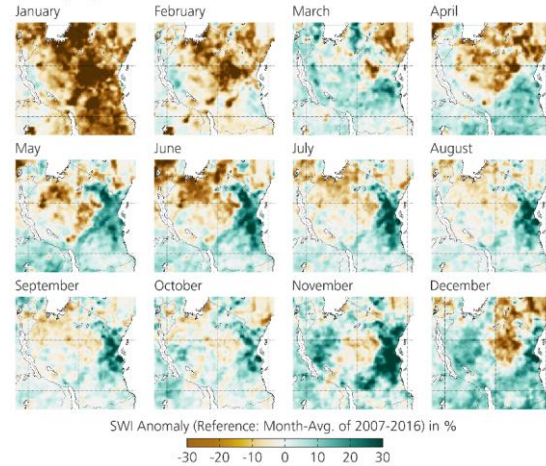
Refugee Camp Monitoring

Copernicus Global land products

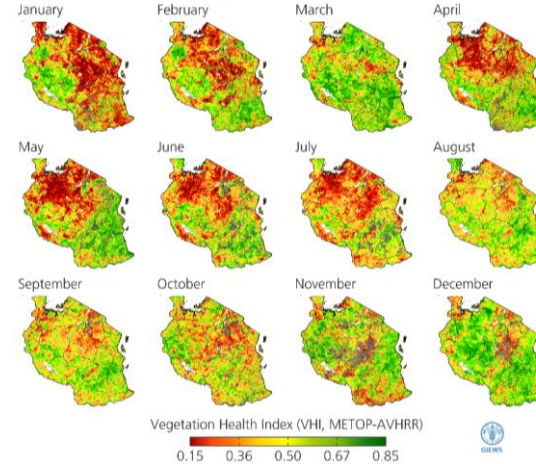
SWI as compared to VHI for droughts in 2017 over Tanzania

Tanzania

SWI10 (T=5) Anomalies



Vegetation Health Index (VHI)



PARTNERSHIP WITH USERS

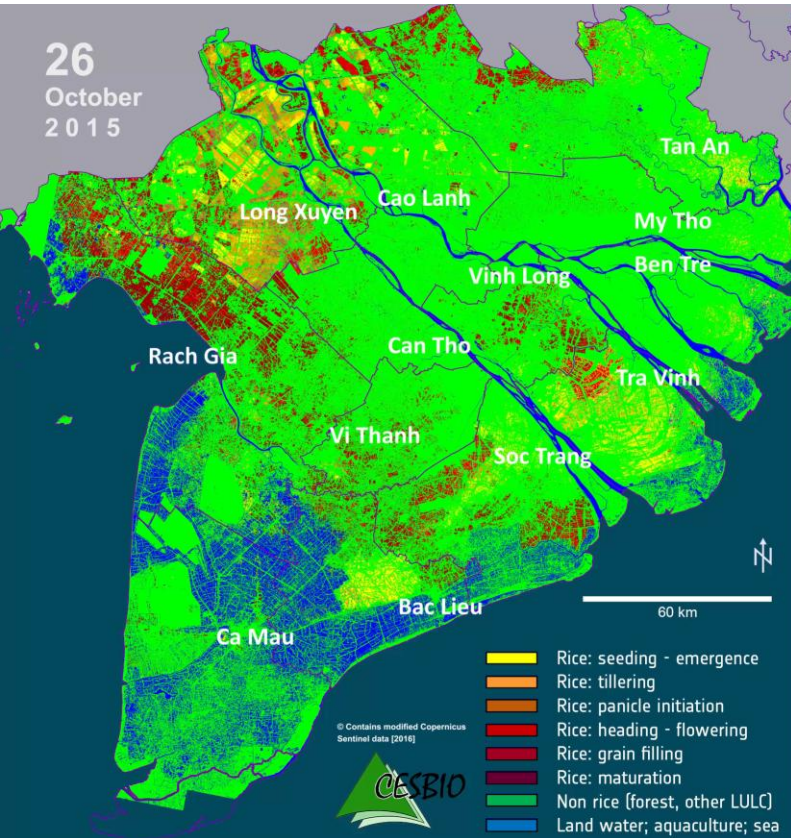


- Bringing together diversity of actors
 - Farmers and cooperatives associations, main international food security organisations, other UN, NGOs, scientists, insurance, development aid, agro-industry, App developers, commercial service providers, int. initiatives
- Improved understanding of challenges of actors in food security
- Defining user needs
 - incl. cap. build.
- Lessons learnt
- Preparing activities

User consultation Workshop 11-12 April 2016 in ESRIN

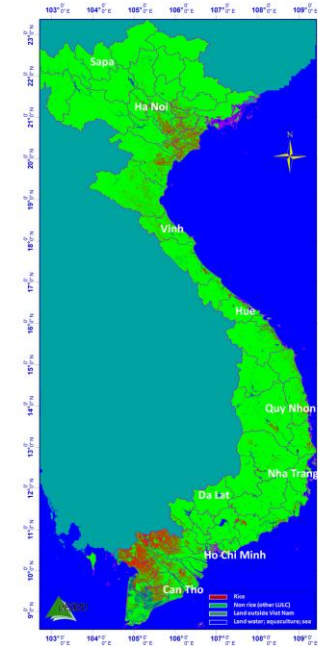


Rice Monitoring: Crop Stages & Area



Winter-Spring Rice 2015/16

- March 2016: 1.4 Million ha rice
- March 2015: 1.7 Million ha rice
- **16.5% loss in rice area** due to drought & salt water intrusion caused by El Nino
- 976.000 people affected, 67 Mil.\$ estimated damage (UN estimates)



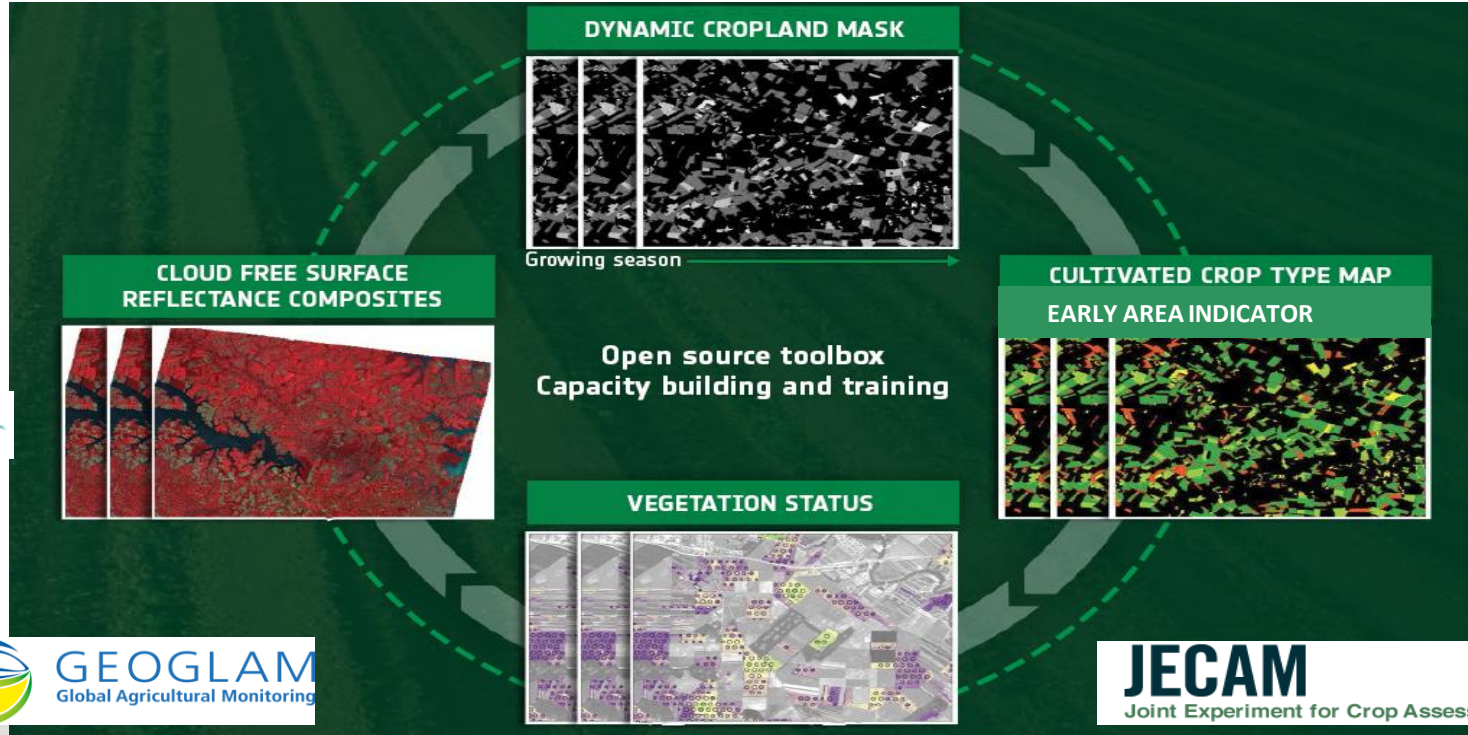
The Mekong Delta, Vietnam
300 km x 300 km, 20 m resolution



Sentinel-2 for Agriculture

Towards exploitation of Sentinel-2 for local to global agricultural monitoring - contribution to GEOGLAM

Project
UCL
Université
catholique
de Louvain



Key Users



JECAM
Joint Experiment for Crop Assessment and Monitoring

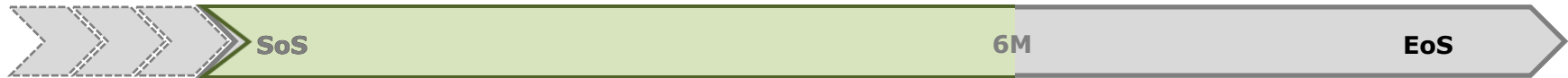
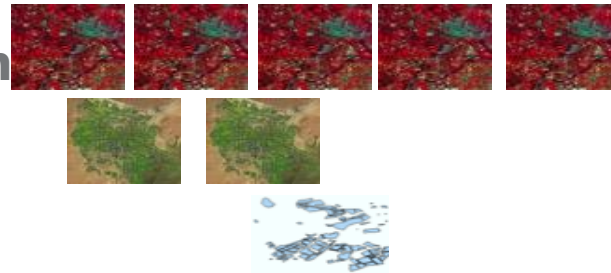
Dynamic Crop mask

Automatic EO data download
Manual in situ data upload

Before the start of the monitoring period

Monitoring period

System initialization



EO data providers



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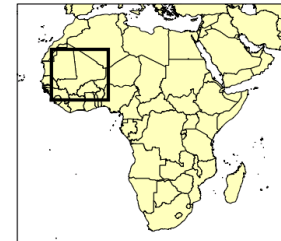
sentinel-2

Mali: National Statistics

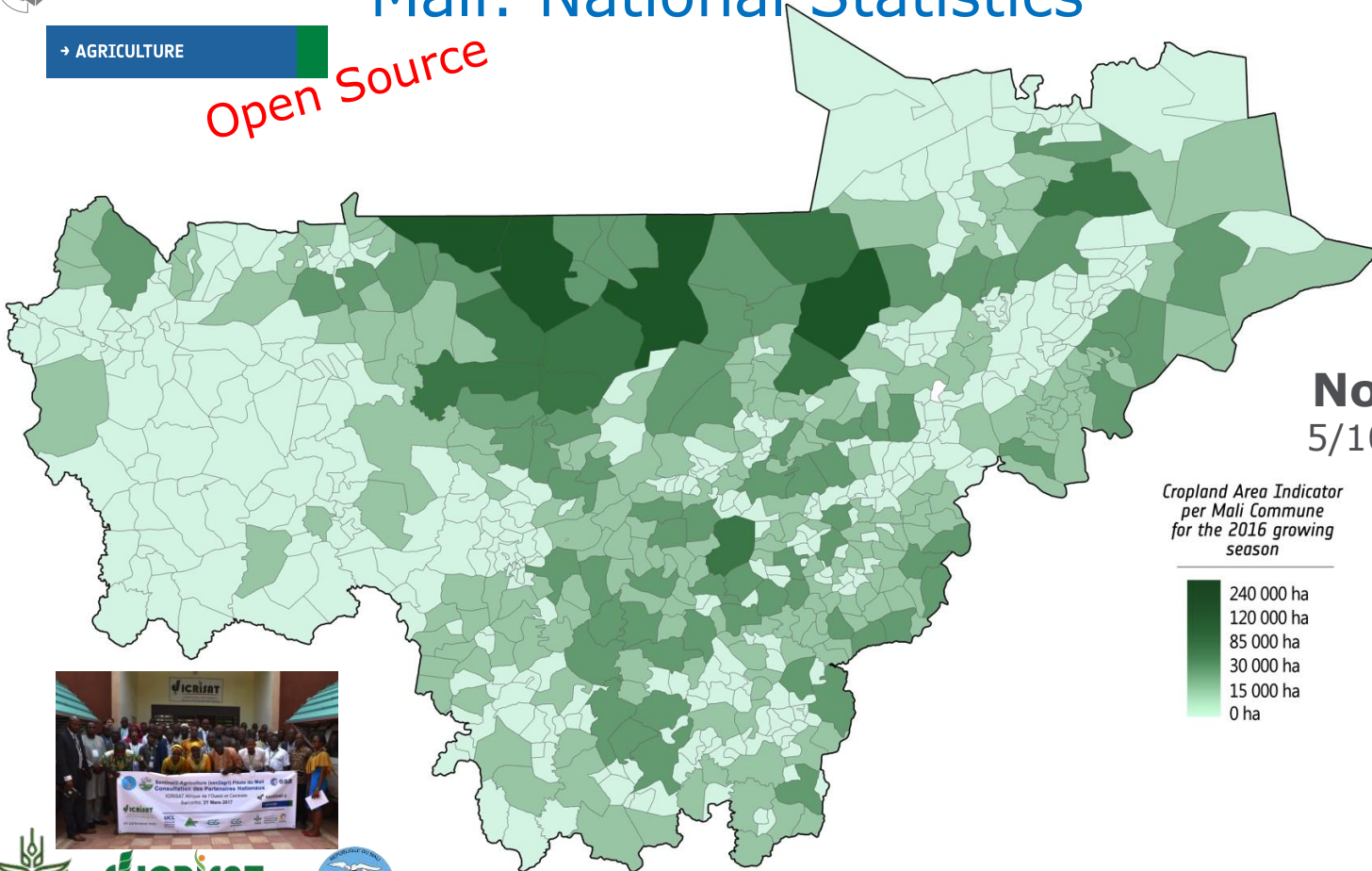


→ AGRICULTURE

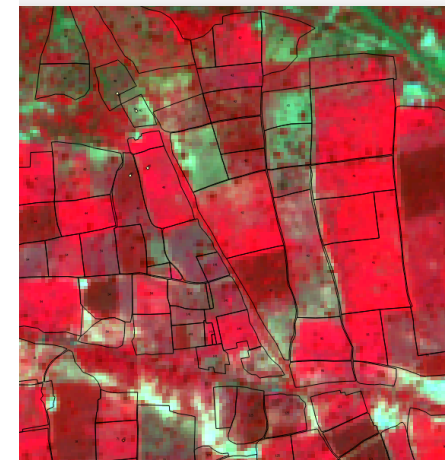
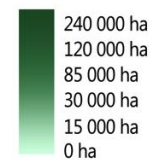
Open Source



November 2016
5/10/2016-25/11/2016



*Cropland Area Indicator
per Mali Commune
for the 2016 growing
season*



Growth Monitoring at Field Scale



4
3
2
1
0

17/00572016 → 09/2016

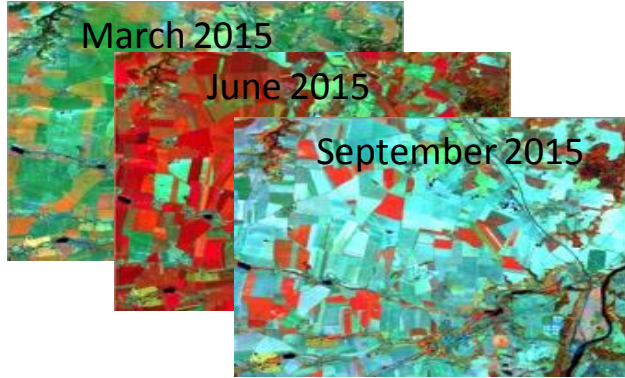


26/08/2016 ← 17/00572016

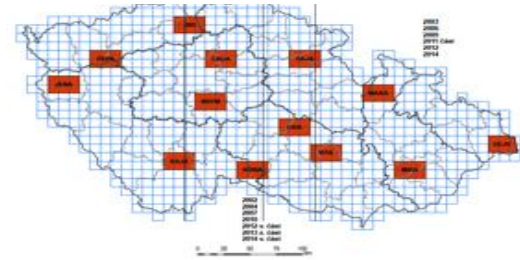


Czech-Agri: National Demonstration

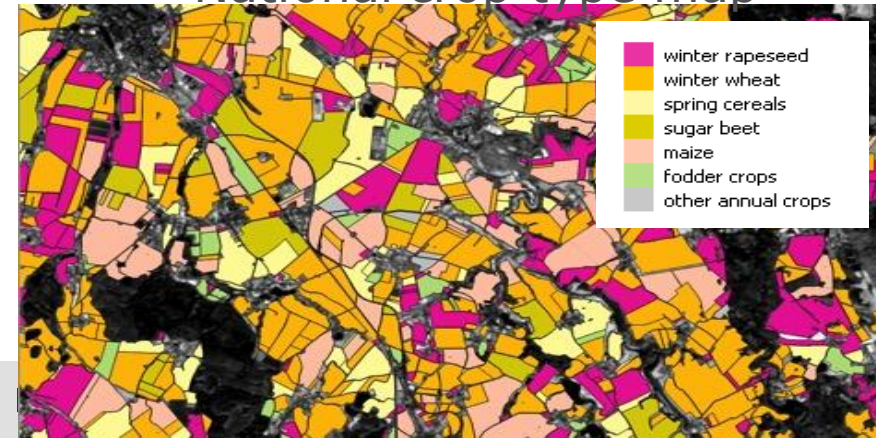
Landsat & Sentinel-2 time series



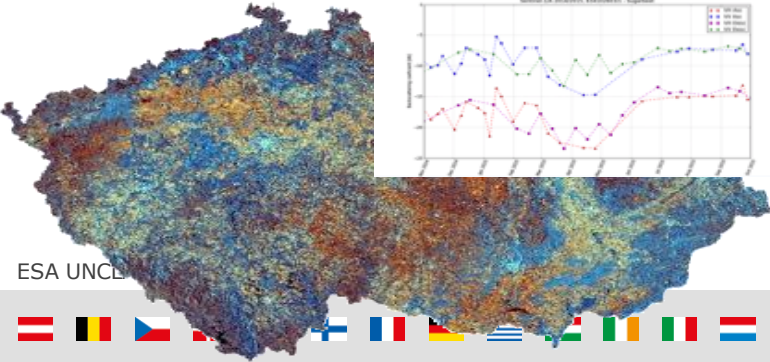
Land Parcel Identification System (2300 parcels for calibration & validation)



National crop type map



Sentinel-1 time series

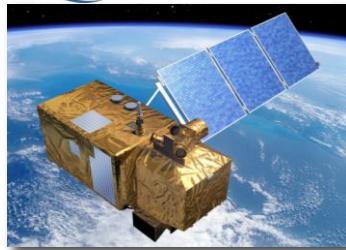


Sen4CAP – preparing a CAP monitoring approach



Paying Agencies & Farmers

Copernicus



Continuous Monitoring


DG-Agri, JRC,
DG-Grow

Open Source



sen4cap
common agricultural policy

Validated Performance

CAP2020 Reform


EO Experts

National Demonstration

Cloud Technology (DIAS)

Innovative Practices



step.esa.int



CGI



Food Security Platform



food security

tep



Access to nutritious food is crucial to end hunger and malnutrition

Efficient use of satellite data and spatial information can

- sustainably increase agricultural and aquacultural productivity
- help farmers adapt to global change
- improve early warning initiatives



ESA TEPs**

“Bringing the users to the data”

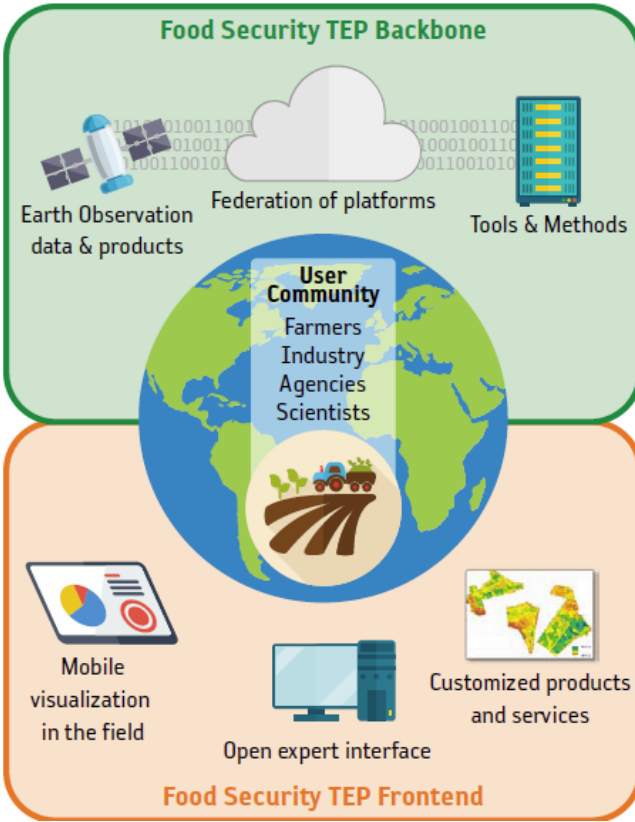
A collaborative virtual work environment with

- access to EO data and tools
- processors and ICT resources
- one coherent interface

tep
thematic exploitation platform

**





Access to key satellite products and ancillary data, backed up by a **scalable processing infrastructure**

Universities

Interact with a range of users through a dedicated **forum**

App developers

Ability to **easily develop new services**, with the ability to share processors and outputs only with selected user groups

Service Providers

New Business Model offer for private companies

Start-Ups

Access to **tools** to derive **agricultural and aquacultural** products

Researchers

Technical support for platform use

Public Entities

Provision on request of **high-accuracy, quality checked** vegetation parameters (LAI, fAPAR, etc), suitable for use in operational scenarios.

Int. Bodies

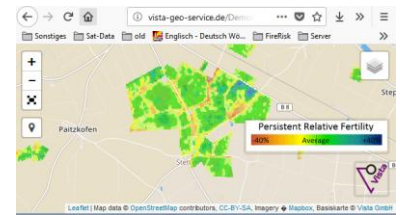
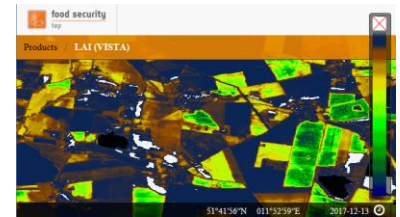
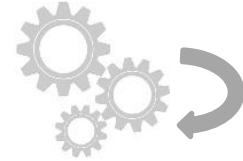
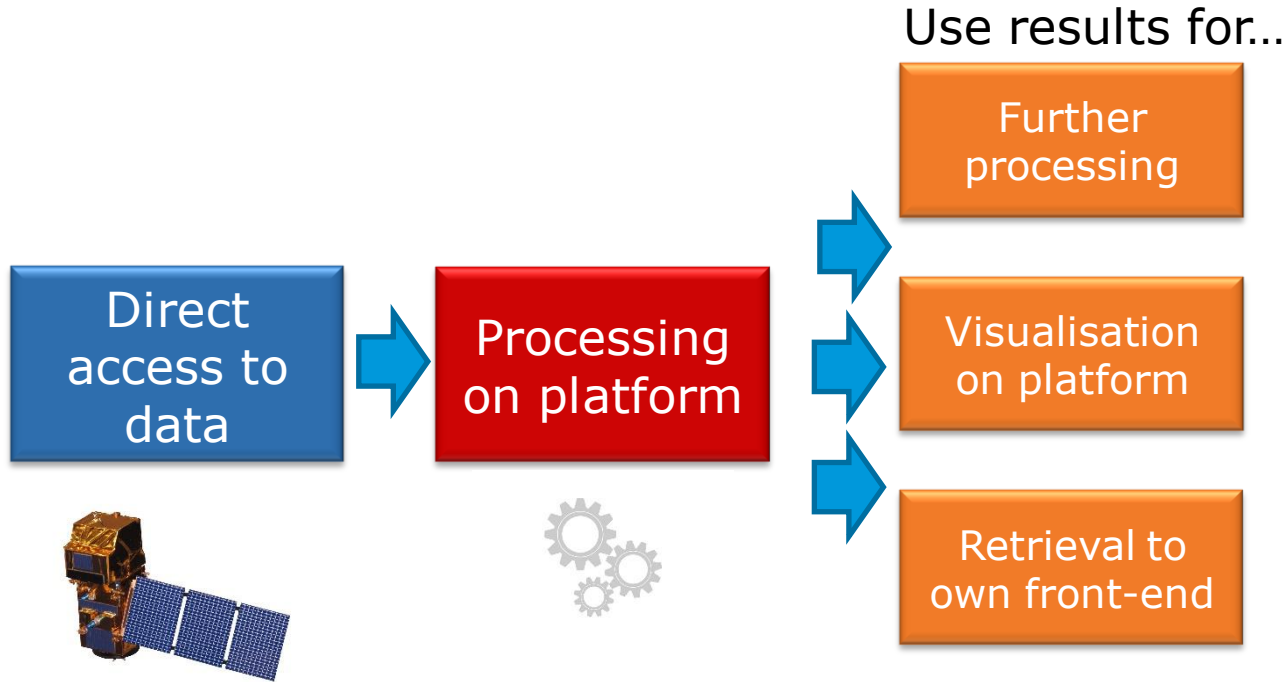
Access to **ready-to-use products** or customized services

Finance Ind.

Farmers

Ag & Aquac. Industry





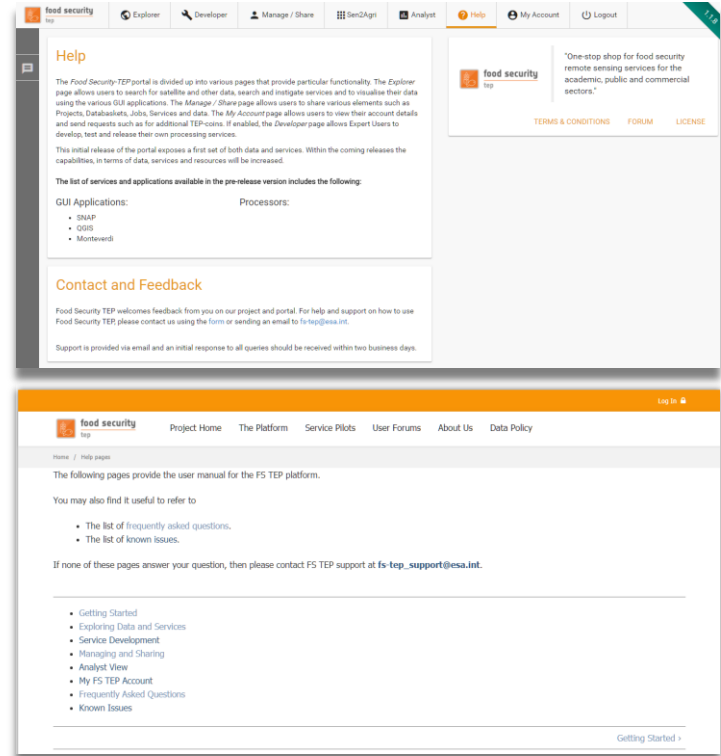
Integrated tools and services:

- The following tools are already integrated as **GUI applications**: SNAP, R Studio, QGIS, Monteverdi, Jupyter notebooks
- **Parallel execution of pre-configured workflows** is possible using SNAP graphs, R scripts, Sen2Agri workflows
- **Inputs and outputs** of tool applications are stored on the TEP and then manageable and shareable by the user
- **New processing services** (e.g. new indices) can be easily set up using pre-configured templates of SNAP and R processors
- Virtually **any application** or tool can be integrated with Docker technology by domain experts themselves

Current documentation and support



- (1) **Online User Manual:** Regularly updated with each release by the main developers
- (2) **User Forums:** Access to the user community as well as dedicated help sections for service providers and open-source developers
- (3) **Help desk:** First level of support for EO SSO registered platform users
- (4) **Technical support** from the Food Security Platform team, including addition of new features and data upon user request (subject to available resources).



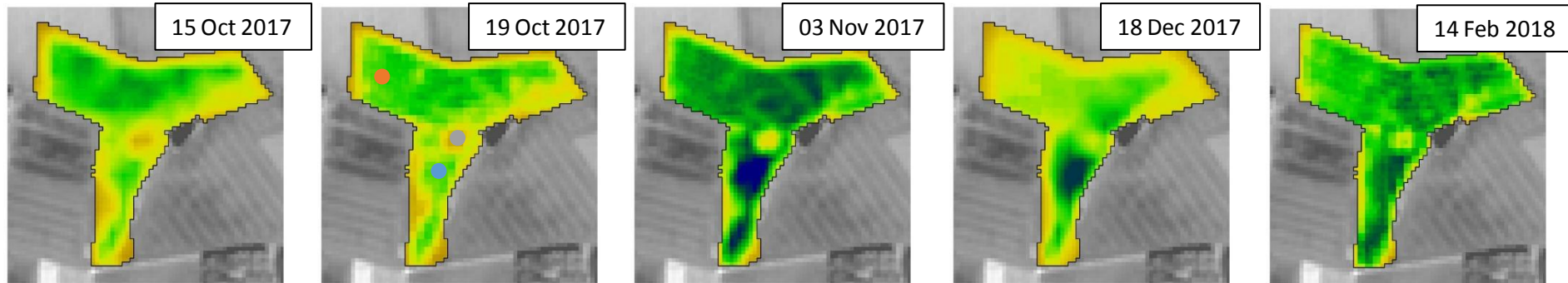
The Main Platform Interface



The Food Security TEP Open Expert interface allows

- **Exploring** EO data, products, uploaded data & services
- **Developing** your own services as Docker applications
- **Managing & Sharing** your data, services & jobs
- Accessing **Sen2Agri** automatic workflows
- Visualization of products in the **Analyst**
- **Account** management

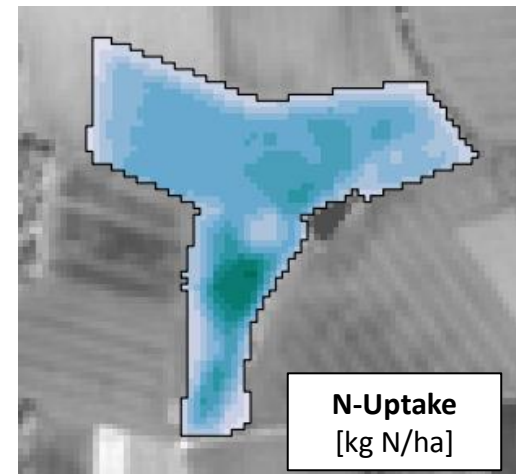
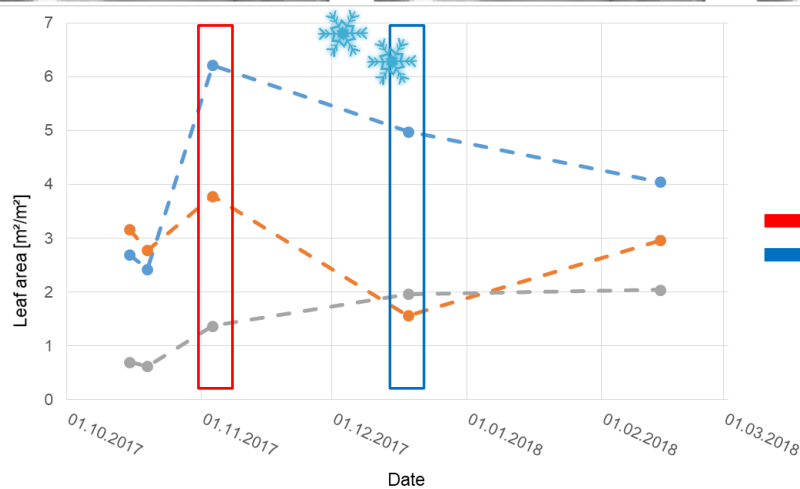
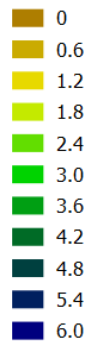
Pilot 1b: Oil Rapeseed – Using satellite data for calculating site-specific N-Uptake



Leaf Area Oil Rapessed

□ Field boundary

Leaf Area [m^2/m^2]



Official U



Food Security TEP green leaf area products

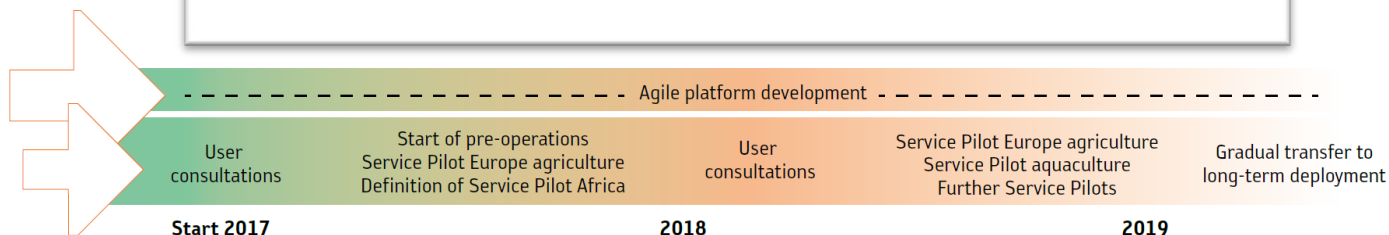
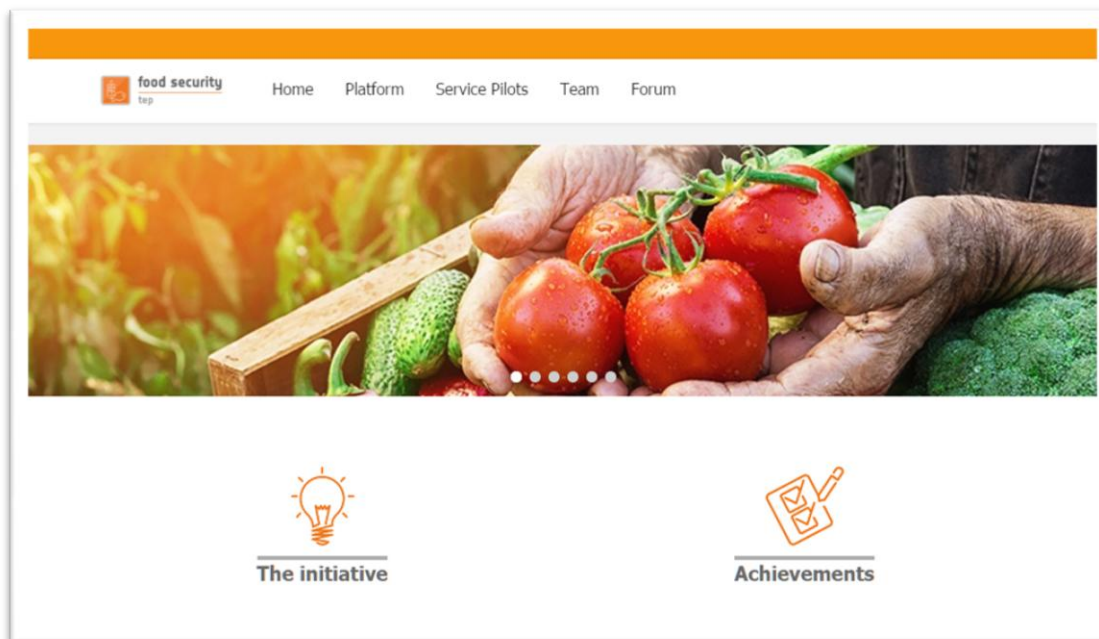


Visualization of green leaf area of agricultural areas near Berlin, Germany showing the decrease of plant health during the summer drought 2018

Supplemental Dataset	Spatial resolution
European Soil Database Derived Data	1 km
Harmonized World Soil Database (HWSD)	30 arcsec
Global Surface Water data (JRC)	30 m
ALOS Global Digital Surface Elevation Model	30 m
GFSAD30 Global Cropland Extent	30 m
IACS Land Parcel Information System data	(vector)
FAO-UN Global Administrative Unit Layers (GAUL)	(vector)
CHIRPS meteorological data	0.05°
ERA5 Global Reanalysis meteorological data	32 km
TAMSAT precipitation for Africa	4 km
ECMWF seasonal forecasts	0.75°

Additional Data Services

- A major development over Phase 2 will be to provide access to various supplemental datasets
- Part of the data will be hosted on the platform, other data will be accessed on the fly
- Proba-V and SPOT-Vegetation data as well as Copernicus Global Land products will be accessible by federation with Proba-V MEP



SMOS: Soil Moisture & Ocean Salinity Mission



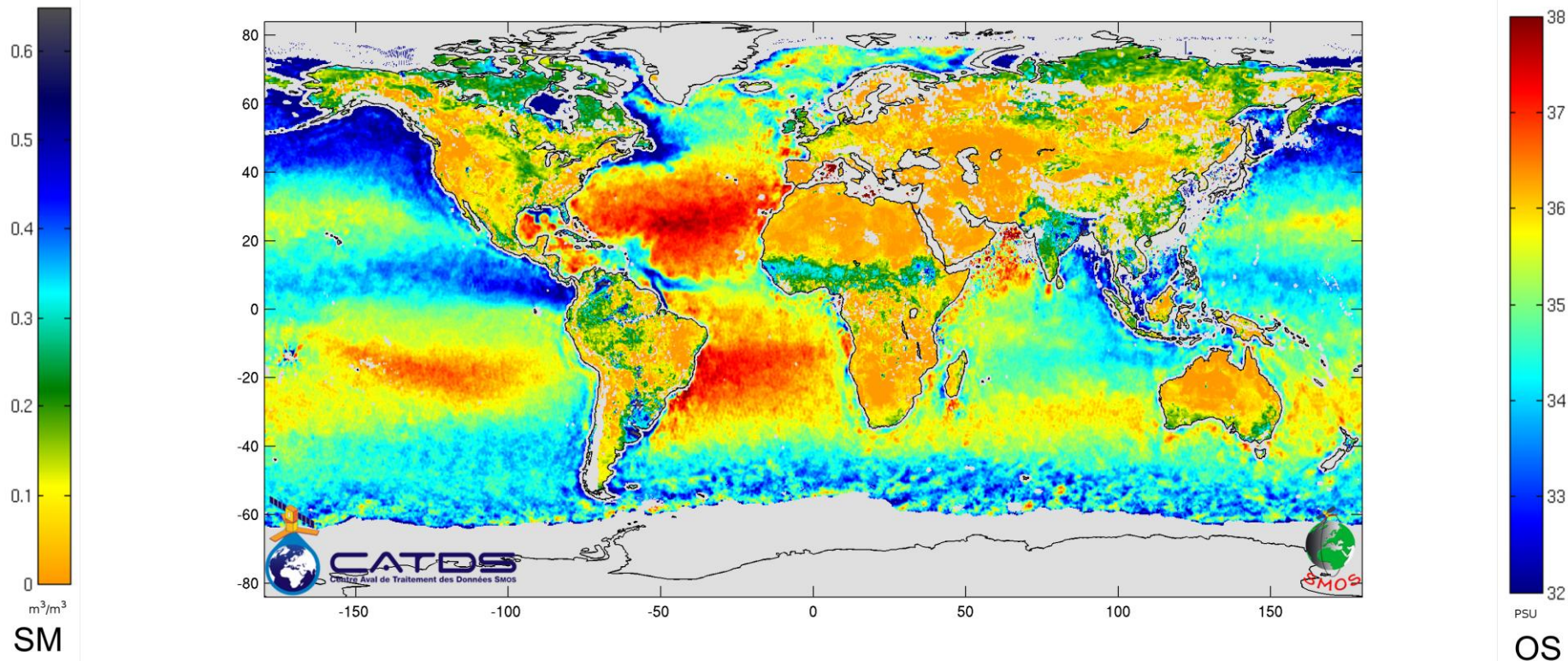
- Launched 02 November 2009
- Data delivery since February 2010
- Complete Earth coverage within three days
- Radio Frequency Interference (RFI) mitigation continues
- Outstanding international cooperation



SMOS Measurements



Aug 2015



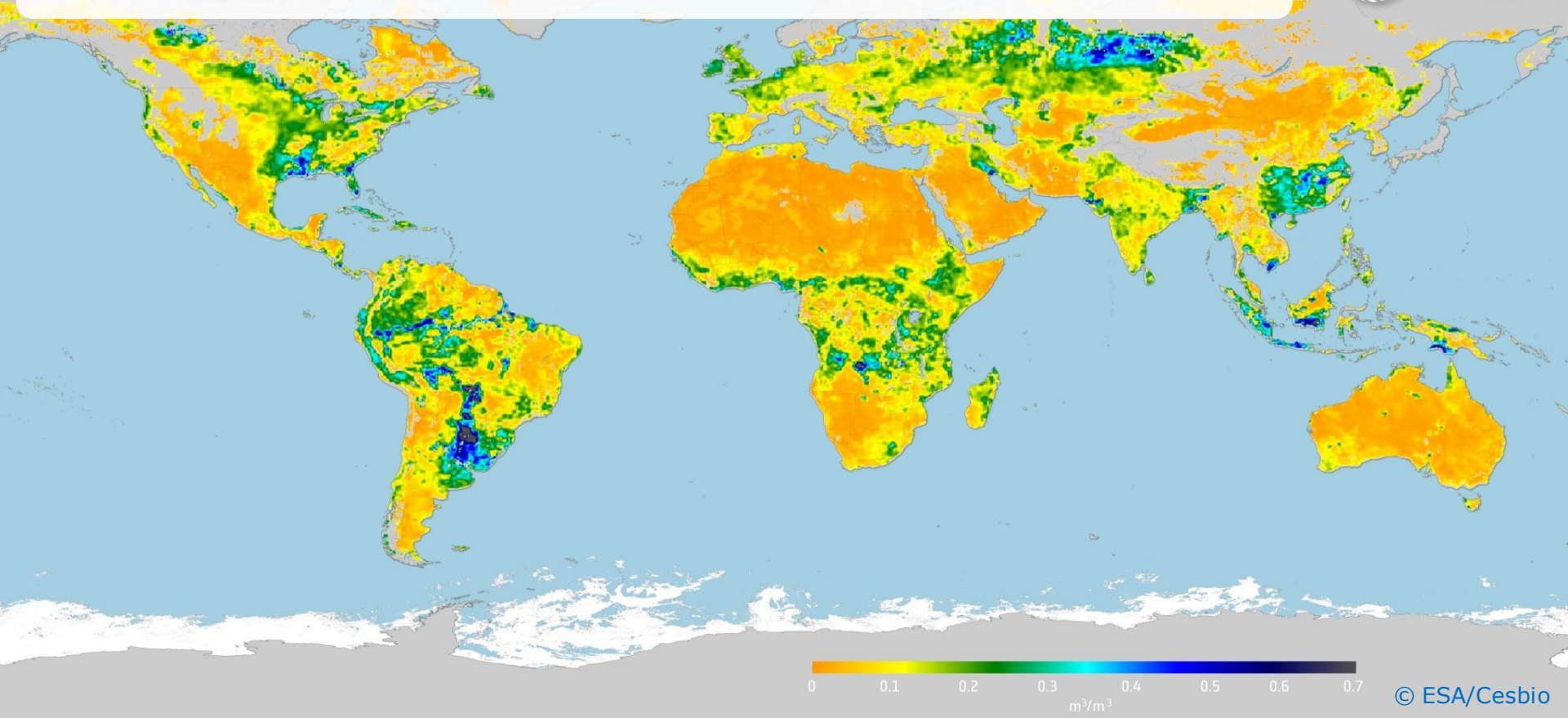
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European Space Agency

SMOS: Root zone Soil Moisture, May 2016



© ESA/Cesbio

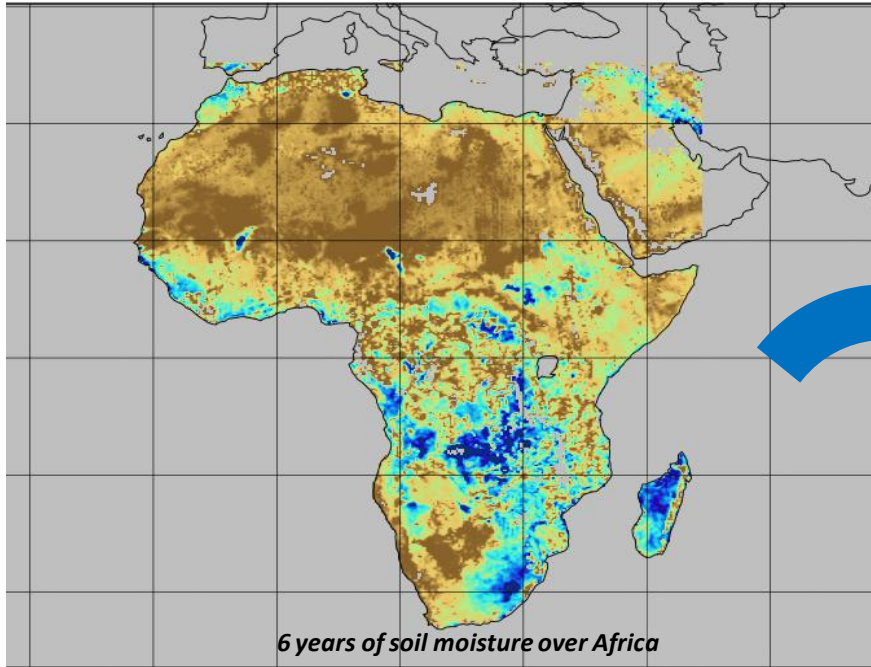


European Space Agency

Soil Moisture for Drought Monitoring

SMOS mean monthly soil moisture (2011-2016)

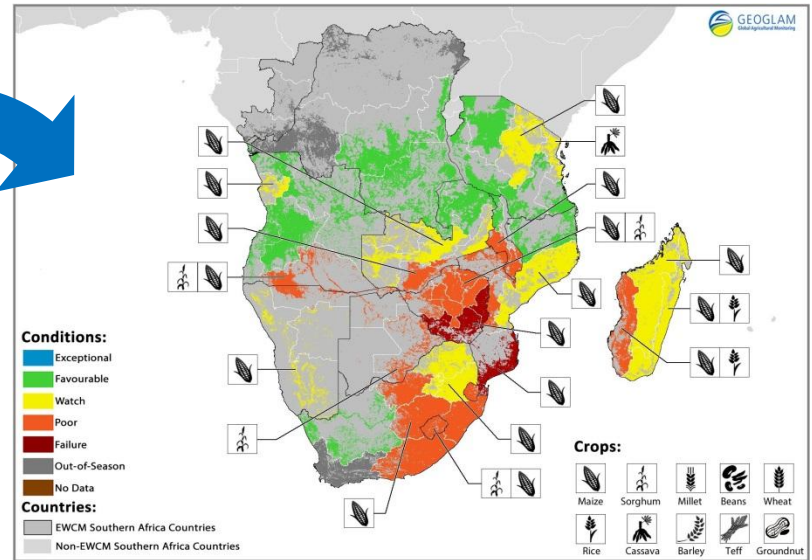
Time: 1 of 72



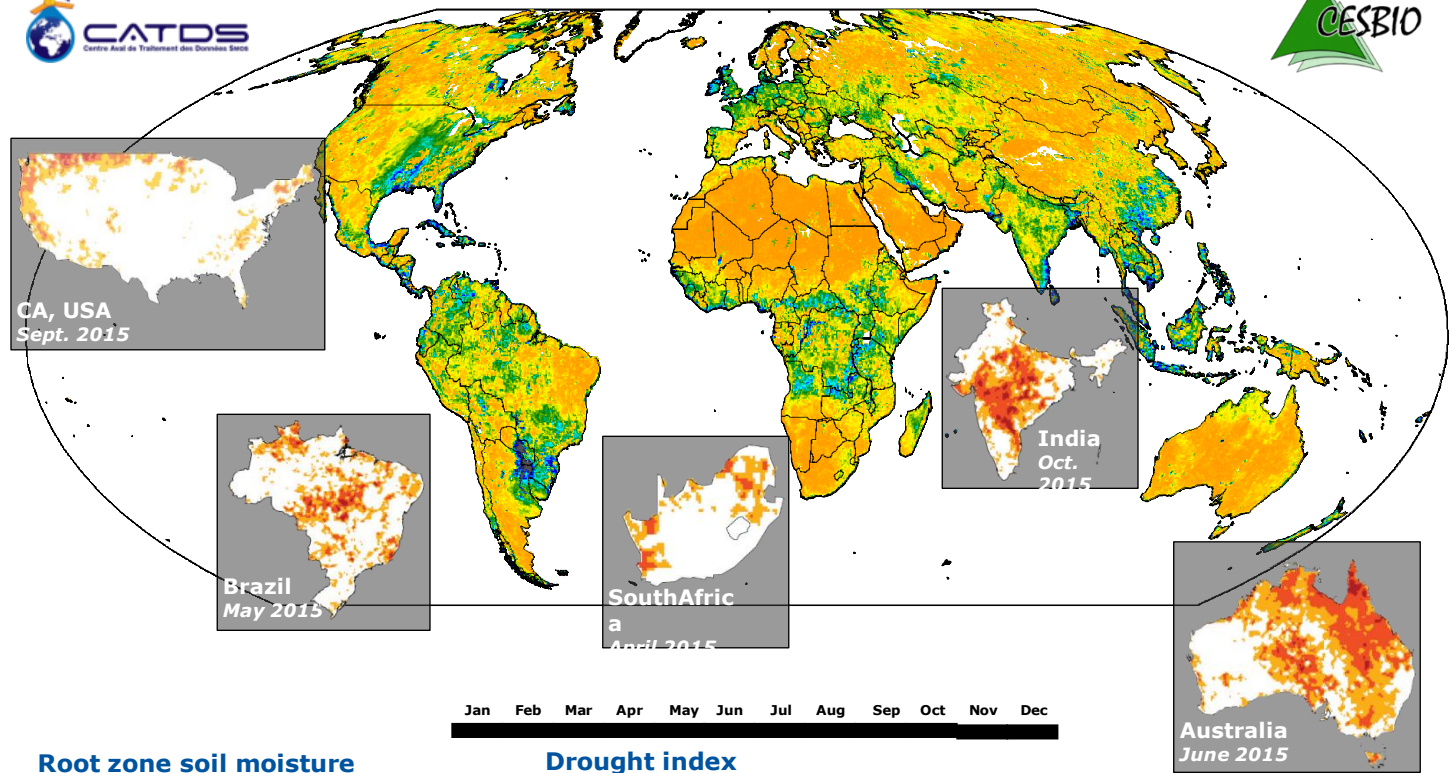
Retrieved soil moisture value (m³.m⁻³)



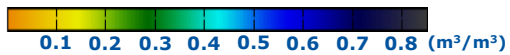
Anticipated crop failure can be used to predict & prevent famine



SMOS monitoring major droughts in 2015



Root zone soil moisture



Drought index



ahmad.albitar@cesbio.cnrs.fr

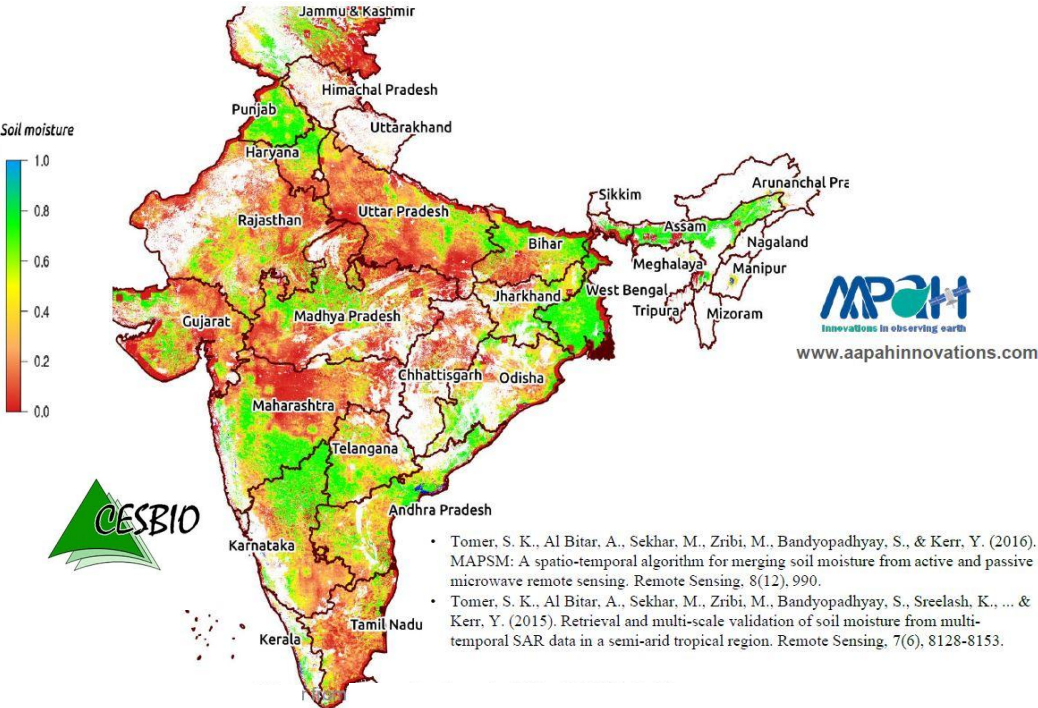
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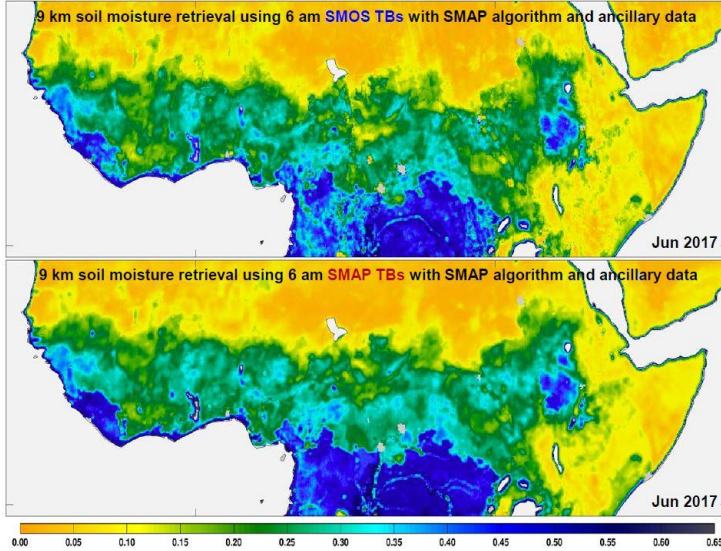
European Space Agency

SMOS Developments



- Tomer, S. K., Al Bitar, A., Sekhar, M., Zribi, M., Bandyopadhyay, S., & Kerr, Y. (2016). MAPSM: A spatio-temporal algorithm for merging soil moisture from active and passive microwave remote sensing. *Remote Sensing*, 8(12), 990.
- Tomer, S. K., Al Bitar, A., Sekhar, M., Zribi, M., Bandyopadhyay, S., Sreelash, K., ... & Kerr, Y. (2015). Retrieval and multi-scale validation of soil moisture from multi-temporal SAR data in a semi-arid tropical region. *Remote Sensing*, 7(6), 8128-8153.

SMOS and S1 HR Soil Moisture 500m. Source: CESBIO



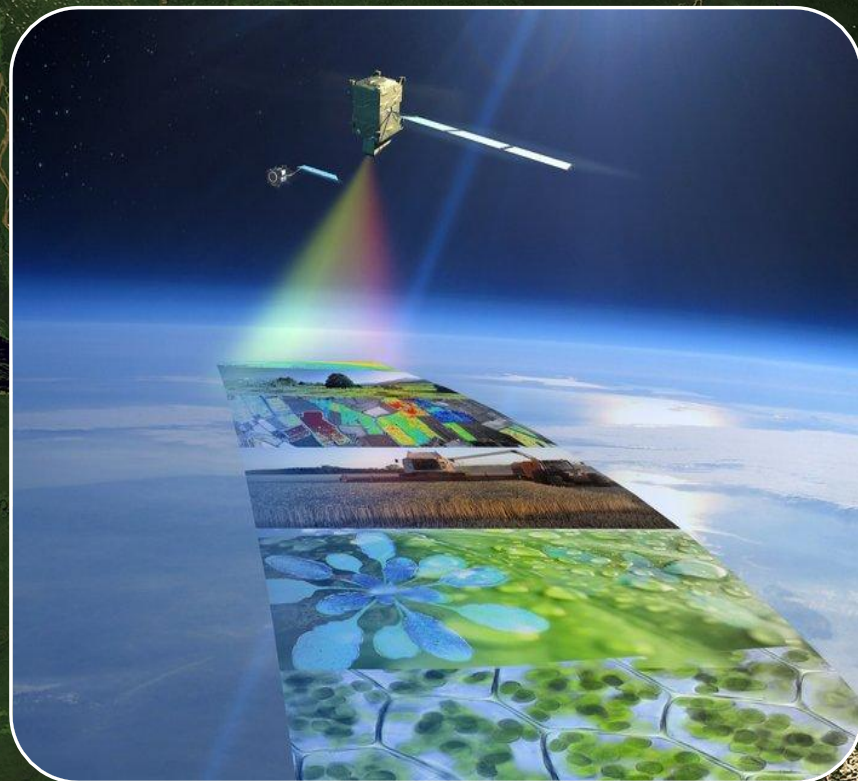
Consistent SMOS and SMAP TBs, algorithm, and ancillary data lead to a new consistent SMOS/SMAP soil moisture product. Source: CESBIO/NASA;



FLEX



Mission	Study & monitoring of fluorescence signal linked to vegetation stress; pixel 300m.
Swath	150 km
Payload	FLORIS, 2 channels spectrometers (O ₂ lines)
Orbit	SSO, alt: 814 km; LTDN: 10h00
Satellite	470 Kg
Consortium	Prime: TAS Instrument: Leonardo
Launch date	end 2022
Lifetime	3.5 years



FLuorescence EXplorer FLEX – Mission Concept



Scientific Objectives:

- FLEX will quantify **actual photosynthetic activity** of terrestrial ecosystems
- FLEX will provide **physiological indicators** for vegetation health status
- by direct measurements of **vegetation fluorescence** at relevant spatial scales

Photosynthesis is the central metabolic process that determines plant productivity

Photosynthesis dynamically adapts to environmental stress

Could help farmers detect disease, droughts and other problems before crops are heavily impacted



Thank you for your attention!

www.esa.int