



DG INTERNAL MARKET, INDUSTRY, ENTREPRENEURSHIP AND SMES



# Use of InSAR in Copernicus

FRINGE workshop, ESRIN 23 March 2015

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Brussels

## **Outline**





- Copernicus programme overview
- State of play of services and space infrastructure
- SAR interferometry in Copernicus:
  - Emergency Management Service
  - Land Service



## **Copernicus** architecture







6 services use
Earth
Observation
data to deliver



**Sentinels** 



**Contributing missions** 









in-situ

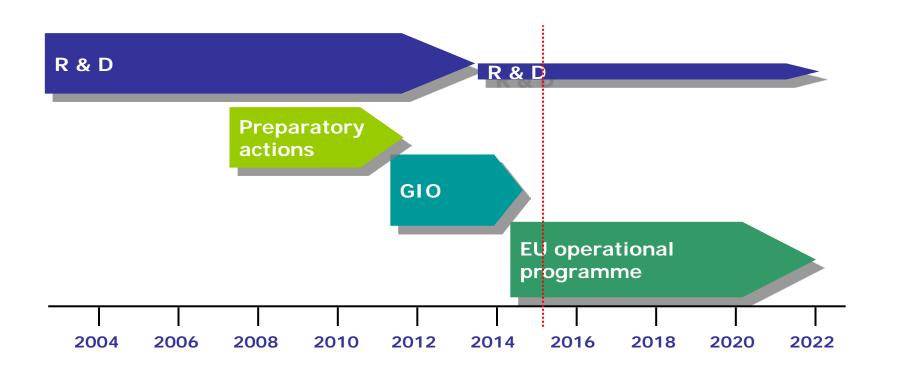
...added-value products





#### Service evolution

### Activities now moving to operations







## Six Copernicus services are necessary to meet user needs

Earth monitoring



**Land Monitoring** 



Marine Environment Monitoring



**Atmosphere Monitoring** 

Transversal services



**Emergency Management** 



**Security** 

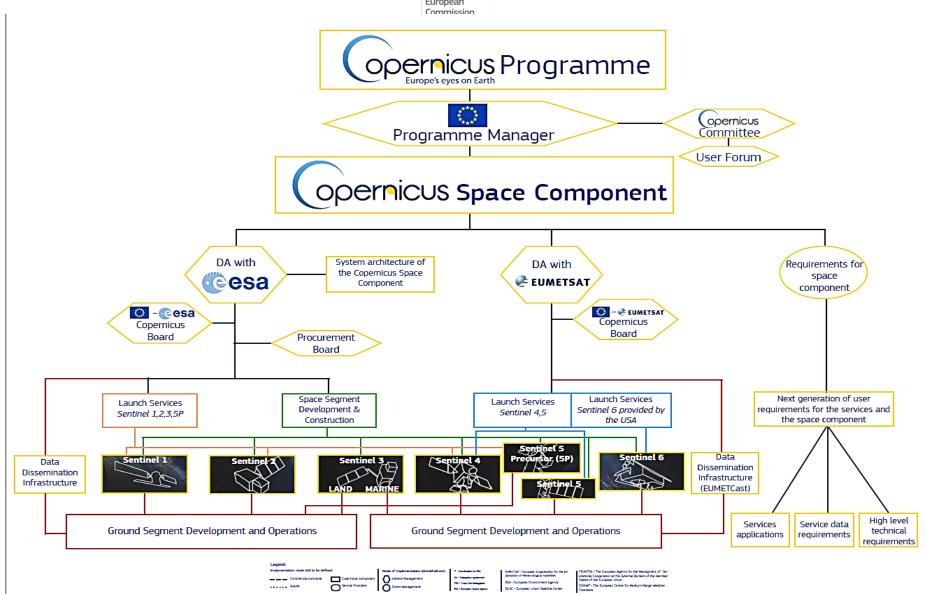


**Climate Change** 

### Copernicus governance



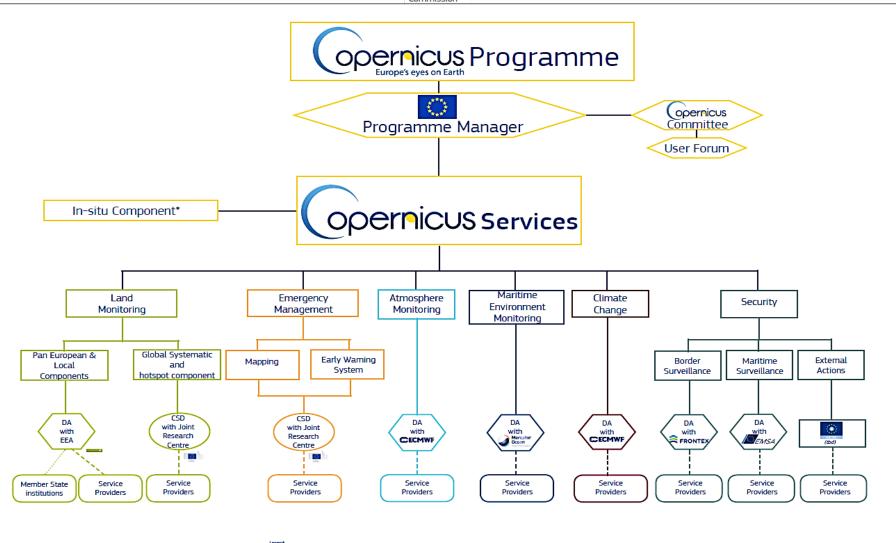
### **Space component**



### Copernicus governance



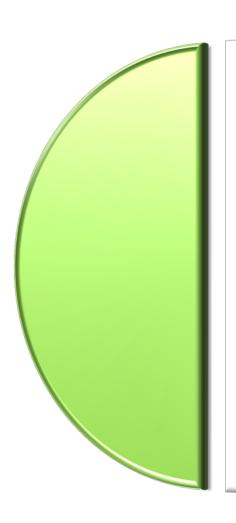
### Service component



### **Current status**







## Six Milestones reached:

- Full, free and open access to data
- Successful launch
   of Sentinel 1A, free
   data becoming
   progressively
   available also for
   InSAR apps
- Programme
   Regulation adopted
- budget of € 4.3 Bn for 2014-2020
- First images presented
- Funds delegated to ESA

Next: launch of Sentinel-2A, June 2015



### **DEPLOYMENT SCHEDULE**



#### Launch schedule

Sentinel-1A Launch - 3 April 2014

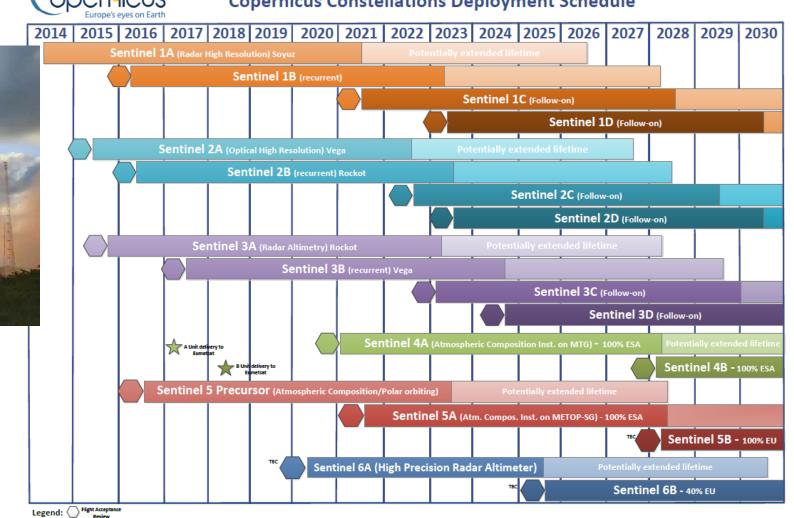
QAR - March 2015 Sentinel-2A Sentinel-3A **QAR - July 2015** 

Sentinel-1B **FAR - Nov. 2015** 

Status 23 January 2015



#### **Copernicus Constellations Deployment Schedule**



## Sentinel-1A operational phase





- Start of Sentinel-1A data flows since October 2014
- Ramp-up phase to be completed in May 2015
- 12-day revisit time, interferometric wide swath mode optimised for InSAR
- With launch of Sentinel-1B foreseen in early 2016, revisit time goes down to 6 days
- Scientific data hub up and running: <u>https://scihub.esa.int/</u>
- Full, free and open data policy considered a gamechanger
- Sentinel-1 toolbox available for end-users, allowing anybody to do InSAR processing

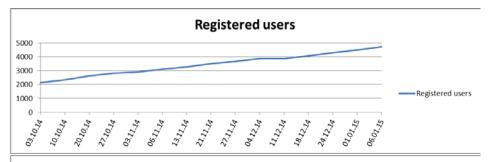
## Sentinel-1A data uptake

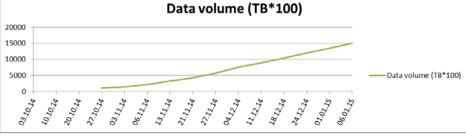


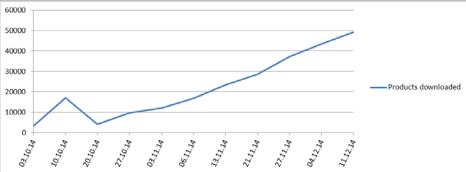


- More than 5500 User registrations
- ~100-150 new registrations/week
- About 70000 products currently published
- The number of downloaded products have increased to 20000 per week
- And more recently even reaching more than 40000 per week...
- About 600 TB of data downloaded by users









## **Services Deployment**





Status 1st September 2014

OPETNICUS Copernicus Services Implementation Schedule								
2014	2015	2016	2017	2018	2019	2020		
JRC	Emergency	Management						
EEA	Land Monit	toring – Pan-EU a	nd Local					
JRC	Land Monit	oring – Global						
ECMWF	Atmospher	e Monitoring Pha	se l	Phase II				
MERCATOR OCEAN	Marine Env	rironm. Monitorin	g Phase I	l Phase II				
FRONTEX		Security – Borde	er Surveillance					
EMSA	Secu	urity – Maritime S	urveillance					
JRC/EUSC		Security – Sup	port to External A	Action				
ECMWF		Clin	nate Change Pha	ase I Phase	I Phas	e III		
EEA Ir	n-Situ Coordinatio	on						

# InSAR for Copernicus





## Two major application domains for Sentinel-1 SAR interferometry

- Emergency management
- Land Monitoring

## **Emergency Monitoring Service**





**Objective**: to provide information in relation to different type of disasters in Europe and beyond

EMS mapping service:

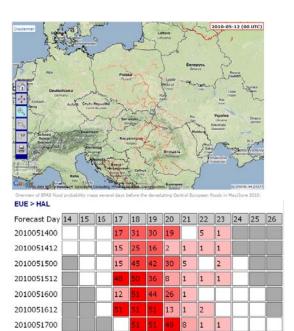
to measure the impact and respond to natural and man-made disasters, on a 24/7/365 basis

Rush mode: immediate response needed, Non-rush: prevention, disaster risk analysis, recovery;

 EFAS European Flood Awareness System:
 First operational alert system for floods and hydrological network

**Added value**: better preparedness and improved disaster and crisis management in Europe with transnational flood early warning information to EC civil protection and Member State authorities





## **Emergency Management Service**





### ☐ How many activations?

135 in total since April 2012:

→ 69 in Europe, 66 outside

#### Which kind of disaster?

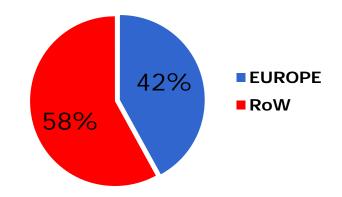
14 Fires, 76 Floods, 4 Earthquakes,4 Industrial accidents, 37 Other

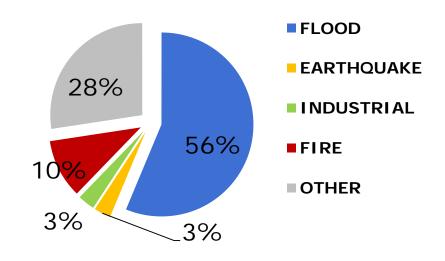
- In Europe: mostly floods
- Outside Europe: many humanitarian

### ■ Who is activating?

**Activations are received by:** 

- MS Civil Protection,
- European Services or
- UN agencies via DG ECHO





## **Insar for EMS**





- Limited use of InSAR in the core Copernicus Emergency Management service
- Special cases e.g. EMS map provision by E-Geos
  - Iceland volcano monitoring; Fogo volcano (Cape Verde) monitoring
  - Main InSAR applications: Lava flow mapping through interferometric coherence change detection;
     Displacement map
- Many research projects related to GMES/Copernicus use InSAR, mostly for risk mitigation

## FP7 projects with links to EMS





### APHORISM (start Dec 2013) <a href="http://www.aphorism-project.eu/">http://www.aphorism-project.eu/</a>

- volcanic ash cloud estimation product
- seismic crisis product (APE, "A Priori information for Earthquake damage product"): derivation of likelihood index damage map from a pre-crisis InSAR velocity map and ground seismological data

### RASOR (start Dec 2013) <a href="http://www.rasor-project.eu/">http://www.rasor-project.eu/</a>

- Multi-hazard risk management platform to support analysis and mitigation for decision making
- Using InSAR data for ground deformation monitoring of seismic and subsidence hazards risks

#### PanGeo (end Jan 2014) <a href="http://www.pangeoproject.eu/">http://www.pangeoproject.eu/</a>

 A GMES-Copernicus service enabling access to geological information (Geohazard products for cities integrating terrainmotion measurements derived from INSAR with local information)

# FP7 projects with links to EMS -





#### LAMPRE (end Febr 2015) <a href="http://www.lampre-project.eu/">http://www.lampre-project.eu/</a>

- Products on landslides (inventory maps, statistics, susceptibility models and maps, 3D surface model to predict future.
- Uses Differential SAR interferometry data (DInSAR)

### DORIS (end Sep 2013) <a href="http://www.doris-project.eu/">http://www.doris-project.eu/</a>

 Advanced downstream service for the detection, mapping, monitoring, and forecasting of ground deformations (e.g. landslides and subsidence phenomena), using DInSAR derived products

#### SENSUM (end Dec 2014) http://www.sensum-project.eu/project

 InSAR for the assessment of landslide activity in Southern Kyrgyzstan; methodologies and software tools for vulnerability assessment and disaster recovery monitoring



# FP7 projects with links to EMS -





### INCREO (end Dec 2014) http://www.increo-fp7.eu/

 Test case in Romania with harmonized earthquake and landslide risk maps. InSAR technique is used for the landslide susceptibility maps which is an input to the risk maps.

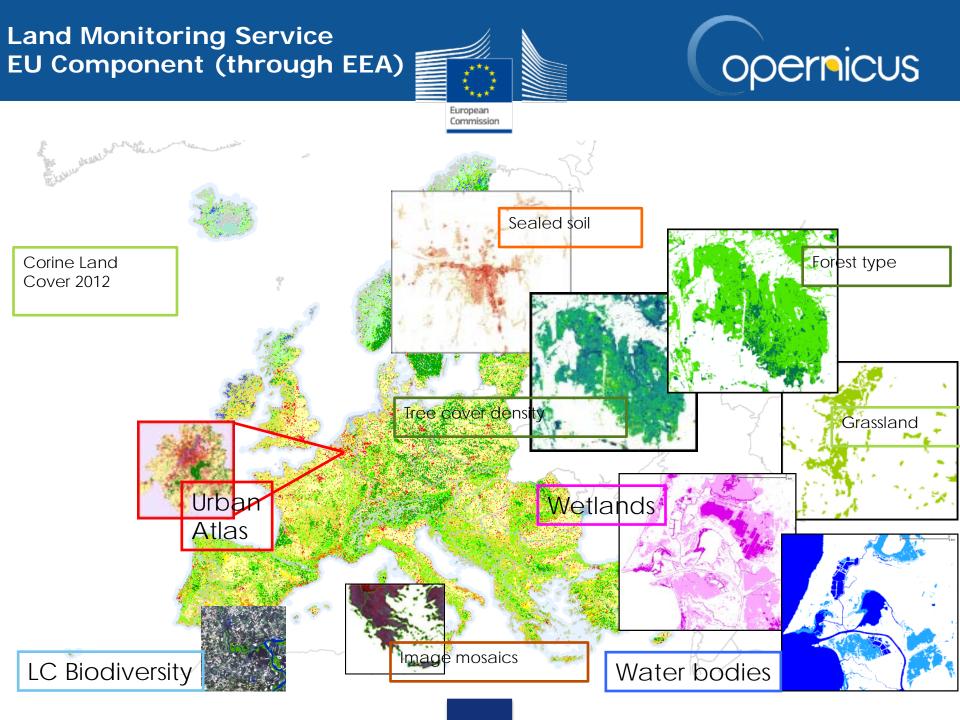
#### **EVOSS** (end 2013)

http://cordis.europa.eu/result/rcn/147474\_en.html

 Services for volcano observation incl. monitoring of ground deformation by the SqueeSAR(TM) methodology, an evolution of the PS-InSAR method

#### SubCoast (end 2013) <a href="http://www.subcoast.eu/">http://www.subcoast.eu/</a>

 Developed a GMES-downstream service for assessing and monitoring subsidence hazards in coastal lowland areas around Europe. (Dynamic DEM product relying on InSAR data to map current situation and predict future elevation changes)



## Global Land Monitoring Service (JRC)





#### Service portfolio: 9 product variables provided in Near Real Time

Variable	Temporal Coverage	Temporal resolution	Spatial coverage	Spatial resolution	Sensor
LAI/FAPAR/FCover	1999 – present	10 days	Global	1km	SPOT/PROBA V
NDVI/VCI/VPI	1999 – present	10 days	Global	1km	SPOT/PROBA V
Dry Matter Productivity	2009 – present	10 days	Global	1km	SPOT/PROBA V
Burnt Area	1998 – present	1 day	Global	1km	SPOT/PROBA V
TOC Reflectance	2013 – present	10 days	Global	1km	SPOT/PROBA V
Surface Albedo	1999 – present	10 days	Global	1km	SPOT/PROBA V
Land Surface Temperature	2009 – present	1 hour	Global	0.05 °	$\Sigma$ Geo
Soil Water Index	2007 – present	1 day	Global	0.1°	Metop / ASCAT
Water bodies	1999 – present	10 days	Global*	1km	SPOT/PROBA V

Service evolution: Move from 1 km resolution to 300 m in 2015

## Global Land Monitoring Service





#### **INTERNET Dissemination**

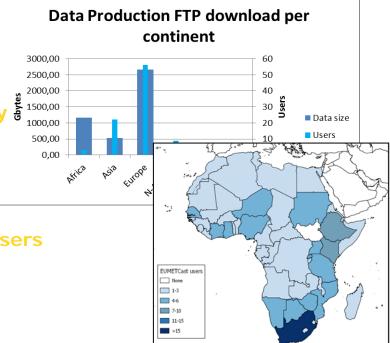
- FTP data access: more than 700 regular users
- New Sept 2014 Web access: 214 registered users
- New Jan 2015 service offer already downloaded by 92 users from 39 countries (16 in EU)
- Around 1 Tb delivered each month thru INTERNET

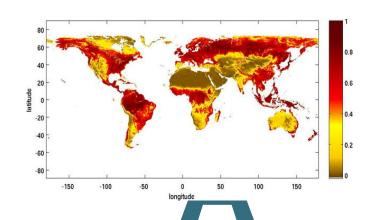
**EUMETCAST Dissemination** 

**EUMETCAST** serves additionally to INTERNET, 552 users

**EUMETCAST** serves in Africa

More than 250 receiving stations More than 300 regular users







## InSAR in Land Service





Two major application areas:

Digital Elevation Model (DEM) generation

Differential InSAR (DInSAR) for Earth movement

In the current land monitoring service portfolio, there are no services based on the use of InSAR.

However, ongoing activities under FP7 address preoperational developments using InSAR.

# Land service projects using InSAR



- ADVANCED\_SAR (start Oct 2013) <a href="http://www.fgi.fi/advancedsar/">http://www.fgi.fi/advancedsar/</a> (Advanced Techniques for Forest Biomass and Biomass Change Mapping Using Novel Combination of Active Remote Sensing Sensors):
  - Develop advanced EO methods for forest biomass estimation and biomass change mapping using canopy height information.
  - The methodology is based on object-based, multi-date analysis of Sentinel-1 (C-band), TerraSAR/TanDEM-X (X-band), ALOS-2 PALSAR-2 (L-band) SAR data utilizing radargrammetry and InSAR.
- North-State (start Oct 2013) <a href="http://northstatefp7.eu/">http://northstatefp7.eu/</a> (Enabling Intelligent GMES Services for Carbon and Water Balance Modeling of Northern Forest Ecosystems):
  - Innovative methods applied to Sentinel data streams combined with models to monitor carbon and water fluxes for pan-boreal Europe, (study sites in Finland, Iceland and Russia)
  - Extraction methods for forest stem-volume and tree-height estimation with combined SAR interferometry and optical data

## **New opportunities**





## Generic H2020 calls addressing Sentinel service development

<u>http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/2448-eo-1-2015.html</u>

https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/2449-eo-2-2015.html

