



# EUMETSATs Network of Satellite Application Facilities

Lothar Schüller



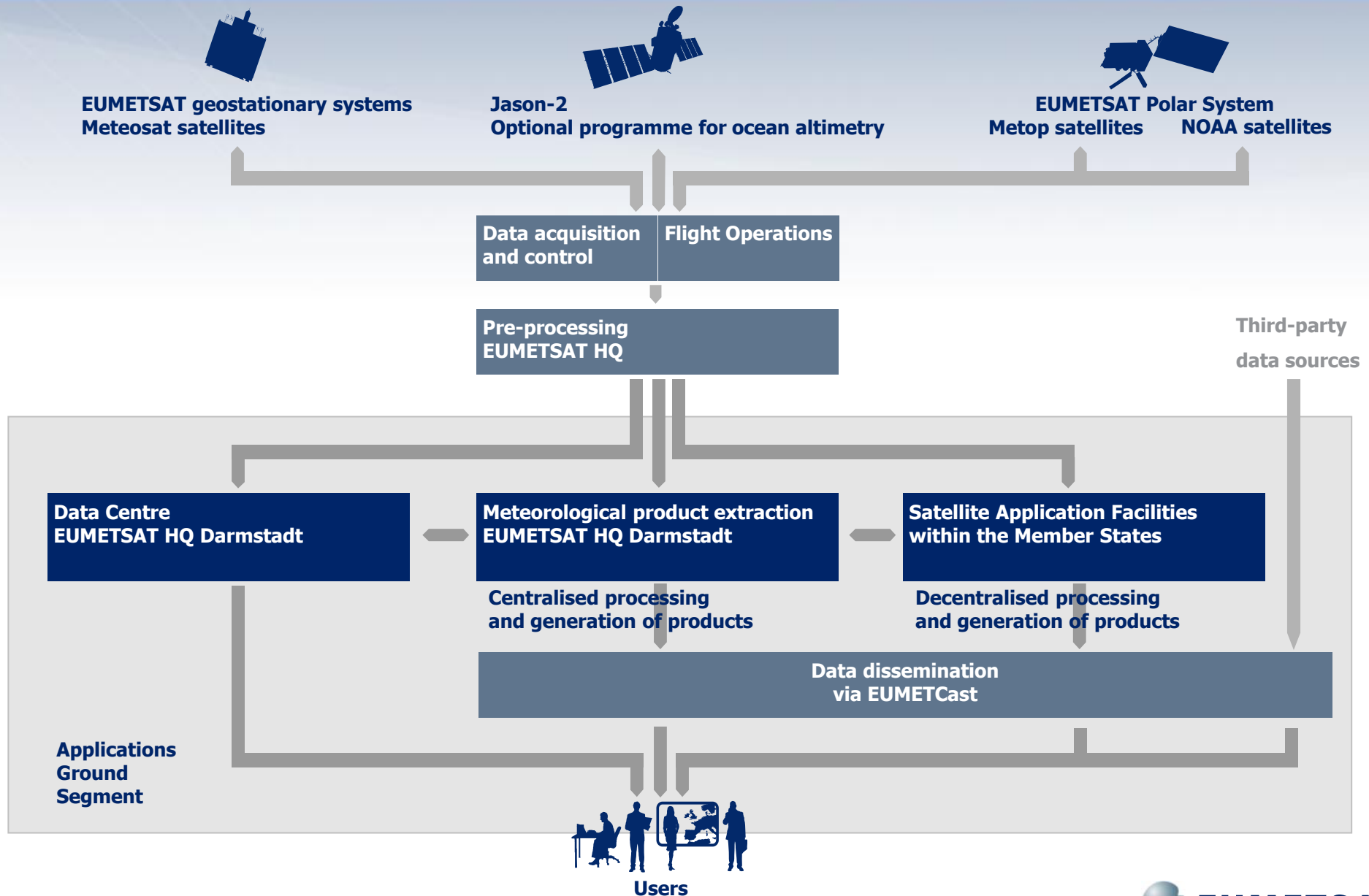
The EUMETSAT Network of  
Satellite Application Facilities



# Outline

- Programmatic framework
- SAF concept and establishment
- SAF structure and processes
- SAF types and categories
- SAF product characteristics
- Current SAF Network
- SAF interaction with users
- SAF phasing
- Research to Operations

# EUMETSAT ground segment overview





# Why SAFs ? Facts and Objectives

## Facts:

- New generation of Meteorological Satellites (MSG and Metop as well as MTG and EPS-SG) have much wider areas of application
- specific expertise available in EUMETSAT's Member and Cooperating States

## Objectives:

- SAF concept encourage the utilisation of existing skills and infrastructure in Member- and Cooperating States for developing geophysical data products and services
- Facilitating cost-effective exploitation by ensuring services are distributed in the most appropriate way
- SAFs improve the ability of EUMETSAT Member States to exploit satellite data
- Fostering development of cooperation with non-Member States and other organisations



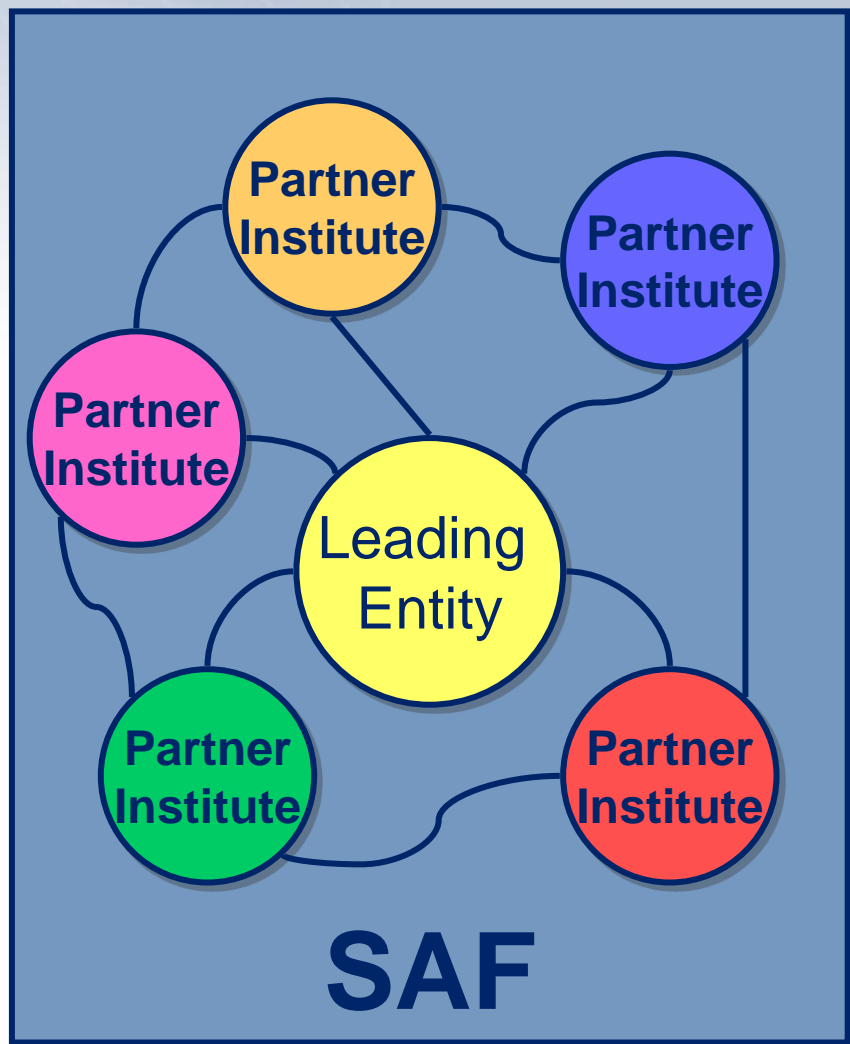
# What is a SAF?



- SAF = **Satellite Application Facility**
- part of the EUMETSAT application ground segment
- complement production of standard meteorological products at EUMETSAT central facility
- providing products and services to users
- specialised on topics and themes
- located at Weather Services in EUMETSAT Member and Co-operating States
- developed and operated by consortium of partners



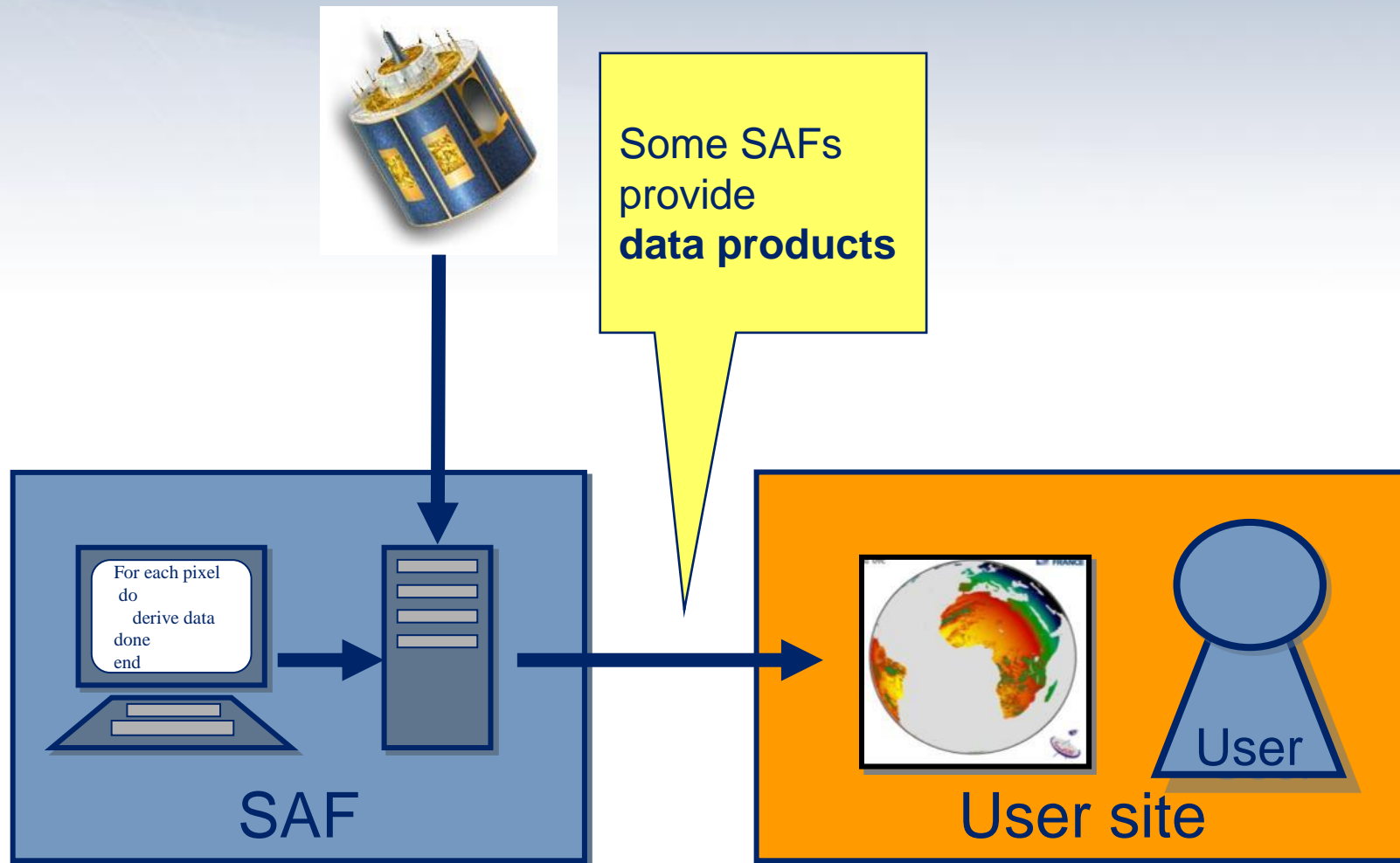
# What is a SAF?



- SAF is developed and operated in a consortium
- lead by a **Leading Entity** (a National Meteorological Service)
- involving partners in EUMETSAT Member and Co-operating states
  - National Meteorological Services
  - Other operational organisations
  - Universities and Research Institutes

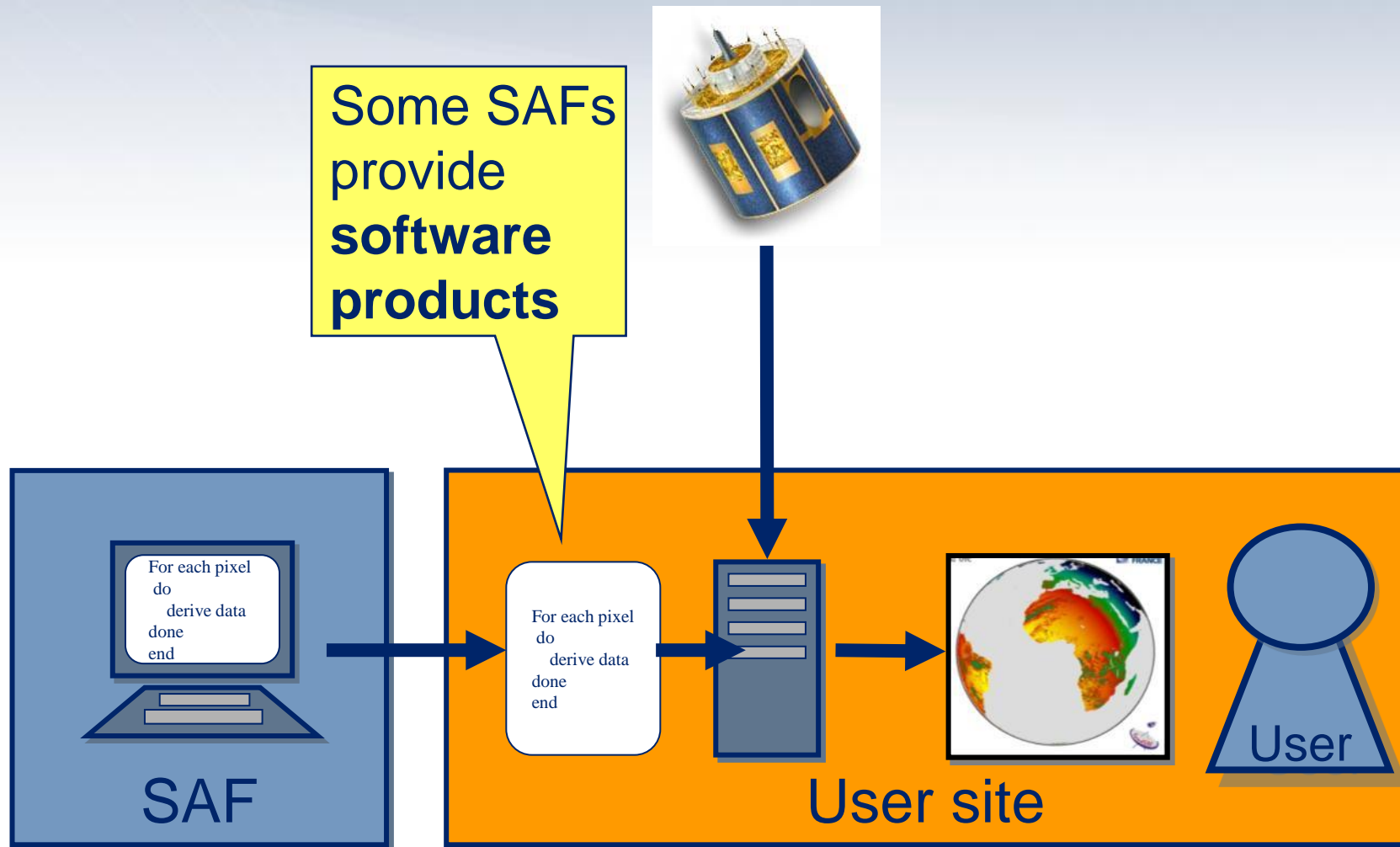


# How do SAFs work? Providing data products





# How do SAFs work? Providing Software products







# Nature of SAF products

The objective of SAFs is to provide **operational** products.

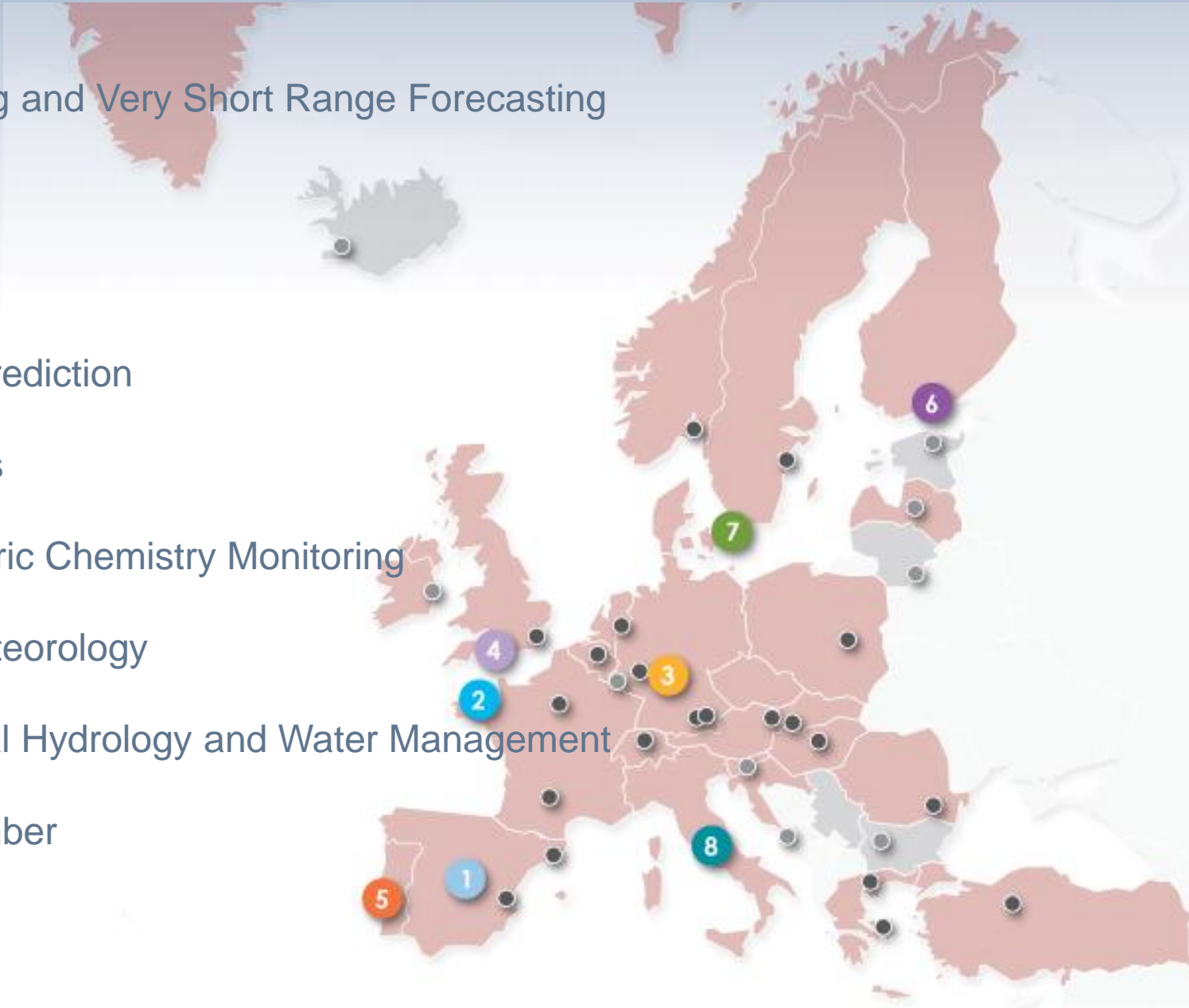
“Operational” means:

- Continuity of product provision
- Continuity of product improvements
- Continuous quality monitoring
- Committed user services
- Validation and review before official release
- Complete Documentation of Products, Algorithms, Validation Results
- ...



# EUMETSAT's 8 Satellite Application Facilities

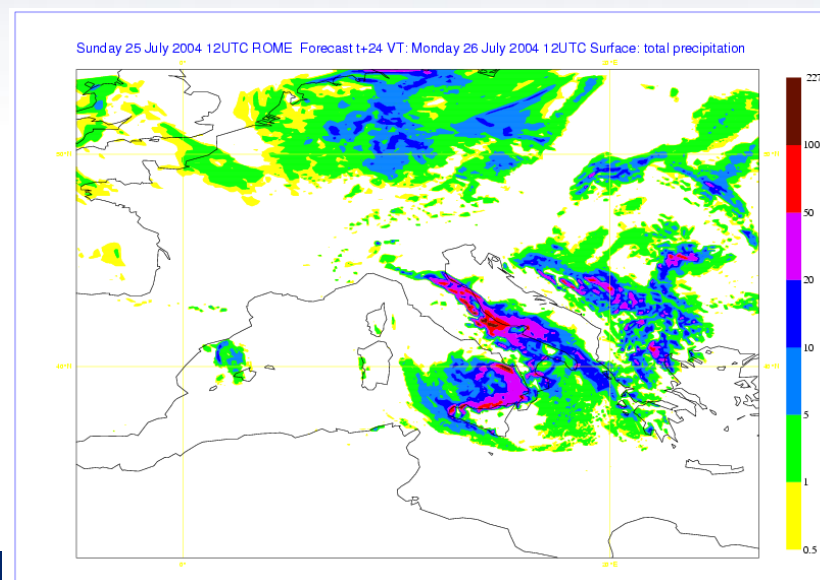
- ① Support to Nowcasting and Very Short Range Forecasting
- ② Ocean and Sea Ice
- ③ Climate Monitoring
- ④ Numerical Weather Prediction
- ⑤ Land Surface Analysis
- ⑥ Ozone and Atmospheric Chemistry Monitoring
- ⑦ Radio Occultation Meteorology
- ⑧ Support to Operational Hydrology and Water Management
- SAF Consortium Member



# Hydrology SAF

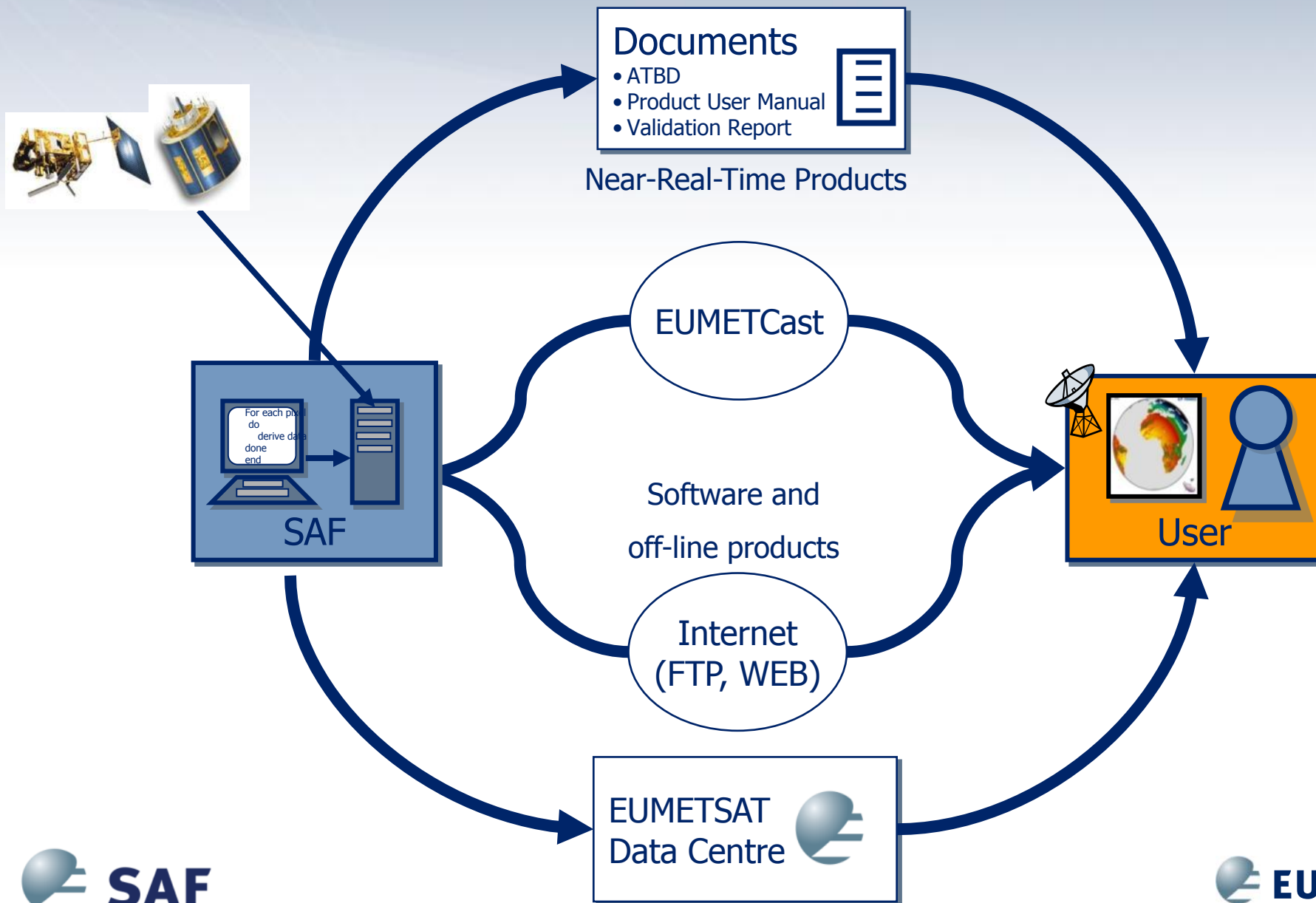


- SAF on Support to Operational Hydrology and Water Management
- Leading Entity: Italian Meteorological Service (USAM)
- SAF products focuses on
  - ▶ precipitation
  - ▶ soil moisture
  - ▶ snow parameters
  - ▶ utilisation of these parameters in hydrological models and NWP

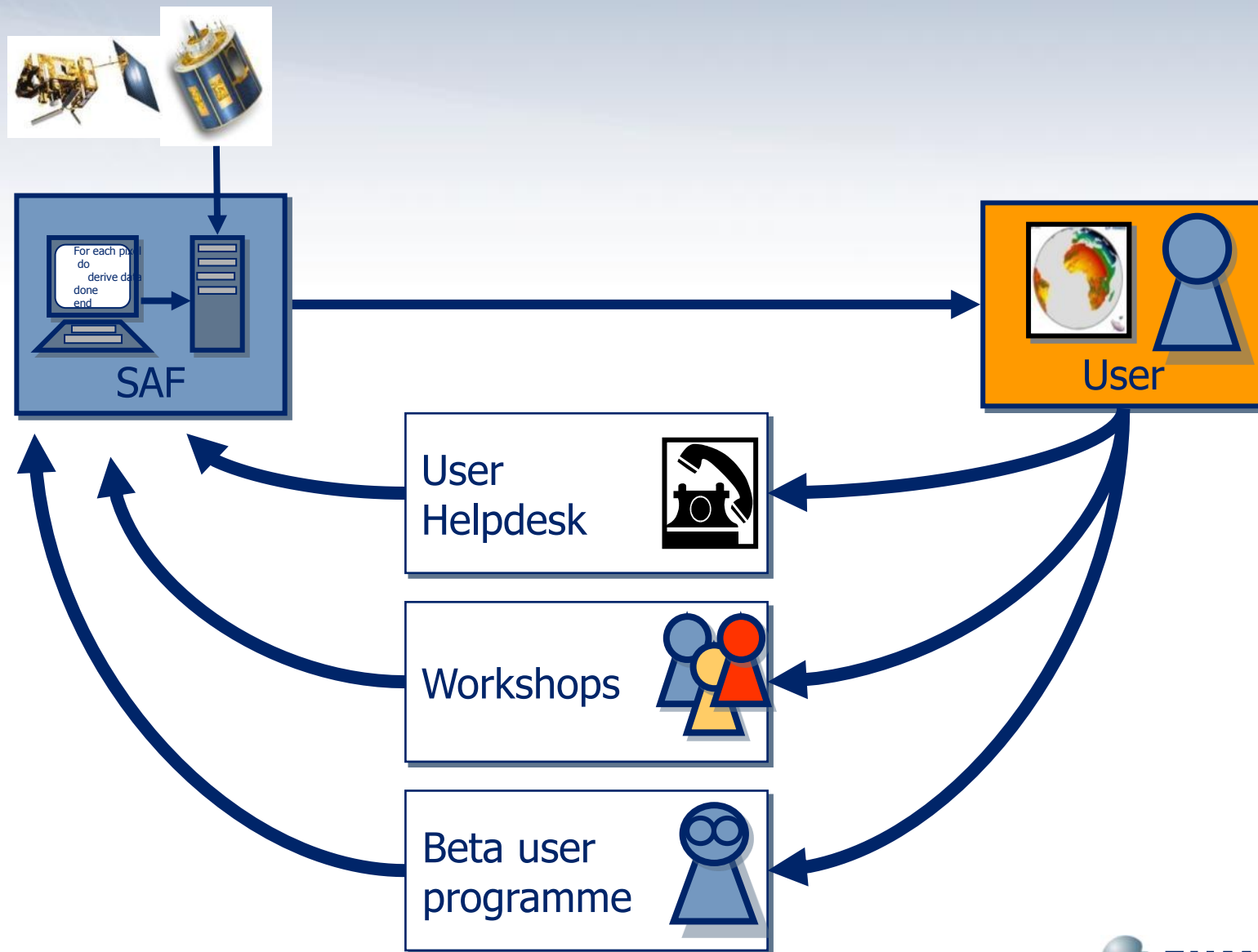




# Interaction with Users: Services provided to users



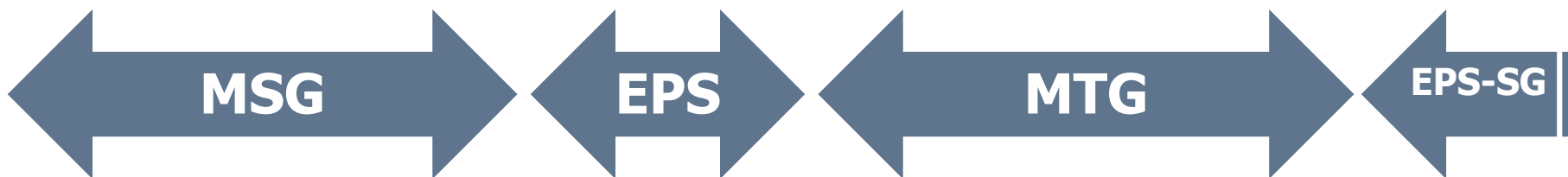
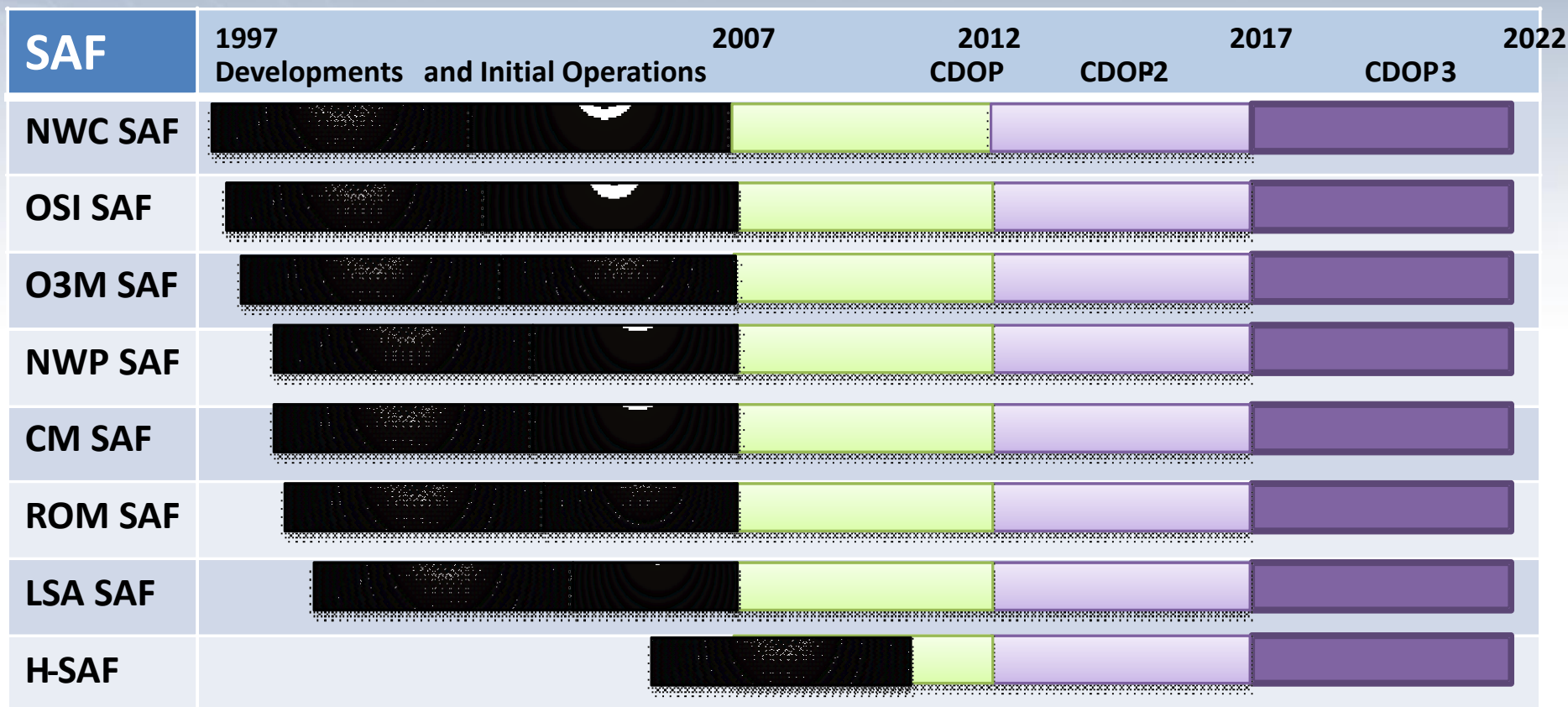
# Interaction with Users: Feedback provided to SAFs







# SAF Network Phasing

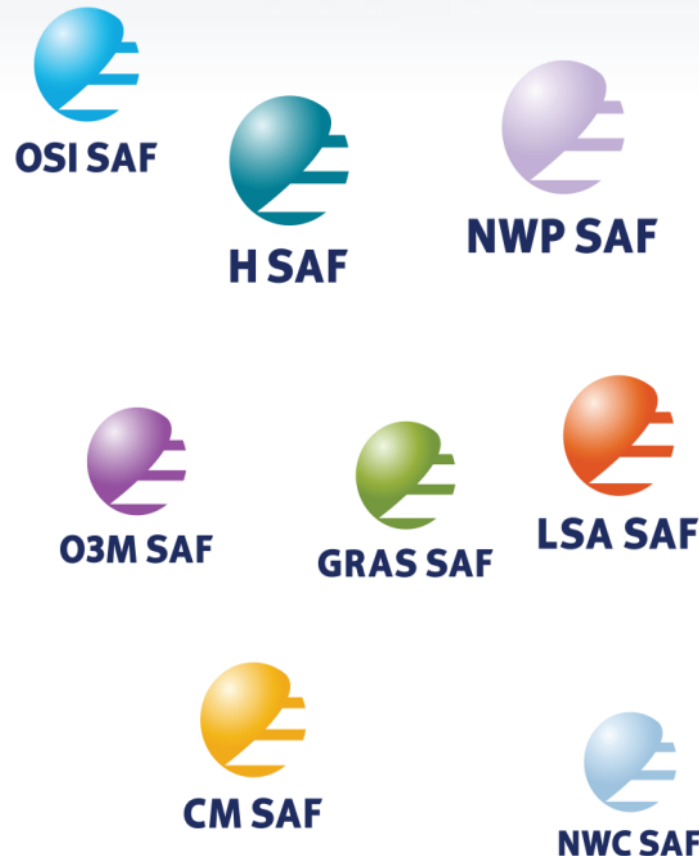




# Synergy: Research -> Operations

- SAFs embedded programmatically in the EUMETSAT mandatory programmes, currently secured until 2022.
- The purpose and commitment of SAFs is to:
  - deliver operational products addressing requirements of the EUMETSAT member states
  - develop new products implementing mature retrievals validated by Research (transition from Research to Operations)
- Upstream research not in the mandate of EUMETSAT, and hence expected to be funded from other sources (ESA, EC, national research...)
- Next SAF development and operations phase (CDOP-3 for 2017-2022): proposals expected end of 2015.

# Summary



- SAF = Satellite Application Facility
- providing products and services to users on an operational basis with a long-term perspective
- specialised on topics and themes
- located at Weather Services in EUMETSAT Member and Co-operating States
- developed and operated by consortium of partners
- part of the EUMETSAT application ground segment
- complement production of standard meteorological products at EUMETSAT central facility in Darmstadt
- Data and software are usable free of charge

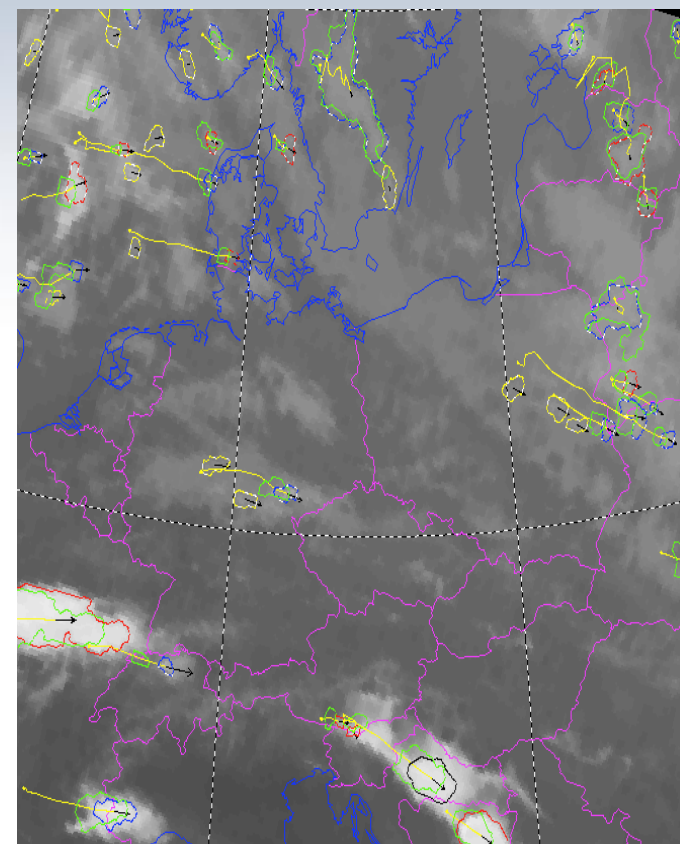


# BACKUP SLIDES



## "Support to Nowcasting and Very Short Range Forecasting" (NWC SAF)

- established to utilise the new data from Geostationary satellites (Meteosat and others) and the polar platforms (Metop, NOAA, Soumi NPP) for enhancing Nowcasting
- Development of Software packages for the operational extraction of products relevant to Nowcasting and for local installation
- Leading Entity is the Spanish Meteorological Agency AEMET in Madrid
- Regular updated software packages since October 2004



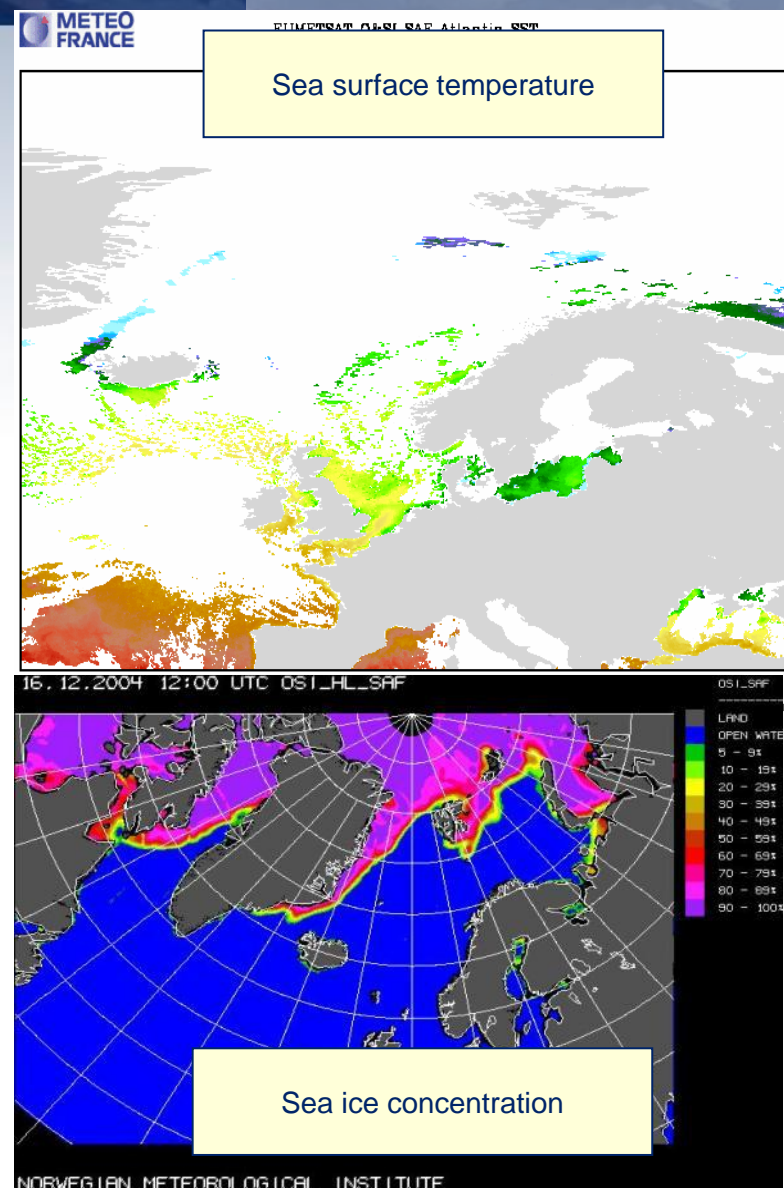
Rapidly developing Thunderstorm Product



# Ocean and Sea Ice SAF



- Ocean and Sea Ice (OSI) SAF routinely produces and disseminates products characterising the ocean surface and the energy fluxes across the sea surface
- Operationally produces information on the sea ice characteristics (extent, concentration, ...)
- Leading Entity is Météo-France in Lannion
- OSI SAF distributes near real-time products based on NOAA, MSG, Metop, Oceansat, DMSP and GOES data



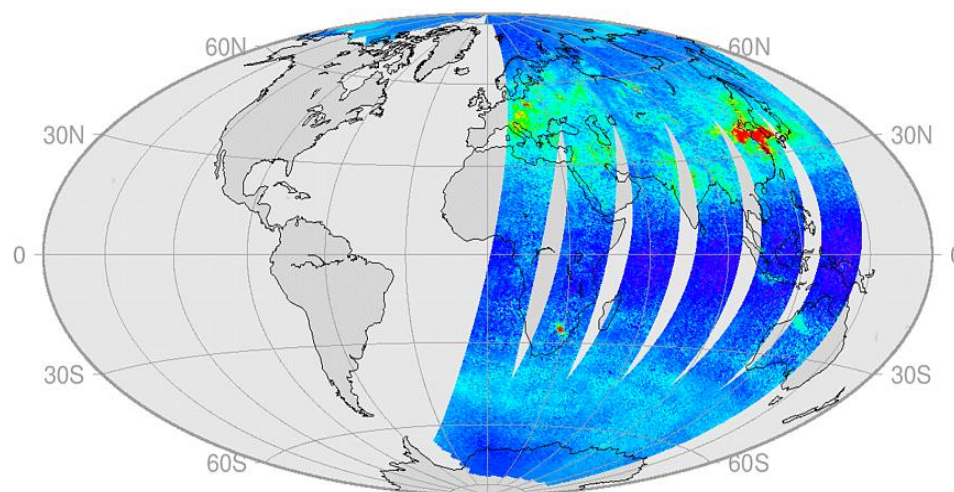


- SAF on Ozone and Atmospheric Chemistry Monitoring (O3M SAF)
- developed for the processing of data on ozone, other trace gases, aerosols and ultraviolet radiation
- Emphasis on the Global Ozone Monitoring Experiment (GOME-2) and IASI on EPS (Metop)
- Leading Entity is the Finnish Meteorological Institute FMI, Helsinki
- First release of products in Summer 2007

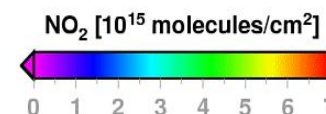
GOME-2 / MetOp

Mar 26, 2009

NO<sub>2</sub> Vertical Column Density



One-day Composite  
Lv2 Version: GDP-4.3  
<http://wdc.dlr.de>





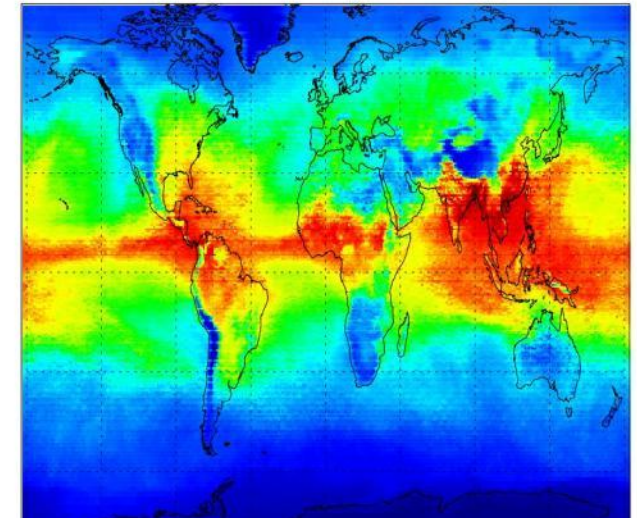


# Climate Monitoring SAF

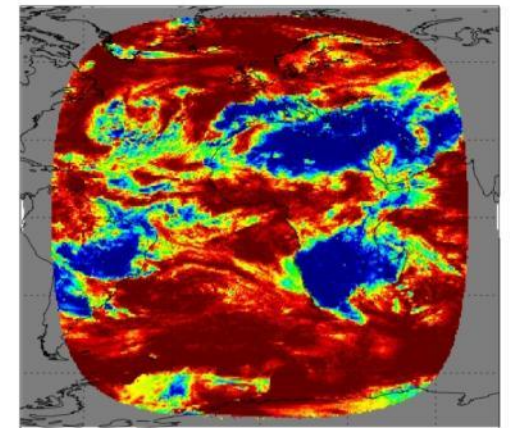


- SAF on Climate Monitoring
- generates and archives high-quality data-set for specific climate application areas
- Currently concentrates on:
  - cloud parameters
  - radiation budget parameters
  - atmospheric humidity
- Leading Entity is the German Weather Service DWD, Offenbach
- NOAA-AVHRR based data operationally produced since November 2004, MSG based data from October 2005, Metop data used since 2009.
- Climate Data Records: 20 years of SSM/I Water Vapour information released in 2009.
- NOAA-AVHRR based 20 years of homogeneous data record (clouds, surface radiation) released 2012
- Upcoming Climate Data Records based on SEVIRI, ATOVS, SSM/I

TPW (average, 06 2005)  $\text{kg m}^{-2}$

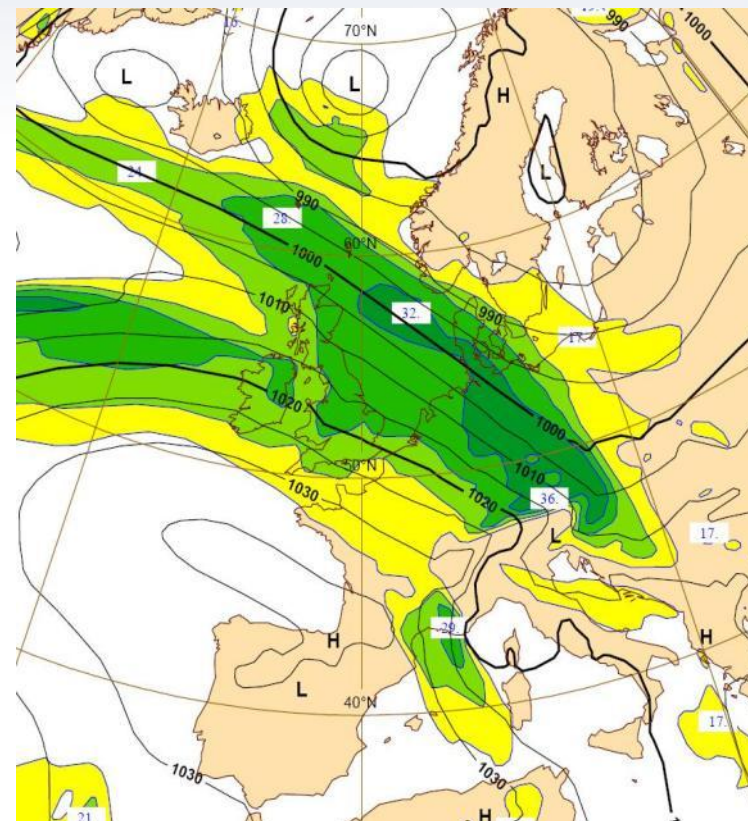


cloud fraction / %



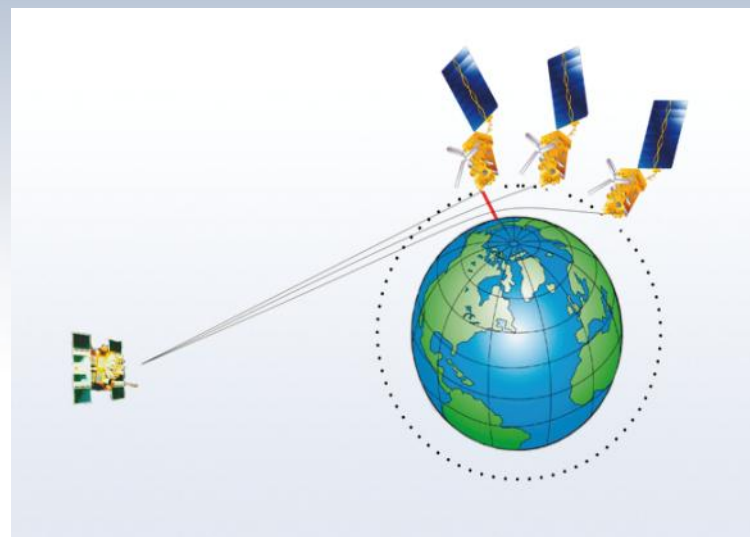


- SAF on Numerical Weather Prediction (NWP SAF)
- aims at increasing the benefits to Met.-Services from Numerical Weather Prediction (NWP)
- develops advanced techniques for the effective use of satellite data
- development and maintenance of RTTOV radiative transfer model, ATOVS and AVHRR Pre-processing Package (AAPP)
- Leading Entity is the UK MetOffice, Exeter





- SAF on Radio Occultation Meteorology
- GRAS: Global Positioning System (GPS) Receiver for Atmospheric Sounding flown on EPS/Metop satellites
- near real-time and offline:
  - ▶ sounding data (temperature, pressure, humidity)
  - ▶ corresponding validation products, and
  - ▶ assimilation software
- The Leading Entity is the Danish Meteorological Institute DMI, Copenhagen
- Software packages released since 2007, first NRT product dissemination in October 2008

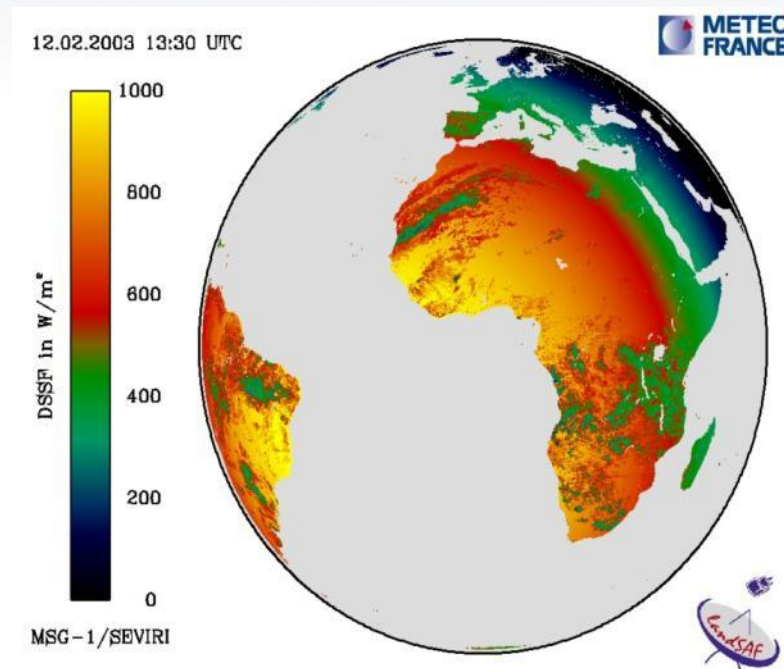




# Land Surface Analysis SAF



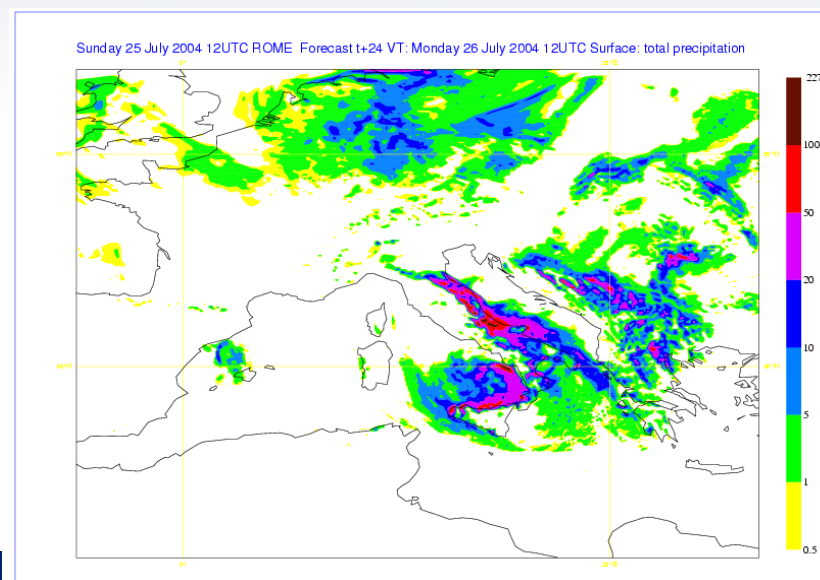
- SAF on Land Surface Analysis (LSA SAF)
- established to increase the benefit from MSG and EPS data related to land, land-atmosphere interaction and biospheric applications
- Generates operationally data services related to Surface Radiation, Vegetation and wild fire
- Leading entity is the Portuguese Institute for Meteorology IM, Lisbon



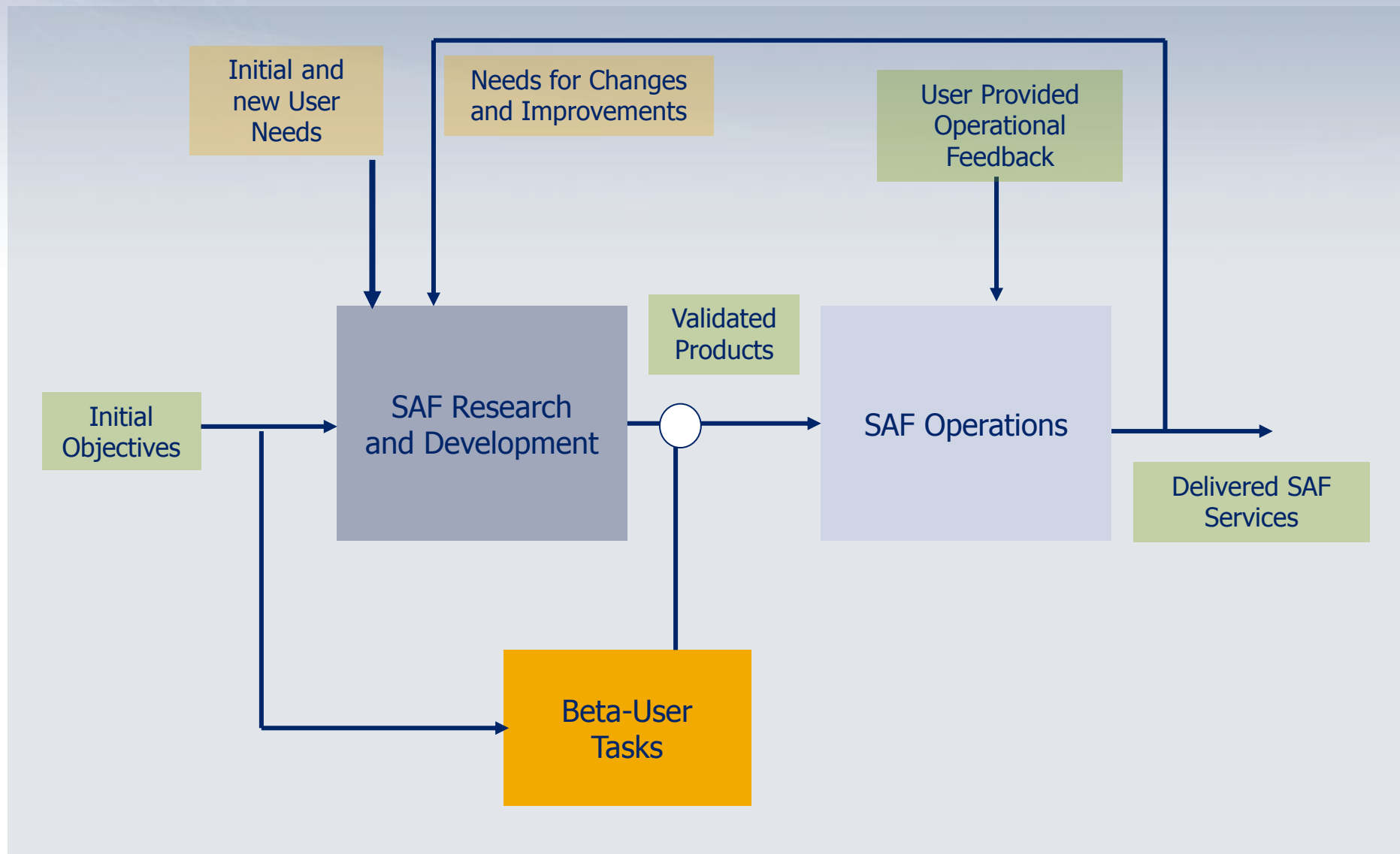
# Hydrology SAF



- SAF on Support to Operational Hydrology and Water Management
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- SAF products focuses on
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  - ▶ soil moisture
  - ▶ snow parameters
  - ▶ utilisation of these parameters in hydrological models and NWP



# SAF Development and Service Model







# CDOP-2: Second slice of the Continuous Development and Operations Phase

## SAF Network after 2012:

- funding for 5 years of CDOP-2 and 5 more years for a CDOP-3 foreseen within the MTG budget
- CDOP-2 started March 2012
- Operational Continuation of existing products
- Development of new products and services (list of committed SAF products soon to be available).
- Preparation activities of Meteosat Third Generation (MTG) based products
- Exploitation of synergies within the Application Ground Segment (SAF Network + Central Facilities)
- Reprocessing and homogeneous data set generation (e.g. for climate applications)
- Integration and interfacing with other initiatives: GMES, WMO SCOPE-CM, EUMETCaI, GHRSSST, GODAE, ESA CCI, etc.

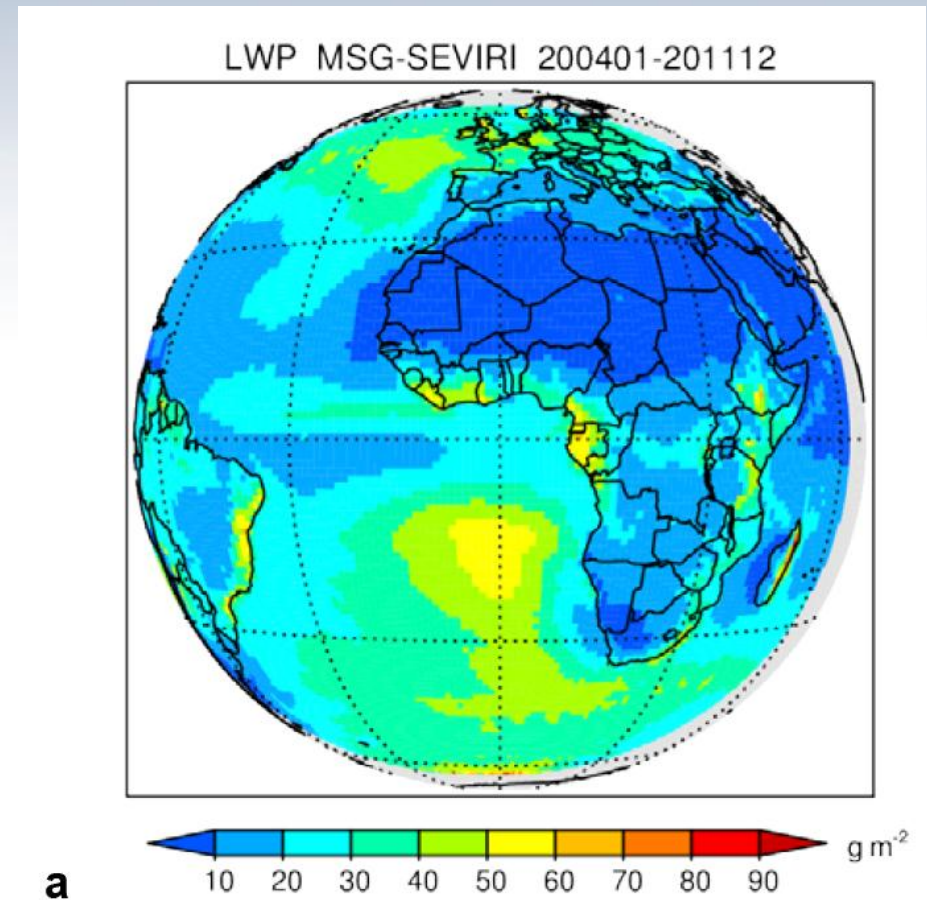




# Examples for new Developments in CDOP-2

Long-term satellite data records:

- CM SAF: Meteosat since 1982
- O3M SAF: GOME-2 since 2006
- OSI SAF: Sea Ice since 1978, Sea Surface Temperature since 2002
- ROM SAF: Reprocessing of all GNSS-RO missions (since 1995)
- LSA SAF: reprocessing of SEVIRI products (since 2002)

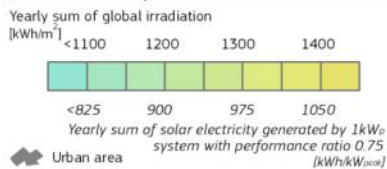




Global irradiation and solar electricity potential

Optimally-inclined photovoltaic modules

**GERMANY / DEUTSCHLAND**

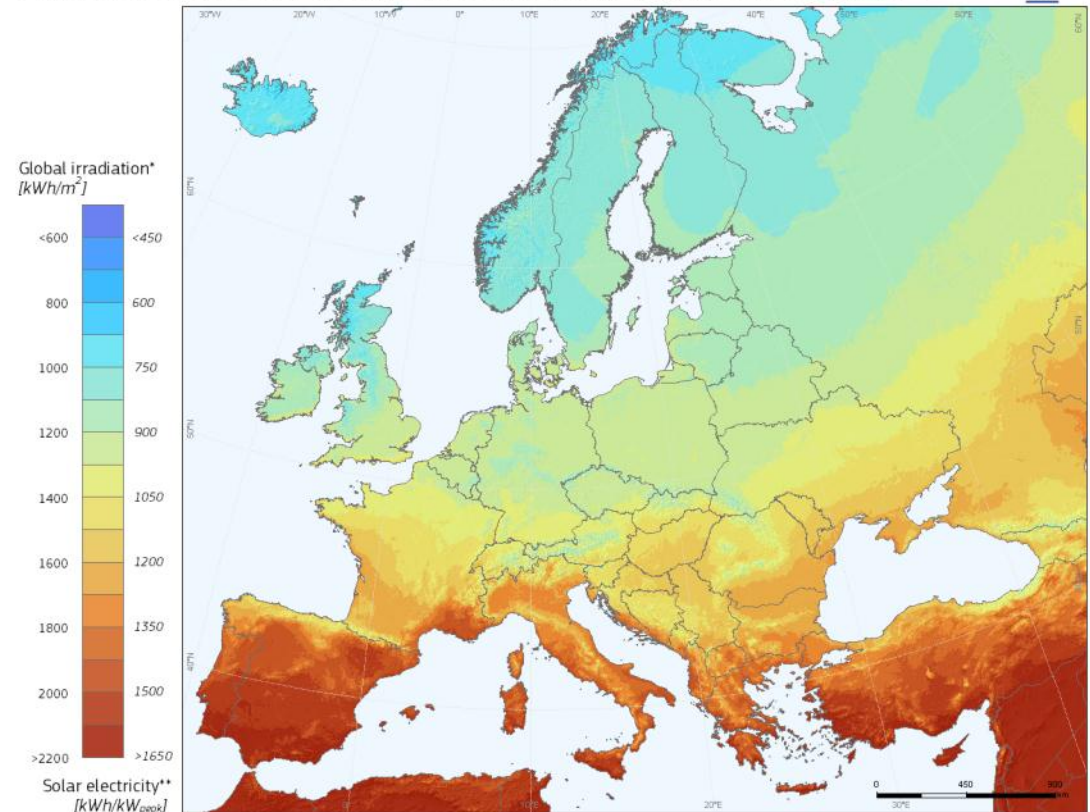


Joint  
Research  
Centre

Authors: Thomas Huld, Irene Pinedo-Pascua  
European Commission - Joint Research Centre  
Institute for Energy and Transport, Renewable Energy Unit  
PVGIS <http://re.jrc.ec.europa.eu/pvgis/>

## Country-scale and Europe / Africa Maps

Photovoltaic Solar Electricity Potential in European Countries



\* Yearly sum of global irradiation incident on optimally-inclined south-oriented photovoltaic modules

\*\*Yearly sum of solar electricity generated by optimally-inclined 1kW<sub>p</sub> system with a performance ratio of 0.75

© European Union, 2012  
PVGIS <http://re.jrc.ec.europa.eu/pvgis/>

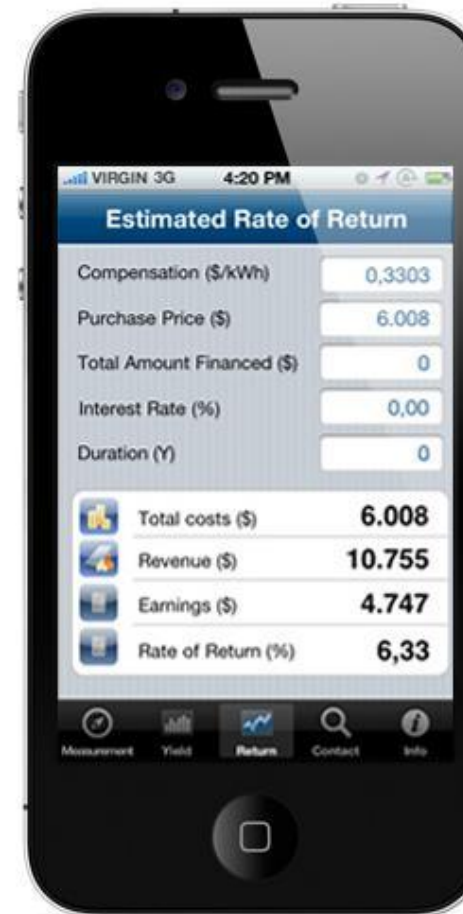
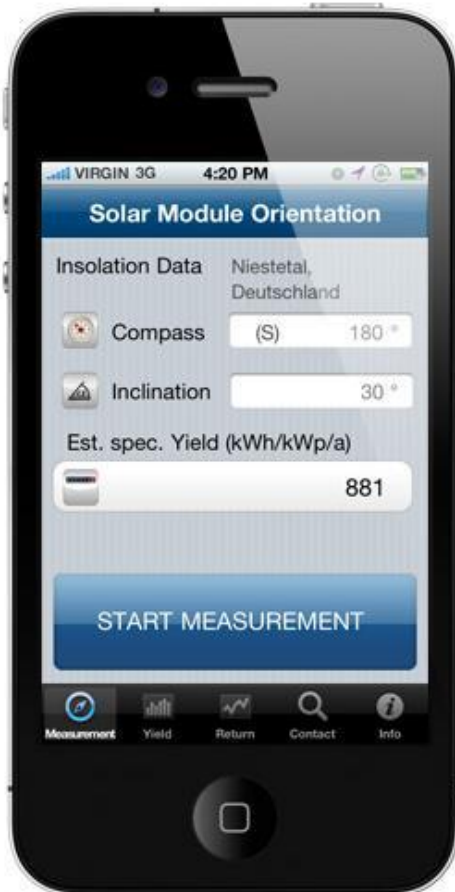
Authors: Thomas Huld, Irene Pinedo-Pascua  
EC - Joint Research Centre  
In collaboration with: CM SAF, [www.cmsaf.eu](http://www.cmsaf.eu)

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## SOLARCHECKER

Is It Worth Installing Solar Power on My Roof?

Available on the  
App Store



[www.sma.de](http://www.sma.de)

→ Products

→ Plant Planning

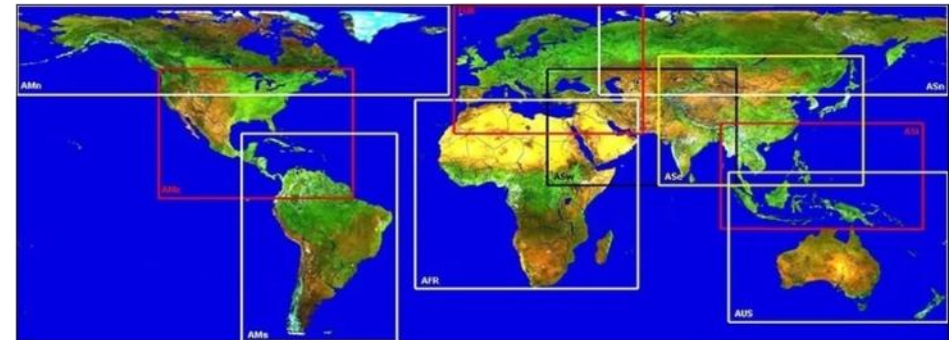
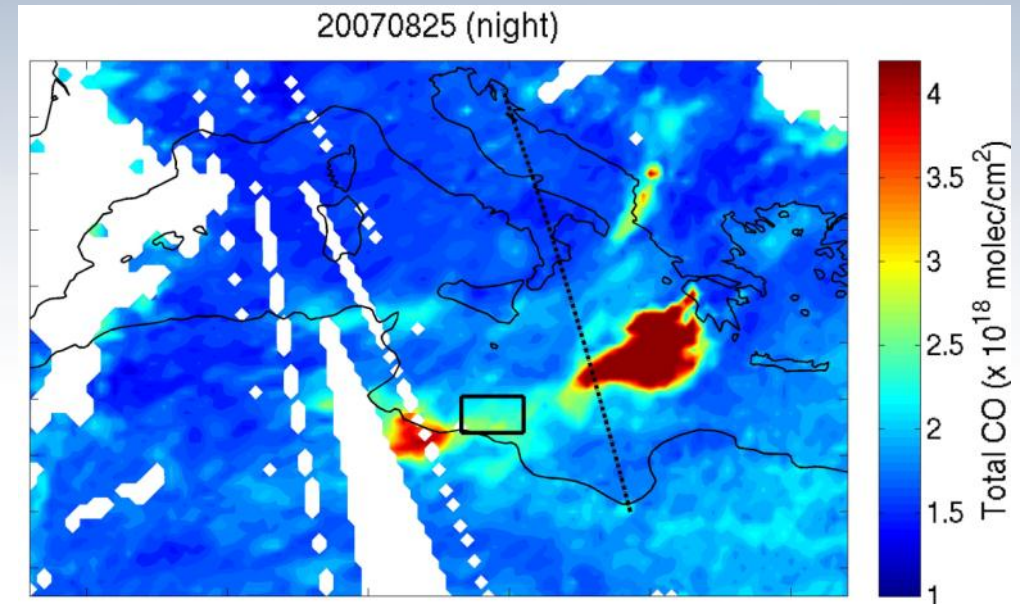




# Examples for new Developments in CDOP-2

Bringing external developments into operations:

- O3M SAF: IASI products developed at LATMOS
- LSA SAF: NDVI (vegetation index from VITO, Belgium)
- NWC SAF: Precipitation based on cloud microphysics (KNMI)





## V2013, GEO-CRRv4.0 outlook

**CTMP Function: Based on the one developed by Roebeling and Holleman\***

**Cloud Top Microphysical Properties used by this algorithm:**

- Phase (Ph)
- Effective radius ( $R_{\text{eff}}$ )
- Cloud water path (CWP)  $\longrightarrow$   $\left\{ \begin{array}{l} \text{Liquid water path (LWP)} \\ \text{Ice water path (IWP)} \end{array} \right.$

**Two steps:**

- 1.- Delimitation of the precipitation area**
- 2.- Assignment of rain rates**

**(\*) Roebeling, R. A. and I. Holleman, 2009: SEVIRI rainfall retrieval and validation using weather radar observations. J. Geophys. Res., VOL. 114, D21202.**



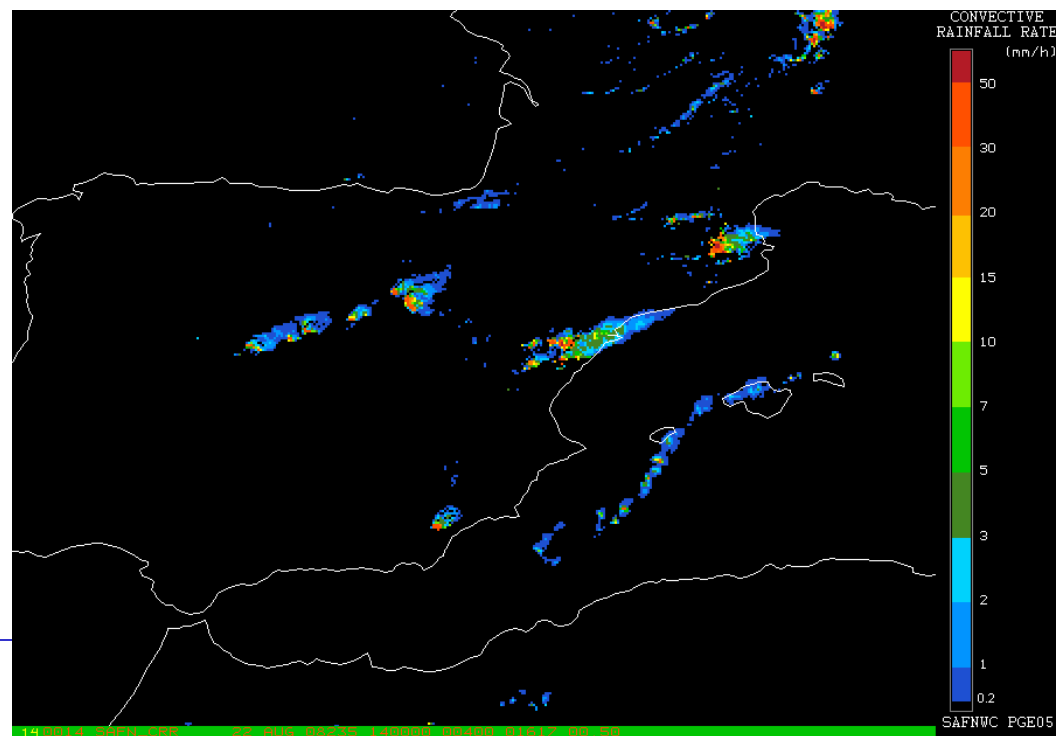
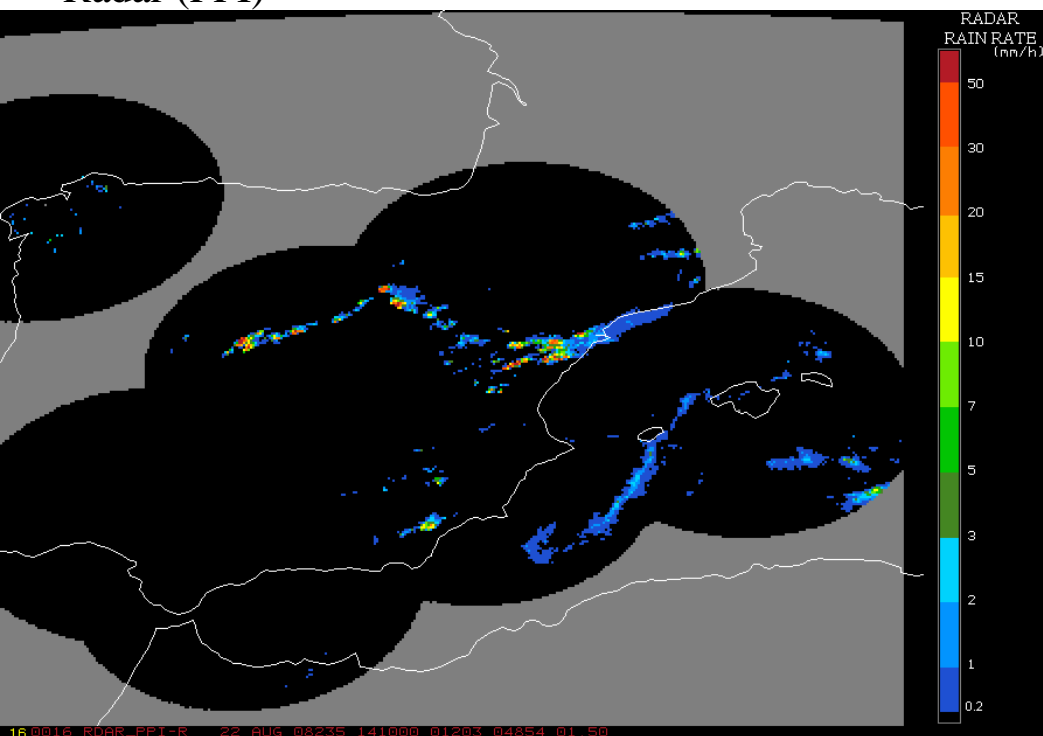
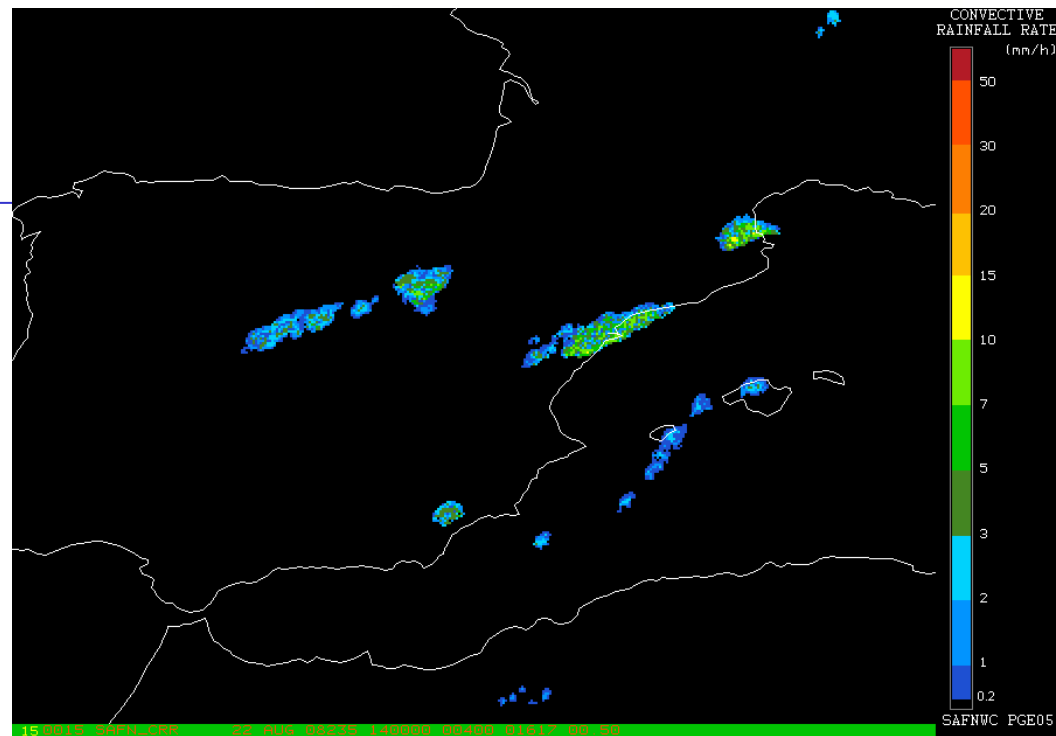
# PREPARATIONS FOR V2013 – DAY-TIME ALGORITHM Example over Spain

22th August 2008 at 14:00 UTC

CRR (3D Matrices)

CRR (CTMP function)

Radar (PPI)

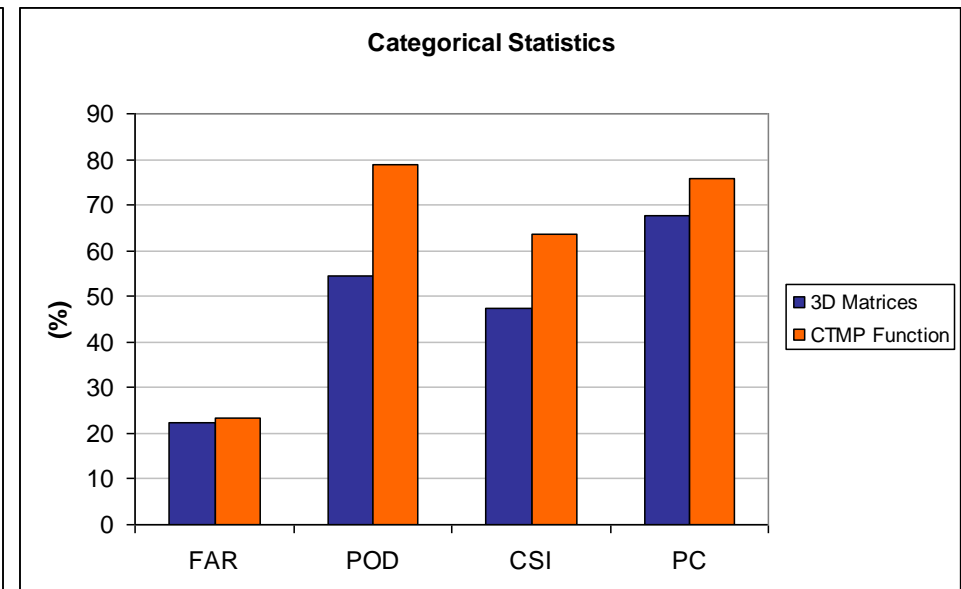
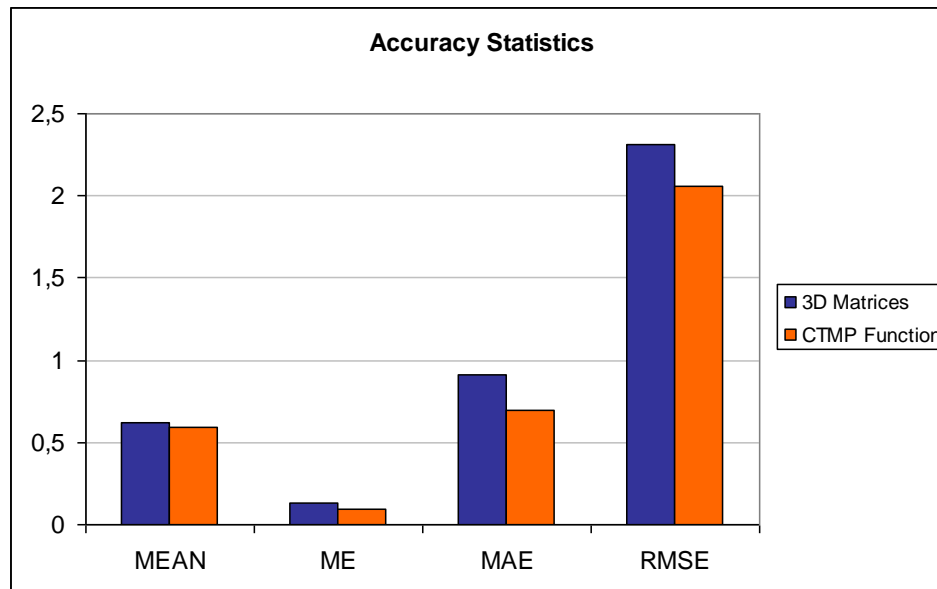


## PREPARATIONS FOR V2013 – DAY-TIME ALGORITHM

### Comparison: 3D Matrices vs CTMP function

#### Dataset:

Spain: 46 days, May-September 2008, 10:00 – 14:00 UTC every 30 min



RMS error decreases with CTMP function because precipitation maxima are better located and precipitation pattern is more accurate.

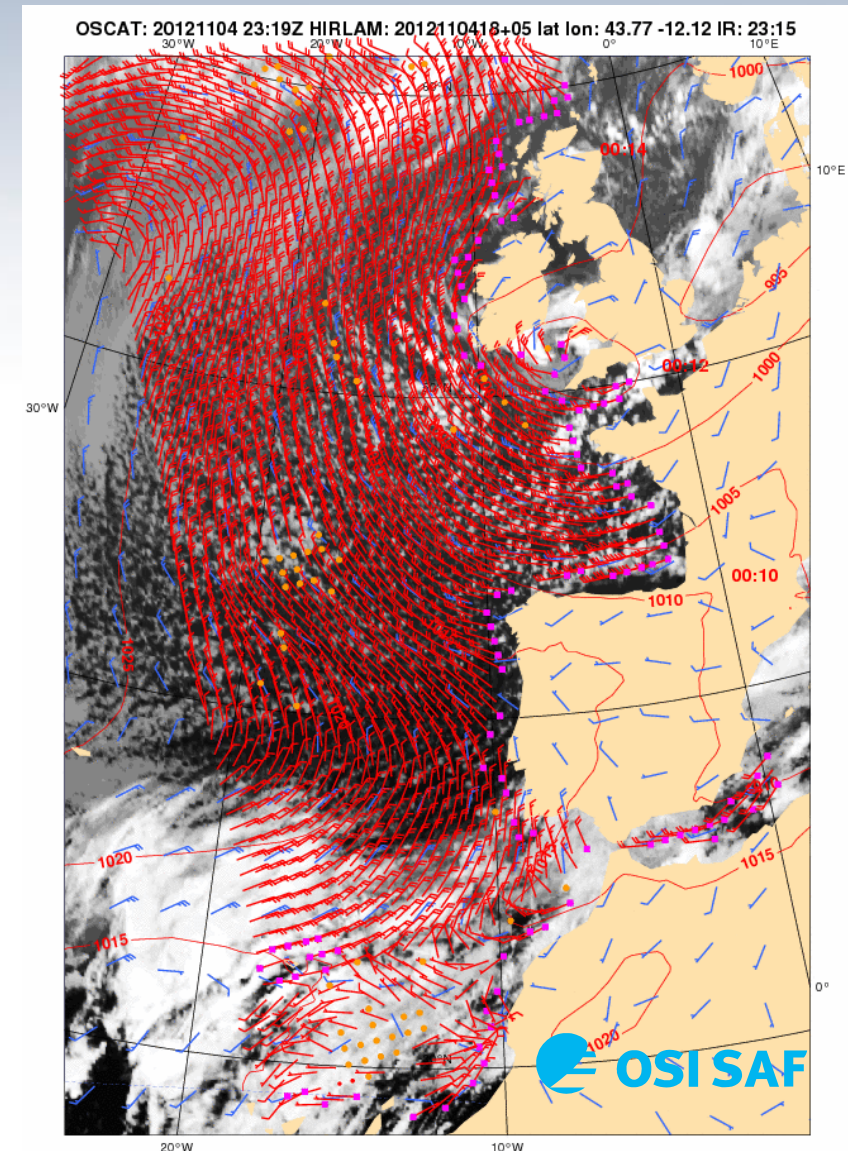
False alarms increases 1% while probability of detection increases 24% for this dataset.



# Examples for new Developments in CDOP-2

## New satellite sensors:

- OSI SAF: OSCAT based wind products
- H SAF: GPM data
- NWC SAF: Soumi NPP VIIRS, additional GEO imager
- ROM SAF: cosmic
- Preparation for MTG and EPS-SG



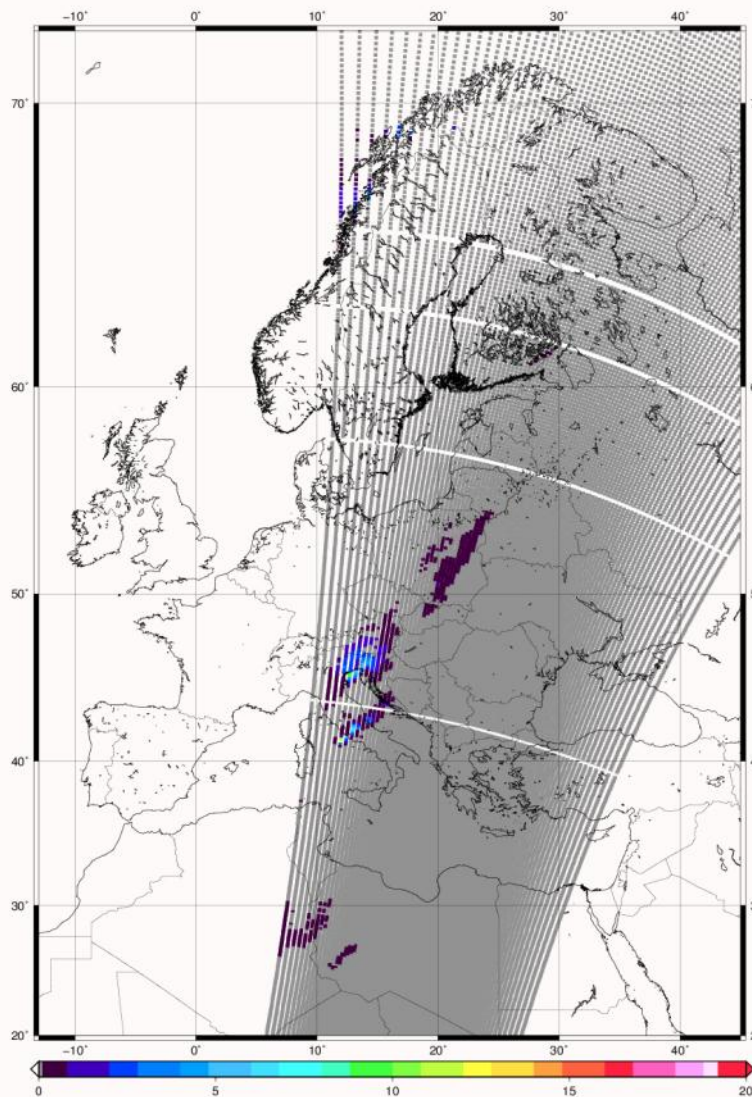
(c) EUMETSAT/KNMI



# Development of PR-OBS-2

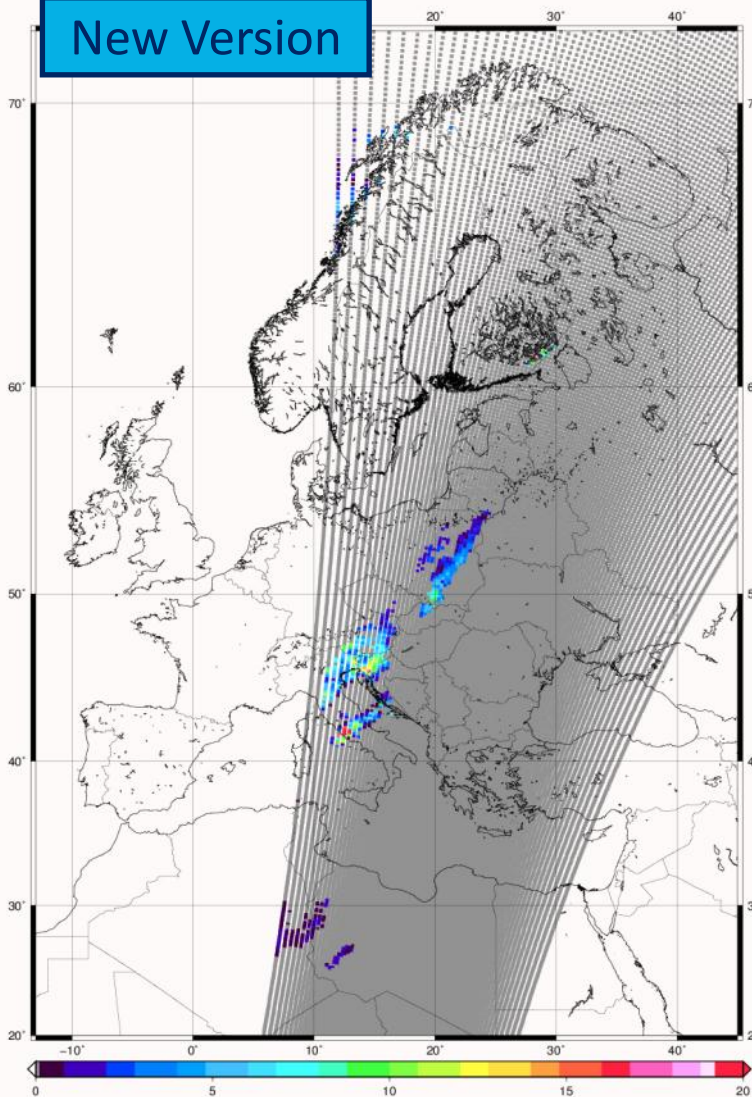
## Precipitation rate at ground by MW cross-track scanners

NN trained with global  
Cloud Radiation Database CRD



NN trained with  
Cloud **Dynamics** and Radiation Database CDRD

New Version



**Rome, Italy  
Flash Flood  
20 Oct 2011**

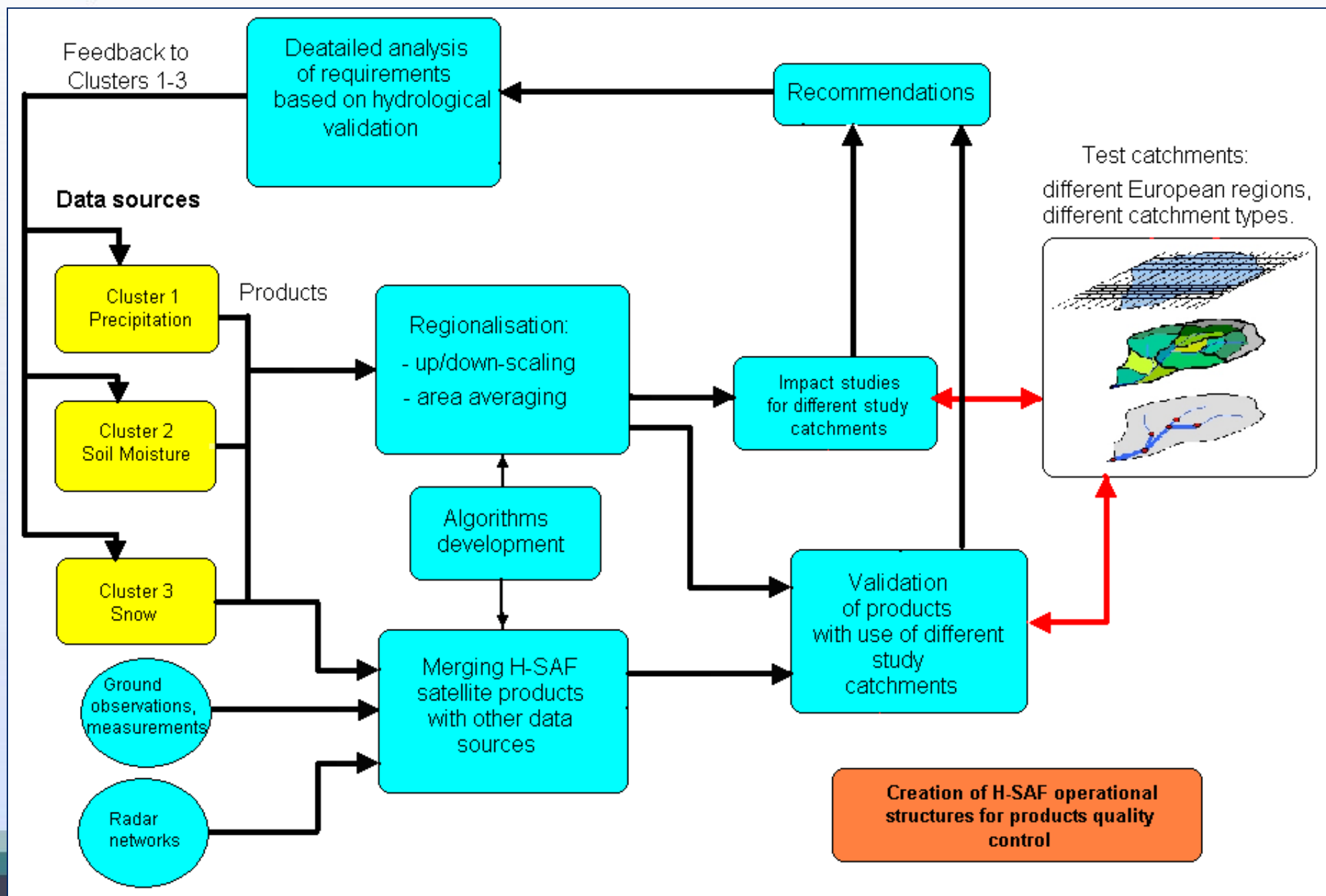
8:20 UTC  
MetOp-A  
AMSU/MHS



# H SAF

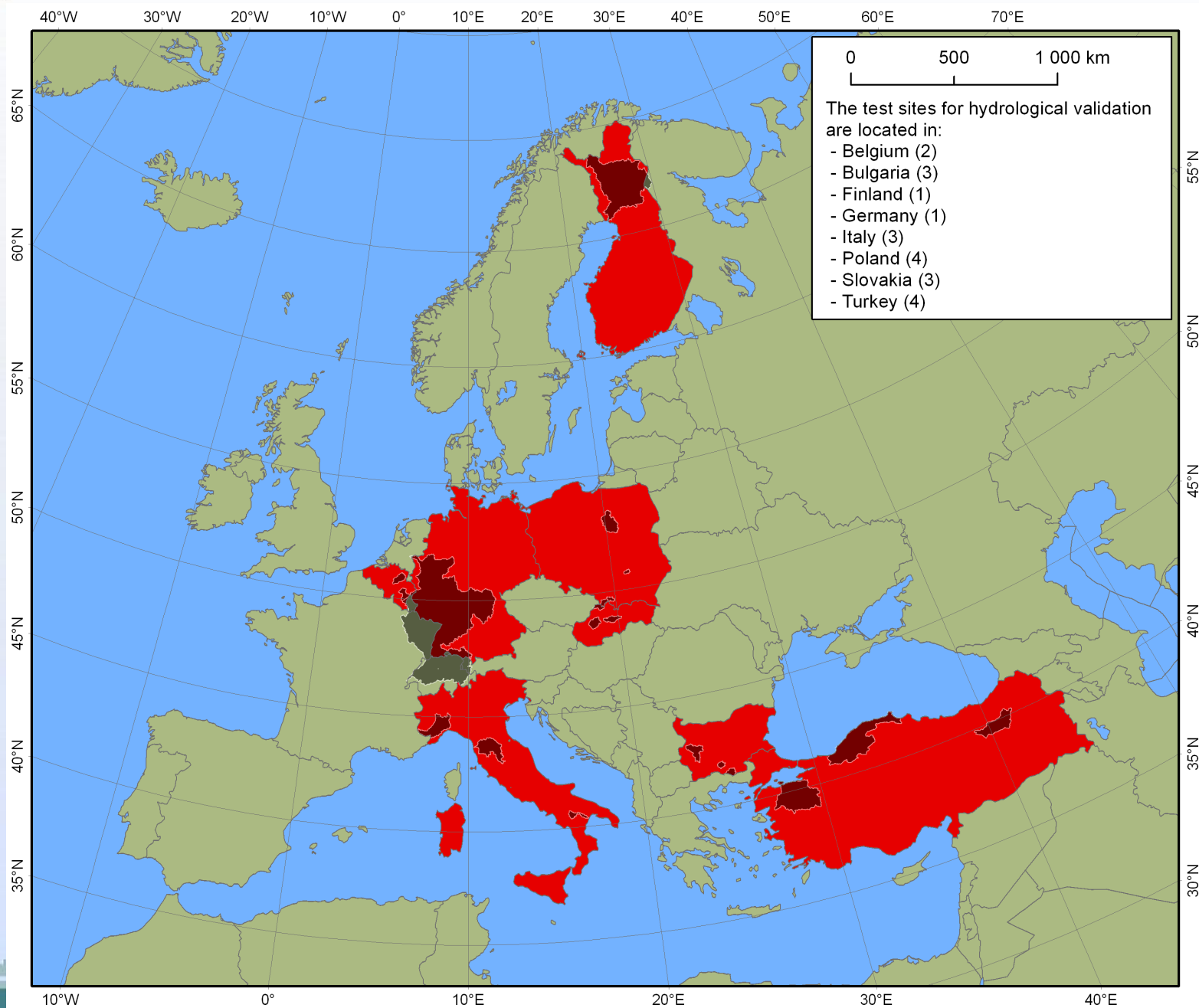
Support to Operational  
Hydrology and Water  
Management

## Concept of the Hydrological Validation





# Test catchments of the Hydrological Program





# Examples for new Developments in CDOP-2

## New product developments:

- NWC SAF: Convection Initiation, Extrapolated Imagery, precipitation approach
- O3M SAF: trace gases (Formaldehyde, BrO, ..) and aerosol properties from GOME-2
- LSA / CM SAF: long-wave surface radiation from SEVIRI