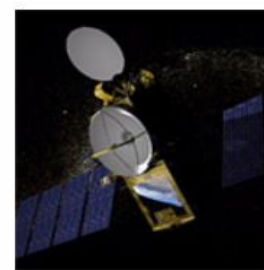
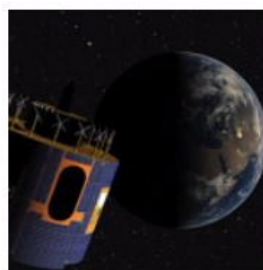


# European Organisation for the Exploitation of Meteorological Satellites - EUMETSAT and Satellite Applications at ARSO

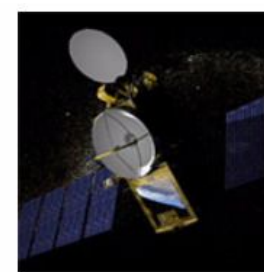
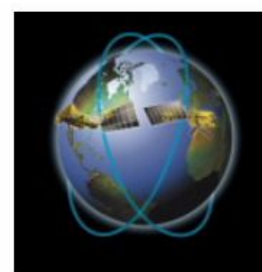
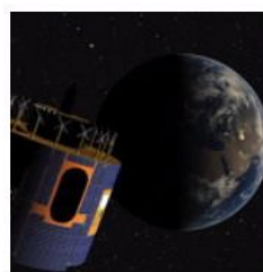
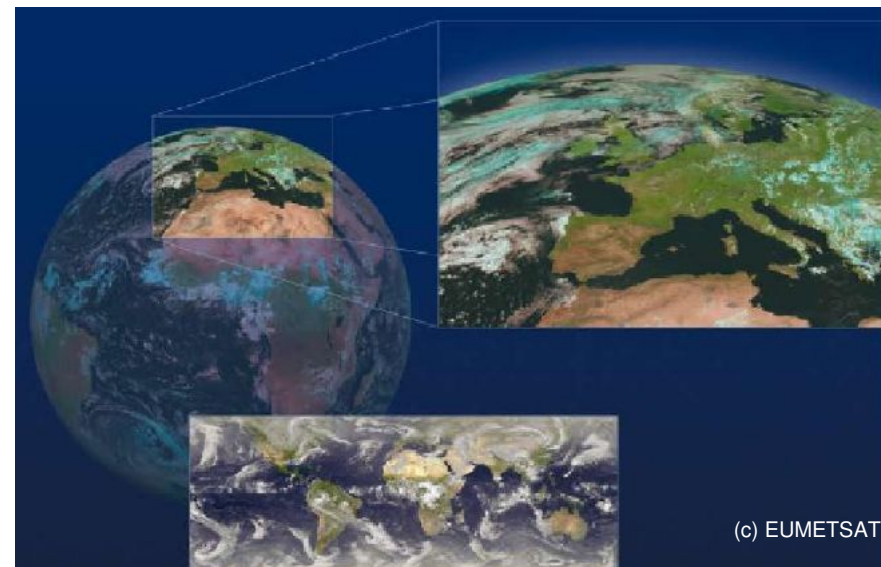
mag. Mateja Iršič Žibert  
Agencija RS za okolje (ARSO)





# Outline

- EUMETSAT organisation
- Meteorological Satellites
- EUMETSAT Satellite Application Facilities:
  - Nowcasting
  - Land applications
  - Ocean Monitoring
  - Support to hydrology
  - Air Pollution





# European Organisation for the Exploitation of Meteorological Satellites EUMETSAT

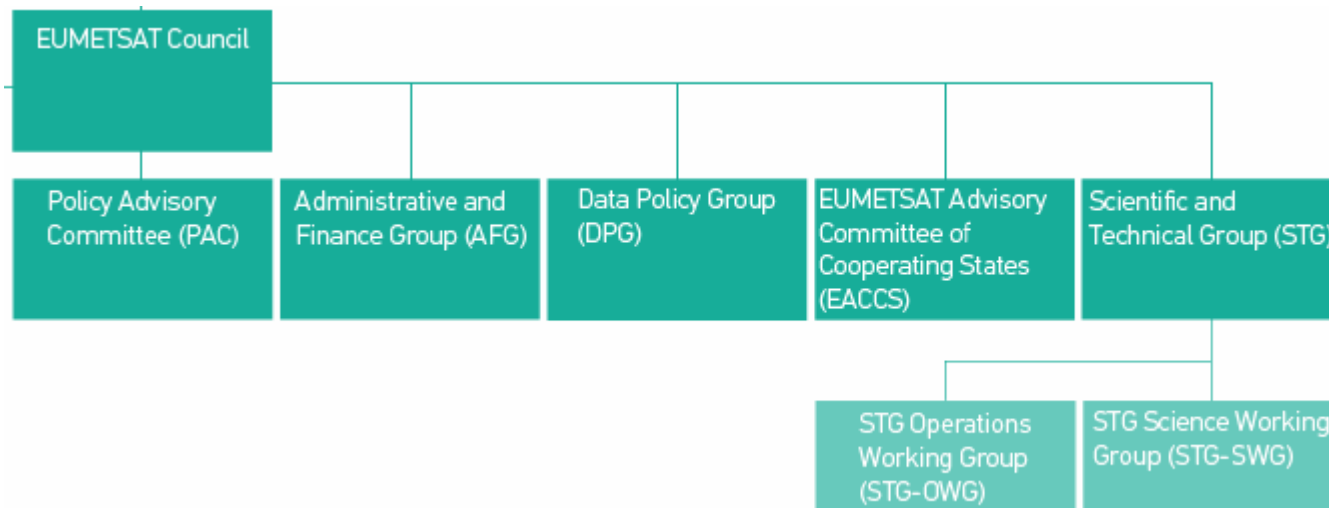


- 27 Member states
- 4 Cooperating states



EUMETSAT is an intergovernmental organisation and was founded in 1986. The purpose of EUMETSAT is to supply **weather and climate-related satellite data, images and products** – 24 hours a day, 365 days a year – to the **National Meteorological Services** of the Member and Cooperating States in Europe, and other users worldwide.

**Slovenia** started to receive Meteosat data from 1985, was a cooperating state from 2003-2007 and become a full Member State of EUMETSAT in **2008**.



The **Council** is composed of high level representatives from the Member States which jointly fund EUMESAT programmes and activities.

The decisions of Council are prepared by advisory bodies:

The Policy Advisory Committee (PAC)

The Administrative and Finance Group (AFG)

The Data Policy Group (DPG)

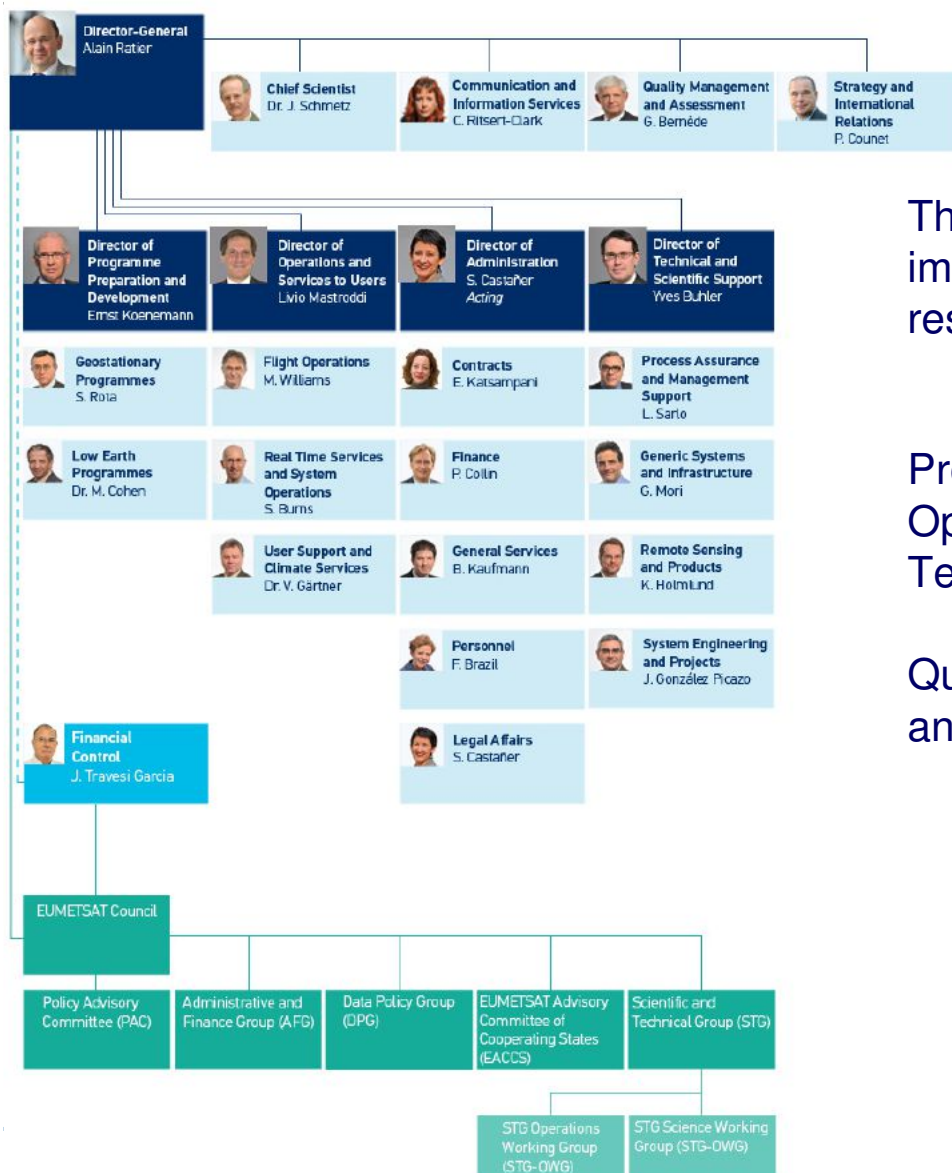
The Scientific and Technical Group (STG)

The EUMETSAT Advisory Committee on Cooperating States



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MINISTRY OF AGRICULTURE AND THE ENVIRONMENT  
SLOVENIAN ENVIRONMENT AGENCY

# EUMETSAT



The EUMETSAT programmes and activities are implemented by the **Secretariat** under the responsibility of the Director-General.

Programme preparation and Development  
Operations and Services to users  
Technical and Scientific Support Administration

Quality Management and Assessment Strategy  
and International Relations



# EUMETSAT Headquarter

## Central Facility

The Central Facility is responsible for the generation of level 1 processed satellite data and the generation of higher level 2 products.



The EUMETSAT Mission Control Centres (MCC), based at our headquarters are responsible for the safe operations of all satellites.



(c) EUMETSAT



## Meteosat Satellites operational and planed

- **Meteosat First Generation** is a series of geostationary satellites that have provided images of the full Earth disc, and data for weather forecasts, in a continuous and reliable stream for a quarter of a century. Meteosat-7 is the last operational satellite in this series and is now in orbit above the Indian Ocean.
- **Meteosat Second Generation** (MSG) is a significantly enhanced follow-on system to the previous generation of Meteosat. MSG consists of a series of four geostationary meteorological satellites that will operate consecutively until 2020.
- **Meteosat Third Generation** EUMETSAT is preparing for the next European operational geostationary meteorological satellite system in the form of the Meteosat Third Generation (MTG).





# Meteosat

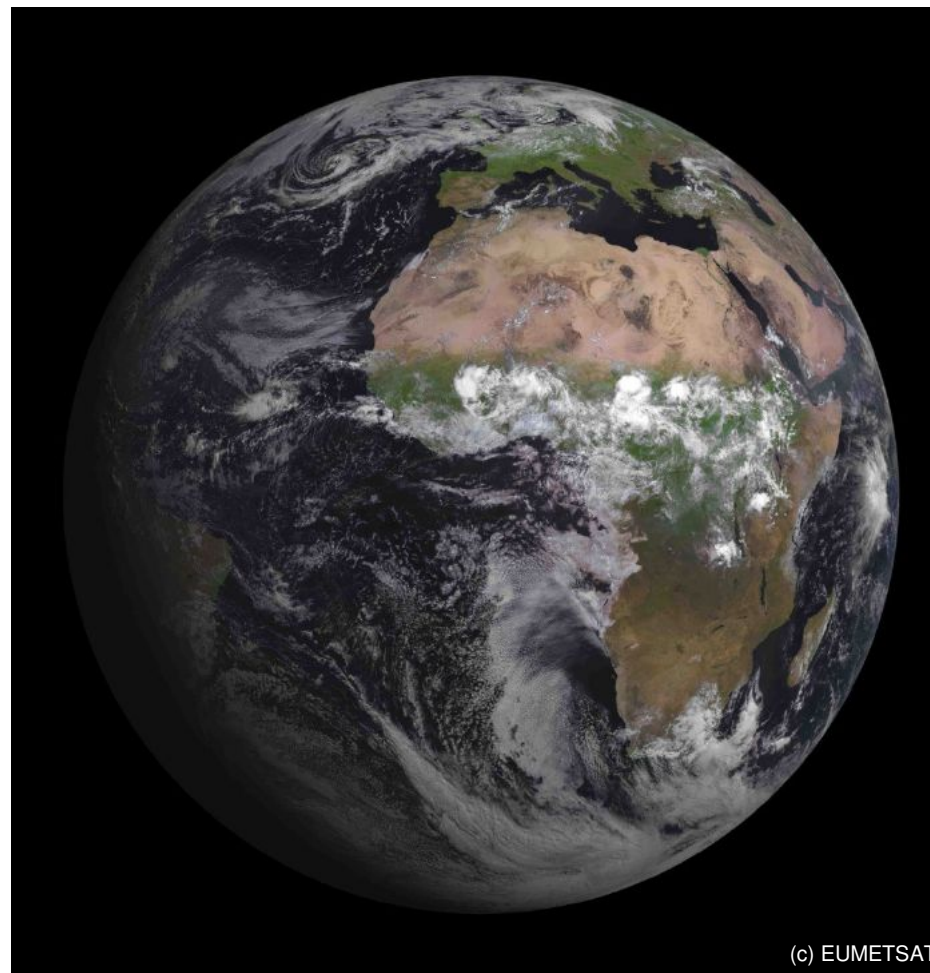


## 11 Channels:

3 km sampling distance at sub-satellite point

## High Resolution VIS channel:

1km sampling distance at sub-satellite point





# Low-orbital Satellites operational and planed

- **Metop** is Europe's first polar orbiting operational meteorological satellite system, and it is the European contribution to the Initial Joint Polar-Orbiting Operational Satellite System (IJPS).
- Preparation of the **EPS Second Generation** Activities are on-going for the definition of the follow-on EUMETSAT Polar System, to replace the current satellite system in the 2020 timeframe.
- **Jason-2** is a Low Earth Orbiting (LEO) satellite, flying at an altitude of around 1,300 km. The main instruments on board are a radar altimeter, a microwave radiometer, and several precise orbit determination systems.
- **Jason-3** The Jason-3 programme is led by EUMETSAT and the US National Oceanic and Atmospheric Administration (NOAA).
- **Sentinel-3** is primarily a mission to support services relating to the marine environment, with capability to serve numerous land-, atmospheric- and cryospheric-based application areas (Copernicus).





# Polar –orbital satellite METOP

## Sensors on-board METOP

### AVHRR - Advanced Very High Resolution Radiometer

for visible and infrared imagery

### MSU : Microwave Sounding Unit

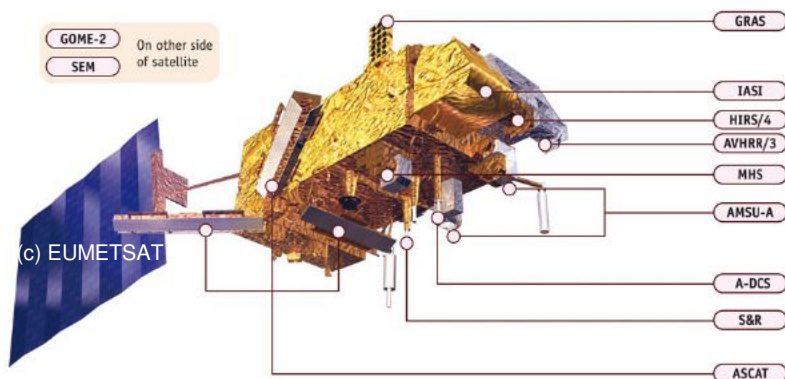
### AMSU-A : Advanced Microwave Sounding Unit-A

a 15-channel radiometer for temperature soundings flown in polar orbit).

### AMSU-B : Advanced Microwave Sounding Unit-B

a 5-channel radiometer for humidity soundings flown in polar orbit

### HIRS : High Resolution Infrared Radiation Sounder



### IASI: Infrared Atmospheric Sounding Interferometer

### ASCAT : Advanced Scatterometer

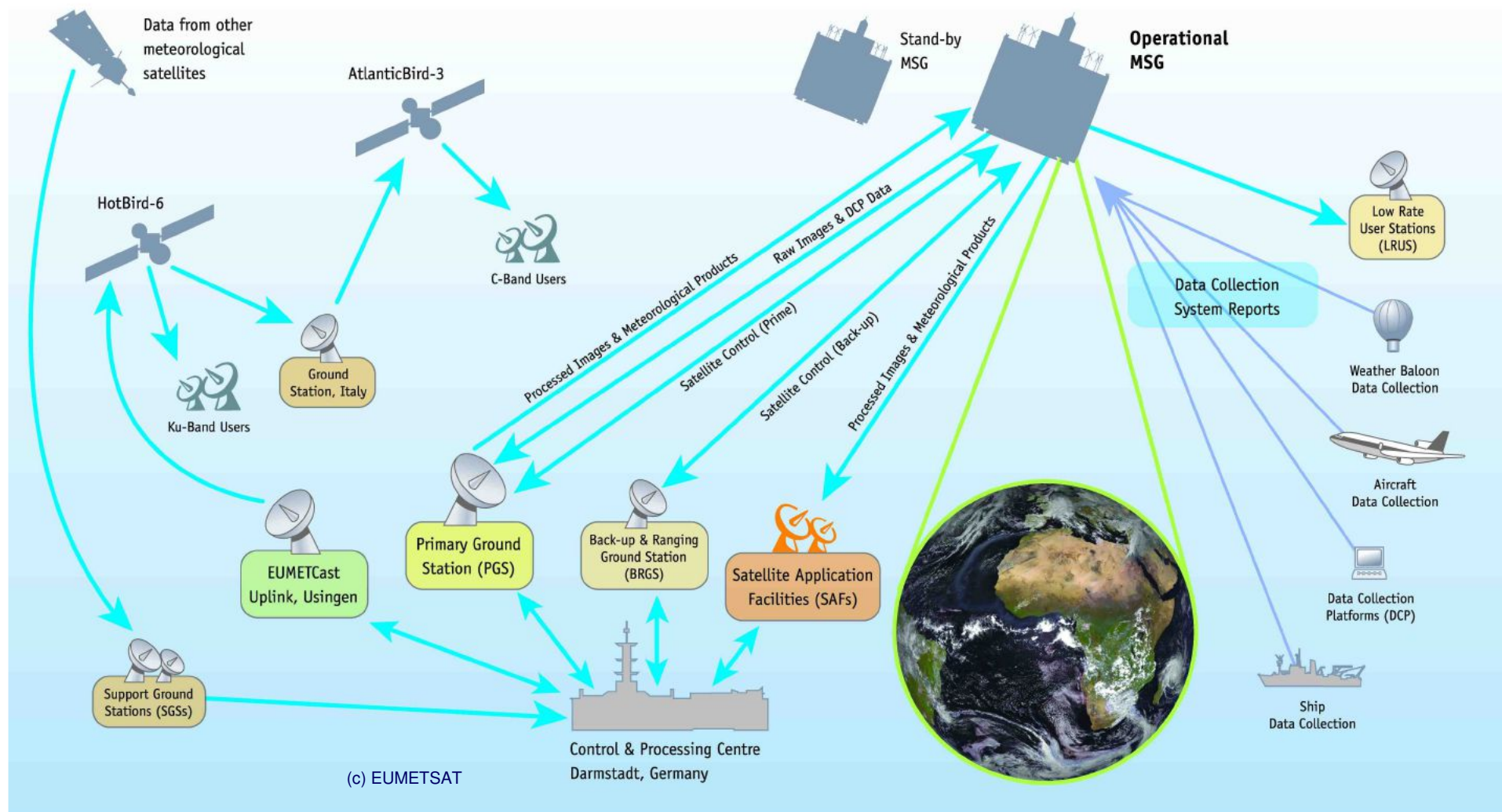
GRAS: GNSS Receiver for Atmospheric Sounding

SEM: Space Environmental Monitor

GOME: Global Ozone Monitoring Experiment



# Satellites and communication system





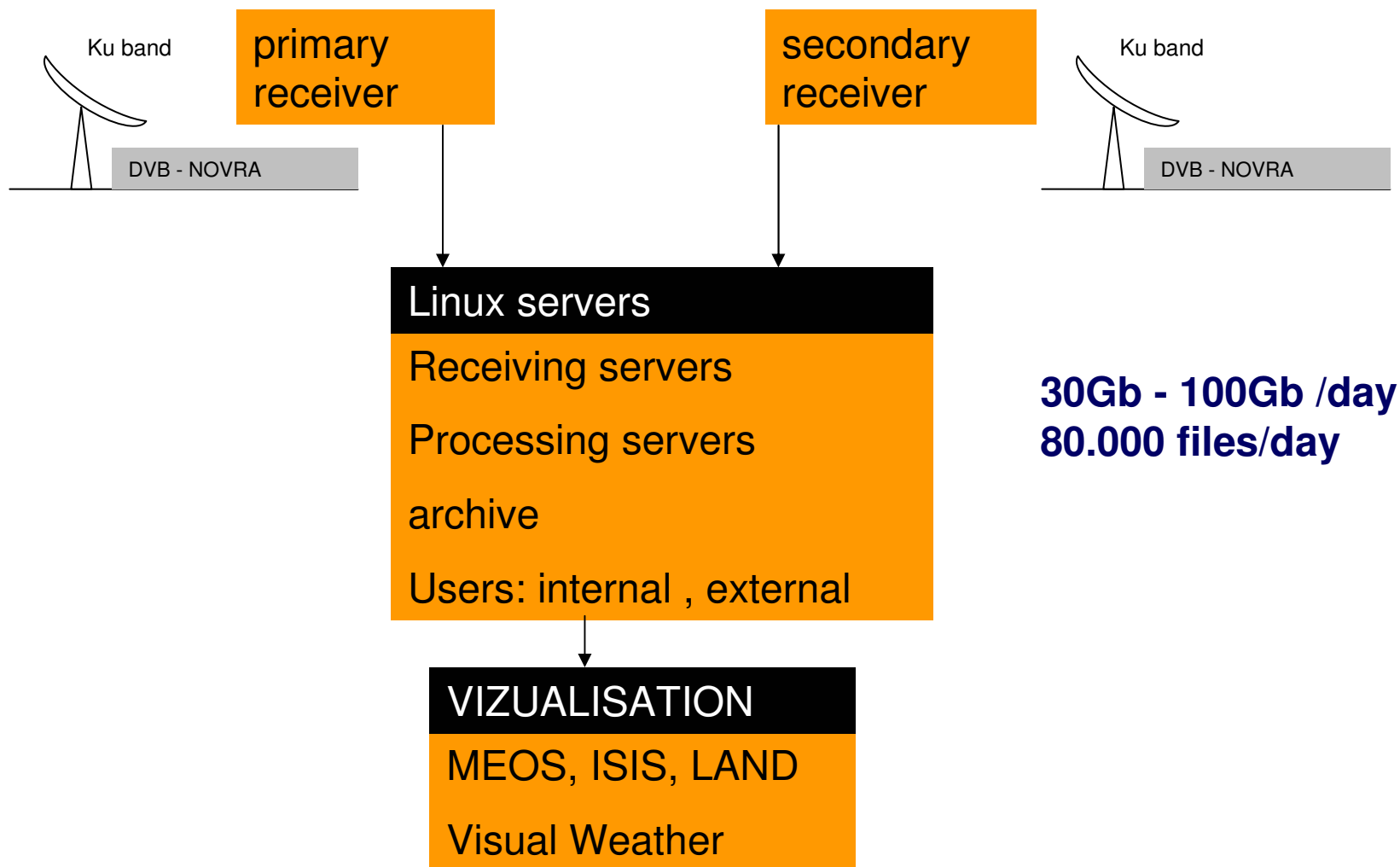
# Global Operational Satellite Observation System (GOS)





# ARSO satellite receiving sistem

## EumetCast





# Satellite Application Facilities - SAFs

(c) EUMETSAT

## EUMETSAT NETWORK OF SATELLITE APPLICATION FACILITIES

Utilising specialist expertise from the Member States, Satellite Application Facilities (SAFs) are dedicated **centres of excellence** for processing satellite data.



Support to Nowcasting and Very Short Range Forecasting

Led by Agencia Estatal de Meteorología, Spain



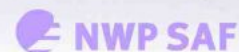
Ocean and Sea Ice

Led by Météo France



Climate Monitoring

Led by Deutscher Wetterdienst, Germany



Numerical Weather Prediction

Led by Met Office (UK)



Land Surface Analysis

Led by Portuguese Meteorological Institute



Ozone and Atmospheric Chemistry Monitoring

Led by Finnish Meteorological Institute



Radio Occultation Meteorology (formerly GRAS SAF)

Led by Danish Meteorological Institute



Support to Operational Hydrology and Water Management

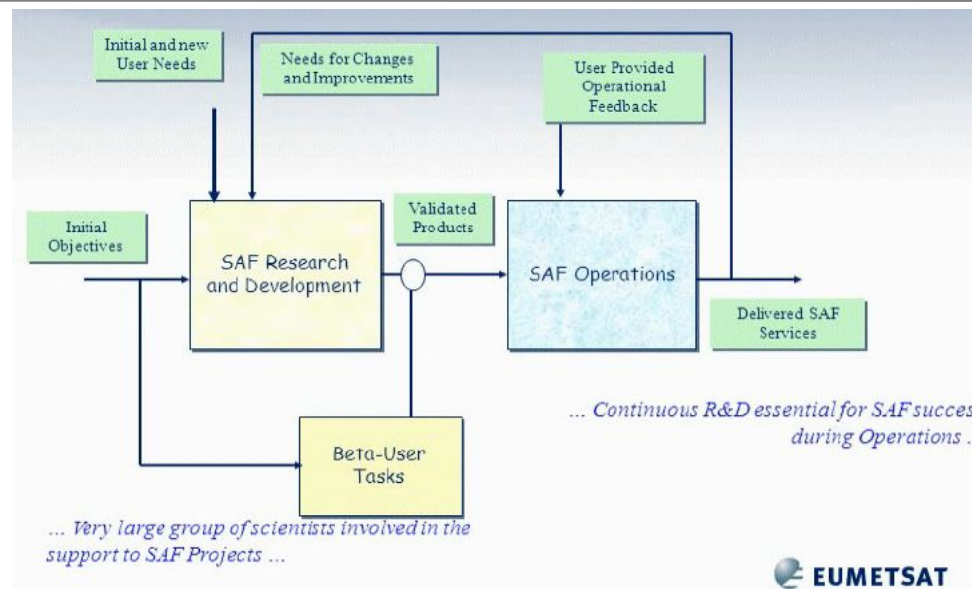
Led by Italian Meteorological Institute



## Satellite Application Facilities (SAFs)

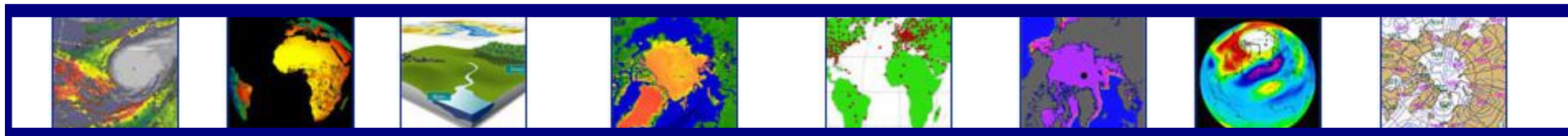
The goal of SAFs is to provide operational products:

- Continuity of products provision
- Continuity of product **improvements**
- Continuous **quality monitoring**
- Committed **user services**
- **Validation and review** before official release/launch
- Complete **documentation** of Products, Algorithms, Validation Results
- Approved **budget** until 2020





# Satellite Application Facility



1. **NWCSAF: SAF on Support to Nowcasting and Very Short Range Forecasting**
2. **LAND SAF: SAF on Land Surface Analysis**
3. **H-SAF: SAF on Support to Operational Hydrology and Water Management**
4. **OSI SAF: SAF on Ocean and Sea Ice**
5. **O3M SAF: SAF on Ozone & Atmospheric Chemistry Monitoring**
6. **GRAS SAF: SAF on GNSS Receiver for Atmospheric Sounding Meteorology**
7. **CM SAF: SAF on Climate Monitoring**
8. **NWP SAF: SAF on Numerical Weather Prediction**



## Nowcasting SAF

### MSG Cloud Products:

- Cloud Mask
- Cloud Type
- Cloud Top Temperature and Height

### MSG Precipitation & Convection Products:

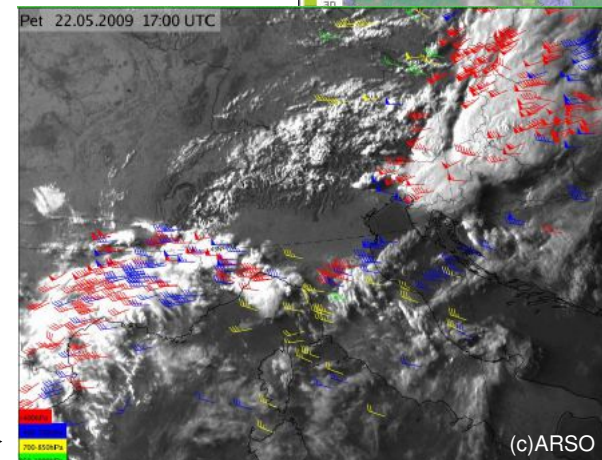
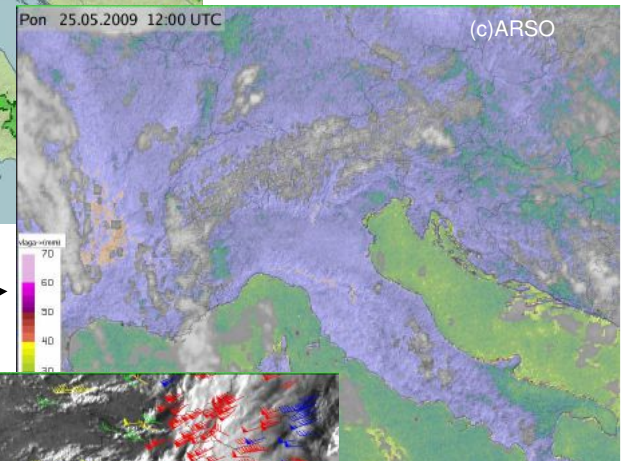
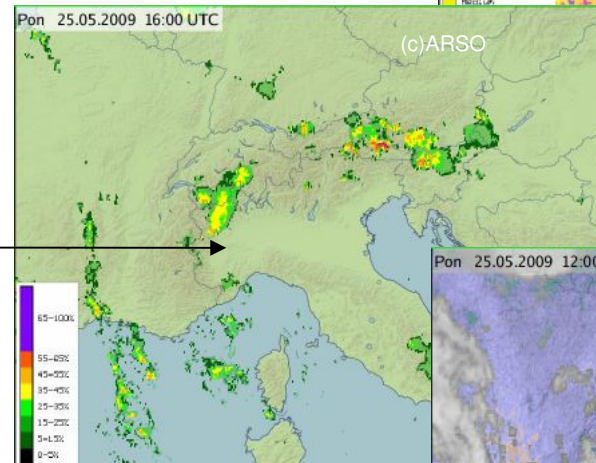
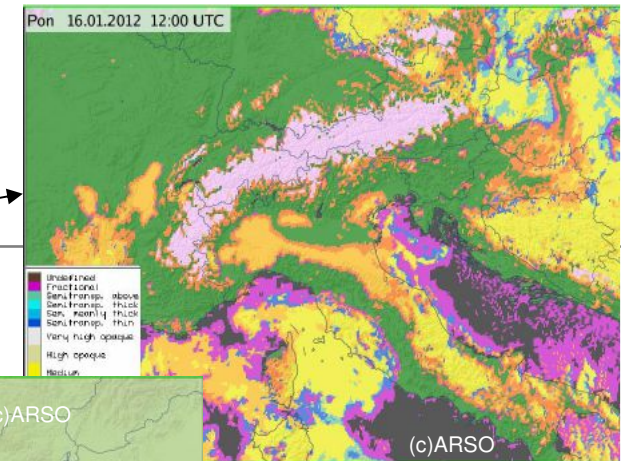
- Precipitating Clouds
- Convective Rainfall Rate
- Rapid Development Thunderstorms

### MSG Clear Air Products:

- Total Precipitable Water
- Layer Precipitable Water
- Stability Analysis Imagery

### MSG Conceptual Model and Winds Products:

- Air Mass Analysis
- Automatic Satellite Image Interpretation
- High Resolution Winds





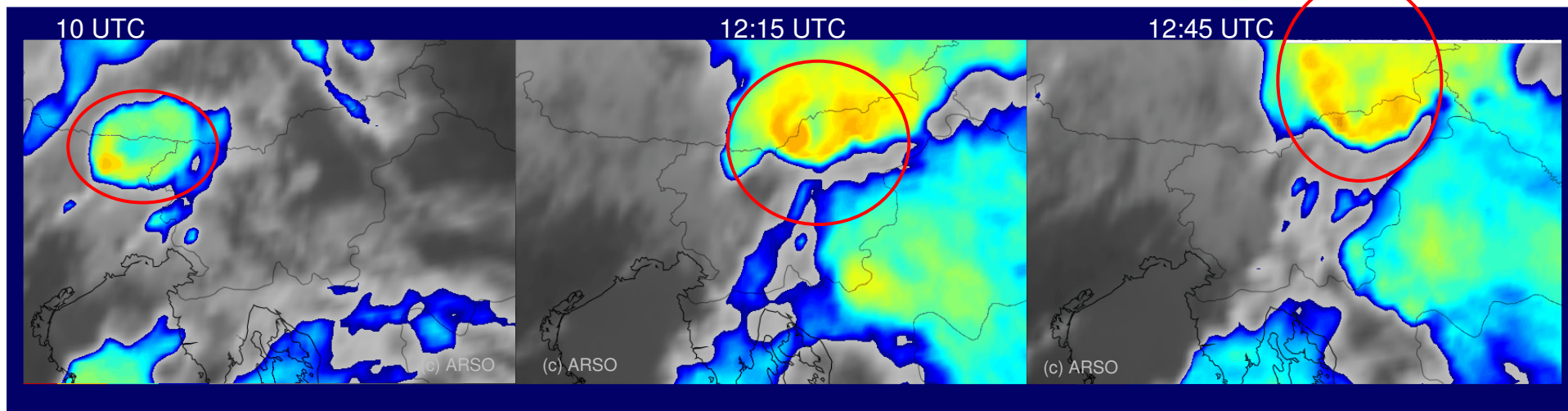
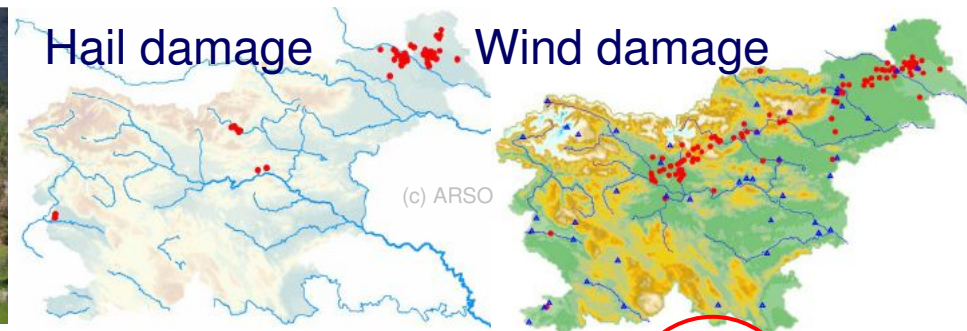
REPUBLIC OF SLOVENIA  
MINISTRY OF AGRICULTURE AND THE ENVIRONMENT  
SLOVENIAN ENVIRONMENT AGENCY

Meteosat

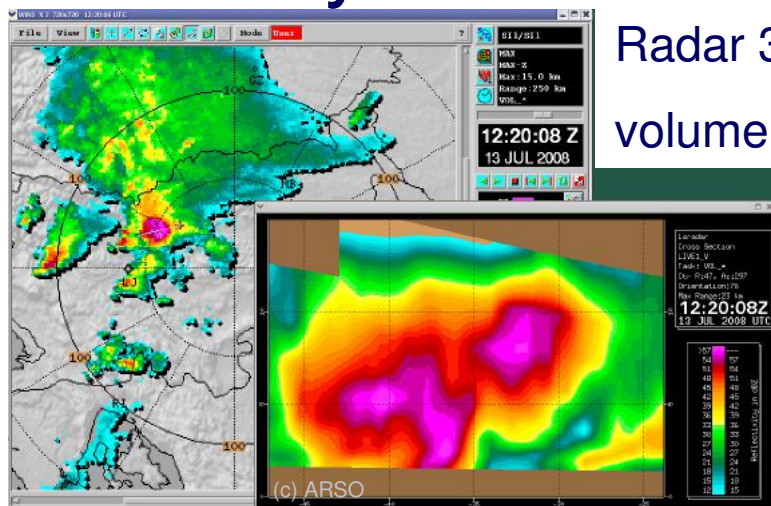


Hail damage

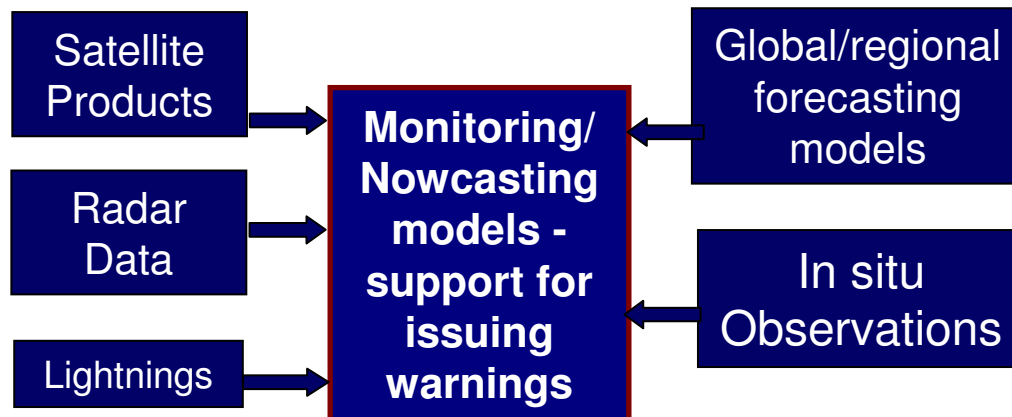
Wind damage



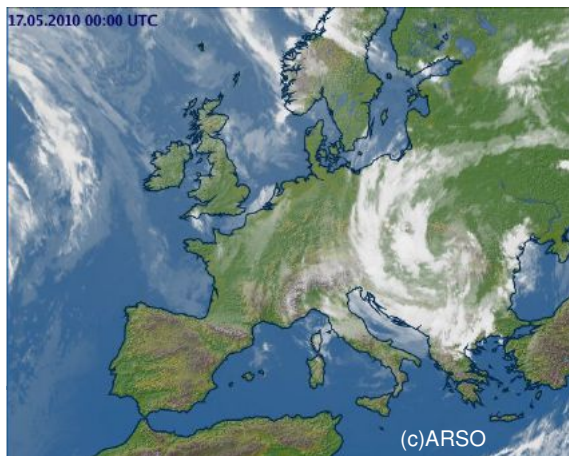
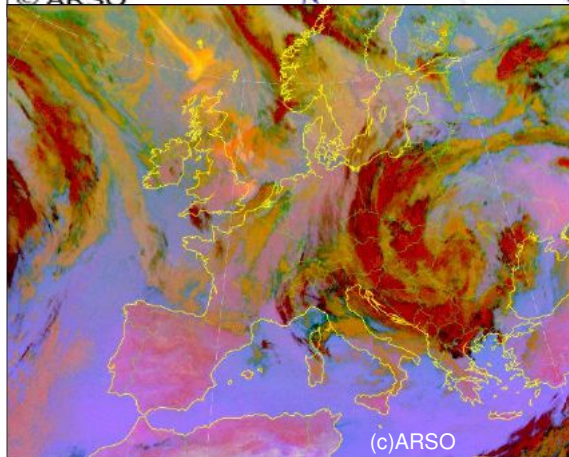
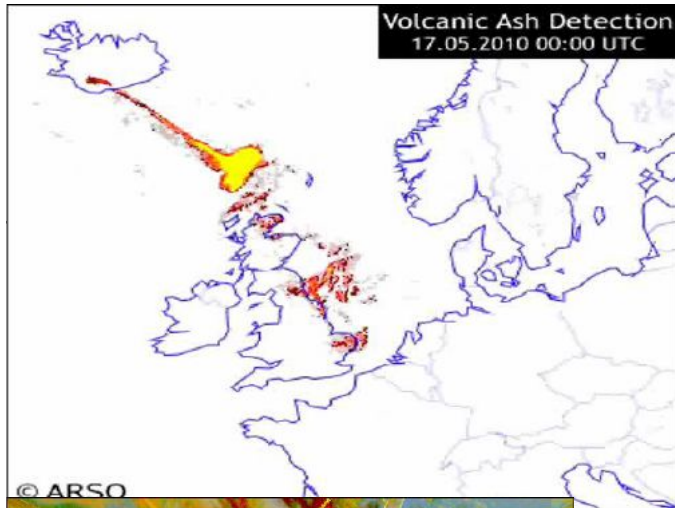
13 July 2008



Radar 3D  
volume scan



# Volcanic Ash Detection Using Meteosat Data



- Volcanic eruption, started on 14 April 2010 in Iceland, was monitored by satellite Meteosat:
  - high concentration of ash cloud were monitored day and night
- Detailed monitoring of volcanic ash (detection and movement) is essential for **air-traffic safety**



Volcano Eyjafjallajokull in Iceland

## LAND

DATA

DATA DELIVERY

PRODUCTS

LEVEL 1 DATA

ATMOSPHERE

LAND

CLIMATE

OCEAN

FORMATS

SOFTWARE PRODUCTS

METEOSAT DATA COLLECTION SERVICES

THIRD PARTY

CALIBRATION

TRAINING

SERVICE STATUS

WHAT YOU SAY

### Satellite coverage provides information on the state of the land and on land processes.

Satellite coverage provides information on the state of the land and on land processes. This information is of considerable benefit for agriculture; forestry; surface transport management, and the monitoring of ecological and hydrological systems.

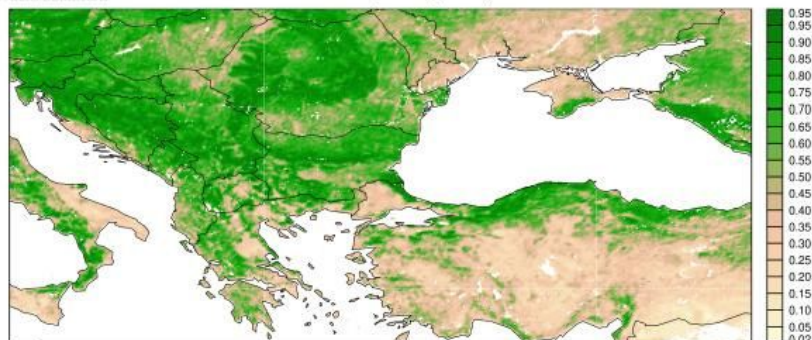
Click on the product names below to view further details in our [▶ Product Navigator](#).

The [▶ LSA SAF](#) develops techniques to retrieve products related with land applications.



#### Land Products

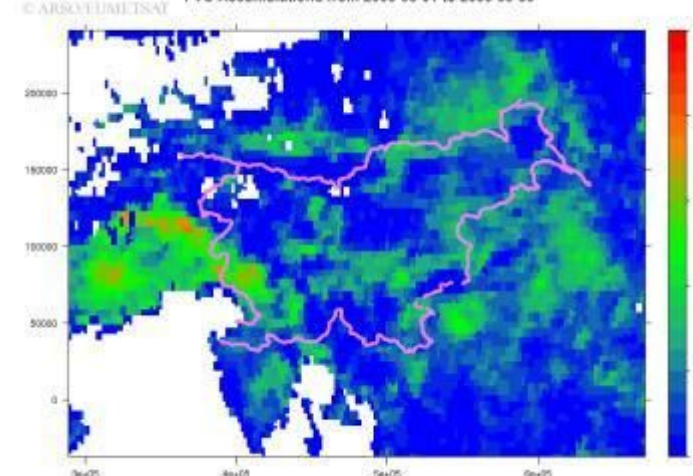
TITLE	RESOURCES	INSTRUMENT
▶ <a href="#">ASCAT Soil Moisture at 12.5 km Swath Grid - Metop</a>	<a href="#">▶ ASCAT Product Guide</a> <a href="#">▶ ASCAT Level 2 Soil Moisture Reprocessing Phase 1 - Dataset Description (PDF)</a> <a href="#">▶ ASCAT Soil Moisture Product Handbook (PDF)</a>	ASCAT
▶ <a href="#">ASCAT Soil Moisture at 25 km Swath Grid - Metop</a>	<a href="#">▶ ASCAT Product Guide</a> <a href="#">▶ ASCAT Level 2 Soil Moisture Reprocessing Phase 1 - Dataset Description (PDF)</a> <a href="#">▶ ASCAT Soil Moisture Product Handbook (PDF)</a>	ASCAT
▶ <a href="#">ASCAT Winds and Soil Moisture at 12.5 km Swath Grid - Metop</a>	<a href="#">▶ EUMETSAT OSI SAF page</a> <a href="#">▶ OSI SAF</a> <a href="#">▶ OSI SAF ASCAT 12-km product viewer</a> <a href="#">▶ ASCAT Wind Product User Manual (PDF)</a> <a href="#">▶ ASCAT Product Guide</a> <a href="#">▶ WMO operational formats descriptions</a>	ASCAT
▶ <a href="#">ASCAT Winds and Soil Moisture at 25 km Swath Grid - Metop</a>	<a href="#">▶ EUMETSAT OSI SAF page</a> <a href="#">▶ OSI SAF</a>	ASCAT



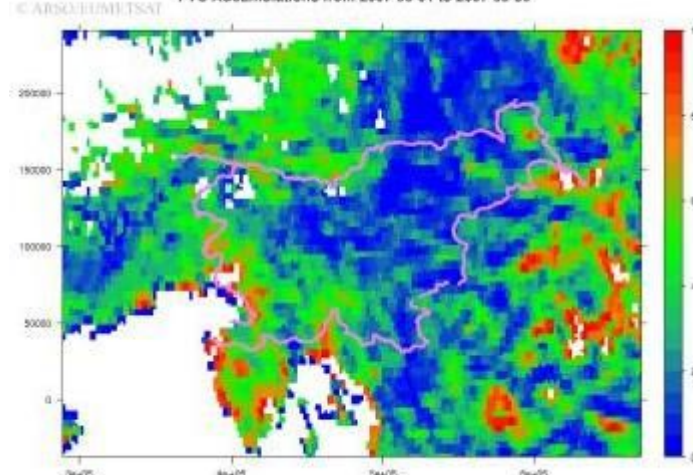
## LANDSAF, EU domene

	updated
Land Surface Temperature	15min
Fire Radiative Power	15min
Fraction of Vegetation Cover	1day
Leaf Area Index	1day
Fraction of Absorbed Photosynthetic Active Radiation	1day
Snow Cover	1day
Surface Albedo	1day
Down-welling Surface Short-wave Radiation Flux	1day
Down-welling Surface Long-wave Radiation Flux	1day
Evapotranspiration	30min, 1 day

FVC Accumulations from 2005-06-01 to 2005-09-30



FVC Accumulations from 2007-06-01 to 2007-09-30





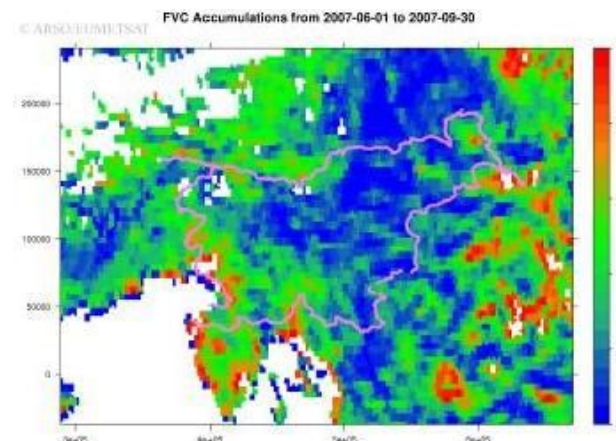
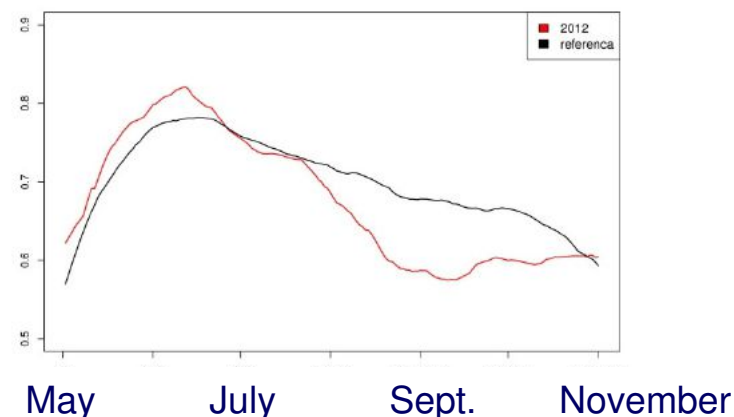
# Drought monitoring at ARSO

Vegetation LANDSAF indexes are compared to reference values.

Reference values are variable for every:

- day (to capture seasonal variation)
- satellite pixel (spatial variability)

Indication for drought is accumulation of such deviation.

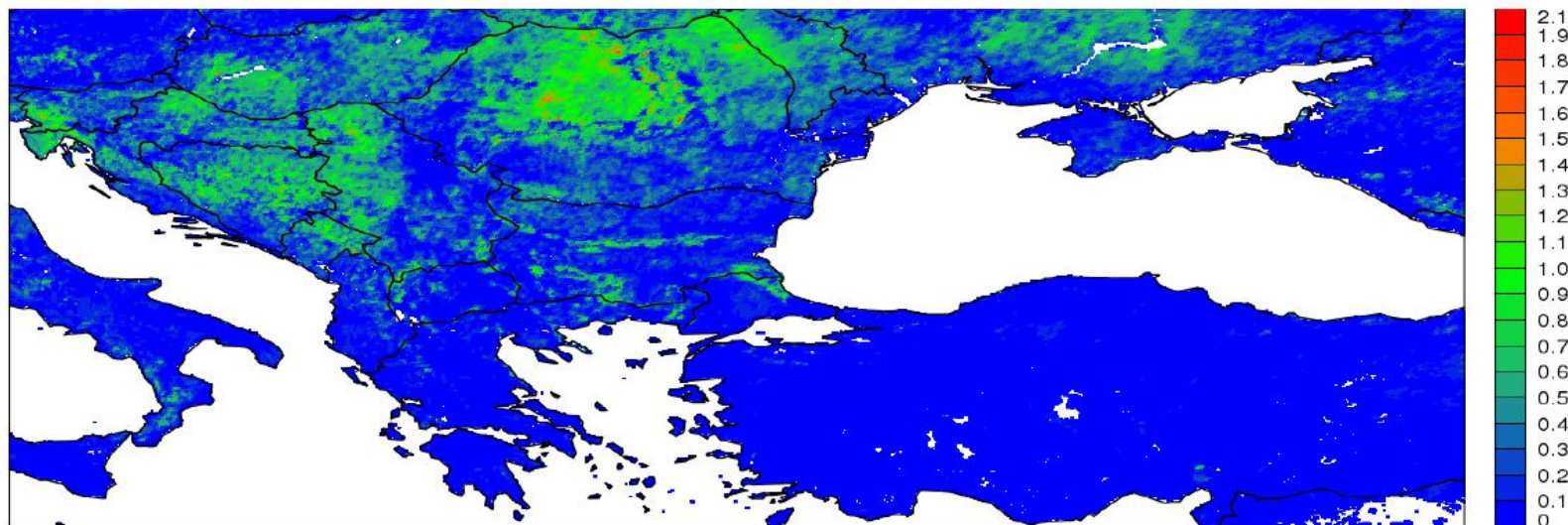




# Vegetation index LANDSAF Leaf Area Index (LAI)

© ARSO/EUMETSAT

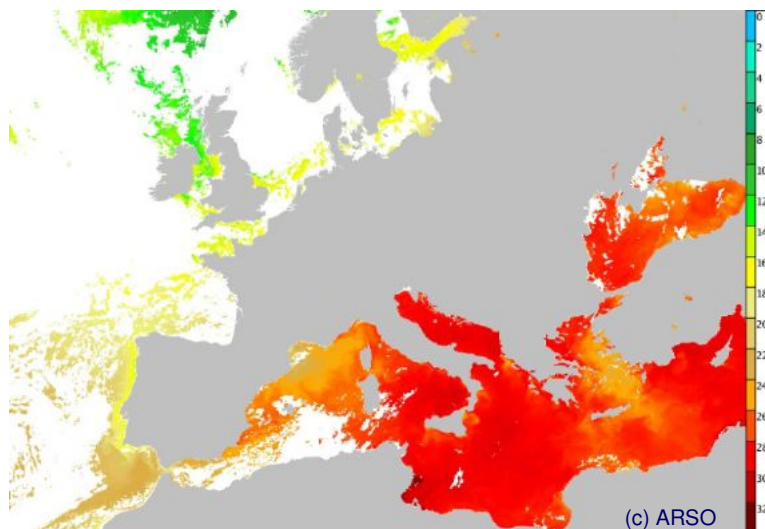
Monthly LAI Accumulations ( 20120801 - 20120830 )



Leaf Area Index mean monthly accumulations are calculated on DMCSEE domain displaying drought impact over Southeastern Europe.

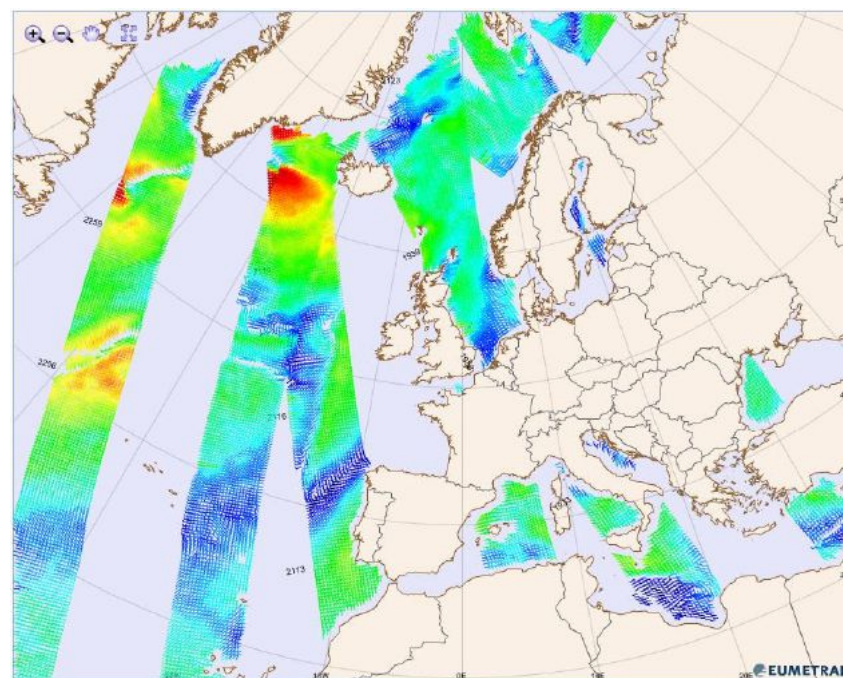


# Ocean and Sea Ice



**Sea Surface Temperature** 1h  
**Surface Solar Irradiance** 1h  
**Downward Longwave Irradiance** 1h

**ASCAT wind**  
25 km, 12.5 km, coastal. 12h  
Global Sea Ice Concentration 1day  
Global Sea Ice Edge 1day  
Global Sea Ice Type 1day





REPUBLIC OF SLOVENIA  
MINISTRY OF AGRICULTURE AND THE ENVIRONMENT  
SLOVENIAN ENVIRONMENT AGENCY

Mean Absolute Error  
of Sea Surface  
Temperature is below  
0.5 K as compared to  
measurements from  
buoy Piran 3 m below  
the surface.

## Verification of OSI SAF Sea Surface Temperature (METOP, MSG and NOAA) over North Adriatic in 2012

Mateja Iršič Žibert (mateja.irsic-zibert@gov.si), Boštjan Muri

Slovenian Environment Agency (ARSO), Vojkova 1b, 1000 Ljubljana, Slovenia

### OSI SAF SST

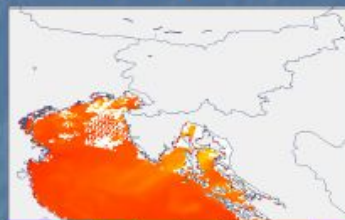


Fig. 1. Zoom over Northern Adriatic of SST from OSI SAF NAR METOP at 10 UTC on 9 August 2012. © EUMETSAT and © ARSO.



Fig. 2. SST from OSI SAF NAR METOP at 10 UTC on 9 August 2012. © EUMETSAT and © ARSO.

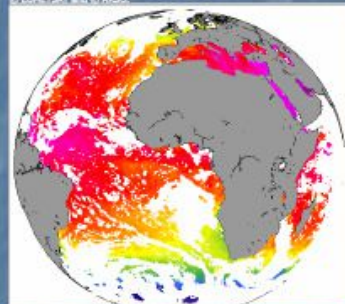


Fig. 3. Sea surface temperature SST from OSI SAF from MSG at 11 UTC on 9 August 2012. © EUMETSAT and © ARSO.

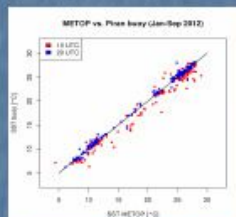


Fig. 8. Scatter plots OSI SAF NAR SST METOP vs. buoy Piran for the period from January–September 2012. For morning overpass in red and for afternoon overpass in blue. © EUMETSAT and © ARSO.

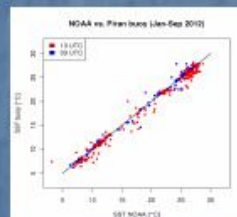


Fig. 8. Scatter plots OSI SAF NAR SST NOAA vs. buoy Piran for the period from January–September 2012. For morning overpass in red and for afternoon overpass in blue. © EUMETSAT and © ARSO.

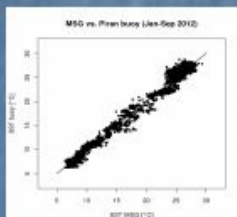


Fig. 7. Scatter plot OSI SAF SST MSG vs. buoy Piran. © EUMETSAT and © ARSO.

### Verification scores with buoy Piran in 2012



Fig. 4. Location of buoy Piran indicated with yellow dot. Red dot represent the location of Marine Biology Station in Piran (MBSS) which own the buoy. © MBSS.



Fig. 5. Photo of instruments on buoy Piran. © MBSS.

#### About oceanographic buoy Vida Piran (MBSS):

Buoy Vida is located near the Slovenian coast near place Piran. On the buoy there are several instruments:

- an acoustic Gill's Instruments 3D anemometer (height 5 m),
- a Vaisala air temperature and humidity sensor (height 3.5 m),
- a Seacat of Seabird for temperature and C probe (depth 3 m) with a Wetlab fluorometer for Chl-a measurements,
- an oxygen sensor 'Optode' of Aanderaas, also at a depth of 3 m.
- An Xsens motion sensor (accelerometer/compass-tilt sensor) is placed in the buoy's hull just below the top-cover of the hull and under the mast. An AWAC current meter from Nortek As is mounted at the seafloor, at a depth of 22 m.
- There are three surveillance web cameras. One underwater camera is mounted at the bottom of the buoy at about 2 m depth.
- The buoy is also equipped with three solar panels and a wind generator.

Exact location of buoy Vida is indicated in Fig. 4 with yellow dot:

45° 32' 55,68" N, 13° 33' 1,89" E

Table 1. Bias and Mean Absolute Error (MAE) for OSI SAF SST at location buoy Piran. The number of cloud free cases are indicated in the time period January–September 2012. © EUMETSAT and © ARSO.

	Time	no.	bias (K)	MAE (K)
MSG	All	3078	0.06	0.65
MSG	12 - 14 UTC	437	0.45	0.80
MSG	2 - 4 UTC	363	-0.18	0.61
METOP	all	311	0.22	0.68
METOP	10 UTC	166	0.54	0.94
METOP	20 UTC	145	-0.15	0.38
NOAA	all	322	0.26	0.66
NOAA	13 UTC	172	0.53	0.88
NOAA	3 UTC	150	-0.04	0.40

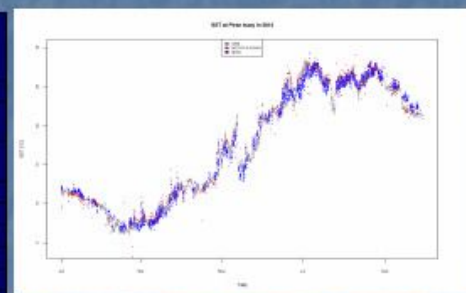


Fig. 6. Sea surface temperature SST from OSI SAF from MSG (blue) and NAR METOP AND NOAA (red) for the period from January to September 2012 as compared to the buoy measurement (grey). © EUMETSAT and © ARSO.

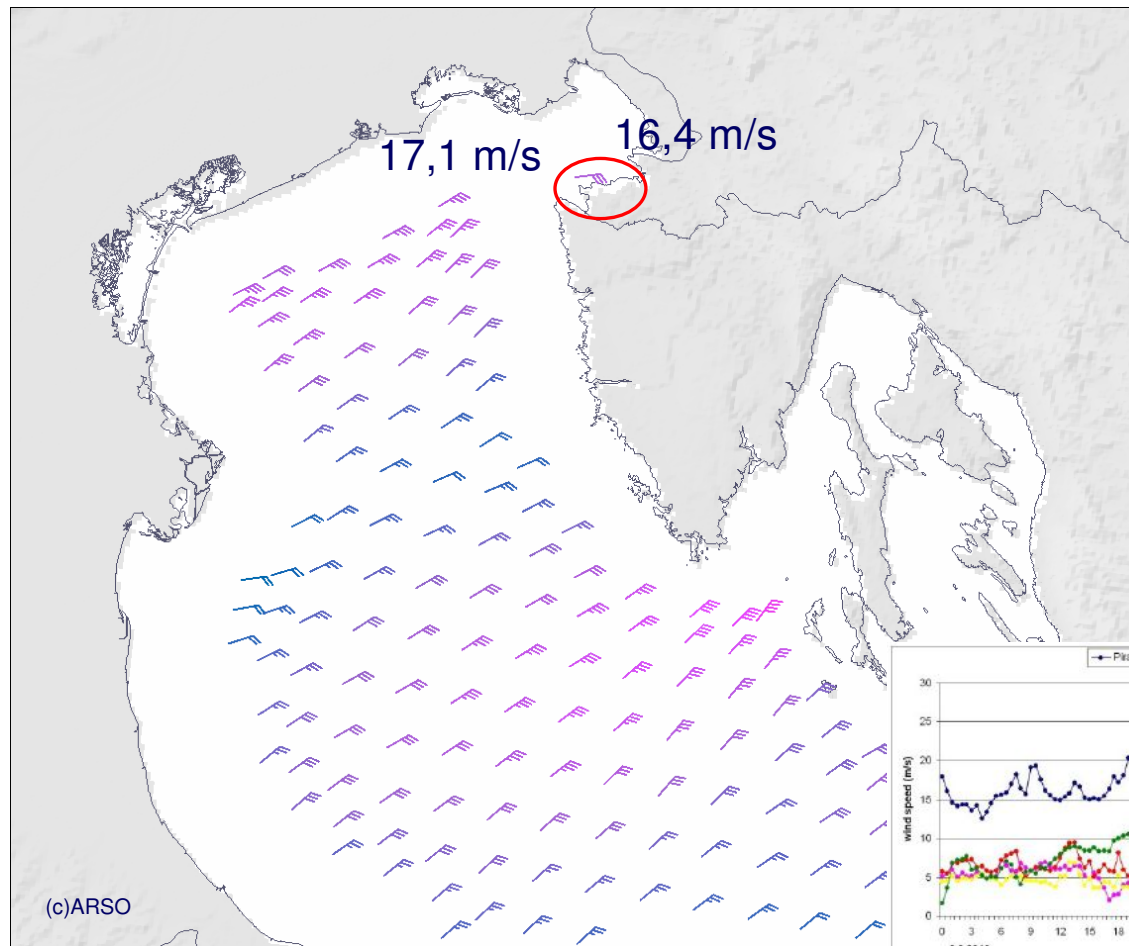
For the location buoy Piran the SST from OSI SAF has almost no bias for SST NOAA during the night and a slightly negative bias for METOP (-0.15 °C) and MSG (-0.18 °C) in the selected period. See Table 1. The MAE during the night is around 0.5 °C, slightly better for METOP (0.38 °C) and NOAA (0.4 °C) as compared to MSG (0.6 °C). During the daytime there is bias of around 0.5 °C for all three products and MAE around 0.9 °C, see Table 1. Looking at the scores of all intervals MSG exhibits almost no bias, where METOP and NOAA have slightly positive bias (around 0.2 °C) and the total MAE are below 0.8 °C.

In the Fig. 6 there is a comparison between buoy temperature measurements and OSI SAF SST from MSG and METOP and NOAA. There are only a few outliers. In the Fig 7.-9. scatter plots for each satellite are shown separately.

### References

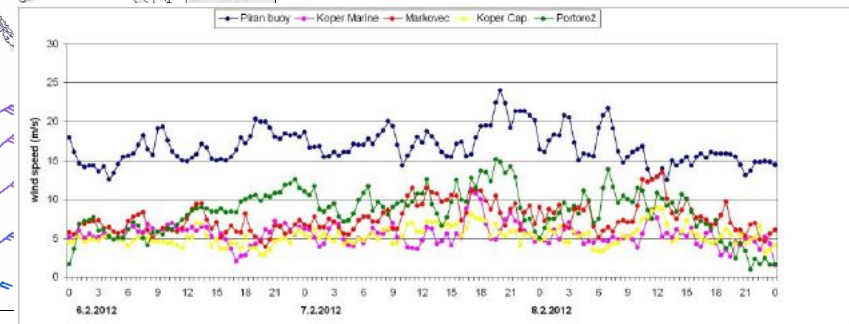


# Satellite ASCAT wind measurements



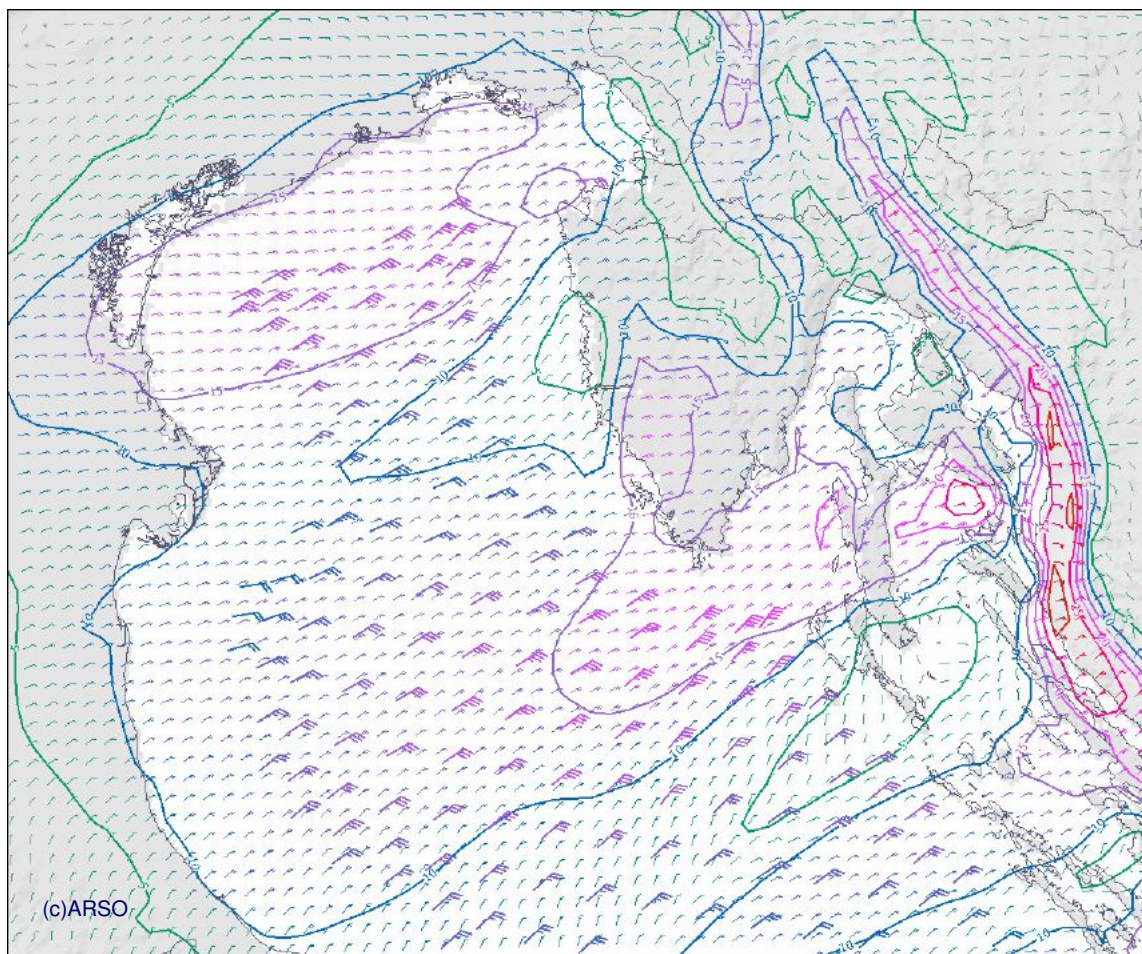
Strong Bora wind case

Coastal ASCAT wind measurements with ground resolution 12.5 km on 8 Feb. 2012 at 9 UTC and wind measurements on buoy Piran, (c) ARSO/EUMETSAT.





# Satellite ASCAT wind measurements



Strong Bora wind case

Coastal ASCAT wind measurements with ground resolution 12.5 km on 8 Feb. 2012 at 9 UTC, measurement from buoy Piran. Additionally with smaller wind-bars and contours ALADIN model wind at 10m, (c) ARSO/EUMETSAT



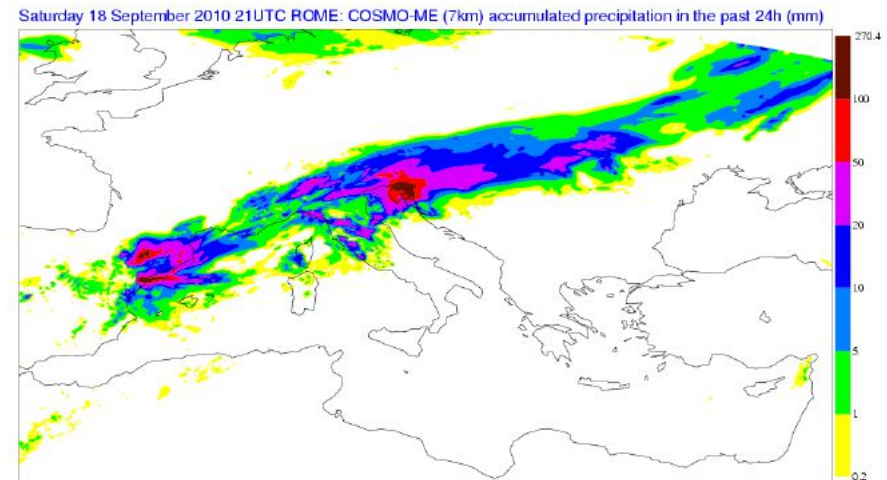
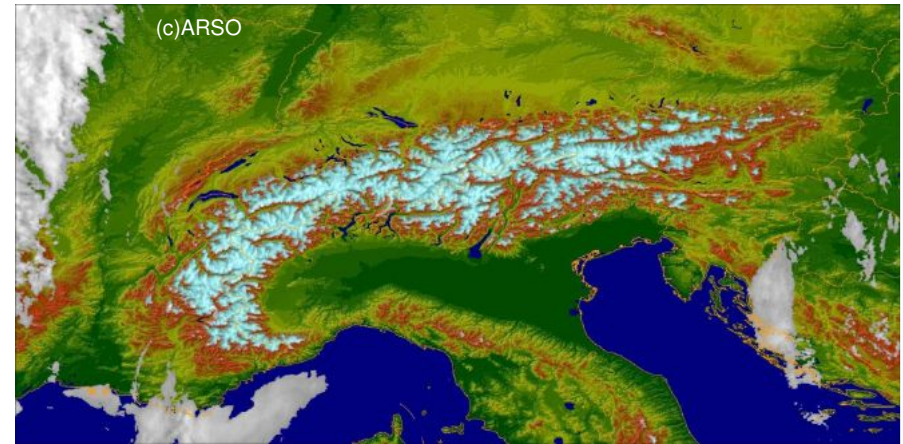
# Support to hydrology SAF

The H-SAF operationally generates, validates, distributes and archives high-quality data sets and products for operational hydrological applications, starting from the acquisition and processing of data from Earth observation satellites in geostationary and polar orbits.

Generation of products:

- Precipitation products (7 products)
- Soil moisture products (3 products)
- Snow parameters (4 products)

Independent validation of the benefit of the new products for hydrological applications.





## Atmospheric composition O3M SAF

NRT Product	Status
NRT Total Ozone	
NRT Total Nitrogen Dioxide	
NRT Ozone Profile	
NRT UVI	
NRT Tropospheric Nitrogen Dioxide	

Offline Product	Status
Offline Total Ozone	
Offline Total Nitrogen Dioxide	
Offline Total Bromine Oxide	
Offline Total Sulfur Dioxide	
Offline Total Formaldehyde	
Offline Total Water Vapour	
Offline Ozone Profile	
Absorbing Aerosol Index	
Offline surface UV, 13 products	
Offline Tropospheric Nitrogen Dioxide	
Offline Total Chlorine Dioxide	Demonst

IASI on METOP

Ground resolution: 12 km 8461 channels

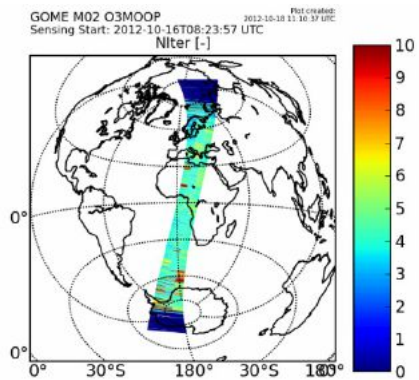
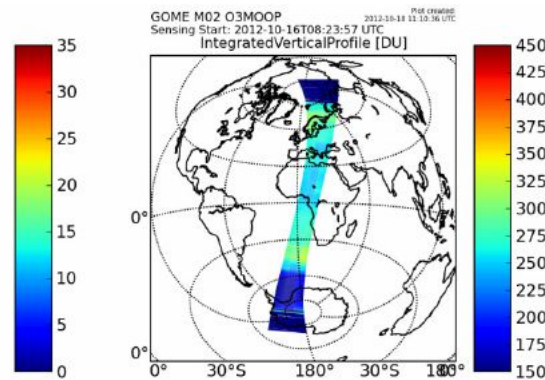
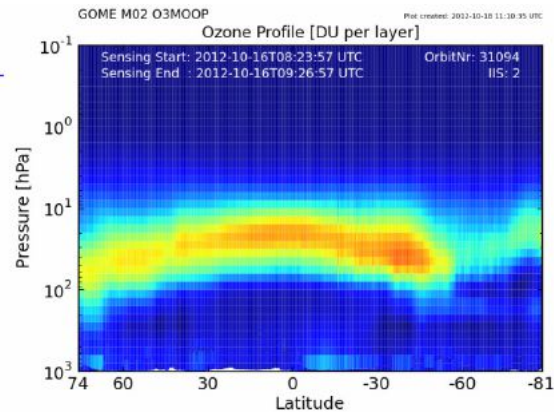
GOME on METOP satellite

Ground resolution: 80x40 km<sup>2</sup>

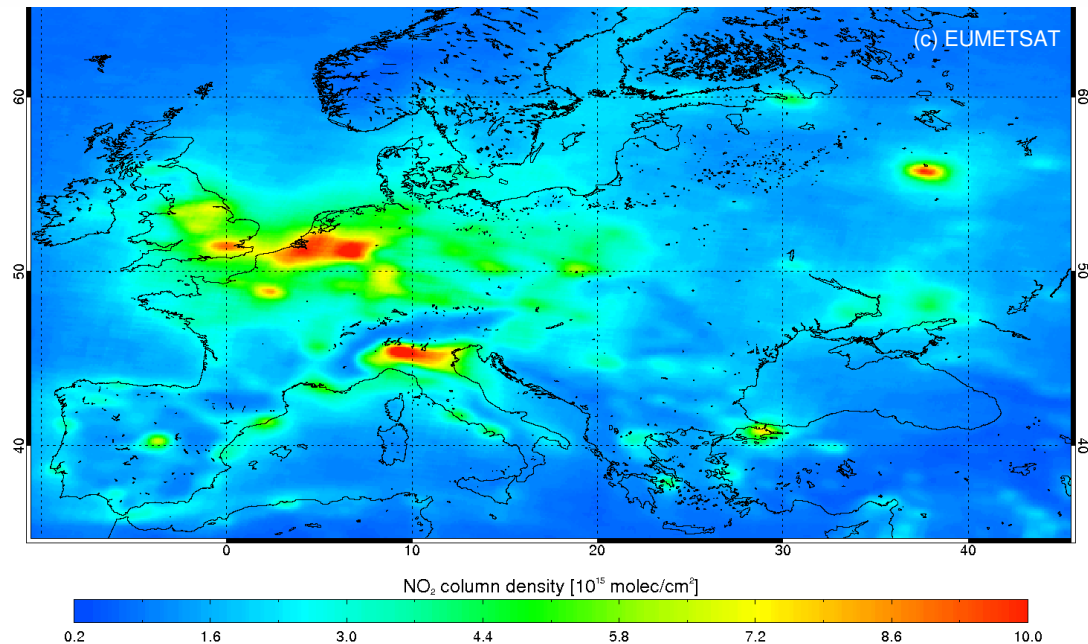


## Ozone profiles

KNMI  
O3MSAF  
EUMETSAT



Global Ozone Monitoring  
Experiment  
Tropospheric NO<sub>2</sub>  
2007-2011





## **Cloud Characteristics (NWCSAF):**

- Characteristics of cloud systems important for nowcasting, aviation, integration into multi source nowcasting systems (updated every 5-15 minutes) important in case of severe weather

Assimilation of satellite data into **Numerical Weather Prediction** models (NWP SAF)

## **Drought Monitoring (LANDSAF)**

- Drought on regional scale (vegetation indexes over vegetation season)

## **Monitoring of Oceans (OSI SAF):**

- Sea Surface Temperature (ground resolution 2x2 km give Mean Absolute Error 0.5 K)
- Wind measurements also over cloudy areas (ground resolution 12,5 km)

## **Snow Cover (NWCSAF, LANDSAF, HSAF):**

- Snow mask (ground resolution 1 km, refreshed every 15 minutes)
- Snow water content

## **Monitoring of Wild Fires (LANDSAF)**

Ozone and **Atmospheric Chemistry** Monitoring (O3M SAF)

- Total O3, NO2, SO2,... (ground resolution ~10 km)



Thank you for your attention

