



Space technologies for meteorological extreme events forecast and monitoring in Romania

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Introduction

- ❖ The Romanian National Meteorological Administration (Meteo Romania) is a legal entity of national, public interest whose main aim is to ensure the meteorological protection of life and property.
- ❖ Romania is a founding member of the International Meteorological Organization (IMO), and a signer, in 1948 of the Convention for the settlement of the World Meteorological Organization (**WMO**).
- ❖ Romania is a co-operating state of the European Centre for Medium-Range Weather Forecasts (**ECMWF**).
- ❖ MeteoRomania is member of the Consortium for Small-scale Modeling (**COSMO**) and of the Regional Cooperation for Limited Area modeling in Central Europe (**RC LACE/ALADIN**) Consortium.
- ❖ MeteoRomania is cooperating member of the Economic Interest Grouping of the National Meteorological Services of the European Area (**ECOMET**).
- ❖ MeteoRomania is a member of the European National Meteorological Services Network (**EUMETNET**).
- ❖ Romania is a **EUMETSAT full member** (2010).
- ❖ Since 2011, Meteo Romania represents Romania at the **Copernicus User Forum Committee**.



Intoduction (cont.)

The main tasks of Meteo Romania as the national authority in meteorology are:

- **provide weather forecasts and warnings as well as operational meteorological services for agriculture, transport, national defense and security;**
- **deploys specific activities for defense and national security.**
- coordinate the activity of the National Meteorological Observations Network in the framework of 7 Regional Meteorological Centers,
- participates to the international meteorological data exchange with 23 weather stations in Regional Basic Synoptic Network (RBSN), and 14 stations in Regional Basic Climatological Network (RBCN).
- supplying and running weather forecasting models and systems suitable to the country's geographic area;
- administration of the national meteorological data base, supplying climatic data and climate monitoring;
- **extreme meteorological/hydrological events monitoring and warning.**

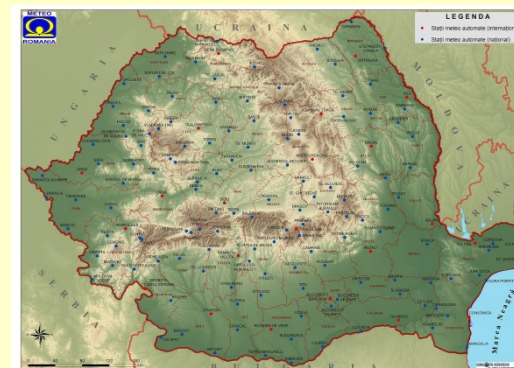


The National Integrated Meteorological System

The National Integrated Meteorological System (SIMIN) is conceived as an integrated system, receiving and processing the data coming from multiple observation sub-systems (surface, radar, satellite sub-systems, etc.) and a lot of types of equipment. **The main benefit is relevant for the nowcasting activities, allowing the early detection, surveillance and prediction of severe meteorological phenomena.** The SIMIN system includes a quasi-real time dissemination component of the meteorological information, so that the local authorities and the other users could be promptly informed about the occurrence of severe meteorological events, being able to take, in time, the necessary steps to avoid disasters and damages.

The National Integrated Meteorological System contains:

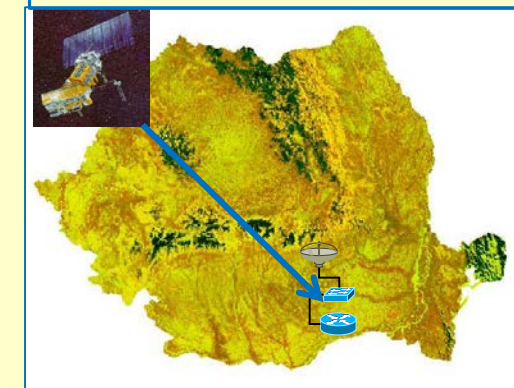
- The surface measurements network: 158 automatic weather stations, from which 55 with dedicated agrometeorological program (25 soil moisture portable systems), 36 stations with radiometric program, 1 upper air station.
- The radar network: 8 Doppler radar systems.
- The satellite receiving & processing station: EUMETCast receiving station, Ku-band and C-band antenna, processing servers, storage system.
- The forecast and dissemination network.
- The specialized communication network.



AWS network



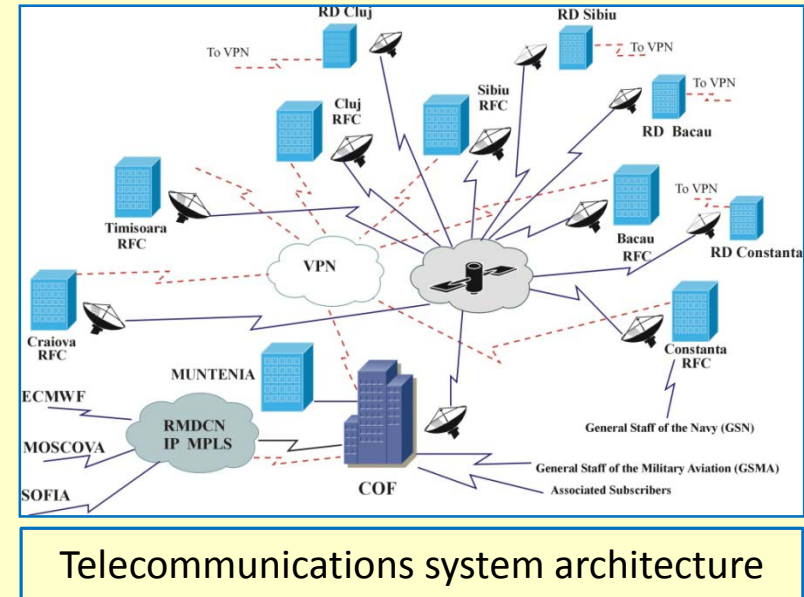
Radar network



Satellite data reception and processing station

The Meteorological Telecommunications System

The National Integrated Meteorological System is based on a specialized meteorological telecommunications system endowed with a dedicated telecommunications network which ensures the connectivity and the operational transfer of the primary and processed data in the entire network of the National Meteorological Administration.



Through this telecommunications network, the meteorological data and products are collected from the weather stations and that of the radar units and transmitted at the Regional Weather Forecasting Services (RWFS) and at the National Weather Forecasting Centre (NWFC), for validation, building up the collective products and processing. From the national Centre, transmission is made to RWFSs of data and information necessary for elaborating the local forecasts.

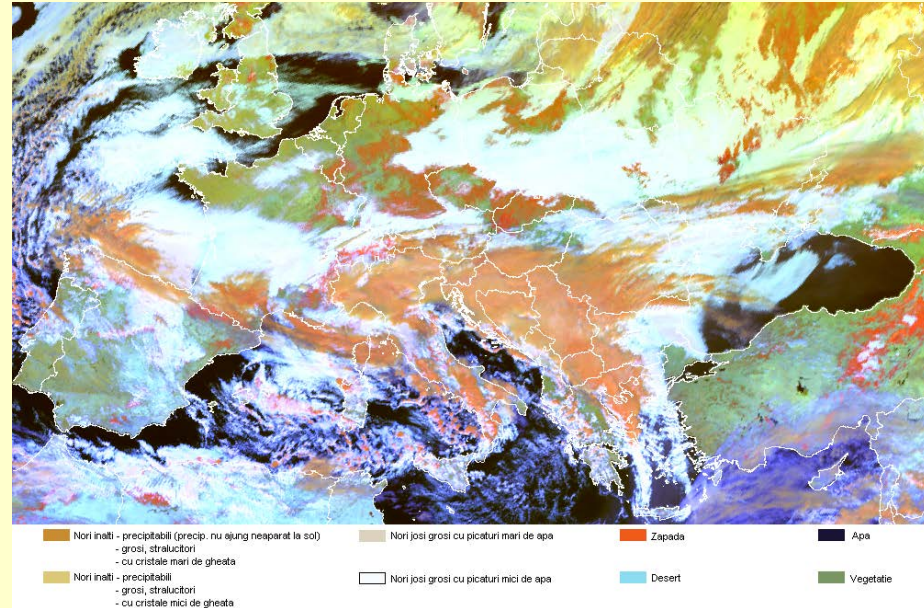
The **VSAT satellite WAN network** is the principal solution that connects in the network 4 radar sites (Barnova, Medgidia, Tarnaveni and Oradea), six Regional Weather Forecasting Services (RWFSs) (Bacau, Constanta, Sibiu, Cluj, Timisoara and Craiova) and National Weather Forecasting Centre (NWFC) in Bucharest, being a 11-node full-duplex network.

Role of satellite systems for extreme meteorological events forecast and monitoring

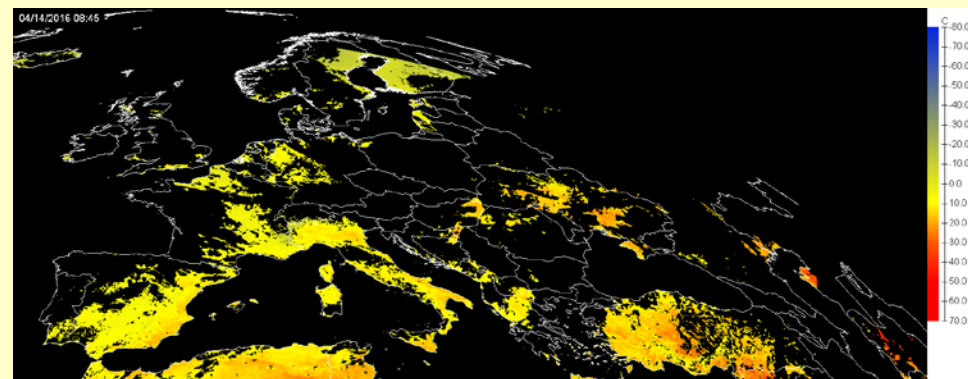
- Meteorological satellites play a vital role in **modern weather reliable forecasting**. They provide a unique global view of atmospheric conditions, particularly over oceans, where other types of observations are impractical.
- The Sendai Framework for Disaster Risk Reduction 2015 - 2030 highlighted that natural disasters are of increasing frequency and severity in the modern world, with important impacts on human lives and the economy.
- Stronger and more frequent **weather extremes** will likely occur under climate change; in this respect the meteorological satellite systems can provide key **early warnings and potential disaster alerts** in the case of thunderstorms, tornadoes, heat waves, snowstorms, floods, and other violent and potentially lethal meteorological events.
- The combination of polar orbiting and geosynchronous satellites has allowed higher resolution images to be combined into accurate regional and global displays to see broad patterns of weather formations.
- **Taking into account that Nowcasting activity today relies heavily on the availability of satellite image products in near real time, the development of these products and their distribution in compact software with an efficient user support and training, allow a reliable way for the use by the forecaster.**

Use of satellite data and product for extreme meteorological events forecast and monitoring

- **MSG RGB:** Air Mass Analysis, Convection, Dust, Day Microphysics RGB, Snow, etc.;
- **Clouds products:** Cloud Mask, Cloud Type, Cloud Top Temperature and Height, Precipitating Clouds, Convective Rainfall Rate, etc.
- **Wild Fires products:**
 - PIXEL Fire Radiative Power
 - GRID Fire Detection and Monitoring Fire Risk Map
- **Vegetation Stress**
 - Evapotranspiration
- **Surface Radiation Budget**
 - Land Surface Temperature (15 mins)
 - Downward Surface Shortwave and Longwave Fluxes
 - Albedo Bi-Directional Reflectance Factor
 - Land Surface Emissivity
- **Vegetation State**
 - Fraction of Vegetation Cover Leaf Area Index
 - Fraction of Absorbed Photosynthetic Active Radiation
 - Normalized Difference Vegetation Index
- **Snow Cover**



Snow cover MSG RGB (06.02.2015)



Land Surface temperature
(14.04.2016, 08:45 UTC)

Meteorological satellite systems: dependencies, vulnerabilities and threats



The meteorological satellites are useful in all the phases of a extreme weather-related disaster events: preparation, monitoring and recovery.

Preparation: For monitoring the Earth prior to a disaster, space systems can provide information on meteorology, by gathering, storing, processing and delivering geographic or spatially referenced information. There is a **high dependency on space for the collection of meteorological data**, as well as for those models that are used to forecast meteorological events.

Monitoring: During a disaster, it is very likely that Earth-based infrastructure will be disrupted and hence dependency on space for ground-truth data will increase. Monitoring a weather-related disaster will therefore have **a high dependency on space for meteorology and a very high dependency on space for rapid provision of relevant geomatic data**. During some events, satellites may be the only source of updated mapping and geographic data.

Recovery: The operations support element will have **a high dependency on space for logistic support due to disruption of ground systems**. The execute/sustain element will have moderate dependency for communications. Reach back may have a critical dependency on space communications and hence will have significant dependency on space.

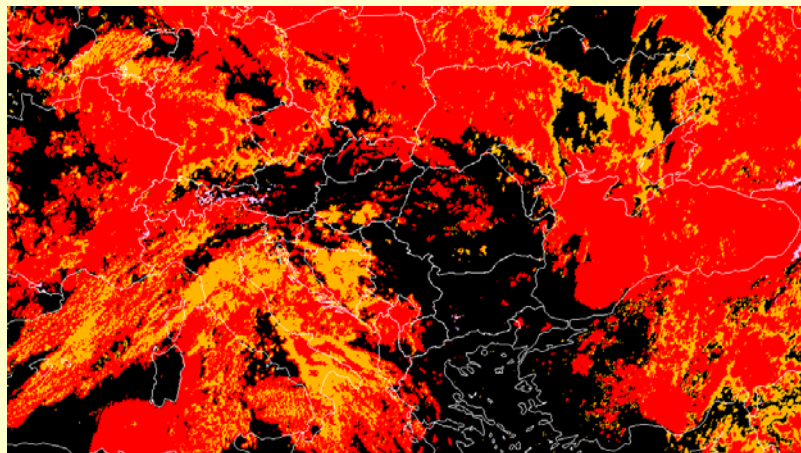
Meteo Romania: use of satellite data/products in nowcasting and monitoring of extreme meteorological events

In the National Weather Forecasting Centre the satellite data and products represent a very important information in case of severe meteorological events nowcasting and monitoring.

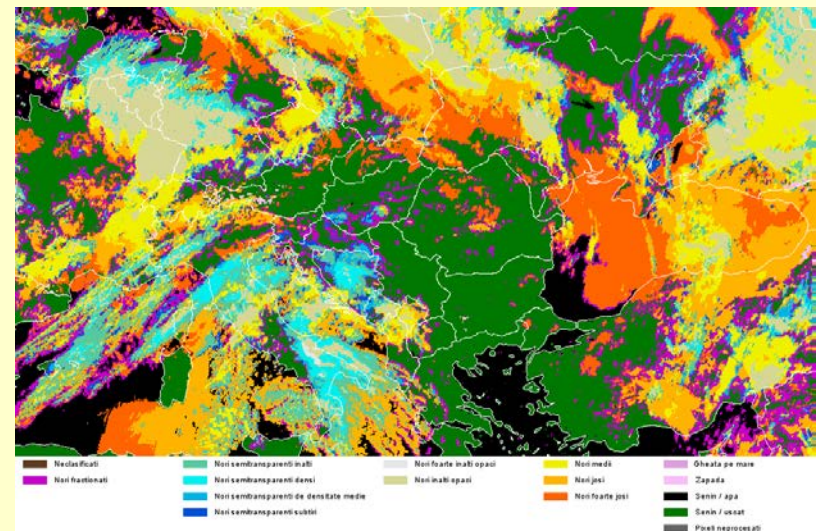
The satellite data and products are provided by EUMETSAT and locally post-processed to meet the requests from systems that visualize, distribute and draw out weather parameters (sectorization, projection change, export of graphic format etc.).

For this activity the main satellite data and products used are:

- **MSG channels**
- **MSG RGB:** Air Mass Analysis, Convection, Dust, Day Microphysics RGB, Snow, etc.;
- **Nowcasting SAF products:** Cloud Mask, Cloud Type, Cloud Top Temperature and Height, Precipitating Clouds, Convective Rainfall Rate, etc.

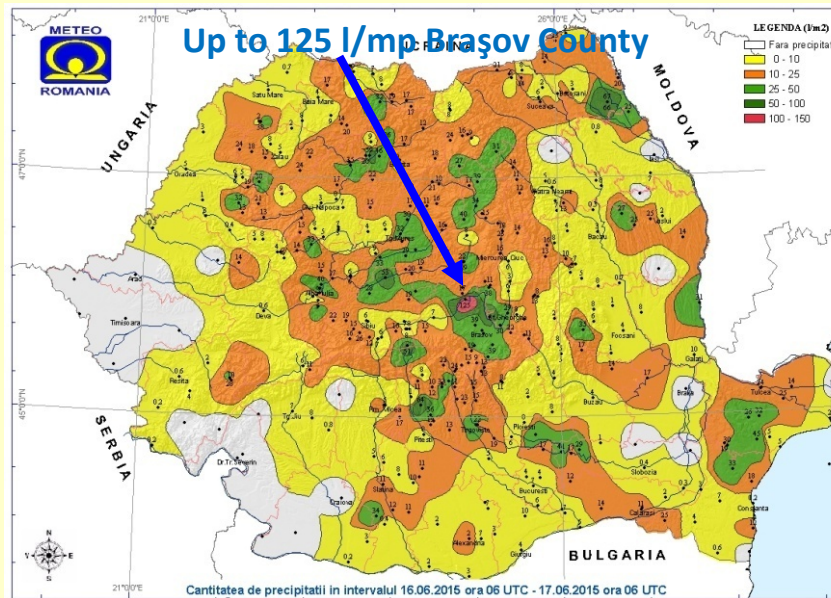


MSG Cloud Mask 13.04.2016

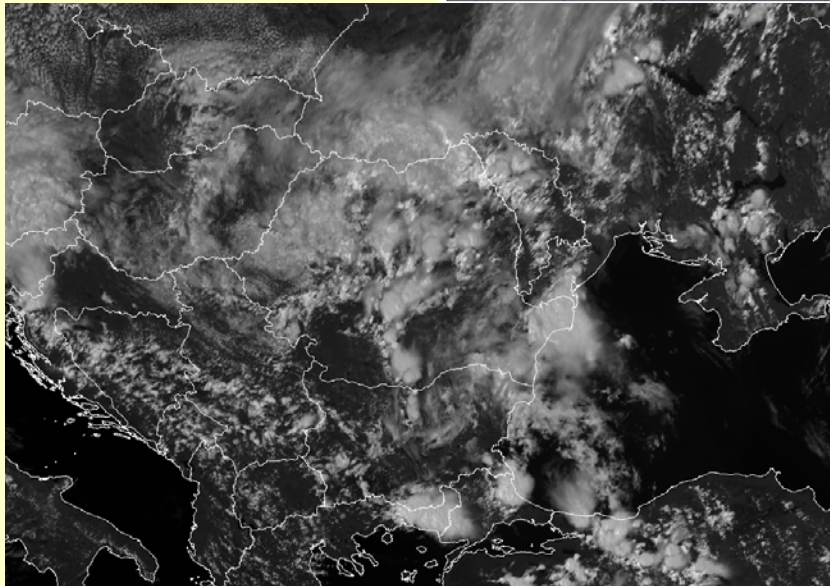


MSG Cloud Type 13.04.2016

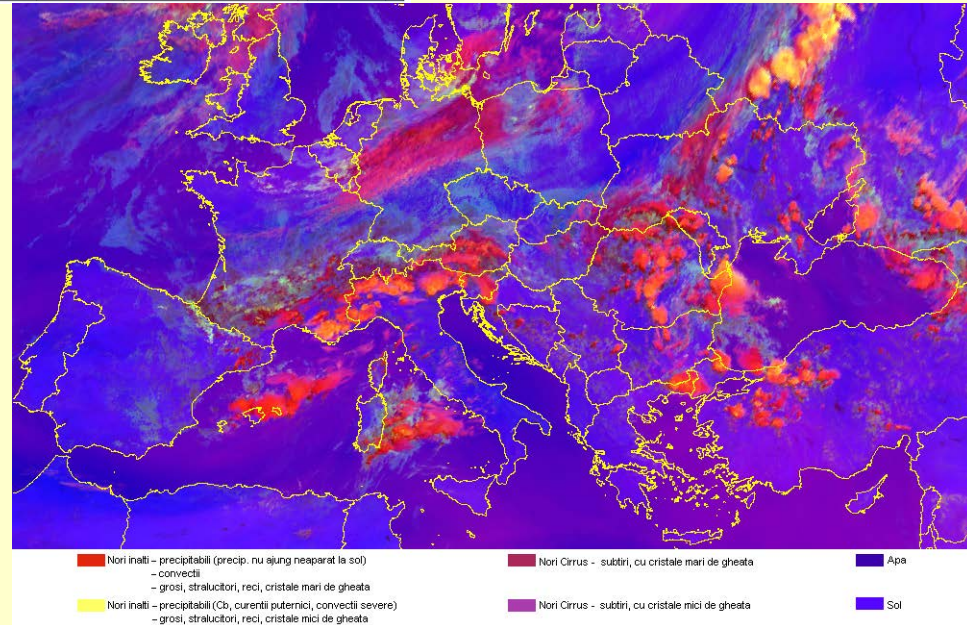
16 – 17 June 2015 Severe Atmospheric Instability



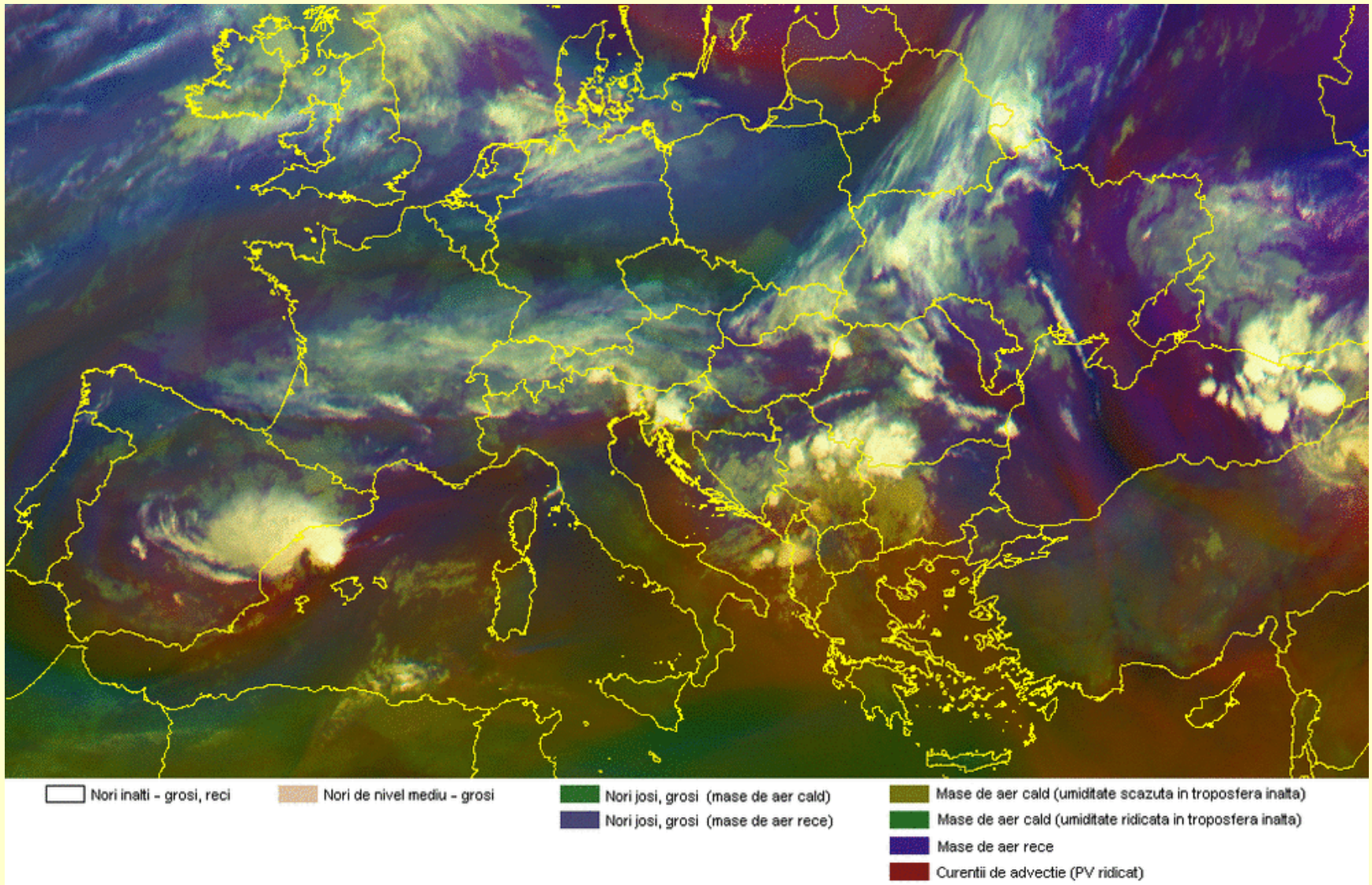
**MSG HRV 16.06.2015
12:00 UTC**



**Convection MSG RGB
16.06.2015
12:00 UTC**



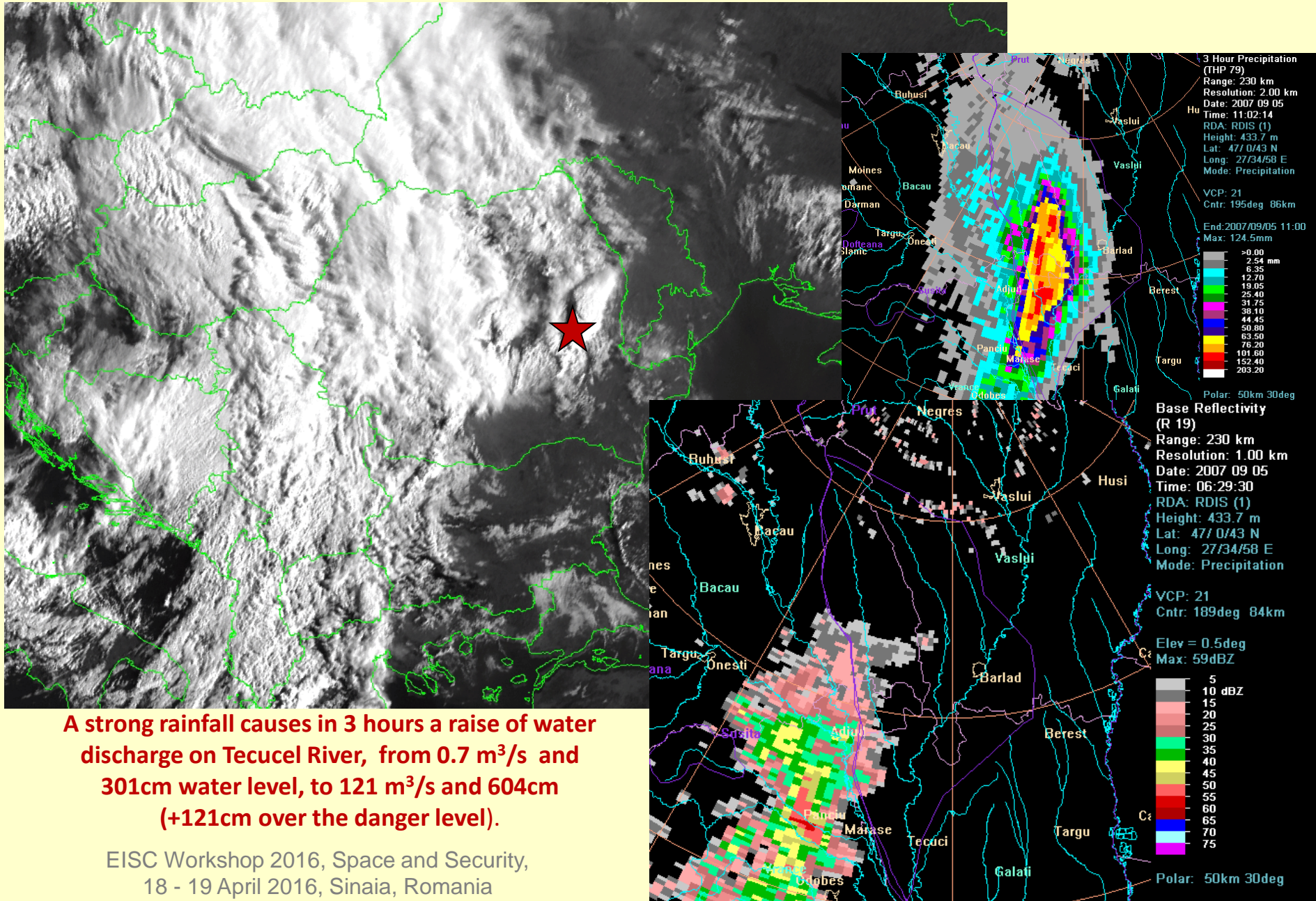
16 – 17 June 2015 Severe Atmospheric Instability



Airmass MSG RGB animation (16 .06.2015, 24 h) provide the location and intensity of the initial convection and a proper monitoring of the storm development and trajectory.

EISC Workshop 2016, Space and Security, 18 - 19 April 2016, Sinaia, Romania

05.09.2007 - Flash flood on Tecucel River

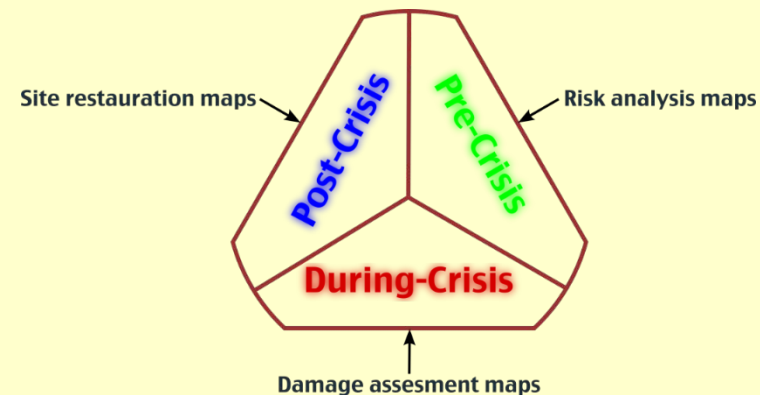


Satellite based flood mapping service

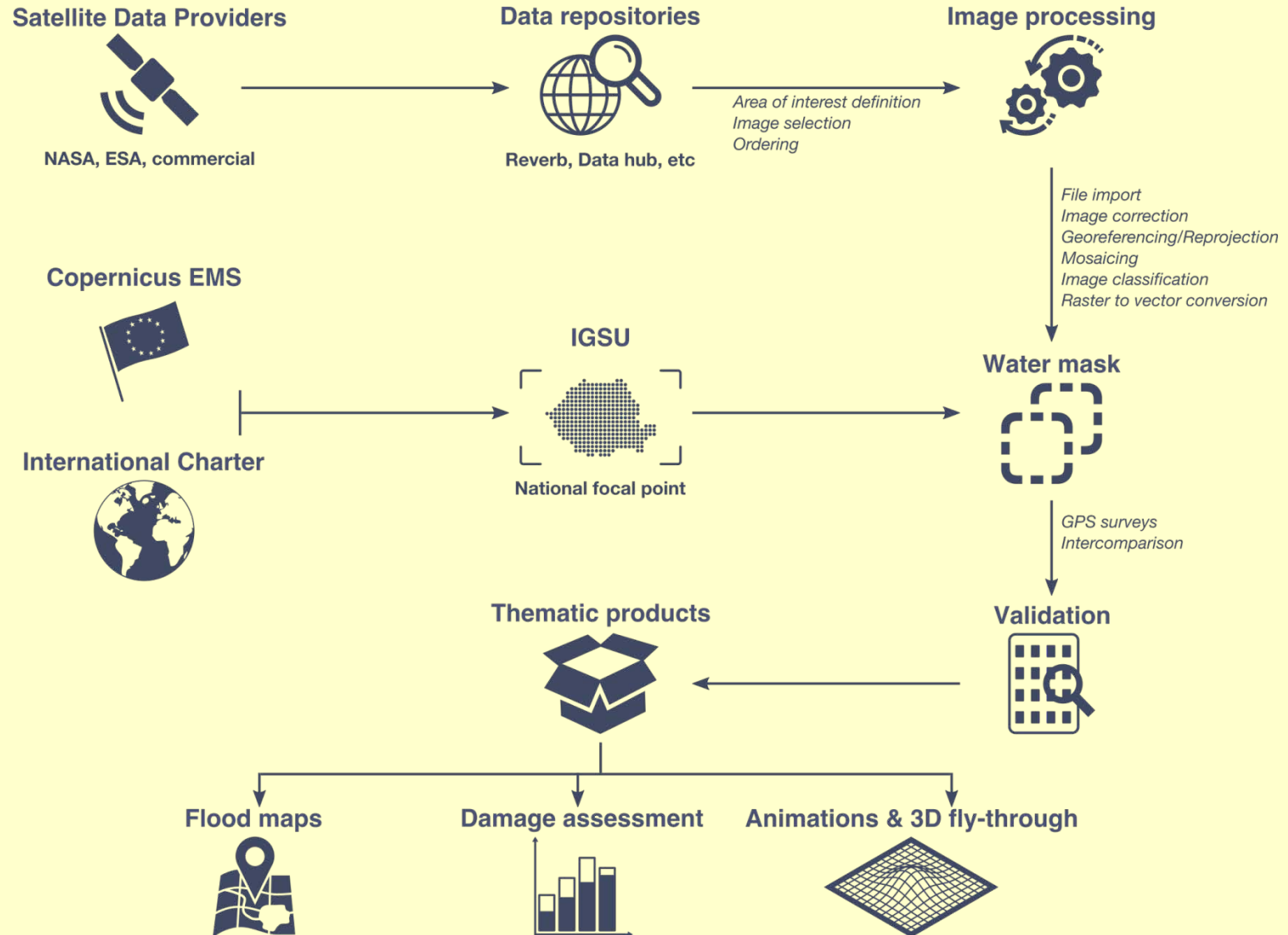
Romania is a flood hotspot in Europe, which experienced significant human and economic losses in the last decade. Since 2000, Romania has been affected by 55 natural disasters from which 34 were floods (62%), according to the International Disaster Database.

The satellite based flood mapping service was designed and developed by an consortium made up of relevant governmental institutions and companies in the framework of several research projects, following the principles of the Copernicus down stream services and the end-users requirements.

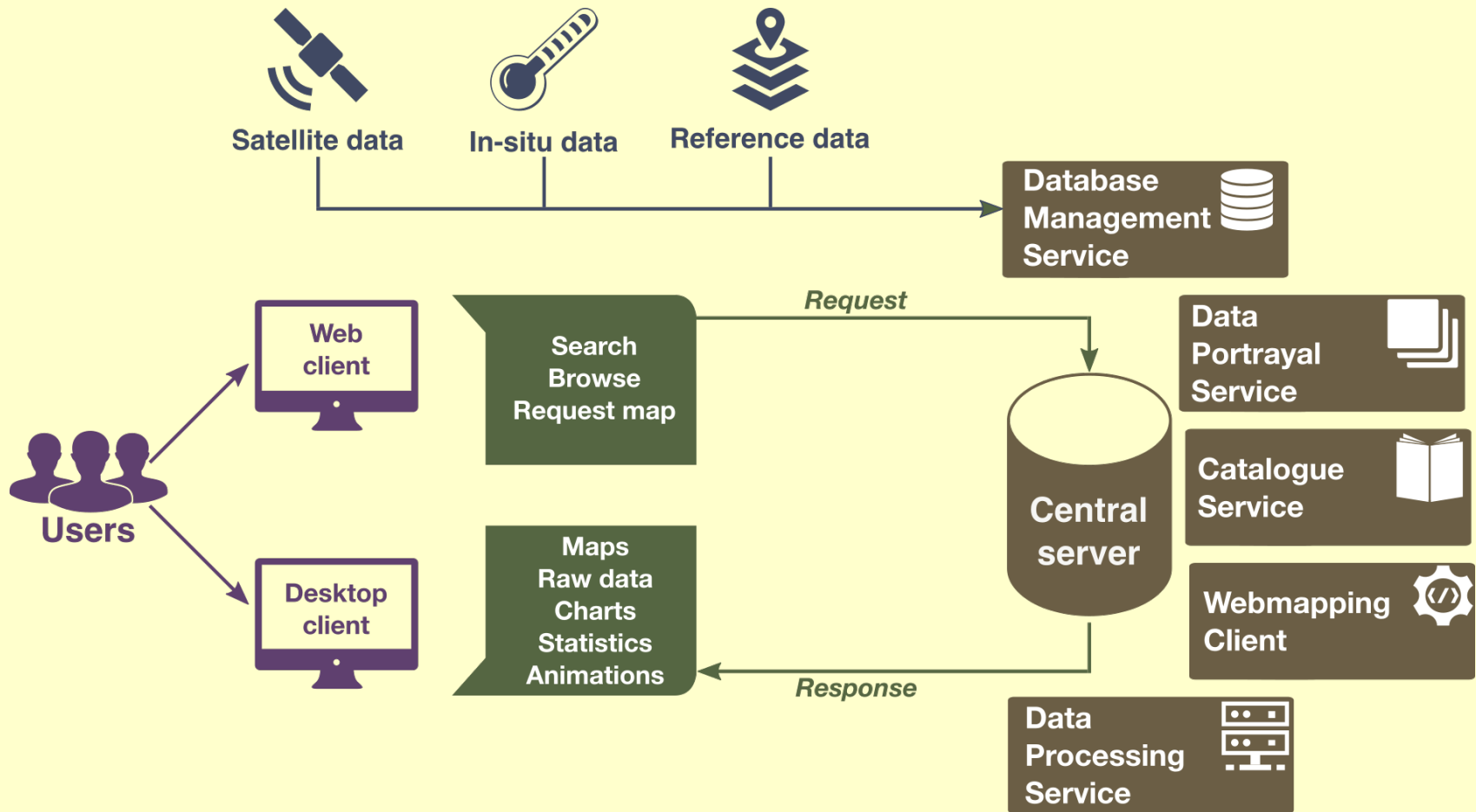
The main aim of the national downstream service for emergency response is to reinforce the Romanian capacity to flood related disaster management, based on geoinformation, covering all the phases of a disaster cycle: **prevention, preparedness, response and recovery**. The emphasis is put on value-added, validated products and services for each phase of the disaster management. The products are generated using adapted and improved processing algorithms.



Satellite data processing chain

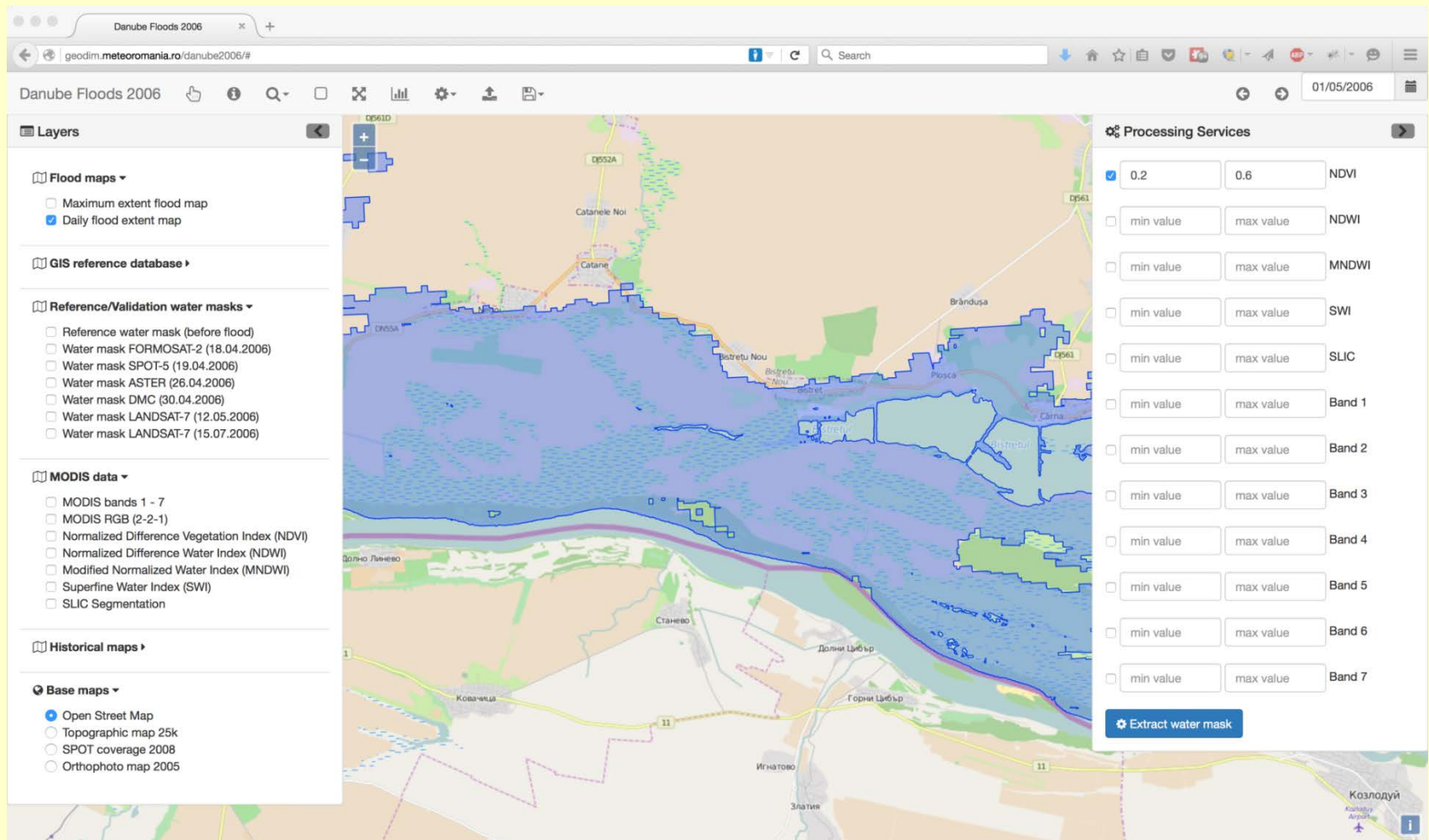


System architecture



A dedicated geoportal is based on free and open source software, following a distributed architecture, offering an efficient access to geospatial flood-related products

Products dissemination geoportal



Depending on the privileges, the end-users are able to access the system using a simple web browser to: view and query the flood related product archive; download the selected products; validate the products.

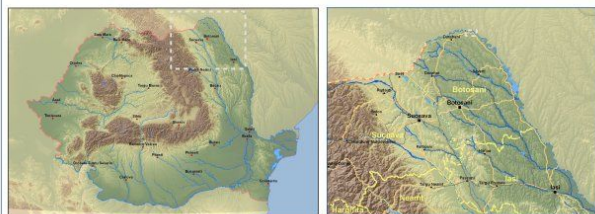
Flood mapping products

Romania. Flooded areas near Radauti-Prut village. 29.07.2008 09:40 UTC

Charter Call ID- 212
Product no. RO-05



LOCATION



LEGEND

- Flooded areas
- European and national roads
- County roads
- Railroads



0 0.2 0.4 0.8 1.2 1.6 Km

INTERPRETATION

Following the historical discharge measured in July 2008 on Prut river several villages, located upstream Stanca Costesti dam, were flooded. The most severe damages was reported in Radauti-Prut village.

The flooded areas were extracted from the TerraSAR-X image, acquired on 28.07.2008 (3 meters cell size).

The background image (orthophotomage, Copyright National Agency for Cadastre and Land Registration – spatial resolution 0.5 meters) presents the situation in 2005.

Projection: Stereographic 1970 (EPSG: 31700).

ATTENTION: The accuracy of the flood delineation is closely related to spatial resolution of input data. Some small affected areas may not be represented.

CONTACT

The product was elaborated by the National Meteorological Administration (Remote Sensing and GIS Laboratory) and the Romanian Space Agency for the International Charter "Space and Major Disasters" call 212, in the framework of PNCD SIGUR Project.

For more details you can contact us by using one of the following addresses:

web: cracunesco@meteo.nmth.ro, ion.redicu@rosa.ro

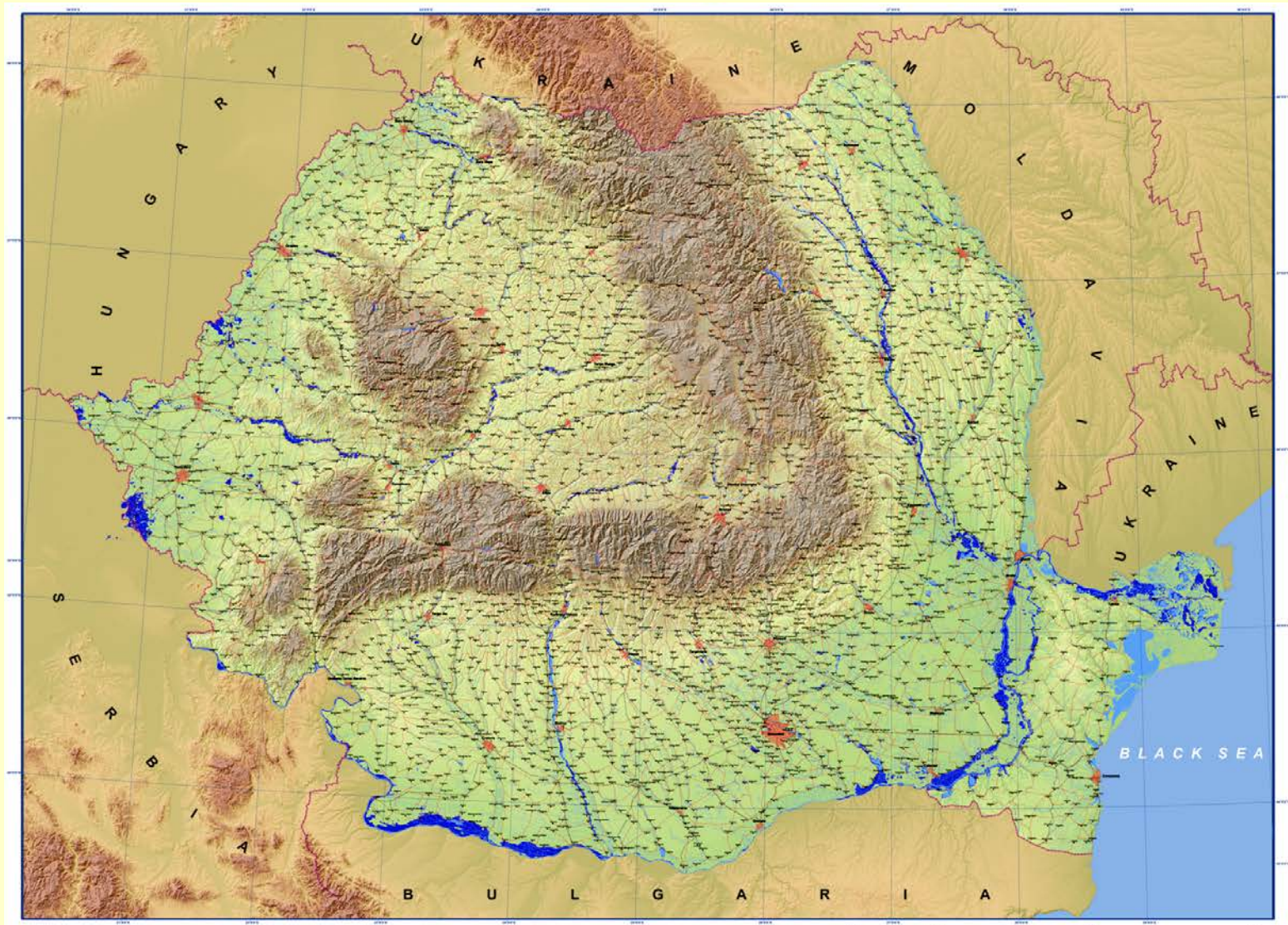


Project PNCD12 SIGUR
Satellite Based Emergency Response
Services.
<http://sigur.rosa.ro>

Since 2000, **286 flood extension cartographic products** have been elaborated

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Romania flood hazard map (2000 – 2015)



Since 2000, around 300 satellite based flood cartographic products have been elaborated

Conclusions

- Stronger or more frequent and intense weather extremes will likely occur under climate change, such as thunderstorms, tornadoes, heat waves, snowstorms, floods, and other violent and potentially lethal meteorological events.
- Improved weather prediction, therefore, will be vital to giving communities more time to prepare for dangerous storms, saving lives and minimizing damage to infrastructure.
- Monitoring meteorological extreme events and the nowcasting activity, today heavily relies on the availability of the geostationary and polar-orbiting satellites data and products, in near real time.
- The disruption of capabilities that satellites assets, due to space vulnerabilities and threats would dramatically affect the extreme meteorological events forecast and monitoring, with major economic and geostrategic consequences.