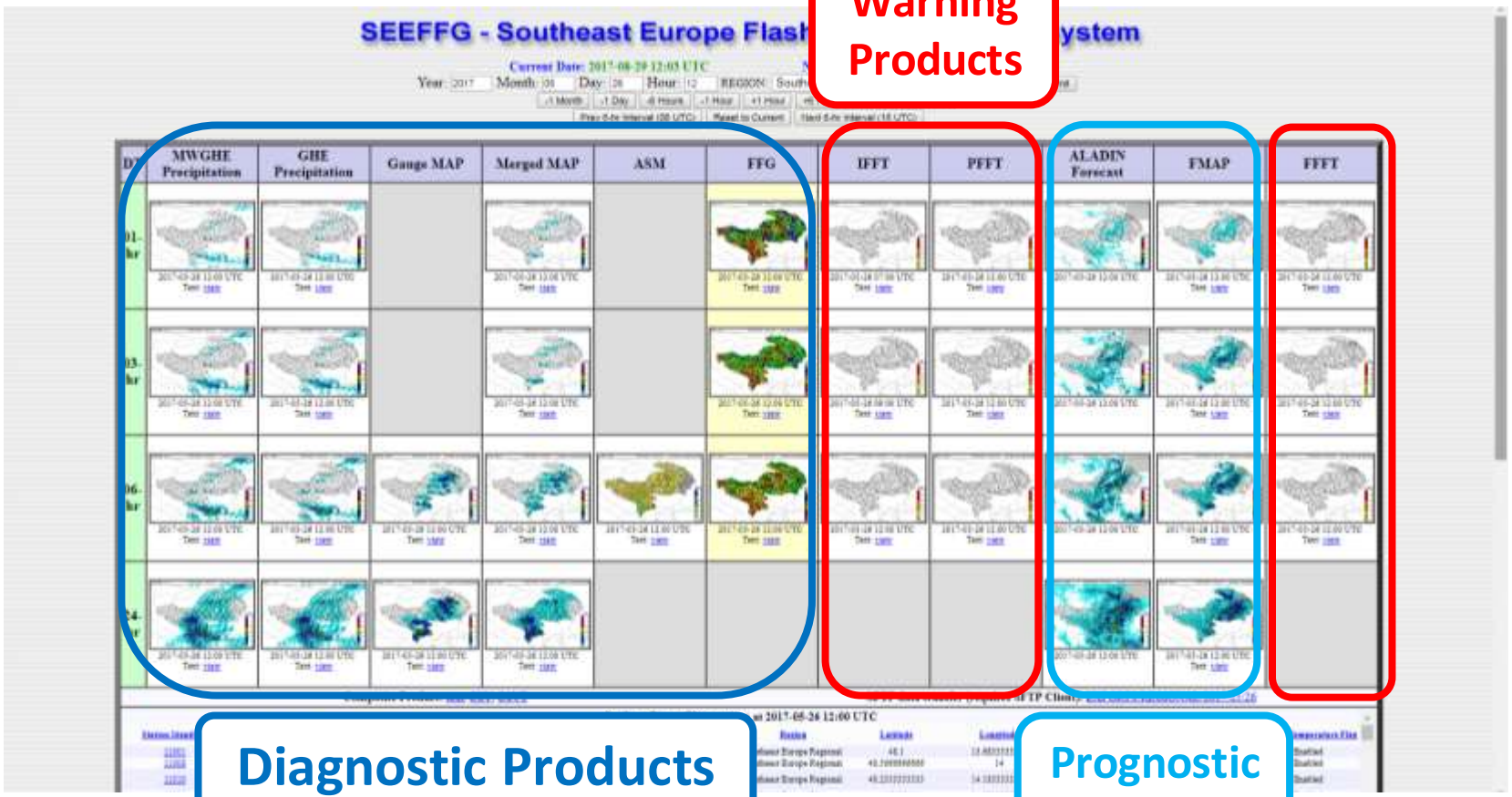
WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

# Overview of the SEEFFGS Products:

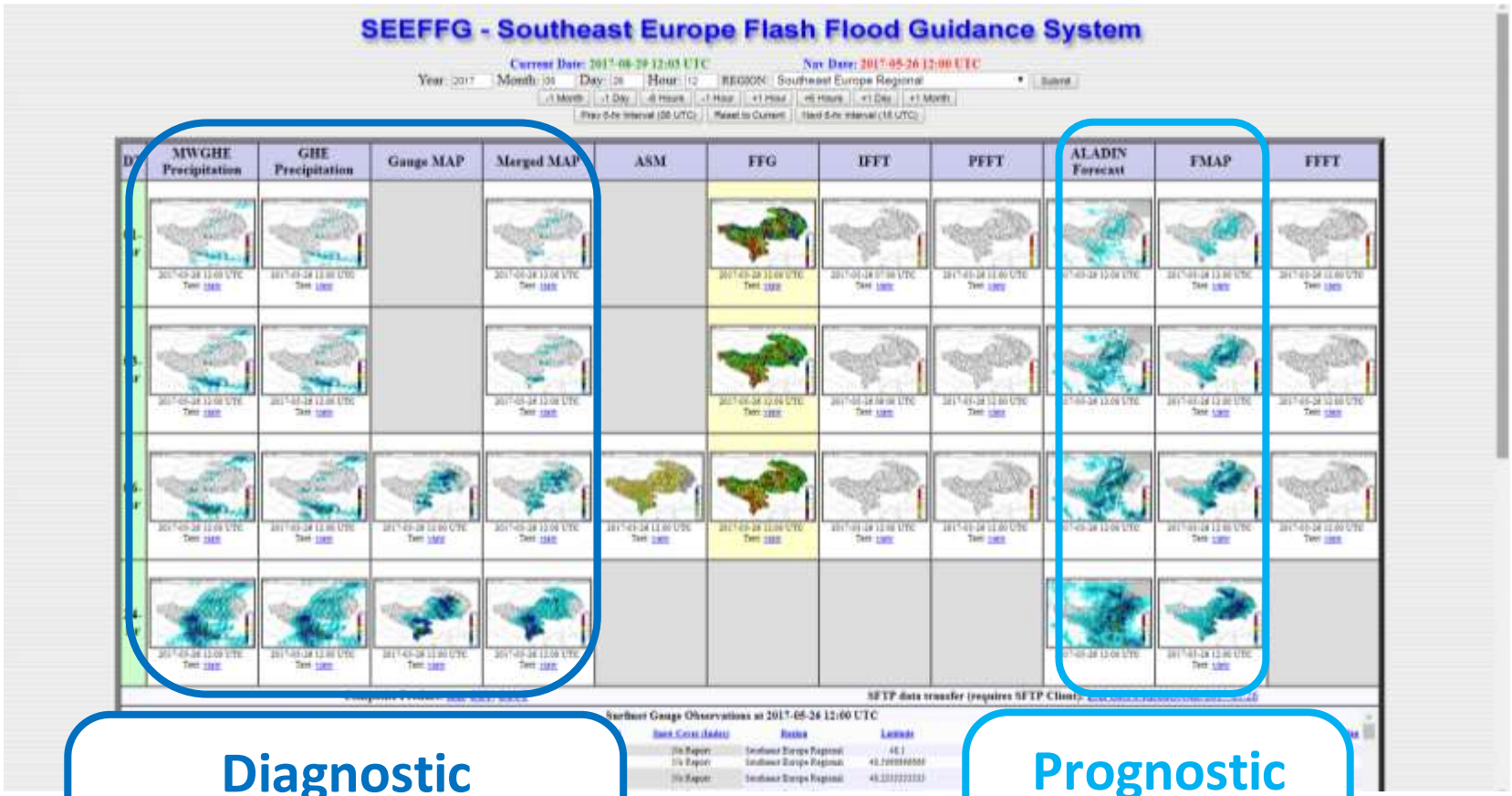
# Precipitation

WMO OMM
World Meteorological Organization
Organisation météorologique mondiale

# SEEFFGS Forecaster (Product) Console



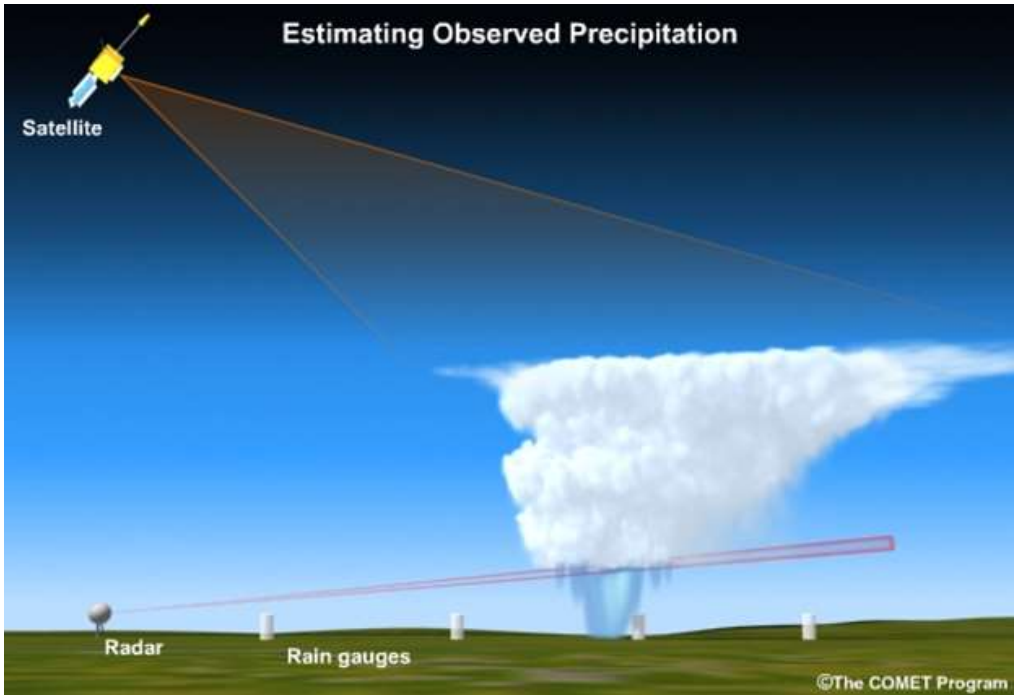
# SEEFFGS Precipitation Products




**Diagnostic Precipitation Products**

**Prognostic Precipitation Products**

# Satellite Precipitation Estimates

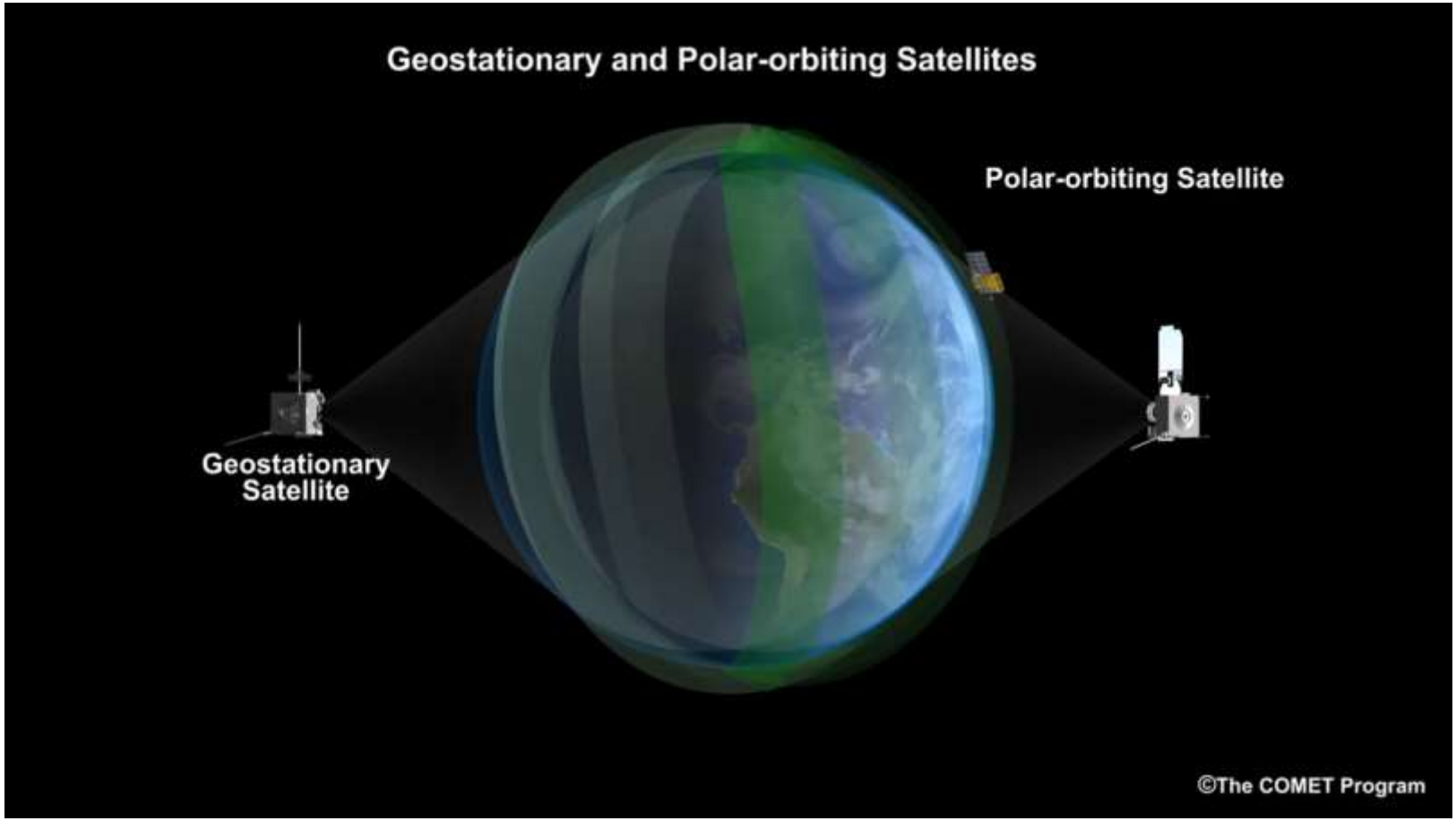



Conceptualized image of three main precipitation estimation technologies: a satellite, radar and a network of ground-based rain gauges

- The big advantage of the meteorological satellites is that they are **covering the entire globe**, which is very important in regions with sparse coverage by traditional gauge or radar networks.
- The relatively **high spatial and temporal resolution** is critical since heavy rain often covers a relatively small area and can change very quickly.

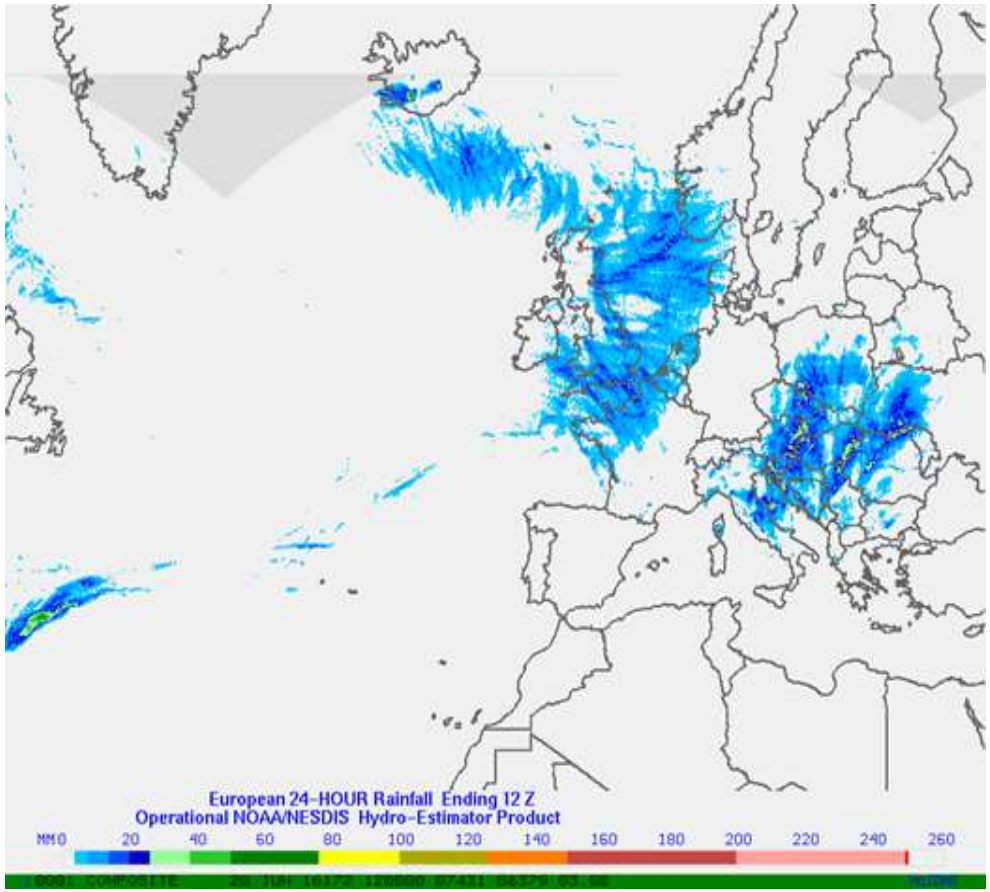
- In addition, because of short latency, data can be made available to the forecasters in less than half an hour. These are all reasons why satellite rainfall estimates form is an important part of the FFGS.

# Satellite Precipitation Estimates




The most successful space-based precipitation products are based on combinations of IR and MW observations.

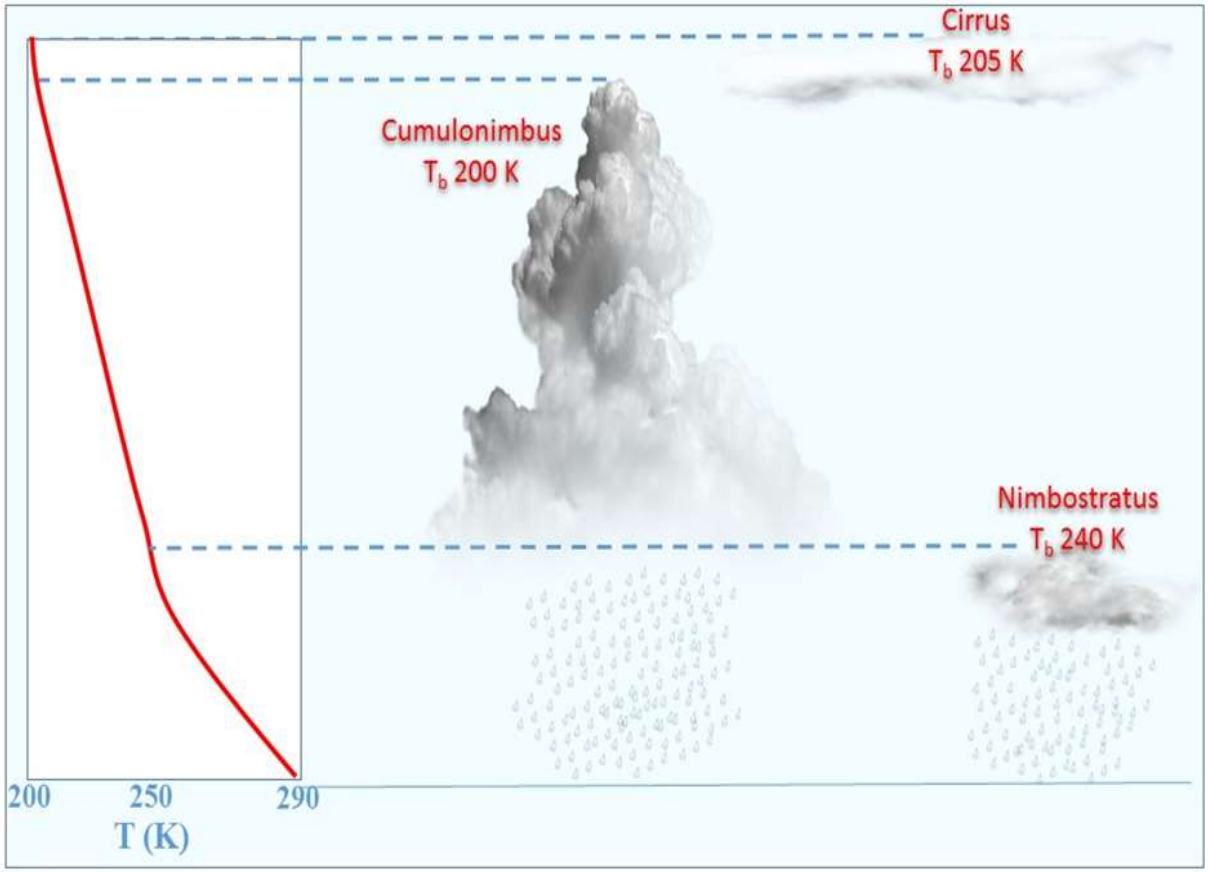
# GHE (GLOBAL HYDRO ESTIMATOR) SATELLITE-BASED PRECIPITATION ESTIMATES




NOAA/NESDIS 24-hour rain accumulations 20th of June 2016

- The GHE is satellite based NOAA NESDIS (National Environmental Satellite, Data, and Information Service) precipitation product.
- Provides hourly accumulations (mm) of precipitation with latency of up to 20 min and with resolution of 4 km by 4 km at the equator.
- The Hydro-Estimator has been operational precipitation algorithm since 2002 to produce precipitation estimates for the entire globe using five different geostationary satellites.

# GHE (GLOBAL HYDRO ESTIMATOR) SATELLITE-BASED PRECIPITATION ESTIMATES




**Infrared signal and rain rate relationship**

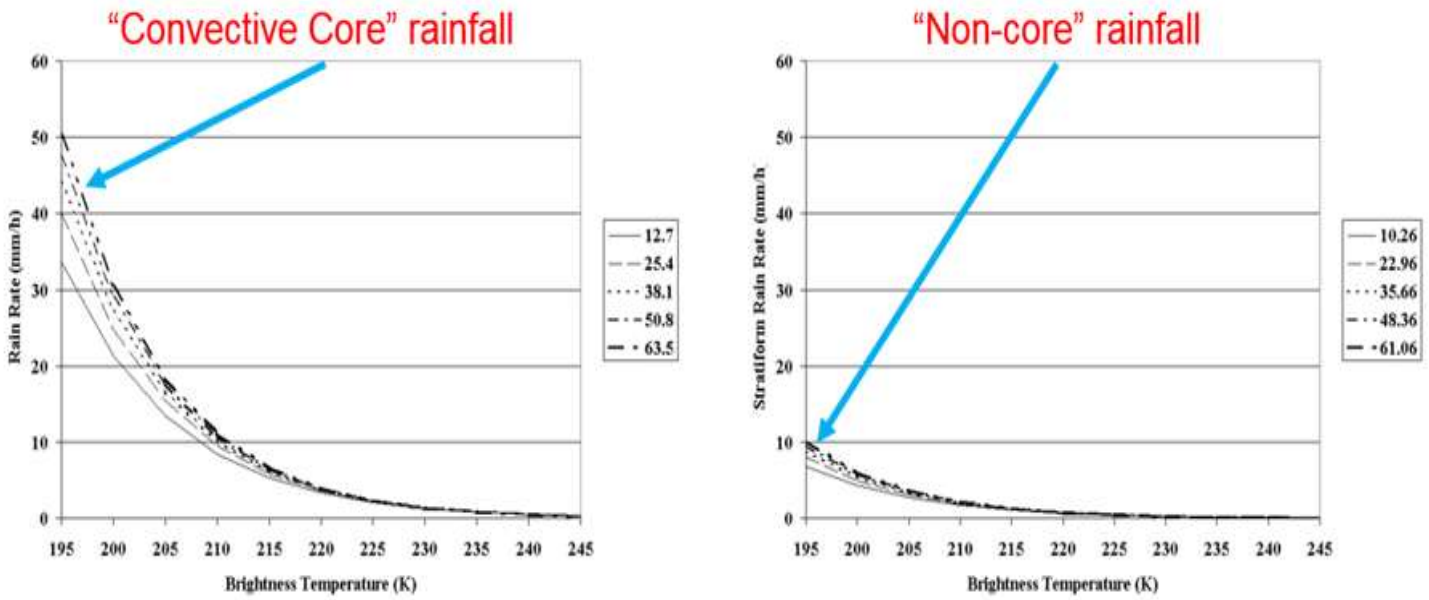
**IR based (10.7 µm)**

Rain Rate = Function of brightness temperature

Enhanced for:

1. Atmospheric moisture effects
2. 2. Orography (upslope/downslope
3. Convective Eqlb. Level (warm-top convection)
4. 4. Local pixel T difference with surroundings
5. Convective core/no-core region

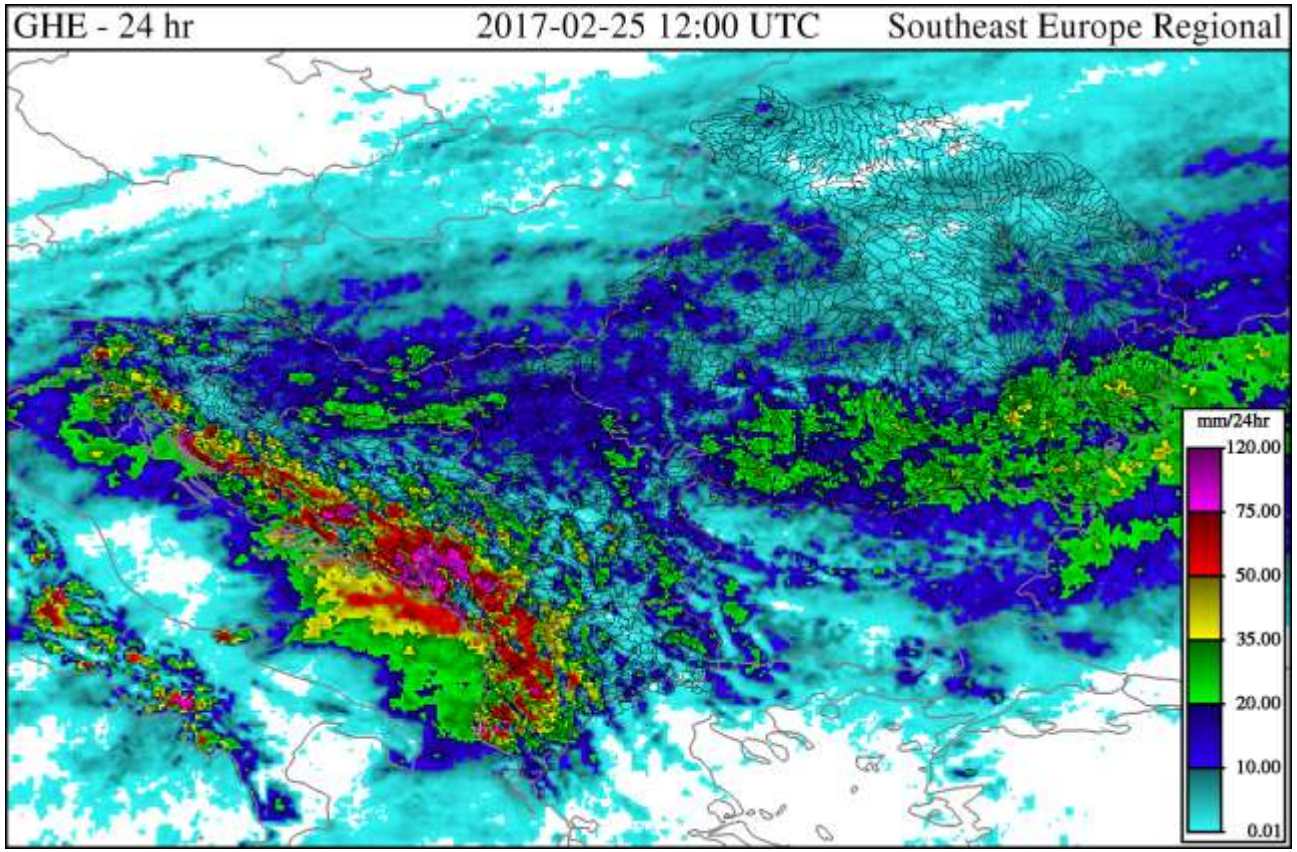
# GHE (GLOBAL HYDRO ESTIMATOR) SATELLITE-BASED PRECIPITATION ESTIMATES




**Relationship between rain rates, brightness temperature and convective (non-)core rainfall**

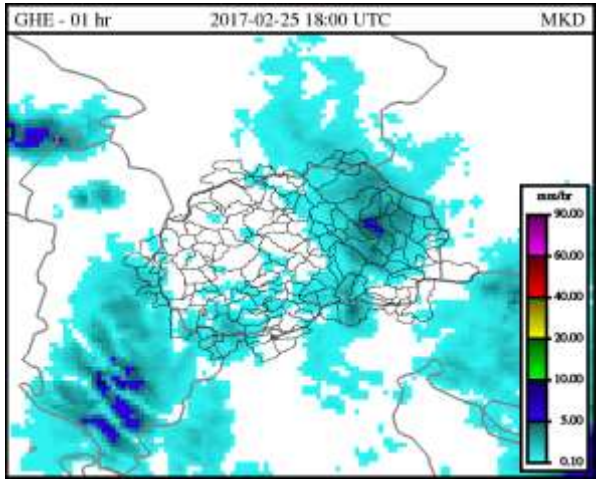
- The GHE also uses relative temperature to determine the rain rate.
- It assumes that the pixels that are closest to coldest pixels are at the centre of the convective core and have the highest rain rates, whereas pixels farther away will have a lower rain rate for a given brightness temperature.

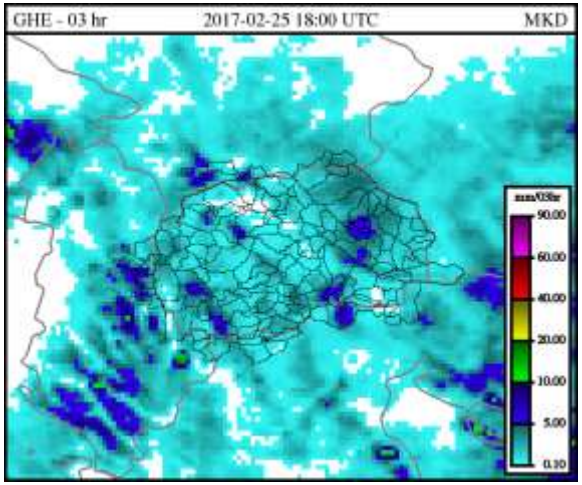
# GHE (GLOBAL HYDRO ESTIMATOR) SATELLITE-BASED PRECIPITATION ESTIMATES

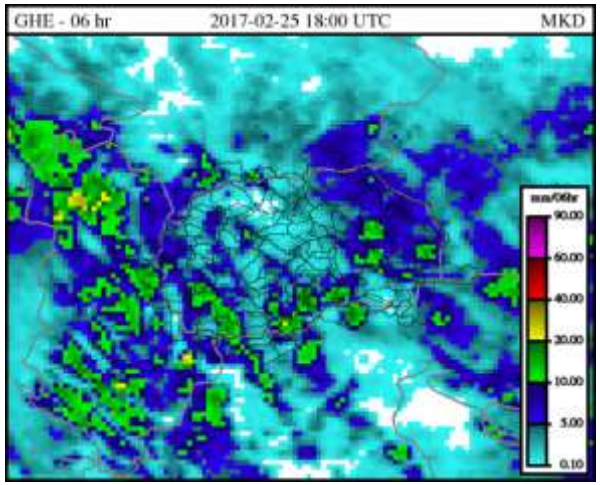


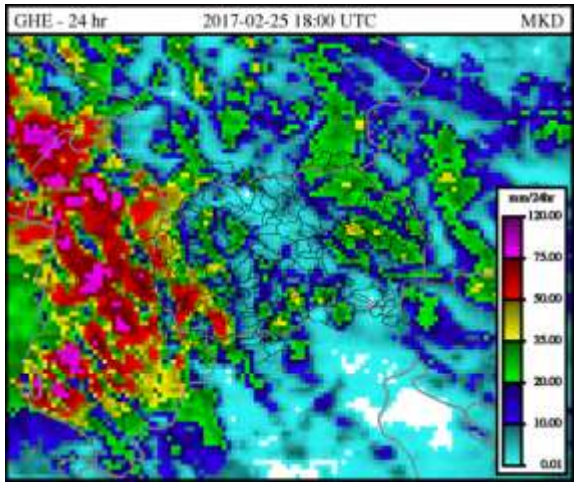

- The NOAA/NESDIS provides a 1-hr precipitation accumulation that is then used in the SEEFFGS to determine 1-hr, 3-hr, 6-hr and 24-hr accumulations of satellite-based rainfall estimates (mm) ending on the current hour from the HE.

# GHE (GLOBAL HYDRO ESTIMATOR) SATELLITE-BASED PRECIPITATION ESTIMATES



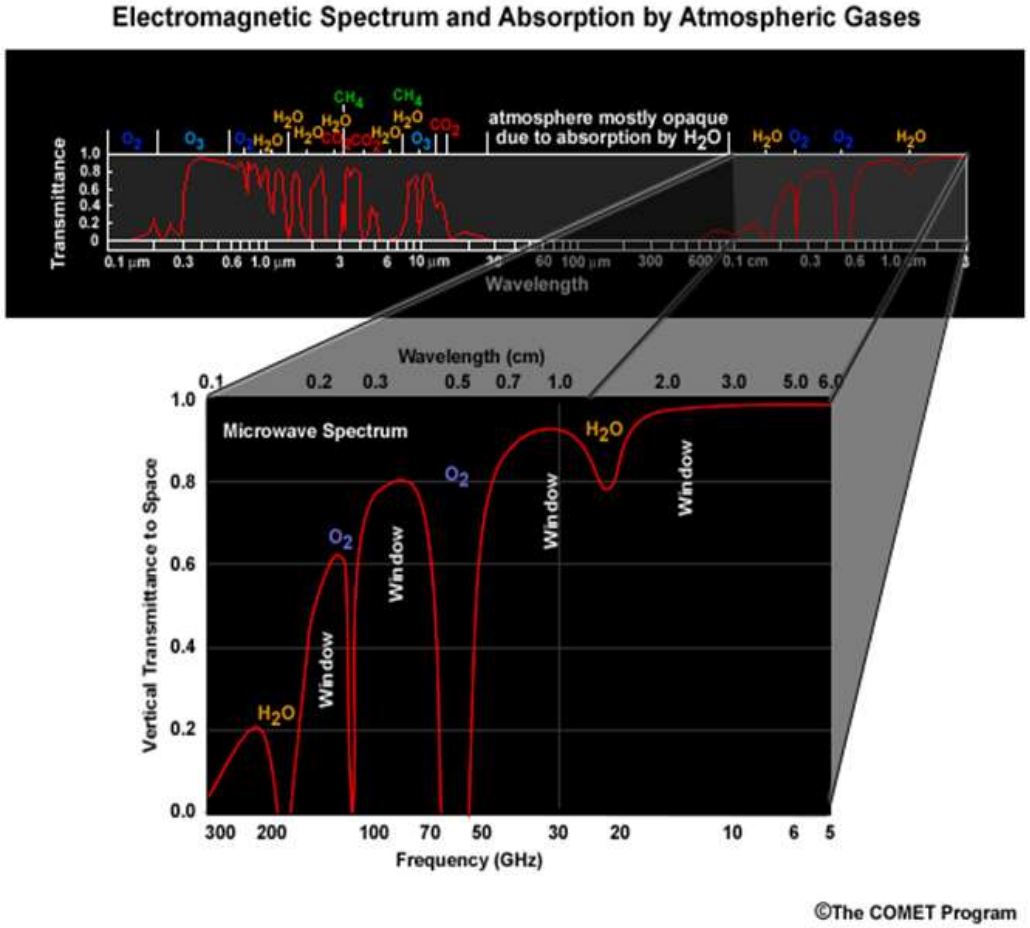



# Microwave adjusted Global Hydro Estimator (MWGHE)

- MW satellite sensors like Advanced Microwave Sounding Unit (AMSU) have fundamentally changed how we discern cloud properties and measure precipitation from satellites because they directly detect precipitation particles in and below clouds - an advantage over IR-techniques.

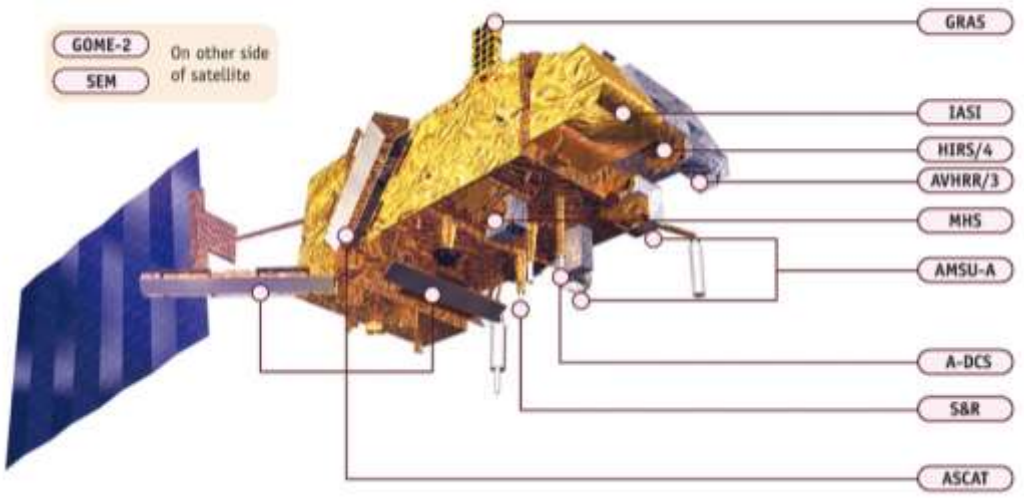



The microwave portion of the EM spectrum and its relative location on the EM spectrum

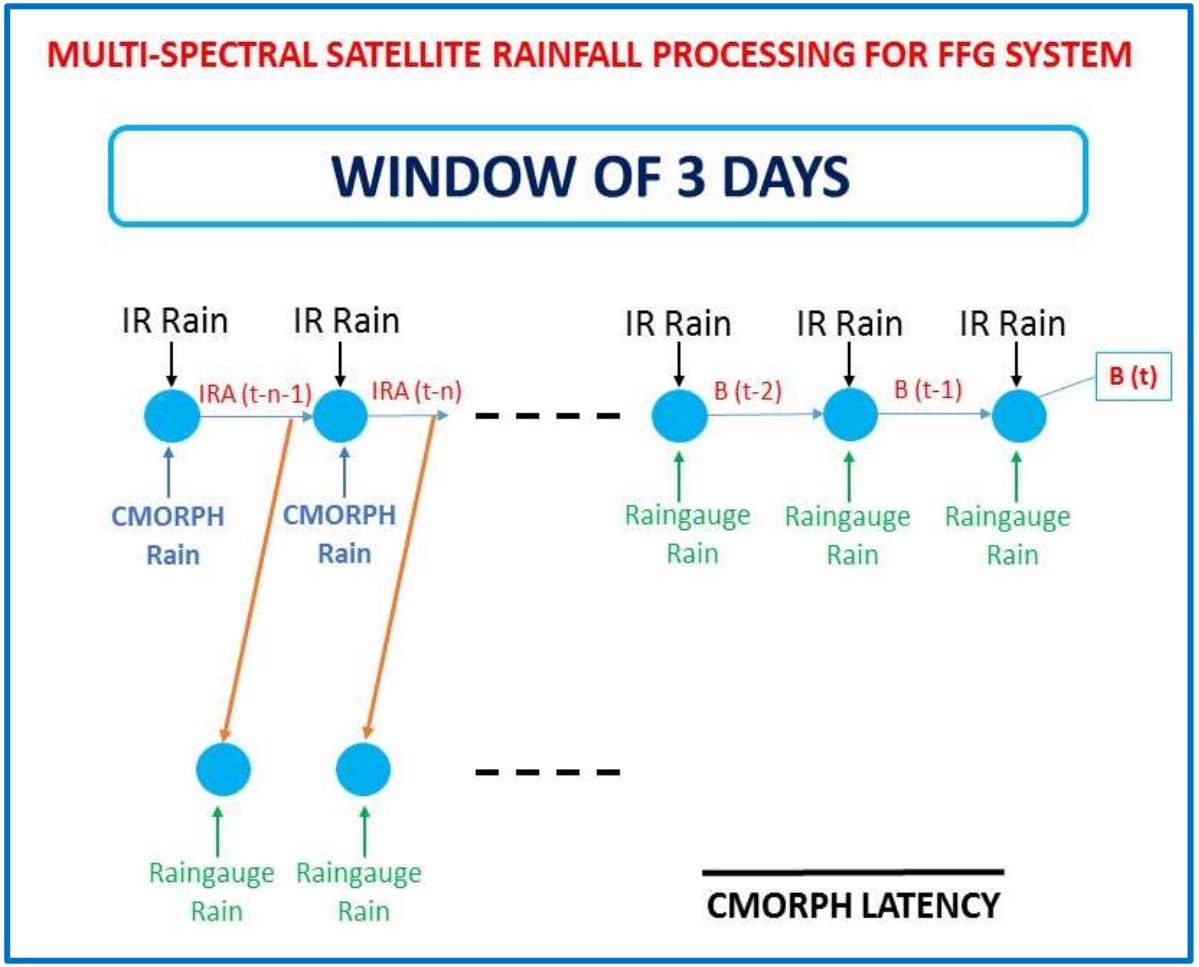
# Microwave adjusted Global Hydro Estimator (MWGHE)

- The AMSU passive MW instrument has been flying on the NOAA and European Metop polar-orbiting satellite series as part of a cooperative agreement between NOAA and EUMETSAT.

- Different channels of MW instrument measure either the scattering of high-frequency radiation by hydrometeors or the absorption of low frequency radiation by raindrops.



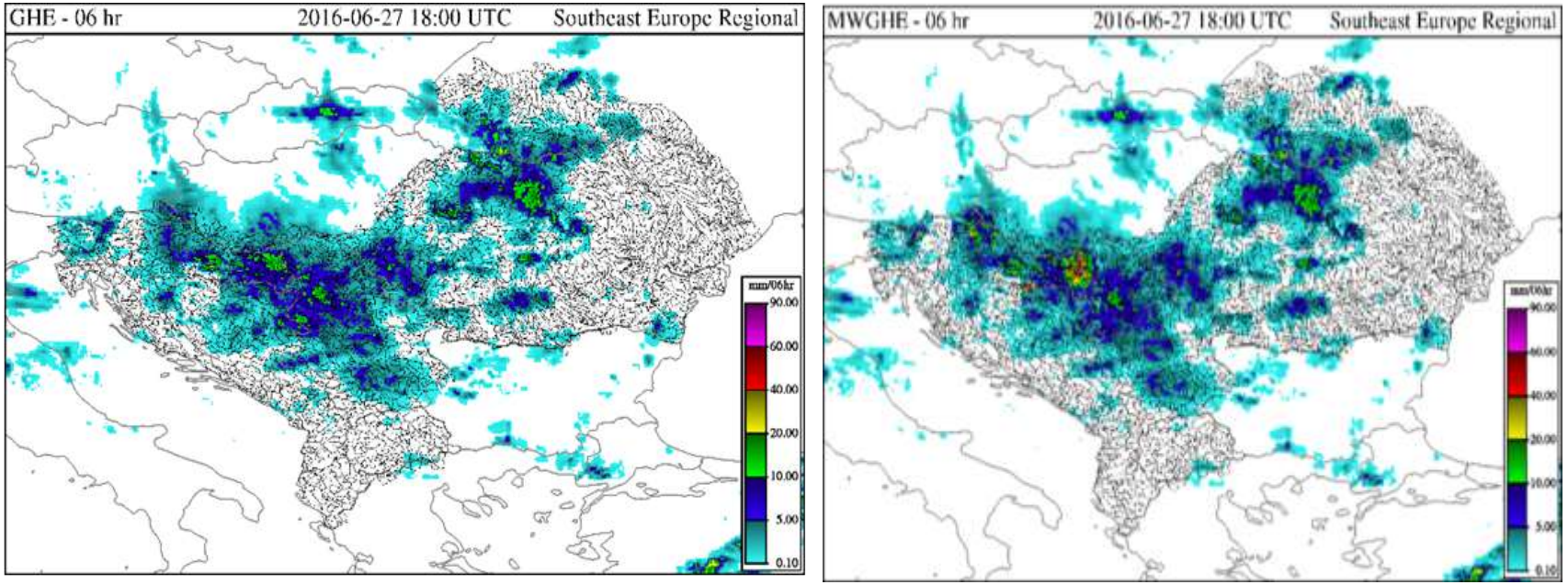
# Microwave adjusted Global Hydro Estimator (MWGHE)




- The CMORPH, short for the Climate Prediction Center (CPC) morphing method, does not use IR precipitation estimates, rather it uses IR-based cloud top temperature to derive propagation vectors for cloud tops to interpolate the MW-based precipitation estimates and to produce half hourly 8 km resolution precipitation estimates.

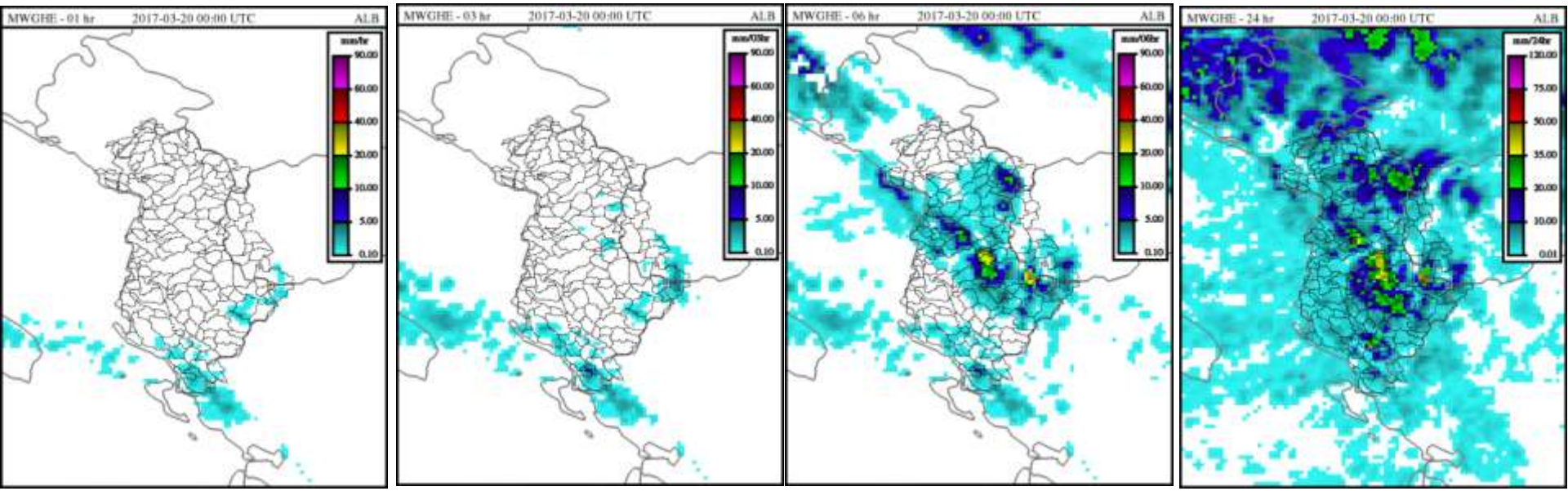
# Microwave adjusted Global Hydro Estimator (MWGHE)

The images and text provide gridded 1-hour, 3-hour, 6-hour and 24-hour accumulations of satellite-based rainfall estimates (mm) ending on the current hour from the NOAA-NESDIS GHE (IR-based) and adjusted by the NOAA-CPC CMORPH MW-based satellite rainfall product.




**SEEFFG GHE precipitation accumulations without (GHE) and with (MWGHE) CMORPH adjustment**

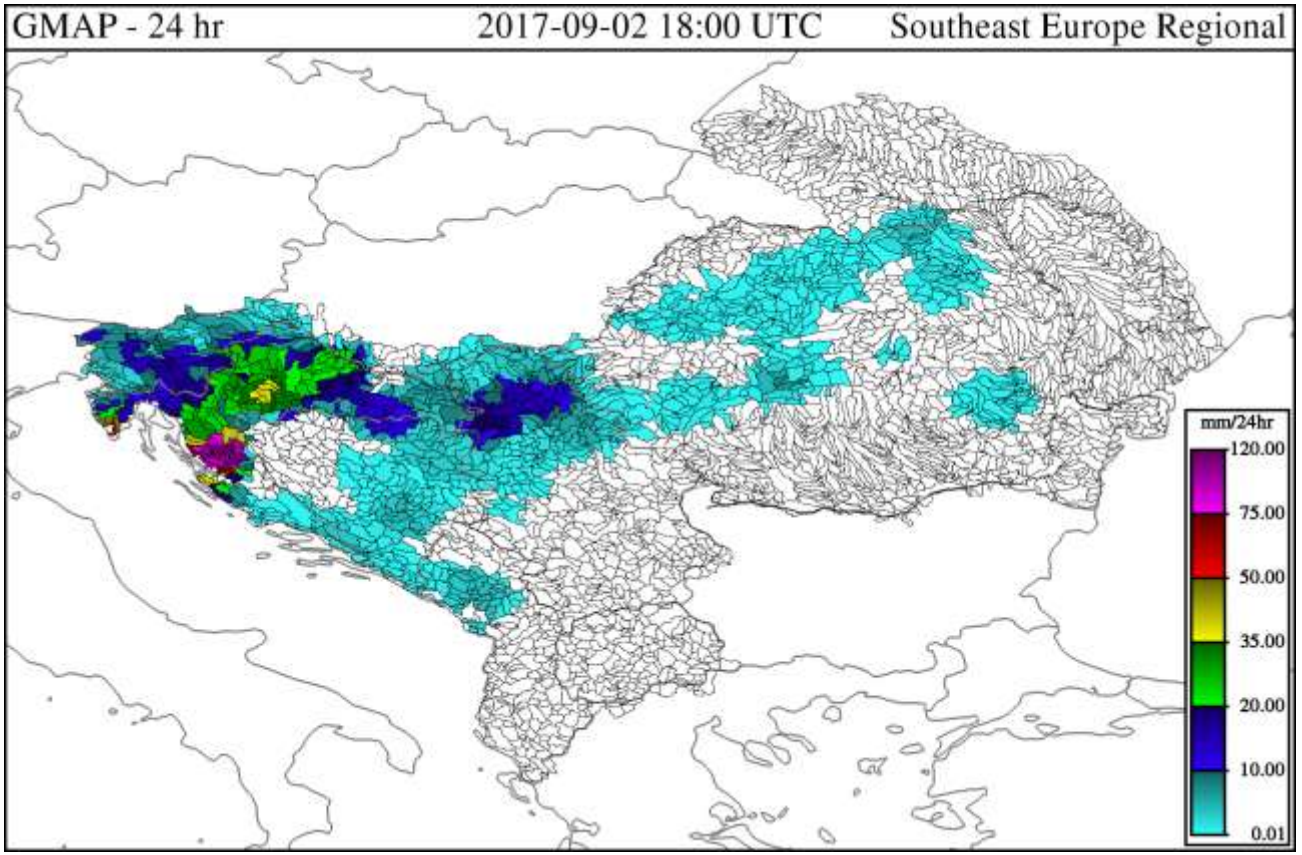
# Microwave adjusted Global Hydro Estimator (MWGHE)




1-hr, 3-hr, 6-hr, and 24-hr MWGHE precipitation estimates for Albania on 20 March 2017 at 00 UTC

# Gauge Mean Areal Precipitation (GMAP)

- Gauge MAP is generated by using synoptic observations that are disseminated through the WMO Global Telecommunication System (GTS).



# Gauge Mean Areal Precipitation (GMAP)

**Composite Product:** text, CSV, CSVT

| | | | | | | |
|---|---|---|---|---|---|---|
| 14235 | Puntijarka | 2.00 | 10.70 | No Report | No Report | Croatia |
| [illegible] | Zagreb / Gric | 0.30 | 18.00 | No Report | No Report | Croatia |
| 14240 | Zagreb / Maksimir | 0.40 | 17.85 | No Report | No Report | Croatia |
| [illegible] | Zagreb / Pleso | 0.80 | 17.35 | No Report | No Report | Croatia |
| 14244 | Sisak | 4.00 | 16.40 | No Report | No Report | Croatia |
| 14246 | Varazdin | 6.00 | 16.45 | No Report | No Report | Croatia |
| 14248 | Krizevci | 1.00 | 17.15 | No Report | No Report | Croatia |
| 14253 | Bjelovar | 20.00 | 15.55 | No Report | No Report | Croatia |
| 14256 | [illegible] | 0.00 | 16.75 | No Report | No Report | Croatia |
| 14258 | | | | | No Report | Croatia |
| 14280 | | | | | No Report | Croatia |

| | |
|---|---|
| **Station Identifier** | 14240 |
| **Station Name** | Zagreb / Maksimir |
| **Region** | Croatia |
| **Latitude** | 45.8166666666 |
| **Longitude** | 16.0333333333 |
| **Elevation (m)** | 123 |
| **Agency** | Croatia |
| **Type** | FM-12 |
| **Precipitation Enabled Flag** | Enabled |
| **Temperature Enabled Flag** | Enabled |

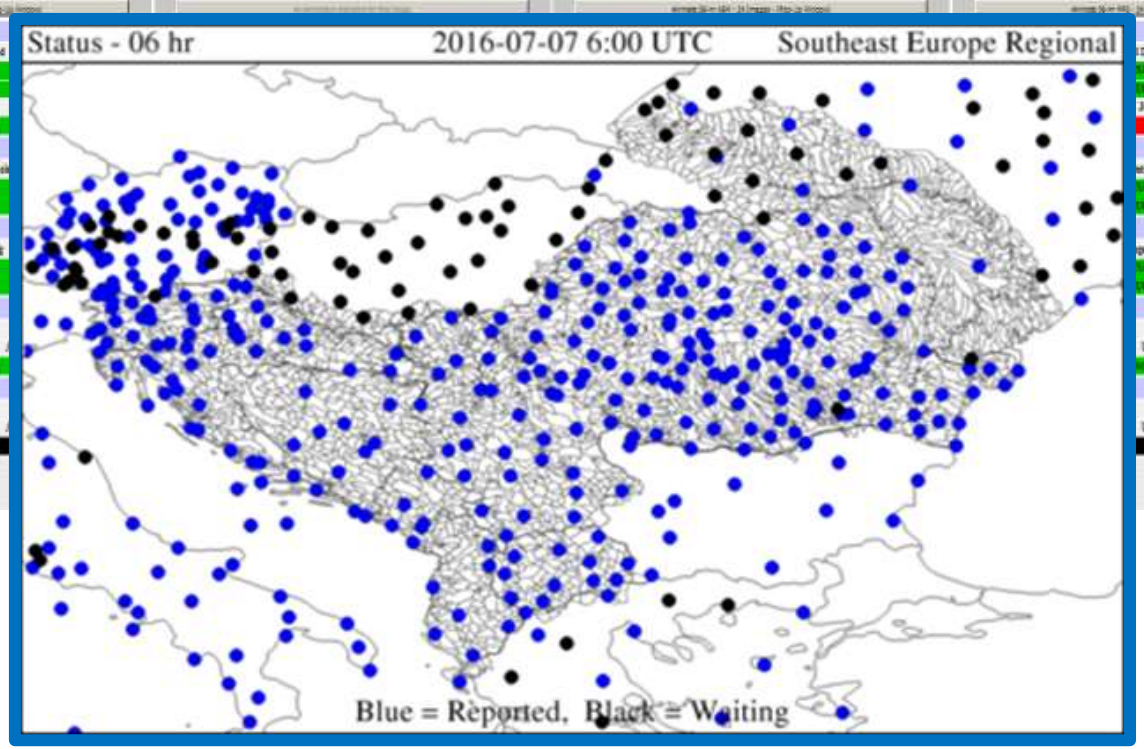
**Reported Surfmet Gauge Observations from Station '14240' within the past 30 days**

| Station Identifier | Observation Date & Time | Precipitation (mm/06hr) | Temperature (C) | Snow Depth (cm) | Snow Cover (Index) |
|---|---|---|---|---|---|
| 14240 | 2017-05-15 12:00:00+00 | 0.40 | 17.85 | No Data | No Data |
| 14240 | 2017-05-15 06:00:00+00 | 8.00 | 15.20 | No Data | No Data |
| 14240 | 2017-05-15 00:00:00+00 | 0.00 | 17.10 | No Data | No Data |
| 14240 | 2017-05-14 18:00:00+00 | 0.20 | 20.75 | No Data | No Data |
| 14240 | 2017-05-14 12:00:00+00 | 0.70 | 21.50 | No Data | No Data |

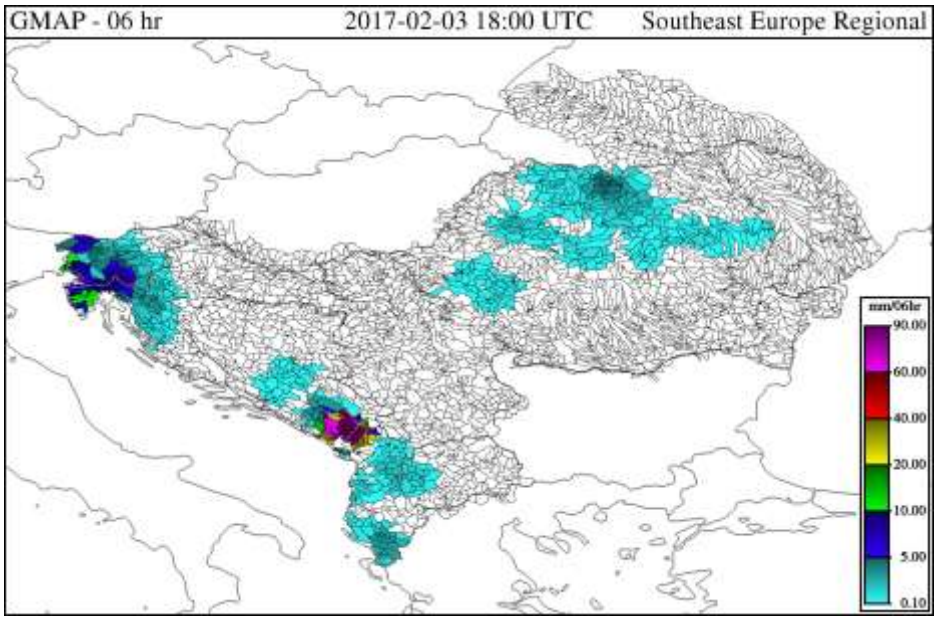
Example gauge station metadata and measured timeseries

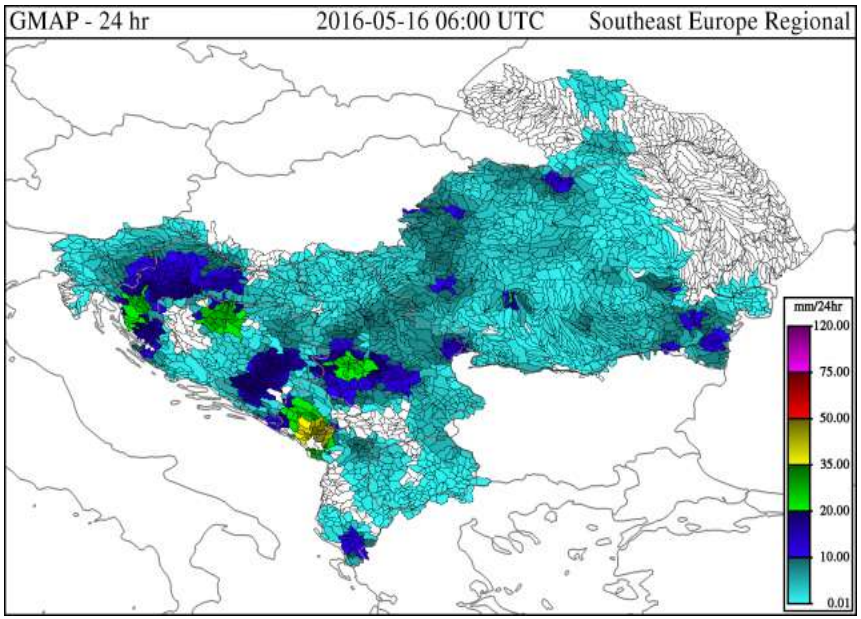
# Gauge Mean Areal Precipitation (GMAP)

**Meteorological Stations Data Reception**



# Gauge Mean Areal Precipitation (GMAP)



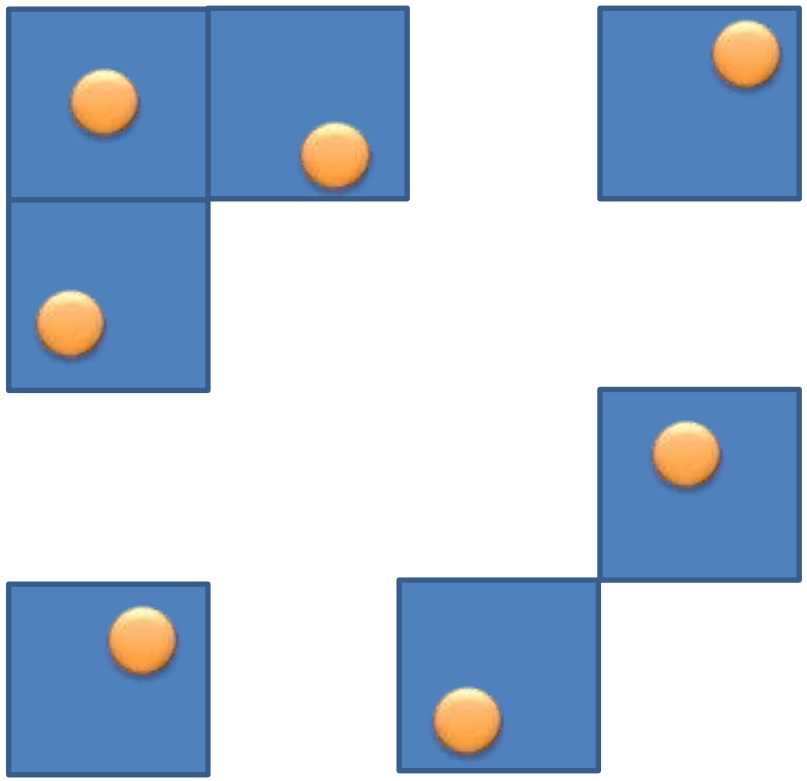




- Gauge MAP is used for the bias adjustments of MWGHE and GHE precipitation products.

# Bias Adjustments

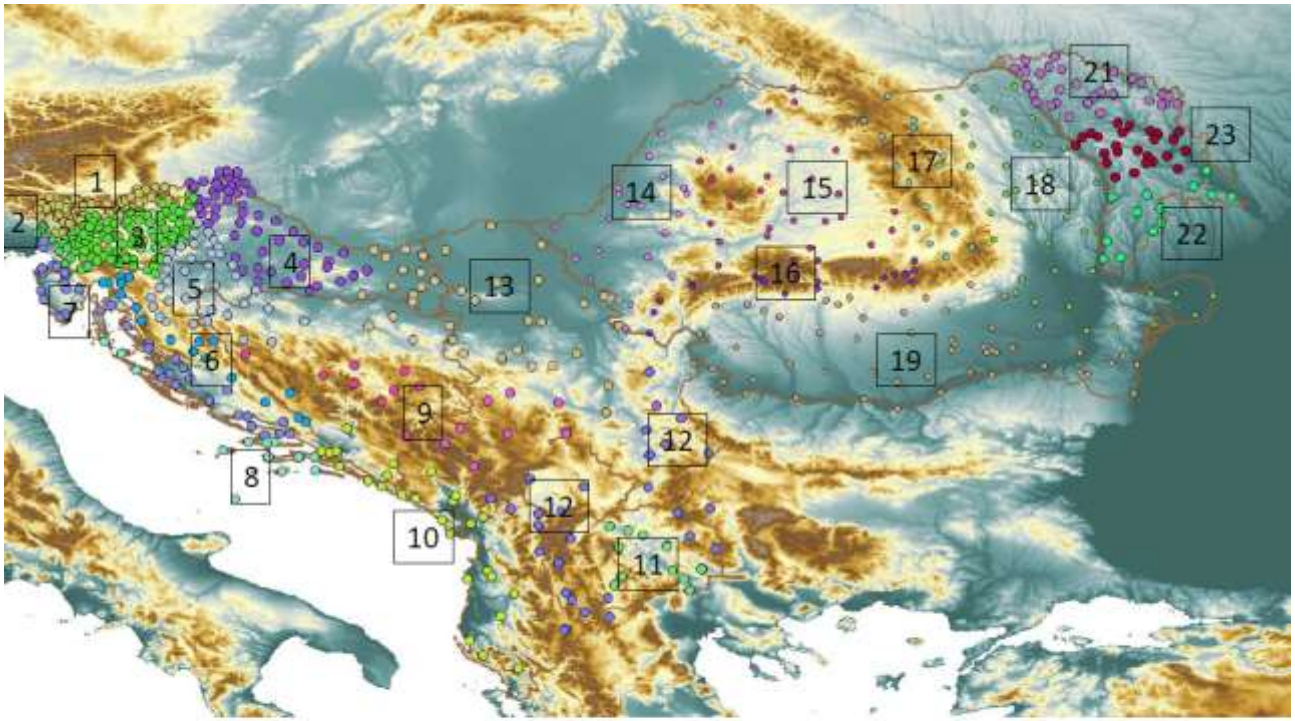
- The FFGS under consideration allows climatological bias corrections and real-time bias corrections to remotely sensed data.
- Both corrections are based on the estimation of regional bias factor (B) computed from rain gauge rainfall reports and corresponding satellite rainfall grids:

$$B = \frac{\sum_{i=1}^{N_G} R_{G_i}}{\sum_{j=1}^{N_G} R_{S_j}}$$



Example of raingauge-satellite pairs

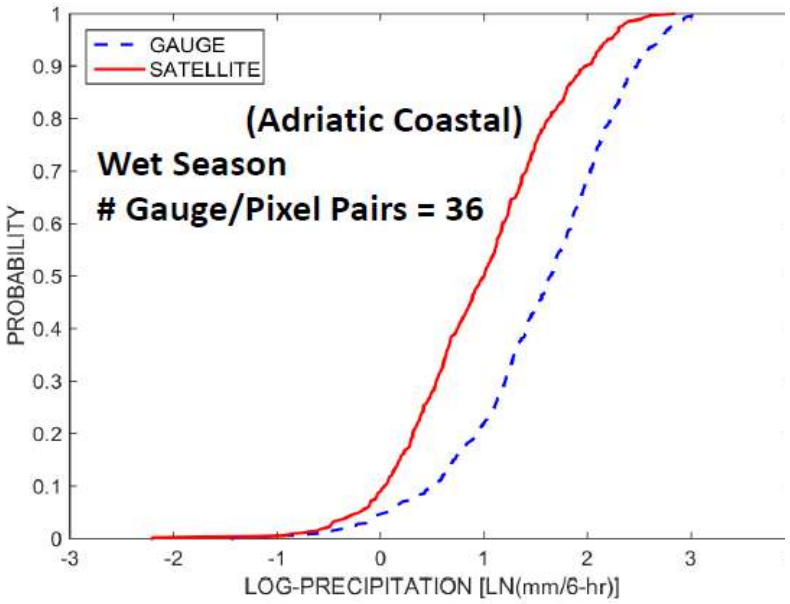
# Bias Adjustments

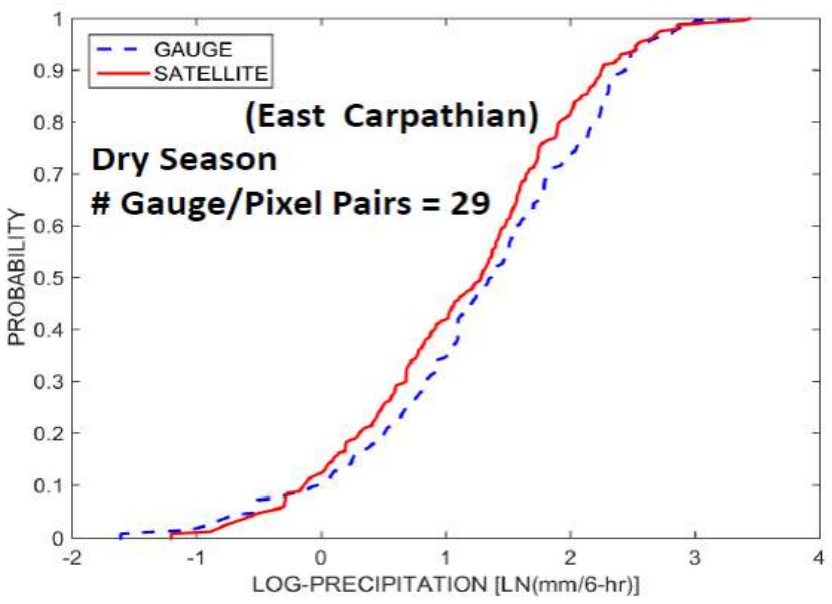



1: Slovenia, north
2: Slovenia, low
3: Slovenia, pre-alpine, central
4: Slovenia & Croatia, low land
5: Croatia & Bosnia-H., inland
6: Croatia, coastal mtn
7: Croatia & Slovenia, coastal
8: Croatia, coastal islands
9: Bosnia-H. & Serbia, contin.
10: BiH, Monte, Alb - coastal
11: Macedonia, low elev
12: Albania, Macedonia, mtns
13: Croatia-Serbia, low elev
14-19: Romania
21-23: Moldova

**SEEFFG Sub-regions of similar precipitation, climate and topography**

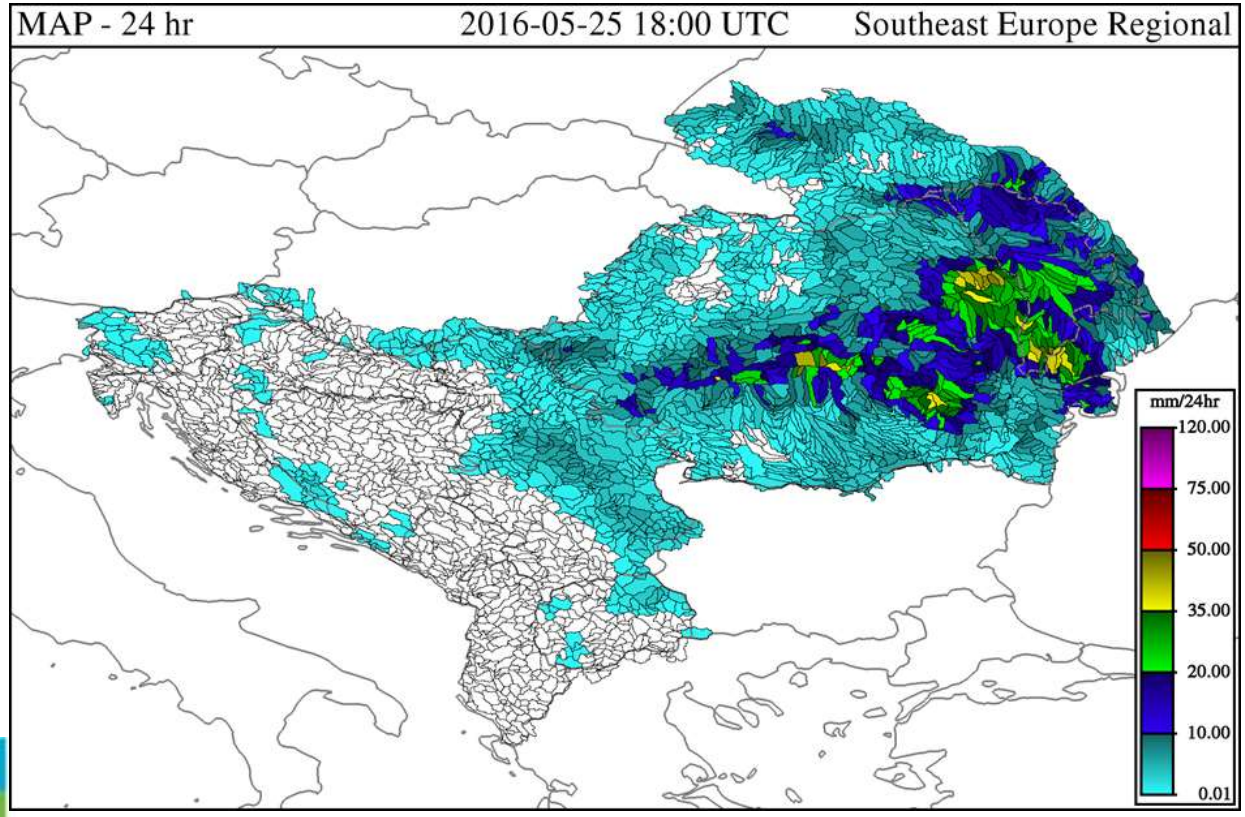
# Bias Adjustments



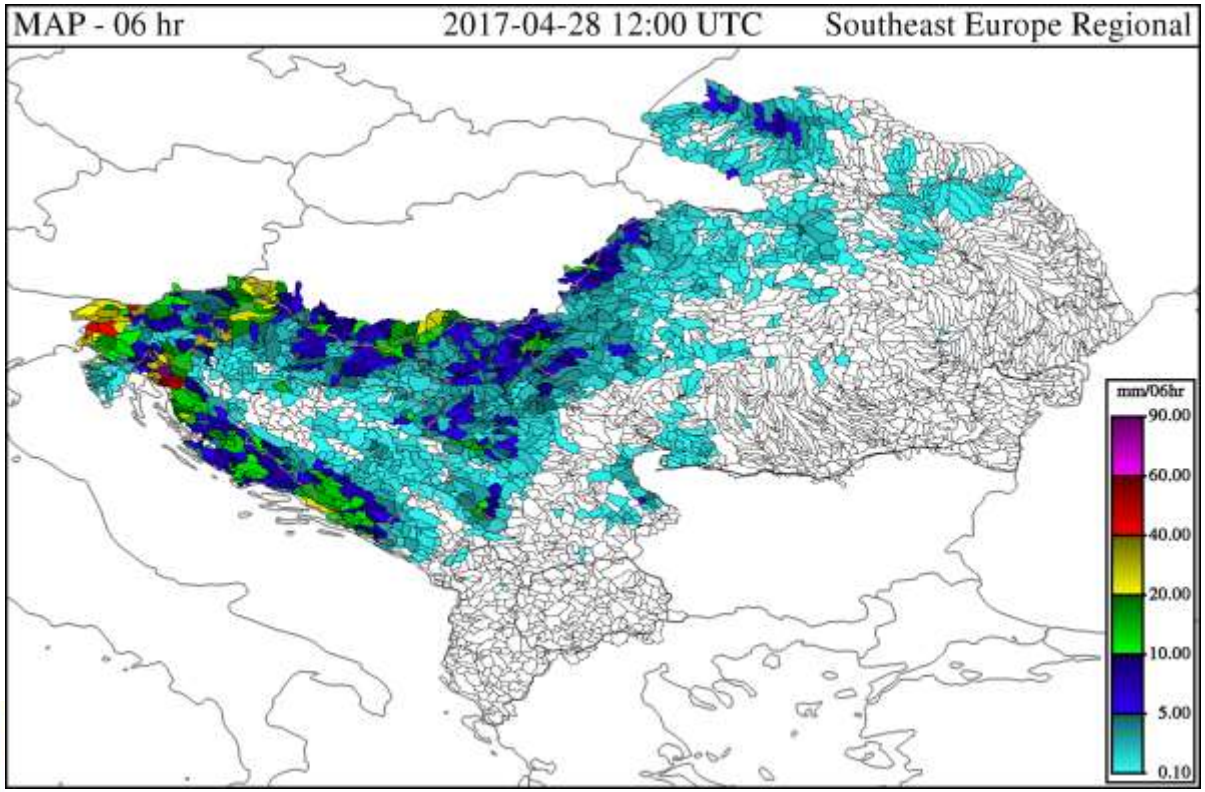

- Climatological precipitation bias adjustment should be reviewed and updated on regular basis (every 2-3 years).
- Updates could include additional stations (i.e., not in real-time archive) with consistent resolution.

# Merged Mean Areal Precipitation (Merged MAP)




- Merged MAP in SEEFFGS provides bias-corrected, best estimates of 1, 3, 6 and 24-hr precipitation accumulations over each of FFGS basins.
- Derived by selecting the best-available 01-hr precipitation input product for each basin from the bias-adjusted MWGHE or bias-adjusted GHE or the gauge-interpolations, with preference for selection in that order.

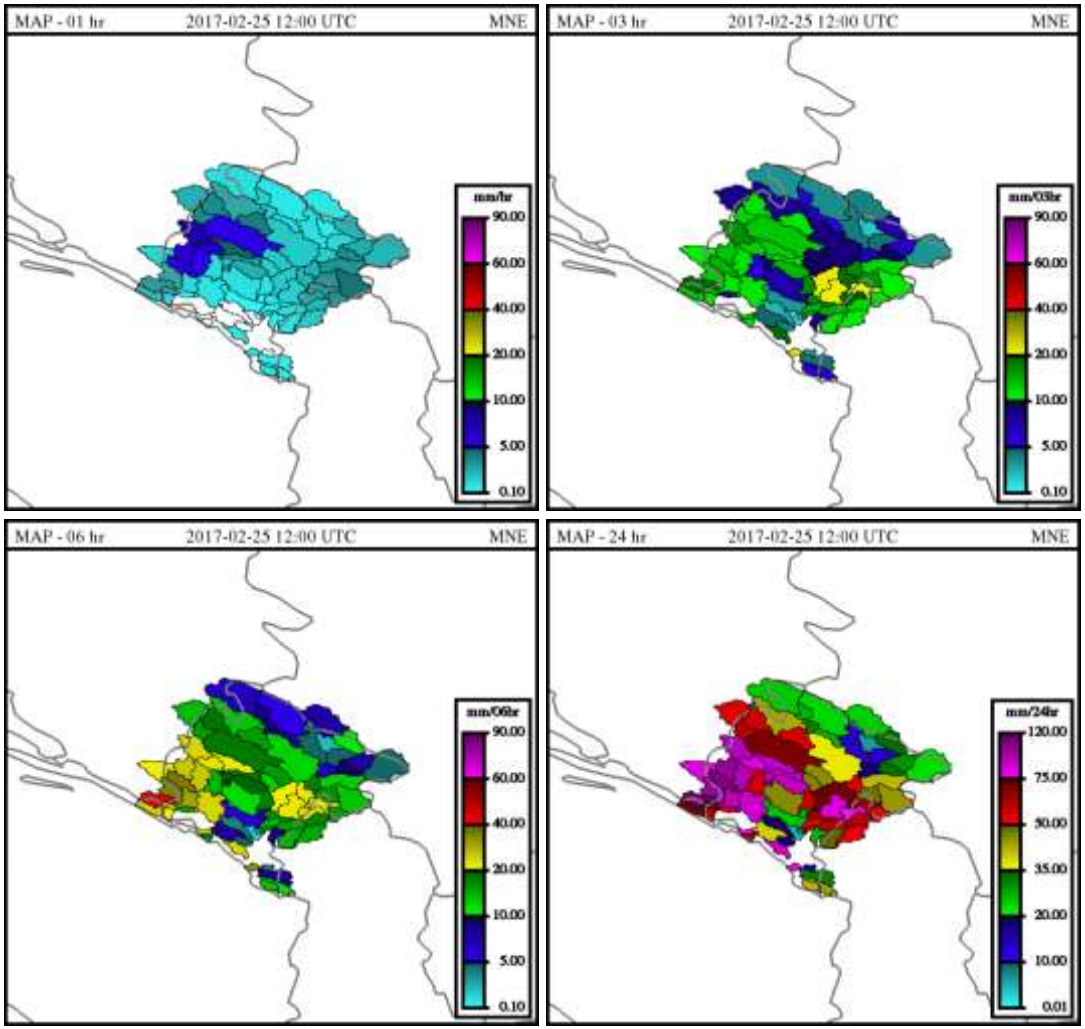
# Merged Mean Areal Precipitation (Merged MAP)



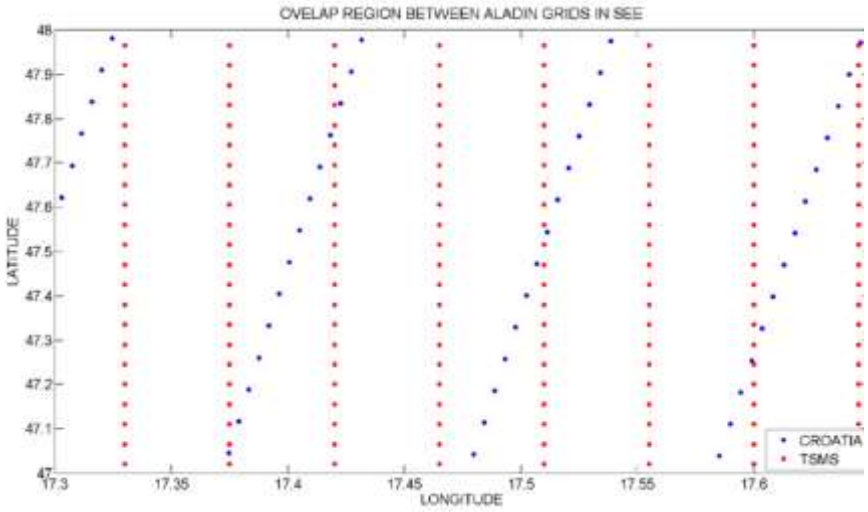

The Merged MAP data products are updated every hour.

The Merged MAP 6-hr accumulation product is applied during model processing as the precipitation input to the Snow-17 Model, the Sacramento Soil Moisture Accounting Model and flash flood threat model.

# Merged Mean Areal Precipitation (Merged MAP)

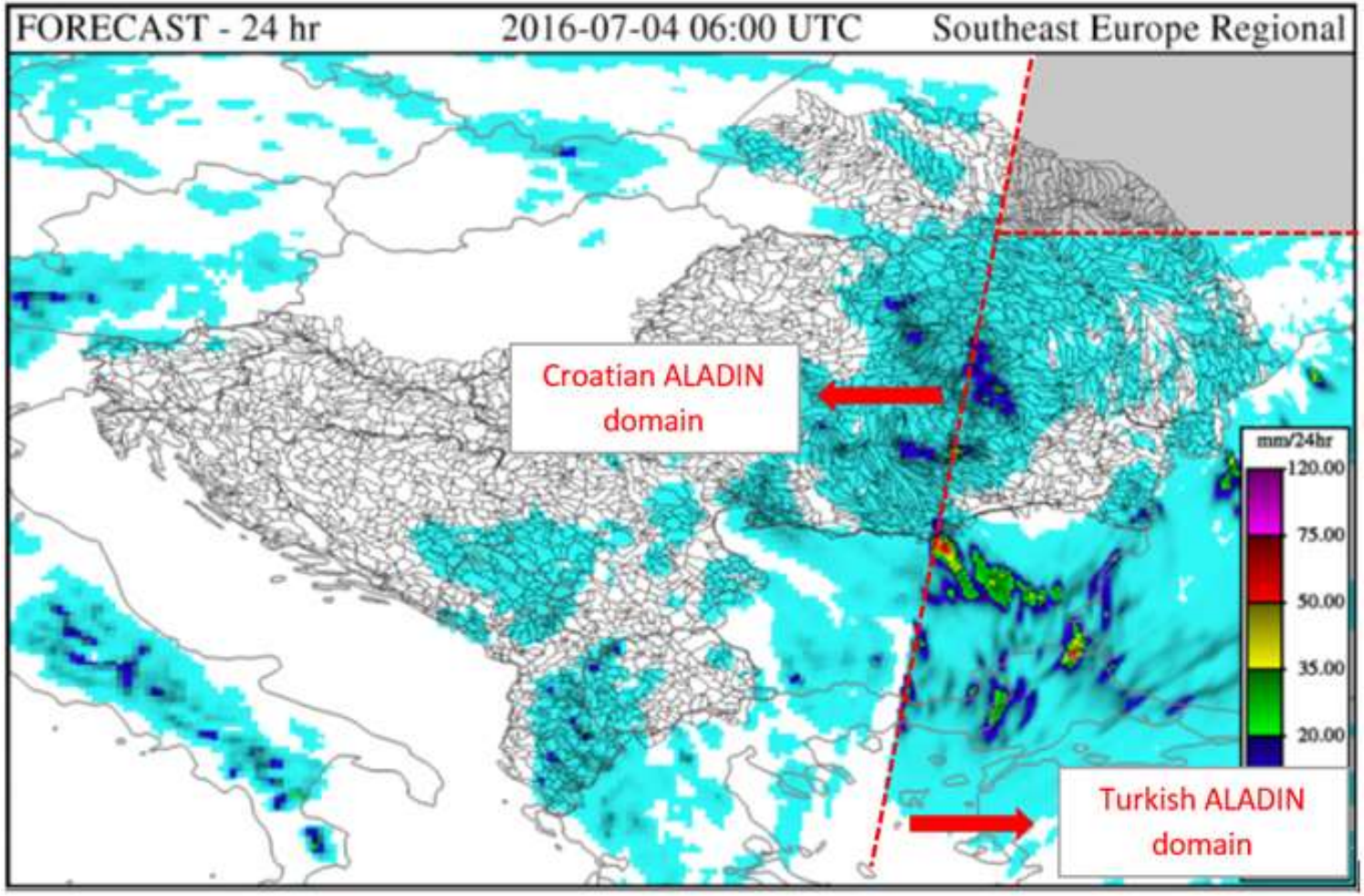


# ALADIN Forecast




- Croatian Meteorological and Hydrological Service is running **hydrostatic version** of ALADIN with **4 km horizontal resolution** which runs four times a day at 00, 06, 12 and 18 UTC.
- Turkish State Meteorological Service is running a **non-hydrostatic version** of ALADIN with **4.5 km horizontal resolution**. It also runs four times a day at 00, 06, 12 and 18 UTC producing precipitation forecasts out to 72 hours.
- 1, 3, 6, and 24-hour ALADIN precipitation products are generated and updated every hour and displayed in the SEEFFGS Main Products console.

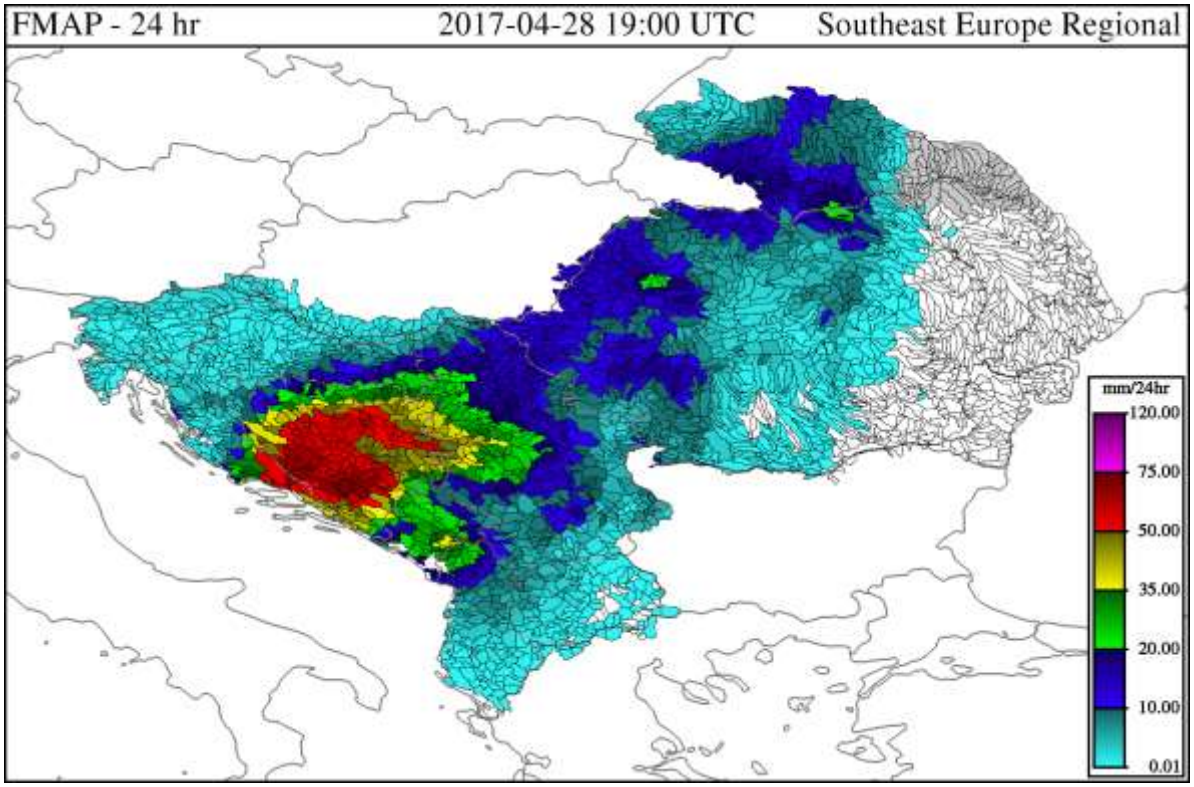
# ALADIN Forecast



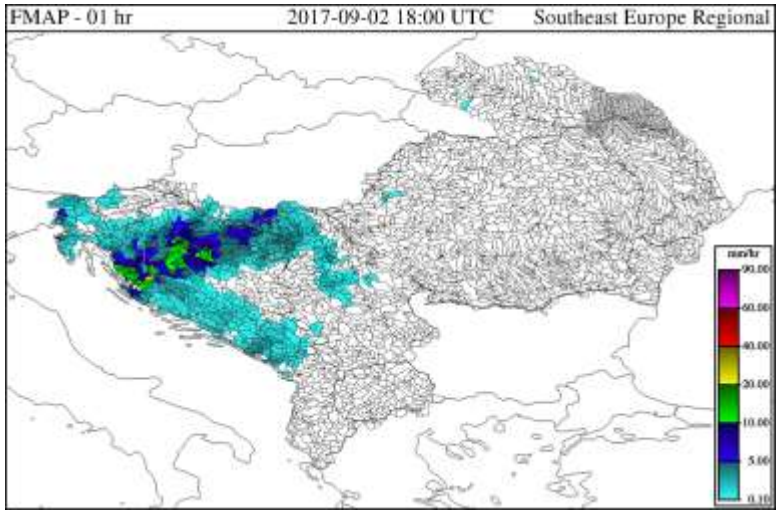

The SEEFFGS is using two merged ALADIN forecasts, Croatian and Turkish

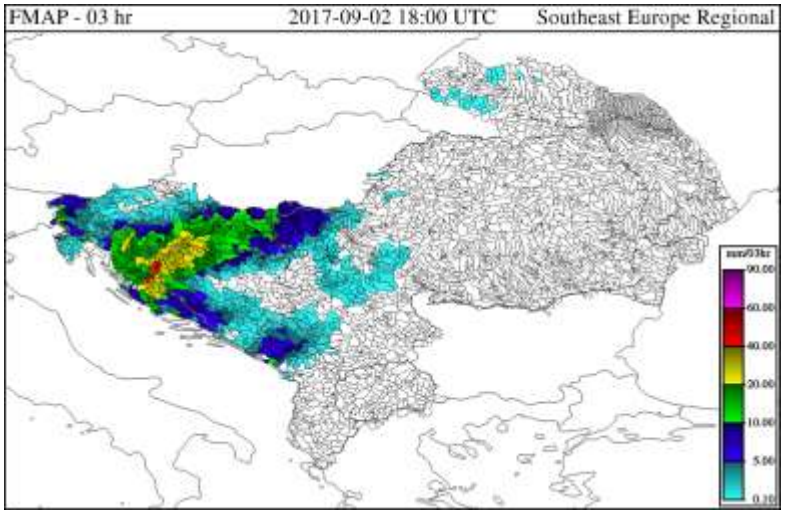
# Forecasted MAP (Mean Areal Precipitation)

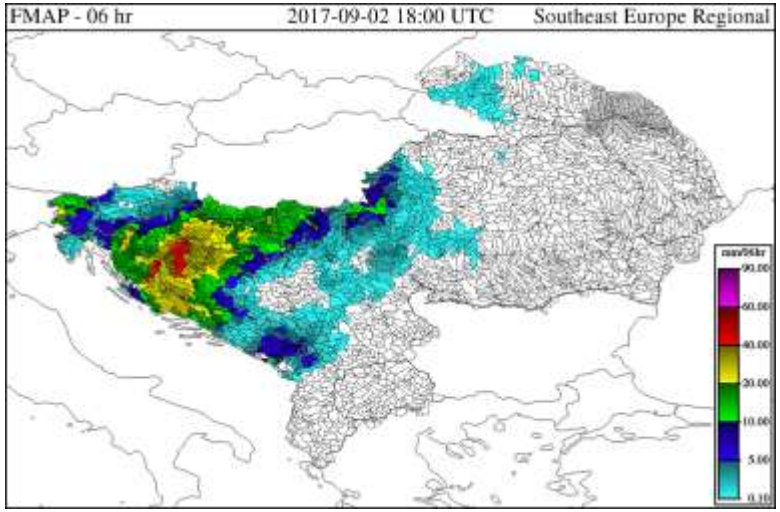
- FMAP products are generated from the NWP precipitation forecasts for each catchment for 1-hour, 3-hours, 6-hours and 24-hours

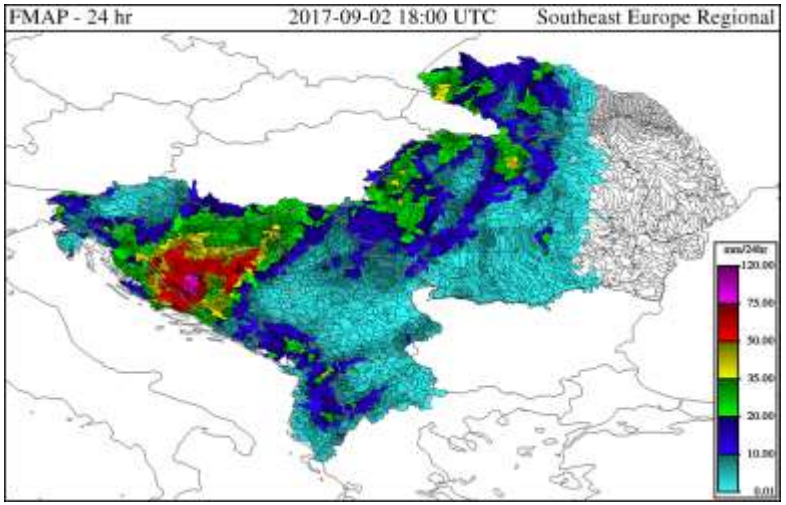


# Forecasted MAP
# (Mean Areal Precipitation)



# Thank you

Paul Pilon
ppilon@wmo.int
Ayhan Sayin
asayin@wmo.int
Petra Mutic
pmutic@wmo.int

| | |
|---|---|
| **For more information please visit:** | **http://www.wmo.int/ffgs** |
| | **http://www.hrcwater.org** |

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

WMO OMM
World Meteorological Organization
Organisation météorologique mondiale