

Heavy rain and flooding event – 12.12.2021 in South Bulgaria

Use Cases



Table of Contents

1	Summary.....	4
2	Short Introduction/Abstract.....	5
3	Description	6
4	Related content	16

Use Cases – Heavy rain and flooding event – 12.12.2021 in South Bulgaria

Title	Heavy rain and flooding event - 12.12.2021 in South Bulgaria
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Case type	case study

1 Summary

Assessment of 24h accumulated values of heavy rain in South Bulgaria through comparison between satellite products and measured data

Date & Time	11 December 2021 06:00 UTC–12 December 06:00 UTC
Region	South Bulgaria Provinces
Satellites	DMSP, Meteosat, Metop-B, NOAA-19, GPM-Constellation
Instruments	SEVIRI, SSMIS, AMSU-MHS, DPR, GMI
Channels/Products	Infrared, MW, H01, H02 (B), H18, H05 (B), and GPM(IMERG-V06)
Latitude/Longitude	41.3170 N, 25.3500 E

2 Short Introduction/Abstract

As a result of Mediterranean cyclone during the period of 06 UTC at 11 to 06 UTC between 11 and 12 December 2021 in the area of South Bulgaria (more than 13000 km²), was recorded intensive rain that caused high flood events and landslides. Average measured 24h accumulated precipitation amount in the affected area was about 42 mm with higher values ranging from 99 to 159 mm. The event was recorded by automatic hourly accumulating gauges and manual 24h accumulating rain gauges. Satellite products H01, H02, H18, H05 (B), and GPM (IMERG-V06) late run were compared to the measured precipitation values.

3 Description

Case study analysis in Bulgaria (NIMH)

1. Meteorological event of the case study

A Mediterranean cyclone passes through the Balkans – 10-14 December 2021.

2. Meteorological event description - December 10-14, 2021

During the period 5-8 December, a Mediterranean cyclone passes through the Balkans. Two days later (December 10, 2021) a new Mediterranean cyclone formed over the Gulf of Genoa, which was even deeper than the previous one, and a new rainfall situation was created, which lasted until December 14, 2021. During the last two days (13 and 14) the ground cyclone is already far from Bulgaria, but in height (at 500 hPa) there is still a cyclone, which is the reason for the ongoing rainfall. The most significant precipitation was on December 11 and in the morning of December 12 in the Rilo-Rhodope region (Fig. 2) – more than 100 mm.

Precipitation in fig.1 and Fig.2 are based on 24 h accumulating precipitation stations in the National Institute of Meteorology and Hydrology (NIMH) network.

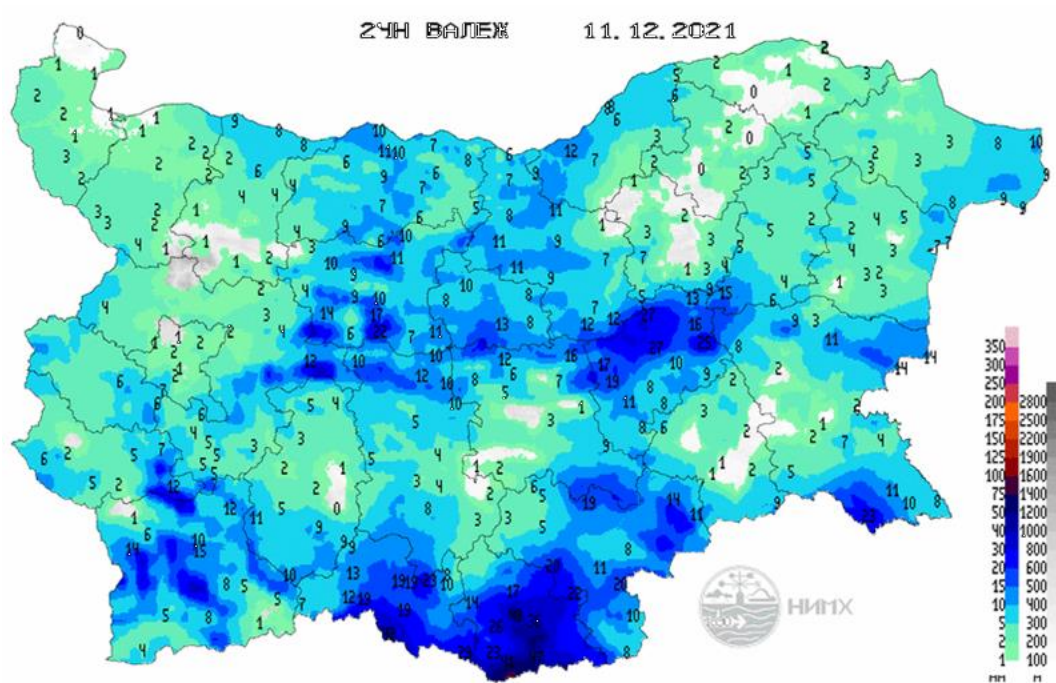


Figure 1: Precipitation over Bulgaria from 7:30 LT of 10.12.2021 to 7:30 of 11.12.2021.

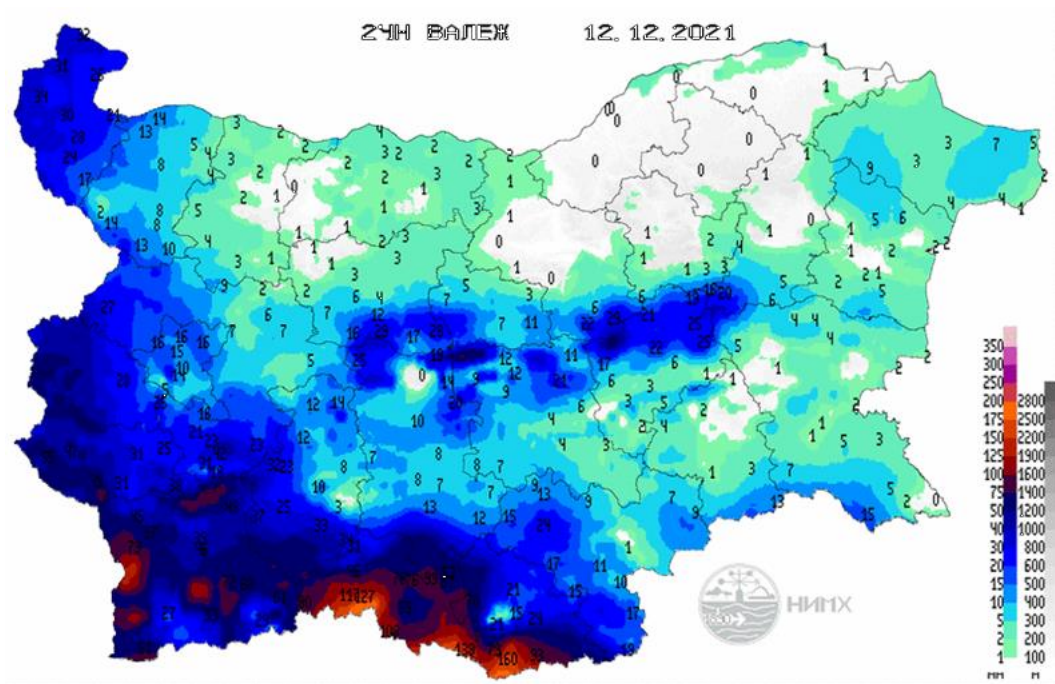


Figure 2: Precipitation over Bulgaria from 7:30 LT of 11.12.2021 to 7:30 of 12.12.2021

Figure 3 shows the synoptic situation at 00 UTC on 12 December 2021. The surface pressure field, synoptic stations and frontal systems are shown in the figure. A Mediterranean cyclone is located over the Balkans, which has 2 centers and is the cause of the rainfall in Bulgaria. A cold front passes through Eastern Bulgaria, while there is an occlusion front over Western Bulgaria. The cold front is also very well visible on the satellite image in figures 5 and 6. The next 3 figures (Fig. 4, 5 and 6) show the movement and development of the Mediterranean cyclone during the period 11-12 December 2021, when the precipitation is the most significant (Fig. 2). It can be seen that on December 11 at 12 UTC (Fig. 4), the center of the cyclone is over Italy. At 0 o'clock on December 12 (Fig. 5), the center of the cyclone is already over the Adriatic Sea, and another center forming over Bulgaria. 12 hours later, at 12 o'clock on December 12 (Fig. 6), the two centers are over Greece and Romania, and the cold atmospheric front passes over Eastern Bulgaria. There is also a large occlusion front attached to the center in height (at 500 hPa), while near the ground an area of high pressure builds between the two centers and even colder air begins to penetrate. By the evening, temperatures will drop below 0 °C and snowfall will begin in Western Bulgaria. For Figure 4, 5 and 6 eumetrain.org was used as a source.

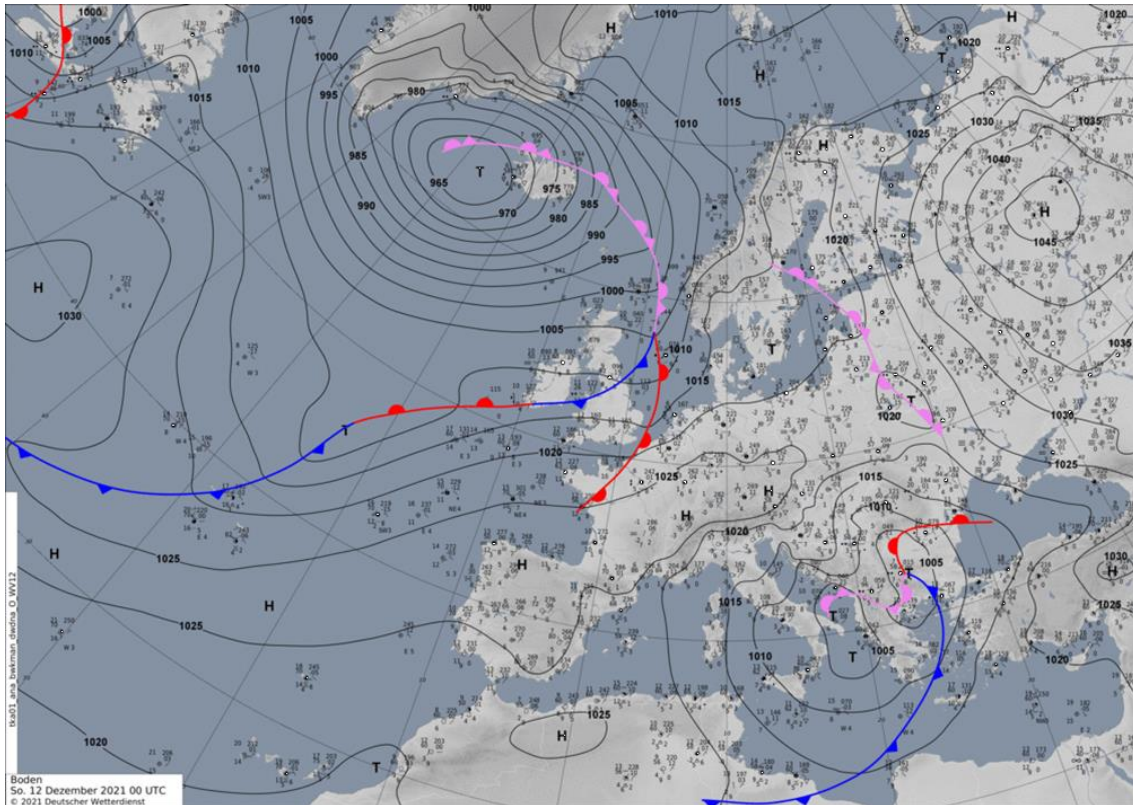


Figure 3: MSLP, synoptic stations and frontal systems from 12.12.2021 00UTC.

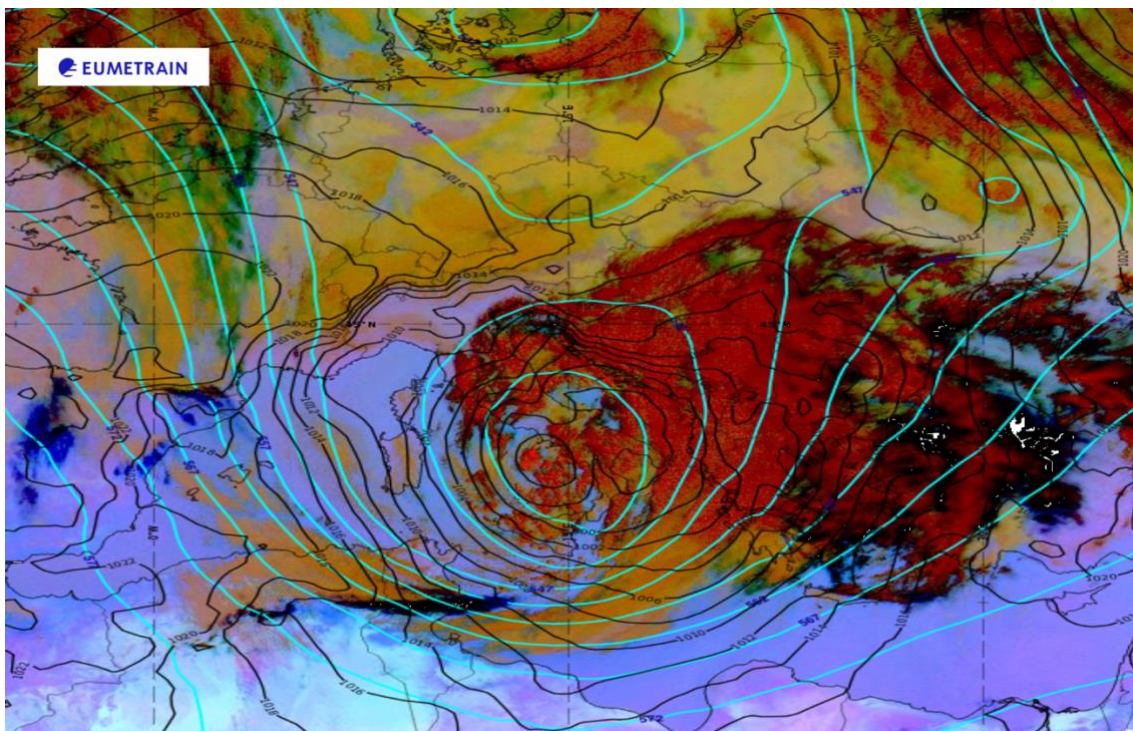


Figure 4: MSLP, 500 hPa geopotential and Eumetsat RGB-Dust from 11.12.2021 12UTC.

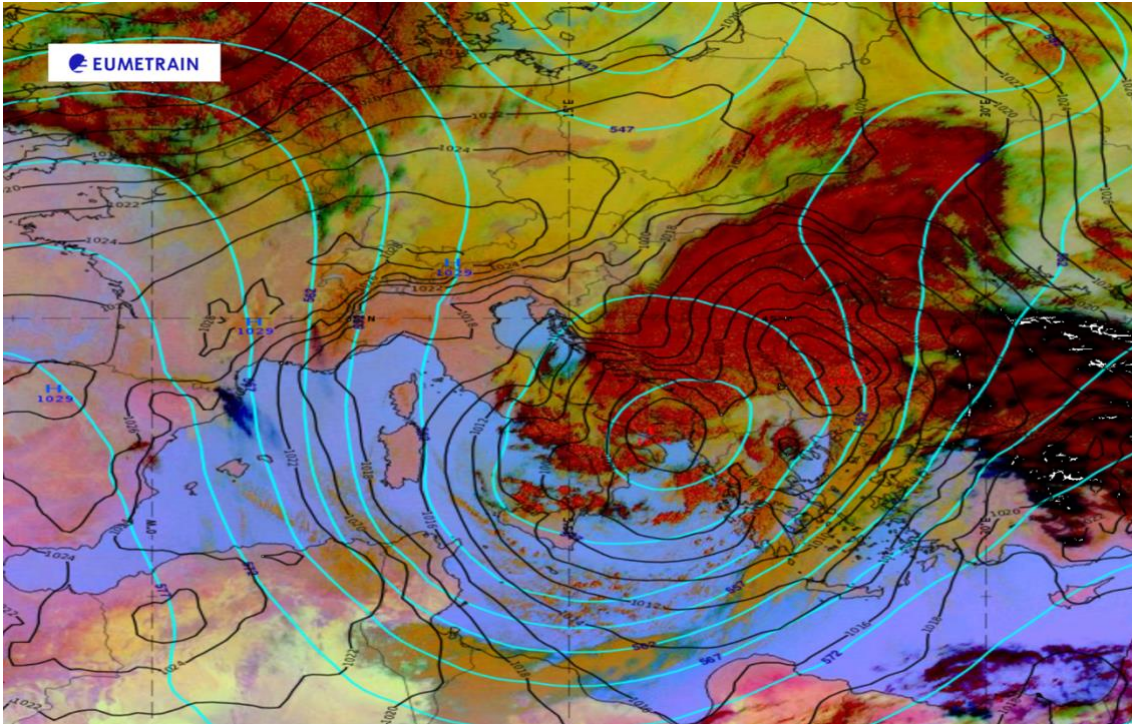


Figure 5: *MSLP, 500 hPa geopotential and Eumetsat RGB-Dust from 12.12.2021 00UTC.*

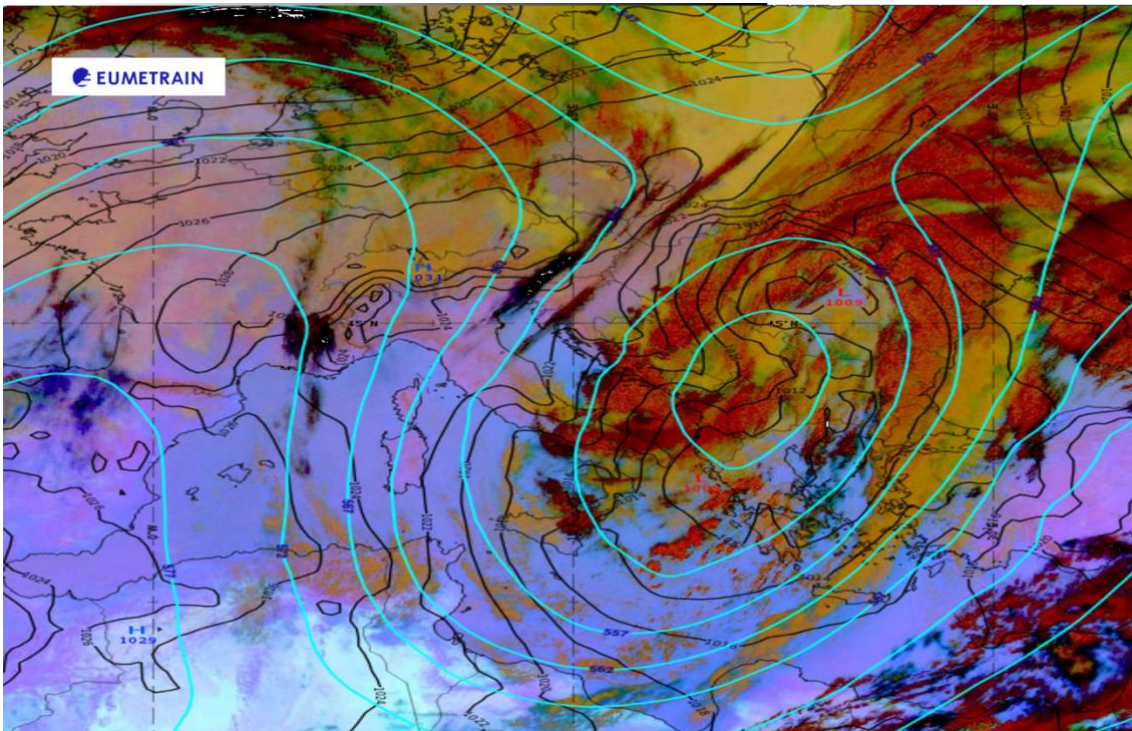


Figure 6: *MSLP, 500 hPa geopotential and Eumetsat RGB-Dust from 12.12.2021 12UTC.*

3. Evaluation of precipitation products against measured values

As a result of the Mediterranean cyclone during the period of 06 UTC at 11 to 06 UTC between 11 and 12 December 2021 in the area of South Bulgaria (more than 13000 km²), was recorded intensive rain that caused high flood events and landslides. Average measured 24h accumulated precipitation amount in the affected area was about 42 mm with higher values ranging from 99 to 159 mm. The event was recorded by 27 automatic hourly accumulating gauges and 65 manual 24h accumulating rain gauges. H-SAF satellite products H01, H02, H18,

H05 (B), and GPM (IMERG-V06 late run) for the above period were downloaded and visually compared to the measured hourly precipitations. Accumulated values of H05 and GPM products were spatially interpolated over South Bulgaria with the same resolution as the measured data is interpolated.

At the measuring stations higher intensities were observed between 17:00 at 11 December and 02:00 at 12 December – ranging between 8 and 22 mm/h and increasing from North to South. The maximum was observed for 23:00 UTC at 11 December at Kirkovo station – 22 mm/h followed by 2 other stations with 17 mm/h at 00:00 on 12 December. Fig.07 shows hourly precipitation sums for the central part of South Bulgaria and Fig.13 shows hourly accumulation of five station with maximum intensities between 07UTC at 11 December and 06UTC at 12 December: Kirkovo, Zlatograd, Pamporovo, Rozhen and Trigrad

During this specific case H01 that is used in some cases to produce blended results (H05) had 5 passes covering entirely or partially the affected area: at 11 December at 15:44 (Fig.08), 16:11 and 16:54 and at 12 December at 04:40 and 04:52. These scans show intensities below 8 mm/h in the area but mostly in South-West part of the country.

H02 product had scans at 11 December at 9:18, 10:45, 21:31, 23:17 and at 12 December at 9:04. All the scans show intensities below 8 mm/h (Fig.9) mostly in South-West part of the country.

H18 has 4 scans in the same period over the area (Fig.10). Maximum of registered intensity is below 8 mm/h.

Accumulated precipitation product H05(B) (24h accumulation) for 12.12.2021 06UTC shows maximum accumulated values up-to 20 mm (Fig.11, Fig.12) in North and South-West part of Bulgaria but not in South-Central part where the highest daily sum was recorded (Fig.02, Fig.11).

Accumulated product GPM (IMERG-V06 late run) (24h accumulation) for 12.12.2021 06UTC shows maximum values up-to 42 mm/day in South-Central part of the country (Fig.14) that is more realistic compared to H05 product.

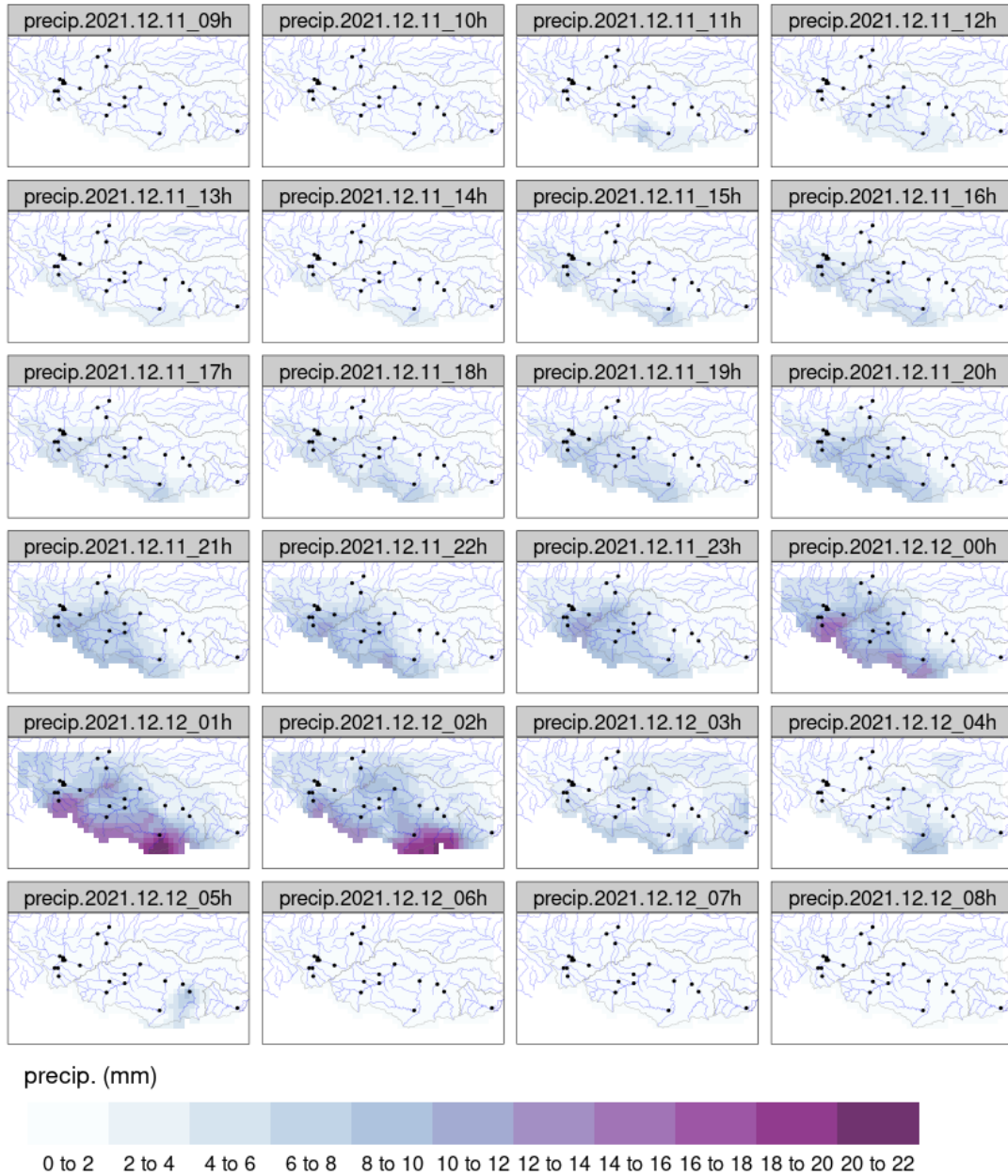


Figure 7: Measured accumulated hourly precipitation in South-central part of Bulgaria between 11.12.2021 6UTC to 12.12.2021 6UTC.

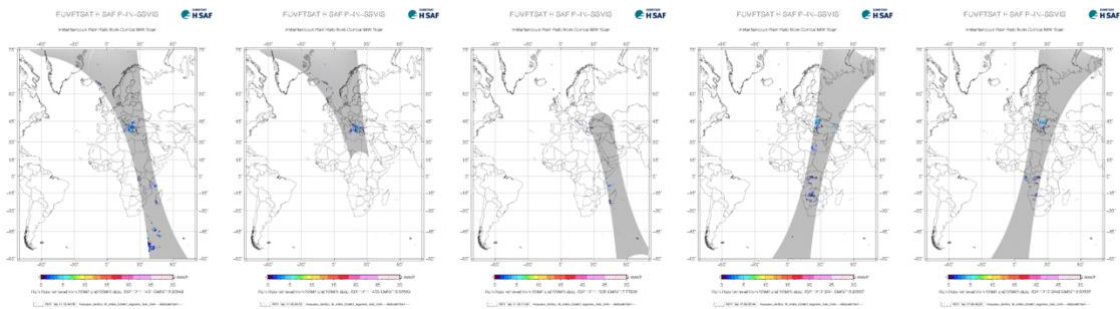


Figure 8: Consecutive images of product H01 for the period 11.12.2021 8UTC to 12.12.2021 8UTC

Use Cases – Heavy rain and flooding event – 12.12.2021 in South Bulgaria

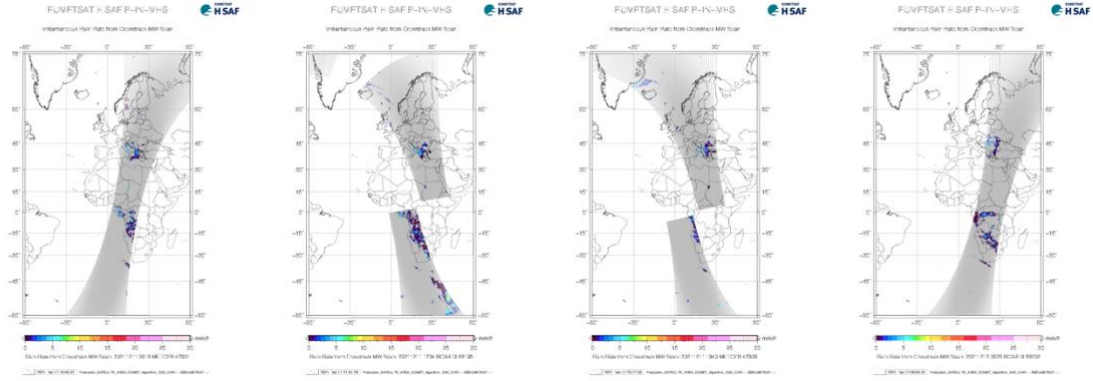


Figure 9: Consecutive images of product H02 for the period 11.12.2021 8UTC to 12.12.2021 8UTC

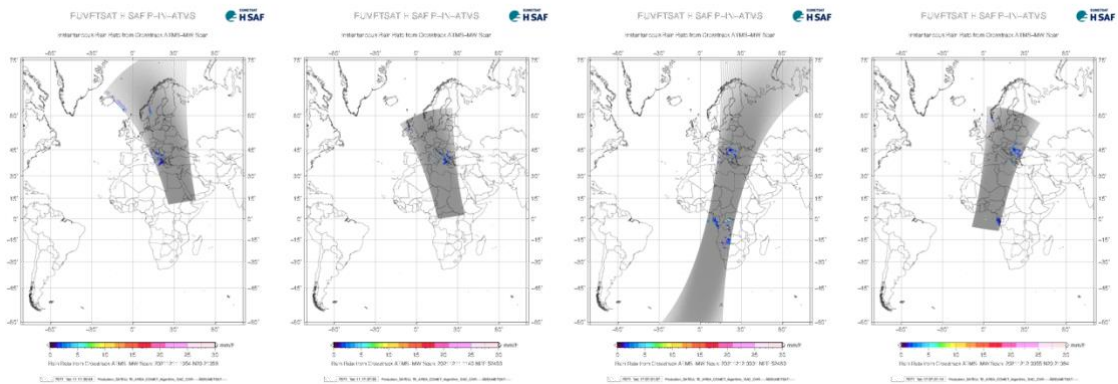


Figure 10: Consecutive images of product H18 for the period 11.12.2021 8UTC to 12.12.2021 8UTC

EUMETSAT HSAF P-AC-SEVIRI

Accumulated Precipitation in the previous 24 hours

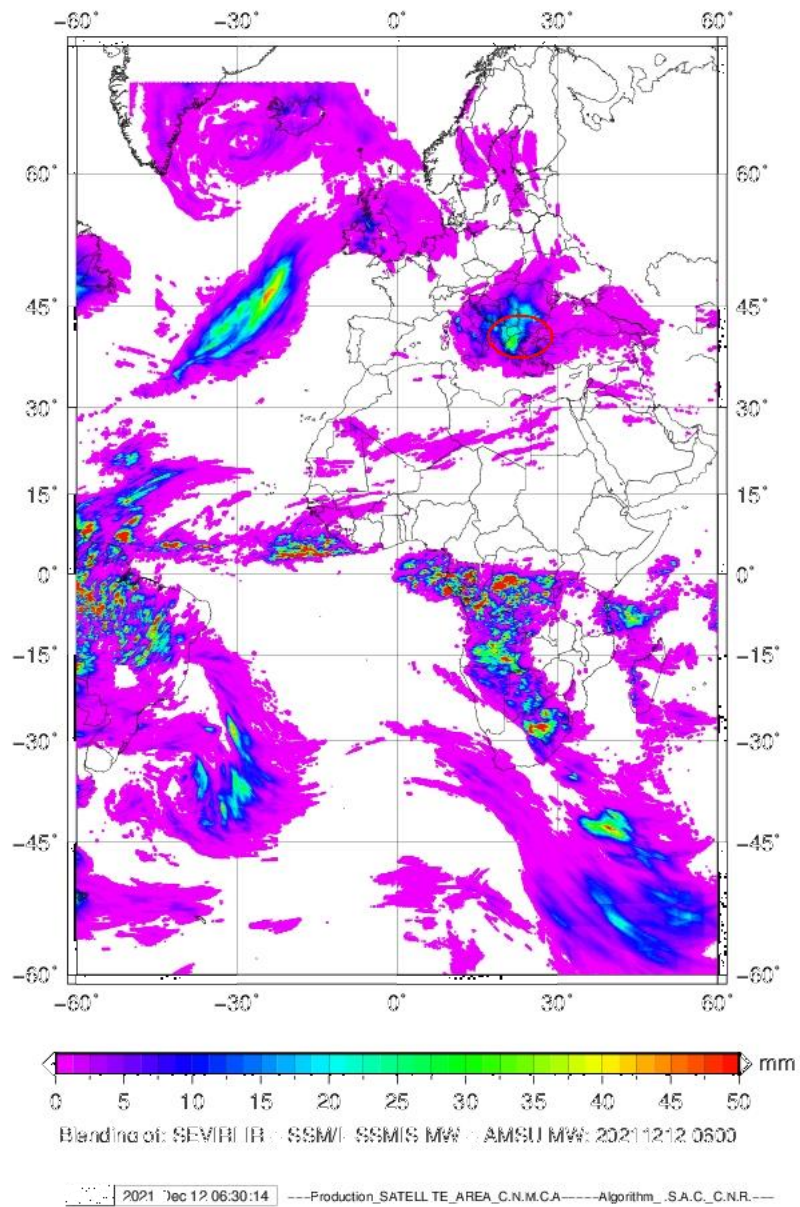


Figure 11: Accumulated precipitation for 24h – product H05B for 12.12.2012 06UTC

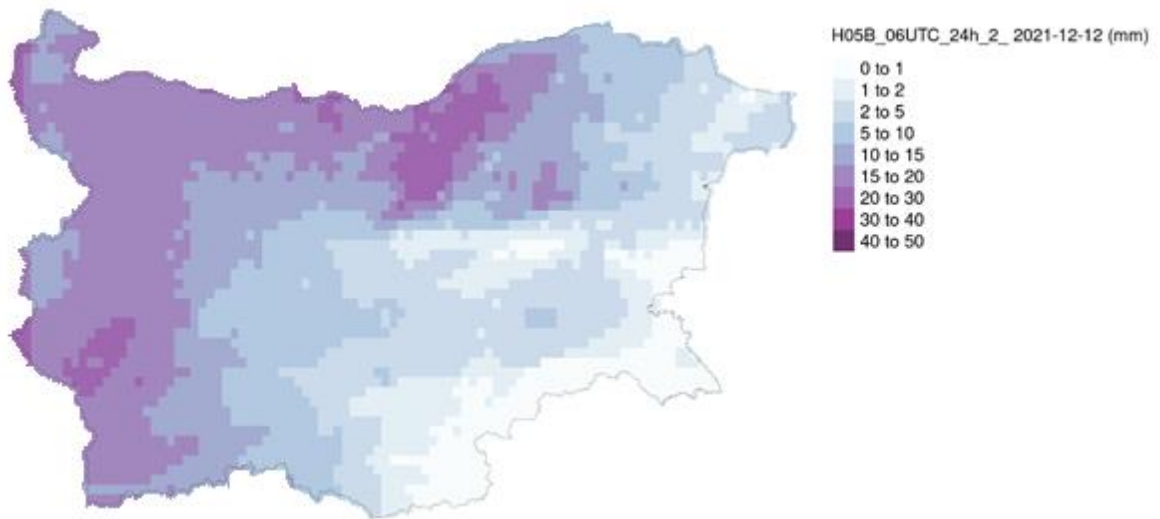


Figure 12: Accumulated precipitation for 24h – product H05B for 12.12.2012 06UTC interpolated over Bulgaria.

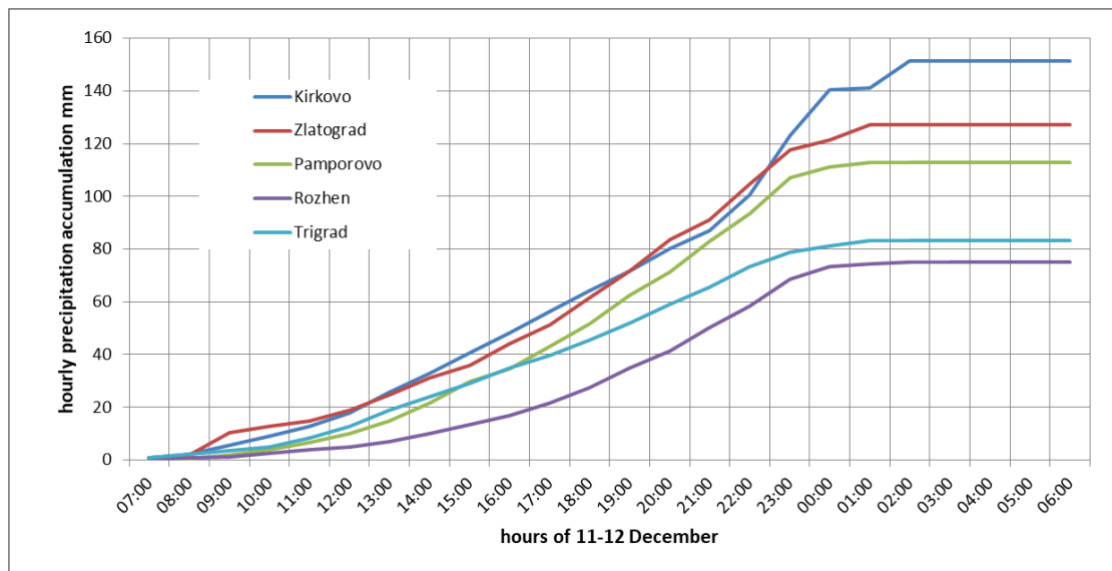


Figure 13: Accumulated lines of 24h precipitation of some NIMH stations until 12.12.2012 06UTC

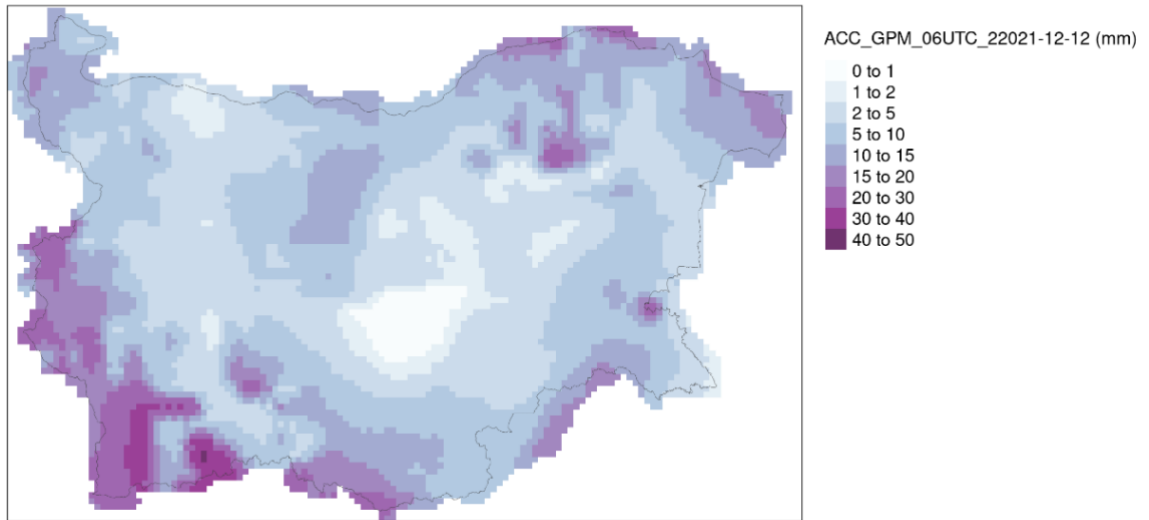


Figure 14: Accumulated precipitation for 24h – product GPM-IMERG for 12.12.2021 06UTC

4 Related content

Title	URL	Source
State of emergency declared in Smolyan district over torrential rains	https://bnr.bg/en/post/101571167/state-of-emergency-declared-in-smolyan-district-over-torrential-rains	Bulgarian National Radio (BNR)
4 districts of Bulgaria affected by rainfall and overflowing rivers	https://bnr.bg/en/post/101571405/4-districts-of-bulgaria-affected-by-rainfall-and-rivers	Bulgarian National Radio (BNR)
Situation in Smolyan region after the heavy rains is still complicated	https://bnt.bg/news/situation-in-smolyan-region-after-the-heavy-rains-is-still-complicated-301381news.html	Bulgarian National Television (BNT)