Overview of failure cases collected by WG4

Anastasia Bundel

COSMO GM in Rome, 09 September 2019

WG4

Cases of model failures

- GM at Saint Petersburg: STC request "to perform a collection of cases of model failures relevant for the different COSMO countries according to the forecasters, through the contact points belonging to WG4, 2-4 cases by each country".
- It was mentioned that the most interesting and important cases are those where the high-resolution model fails to predict the processes it's best suited for, e.g., convection development

Participants

- MCH (Daniel Cattani)
- HNMS (Dimitra Boucouvala)
- CNMCA (Alessio Canessa)
- IMGW-PIB (Andrzej Mazur and Joanna Linkowska)
- ARPAE-SIMC (Maria Stefania Tesini and Giacomo Pincini)
- RHM (Anastasia Bundel, Tatiana Dmitrieva, Denis Zakharchenko)
- NMS (Bogdan Maco)

IDEA: To create a repository with cases description

- Good feedback gathered
- An extensive collection of cases of different nature
- Impossible to include all the cases in this talk
- Very valuable information to refer to in future
- Each institution gathers this information regularly
- So – we are going to upload the ppts with the cases to WG4 repository and to update it with new cases now and then

MCH, winter precipitation cases

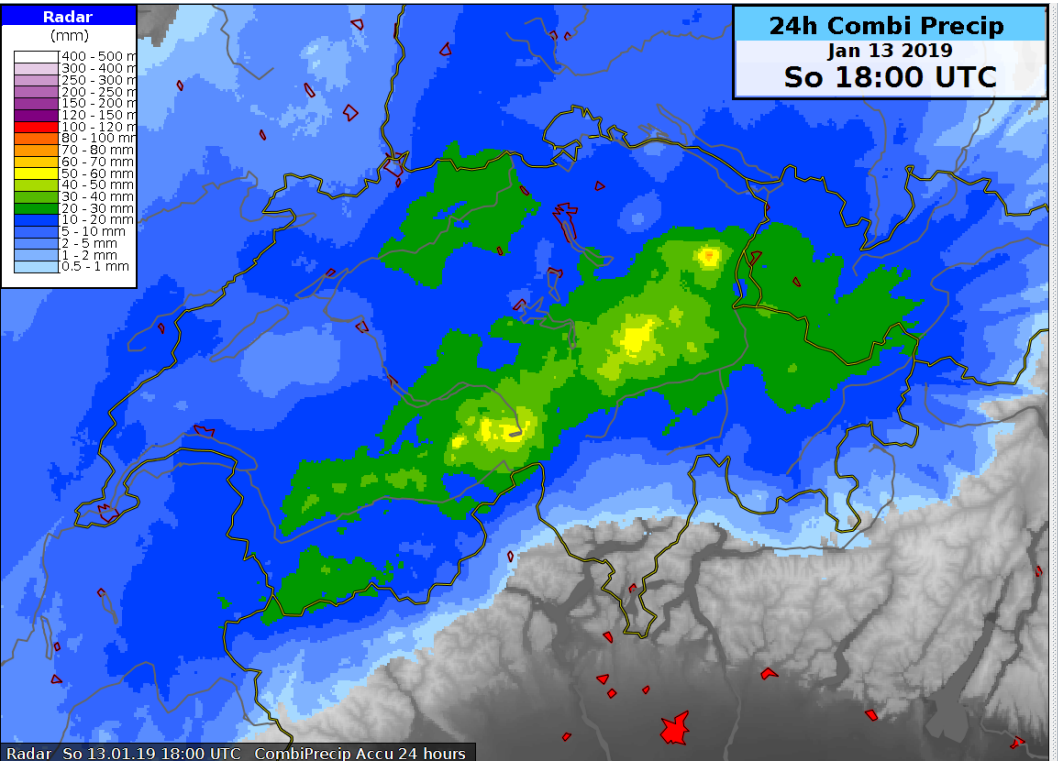
- 29-30 October 2019 : models, especially COSMO, forecasted very heavy precipitation, warnings issued based on that forecast were overestimated
- 12-15 January 2019 A case of strong snowfalls, in this case COSMO-e has also overestimated the precipitation

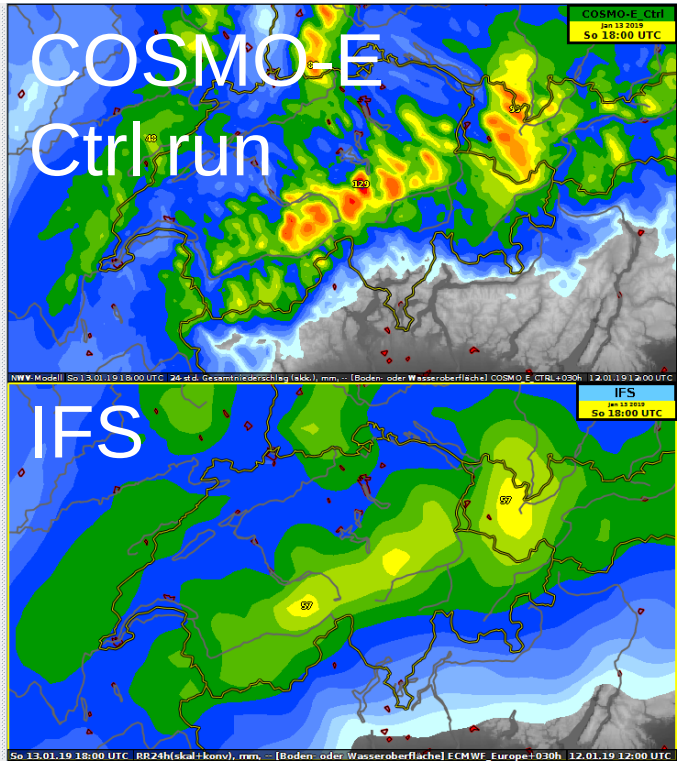
Those two cases were important for MeteoSwiss as not so correct warnings were issued based on the models

13 Jan 2019, 18:00, 24 h precip accumulation

Combined Observations

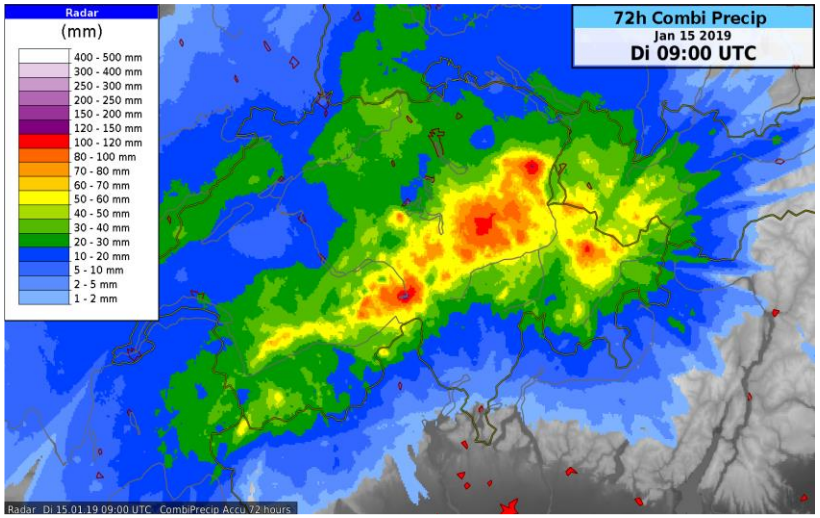
Models, runs from 12 Jan 00 UTC



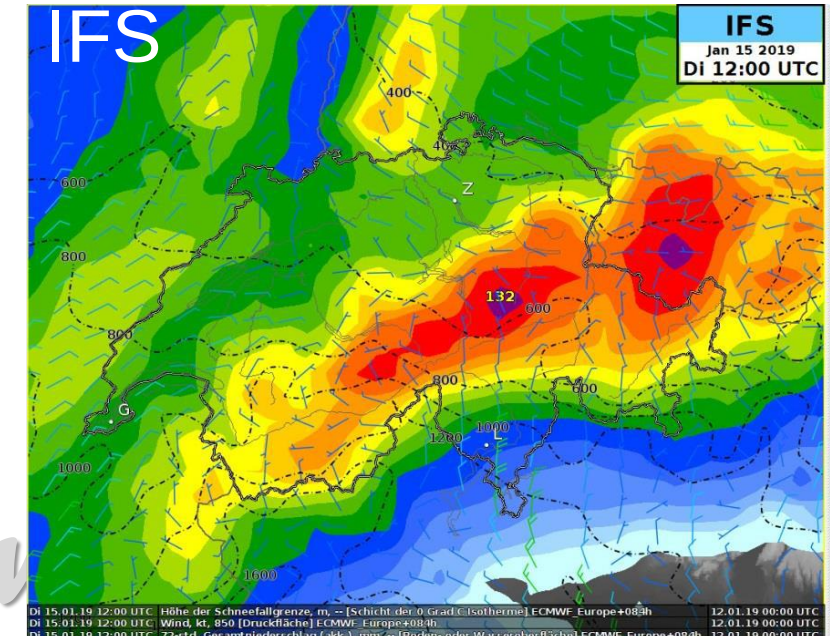


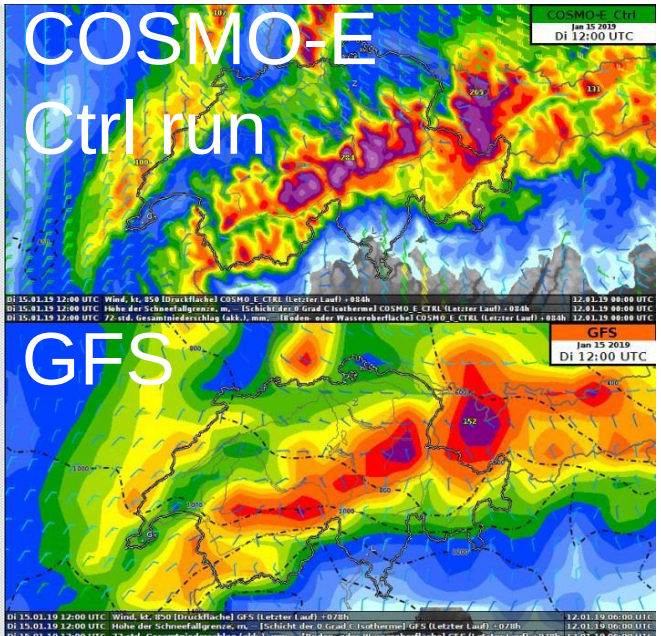
15 Jan 2019, 18:00, 72 h precip accumulation

Combined Observations



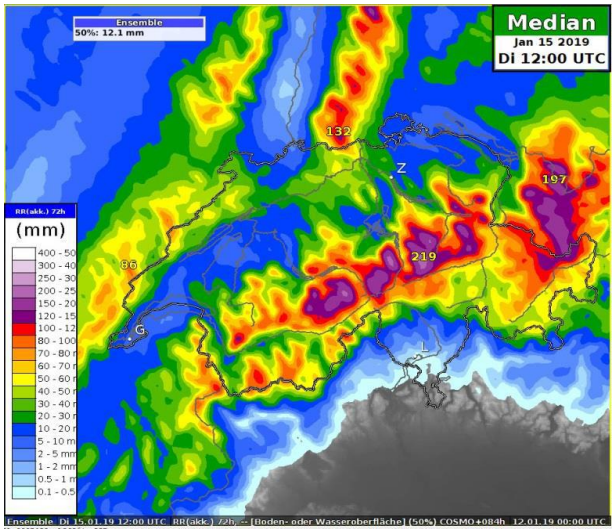
Models, runs from 12 Jan 00 UTC





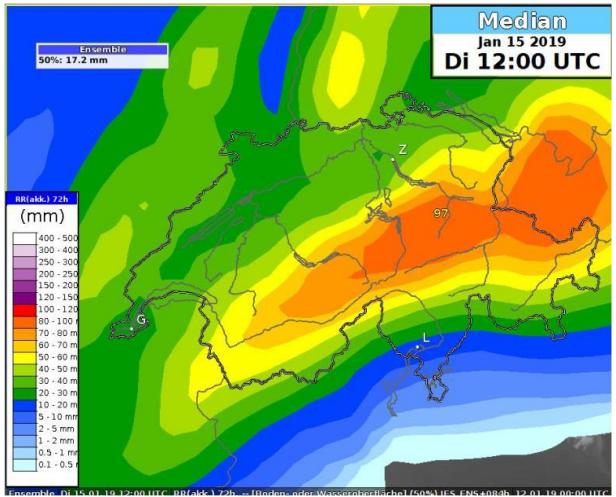
COSMO-E median

runs from 12 Jan 00 UTC



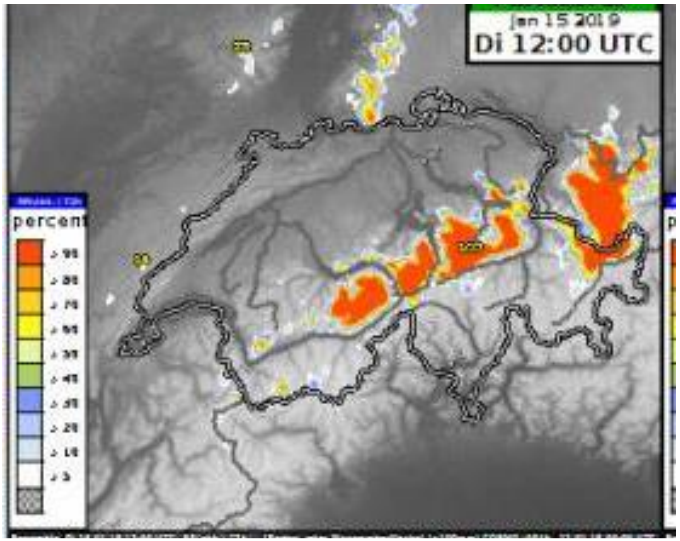
IFS median

runs from 12 Jan 00 UTC

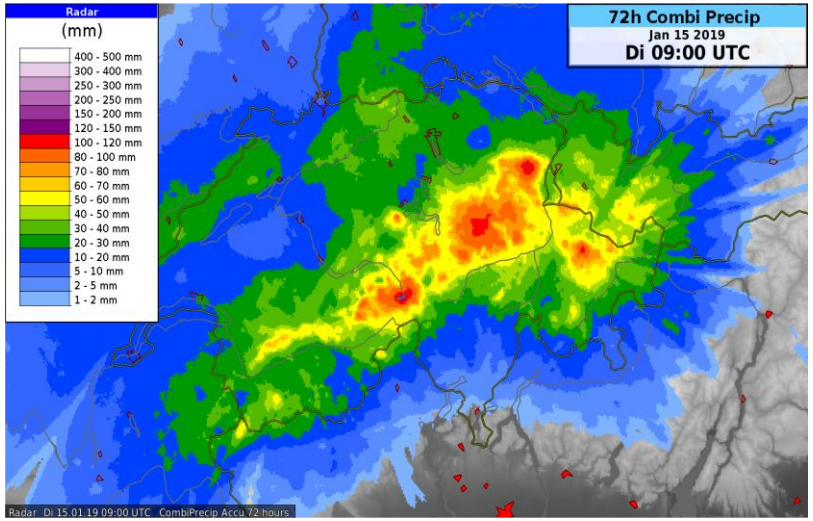


COSMO-E, Probability of precip > 100 mm/72h

runs from 12 Jan 00 UTC



Combined Observations



MCH, 29-30 October 2019

- An intense southern stream at high altitude brought the humid and warm Mediterranean air to the Alps until the morning of 30 October

Summer 2019

- Many cases of heavy rain in Europe (Tornado in Rome!)
- A challenge for forecasters in our institutes

HNMS

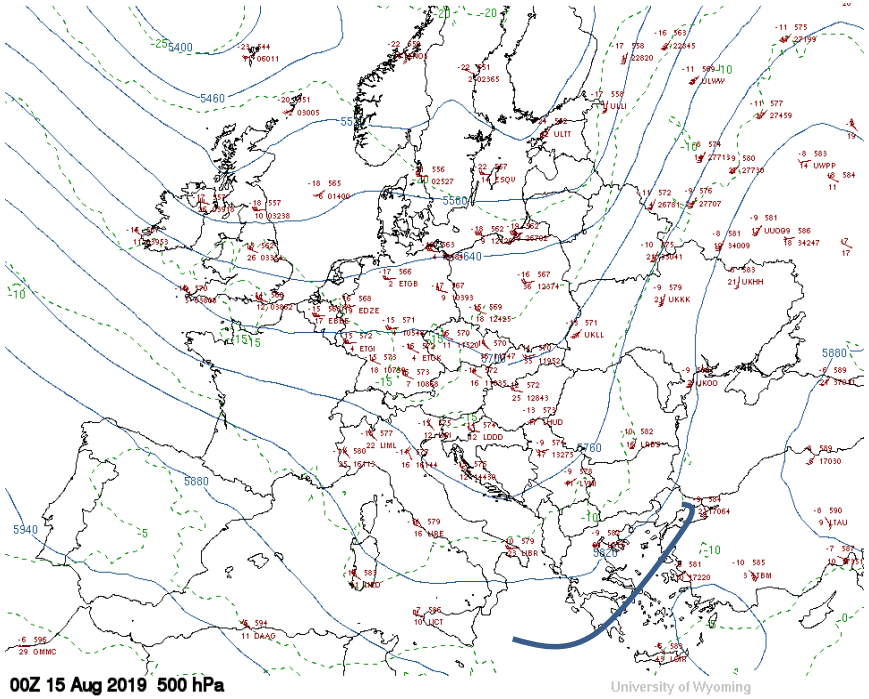
- 28 May 2019 A case of COSMO4 precipitation overestimation

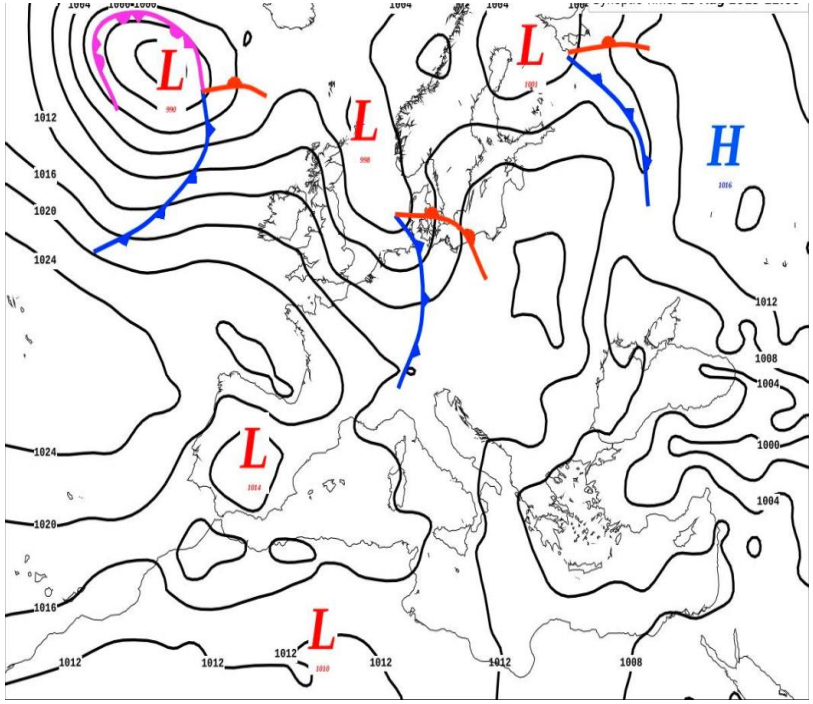
Precipitation over northern and western parts of Greece is expected when low systems from the west produce SW flow, mainly in winter time, and are usually well captured by the model.

However, in transition seasons, especially in spring, forecast precipitation is often misleading either with higher or lower predicted precipitation amounts.

- 14-15 August 2019 A case of COSMO4 precipitation miss

14-15 August 2019



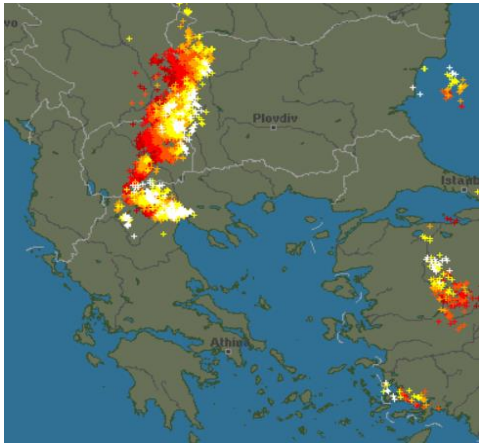


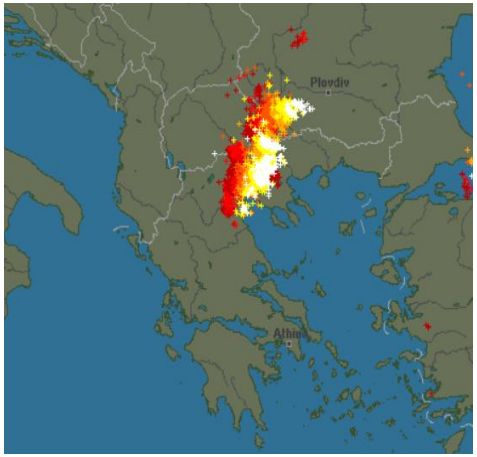
After a series of warm days, an intrusion of cold air from the North over Greece combined with thermal forcing produced convective precipitation around noon. However, around 20:00 UTC, unexpectedly, when only dynamical forcing prevailed, a block of thunderstorms locally over Western and Central Macedonia appeared in the evening of 14 August and remained till the first morning hours of 15 August. This limited area event was not captured by COSMO model.

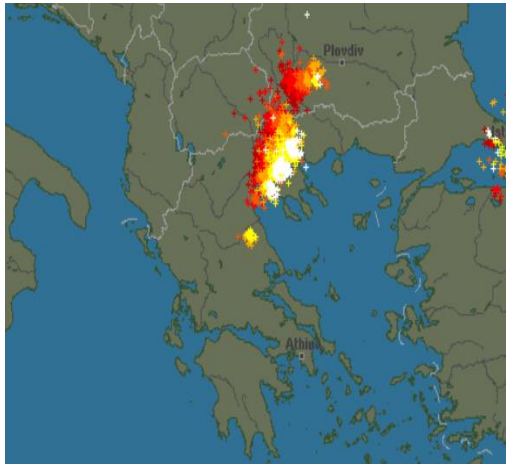
14/8 2100

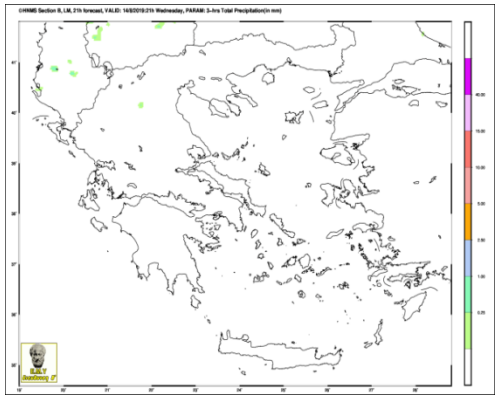
15/8 0000

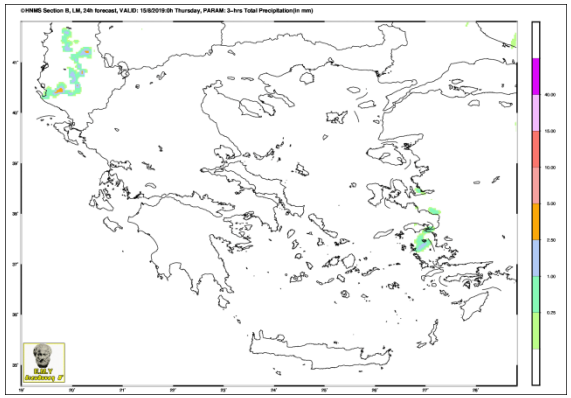
15/8 0300

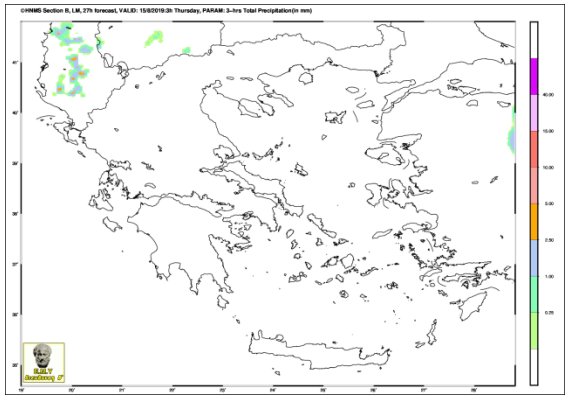












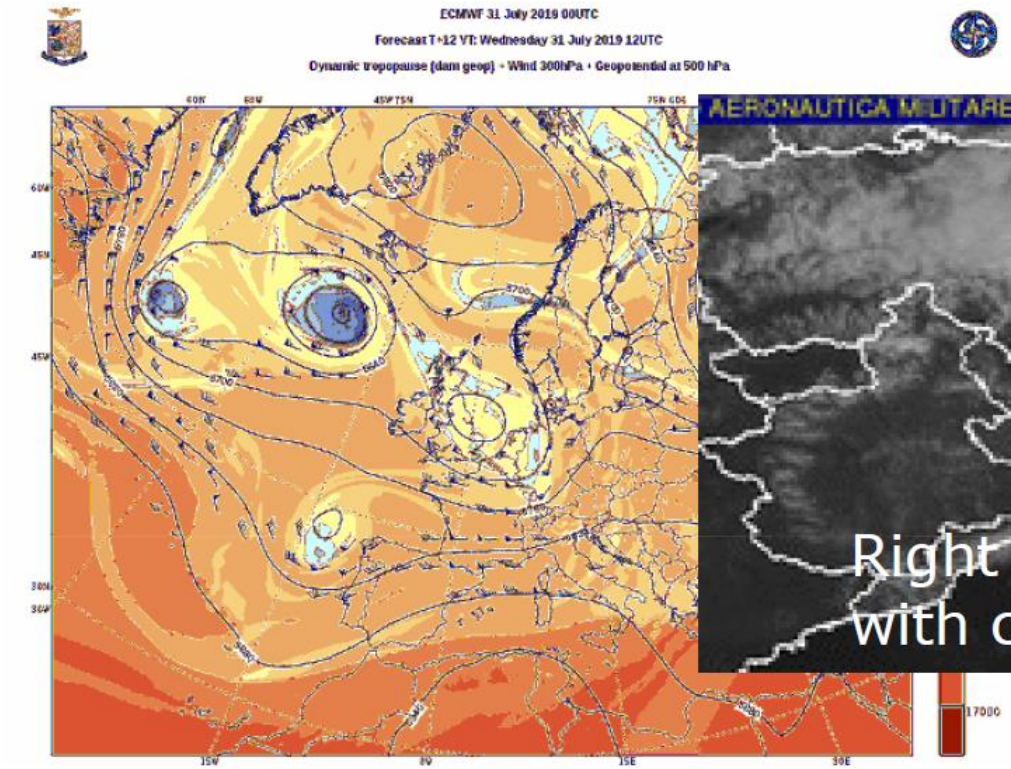
COSMO Model Runs of 14/5 00 UTC

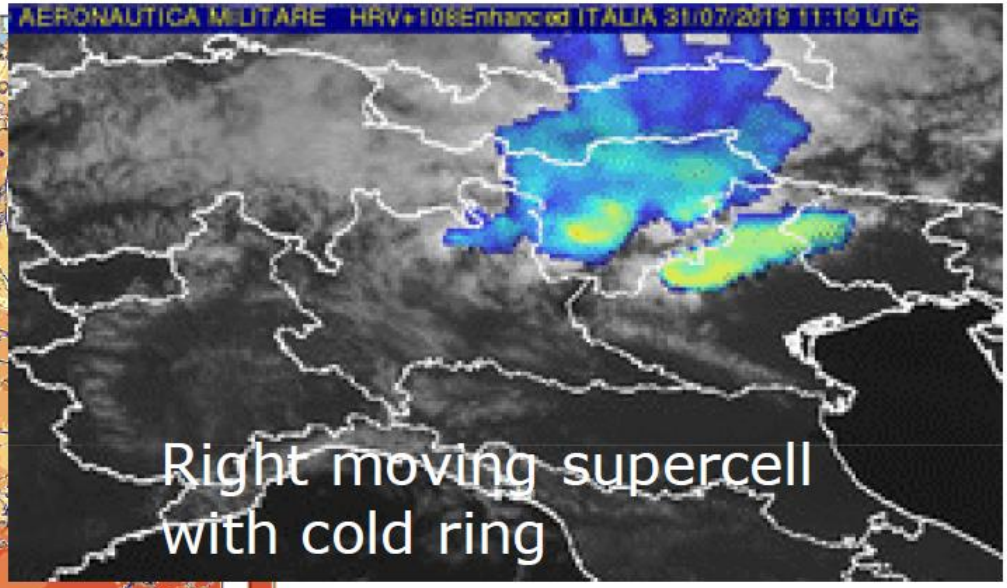
CNMCA

Cases of model failures

- 2 july 2018 Piemonte (heavy rain)
- 28 july 2019 Rome (heavy rain and Tornado)
- 31 july 2019 Po valley (Supercell - large hail)
- 2 august 2019 Marche (Supercell – heavy rain and downburst)
- 7 august 2019 Genova (excessive rainfall)
- 8 august 2019 17-18 UTC Udine (Supercell – heavy rain and downburst)

31 july 2019 Po valley 1230-1430UTC (Supercell - large hail+downburst)





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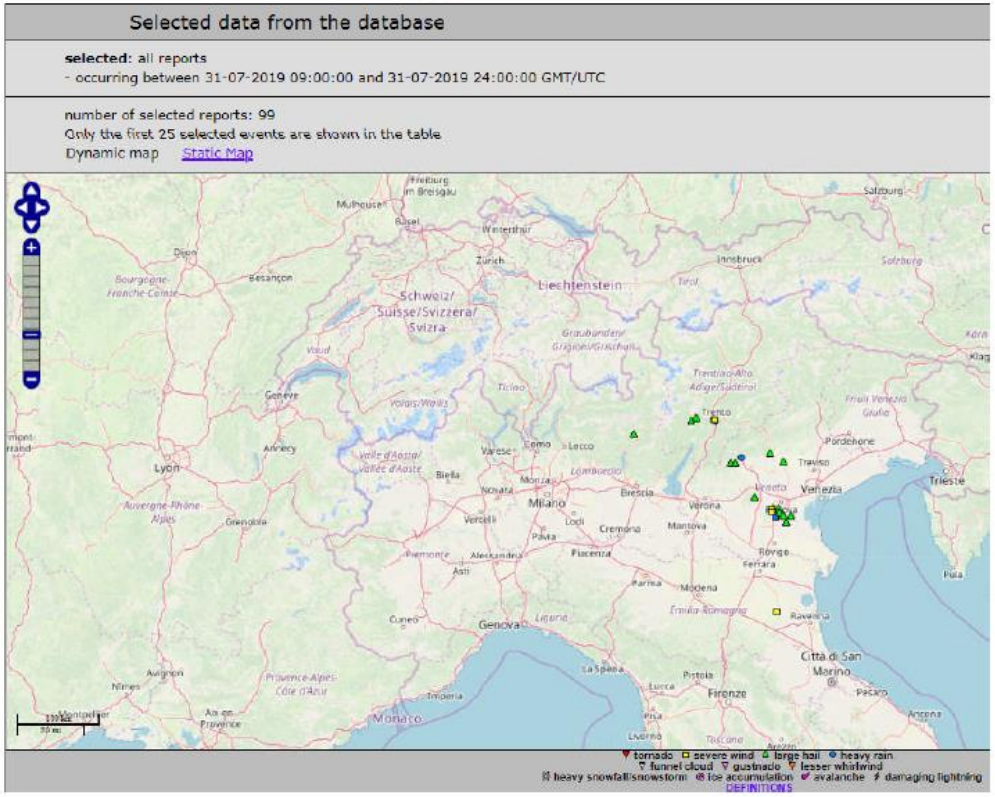
31 july 2019 Po valley 1230-1430UTC (Supercell - large hail+downburst)



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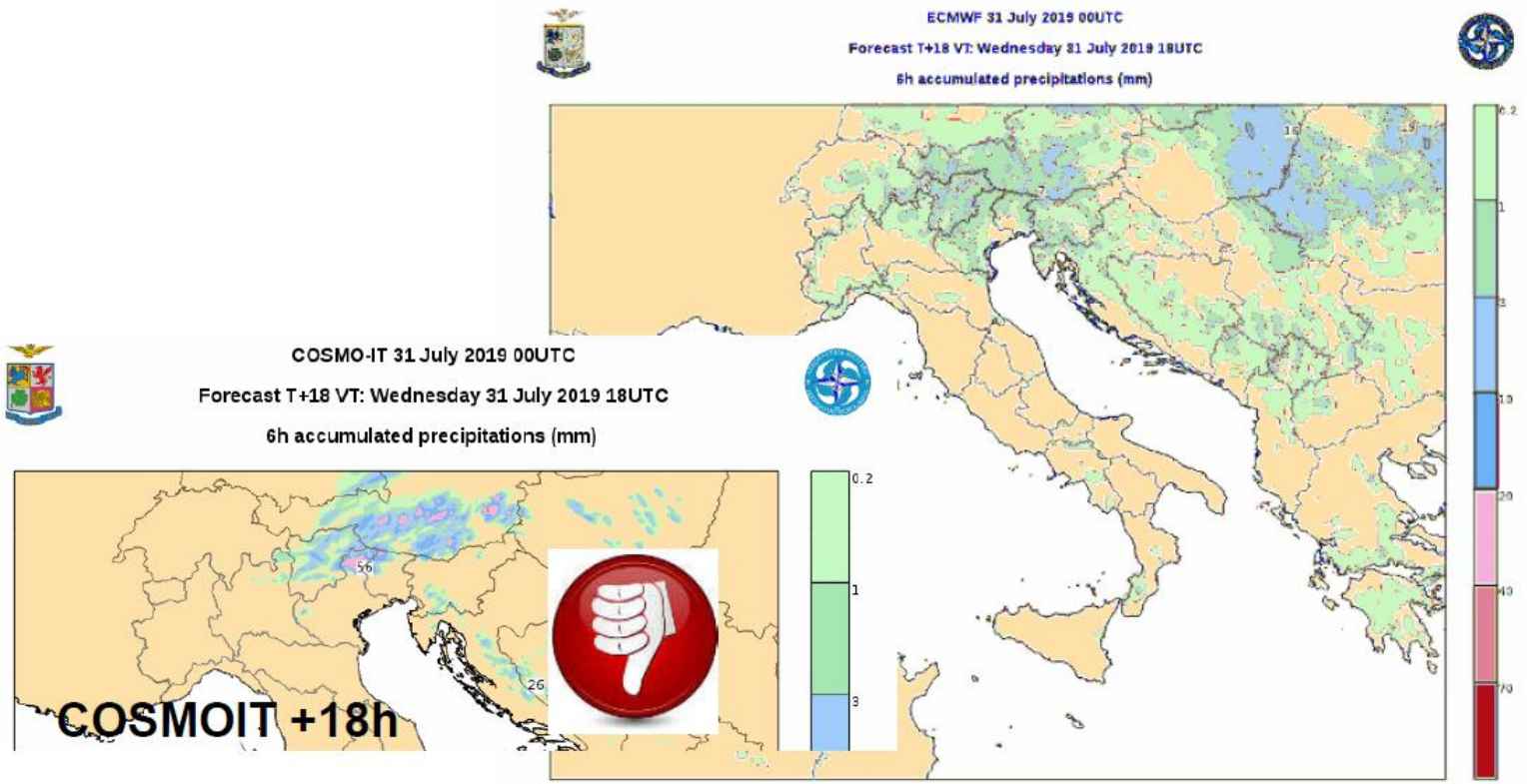
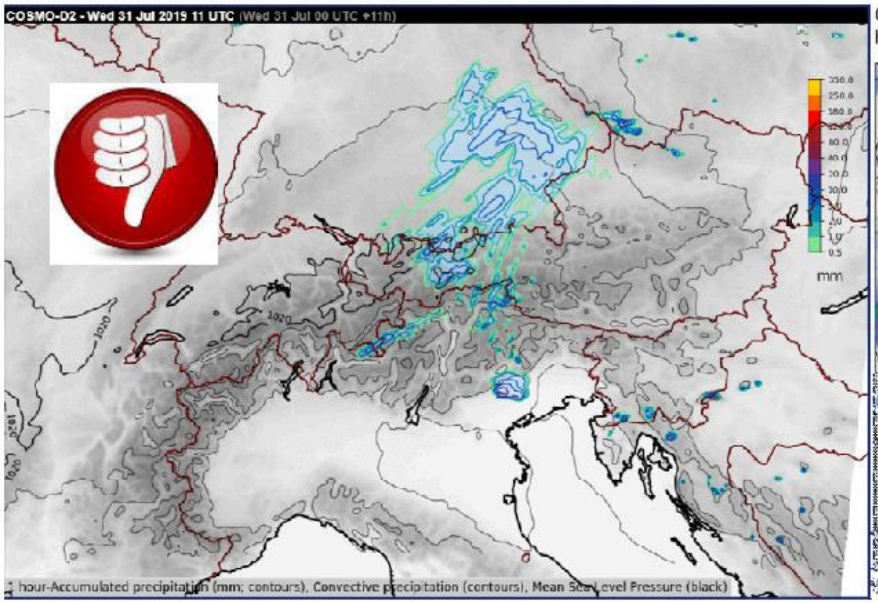
31 july 2019 Po valley 1230-1430UTC (Supercell - large hail+downburst)



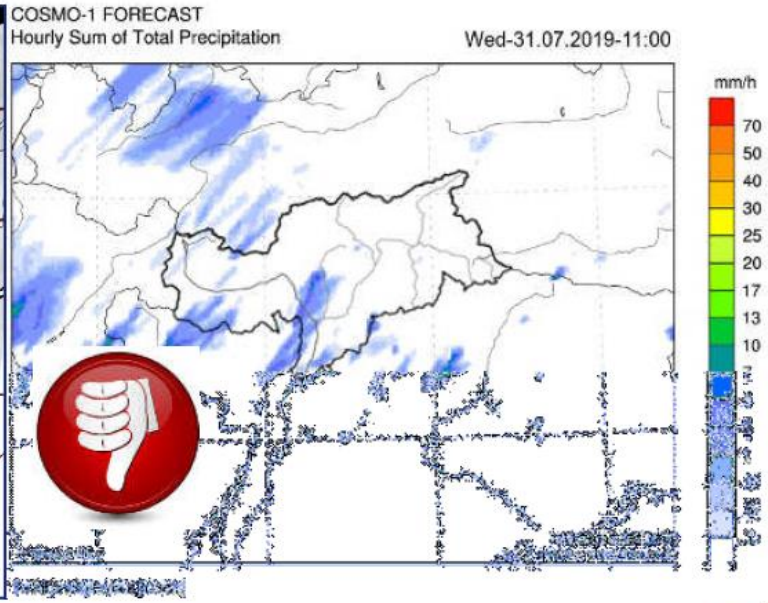
WG4

31 july 2019 Po valley 1230-1430UTC (Supercell - large hail+downburst)

COSMO D2



COSMO-1



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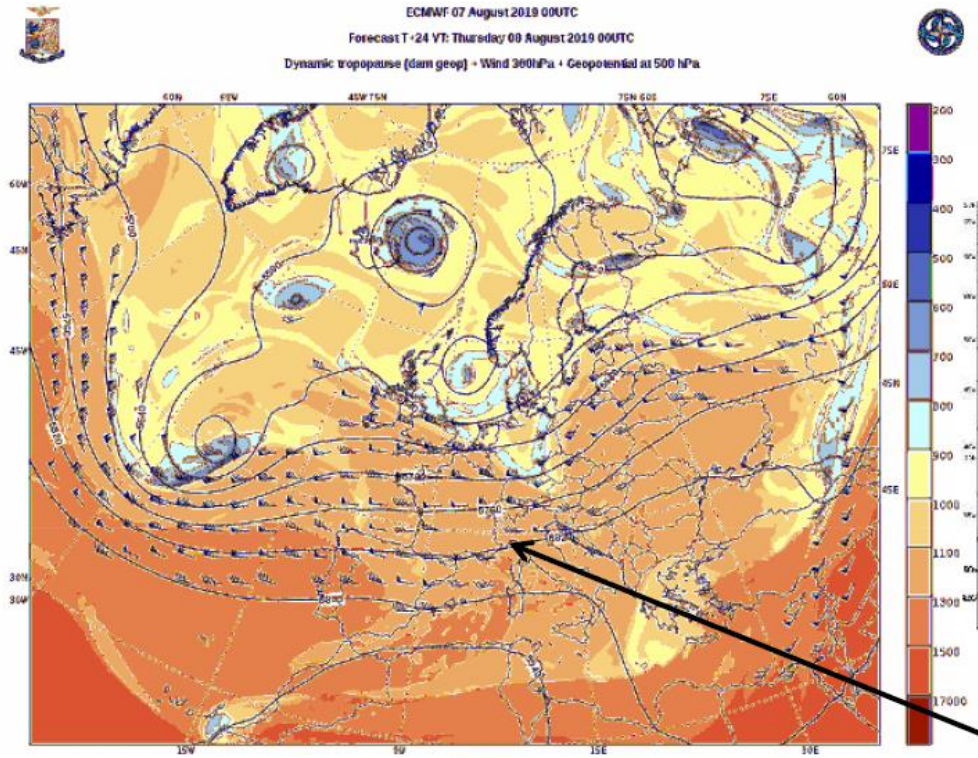
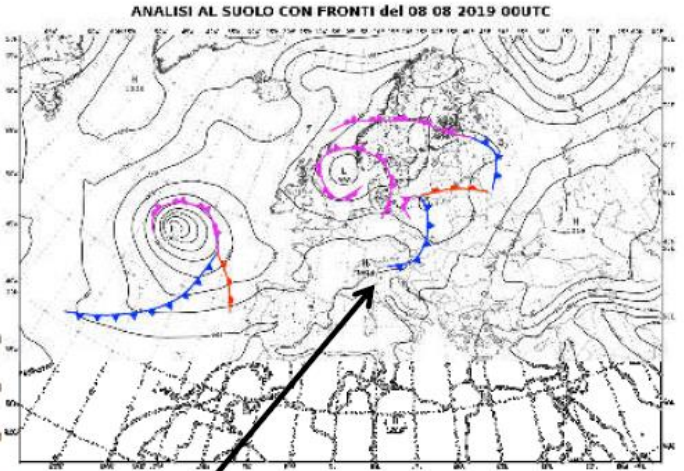
WG4

7 august 2019 Genova 21-22 UTC (excessive rainfall)

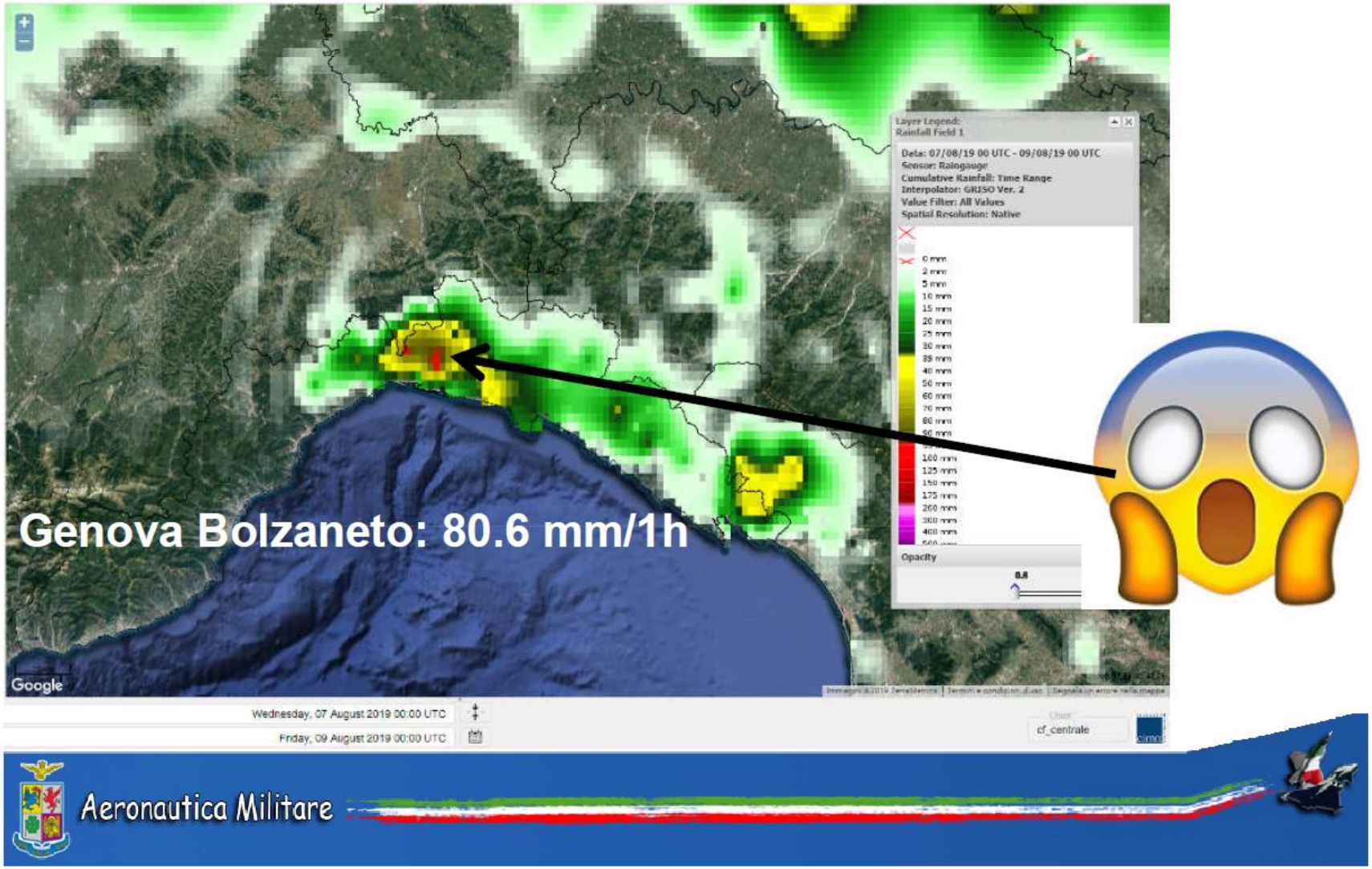




Genova

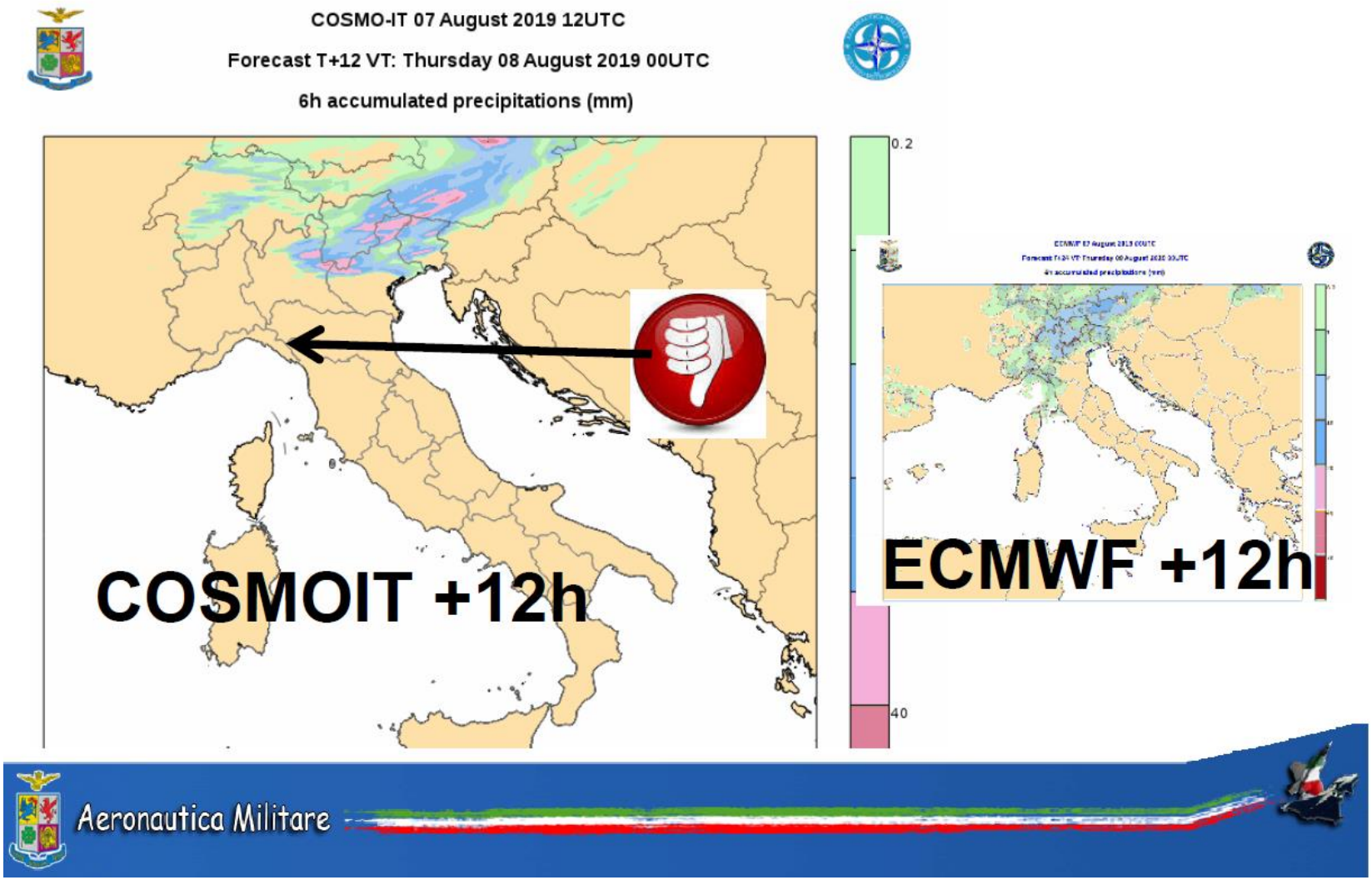
Aeronautica Militare

7 august 2019 Genova 21-22 UTC (excessive rainfall)



WG4

7 august 2019 Genova 21-22 UTC (excessive rainfall)



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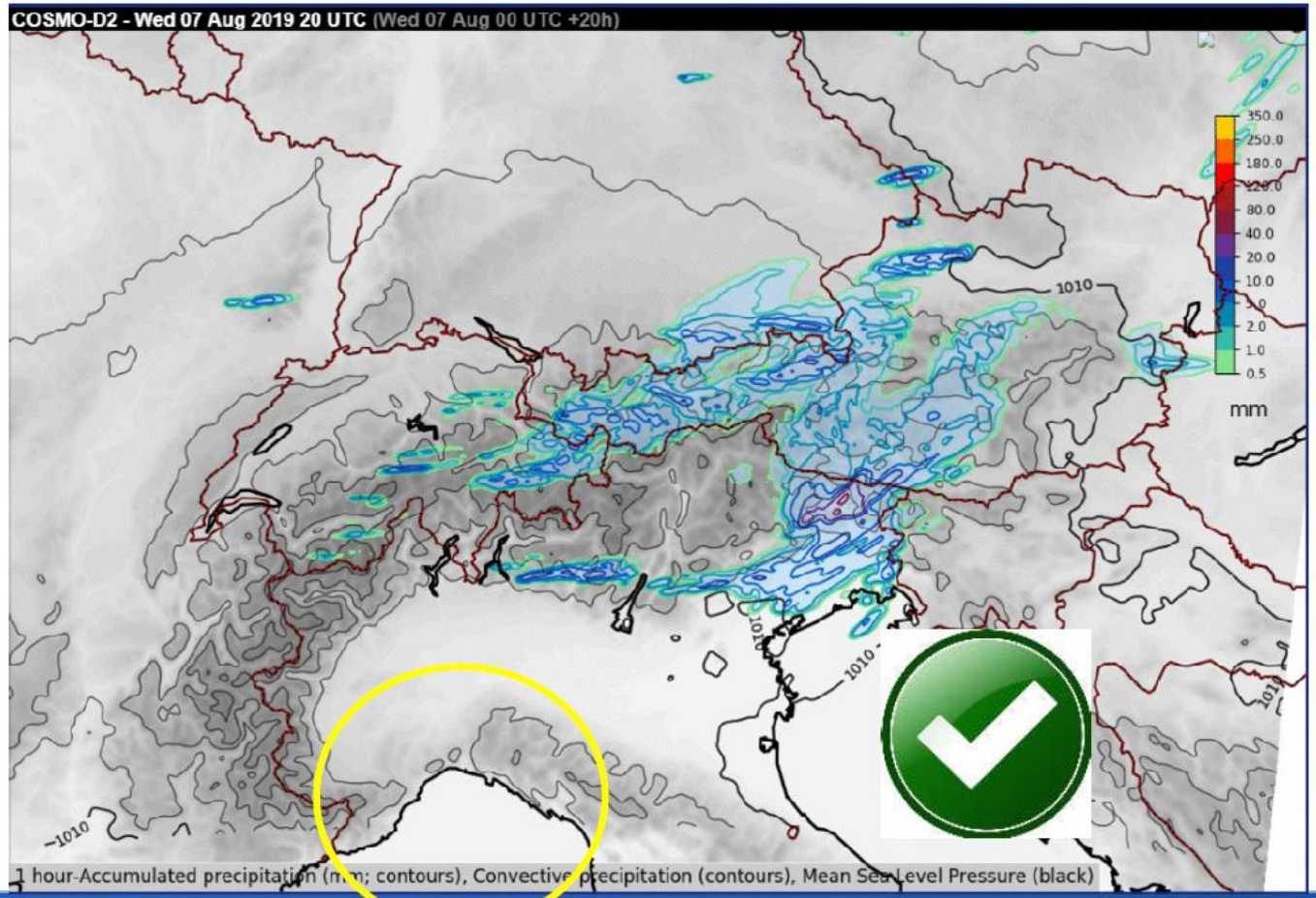


Aeronautica Militare

IMGW-PIB

Overview of IMGW-PIB tasks within PP AWARE

COSMO-PL "failures"

Setup

To assess (more or less automatic) poor forecasts surface parameters were used.
T2M, TD2M, RH, U10M, SFC Press. and PMSL were selected to assess the questionable forecasts and their quality.
The values of all elements have been normalized as follows:

N_Val = abs (FCST-OBS) / maxdif (OBS, FCST; *dt*)

0 <= N_Val <= 1

with *dt* being the period (climatological, 2012-2018), maxdif - maximum difference between OBServation and ForeCaST in a given period
The sum of N_Val from the above elements was determined. The worst forecasts were determined – those for which this sum was the highest.

COSMO-PL ”failures”

Results

One situation was selected for each year for which the forecast deviated most from the measurements.

2018.06.08.00 (two consecutive poor forecasts)
2017.02.13.12
2016.09.25.06
2015.03.20.00
2014.05.29.00 (two consecutive poor forecasts)
2013.01.10.12 (three consecutive poor forecasts)
2012.10.12.06

COSMO-PL "failures"

Results

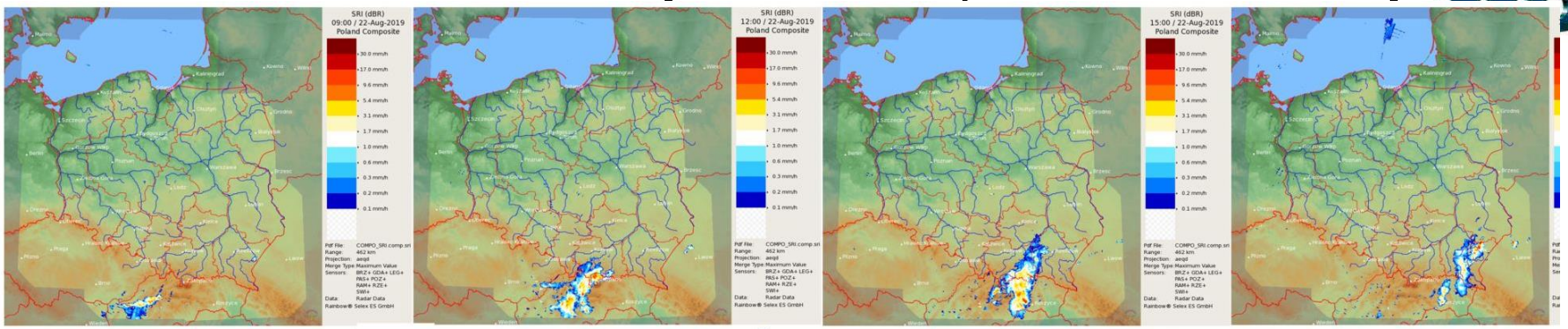
In addition, two terms related to HIW, and especially to intense convective phenomena, were selected to the complete set. 2017.08.11 - most likely supercell moving from south to north, caused major material damage, two deaths at a scout camp, prosecutor's investigation and allegations against synoptics. 2019.08.22 Intensive storm in the Tatra Mountains, the most tragic in the last 80 years - 4 people were killed, more than 100 wounded.

Key issue: given a forecast, should a top-level warning be issued?

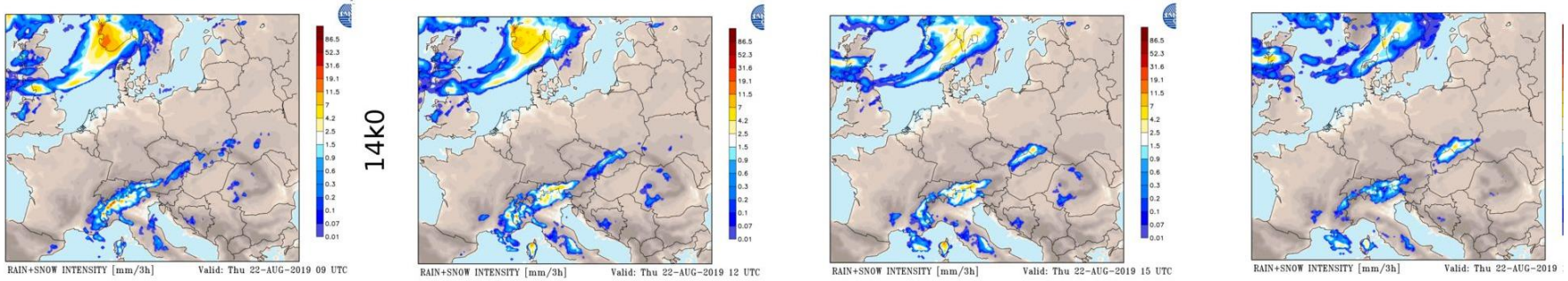
HIW on 2017.08.11 was examined in both EPS and deterministic approaches using increasing resolution in nested domains from 7 km through 2.8 to 0.7 (preliminary approach).

Curiosity: VGUST bubble forecasted at a resolution of 2.8 km, 2019.08.30

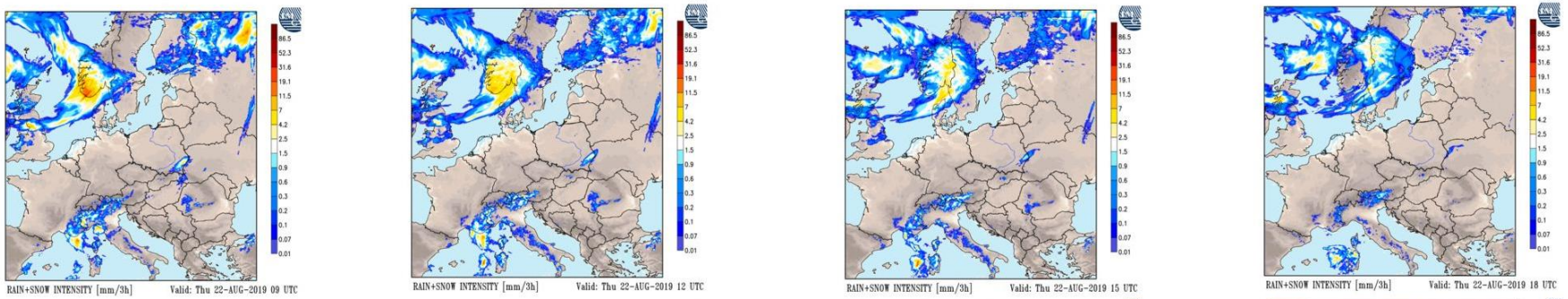
Storm in the Tatra mount. (2019.08.22, fcst start 00:00)



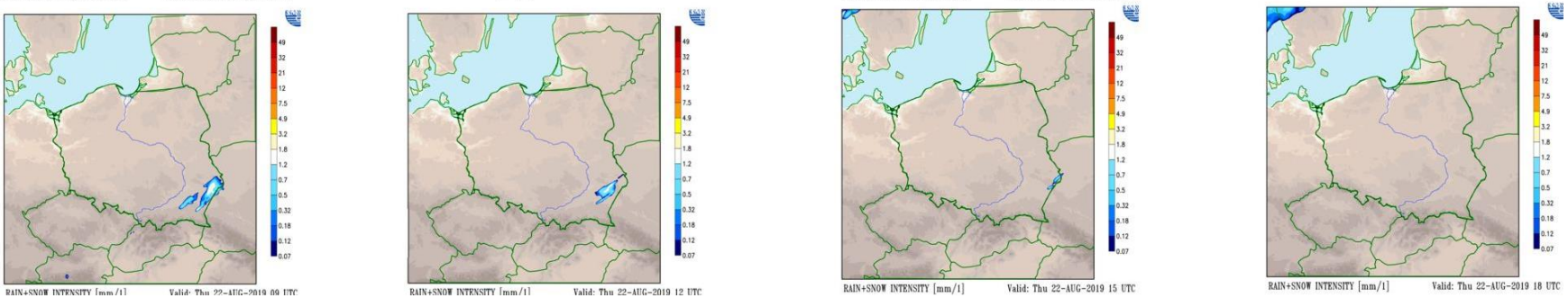
14k0



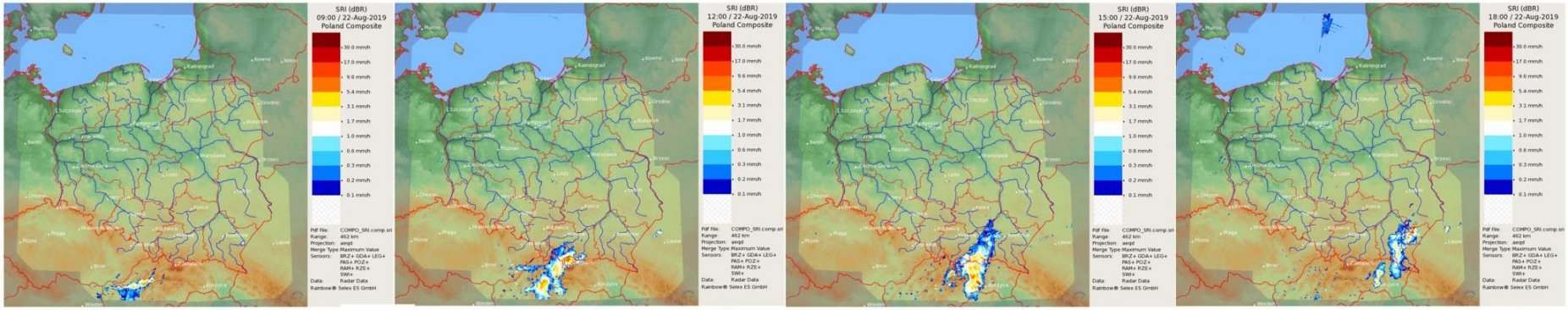
7k0



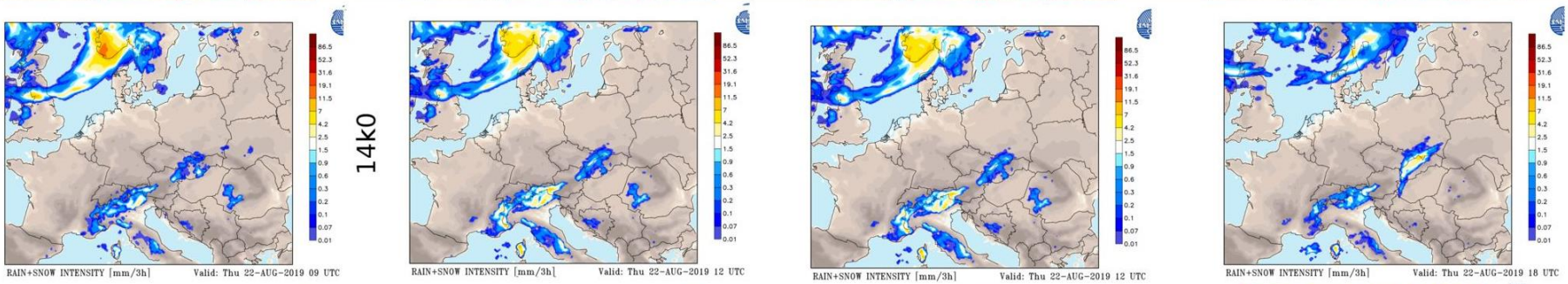
2k8



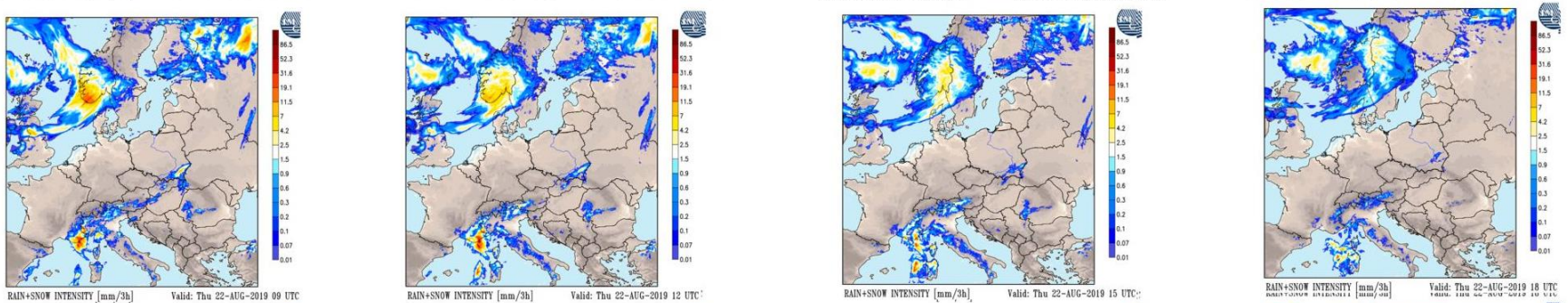
Single case – HIW event (2019.08.22, fcst start 06:00)



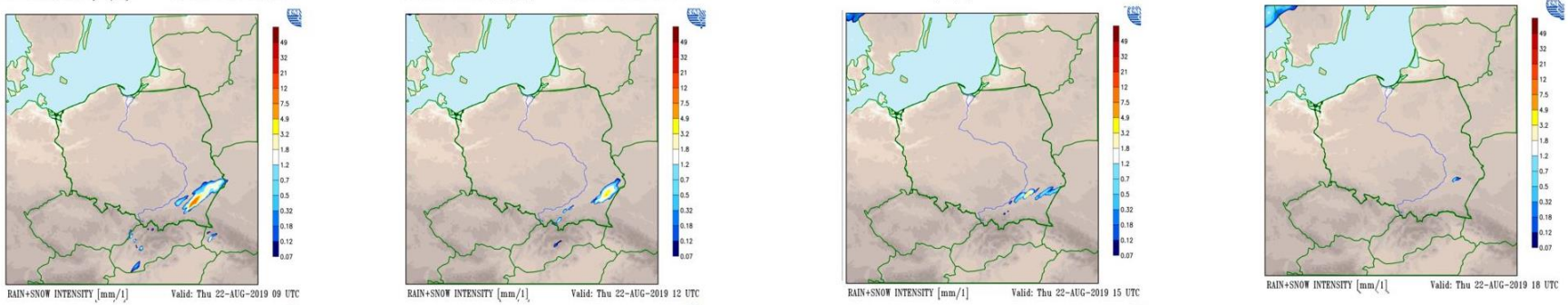
14k0



7k0



2k8



Conclusions

Most effective in very high resolution – Supercell Detection Index. (identifies the path of the supercell northward), VMAX (as DMO), reflectivity forecasts.

Fuzzy logic verification looks promising as a tool to assess a quality of forecast.

Single case – HIW event (2019.08.22) – strange that only 14km (and EPS 2.8) COSMO-PL predicted precipitation correctly, regardless of the forecasts start…

Single case – the huge bubble VGUST forecasted at a resolution of 2.8 km – definitely a very thorough investigation needed!

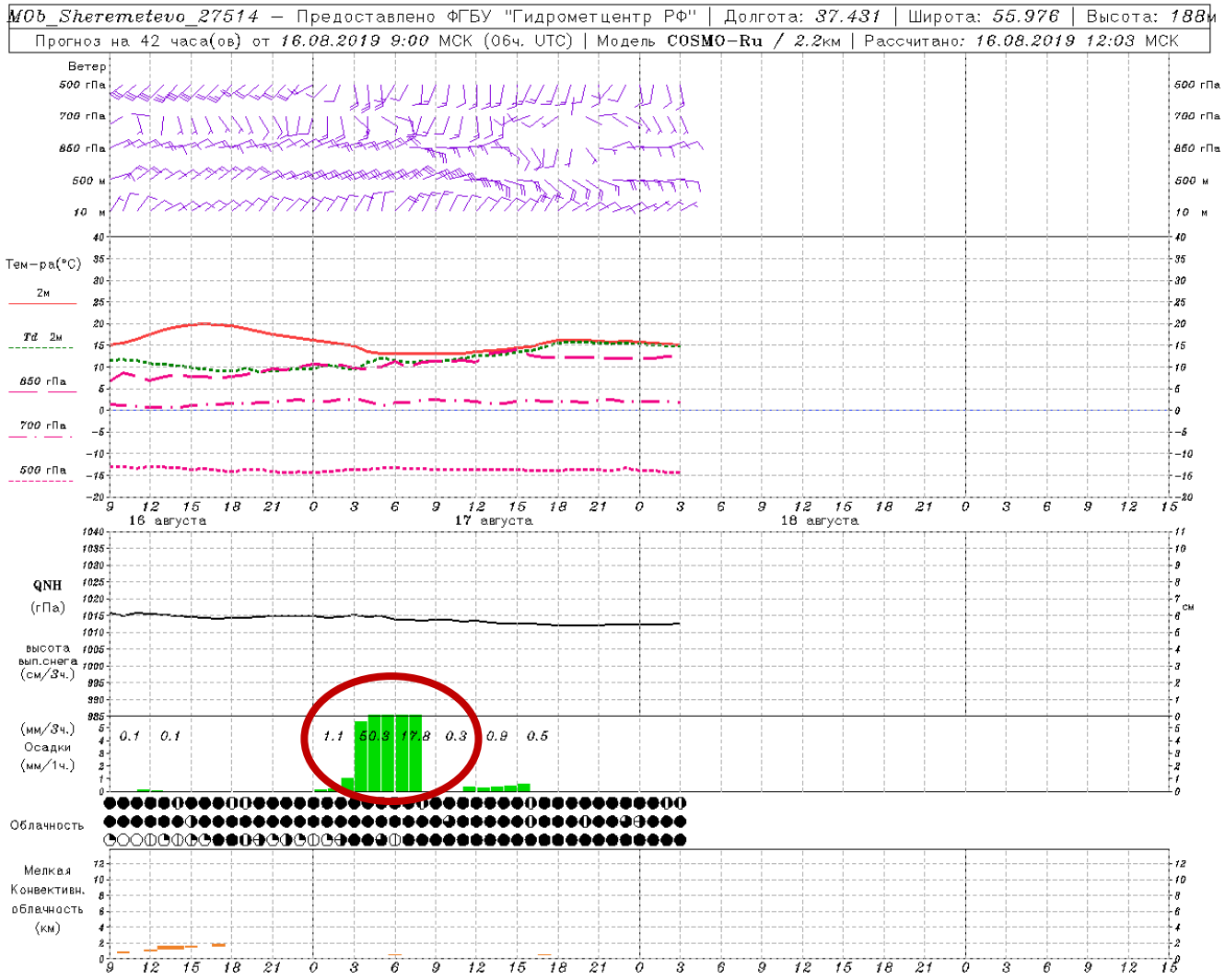
RHM

- NIGHT OF 14-15 AUGUST 2019:
  Only COSMO-Ru07 predicted rain,
  But about 3 hours later
  COSMO-Ru02 and COSMO-Ru01 – no rain
- 17 AUGUST 2019 COSMO-Ru02, 06 UTC run, **precipitation is overestimated and shifted**
- 30 MAY 2019 **Showers and thunderstorms in Moscow and Moscow region**
  COSMO-Ru01 with TERRA-URB : added value compared to COSMO-Ru02
- 13 JULY 2016: **Thunderstorm in the Moscow region, Tornado passage**

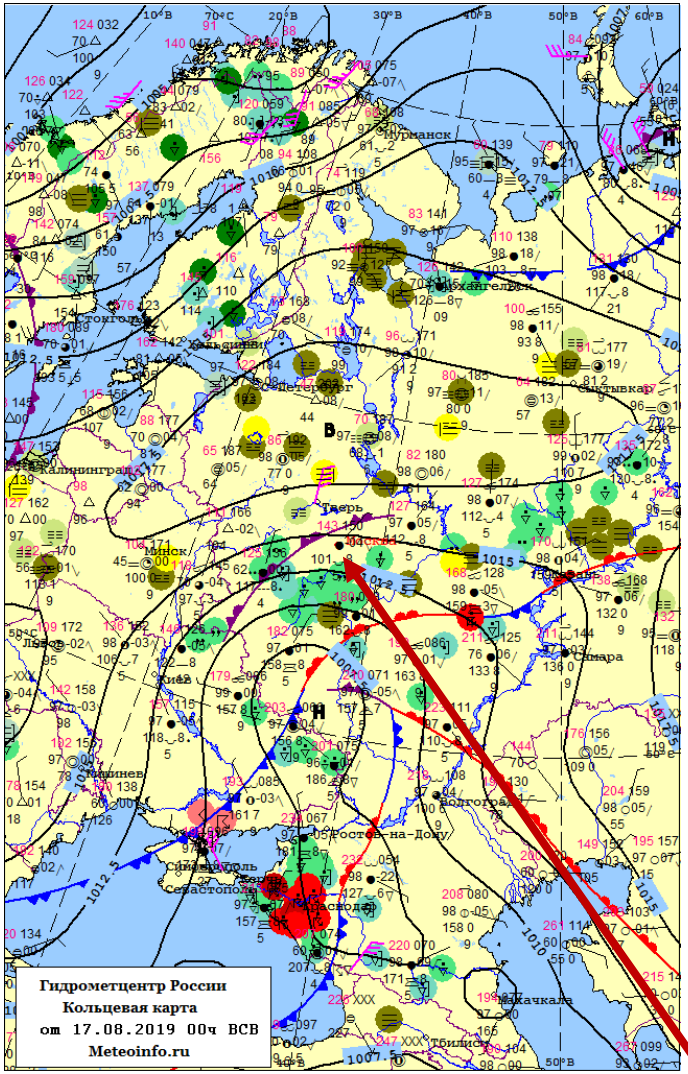
RHM: 17 AUGUST 2019

COSMO-Ru02 precipitation is overestimated and shifted

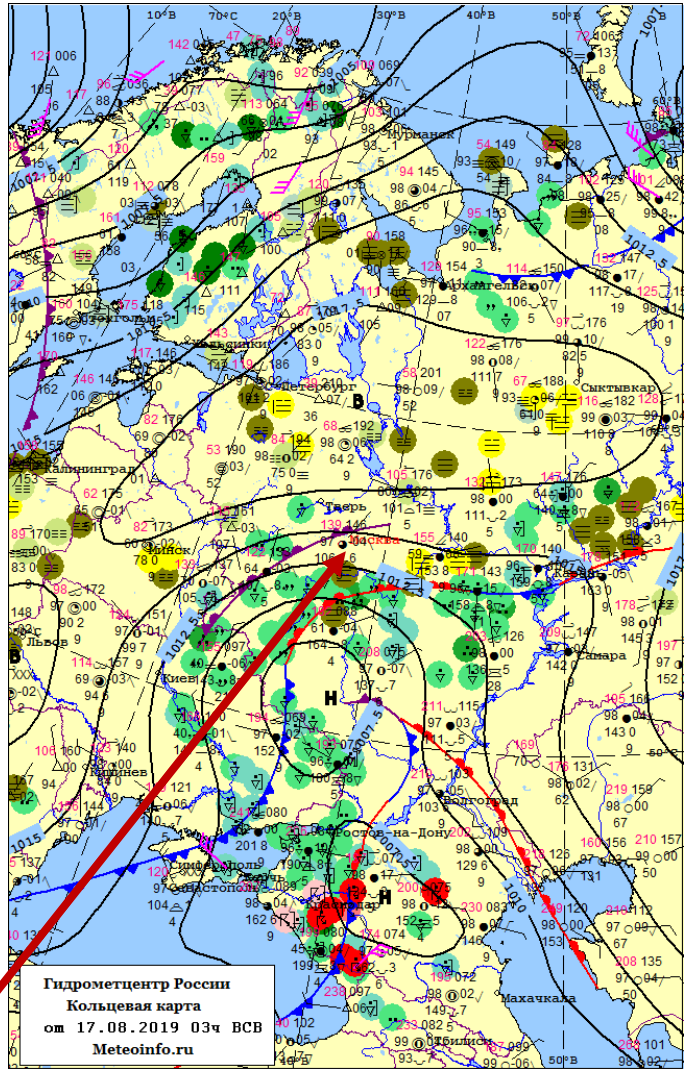
COSMO-Ru02 meteogram at Sheremetyevo airport, 17 Aug 2019, about 70 mm rain in 6 hours, 50 mm between 03 and 06 LT, run from 06 UTC 16 Aug 2019



RHM Surface analysis, 17 Aug 2019, 00 UTC, 03 LT (local time)

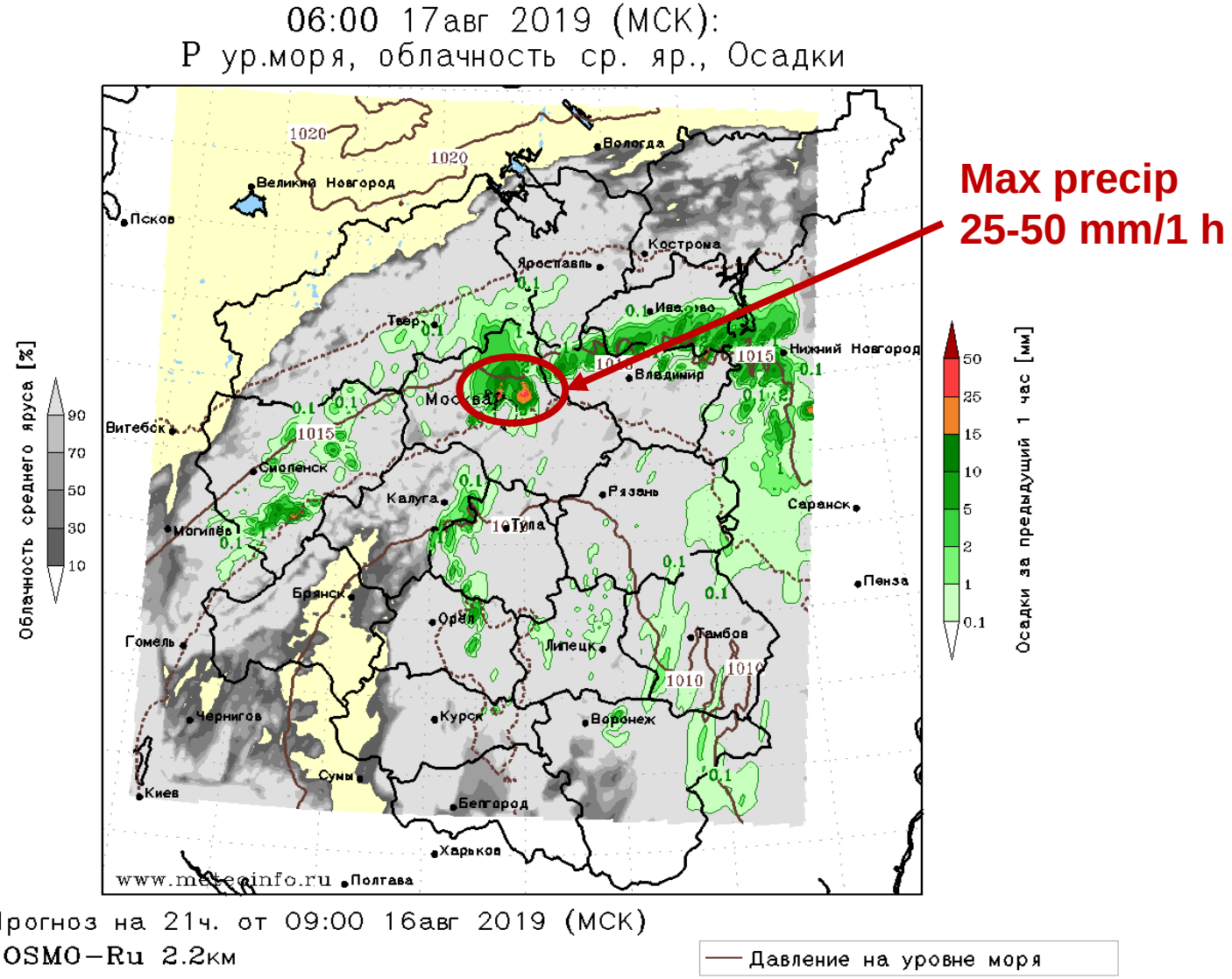


RHM Surface analysis, 17 Aug 2019, 03 UTC, 06 LT (local time)

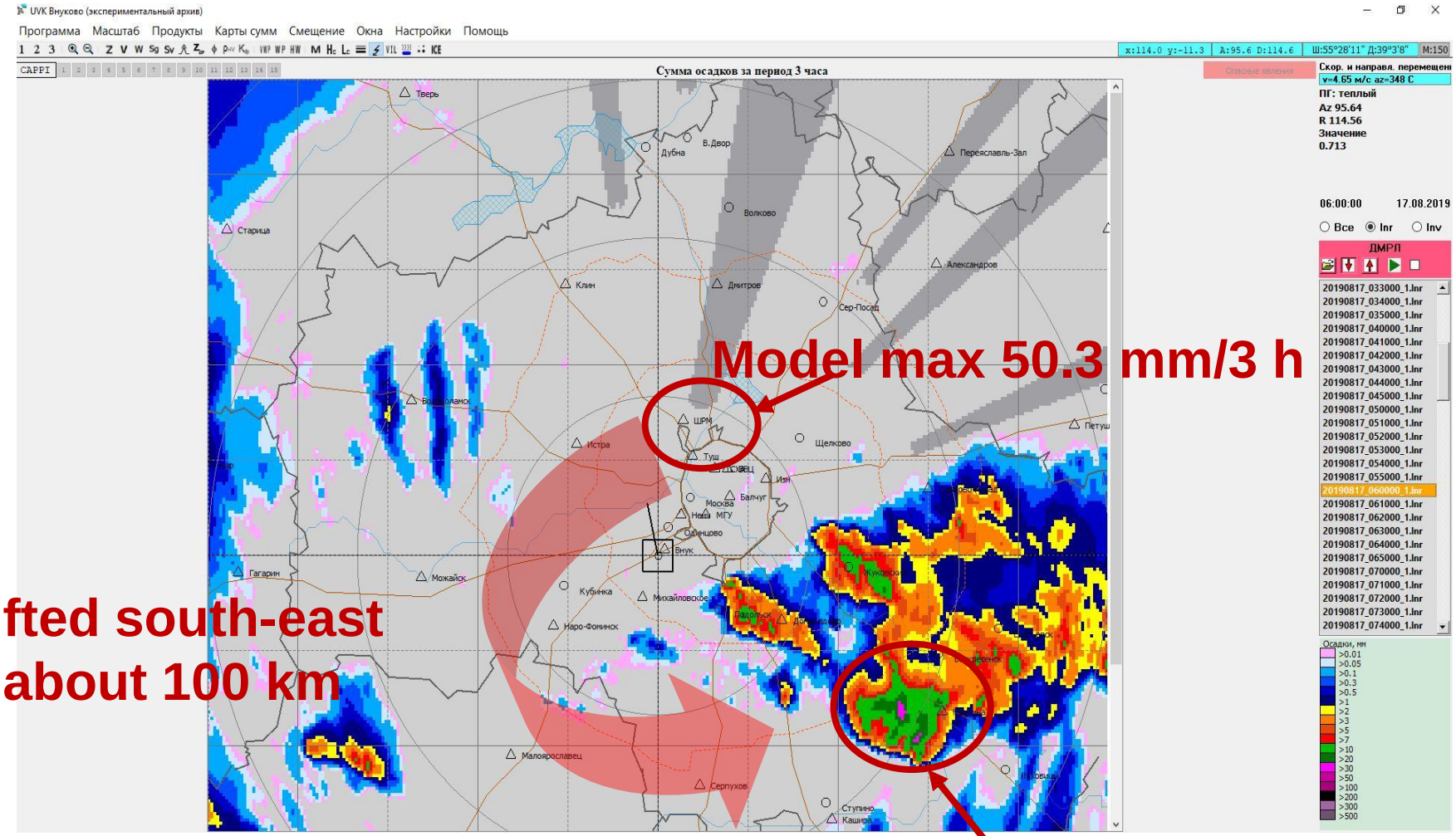


Moscow is in a periphery of a low

COSMO-Ru02 forecast 17 Aug 2019, 1 h precip accumulation 05-06 LT (local time), lead-time 21 h, run from 06 UTC 16.08.2019



In reality: maximum accumulation by the radar data 37 mm/3h



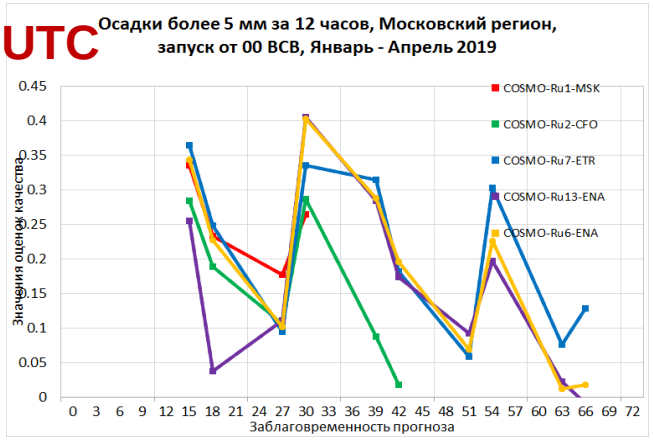
Forecasters feedback:

- **COSMO-Ru02 forecasts from 06 UTC often overestimate intense precipitation in the Moscow region**
- **The hypothesis of forecasters: incorrect assimilation of satellite data in the driving model, and thus too much cloud water**

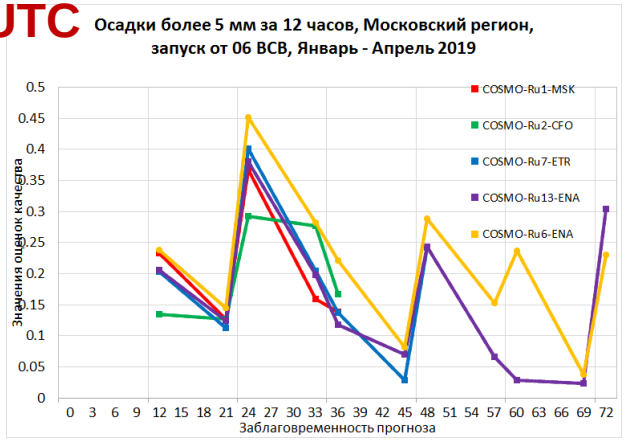
COSMO-Ru verification Jan-Apr 2019
ETS of precipitation higher than 5 mm/12 h

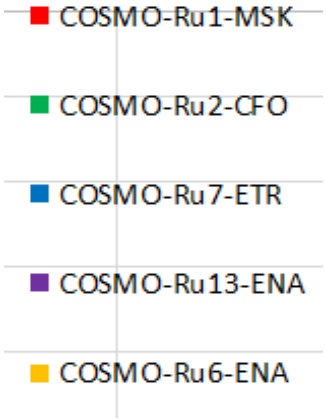
CONSORTIUM FOR SMALL SCALE MODELING COSMO

00 UTC

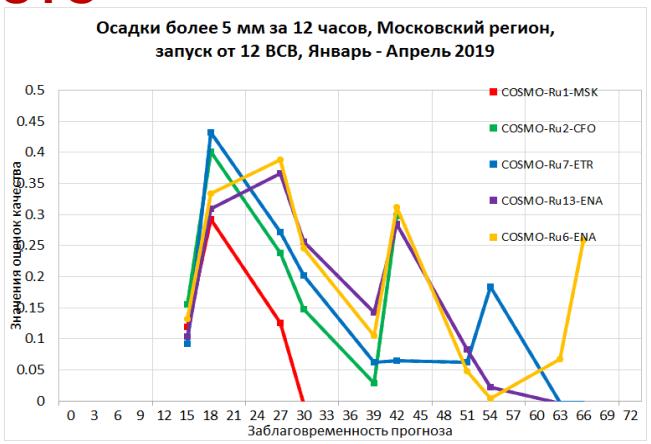


06 UTC

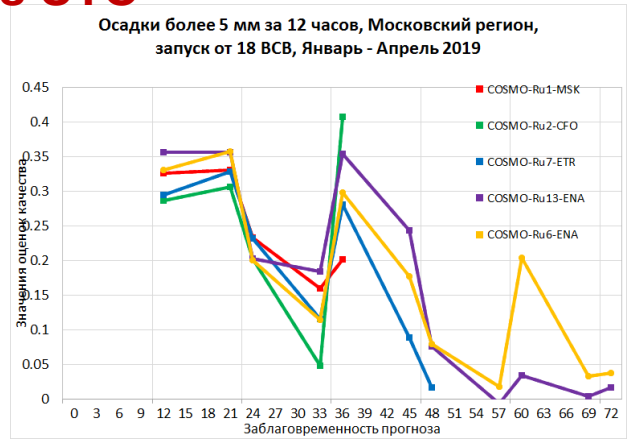




12 UTC



18 UTC



No significant difference for 06 UTC run compared to other runs,
To further investigate this, summer scores are being processed,
and spatial scores will be added soon

WG4

RHM: 13 JULY 2016

Thunderstorm in the Moscow region

Tornado passage

(Analysis by Denis Zakharchenko,

MSU PhD student, researcher at the Hydrometcentre of Russia)

WG4

13 July 2016 Tornado damage

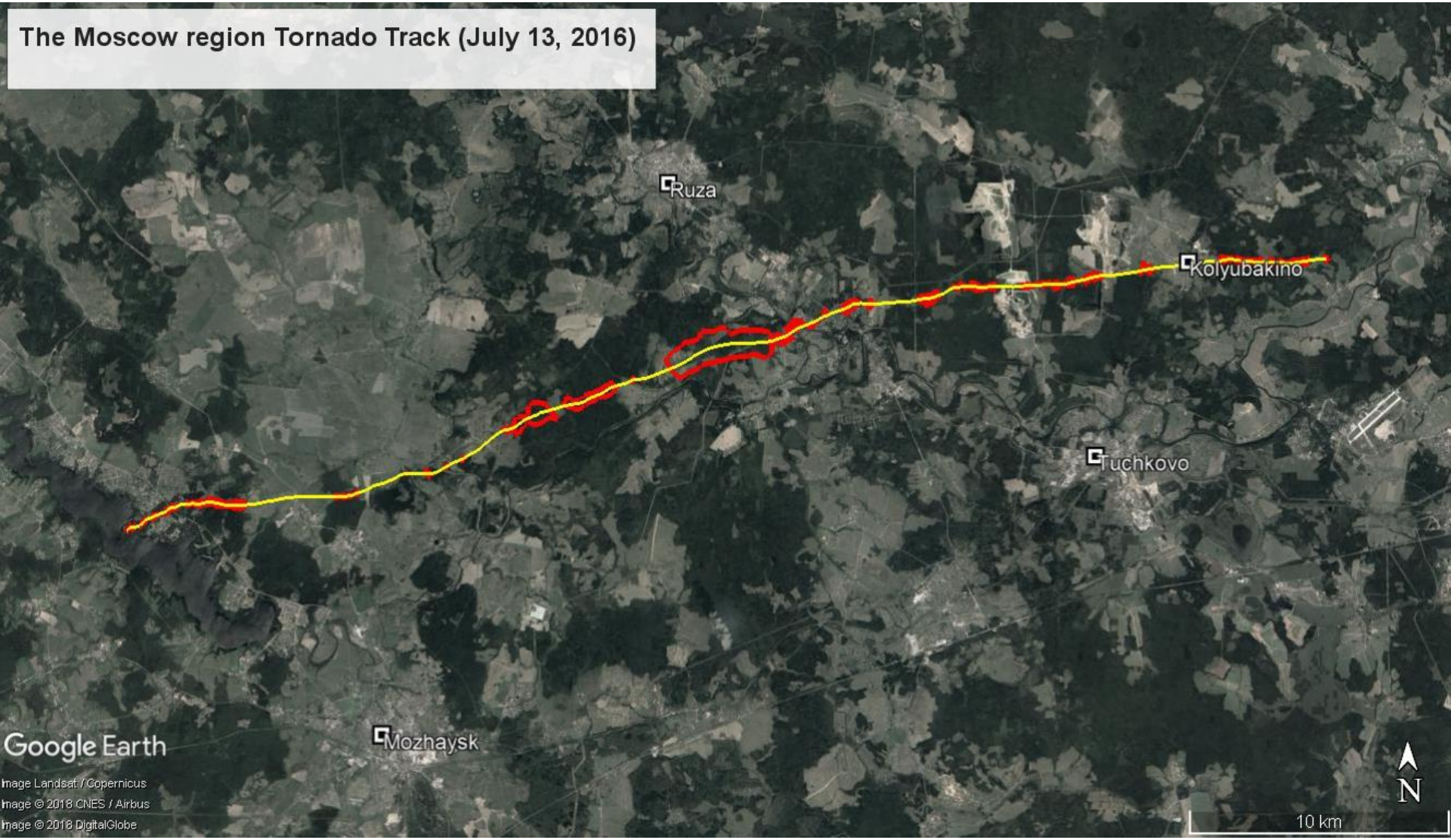
Two deaths, 17 wounded,
100 houses destroyed in the Moscow Region, Kolyubakino village suffered most

In Moscow: 9 wounded,
2 hit by lightning

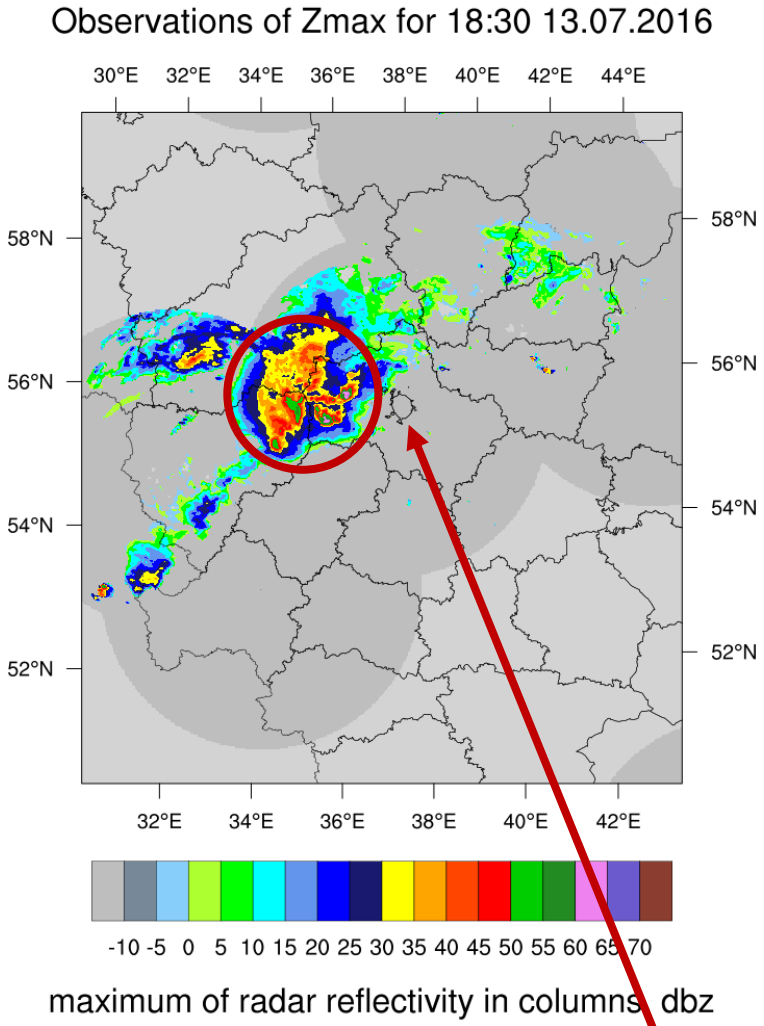
Thousands of trees broken

WG4

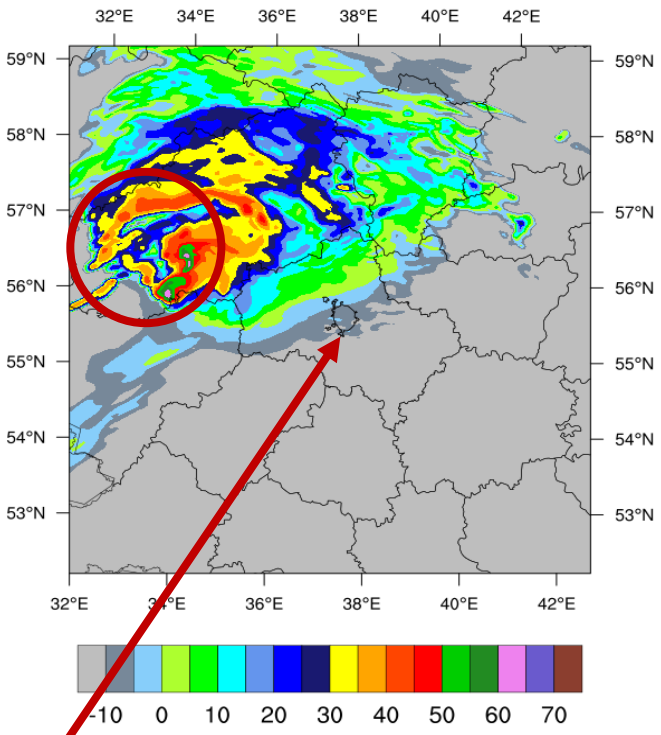

Tornado-induced Tree Fall Pattern
Google Earth
Image © 2018 DigitalGlobe
N
100 m


The Moscow region Tornado Track (July 13, 2016)
Ruza
Kolyubakino
Tuchkovo
Mozhaysk
Google Earth
Image Landsat / Copernicus
Image © 2018 CNES / Airbus
Image © 2018 DigitalGlobe
N
10 km

Maximum radar reflectivity, dBZ
18:30 UTC 13 July 2016



COSMO-Ru02 forecast for 18:30 UTC,
run from 13 Jul 2016, 12 UTC



Moscow

The high maximum reflectivity is forecasted by COSMO-Ru02 but shifted to North-west by about 200 km

The official forecast was

- **Yellow warning level**
- **Thunderstorms and wind increase up to 15 m/s in the North-Western part of the Moscow region**

Outlook

- **At present, with the models with grid mesh of 1-2 km, the risk of tornado can be predicted mainly from the maximum reflectivity structure and convective instability indices (CAPE, SRH, SCP, …)**
- **The experiments are planned with ICON-LAM with very high resolution (sequence 1000 m -> 500 m -> 200 m, later on up to tens of meters) to assess the feasibility of direct tornado risk forecast**

ARPAE-SIMC

- **1-5 December 2018: air quality case**
- **2 August 2019:** The entry of cold air at high altitude, linked with the trough axis, activates a frontal passage moving from NW to SE, with the formation of an intense storm system that crosses Emilia Romagna. A storm cell develops near Bologna, where hail to medium-large size is recorded between Budrio and Medicina. **COSMO 5M wrong precipitation pattern and understimation of precipitation amount, COSMO-2I good forecast. Wind gusts are predicted well in both model versions**

  Note that COSMO-ME (5 Km) from COMET had a precipitation and wind pattern very similar to COSMO-5M

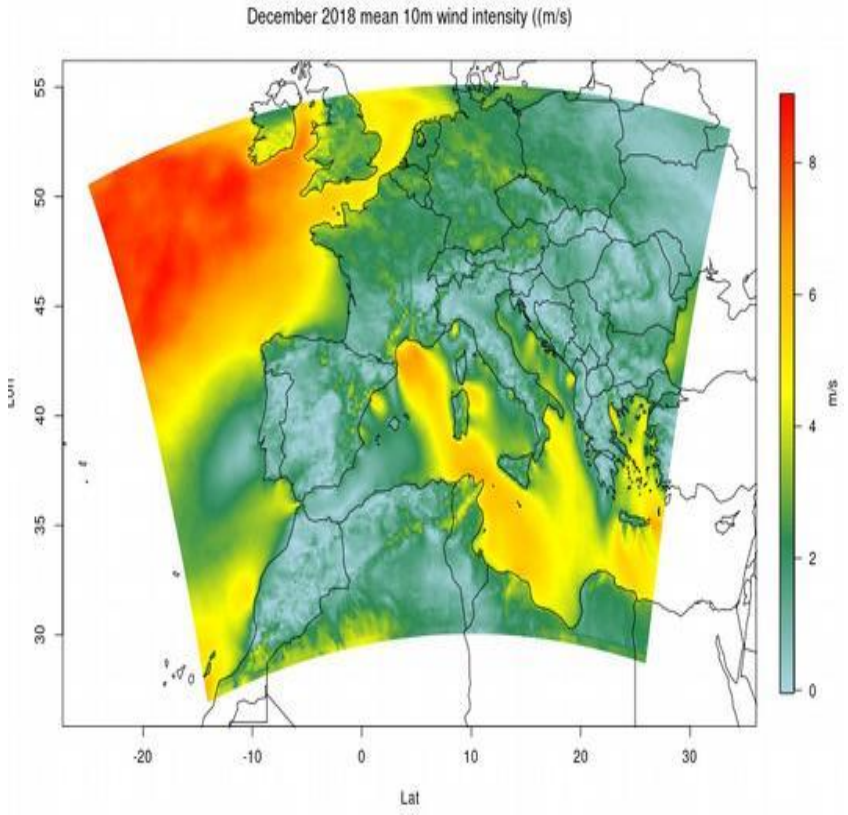
1-5 December 2018

An application to air quality

The problem: December 2018 in the Po Valley

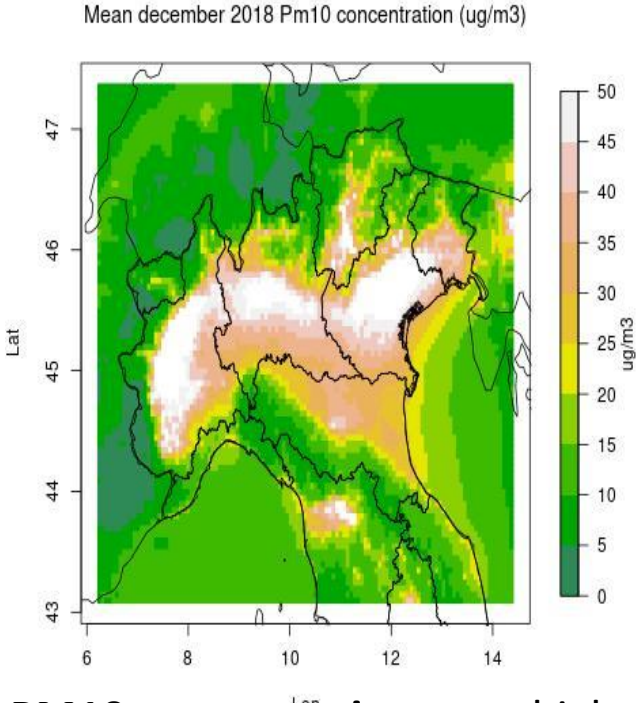
The peaks in pollutants concentrations occurring in the Po Valley are mainly due to ''unlucky'' meteorological condition associated with high static stability and unfavourable dispersion situation in the lower layers

Analysis from CHIMERE model: mean wind intensity for December 2018



Wind intensity: very weak winds in the Po Valley

Analysis from CHIMERE model: mean PM10 concentration for December 2018



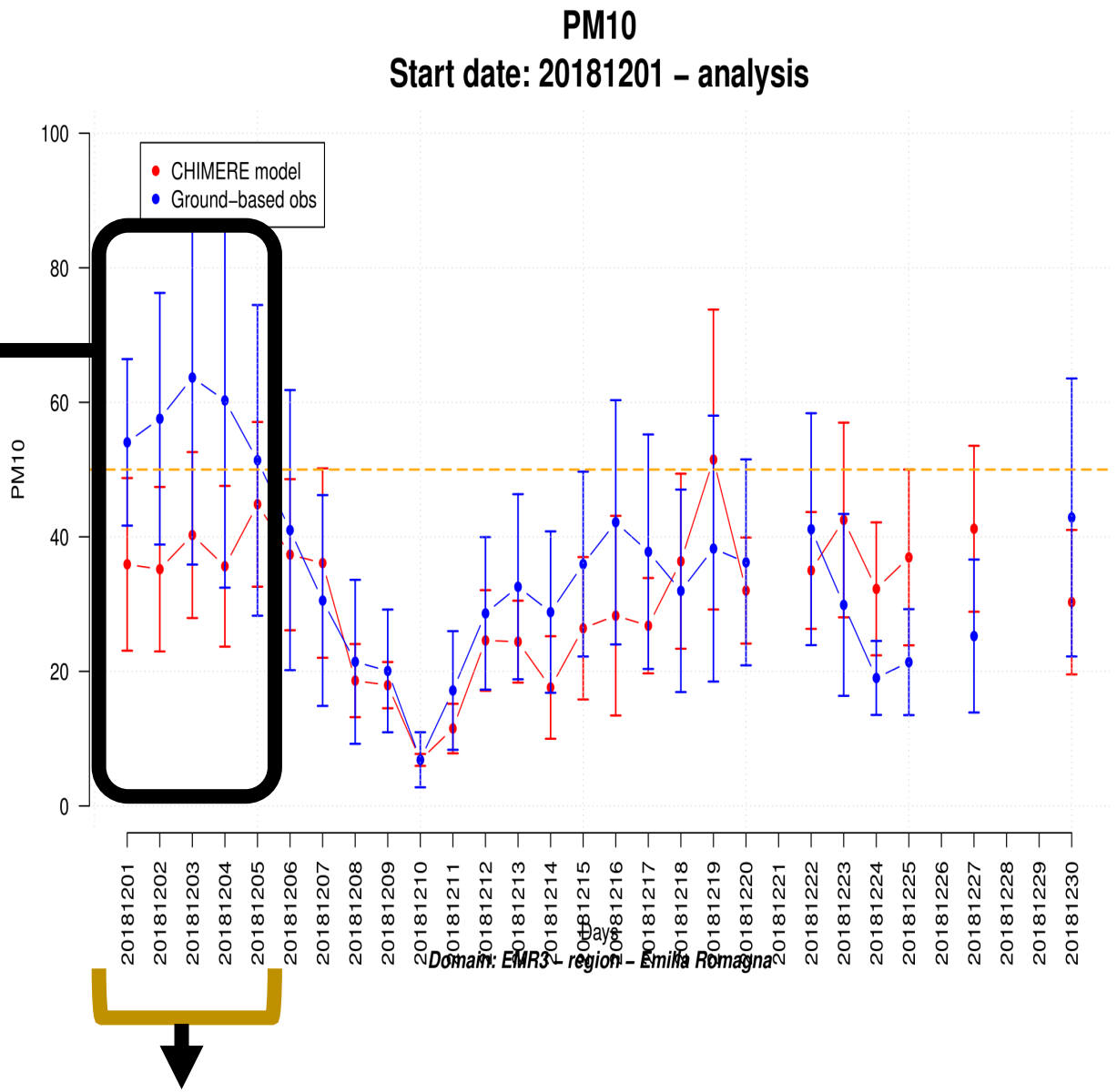
PM10 concentration: very high concentrations of atmospheric particulate over the Po Valley, especially on the northermost part

The problem

There is a great difference between the observations and the forecasts, interalia through the legal limit of 50ug/m^3

CHIMERE uses the meteorology of COSMO 5M

Ground-based observations are obtained from regional averages with standard deviation

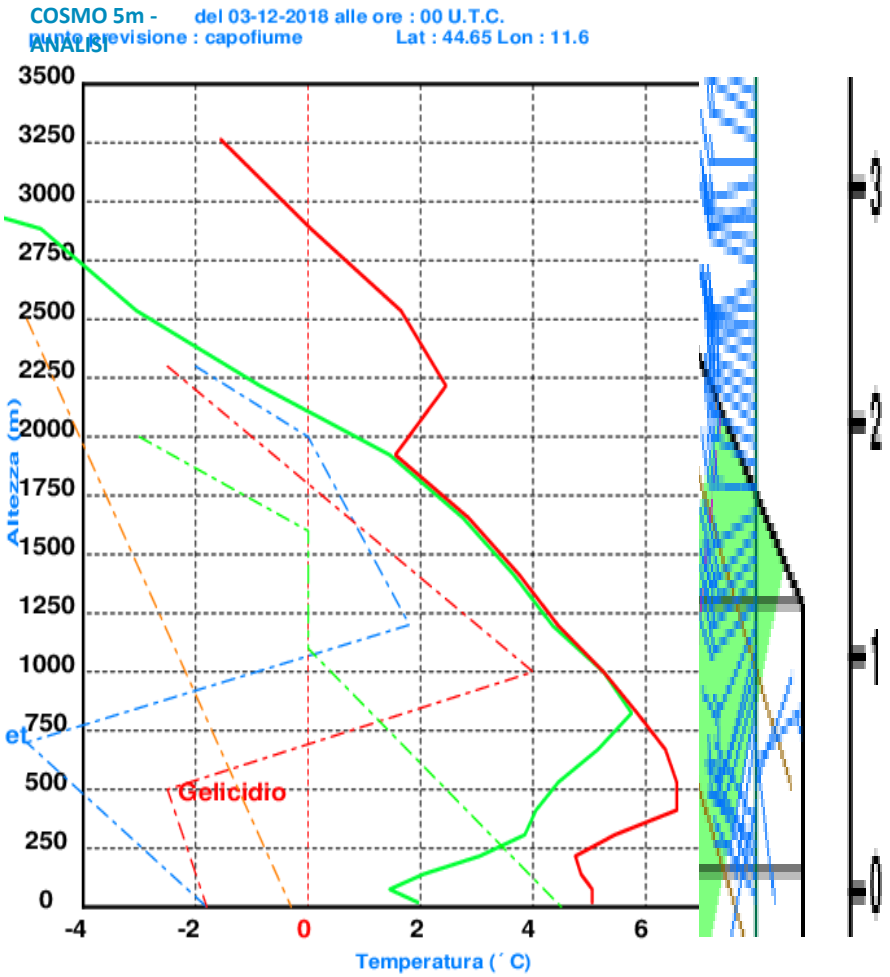


From 1/12/2018 to 5/12/2018

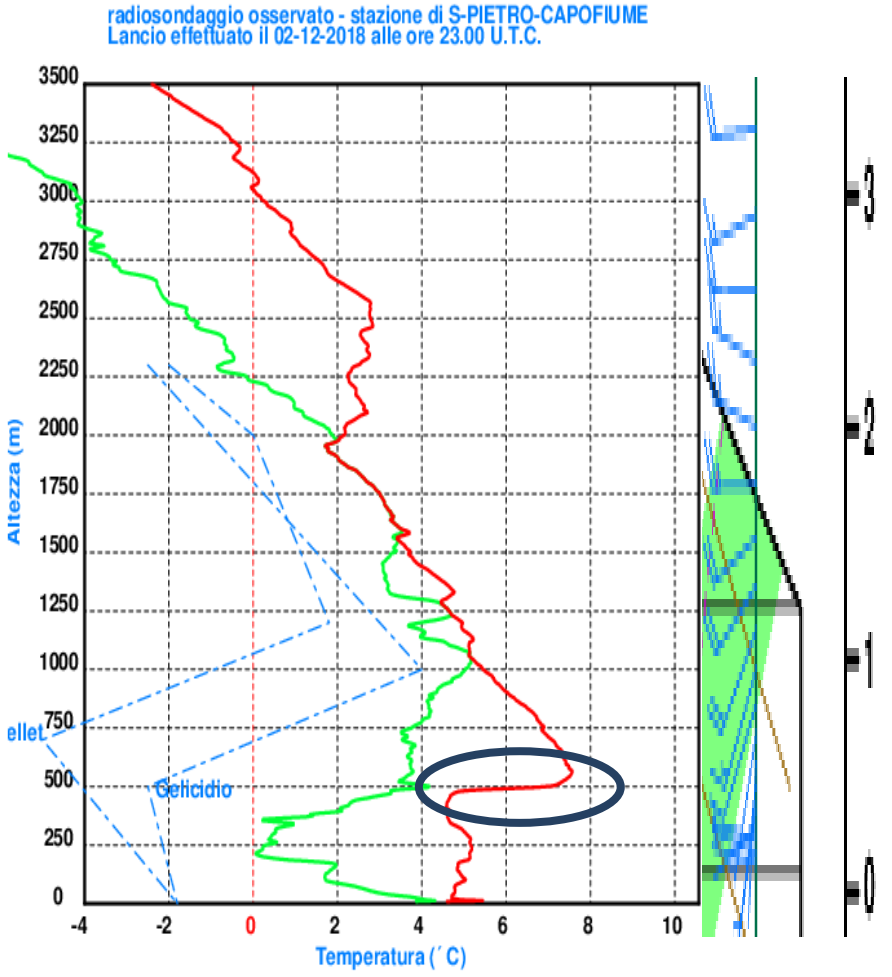
Thermodynamic profile of the atmosph

Radio sounding San Pietro Capofiume

Analysis

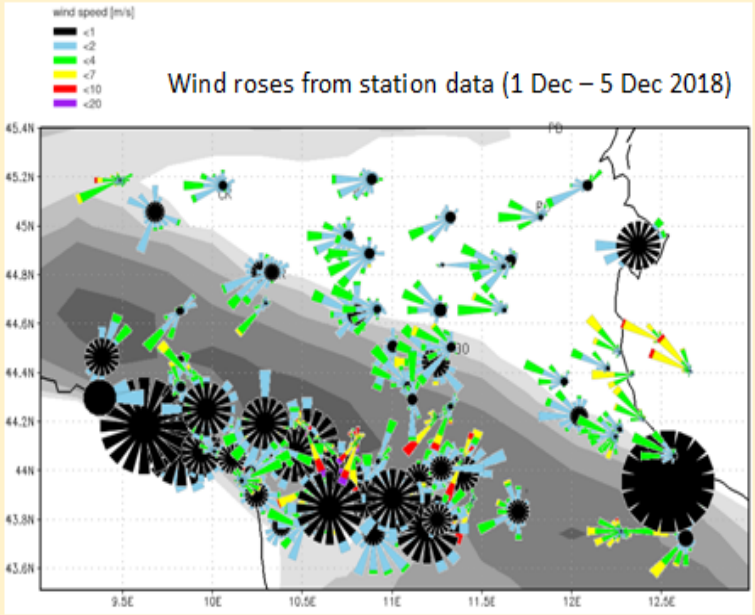


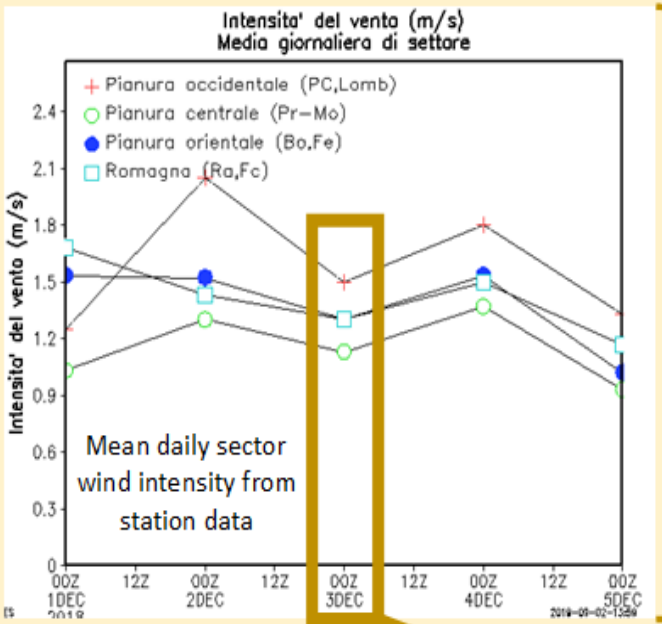
Observation



Stronger inversion at about 500m

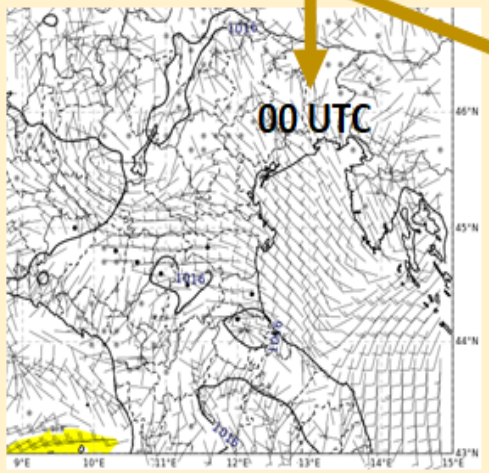
Wind

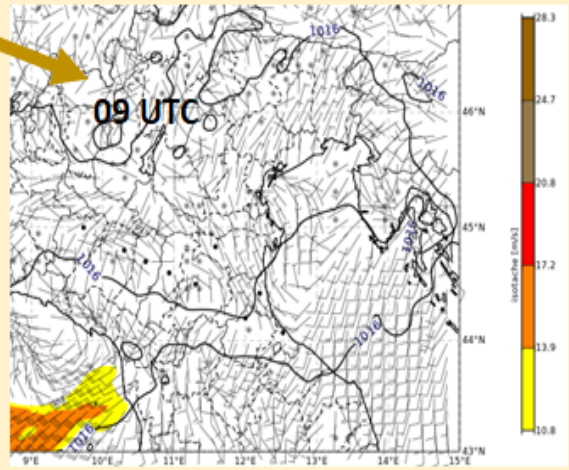




Observed weak NW winds over the plain

Example 3 Dec 2018: the the wind forecasted by COSMO 5M is too strong compared to the observations (almost > 5 kn = 3 m/s)





WG4

Summarising

In the Po Valley

In very stable atmospheric conditions, when synoptic forcing is missing and thermodynamic processes are very important

	MODEL
INVERSIONS	≈
WIND INTENSITY	>
CLOUD COVER	≈
POLLUTANTS	-

[Small inaccuracies in meteorological parameters are sufficient to create large differences between expected and observed pollutants concentration]

MeteoRomania: Summer 2019 very challenging for forecasters (May, JJA) and COSMO-RO (7km)!

- particular cases:

  May (31.05)

  June (6.06, 7.06, 9.06-11.06, 19.06-25.06, 27.06-28.06)

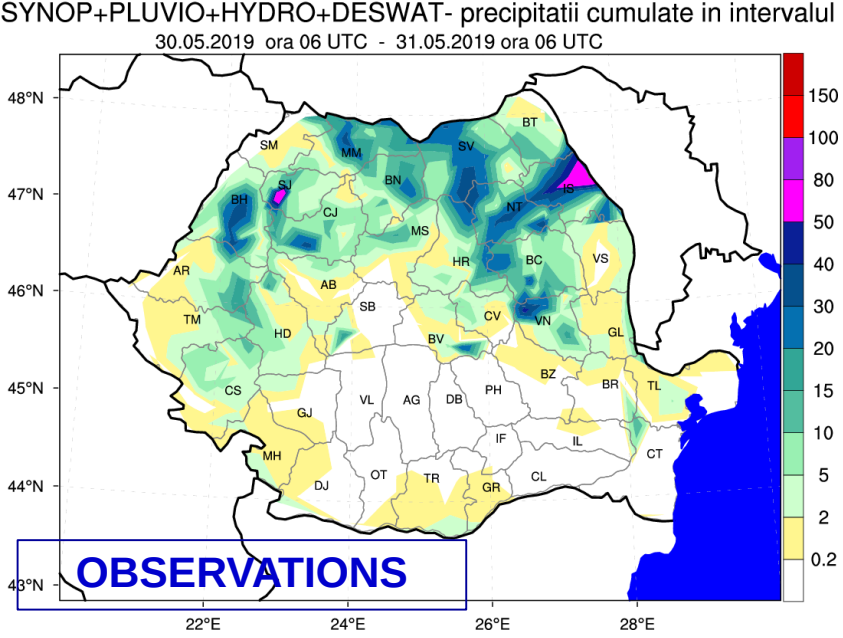
  July (2.07-5.07)

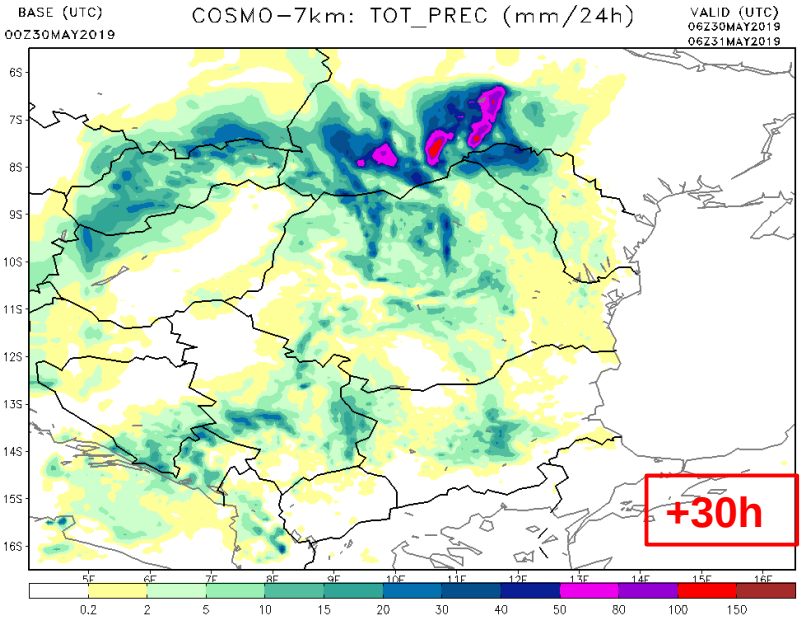
  August (1.08)

- **similar behavior for most country domain for these cases (observations)**:

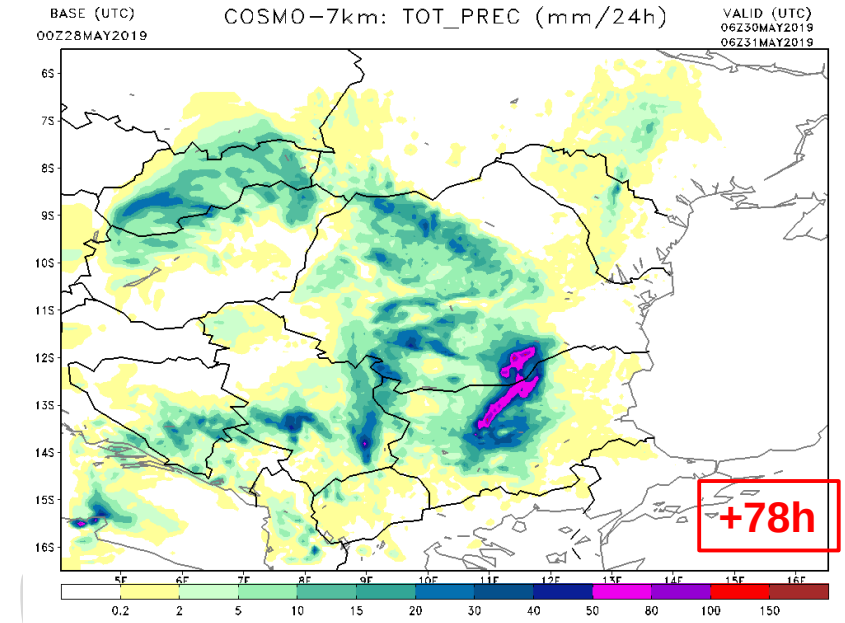
  either no precipitation for entire domain or heavy precipitation in most regions of the country

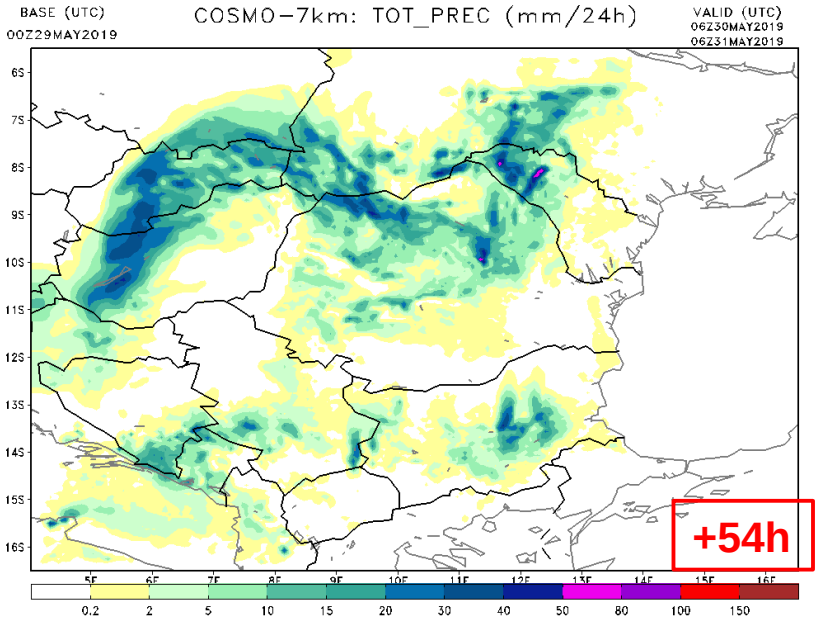
  COSMO-RO7 strongly underestimated precipitation in these cases of heavy observed precipitation, in particular, in the E and SE regions of Romania

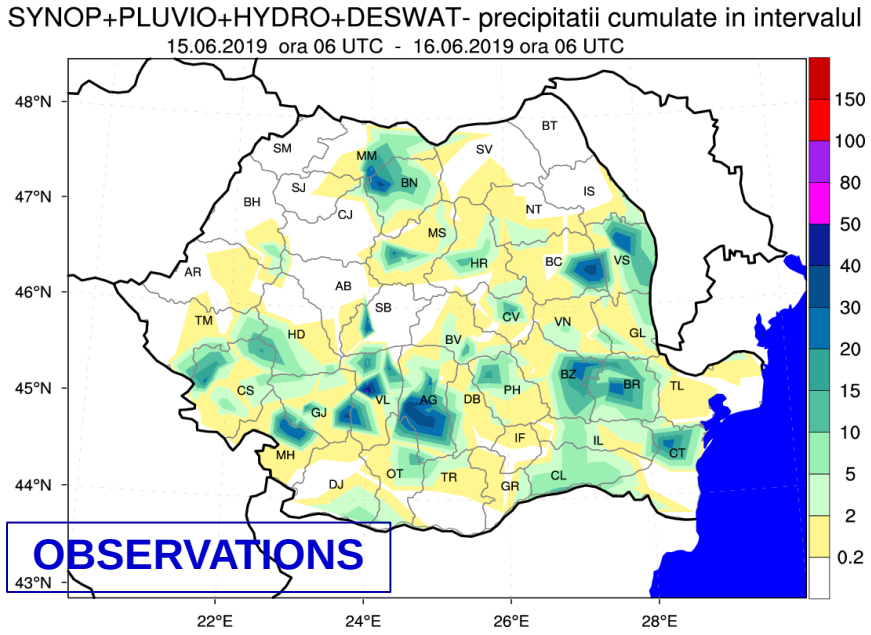


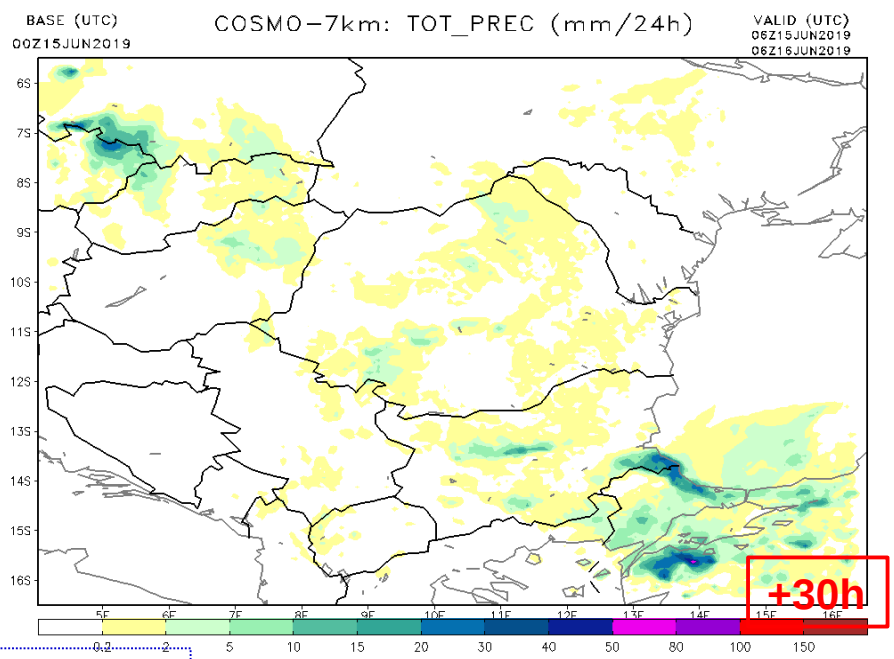


30.05-31.05 06UTC

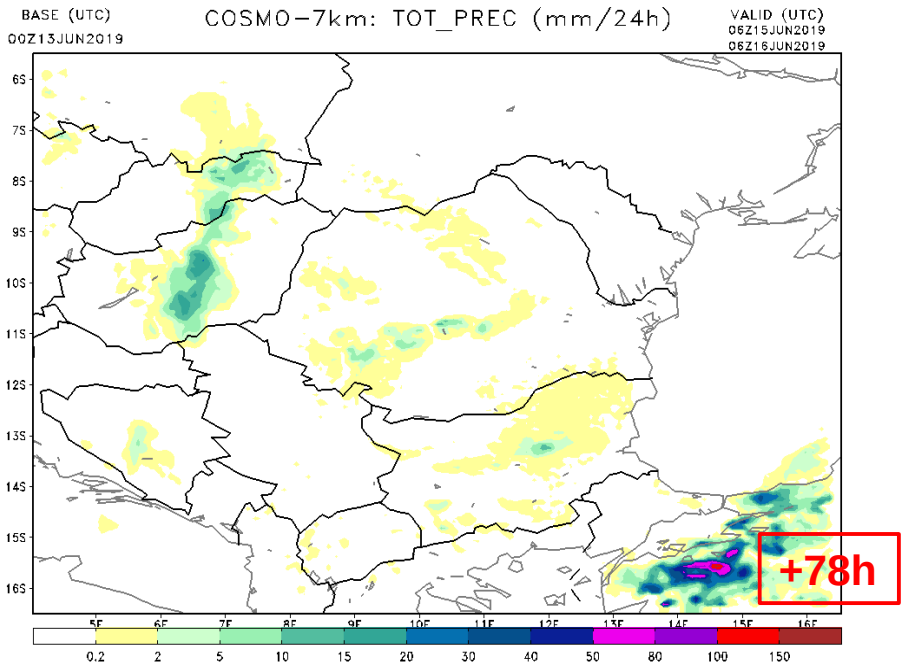


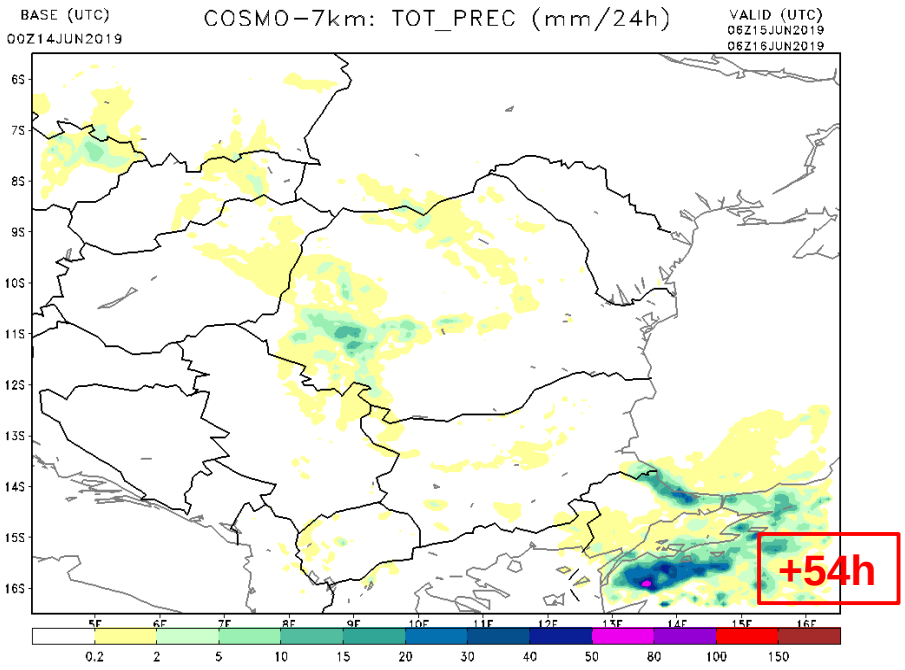






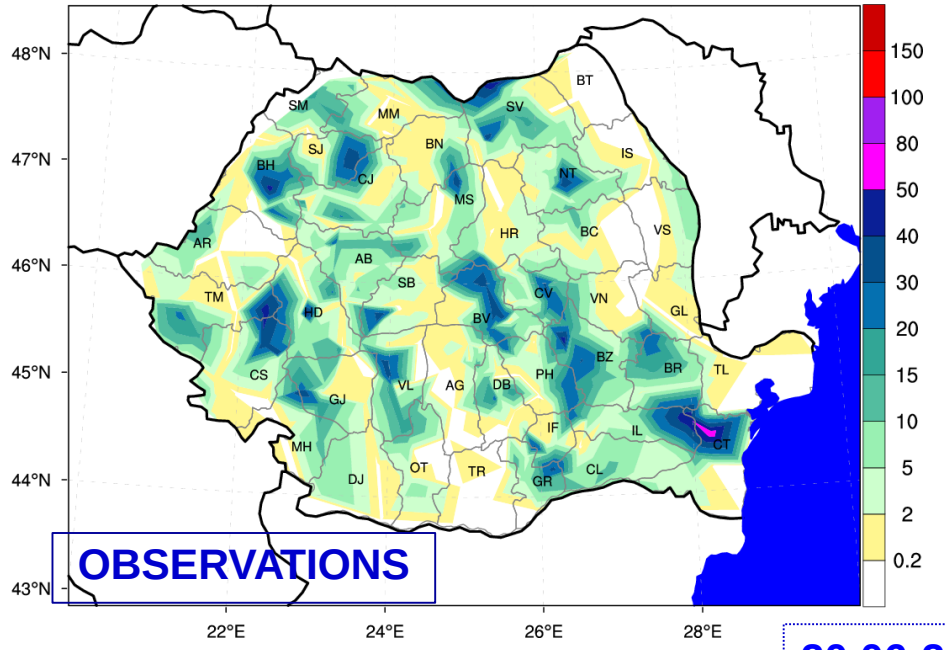
15.06-16.06 06UTC

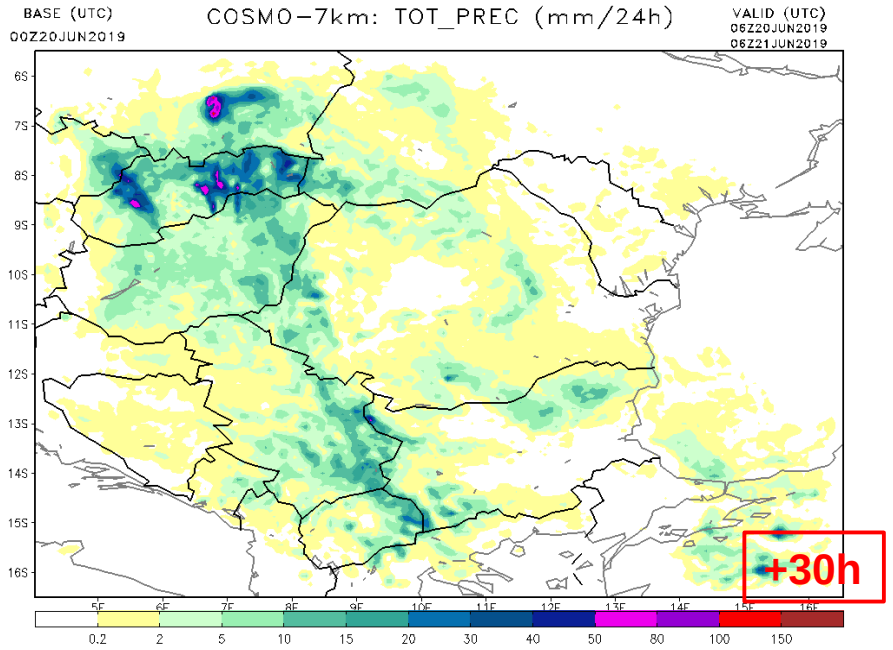




SYNOP+PLUVIO+HYDRO+DESWAT- precipitatii cumulate in intervalul

20.06.2019 ora 06 UTC - 21.06.2019 ora 06 UTC





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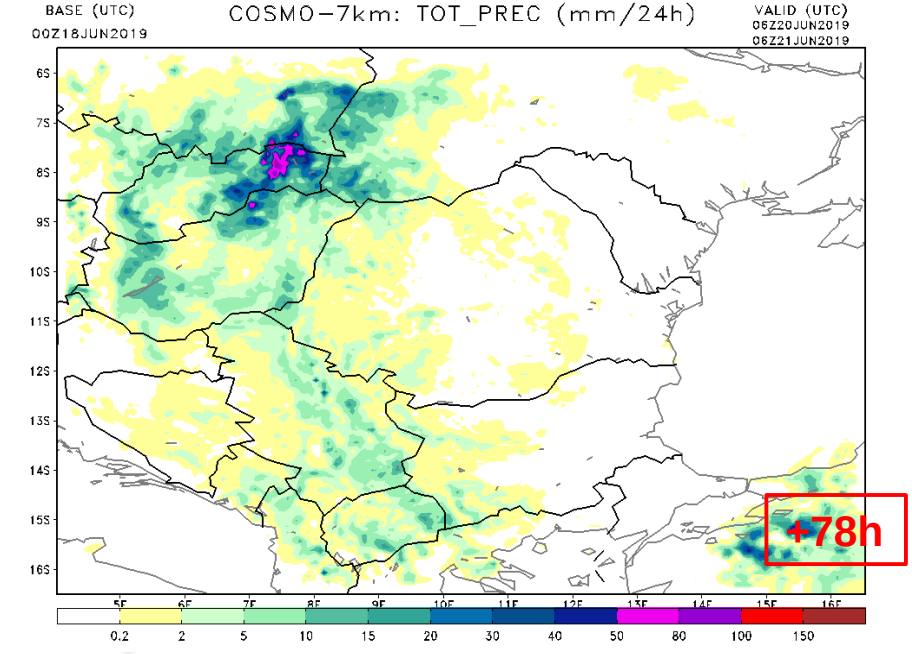
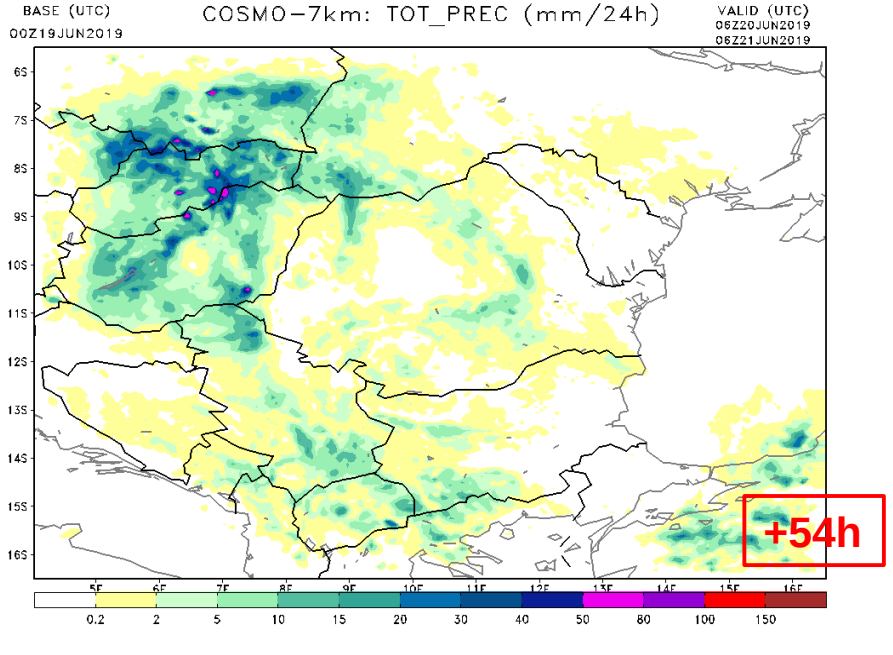
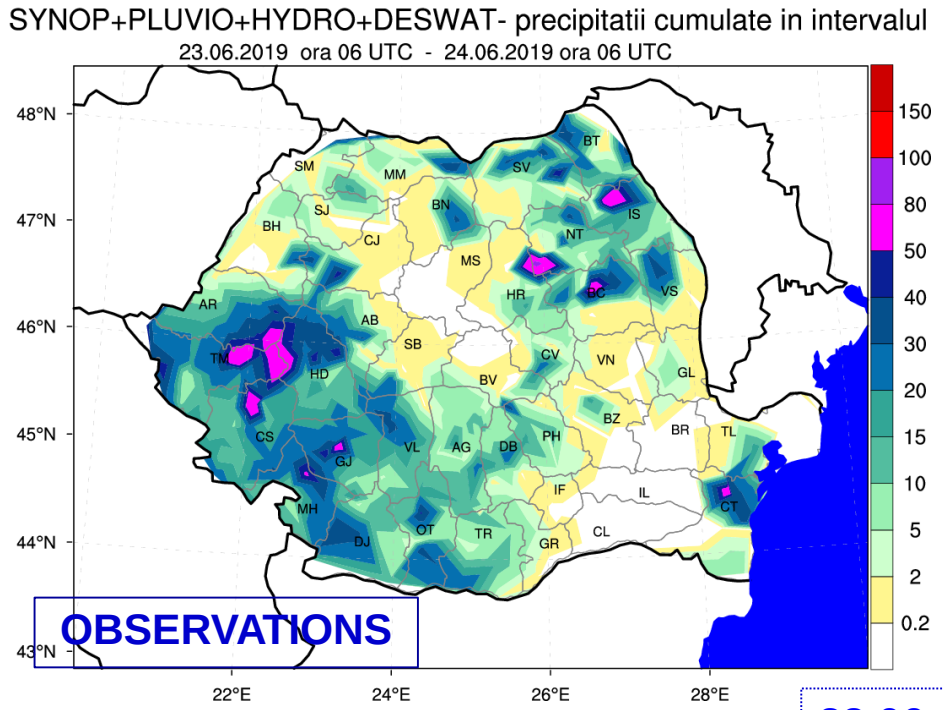
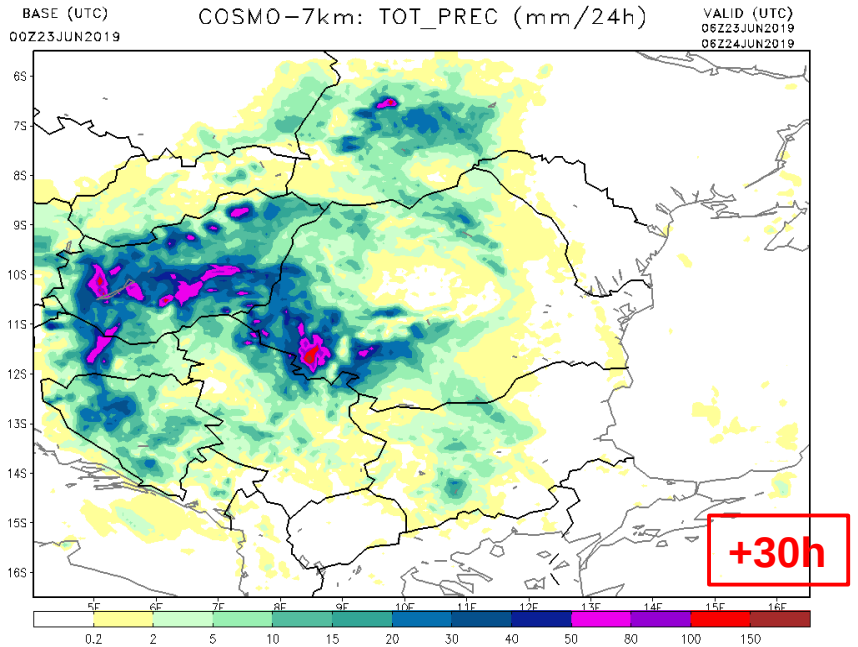
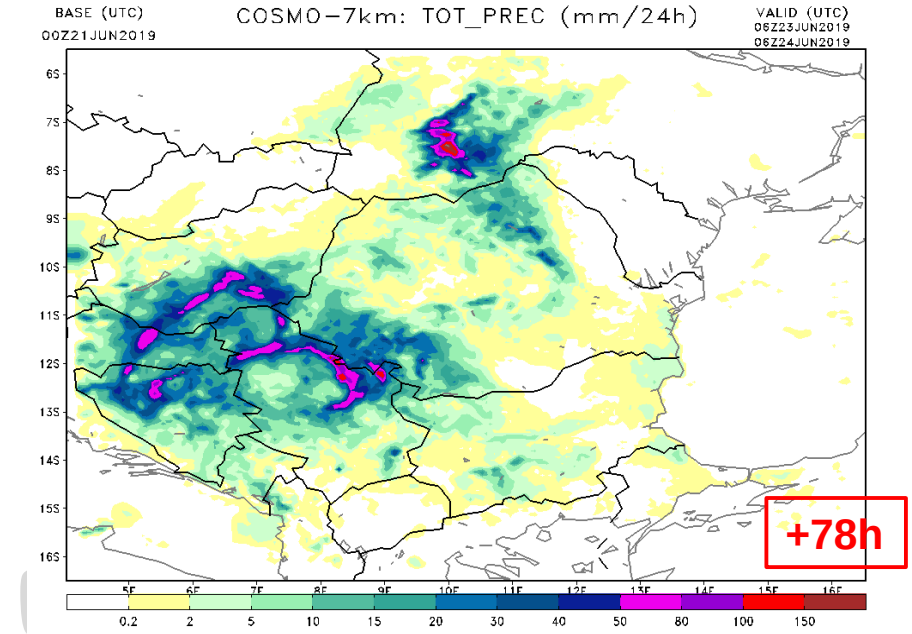


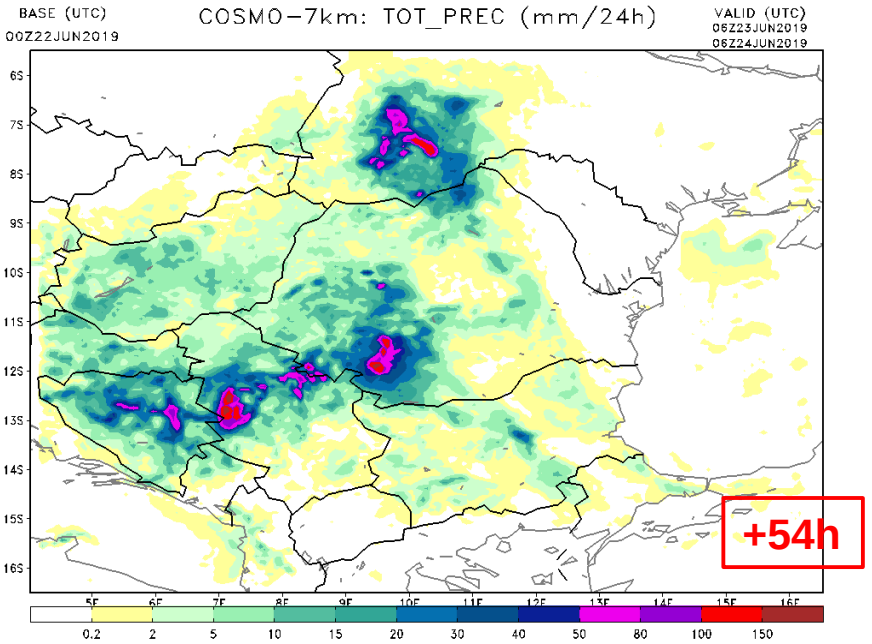






23.06-24.06 06UTC





Thank you!

WG4