Overview of WG4 activities

Anastasia Bundel

COSMO GM in Rome, 10 September 2019

WG4

Outlook

- **Overview of cases of model failures**
- **Activity in COSMO institutes**
- **WG4 for the PP C2I:**

  task 5.6 orecasters' feedback

Cases of model failures

- GM at Saint Petersburg: **STC request "<u>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</u>".**
- 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 analyses of cases

- Good feedback gathered
- An extensive collection of cases of different nature
- Valuable information to refer to in the future
- We are decided to upload the ppts with the cases to WG4 repository and to update it with new cases as they appear

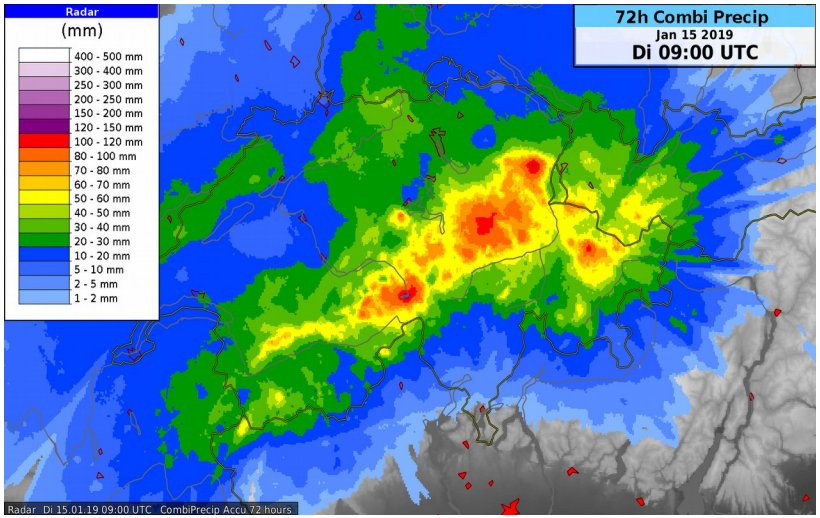
MCH, winter precipitation cases

- 29-30 October 2018 : 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

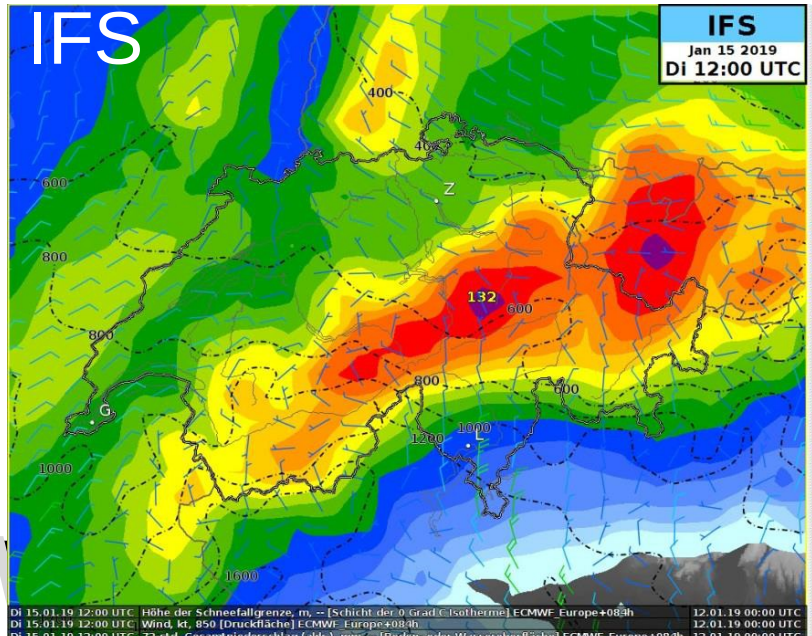
  Those two cases were important for MeteoSwiss as the warnings issued based on the models were not so correct

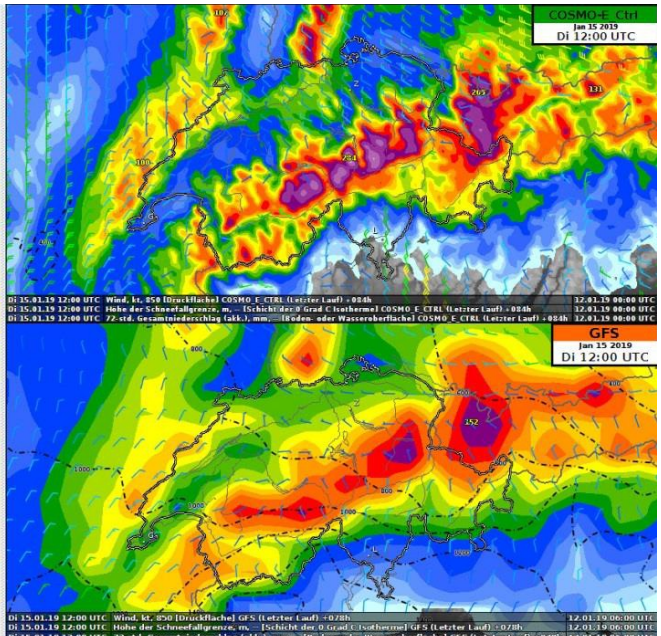
15 Jan 2019, 18:00, 72 h precip accumulation

Combined Observations



Models, runs from 12 Jan 00 UTC



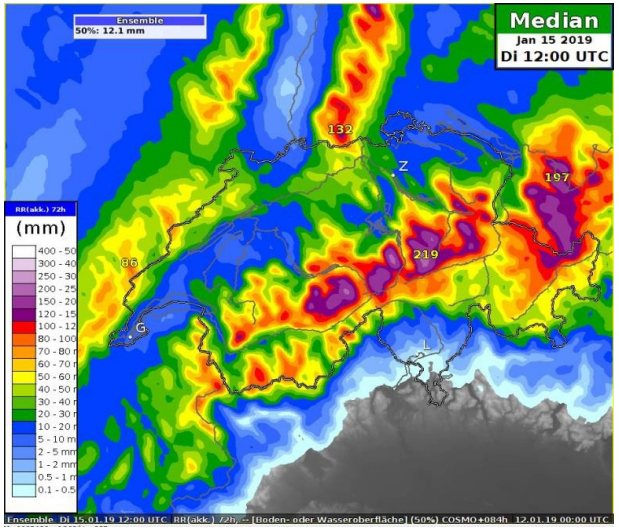


COSMO-E Ctrl run

GFS

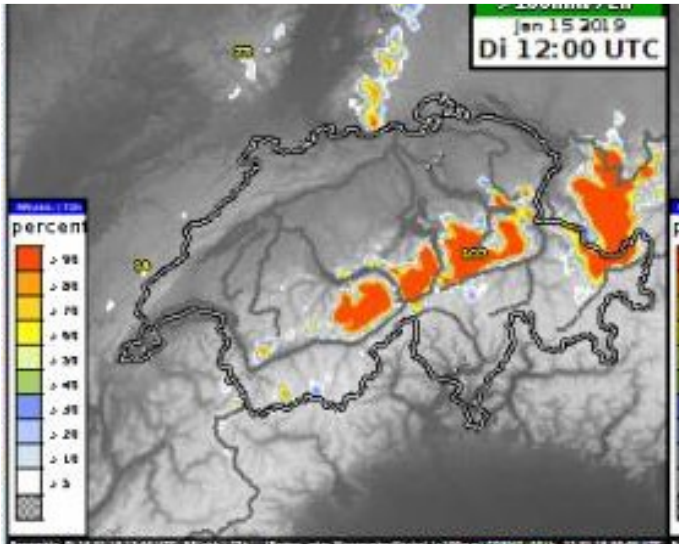
COSMO-E median

runs from 12 Jan 00 UTC



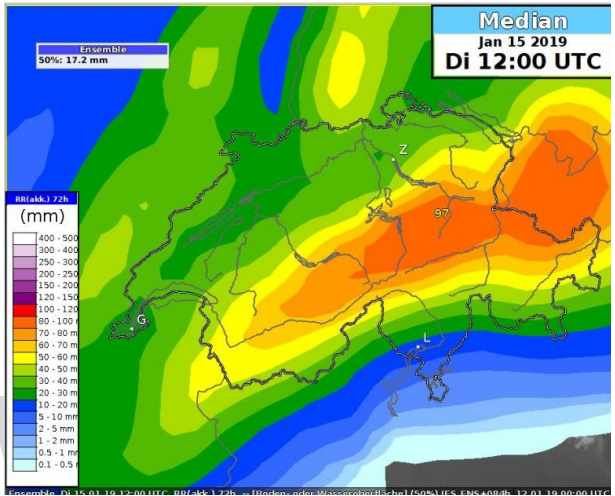
COSMO-E, Probability of precip > 100 mm/72h

runs from 12 Jan 00 UTC

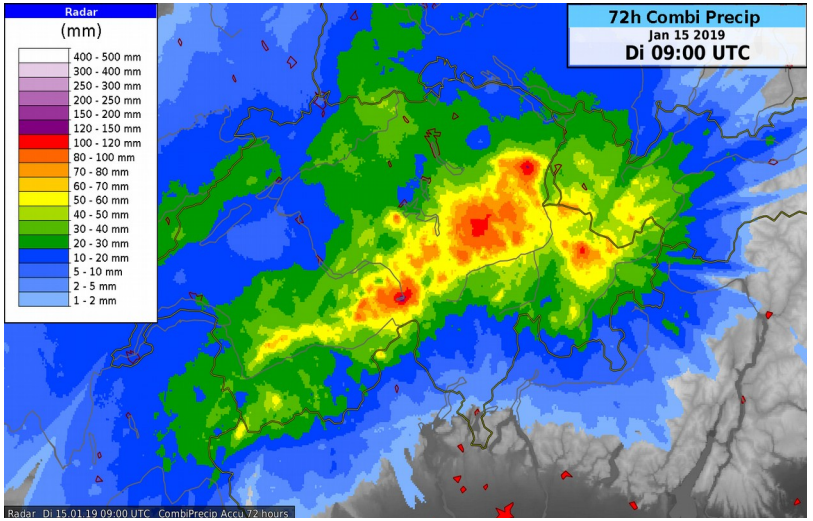


IFS median

runs from 12 Jan 00 UTC



Combined Observations



Summer 2019

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

HNMS

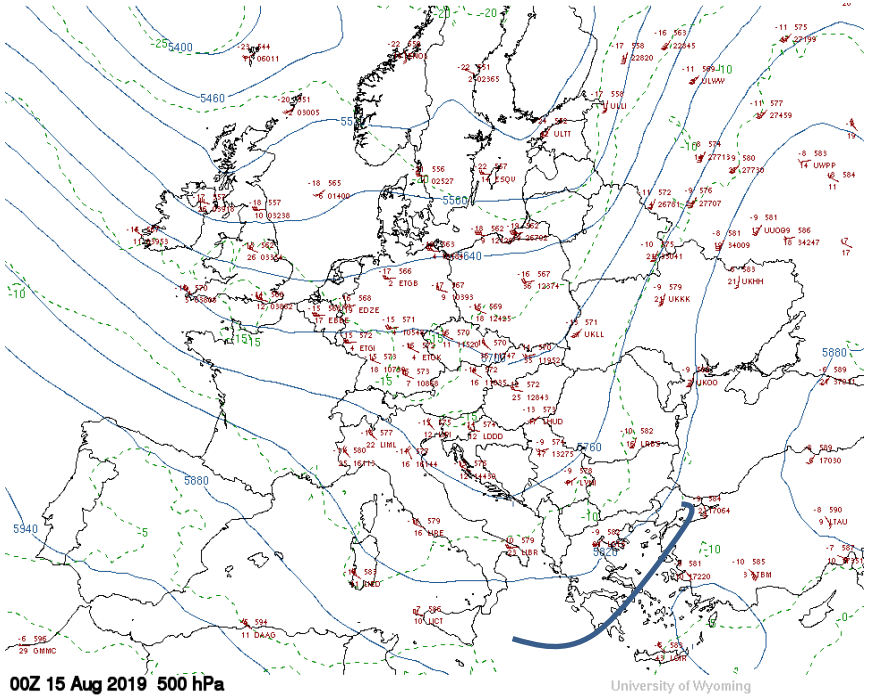
- 28 May 2019 A case of COSMO4 precipitation overestimation

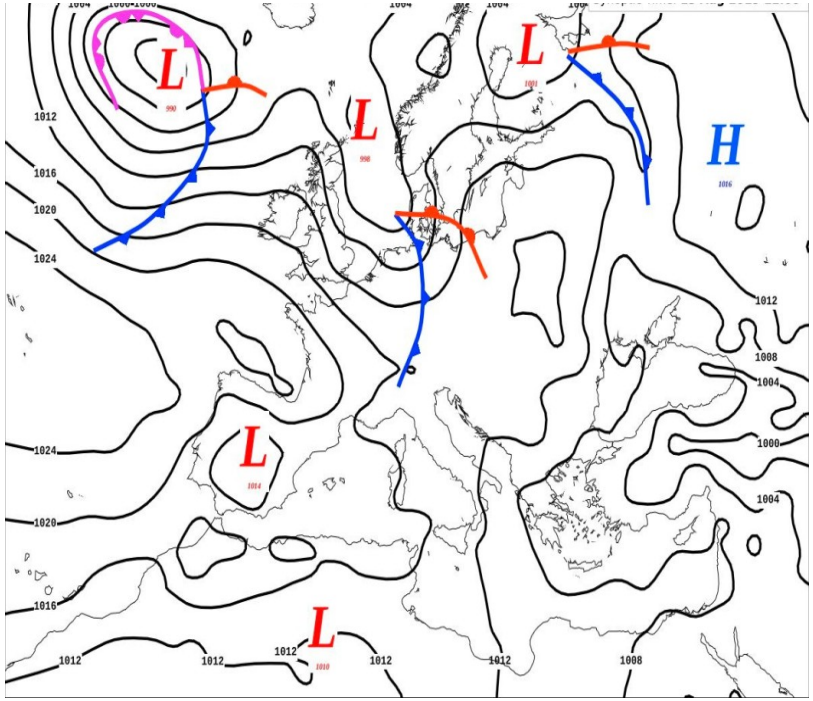
Precipitation over northern and western parts of Greece is expected when low systems from the west produce SW flow, mainly in winter time, and are usually well captured by the model.

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



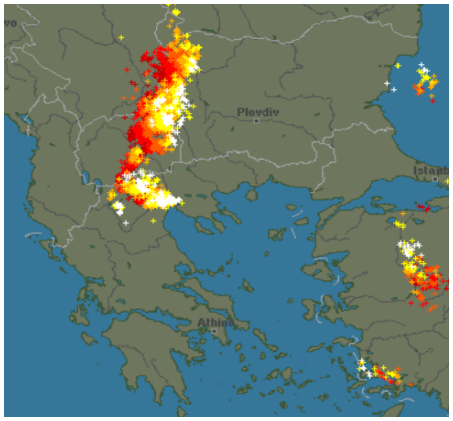


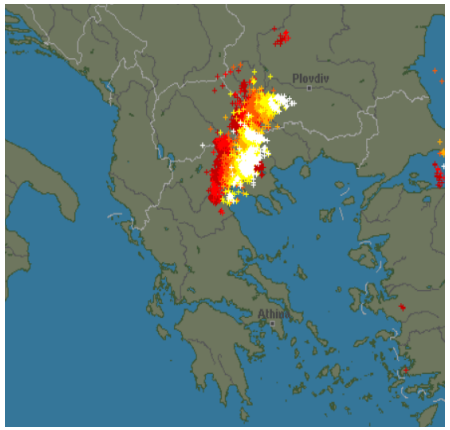
After a series of warm days, an intrusion of cold air from the North over Greece combined with thermal forcing produced convective precipitation around noon. However, around 20:00 UTC, unexpectedly, when only dynamical forcing prevailed, a block of thunderstorms locally over Western and Central Macedonia 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.

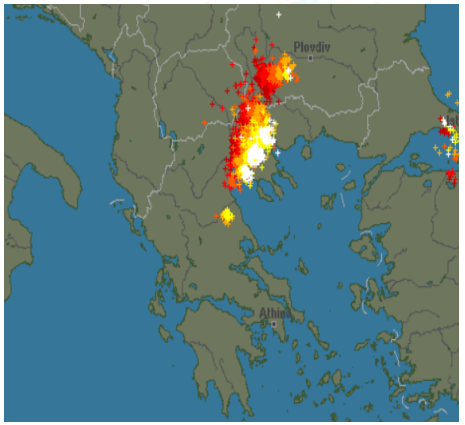
14/8 2100

15/8 0000

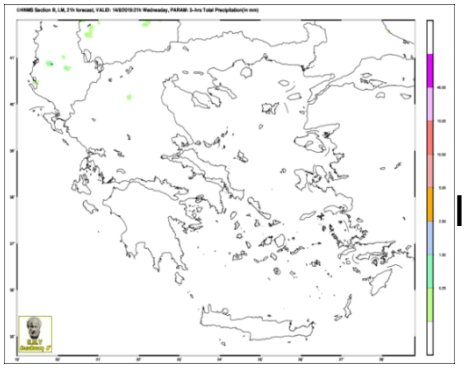
15/8 0300

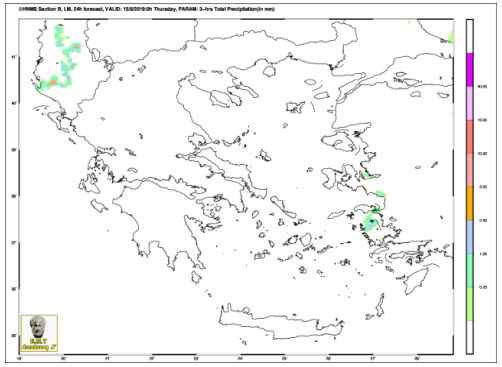




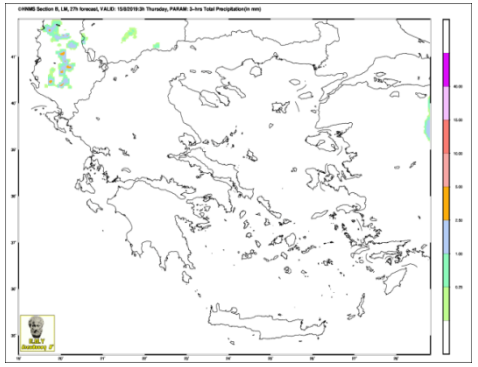


ICON

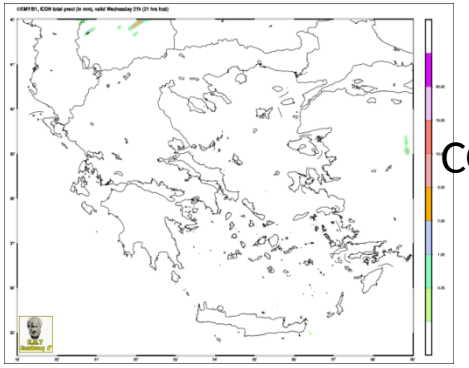


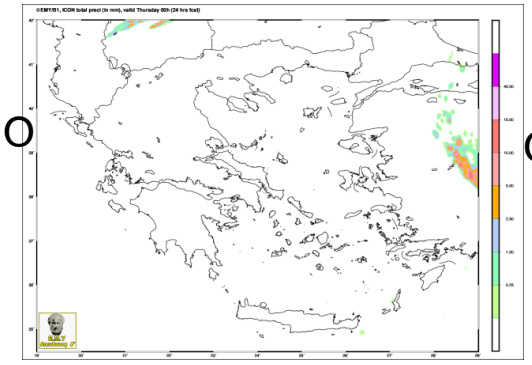


ICON

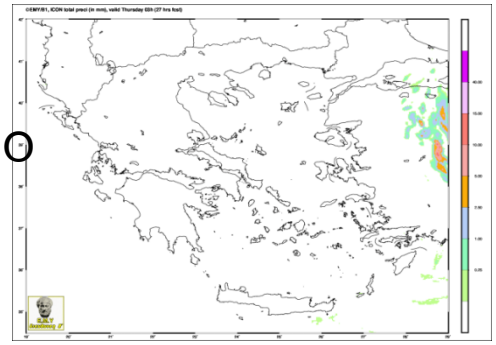


COSMO





COSMO



WG4

ICON and COSMO Model Runs of 14/5 00 UTC. No precipitation

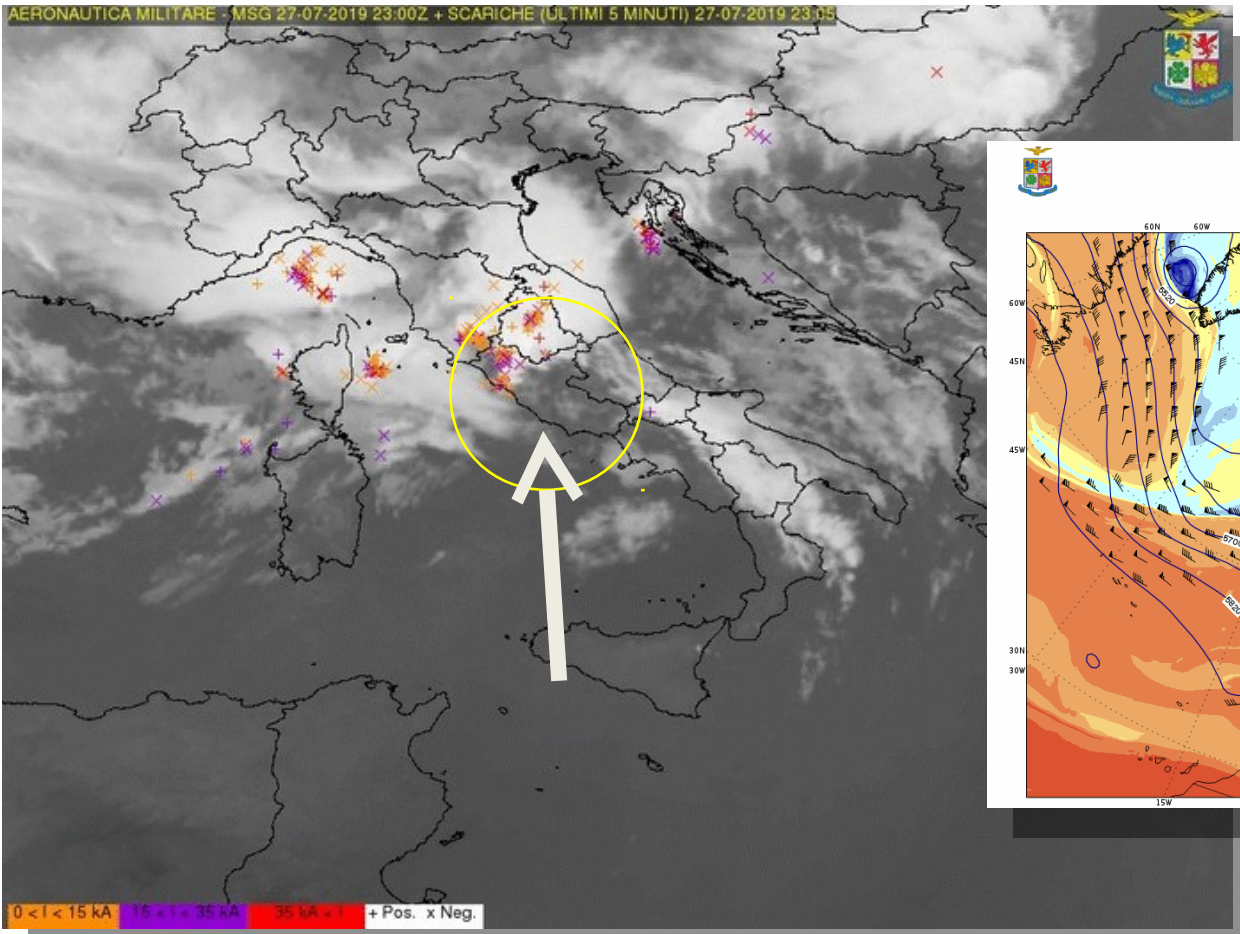
CNMCA

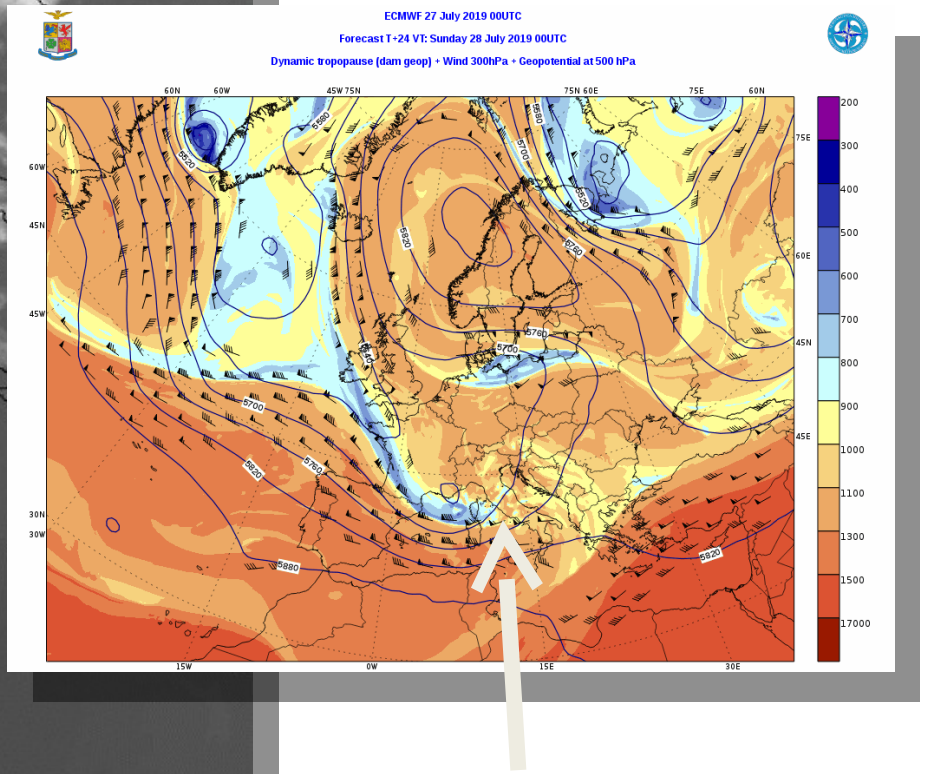
Cases of model failures

- 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)

28 july 2019
00-06UTC
Rome
(heavy rain and a Tornado at 00.30UTC - 1 victim)

28 july 2019 Rome (heavy rain and a Tornado 00.30UTC - 1 victim)

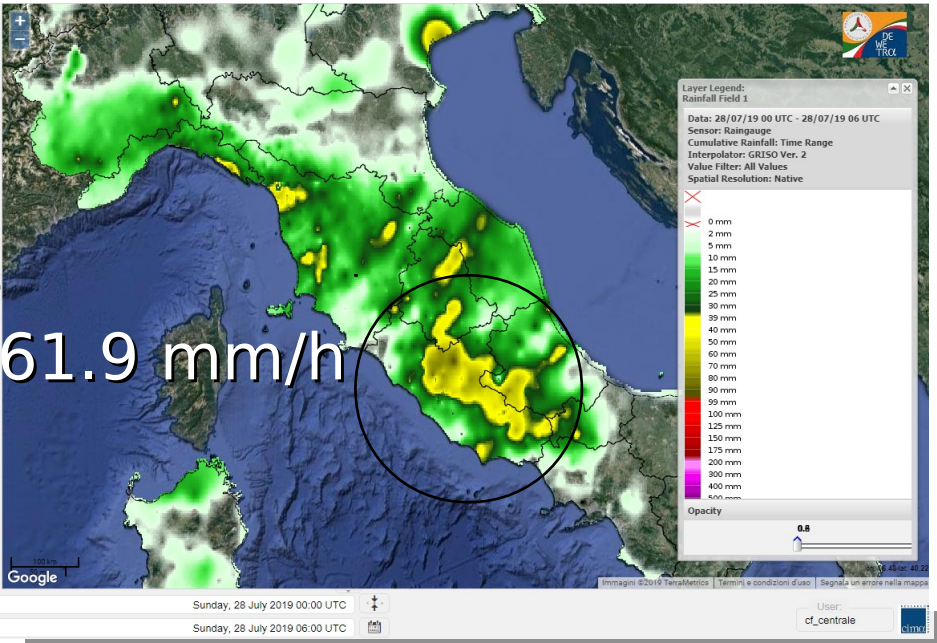


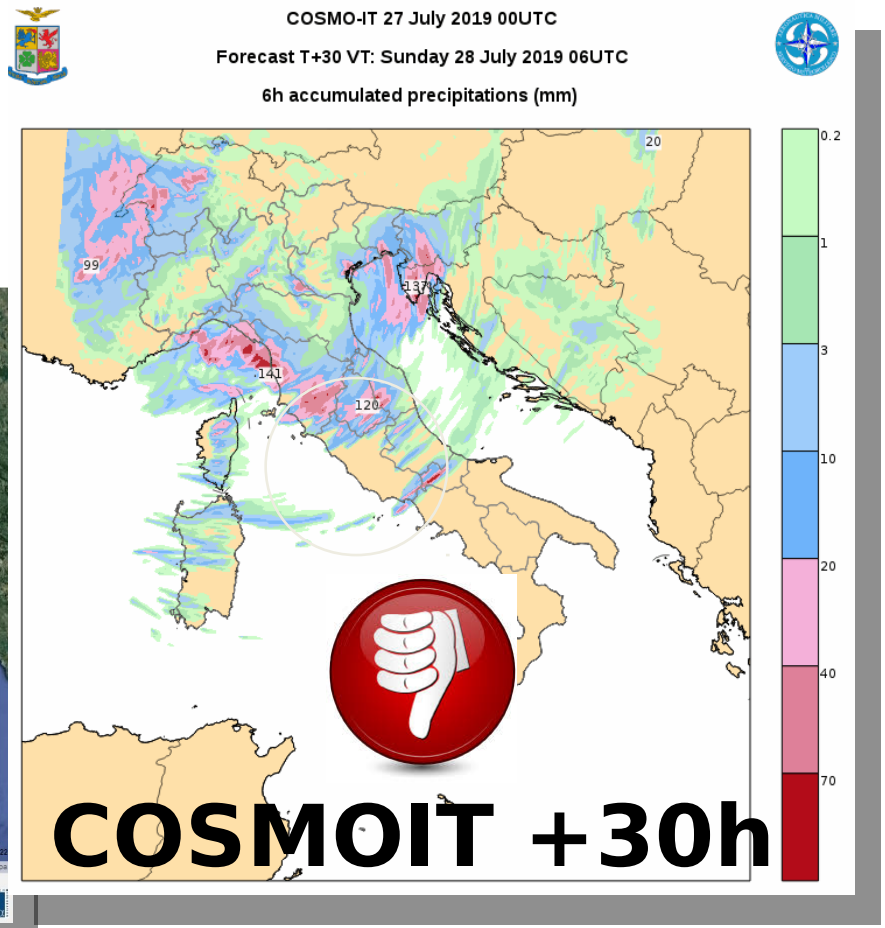


WG4

28 july 2019 Rome (heavy rain and a Tornado 00.30UTC - 1 victim)

observed





28 july 2019 Rome (heavy rain and a Tornado 00.30UTC - 1 victim)

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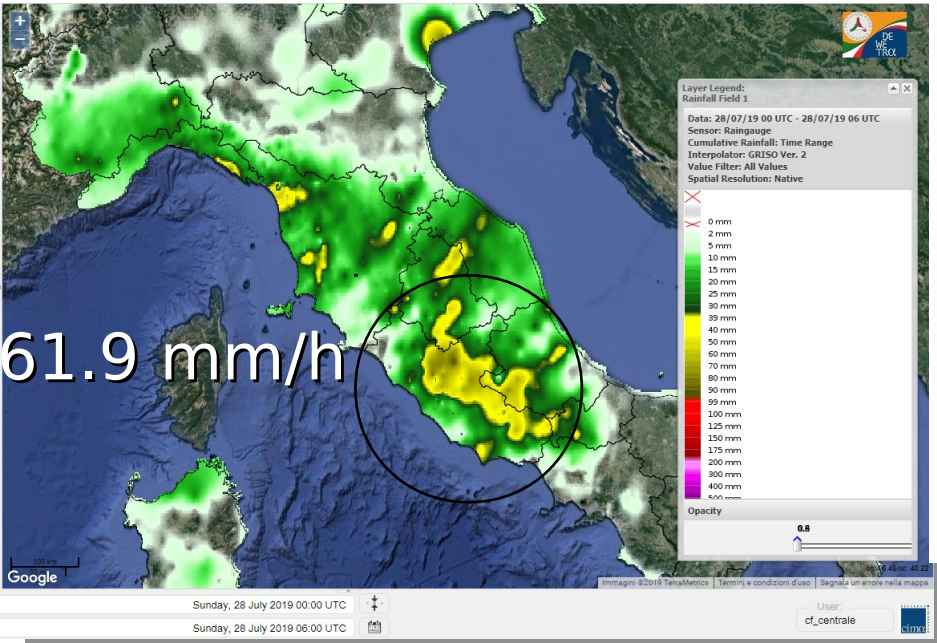

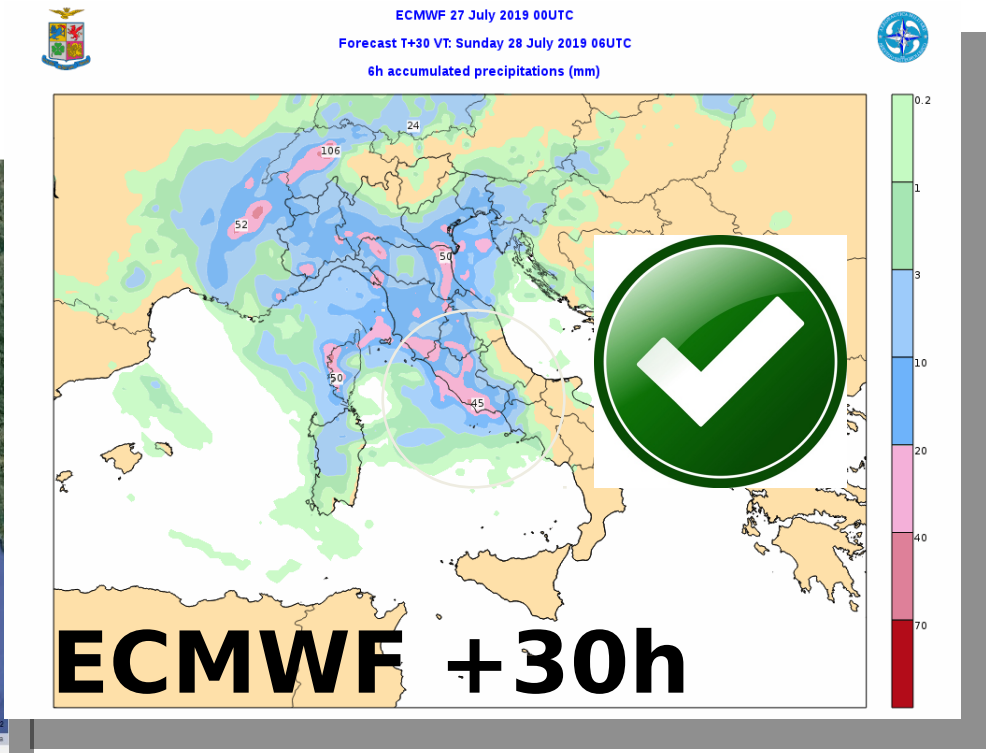

WG4

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

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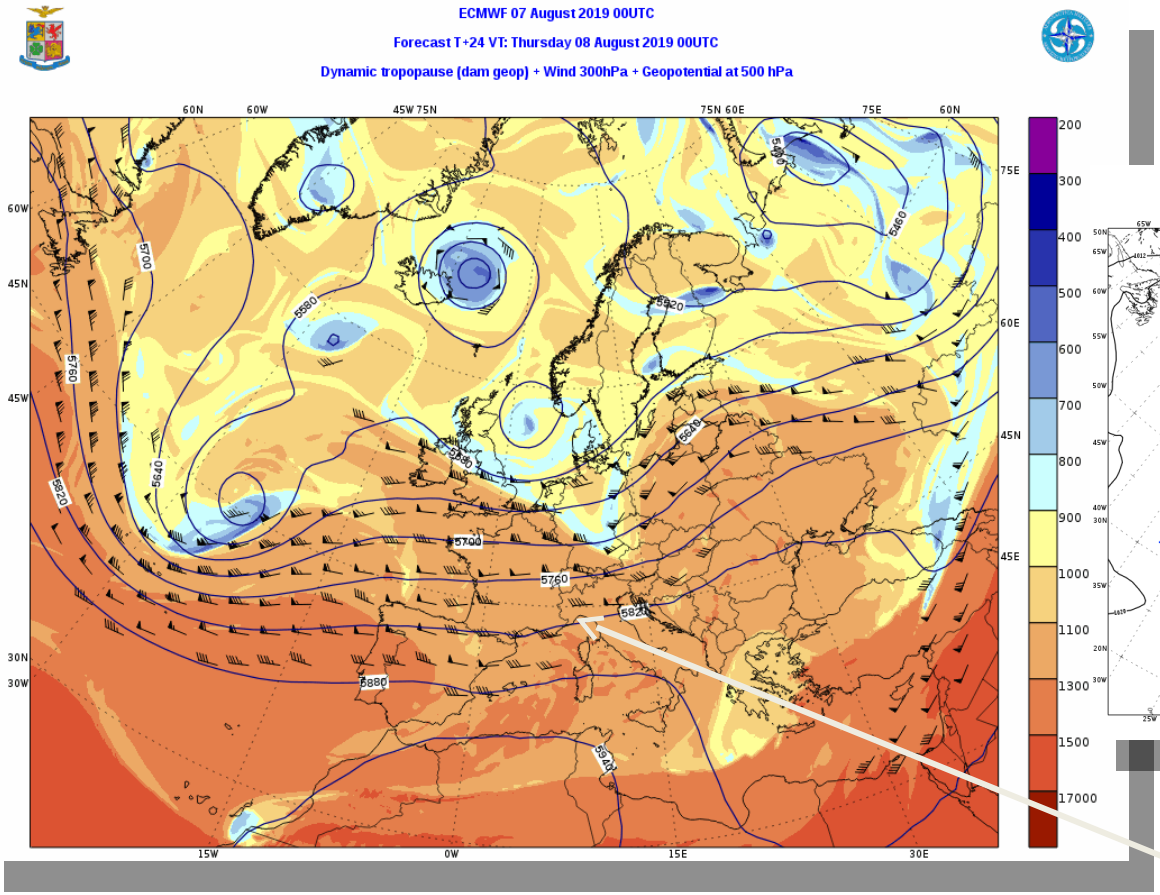
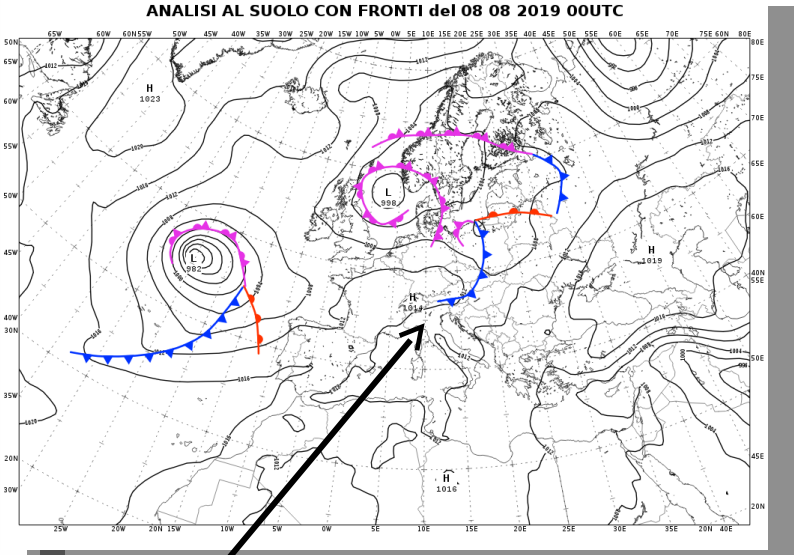
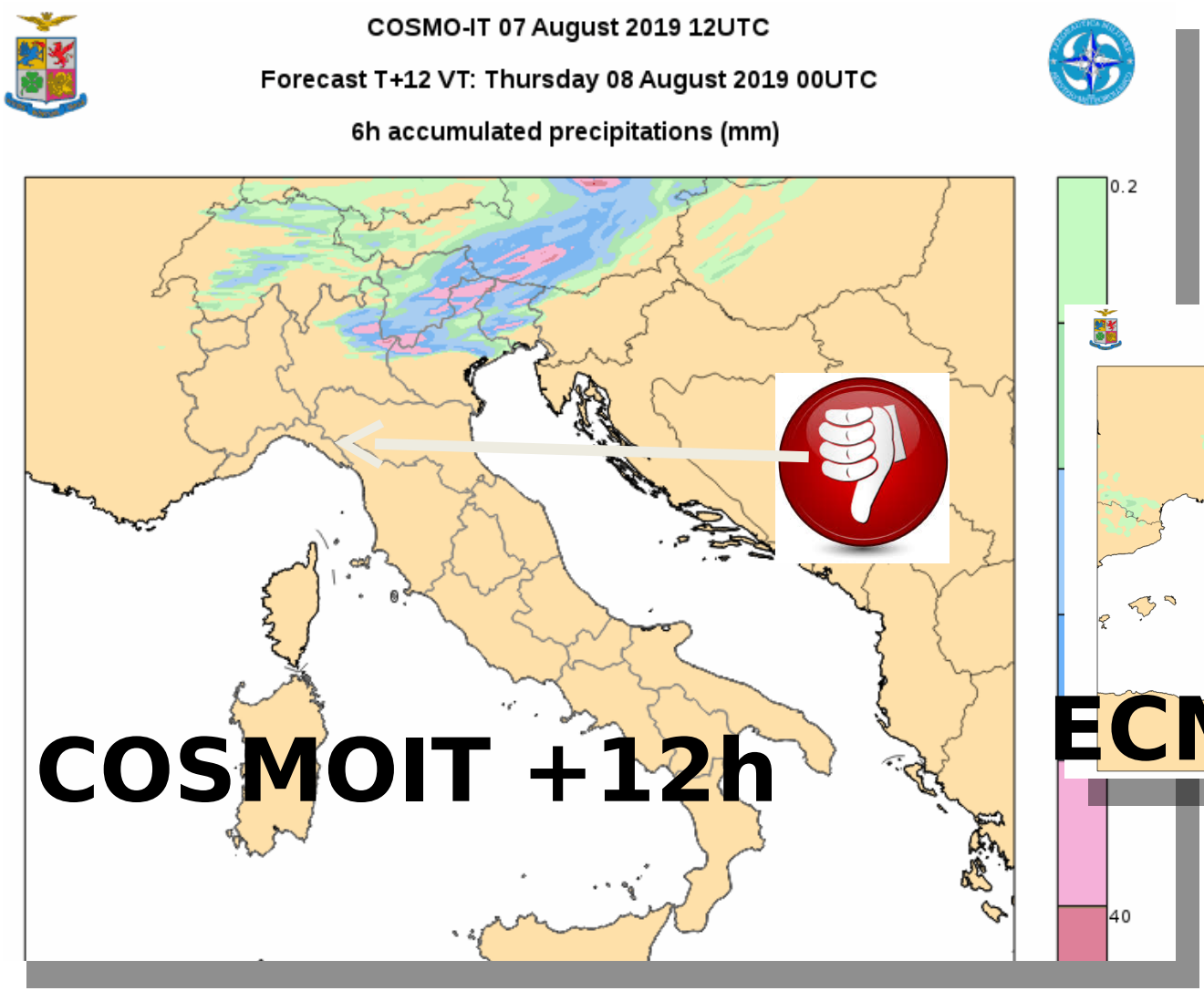


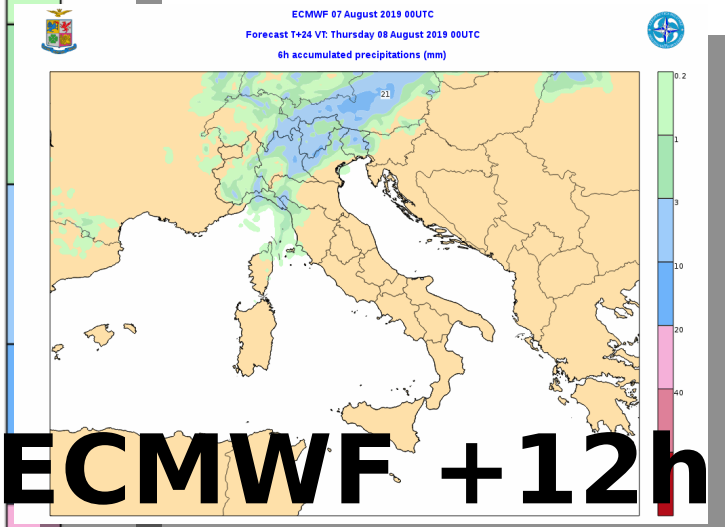


Genova

WG4

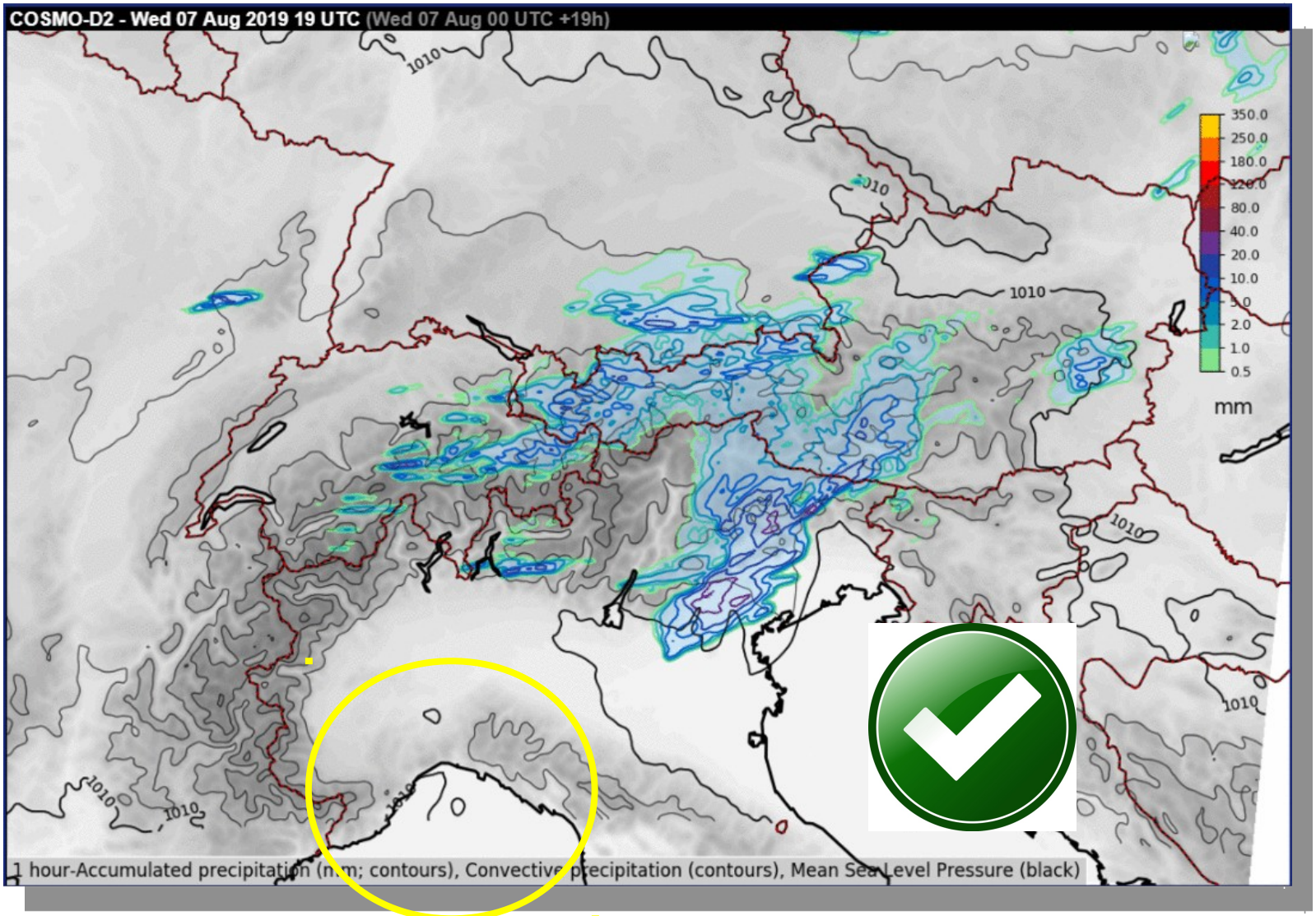
7 august 2019 Genova 21-22 UTC (excessive rainfall)





WG4

COSMO-D2: 7 august 2019 Genova 21-22 UTC (excessive rainfall)



WG4

Overview of IMGW-PIB tasks within PP AWARE

COSMO-PL "failures"

Setup

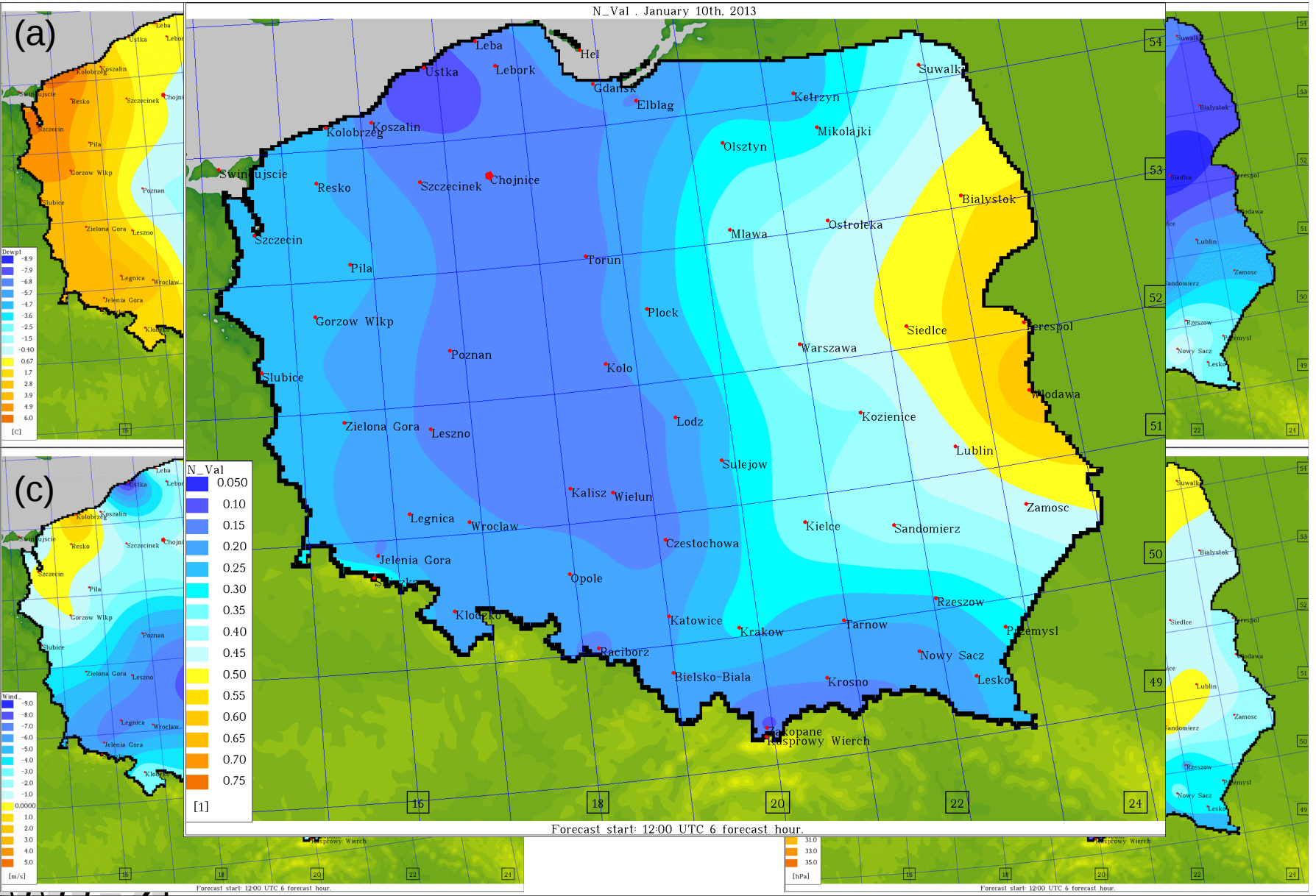
To assess (more or less automatic) poor forecasts surface parameters were used.
T2M, TD2M, RH, U10M, SFC Press. and PMSL were selected to assess the questionable forecasts and their quality.
The values of all elements have been normalized as follows:

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

0 <= N_Val <= 1

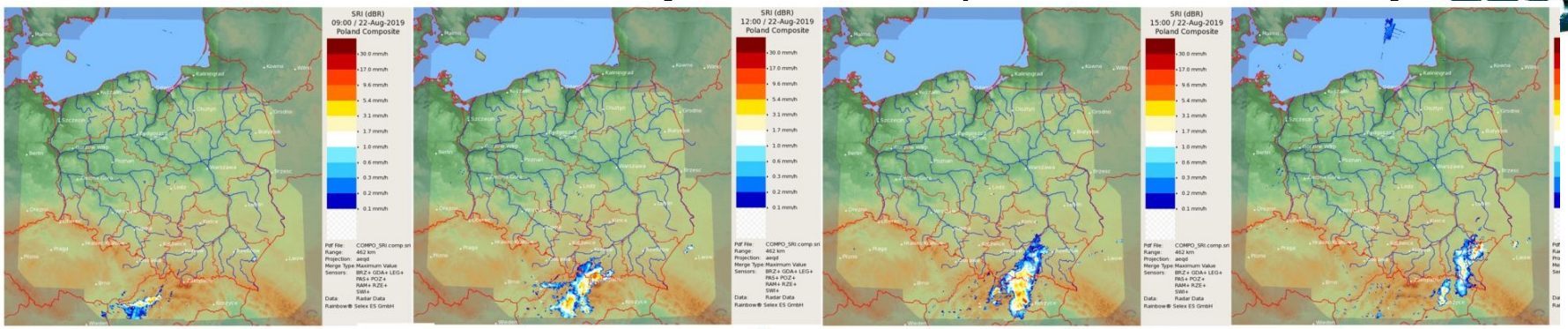
with *dt* being the period (climatological, 2012-2018), maxdif - maximum difference between OBServation and ForeCaST in a given period
The sum of N_Val from the above elements was determined. The worst forecasts were determined – those for which this sum was the highest.

COSMO-PL ”failures”

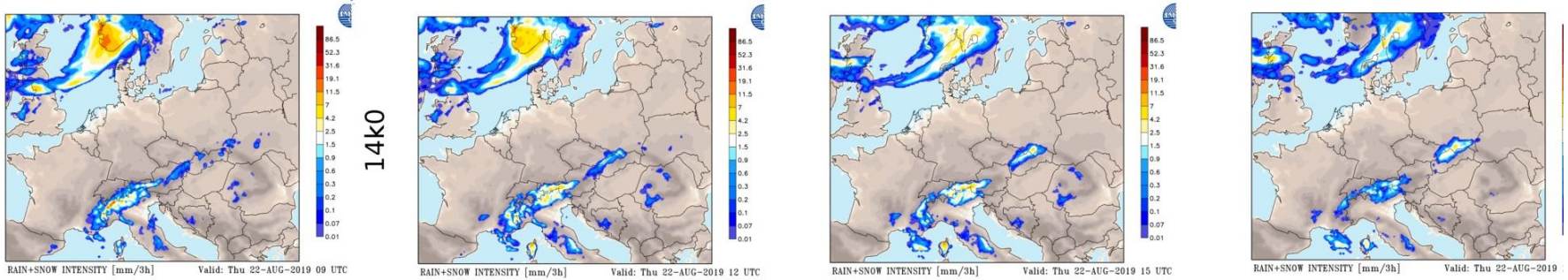


FORFEIT

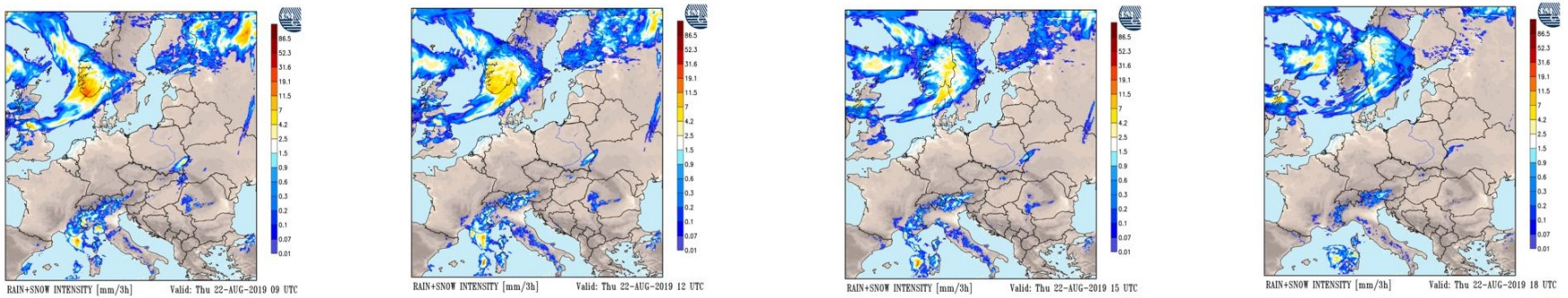
Storm in the Tatra mount. (2019.08.22, fcst start 00:00)



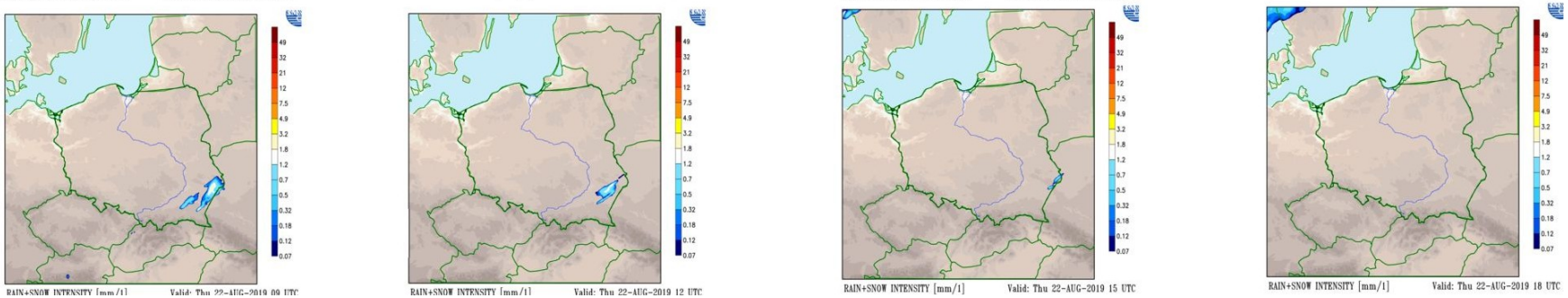
14k0



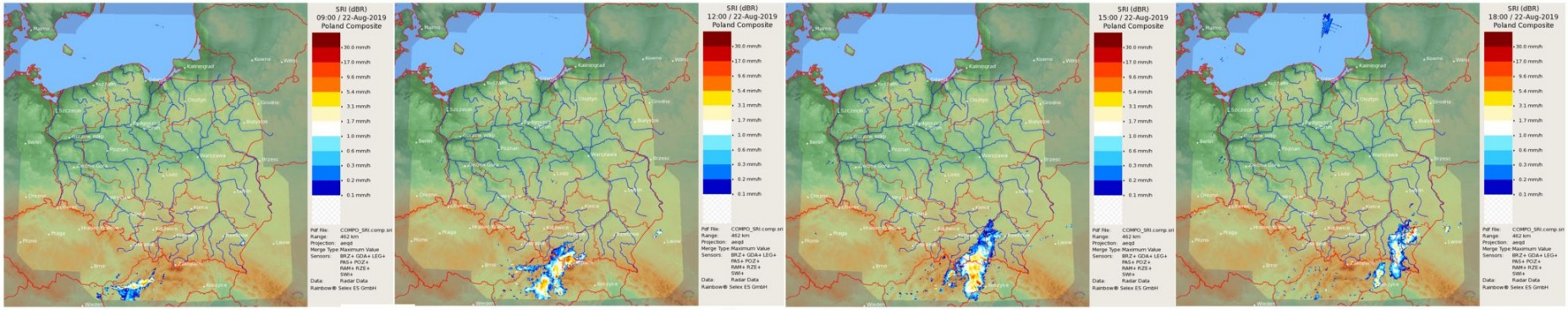
7k0



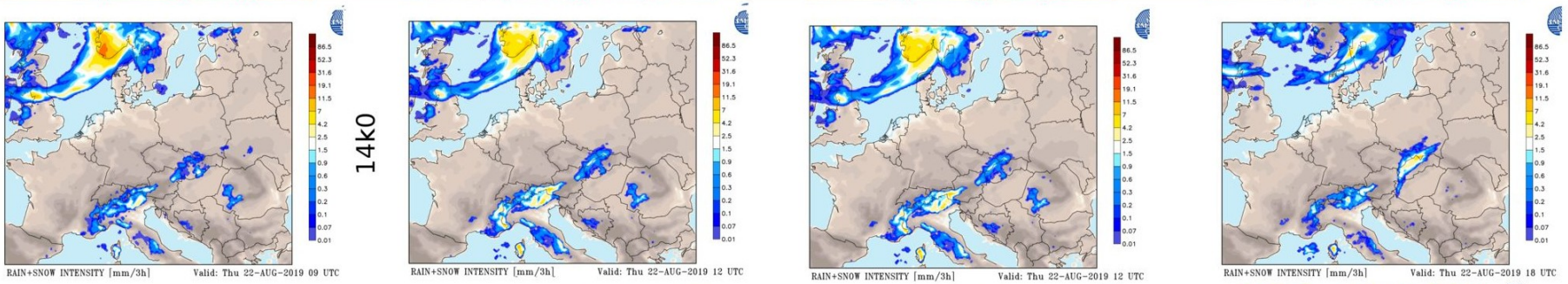
2k8



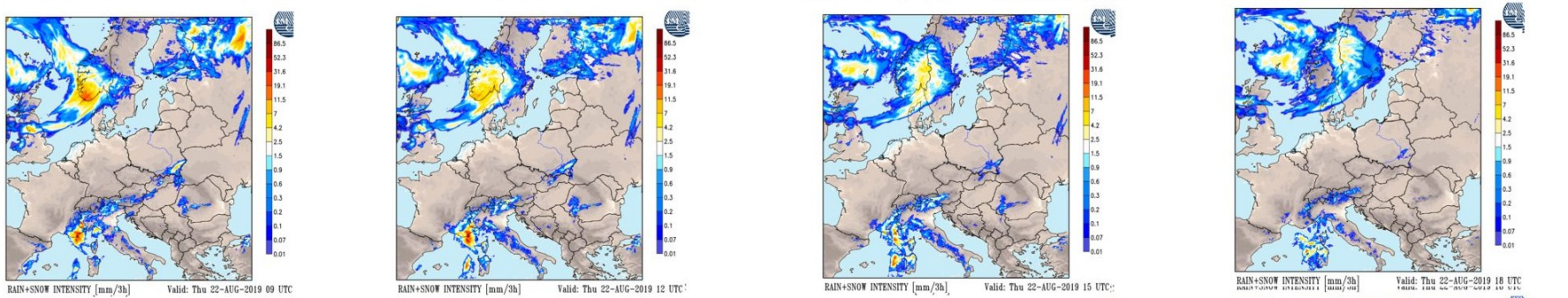
Single case – HIW event (2019 08 22, fcst start 06:00)



14k0



7k0



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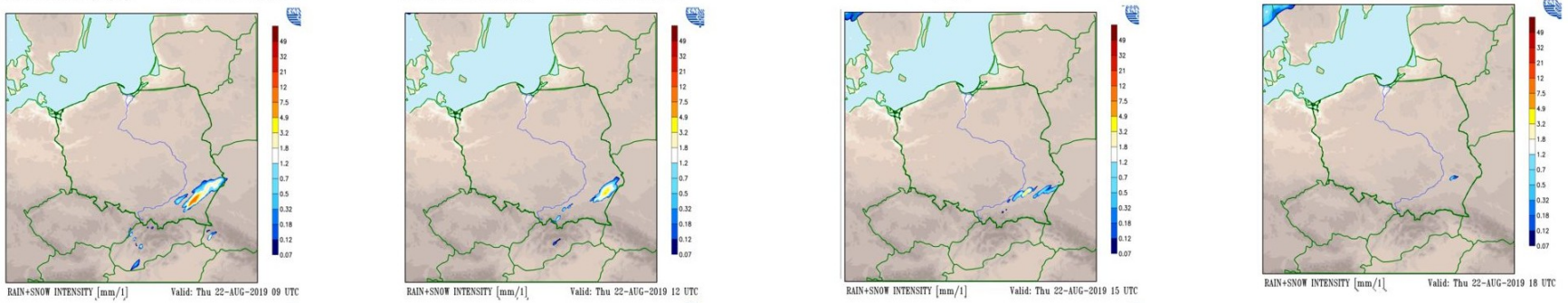


RHM

- 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: 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

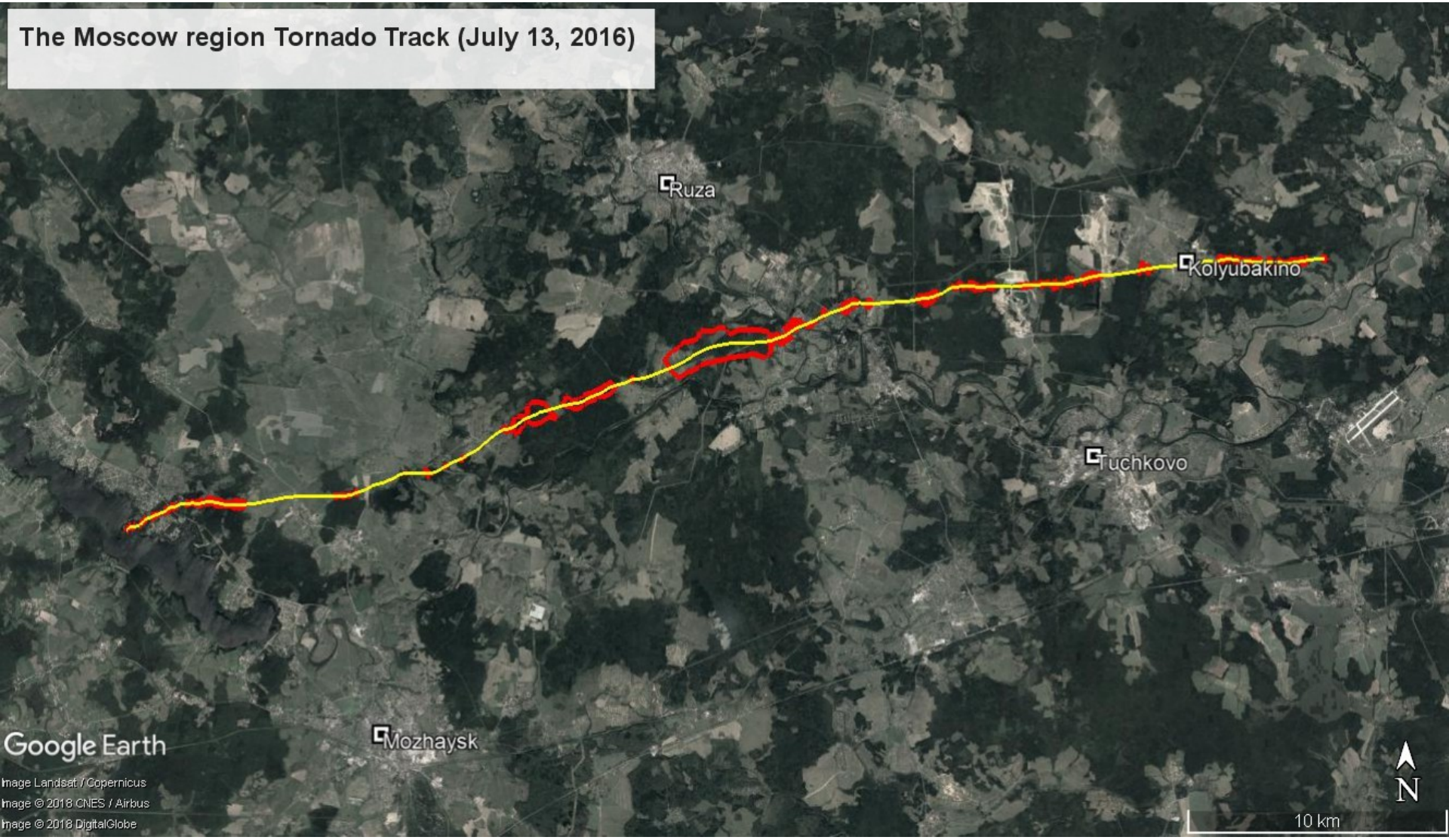
Two deaths, 17 wounded,
100 houses destroyed in the Moscow Region, Kolyubakino village suffered most

In Moscow: 9 wounded,
2 hit by lightning

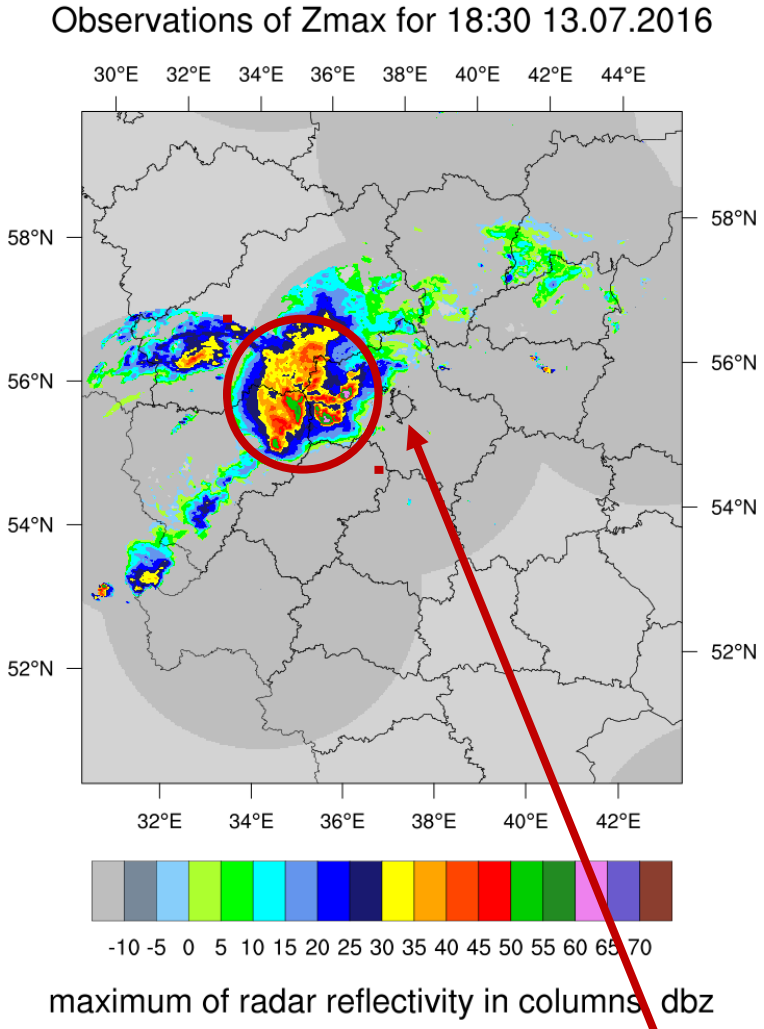
Thousands of trees broken

WG4

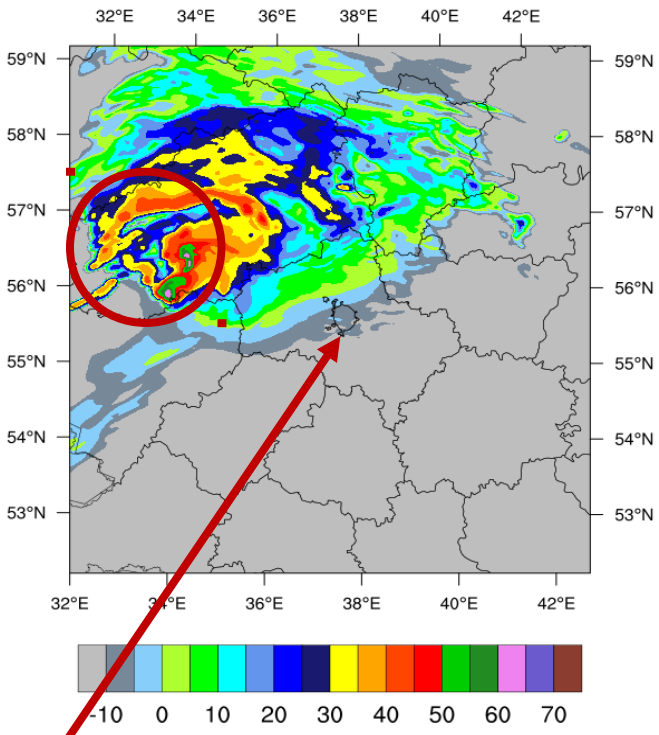

Tornado-induced Tree Fall Pattern
Google Earth
Image © 2018 DigitalGlobe
N
100 m


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

WG4

RHM: 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

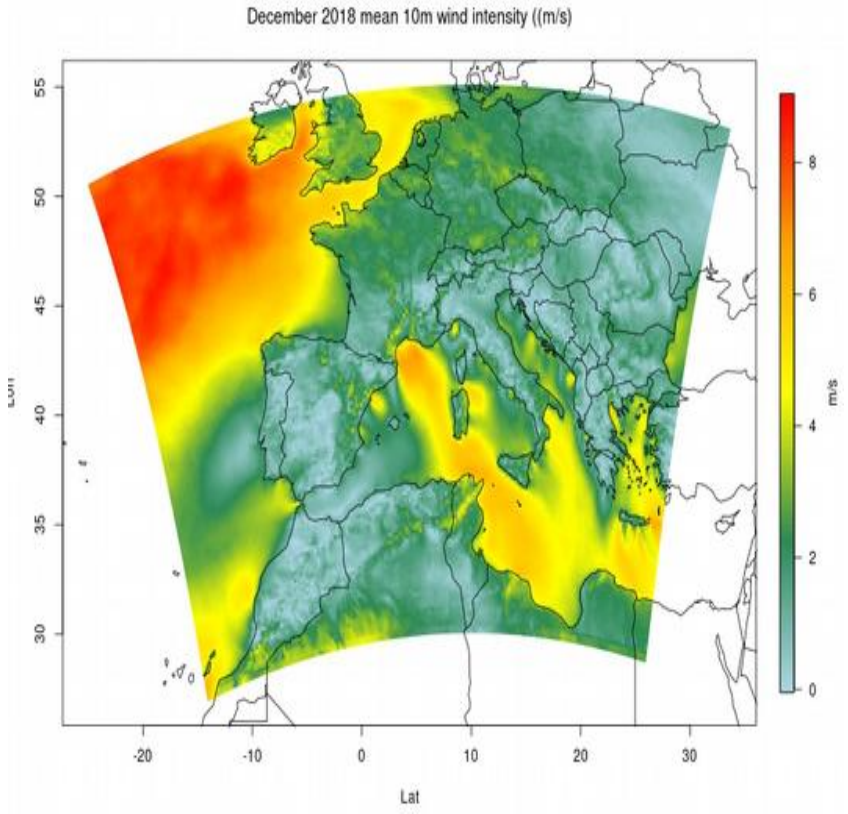
1-5 December 2018
ARPAE-SIMC

An application to air quality

The problem: December 2018 in the Po Valley

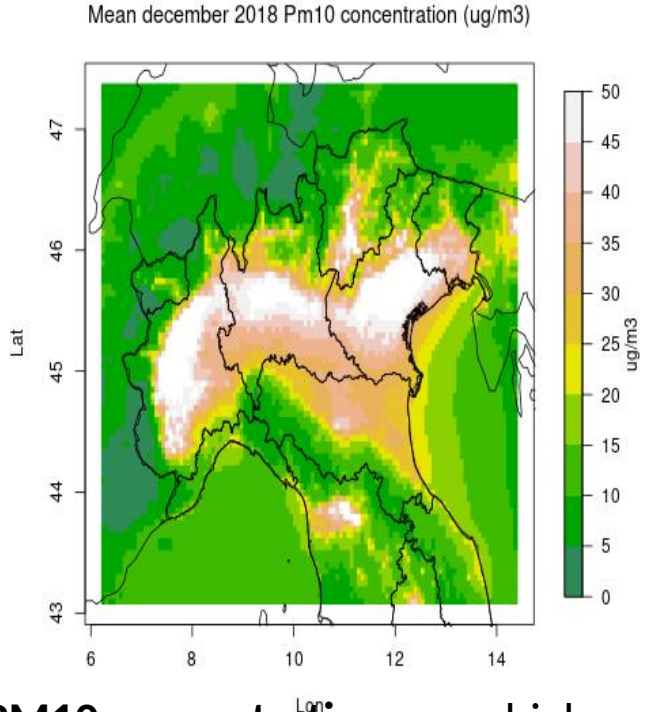
The peaks in pollutants concentrations occurring in the Po Valley are mainly due to ''unlucky'' meteorological condition associated with high static stability and unfavourable dispersion situation in the lower layers

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 northernmost part

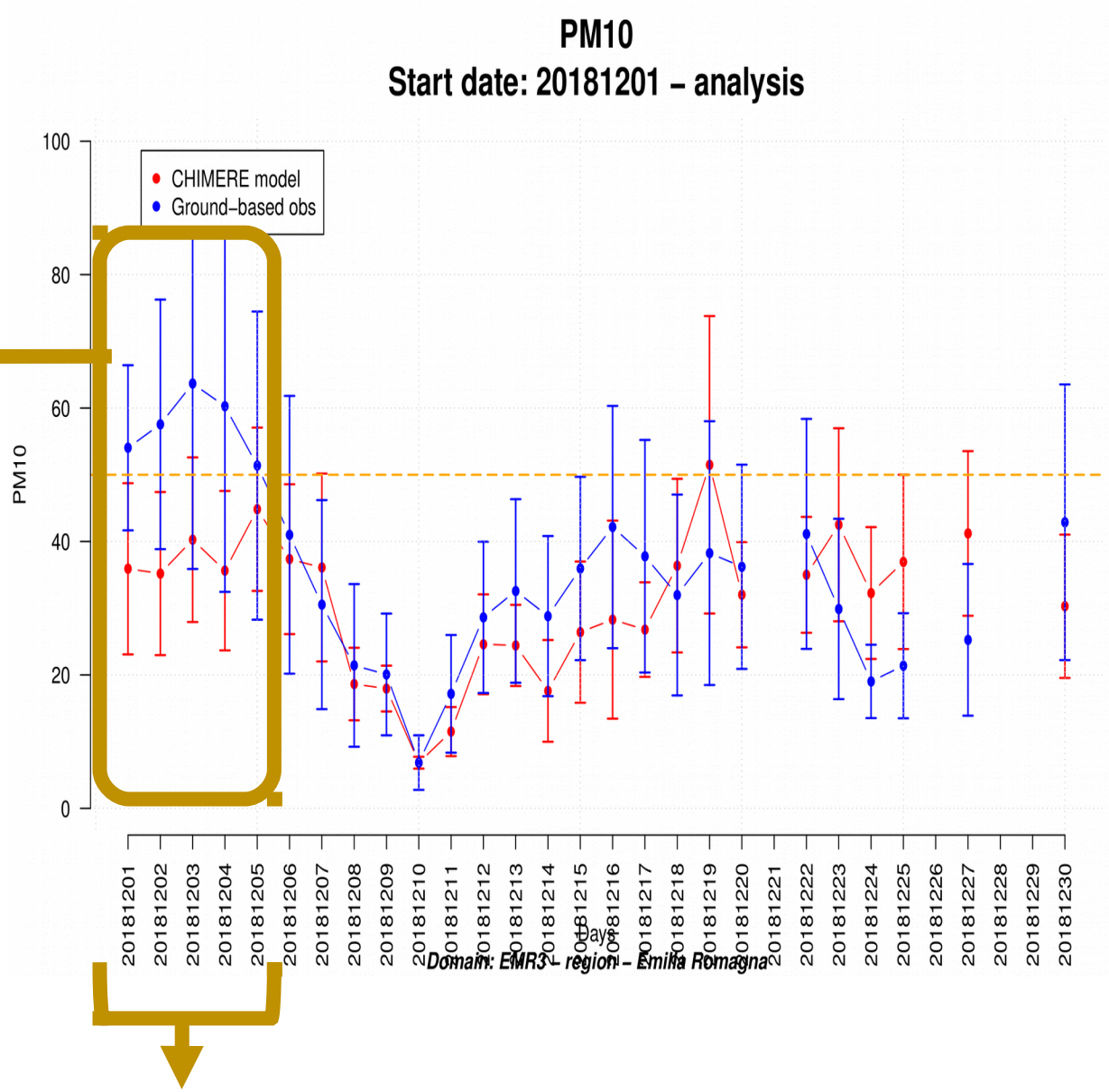
WG4

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

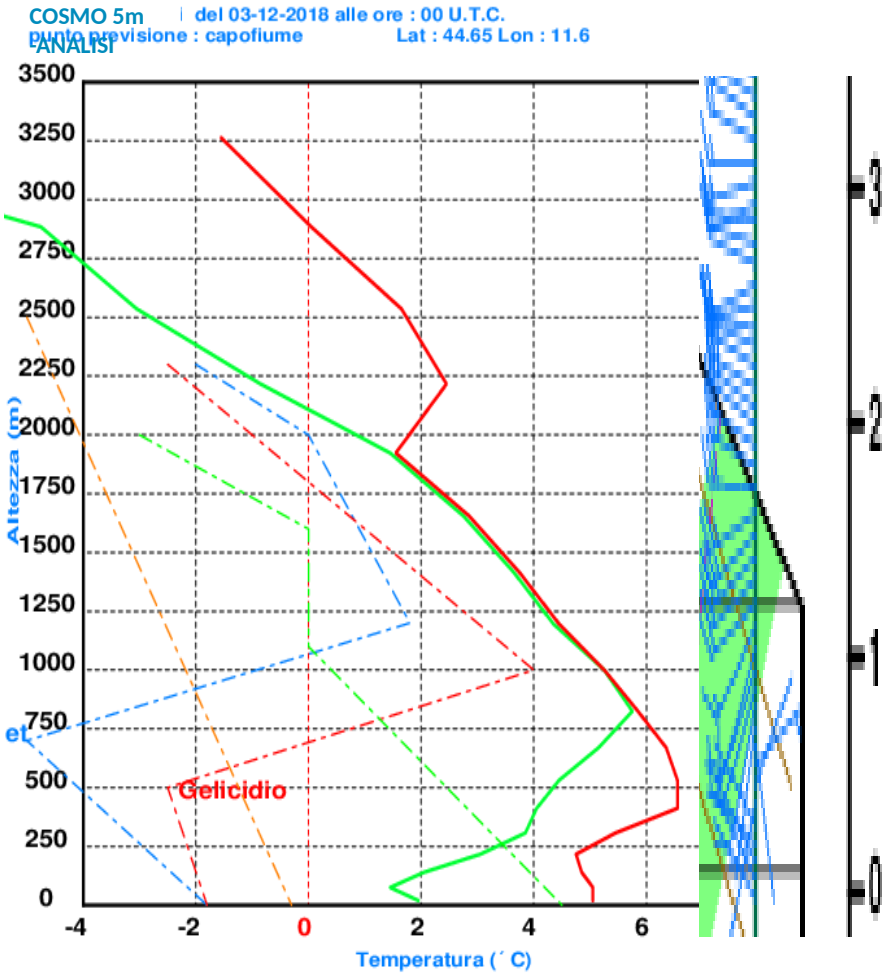


From 1/12/2018 to 5/12/2018

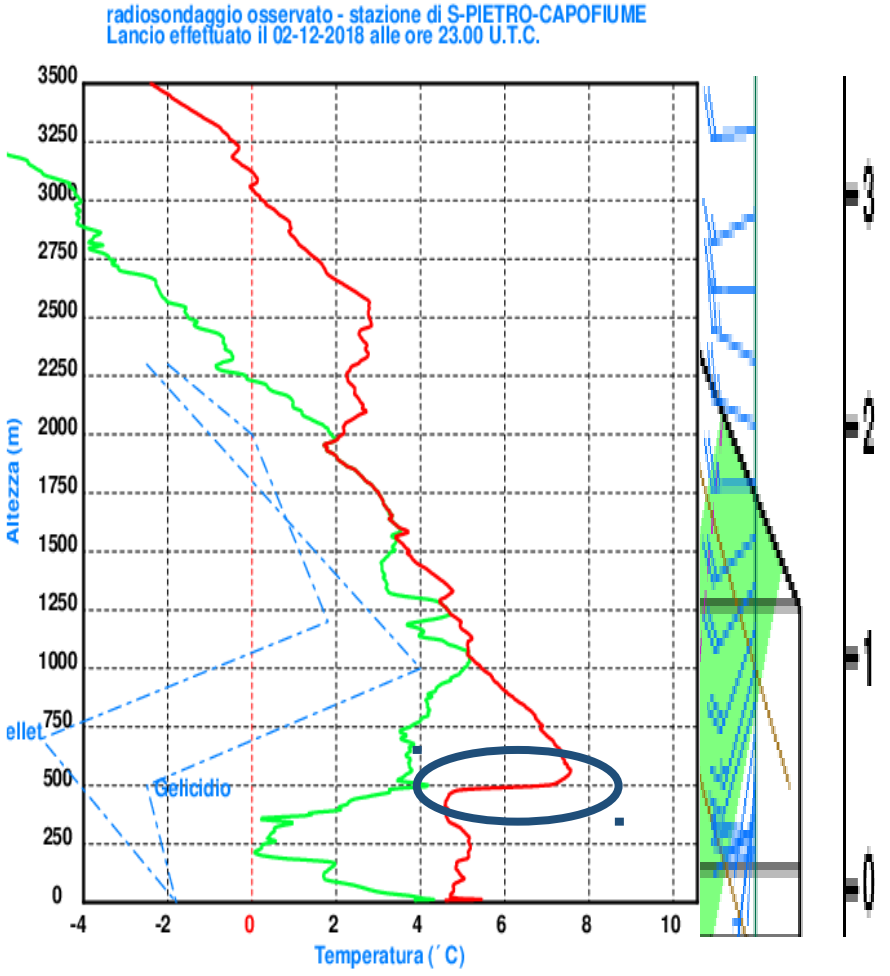
Thermodynamic profile of the atmosphere

Radio sounding San Pietro Capofiume

Analysis



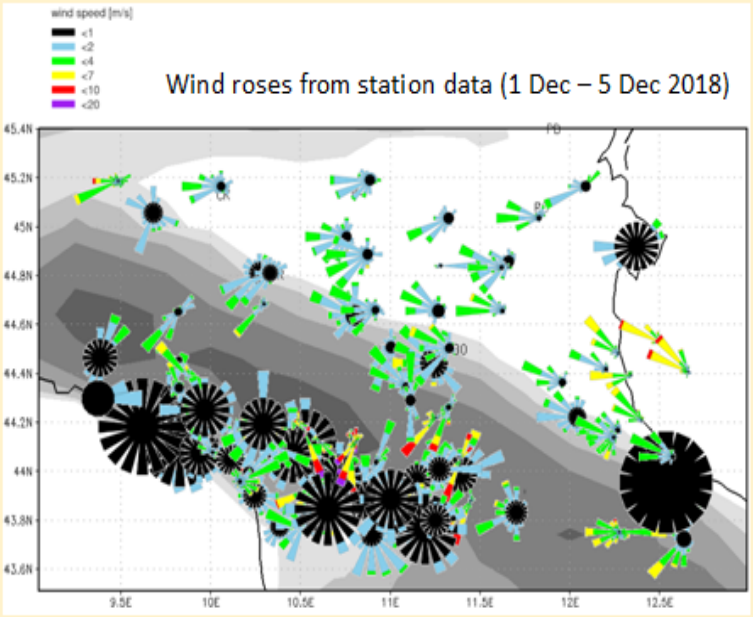
Observation

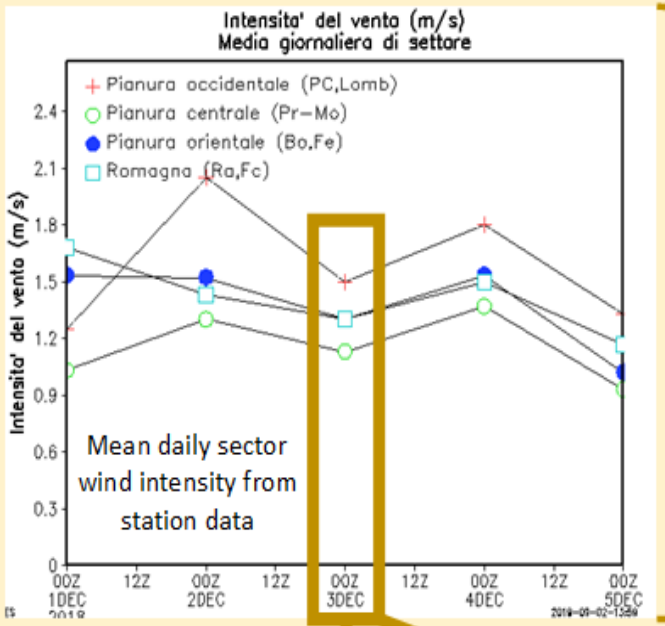


Stronger inversion at about 500m

WG4

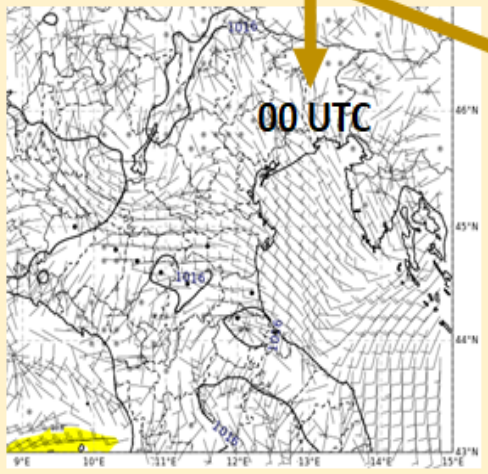
Wind

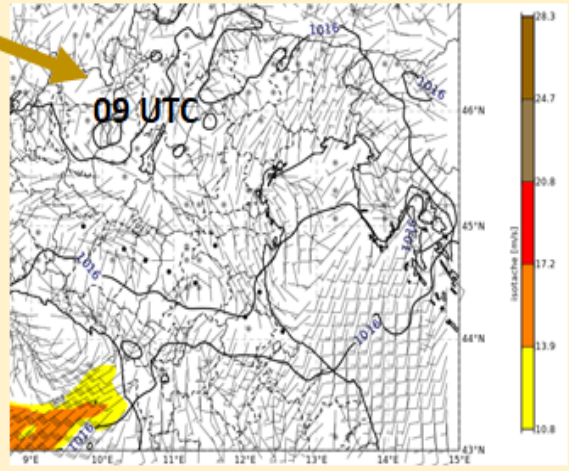




Observed weak NW winds over the plain

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





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 for COSMO-RO (7km) too!

- particular cases:

  May (31.05)

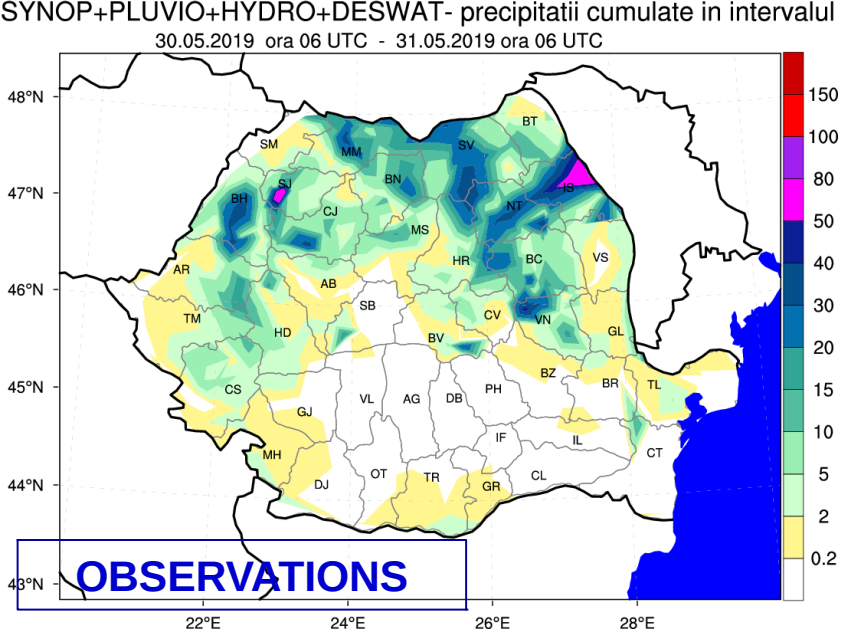
  June (6.06, 7.06, 9.06-11.06, 19.06-25.06, 27.06-28.06)

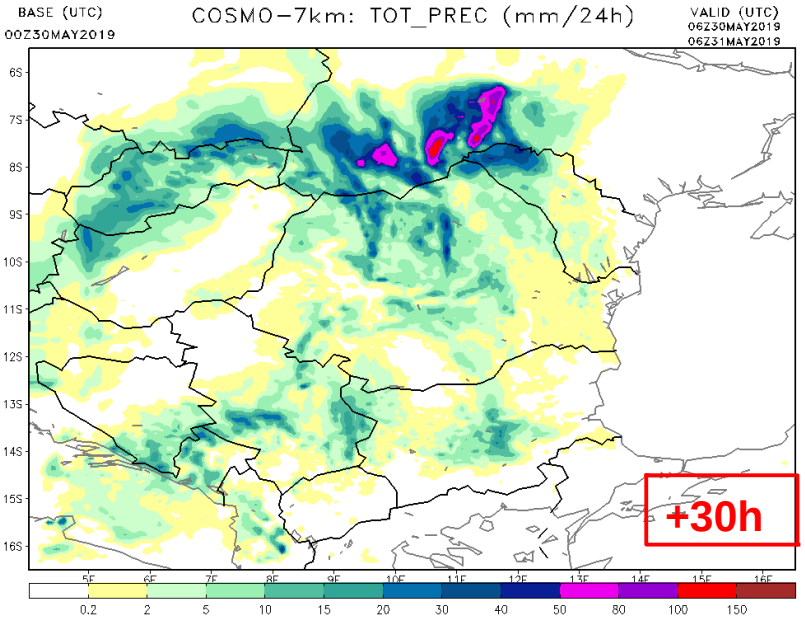
  July (2.07-5.07)

  August (1.08)

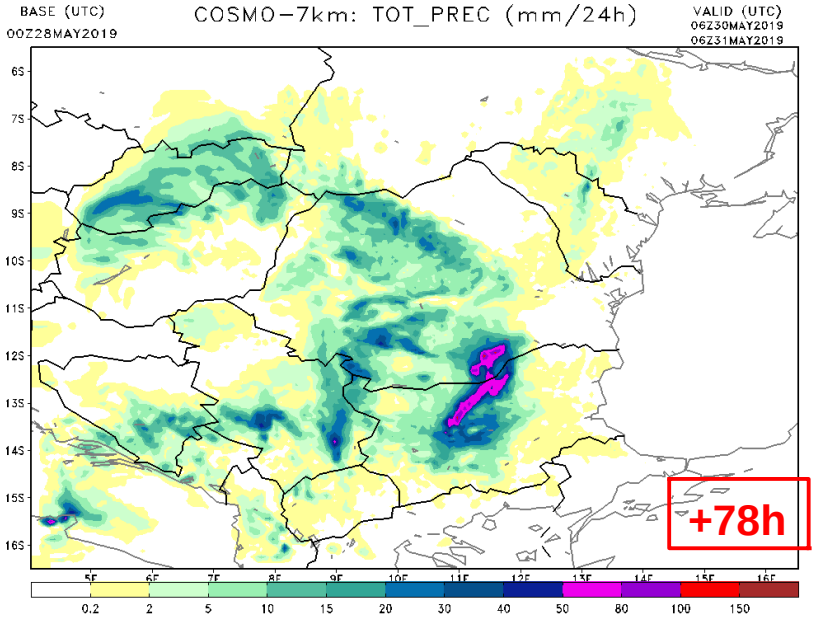
- **similar behavior for most country domain for these cases (observations)**:

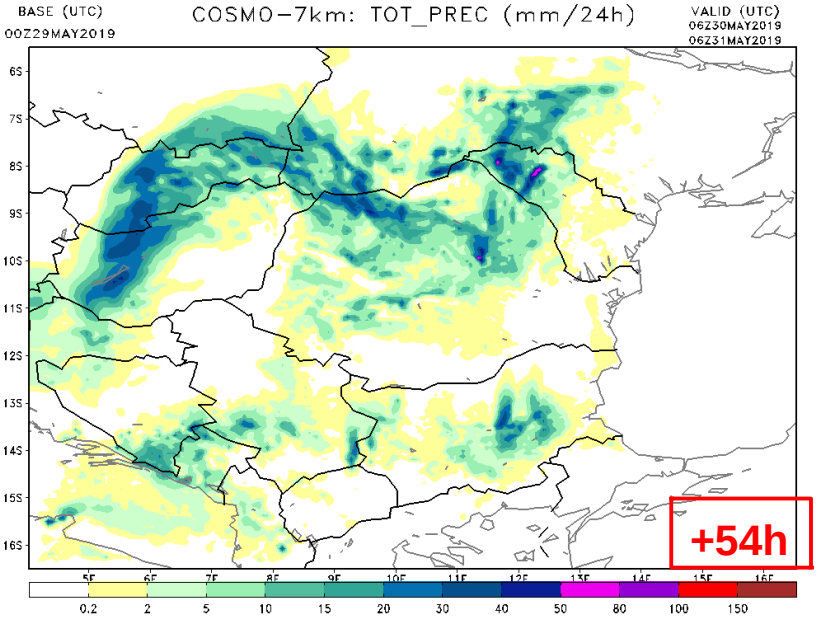
  COSMO-RO7 strongly underestimated precipitation in these cases of heavy observed precipitation, in particular, in the E and SE regions of Romania

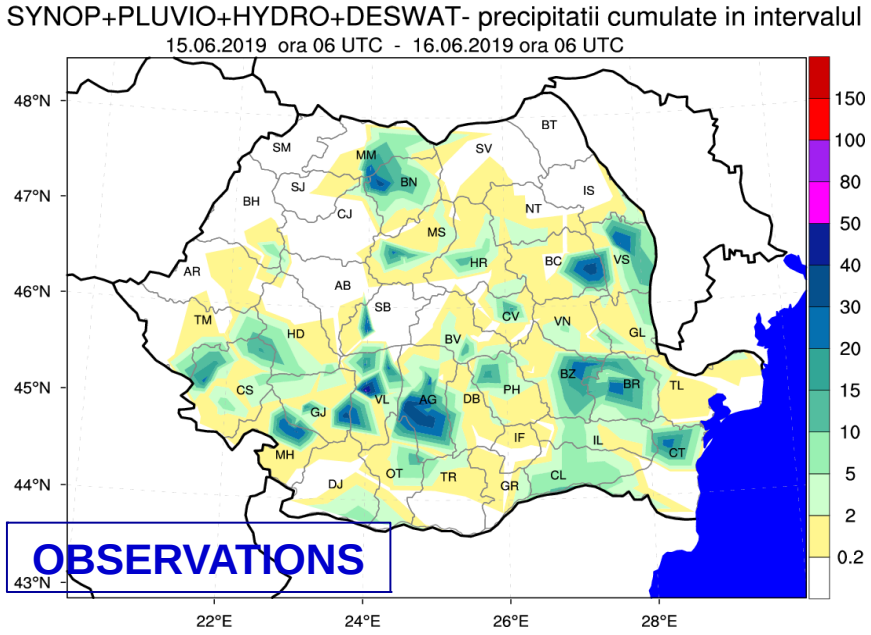


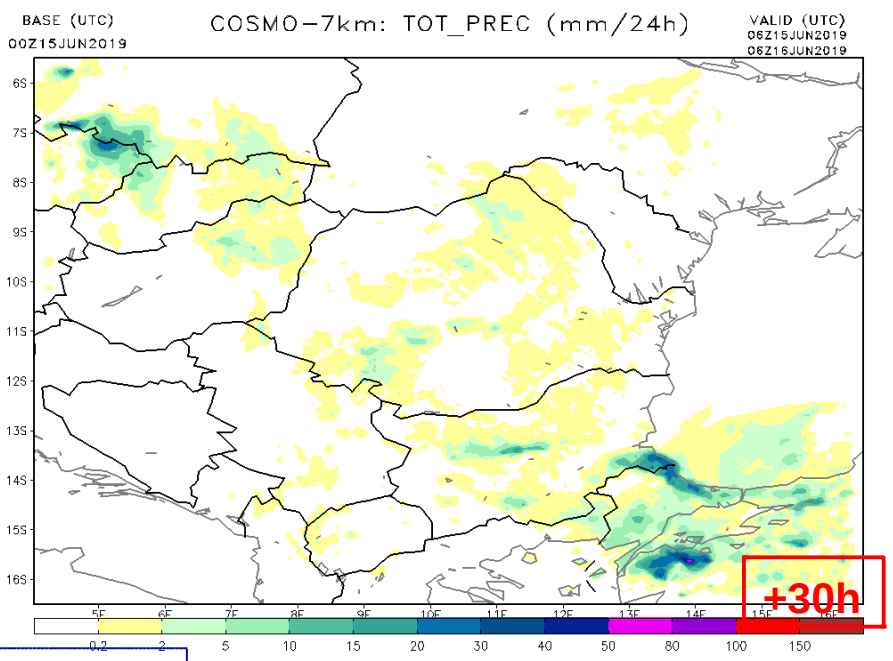


30.05-31.05 06UTC

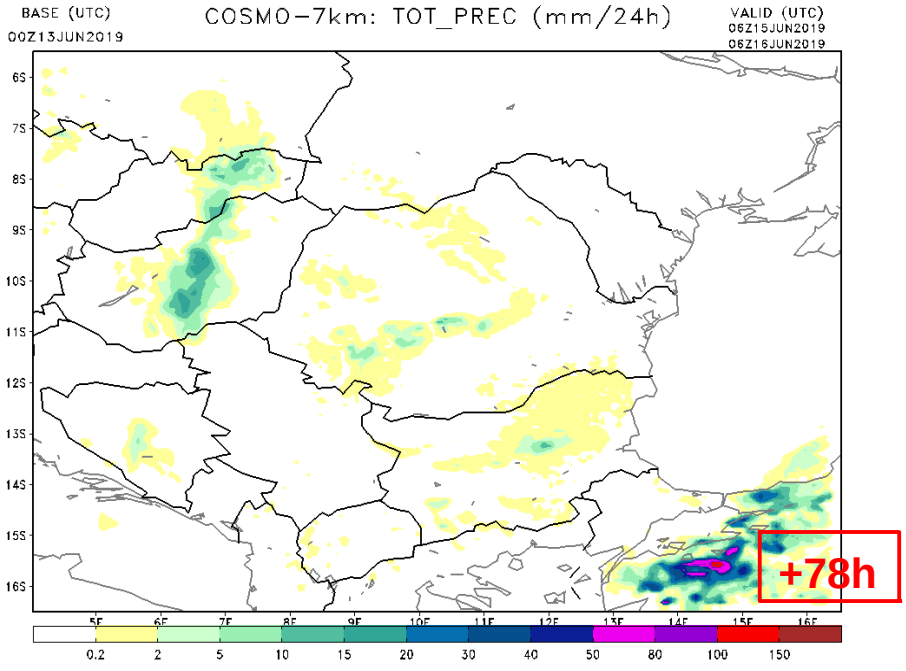


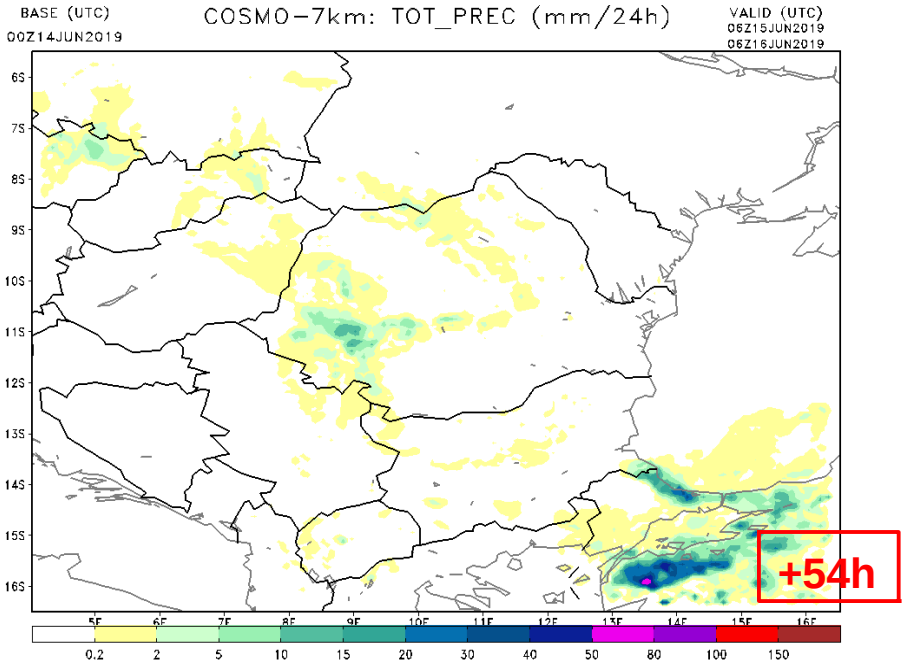


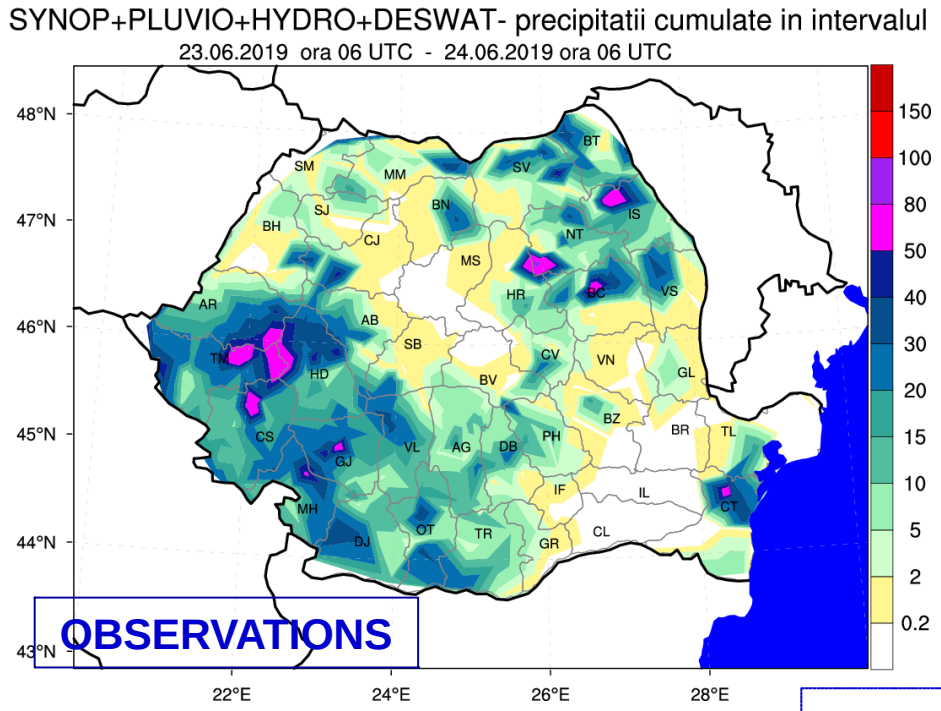


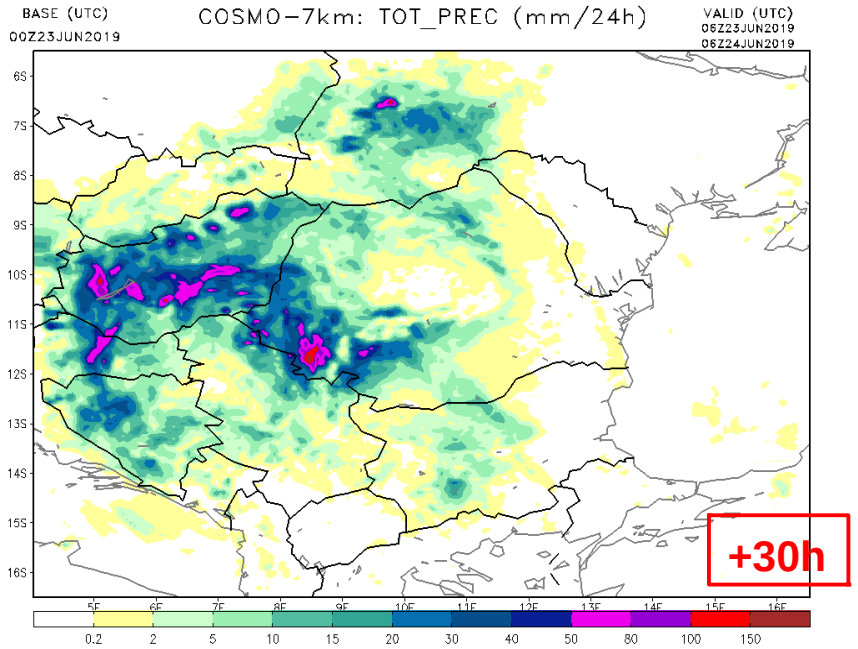


15.06-16.06 06UTC









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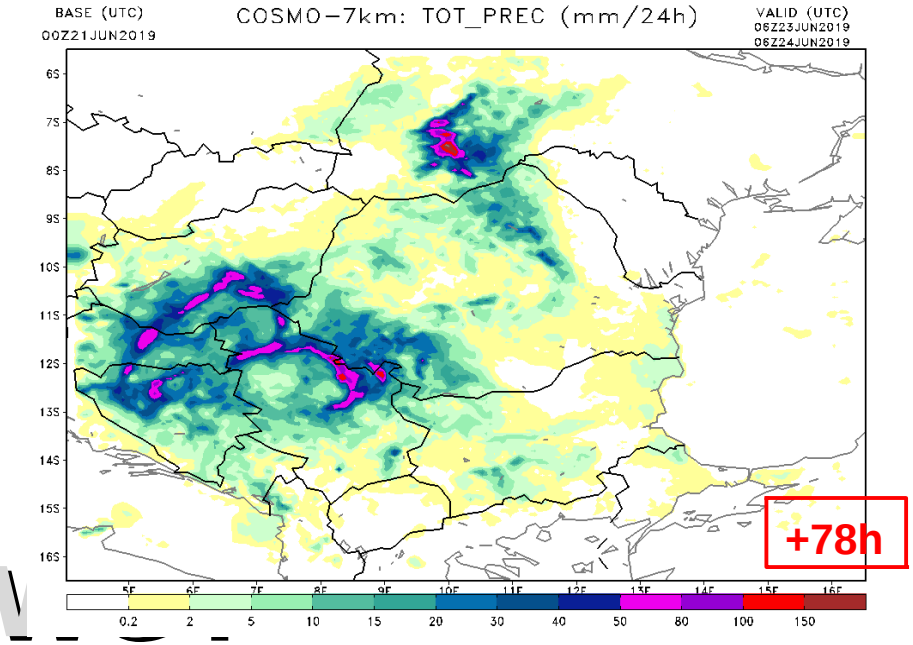

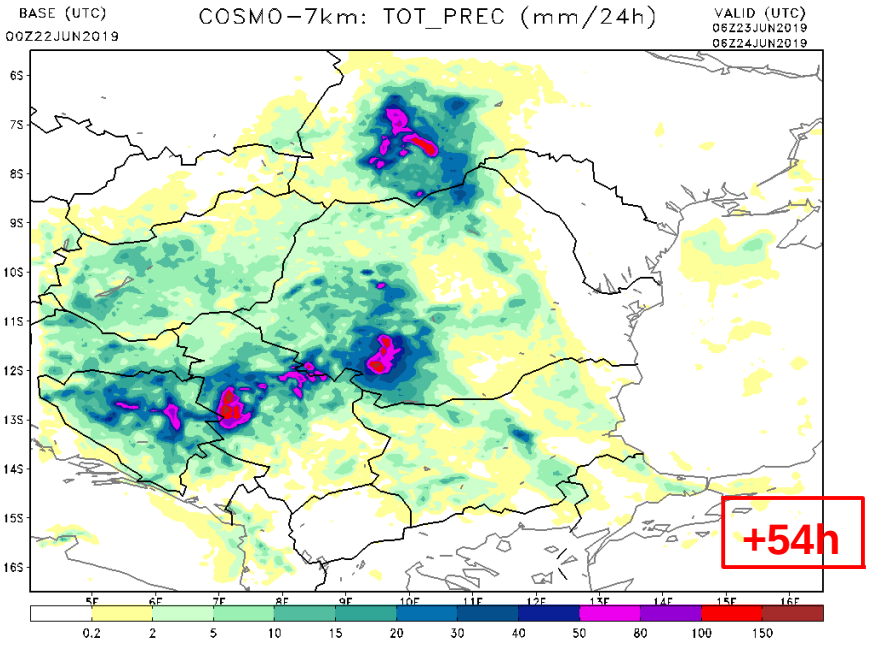

Conclusions from the overview of cases of model failures

- Cases are not in deficit… In particular in this summer
- Most of the cases are related to precipitation. In case of well formed lows or troughs, the global models provide good guidance. Also in winter, when the convection is rare
- For convective cases (e.g., supercells and the HIW related to them: wind gusts, showers, downbursts) the high-resolution models are useful, but mostly the reflectivity fields and the convective indices (CAPE, supercell detection index, etc.)
- Intense precipitation objects are often over- or underestimated and shifted by models
- These analyses are a good groundwork for the PP AWARE as relate usually to HIW

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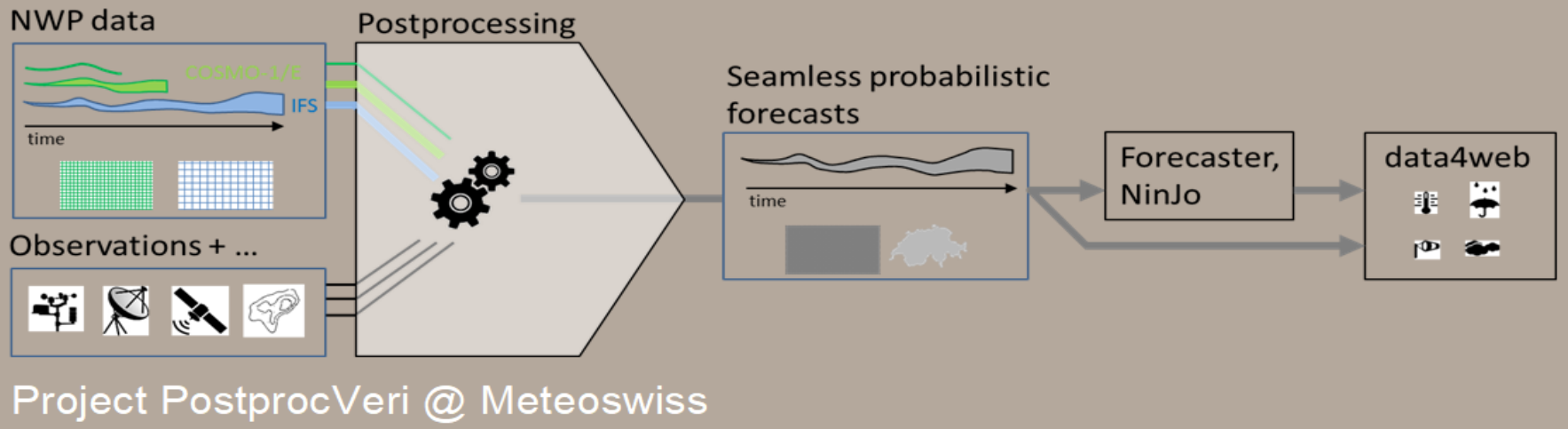
Recent developments on postprocessing

By MeteoSwiss

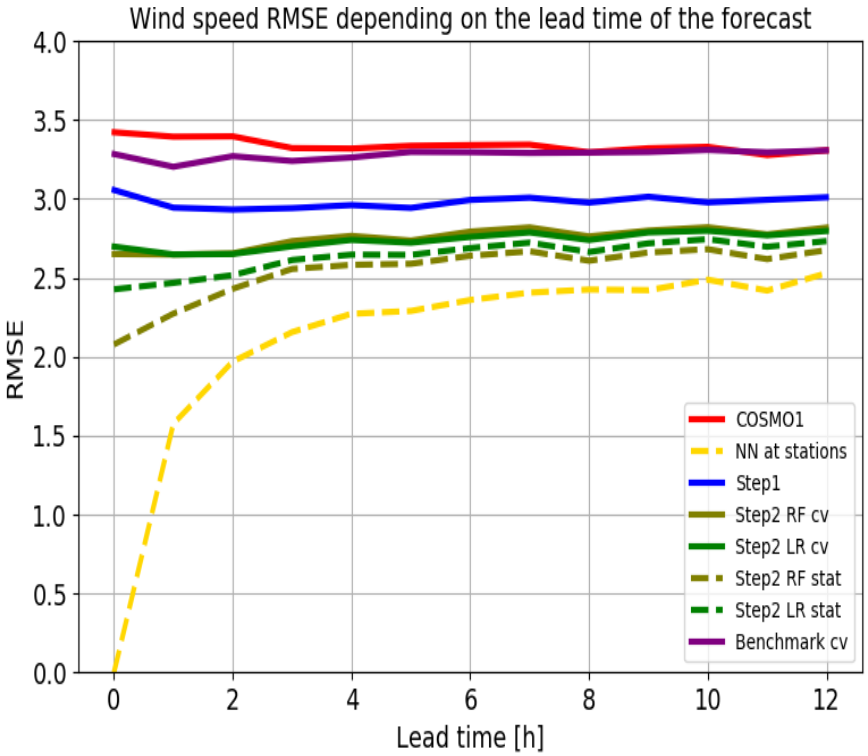
WG4

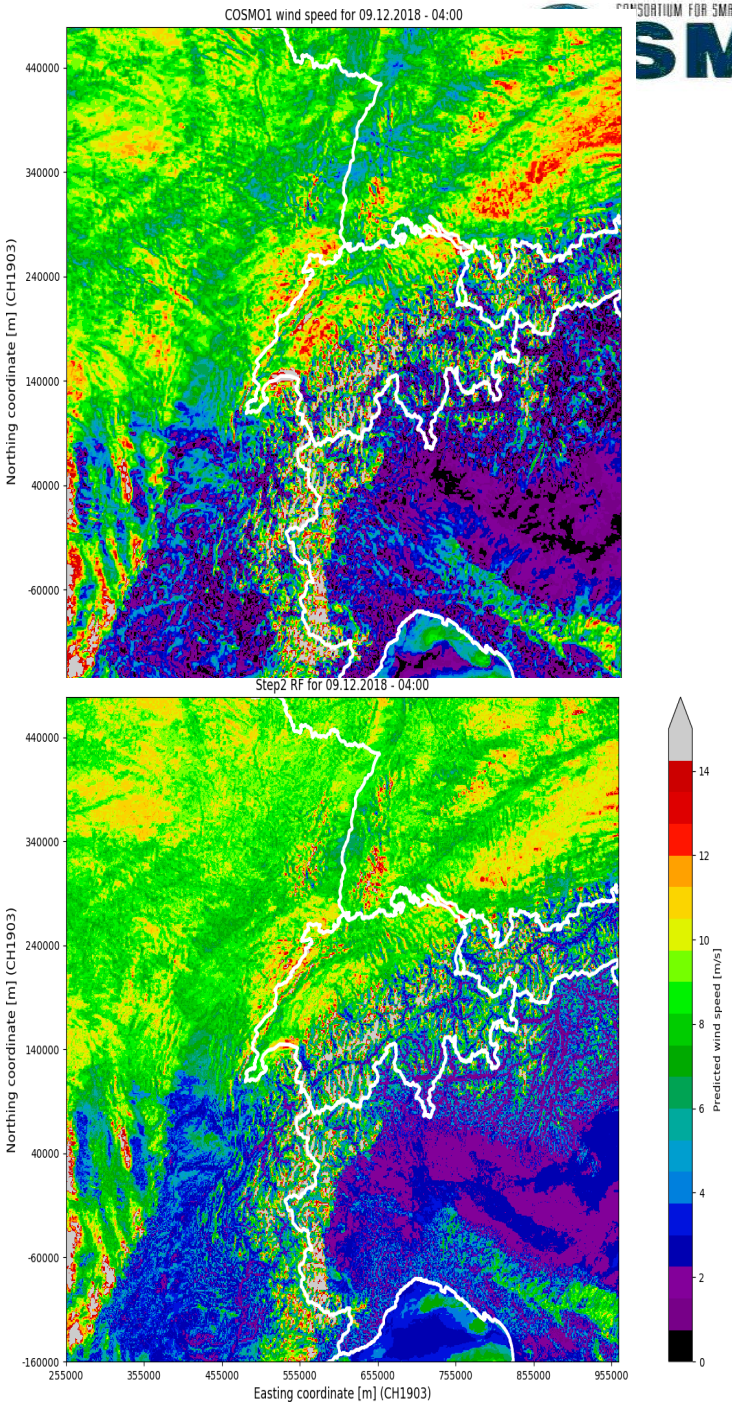
PostprocVeri @ Meteoswiss



Wind forecast

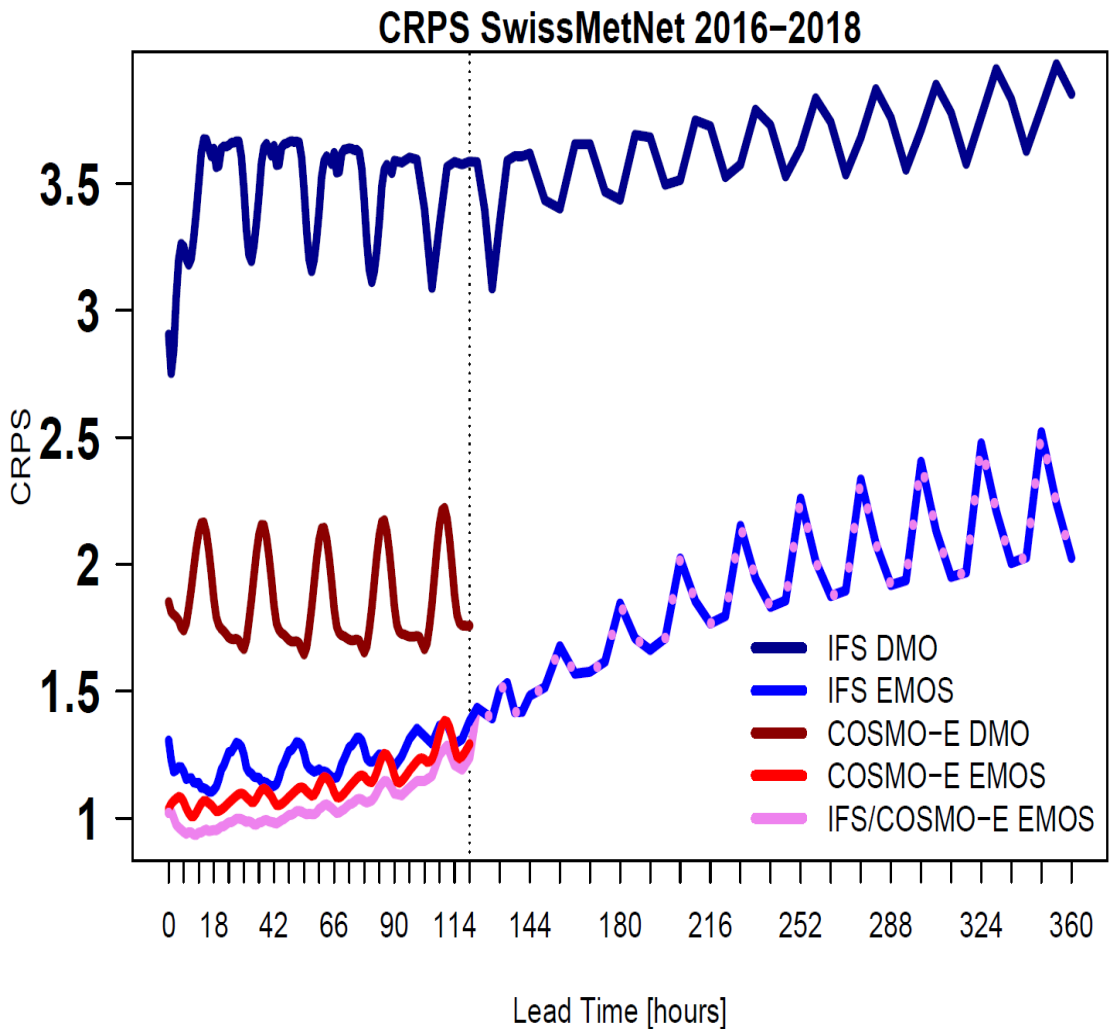
ML on COSMO-1





WG4

Temperature: Skill (CRPS) of DMO and EMOS



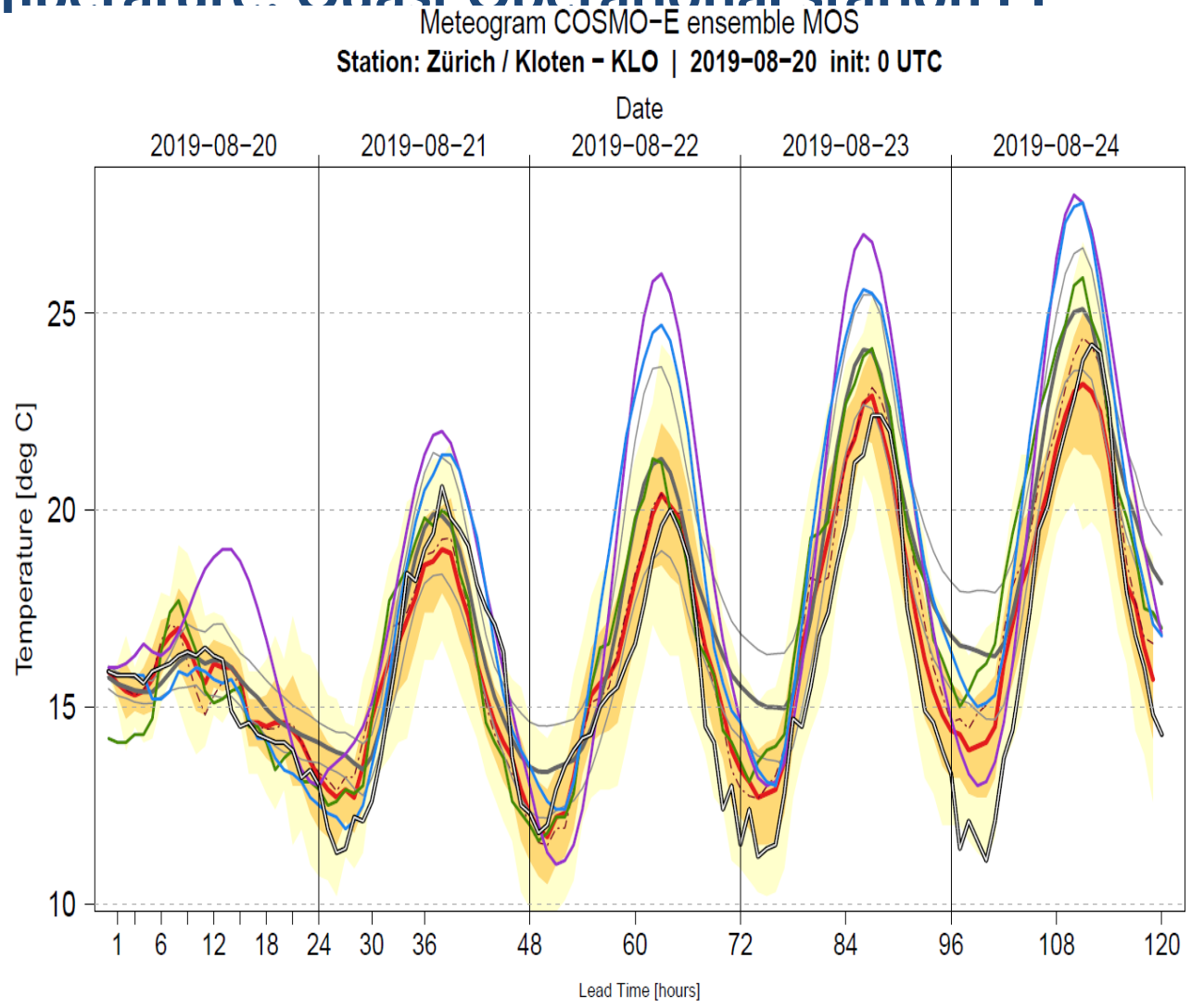
Swiss station-mean CRPS of temperature forecasts from IFS and COSMO DMO and EMOS, and a multi-model approach

-COSMO improves IFS substantially.

-Post-processing via EMOS leads to a further improvement .

-Combination of both (IFS and COSMO-E) able to outperform COSMO-PP output.

Temperature: Quasi-Operational station PP



MAE in 6h-period	−6	−12	−18	−24	−30	−36	−42	−48	−54	−60	−66	−72	−78	−84	−90	−96	−102	−108	−114	−120h	mean
EMOS mean	0.3	0.6	0.5	0.5	1	1.1	1.2	1.6	0.5	0.7	0.9	1.3	1.3	1.6	0.9	1	2.3	1.5	0.7	0.6	1
EMOS ctrl	0.2	0.9	0.6	0.5	1.3	1.4	0.9	1.7	0.8	0.6	1	1	1.3	1.6	0.8	1.5	2.9	2.3	0.7	0.9	1.1
COSMO-E mean	0.3	0.2	0.7	0.7	1.8	0.6	0.6	1.3	0.8	0.9	2	2.3	3.3	1.9	1.9	2.5	4.5	2.5	1.6	2.3	1.7
KalmanFilter	1.5	0.8	0.7	0.3	0.8	1.6	0.7	2	0.6	1.5	1.7	1.2	1.9	2.7	1.8	2.1	3.8	4	1.9	1.6	1.7
MOSMIX	*0.2*	*0.6*	*0.5*	*0.4*	*0.5*	*0.8*	*1.3*	*0.9*	*0.9*	*3.1*	*5.2*	*2.9*	*1.9*	*3.4*	*3.5*	*3.2*	*3.6*	*4*	*3.9*	*2.2*	**2.1**
data4web	0.4	1	3.4	0.9	1.7	2	1.8	0.8	1.4	2.4	6.3	4.1	1.7	2.8	4.6	2.9	1.7	2.5	4.2	3.1	2.5

WG4

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Lightning Potential Index (LPI) and Hailcast in COSMO-1

Xavier Lapillonne

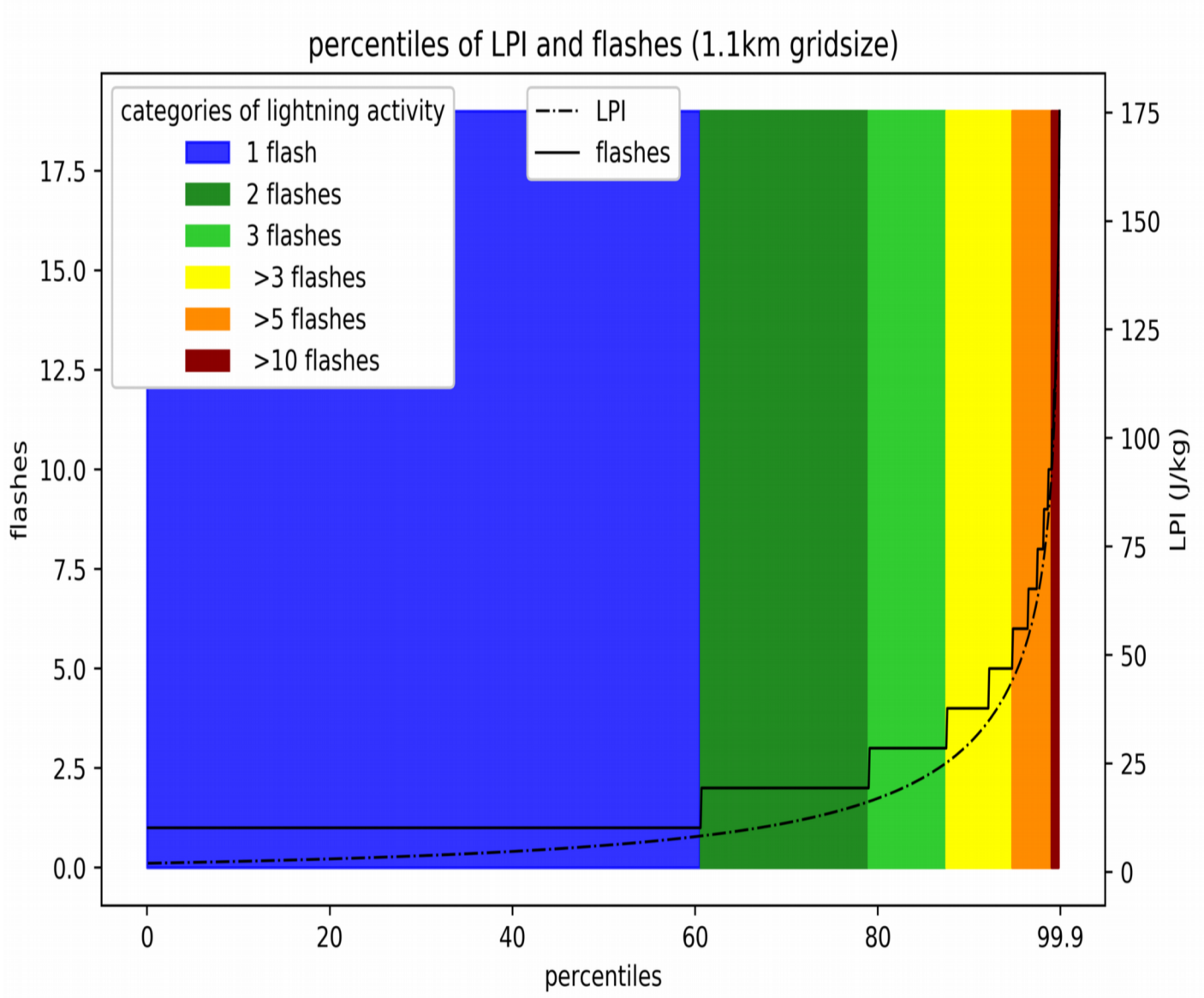
COSMO General Meeting 2019, Rome, Italy

Sources : Master Thesis Jonas Jucker, LPI

Master Thesis Raffael Aellig, Hailcast

xavier.lapillonne@meteoswiss.ch

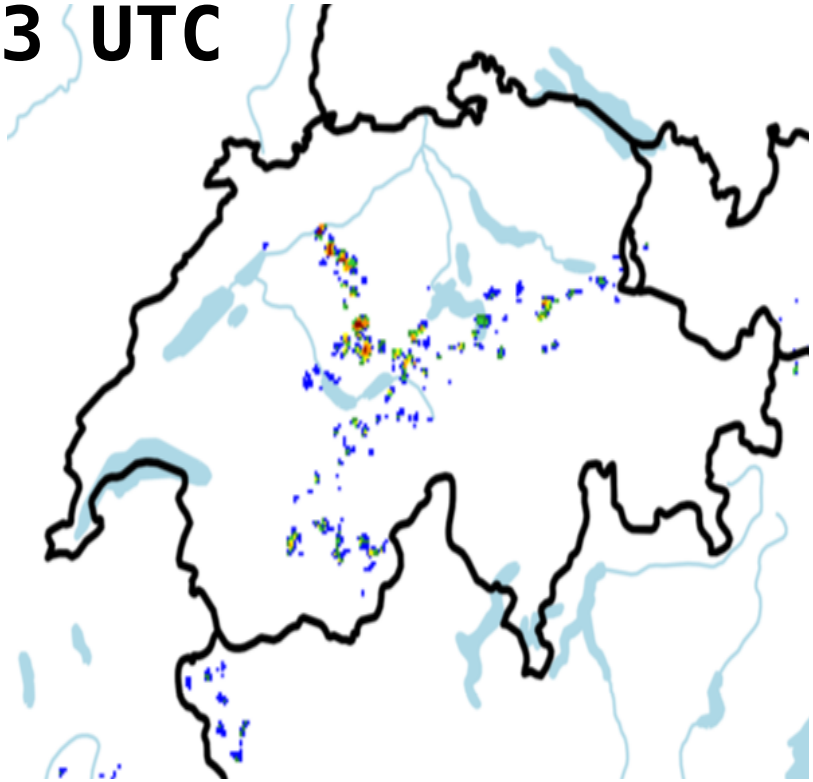
From LPI to flash rate



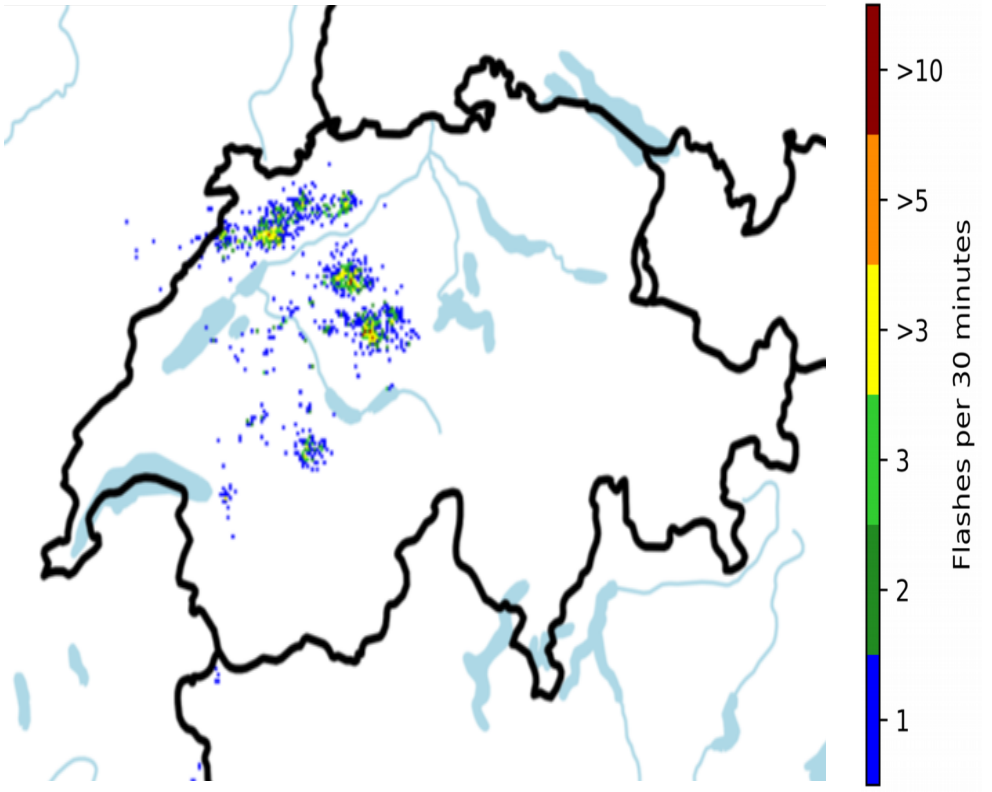
WG4

Case study 24th of August

Flashrate from LPI
13 UTC



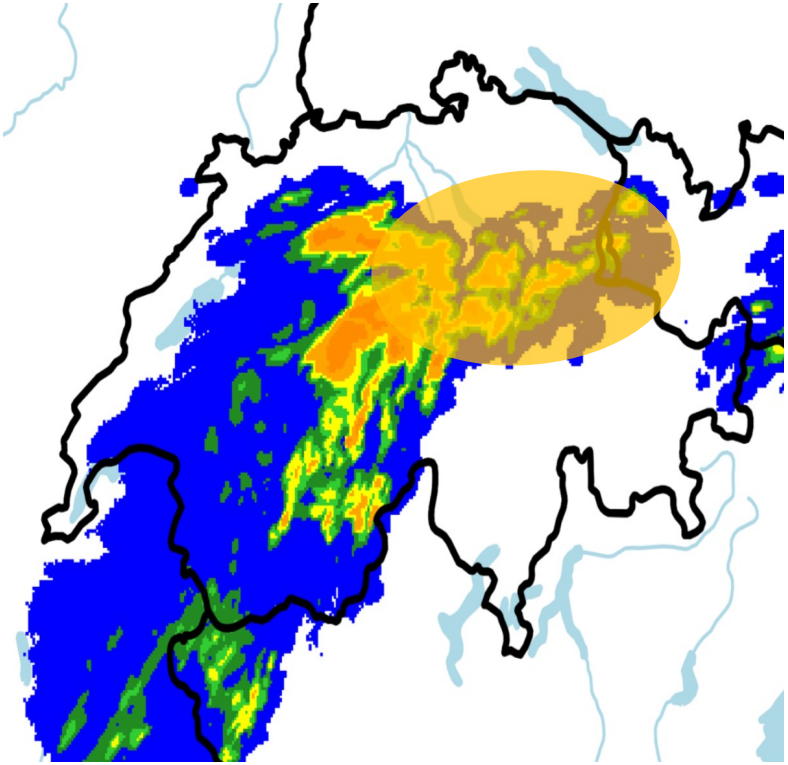
observations +/- 15 m



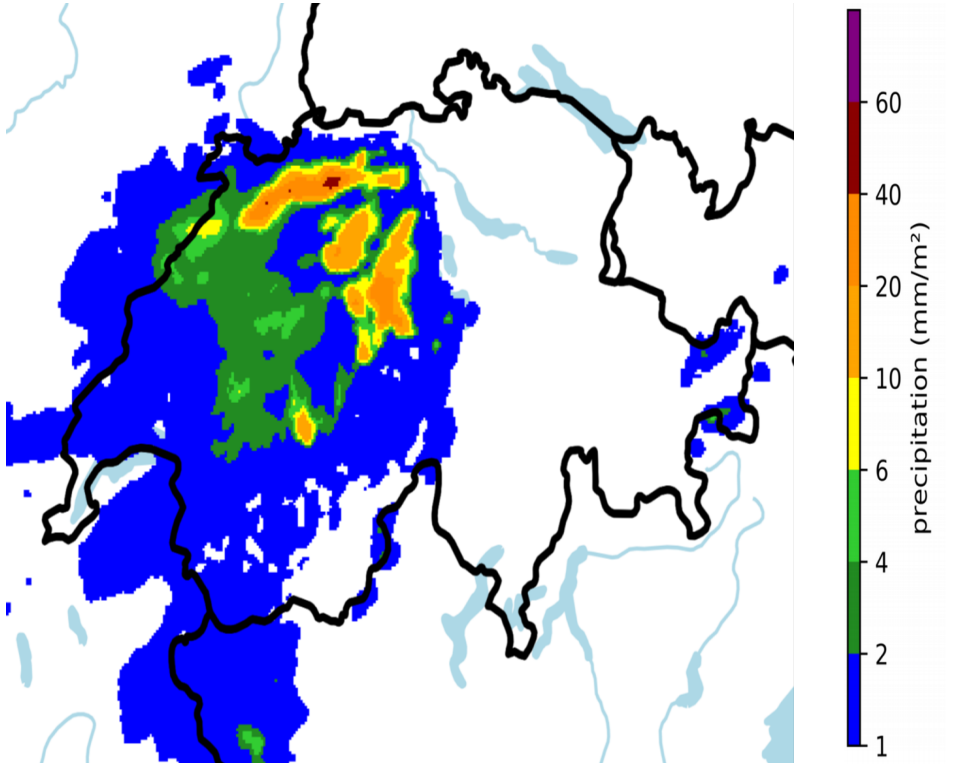
WG4

Case study 24th of August

TOT_PREC 13-14 UTC



CombiPrecip 13-14 UTC



HAILCAST Model

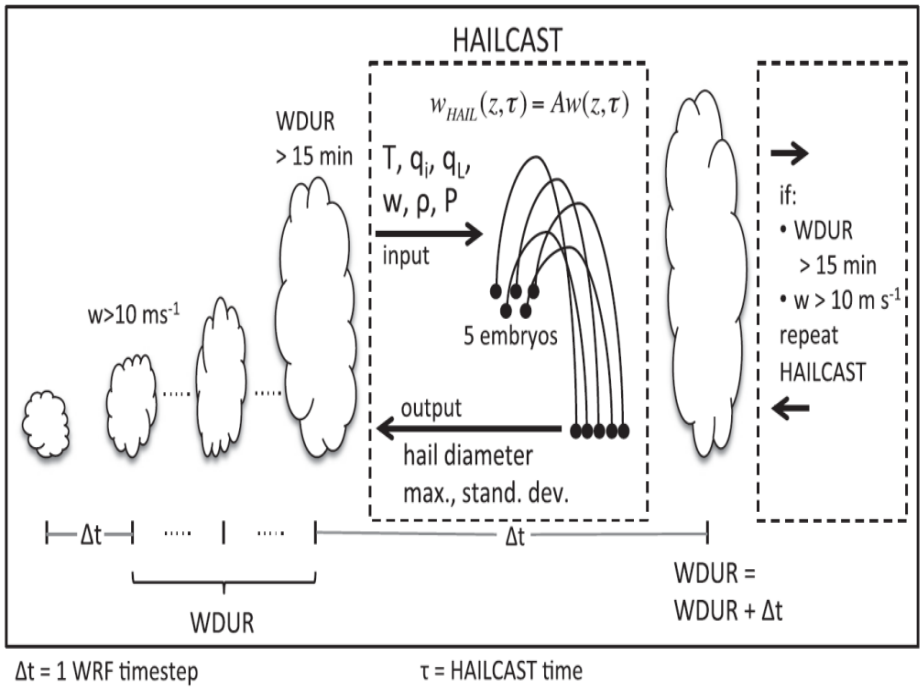


FIGURE 2.1: Illustration of the concept of the HAILCAST model (Adams-Selin and Ziegler, 2016)

- One-Dimensional diagnostic hail prediction model originaly implemented in WRF
- Based on updraft strength and duration, the model is activated
- 5 initial hail embryos to hailstones
- Output is a maximum hail diameter out of the 5 initial diameters

Heidke-Skill-Score (HSS)

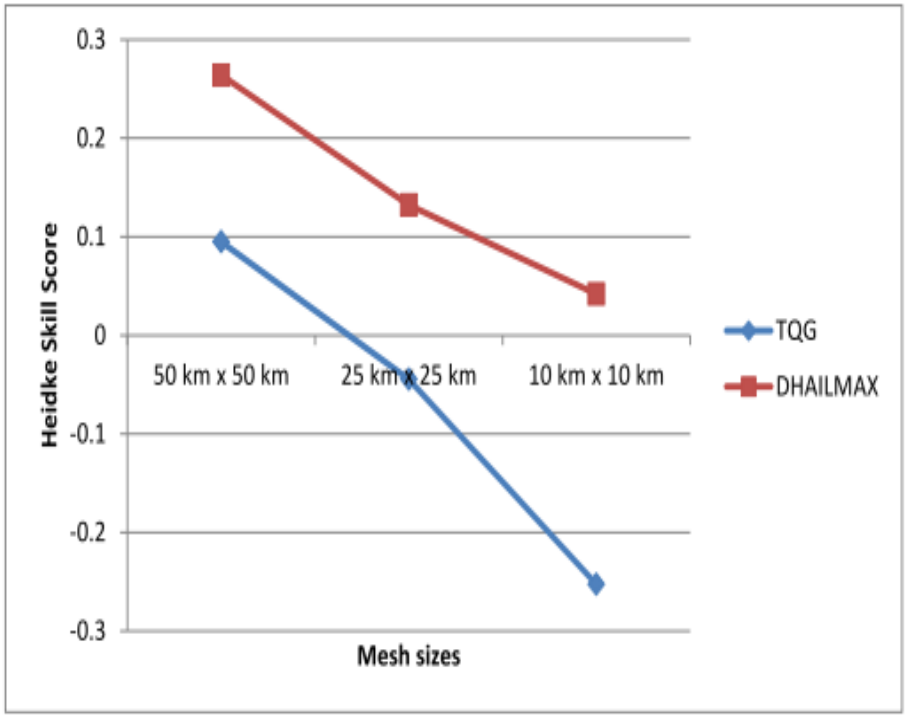


FIGURE 3.10: Heidke Skill Score comparison of TQG and DHAIL-MAX with MESHS for patterns sizes 10 x 10 km, 25 x 25 km, and 50 x 50 km

- HSS : Contingency based skill score.
- Hailcast always better than TQG.
- Hailcast has skill >0 down to 10x10 km area.

Forecasters survey within task 5.6 of the PP C2I

- A draft of the survey is prepared with about 20 questions
- It aims at subjective evaluation of ICON/ICON-LAM added value compared to COSMO by forecasters

- overall

- for particular variables

-seasons

- runs

-In severe weather situations

Forecasters survey within task 5.6 of the PP C2I (cont)

- It will also assess the data format requirements
- Need for additional output variables
- Timeliness and convenience of visualization

The survey draft will be sent to WG4 for comments and suggestions

Thank you!

Project flowchart