*Regional Cooperation for*
*Limited Area Modeling in Central Europe*

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# ALARO experiences@SHMU

(ALARO-1 working days, 3-5 March 2025, Krakow)

M. Derková & A. Simon
with contributions from M.Belluš, M. Imrišek, O. Španiel

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# ALARO CSCs @SHMU (!A-LAEF)

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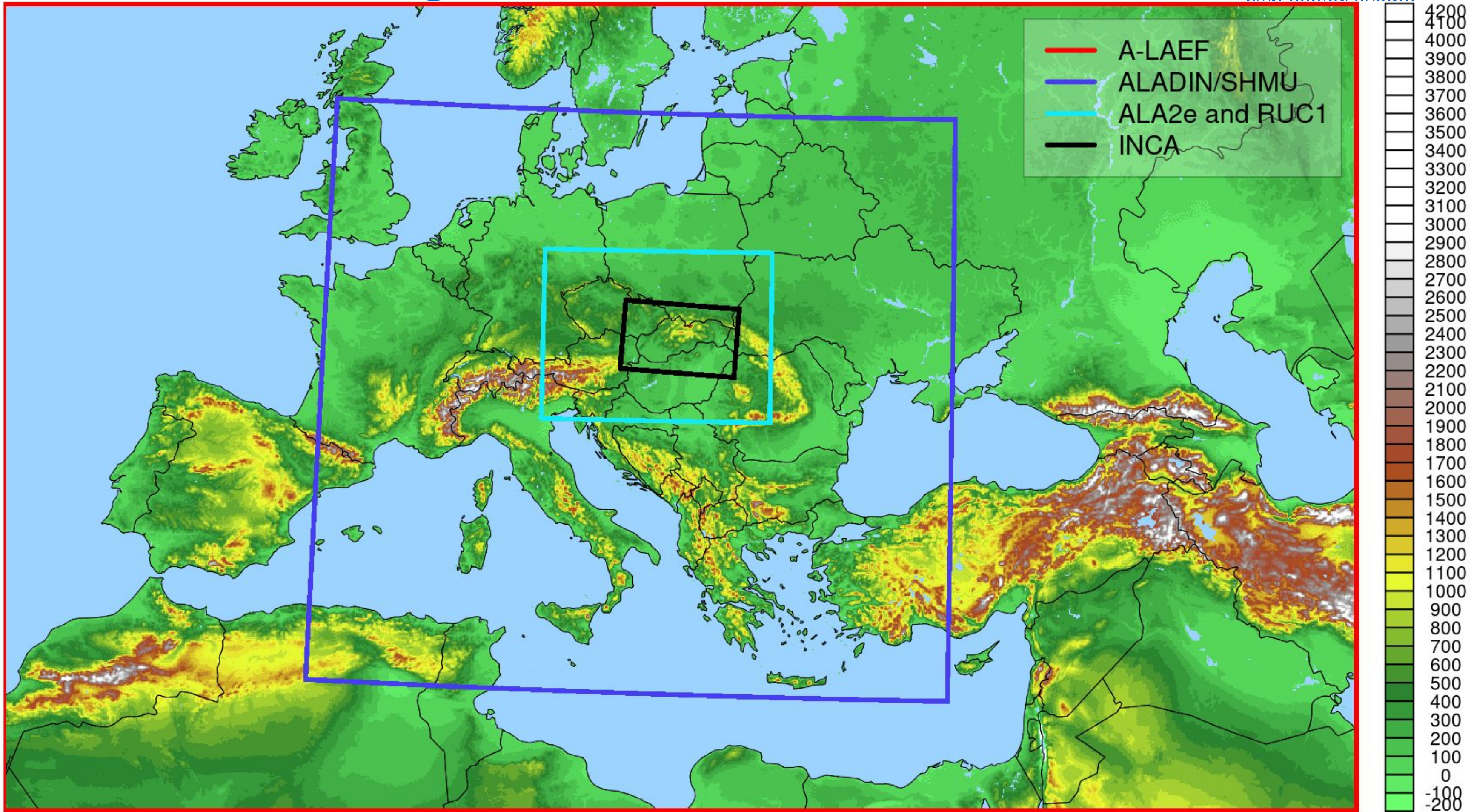
| *CSC* | **ALARO/SHMU** | **ALA2E** | **RUC1** |
|---|---|---|---|
| *status* | operational | operational | experimental |
| *code version* | CY46T1bf07 | CY48T3 | CY46T1bf07 |
| *physics* | ALARO-1vB | | |
| *add-ons* | wet snow, max. subgrid wind | prognostic graupels | |
| *dx (points)* | 4.5 km (625 x 576) | 2.0 km (512 x 384) | 1.0 km (1024 x 768) |
| *vertical levels* | 63 | 87 | 87 |
| *dynamics* | hydrostatic | nonhydrostatic | nonhydrostatic |
| *tstep* | 180 s | 90 s | 30 s |
| *forecast ranges* | 78/72/72/60 (a' 1h) | 84/-/84/- (a' 1h) | hourly +12 h, (a' 1h) |
| *coupling model* | ARPEGE (long & short cut off) | ECMWF, 6 h lagged | ARPEGE short cut off, lagged |
| *coupling freq.* | 3 h | 3 h | 1 h |
| *assimilation* | BLENDVAR & CANARI surface DA | A-LAEF CTRL member downscaled | 3D-Var & CANARI surface DA |
| *initialization* | none | DFI | DFI |
| *HPC* | NEC-LX, 240 nodes (40 nodes used for each CSC) | | |
| *output format* | GRIB2 | | |

# ALARO CSCs @SHMU

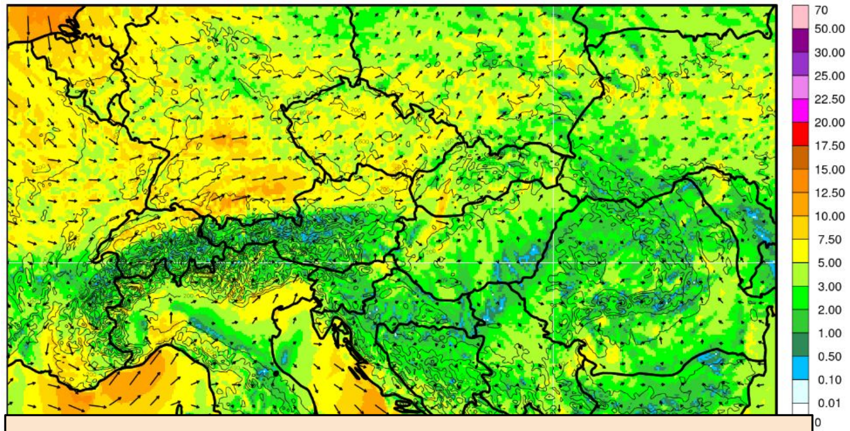


# ALADIN/SHMU 4.5 km/L63

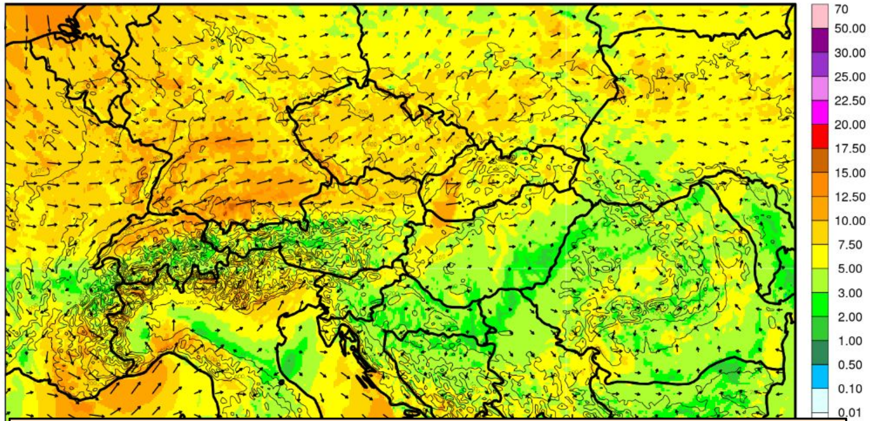
- main operational application
  - provides data for public web page and for customers
- changelog since last ALARO WD
  - 04-2023: upgrade BLENDING -> BLENDVAR
  - 11-2023: upgrade to CY46t1_export
- ongoing tests for future upgrades
  - L63 → L87 (for ZTD DA); +102 h
  - retuning of surface: new climate files, deep soil wetness smoothing
- upgrade to CY46t1_cz or CY48t3 or CY49t2?

# ALADIN/SHMU: max subgrid wind *(A. Simon)*

local development, documented (report): estimation of the spatial variability of the maximum wind speed in the subgrid space in 4.5 km grid. based on simulations with 0.3 km grid, important when the difference between mode and real orography is high (~100 m)




10 m WS: 2024-04-19_00+15, max=14.6 m/s




max subgrid WS: 2024-04-19_00+15, max=18.1 m/s

# ALADIN/SHMU: wet snow accretion *(A. Simon)*

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**Extreme Value Analysis and Modelling of Wet Snow Accretion on Overhead Lines in Hungary**

Katalin Somfalvi-Tóth, André Simon

*Atmosphere* **2023**, *14*(1), 81; **https://doi.org/10.3390/atmos14010081**

atmosphere MDPI

*Article*

**Extreme Value Analysis and Modelling of Wet Snow Accretion on Overhead Lines in Hungary**

Katalin Somfalvi-Tóth [1,*] and André Simon [2,3]

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[2] Slovak Hydrometeorological Institute (SHMÚ), 83315 Bratislava, Slovakia
[3] Hungarian Meteorological Service (OMSZ), 1024 Budapest, Hungary
* Correspondence: somfalvi-toth.katalin@uni-mate.hu

**Abstract:** Wet snow events in Hungary can occasionally cause damage to overhead power lines and serious power supply failures. Return period calculation of such high snow mass events was determined upon a 50-year long data series available at 12 meteorological stations. Wet snow masses were estimated with a model of cylindrical accretion around wire of 3.1 cm diameter. Trends in the return periods and ice classes (according to the ISO 12494 standard) were assessed from division of the dataset into two periods (1965–1990 and 1991–2016). Ice classes in the range of R2 to R5 (mass of 0.7–6.1 kg $m^{-1}$) were identified. The wet snow risk decreased in southern or central Hungary, while an increase was found in the western part of Hungary. Ice classes R6–R8 (up to 40 kg $m^{-1}$) could occur in mountain areas of Hungary as indicated by numerical simulations in case studies. However, their return period is unknown due to the lack of long observation series.

**Keywords:** wet snow; accretion masses; extreme value analysis; POT method; ALADIN; numerical models; return period

check for updates

**Citation:** Somfalvi-Tóth, K.; Simon, A. Extreme Value Analysis and Modelling of Wet Snow Accretion on Overhead Lines in Hungary. *Atmosphere* 2023, *14*, 81. https://doi.org/10.3390/atmos14010081

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**1. Introduction**

Wet snow occurs at both middle and higher latitudes, as an annual phenomenon. On exposed objects, especially on overhead power lines, cylindrical accumulation of snow can be significant and can cause extensive damage to transmission line networks. For decades, diversified scientific examinations have been conducted to study the appearance and formation [1–5], the possibility and reliability of its prediction [6–9] and to develop prevention methods [10–12]. The formation of wet snow crystals needs special atmospheric conditions. The dry snowflakes, while falling pass through a layer with a slightly positive temperature, partially melt, so liquid water (optimally 10–15%) appears among the crystal branches. Due to the liquid water content, snowflakes can strongly adhere to objects reaching critical masses for damages. In the accumulation phase, the height of the 0 °C isotherm, the moisture content of both the air and the snowflakes, furthermore the wind conditions experienced during snowfall hold decisive importance. Based on the study of Somfalvi-Tóth [13] the optimal vertical stratification for wet snow formation is a 300–400 m thick, slightly positive (maximum + 2 °C) layer near the ground under a negative temperature layer, which is also demonstrated by a narrow interval of lapse rate (3–4 °C $km^{-1}$). The 850/1000 hPa relative topography also moves in a narrow range (1292–1307 gpm) during wet snow events. The relative humidity of the air is mostly between 90–95%. Besides these components, wind speed is also an important factor. If the wind speed is initially weak (below 5 m $s^{-1}$), the accumulation starts at the top of the transmission lines, almost perpendicular to its longitudinal axis. If the wind speed does not exceed 5 m $s^{-1}$, the rotation of the wire around its axis is not able to start due to the weak compressive force of the wind ($\overrightarrow{F_{wind}}$). If the wind speed exceeds 5 m $s^{-1}$, the snowflakes accumulate on the

*Atmosphere* 2023, *14*, 81. https://doi.org/10.3390/atmos14010081 https://www.mdpi.com/journal/atmosphere

**Some Scots could be without power for days - as snow hits power lines**

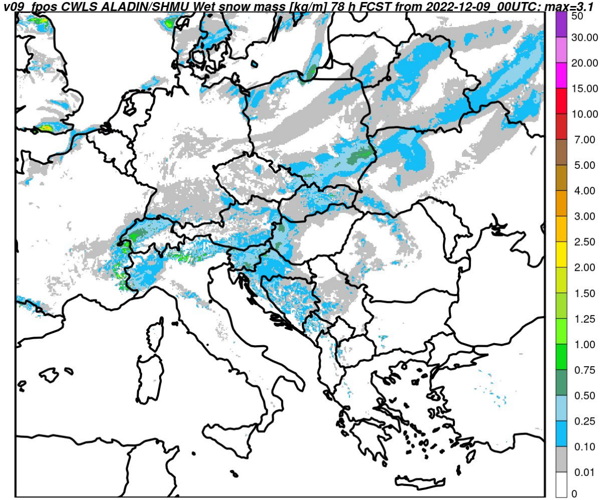
13th December 2022

(Image: SSEN)



Príčina č. 1 ochabnutej pokožky na t
Pozor: vek za to nemôže
gogoldentree.sk

v09_fpos CWLS ALADIN/SHMU Wet snow mass [kg/m] 78 h FCST from 2022-12-09_00UTC: max=3.1




available in the T-codes sicnce CY43t2

# SHMU web: new epsgrams visualisation

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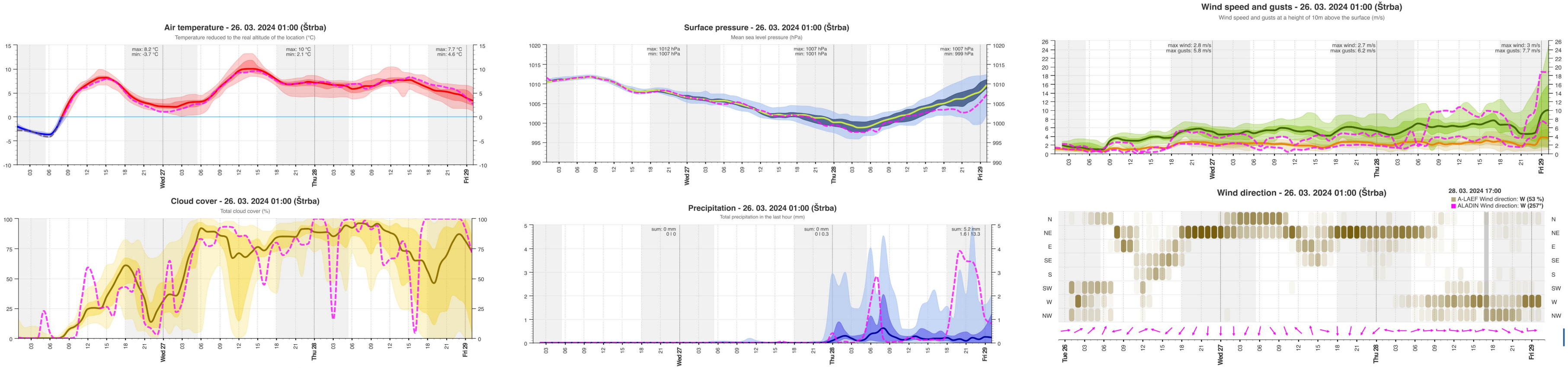
New interactive visualisation of the A-LAEF, ALADIN/SHMU and ECMWF products was prepared. Based on JSON data, the highcharts enable to read values of meteorological parameters with the use of the mouse pointer. The EPSGRAMS are generated for over 1000 settlements in Slovakia, showing the spread (quartiles), maxima and minima and EPS median values, as well as the deterministic forecast of ALADIN/SHMU (in pink).

[https://www.shmu.sk/en/?page=2673&nwp_mesto=31357#alaef](https://www.shmu.sk/en/?page=2673&nwp_mesto=31357#alaef)



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# ALADIN/SHMU L63 -> L87 (*M. Imrišek*)

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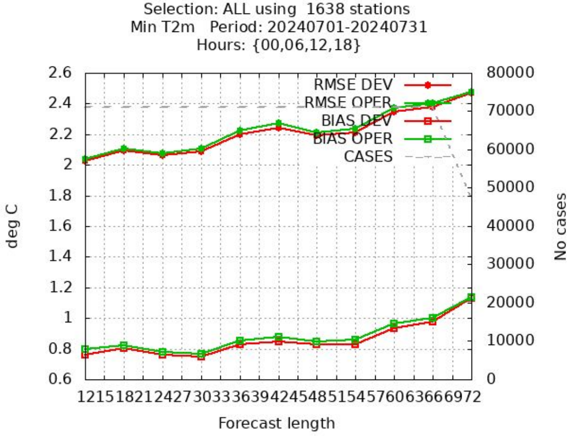


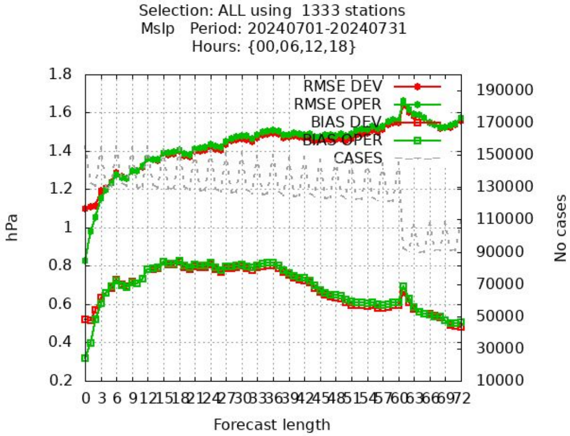


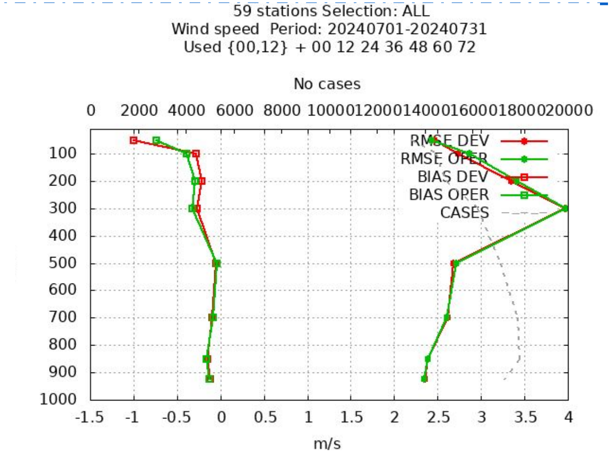


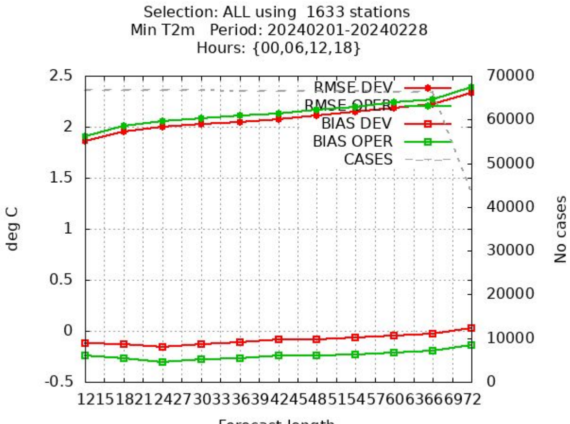


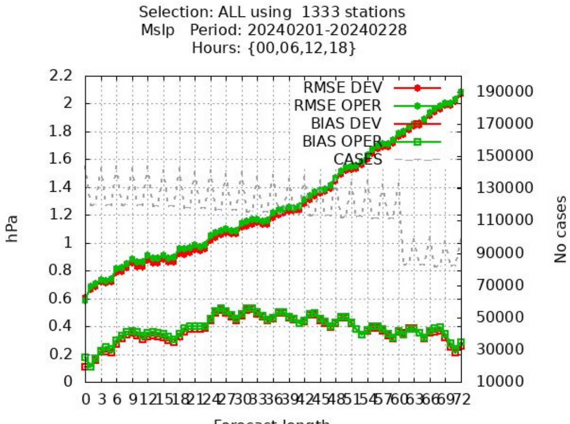


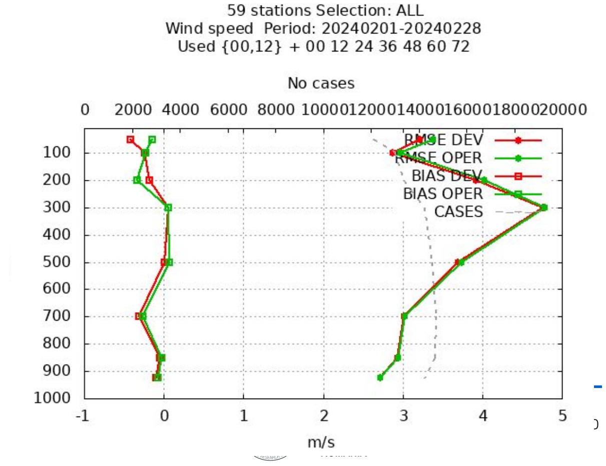

# ALA2E 2.0 km/L87

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- DADA + DFI, A-LAEF CTRL INIT, ECMWF LBC
  - inspired by CSC setup successfully used in DEODE by AQ WG
  - requested for operational usage for CMAQ model
  - also used by forecasters - extreme weather & convective situations
  - provides new diagnostic parameters
- changelog
  - 05-2023: ALA2E operational
  - 08-2023: ALA2E with lagged coupling
  - 05-2024: upgrade ALA2E to CY48t3
  - 11-2024: upgrade ALA2E to CY48t3 with graupels
- future: test with CY49t2



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# ALA2E 6h lagged LBC (*M.Belluš*)

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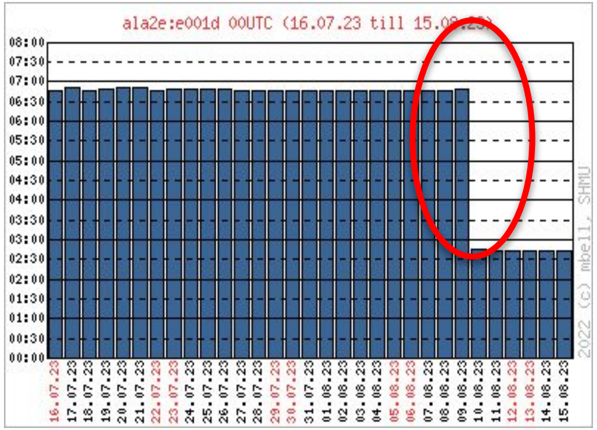
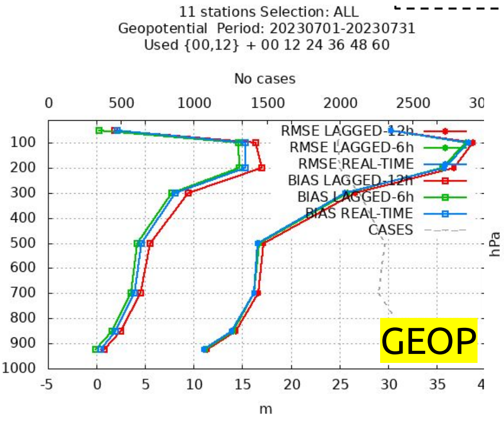
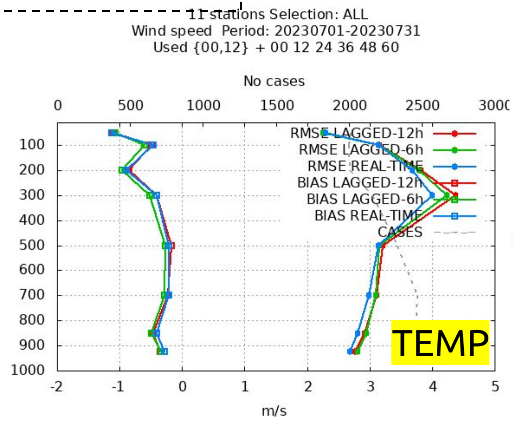
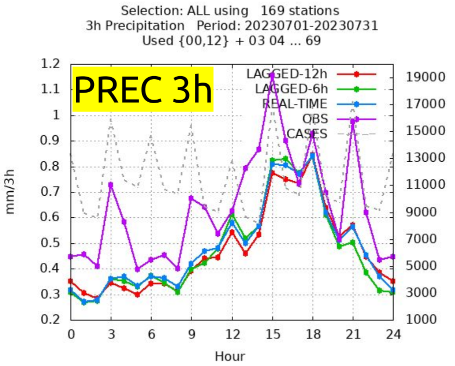
Earlier delivery requested by AQ modellers => tests with lagged coupling. The tradeoff between slight scores deterioration vs. data availability.

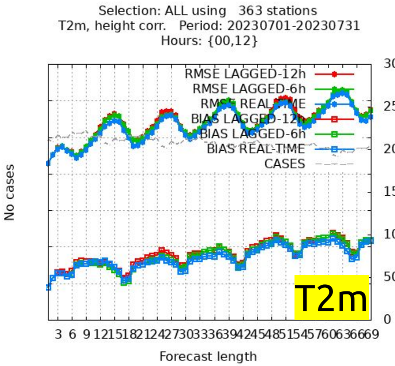



time-lag 6h
time-lag 12h
realtime REF
observations



# Hourly precipitation forecasts - cases

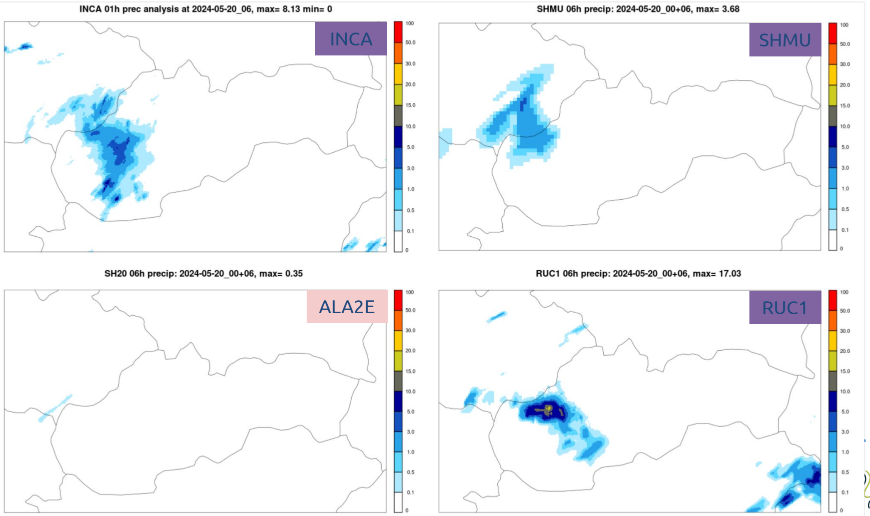
sometimes ALA2E misses the precipitation events (and sometimes not)

.

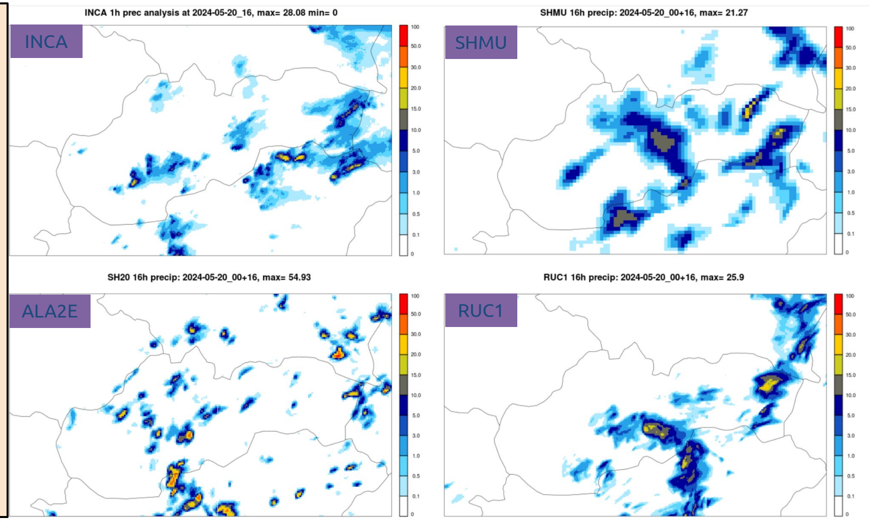
INCA = precipitation analysis

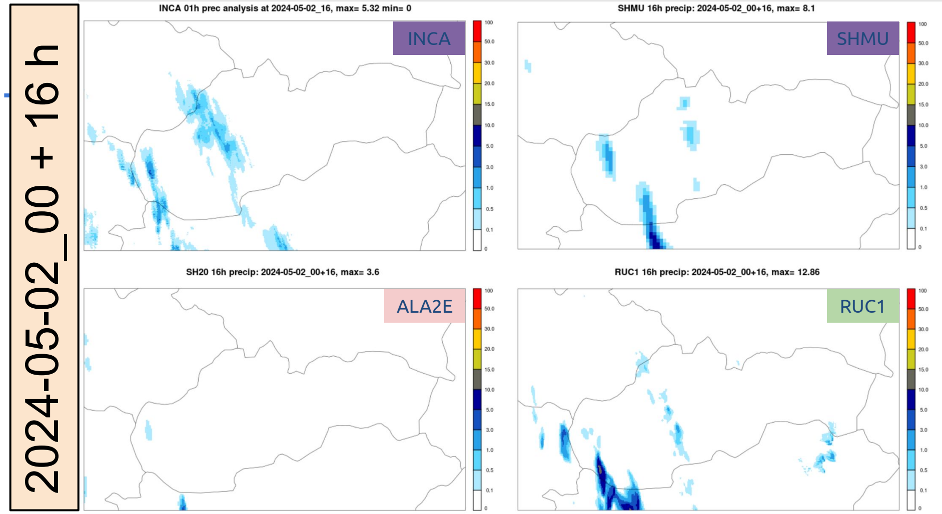
comparison of SHMU (OPER) vs. ALA2e vs RUC1

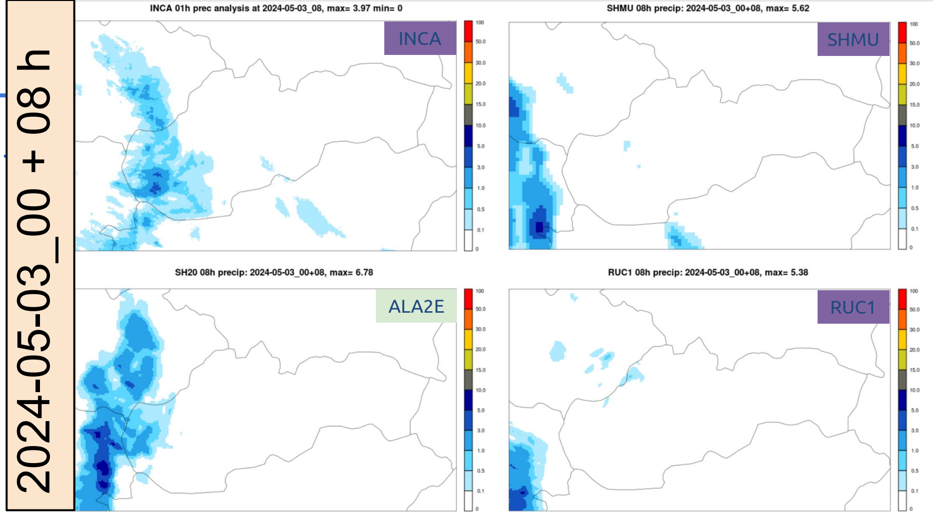
2024-05-20_00 + 06 h

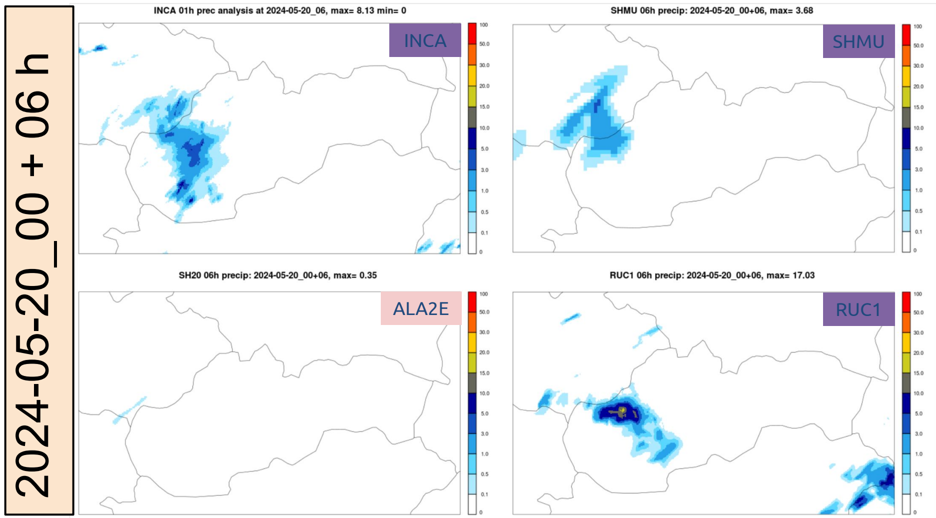


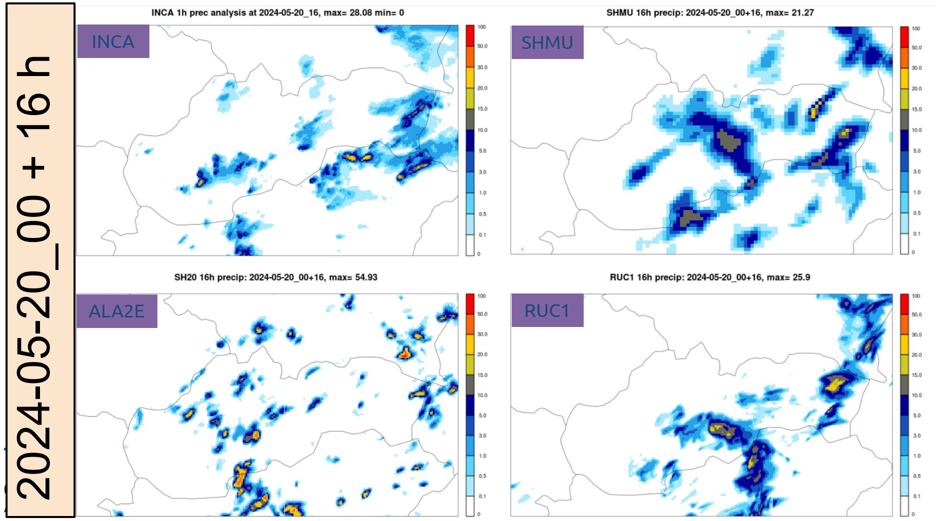

2024-05-20_00 + 16 h




2024-05-02_00 + 16 h
INCA 01h prec analysis at 2024-05-02_16, max= 5.32 min= 0
INCA
SHMU 16h precip: 2024-05-02_00+16, max= 8.1
SHMU
SH20 16h precip: 2024-05-02_00+16, max= 3.6
ALA2E
RUC1 16h precip: 2024-05-02_00+16, max= 12.86
RUC1

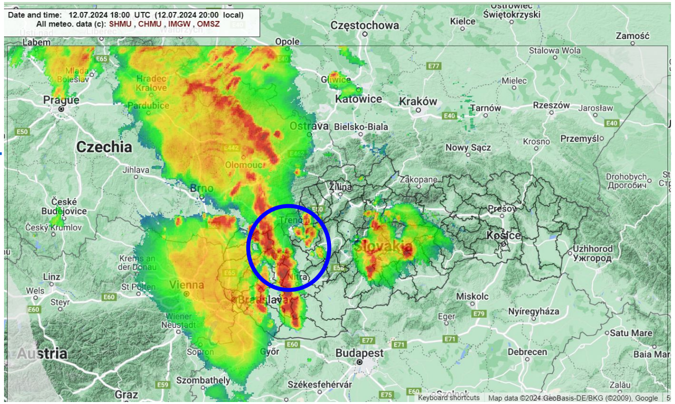

2024-05-03_00 + 08 h
INCA 01h prec analysis at 2024-05-03_08, max= 3.97 min= 0
INCA
SHMU 08h precip: 2024-05-03_00+08, max= 5.62
SHMU
SH20 08h precip: 2024-05-03_00+08, max= 6.78
ALA2E
RUC1 08h precip: 2024-05-03_00+08, max= 5.38
RUC1


2024-05-20_00 + 06 h
INCA 01h prec analysis at 2024-05-20_06, max= 8.13 min= 0
INCA
SHMU 06h precip: 2024-05-20_00+06, max= 3.68
SHMU
SH20 06h precip: 2024-05-20_00+06, max= 0.35
ALA2E
RUC1 06h precip: 2024-05-20_00+06, max= 17.03
RUC1


2024-05-20_00 + 16 h
INCA 1h prec analysis at 2024-05-20_16, max= 28.08 min= 0
INCA
SHMU 16h precip: 2024-05-20_00+16, max= 21.27
SHMU
SH20 16h precip: 2024-05-20_00+16, max= 54.93
ALA2E
RUC1 16h precip: 2024-05-20_00+16, max= 25.9
RUC1

# POHODA

open air music festival hit by the series of storms with strong winds in the evening on 12-07-2024, leading to the large stage tent collapse and 29 people injured.







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# POHODA

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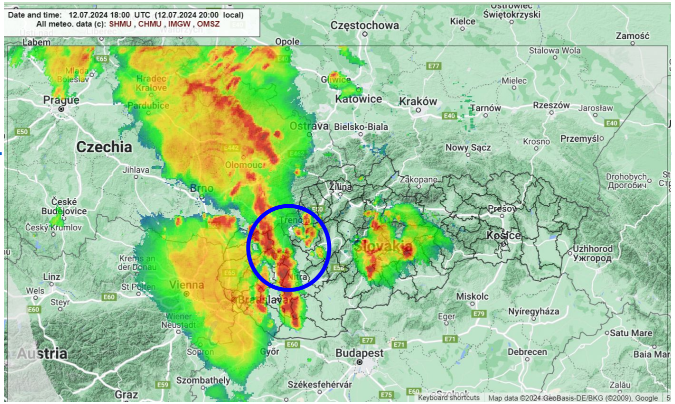
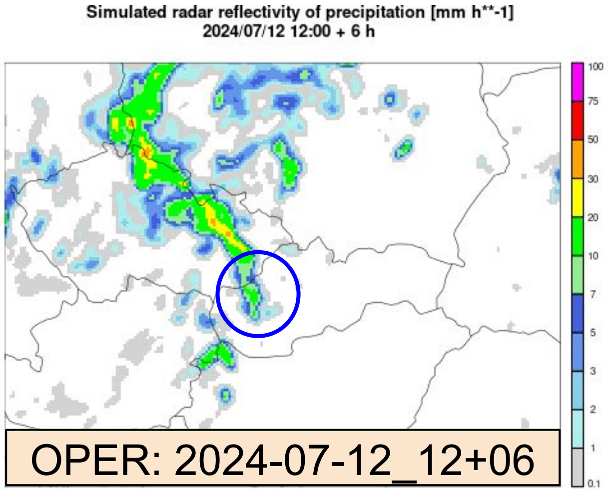
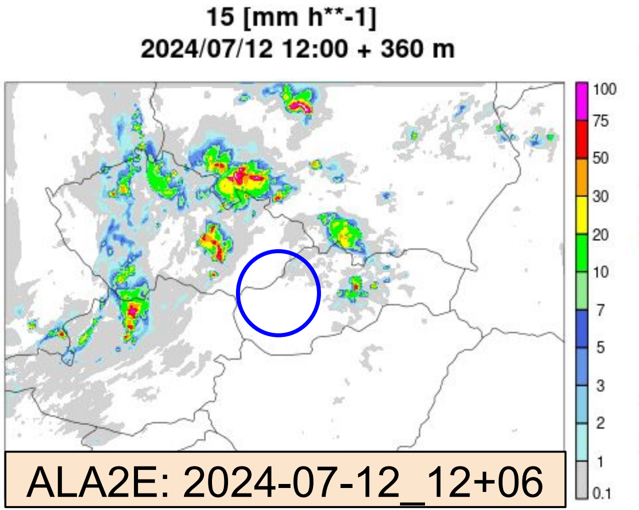


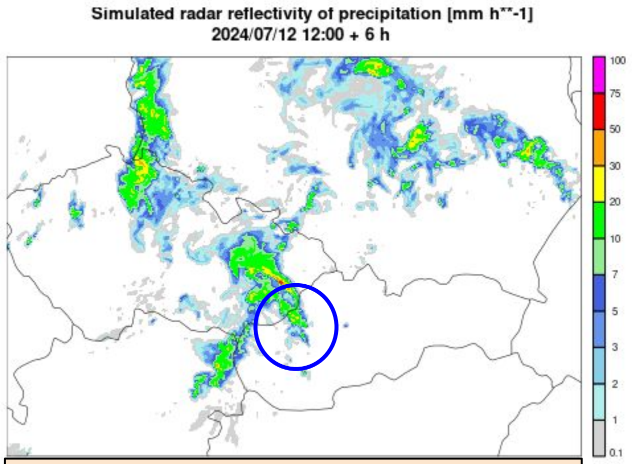





OPER: 2024-07-12_12+06




ALA2E: 2024-07-12_12+06




RUC1: 2024-07-12_12+06



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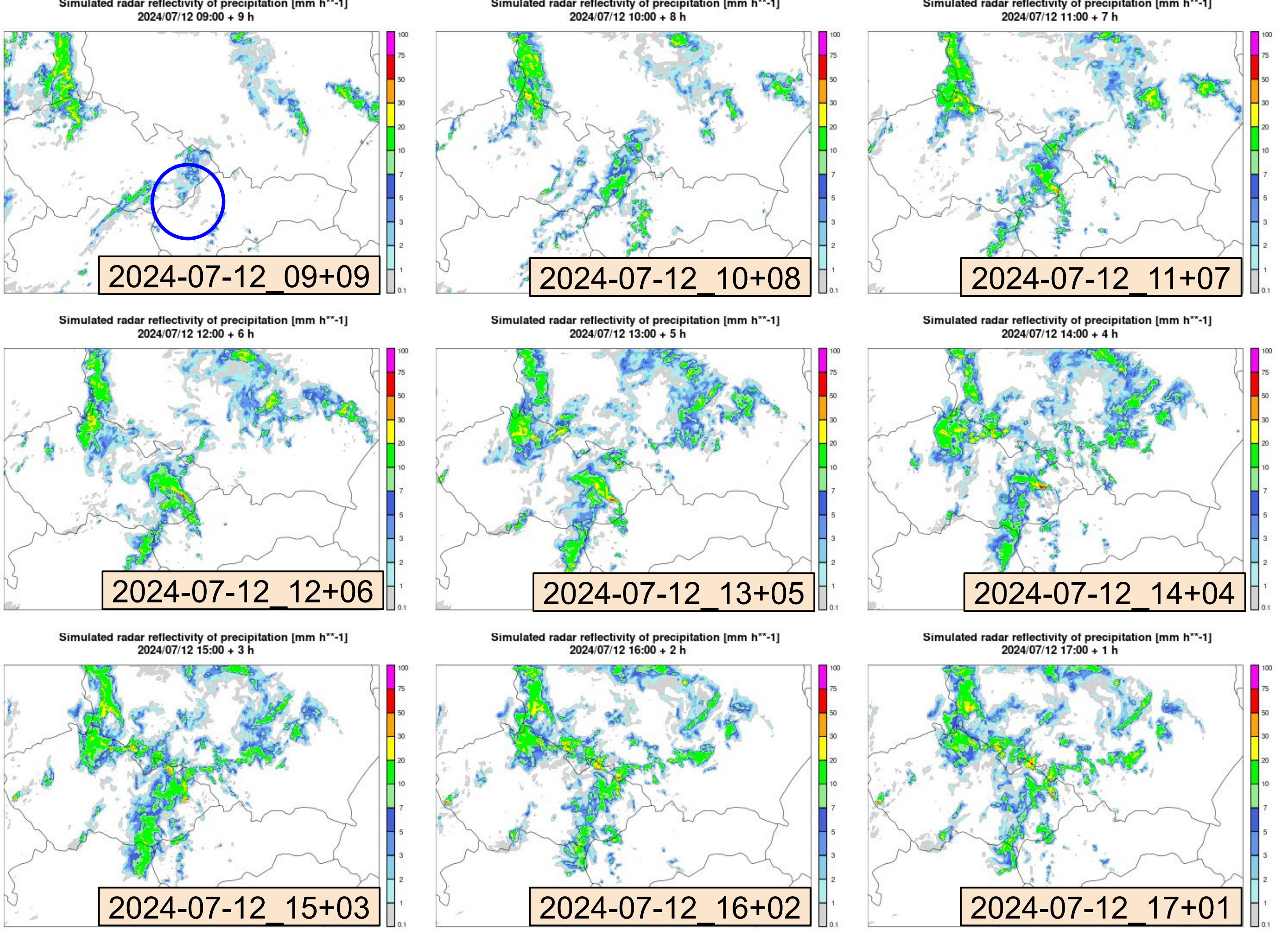
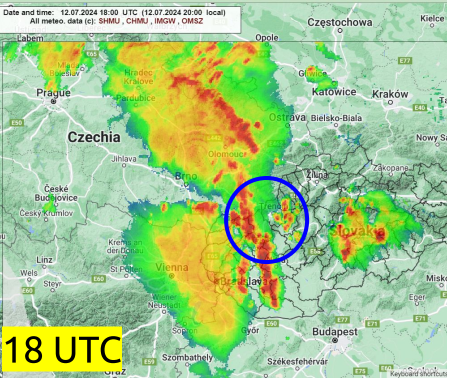
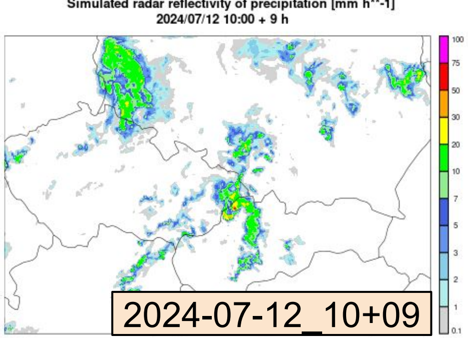
# POHODA


Simulated radar reflectivity of precipitation [mm h**-1]
2024/07/12 09:00 + 9 h
2024-07-12_09+09
Simulated radar reflectivity of precipitation [mm h**-1]
2024/07/12 10:00 + 8 h
2024-07-12_10+08
Simulated radar reflectivity of precipitation [mm h**-1]
2024/07/12 11:00 + 7 h
2024-07-12_11+07
Simulated radar reflectivity of precipitation [mm h**-1]
2024/07/12 12:00 + 6 h
2024-07-12_12+06
Simulated radar reflectivity of precipitation [mm h**-1]
2024/07/12 13:00 + 5 h
2024-07-12_13+05
Simulated radar reflectivity of precipitation [mm h**-1]
2024/07/12 14:00 + 4 h
2024-07-12_14+04
Simulated radar reflectivity of precipitation [mm h**-1]
2024/07/12 15:00 + 3 h
2024-07-12_15+03
Simulated radar reflectivity of precipitation [mm h**-1]
2024/07/12 16:00 + 2 h
2024-07-12_16+02
Simulated radar reflectivity of precipitation [mm h**-1]
2024/07/12 17:00 + 1 h
2024-07-12_17+01
100
75
50
30
20
10
7
5
3
2
1
0.1


Date and time: 12.07.2024 18:00 UTC (12.07.2024 20:00 local)
All meteo. data (c): SHMU , CHMU , IMGW , OMSZ
Częstochowa
Kielce
Opole
Prague
Katowice
Kraków
Czechia
Ostrava
Bielsko-Biala
Jihlava
Brno
Žilina
České Budějovice
Český Krumlov
Linz
Vienna
Bratislava
Győr
Budapest
Szombathely
Székesfehérvár
18 UTC

# POHODA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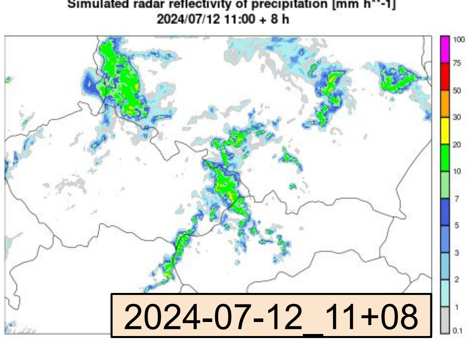
2024-07-12_10+09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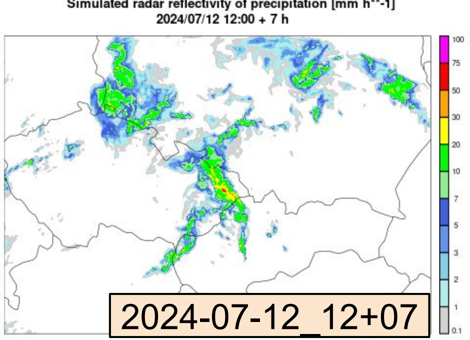
2024-07-12_11+08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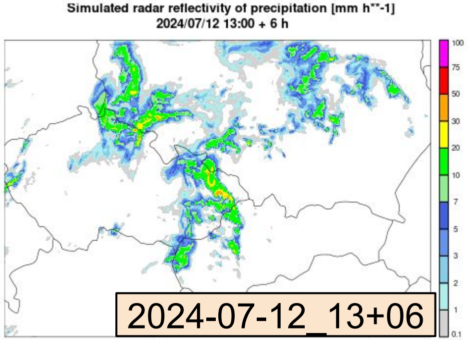
2024-07-12_12+07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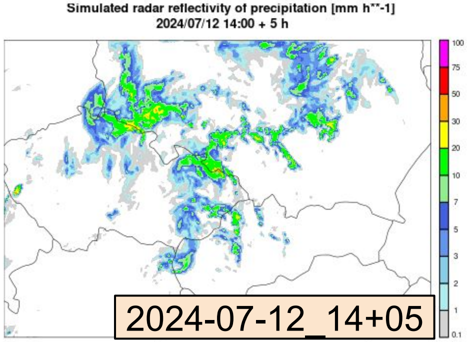
2024-07-12_13+06


Simulated radar reflectivity of precipitation [mm h**-1]
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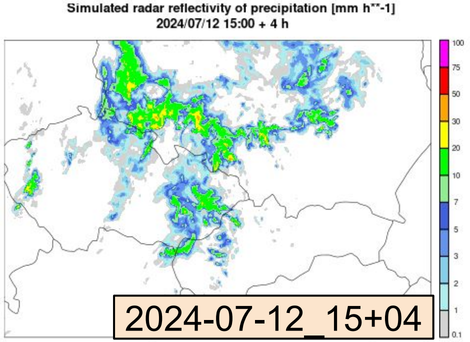
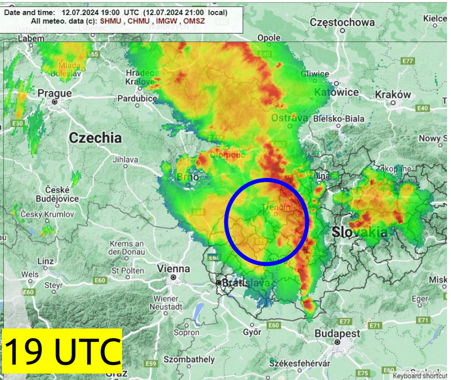
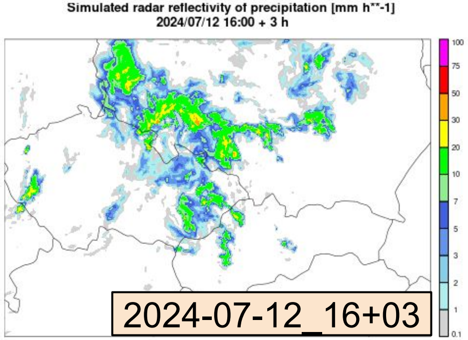
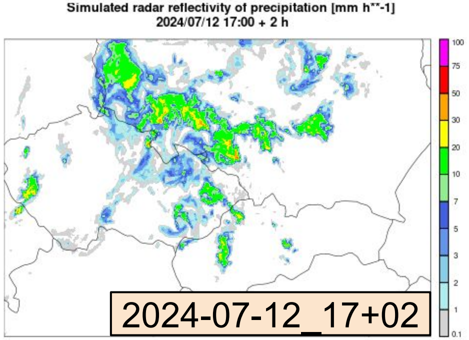
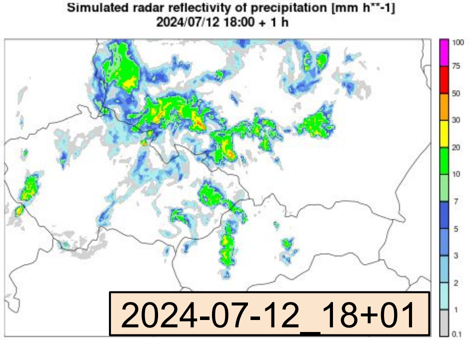
2024-07-12_14+05


Simulated radar reflectivity of precipitation [mm h**-1]
2024/07/12 15:00 + 4 h
2024-07-12_15+04

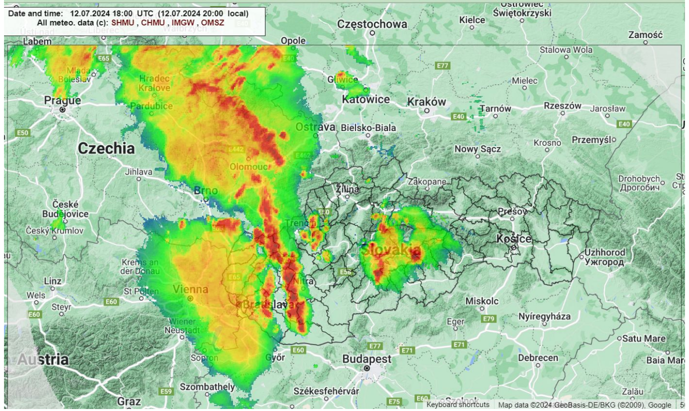

Date and time: 12.07.2024 19:00 UTC (12.07.2024 21:00 local)
All meteo. data (c): SHMU , CHMU , IMGW , OMSZ
Częstochowa
Prague
Czechia
Ostrava
Katowice
Kraków
Brno
Slovakia
Vienna
Bratislava
Budapest
19 UTC


Simulated radar reflectivity of precipitation [mm h**-1]
2024/07/12 16:00 + 3 h
2024-07-12_16+03

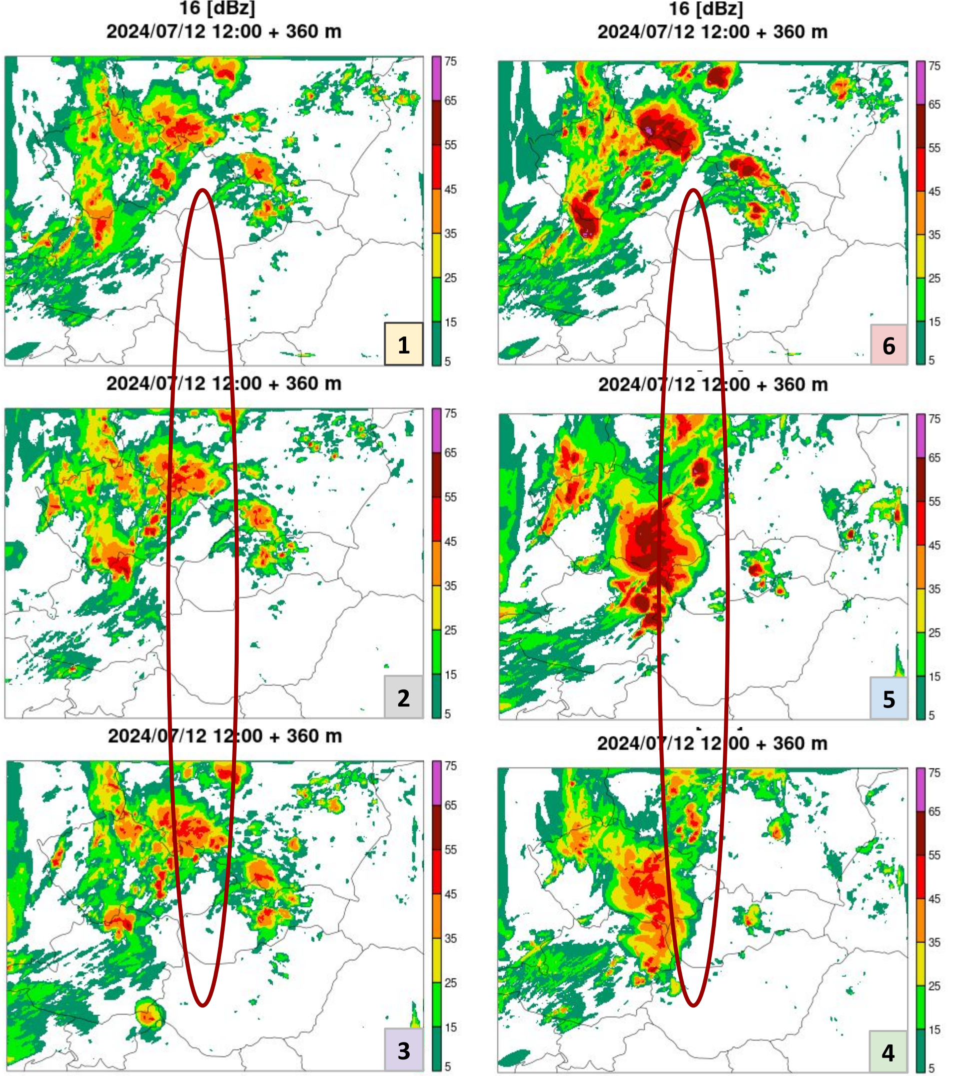

Simulated radar reflectivity of precipitation [mm h**-1]
2024/07/12 17:00 + 2 h
2024-07-12_17+02


Simulated radar reflectivity of precipitation [mm h**-1]
2024/07/12 18:00 + 1 h
2024-07-12_18+01

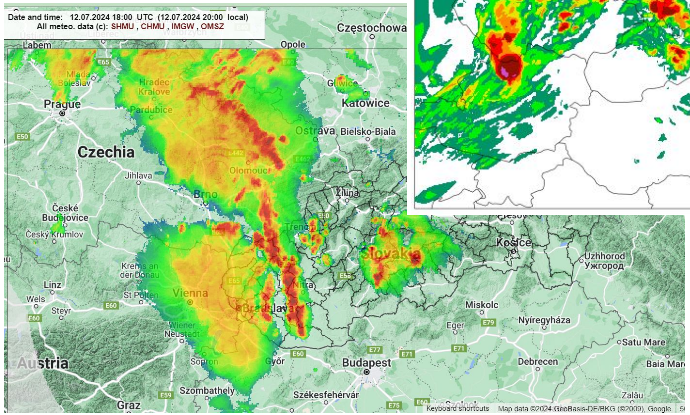
# POHODA

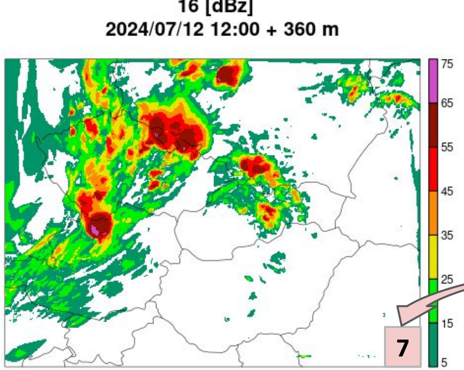


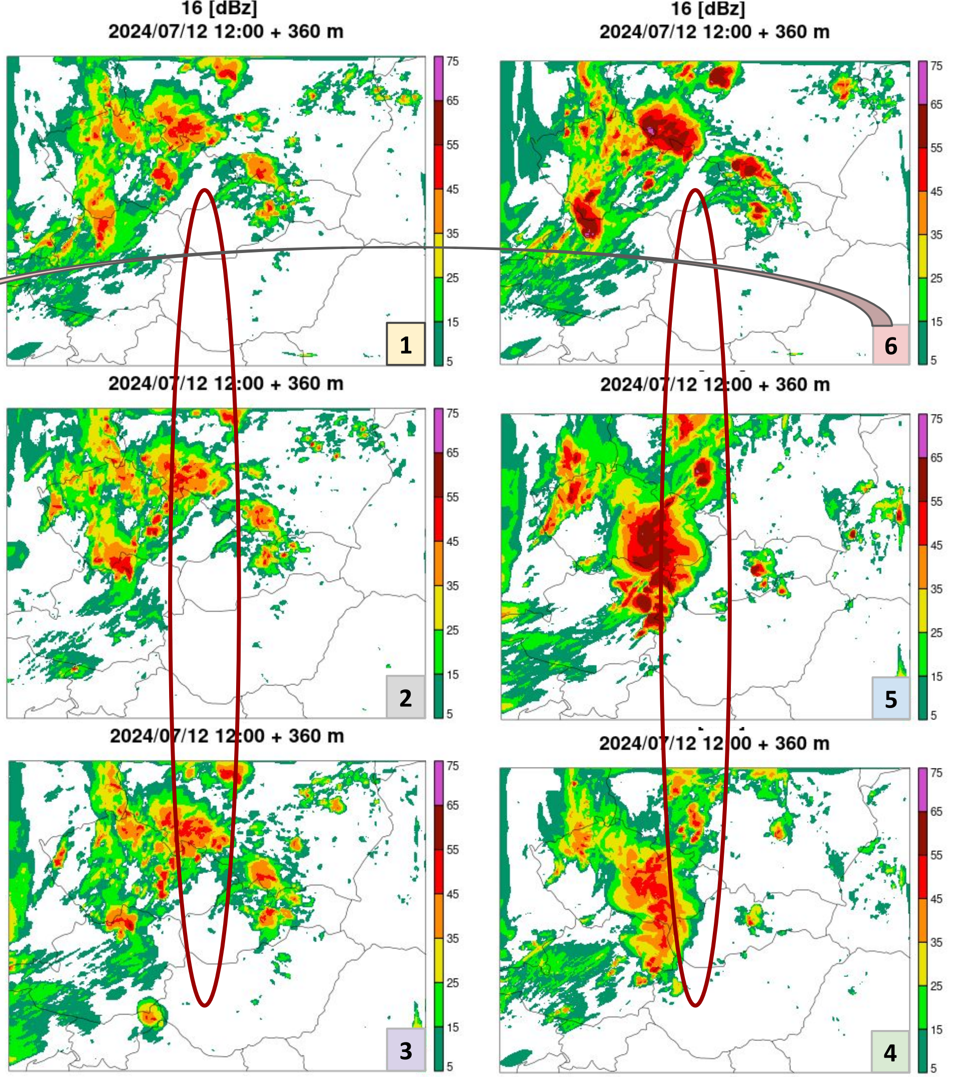

| exp NO | INIT | LBC | LBC time | LGRAPRO | |
|---|---|---|---|---|---|
| 1 | A-LAEF | ECMWF | 06 UTC | TRUE | 😕 |
| 2 | A-LAEF | ECMWF | 12 UTC | TRUE | 😕 |
| 3 | A-LAEF | ARPEGE | 12 UTC | TRUE | 😕 |
| 4 | ARPEGE | ARPEGE | 12 UTC | TRUE | 🙂 |
| 5 | ARPEGE | ARPEGE | 12 UTC | *FALSE* | 🙂❗❓ |
| 6 | A-LAEF | ECMWF | 06 UTC | *FALSE* | 😕 |



# POHODA

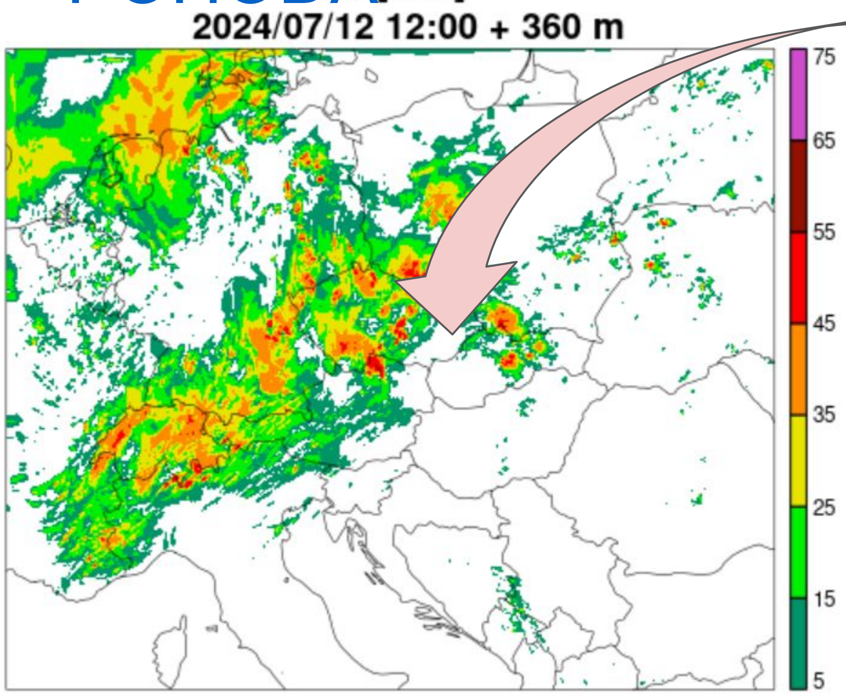


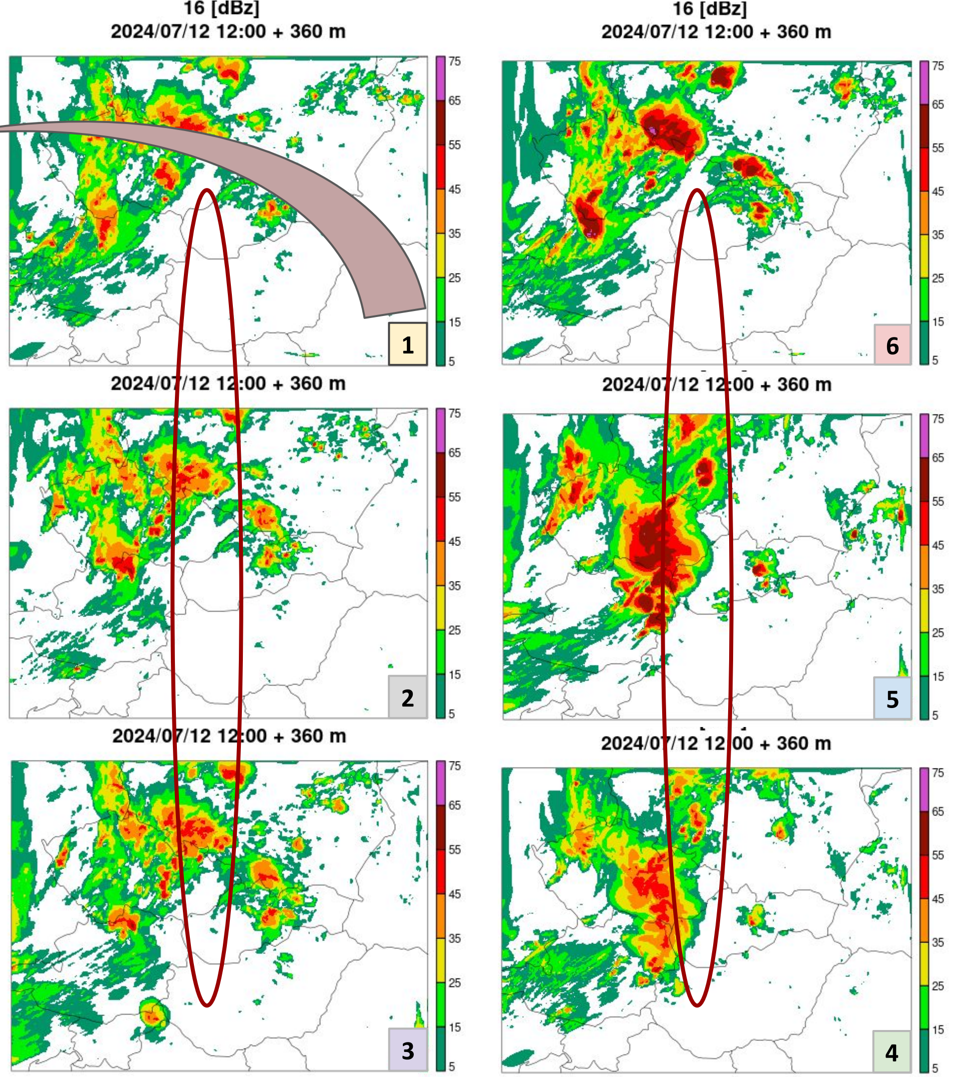




| exp NO | INIT | LBC | LBC time | LGRAPRO | |
|---|---|---|---|---|---|
| 1 | A-LAEF | ECMWF | 06 UTC | TRUE | 😕 |
| 2 | A-LAEF | ECMWF | 12 UTC | TRUE | 😕 |
| 3 | A-LAEF | ARPEGE | 12 UTC | TRUE | 😕 |
| 4 | ARPEGE | ARPEGE | 12 UTC | TRUE | 🙂 |
| 5 | ARPEGE | ARPEGE | 12 UTC | *FALSE* | 🙂❗❓ |
| 6 | A-LAEF | ECMWF | 06 UTC | *FALSE* | 😕 |
| 7 | A-LAEF | ECMWF | 06 UTC | *FALSE* | noDFI |

# POHODA




| | | | | | |
|---|---|---|---|---|---|
| 4 | ARPEGE | ARPEGE | 12 UTC | TRUE | 🙂 |
| 5 | ARPEGE | ARPEGE | 12 UTC | *FALSE* | 🙂❗❓ |
| 6 | A-LAEF | ECMWF | 06 UTC | *FALSE* | 😕 |
| 9 | A-LAEF | ECMWF | 06 UTC | TRUE | sk24 |

# RUC1 with prognostic graupels *(A.Simon)*

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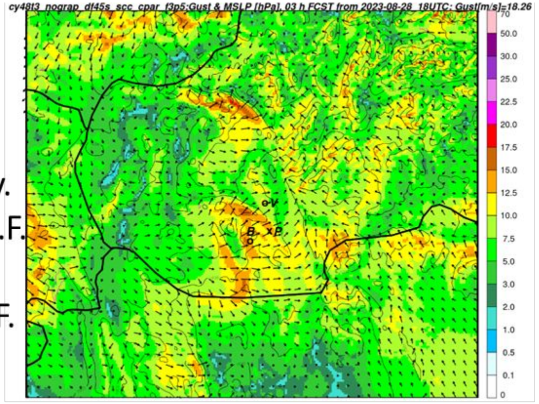
case 28-08-2023 _18 + 03 h
strong wind gust measured
forecast improved with
LGRAPRO (CY48t3)

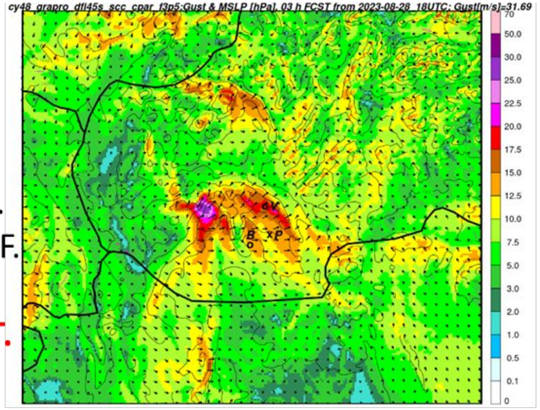
DFI+SCC
param. conv.
LSTRAPRO=.F.

LGRAPRO=.F.

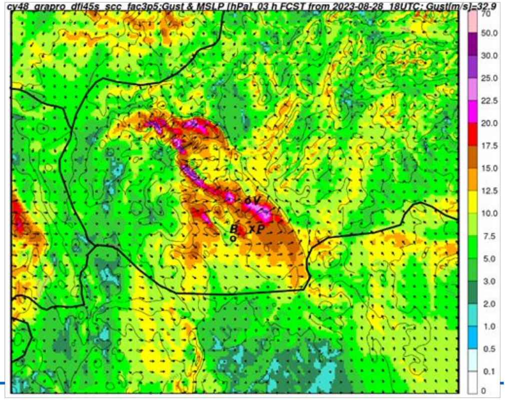



DFI+SCC
param. conv.
LSTRAPRO=.F.

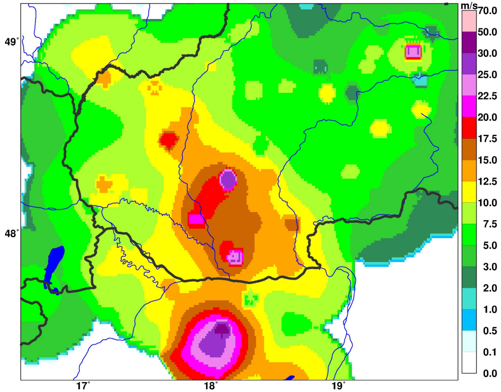
**LGRAPRO=.T.**




DFI+SCC
**explicit conv.**
LSTRAPRO=.T.
LGRAPRO=.T.




Maximum 1h gust [m/s] on 28/08/2023 between 2010 and 2110 UTC

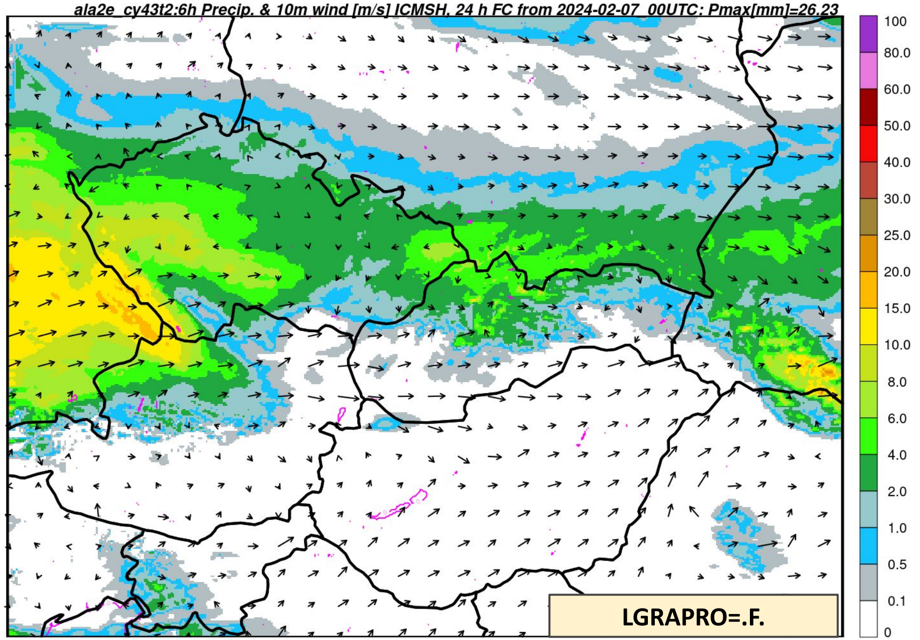


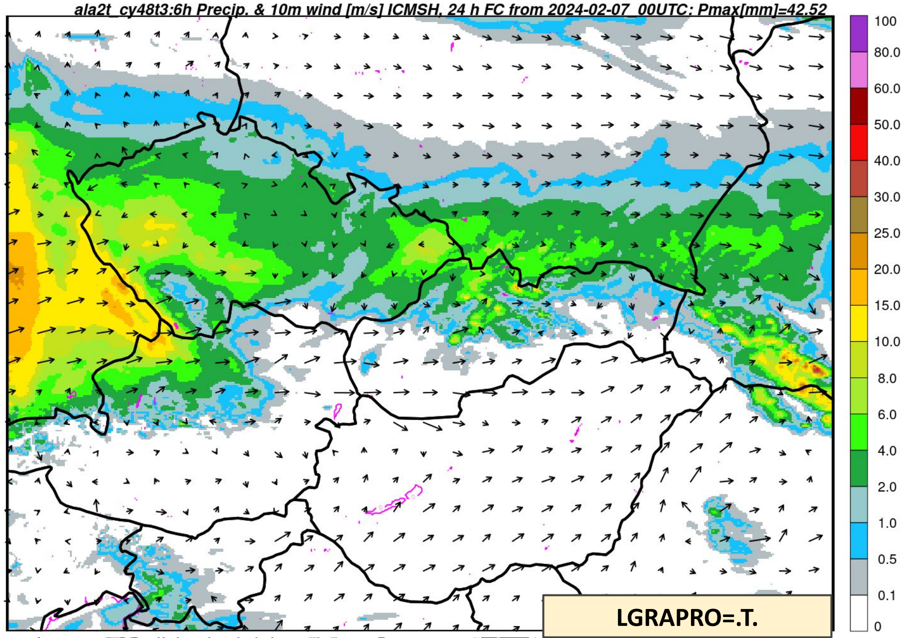


GeoSphere Austria DHMZ Czech Hydrometeorological Institute HungaroMet ROMANIA SHMU ARSO METEO Slovenia

# ALA2E with prognostic graupels *(A.Simon)*

prognostic graupels improve forecast of the extreme weather phenomena (summer), but lead to unrealistic precipitation forecast in winter



# RUC1 single precision tests *(A.Simon, O.Španiel)*

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- SP tests show that several types of severe weather (supercells, floods, downbursts, squall lines) associated with convection can be forecast satisfyingly. The micro- and mesoscale structure and severity aspects of the studied events were maintained. The impact of using SP was even smaller than impact of changing physical parameterization or cycling frequency, which had been tested before SP and which had more negative features in the above mentioned situations.
- SP can shorten the computational time considerably (by 35-40% in our case)
- Scores were not neutral…
- Though most of the runs were stable up to +24h, we experienced one crash and some other technical problems
- CY46t1

**double_prec** (RUC1 reloaded)

**single_prec_rucnam** (single precision, RUC setup)

# RUC1 single precision tests *(A.Simon, O.Španiel)*

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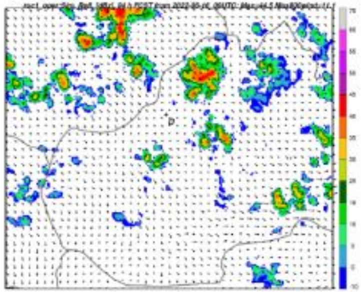
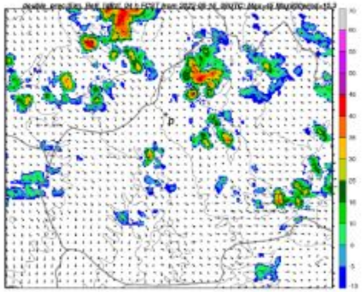
## 16 August 2022, simulated radar reflectivity

- Reflectivity is weaker in SP experiment compared to DP and oper

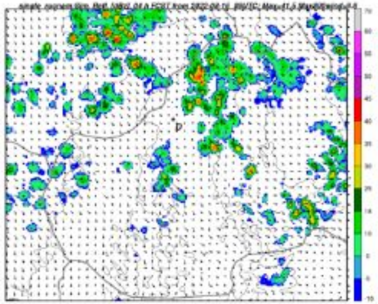


Regular RUC1 (1hcycling, CY43T2,63L)

SHMU 2km CAPPI radar reflectivity, HWIND 1km



**double_prec** (RUC1 reloaded, CY46T1)



single_prec_rucnam (single precision, RUC setup)

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# RUC1 single precision tests *(A.Simon, O.Španiel)*

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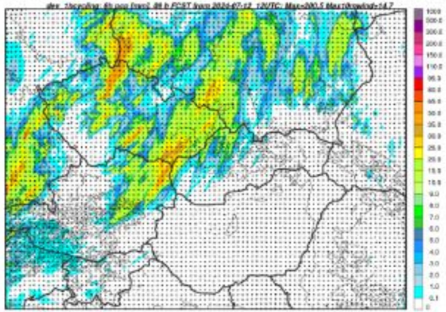
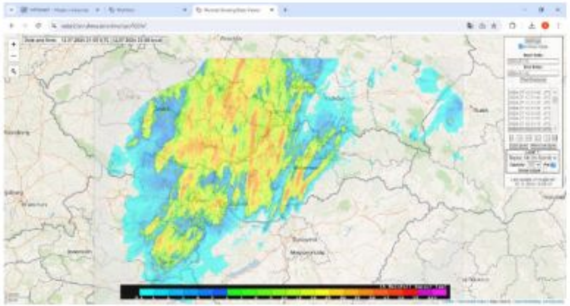
## MCS, windstorm, 12 July 2024, precipitation

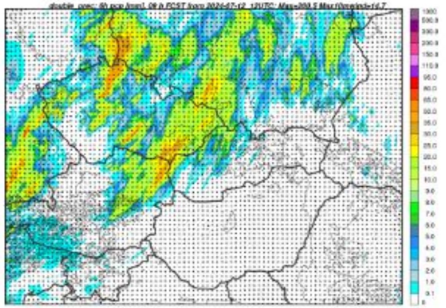
- Original RUC1 reproduced in dev (same norms) and consequently by double_prec, weaker patterns with SP but more precipitation in NW Slovakia as also observed



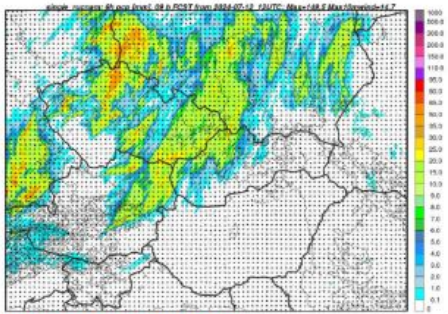
dev:reproduced RUC1 (1hcycling, CY46T1,87L)



SHMU radar 6h precipitation



**double_prec** (RUC1 reloaded, CY46T1)



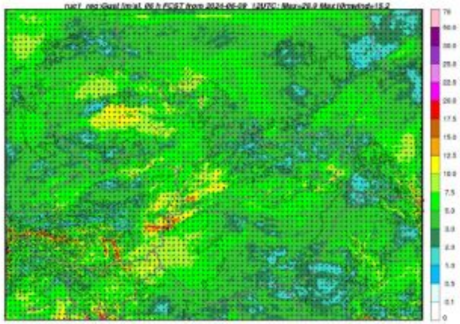
single_prec_rucnam (single precision, RUC setup)

# RUC1 single precision tests *(A.Simon, O.Španiel)*

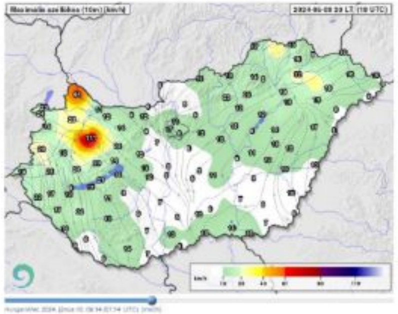


## 09 June 2024 wind gust

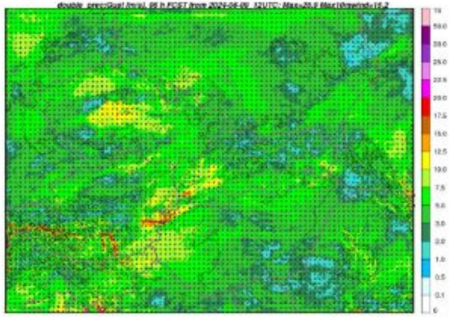
- Gusts repeated in double_prec, SP provided even stronger gusts



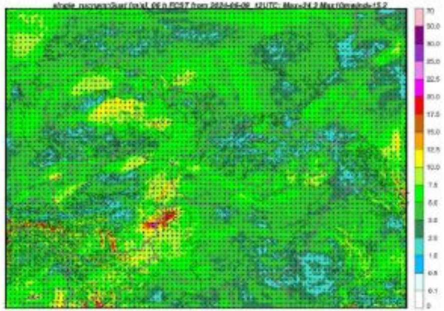
Regular RUC1(1hcycling, no modset)



HungaroMet 1h wind gust



**double_prec** (RUC1 reloaded)



**single_prec_rucnam** (single precision, RUC setup)

# RUC1 single precision tests *(A.Simon, O.Španiel)*

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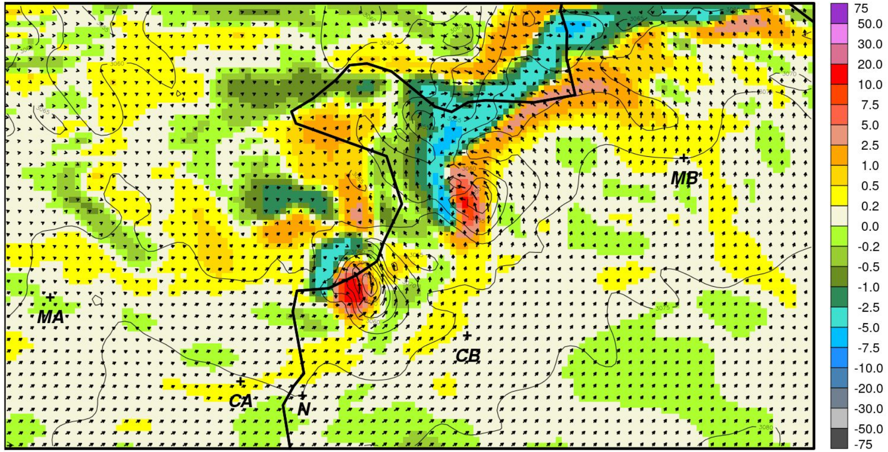
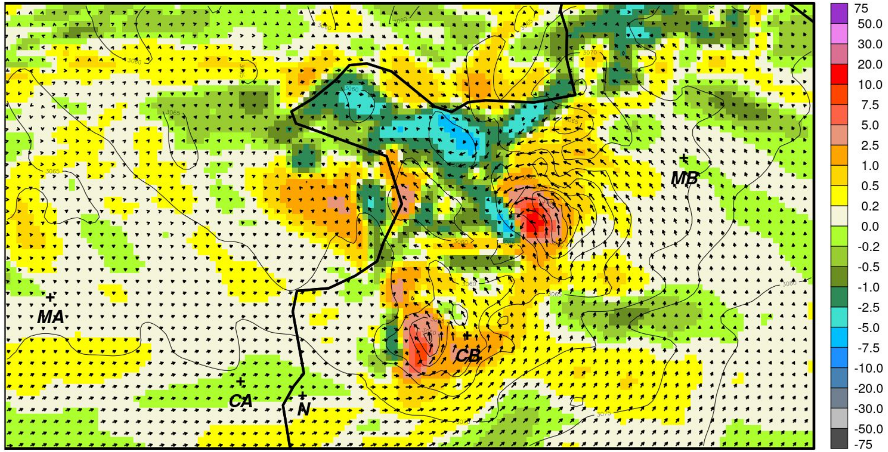
## 09 June 2024 vertical vorticity, zoom

double_prec:1000*Vorticity 700hPa [1/s], 06 h FCST from 2024-06-09_12UTC: Min.=-6.8 Max. =14.1




**double_prec** (RUC1 reloaded)

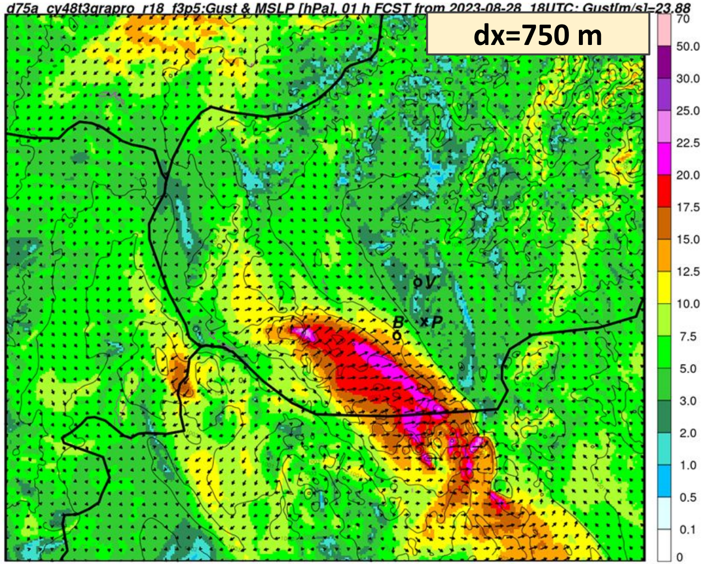
single_rucnam:1000*Vorticity 700hPa [1/s], 06 h FCST from 2024-06-09_12UTC: Min.=-6.4 Max. =11.4

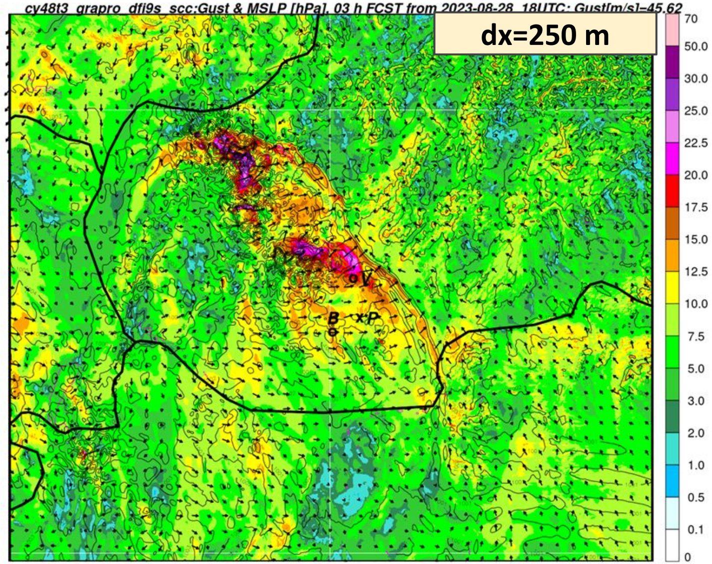



**single_prec_rucnam** (single precision, RUC setup)

# Hectometric tests *(A.Simon)*

Hectometric runs provided similar results to their mother models with possibly more intense convection (should be verified using more parameters). The output fields were more detailed but not more informative as the 1 km runs.



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# Thank you for your attention.

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