



**Instytut Meteorologii i Gospodarki Wodnej**  
Państwowy Instytut Badawczy

# **ALARO experience in Poland**

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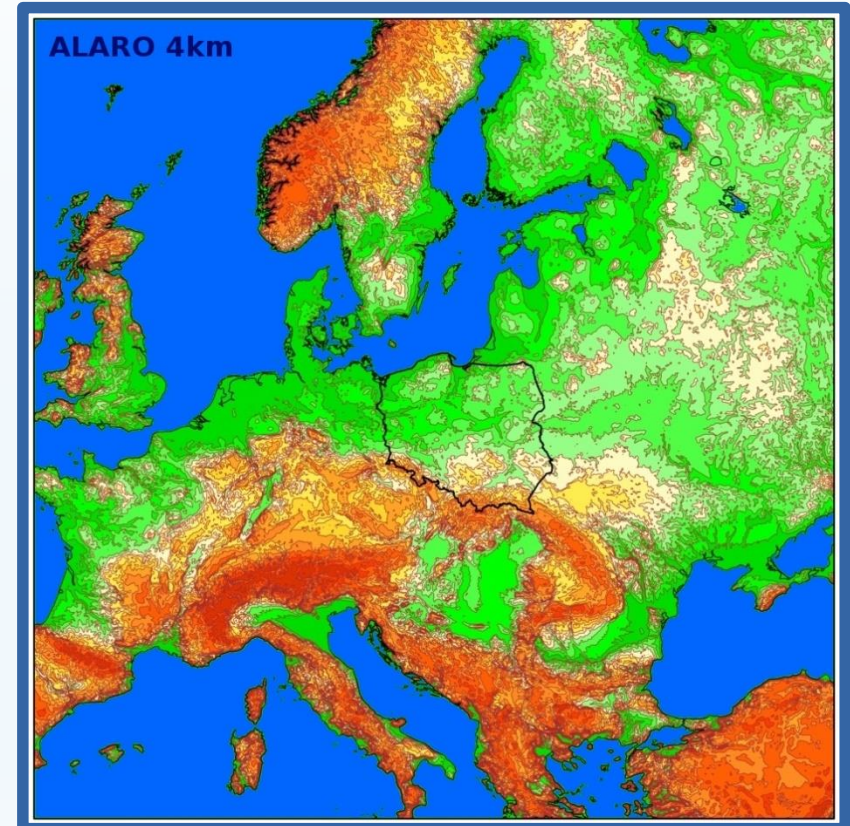
# Presentation plan

1. ALARO - operational version
2. ALARO with assimilation - verification
3. Kilometric scale models
  - Temperature vertical gradients in Polish Western Carpathian Mts.
  - Vertical profiles – sounding
4. ALARO v43 non-hydrostatic & hydrostatic core
  - Case study – heavy rain at 17-19.07.2018
  - Models verification
5. Seasonal variability of precipitation ALARO model
6. Conclusions

# 1. ALARO – operational version

## ALARO-v1B (CY40T1) hydrostatic model

<b>Horizontal resolution</b>	4 km x 4 km
<b>Domain size</b>	789x789
<b>Vertical levels</b>	60
<b>Lowest model level</b>	10 m
<b>Projection</b>	Lambert
<b>Coupling frequency</b>	3 h
<b>Length of forecast</b>	66 h
<b>Time step</b>	180 s.
<b>LBC</b>	ARPEGE 15.7 km res.



Output files of ALARO forecast are used as initial/boundary conditions for AROME model.



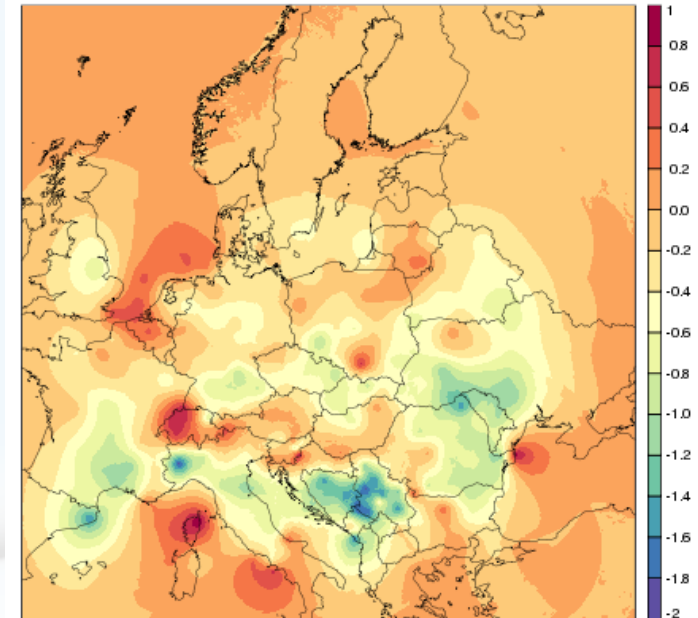
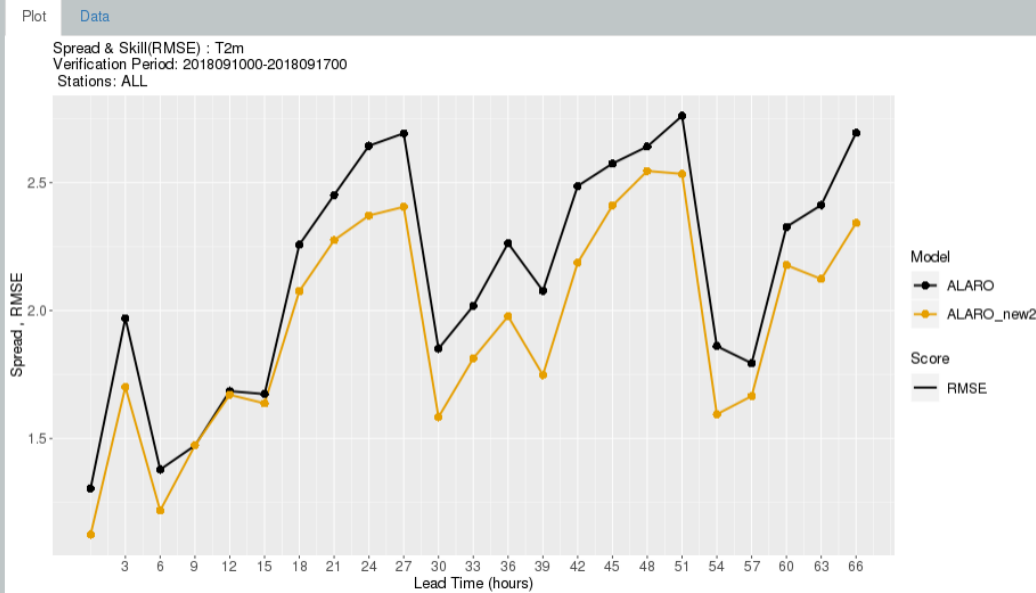
## Data

- for now just OPLACE base

## Surface

- Data assimilation using CANARI
- Standard setting, no special tuning
- Test once per day run at 00UTC
- (background our 6h forecast from 18UTC, SST copied from ARPEGE analysis, CANARI and then 66h forecast)

## HARP verification

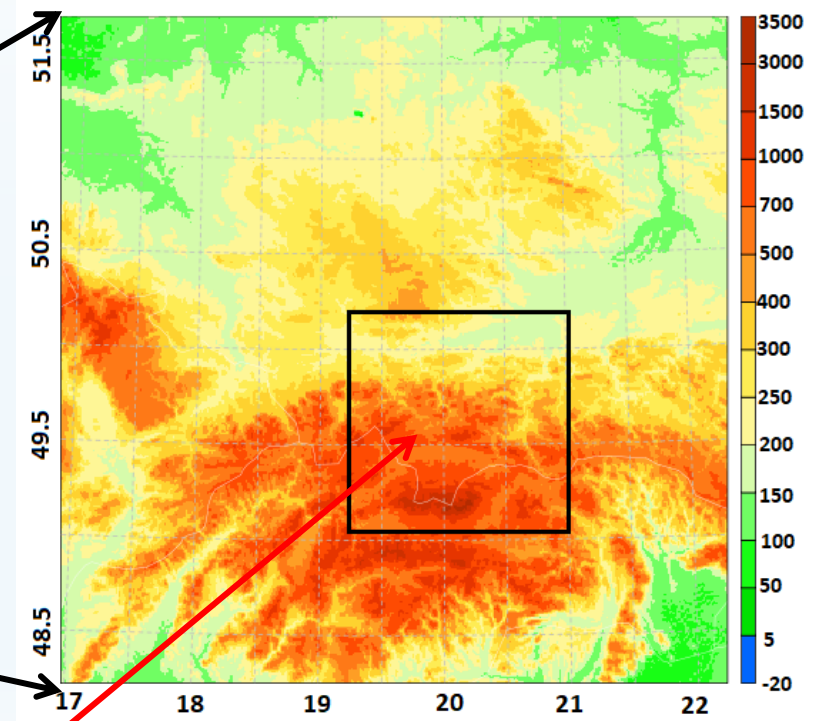
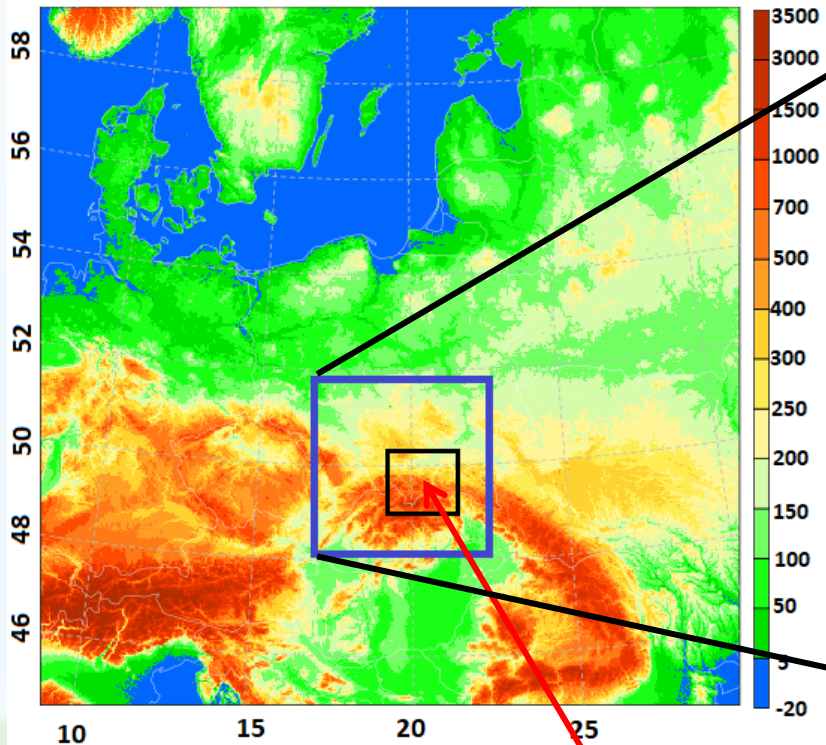


### 3. Kilometric scale models

AROME 1 km x 1 km (same configuration as AROME 2 km )

AROME oper. 2 km x 2 km

ALARO NH 1 km x 1 km

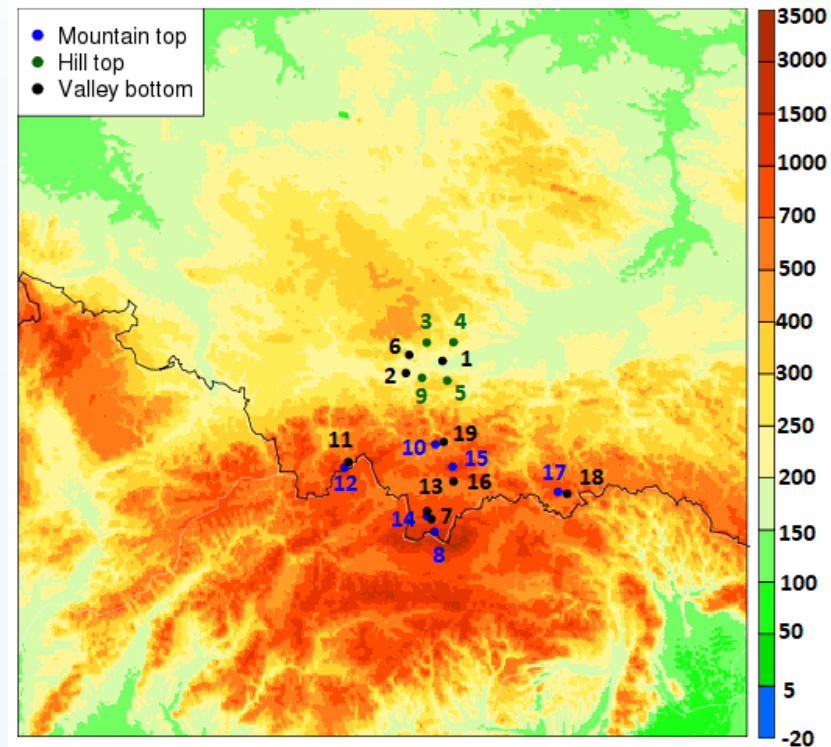


Analyzed area - Polish Western Carpathian Mts.

## Temperature gradients in Polish Western Carpathian Mts.

- 19 stations
- Verification period: 1.01-16.02.2017, one run per day at 12:00 UTC (possible data: 31 of 47 days).
- Stations were selected accordingly the rule:  
*One station located at valley, second, in the nearest area at hill or mountain peak.*
- Selected stations were used to calculate temperature gradients between this pair of stations.
- Stations were selected into two groups (mountain/hill top or valley bottoms)

Horizontal resolution	1 km x 1 km
Domain size	389 x 389
Vertical levels	105
Lowest model level	9 m
Projection	Lambert
Coupling frequency	3 h
Length of forecast	18 h
Time step	30 s.
LBC	ARPEGE 15.7 km res.



## Temperature in Polish Western Carpathian Mts.

Verification of air temperatures in stations located at valleys and mountain/hill tops points out that change of horizontal resolution from 2 km x 2 km to 1 km x 1 km hasn't significant influence on predicted air temperature in complex terrain orography.

Slightly better compatibility of forecast were measured for stations in valleys for ALARO NH.

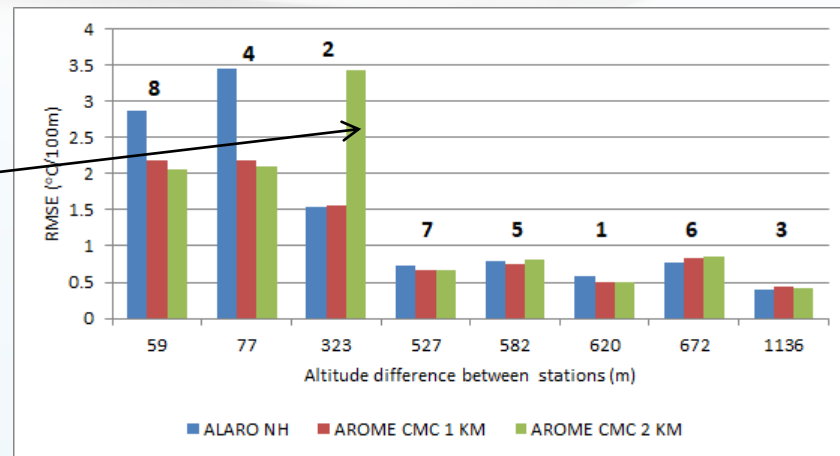
	ALARO NH		AROME CMC 1km		AROME CMC 2 km	
	RMSE [°C]	BIAS [°C]	RMSE [°C]	BIAS [°C]	RMSE [°C]	BIAS [°C]
	Hill and mountain tops (8 stations)					
<b>Mean value</b>	<b>2.60±0.58</b>	<b>-0.04±1.16</b>	<b>2.36±0.89</b>	<b>0.70±1.17</b>	<b>2.45±0.80</b>	<b>0.83±1.03</b>
	Valley bottoms (8 stations)					
<b>Mean value</b>	<b>3.14±0.68</b>	<b>1.15±1.01</b>	<b>3.55±1.03</b>	<b>1.78±1.24</b>	<b>3.50±1.13</b>	<b>1.81±1.06</b>



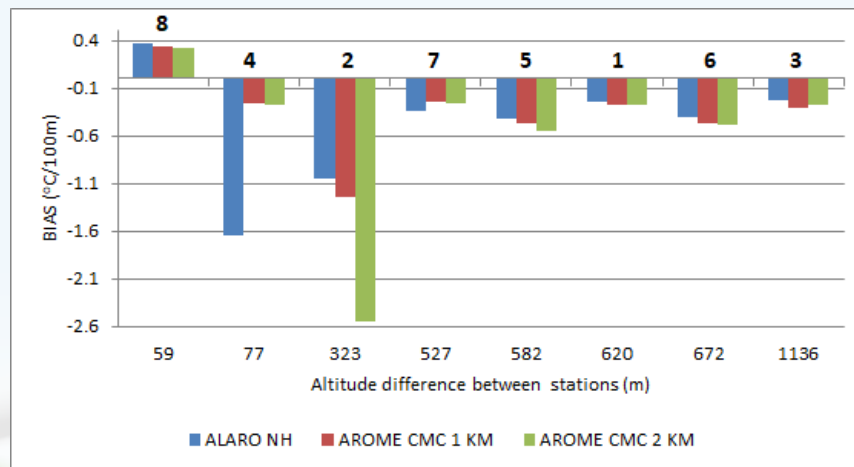
## Temperature gradients in Polish Western Carpathian Mts.

Pair No.	Number of top station	Number of valley station	Real altitude difference [m]	Altitude diff. in the model dom. with res. 2 km x 2 km [m]	Altitude diff. in the model dom. with res. 1 km x 1 km [m]
1	12	11	620	538	621
2	14	13	323	50	315
3	8	7	1136	971	1150
4	9	6	77	41	72
5	10	19	582	307	434
6	15	16	672	543	669
7	17	18	527	312	448
8	3	2	59	64	50

### RMSE values for predicted temperature gradients



### BIAS values for predicted temperature gradients



For altitude difference between stations higher than 500 m, RMSE and BIAS values are comparable to all 3 verified models.

Two configurations of model AROME have similar forecast accuracy for predicted temperature gradients (exception is stations pair no. 2).

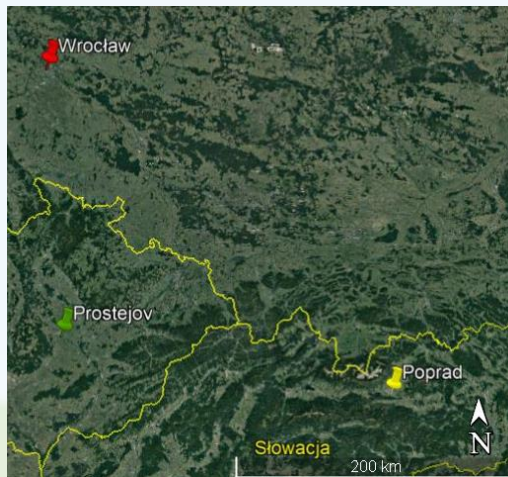


## Vertical profiles – sounding

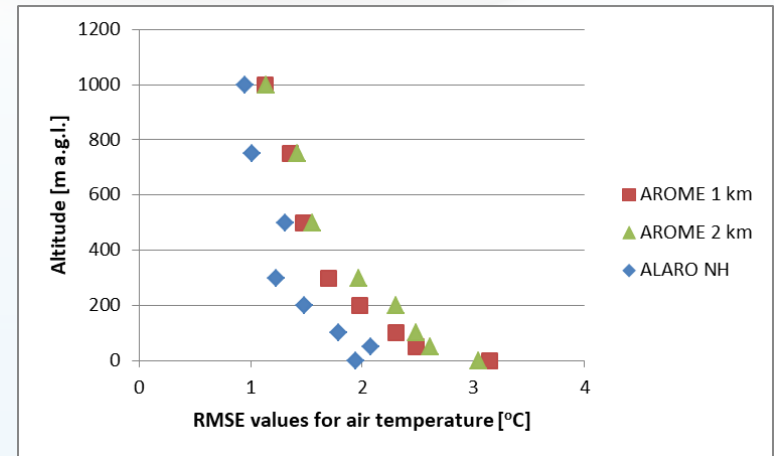
Wrocław – 12425  
Poprad - 11952  
Prostejov - 11747

Results has been compared with 8 vertical levels:

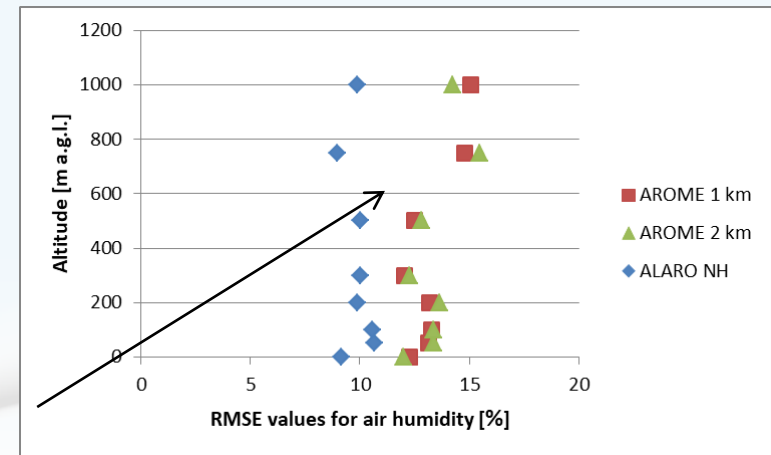
- 0 m a.g.l.
- 50 m a.g.l.
- 100 m a.g.l.
- 200 m a.g.l.
- 300 m a.g.l.
- 500 m a.g.l.
- 750 m a.g.l.
- 1000 m a.g.l.



### Air temperature profiles - verification



### Air humidity profiles - verification





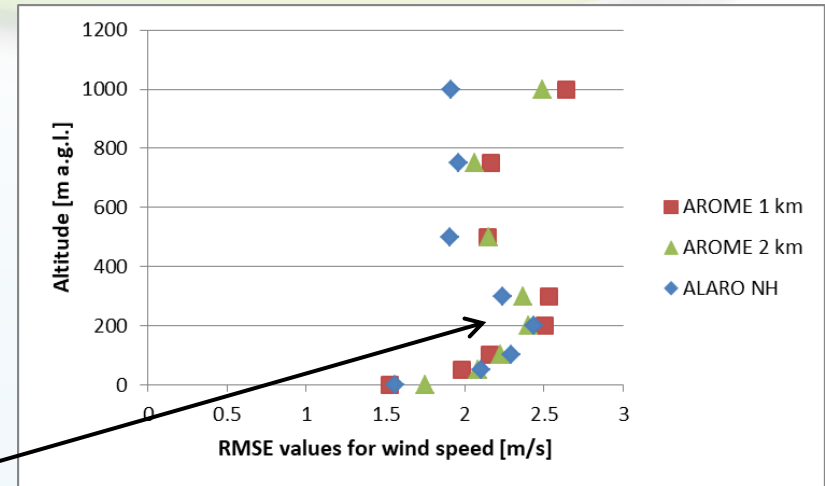
Better accuracy for ALARO NH model compared with AROME two configurations for:

- Vertical temperature profile
- Vertical air humidity profile (significant difference)

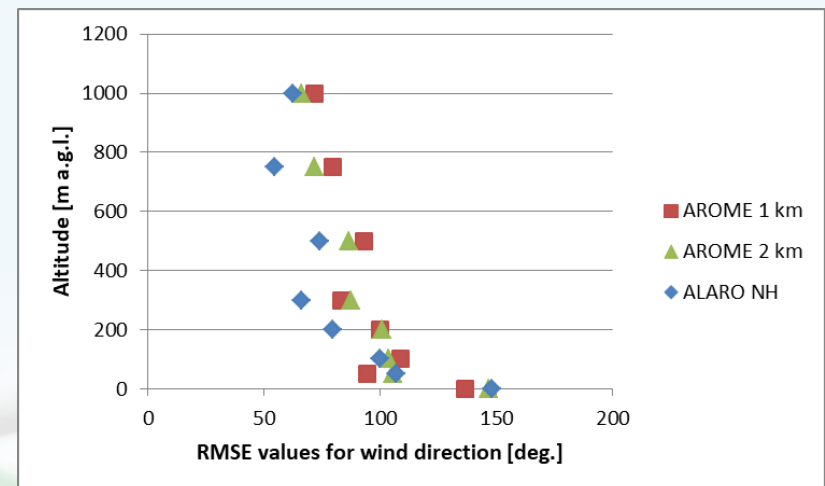
Local maximum of RMSE error for wind speed profile observed at level 200-300 m a.g.l.

Lower RMSE error of wind direction for higher altitudes.

### Wind speed profiles - verification



### Wind direction profiles - verification





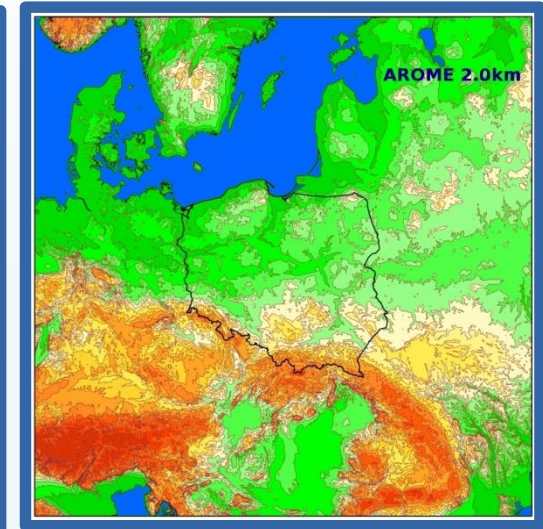
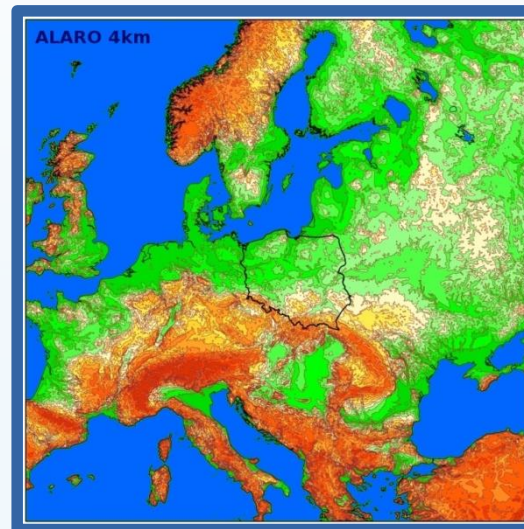
## Further developments - ideas

- Different location of vertical levels (for res. 1 km - lowest model level 5 m, res. 500 m – 1 m) – suggested by Rachel Honnert.
- Tests of ALARO res. 500 m (switch off PBL scheme)

## ALARO cy43 vs. ALARO cy40

### ALARO cy43

<b>Horizontal resolution</b>	4 km x 4 km	2 km x 2 km
<b>Domain size</b>	789x789	799 x 799
<b>Vertical levels</b>	60	-  -
<b>Lowest model level</b>	10 m	-  -
<b>Projection</b>	Lambert	-  -
<b>Coupling frequency</b>	3 h	-  -
<b>Length of forecast</b>	66 h	30 h
<b>Time step</b>	180 s.	60 s.
<b>LBC</b>	ARPEGE 15.7 km res.	-  -



Tested configurations for version cy43:

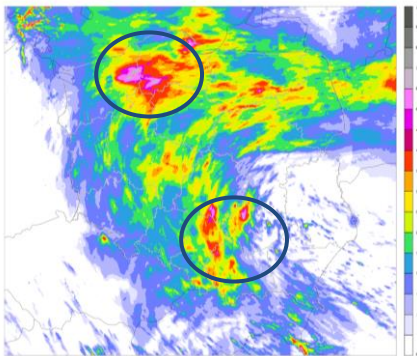
ALARO NH – res. 4 km

ALARO NH – res. 2 km

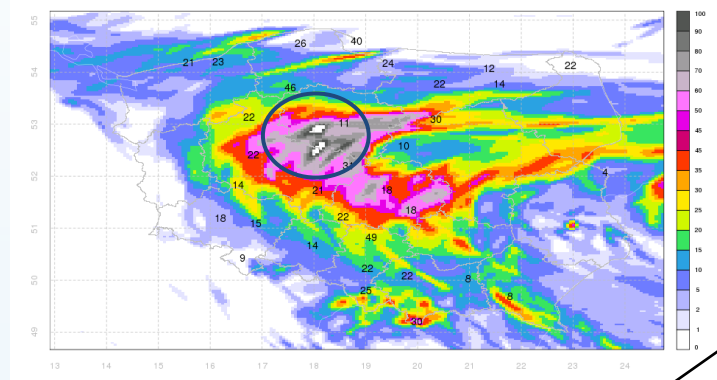
ALARO HYD – res. 4 km

Forecast of 24-h sum of precipitation for date 2018/07/17 (start run at 00:00 UTC)

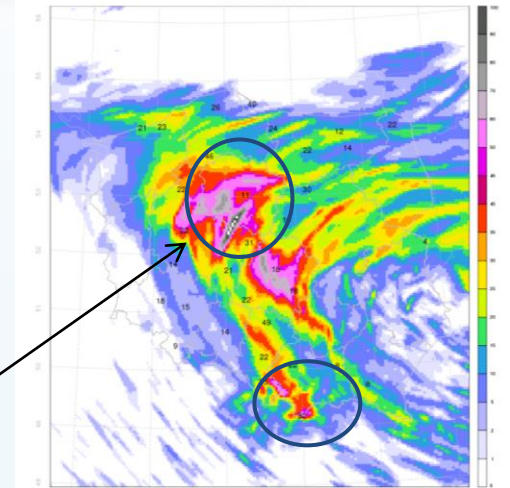
Radar data



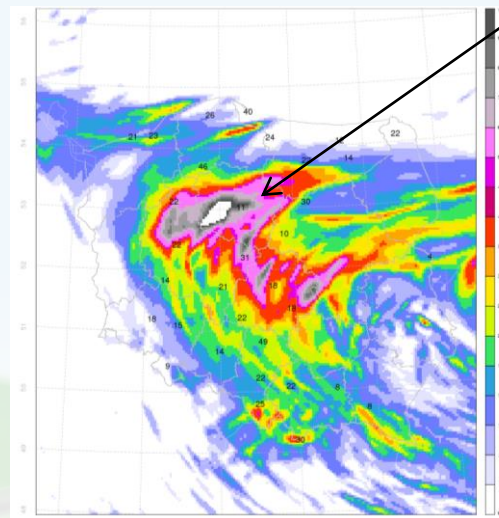
ALARO v. 40



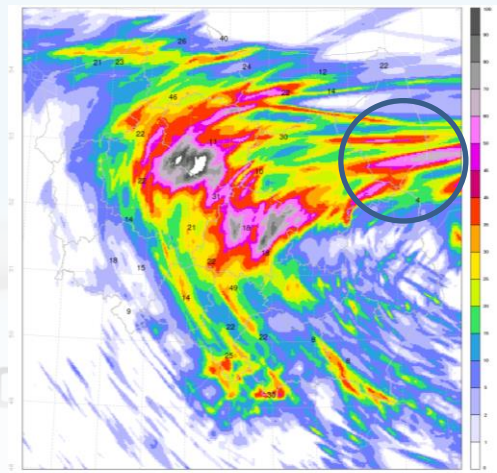
ALARO v. 43 NH 4 km



ALARO v. 43

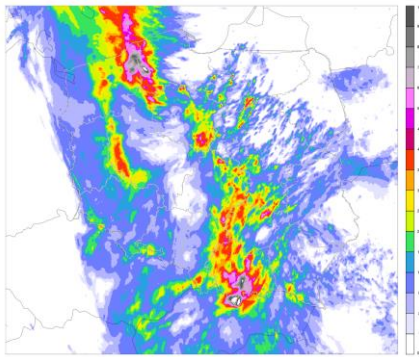


ALARO v. 43 NH 2 km

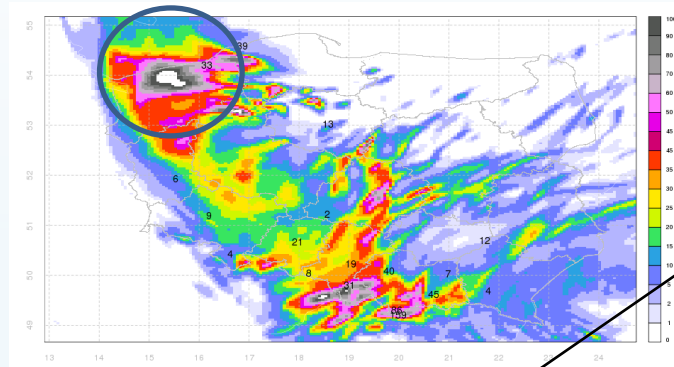


Forecast of 24-h sum of precipitation for date 2018/07/18 (start run at 00:00 UTC)

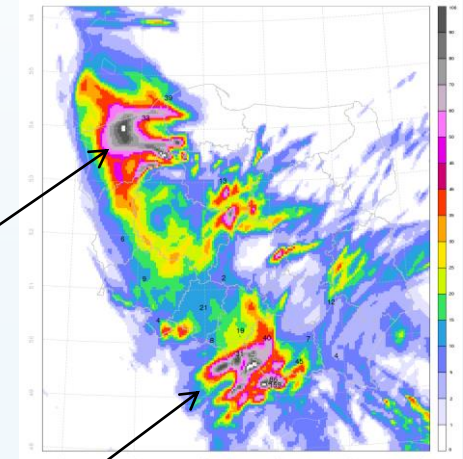
Radar data



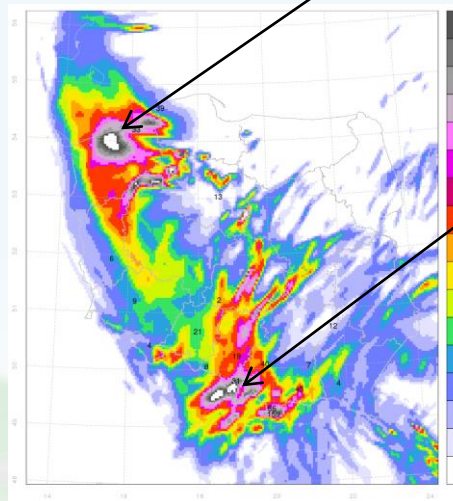
ALARO v. 40



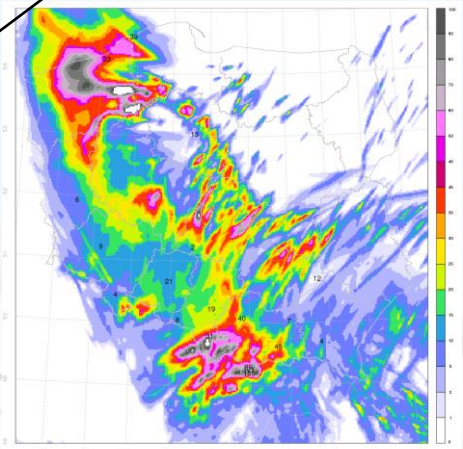
ALARO v. 43 NH 4 km



ALARO v. 43



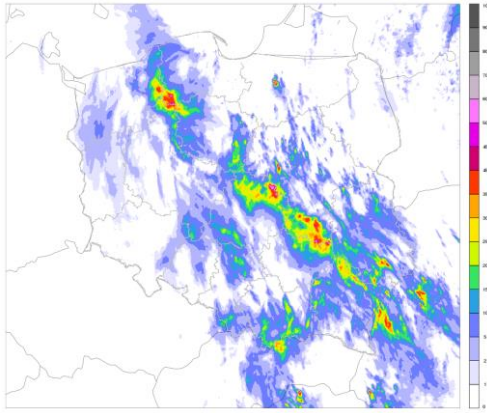
ALARO v. 43 NH 2 km



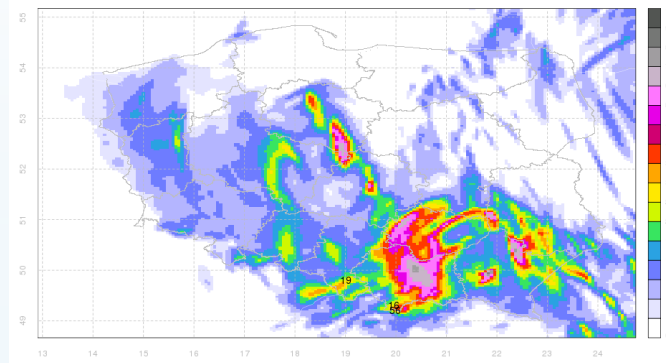
Best forecast

Forecast of 24-h sum of precipitation for date 2018/07/19 (start run at 00:00 UTC)

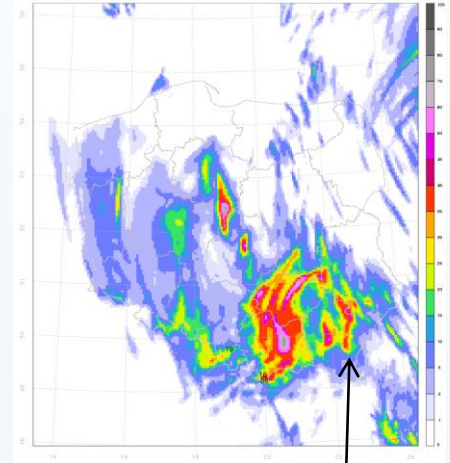
Radar data



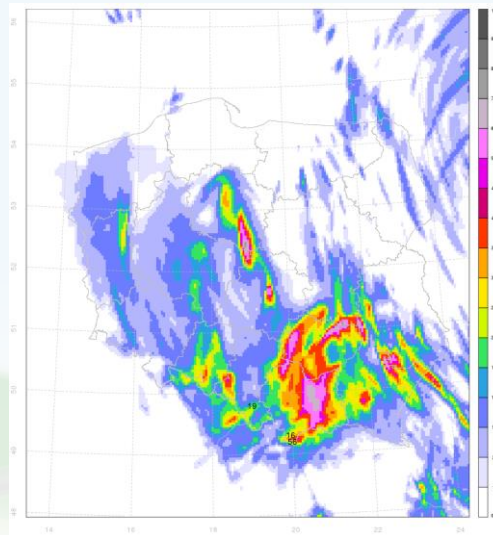
ALARO v. 40



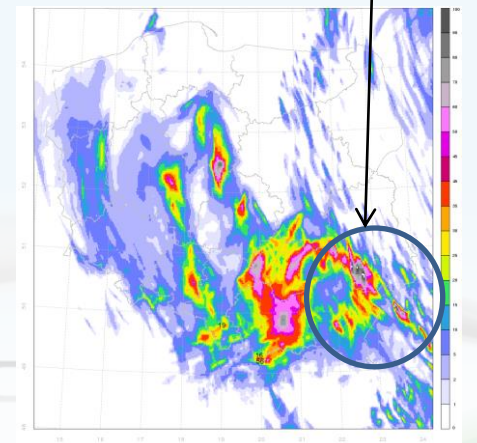
ALARO v. 43 NH 4 km



ALARO v. 43



ALARO v. 43 NH 2 km





# Verification of 24-h sum of precipitation using HARP2 spectral (model version cy40)

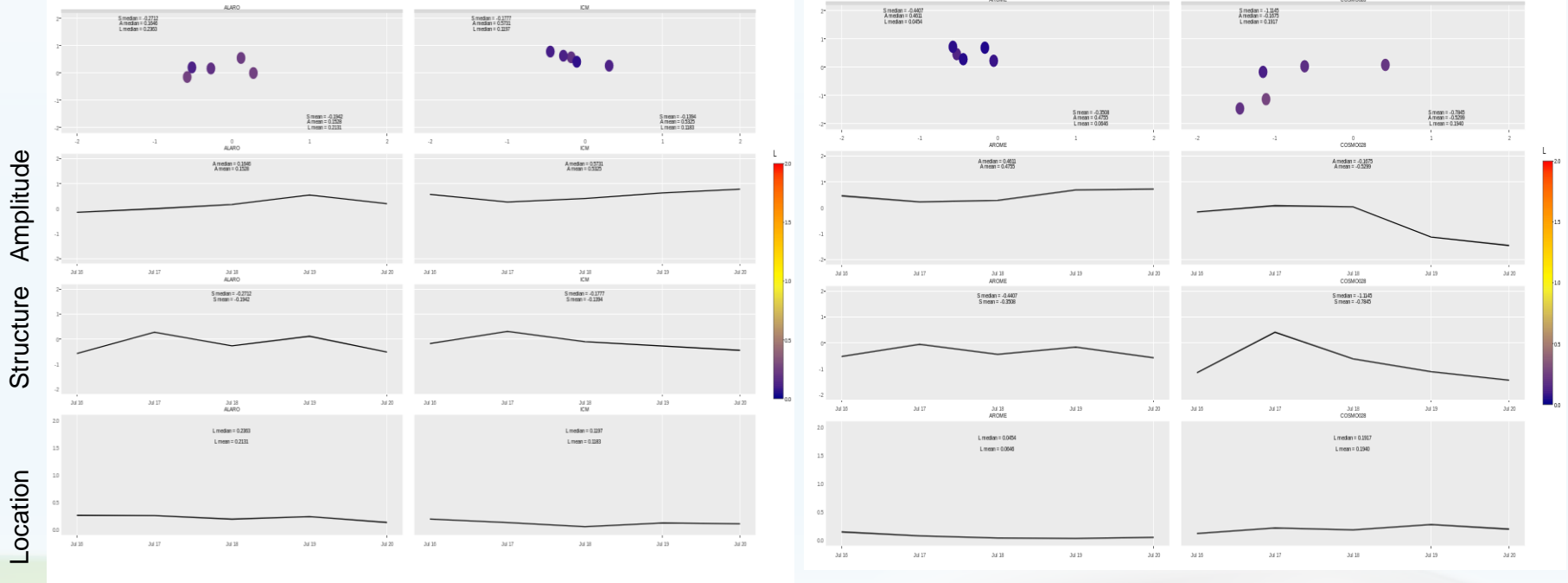
Analyzed period: 16-20.07.2018

ALARO

UM (ICM UW)

AROME

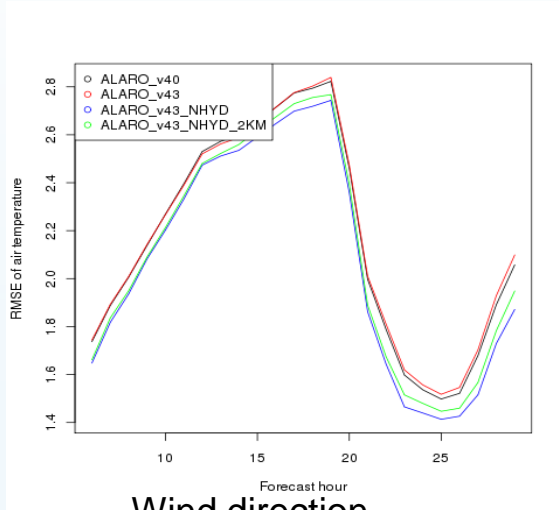
COSMO 2.8 km



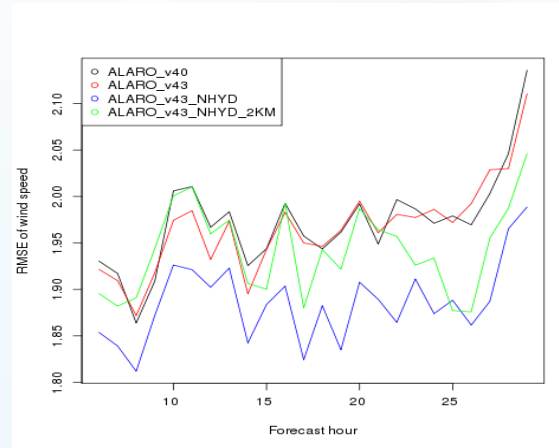




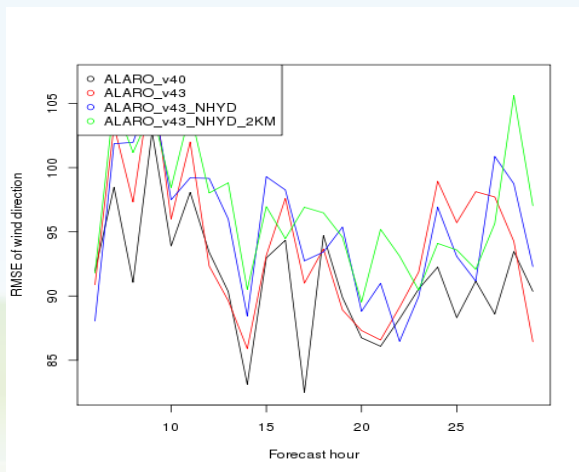
Air temperature



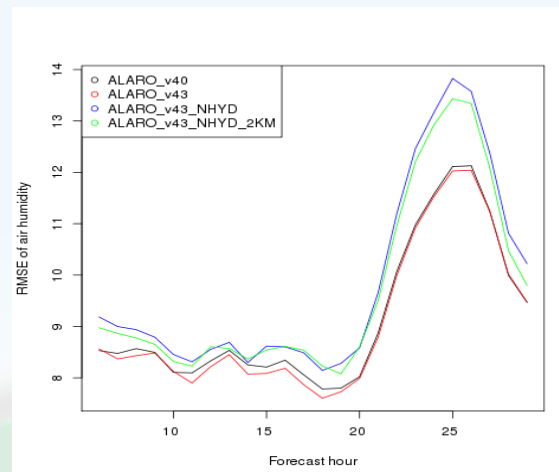
Wind speed



Wind direction

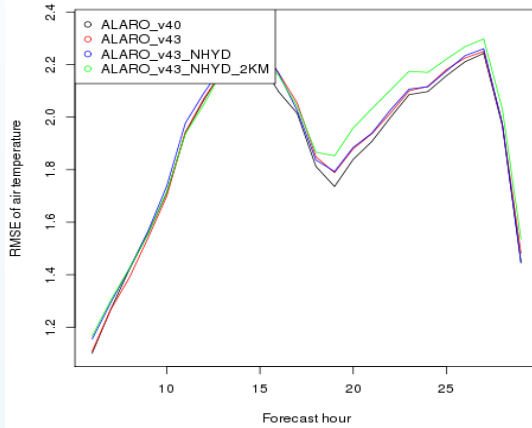


Air humidity

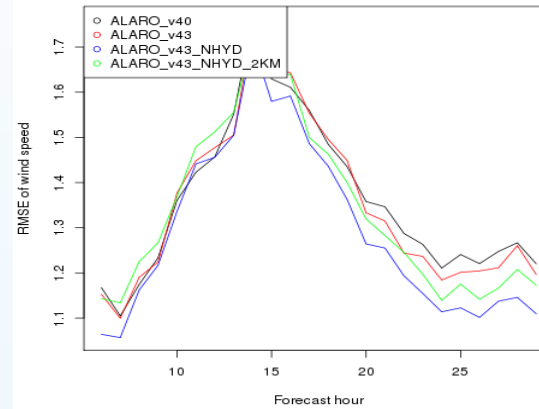




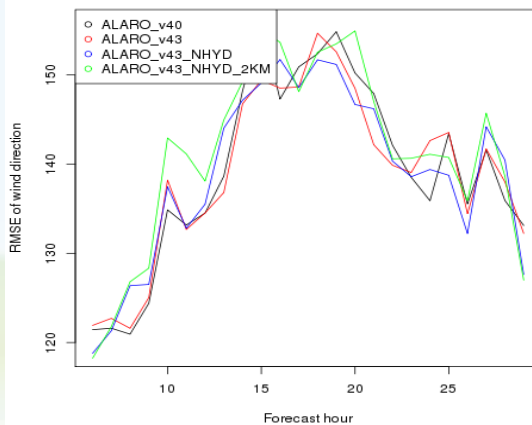
Air temperature



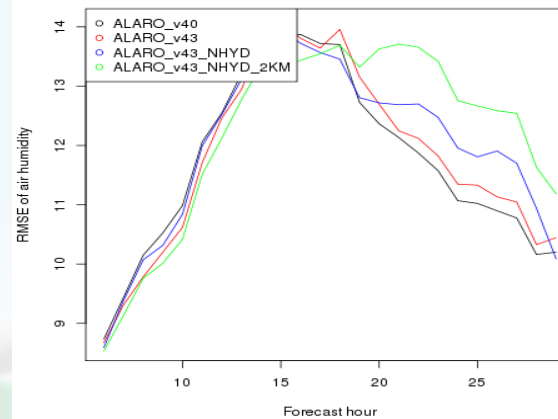
Wind speed



Wind direction



Air humidity

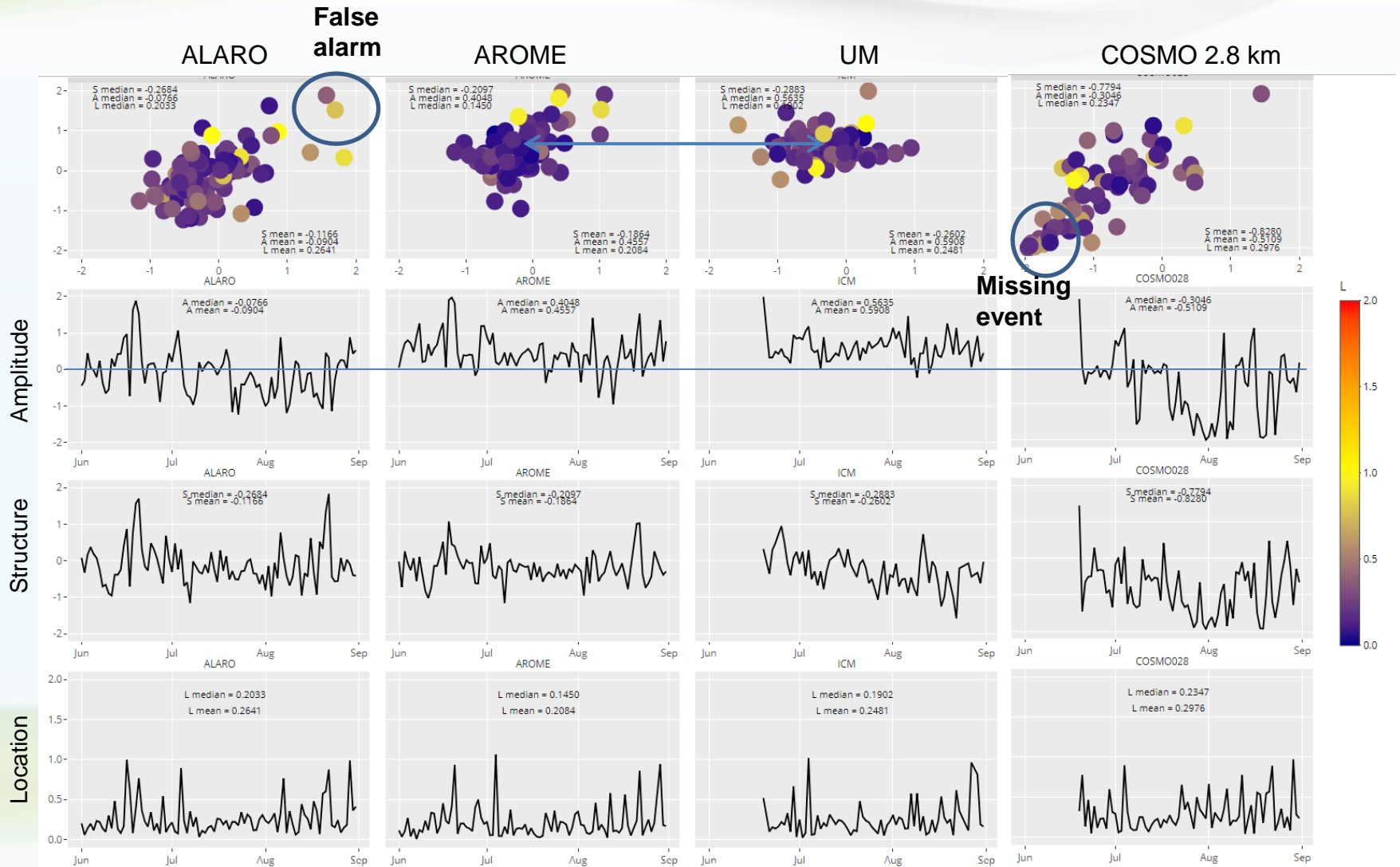




# Instytut Meteorologii i Gospodarki Wodnej

## Parqueo.com Instytut Meteorologii i Gospodarki Wodnej

### Seasonal verification – summer 24h sum

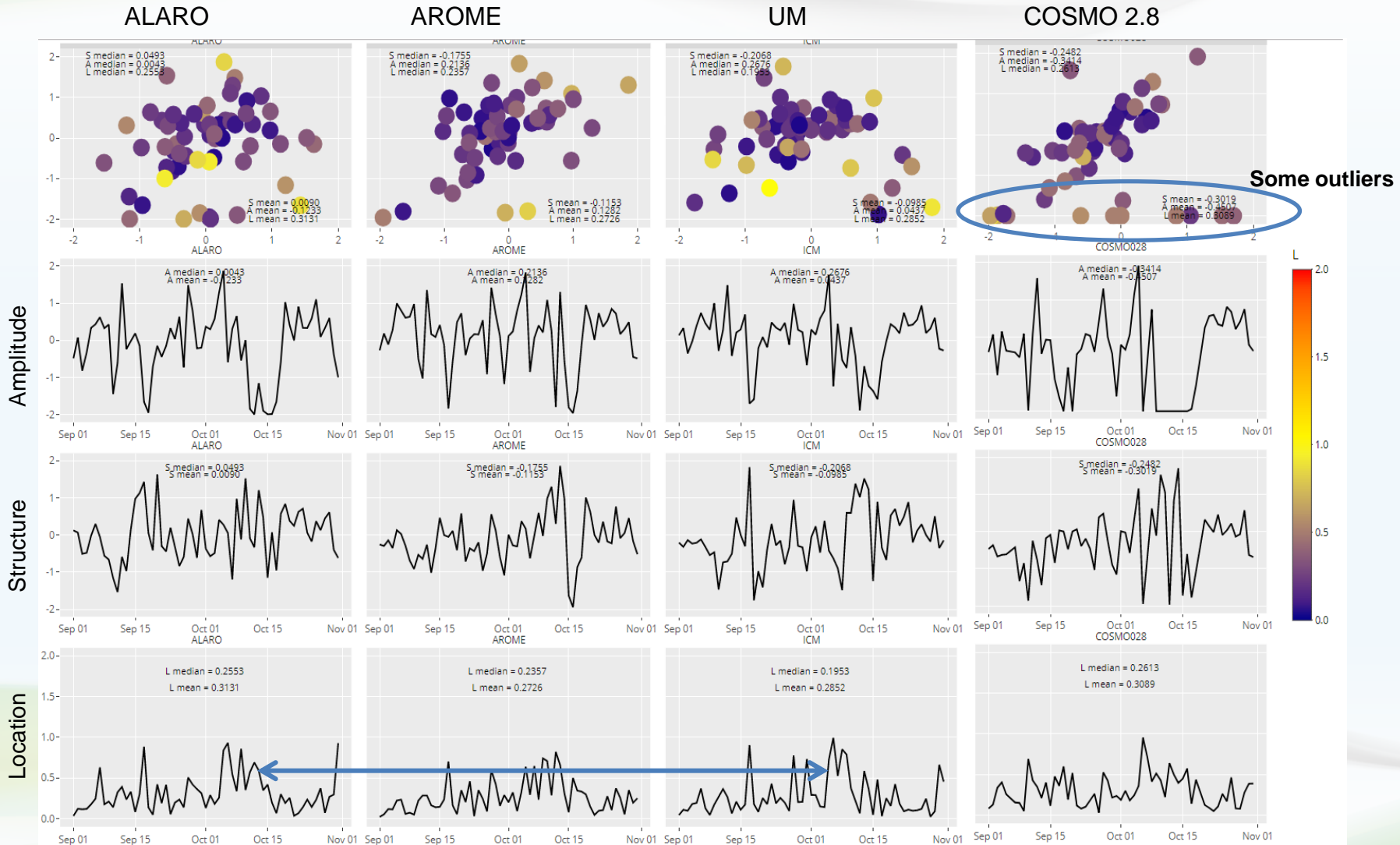




# Instytut Meteorologii i Gospodarki Wodnej

## Państwowy Instytut Badawczy

### Seasonal verification – autumn 24h sum





## Conclusions

- Necessary are further tests of ALARO HYD and ALARO NH cy43
- Forecast of 24-h sum of precipitation for models ALARO, AROME and UM (cy40) for analyzed period are similar.
- Sum of 24-h precipitation are comparable for ALARO HYD cy40 and cy43.
- Better forecast of maximum sum of precipitation for model ALARO NH 4 km compared with ALARO HYD 4km (ver. 43).
- Necessary are further analyses of seasonal variability NWP models.