

Verification results of AROME-EDA

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3rd ACCORD All Staff Workshop
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Tallinn and hybrid



Content

Downscaled AROME EPS and EDA setup

Evaluation

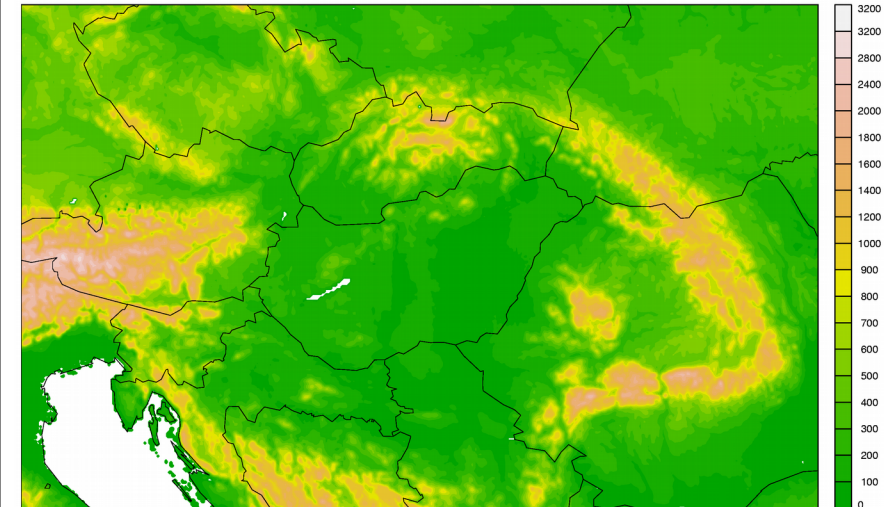
- Method
- Summer and winter experiments
- Parallel suite in winter

Conclusions and plans



Ensembles setup

	AROME-EPS	AROME-EPS EDA
CMC	AROME	AROME
Code version	43T2_bf11	43T2_bf11
Horizontal resolution	2.5 km	2.5 km
Vertical levels	60	60
Runs per day	2 (00, 12 UTC)	2 (00, 12 UTC)
Forecast length	+48h	+48h
Members	11	11
Assimilation cycle	no	yes (3h)
Coupling	ECMWF ENS (1h)	ECMWF ENS (1h)
IC perturbation	-	3DVAR + SEKF
Used measurements	-	SYNOP, AMDAR, TEMP, GNSS-ZTD, Mode-S MRAR (SI, CZ), Geowind, HRWind AMV
Model perturbation	-	SPP planned



AROME/HU and AROME-EPS domain

Verification method

Objective



Objective Verification **SY**stem

- Perl-based
- Pointwise verification
- **Deterministic** verification metrics
- RMSE, bias

- EPS-mean, EPS-control



Self-developed verification system

- **Probabilistic** verification metrics
- Fortran + Metview macros
- CRPS, Spread-Skill, Brier-score, bias, Percentage of outliers, Talagrand



Hirlam-Aladin **R** Package for verification

- **Probabilistic** verification metrics
- First tests at the end of 2020
- Available from Autumn of 2022

Subjective

By the model developer
By the forecasters

HAWK macros



Local perturbation tests: EDA experiments

3 periods:

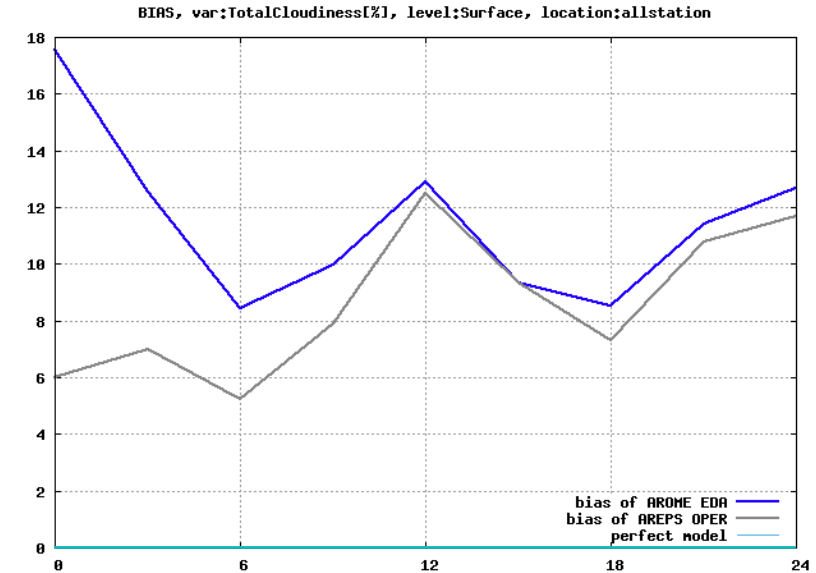
- **1-31 July of 2021**, Forecasts at 00 UTC, +24h, Spinup: 10 days
- **1-31 January of 2022**, Forecasts at 00 UTC, +24h, Spinup: 10 days
- **15.11-15.12. 2022**, Forecasts at 00, 12 UTC, +48h, **quasi-operational** run: August 2022

1. AROME-EPS-EDA experiment: 1-31 July 2021

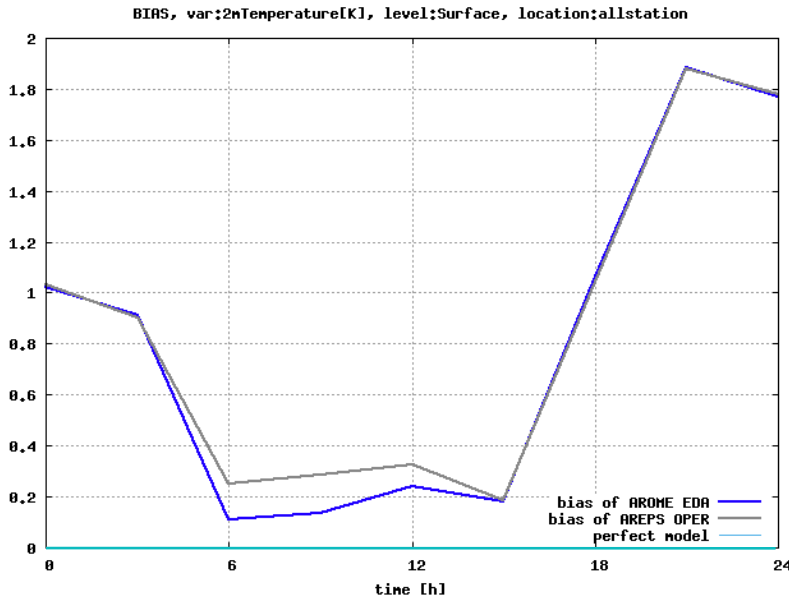
- Forecast at 00 UTC +24h
- 3 hourly assimilation cycle: 3DVAR + **OI-MAIN**
- Verification used 30 stations in Hungary (expect TTC - 10)
- **Improvement:** in surface parameters
 - Mostly in first 6h (slight impact in the evening)
 - Reducing the under- and overestimation
 - SEKF test caused larger spread (during the day) and reduced night RMSE (main positive effects)
- Degradation: total cloudiness and RH in first 6h

AREPS_EDA
AREPS_OPER
 perfect model

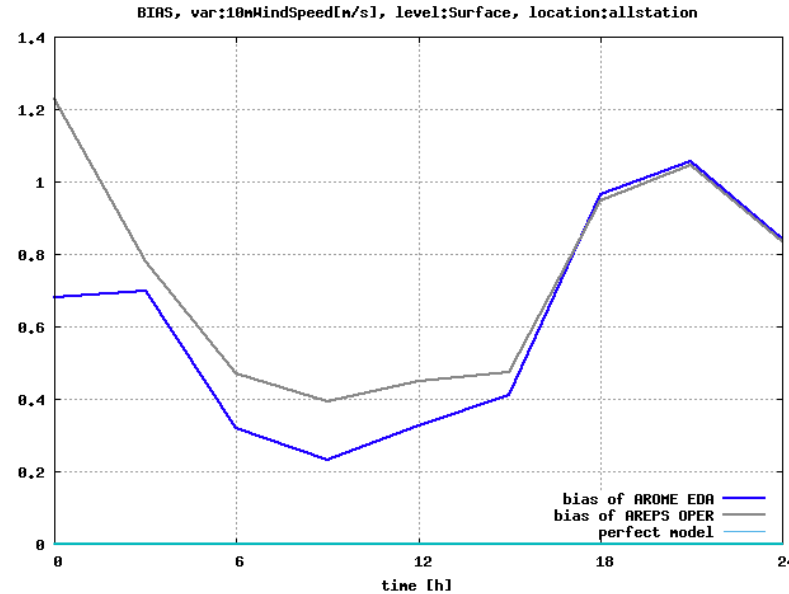
MEAN- TTC bias



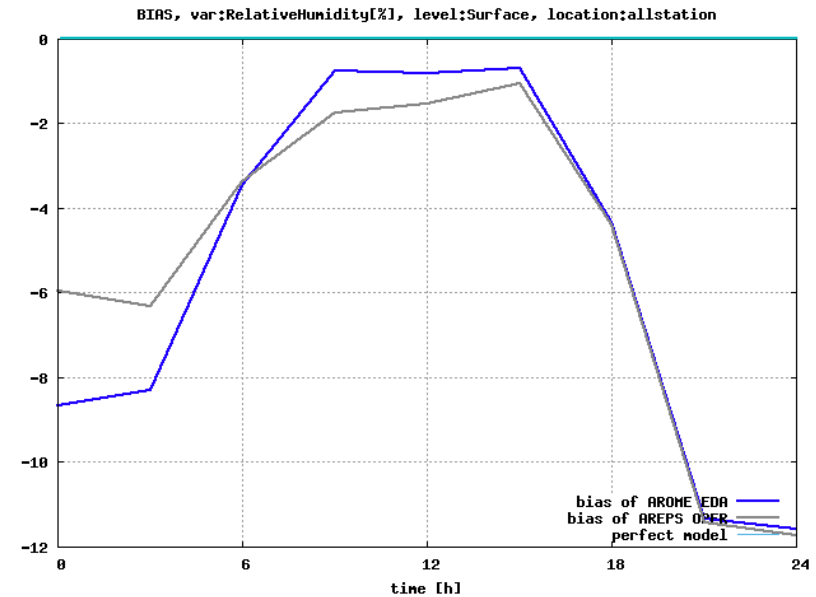
MEAN- T2m bias



MEAN- WSp10m bias



MEAN- RH2m bias

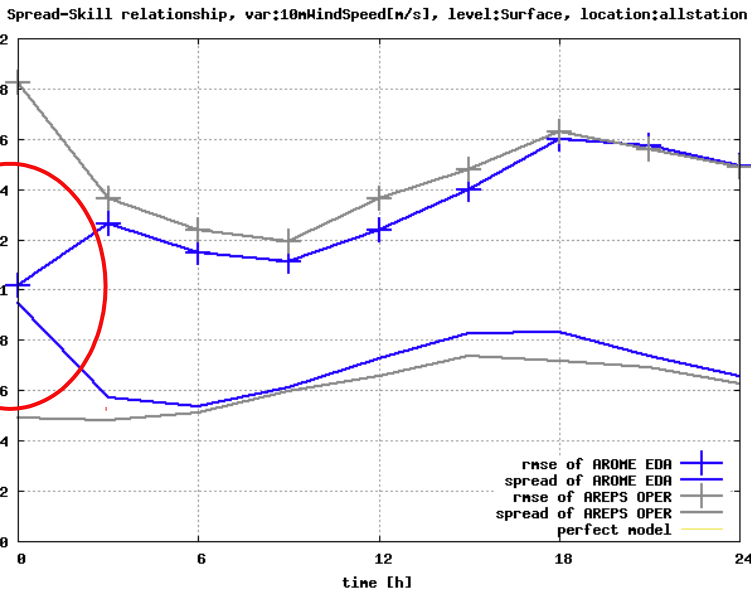


1. AROME-EPS-EDA experiment: 1-31 July 2021

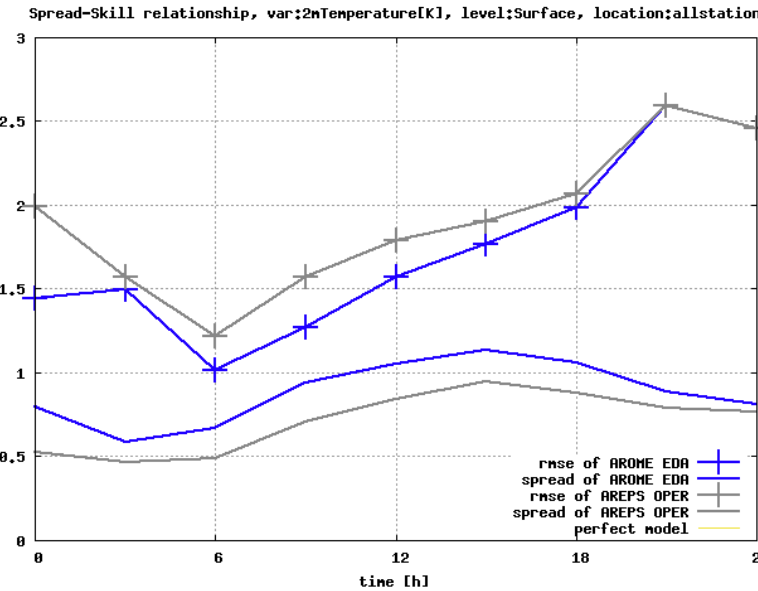
- **Improvement:** in surface parameters
 - RMSE decreasing
 - While spread is increasing (for whole fc time)

small RMSE
large spread

Spread-Skill WSp10m

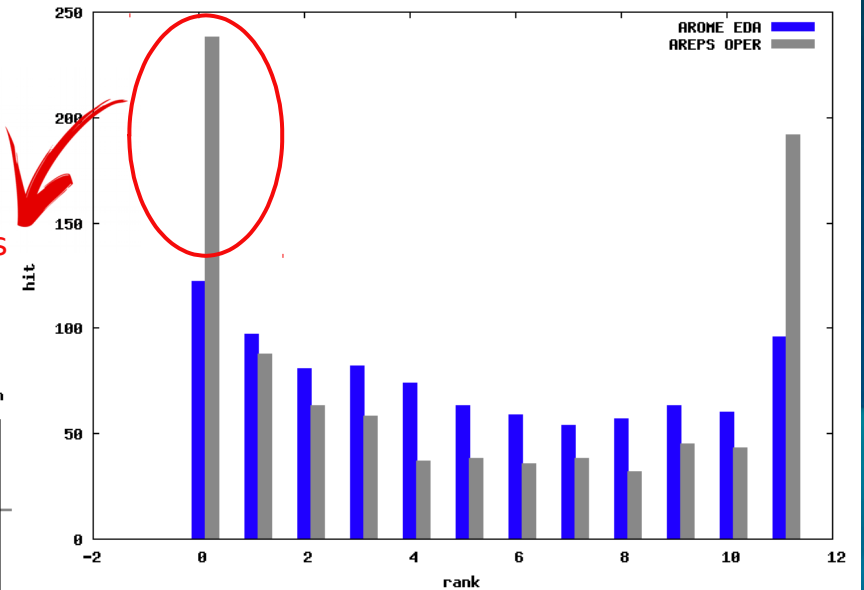


Spread-Skill T2m



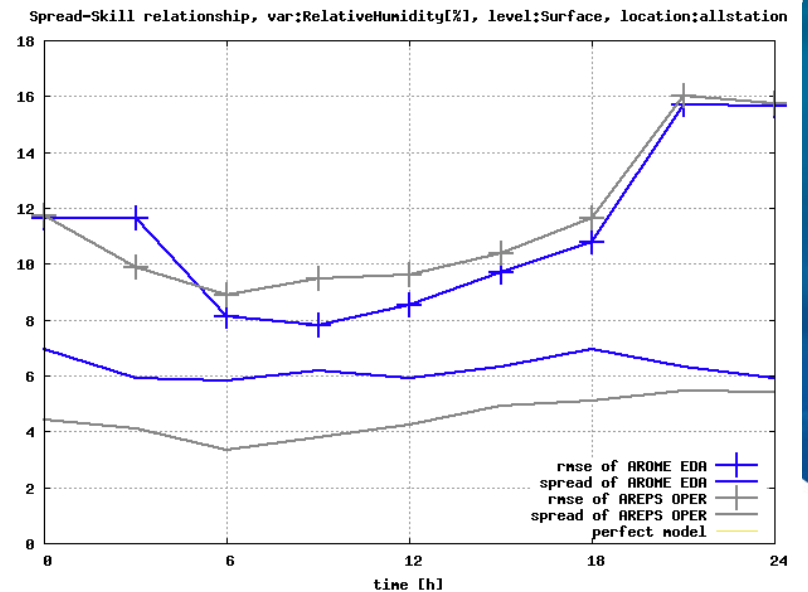
Talagrand +9h T2m

Talagrand, var:2nTemperature[K], hour:+9



Reduce the bias
better spread

Spread-Skill RH2m



AREPS_EDA RMSE ++

AREPS_EDA spread —

AREPS_OPER RMSE ++

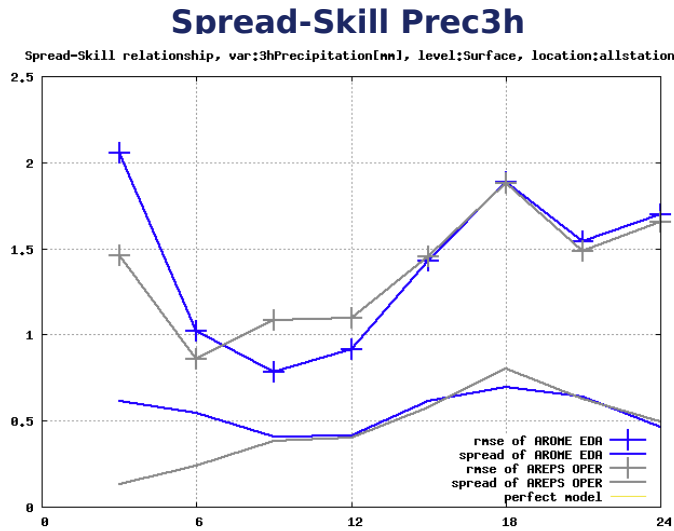
AREPS_OPER spread —

1. AROME-EPS-EDA experiment: 1-31 July 2021

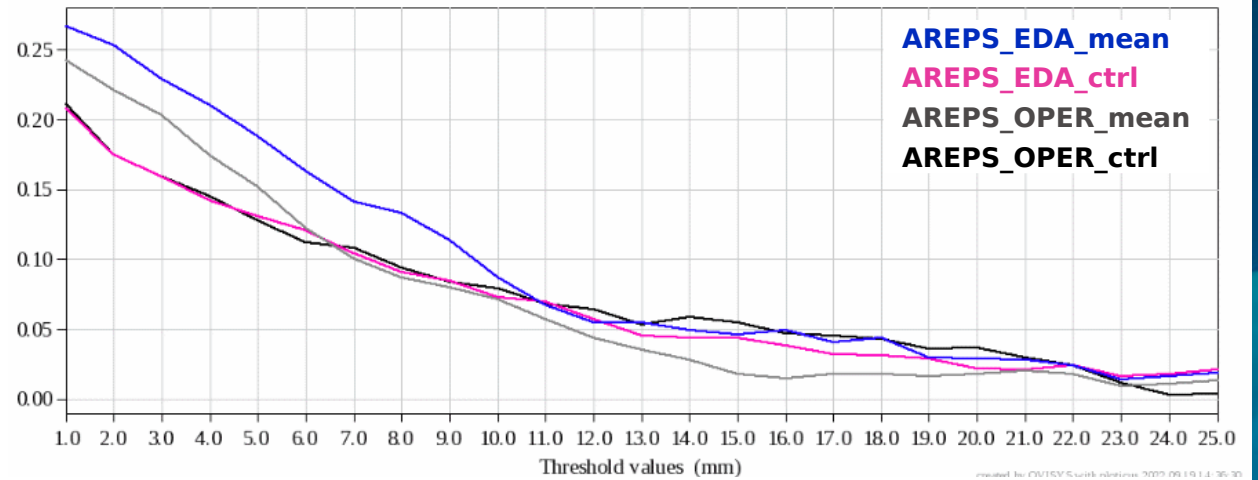
Precipitation:

- Larger RMSE in first 6h
- At bigger amount EDA ctrl gets better

AREPS_EDA RMSE ++
AREPS_EDA spread —
AREPS_OPER RMSE ++
AREPS_OPER spread —



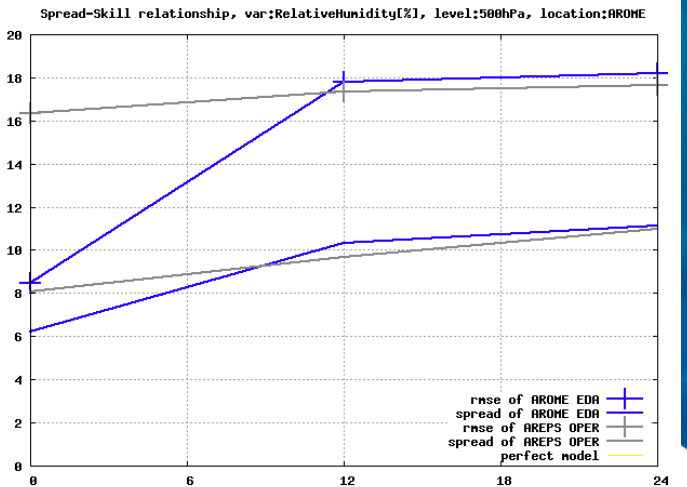
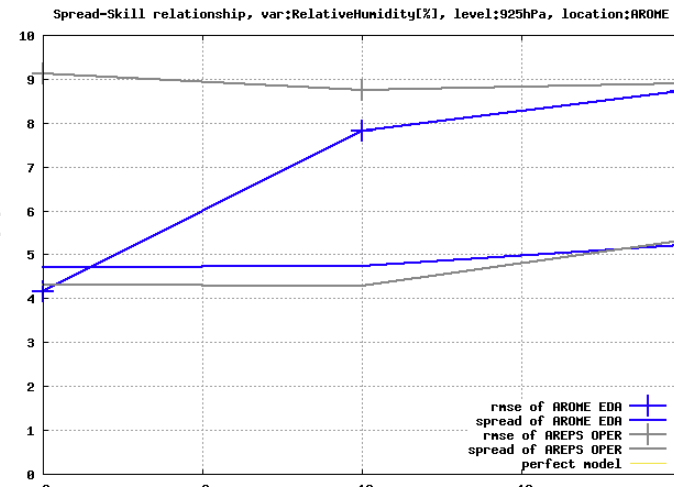
ETS Prec12h 00+18h



Upper air:

- Noticeable improvement in T and RH
- Best results near surface
- Positive impact becomes smaller with height

Spread-Skill Relative Humidity



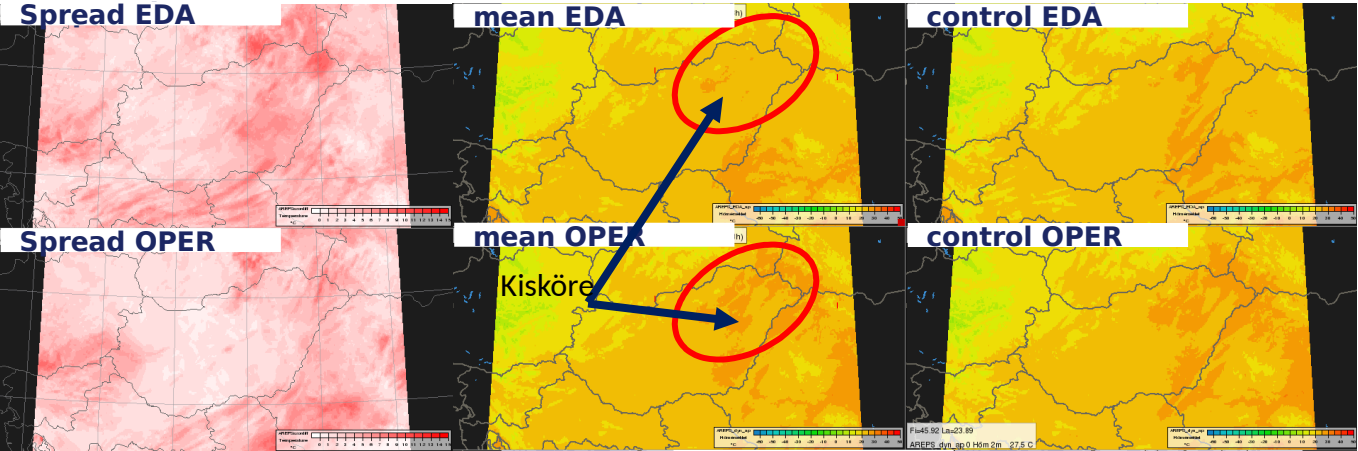
925 hPa, against TEMP

700 hPa, against TEMP

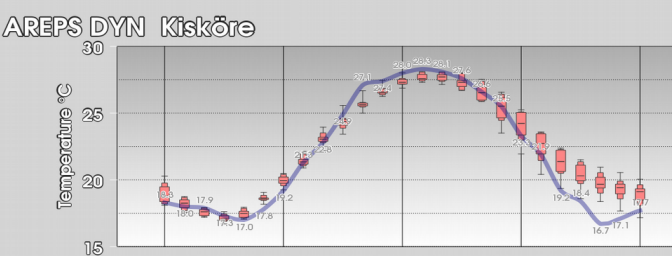
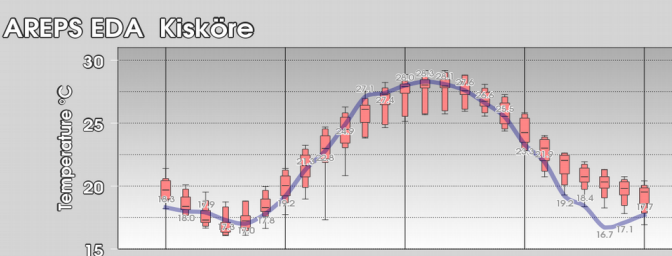
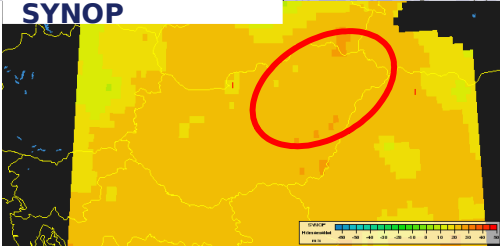
1. AROME-EPS-EDA experiment: 1-31 July 2021

- **Case study:** 1 July of 2021

Larger spread



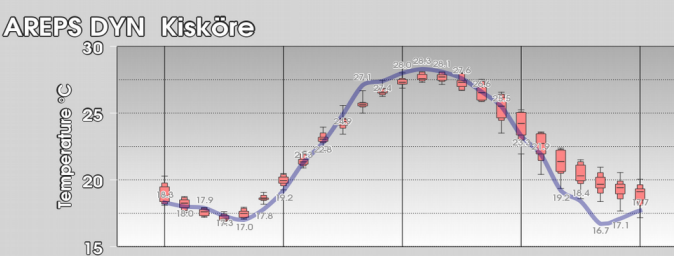
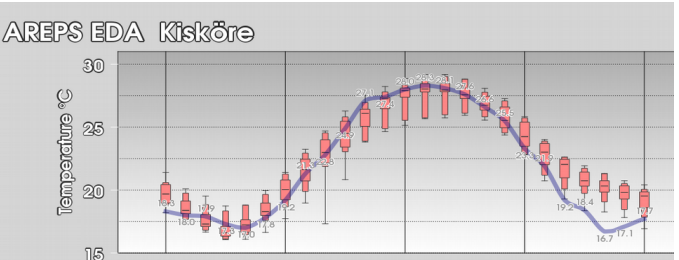
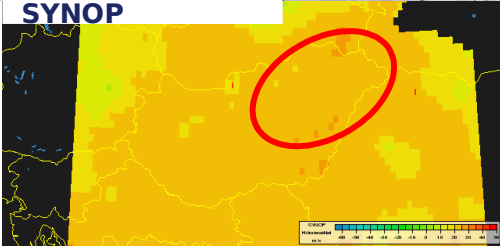
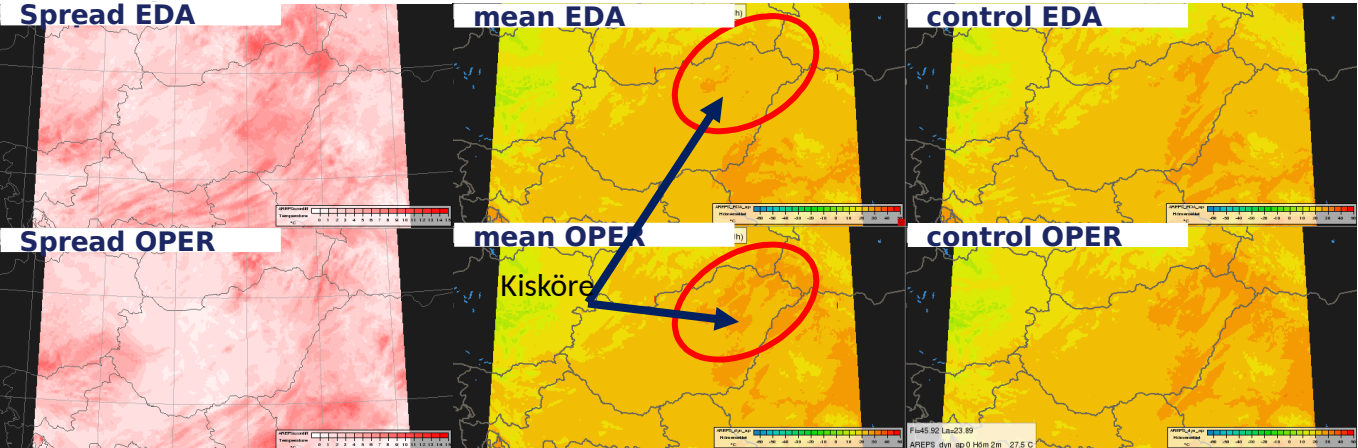
T2m 00UTC+08h



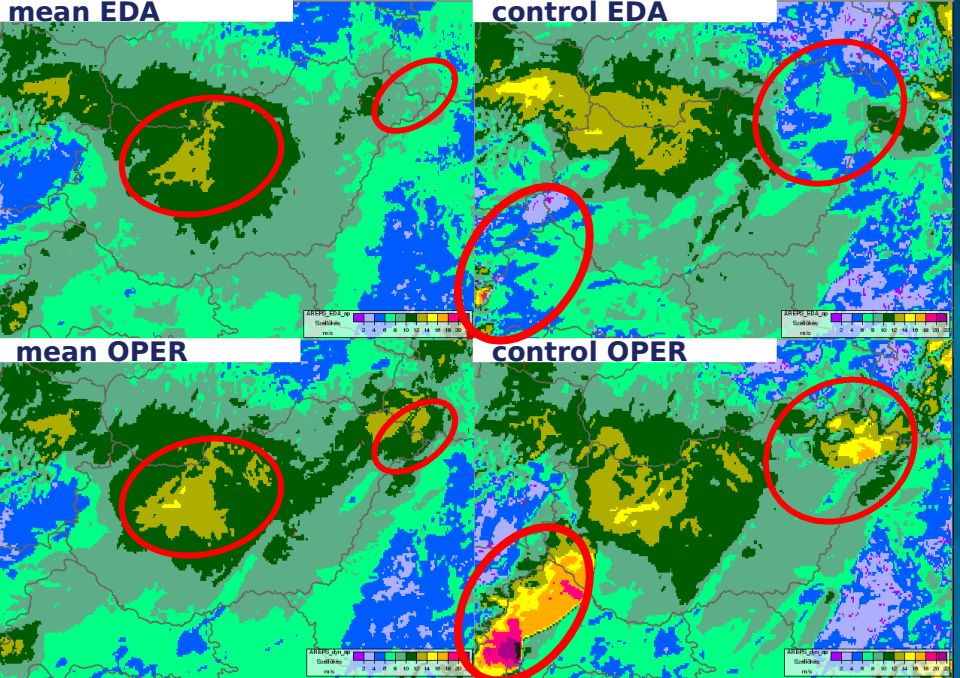
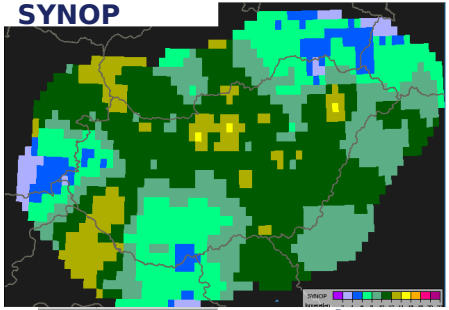
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- **Case study:** 1 July of 2021

Larger spread



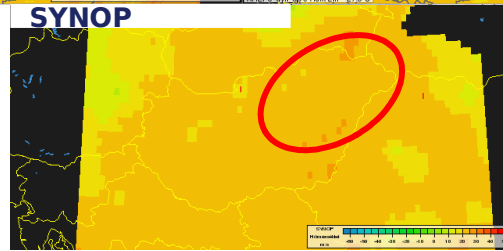
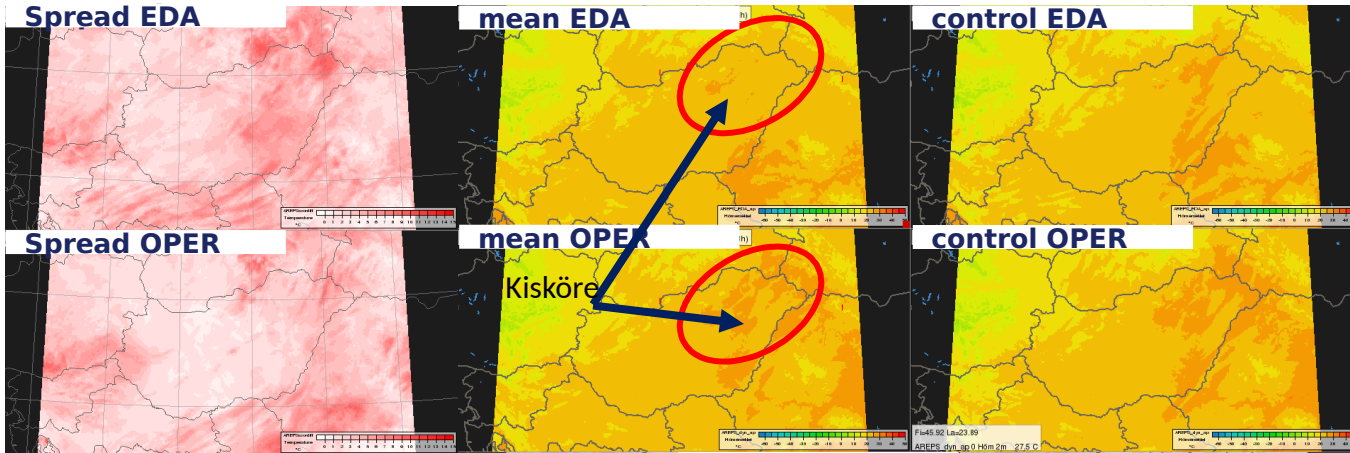
WindGust
 10m
 00UTC+15h



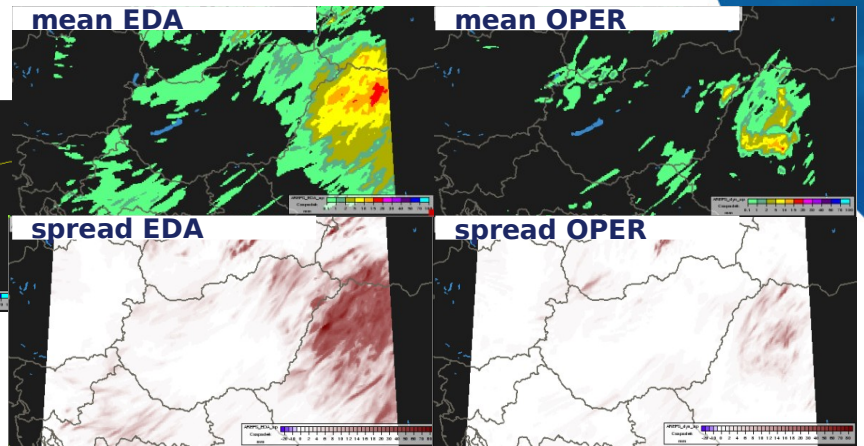
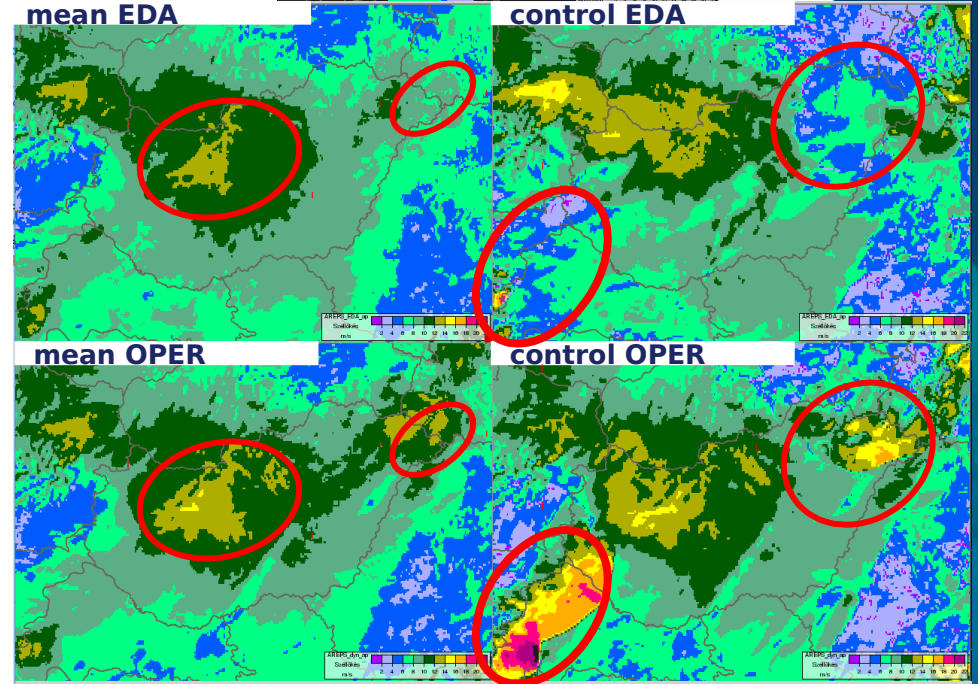
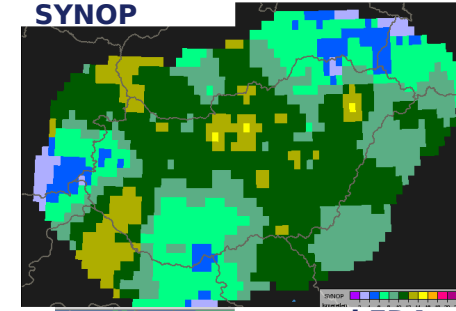
1. AROME-EPS-EDA experiment: 1-31 July 2021

- **Case study:** 1 July of 2021

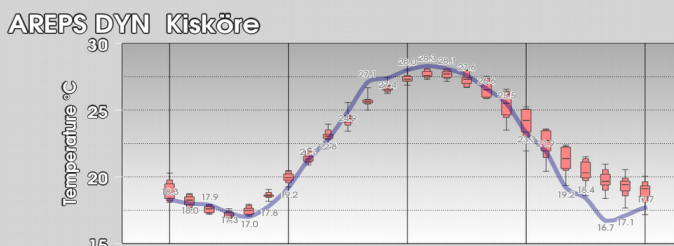
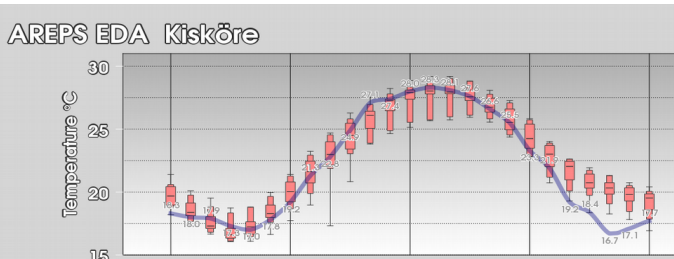
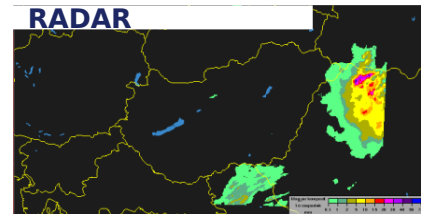
Larger spread



WindGust
10m
00UTC+15h



Prec3h
00UTC+03h

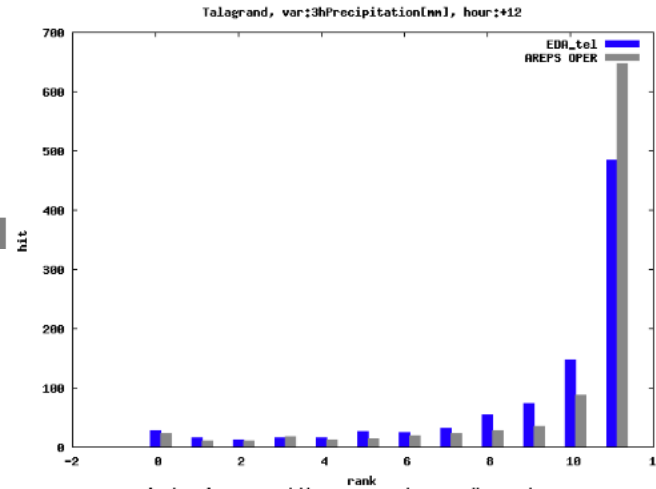


2. AROME-EPS-EDA experiment 1-31 January 2022

- Forecast at 00 UTC +24h
- 3 hourly assimilation cycle: 3DVAR + **OI-MAIN**
- Verification used 30 stations in Hungary
- **Results:**
 - Less improvement
 - Impact is rather neutral (expect in first few hours)
 - Spread increases, but in some cases RMSE also slightly increases

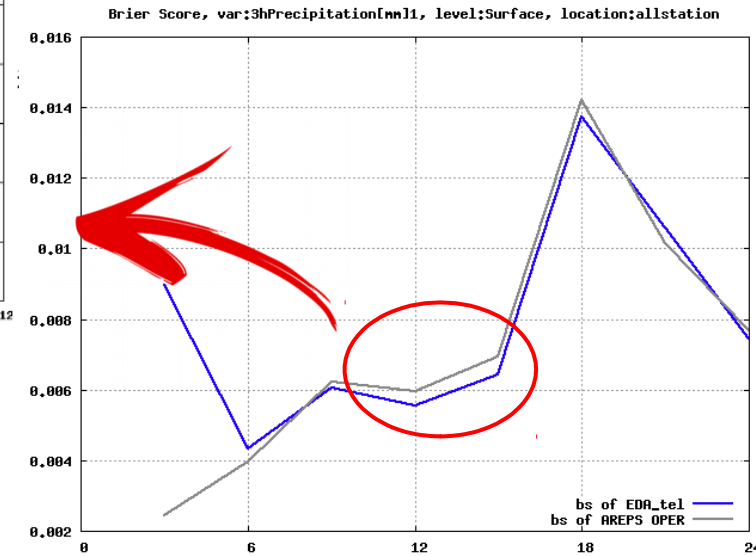
Best results

Talagrand +12h Prec3h

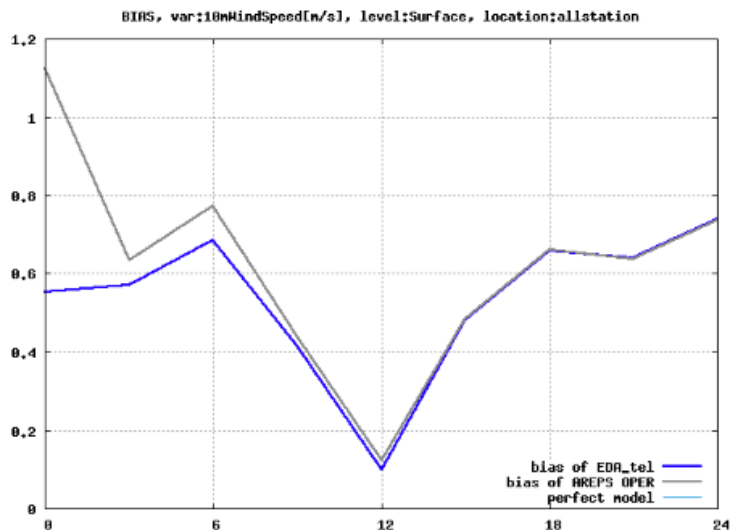


AREPS_EDA
AREPS_OPER

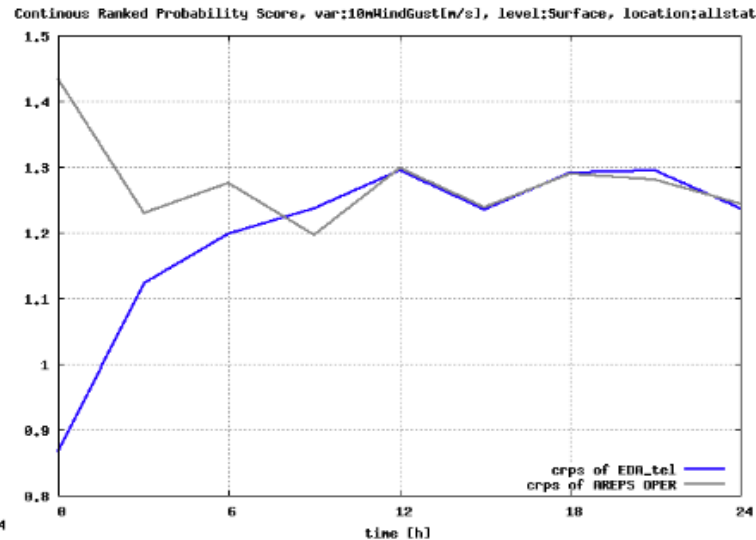
1mm Brier Score Prec3h



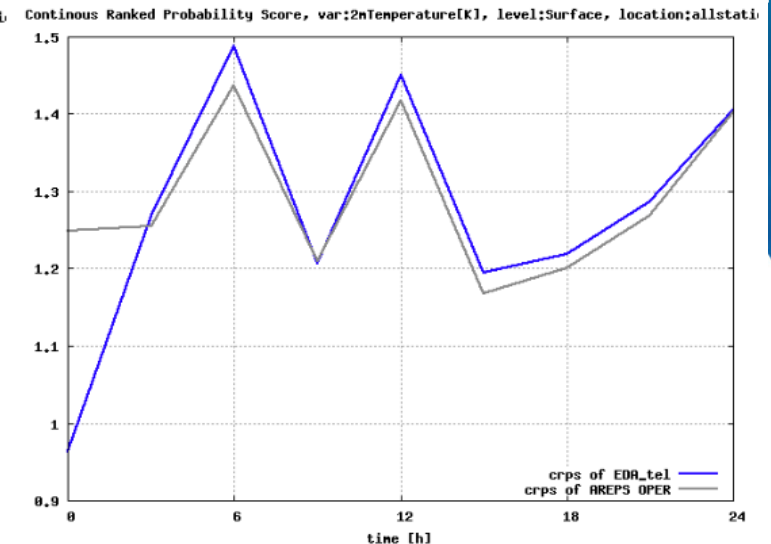
CRPS WSp10m



CRPS WG10m



CRPS T2m

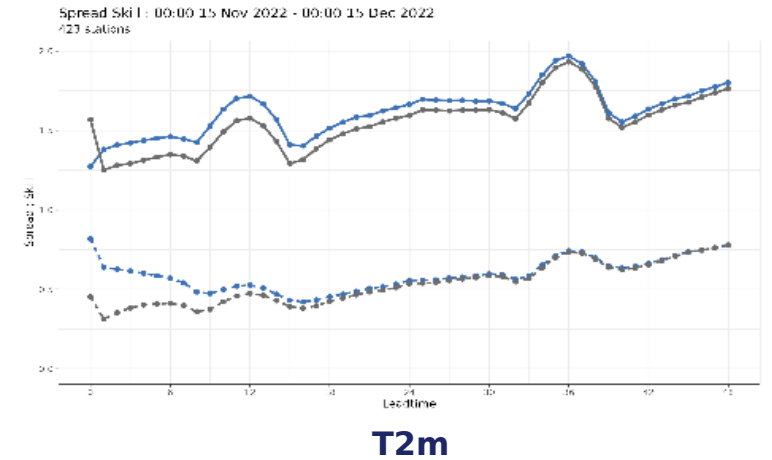
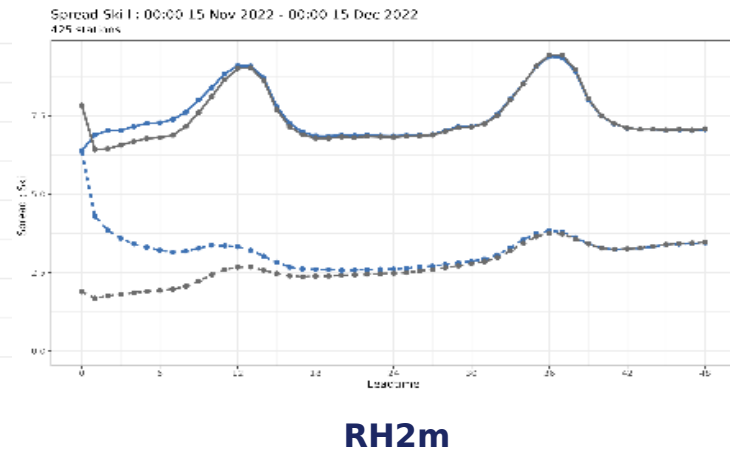
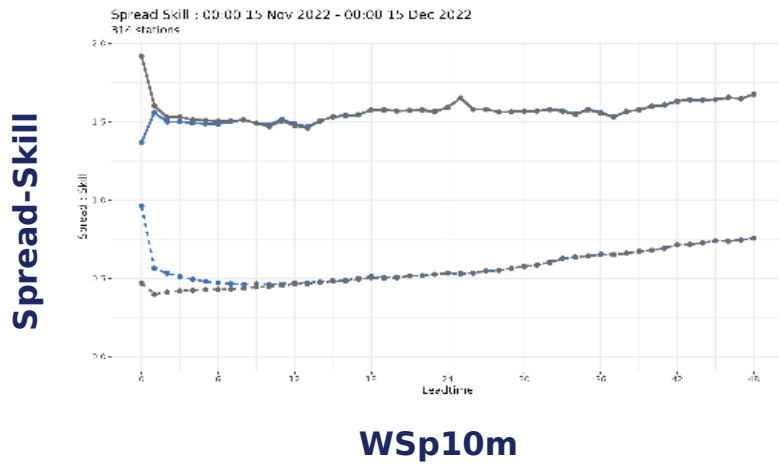


3. Parallel AROME-EPS-EDA run: 15.11-15.12 2022

- Forecast at 00 UTC and **12 UTC +48h**
- 3 hourly assimilation cycle: 3DVAR + **SEKF** + **HARP, subjective evaluation**

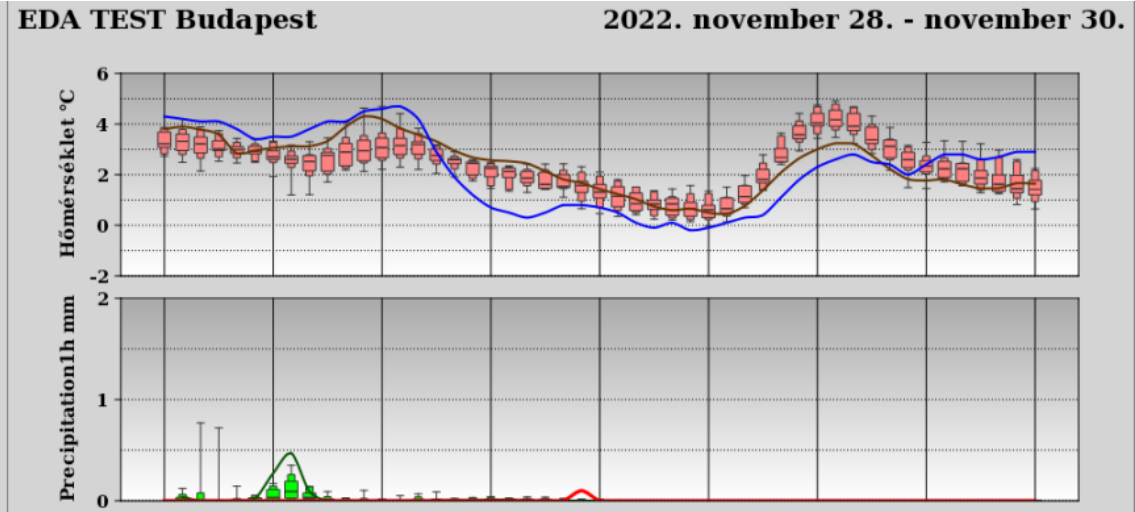
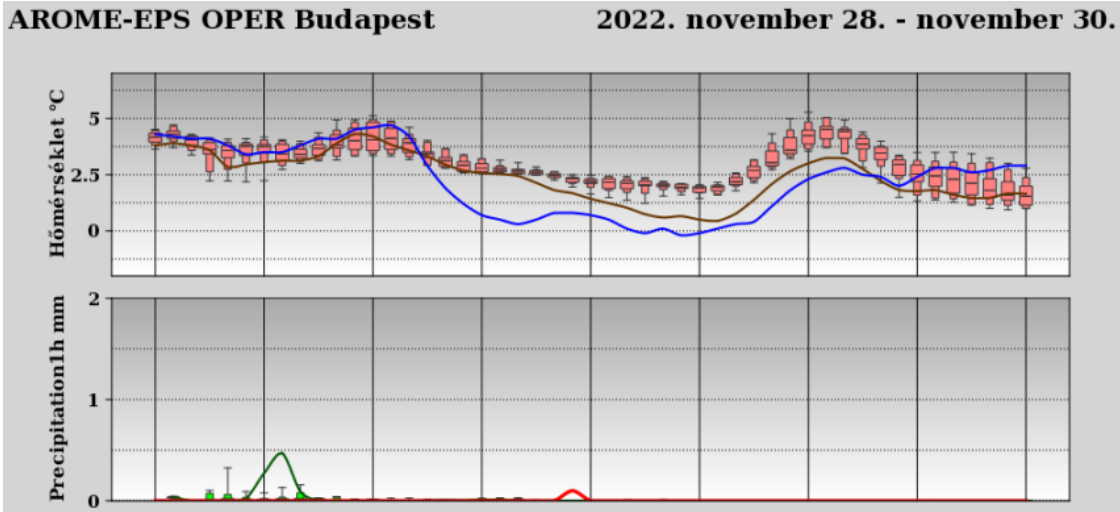
Results:

- Similar results as before
- Quite weather situation dependent
- The advantage of EDA remains for ~9h (Wsp, WG)
- In general 12 UTC runs could improve the forecast
- At upper-level parameters the positive impacts disappear after +12h

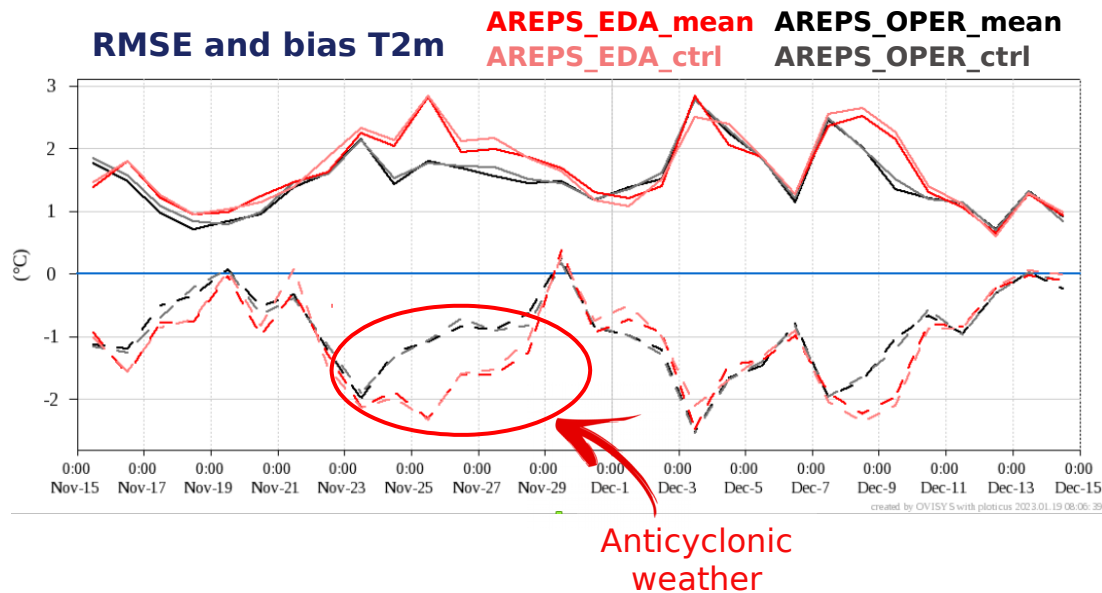


3. Parallel AROME-EPS-EDA run: 15.11-15.12 2022

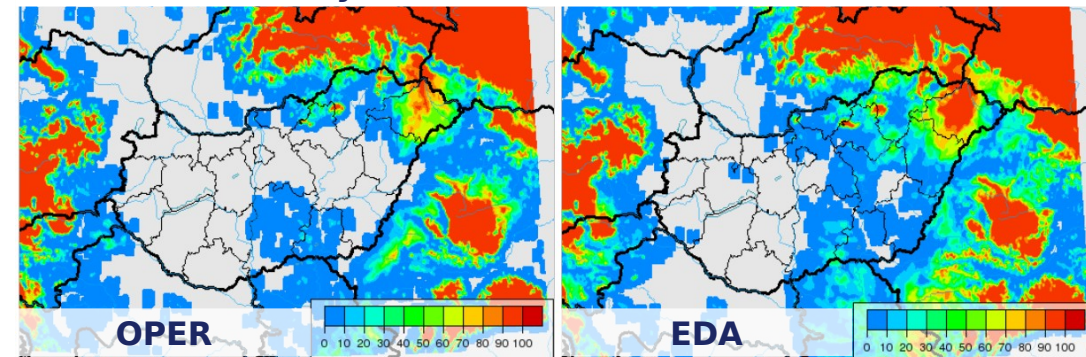
- Larger spread caused more correct analysis and forecast (in most weather situation)



- Anticyclonic weather → EDA is more stable
 → Overestimated low level cloud
 → predicted lower temperature
Advantageous in many cases and places!



Probability of T < 0°C (00+12h 28.11.2022.)



3. Parallel AROME-EPS-EDA run: 15.11-15.12 2022

- **Precipitation:**

- Minimal difference was mentioned
- At night EDA reduces underestimation

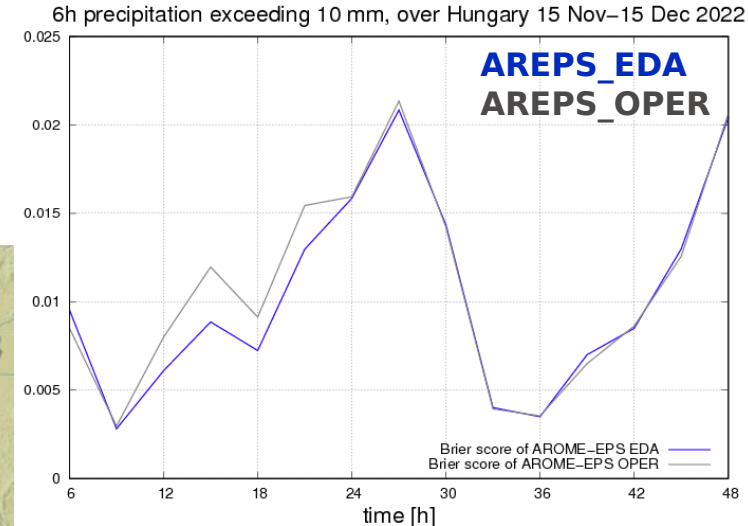
- **Snow and freezing:**

- EDA gives lower probabilities
- But covers larger area

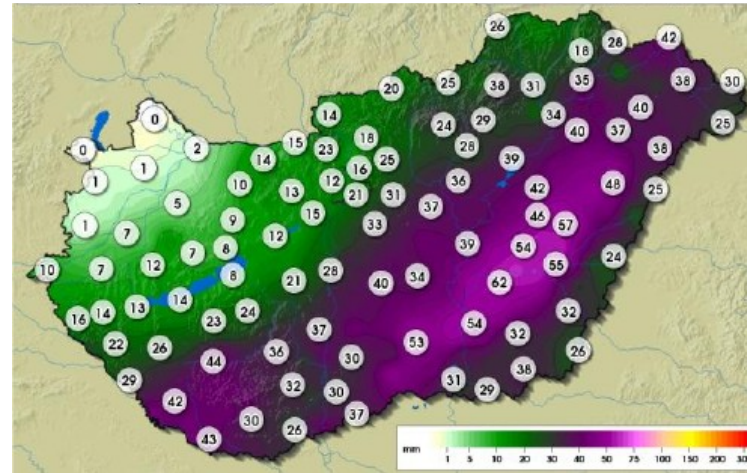
- **Case study: 10-11. December 2022**

- Mediterranean cyclone
- Incoming cold front
- Huge amount of precipitation

10 mm Brier score Prec6h



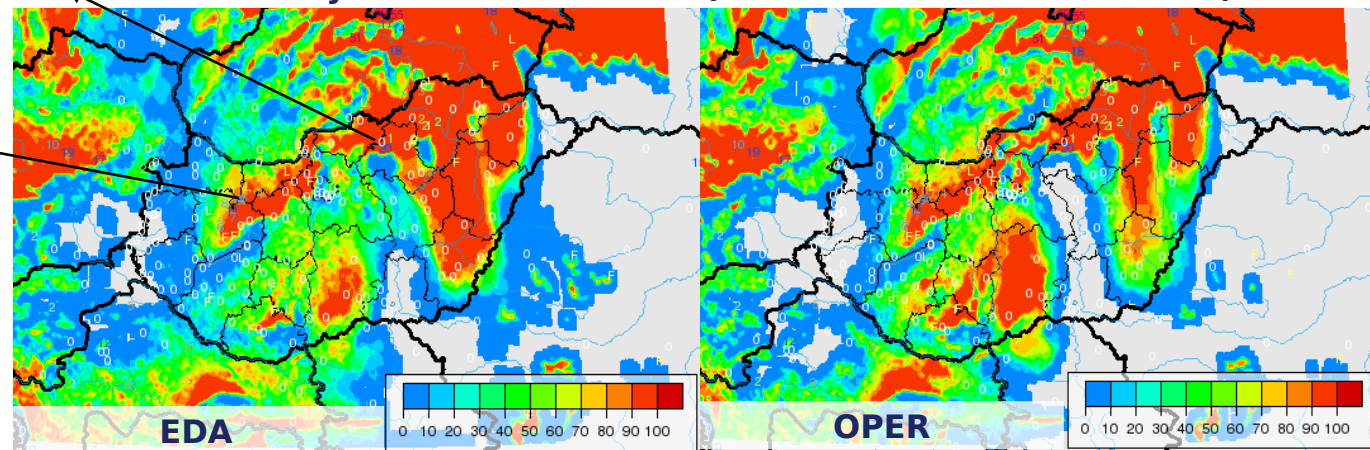
Prec24h 11. December 2022. 06UTC



20 mm

Probability of snow1h > 0 mm (11. December 2022. 06 UTC)

11 mm



Conclusions and Plans

- Ensemble data assimilation has more positive effects at the beginning of forecasts
- Best results primarily in near surface parameters (mostly in Wsp, WG)
- EDA caused more improvement in summer period
 - Spread growing in all cases with reduced errors (T, RH, Wsp, WG, P3h)
- Some parameters (MSLP, TTC, in winter: T, RH2m) had slightly negative or neutral effects



Operational introduction: 20 March 2023

Conclusions and Plans

- Introduce the 06 UTC runs
- Planned to apply SPP

Thank you for your attention!

