COSMO-2I-EPS: recent investigations and their results

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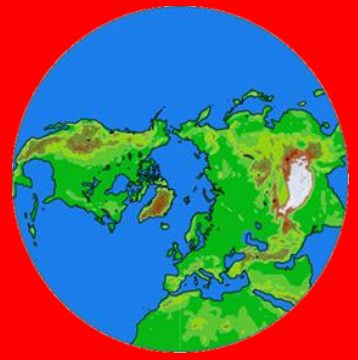
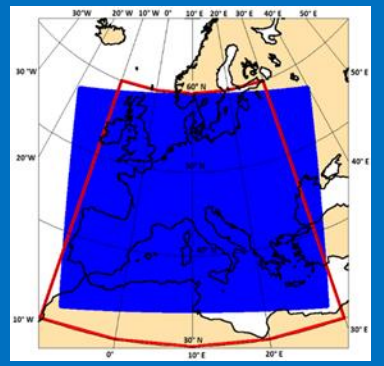
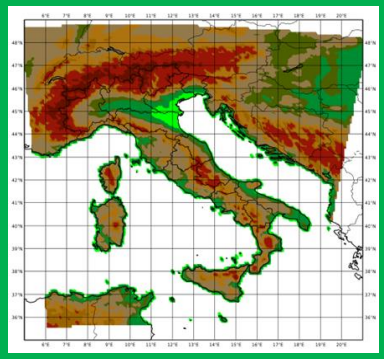
ENSEMBLE PREDICTION SYSTEMS IN arpae

MAIN TECHNICAL FEATURE \ ENSEMBLE SYSTEM	ECMWF ENS	COSMO-LEPS	COSMO-2I-EPS
Integration domain:			
Hor/Vert resolution	18km /91 lev	7km/40lev	2.2km/65lev
Initial Conditions	Hybrid-EnVar	ENS (+cluster analysis)	LETKF
Boundary Conditions	-	ENS (+cluster analysis)	AM ENS (nested on ENS)
Model Perturbation	Stochastic scheme	Parameter perturbation	-
Forecast range (hours)	240	132	48
Type of model	Hydrostatic model	Non-hydrostatic model	Non-hydrostatic model
Type of convection	Parameterized convection	Parameterized convection	Explicit convection
Ensemble size	51	20	20
Starting times (UTC)	00, 06, 12, 18	00, 12	21

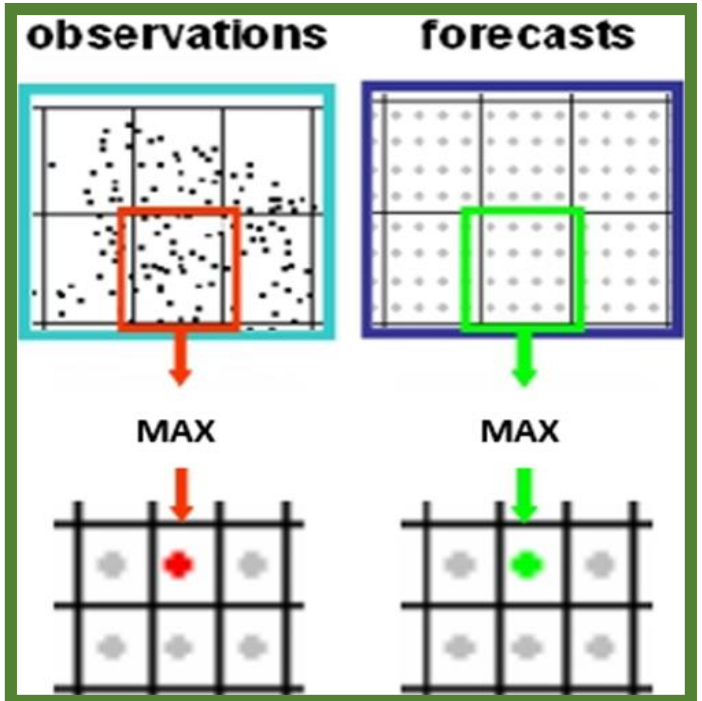
DESCRIPTION OF THE EXPERIMENTS

The intercomparison between the three ensemble systems is performed starting at **00 UTC** and with a forecast range of **48 hours** (post-processing frequency every 6 hours).

The systems are compared over the **Italian region**

Italian domain
Latitude: 35N – 48N
Longitude: 6E – 19E

DPCN Observational network
5524 stations



The domain is divided in squared area **(0.25° x 0.25°)**;
the precipitation values of all stations and all model grid points falling in the same box are aggregated and processed.
The **maximum** value for the precipitation field in each **box** has been performed.

What were we talking about in September?

1° verification period
21 Jan – 30 Apr 2019

	Score	Results COSMO-2I-EPS
tp 6h	RPS	
	% outliers	
	BS	
	ROC Area	
	Rank histogram	
	Performance diagram	
T2m	RMSE	
	Bias	

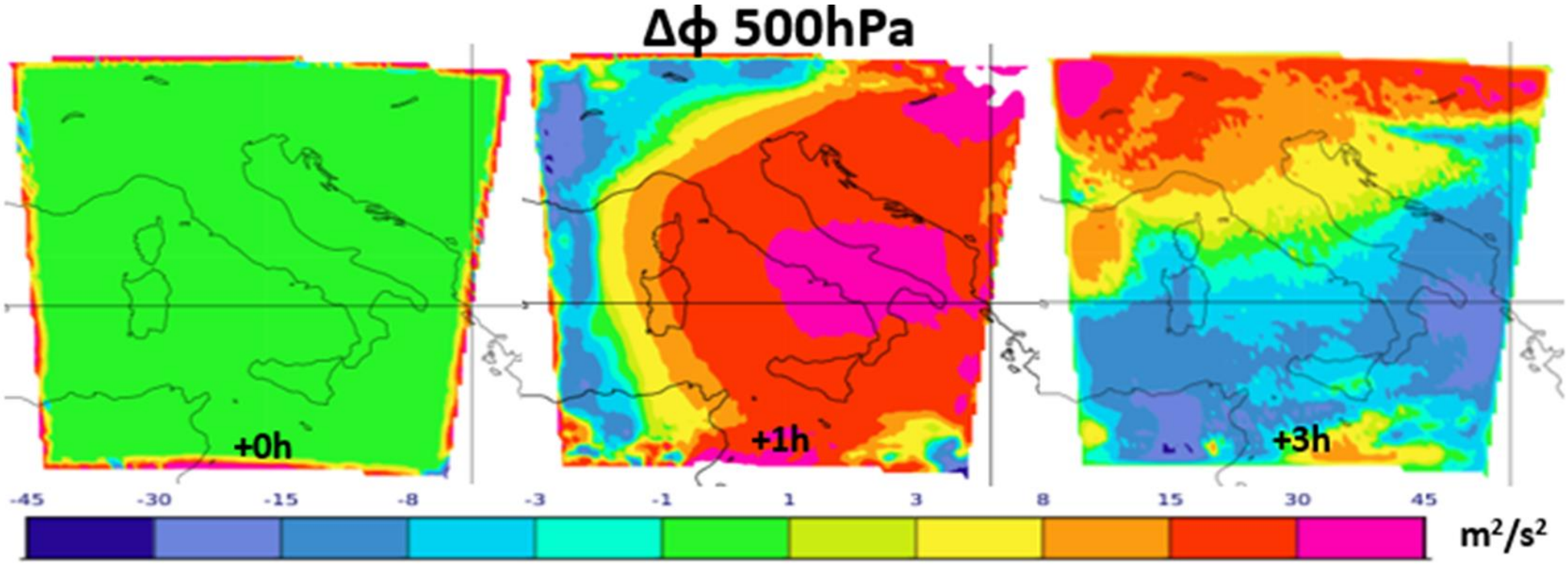
Legend:
- COSMO-2I-ESP is the worst
- COSMO-2I-EPS is the better

The results obtained from the statistical scores for COSMO-2I-EPS were not satisfactory, particularly for the first six hours of the forecast range.

We therefore made further investigations

From the first verification period to the second one

To solve the problem that COSMO-2I-EPS seems to have at the beginning of the forecast range in the first verification period, **the first boundary condition of COSMO-2I-EPS was changed from AM to KENDA**.
This test was made for the run of **22 May 2019.**
The results are meaningful for the **geopotential at 500hPa**.
In the images below the geopotential difference is plotted for the same COSMO-2I-EPS run inizialized once with the first boundary condition from AM and once from KENDA.
At zero time on the edge of the domain a considerable variation of geopotential was observed with respect to the case with boundary condition from AM.
In the following three hours this variation of geopotential spreads within the domain.
The change in the first boundary condition of COSMO-2I-EPS has remained unchanged since then.



What were we talking about in September?

	Score	1° period 21 Jan – 30 Apr 2019 Results COSMO-2I-EPS	2° period 23 May – 30 Jun 2019 Results COSMO-2I-EPS	Better or worse?
tp 6h	RPS			↑
	% outliers			↑
	BS			↑
	ROC Area			=
	Rank histogram			
	Performance diagram			↓
T2m	RMSE			↓
	Bias			↓

Legend:
- COSMO-2I-ESP is the worst
- COSMO-2I-EPS is the better

How did **COSMO-2I-EPS** behave in the two verification periods?
Is there an improvement or a deterioration?

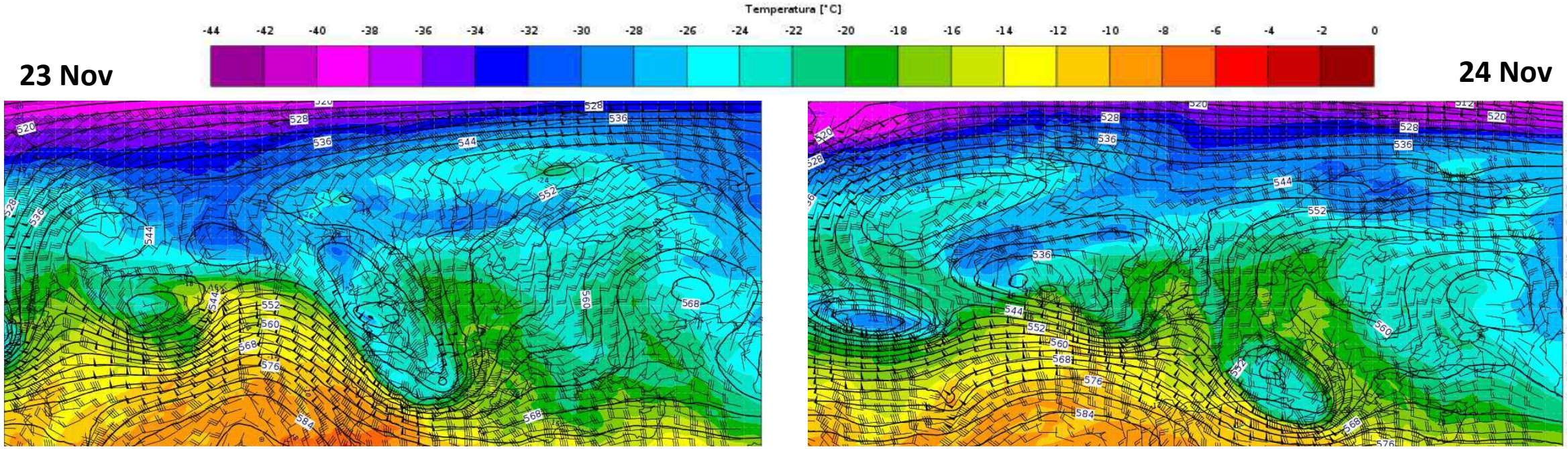
- ✓ In the two periods analyzed some scores improve others worsen, probably due to **different statistics** and **different climatology**
- ✓ **The problem for the first six hours has not been solved**

New investigations

Since the modification on the first boundary condition of COSMO-2I-EPS is not effective in improving the scores of this ensemble system, we have developed another test.

We have chosen a very rainy week (from 22 November 2019 to 28 November 2019) and on this one we have rerun COSMO-2I-EPS using the ECMWF boundary conditions instead of the AM boundary conditions.

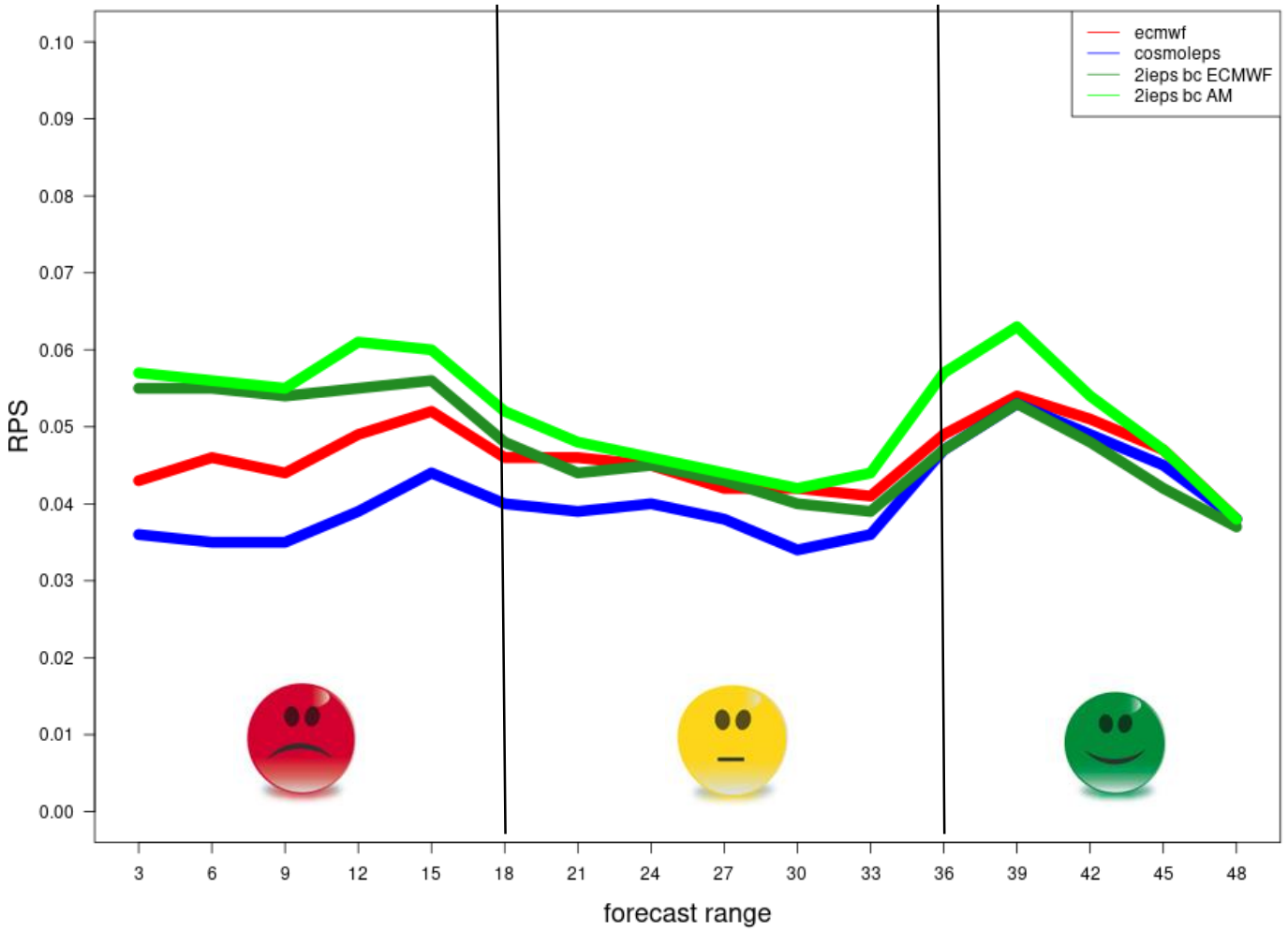
For this interesting week of November, we have studied the performance of COSMO-2I-EPS so modified and its operational version, in the verification are always included also COSMO-LEPS and ECMWF ENS.



500hPa geopotential height and temperature

Atlantic through on the western Mediterranean: favourable condition for very heavy rainfall over Italy.

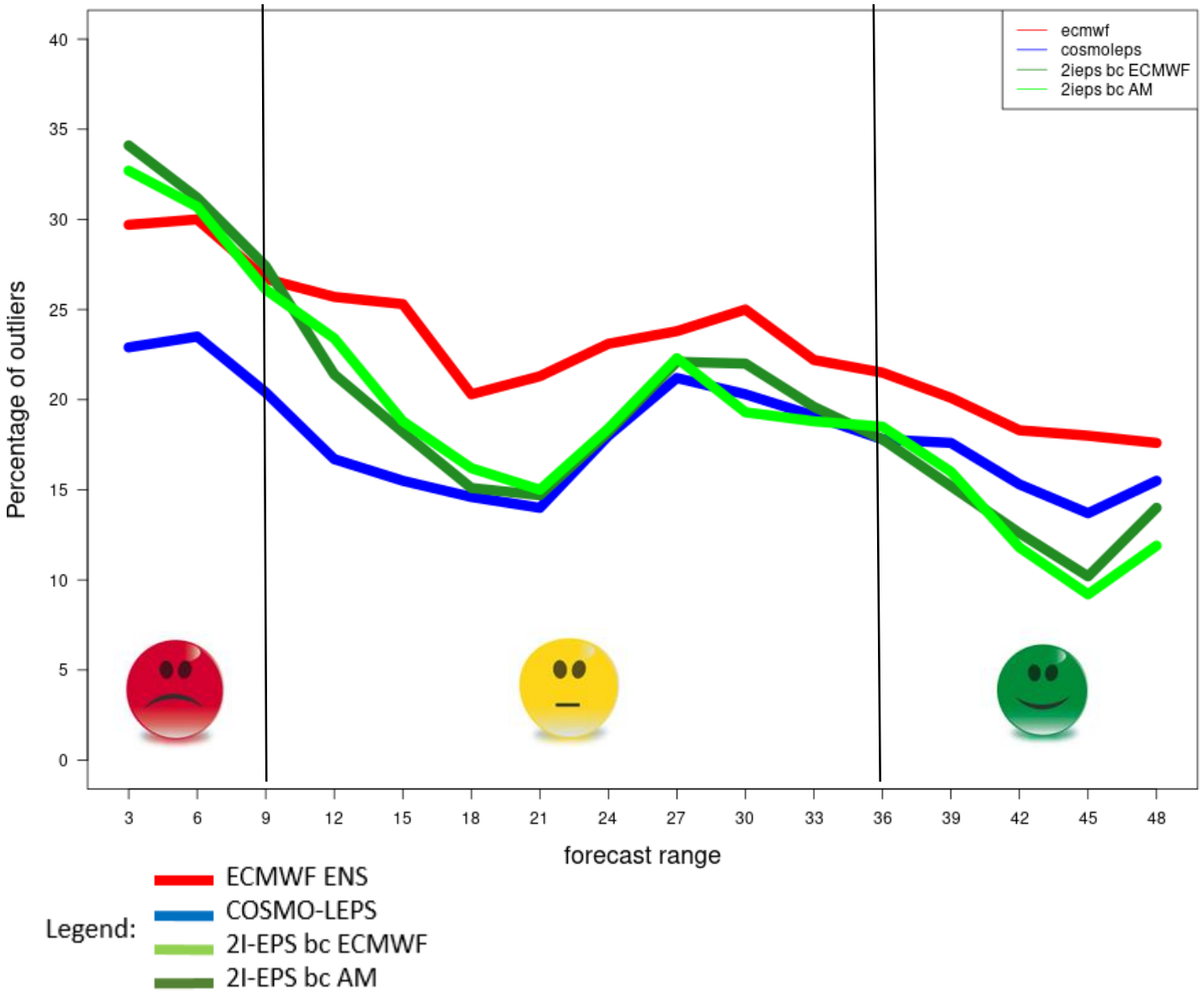
Ranked Probability Score



- COSMO-LEPS has the best RPS except in the last hours of the forecast range, when the experimental version of COSMO-2I-EPS gets lower values.

- In the first hours of the forecast range the change of COSMO-2I-EPS boundary conditions does not bring a significant improvement.

Percentage of outliers



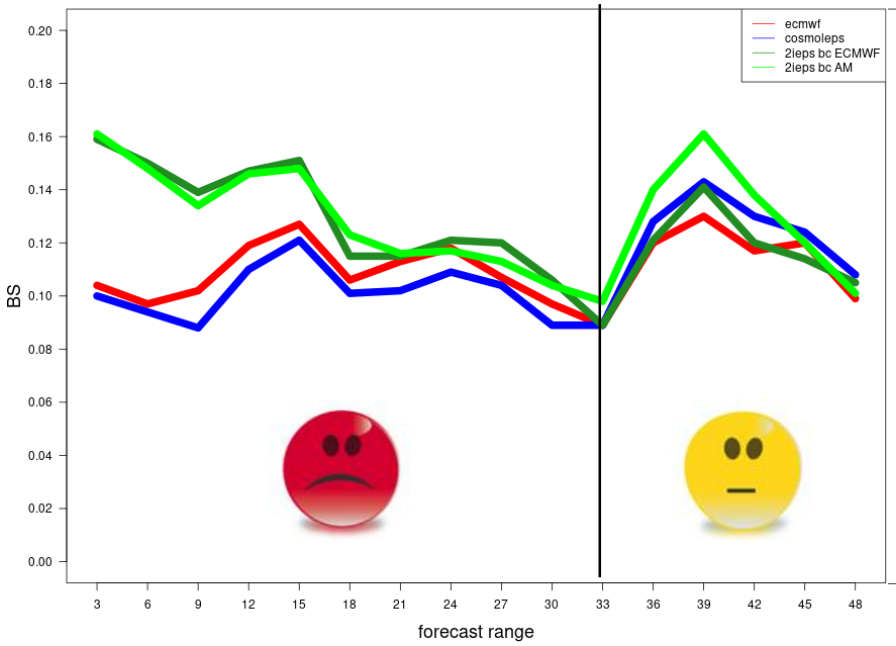
- The change in boundary conditions does not lead to significant changes in COSMO-2I-EPS percentage of outliers.

- Again COSMO-2I-EPS is the worst of the three ensemble systems at the beginning of the forecast range, the best at the end.

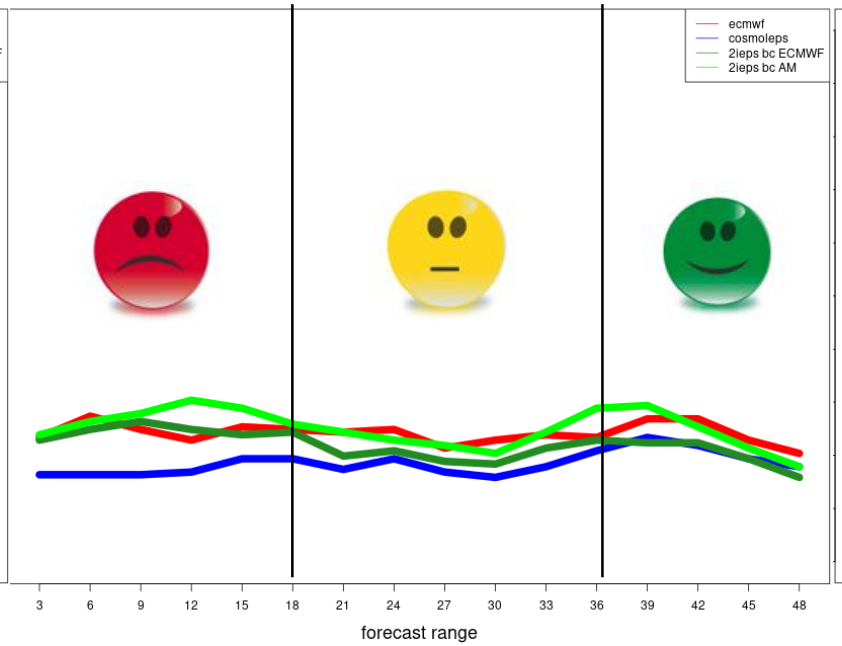
Brier Score

Legend:
- ECMWF ENS
- COSMO-LEPS
- 2I-EPS bc ECMWF
- 2I-EPS bc AM

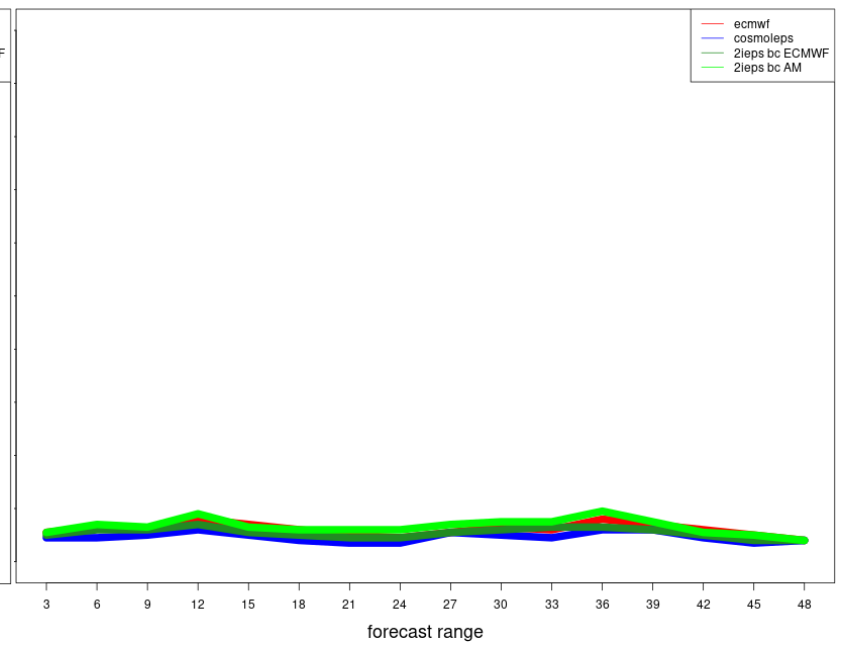
1 mm



10 mm



25 mm

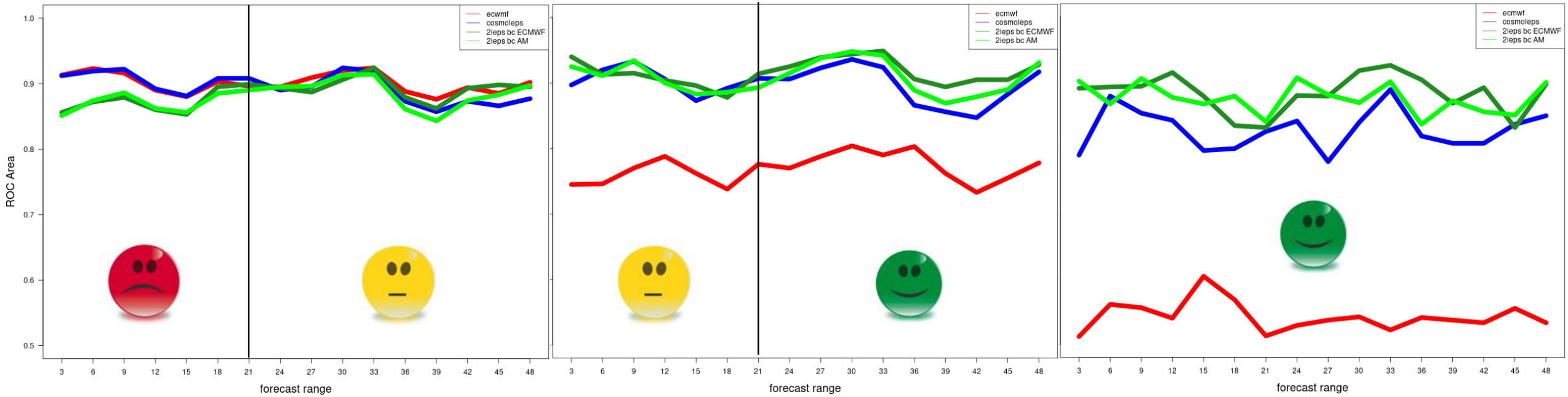


- ✓ COSMO-LEPS is the ensemble system with the best BS for almost all deadlines, for the 1mm and 10mm thresholds.
- ✓ The results for the 25 mm threshold are all very similar to each other and therefore not significant for a comparison between the three ensemble systems.
- ✓ Also in this case COSMO-2I-EPS is worse than the other ensemble systems in the first hours of the forecast range and the change of boundary conditions shows results especially at the end of the second day of forecast.

ROC Area

Legend: ECMWF ENS, COSMO-LEPS, 2I-EPS bc ECMWF, 2I-EPS bc AM

1 mm | **10 mm** | **25 mm**



❖ Even in the case of the ROC area, the change in boundary conditions is mostly effective in improving the score, especially at the end of the forecast range.

❖ The ROC area of COSMO-2I-EPS improves significantly as the threshold increases and in part as the forecast range increases.

Conclusions

- The change in boundary conditions from AM conditions to ECMWF conditions mainly leads to improved scores, especially in the last hours of the forecast range.
- This improvement is often not yet sufficient to close the gap with other ensemble systems.
- It is evident that COSMO-2I-EPS still has some **problems in the first hours of the forecast range**, and then align with the other ensembles; in some cases the 2.2km ensemble improve at the end of the second day of forecast.

What penalizes COSMO-2I-EPS forecast until about one day after initialization?

The problem highlighted in the first hours of the COSMO-2I-EPS forecast range could be due to a **too old analysis**.

Therefore for the first 10 days of March we are running COSMO-2I-EPS with this setup:

- **operational Boundary Conditions (from AM) initialized at 00 UTC instead 12 UTC,**
- **most recent analysis at 00 UTC instead 21 UTC**

I will show you the results at the next opportunity.


Thanks for the attention