Sensitivity of COSMO-LEPS forecast skill to the verification network: application to MesoVICT cases

Andrea Montani, C. Marsigli, T. Paccagnella

Arpae Emilia-Romagna Servizio IdroMeteoClima, Bologna, Italy

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CONSORTIUM FOR SMALL SCALE MODELING COSMO

Outline

- Introduction to MesoVICT project.
- Available datasets:
  - analysis (gridded and sparse obs),
  - model (mesoscale ensemble system).
- Verification methodologies.
- Results.
- Conclusions and plans.

MesoVICT: what is it?

MesoVICT (**Meso**cale **V**erification **I**ntercomparison in **C**omplex **T**errain) is a WMO-endorsed project dealing with the inter-comparison of verification methods **(no inter-comparison of models!).**

Aims of MesoVICT:

- to investigate the ability of spatial verification methods to verify fields other than deterministic precipitation forecasts, like ensemble forecasts.
- to demonstrate the capability of spatial verification methods over complex terrain.
- to provide a community testbed where common data sets are available.

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- Available datasets:
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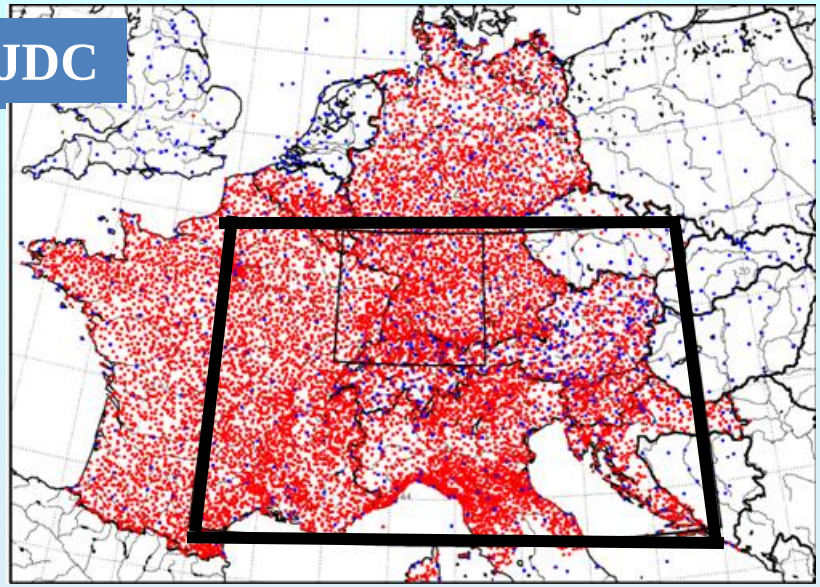
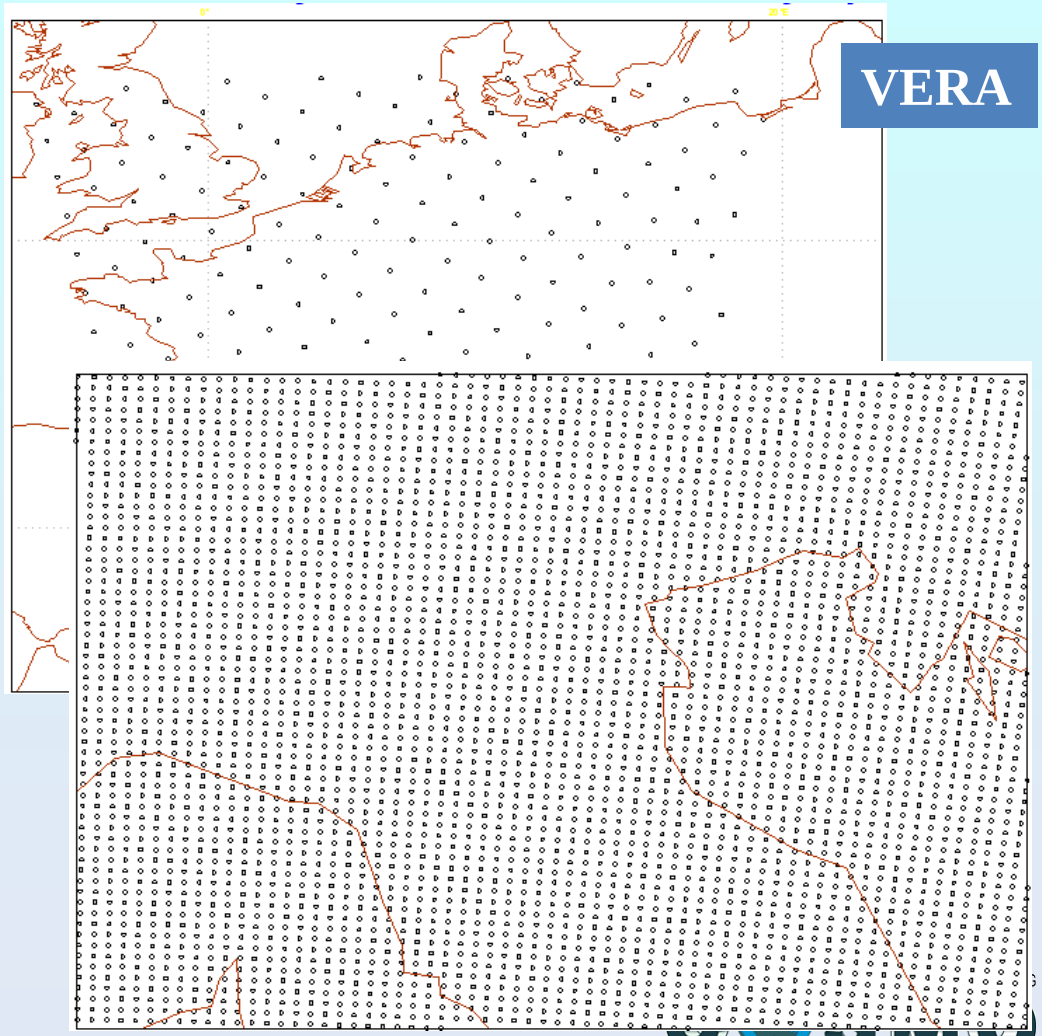
MesoVICT: what does it provide?

Verification networks covering 2007:

JDC (**J**oint **D**Phase-**C**ops) dataset: about 12000 obs – mean station distance ~ 12 km.

VERA (**V**ienna **E**nhanced **R**esolution **A**nalysis): gridded analysis at the resolution of 8 km.





Verification will be performed over the DPHASE area (43-50N, 2-18E).

Gorgas et al., 2009, Ann. Meteorol.
Gorgas and Dorninger, 2012,QJRMS.

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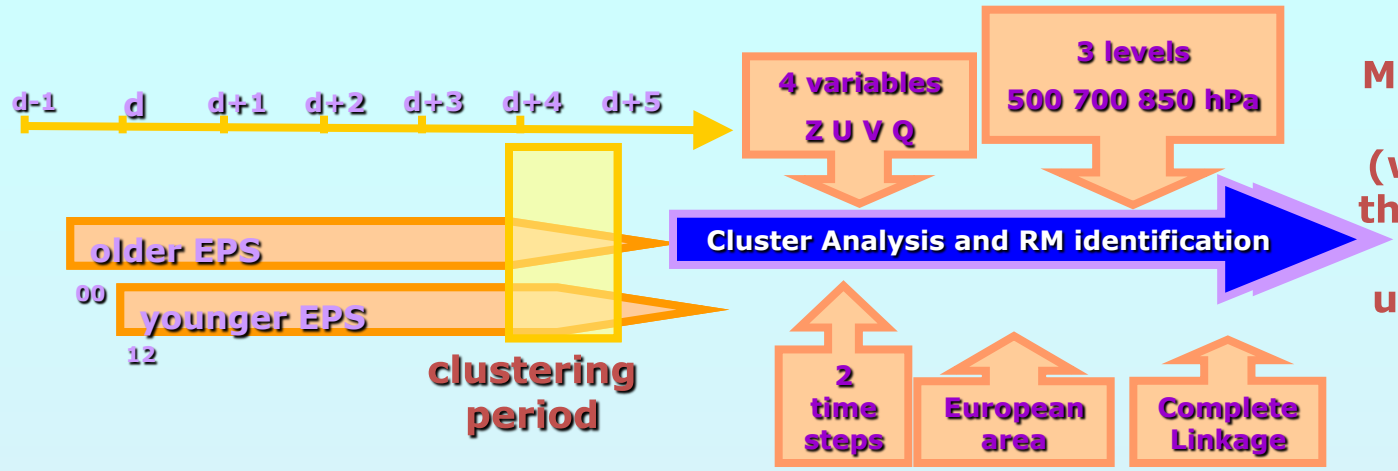
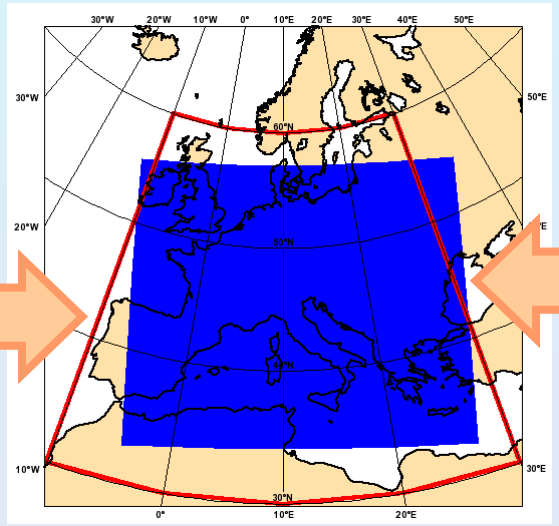
Outline

- Available datasets :
  - model (mesoscale ensemble system).

COSMO-LEPS suite @ ECMWF: status in 2007

Limited-area-model Ensemble Prediction System based on COSMO model





- suite runs as a "time-critical application" managed by ARPA-SIMC; runs ONLY at 12UTC; 6-hourly post-processing;
- Δx ~ 10 km; 32 ML; fc+132h;
- COSMO v3.20 in 2007,
- computer time provided by the COSMO partners which are ECMWF member states.

Montani et al., 2011, Tellus A

Verification networks and methodologies

COSMO-LEPS is verified against the following networks/methodologies **for all mesoVICT cases (6 cases, 18 verification days)**:

Network \ Methodology	Nearest grid point	Bilinear interpolation	Boxes (DIST): 0.5x0.5, 1.0x1.0, 1.5x1.5
VERA gridded analysis	done	done	done, done, done
JDC sparse obs	done	done	done, done, done

Overall aims:

- to test the forecast skill of COSMO-LEPS in terms of total precipitation for different verification networks and different verification methods,
- to understand the meaning of the differences in the verification scores.

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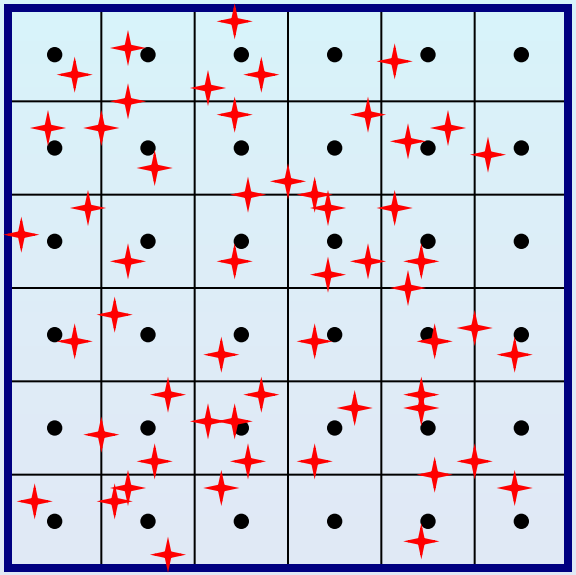
Verification with boxes of the distributions (DIST)

The verification can be performed in terms of:

- **Average value**
- *Maximum value*
- 50th percentile (Median)
- 75th, 90th, 95th percentiles

} in a **box**



Station observation

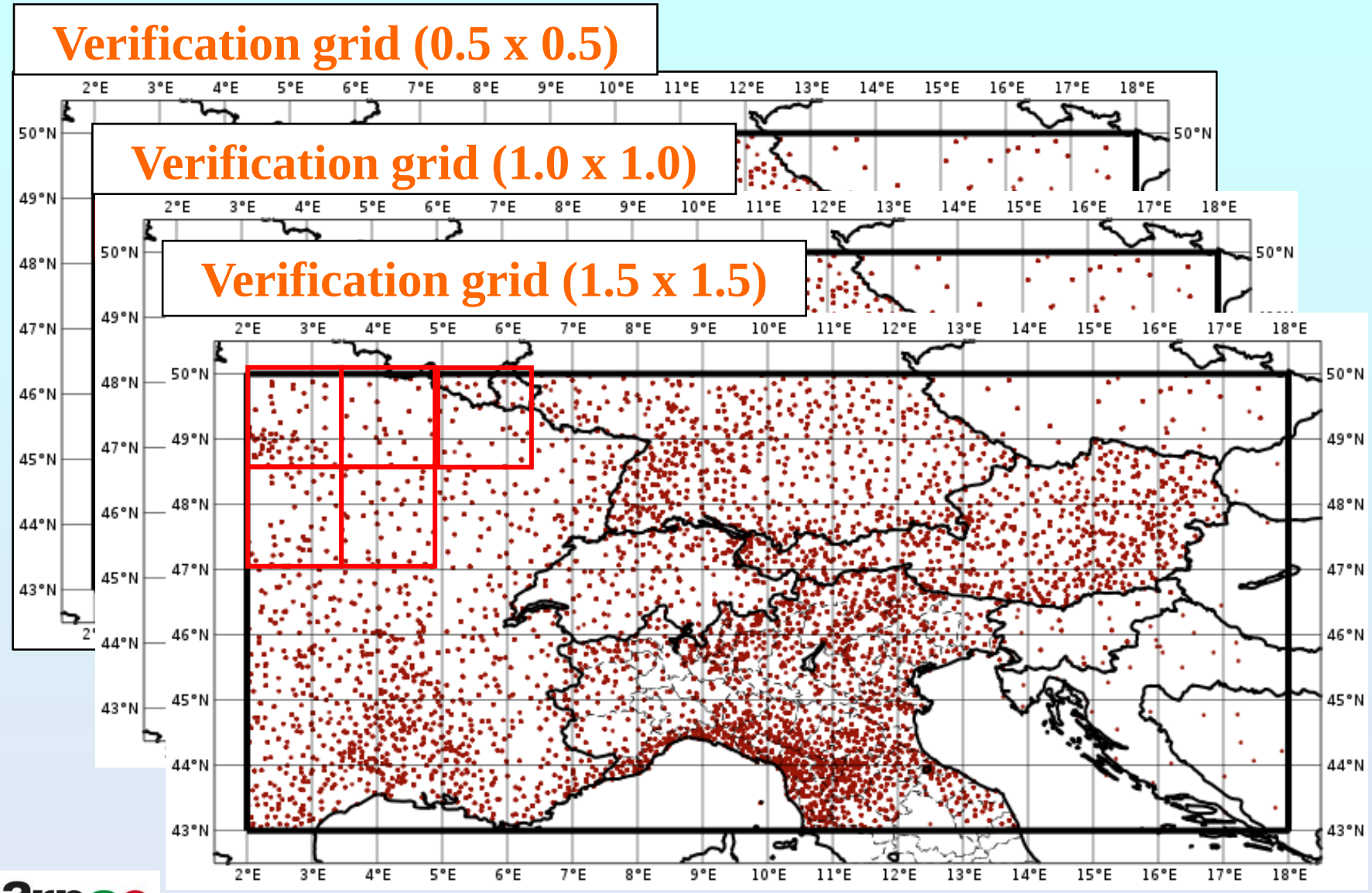
Grid point forecast

Two measures of precipitation are investigated:

- **the average volume of water deployed over a specific region;**
- *the rainfall peaks occurring within the same region.*

Marsigli et al., 2008, Meteorol. Appl.

OBSERVATION MASKS



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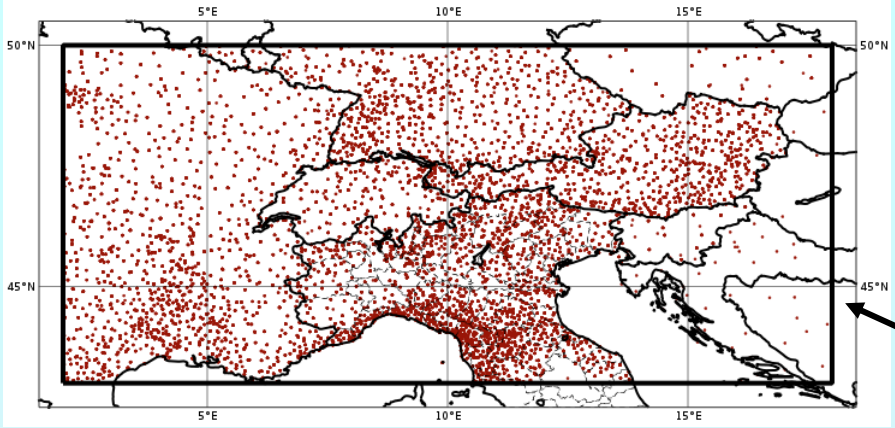
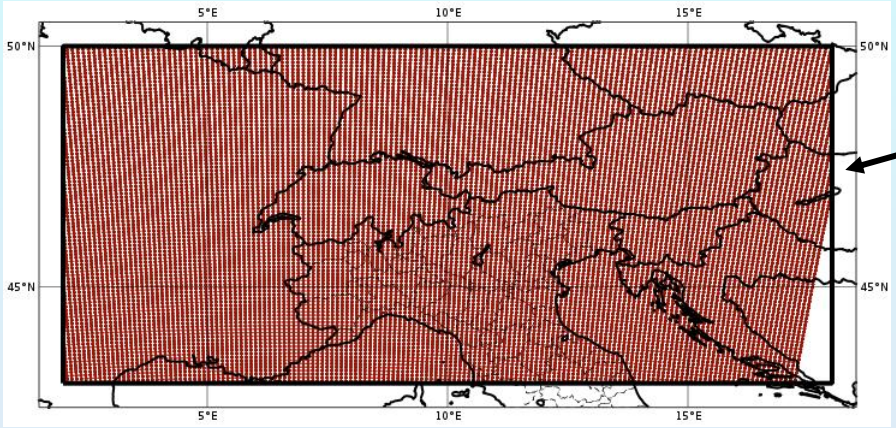
Objective verification of COSMO-LEPS





Main features:

variable: 6h cumulated precip (0-6, ..., 18-24 UTC);

period: all 6 mesoVICT cases (Jun – Sep 2007);

region: 43-50N, 2-18E (D-PHASE area);

method: NGP, BILIN, BOXES of different sizes;

obs: JDC or VERA;

fcst ranges: 0-6h, 6-12h, ..., 126-132h;

thresholds: 1, 5, 10, 15, 25, 50 mm/6h;

system: COSMO-LEPS;

scores: ROC area, RPS, Outliers, ...

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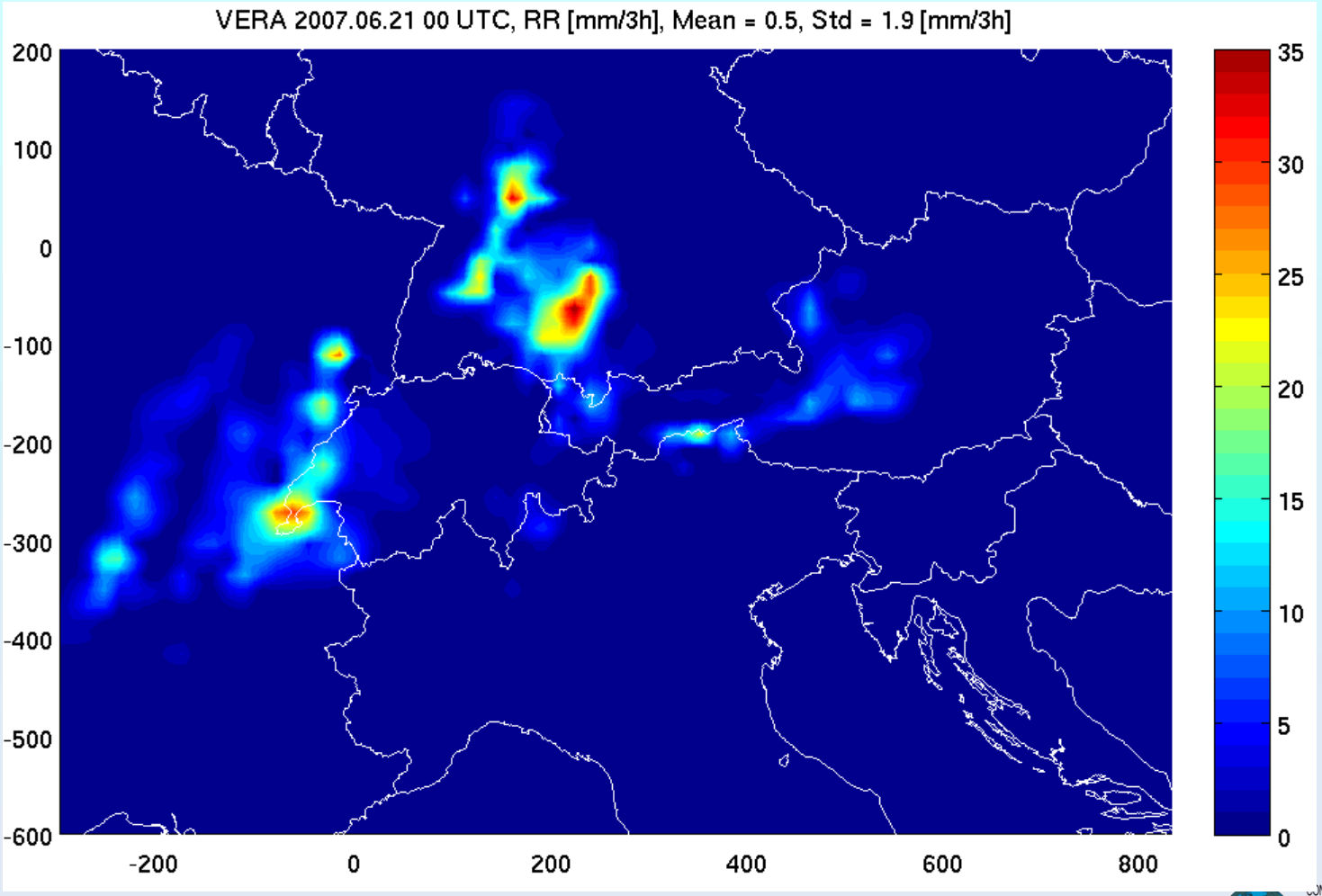
Example: Core case of 20-22 June 2007 (obs)

Convective events North of the Alps.
tot_prec for the **3-hour** period ending at 00UTC of 21 June 2007



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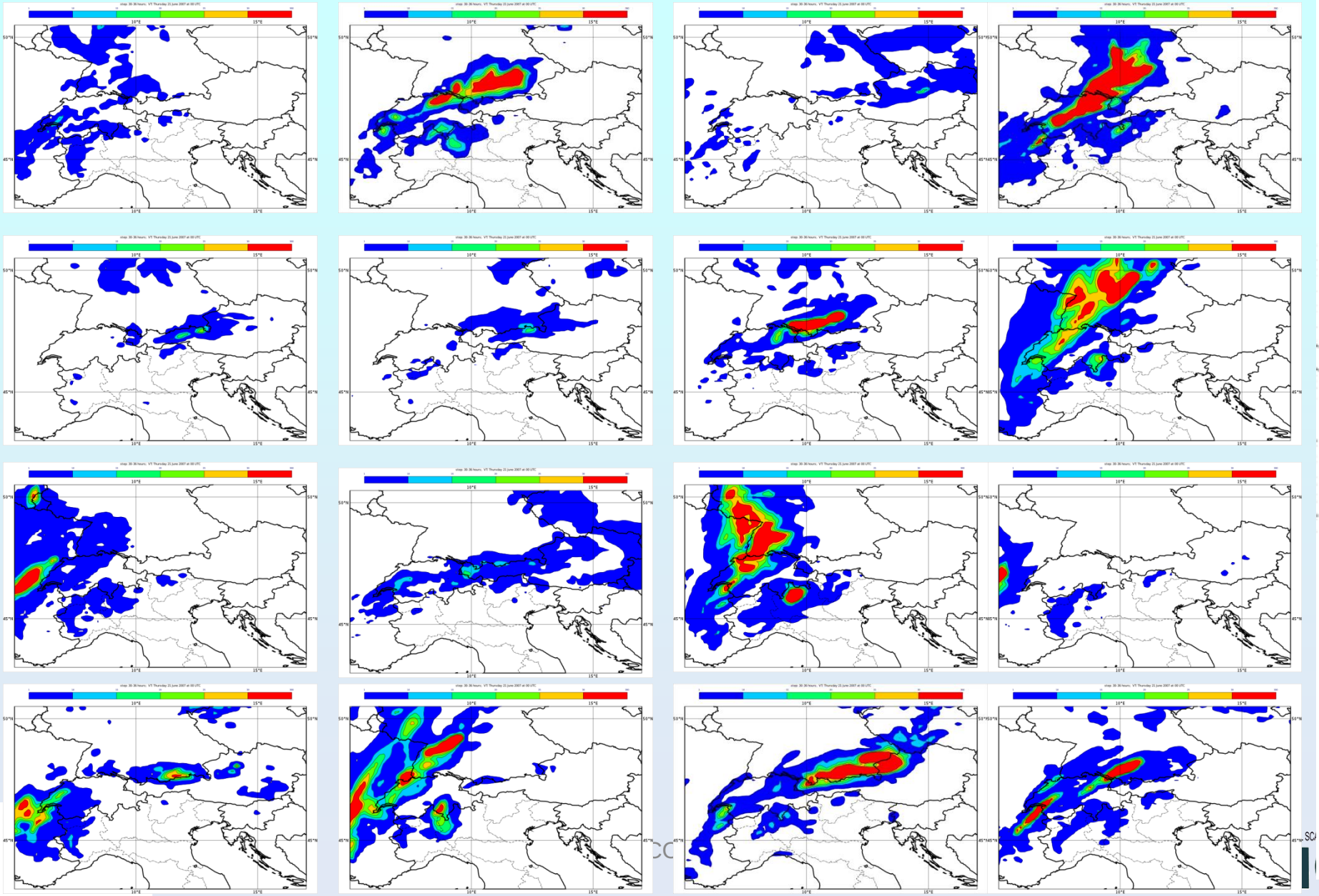
Core Case: model

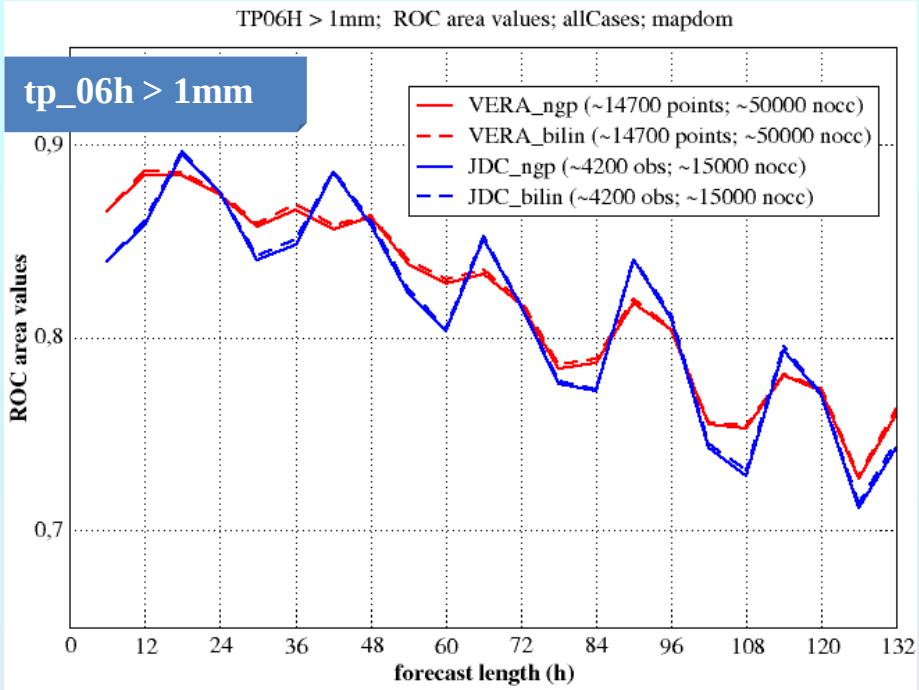
COSMO-LEPS starting at 12UTC of 19 June 2007, fc 30-36h.
tot_prec for the **6-hour** period ending at 00UTC of 21 June 2007

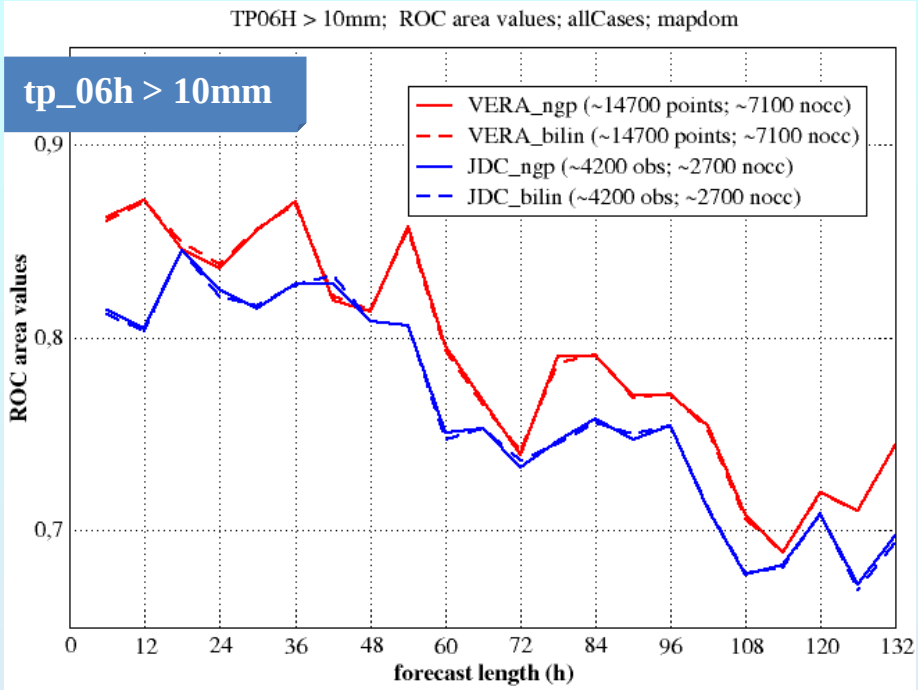


All Cases

Probabilistic prediction: ROC area (ngp vs bilin)

- Area under the curve in the HIT rate vs FAR diagram; the higher, the better …
- Valuable forecast systems have ROC area values > 0.6.
- Consider two events: 6-hour precipitation exceeding 1 mm and 10 mm.





- **1mm**: similar performance of the system with respect to the 2 verification networks.
- **10 mm**: higher skill when COSMO-LEPS is verified against **VERA** gridded analysis.
- Almost no impact of the verification technique (ngp ~ bilin) for both thresholds.

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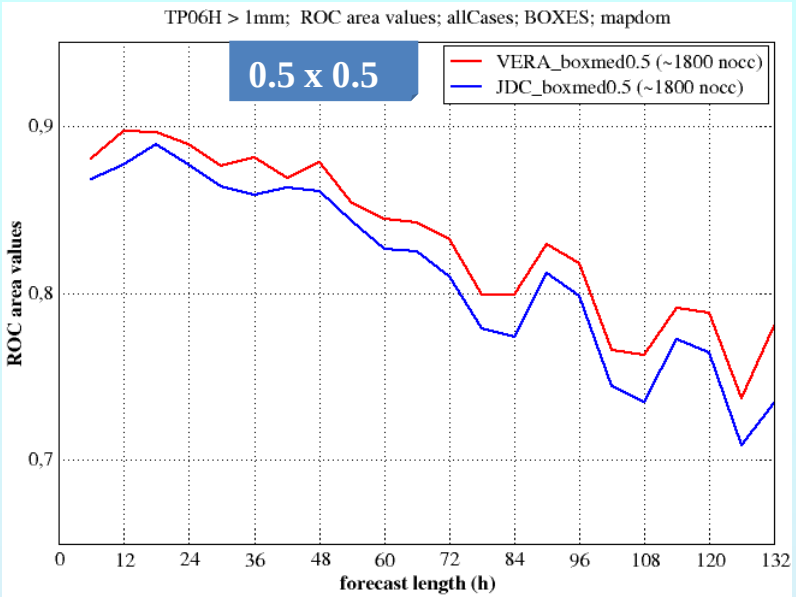
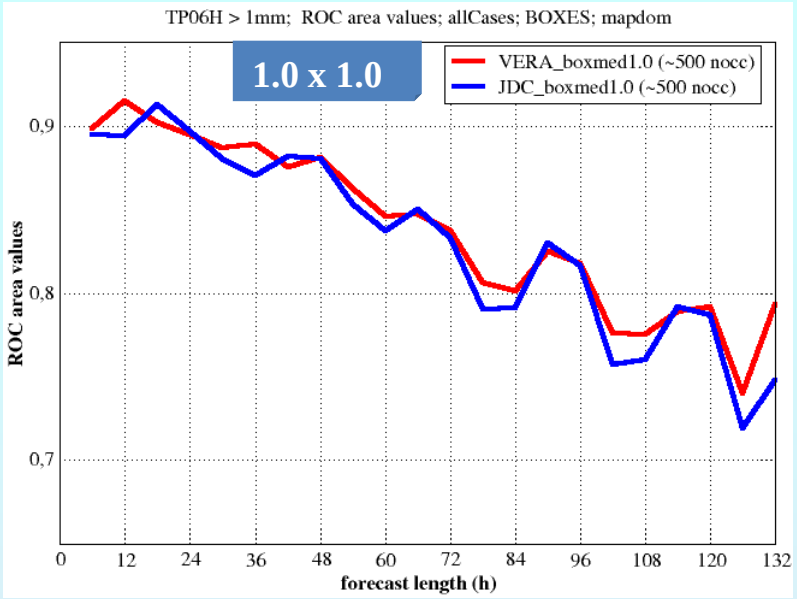
All Cases

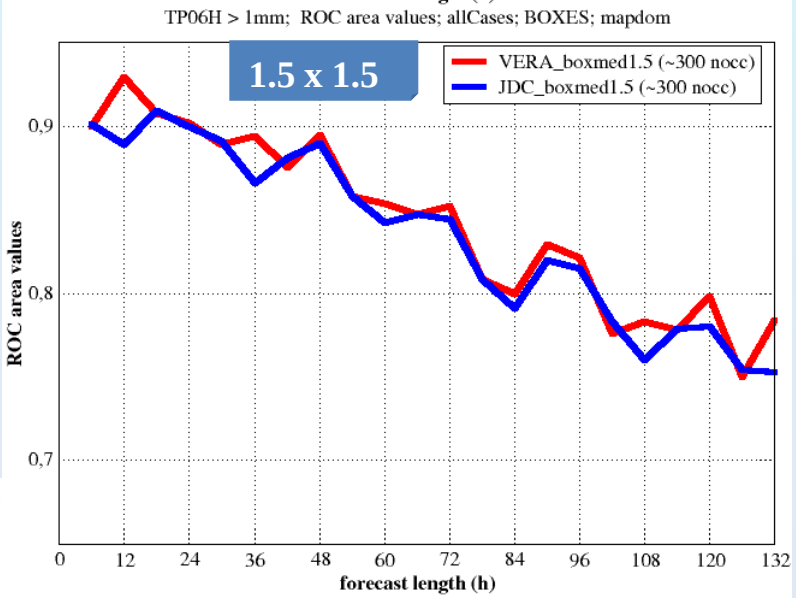
Probabilistic prediction: ROC area (boxes_1)

tp_06h > 1mm

➢ Consider the event: average 6-hour precipitation exceeding 1 mm **within boxes of increasing size**







- Slightly higher skill when COSMO-LEPS is verified against **VERA** gridded analysis.
- The skill increases with increasing box size.
- **Increasingly less dependence of the score on the verification network for larger boxes.**

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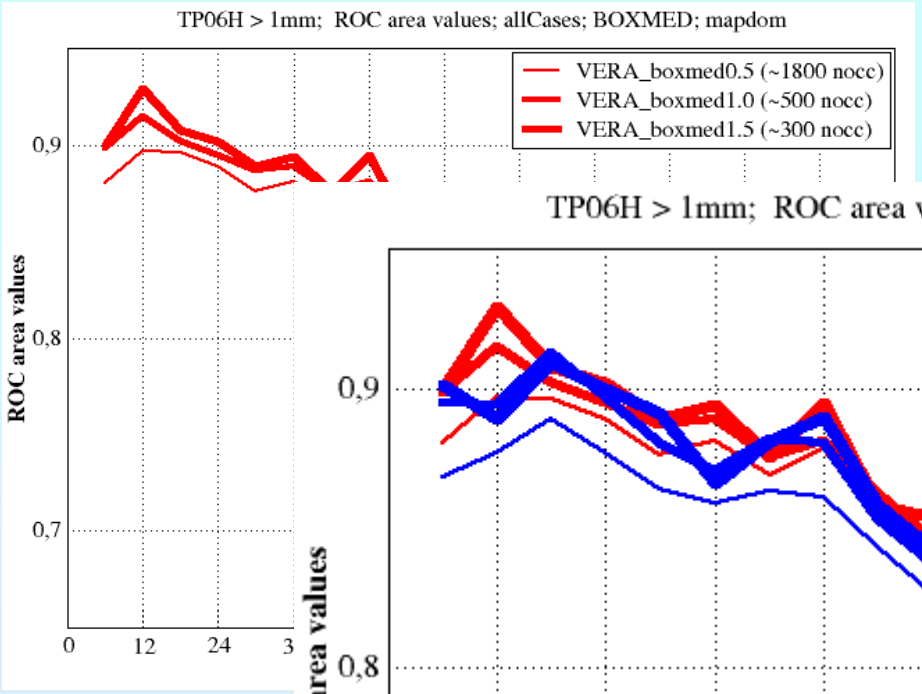
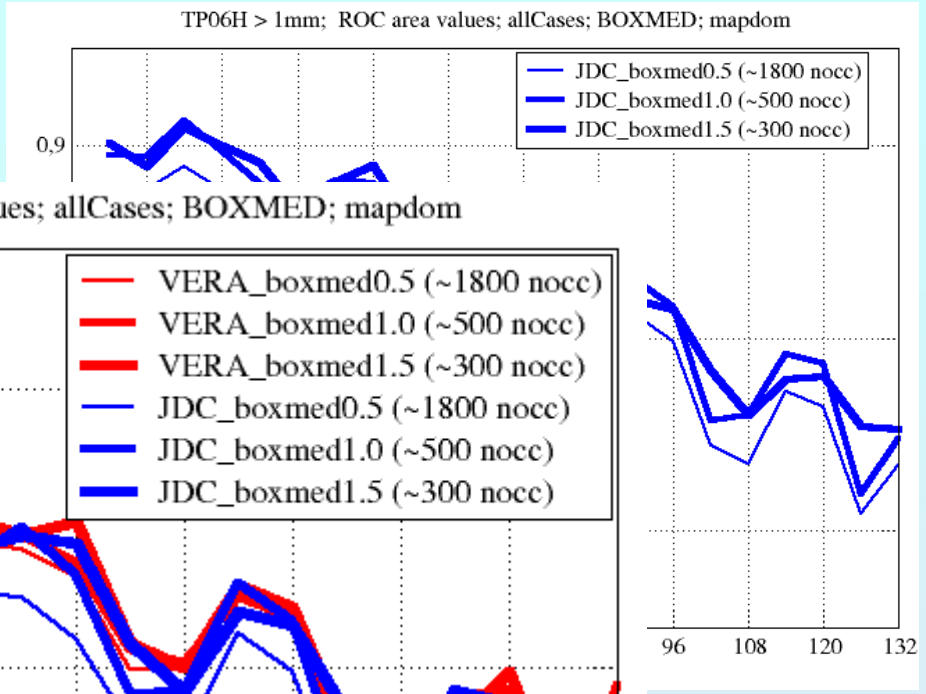
All Cases

Probabilistic prediction: ROC area (boxes_2)

tp_06h > 1mm

➢ Consider the event: average 6-hour precipitation exceeding 1 mm within boxes of increasing size!





- Similar perfo … inally higher skill when CO…
- The skill incr…

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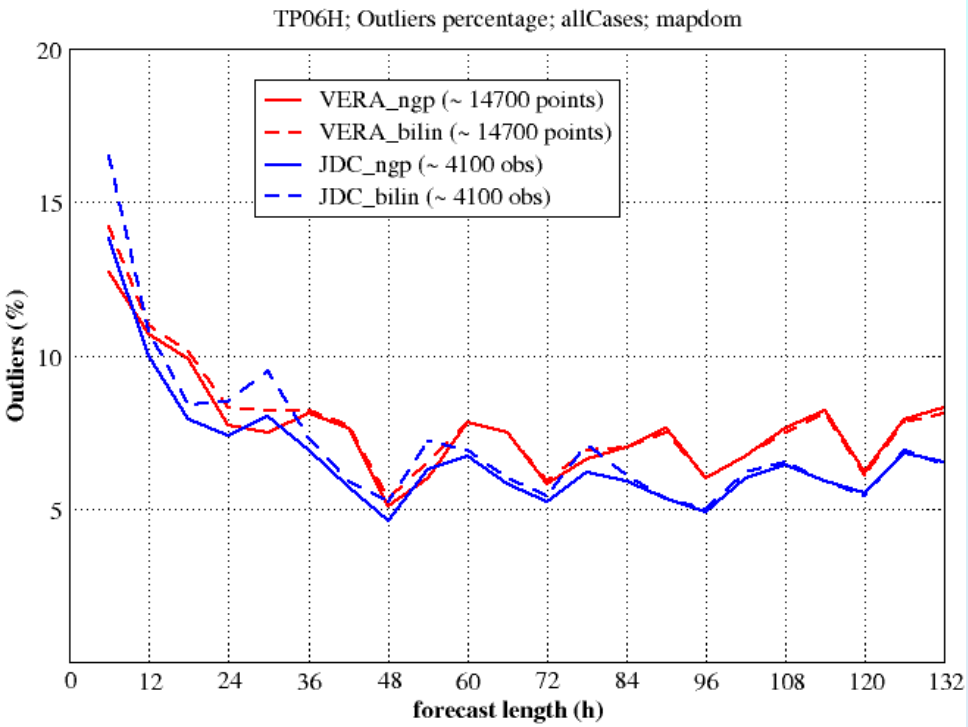
All Cases

Outliers (ngp vs bilin)

- How many times the analysis is out of the forecast interval spanned by the ensemble members.
- … the lower the better …



- In the short range, fewer outliers for NGP with respect to BILIN technique: the system performs better with NGP .
- For longer ranges, some dependence of the score on the verification network: the system performs better against **JDC** analysis.

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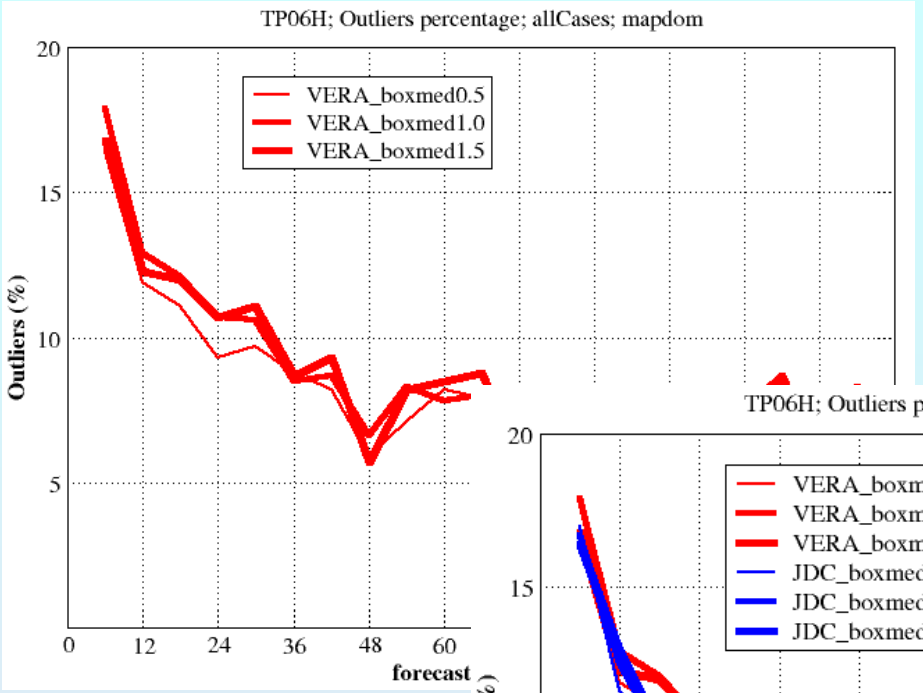
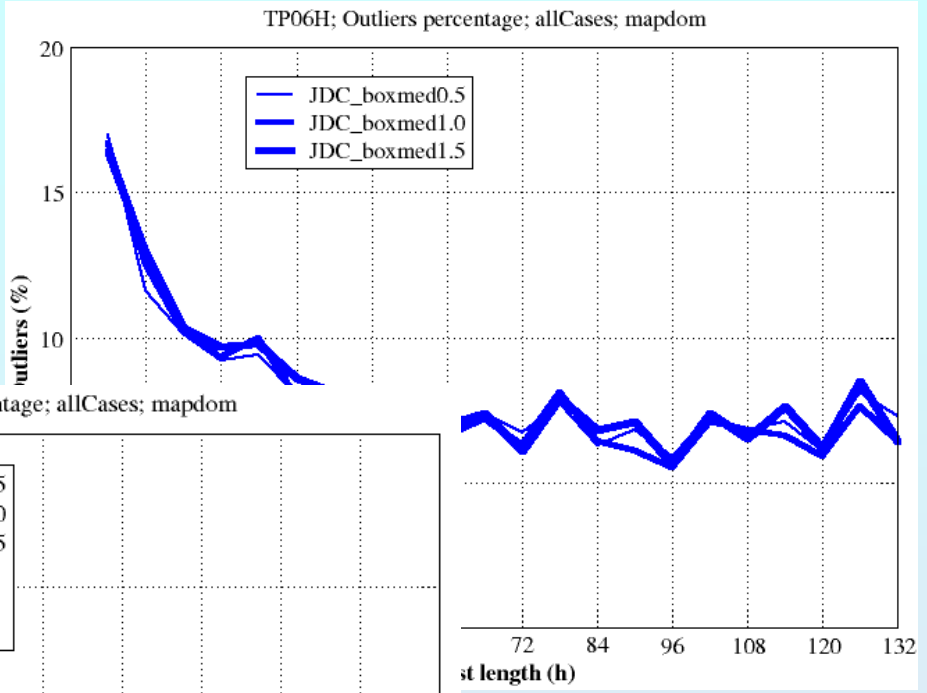
CONSORTIUM FOR SMALL SCALE MODELING COSMO

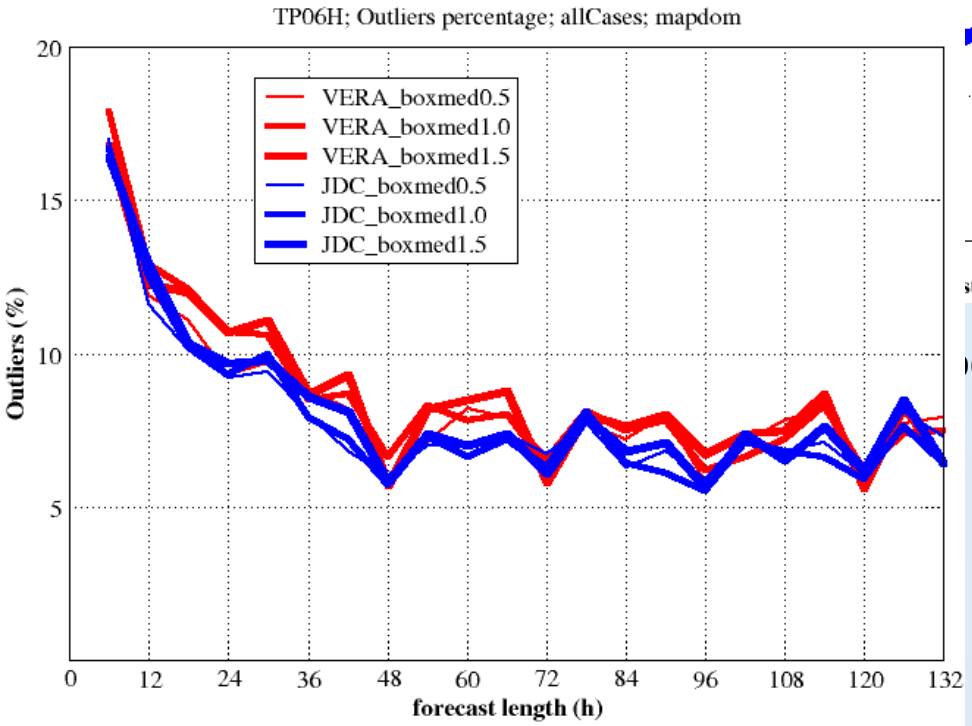
All Cases

Outliers (boxes)

- How many times the analysis is out of the forecast interval spanned by the ensemble members.
- … the lower the better …







- Weak dependence of t oxes.
- Still better scores for

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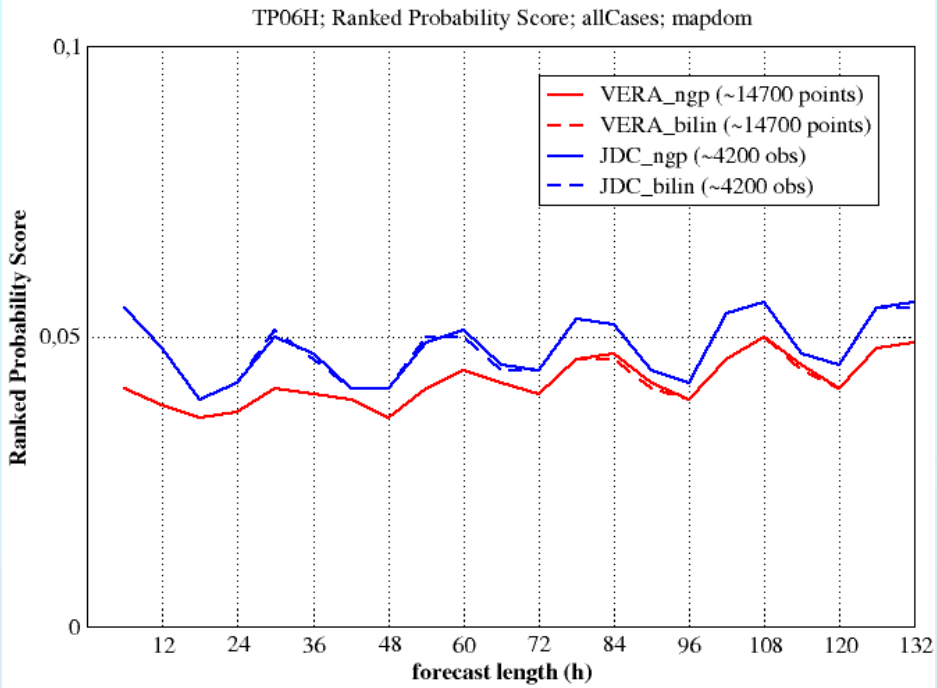
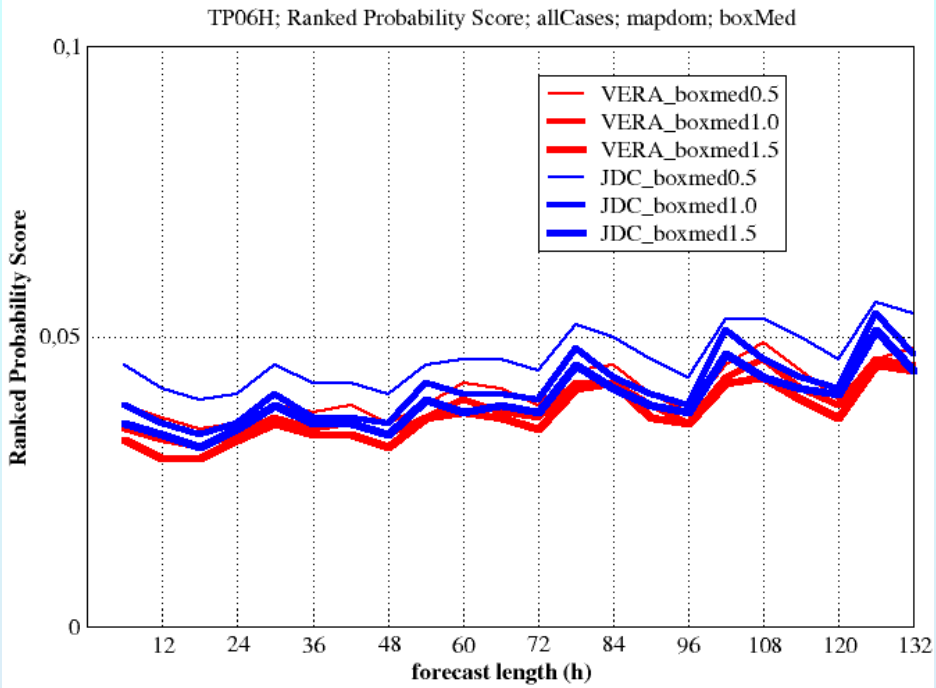
All Cases

Ranked Probability Score

- BS "cumulated" over all thresholds. RPS is the extension of the Brier Score to the multi-event situation.
- RPS: the lower, the better.





- RPS: slightly higher skill when COSMO-LEPS is verified against VERA; NGP or BILIN makes almost no difference.
- Higher skill of the system to predict TP occurring between 00 and 06UTC (for both networks).
- **Reduced, but slightly positive, impact of larger box sizes on the score.**
- **For larger boxes, the verification network counts less.**

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Conclusions

- **NGP vs BILIN**: similar COSMO-LEPS forecast skill using either gridded analysis or sparse obs (**VERA** or **JDC**) for verification network.
- **Average precipitation in BOXES**: similar scores for verification against gridded analysis or sparse obs for larger and larger boxes.
- As long as I "throw" everything in a box and I compare average values (similar results considering the max values), the verification network does not make too much difference.

Future work

- Try to interpret further the results.
- **CONSIDER OBSERVATION UNCERTAINTY**: work with ensembles of VERA analysis and quantify scores variability.
- Work on higher-resolution ensembles (COSMO-E reruns).

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Thanks for your attention!

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