Latest results of comparison of 1D-Var+nudging and LHN over Northern Italy

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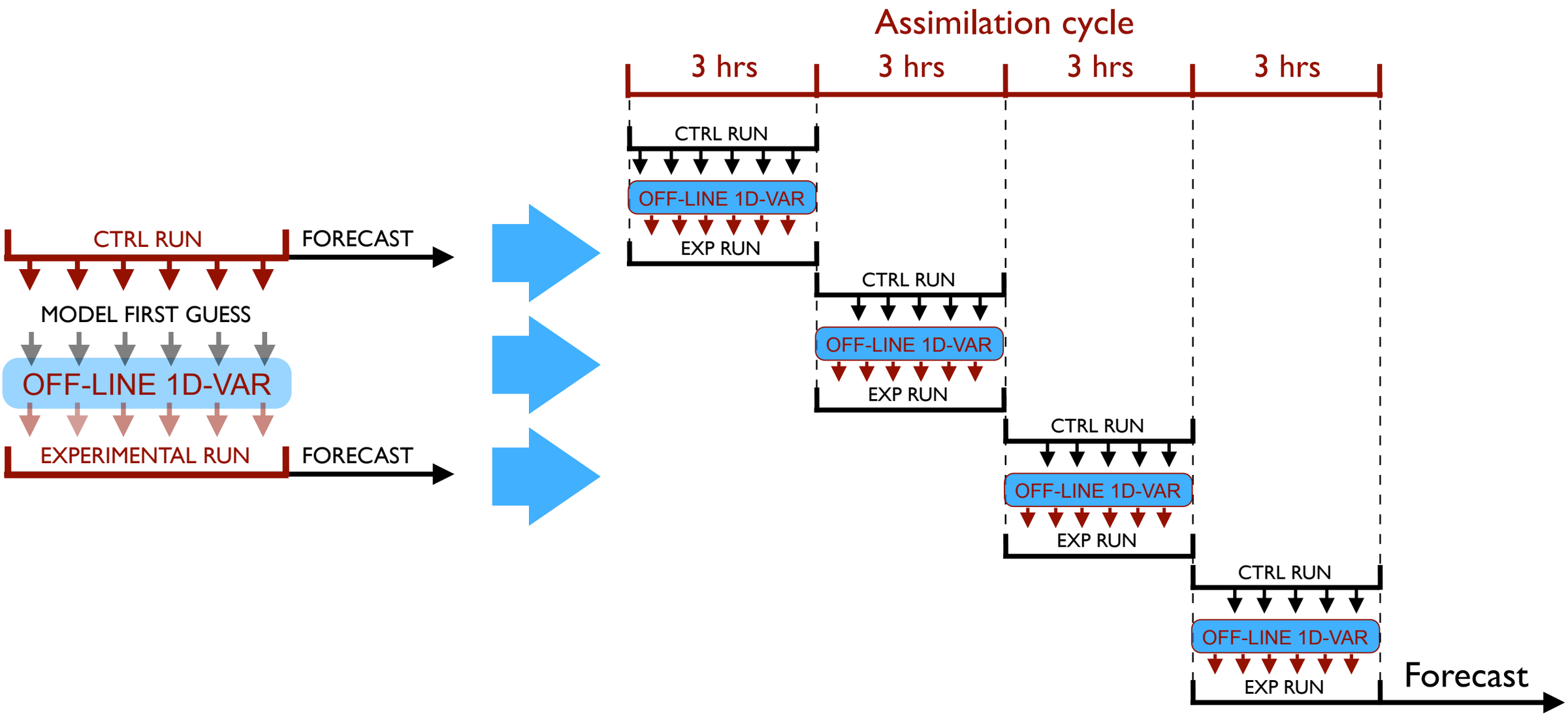
Modifications/improvements made in latest years

TOPIC: FRAMEWORK

Limitation: off-line application of 1D-Var algorithm

Solution: framework change



Modifications/improvements made in latest years

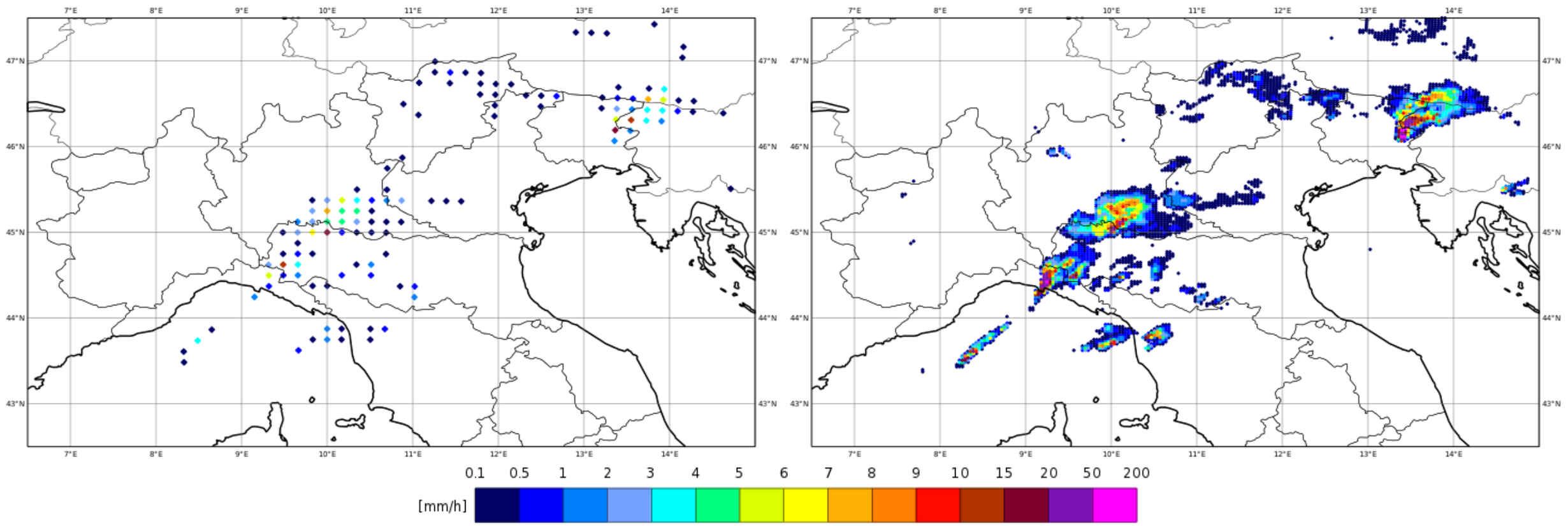
TOPIC: DATA THINNING

The amount of data over selected domain is very large (57491 profiles every 15 minutes). It is needed a reduction of the number of data because:

- a spatial and/or temporal high density violates the assumption made in the most of operative models and experimental schemes in which observational errors are independent;
- the use of all of the observations generates AOFs too big which cause the killing of the run by the system because of memory problems.

Limitation: choice of one observation every 5 gridpoints in both directions in order to limit total observations

Solution: application of 1D-Var algorithm to those points for which $RR_{fg} > 0$ and $RR_{obs} > 0$ (Lopez 2010, Tech. Memo 627)



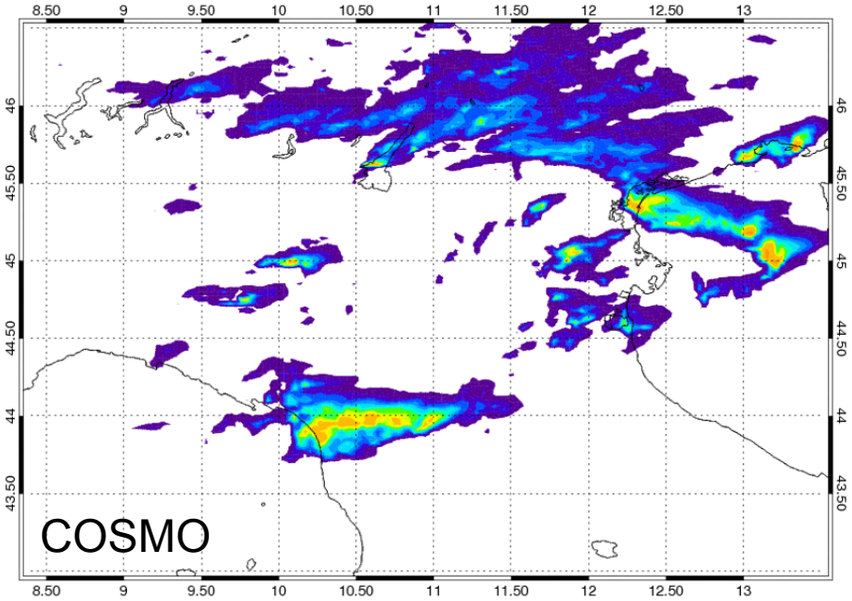
Modifications/improvements made in latest years

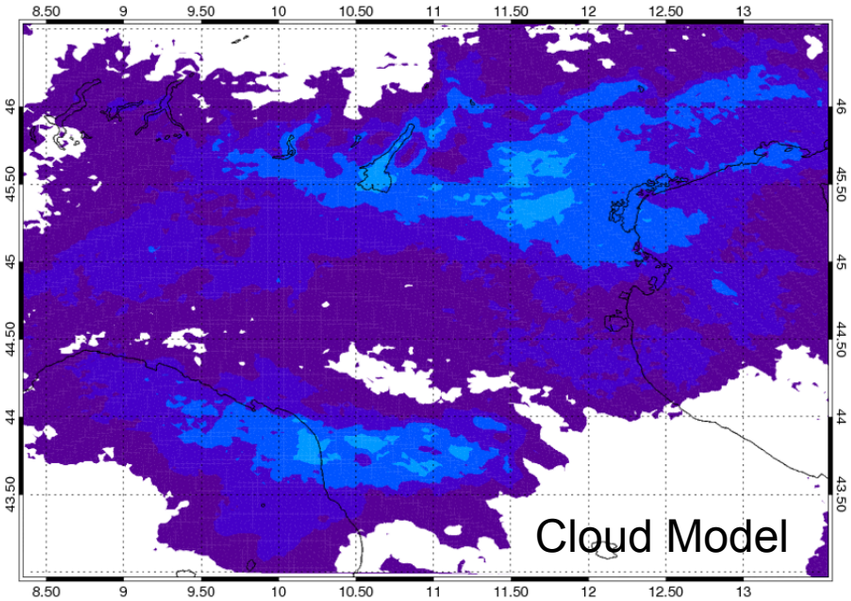
TOPIC: BIAS CORRECTION

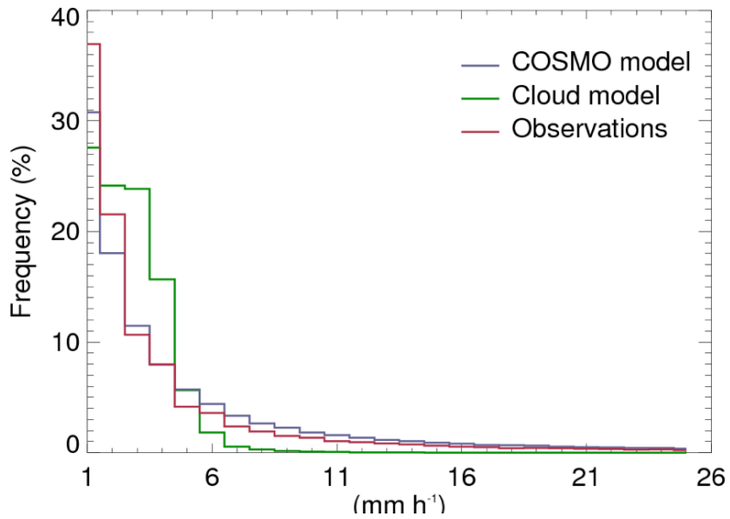
The variational approach works in a statistically optimal way if observations and model errors are unbiased. The forward operator H, which is a simplified version of the cloud scheme implemented in the ECMWF forecast model, has a different physics with respect to the actual one implemented into the COSMO model.

Limitation: different physical parameterizations do not reproduce strong rain rates, mean rainfall field is weak and diffuse

Solution: bias correction is applied to those observed precipitation rates for which there is an overestimation/underestimation compared to cloud model values







Even if the application of a bias correction seems to have a good impact on results, in particular in the forecast cycle, the calculation of bias, as implemented, is suitable only for case studies. Actually it is calculated after the event and it changes at every event.

Modifications/improvements made in latest years

TOPIC: BIAS CORRECTION

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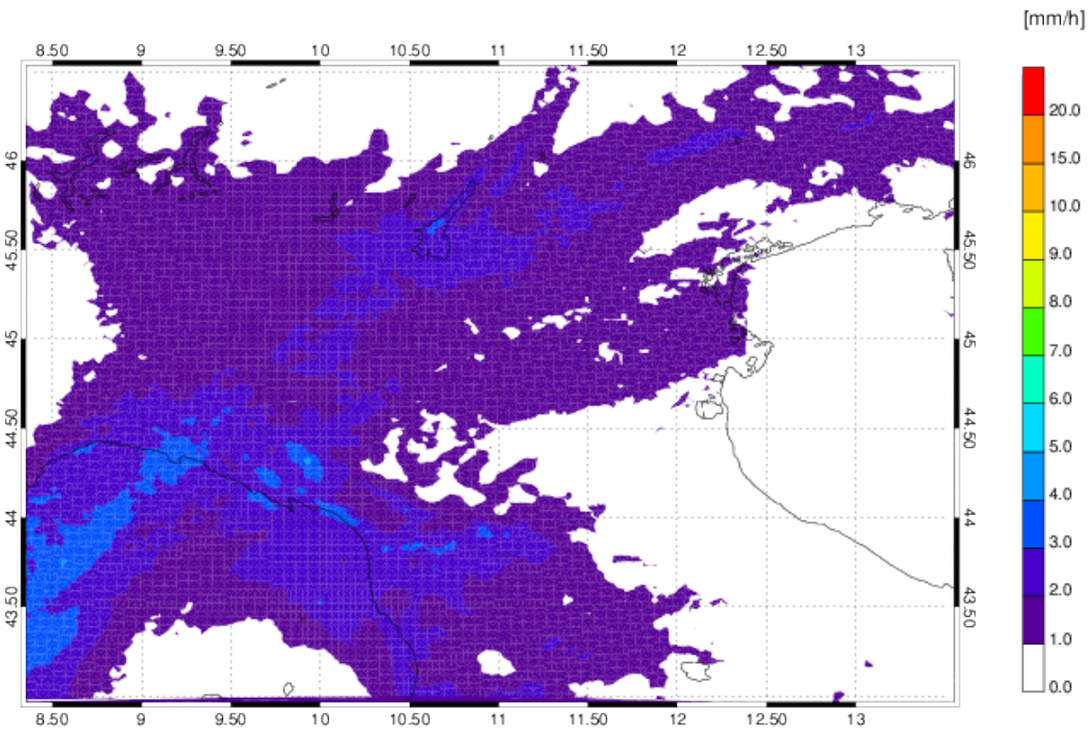
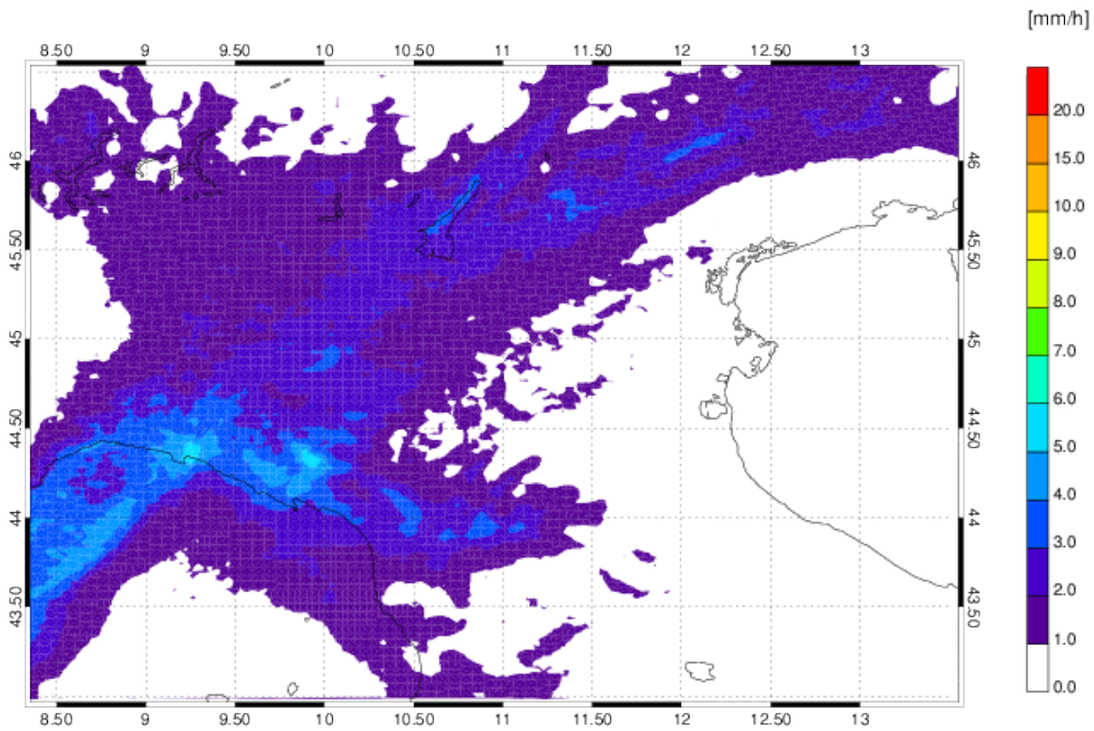
Limitation: different physical parameterizations do not reproduce strong rain rates, mean rainfall field is weak and diffuse

Solution: modification of some parameters in the 1D-Var algorithm in order to adjust the amount of precipitation

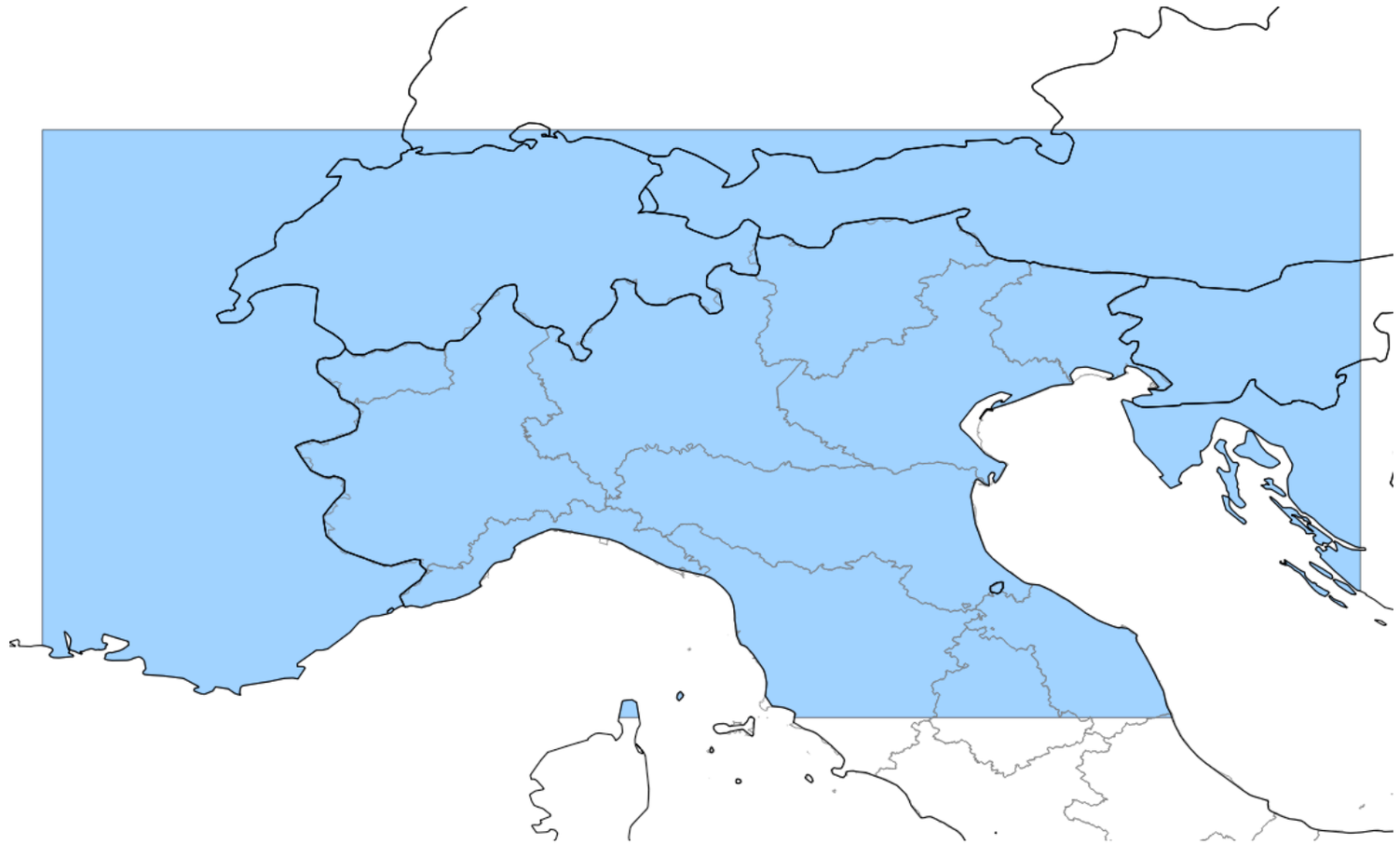




Changed parameters:
Convective cloud cover
Autoconversion timescale of large cloud condensate to precipitation
Autoconversion rate of convective cloud water to convective precipitation

Verification methodology

Areal mean of accumulated precipitation over a shapefile



RESULTS VERIFICATION

- comparison of 12 h accumulated precipitation in the assimilation cycle
- comparison of 0-12 h accumulated precipitation in the forecast cycle

Case studies

Requirements:

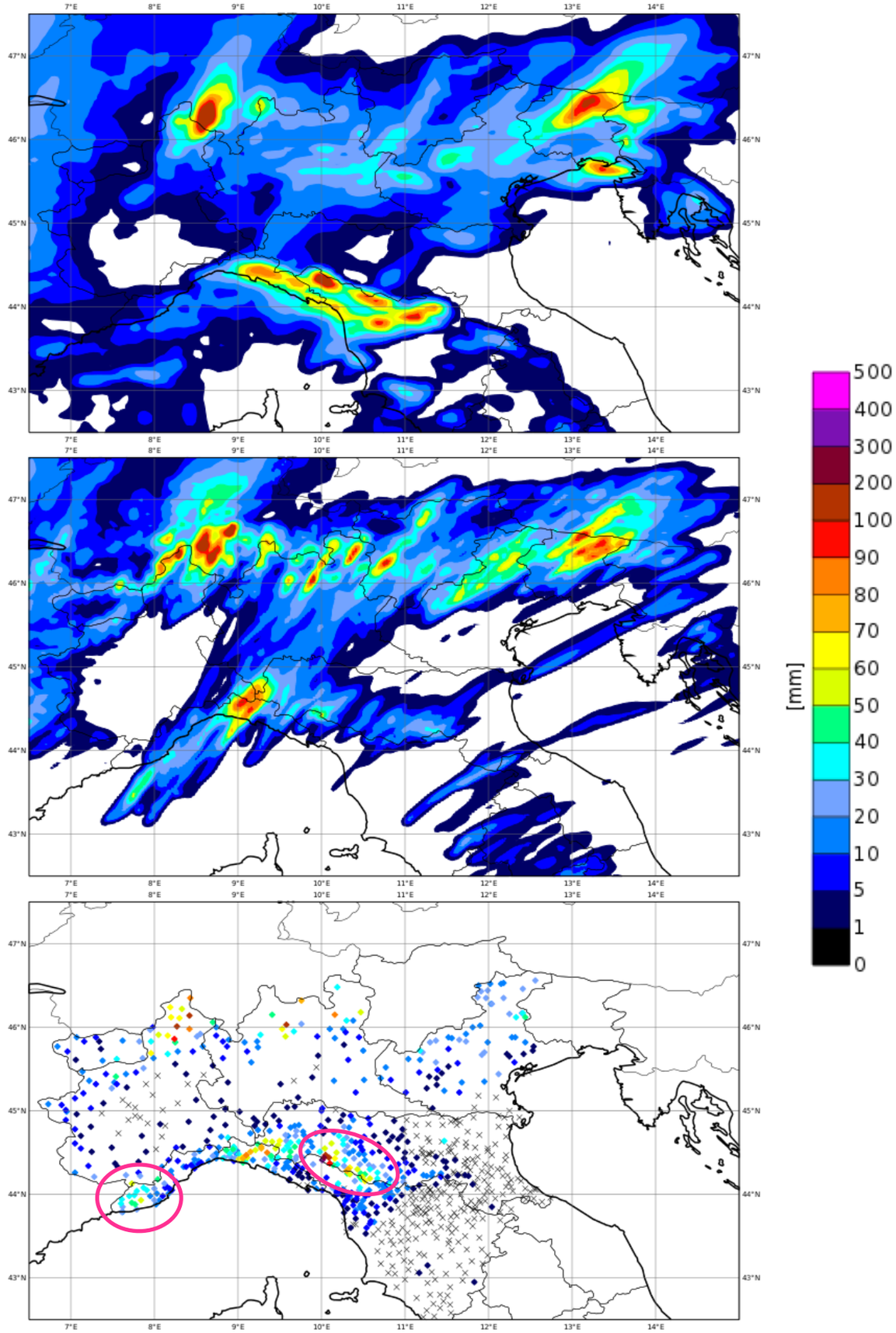
- Presence of convective structures (short-lived small-scale)
- High resolution COSMO model misses forecasted precipitation

2012/09/26 00:00 - 2012/09/27 00:00

COSMO I7 - Forecasted total precipitation

COSMO I2 - Forecasted total precipitation

Observed total precipitation



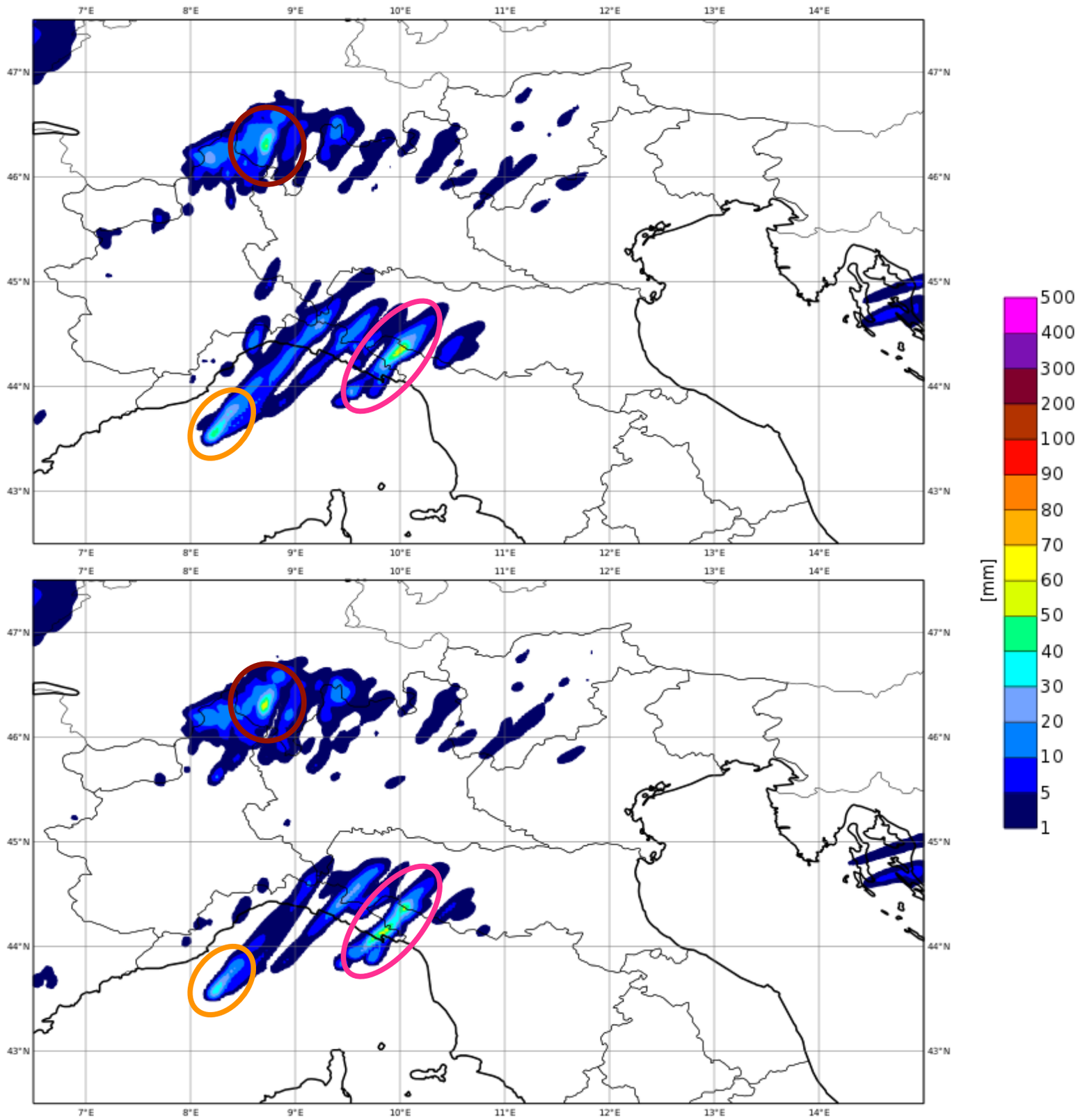
New cloud model parameterization:assimilation

12 h accumulated precipitation

26 September 2012 00-12 UTC

Standard cloud model parameterization

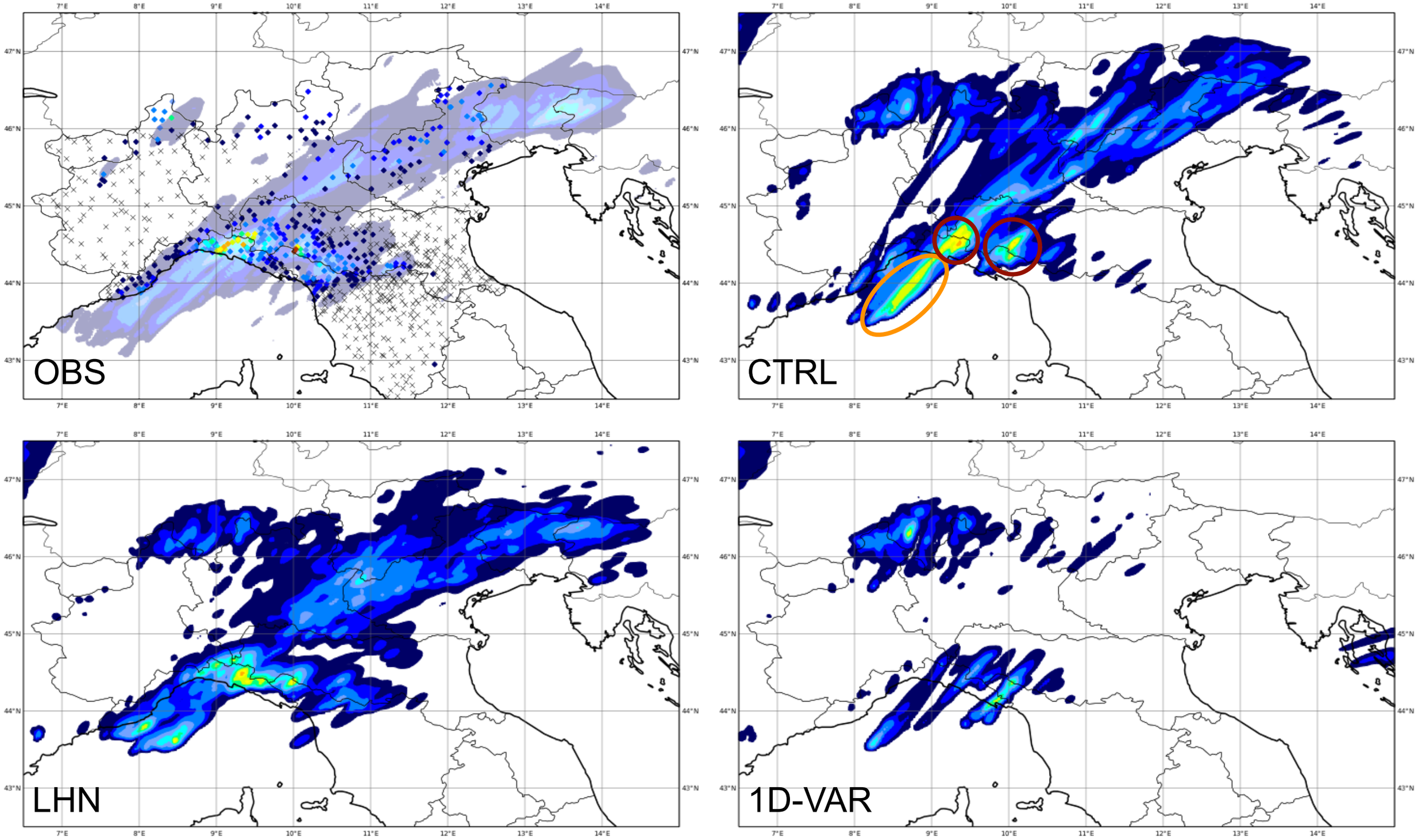
“Convective” cloud model parameterization



Assimilation cycle

12 h accumulated precipitation

26 September 2012 00-12 UTC



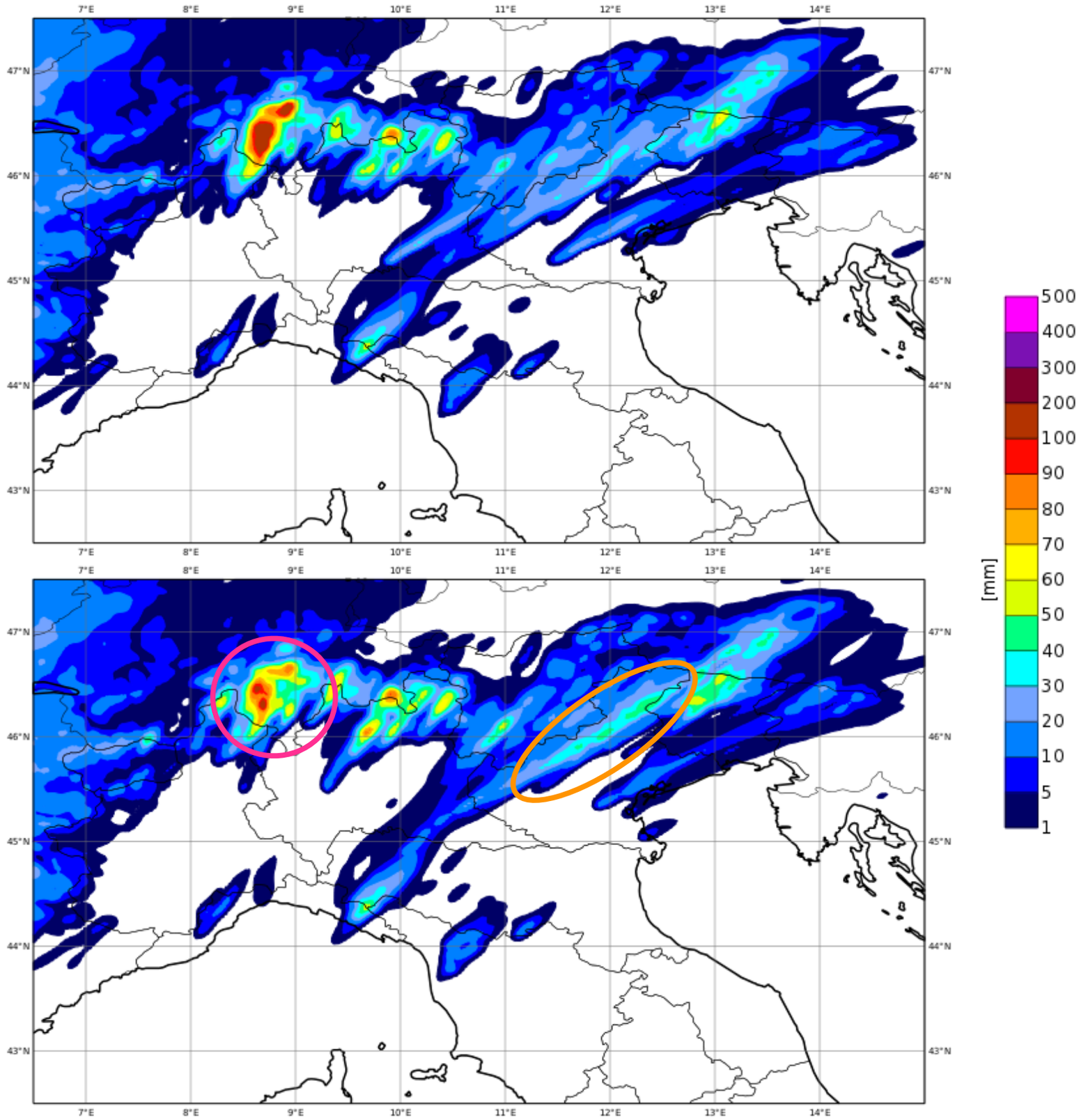
New cloud model parameterization: forecast

12 h accumulated precipitation

26 September 2012 12-24 UTC

Standard cloud model parameterization

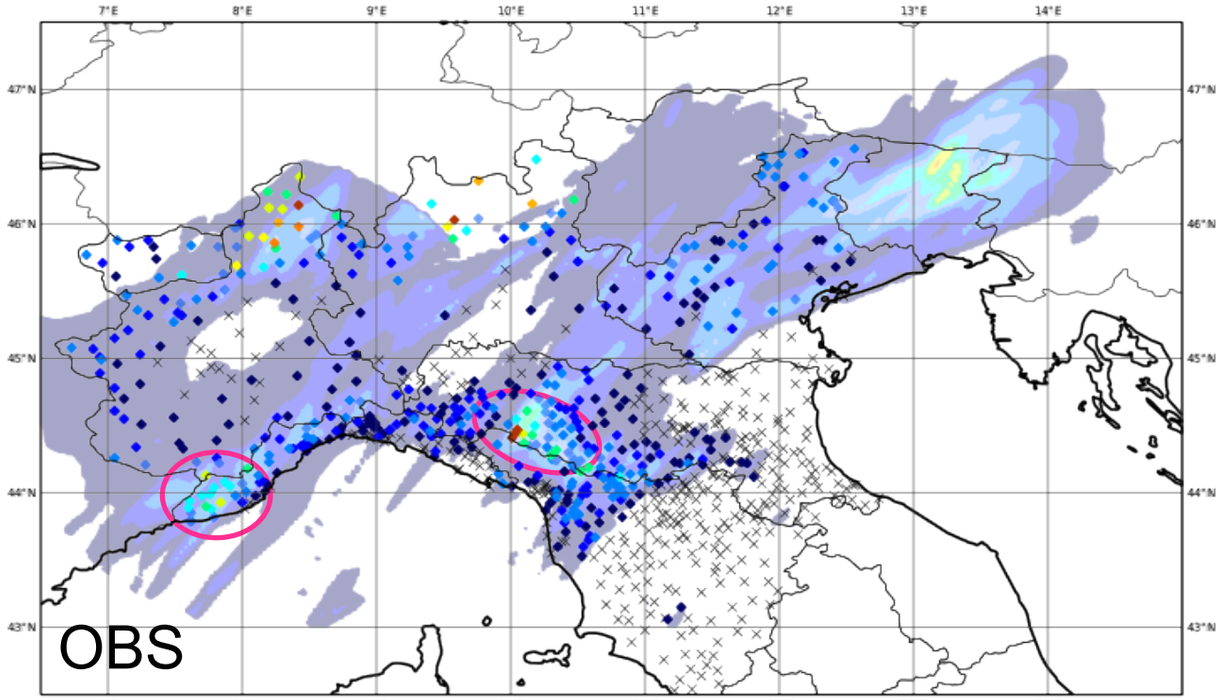
“Convective” cloud model parameterization

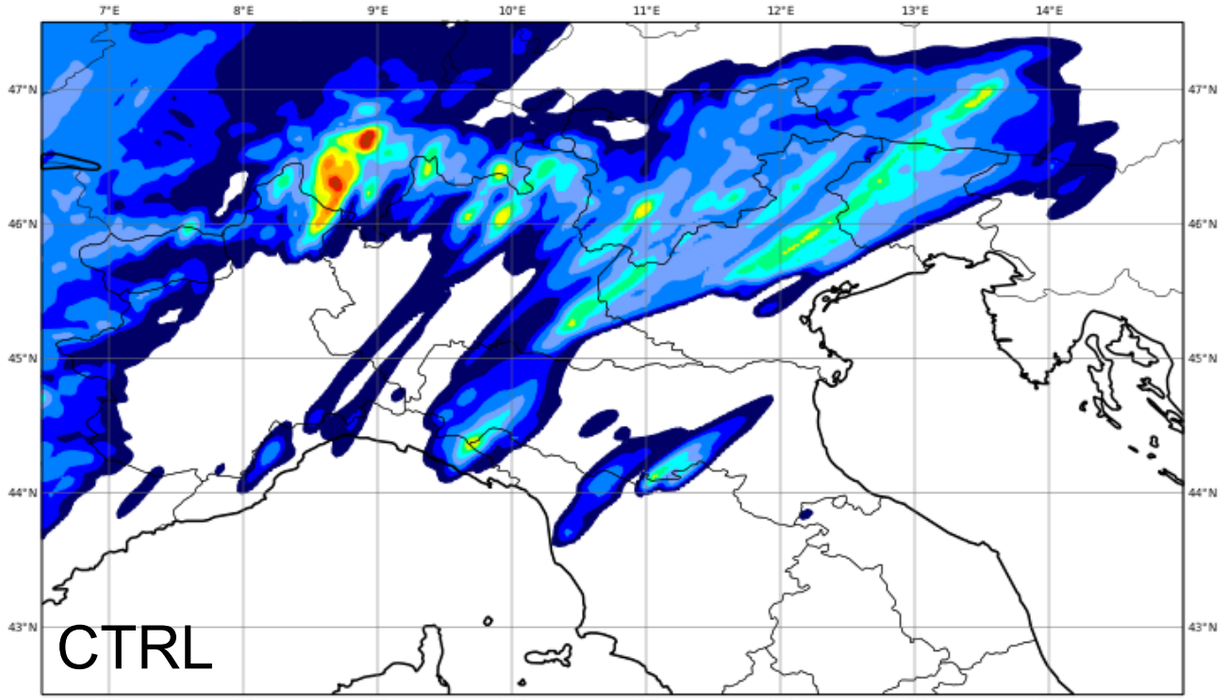


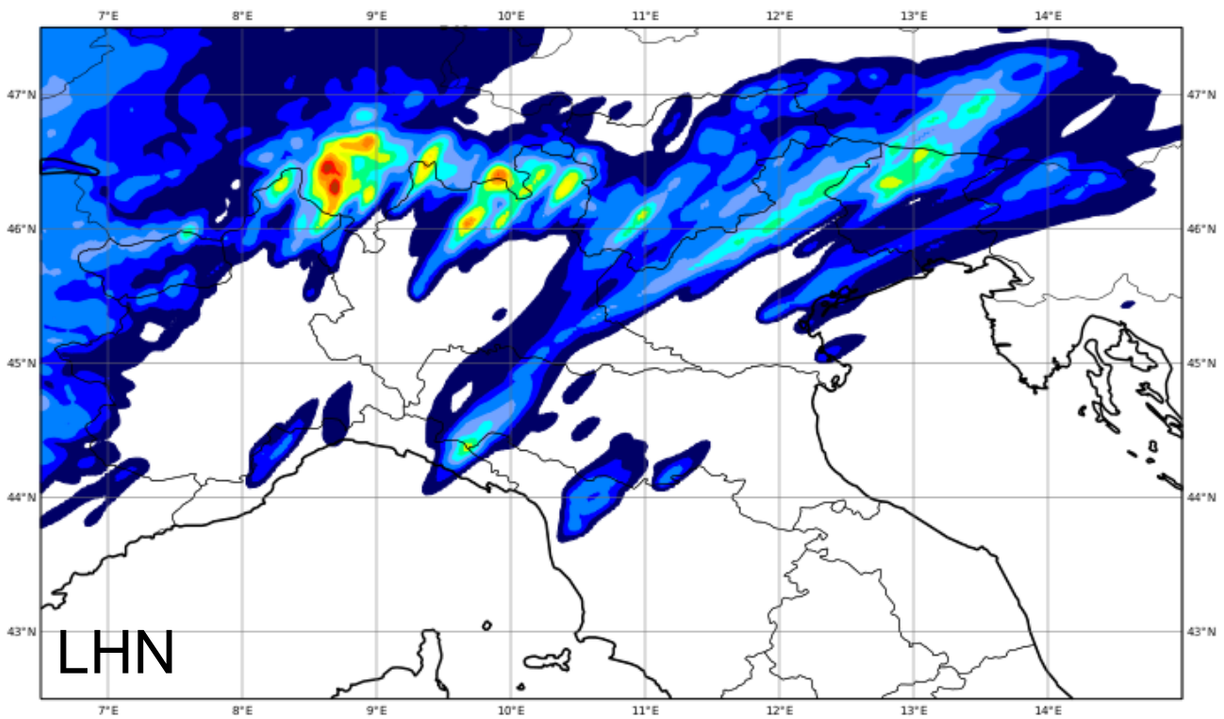
Forecast cycle

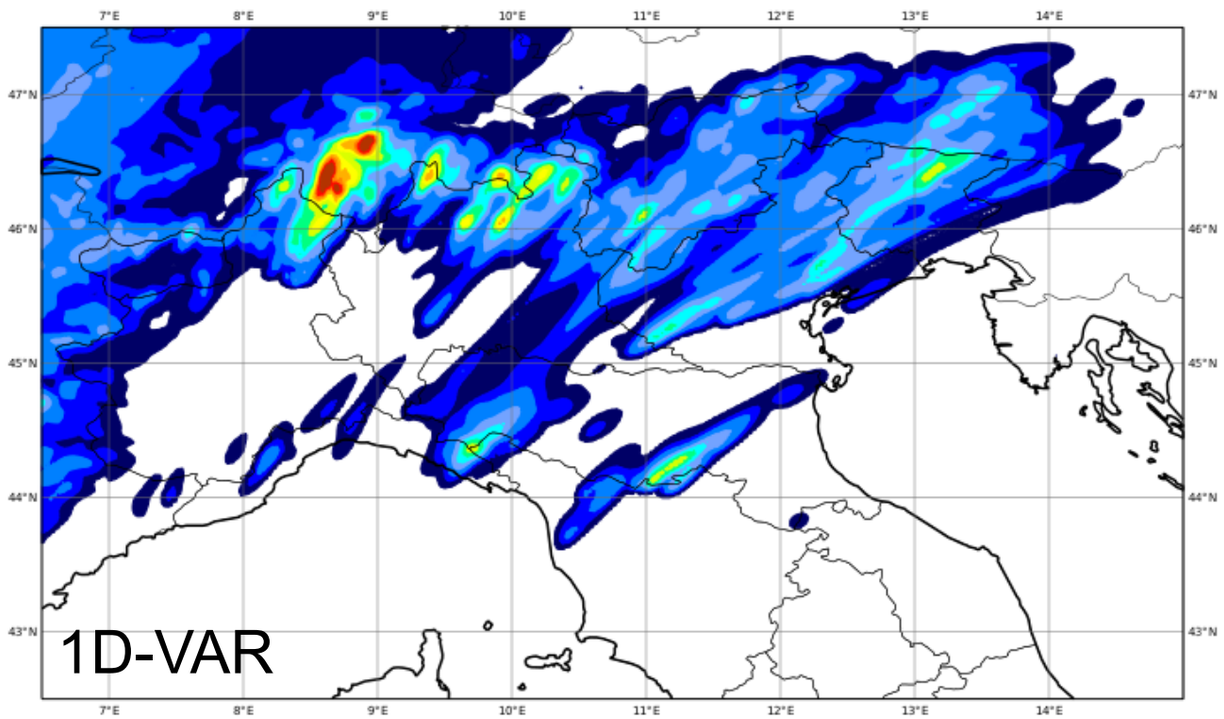
12 h accumulated precipitation

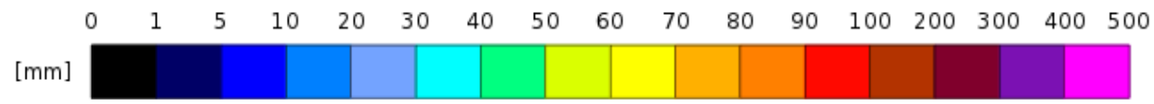
26 September 2012 12-24 UTC



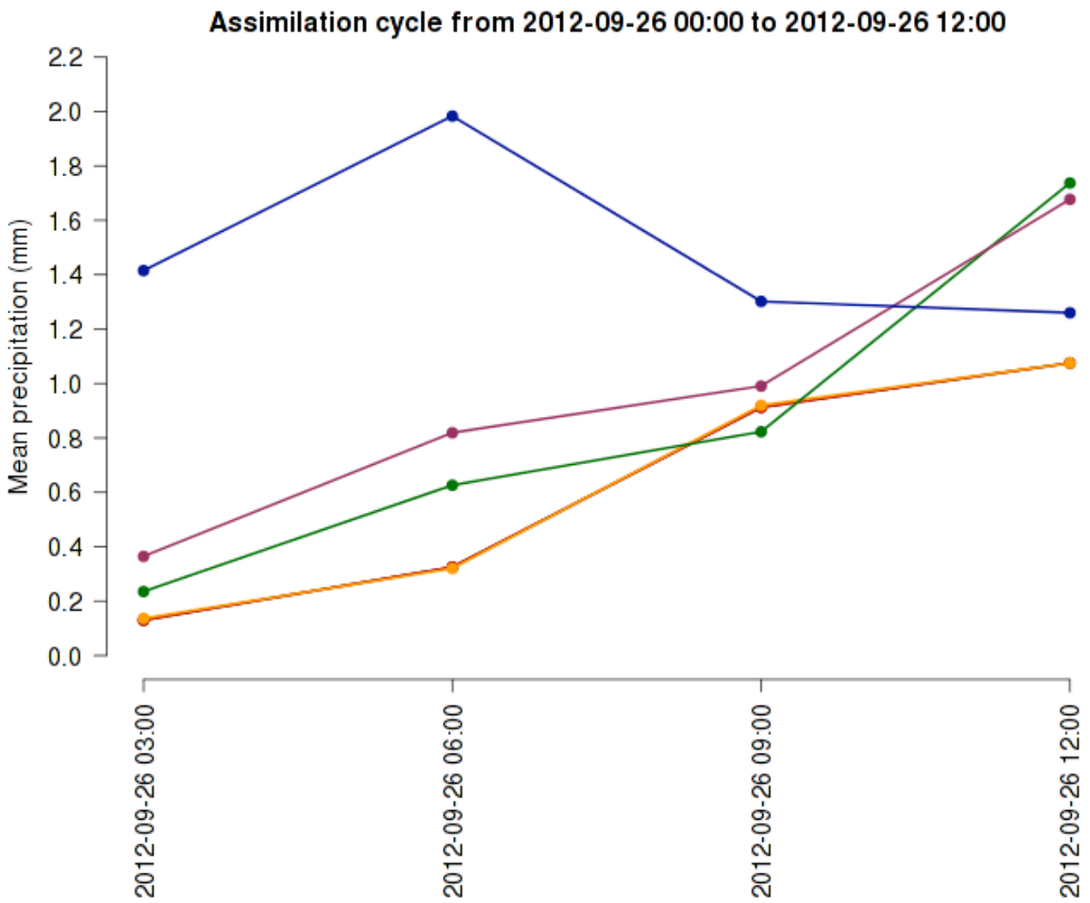


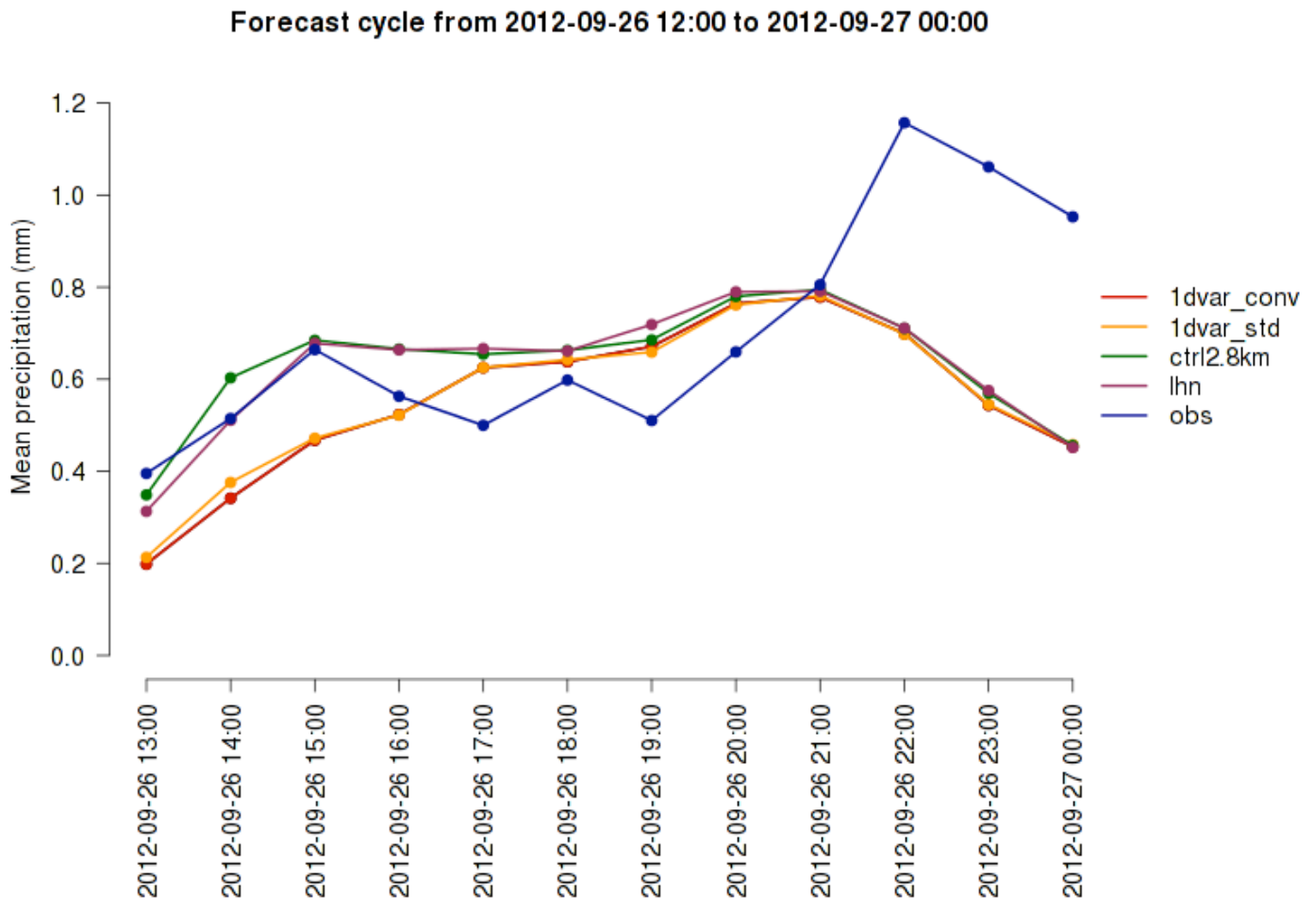




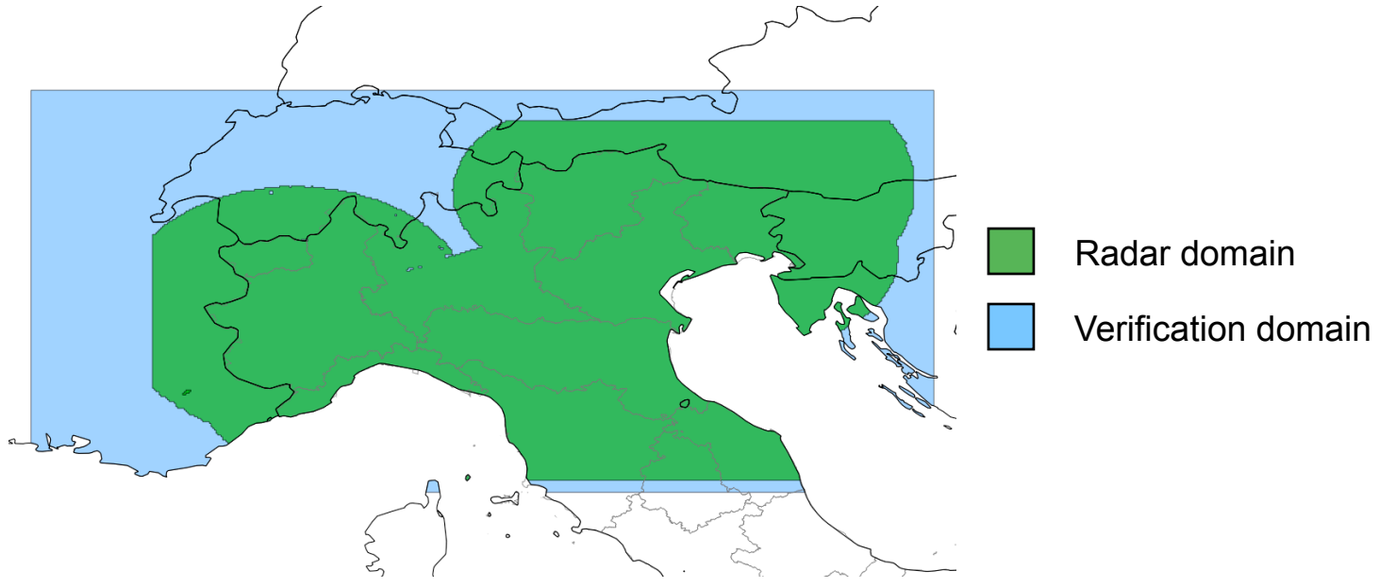


Verification scores





Case study: 2012/09/26

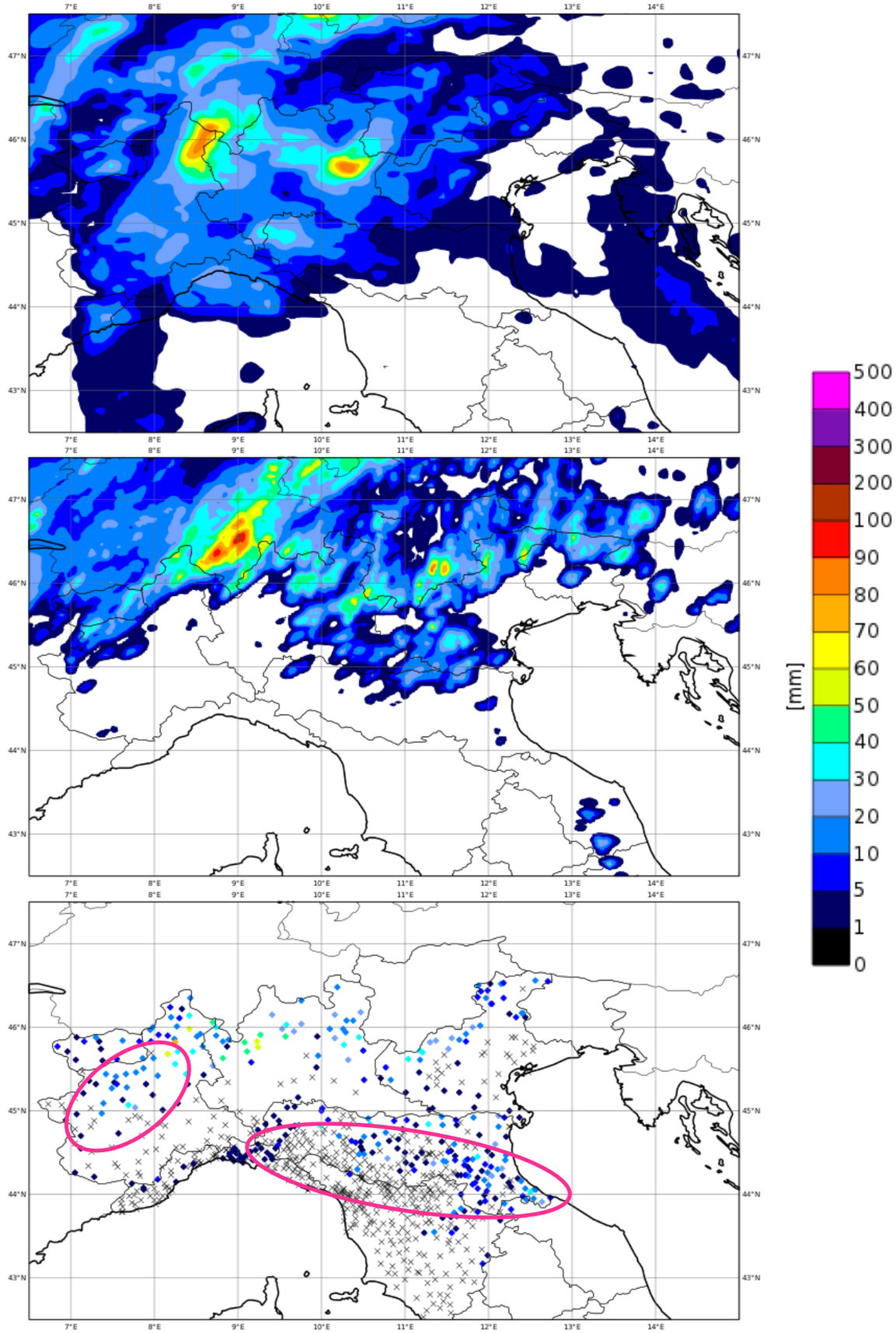


2012/07/06 00:00 - 2012/07/07 00:00

COSMO I7 - Forecasted total precipitation

COSMO I2 - Forecasted total precipitation

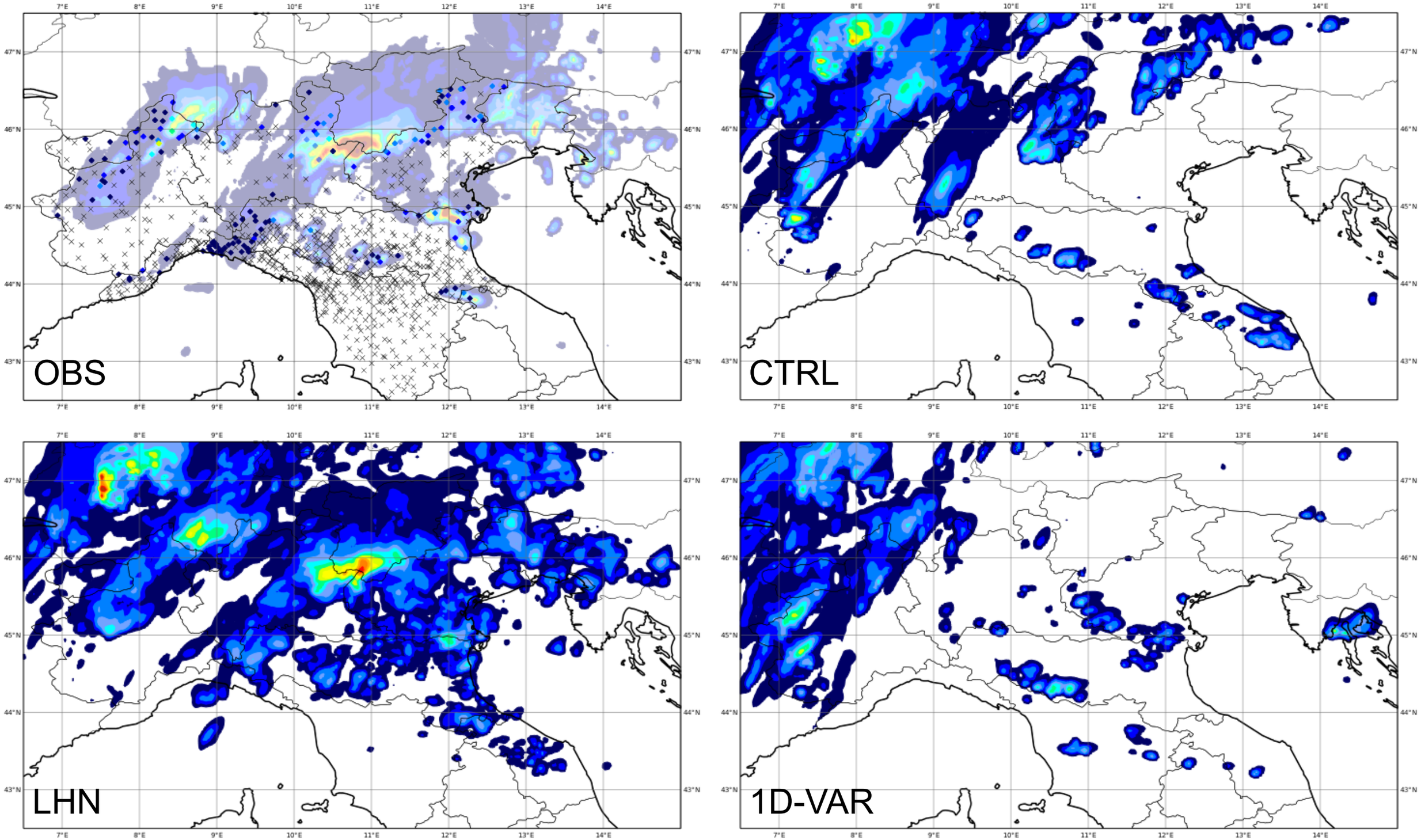
Observed total precipitation



Assimilation cycle

12 h accumulated precipitation

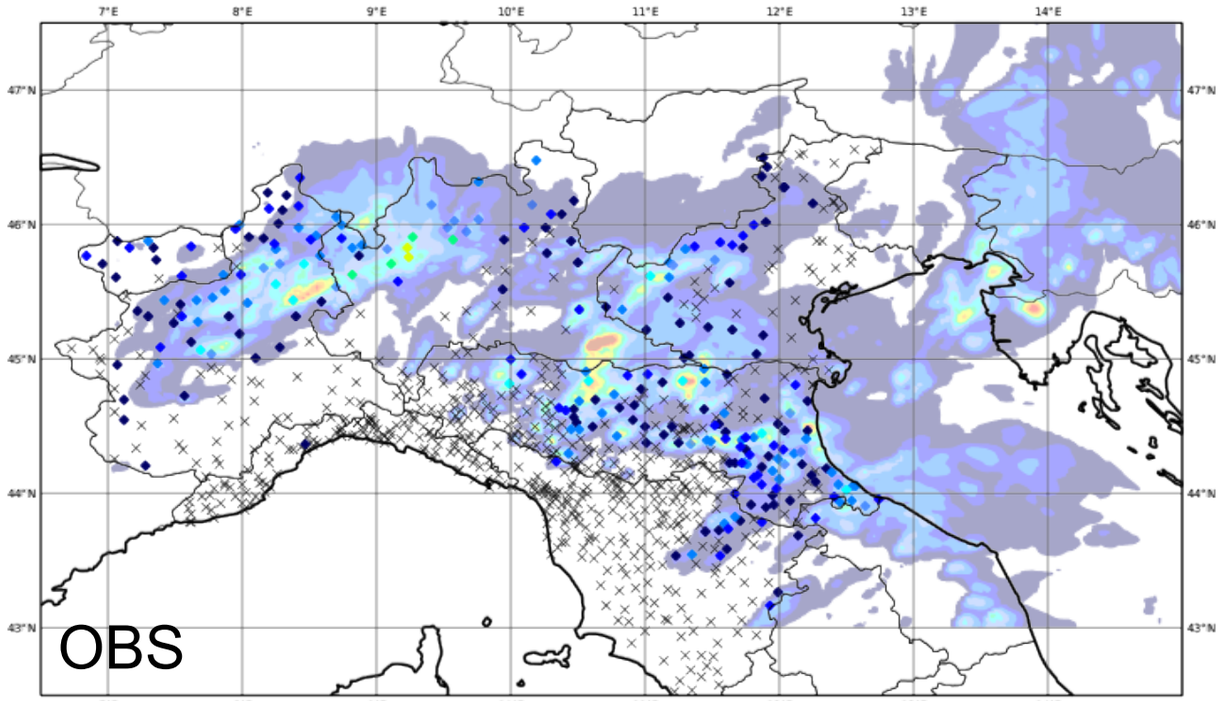
6 July 2012 00-12 UTC

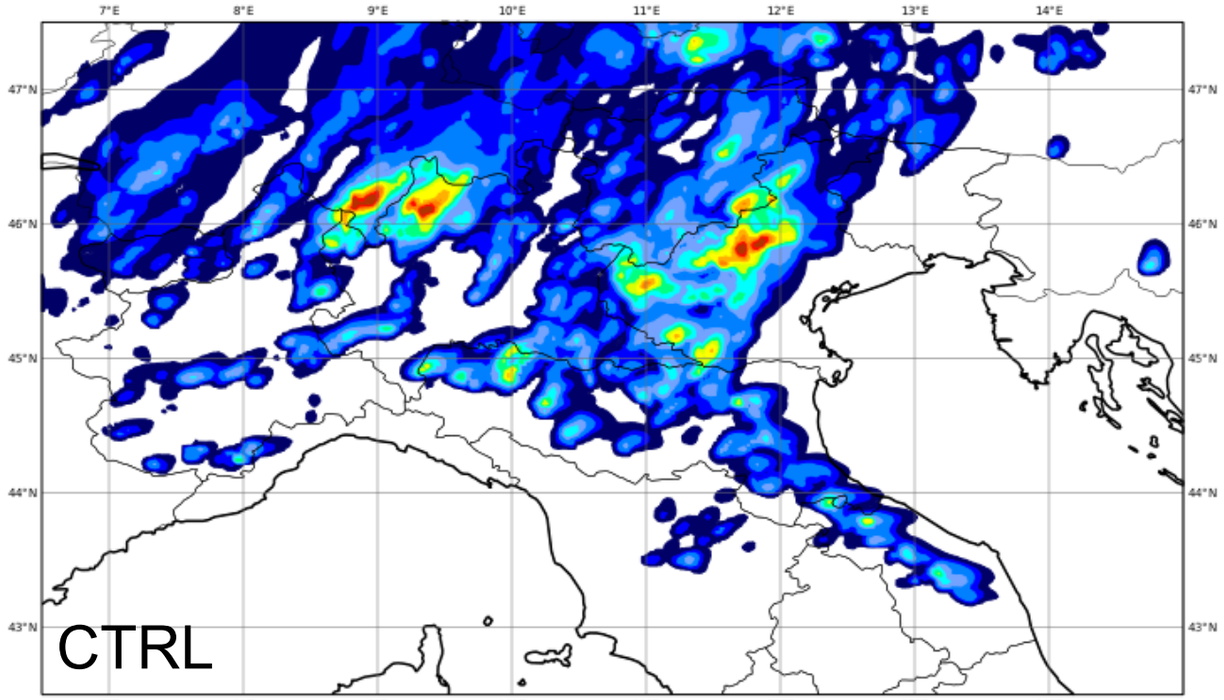


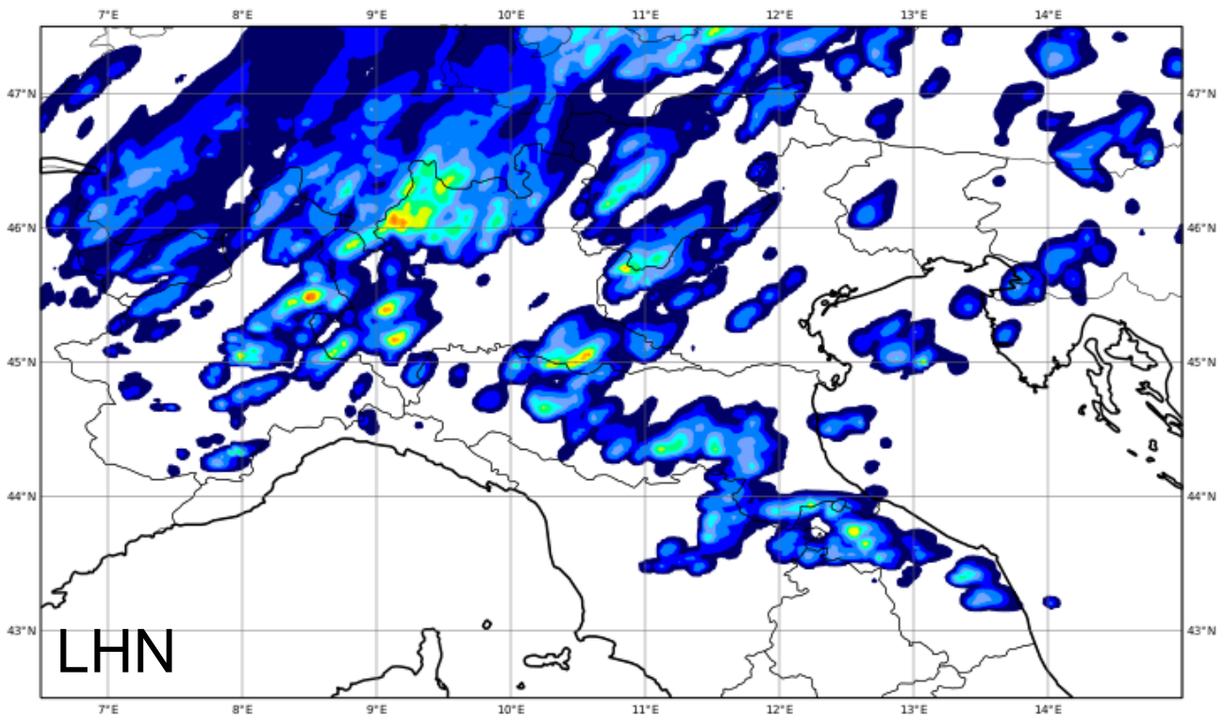
Forecast cycle

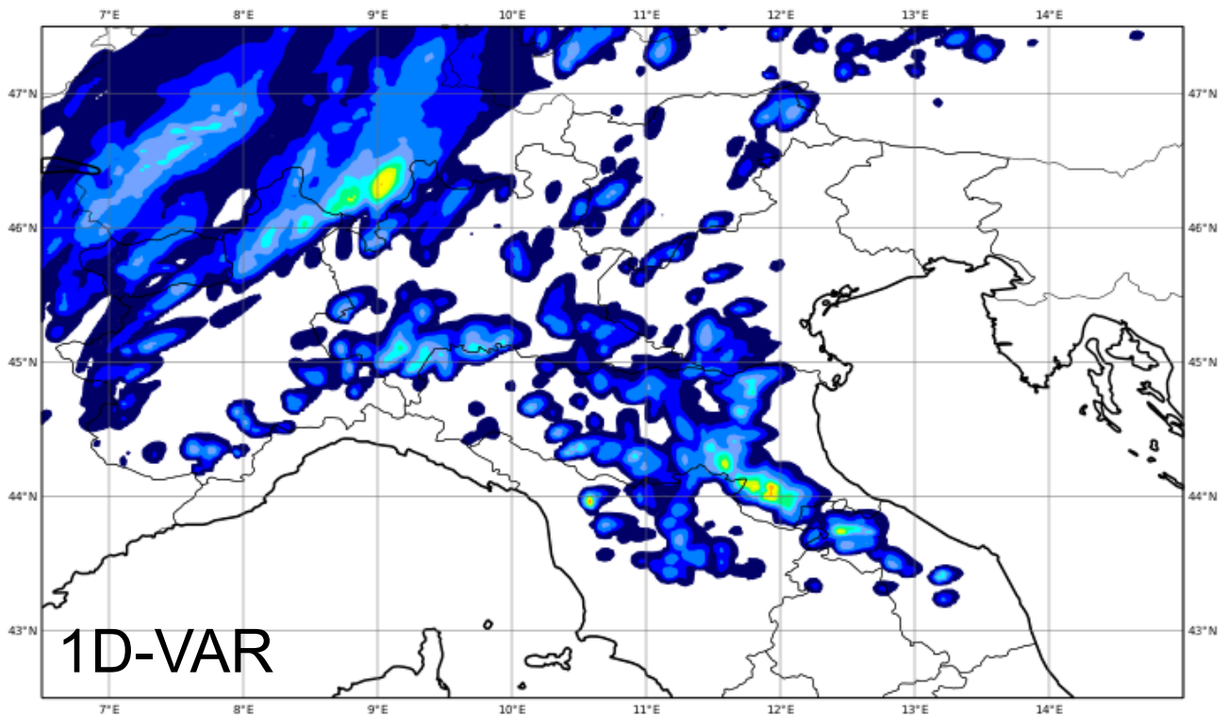
12 h accumulated precipitation

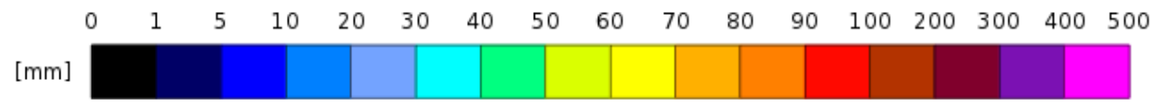
6 July 2012 12-24 UTC



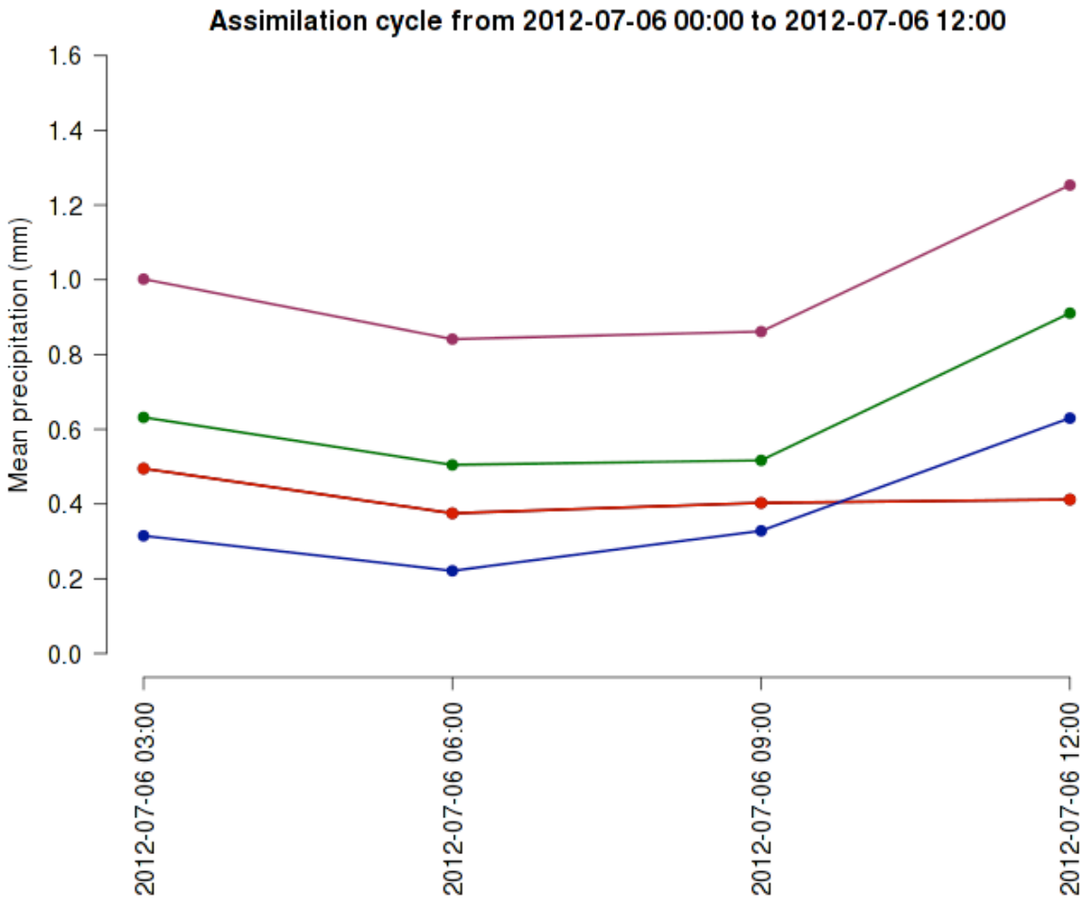


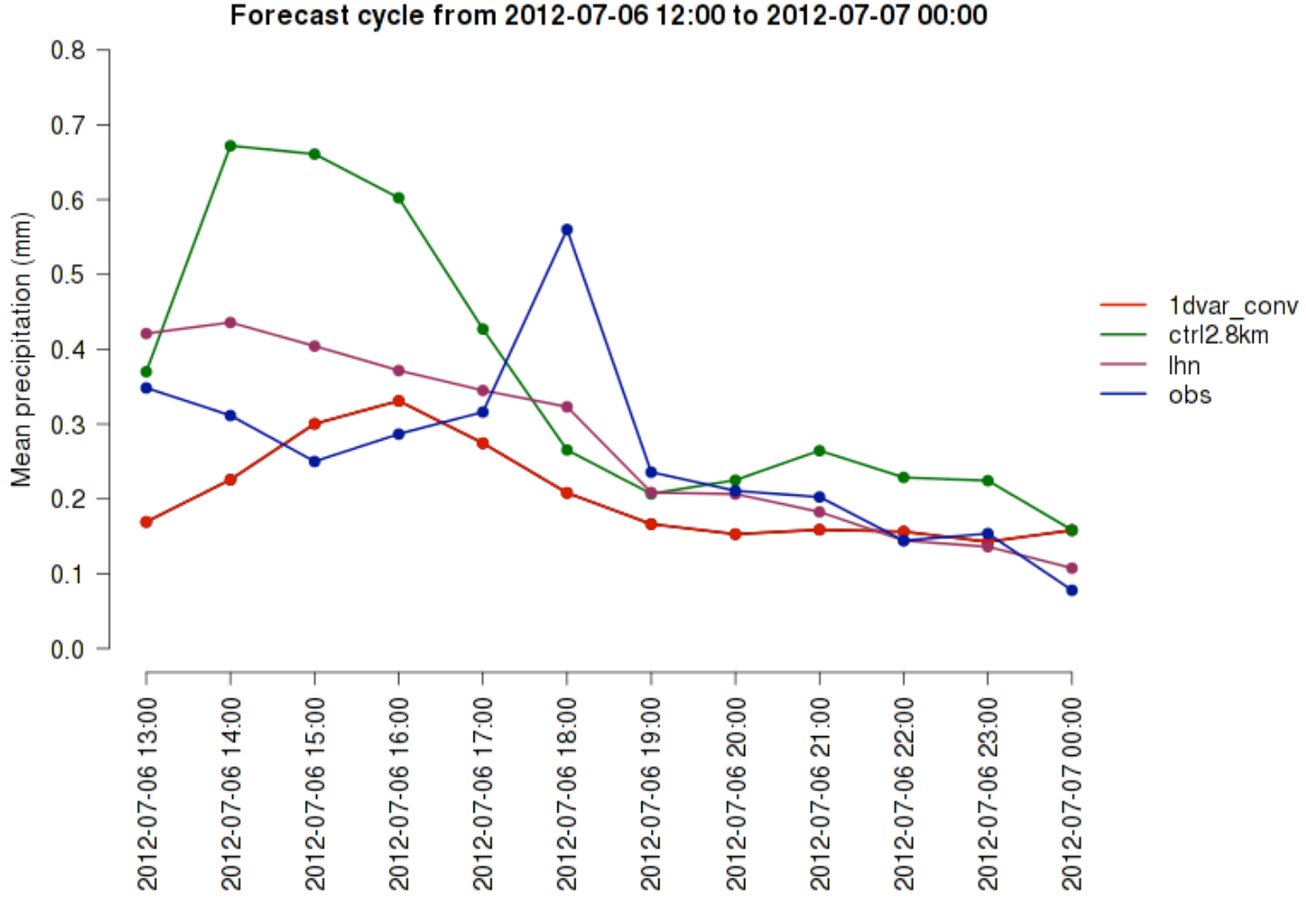




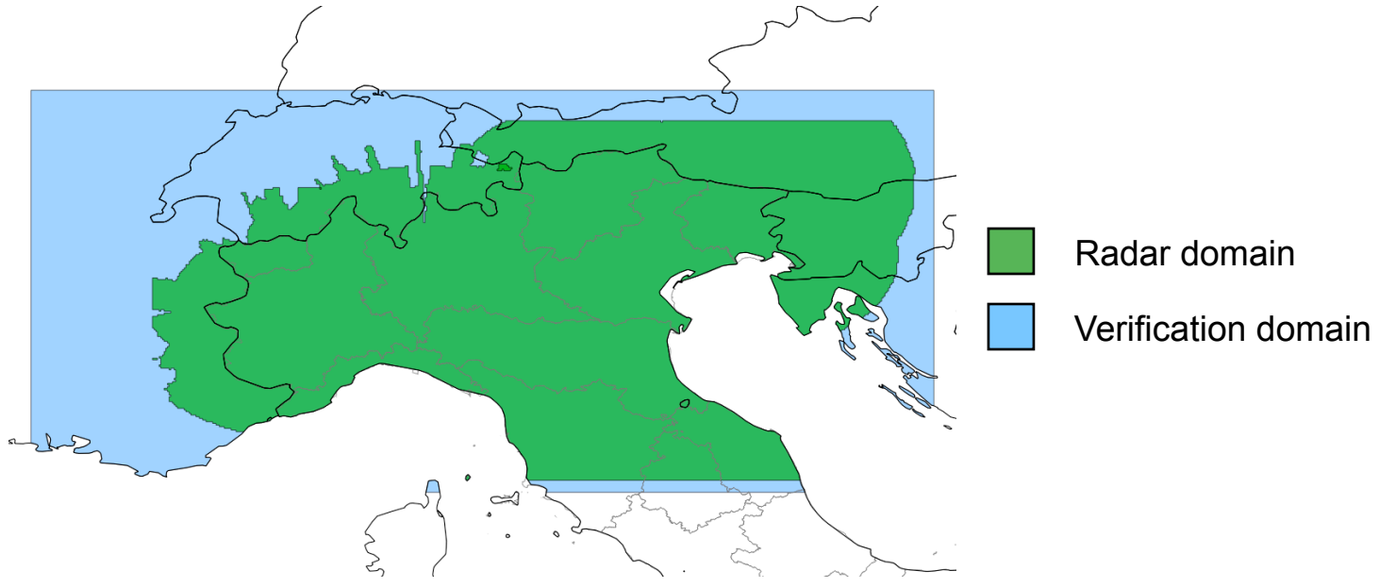


Verification scores





Case study: 2012/07/06

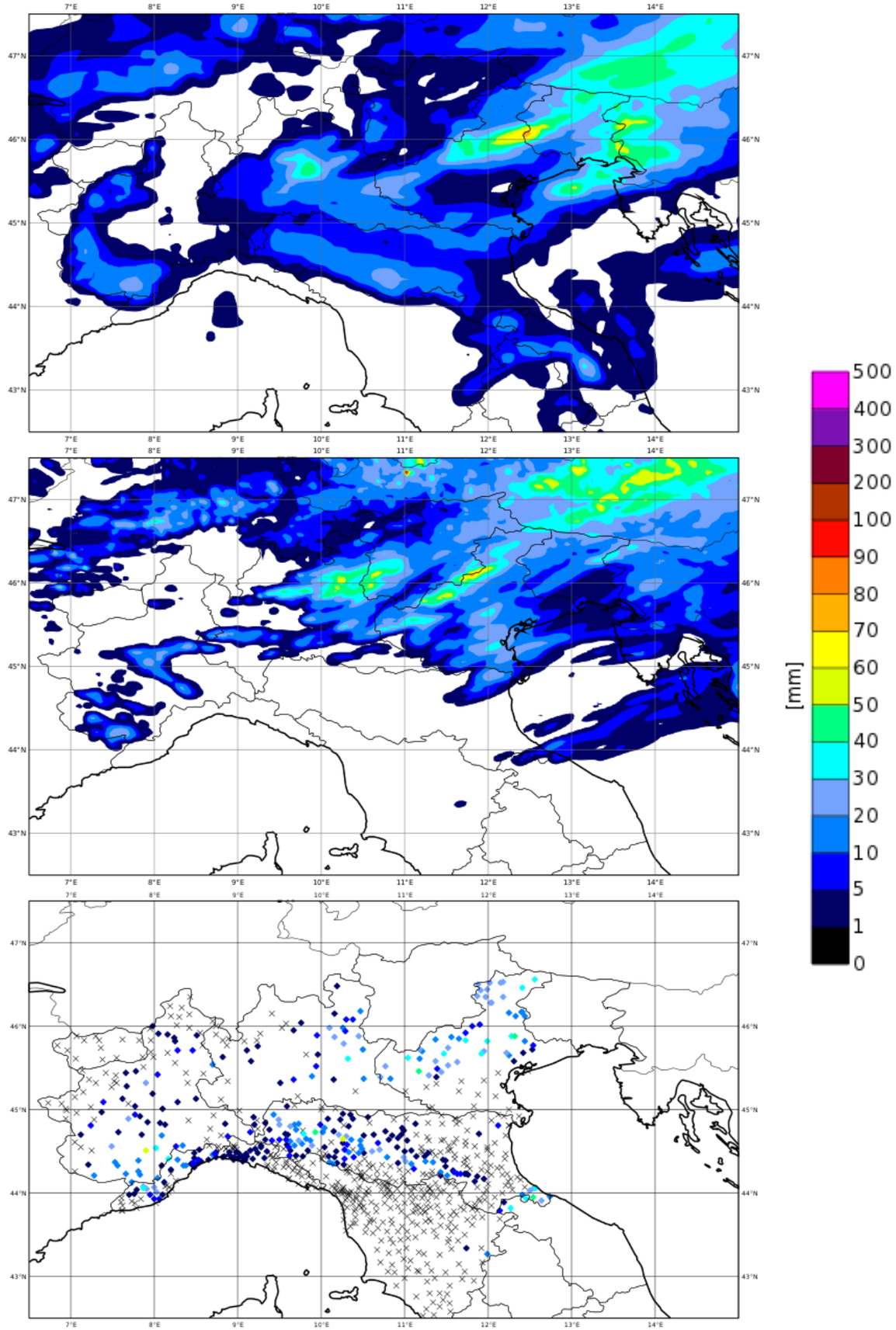


2012/07/21 00:00 - 2012/07/22 00:00

COSMO I7 - Forecasted total precipitation

COSMO I2 - Forecasted total precipitation

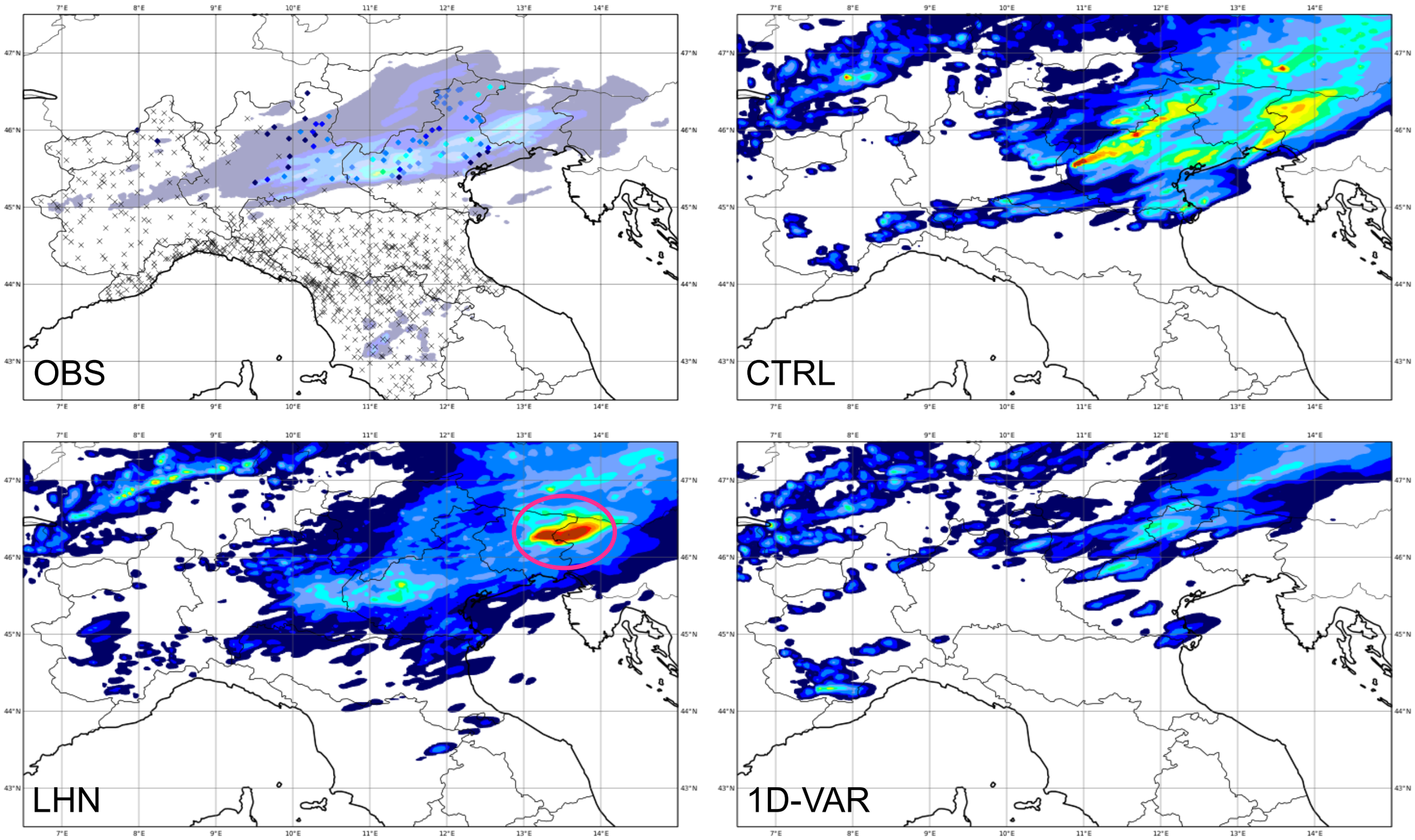
Observed total precipitation



Assimilation cycle

12 h accumulated precipitation

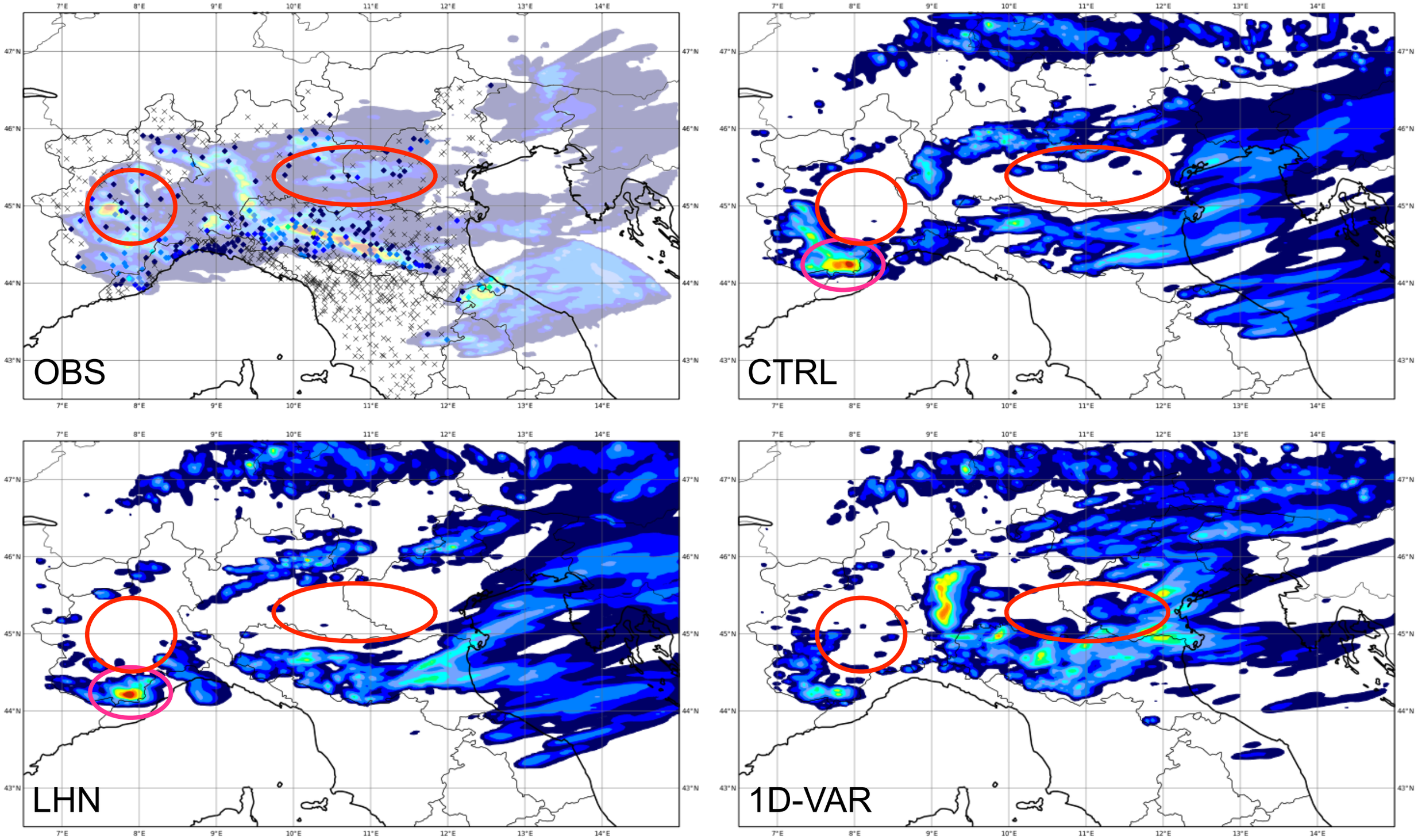
21 July 2012 00-12 UTC



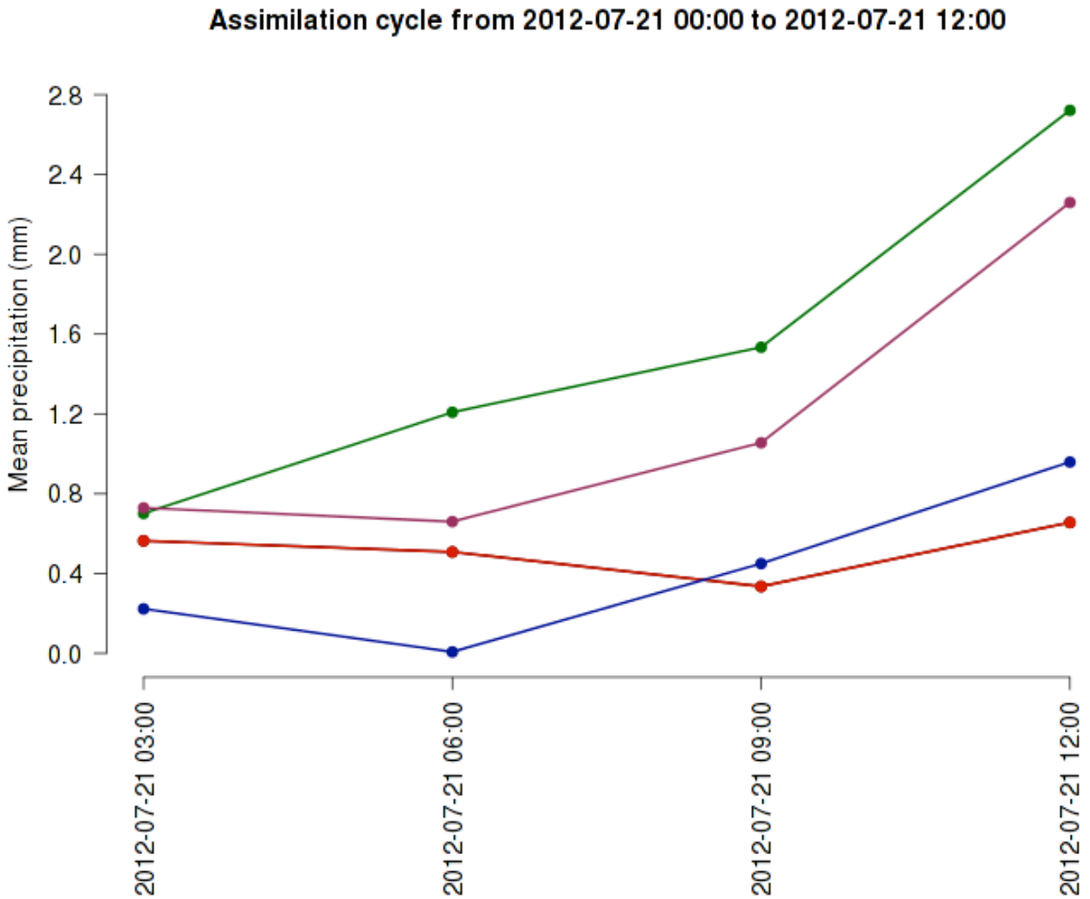
Forecast cycle

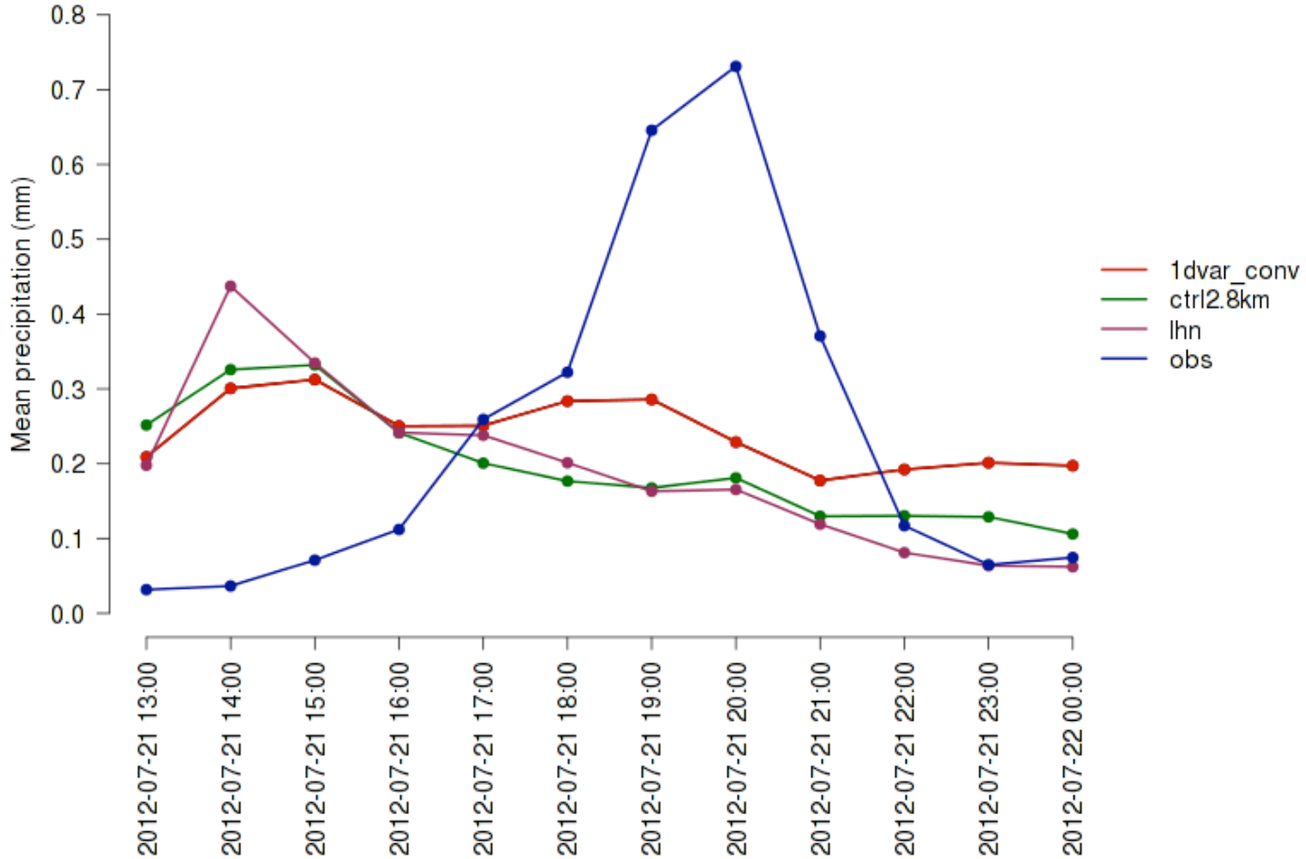
12 h accumulated precipitation

21 July 2012 12-24 UTC

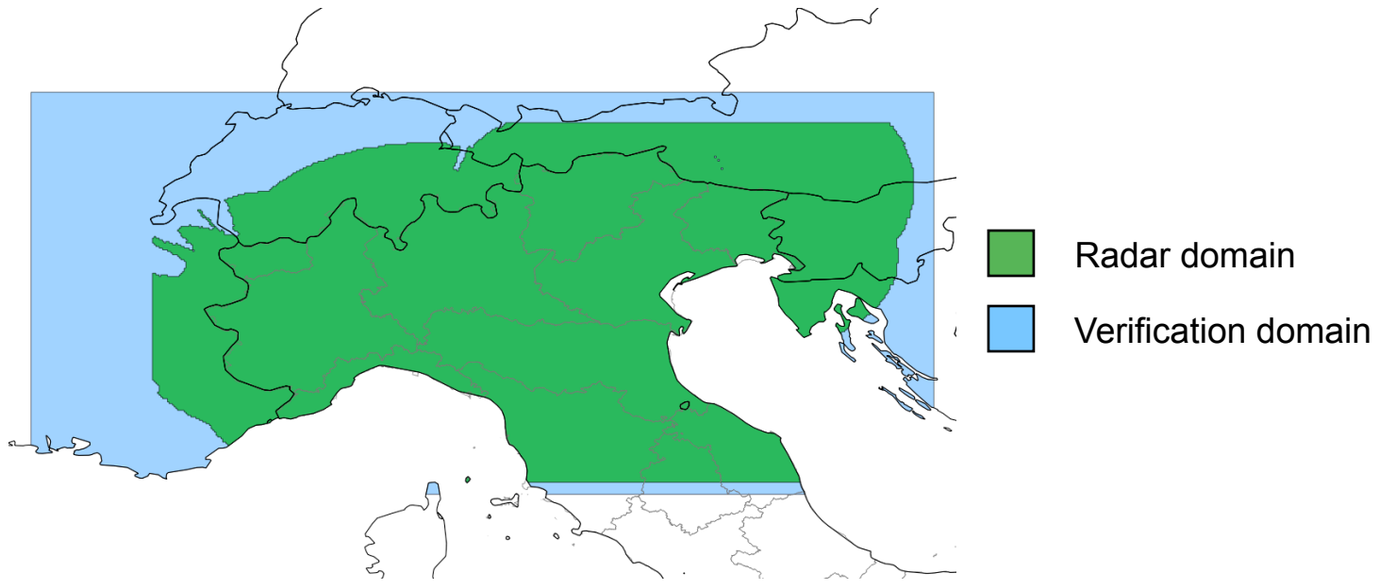


Verification scores

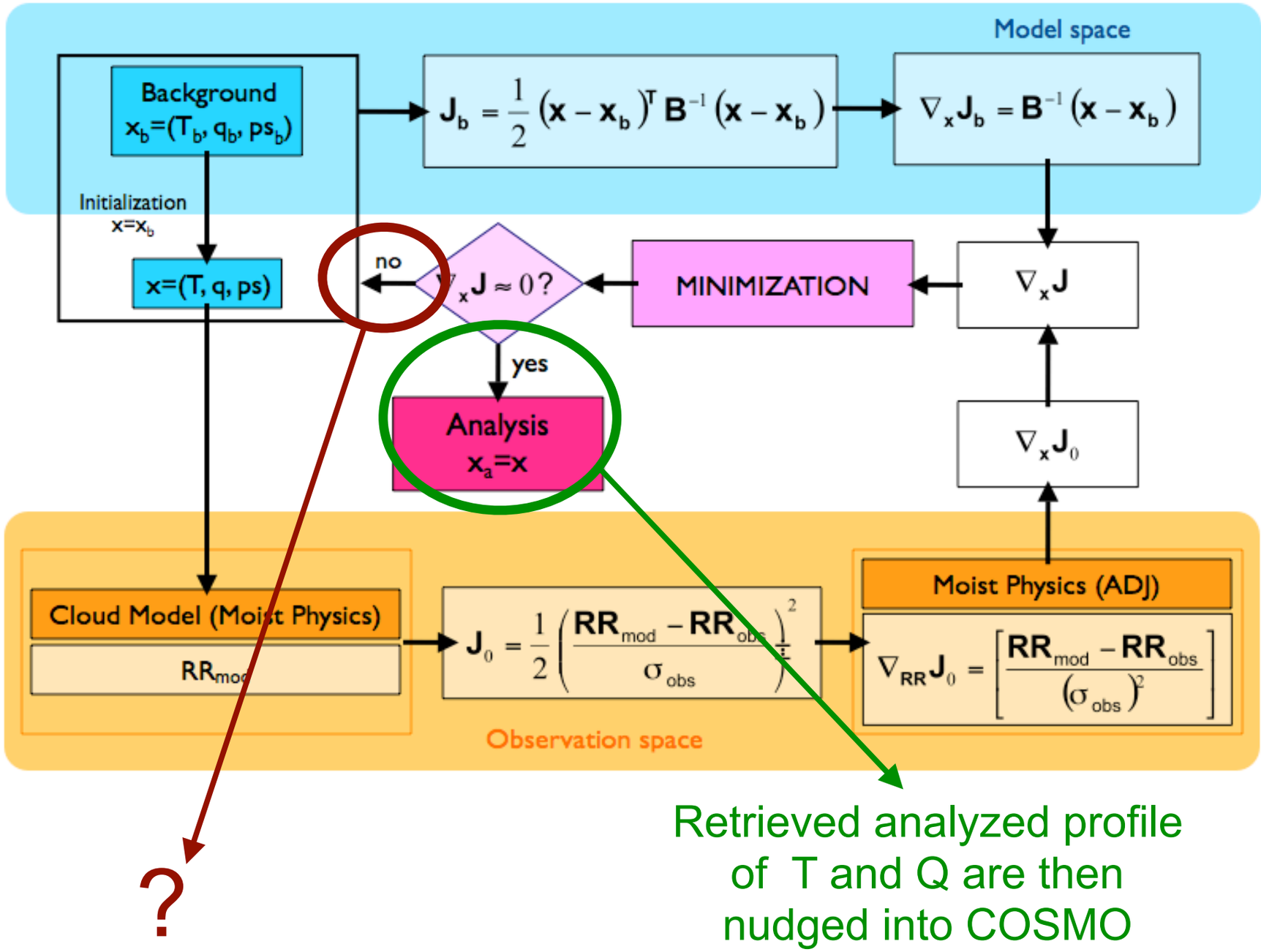




Case study: 2012/07/21



What is wrong?



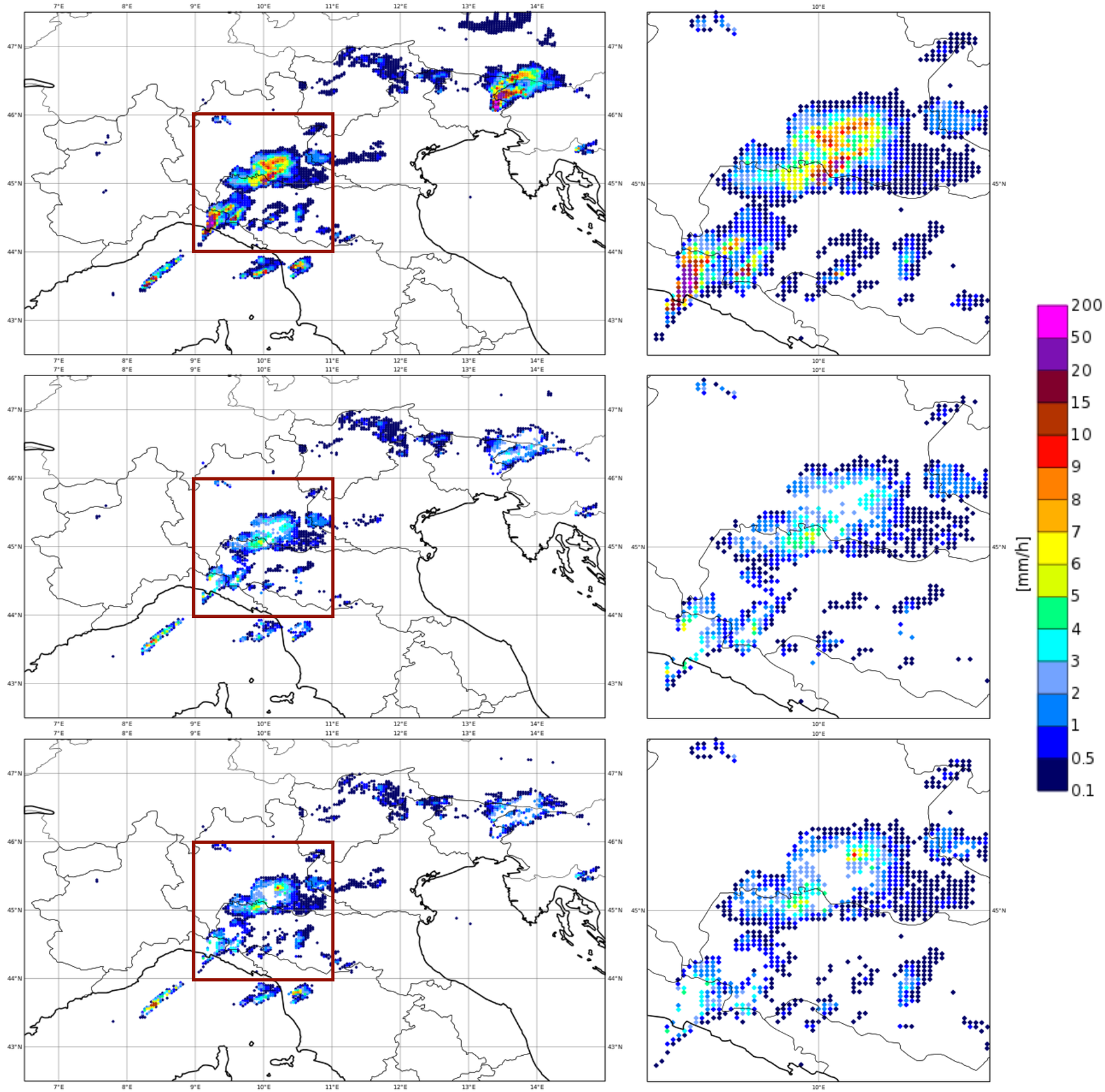
Statistical analysis of 1D-Var outputs indicates that about the 70% of data in input converges.
What about data in which minimization fails?

1D-Var output

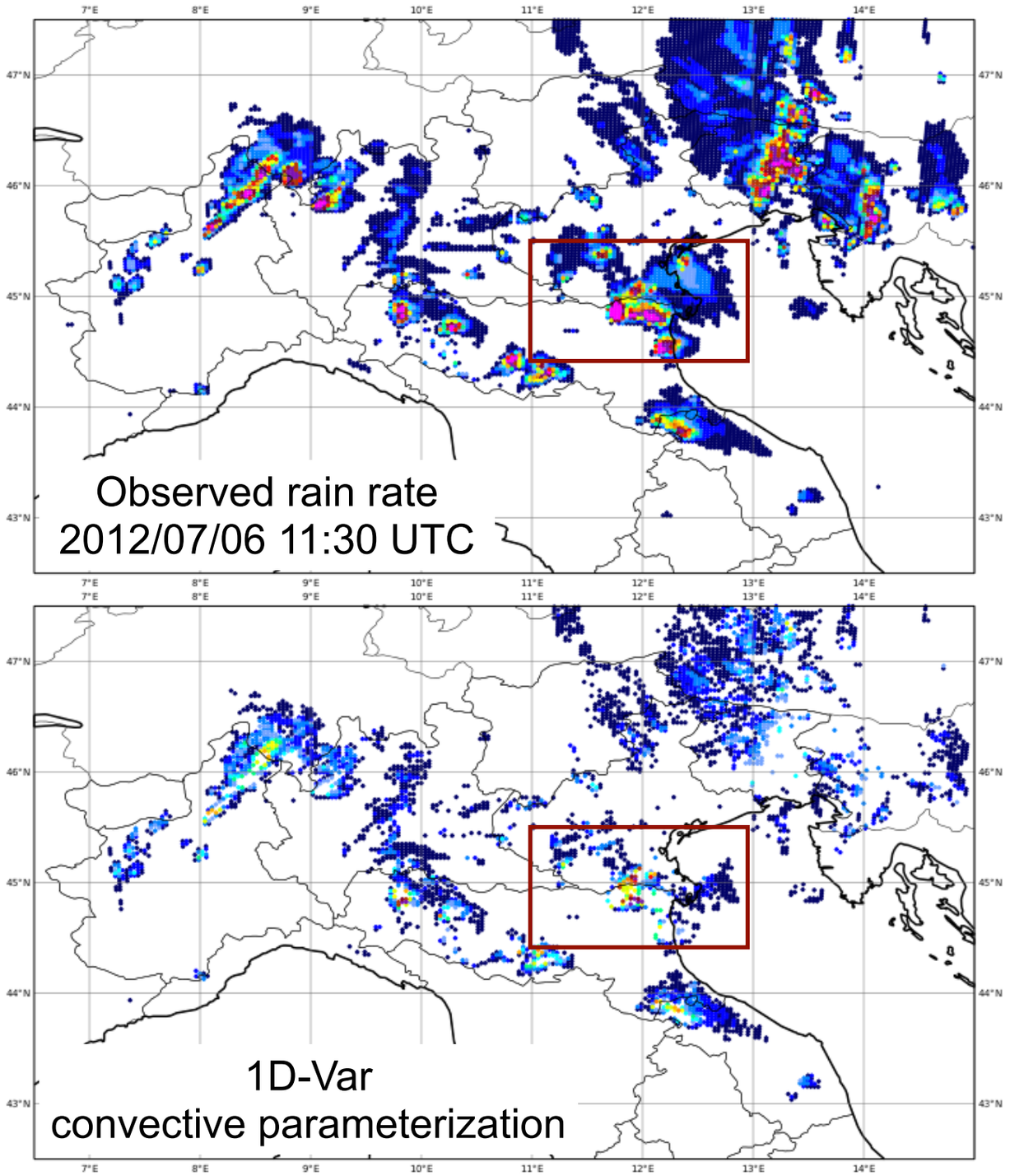
Observed rain rate
2012/09/26 07:00 UTC

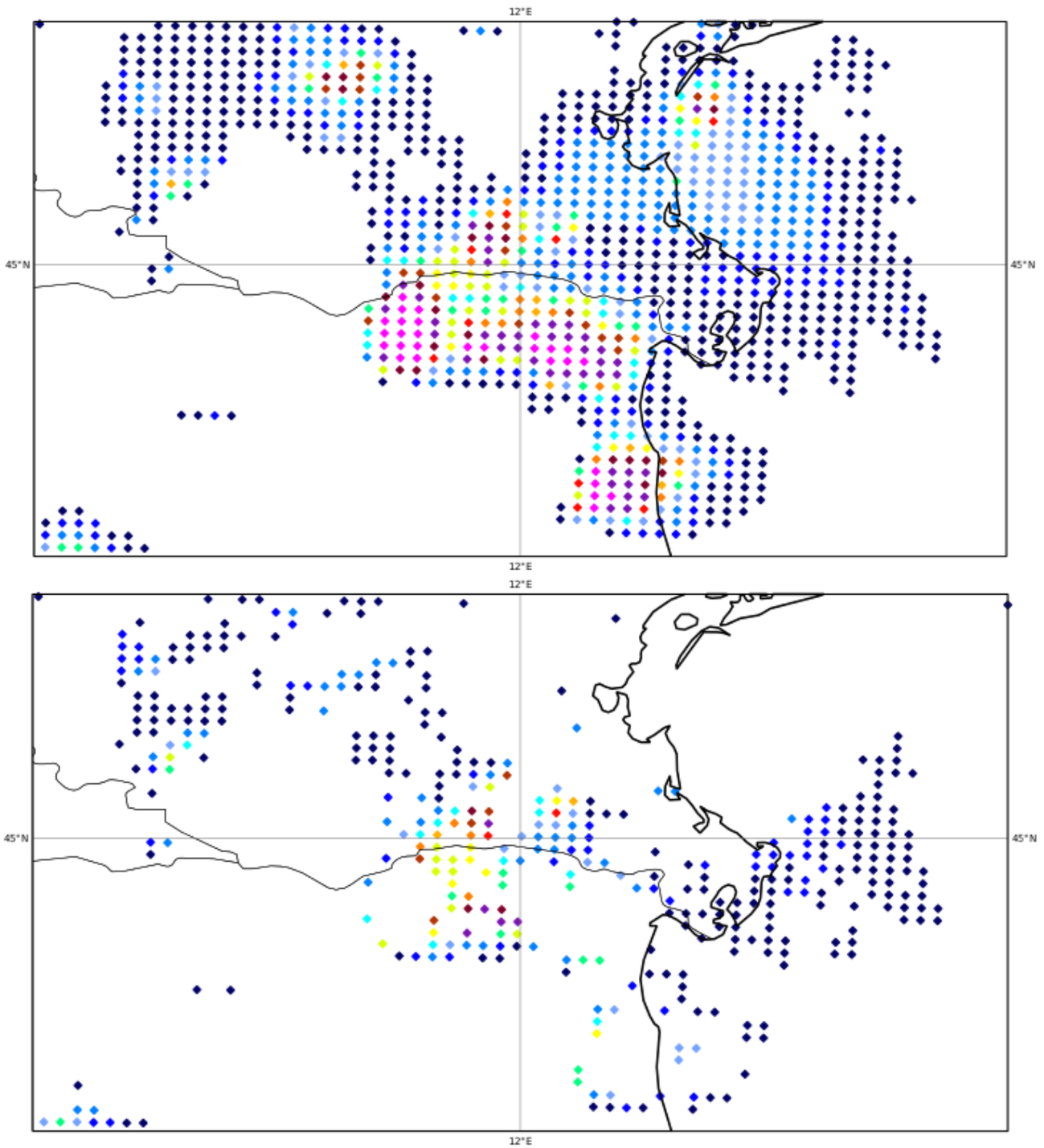
1D-Var
standard parameterization

1D-Var
convective parameterization



1D-Var output





Conclusions

In latest years many modifications were made in order to understand how and how much the assimilation of radar data through the 1D-Var + nudging technique affects the precipitation forecast.

Results were verified subjectively and objectively analysing 12 h accumulated precipitation. Despite changes, results show that LHN scheme outperforms the proposed methdology.

These poor results are mainly due to two different reasons:

- the moist physics implemented in the 1D-Var differs from the one of the COSMO model;
- the use of a linearized moist physics that has been designed at coarse resolutions.

These conclusions imply that this methodology is not suitable for assimilation of high resolution data.

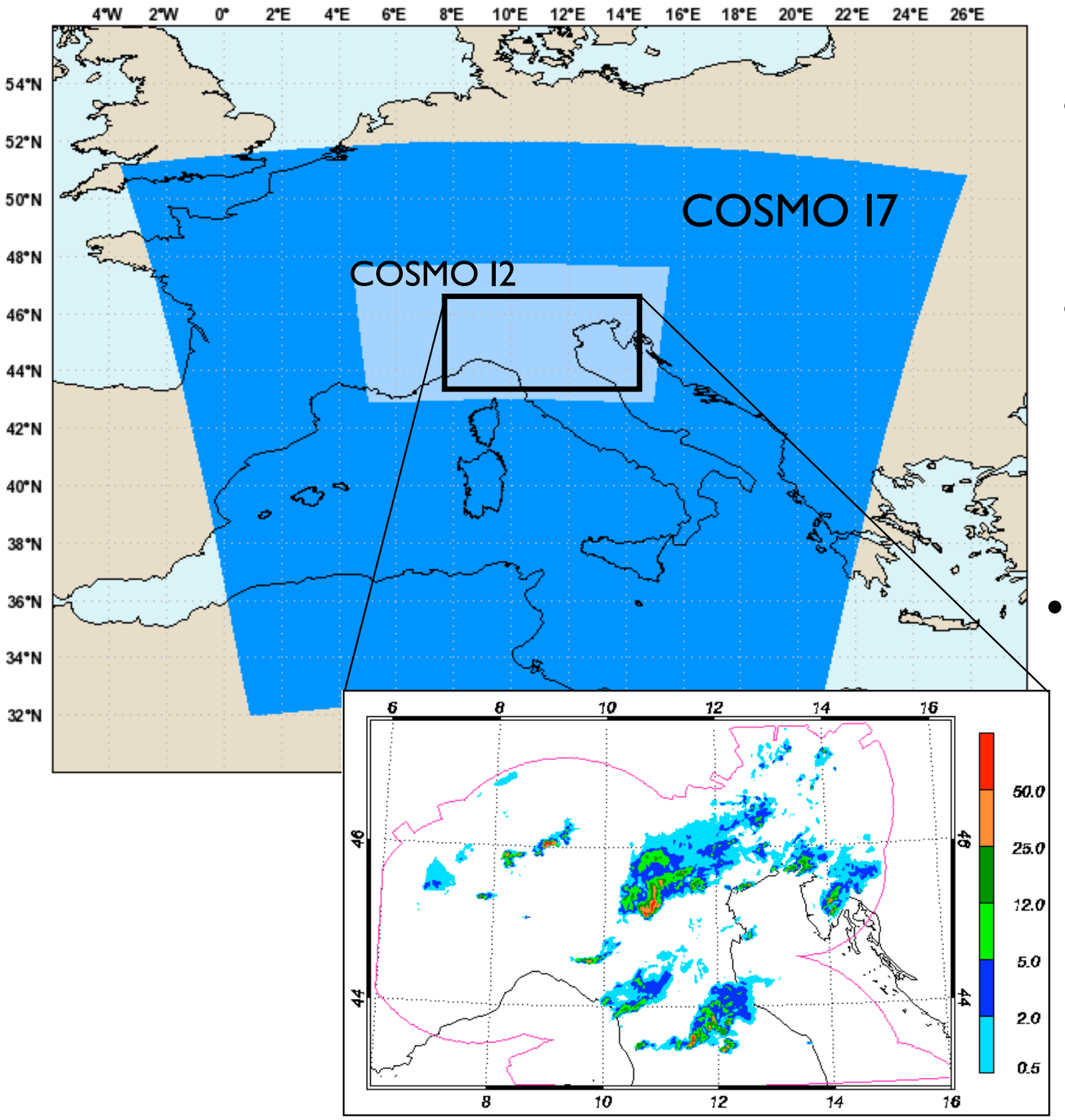
“Non tutte le ciambelle riescono con il buco”

Not all of the donuts come out with the hole

Things can’t be expected to turn out right every time

Thank you for the attention

Numerical model and radar data



- COSMO I2, version 4.21
  - horizontal resolution=2.8 km
  - 45 vertical levels
- Nested in COSMO I7
  - horizontal resolution=7 km
  - 40 vertical levels
- Radar data from the radar network of italian Department of National Civil Protection
  - Horizontal resolution: 1 km
  - Temporal resolution: 15 min
  - Selected domain: Northern Italy
  - Data are interpolated on COSMO I2 grid before their assimilation