# "Sensitivity tests on assimilation of radar reflectivity volumes in KENDA"

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## INTRODUCTION

Reflectivity volumes from the Italian radar network can be assimilated into the Kilometer-scale ENsemble Data Assimilation (KENDA) LETKF system[1] by means of the ODIM HDF5 reader specifically written for the COSMO Radar Forward Operator (EMVORADO)[2]. This reader permits the ingestion of all the radar data coded in HDF5 according to OPERA data information model.

The experimental framework is a continuous assimilation cycle implemented with a 3-hourly step, with Boundary Conditions (and Initial Conditions for the cold start) from 20 members of the ECMWF ensemble, 32 km horizontal resolution, and from IFS deterministic run, 16 km horizontal resolution. The COSMO model is run at a 2.8 km resolution.

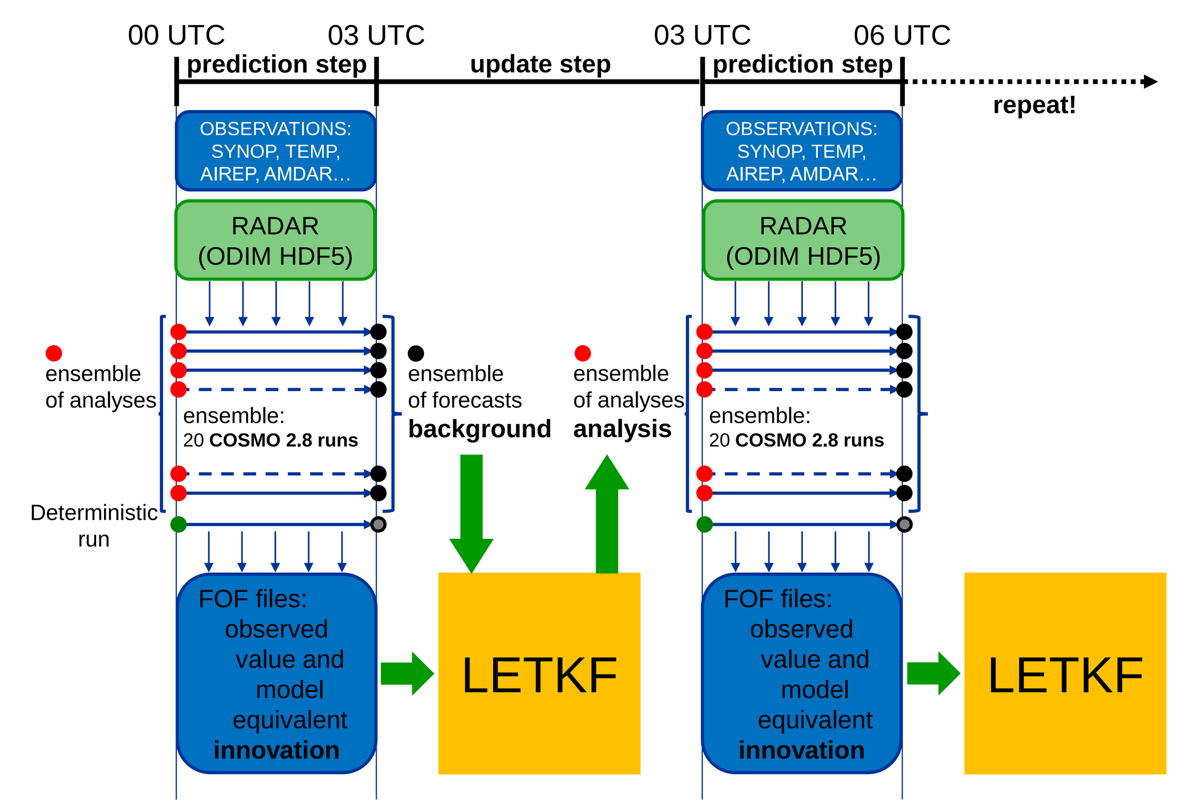
Sensitivity tests were accomplished to understand the impact of different configurations both of the COSMO model and of the LETKF scheme. In particular, in EMVORADO, different superobbing values and different scattering options are considered, while in the LETKF scheme the considered parameters are the horizontal localization, and the different inflation methods (RTPP vs RTPS).

*References:*

*[1] Schraff et al., 2016: Kilometre-scale ensemble data assimilation for the COSMO model (KENDA). Q.J.R. Meteorol. Soc. ,142, 1453-1472.*

*[2] Bick et al., 2016: Assimilation of 3D Radar Reflectivities with an Ensemble Kalman Filter on the Convective Scale ). Q.J.R. Meteorol. Soc. ,142, 1490-1504.*

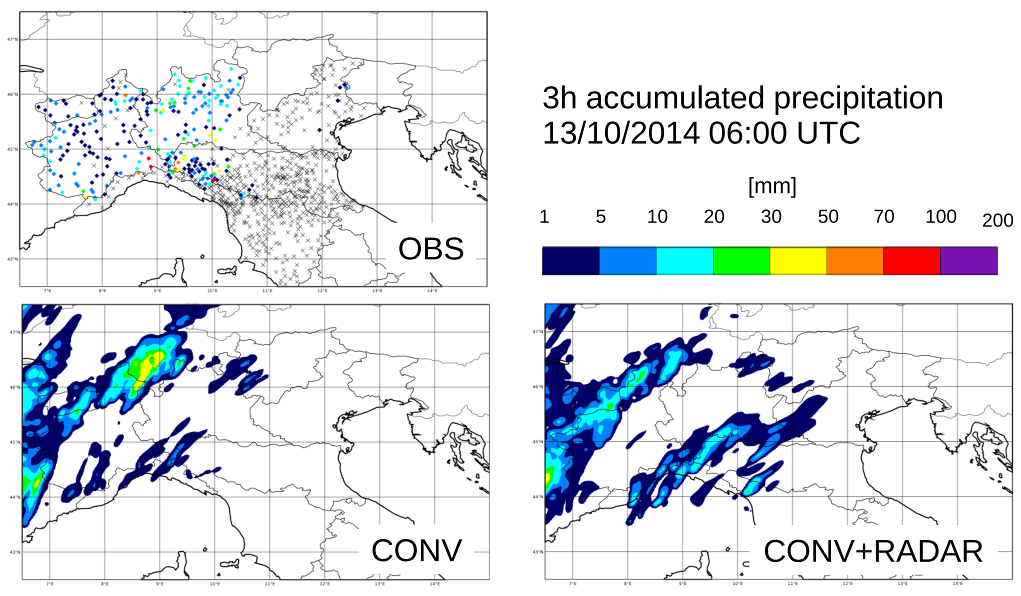
## KENDA SET-UP




## MOTIVATION FOR NEW SENSITIVITY TESTS

First, results were verified comparing rainfall fields both during the assimilation and the forecast cycles. The assimilation of reflectivity volumes had a good impact in terms of rainfall pattern and intensity.

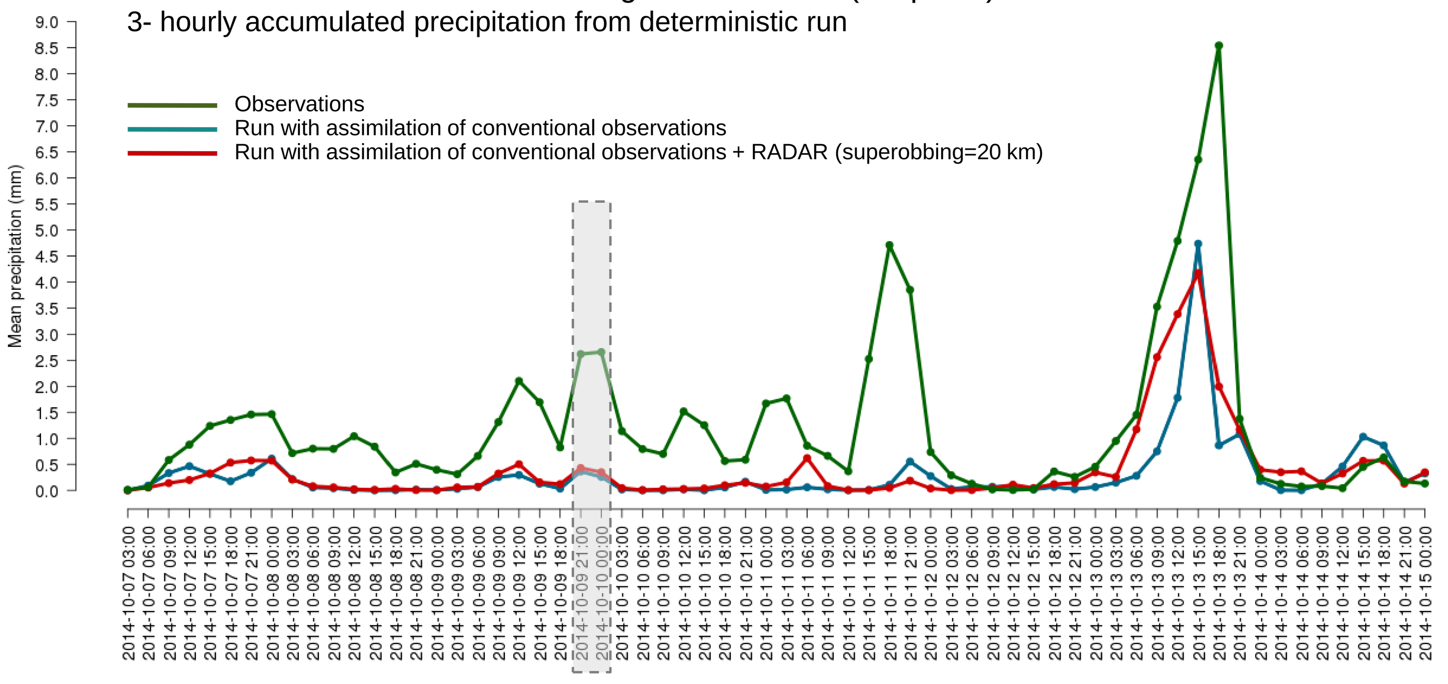
The assimilation of radar volumes (CONV+RADAR) is compared against the assimilation of conventional observations only (CONV).

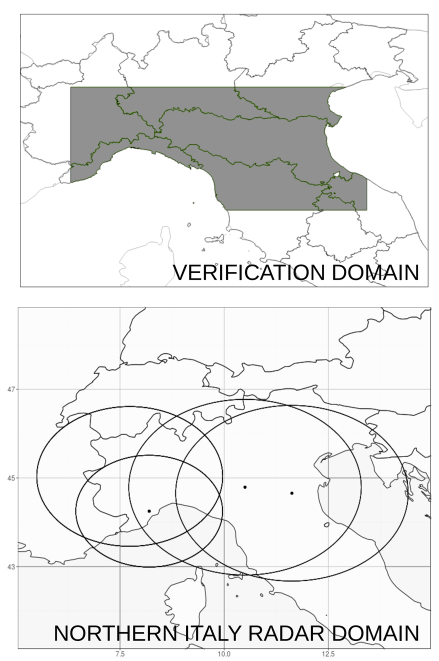



The objective verification, based on the average precipitation over an area, did not indicate a significant improvement. This brought to supplementary analyses.

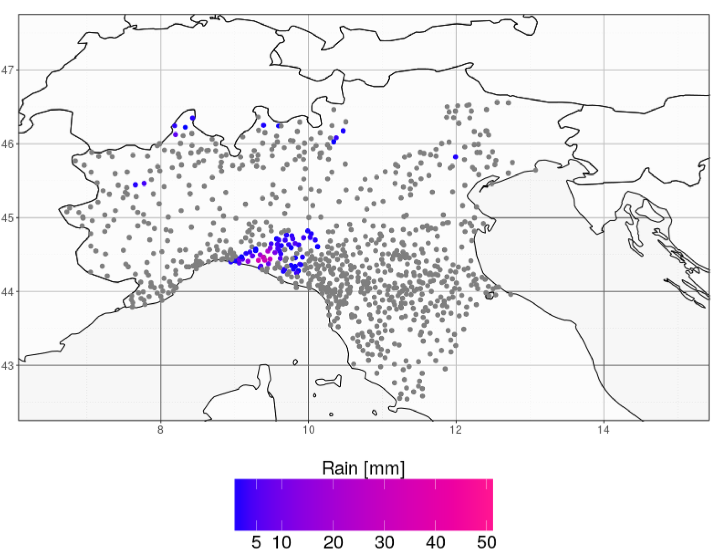
## USE OF THE RADAR OBSERVATIONS INTO THE ASSIMILATION CYCLE

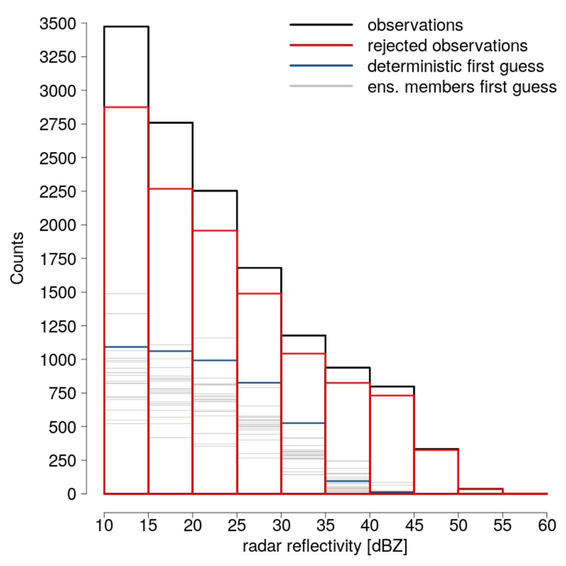
PRECIPITATION ANALYSIS: average over an area (shapefile)
3- hourly accumulated precipitation from deterministic run



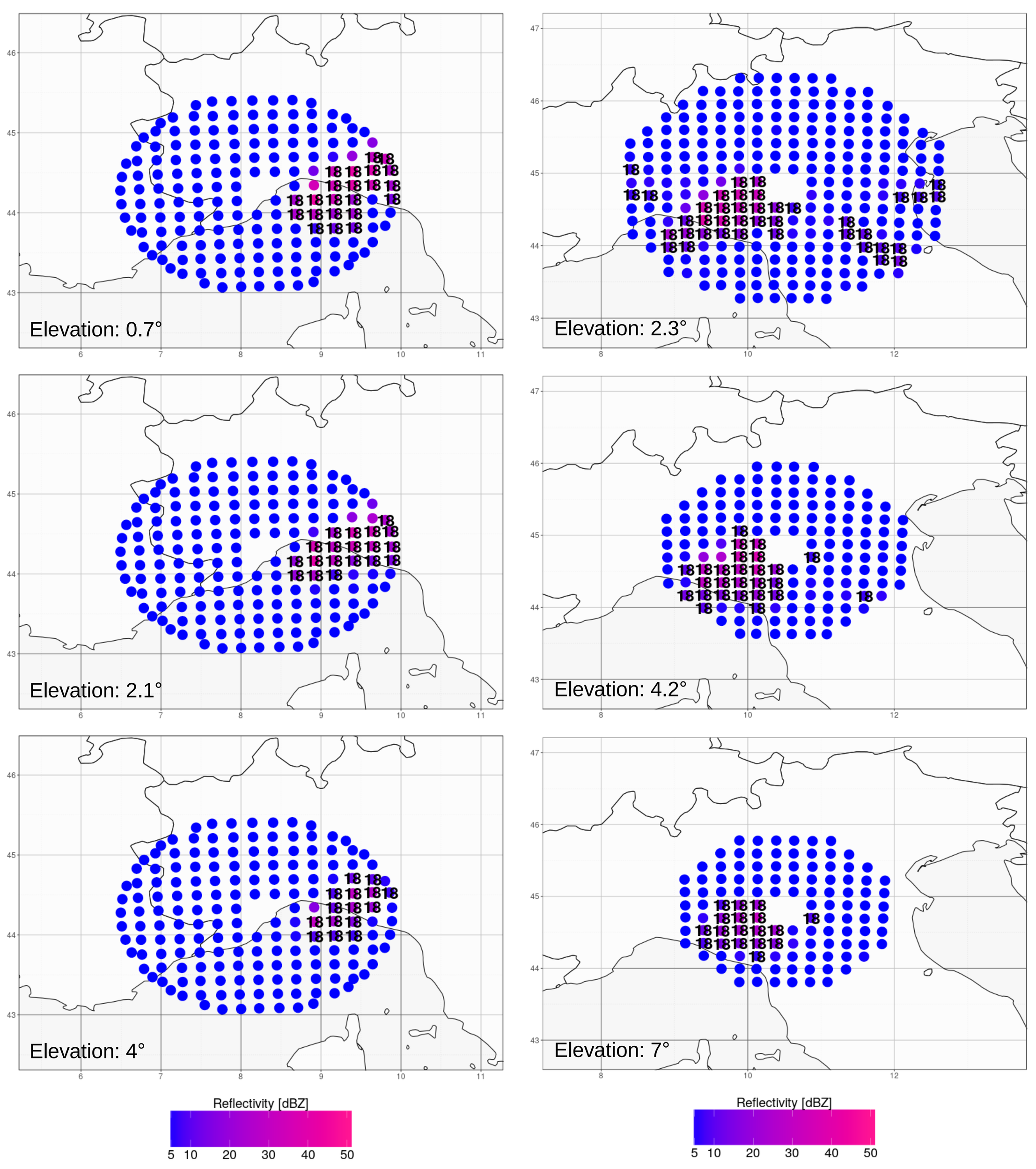




RAIN GAUGES:
3-hourly accumulated precipitation at 10/10/2014 00 UTC



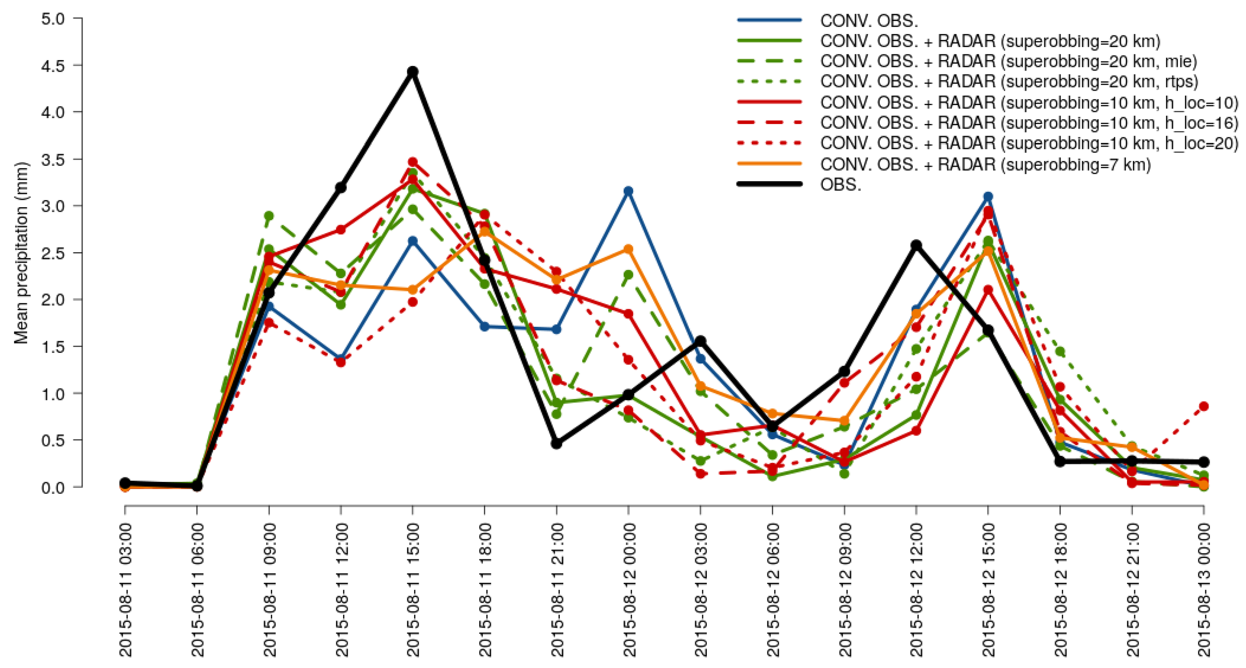

REFLECTIVITY POLAR VOLUMES
Settepani radar
Gattatico radar

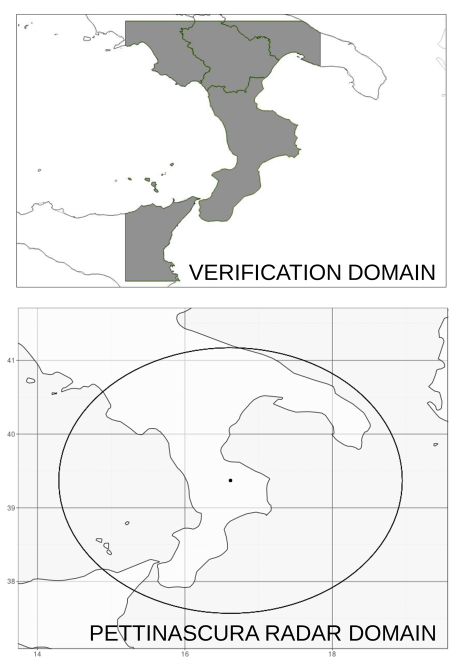



In a case where the model run is dry, the assimilation of radar reflectivity volumes has an impact not significant, even if rain gauges show intense precipitation. The reflectivity fields display that the large part of observations are rejected during the assimilation step, due to a great difference between observed reflectivity values and simulated ones (first guess values). Precipitation signal, that can be recognized as high reflectivity values (purple dots) and at different elevation angles is almost completely discarded.

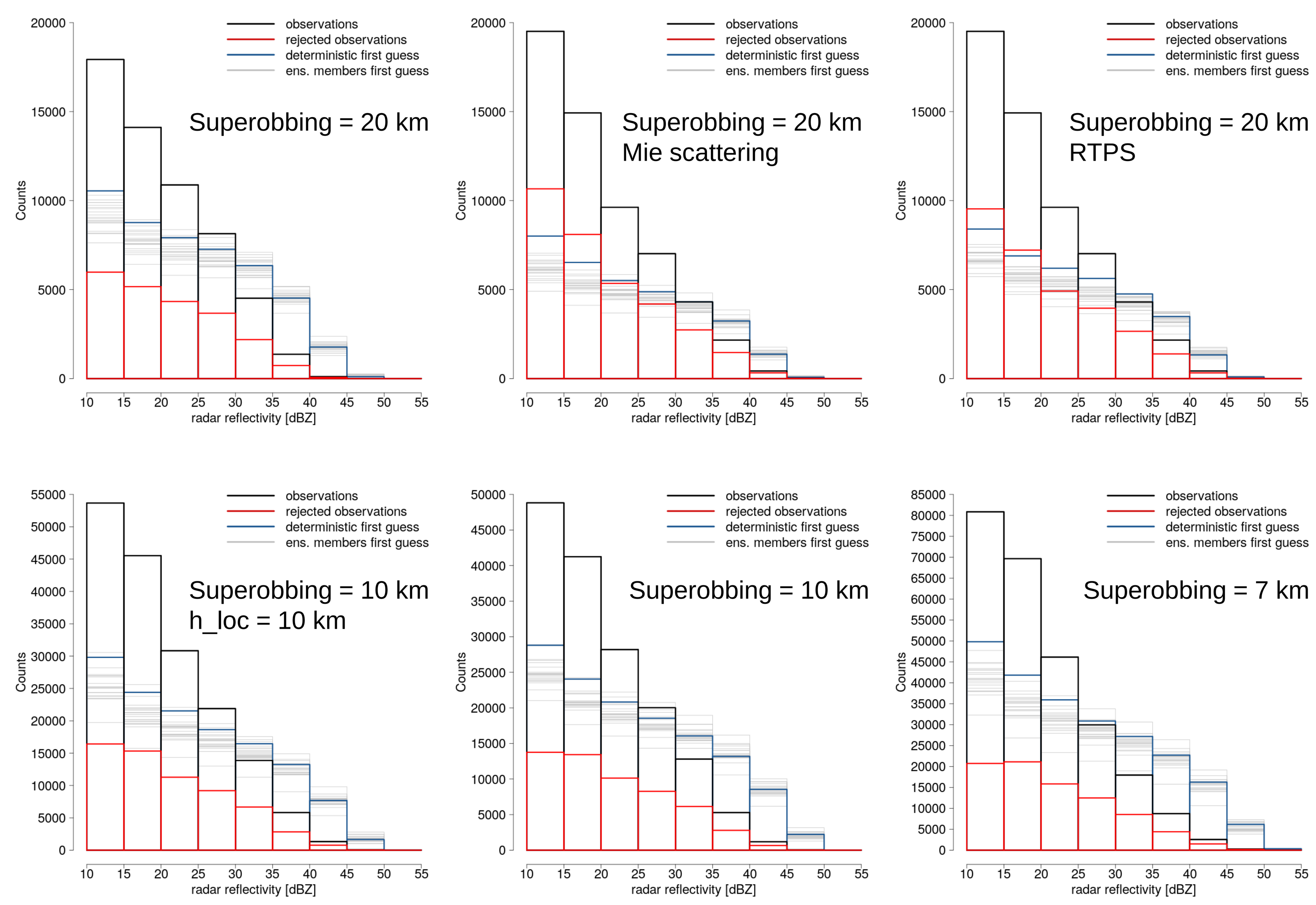
## SENSITIVITY TESTS ON DIFFERENT CONFIGURATIONS

PRECIPITATION ANALYSIS: average over an area (shapefile)




REFLECTIVITY ANALYSIS

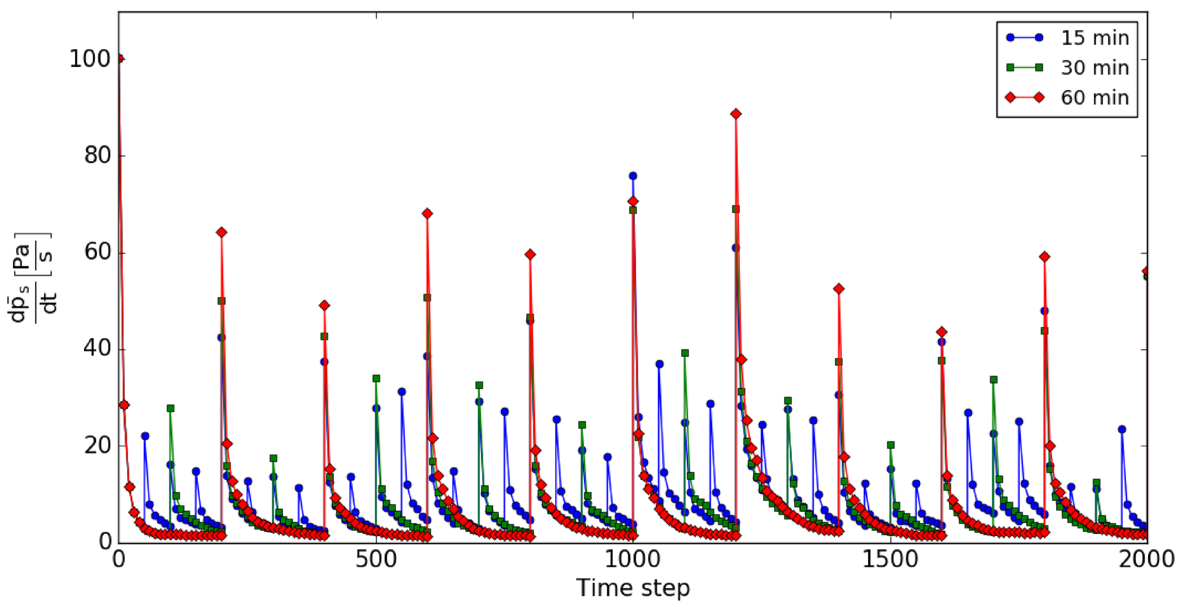


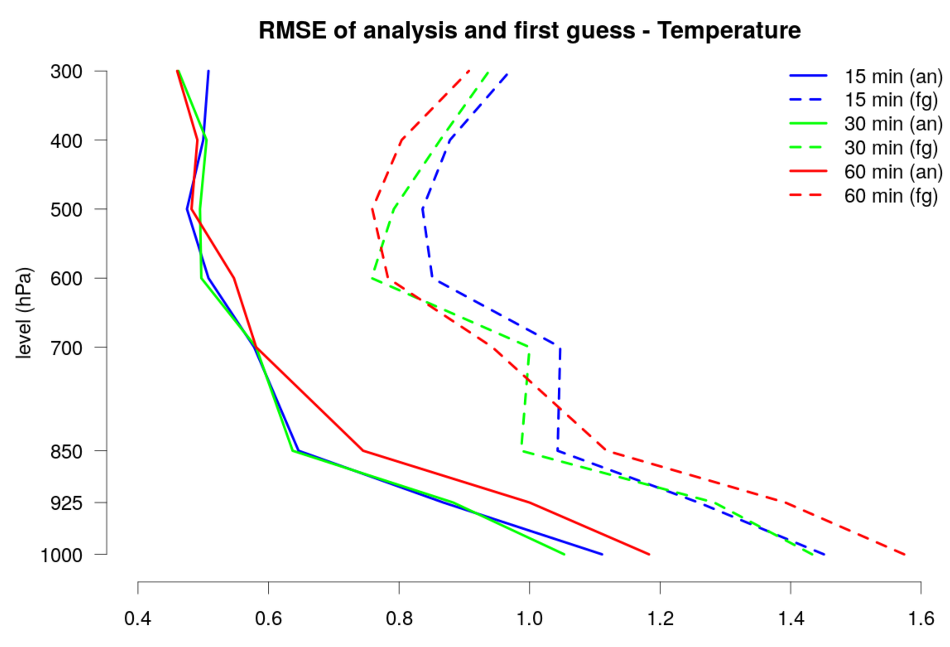

If the model already forecasts precipitation, the assimilation of reflectivity volumes, for most of the different configurations chosen, improves the forecast, with a variable performance. In this case, reflectivity values simulated by the model have a more similar tendency with respect to observations. Nevertheless a lot of observations are discarded by the first guess check. In particular are rejected those observations with higher reflectivity values. Between the different configurations the one with the Mie scattering, set into EMVORADO, is the one with the higher number of rejected points. Horizontal localization parameter into LETKF, instead, do not seem to have a significant impact on the number of dismissed observations.

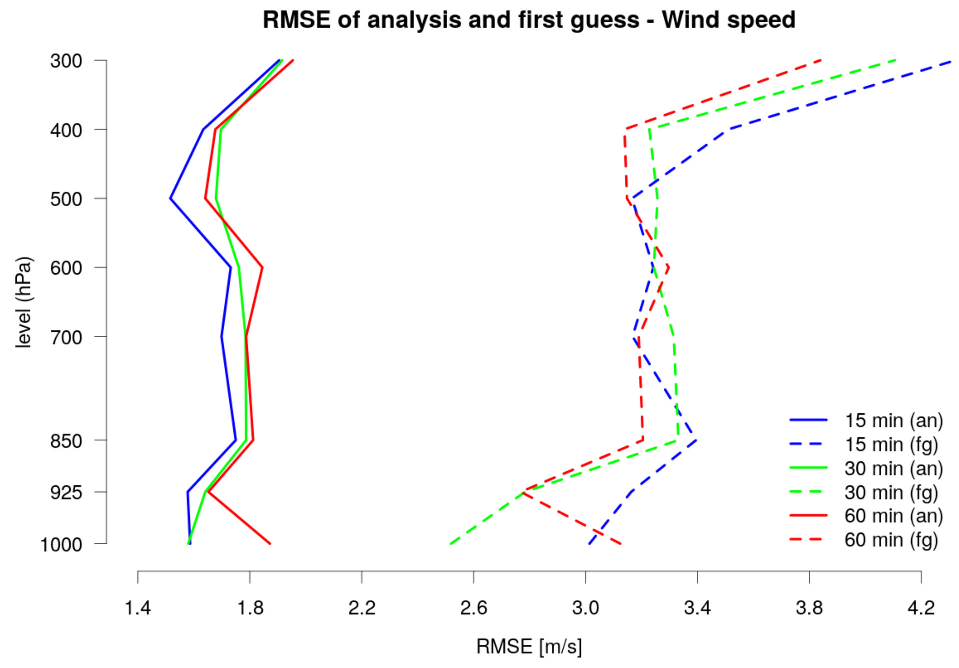
## SHORT ASSIMILATION CYCLES

The next step will be to test the impact of reflectivity data in very short assimilation cycles. For this purpose, hourly and sub-hourly (15 and 30 minutes) cycles have been implemented.

A first test of 18 hours is carried out on the Italian domain assimilating only conventional data and using COSMO at a resolution of 2.2 km. Analyses produced by shorter assimilation cycles are in slight better correspondence with observations but the model is not able to remove the noise introduced by data assimilation before a new analysis is computed. This implies that analyses are physically less balanced and so forecasts initialized with these analyses could lead to worse results.




## FUTURE WORK

Results of the assimilation of polar volumes of radar reflectivity are promising, but some issues require a more detailed examination.

- An investigation of the first guess check will be performed to understand if default check values used into the assimilation step are appropriate for reflectivity observations
- The impact of radar volumes in short assimilation cycles will be assessed to verify the improvements respect to 3-hourly assimilation cycles, focusing on the noise and unbalancing that can be introduced into the analyses
- The use of other radar volumes from the Italian network will imply further tests to find the best combination of EMVORADO and LETKF configurations, to optimize execution time and resources
- The ODIM HDF5 reader should be extended also to radial wind velocity
- A correct management of data quality is needed. In particular, the Italian radar network is managed by different Regional Services and by the National Department of Civil Protection and a common strategy on the definition of quality should be chosen and a homogeneous quality estimation is needed