Statistical analysis of radar reflectivities observed and simulated by EMVORADO

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INTRODUCTION

In the COSMO Consortium (Consortium for Small-scale Modeling), the assimilation of radar data is now on-going into the Kilometer-scale ENsemble Data Assimilation (KENDA) LETKF system by means of the COSMO Radar Forward Operator (EMVORADO). At Arpae-SIMC, the HydroMeteorological and Climate Service of the Emilia-Romagna (Italy), the attention is focused on the assimilation of radar reflectivity volumes.

The off-line version of EMVORADO, i.e. not included in the assimilation cycle, has been implemented to calculate the reflectivity volumes from KENDA analyses in order to estimate the observation error by means of a method based on statistical averages of observation-minus-background and observation-minus-analysis residual.
As a side result, the comparison between the observed and simulated reflectivities allows us to understand how much the values derived by the operator deviate from reality. Hence, the use of the off-line operator makes it possible to verify how the reflectivity distributions vary both using different analyses, coming from various KENDA configurations, and by directly modifying the parameters of the operator himself.

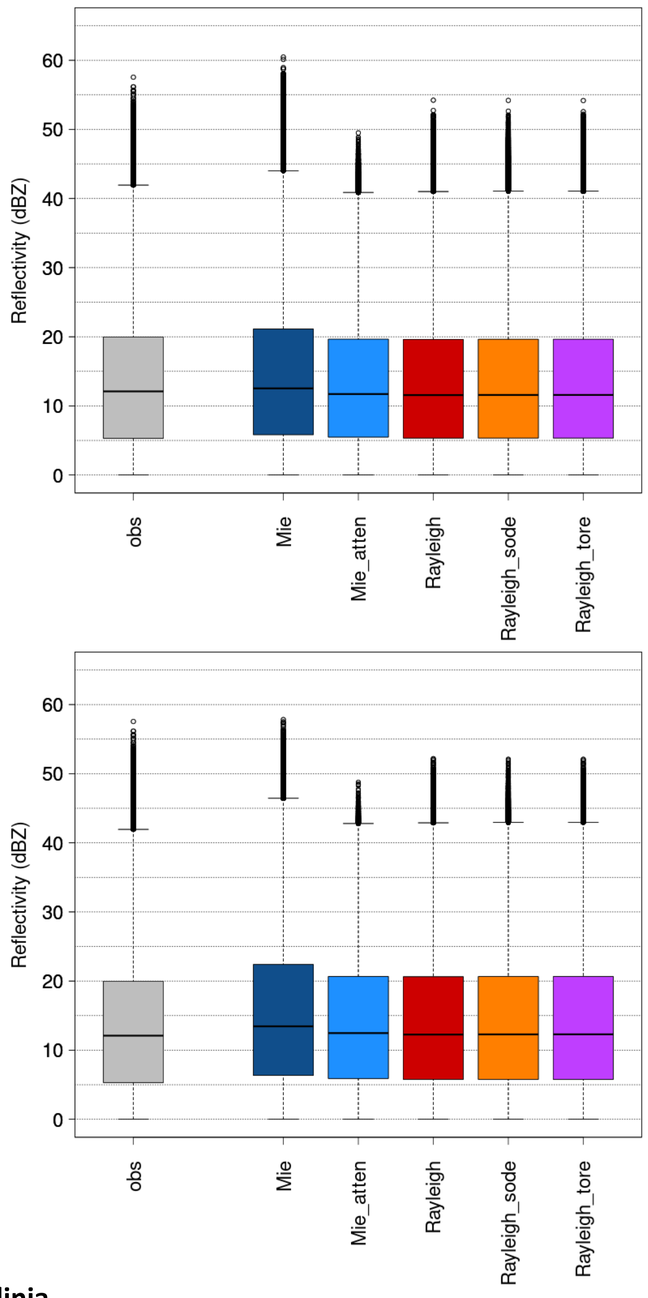
Event	Start of the event	End of the event	Type of event
September 2018	31/08/2018 01:00	09/09/2018 00:00	thunderstorms
October 2018	30/09/2018 16:00	14/10/2018 00:00	thunderstorms and organized convective structures
November 2018	26/10/2018 13:00	11/11/2018 00:00	more stratiform structures with some convective episodes at the beginning of the period

Input analyses

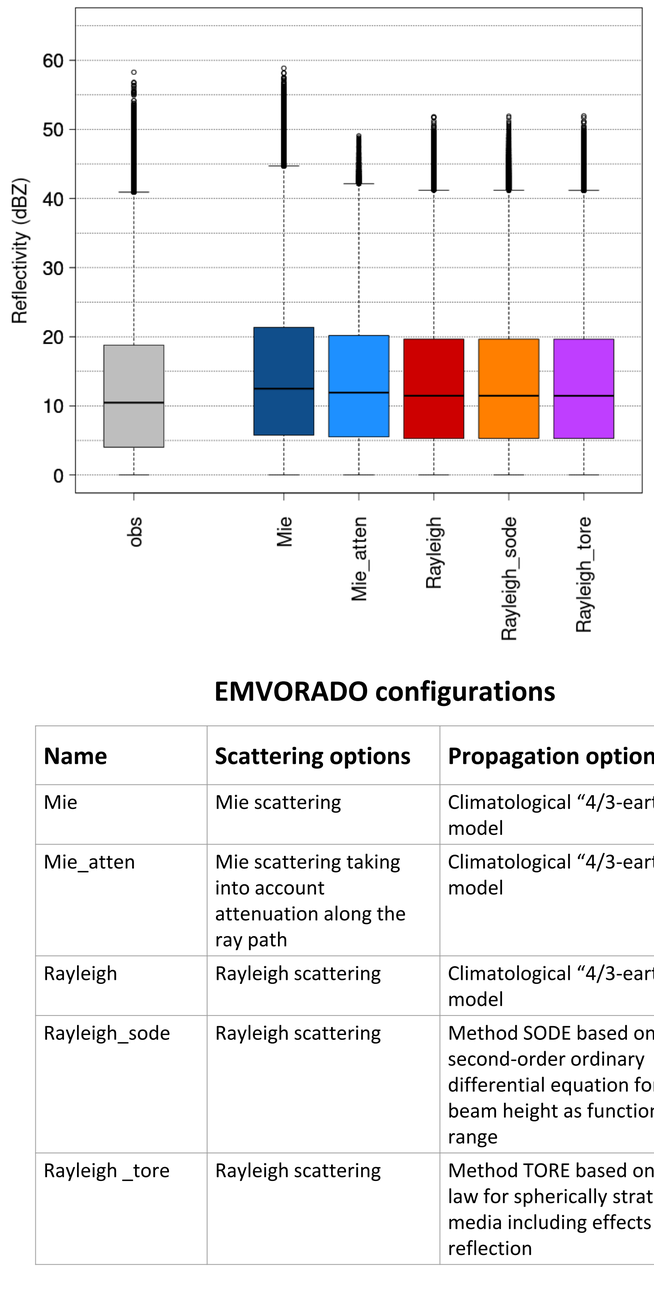
Hourly analyses from KENDA with the assimilation of conventional observations (SYNOP, TEMP and AIREP)

Hourly analyses from KENDA with the assimilation of both conventional data and radar reflectivity volumes at the analysis time

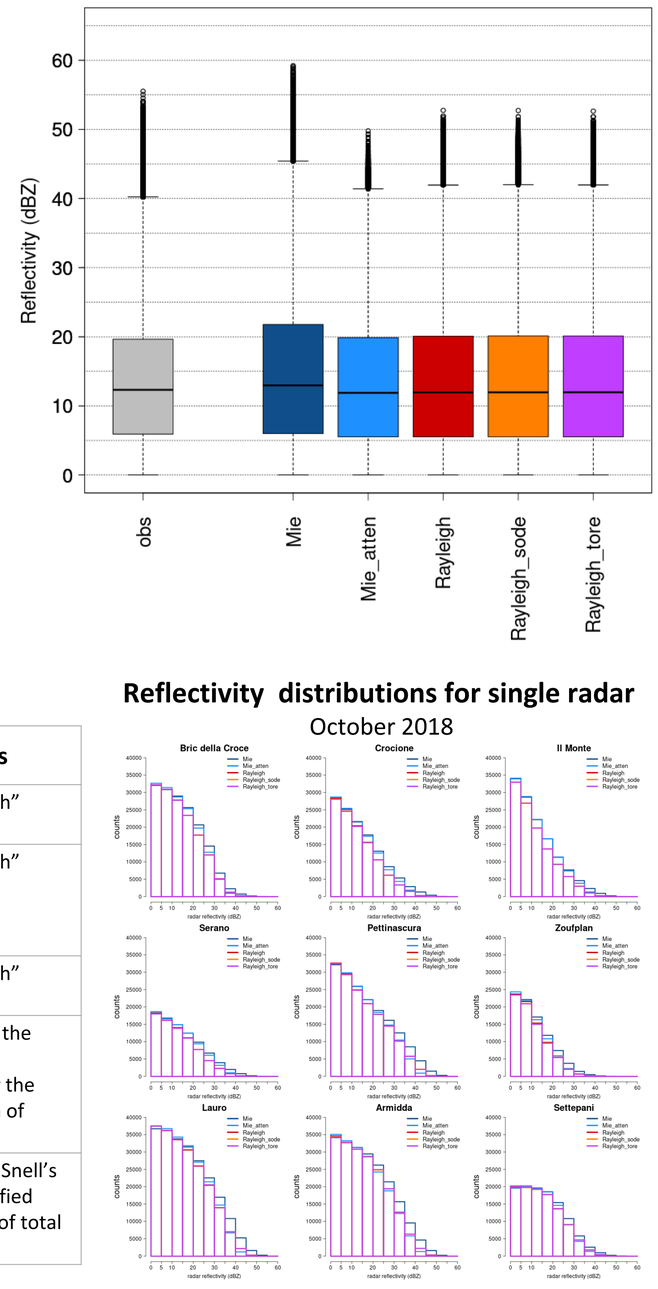
October 2018



September2018



November 2018



EMVORADO configurations

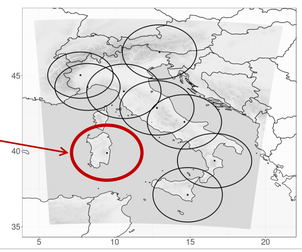
Name	Scattering options	Propagation options
Mie	Mie scattering	Climatological “4/3-earth” model
Mie_atten	Mie scattering taking into account attenuation along the ray path	Climatological “4/3-earth” model
Rayleigh	Rayleigh scattering	Climatological “4/3-earth” model
Rayleigh_sode	Rayleigh scattering	Method SODE based on the second-order ordinary differential equation for the beam height as function of range
Rayleigh _tore	Rayleigh scattering	Method TORE based on Snell’s law for spherically stratified media including effects of total reflection

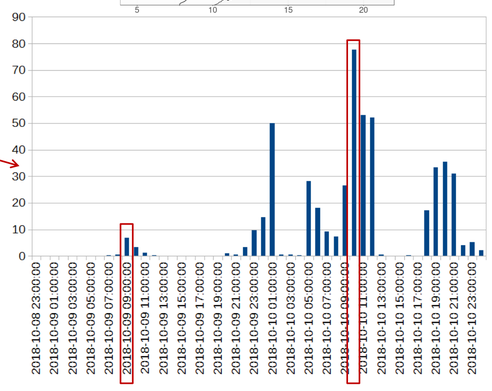
Reflectivity distributions for single radar

October 2018

October 2018 – Flooding in Sardinia

Raingauges: accumulated precipitation
from 09/10/2018 00 UTC to 11/10/2018 00 UTC





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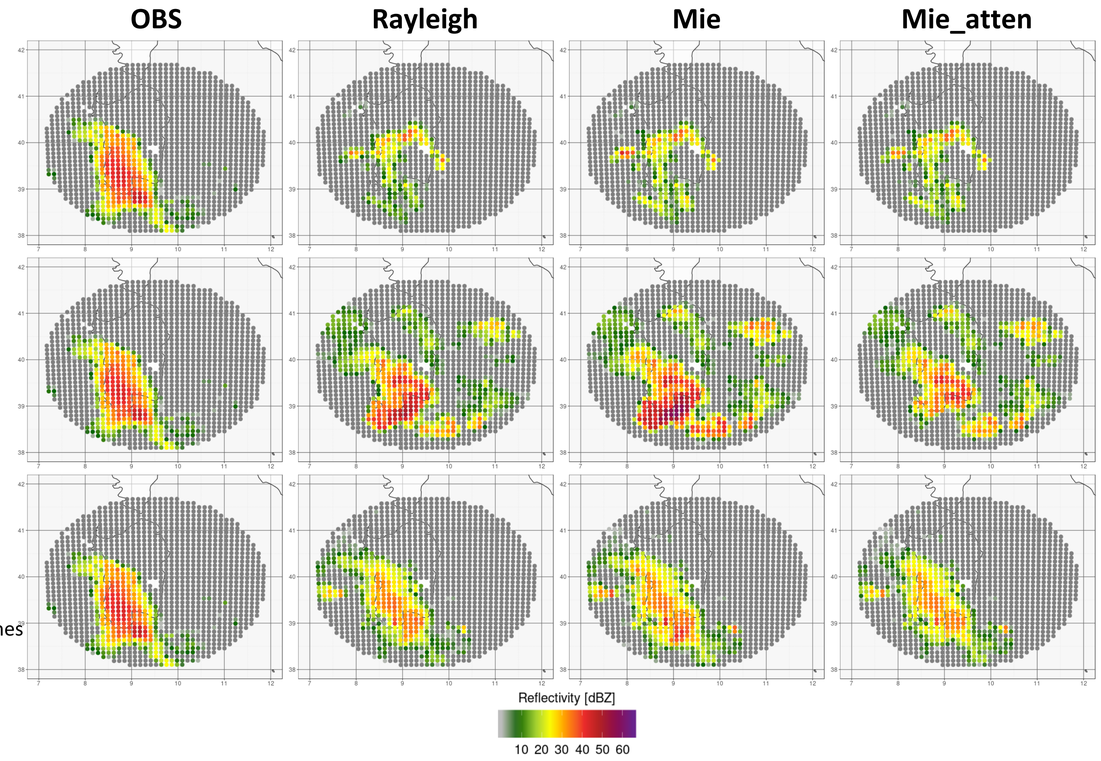
Hourly analyses from KENDA with the assimilation of conventional observations (SYNOP, TEMP and AIREP) and LHN

Hourly analyses from KENDA with the assimilation of both conventional data and radar reflectivity volumes at the analysis time



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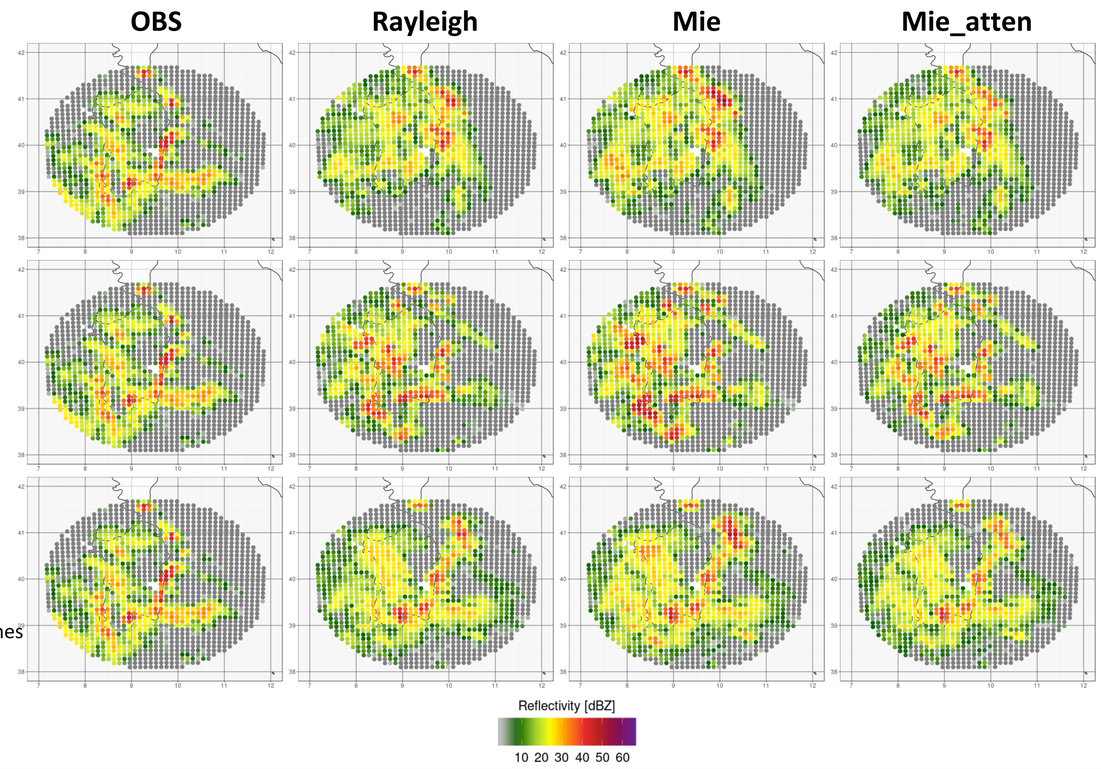

- Structures are better simulated if the analyses come from KENDA with the assimilation of radar volumes
- Simulations starting from analyses in which LHN is used overestimates reflectivities
- Mie simulations tend to overestimate reflectivity values especially when analyses are derived from KENDA with assimilation of conventional observations and conventional observations + LHN
- The use of attenuation improves Mie overestimation by bringing simulations closer to those obtained using Rayleigh scattering
- Comparing simulations with observations for this case study the use of Mie scattering provides the best results

CONCLUSIONS and FUTURE WORK

- The results obtained from this case study deviate partially from what is highlighted by the distributions of reflectivity on all events. In this case, the use of Mie scattering seems to provide the best results, while the distributions show a clear overestimation of the values with respect to the observations
- At the moment the forecasts initialized with KENDA analyses, obtained with the configuration of EMVORADO with Rayleigh scattering , provide a good improvement over the operational runs. However, the Mie scattering will be used for the case studies presented, providing a comparison between the forecasts.