Response to review of an ensemble study of HyMeX IOP6 and IOP7a: sensitivity to physical and initial and boundary conditions

Anonymous Referee #1

The authors wish to thank the anonymous reviewer for his/her constructive comments which led to an improvement in the quality of our paper.

1) Recently, there appeared a number of articles that are very relevant for the present manuscript: please add (and discuss) the following references (from the COSMO community):
* Gebhardt C, Theis SE, Paulat M, Ben Bouallegue Z. 2011. Uncertainties in COSMO-DE precipitation forecasts introduced by model perturbations and variation of lateral boundaries. Atmospheric Research 100: 168-177.

Now included in the introduction in the list of previous studies to have constructed convective-scale ensembles as follows: "More recently, Gebhardt et al. (2011), Clark et al. (2011), Bouttier et al. (2012), Fresnay et al. (2012), Leoncini et al. (2013) and Hally et al. (2013) constructed convection-permitting short-range ensembles."

* Keil, C., F. Heinlein and G. C .Craig 2014: The convective adjustment time-scale as indicator of predictability of convective precipitation. Quart. J. Roy. Meteor. Soc., DOI:10.1002/qj.2143

Referenced and discussed in the conclusion as evidence of the case dependant nature of microphysical perturbations upon simulations of HPEs. "This confirms the results reported in the previous studies of Hally et al. (2013) and Fresnay et al. (2012) and also complements the recent work of Keil et al. (2014), who described the increased impact of physics perturbations in the case of a weakly forced heavy rainfall event."

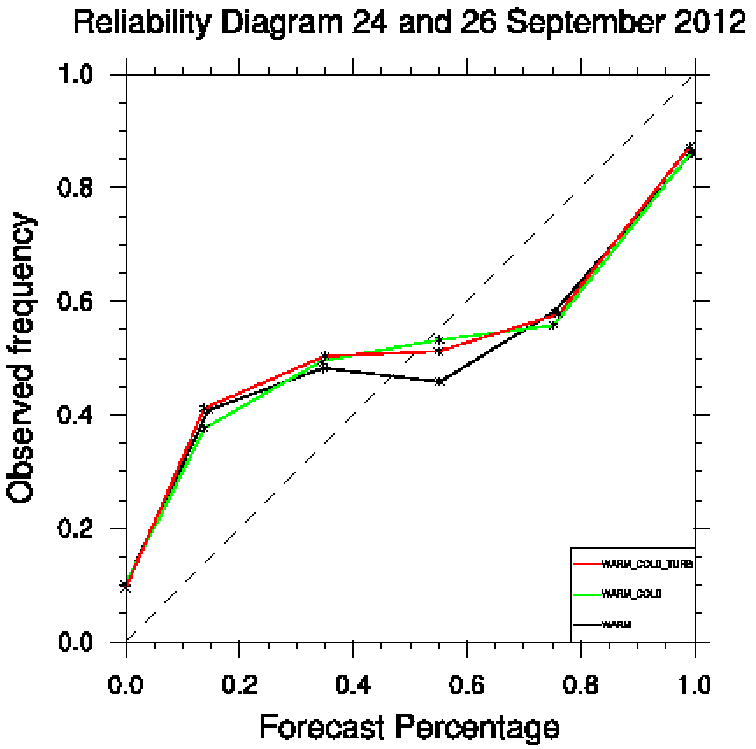
* Kühnlein, C., C. Keil, G. C. Craig, C. Gebhardt 2014: The impact of downscaled initial condition perturbations on convective-scale ensemble forecasts of precipitation. Quart. J. Roy. Meteor. Soc. DOI:10.1002/qj.2238
* Peralta C, Bouallegue ZB, Theis SE, Gebhardt C, Buchhold M. 2012. Accounting for initial condition uncertainties in COSMO-DE-EPS. J. Geophys. Res. 117: D07108, doi:10.1029/2011JD016581.

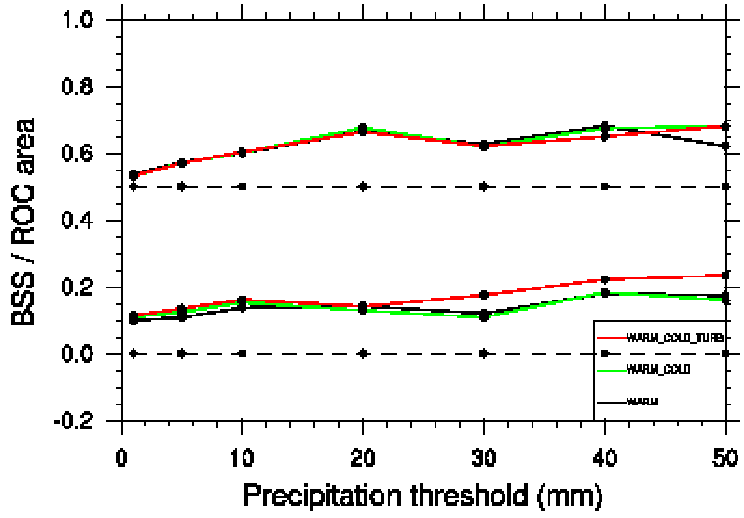
Both of the above references are now included in the introduction and serve to demonstrate the merits of investigating IC and BC uncertainties when constructing kilometric-scale ensembles. "Studies from both the COSMO and AROME communities (Peralta et al., 2012; Kuhnlein et al., 2014; Vi´e et al., 2011, 2012) demonstrated that the simulation of precipitation events is quite sensitive to perturbations upon the IC and BC."

The author thanks the reviewer for bringing these articles to our attention as they were of great value in strengthening the points raised within our manuscript

2) As pointed out above, the results are presently investigated purely in a deterministic manner. The probabilistic perspective would complement this ensemble study nicely, and I recommend to compute probabilistic scores like BSS or ROC (as in Hally2013)?

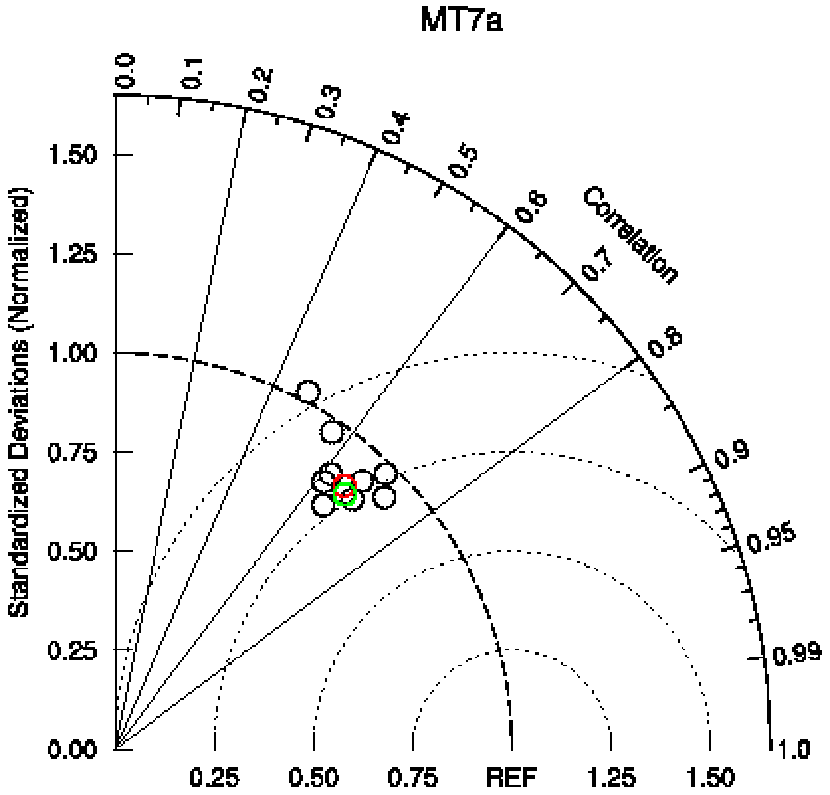
The authors are in agreement with the reviewer on this point and have computed and plotted the probabilistic reliability diagram, BSS and ROC scores for both of these cases. However, the authors are reluctant to add more images to the manuscript. The authors also have some reservations about drawing any meaningful conclusions from such probabilistic scores for solely two days, as they are more usually computed over longer periods and thus with larger datasets, which allows a greater significance to be given to their value. Nevertheless, a reliability diagram along with a plot demonstrating the BSS and area under the ROC curve have been inserted for the benefit of the reviewer.





3) I feel it difficult to discern the tiny differences in the (numerous) Taylor diagrams. Is it possible to condense the information? Could one extract more valuable information from Taylor diagrams based on, say, 3 hourly precipitation sums?

The authors agree that it is difficult to notice the small differences between the Taylor diagrams. Diagrams using 6 hourly precipitation accumulations have been plotted and they show that according to the period of rainfall investigated, the level of dispersion is more (or less). For example, for the IOP7a case, the 6 hourly Taylor diagram of the MT7a ensemble which covers the convective precipitation window gives a lower spatial correlation than the overall 24h Taylor diagram, and it also displays further dispersion amongst its members, suggesting a weaker model skill in forecasting the convective line but also a more important contribution to its development from the microphysical and turbulence processes.



As fairly pointed out by the reviewer, there exists already numerous Taylor diagrams within the manuscript and so the authors do not wish to add others. Unless the reviewer believes the 24h diagrams should be replaced?

4) Do you have an idea why IFS based forecasts are worst for IOP6? Is the resolution difference (16km vs 2.5km) and/or the 6 h availability of BC problematic?

Following further simulations to investigate the relative importance of the IC and BC for this case, it was found that the BC played a very important role in the development of the convective rainfall. This leads us to believe that the 6h

availability of the BC was conducive to the poor quality of the IFS forced simulation for this case.

5) p7745 l 14: Are there more informative (daytime) CAPE observations? Did you look at forecast CAPE values?

The peak in precipitation for this case took place at 02UTC, and thus this was the reason for choosing the sounding at 00UTC on the 24th. However, a sounding performed at 06UTC on the 24th gave a CAPE value of 176 Jkg^{-1} which is indicative of the convective potential that existed and most probably contributed to a second (less intense) precipitation peak observed at 08UTC. This value is now included in the text along with the value from the sounding at 00UTC. "Soundings taken at the Nımes station gave a CAPE value of 57 Jkg−1 at 00:00UTC on the 24 and a value of 176 Jkg−1 at 06:00UTC on the 24."

Forecast values were not taken into account for either of these two cases, but perhaps in hindsight could have been.

6) p7749 l 22: Please define 'normalized standard deviation'.

A definition has now been included in the text following the definition in Taylor(2001). "Taylor (2001) defines this normalised standard deviation as a ratio of the modelled over the observed variability."

7) p7768 Fig.4 and following captions: Please add 'daily' and give respective date.

These have now been included.

8) p7776 Fig 11: ICBC7a

This has been rectified.

Typos: p7745 l 1: omit 'in' p7750 l15: delete once 'were compared'

These typos have been corrected.