Responses to referee#2

General comments

First of all we are grateful to anonymous referee for the great contribution to the manuscript coming from useful comments.

We wanted to take advantage of the numerous Italian Intensive Observing Periods (IOPs) that affected the three Italian Target Areas (TAs) during the First Special Observation Period (SOP1) of the HyMeX campaign, but above all Central Italy (CI). Later, the choice fell on the IOP4 first of all because all the instruments activated was very successful (radar, sodar and microwave sensors were on alert in the Central Italy site from the evening Thursday 13 until Saturday 15 September 00UTC; extra operational soundings were performed on 13 September 18 UTC, 14 September 12 and 18 UTC in L'Aquila) and secondly it was a very interesting case with convective cells producing a remarkable amount of precipitation in a few hours (more than 150 mm) over Central Italy (Coastal Marche and Abruzzo) with precipitation peak of 300mm/24h. The event was quite well forecasted by all models operational during the campaign well in advance, but uncertainties remained until a few hours before the event regarding the exact location and amount of precipitation. Moreover, we didn't find another Italian IOP, among those that have affected Central Italy, with so many radars activated simultaneously to enrich the analysis (for example during the IOP13 Monte Midia radar was out of service, whereas during the IOP16 Polar 55C was affected by some technical problems).

Concerning the novelty we claim, we know that many topics addressed in the manuscript have been already mentioned in previous studies, but except for Maiello et al. 2014, it is the first Italian experiment conducted on the Italian territory using the data of the Italian radars. Nevertheless, we accept the advice to go deeply into the meteorology of the event to see which is its interaction with the data assimilation method and making more explicit links to other work in the HyMeX project (i.e. Ducrocq et al. 2014, Davolio et al. 2015, Llasat et al. 2013).

We hope that the organization of the paper is now improved: section 2.2 has been moved after the presentation of the model configurations; section 4.1 has been shrink to few sentences and figures 6 and 7 have been removed; a table that summarizes the characteristics of the radars has been added. Moreover, several English mistakes have been corrected, the literature review has been updated and the quality of some figures has been improved. Also the title and the abstract have been modified.

Specific comments

Line 1: The word "Doppler" has been removed and the title has been modified as follow: "Impact of Multiple Radar reflectivity data assimilation on the numerical simulation of a Flash Flood Event during the HyMeX campaign"

Line 20: The sentence has been modified as follows: "causing several damages to buildings, infrastructures and roads".

Lines 39-42: We agree with the reviewer that the paper could have a great potential on demonstrate novelty if it is focused on building systems for flood forecasting in the central Adriatic region or central Italy in general. So the manuscript has been rearranged following this idea.

Line 119: Some details about radar format conversion has been added in the text as follows: "conversion to the model format is applied to all radars data (an ad hoc shell script in Fortran

language has been written and adapted to each radar characteristics)." See the response to a comment of referee1 for a detailed explanation about the format conversion of SYNOP and TEMP.

Line 179: The following sentence has been added in the text: "T+24 minus T+12 is typical for regional applications; it is important to include forecast differences to remove the diurnal cycle."

Lines 232-238: The statistical indexes used in this study are the ones commonly used for meteorological study, anyway you can find more details in the MET Guide (Developmental Testbed Center, 2013: MET: Version 4.1 Model Evaluation Tools Users Guide. Available at http://www.dtcenter.org/met/users/docs/overview.php. 226 pp.). The reference will be added in the lines 251-253.

Line 279: The meaning of the sentence here is the following: we found that when the assimilation is performed on the highest resolution domain only few SYNOP and even less TEMP fell down in the 3km domain at the analysis time of the assimilation procedure. For example after applying the WRFDA Observation Preprocessing procedure only a total of 338 observations (331 SYNOP and 7 TEMP) have been ingested into the D02 (Italy), compared to a total of 989 (967 SYNOP and 22 TEMP) into the D01 (Europe). In Italy (D02) we don't have a sufficiently dense observation network, above all of TEMP data.

Lines 306-310: We agree with the reviewer; the sentence has been modified as follows: "In summary, simulations results show that the assimilation of conventional data is better to perform on the lowest resolution domain because more observations were used in the coarser domain, whereas when the assimilation is performed on the highest resolution domain only few SYNOP and even less TEMP fell down in the 3km domain at the analysis time of the assimilation procedure."

Line 336: The sentence here has been rearranged as follows: "However, this work was an interesting study in 3D-Var reflectivity data assimilation that can encourage to investigate more flash flood cases occurred over central Italy, in order to make this proposed approach suitable to provide a realistic prediction of possible flash floods both for the timing and localization of such events. To confirm and consolidate these initial findings, apart from analyzing more case studies, a deeper analysis of the meteorology of the region and of the performance of the data assimilation system throughout longer trials in a "pseudo-operational" procedure is necessary."

Figures 6, 8 and 10: Figure 6 has been removed as suggested by referee1. Figures 8 and 10 have been improved.

Technical corrections:

Line 22: Done

Line 22: Done

Line 25: Done

Line 29: Done

Line 30: Done

Line 33: The sentence has been modified as follows: " the accuracy of the mesoscale NWP models is mostly dependent on "

Line 34: Done

Line 87: Done

Line 93: Done

Line 94: Done. The acronym CI has been already defined in line 68.

Line 108: Done

Line 112: Done

Line 176: The sentence has been modified as follows: " strongly depends on the quality "

Lines 185-186: The sentence has been modified as follows: " The previous coarser resolution WRF forecast at 00:00UTC is used as the first guess (FG) in the 3D-Var experiment, because 00:00UTC has been selected as the "*analysis time*" of the assimilation procedure."

Line 214: Done

Lines 248-250: The sentence has been modified as follows: "Observing the outputs of different experiments (Fig. 8) listed in Table 2, best simulation is found for CONMMPOLSPC_LR_12KM (black arrow in Fig.8e): the rainfall maximum over Campo Imperatore is very well simulated, however a cell displacement is noticeable. Furthermore the precipitation feature along the coasts (black oval) is also forecasted."

Lines 264-265: The sentence has been modified as follows: "In order to investigate the impact of the assimilation at different resolutions, we analyzes.... "