Interactive comment on "Effects of Multiple Doppler Radar data assimilation on the numerical simulation of a Flash Flood Event during the HyMeX campaign" *by* Ida Maiello et al.

Anonymous Referee #2

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General Comments

The subject of the paper, describing experiments in radar data assimilation for a numerical weather prediction model to forecast a flash flooding event, is within the scope of HESS. This is an area where there is great potential for improved flood forecasting. I agree with many of the points made by the first anonymous referee. The area claimed as novelty in the paper, regarding the use of multiple radars with a high resolution forecast in complex orography, has been explored previously, as discussed by the first referee, and the study uses existing techniques and tools to analyse the case study presented. A stronger case for novelty could be made by exploring the meteorology of the case study in more depth, and making more explicit links to other work in

the HyMeX project. The conclusions are limited to the performance of different model configurations within the single case study, which may be useful in providing guidance for the development of a flood forecasting system in this context, but do not provide a significant contribution to the knowledge of the wider community. The methods used to investigate the case study are appropriate, but the case could have been explored in greater depth, with a greater focus on the interaction between the data assimilation system and the meteorology, for example an analysis of the data assimilation increments. Further, a number of statistical scores are produced, but the meaning of these indices, and their significance in a single case study, is not discussed. In a number of cases more detail could be given, for example the method by which radar data is mapped to the model grid. The paper does not indicate the use of Doppler velocity observations, and therefore the word Doppler should be removed from the title. The abstract is generally clear, although the stated aim to establish a general methodology to quantitatively assess the performance of a numerical weather prediction system exceeds what is demonstrated in the paper. I agree with the reviewer that the paper would be clearer if the model framework were introduced before section 2.2 on observations, which refers to the model domains before they have been introduced. There are a number of mistakes in the English spelling and structure of sentences, and I suggest that the paper would benefit from proof reading. I have identified some of these errors in the technical comments below. The literature review does not represent the breadth and extent of previous work in this area. The first reviewer has suggested a number of citations relating to previous work using WRF-3DVAR in particular. I would further suggest that the 3D-VAR technique used be put into the broader context of data assimilation methods used for radar data, such as latent heat nudging, 4D-VAR, and ensemble based methods, with consideration of the advantages and disadvantages of the particular technique used. A number of the figures are rather poor quality and could be improved by the use of higher resolution images. In summary, I would suggest:

(1) a detailed analysis of the meteorology of the case and the interaction of the data assimilation method with the model state,

(2) linking this paper more explicitly to its context within the HyMeX project,

(3) a more extensive literature review, considering the range of data assimilation methods which have been used for radar data,

(3) and proof reading the paper for quality of English.

Specific comments

Line 1: Remove Doppler from the title, this is misleading.

Line 20: "several damages" Be more specific, damage to buildings, infrastructure.

Lines 39:42 The citations here show an interest in the local context of the Adriatic region. If the focus of the paper is on building systems for flood forecasting in that region, for which this paper has greater potential to demonstrate novelty than in the demonstration of radar data assimilation techniques which already well documented in the literature, then this should be made more explicit, and the meteorology of the region and operational flood forecasting systems described in more detail.

Line 119: Please give some details of the format conversion.

Line 179: A comment on why 12 hour differences were used would be useful.

Lines 232:238 A number of statistical score values are listed, but the meaning and significance of these scores in these contexts is not considered.

Line 279: It is stated that a smaller number of conventional observations were ingested into the finer resolution domain than the coarser domain. Why is this? I would typically expect observations to be used at higher density with a finger resolution model.

Lines 306:310. I believe it is important to qualify the summary statement that the assimilation of conventional observations performed better with the coarser domain with the fact that more observations were used in the coarse domain model.

Line 336: I would describe the work in the paper as an interesting study in 3D-VAR

reflectivity assimilation in a flash flood case, which could be investigated further. I am not sure the paper presents a general approach. I agree that longer trials would be more informative, assuming that is what is meant by "pseudo-operational", as well as more in depth analysis of the meteorology and performance of the data assimilation system.

Figures 6, 8 and 10: These figures are quite low resolution and notably blurred. Sharper images would be clearer.

Technical corrections

Line 22: "multiple horizontal resolution" should be "multiple horizontal resolutions"

Line 22: "multiple radars data" should be "data from multiple radars"

Line 25: "rain gauges data" should be "rain gauge data"

Line 29: "recognized" recognizes

Line 30: "the very short term" "the" is unnecessary

Line 33: "subjected to" perhaps "limited by"?

Line 34: "Several researches" studies

Line 87: "It is worthwhile to point out" This is a redundant phrase and should be removed.

Line 93: intense precipitation which occurred

Line 94: "Zoom over CI target area" The zoom over the CI target area. Also CI is not defined.

Line 108: Define ISAC-CNR in the text

Line 112 "As is common knowledge" is rather informal and should be removed.

Line 176: "widely depends on the goodness" strongly depends on the quality?

Lines 185:186 This is unclear, I am not sure what is meant.

Line 214: "cover" coverage

Lines 248:250 "attempt" is not an appropriate word for describing a model forecast. Simply state whether a precipitation feature is forecast or not and evaluate its location and intensity.

Lines 264: 265 "Aiming to..." and "we start analyzing" is rather informal language.