Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-320-RC1, 2016

Hydrology and Earth System Sciences
Discussions

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 #1

Received and published: 18 August 2016

General comments

The manuscript describes data assimilation experiments of radar reflectivity observations with a view to improving the prediction of flash-flood events. This topic is an area of active research and it is at the core of hydro-meteorological research. Therefore, the paper undoubtedly fits within the scope of *HESS*.

However, the scientific significance of the paper seems quite low. The study is done for one single case, only one analysis is performed, and the tools (WRF ARW and its 3D-Var data assimilation system) are used without any clear novelty. The authors

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claim that the novelty lies in the use of *multiple* radars in a *complex orography* to predict *intense precipitation*. Many studies have already addressed these points. WRF 3D-Var has been around for more than one decade and numerous reflectivity data assimilation studies of heavy-rainfall cases have been performed with it (e.g., Ha *et al.* 2011; Kiran Prasad *et al.* 2014; Maiello *et al.* 2014; Das *et al.* 2015, to cite a few of them), including with *multiple* radars and *complex orography* (e.g., Lee *et al.* 2010; Liu *et al.* 2013; Schwitalla and Wulfmeyer 2014). All the topics addressed in the manuscript have somehow been mentioned in previous studies. The impact of partial beam blockage has been reported by Chang *et al.* (2014). The sensitivity to the outer loops has been studied by Hsiao *et al.* (2012) and Maiello *et al.* (2014).

In the abstract, it is stated that the 'main goal is to establish a general methodology to quantitatively assess the performance of flash-flood numerical weather prediction at mesoscale'. However, I do not see anything in the manuscript but Observing System Experiments, which is a well-known framework to evaluate the impact of observations in a NWP system.

Furthermore, the results are limited to maps of quantitative precipitation forecasts and relating scores. Though statistical scores could suffice for a study bearing on a long time period, a single-case study should go more deeply into the data assimilation process and its relationship to the physics of the meteorological situation. For instance, what is the impact of the different configurations on the initial conditions? What is going on during the minimization step when the outer loop strategy is chosen? What are the consequences on the analysis? etc.

In short, I suggest the authors *i)* make their incremental contribution to the field more obvious and *ii)* investigate the data assimilation process itself directly and determine how the observations actually modify the initial state and what it implies for the short-range forecasts.

The organization of the paper could be improved. In section 2.2, assimilated observations are presented with some detail (amount of ingested observations), but the reader does not yet know in which domain(s) and at which hour(s) the data are assimilated. I suggest moving this section after the presentation of the model configurations (section 3.3).

Specific comments

- l 1: The title is misleading. The term 'Doppler' is used whilst no radial velocity is used. I suggest to drop it.
- l 16: I do not think that 'flash-flood numerical weather prediction' means anything sensible. In any case, there is no flash-flood forecasting in the manuscript.
- ll 31-34: The accuracy of model forecasts also depends on the model itself.
- l 53: Are there any references for 'HyMeX' and/or 'SOP1'?
- l 71: 'During IOP4' is not much specific. When did it occur?
- l 78: Are there any references for DEWETRA?
- ll 102-111: A table summarizing the characteristics of the radars would be welcome. Why is radial velocity not assimilated?
- ll 112-119: Is there any thinning applied to the reflectivity data? How is the conversion to the model format performed? Does it mean that the resolution of the data is the same as that of the model?
- l 130: The term 'independent' is at least ambiguous here because running the model over the innermost domain requires boundary conditions from the model

running over the outermost domain. So the run over the innermost domain actually depends on the run over the outermost domain.

- ll 150-152: Data assimilation is not restricted to 'atmosphere and ocean'.
- l 162: I do not understand the word 'fonts' in this context. Maybe 'sources' is meant here?
- l 165: What is 'pseudo' relative humidity?
- l 171: Can the authors briefly comment on the inconsistency between the drop size distributions in the observation operator and in the microphysics scheme of WRF?
- ll 200-205: The experiment names in the text and in table 2 are not consistent. What does LR (and later HR) mean?
- ll 221-241: If the goal of the paper is to evaluate the assimilation of radar data as the title suggests it, section 4.1 should shrink to one sentence or two at most, and figures 6 and 7 should be removed.
- ll 251-253: The authors should recall how the statistical indices are computed or mention references. I do not understand what is plotted in figure 9. When do the precipitation accumulations start and stop? It is written 'MEAN' and '2012-09-14 12:00:00 to 2012-09-16'. Does it mean that the scores are averaged over various forecast ranges?
- ll 251-253: The results are not as clear-cut as the authors claim it, and thus should be tempered. How many data points are used to compute the scores for 50 mm?
- ll 277-280: I do not understand why the ingestion of conventional observations produces the worst results.

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- ll 307-309: Why is reflectivity in blocked regions neither corrected nor filtered out?
- ll 336-337: Well, the assimilation of radar data is already operational at several national meteorological services. The Korean Meteorological Administration has been doing it with WRF-3DVar since 2006! (see Xiao *et al.* 2008)
- ll 392-393: The paper has been published and the reference should be updated.
- l 397: 'Su' should be replaced with 'Sun'. The references should be checked carefully because there are other typos here and there.
- Fig 1: The quality (legibility) of the figure should be improved. Which model is shown? In the bottom panel, it should be specified what corresponds to isolines and colour shades, respectively.
- Fig 2: What do the coloured circles represent?
- Fig 3: Units and a scale are missing.

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