

Interactive comment on “A study on weather radar data assimilation for numerical rainfall prediction” by J. Liu et al.

J. Liu et al.

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The anonymous reviewer #1 has raised some interesting points and here are our reflections on them. Further discussions on them are welcome.

Point 1: The use of the English language, particularly in Introduction, should be improved.

Reply : We have already found some minor grammatical errors in the manuscript. Generally, they do not cause difficulties for international readers to understand the paper. The manuscript will be further checked and polished in its revised edition.

Point 2: The literature references do not seem to be fully up to date. In particular, ref-C4858

erences to important recent work on radar rainfall nowcasting from MeteoSwiss (Germann et al.), McGill University (Zawadzki et al.) as well as UPC Barcelona (Berenguer et al.) is lacking.

Reply: Many thanks for providing the updated literatures. We have gone through them and found that they are complementary to the study in some extent. Literatures of the three people will be added in the manuscript in the revised edition. However, it should be noted that this study mainly deals with the assimilation of radar data in numerical weather modelling, rather than nowcasting using only radar images. A good literature review for improving WRF performances by assimilating radar data can be found in the introduction part of this paper.

Point 3: Where do the coefficients in the observation operator (Eq.(2)) come from? How appropriate are they for the climatological conditions in Southwest England? What could be the potential bias and uncertainty associated with these coefficients and how would they affect the presented results?

Reply: Eq. (2) is the formula adopted in WRFDA, which is beyond the control of WRFDA users. However, the concerns raised by the reviewer are valid and should be a research project by itself. We are planning to collaborate with the WRFDA team in the future to explore those issues.

Point 4: What is the influence of resampling the radar rainfall data on 2x2 km and 5x5 km cartesian grids (Section 3.3) instead of using the original polar data? Why is the potentially important information contained in the vertical profile of reflectivity (which could have been derived from the original volume-scan reflectivity data) not employed in the presented data assimilation study? In summary, can such a relatively old (albeit well documented) radar rainfall dataset (from the mid 1990's) still be employed to present the state-of-the-art when it comes to radar rainfall data assimilation in NWP-models in the year 2012?

Reply: This study is for hydrologists to use data assimilation for improving real time

flood forecasting. In the UK, the weather radar data received by the Environment Agency does not include polar data format (only 2km and 5km Cartesian grids are available). Also, multiple-vertical scan data is not available to hydrological users. The study is aimed at using the data available to hydrologists instead of all the data available to radar operators. As to the 'old' data, it should be pointed out that the national radar network in the UK nowadays employs the same C-band radar network as in the late 1990 and there have been no major breakthroughs in improving radar data quality since then.

Point 5: How appropriate is the employed Z-R relationship (Eq.(3)) for the climatological conditions in Southwest England? What could be the potential bias and uncertainty associated with these coefficients and how would they affect the presented results?

Reply: Eq.(3) is the standard equation used in radar rainfall conversion. Z-R relation is a very complex issue and there are numerous studies on Z-R relations. It would make this study intractable if we consider all the complications with various Z-R relations.

Point 6: The authors state that "[...] catchment areal rainfall [is] obtained by averaging the rain gauge observations using the Thiessen polygon method. It is treated as the ground truth for evaluating the WRF results". It seems to be doubtful to assume the classical Thiessen polygon method to represent the method of reference in the presented data assimilation framework, as if more appropriate geostatistical (kriging) methods would not have become available over the past decades. In particular, such methods would allow a quantification of the associated uncertainty in the interpolated rain gauge fields, an important aspect which is not treated in the current study.

Reply: There are numerous rainfall interpolation and average schemes (such as Kriging, reciprocal-distance-squared, shepherd method, thin plate, B-cubic spline, temporal-spatial model,...) and even Kriging itself is divided into universal Kriging, ordinary Kriging, Cokriging, etc. Therefore, it is a research topic itself to choose the best scheme for the Brue catchment. However, this study is about catchment average rain-

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fall for hydrology. With 49 rain gauges over 135 sq km, the classical Thiessen polygon method should be sufficient to work out the catchment average rainfall.

Point 7: Finally, although the authors claim to attempt to present an analysis of radar rainfall assimilation in NWP-models from a hydrological perspective, they do not treat the important aspect of the hydrological application of their results, e.g. in hydrological modeling and/or short-term hydrological forecasting (nowcasting).

Reply: As mentioned in 'Introduction', this study is about short term rainfall forecast on a catchment scale, which is of interest to hydrological applications such as real time flood forecasting. In contrast, many similar studies have been focused on other hydrometeorological variables at synoptic scales which are of less relevant to hydrology.

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