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Hydrology and Earth System Sciences Discussions

Interactive comment on "

Potential of high-resolution detection and retrieval of precipitation fields from X-band spaceborne Synthetic Aperture Radar over land" *by* F. S. Marzano et al.

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The paper is interesting and brings about new results in estimating rainfall fields from

XSAR sensors. The authors succeed in demonstrating the value of their proposed method. However, a number of points need clarification before the paper be considered for final publication. »> We thank the reviewer for the substantial appreciation of the work.

Major comments The applicability of high-resolution rainfall analyses with SAR imagery to improve over passive microwave estimates is far from being duly demonstrated. While the reviewer recognizes that new insights are provided by using any kind of sensor, the discussion in the Introduction on the problems of passive microwave estimates in view of SAR based estimates is debatable and not exactly demonstrated by the work discussed in the paper. I would thus avoid expanding on this subject. Moreover, the "incipit" on the assimilation at high resolution makes the reader think that SAR is going to improve over existing retrieval systems and methods. Well, this isn't true at present, given the development stage of the algorithms and also the orbit repetition time. So, please lower the expectations as it is only proper at this early immature stage. »> We have incorporated into the new version of the Introduction the suggestion of the reviewer by i) recognizing the initial stage of XSAR retrieval exploitation; ii) specifying the role of XSAR rainfall estimation together with its potential (i.e., high-spatial resolution access to remote regions, non-instrumented areas, ocean surfaces and mountainous regions) and limitations (i.e., low temporal resolution or repetition period due to limited swath, typically less than 200 km, and orbit duty cycle, typically less than 20%).

The two cases are discussed at two different levels of detail. The second one over Italy is more or less completely described with figures and all the appropriate evidence. On the contrary, the first one is more or less sketched and needs reworking. For example, I might miss something, but Fig. 2, 3, 4 and 5 are never cited in the text. Why are they included? »> We are very sorry! When correcting the proofs we did not realize that Figs. 2 to 5 were not cited: these figures were indeed cited in the original text as they illustrated the case study from space using TRMM, TSX and showing the rain rate retrieval results. We have amended this proofreading error re-inserting the text below: “Fig. 1 shows the ground-based NEXRAD National Radar Reflectivity mosaic at 12:00 UTC (corresponding to TSX observation). The spiral cyclonic signature of the Hurricane “Gustav” is quite evident and a significant enhancement of reflectivity over Louisiana and Mississippi is also noted. In the next hours NEXRAD imagery showed a slight increase of the hurricane activity with a relative small shift northwestward in the 15:00 UTC NEXRAD image. Fig. 2 shows the available TRMM satellite observations whose time sampling is dictated by the inter-tropical low-Earth orbit (e.g., Kummerow et al., 2000). The figure shows the acquired horizontally-polarized TMI brightness temperatures (TB) at 37 GHz and 85.5 GHz (obtained from TRMM 1B11 product). The TMI image swath is about 760 km wide, the ground resolution about 16 x 9 km2 at 37 GHz and 7 x 5 km2 at 85.5 GHz. Data were acquired at 15:30 UTC, three hours and half after the TSX ones, so that a direct intercomparison it is not possible. Nevertheless, we believe it is still useful to show this picture as an example of the capabilities of MW radiometer and radar spaceborne imagers. The hurricane signature is quite evident, but the impact of the different spatial resolution between the two radiometric channels is also striking. Fig. 2 also illustrates the PR reflectivity factor (dBZ) at 14 GHz and closest to the surface for both the “normal sampled” range bin 75 and the “rain oversampled” range bin 16 (as obtained from TRMM 1C21 product). The PR swath is 220 km for the “normal sampled” product, but it is reduced for the “rain oversampled” one due to oversampling; the height resolution is about .25 km. The “rain oversampled” product aims to register the detailed vertical profile of the rain. Fig. 2 shows that the spiral tails of the hurricane are detectable with a moderate spatial resolution, but only the combination with TMI can provide the general features of the hurricane due to the relatively smaller swath. The latter argument, indeed, applies to most active microwave sensors whose scanning capabilities are usually limited with respect to passive ones. Page 10, Line 18. Fig. 3 shows the Plan Position Indicator (PPI) reflectivity map (dBZ), acquired at 0.86° elevation angle by the S-Band NEXRAD WR of Mobile (AL), indicated as “KMOB” in figure. This map shows a geographical zoom of Fig. 1. The indicated elevation angle has been used as representative of near-surface rainfall field. Enclosed within the white rectangle is the quick-look of the TSX selected scene (about 154 x 105 km2); the quick-look resolution is 0.1 km. The feature similarity between TSX and WR maps, especially within the hurricane rain band, is noticeable; moreover we can qualitatively appreciate the higher spatial resolution of TSX imagery with respect to TRMM-PR and TRMM-TMI one, as shown in Fig. 2." Page 11, Line 26 "Fig. 4 shows the obtained coregistered maps, where the rain pattern is evident in both images with detailed spatial features. The maximum intensity of the hurricane "Gustav" precipitation can be deduced from WR reflectivity measurements; Z maximum is about 59.1 dBZ, denoting torrential convective rainfall probably mixed to some hail (Ryzhkov et al., 2005). The same image also shows a significant negative correlation between TSX retrieved Normalized Radar Cross Section (NRCS) ïĄşSAR and WR reflectivity Z, demonstrating that the first tends to decrease whereas the second increases, mainly due to the increase of the two-way rain path attenuation. This behavior is well described by current numerical models of X-SAR response, as summarized in Eq. (1) (e.g., Marzano and Weinman, 2008)."

The English of the manuscript needs reworking and is sometimes difficult to understand. The reviewer has tried to fix some of the problems (see minor comments below), but a complete fine combing of the text is absolutely needed. »> Thank you for the effort. We have revised and hopefully improved the English.

Minor comments - pag. 7454, row 14. "projected" is probably "planned". - pag. 7456, row 6-7. The two references need to be enclosed in the same bracket. - pag. 7456, row 19. GMT needs to be UTC. Same on all other occasions. - pag. 7456, row 22. "supports" needs to be "support". - pag. 7457, row26. Instead of "the whole USA" write "Conterminous United States (CONUS)". - pag. 7461, row 17 and 19. "Eq.(3)" should be "Eq.(2)". – pag. 7462, row 1, 2 and 6. "Eq.(4)" should be "Eq.(3)". - pag. 7461, row 13. "accessing to the archive" should be "accessing the archive". - pag. 7461, row 24. "contributes" should be "contributions". - pag. 7464, row 2. "close to l'Aquila city" should be "city of L'Aquila". - pag 7473-7474. Iguchi et al. after Kummerow et al. Please fix. - pag. 7473, row 22. Space after “Propagation”. »> All suggested corrections have been implemented.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 7451, 2010.

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