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Discussions

Interactive comment on "Evaluation of TRMM 3B42 (TMPA) precipitation estimates and WRF retrospective precipitation simulation over the Pacific-Andean basin into Ecuador and Peru" by A. Ochoa et al.

Anonymous Referee #2

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General Comments

This paper compares TRMM 3B42 v6 and v7 satellite-based rainfall estimates and the rainfall output from a NWP model, evaluating these against an interpolated gauge-based rainfall dataset over 21 mountainous catchments in Ecuador and Peru. The main focus of the evaluation is on the spatial and temporal patterns of rainfall as captured by the different rainfall products. However, in my view, the specific issues outlined below and the technical corrections suggested need to be taken into full consideration first,

before the paper can be suitable for publication. Once these are addressed, it would be of interest to HESS readers.

Specific Comments

The structure of the paper needs improvement. In the current version of the paper, the aim and objectives of the comparison are not clearly stated upfront. For instance, it is not clear if the paper is focused on the use of rainfall products where gauge-based observations are lacking in space or over time, or for specific applications such as hydrological modeling or nowcasting. A justification of the methodological steps selected is often lacking. For example, why is not CMORPH part of the rainfall product evaluation? Once these are addressed, the methodology and presentation of results, as well as the discussion sections will need more work to bring out the key messages from this paper. In its current version, the paper is too long, and the results and discussion sections are particularly muddled. An attempt is made to attribute differences in the performance of rainfall products to meteorological drivers, but some of the discussion of previous work on this would probably fit better in the background section. The paper can be usefully shortened and needs a thorough revising for clarity and concision. Most figures and captions need to be improved. See the Specific Comments below for suggestions. The level of English language usage varies throughout the manuscript, breaking the readability of the paper. Some errors are noted in the Specific Comments below, and a thorough edit will significantly improve the paper.

Technical Corrections

p.412 Title: Consider revising for length and clarity, avoiding undefined acronyms and non-essential words. Abstract: Consider revising to provide a clear and complete summary, taking into account the below. General: Consider clarifying the objectives of the study: are the satellite-based and model-based products evaluated against ground observations on how well they capture seasonal features of precipitation and the spatial distribution of mean annual precipitation? L2-5: In the first sentence, 'data scarcity'

implies lack of ground-based rainfall observations. In the next sentence, 'a comprehensive dataset of ground precipitation' negates this statement. L6: Delete 'version the 3B42'. L7: What does 'OA-NOSA30' stand for? L9: Basin needs not to be capitalized here. L14: What is meant by detection probability? POD? If so, please report the key quantitative outcomes in the abstract. L17: TMPA has not been defined. p.413 General: This section should introduce the background and objectives of the study, outlining the strengths and weaknesses of the different types of rainfall estimation, i.e. ground/gauge observations, satellite-based products and NWP model outputs. L2: Insert ground-based between 'for' and 'measuring'. L8-9: In fact, in many regions gauge densities are decreasing (see Becker et al. 2013). Becker, A., P. Finger, A. Meyer-Christoffer, B. Rudolf, K. Schamm, U. Schneider, & M. Ziese, 2013: A description of the global land-surface precipitation data products of the Global Precipitation Climatology Centre with sample applications including centennial (trend) analysis from 1901–present. ESSD, 5, 71–99. p. 415 L21: Replace 'in the' with 'along'. p. 417 L10-12: Edit sentence for correct use of English language. L19: Delete 'missing', replace 'deleted' with 'excluded', replace 'time series of daily rainfall' with the following: 'locations with daily rainfall time series'. Also, were values outside the time period of interest also excluded from the dataset? The rest of the text in this section needs a definition of what is considered in this case to be a spatially and temporally homogeneous station record. p. 418 L18: This section should probably include more specific summary of the findings from the literature on validating TRMM 3B42 V6 and/or comparing V6 and V7. See suggested reference below. L19-20: TRMM 3B42RT is mentioned but not considered in the comparison. Why? This section should provide a clear and complete description of the datasets used in the study, justifying choices as appropriate. p. 419 L1-5: This sentence contains too many 'and' – consider revising for correct use of English language punctuation, i.e. use comma as appropriate. L7: Replace 'in' with 'having' or similar. L8: It is not yet clear why the analysis starts in 1998 and stops in 2008. This has to be stated (although having read the next section it becomes apparent that this was mandated by the end date of the WRF simulation). Could you not

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produce a longer WRF simulation (e.g. 1998-2013) to provide say 15-years long time series for this comparison? p. 420 L3: It makes logical sense to discuss the generation of the gridded rainfall dataset immediately after Section 2.3.1. L14: How many GTS stations were excluded from the analysis, is it only three? If that is the case, spell out the number instead of '(03)'. And where are they situated (in case that had any effect on the TRMM 3B42 rainfall products)? p. 422 L12: Insert 'Rainfall' before 'products' in the sub-section heading. p. 423 L21-22: Edit sentence for correct use of English language. p. 424 Some of the material under section 3.1 is probably more relevant to the methodology section. L28: Change 'outperform' to 'outperforms'. Consider revising the entire sentence, as it sounds vague: by what criteria does KED outperform other interpolation techniques? p. 425 L2: Replace 'explain how good' with 'indicate how well'. L4: Revise sentence for clarity. What is meant by 'foregoing' here? L5: Delete 'as a variable'. L10: Delete 'for' before 'which', delete 'we believe' after 'which'. L11: Replace 'effects' with 'features' or similar. The last two sentences in this section are not clear, consider revising. p. 427 L2: Replace 'notorious' with 'notable' or similar, if that reflects the intended meaning. L6: Either show the data or do not discuss results that will not be shown. p. 428 L5: Change 'TMPA's detects' to 'TMPA products detect'. p. 429 L20: Insert reference to Table 1, which provides a summary of gauge densities across sub-catchments. It might be worth mentioning that the success of kriging-based techniques for spatial interpolation may differ for areas with lower gauge densities (not tested in this study). p. 430 L4: Explain what is meant by '...have equal tendency although bias and correlation values are different.' It is not clear. L7: Have these studies also compared TRMM 3B42 rainfall products, or WRF model outputs as well? L12: Delete 'surprisingly'. L14: Replace 'less correlation' with 'correlation is lowest', replace 'a higher bias percentage is evident' with 'bias percentage is highest'. L16-18: This sentence repeats what was previously said. L19-26: Consider revising this paragraph, it is not clear, especially the last sentence. p. 431 General: It is not clear how some of the meteorology material in this section is related to the comparison of the satellite- and NWP-based rainfall products. This can be amended by clarify the

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objectives of the study at the start and following through with the relevant methodologies, results, and discussion. Only then will references provide a meaningful context for the discussion. L4: Replace 'higher skills than' with skill that is higher than that of'. L6: Consider revising this sentence to avoid using words connected by a slash, i.e. 'improvement/detriment'. L19: 'increase' should be 'increases'. L21: It is not good style to use 'They' when referring to the authors of a cited study. L24-26: This sentence is technically inaccurate and confusing, as TMPA does not estimate precipitation solely from brightness temperature at the cloud top. p.432 L2: Replace 'better explains' with 'help to explain'. L5: It seems somewhat unusual to introduce a new figure in the Discussion section. Consider revising. L14: Replace 'high occurrences' with 'frequent occurrence'. L27: Insert a blank character space before '700 mm'. p. 433 L4: Replace 'considerable' with 'considerably'. L4-9: Consider revising this entire sentence for concision and clarity, it is far too long and vague. L14: Replace 'probably particularly for' with 'over'. L16: Replace 'for' with 'by' and 'spillover' with 'movement' or similar. L17: Replace 'be' with 'being', or even better, consider revising the entire sentence for clarity. L21: What does NNRP stand for? If defined previously in the text, it might need to be re-defined or edited, if the reference to it is not essential. In fact, it is very unclear how the rest of this section is directly related to the findings and discussion of results here. p. 434 L13: Replace 'inherent to detection of' with 'to detect better'. L18: What is the authors' defintion for 'acceptable skills'? L19: Replace comma at the end of the sentence with a full stop. p. 435 L3-9: These few sentences need to rest on a clear definition of the objectives for evaluation and comparison of the three rainfall products that is undertaken in this study, and how each part of the evaluation helps to address these objectives. It is well known that different applications will require different evaluation approaches and/or performance metrics, but this has not been clearly stated. L10-15: Delete entire paragraph, it does not contribute to the paper. p. 437 L13, 15: Isn't 'Human' meant to be 'Huffman'? L19: 'Their' needs not be capitalized. Plus, check the rest of the references for typos and errors. p. 441, Table 2 Caption OD stands for ordinary kriging, not 'original kriging'. p. 442, Figure 1 This figure and caption need to

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be improved: (i) Replace 'delineation of the Ecuadorian and the Peruvian catchments' with 'boundaries of the 21 catchments in Ecuador and Peru'. (ii) Catchment labels need to be listed somewhere (in the figure or caption) so that the figure and caption on their own can be read and understood without having to refer to the text. (iii) 'homogeneous rain gauge stations' is not clear without further definition/explanation. (iv) Delete 'of which the codes are detailed in'. (v) Instead of 'DEM' use 'Elevation [meters]' for the color bar label. p. 443, Figure 2 Same as for Figure 1, both figure and caption need to be improved: (i) The map coordinates are hardly legible. (ii) What are the units for the 'uncertainty'? Is it in mm day-1? (iii) Delete 'Topographic map is gray shaded.' and instead of 'DEM' use 'Elevation [meters]' for the color bar label. p. 444, Figure 3 In the figure caption, authors refer to TRMM, while in the figure legend, the reference is to TMPA. This inconsistency is present throughout the entire manuscript; consider revising for consistent use of terminology and abbreviations. The figure caption contains a typo in what should read 'corresponding'. The horizontal axis labels are not easy to read at 90-degrees angle. p. 445, Figure 4 It is uncommon to refer to POD, FAR, ETS, etc. as 'precipitation detection indexes'; consider revising to use appropriate terms here and throughout the manuscript. Insert 'rainfall' after 'average'. Figure quality needs improvement – why is there a rightward shift of the last row of plots? Also, the legend needs to be shown clearly just once, not trice. It would help the interpretation of the figure, if all x and y axes have the same scale. p. 446, Figure 5 Use units consistently, i.e. either mm/month or mm month-1, here and throughout the manuscript, including figures and tables. Again, figures should be readable on their own so acronyms do need definitions. p. 447, Figure 6 Insert 'and' and replace 'Bias' with 'bias' in figure caption. p. 448, Figure 7 Map coordinate labels appear larger for plot d), but are hardly legible for the other plots in this figure; consider amending the quality of the figure. According to this figure, the NWP output struggles with the estimation of mean annual rainfall totals. p. 449, Figure 8 This figure was introduced in the Discussion section and perhaps the authors need to reconsider how essential it is to the work reported on in this paper.

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Further references for consideration

De Vera, A., and R. Terra, 2012: Combining CMORPH and Rain Gauges Observations over the Rio Negro Basin. J. Hydrometeorol., 13, 1799–1809. Jin Meng, Li Li, Zhenchun Hao, Jiahu Wang, Quanxi Shao, Suitability of TRMM satellite rainfall in driving a distributed hydrological model in the source region of Yellow River, Journal of Hydrology, 509: 320-332. Karimi, P. and Bastiaanssen, W. G. M.: Spatial evapotranspiration, rainfall and land use data in water accounting – Part 1: Review of the accuracy of the remote sensing data, Hydrol. Earth Syst. Sci. Discuss., 11, 1073-1123. (See Table 1 for more references). Vila, D. A., L. G. G. de Goncalves, D. L. Toll, J. R. Rozante, H. S. Branch, and C. Paulista, 2009: Statistical Evaluation of Combined Daily Gauge Observations and Rainfall Satellite Estimates over Continental South America. J. Hydrometeorol., 10, 533–543. Xianwu Xue, Yang Hong, Ashutosh S. Limaye, Jonathan J. Gourley, George J. Huffman, Sadiq Ibrahim Khan, Chhimi Dorji, Sheng Chen, Statistical and hydrological evaluation of TRMM-based Multi-satellite Precipitation Analysis over the Wangchu Basin of Bhutan: Are the latest satellite precipitation products 3B42V7 ready for use in ungauged basins?, Journal of Hydrology, 499: 91-99.

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