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Manuscript

Evaluation of TRMM Multi-satellite Precipitation Analysis (TMPA) performance in the Central Andes region and its dependency on spatial and temporal resolution

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Overall Recommendation

This paper presents the evaluation of daily precipitation rate retrievals from the TMPA scheme over the Andes mountains. The TRMM 3B42 V6 data were compared against the rain gauge observations near two TRMM 3B42 V6 grid boxes during the period 1998 till 2008 (Cuzco) and the period 2004 till 2008 (La Paz). The authors investigate the effect of spatial and temporal averaging on the correlations between both TRMM 3B42 V6 data and rain gauge observations and the biases of TRMM 3B42 V6 data as function of daily precipitation rates. Finally, they present a procedure to blend the TRMM 3B42 V6 data with rain gauge observations.

The paper is generally well structured and easy to read, but the presentation and analysis of the results need to be improved. The authors are not always precise in defining their datasets. The objective of the paper is to evaluate occurrence and amount of precipitation. However, the evaluation of occurrence is not presented in the text. The results of this evaluation can only be found in Table 1. In addition, some graphs seems missing. The analysis of the evaluation of precipitation amount retrievals can be improved. Suggestions hereto are given in the review. The paper needs major and minor revisions before it can be published. Below the major criticisms are indicated, then followed by a chronological order of minor criticisms.

MAJOR CRITICISMS

Point A (Analysis precipitation occurrence)

- The authors claim that they evaluate both precipitation amount and occurrence in their paper. However, the majority of the work deals with the evaluation of precipitation amount. In fact, the only results that refer to the evaluation of the occurrence retrievals are found in Table 1 where the POD, FAR and FBI are presented. In the text the results of Table 1 are not discussed. In addition, from the manuscript it is not clear how ground truth observations of precipitation occurrence were determined. Please clarify this work throughout the manuscript

Point B (Blended product)

- The presentation of the blended product is not confining. Section 4.5 deals mainly with the comparison of TRMM 3B42 V6 data against the ordinary co-kriging data. The blended product is only presented qualitatively for a single day in Figure 15. A more detailed description of the blending method is needed and its performance, relative to TRMM 3B42 V6 and oK, needs to be presented for the same dates as shown in Table 2. Otherwise it is better to leave this section outside the paper.

Point C (Sample uncertainties)

- The authors compare daily precipitation values from different gauges against TRMM 3B42 V6 data that are provided every 3 hours. In order to reduce the sample errors they use several rain gauges within and in the neighborhood of the TRMM 3B42 V6 grid box. The choice of the spatial and temporal synchronization methods seems arbitrary. Can the authors motivate, preferably with references to more detailed studies on this topic, why they have chosen this sampling strategy. Also, discuss the risk for biases in the precipitation sums due to looking in a very mountainous terrain. For example, have there been studies in Switzerland using weather radar data to determine optimum sampling strategies in mountainous terrain? For examples of studies on optimized sampling strategies see:

  Deneke H. M., W. H. Knap, C. Simmer (2009), Multiresolution analysis of the temporal variance and correlation of transmittance and reflectance of an atmospheric column, J. Geophys. Res., 114, D17206, doi:10.1029/2008JD011680.

  Schutgens, N.A.J. and R.A. Roebeling, 2009, Validating the validation: the influence of liquid water distribution in clouds on the intercomparison of satellite and surface observations, *J. Atmos. Ocean. Tech.*, 26, 8, 1457-1474, doi:10.1175/2009JTECHA1226.1.

Point D (independence of the validation dataset)

- Reading the paper one wonders about the independence of the validation dataset. The authors compare the TRMM 3B42 V6 data against rain gauge data over the Andes Mountains. However, the TMPA scheme calibrates and merges the TRMM data with rain gauge observations to produce the TRMM 3B42 V6 dataset. The authors should underpin that the rain gauges used for validation are not used to retrieve the TRMM 3B42 V6 dataset, and thus validation is done with an independent dataset.
- Above risen point also holds for the blending of daily precipitation gauge measurements with TRMM 3B42 V6 dataset. Are similar rain gauge observations used twice, once to generate the TRMM 3B42 V6 dataset and once for the blending procedure.

MINOR CRITICISMS

Introduction

- **Page 8548 (line 20-25):** The introduction only briefly mentions alternative precipitation products. Can they give a more detailed overview of other precipitation

products rather than the TRMM 3B42 V6 products. Especially because later in the manuscript some other products are mentions (GPCC, GPCP) the authors should spend some words on the pro's and con's of other dataset (GPCP, CMORPH, TAMSAT, ..), and provide references to citable papers.

Investigation areas and data

- **Section 2.2.1 (Ground data):** This section does not describe how information on precipitation occurrence was collected. Please clarify this in section 2.2.1.
- **Page 8553 (line 5):** *"(GPCC; GPCP.."* It is not clear here which dataset is used for the rain gauges. GPCC, the interpolated rain gauge dataset of DWD with global coverage only over land, or GPCP, the merged rain gauge and satellite IR and microwave dataset with global coverage. Please clarify.

Verification methods

- **Page 8555 (line 10):** As mentioned under points of major revisions, the analysis of precipitation occurrence is mentioned here, but I can not find the evaluation in the results section.

Results

- **Fig 8 and Fig 11:** These scatterplots provide little information. In order to quantify the effects of sampling time and sampling area at least the slope, offset, correlation and RSME should be given for these figures as well. Another option is to present in one Figure the gain and offset and in another Figure the correlation and RMSE (actually in a similar manner as in Fig 7 and 10).
- **Fig 9:** Panel a,b,c,d are exactly identical. The authors presumably made a copy and paste error here. Please check.
- **Section 4.3**: The authors use different numbers of rain gauges to analyze the correlation between the TRMM 3B42 V6 product and rain gauges at different spatial resolutions. Did the authors also research the sensitivity of their results to using less or different rain gauges, and thus set error bars on the correlations presented in Figure 10?
- **Section 4.4**: The presentation of the evaluation of hourly TRMM 3B42 V6 values is very brief. It would be more logical to make this analysis part of section 4.2 (verification of different temporal resolutions), taking the hourly values as the finest temporal resolution.
- **Section 4.5:** Figure 13 and 14 do not add much new information. In this section it would be more interesting to present in Table 2 the comparison of TRMM 3B42 V6, oK and the Blended product for all studied days. Also see major comment B &D.

Discussion

- **Page 8562 (line 15)**: "*GPCP derived ground truth*" . Note GPCP is not a ground-truth products. It combines ground based and satellite derived information to determine rain amounts. The term "derived ground truth" can only be used for the interpolated rain gauge product of GPCC.

- Mention also in the discussion that IR data are only indirectly related to precipitation. Although the optically thin cirrus clouds in the anvil of convective system do not produce precipitation they still contribute to the precipitation estimates from IR data.
- Mention also in the discussion the effect of evaporation of precipitation below the cloud base. Especially in mountainous terrain the amount of evaporation, which among others depends on the distance between cloud base and surface, will vary significantly. See for example:

  Petty, Grant W., 2001: Physical and Microwave Radiative Properties of Precipitating Clouds. Part II: A Parametric 1D Rain-Cloud Model for Use in Microwave Radiative Transfer Simulations. *J. Appl. Meteor.*, **40**, 2115–2129.
  doi: 10.1175/1520-0450(2001)040

Grammatical slips

In general the paper is easy to read. However, there are grammatical slips, whereas some sentences need rephrasing, and the spelling needs to be checked. I advise to the authors to thoroughly check the grammar and spelling of the manuscript before submitting the revised version of their manuscript. Below some grammatical and spelling errors are listed.

- **Page 8549 (line 4)**: *"60 N and S"* should be *"60 N and 60 S"*
- **Page 8552 (line 15 -20)**: "*This method …platforms*" this is a very long and difficult to read sentence, please rephrase.
- **TRMM 3B42 V6** or **TRMM 3B42 RT** or **TMPA**. The authors use alternating TMPA or TRMM 3B42 V6 for their dataset. If I understand correct TMPA is referring to the retrieval method and TRMM 3B42 V6 the dataset that is produced with the TMPA scheme. The authors should use these terms consistently throughout the manuscript. Thus "TMPA data" should be replaced by either "TRMM 3B42 V6 data" or "TRMM 3B42 RT data"
- **Page 8564 (line 17)**: *"a weak underestimation.."* mention here which dataset shows a weak underestimation.