

## Reply to reviewers

### 1. Anonymous Referee #1

#### 1.1. Specific comments

Overall quality is poor. The organization and write up are very poor. There are many expression errors. The authors include a few equations but are unable to clearly explain them. There are some vague details of the methodology in the figure legends, which is strange. They should have used the methodology section to clearly state and explain (the meaning and purpose) them. The two different aspects, namely, the underestimation of precipitation by the models and the effect of SST on the variability of precipitation, are mixed up in a poorly written manuscript. Therefore, discussion is very tiring to read, much more tiring to understand the authors' point of view, if there is any.

**Authors:** We understand the reviewer's concerns and acknowledge that his detailed questions were extremely useful to motivate us to make substantial reprocessing of data and new analyses with the model outputs. The effort was certainly worth it and we believe the revised version of the manuscript is better written and improved. Complying with the reviewers' suggestions, we have detailed the equations and description of the approaches in the methodology section.

We understand that the reviewers' points raised about the relations between the underestimation of precipitation by the models and the effect of SST on the variability of precipitation are also reflected in the second reviewer's criticism and in the interactive comment included by Dr. H. Barbosa.

We agree that it is a complex issue to relate possible effects of SST anomalies to the precipitation mechanisms in Amazonia and aimed to do this in this manuscript in a concise but as much as possible integrated analysis of the rainfall biases, moisture transport, evapotranspiration and SST impacts.

Many previous analyses have shown links between variability of SST, impacting atmospheric circulation and moisture transport, and subsequent effects in Amazonia rainfall (e.g. Ronchail et al., 2002, Yoon and Zeng, 2010, Yin et al., 2012).

With a detailed investigation of how the models simulate all the processes (rainfall, convergence, evaporation and SST impacts) we try to gain insight into how they are inter-linked in the region.

#### 1.2 Individual scientific questions

**Reviewer:** What is the basis for choosing the areas B1 to B4 for your study?

**Authors:** Since rainfall in the Amazon is irregular both in time and in space (Zeng, 1999), we divided in those 4 areas to better analyze the spatial variability of the processes. The climatological precipitation figure for B1 to B4 areas was created and will be included in the text.

**Reviewer:** Why did you not calculate the annual precipitation (by summing the monthly precipitations) and compare them with the annual (observed) precipitation? This comparison is more effective than calculating biases.

**Authors:** Complying with the reviewer's suggestion, this graphic was created.

**Reviewer:** The calculation of vertically integrated moisture transport and convergence with the monthly means of  $u$ ,  $v$  and  $q$  is not recommended. These diagnostics have to be calculated on daily basis in order to obtain, by summation, the monthly means (or monthly totals) as is done in Satyamurty et al. (2013).

**Authors:** We thank the reviewer for this suggestion. Indeed, we recalculated all the monthly means using daily data to address the reviewer's point. This was a good improvement in the manuscript as possible transport caused by daily weather variability is now considered in the analysis.

**Reviewer:** Another question is how trustworthy are the evapotranspiration estimates? What was the methodology to obtain these estimates? (I guess they are obtained by subtracting the moisture convergence from the precipitation. If so, why don't you make such an estimation from your calculations?).

**Authors:** Evapotranspiration was also estimated by the difference between the precipitation of GPCP and moisture convergence of ERAI. We added a sentence explaining the uncertainty in these results.

**Reviewer:** You use the phrase moisture recycling for discussing the role of moisture convergence in the hydrological cycle, if I understood well. Moisture recycling is, in my opinion, the (percentage) role of evapotranspiration in the convective activity and subsequent rain, locally or regionally. The inability of the models to produce enough moisture convergence over the Amazon Basin, and as a consequence underestimate monthly precipitation, is related to the model physics and dynamics, not to the variability of SST.

**Authors:** We agree and made sure this confusion is eliminated from the text.

**Reviewer:** There are some conceptual errors in the manuscript. For example, in the Abstract I find "The moisture balance is always positive, which indicates that Amazonia is a source of moisture to the atmosphere." I can't agree with this statement. Actually, Amazon Basin is a sink for atmospheric moisture.

**Authors:** The text has been corrected.

**Reviewer:** You say at some places that similar results were obtained by other authors. That being the case, what additional information your discussions brings out?

**Authors:** We aimed to present a more coherent, integrated picture, including rainfall, convergence, evaporation and SST impacts. None of the other papers present this overview.

### 1.3 Technical corrections

- (1) P672 L4: Rewrite "... important to understand the reasons for this drawback."
- (2) P672 L8: "these processes". Which processes?
- (3) P672 L13: use "vertical velocity" instead of "pressure velocity". Anyway you are multiplying omega by (-1).
- (4) P672 L23-24: I don't agree with your affirmation that Amazon Basin is a source region to atmospheric moisture. See the "Individual scientific questions" part above.
- (5) P673 L8: What is land productivity?
- (6) P674 L6-12: Should be rewritten. Not clear.
- (7) P674 L9-10: In which part of the globe rainfall is not important?
- (8) P674 L26: The words "combining" and "combined" do not sound well. Replace the word "combined" by "and".
- (9) P675 L9: Interchange u and v.
- (10) P676 L7: Drop the adverb "very".
- (11) P677 L7, 10: Better to replace the word "flow" by "flux". Drop the second "in".
- (12) P678 L1: "..., lat1(lat0) represents the latitude ...."
- (13) P678 L9: Denote bias by a symbol, not by %. The units are %, but it should have a symbol.
- (14) P678 L19-21: You have already said that all models captured the seasonality to a lesser or greater extent. So, drop the sentence.
- (15) P679 L12-13: The reason for the underestimation of rainfall or precipitation by the models is that they underestimate the moisture convergence over the Amazon Basin. Say it.
- (16) P679 L14-18: The whole sentence is badly written and very confusing.
- (17) P679 L28: There is no a priori "relationship" between model precipitation and observed precipitation. Simply put "In general, the CMIP5 models are unable to simulate the observed precipitation satisfactorily in the Amazon." Drop the words "in the present climate".
- (18) P680 L2: "... GPCP for the dry (JJA, gray bar) and rainy (DJF, white bar) seasons in the period ...."
- (19) P688 L4: What is overestimation of ITCZ? It should be "overestimation of moisture convergence and therefore precipitation in the ITCZ".
- (20) In the Conclusions section the first paragraph is a repetition. Drop it entirely.
- (21) P688 L28: "precipitation producing mechanisms", not systems.

**Authors:** We thank the reviewer for his careful revision. All technical corrections were made.