

1 **Precipitation in the Amazon and its relationship with moisture transport and tropical Pacific**
2 **and Atlantic SST from the CMIP5 simulation**

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4 **Suggestions of reviewers**

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6 **1. Anonymous Referee #1**

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8 **1.1. Specific comments**

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

17
18 **1.2 Individual scientific questions:** What is the basis for choosing the areas B1 to B4 for your
19 study? The models (almost all) underestimate the precipitation and the convergence of moisture,
20 although the seasonality is maintained. Why did you not calculate the annual precipitation (by
21 summing the monthly precipitations) and compare them with the annual (observed) precipitation?
22 This comparison is more effective than calculating biases. The calculation of vertically integrated
23 moisture transport and convergence with the monthly means of u , v and q is not recommended.
24 These diagnostics have to be calculated on daily basis in order to obtain, by summation, the
25 monthly means (or monthly totals) as is done in Satyamurty et al. (2013). Another question is how
26 trustworthy are the evapotranspiration estimates? What was the methodology to obtain these
27 estimates? (I guess they are obtained by subtracting the moisture convergence from the
28 precipitation. If so, why don't you make such an estimation from your calculations?). You use the
29 phrase moisture recycling for discussing the role of moisture convergence in the hydrological cycle,
30 if I understood well. Moisture recycling is, in my opinion, the (percentage) role of
31 evapotranspiration in the convective activity and subsequent rain, locally or regionally. The inability
32 of the models to produce enough moisture convergence over the Amazon Basin, and as a
33 consequence underestimate monthly precipitation, is related to the model physics and dynamics, not
34 to the variability of SST. The modelers want to get clues as to what part or detail of the model
35 dynamics is deficient. This is not addressed at all, nor even speculated, in the manuscript. There are
36 some conceptual errors in the manuscript. For example, in the Abstract I find "The moisture balance
37 is always positive, which indicates that Amazonia is a source of moisture to the atmosphere." I can't
38 agree with this statement. Actually, Amazon Basin is a sink for atmospheric moisture. The definition
39 of source and sink is simple: If precipitation exceeds evapotranspiration over a region, this region is
40 a sink region for the atmospheric moisture. Moisture is transported by the winds to a sink region
41 where it converges. (A large part of the moisture transported into the Amazon Basin precipitates
42 over the basin, and the remaining is transported out to Southeast and South Regions of Brazil. This
43 southward transport is mostly accomplished by the low level jet east of the Andes. Thus, the
44 "Amazon moisture" is considered a source for the rains in Southeast and South Regions of Brazil
45 and to Paraguay and northern Argentina.). You say at some places that similar results were obtained
46 by other authors. That being the case, what additional information your discussions brings out?

- 53 **1.3 Technical corrections:** There are so many and it is difficult to list all of them. I give, as
54 examples, a few corrections below.
55
- 56 (1) P672 L4: Rewrite "... important to understand the reasons for this drawback."
57
- 58 (2) P672 L8: "these processes". Which processes?
59
- 60 (3) P672 L13: use "vertical velocity" instead of "pressure velocity". Anyway you are multiplying
61 omega by (-1).
62
- 63 (4) P672 L23-24: I don't agree with your affirmation that Amazon Basin is a source region to
64 atmospheric moisture. See the "Individual scientific questions" part above.
65
- 66 (5) P673 L8: What is land productivity?
67
- 68 (6) P674 L6-12: Should be rewritten. Not clear.
69
- 70 (7) P674 L9-10: In which part of the globe rainfall is not important?
71
- 72 (8) P674 L26: The words "combining" and "combined" do not sound well. Replace the word
73 "combined" by "and".
74
- 75 (9) P675 L9: Interchange u and v.
76
- 77 (10) P676 L7: Drop the adverb "very".
78
- 79 (11) P677 L7, 10: Better to replace the word "flow" by "flux". Drop the second "in".
80
- 81 (12) P678 L1: "..., lat1(lat0) represents the latitude"
82
- 83 (13) P678 L9: Denote bias by a symbol, not by %. The units are %, but it should have a symbol.
84
- 85 (14) P678 L19-21: You have already said that all models captured the seasonality to a lesser or
86 greater extent. So, drop the sentence.
87
- 88 (15) P679 L12-13: The reason for the underestimation of rainfall or precipitation by the models is
89 that they underestimate the moisture convergence over the Amazon Basin. Say it.
90
- 91 (16) P679 L14-18: The whole sentence is badly written and very confusing.
92
- 93 (17) P679 L28: There is no a priori "relationship" between model precipitation and observed
94 precipitation. Simply put "In general, the CMIP5 models are unable to simulate the observed
95 precipitation satisfactorily in the Amazon." Drop the words "in the present climate".
96
- 97 (18) P680 L2: "... GPCP for the dry (JJA, gray bar) and rainy (DJF, white bar) seasons in the period
98"
99
- 100 (19) P688 L4: What is overestimation of ITCZ? It should be "overestimation of moisture
101 convergence and therefore precipitation in the ITCZ".
102
- 103 (20) In the Conclusions section the first paragraph is a repetition. Drop it entirely.
104

105 (21) P688 L28: “precipitation producing mechanisms”, not systems.
106

Modifications suggested by the reviewers

1. Anonymous Referee #1

1.1 Specific comments

Line 11: The authors include a few equations but are unable to clearly explain them.

Authors: The equations were expanded and its terms form explained in order to facilitate their understanding.

Lines 11-13: 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.

Authors: Part of the methodology section was rewritten and information about the explanations of the terms of the equations were explained for better understanding.

Lines 13-15: 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.

Authors: We agree but, as discussed in Yin et al. (2013) in CMIP5 models the net surface radiative flux is overestimated all year round, and is balanced by excessive surface latent flux during the wet season. The latter in turn cause excessive soil moisture loss during the wet season, hence reduced soil moisture storage that reduces latent flux and increases sensible flux during the subsequent dry season. These biases of surface latent and sensible fluxes would reduce dry season rainfall, further exacerbating surface dry biases through a positive soil moisture feedback. Dry biases in rainfall, together with underestimated cloudiness, can enhance atmospheric longwave cooling and compensational subsidence, which in turn causes excessive moisture divergence, and further suppresses rainfall. These positive feedbacks between land surface latent flux, rainfall, atmospheric radiation and large-scale circulation are likely responsible for the dry biases in most of the models. Underestimated cloudiness not only initiates these feedbacks during the wet season, but also enhances them during the dry season through increase of surface Bowen ratio and atmospheric radiative cooling.

Reference: Yin, L.; Fu, R.; Shevliakova, E.; Dickson, R. E.: How well can CMIP5 simulate precipitation and its controlling processes over tropical South America? *Climate Dynamics*, 41, 3127–3143, 2013.

1.2 Individual scientific questions

Lines 18-19: What is the basis for choosing the areas B1 to B4 for your study?

Authors: The rainfall in the Amazon is irregular both in time and in space as shown by Zeng, 1999. The figure of climatological precipitation for the areas B1 to B4 areas was created and included in the text.

159 **Lines 20-22:** Why did you not calculate the annual precipitation (by summing the monthly
160 precipitations) and compare them with the annual (observed) precipitation? This comparison is
161 more effective than calculating biases.

162
163 **Authors:** We did the figure of annual rainfall and inserted in the main body of the article.

164
165 **Lines 22-25:** The calculation of vertically integrated moisture transport and convergence with the
166 monthly means of u, v and q is not recommended. These diagnostics have to be calculated on daily
167 basis in order to obtain, by summation, the monthly means (or monthly totals) as is done in
168 Satyamurty et al. (2013).

169
170 **Authors:** Daily data for the calculation of lateral flux of moisture were obtained and then were
171 calculated conforms recommendation reviewers.

172
173 **Lines 25-28:** Another question is how trustworthy are the evapotranspiration estimates? What was
174 the methodology to obtain these estimates? (I guess they are obtained by subtracting the moisture
175 convergence from the precipitation. If so, why don't you make such an estimation from your
176 calculations?).

177
178 **Authors:** Evapotranspiration was created by the difference between the precipitation of GPCP and
179 moisture convergence of ERAI. We added a sentence explaining the uncertainty in these results.

180
181 **Lines 28-34:** You use the phrase moisture recycling for discussing the role of moisture convergence
182 in the hydrological cycle, if I understood well. Moisture recycling is, in my opinion, the
183 (percentage) role of evapotranspiration in the convective activity and subsequent rain, locally or
184 regionally. The inability of the models to produce enough moisture convergence over the Amazon
185 Basin, and as a consequence underestimate monthly precipitation, is related to the model physics
186 and dynamics, not to the variability of SST.

187
188 **Authors:** We agree and made sure this confusion is eliminated from the text.

189
190 **Lines 35-38:** There are some conceptual errors in the manuscript. For example, in the Abstract I
191 find "The moisture balance is always positive, which indicates that Amazonia is a source of
192 moisture to the atmosphere." I can't agree with this statement. Actually, Amazon Basin is a sink for
193 atmospheric moisture.

194
195 **Authors:** We check all the concepts and revised in accordance with the request of the reviewers..

196
197 **Lines 45-46:** You say at some places that similar results were obtained by other authors. That being
198 the case, what additional information your discussions brings out?

199
200 **Authors:** We aimed to present a more coherent, integrated picture, including rainfall, convergence,
201 evaporation and SST impacts. None of the other papers present this overview.

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211 **1.3 Technical corrections**

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Authors: All technical corrections were made.

Line 56: (1) P672 L4: Rewrite "... important to understand the reasons for this drawback."

Line 58: (2) P672 L8: "these processes". Which processes?

Line 60: (3) P672 L13: use "vertical velocity" instead of "pressure velocity". Anyway you are multiplying omega by (-1).

Line 63: (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.

Line 66: (5) P673 L8: What is land productivity?

Line 68: (6) P674 L6-12: Should be rewritten. Not clear.

Line 70: (7) P674 L9-10: In which part of the globe rainfall is not important?

Lines 72-73: (8) P674 L26: The words "combining" and "combined" do not sound well. Replace the word "combined" by "and".

Line 75: (9) P675 L9: Interchange u and v.

Line 77: (10) P676 L7: Drop the adverb "very".

Line 79: (11) P677 L7, 10: Better to replace the word "flow" by "flux". Drop the second "in".

Line 81: (12) P678 L1: "..., lat1(lat0) represents the latitude"

Line 83: (13) P678 L9: Denote bias by a symbol, not by %. The units are %, but it should have a symbol.

Lines 85-86: (14) P678 L19-21: You have already said that all models captured the seasonality to a lesser or greater extent. So, drop the sentence.

Lines 88-89: (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.

Line 91: (16) P679 L14-18: The whole sentence is badly written and very confusing.

Lines 93-95: (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".

Lines 97-98: (18) P680 L2: "... GPCP for the dry (JJA, gray bar) and rainy (DJF, white bar) seasons in the period"

Lines 100-101: (19) P688 L4: What is overestimation of ITCZ? It should be "overestimation of moisture convergence and therefore precipitation in the ITCZ".

263 **Line 103:** (20) In the Conclusions section the first paragraph is a repetition. Drop it entirely.

264

265 **Line 105:** (21) P688 L28: “precipitation producing mechanisms”, not systems.