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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Forecasting terrestrial water storage changes in the Amazon Basin using Atlantic and Pacific sea surface temperatures" *by* C. de Linage et al.

Anonymous Referee #1

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General Comments:

The authors relate remotely sensed terrestrial water storage (TWS) anomalies (TWSA) in several regions of the Amazon Basin to oceanic SST indices to develop empirical modeling frameworks for seasonal prediction of future anomalies. There is a growing body of evidence that droughts, in particular, have large-scale precursors with some predictability. Even though the purpose of this paper is to describe the model development, the authors could do a better job linking their findings such as recession times to dynamical processes in the region. The references are light on ocean or atmospheric dynamics papers for such critical features as the South Atlantic Convergence

Zone(SACZ) and the South American monsoon. While SSTs are the fundamental drivers of the system, the proximate causes of water storage anomalies are the regional to local circulation systems governing local P-E. It is the blizzard of non-linear interactions in the land-atmosphere system at convective to regional scales that introduce the noise into the SST-TWSA relationships in this region.

In summary, this paper has the potential to contribute to our understanding of and ability to use predictability in the Amazon Basin but needs more physical connections to the ocean-atmosphere dynamics. Creating a robust empirical modeling system depends on a firm understanding of the potential sources and sinks of predictability.

Specific Comments:

This research appears to have been carried out with care and competence. The authors use methods pioneered in previous work and take a step by step approach to isolate spatial variability and forecast lead times. Given they are using linear regression with particular oceanic indices, it does not appear that they can much improve their R-sq with additional tinkering with these inputs unless they test new inputs. What can be improved is the understanding of sinks and sources of predictability so that the forces behind the unexplained variance can be identified.

Although there is not space for detailed discussion, I point out a number of areas in the paper that need physical context or at the least, better referencing to proximate causes to achieve better understanding of the results.

While South America is a rather understudied continent compared to Africa or North America, the authors will find papers by Brant Liebmann, Tsing-Chang Chen, Leila Carvalho, Charles Jones, Kerry Cook, Rene Garreaud, Josefina Arraut, Julia Nogués-Paegle, Marcelo Seluchi, and Mattias Vuille useful for understanding South American land-ocean-atmosphere dynamics. More fundamental work on tropical dynamics by Paul Roundy, George Kiladis, A.J. Matthews, Brant Liebmann, Charles Jones, and K.M. Lau is also essential reading for understanding the time and space scales of SST

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forcing on the land-atmosphere system.

12455, Lines 1-18: Droughts tend to affect a much larger spatial scale than floods. The scales of the disasters mentioned in the opening paragraph should be quantified so that this difference may be appreciated.

12455-12456, Line 26- : The discussion of Atlantic links is superficial. Because the Atlantic, unlike the Pacific, is a more direct driver of the South American seasonal cycle, this paragraph should offer a more nuanced and holistic view of links to Atlantic rather than focusing on a single circulation feature and its role in particular droughts. The critical role of the SACZ, in South American monsoon dynamics is not mentioned. Interannual variability in rainfall and the role of the SACZ are well documented, starting with Nogués-Paegle and Mo (1997).

The study areas cannot be easily deduced from the very busy Figure 1. I suggest a separate panel just showing elevation (shaded) and the outlines of the subregions.

12458, Lines 17-21: The regional variations in rainfall anomalies with respect to ENSO phase are considerable. Areas of the basin experience anomalies of the opposite sign during the same phase of ENSO. Here, only one relationship is mentioned. This opening should provide a better perspective on these regional variations or provide references that do explore these variations.

12459, Lines 5-6: It is stated that the AMO is related to North Atlantic SST variability and implicated in US drought. Instead of commenting on the Northern Hemisphere, can the authors substitute comments and references that show that this index and dataset have been shown to be relevant to the Southern Hemisphere, affecting South American monsoon system?

12459, Line 11: “Atlantic Meridional Model” should be “Atlantic Meridional Mode”.

12462, Lines 1-15: This brief physical explanation would benefit from considering previous studies of interannual variability of precipitation and/or streamflow (e.g., Carvalho

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et al. 2004) and commenting on how these results are more or less consistent with previous work. The position and intensity of features such as the SACZ and the seasonal cycle of the monsoon are the proximate causes of TWSA. For these significant droughts, how did the SSTs impact the progression and intensity of the monsoon? This paragraph also offers the opportunity to explain or at least propose a hypothesis why region C's explained variance (12461, Line 21) is so much lower than the other regions. This needs more follow-up.

Section 4.2: When there is little context and no proximate causes offered, the relaxation times are just numbers that change from place to place. While there may not be room to go into detail, references relevant to understanding these relaxation times could be provided.

12464, Lines 13-21: The report of differences in the timing of influence of TNAI vs. Niño 4 is interesting but again, suffers from a lack of context here or later in the paper. Do the authors have any comments or can any references be made that can shed light on why these results were obtained?

12465, Lines 17-19: The authors appear to assume that they can isolate the signals from the two oceans. Before making such an assertion, they should dig into the literature on tropical-extratropical interactions (Paul Roundy's work for a start) to make a more informed judgment on the separability of these signals.

12466, Lines 15-20: The discussion of future work is well-conceived. I highly encourage the authors to perform (1) and then report on the results as a follow on to this paper. Too many empirical models, however carefully derived, have fallen down on the job during independent testing using new data. As for (3), I raise a lot of questions about physical mechanisms in this review that may require their own paper. However, even with the limited space here, additional comments, hypotheses formulated by the authors, and certainly additional relevant references can be offered to provide a bit more context to the results.

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12466, Lines 24-25: For future work, I would encourage the authors to adopt a more complete view of the ocean-atmosphere system and look harder at the atmospheric dynamics. The link between the oceans and the local P-E is the non-linear interaction of the atmosphere at multiple spatial scales, from convective to regional. The relaxation time for Region C could relate to the time scale of the Bolivian High-Nordeste Low circulation (e.g., Chen et al. 1999), a circulation system that controls the moisture transports within Region C. This circulation is established by an intercontinental short-wave train wave train resulting from a complex combination of latent heating from deep convection in South America, Africa, and the Western Pacific interacting with the unique topography of South America. This is not going to be fully described by a simple linear combination of SST indices and thus contribute mightily to the unexplained variance in the model.

Section 6 (conclusions): Although part of the Amazon was quite reducible to SST variations (66% in the northeast), the other sections had far more unexplained variance. More confidence is expressed in this closing than is warranted, particularly since the connections between regional water balances to the relevant ocean-atmosphere-land dynamics are not yet laid out.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 12453, 2013.