Influence of Amazonian vegetation on moisture transport toward equatorial America: a modeling perspective

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1. Motivation

• The vulnerability of the Amazonian rainforest, and the ecological services that it provides, depend on an adequate supply of dry-season water, either as precipitation or stored soil moisture.

• Recent studies have noticed an increase in the length of the dry season over southern Amazonia (Boisier et al, 2015; Fu et al, 2013; Debortoli et al, 2015). This is related to reduced precipitation rates and increased extension of savanization, with a consequent loss of forest carbon stock and uptake capacity.

• Arias et al. (2015) suggest that this lengthening is related with other phenomena such as earlier retreats of the North American monsoon and late onsets of the South America monsoon, which can induce variations of the regional circulation patterns due to a thermodynamical response of sea surface temperature variations, causing local drier conditions over Amazon.

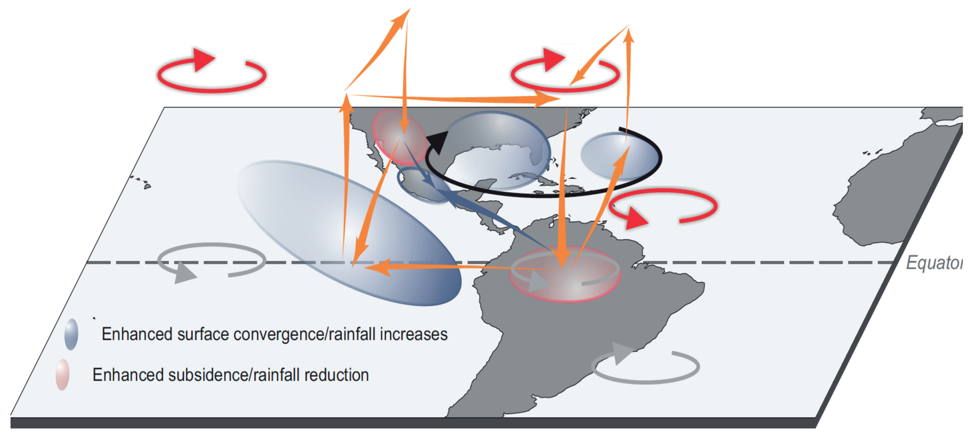


Fig 1. Schematic diagram of mechanisms involved in recent regional circulation patterns associated to a lengthening of the Amazon dry season. From Arias et al. (2015).

Thus, we need a better understanding and simulation of these changes over southern Amazonia and their possible implications for northern South America.

Scientific Question:

- Is there an increase of moisture convergence in the equatorial region due to the lengthening of the dry season in the southern Amazon?

- Where does the humidity involved in this possible increase of atmospheric moisture transport toward equatorial region come from?

2. Data and Methods

• **ERA-Interim:** 0.75°x0.75°, daily, 1980-2015. (Dee et al. 2011). Variables: Precipitation, evaporation, precipitable water and vertical integral of eastward and northward water vapour flux. These variables were used to implement a dynamical precipitation recycling model - DRM (Dominguez 2006).

• **Salazar 2012:** 0.3°x0.3°, monthly. Information obtained from Salazar (2012) modeling experiment to evaluate possible changes in atmospheric moisture transport in northern South America due to changes in cover vegetation.

The two scenarios differ mostly in cover vegetation for southern and eastern Amazon regions, where the vegetation changes from forest to savanna.

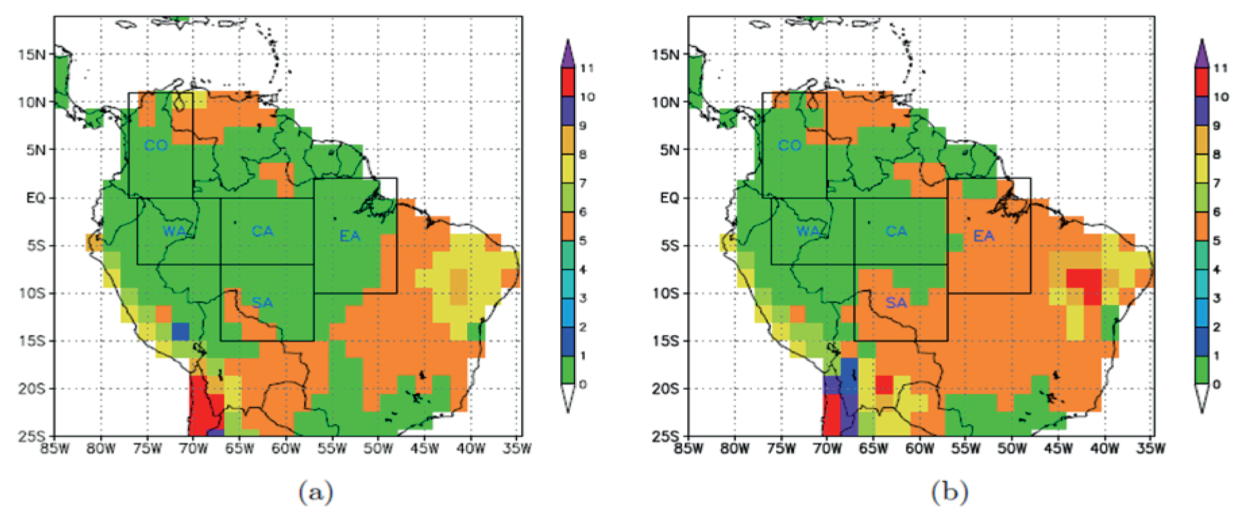
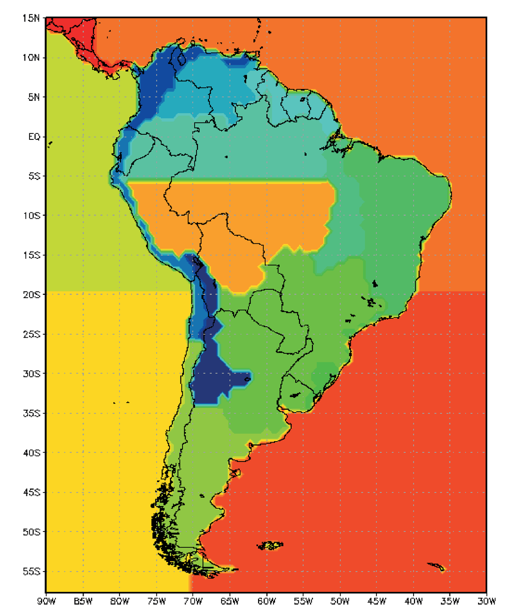


Fig 2. Vegetation cover scenarios proposed by Sampaio (2008) and used by Salazar (2012) modeling experiment

3. DRM Model



The DRM is an analytical model derived formally from the conservation mass equation formulated for a semi-lagrangian framework that allows a recycling analysis at a range of temporal scales, from daily to monthly and longer time scales. (Dominguez 2006).

Fig 3. Domain used to implement the DRM. The domain is divided in 17 regions to study the atmospheric moisture transport.

4. Results

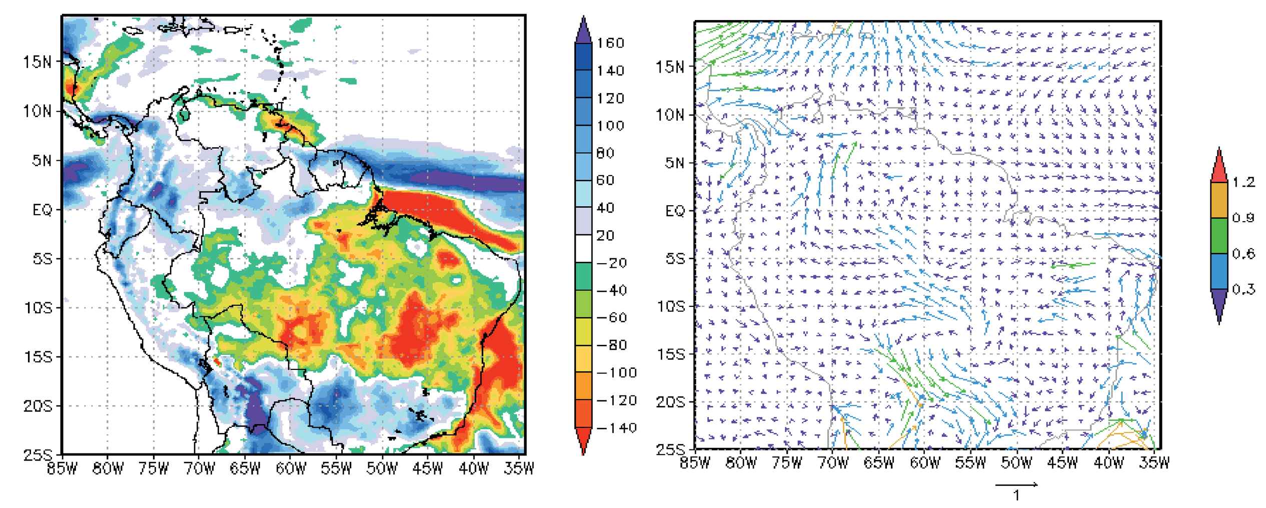


Fig 4. DJF rainfall (mm) and surface winds (m/s) response to a savanna scenario.

Under a savanna scenario:

• Reduced rainfall over the Amazon region.
• Increased precipitation over the intertropical convergence zone (ITCZ).
• Enhanced northward cross-equatorial flow from the Amazon to northern South America.

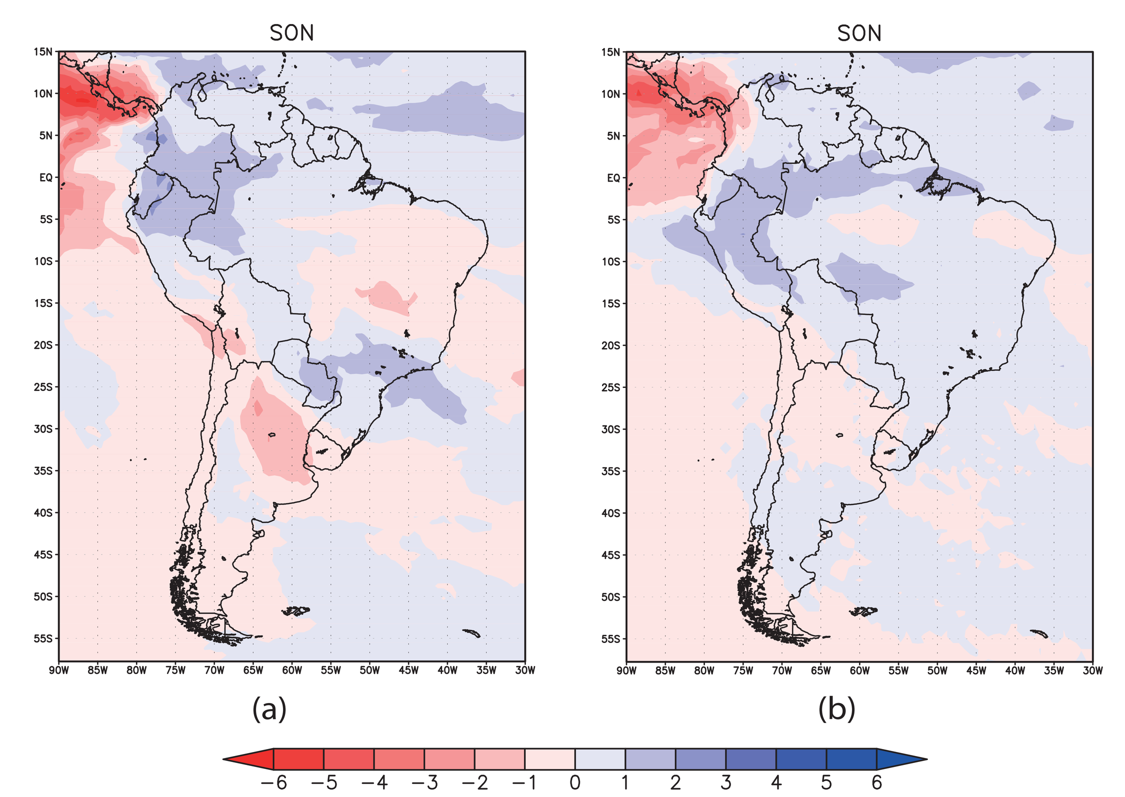


Fig 5. SON Precipitable water (mm). Differences between longest and shortest dry seasons in the Amazon for entire domain contributions (a) and Equatorial Atlantic ocean, Orinoquia and northern Amazonia contributions (b)

5. Discussion

Under savanna conditions:

• Reduction of precipitation over Amazon forest and increase over the ITCZ.

• Increase of surface convergence over equatorial Americas, favoring moisture transport to the region.

Are precipitation recycling models able to simulate a stronger moisture transport toward the equatorial Americas during long dry seasons in the Amazon?

Focused on this discussion, the DRM model is implemented in order to have a better knowledge about two particular ideas:

- Is the model able to simulate the increasing convergence over equatorial America?

- Does the model allow us to identify the main regions contributing to the increase of moisture in this region?

It is observed that the model identifies increased moisture in the equatorial region, while reduced moisture is observed over the Amazon region, in agreement with a longer dry season. This pattern is observed when considering moisture contributions from all regions (Fig. 5a) as well as only the Atlantic Ocean, northern Amazon, and Orinoco basin together (Fig. 5b).

Finally, in order to answer the question: where does the extra moisture to equatorial America come from? Fig. 5 suggests that the regions that contribute the most to the increase of moisture in the tropics are located in northern South America.

7. Future work

The results obtained so far show patterns of atmospheric transport only for South America domain.

Our future work proposes:

- To consider a new domain of study covering both tropical America and oceanic regions further north, in order to implement the DRM Model again.
- To analyze surface convergence and moisture transport using this new domain.
- To determine the main sources of atmospheric moisture to the equatorial Americas during long dry seasons in the Amazon.

6. References

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7. Acknowledgements

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