Influence of the Madden-Julian oscillation on intraseasonal rainfall over the Amazon basin

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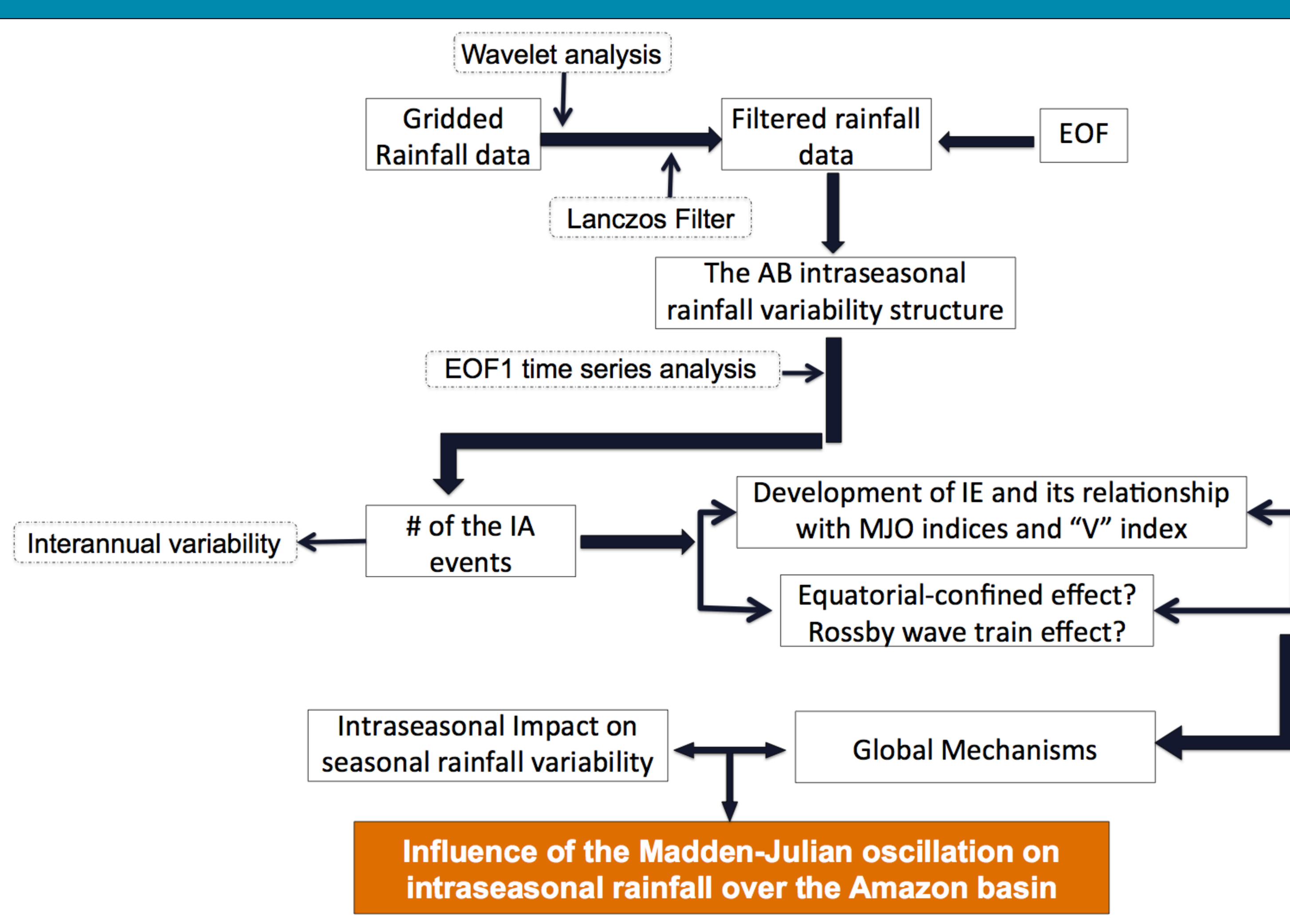
Introduction

The rainfall in the Amazon basin (AB) is a result of complex interactions of various large-scale physical and dynamic processes as well as local features, which are responsible for the temporal and spatial distribution of precipitation (e.g. Espinoza et al., 2009).

It is well-known that on intraseasonal time scales, the Madden–Julian oscillation (Madden and Julian, 1994; Zhang, 2005, and references therein) is the most dominant mode of intraseasonal variability across the tropics. This modulation has been shown to influence rainfall and extreme events in many locations worldwide (Jones et al., 2004; Carvalho et al., 2004).

Although the MJO is a phenomenon observed throughout the year, several studies have been focused on the rainy season. This work main aim is to analyze the influence of the MJO on the intraseasonal rainfall in the AB, considering the entire seasonal cycle. The approach we have used in this study will provide a quantitative analysis of the intraseasonal rainfall variability and a discussion of the associated large-scale circulation.

Methods



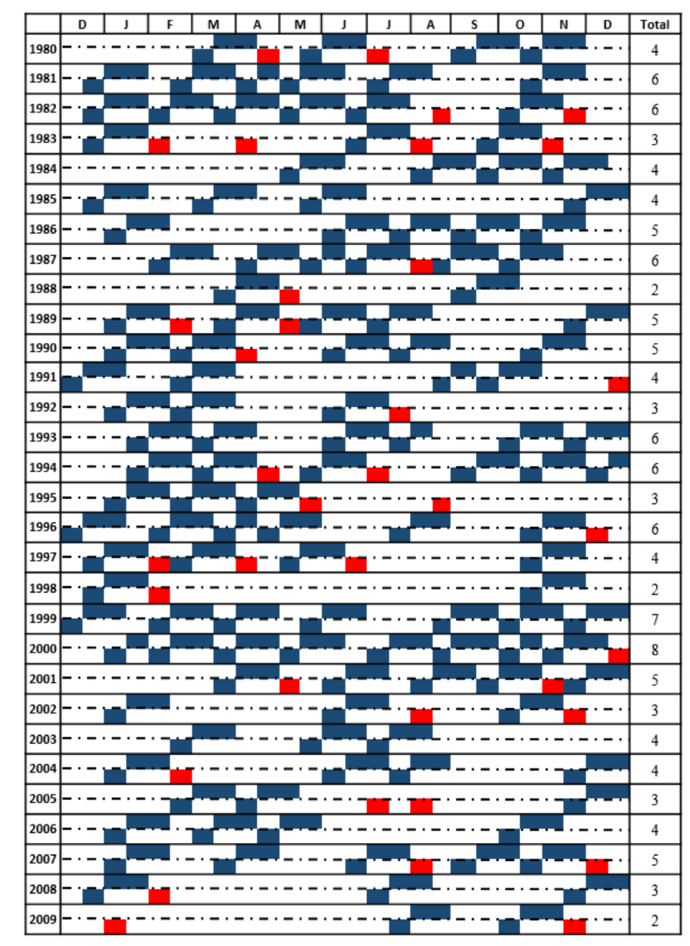
Results

The number of Intraseasonal Events (IE) observed during ENSO years and the severe drought of 2005 demonstrate that the MJO exerts influence over the tropical Pacific and Atlantic Ocean on an interannual timescale (**Table 1**). In addition, the coherent relationship between the development of an Intraseasonal event and the MJO indices can be used for monitoring their impacts on the Amazon basin (**Fig. 1**).

About 65% to 85% of the total number of IE are associated to the canonical eastward propagation of deep convection and upper level divergence associated with the MJO in the tropical region. Consequently, not all IE identified with the rain gauge precipitation in the AB are associated to classical MJO events: there are other mechanisms (e.g. through Rossby wave trains in the Southern Hemisphere)

On a global scale, the lagged composites of the 0.21 sigma-level velocity potential, OLR, vertically integrated moisture flux, exhibit the eastward-propagating signal of the MJO (**Fig. 2**).

The MJO plays an important role throughout the year, especially in the austral winter, when the percentage of the MJO contribution to the positive rainfall anomaly in some Amazon regions is greater than 70% (**Fig. 3**).



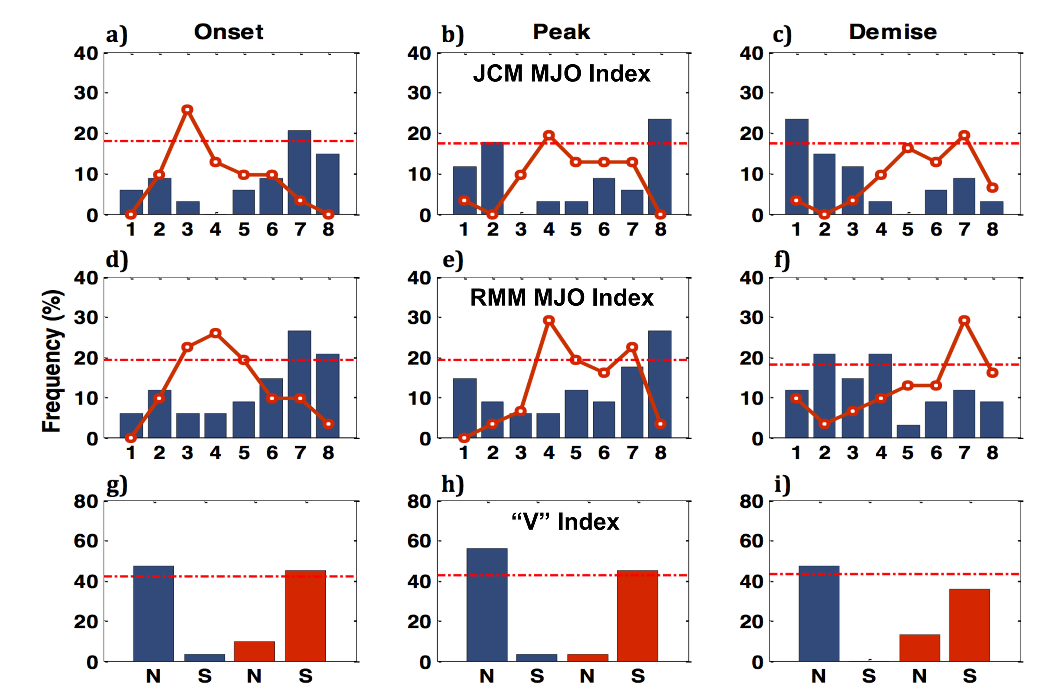


Table 1. Calendar dates of the intraseasonal rainfall events.

Fig. 1. Transition phase: onset (O)-peak (P)-demise (D) and its relationship with the different MJO indices and Wang and Fu regime for austral summer.

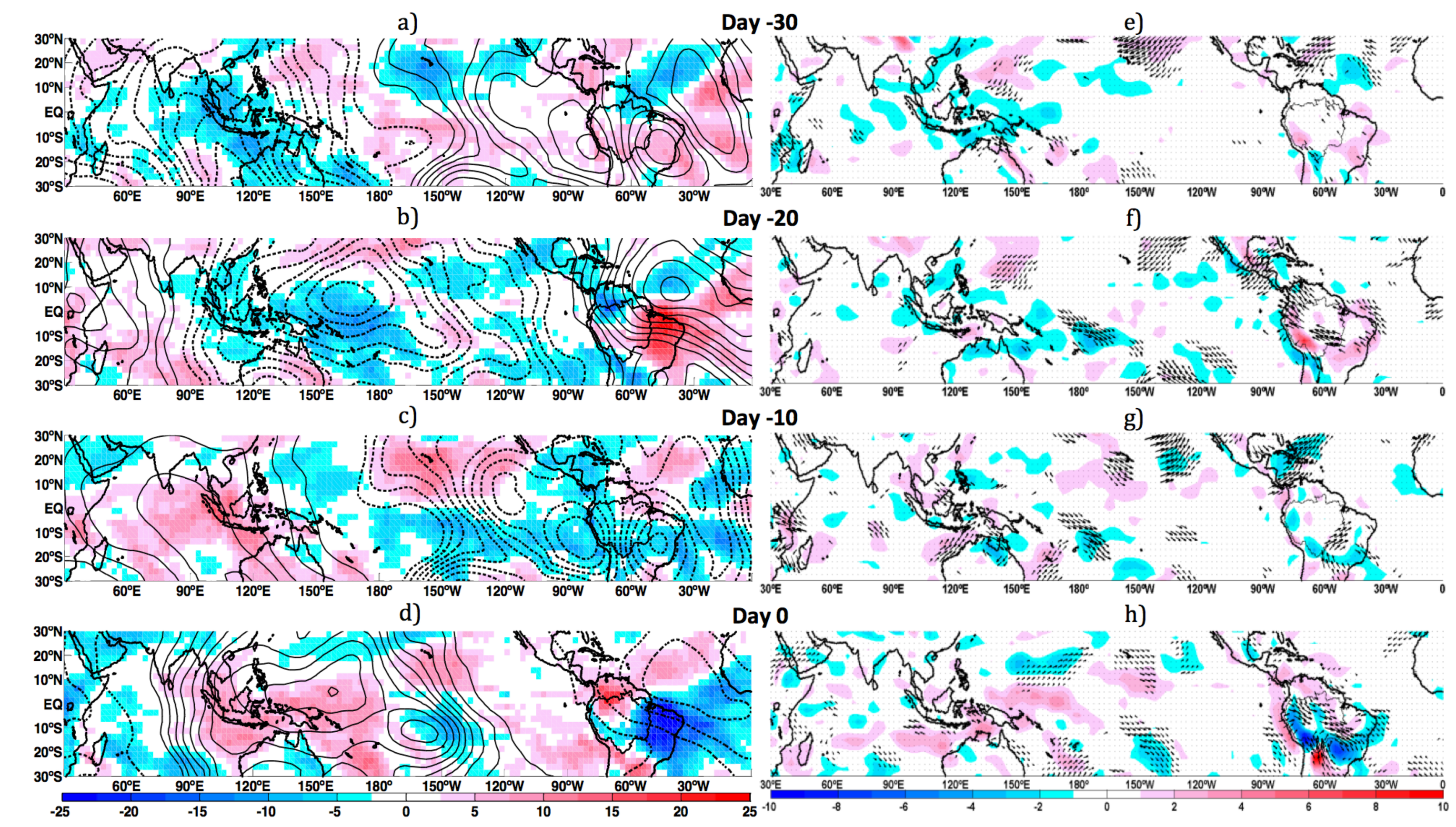


Figure 2. The left column is the composite of DJF OLR anomalies and 0.21 sigma-level velocity potential. The right column represents the vertically integrated moisture-flux and its divergence.

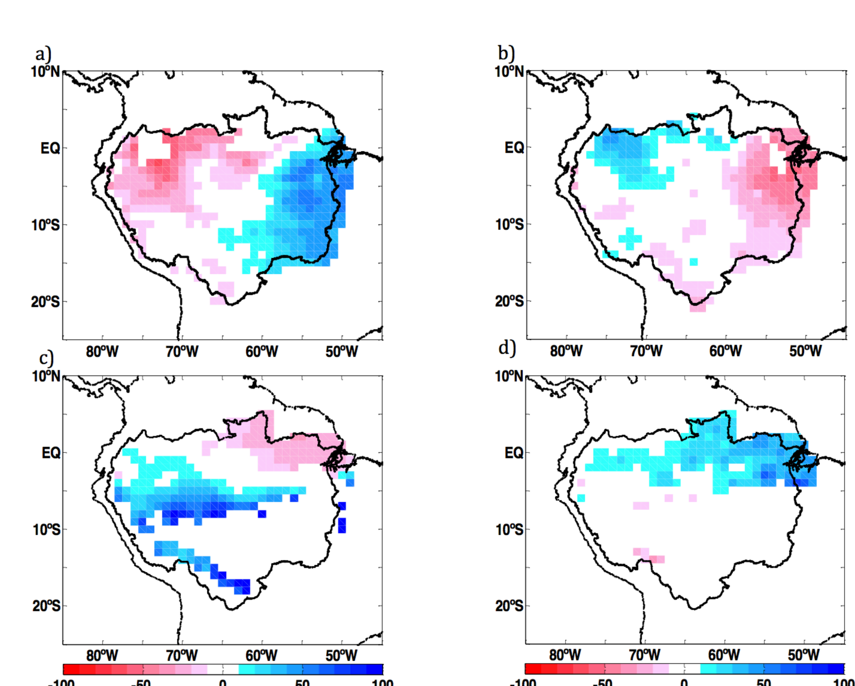


Figure 3. Percentage of enhanced (suppressed) rainfall during active (day-0) and break (day-20) MJO phase over the Amazon basin.

Conclusion

The MJO influence on the intraseasonal rainfall variability over the Amazon basin was investigated. Our results provide evidences that the MJO is the main atmospheric-mechanism modulator of rainfall variation in intraseasonal time scales in all seasons, playing an important role as a modulator of circulation, moisture-flux convergence and convection during its passage over tropical South America, particularly during the austral winter

References

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