

Supplementary Material

1. Evolution of the Regional Convection and Horizontal Wind over South America during the Rainy Season Onset in MRB

Figure S1 shows OLR and 600 hPa horizontal wind prior to, during, and following the climatological onset of the rainy season between PEN -4 and PEN +4. On PEN -4, MRB presents OLR higher than 240 W/m^2 and 600 hPa southeasterly wind, which is part of an anticyclonic wind located off the coast of central Peru. Figure S1a also features 600 hPa easterly wind and OLR lower than 240 W/m^2 are present north of 8°S , 600 hPa westerly winds and OLR higher than 280 W/m^2 prevail over entire Chile and Argentina south of 19°S and an anticyclonic circulation is centered over eastern Brazil (43°W , 16°S). All these circulations patterns are consistent with the southward propagation of the convective region of the South American Monsoon during end-September [26,61]. The OLR located over northwestern of the SA weakens and starts propagating toward south reaching the MRB, when its intensity is lower than 240 W/m^2 , on PEN -3; while convective region reaches the western part of northeastern Brazil on PEN -1 (Figure S1b–d). These circulation patterns are consistent with the change of pattern of upper-level horizontal wind over South America at 200 hPa (Figure S2a–d). On PEN -4, Figure S2a illustrates that the presence of 200 hPa westerly wind over MRB but even prevail in the rest of the continent south 12°S while northeasterly wind prevails over the northwestern most part of SA north of 5°S . The 200 hPa westerly wind over MRB and the 200 hPa northeasterly wind located over northwesternmost part of SA weaken in the following PENs (PEN -3, -2 and -1) (Figure S2b–d). This latter explains the southward displacement of the convective region, from the Caribbean region toward the central Amazon basin. These circulation patterns agree with the southward propagation of the convection region of the SAMS comes from the northwestern part of SA to central Brazil [26].

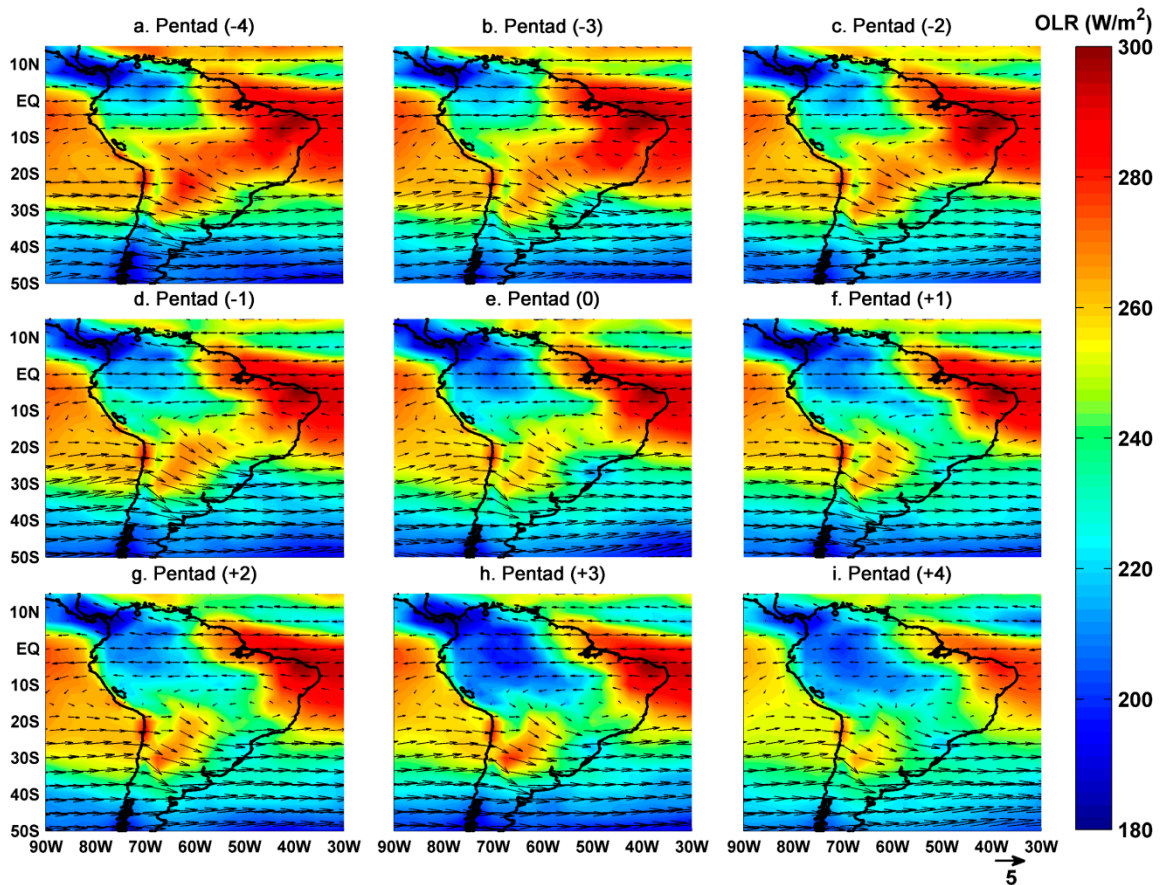


Figure S1. Superposed epoch analysis for OLR (W/m^2) and 600 hPa winds (m/s) for the period prior (4 PENs before) and immediately following (4 PENs after) of the rainy season onset (PEN 0: 24-28 September) over the MRB for the 1979-2013 period. Analysis based on ERA-Interim reanalysis. The OLR data set has a 2.5° latitude-longitude resolution.

At PEN 0, [Figure S1e](#) displays 600 hPa northeasterly wind and OLR lower than 240 W/m^2 over the entire Peruvian Andes. [Figure S1e](#) also displays a strengthening of the westerly wind and easterly wind south 18°S and north of 8°S respectively. At 200 hPa, [Figure S1e](#) shows clearly a weakening of the westerly wind over MRB while at the same time northwesterly wind appears over eastern Brazil. The last feature evidence the apparition of the SACZ [60]. For the rest PENs (PEN +1, +2, +3 and +4), the 600 hPa circulation patterns maintain their structures but the anticyclonic circulation moves westward toward the western part of northeastern Brazil (50°W , 19°S) ([Figure S1f-i](#)). At 200 hPa, the weakening of westerly wind over MRB persist while at the same time the 200 hPa easterly wind appears over northwesternmost part of SA and a strengthening of the westerly wind is observed over the entire continent south of 16°S ([Figure S1f-i](#)).

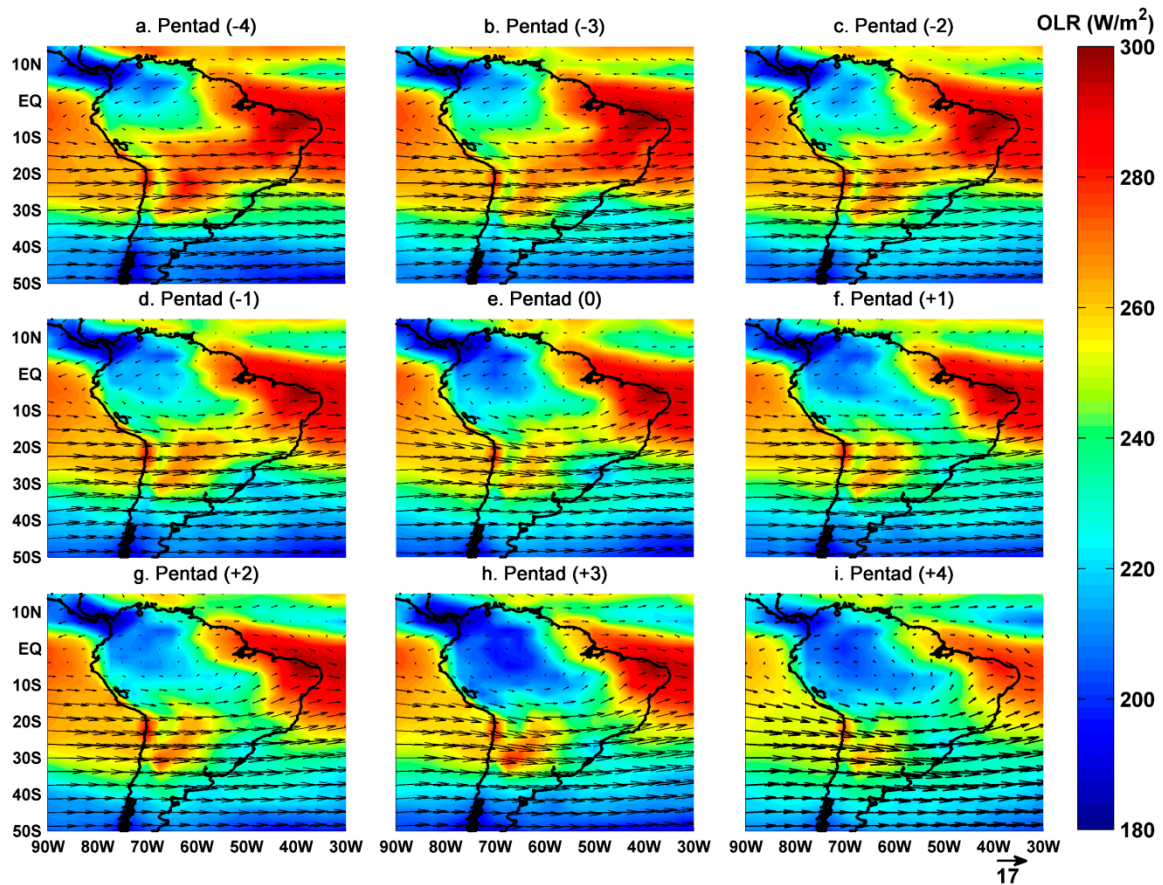


Figure S2. As in Figure 1S, but for 200 hPa

The spatial distribution of the onset dates is consistent with the change of OLR and winds over South America at 600 hPa and 200 hPa (Figures S3 and S4). For example, the southward propagation of the onset day of the rainy season over MRB is consistent with OLR lower than 240 W/m² that are part of the southward propagation of the convective region from the Caribbean region. The OLR region observed over MRB is consistent with the weakening of the 600 hPa southeasterly wind and a simultaneous weakening of the 200 hPa westerly wind over the study area (Figures S3, and S4 respectively).

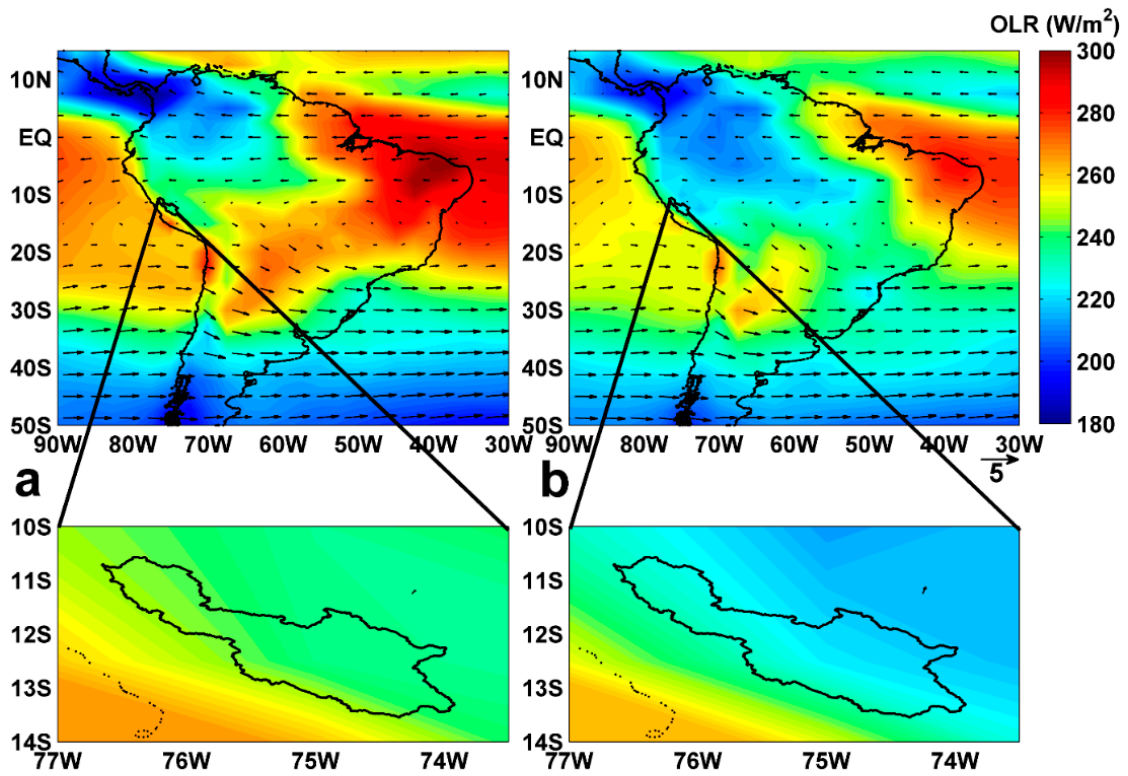


Figure S3. Composite of 600 hPa wind (m/s) and OLR (W/m^2) over South America for **a)** four previous PENs to onset of the rainy season (PEN 14–17), **b)** four PENs after the onset of the rainy season (PEN 19–22). Analysis based on the 1979–2013 period. ERA-Interim reanalysis was used in this analysis. The OLR data set has a 2.5° latitude-longitude resolution.

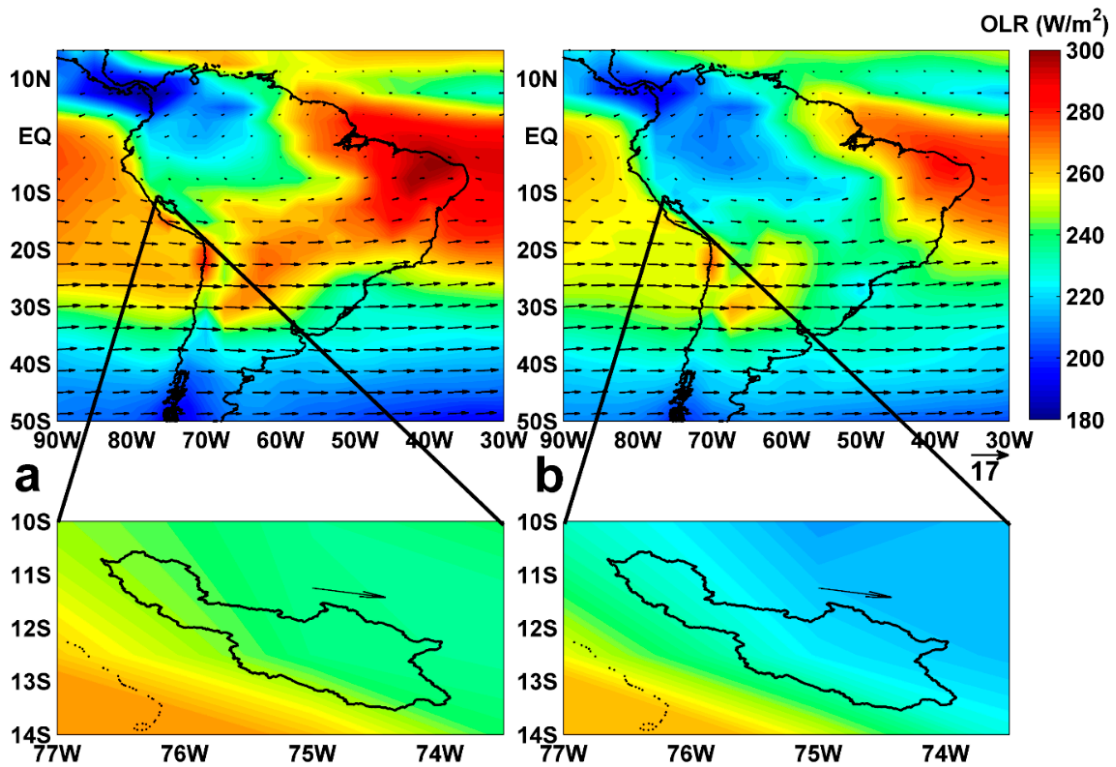


Figure S4. As in Figure S3, but at 200 hPa.