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Interdecadal variability during the monsoon season in South America

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Modes of interdecadal variability of monsoon precipitation (austral spring and summer) over South America (SA) are provided on a continental scale, based on reasonably extensive and reliable set of data (1950-2000), and their connection to well known climatic indices (NAO, AMO, IPO, PDO, SAM, etc) and SST anomalies is assessed. The main modes produce differences around 50% between their opposite phases in the monsoon precipitation over very populated regions with great hydropower generation and intensive agricultural activity. The continental modes presented are reproduced in three different sub-periods, and are consistent with previous studies for specific regions. Besides, their factor loadings are consistent with those of modes obtained from longer time series over smaller domain, in the regions covered by both data sets, and their factor scores are very significantly correlated in the overlapping period. The regions with strongest interdecadal oscillations in the first five summer modes have intense precipitation in this season. Some of the modes display low frequency co-variability of precipitation between different regions of SA. This is useful information for hydropower generation, since the distribution networks are interconnected in Brazil, and some countries in the continent share hydropower generation plants that depend on rainfall over large basins. There are significant relationships between the interdecadal variability in spring and summer, indicating local and remote influences. The first modes in both seasons are dipole-like, displaying opposite anomalies in central-east and southeast SA. They tend to reverse their polarity from spring to summer, affecting strongly the rainfall regimes in the affected regions (such as in the SACZ). These dipole-like modes were only known in intraseasonal and interannual variability, but they also exist on interdecadal time scales, modulating higher frequency variability. The second summer mode, which affects the core monsoon region in central Brazil and central/northwestern Argentina, is significantly correlated to the fourth mode in spring, which shows similar factor loadings, indicating persistence of anomalies from one season to the other, contrary to the first modes. This is why this mode (and not the first ones) has the largest contribution to the first interdecadal mode of annual precipitation. Those relationships are also useful information for agriculture, hydropower generation, and other sectors. Significant connections with different combinations of SST-based or atmosphere-based modes and indices provide physical basis for the presented modes. Three show strongest connections with SST-based modes and two have strongest connections with atmospheric modes. However, the first modes show connections with more than one climatic mode, stressing the importance of combined influence. For instance, the first spring and summer modes are result of the influence of both Pacific and Atlantic oceans. Both modes display associated SST anomalies in the tropical central/eastern Pacific, with opposite sign in the subtropics, being especially strong the anomalies in the subtropical southern Pacific. In the North Atlantic, the anomalies have the same sign as in the central/eastern tropical Pacific, while in the South Atlantic they are predominantly opposite.