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Sahel rainfall and decadal to multi-decadal sea surface temperature variability

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Sahel rainfall variability at decadal time-scales has been mainly driven by Sea Surface Temperatures (SSTs) in the 20th century. During that period, SSTs have shown a marked long-term trend of global warming (GW) that was externally forced by natural and anthropogenic sources. Superimposed on this long-term trend, patterns of decadal variability have been observed. Centred in the North Atlantic, the Atlantic Multidecadal Oscillation (AMO) is a pattern of variation related to the oceanic thermohaline circulation. The Pacific basin also hosts a pattern of oscillation at decadal time-scales called the Interdecadal Pacific Oscillation (IPO). In this work we investigated the relative contribution of each component to Sahel precipitation variability at decadal time-scales. For the sake of completeness, we also analysed the contribution of Indian decadal variability (IDV). For this aim we used simulations forced by idealized patterns of world-wide SST anomalies representative of these components.

The simulations show that all four SST signals have a significant impact over West African Monsoon: the positive phases of GW, IPO and IDV lead to drought over the Sahel, while a positive AMO enhances Sahel rainfall. Our simulations also show that tropical warming of SST is the main cause for the GW impact on Sahel. Regarding AMO, the pattern of anomalous precipitation is established by the SSTs in the Atlantic and Mediterranean basins. Conversely, the Pacific basin alone can not account for the IPO effect over WAM. In turn, the tropical SSTs control the IDV impact on WAM. Though GW, AMO and IPO signals are highly unrelated among them, IDV is found to be mostly explained by AMO and IPO global signals.

Our results suggest that decadal evolution of Sahel rainfall can be interpreted as the competition of three factors: the effect of GW, AMO and IPO. Following this interpretation, our results show that 40 to 50% of Sahel drought in the 1980s is explained by the change to a negative phase of the AMO, and that GW contributed between 10 and 30%. In addition, the partial recovery of Sahel rainfall in recent years was mainly driven by the AMO.