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Decadal prediction of Sahel rainfall using a dynamics-based index

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In this work, the capability of state-of-the-art of climate models in predicting precipitation in Sahel at decadal time scale is assessed. A set of 13 coupled models participating in the Coupled Model Intercomparison Project Phase-5 (CMIP5) is selected and two experiments are analysed. Initialized experiments (hindcasts) are compared to historical simulations in the period 1960-2005 to evaluate the effectiveness of initialization in predicting the July-to-September (JAS) monsoonal precipitation. Moreover, model internal variability is separated from external forcing to assess the respective weight in decadal variability.

Considering the strong linkage of the atmospheric circulation signatures over West Africa with the monsoonal precipitation variability over Sahel, the potential of using wind fields for decadal predictions is explored. Namely, a West African Monsoon Index (WAMI) is defined, based on the coherence of low (925 hPa) and high (200 hPa) troposphere wind fields, which accounts for the intensity of the monsoonal circulation. The WAMI predictive skill is assessed by comparing WAMI from coupled models with WAMI from reanalysis products and with a standardized precipitation index (SPI) from observations.

Results show that hindcasts are more skillful than historical simulations, with a prominent role of the internal variability in driving decadal variability, which points out the added value of initialization for decadal predictability. Moreover, coupled models are more skilful in predicting SPI than WAMI from reanalysis. WAMI performance is also compared with decadal predictions from CMIP5 models realized using a Sahelian precipitation index, and an improvement in predictive skill is observed in some models when WAMI is used.

However, skill depends on the geographical definition of WAMI, and on the capability of models to realistically reproduce the low-high troposphere coherence of monsoonal circulation. Concluding, a dynamics-based index is potentially more effective for decadal prediction of precipitation in Sahel than precipitation-based indices, for the intrinsic robustness of simulated dynamics fields compared to precipitation.