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Seasonal and interannual variations of the tropical hydrological cycle in response to insolation changes and climate feedbacks (Milutin Milankovic Medal Lecture)

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It is now widely recognised that the slow variations of the Earth's orbital parameters have driven the long term climate fluctuations. The orbital forcing is amplified by various feedbacks from the ocean, the cryosphere and the vegetation that are not yet fully understood. Simulations performed as part of the Paleoclimate Modeling Intercomparison Project offer the possibility to analyse how these feedbacks enhance the climate response to the insolation forcing and to test against available proxy data the realism of the simulated climate. This will be illustrated considering the Afro-Asian monsoon, for which the change in the hydrological cycle remain uncertain in future climate projections. The comparison of simulations for different climatic periods across the Eemien and the Holocene shows that changes in seasonality induced by the Earth's parameters alter differently the Indian and the African monsoon. This stresses the role of the seasonal phasing between the climate forcing and the climate phenomenon considered. The magnitude and the climatic impact of the ENSO phenomenon are also affected by the insolation forcing. Simulations of the Holocene show that ENSO strengthens across the Holocene, as suggested by coral data or lake sediments. For the mid-Holocene, model results are quite consistent. This is not the case for the Last Glacial Maximum for which there is no consensus between model results as it is the case for future climate. These examples illustrates how the analyses of past climates help to better understand the relationship between climate forcings, climate feedbacks and climate phenomenon operating at seasonal or interannual time scales.