Geophysical Research Abstracts
Vol. 21, EGU2019-8266, 2019
EGU General Assembly 2019

A long term perspective on Monsoon variability and extreme dry or wet years

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The Indian and West African monsoons vary on a large variety of timescales, with alternation of extremely wet and dry years having huge impacts on local economy and society. Some of these extreme monsoon events result from the chaotic nature of climate. They are also favored by teleconnection with various modes of climate variability ranging from interannual (e.g., El Nino Southern Oscillation and the Indian Ocean dipole) to decadal (e.g., Atlantic dipole and Atlantic meridional oscillation) timescales. However the relationships between extreme monsoon years and these multi-time scales of varability are not fully understood. The last 6000 years offers a wide range of test cases to analyze these relationships and the diversity of events.

The mid-Holocene, 6000 years BP, is characterized by increased monsoon precipitation in West Africa and India compared to modern conditions. This is caused by the Earth's orbital configuration. The seasonal cycle of incoming solar radiation was enhanced in the northern Hemisphere and reduced it in the southern Hemisphere, thereby enhancing the monsoon flow between ocean and land. The retreat of the two monsoon systems back to present day conditions has been punctuated by periods of rapid transitions and periods of mega droughts that had significant imprints on the environment.

We consider extreme monsoon events in a multi-complexity ensemble of transient simulations of the last 6000 years ran with the IPSL Earth system model. These simulations allow us to analyze the monsoon response to Earth's orbit and trace gazes, and how multiscale interactions affect extreme African and Indian monsoon events. First results indicate that interannual to decadal variability in Indian precipitation increases with time when its mean amount decreases. This likely relates to increased ENSO variability in the model, the latter being consistent with paleo-reconstructions from coral and bivalves in the Pacific. By sorting the results in different frequency band or type of extreme events, we also explore the relative changes in variability between the Indian and African monsoon, the characteristics of period with high monsoon or prolonged droughts as well as their relationship with modes of climate variability.