



The contribution of ocean variability to droughts in the tropics

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Variations in ocean temperature are known to modulate rainfall variability over land. For example, the El Niño – Southern Oscillation (ENSO) has been associated with droughts and floods in many regions around the globe. In this study we investigate how much of rainfall mean and variability in the tropics can be attributed to interannual variations in sea surface temperature (SST).

We use numerical simulations with the National Center for Atmospheric Research (NCAR) Community Earth System Model (CESM) to separate the contribution of the oceans to rainfall. Firstly, a fully coupled simulation is performed for 1000yrs to allow all components of the climate system to interact with each other. Secondly, we eliminate the ocean interannual variability by integrating an atmospheric simulation for 1000yrs forced with the simulated climatology of the SST derived from the fully coupled run. This second simulation provides us with an estimate of the rainfall mean and variability caused by internal atmospheric variability, i.e. in a world where there is no ENSO or other type of ocean variability larger than 1 year. A third simulation is performed for 500yr where the atmosphere is forced with the simulated monthly varying SST from the fully-coupled simulation. This way we can quantify the effect of the ocean feedback to the atmosphere.

Results show that rainfall variability decreases by about 30% everywhere in the globe when ocean inter-annual variability is eliminated from the simulations. This means that the large-scale modes of sea surface temperature such as ENSO make droughts and pluvials more severe. Interestingly, rainfall mean over certain tropical areas also changes in the absence of ocean variability. For example, northeastern South America and the Maritime Continent receive more rain in the simulation without ocean variability than in the fully-coupled system run. An even less obvious result is that in general droughts tend to last longer when ocean variability is eliminated from the simulations. The differences in rainfall mean and extremes with and without ocean variability are mostly likely related to the way ENSO affects the tropics. Those differences will be discussed in this study.