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Understanding precipitation sensitivity to sea surface temperature variability in the tropics

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The great dependence of human society and natural ecosystems on rainfall makes precipitation variability an essential aspect of the earth's climate. Precipitation variability is particularly important in the tropics, as it not only affects local water supply but also regulates global weather and climate patterns. It is well accepted that the ocean plays a crucial role in tropical precipitation variability through variations in sea surface temperatures (SSTs). An important question is: how strong is the SST forcing? From a thermodynamic perspective, we would expect a larger precipitation response to SST variability at higher base SSTs, since SST anomalies over warmer regions should induce larger perturbations of boundary layer moist static energy, as low level atmospheric moisture is expected to increase exponentially with SST. Indeed, observational studies in the 1980s showed strong correlation between SST and precipitation variability when the base SSTs reach approximately 27.5oC, but surprisingly little correlation when the base SSTs are very high. Implication of such observation has been debated since then, but the actual sensitivity of precipitation variability to SST forcing has yet to be quantified. In this seminar, I will show that simultaneous SST-rainfall relationships in any coupled system, including observations, are inadequate for quantifying precipitation sensitivity to SST forcing. This is due to the impact of atmospheric intrinsic variability on SST. Results from uncoupled simulations show that the SST forcing in fact becomes larger for higher base SSTs. I will show that these results are in fact consistent with the basic theories of moist static stability. Future endeavors to quantify feedbacks between the SST and hydrological cycle will be presented with the aim of improving model simulations of tropical air-sea interaction and understanding tropical-extratropical teleconnections.