Geophysical Research Abstracts
Vol. 19, EGU2017-13621, 2017
EGU General Assembly 2017

Dynamically driven super C-C intensification of the tropical hydrological cycle

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Improving our understanding of the hydrological cycle and the way it responds to a warming world represents one of the greatest challenges in current climate research. We expect global mean precipitation to increase by about 2% per degree of surface warming, constrained by the atmospheric energy budget on the one hand and the availability of atmospheric water vapor (Clausius-Clapeyron) on the other. Regional changes in precipitation pattern and intensity are less well known and often described by the 'wet gets wetter and dry gets drier' paradigm. The currently wettest region of our planet is characterized by organized deep tropical convection over the equatorial oceans and referred to as the Inter-Tropical Convergence Zone (ITCZ). To quantify potential changes of the tropical water cycle in a warmer climate, we have analyzed a great amount of independent observational datasets collected over multiple decades. With this we reveal a strong, positive feedback on tropical convection in the Pacific associated with the short-term climate variations of the El Niño/Southern Oscillation (ENSO). This dynamical feedback is in addition to the established Bjerknes (positive) and surface heat flux (negative) feedbacks and is a result of coupled dynamical-radiative-convective processes that produce observed responses in precipitation and cloud amount far beyond those expected from the Clausius-Clapeyron (CC) response alone. We have indication that this dynamical feedback is driven by differential atmospheric heating rates in the convective regions (heating) and adjacent regions to the south, north and west (cooling) leading to inflow that feeds the convectively active zones. This evidence is supported by analysis of observed surface wind divergence and vertical motion from reanalysis. While super-CC responses to global warming have been examined with respect to local and short-term weather events, this study provides the first observational evidence of a much larger scale response on seasonal and longer time scales.