Geophysical Research Abstracts
Vol. 19, EGU2017-11226, 2017
EGU General Assembly 2017

Global warming and tropical Pacific sea surface temperature: Why models and observations [U+FFFC] do not agree

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The pattern of sea surface temperature (SST) in the tropical Pacific Ocean provides an important control on global climate, necessitating an understanding of how this pattern will change in response to anthropogenic radiative forcing. State-of-the-art climate models from the Coupled Model Intercomparison Project phase 5 (CMIP5) overwhelmingly project a decrease in the tropical Pacific zonal SST gradient over the coming century. This decrease is, in part, a response of the ocean to a weakening Walker circulation in the CMIP5 models, a consequence of the mass and energy balances of the hydrologic cycle identified by Held and Soden (2006). CMIP5 models, however, are not able to reproduce the observed increase in the zonal SST gradient between 1900-2013 C.E., which we argue to be robust using advanced statistical techniques and new observational datasets. While this increase is suggestive of the ocean dynamical thermostat mechanism of Clement et al. (1996), we provide evidence that a strengthening Equatorial Undercurrent (EUC) also contributes to eastern equatorial Pacific cooling. Importantly, the strengthening EUC is a response of the ocean to a weakening Walker circulation and thus can help to reconcile the range of opposing theories and observations of anthropogenic climate change in the tropical Pacific Ocean. Because of a newly identified bias in their simulation of equatorial coupled atmosphere-ocean dynamics, however, CMIP5 models do not capture the magnitude of the response of the EUC to anthropogenic radiative forcing. Consequently, they project a continuation of the opposite to what has been observed in the real world, with potentially serious consequences for projected climate impacts that are influenced by the tropical Pacific Ocean.