Development of processes oriented metrics for ENSO-related Precipitation anomalies along the equatorial Pacific in climate models

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In climate models, to demonstrate the hypothesis that SST anomalies associated with ENSO serves as the source predictability of seasonal to interannual climate anomalies over North America and U.S. affiliated Pacific Islands (USAPI) require translating these SST anomalies into precipitation and latent heating anomalies by models' physical parameterizations. While CMIP5 assessment studies suggest improvement in representing ENSO-related SST anomalies, representation of precipitation anomalies along the equatorial central and eastern Pacific and therefore tropical to extratropical teleconnection have not improved. We hypothesize that climate models' fidelity in representing organized ENSO-related precipitation anomalies require models' ability in accurately representing relative contributions of entropy forcing terms to convection (e.g., surface fluxes, net radiative flux into the column), and "water vapor-convection" and "cloud-radiation" feedbacks. To quantify these processes, vertically integrated moist static energy (MSE) budget analysis has been applied to CMIP5 model solutions with a particular focus on ENSO winters. Further process-based diagnostics such as precipitation relationship to column relative humidity (CRH) and boundary layer *versus* free troposphere moisture variations are also examined.

The process-based diagnostics indicate that: (i) when compared to ERA-Interim products, models that realistically represent the climatological vertical structure of vertical velocity over the central and eastern equatorial Pacific capture the relative contributions of various MSE terms realistically during ENSO winters; (ii) when terms are projected onto the vertical advection of anomalous MSE, anomalous net radiative flux into the column dominates the contribution and stresses the need for realistic representation of cloud-radiative feedbacks; (iii) models that have unrealistic representation of anvil cirrus clouds and hence weak cloud-radiative feedbacks fail to represent ENSO-related precipitation and (iv) models that have realistic representation of free troposphere moisture variations (implying water vapor-convection feedbacks) capture realistic precipitation intensity. Based on these process-based diagnostics, we will present a series of metrics that identify systematic errors and offer pathways for model physical parameterizations.