



Relationship between the annual-cycle strength and ENSO amplitude pivoted on the annual-mean state

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The influences of the annual-mean climate states on the tropical Pacific annual cycle and ENSO variability are studied using twelve different coupled general circulation models (CGCMs). In most CGCMs, an intensified annual-cycle of the sea surface temperature (SST) in the tropical eastern Pacific is related to the suppressed ENSO amplitude, and vice versa (i.e., the negative correlation). The number of CGCMs that show this negative correlation are increased in the greenhouse warming experiment. To reveal what causes this negative correlation, we particularly focus on a CGCM developed by Max Planck Institute for Meteorology. From the higher greenhouse concentration experiment of the CGCM, we found that the large-scale air-sea coupling strength defined by using the maximum covariance analysis is larger during the weak annual-cycle periods compared with that during the strong annual-cycle periods. Furthermore, the eigenanalysis using the intermediate El Nino-Southern Oscillation (ENSO) model verified that the large (small) amplitude of ENSO (here, actually referring the growth rate of ENSO mode) is related to the annual-mean climate state associated with the weak (strong) annual-cycle periods. In particular, the annual-mean SST change plays an important role to modify the ENSO amplitude. The annual-mean climate state also modified the intensity of annual cycle in the tropical eastern Pacific. It has been verified by using the hybrid coupled model, in which the annual-mean climate states are prescribed. The strong annual cycle in the tropical eastern Pacific

is produced by the hybrid model, when the annual-mean climate state associated with the strong annual-cycle periods are prescribed, and vice versa. Analysis as well as the model experiments suggests that the changes in the annual-mean climate state control both the annual-cycle strength and ENSO amplitude at the same time and have them to be negatively correlated.