



## Biennial coupled characteristics among Indian Ocean, Western North Pacific and ENSO

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The biennial coupling between tropical Indian Ocean and Pacific Ocean and their decadal change are explored on the basis of Indian Ocean dipole (IOD), El Nino Southern Oscillation (ENSO), Indian Ocean basin-wide warming (IOBW) and the western North Pacific high (WNPH). The coupling has been defined as the year to year tendency for a positive IOD-ENSO-IOBW-WNPH cycle followed by a negative cycle, with transitions occurring in northern summer. Seasonal locked characteristics of these phenomena under the annual cycle explain a full cycle of quasi-biennial coupling involving Indian Ocean leading Pacific Ocean through the wind-evaporation and oceanic thermocline feedbacks over the western Pacific. The results here suggest that the IOD does not always accompany El Nino condition, but El Nino peak and demise are controlled through this biennial coupling, with being stronger in the magnitude and faster in the transition to La Nina. On the other hand, El Nino events without the biennial coupling tend to be warm pool-type condition with relatively weak impact on IOBW. It is possible that the biennial characteristics of Indo-Pacific atmosphere-land-ocean interaction are the key role in the biennial coupling between Indian Ocean and Pacific Ocean. However, unlike the tropical biennial oscillation which is defined as the year to year flip-flops of Indian monsoon, the cycle has close relationship with WNPH rather than Indian monsoon. We also demonstrate that the biennial coupling has been abruptly enhanced since mid-1970s and it is derived by the changes in IOD-ENSO relationship.