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Thermocline feedback associated with the increasing occurrence of Central Pacific ENSO assessed using a linear, multi-mode model

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The change of thermocline feedback responsible for ENSO diversity has been under debate. Yeh et al, (2009) suggest that a flatten thermocline in the equatorial Pacific and increasing thermocline feedback in the central Pacific (CP) attribute to the increasing occurrence of CP ENSO events. Lübbecke and McPhaden, (2014) argued that, however, the CP-events-prevailing decade (2000-2010) is featured by a steepened thermocline and weakened thermocline feedback in the central-eastern Pacific.

Here we combine the sea level variations simulated by a linear, multi-mode model of Zhu et al, (2017) for the period 1961-2014 and satellite measurements to assess and interpret the thermocline feedback in the equatorial Pacific. After the 1976/77 climate shift, the thermocline feedback in the central Pacific is found to increase strongly. At the same time, the Bjerknes feedback mechanism is shown to increase in strength in the Nino4 region, concurrent with the increased occurrence of CP ENSO events. An important point is that the emergence of the thermocline feedback in the Nino4 region can be related to changes in the wind field over the equatorial Pacific; in particular, the westward shift of the pivot point for sea level (and hence thermocline) variations associated with the increase in zonal wind stress variance in the western equatorial Pacific, the latter in turn being related to the increased frequency of CP events due to the Bjerknes feedback. As the pivot point shifts westward, the Nino4 region is found increasingly to the east of the pivot point enabling the thermocline feedback to operate there. These arguments imply a positive feedback in which CP events are self-maintaining and suggest that they may be part of the natural variability of the climate system and could occur episodically without the need for changes in external forcing.