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The Relationship between Thermocline Depth and SST Anomalies in the Eastern Equatorial Pacific: Seasonality and Decadal Variations

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ABSTRACT

Even though the vital role of thermocline fluctuation in ENSO cycle has been established previously, the direct relationship between the thermocline depth and SST anomalies in the equatorial Pacific is yet to be fully understood, especially its seasonality. Thermocline depth anomalies were found to lead SST anomalies in time with a longitude-dependent delay, but our study suggests that the relationship shows strong seasonal dependency, which is the most (least) significant during the boreal spring (summer). Over the eastern equatorial Pacific where there is the least delay comparing with western and central Pacific, the connection between thermocline and SST is the weakest during the boreal spring (Fig. 1). This feature is one of origins for ENSO spring persistence barrier, as evidenced by the weakest thermocline and Bjerknes feedbacks occurring in spring (Fig. 2). Furthermore, the thermocline-SST connections exhibit significant decadal variations, which are remarkably consistent with the decadal changes in the persistence barrier of SST anomalies over the eastern Pacific. It is also found that the decadal shift in the timing of the thermocline-SST connection barrier is caused by the

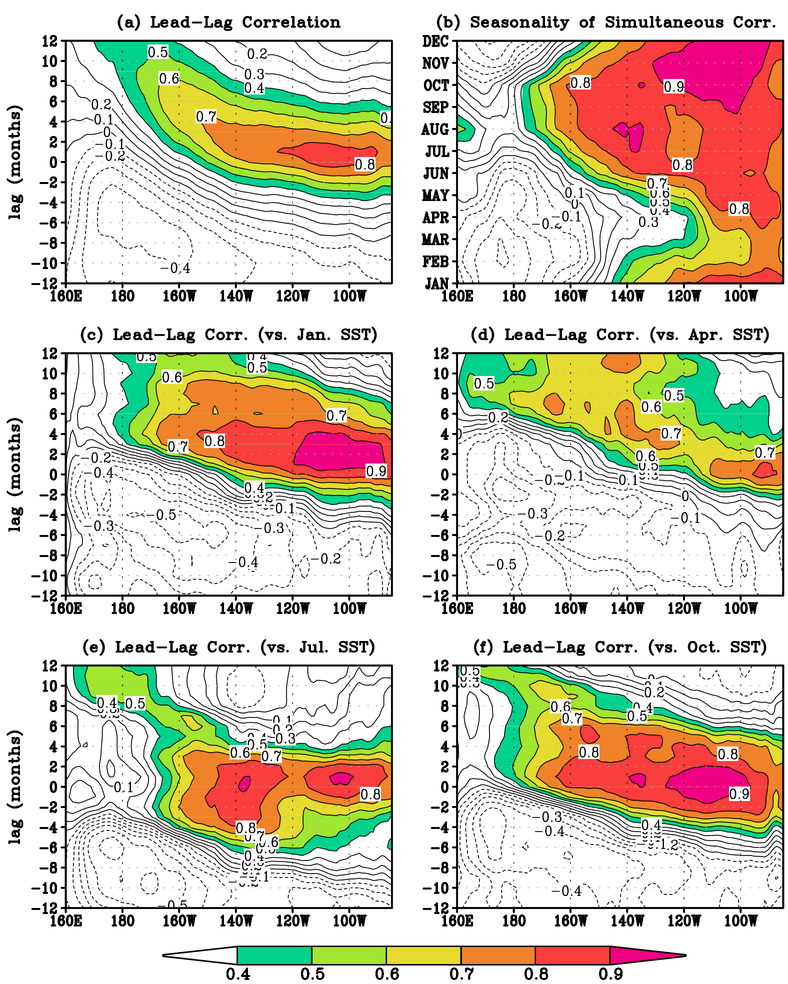

Fig. 1 Lead-lag correlations between observed Z20 and SST anomalies for (a) all months regardless of season, (c) January, (d) April, (e) July and (f) October. (b) Simultaneous correlations between observed Z20 and SST anomalies as a function of season. Positive lag means Z20 leads SST. All calculations are based on 1982-2011 and presented along the equator (averaged over 2ºS-2ºN).

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changes in the seasonal cycle of tropical trade winds and thermocline depths (Fig. 3).

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References

Zhu, J., A. Kumar, and B. Huang, 2015: The relationship between thermocline depth and SST anomalies in the eastern equatorial Pacific: Seasonality and decadal variations. *Geophys. Res. Lett.*, **42**, 4507–4515. doi: 10.1002/2015GL064220.

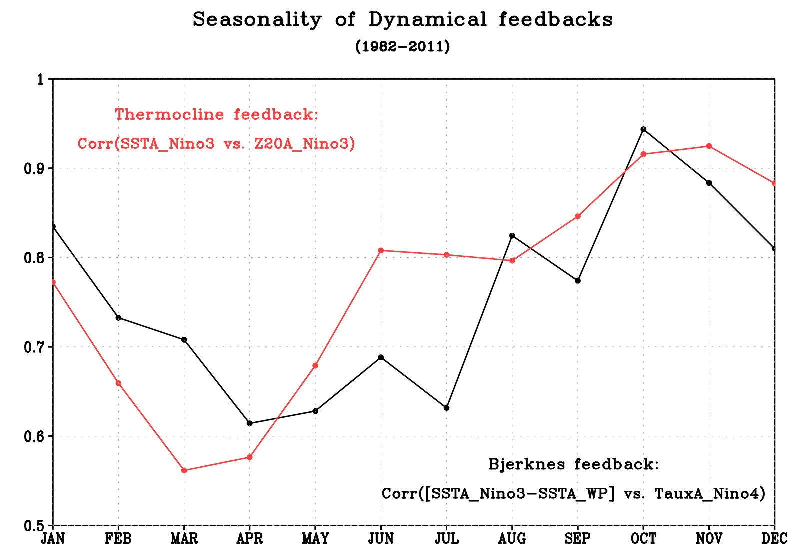

Fig. 2 Simultaneous correlations as a function of season between the observed Z20 and SST anomalies averaged over the Niño3 region (red curve), and between the observed SST zonal gradients and the surface zonal wind stress anomalies averaged over the Niño 4 region (black curve). The SST zonal gradient is defined as the difference between the western Pacific region (120ºE-160ºE, 5ºS-5ºN) and the Niño 3 region. Calculations are performed for 1982-2011.

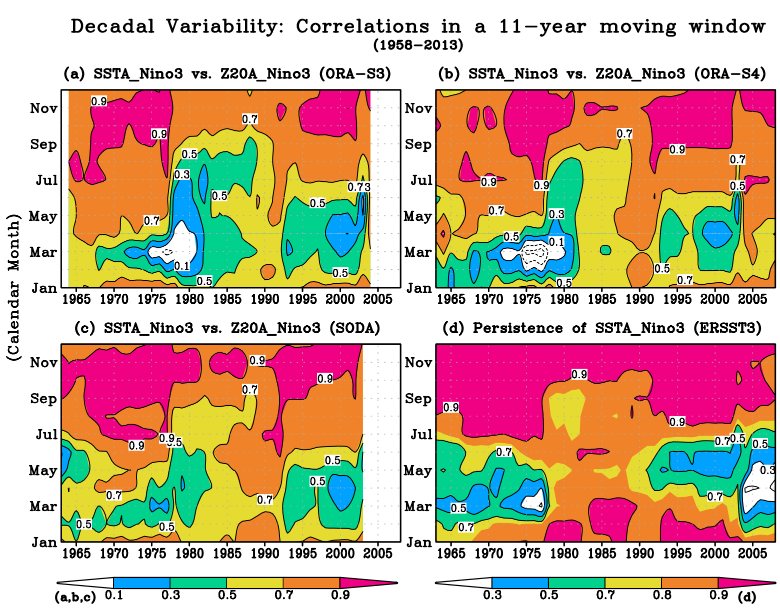

Fig. 3 Simultaneous correlations between Z20 and SST anomalies averaged over the Niño3 region as a function of season within an 11-year moving window, with SST data from ERSST3 and Z20 data from (a) ORA-S3, (b) ORA-S4 and (c) SODA. (d) Seasonality of Niño3 SST anomalies persistence within an 11-year moving window. The persistence for a given month (e.g., March) is defined as the correlation between two time series for one month earlier (February) and later (April) than the month. The 11-year window is shifted year by year from 1958 to 2013.