The Warm Pool Variability of the Tropical NE Pacific and its Relation to the Atlantic Warm Pool

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INTRODUCTION

The eastern Pacific warm pool (EPWP) is defined as the area enclosed by the 28.5 °C sea surface temperature (SST) isotherm, and is a part of the Western Hemisphere Warm Pool (WHWP.) The goal of this research is to objectively define the onset, demise and length of the EPWP season, as well as investigate its teleconnections with rainfall, 500hPa geopotential heights and 850hP winds in North and Central America. The Atlantic Warm Pool (AWP) is the larger Atlantic counterpart of the WHWP and appears in early boreal summer and is preceded by the EPWP. The correlation between the EPWP and the AWP will also be investigated.

DATA

The SSTs used in this study are from the NOAA Optimally Interpolated daily values version 2 (Reynolds et al. 2007) available at 0.25°x0.25° resolution globally. The rainfall data analyzed for this work comes from the Climate Prediction Center (CPC) Unified Gauge-Based Analysis of Global Daily Precipitation on a 0.5° degree grid (Chen et al. 2008). The upper air variables are from the National Centers for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR; Saha et al. [2010]). The time period of the observational analysis conducted in this paper is for a 35-year period from 1979 to 2013.

DEFINING THE ONSET AND DEMISE

In order to calculate the onset and demise for each year, the daily cumulative anomalies of the area were calculated using the following equation:

$$DCA_k(m) = \sum_{i=1}^{m} \{A_k'(i)\}$$

Fig. 1 shows the EPWP cumulative anomalies for the year 2010 in red. The onset of the EPWP season is defined as the minimum value of the cumulative anomalies after the first day of the year, which coincides with the day the daily anomalies of the area of EPWP exceed the climatological annual mean EPWP area. Similarly, the demise of the EPWP season is defined as the maximum value of the cumulative anomalies after the first day of the year, which coincides with the day the daily anomalies of the area of the EPWP fall below the climatological annual mean EPWP area after the onset date is detected.

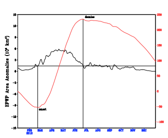

Figure 1. The time series of daily cumulative anomalies (in red) and the daily anomalies of the EPWP area for the year 2010. The date of onset and demise of the EPWP is marked.

CHARACTERISTICS OF THE EPWP

The climatological onset of the EPWP is March 22 and the climatological demise is August 16. The climatological peak is May 2. The seasonal evolution of the EPWP has a strong asymmetry, with the climatological peak of the EPWP area occurring approximately 41 days from the onset while the demise of the season occurs after nearly 106 days from the climatological peak. During El Niño years, the onset occurs 2 days later and the demise occurs 53 days later than climatology. During La Niña years, the onset occurs 11 days earlier and the demise occurs 30 days earlier than climatology.

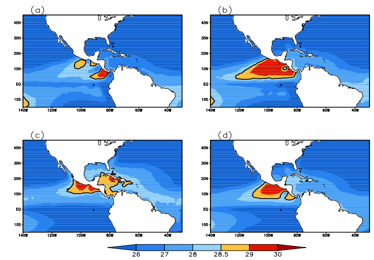

Figure 2. The climatological mean SST at time of a) onset, b) peak, c) demise of the EPWP and d) the climatological mean SST between onset and demise dates of the EPWP.

CORRELATIONS WITH AWP AND RAINFALL

The EPWP can be correlated to the season of the AWP. Table 1. suggests that an early (late) demise date or shorter (longer) EPWP season is also likely to be associated with an early (late) demise or shorter (longer) season of the AWP. However these correlations, despite being statistically significant, are relatively weak (in the range of 0.3-0.5). It is important to note that besides the demise date and length of the EPWP, all other variants of EPWP seem to have insignificant relationship with the AWP. Fig. 3 suggests that an early (late) onset of the EPWP is likely to associated with less (more) AMJ rainfall over Southeastern Mexico and Southwestern US (Pacific Northwest and over the Ohio Valley).

Table 1. Linear correlations between EPWP and AWP. We have also indicated correlation in brackets after the corresponding linear trends are removed both in EPWP and AWP variants. (Statistically significant values at 90% confidence interval is in bold).

	Onset date of the warm pool in the tropical northeast Pacific (WNEP)	Demise date of the WNEP	Length of the WNEP season	Seasonal average of the area of the WNEP
Onset date of AWP	0.37 (0.35)	-0.16 (-0.06)	-0.25 (-0.07)	-0.36 (-0.30)
Demise date of the AWP	-0.24 (-0.21)	**0.46** (0.21)	**0.48** (0.25)	0.23 (0.18)
Length of the AWP	-0.35 (-0.34)	0.35 (0.07)	**0.41** (0.18)	0.33 (0.29)
Seasonal average of the area of the AWP	-0.27 (-0.21)	0.33 (0.07)	0.37 (0.14)	0.17 (0.07)

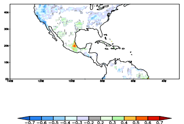

Figure 3. The correlation of the variability of the seasonal mean April-May-June (AMJ) rainfall with the onset of the EPWP season. Only significant values at 90% confidence interval are shaded.

TELECONNECTIONS

The remote teleconnections in Fig. 3 can best be understood with the regression of the mean AMJ 500hPa geopotential heights with the onset date of the EPWP (Fig. 5a). These linear regressions show the weakening of the North Pacific High and general increase in the 500hPa heights in the tropics with an early onset of EPWP, which is consistent with the atmospheric response to warm ENSO forcing (Wallace and Gutzler 1981). Likewise, the regression of the mean AMJ 850hPa winds with the onset date of the EPWP season shows that early (late) onset relates to weakening (strengthening) of the easterlies (Fig. 5b) that is akin to the ENSO modulation of the trade winds.

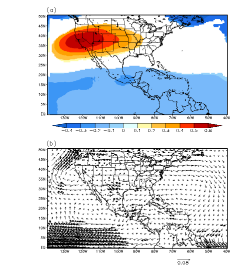

Figure 5. The regression of the a) 500hPa geopotential heights and b) winds at 850hPa with the onset date of the EPWP season. Only significant values at 90% confidence interval are shaded in (a) and are shown with bold arrows in (b).

CONCLUSIONS

The onset date variability of the EPWP season is closely related to the variability of the seasonal mean area of the EPWP season. The variations of the onset of the EPWP season are shown to have a significant relationship with variations of the subsequent AMJ seasonal mean continental rainfall variability over North America and Central America. These remote teleconnections are facilitated by the modulation of the large-scale circulation as observed in the modulation of the North Pacific High and the 500hPa geopotential height patterns, which are very similar to the atmospheric response to ENSO forcing. This study reveals that the relationship between the EPWP and the AWP is weak even though they are both considered to be part of the WHWP.

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