Seasonal Transition of the Southeast Pacific Anticyclone

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\textbf{1. Introduction}

Southerly flow along the coast of Chile ($v$) is driven by the southeast Pacific (SEP) anticyclone and the wind stress forces upwelling along the coast. Marked seasonal variation occurs especially near Punta Lavapié and Punta Lengua de Vaca as the SEP shifts meridionally (Fig. 1). Year-to-year variability can be large and impact the timing, duration, and nature of the transition. Detection of the transition is often clear at Punta Lavapié, but unclear at Punta Lengua de Vaca. Thus, an objective method must be employed to detect these changes.

\textbf{2. Method}

Pseudo-wind stress ($v^*|v|$) is used to calculate a cumulative upwelling index (CUI). Near Punta Lavapié the transition is usually unambiguous since CUI often shifts from a negative to positive slope at the beginning of the season. Examples in Fig. 2 and 3 are for 1989-1990 (ENSO-neutral) and 2008-2009 (weak La Niña). To objectively distinguish more subtle changes in slope at Punta Lengua de Vaca, we employ a two-phase regression model:

$$X_t = \begin{cases} a_1 + b_1 t + e_t & 1 \leq t \leq c \\ a_2 + b_2 t + e_t & c < t \leq n \end{cases}$$

Equation (1) can be rewritten as:

$$c = \frac{a_1 - a_2}{b_1 - b_2}$$

To detect changes, the likelihood ratio statistic is used:

$$F = \frac{S_0 - S}{3} / \frac{S}{n - 4}$$

Since this technique is sensitive to the time period used, it was repeated in a 90-day moving window over the period 1 June-1 March. The distribution of $F$ for all time windows is shown in Fig. 3 as thin gray lines, and the maximum $F$ of all windows on each day is the bold black line. Peaks correspond to the beginning or end of the upwelling season at Punta Lengua de Vaca.

\textbf{3. Results}

This method can objectively determine the beginning and end of the upwelling season at Punta Lengua de Vaca, which is more subtle than at Punta Lavapié. Smaller windows can give more detail of sub-seasonal shifts, but the 90-day window works well to detect the upwelling season.

Long-term composites indicate phases 4, 5, and 6 (7, 8, and 1) of the Madden Julian Oscillation (MJO) tend to have stronger (weaker) northerly alongshore wind. Many years indicate some relationship with the onset of the upwelling season by delaying or expediting the transition, but it is not the case every year and many other factors can be involved.

\textbf{4. References}


