Subseasonal Easterly Wind Surges and the Onset of La Niña Events

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Abstract

Although warm El Niño-Southern Oscillation (ENSO) events, also called El Niño events, first caught the attention of the wider scientific community for their impacts on global seasonal weather anomalies, it is now widely recognized that cool-ENSO (La Niña) events, also drive socio-economically important anomalies. The importance of better understanding the effects and processes controlling the predictability and impacts of La Niña events rivals the importance of improving the understanding of these aspects of El Niño events. We show here that subseasonal events of easterly wind stress in the western and central tropical Pacific play an important role in the onset and evolution of La Niña events. These easterly wind surge events are identified using reanalysis wind stress fields, validated against buoy measurements. Analysis of the observed changes in sea surface temperature following them in the 1986-2012 period, as well as experiments with easterly wind surge forcing of an ocean general circulation model, show that these easterly surges, whose frequency is a function of ENSO state, are able to affect La Niña events in a fashion analogous to their westerly wind event counterparts that have been shown to be important in the onset and evolution of El Niño events.

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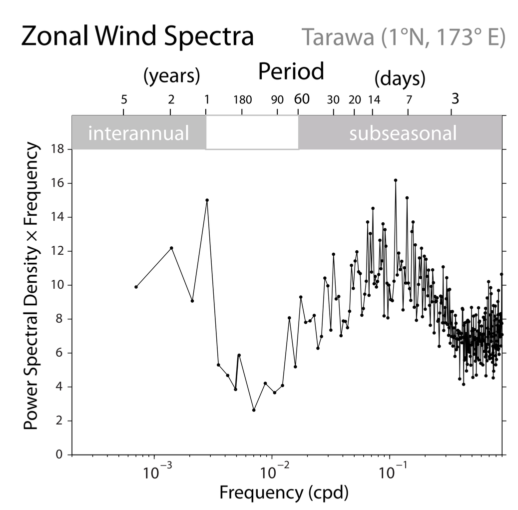

Zonal Wind Spectra in the Western Tropical Pacific have a broad peak in the 3 to 60 day band

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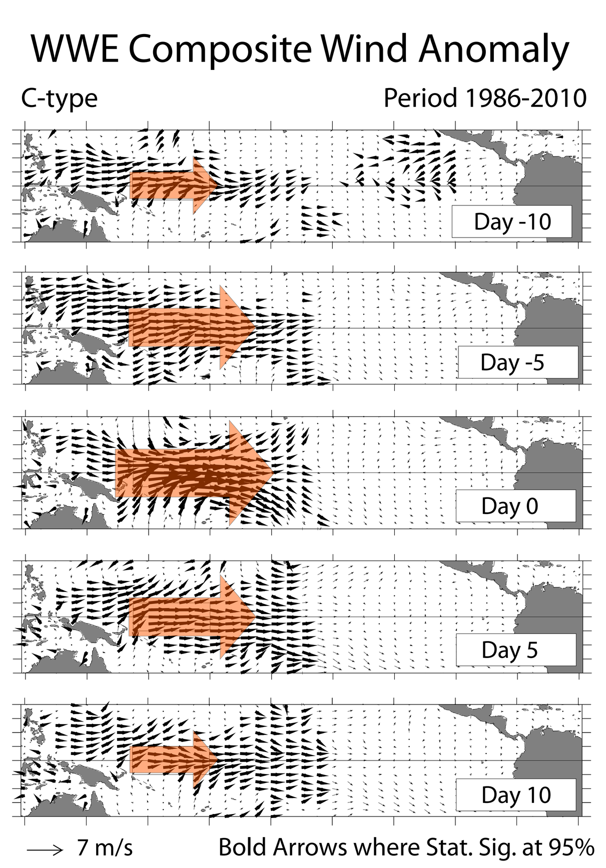

Westerly Wind Events (WWEs) are a class of subseasonal wind events associated with this 3-60 day peak. WWEs have been shown to be important to El Nino onset and development.

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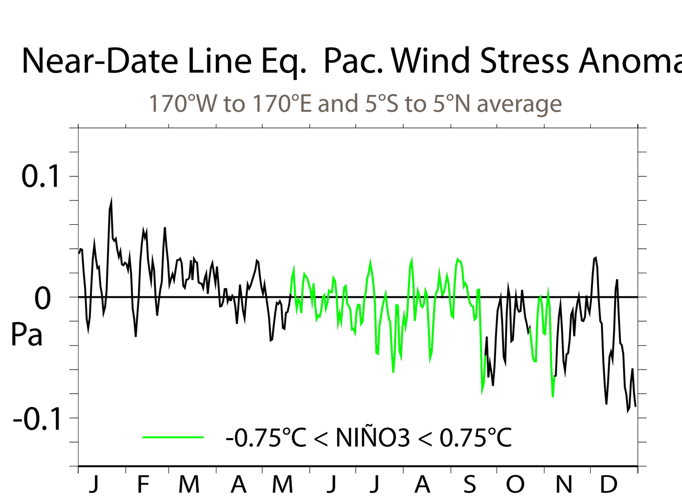

Just as the weakening of the background easterly trade winds does not occur smoothly during the transition to El Niño state, their strengthening during La Niña is punctuated by easterly events

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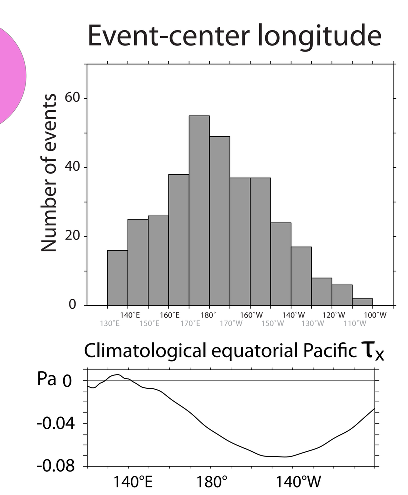

Using a definition based on the WWE ***wind stress*** scales we find that easterly wind events, which we call Easterly Wind Surges (EWS) are a prominent component of Eq. Pac. zonal wind stress variability.

EWSs occur across the entire Eq. Pacific, but are largest in number around the Date Line.

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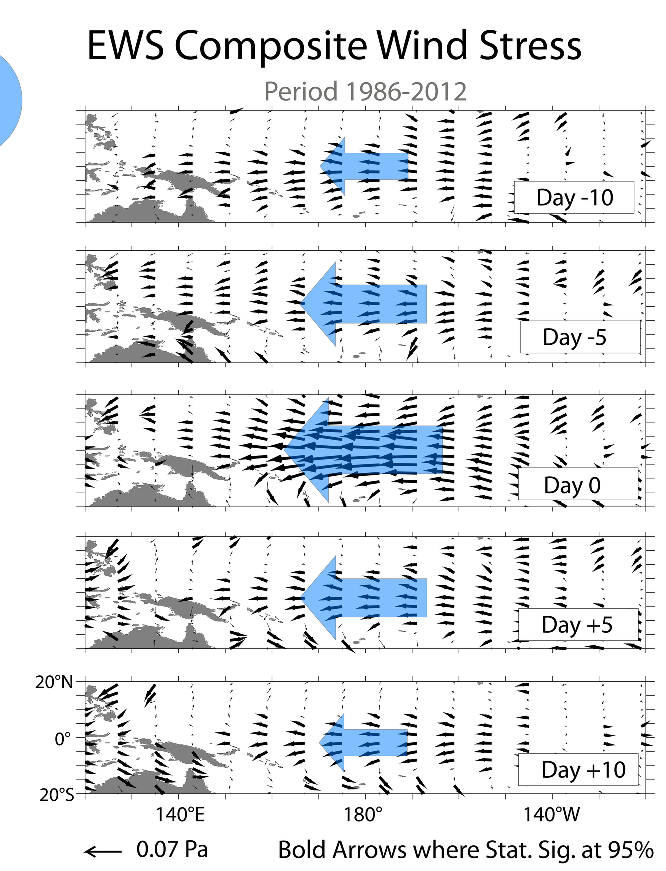

EWSs have smaller *wind speed* scales than WWEs, but comparable *wind stress anomaly* amplitudes. EWSs occur across the entire Eq. Pacific Ocean, with highest numbers near the Date Line.

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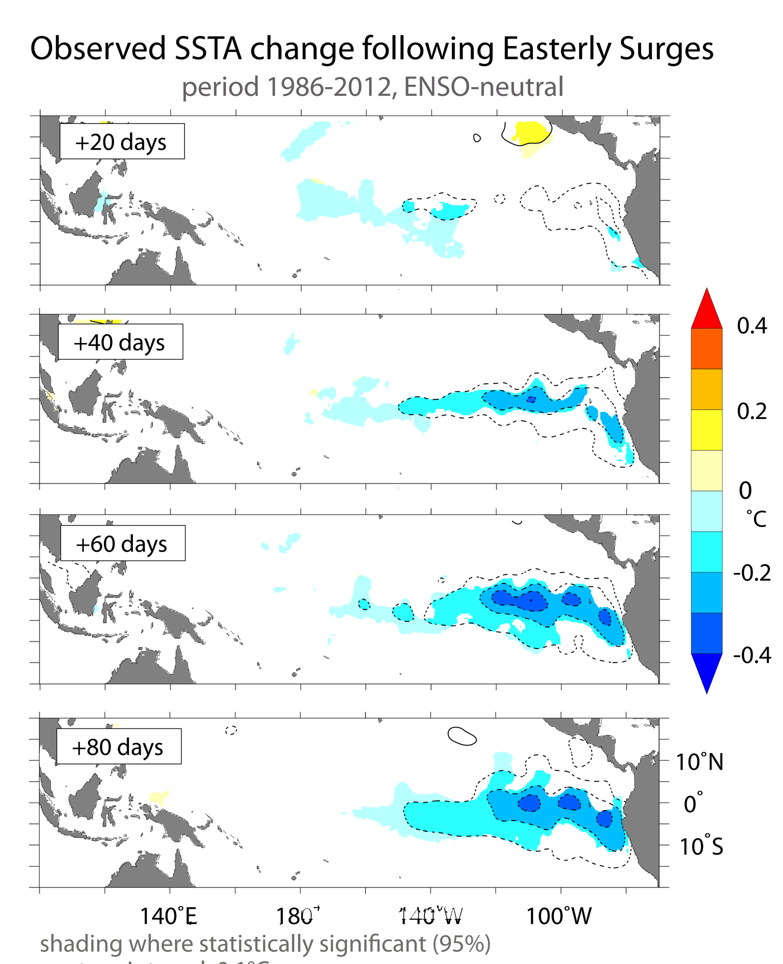
A single EWS that occurs during ENSO-neutral conditions drives waveguide cooling of a few tenths of a degree C, just like single WWEs drive a few tenths of warming.



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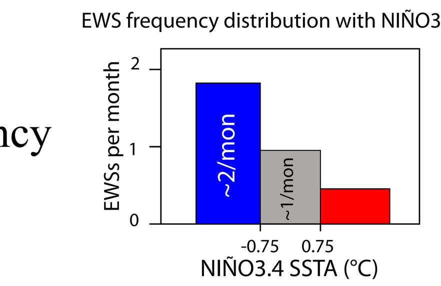
By our identification methods, EWSs occur at an average rate of ~1/month during ENSO neutral conditions, and increase in frequency (roughly double) as the system transitions (cools) to La Niña.



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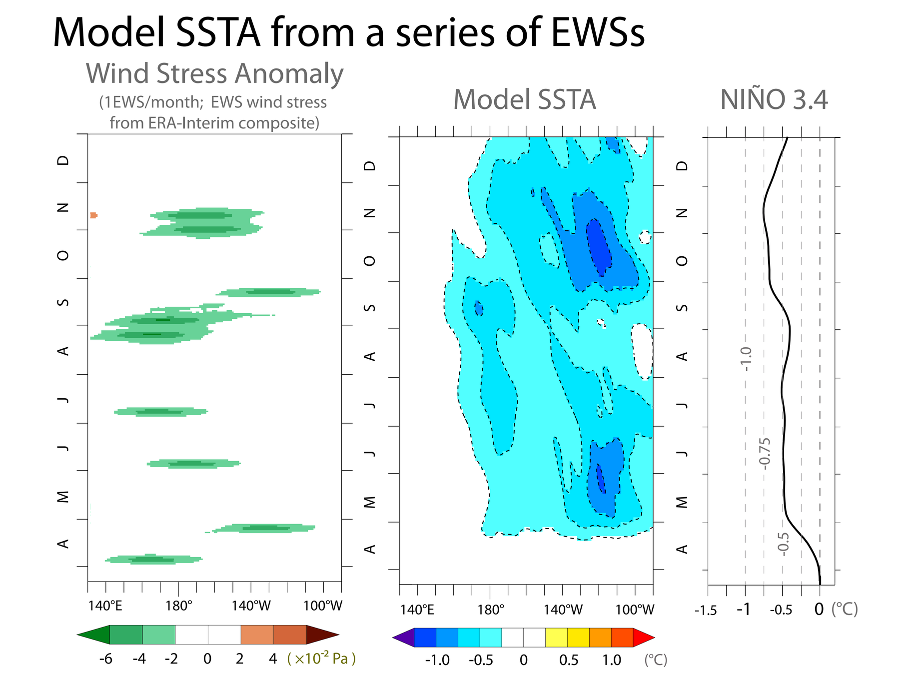

Ocean general circulation model experiments reveal that a 1/month series of EWSs will rapidly drive, then maintain a cooling of ~0.5C, averaged over the NINO3.4 region, in the absence of other forcing.

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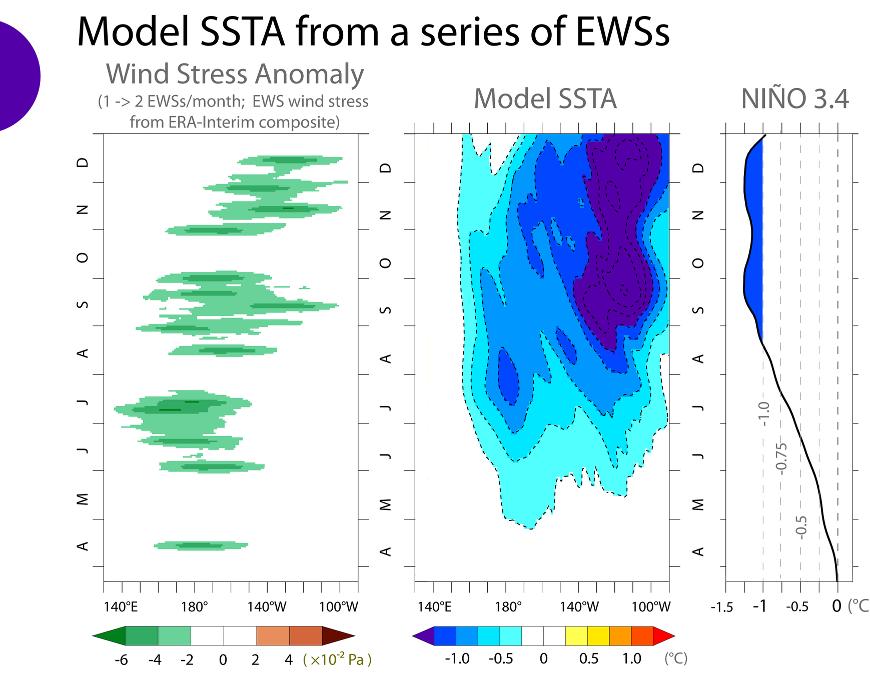

A series of EWSs that includes the ramp-up in frequency associated with cooler ENSO SSTAs is sufficient to drive a La Niña in the model.

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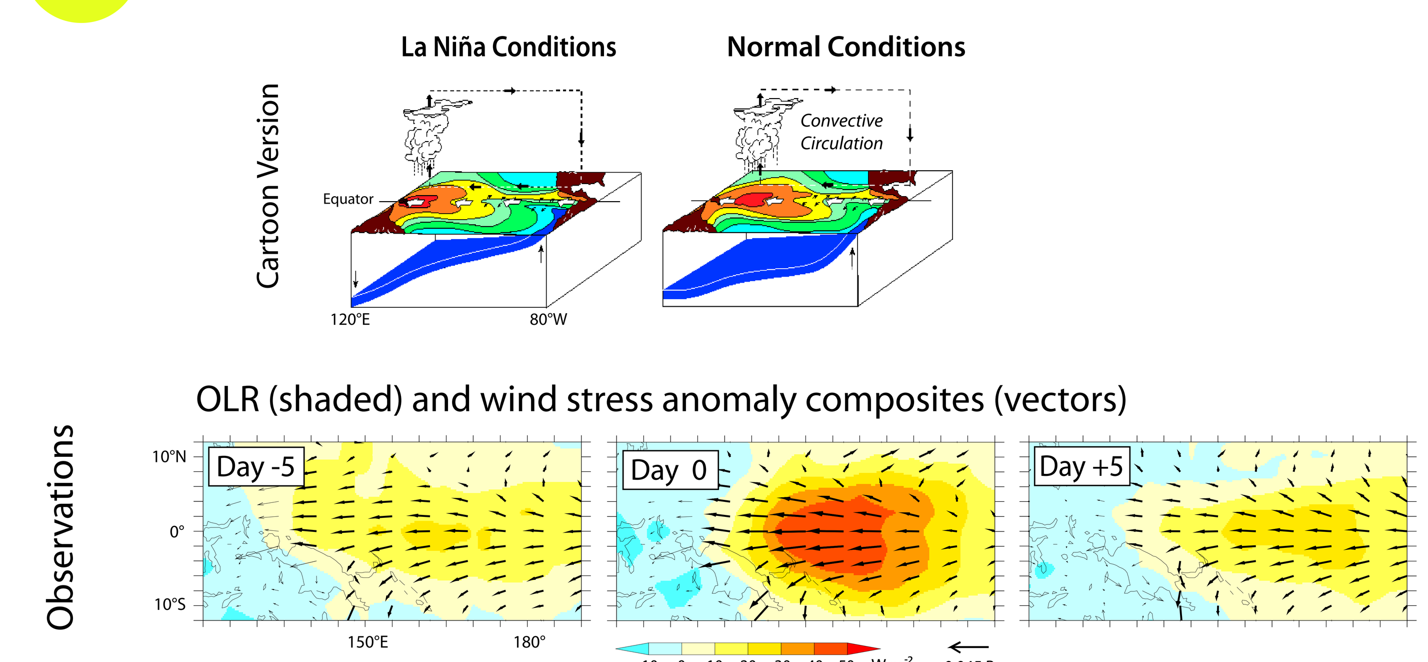
High outgoing-longwave-radiation (OLR) days link to easterly wind stress events



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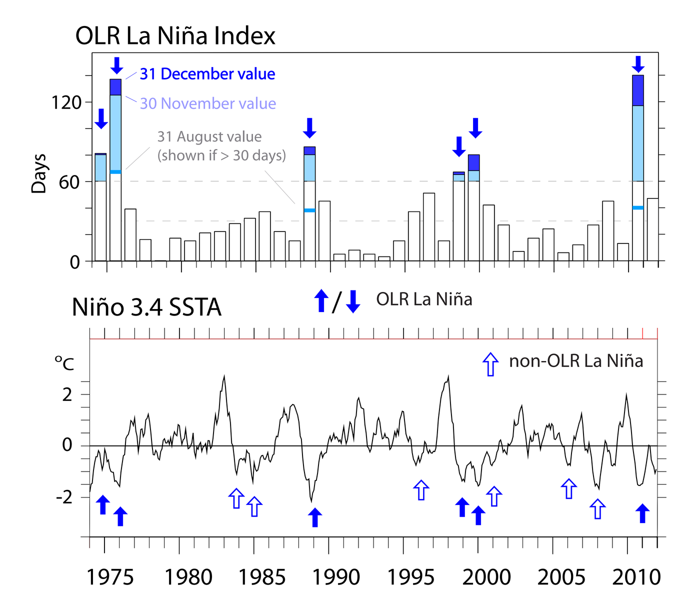

Summing the number of "clear sky" days seen from Mar to Dec each year leads to an OLR La Nina index that clearly identifies a subset of the years defined as La Nina based on NINO3.4 and the common definitions. We refer to these as the "OLR La Nina" years. In the 1974-2011 period there are 6 OLR La Nina years, and 6 others with La Nina status by SSTA, but not OLR (the "non-OLR La Nina years").

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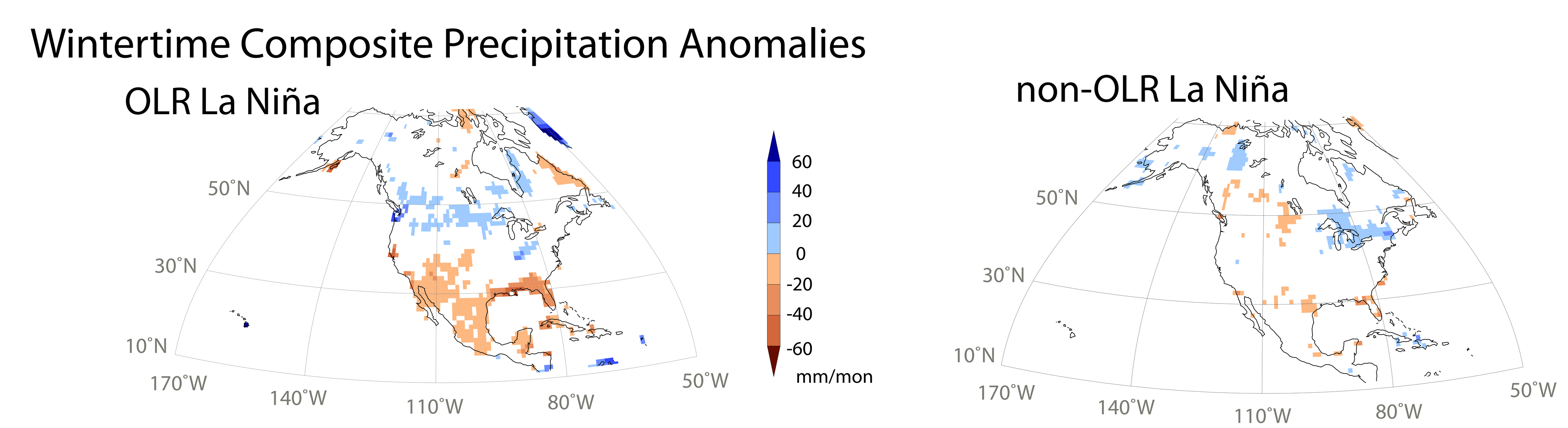
The OLR La Nina years have a usefully strong connection to seasonal weather anomalies over most of the regions conventionally found to have La Nina-associated anomalies. The non-OLR La Nina years have much weaker associations.

Wintertime Composite Precipitation Anomalies



References: Chiodi, A.M., and D.E. Harrison (2015): Equatorial Pacific easterly wind surges and the onset of La Niña events. J. Climate, doi: 10.1175/JCLI-D-14-00227.1. [In press]

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