Simulating ENSO SSTA with moored buoy and scatterometer winds

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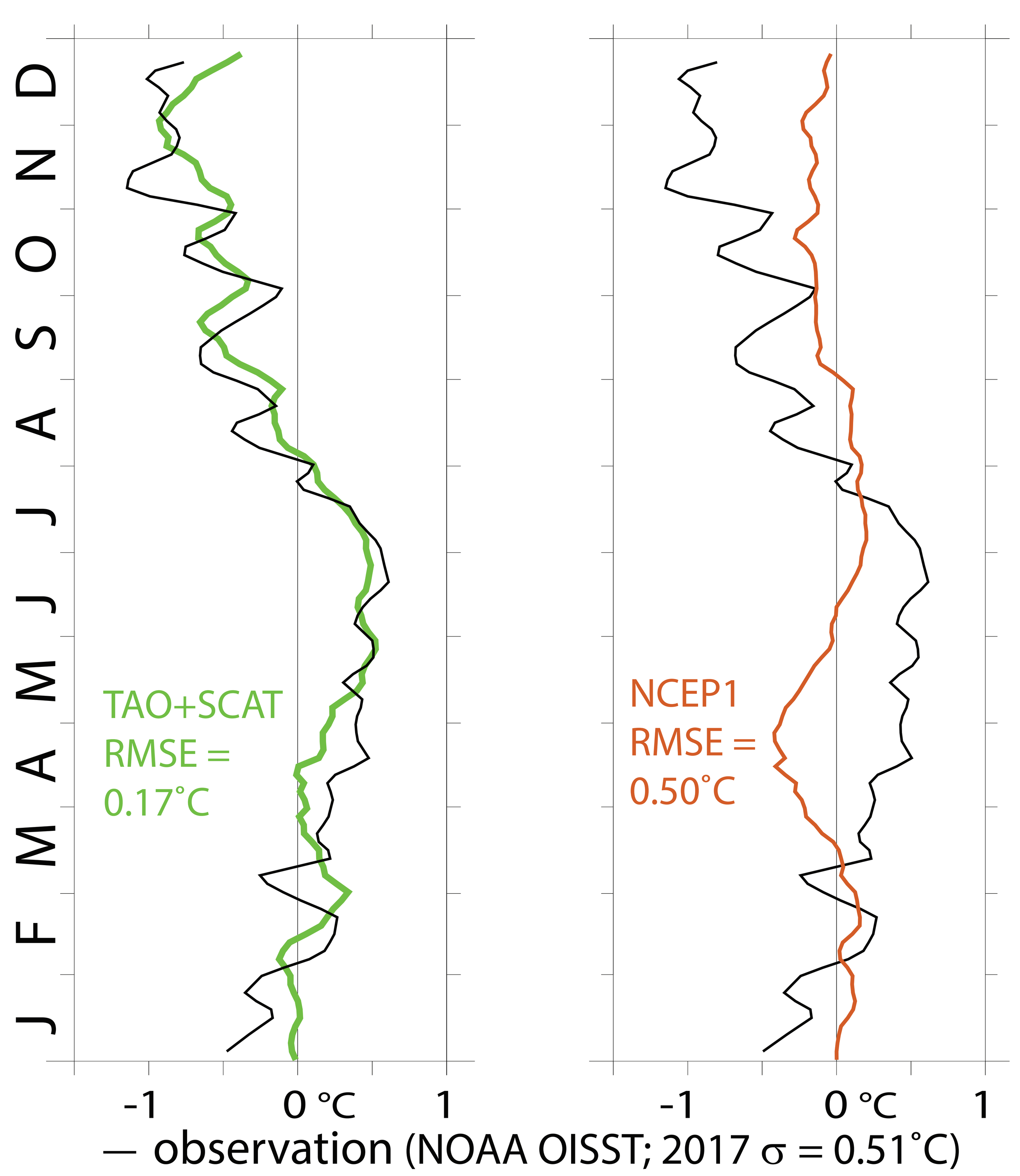
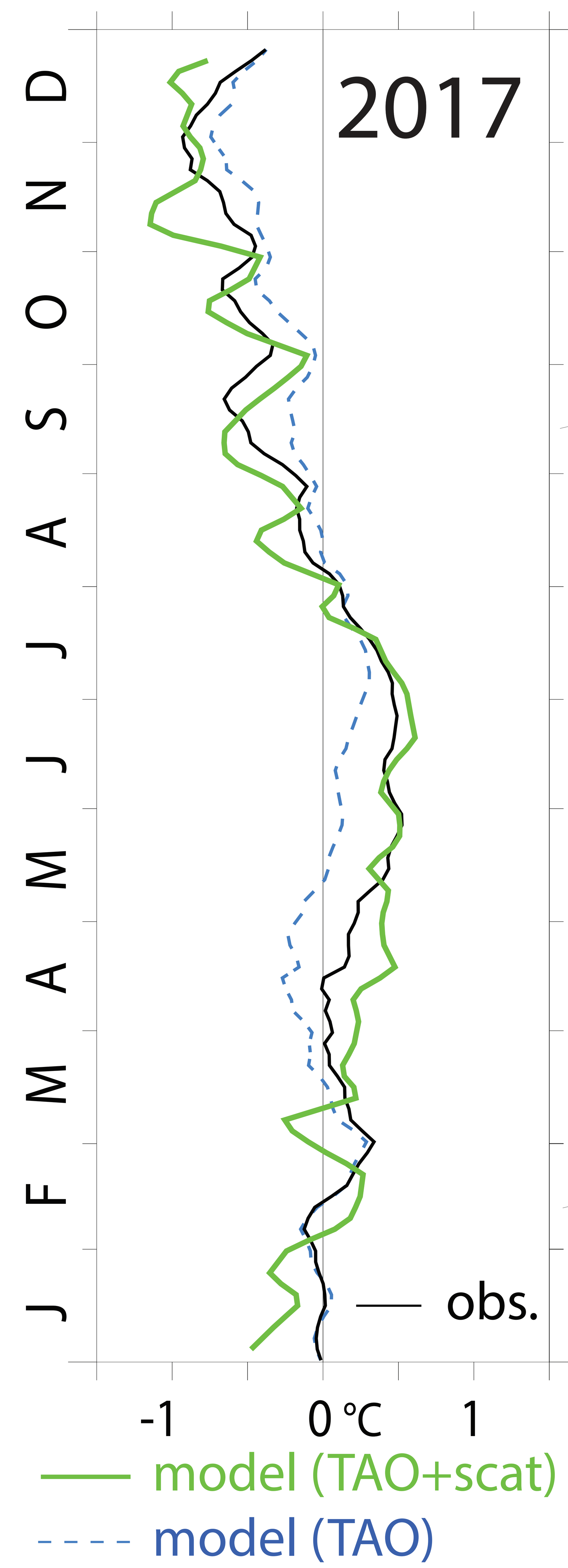
The surprising character of the sea surface temperature anomaly (SSTA) development patterns observed over the equatorial Pacific in the past few years has called attention to the important role that subseasonal wind events can play in the onset and development of El Niño-Southern Oscillation (ENSO) events. Understanding the effects of the wind event distribution in a particular year, however, requires having accurate knowledge of wind stress variability over the entire Pacific Ocean waveguide. Forced-ocean model studies have revealed that usefully accurate ENSO SSTA simulation is feasible based on waveguide wide zonal wind stress fields synthesized from the wind observations provided by the tropical Pacific moored buoy array - when data return rates from the array are good (Chiodi and Harrison 2017a). Unfortunately, data return was poor in at least some equatorial Pacific regions in many recent periods of interest, leading to gaps in our knowledge of wind variability based on the array (Chiodi and Harrison 2017b). Further study has revealed oceanically important biases in the trend and variability of winds in the reanalysis and satellite synthesis products used in recent ENSO studies. Using these products to fill the buoy dropout gaps only degraded the simulation accuracy. This work demonstrates, with 2017 as a case study, that winds from individual scatterometers can be used to fill the wind knowledge gaps caused by buoy-dropouts and increase the forced-ocean model simulation accuracy. This approach offers near real-time knowledge of equatorial Pacific zonal wind stress variability adequate for both understanding observed ENSO SSTA development and identifying sub-seasonal wind events.

2017 Niño 3.4



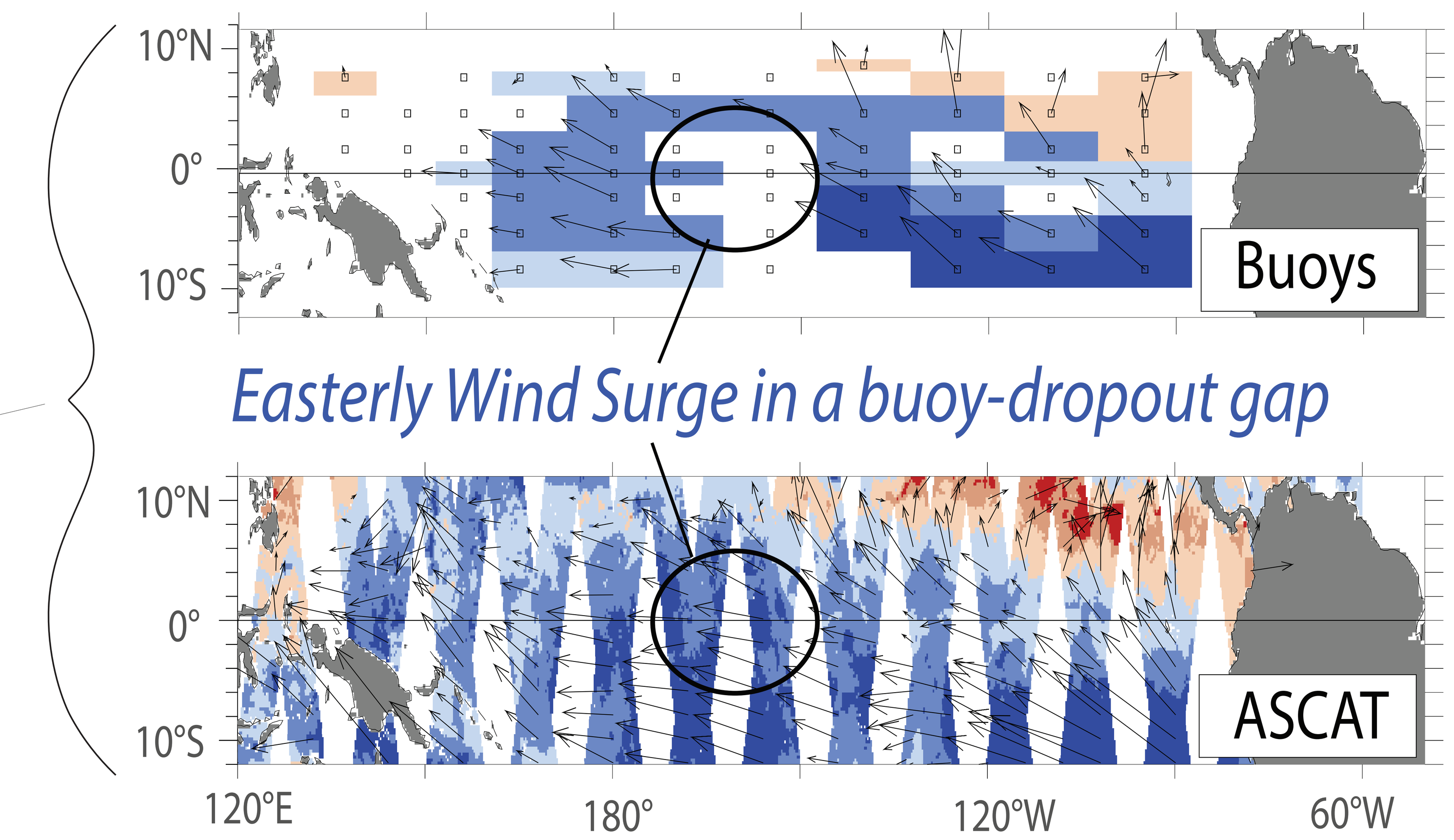
The forced ocean model simulations illustrated above were run in late December 2017 as diagnostics understanding the past year's Nino 3.4 SSTA development. The NCEP/NCAR reanalysis is one of the only major analyzed products available in near real-time, but contains oceanically important wind biases over the equatorial Pacific that lead to highly inaccurate simulations (noise-to-signal ratio RMSE/σ=1 in the 2017 case). Forcing the model instead with a basin wide zonal wind stress field synthesized from the TAO/Triton buoy winds when they are available and using ASCAT-A winds to fill the gaps caused buoys drop-outs leads to usefully accurate simulations, thereby providing a basis for understanding the observed SSTA development.

Niño 3.4

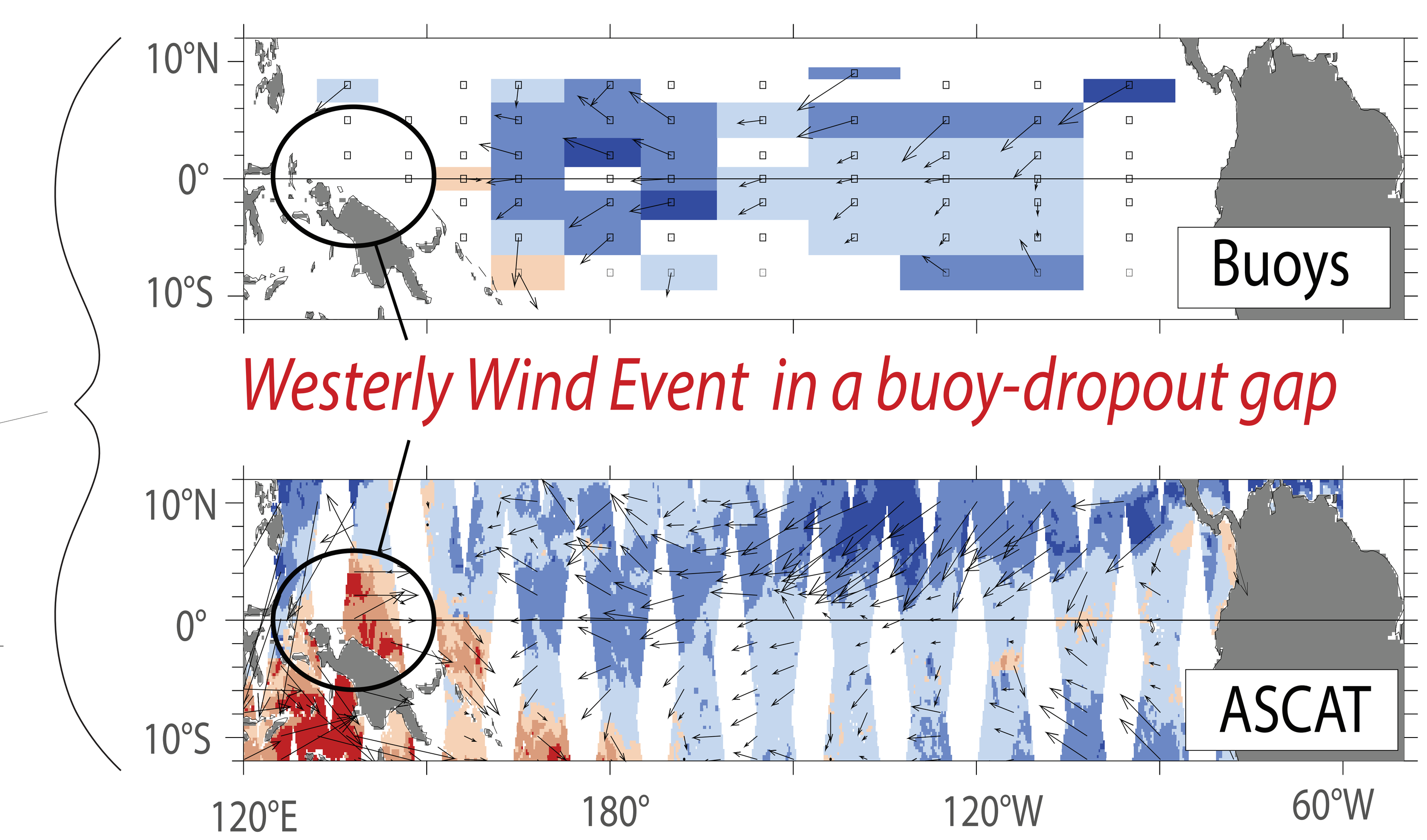


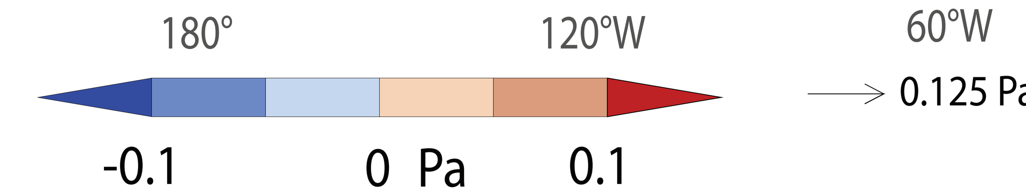
Wind Knowledge

10 Sep 2017. Buoys miss an easterly surge: not enough cooling in following months in simulation forced by buoys on their own.



12 Feb 2017. Buoys miss a westerly event: not enough warming in following months in simulation forced by buoys on their own.





The forced ocean model simulation experiments of Chiodi and Harrison (2017a) confirm that the TAO/Triton array - when complete, or nearly so - works as it was designed for the purpose of providing knowledge of near surface equatorial Pacific wind variability adequate for simulating ENSO SSTA development. Unfortunately, gaps caused by buoy dropouts can leave holes in this understanding that, in unfortunate circumstances, can keep important synoptic scale wind events from being directly observed by the buoys. In fact, this is what happened in 2017 based on additional wind information provided by the ASCAT-A scatterometer (see figure above). Although we have found that the ASCAT-A winds on their own force simulations that are less accurate than those forced by the buoy winds, we have also demonstrated that combining the information from these two wind measuring platforms leads to a knowledge base that surpasses that made available by either platform individually when understanding ENSO development is the goal. The figures above illustrate how a pair of synoptic scale wind events that were missed by the buoy array due to buoy dropouts were captured by the scatterometer winds, and how patching the buoy-dropout holes with the scatterometer information leads to a substantially improved wind-forced ocean model simulation of the observed 2017 Nino 3.4 SSTA trajectory.

References

Chiodi and Harrison 2017a: Simulating ENSO SSTA from TAO/Triton winds: The impacts of 20 years of buoy observations in the Pacific waveguide and comparison with reanalysis products. J. Climate, 30(3), 1041-1059, doi:10.1175/JCLI-D-15-0865.1

Chiodi and Harrison 2017b: Observed El Nino SSTA development and the effects of Easterly and Westerly Wind events in 2014-2015. J. Climate, 30(4), 1505-1519, doi:10.1175/JCLI-D-16-0385.1