Occurrence and trends of eastern and central Pacific El Niño in different reconstructed SST data sets

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Abstract

Interest in El Niño diversity has increased in the past decade, with much attention given to the hypothesis that there exist distinct eastern Pacific (EP) and central Pacific (CP) types. It is well known that classification systems in the literature differ, sometimes dramatically, by methodology. We test to what extent differences may occur due to the use of different sea surface temperature (SST) reconstructions, focusing on the newly released version 4 of the Extended Reconstructed Sea Surface Temperature (ERSST) data set, two earlier versions of the ERSST data set, and an independent data set, Hadley Centre Global Sea Ice and Sea Surface Temperature (HadISST). The updated ERSST data set identifies more CP El Niños than the two older versions of ERSST and HadISST. Classification differences occur throughout the entire record rather than being restricted to the early period. We explore the potential influence of SST data set choice on the study of El Niño diversity impacts using precipitation anomalies in the western United States.

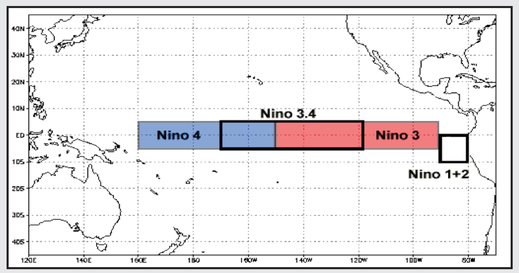


Figure 1
Summary of Niño regions used by NOAA and this study, from «https://www.ncdc.noaa.gov-/teleconnections/enso/indicators/sst.php#oni».

We focus on the Niño 3 and Niño 4 indices, which are spatially averaged SST anomalies (SSTA) of the red and blue boxes shown, respectively.

Methods

-Years classified as EP El Niño if the boreal winter (Dec.-Jan.-Feb.) Niño 3 index exceeded 0.5 °C and the Niño 4 index and as CP El Niño if the DJF Niño 4 index exceeded 0.5 °C and the Niño 3 index

-Classifications made independently for ERSST.v4, ERSST.v3b, ERSST.v2, and HadISST

-Composite EP (CP) events refer to the average SSTA or precipitation fields for all EP (CP) events identifed by a particular data set

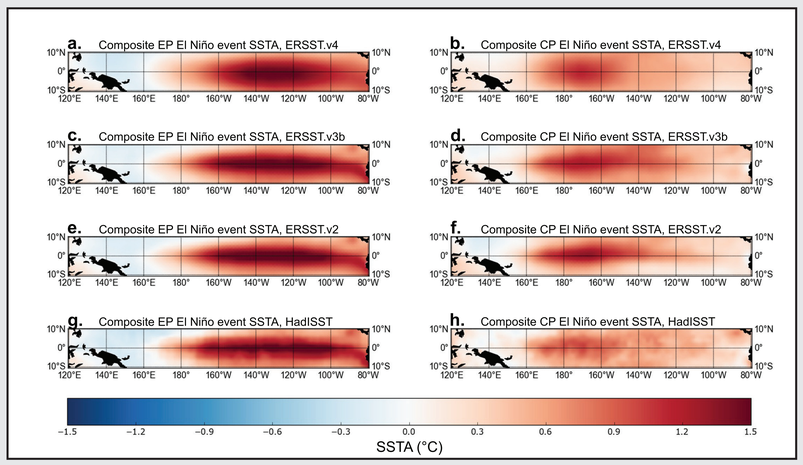


Figure 2
Composite EP and CP events as identified by all four SST reconstruction data sets analyzed.

Main Result: Differences in classification due to differences in SST reconstruction data sets persist throughout the entire historical record.

	ERSST.v4	ERSST.v3b	ERSST.v2	HadISST
	1871-2009			
# El Niños	49	42	36	41
# EP events	32	33	30	29
# CP events	17	9	6	12
% CP events	35%	21%	17%	29%
	1950-2009			
# El Niños	26	25	22	22
# EP events	13	16	16	12
# CP events	13	9	6	10
% CP events	50%	36%	27%	45%

Table 1
Summary of results for over the full range of years for which data are available from all data sets, 1871–2009, and the modern range of more reliable data, 1950–2009.

All four SST datasets show a trend toward increasing CP El Niño event frequency, consistent with prior work. However, the fraction of CP events differ substantially between datasets, even in the modern period with more reliable data.

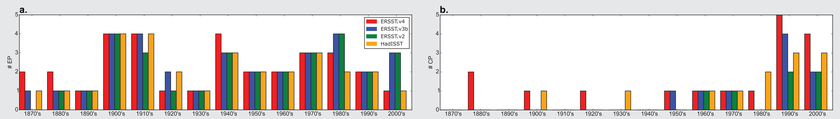
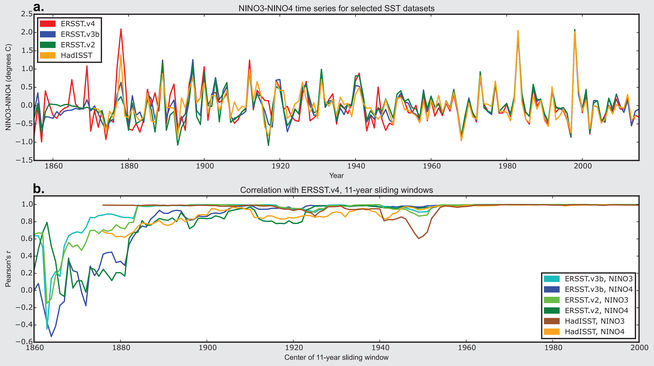


Figure 3
Occurrence of (a) EP El Niño and (b) CP El Niño events by decade. Classification differs substantially, even between 1980 and 2009.

Figure 4
(a) Difference between the Niño 3 and Niño 4 regions over time for each SST data set. (b) Sliding 11-year correlation between the Niño 3 and 4 indices from ERSST.v4 with those from the other three data sets. Despite the near-perfect correlation past 1960, the data sets continue to produce different classification results.



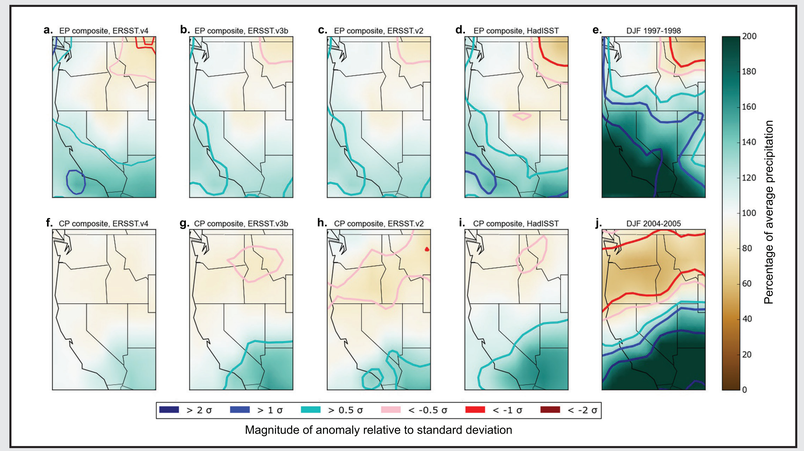


Figure 5
Case study of precipitation anomalies (from the Global Precipitation Climatology Project) over the western United States for the composite EP and CP El Niño events using the four different data sets. Examples of (e) EP (DJF 1997–1998) and (j) CP (DJF 2004–2005) events with particularly strong anomalies are provided for comparison.

Shading represents precipitation as a fraction of the 1980–2015 mean. Contours mark precipitation anomalies normalized through division with the interannual, ENSO-corrected standard deviation. Positive (negative) anomalies with magnitudes greater than 0.5, 1, and 2 standard deviations are shown in shades of blue (red).

Conclusions

-The differences in El Niño classification due solely to differences in SST data sets are substantial and comparable to those due to different classification methodologies

-*Yu & Kim* [2013] compared four different methods (all using ERSST.v3b) for differentiating between EP and CP El Niños, and since 1950, the fraction of CP El Niños relative to all events ranged from approximately 25% to 60% between methods, which is similar to our 27% to 50% range over the same period.

-From the case study of precipitation anomalies, it can be seen that the choice of SST data set can affect the statistical significance of results when studying the impacts of El Niño diversity

-Studies that rely on observed CP:EP ratios to select models that realistically simulate ENSO must be cautious given the large uncertainty in even recently observed data

Take-Home Message: *It is important to check results using multiple methods* ***and*** *data sets when studying El Niño diversity, even when restricting analysis to periods with more reliable data.*

References and Acknowledgements

This poster cites Yu & Kim, 2013, "Identifying the types of major El Niño events since 1870," *International Journal of Climatology*, pp. 2105-2112 and is based on work that has recently been published as Diamond & Bennartz, 2015, "Occurrence and trends of eastern and central Pacific El Niño in different reconstructed SST data sets," *Geophysical Research Letters*, doi:10.1002/ 2015GL066469. The *Diamond & Bennartz* [2015] paper can be accessed via the QR code provided on this poster.

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