

## ***Interactive comment on “A unified proxy for ENSO and PDO variability since 1650” by S. McGregor et al.***

**S. McGregor et al.**

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Firstly, we would like to thank anonymous reviewer 2 for their positive and constructive review of our manuscript.

We have listed each of the anonymous reviewer 2’s major comments below along with our response to the comment.

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Major comment 1: Page 2186, first sentence. Decadal variability is of interest in this paper. Please report the correlations between the UEP and the SOI, Kn34, Hn34 and Bn34 indices after they have been filtered so that the decadal signal and lower frequency variability remains. Bn34 claims to have constructed a monthly Niño-3.4

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index that has been verified with closely physically related indices on both interannual and decadal time scales since 1877 so it would be particularly interesting to see the correlation of the UEP with this index for decadal and longer variability.

Response: The correlation coefficients between the 13-year lowpass filter UEP and observed indices of ENSO are now presented in the text of the revised manuscript. Please see the first few lines of paragraph 3 in the “Multi-decadal Variability” subsection of the revised manuscript which reads “Comparing the multi-decadal variability (defined as the 13-yr low-pass filtered data) of the UEP and that of the SOI, Kn34, Hn34 and Bn34 gives correlation coefficients (R) of -0.69, 0.66, 0.72 and 0.63 respectively and each of these coefficients is statistically significant above the 95% confidence level.”

Major comment 2: Page 2189, second paragraph. Visually the chronologies in Fig. 6 often do not line up very well. The authors carry out a Monte Carlo procedure to show that there is a significant correspondence between the UEP and ENSO chronologies at the 99% level. But this is not impressive if the correspondence between the chronologies is low. One way to measure the correspondence between the UEP and another time series numerically would be to consider the set containing all years (say N years) when either the UEP or the other time series predicts an El Niño. For these N years for each time series allot unity for an El Niño and zero otherwise. Remove the means of each time series and calculate the correlation coefficient. This correlation coefficient might be significantly different from zero, but if it is less than (say) 0.4, the correspondence would not be impressive.

Response: We appreciate the reviewers’ comment, however we put a great deal of thought into identifying the appropriate way to assess the correspondence between the UEP and the categorical, essentially binary, data of El Niño chronologies. It was found that a correlation coefficient is not a good measure of the correspondence because it assumes a gaussianity of the input time series distribution which does not exist

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in categorical data. The correspondence between these data sets can be accurately assessed using a contingency table, and the relevant components of this table are presented in Table 5 of the submitted (and revised) manuscript.

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Major comment 3: Page 2192, third paragraph. “: : : there is a clear linear increasing trend in the number of El Niño events : : :” in each of the time series in Fig. 9b-e. By eye I do not see such a clear linear increasing trend. What is the correlation coefficient for a straight line regression fit to the data? Does the 95% confidence interval only include positive values of the correlation coefficient?

Response: The correlation coefficients between the 30-year running window El Niño count of Garcia-Herrera et al. (2008), Ortlieb (2000), Gergis and Fowler (2009) and Quinn and Neal (1992) (between 1650 and the end of the record) and a regression fit straight line are 0.39, 0.74, 0.74, 0.59 respectively. For each of these correlation coefficients the regression coefficient is positive and its value is significant above the 95% level. Thus, each of the chronologies does display a linear increasing trend in the number of El Niño events in a 30-year running window. We have now reworded the text in this sentence “In regards to the increasing trend in variance, there is a statistically significant (above the 95% level) linear increasing trend in the number of El Niño events that occur in the 30-yr running windows in the period starting 1650 and ending at the end of each record of the four chronologies” to highlight this significance in the trend. See sentence 4 of paragraph 6 in the ‘Changes in ENSO variance’ section of the revised manuscript.

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All of this reviewers’ minor editorial comments have been incorporated in the revised manuscript.

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