Comment on "Global wave number-4 pattern in the southern subtropical sea surface temperature"

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Contents

Keywords:

Highlights:

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## Attaching package: 'ggplot2'
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## The following object is masked from 'package:data.table':
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(Senapati, Dash, and Behera 2021) use Empirical Orthogonal Modes to detect a global wave-4 pattern in subtropical Sea Surface Temperatures (SST).

And indeed. The first EOF is kind of ENSO-like (not really full ENSO, because I'm missing the equatorial SSTs, which is where ENSO really shines) and the second EOF looks pretty much identical to the their Figure 1.a save the different prime meridian. The time series associated with the second EOF is also almost exactly the same.

OK, I'm on the right track.

Now, my main concern with this paper is whether this pattern is actually, as the title of the paper says, a **global** pattern. EOF is a great technique for dimensionality reduction, but it's too easy to end up with statistical patterns that are a mix of actual physical patterns or even just noise.

The authors agree, and they say that..

> In order to examine the synchronization of the W4 pattern among all the basins, point correlation analysis has been performed. For this purpose, eight points [i(37.5°S, 173.5°W), ii(37.5°S, 133.5°W), iii(44.5°S, 90.5°W), iv(39.5°S, 40.5°W), v(29.5°S, 2.5°W), vi(41.5°S, 41.5°E), vii(30.5°S, 86.5°E), viii(35.5°S, 130.5°E)] corresponding to the loading centres are selected (marked by green dots, i-viii, in Fig. 1a). The time series of SST anomaly is computed at each grid point after removing the contributions of the first EOF mode (henceforth, reconstructed SST anomaly). Further, point correlation is performed for the time series at the loading centers (Fig. 1a) with the reconstructed SST anomaly (Fig. 2a–h corresponding respectively to points (i) to (viii) of Fig. 1a).

The problem, IMHO, is that their Figure 2 doesn't really show as much synchronisation as they claim. First, let's reproduce it here.

Again, aside from the points in the Pacific, there is not a lot of long-range relationships between points. As I see it, I strongly suspect that this PC2 pattern is not really robustly **global**.

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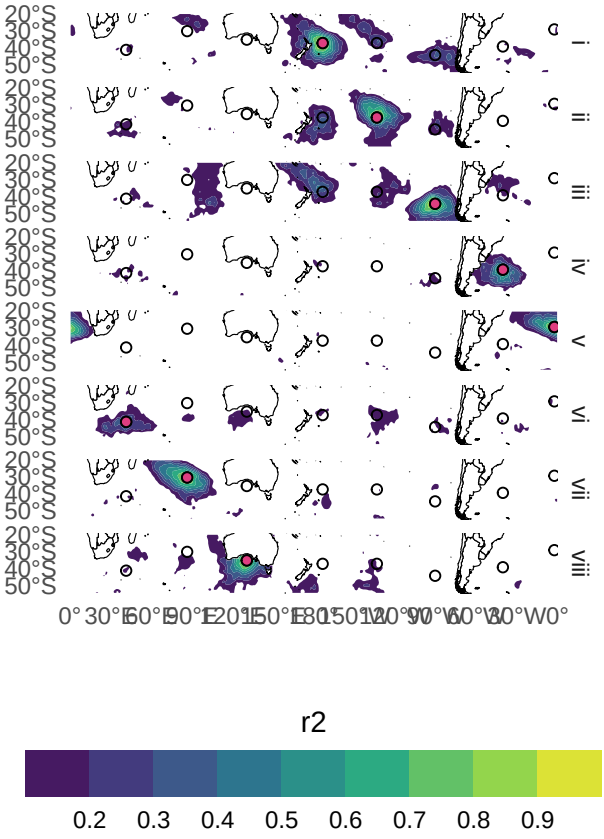

Figure 1: Coefficient of determination (r^2) computed from the correlations with the filtered SST in Figure **??**. Contours only show areas with $r^2 > 0.1$.

Let's try something else. From the correlation maps above (and previous knowledge), it's pretty obvious that the Pacific sector does behave somewhat coherently. So what I'm going to do is to split the spatial pattern into the Pacific basin (between 150°E and 290°E) and the Atlantic-Indian basins (the rest of the hemisphere). Then, I'm going to project each pattern onto the corresponding SST fields to get two indices. If the patterns is really coherent in time, then both indices must be strongly correlated.

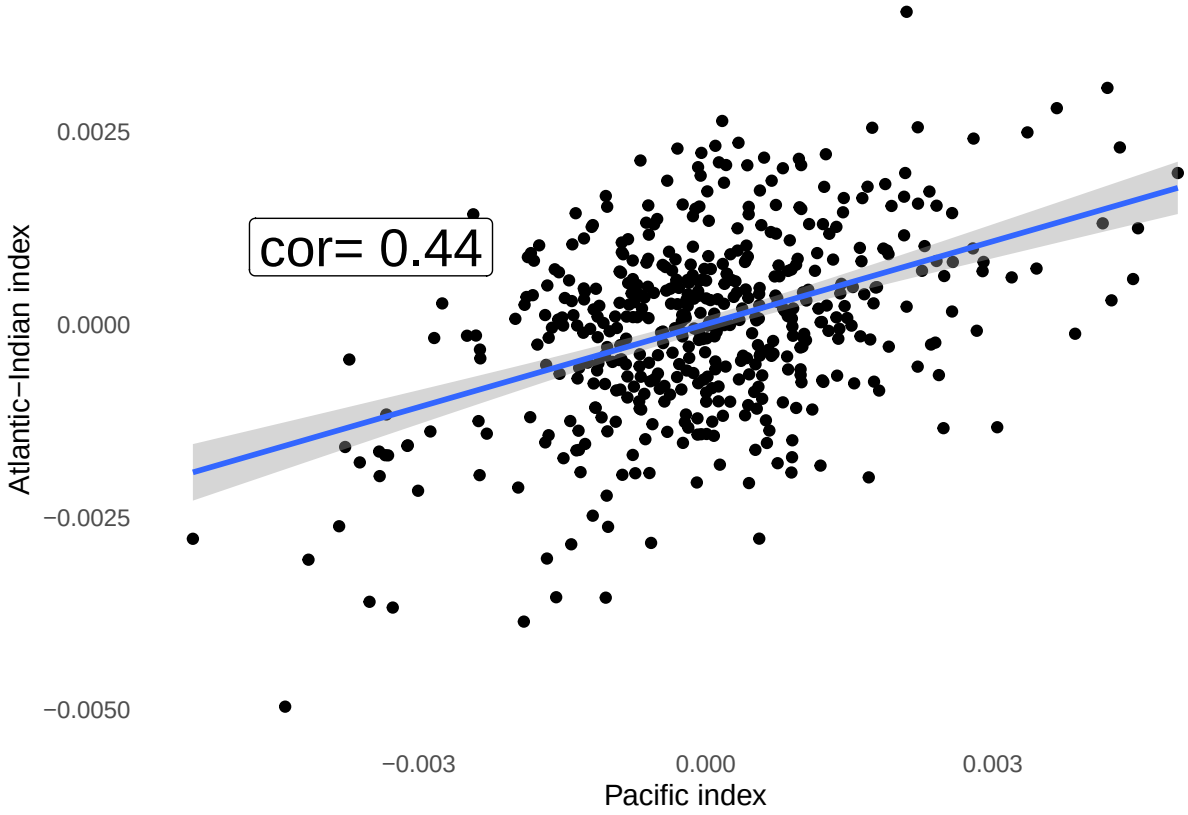

Figure 2: Relationship between the Pacific index and Atlantic-Indian index.

I mean... A correlation of 0.44 is not nothing, but it's also not a lot.

Let's do the correlation map of each index. Again, if the pattern is really global, then the correlation map of the Pacific Index should also show the Atlantic-Indian pattern and vice versa.

Again... kinda? For the Atlantic-Indian index, the Pacific signal is barely there and it's actually completely missing in the Western Pacific. And for the Pacific index, the there is *some* signal in the Indian ocean, but barely any signal in the Atlantic.

Now one last test. To extend this analysis, I'll do the same computation but for every longitude. That is, for each longitude, take a 140° wide section of SST centred in that longitude and project the corresponding wave-4 pattern onto it to get a time-varying index. The result, then, is one "local wave-4 index" for each longitude.

Figure 4 shows the pairwise correlation between all indices. Correlation drop rapidly with distance, but there are three clearly defined regions of high correlation that could represent various teleconnected areas. Perhaps not coincidentally, they correspond approximately to the three oceanic basins. The Indian between 15°E and 100°E, Western Pacific between 100°E and 120°W and Eastern Pacific and Atlantic between 120°W and 15°E.

So instead of dividing SST into two basins more or less arbitrarily, let's use those three basins. I'll classify each longitude using hierarchical clustering with `1 - abs(correlation)` as the distance metric. Then, I'll use the same methodology of projecting the corresponding SST pattern onto the SST fields for each basin to

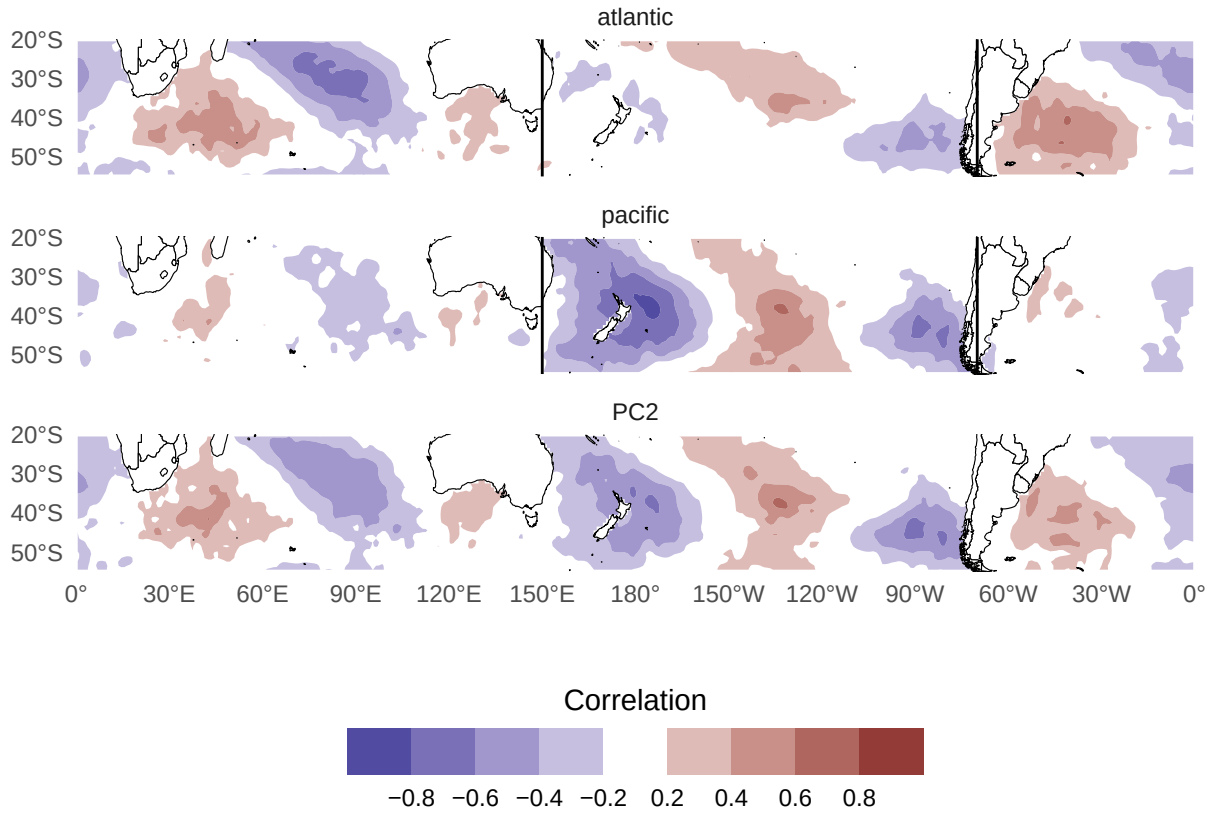

Figure 3: Correlation patterns with the Pacific index, the Atlantic-Indian index and the PC2.

have one index for each basin and finally computing the field correlation between each index and SSTs.

(ref:patterns_k2-cap) Correlation maps between SST and each of the three basin-dependend wave-4 index. Overlayed in gray, the tree distinct areas of shared variability identified in Figure 4 by hierarchical clustering and selecting 3 clusters.

The field correlations are shown in Figure @ref(fig:patterns_k). Correlations are high within each area of shared variability, but outside those areas, there's very little correlation. Moreover, the patterns coherent with the West Pacific index looks different

Senapati, Balaji, Mihir K. Dash, and Swadhin K. Behera. 2021. "Global Wave Number-4 Pattern in the Southern Subtropical Sea Surface Temperature." *Scientific Reports* 11 (1): 142. https://doi.org/10.1038/s41598-020-80492-x.

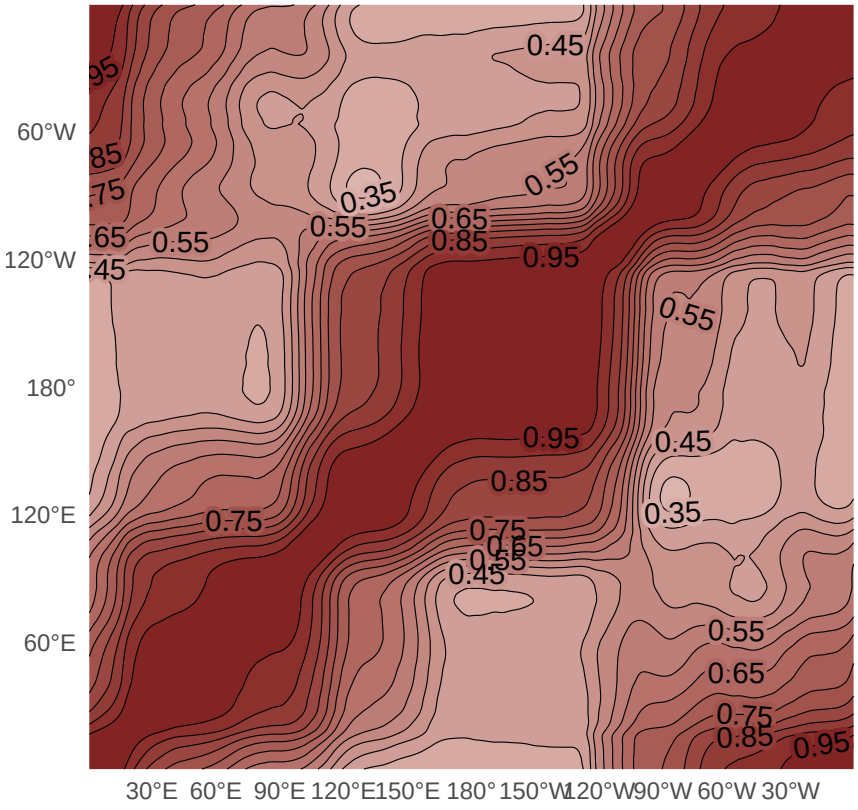

Figure 4: Pairwise correlation of "local wave-4" indices.

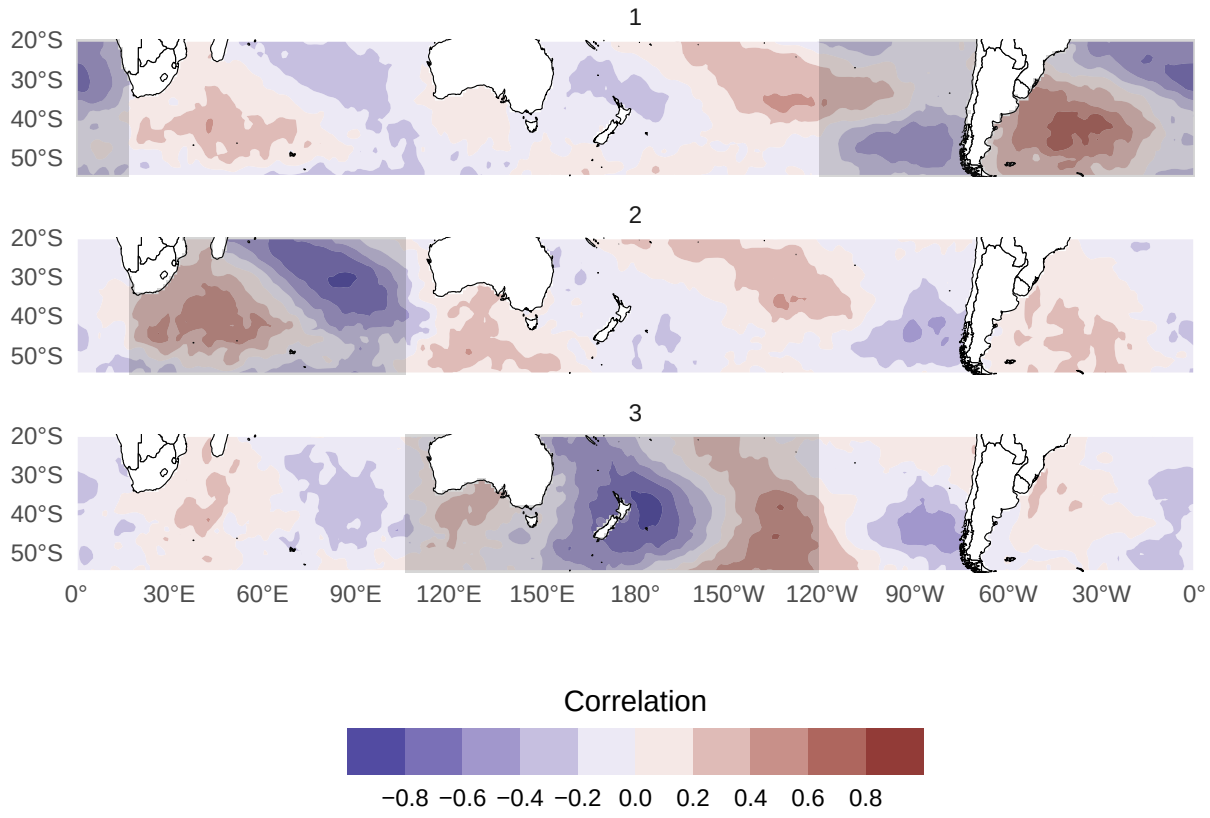

Figure 5: (#fig:patterns_k2)(ref:patterns_k2-cap)