

Originally ‘Contributions from intrinsic low-frequency climate variability to the accelerated decline in Arctic sea ice in recent decades’

Title changed to ‘Changes in sea surface temperature and atmospheric circulation patterns associated with reductions in Arctic sea-ice cover in recent decades’

Referee report:

General comments:

The authors have provided more information and revised the discussions in response to the referees’ comments, and have improved their manuscript.

Some aspects of the SOM patterns are still not clear to me, and the discussion of mechanisms needs more detail to be clearer.

I am not convinced that asymmetries in North Pacific SST anomalies are as important as the authors claim, so that aspect could be more speculative.

Thus I recommend further revision as follows:

Specific comments:

Are composite results sensitive to the selection of the SOM matrix of patterns? As in the example in the supplement, patterns similar to node1 and node 9 also occur and dominate other choices of matrix, and the selection of years for composites is likewise similar for other array choices.

On reading again the section on potential mechanisms, I think it could be made clearer and improved by providing more precise information about geographic regions mentioned, and linking more clearly to the sea ice concentration features in the nodes.

e.g. line 162 (and 187): specify latitude/longitude for the region of interest in the western tropical Pacific; likewise line 168 for the ‘region between two centers’, line 171 for region of reduced sea ice concentration, line 174 for the region of anomalous high pressure, line 176 for the region of anomalous low pressure, etc.

Line 207/208: apart from opposite sign, the differences in SST patterns are rather small, and it is difficult to attribute the differences in high-latitude circulation to the SST patterns without more direct evidence, so this should be stated as a hypothesis. (The SST anomaly sign difference alone and nonlinear effects might be the main cause of any SST-related circulation differences.)

It would be informative if one or two example scatterplots could be added to illustrate how particular regional values in ice cover and in atmospheric variables are related in in years making up composites.

Further minor comments:

It would be helpful to mention the use of composites in the abstract.

line 25: ‘...remain a subject of ..’

line 31: ‘...On larger scales, ...’

line 50: ‘... (ENSO) events to the ...’

line 78: what is the resolution of the OLR data grid?

Line 81: it would be helpful to add a statement about what is optimised in SOM

Line 85: I am not sure what the sentence ‘All patterns in ...’ means, as the patterns represent a subset of the input data.

Line 94: it would be clearer to say ‘The best matching SOM pattern for each autumn is determined on the basis of minimum Euclidean distance ...’. It would be useful to provide an equation for this. It would also be better to place this later in the paragraph (e.g. after line 105), after defining the patterns.

Line 107: It would be clearer to define frequency of occurrence as the number of autumns for which a pattern is selected as ‘best matching’ divided by the total number of autumns.

Line 110: I am not sure what is meant by ‘linear regression of the number of the projections’ : an equation would be useful.

Fig. 1: are the patterns normalised?

(It might be worth noting that the sign of the pattern is important, unlike EOFs for which the sign is arbitrary. An EOF analysis would give one pattern like nodes 1 and 9, with different signs of projection in early/late years in the data.)

Line 122: it would help to say that 24% corresponds to 9/38.

Line 127: omit ‘much’ (the occurrence difference is between 5/38 and 3/38)

Line 130: ... Figs 2 and 3

Fig. 4: are the labels correct? The SOM-associated trend seems larger than the observed trend. Also, the ‘dots’ indicating significance are very hard to see in the figure.

Line 155: Suggest better to put ‘To explore the processes associated with the spatial patterns ...’

Line 213: better to also state the years used in the before and after 2000 composites.

Line 217: to me, the dominant feature of the SST patterns associated with node1 and node9 is their similarity, with small differences. Further evidence is required if circulation and sea-ice concentration differences are to be attributed to the influence of the small SST pattern differences – perhaps you could state that further

investigation is required to support your statements, particularly as this effect forms a large part of your conclusions in section 8.

Fig. 2 caption: Better to say that the figure indicates which mode best matched the observed sea ice concentration in each autumn.

Fig. 3 caption: Rather than 'explained', this figure just shows the linear trend associated with each pattern when projected on the observations?

Fig. 4: check the content, labelling and dots.

Fig. 5 and Fig. 8: It would be helpful to repeat in the caption the actual years used for each composite.