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Interactive comment on "Contributions from intrinsic low-frequency climate variability to the accelerated decline in Arctic sea ice in recent decades" *by* Lejiang Yu and Shiyuan Zhong

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Anonymous Referee #2 Received and published: 19 June 2018 The authors used the Self Organizing Maps (SOM) method to examine both the variability and trend of autumn Arctic sea ice over the past few decades. They found that about 60% of the recent autumn Arctic sea ice decline can be explained by 9 intrinsic modes, and specifically, SST anomalies over the North Pacific and North Atlantic, resulting atmospheric circulation and water vapor radiative processes. The application of the SOM method to Arctic sea ice looks new to me and some interesting results are found. However, I have some major comments about this manuscript. I would recommend publication

in ACP when they are addressed. Major comments: 1. About the number of nodes selected. Although the authors claimed that they chose 3x3 SOM grid because there is a large increase in correlation from 2x4 to 3x3, I feel the correlation increase looks pretty gradual to me and thus the choice of 3x3 is not very convincing. As the authors also claimed that "larger grids, : : :, do not alter the results and conclusions", I would suggest the authors include this information perhaps in the Supplementary Materials to better support the conclusions. Since, based on Table 1, increase of nodes after 3x5 does not seem to increase the correlation anymore, I would suggest the authors provide the results using 3x5. As suggested by the reviewer, we now provide, as Supplemental Materials, the SOM patterns and their occurrence time series for the 3×5 grid (Figures S1and S2). As expected, with more nodes, the 3x5 grid depict more details and each node has smaller frequency compared to the 3x3 grid. However, the dominant nodes (also nodes 1 and 9) show nearly identical patterns as those in the 3x3 grid. Like the 3×3 grid, nodes 1 and 9 in the 3×5 grid make greater contributions to the trend in autumn Arctic sea ice than other nodes (Figure S3). Also as expected, the trend explained by nodes 1 and 9 in the 3x5 grid is smaller (46%) compared to 54% by the same two nodes in the 3×3 grid.

2. About reference of previous studies. Although the application of the SOM method to Arctic sea ice is new, some of the results and conclusions drawn from the analysis have been found in previous studies but the authors failed to include them. Some of the relevant studies are listed below - Gong, T., S. Feldstein, and S. Lee, 2017: The Role of Downward Infrared Radiation in the Recent Arctic Winter Warming Trend. J. Climate, 30, 4937–4949, https://doi.org/10.1175/JCLI-D-16-0180.1 Lee, S., Gong , T., Feldstein, S. B.,Screen, J. A., & Simmonds, I. (2017).Revisiting the cause of the 1989–2009Arctic surface warming using the sur-face energy budget: Downward infraredradiation dominates the surface ïnËĞC′ uxes.Geophysical Research Letters, 44,10,654–10,661. https://doi.org/10.1002/2017GL075375 I would suggest the authors cite these references and add discussions on the consistency/ inconsistency as compared to previous studies. Thanks for pointing to these references. We have now added them to

section 4 along with some discussion.

Minor comments: Line 36: "natural processes"? why are these processes all natural? We deleted 'natural'. Lines 40-45: The authors failed to explain the advantages of the SOM method here. The EOF method also provides "a manageable number of representative patterns". In the third paragraph of the Methods section, we provide the advantages of the SOM over EOF. Line 48: NAO has been defined before Changed Line 49: ENSO has not been defined Added Line 80: The authors might want to better define what is "Euclidean distance" in the SOM method The definition of Euclidean distance has been added. Line 85: smaller number of grids Changed Line 86: larger number of grids Changed Lines 96-98: The authors should reference Fig. 4a here? The sentence refers to Figure 1. Line 134 and 152: It's not easy to tell that it is zonal wave number 2 here. Changed Line 193: "decadal-scale natural climate variability to Arctic climate change", why the authors concluded natural here? Can't the SOM nodes include anthropogenic components too? 'natural climate variability' has been changed into 'SST variability'. Fig. 4: I don't see dots in (a)? Dots are enlarged.

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2018-127/acp-2018-127-AC2-supplement.pdf

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Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-127, 2018.
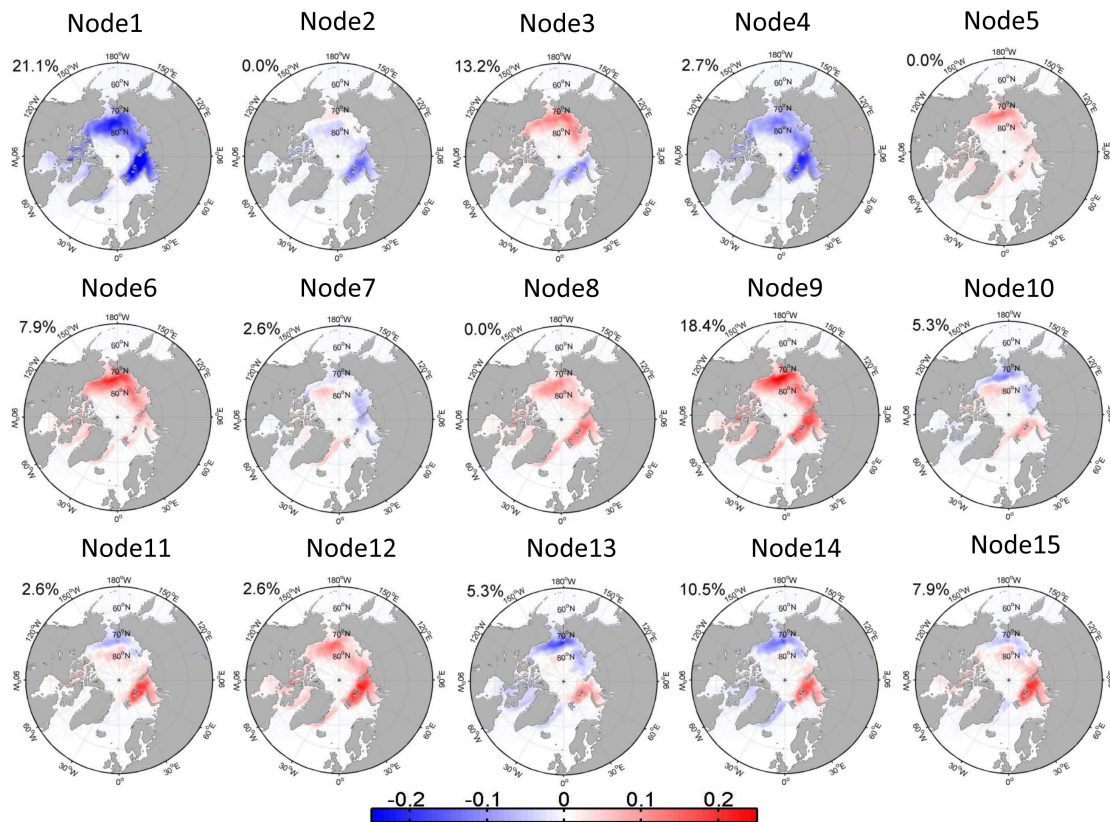
Fig. 1. Figure S1 The SOM patterns of the anomalous autumn (September-November) Arctic sea ice
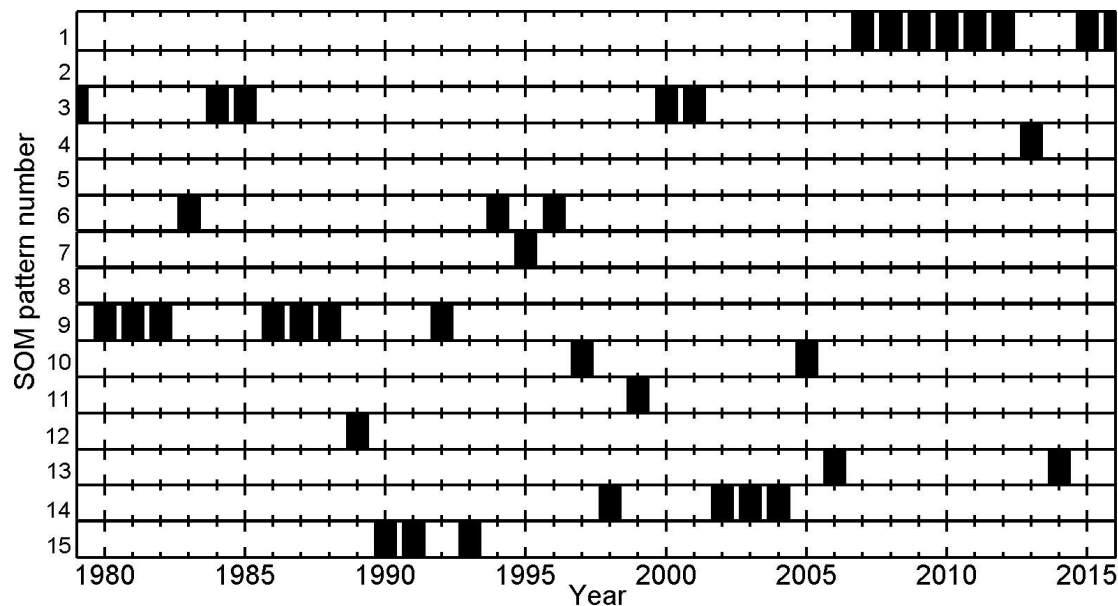
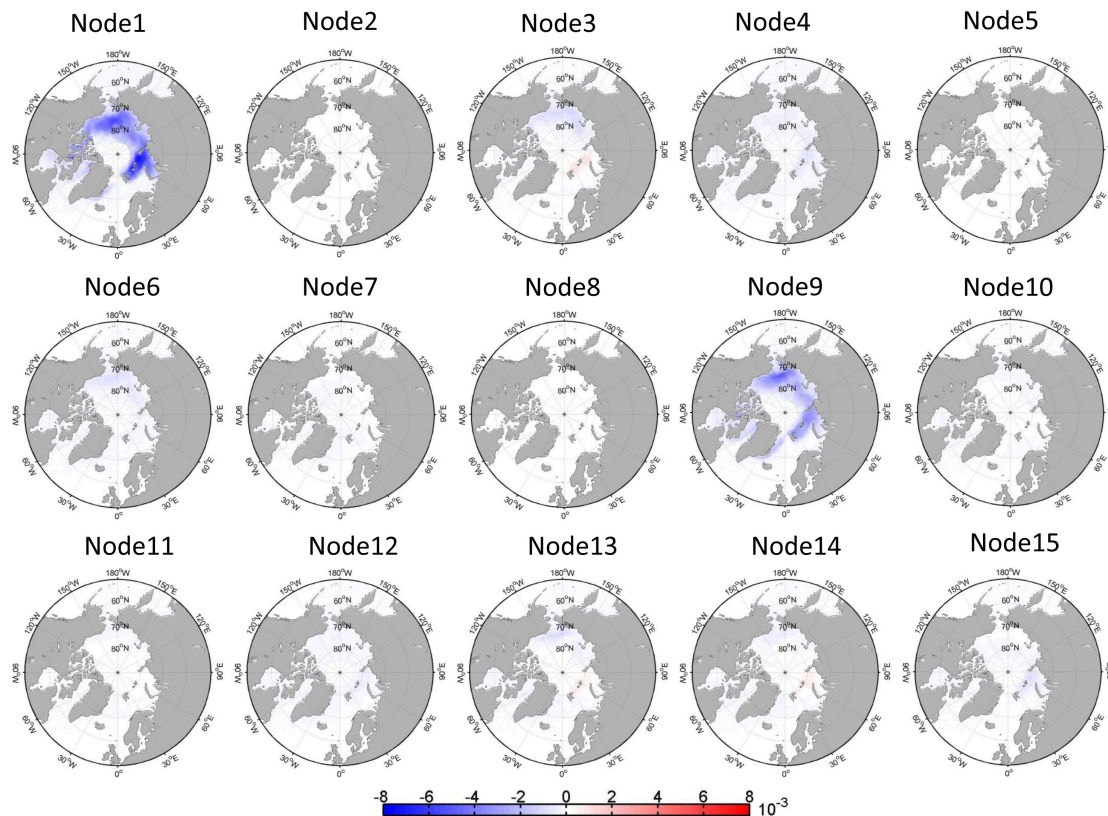**Fig. 2.** Figure S2. Occurrence time series for each SOM pattern in Figure S1.

C5

Fig. 3. Figure S3. Trends in the anomalous autumn Arctic sea ice concentration explained by each SOM pattern (Units: yr-1).
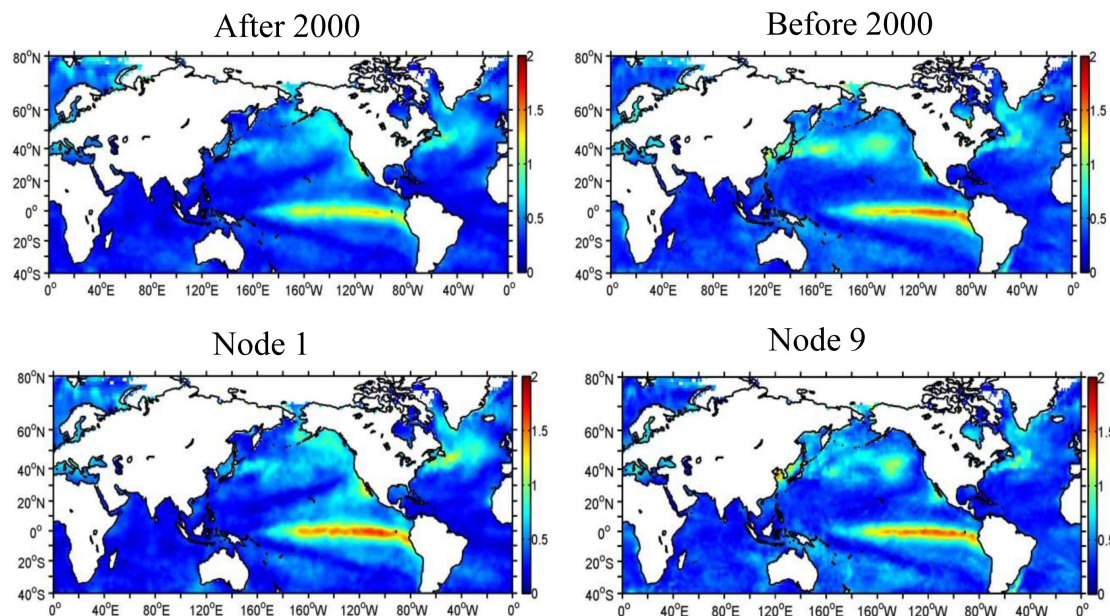
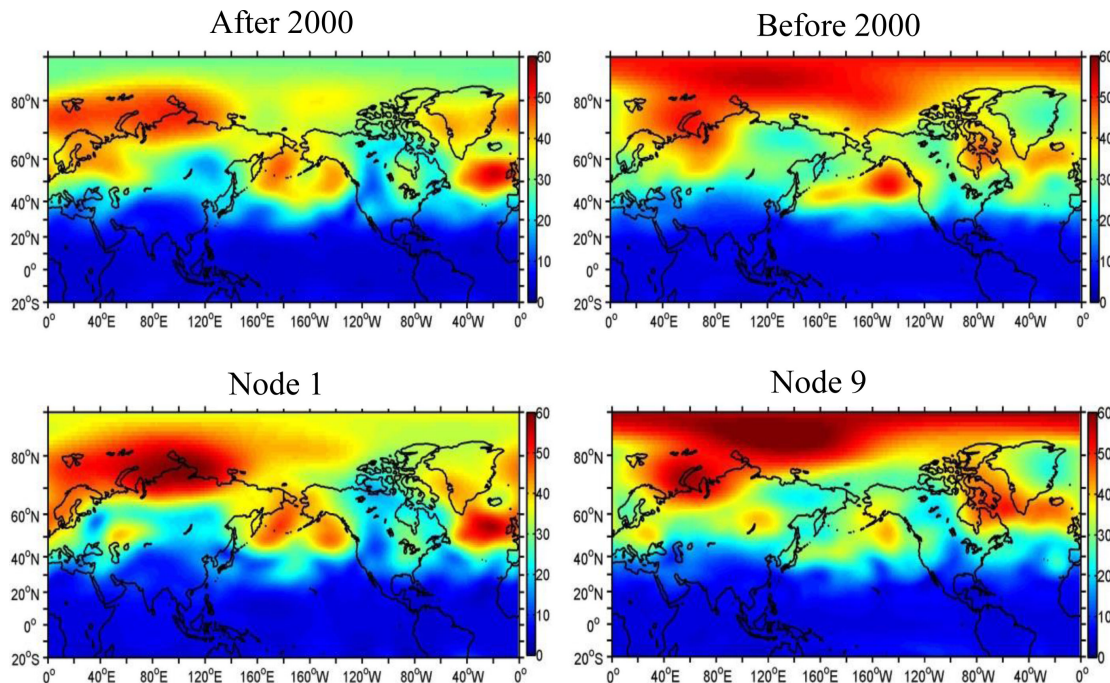**Fig. 4.** Figure S4 The standard deviations of composite SST for Nodes 1 and 9, and after and before 2000.

Fig. 5. Figure S5 The standard deviations of composite 500-hPa height for Nodes 1 and 9, and after and before 2000.

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Node 1 and after 2000
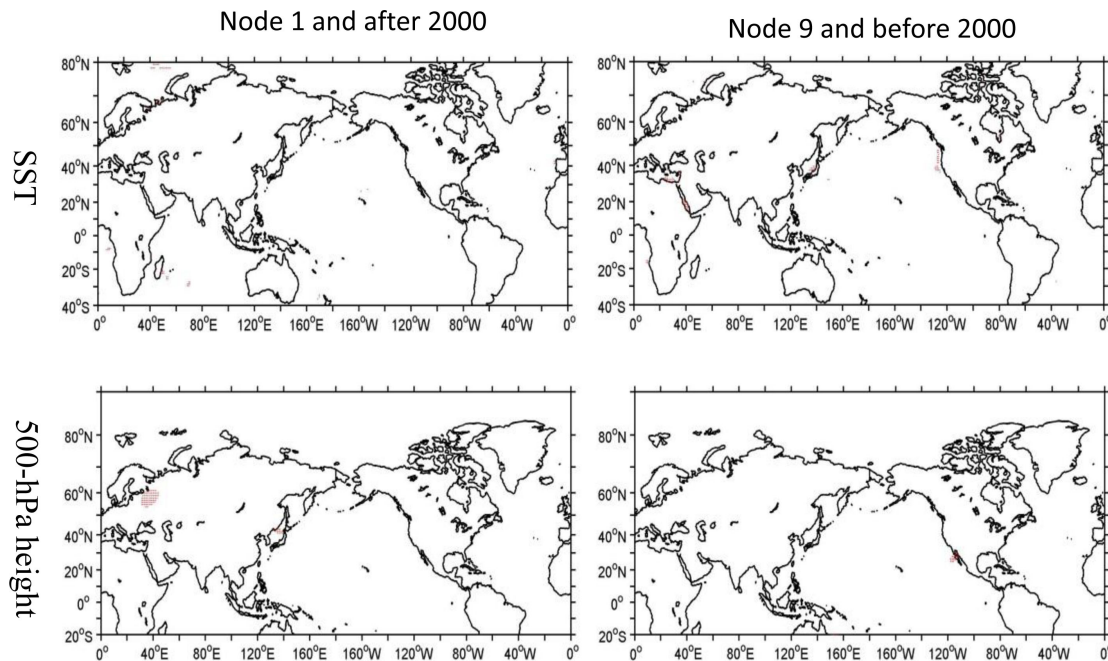
Node 9 and before 2000

Fig. 6. Figure S6 The significant test of standard deviation for SST and 500-hPa height between Node 1 and after 2000, and Node 9 and before 2000 using F test. Red dots denote above 95% confidence level.