

The Cryosphere Discuss., author comment AC1  
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## Reply on RC1

Dongyang Fu et al.

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Author comment on "Multiscale Variations in Arctic Sea Ice Motion, Links to Atmospheric and Oceanic Conditions" by Dongyang Fu et al., The Cryosphere Discuss.,  
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First of all, we (the authors) would like to express our sincere gratitude to the Anonymous Referee for their time, effort, and recognition given to our manuscript. Secondly, it is worth pointing out that Referee comments and suggestions have really helped us improve the quality and presentation of our manuscript further. In light of such inspiring comments and suggestions, we have revised the original manuscript duly and carefully, with the answer to the Referee comments listed below.

**Comment:** 3 Arctic sea ice motion of sea ice

**Response:** Thanks so much for the reminding. We have removed the superfluous word "of sea ice".

**Comment:** 6 the three major Arctic sea ice drift patterns. 7 the three main sea ice drift patterns – there are others – why are these the main ones?

**Response:** In this study, we employed the EOF method to extract the spatial patterns of sea ice drift over 40 winter season data sets from 1979 to 2018. The EOF method yields eigen patterns of variability and corresponding principal component time series for spatiotemporal data analysis. That is to say, we can extract the same number of spatial patterns with the same length of time series by using EOF analysis method, but the variance contribution rate is mainly concentrated in the first few patterns, so we call it the main patterns, which is the same as the concept of principal component analysis. In this study, we selected the first three spatial patterns for analysis according to the variance contribution rate. The first three EOF patterns account for 30.2%, 19.1% and 11.0% of the total variance.

[Reference] Iida, T. and Saitoh, S. I.: Temporal and spatial variability of chlorophyll concentrations in the Bering Sea using empirical orthogonal function (EOF) analysis of remote sensing data, Deep Sea Research Part II Topical Studies in Oceanography, 54, 2657–2671, 2007.

**Comment:** 20-23 A little too basic for anyone reading this

**Response:** Thanks so much for the suggestion. At the beginning of the article, the

authors give a brief overview of our research area and hope to give other readers who want to study the Arctic a simple beginning.

**Comment:** 33-35 Repetitive: significantly affects the thickness distribution of sea ice

**Response:** Thanks so much for the reminding. We have removed the repeated sentence.

**Comment:** 40 Eliminate "The"

**Response:** Thanks so much for the reminding. We have removed the word "The".

**Comment:** 40 Earlier there were 3 drift patterns cited – now there are 4?

**Response:** In this study, we employed the EOF method to extract the spatial patterns of sea ice drift over 40 winter season data sets from 1979 to 2018. The EOF method yields eigen patterns of variability and corresponding principal component time series for spatiotemporal data analysis. That is to say, we can extract the same number of spatial patterns with the same length of time series by using EOF analysis method. However, the variance contribution rate is mainly concentrated in the first few patterns, so we call it the main patterns, which is the same as the concept of principal component analysis. In this study, we selected the first three spatial patterns for analysis according to the variance contribution rate. We extracted the main EOF spatial patterns, which were consistent with previous studies.

[Reference] Iida, T. and Saitoh, S. I.: Temporal and spatial variability of chlorophyll concentrations in the Bering Sea using empirical orthogonal function (EOF) analysis of remote sensing data, *Deep Sea Research Part II Topical Studies in Oceanography*, 54, 2657–2671, 2007.

**Comment:** 67-68 We know that sea ice movement affects ocean currents. Is the converse also true?

**Response:** Sea ice drift is controlled by the interplay of wind stress, ocean drag (ocean current), and internal ice friction (Campbell, 1965).

[Reference] Campbell, W. J. (1965), The wind-driven circulation of ice and water in a polar ocean, *J. Geophys. Res.*, 70(14), 3279–3301.

**Comment:** 74 (Tschudi and C., 2019) - bad reference. Should be:

Tschudi, M., W. N. Meier, J. S. Stewart, C. Fowler, and J. Maslanik. 2019. Polar Pathfinder Daily 25 km EASE-Grid Sea Ice Motion Vectors, Version 4. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: <https://doi.org/10.5067/INAWUWO7QH7B>.

**Response:** Thanks so much for the reminding. We have corrected the bad reference.

**Comment:** 148 Summer sea ice extent is much lower than winter, so in the summer there is substantially less ice to track, resulting in no drift speeds for large portions of the Arctic, where there is no ice cover.

**Response:** Thanks so much for your comment. Your idea is a strong illustration of why we chose winter data for EOF analysis, and we will add your suggestion to our paper.

**Comment:** 174 Also quite important that there is less ice in the summer (see above)

**Response:** Thanks so much for your comment. Your idea is a strong illustration of why we chose winter data for EOF analysis, and we will add your suggestion to our paper.

**Comment:** 300 How do you know causality here? In other words, as you've stated, ocean currents can affect sea ice motion by drag, but ocean current speed and direction can also be impacted by the movement of the sea ice. Which is driving which? We know that large-scale oceanic currents, like those in the thermohaline circulation, are driven by sea ice melting/freezing. You probably also mentioned this, but again, I think it's difficult to say how much the ocean is influencing the sea ice motion vs the sea ice motion influencing the ocean. It may be better to conclude that the RELATIONSHIP between sea ice motion and ocean movement is strong in certain areas and periods, rather than the INFLUENCE of the ocean environment of sea ice movement.

**Response:** Thanks so much for your comment. As you stated, the sea ice movement and ocean currents have a process of mutual influence, we will modify the word "influence" in the manuscript to "relationship".

**Comment:** 352 We have found the opposite: summer sea ice tends to drift faster than winter, since it is thinner, has lower concentration, and is more easily influenced by winds.

**Response:** Thanks so much for your comment. You've given very interesting findings, but I think your research is quite different from ours on a temporal and spatial scale. Our study presents an average state of climatological distribution of the sea ice drift speed field in the Arctic, with winter being larger than summer. This is because the large scale wind field is larger in winter than in summer. Your finding, I suspect, is for some period of time in regional seas or marginal seas.