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Interactive comment on "Analyzing links between simulated Laptev Sea sea ice and atmospheric conditions over adjoining landmasses using causal-effect networks" *by* Zoé Rehder et al.

Anonymous Referee #1

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The study by Rehder et al. is an attempt to analyze links between sea ice dynamics in the Laptev Sea and the adjacent land. While the study is interesting, I have a couple of remarks about the model setup and its relevance in the context of earlier studies on this topic.

First of all, the authors find that the atmosphere mostly drives sea ice conditions in spring, that there's no strong link in summer between sea ice and the atmosphere (nor extending to the adjacent land), but that there's a stronger southward transport of both energy and moisture in low sea ice autumns, when the sea ice starts to freeze again. This is not a new finding. This has been shown before at the pan-Arctic level in several

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publications by James Screen and co-authors (see e.g. Screen et al., 2012b, 2012a; Screen and Simmonds, 2010) but also others (For example Bintanja and Selten, 2014; Pithan and Mauritsen, 2014; Serreze et al., 2009; Serreze and Barry, 2011). It's surprising that none of these studies have been cited in this paper (although the authors cite another, less relevant, paper by Pithan et al. from the same year. Wrong citation perhaps?). At least some of these should be added next to the papers by Lawrence et al and Parmentier et al. that are already cited. Btw, the latter found strong correlations only in spring and autumn, but they argued that these correlations were contemporary in spring and only causal in the autumn, which corresponds to the findings by this study (but this is not mentioned here). The work by Graversen et al. is also a nice addition, since it shows a different view on the role of sea ice in arctic amplification (that northward atmospheric transport of heat may be more important). An alternate view on arctic amplification is given in the cited paper by Ogi et al but that's a very limited study of just nine weather stations, which is far from enough to grasp the drivers of arctic amplification beyond some local effects. While I appreciate the introduction of causal-effect networks to study ocean-atmosphere interactions, the general conclusions about the role of sea ice in ocean-atmosphere feedbacks are not new and the studied region is rather small, which makes it hard if not impossible to generalize to the whole of the Arctic.

Second, the paper starts of by presenting itself as a study where links are investigated between the ocean, the atmosphere and subsequently the land (i.e. permafrost thaw and carbon fluxes). However, despite using a regionally coupled model, they do not appear to have included a land surface model to actually model the response of the land surface (apart from runoff). So, in the end, the response of permafrost and carbon fluxes to changes in the atmospheric forcing due to sea ice decline remains unclear. The authors mention that this study is a first step, but the introduction suggests that this topic will be investigated in more detail – which isn't the case – and the topic doesn't come back until the conclusions as a possible outcome, but it has not been analyzed. So why lead with this topic in the first sentence of both the abstract and the main text

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if the paper does not deal with this topic at all? Also here, the literature already holds many examples of possible connections which should be acknowledged if this topic is to be studied at a later stage (see e.g. Bhatt et al., 2010; Macias-Fauria et al., 2017; Parmentier et al., 2013; Post et al., 2013).

Apart from excluding a land surface model, the model setup also raises a few questions. First of all, why only focus on the Laptev Sea and the adjacent land? The regional model appears to have been run for most of the northern hemisphere and repeating the same analysis for other regions should be trivial. It would also show whether the found connections hold up in other regions where sea ice export is strong (e.g. along the coast of Greenland).

Also, why did the authors choose to run the model for the era before sea ice melt truly began (1950-1989)? This may lead to an underestimation of the role of sea ice in arctic climate feedbacks. If this is to be investigated, why not do this analysis for the period where sea ice started to decline and perhaps compare to the era of relatively stable ice conditions? The authors also repeat the same time period 4 times, but sea ice conditions are quite different between the four model runs. Why is this? It is not explained in the paper.

Overall, I think that the study is interesting, but the authors appear to present it as more novel than it is, and they should contextualize it better in the existing literature. A lot of work has been done on this topic, and a rather limited regional analysis over a historical time period with stable sea ice cannot be used in this way to draw strong conclusions on how sea ice decline has affected the whole arctic system, including the adjacent land, in recent decades.

A few other remarks:

- A diagram of which time periods and variables are compared to each other would be useful. From the text it can be difficult to follow which is being discussed. Perhaps label them?

- Page 5, line 94: which drivers of variables? Please specify.

- Page 10, line 195-196: why wasn't the causal effect network reanalyzed with long-wave radiation added? Seems important.

- Page 14, line 317-321: this conclusion is a rather big statement for an analysis of a limited area during an era of stable sea ice. It's not supported by this study nor the existing literature. Perhaps the link to land has been weak for the Laptev region during 1950-1989 but that doesn't mean it hasn't been strong in the past two decades in the same region or other parts of the Arctic!

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