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The Cryosphere Discussions

Interactive comment on "What historical landfast ice observations tell us about projected ice conditions in Arctic Archipelagoes and marginal seas under anthropogenic forcing" *by* Frédéric Laliberté et al.

Anonymous Referee #1

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This paper examines slow and packed ice as a proxy for landfast ice in reanalysis data and climate models. The main result is that models which are closer to observations of landfast ice from 1980 to 2015 project landfast ice to remain till 2080, while models which are less realistic indicate little landfast ice by 2080. The authors conclude that winter ice conditions in the Canadian Arctic Archipelago and the Laptev Sea are very sensitive to the representation of landfast ice conditions. While interesting results are presented, there are issues regarding the methods, the rigour and the significance which needs to be addressed.

1. The authors derive slow and packed ice as a proxy for landfast ice in climate simulations and reanalysis data. They define "slow ice" for ice drifting less than 1 cm/s and "packed ice" for ice concentration below 85 % (weekly means). I am not convinced by the 85 % threshold. Assuming an ice thickness of 1.5 m, a snow depth of 25 cm and a surface temperature of -30 deg C, the basal ice growth rate would be around 0.5 cm/day. Over a lead with an air temperature of -30 deg C and a wind speed of 5 m/s the growth rate would be around 20 cm/day. Thus, for a lead fraction of more than 2.5 % the ice growth in the lead would dominate the basal ice growth. Thus, your slow and packed ice seems to be not a suitable proxy for landfast ice, because in contrast to landfast ice, the ice growth in the model is determined by the lead fraction and thus by sea ice dynamics. This is contradicting your bellwether argument. A higher threshold value is required and information about the sensitivity would be useful.

2. The focus of your study lies on 3 regions: the CAA, Northwest Passage and the Laptev Sea. The first two are characterized by narrow streets which cannot be resolved accurately in CMIP5 climate simulations due to limitations regarding the horizontal resolution. How meaningful is the analysis of climate models in these regions?

3. Your separation between realistic and unrealistic models and the different behaviour in climate projections is interesting, but what is the impact of the representation of landfast ice? Could it not be mainly a question how well ocean streets are resolved in the climate simulations. Some discussion about potential reasons why certain models might be more realistic would be required.

4. Large part of your conclusions is repetition of Howell et al. (2016). You refer to the study, but reference is missing under literature. The message of the added paragraph is not robust given the issues stated above.

5. The results from the ice-ocean simulation with landfast ice parameterization (3.5) are promising and extending this work (impact study by comparing simulations with and without landfast ice parameterization) could improve this paper.