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The Cryosphere Discussions

Interactive comment on "Statistical predictability of the Arctic sea ice volume anomaly: identifying predictors and optimal sampling locations" *by* Leandro Ponsoni et al.

Anonymous Referee #1

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GENERAL OVERVIEW

The manuscript presents a statistical model for predicting the pan-Arctic Sea Ice Volume (SIV) anomaly on an interannual timescale. The long-term variability and the seasonal cycle have been subtracted to focus on the interannual SIV anomalies only, therefore excluding other better-understood signals. The statistical model is trained on the output of three coupled climate models produced in the frame of the HighResMIP. A low and high-resolution version of each model is analyzed.

The first part of the study inspects the capability of seven predictors to represent the sea ice volume up to 12 months in advance. The authors focus on two target months:

March (post-winter conditions) and September (late summer conditions). These predictors are tested and combined, both on a pan-Arctic and regional scale. The results show that the best predictive skill comes from the SIV itself, and by the Sea Ice Thickness (SIT), while the other considered variables are progressively less skillful.

The study presents afterward a method to determine some optimal locations that are representative of the SIV anomaly variance. Those locations are picked in a smart way to avoid clustering of points in certain regions, while other parts of the Arctic Ocean are underrepresented. The authors show that the statistical model can reconstruct approximately 70% of the SIV anomaly variance when fed with only 4 well-placed locations.

Even though the results here presented are in line with our expectations and not surprising, the manuscript tries to establish a robust protocol to predict the SIV anomaly. Furthermore, the fact that a large part of this variance can be predicted with only a few sparse observations in strategic locations is certainly interesting and can guide the design of future observation campaign in the Arctic region. The comparison of high and low resolutions contributes to the ongoing discussion in the modeling community about the benefit of resolving small features compared to the computational costs.

The approach followed by the authors as well as the application of this methodology to the SIV anomaly is quite novel. The purpose of the work is well presented and the methodology is adequately explained. The model data here analyzed are cutting edge in terms of model physics and resolution. The manuscript is well written and the figures and tables convey the message effectively.

The content of the study is certainly appropriate for The Cryosphere and I recommend the publication of this manuscript. Below I include a few minor points and suggestions that the authors should be able to address easily.

SPECIFIC COMMENTS

The manuscript provides several sampling locations with a multi-model approach. In

my understanding, these locations are computed based on annually-averaged fields. I am wondering if the sampling locations could be different for different target months. Also, some of the selected sampling locations might be ice-free in some periods of the year. Could the authors comment on this?

I believe that an interesting exercise would be comparing the performance of the statistical model in the optimal location to that in randomly chosen locations. This would show that the described method is robust and in fact, needed.

While the current model results provide an average representation of some variables inside a grid cell with a substantial extension, and the gradients between different cells are generally small, real-world observations would be much more localized and heterogeneous. Would this heterogeneity introduce some sampling errors and consequently require more observations to explain the SIV anomaly variance?

Is the whole time period ($\sim$150 years) necessary to reach the described results? I think it would be interesting to assess how many years of observations would be necessary to train adequately the statistical model here presented, and robustly reproduce the HighResMIP results.

1 – Line 16: It is worth mentioning also the SMOS sea ice thickness product.

2.1 – Line 6: Are the analysis on AWI-CM performed on the original FESOM2 grid or was the model output interpolated to a regular grid?

2.1 – Line 7: I would mention that the resolution difference between HR and LR in the Arctic is much lower in AWI-CM compared to the other two systems.

2.2 – Line 34: Is there a particular reason for choosing AWI-LR?

2.4 – Line 12: Be specific about the “common grid”. Is it a low or high-resolution grid. Can this have an impact on the results?

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