Summary

This paper presents a novel approach for estimating daily sea ice freeboard across the Arctic, using the Bayesian inference approach of Gaussian Process Regression (GPR). Benefits of such an approach include 1.) fewer days of data required to estimate Arctic-wide sea ice freeboard and 2.) improved temporal variability of a daily Arctic-wide freeboard product. It's great to see data from CryoSat-2, Sentinel-3A and Sentinel-3B being utilized together in this way. It was also refreshing to read a paper that has a good understanding of the relevant literature and other's methodology, so thank you to the authors for that. I do have a few concerns that should be addressed before publication, and these are summarized in my General and Specific Comments below.

General Comments

My one major concern with the paper was the limited assessment of improvements in temporal variability of daily sea ice freeboard (presented in Section 5). The authors show in In Fig. 6 we can see how the day-to-day variability is increased with the CS2S3 product, compared to the CryoSat-2 and Sentinel-3 31-day running means. Then, lines 265-266 state that "A natural question is then whether the variability we see in the time series in Fig. 6 represents real physical signal, or is just noise related to observational uncertainty". I'd suggest that this isn't just a natural question, but really the main question, and one I had throughout the paper until this point. It's really the crux of "why bother doing this work"? While I appreciate the development of innovative methods for improving sea ice products, the reader still needs to be sold on its benefits.

Although Figure 6 is very interesting, I'd like to see a more quantitative assessment of the temporal variability from GPR and monthly running means, compared with the benchmark (especially in regions where there are less training data). How much of an improvement in "true" temporal variability does GPR provide? The authors have clearly done most if not all of the relevant work, so please expand. Then, add mention of this in the abstract to strengthen the importance of the study.

Specific Comments

P1 L19: "reductions in the sea ice cover" is too general a statement. Specify what each instrument measures and over what time frame. We haven't seen reduction in thickness from altimetry for four decades, or in summer. We also haven't seen reduction in extent from altimetry. So, please be more specific here to avoid confusion.

P2 L23: Are AGU talks suitable references (I'm not sure on TC's stance on this)? If so, please provide a link to the publicly available version of the talk.

P2 L31: I'd consider Allard et al. (2018) to be a key paper that's missing here

P2 L35: Snow depth is also assumed

P2 L43: I believe Tilling et al. (2016) was 2 days

P2 L55: Change "containing" to "assimilating", for clarity

P3 L60: This first sentence doesn't add anything. I suggest using at this point to highlight the benefits of the GPR method vs. a monthly moving average that is very simple the produce. It's not just the need for a daily freeboard product based on observations that is well motivated, but a daily freeboard product that more accurately represents temporal variability. This new approach can (in theory) provide both.

P3 L75: For me, Section 5 is currently insufficient at providing "an assessment of the improved temporal variability achieved by the use of a daily product". See my General Comments above.

P4 L99: Introduce the "CS2S3" acronym here

P4 L120: On average, what percentage are co-located?

References

Allard, R. A., Farrell, S. L., Hebert, D. A., Johnston, W. F., Li, L., Kurtz, N. T., et al. (2018). Utilizing CryoSat-2 sea ice thickness to initialize a coupled ice-ocean modeling system. *Advances in Space Research*, *62*(6), 1265–1280.

Tilling, R. L., Ridout, A., & Shepherd, A. (2016). Near Real Time Arctic sea ice thickness and volume from CryoSat-2. *The Cryosphere*, *10*, 2003–2016.