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## Rigorous Error Analysis Not Performed

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Community comment on "ArcticBeach v1.0: A physics-based parameterization of pan-Arctic coastline erosion" by Rebecca Rolph et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-28-CC1>, 2021

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### Summary

This manuscript describes a model for Arctic coastal erosion that is based on a simplified physical erosion model of a partially frozen cliff and beach, coupled to a storm surge model. It is presented as a first step toward a parameterization of pan-Arctic shoreline erosion at a coarse spatial scale for capturing erosion rates on the order of years to decades. It uses physical data as boundary conditions, such as wind speeds and directions, wave period and height, and sea surface temperature, as well as accounting for sea ice cover. The authors claim the new model provides a promising starting point to project the retreat of Arctic shorelines, or to evaluate historical retreat in places that have had few observations.

### General Summary of Comments

I do not recommend publication in its current form. The model presented (ArcticBeachv1.0) is under-developed and the authors have not shown that this model has any predictive skill that outperforms a random number generator (proof described in detail in my review). For transparency, I have also included the Python script which performs this analysis at the end of the detailed review (attached). My suggestion to the authors is further development of the model and resubmission for publication at a later date and after further collaboration and consultation with peers in this research field. One benefit of the model presented is its low computational cost. If the low computational cost can be maintained while improving its ability to robustly predict coastal retreat rates, this would represent a ground-breaking advance in the field!

The results summarized in Figure 4 show the modeled annual and cumulative retreat at Mamontovy Khayata (MK) and Drew Point (DP) vs observations at each site. At first glance, the modeled retreat looks poor, but an error analysis was not provided to quantify model performance. For any predictive model, a thorough analysis of model predictive skill is required to evaluate its performance and ability to make reliable, robust predictions. One of the simplest routines is to test model predictions against a random prediction. If the model has good predictive skill, it should outperform a prediction generated at random within a plausible range of possible outcomes. This is essentially like posing the null hypothesis and showing that the model can disprove the null hypothesis. In this case, the null hypothesis states that, 'ArcticBeachv1.0 cannot predict the annual erosion rate any

better than a random number generator can.' If the ArcticBeachv1.0 model can predict annual erosion rate statistically significantly better than a random number generator, then it can rightfully claim predictive skill. My concern here for both locations is that, while there are a few years where modeled erosion matched observed erosion fairly well, there are also many years in this time series where the erosion is far outside of the running average. In these years, a model with high predictive skill should be able to reproduce the trend, if it has captured the correct physics. However, the ArcticBeachv1.0 model predictions end up under- or over-estimating the retreat, in the OPPOSITE direction just as many times as they estimate the retreat in the CORRECT direction (above or below the mean retreat).

The conclusion from the analysis for predictive skill (described in full detail below) shows that the ArcticBeachv1.0 model has no predictive skill at the DP location, and has inverse predictive skill at the MK location. Based on the error analysis, I disagree with the authors, as stated in the abstract, that the ArcticBeachv1.0 model provides a promising starting point to project the retreat of Arctic shorelines, or to evaluate historical retreat in places that have had few observations. The results of this analysis at both locations indicate that the model in its current form is under-developed, and cannot be relied upon to provide robust and skillful predictions for coastal retreat rates in the Arctic more than a randomly generated number can (in the case of the DP location) nor can be relied to provide a prediction in the correct trend direction (in the case of the MK location).

### **Detailed Analysis**

Please see the attached document for the detailed analysis.

Please also note the supplement to this comment:

<https://gmd.copernicus.org/preprints/gmd-2021-28/gmd-2021-28-CC1-supplement.pdf>