Full discussion: https://egusphere.copernicus.org/preprints/2024/egusphere-2024-1656/
Referee comments are in black
Authors responses are in blue, with proposed **new text** in bold

Author Response for Referee #3 (Anonymous)

Referee #3: Anonymous

This is a very well written paper that explores shoreline change for a region of the Alaskan Beaufort Sea Coast near Drew Point. They utilize ICESat2 data alongside high-resolution Planet imagery to quantify coastal change rates and morphology. Through this exploration, they examine the processes controlling coastal change and variability in process and form along the shoreline in three different regions.
I found this paper extremely easy to read and follow. I often found myself writing a comment to suggest some addition, only to find that it was addressed in the next paragraph I read. Thus, my review is quite short, as this paper is clear and worthy of prompt publication.
My only significant comment is that the authors would benefit from more clearly and directly explaining the novelty and scientific advance. I think that lies in two areas: first in the use of ICESat2 to explore coastal change and second in the authors' ability to interpret mechanisms and processes of coastal change from remotely sensed data, which is often quite difficult if not impossible. These are both stated in the paper, but the language can be beefed up a bit in the intro, discussion, and conclusions to really emphasize this.
We thank the reviewer for the thorough and positive review, in particular for their suggestions of additional reference materials. We agree that the novelty of our use of ICESat-2 and satellite imagery to explore coastal processes should be emphasized, and propose the following changes to achieve this:

-**L3**: "Here, we use **a novel combination** of shoreline boundaries from multispectral imagery from Planet and topographic profiles from ICESat-2 satellite altimetry to compare year-to-year changes in shoreline position and morphology across different shoreline types "

-**L67-70**: Move the last sentence of the preceding paragraph to the beginning of the next paragraph:

"Elevation measurements from airborne lidar (e.g., Jones et al., 2013) and aerial photogrammetry (e.g., Gibbs et al., 2019; Lim et al., 2020a, b) can be used to qualitatively characterize the shoreline, provide high-resolution estimates of shoreline position, capture short-term topographic change, and enable comparisons of retreat rates between different geomorphic units (e.g., Lim et al., 2020a) on seasonal (e.g., Gibbs et al., 2019; Lim et al., 2020a) to multi-year (e.g., Jones et al., 2013) timescales and over km-scale areas e.g., Lim et al. 2020a). ~~Satellite-based elevation measurements enable annual and seasonal high-resolution (< 5 m) coastal elevation~~

~~estimates on a pan-Arctic scale, providing the potential to expand on this work and transform our understanding of Arctic shoreline morphology and change~~.

The Ice, Cloud and land Elevation Satellite 2 (ICESat-2) laser altimeter collects repeat cross-shore elevation profiles, **providing the potential to expand on previous elevation-based work and transform our understanding of Arctic shoreline morphology and change..."**

-**L88**: Add a new topic sentence to this paragraph: **" Here, we present a case study demonstrating how repeat altimetry from ICESat-2 can be utilized in tandem with satellite imagery to track annual shoreline change and provide insight on short-term and local shoreline processes."**

-**L445**: Add a new topic sentence: **"Analyses of both the geolocated photon data and derived elevation profiles from ICESat-2 provide valuable insight on shoreline change."**

-**L491**:Add sentence: "**By integrating satellite altimetry and multispectral imagery, we can study mechanisms of coastal change that have previously been challenging to identify with satellite remote sensing.**"

Other, more minor comments:

L91-92: I don't think this rate is representative of the entire Beaufort Sea Coast of Alaska. Isn't the average reported rate there on the order of -1 m/yr? This is according to the Gibbs and Richmond 2017 data. Erosion is locally very fast at Drew Point, but this region is not representative of the broader Alaskan Beaufort Sea coast (Piliouras et al., 2023).

We agree that this is an important distinction to make, and have updated this sentence: " We focus on the ~~Beaufort Sea Coast of Alaska,~~ **the coastline surrounding Drew Point, Alaska,** where shoreline change rates are both high (averaging -22 m/a over the last decade) and variable (-48.8 m/a to 0 m/a on ~ 10 m length scales) (Jones et al., 2018"

The rate of retreat of the larger Beaufort Sea Coast Region is given in L23.

What is the reasoning/justification for calculating shoreline change in the north-south orientation rather than perpendicular to the local shoreline? This should be included in the paper.

Shoreline change was calculated in the north-south direction for ease of computation, and because the majority of the shoreline is approximately east-west oriented, such that the north-south is approximately equal to the cross-shore direction. However, based on feedback from reviewers, we have decided to update our shoreline change estimates to be calculated in the north-south direction. Based on our estimates of the difference between shoreline change calculated in the north-south and local perpendicular direction (L188-195, Fig. A2), we expect the impacts on our reported results to be small. As a result of this change, we have removed L188-195 and Figure A2.

The authors state that they manually identified the boundaries for the lower and upper shorelines from ICESat2 data. Can you provide some information in the main text about the criteria used to delineate these?
We have updated the text to clarify how these boundaries were delineated
" We manually identified the point corresponding to the backshore/onshore boundary (henceforth referred to as the “upper shoreline”) and backshore/beach boundary (the “lower shoreline”) **based on the visual breaks in the along-track slope**"

To what extent could you use other geospatial data products to help interpret these results? This may be especially helpful if you are concerned that ShoreZone is out of date given the rates of erosion here. The Jorgenson 2014 maps of thermokarst, ice content, etc. may be especially helpful and can be directly overlain on the modern landscape/shoreline, or Lara et al., 2018 landform mapping. References below.
We thank the reviewer for bringing these data products to our attention. We note that the Jorgenson et al. (2014) database classifies our entire study region as one unit, such that it doesn't provide any additional information on the spatial variability of shoreline characteristics. We have added it as an additional reference when discussing the general setting of our study site:

“This study arealargely consists of exposed ice-rich bluffs with narrow beaches along the coast and thermokarst **features such as** lakes and drained lake basins onshore (**Jorgenson et al., 2014;** Gibbs and Richmond, 2015)”

The Lara et al. (2018) landform provides a higher-resolution and more detailed landform map compared to ShoreZone. While there are a couple coastline-specific classes (such as sand dunes), we feel that an analysis of the specific classes presented here (such as the various types of polygonal terrain) is beyond the scope of this study.

Several typos throughout (some examples):

L103 typo ‘strudy’ should be ‘study’
We have corrected this typo

L156 typo ‘only occur when retreat when ocean temperatures’
We've removed "when retreat", which was a typo

L252: spatially averaged shoreline **retreat rate**? Missing ‘retreat rate’
We have updated this sentence to: " **The** spatially averaged shoreline **change rate** in our study area was ..."

The Gibbs & Richmond dataset citation is, I believe, incorrect. And the DOI link ‘cannot be found.’ The 2017 reference should be more appropriate:
https://pubs.usgs.gov/publication/ofr20171107
We thank the reviewer for bringing the incorrect doi and updated report to our attention. We have updated the doi link to: **https://doi.org/10.3133/ofr20151048**. We note that the referenced 2017 report contains updated shoreline statistics for each region, but not

in the level of spatial detail needed for the shoreline estimates reported in L107, L335, L347-348, and L355. It also doesn't include the general site descriptions that we reference in section 2.1. Therefore, we feel that it is more appropriate to keep the original 2015 citation.

The referencing is mostly quite thorough, but a few others that I would suggest and have referenced above in individual comments:

Baranskaya A, Novikova A, Shabanova N, Belova N, Maznev S, Ogorodov S and Jones B M 2021 The role of thermal denudation in erosion of ice-rich permafrost coasts in an enclosed bay (Gulf of Kruzenstern, Western Yamal, Russia) Front. Earth Sci. 8 566227

Erikson L H, Gibbs A E, Richmond B M, Storlazzi C D, Jones B M and Ohman K A 2020 Changing storm conditions in response to projected 21st century climate change and the potential impact on an arctic barrier island–lagoon system—a pilot study for Arey Island and Lagoon, eastern Arctic Alaska U.S. Geological Survey Open-File Report 2020–1142 p 68

Jorgenson T, Shur Y, Kanevskiy M and Grunblatt J 2014 Permafrost database development—Characterization and mapping for Northern Alaska

Lara M J, Nitze I, Grosse G and McGuire A D 2018 Tundra landform and vegetation productivity trend maps for the Arctic coastal plain of northern Alaska Sci. Data 5 180058

Piliouras A, Jones B, Clevenger T, Gibbs A and Rowland J C 2023 Variability in terrestrial characteristics and erosion rates on the Alaskan Beaufort Sea coast. Env. Res. Letters.

Wobus C, Anderson R, Overeem I, Matell N, Clow G and Urban F 2011 Thermal erosion of a permafrost coastline: improving process-based models using time-lapse photography Arct. Antarct. Alp. Res. 43 474–84
We thank the reviewer for these recommendations, and have updated the text to include these additional citations when referencing drivers and mechanisms of shoreline change in sections 1 and 2. As mentioned above, we feel the Lara et al. paper is outside of the scope of our work.