Overall comments

This paper effectively utilises a wide variety of remote sensing datasets and methods to enhance our understanding of the dynamics of Abramov glacier and address gaps in the existing observational record. The 55-year compilation of changes in glacier velocity, elevation, and terminus position convincingly demonstrates that this glacier undergoes cyclical dynamic instabilities, despite its use as a reference glacier for mass balance in this region. The manuscript is well-written, with the authors thoroughly explaining their methodology and the quantification of uncertainties. These methods have the potential for broader application, and the high level of detail achieved could be used to update regional inventories of surge-type glaciers, which likely overlook the dynamic instabilities of several smaller glaciers. Furthermore, this paper raises the question of whether other reference glaciers experience unstable flow, a possibility that a wider application of this approach might reveal. I recommend some minor revisions as outlined in the specific comments below.

Specific comments

Introduction:

- L41–65: In this paragraph, it would be beneficial to include more general information about glacier surging in Central Asia, such as the known ranges for the lengths of the active phase, quiescent phase, and recurrence intervals of surge-type glaciers in this region.
- L75–77: Glacier pulses have also been described in the Canadian Arctic in this paper (Van Wychen et al., 2016; https://doi.org/10.1002/2015JF003708). It may be worth citing this paper.
- L81: Consider slightly expanding on “a sudden shift in basal condition” for clarity.

Methods:

- L99–100: Refer to Section 2.3.2 here, as this statement mentions a newly produced dataset rather than analysis-ready data: “We used these scenes to derive surface ice velocities at annual frequency (Sect. 2.3.2).”
- L188: Change “aggregation polygons” to “aggregated polygons”
- L195: Change the title of section 2.3.2 to “Ice surface velocity” or “Glacier surface velocity”. Make this change throughout the text wherever “surface ice velocity” is mentioned.
- L201: Spell out “pixel”, i.e., “128 pixel window size”

Results:

- L299: The median rate would be a more appropriate measure than the mean rate, as it is less sensitive to outliers and would therefore be less skewed by the two periods of terminus advance. I therefore recommend using the median instead of the mean.
- L300: For added clarity, change “front advance” to “terminus advance” or “glacier front advance”.
- L313: Once again, the median would be a more appropriate measure than the mean represent these velocities.
- L314–315: Use “–“ for the date ranges rather than “/” here and throughout the text (e.g., “1996–1997”).

- L343–344: "…ice thickness significantly increased at the terminus, reaching 90 ± 5 m in the first phase and 39 ± 4 m in the second one": it is unclear whether you are reporting ice thickness values here or changes in ice thickness (dh). If you are reporting the latter, these maximum values of thickness change may be due to the glacier advancing over previously unglaciated terrain, which should be mentioned in the text if this is the case. For better representation of the overall trends of glacier thickness changes, you should also report median thickness changes over the terminus region and at higher elevations during both the active and quiescent phases, rather than just mentioning the maximum values.
- L349: Change "the lowest 0.6 km^2 before front advance" to "the lowest 0.6 km^2 before the glacier front advance".

Discussion:

- L381–382: Consider citing this paper by Hoinkes (1969), which also supports the claim that negative mass balance conditions can transition a glacier away from unstable flow conditions: https://doi.org/10.1139/e69-086.
- L386: I suggest also citing Copland et al. (2011) here, as they attributed increased surging activity in the Karakoram during the 1990s and early 2000s to increased precipitation: https://doi.org/10.1657/1938-4246-43.4.503.
- L387: "…which was quantified at about 50 % since the 1970s in the upper accumulation area (Kronenberg et al., 2021)": mention the specific time interval over which this increase in net annual accumulation rates was quantified.
- L442–443: To slightly enhance clarity, I suggest changing the sentence as follows: "For that period, the temperature-index approach in Barandun et al. (2018) — which is constrained by transient snow line elevation from Landsat — provides the most comparable results."
- If you have space for it in the final manuscript, consider including a short section in the discussion that compares Abramov Glacier to the behavior of other surge-type glaciers in the region. This comparison could provide valuable context for understanding the unique dynamics of Abramov glacier, namely in relation to the frequency and magnitude of surges, active and quiescent phase durations, and responses to climate variability. Highlighting similarities and differences with other glaciers can also help elucidate the underlying mechanisms driving glacier behavior in this specific geographic and climatic setting.

Figures and tables

- Figure 1: Specify the source of the glacier outline used in this figure. Is it from RGI 7.0, or what is it manually created for this study?
- Table 1: To enhance clarity and make it easier for readers to compare the data across different platforms and sensors, I suggest providing consistent units of measurement for resolution (i.e., use either meters (m) or arc-seconds or (")).
- Figure 5: The labels should be corrected from "(c) Active phase of 2000–2003. (d) Quiescence over 2003–2020" should be "(e) Active phase of 2000–2003. (f) Quiescence over 2003–2020" to match the letters in the figure.
- Figure 5: Change "by a same amount" to "by the same amount" in the last sentence of the figure caption.
- Table 3: Rows are not aligned. Ensure this is fixed in the final version of the paper.

References

Copland, L., Sharp, M. J., & Dowdeswell, J. A. (2003). The distribution and flow characteristics of surge-type glaciers in the Canadian High Arctic. *Annals of Glaciology*, *36*, 73-81. https://doi.org/10.3189/172756403781816301

Hoinkes, H. C. (1969). Surges of the Vernagtferner in the Ötztal Alps since 1599. *Canadian Journal of Earth Sciences*, *6*(4), 853–861. https://doi.org/10.1139/e69-086

Van Wychen, W., Davis, J., Burgess, D. O., Copland, L., Gray, L., Sharp, M., & Mortimer, C. (2016). Characterizing interannual variability of glacier dynamics and dynamic discharge (1999–2015) for the ice masses of Ellesmere and Axel Heiberg Islands, Nunavut, Canada. *Journal of Geophysical Research: Earth Surface*, *121*(1), 39–63. https://doi.org/10.1002/2015JF003708