Review of egusphere-2025-5193: High spatio-temporal velocity variations driven by water input at a Greenlandic tidewater glacier

Summary

This manuscript investigates short-term ice-flow speed variability at Eqalorutsit Kangilliit Sermiat, South Greenland, over sub-diurnal to multi-day timescales using Terrestrial Radar Interferometer (TRI) measurements. The authors document clear diurnal and multi-day velocity variations that are associated with episodic water inputs, including surface melt, supraglacial lake drainage, and subglacial or marginal lake drainage events. A significant difference between the two transition regimes is the glacier's response at the terminus, where acceleration and deceleration during high-velocity periods are larger than at locations further upstream. When water input decreases, basal water pressure appears to collapse in a block-wise pattern, resulting in abrupt deceleration of basal sliding at the terminus that subsequently propagates upstream. During such events, this mechanism overrides the downward-propagating diurnal signal observed during low-velocity periods and prevents the more uniform acceleration and deceleration behavior of the glacier.

The study demonstrates the strong potential of TRI observations to resolve short-term velocity changes, and the resulting dataset is highly valuable. Overall, the interpretations are well aligned with the scope of The Cryosphere and provide meaningful insights into short-term glacier dynamics. I have some suggestions to improve this manuscript, as below.

General Comments

- The advantages of using TRI are not sufficiently articulated. In particular, the rationale for the chosen temporal resolution (30 minutes) and cut-off period (3 hours) is unclear. Please provide justification for these choices, including discussion of coherence, signal-to-noise considerations, and any thresholds applied.
- L58-63: This is not the first study to use TRI for this type of analysis. Additional relevant literature should be cited (e.g., Drews et al., 2021; Holland et al., 2016; Voytenko et al., 2015; Xie et al., 2018, 2019).
- L77-86: The TRI azimuth resolution varies with range. If the region of interest is within 6 km, what is the effective resolution near the ice front and at upstream locations? While the resolution of 6.9 m at 1 km and the maximum system range of 16 km are stated as system specifications, more detailed information is needed for the actual region of interest. Please also specify the multilook factors applied and explain why these choices were made.
- L104: The plume extents are classified as (1) none, (2) small, (3) medium, and (4) large. Please clarify the criteria or thresholds used for this classification. Was this done

qualitatively (e.g., visual inspection) or quantitatively? A similar clarification is needed for L168 regarding the definitions of small, medium, and large mélange-covered areas.

- L236: The statement describing a lag of approximately two hours between the terminus and the location 6 km upstream is unclear. For example, deceleration appears to occur earlier and more strongly at the terminus on 2023-08-10, 2024-07-15, and 2024-07-20. Please clarify how the lag was determined and how it varies among events.
- L243-252: The description of Figure 6 would benefit from clearer visual guidance. Please consider annotating the figure (e.g., with arrows or highlighted regions) to indicate the areas discussed in the text, as the current presentation is not very intuitive.
- L262: The manuscript states that a Fourier analysis of the two velocity time series revealed strong 24 h peaks for both years, but the results are not shown. To support the subsequent conclusion that this reflects a solar rather than lunar influence (12.4 h), the Fourier analysis should be presented, at least in the Appendix.
- L274: The manuscript suggests that the relatively low precipitation rate resulted in only a small velocity response. Please clarify the basis for this interpretation. Is this because precipitation does not immediately translate into enhanced basal lubrication? Is there any relationship between precipitation and the acceleration observed on 2024-07-24?
- L298: If Sentinel-1 imagery is not shown or analyzed in this paper, please clarify why it is mentioned here, or include the corresponding results in the Appendix.
- L303: The manuscript refers to acceleration during the night of 2023-08-10. However, this pattern is not clearly shown in Figures 2a and 4c. Please clarify this interpretation or revise the text and/or figures accordingly.
- L369: Several previous studies have used GPRI for similar analyses, rather than relying solely on GPS point measurements along the glacier centerline. These studies should be cited, including Kane et al. (2020), Xie et al. (2018, 2019), and Drews et al. (2021).

Figures

In general, the figures, axis labels, tick labels, colorbars, and legend texts are too small and difficult to read. Please enlarge them to improve clarity.

- Figure 7: This figure appears to add limited new information to the manuscript. Consider moving it to the appendix.
- Figure A3: Please consider also showing the Sentinel-2 images corresponding to drainage event L1.
- Figure A4 and A5: Including 2D spatial velocity maps as animations or videos would be more effective in illustrating diurnal velocity fluctuations.
- Figure A7: Please consider overlaying the glacier centerline to improve interpretability, particularly in panel (a).

Minor comments

- The manuscript uses both “ocean-terminating glacier” and “marine-terminating glacier.” Please choose one term consistently throughout the text (or, “tidewater glacier”).
- L69: The statement that the glacier’s terminus has advanced over the past few decades should be quantified (e.g., by how much).
- L73: Citation error (also occurs at L330).
- L125: The statement “which has a sensitivity of less than 1 mm” requires a reference.
- L206: Please consider showing the Sentinel-1 data, at least in the Appendix.
- L237: “Fig. 4c and Fig. 4c” typo.
- L287: “Fig. 5d” no such panel exists.