Overestimation and Adjustment of Antarctic Ice Flow Velocity Fields Reconstructed from Historical Satellite Imagery

by Rongxing Li et al.

Review by Chad A. Greene, NASA/JPL.

This paper identifies three key shortcomings of a common velocity measurement technique, and provides a solution that addresses all three. At issue are 1. the true location of a feature-tracked velocity measurement, 2. the acceleration that a parcel of ice may experience between image acquisition times, and 3. the fact that ice does not always move in a perfectly straight line between image acquisition times. The problem and solution are described well in this paper, and the authors demonstrate that they have a good handle on the data and how velocities are interpreted from a glaciological standpoint.

This work will be of value to the community, both to raise awareness of the overestimation issue, and to provide a solution to it. I recommend publication, with just a few suggestions that may help readers understand the impact of overestimation and how it should affect our interpretation of previous studies.

Main issues

The paper does a good job of describing the problem and solution from a technical standpoint, and anyone who has written feature-tracking algorithms will benefit from reading the paper. However, there are many readers who don't write their own algorithms, but will nonetheless want to understand how overestimation might affect their scientific results. Some work could be done in this paper to better communicate the overall impact of how overestimation impacts long-term studies.

Here's a type of analysis that I would find much more insightful than the stats for PIG, Totten, and David Gl that are currently presented in the abstract: I would like to see a figure showing Eulerian grounding line flux calculations as a function of dt, where dt might range from a day to 20 years. This would provide readers with some intuition for a threshold value of dt, beyond which Eulerian measurements produce significantly different estimates of ice flux. It's possible that the percentage reduction in GL flux as a function of dt might vary regionally, and that diversity could be interesting to show as well.

In addition to a figure showing how dt affects GL flux in Eulerian measurements, I'd like some clear guidance in the abstract for when the Eulerian approximation is sufficient or insufficient.

In the abstract and/or discussion, I suggest flipping the logic/wording around at least once to make it clear that the overestimation of historical velocities could mean that previous papers have *underestimated* the magnitude of glacier acceleration over the past few decades. It's only a minor change in wording, but I think it's an important take-home message of this paper that should be stated directly.

Minor comments

Abstract: The case studies of PIG, Totten, and David Glacier provide decent testing grounds for the methods presented in this paper, but the details of these studies feel somewhat anecdotal and very specific to the exact images that were used in these particular cases. I recommend generalizing the results in the abstract to give readers a better overview of the problem. Only after discussing the overall impact of the overestimation, then it may be helpful to mention a specific case of PIG, Totten, or David to as a tangible example.

L29: This line mentions "the input-output method" and some good references are provided for it, but some readers may be unfamiliar with the term. If the term is necessary for some point that's being made, then I recommend briefly describing what is meant by "the input-output method" here. If the term is not important for this paper, then consider removing it.

L69: Recommend changing "It is proven that…" to "We show that…" to make it clear that the correction is original work that is presented in this paper.

L80: I'm not entirely sure what "descending passages" means. Consider rewording.

L160: "At each grid…" I think this should be "At each grid cell…" or "At each pixel…"

Figure 5 is very compelling, and I want to make sure I understand it. Unfortunately, the labels and caption are somewhat cryptic, so I'm not sure if I'm even getting the main message right. The caption contains a list of the data labels that are mostly redundant with labels that are presented directly in the figure. What's missing is physical interpretation or any direct take-home message. For example, the variables U, U', and V are labeled in the figure and in the caption, but there's no physical definition of what U, U', or V mean. Help readers by providing a sentence or two in the caption that directly states the main point and any secondary point(s) that may be worth noticing. The main point, I assume, is that the black line is consistently higher than the red and blue curves. State that in the caption, in terms of what it means physically. What causes the red and blue curves to cluster together or spread apart from each other? Mention the underlying mechanism in the caption. Most of these points are described in detail on page 11, but most readers will appreciate having the main points stated directly in the figure caption.