GLAcier Feature Tracking testkit (GLAFT): a statistically and physically based framework built on top of open science workflows for evaluating glacier velocity maps

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Abstract

Accurate assessments of glacier velocity are essential for understanding ice flow mechanics, monitoring natural hazards, and projecting future sea-level rise. However, the most commonly used method for deriving glacier velocity maps, known as feature tracking, relies on empirical parameter choices that rarely account for glacier physics or uncertainty. The GLAcier Feature Tracking testkit (GLAFT) aims to assess velocity maps using two statistically and physically based metrics. Velocity maps with metrics falling within our recommended ranges contain fewer erroneous measurements and more spatially correlated noise than velocity maps with metrics that deviate from those ranges. Consequently, these metric ranges are suitable for refining feature-tracking workflows and evaluating the resulting velocity products. GLAFT provides modulized workflows for calculating these metrics and the associated visualization, facilitating the velocity map assessments. To ensure the package is available, reusable, and redistributable to the maximum extent, GLAFT adopts several open science practices including the narrative documentation and demos using Jupyter Book and cloud access using Ghub. By providing the benchmarking framework for evaluating the quality of glacier velocity maps procedure, GLAFT enables the cryospheric sciences and natural hazards communities to leverage the rich glacier velocity data now available, whether they are sourced from public archives or made through custom feature-tracking processes.

Plain Language Abstract

We design and propose a method that can be used to evaluate the quality of glacier velocity maps. The method is composed of two numbers that we can calculate for every velocity map. Based on statistics and ice flow physics, velocity maps with numbers close to the recommended values are considered to have good quality. We release an open-sourced software tool called GLAFT to help users assess their velocity maps. GLAFT is available by local installation and cloud access with executable documentation and demos, suitable for research and educational purposes.

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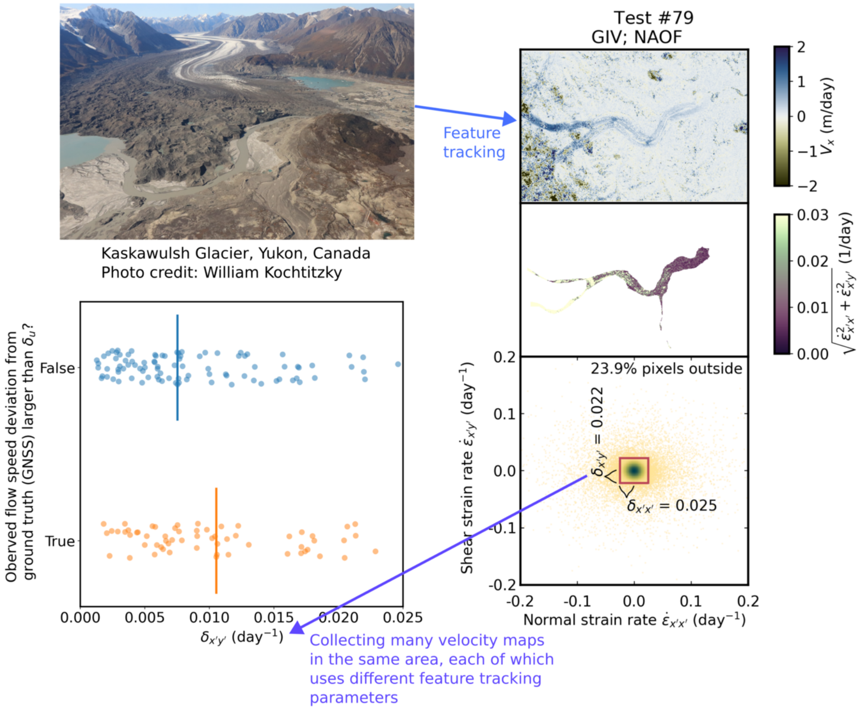

Figure 1: Visual abstract.

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Which glacier velocity map has the best quality?

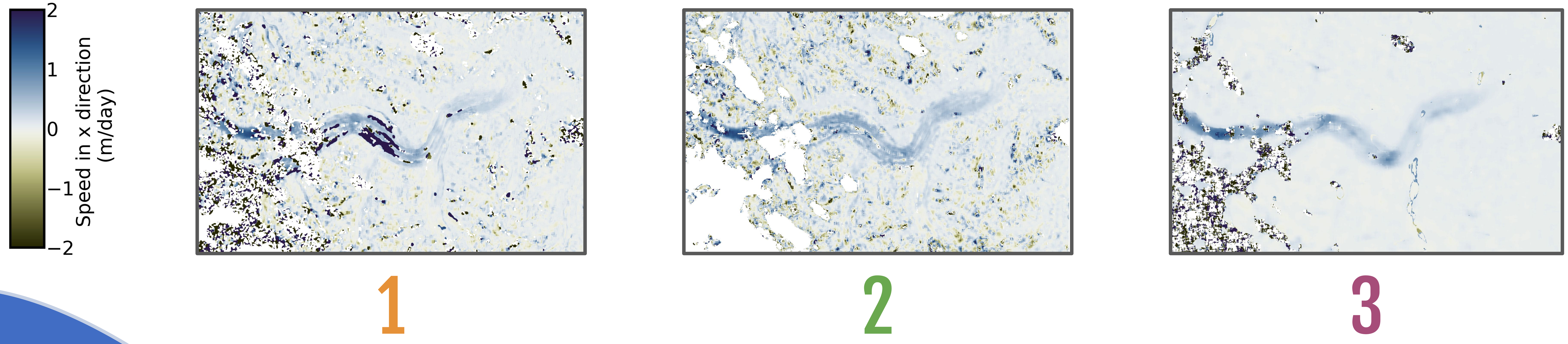

Fig 1. Kaskawulsh glacier (Yukon, Canada) flow speed in E-W. High-speed zone in the middle reveals the main channel. Three maps are derived from the same Landsat 8 pairs (2018.08.02-18) but are prepared using different feature tracking software and parameters. Full width ≅ 55 km.

Having trouble? Introducing GLAFT (GLAcier Feature Tracking testkit)

GLAFT: a statistically and physically based framework built on top of open science workflows for evaluating glacier velocity maps

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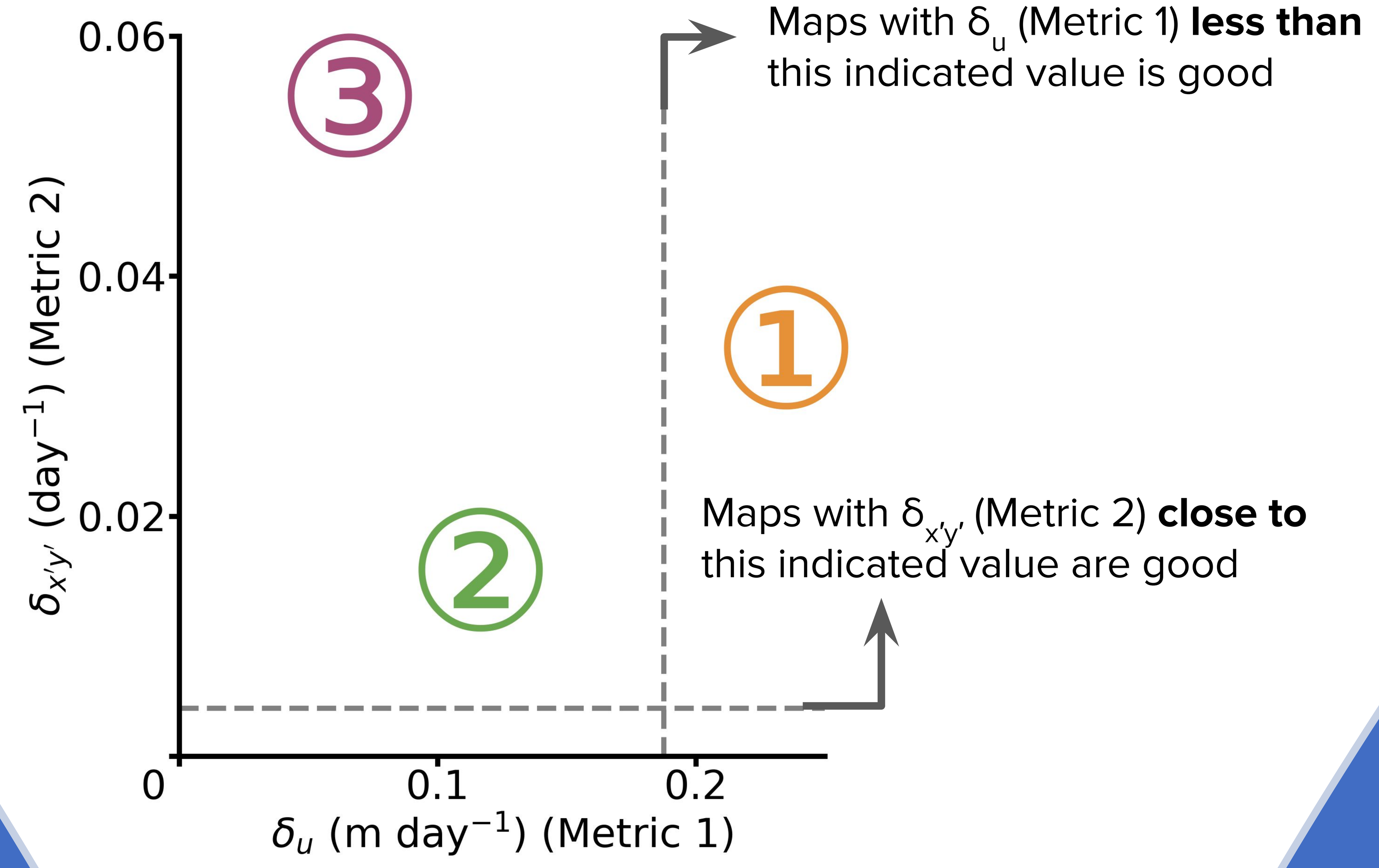

Fig 2. GLAFT-calculated metrics for the three velocity maps above, indicating the data quality.

Try GLAFT:

Why GLAFT?

GLAFT evaluates the quality of glacier velocity maps retrieved from large open data sets (e.g., ITS_LIVE) or derived using custom feature-tracking workflows.

- Refine/smooth the velocity maps based on physics-informed metrics
- Python-based & open sourced
- Cloud access (Ghub) + local installation

What are these metrics?

Metric 1 (δ_u): velocity over static terrain
Standard deviation of the kernel density estimation (KDE) calculated using correctly matched measurements only.

Best if $\leq 0.2 \times \frac{\text{pixel size of source images}}{\text{duration of source image pair}}$.

Metric 2 ($\delta_{x'y'}$): along-flow strain rates at glacier surface
Using the same KDE method from Metric 1.

Best if $\approx \bar{u}_{x'} \frac{2Y}{H^2}$. ($\bar{u}_{x'}$=avg surface along-flow speed, Y=channel half-width, H=ice thickness)

For more details, see the GLAFT publication at https://doi.org/10.5194/tc-17-4063-2023 or scan the QR code!