ITS_LIVE Regional Glacier and Ice Sheet Surface Velocities
- Known Issues -

Last Update

June 2, 2019

Surface Skipping/Locking

ITS_LIVE velocities are produced by finding correlated features between two image chips, a process referred to as feature tracking. Feature tracking can be susceptible to “skipping”, where the correlation can lock to either the displaced surface (what we want) -OR- high-frequency radiometric features that are not removed by the high-pass filter, and are stationary because of topography, surface water, curved flow lines (constrains both x and y), crevasse chains or some combination of all (Figure 1). Radar speckle tracking will also suffer from “skipping” where high frequency stationary features exist in the amplitude image (ice falls, curved flow lines, surface water). The degree of locking/skipping will be dependent on the surface feature, the sensor characteristics (spatial resolution, radiometric resolution), the high-pass preprocessing filter and the search chip size.

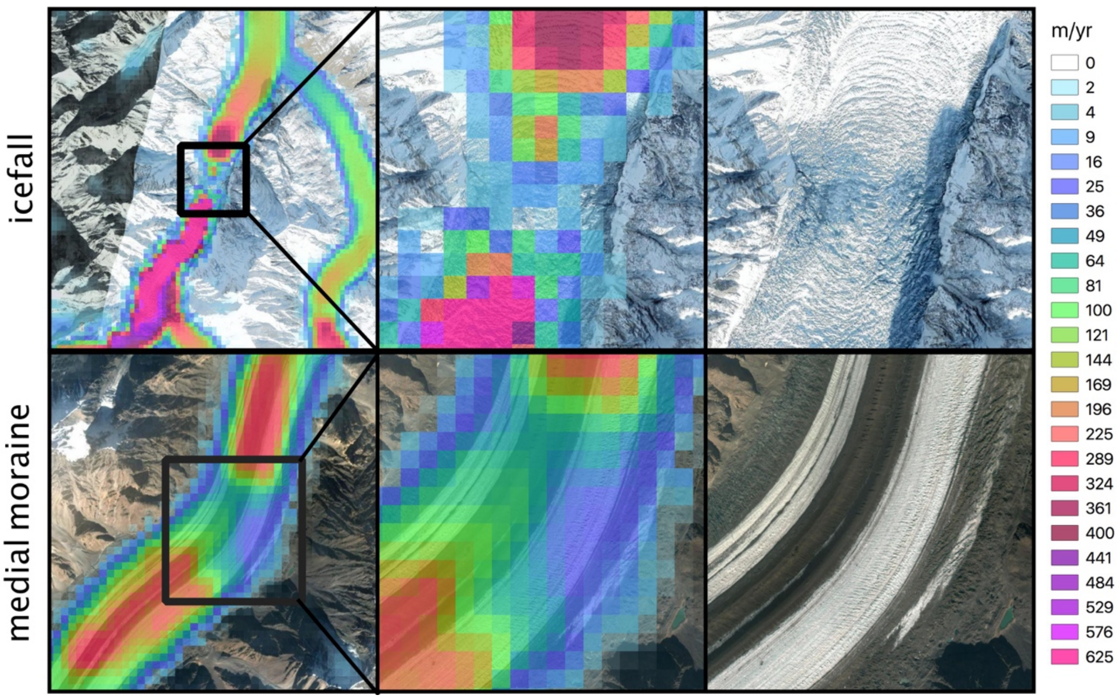

Figure 1: Example of skipping/locking due to localized topographic feature (icefall, top row) and time-invariant radiance (curved moraine, bottom row).

Inter-sensor bias

Biases in surface velocities can occur due to differences in sensor characteristics (Figure 2). These biases are most prevalent for narrow outlet and mountain glaciers, where the search and template chips used for feature tracking have strong gradients in radiance and/or contain some fraction of non-moving rock features. These biases are the result of differences in sensor radiometric range and quality that can change the location of the maximum correlation peak that is used to determine the offset between search and template chips (i.e., the surface velocity). This phenomena is well described in the supplementary material of Dehecq et al. (2019): https://static-content.springer.com/esm/art%3A10.1038%2Fs41561-018-0271-9/MediaObjects/41561_2018_271_MOESM1_ESM.pdf. For High Mountain Asia glaciers, Dehecq et al. (2019) found that Landsat 4 & 5’s Thematic Mapper sensors have a ~5 m/yr slow bias relative to Landsat 8’s Operational Land Imager sensor.

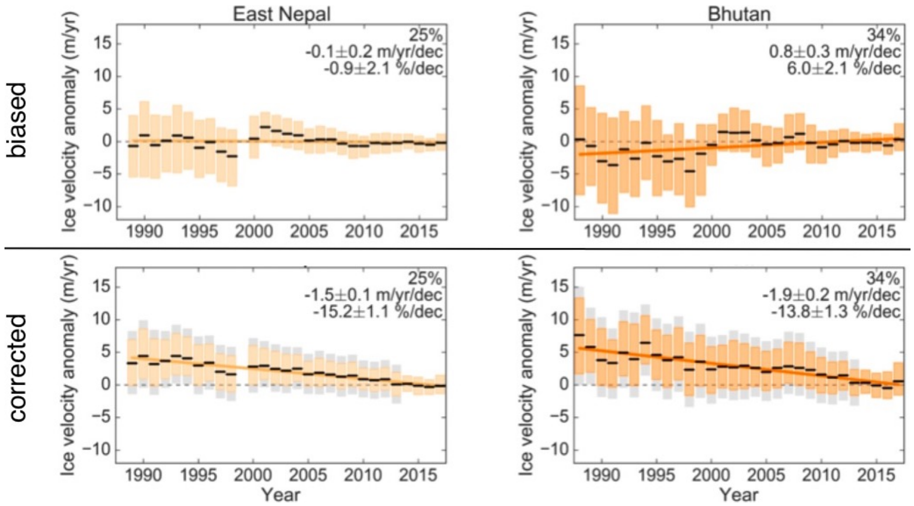

Figure 2: Regional velocity anomaly before (top) and after (bottom) inter-mission bias correction for two High Mountain Regions. Adapted from Dehecq et al. (2019).

Sensor precision bias

Differences in velocity uncertainty also cause a bias in the velocity magnitude between sensors. Sensors with higher uncertainty produce velocity magnitude estimates that are biased high relative to sensors with lower uncertainties (Figure 3). This is not true for velocity components (*vx*, *vy*), or for velocity magnitudes that have been projected onto a common flow vector. This can be illustrated with the simple case where the true velocity is zero. A noisy retrieval will give a *vx* and *vy* that deviate farther from zero than a less-noisy retrieval. Since *vx* and *vy* can be in either the negative or positive direction, component errors will be symmetric about zero. When the velocity magnitude is calculated from the complement velocities the symmetry about zero becomes lost and the distribution of errors takes on a Rice distribution, making the velocity magnitude biased high. To retain an error distribution that is symmetric about zeros the velocities magnitudes should be projected onto a common vector orientation. An example of the impact of this type of error on off-glacier velocities is provided in figures S8 and S9 of the supplementary material of Dehecq et al. (2019): https://static-content.springer.com/esm/art%3A10.1038%2Fs41561-018-0271-9/MediaObjects/41561_2018_271_MOESM1_ESM.pdf.

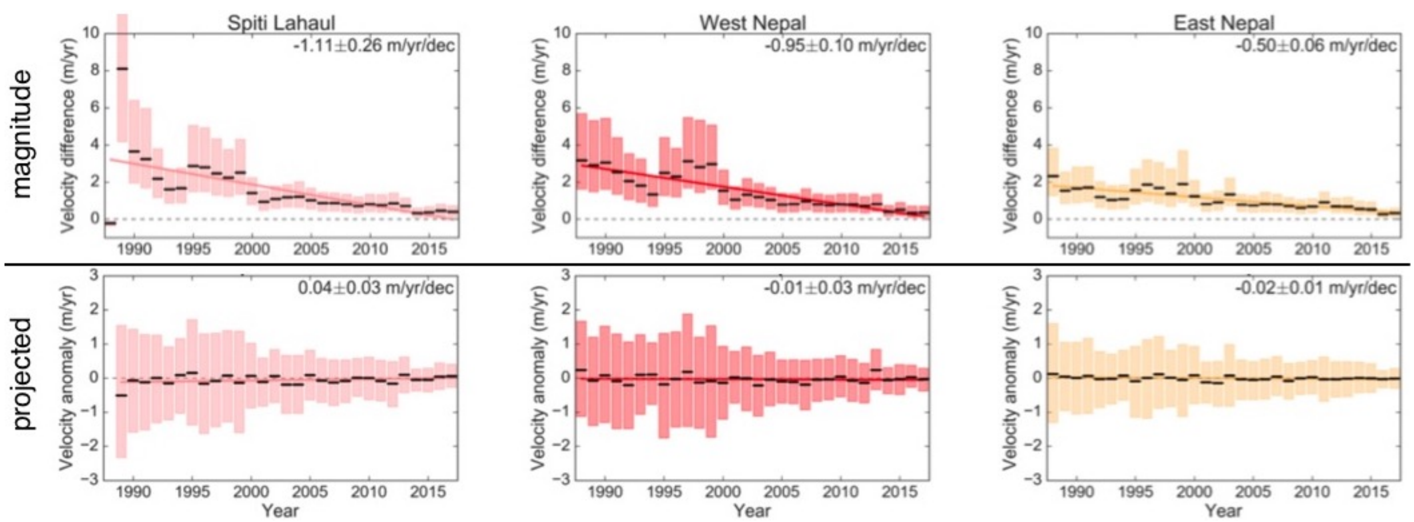

Figure 3: Example of sensor dependent bias in velocity magnitude (top row) vs. no bias in projected velocities (bottom row) over stable non-moving surfaces for three regions in High Mountain Asia. Adapted from Dehecq et al. (2019).

Formal errors are biased low

Formal errors are derived by taking the RSS of the standard error in velocities relative to a stable surface (see user documentation). This approach provides a formal estimate of the error over stable surfaces that does not always extrapolate well over the rest of the glacier. This is particularly true for areas of high accumulation (e.g. southwest Greenland, Iceland, Patagonia) where velocities suffer from a lack of cloud-free imagery, and low feature surfaces when viewable from space. Because of this, few retrievals can be made over these areas, making it difficult to automatically identify large errors/blunders when building the velocity mosaics. An example of large accumulation area blunder in velocity with corresponding formal errors and scene-pair velocity counts is shown in Figure 4. Notice that the formal errors grossly underestimate the true error but that both the formal errors and scene-pair count provide good relative metrics for identifying poor data.

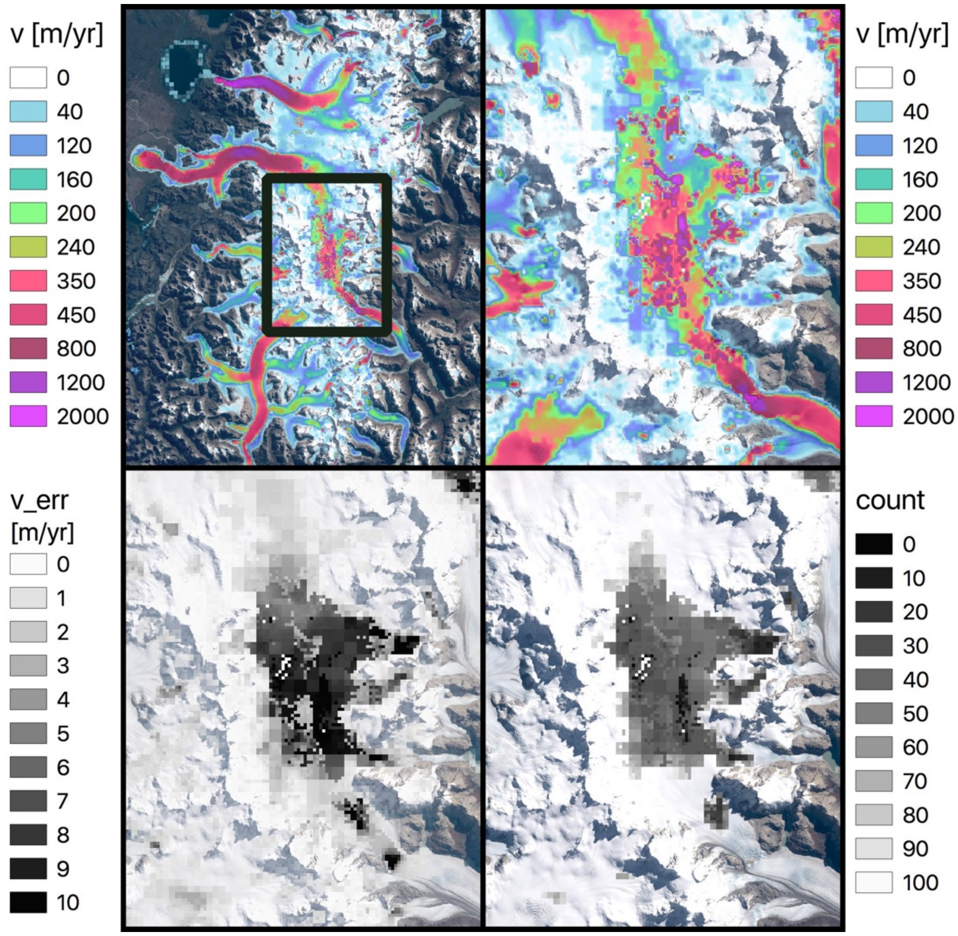

Figure 4: Example of blunders in surface velocities (top row) in the accumulation area of the Northern Patagonia Icefield with corresponding formal errors (bottom left) and scene-pair counts (bottom right). Notice that the formal errors grossly underestimate the true error but that both the formal errors and scene-pair count provide good relative metrics for identifying poor data.

Annual mosaics with little or no data

For some regions in some years it is possible to download annual data files that contain little or no valid data. This is a result of the automated nature of the ITS_LIVE processing and the uniform data access structure. To help limit the downloading of such files, quicklook images are displayed in the data access tool that show the data coverage.

References

Dehecq, A., Gourmelen, N., Gardner, A. S., Brun, F., Goldberg, D., Nienow, P. W., et al. (2019). Twenty-first century glacier slowdown driven by mass loss in High Mountain Asia. Nature Geoscience, 12(1), 22–27. https://doi.org/10.1038/s41561-018-0271-9