Imaging Geodesy of the Stikine Icefield, Juneau Icefield, and St. Elias Range in Southeast Alaska

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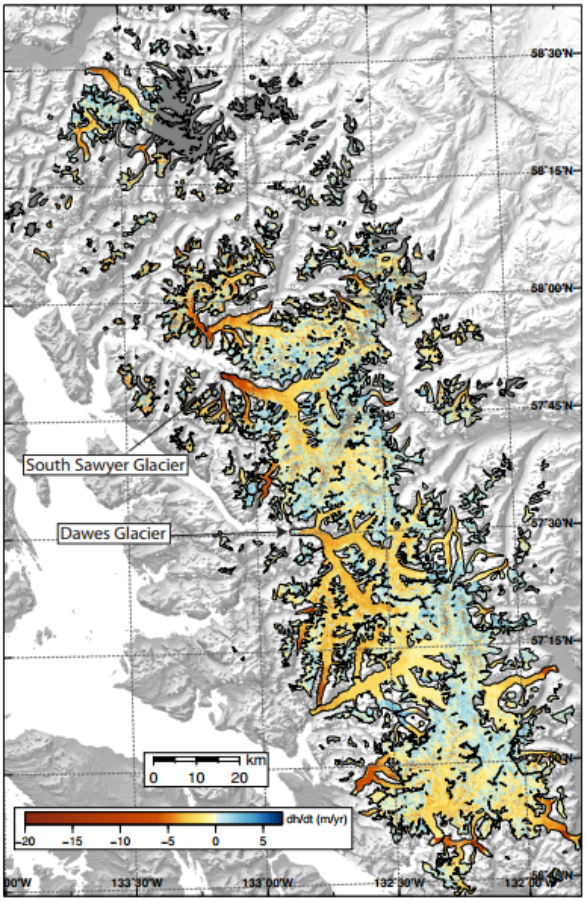
Various geodetic techniques, including pixel-tracking, Interferometric Synthetic Aperture Radar (InSAR), and tracking of elevation changes using multiple Digital Elevation Models (DEMs) are used to study glacier velocities and thickness changes. These methods cover entire icefields while still resolving individual glaciers. Here, we apply them to the Stikine Icefield, Juneau Icefield and glaciers in the St. Elias range to investigate changes (or lack-thereof) between 2000 and 2009/2012-2014.

Surface elevation change rates (dh/dt) between 2000 and 2009/2013 are obtained for the Juneau Icefield by applying a weighted linear regression to the Shuttle Radar Topography Mission (SRTM) DEM stacked with DEMs derived from imagery acquired by the Advanced Spaceborne Thermal Emission and Reflection (ASTER) DEMs. We multiply these dh/dt by area to get a volume change rate, then multiply that by a density of 900 kg m^{-3} to estimate mass change. We do not find significant mass loss from the Juneau Icefield between 2000 and 2009/2013, largely due to the positive mass balance of Taku glacier compensating for the thinning occurring at the lower elevations of the remaining glaciers. Glaciers in the Juneau Icefield do not lose a significant amount of mass through calving and have not significantly accelerated over the last 10 years. This suggests that mass loss is driven by melt rather than dynamic processes.



Stikine Icefield (~5400 km²) - dh/dt

Thinning at the Stikine Icefield is more rapid than at the Juneau Icefield. Part of the difference is due to dynamic thinning at several tidewater glaciers. The Stikine Icefield's tidewater glaciers have similar hypsometries to the region's land terminating glaciers, and while the tidewater glaciers have an area ~75% that of the land terminating glaciers, they account for ~1.7 times as much mass loss (-1.48 Gt/yr vs -0.87 Gt/yr).

In the St. Elias mountain range, the neighboring Guyot and Yahtse tidewater glaciers show opposite behaviors. Between 2000 and 2012, Guyot glacier retreated ~2km (McNabb et al., 2014), more than any other glacier in this study . Differencing a 2012 WorldView DEM with the 2000 SRTM DEM yields thinning rates at the 2012 terminus position of -4- -7 m/year. We observe a slowdown in the speed of Yahtse glacier from 25 m/day in May 2000 to 15 m/day in May 2014 measured 1 km up-glacier from the terminus. This deceleration is concurrent with an advance of ~1km (McNabb et al., 2014) and average frontal thickening of 1-5 m/year that is in agreement with thickening from 2000 to 2007 of 0->3 m/year reported by Arendt et al. (2008). The advance, thickening, and deceleration Yahtse glacier is likely enabled by a submarine terminal moraine.