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Multi-Decadal Elevation Changes on Bagley Ice Valley and Malaspina Glacier, South-Central Alaska (Extended Abstract)

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The St. Elias and eastern Chugach Mountains bordering the Gulf of Alaska, location of the largest connected glacier and icefield complex in continental North America, include the Bering and Malaspina glacier systems. The former, which includes Bagley Ice Valley and tributaries such as Quintino Sella Glacier, has a total area of about 5,200 km^2. The latter, including Seward Glacier in Yukon, Canada, and all tributaries, has a total area of about 5,000 km^2 (Molnia, 2001). These coastal mountains, which include peaks as high as Mount Logan (5,959 m a.s.l.; Holdsworth and Sawyer, 1993), mark the boundary between the North American and Pacific Plates (Plafker and others, 1994). This geographic location thus offers a unique opportunity to study the interactions among climate, glacier, and tectonic processes (Jaeger and others, 2001). The yearly seasonal storm track moves moist Pacific air masses northward, where the mountains induce heavy precipitation on the order of 6 m per year, mostly as snow (Mayo, 1989). Many of the glaciers in this region are surge-type, with repeat intervals ranging from about 5 to 30 years (Post, 1969, 1972). The last major two-pulse surge of Bering Glacier occurred in 1993-'95 (e.g., Lingle and others, 1993; Molnia and Post, 1995; Herzfeld and Meyer, 1997; Fatland and Lingle, 1998). An analysis of an ice core obtained from Mount Logan at 5,340 m a.s.l. shows a trend of increasing winter accumulation starting in about 1851, with the most rapid increase in winter accumulation occurring during 1976 to 2000 (Moore and others, 2002).

We have estimated multi-decadal surface-elevation changes from 1972 to 2000 using co-located (i) airborne X-band interferometric synthetic aperture radar (InSAR) digital elevation models (DEMs) derived by Intermap Technologies, Inc., from data acquired by them in 2000; (ii) Shuttle Radar Topography Mission (SRTM, 2000) X-band (InSAR) DEMs; and (iii) the U.S. Geological Survey (USGS) 15-min. DEMs derived from 1972-'73 stereo aerial photography. Our analysis includes estimates of systematic error in the USGS DEMs caused by photogrammetric vertical control uncertainty and contour "flotation" on relatively featureless icefields. The accuracy of the Intermap InSAR

DEM of the Bagley Ice Valley glacier surface was verified with near-concurrent small-aircraft laser altimeter data (see Echelmeyer and others, 1996), and was found to be better than 3 m RMS (Muskett and others, 2001). Snowfall on Bagley Ice Valley between the time of the small-aircraft altimetry acquisition and the time of the Intermap airborne-InSAR survey was estimated using the precipitation-temperature-area-altitude mass balance model of Tangborn (1999), and was taken into account in the accuracy assessment. The SRTM DEM has a relative vertical accuracy of 6 m, and an absolute vertical accuracy of 16 m, at the 90% confidence level (Geudtner and others, 2002).

Our preliminary estimates on Bagley Ice Valley (Intermap DEM minus USGS DEM) indicate thinning below the equilibrium line of about 30 ± 9 m, on average. Spatially non-uniform thickening of about 10 ± 7 m, on average, occurred above the equilibrium line to the Alaska-Yukon (Canada) border. Quintino Sella, a major tributary glacier of Bagley Ice Valley, thinned by about 100 ± 11 m, on average, during the 28 year time period.

Our preliminary estimates of elevation change on the glaciers of the Malaspina complex (SRTM DEM minus USGS DEM) indicate the Seward lobe thinned by 41 ± 5 m, on average. Agassiz Glacier thinned by 20 ± 4 m, and Marvine Glacier thinned by 49 ± 3 m, on average. Hayden Glacier thinned by 29 ± 3 m, on average, from 1972 to 2000.

Thinning and thickening on these glaciers has been spatially non-uniform. Agassiz Glacier, for example, experienced local thickening of up to 46 ± 4 m, and Marvine Glacier experienced local thinning in excess of 100 ± 4 m. Tyndall Glacier-a tidewater glacier terminating in Icy Bay-thinned by 52 ± 5 m, on average, with local thinning in excess of 200 ± 5 m, while the terminus rapidly retreated 13 km up-fjord during the 28 year time period.

These results are consistent with the findings of Arendt and others (2002) who, using a small-aircraft laser altimeter profiling system (Echelmeyer and others, 1996), found that most of the glaciers surveyed by them in Alaska and northwestern Canada experienced rapid wastage in their ablation areas, with much more modest thinning or even slight thickening in their accumulation areas, from the 1950's to 2001. The preliminary results summarized in this abstract express the interplay between glacier dynamics, climate change, and-in the case of Tyndall Glacier-the ocean, in northwestern North America.

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