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Seasonal and spatial variations in the advance of Hubbard Glacier, south-central Alaska, U.S.A.

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Hubbard Glacier, the largest tidewater glacier in North America, extends 122 km from a flow divide at about 2,600 m in Canada's Yukon Territory, NE of Mt. Logan (5,959 m), to Disenchantment Bay and Russell Fjord near the coastal community of Yakutat, Alaska, where icebergs calve from its 90 to 100 m high calving front. The width of the main trunk ranges from about 3 to 7 km; its total area, including tributaries, is about 3,400 kmˆ2 (Mayo, 1989). Interestingly, ca. 1130 A.D. Hubbard Glacier, which filled Yakutat Bay at that time, began a retreat of about 60 km that continued for 7 centuries through the Little Ice Age to 1891 A.D. (e.g. Mayo, 1987; Winkler, 2000). However, it has been in the advance phase of its tidewater glacier cycle (Post, 1975; Meier and Post, 1987) since it was first mapped by the International Boundary Commission in 1895 (Davidson, 1903). Hubbard Glacier's continuing advance since then has occurred during the post-Little Ice Age period when most glaciers throughout Northwestern North America and the world have been in retreat. It is thus an important example of tidewater glacier dynamics, particularly because its repeated blockage of freshwater discharge from Russell Fjord, in 1986 and 2002, is threatening to cause a redirection of local drainage that may harm the fisheries-based economy of Yakutat if formation of a stable ice dam causes long-term fjord closure (Mayo, 1989; Trabant, Krimmel, Echelmeyer, Zirnheld, and Elsberg, 2003).

Spaceborne SAR imagery acquired by ERS-1/–2 and Radarsat-1, and Landsat 7 imagery, acquired from exact-repeat orbits during winter, spring, summer, and fall of each year, 1992-2005, have been used to map seasonal to multi-year changes in terminus position during this 13-year time period. (The exact repeat time intervals are dif-

ferent for each of these satellites.) The calving front, which has a curvilinear width of about 11 km, was subdivided into 5 segments exhibiting differing advance behaviors. The seasonal and annual advance rates were measured for each segment. In addition, multi-decadal changes in surface elevation along the central flow line were measured using the method of small-aircraft laser altimetry (Echelmeyer et al., 1996) during the time periods 1959/1976 (topographic map dates) to 2000 (Trabant et al., 2003) and, more recently, in late summer 2003. These profiles show longitudinally varying as well as mean elevation changes that are positive, corresponding to positive mass balances. Altimeter profile data (not yet analyzed) were also acquired in late summer 2005.

The advance rate of Hubbard Glacier's calving front is found to vary significantly, seasonally and annually, as a function of position across the transverse width of the calving front. The advance rate is the forward component of the ice velocity less the calving velocity, so this indicates spatial and temporal variation of the ice velocity, the calving velocity, or both. Interpretations of this and our recent airborne altimetry results will be presented.