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Elevation and mass balance changes in Alaska glaciers from airborne LiDAR surveys

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Since 1993, the University of Alaska (UAF) Glaciers Group has monitored glacier elevation changes across Alaska (AK) and northwest Canada (NWC) using airborne laser altimetry surveys. Since 2009, this effort has been part of NASA's Operation Ice Bridge. The ongoing campaign has measured centerline elevation profiles for over 200 glaciers in the region. We will present updated mass balance and volume change estimates of glaciers and ice fields throughout AK and NWC. In addition, we estimate the contribution to sea level rise (SLR) from AK and NWC glaciers. In 2009 the single-point laser altimeter was replaced by a scanning LiDAR system, which vastly improves the sampling rate and spatial coverage of the laser returns. The combination of updated glacier outlines, upgraded LiDAR system, and improved analysis techniques provides more accurate results and more robust uncertainty analysis of the glacier mass balances and SLR calculations.

Our recent results suggest that AK and NWC glaciers overall continue to show loss of surface elevation and decreasing mass balances. AK and NWC glaciers show high variability in the relationships between mass balances and glacier-type, geographic distribution, and climate. In Denali National Park, most of the surveyed glaciers show negative mass balances increasing by approximately 50% from about -0.7 m/yr w.e. to -1.2 m/yr w.e. Mountain glaciers in Lake Clark National Park followed similar trends of slightly positive mass balances from 1996-2001 ($\sim$0.2 m/yr w.e.),and slightly negative mass balances from 2001-2008 ($\sim$ -0.6 m/yr w.e.). In the Juneau Icefield, Taku Glacier has maintained positive mass balances in recent decades, but from 2007 to 2011 its mass balance decreased to values of zero to slightly negative (-0.1 $\pm$ 0.1 m/yr w.e.). This decrease in the mass balance of Taku Glacier appears to be driven by loss of surface elevations in the upper areas of the glacier. The mass balances of glaciers in Glacier Bay National Park generally show negative mass balances over the past 20 years with mass balances ranging from about -0.5 to -2.5 m/yr w.e. However, unlike other areas of Alaska the mass balances in Glacier Bay are often remaining relatively constant. For example, the mass balance on Brady Glacier remained relatively constant over the past twenty years with a mass balance of -1.1 $\pm$ 0.2 m/yr w.e. between 1995 and 2000 and a balance of -1.3 $\pm$ 0.2 m/yr from 2009 to 2011. While we do not have direct measurements of accumulation rates in Glacier Bay, the elevation changes are consistent with increased accumulation balancing any increasing loss of ice.

Our data suggests that volume changes and mass balances of Alaska Glaciers are high variability with weak correlations between mass balance and glacier-type or location in AK and NWC. However, the estimates of region-wide mass balance and regional contributions to SLR benefit from the project's broad coverage of AK and NWC glaciers.