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Glacier changes in southeast Alaska and contribution to sea level rise

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Digital elevation models from the 2000 Shuttle Radar Topography Mission (SRTM) were differenced from the U.S. Geological Survey National Elevation Dataset (NED), which is based on air photos dating from 1948 to 1972, to generate maps of glacial change in southeast Alaska. Prior to differencing, the SRTM accuracy over 12 glaciers was assessed through comparison with laser altimetry measurements from the spring and summer of 2000, and found to be in agreement to within $\pm$ 5 m. Glacier thinning and retreat occurred over roughly 75 % of the 10,625 km^2 glacier-covered area analyzed, some areas quite dramatically with Yakutat, Grand Plateau and Dawes glaciers thinning as much as 350 m. We attribute this wastage to a combination of climate change, glacier geometry relative to rising regional equilibrium line altitudes, and calving retreats of tidewater and lacustrine glaciers. However, several glaciers were also found to be thickening and advancing. All the glaciers currently experiencing growth are known to have undergone tidewater glacier retreats, and now appear to be in the advancing stage of the tidewater glacier cycle. The total volume change from thinning glaciers in the area mapped is 562 $\pm$ 125 km^3; from thickening glaciers it is 90 $\pm$ 43.5 km^3, for a total ice loss of 472 $\pm$ 168 km^3, which corresponds to a contribution to global sea level rise of 1.31 $\pm$ 0.45 mm or an average of 0.025 $\pm$ 0.009 mm a^{-1}.during the later half of the 20^{th} century.

We also report on the post Little Ice Age (LIA) collapse of a huge continuous icefield that filled Glacier Bay, Alaska, and covered more than 6000 km^2 as recently as 250 years ago. The collapse of this icefield between 1750 and 1950 AD resulted in a volume loss of over 3000 km^3, equivalent to 8.3 mm of global sea level rise or an average of 0.042 mm a^{-1}. This localized volume loss represents the largest modern deglaciation known to us, exceeding the volume of the Larsen B Iceshelf Collapse

several times over. The combination of the post-LIA collapse of the Glacier Bay icefield and the ongoing rapid melting of glaciers is driving extreme rates of viscoelastic uplift (up to 30 mm a^{-1}) centered on Glacier Bay and near the Yakutat Icefield.