Mount Shasta's Glaciers: An Endangered Resource?

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We have documented a 30% elongation over the last five decades of one of Mt. Shasta's glaciers, the Whitney Glacier. This trend represents a scenario in which increased precipitation due to a warming Pacific Ocean can increase the spring snow accumulation at high elevations and, consequently, foster glacier growth. As lower elevation snow packs thin, higher elevation glaciers grow. Such a scenario would have far reaching impacts on the accurate assessment of California's snow reservoir during a warming climate.

Seasonal melt of Mt. Shasta's glaciers represents a significant dry season and drought period water source to north central California. Deterioration of these glaciers during a warming climate would have a significant impact on the water supply for the region. The latest climate models predict that northern California will warm by several degrees Celsius over the next century. If this prediction holds true, it is feasible that we may see a significant shrinkage or even a complete extinction of this glacier system in the next several decades. In this study we are assessing the stability of Mt. Shasta's glacier system through temporal analysis of ice volume and modeling of its possible response to climate warming.

First, photogrammetric analysis revealed that glaciers on Mt. Shasta have increased in areal extent nearly continuously from the 1940's through the present day. The Whitney glacier, North America's most southerly valley glacier, advanced 850m, or approximately 30% of its length, since 1951 and continues to expand. Comparison with available meteorological data over the past century suggests that this expansion is linked to an increase in winter precipitation accompanied by a decrease in summer temperatures, resulting in a positive annual snow balance. While there has also been an increase in winter temperature, resulting in a thinner spring snow pack at lower elevation, the high elevations of the glaciers are insensitive to this warming, remaining below the freezing level for most of the winter.

Second, field measurements of mass balance, ice thickness and velocity provide parameters for numerical models. Several methods were employed for field data collection, including high-precision GPS, ground penetrating radar, and sonic distance metering.

Fieldwork on the Hotlum Glacier.

Based on these field parameters, we constructed a numerical model of glacier flow, calibrated using the 100 year record of glacier length and concurrent meteorological data. This model was used to examine glacier sensitivity to potential warming scenarios. At current temperature trends, it is likely that high elevation glaciers will continue to increase in size due to increasing precipitation. However, these results stand in contrast to predictions of a regional climate model that suggest disappearance of the glaciers in the next 50-100 years as temperatures increase.

The trend we have observed is significant because it presents a scenario in which climate warming may result in increased spring snow accumulation at high elevations and glacier growth. This would have far reaching implications for assessments of the impact of climate change on California's snow reservoir.

Professional Presentations

Howat, I.M., S. Tulaczyk, M. Snyder,.,L.C. Sloan, California's Snow Gun, AGU Fall Meeting, San Francisco, CA., December 9, 2003.

Howat, I.M., S. Tulaczyk, Trends in California's snowpack under warming. California Energy Commission Conference on Climate Change, Sacramento, CA., May 28th, 2004

Publications

Howat, I. M., and S. M. Tulaczyk (in press), Trends in California's snow water volume over a half century of climate warming, Ann. Glaciol., 40.

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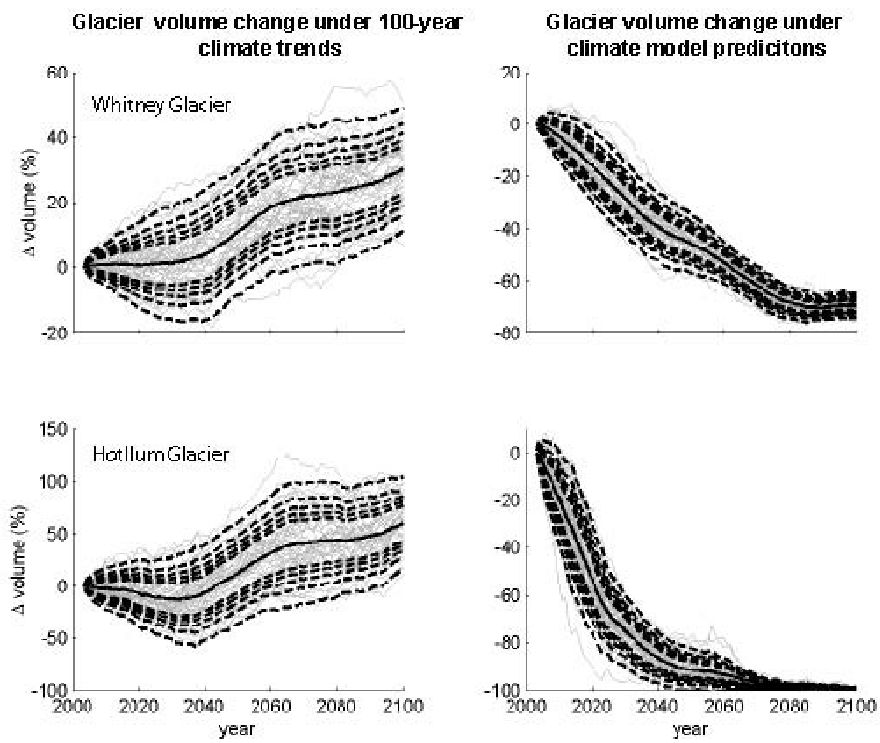

Dotted lines are confidence interval contours from 55-95%

Output of numerical model of the (above) Whitney and (below) Hotlum glaciers run with (left) the 100-year climate trend and (right) using the output of a regional climate model. Dotted lines are contours of prediction confidence from 55% to 95% with solid line as the mean estimate.