Using Cosmogenic Surface Exposure Dating to Reconstruct Late-Holocene Glacier and Climate Stability to Determine Precedence for Recent Declines in Snowpack and Water Resources in the American Pacific Northwest

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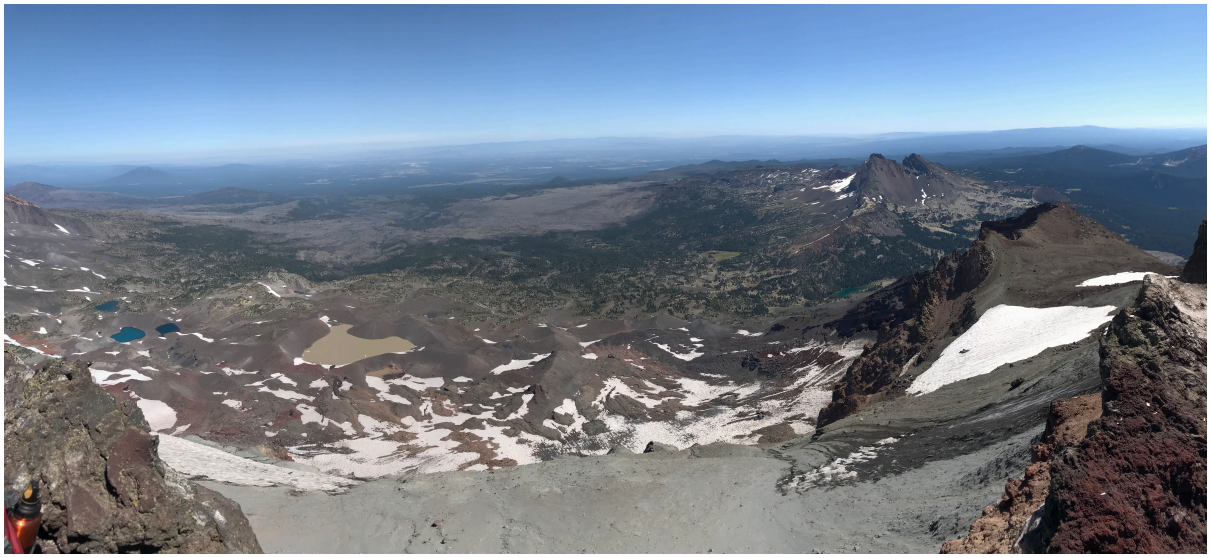
Background: The American Pacific Northwest relies heavily on its snowpack in the High Cascades as a water resource, which responds to sub-decadal to decadal shifts in Pacific Ocean climate. The snowpack acts as a natural reservoir with its melt supporting stream flow throughout the dry summer months. Cascade snowpack has declined in the recent decades, but with large annual to decadal variability, hampering detection of a long-term trend independent of natural variability. It is also unclear how Pacific-climate patterns affect the region on centennial timescales. Projections point to further declines in Cascade snowpack, but are based on arbitrary warming schemes or global climate-model downscaling exercises with substantial uncertainty. In contrast, Cascade glacier extents provide a filtered record of centennial-scale changes in the Cascade snowpack, because glaciers respond to the same two variables (winter precipitation and summer temperature) as the snowpack, just with a longer response time via ice flow that smooths annual to decadal variability to century-scale responses/trends.

Methods: The American Pacific Northwest relies heavily on its snowpack in the High Cascades as a water resource, which responds to sub-decadal to decadal shifts in Pacific Ocean climate. The snowpack acts as a natural reservoir with its melt supporting stream flow throughout the dry summer months. Cascade snowpack has declined in the recent decades, but with large annual to decadal variability, hampering detection of a long-term trend independent of natural variability. It is also unclear how Pacific-climate patterns affect the region on centennial timescales. Projections point to further declines in Cascade snowpack, but are based on arbitrary warming schemes or global climate-model downscaling exercises with substantial uncertainty. In contrast, Cascade glacier extents provide a filtered record of centennial-scale changes in the Cascade snowpack, because glaciers respond to the same two variables (winter precipitation and summer temperature) as the snowpack, just with a longer response time via ice flow that smooths annual to decadal variability to century-scale responses/trends.

Outcomes: Determining precedence for recent Cascade glacier retreat and related snowpack decline at timescales longer than direct observations has broad implications for fishery, agricultural, forestry and municipal planners, tourism, fire fighters, and hydropower. Results will provide a novel target for testing regional climate and glacier models that are necessary for accurate future projections of snowpack and glacier changes. Results will be published in high-profile journals and the PhD student will have the opportunity to present major findings in at least one international conference.



Training: This is a multidisciplinary project, with significant training in field, laboratory, and analytical methods. This project will provide development of skills and experience across the geosciences, including glacial geomorphology, paleoclimatology, volcanology, geo- and radiochemistry, nuclear physics, and water resource assessment. Skills will be developed in field data collection (for glaciers on high-altitude, active volcanoes in the northwestern USA), chemistry and accelerator mass spectrometry laboratory procedures (in the UK, California, and Australia), as well as regional climatology and numerical modelling methods. Importantly, integrating data and observations at the intersections of these disciplines will be a unique quality of this project. Thus the studentship will provide a unique experience to undergo rigorous training combined with participation in a program of significant societal relevance. **A passion for science that matters to society is critical.** The student will collaborate with international project partners in academia, government, and industry, and establish skills and networking connections important for further career opportunities in any of these scientific realms.

References:

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