

## Centennial glacier retreat as categorical evidence of regional climate change

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The near-global retreat of glaciers over the last century provides some of the most iconic imagery for communicating the reality of anthropogenic climate change to the public. Surprisingly, however, there has not been a quantitative foundation for attributing the retreats to climate change, except in the global aggregate. This gap, between public perception and scientific basis, is due to uncertainties in numerical modelling and the short length of glacier mass-balance records. Here we present a method for assessing individual glacier change based on the signal-to-noise ratio, a robust metric that is insensitive to uncertainties in glacier dynamics. Using only meteorological and glacier observations, and the characteristic decadal response time of glaciers, we demonstrate that observed retreats of individual glaciers represent some of the highest signal-to-noise ratios of climate change yet documented. Therefore, in many places, the centennial-scale retreat of the local glaciers does indeed constitute categorical evidence of climate change.

**Gerard Roe** received his PhD from Massachusetts Institute of Technology in 1999. Since September 2012, he has been a full professor in the Department of Earth and Space Sciences and an adjunct professor in the Department of Atmospheric Sciences at the University of Washington. His research is wide-ranging and often probes first-order questions about how different components of the Earth system interact.

