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Deformation on Bering Glacier, Alaska: Modeling of continuum damage with comparisons to aerial observations

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Bering Glacier, located in southeast Alaska, is the world's largest temperate glacier and is characterized by its surge-type behavior. After long periods of quiescence (~20 yrs), Bering Glacier will suddenly enter a surge phase (2-3 yrs) where the ice-flow rapidly accelerates resulting in large-scale deformation and significant elevation change.

A numerical representation of Bering Glacier and the greater Bering-Bagley Glacier System (BBGS) was created using the finite element software Elmer/Ice. Recent developments in Elmer/Ice have allowed considerations of continuum damage mechanics (CDM) [1]. Damage is a mesoscale feature of the ice and is advected by the flow. The accumulation of damage acts to soften the ice and accelerate creep effectively altering the ice viscosity [2].

Modeled damage is then compared to aerial observations acquired in field campaigns in 2011, 2012 and 2013 when Bering Glacier was experiencing a surge. Laser altimeter data were used to estimate crevasse depth, spacing and age [3]. Altimeter data, along with aerial and satellite imagery, were geostatistically classified following Herzfeld 2008 [4], which allowed the mapping of deformational provinces throughout the glacier. These data are used to constrain and optimize damage specific parameters, such as the stress threshold for damage initiation.

Figure 1: A large rift in upper Bering Glacier, Alaska, which opened during the latest surge and separates two deformational provinces.

References:

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