A connectionist approach to mapping deformation in fast-moving glaciers

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Deformation is a class of highly non-linear geophysical processes from which one can infer other geophysical variables in a dynamical system. For example, in an ice-dynamic model, deformation is related to velocity, basal sliding, surface elevation changes, and the stress field at the surface as well as internal to a glacier. While many of these variables cannot be observed, deformation state can be an observable variable, because deformation in glaciers (once a viscosity threshold is exceeded) manifests itself in crevasses.

Given the amount of information that can be inferred from observing surface deformation, an automated method for classifying crevasse types in surface imagery becomes increasingly desirable. In this paper, we introduce a connectionist-geostatistical approach to mapping crevasse types and hence deformation types. The approach results in a Neural Network for crevasse classification. An aspect of interest to the glaciological community is that a new Neural Net can be derived in a semi-automated way, requiring minimal pre-sorting of imagery, and this can be carried out by non-experts in NNs.

The connectionist-geostatistical approach uses directional experimental (discrete) variograms to parameterize images into a form that the Neural Network can recognize. Recognizing that each tpe of fast glacier movement results in different crevasse types and that environmental conditions affect the appearance in imagery, we have developed a semi-automated pre-training software to adapt the Neural Net to changing conditions and surface types, as well as to different types of imagery, such as airborne videography and satellite imagery.

Applications to different types of fast-moving glaciers will be presented, including Amundsen Embayment Glaciers (Pine Island Glacier, Thwaites Glacier), Bering Glacier (Alaska) and Jakobshavn Isbrae, Greenland.