Flow variability and propagation behavior in the Ross Ice Shelf

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Fracture geometries in the Ross Ice Shelf, observable using visible band satellite imagery from the MODIS Mosaic of Antarctica (MOA) and the Landsat Image Mosaic of Antarctica (LIMA) provide a unique opportunity to study fracture propagation behavior and discharge variability in the ice streams and outlet glaciers feeding the shelf. Propagation is driven by changes in fracture length, near-field stress conditions, and the material properties of the ice. Changes in ice stream discharge and the development of ñsticky spots,ò in both ice streams and within the shelf, lead to redirection of flow, changes in lateral gradients of ice velocity, and the propagation of fractures in response to changes in near-field stresses. The propagation behaviors most commonly observed are the growth in the transverse direction of a fracture that formed within a shear zone and mechanical interactions between adjacent fracture tips. A fracture type that forms at lateral corners of the shelf within a zone of both shearing and compression is also highlighted.

We use fracture mechanics theory and remote-sensed imagery to categorize fracture patterns and longitudinal zones of fractured ice in the Ross Ice Shelf. Near current sites of formation, simple fracture geometries and principal stresses are used to illustrate physical processes related to the formation and propagation of fractures. To compute flow lines and principal stresses, we derive a velocity map of the Ross Ice Shelf by merging two velocity datasets using a combination of statistical methods. A structural map of the Ross Ice Shelf is constructed, with fracture geometries, relict shear margins, and structural boundaries, observable in the imagery. Using the ice shelf features, present-day flow lines, and principal stresses, we investigate the manner in which principal stresses affect propagation behavior and the variability of ice stream discharge into the shelf.