Automation of Ice Fractures and Calving Events Monitoring Using Medical Imaging Ridge Detection Algorithms

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Ice shelves, i.e. the floating extension of the AIS, are playing an active role in controlling ice loss from the Antarctic ice sheet. Laterally constraint in embayment or by ice rises, they are participating as regulators of the ice discharge, by exerting a back stress to the ice flow. When losing mass, these ice shelves lose their gatekeeper property, with potential local destabilization of the AIS. Losing mass from calving is a sophisticated process that is rarely coupled with observations in ice sheet models. However, calving and damages are visible in SAR remote sensing products. In this study, we built the hypothesis that state-of-the-heart ridge detection techniques from the medical imaging field can be transposed to the cryosphere field. Looking at the local Hessian matrix in SAR acquisitions, we analyzed the eigenvectors that indicate the presence of ridges. Over ice shelves, these edges correspond to the calving front of the ice shelf, or crevasses. Using time series, we can monitor the evolution of crack propagation and calving events. Results over Pine Island Glacier and the Brunt Ice Shelf show a precise delineation of calving events, as well as the damaged areas. These encouraging results support the idea of the integration of ice damage detection from SAR remote sensing into ice sheet models.