Fingerprint matching for ice shelves. How to identify sources of thickness change to the Ross Ice Shelf, Antarctica

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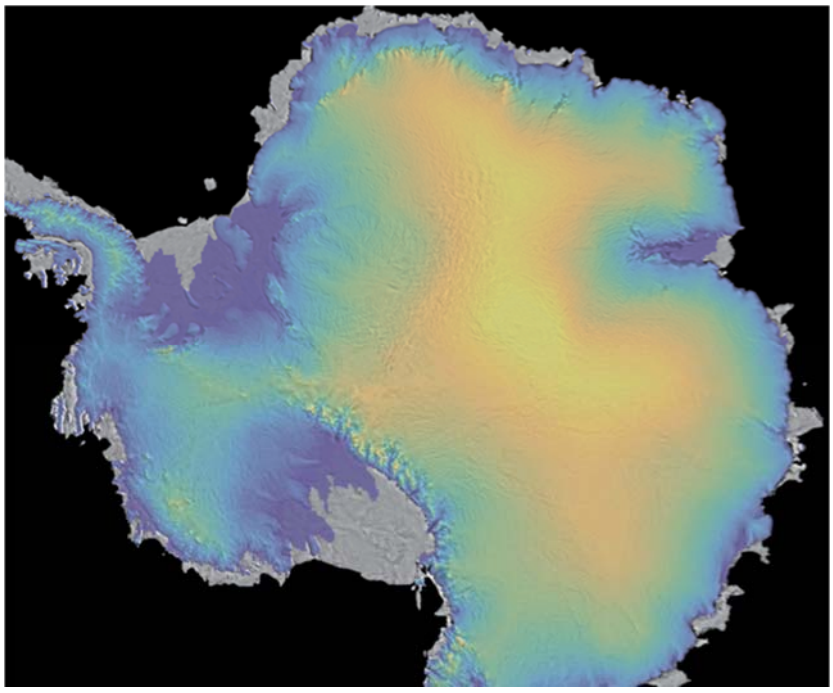

Abstract: Satellite observations of Earth's cyrosphere have given us a detailed record of present-day changes to the Antarctic. Correct interpretation of contemporary change on the Ross Ice Shelf (RIS) requires a theoretical framework for understanding ice-shelf variability. The RIS is prone to many sources of variability: glaciers and ice streams that feed into the RIS change their discharge, ice plains ground and unground, tabular icebergs are released from the front. These changes in boundary conditions produce long-lived transients will arise in both velocity and ice thickness. Ice shelves respond to changes in boundary conditions over a range of time scales. A change in ice thickness or velocity measured today may thus represent an integrated response to all past variations in boundary conditions. Using a computational model appropriate for floating ice, we examine this situation for the RIS and develop a method for fingerprinting changes associated with boundary perturbations including iceberg calving, grounding and ungrounding events, and variations of input from surrounding glaciers and ice streams. Characteristic spatial and temporal patterns in velocity and thickness are discovered, associated with specific perturbations to the RIS. I apply our theoretical tools to thickness-change time series derived from high-resolution surface elevation from the IceSAT campaign. The acceleration of Byrd Glacier between 2005 and 2007 is distinctly captured by this process. We also demonstrate that recent tabular iceberg calving and flow variation in Whillans Ice Stream are detectable. Identifying characteristic patterns in ice-shelf changes gives the ability to correctly attribute changes already detected and those that will be measured by future observational campaigns.

School of Surveying
Te Kura Kairūri

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L1 Lecture Theatre
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