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Towards pan-Arctic glacier calving front variability with deep learning

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The Arctic has been warming four times faster than the global mean over the last forty years. In response, glaciers across the Arctic have been retreating and losing mass at accelerated rates in recent years, including Greenland, Alaska, Canadian Arctic, Iceland, Svalbard and Russian Arctic. To predict their evolution with confidence, it is important to understand the mechanisms driving mass loss across the Arctic, especially the interconnected relationships between glacier retreat, ice dynamics, and mass imbalance. Over the past several decades, satellite remote sensing has been used to image glaciers over large spatial scales and at high temporal resolution. The volume of data produced, however, has challenged the traditional manual-based approaches to quantify glacier calving dynamics at a sub-annual scale across the whole Arctic. To address this limitation, we use a fully automated deep learning approach to generate a new calving front dataset for pan-Arctic glaciers at a high temporal resolution, by harmonizing multiple satellite missions that are available from the 1970s onwards, including optical missions such as Landsat, ASTER and Sentinel-2, and various SAR missions such as ERS-1/2, Envisat, RADARSAT-1, TerraSAR-X and Sentinel-1. We first present a new training dataset for the Arctic glaciers. We then present a new deep-learning framework for mapping the pan-Arctic glacier calving fronts. We show the interannual and seasonal variability of glacier termini positions by applying this method at scale and investigate the responses of Arctic glaciers to climate change.