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Large-scale and High-resolution Frontal Ablation Estimates in the Arctic through a Machine Learning Approach

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Frontal ablation is an important component of tidewater glacier mass loss, however, high temporal resolution estimates have remained elusive due to difficulty in reliably capturing terminus position changes with satellite imagery. Recent developments in machine learning-based radar image segmentation to automatically delineate glacier fronts has opened an opportunity to calculate frontal ablation over fine timescales. Through segmentation of Sentinel-1 synthetic aperture radar image sequences, we aim to quantify seasonal and annual frontal ablation across several Arctic regions, using a deep learning-based terminus segmentation algorithm. Svalbard, an Arctic region characterized by variable and complex glacier and fjord geometries, will serve as a methodological test site before expanding the scope to the Canadian Arctic, Greenland periphery, and Russian Arctic, or ~1400-1500 marine-terminating glaciers in the Northern Hemisphere. The derived frontal ablation information is valuable to climate and glacier models, which could benefit from high-resolution reference data, resulting in improved calibrations and parameterizations. Future project efforts will include quantifying total mass budget for all glaciers in the study by integrating frontal changes, ice discharge calculations from ice thickness and surface velocity products, and climatic mass balance data. To identify and evaluate external drivers of glacier change, the frontal ablation and mass balance products will be combined with modeled and observational atmospheric, oceanic, and sea ice data. Through multivariate statistical analyses between these Earth system datasets and mass balance components, we look to provide an improved understanding of dynamic tidewater glacier processes, their spatio-temporal variability, and the influence of glacier geometry on observed changes throughout the Arctic.