Rebuilding glacial retreat histories using inverse methods and surface exposure age data

Claire Todd, Ed Waddington, Michelle Koutnik, Howard Conway, and John Stone
Department of Earth and Space Sciences, University of Washington

Ice thinning and retreat at Reedy Glacier, in the southern Transantarctic Mountains, is controlled by the thickness of grounded ice in the southern Ross Sea. Thus, the surface profile of the glacier is an indicator of the extent and volume of grounded ice in the Ross Sea Embayment, the largest embayment in West Antarctica. We want to reconstruct the evolution of the surface profile of Reedy Glacier from the Last Glacial Maximum (LGM) configuration to the modern ice surface in order to constrain LGM ice thickness in the southern Ross Sea and to improve constraints on the region's contribution to sea level since the LGM.

Surface exposure ages from lateral deposits at Reedy Glacier track the retreating ice margin and provide a chronology of retreat at different locations along the length of the glacier, but sampling is often limited by the availability of glacially-derived material at accessible and appropriate sampling sites. As a consequence, even exhaustive sampling of suitable sites can result in an incomplete or piecemeal deglaciation chronology. To address this problem, we use a one-dimensional, steady-state glacier flowband model to infer past glacier surfaces between locations of contemporary deposits. This forward model requires estimates of the flux of ice into the head of the glacier, accumulation rate at discrete locations along the length of the glacier, bed elevation, glacier width, and an ice elevation at the mouth of the glacier. We are developing an inverse procedure to apply to our forward model that will solve for the glacier surface history that best fits the surface exposure age data. Our procedure will find a tradeoff between fitting the data and requiring model parameters to be smooth in time. Through this study, we hope to constrain the range of possible LGM ice thicknesses in the southern Ross Sea, improve our understanding of the response of Reedy Glacier to deglaciation, and develop an inverse procedure applicable to other surface exposure age data sets from glacial environments.