Subaqueous melting of Store Glacier, West Greenland from three-dimensional, high-resolution numerical modeling

Yun Xu[1], Eric Rignot[1,2], Dimitris Menemenlis[2], Mar Flexas[2], Ian Fenty[2]

[1] Earth System Science, University of California Irvine, Irvine, CA, USA

[2] Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA

Abstract

Subglacial freshwater discharge and subsurface ocean heat transport have fundamental impacts on the subaqueous melting of Greenland tidewater glaciers, which in turn plays a critical role in the evolution of their state of mass balance. Here, We present three-dimensional, high-resolution (1-m grid spacing) simulations of melting on the calving face of Store Glacier, a tidewater glacier in Central West Greenland, using the Massachusetts Institute of Technology general circulation model (MITgcm), and we compare the results with a direct estimate of ice melt from oceanographic data. The simulated summer melt rate of 2.0 ± 0.3 m/d compares well with the calculated rate of 1.5 ± 0.8 m/d. The simulation replicates the turbulent upwelling and spreading of the buoyant, freshwater-laden plumes along the ice face and the vigorous melting rates of meters per day. Melting is not uniform and is largest at depth, hence undercutting the glacier front. The melt rate increases less than linearly with the subglacial water flux and more than linearly with ocean thermal forcing; but the sensitivity to these processes decreases slightly at high subglacial flow regimes. We find that the unknown spatial pattern of subglacial discharge is a significant source of uncertainty (30%) in predicting melt rates.