Post-LGM & Holocene accumulation rates in West Antarctica: steady-state or not?

Brian Welch (welchb@stolaf.edu), Alison Hagen, Robert Jacobel
Physics Department, St. Olaf College, Northfield, MN 55057

Holocene accumulation rates throughout much of interior Greenland appear to be nearly steady-state (Fahnestock et al. 2001a and Fahnestock et al., 2001b). In contrast, accumulation measurements and calculations near Siple Dome (Nereson et al. 2000) and the WAIS divide (Neumann et al., 2005) indicate that Holocene accumulation rates in West Antarctica were not steady. We examine the sensitivity of three, one-dimensional steady-state ice flow models to assess the stability of accumulation rates over a broader region of the WAIS by using dated stratigraphy from the US-ITASE traverses. By rewriting the general form of the Dansgaard-Johnsson model so that the boundary conditions are applied either at the surface or at the bed of the ice sheet, we can examine the sensitivity of the model to parameters such as total ice thickness, stratigraphic dating errors, and past changes in accumulation or vertical strain rate (due to ice horizontal flow).

In general, the agreement between all of the models is sufficient to note a continental-scale trend in the accumulation rate: generally low accumulation in the Ross Sea drainage increasing toward the WAIS divide, and then generally higher rates across the Amundsen Sea drainage. In regions where the three-dimensional ice flow is complex (e.g. mountainous regions and ice stream tributaries), the accumulation rates diverge greatly depending upon the modeling method and the selection of stratigraphic layers. We find that the model results are sensitive to dating errors and even to which internal layers are selected for use with the model. Thus, while some regions of the WAIS appear to be in steady-state in a given model run, examination of the same location with a different model or by simply choosing a different combination of dated layers can alter the outcome to appear non-steady.

Based on the model results we conclude that the WAIS does not exhibit the near-uniform steady-state conditions that seem to be the norm throughout much of the Greenland ice sheet interior. Instead, ice flow and changes in accumulation rates during the Holocene create a more complicated picture in West Antarctica that requires a more complete multi-dimensional flow model.

Fahnestock, M., W. Abdalati, I. Joughin, J. Brozena, and P. Gogineni, 2001a, High geothermal heat flow, basal melt, and the origin of rapid ice flow in Central Greenland, *Science*, **294**, 2338-2342.
Fahnestock, M., W. Abdalati, S. Luo, and S. Gogineni, 2001b, Internal layer tracing and agedepth-accumulation relationships for the northern Greenland ice sheet, *J. of Geophys. Res.*, **106**(D24), 33789-33797.
Nereson, N.A., C.F. Raymond, R.W. Jacobel, E.D. Waddington, 2000, The accumulation pattern across Siple Dome, West Antarctica, inferred from radar-detected internal layers, *J. of Glaciol.*, **46**(152), 75-87.
Neumann, T., H. Conway, S. Price, E. Waddington, D. Morse, 2005, Inferred accumulation and thickness histories near the Ross/Amundsen divide, West Antarctica, [abs], 2005 WAIS Meeting.