# Limits to WAIS Predictability?

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Model Simulations of the WAIS suggest that sporadic, perhaps chaotic, collapse (complete mobilization) of the ice sheet can occur 3 or 4 times each million years. This irregular behavior in the model is due to the slow, millennial-scale thermal equilibration time of distributed basal till which lubricates ice-stream motion. The net effect is that the relationship between the ice sheet's volume and environmental conditions (e.g., regional surface temperature, precipitation and, possibly, conditions which influence ice-shelf buttressing) is not linear. Success of the effort to predict the ice-sheet volume changes over the next 100 years, for example, will depend on the ability to know present basal conditions that can either predispose the ice sheet toward rapid collapse, or alternatively, predispose the ice sheet toward basal freeze-up and ice-flow slowdown. Results of the simulations are presented in:

http://geosci.uchicago.edu/people/MacAyeal_irregularWAIS.pdf

Observational support of the notion that basal water and sediment conditions may adversely influence the short-term predictability of ice-stream behavior is found in two arenas: the decadal-scale fluctuations of sub-ice-stream lake volume reported by Fricker and others [2007], and the decadal-scale fluctuations of sub-ice-stream sedimentary systems undergoing erosion, deposition and molding reported by King and others [2009]. The combined effects of the millennial-scale thermal equilibration time of the WAIS sedimentary lubricating bed and the decadal-scales of hydrological and sediment redistribution processes suggests that predictability of the WAIS over a 100 year time span is not immediately obvious.

In spite of this difficult aspect of ice-sheet modeling, ice-sheet predictologists should take heart in the fact that other natural systems also have limited predictability. The problem of forecasting weather is another example of where nature rules out simple deterministic predictability. The unpredictability of weather does not, however, rule out all forecasting success. There are several good examples where forecasts have been made in spite of: (a) not knowing all of the physics that drive weather systems and (b) flaws in observation, numerical technique and specification of initial conditions. A forecast of great historical significance which demonstrates this point was undertaken on 4 June, 1945, for the invasion of Normandy by the Allied Expeditionary Force on the following day. The plans for the invasion were significantly modified using weather forecasts that predicted unfavorable conditions on the 5$^{th}$ of June. These forecasts were made by Norwegian Sverre Petterssen of the Bergen School of Meteorology at a time when potential vorticity dynamics was unknown, the existence of the jet stream was only sketchy and the ability to observe meteorological conditions in the North Atlantic was marred by naval warfare. The effort to forecast the future of WAIS volume in the context of a new IPCC analysis should take heart from this historical example.