Histories of ice dynamics and climate inferred from ice cores and radar-detected layers

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Changes in activity of fast-flowing outlet glaciers and ice streams in Greenland and Antarctica exert strong control on the mass balance of ice sheets through discharge of inland ice to the ocean (e.g. Rignot et al., 2008; Pritchard et al., 2009). Furthermore, recent rapid changes in discharge of these fast-flowing outlets show that dynamical responses to warming play a much larger role in the future mass balance of ice sheets than previously considered (Alley et al., 2005; Truffer and Fahnestock, 2007). In West Antarctica, mass balance today is dominated by the recent slowdown of the Ross Ice Streams (Joughin and Tulaczyk, 2002), and the remarkable speedup and thinning of relatively few outlet glaciers on the Antarctic Peninsula and the Amundsen Sea sector of West Antarctica (Rignot et al., 2008). A remaining unanswered question is whether the recent changes in speed are unusual or whether they reflect ongoing adjustments to changes in climate and sea level since the last glacial maximum.

One way to give longer term perspective to these recent and possible future changes is to examine past conditions using ice-flow models constrained by radar-detected layers. Radar layers are flushed through fast-flowing outlets over short timescales; the history recorded in these outlets is typically limited to a century scale. Observations and model results show that changes in buttressing or sub-shelf melting near grounding lines affect glacier speed and force balance far inland; dynamical changes at the margins affect slow moving inland ice. The shape of radar-detected layer within inland ice contains information about past flow and climate and the layer shapes can be used to infer these histories. If the age of the radar layers can be determined from an ice core then we can infer the timing of the ice-flow and climate changes.

Here we present histories of climate and ice dynamics inferred from Roosevelt Island, Siple Dome and WAIS Divide. We also discuss these results in context with histories of deglaciation calculated directly from dated moraine limits (Stone et al., 2003; Todd et al., 2008) and glacial marine deposits (Anderson et al., 2002).