Using ice-flow models to evaluate potential sites of million year-old ice in Antarctica

Frank Pattyn[1] and Brice Van Liefferinge[1]
[1]*Laboratoire de Glaciologie, Université Libre de Bruxelles, CP160/03, Av. F.D. Roosevelt 50, B-1050 Brussels, Belgium*

Finding suitable potential sites for an undisturbed record of million-year old ice in Antarctica requires slow-moving ice (preferably an ice divide) and basal conditions that are not disturbed by large topographic variations. Furthermore, ice should be thick and cold basal conditions should prevail, since basal melting would destroy the bottom layers. However, thick ice (needed to resolve the signal at sufficient high resolution) increases basal temperatures, which is a conflicting condition for finding a suitable drill site. In addition, slow moving areas in the center of ice sheets are also low-accumulation areas, and low accumulation reduces potential cooling of the ice through vertical advection. While boundary conditions such as ice thickness and accumulation rates are relatively well constrained, the major uncertainty in determining basal thermal conditions resides in the geothermal heat flow (GHF) underneath the ice sheet. We explore uncertainties in existing GHF datasets and their effect on basal temperatures of the Antarctic Ice Sheet, and propose an updated method based on Pattyn (2010) to improve existing GHF datasets in agreement with known basal temperatures and their gradients to reduce this uncertainty. Both complementary methods lead to a better comprehension of basal temperature sensitivity and a characterization of potential ice coring sites within these uncertainties. The combination of both modeling approaches show that the most likely oldest-ice sites are situated near the divide areas (close to existing deep drilling sites, but in areas of smaller ice thickness) and across the Gamburtsev Subglacial Mountains.

References

Pattyn, F. (2010) Antarctic subglacial conditions inferred from a hybrid ice sheet/ice stream model. Earth and Planetary Science Letters 295: 451-461.