CosmoDrillWAIS: Novel application of cosmogenic isotopes from subglacially-drilled bedrock to determine direct evidence of West Antarctic Ice Sheet collapse during interglacials

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The West Antarctic Ice Sheet (WAIS) is an important control on global sea level but is thought to be inherently unstable. Understanding the risk of WAIS collapse has been identified as one of science's Grand Challenges but requires robust models of the WAIS, fully tested against geological data. A wide variety of such data exists and suggests that the WAIS has probably collapsed in the past, but with substantial uncertainty and disagreement between the proxy records of precisely when. Some records even suggest no collapse has occurred in the last 2 million years. The only well-dated evidence is largely indirect and from outside Antarctica (e.g. past sea-levels in low latitudes) and is difficult to directly ascribe to WAIS, whilst the only direct evidence from beneath WAIS itself is not well dated. We argue that what is needed is a fresh approach, one that provides evidence of WAIS retreat that is both *direct* and *can be dated*. *CosmoDrillWAIS* aims to provide this evidence via a new approach that exploits the potential of rapid drilling to the ice sheet bed to retrieve direct records of past collapse and critically assess the published hypotheses of collapse timing. We present new modelling of cosmogenic isotope concentrations for a range of scenarios. This shows that the different hypotheses for WAIS collapse can be discriminated by measurement of isotopes on subglacial bedrock from sites carefully selected on the basis of key criteria. The objectives of *CosmoDrillWAIS* are to develop a new subglacial rock drill - for which a design concept is presented - and once built and tested to gain access to the bed of WAIS using hot water drilling technology and sample bedrock cores. We propose a transect drilling approach, whereby bedrock will be sampled at progressively deeper locations, and used to determine past downdraw of the ice surface associated with WAIS collapse. At each drillhole, cosmogenic isotope analysis on the rock core will test collapse scenarios. Numerical modelling will be used to link the measured changes in past ice levels to grounding line change, and furthermore to quantify the sea level contribution of each collapse, and explore the forcing factors responsible. The proposal is timely because it exploits a combination of developments in engineering technology and in laboratory analytical and modelling techniques.