Extensive Holocene grounding line retreat and uplift-driven readvance across Ross and Ronne sectors of the West Antarctica

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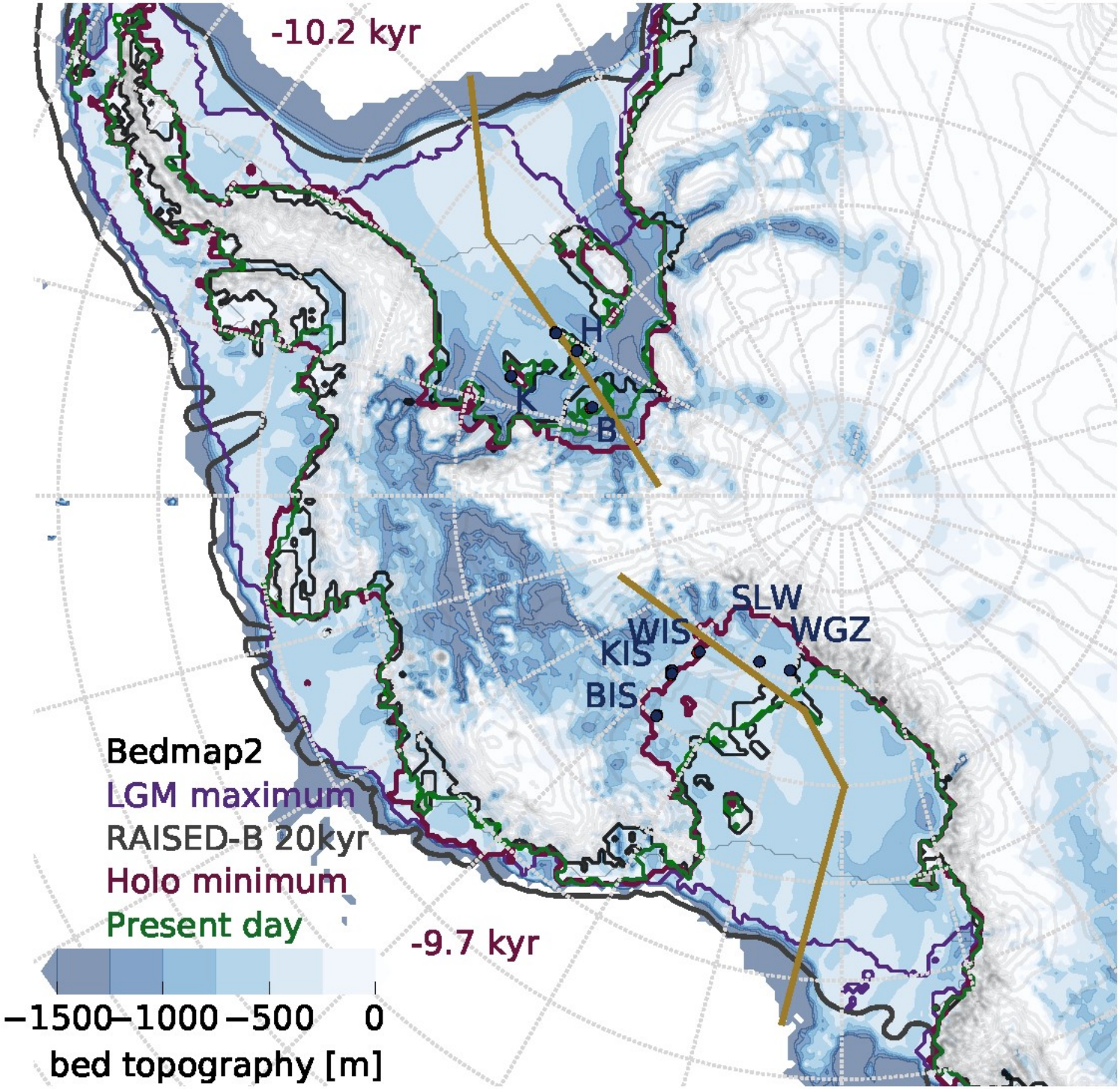
Abstract

The West Antarctic Ice Sheet (WAIS) reached its Last Glacial Maximum (LGM) extent 29-14 kyr ago. Numerical models used to project future ice-sheet contributions to sea-level rise exploit reconstructions of post-LGM ice mass loss to tune model parameterizations. Ice-sheet reconstructions are poorly constrained in areas where floating ice shelves and a lack of exposed geology obstruct conventional glacial-geological techniques. In the Weddell and Ross Sea sectors, ice-sheet reconstructions have assumed progressive groundling line (GL) retreat throughout the Holocene. Contrasting this view, using three distinct lines of evidence, we show that the GL retreated hundreds of kilometers inland of its present position, before glacial isostatic uplift during the Mid to Late Holocene caused the GL to readvance to its current position. Evidence for post-LGM retreat and readvance during the last glacial termination includes (1) widespread radiocarbon in sediment cores recovered from beneath currently grounded ice streams along the Siple and Gould Coasts, indicating marine exposure at least 200 km inland of the current GL, (2) ice-penetrating radar observations of ice-shelf rifts preserved in slow-moving grounded ice, indicating ice-shelf grounding and (3) an ensemble of new ice-sheet simulations showing widespread post-LGM retreat of the GL inland of its current location and later readvance. The model indicates that GL readvance across low slope ice-stream troughs requires uplift-driven grounding of the ice shelf on topographic highs (ice rises). Our findings highlight ice-shelf pinning points, mantle viscosity and lithospheric unloading response as drivers of major ice-sheet fluctuations. Our findings suggest that full WAIS collapse, as has been documented for past interglacials, may require GL retreat well beyond its current position in the Ronne and Ross Sectors coupled with linkage via Amundsen Sea sector glaciers.

Keywords: WAIS, Grounding Line, Holocene, retreat, readvance, PISM, radiocarbon, radar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