Geophysical Research Abstracts
Vol. 14, EGU2012-695, 2012
EGU General Assembly 2012

The Ellsworth Subglacial Highlands and the inception and retreat of the West Antarctic Ice Sheet

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Laying on a bed in places >2km below sea level, the West Antarctic Ice Sheet (WAIS) is thought to be prone to major rapid decay due to melting from the ocean, which induces grounding line retreat. A feedback may occur, in which migration of the grounding line to deeper regions leads to further ice loss. Highland regions of the subglacial bed will act both as seeding centres for ice sheet growth and points of stability ('pinning points') during ice sheet recession. While several highland regions exist beneath the WAIS, none have been confirmed as ice sheet seeding centres/pinning points. Studies of subglacial East Antarctica have demonstrated the utility of radio-echo sounding (RES) in the identification of glacial geomorphology from which past ice sheet conditions can be appreciated. Here, we characterise the detailed glacial morphology of the Ellsworth Subglacial Highlands (ESH), from ground-based and airborne RES surveys. We document well-preserved classic features associated with restricted, dynamic, marine-proximal alpine glaciation, with hanging tributary valleys feeding significant over-deepened troughs cut by valley (tidewater) glaciers. Fjord-mouth threshold bars down-ice of overdeepenings define the termini of palaeo outlet-glaciers. We show how MODIS satellite imagery of the ice surface reflects the gross subglacial morphology. The imagery reveals numerous glaciated valleys cutting through the ESH, terminating at the edge of the deep Bentley Subglacial Trench. The landscape obviously predates the present ice sheet, and is likely to have been formed by a small dynamic ice cap at times when the marine sections of the WAIS were absent. As well as acting as a key WAIS seeding point, the ESH would be critical for 'pinning' the ice sheet during any large-scale retreat event.