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Earth Surface Dynamics Discussions

Interactive comment on "Rapid marine deglaciation: asynchronous retreat dynamics between the Irish Sea Ice Stream and terrestrial outlet glaciers" *by* H. Patton et al.

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We thank both reviewers, and the editor, for their positive and discerning comments on the manuscript. The suggestions raised we believe are fairly made, and we will be very happy to incorporate the changes into an improved manuscript. In particular a more detailed explanation of the model experiment referenced in the study is seen as a priority. Specific responses to each comment are given below:

James Scourse

1. A brief reference to the wider scale BIIS dynamics found in the IRD record here is agreed, and would be beneficial, not only to put the local Cardigan Bay dynamics

into a regional context, but also to emphasise the fact that these short-term dynamic changes are likely prevalent across all sectors of the British-Irish ice-sheet.

2. The re-calibrated cosmogenic-nuclide ages derived from McCarroll (2010) and presented by Chiverrell et al (2013) do indeed point to an earlier deglaciation and should therefore be correctly referred to in this manuscript. The non-linear retreat of the ISIS, as indicated by the Bayesian modelling of Chiverrell et al (2013), in combination with the findings in this study illustrate the various time- and spatial-scales at which internal and external drivers control dynamic retreat patterns/interactions of outlet glaciers of the BIIS.

Ola Fredin

1. We are happy to change terminology to the more generic term 'ice-marginal moraine' (from latero-frontal moraine).

2. Processes leading to 'hummocky moraine' are still debated - in this case the linearity of the described features is suggested to have been imparted by ice structure, specifically foliation and debris bands in the glacier snout, rather than inherited through regional stagnation (cf. Evans 2009). However, the nearby exposures at Glanllynau offer a probable extension of this landsystem, which Boulton (1977) interpreted to be the result of stagnating ice-cored ridges. The discovery of further landforms offshore could potentially warrant a re-examination of these sediments, now that they can be better placed within a broader context.

3. The only site-specific study of Sarn Badrig involved a clast-provenance methodology (Foster 1970), rather than examining its internal structure or the sediments within. The boreholes and geophysical data mentioned in this manuscript were carried out by Garrard and Dobson (1974) in between the sarns, and indicate Welsh glacial 'drifts' reach considerable thicknesses e.g 100m below sea level in Tremadog Bay (and also 77m below OD onshore at Mochras), lending support to repeated deliveries of glacial materials from the Welsh hinterland. Furthermore, the BGS borehole at Mochras Point

(near to the head of Sarn Badrig) has been reported to contain 'a large number of different drift units' (O'Sullivan 1971), some of which have been speculated to be of pre-Devensian age. Unfortunately no conclusive ages have been found of these sediments (cf. Herbert-Smith 1971)

4. Based on the available evidence (just multibeam echosounder data), our intention was to avoid assigning a single definitive interpretation on these somewhat subjective landforms. To 'soften' the interpretation in the text, a rewording of the paragraph (p287) is proposed:

"An alternative interpretation is that the intervening sub-parallel ridges are constructional glacigenic features. In the light of only geomorphological data, several possibilities for their formation exist: 1) closely spaced recessional moraines, laid down at the retreating margin of a large (probably land-terminating) outlet glacier. Numerous analogous landforms currently exist around the margins of he present-day ice sheet and large ice caps in Greenland and Iceland (Evans & Twigg, 2002, QSR; Forman et al., 2007, Boreas). 2) Low-amplitude Rogen (ribbed) moraines, formed by subglacial deformation under a partially thawed or warm-based thermal regime (Lundqvist, 1989; Möller, 2006). The long axes of these short ridges align transverse to ice-ïňĆow, consistent with the main Welsh ice flow direction from Snowdonia, however their morphology is subdued and not typical of these landforms. 3). Polygenetic ridges, possibly formed by ice over-riding and reshaping/modifying pre-existing ice-marginal moraines. Some workers have proposed this model for suites of closely spaced transverse ridges where sedimentary structures reveal complex (polyphase) formation histories (e.g. Moller, 2006, QSR). Without knowledge of the sediment facies or structures within these submarine landforms in Tremadog Bay, their precise origin remains speculative."

5. An important point, and a more detailed description of the referenced model experiment should be included in the text (and what is meant by optimal). For example:

'E397 is an 'optimal' reconstruction derived by using an ensemble approach, whereby

the sensitivity of key individual model parameters in the model was examined through the systematic perturbation of their values. Key characteristics of this model experiment include a maximum temperature suppression at the LGM of 11.85ˆC, combined with a precipitation reduction of $\sim$ 1/3rd of present day values. Moraine limits to the east of the domain were matched by applying a further enhanced west-east precipitation gradient (rain-shadow effect). Post LGM, temperature and precipitation suppressions were moderately relaxed, although still kept scaled with the GISP2 climate curve.'

6. A common vertical scale would certainly improve this figure, and could be easily applied. Merging all five I believe would make the figure too busy, as Ola indicates. A possible compromise would be to merge the three landform transects A-C, and the two gully transects D&E.

Interactive comment on Earth Surf. Dynam. Discuss., 1, 277, 2013.