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Comment

***Interactive comment on “Are longitudinal ice-surface structures on the Antarctic Ice Sheet indicators of long-term ice-flow configuration?” by N. F. Glasser et al.***

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An interesting question – the authors make a case that the answer is YES. They argue that persistence of these features is evidence that, with a few exceptions, the dynamic configuration of the Antarctic Ice Sheet has remained unchanged for thousands of years, even back to the end of the last glacial maximum.

Of course exceptions are expected because there is good evidence that the West Antarctic Ice Sheet expanded during the LGM and has subsequently thinned and retreated dynamically (e.g. Stuiver et al., 1981; Whitehouse et al. 2012; RAISED Consortium, 2014). The pattern of streak lines in the Ross Ice Shelf have been used to

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infer century- to millennial-scale variations in the flow dynamics of not only Kamb Ice Stream but all of the Siple Coast and Gould Coast ice streams (Fahnestock et al. 2000; Hulbe and Fahnestock, 2004, 2007). Streaklines in the Ronne-Filchner Ice shelf have also been analyzed to infer histories of flow dynamics (e.g. Hulbe et al. 2010; Ross et al. 2010). The two exceptions are important. They contain histories of deglaciation of West Antarctica and together with those from the Antarctic Peninsula (not discussed in this paper), suggest the answer is NO.

The goal of the paper is not clear and it is not at all clear that the question posed in the title has been answered. A more quantitative examination of the shape and continuity of streaklines is needed to address the question.

Some detailed comments:

P912 line 18: What about work by Hulbe and Fahnestock, (2004, 2007); Ng and Conway, 2004; Siegert et al. 2013, which discuss century- to millennial-scale variations in ice-flow? Interpretations of thinning and divide migration from ice cores (e.g. Nereson et al. 1998; Conway et al. 1999; Waddington et al., 2005; Martin et al. 2006, 2009; Price et al 2007).

Page 913, lines 19 ff. The assessment of origin of streaklines does not need to be duplicated; it is repeated in the summary of Glasser and Gudmundsson, (2012) presented on p 914.

P913 I do like Fig. 3, but I am not at all clear how it fits in this paper, unless the primary focus is the origin of flow stripes.

P915 line 7: No mention of surface expression of subglacial channels such as those described by Le Brocq et al. (2013), Millgate et al, (2013).

p. 916 line 1: How do these structures indicate the magnitude of ice-surface flow? Earlier the implication is that some (but not all) originate from basal sliding over a rough bed. And not all stripes are aligned with present-day flow direction. Many may

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represent past flow directions, and sub-surface channels are not always aligned with flow (Le Broq et al (2013).

### 3. Results

p916 line13ff. Draws attention to comparisons of surface structures to SAR images, velocity maps, and subglacial topography (Fig. 4). The comparisons are not compelling - it is not possible to make quantitative comparisons from plots like these. The reader is asked to note co-location of streaklines with regions of fast flow and deep subglacial topography, but even a qualitative assessment is not possible. Some other metric is needed to make a convincing case. Also, most mapped streaklines are from the Ross Sea and the Ronne Filchner (Fig. 4b), which, as stated in the manuscript, are “exceptions” where streaklines do not follow present-day flow field and may not be continuous.

p. 917 line 8 ff. As discussed above, the two regions (the Ross Sea and the Ronne Filchner) show evidence of major changes in flow dynamics. They cannot be dismissed.

P 917 line 29ff. Discussion of Fig. 5. Why would we logically expect rapid flow through the Thiel Trough? Presumably driving stresses are insufficient? If the focus of the manuscript is glacial history, it would be useful to constrain some point in the past (P 918 line 9). This work has been reported and discussed by Siegert et al (2013), who also placed a constraint on the timing of the switch in flow.

### 4. Discussion and Conclusions

P 920 line 15ff: Discussion of timescales and Fig. 6. This should be a key conclusion, but I do not understand the figure. Presumably the first blue dot is at the first location that the streakline is observed (since it is stated that streaklines are not evident when ice is not sliding). Assuming this is correct, the residence time for say the Byrd streakline would be about (18,500 – 11,000) or 7,500 yrs (rather than 18,500) IF

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the streaklines originated from a point and propagated down flow at the same velocity as present. However this is a big IF; alternative hypotheses relating to the origin and evolution of streaklines need to be considered.

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