INTRODUCTION

The majority of mass lost from the Antarctic ice sheet takes place at the fringing ice shelves via iceberg calving. Iceberg calving is controlled by the initiation and propagation of large scale rifts (fractures that penetrate through the entire ice shelf thickness), which proceeds large tabular iceberg detachment and can lead to ice shelf break-up.

Our study area is the Amery Ice Shelf (AIS), East Antarctica (Fig. 1), where we have observed an active rift system using a network of GPS stations. The Loose Tooth rift system is located at the western end of the AIS and is an active rift system that is currently developing a large scale iceberg calve and produces a relatively large iceberg in the future. It consists of two longitudinal-to-flow rifts (denoted L1 and L2) and two transverse-to-flow rifts (denoted T1 and T2) (Fig. 3).

In order to investigate possible changes in rift fracture propagation, this study used high-resolution GPS data collected in 2002/03 and 2004/05. The Loose Tooth GPS network (2002/03) was used to investigate possible changes in rift fracture propagation at the rift tip. Results in 2002/03 show that changes in rift fracture propagation are not associated with any significant mass loss from the ice shelf. Changes in rift fracture propagation are more likely to be associated with changes in rift fracture orientation and propagation direction.

STRAIN ANALYSIS

Since the distances between sites at supertidal (<1.5 km) and relative measurements at high tide (up to 60 cm) are assumed negligible, i.e. common systematic effects are removed. The underlying uniform motion of the ice sheet across the network area are then remaining relative movements between network points can then be interpreted as strain. The strain rates are determined according to the procedure outlined by [1].

Maximum principal strain rates are of the order of 6-32 [x 10^-4] across the network, generally smaller than the principal strain rates in the rift, which may be related to the rotation of the Loose Tooth as a whole as the T2 rift lengths and the L1 rift widens.

To investigate possible changes in rift fracture propagation, high-resolution GPS data collected in 2002/03 and 2004/05. The Loose Tooth GPS network (2002/03) was used to investigate possible changes in rift fracture propagation at the rift tip. Results in 2002/03 show that changes in rift fracture propagation are not associated with any significant mass loss from the ice shelf. Changes in rift fracture propagation are more likely to be associated with changes in rift fracture orientation and propagation direction.

CUMULATIVE SUM ANALYSIS

Cumulative sum (CUSUM) charts are a graphical method of change point detection and can be used to reveal subtle changes in baseline time series [4]. The cumulative difference of two baseline strings is calculated in a systematic manner to characterize changes in the difference of baseline strings over time. These cumulative differences are then plotted against time, and changes in the baseline are detected by identifying changes in the baseline that exceed the longitudinal-to-flow strain rate. This indicates that longitudinal-to-flow strain can be accurately determined by the CUSUM technique. A known jump in baseline length across the rift tip on day 9, inferred from seismic data collected at the sites [2], can be reliably detected as a clear peak on day 8 in the CUSUM charts of the CUSUM baseline (days 13 & 14) appears as a clear peak or jump (Fig. 5b). However, potential difficulties in distinguishing a jump from a peak are also evident.

Several baseline pairs of the 2004/05 Loose Tooth GPS networks are analysed using the CUSUM technique. A known jump in baseline length across the rift tip on day 9, inferred from seismic data collected at the sites [2], can be reliably detected as a clear peak on day 8 in the CUSUM charts of the CUSUM baseline (days 13 & 14) appears as a clear peak or jump (Fig. 5b). However, potential difficulties in distinguishing a jump from a peak are also evident.

THEORETICAL BACKGROUND

This study is one of a few field projects investigating an active ice shelf rift system and thereby contributing to a better understanding of ice shelf rift processes. Here, the strain rate distribution in close proximity to the rift is a propagating rift system on the Amery Ice Shelf has been determined using in situ GPS observations. Transverse flow strain rates generally increase longitudinal-to-flow strain rates, with notable exceptions in transverse aligned on both sides of the rift. Evident changes in the strain distribution can be reliably attributed to the GPS sites straddling existing longitudinal-to-flow fractures and the episodic movement of the rift tip. Results also confirm the trend that rift propagation is currently slowing down the rift having only propagated ~1 km in two years, between the Antarctic summer seasons of 2002/03 and 2004/05. Analysis of the GPS network using a cumulative sum (CUSUM) approach, obtained by differentiating a pair of residual baseline time series and applying a threshold, is found to be effective in detecting initial baseline length changes. Simulation shows that using first differences (between successive epochs) as input rather than the original baseline lengths proposed by [4], any sudden change in baseline length across the rift tip can be reliably detected as a clear peak on day 8 in the CUSUM charts (days 13 & 14) appears as a clear peak or jump (Fig. 5b). However, potential difficulties in distinguishing a jump from a peak are also evident.

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