E1 Supplemental Figures

Figure E1. Oblique photographs of Columbia Glacier's terminus before (A, C and E) and after (B, D and F) major calving events. After all three events, the glacier calved back to pre-existing flow-perpendicular rifts, indicated by the black arrows. Between A and B (20 minutes apart) the slab in front of the rift slowly rolled forward until it capsized and disintegrated. Photographs E and F (one hour apart) depict a sudden disintegration of parts of the terminus region in front of a rift approximately one ice thickness behind the calving front. The terminus ice cliff is about 70 m high. Photographs C and D were also taken one hour apart.

Figure E2. Examples of large scale calving before (top row, 2005) and after flotation (middle and bottom rows, 2009), with associated velocity seismograms and spectrograms. All spectrograms are produced and scaled identically encompassing 15 minutes of time and spanning 0.03 – 25 Hz with linear scaling. Colors represent relative magnitude (dB). The camera position is similar, but not identical in each image sequence., The 2005 image was shot with a longer lens; bergs produced in 2009 events are substantially larger than those typical of grounded conditions.

E2 Details on Data Acquisition

The Guralp 40T seismometer deployed at station BBB has a flat response from 30 seconds to 50 Hz. In 2004-2005 data were digitized and stored with a Reftek RT 130. In 2008-2009 data were digitized with a Quanterra Q330 and stored on a Quanterra Packet Baler. In both seasons, the sampling frequency was fixed at 100 Hz. For the PSD-PDF analysis, all data were corrected to true ground motion using the instruments' complete transfer function. In 2004-2005 data acquisition was interrupted several times due to power failures and memory limitations. Continuous measurements were obtained for the following periods: 18 June to 2

September 2004; 2 October to 11 December 2004; 11 June to 4 September 2005; with some isolated continuous measurements of a few days duration in between. In 2008-2009 the station continuously operated between 17 June 2008 and present (January 2010, only data recorded before 26 August 2009 is used in this study); however, digitizer errors resulted in regular recording gaps. Before 12 May 2009, gaps of 8-9 hours were separated by 6-7 hour-long periods of successful data collection. Between 12 May and 25 July data gaps were reduced to about 2-3 hours per day. After 25 July 2009, recording proceeded without interruptions.

E3 Event Detection

Focusing on the vertical channel, we processed seismic data in 1-hour segments by calculating power spectral densities (PSD) for 50% overlapping data windows consisting of 2500 samples. In the compilation of the detection catalog we did not remove the complete instrument response transfer function. Instead, amplitudes were corrected only for instrument sensitivity. This should not significantly bias PSD power since the calving band (1-3 Hz) and the fracture band (10-20 Hz) both lie well within the flat response of the seismometer (0.033-50 Hz). A sensitivity test was performed by completely removing the instrument response for 1 day of data. We found no changes resulted in the catalog.

Event detection was initiated when windowed 1-3 Hz power exceeded a signal-to-noise threshold of 17 for that segment. When the ratio fell below this threshold, detection turned off. We determined detection parameters for 2004-2005 by comparing visual and photogrammetric calving records with seismic data using a penalty function analysis [*O'Neel et al.*, 2007]; in 2008-2009 we used the same parameters.

There were 52,652 and 15,666 calving detections in 2004-2005 and 2008-2009, respectively. They were recorded during 5764 and 5912 recording hours in 2004-2005 and 2008-2009, respectively. Splitting data into complete hourly periods

during which the station was recording in both years gave a total of 3045 hours in 2004-2005 and 5143 hours in 2008-2009.

E4 Supplemental Video

Time lapse video of Columbia Glacier terminus from 6/21 to 8/15 2008 demonstrating floating terminus region. Time stamps in UTC time. Images shot from Great Nunatak (Figure 1). Footage made possible via collaboration with University of Colorado's Institute of Arctic and Alpine Research and the Extreme Ice Survey.