Supplement

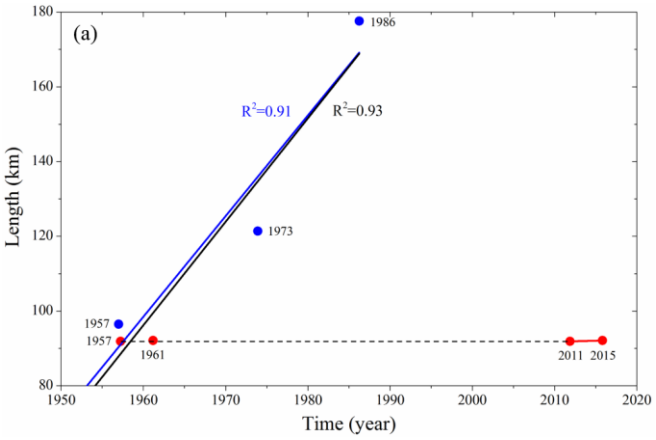
Data and computational details for the timing of the next major calving event in Filchner Ice Shelf

A set of parameters, including rift length, width, maximum width, distance to the Grand Chasm, distance to the ice shelf front, and depth are listed in Table 2. The depth of the Grand Chasm was also given. The measurements after 1957 made in this study were based on satellite images. The 1963 Antarctic mosaic of ARGON images has partial cloud cover (Kim et al., 2007, Li et al., 2016), and the fracture length cannot be measured (Table 2). The next two sets of measurements were made using Landsat MSS (Multi-Spectral Scanner) data from 1973 and 1986. The 1986 images taken in February and March provided the parameters right before the major calving event that started in mid-April 1986. The observations of the new large rifts called Rifts 1 and 2 were made using the continuously improved Landsat data for horizontal measurements and ICESat and WV-2 data for rift depth information.

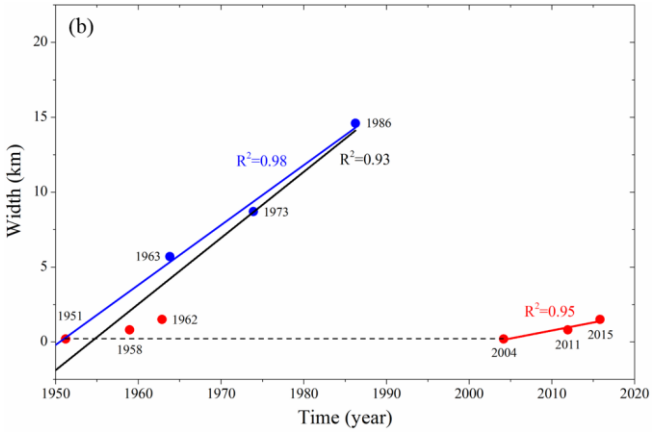
Based on the time series measurements in Table 2, there is only rift depth information from the 1957 aerial photographs and from the 2012 and 2016 WV-2 stereo images. Thus, the depth measurements are not sufficient for use in identifying parameters for event timing estimations. Neither are the measurements of the distance to the frontline because they are relative measurement and are almost constant over each observational period.

For each remaining parameter, a linear regression analysis of the measurements over the observational period is performed (Figure S1). For example, in Figure S1c, the four maximum width measurements before the event in 1986 (blue dots, also see data in Table 2) are employed to estimate the linear growth trend of the maximum width of the Grand Chasm (blue line). In addition, there are three maximum width measurements (red dots) of Rifts 1 and 2 from 2004/2015. We project the first maximum width measurement of Rifts 1 and 2 in 2004 to the blue line using its maximum width (dotted line). Correspondingly, the other two measurements are also projected onto the observations preceding the 1986 event. We assume that the overall setting of the FIS before and after the 1986 event were not significantly changed and that the growth trend of the maximum widths of Rifts 1 and 2 would not be very different from that of the Grand Chasm. Therefore, the measurements before and after the 1986 event (blue and red dots) are combined and used to generate a new regression line (black line) that considers the knowledge from both the last calving process and the new developments of Rifts 1 and 2.

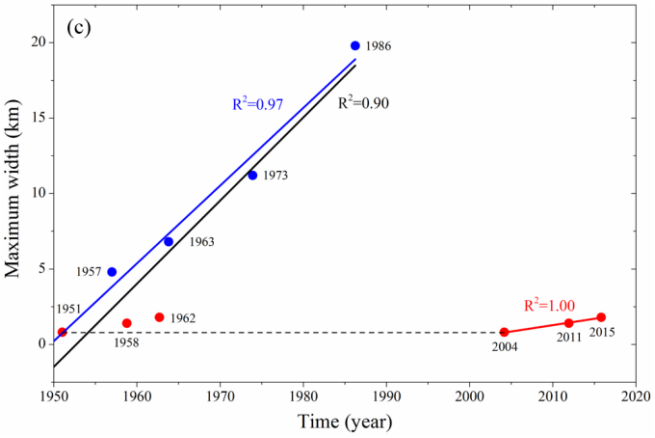
Given the latest maximum width of the Grand Chasm in mid-April of 1986 and the new regression line (black), the potential upcoming major calving events estimated from the maximum width measurements will be $T_{m\text{-}width}$ = 2048. Similarly, the estimates using the other three parameters (length, width, and distance to Grand Chasm) are T_{lenth} = 2048, T_{width} = 2045 and $T_{dist\text{-}gc}$ = 2063, respectively (Fig. S1).



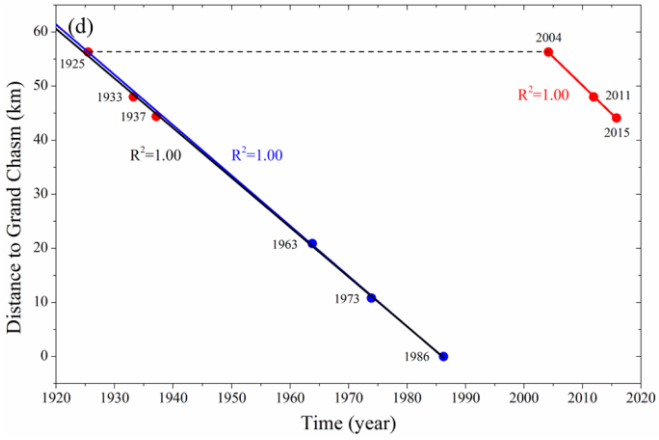
(a)



(b)



(c)



(d)

Figure S1. Regression computation for the estimation of the potential upcoming major calving event using four parameters: (a) rift length, (b), rift width along a given flow line, (c) maximum rift width, and (d) the distance to the Grand Chasm position during the last calving event