Supporting Information for "Bed elevation of Jakobshavn Isbræ, West Greenland, from high-resolution airborne gravity and other data"

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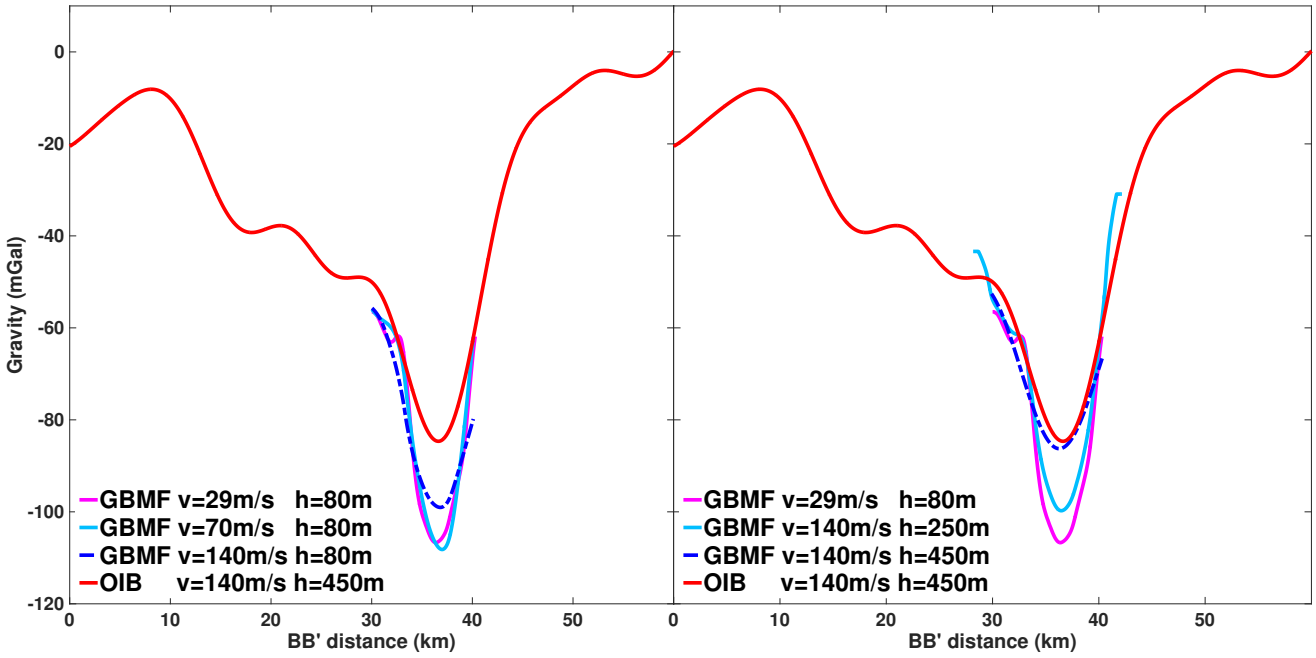

Figure S1: Comparison of NASA Operation IceBridge (OIB) and GBMF free-air gravity anomalies measured over Jakobshavn Isbræ (JI), West Greenland, along profile B-B' (Figure 1) using (a) increased platform speeds only and (b) both increased speeds and terrain clearance heights. Platform speeds are simulated using the ratio of original and target speeds to rescale a time based low pass filter.Higher terrain clearances are calculated using upward continuation of the GBMF gravity grid. The results show that the GBMF free-air gravity anomalies in the 750 m half-wavelength grid (approximatedly 26 s equivalent half-wavelength time filter at 29 m/s flight speed) capture the ture gravity anomaly associated with the JI trough whereas the OIB 35 s half-wavelength time filter data underestimate its magnitude mainly due to a higher ground clearance and a higher survey speed.

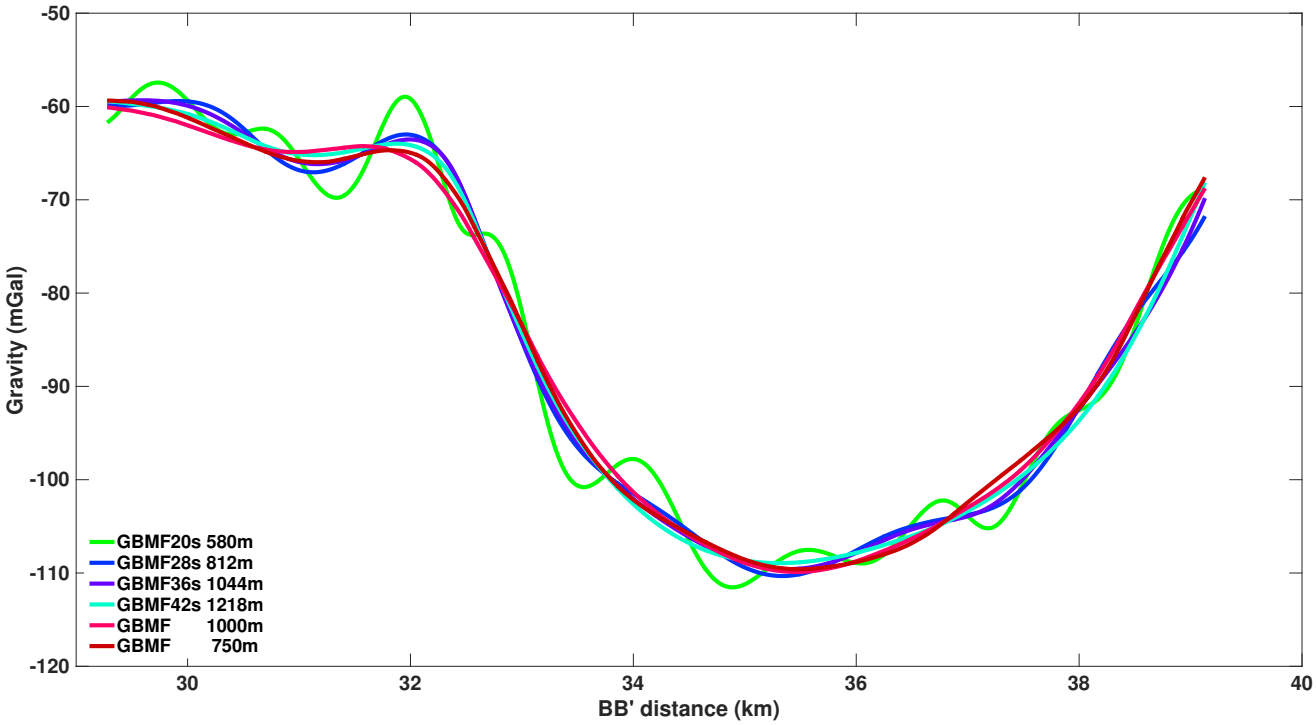

Figure S2: Free-air gravity anomalies recorded over Jakobshavn Isbræ, West Greenland, along a single line of data that followed profile B-B' (Figure 1) displayed with different half-wavelength time filters applied: 20 s (green), 28 s (dark blue), 36 s (purple), and 42 s (cyan). The length in meters indicates the corresponding half-wavelength spatial resolution for each time filter at the 29 m/s average flight speed. The gridded data, shown sampled along the same track with 1000-m (red) and 750-m (dark red) half-wavelength grid-based filter, are smoother than the equivalent time-based filter of the single line.

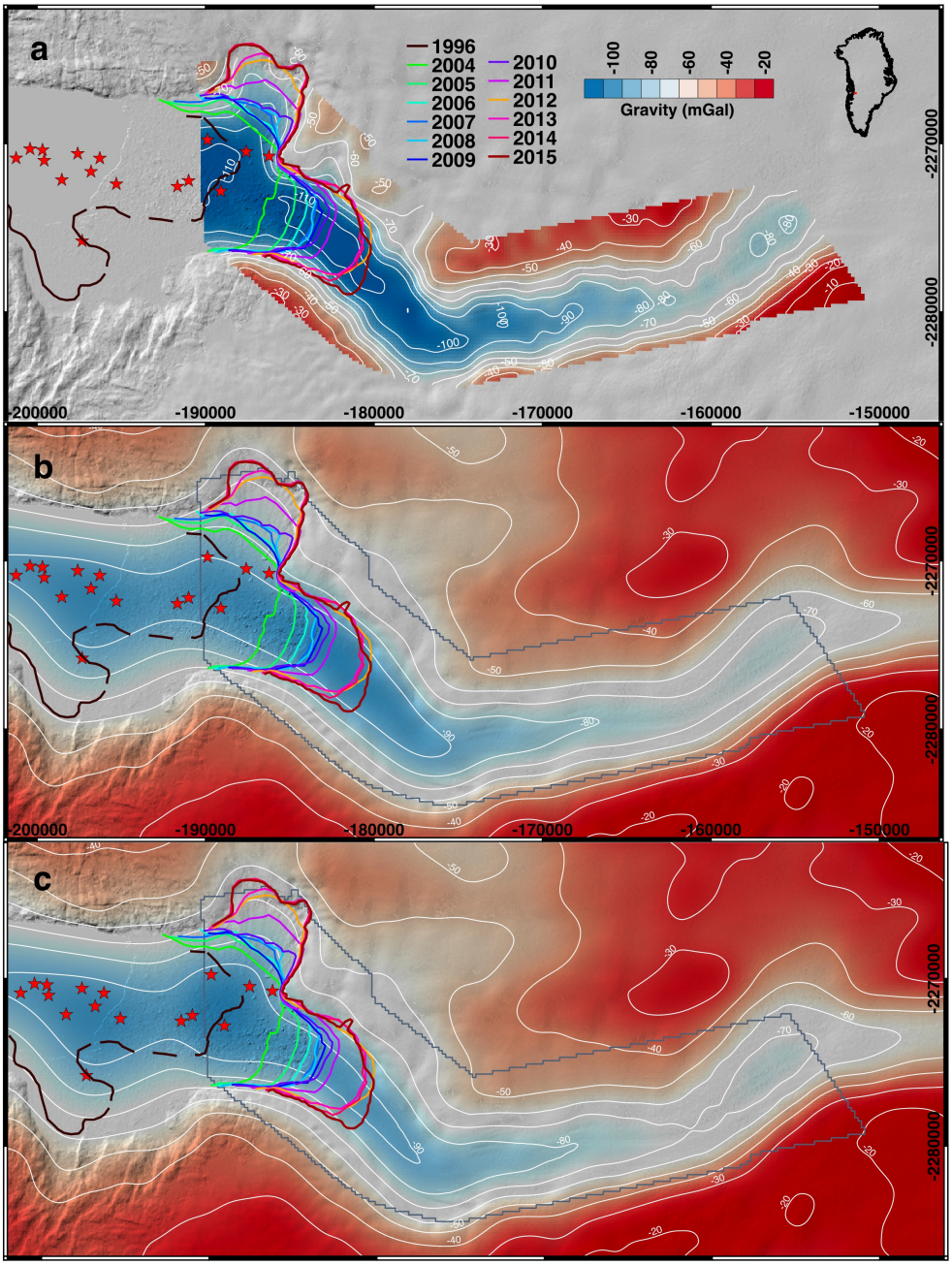

Figure S3: (a) Airborne, high-resolution, free-air gravity anomalies measured in 2012 for the GBMF survey over Jakobshavn Isbræ, West Greenland with a color scale in mGal(1 mGal=10^{-5} m^2/s), (b) forward model calcualted gravity and (c) forward model calcualted gravity over Jakobshavn Isbræ, West Greenland, knitted together with observered gravity after upward continuation to 1,220 m overlaid on a shaded relief digital elevation model of Greenland [Howat et al.,2014]. Contour level is every 10 mGal in white.

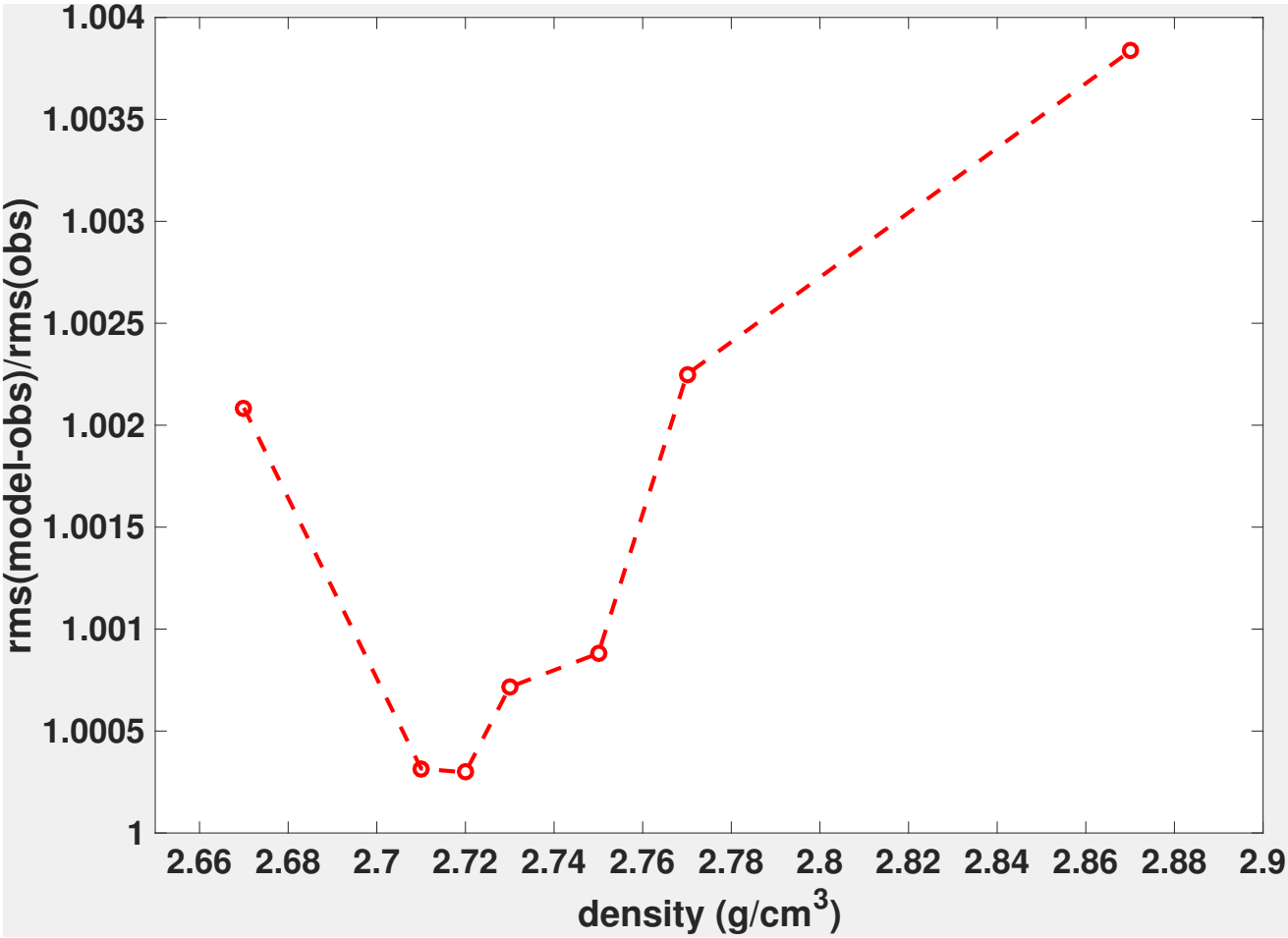

Figure S4: Optimization of the bedrock density beneath Jakobshavn Isbræ, West Greenland, obtained by comparing the r.m.s. of the modeled gravity solution versus the observed gravity divided by the r.m.s of the observed gravity for density values varying from 2.6 to 3.0 g/cm^3. The results reveal the existence of a minimum at a density of 2.72 g/cm^3. The density value of 2.72 g/cm^3 is in excellent agreement with the density of Orthogneiss (mainly granodioritic to tonalitic) present in this area according to the geologic maps of the Geological Survey of Denmark and Greenland (GEUS). `http://data.geus.dk/map2/geogreen/#Z=7&N=7717252&E=63666`

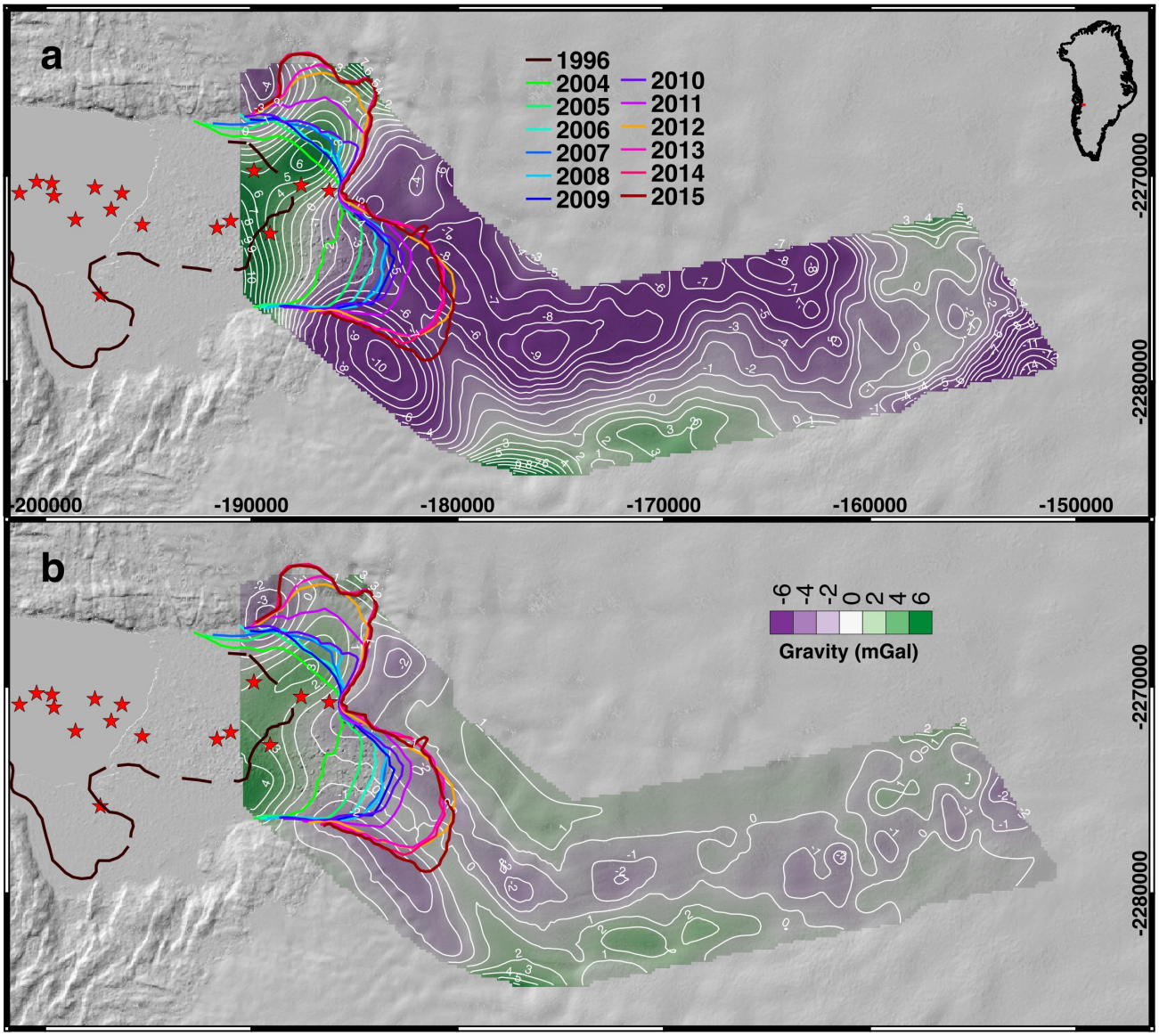

Figure S5: (a) Forward model gravity misfit (model minus observation) over Jakobshavn Isbræ, West Greenland, after upward continuation to 1,220 m and (b) inversion model gravity misfit in milligal (mGal) overlaid on a shaded relief digital elevation model of Greenland [Howat et al.,2014]. Contour level is every 1 mGal for the misfit. Inset on top right shows the location of the survey area in Greenland. Red stars show the location of bathymetry measurements in Ilulissat fjord.

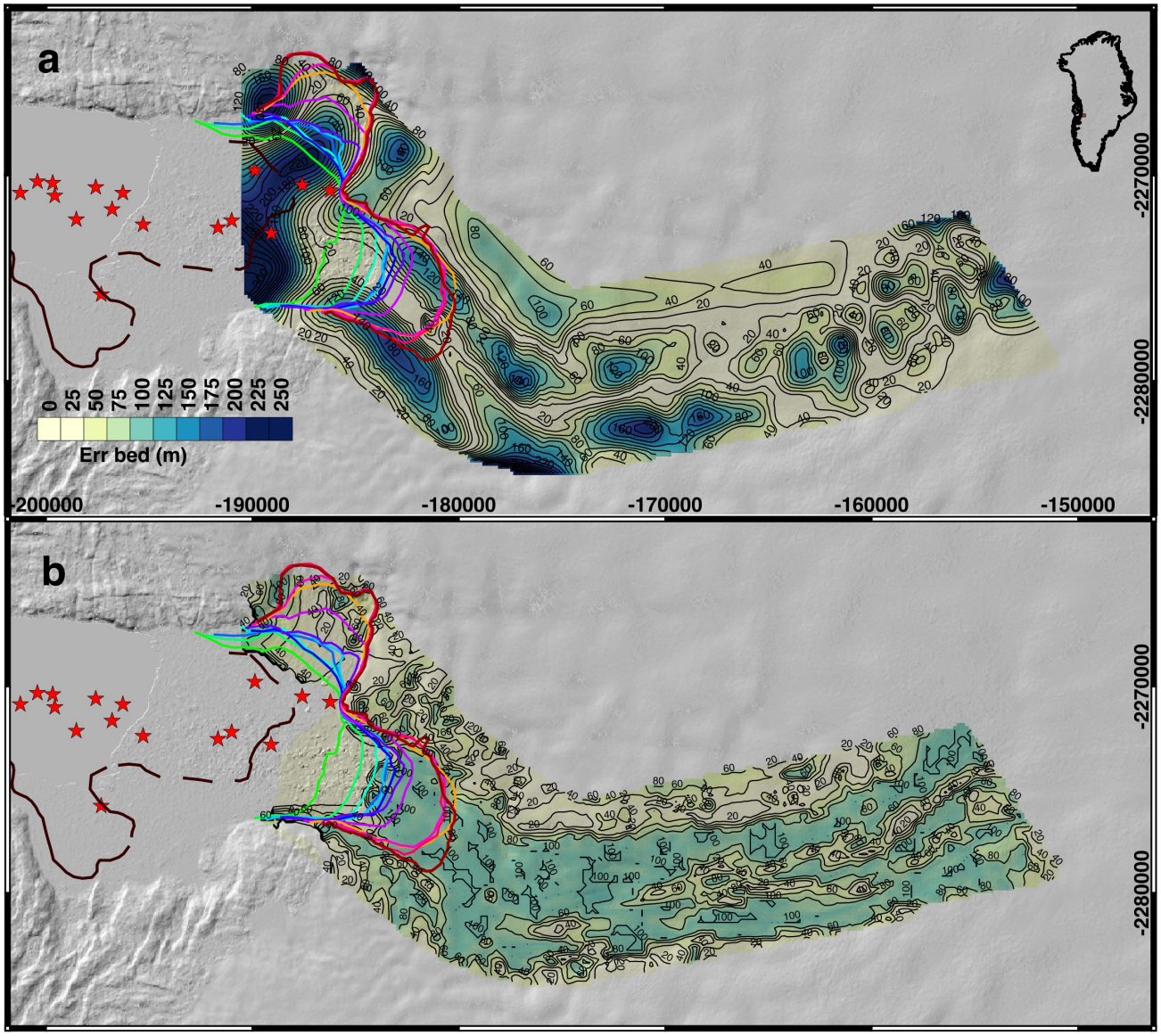

Figure S6: Bed error map (a) calculated from gravity inversion model gravity misfit with the bed result by +100 m shifting, and (b) bed error map from MC in meter (m) overlaid on a shaded relief digital elevation model of Greenland [Howat et al.,2014]. Contour level is every 20 m in black. Inset on top right shows the location of the survey area in Greenland. Red stars show the location of bathymetry measurements in Ilulissat fjord.

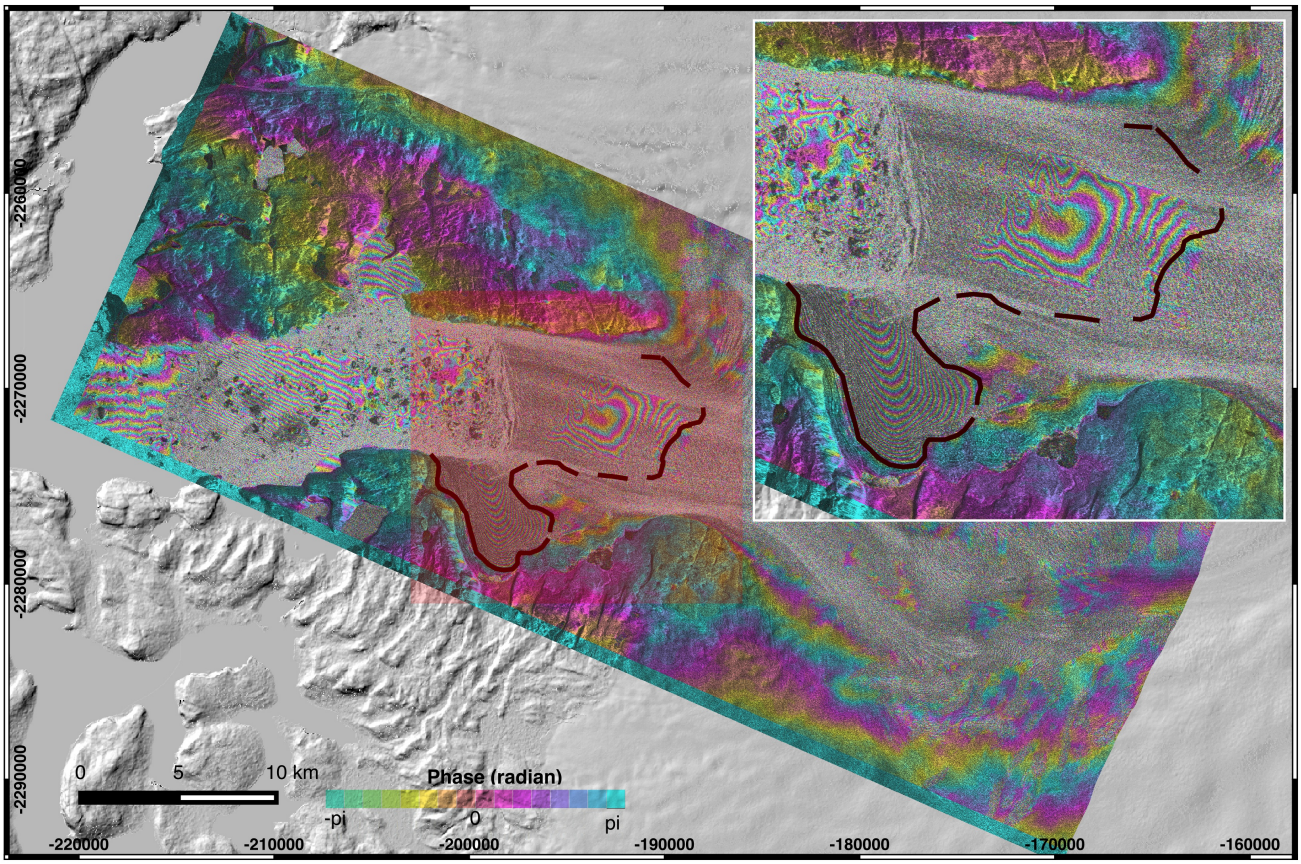

Figure S7: Differential SAR interferograms (DSIs) of Jakobshavn Isbræ, West Greenland, obtained from Earth Remote Sensing satellite 1 and 2 (ERS-1/2) data collected in winter 1996 overlaid on the GIMP shaded relief map of Greenland [Howat et al.,2014]. Grounding line position in 1996 is brown. Each fringe color coded from blue to yellow, purple, and blue again is a 360 cycle in interferometric phase. Note, some portion of the grounding line mapping is based on the mapping of ice rumples by Clarke and Echelmeyer [1996].

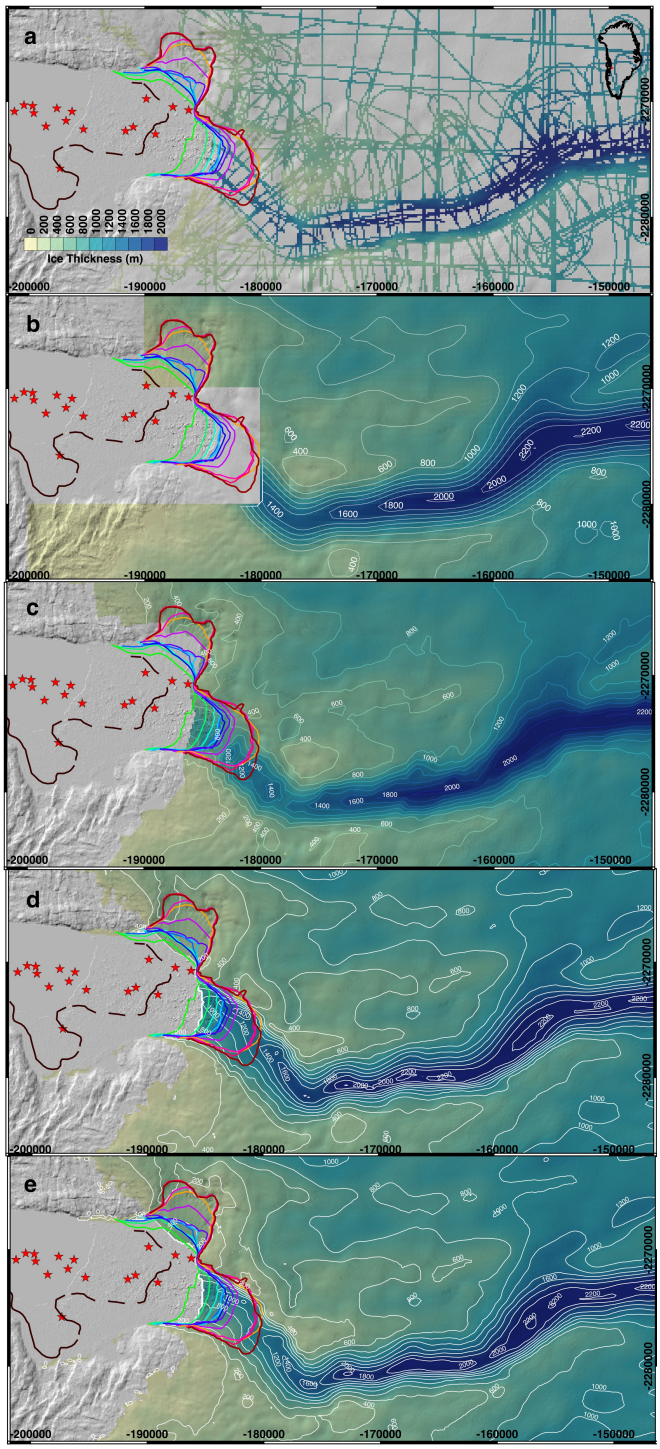

Figure S8: Ice thickness of Jakobshavn Isbræ, West Greenland (in meters of solid ice) from (a) CReSIS radar-derived thickness profiles color coded from yellow (no ice) to green and blue (up to 2,000 m of ice), (b) a 500 m thickness grid by CReSIS from 2006 to 2014 composite, (c) Bamber et al. [2013], (d) MC and (e) ice thickness derived from GBMF gravity data. Contour level is every 200 m of solid ice.

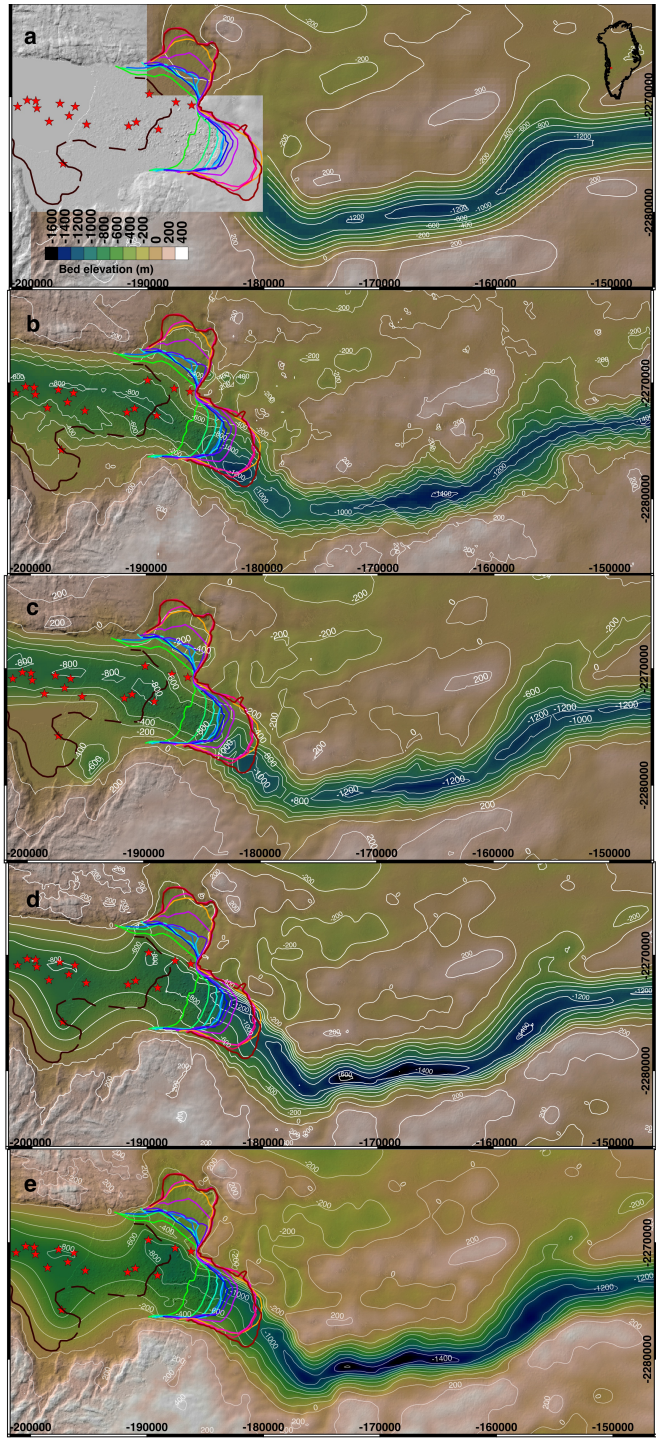

Figure S9: Bed elevation (in meters above sea level) of Jakobshavn Isbræ, West Greenland (a) a 500 m grid by CReSIS from 2006 to 2014 composite, (b) Joughin et al. [2014], (c) Bamber et al. [2013], (d) MC and (e) bed elevation inferred from the GBMF airborne gravity data. Contour level is every 200 m. Grounding line positions are color coded from black (1996) to brown (2015).

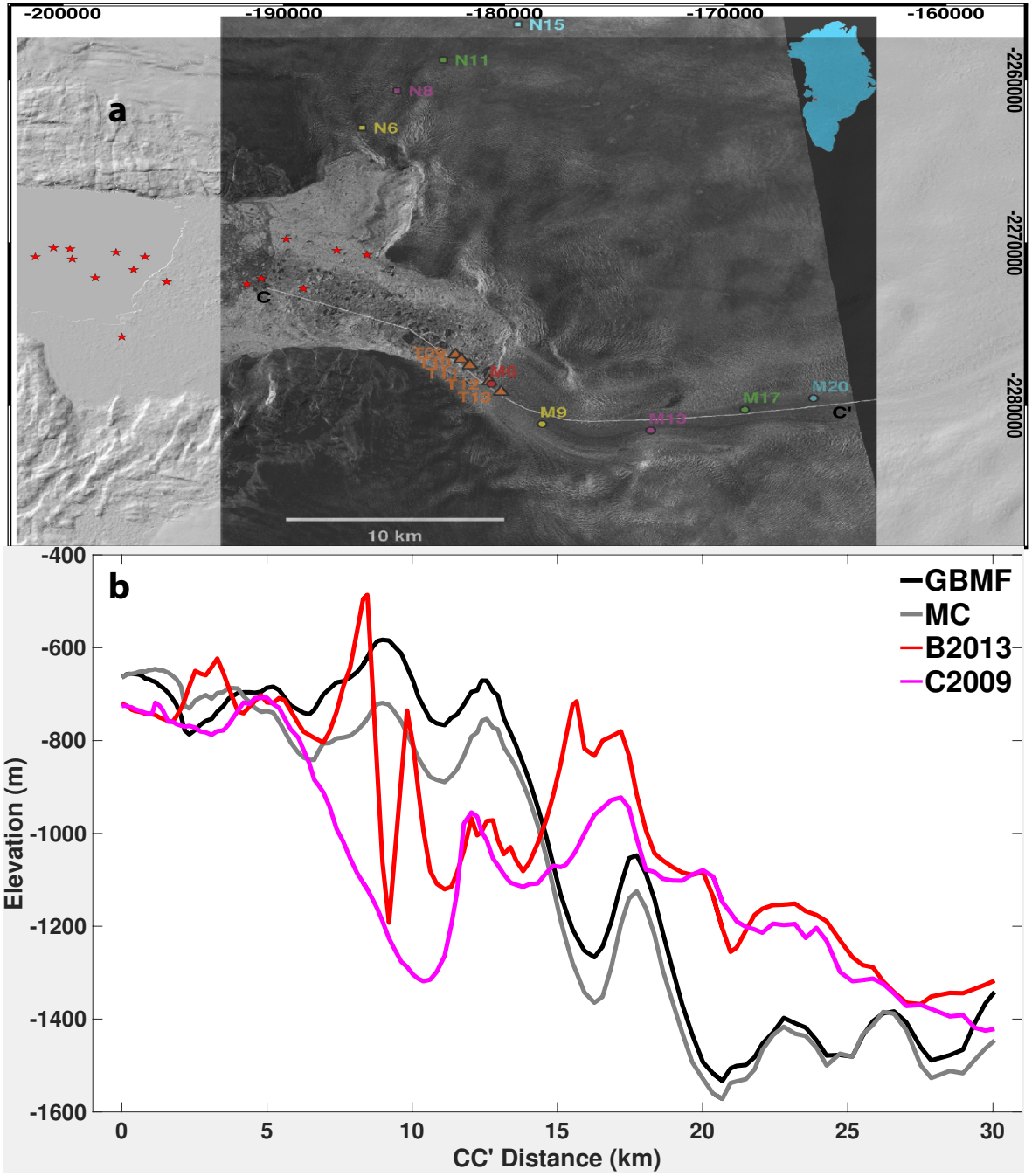

Figure S10: (a) Figure 1 from Joughin et al., 2014 over Jakobshavn Isbræ, West Greenland, the white profile named C-C' overlaid on a shaded relief digital elevation model of Greenland [Howat et al.,2014] and (b) bed elevation comparision along profile C-C' with GBMF,MC,B2013 and C2009. Red stars show the location of bathymetry measurements in Ilulissat fjord.

Table S1: Ice speed at the center of the calving front from 2002 to 2015

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ice speed (km/yr)	14.0	12.4	14.0	12.1	12.0	12.8	12.0	12.0	11.4	13.2	12.8	13.5	11.4	13.35