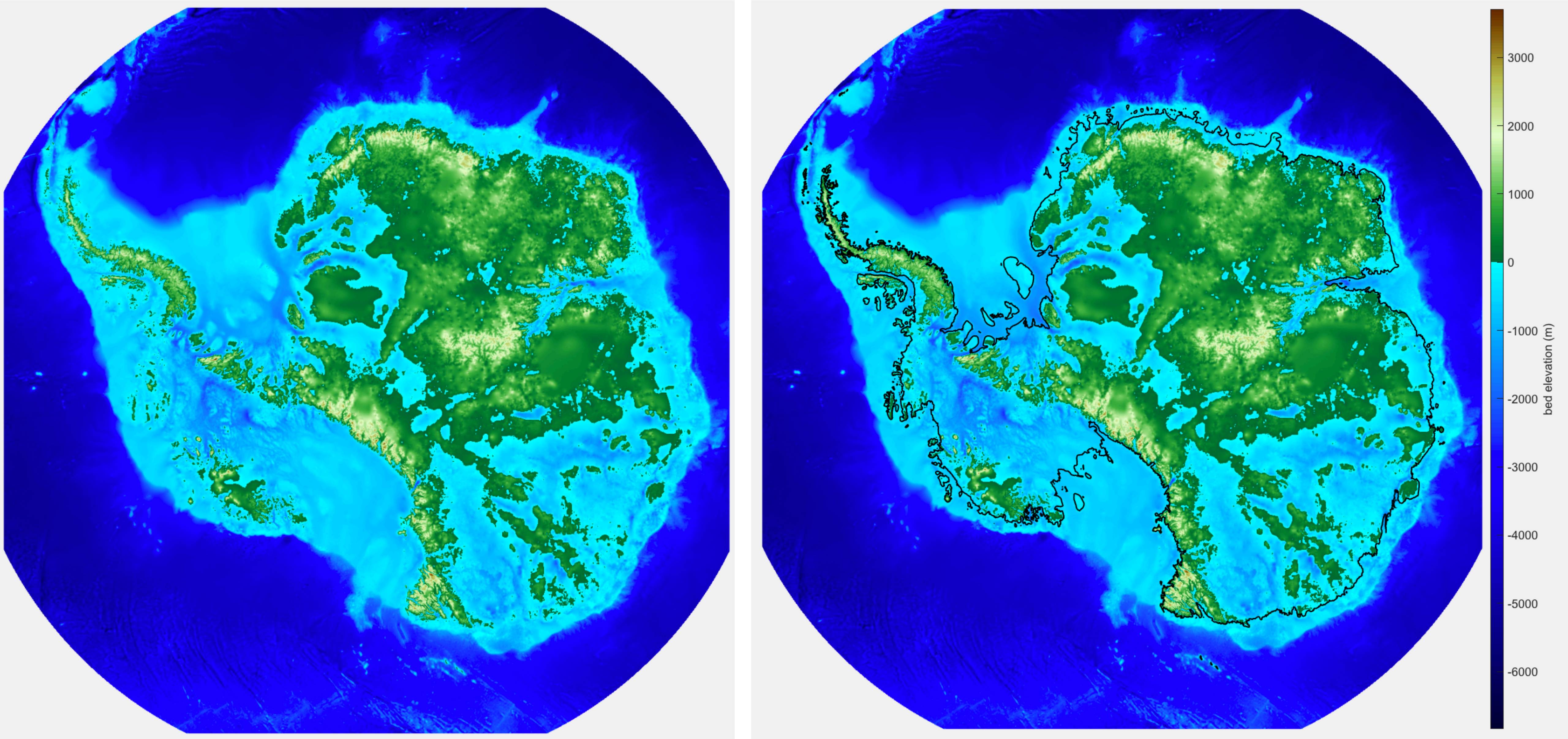
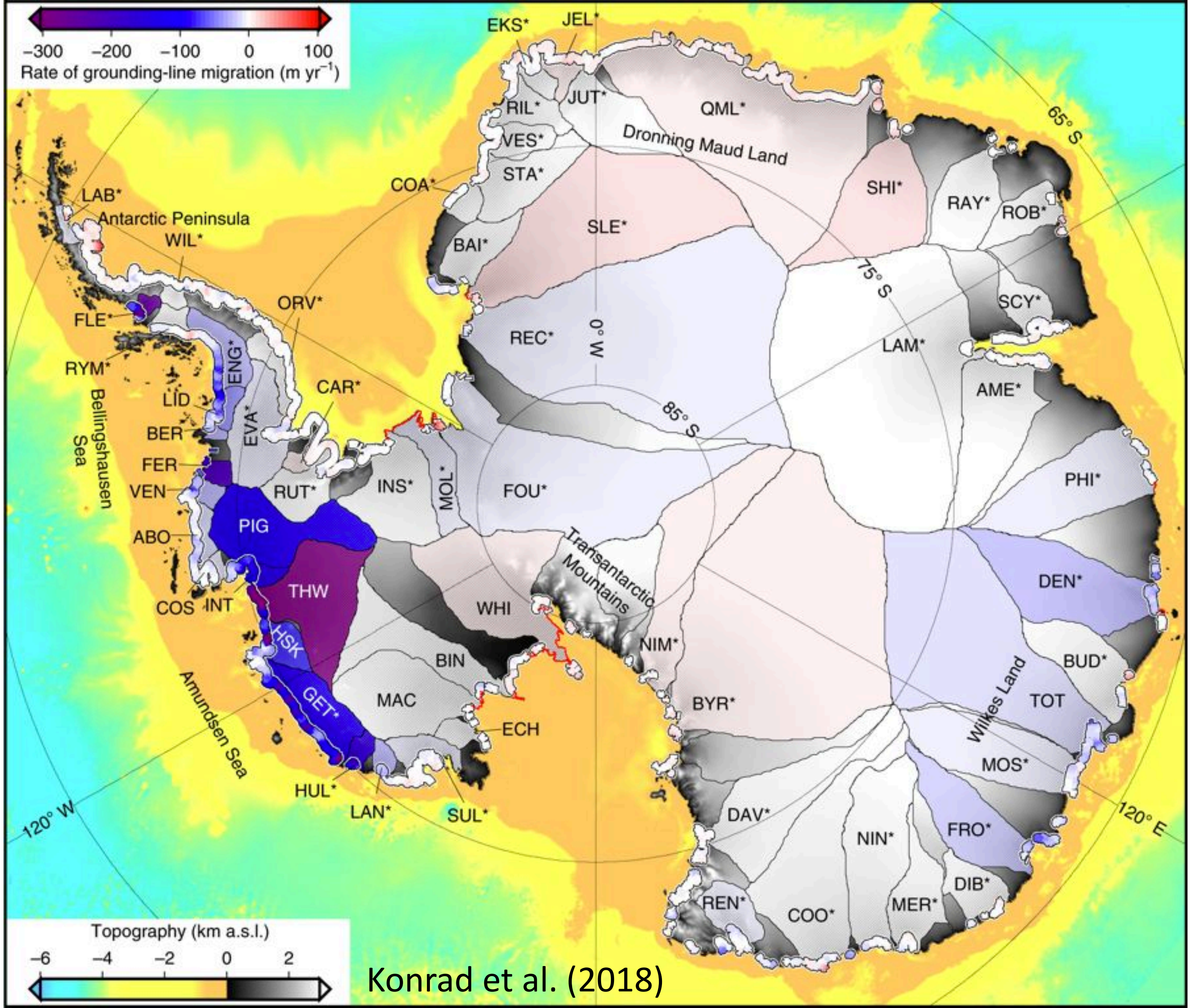
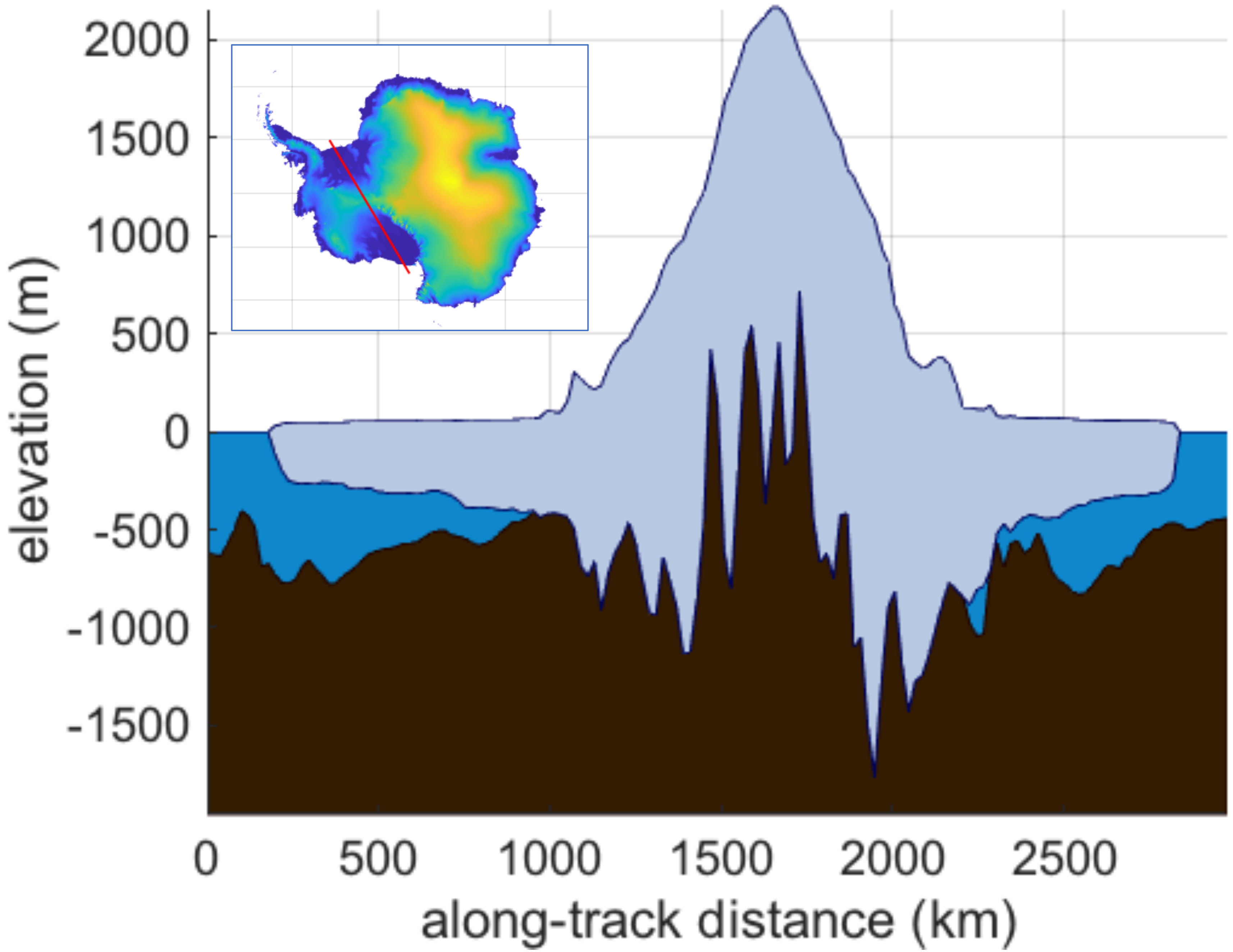
Marine ice sheets and the grounding line





Konrad et al. (2018)


elevation (m)
2000
1500
1000
500
0
-500
-1000
-1500
0
500
1000
1500
2000
2500
along-track distance (km)

Rignot et al
2014 GRL

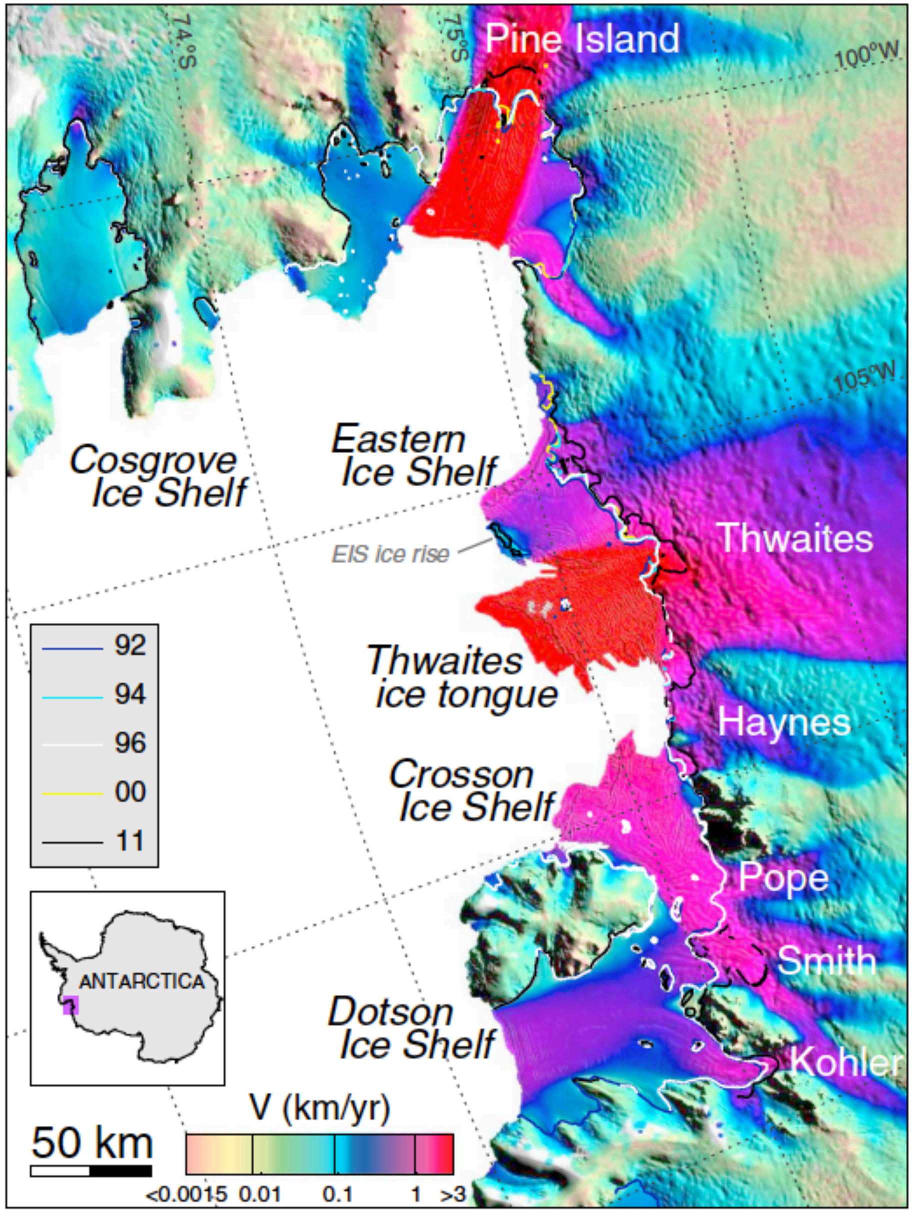


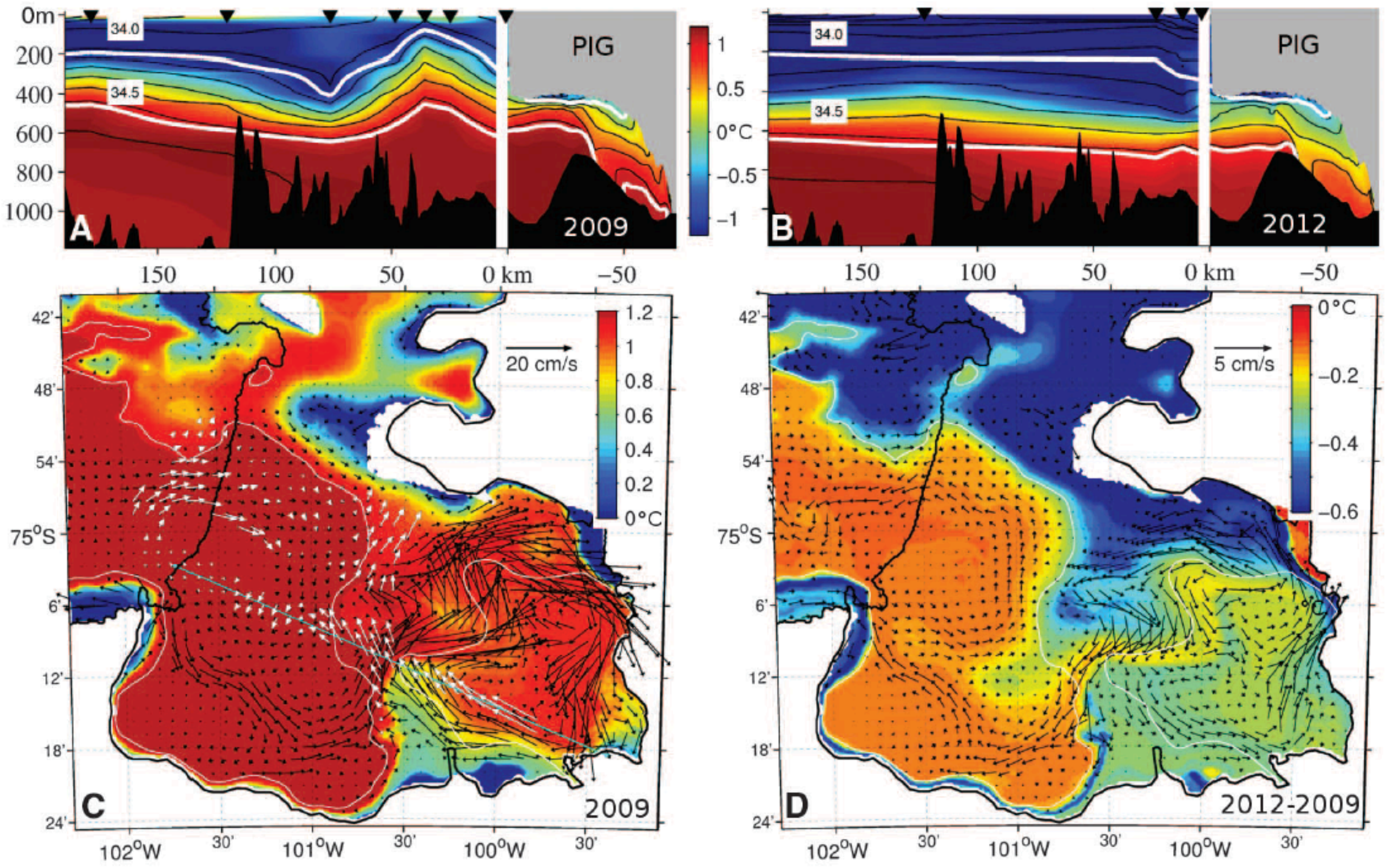
Figure 1. Velocity of the Amundsen Sea (AS) sector of West Antarctica derived using ERS-1/2 radar data in winter 1996 with a color coding on a logarithmic scale and overlaid on a Moderate Resolution Imaging Spectroradiometer mosaic of Antarctica. Interferometrically derived grounding lines of the glaciers are shown in color code for years 1992, 1994, 1996, 2000, and 2011, with glacier and ice shelf names. Note that for Pine Island and Smith/Kohler, the figure merges two independent differential interferograms to show a more complete spatial coverage of grounding lines.

”Classic” Grounding line problem first considered by Nye, Hughes, and others in the 1970’s.

More recent treatments have focused other forcings:

- Basal Melting
- Glacial isostatic adjustment
- Coupled gravitationally-consistent sea level

Fig. 3. Observed and simulated hydrography and circulation in 2009 and 2012. (A) Section of observed and simulated 2009 potential temperatures (color) and salinity (black contours) along the eastern Amundsen Sea trough and underneath the PIG ice shelf. White lines show the surface-referenced 27.47 and 27.75 isopycnals. The panel shows observations outside the PIG cavity, and simulation results within it. Observations are linearly interpolated from profiles (black triangles) indicated in Fig. 1B. **(B)** Same as (A) but for the 2012 observations and simulation. **(C)** Modeled potential temperature (color) and velocity (black vectors; every fifth vector is shown) averaged within 50 m of the seabed for the 2009 simulation. White vectors show the corresponding velocity observed by Autosub (binned on the model grid, see also fig. S2A). The cyan line indicates the position of the section used in (A) and (B). The white line indicates 750-m seabed depth. **(D)** Same as (C), but for the difference between the 2012 and the 2009 simulations.



Dutrieux et al., 2014

Favier et al (2014) PIG inter-comparison

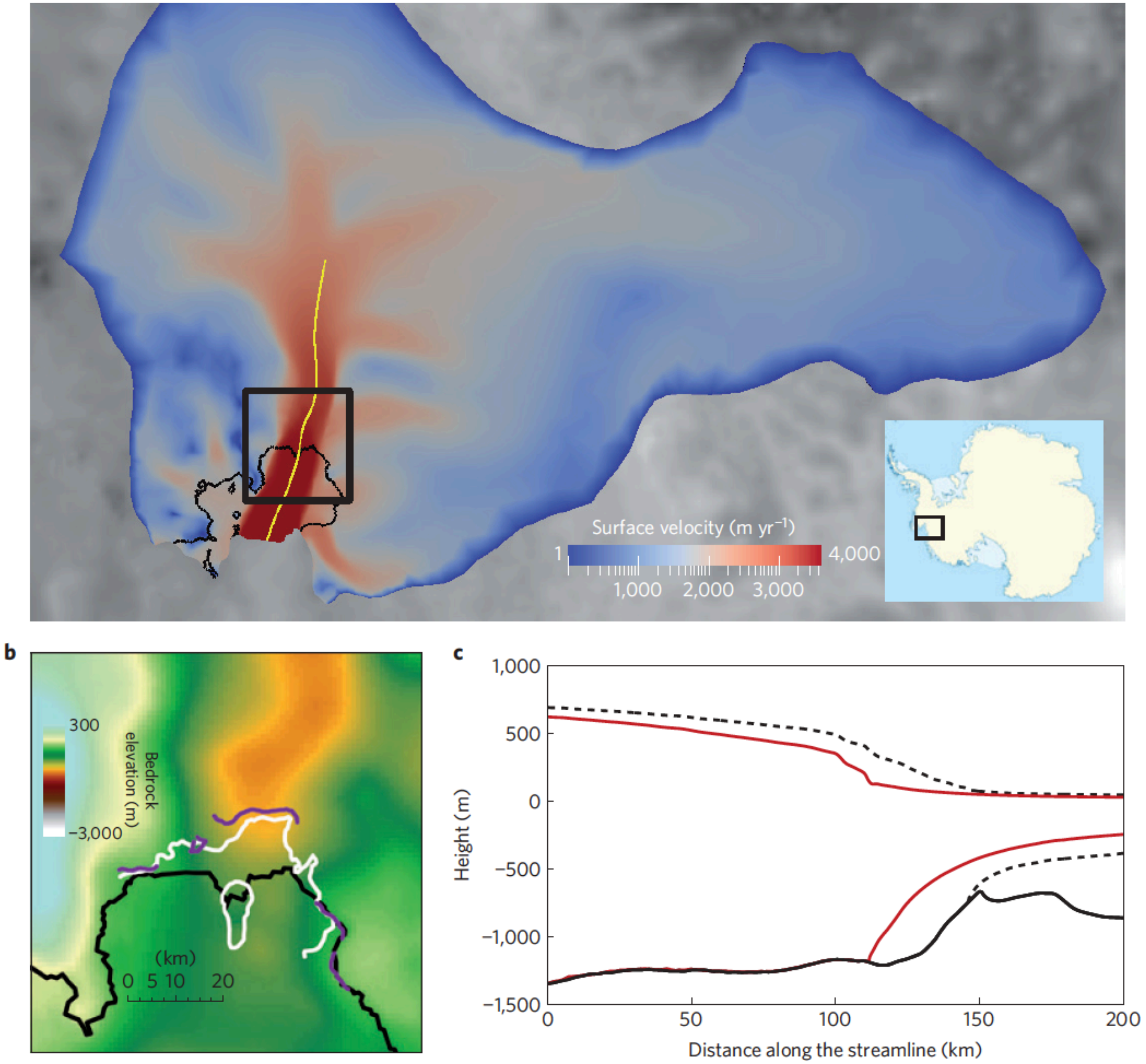


Figure 1 | PIG location and geometry. a, Relaxed surface velocities plotted on the Elmer/Ice computational domain, the solid black line represents the relaxed grounding line. **b**, Domain zoom-in with the bedrock elevation (in m). The 2011 grounding line from ref. 5 is shown in purple, the 2009 grounding line from ref. 8 is in white. **c**, Geometry of PIG produced by Elmer/Ice along the yellow flowline shown in **a** at time (*t*) = 0 (dotted line) and after 50 years under melting scenario m2 (red line).

Favier et al (2014) PIG inter-comparison

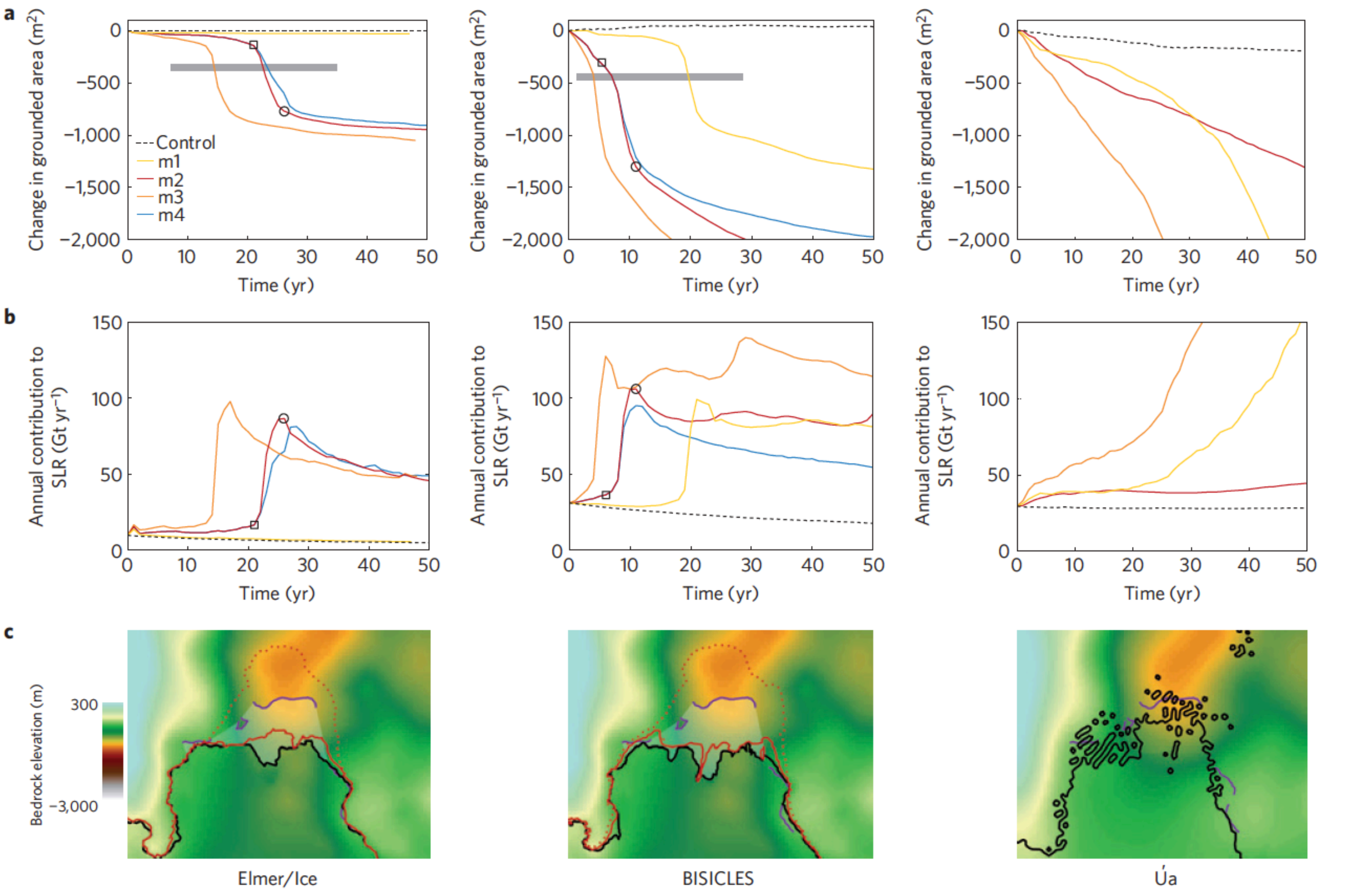


Figure 2 | Melting experiments. a–c, Results of the melting experiments for Elmer/Ice (left), BISICLES (middle) and Úa (right, for which m4 is similar to m2 and not therefore visible) for: change in grounded areas (**a**) and annual contribution to SLR (**b**). Elmer/Ice and BISICLES respond to enhanced melting with a rapid retreat across the steep reverse slope followed by slower retreat thereafter, whereas Úa increases its rate of retreat throughout the simulations. The bedrock altitude (m) and the initial grounding lines for each model (solid black line), as well as the grounding lines, computed during the m2 experiment, at the beginning (solid red lines) and at the end (dashed red line) of the rapid retreat for Elmer/Ice and BISICLES (Úa is not shown here because of the difficulty of identifying these two times) are shown in **c**. Corresponding times are indicated by a square and a circle respectively in **a**,**b**. **c** also shows the areas (shaded) separating the grounding line as observed in 2011 (purple line[5]) from the relaxed model grounding lines, which cover 364 ± 50 km^2, 426 ± 50 km^2 for Elmer/Ice and BISICLES, respectively (not shown for Úa because of the non-continuous profile of the grounding line). The thick grey lines in **a** indicate the same area.