Supplementary Material
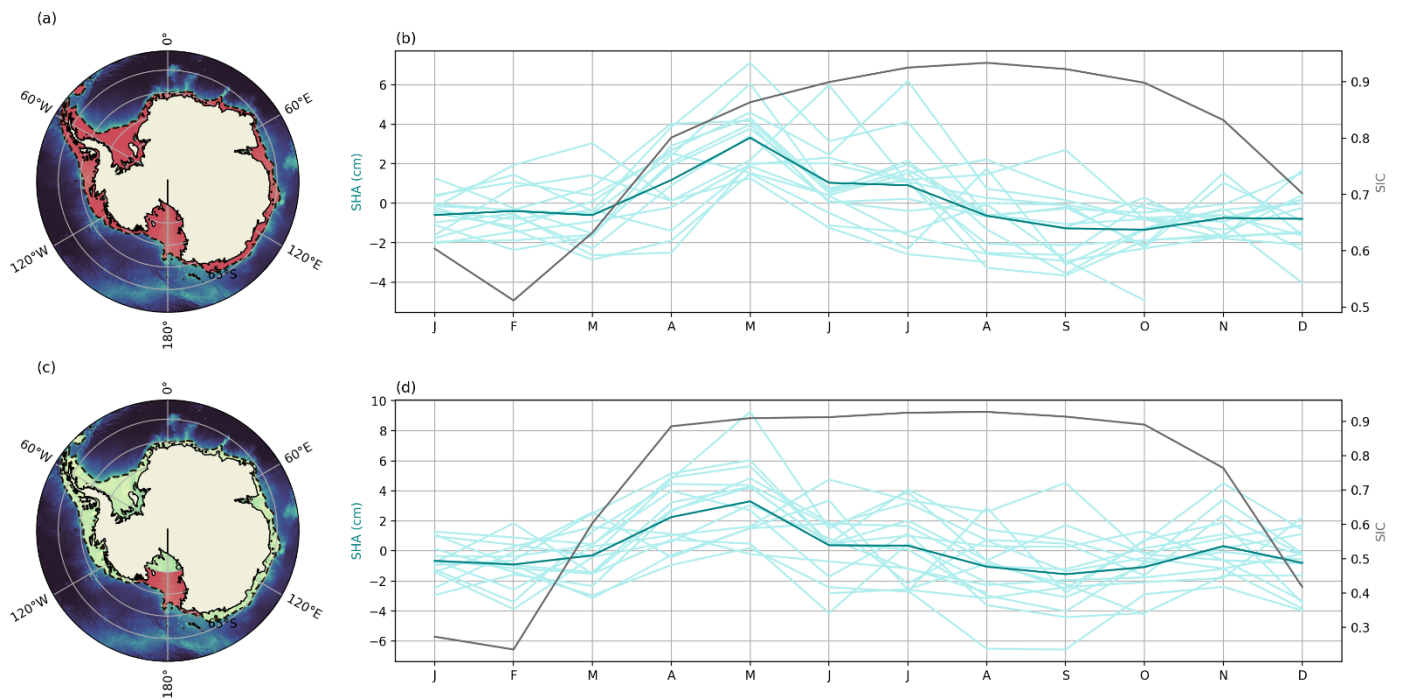
Figure S1: (a) The continental shelf region and **(b)** the yearly steric height anomaly (SHA) in each month averaged across the shelf region. Light colours show individual years and the dark line shows the climatology. The grey line shows the sea ice concentration (SIC). **(c), (d)** as for **(a), (b)** but restricted to the Ross Sea shelf region (South of the 1000m isobath).
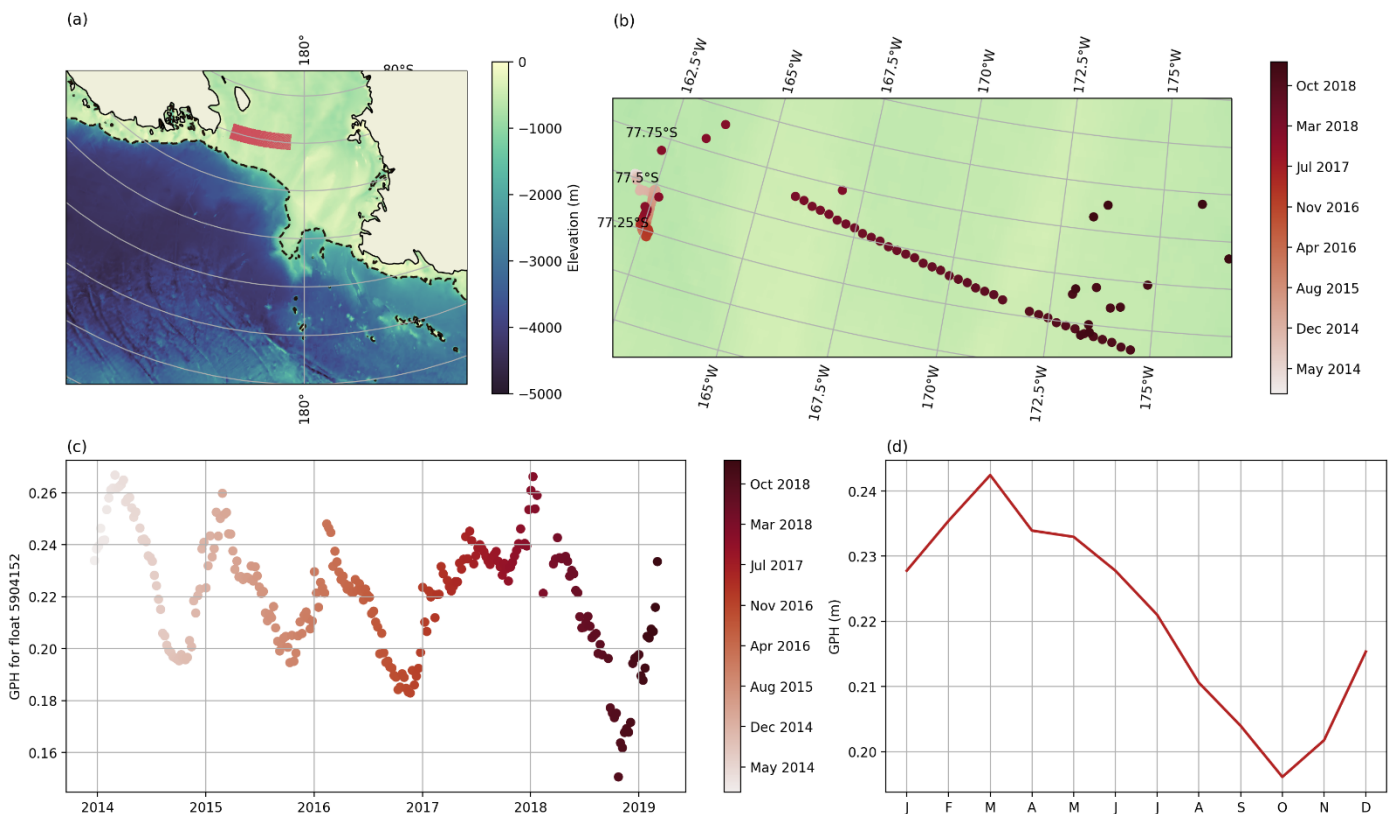
Figure S2: (a) The Ross Sea showing the total area covered by Argo float 5904152 in red. The 1000m isobath is shown (black, dashed). **(b)** The locations of individual Argo profiles within the region shown in (a). Point colour indicates the date the profile was recorded (darker is more recent). Points in a straight line show where profiles recorded beneath the ice have had their location computed by interpolation. **(c)** Time series of the geopotential height (GPH) for float 5094152. **(d)** Climatology of GPH for float 5094152.
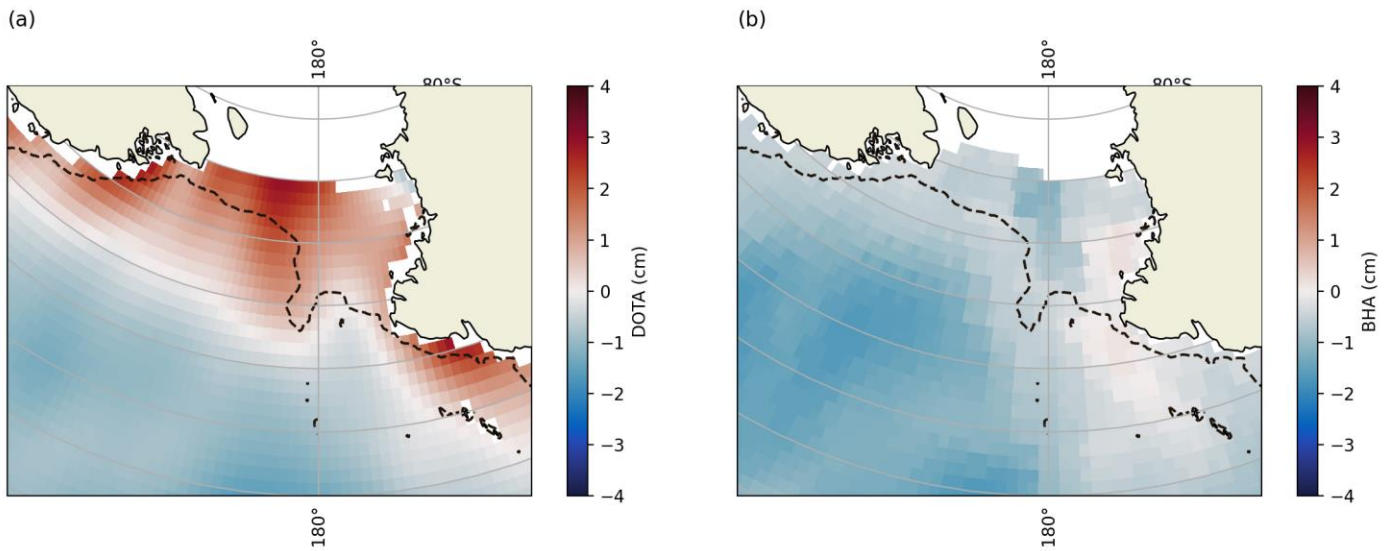
Figure S3: (a) Dynamic Ocean Topography anomaly (DOTA) and (b) barystatic height anomaly (BHA) in the Ross Sea during austral autumn (April – June).
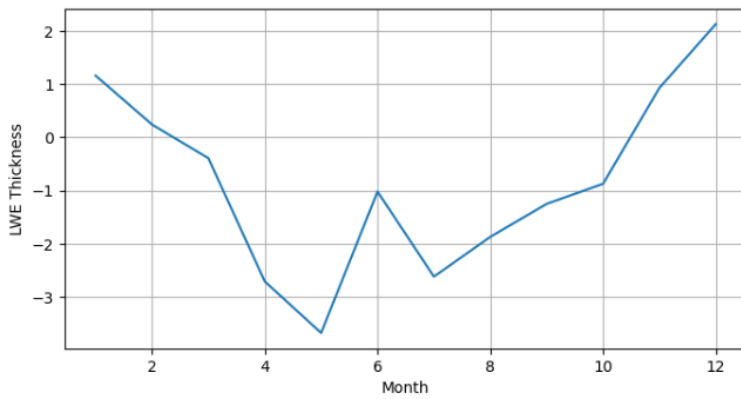
Figure S4: Climatology of GRACE RL06 barystatic height (in units of liquid water equivalent (LWE) thickness used in this study for the same period and location as the comparison between the JARE BPR and GRACE shown in Hayakawa et al., 2012 (Figure 4a).
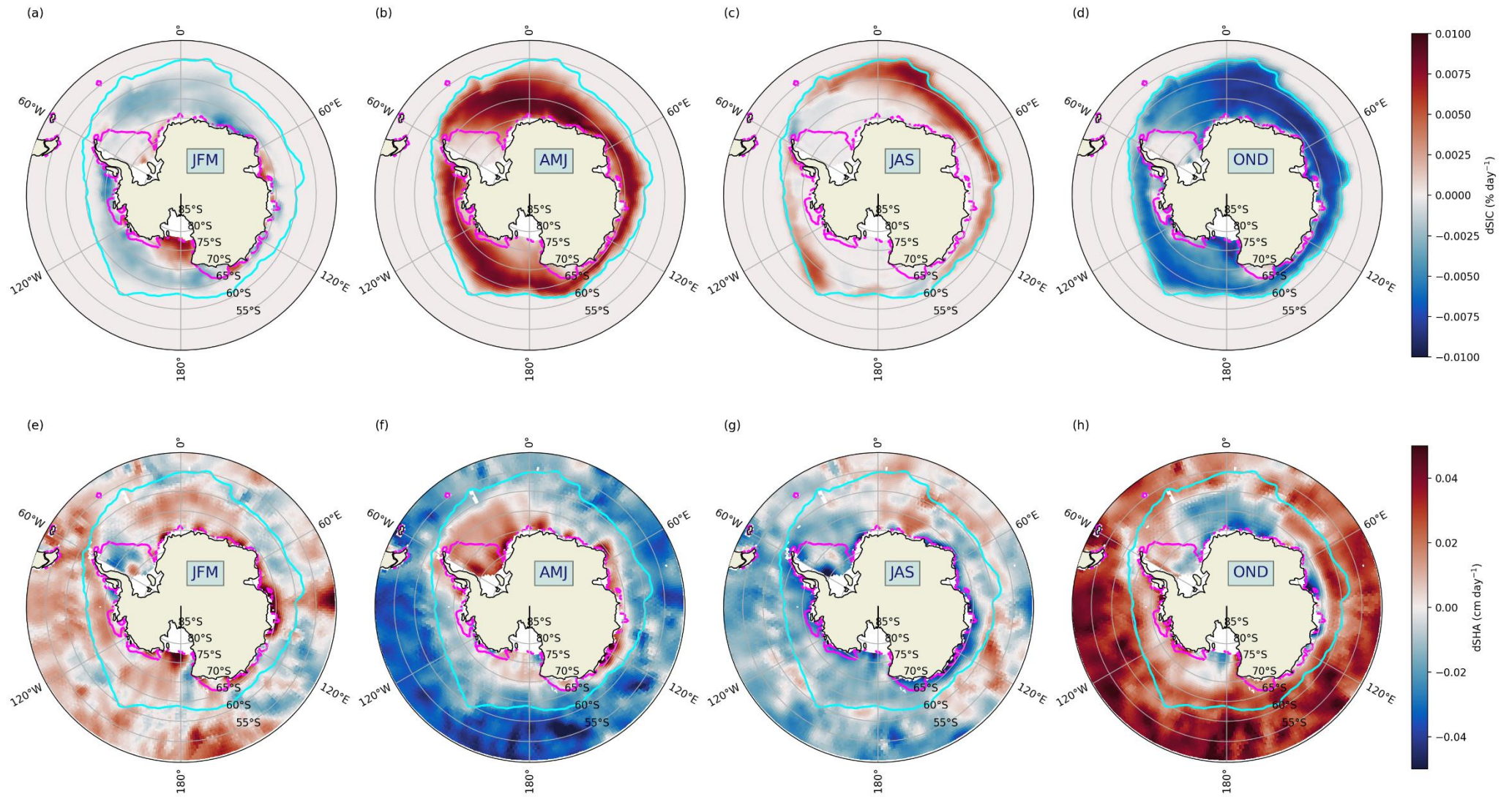
Figure S5: (a-d) The rate of change of Sea Ice Concentration (dSIC) in each season: austral Summer (JFM), Autumn (AMJ), Winter (JAS) and Spring (OND). (e-h) As (a-d) but showing the rate of change of steric height anomaly (dSHA). The seasonal ice zone is shown in light blue and permanent ice zone in pink.
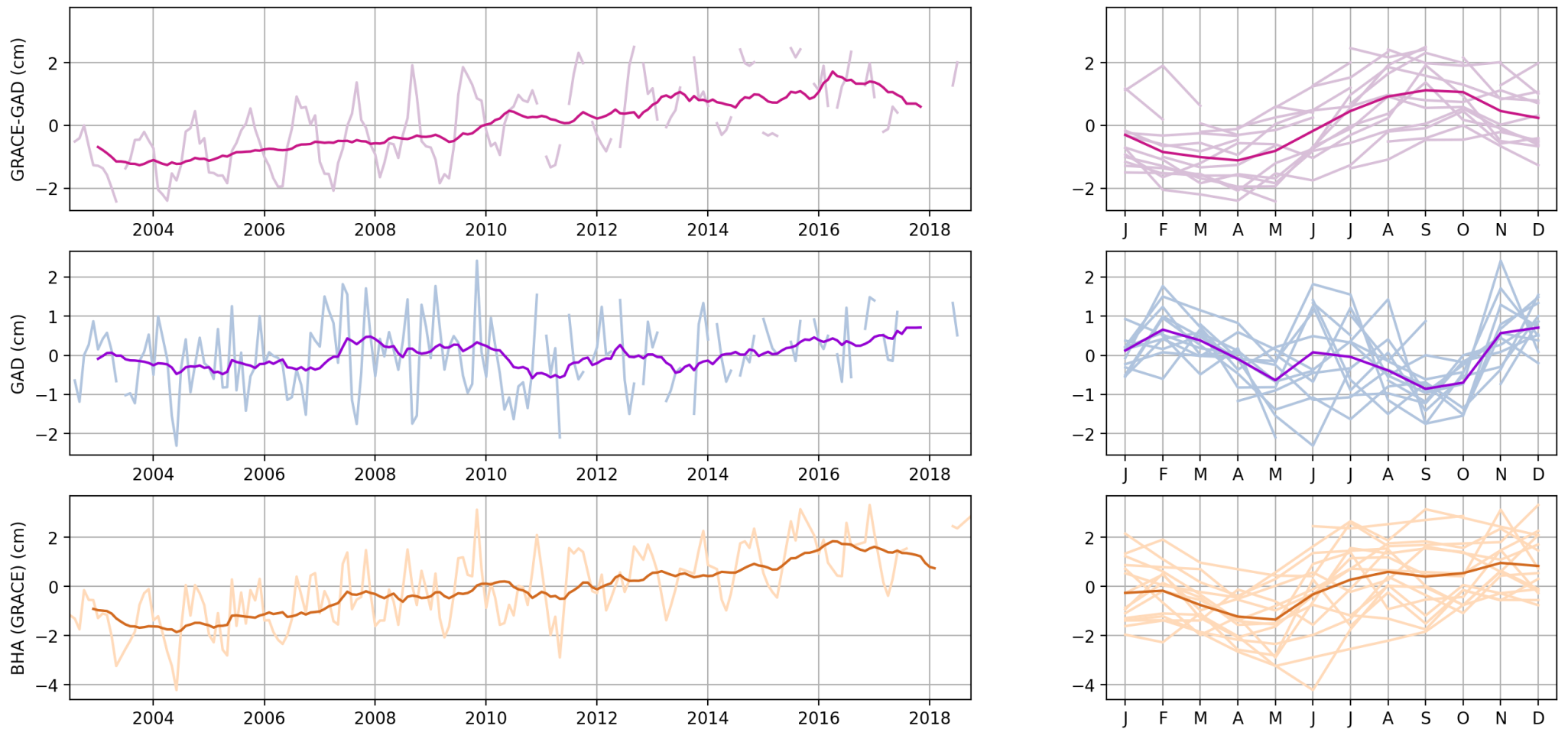
Figure S6: a) Timeseries of GRACE barystatic height anomaly (BHA), with the GAD product removed. The 12-month rolling mean has been superimposed. **b)** The monthly timeseries of GRACE BHA with GAD removed for each year, with the climatology superimposed. **c), d)** As a), b) but showing the GAD product alone. **e), f)** As a), b) but showing the GRACE BHA where GAD has been included.
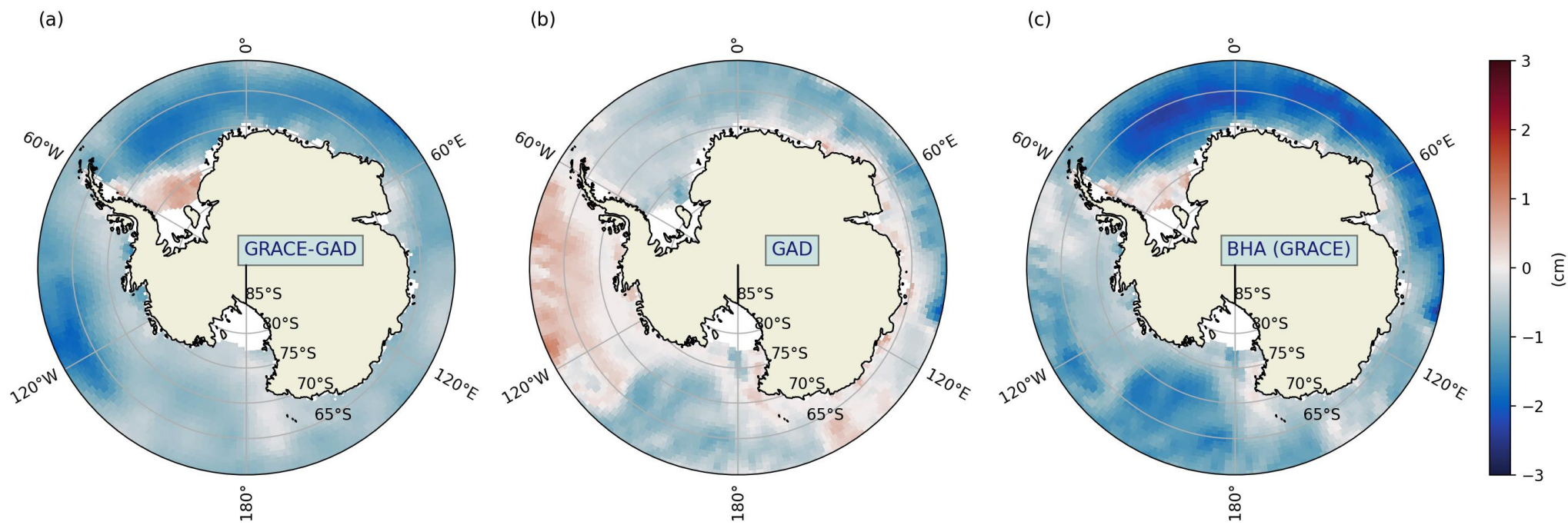
Figure S7: The Autumn (AMJ) average a) GRACE barystatic height where GAD has been removed, b) GAD product alone, c) GRACE barystatic height where GAD has been included (as used to compute steric height anomaly)