

#R.Marsh Referee

The authors present improved representation of iceberg melting in the ORCA025 configuration of the NEMO ocean model. Improvements are specifically developed in the melting associated with three processes: wave erosion; basal melting; sidewall melting. Key improvements are in the vertical distribution of meltwater, in relation to upper ocean stratification and the mixed layer in particular. The experiments are clearly designed and the analysis is revealing of the meltwater partitioning – and hydrographic impacts – above/below the mixed layer depth, and between offshore waters and the continental shelf. The shift away from wave erosion to lateral melt is particularly striking. Clear logic is evident throughout and the useful conclusion is that surface-confined meltwater is a good approximation, with some local exceptions, subject also to better observations of iceberg melting.

Regarding experimental details, 15 years is not long for bottom T and S differences to be established far from Antarctica. The authors explain that **‘After the spin-up period, the 5 simulations are run for 25 years to allow the new melting parameterisations to equilibrate, and the annual and monthly climatologies are computed by averaging the final 15 years of this run’**. While it is clear in Fig. 3 that total ice volume stabilizes around 2015-20 (run years 15-20), the slow advective timescales around Antarctica imply a longer adjustment timescale for the deeper circulation and hydrography. Are deeper T and S significantly trending after 25 years? Can the authors comment on this caveat, in both results and discussion?

We thank the reviewer for raising this important point. We have first clarified and better justified our choice of the adjustment and averaging periods (Lines 209 and 212). The iceberg freshwater flux has already reached a quasi-steady state during the spin-up period, as can be seen in Olivé Abelló et al. (2025). After modifying the melting parameterisations and meltwater distribution, we allow an additional 10 years for the associated surface ocean-sea-ice system to adjust before computing the 15-year climatologies. This timescale is consistent with the 5-10-year adjustment of Antarctic sea ice following changes in freshwater forcing reported by Pauling et al. (2016).

In the revised Discussion (Lines 430–437), we explicitly address the incomplete deep-ocean equilibration as a caveat and examine the evolution of bottom temperature and salinity over the simulations (new Figure S7). Both variables continue to evolve in the abyssal Ross and Weddell gyres (not shown). However, over the Antarctic continental shelf, the Amundsen Sea, the western Ross Sea and western Weddell Sea tend towards stabilization, especially in the last 15 years. As these trends are largely shared across experiments, we expect incomplete equilibration to have a limited impact on our bottom properties distribution.

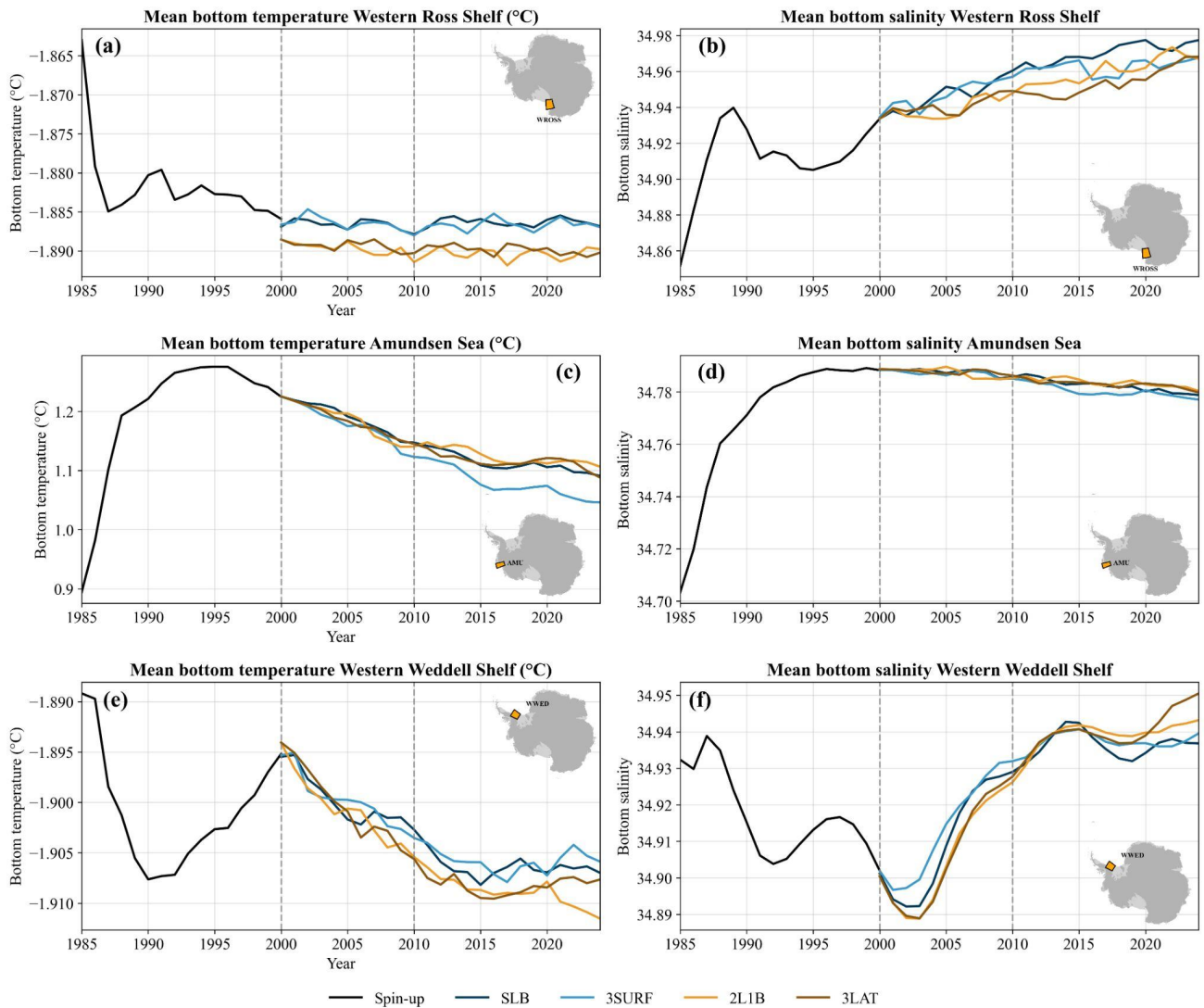


Figure S7. Mean bottom temperature and salinity evolution in the (a, b) western Ross Sea, (c, d) Amundsen Sea and (e, f) western Weddell Sea. The black line shows the 15-year spin-up simulation (1985–2000), while the coloured lines show the four sensitivity experiments (SLB, 3SURF, 2L1B, and 3LAT) over the subsequent 25-year simulations (2000–2024). The vertical dashed lines indicate the start of the sensitivity experiments (2000) and the beginning of the 15-year period used to compute the climatologies (2010).

A further thought regards the small hydrographic impacts around Antarctica: ‘slight cooling and freshening of bottom waters in East Antarctica and the western Ross Sea, and slight warming and salinification of shelf bottom waters in the Amundsen Sea’. Given the similarly small trends and anomalies reported in deeper and abyssal waters over recent years (see Gunn et al. 2023 and references therein; notably AABW freshening in the Ross Sea sector, attributing to ‘increasing glacial meltwater’), can the authors comment on the relative size of differences between T and S between their experiments? The question is whether changes in iceberg melting (due to changes in calving, draft, wave influence, etc.) might account for some of the observed changes?

We further examined how freshwater injection at depth changes bottom temperature and salinity between SLB and 3SURF, the two experiments with the strongest anomalies in the Australian–Ross Sea sector, where the AABW cascading signal is most apparent. Over the continental shelf, the mean bottom-salinity difference is only $+0.003 \text{ g kg}^{-1}$, although local anomalies can reach 0.11 g kg^{-1} in the

southwestern Ross Sea. Despite these locally significant changes, the net export of DSW (Dense Shelf Water, a precursor of AABW) across the 1020-km section along the Ross Sea continental shelf break increases by only 0.075 Sv (4.3%) relative to 3SURF (Figure S8 below). For comparison, Gunn et al. (2023) associated Australian–Ross Sea AABW salinity changes of 0.04 g kg^{-1} during 1992–2011 and 0.03 g kg^{-1} during 2011–2018 with substantial changes in AABW volume and transport, including a decrease of $\sim 4.4 \text{ Sv}$ during the first period and a recovery of 2.2 Sv during the second. Changes in the depth of iceberg meltwater injection can locally modify shelf-sea floor properties, but in our experiments these small anomalies do not translate into a comparably strong DSW export response. We have added this discussion to the revised manuscript (Lines 450 and 456) and included an additional figure in the Supplementary Material (Figure S8) showing the bottom-salinity changes and the section used to quantify DSW export.

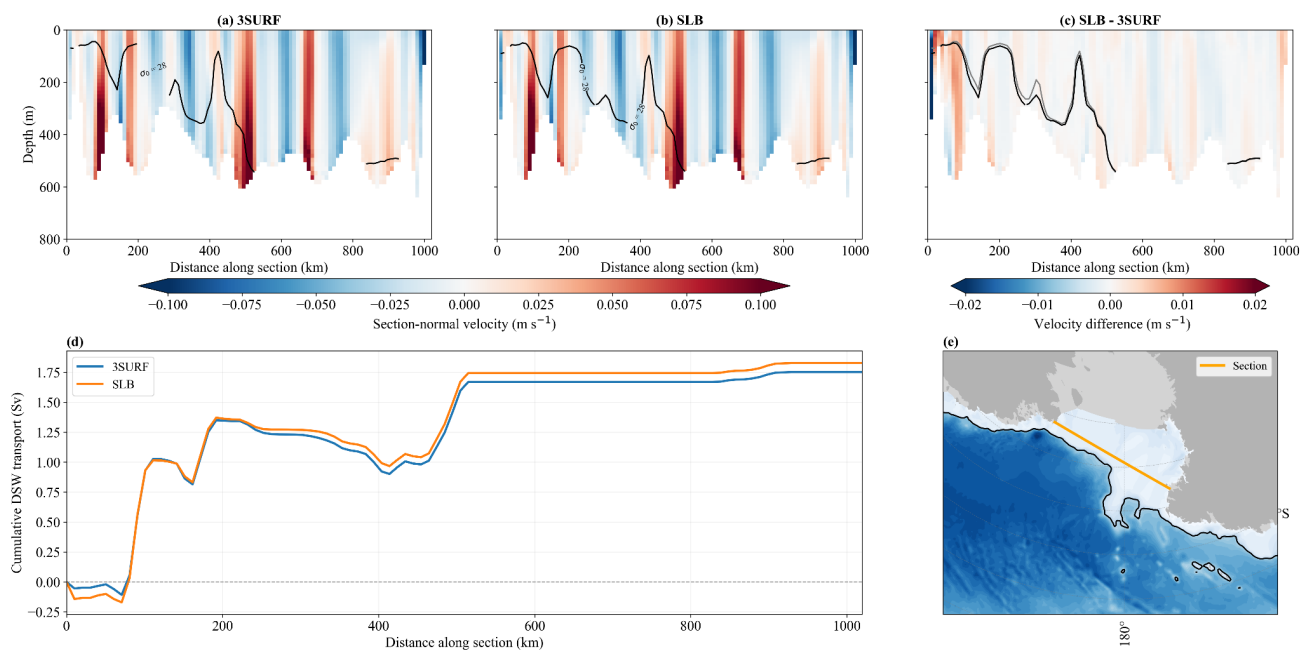


Figure S8. Section-normal velocity for (a) 3SURF and (b) SLB, and (c) their difference (SLB – 3SURF), along the 1020-km section parallel to the Ross Sea continental shelf break. Black contours indicate the $\sigma_0 = 28 \text{ kg m}^{-3}$ isopycnal used to identify DSW (grey contours in panel c show its position in 3SURF for comparison). (d) Cumulative DSW transport along the section for 3SURF and SLB. (e) Location of the section across the Ross Sea continental shelf break. Positive velocities and transport represent offshore DSW export.

Reference:

Gunn, K.L., Rintoul, S.R., England, M.H., et al. Recent reduced abyssal overturning and ventilation in the Australian Antarctic Basin. *Nat. Clim. Change*, **13**, 537–544 (2023). <https://doi.org/10.1038/s41558-023-01667-8>