

## **The impacts of Stratospheric Aerosol Injection on Antarctic ice loss depend on injection location**

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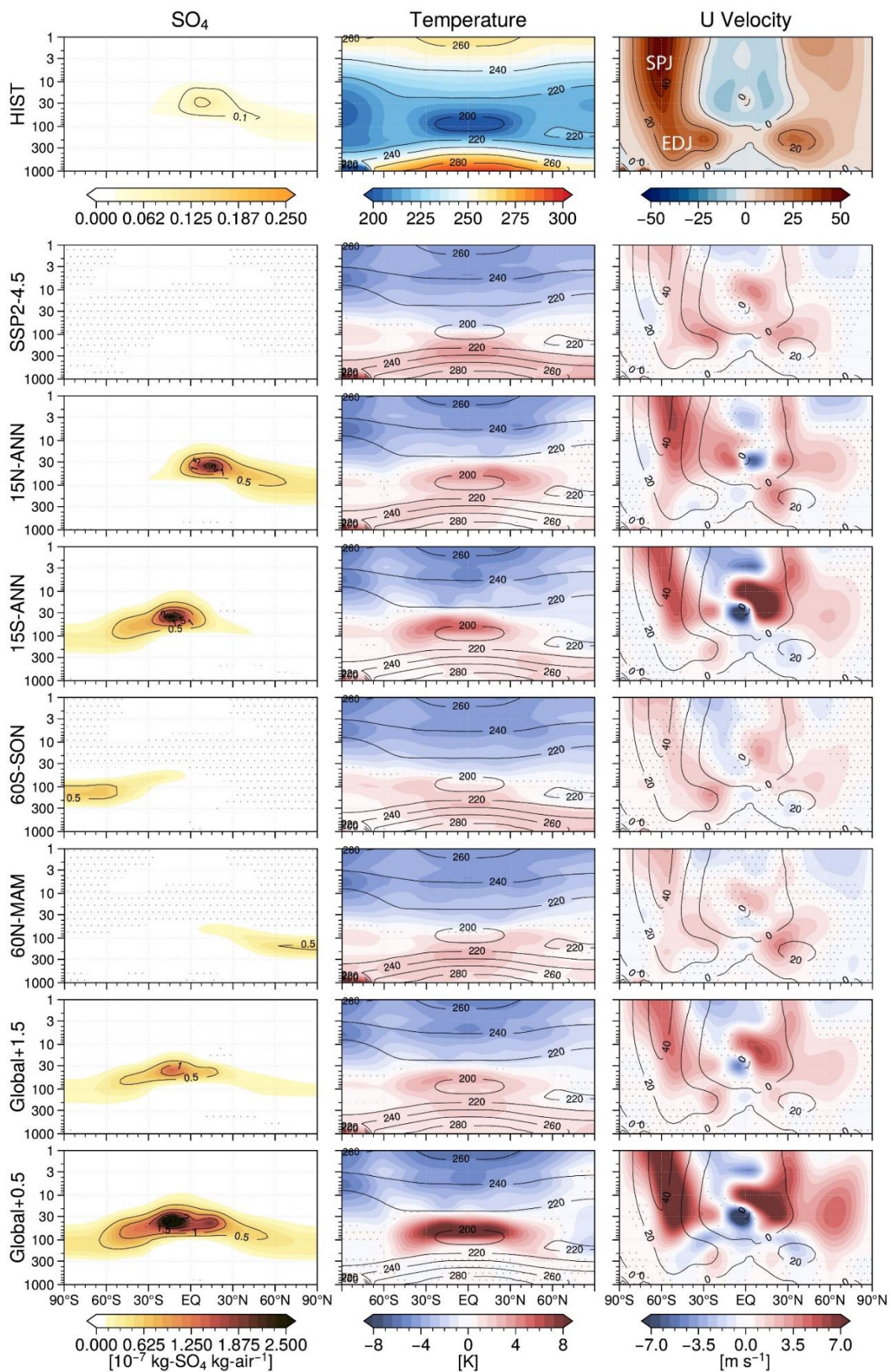
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### **Contents of this file**

Figures S1 to S17

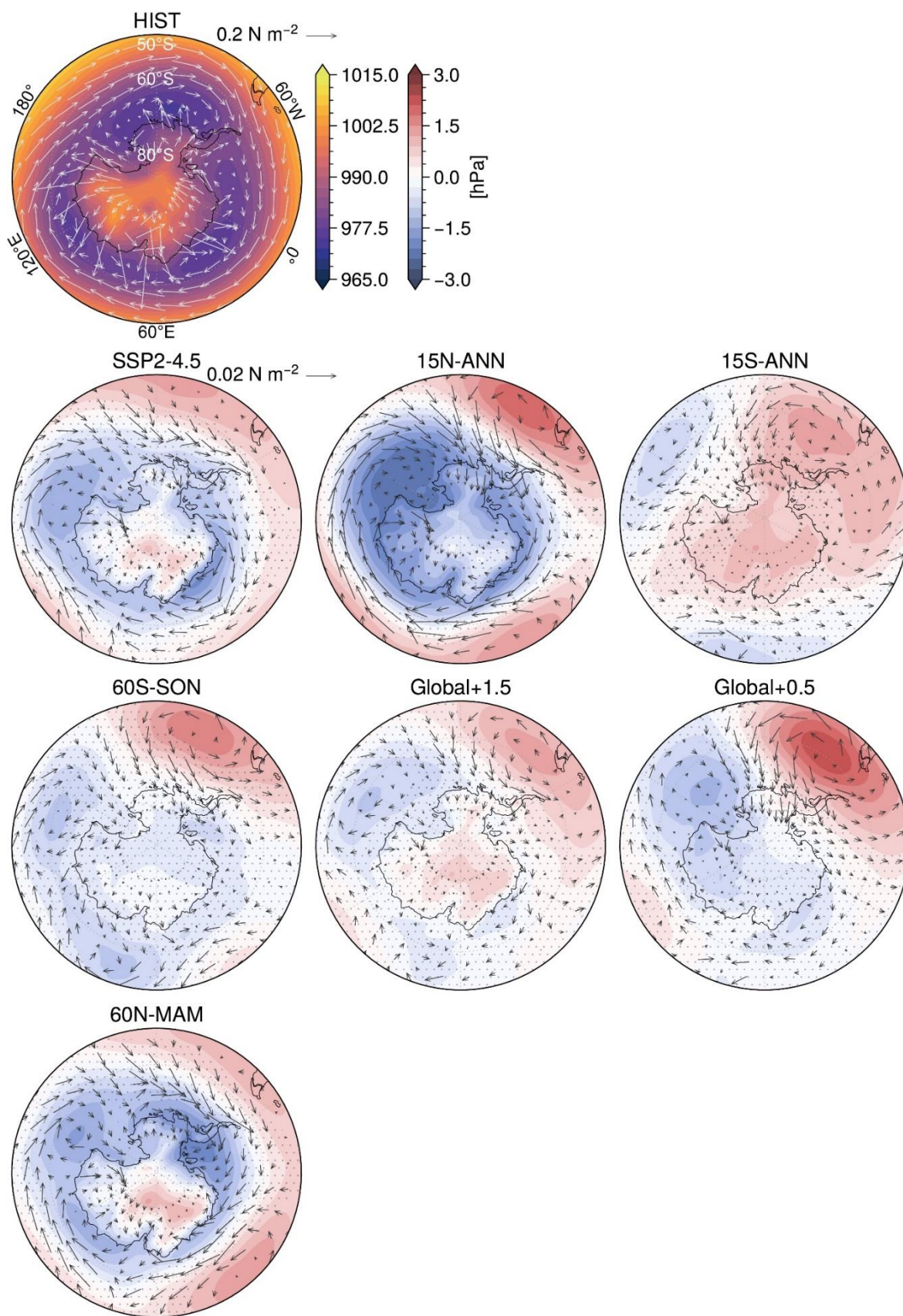
### **Introduction**

This file contains supporting figures for the Main Text. Most of these figures are complementary to the Main Figures and show the additional Stratospheric Aerosol Injection cases – namely, 15N-ANN, 15S-ANN, 60N-MAM, 60S-SON, Global+1.5, and Global+0.5.

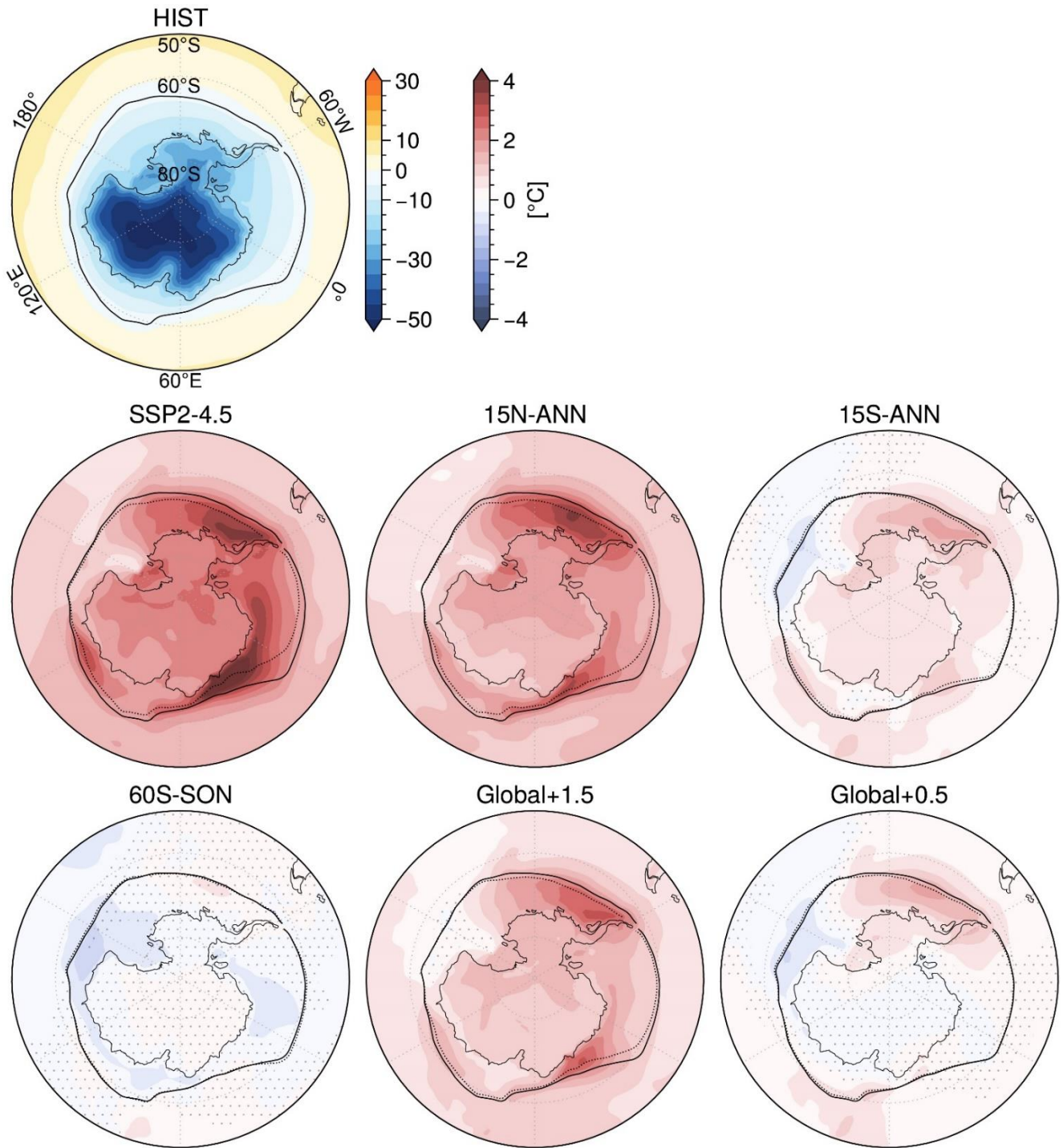


**Figure S1.** The top row shows the Historical annual ensemble mean (1990-2009) zonal mean sulfate burden ( $10^{-7}$  kg-SO<sub>4</sub> kg-air<sup>-1</sup>), temperature (K), and zonal velocity (m s<sup>-1</sup>). Shading in the following rows show the annual ensemble mean anomalies (2050-2069) from the Historical with respect to SSP2-4.5 and the stratospheric aerosol injection (SAI) cases. Contours in the first column show the sulfate burden difference from the Historical, whereas, in column two and three, contours show the corresponding temperatures and zonal velocity in the Historical simulation for reference. Stippling shows the regions where the difference is not statistically significant. SPJ = southern hemisphere stratospheric polar jet; EDJ = southern hemisphere eddy-driven jet.



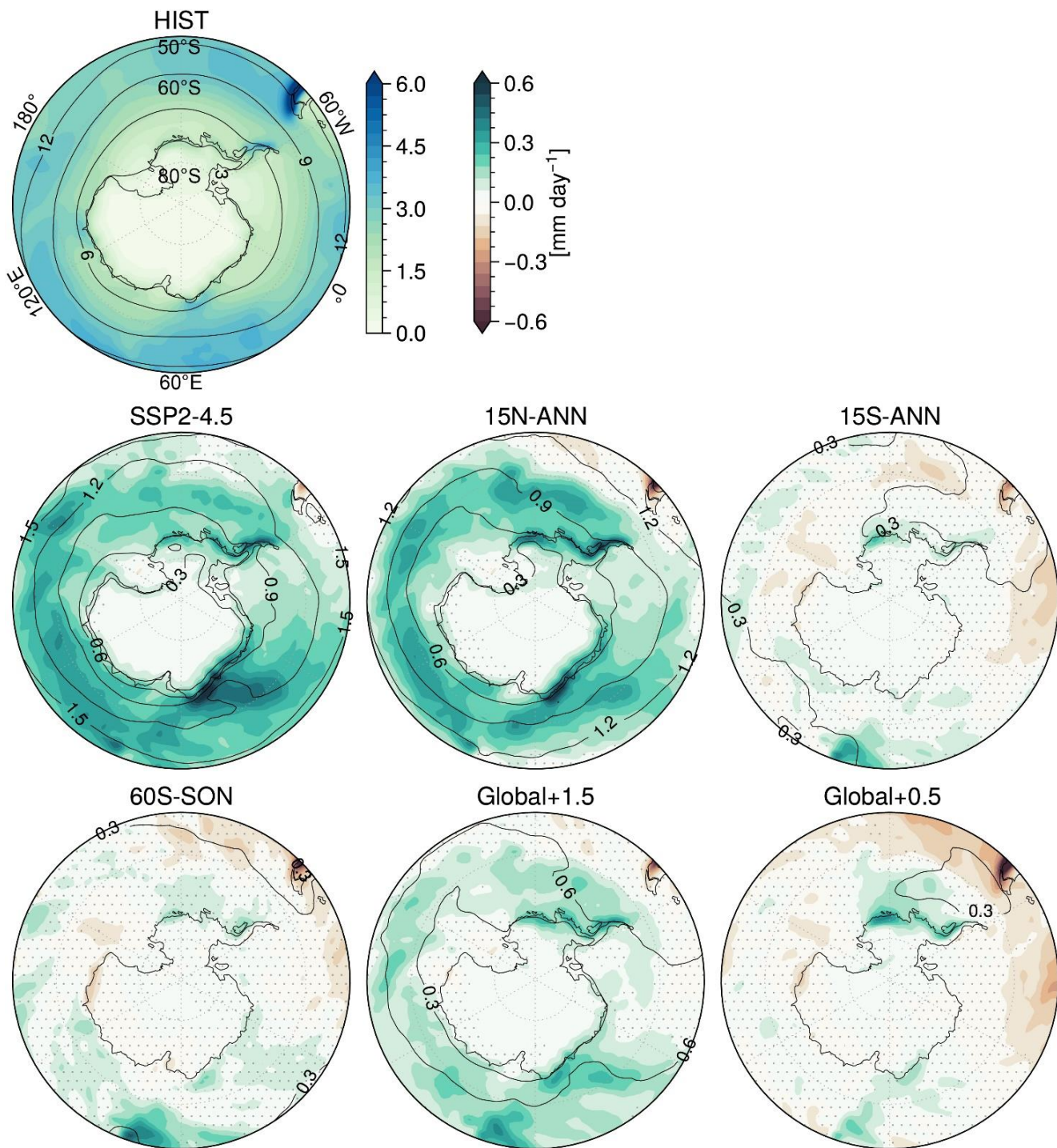


**Figure S2.** The top left panel shows the Historical annual ensemble mean (1990-2009) sea level pressure (hPa) and surface wind stress vectors ( $\text{N m}^{-2}$ , in the direction of the surface winds). The following rows show the annual ensemble mean anomalies (2050-2069) from the Historical with respect to SSP2-4.5 and the SAI cases. Stippling shows the regions where the sea level pressure difference is not statistically significant. Note, hereafter 60N-MAM results are not included in the Supporting Material as this simulation is no longer discussed in the Main Text.



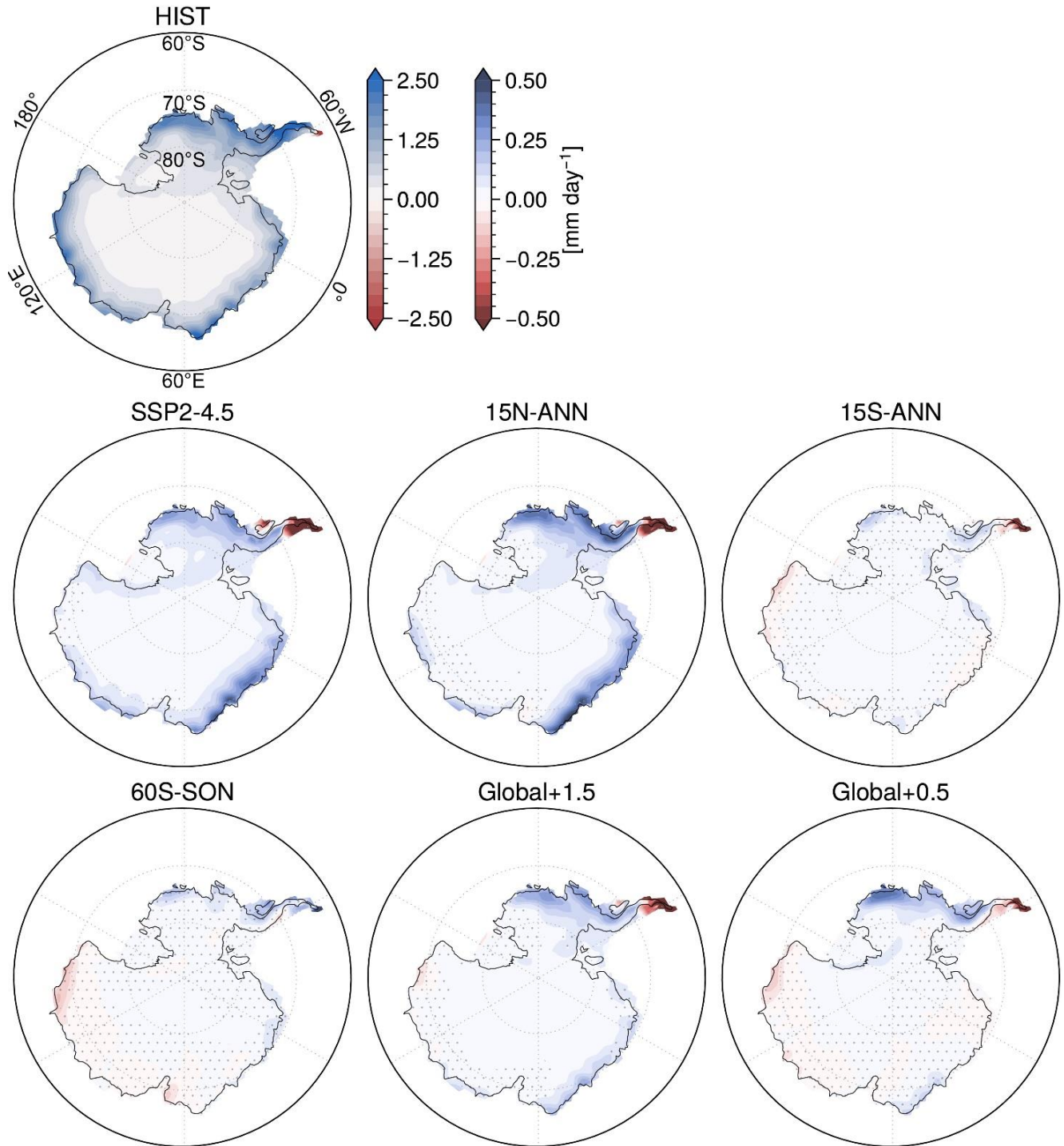
**Figure S3.** The top left panel shows the Historical annual ensemble mean (1990-2009) surface air temperature (SAT, °C) with a solid black contour showing the sea ice extent (at 25% concentration). Shading in the following rows show the annual ensemble mean SAT anomalies (2050-2069) from the Historical with respect to SSP2-4.5 and the SAI cases. Each SAI case panel shows the Historical sea ice extent contour (solid) and the SAI case contour (dashed). Stippling shows the regions where the SAT difference is not statistically significant.





**Figure S4.** The top left panel shows the Historical annual ensemble mean (1990-2009) total precipitation (mm yr<sup>-1</sup>) with black contours showing total precipitable water (kg m<sup>-2</sup>). Shading in the following rows show the annual ensemble mean total precipitation anomalies with black contours showing total precipitable water anomalies (2050-2069) from the Historical with respect to SSP2-4.5

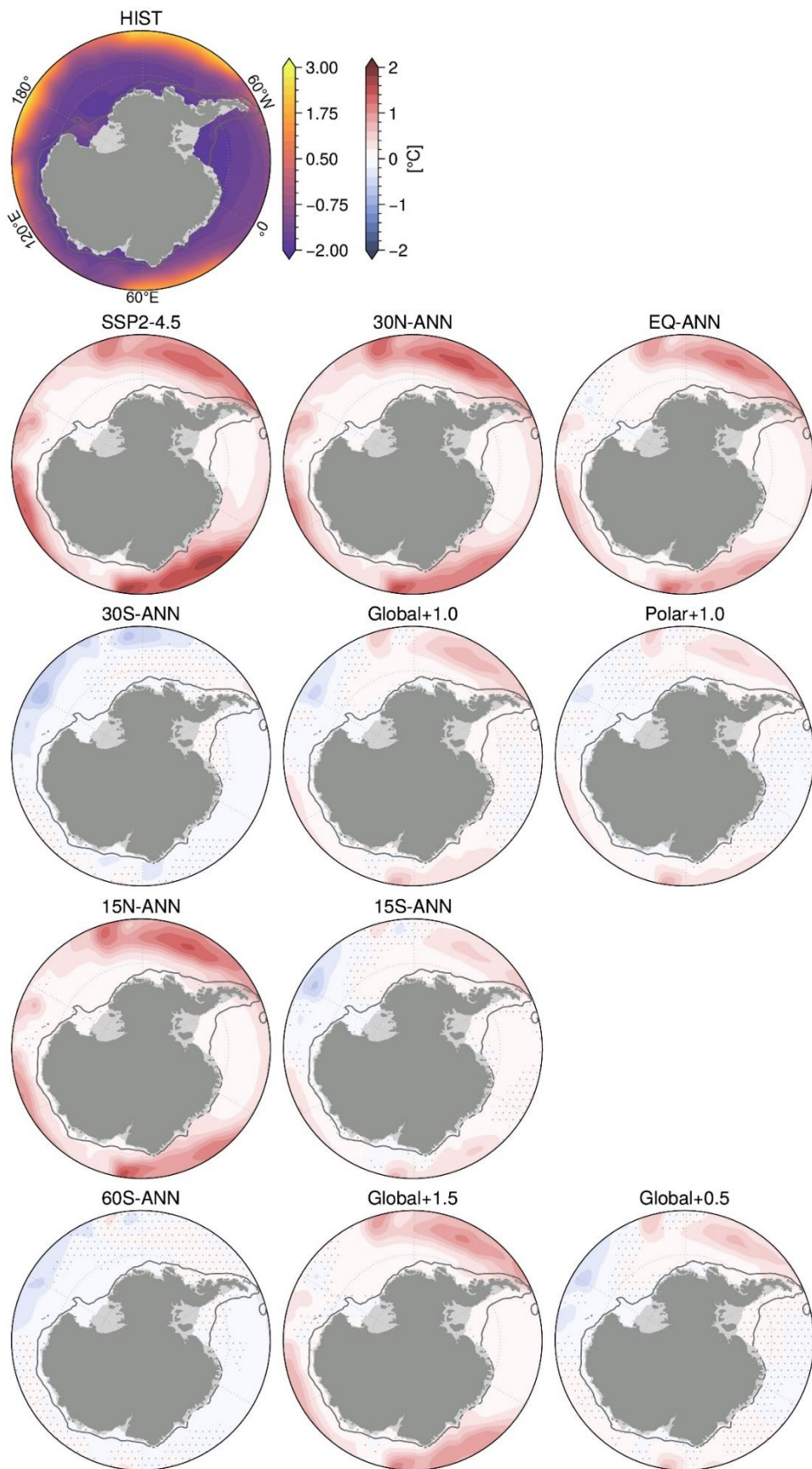
and the SAI cases. Stippling shows the regions where the total precipitation difference is not statistically significant.



**Figure S5.** The top left panel shows the Historical annual ensemble mean (1990-2009) net surface ice accumulation ( $\text{mm day}^{-1}$ ). Shading in the following rows show the annual ensemble mean ice accumulation anomalies (2050-2069) from the Historical with respect to SSP2-4.5 and the SAI cases. Stippling shows the regions where the accumulation difference is not statistically significant.

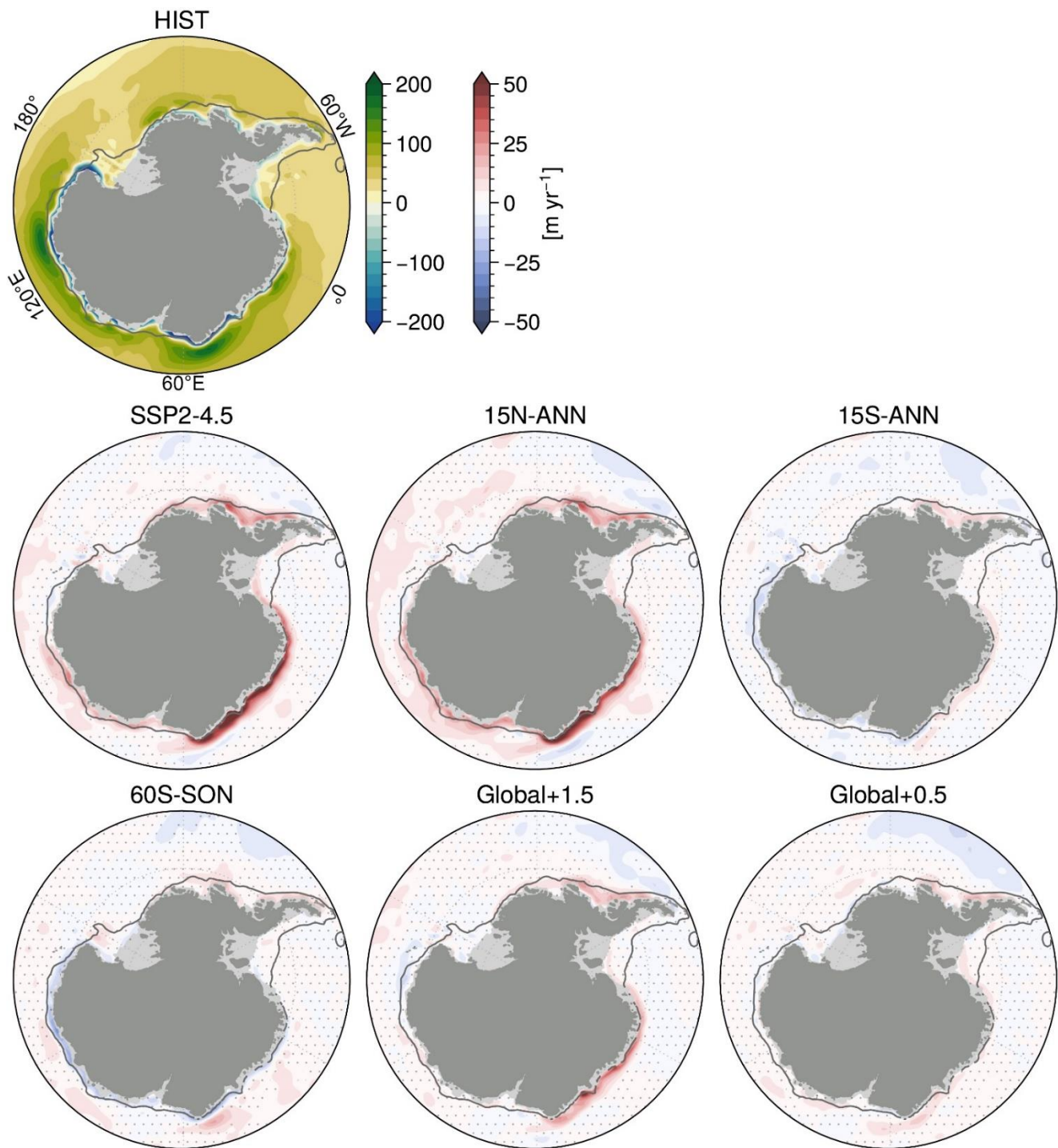




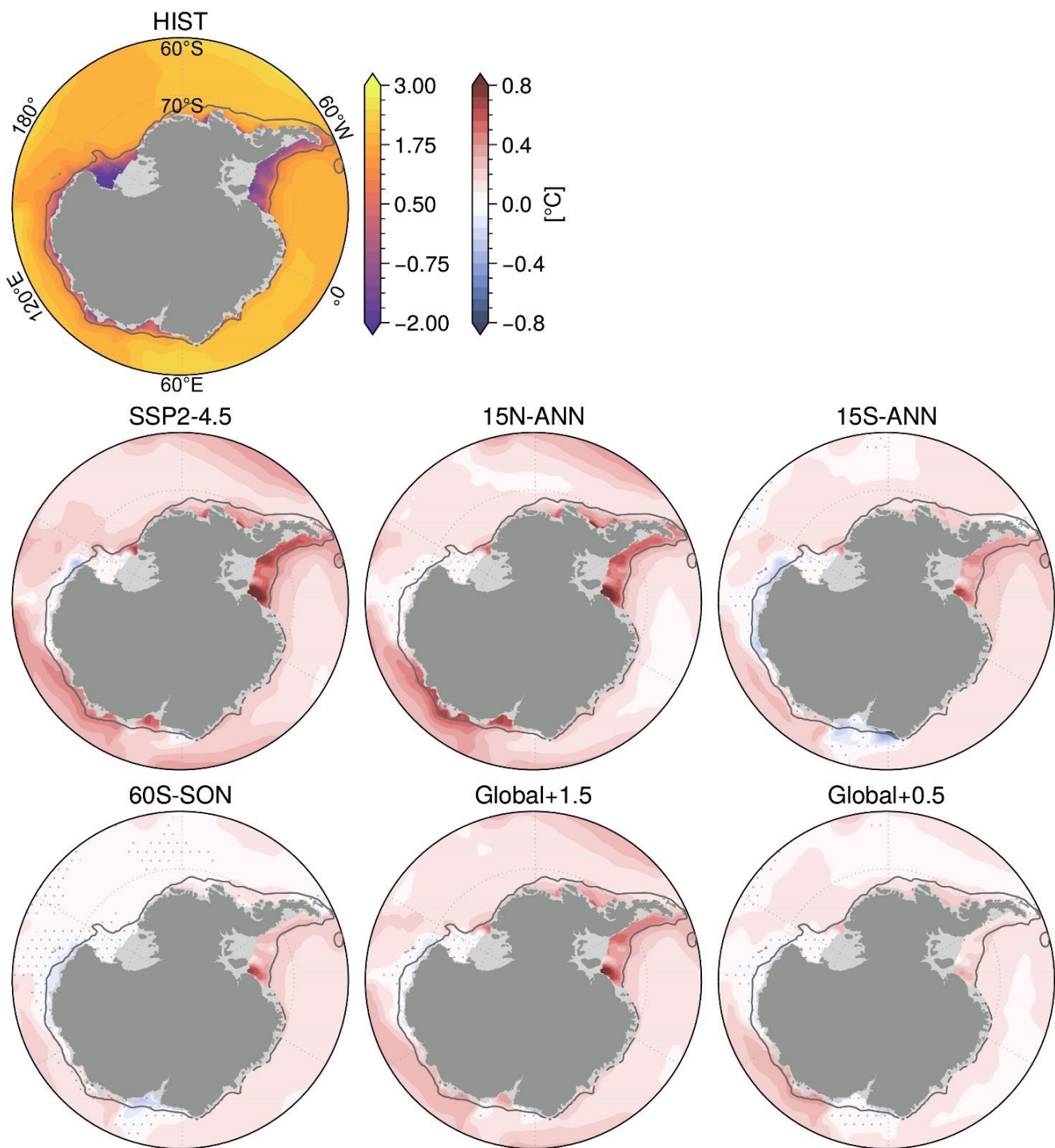


**Figure S6** (Above). The top left panel shows the Historical annual ensemble mean (1990-2009) 0-100 m mean ocean potential temperature (°C). Shading in the following rows show the annual ensemble mean anomalies (2050-2069) from the Historical with respect to SSP2-4.5 and the SAI cases. Stippling shows the regions where the difference is not statistically significant.

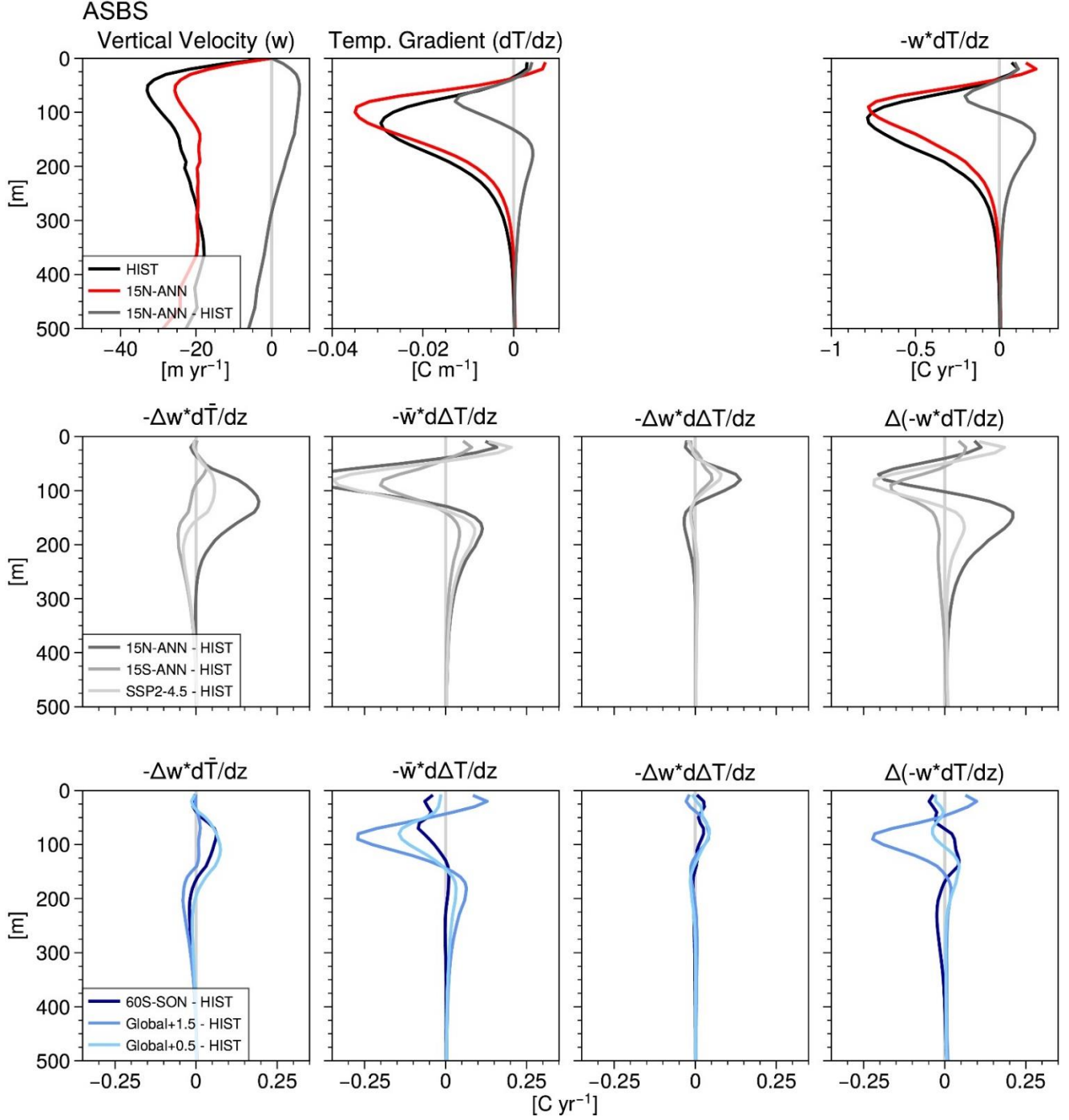




**Figure S7.** The top left panel shows the Historical annual ensemble mean (1990-2009) Ekman upwelling (positive values) and Ekman pumping (negative values) ( $\text{m yr}^{-1}$ ). Shading in the following rows show the annual ensemble mean anomalies (2050-2069) from the Historical with respect to SSP2-4.5 and the SAI cases. Stippling shows the regions where the difference is not statistically significant.



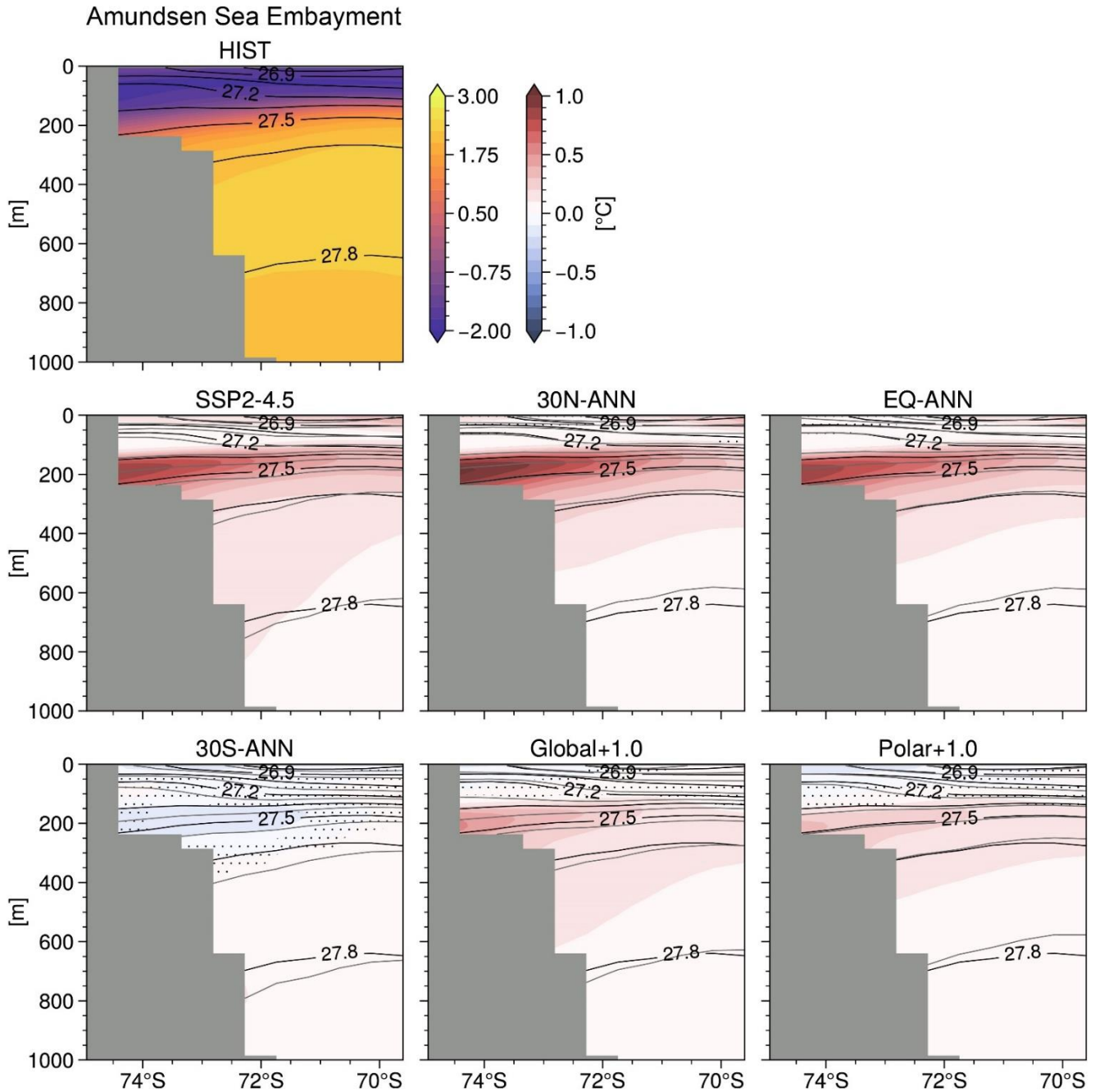
**Figure S8.** The top left panel shows the Historical annual ensemble mean (1990-2009) 100-1,000 m mean ocean potential temperature (°C). Shading in the following rows show the annual ensemble mean anomalies (2050-2069) from the Historical with respect to SSP2-4.5 and the SAI cases. Stippling shows the regions where the difference is not statistically significant.



**Figure S9.** Vertical temperature advection and contributions to its change above the shelf in the ASBS sector. The top row shows Historical and 15N-ANN vertical velocity (m yr<sup>-1</sup>), vertical temperature gradient (where negative values represent increasing temperature with increasing depth, C m<sup>-1</sup>), and vertical temperature advection (where the negative values represent a downward advection of colder surface water, C yr<sup>-1</sup>). The second and third row show the change in vertical temperature advection (far right column,  $\Delta(-w \times dT/dz)$ ) and the contributions to this term due to the change in vertical velocity ( $-\Delta w \times d\bar{T}/dz$ ), change in temperature gradient ( $-\bar{w} \times d\Delta T/dz$ ), and change in vertical velocity ( $-\Delta w \times d\Delta T/dz$ ).

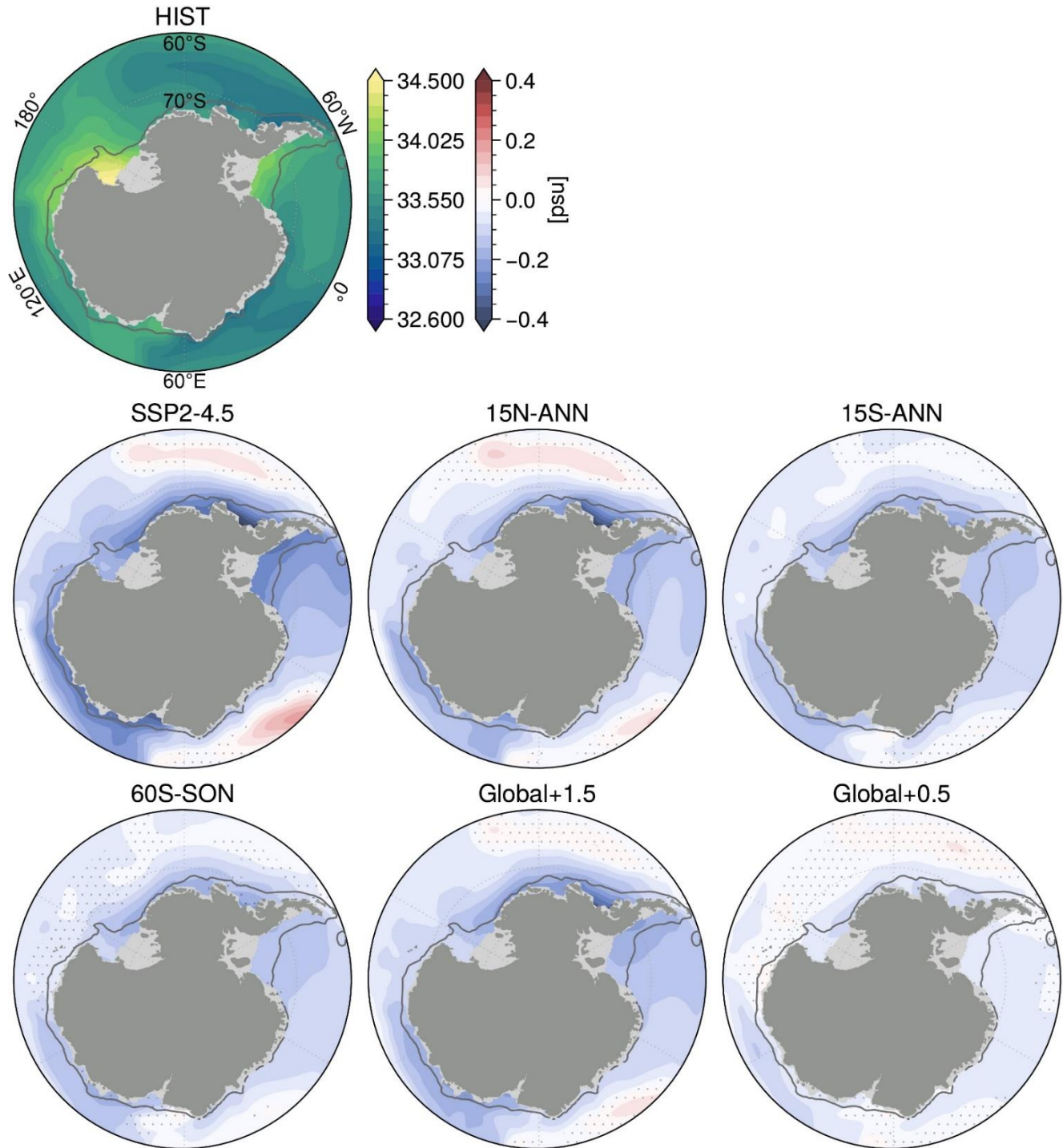


$\Delta w \times d\bar{T}/dz$ , in the vertical temperature gradient ( $-\bar{w} \times d\Delta T/dz$ ), and in the interaction between these perturbations ( $-\Delta w \times d\Delta T/dz$ ), where the overbar denotes the Historical mean.



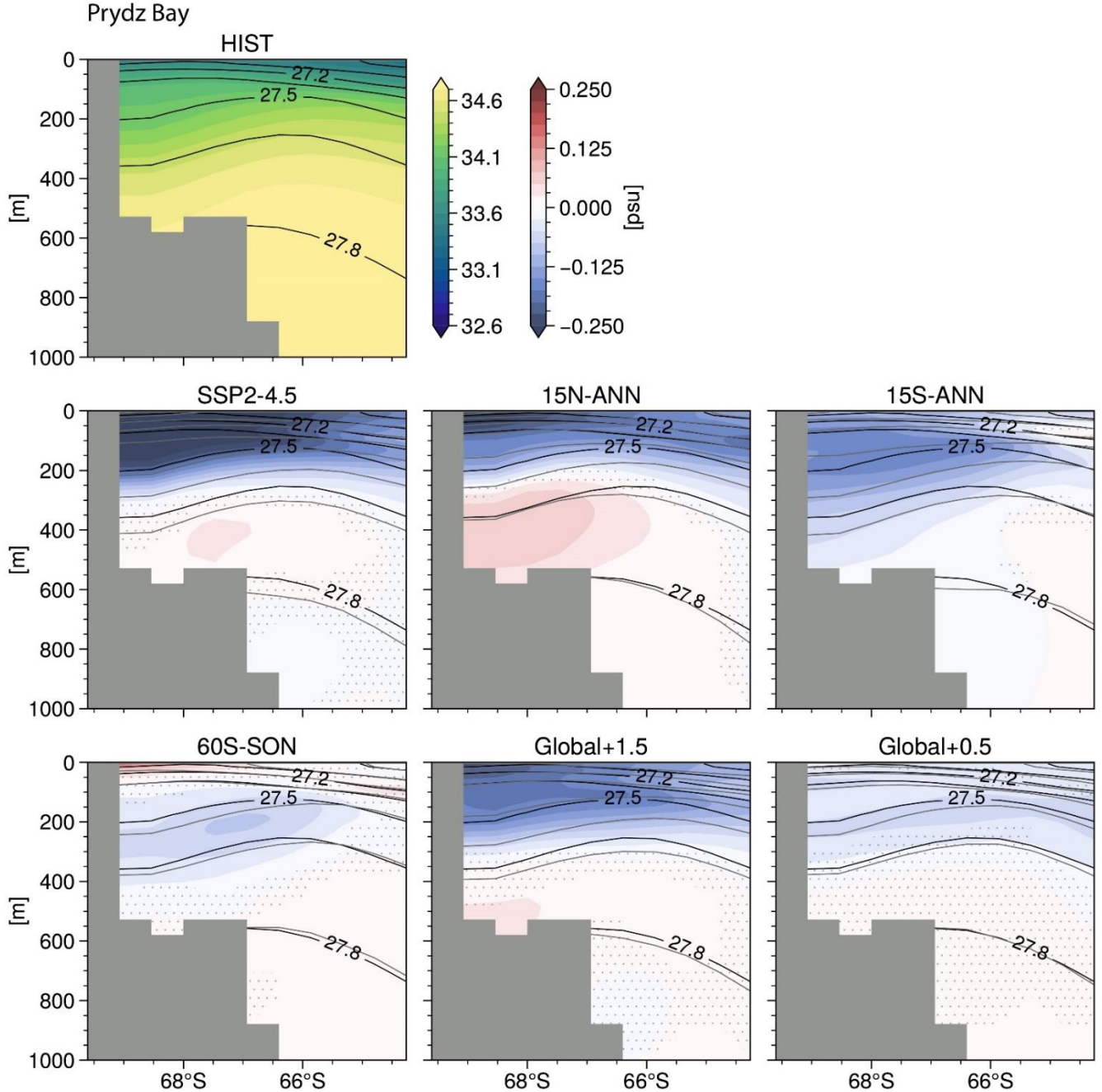
**Figure S10.** The top left panel shows the Amundsen Sea embayment cross-shelf transect at 106°W of potential temperature referenced to the surface (°C) with contours of constant potential density (isopycnals, minus 1,000 kg m<sup>-3</sup>) for the Historical ensemble mean (1990-2009). Shading in the following rows show the annual ensemble mean temperature anomalies (2050-2069) from the Historical with respect to SSP2-4.5 and the SAI cases where stippling shows the regions where the difference is

not statistically significant. In the difference panels, black contours mark the Historical isopycnals and gray contours mark the perturbed isopycnals (the lowest perturbed isopycnal is also  $27.8 \text{ kg m}^{-3}$ ).



**Figure S11.** The top left panel shows the Historical annual ensemble mean (1990-2009) 0-100 m mean salinity (psu). Shading in the following rows show the annual ensemble mean anomalies (2050-2069)

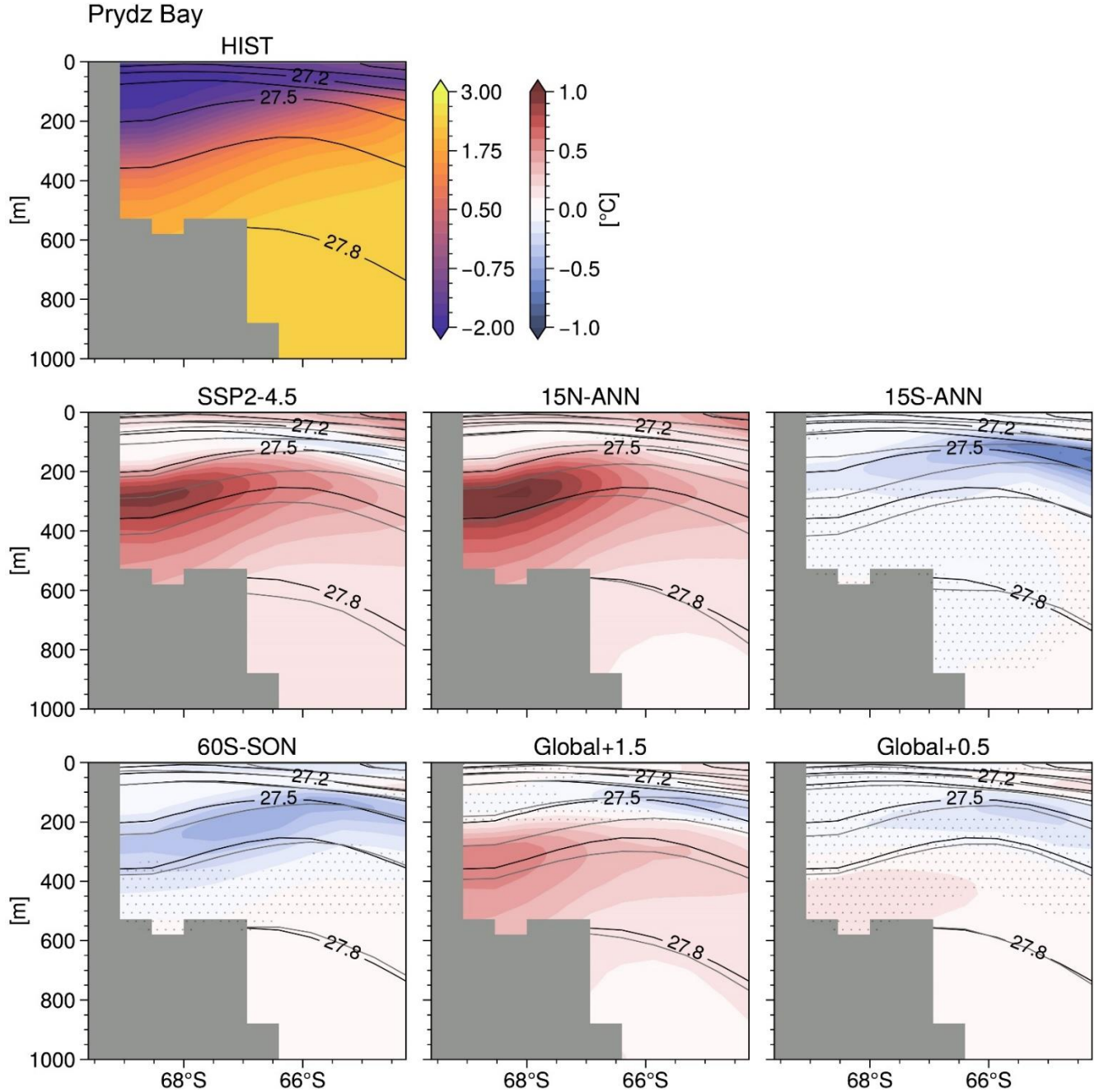
from the Historical with respect to SSP2-4.5 and the SAI cases. Stippling shows the regions where the difference is not statistically significant.



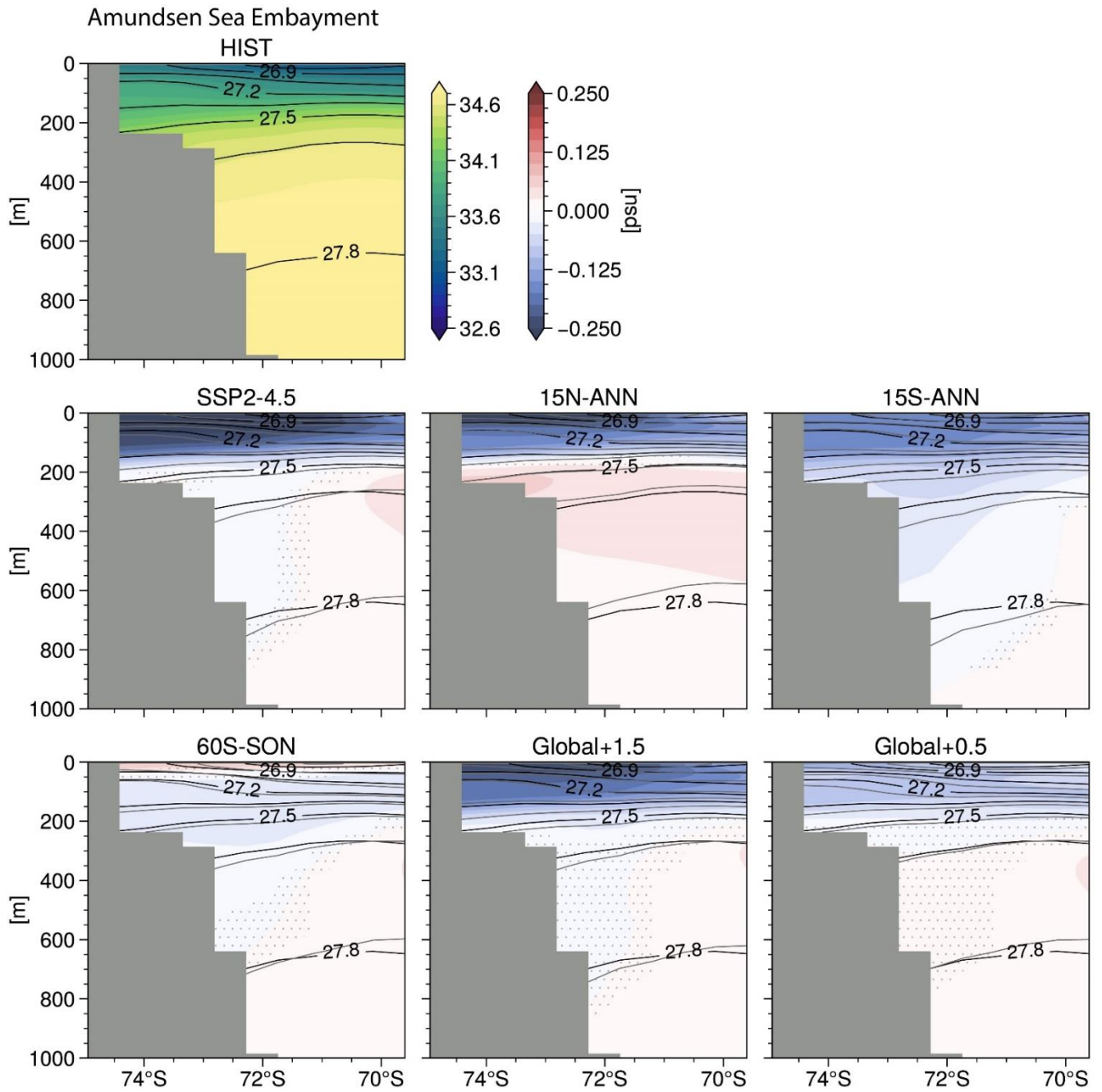
**Figure S12.** The top left panel shows the Prydz Bay cross-shelf transect at 74°E of salinity (psu) with contours of constant potential density (isopycnals, minus 1,000 kg m<sup>-3</sup>) for the Historical ensemble mean (1990-2009). Shading in the following rows show the annual ensemble mean temperature anomalies (2050-2069) from the Historical with respect to SSP2-4.5 and the SAI cases where stippling shows the



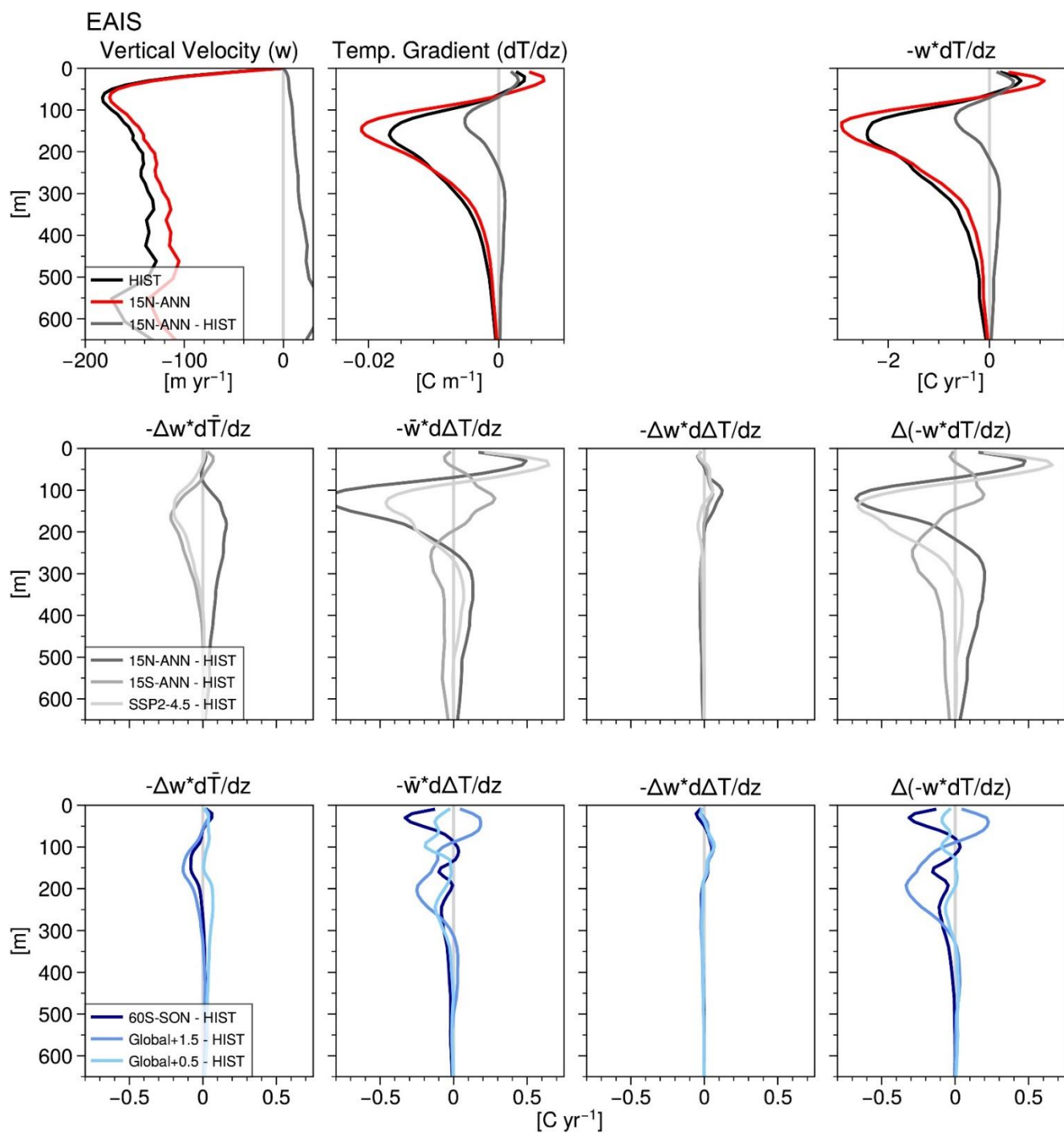
regions where the difference is not statistically significant. In the difference panels, black contours mark the Historical isopycnals and gray contours mark the perturbed isopycnals (the lowest perturbed isopycnal is also  $27.8 \text{ kg m}^{-3}$ ).



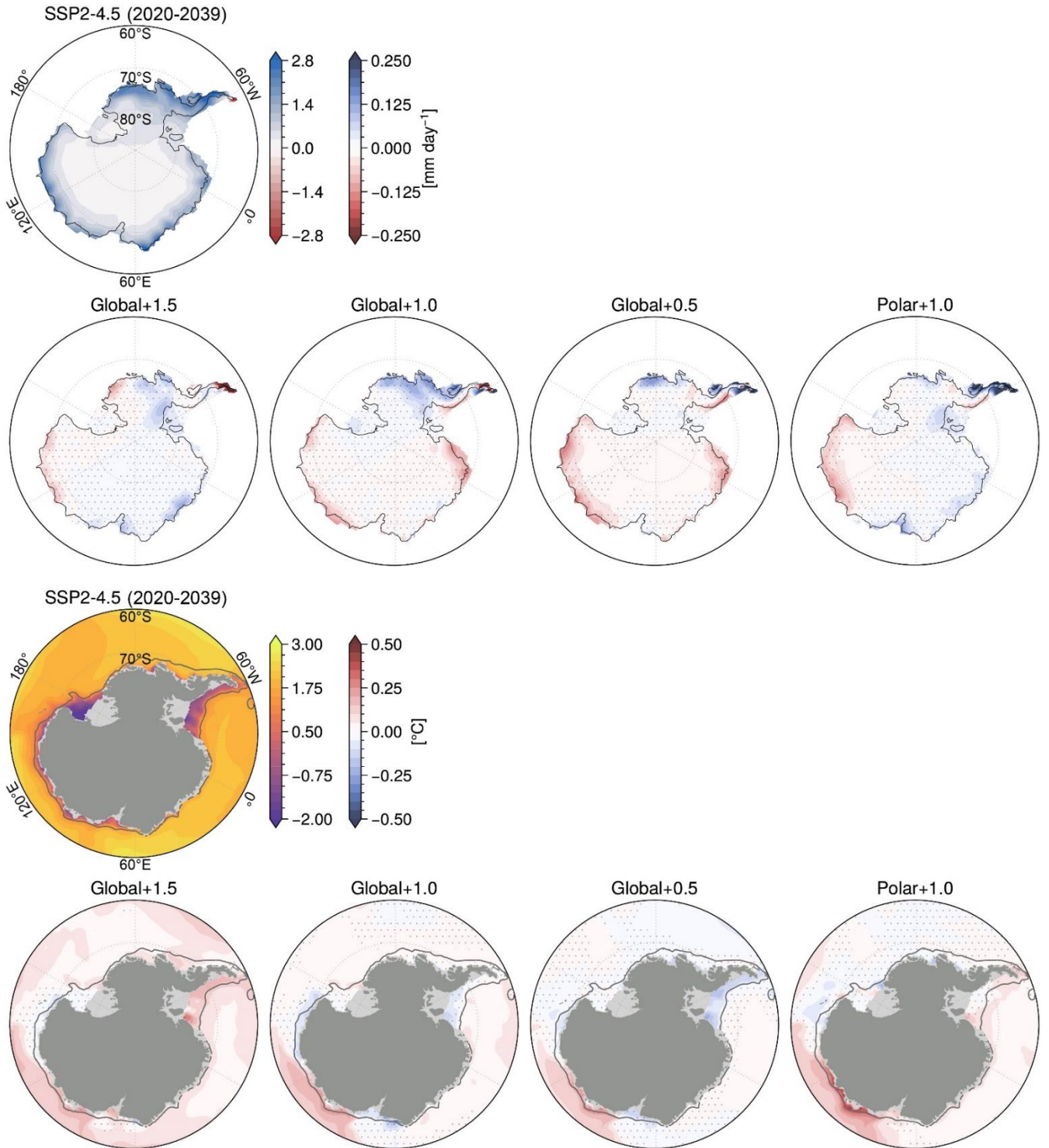
**Figure S13.** Same caption as for Figure S10 but showing the Prydz Bay cross-shelf transect at  $74^\circ\text{E}$ .



**Figure S14.** Same caption as for Figure S12 but showing the Amundsen Sea embayment cross-shelf transect at 106°W.



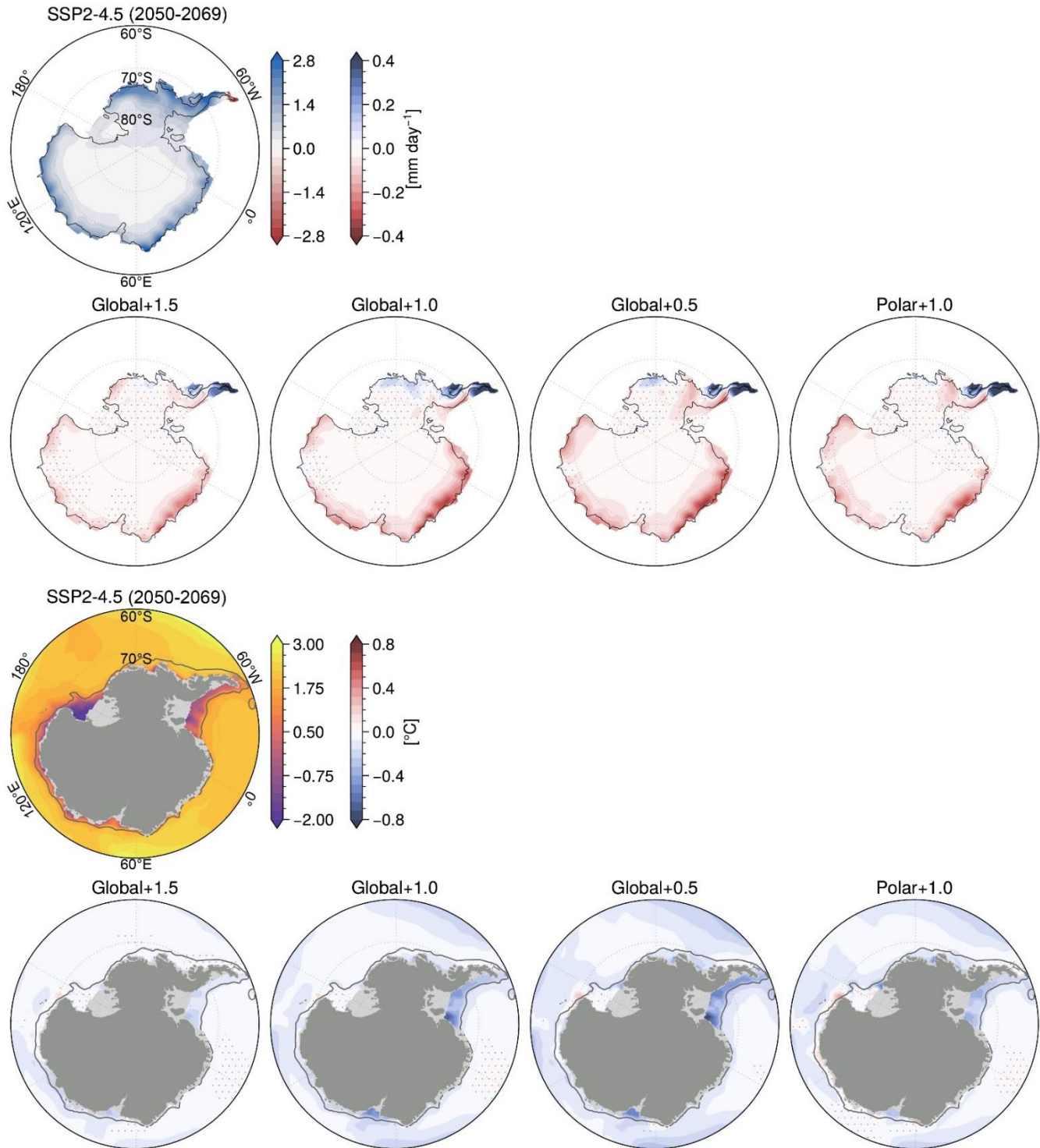
**Figure S15.** Same caption as for Figure S9 but showing the EAIS sector.



**Figure S16.** The first row and third row show the SSP2-4.5 annual ensemble mean (2020-2039) net surface ice accumulation ( $\text{mm day}^{-1}$ ) and 100-1,000 m mean ocean potential temperature ( $^{\circ}\text{C}$ ), respectively. The second row shows the annual ensemble mean ice accumulation anomalies (2050-2069) from the SSP2-4.5 (2020-2039) for the four multi-latitude SAI cases. The fourth row shows the annual ensemble mean 100-1,000 mean temperature anomalies (2050-2069) from the SSP2-4.5 (2050-2069) for



the four multi-latitude SAI cases. The dark gray contour follows the 1,500 m isobath. Stippling shows the regions where the difference is not statistically significant.



**Figure S17.** Same caption as for Figure S16 but using results from SSP2-4.5 2050-2069 instead of SSP2-4.5 2020-2039.