

# Supporting Information for "Strongly eddying ocean simulations required to resolve Eocene model-data mismatch"

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## Contents of this file

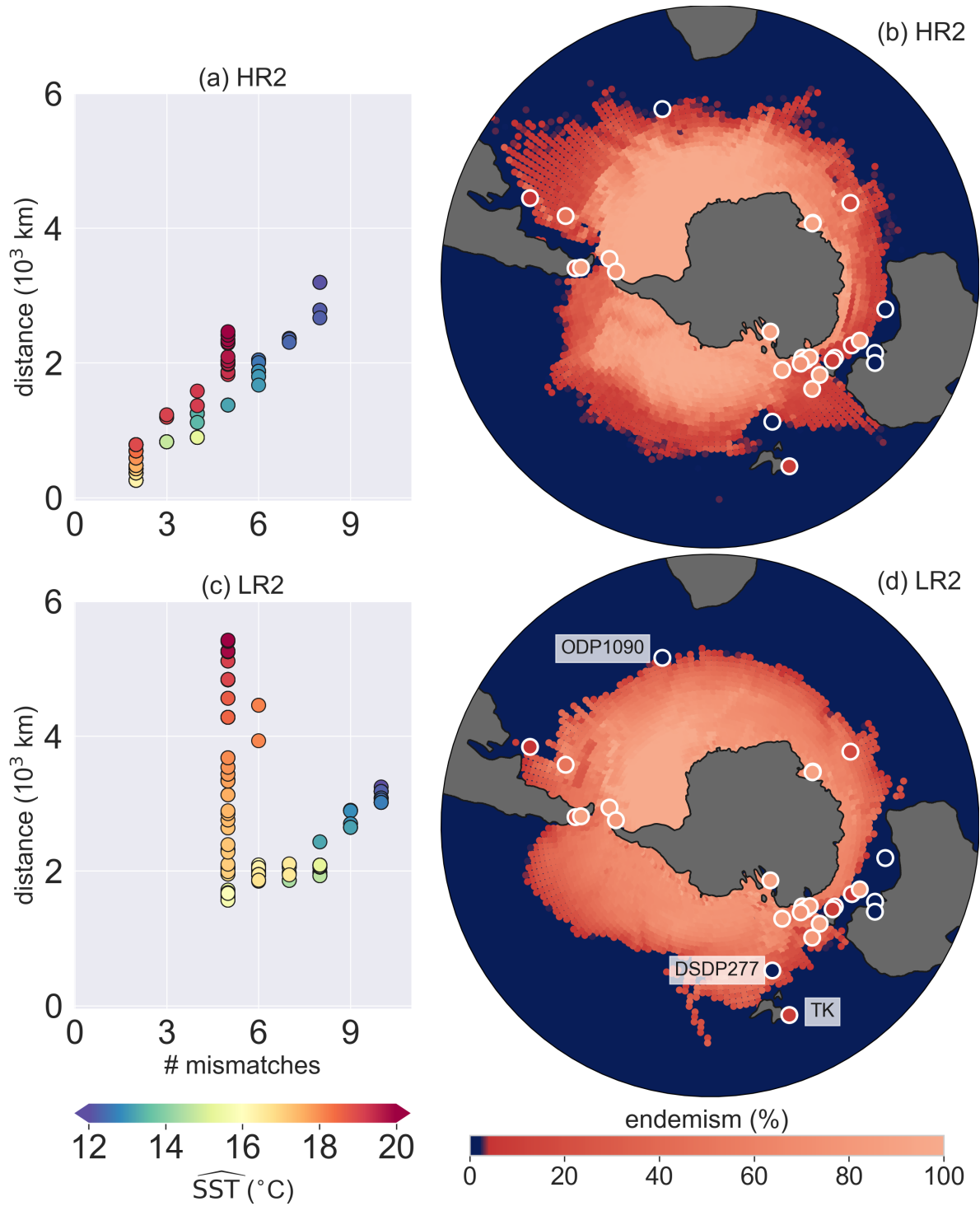
1. Figures S1 to S10

## Additional Supporting Information (Files uploaded separately)

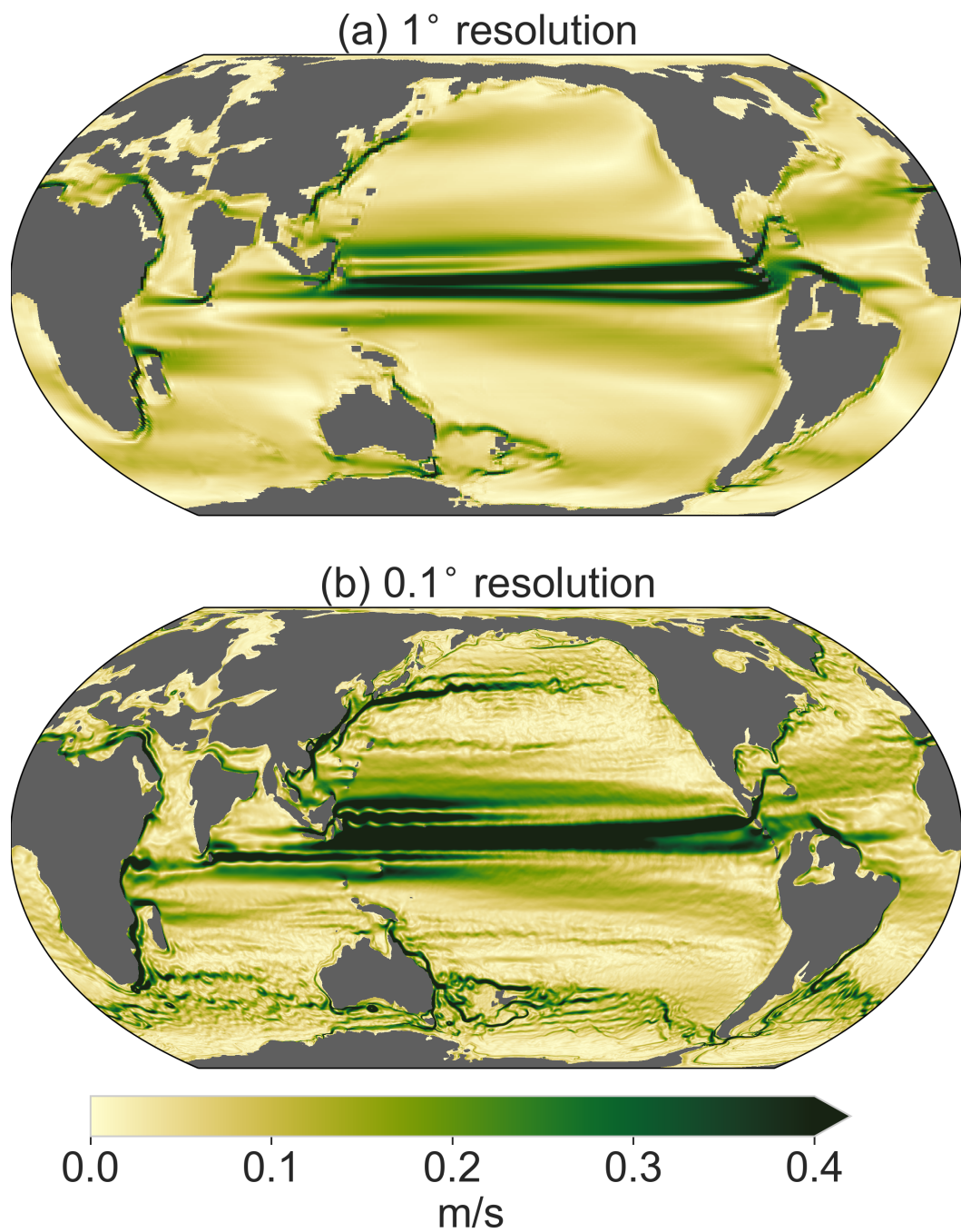
1. Caption for Movie S1

**Introduction** These Supplementary Materials include 11 figures and 1 animation that support the results described in the main article.

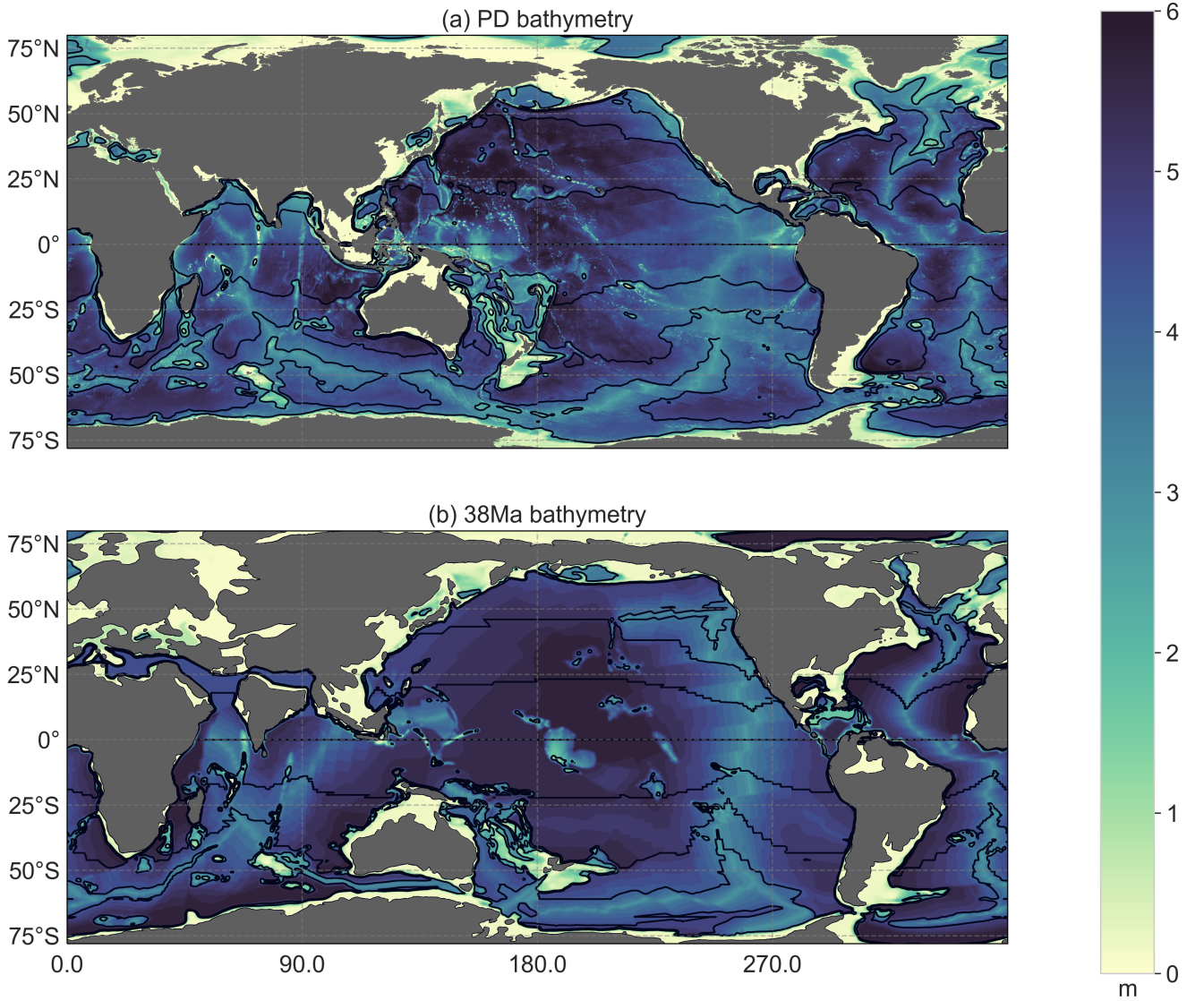
**Movie S1.** Animation of sea surface temperature during the spin-up of the LR2 simulation.



**Figure S1.** Same as figure 2, but for the  $2\times$ pre-industrial case (LR2 and HR2).

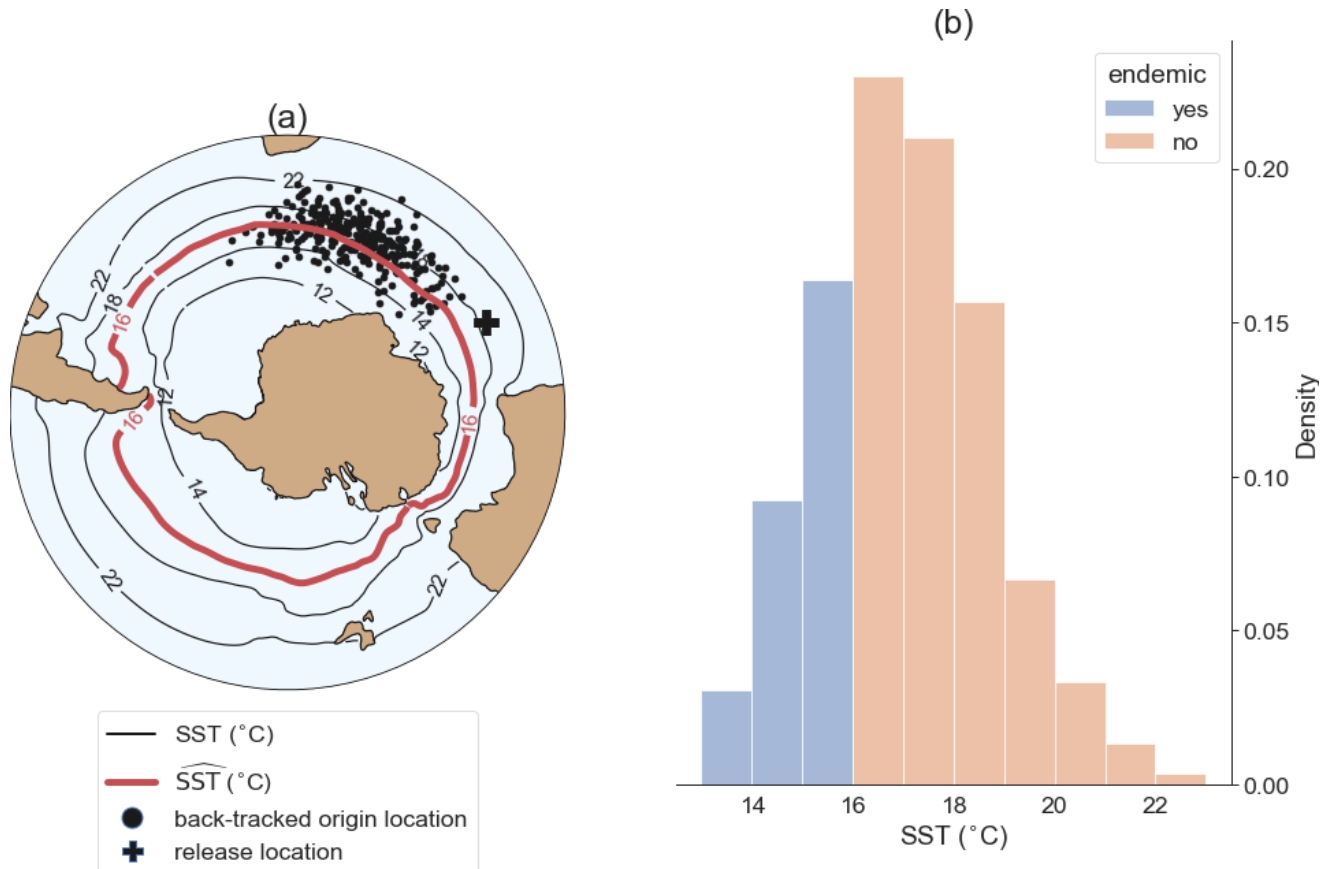


**Figure S2.** Same as figure 1, but for the  $2\times$ pre-industrial case (LR2 and HR2).

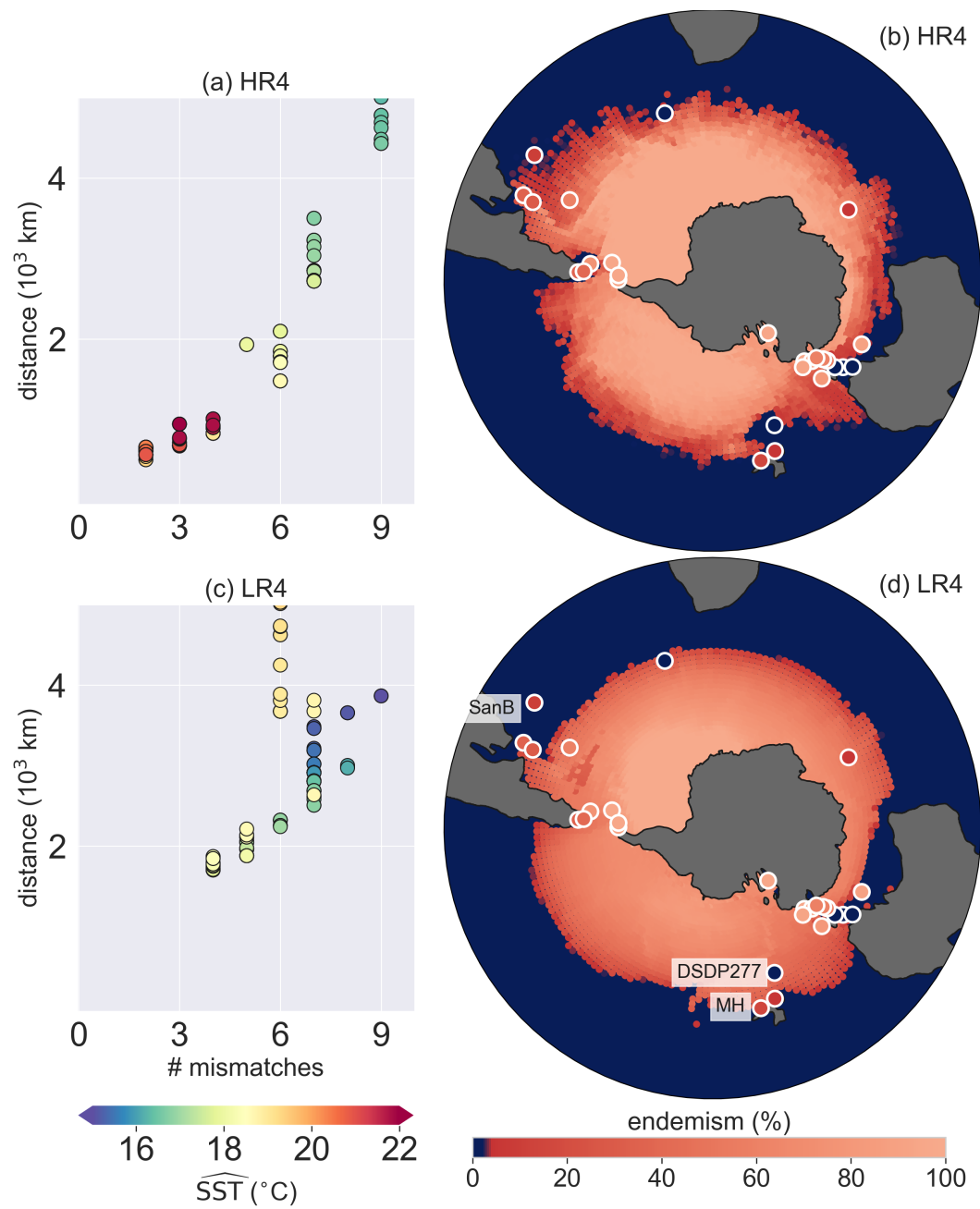


**Figure S3.** Global bathymetry in (a) the present-day (PD) and (b) the middle-late Eocene (38Ma). Black contours are lines of constant  $\frac{f}{H}$  that the flow tends to follow in eddying simulations to conserve potential vorticity, with  $f = 2\Omega \sin(\phi)$  the coriolis parameter ( $\Omega$  is the rotation rate of the Earth and  $\phi$  the latitude) and  $H$  the bathymetry.

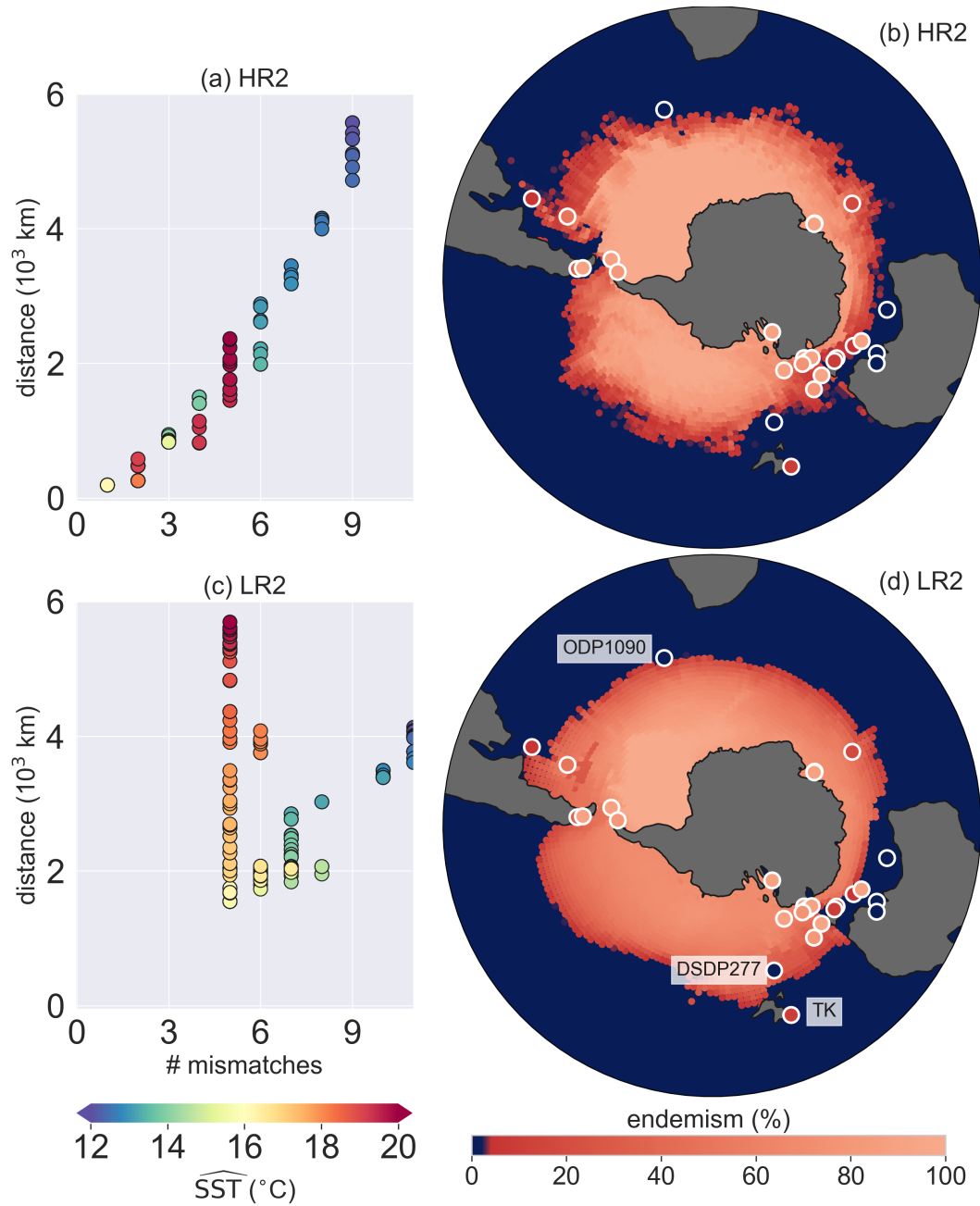




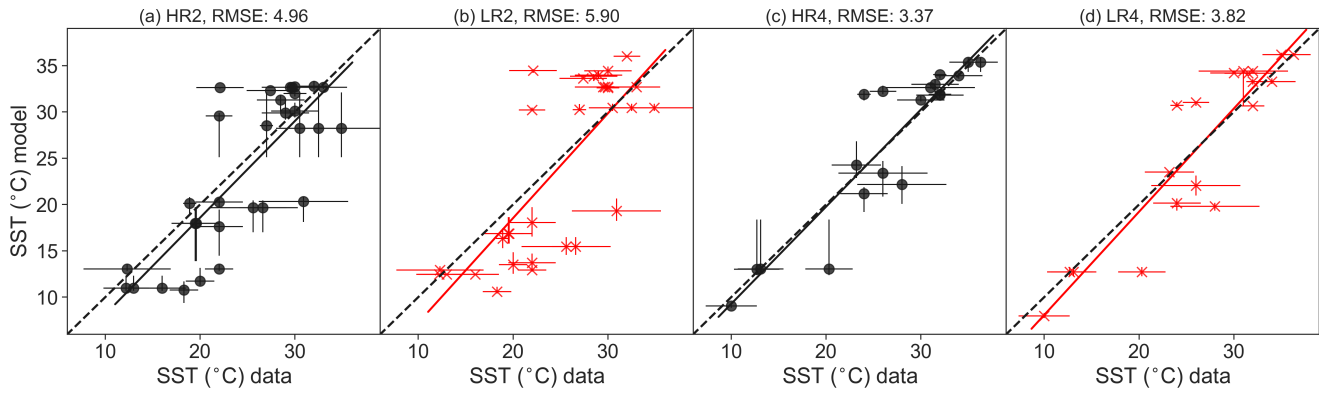
**Figure S4.** Illustration of the modelled dinocyst endemism near Antarctica. (a) Virtual particles are released at the bottom release location and tracked back in time with some sinking speed to determine their surface origin location. If the SST at the back-tracked origin location is lower than the threshold SST ( $\widehat{SST} = 16^{\circ}\text{C}$  in this illustration), it is assumed to originate close to Antarctica, hence it is flagged as endemic. (b) A histogram of SSTs at the surface origin locations.



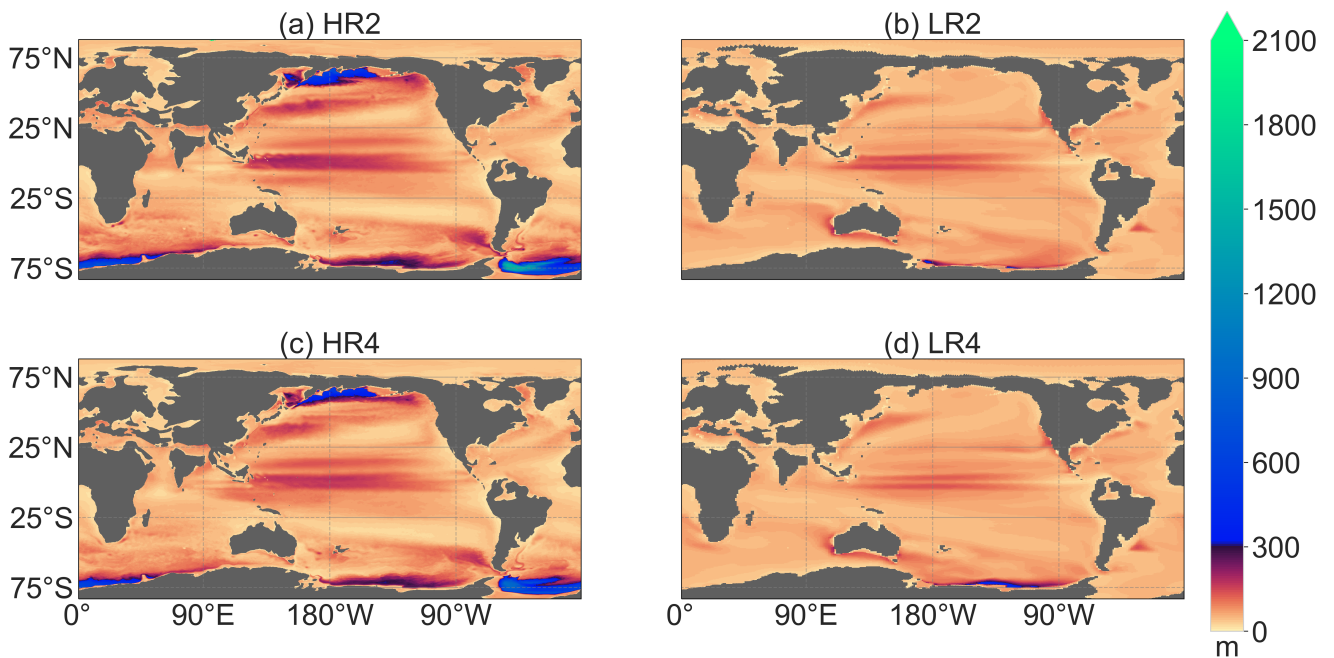
**Figure S5.** Same as figure 2, but with  $25 \text{ m day}^{-1}$  sinking speed.



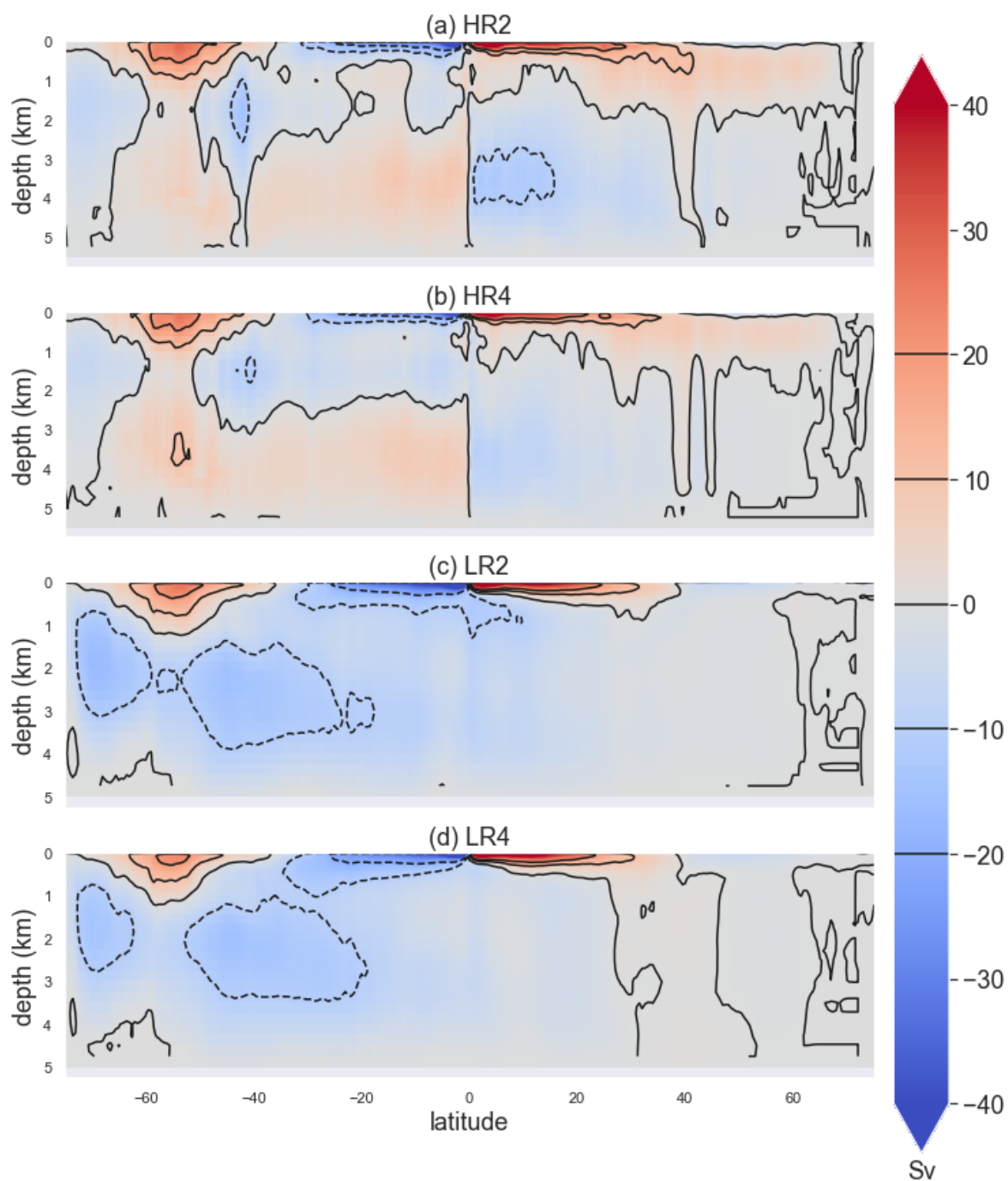
**Figure S6.** Same as figure 2, but with  $25 \text{ m day}^{-1}$  sinking speed and  $2\times$ pre-industrial case (LR2 and HR2).



**Figure S7.** Same as figure 4g-j, but with a point-to-point comparison of model and data. The vertical uncertainty bars show the SST spread (minima and maxima) within a  $4 \times 4^\circ$  box around the sites.

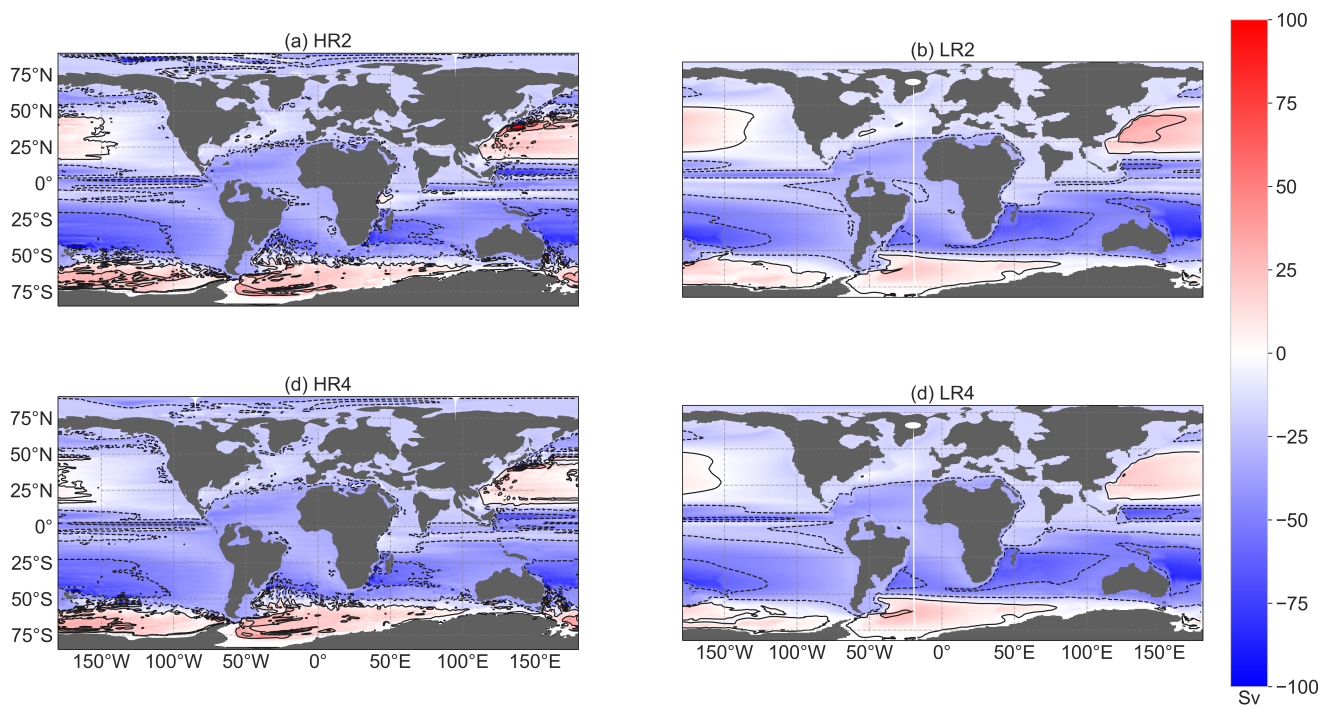


**Figure S8.** Maximum monthly mean of the mixed layer depth.



**Figure S9.** Meridional overturning stream function of the time-mean flow (over the same years as figure 1) in configuration (a) HR2, (b) HR4, (c) LR2 and (d) LR4.





**Figure S10.** Barotropic stream functions of the annual mean circulation.