SUPPLEMENTARY MATERIAL

Parameter calibration

We calibrated six parameters controlling ice flow: the shallow ice and shallow shelf Enhancement Factors (SIAe and SSAe, respectively) can have a strong impact of the flow of ice as direct coefficients in the stress-strain relationship. High values of SIAe (up to 3) and SSAe values (up to 2.5) were included in the initial calibration process so that ice stream velocity might be induced to produce close to modern surface velocities, if such values were necessary. The calibration found stable values for these two parameters around 1.0 for SIAe and 1.25 for SSAe, respectively. The parameters and ranges of values used are given in Table 1, and the results of this tuning are shown in Fig. 3.

Both the lower limit of till effective pressure as a fraction of overburder δ and pseudo-plastic q had relatively stable values from the calibration. The Pseudo-plastic q had a value very close to 1, implying a nearly linear sliding relationship such that basal shear stress is close to linear with velocity. The two parameters which the calibration did not strongly constrain were the till friction angle depth min and till friction angle depth range. These two were more correlated than most parameters, at an r-value of 0.26 (Fig. 3), yet in particular the distribution of the till friction angle depth min value appeared to be nearly uniform across the entire range.

Mass balance by scenario

Mass balance with time is given in Fig. S2. The extremely high calving rates near 2070 and 2080 in the $+1$ °C ocean warming scenario are due to a sudden collapse in these scenarios of the Brunt Ice Shelf. Likewise this collapse happens in the early 2030s in the $+2$ °C ocean warming scenario, and in 2022 in the $+3$ °C scenario. In the ocean warming scenarios there is a low spread for most of these mass balance terms as the climate forcing was identical for each ensemble member.

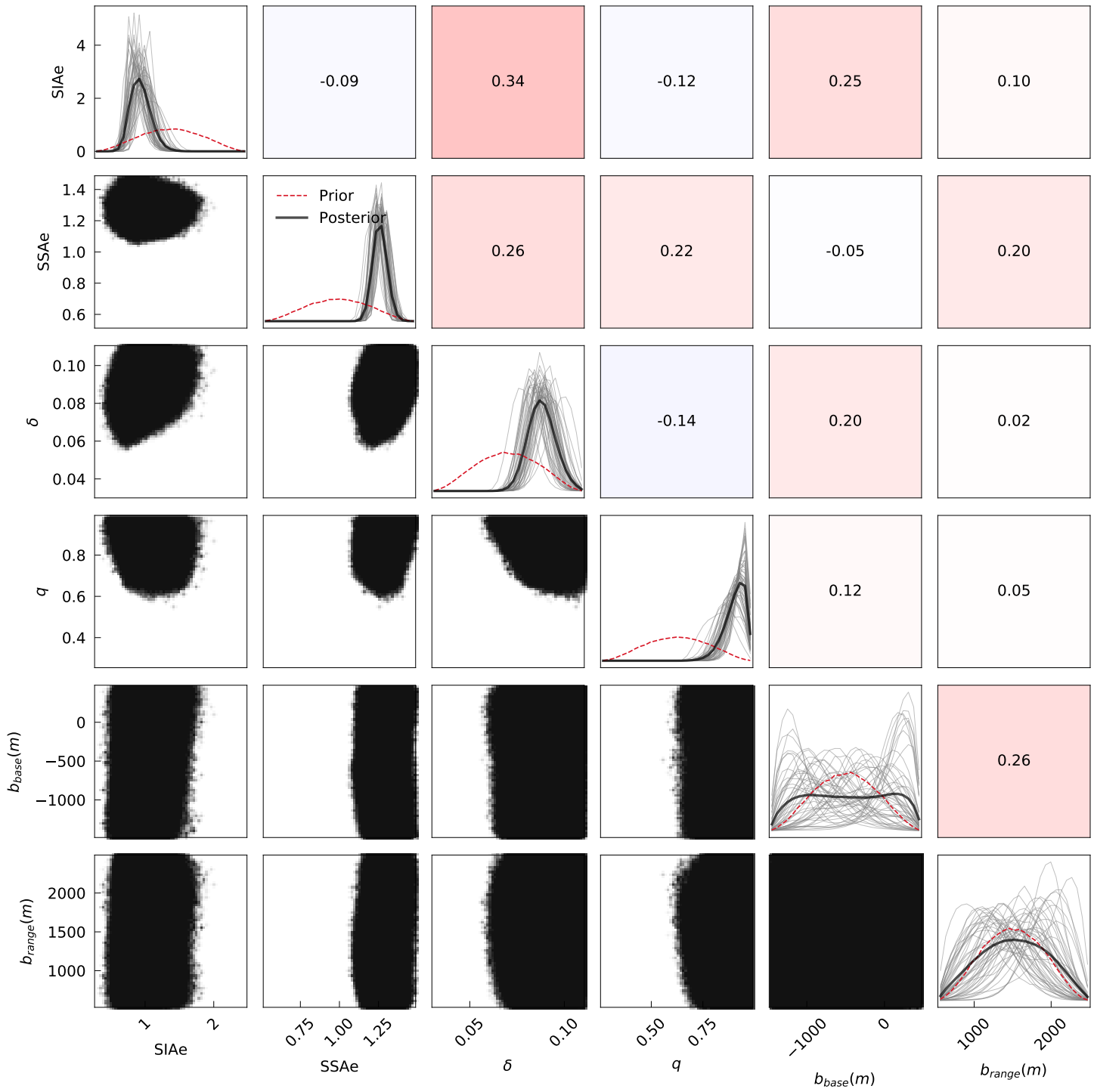

Fig. S1. Surrogate model analysis results. Color-coded boxes above the diagonal show the correlation coefficients between parameters, the diagonal shows prior (red) and posterior distributions (black) in the MCMC sampling, along with each emulator (grey), and plots below the diagonal show all the parameter configurations.

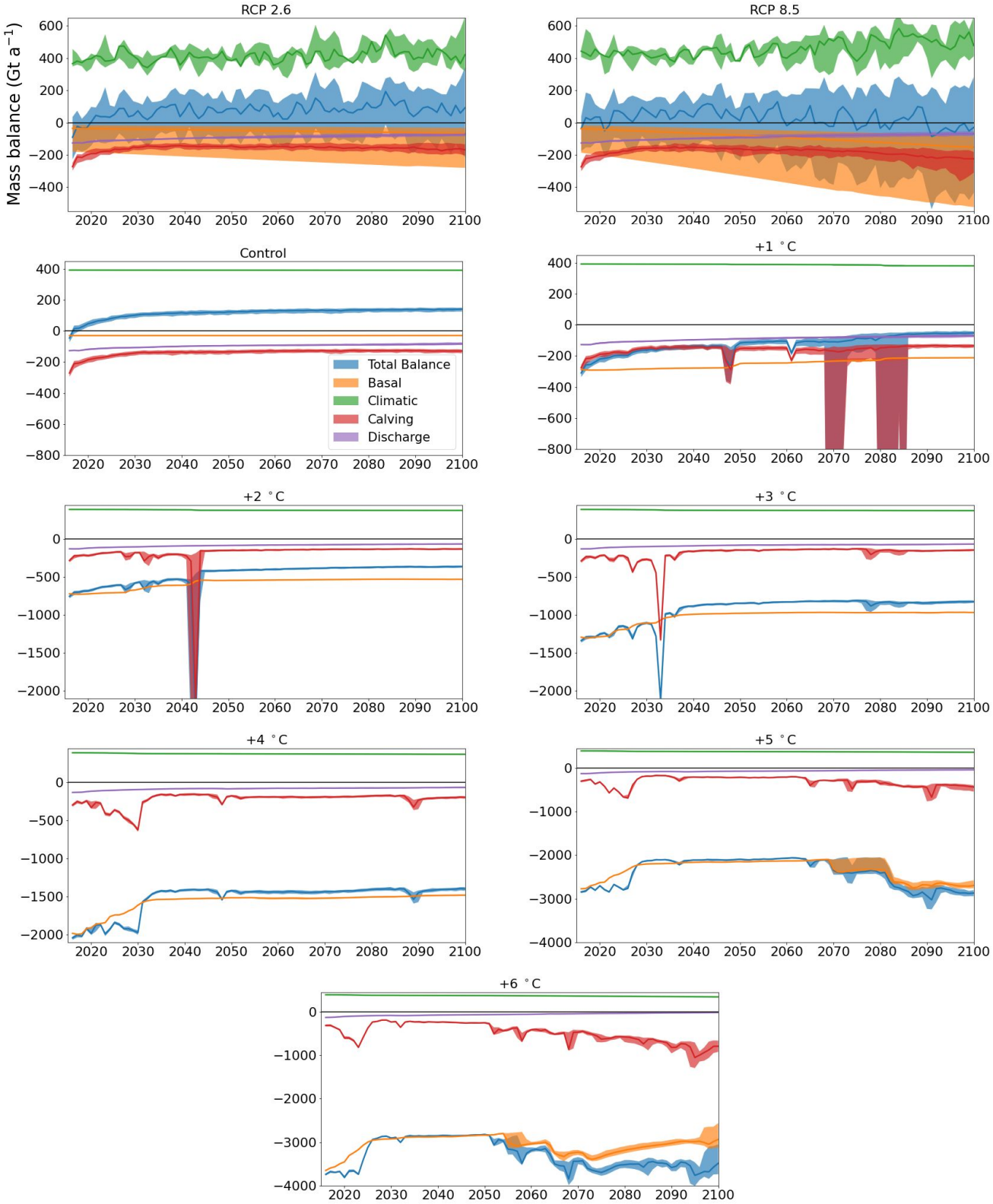

Fig. S2. Mass balance terms for each ensemble scenario. The 90% credible interval is shown for each parameter, with a line for the median given.