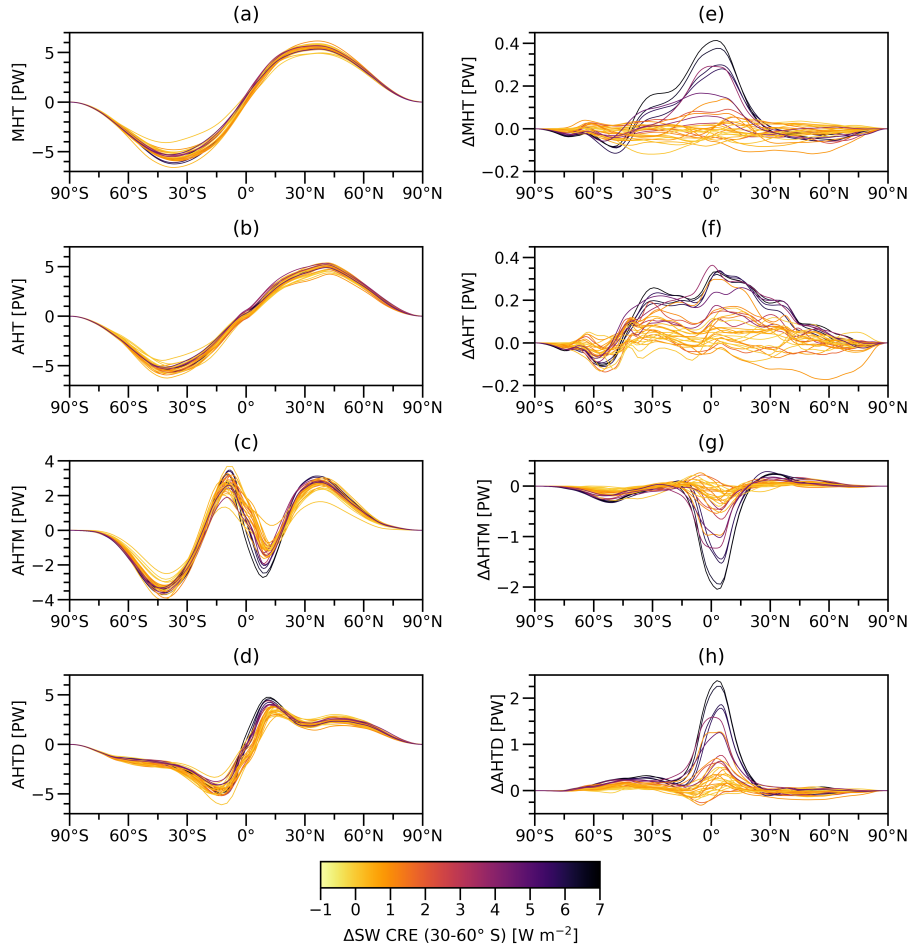
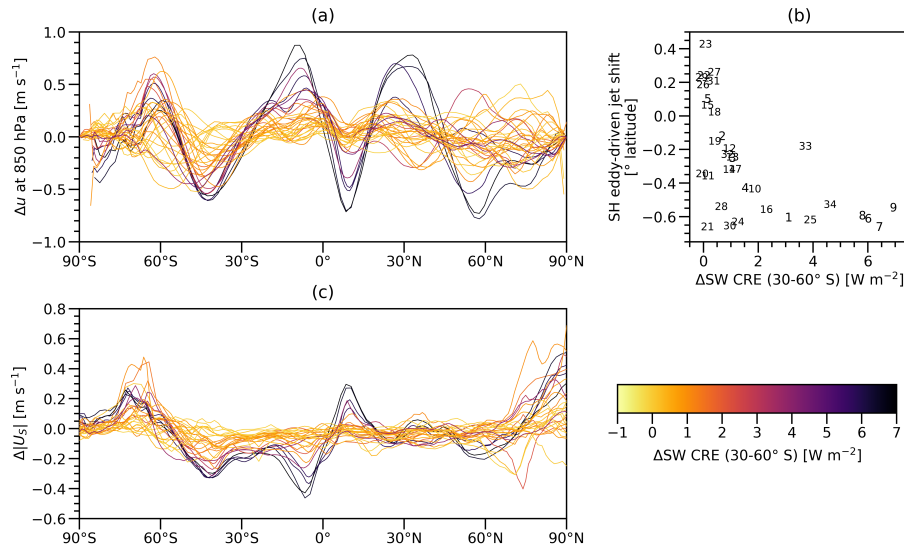
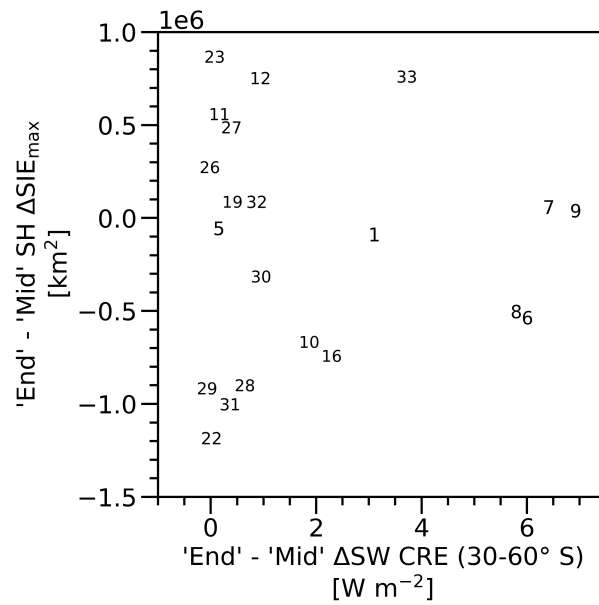
Supplementary Figure S1. Model mean asymmetries (northern minus southern hemispheric means) in pre-industrial (PI) control simulations, in terms of differences in upwelling short wave radiation at the top of the atmosphere in W m^{-2} (bottom axis) and albedo fraction (top axis); error bars represent the standard deviation of 12-month running mean asymmetries.

Supplementary Figure S2. Left column (a-d): mean profiles of inferred meridional heat transport (MHT) and its components (AHT: atmospheric heat transport; AHTM: moist atmospheric heat transport; and AHTD: dry atmospheric heat transport), respectively, as calculated in the method outlined in Section 2.2 during the 'End' period of the simulation (years 130-150). Right column (e-h): mean differences in MHT and its components AHT, AHTM, and AHTD, respectively, between the 'End' and 'Mid' periods. The color of each curve represents the 'End' minus 'Mid' difference in area mean short wave cloud radiative effect (SW CRE) over 30-60° S.

Supplementary Figure S3. (a) Meridional profile of differences in zonal mean zonal wind u at 850 hPa between the 'End' and 'Mid' periods. (b) Mean difference of SH eddy-driven jet position between the 'End' and 'Mid' periods, plotted against the 'End' minus 'Mid' difference in area mean SW CRE over 30-60° S; the latitudinal positions of maxima of zonal mean u are here estimated by taking the meridional derivative of u and interpolating the intercept. The models are numbered as given in Table 1. (c) Meridional profile of differences in zonal mean near-surface wind speed $|U_S|$ between the 'End' and 'Mid' periods. The color of the curves in (a) and (c) represent the 'End' minus 'Mid' difference in mean SW CRE over 30-60° S.

Supplementary Figure S4. Differences in 30-60° S mean SW CRE versus differences in mean SH sea ice extent maxima SIE_{max} (calculated by multiplying sea ice concentration by grid cell area and taking the annual maxima, then averaging over multiple years) between the 'End' and 'Mid' periods; the models are numbered as given in Table 1.