

1 Supplementary Material

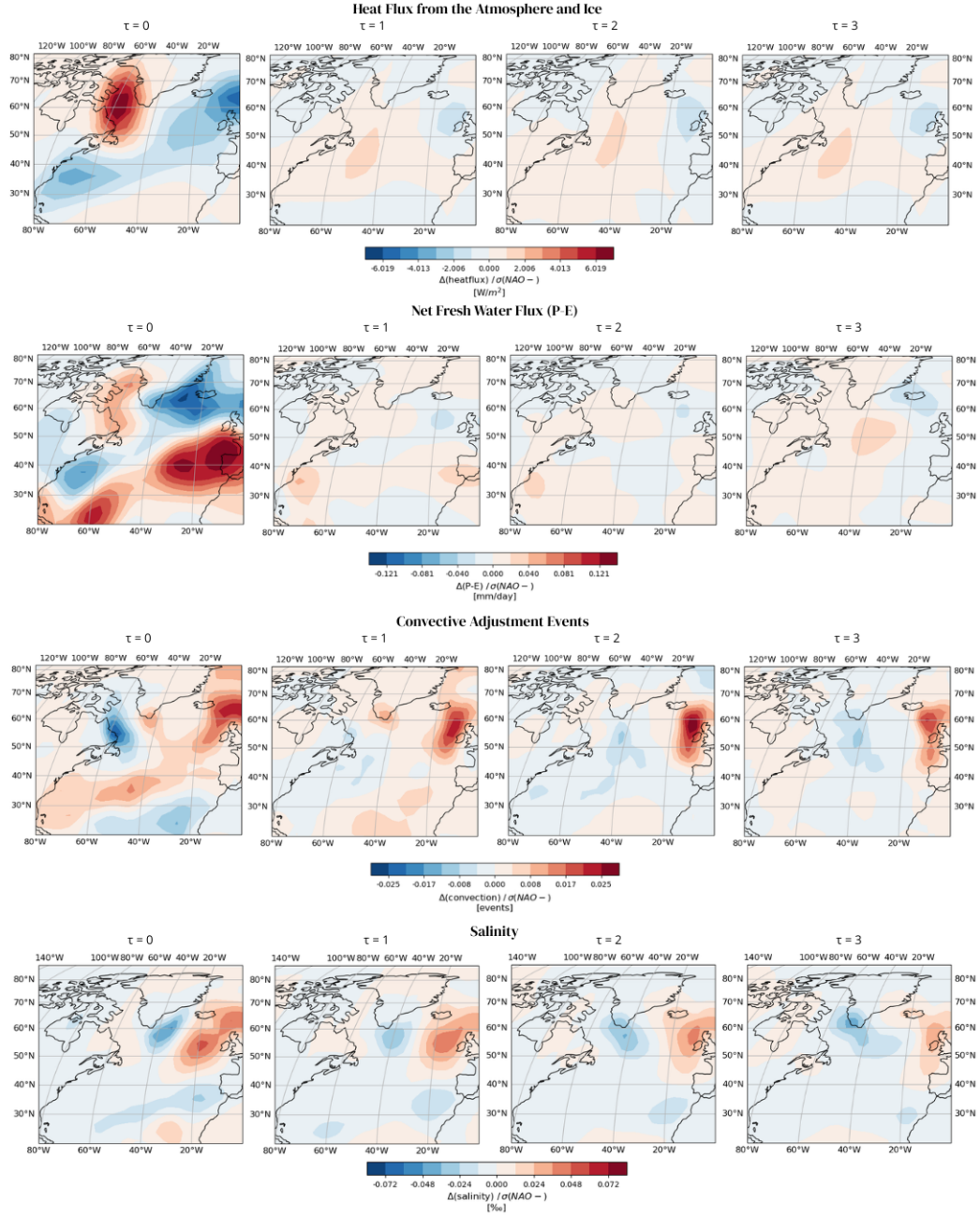


Figure S1: **Lagged linear regressions in the control run.** As in Fig. 3 of the main manuscript, but showing linear regressions at lags $\tau = 0, 1, 2, 3$, with positive τ denoting negative NAO leading.

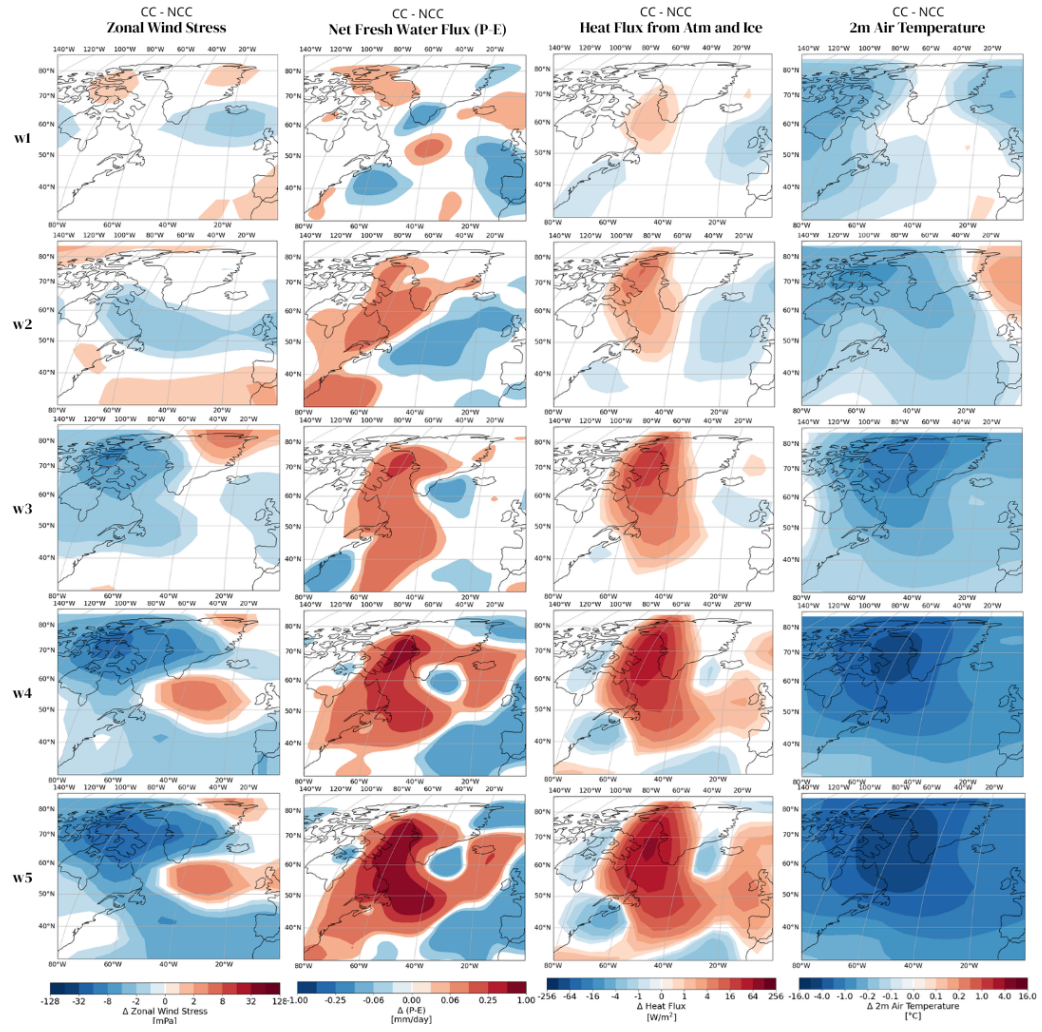


Figure S2: Spatial differences between WA and NWA clusters across time windows w1–w5. As in Fig. 5 of the main manuscript, but for zonal wind stress, net freshwater flux, heat flux, 2m air temperature.

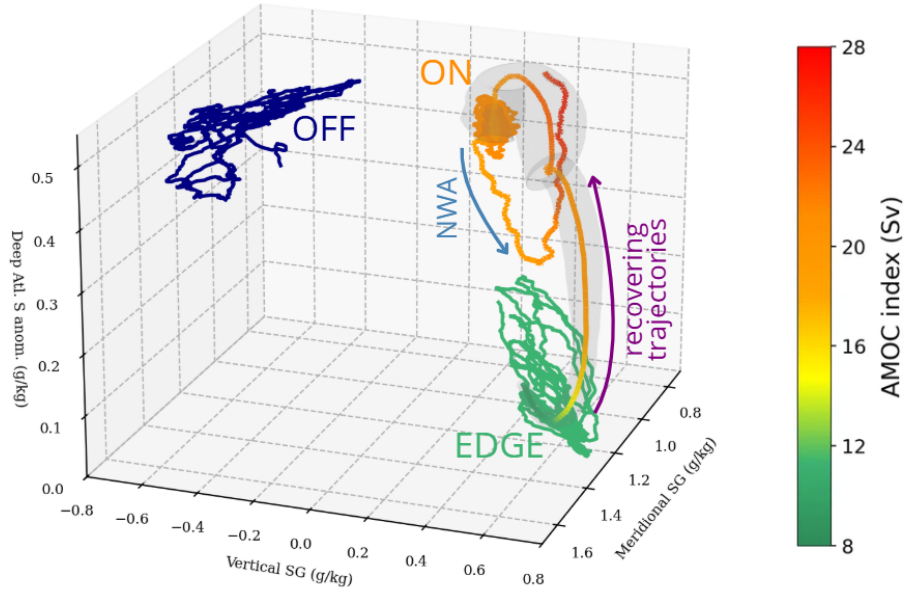


Figure S3: **Return corridor to the ON state.** Reduced phase-space projection of AMOC trajectories (as in Fig. 6-7 of main manuscript), colored by AMOC strength (colorbar, Sv). Arrows indicate the direction of time. Trajectories of the NWA cluster depart from the ON attractor and are pushed toward the edge state under negative NAO forcing, but before reaching it, turn back toward the ON state (lightblue arrow). Trajectories that recover from the edge state without forcing follow a similar pathway back to the ON state (purple arrow). Both sets of trajectories pass through the same phase-space region (grey envelope), in which AMOC strength temporarily overshoots its ON-state value.

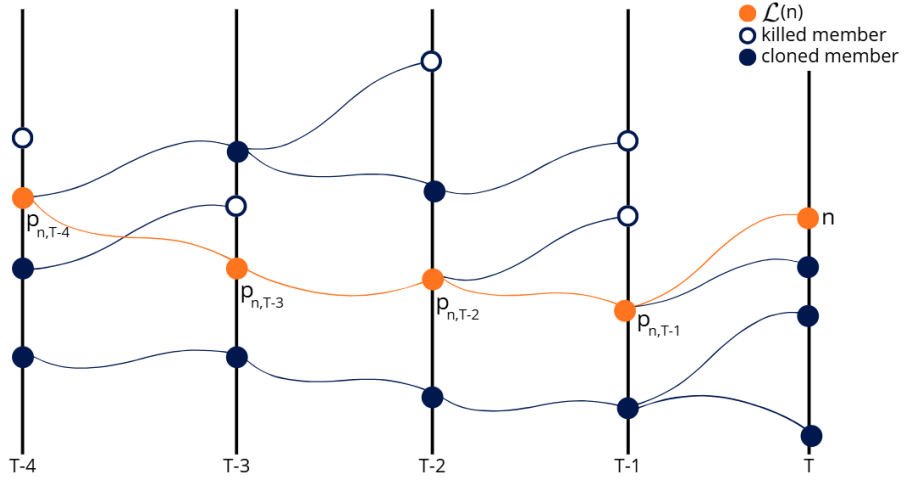


Figure S4: **Rare event algorithm trajectories.** Reconstruction of the genealogical lineage $\mathcal{L}(n)$ for a final member n at time T . Vertical lines indicate successive resampling times; markers denote ensemble members. Open circles represent discarded members, filled circles represent surviving or cloned members. Orange markers trace the reconstructed lineage from the initial ancestor to the final member. Curves indicate parent-child links recorded in the genealogy matrix.