Figure S1. The monthly distribution of isentropic level reached by WCB outflow at the minimum pressure level for (a) NH and (b) SH. The solid line denotes the median, and the shaded region is the interquartile range.

Month	θ^*(NH)	θ^* (SH)
1	315	335
2	315	335
3	320	330
4	320	325
5	330	320
6	340	315
7	345	315
8	340	315
9	335	315
10	325	320
11	320	325
12	320	330

Table S1. The median isentropic levels selected for each month and hemisphere according to the distribution in Figure. S1
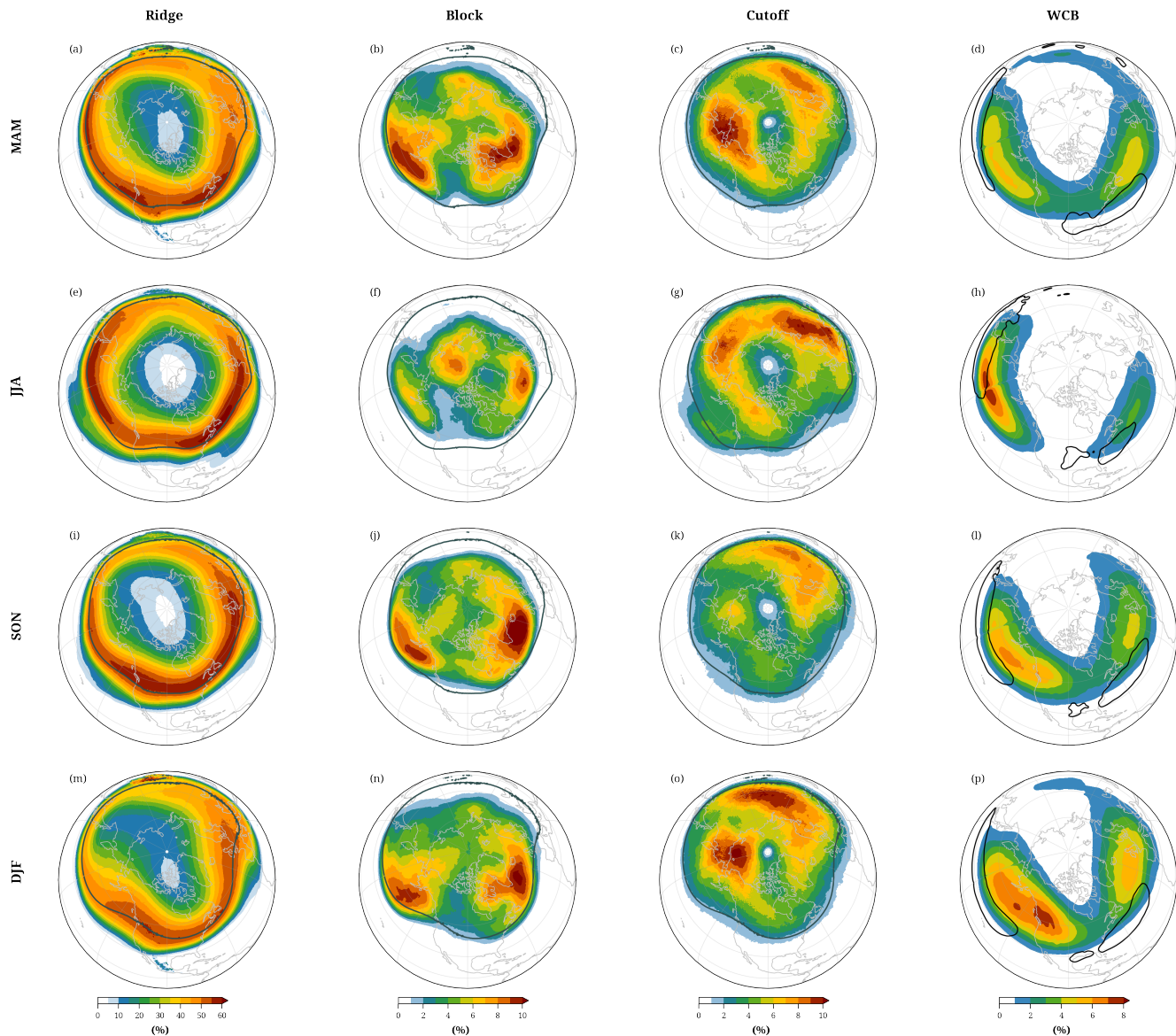
Figure S2. The climatological frequency of occurrence of weather features for different seasons in NH: **(a-d)** MAM, **(e-h)** JJA, **(i-l)** SON, and **(m-p)** DJF, showing (a,e,i,m) ridges, (b,f,j,n) blocks, (c,g,k,o) tropospheric cutoffs, and (d,h,l,p) WCBs at end-of-ascent. Note the different contour values in the four panels. The black contours illustrate in (d,h,l,p) the 95th percentile of the WCB start-of-ascent frequency and, in others, the climatological mean waveguide (i.e., the 2 PVU contour averaged for the four isentropes selected).
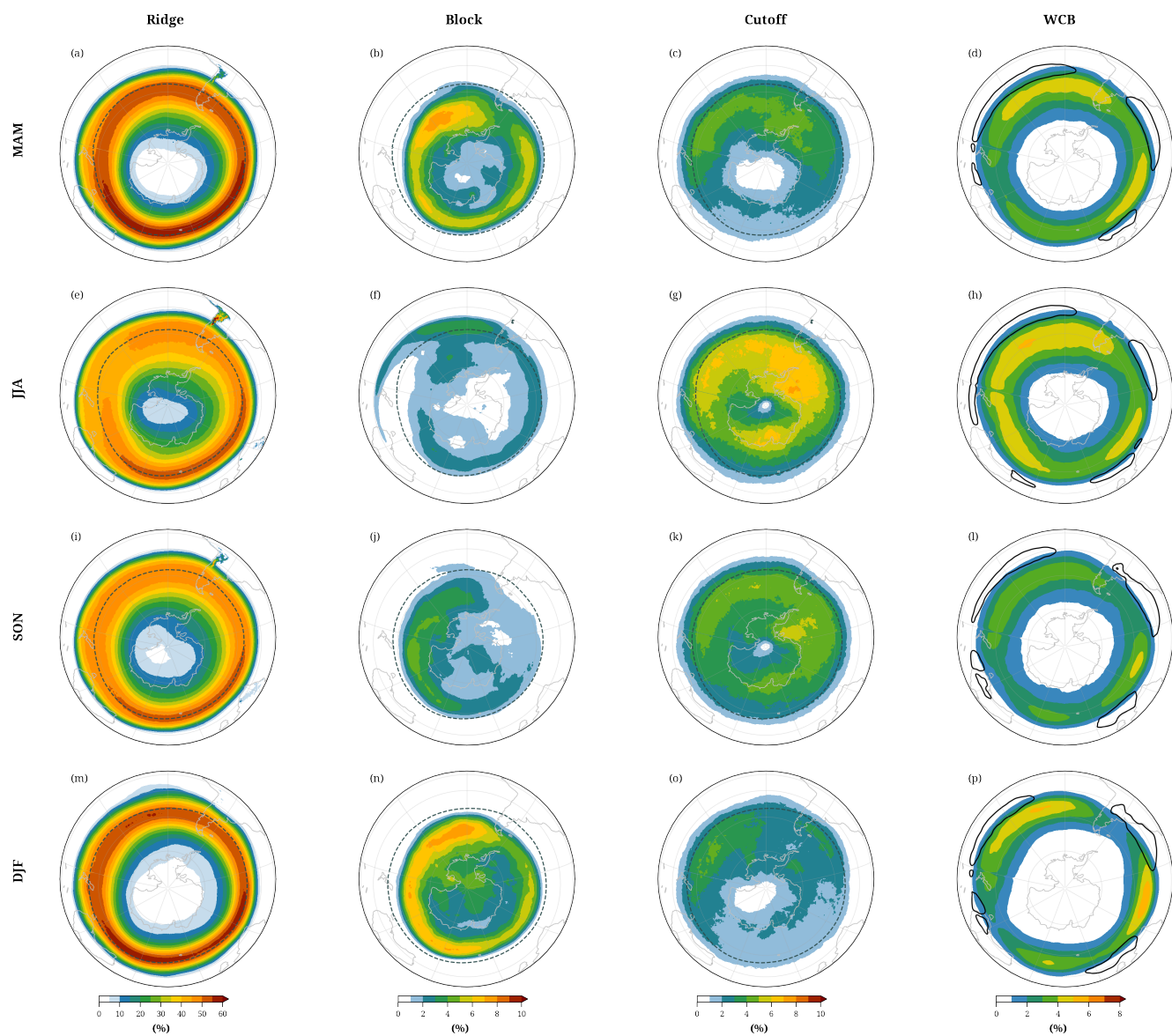
Figure S3. As Fig. S2, but for SH
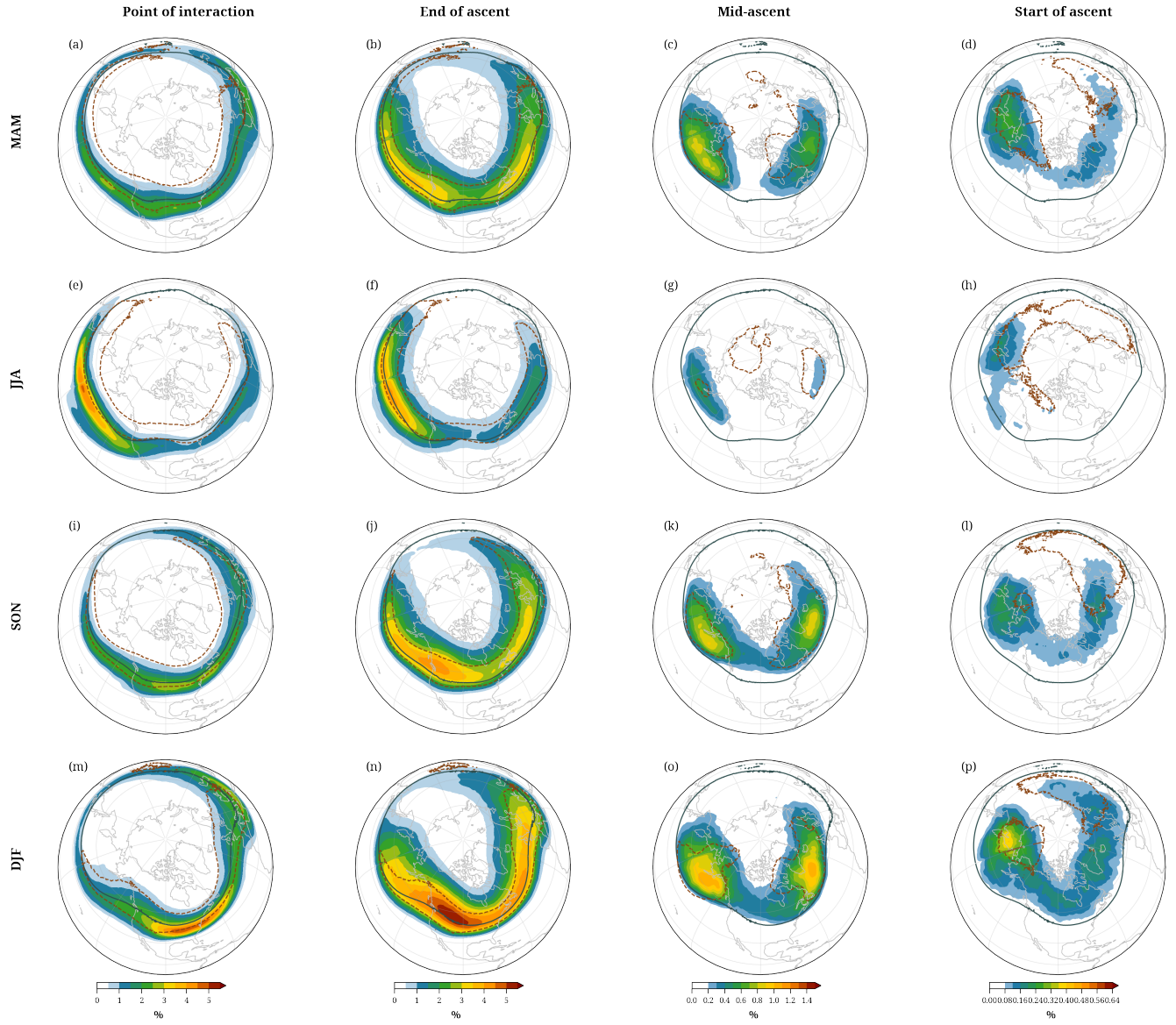
Figure S4. The climatological frequency of occurrence of WCB trajectories at their point of interaction (colors, in %), for different seasons in NH: **(a-d)** MAM, **(e-h)** JJA, **(i-l)** SON, and **(m-p)** DJF, showing the four interaction types (a,e,i,m) no-interaction, (b,f,j,n) ridge, (c,g,k,o) block, and (d,h,l,p) cutoff interactions. Note the different contour values in the four panels. The black contours illustrate the climatological mean waveguide in the particular season (2 PVU), and the dashed red contours show the 95th percentile regions of the associated weather features (a,b,e,f,j,i,m,n) ridges, (c,g,k,o) blocks, and (d,h,l,p) cutoffs.
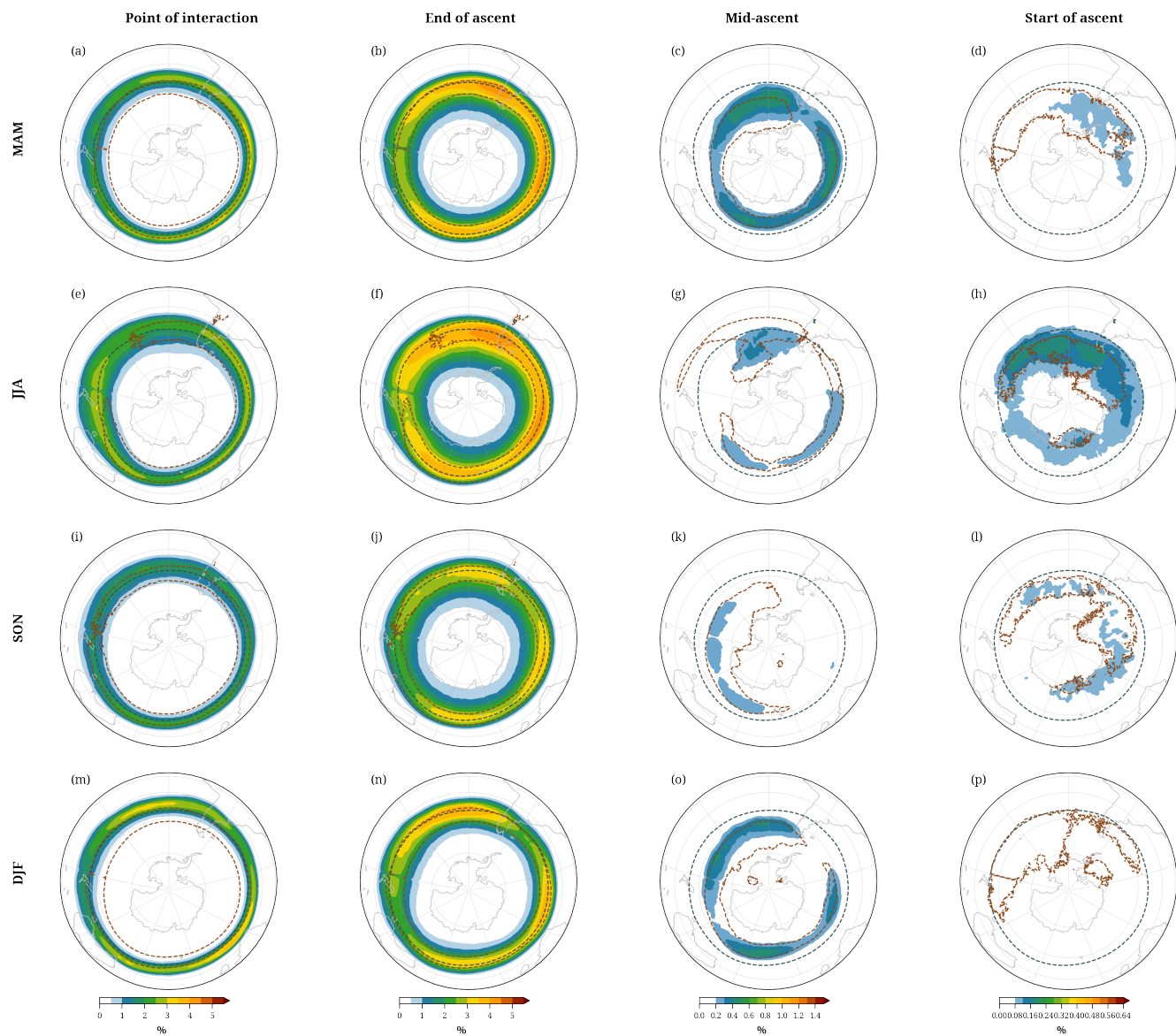
Figure S5. As Fig. S4, but for SH
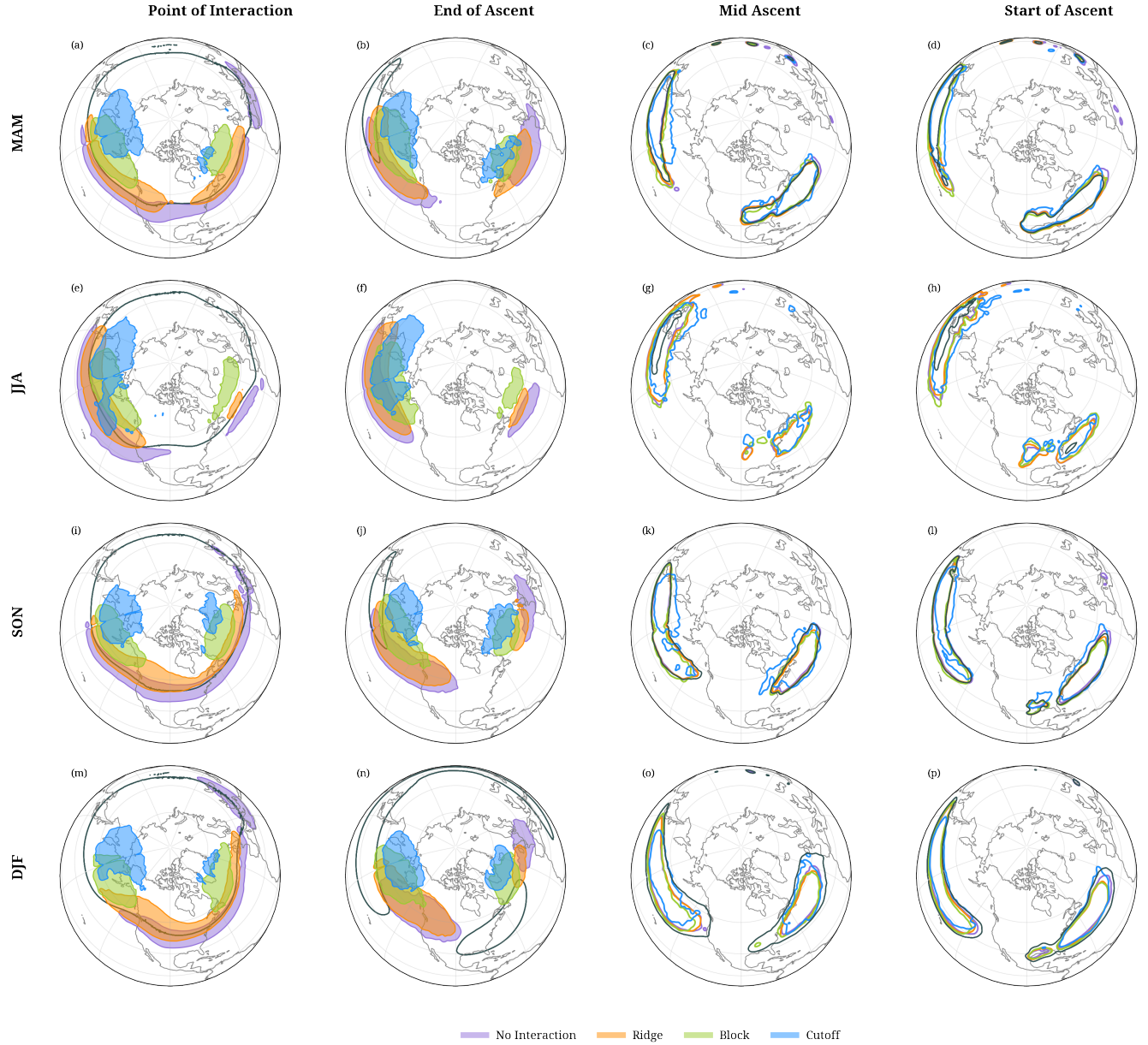
Figure S6. The main climatological frequency maxima (95th percentile regions) of WCB trajectories for: no-interaction (purple shading and contours denoting the regions where the interaction type frequency exceeds the 95th percentile), ridge interaction (orange), block interaction (green), and cutoff interaction (blue) at the four trajectory phases for different seasons in NH: **(a-d)** MAM, **(e-h)** JJA, **(i-l)** SON, and **(m-p)** DJF, showing (a,e,i,m) point of interaction, (b,f,j,n) end-of-ascent, (c,g,k,o) mid-ascent and (d,h,l,p) start-of-ascent. In (c,d,g,h,k,l,o,p) shading is omitted to enhance readability. The black contours in (a,e,i,m) illustrate (a) the climatological mean waveguide and (b,f,j,n) the climatological jet stream indicated by a wind speed of $30\,\mathrm{m\,s^{-1}}$, averaged over the four isentropic levels considered, and 95th percentile regions of total WCB (c,g,k,o) mid-ascent and (d,h,l,p) start-of-ascent.
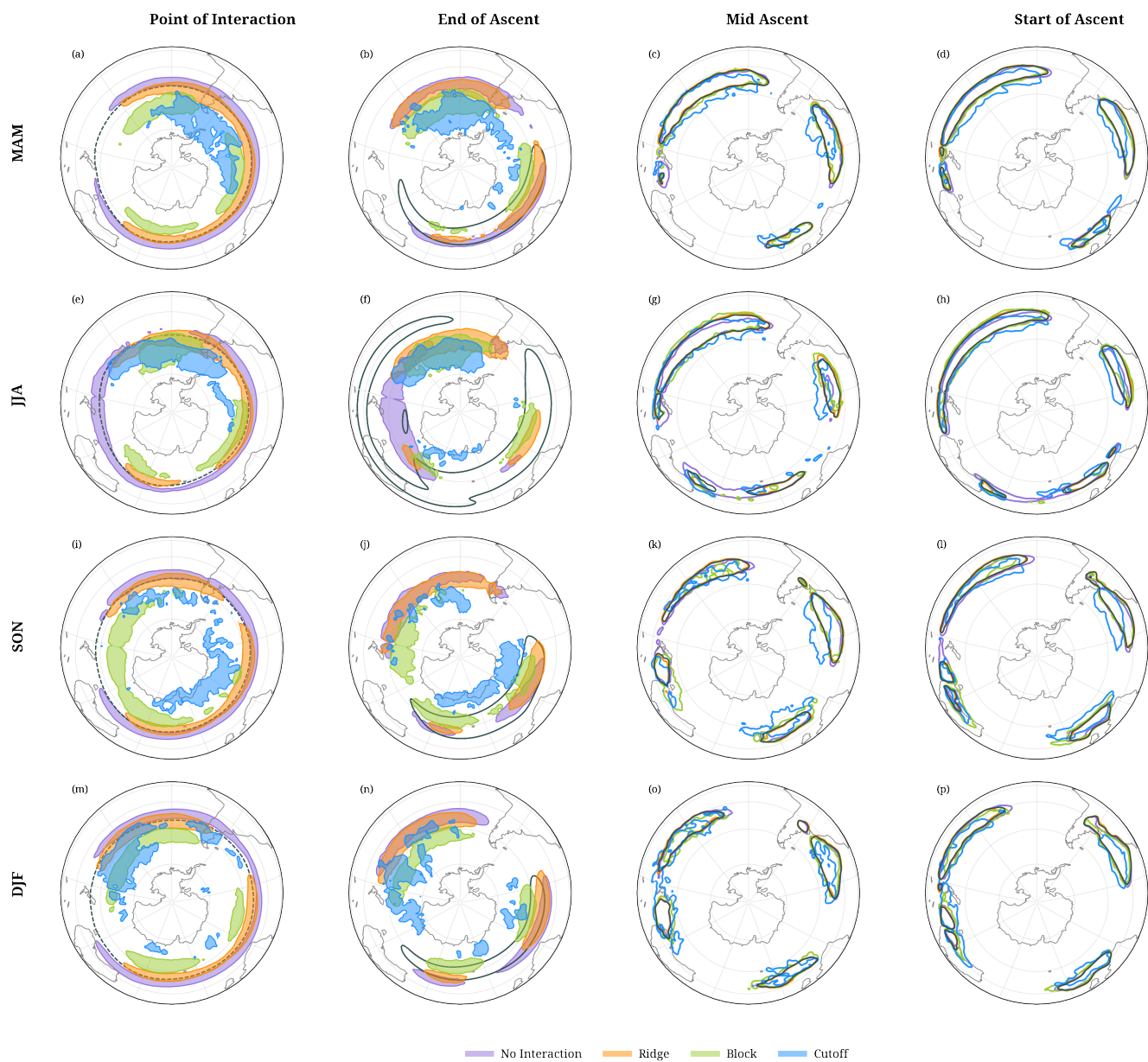
Figure S7. As Fig. S6, but for SH
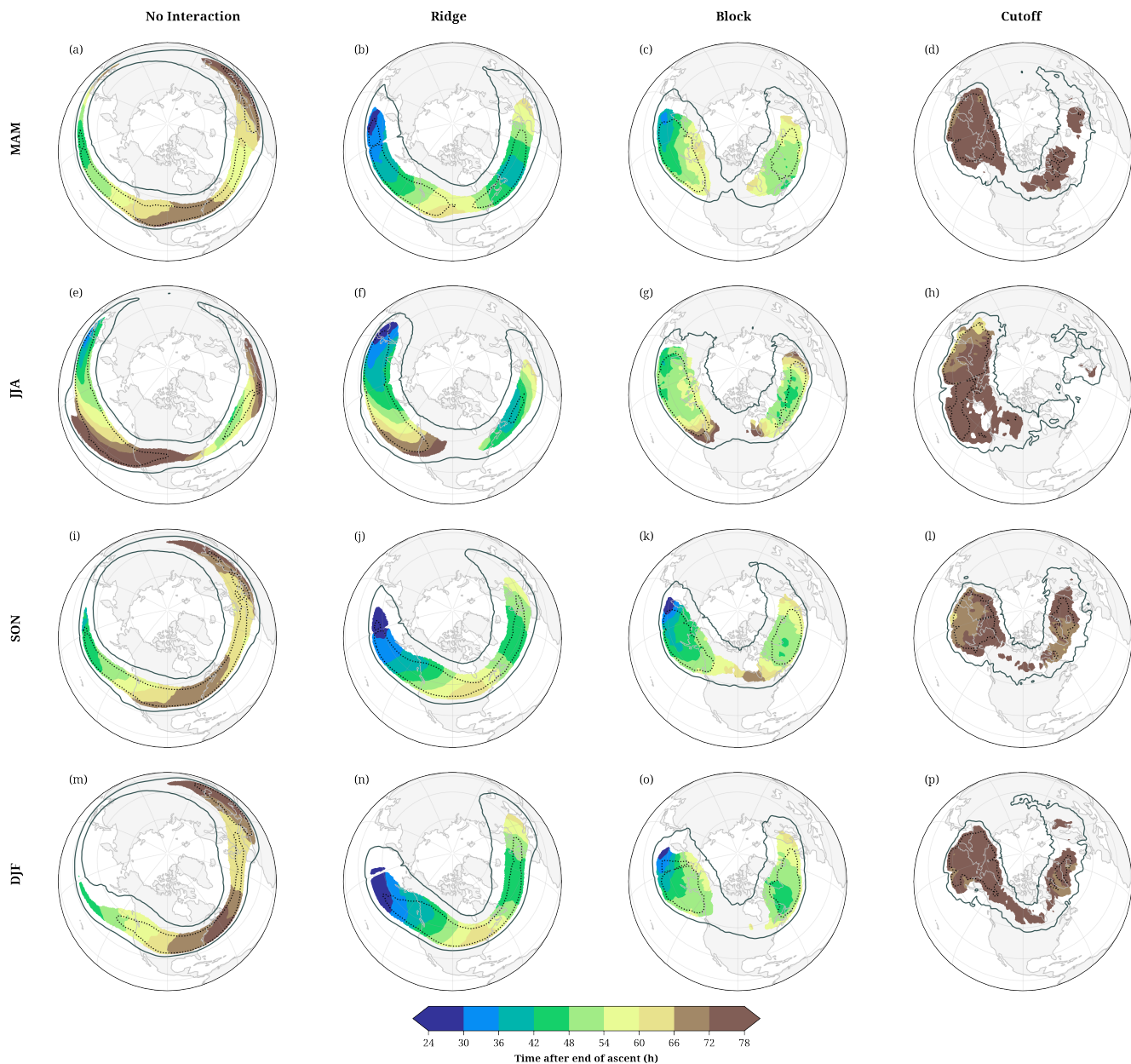
Figure S8. The climatological mean outflow age at the point of interaction (colors, in h) for different seasons in NH: **(a-d)** MAM, **(e-h)** JJA, **(i-l)** SON, and **(m-p)** DJF, showing (a,e,i,m) no-interaction, (b,f,j,n) ridge, (c,g,k,o) block, and (d,h,l,p) cutoff interaction categories. The black contours show the 80th (solid) and 95th (dotted) percentiles of WCB frequencies at the point of interaction for the respective interaction types.
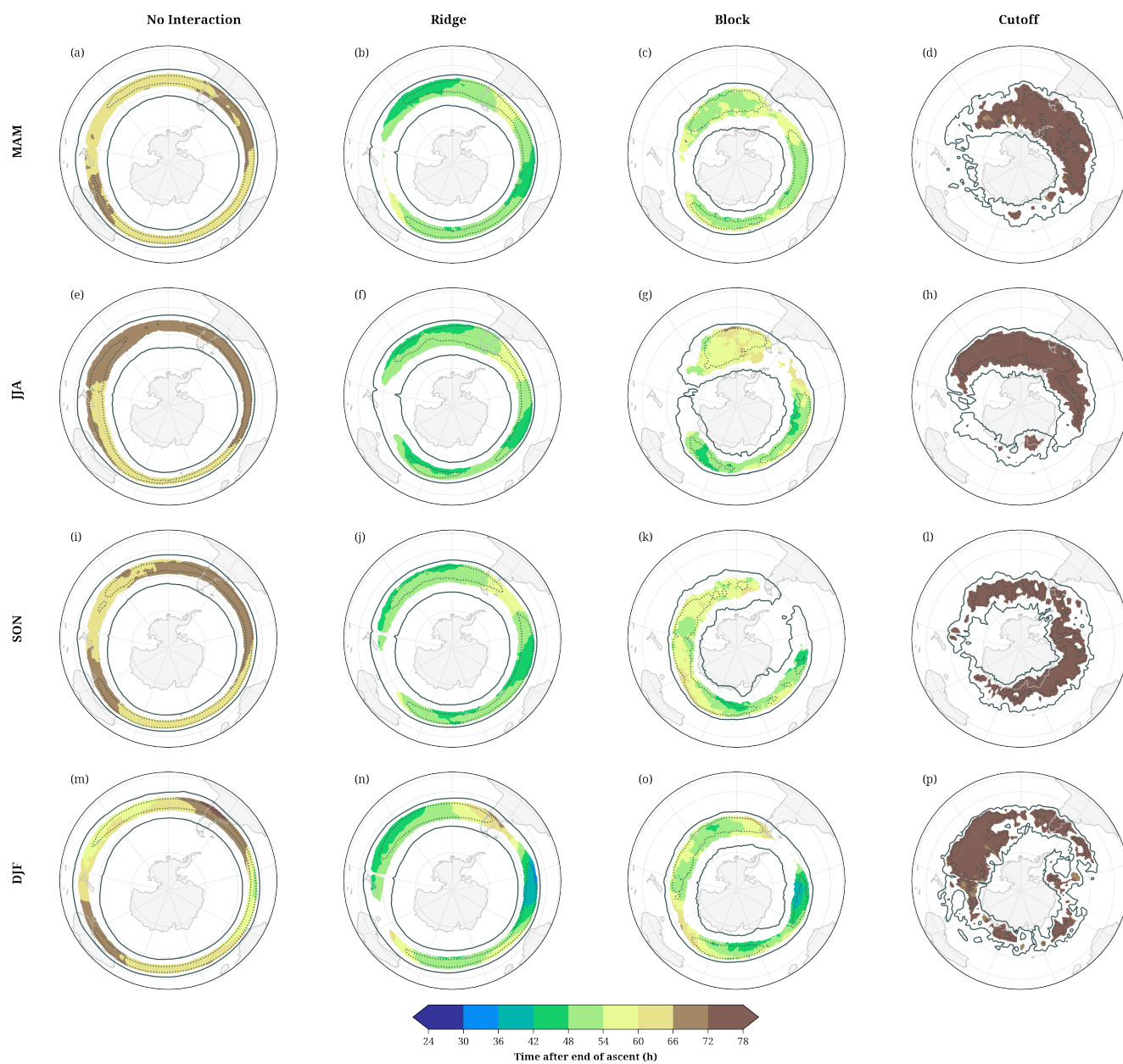
Figure S9. As Fig. S8, but for SH
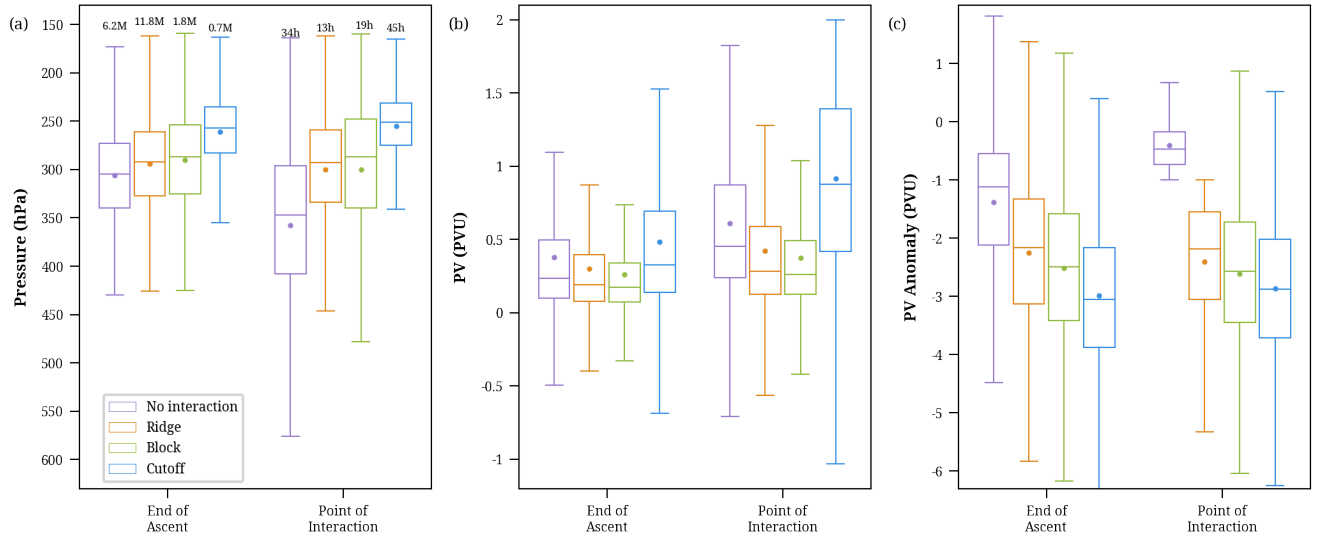
Figure S10. Characteristics of different WCB interaction types at the end-of-ascent and point-of-interaction for NH in MAM. Shown are box plots of **(a)** pressure (hPa), **(b)** absolute PV (PVU), and **(c)** PV anomalies (PVU). Indicated are the median (horizontal line), the mean (circular dot), the interquartile range (box), and the whiskers extending to the 5th and 95th percentiles; outliers are not shown. The numbers in (a) above the bars indicate (left) the total number of trajectories and (right) the median outflow age.
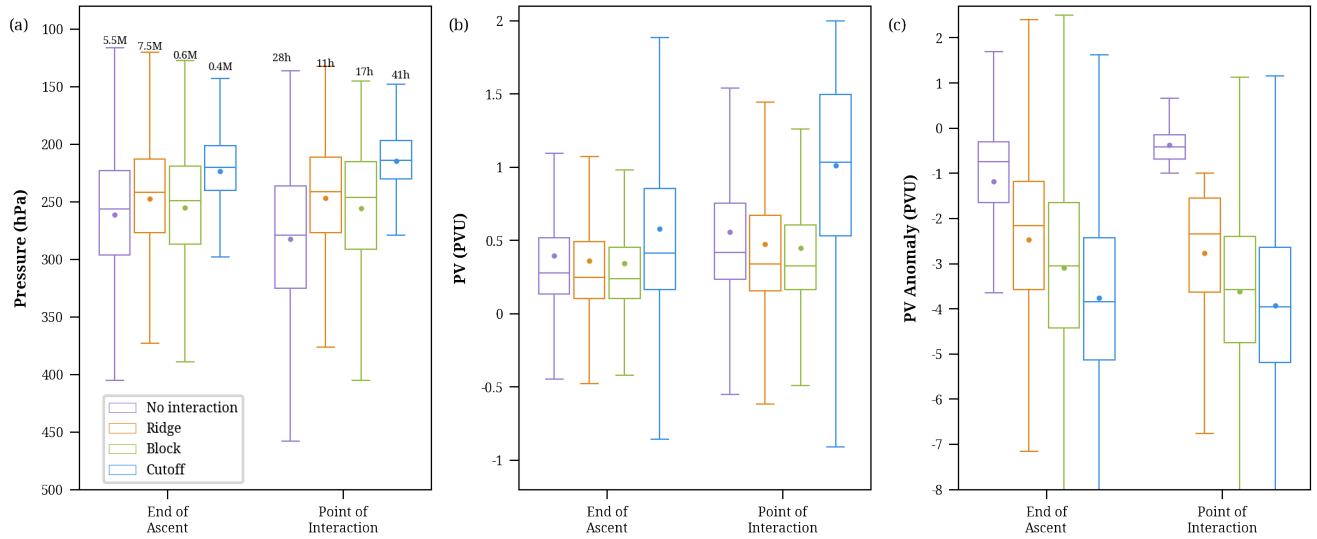
Figure S11. As Fig. S10, but for JJA
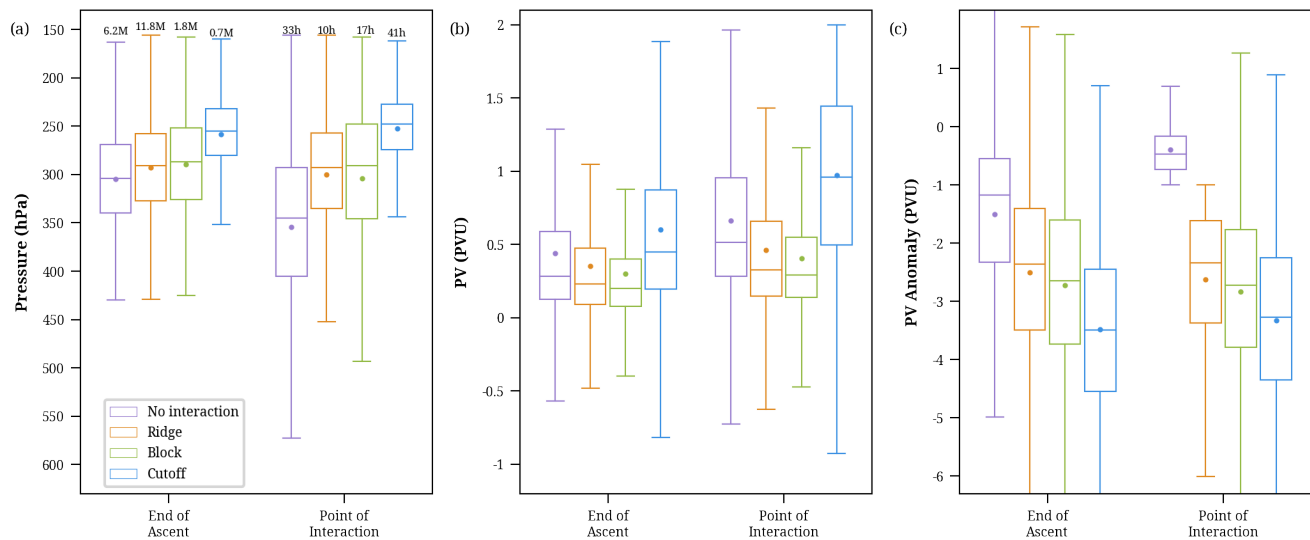
Figure S12. As Fig. S10, but for SON
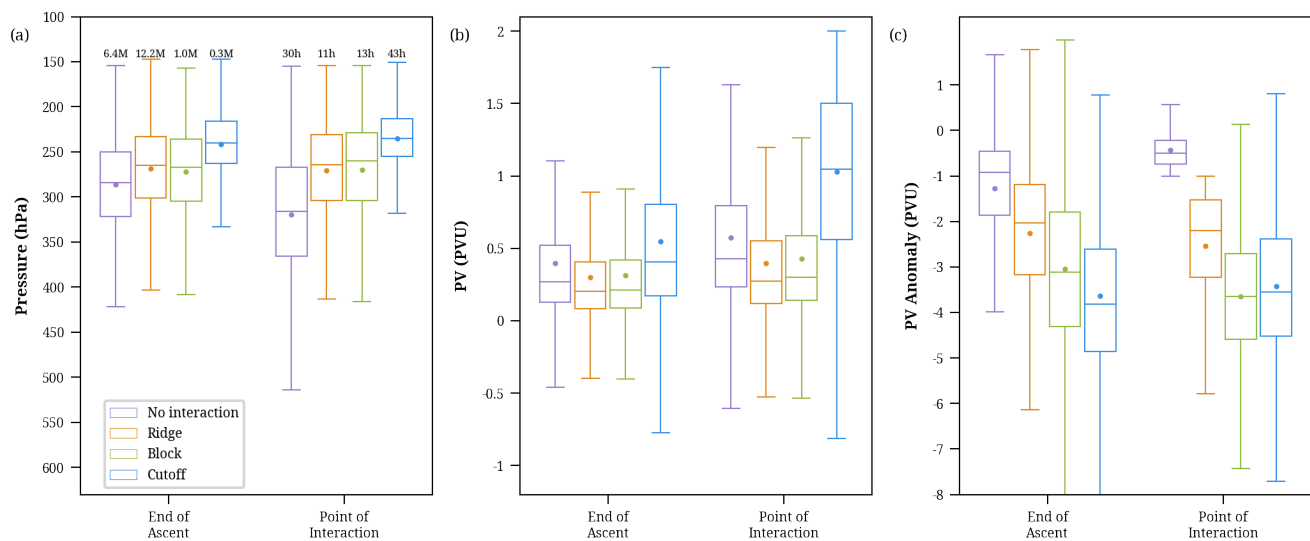
Figure S13. As Fig. S10, but for SH in JJA. PV values are multiplied by -1.
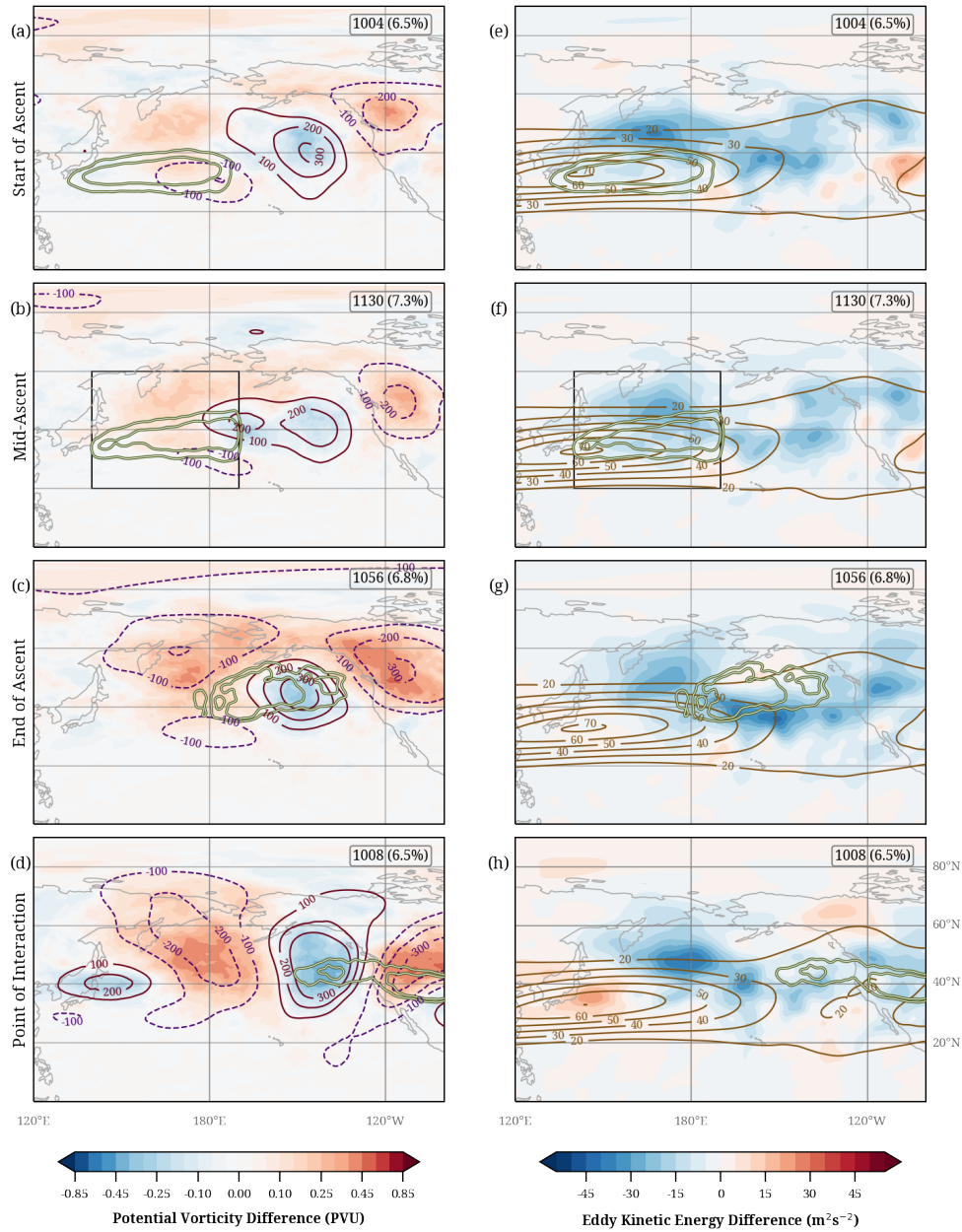
Figure S14. Composites of no-interaction time steps over North Pacific for the four trajectory phases: point of interaction **(a,e)**, end-of-ascent **(b,f)**, mid-ascent **(c,g)**, and start-of-ascent **(d,h)**. (a-d) show PV at 320 K and geopotential height anomalies at 250 hPa (solid and dashed lines for positive and negative values, respectively). (e-h) show 500 hPa EKE anomalies and low-pass filtered zonal wind at 250 hPa (brown lines). The highlighted white-green contours in (a-h) show the 98th and 99th percentile of occurrence frequency of the ridge-interaction WCB air parcels in the corresponding phases. Only the WCB air parcels that ascend within the rectangle (c,g) are selected for the analysis. The number of time steps included in each composite and the corresponding percentage w.r.t. all DJF time steps in the considered 43-y period are given in each panel.
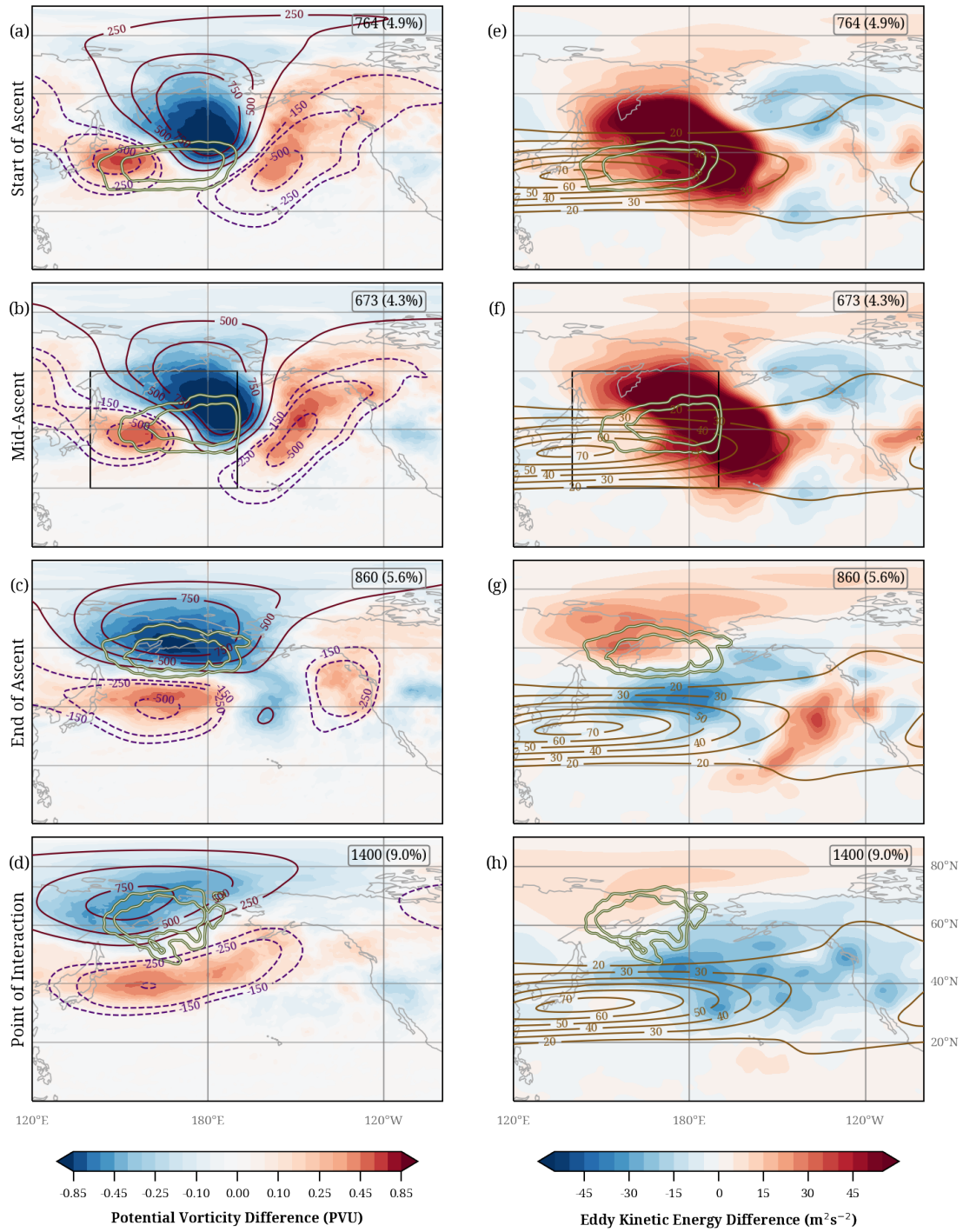
Figure S15. As Fig. S14, but for cutoff interaction time steps.
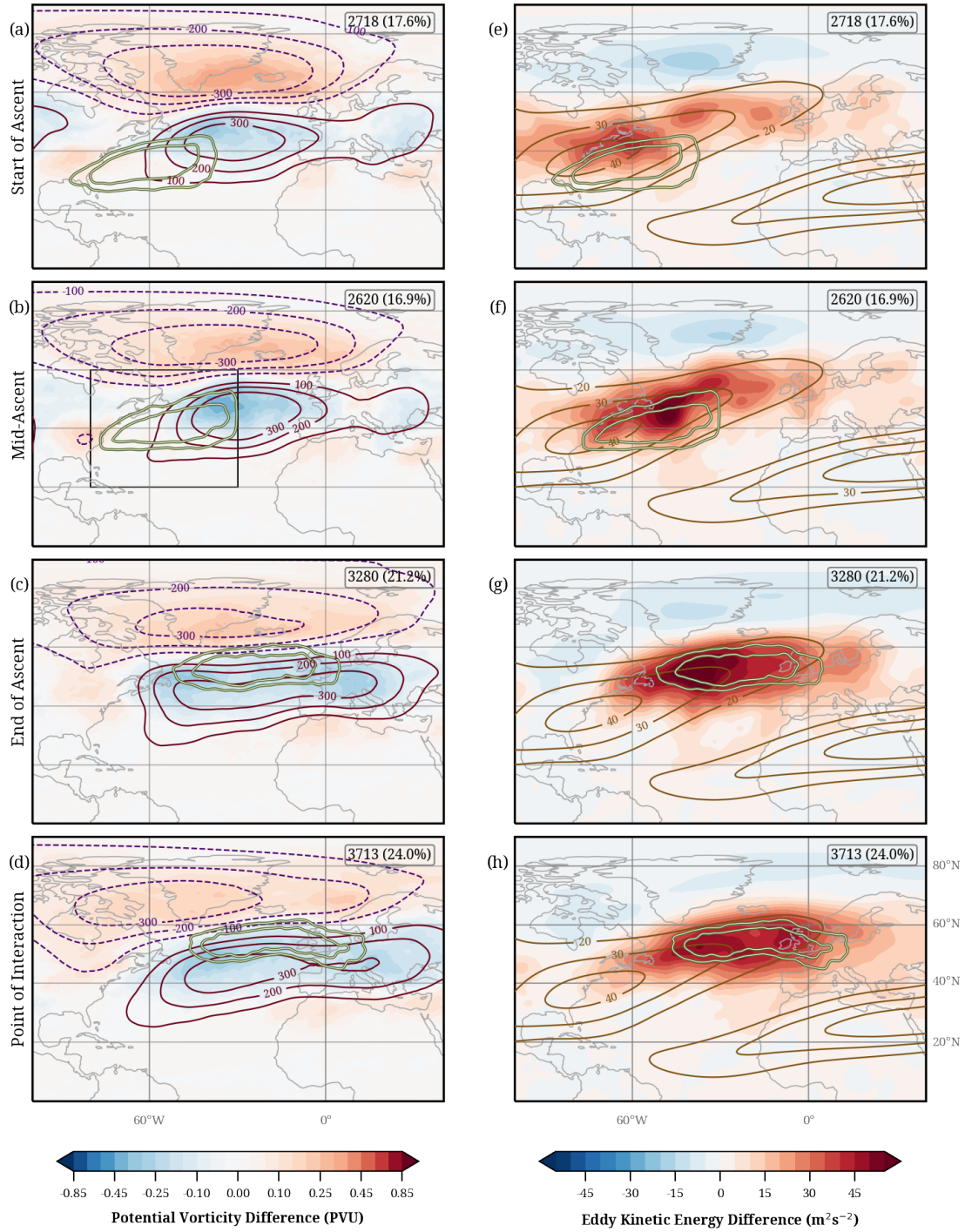
Figure S16. As Fig. S14, but for ridge interaction time steps over the North Atlantic domain.
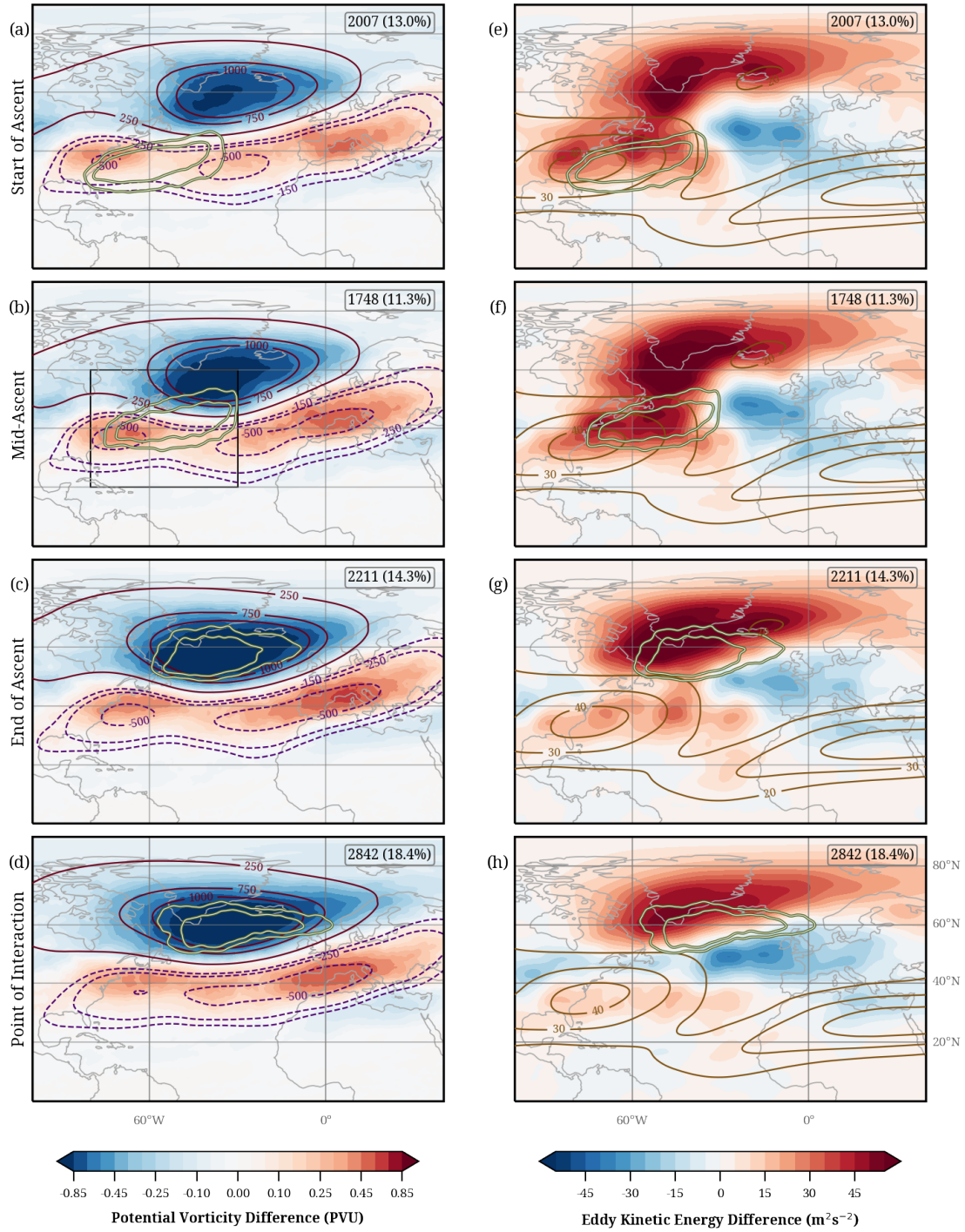
Figure S17. As Fig. S14, but for block interaction time steps over the North Atlantic domain.
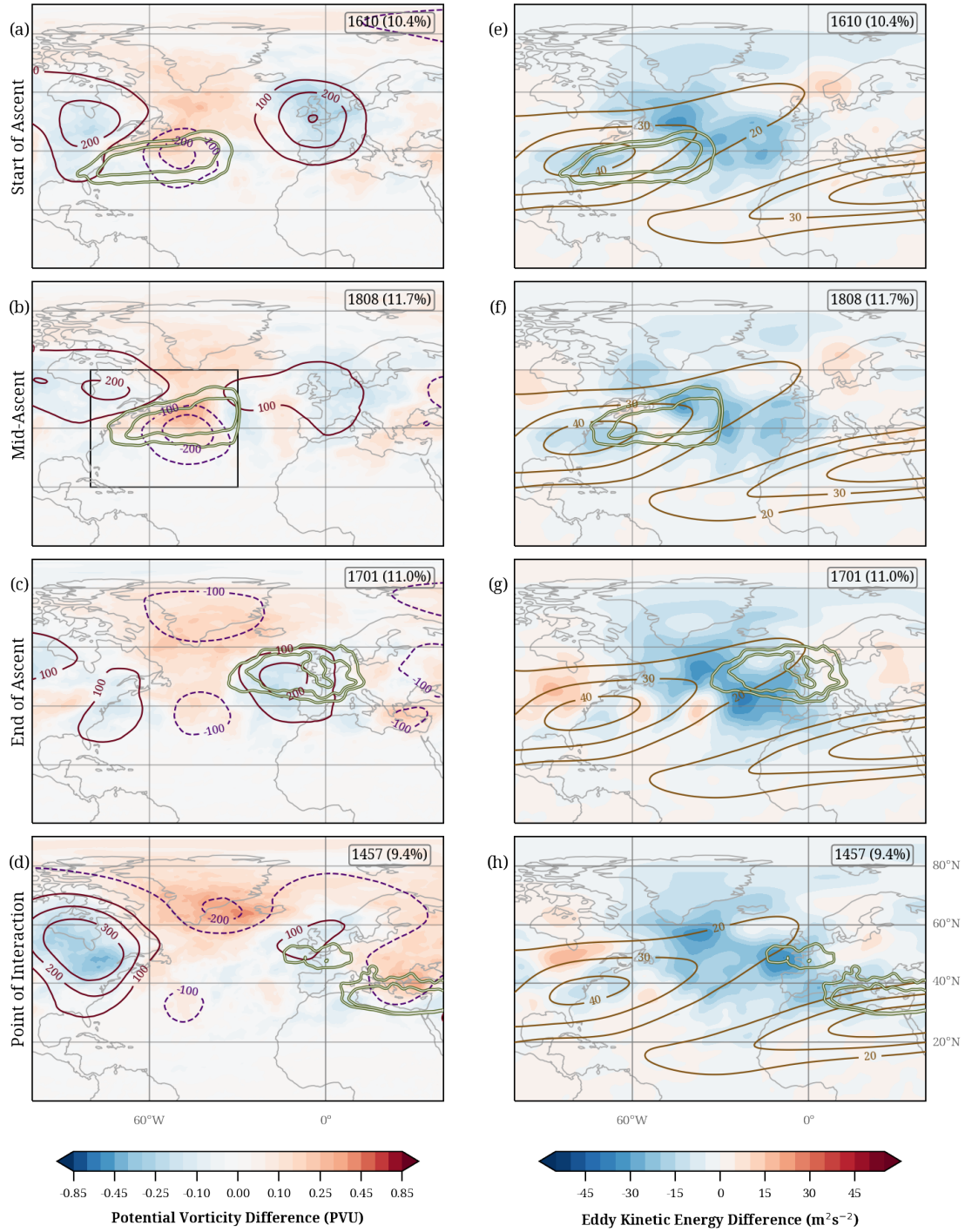
Figure S18. As Fig. S14, but over the North Atlantic domain.
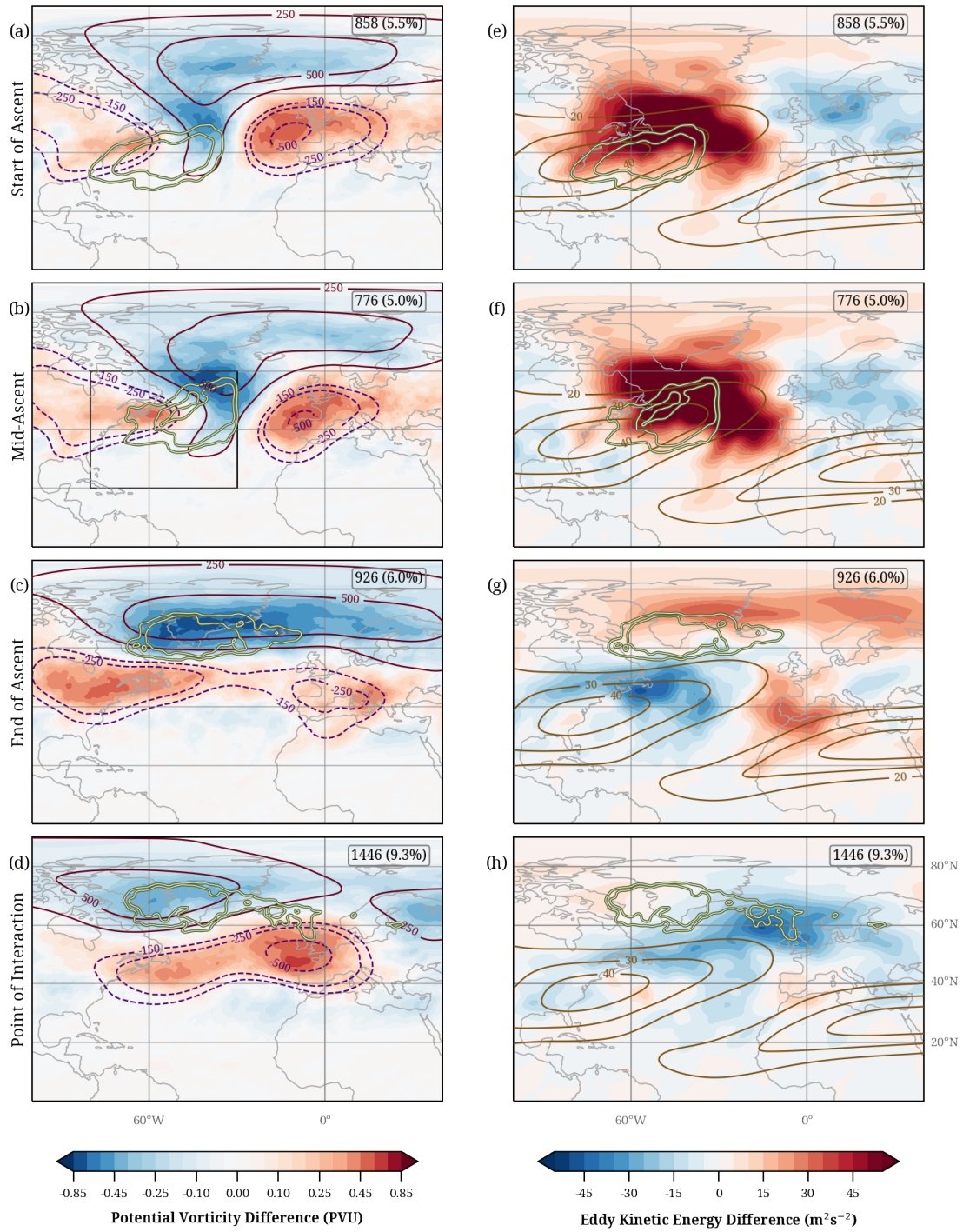
Figure S19. As Fig. S14, but for cutoff interaction time steps over the North Atlantic domain.