

# Supplementary Materials

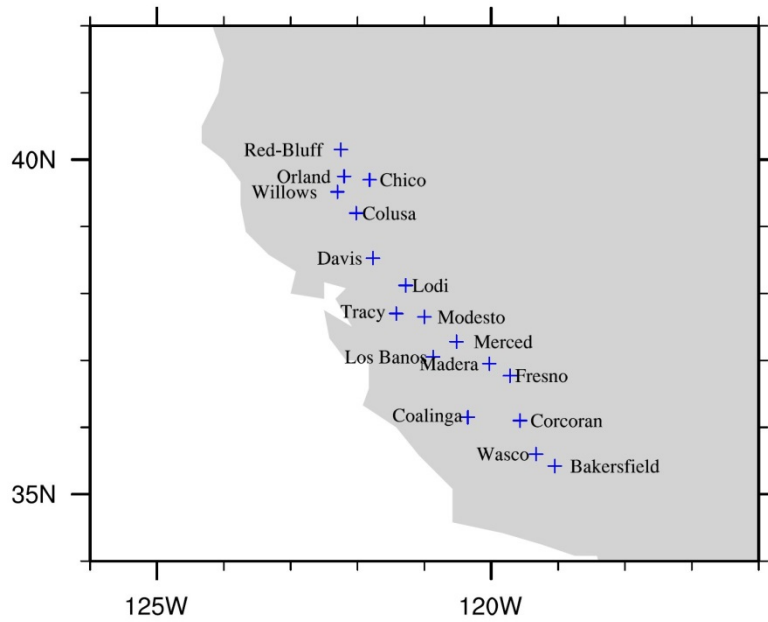
Synoptic Analysis of Cold Air Outbreaks Over California Central Valley

Richard Grotjahn and Rui Zhang

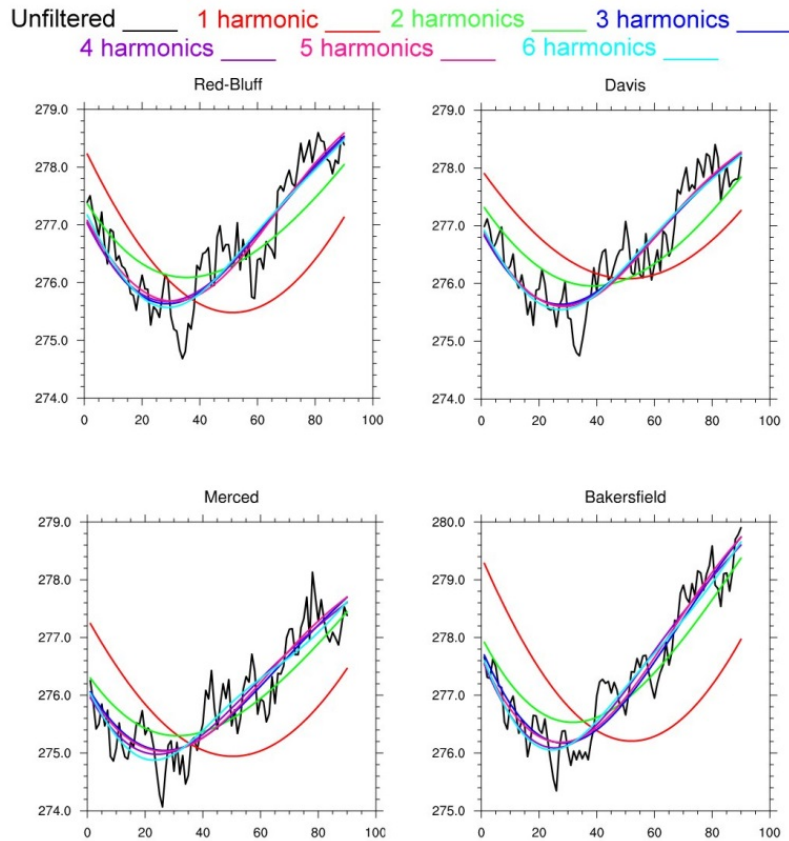
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## A. Methodology details



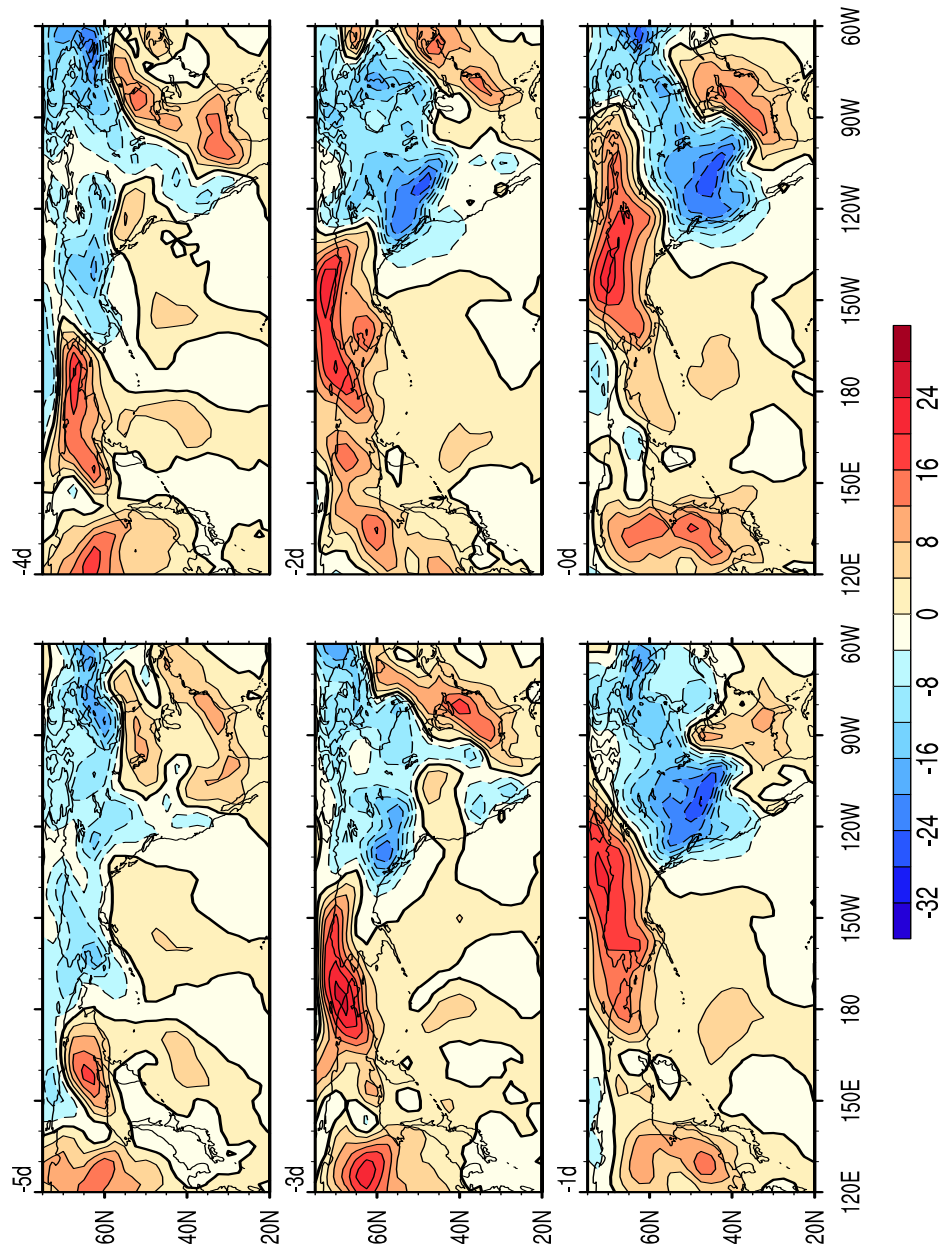
**Figure S1.** Central valley surface stations used for the event identification.

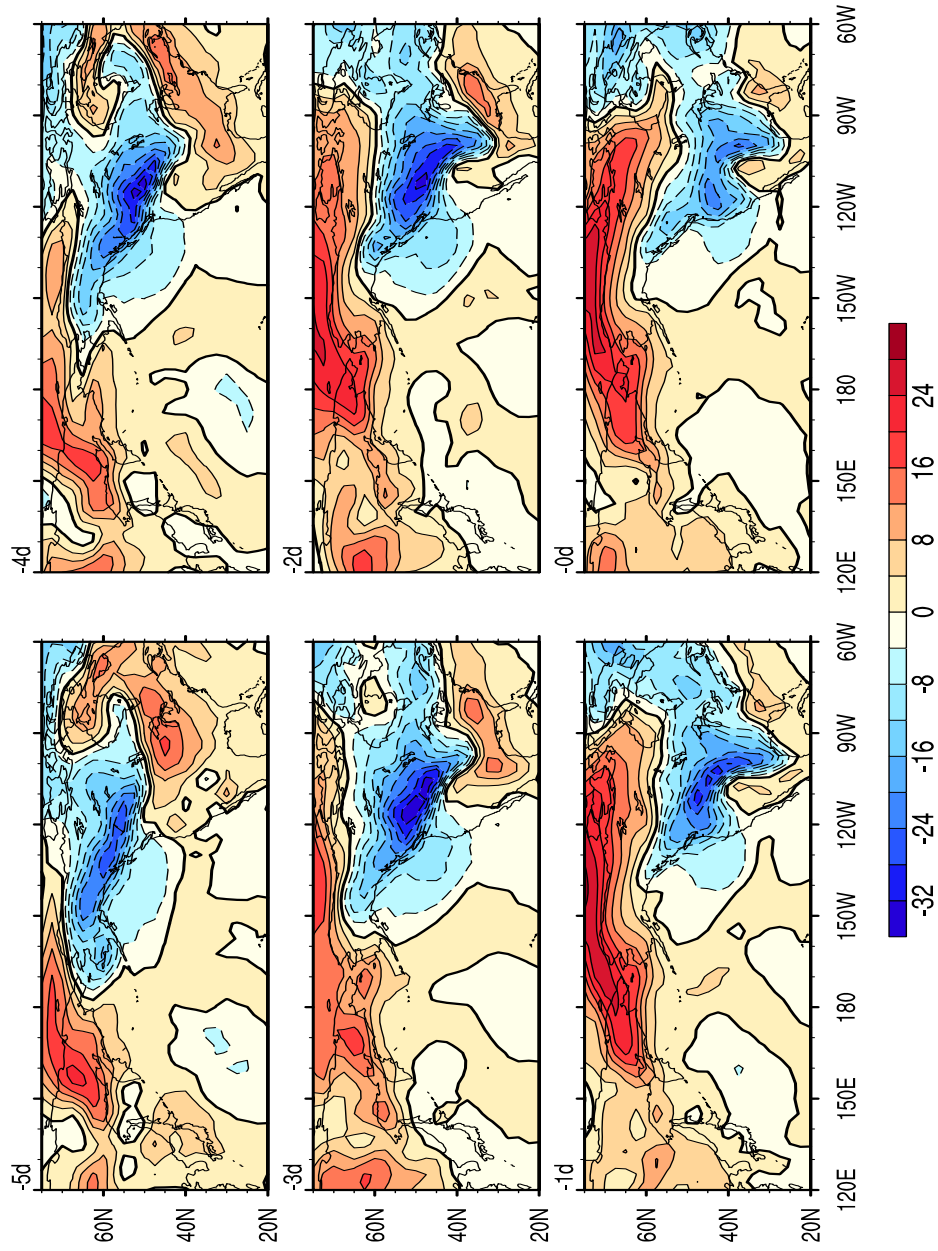


**Figure S2.** Comparisons of the 63-year long term daily mean (LTDM) values (black line) against Fourier decompositions (using an entire year of LTDM data) at four representative stations spanning the length of the CCV. The red curve is the first annual harmonic. The green curve uses the annual and semi-annual, i.e. the first two, harmonics. The blue, purple, dark pink, and cyan curves use the first three, four, five, and six harmonics respectively. The ordinate is the station LTDM temperature in K. The abscissa indicates dates in the 90-day period from 1 December (value=1) through 28 February (value=90).

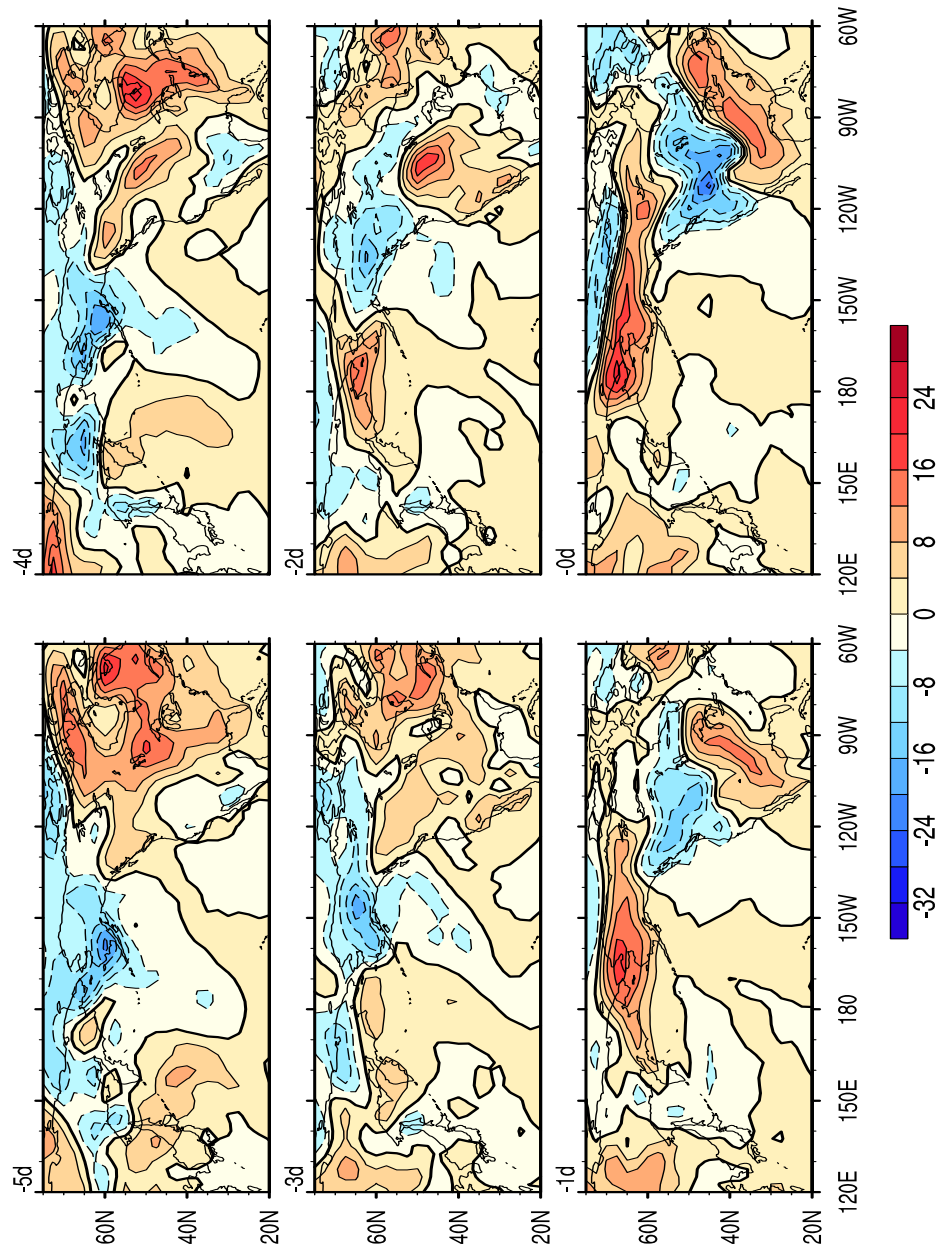
**B. Surface temperature anomalies and sea level pressure (SLP) for each individual event.**

**Figure S3.** (beginning on next page) Surface temperature anomalies for event 1 in Table 1 at sigma 0.995 for days before onset. The label ‘-Nd’ in the upper left corner of each map denotes N days prior to the onset (all times are 12 UTC). The contour interval is 4°C.

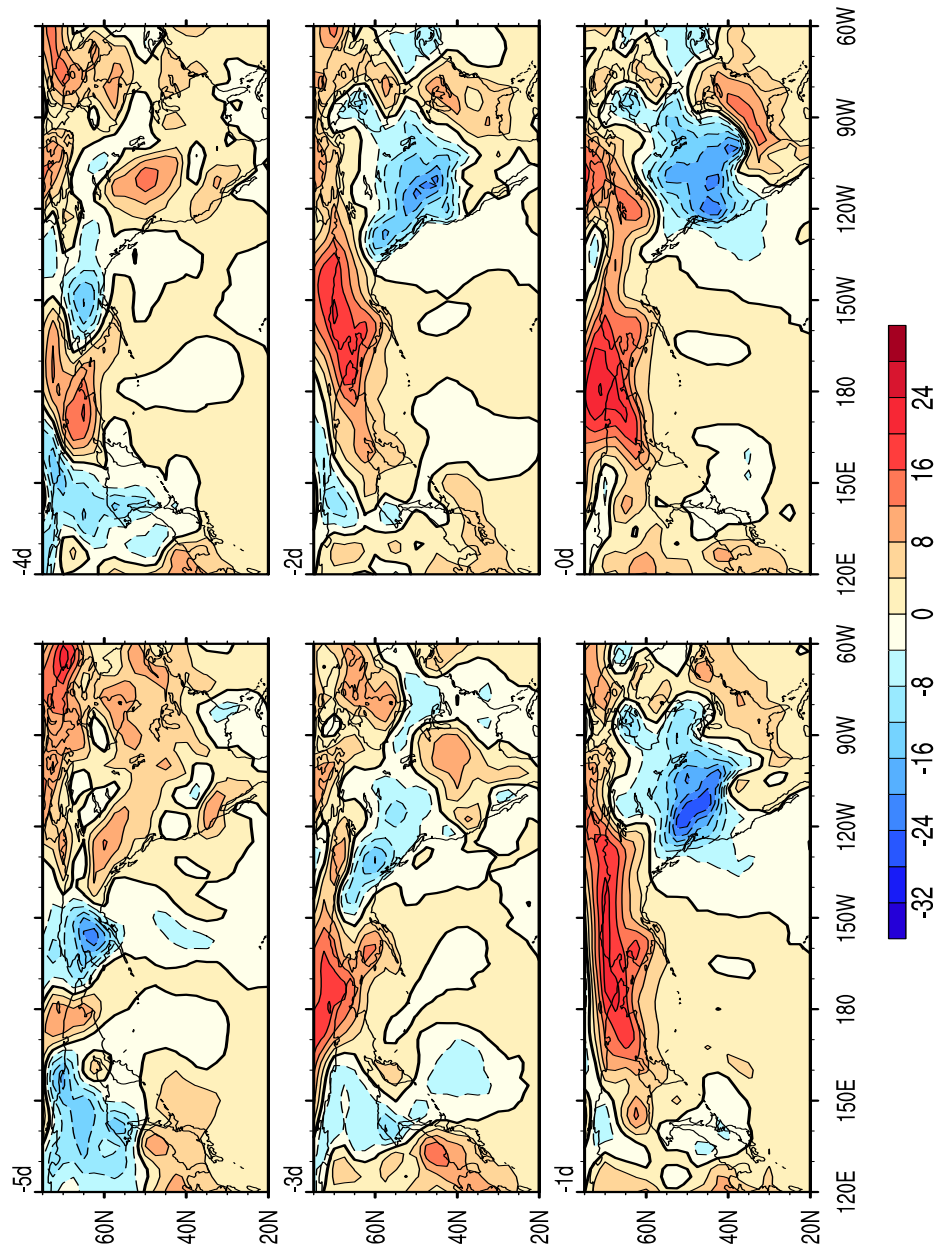




**Figure S4.** Same as Figure S3, but for event 2 in Table 1.

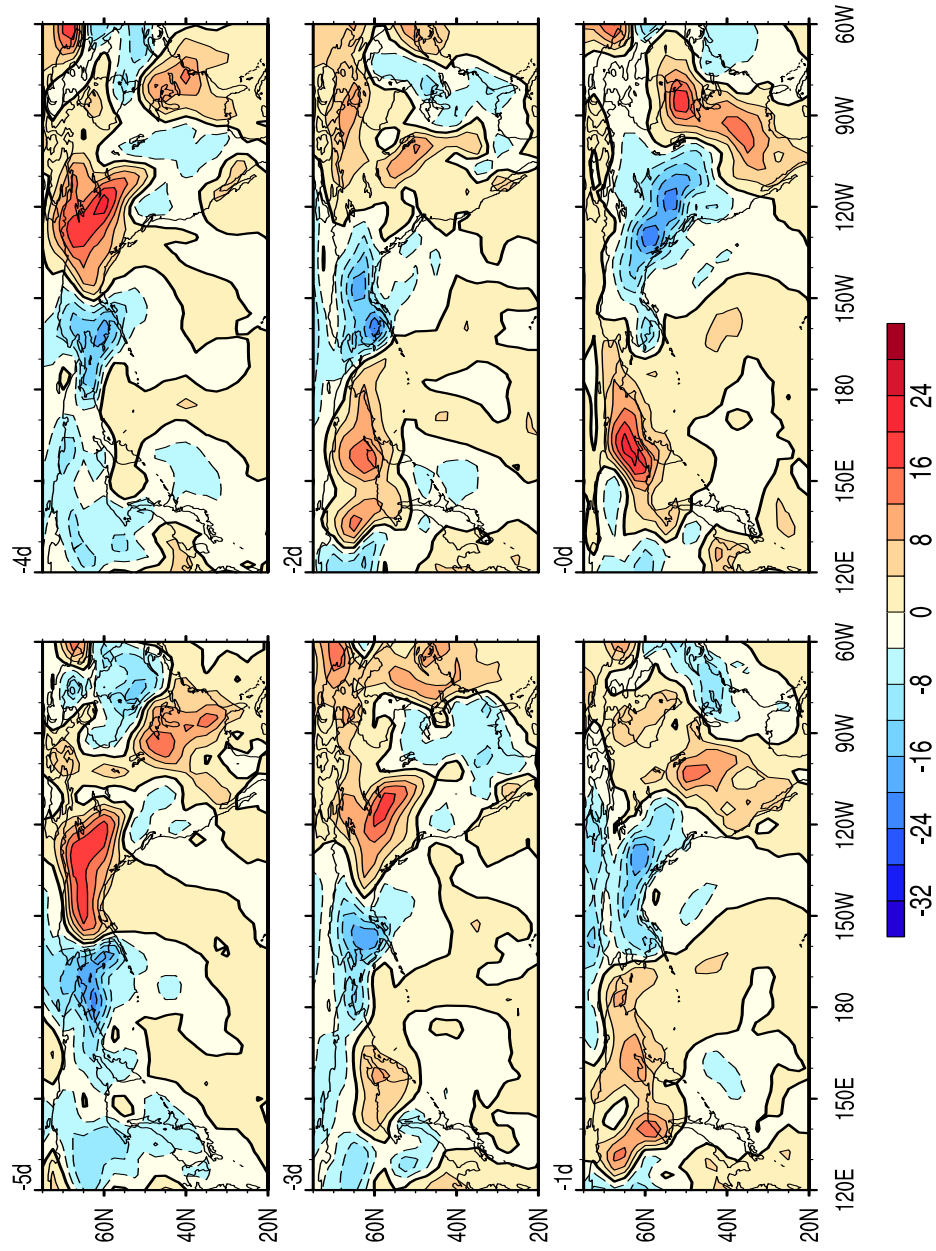


**Figure S5.** Same as Figure S3, but for event 3 in Table 1.

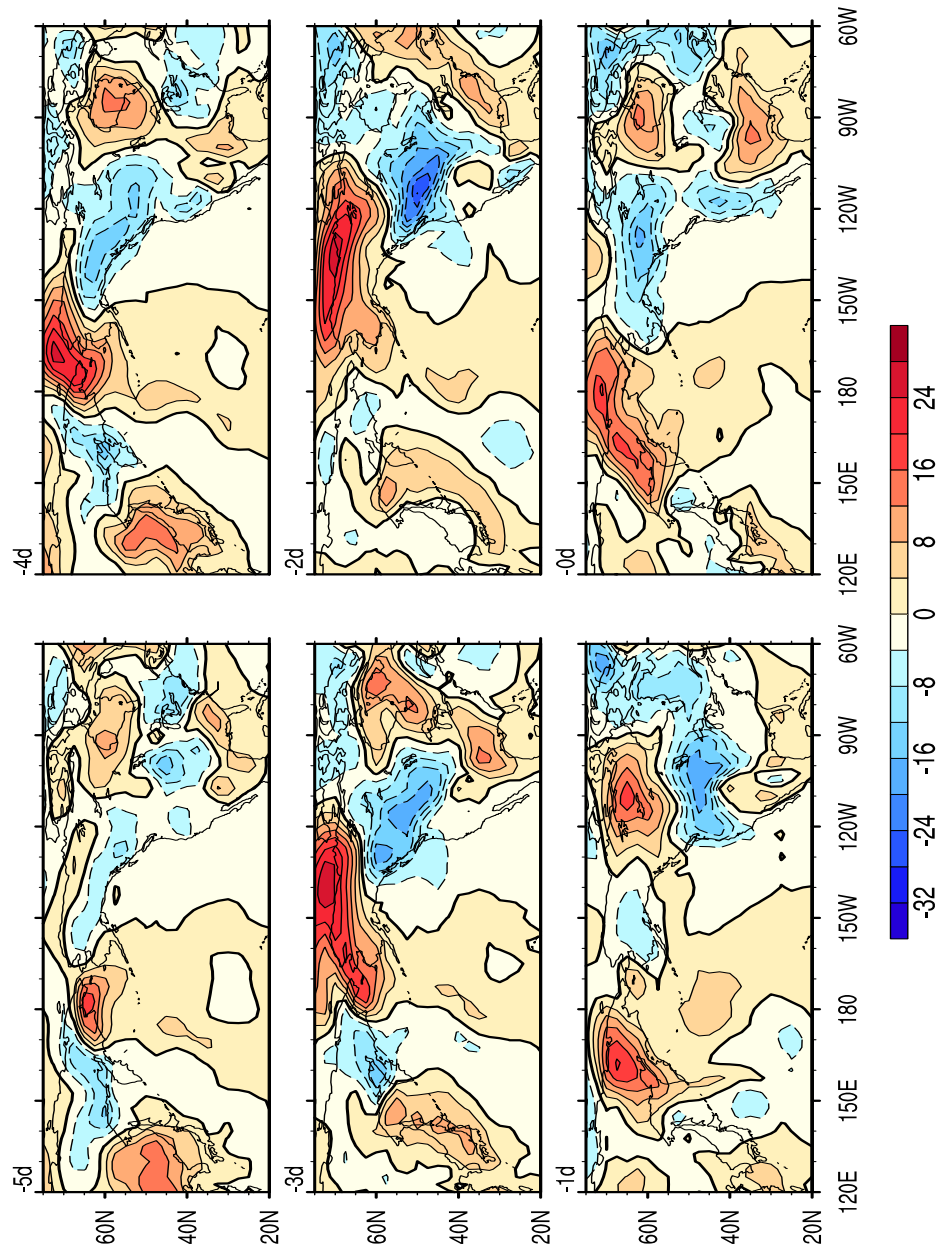


**Figure S6.** Same as Figure S3, but for event 4 in Table 1.



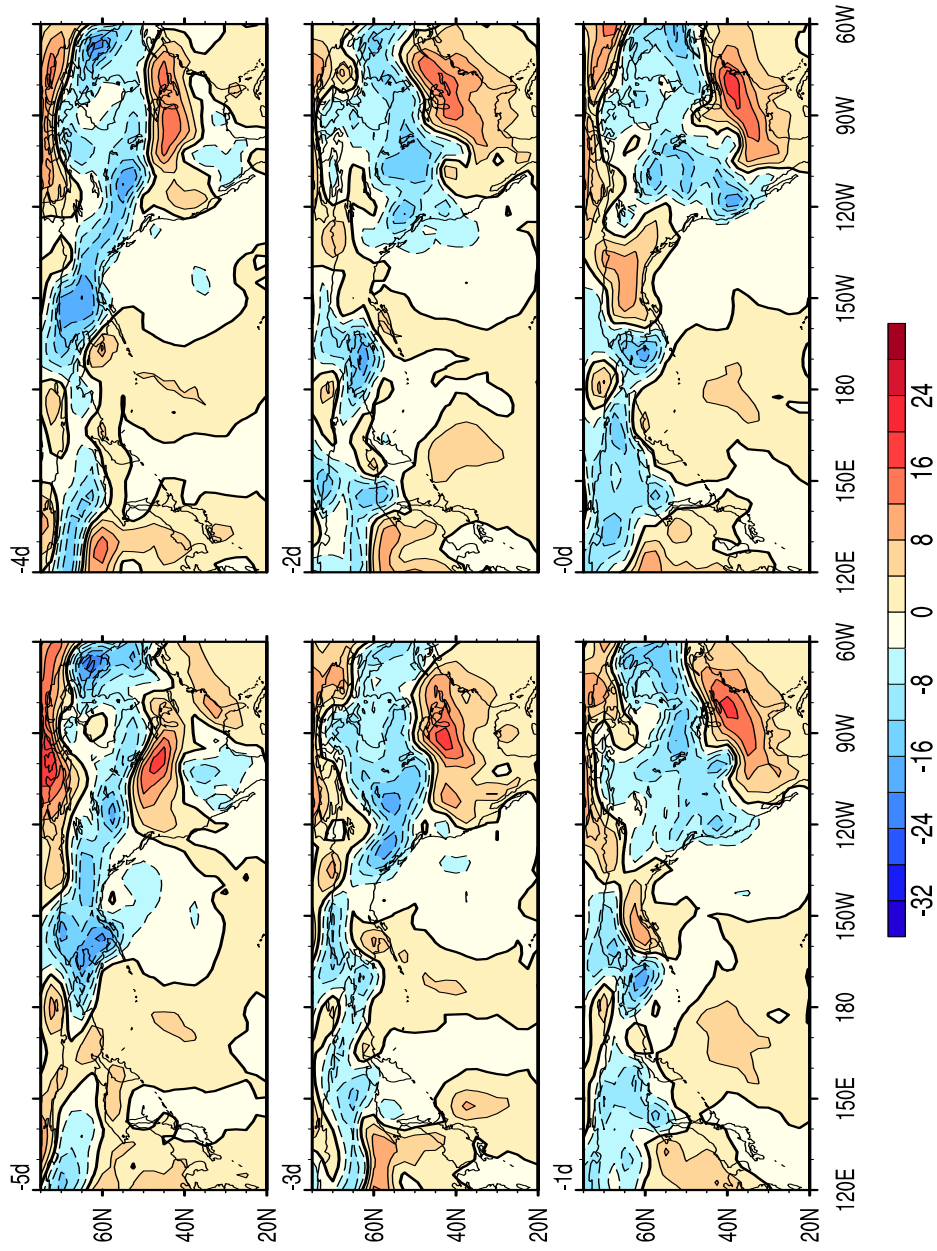


**Figure S7.** Same as Figure S3, but for event 5 in Table 1.

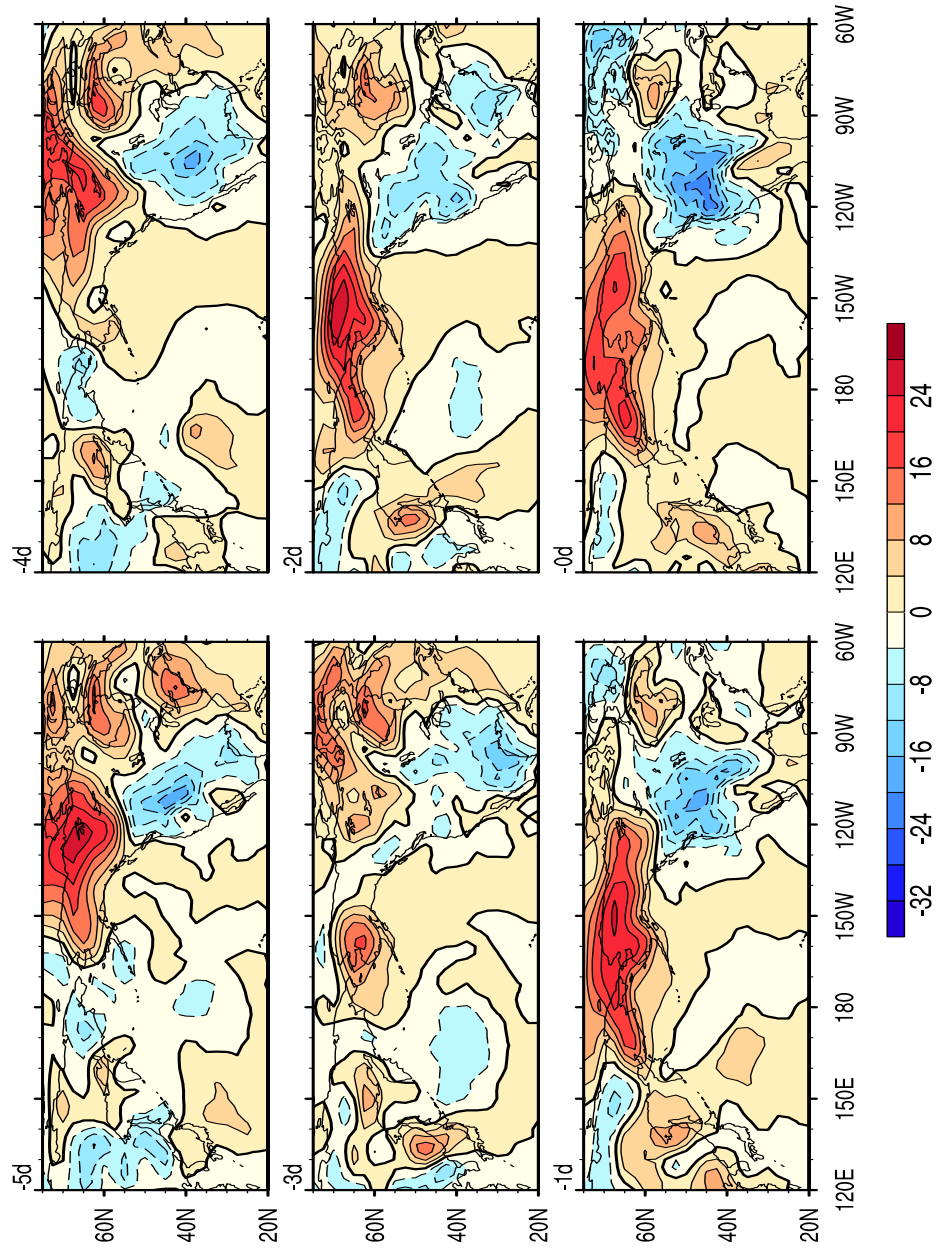


**Figure S8.** Same as Figure S3, but for event 6 in Table 1.

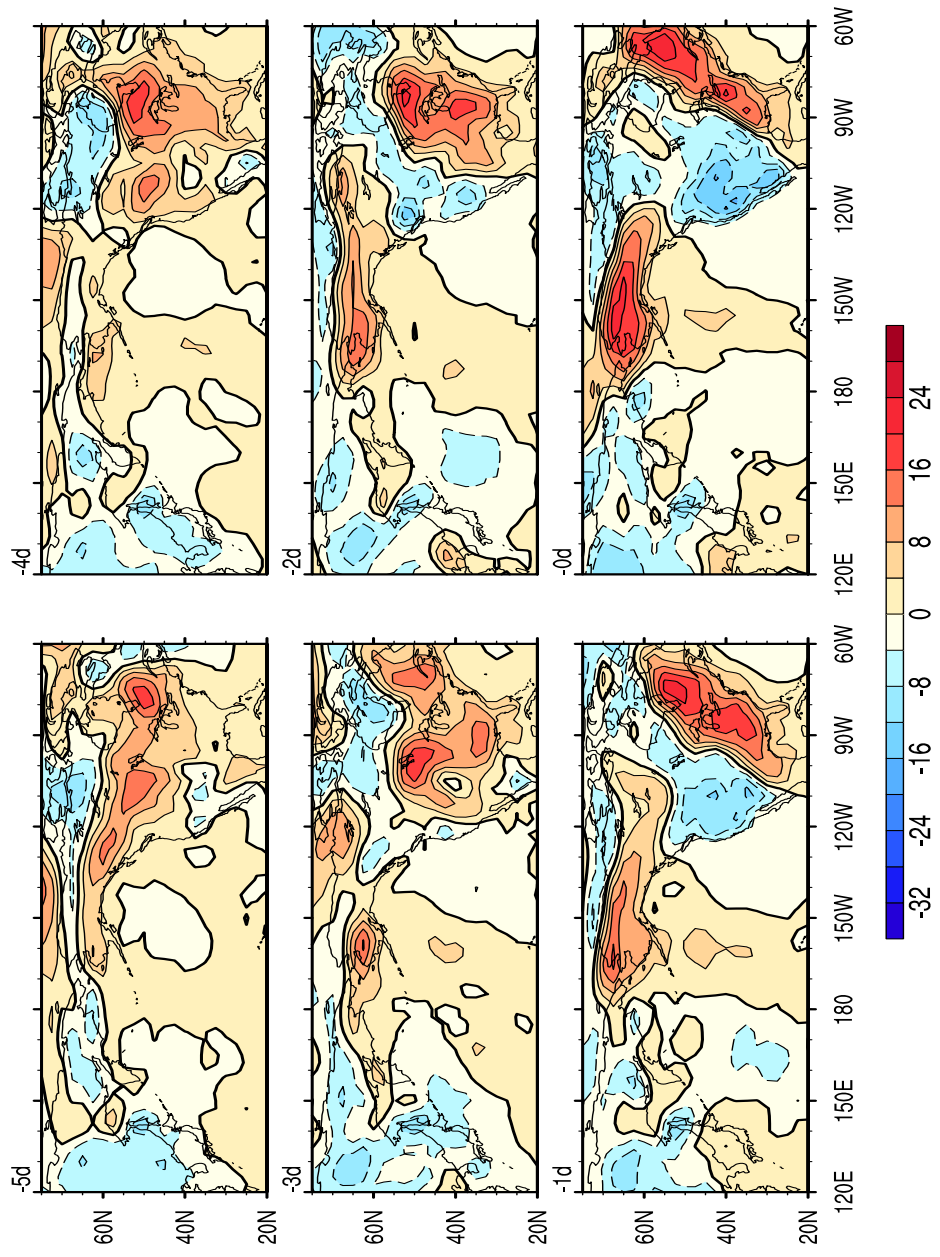




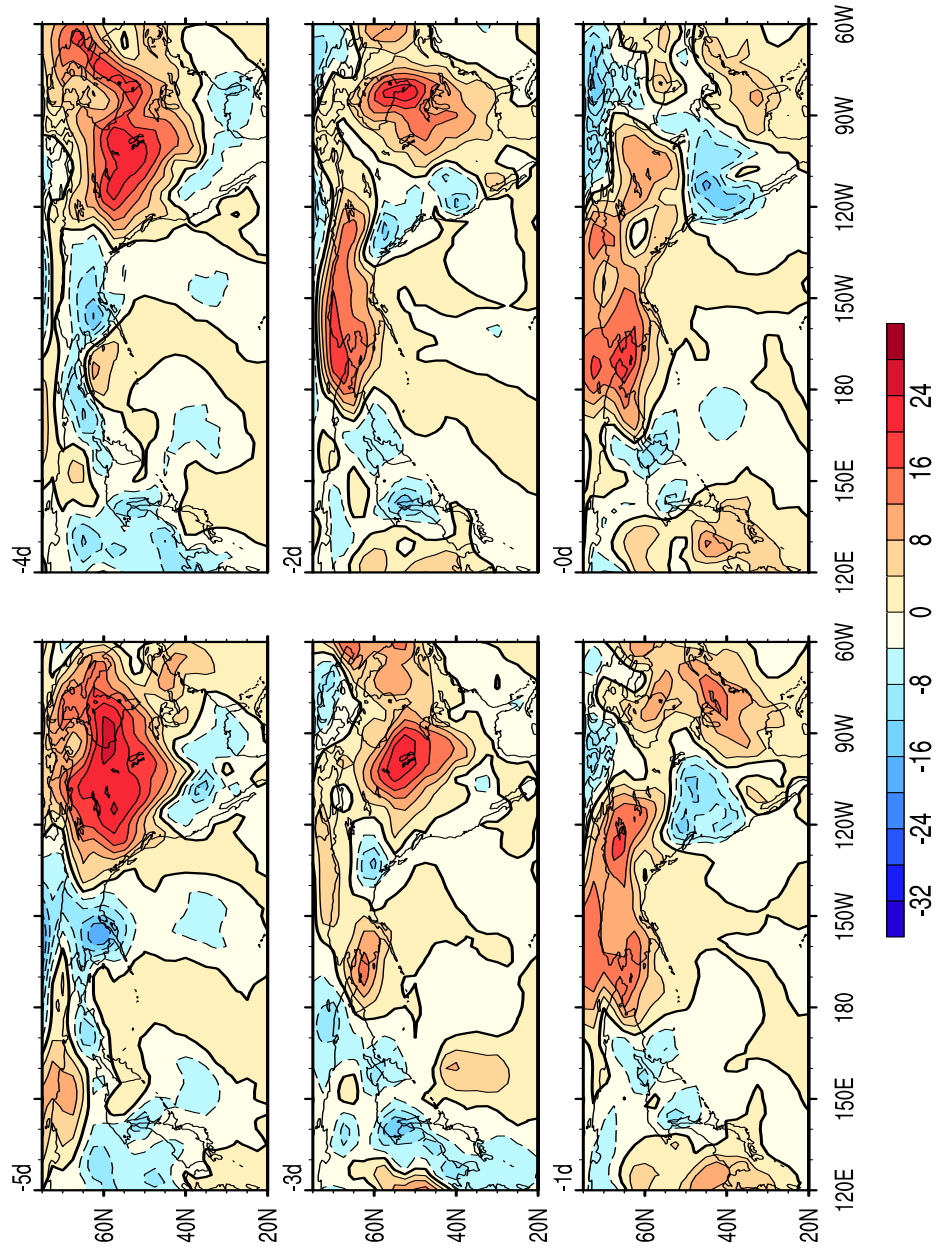
**Figure S9.** Same as Figure S3, but for event 7 in Table 1.



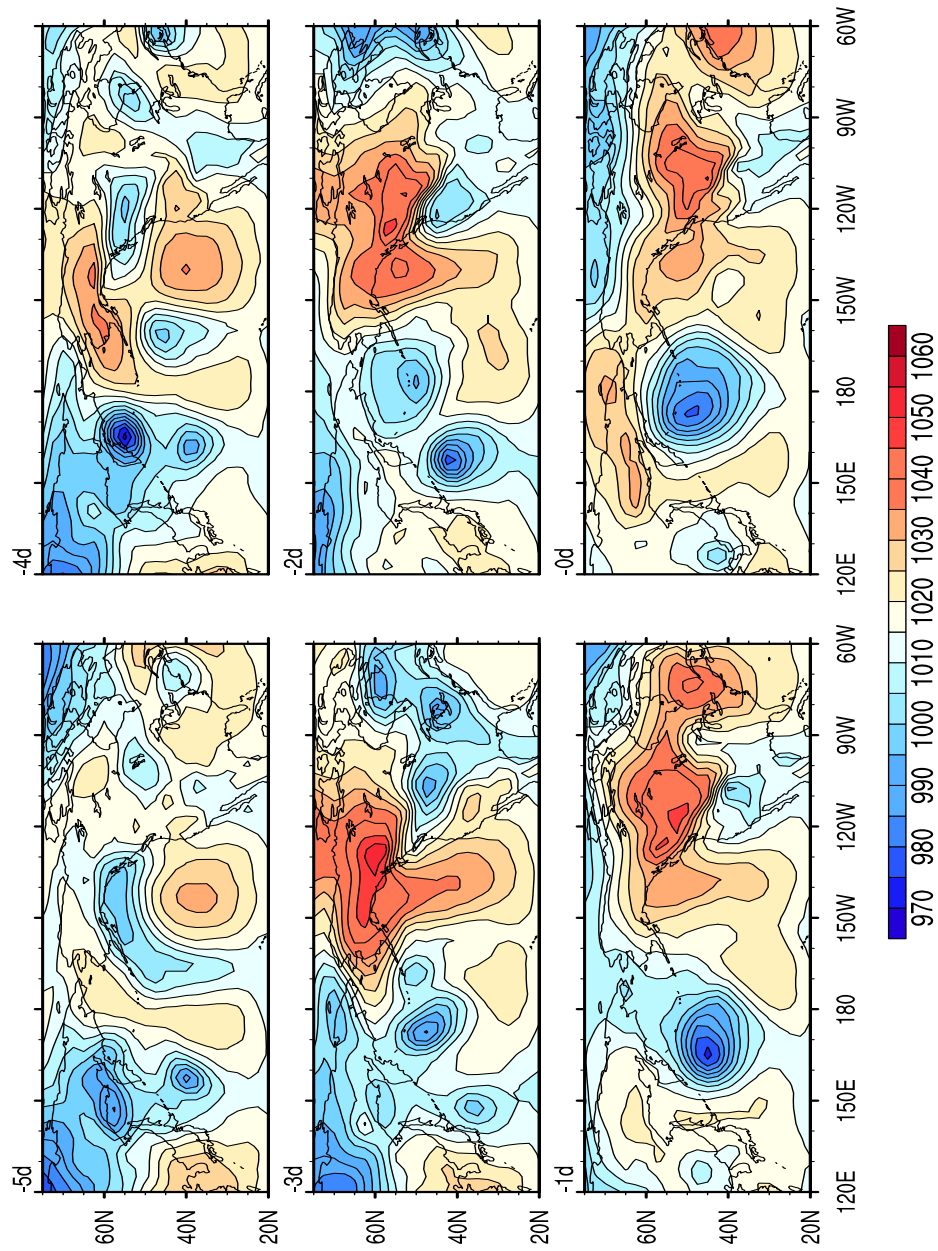
**Figure S10.** Same as Figure S3, but for event 8 in Table 1.



**Figure S11.** Same as Figure S3, but for event 9 in Table 1.

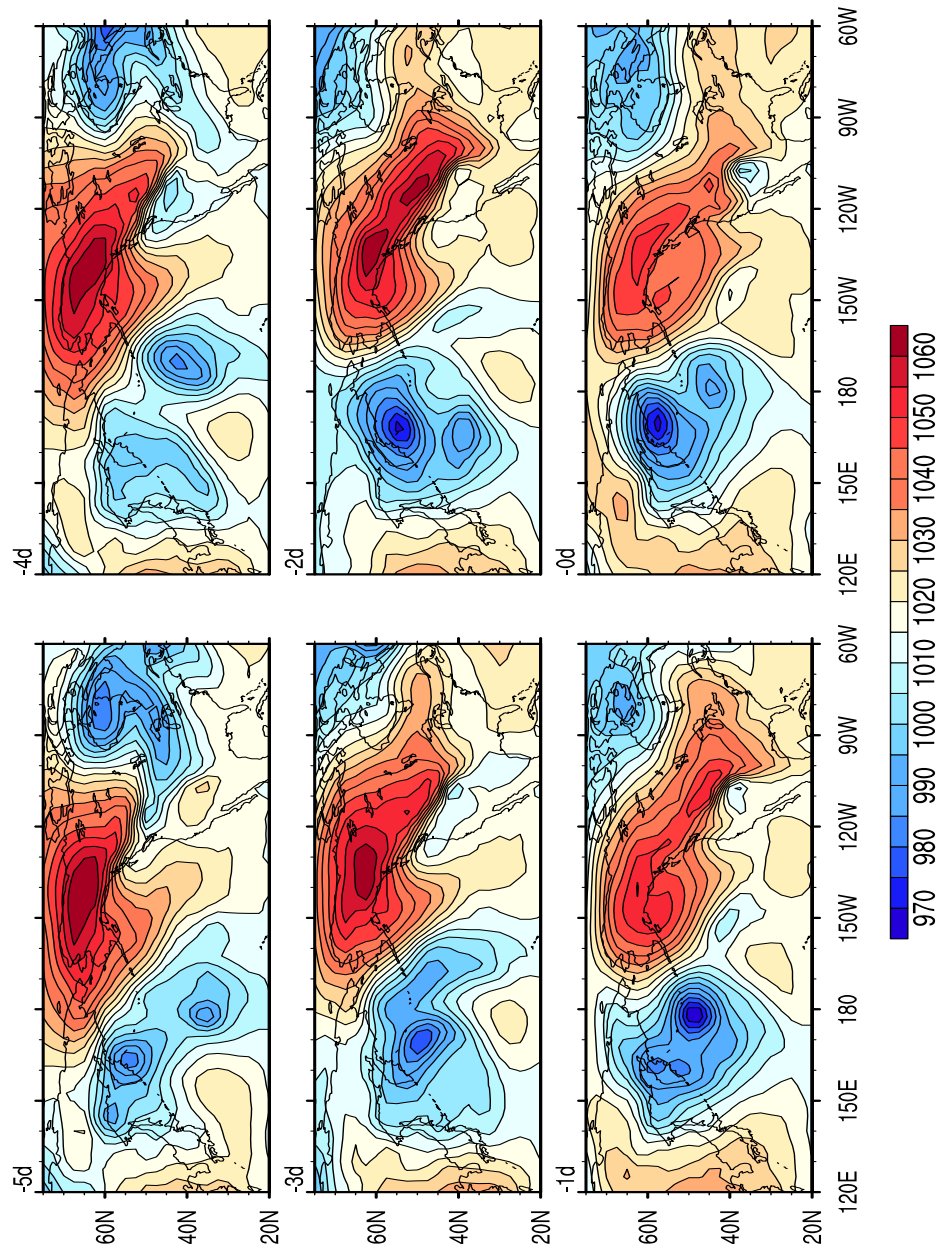


**Figure S12.** Same as Figure S3, but for event 10 in Table 1.

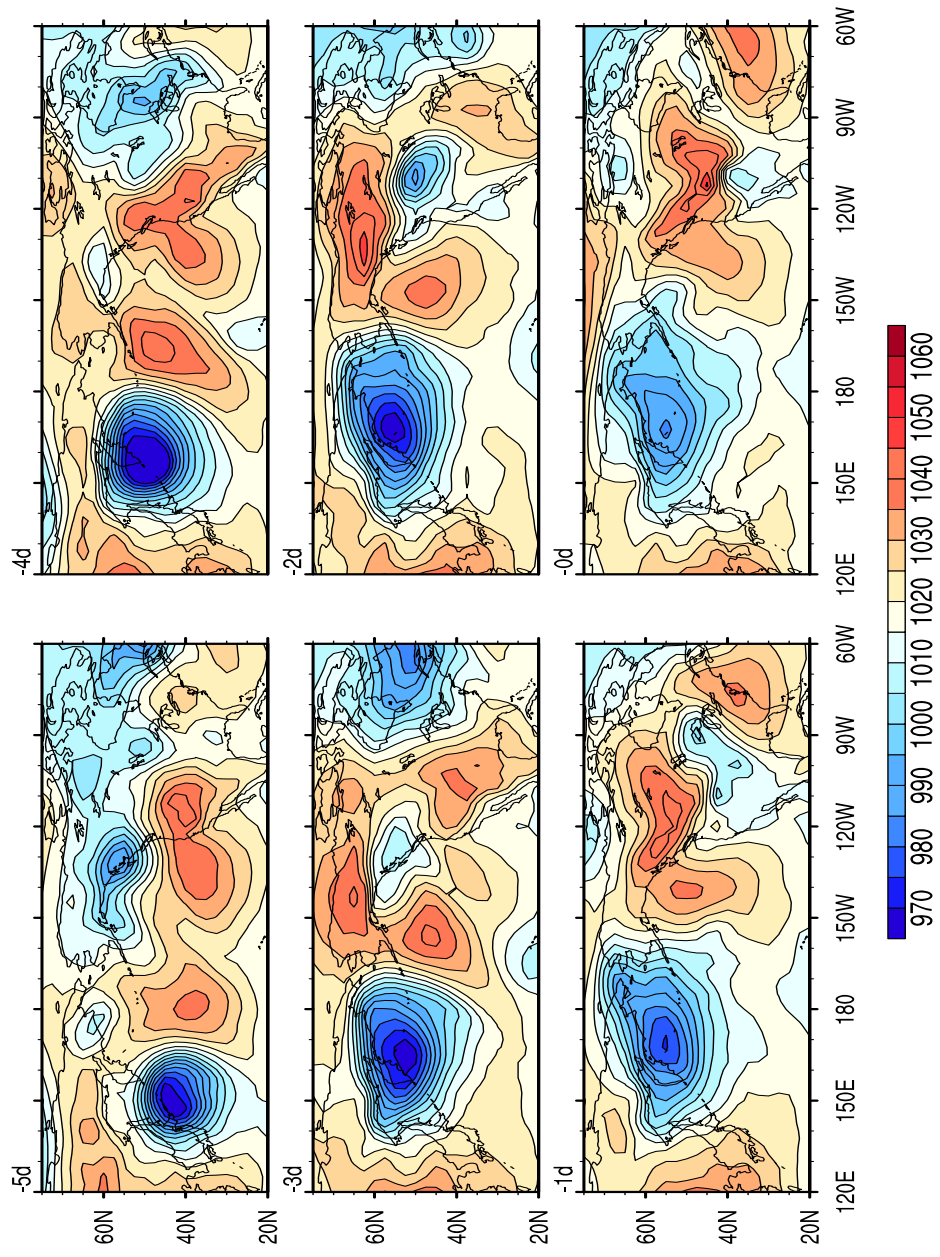


**Figure S13.** SLP for event 1 in Table 1 before and at onset. The label ‘-Nd’ in the upper left corner of each map denotes N days prior to the onset (all times are 12 UTC). 500 Pa contour interval.

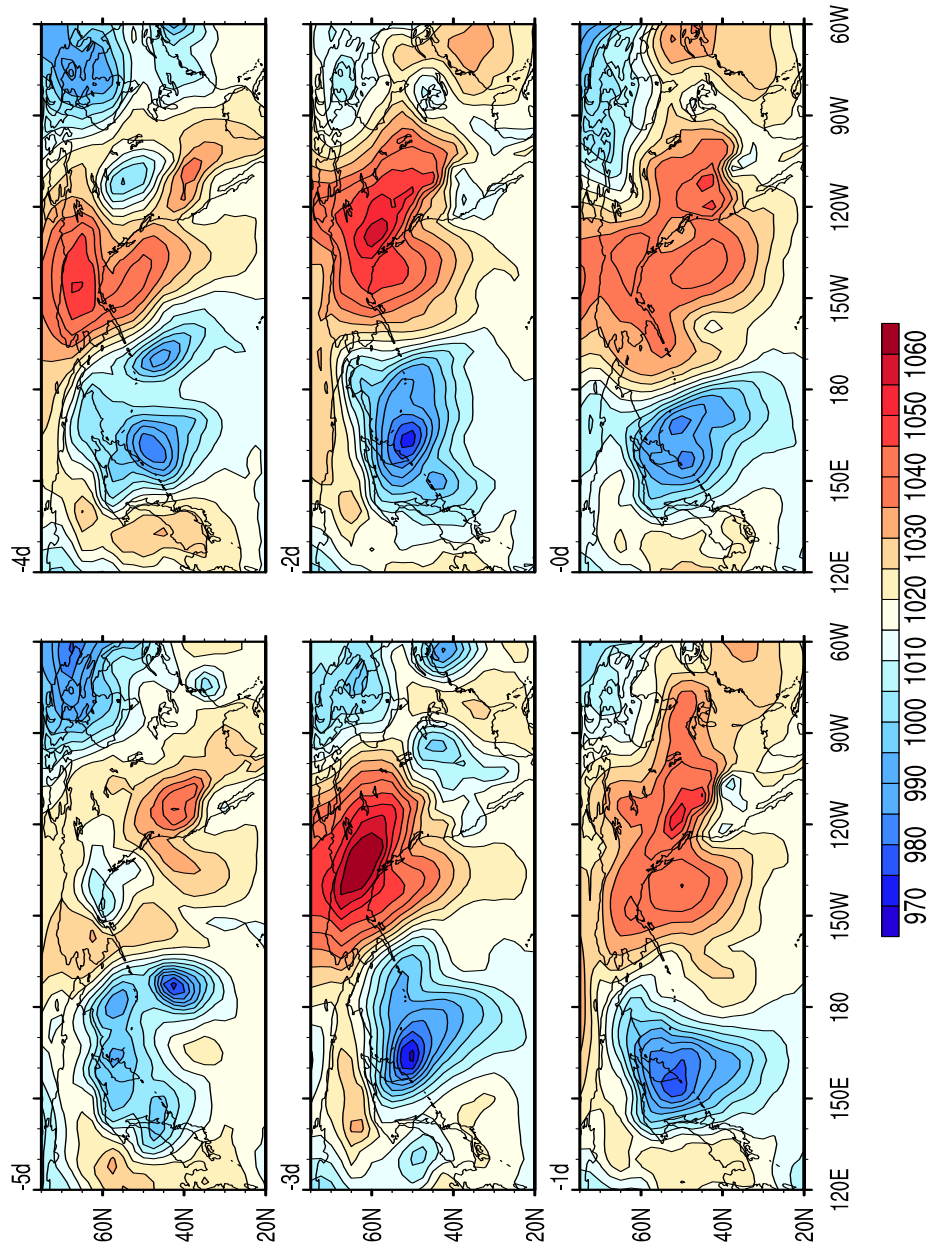




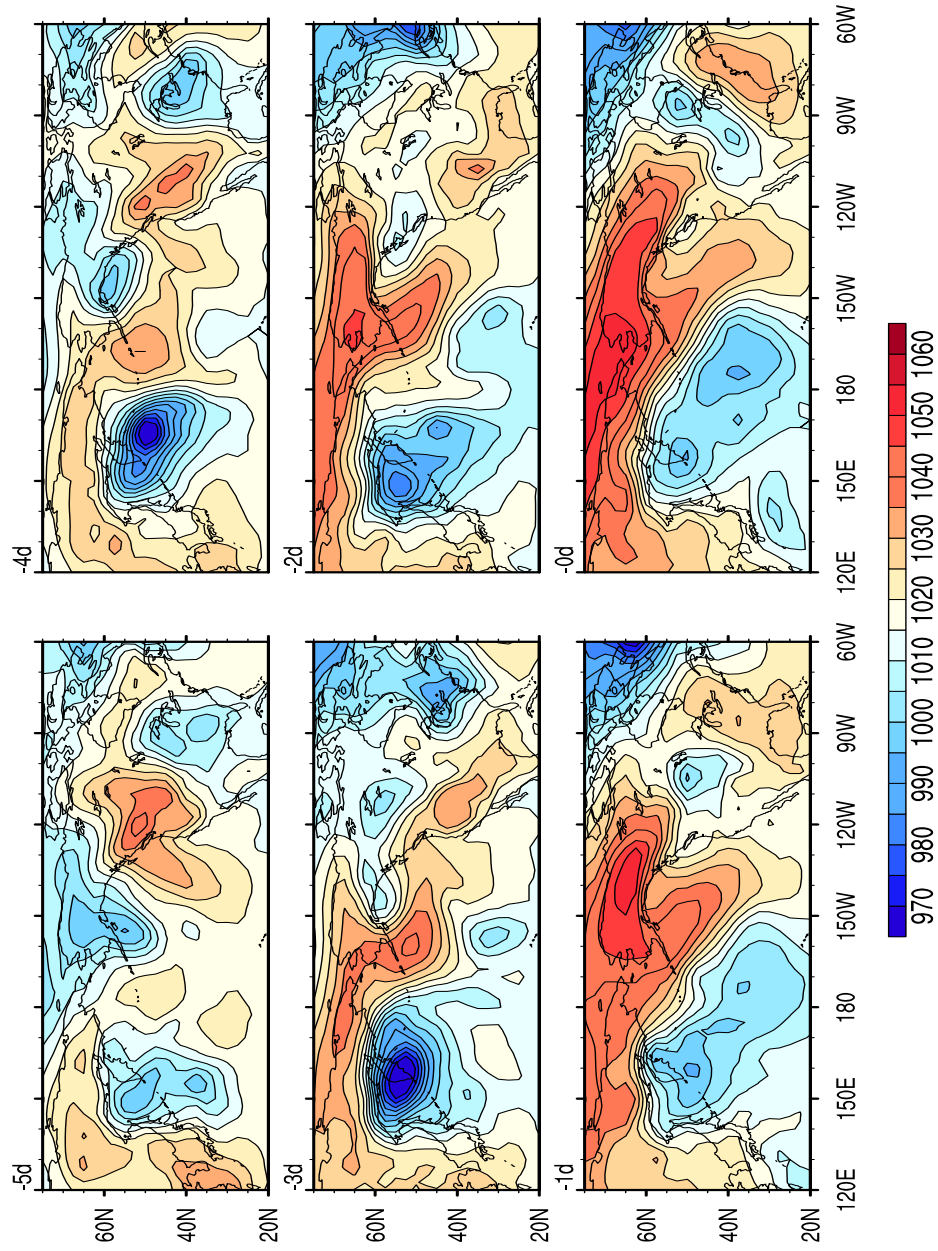
**Figure S14.** Same as Fig. S13 except for event 2 in Table 1.



**Figure S15.** Same as Fig. S13 except for event 3 in Table 1.

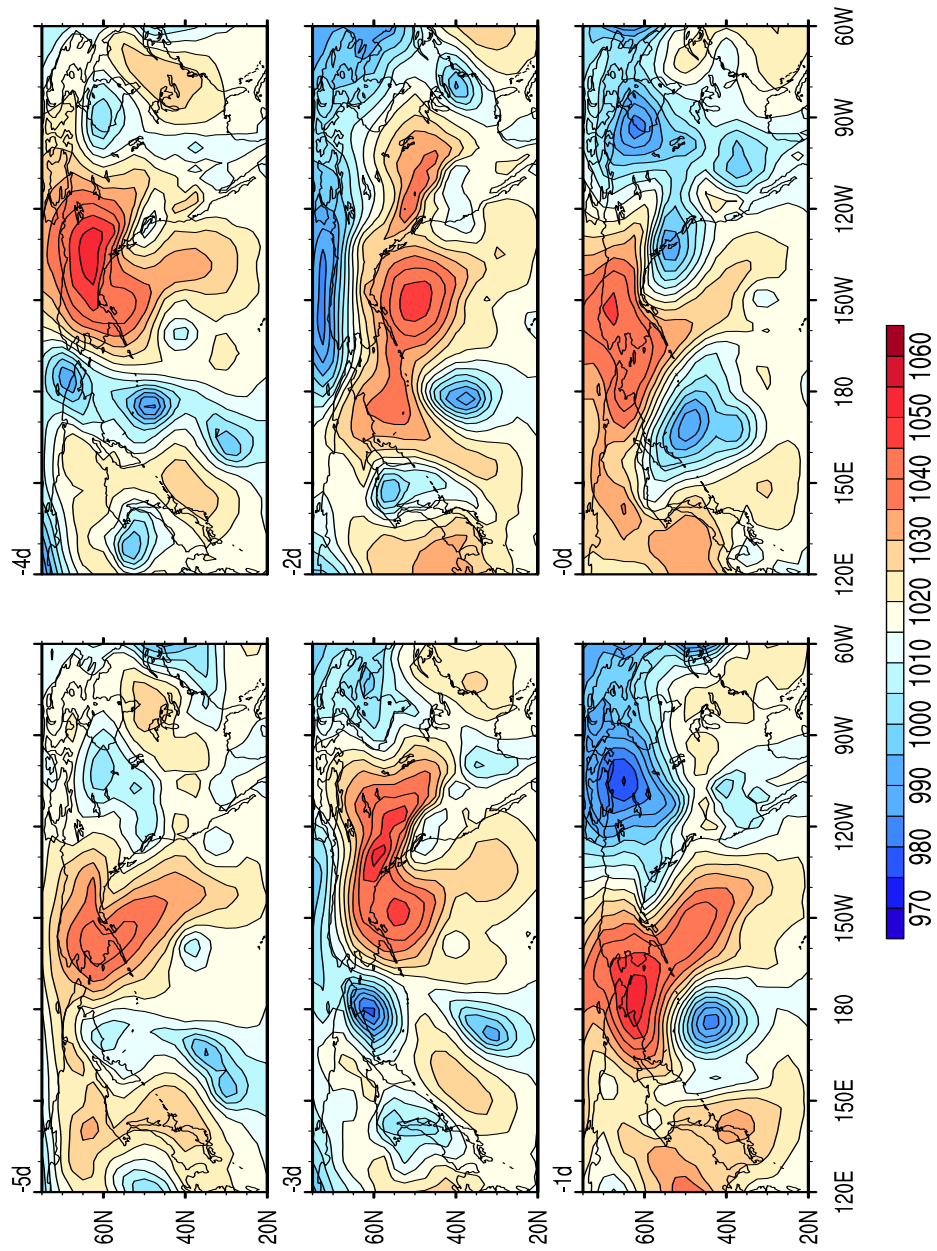


**Figure S16.** Same as Fig. S13 except for event 4 in Table 1.



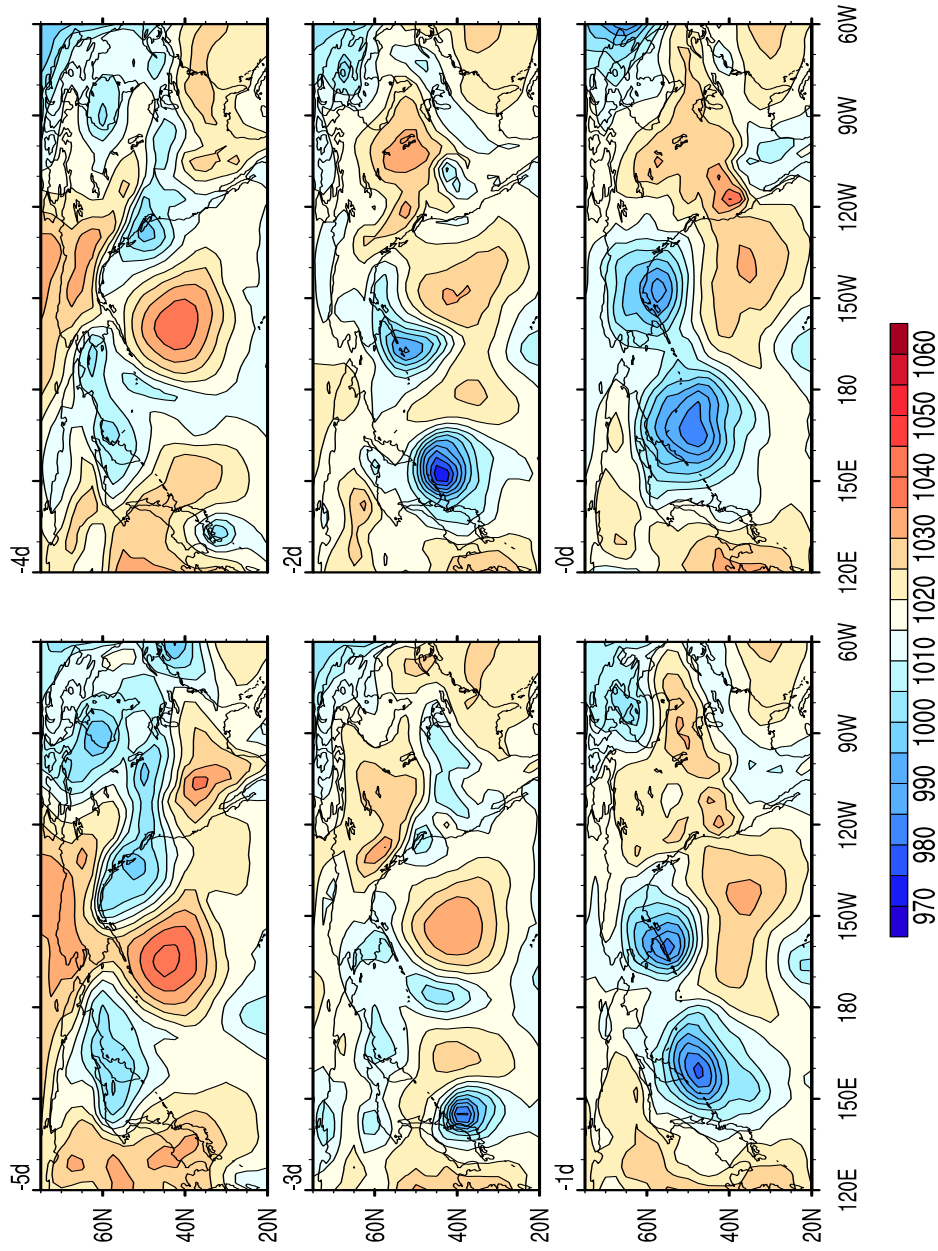
**Figure S17.** Same as Fig. S13 except for event 5 in Table 1.



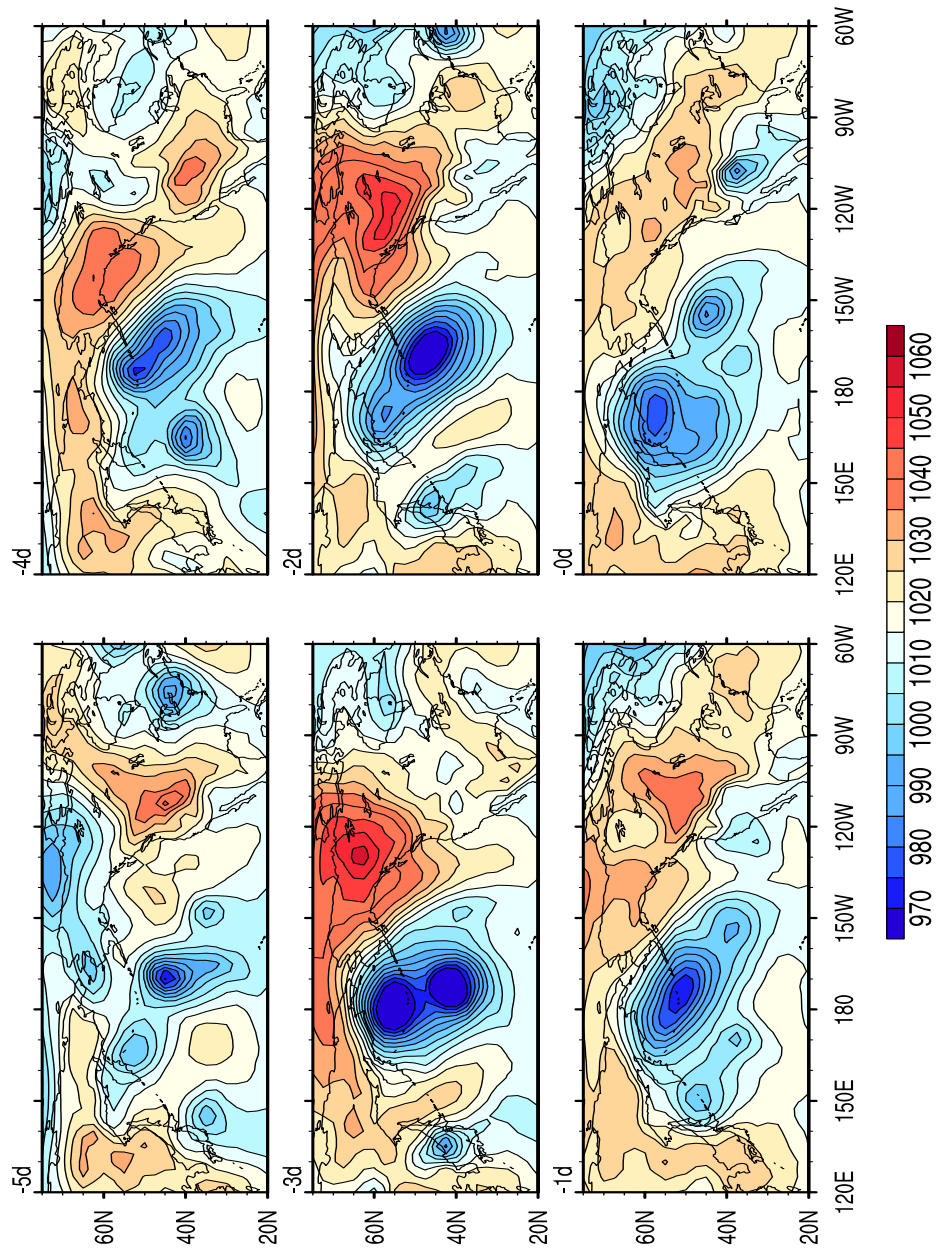


**Figure S18.** Same as Fig. S13 except for event 6 in Table 1.

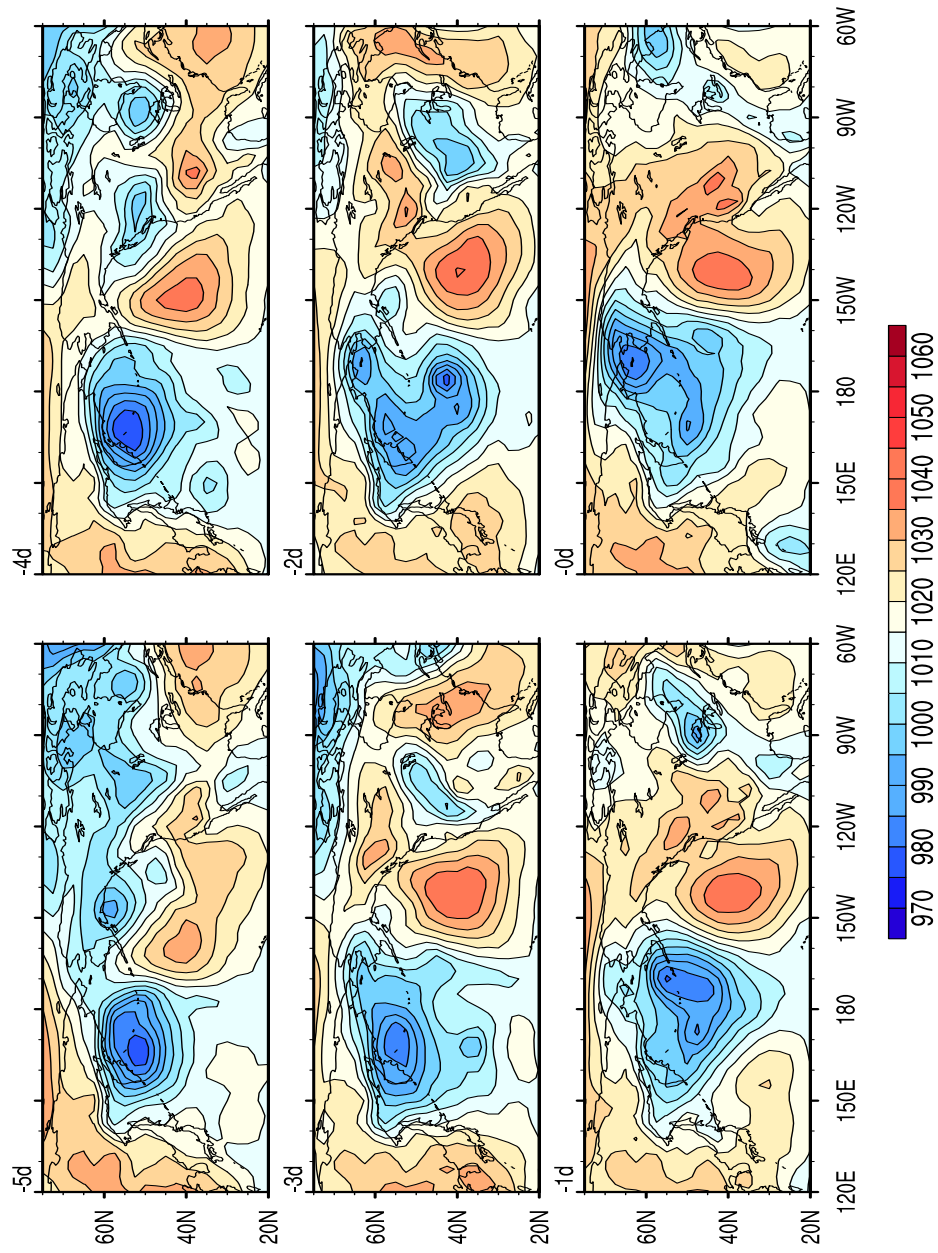




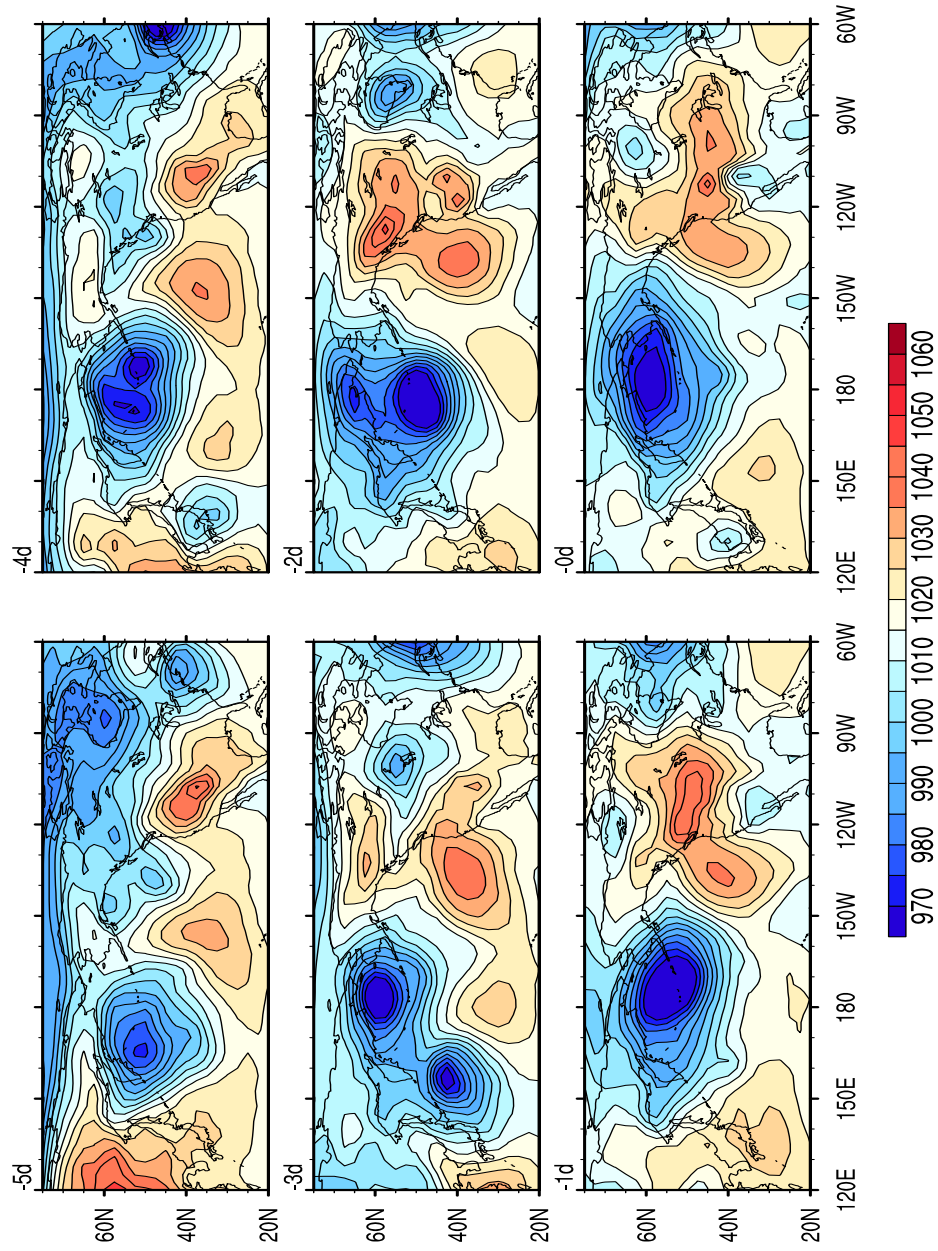
**Figure S19.** Same as Fig. S13 except for event 7 in Table 1.



**Figure S20.** Same as Fig. S13 except for event 8 in Table 1.

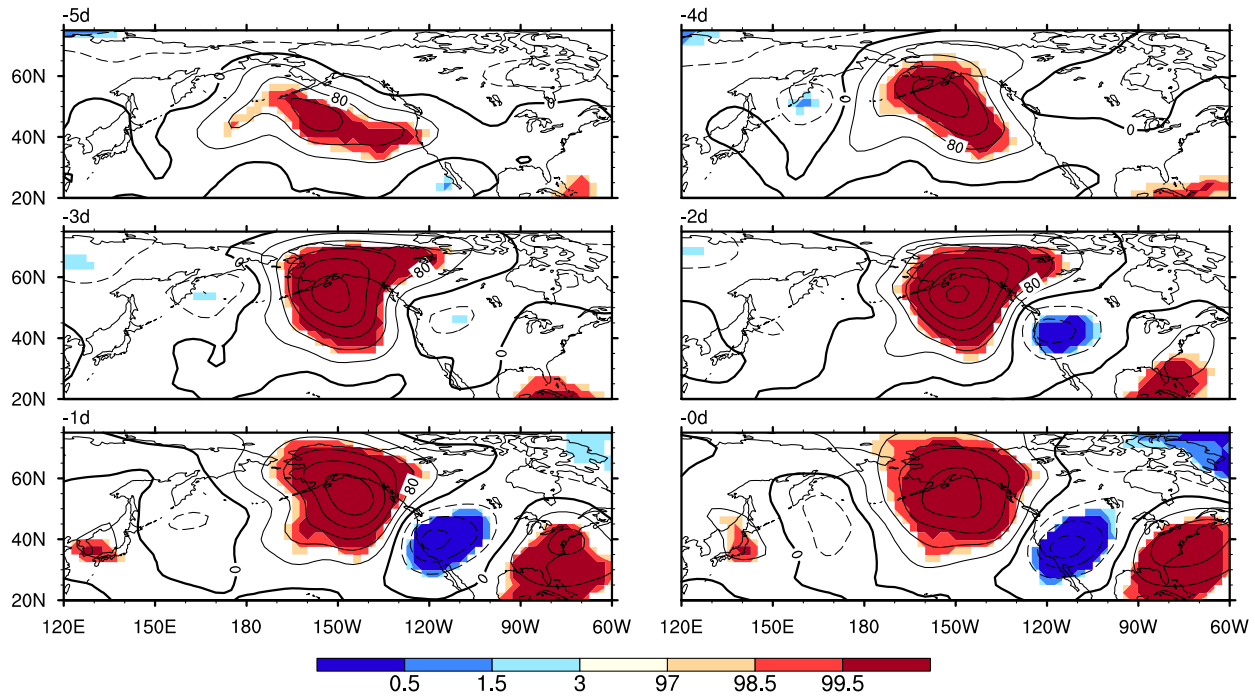


**Figure S21.** Same as Fig. S13 except for event 9 in Table 1.



**Figure S22.** Same as Fig. S13 except for event 10 in Table 1.

### C. Geopotential height anomaly at 700hPa.

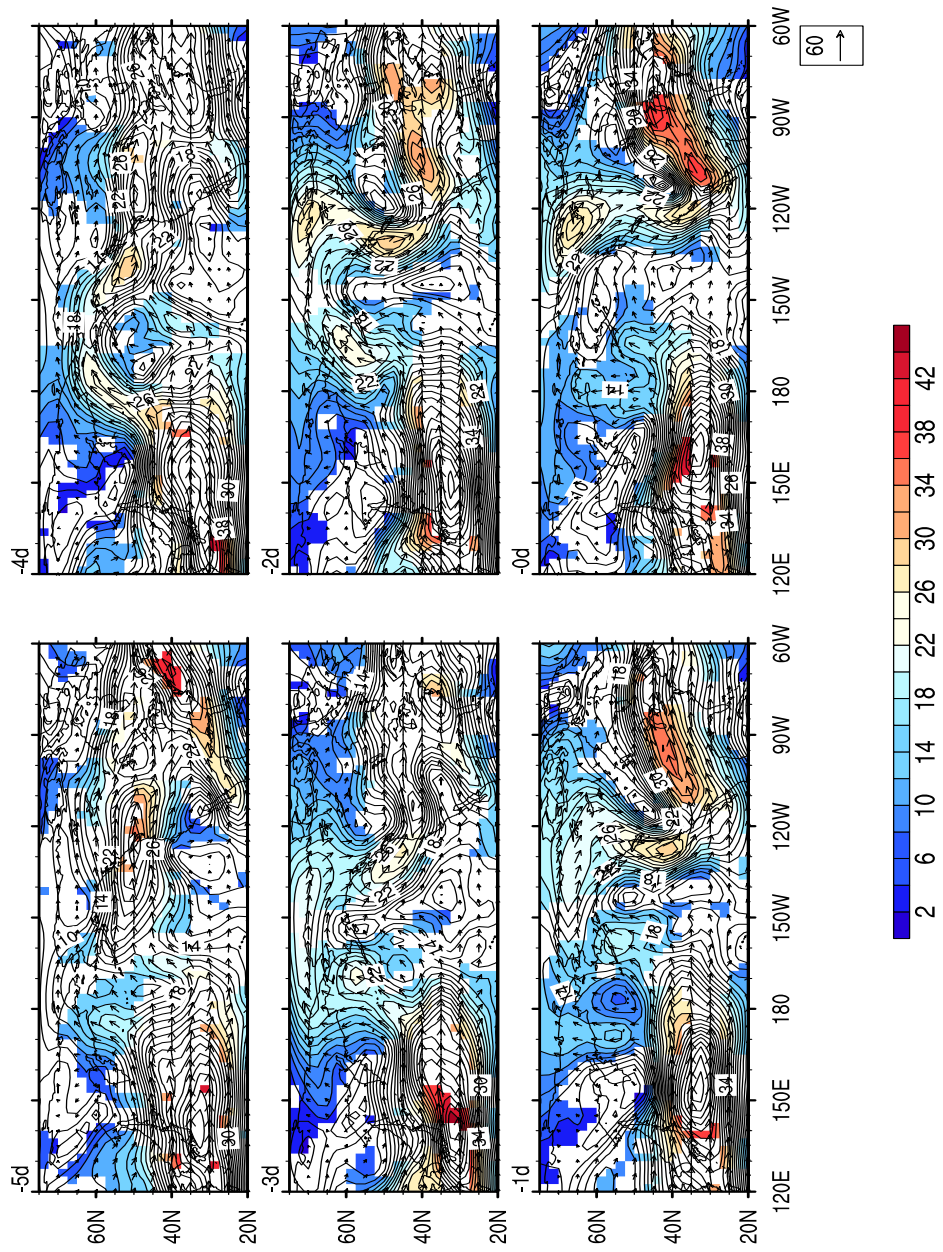


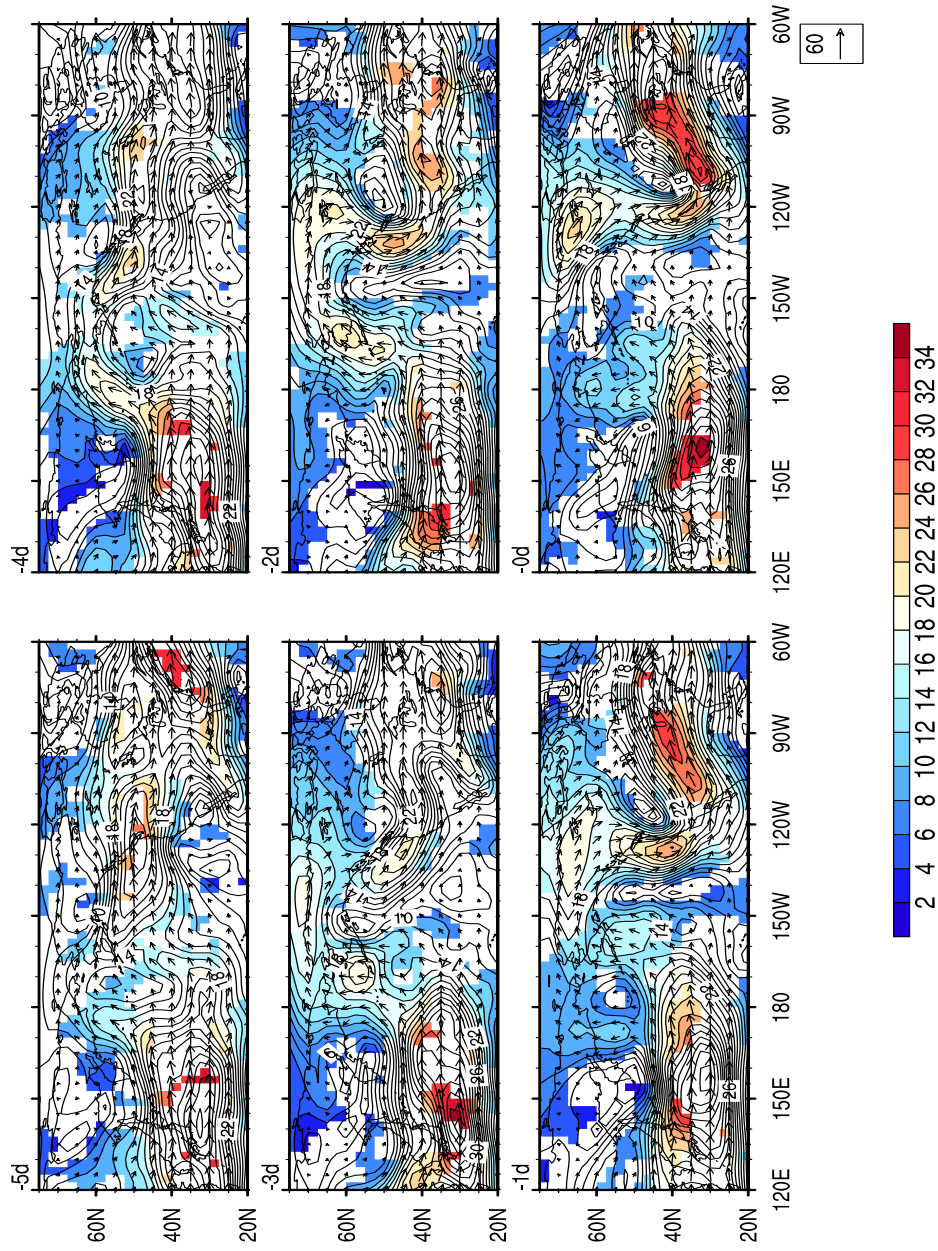
**Figure S23.** Composites of the 10 CAOs for geopotential height anomaly at 700hPa (contours), shadings indicate the significant areas which pass the Bootstrap test. Negative values have dashed contours while positive values use solid contours. Contour interval is 40m. The string ‘-Nd’ in the upper left corner of each map denotes N days prior to the onset (all times are 12 UTC).

### D. Horizontal winds at multiple vertical levels.

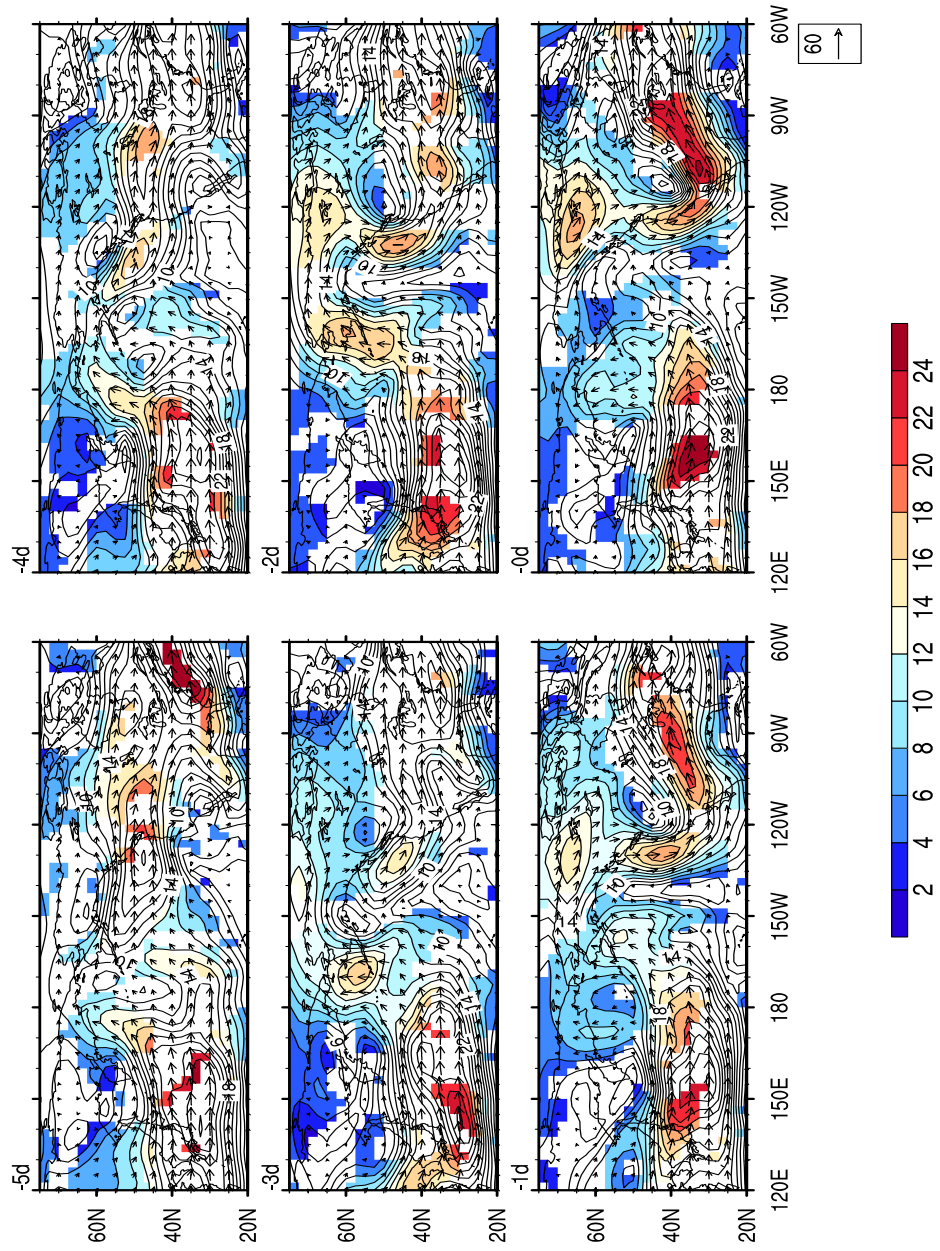
**Figure S24.** (next page) Composites of 10 CAOs for horizontal wind at 400hPa. The string ‘-Nd’ in the upper left corner of each map denotes N days prior to the onset (all times are 12 UTC). Contours indicate the speed of the wind. The contour interval is 2m/s. Meridional wind is used to calculate the sign count. Grid points where absolute values of sign count are greater than 3 are shown in shaded color.





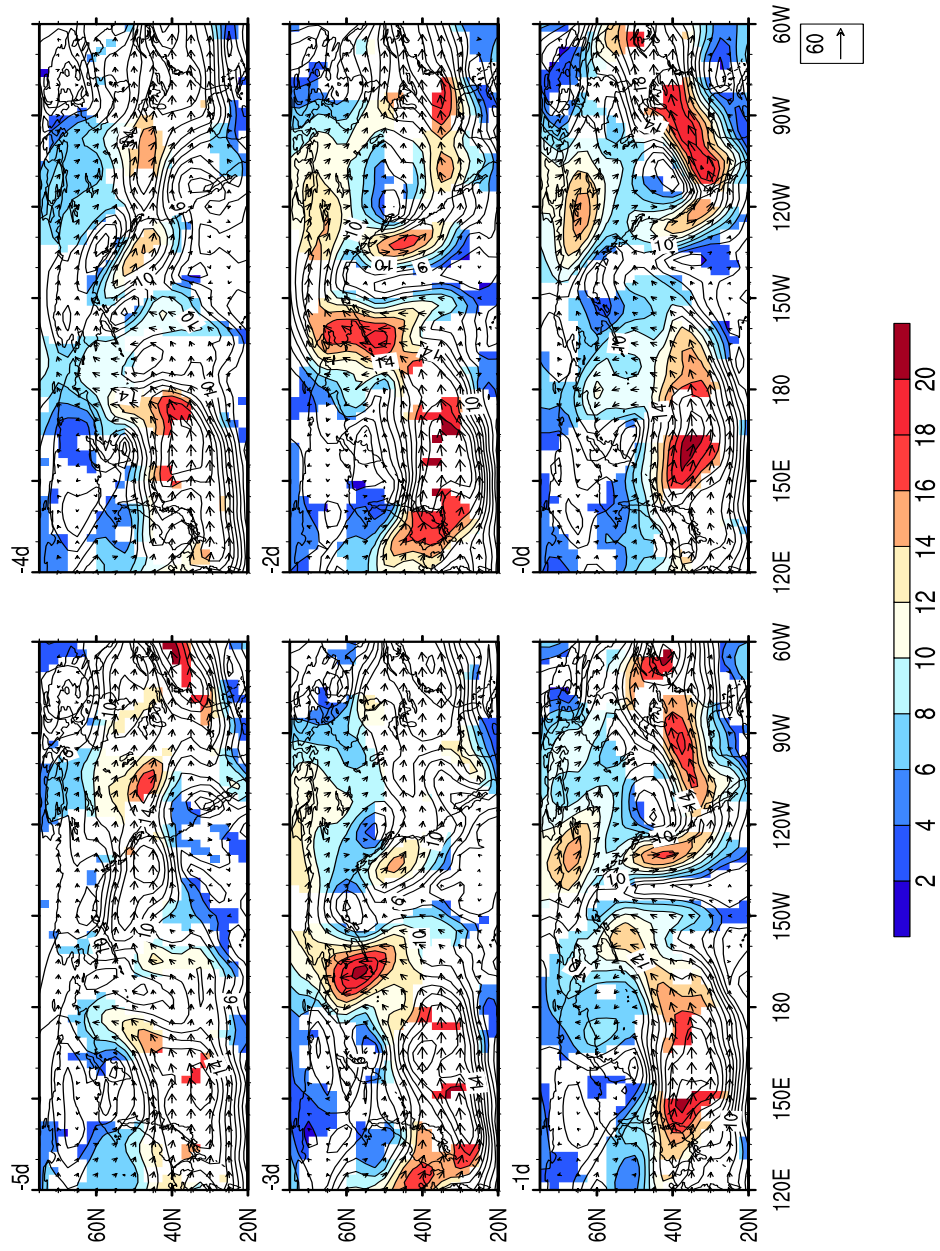


**Figure S25.** Same as Figure S24, but for 500hPa.

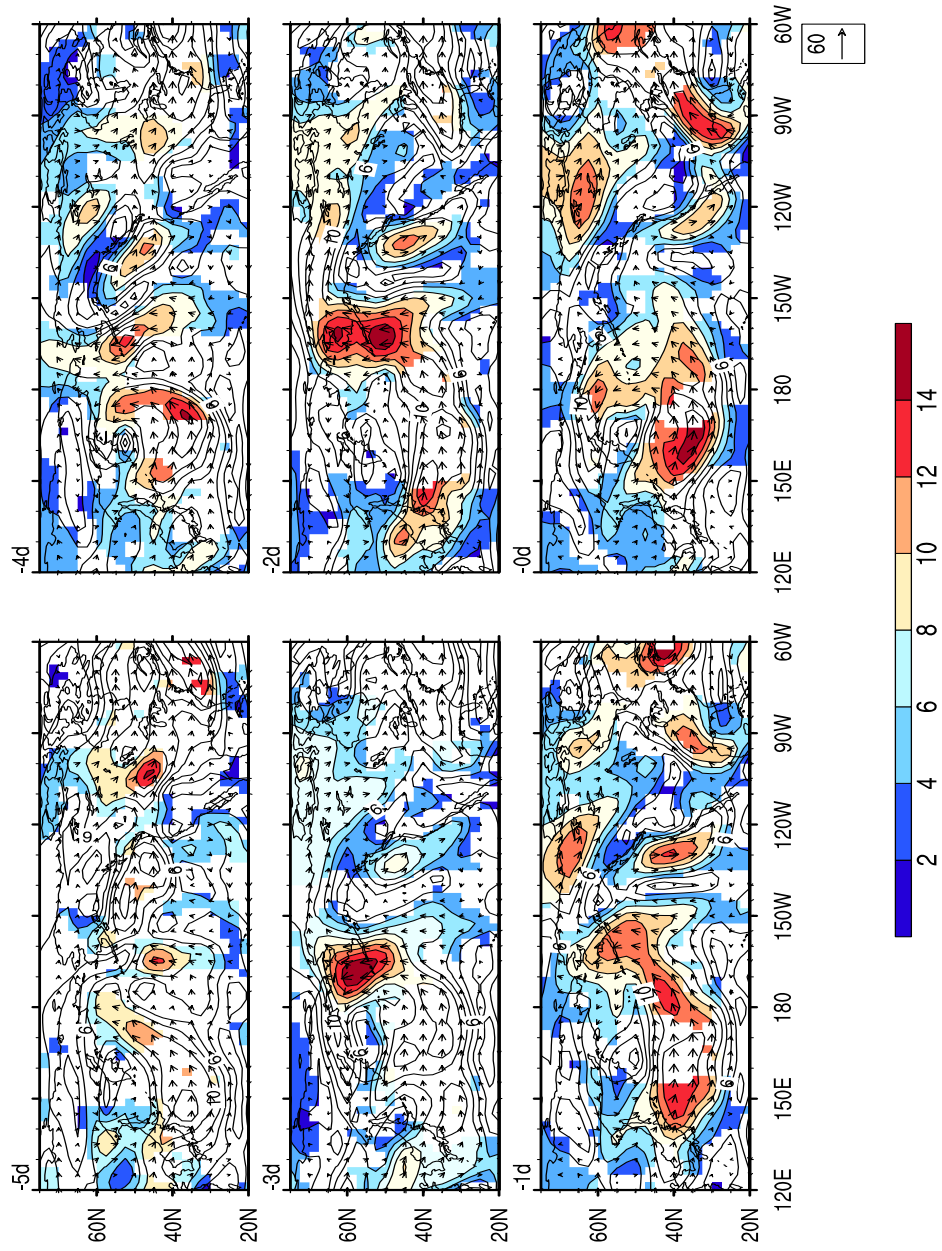


**Figure S26.** Same as Figure S24, but for 600hPa.





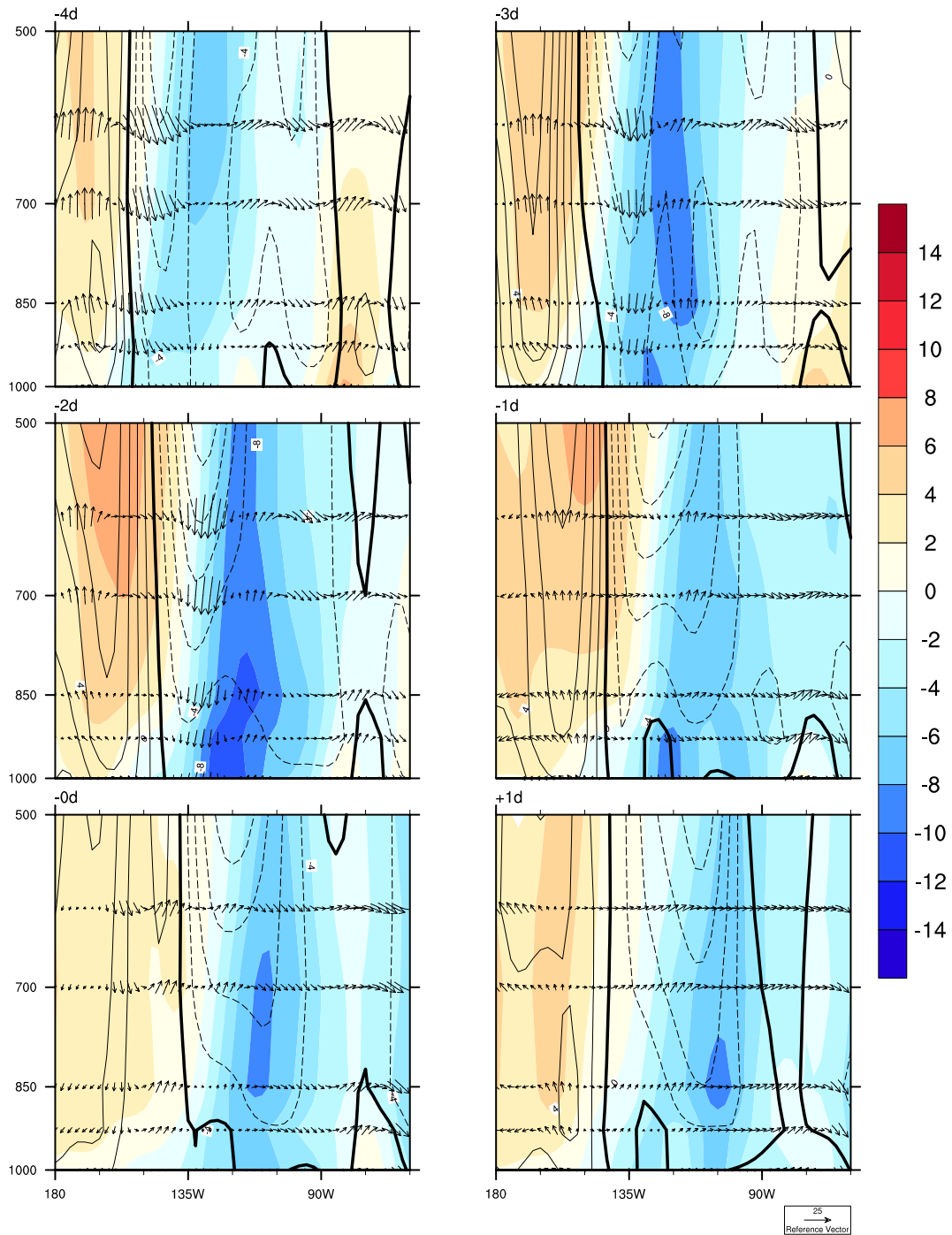
**Figure S27.** Same as Figure S24, but for 700hPa.



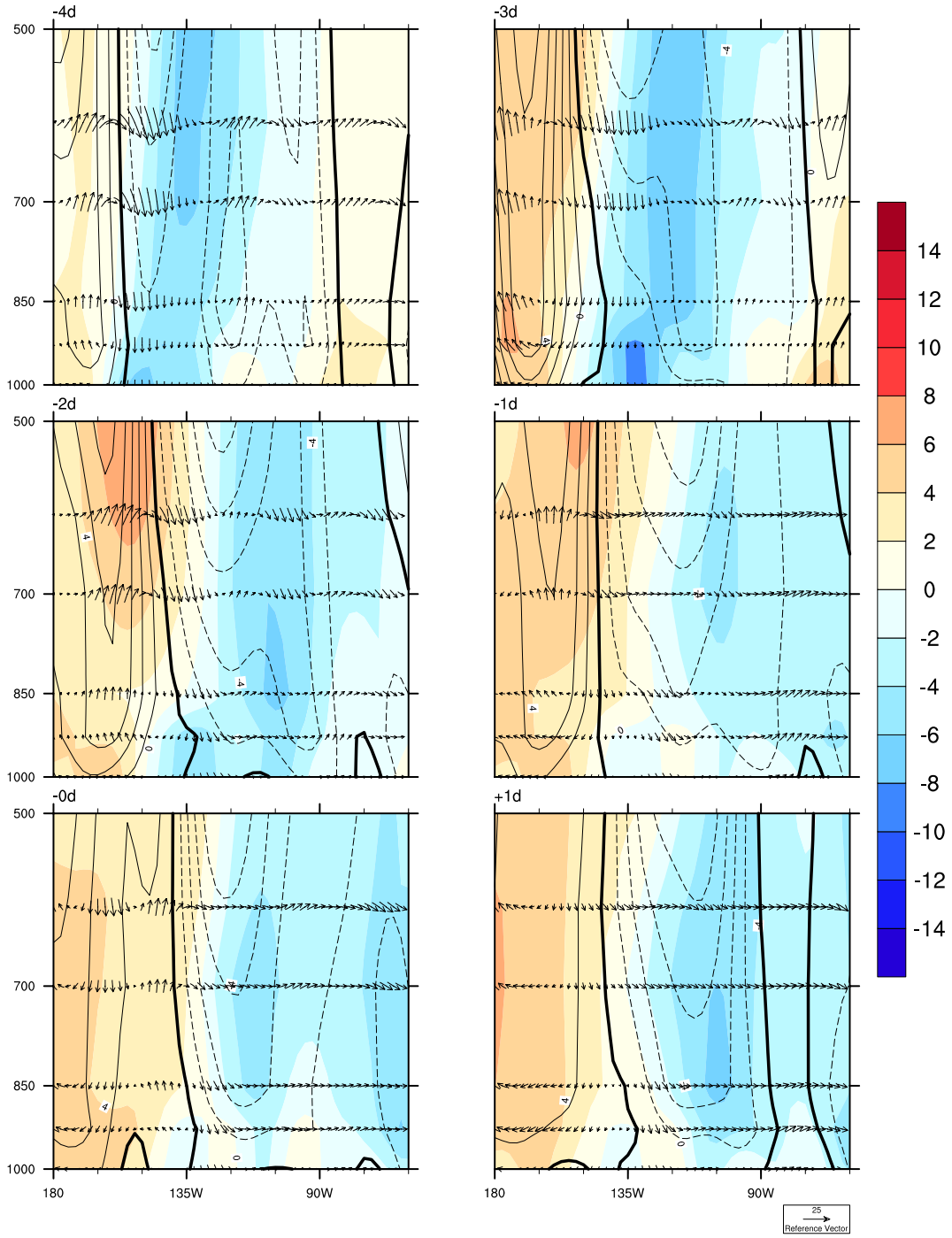
**Figure S28.** Same as Figure S24, but for 850hPa.

**E. Additional cross sections.**





**Figure S29.** Pressure-longitude cross section at 55N for 10 CAOs. Temperature anomaly is colored with 2K interval. Meridional wind contours at 4m/s interval; negative values (northerlies) are dashed while positive values are solid. Zero contour is a darker solid line. Vectors are of zonal wind and scaled vertical wind; the magnitude of the vertical component is scaled by the domain aspect ratio. Text string ‘-Nd’ (+Nd) in the upper left corner of each map denotes N days prior to (after) the onset (all times are 12 UTC). The CCV is near ~120W longitude.



**Figure S30.** Same as Figure S29, but at 60N.