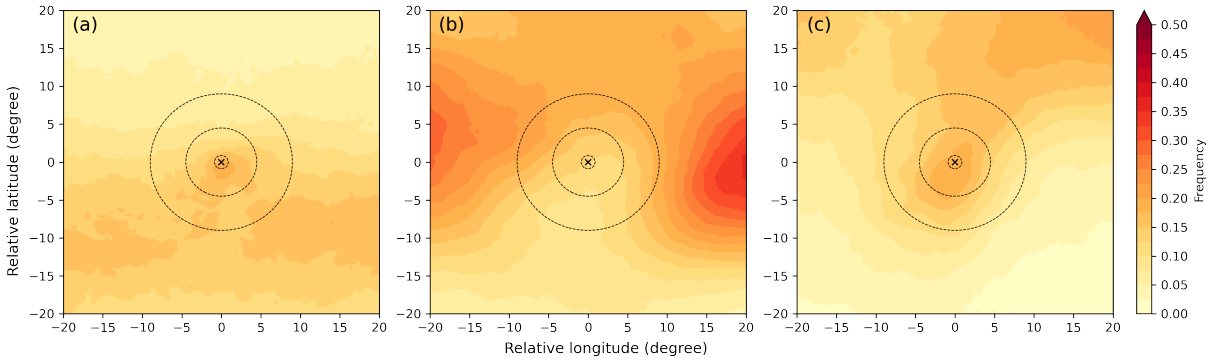

Figure S1. Event-centred composite frequency of **(a)** tropopause fold, **(b)** surface anticyclone, and **(c)** surface cyclone mask. The event location is denoted by the cross at the centre and the dashed circles indicate 100, 500, and 1000 km distance from it.

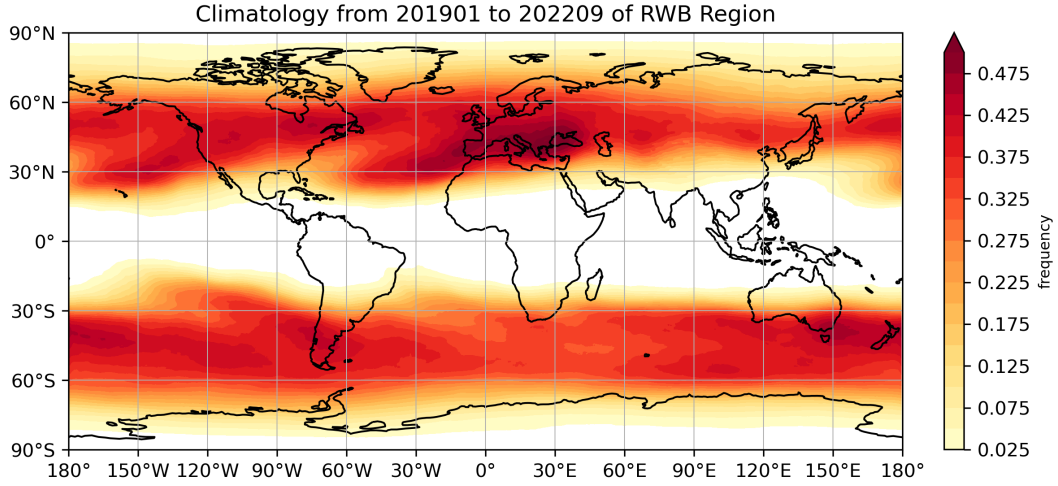

Figure S2. Climatological frequency of RWB region (projected PV streamer, 305 – 350 K) from January 2019 to September 2022.

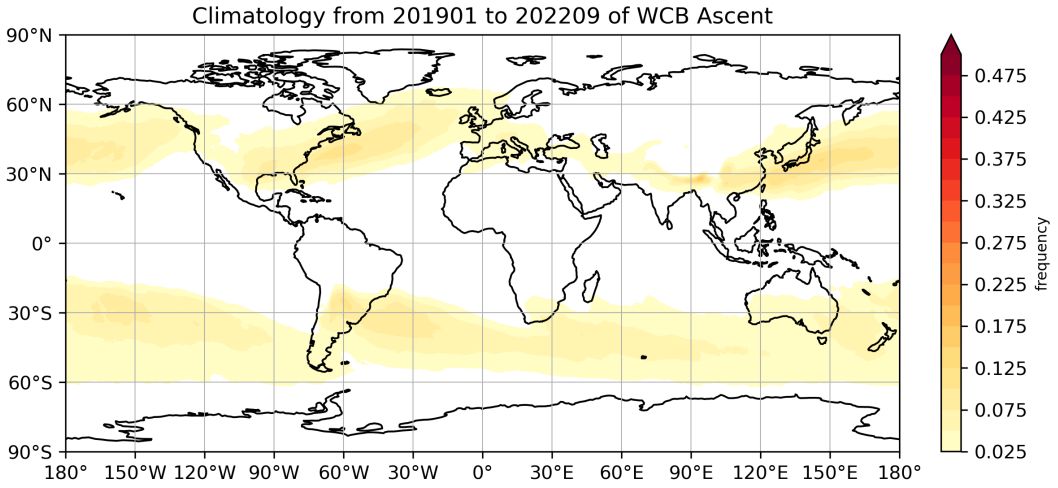

Figure S3. Climatological frequency of WCB ascent from January 2019 to September 2022.

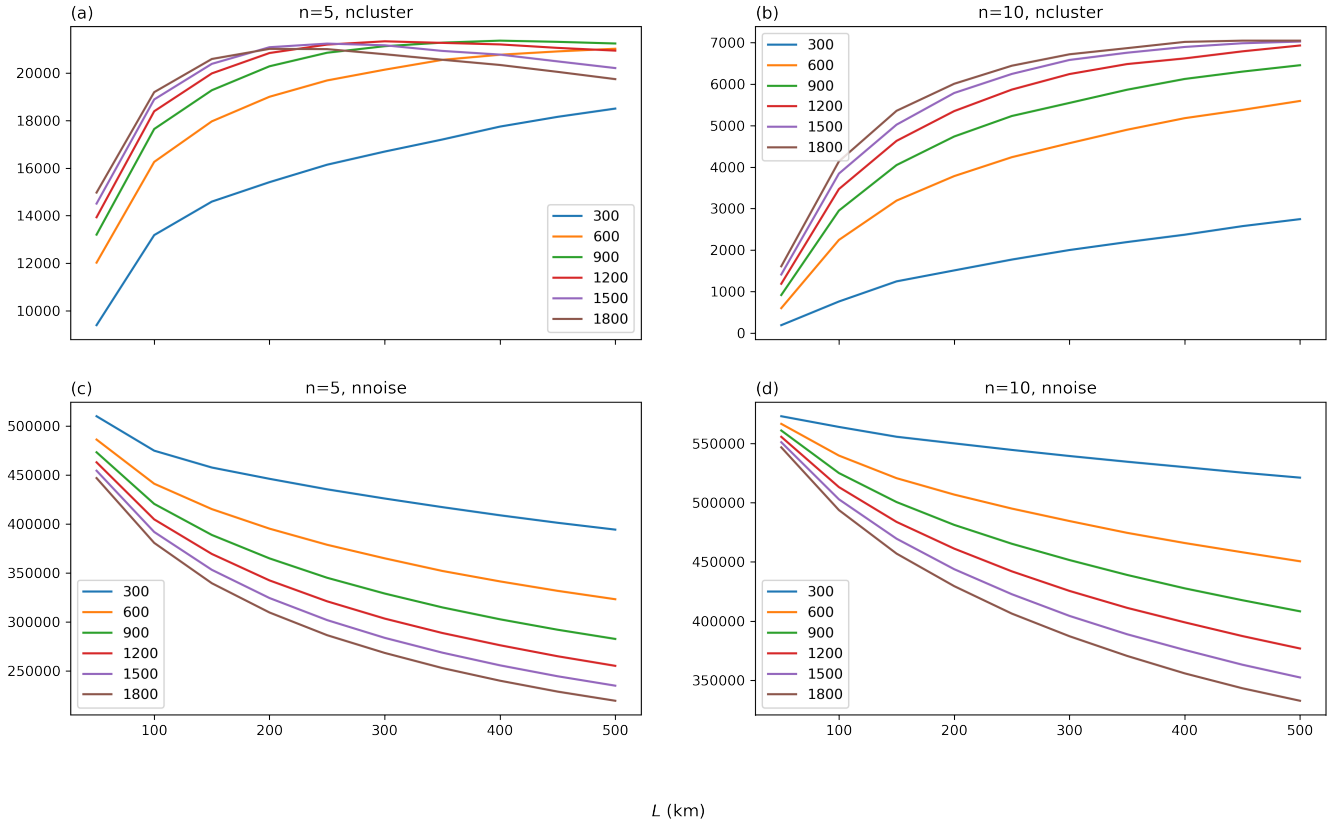

Figure S4. The number of clusters (ncluster) **(a,b)** and number of noise data points (nnoise) **(c,d)** identified by the DBSCAN algorithm as a function of L (km), with (a,c) $N = 5$ and (b,d) $N = 10$. The values of T (in s) are indicated by the different colours of the curves.

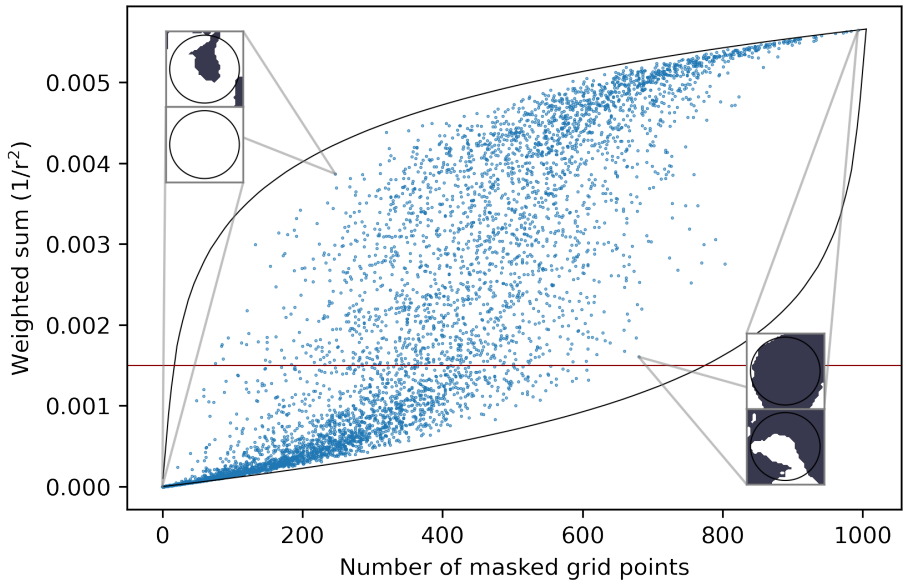

Figure S5. Scatter plot showing the weighted sum (weighting function with $1/r^2$ dependence) as a function of the number of RWB region (projected PV streamer) masked grid points for all events. The upper and lower curves indicate the maximum and minimum values of the weighted sum given the number of masked grid points. The threshold of 0.0015 km^{-2} is shown by the dark red horizontal line and it separates the two clusters with minimal and maximal overlaps. The RWB region masks of 4 selected events are shown (square panels, with the mask coloured in grey and the 1000 km neighbourhood indicated by the black circle).