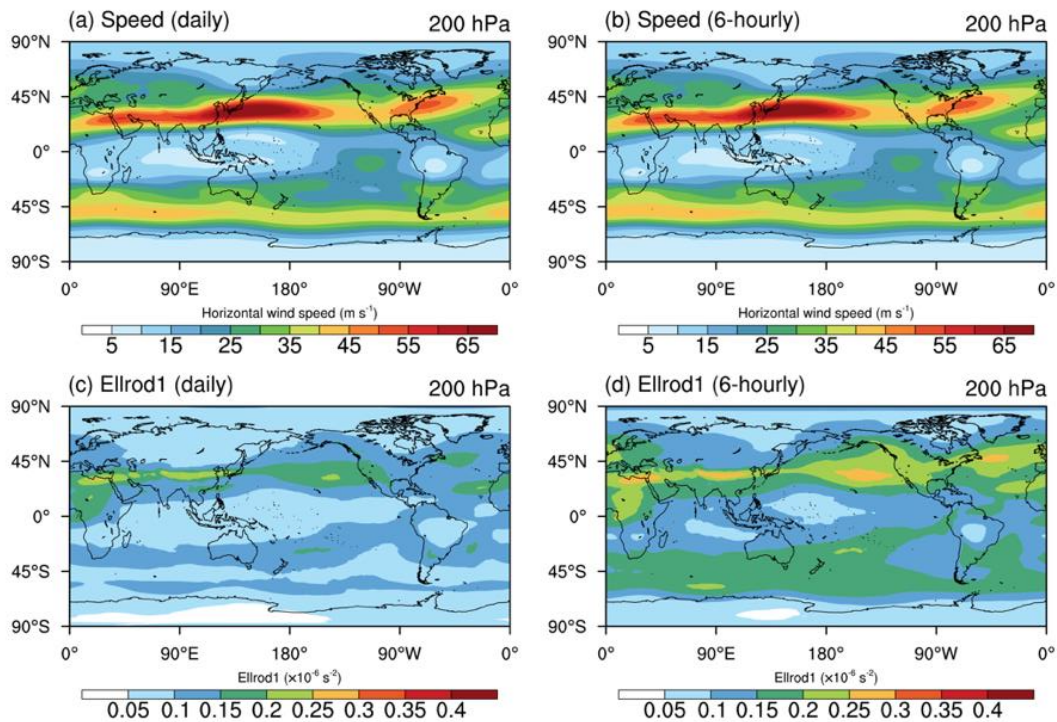**Supplementary Figure 1. Column-maximum convective heating rate and cloud-top momentum flux of convective gravity waves obtained from historical and SSP5-8.5 experiments.** The 45-year averaged column-maximum convective heating rate (CHR) and convective gravity wave cloud-top momentum flux (CTMF) for (a) DJF and (b) JJA. The leftmost and middle panels show the historical (1970-2014) and high-emissions (2056-2100) experiments, respectively. The rightmost panel shows the difference inferred from SSP5-8.5 minus historical experiments.

Supplementary Figure 2. Percentage change in the frequency of upper-level aviation turbulence (CAT, MWT, and NCT) with different MOG-level thresholds under the specified climate change scenario. The bar charts show the percentage change of occurrence frequency of MOG turbulence diagnosed by the 30 CAT, 14 MWT, and 2 NCT indices between 200 and 250 hPa for the 45-year (a) winter and (b) summer. The uppermost, middle, and lowest panels are for the global, extratropics, and tropics regions, respectively. The maximum, minimum, and median estimates between each type of turbulence are written in each figure (black: CAT, blue: MWT, and green: NCT). In Figs. S2a and S2b, (left) the 95th, (middle) the 98th, and (right) the 99.6th percentile are used as MOG-level threshold.

Supplementary Figure 3. The 45-year (2056-2100) averaged horizontal wind speed and the Ellrod1 index at 200 hPa for DJF. The 45-year averaged (a,b) horizontal wind and (c,d) Ellrod1 index at 200 hPa for DJF are computed using (a,c) the daily-mean data and (b,d) the 6-hourly data for the high-emissions (2056-2100) experiments.
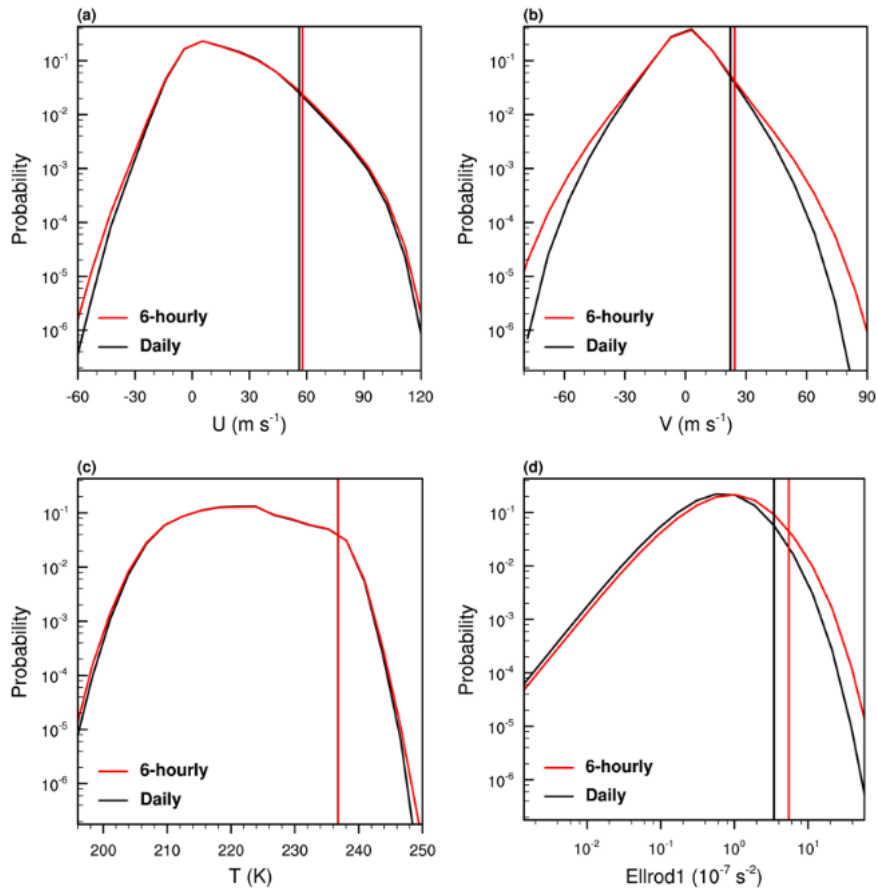
Supplementary Figure 4. Probability distributions of meteorological variables and the Ellrod1 index. The global probability distributions of (a) zonal wind, (b) meridional wind, (c) air temperature, and (d) Ellrod1 index between 200 and 250 hPa computed using (black) daily-mean and (red) 6-hourly data for 45 years (2056-2100) of the high-emission experiments. The 98th percentile is represented as a vertical line.