Supplementary Figure 1: JAS Black Carbon (BC) burden anomalies from the direct-atmospheric response simulations for 1970s minus 1950s (a) and 2000s minus 1970s (b). Solid contours indicate the regions in which the BC burden anomaly for a given regional emissions simulation accounts for more than 50% of the total BC burden anomaly and has a magnitude greater than $5 \times 10^8$ kg/m². The geographic region used to define the emissions from a given region are outlined using dashed lines in blue (N AM), purple (EURO), green (AFRI), and red (ASIA).
Supplementary Figure 2: Sum of SO4 (a, b) and BC (e, f) anomalies from the regional emission perturbation experiments for the 1970s minus 1950s (left column) and 2000s minus 1970s (right column). The difference between the sum of regional experiments and global emission change experiments is shown for SO4 (c, d) and BC (g, h). Hatching indicates grid points where the anomaly is significant at the 95% level.
Supplementary Figure 3: Sum of precipitation anomalies for the regional emission (a, e) and regional SST (c, g) perturbation experiments for the 1970s minus 1950s (top row) and 2000s minus 1970s (bottom row). The difference between the global emission change experiments and the sum of regional emission experiments are shown in b, f. The difference between the sum of regional SST experiments and global SST experiments are shown in d, h. Hatching indicates grid points where the anomaly is significant at the 95% level.
Supplementary Figure 4: 200hPa Velocity potential (a-d) and 850hPa Zonal wind (e-h) anomalies from the North American and Asian emission experiments for the 1970s minus 1950s (left column) and 2000s minus 1970s (right column). Hatching indicates grid points where the anomaly is significant at the 95% level. The FDR criterion is calculated, but returns a threshold of p=0, thus no grid points pass the FDR test.
Supplementary Figure 5: Clear-sky atmospheric SW absorption shortwave anomalies (a, b, e, f) and Clear-sky Top of Model (TOM) (c, d, g, h) for the Asian (1970s minus 1950s: b and d; 2000s minus 1970s: f and h) and North American (1970s minus 1950s: a and c; 2000s minus 1970s: e and g) emission change simulations. Hatching indicates regions of statistical significance, while cross hatching indicates regions that additionally pass the FDR criterion. Grid points in which there are statistically significant ($p < 0.05$) drying (brown) or wetting (green) signals are shown in contours.
Supplementary Figure 6: JAS 200hPa Velocity Potential anomalies from the Global SST (top - a, b) and Sum of regional SST perturbation experiments (middle - c, d) for the 1970s minus 1950s (left column) and the 2000s minus 1970s (right column). The differences between the global SST experiment and the sum of regional SST experiments are shown in (bottom - e, f).
Supplementary Figure 7: JAS 200hPa Velocity Potential anomalies from the Global emission (top - a, b) and Sum of regional emission perturbation experiments (middle - c, d) for the 1970s minus 1950s (left column) and the 2000s minus 1970s (right column). The differences between the global SST experiment and the sum of regional SST experiments are shown in (bottom - e, f).