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Supporting Information for

The Evolutions and Large-scale Mechanisms of Summer Stratospheric Ozone Intrusion across Global Hotspots

J. Lee[1], Y. Wu[1], and X. Wang[2]

[1]Lamont-Doherty Earth Observatory of Columbia University, New York, NY

[2]Department of Atmospheric and Oceanic Sciences, University of Colorado Boulder, Boulder, CO

Contents of this file

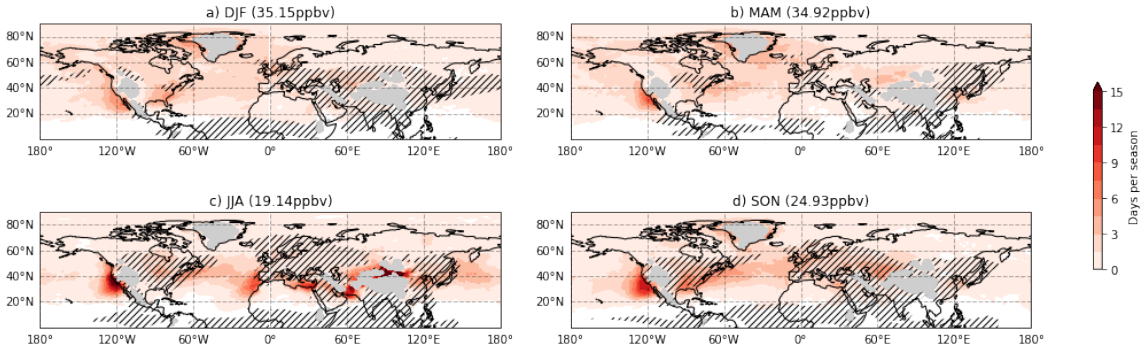

Figure S1. The average days per season when 850 hPa O_3S exceeds 99% of NH O_3S each season. The 99% O_3S threshold across the entire NH for each season is written in parentheses. Red shadings are days per season, and gray shadings are masked topography. Regions where R-squared values between anomalous O_3 and O_3S below 0.5 are hatched.

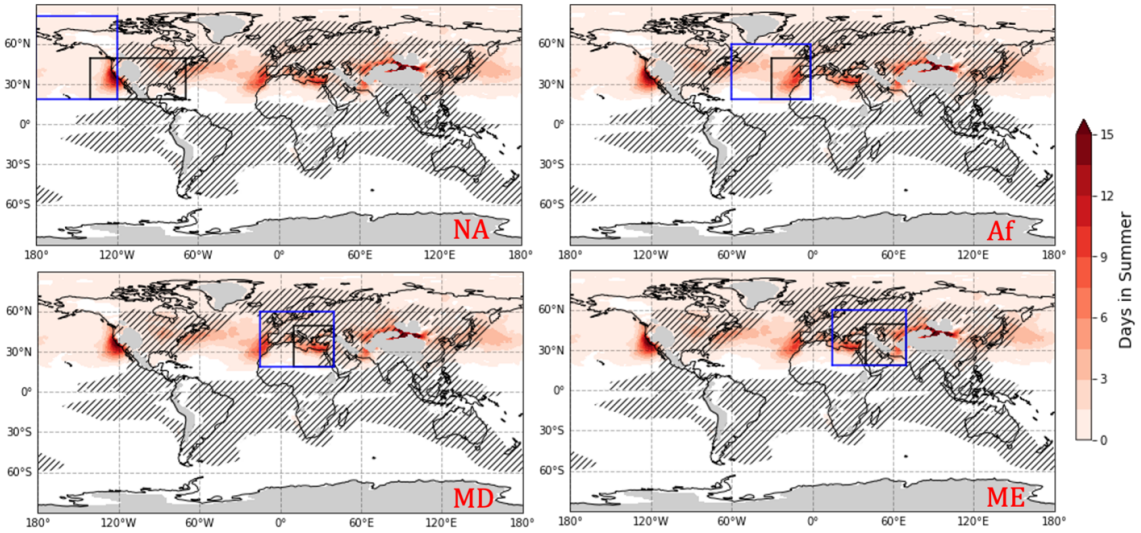

Figure S2. Boxes are drawn on top of Fig. 1 for MCA and composite analysis. Black boxes show where MCA is conducted for each hotspot. They all have the same latitude range of 20º-50ºN. The ranges of longitude for each hotspot are NA (140º-70ºW), Af (30ºW-0º), MD (10º-40ºE), and ME (40º-70ºE). Blue boxes show where stratospheric ozone intrusion speed has been estimated from box-averaged O_3S anomaly. The latitude range for NA is 20º-80ºN, while others all have the same latitude range of 20º-60ºN. The ranges of longitude for each hotspot are NA (180º-120ºW), Af (60ºW-0º), MD (15ºW-40ºE), and ME (15º-70ºE).

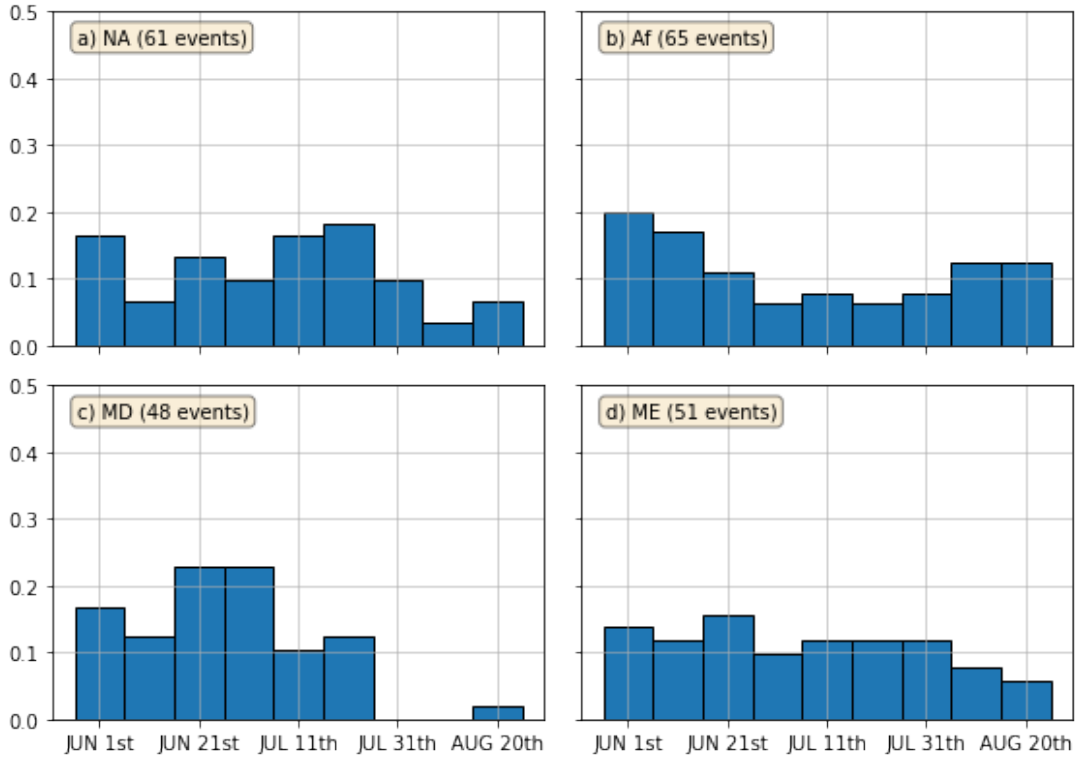

Figure S3. The density histogram of the start date of extreme events for every global hotspot. The extreme events are defined following section 3.2 and calculated for the MCA's leading mode. Each bin is 10 days long except for the last bin, which is 12 days. Each hotspot's total number of events is written in the parenthesis next to the hotspot name.

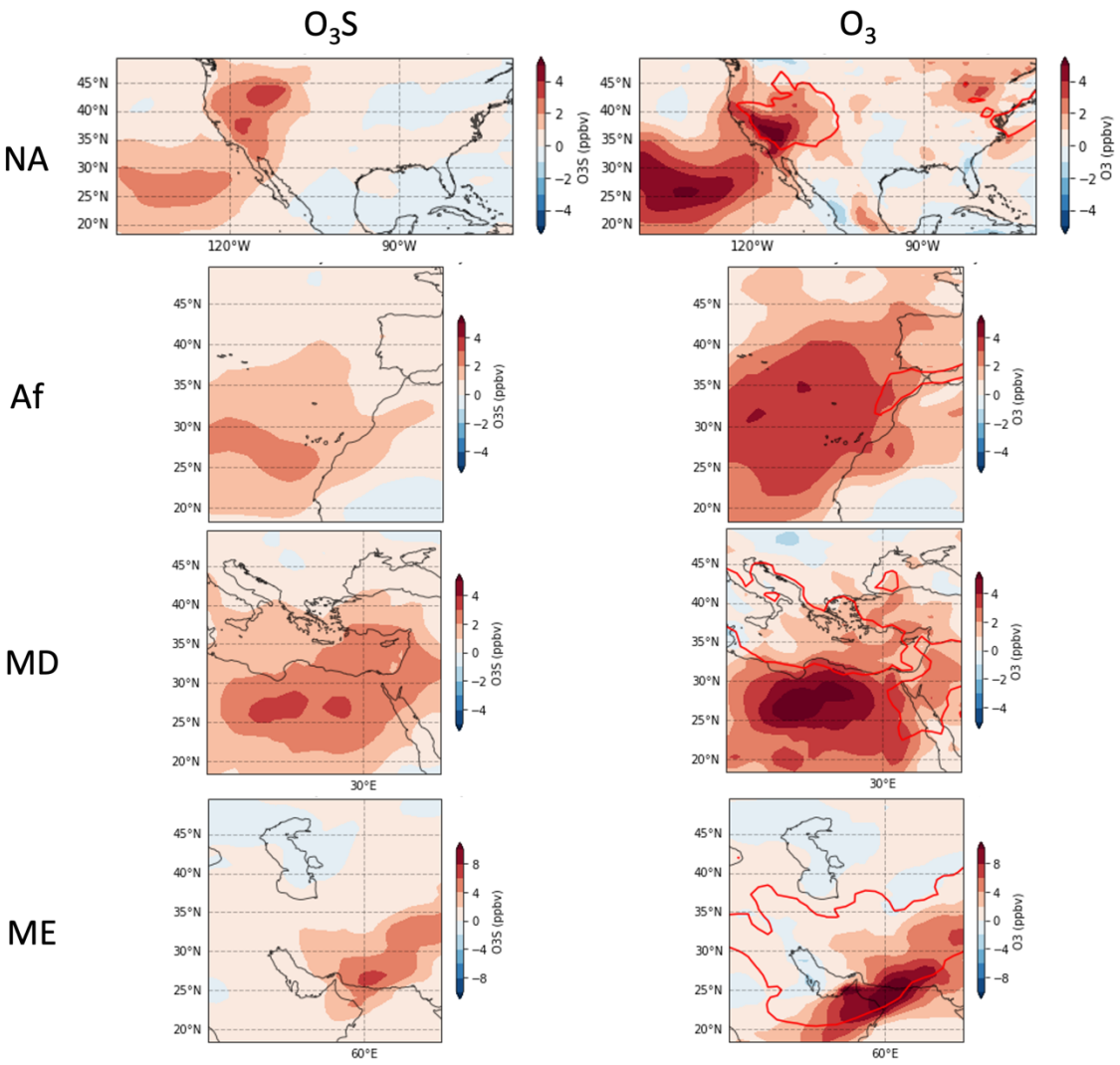

Figure S4. The lowest model level O_3S (left) and O_3 (right) anomaly (shading) composites 1 day after the MCA-identified extreme events at 850 hPa are shown (shading). The 50 ppbv O_3 level is shown in red contour only on the right column. From the top to the bottom, each row represents 4 hotspots: NA, Af, MD, and ME.

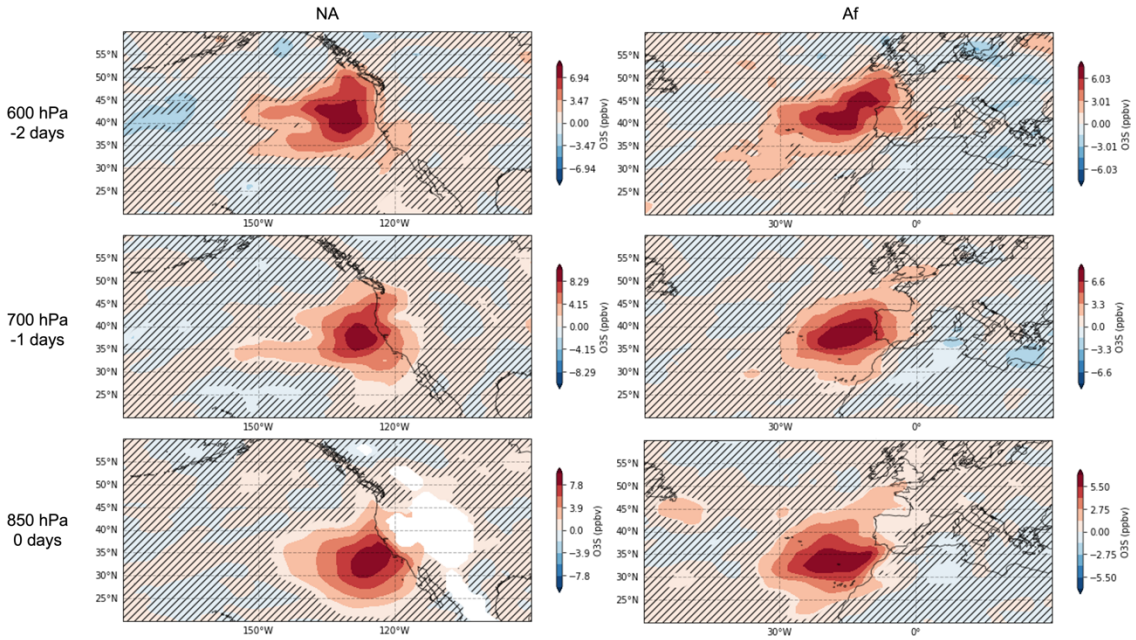

Figure S5. The gradual descent of the O_3S anomaly from 600 hPa to 850 hPa is shown (shading). The dates are specified based on a rough estimate of the average descending speed (600 hPa -2 days, 700 hPa -1 days, 850 hPa 0 days). The hatched area is where the p-value exceeds 0.05. The left column shows the NA hotspot and the right column shows the Af hotspot.

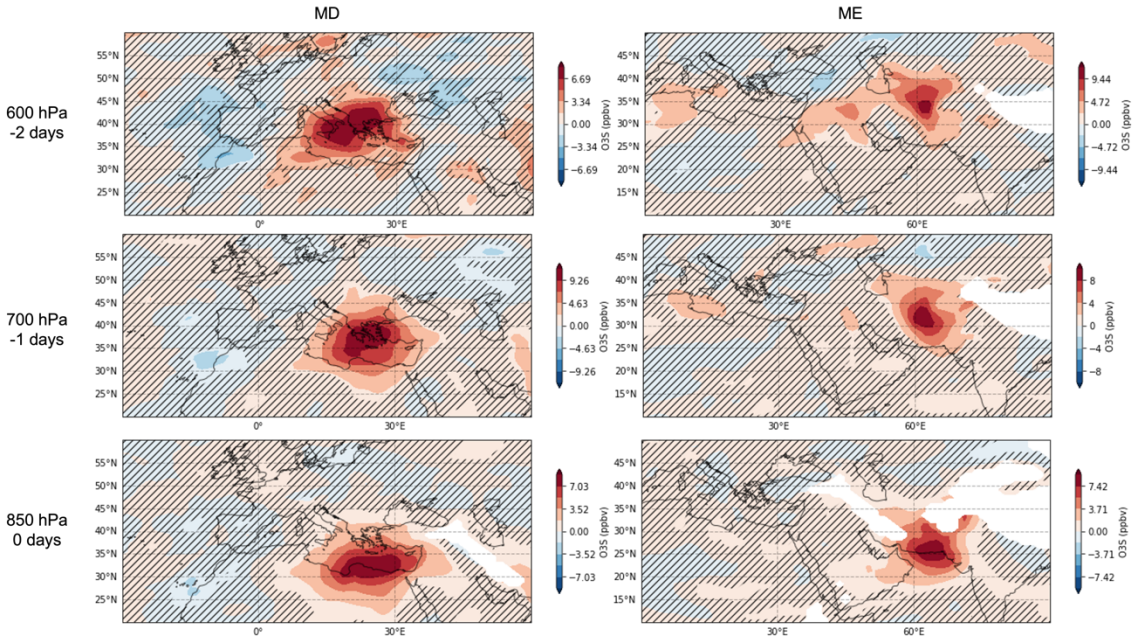

Figure S5 continued. Same as the previous figure. The left column shows the MD hotspot, and the right column shows the ME hotspot.