

Auxiliary Figures S1-S8

Lin M., A. M. Fiore , O. R. Cooper , L. W. Horowitz , A. O. Langford , Hiram Levy II , B. J. Johnson , V. Naik , S. J. Oltmans , C. Senff (2012): Springtime high surface ozone events over the western United States: Quantifying the role of stratospheric intrusions, *Journal of Geophysical Research*, 2012JD018151

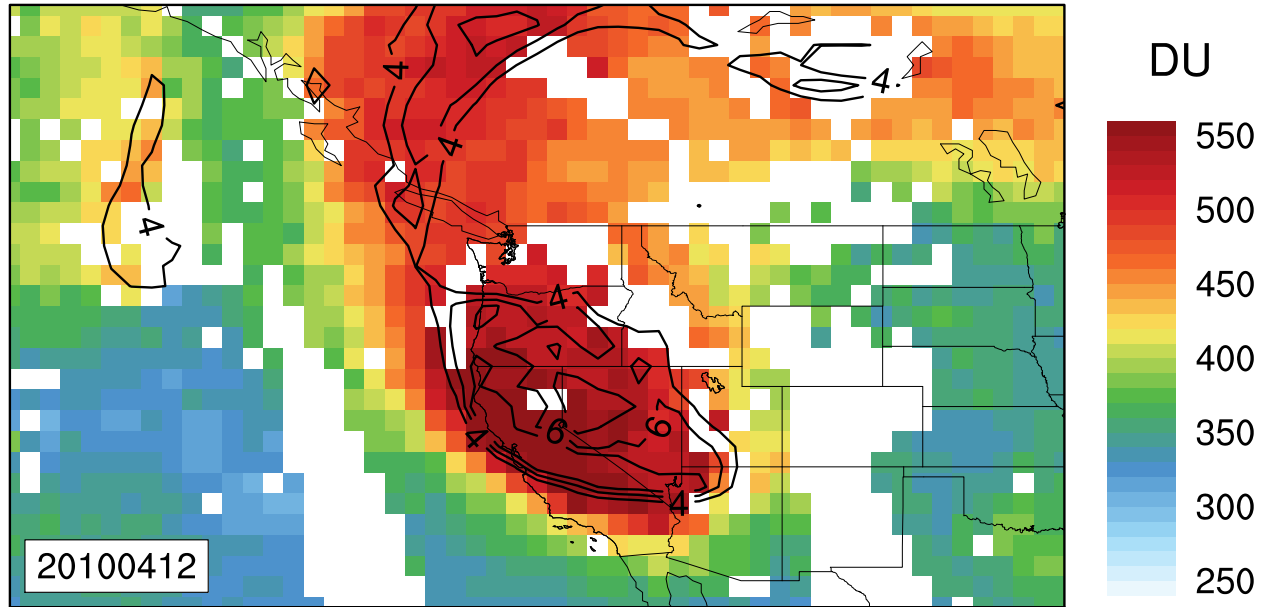


Figure S1. The April 12 stratospheric O₃ intrusion as observed by the AIRS instrument aboard NASA Aqua satellite during ascending orbit (~1:30pm local time), showing total O₃ column (shading) in excess of 400-550 Dobson Units coinciding with 4-8 PVU of potential vorticity at 300 hPa (contours) computed from GFS FNL analysis.

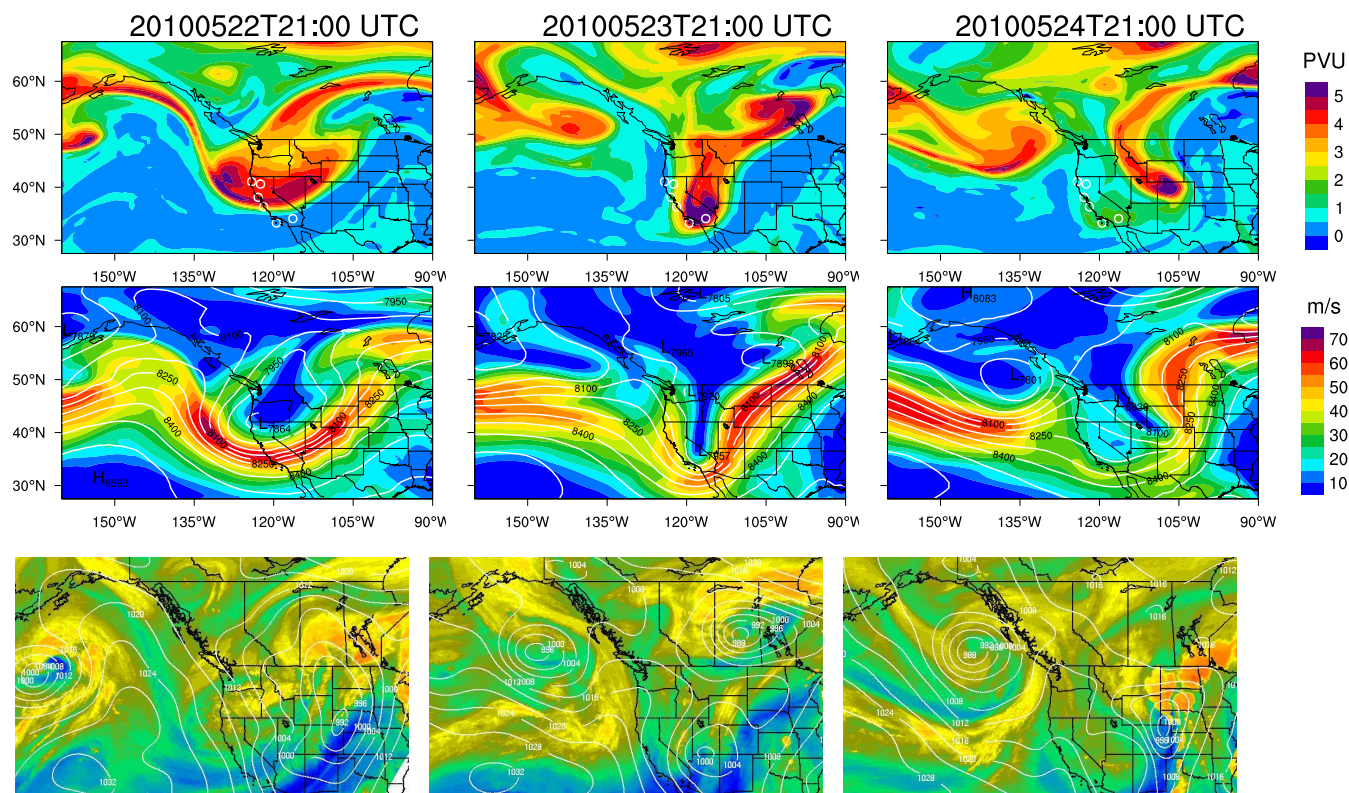


Figure S2. Synoptic conditions during the May 22-24 intrusion, showing propagation of an upper-level trough over the western United States: (top) AM3 250 hPa potential vorticity in PVU, (middle) AM3 250 hPa wind speed (shading) with 350 hPa geopotential height (contoured in gpm) from GFS FNL analysis, and (bottom) GOES-West water vapor images (with mean sea level pressure).

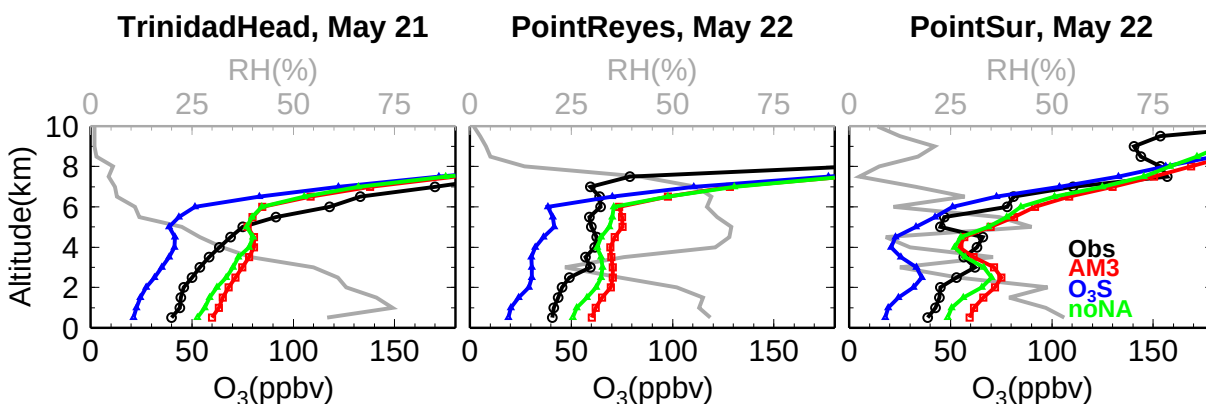


Figure S3. Same as Figure 3, but for May 21-22, showing penetration of a large tropopause fold to 6-8 km a.s.l. at the soundings located within the trough over Northern California (shown in the left panels of Figure S2).

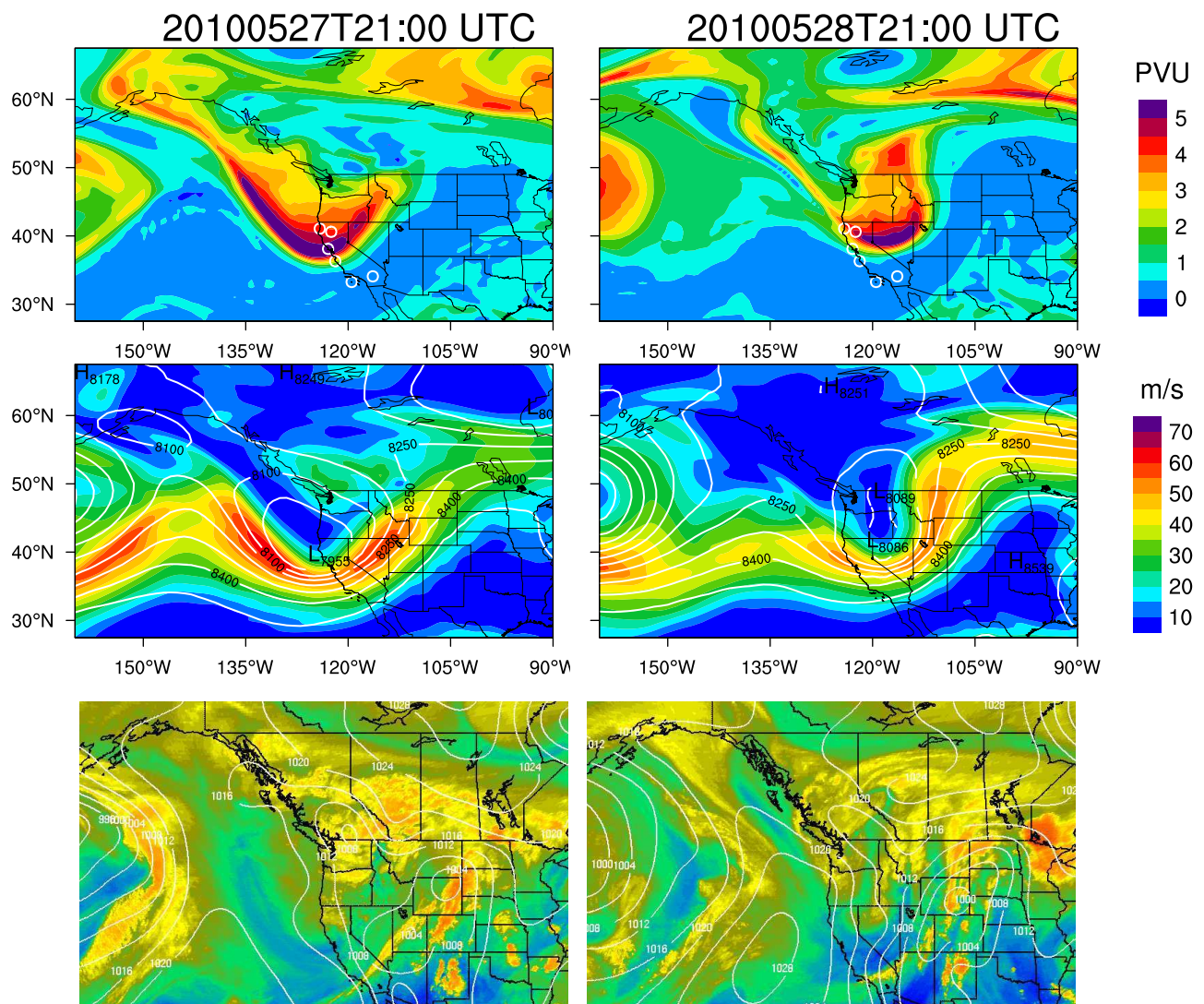


Figure S4. Same as Figure S2, but showing synoptic conditions for the May 27-29 intrusion.

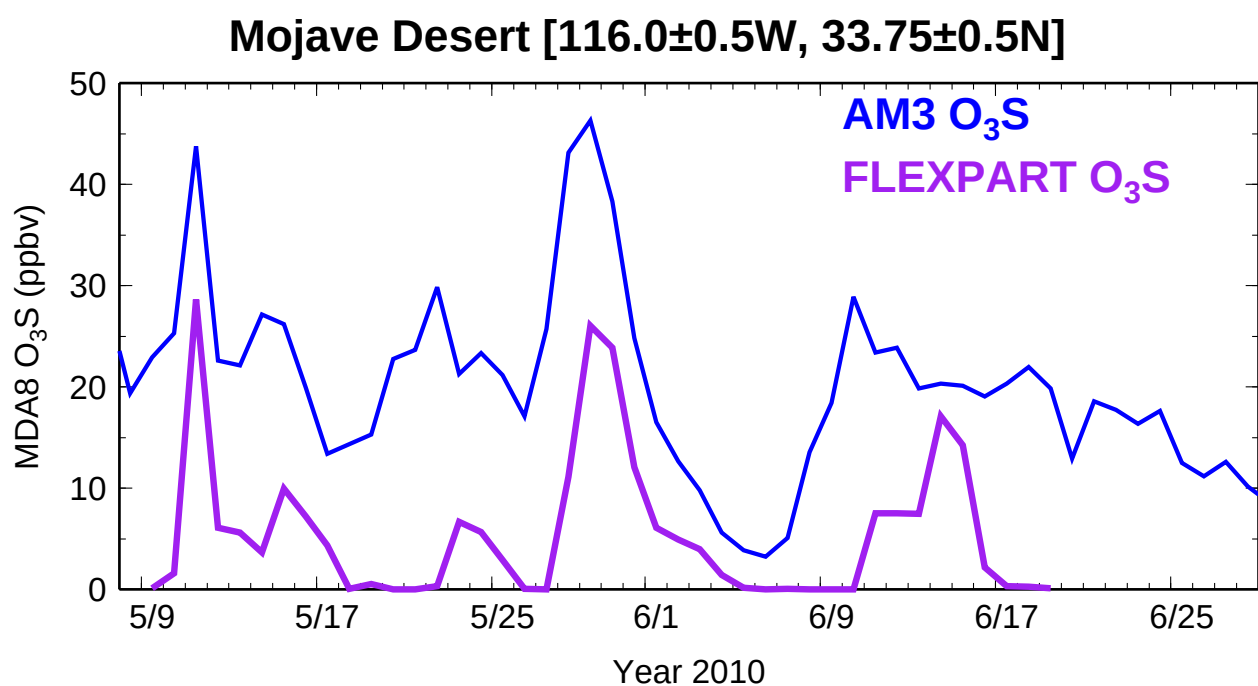
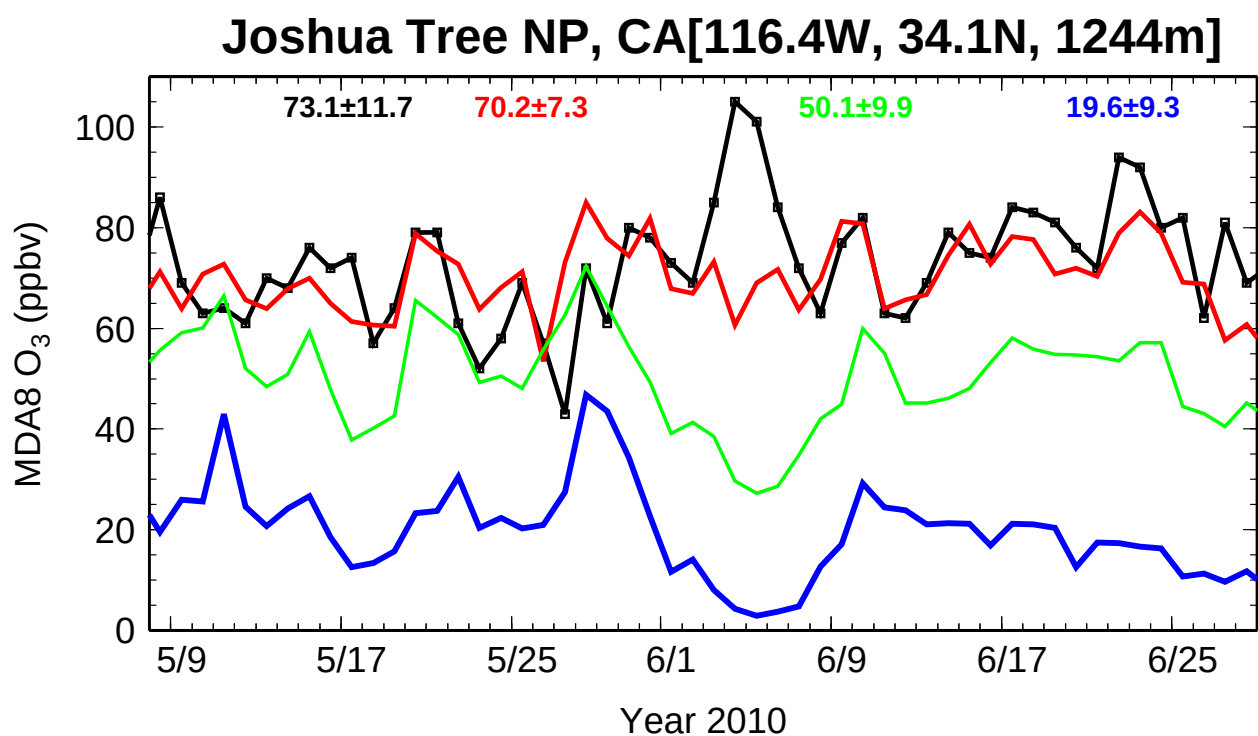


Figure S5. Stratospheric impacts on surface ozone over Southern California, showing (top) time series at Joshua Tree National Park (labels as Figure 9) and (bottom) comparison of AM3 and FLEXPART stratospheric O_3 tracers (Section 2.3) in surface air over the Mojave Desert from May 9-June 29, 2010. The higher concentration found in AM3 reflects the influence of background.

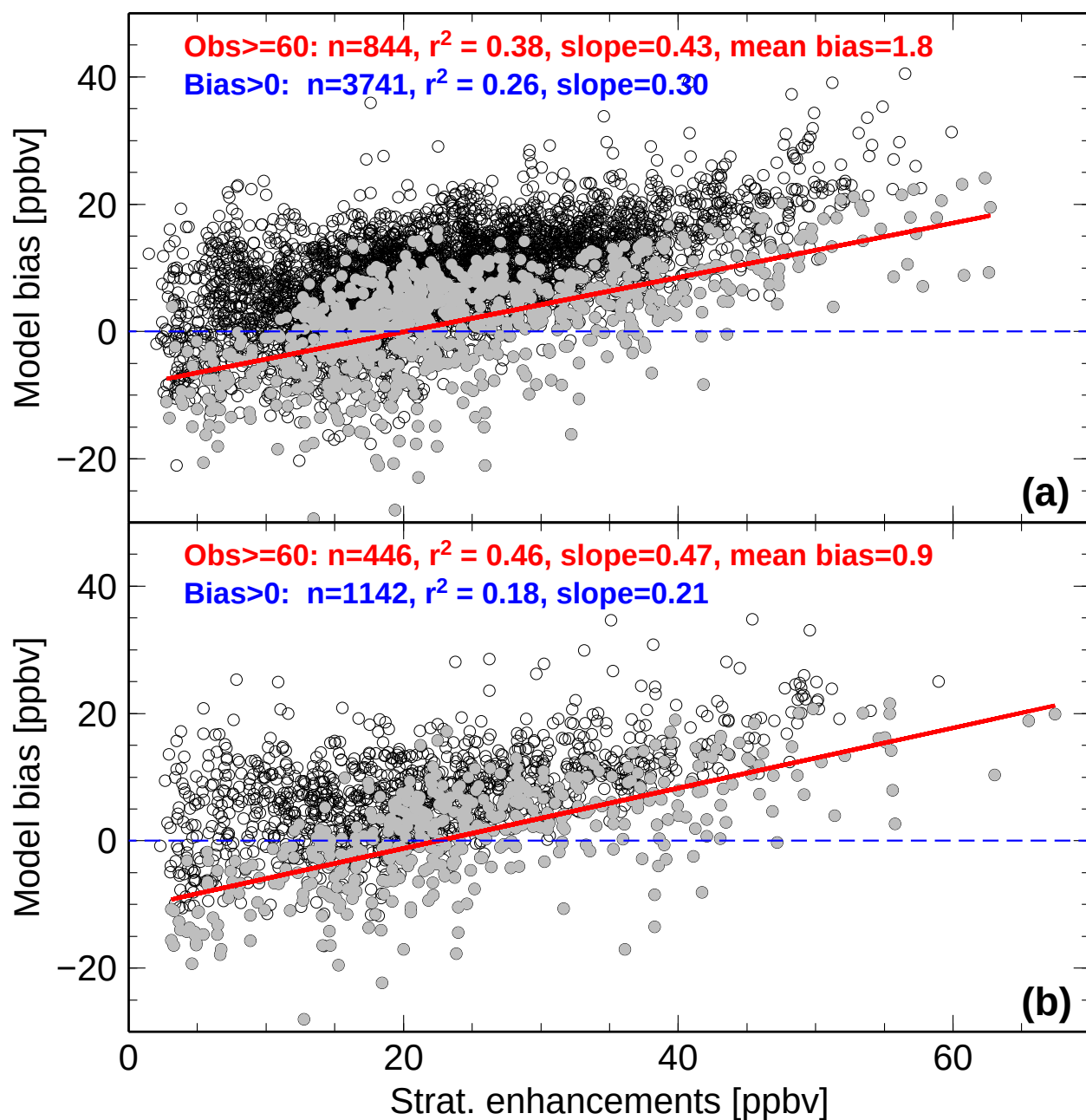


Figure S6. Scatter plots of model biases in surface MDA8 O₃ versus stratospheric enhancements for April-June 2010 (a) for AQS sites in EPA Region 8 (red box in Fig.1) and (b) for 15 high-elevation sites (green symbols in Fig.1). Statistics from the linear regression are given for points with observed MDA8 O₃ ≥ 60 ppb (gray) and points with high model bias (above the blue line).

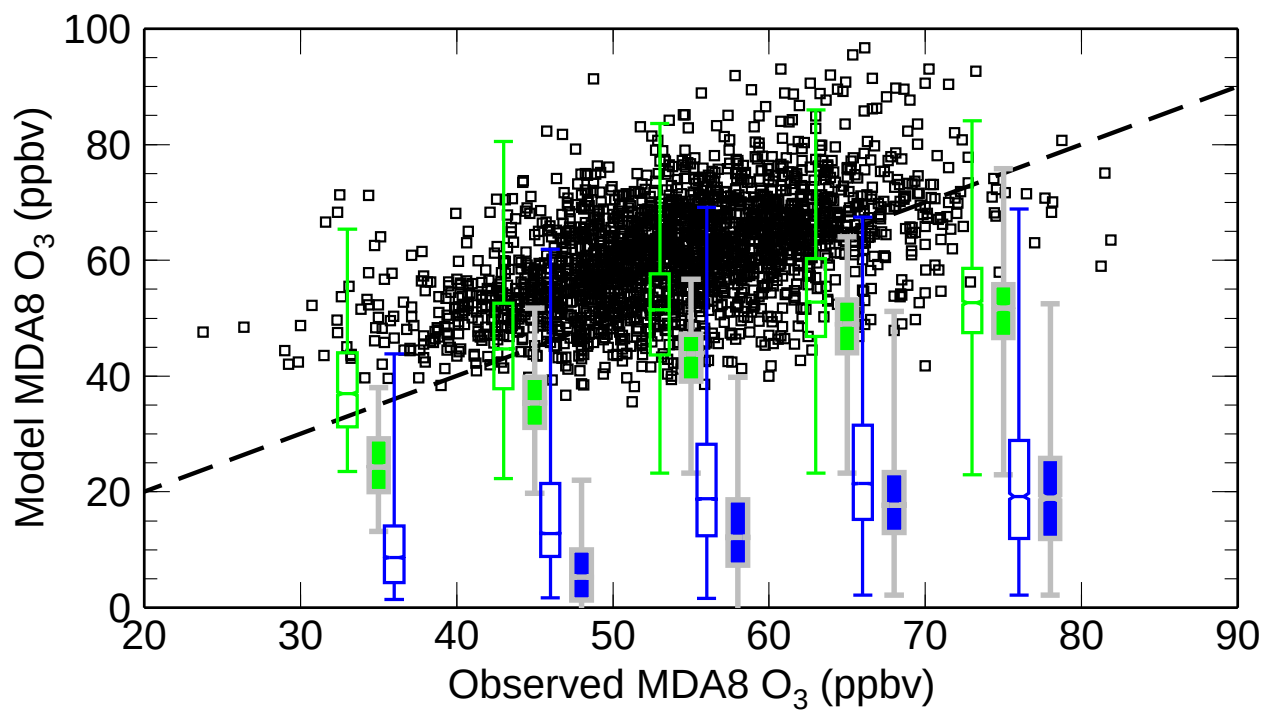
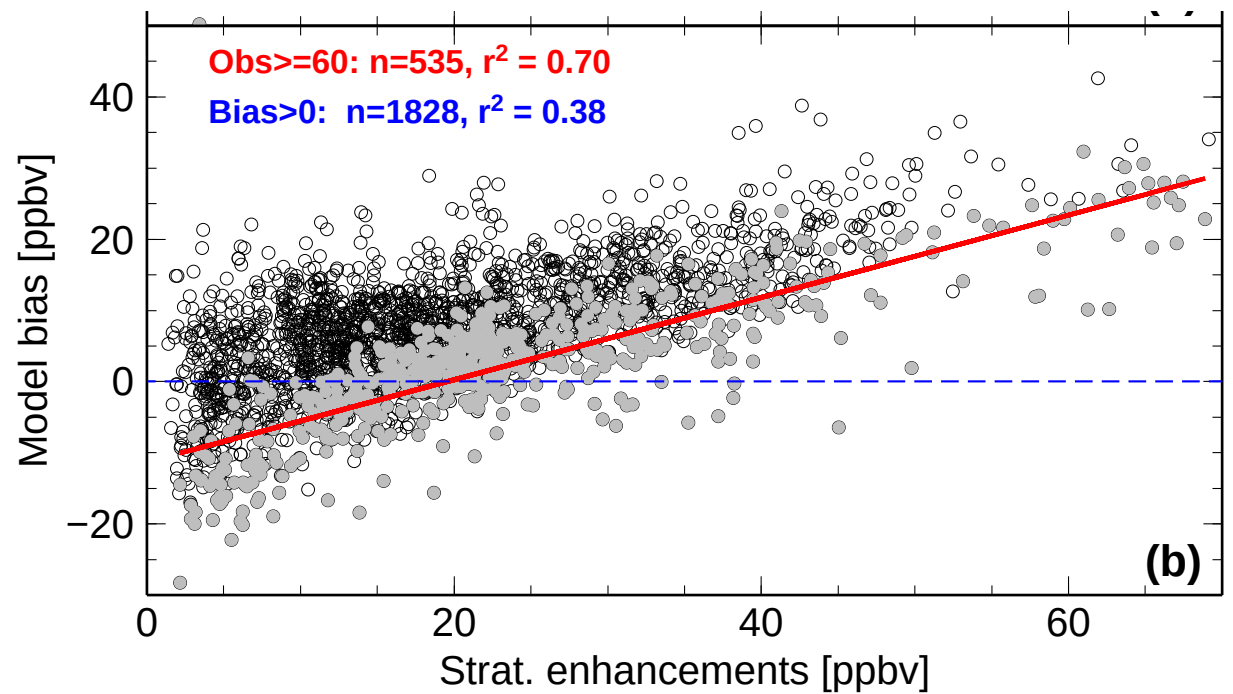


Figure S7. Same as (top) Figure S6 and (bottom) Figure 12, but for all AQS and CASTNet sites in Arizona, New Mexico, and Western Texas.

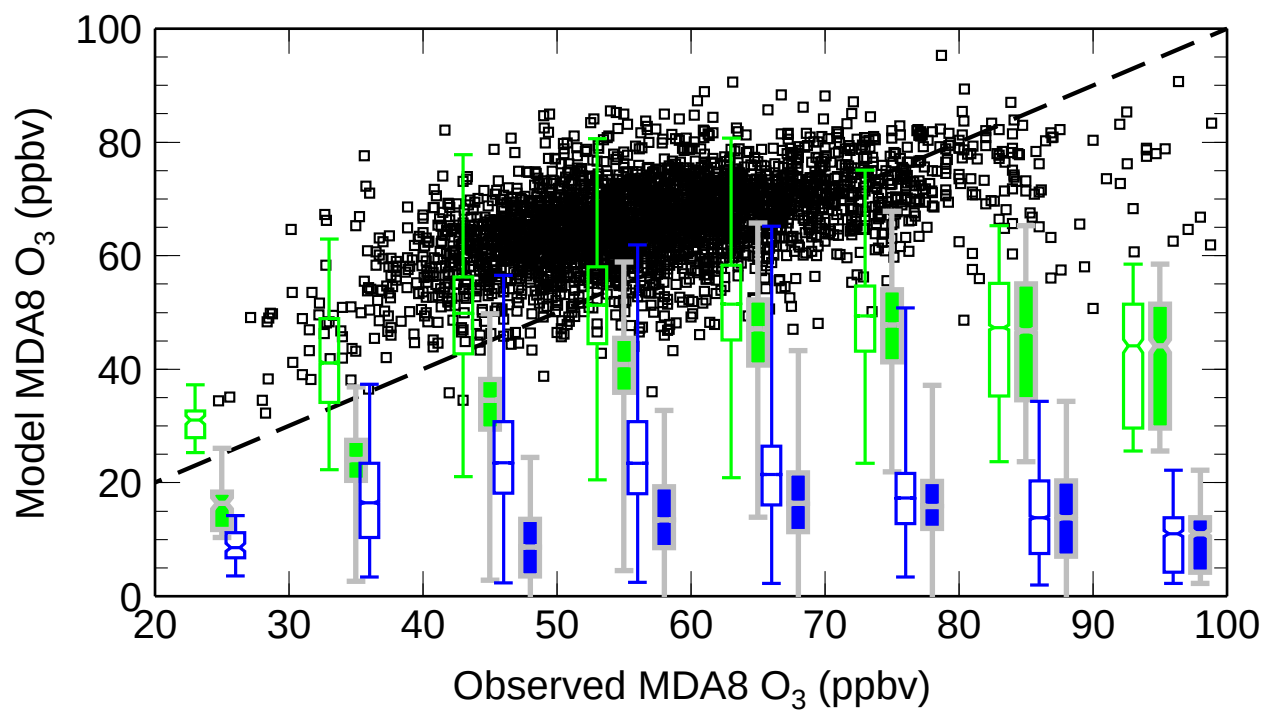


Figure S8. Same as Figure 14, but for polluted sites in the densely populated regions of Central Valley, Southern California, and Las Vegas, identified based on observed median MDA8 O₃ in April-June 2010 equal to or greater than 50 ppbv.

Auxiliary Table

Lin M., A. M. Fiore , O. R. Cooper , L. W. Horowitz , A. O. Langford , Hiram Levy II , B. J. Johnson , V. Naik , S. J. Oltmans , C. Senff (2012): Springtime high surface ozone events over the western United States: Quantifying the role of stratospheric intrusions, Journal of Geophysical Research, 2012JD018151

Table S1: A list of surface monitoring sites that were strongly affected by the stratospheric intrusion events over the western U.S. from April to June 2010. These sites are identified based on the locations and times of upper-level troughs in the satellite imagery, the days when observed ozone enhancements are coincident with dry and cold conditions at CASTNet sites (e.g. Fig.6a), an abrupt increase in surface ozone at the AQS sites coincident with ozone enhancements at the nearby CASTNet sites, and the model stratospheric ozone tracer.

Date	State	EPA Region	Site ID	Network	Elevation (m)	Peak MDA8 O ₃ (ppb)	Exceedance
April 7, 2010	New Mexico	6	35-017-1003	AQS	1823	71	No
April 9, 2010	Wyoming	8	56-035-0101	AQS	2191	75	Yes
	Wyoming	8	56-035-0100	AQS	2375	74	No
	Wyoming	8	PND165	CASTNet	2388	73	No
	Wyoming	8	56-035-0099	AQS	2360	73	No
	Wyoming	8	56-013-0099	AQS	2526	70	No
April 13-15, 2010	Colorado	8	08-041-0016	AQS	1955	86	Yes
	Colorado	8	08-069-0007	AQS	2743	82	Yes
	Colorado	8	ROM406	CASTNet	2743	82	Yes
	Colorado	8	08-041-0013	AQS	1971	81	Yes
	Colorado	8	08-059-0013	AQS	2473	80	Yes
	Colorado	8	08-035-0004	AQS	1676	79	Yes
	Colorado	8	GTH161	CASTNet	2926	79	Yes
	Colorado	8	08-123-0009	AQS	1484	79	Yes
	Colorado	8	ROM206	CASTNet	2804	77	Yes
	Colorado	8	08-069-0011	AQS	1571	76	Yes
	Wyoming	8	CNT169	CASTNet	3178	75	Yes
	Colorado	8	08-059-0005	AQS	1742	75	Yes
	Colorado	8	08-069-0012	AQS	2058	75	Yes
	Colorado	8	08-005-0002	AQS	1747	74	No
	Colorado	8	08-067-1004	AQS	2367	74	No
	Colorado	8	08-005-0006	AQS	1799	74	No
	Arizona	9	PET427	CASTNet	1747	74	No
	Arizona	9	04-017-0119	AQS	1743	74	No
	Colorado	8	08-059-0006	AQS	1802	73	No
April 21-23, 2010	Colorado	8	08-067-7001	AQS	1983	72	No
	Colorado	8	08-067-1004	AQS	2367	70	No
	Colorado	8	08-067-7003	AQS	1920	70	No
	New Mexico	6	35-045-0018	AQS	1950	70	No
	New Mexico	6	35-045-0009	AQS	1713	71	No
May 11-13, 2010	Arizona	9	CHA467	CASTNet	1570	74	No
	Arizona	9	PET427	CASTNet	1747	73	No
	Arizona	9	04-017-0119	AQS	1723	73	No

May 20-21, 2010	Arizona	9	04-005-1008	AQS	2120	71	No
	New Mexico	6	35-049-0021	AQS	1930	72	No
	Utah	8	49-053-0130	AQS	1213	74	No
	Wyoming	8	56-013-0099	AQS	2526	68	No
May 24, 2010	Wyoming	9	PND165	CASTNet	2388	64	No
	New Mexico	6	35-017-1003	AQS	1823	79	Yes
	Colorado	8	08-041-0016	AQS	1955	77	Yes
	Colorado	8	08-005-0006	AQS	1799	75	Yes
May 28-29, 2010	Colorado	8	08-035-0004	AQS	1676	75	Yes
	Colorado	8	08-041-0013	AQS	1971	74	No
	Colorado	8	08-059-0005	AQS	1742	72	No
	Colorado	8	08-059-0013	AQS	2473	72	No
May 28-29, 2010	Colorado	8	08-005-0002	AQS	1747	73	No
	Arizona	9	04-005-1008	AQS	2120	82	Yes
	Colorado	8	08-067-1004	AQS	2367	81	Yes
	Colorado	8	MEV405	CASTNet	2165	77	Yes
June 8, 2010	Colorado	8	08-083-0101	AQS	2165	77	Yes
	Colorado	8	08-083-0006	AQS	1890	77	Yes
	California	9	JOT403	CASTNet	1244	72	No
	Utah	8	49-053-0130	AQS	1213	71	No
June 8, 2010	Colorado	8	08-077-0020	AQS	1521	71	No
	Arizona	9	GRC474	CASTNet	2073	70	No
	Arizona	9	04-005-8001	AQS	2152	70	No
	Wyoming	8	56-041-0101	AQS	2167	76	Yes
June 8, 2010	Wyoming	8	56-037-0300	AQS	1966	75	Yes
	Utah	8	49-049-5010	AQS	1380	75	Yes
	Wyoming	8	56-007-0100	AQS	2060	74	No
	Wyoming	8	56-013-0099	AQS	2526	74	No
June 10-15, 2010	Wyoming	8	56-035-1002	AQS	2145	74	No
	Utah	8	49-049-5008	AQS	1485	73	No
	Wyoming	8	56-037-0200	AQS	2176	73	No
	Utah	8	49-035-0003	AQS	1335	73	No
June 10-15, 2010	Wyoming	8	56-035-0099	AQS	2360	71	No
	Utah	8	49-049-0002	AQS	1402	70	No
	Wyoming	8	CNT169	CASTNet	3178	69	No
	Wyoming	8	PND165	CASTNet	2388	67	No
June 23, 2010	Utah	8	49-053-0130	AQS	1213	73	No
	Arizona	9	CHA467	AQS	1570	72	No
	New Mexico	6	35-017-1003	AQS	1823	69	No
	New Mexico	6	35-013-0023	AQS	1219	68	No
June 23, 2010	Utah	8	CAN407	AQS	1809	66	No
	Colorado	8	ROM406	AQS	2743	77	Yes
	Colorado	8	ROM206	AQS	2804	73	No
	Colorado	8	08-067-7003	AQS	1920	70	No