Supplement of Atmos. Chem. Phys., 16, 14687–14702, 2016
http://www.atmos-chem-phys.net/16/14687/2016/
doi:10.5194/acp-16-14687-2016-supplement
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Atmospheric Chemistry and Physics
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EGU

Supplement of

Wildfire influences on the variability and trend of summer surface ozone in the mountainous western United States

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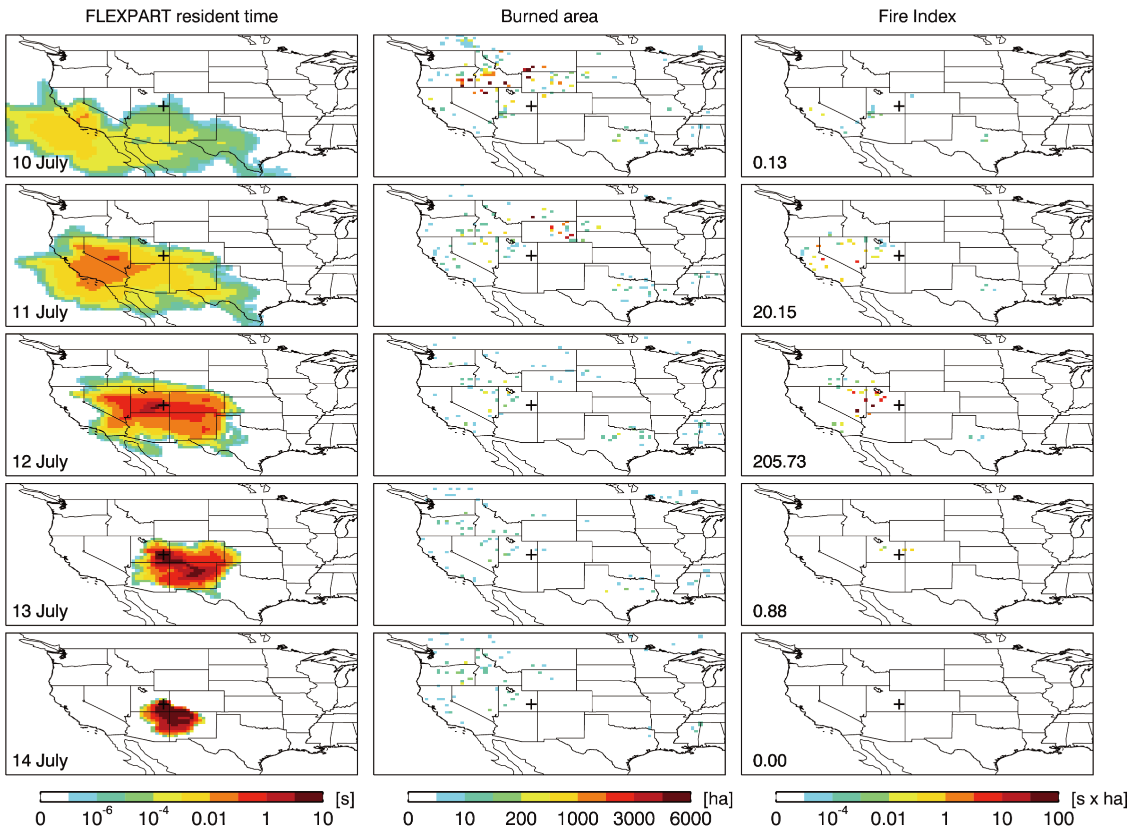

Figure S1. Example of the Fire Index calculation for July 14, 2006 at CASTNet site CAN (marked as black cross). Left panels show the daily mean residence time calculated by FLEXPART for each backward day, middle panels show the daily wildfire areas burned for that day, and right panels show the mapped Fire Index (product of the left and middle panel), with the sum FI for that day shown inset . Fire Index (1) is then defined as the residence time of July 10 times wildfire areas burned on the same day, results in 0.13. Total Fire Index is the sum of Fire Index (1)~(5), results in 226.89.

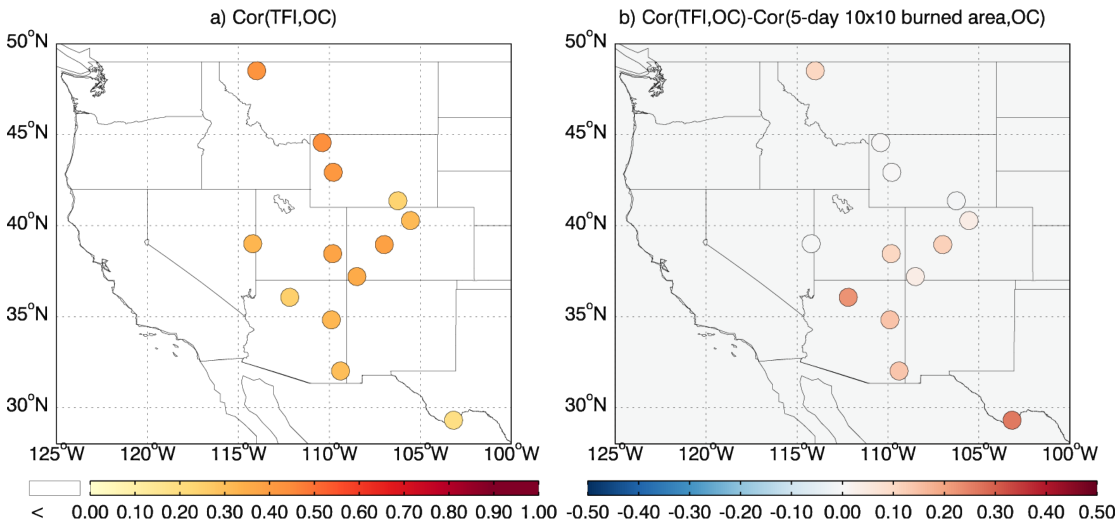

Figure S2. Correlation coefficients between the Total Fire Index (TFI) and measured OC aerosol concentrations at 13 collocated CASTNet and IMPROVE sites in the Intermountain West for the summers 1989-2010. The right panel shows the correlation differences with respect to those using 5-day wildfire areas burned within 10°×10° regions rather than TFI.

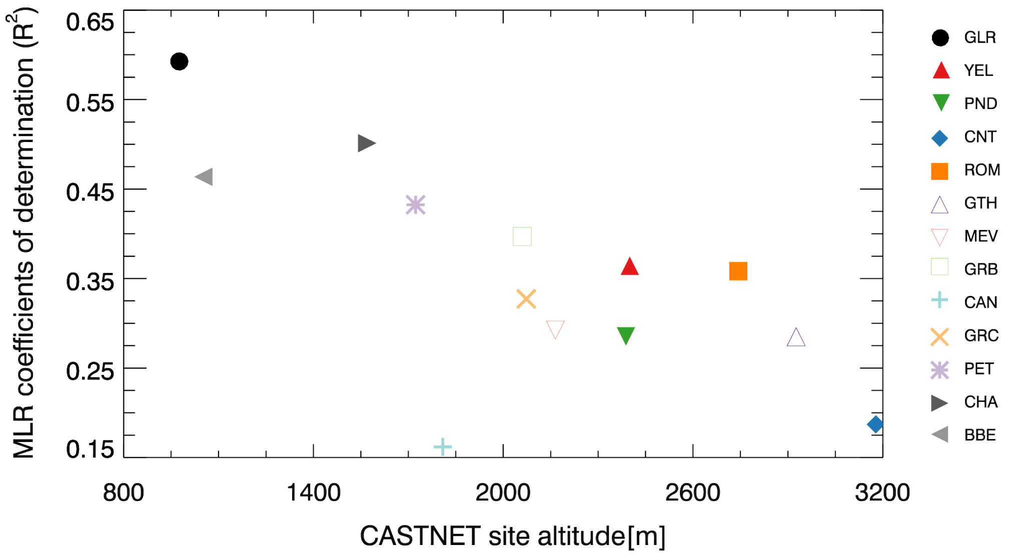

Figure S3. Scatter-plot of CASTNet site altitude vs. MLR model coefficient of determination (R^2) as listed in Table 2.

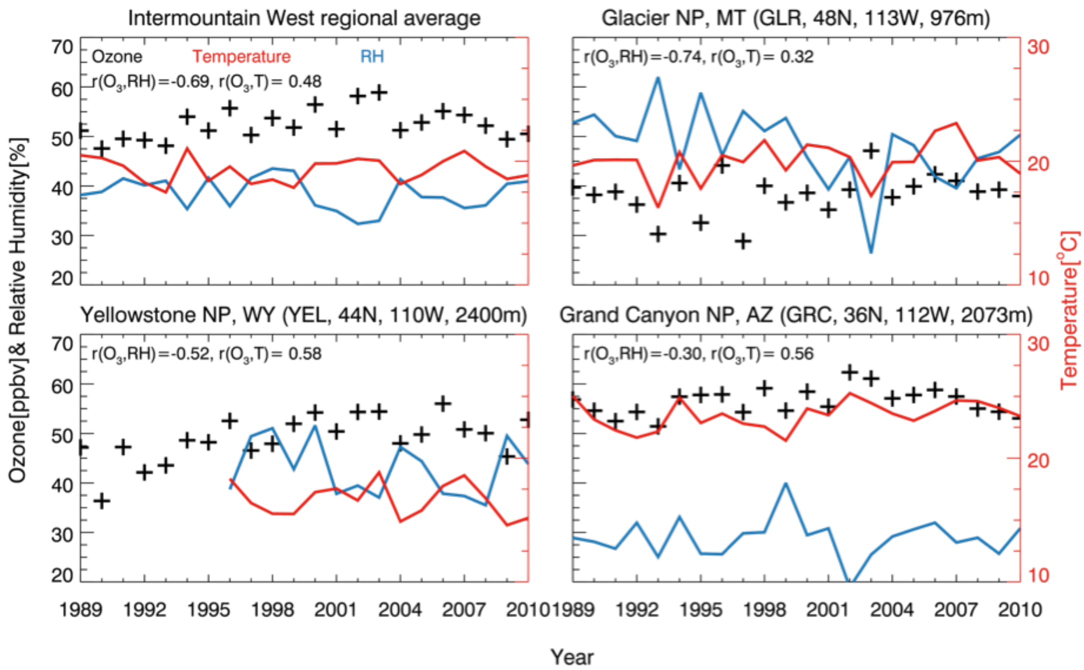

Figure S4. Time series of summer mean MDA8 ozone concentrations (black pluses), daytime mean relative humidity (RH, blue lines, left axis) and temperature (T, red lines, right axis) for the regional averages of 8 CASTNet sites with complete 22-year measurements as well as 3 individual sites. The correlations between ozone and the two meteorological parameters are shown inset.

Table S1. Correlation coefficients (r) between OC aerosol concentration measurements and Total Fire Index integrated over different backward days and different footprint layers (i.e., model output layer where fire emissions are lifted) at 13 Intermountain West CASTNet sites in summers 1989-2010.

Site	**5-day**				**2-day**	**3-day**	**4-day**	**Record**
	5000m	**2000m**	**1500m**	**100m**	**2000m**	**2000m**	**2000m**	**number**
GLR	0.44** [a]	0.41**	0.40**	0.40**	0.40**	0.41**	0.41**	529
YEL	0.44**	0.41**	0.41**	0.43**	0.37**	0.40**	0.41**	372
PND	0.41**	0.39**	0.38**	0.38**	0.36**	0.37**	0.38**	564
CNT	0.24*	0.19	0.20	0.20*	0.11	0.17	0.18	91
ROM	0.32**	0.32**	0.30**	0.30**	0.27**	0.30**	0.31**	558
GTH	0.39**	0.36**	0.34**	0.33**	0.29**	0.34**	0.35**	316
MEV	0.36**	0.38**	0.35**	0.36**	0.35**	0.38**	0.37**	331
GRB	0.33**	0.32**	0.27**	0.26**	0.30**	0.31**	0.32**	512
CAN	0.38**	0.37**	0.34**	0.36**	0.33**	0.35**	0.37**	564
GRC	0.25**	0.24**	0.23**	0.23**	0.23**	0.28**	0.23**	337
PET	0.32**	0.32**	0.31**	0.32**	0.32**	0.32**	0.32**	489
CHA	0.30**	0.29**	0.27**	0.27**	0.30**	0.29**	0.29**	492
BBE	0.19**	0.28**	0.15**	0.12*	0.21**	0.20**	0.26**	284
Mean	0.34**	0.33**	0.30**	0.31**	0.29**	0.32**	0.32**	

[a] Double asterisk (**) denotes the correlations that are strongly significant ($p < 0.01$), and single asterisk (*) denotes the correlations that are significant ($p < 0.05$).

Table S2. Coefficients of the multi-linear regression (MLR) models for summer MDA8 ozone at 13 Intermountain West CASTNet sites[a] (Fire impacts: FI_s, FI_l, $SqrFI_s$, $SqrFI_l$ are denoted in bold)

Sites (Altitude)	Total R^2(N)	Group[b] Num.	TFI mean	Ozone mean	R^2 (N)	Variables (coefficient)[c]	*c*
GLR (976 m)	**0.59 (1809)**	1	0	34.5	0.59(228)	RH(-0.39), HGT850(-0.07), SH850(-861.61), dT(-1.86)	178.1
		2	44.96	36.6	0.57(799)	RH(-0.30), Ome700(-19.02), HGT850(-0.31), SRAD(0.009), WSPsurf(1.56), U500(-0.159), SH700(-1040.27), V700(0.197), **SqrFI$_l$(0.377)**, HGT700(0.37), T850(-0.9)	-170.7
		3	27144.1	41.1	0.50(782)	RH(-0.22), T500(-0.69), SRAD(0.01), **SqrFI$_s$(0.007)**, U850(0.83),Ome700(-18.34), U500(-0.232), SH500(-1253.7), T700(0.72)	36.08
YEL (2400m)	**0.35 (1611)**	1	0	45.5	0.40(91)	WSP500(0.722), RH(-0.19), WSPsurf(-2.034), HGT850(-0.05)	124.05
		2	256.8	47.3	0.34(766)	RH(-0.29), V700(0.38), Tsurf(-1.21), T700(1.27), SRAD(0.01), HGT500(-0.03), OME500(11.06), WSP850(-0.35), U500(0.26), WSPsurf(-0.69)	221.91
		3	35700.0	51.2	0.22(754)	RH(-0.07), V700(0.53), SRAD(0.01), **SqrFI$_s$(0.005), SqrFI$_l$(0.31),** SH700(-833.17), dT(2.25), **FI$_l$(-0.006)**	30.46
PND (2388m)	**0.28 (1888)**	1	0	53.1	0.34(86)	T700(2.0), SH700(-2399.23), T500(-1.63)	32.84
		2	242.1	53.8	0.24(895)	V700(0.35), RH(-0.08), Tsurf(0.09), HGT850(-0.05), SRAD(0.03), WSP700(-0.28),WSPsurf(0.10), SH700(-1433.4), T700(0.17)	127.33
		3	29574.8	56.7	0.24(907)	RH(-0.17), V500(0.27), **SqrFI$_l$(0.24)**, U700(-0.43), **SqrFI$_s$(0.02), FI$_s$(-1.98E-5),** HGT850(-0.03), Ome700(13.86), T500(-0.27), SH500(569.94)	92.21
CNT (3178m)	**0.19 (1925)**	1	0	54.0	0.35(53)	SH850(2293.8), SH500(-3435.6), T500(-0.75)	31.4
		2	153.5	56.2	0.14(913)	RH(-0.10), SH500(-1514.43), HGT850(-0.023), **SqrFI$_l$** (0.225), U700(-0.458), WSP850(0.27)	98.8
		3	10517.1	58.9	0.18(959)	RH(-0.12), T500(0.68), U700(-0.30), **SqrFI$_s$(0.3), FI$_s$(-5.02E-5)**	68.89
ROM (2743m)	**0.36 (1347)**	1	0	52.5	0.25(36)	RH(-0.20)	64.37
		2	107.6	54.6	0.34(581)	RH(-0.10), WSPsurf(3.18), U700(-0.88), Tsurf(0.11), SH500(-1967.9), T850(0.43), SRAD(0.005), **SqrFI$_l$(0.03), SqrFI$_s$(0.04)**	47.35
		3	7976.7	59.0	0.38(730)	RH(-0.16), U700(-0.96), WSPsurf(2.91), T500(1.21), SRAD(0.01), **FIs(3.3E-5),** Ome500(-14.89), PRCP(-0.03)	37.84
GTH (2926m)	**0.29 (1906)**	1	0	50.7	0.32(78)	RH(-0.17), T500(-1.11), Ome850(-39.32)	48.03
		2	108.1	51.9	0.30(913)	RH(-0.20), HGT500(-0.04), WSPsurf(1.53), U500(-0.21), **SqrFIl(0.30),** SH850(216.48), V850(-0.25)	273.78
		3	8100.3	54.4	0.22(915)	RH(-0.15), **SqrFI$_l$(0.32),** T500(-0.67), V850(-0.45), FIl(-0.01), Ome500(-11.51), WSP500(-0.19), HGT850(-0.03), WSPsurf(0.72), dT(1.67)	72.45
MEV (2165m)	**0.23 (1321)**	1	0	52.3	0.43(60)	RH(-0.26)	63.73
		2	90.44	54.6	0.16(555)	RH(-0.15), U700(-0.51), T700(-1.49), WSPsurf(-0.91), dT(3.15), V700(0.35), Tsurf(0.38),	28.41
		3	13658.64	57.6	0.19(706)	Tsurf(0.23), **SqrFI$_l$(0.20), SqrFI$_s$(0.01),** RH(-0.06), U850(-0.60), SRAD(0.01)	48.49
GRB (2060m)	**0.40 (1360)**	1	0	54.3	0.38(50)	WSPsurf(2.39), Ome850(-116.10), SH500(-3840.94)	48.00
		2	77.4	55.4	0.40(649)	Ome700(-60.71), Ome850(44.89), WSP500(-0.41), SRAD(0.01), Tsurf(1.01), SH700(-1013.96), **SqrFI$_l$(0.88),** HGT500(-0.05)	340.53
		3	16182.4	57.5	0.38(661)	Tsurf(1.11), HGT700(-0.09), **SqrFI$_s$(0.02), SqrFI$_l$(0.16),** WSPsurf(0.98), U850(-0.67), WSP500(-0.18), **FI$_s$(-1.61E-5)**	315.28

Table S2. Continued

Sites (Altitude)	Total R^2(N)	Group[b] Num.	TFI mean	Ozone mean	R^2 (N)	Variables (coefficient)[c]	*c*
CAN (1809m)	**0.16 (1379)**	**1**[d]	0	55.2	NAN	NAN	NAN
		2	99.43	56.6	0.10(638)	**SqrFI$_s$(0.14), SqrFI$_l$(0.28),** V850(-0.45), Ome500(-19.72), T850(-0.75), Tsurf(0.55)	59.21
		3	12448	59.4	0.13(741)	**SqrFI$_l$(0.34),** RH(-0.10), **FI$_l$(-0.01),** Ome700(-16.03), V500(-0.18), WSPsurf(0.31)	58.51
GRC (1874m)	**0.34 (1912)**	**1**	0	52.2	0.33(153)	SH700(-1564.2), WSP850(-1.23), HGT850(-0.18), HGT500(0.05), PRCP(0.05), SRAD(0.01), SH500(2233.7)	50.60
		2	46.1	54.4	0.28(873)	RH(-0.10), HGT850(-0.05), **SqrFI$_l$(0.46),** Ome850(36.02), V700(-0.41), WSP500(0.41), T850(0.79), SH700(-575.21), SRAD(-0.01)	120.34
		3	17075.1	58.1	0.31(886)	V700(-0.39), WSP500(0.34), SH850(-569.03), **SqrFI$_l$(0.545), FI$_l$(-0.02),** SRAD(0.01), Ome700(-24.27), Ome850(28.77), U700(0.64), WSPsurf(-0.86), T700(1.07), HGT500(-0.05)	313.44
PET (1723m)	**0.43 (654)**	**1**	0	50.7	0.28(41)	RH(-0.19), HGT850(0.12)	-125.93
		2	73.0	56.3	0.39(240)	SRAD(0.02), SH500(2963.8), dT(-3.40), RH(-0.33), V500(-0.50), WSP850(-1.21), T850(0.95), WSP500(0.26)	92.40
		3	38379.5	58.2	0.39(373)	V500(-0.50), dT(-2.60), SRAD(0.01), SH500(1412.40),HGT850(-0.06), RH(-0.28), Ome850(33.91), Ome500(-22.14), SH700(898.18), **SqrFI$_l$(0.19)**	173.85
CHA (1570m)	**0.50 (1754)**	**1**	0	47.2	0.32(384)	RH(-0.21), WSP700(-1.60), WSP500(0.66), V850(-1.15), U850(-0.76)	58.16
		2	40.0	53.6	0.41(677)	RH(-0.21), WSP700(-0.86), WSP500(0.37), **SqrFI$_l$(0.64),** dT(-1.23), PBLH(0.001), SH500(980.48), SRAD(0.01), HGT500(-0.024), V850(-0.35)	210.4
		3	14972.1	57.1	0.38(693)	WSP700(-0.65), SRAD(0.01), **SqrFI$_l$(0.81),** V500(-0.25), V850(-0.76), **FI$_l$(-0.03),** RH(-0.11), T700(-0.52)	62.80
BBE (1052m)	**0.46 (1196)**	**1**	0	39.6	0.37(450)	V700(-1.31), RH(-0.12), V850(-0.61), WSPsurf(1.27), U500(0.20)	42.87
		2	6.6	44.8	0.34(373)	V700(-0.51), WSP850(-0.57), WSP500(0.56), RH(-0.22), T700(-1.07), HGT500(-0.06), SRAD(0.002), **FI$_l$(-0.06), SqrFI$_l$(-0.79)**	423.05
		3	3423.7	48.0	0.35(373)	V700(-0.46), WSP850(-0.61), WSP500(0.55), RH(-0.22), T700(-1.08), HGT500(-0.06), SRAD(0.002), **SqrFI$_s$(1.84), SqrFI$_l$(1.07), FI$_l$(-0.10), FI$_s$(-0.37)**	416.83

[a] The multi-linear regression (MLR) models are applied to measured MDA8 ozone concentrations in the summers 1989-2010. The regressions follow Equation (3) described in the text.

[b] Groups are separated by the TFI values at each site (group 1: TFI=0, group 2: the lower 50% TFI (with TFI=0 excluded), group 3: the upper 50% TFI).

[c] Variables included in the MLR models in order of significance (e.g., For group 1 at GLR site, RH has the highest significance representing the first variable included in the MLR model).

[d] No MLR model is derived for this case. The records from group 1 and group 2 are then combined.