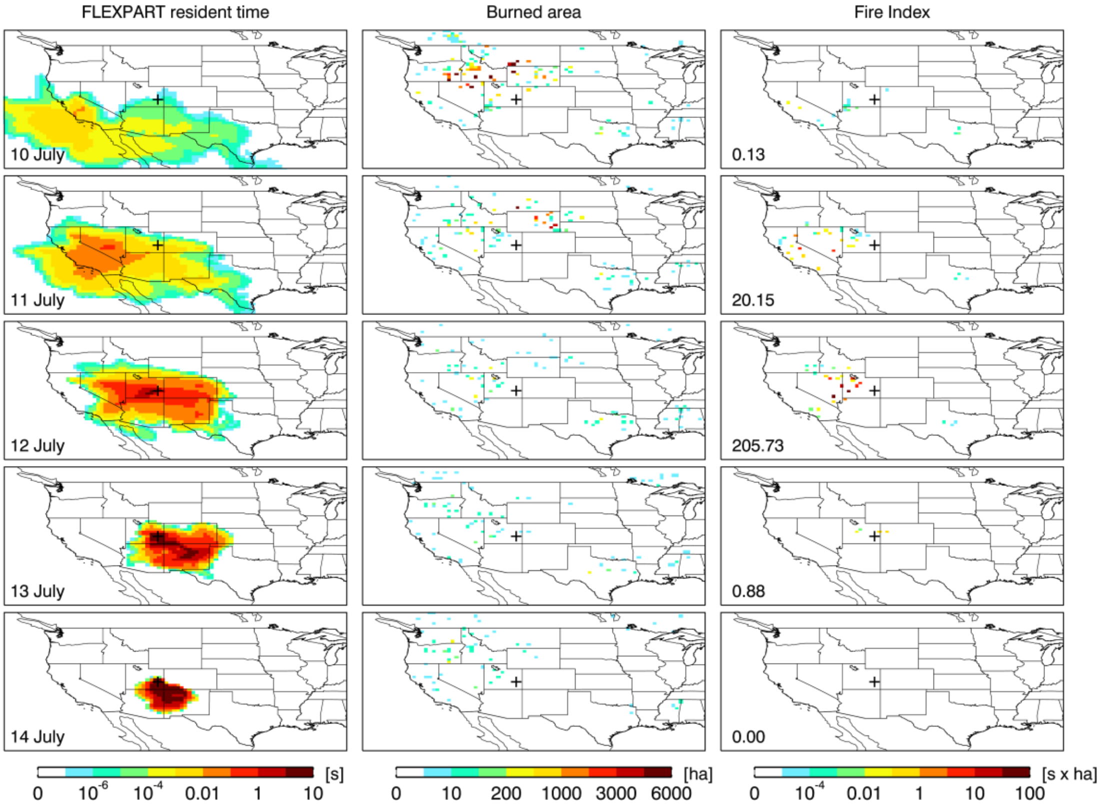

Figure S1. Example of the Fire Index calculation for July 14, 2006 at CASTNet site CAN (marked as black cross). Left panels show the daily mean resident time calculated by FLEXPART for each backward day, middle panels show the daily wildfire areas burned for that day, and right panels show the mapped 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 resident time of July 10 multiplying wildfire areas burned on the same day, resulting in the value of 0.13. Total Fire Index is the sum of Fire Index (1) to (5): 226.89.

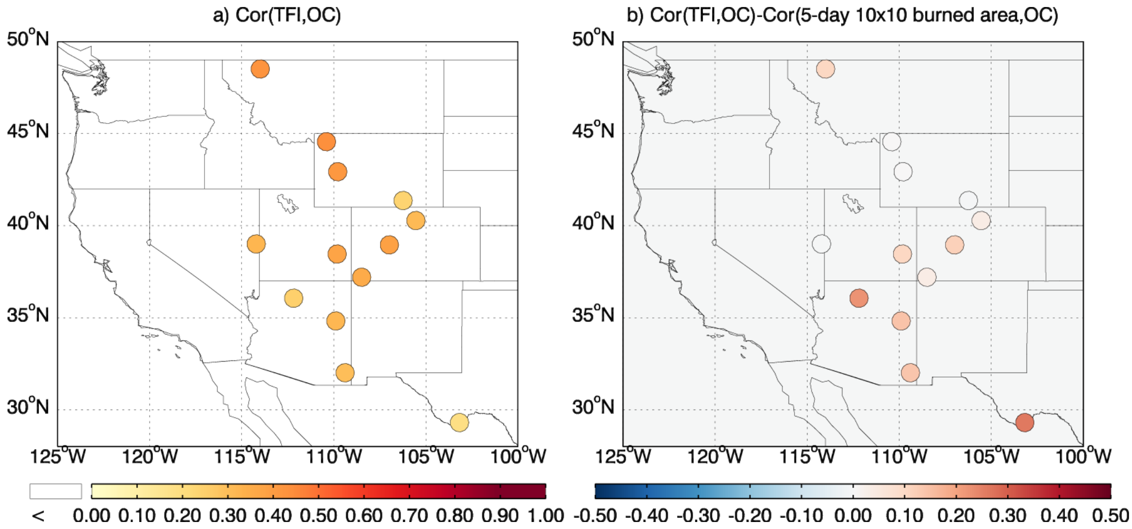

Figure S2. Correlation coefficients between the Total Fire Index (TFI) and measured OC aerosol concentrations at 13 collocated CASTNet and IMPROVE sites in the Intermountain West for the summers 1989-2010. The right panel shows the correlation differences with respect to those using 5-day wildfire areas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

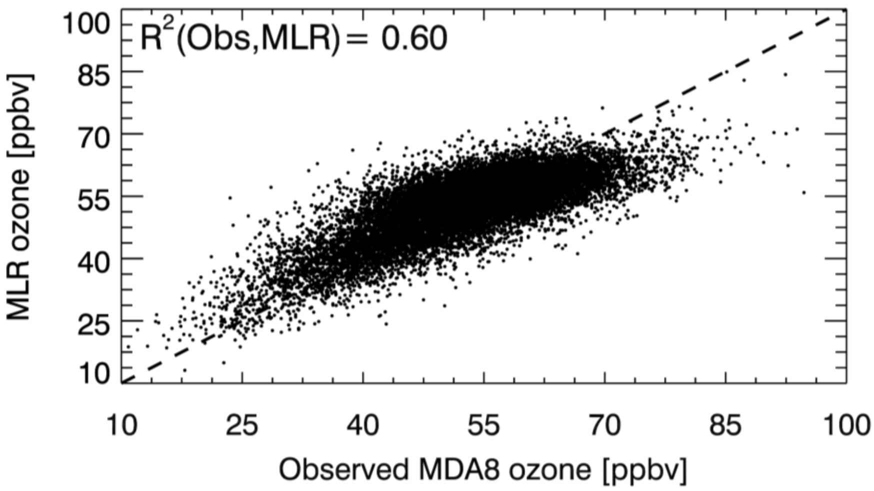

Figure S3. Comparison of the measured versus MLR predicted MDA8 ozone concentrations in the summers 1989-2010 for the ensemble of 13 Intermountain West CASTNet sites. The 1:1 line (dashed line) and the coefficient of determination (R^2) are shown in the inset.

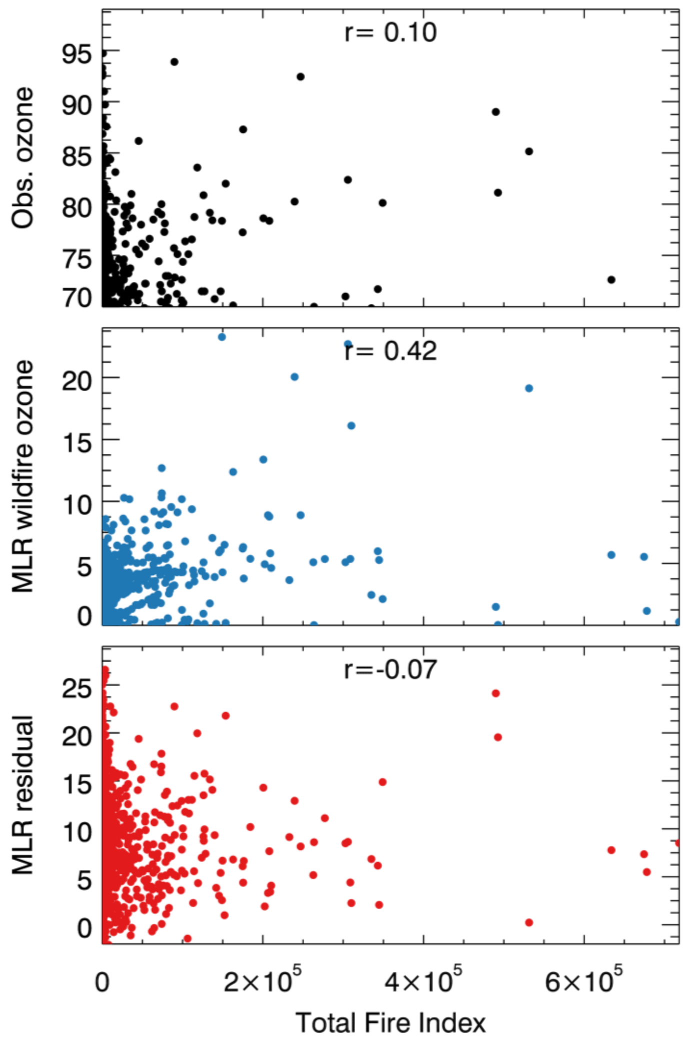

Figure S4. Evaluation of the MLR model low biases (MLR residuals) when measured MDA8 ozone exceeds 70 ppbv as indicated in Figure S3. Scatter-plots of Total Fire Index (TFI) versus measured MDA8 ozone (top panel), MLR wildfire ozone enhancements (middle panel), and MLR residuals (bottom panel) are shown. The correlation coefficients are also shown inset. The poor correlation between TFI and MLR residuals indicates that the low biases may not result from model underestimates of wildfire influences.

Table S1. Variables used in the MLR models.

Variable	**Predictors used in MLR model** [a]	**Data source**
FI_s, FI_l	Fire Index for short/long period	FLEXPART 5-day backward trajectories and 0.5 °×0.5 °wildfire areas burned
$SqrFI_s$ $SqrFI_l$	Square root of Fire Index	
Tsurf	Daytime mean[b] surface temperature	CASTNet surface monitoring sites in the US Intermountain West (http://www.epa.gov/castnet), for 13 CASTNet sites only
WSPsurf	Daytime mean wind speed	
RH	Daytime mean relative humidity	
SRAD	Daytime mean solar radiation	
Tmax	Daily maximum temperature	NOAA, National Climatic Data Center: Climate Data Online (http://www.ncdc.noaa.gov/cdo-web/), for Salt Lake City urban site only
AWND	Daily average daily wind speed	
PBLH	Gridded daily maximum planetary boundary height	NCEP Climate Forecast System Reanalysis (http://rda.ucar.edu/datasets/ds093.0/)
PRCP	Gridded daily precipitation	Climate Prediction Center of the National Weather Service (ftp://ftp.cpc.ncep.noaa.gov/precip/CPC_UNI_PRCP/GAUGE_CONUS/V1.0/)
U	Gridded daily mean 850, 700, 500 hPa zonal wind	NCEP/NCAR Reanalysis dataset (http://www.esrl.noaa.gov/psd/data/timeseries/daily/)
V	Gridded daily mean 850, 700, 500 hPa meridional wind	
WSP	Gridded daily mean 850, 700, 500 hPa horizontal wind	
Ome	Gridded daily mean 850, 700, 500 hPa vertical velocity	
SH	Gridded daily mean 850, 700, 500 hPa specific humidity	
HGT	Gridded daily mean 850, 700, 500 hPa geopotential heights	
T	Gridded daily mean 850, 700, 500 hPa temperature	
dT	Gridded daily mean temperature at 1000mb minus that at 850 hPa	

[a] Units are ℃ (Tsurf, T, dT, Tmax), m s^{-1} (WSPsurf, WSP, U, V, AWND), % (RH), W m^{-2} (SRAD), m (PBLH), geopotential height (HGT), kg • kg^{-1} (SH), 0.1 mm (PRCP) , and pa s^{-1} (Ome).

[b] Daytime mean represent average for 10:00-17:00 local time.

Table S2. 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 S3. Coefficients of the multi-linear regression (MLR) models for summer MDA8 ozone at 13 Intermountain West CASTNet sites[a]

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 S3. 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). Fire impacts (FI$_s$, FI$_l$, SqrFI$_s$, SqrFI$_l$) are denoted in bold.
[d] No MLR model is derived for this case. The records from group 1 and group 2 are then combined.