

Observation-Based Summer O₃ Control Effect Evaluation: A Case Study in Chengdu, a Megacity in Sichuan Basin, China

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Received: 09 November 2020; Accepted: 24 November 2020; Published: date

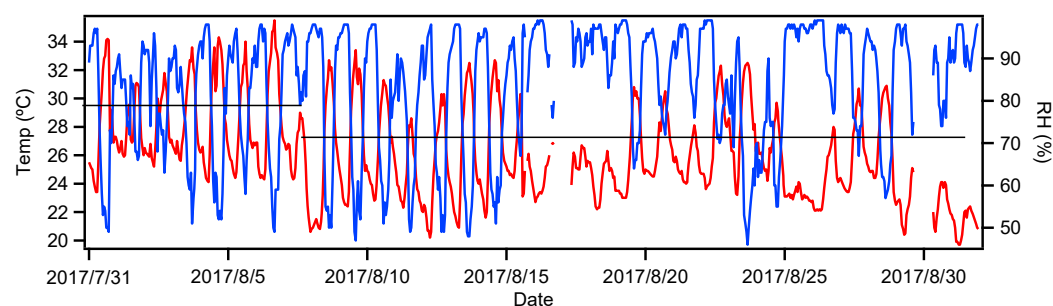


Figure S1. Temporal profiles of temperature and relative humidity (RH) during study period.

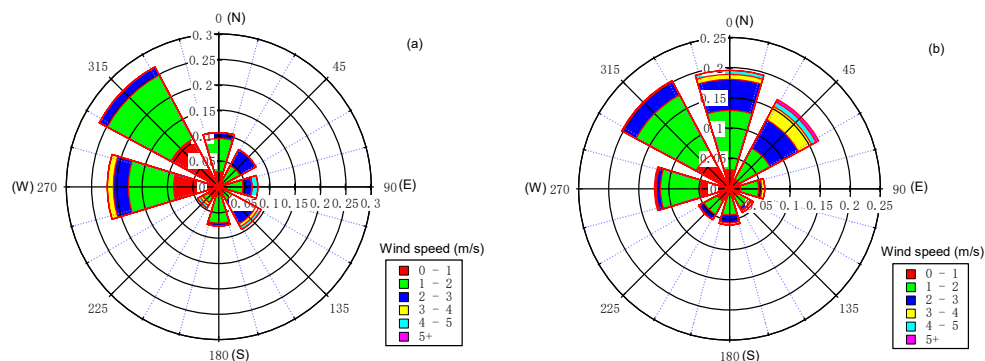


Figure S2. Wind direction and wind speed before (a) and during (b) the enforcement period.

Table S1. The detection limits of measured VOCs by using online GC-FID/MS system.

VOC Species	Detection Limit (ppbv)
ethylene	0.041
acetylene	0.035
ethane	0.040
propylene	0.058
propane	0.032
acetaldehyde	0.204
1 - butylene	0.075
trans - 2 - butene	0.141
cis - 2 - butene	0.129
crotonaldehyde	0.102
cyclopentane	0.086
isobutane	0.107
n-butane	0.085
isopentane	0.123
Is pentane	0.093
2, 2-dimethyl butane	0.078
2,3-Dimethylbutane	0.070
2-methylpentane	0.068
2, 4-dimethylpentane	0.059
2 - butanone	0.353
heptane	0.059
2,3, 4-trimethylpentane	0.023
Methyl isobutyl ketone	0.018
Is octane	0.023
N-butyl aldehyde	0.093
Amyl aldehyde	0.039
hexanal	0.040
Isopropyl alcohol	0.076
Methylene chloride	0.066
Methyl chloride	0.082
1, 3 - butadiene	0.067
1 - amylene	0.089
Anti - 2 - amylene	0.077
Shun - 2 - amylene	0.080

acrolein	0.193
3-methylpentane	0.054
1 - hexene	0.053
Methyl cyclopentane	0.057
n-hexane	0.117
2,2, 4-trimethylpentane	0.017
2-methylheptane	0.023
3-methylheptane	0.021
Is nonane	0.022
decane	0.016
undecane	0.016
dodecane	0.017
propanal	0.152
acetone	0.171
2 - hexanone	0.025
1, 1-dichloroethylene	0.061
Vinyl chloride	0.068
1, 2-dichloroethane	0.070
1, 1-dichloroethane	0.040
1, 2-dichloropropane	0.031
chloroethane	0.139
isoprene	0.067
Methyl methacrylate	0.027
Methylacrolein	0.053
2, 3-dimethylpentane	0.039
3-methylhexane	0.033
Methyl tert-butyl ether	0.070
Anti-1, 3- dichloropropylene	0.019
Cis-1, 3- dichloropropylene	0.022
chlorobenzene	0.025
benzaldehyde	0.045
benzene	0.048
chloroform	0.024
Methyl cyclohexane	0.025
Bromomethane	0.069
dichloromethane	
1,1,2, 2- tetrachloroethane	0.089

cyclohexane	0.051
2-methylhexane	0.023
1, 4-dioxane	0.028
toluene	0.045
Ethyl benzene	0.043
M/P xylene	0.100
o-xylene	0.043
Normal propyl benzene	0.016
Benzyl chloride	0.022
Methyl bromide	0.078
Minus 1, 2- dichloroethylene	0.064
Cis-1, 2-dichloroethylene	0.062
1,1, 1-trichloroethane	0.082
1,1, 2-trichloroethane	0.066
Freon 11	0.069
Freon 113	0.039
styrene	0.050
Isopropyl benzene	0.019
M-ethyl toluene	0.023
P-ethyl toluene	0.046
1,3, 5-trimethylbenzene	0.054
O-ethyl toluene	0.017
1,2, 4-trimethylbenzene	0.043
1,2, 3-trimethylbenzene	0.015
1, 2-dibromoethane	0.022
Carbon tetrachloride	0.107
M-diethyl benzene	0.016
P-diethyl benzene	0.015
Dibromochloromethane	0.065
trichloroethylene	0.040
Freon 114	0.048
1, 3 - two chlorobenzene	0.018
1, 4 - dichlorobenzene	0.033
1, 2 - dichlorobenzene	0.021

Table S2. Average meteorological condition before and during control periods in Chengdu.

	Before Control	During Control
Temperature (°C)	28.2	25.5

Relative Humidity (%)	80.1	84.0
Wind Speed (m/s)	1.45	1.51

Table S3. The averaged mixing ratio of the measured species before and during control periods at each monitoring site.

VOCs Species	Mixing Ratio (ppbv)				VOCs Species	Mixing ratio (ppbv)	
	SL before	SL during	XD before	XD during		JPJ before	JPJ during
Acetaldehyde	3.876	2.540	10.926	3.982	Ethane	2.085	2.467
acrolein	0.258	0.164	0.305	0.189	Propane	1.056	1.103
Propanal	0.434	0.262	0.424	0.247	IsoButane	0.383	0.305
Acetone	5.472	2.951	5.282	3.293	n_butane	0.510	0.342
MTBE	0.680	0.309	0.445	0.314	Cyclopentane	0.084	0.095
Methacrolein	0.352	0.187	0.454	0.214	Isopentane	0.618	0.484
n-Butanal	0.147	0.079	0.187	0.087	n_Pentane	0.477	0.274
Methylvinylketone	0.541	0.325	0.715	0.337	2_Methylheptane	1.250	0.221
Methylethylketone	1.193	0.498	1.533	0.580	3_Methylheptane	0.072	0.067
2-pentanone	0.033	0.028	0.045	0.033	Methylcyclohexane	0.147	0.164
n-Pentanal	0.089	0.057	0.140	0.074	22_Dimethylbutane	0.267	0.240
3-pentanone	0.037	0.035	0.050	0.039	23_Dimethylbutane	0.316	0.288
n-Hexanal		0.265		0.466	n_Heptane	0.523	0.358
Benzene	0.823	0.603	0.587	0.517	24_Dimethylpentane	1.115	0.134
Toluene	2.374	1.570	1.389	0.926	23_Dimethylpentane	0.362	0.079
Ethylbenzene	0.956	0.399	0.949	0.355	Cyclohexane	0.169	0.071
m/p-xylene	2.216	0.941	2.415	0.822	2_Methylheptane	0.161	0.056
o-xylene	0.891	0.337	0.976	0.316	3_Methylheptane	0.563	0.113
styrene	0.540	0.145	0.496	0.123	n_Heptane	0.453	0.122
isopropylbenzene	0.030	0.018	0.025	0.013	224_Trimethylpentane	0.526	0.080
n-Propylbenzene	0.042	0.029	0.031	0.021	234_Trimethylpentane	0.182	0.067
3-ethyltoluene	0.101	0.057	0.080	0.042	Methylcyclohexane	0.189	0.053
4-ethyltoluene	0.061	0.040	0.047	0.025	2_Methylpentane	0.194	0.086
1,3,5-trimethylbenzene	0.050	0.038	0.040	0.024	3_Methylpentane	0.737	0.128
2-ethyltoluene	0.050	0.033	0.041	0.022	n_Octane	0.412	0.088
1,2,4-trimethylbenzene	0.248	0.123	0.199	0.089	n_Nonane	0.589	0.122
1,2,3-trimethylbenzene	0.047	0.039	0.039	0.026	n-Decane	0.642	0.165
1,3-diethylbenzene	0.022	0.020	0.012	0.011	Undecane	0.330	0.082
1,4-diethylbenzene	0.040	0.030	0.027	0.021	Ethylene		2.595
Freon114	0.009	0.010	0.011	0.009	Propylene	0.635	0.351
Chloromethane	1.030	0.752	1.142	0.715	trans_2_Butene	0.151	0.112
Vinylchloride	0.012	0.029	0.044	0.066	1_Butene	0.141	0.292
Bromomethane	0.006	0.006	0.011	0.008	cis_2_Butene	0.205	0.202

Chloroethane	0.041	0.024	0.068	0.045	trans_2_Pentene	0.401	0.172
Freon11	0.399	0.326	0.369	0.259	1_Pentene	0.138	0.127
Freon113	0.082	0.074	0.080	0.070	cis_2_Pentene	0.163	0.194
1,1-Dichloroethylene	0.001	0.001	0.002	0.002	1_Hexene	0.124	0.137
Dichloromethane	3.438	1.617	3.069	2.132	Isoprene	0.319	0.218
1,1-Dichloroethane	0.022	0.015	0.018	0.012	Acetylene	2.450	2.130
cis-1,2-Dichloroethylene	0.004	0.003	0.004	0.003	Benzene	0.100	0.105
Chloroform	0.447	0.453	0.097	0.079	Toluene	0.109	0.257
1,1,1-Trichloroethane	0.002	0.002	0.005	0.004	Ethylbenzene	0.180	0.086
tetrachloromethane	0.305	0.664	0.098	0.083	Styrene	0.088	0.070
1,2-Dichloroethane	1.432	0.763	1.293	0.433	m/p_Xylene	0.111	0.088
1,2-Dichloropropane	0.366	0.190	0.277	0.128	o_Xylene	0.103	0.082
Bromodichloromethane	0.001	0.001	0.002	0.003	Cumene	0.066	0.054
trans-1,3-Dichloropropene	0.012	0.007	0.012	0.007	n_Propylbenzene	0.072	0.036
cis-1,3-Dichloropropene	0.001	0.002	0.004	0.003	m_Ethyltoluene	0.053	0.052
1,1,2-Trichloroethane	0.010	0.007	0.013	0.010	p_Ethyltoluene	0.039	0.031
Tetrachloroethylene	0.248	0.209	0.048	0.044	o_Ethyltoluene	2.092	1.460
1,2-Dibromoethane	0.000	0.002	0.003	0.002	135_Trimethylbenzene	0.053	0.057
Chlorobenzene	0.006	0.006	0.006	0.005	124_Trimethylbenzene	0.073	0.049
1,3-Dichlorobenzene	0.002	0.004	0.003	0.004	123_Trimethylbenzene	0.075	0.037
1,4-Dichlorobenzene	0.099	0.066	0.033	0.027	m_Diethylbenzene	0.062	0.036
Benzylchloride	0.002	0.005	0.003	0.003	p_Diethylbenzene	0.062	0.052
1,2-Dichlorobenzene	0.002	0.004	0.004	0.004			
Acetylene	3.410	2.407	2.847	2.597			
Ethane	3.667	3.673	7.802	13.029			
Propane	3.426	2.239	3.099	4.186			
Isobutane	1.316	0.789	1.026	1.081			
n-Butane	2.294	1.506	1.588	1.695			
Cyclopentane	0.125	0.095	0.056	0.059			
Isopentane	1.847	1.261	1.638	1.410			
n-Pentane	0.686	0.497	0.618	0.628			
2,2-dimethylbutane	0.091	0.046	0.054	0.049			
2,3-dimethylbutane	0.127	0.069	0.165	0.075			
2-methylpentane	0.716	0.370	0.464	0.307			
3-methylpentane	0.540	0.291	0.360	0.275			
n-hexane	0.404	0.250	0.307	0.269			
2,4-dimethylpentane	0.069	0.037	0.041	0.028			
methylcyclopentane	0.268	0.153	0.169	0.131			
2-methylhexane	0.188	0.091	0.082	0.062			
Cyclohexane	0.138	0.077	0.093	0.109			

2,3-dimethylpentane	0.089	0.048	0.037	0.032
3-methylhexane	0.202	0.112	0.104	0.083
2,2,4-trimethylpentane	0.099	0.069	0.056	0.047
n-heptane	0.249	0.124	0.119	0.095
Methylcyclohexane	0.272	0.120	0.133	0.174
2,3,4-trimethylpentane	0.053	0.033	0.028	0.022
2-methylheptane	0.040	0.026	0.029	0.025
3-methylheptane	0.038	0.024	0.025	0.021
octane	0.082	0.051	0.050	0.043
n-Nonane	0.062	0.039	0.043	0.028
n-decane	0.053	0.038	0.032	0.026
Udecane	0.077	0.047	0.027	0.025
Dodecane	0.135	0.128	0.442	0.101
Ethylene	2.469	1.836	1.985	1.648
Propene	0.441	0.373	0.511	0.368
trans-2-Butene	0.026	0.016	0.099	0.105
1-Butene	0.089	0.069	0.157	0.166
cis-2-Butene	0.024	0.016	0.097	0.094
1,3-Butadiene	0.053	0.032	0.045	0.028
1-pentene	0.034	0.023	0.043	0.027
trans-2-pentene	0.018	0.005	0.020	0.016
isoprene	0.651	0.352	1.432	0.614
cis-2-pentene	0.011	0.005	0.011	0.011
1-hexene	0.028	0.016	0.028	0.017
Trichloroethylene	0.098	0.054	0.079	0.052
Acetonitrile	0.394	0.310	0.449	0.322

Table S4. MIR values derived from study by Carter (Carter 2010).

	VOCs	MIR (mg·O ₃ /mg·VOC)
Alkane	Ethane	0.28
	Propane	0.49
	n-Butane	1.15
	2,2-dimethylbutane	1.17
	Isobutane	1.23
	n-Heptane	1.07
	Octane	0.90
	n-Decane	0.68
	2-Methylpentane	1.50

	Dodecane	0.55
	n-Hexane	1.24
	2-Methylheptane	1.07
	2,3-dimethylbutane	0.97
	Isopentane	1.45
	2-Methylhexane	1.19
	n-Pentane	1.31
	Methylcyclopentane	2.19
	Cyclopentane	2.39
	3-Methylpentane	1.80
	3-Methylhexane	1.61
	n-Nonane	0.78
	3-Methylheptane	1.24
	2,4-Dimethylpentane	1.55
	Undecane	0.61
	2,3-Dimethylpentane	1.34
	2,3,4-trimethylpentane	1.03
	2,2,4-trimethylpentane	1.26
	Methylcyclohexane	1.70
	Cyclohexane	1.25
	1,4-Dioxane	2.62
Alkene	Ethylene	9.00
	1-Butene	9.73
	Isoprene	10.61
	1-Hexene	5.49
	cis-2-Butene	14.24
	Propylene	11.66
	trans-2-Butene	15.16
	1-Pentene	7.21
	trans-2-Pentene	10.56
	1,3-Butadiene	12.61
	cis-2-Pentene	10.38
	Acetylene	0.95
Aromatics	Toluene	4.00
	Benzene	0.72
	m/p-Xylene	5.84
	o-Xylene	7.64
	Ethylbenzene	3.04
	Benzaldehyde	-0.67
	Naphthalene	3.34

	1,2,4-Trimethylbenzene	8.87
	Styrene	1.73
	4-Ethyltoluene	4.44
	n-Propylbenzene	2.03
	Isopropylbenzene	2.52
	1,3,5-Trimethylbenzene	11.76
	3-Ethyltoluene	7.39
	2-Ethyltoluene	5.59
	1,2,3-Trimethylbenzene	11.97
	1,4-Diethylbenzene	4.43
	1,2-dichloro-benzene	0.18
	1,3-Diethylbenzene	7.10
Halohydrocarbon	cis-1,3-Dichloropropene	3.70
	Methylene chloride	0.04
	Chloromethane	0.04
	1,2-Dichloroethane	0.21
	1,1-Dichloroethane	0.07
	Chloroform	0.02
	1,4-Dichlorobenzene	0.18
	Vinylchloride	2.83
	1,2-Dichloropropane	0.29
	tetrachloromethane	0.00
	1,1,2-Trichloroethane	0.09
	Chloroethane	0.29
	Chlorobenzene	0.32
	1,1,1-Trichloroethane	0.64
	Bromomethane	0.02
	trans-1,2-dichloroethene	1.70
	Tetrachloroethylene	0.03
	trans-1,3-Dichloropropene	5.03
	1,1-Dichloroethylene	1.79
	1,2-Dibromoethane	0.10
OVOC	Acetaldehyde	6.54
	Acetone	0.36
	Ethanol	1.53
	Propanal	7.08
	n-Butanal	5.97
	2-Butanone	1.48
	Crotonaldehyde	9.39
	n-Hexanal	4.35

	2-Propanol	0.61
	n-Pentanal	5.08
	acrolein	7.45
	Ethyl Acetate	0.63
	Methacrolein	6.01
	MTBE	0.73
	Methyl Isobutyl Ketone	3.88
	2-Hexanone	3.14
	Tetrahydrofuran	4.31
	Methyl methacrylate	15.61
	Acetic acid ethenyl ester	3.20
SVOC	Carbon disulfide	0.25

Table S5. VOC emission sources and corresponding tracers used in PMF source apportionment.

VOC Tracers	Sources
Acetylene	Fuel combustion products, and vehicle exhaust
Propane, isobutane and n-butane	Liquefied petroleum gas (LPG)
Isopentane, 2-methylpentane, n-hexane, 2-methylhexane	Gasoline components, characteristic species of Gasoline volatilization
C3-C5 alkane	Fossil fuel combustion
Decane and undecane	Gas emissions from diesel vehicles
1-butene, isobutylene	Gasoline exhaust
Acetonitrile, methyl chloride,	Biomass burning
MTBE, dichloromethane	Vehicle exhaust, organic solvent
BTEX, n-hexane	Solvent and coating
MVK, Isoprene	Natural source emissions
BTEX	Motor vehicle exhaust and solvent coatings
1,2,4-trimethylbenzene	Motor vehicle source
Methyl chloride	Automobile exhaust
Halogenated hydrocarbon (tetrachloroethylene, chloroform)	Industrial stationary source
Acetaldehyde, acetone	vehicle exhaust and secondary formation