Supplement

# Characterization of gas-phase organics using proton transfer reaction time-of-flight mass spectrometry: fresh and aged residential wood combustion emissions

Emily A. Bruns, Jay G. Slowik, Imad El Haddad, Dogushan Kilic, Felix Klein, Josef Dommen, Brice Temime-Roussel, Nicolas Marchand, Urs Baltensperger and André S. H. Prévôt

**Potential fragmentation**

In most cases, possible reactions of species relevant to wood combustion to produce ions other than $[M+H]^+$ in the PTR-ToF mass spectrometer are negligible, however, these reactions can be more considerable in the following cases (the nominal $[M+H]^+$ *m/z* is given in parentheses and only literature results obtained under the most similar instrumental conditions are discussed):

- *Ethanol (m/z 47)*: Reactions to produce ions in addition to $[M+H]^+$ are highly dependent on instrumental conditions and do not necessarily correlate with *E*/*N*. At an *E*/*N* of 142 Td, Baasandorj et al. (2015) found that ~80 to >95% of the signal undergoes dehydration to form *m/z* 29, whereas Blake et al. (2006) observed only 7% of the signal at *m/z* 29 at a higher *E*/*N* of 165 Td and Buhr et al. (2002) observed ~25% of the signal at *m/z* 45 and ~4% at *m/z* 65 at a lower *E*/*N* of ~120 Td.

- *Isomers of acetic acid/glycolaldehyde (m/z 61)*: At an *E*/*N* of 142 Td, Baasandorj et al. (2015) found that ~30-50% of acetic acid and ~45-60% of glycolaldehyde undergoes dehydration to form $[C_2H_3O]^+$ at *m/z* 43. At an *E*/*N* of 132 Td, Haase et al. (2012) also found that ~30-50% of acetic acid fragments to *m/z* 43. Reported emission factors for $[C_2H_4O_2+H]^+$ are thus lower limits and could increase by up to ~30% (assuming $[C_2H_3O]^+$ originates entirely from $[C_2H_4O_2+H]^+$).

- *Isomers of (E)-pent-2-ene/(Z)-pent-2-ene/2-methylbut-1-ene/2-methylbut-2-ene/pent-1-ene/3-methylbut-1-ene (m/z 71)*: Gueneron et al. (2015) found 46-48% of the signal at *m/z* 43 and ~10% of the signal at *m/z* 41 at an *E/N* of 120 Td.

- *Butane-2,3-dione (m/z 87)*: At an *E*/*N* of ~120 Td, Buhr et al. (2002) found ~7% of the signal at *m/z* 59 and 5% at *m/z* 88, whereas Karl et al. (2007) found 34% of the signal at *m/z* 59 and the remainder at $[M+H]^+$ at an *E*/*N* of ~120 Td.

- *Ethyl benzene (m/z 107)*: At an *E*/*N* of 145 Td, Jobson et al. (2010) found that 40% of ethylbenzene fragments to interfere with the benzene signal at *m/z* 79. Using this fragmentation pattern in the current experiments, if the entire signal at $[C_8H_{10}+H]^+$ arises from ethylbenzene, this would result in a negligible overestimate of the benzene signal of less than 1% in experiments 1 and 3-5 and ~2% in experiment 2.

**Table S1.** Applied reaction rates[a,b]

| ion | species | reaction rate ($10^{-9}$ $cm^3$ $s^{-1}$) |
|---|---|---|
| $[CH_3OH+H]^+$ | methanol | 2.14 |
| $[C_2H_3N+H]^+$ | acetonitrile | 3.82 |
| $[C_2H_4O+H]^+$ | acetaldehyde | 3.02 |
| $[C_3H_6+H]^+$ | propene | 1.62 |
| $[CH_2O_2+H]^+$ | formic acid | 1.89 |
| $[C_2H_6O+H]^+$ | ethanol | 2.04 |
| $[C_4H_6+H]^+$ | buta-1,3-diene | 1.82 |
| $[C_3H_4O+H]^+$ | prop-2-enal | 3.43 |
| $[C_2H_2O_2+H]^+$ | oxaldehyde | 1.35 |
| $[C_3H_6O+H]^+$ | propan-2-one/propanal | 3.10 |
| $[C_2H_4O_2+H]^+$ | acetic acid/glycolaldehyde | 2.11 |
| $[C_4H_4O+H]^+$ | furan | 1.69 |
| $[C_5H_8+H]^+$ | isoprene/cyclopentene | 1.88 |
| $[C_4H_6O+H]^+$ | (*E*)-but-2-enal | 3.45 |
| | 3-buten-2-one | |
| | 2-methylprop-2-enal | |
| $[C_5H_{10}+H]^+$ | (*E*)-/(*Z*)-pent-2-ene | 1.91 |
| | 2-methylbut-1-ene | |
| | 2-methylbut-2-ene | |
| | pent-1-ene | |
| | 3-methylbut-1-ene | |
| $[C_4H_8O+H]^+$ | butan-2-one | 3.09 |
| | butanal | |
| | 2-methylpropanal | |
| $[C_3H_6O_2+H]^+$ | methyl acetate | 2.24 |
| $[C_6H_6+H]^+$ | benzene | 1.93 |
| $[C_6H_{12}+H]^+$ | (*E*)-hex-2-ene | 2.02 |
| | 2-methyl-pent-2-ene | |
| $[C_4H_6O_2+H]^+$ | butane-2,3-dione | 1.70 |
| $[C_4H_8O_2+H]^+$ | ethyl acetate | 4.15 |
| $[C_7H_8+H]^+$ | toluene | 2.08 |
| $[C_6H_6O+H]^+$ | phenol | 2.13 |
| $[C_5H_4O_2+H]^+$ | 2-furaldehyde | 3.88 |
| $[C_7H_{14}+H]^+$ | methylcyclohexane/hept-1-ene | 2.13 |
| $[C_6H_{12}O+H]^+$ | hexanal | 3.15 |
| $[C_8H_8+H]^+$ | styrene | 2.27 |
| $[C_7H_6O+H]^+$ | benzaldehyde | 3.63 |
| $[C_8H_{10}+H]^+$ | *m*-/*o*-/*p*-xylene | 2.26 |
| | ethylbenzene | |
| $[C_7H_8O+H]^+$ | *m*-/*o*-/*p*-cresol | 2.27 |
| $[C_7H_{14}O+H]^+$ | heptanal | 2.74 |
| $[C_9H_8+H]^+$ | 1*H*-indene | 2.42 |
| $[C_8H_8O+H]^+$ | 1-phenylethanone | 3.23 |
| | 3-/4-methylbenzaldehyde | |
| $[C_9H_{12}+H]^+$ | *i*-propylbenzene | 2.39 |
| | *n*-propylbenzene | |
| | 1,3,5-trimethylbenzene | |
| $[C_{10}H_8+H]^+$ | naphthalene | 2.45 |
| $[C_{11}H_{10}+H]^+$ | 1-/2-methylnaphthalene | 2.71 |
| $[C_{12}H_8+H]^+$ | acenaphthylene | 2.86 |
| $[C_{12}H_{10}+H]^+$ | 1,1'-biphenyl | 2.81 |
| | 1,2-dihydroacenaphthylene | |
| $[C_{13}H_{10}+H]^+$ | fluorene | 2.88 |
| $[C_{14}H_{10}+H]^+$ | phenanthrene | 2.97 |
| | anthracene | |
| $[C_{16}H_{10}+H]^+$ | fluoranthene | 3.37 |
| | pyrene | |
| | acephenanthrylene | |

[a]Reaction rates taken from Cappellin et al. (2012) at a drift temperature of 90 °C and an *E*/*N* of 140 Td. A reaction rate of $2\times10^{-9}$ $cm^3$ $s^{-1}$ is applied to all other ions.

[b]In the cases of isomers, an average of the available rate constants is applied.

**Table S2.** Aged gas-phase emissions (mg $kg^{-1}$) measured using PTR-ToF-MS at an OH exposure of (4.5-5.5)×$10^7$ molec $cm^{-3}$ h[a]

| species | monoisotopic *m/z* | structural assignment[b] | functional group | experiment 1 | 2 | 3 | 4 | 5 | average[c] |
|---|---|---|---|---|---|---|---|---|---|
| NMOG | | | | 2600 | 9100 | 7100 | 2600 | 1600 | 5000±3000 |
| acid | | | | 990 | 4600 | 3500 | 960 | 570 | 2000±2000 |
| O-containing | | | | 680 | 2600 | 1900 | 620 | 390 | 1000±1000 |
| carbonyl | | | | 210 | 730 | 490 | 170 | 130 | 300±300 |
| oxygenated aromatic | | | | 34 | 56 | 55 | 35 | 26 | 40±10 |
| alcohol | | | | 140 | 590 | 350 | 100 | 65 | 200±200 |
| furan | | | | 24 | 72 | 51 | 20 | 14 | 40±20 |
| O- and N-containing | | | | 120 | 87 | 110 | 120 | 100 | 100±20 |
| $C_xH_y$ | | | | 59 | 69 | 83 | 61 | 42 | 60±10 |
| aromatic hydrocarbon | | | | 180 | 81 | 270 | 380 | 140 | 200±100 |
| N-containing | | | | 31 | 46 | 42 | 28 | 24 | 34±9 |
| other | | | | 180 | 260 | 280 | 180 | 140 | 210±60 |
| $[CH_3OH+H]^+$ | 33.034 | methanol | alcohol | 110 | 590 | 340 | 92 | 56 | 200±200 |
| $[C_2H_3N+H]^+$ | 42.034 | acetonitrile | N-containing | 3.6 | 3.6 | 4.4 | 3.3 | 2.7 | 3.5±0.6 |
| $[C_3H_6+H]^+$ | 43.055 | propene | $C_xH_y$ | 7.7 | 17 | 13 | 6.4 | 5.2 | 10±5 |
| $[C_2H_4O+H]^+$ | 45.034 | acetaldehyde | carbonyl | 50 | 130 | 94 | 42 | 30 | 70±40 |
| $[CH_2O_2+H]+$ | 47.013 | formic acid | acid | 280 | 580 | 570 | 310 | 190 | 400±200 |
| $[C_2H_6O+H]^+$ | 47.050 | ethanol | alcohol | 33 | 1.1 | 6.8 | 8.9 | 9.1 | 10±10 |
| $[C_4H_6+H]^+$ | 55.055 | buta-1,3-diene | $C_xH_y$ | 6.4 | 8.0 | 9.7 | 5.9 | 7.5 | 7±2 |
| $[C_3H_4O+H]^+$ | 57.034 | prop-2-enal | carbonyl | 6.9 | 39 | 27 | 7.4 | 1.8 | 20±20 |
| $[C_2H_2O_2+H]^+$ | 59.013 | oxaldehyde | carbonyl | BDL | BDL | BDL | BDL | BDL | BDL |
| $[C_3H_6O+H]^+$ | 59.050 | propan-2-one<br>propanal | carbonyl | 64 | 170 | 120 | 46 | 48 | 90±50 |
| $[C_2H_4O_2+H]^+$ | 61.029 | acetic acid<br>glycolaldehyde | acid | 710 | 4000 | 2900 | 650 | 370 | 2000±2000 |
| $[C_4H_4O+H]^+$ | 69.034 | furan | furan | 4.1 | 16 | 11 | 3.9 | 2.3 | 8±6 |
| $[C_5H_8+H]^+$ | 69.070 | isoprene<br>cyclopentene | $C_xH_y$ | 3.3 | 4.4 | 4.5 | 1.6 | 1.6 | 3±1 |
| $[C_4H_6O+H]^+$ | 71.050 | (*E*)-but-2-enal<br>3-buten-2-one<br>2-methylprop-2-enal | carbonyl | 4.3 | 16 | 11 | 3.7 | 2.1 | 7±6 |
| $[C_5H_{10}+H]^+$ | 71.086 | (*E*)-/(*Z*)-pent-2-ene<br>2-methylbut-1-ene<br>2-methylbut-2-ene<br>pent-1-ene<br>3-methylbut-1-ene | $C_xH_y$ | BDL | BDL | 1.1 | BDL | BDL | 0.2±0.5 |
| $[C_3H_4O_2+H]^+$ | 73.029 | 2-oxopropanal | carbonyl | 18 | 60 | 48 | 17 | 11 | 30±20 |
| $[C_4H_8O+H]^+$ | 73.065 | butan-2-one<br>butanal<br>2-methylpropanal | carbonyl | 9.7 | 39 | 24 | 6.7 | 7.0 | 20±10 |
| $[C_3H_6O_2+H]^+$ | 75.045 | methyl acetate | O-containing | 59 | 350 | 220 | 46 | 30 | 100±100 |
| $[C_6H_6+H]^+$ | 79.055 | benzene | aromatic hydrocarbon | 170 | 65 | 240 | 350 | 130 | 200±100 |
| $[C_5H_6O+H]^+$ | 83.050 | 2-methylfuran | furan | 2.1 | 9.0 | 5.9 | 2.1 | 1.4 | 4±3 |
| $[C_5H_8O+H]^+$ | 85.065 | 3-methyl-3-buten-2-one | carbonyl | 3.0 | 14 | 8.9 | 2.7 | 2.1 | 6±5 |
| $[C_6H_{12}+H]^+$ | 85.102 | (*E*)-hex-2-ene<br>2-methyl-pent-2-ene | $C_xH_y$ | BDL | BDL | BDL | BDL | BDL | BDL |
| $[C_4H_6O_2+H]^+$ | 87.045 | butane-2,3-dione | carbonyl | 48 | 250 | 150 | 39 | 24 | 100±100 |
| $[C_7H_8+H]^+$ | 93.070 | toluene | aromatic hydrocarbon | 11 | 7.4 | 15 | 17 | 6.6 | 11±5 |
| $[C_6H_6O+H]^+$ | 95.050 | phenol | oxygenated aromatic | 2.3 | 3.5 | 6.4 | 6.1 | 4.0 | 4±2 |
| $[C_5H_4O_2+H]^+$ | 97.029 | furan-2-carbaldehyde | furan | 11 | 23 | 19 | 8.4 | 5.8 | 13±7 |
| $[C_6H_8O+H]^+$ | 97.065 | 2,4-/2,5-dimethylfuran | furan | 0.99 | 3.5 | 2.6 | 1.2 | 0.82 | 2±1 |
| $[C_4H_2O_3+H]^+$ | 99.008 | maleic anhydride[d] | O-containing | 110 | 260 | 200 | 92 | 74 | 140±80 |
| $[C_8H_8+H]^+$ | 105.070 | styrene | aromatic hydrocarbon | 0.88 | 1.5 | 1.5 | 1.3 | 0.61 | 1.2±0.4 |
| $[C_7H_6O+H]^+$ | 107.050 | benzaldehyde | oxygenated aromatic | 5.8 | 4.0 | 6.6 | 7.4 | 4.0 | 6±2 |
| $[C_8H_{10}+H]^+$ | 107.086 | *m*-/*o*-/*p*-xylene<br>ethylbenzene | aromatic hydrocarbon | 0.95 | BDL | 1.5 | 1.5 | BDL | 0.8±0.8 |
| $[C_7H_8O+H]^+$ | 109.065 | *m*-/*o*-/*p*-cresol | oxygenated aromatic | BDL | 0.96 | 1.1 | 0.94 | 0.48 | 0.7±0.4 |
| $[C_6H_6O_2+H]^+$ | 111.045 | *m*-/*o*-/*p*-benzenediol<br>2-methylfuraldehyde | oxygenated aromatic | 6.8 | 18 | 13 | 5.0 | 3.8 | 9±6 |
| $[C_9H_8+H]^+$ | 117.070 | 1*H*-indene | aromatic hydrocarbon | BDL | BDL | 0.80 | 0.79 | BDL | 0.3±0.4 |
| $[C_9H_{10}+H]^+$ | 119.086 | 2,3-dihydro-1*H*-indene | aromatic hydrocarbon | BDL | BDL | BDL | BDL | BDL | BDL |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $[C_8H_8O+H]^+$ | 121.065 | 1-phenylethanone<br>3-/4-methylbenzaldehyde | oxygenated aromatic | 3.0 | 2.8 | 3.3 | 2.7 | 1.8 | 2.7±0.6 |
| $[C_9H_{12}+H]^+$ | 121.102 | *i*-propylbenzene<br>*n*-propylbenzene<br>1,3,5-trimethylbenzene | aromatic hydrocarbon | BDL | BDL | BDL | BDL | BDL | BDL |
| $[C_8H_{10}O+H]^+$ | 123.081 | 2,4-/2,6-/3,5-dimethylphenol | oxygenated aromatic | BDL | BDL | BDL | BDL | BDL | BDL |
| $[C_7H_8O_2+H]^+$ | 125.060 | 2-methoxyphenol<br>methylbenzenediols | oxygenated aromatic | BDL | 5.5 | 3.7 | 0.94 | BDL | 2±2 |
| $[C_6H_6O_3+H]^+$ | 127.040 | 5-(hydroxymethyl)furan-2-carbaldehyde | furan | 6.1 | 21 | 13 | 4.4 | 3.4 | 9±7 |
| $[C_{10}H_8+H]^+$ | 129.070 | naphthalene | aromatic hydrocarbon | BDL | BDL | 4.6 | 4.6 | 0.84 | 2±2 |
| $[C_8H_{10}O_2+H]^+$ | 139.076 | 2-methoxy-4-methylphenol<br>4-(2-hydroxyethyl)phenol | oxygenated aromatic | BDL | 2.9 | 2.1 | 0.71 | BDL | 1±1 |
| $[C_{11}H_{10}+H]^+$ | 143.086 | 1-/2-methylnaphthalene | aromatic hydrocarbon | BDL | BDL | BDL | BDL | 0.4 | 0.07±0.2 |
| $[C_9H_6O_2+H]^+$ | 147.045 | 2,3-dihydroinden-1-one | oxygenated aromatic | 3.8 | 3.6 | 4.8 | 3.8 | 2.5 | 3.7±0.8 |
| $[C_8H_4O_3+H]^+$ | 149.024 | phthalic anhydride[d] | O-containing | 55 | 71 | 74 | 59 | 55 | 63±9 |
| $[C_8H_8O_3+H]^+$ | 153.055 | 4-hydroxy-3-methoxybenzaldehyde | oxygenated aromatic | 1.2 | 3.3 | 2.6 | 1.4 | BDL | 2±1 |
| $[C_{12}H_8+H]^+$ | 153.070 | acenaphthylene | aromatic hydrocarbon | BDL | BDL | BDL | BDL | BDL | BDL |
| $[C_9H_{12}O_2+H]^+$ | 153.092 | 4-ethyl-2-methoxyphenol<br>1,2-dimethoxy-4-methylbenzene | oxygenated aromatic | BDL | BDL | BDL | BDL | BDL | BDL |
| $[C_8H_{10}O_3+H]^+$ | 155.071 | 2,6-dimethoxyphenol | oxygenated aromatic | BDL | BDL | BDL | BDL | 0.5 | 0.1±0.2 |
| $[C_{12}H_{10}+H]^+$ | 155.086 | 1,1'-biphenyl<br>1,2-dihydroacenaphthylene | aromatic hydrocarbon | BDL | BDL | BDL | 1.2 | BDL | 0.2±0.5 |
| $[C_{12}H_{12}+H]^+$ | 157.102 | dimethylnaphthalene | aromatic hydrocarbon | BDL | 1.7 | 1.4 | BDL | BDL | 0.6±0.9 |
| $[C_{10}H_{12}O_2+H]^+$ | 165.092 | 2-methoxy-4-[(*E*)-prop-1-enyl]phenol<br>2-methoxy-4-prop-2-enylphenol<br>2-methoxy-4-[(*Z*)-prop-1-enyl]phenol | oxygenated aromatic | BDL | BDL | BDL | BDL | BDL | BDL |
| $[C_9H_{10}O_3+H]^+$ | 167.071 | 1-(4-hydroxy-3-methoxyphenyl)ethanone<br>2,5-dimethylbenzaldehyde<br>3,4-dimethoxybenzaldehyde | oxygenated aromatic | 1.4 | 1.9 | 1.9 | 0.96 | BDL | 1.2±0.8 |
| $[C_{13}H_{10}+H]^+$ | 167.086 | fluorene | aromatic hydrocarbon | BDL | BDL | BDL | BDL | BDL | BDL |
| $[C_{10}H_{14}O_2+H]^+$) | 167.107 | 2-methoxy-4-propylphenol | oxygenated aromatic | BDL | BDL | BDL | BDL | BDL | BDL |
| $[C_9H_{12}O_3+H]^+$ | 169.086 | 2,6-dimethoxy-4-methylphenol | oxygenated aromatic | BDL | BDL | BDL | BDL | BDL | BDL |
| $[C_{14}H_{10}+H]^+$ | 179.086 | phenanthrene<br>anthracene | aromatic hydrocarbon | 2.8 | 2.1 | 1.9 | 1.6 | 3.9 | 2.5±0.9 |
| $[C_{13}H_8O+H]^+$ | 181.065 | fluoren-9-one<br>phenalen-1-one | oxygenated aromatic | 4.2 | 4.1 | 3.7 | 2.5 | 4.2 | 3.7±0.7 |
| $[C_{10}H_{12}O_3+H]^+$ | 181.086 | 1-(4-hydroxy-3-methoxyphenyl)propan-2-one | oxygenated aromatic | BDL | BDL | BDL | BDL | BDL | BDL |
| $[C_9H_{10}O_4+H]^+$ | 183.066 | 3,4-dimethoxybenzoic acid<br>4-hydroxy-3,5-dimethoxybenzaldehyde | oxygenated aromatic | BDL | BDL | BDL | BDL | BDL | BDL |
| $[C_{10}H_{14}O_3+H]^+$ | 183.102 | 4-ethyl-2,6-dimethoxyphenol | oxygenated aromatic | BDL | BDL | BDL | BDL | BDL | BDL |
| $[C_{15}H_{12}+H]^+$ | 193.102 | 1-/2-/3-/9-methylphenanthrene<br>2-methylanthracene | aromatic hydrocarbon | 0.71 | BDL | 0.60 | BDL | 0.77 | 0.4±0.4 |
| $[C_{11}H_{14}O_3+H]^+$ | 195.102 | 1,3-dimethoxy-2-prop-2-enoxybenzene<br>2,6-dimethoxy-4-[(*Z*)-prop-1-enyl]phenol | oxygenated aromatic | BDL | BDL | BDL | BDL | 0.43 | 0.09±0.2 |
| $[C_{16}H_{10}+H]^+$ | 203.086 | fluoranthene<br>pyrene<br>acephenanthrylene | aromatic hydrocarbon | BDL | BDL | BDL | BDL | 0.45 | 0.09±0.2 |

[a]BDL indicates value is below the detection limit, the determination of which is described in the text.

[b]Multiple structural assignments for a given ion correspond to possible isomers.

[c]Uncertainties correspond to one sample standard deviation of the replicates.

[d]Structural assignment based on known products produced during oxidation of aromatics (Bandow et al., 1985; Chan et al., 2009; Praplan et al., 2014).

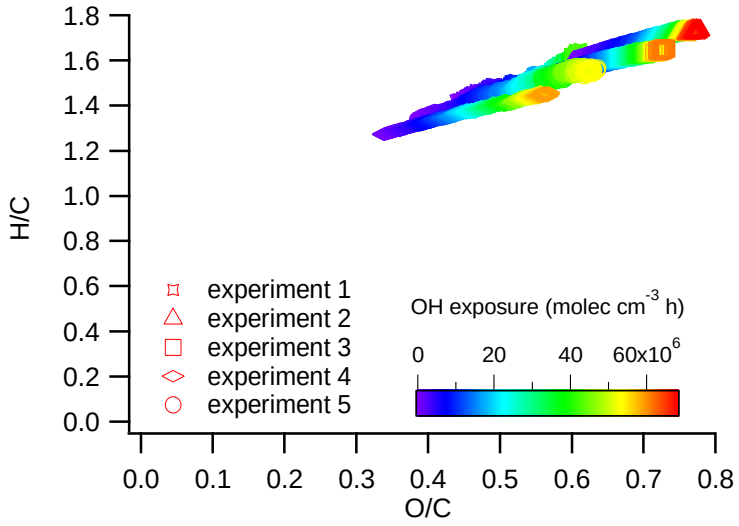


**Figure S1.** Elemental composition of the speciated NMOG bulk as a function of OH exposure for all experiments.

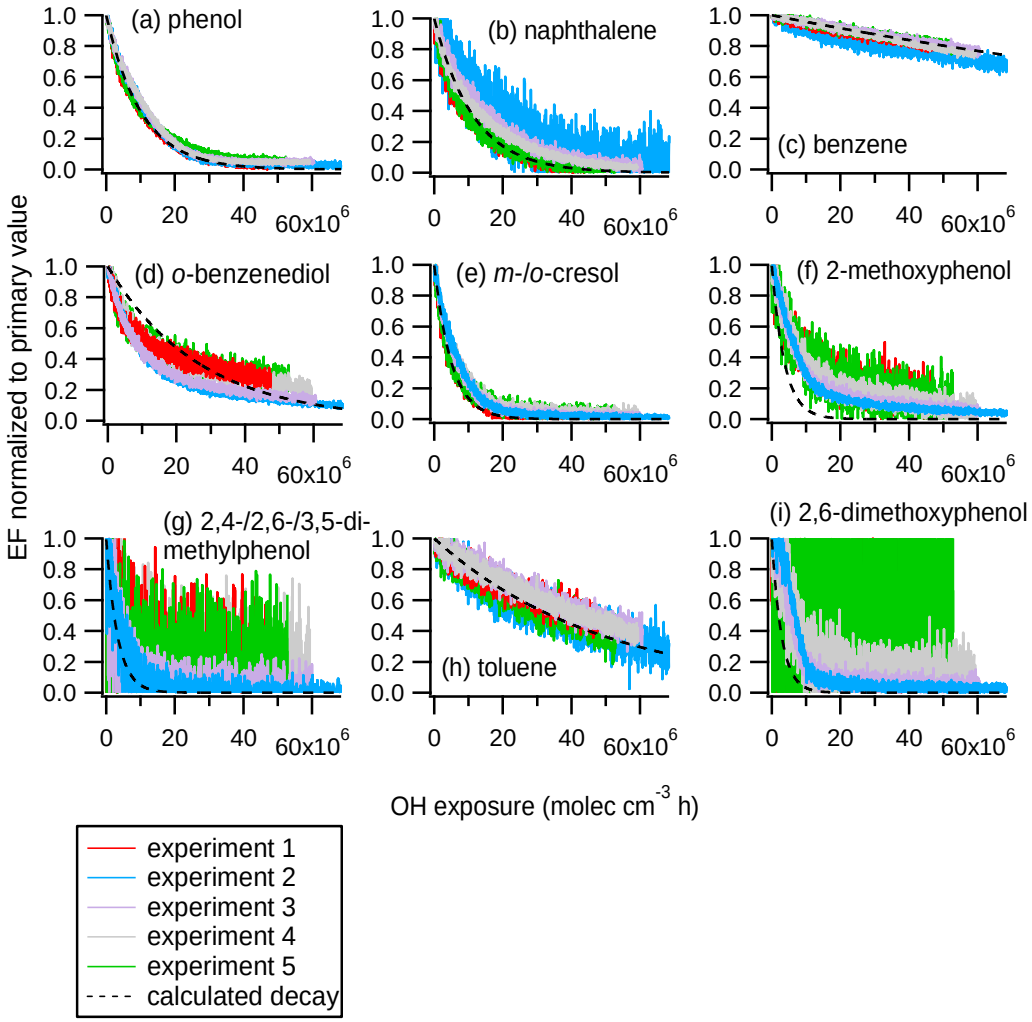


**Figure S2.** (a-i) Behavior with aging of individual compounds contributing the most to SOA formation for experiments 1-5. The black, dashed line in each panel is the expected decay rate of each species based on the OH concentration and reaction rate with OH.

## References


Baasandorj, M., Millet, D.B., Hu, L., Mitroo, D. and Williams, B.J.: Measuring acetic and formic acid by proton-transfer-reaction mass spectrometry: sensitivity, humidity dependence, and quantifying interferences, Atmos. Meas. Tech. 8, 1303-1321, 2015.

Bandow, H., Washida, N. and Akimoto, H.: Ring-cleavage reactions of aromatic hydrocarbons studied by FT-IR spectroscopy. I. Photooxidation of toluene and benzene in the $NO_x$-Air System, B. Chem. Soc. Jpn. 58, 2531-2540, 1985.

Blake, R.S., Wyche, K.P., Ellis, A.M. and Monks, P.S.: Chemical ionization reaction time-of-flight mass spectrometry: Multi-reagent analysis for determination of trace gas composition, Int. J. Mass. Spectrom. 254, 85-93, 2006.

Buhr, K., van Ruth, S. and Delahunty, C.: Analysis of volatile flavour compounds by Proton Transfer Reaction-Mass Spectrometry: fragmentation patterns and discrimination between isobaric and isomeric compounds, Int. J. Mass. Spectrom. 221, 1-7, 2002.

Cappellin, L., Karl, T., Probst, M., Ismailova, O., Winkler, P.M., Soukoulis, C., Aprea, E., Märk, T.D., Gasperi, F. and Biasioli, F.: On quantitative determination of volatile organic compound concentrations using proton transfer reaction time-of-flight mass spectrometry, Environ. Sci. Technol. 46, 2283-2290, 2012.

Chan, A.W.H., Kautzman, K.E., Chhabra, P.S., Surratt, J.D., Chan, M.N., Crounse, J.D., Kürten, A., Wennberg, P.O., Flagan, R.C. and Seinfeld, J.H.: Secondary organic aerosol formation from photooxidation of naphthalene and alkylnaphthalenes: implications for oxidation of intermediate volatility organic compounds (IVOCs), Atmos. Chem. Phys. 9, 3049-3060, 2009.

Gueneron, M., Erickson, M.H., VanderSchelden, G.S. and Jobson, B.T.: PTR-MS fragmentation patterns of gasoline hydrocarbons, Int. J. Mass. Spectrom. 379, 97-109, 2015.

Haase, K.B., Keene, W.C., Pszenny, A.A.P., Mayne, H.R., Talbot, R.W. and Sive, B.C.: Calibration and intercomparison of acetic acid measurements using proton-transfer-reaction mass spectrometry (PTR-MS), Atmos. Meas. Tech. 5, 2739-2750, 2012.

Jobson, B.T., Volkamer, R.A., Velasco, E., Allwine, G., Westberg, H., Lamb, B.K., Alexander, M.L., Berkowitz, C.M. and Molina, L.T.: Comparison of aromatic hydrocarbon measurements made by PTR-MS, DOAS and GC-FID during the MCMA 2003 Field Experiment, Atmos. Chem. Phys. 10, 1989-2005, 2010.

Karl, T.G., Christian, T.J., Yokelson, R.J., Artaxo, P., Hao, W.M. and Guenther, A.: The Tropical Forest and Fire Emissions Experiment: method evaluation of volatile organic compound emissions measured by PTR-MS, FTIR, and GC from tropical biomass burning, Atmos. Chem. Phys. 7, 5883-5897, 2007.

Praplan, A.P., Hegyi-Gaeggeler, K., Barmet, P., Pfaffenberger, L., Dommen, J. and Baltensperger, U.: Online measurements of water-soluble organic acids in the gas and aerosol phase from the photooxidation of 1,3,5-trimethylbenzene, Atmos. Chem. Phys. 14, 8665-8677, 2014.