

Table 1. Experimental Conditions and Results of the Photooxidation Experiments

cooking oil	[NMOG] ₀ ^a (ppb)	[NO] ₀ ^{a,b} (ppb)	[NO ₂] ₀ ^{a,b} (ppb)	[NMOG] ₀ : [NO _x] (ppbC:ppb)	[AS] ₀ ^a (μg m ⁻³)	[POA] ₀ ^c (μg m ⁻³)	OH exposure (×10 ¹⁰) molecules cm ⁻³ s	[SOA] ₀ ^d (μg m ⁻³)	effective SOA yield
sunflower	352	167	248	4.9	23.3	0.8	1.0 ± 0.16	45.0	0.50
olive	262	173	185	4.0	42.6	42.3	1.3 ± 0.14	30.6	0.31
peanut	219	273	246	2.6	66.5	1.4	2.1 ± 0.15	35.0	0.28
corn	216	199	206	3.2	71.5	0.9	1.8 ± 0.15	27.1	0.18
canola	595	293	243	5.4	58.4	1.0	3.5 ± 0.20	36.2	0.07
soybean	257	246	205	3.4	55.8	1.1	1.7 ± 0.081	16.4	0.10
palm	1392	232	194	18.9	59.4	9.3	1.3 ± 0.064	107.5	0.16

^aMass concentrations when black lights were turned on. ^bAs measured by a chemiluminescence NO_x monitor. Note the interference of HONO in NO_x measurements. ^cThe concentration of POA was determined after the introduction of emissions from heated cooking oils. ^dThe wall-loss-corrected concentration of SOA was determined at the end of the experiment. For peanut, corn, canola, and soybean oils, the $\omega = 1$ method^{41–43} was used to correct particle wall loss. For sunflower, olive, and palm oils, the $\omega = 0$ method^{41,42} was used.

>90% of the global consumption of vegetable oils.²⁸ All experiments were conducted at 25 °C and a relative humidity (RH) of <5%. Ammonium sulfate (AS) seed particles were introduced into the chamber by an atomizer followed by a diffusion dryer. These seed particles, which had a geometric mean diameter of approximately 120 nm, served as condensation sinks to reduce organic vapor wall loss.²⁹

After the injection of seed particles, 250 mL of vegetable oil was heated at approximately 200 °C, which is below the smoke point of all of the oils studied and representative of typical cooking temperatures,^{30,31} for 1–1.5 h in a 500 mL flask in a dimethyl silicone oil bath. Emissions were introduced into the chamber via an air stream passing through a 2 m Teflon tube heated to 70 °C. The residence time in the transfer line was <1 s, resulting in particle number wall losses of <3%, according to Liu et al.³²

Nitrous acid (HONO) was then introduced into the chamber as a source of hydroxyl radical (OH) following the methods of Ng et al.³³ The initial ratio of non-methane organic gases (NMOGs) to NO_x (NMOG:NO_x) typically fell between 2.6 and 5.4 ppbC:ppb, except for the palm oil experiment, in which it measured 18.9 ppbC:ppb. These ratios were higher than the typical urban level of ~3.³⁴ After all gases and particles had been well mixed, the emissions were exposed to black lights (60 W Philips/10R BL, Royal Dutch Philips Electronics Ltd., Amsterdam, The Netherlands) for 2.0–4.5 h. A control experiment without emissions from heated cooking oils was also conducted to characterize the contribution of matrix gases and residual pollutants in the transfer line between the oil flask and the chamber, and the concentration of SOA formed in this experiment was <0.1 μg m⁻³.

2.2. Characterization of Gas- and Particle-Phase Chemical Compositions. NMOGs were sampled through a heated line (70 °C) followed by a filter to remove particles and characterized using a commercial proton-transfer-reaction time-of-flight mass spectrometer (PTR-TOF-MS, model 2000, H₃O⁺ reagent ion, Ionicon Analytik GmbH, Innsbruck, Austria).^{35,36} The observed NMOG masses were assigned to the most likely compounds on the basis of online and offline analyses of NMOG emissions from heated cooking oils.^{14–16,37} Fragmentation patterns of aldehydes were estimated from literature data^{16,38} and applied to the fragmentation corrections (Table S1). More detailed descriptions of operation conditions, calibrations, and fragmentation corrections are provided in the Supporting Information. Chamber OH concentrations were determined from the decay of acrolein or heptenal^{21,26} (Figure S1; see the Supporting Information for details).

A scanning mobility particle sizer (SMPS, TSI Inc., classifier model 3080, CPC model 3775) was used to measure particle number concentrations and size distributions. Nonrefractory components, including organics, nitrate, sulfate, and ammonium, were chemically characterized using a high-resolution time-of-flight aerosol mass spectrometer (hereafter AMS, Aerodyne Research Inc.)³⁹ (see the Supporting Information for further details). Using the method of Farmer et al.,⁴⁰ we found that all nitrates formed were organic nitrates in our experiments.

2.3. Data Analysis. Particle wall loss is typically corrected by assuming that organic vapors condense solely on suspended particles ($\omega = 0$)^{41,42} or remain in equilibrium with both wall-bound and suspended particles ($\omega = 1$).^{41–43} The $\omega = 1$ method was used for experiments involving OA internally mixed with AS seed particles (peanut, corn, canola, and soybean oil experiments). The wall-loss-corrected SOA concentration was calculated using the following equation:

$$[\text{SOA}]_t = \frac{[\text{OA}]_{\text{sus},t}}{[\text{AS}]_{\text{sus},t}} [\text{AS}]_{\text{sus},0} - [\text{OA}]_{\text{sus},0} \quad (1)$$

where $[\text{OA}]_{\text{sus},t}$ and $[\text{AS}]_{\text{sus},t}$ are the concentrations of suspended OA and AS seed particles, respectively, measured by the AMS at time t . $[\text{OA}]_{\text{sus},0}$ and $[\text{AS}]_{\text{sus},0}$ are the concentrations of suspended OA and AS seed particles at the time when the black lights were turned on, respectively, and these values were determined from the particle volume concentration measured by the SMPS and the ratio of $[\text{OA}]_{\text{sus},0}$ to $[\text{AS}]_{\text{sus},0}$ measured by the AMS. Densities of 1.77 g cm⁻³,³³ 1.0 g cm⁻³,²¹ and 1.4 g cm⁻³,²⁰ were assumed for AS, POA, and SOA, respectively, for the conversion of particle volume to mass. For the $\omega = 0$ method, the particle wall loss rate constant was determined by fitting an exponential decay to the SMPS volume concentration for the period after SOA production completed. This wall loss rate constant was then applied to the entire experiment to correct for particle wall loss.⁴² Application of the $\omega = 0$ method to these same experiments yielded a <10% difference in the wall-loss-corrected SOA concentrations compared with those of the $\omega = 1$ method. This small difference is similar to that reported by Chacon-Madrid and Donahue⁴⁴ and Trump et al.⁴⁵ for fast oxidation of long-chain *n*-alkanes, *n*-ketones, *n*-aldehydes, and α -pinene. For the other experiments, in which OA was externally mixed with AS seed particles (sunflower, olive, and palm oil experiments), the $\omega = 1$ method cannot be used.⁴² Because the use of $\omega = 1$ and $\omega = 0$ methods did not yield significant differences in the internal mixture experiments