Supporting Information

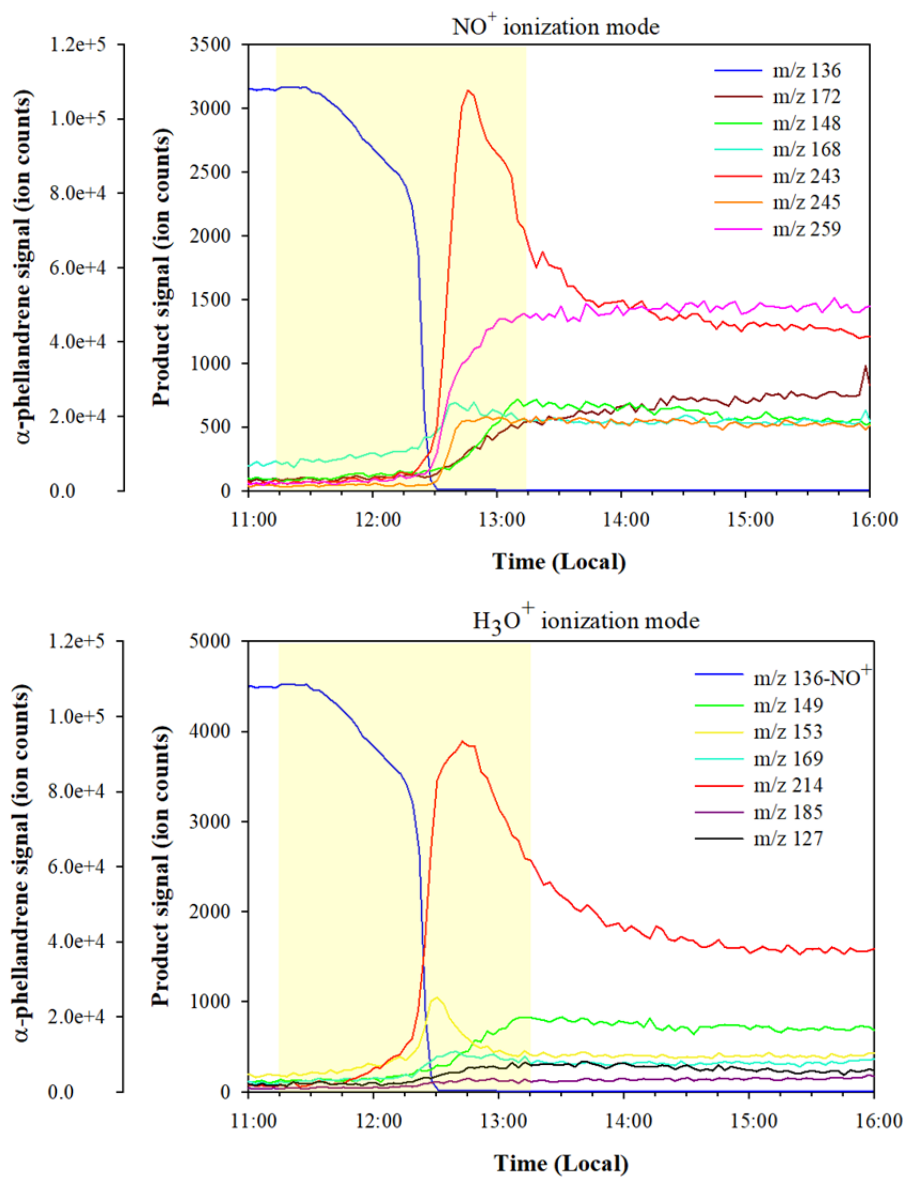



Figure S1: Example of typical time profiles of α-phellandrene and products detected with PTR-ToF-MS (NO⁺ and H₃O⁺ ionization modes) for the experiment of 06/03/2021. The N₂O₅ injection period is shown by the yellow area.

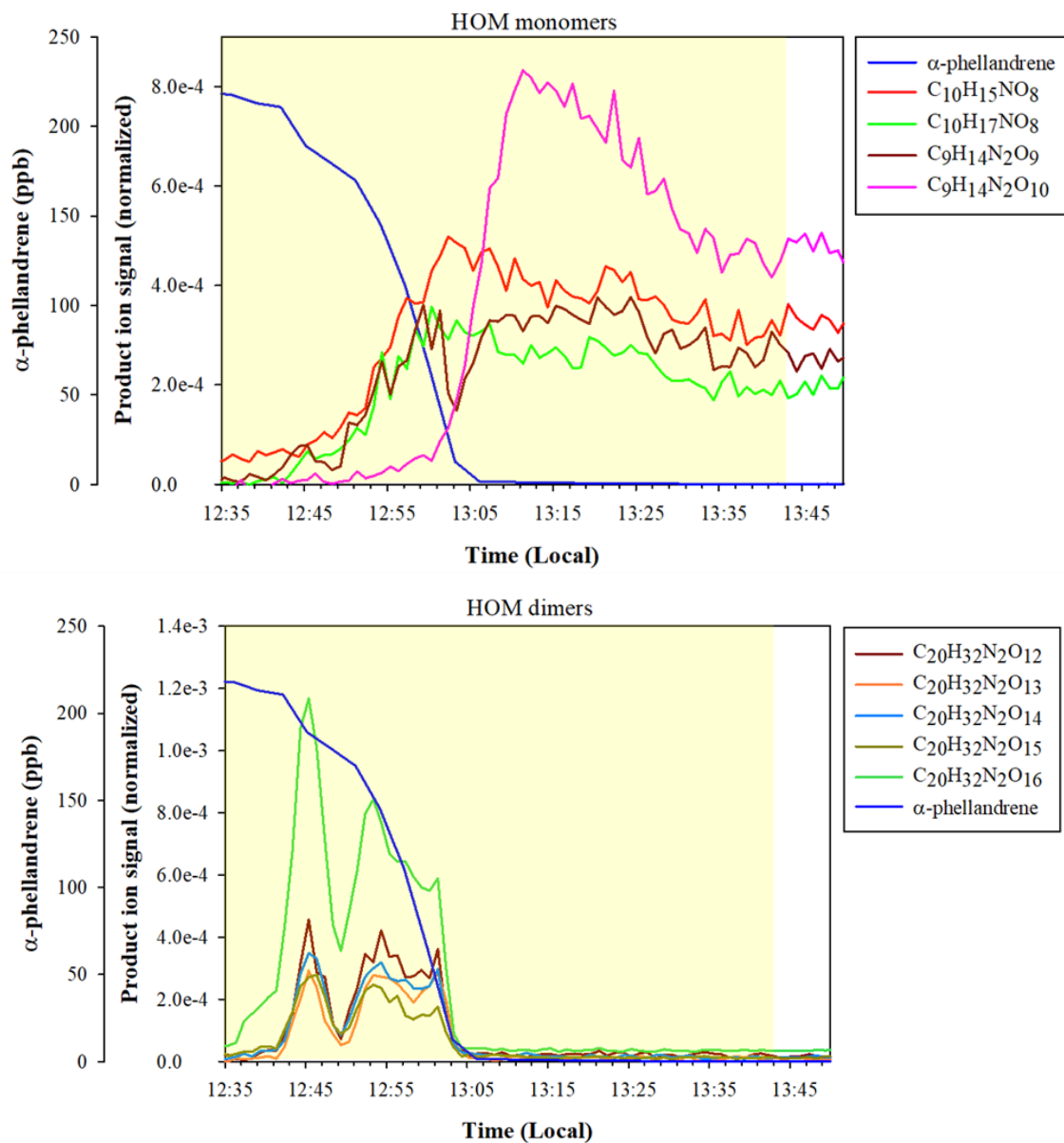



Figure S2: Time profiles of a selection of gas-phase HOM monomers and dimers produced by the oxidation of α-phellandrene by NO₃ radical (experiment 06/02/2021). The N₂O₅ injection period is shown by the yellow area.

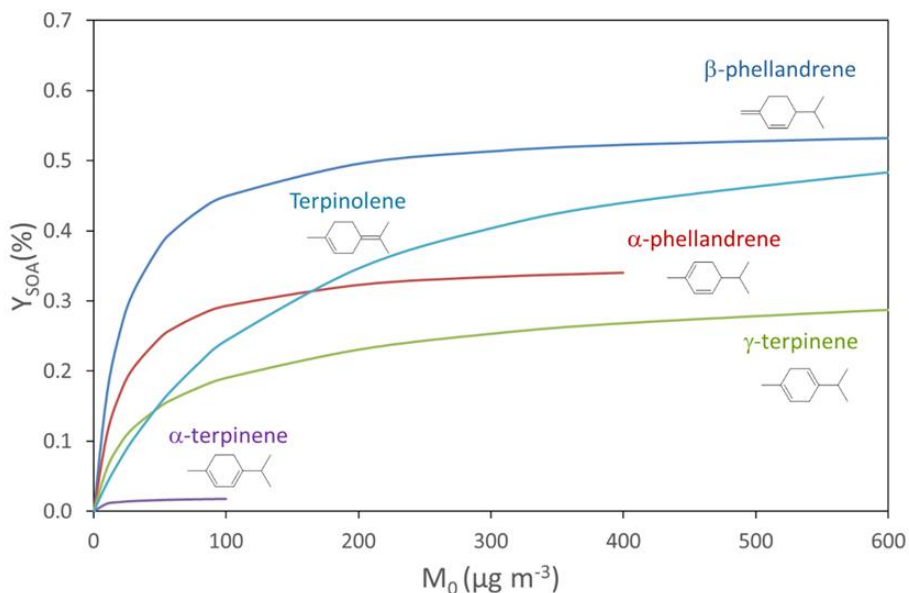



Figure S3: Odum parametrization describing the dependence of the SOA yields with the aerosol content (in µg/m³) for α- and β-phellandrenes (this study), α- and γ-terpinenes (Fouqueau et al., 2020) and terpinolene (Fouqueau et al., 2022).

Table S1: Products detected by PTR-ToF-MS in H₃O⁺ and NO⁺ ionization modes for the oxidation by NO₃ radical of α- and β-phellandrenes: raw formula, molecular weight, detected mass, ionization process (H⁺ as proton adduct; NO⁺ as NO⁺ adduct; CT as charge transfer), and behavior.

Molecule		H₃O⁺ ionization mode			NO⁺ ionization mode		
Raw formula	M (g mol⁻¹)	m/z	Process	Behavior	m/z	Process	Behavior
α-phellandrene							
C_3H_6O	58	59.0383	H⁺	Primary-Secondary	88.0268	NO⁺	Primary-Secondary
$C_3H_4O_2$	72	73.0133	H⁺	Secondary	102.0035	NO⁺	Secondary
$C_7H_{10}O_2$	126	127.0457	H⁺	Secondary	/	/	/
$C_7H_{12}O_2$	128	129.0452	H⁺	Secondary	/	/	/
$C_5H_{10}O_4$	134	/	/	/	164.0281	NO⁺	Secondary
$C_7H_{10}O_3$	142	/	/	/	172.0275	CT	Secondary
$C_6H_{12}O_4$	148	149.0441	H⁺	Secondary	148.0484	CT	Secondary
$C_{10}H_{16}O$	152	153.0848	H⁺	Primary	/	/	/
$C_{10}H_{16}O_2$	168	169.0742	H⁺	Primary	168.0816	CT	Primary
$C_{10}H_{16}O_3$	184	185.0637	H⁺	Secondary	/	/	/
$C_{10}H_{15}NO_4$	213	214.0419	H⁺	Primary	243.0469	NO⁺	Primary

$C_{10}H_{15}NO_5$	229	230.0278	H^+	Primary	259.0345	NO^+	Primary
$C_{10}H_{15}NO_6$	245	/	/	/	245.0431	CT	Secondary
β-phellandrene							
C_3H_6O	58	59.0365	H^+	Primary	88.0198	NO^+	Primary
$C_7H_{12}O_2$	128	129.0438	H^+	Secondary	128.0340	CT	Secondary
$C_5H_{10}O_4$	134	/	/	/	164.0050	NO^+	Secondary
$C_3H_3NO_5$	133	/	/	/	163.9707	NO^+	Secondary
$C_9H_{14}O$	138	139.0622	H^+	Primary	/	/	/
$C_6H_{12}O_4$	148	149.0394	H^+	Primary	/	/	/
$C_{10}H_{16}O$	152	153.0670	H^+	Primary	/	/	/
$C_{10}H_{16}O_2$	168	169.0610	H^+	Primary	168.0551	CT	Primary
$C_9H_{13}O_3$	170	171.0396	H^+	Secondary	/	/	/
$C_{10}H_{15}NO_4$	213	214.0263	H^+	Primary	/	/	/
$C_{10}H_{15}NO_5$	229	230.0278	H^+	Detected	/	/	/

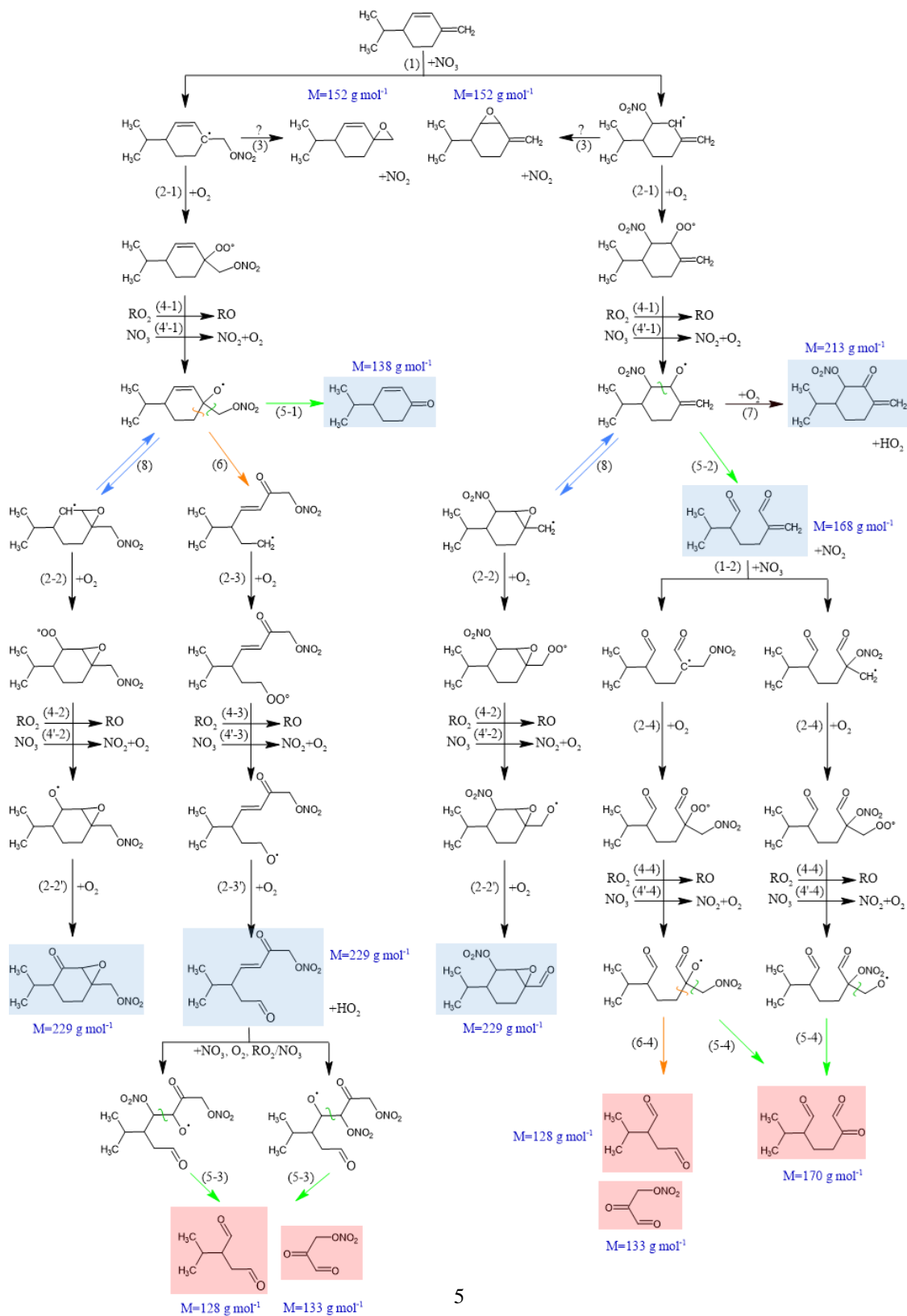



Figure S4: Proposed mechanism for the reaction β-phellandrene+NO₃. First-generation products are colored in blue, and second-generation ones are colored in red.

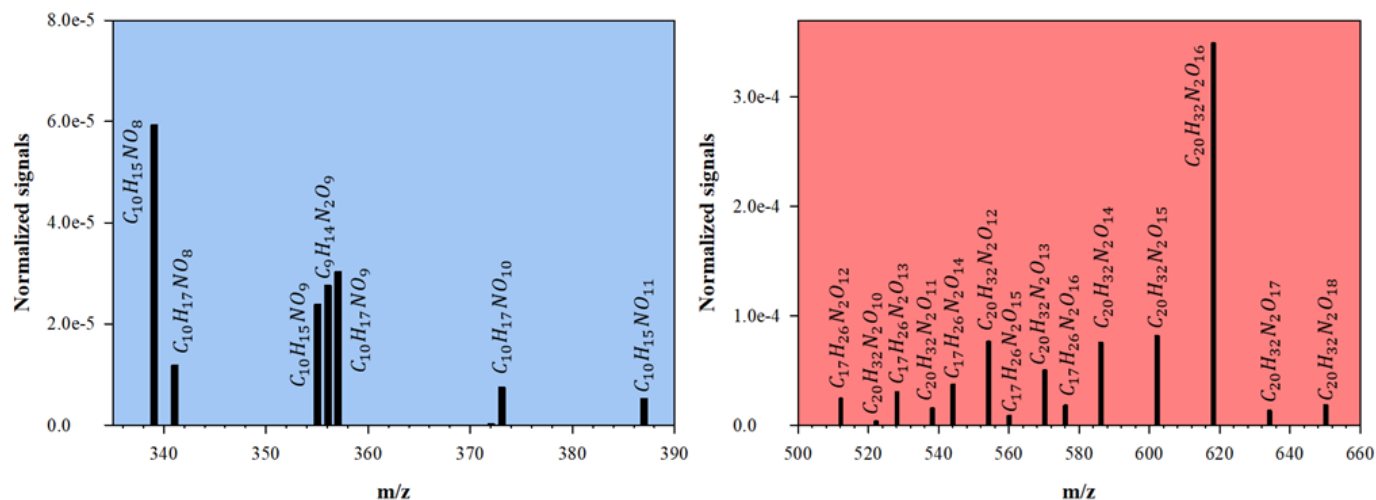



Figure S5: Average mass spectra of gas-phase HOMs for the NO₃-oxidation of α-phellandrene (average performed over 10 min following the start of the oxidation - experiment 02/06/2021). Labels display raw formulas of detected species, excluding the nitrate reagent ion cluster, but the *m/z* values (x-axis) include the nitrate mass (61.9883 *m/z*). Product signals are normalized to the reagent ion signals.

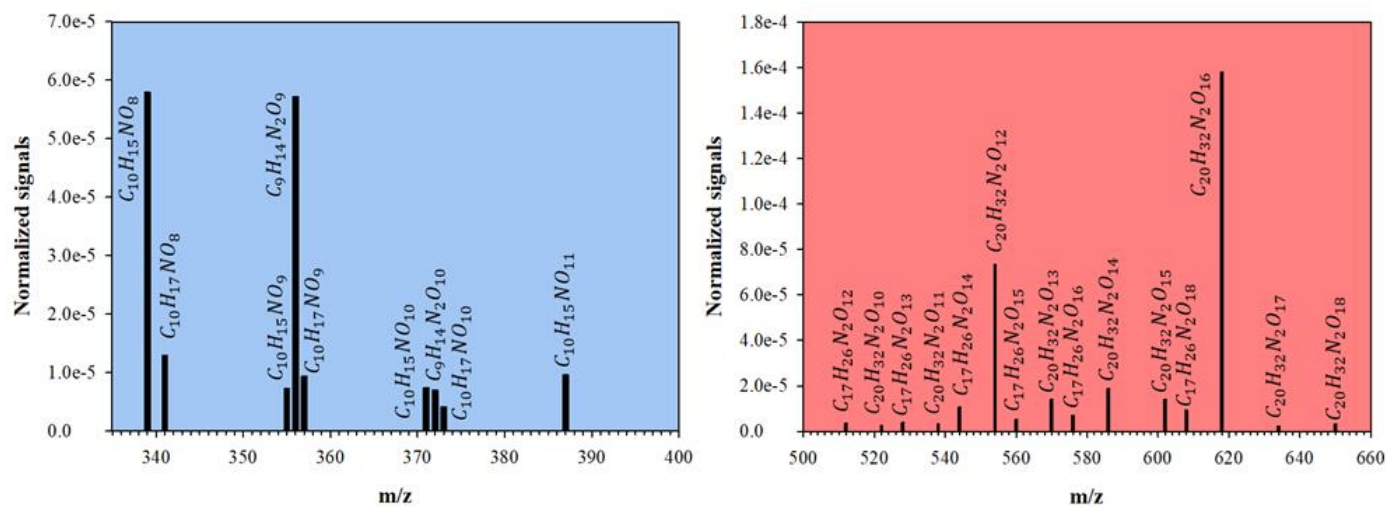



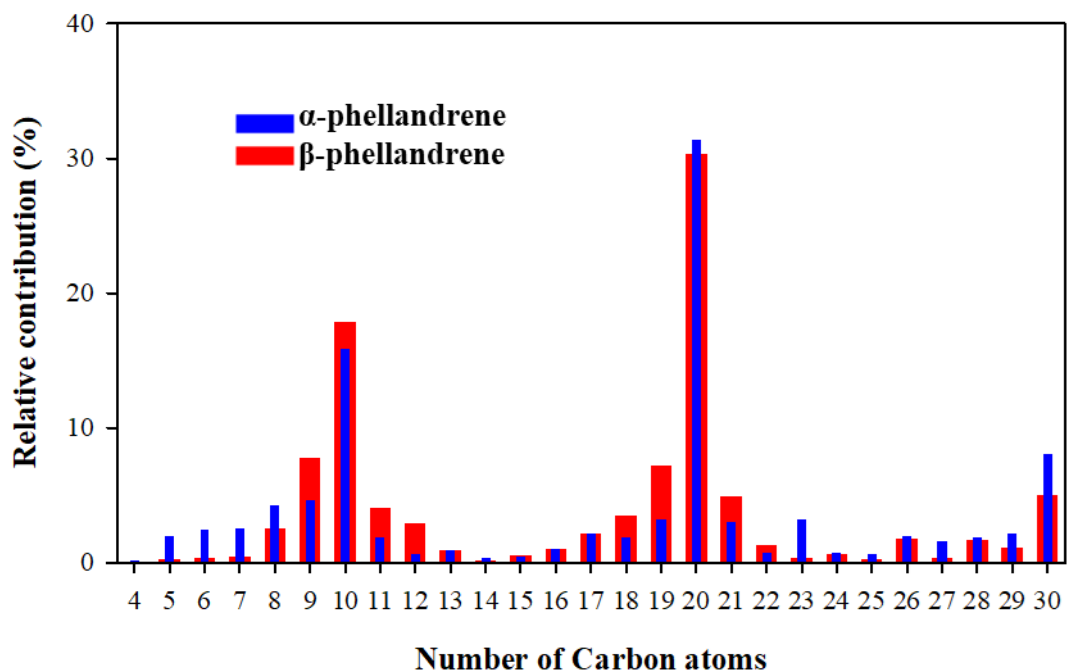
Figure S6: Average mass spectra measured of gas-phase HOMs for the NO₃-oxidation of β-phellandrene (average performed over 10 min following the start of the oxidation – experiment 03/24/2021). Labels display raw formulas of detected species, excluding the nitrate reagent ion cluster, but the *m/z* values (x-axis) include the nitrate mass (61.9883 *m/z*). Product signals are normalized to the reagent ion signals.

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Figure S7. Distribution of the products detected in the aerosol phase as a function of the number of carbon atoms, for α- and β-phellandrenes.