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The oxidation of oleic acid and oleic acid/NaCl(aq) mixture droplets with ozone: the changes of hygroscopicity and the role of secondary reactions

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The heterogeneous reactions of millimeter-sized oleic acid and oleic acid/NaCl(aq) mixture droplets with ozone are studied at different relative humilities (RH) by using attenuated total reflectance infrared spectroscopy (ATR-IR). The ozone concentration profiles are monitored by UV-VIS spectrometry. In the oleic acid case, the ATR-IR spectra at high RH (90% in this study) show that the hydrophobic oleic acid droplets can uptake water slightly as they are exposed to ozone. For internally mixed oleic acid/NaCl(aq) droplets, the oleic acid outer layer on the droplet inhibits the water uptake of NaCl(aq) when RH is increased from 80% to 90%. However, the liquid water content of oleic acid/NaCl(aq) mixture droplets increases initially and then decreases significantly when they are exposed to ozone at RH = 90%. The observed decrease of the water content during the oxidation process indicates that either the hygroscopic properties or the growth factors of the droplets are reduced as the oxidation products of oleic acid present simultaneously with NaCl. The ozone profiles recorded by UV-VIS spectrometry for all cases show that the number of consumed ozone molecules is less than 50% of the oleic acid molecules. The results indicate that the secondary reactions of oleic acid attacked by the oxidation intermediates on the double bond of oleic acid might significantly reduce the ozone uptake by the droplets. In this study, the observed ozone profile can only be simulated well by a kinetic model when the secondary reactions are included. Overall, this study shows that the oxidation of oleic acid droplets by ozone is a complicate process and the products can change the water content of pre-existing aerosol and further modify the direct radiative forcing of aerosols.