Formation of secondary organic aerosols from biogenic precursors: A case study over an Isoprene emitting forest.

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Abstract

As part of the Chemistry-Aerosol Mediterranean Experiment (CHARMEX) experiment in July 2014, a series of aerosol and gas phase measurements were deployed aboard ATR-42 research aircraft. Research flights were performed over the Mediterranean Sea as well as over a number of forested regions in the south of France. A compact time of flight aerosol mass spectrometer (C-ToF-AMS) and a proton transfer mass spectrometer was used to characterise aerosol and gas-phase chemical properties. Gas-phase concentrations of O_3, NO_X, and CO were additionally measured. Complementary to chemical characterization of the air mass, several physical properties were measured including aerosol size distributions using a scanning mobility particle sizer (SMPS) and off line filter analysis. The non-refractory species measured by the C-ToF-AMS instrument were dominated by organic species (72%) followed by ammonia and sulphate aerosols (25%), the contribution from nitrate species were on average < 5%. Measurements of non-refractory species from off-line transmission electron microscopy (TEM) were coherent with the C-ToF-AMS instrument, and showed that 35% of the organic aerosol was externally mixed and 15% of the sulphate particles were externally mixed. Only about 10% of the measured aerosols were internally mixed. Measurements of refractory species from TEM analysis showed a significant contribution of sea salt species and dust particles depending on the air mass trajectory. Positive matrix factorization analysis of the organic mass spectra measured by the C-ToF-AMS identified two different types of oxidised organic aerosol (MOOA, LOOA). MOOA is associated with inorganics species and is more oxidised than LOOA. LOOA, not associated with inorganic species, correlates better with biogenic volatile organic species. Using the combination of both aerosol and gas-phase measurements, the formation of SOA from biogenic precursors is observed. We observe increases in the organic aerosol as a function of the photochemical age of the air mass (provided by the measured VOC species). These results provide a suitable case study that can be used to validate numerical models and to understand the formation of SOA far from source regions and over forested regions.