Rethinking organic aerosol sources in Greece

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Abstract

Organic aerosol (OA) constitutes a major fraction of the submicron aerosol mass in the atmosphere (up to 80%). Transportation sources have been traditionally assumed to be its major sources especially in urban centres. In order to explore the OA sources and their contribution in Greek cities, field campaigns were conducted in Athens and Patras covering both winter and summer seasons. 18-65% of the OA was attributed to oxygenated OA. Surprisingly fresh transportation OA accounted only for 7-17% of the OA, indicating that new emission control technologies applied to the vehicles during the last decade have reduced the levels of the corresponding primary particulate pollutants. During the winter, biomass burning OA contributed significantly (40-60%) as a result of the crisis, which turned Greeks to more traditional ways of residential heating, such as fireplaces and pellet stoves. However, during our campaigns a number of additional relatively unexpected OA sources were detected.

Biogenic secondary OA was identified during the summer in Patras contributing 21% of the OA. This biogenic OA was related to air masses passing over the forested mountains of Central Greece, an area characterized by high terpene and isoprene emissions. Cooking OA, associated with meat charbroiling, accounted for 11-17%, while on Fat Thursday at Patras its fraction reached up to 85% from 10:00 to 12:00. Olive tree branches burning OA was detected during the olive tree burning season (November-February) at Patras with an average contribution of 34%. Burning of olive tree branches is a common agricultural waste management technique after the pruning of olive trees around the Mediterranean and thus it is an important source in the Greek and the Mediterranean Area during the winter months.

Experiments in the ICE-HT environmental chamber were performed in order to characterize the two additional anthropogenic sources identified in the field. Meat charbroiling and olive tree branches burning direct source-sampling experiments were conducted. We used a suite of instrumentation for the measurement of both particle and gas phase species. The mass spectrum of the meat charbroiling after a degree of oxidation resembles the corresponding spectrum found in the field, but it is different compared to the cooking OA factors found in other cities (e.g., Paris and Barcelona). The chamber olive tree branches burning spectrum was also close to the corresponding ambient factor, while it differs from other biomass burning OA spectra, mainly due to the very low levoglucosan contribution.