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Sugars in atmospheric aerosols over the Eastern Mediterranean

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Abstract The role of biomass combustion and primary bio-particles in atmospheric PM_{10} aerosols in the Eastern Mediterranean over a two-year period was estimated by studying sugar tracers. Sugar concentrations ranged from 6 to 334 ng m^{-3}, while their contributions to the organic carbon (OC) and water soluble organic carbon (WSOC) pools were 3 and 11%, respectively. Over the studied period, glucose and levoglucosan were the two most abundant sugars accounting equally about 25% of the total sugar concentration in PM_{10} aerosols whereas fructose, sucrose, and mannitol represented 18%, 15% and 10%, respectively.

Primary saccharides (glucose, fructose, and sucrose) peaked at the beginning of spring (21, 17 and 15 ng m^{-3}, respectively), indicating significant contributions of bioaerosols to the total organic aerosol mass. On the other hand, higher concentrations of anhydrosugars (burning biomass tracers including levoglucosan, mannosan and galactosan) were recorded in winter (19, 1.4 and 0.2 ng m^{-3}, respectively) than in summer (9.1, 1.1 and 0.5 ng m^{-3}, respectively). Levoglucosan was the dominant monosaccharide in winter (37% of total sugars) with less contribution in summer (19%) probably in relation with enhanced photochemical oxidation reactions by hydroxyl (·OH) radicals impacting anhydrosugars. We estimate that atmospheric oxidation by ·OH decreases levoglucosan levels by 54% during summer.

Biomass burning, based on levoglucosan observations, was estimated to contribute up to 13% to the annual average OC measured at Finokalia. Annual OC, WSOC, and carbohydrate dry deposition fluxes for the studied period were estimated to 414, 175, and 9 mg C m^{-2} y^{-1}, respectively. Glucose and levoglucosan accounted for 34% and 2% of the total sugar fluxes. According to our estimations, atmospheric OC and WSOC inputs account for ∼0.70% of the carbon produced by annual primary production (PP) in the Cretan Sea. Considering the entire Mediterranean, dry deposition of OC could provide at least 3 times more C than the riverine inputs of the Rhone River. Carbohydrate dry deposition fluxes represented ∼0.04% of the C used for the PP in the Cretan Sea, and <0.01% for the entire Mediterranean basin. OC and WSOC contributions in the order of 0.33% and 0.14% for the whole basin further underline the significant role of the atmosphere in the carbon cycle of the Mediterranean Sea.

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