

Seasonal variability in biomass and primary production in the Eastern Mediterranean Sea, determined by saccharidic tracers in atmospheric aerosols

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The role of biomass combustion and primary bioparticles in atmospheric aerosol in the Eastern Mediterranean was estimated by studying saccharidic tracers. Primary saccharides (arabinose, galactose, glucose, manose, fructose and sucrose), sugar alcohols, and anhydrosugars (xylitol, levoglucosan, sorbitol, mannitol, mannosan and galactosan) were simultaneously measured in PM₁₀ filters using high-performance anion-exchange chromatography (HPAEC) with pulsed amperometric detection (PAD).

In order to assess their sources and seasonal variations in the marine boundary layer of the Eastern Mediterranean, ambient aerosols samples were collected at the remote background site of Finokalia, Crete. PM₁₀ samples were collected on Quartz filters (QMA, 47mm, Whatman and Flex Tissuquartz, 2500QAT-UP 47mm, Pall) at the rural site on a daily basis during the period April 2009 to March 2010 and during 2013. Sugar analyses were performed for a total of 220 samples (135 in 2009-2010 and 85 in 2013). Moreover, a complete chemical analysis was performed in the aforementioned samples including anions (Cl⁻, Br⁻, NO₃⁻, HPO₄²⁻, SO₄²⁻ and C₂O₄²⁻), cations (Na⁺, NH₄⁺, K⁺, Mg²⁺ and Ca²⁺), organic carbon (OC), elemental carbon (EC), and water soluble organic carbon (WSOC).

Results

Finokalia is a maritime background site with limited local emission sources. Under the influence of the continental outflow in winter, higher abundances of anhydrosugars in Eastern Mediterranean aerosols were observed. This may be related to long-range transport of biomass burning emissions in conjunction to an increase lifetime of levoglucosan (Simoneit et al., 1999). The seasonal variation of levoglucosan, a key tracer of biomass burning, is depicted in Fig. 1.

In contrast to levoglucosan, sucrose and glucose were more abundant in the coarse fraction of aerosols organic matter exhibiting spring/summer maxima and winter minima. This seasonal variation further reflects their continental source, given the fact that they are marker compounds for fugitive dust from biological active surface soils.

The relative ratio of levoglucosan to mannosan used for source reconstruction of combustion derived byproducts in atmospheric aerosols was equal to

approximately 11, suggesting hardwood as the main source in Finokalia.

A positive correlation of levoglucosan and mannosan with nssK⁺, another typical biomass burning tracer, is an indicative that they derive from similar emission sources. Moreover, the K⁺/OC ratio of 0.06 for Finokalia, suggests that most of the particulate organic carbon in the region is of continental origin, thus an indication of biomass combustion.

Finally it was estimated that the subtotal of all 12 determined sugars was an important water-soluble organic constituent of atmospheric particulate matter, contributing approximately 11% of WSOC levels. Additionally, the 12 sugars studied comprised about 4% of organic carbon. The highest contributions for both WSOC and OC were observed during winter.

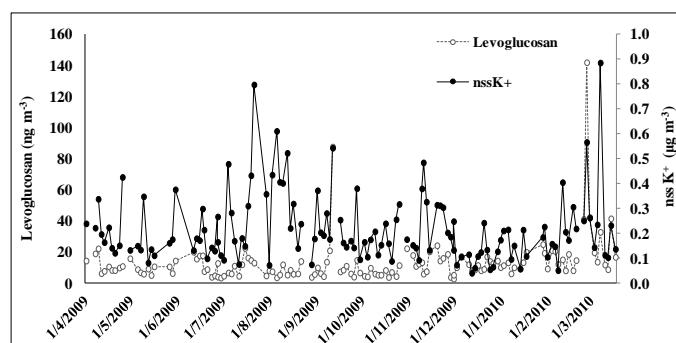


Figure 1. Time series of levoglucosan and nssK⁺.

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