Thermal-optical analysis of elemental carbon (EC) in environmental samples – differences observed when using various protocols

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Several methods are used nowadays for assessing of elemental- and organic carbon (EC, OC) in the atmospheric samples. Their classification and selection depends on the principle of the measurement (e.g., thermal, optical) and furthermore also on the type (e.g., solid, liquid, gaseous), quality and quantity of the sample. Due to basic differences a comparison between methods need not result in perfect agreement, especially when analyzing environmental samples. More demanding is the task, that it was already noticed that even the same method reveals often not uniform resuts, depending on applied settings (e.g., Baumgardner *et al.*, 2012)

Thermal-optical carbon analysis is a standard method applied and recommended for analysis of EC and OC in atmospheric aerosols collected on filter media. For this purpose several protocols (IMPROVE, NIOSH 5040, EUSAAR2, NIOSH-like protocols - e.g., *quartz.par*) are available (Chow et al., 1993, Birch and Cary, 1996, Cavalli et al., 2009). Applying of different temperature steps with varying length and a diverse optical correction mode (transmission or reflection mode) might significantly affect the result.

With relation to the samples presented below following analytical questions are to be answered:

- How do pure wood burning emission PM10 behave during EC-OC analysis with different protocols?
- How do ambient particulate matter with a significant wood combustion PM10 behave during EC-OC analysis with different protocols?
- Which factors influence the observed differences (if any)?
- How could the choice of the protocol for analysis be simplified?

Wood burning emission samples (PM10) have been taken during stove tests conducted at TU Vienna (AQUELLIS FB Project, Schmidl *et al.*, 2008). Particles were sampled from a dilution exhaus on quartz fibre filters (Pall, 47mm), using Low-Vol PM10 separators (~1m³/h). The samples were highly loaded (3-5 mg/filter) with dark brown or black particles. Another set of emission samples was collected at Bioenergy 2020+. Again particles were sampled on quartz fibre filters (Pall, 47 mm) and were chosen to reflect different conditions of wood burning. Filters showed lower mass loadings during this smpling campaign.

Ambient air particulate matter (PM10) samples were collected on quartz fibre filters (Pallflex, 150 mm) with Hi-Vol samplers (~30m³/h) during winter (February 2011) and summer (July 2011) campaigns conducted in Austria and Slovenia (PMinter Project, Kistler *et al.*, 2013).

The winter samples were highly concentrated with dark brown/black loadings exceeding 35 mg/filter. Summer sample loadings were only about 10 mg/filter with no visible soot (grey dust).

Measurements of EC and OC in both ambient air and emission samples were conducted with an Sunset Laboratory Lab OCEC Analyser using EUSAAR2 and *quartz.par* temperature protocols. Measurements with *quartz.par* method were additionally evalueted in reflectance mode.

Aditional analyses of the filters (inorganic ions, saccharides, HULIS (humic like substances), selected elements) were performed and are available to gain a general chemical characteristic of the samples.

Among ambient air samples the problem of overloading did not occur. Nevertheless the agreement between results for measurement with both protocols was not constant. In several cases (concerning whole measurement series) EC differ more than 3 times, showing an evident coherrence with factors describing the collected aerosol (age and chemical composition).

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