Performance of the new continuous carbonaceous aerosol measurement system FATCAT during long term unattended measurement campaigns

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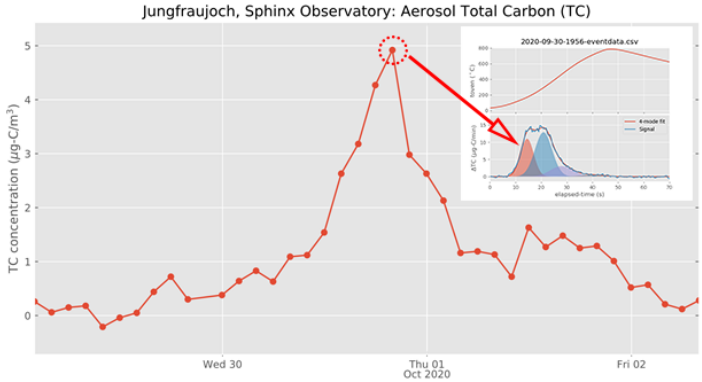
Total aerosol carbonaceous mass (TC) is a major constituent of atmospheric fine aerosol particle mass. However, this fraction is generally not continuously monitored with an adequate time resolution. Adding a TC measurement is crucial to complement the existing measurement programs for a comprehensive interpretation impact of aerosols on our climate. To fill this gap, we developed the “fast thermal carbon totalizator” (FATCAT), a carbonaceous aerosol measurement system for long-term monitoring of TC. FATCAT has been deployed since 2019 at different measurement sites, including Zurich (urban roadside), Windisch (urban background), Payerne (suburban background), and the Sphinx observatory at the Jungfraujoch global GAW station (JFJ; above the planetary boundary layer) for unsupervised long-term measurement campaigns. FATCAT collects a sample on a sinter metallic filter, and subsequently heats it to 800°C under an oxidizing atmosphere. The fast-heating cycle of 50 seconds allows a low limit of detection (LoD) of 0.2 µg of carbon (µg-C).

We will discuss our experience during the first two year of continuous TC measurements and the possibility of using our instrument to distinguish carbonaceous aerosol from different source using its fast thermograms. This unique feature allows us to identify source specific fingerprints. For instance, several high TC episodes during September 2020 at the JFJ station show the typical pattern for biomass combustion. With the identified fingerprint and back trajectories, these episodes were attributed to long-range transported emissions from Californian wildfires (see figure). In general, refractory, crystalline carbon from, e.g., fossil fuel combustion evolves at high temperatures, whereas aerosol particles from, e.g., biomass burning sources containing more amorphous organic carbon decompose and evolve at lower temperatures. The dataset generated by our instrument and post-analysis data products represent an improvement to the available measurement inventory. It can also serve as quality control for other measurement systems. Prominently, measurements of eBC via MAAP or Aethalometer and organic mass using ToF-ACSM require calibration and are susceptible to systematic errors. TC measurement data can be used in parallel for these devices as a quality check but also to warrant total carbon mass closure and reduce systematic biases.



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