Optical and thermal measurements and source apportionment of TC, BC, OC, EC and CM with high time resolution

NEW METHOD

We present newly developed TC-BC method, which combines an optical method for measuring black carbon (BC) by the Aethalometer AE33, and a thermal method for total carbon (TC) determination by the Total Carbon Analyzer TCA08 which can be used to apportionment sources of carbonaceous aerosols in real time with high time resolution. TC-BC method determines organic carbon (OC) fraction of carbonaceous aerosols as:

\[ OC = TC - b \cdot BC, \]

where \( b \cdot BC \) is equivalent to elemental carbon (EC) and the determined proportionality parameter \( b \) is region/site specific but also depends to a large extent on a thermal protocol used to determine the EC fraction with the conventional OC/EC method.

TOTAL CARBON ANALYZER

The TCA-08 Total Carbon Analyzer instrument uses a thermal method for total carbon (TC) determination. The instrument has two parallel flow channels with two chambers, which can be used either for sampling either for thermal analysis. While one channel is collecting its sample for the next time-base period, the other channel is analyzing the sample collected during the previous period.

After collection on the filter, heating modules, that consist of housing and nickel-chrome wire, above and under the quartz filter heat the sample almost instantaneously in a small flow of filtered ambient air. This produces almost complete combustion of all carbonaceous compounds into \( CO_2 \), which creates a short-duration, but large-amplitude pulse of \( CO_2 \) passed to a detector. Since the amount of \( CO_2 \) produced is large compared to the internal volume of the system, the transient concentration of \( CO_2 \) greatly exceeds the ambient-air baseline for the brief duration of the pulse. This means that ambient air may be used as the carrier gas. The \( CO_2 \) concentration over baseline is accurately measured and integrated to give the Total Carbon content of the sample.

CAMPAIGN

- Ljubljana basin (SLO)
- Population 500,000
- Urban background location
- 07 Feb - 10 Mar 2017, 31 days

RESULTS

METHOD COMPARISON

- NEW METHOD
  \( OC = TC - b \cdot BC \)

- NEW INSTRUMENT
  Total Carbon Analyzer TCA-08

- EQUIVALENCE
  SOP: Ljubljana Winter 2017 Campaign

- HIGH RESOLUTION APPLICATIONS
  ACSM/AMS calibration, diurnal profiles

CONCLUSIONS and FUTURE WORK

1. NEW METHOD
   \( OC = TC - b \cdot BC \)

2. NEW INSTRUMENT
   Total Carbon Analyzer TCA-08

3. EQUIVALENCE
   SOP: Ljubljana Winter 2017 Campaign

4. HIGH RESOLUTION APPLICATIONS
   ACSM/AMS calibration, diurnal profiles

GLOBAL CAMPAIGN:
Ljubljana (SLO), Zürich (CH), Magadino (CH), Beijing (CN), New Delhi (IN), Ložki Potok (SLO), London (UK), Milano (IT), Paris (FR), LA (USA)...

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NEW INSTRUMENT - Equivalent

22nd ETH-Conference on Combustion Generated Nanoparticles, June 18th - 21th, 2018 at ETH Zurich, Switzerland