

¹³C- and ¹⁴C- based sources apportionment of submicron carbonaceous aerosol particles in Vilnius, Lithuania

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The effects of aerosols on the atmosphere, climate, and public health are among the central topics in the current environmental research. Submicron aerosol particles (PM₁) contain a substantial fraction (up to 70%) of carbonaceous species. Road traffic, industrial and biomass burning processes are significant sources of direct emissions of carbonaceous particulate matter in the urban environment.

Different approaches can be used to identify carbonaceous aerosol sources. Radiocarbon (¹⁴C) analysis allows distinguishing between fossil and contemporary (biomass burning or biogenic) sources of carbonaceous aerosol. Furthermore, different aerosol sources also have a specific stable carbon isotopic composition (¹³C/¹²C) (Ceburnis et al., 2011).

The main objectives of this study were to distinguish and quantify carbonaceous aerosol particles sources by measuring ¹⁴C/¹²C and ¹³C/¹²C isotope ratios and to estimate aerosol burden due to long-range atmospheric transport in Vilnius.

The measurements were performed from 2014.10.27 to 2015.01.19 in Vilnius (Lithuania). The sampling site is located in the vicinity of Vilnius at the Institute of Physics (54° 64' N, 25° 18' E). The sampling location is situated in a grove and surrounded by the grassland about 10 km west of the city centre.

The samples of PM₁ were taken using the high volume aerosol sampler (Digital AG, DH-77). Aerosol samples were analyzed for total carbon (TC) contents and their isotopic compositions – using an elemental analyzer (EA, FlashEA 1112) connected to the stable isotope ratio mass spectrometer (IRMS, ThermoFinnigan Delta Plus Advantage). Sample preparation for the ¹⁴C(TC) analysis was done using the graphitization system AGE3 (IonPlus AG). ¹⁴C(TC) measurements were performed with the single stage radiocarbon accelerator mass spectrometer (SSAMS, NEC, USA).

Backward trajectories were calculated using a hybrid single particle Lagrangian (HY-SPLIT) model from the National Oceanic and Atmospheric Administration (NOAA), <http://www.arl.noaa.gov/hysplitarc-bin/trajlfile.pl?metdata=FNL>. Backward trajectories were calculated using the model vertical velocity motion for every 3 or 6 h (depending on the period) with a total of 48 h duration at 500 m altitude AGL (Above Ground Level).

Results

The apportionment of ¹⁴C-based sources of carbonaceous aerosol showed the dominance of

biogenic/biomass burning sources (60 - 90 %). Results from the urban background site in Vilnius revealed that fossil fuel accounted for up to 23 ± 9 % of TC. These values were similar to those obtained during winter in Zurich, Switzerland and in Göteborg, Sweden (Szidat et al., 2006, 2009). The contribution of fossil fuel combustion sources depended on the air mass origin. The highest input of fossil fuel combustion sources was registered in western air masses from industrialized areas (Poland, Germany and France) in PM₁ samples.

The distribution of the stable carbon isotope ratio values ranged from -27.4 to -26.2 ‰. δ¹³C values were used to assess the input of biomass burning and terrestrial biogenic aerosol emissions (Masalaite et al., 2015).

The combination of δ¹³C values with radiocarbon data is a powerful tool in the studies of the aerosol particle source apportionment.

Ceburnis, D., Garbaras, A., Szidat, S., Rinaldi, M., Fahrni, S., Perron, N., Wacker, L., Leinert, S., Remeikis, V., Facchini, M. C., Prevot, A. S. H., Jennings, S. G., and O'Dowd, C. D. (2011) *Atmos. Chem. Phys.* **11**, 8593-8606.

Masalaite, A., Remeikis, V., Garbaras, A., Dudoitis, V., Ulevicius, V., Ceburnis, D. (2015) *Atmos. Res.* doi:10.1016/j.atmosres.2015.01.014

Szidat, S., Jenk, T.M., Synal, H.-A., Kalberer, M., Wacker, L., Hajdas, I., Kasper-Giebl, A., and Baltensperger, U. (2006) *J. Geophys. Res.* **111**, D07206, doi:10.1029/2005JD006590.

Szidat, S., Ruff, M., Perron, N., Wacker, L., Synal, H.-A., Hallquist, M., Shannigrahi, A. S., Yttri, K. E., Dye, C., and Simpson, D. (2009) *Atmos. Chem. Phys.* **9**, 1521–1535, doi:10.5194/acp-9-1521-2009.