Air pollution in Paris: A view through $\delta^{13}C$

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Except some jolts (e.g. Rudolph *et al.*, 1997), research on urban pollution has mainly focused on the chemical aspect, although the contribution of stable isotopes may be valuable. In the present study we use, for the first time, the power of carbon stable isotopes to estimate the importance of the different origins in the atmospheric pollution in Paris.

Methods and results

We analysed $\delta^{13}C$ of combustible (or fuel) and exhaust gases from the principal sources taken responsible for atmosphere pollution: cars and fixed heating sources (coal, oil fuel and natural gas), and air from several locations in Paris and rural zones in the vincinity.

Carbon concentrations from cars and heating sources vary widely from 2,000 to 60,000 ppmV and associated $\delta^{13}C$ from −22‰ to −40‰.

Exhaust gases are depleted in ^{13}C, by about 1‰, relative to their source. $\delta^{13}C$ differences among the different combustibles (or fuels) and gases have been established, allowing us to discriminate them into: solid ($\delta^{13}C > -25‰$), liquid ($-30‰ < \delta^{13}C < -27‰$) and gaseous ($\delta^{13}C < -35‰$).

Carbon concentrations in air samples range from 398 to 951 ppmV, and corresponding $\delta^{13}C$ from −8.8‰ to −19.8‰.

We found linear trends between $\delta^{13}C$ and either carbon concentration or its reciprocal.

Discussion

Carbon concentrations from the Paris area present a large range (500 ppmV) of values compared to that of the non-urban data, including those from ice cores, collected by other authors (only 150 ppmV in nearly 40,000 years, e.g. Keeling, 1961; Friedli *et al.*, 1986; Keeling *et al.*, 1989), letting us appreciate the scope of human disturbance.

The linear covariation between $\delta^{13}C$ and the reciprocal of carbon concentration demonstrates that urban atmosphere $\delta^{13}C$ can be explained as a simple mixture between two end-members. In the case of Paris the polluting end-member in the balance equation has a value of $\delta^{13}C$ at ~ −28‰. This isotopic composition suggests that carbon comes from sources that use liquid fuel, i.e. road traffic and fuel-oiled fixed heating sources.

The inversion of data allows us to model the evolution of the isotopic composition of the polluting end-member as a function of carbon concentration in the air. We show that there is a threshold around 500 ppmV above which we suggest pollution comes uniquely from road traffic.

The discrimination of the different categories of cars (leaded, unleaded and diesel) was examined. Exhaust gases $\delta^{13}C$ form a compact pool ranging from −27.6‰ to −29.3‰, but we observe that diesel values present a restricted range of isotopic compositions ($-29.3‰ = \delta^{13}C = -28.6‰$). These $\delta^{13}C$ differences between the car types suggest that estimation of their respective contribution to the road traffic pollution is conceivable.

Samples from cement and chemical manufactures will soon be analysed.

References

Friedli, H., Lötscher, H., Oeschger, H., Siegenthaler, U. and Stauffer, B. (1986) *Nature*, **324**, 237–8.

Keeling, C.D. (1961) *Geochim. Cosmochim. Acta*, **24**, 277–98.

Keeling, C.D., Bacastow, R.B., Carter, A.F., Piper, S.C., Whorf, T.P., Heimann, M., Mook, W.G. and Roeloffzen, H. (1989) *Geoph. Monographs*, **55**, 165–234.

Rudolph, J., Lowe, D.C., Martin, R.J. and Clarkson, T.S. (1997) *Geoph. Res. Letters*, **24**, 659–62.