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Continuous Tracking of Air Parcel Mixing Using Discrete Wavelet Transformation of Urban Ground Level Atmospheric Methane Measurements

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Cavity ring-down spectroscopy systems enable the continuous measurement of the mole fraction and isotopic composition of greenhouse gases. The raw data recorded each second from such systems are noisy and are typically averaged over time intervals of one to five minutes. We present the application of discrete wavelet transformation (DWT) for smoothing the raw data. For this case study, the smoothed data enhance the monitoring of mixing parcels of air with different methane source signatures. The DWT data also provide a more suitable data set for the application of the moving Keeling plot method (Vardag et al. 2016). We demonstrate the application of the workflow on a data set recorded in an urban environment, Sydney, Australia. The mixing of three sources of methane associated with fresh background, urban gas leaks, and mixed urban air is smoothly tracked throughout the day.

It is common practice to characterise the source signature of a plume with several (three or more) ambient air samples using either Keeling or Miller-Tans plots. A Keeling plot of the DWT data highlights a number of pitfalls of relying on a few points to quantify the isotopic signature. It is apparent that most of the time there is gradual mixing of three or more air parcels and that only a small portion of the data is suitable for analysis under the assumption of two end member mixing. Observable within a Keeling plot of the DWT ground level atmospheric methane data are examples of both constant source and varying source mixing. To characterise the isotopic signature of intermittent sources, the window for moving Keeling plot analysis has to be set in the order of minutes.

We expect that the application of the workflow present will enhance our capacity to attribute sources of greenhouse gases where there are potentially many sources in close proximity, such as urban environments.

Reference

Vardag S.N., Hammer S., Levin I. (2016) Evaluation of 4 years of continuous 13C(CO_2) data using a moving Keeling plot method. Biogeosciences, 13, 4237–4251, www.biogeosciences.net/13/4237/2016/ , doi:10.5194/bg-13-4237-2016