Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.7816

# Detection limits for atmospheric $CO_2$ sources with specific $\Delta_{47}$ signals under two component mixing conditions

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In many studies of the atmospheric carbon cycle and its exchange with other reservoirs, $CO_2$ mole fraction, $\delta^{13}C$ and $\delta^{18}O$ are widely used to partition between different processes contributing to sources or sinks. $\Delta_{47}$ is mainly used for applications as a paleothermometer, but was also proposed by [3] and [1], to be used for atmospheric $CO_2$ studies. The temperature dependency of $\Delta_{47}$ gives the possibility to differentiate between high temperature (e.g. by burning fossil fuels) and low temperature sources (e.g. soil respiration). In urban or local process studies, Δ47 can therefore support conventional tracers such as $\delta^{13}C$ or $\delta^{18}O$. The combination of different tracers offers the possibility to better restrict the results in this often under-determined system and thus to interpret them.

Here we present a theoretical study using synthetic data which examines the effect of mixing different source signals into an ambient air mass. The information gained from $\Delta_{47}$ measurements is examined under current and possibly improved measurement uncertainties. In the course of this, various $CO_2$ enhancements caused by different types of sources are simulated and the limits for meaningful measurements are studied. Furthermore, it is shown how to calculate $\Delta_{47}$ under mixing conditions without producing nonlinearities, which have occurred in previous studies[3], [1], [2], [4]. We will present examples where ignoring this effect may lead to wrong conclusions. In this feasibility study we show, with synthetic data, how regular atmospheric $\Delta_{47}$ measurements could be used, and demonstrate their limits.

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