Evaluating New High-frequency, High-precision Measurements of $\delta^{13}C$-CH_4 and δD-CH_4 for Top-down Emissions Estimation

M. Rigby[1], A.J. Manning[2] and R.G. Prinn[3]

[1]School of Chemistry, University of Bristol, Bristol, United Kingdom; +441173317042, E-mail: matt.rigby@bristol.ac.uk
[2]Atmospheric Dispersion Group, UK Meteorological Office, Devon, United Kingdom
[3]Center for Global Change Science, Massachusetts Institute of Technology, Cambridge, MA 02138

A new generation of observations of methane isotopologues are being developed based on quantum cascade laser spectroscopy. These new instruments, when combined with sample pre-concentration techniques, may allow *in situ* measurement of $\delta^{13}C$-CH_4 and δD-CH_4 at higher precision than previously possible and around an hourly frequency. If the anticipated precisions can be achieved, these new measurements should sample much of expected methane isotopologue variability on daily through annual timescales. Using model-generated time series' of $\delta^{13}C$-CH_4 and δD-CH_4, and estimates of source/sink-isotopologue sensitivity functions, we evaluate the benefit of these new observations in inverse estimates of methane sinks and emissions from four major sectors (microbial, fossil fuel, biomass burning and landfill). For global source estimation, we find additional uncertainty reductions of between 1 - 9 Tg/year for these source categories, compared to mole fraction-only inversions. On national scales, we obtain average uncertainty reductions of ~5-10% of the source strength for countries close to high-frequency monitoring sites, although the degree of uncertainty reduction on such small scales varies significantly (from close to 0% to almost 50%) for different sectors and countries.

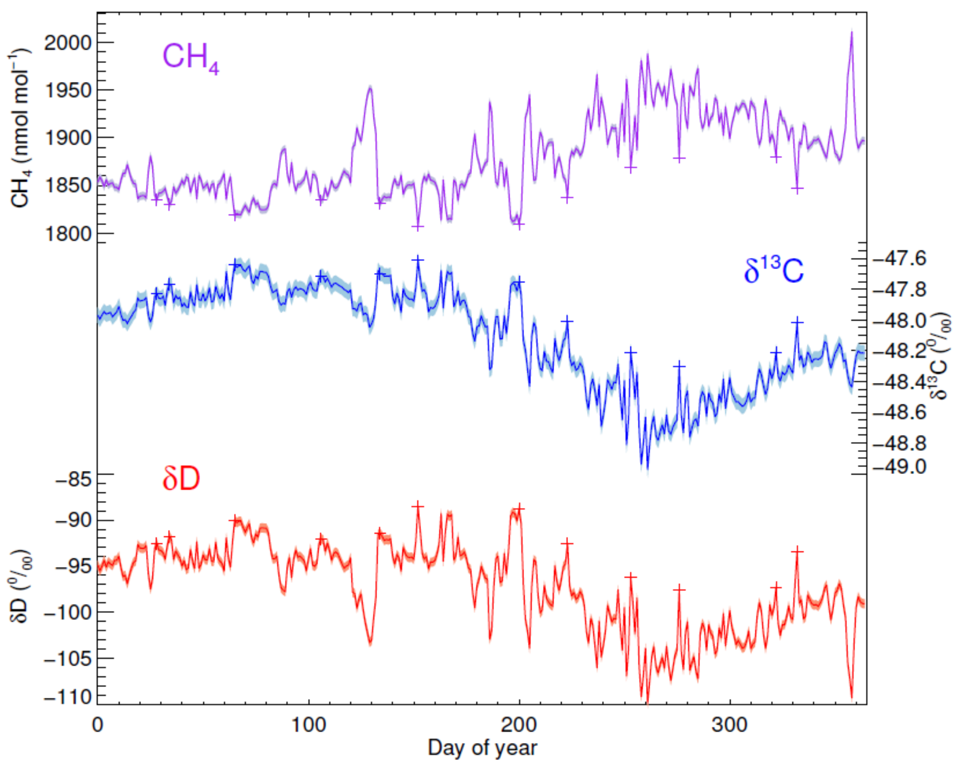

Figure 1. Model-generated daily average methane mole fractions (top panel, purple), and delta values for the two major isotopologues of methane ($\delta^{13}C$-CH_4, blue, and δD-CH_4, red) at Mace Head, Ireland. Anticipated measurement repeatabilities are indicated by the shading. The figure shows that much of the isotopologue variability should be resolved by the new observations.