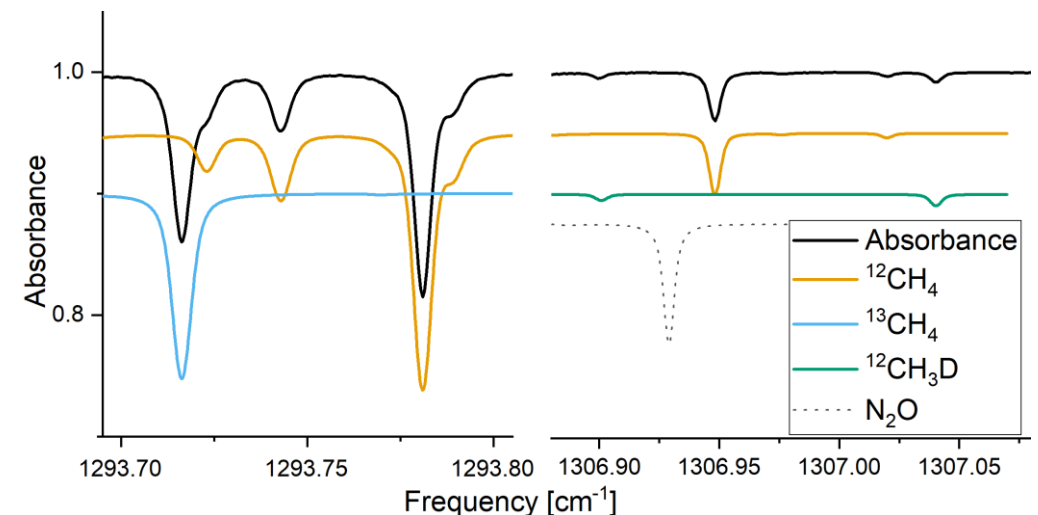
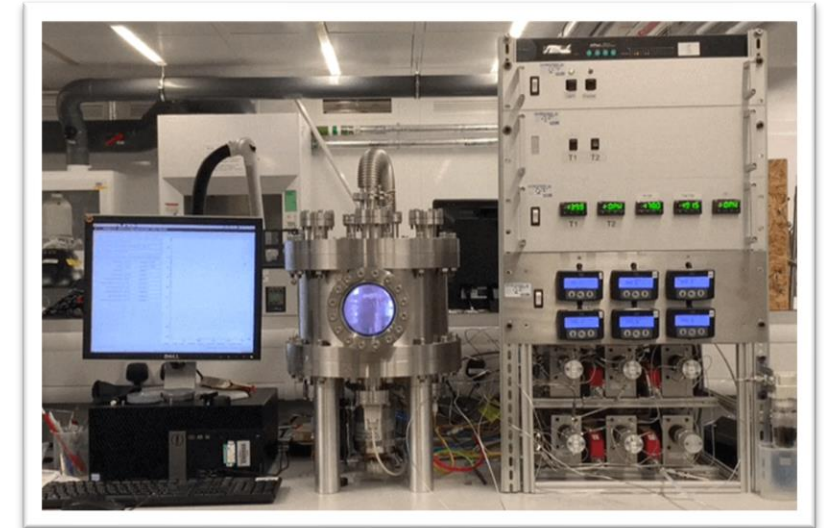
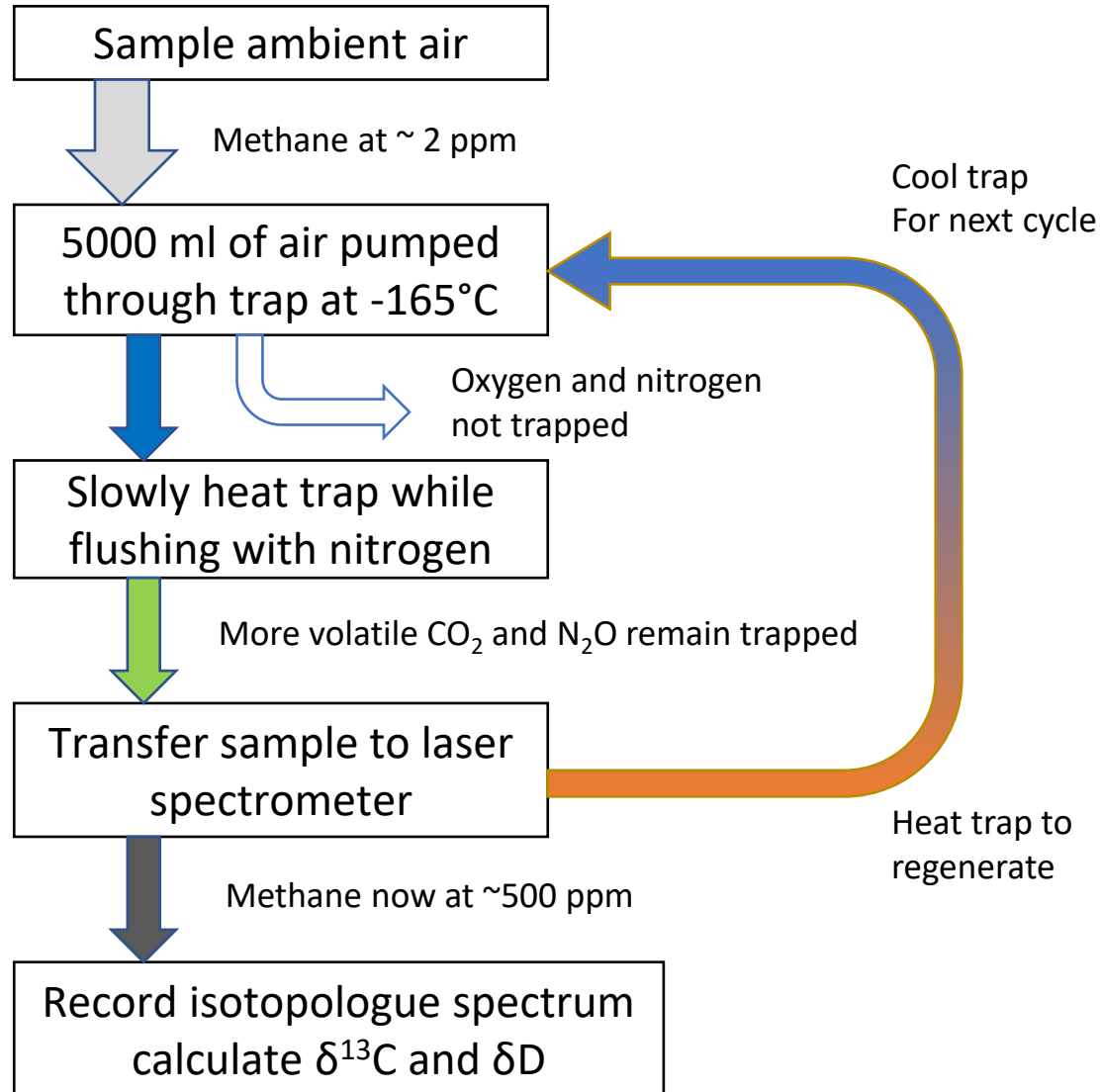




Novel stable isotopic measurements for understanding atmospheric methane

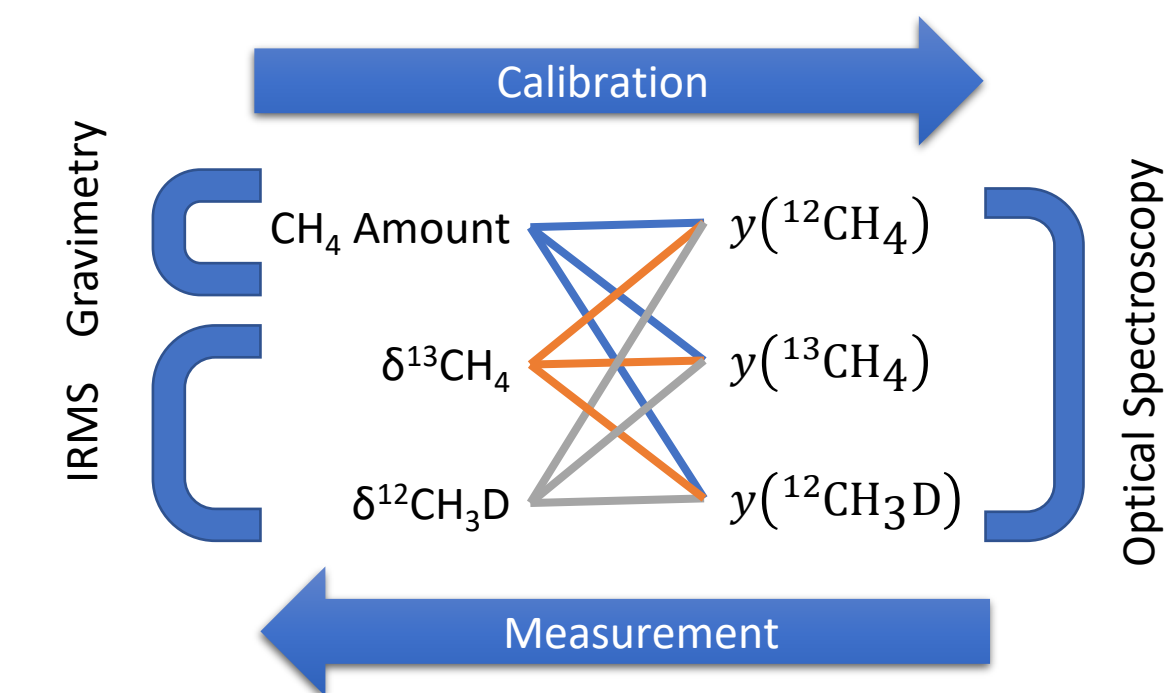
Chris Rennick, Ed Chung, Tim Arnold, Emmal Safi, Alice Drinkwater, Caroline Dylag, Eric Mussell Webber, Ruth Pearce, Dave Lowry, and Alistair Manning

Boreas Methane Preconcentrator

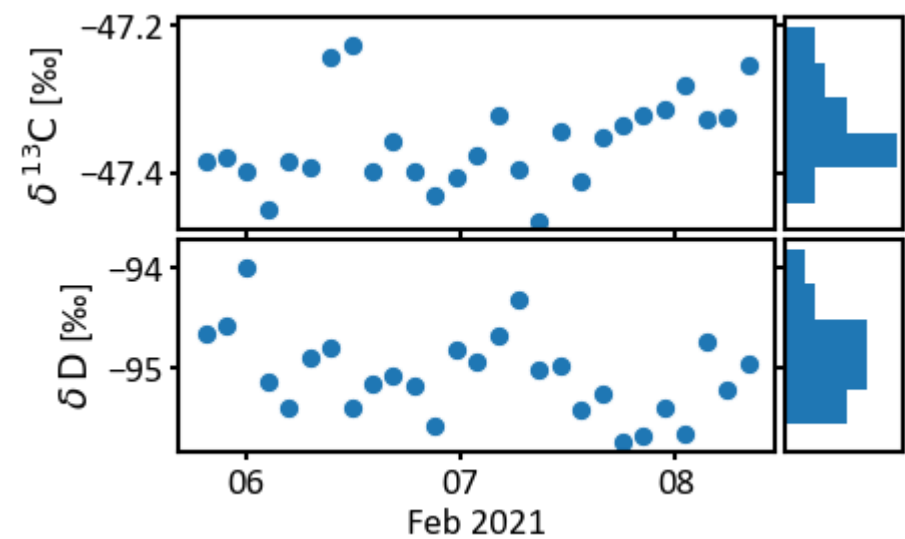


SPECTROMETER CALIBRATION AND MEASUREMENT PRECISION

- Calibration uses 2 reference standards methane amount fraction brackets the sample. $\delta^{13}\text{C}$ and δD are the same.
- Calculate the amount of $^{12}\text{CH}_4$, $^{13}\text{CH}_4$ and $^{12}\text{CH}_3\text{D}$ in each standard.
- Perform calibration and measurement for the amount of each isotopologue
- Calculate $\delta^{13}\text{CH}_4$ and $\delta^{12}\text{CH}_3\text{D}$ for the sample



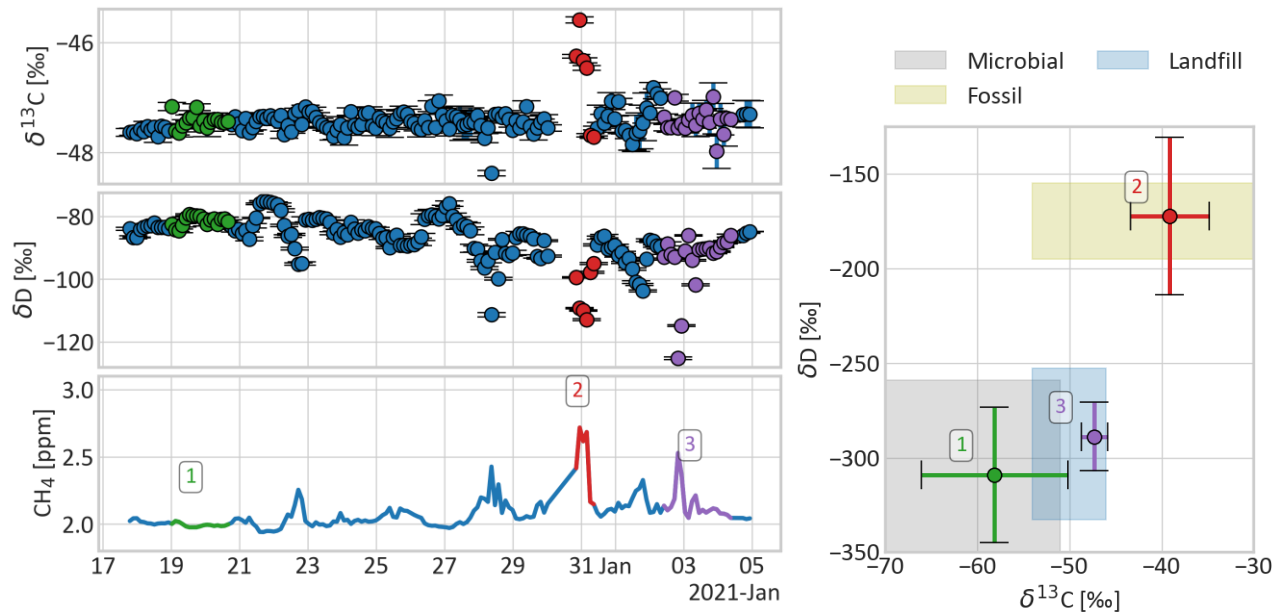
Repeated measurements of whole-air standard



Quantity	Boreas		IRMS	
	Mean [‰]	Std. Dev. [‰]	Mean [‰]	Std. Dev. [‰]
$\delta^{13}\text{C}$	-47.36	0.06	-41.41	0.04
δD	-95.05	0.41		

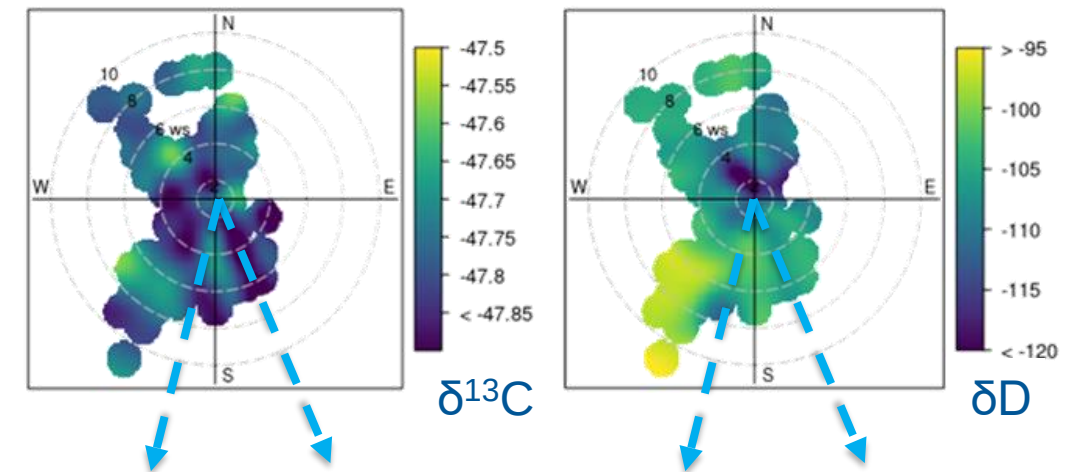
Boreas Methane Preconcentrator

Air measurements at NPL

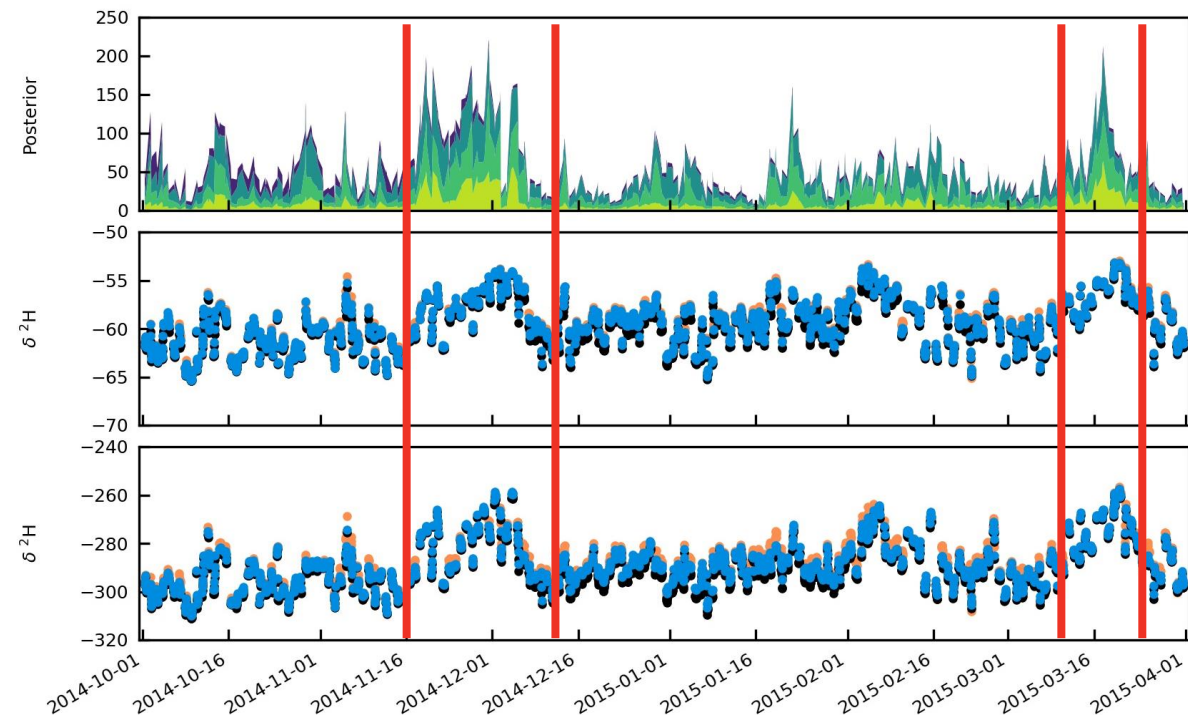
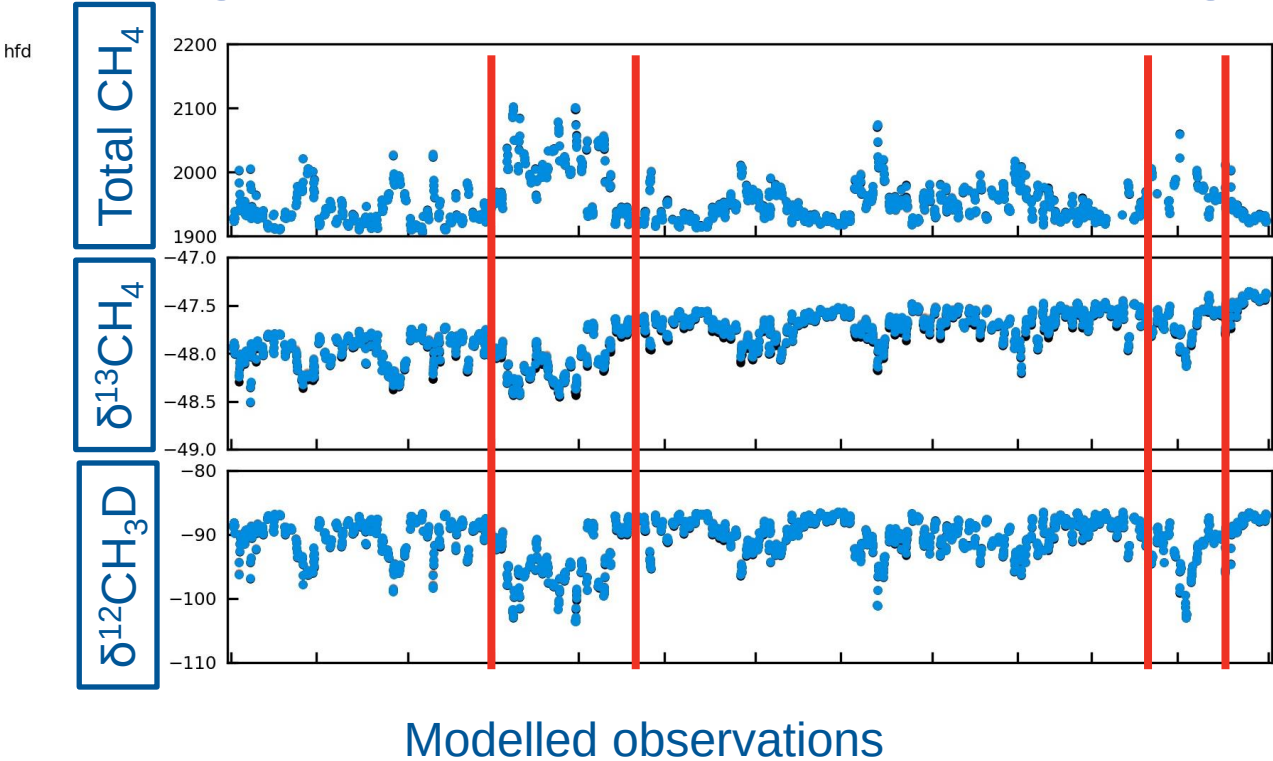


Keeling plot analysis indicates fossil and biogenic sources

Plotting all data on a wind rose shows lighter isotopologues arriving from two southerly directions.



Regional Methane Modelling



Source contributions and combined signatures

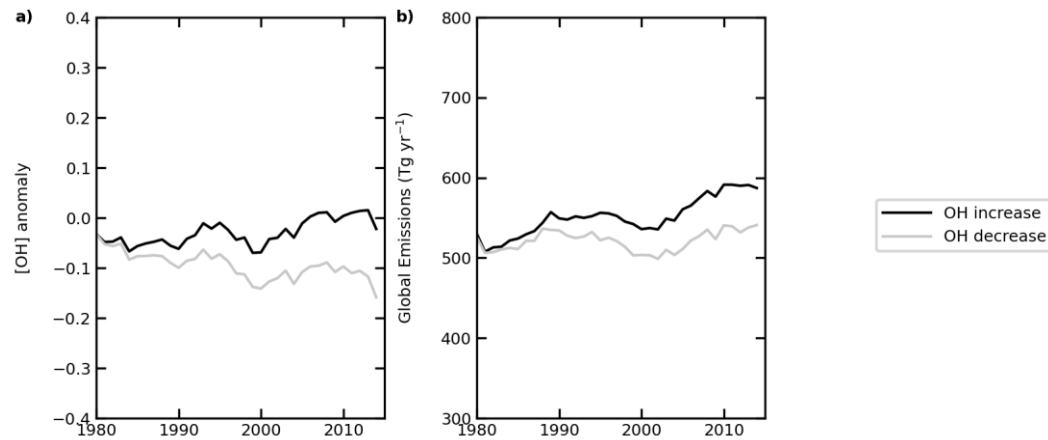
We can use isotopic measurements and source signatures to constrain emissions from different sources, or to study the effects of changing source contributions.

For example, the pollution events at Heathfield shows high contributions from the fossil fuel sector.

But, what if the observed isotopic ratio was lower?

Sources	$\delta^{13}\text{CH}_4$ (‰)	$\delta^{12}\text{CH}_3\text{D}$ (‰)
Fossil Fuel	-40	-175
Waste	-55	-293
Agriculture	-68	-319
Wetlands	-69	-330

Clumped Methane Isotopologues



High emission, high sink
vs
Low emission, low sink

Same net flux

