Supplementary information for: High precision atmospheric GHG measurements for the Orinoco region: The Villavicencio Tower (VLO)

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Supplementary Information

Table S1: Summary of the methods and measurement characteristics used to quantify GHG concentrations and isotopic composition at the VLO tower.

Gas Species	Measurement Method	Analytical Precision	WMO target	Unit
CO_2	GC	0.07	0,1	ppm
CH_4	GC	1.4	2	ppb
CO	GC	0.8	2	ppb
N_2O	GC	0.17	0.1	ppb
H_2	GC	0.7/2.5	2	ppb
SF_6	GC	0.03	0.02	ppt
O_2/N_2	MS	4	2	permeg
Ar/N_2	MS	8	-	permeg
$\delta^{13}C\text{-}CO_2$	MS	0.02	0.01	‰
$\delta^{18}O\text{-}CO_2$	MS	0.02	0.05	‰
$\delta^{13}C\text{-}CH_4$	MS	0.1	0.02	‰
$\delta^{2}H\text{-}CH_4$	MS	1	1	‰



Figure S1: View of VLO tower located within the Barcelona campus of the Universidad de los Llanos, outside the city of Villavicencio, Colombia.

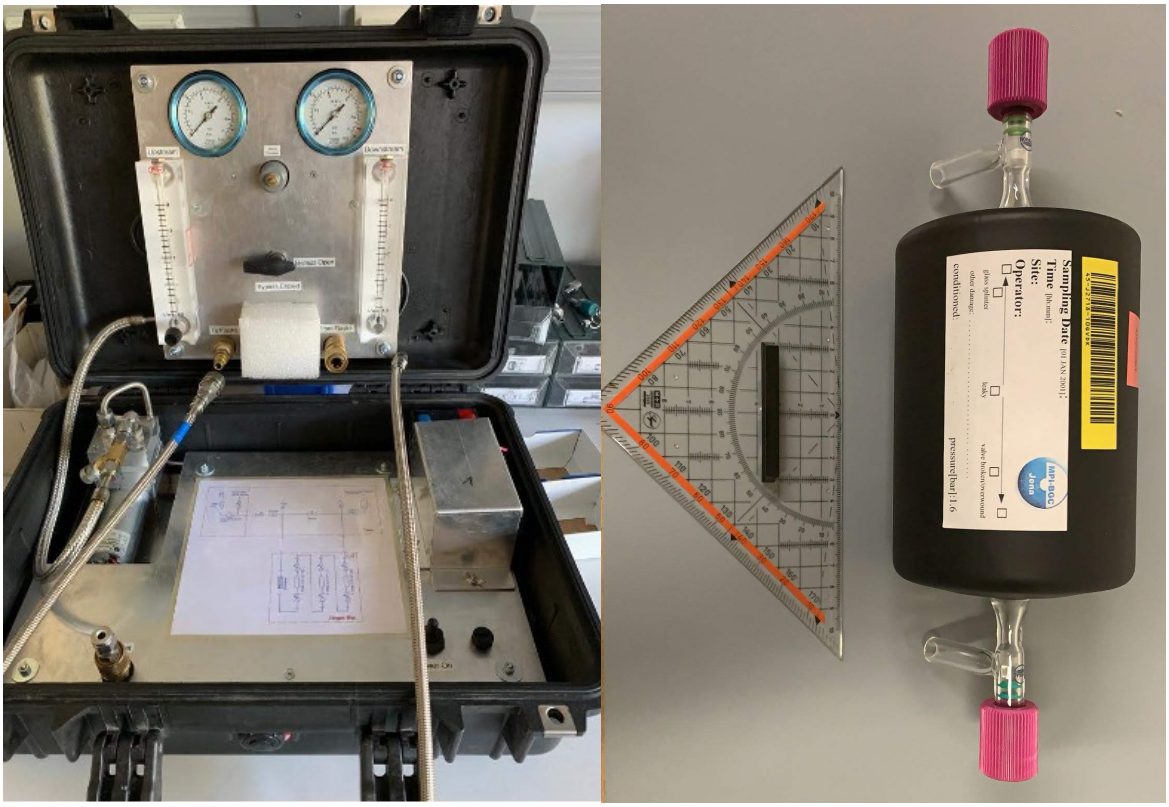


Figure S2: The manual flask sampler used to collect weekly duplicated atmospheric samples and an example of a flask used for atmospheric sampling.

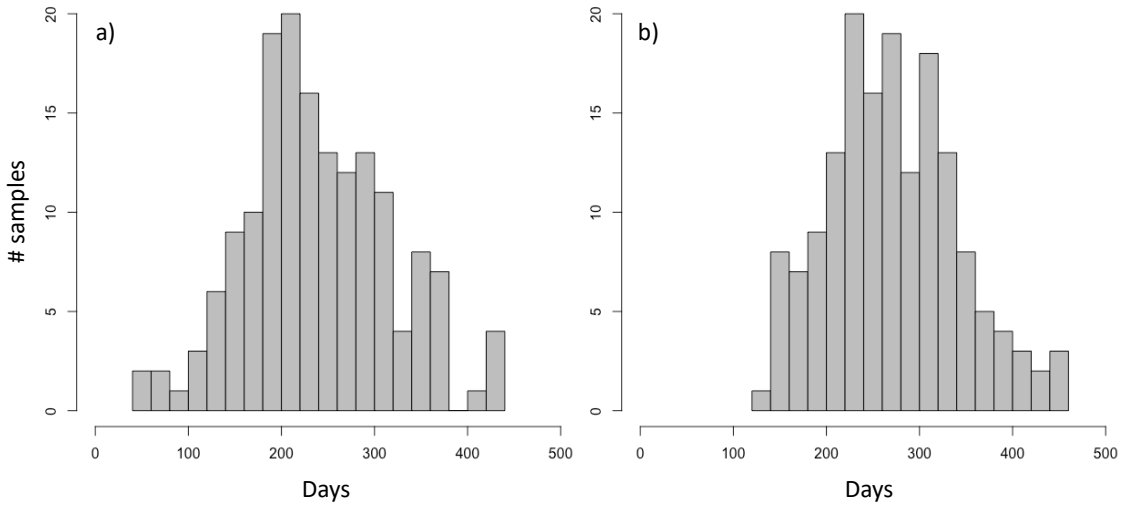


Figure S3: Distribution of the number of days between the day a sample is taken and the day the sample is analyzed for GHG concentration (a) and isotopic composition (b).

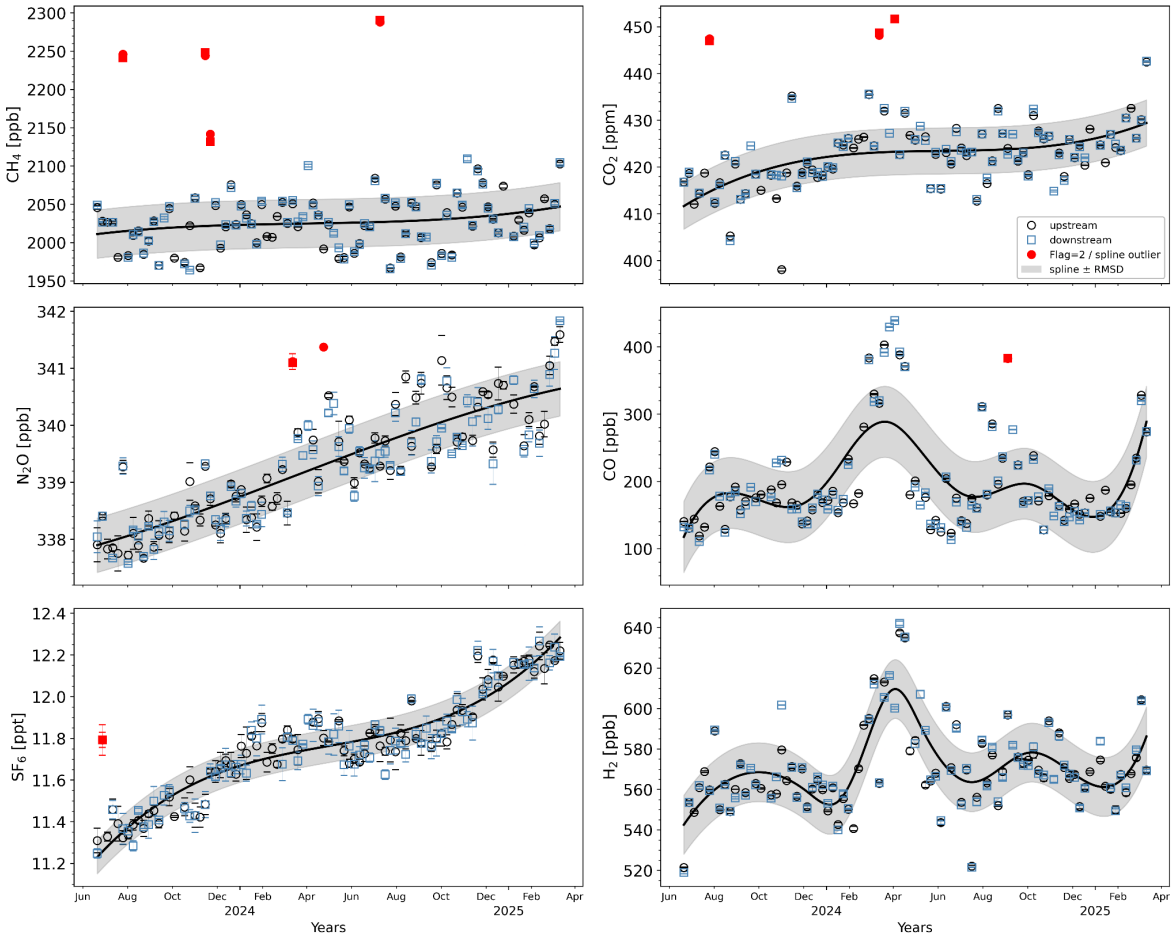


Figure S4. Time series of trace gas mole fractions measured from flask samples at station VLO (Universidad de los Llanos, Villavicencio, Colombia; 4.07°N, 73.58°W; 375 m a.s.l.). Open circles and open squares represent upstream and downstream flask samples, respectively, collected concurrently at 26 m above ground. Error bars denote the analytical uncertainty reported by the Jena GasLab. The solid black line is a robust cubic smoothing spline fitted to the per-timestamp mean; the grey shaded band represents the spline ± the root-mean-squared deviation (RMSD) of the fit. Red markers indicate additional statistical outliers identified by iterative sigma-clipping of the spline residuals (rejection threshold: 3 × RMSD). Flagged points are excluded from the spline fit.

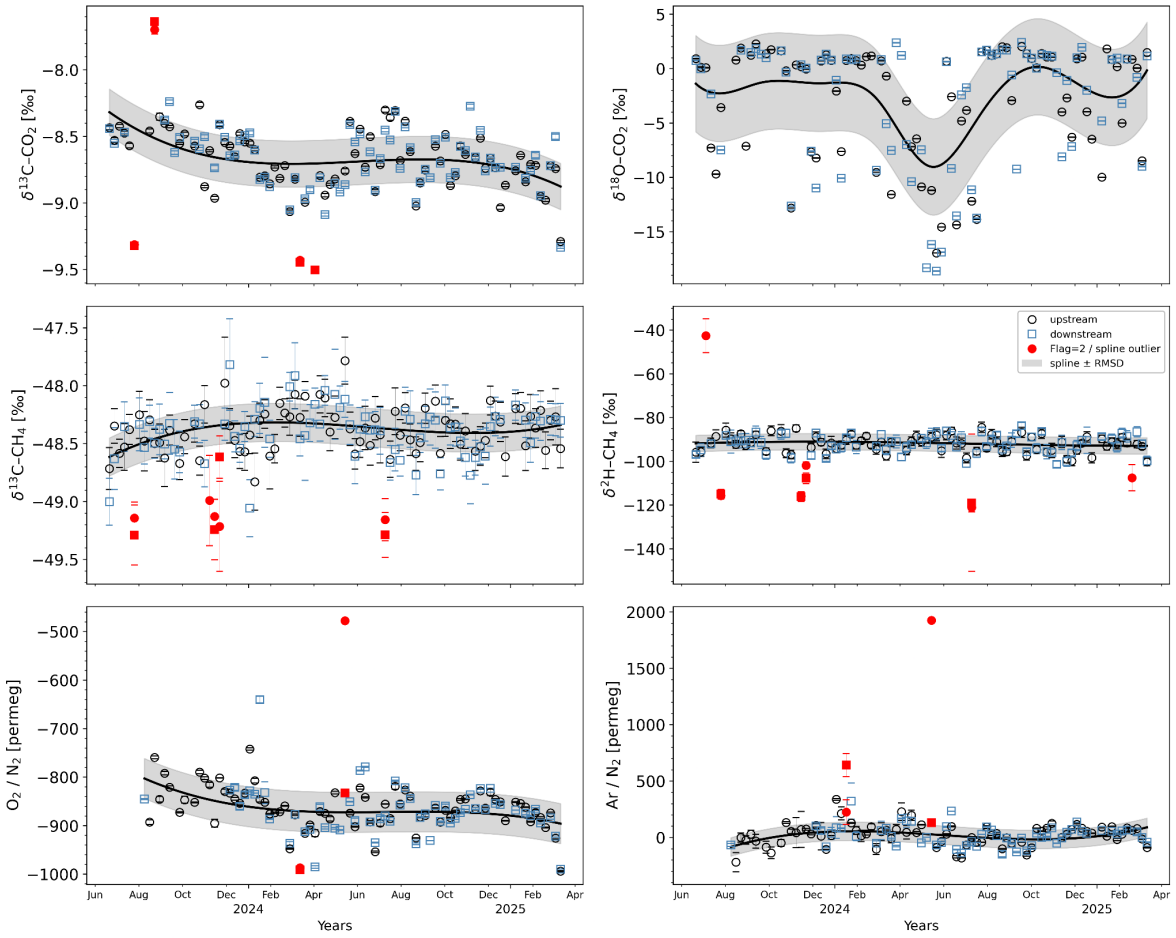


Figure S5: Time series of stable isotope ratios and atmospheric gas ratios at station VLO (Universidad de los Llanos, Villavicencio, Colombia; 4.07°N, 73.58°W; 375 m a.s.l.). Open circles and open squares represent upstream and downstream flask samples, respectively, collected concurrently at 26 m above ground. Error bars denote measurement uncertainties. The solid black line is a robust cubic smoothing spline fitted to the per-timestamp mean; the grey band shows the spline ± RMSD. Red markers indicate sigma-clipping outliers which were excluded from the spline fit.

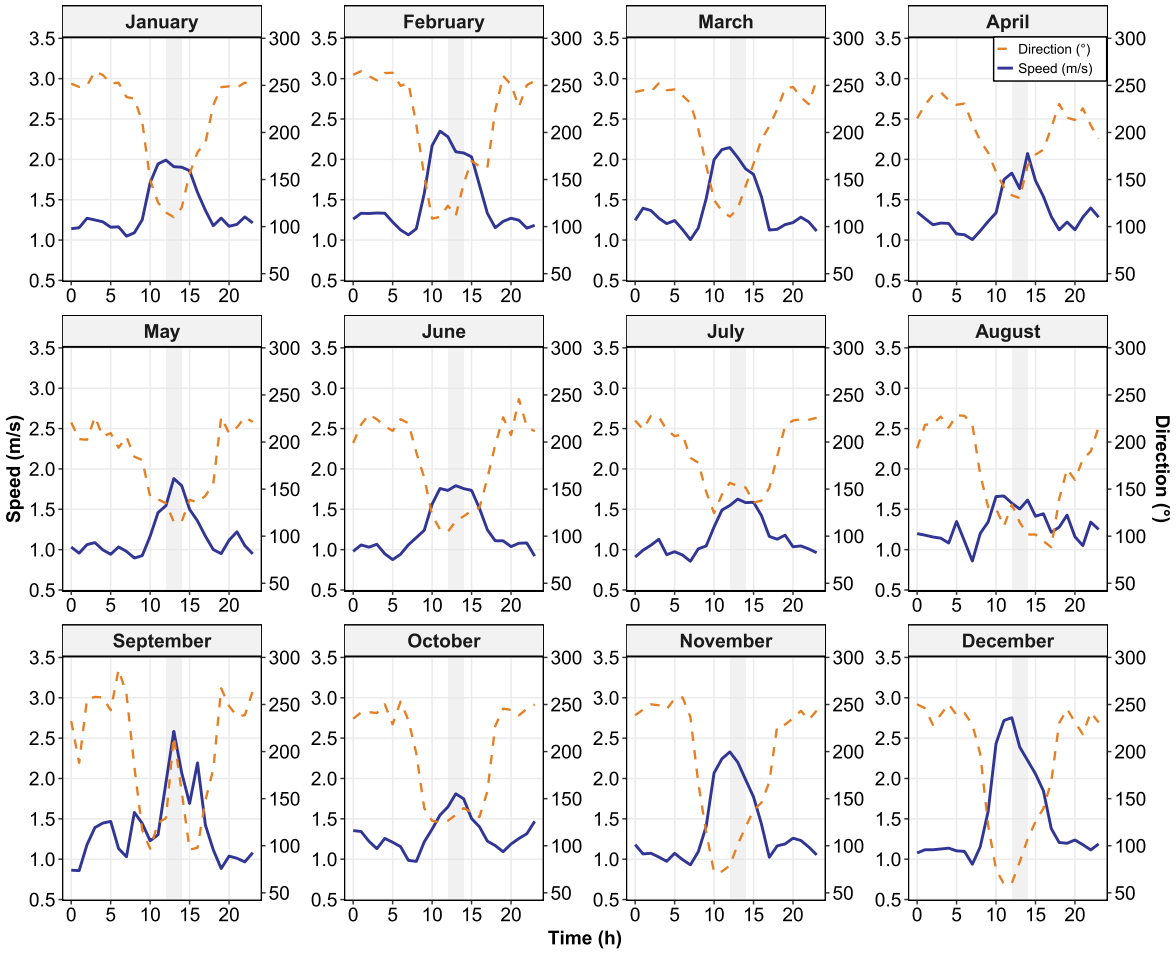


Figure S6. Monthly mean hourly wind speed and direction measured at the tower from 13 May 2025 until 28 April 2026.