Supplement material for “Quantifying area-source methane fluxes with path-averaged laser beam concentration measurements and Bayesian inversion”

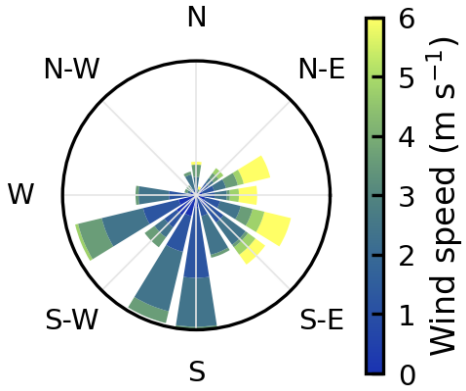

Figure S1: Wind rose for synthetic concentration generation. Wind directions are asymmetrically distributed to maximize upwind background concentration measurement while covering a large area of interest.

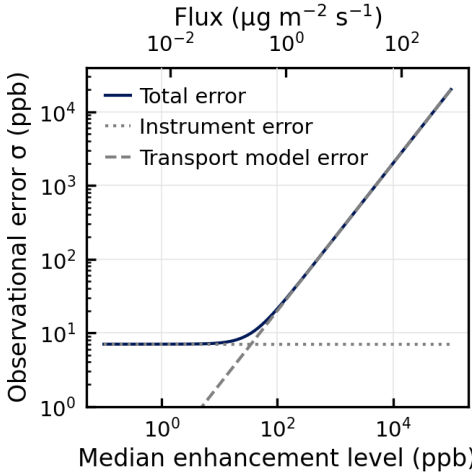

Figure S2: Components of observational error as a function of median enhancement level. The total error (solid blue line) is composed of instrument error (dotted gray line, constant) and transport model error (dashed gray line, proportional to enhancement). At low enhancement levels, instrument noise dominates; at high enhancement levels, transport model uncertainty becomes the dominant error source. Top axis shows the corresponding flux values.

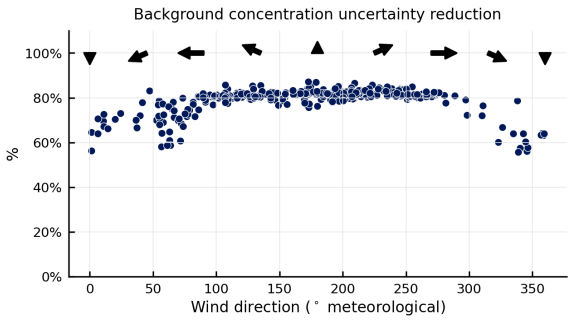

Figure S3: Influence of wind direction on background concentration uncertainty reduction. Each point is one point in time during the week-long inversion period. Arrows indicate wind direction for clarity.

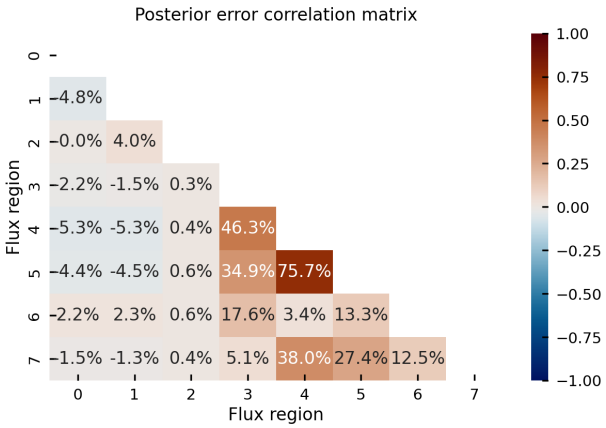

Figure S4: Posterior error correlation matrix for the inversion discussed in Section 3.1. Diagonal elements and repeated top triangle removed for clarity. Correlations between flux regions represent the independence of flux estimates in the posterior distribution with low values indicating independence in the estimates produced by the inversion.

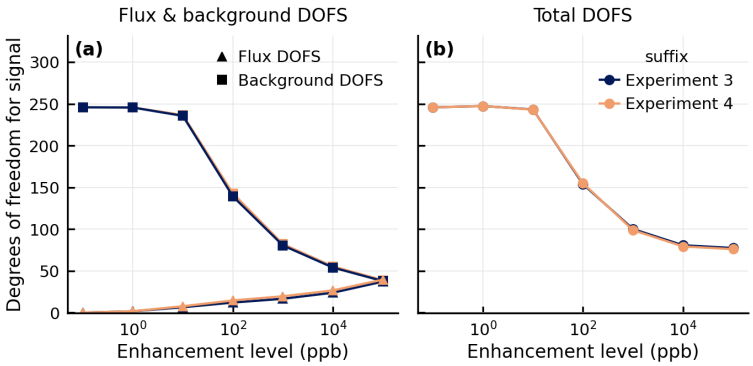

Figure S5: Degrees of freedom for signal (DOFS) analysis as a function of enhancement level. (a) Flux DOFS (triangles) and background concentration DOFS (squares) for two inversion configurations: including all regions in the prior (Experiment 3: blue) and with the far region flux assumed known (Experiment 4: orange). (b) Total DOFS

for each configuration. At low enhancement levels, the inversion is dominated by background estimation; at high enhancement levels, total DOFS drop, but flux estimation becomes the primary contributor to information content.