Supplemental of:

Advancing CH_4 and N_2O retrieval strategies for NDACC/IRWG high-resolution direct-sun FTIR Observations

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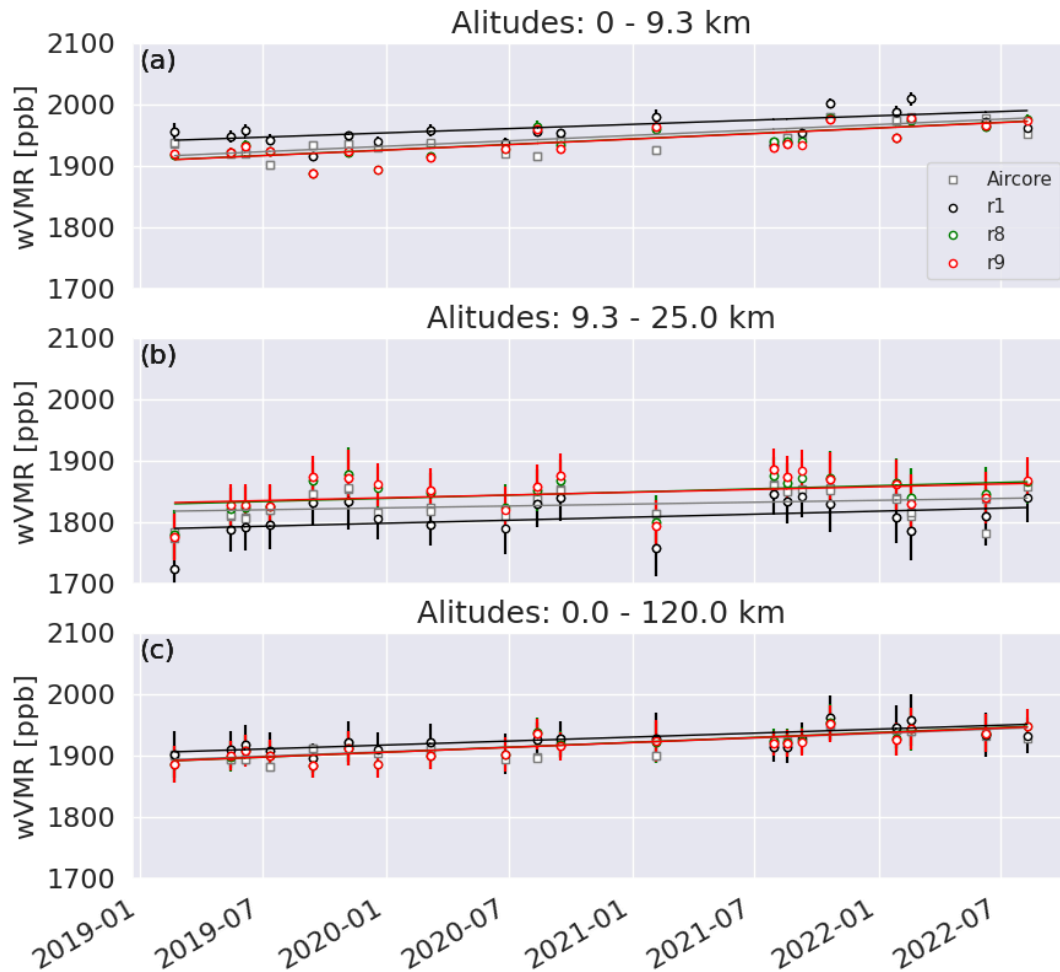
Figure S1. Time series of CH_4 weighted mean mixing ratios using coincident dates between aircore (square gray symbols) and FTIR retrievals (r1-black, r8-green, and r9-red) for three different partial columns between 2019 - 2022. Solid lines represent the linear trend for each time series. The table below shows the linear trend for all retrievals and partial columns.

Table S1. Comparison of linear trends in CH₄ time series at Boulder for tropospheric, stratospheric, and total columns, using different retrievals (r1, r8, r9) and AirCore observations, as illustrated in Figure S1.

	AirCore [%/yr]	r1 [%/yr]	r8 [%/yr]	r9 [%/yr]
Troposphere (1.6 - 9.3 km)	0.91 ± 0.08	0.71 ± 0.1	0.93 ± 0.13	0.93 ± 0.13
Stratosphere (9.3 - 25.0 km)	0.34 ± 0.11	0.54 ± 0.13	0.56 ± 0.13	0.49 ± 0.15
Trop + stratosphere (1.6 - 25.0 km)	0.78 ± 0.06	0.67 ± 0.08	0.84 ± 0.09	0.83 ± 0.08
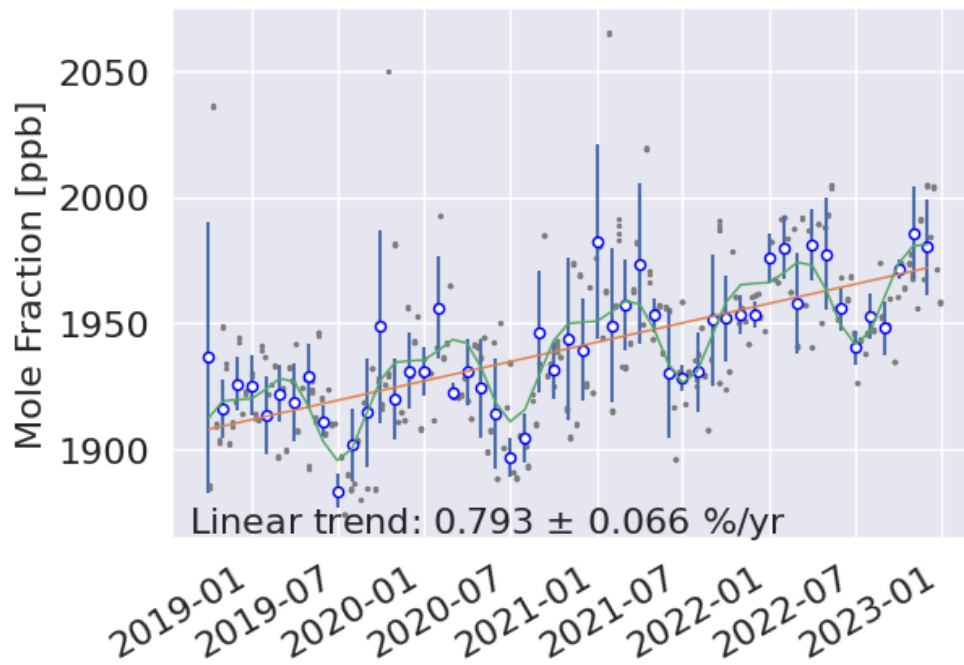
Figure S2. Linear trend analysis of atmospheric CH₄ mole fractions at Niwot Ridge, Colorado, the nearest remote site minimally impacted by local sources, using data from the NOAA GML Carbon Cycle Cooperative Global Air Sampling Network (Lan et al., 2024). The plot shows the linear trend over the same years as Figure S1 (0.793 ± 0.066 %/y).
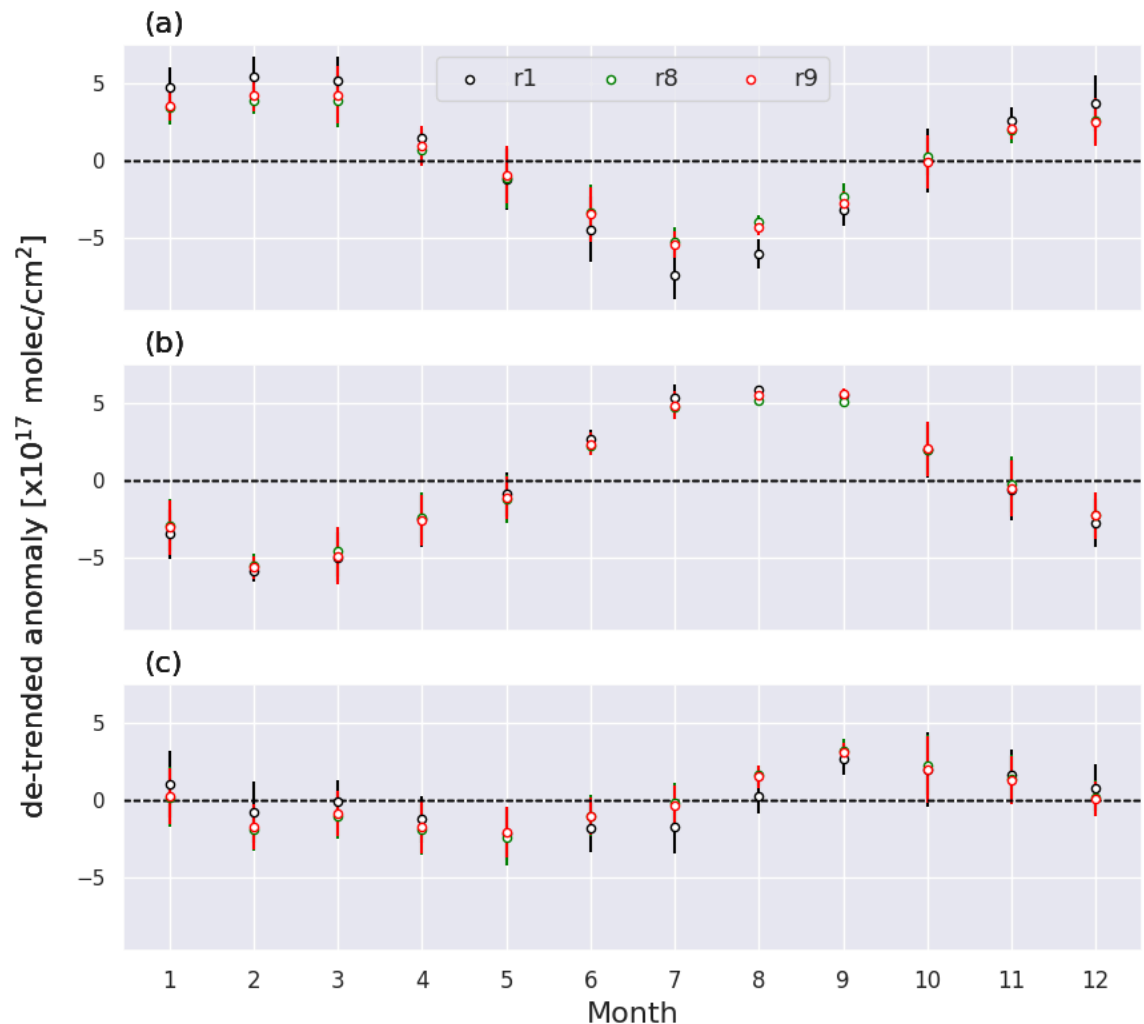
Figure S3. Monthly mean CH$_4$ values from the detrended analysis are shown for Boulder across three retrievals (r1, r8, and r9) for tropospheric (a), stratospheric (b), and total columns (c). Error bars represent the standard deviations of the multi-annual monthly means. Retrievals r8 and r9 align closely, while r1 shows slight differences but remains within the error margins.
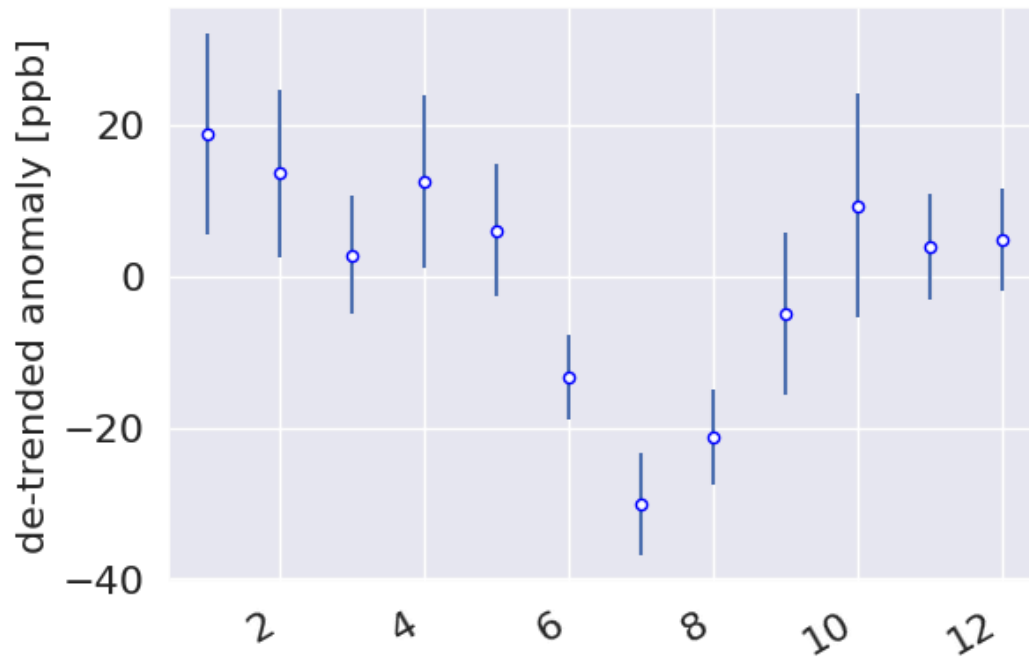
Figure S4. De-trended analysis of atmospheric CH₄ mole fractions at Niwot Ridge, Colorado.

References:

Lan, X., J.W. Mund, A.M. Crotwell, K.W. Thoning, E. Moglia, M. Madronich, K. Baugh, G. Petron, M.J. Crotwell, D. Neff, S. Wolter, T. Mefford and S. DeVogel (2024), Atmospheric Methane Dry Air Mole Fractions from the NOAA GML Carbon Cycle Cooperative Global Air Sampling Network, 1983-2023, Version: 2024-07-30, https://doi.org/10.15138/VNCZ-M766