

Inferring the vertical distribution of CO and CO₂ from TCCON total column values using the TARDIIS algorithm

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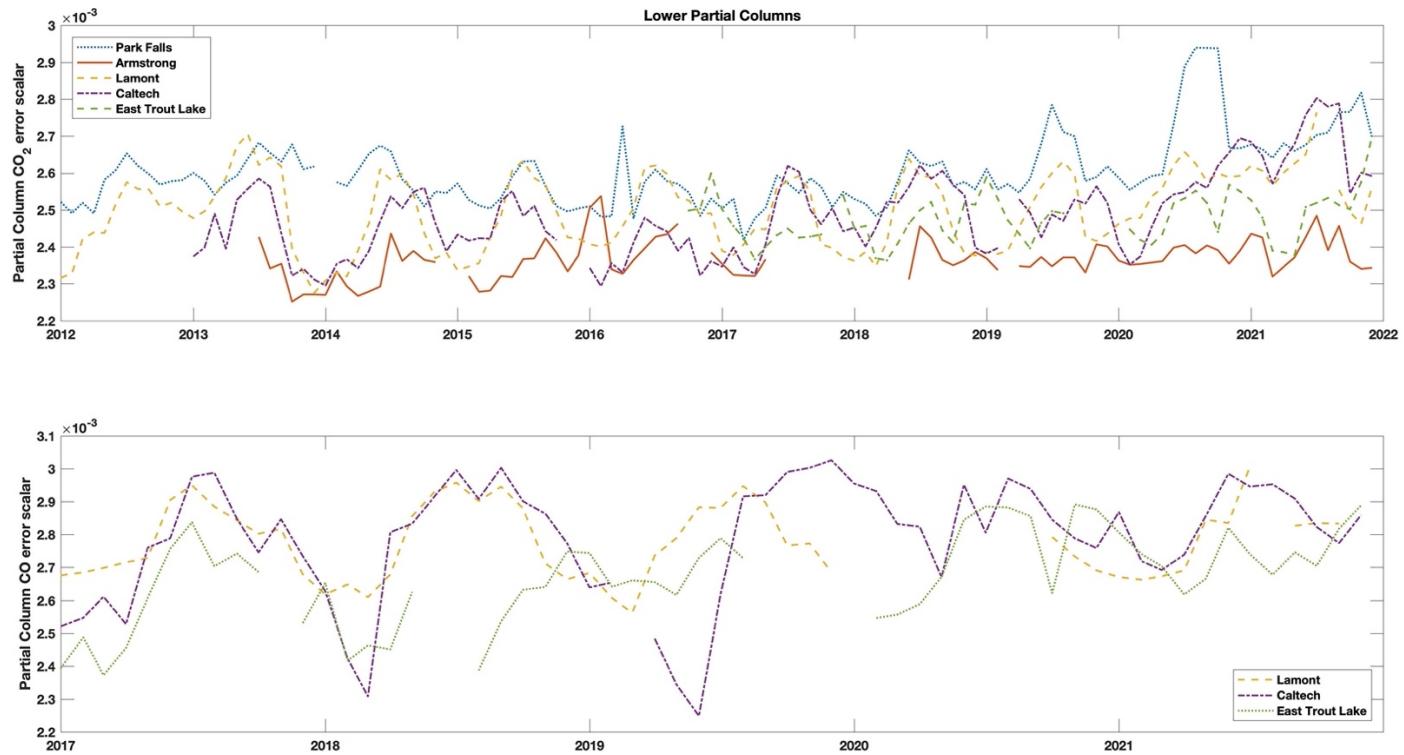
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Supplemental Information:



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Figure S1. Monthly mean lower partial column scalar errors plotted for CO₂ (top) and CO (bottom).

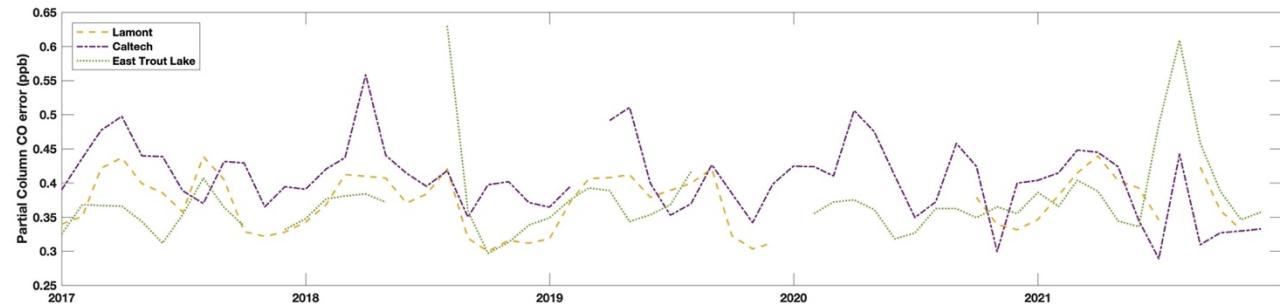
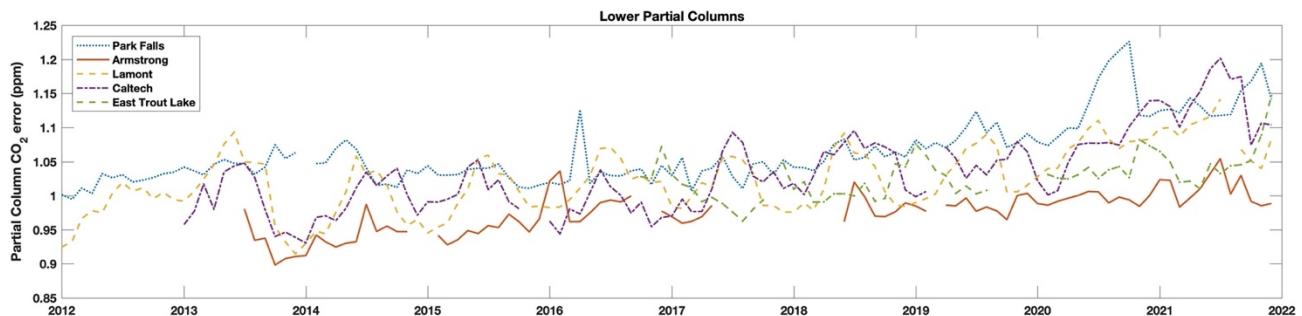
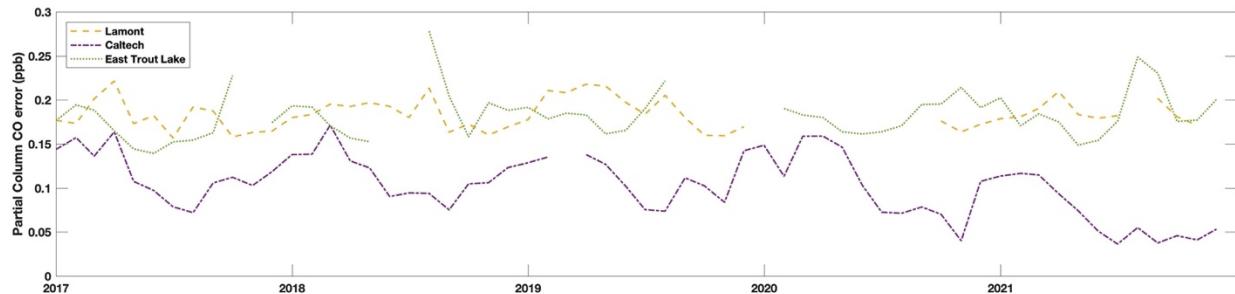
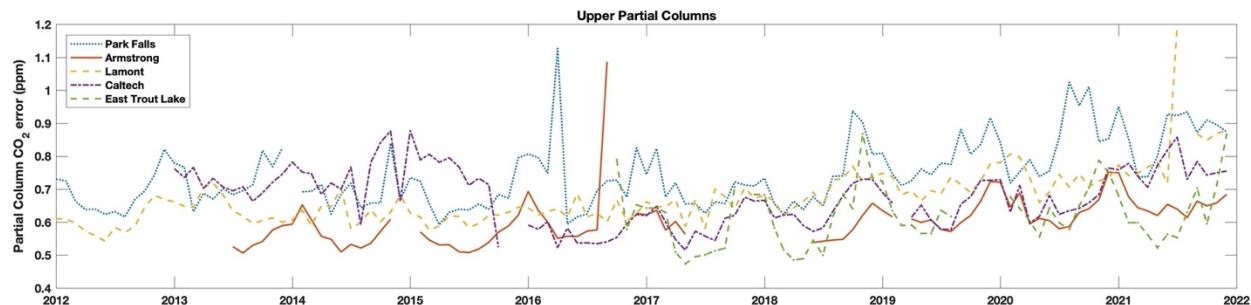


Figure S2. Monthly mean lower partial column errors plotted for CO_2 in ppm (top) and CO in ppb (bottom).

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30 (bottom).

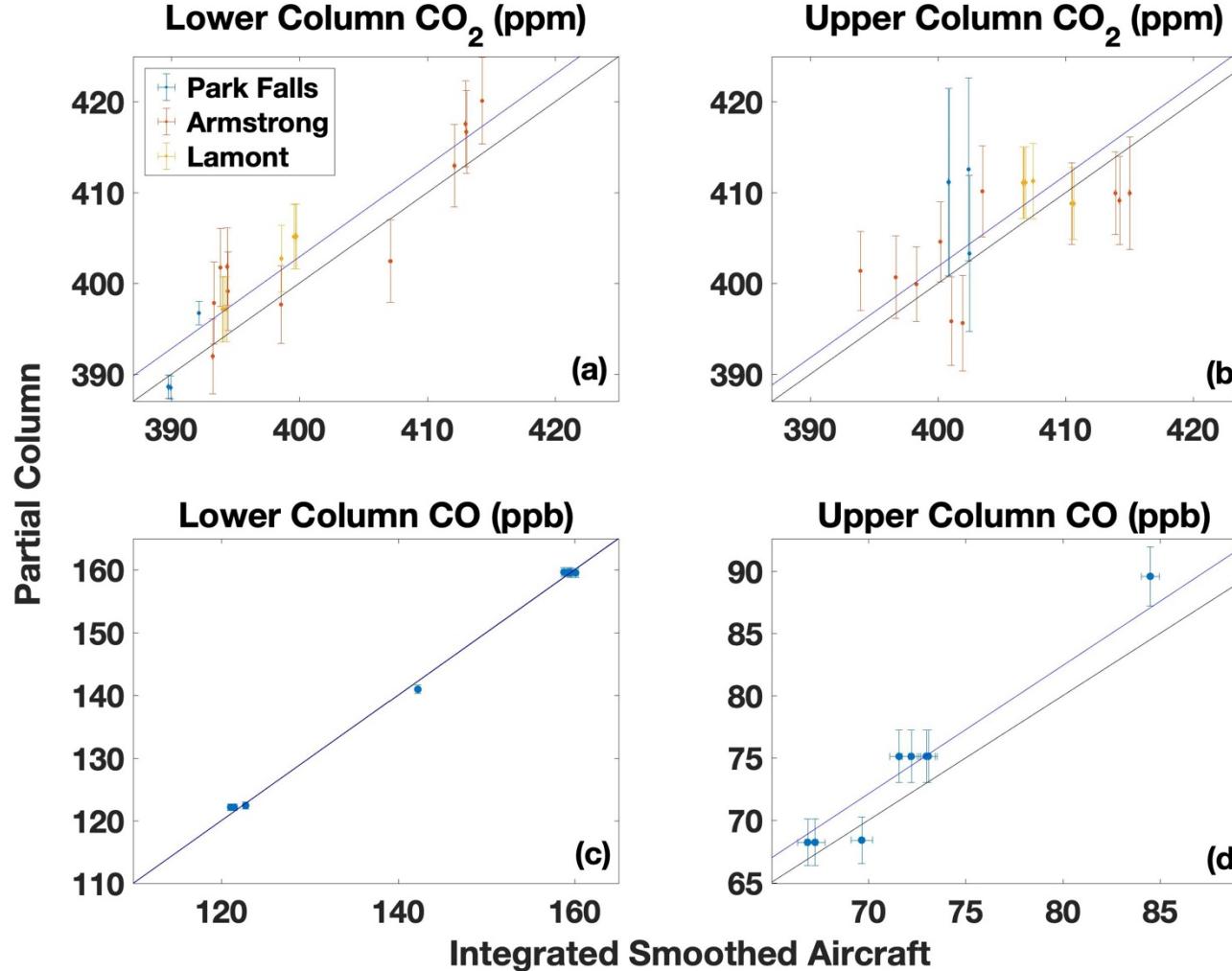


Figure S4. Validation comparisons plotted the same as in Fig. 5 with the error bars in the y-direction scaled by the validation error multipliers shown in Table 5.

TARDIIS Prior Choice	Prior Covariance Matrix Scaling	DoF per measurement (overall)	Lower Column Error (ppm)	Lower Column Validation Slope	Lower Column Mean Ratio Deviation	Upper Column Error (ppm)	Upper Column Validation Slope	Upper Column Mean Ratio Deviation
X12 daily median	10^{-5}	0.450 (19.9)	0.880	1.011	0.011	0.496	1.002	0.004
	10^{-4}	0.845 (36.6)	1.464	1.017	0.017	1.004	1.002	0.004

	5×10^{-5}	0.759 (33.0)	1.301	1.014	0.015	0.847	1.002	0.004
XL2	10^{-5}	0.450 (19.9)	0.880	1.011	0.011	0.496	1.002	0.004
	10^{-4}	0.845 (36.6)	1.464	1.016	0.017	1.004	1.002	0.005
	5×10^{-5}	0.759 (33.0)	1.301	1.014	0.014	0.847	1.002	0.005
	10^{-5}	0.450 (19.9)	0.880	1.013	0.013	0.496	1.000	0.003
Static ideal prior	10^{-4}	0.845 (36.6)	1.464	1.018	0.018	1.004	1.001	0.004
	5×10^{-5}	0.759 (33.0)	1.301	1.016	0.016	0.847	1.000	0.004

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Table S1. Variations in CO₂ retrieval validation slope, mean ratio deviation, comparison error, and DoF for different TARDIIS prior choices and prior covariance matrix scaling values. All values shown here are for retrievals using the unweighted J values.

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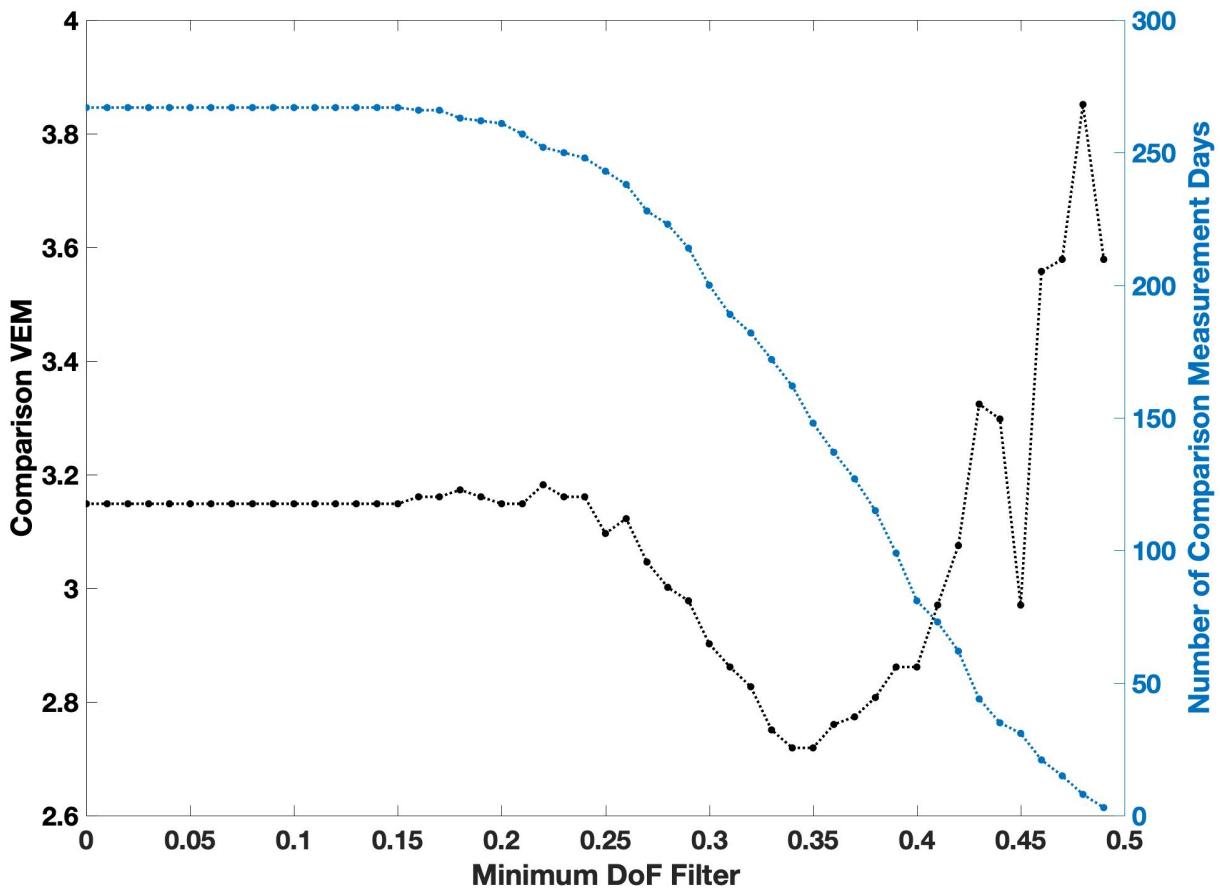


Figure S5. Comparison Validation Error Multiplier (VEM) and number of comparison days plotted by the minimum DoF per measurement filter applied to the comparison data. The retrieved data is in comparison with in situ data measured as a part of the NOAA Global Monitoring 395 Division project from 2008 -2018 at the Lamont measurement site.

Site	Type	Species	Campaign/ Program	Data Availability	Dates
Park Falls	Aircraft	CO ₂	ATom	https://doi.org/10.1175/BAMS-D-20-0315.1 https://doi.org/10.3334/ORNLD AAC/1925	20160822
	AirCore	CO ₂	NOAA AirCore	https://doi.org/10.15138/6AV0-MY81	20180730
					20180730
					20180731
Armstrong	Aircraft	CO ₂	ATom	https://doi.org/10.1175/BAMS-D-20-0315.1 https://doi.org/10.3334/ORNLD AAC/1925	20130923
Armstrong	Aircraft	CO ₂	SEAC4RS	https://doi.org/10.3334/ORNLD AAC/1925	20140820
Armstrong	Aircraft	CO ₂	GSFC	https://doi.org/10.25925/20190319 19	20140820 20140822 20140822 20151002 20160210
Armstrong	Aircraft	CO ₂	KORUS-AQ	https://doi.org/10.1525/elementa.2020.00163	20160618
Armstrong	AirCore	CO ₂	NOAA AirCore	https://doi.org/10.15138/6AV0-MY81	20180716 20180717 20180717 20180718
Lamont	AirCore	CO ₂ , CO	NOAA AirCore	https://doi.org/10.15138/6AV0-MY81	20180723 20180725

				20180725
				20180725
				20180727
				20180727
				20180727
Lamont	Aircraft	CO ₂ , CO	NOAA GGGRN aircraft program	https://doi.org/10.1002/2014JD022591 , 2015. 2008 - 2018
East Trout Lake	Aircraft	CO ₂ , CO	NOAA GGGRN aircraft program	https://doi.org/10.1002/2014JD022591 , 2015. 2017 - 2020

Table S2. Site, measurement type, species, campaign or program, citation, and dates of the in situ profile data used in this work.