



Supplement of

Global and diurnal variations in tropospheric ammonia observed from a constellation of hyperspectral infrared sounders in three different LEO orbits

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Text S1. Sensitivity to the NH₃ a priori profile

For each observation, the spatiotemporally matched NH₃ profile from the GEOS-CF model is selected as the a priori profile. The variable-prior retrievals are then compared with the baseline fixed-prior retrievals over the North China Plain and the Indo-Gangetic Plain for January, April, July, and October, 2024. Three representative days, namely the 5th, 15th, and 25th days of each month are selected. The same strict quality-control filters are applied to both retrieval sets before comparison. The results are shown in Figs. S1–S6. Overall, the fixed-prior and variable-prior retrievals show broadly consistent NH₃ columns after strict filtering, indicating that the main spatial and local-time-dependent patterns discussed in this study are not primarily controlled by the choice between fixed and variable NH₃ a priori profiles.

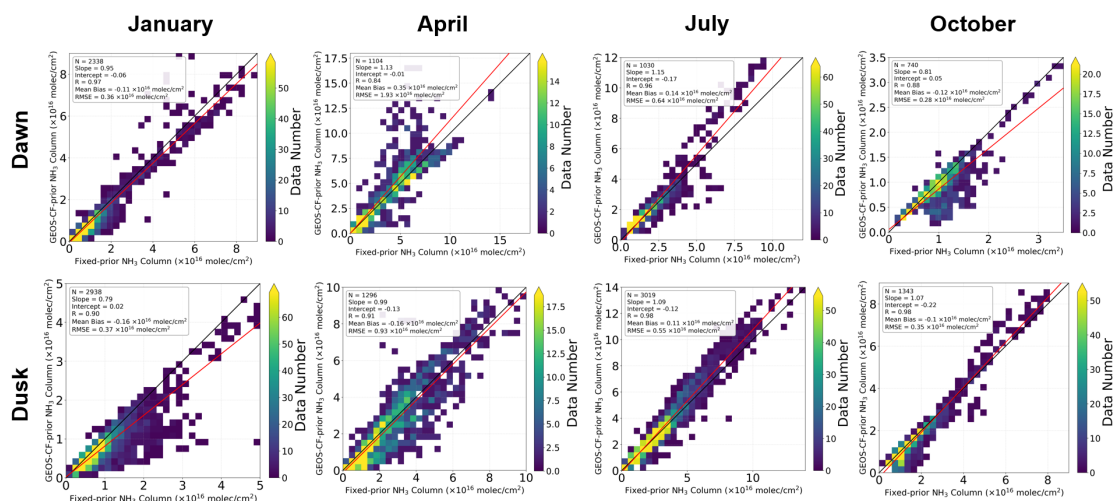


Figure S1. Comparisons of FY-3E/HIRAS-II retrieved NH₃ columns between the baseline retrieval using a fixed a priori NH₃ profile and the sensitivity retrieval using spatiotemporally matched GEOS-CF NH₃ profiles as variable a priori profiles over the North China Plain (25°N–45°N, 110°E–130°E). Results are shown for selected days in January, April, July, and October 2024, including the 5th, 15th, and 25th days of each month. The black solid line represents the 1:1 line, and the red solid line indicates the orthogonal distance regression (ODR) fit. The slope, intercept, correlation coefficient (R), root mean square error (RMSE), mean bias (calculated as the GEOS-CF-prior retrieval minus the fixed-prior retrieval), and number of samples are also provided.

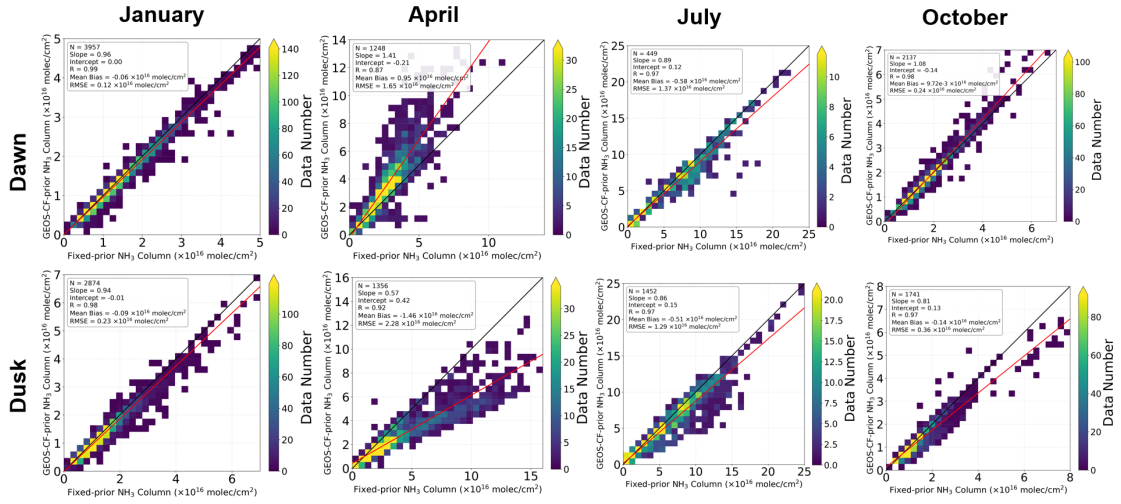


Figure S2. Same as Fig. S1, but for FY-3E/HIRAS-II over the Indo-Gangetic Plain (15°N–35°N, 65°E–95°E).

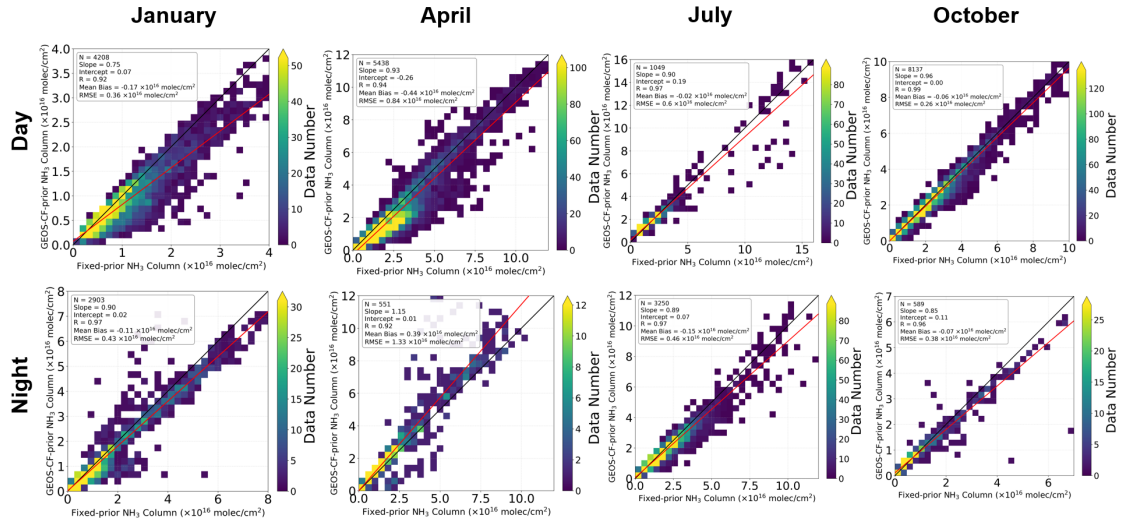


Figure S3. Same as Fig. S1, but for FY-3F/HIRAS-II over the North China Plain (25°N–45°N, 110°E–130°E).

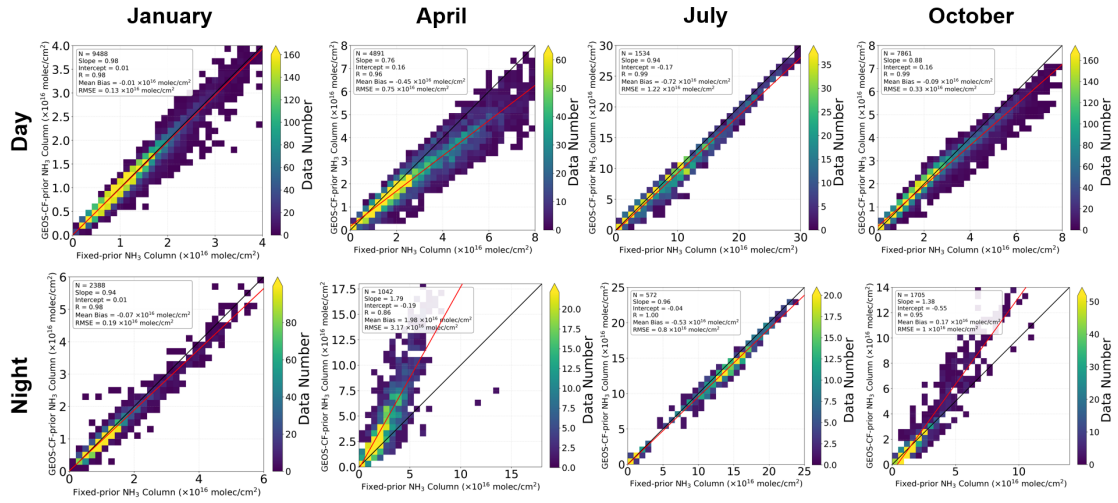


Figure S4. Same as Fig. S1, but for FY-3F/HIRAS-II over the Indo-Gangetic Plain (15°N–35°N, 65°E–95°E).

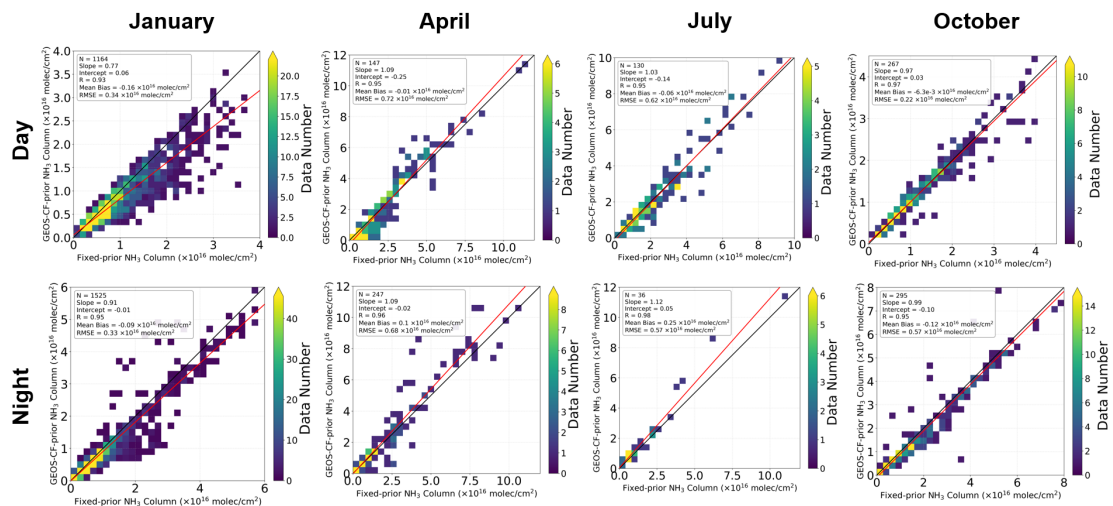


Figure S5. Same as Fig. S1, but for CrIS over the North China Plain (25°N–45°N, 110°E–130°E).

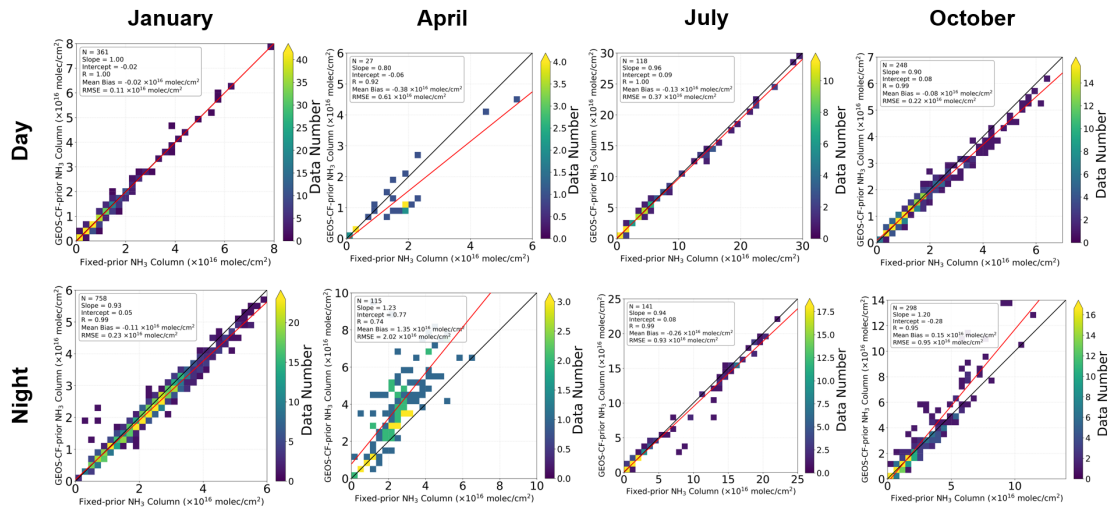


Figure S6. Same as Fig. S1, but for CrIS over the Indo-Gangetic Plain (15°N–35°N, 65°E–95°E).

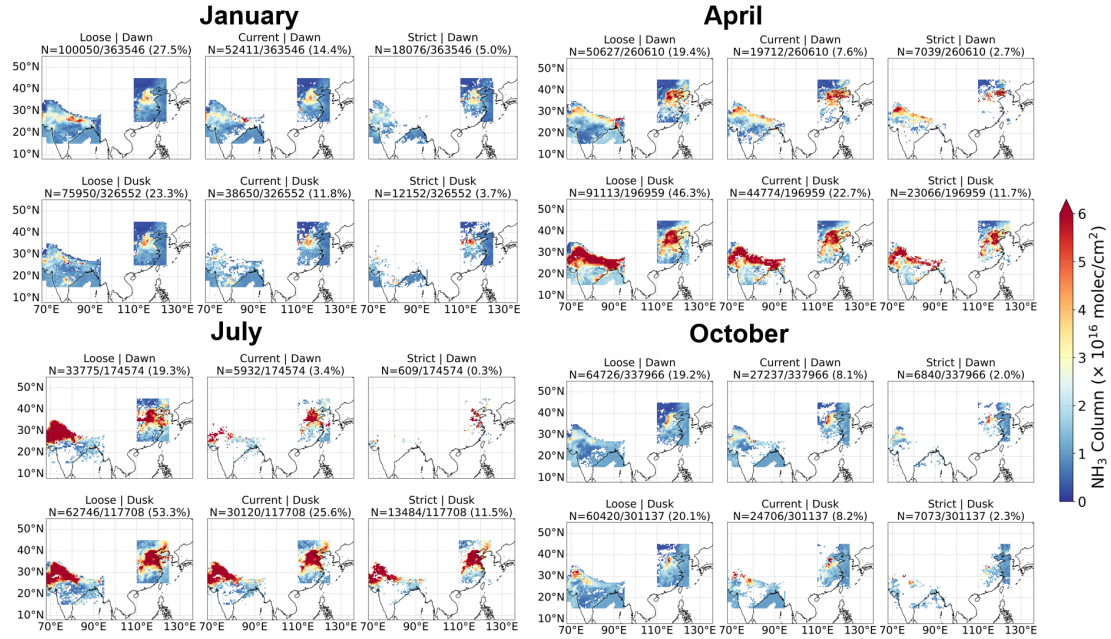


Figure S7. Sensitivity of FY-3E/HIRAS-II NH_3 spatial distributions to filtering criteria over (a) the North China Plain and (b) the Indo-Gangetic Plain. The three columns correspond to the loose filter, current hotspot filter, and strict filter, respectively. N values in the subpanel titles are given as retained retrievals / raw retrievals after applying the corresponding filter, with the retained percentage shown.

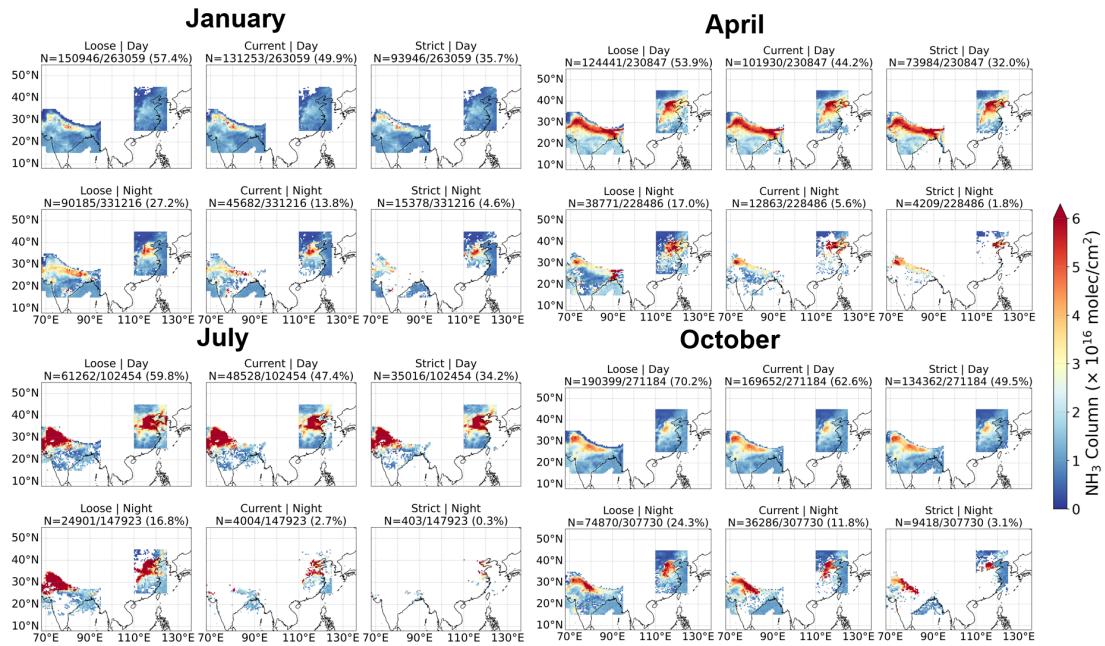


Figure S8. Same as Fig. S7, but for FY-3F/HIRAS-II.

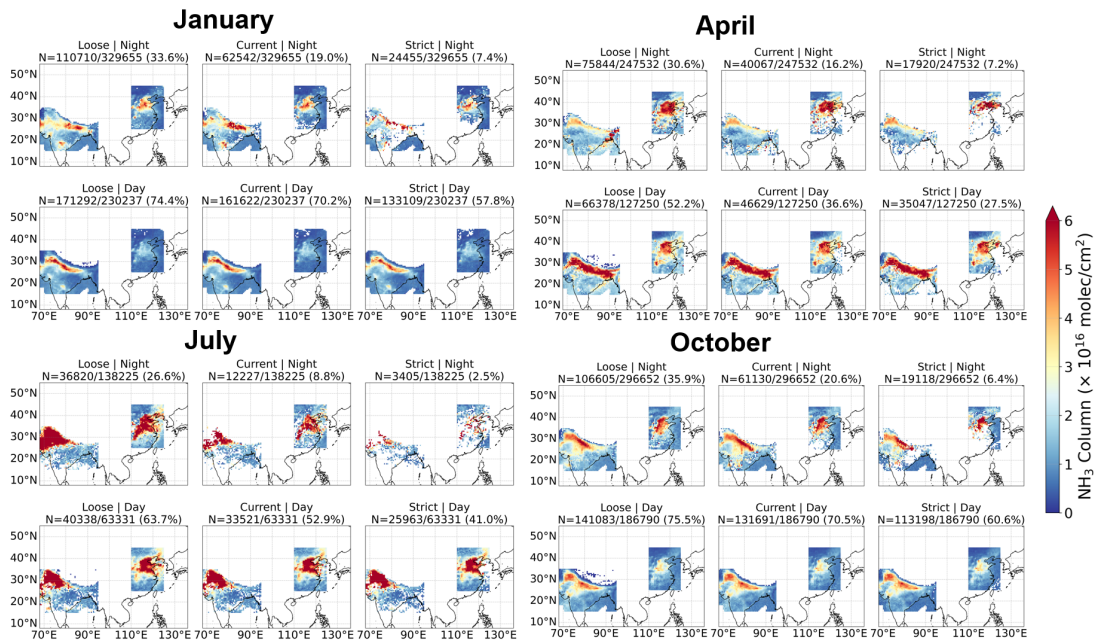


Figure S9. Same as Fig. S7, but for CrIS.

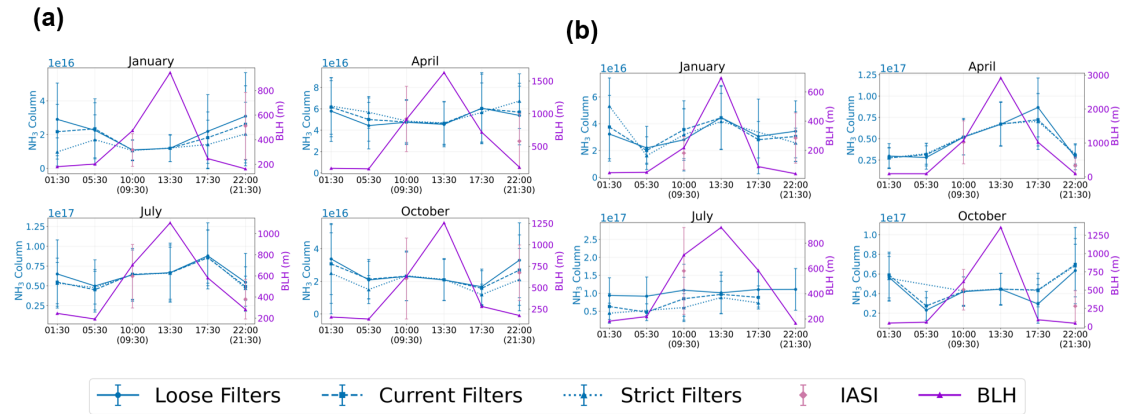


Figure S10. Sensitivity of regional NH_3 diurnal cycles to filtering criteria over (a) the North China Plain (37°N , 118°E) and (b) the Indo-Gangetic Plain (28°N , 78°E). The loose, current, and strict filters correspond to surface AVK > 0.1 and absolute TC > 3 K, surface AVK > 0.3 and absolute TC > 5 K, and surface AVK > 0.4 and absolute TC > 7 K, respectively.

Table S1. Parameters in the state vector to be retrieved from the FY-LeoAIR NH₃ retrieval algorithm.

Variable	Number of variables	A priori values	A priori error
NH ₃	1	GEOS-CF simulations	350%
H ₂ O	1	ECMWF ERA5	30%
O ₃	1	ECMWF ERA5	10%
CO ₂	1	ECMWF CAMS	5%
HNO ₃	1	LBLRTM Standard Atmosphere	10%
N ₂ O	1	LBLRTM Standard Atmosphere	10%
CFC-12	1	LBLRTM Standard Atmosphere	20%
Surface skin temperature	1	ECMWF ERA5	5 K
Air temperature profile	1	ECMWF ERA5	0.5%
Scale factors for surface emissivity	4	[0.0,0.0,0.0,0.0]	[0.1%,0.01%,0.001%,0.0001%]

Notes: LBLRTM Standard Atmosphere data are from

<https://github.com/ReFRACtor/ABSCO/tree/master/VMR> (last access: 14 June 2026). The a priori surface emissivity spectrum is taken from the emissivity database and is adjusted using a multiplicative Legendre polynomial expansion. Four coefficients corresponding to the first- to fourth-order terms are retrieved, while the zeroth-order term is fixed to unity and is not included in the state vector.

Table S2. Number of quality-controlled retrievals used to calculate the monthly means in Fig. 9.

Region	Month	01:30	05:30	10:00	13:30	17:30	22:00
North China Plain	January	238	457	937	1524	296	431
	April	176	157	1306	621	946	127
	July	137	227	1077	807	900	227
	October	263	301	1401	1607	380	346
Indo-Gangetic Plain	January	421	200	101	1606	16	306
	April	1103	907	1701	389	188	824
	July	339	31	291	249	444	0
	October	1462	97	3527	2032	136	596
Central U.S.	January	528	646	326	1279	274	470
	April	400	386	979	804	231	795
	July	209	60	2041	975	582	64
	October	823	938	1862	1777	33	983