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Supplement of

Satellite retrieval of tropospheric NO_2 under fire conditions

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Table S1. Geographic coordinates and altitudes of the PGN sites

PGN site	RichmondCA	MountainViewCA	WrightwoodCA
Location latitude [deg]	37.9130	37.4200	34.3819
Location longitude [deg]	-122.3360	-122.0568	-117.6813
Location altitude [m]	5	50	2207

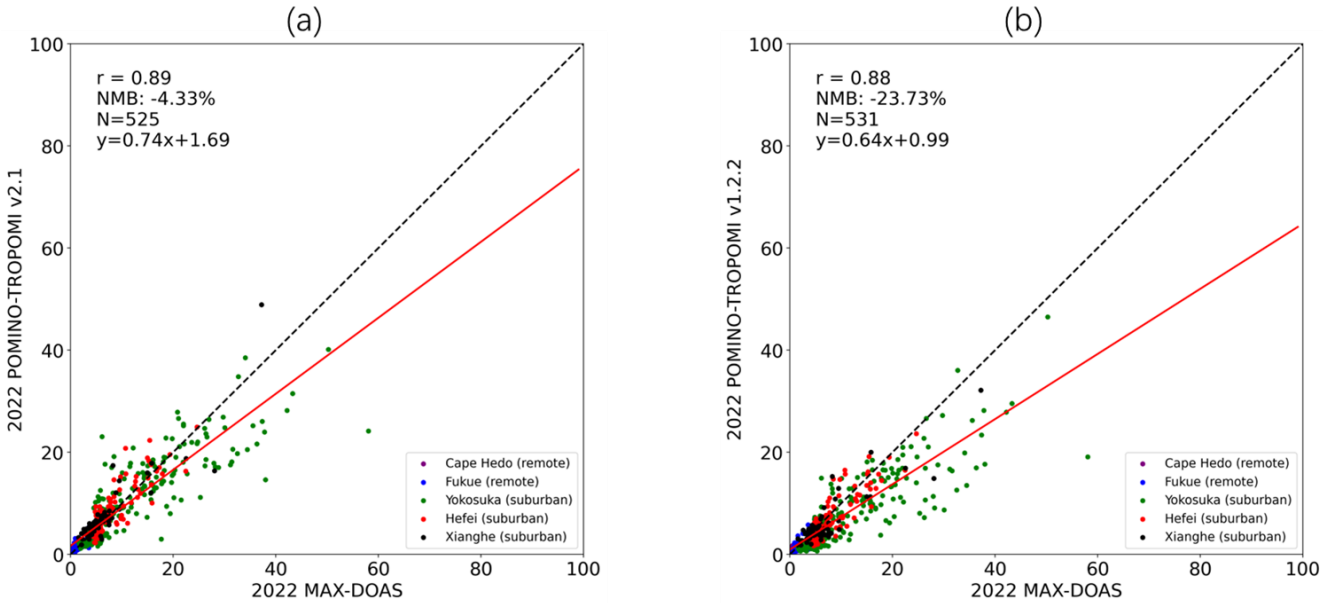


Figure S1. Comparison of tropospheric NO_2 VCDs between POMINO-TROPOMI retrievals and MAX-DOAS observations in 2022. (a) POMINO-TROPOMI v2.1 versus MAX-DOAS. (b) POMINO-TROPOMI v1.2.2 versus MAX-DOAS.

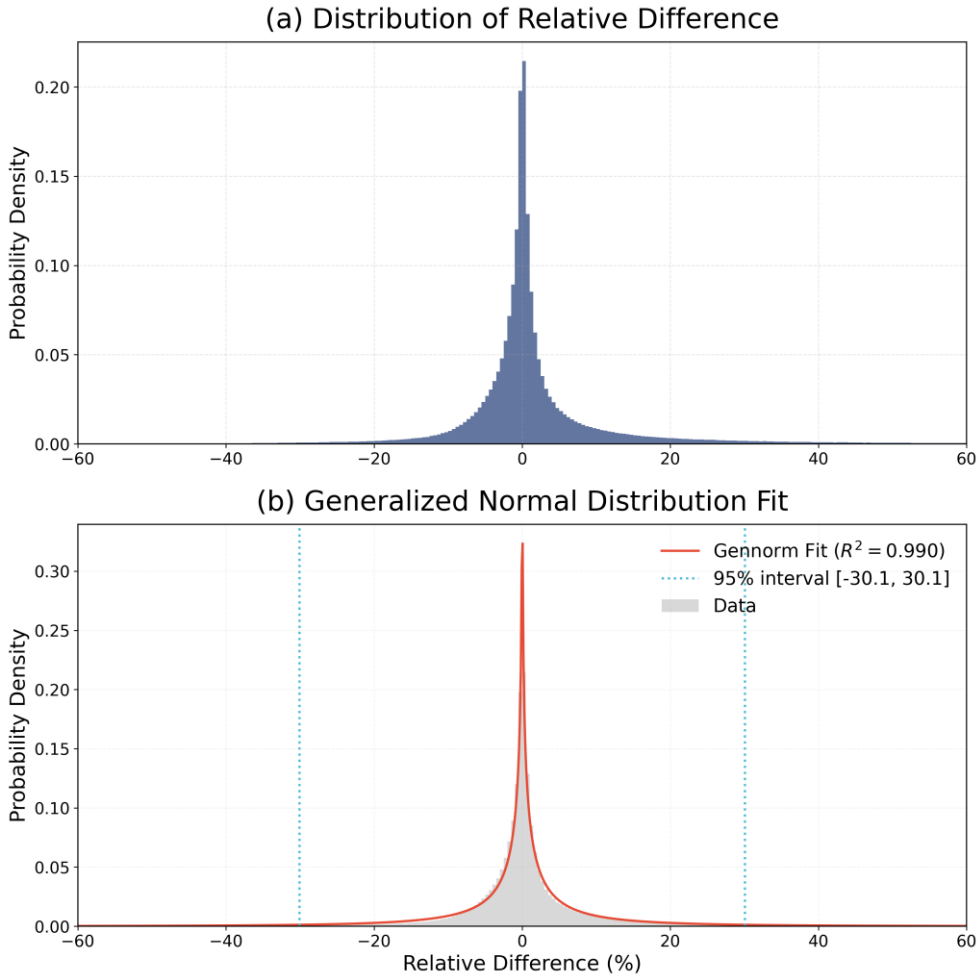


Figure S2. Distribution and generalized normal distribution fit of relative differences between POMINO-GC-Fire and POMINO-GC-NoFire NO_2 VCDs. (a) Probability density distribution of the relative differences in NO_2 VCDs between the POMINO-GC-Fire and POMINO-GC-NoFire. (b) Generalized normal distribution (gennorm) fitted to the relative difference distribution. The red curve represents the fitted probability density function, with an $R^2 = 0.99$, indicating an excellent fit. The blue dashed vertical lines define the central 95% interval, and the gray histogram represents the observed data distribution. Data points falling outside this interval are considered to exhibit relatively large retrieval differences due to the inclusion or exclusion of fire-related a priori information. The distribution is given by the following equation (Nadarajah, 2005): $f(x|\mu,\alpha,\beta) = \frac{\beta}{2\alpha\Gamma(1/\beta)} e^{\left[-\left|\frac{x-\mu}{\alpha}\right|^{\beta}\right]}$, where x denotes the relative VCD difference (%), the parameters μ, α, and β denote the location, scale, and shape of the distribution, respectively, and Γ denotes the gamma function.

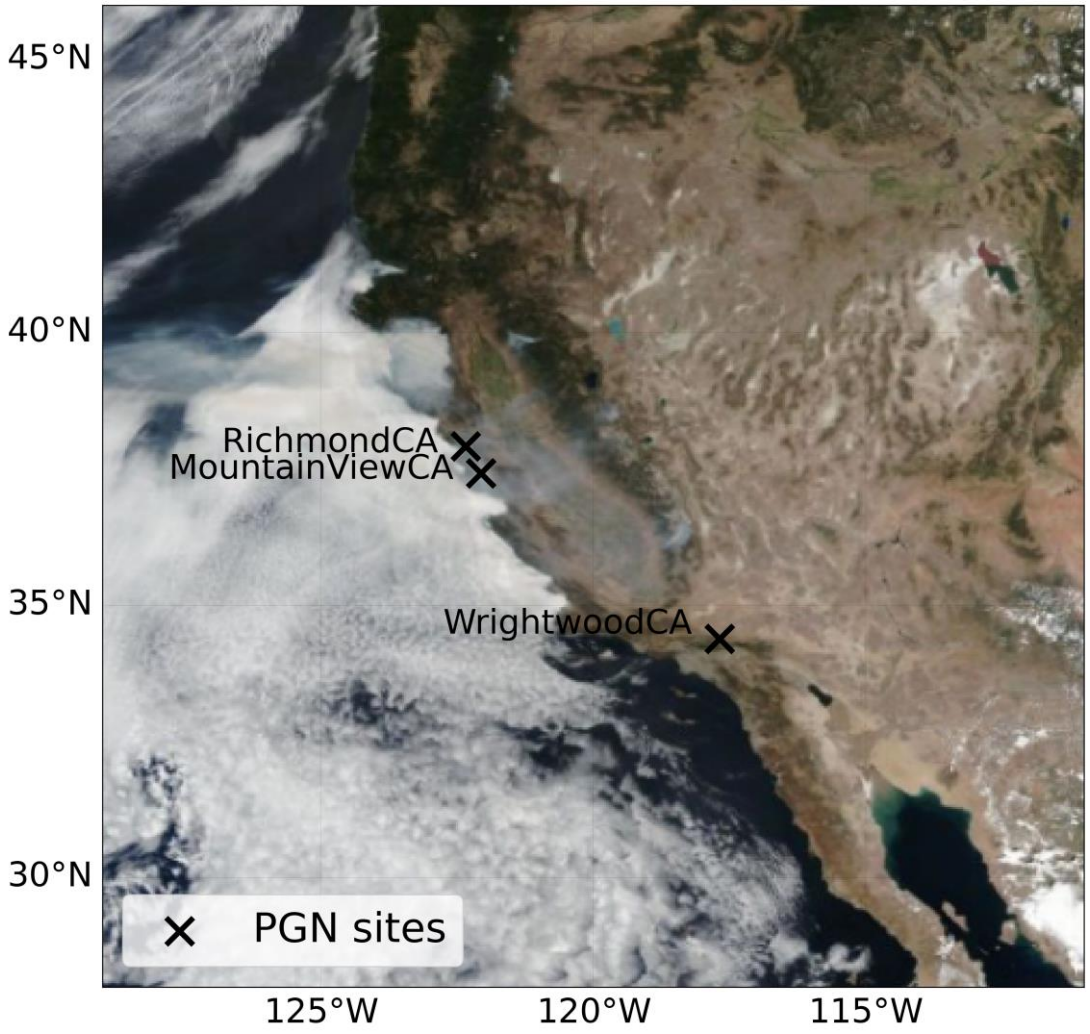


Figure S3. Spatial distribution of the PGN sites listed in Table S1. The map is sourced from NASA's Fire Information for Resource Management System (FIRMS) (NASA-FIRMS, 2026).

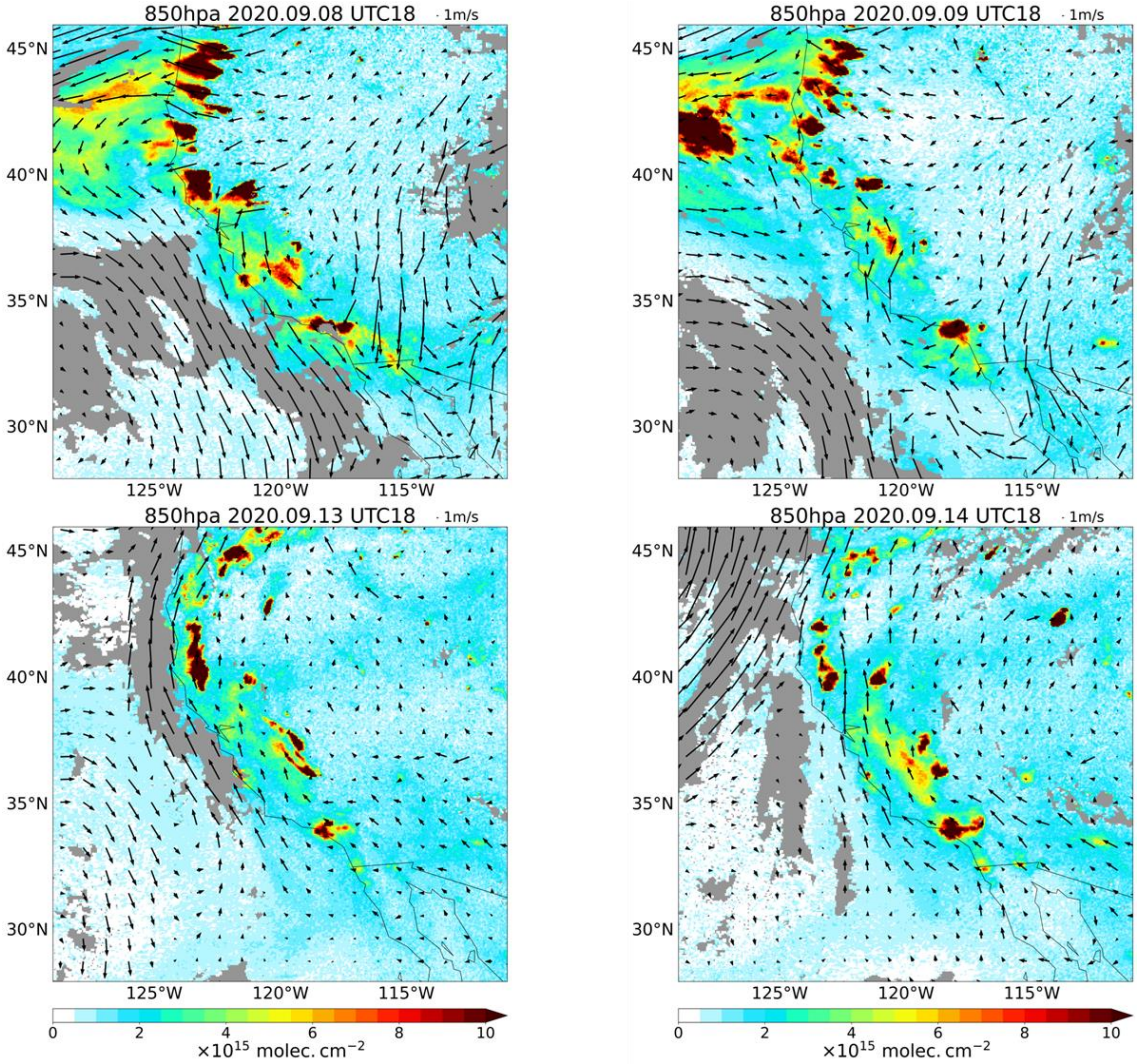


Figure S4. European Centre for Medium-Range Weather Forecasts (ECMWF) real-time analysis 850hpa wind fields with a horizontal resolution of 9 km (subsampled to 90 km for visualization) overlaid on POMINO-GC-Fire daily NO_2 VCDs. The spatial distribution of retrieved NO_2 VCDs demonstrates clear downwind transport from fire regions, consistent with the ECMWF wind fields.

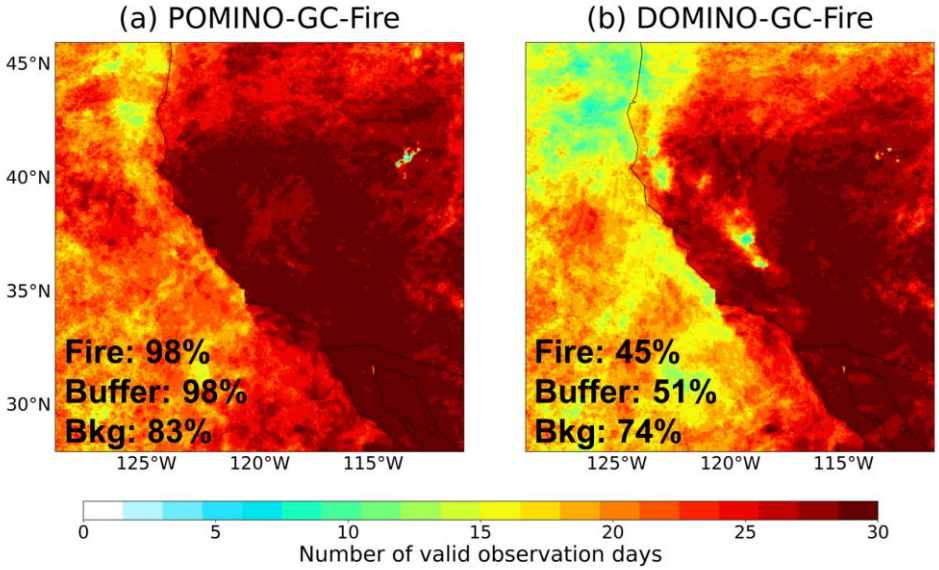


Figure S5. Spatial distributions of valid observation days in September 2020 in different products. (a) Valid days in POMINO-GC-Fire (sampled based on the criteria described in Sect. 2.3). (b) Valid days in DOMINO-GC-Fire (which is the same as valid days in TM5-MP-DOMINO, sampled based on QA ≥ 0.75). The percentages shown in each panel indicate data coverage in the fire (Fire), buffer (Buffer), and background (Bkg) regions. Coverage at each grid cell is the ratio of valid observation days to the total number of days in September.

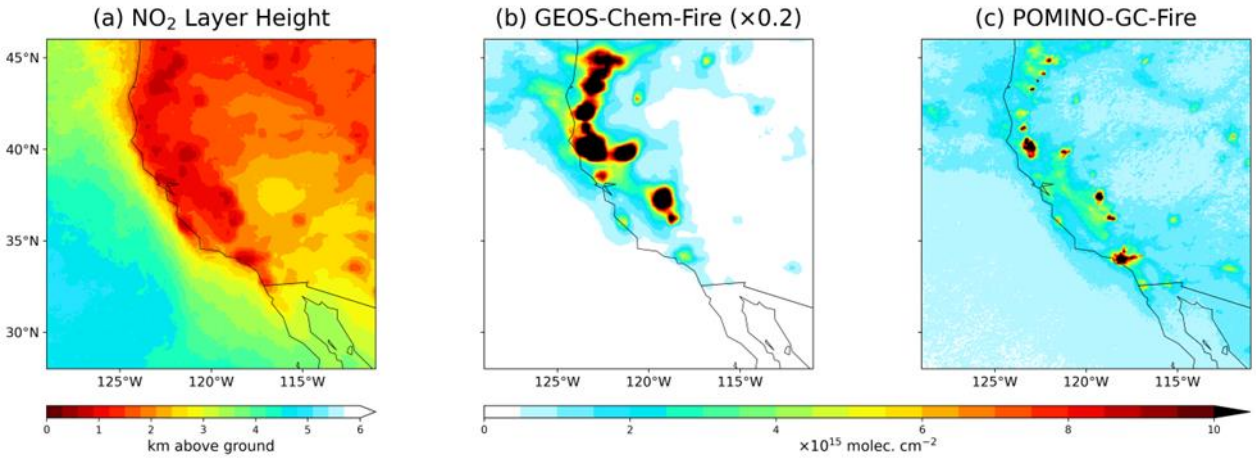


Figure S6. Comparison of monthly mean tropospheric NO_2 VCDs modeled by GEOS-Chem-Fire and retrieved by POMINO-GC-Fire over the western United States in September 2020. (a) NO_2 layer height (NLH) from GEOS-Chem-Fire, expressed as height above ground. (b) NO_2 VCDs modeled by GEOS-Chem-Fire. (c) NO_2 VCDs retrieved by POMINO-GC-Fire. The modeled columns in panel (b) are multiplied by 0.2 for visualization.

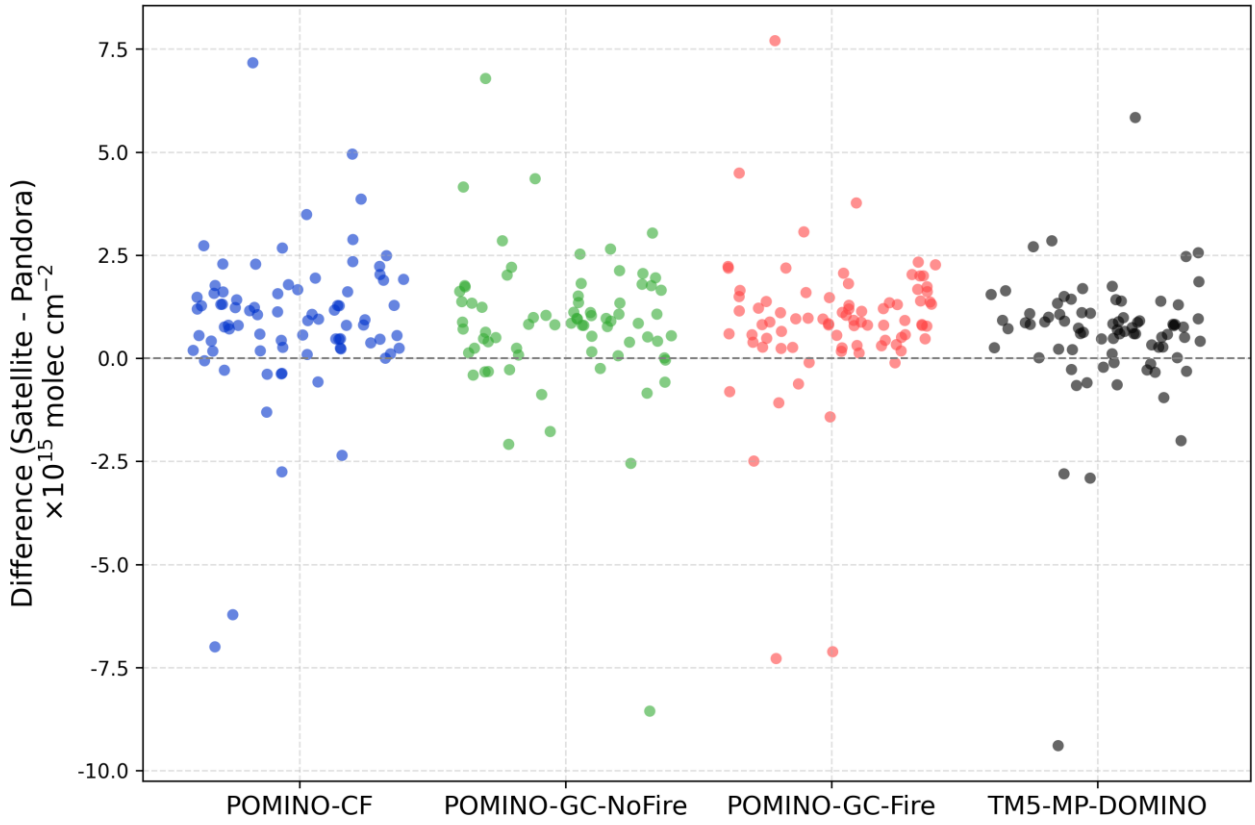


Figure S7. Scatter plot of differences between satellite-derived and PGN NO_2 VCDs

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References

Nadarajah, S.: A generalized normal distribution, Journal of Applied Statistics, 32, 685-694, https://doi.org/10.1080/02664760500079464, 2005.

Fire Information for Resource Management System (FIRMS): https://firms.modaps.eosdis.nasa.gov/map/, last access: 13 May 2026.