Supplement of

First evaluation of the GEMS formaldehyde retrieval algorithm against TROPOMI and ground-based column measurements during the in-orbit test period

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Table S1. Summary of the data field variables archived in GEMS Level 2 HCHO product. Layer, spatial, and image represent the number of vertical layers of the a priori profile, cross-track, and along-track of the GEMS observation.

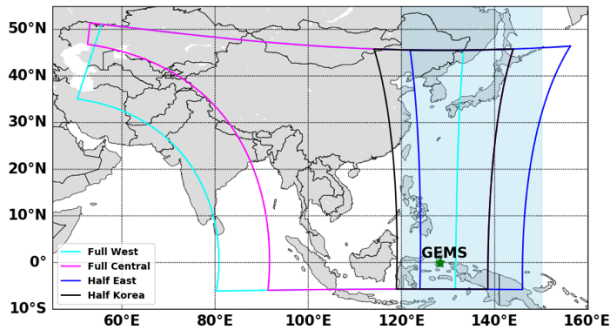| Variable name	Description	Unit	Dimensions
AirMassFactor	AMF	unitless	spatial × image
ClearAirMassFactor	AMF (cloud-free condition)	unitless	spatial × image
AMFCloudFraction	Air mass factorCloud radiance fraction	unitless	spatial × image
AMFCloudPressure	Cloud top pressure	hPa	spatial × image
AMFDiagnostic	Diagnostic flags in AMF calculation	unitless	spatial × image
AMFSurfaceLER	Surface Lambertian-equivalent reflectivity	unitless	spatial × image
ColumnAmount	HCHO VCD	molecules cm^{-2}	spatial × image
ColumnUncertainty	Random uncertainty of the VCD	molecules cm^{-2}	spatial × image
DSCD	Retrieved SCD before background correction	molecules cm^{-2}	spatial × image
FitConvergenceFlag	Degree of convergence of the spectral fitting	unitless	spatial × image
FittingRMS	Fitting root mean square error	unitless	spatial × image
GasProfile	HCHO a priori profile	molecules cm^{-3}	layer × spatial × image
Layer	Pressure profile	hPa	layer × spatial × image
ScatteringWeight	Scattering weight	unitless	spatial × image
ClearScatteringWeight	Scattering weight (cloud-free condition)	unitless	spatial × image
FinalAlgorithmFlags	Final algorithm flags	unitless	spatial × image

Fig. S1. Operational scan domain of GEMS (adapted from Kwon et al., 2019) : half eastern scan (blue), half Korea scan (black), full central scan (magenta), full western scan (cyan), and GEMS location (green star). Shaded areas (120–150° E) represent regions for radiance references and common mode.
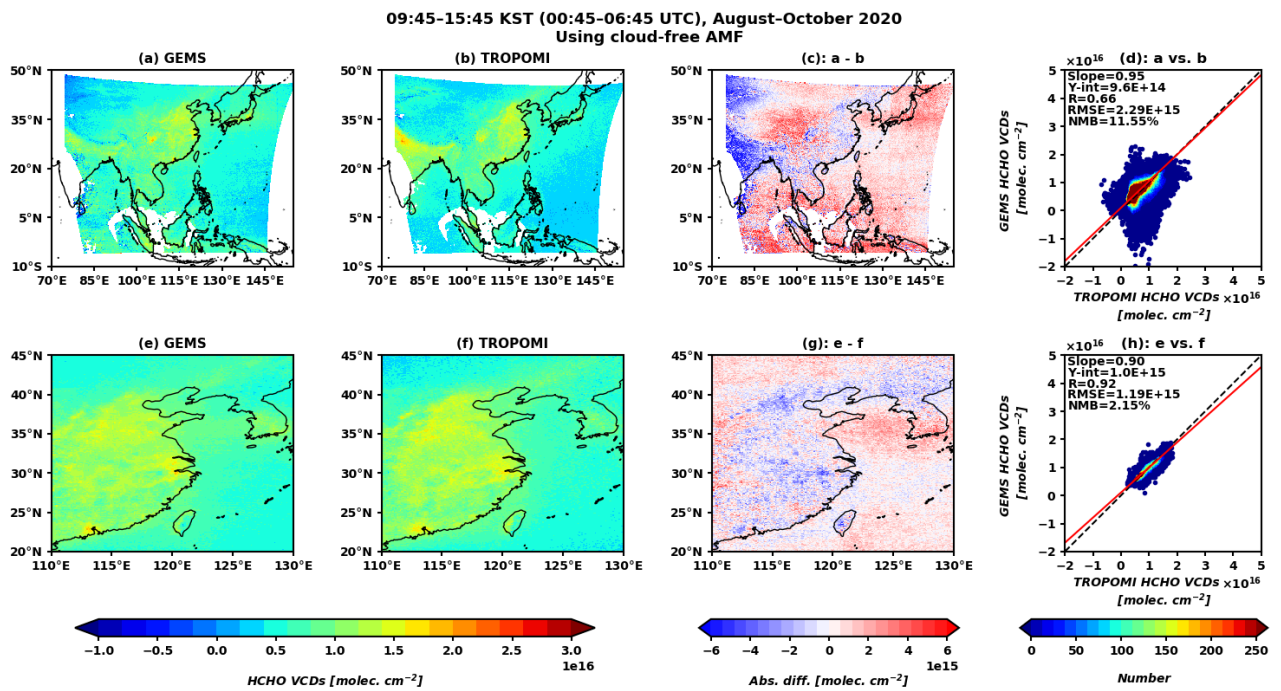

Fig. S2. Same as Fig. 9 except for the AMF computation under the cloud-free assumption.
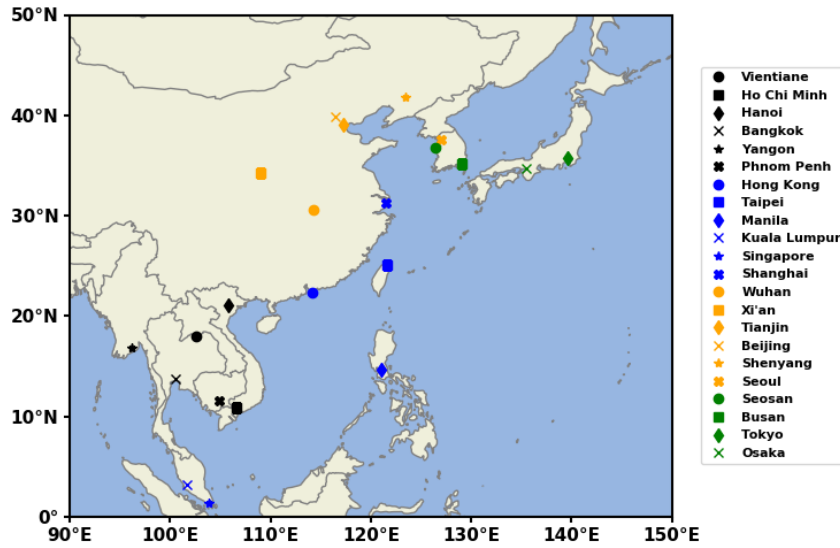
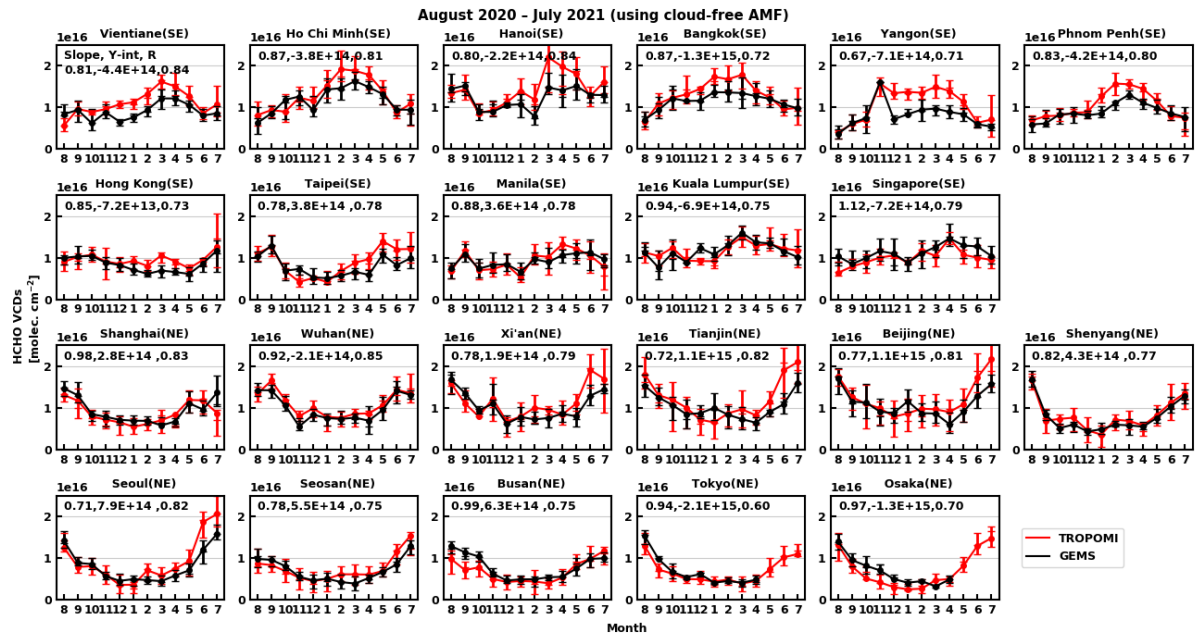**Fig. S3. Regions selected for the comparison between GEMS and TROPOMI.**

Fig. S4. Same as Fig. 11 except for the AMF computation under the cloud-free assumption.
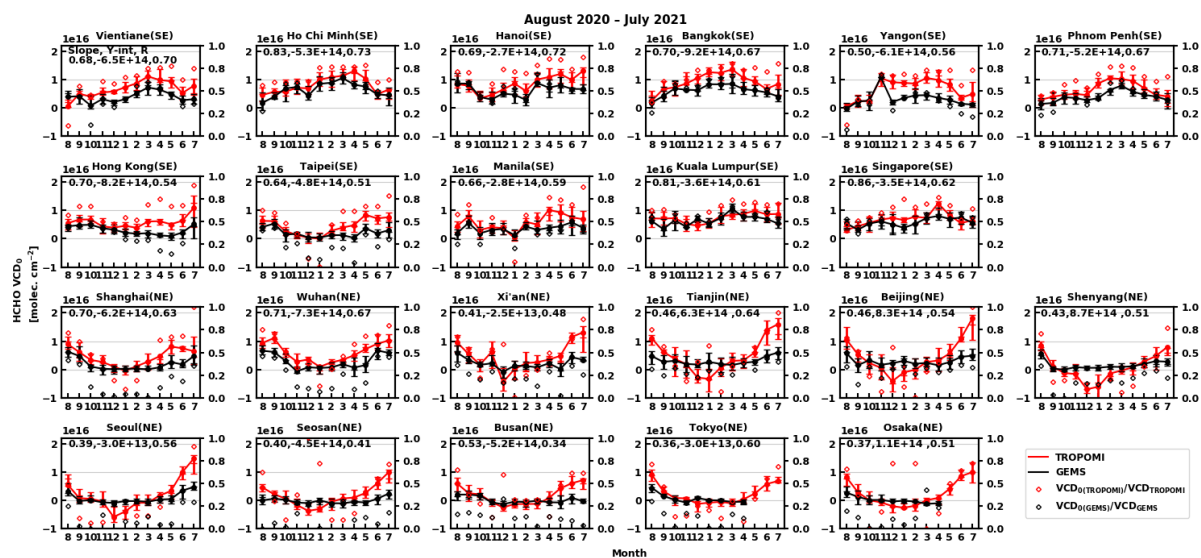
Fig. S5. Same as Fig. 11 but for VCD$_0$ (VCDs without background contributions). Diamonds represent an absolute value of VCD$_0$/VCD.
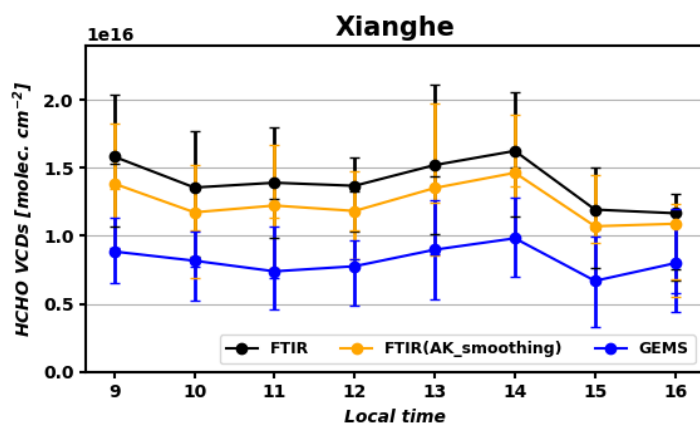

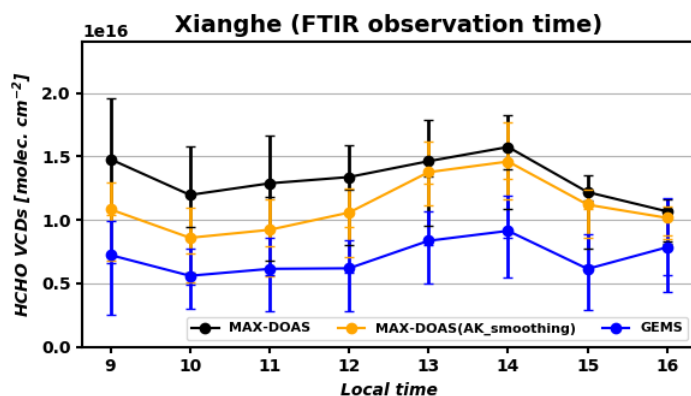**Fig. S6.** Same as. Fig. 16 except for FTIR observation.

Fig. S7. Same as Fig. 13 except for the MAX-DOAS HCHO in FTIR observation time.
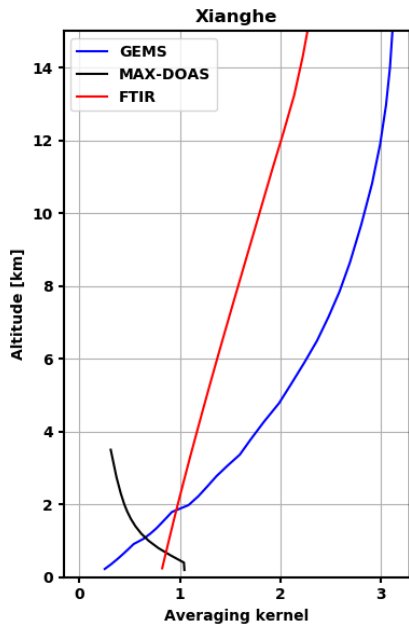
Fig. S8. Daily mean averaging kernels of GEMS (blue), MAX-DOAS (black), and FTIR (red) during 3 August 2020.