Supporting Information for

Improving Ozone Simulations in Asia via Multisource Data Assimilation: Results from an Observing System Simulation Experiment with GEMS Geostationary Satellite Observations

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Table S1. WRF-Chem and GEOS-Chem model configurations.

Configurations	(1) WRF-Chem v4.1	(2) GEOS-Chem v12.9.3
Global simulation	—	2° × 2.5° with 72 vertical layers up to 0.1 hPa, spin-up time of 1 year
Asian simulation	50 km × 50 km (centered at 35°N, 103°E) with 34 vertical layers up to 50 hPa, spin-up time of 72 h	0.5° × 0.625° (11°S–55°N, 60°–150°E) with 47 vertical layers up to 0.1 hPa, boundary conditions updated every 3 h from the global simulation, spin-up time of 6 months
Meteorological conditions	National Centers for Environmental Prediction (NCEP) Final (FNL) operational global analysis (https://rda.ucar.edu/datasets/ds083.3, last access: 28 October 2022), 0.25° × 0.25°	Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2) meteorological fields (Gelaro *et al.*, 2017)
Chemical initial and boundary conditions	Whole Atmosphere Community Climate Model (WACCM) 6 h outputs (Gettelman *et al.*, 2019)	—
Anthropogenic emission	Multi-resolution Emissions Inventory for China (MEIC) (Zheng *et al.*, 2018), 0.25° × 0.25°; Emissions Database for Global Atmospheric Research-Hemispheric Transport of Air Pollution (EDGAR-HTAP) (Janssens-Maenhout *et al.*, 2015) outside China, 1° × 1°	Community Emissions Data System (CEDS) (Hoesly *et al.*, 2018), substituted by MIX inventory (Li *et al.*, 2017) over Asia
Biogenic emission	Model of Emissions of Gases and Aerosols from Nature (MEGAN) (Guenther *et al.*, 2012)	MEGAN
Fire emission	Fire INventory from NCAR (FINN) version 1.5 (Wiedinmyer *et al.*, 2011)	the fourth-generation Global Fire Emissions Database (GFED4) (Giglio *et al.*, 2013)
Chemical mechanism	CBMZ chemical mechanism (Zaveri and Peters, 1999) for gas-phase chemistry and MOSAIC aerosol scheme configured with 4 sectional aerosol bins (Zaveri *et al.*, 2008)	HO_x-NO_x-VOC-ozone-aerosol-halogen tropospheric chemistry mechanism (Bey *et al.*, 2001; Park *et al.*, 2004; Mao *et al.*, 2013)

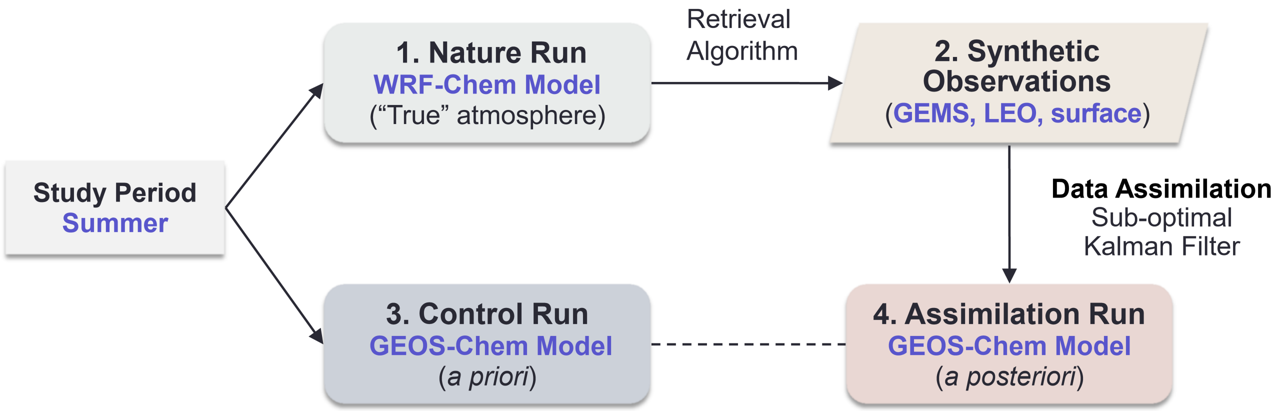

Figure S1. The framework of the Observing System Simulation Experiment (OSSE). Modified from Shu *et al.* (2022).

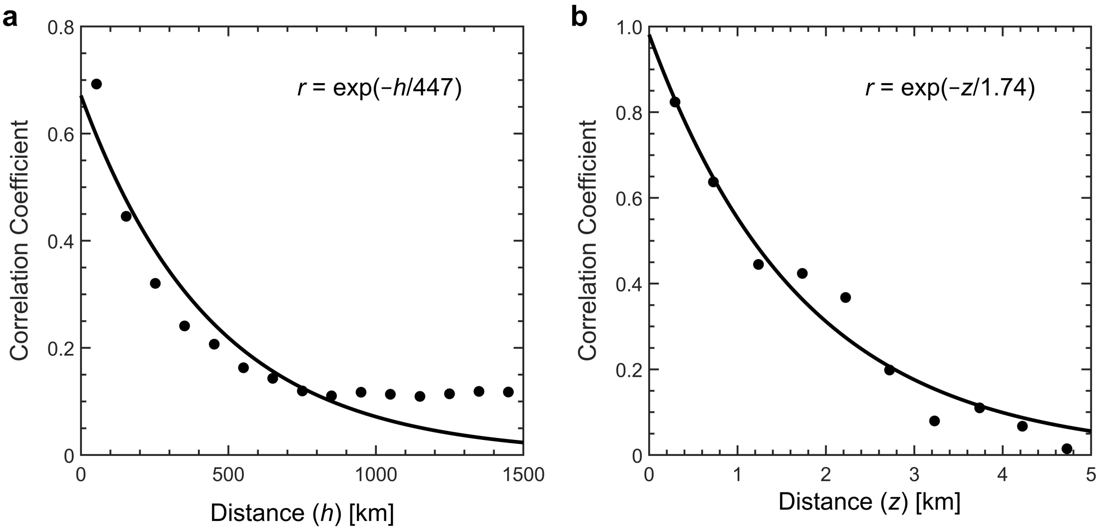

Figure S2. Horizontal and vertical error correlation length for the GEOS-Chem simulation of tropospheric ozone in Asia. The panel (a) shows the correlation coefficients (*r*) of the model errors between pairs of surface monitoring sites relative to surface ozone observations from the China National Environmental Monitoring Center (CNEMC; http://www.cnemc.cn/, last access: 28 October 2022) and plotted against the horizontal distance *h* (in km, binned every 100 km). The panel (b) shows the correlation coefficients of the model errors between pairs of vertical levels (from surface to 8 km altitude) relative to ozonesonde measurements (Shu *et al.*, 2022) and plotted against the vertical distance *z* (in km, binned every 500 m). Exponential fits based on the least-squares method to the data are shown inset.

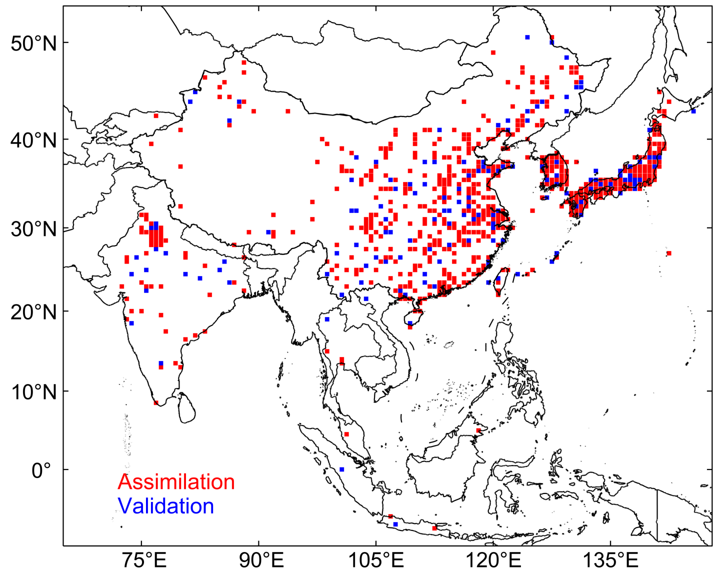

Figure S3. Distribution of super-observation grids for assimilation (red) and validation (blue) over the Asian domain.

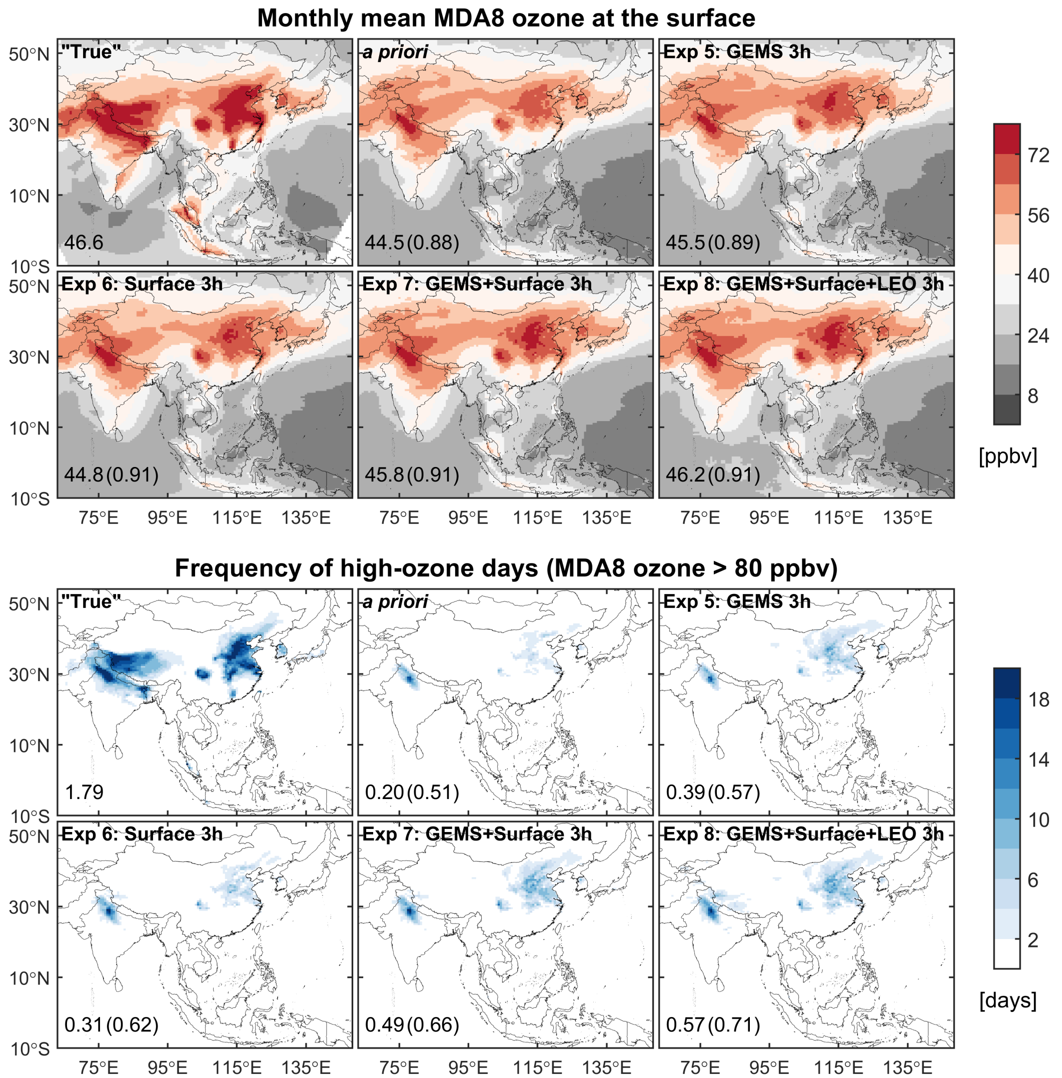

Figure S4. Same as Fig. 4 but for *assimilation runs* with the assimilation time step of 3 h (Exp 5–8 in Table 1).

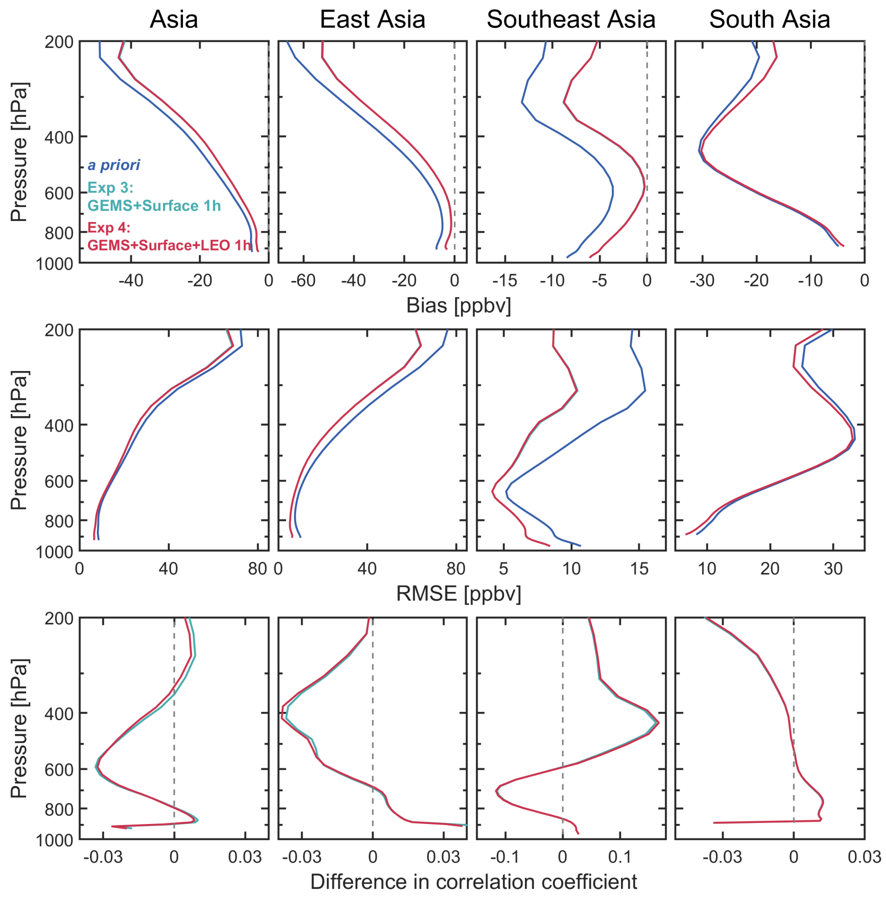

Figure S5. Same as Fig.7 but for *assimilation runs* with the assimilation time step of 1 h (Exp 3 and 4 in Table 1).

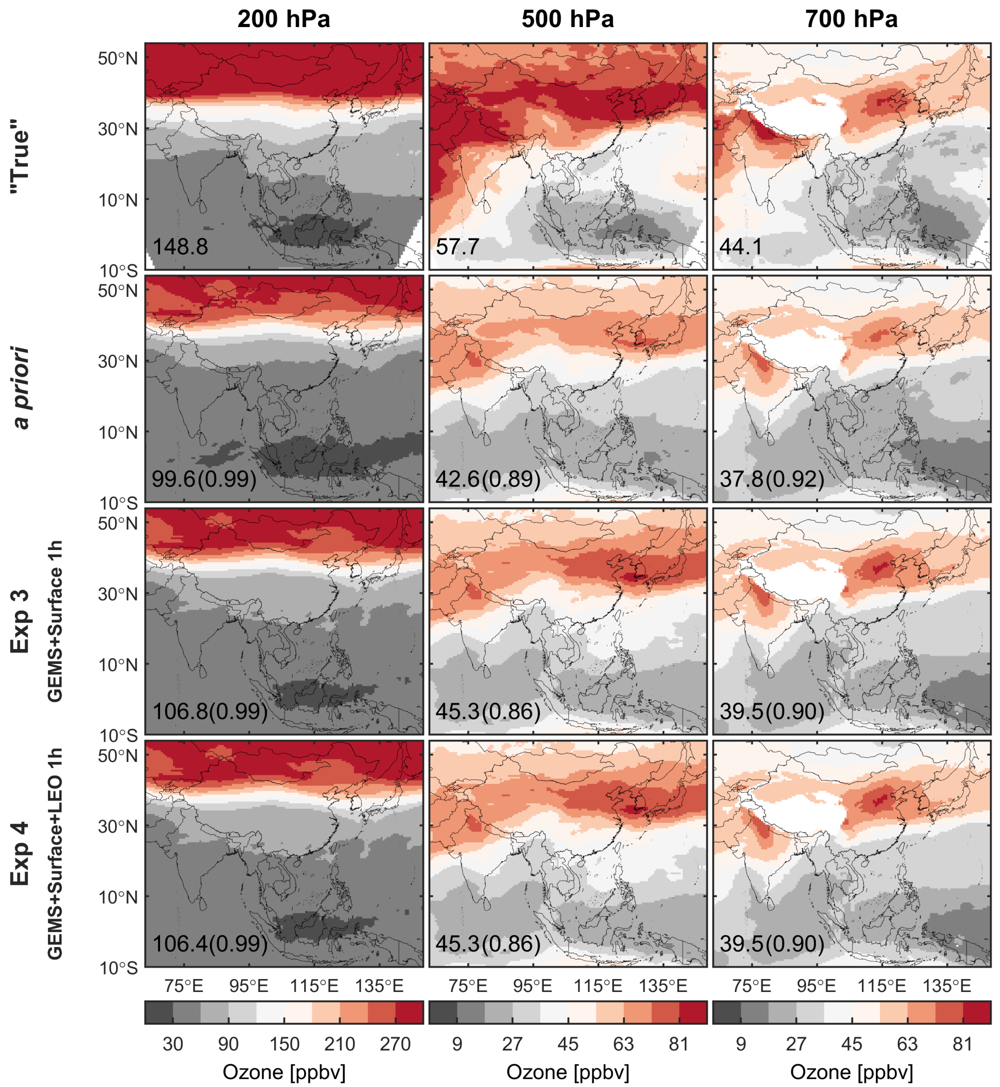

Figure S6. Same as Fig. 8 but for *assimilation runs* with the assimilation time step of 1 h (Exp 3 and 4 in Table 1).

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