

NASA GEOS Composition Forecast System, GEOS-CF: TEMPO Support



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GMAO
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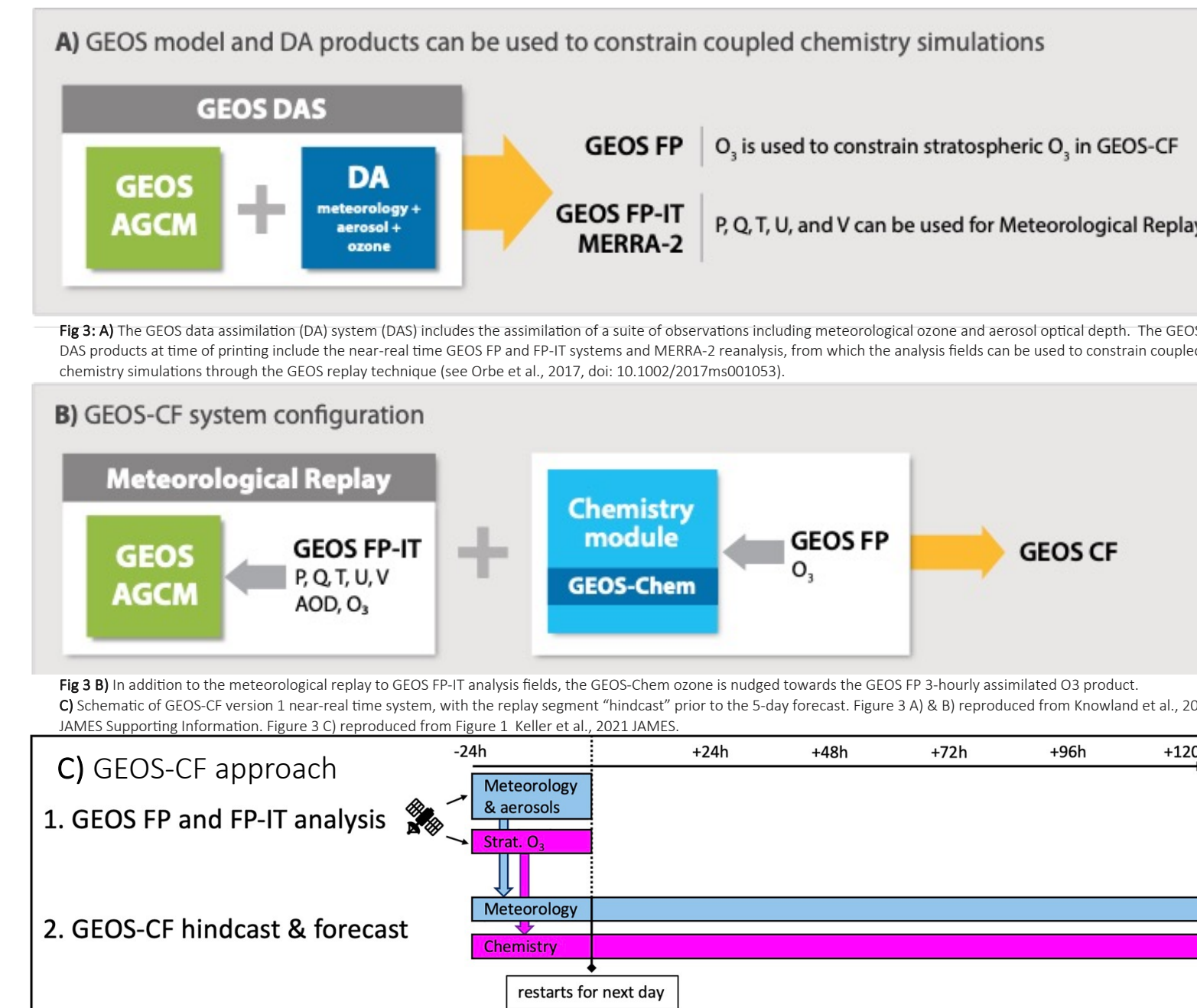


Introduction

GEOS is an Earth System Model designed to advance the use of satellite data products. Since it is a modular system, it can be run as a numerical weather prediction model and coupled to chemistry modules.

GEOS-CF

For version 1 of GEOS-CF, the GEOS AGCM is coupled to the GEOS-Chem chemistry module (version 12) with full tropospheric and stratospheric chemistry



- One 5-day forecast per day
- Initialized at 12z
 - 1-day meteorological replay
 - 5-day forecast
 - c360 (0.25°, ~25x25 km²)
 - 72 layers (surface to 0.01hPa)
- Emissions:
- HTAP v2.2 (global bottom-up) for anthropogenic
 - Near real-time fires (QFED)
 - Online dust, sea salt, plant emissions

Keller, C. A., Knowland, K. E., et al. (2021). Description of the NASA GEOS composition forecast modeling system GEOS-CF v1.0. *Journal of Advances in Modeling Earth Systems (JAMES)*, 13, e2020MS002413. <https://doi.org/10.1029/2020MS002413>

Knowland, K. E., Keller, C. A., et al. (2022). NASA GEOS Composition Forecast Modeling System GEOS-CF v1.0: Stratospheric Composition. *JAMES* <https://doi.org/10.1029/2021MS002852>

Knowland et al., 2022. "File Specification for GEOS-CF Products." GMAO Office Note No. 17 (Version 1.3), available from http://gmao.gsfc.nasa.gov/pubs/office_notes

TEMPO support

A special collection was created for TEMPO “sat_inst_1hr_r721x361_v72” Regional Chemistry and Meteorology Diagnostics to support TEMPO satellite Frequency: *hourly instantaneous from 00:00 UTC*

Spatial Grid: *3D, model-level, subset region of full horizontal resolution*
Dimensions: *longitude=721, latitude=361, every 0.25°*

longitude: 0° to -180°

latitude: 0° to 90°

vertical level: 72 layers

Granule Size: ~258 MB per file

Start date: 00 UTC 1 January 2022

Mode: Replay; Forecasts during mission

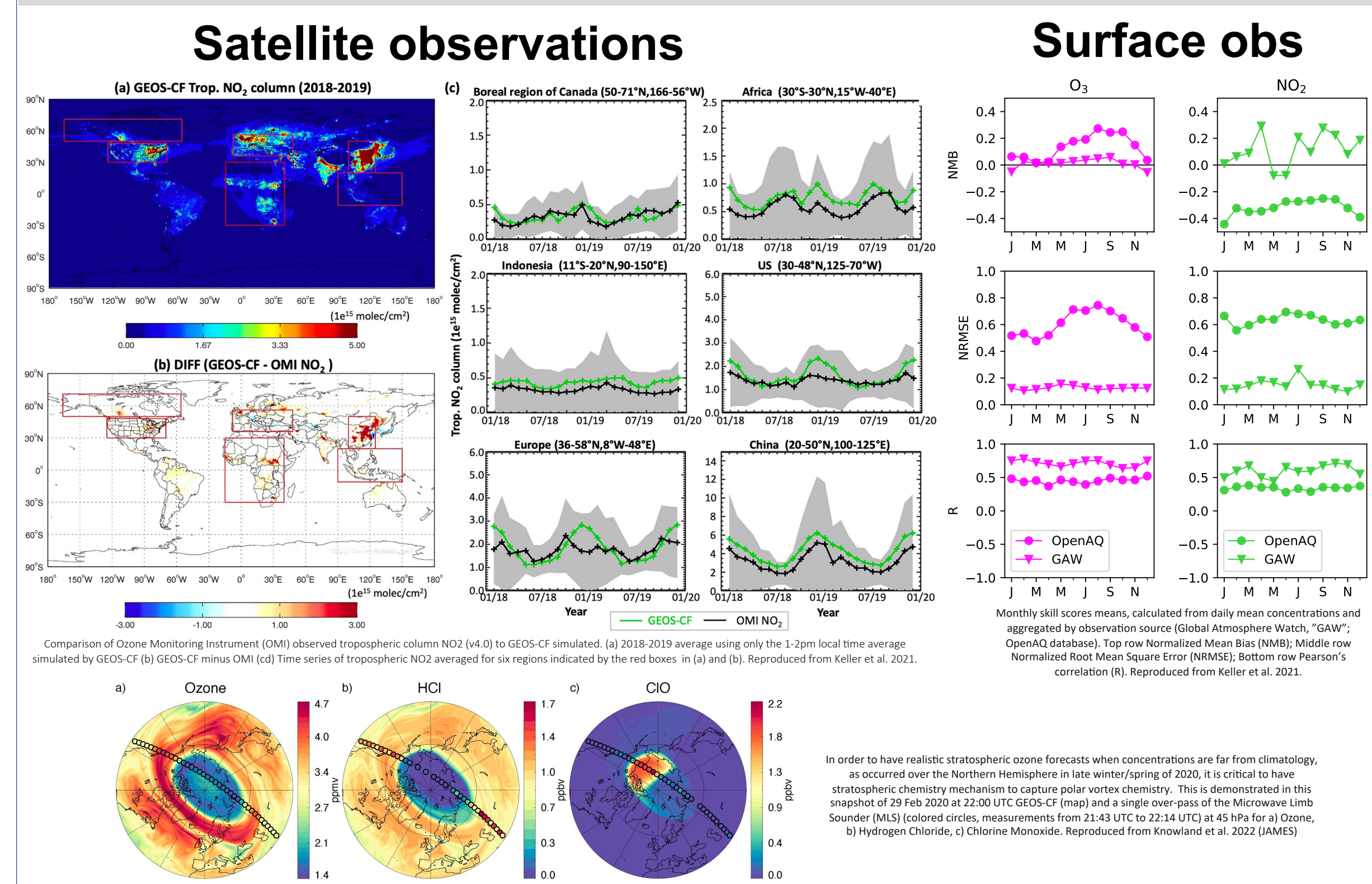
Name	Dim	Description	Units
BrO	tzxy	Bromine monoxide (BrO, MW = 96.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
FRSEACE	tyx	ice covered fraction of tile	1
FRSNO	tyx	fractional area of land snowcover	1
GLYX	tzxy	Glyoxal (CHOCHO, MW = 58.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
HCHO	tzxy	Formaldehyde (CH ₂ O, MW = 30.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
HNO2	tzxy	Nitrous acid (HNO ₂ , MW = 47.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
IO	tzxy	Iodine monoxide (IO, MW = 143.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
NO2	tzxy	Nitrogen dioxide (NO ₂ , MW = 46.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
O3	tzxy	Ozone (O ₃ , MW = 48.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
OCIO	tzxy	Chlorine dioxide (OCIO, MW = 67.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
PHIS	tyx	surface geopotential height	m+2 s-2
PS	tyx	surface pressure	Pa
Q	tzxy	specific humidity	kg kg ⁻¹
SNODP	tyx	snow depth	m
SNOMAS	tyx	Total snow storage land	kg m ⁻²
SO2	tzxy	Sulfur dioxide (SO ₂ , MW = 64.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
T	tzxy	air temperature	K
TROPPB	tyx	tropopause pressure based on blended estimate	Pa
U2M	tyx	2-meter eastward wind	m s ⁻¹
V2M	tyx	2-meter northward wind	m s ⁻¹
ZPBL	tyx	planetary boundary layer height	m

- Files are accessed by the TEMPO team from the NCCS Dataportal e.g., https://portal.nccs.nasa.gov/datastore/gmao/geos-cf/v1/forecast/Y2022/M01/D23/H12/GEOS-CFv01.rpl.sat_inst_1hr_r720x361_v72*.nc4
- The replay files are available since January 1, 2022 e.g., https://portal.nccs.nasa.gov/datastore/gmao/geos-cf/v1/das/Y2022/M01/D01/GEOS-CFv01.rpl.sat_inst_1hr_r720x361_v72*.nc4

- In addition, hourly climatologies are provided to the TEMPO team for the Northern Hemisphere in case of any long delays in GEOS-CF production during mission operation.

Validation

GEOS-CF v1 has been evaluated for both tropospheric and stratospheric composition and forecast skill (Keller et al., 2021; Knowland et al., 2022, JAMES)

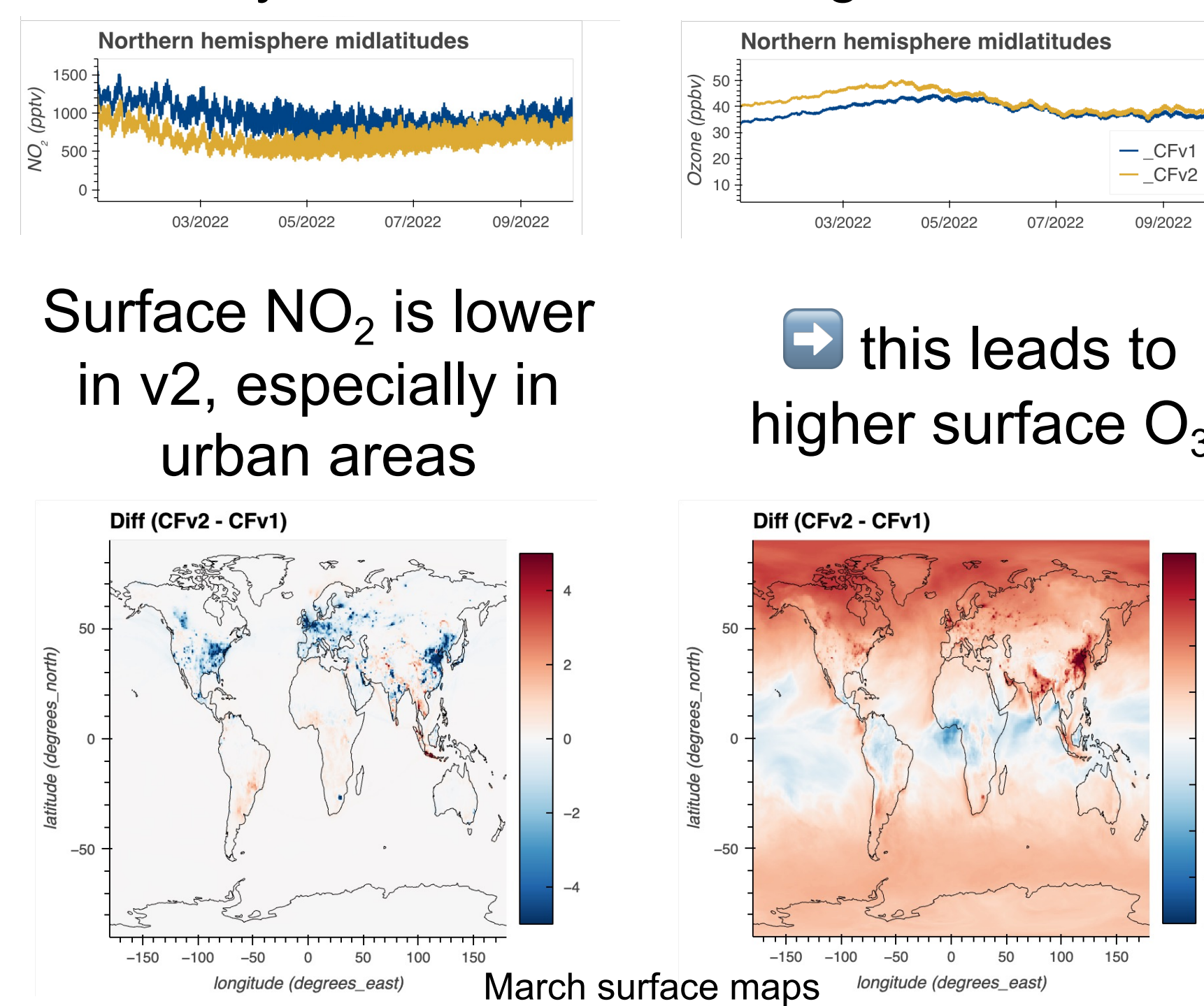


GEOS-CF version 2 development

GEOS-CF v1 was frozen in 2018. Several updates are coming to GEOS-CF version 2, including but not limited to: GEOS AGCM (v10.23.0, release late 2022), new near-real time GEOS for Instrument Teams (GEOS-IT) for meteorological replay segment (see Fig 3b), upgrading to GEOS-Chem v14.0, latest CEDS anthropogenic emissions at 0.1° global resolution up through 2019, data assimilation of Ozone, NO₂, and SO₂ using NASA Aura-based instruments (MLS and OMI).

Early Results of GEOS-CF v2 (2022)

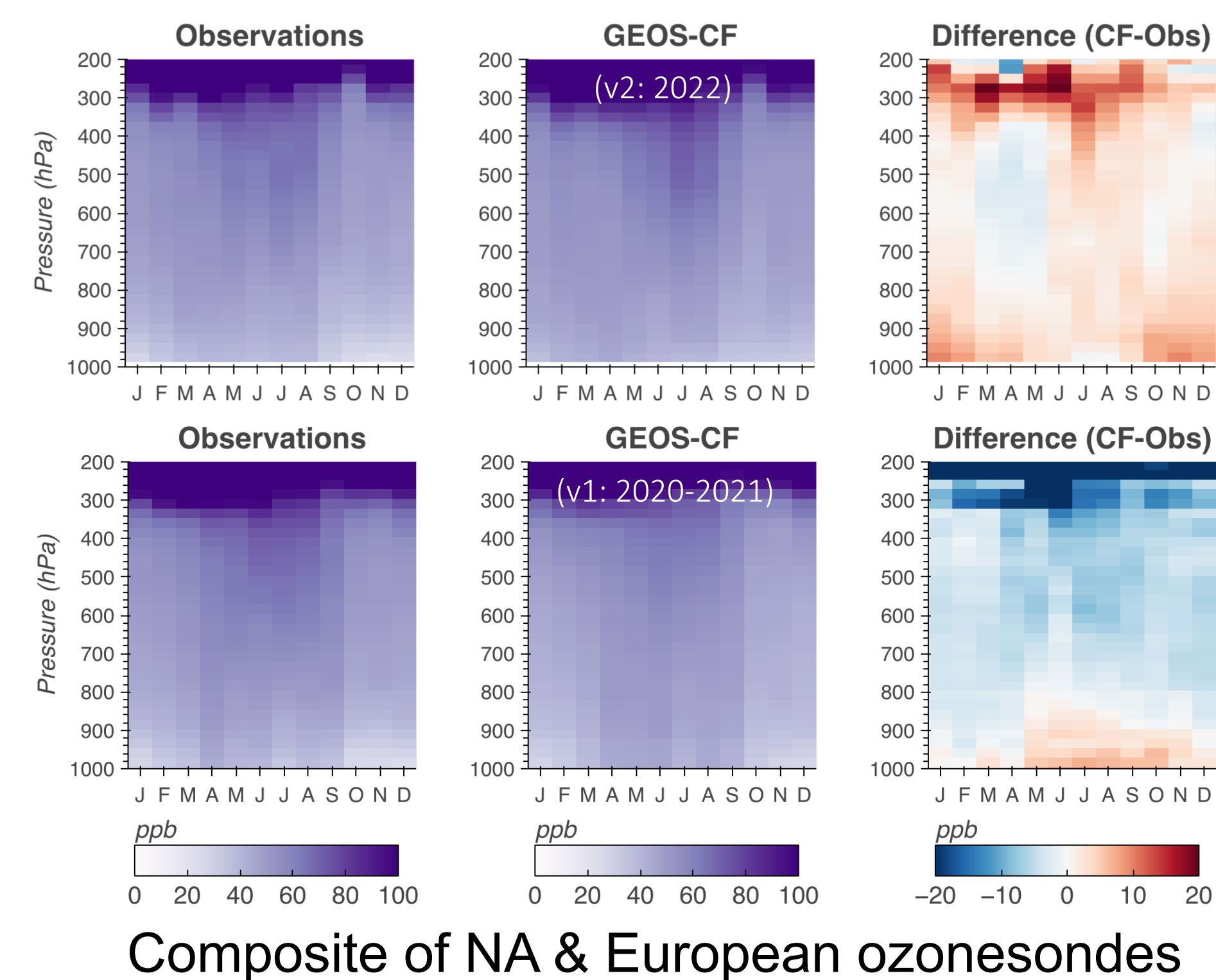
GEOS-CF v1 uses HTAP v2.2 which is now >10 years behind. V2 using latest CEDS



this leads to higher surface O₃

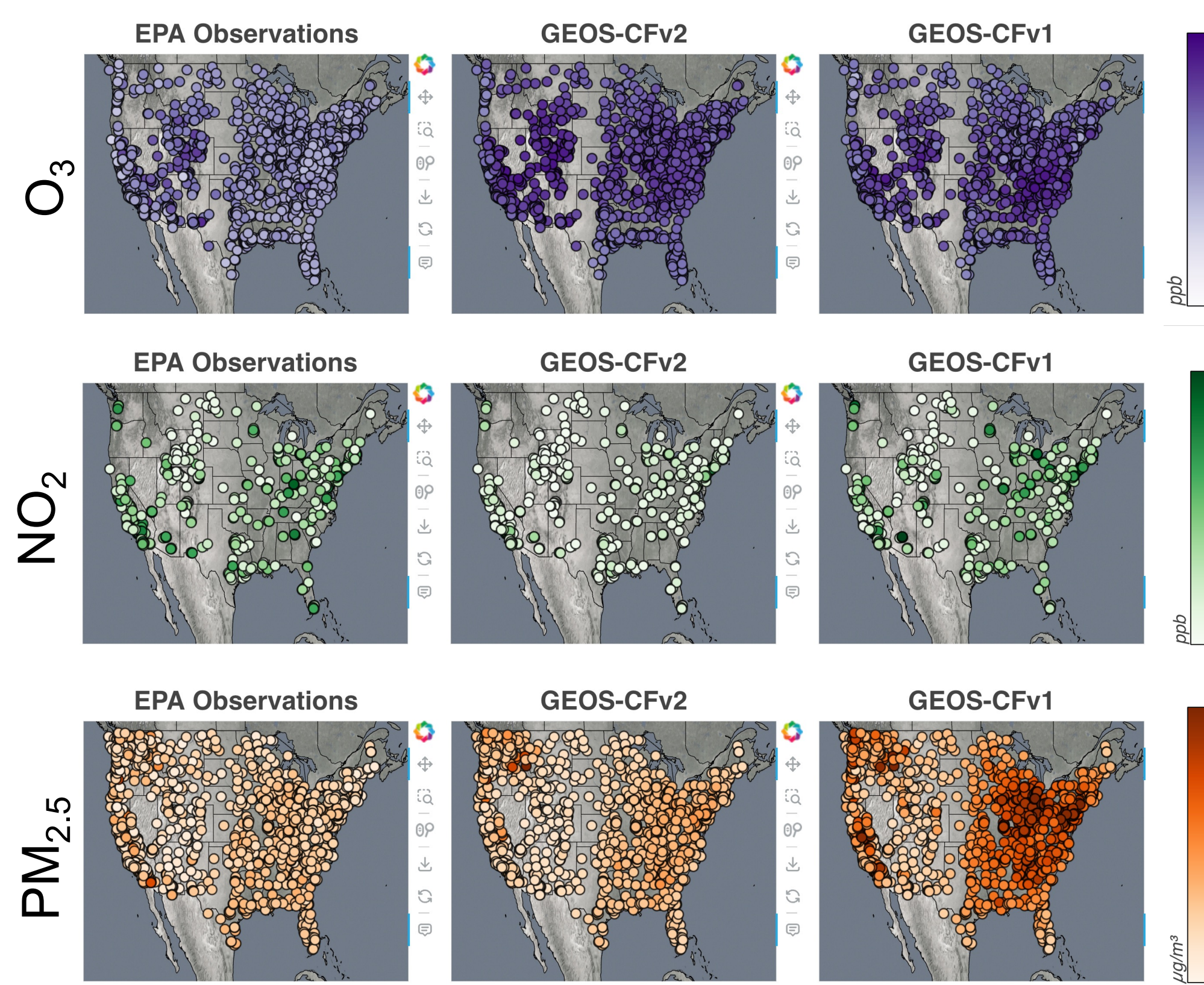
Early Results of GEOS-CF v2 (2022)

Ozone assimilation Improved tropospheric O₃

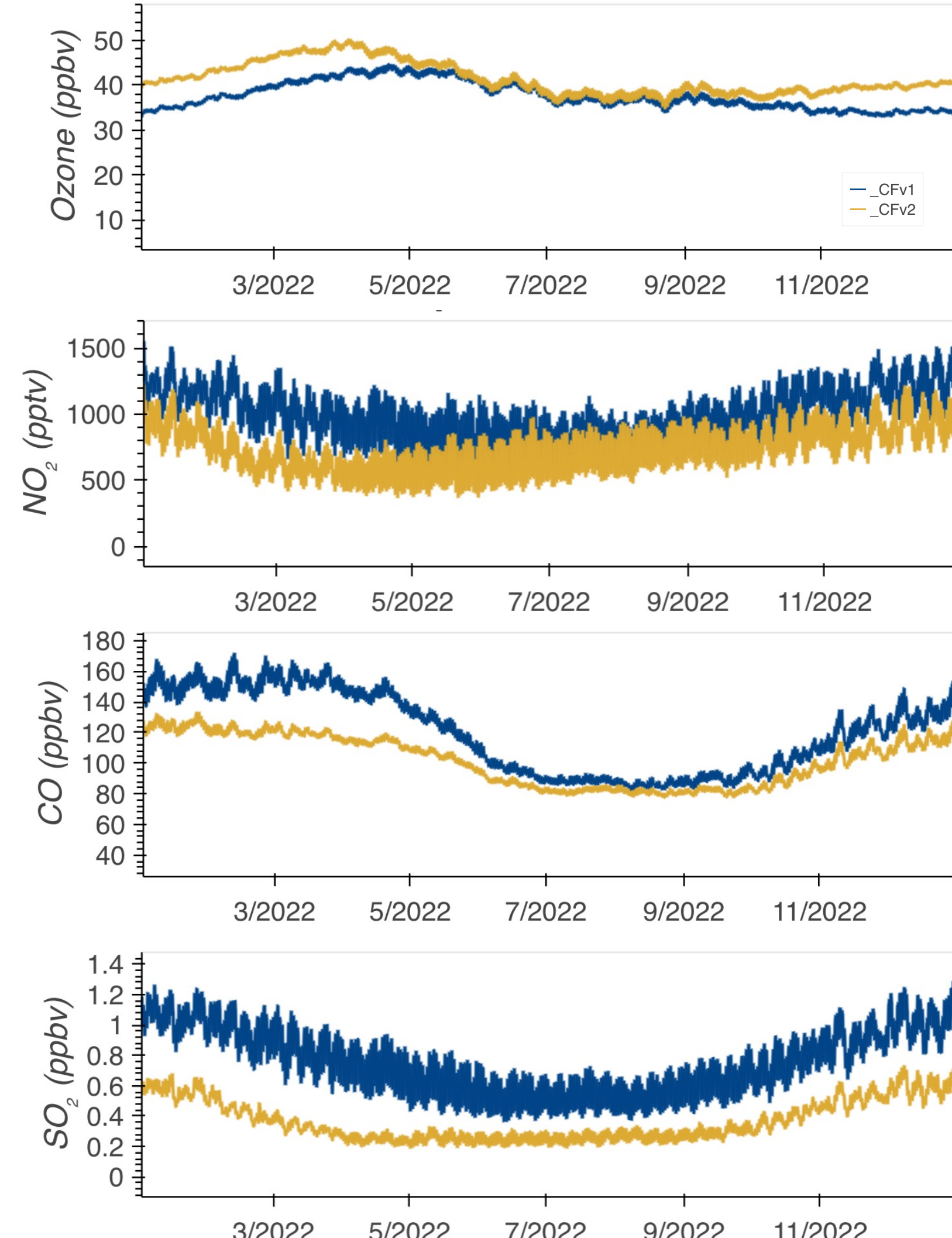


Early Results of GEOS-CF v2 (2022)

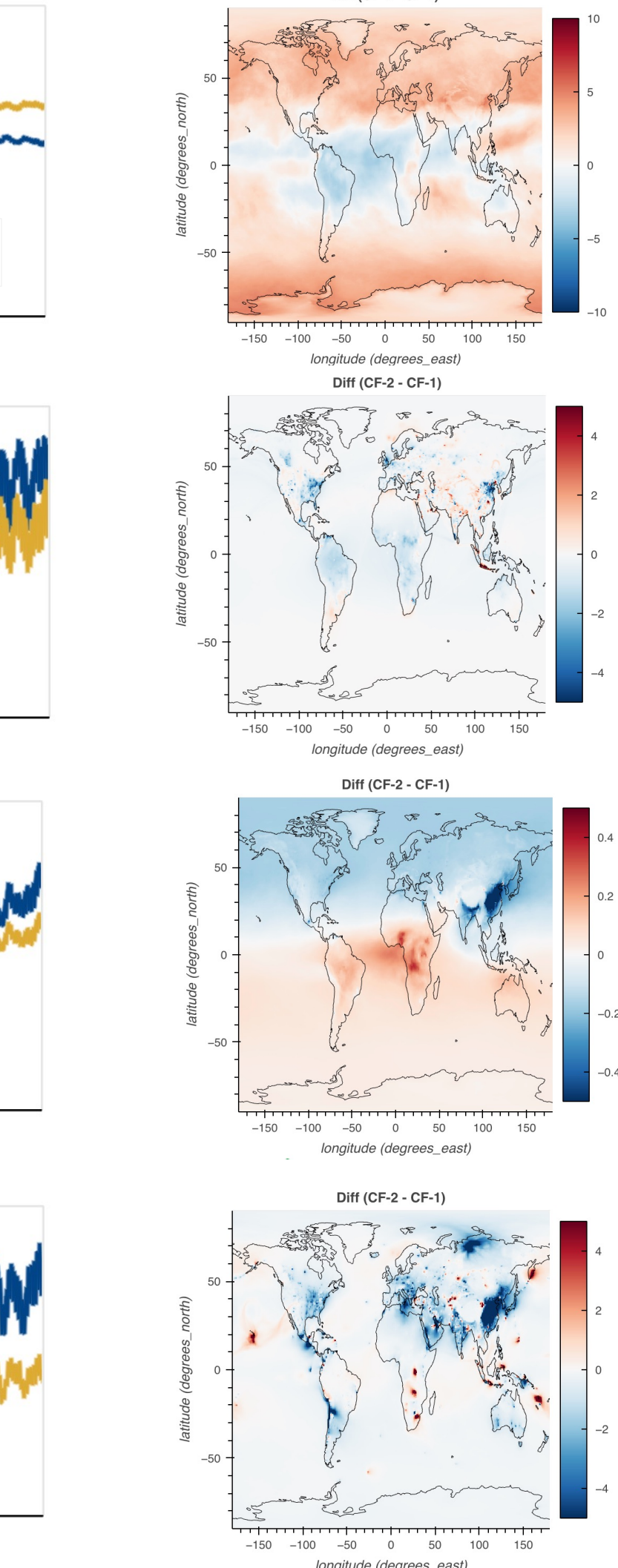
Annual surface concentration comparisons



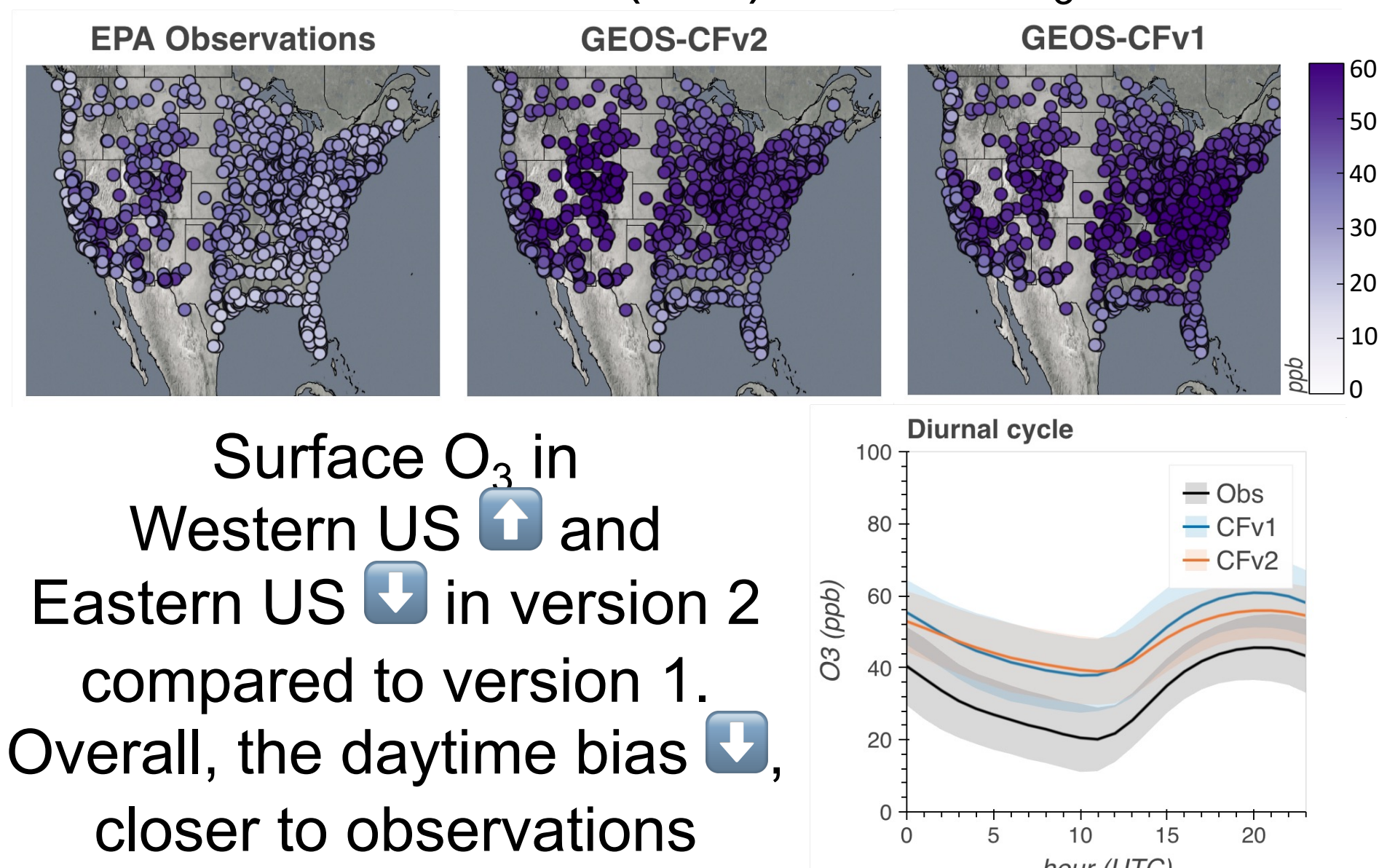
Annual surface concentration Northern hemisphere midlatitudes



Annual tropospheric column



Early Results of GEOS-CF v2 (2022) Summertime (JJA) surface O₃



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