NASA GEOS Composition Forecast system: GEOS-CF

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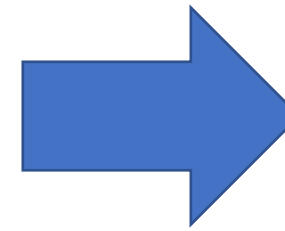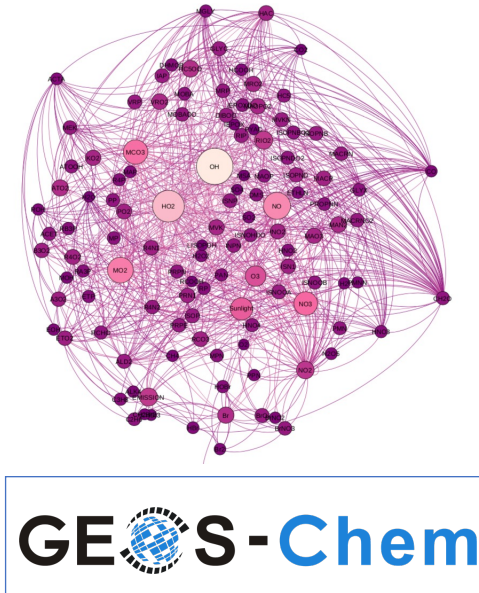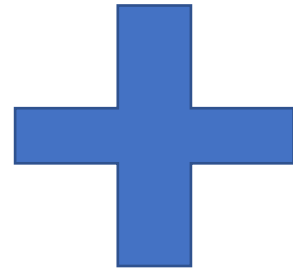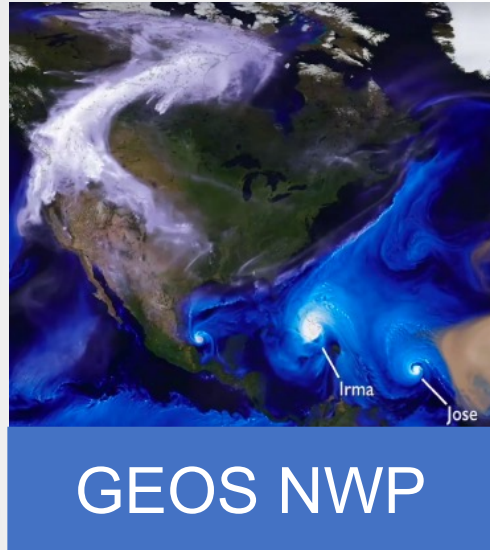
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In collaboration with many other scientists from NASA Goddard Space Flight Center and our partners

GEOS with Coupled GEOS-Chem chemistry

GEOS NWP

GEOS-Chem

G5NR - Chem

GEOS - CF

Hu, L., Keller, C. A., et al (2018). **Global simulation of tropospheric chemistry at 12.5 km resolution: performance and evaluation of the GEOS-Chem chemical module (v10-1) within the NASA GEOS Earth system model (GEOS-5 ESM)**. *Geosci. Model Dev.*, 11, 4603–4620, https://doi.org/10.5194/gmd-11-4603-2018.

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*, 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

GMAO | **Global Modeling and Assimilation Office**
gmao.gsfc.nasa.gov

https://gmao.gsfc.nasa.gov/weather_prediction/GEOS-CF/
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GEOS with Coupled GEOS-Chem chemistry

G5NR-Chem

GEOS-CF

1 July 2013 – 1 July 2014
- Meteorological "replay"
- c720 (0.125 °, ~**12.5 x 12.5 km^2**)
- 72 model layers
- GEOS-Chem v10-01 Tropospheric-only mode
- Default GEOS-Chem emissions
- 1-hour, 29 species

1 January 2018 - present
- 1-day replay + 5-day forecast
- c360 (0.25°, ~**25 x 25 km^2**)
- 72 model layers
- GEOS-Chem v12.0.1, with UCX Tropospheric & Stratospheric
- HTAP v2.2
- 1-hour 2D & 3D output, **including specific TEMPO file for retrievals**

Knowland et al., 2022. "File Specification for GEOS-CF Products." *GMAO Office Note No. 17 (Version 1.2), available from http://gmao.gsfc.nasa.gov/pubs/office_notes*

TEMPO specific collection: "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 0.25º*

   longitude: 0º to -180º

   latitude: 0º to 90º

vertical level: *72 layers*

Granule Size: *~258 MB per file*

Start date: 00 UTC 1 January 2022

Mode: Replay only; Forecasts available based on mission requirements

Knowland et al., 2022. "File Specification for GEOS-CF Products." *GMAO Office Note No. 17 (Version 1.2), available from http://gmao.gsfc.nasa.gov/pubs/office_notes*

Name	Dim	Description	Units
BrO	tzyx	Bromine monoxide (BrO, MW = 96.00 g mol-1) volume mixing ratio dry air	mol mol-1
FRSEAICE	tyx	ice covered fraction of tile	1
FRSNO	tyx	fractional area of land snowcover	1
GLYX	tzyx	Glyoxal (CHOCHO, MW = 58.00 g mol-1) volume mixing ratio dry air	mol mol-1
HCHO	tzyx	Formaldehyde (CH2O, MW = 30.00 g mol-1) volume mixing ratio dry air	mol mol-1
HNO2	tzyx	Nitrous acid (HNO2, MW = 47.00 g mol-1) volume mixing ratio dry air	mol mol-1
IO	tzyx	Iodine monoxide (IO, MW = 143.00 g mol-1) volume mixing ratio dry air	mol mol-1
NO2	tzyx	Nitrogen dioxide (NO2, MW = 46.00 g mol-1) volume mixing ratio dry air	mol mol-1
O3	tzyx	Ozone (O3, MW = 48.00 g mol-1) volume mixing ratio dry air	mol mol-1
OCIO	tzyx	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	tzyx	specific humidity	kg kg-1
SNODP	tyx	snow depth	m
SNOMAS	tyx	Total snow storage land	kg m-2
SO2	tzyx	Sulfur dioxide (SO2, MW = 64.00 g mol-1) volume mixing ratio dry air	mol mol-1
T	tzyx	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

Seasonal & hourly variations in NO$_2$ profiles

Figure produced
by Viral Shah

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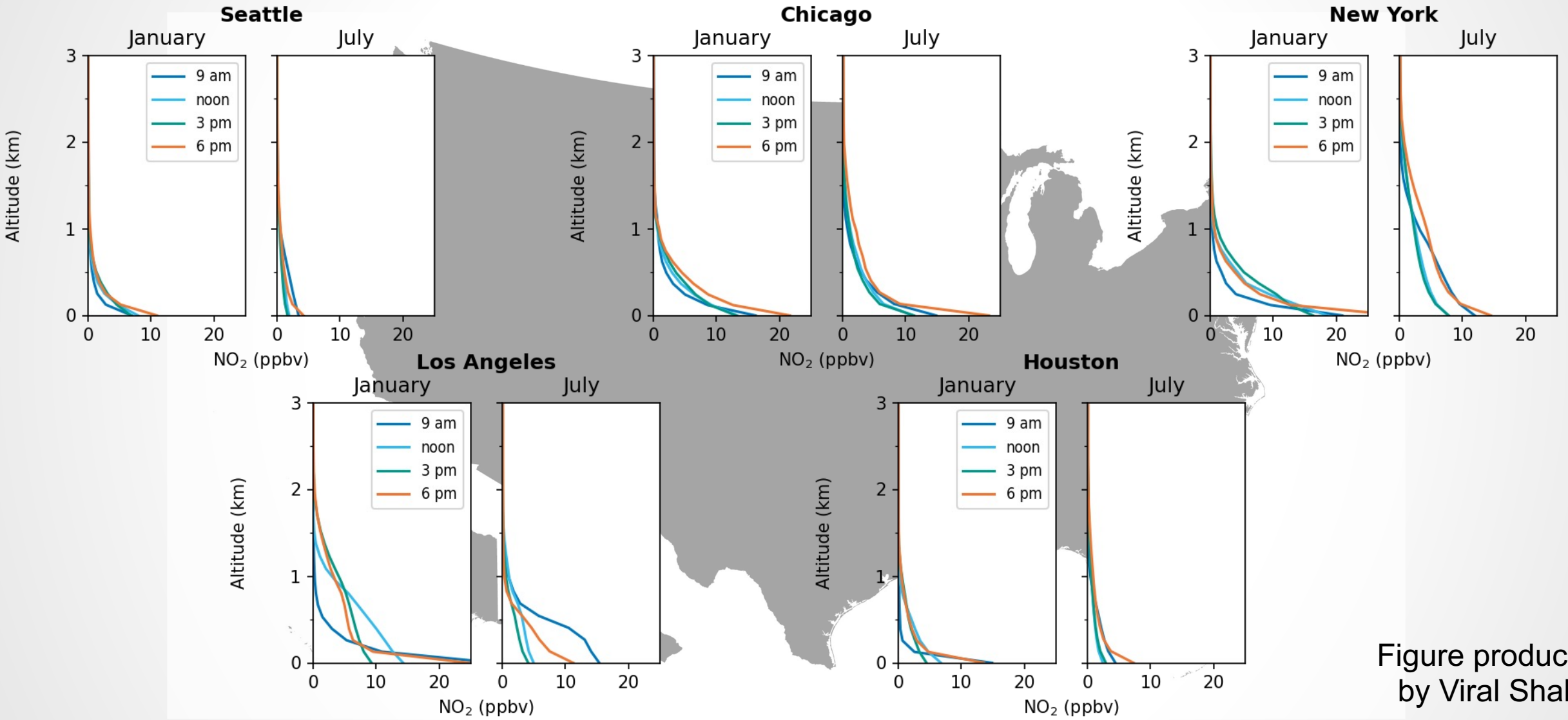https://gmao.gsfc.nasa.gov/weather_prediction/GEOS-CF/
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Spinning up GEOS-CF version 2

➢ Model update to GEOS-Chem v14.0

➢ GEOS AGCM update

➢ CEDS emission inventory (latest release through 2019)

➢ Constituent Data Assimilation System (CoDAS)

• Multi-constituent assimilation with O_3, NO_2, SO_2

❖ We will provide new climatology to TEMPO retrieval team

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