



NASA GEOS Composition Forecast system: GEOS-CF

K. Emma Knowland

Morgan State University/GESTAR-II

NASA Global Modeling and Assimilation Office (GMAO)

Co-author: Christoph Keller (MSU/GESTAR-II, NASA GMAO)

In collaboration with:

NASA GMAO: Steven Pawson, Lesley Ott, Anton Darmonov, Pamela Wales, Larry Coy, Kris Wargan,
Megan Damon, Ben Auer, Arlindo da Silva, Matt Thompson, Atanas Trayanov

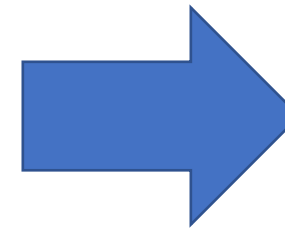
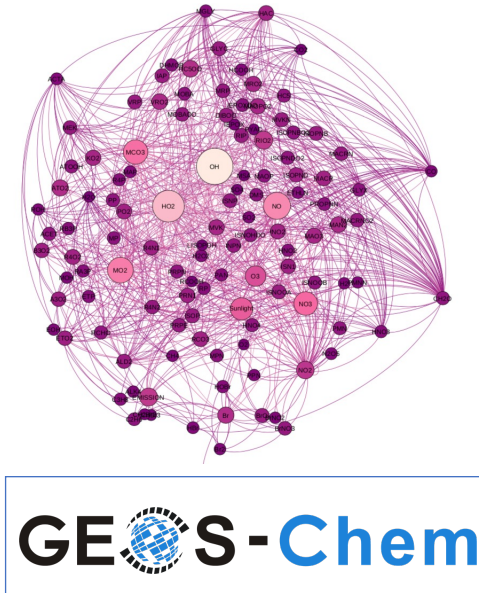
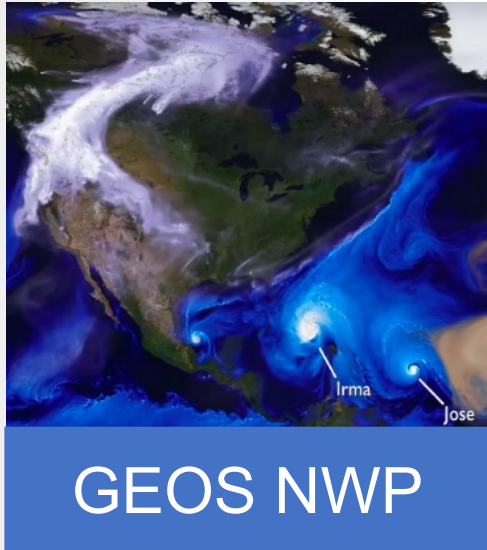
NASA Atmospheric Chemistry and Dynamics Lab: Bryan Duncan, Sarah Strode, Junhua Liu

Harvard University: Daniel Jacob, Mike Long

University of Montana: Lu Hu



GEOS with Coupled GEOS-Chem chemistry



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>



GEOS with Coupled GEOS-Chem chemistry

G5NR-Chem

- 1 July 2013 – 1 July 2014
 - Meteorological “replay”
 - c720 (0.125 °, ~**12.5 x 12.5 km²**)
 - 72 model layers
 - GEOS-Chem v10-01 Tropospheric-only mode
 - Default GEOS-Chem emissions
 - 1-hour, 29 species

GEOS-CF

- 1 January 2018 - present
 - 1-day replay + 5-day forecast
 - c360 (0.25°, ~**25 x 25 km²**)
 - 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 0.25°*

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 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
FRSEACE	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 (CH ₂ O, MW = 30.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
HNO ₂	tzyx	Nitrous acid (HNO ₂ , 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
NO ₂	tzyx	Nitrogen dioxide (NO ₂ , MW = 46.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
O ₃	tzyx	Ozone (O ₃ , 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
SO ₂	tzyx	Sulfur dioxide (SO ₂ , 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



TEMPO specific collection: “sat_inst_1hr_r721x361_v72”

Regional Chemistry and Meteorology Diagnostics to support TEMPO satellite

Mode: Replay only; Forecasts available based on mission requirements

- Forecast test period with TEMPO retrieval team in February-March 2022
- Files were accessed by the TEMPO team from the NCCS Dataportal
e.g., https://portal.nccs.nasa.gov/datashare/gmao/geos-cf/v1/forecast/Y2022/M01/D23/H12/GEOS-CF.v01.rpl.sat_inst_1hr_r720x361_v72*.nc4
- The replay files are still available since January 1, 2022
e.g., https://portal.nccs.nasa.gov/datashare/gmao/geos-cf/v1/das/Y2022/M01/D01/GEOS-CF.v01.rpl.sat_inst_1hr_r720x361_v72*.nc4

<https://portal.nccs.nasa.gov/datashare/gmao/geos-cf/v1/>

GODDARD SPACE FLIGHT CENTER

+ NASA HomePage
+ NASA Center for Climate Simulation

NCCS Dataportal - Datashare

Name	Last modified	Size	Description
Parent Directory	-	-	-
das/	26-Aug-2019 10:41	-	-
forecast/	22-Mar-2019 13:49	-	-

USA.gov Government Made Easy | + Privacy Policy and Important Notices | NASA | Curator: Corey D Jones
NASA Official: Dan Duffy
Last Updated: 03/13/2019

<https://opendap.nccs.nasa.gov/dods/gmao/geos-cf/>

GrADS Data Server - info for /gmao/geos-cf/assim/sat_inst_1hr_r721x361_v72 : [dds](#) [das](#)

OPeNDAP/DODS Data URL: https://opendap.nccs.nasa.gov/dods/gmao/geos-cf/assim/sat_inst_1hr_r721x361_v72

Description: GEOS CF (Composition Forecast)

Documentation: (none provided)

Longitude: -180.0000000000°E to 0.0000000000°E (721 points, avg. res. 0.25°)

Latitude: 0.0000000000°N to 90.0000000000°N (361 points, avg. res. 0.25°)

Altitude: 1.0000000000 to 72.0000000000 (72 points, avg. res. 1.0)

Time: 00Z01JAN2022 to 12Z25MAY2022 (3469 points, avg. res. 0.042 days)

Variables: (total of 21)

bro bromine monoxide (bro, mw = 96.00 g mol-1) volume mixing ratio dry air

snomas total_snow_storage_land

hcho formaldehyde (ch2o, mw = 30.00 g mol-1) volume mixing ratio dry air

co2 sulfur dioxide (co2, mw = 64.00 g mol-1) volume mixing ratio dry air

Planned upgrades for GEOS-CF

- Model update to GEOS-Chem v13.0
- GEOS AGCM update
- CEDS emission inventory (latest release through 2019)
- Constituent Data Assimilation System (CoDAS)
 - Multi-constituent assimilation with O₃, CO, NO₂
- ❖ We will provide new climatology to TEMPO retrieval team

k.e.knowland@nasa.gov :: christoph.a.keller@nasa.gov

