



Supporting NASA missions with the GEOS Composition Forecast System, “GEOS-CF”

K. Emma Knowland

Morgan State University/GESTAR-II

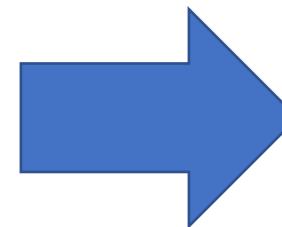
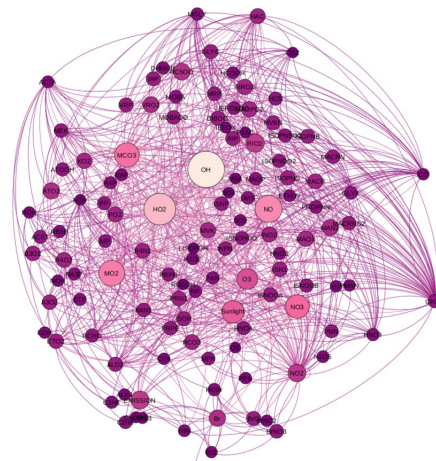
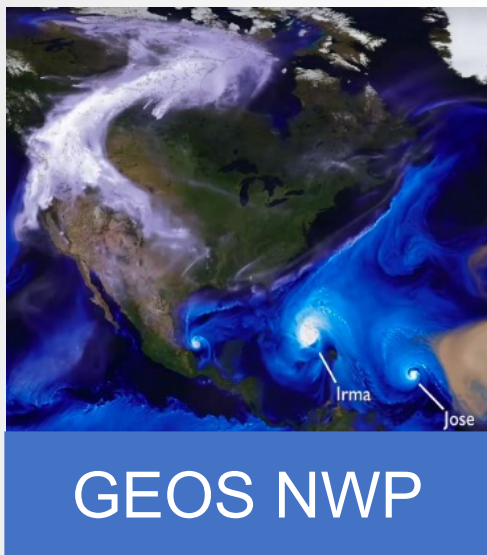
NASA Global Modeling and Assimilation Office (GMAO)

In collaboration with:

Christoph Keller, Pamela Wales, Lesley Ott, Joe Ardizzone, Christine Bloecker, Austin Conaty,
Meredith Nichols, Callum Wayman, Steven Pawson



GEOS Composition Forecast



GEOS - CF



Version 12.0.1

Tropospheric and Stratospheric chemistry

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>



GEOS NWP with Coupled GEOS-Chem chemistry

GEOS-CF v1.0

One **5-day forecast** per day

- Initialized at 12z
- 1-day meteorological replay (“analysis”)
- 5-day forecast
- c360 (0.25°, ~**25x25 km²**)
- 72 layers (surface to 0.01hPa)
- GEOS-Chem v12.0.1

Data distributed via OpenDAP and HTTPS:

- 2D output at 15 minute and hourly frequency
- 3D output at hourly and three hourly frequency, 1-hour 2D & 3D output, **including specific TEMPO file for trace-gas retrievals**

Emissions:

- HTAP v2.2 (global bottom-up) for anthropogenic
- Near real-time fires (QFED)
- Online dust, sea salt, plant emissions

Observation-constraints:

- Currently no direct data assimilation of constituents in GEOS-CF
- GOCART aerosols constrained by satellite measurements of AOD
- Biomass burning emissions from QFED

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

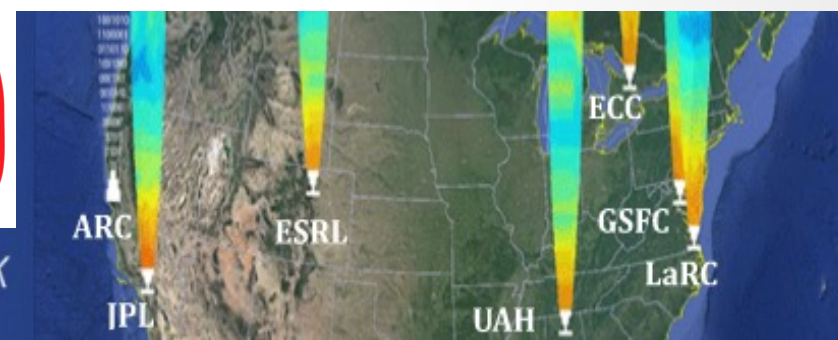
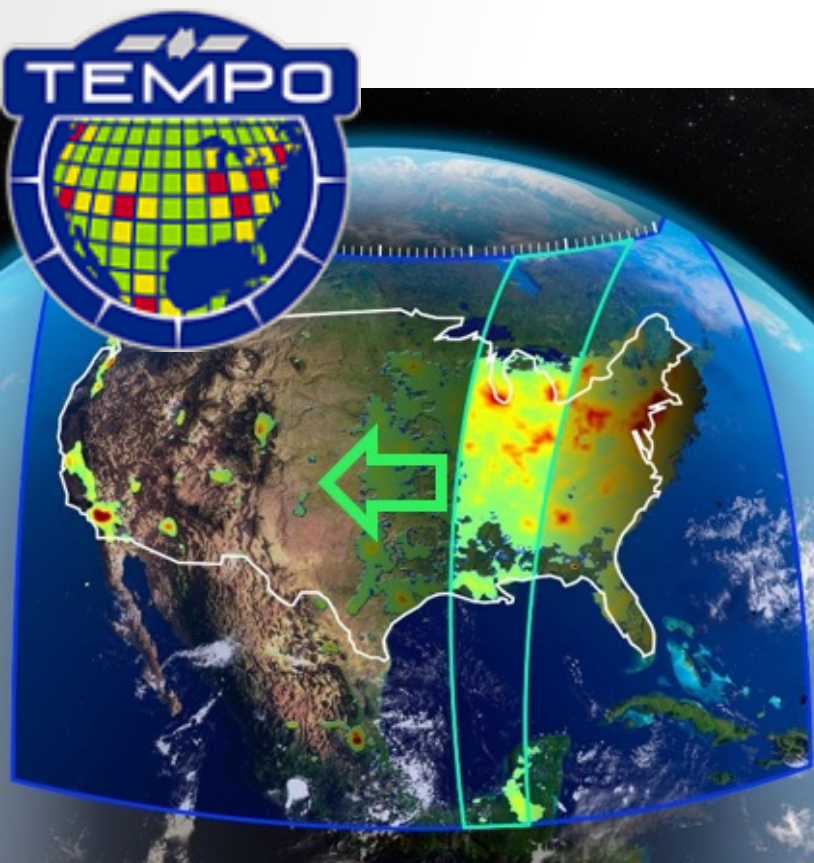


Support a broad range of NASA applications

GEOS - CF

Realistic atmospheric composition in the troposphere **and** stratosphere in GEOS-CF is essential to support a broad range of NASA applications measuring trace gases and aerosols, including:

- Airborne campaigns
- Satellite retrievals of trace gases
- Stratosphere-troposphere exchange





Global Modeling and Assimilation Office

GMAO

<https://fluid.nccs.nasa.gov/missions/>

Weather | Mission Support | CF | Reanalysis | Carbon

https://gmao.gsfc.nasa.gov/field_campaigns/real_time_support_requests.php

Navigation

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- » Contact

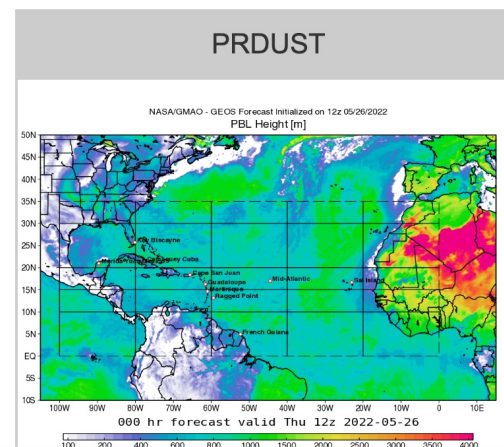
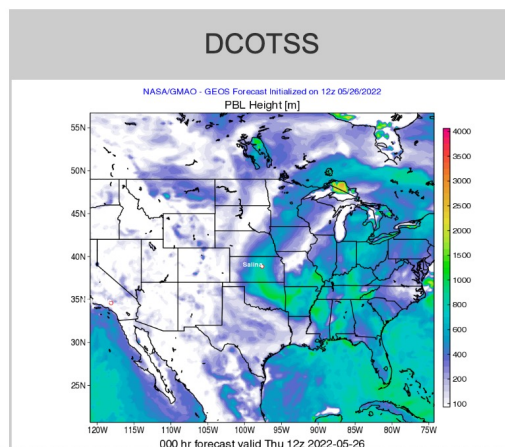
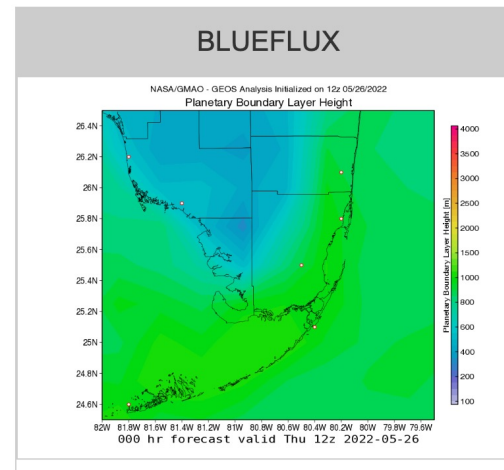
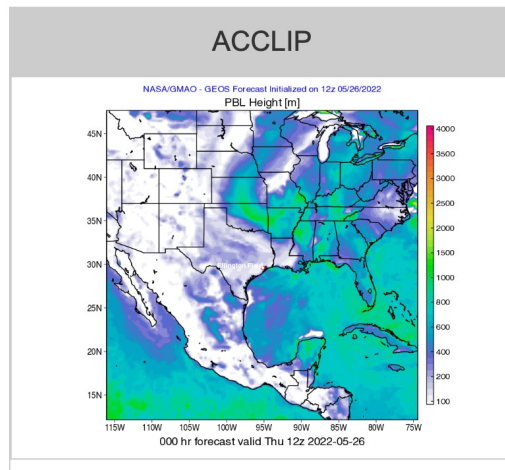
Active Missions

- » ACCLIP
- » BLUEFLUX
- » DCOTSS
- » PRDUST

Non-Active Missions

- » ABOVE
- » ACE-ENA
- » AEOLUS-CALVAL
- » ATOM
- » CAMP2EX
- » EPOCH
- » MOSAIC
- » ORACLES
- » SCOAPE
- » SOCRATES
- » TRACER-AQ

GMAO Active Mission Support



To request GMAO Real-Time Support for NASA Field Campaigns

realtimesupportrequests@gmao.gsfc.nasa.gov

1. NASA field campaign name
2. Brief overview of the campaign
3. Requester's contact information
4. Time period when support is required
5. URL of the campaign website
6. Brief description of the real-time support requested in terms of GEOS products and any campaign-specific needs

Request as soon as possible, but no later than 3 months prior to the start of campaign





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





Summary of GEOS-CF Status

- GEOS-CF daily global composition forecasts at 25km resolution are generated in near-real time:
 - High-resolution historical estimates for fields are available since January 2018
 - Forecasts remain available on data servers for two weeks
 - The forecasts of the five most-requested surface pollutants (O_3 , NO_2 , CO , $PM_{2.5}$, and SO_2) remain accessible via data servers for January 2019-present
- Forecast visualizations and links to data available at: fluid.nccs.nasa.gov/cf and [/cf_map](https://fluid.nccs.nasa.gov/cf_map)
- Applications users include:
 - NASA field missions (e.g., SCOAPE, FIREX-AQ, ACT-America, TRACER-AQ, ACCLIP)
 - Daily alerts sent to NASA TOLNet lidar teams (Matt Johnson, NASA Ames)
 - TEMPO a priori for trace gas product

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