

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

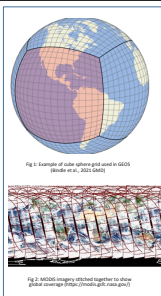
K. Emma Knowland^{1,2}, Christoph A. Keller^{1,2,*}, Viral Shah^{2,3}, Pam Wales^{1,2},
Lesley Ott², Steven Pawson²

¹ Morgan State University/GESTAR-II, ² Global Modeling and Assimilation Office (GMAO), NASA/GSFC, ³ Science Systems and Applications, Inc. (SSAI), *Now with Swiss Re



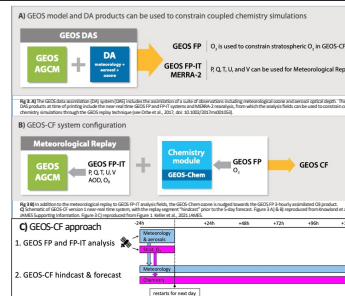
Introduction

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

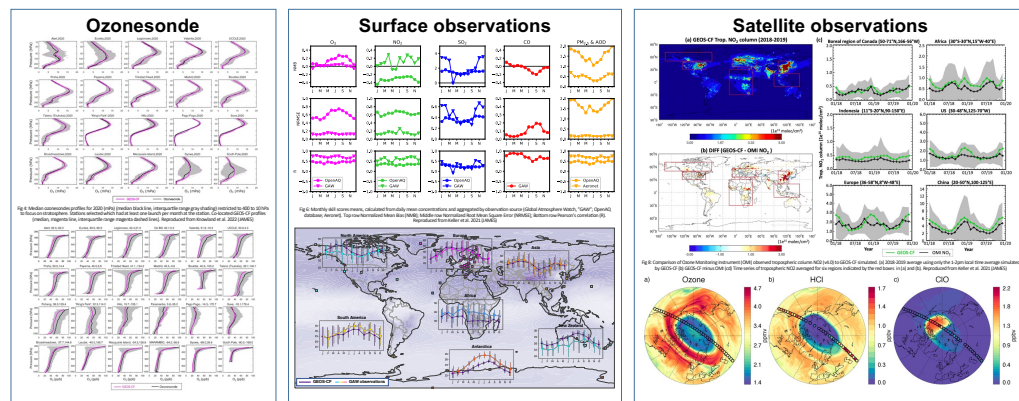
For version 1 of GEOS-CF, the GEOS AGCM is coupled to the GEOS-Chem chemistry module (version 12) with full tropospheric and stratospheric chemistry



- One 5-day forecast per day
- Initialized at 12z
 - 1-day meteorological replay ("hindcast")
 - 5-day forecast
 - 360 (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
 - Available since
 - 1 January 2018 (replay)
 - 1 January 2019 (forecast)
- 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
- 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 System GEOS-CF v1.0: Stratospheric Composition*. *JAMES* <https://doi.org/10.1029/2021MS002832>

Validation

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



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	tzx	Bromine monoxide (BrO, MW = 96.00 g mol ⁻¹) volume	mol mol ⁻¹
FRSEACE	txx	ice covered fraction of tile	1
FRSNO	txx	fractional area of land snowcover	1
GLYX	tzx	Glyoxal (CHOCHO, MW = 58.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
HCHO	tzx	Formaldehyde (CH2O, MW = 30.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
HNO2	tzx	Nitrous acid (HNO2, MW = 47.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
IO	tzx	Iodine monoxide (IO, MW = 143.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
NO2	tzx	Nitrogen dioxide (NO2, MW = 46.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
O3	tzx	Ozone (O3, MW = 48.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
OCIO	tzx	Chlorine dioxide (OCIO, MW = 67.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
PHIS	txx	surface geopotential height	m=2 s-2
PS	txx	surface pressure	Pa
Q	txx	specific humidity	kg kg ⁻¹
SNOOP	txx	snow depth	m
SNOMAS	txx	Total snow storage land	kg m-2
SO2	tzx	Sulfur dioxide (SO2, MW = 64.00 g mol ⁻¹) volume mixing ratio dry air	mol mol ⁻¹
T	tzx	air temperature	K
TROPPB	txx	tropopause pressure based on blended estimate	Pa
U2M	txx	2-meter eastward wind	m s-1
V2M	txx	2-meter northward wind	m s-1
ZPBL	txx	planetary boundary layer height	m

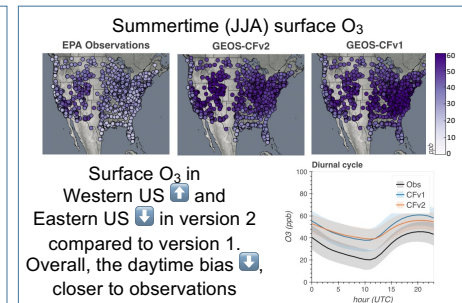
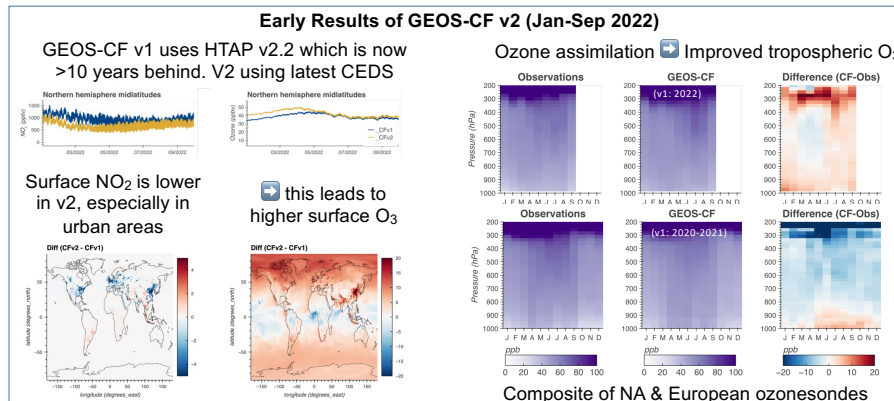
Files are accessed by the TEMPO team from the NCCS Dataportal e.g., https://portal.nccs.nasa.gov/datashare/gmao/geos-cf/v1/forecast/2022/NO1/023/h12/GEOS-CFv01.rpl.sat_inst_1hr_r720x361_v72.nc4

The replay files are available since January 1, 2022 e.g., https://portal.nccs.nasa.gov/datashare/gmao/geos-cf/v1/das/2022/NO1/001/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.

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).



National Aeronautics and Space Administration

