

TRACER-AQ 2021 Measurement Overview

NASA GEOS Composition Forecast (GEOS-CF)



Data Products (selected)

htf_inst_15mn_g1440x721_x1: “Surface” chemistry and meteorology fields every 15 minutes

chm_tavg_1hr_g1440x721_v1: Hourly-average “Surface” chemistry fields

met_tavg_1hr_g1440x721_x1: Hourly-average 2D meteorology

xgc_tavg_1hr_g1440x721_x1: Hourly-average 2D chemistry (including column diagnostics)

chm_inst_1hr_g1440x721_p23: Hourly chemistry fields on 23 pressure levels (1000 to 10 hPa)

met_inst_1hr_g1440x721_p23: Hourly meteorology fields on 23 pressure levels (1000 to 10 hPa)

For Documentation on all publicly available GEOS-CF products:

https://gmao.gsfc.nasa.gov/weather_prediction/GEOS-CF/docs/

Contact Information

Emma Knowland
(k.e.knowland@nasa.gov)



Relevance to Science Plan

Ozone Photochemistry and Meteorology

Chemistry and meteorology on the same spatial and temporal scales, including ozone precursor species.

Modeling and Satellite Evaluation

3D high-resolution global coupled chemistry and meteorology model output available to support satellite and ground-based instrument retrievals and evaluation

Intersection of Air Quality and Socioeconomic Factors

Historical estimates (2018 to present) and daily 5-day forecasts of policy-relevant air quality concentrations available to the public at city-scale (25 km)

Data Highlight

- Using the model data to put the observations into the “big picture”
- Supporting instrument retrievals with prior information

Navigation

- » FLUID Overview
- » Contact

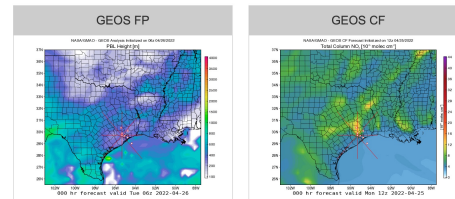
TRACER-AQ Support Products

- » Missions Datagrams
- » WebMaps
- » TRACER-AQ 2D ChemWx
- » TRACER-AQ 3D ChemWx
- » TRACER-AQ Custom

TRACER-AQ CF Products

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- » Custom

GMAO Active Mission Support: TRACER-AQ





NASA GEOS Composition Forecast System: “GEOS-CF”

K. Emma Knowland

MSU/GESTAR-II

NASA Global Modeling and Assimilation Office (GMAO)

In collaboration with:

GMAO: Christoph Keller, Lesley Ott, Steven Pawson, Pamela Wales

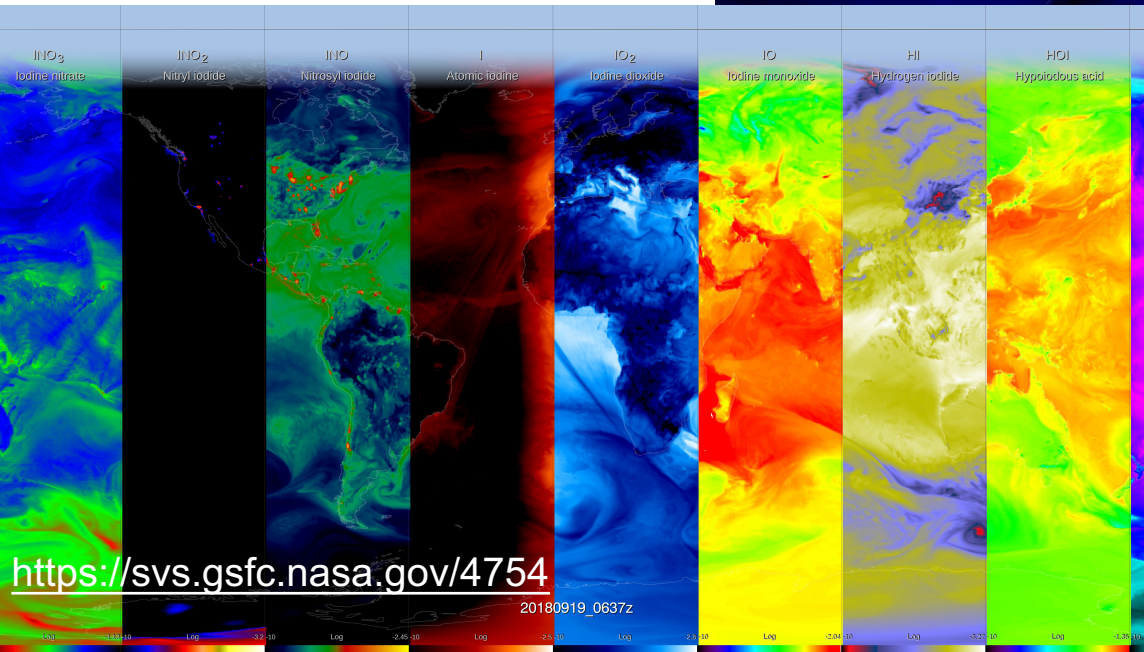
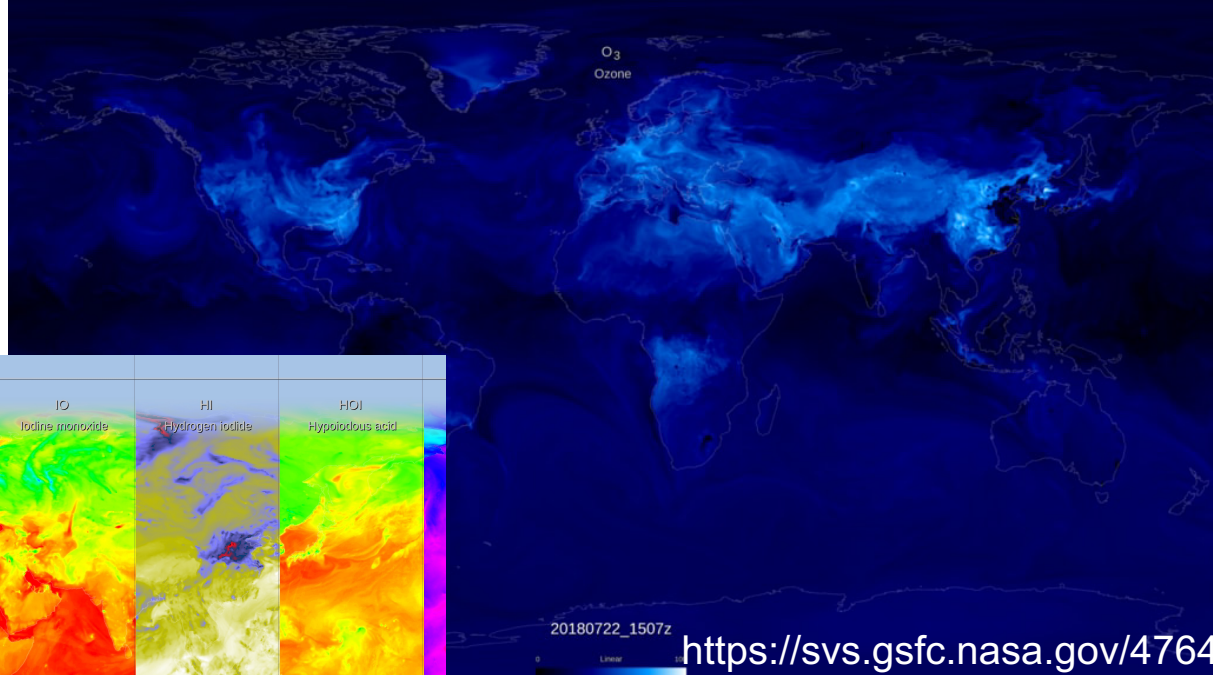
Atmospheric Chemistry and Dynamics Lab: Bryan Duncan, Sarah Strode, Junhua Liu



29 April 2022

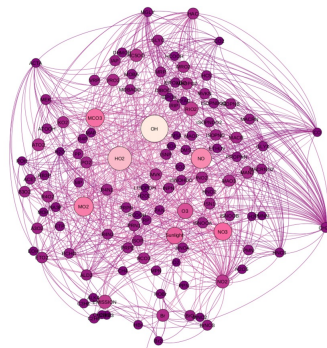


GEOS - CF

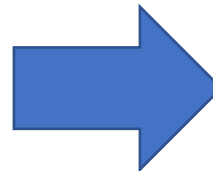


Global historical model estimates and daily 5-day forecasts of major air pollutants like Ozone & PM_{2.5}

GEOS Composition Forecast



GEOS-Chem



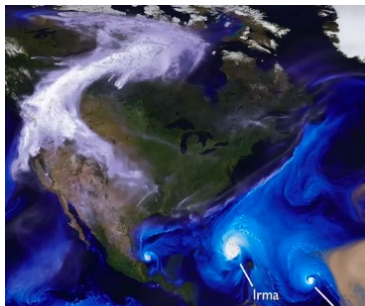
GEOS - CF

Version 12

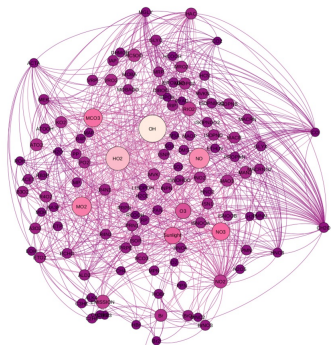
Tropospheric and Stratospheric chemistry

- 250 Chemical Species
- 725 Chemical Reactions

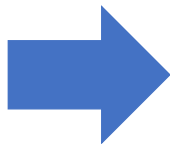
Daily composition forecast



GEOS NWP



GEOS-Chem



GEOS - CF

One **5-day forecast** per day

- Initialized at 12z
- 1-day meteorological replay (“analysis”)
- 5-day forecast
- 25x25 km² resolution, 72 model layers (up to 0.01 hPa)
- Chemistry: O₃, NO_x, PM, CO, VOCs, ...
- Meteorology: T, U, V, RH
- Since January 1, 2018

Emissions:

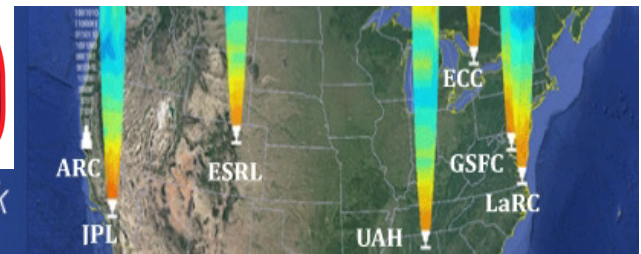
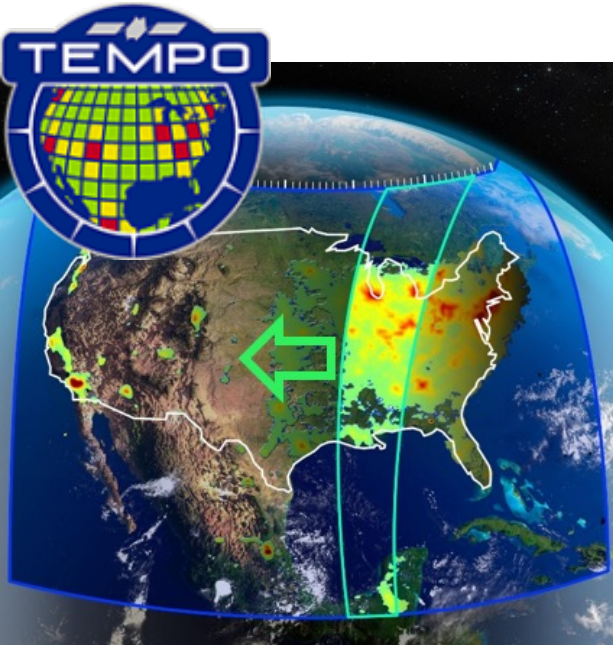
- HTAP (global bottom-up) for anthropogenic
- Near real-time fires (QFED)
- Online dust, sea salt, plant emissions

Daily atmospheric composition forecast

GEOS - CF

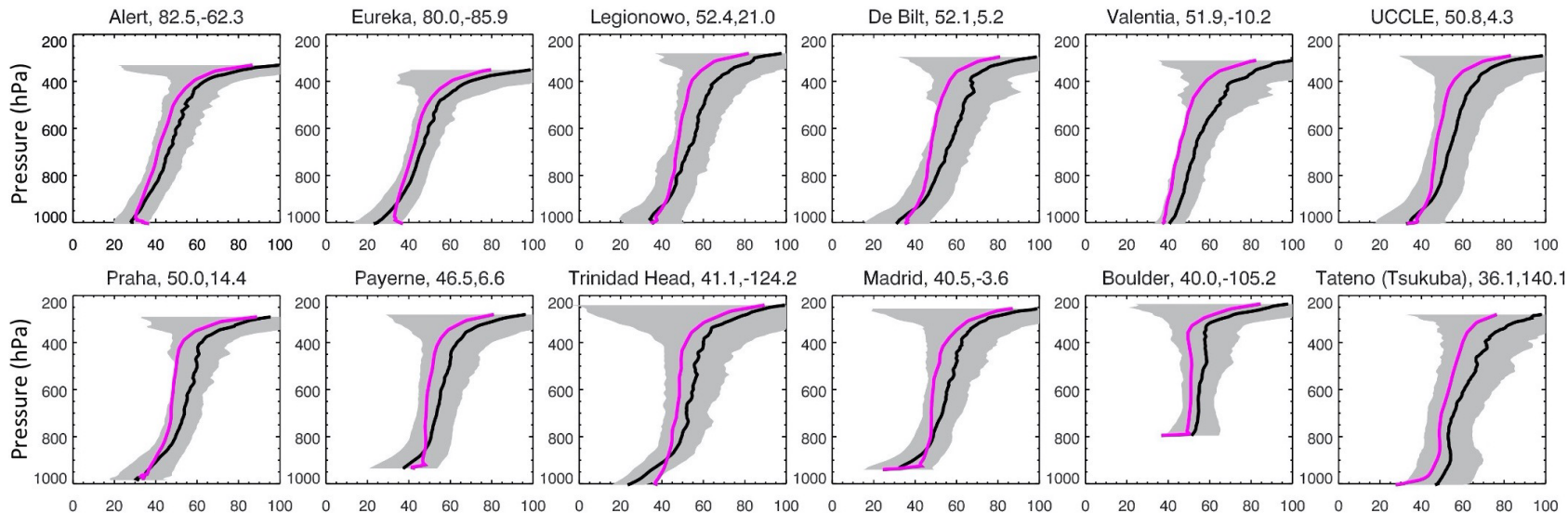
A realistic stratosphere in GEOS-CF is essential to support a broad range of NASA applications, including:

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



GEOS-CF ozone compares well against ozonesondes

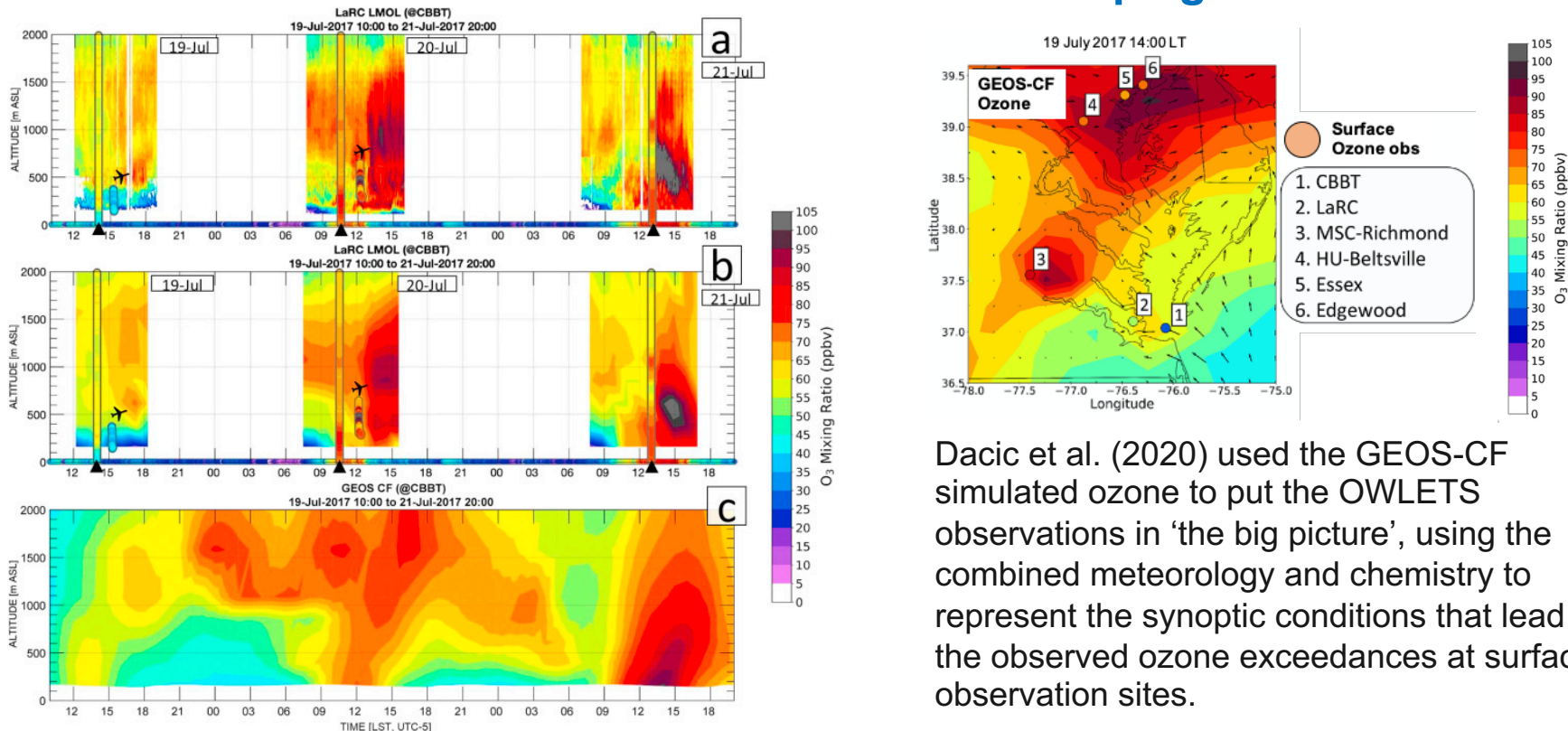
Annual average 2018-2019



■ Sondes ■ GEOS-CF

Keller et al., 2021 JAMES

GEOS-CF evaluation with NASA's OWLETS campaign observations

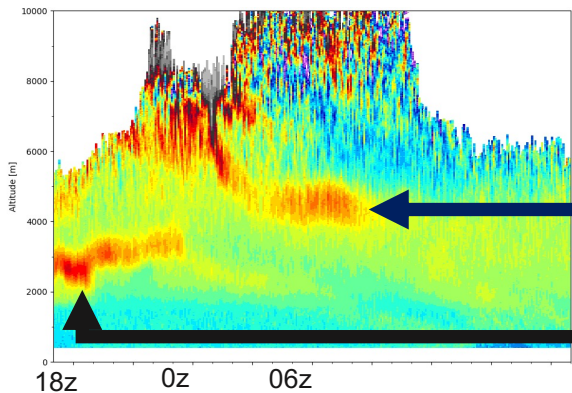


Dacic et al. (2020) used the GEOS-CF simulated ozone to put the OWLETS observations in ‘the big picture’, using the combined meteorology and chemistry to represent the synoptic conditions that lead to the observed ozone exceedances at surface observation sites.

Dacic, N. et al., 2020, Atmos. Environ. “Evaluation of NASA’s high-resolution global composition simulations: Understanding a pollution event in the Chesapeake Bay during the summer 2017 OWLETS campaign”

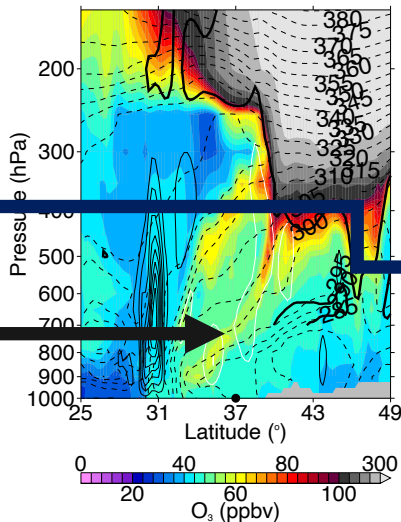
Stratosphere Troposphere Exchange

NASA LaRC Feb 13-14, 2019

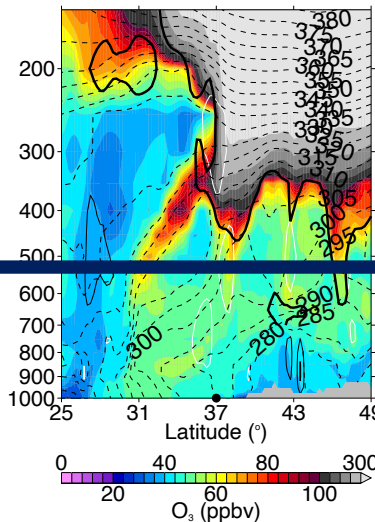


TOPAZ lidar plot courtesy of G. Gronoff

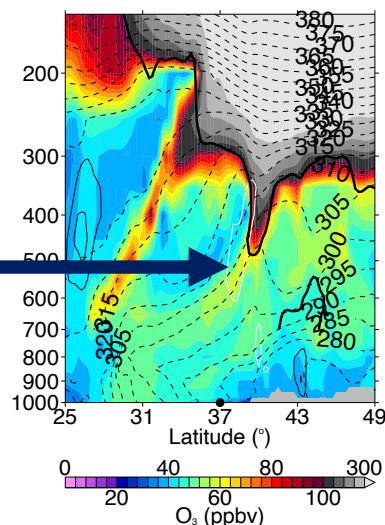
GEOS-CF
Feb 13, 2019 18z



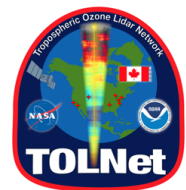
Feb 14, 2019 00z



Feb 14, 2019 06z



Gronoff, G., T. Berkoff, K. Knowland, et al. 2021. "Case study of stratospheric Intrusion above Hampton, Virginia: lidar-observation and modeling analysis." Atmospheric Environment, 118498 [10.1016/j.atmosenv.2021.118498]

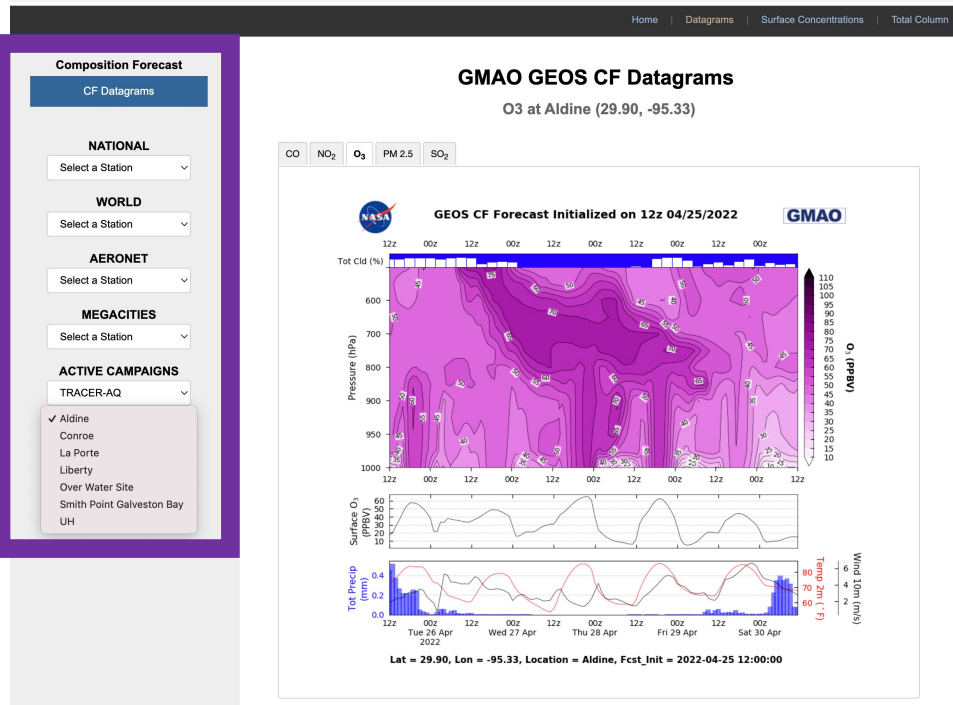


GEOS-CF are available online in near real-time

FLUID is a mobile-friendly website

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

<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

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/chm_tavg_1hr_g1440x721_v1 : [dds](#) [das](#)

OPeNDAP/DODS Data URL: https://opendap.nccs.nasa.gov/dods/gmao/geos-cf/assim/chm_tavg_1hr_g1440x721_v1

Description: GEOS CF (Composition Forecast)
Documentation: (none provided)
Longitude: -180.000000000000°E to 179.750000000000°E (1440 points, avg. res. 0.25°)
Latitude: -90.000000000000°N to 90.000000000000°N (721 points, avg. res. 0.25°)
Altitude: 72.000000000000 to 72.000000000000 (1 points)
Time: 00:30Z01JAN2018 to 11:30Z31OCT2019 (16044 points, avg. res. 0.042 days)
Variables: (total of 52)
xyle xylene (c8h10, mw = 106.16 g mol⁻¹) volume mixing ratio dry air
dst2 dust aerosol, reff = 1.4 microns (mw = 29.00 g mol⁻¹) volume mixing ratio dry air
hno4 peroxyntic acid (hno4, mw = 79.00 g mol⁻¹) volume mixing ratio dry air
pm25su_rh35_gcc sulfate_particulate_matter_with_diameter_below_2.5_um_rh_35

GMAO Mission Support for Field Campaigns



Global Modeling and Assimilation Office

GMAO
<https://fluid.nccs.nasa.gov/missions/>
[Weather](#) | [Mission Support](#) | [CF](#) | [Reanalysis](#) | [Carbon](#)

Navigation

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Active Missions

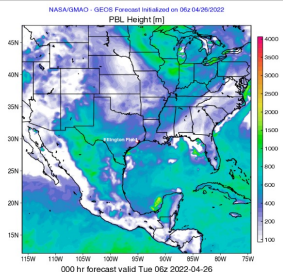
- » ACCLIP
- » BLUEFLUX
- » DCOTSS
- » PRDUST

Non-Active Missions

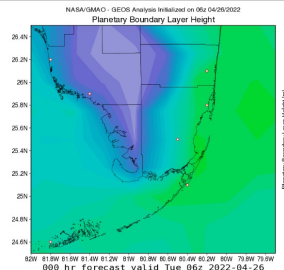
- » ABOVE
- » ACE-ENA
- » AEOLUS-CALVAL
- » ATOM
- » CAMP2EX
- » EPOCH
- » MOSAIC
- » ORACLES
- » SCOAPE
- » SOCRATES

GMAO Active Mission Support

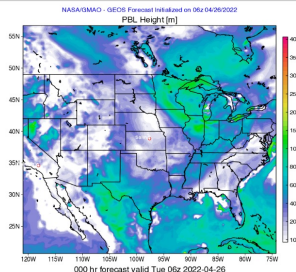
ACCLIP



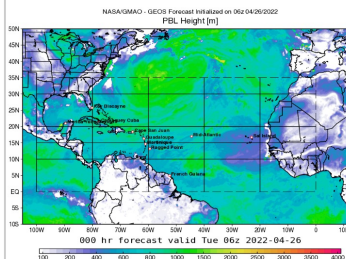
BLUEFLUX



DCOTSS



PRDUST




https://fluid.nccs.nasa.gov/missions/mission_TRACER-AQ
Navigation

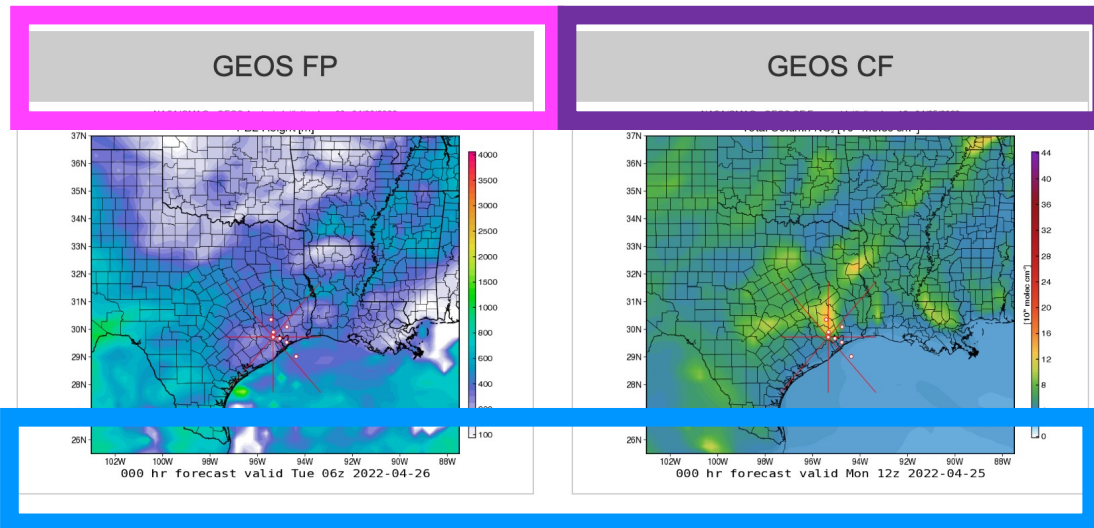
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TRACER-AQ Support Products

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- » WxMaps
- » TRACER-AQ 2D ChemWx
- » TRACER-AQ 3D ChemWx
- » TRACER-AQ Custom

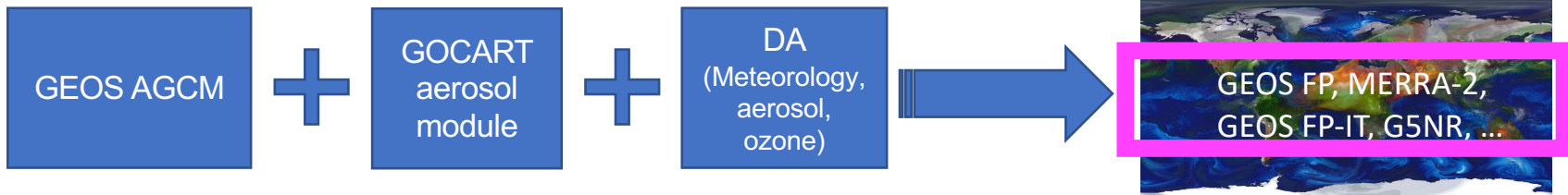
TRACER-AQ CF Products

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- » Custom

GMAO Active Mission Support: TRACER-AQ


Imagery for latest forecast available for TRACER-AQ areas.
GMAO does not archive imagery from the campaign period.

GEOS aerosol data assimilation system



Emissions

Biomass Burning: HFED, QFED

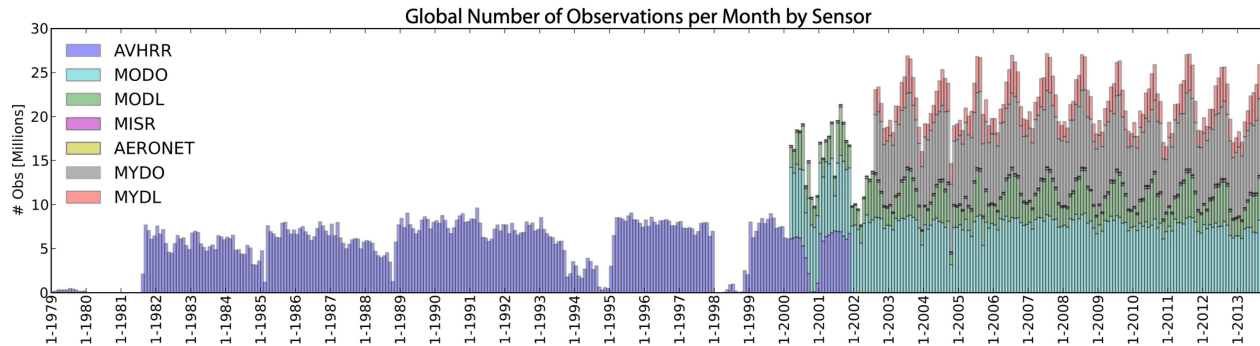
Anthropogenic: Edgar & AeroCom Phase II

Aerosol Observing system

Bias-corrected AOD (550 nm)

Particulate matter (PM):

- Organic Carbon
- Black Carbon
- Sea salt
- Sulfate
- Dust
- Nitrate (GEOS FP)



Randles et al., 2016; NASA/TM-2016-104606/Vol. 45

Randles et al., 2017; DOI: 10.1175/JCLI-D-16-0609.1



https://fluid.nccs.nasa.gov/missions/mission_TRACER-AQ

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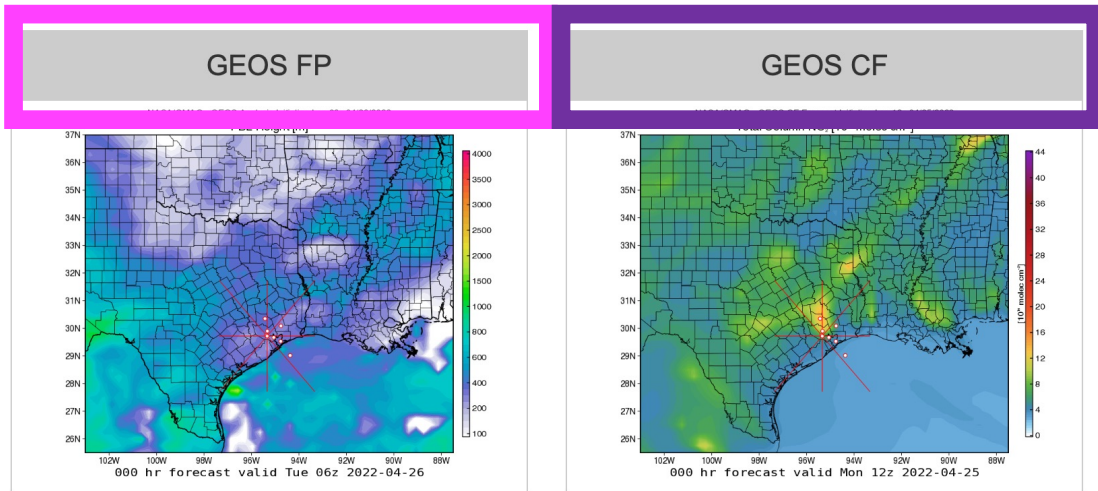
TRACER-AQ Support Products

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TRACER-AQ CF Products

- » Missions Datagrams
- » Custom

GMAO Active Mission Support: TRACER-AQ



FIELDS

CO

CO Column	CO Column Biomass Burning
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BC+OC Carbon

BC+OC AOT	BC+OC Sfc Mass
BC+OC Mass (z-coord)	BCOC S-N
	BCOC W-E
BCOC SW-NE	BCOC NW-SE

PM 2.5

PM25 Mass (z-coord)	PM25 S-N
	PM25 W-E
PM25 SW-NE	PM25 NW-SE

Relative Humidity

RH S-N	RH W-E
RH SW-NE	RH NW-SE

FIELDS

Carbon Monoxide

CO Surface	CO Column
CO Biomass Burning Eurasia	CO Biomass Burning North America
CO Biomass Burning South America	CO Biomass Burning Africa
	CO Fossil Fuel Asia
CO Fossil Fuel Europe	CO Fossil Fuel N. Amer.

Other Gases

Total Ozone	SO2 Col Mass
SO2 Sfc Mass	

Aerosols

Seasalt AOT	Org Carb AOT
Blk Carb AOT	Sulfate AOT
Nitrate AOT	Fine AOT
OC Sfc Mass	BC Sfc Mass
NO3 Sfc Mass	

Aerosols

BC	OC
Dust Mass	PM
PM2.5	PM10
Sea Salt	Sulfate

CO

Total CO	CO BB Eurasia
CO BB Africa	CO BB S. Amer.
CO BB N. Amer.	CO BB Other
CO FF Asia	CO FF Europe
CO FF N. Amer.	

Other Gases

SO2	CFC12 Strat
CFC12 Trop	

REGIONS

Global	North America
TRACER Lg	TRACER Sm

LEVELS

50	70
100	150
200	300
400	500
600	700
850	925



Surface

NO2	SO2
CO	O3
HCHO	PM2.5

VOC/BVOC

Ethane	Propane
Alkanes	Isoprene

Total Column

NO2	SO2
CO	O3
HCHO	

Tropospheric Column

NO2	SO2
CO	O3
HCHO	



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
- Emerging applications users, including:
 - NASA field missions
 - Daily alerts sent to NASA TOLNet lidar teams (Matt Johnson, NASA/Ames)
 - TEMPO a priori for trace gas product