



# Air Pollution Forecasts using the NASA GEOS Model: A unified Tool from Local to Global Scales

**K. Emma Knowland**

USRA/GESTAR

NASA Global Modeling and Assimilation Office (GMAO)

**In collaboration with:**

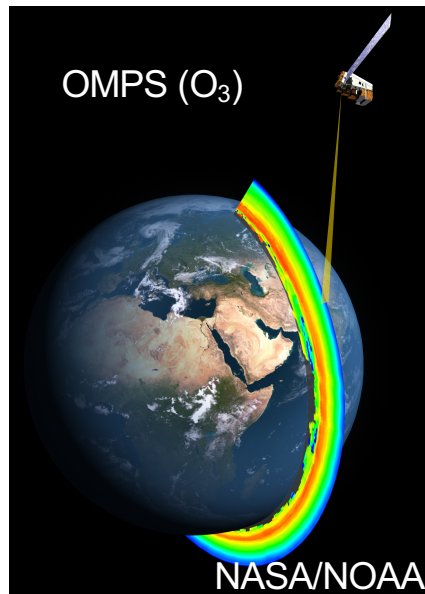
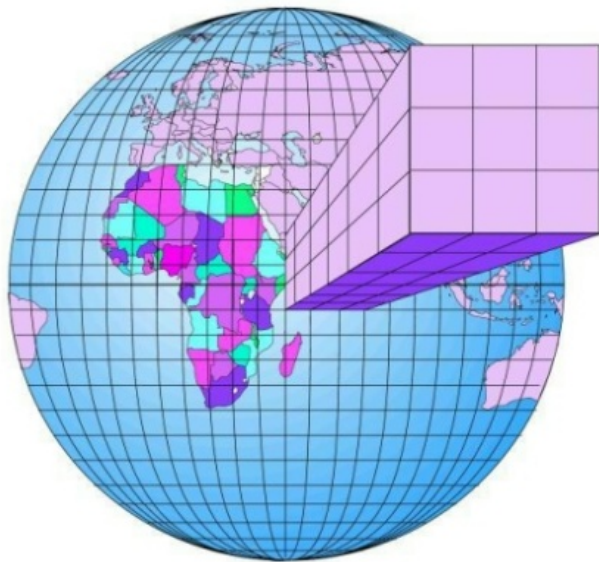
GMAO: Christoph Keller, Lesley Ott, Steven Pawson, Emily Saunders, Pamela Wales

Atmospheric Chemistry and Dynamics Lab: Bryan Duncan, Melanie Follette-Cook,  
Junhua Liu, Julie Nicely



# NASA GMAO global meteorology and chemistry products

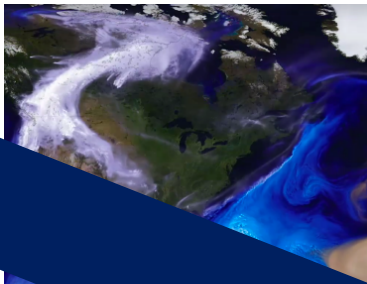
## GEOS



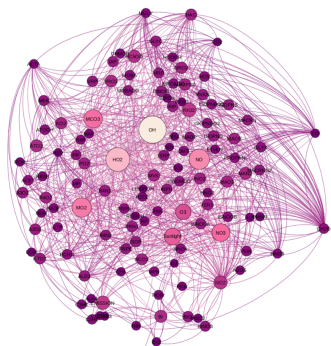
[www.nasa.gov](http://www.nasa.gov)



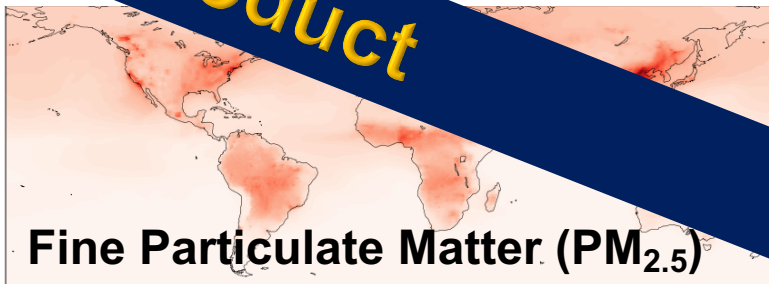
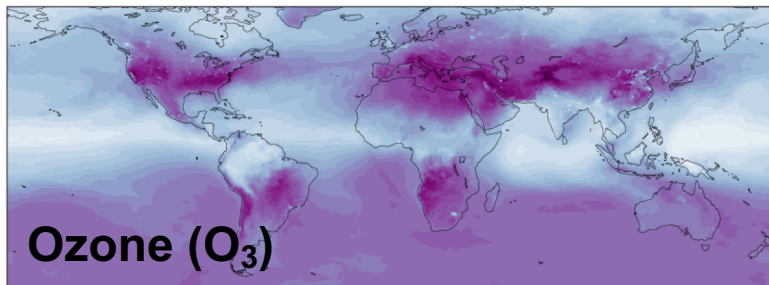
# NASA's composition forecast (GEOS-CF)



GEOS M



GEOS - Chem



**Research product**

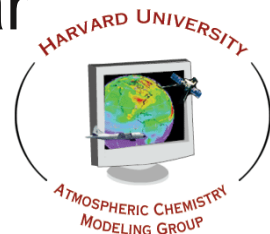


# GEOS-Chem is a state-of-the science chemistry transport model

Tropospheric and Stratospheric full chemistry

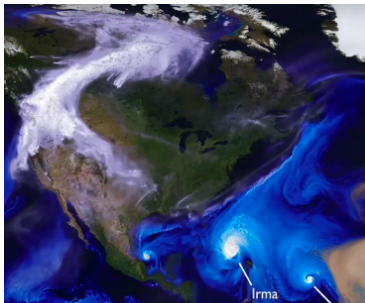
- 250 reactive species, 725 reactions
- 100+ user/developer groups worldwide
- Updated version is released about every year

**GEOS-Chem**

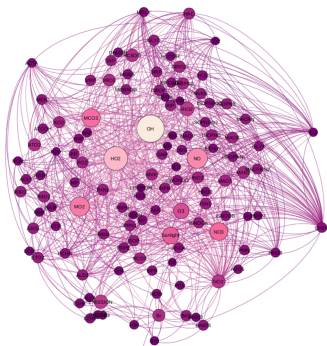




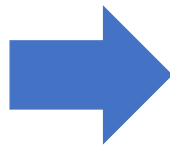
# Daily composition forecast



GEOS NWP



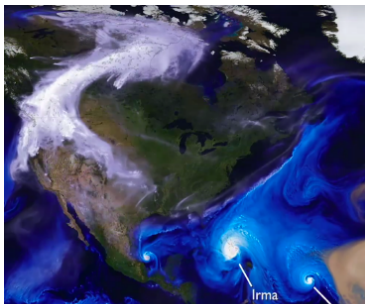
GEOS - Chem



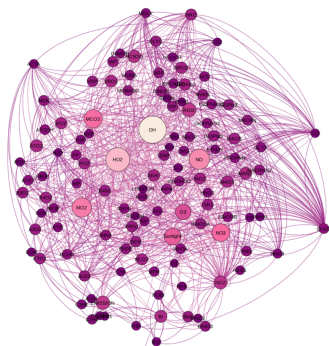
GEOS - CF

One **5-day forecast** per day

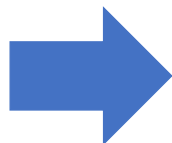
# Daily composition forecast



GEOS NWP



GEOS - Chem

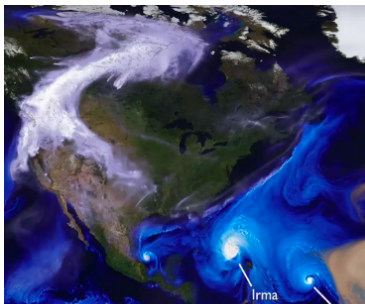


GEOS - CF

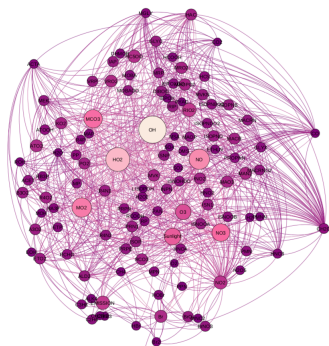
One **5-day forecast** per day

- 1-day “replay analysis”
- 5-day forecast

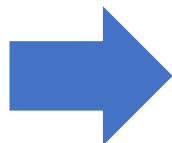
# Daily composition forecast



GEOS NWP



GEOS - Chem

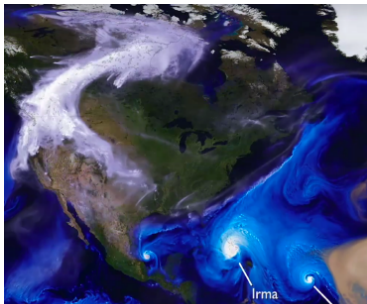


## GEOS - CF

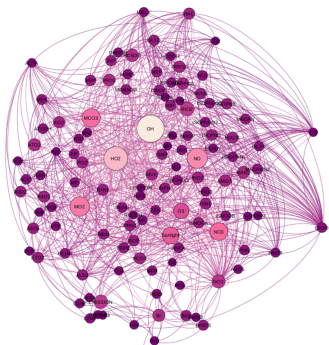
One **5-day forecast** per day

- 1-day analysis
- 5-day forecast
- c360 ( $0.25^\circ$ ,  $\sim 25 \times 25 \text{ km}^2$ ) resolution, 72 model layers

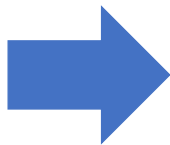
# Daily composition forecast



GEOS NWP



GEOS - Chem



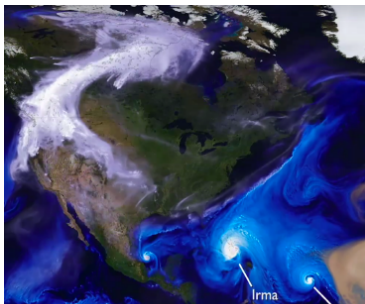
## GEOS - CF

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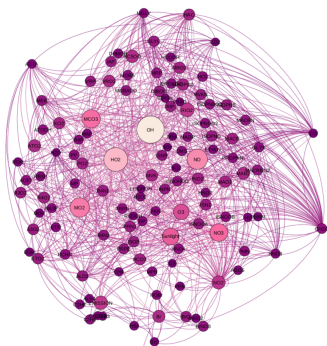
- 1-day analysis
- 5-day forecast
- c360 ( $0.25^\circ$ ,  $\sim 25 \times 25 \text{ km}^2$ ) resolution, 72 model layers
- $\text{O}_3$ ,  $\text{NO}_x$ , VOCs, PM ...



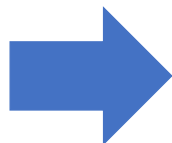
# Daily composition forecast



GEOS NWP



GEOS - Chem

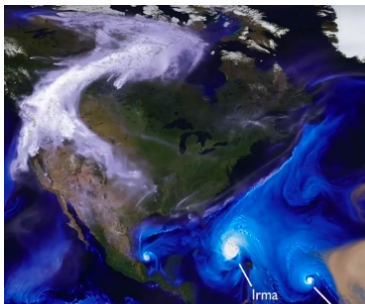


## GEOS - CF

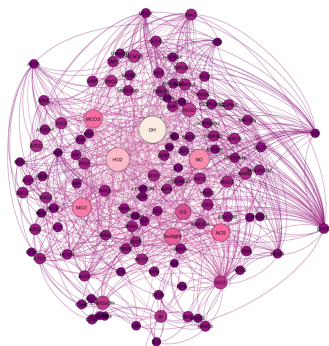
One **5-day forecast** per day

- 1-day analysis
- 5-day forecast
- c360 ( $0.25^\circ$ ,  $\sim 25 \times 25 \text{ km}^2$ )
- **15 minute** “surface”
- **1-hour** average and instantaneous 2D & 3D

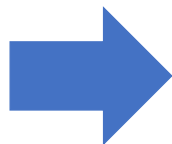
# Daily composition forecast



GEOS NWP



GEOS - Chem



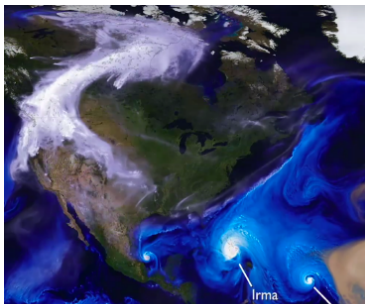
## GEOS - CF

One **5-day forecast** per day

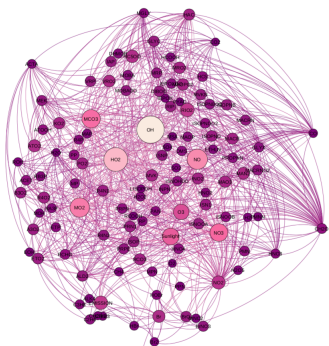
- 1-day analysis
- 5-day forecast
- c360 ( $0.25^\circ$ ,  $\sim 25 \times 25 \text{ km}^2$ )

➤ **1 January 2018 - NRT**

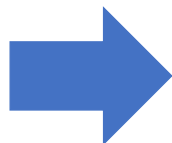
# Chemistry is not cheap!



GEOS NWP



GEOS - Chem



## GEOS - CF

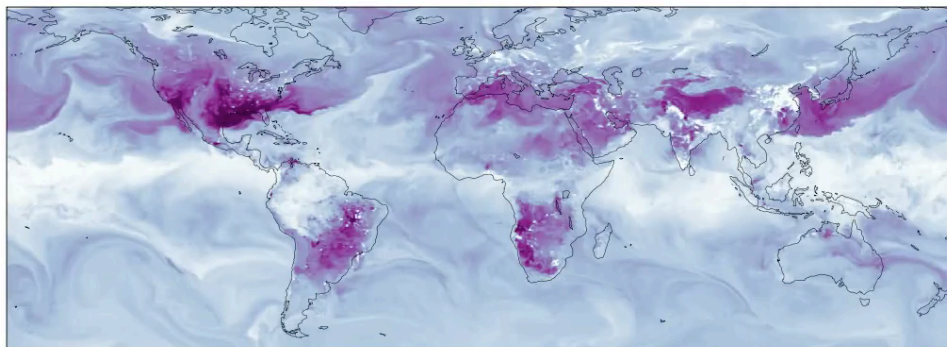
Run on **NASA's** Center for Climate Simulation **supercomputer**

- using the computing power equivalent to **3500** personal computers.

# High-Resolution Global Simulation

GEOS - CF

2017-10-01 00:30 UTC



10 20 30 40 50 60

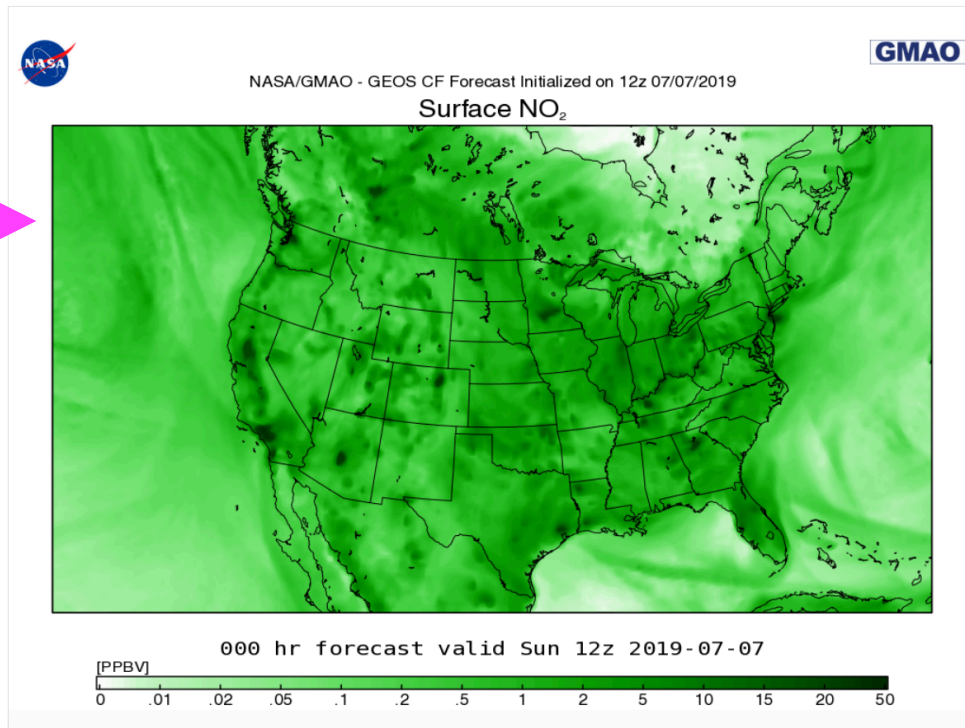
Surface ozone [ppbv]

25 km x 25 km (16 miles)

- **Highest** horizontal resolution of a global atmospheric composition forecast
- **10 x higher** than conventional global atmospheric chemistry simulations.

# Where to find GEOS-CF

Output available at [fluid.nccs.nasa.gov/cf](https://fluid.nccs.nasa.gov/cf)





# Composition Forecast Maps

## FIELDS

CO Sfc

NO2 Sfc

O3 Sfc

PM2.5 Sfc

SO2 Sfc

## REGIONS

United States

## FORECAST INITIAL TIME

07Jul2019 12z

## FORECAST LEAD HOUR

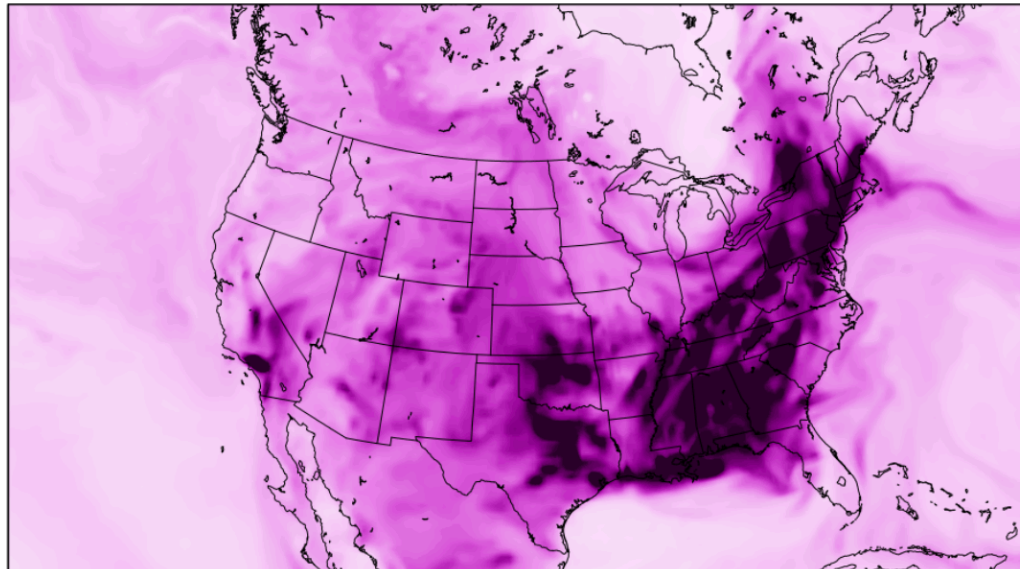
105h 11Jul2019 21z



GMAO

NASA/GMAO - GEOS CF Forecast Initialized on 12z 07/07/2019

Surface O<sub>3</sub>



105 hr forecast valid Thu 21z 2019-07-11

[PPBV]

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

# Model forecast O<sub>3</sub>

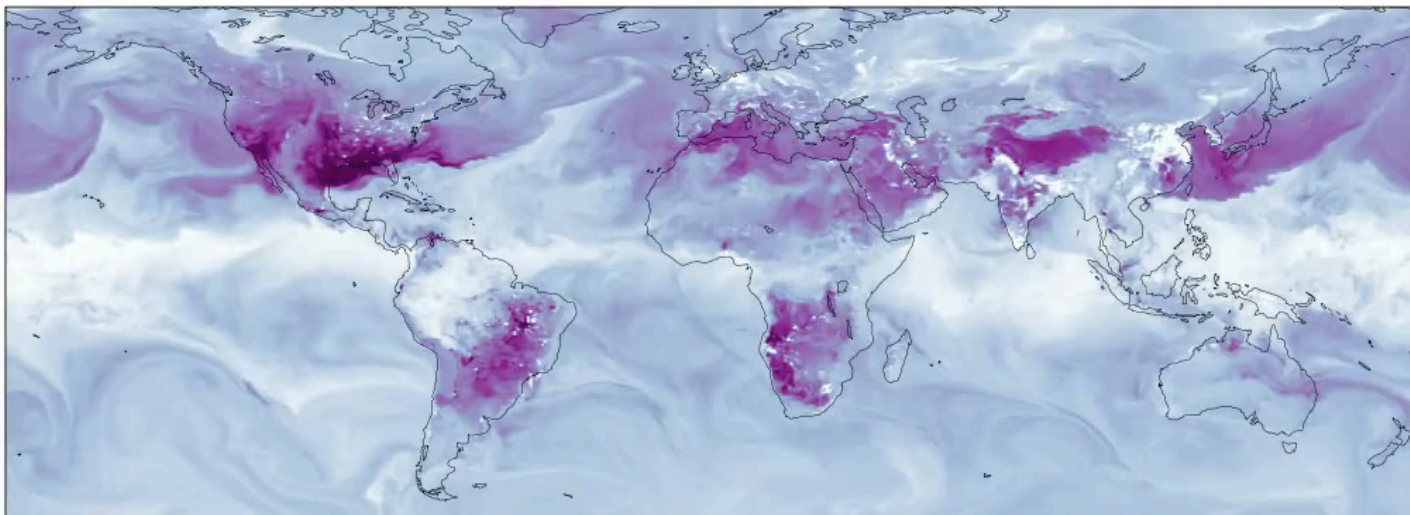
ANIMATE

DOWNLOAD MOVIE



# Thank you!

2017-10-01 00:30 UTC



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