



# Near real-time global composition forecasts at 25km horizontal resolution

**K. Emma Knowland**

USRA/GESTAR

NASA Global Modeling and Assimilation Office (GMAO)

**In collaboration with:**

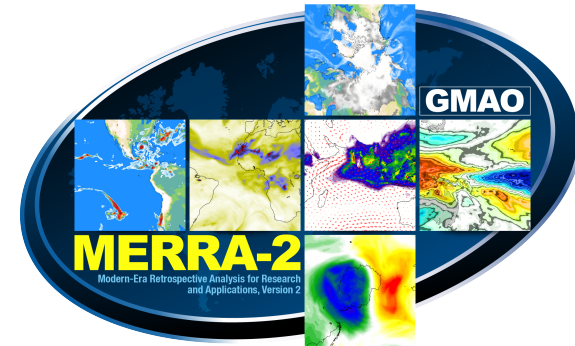
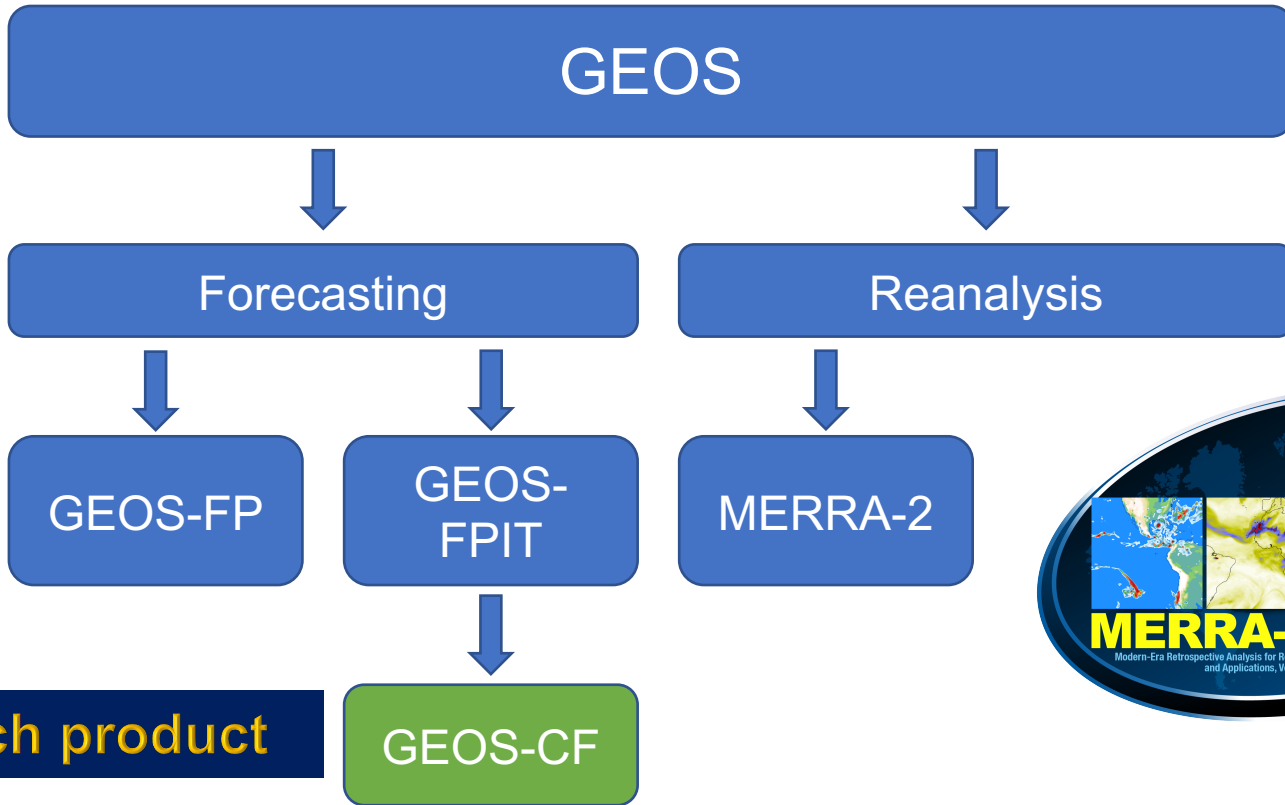
GMAO: Christoph Keller, Steven Pawson, Emily Saunders, Pamela Wales

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

8 May 2019

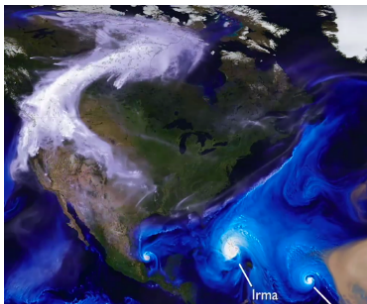


# NASA GMAO global meteorology and chemistry products

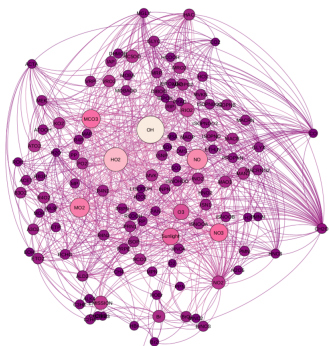


**Research product**

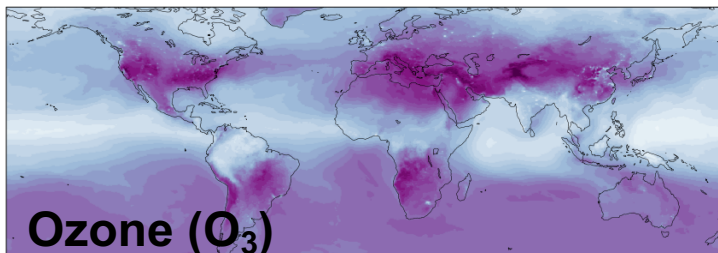
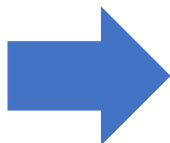
# NASA's composition forecast (GEOS-CF)



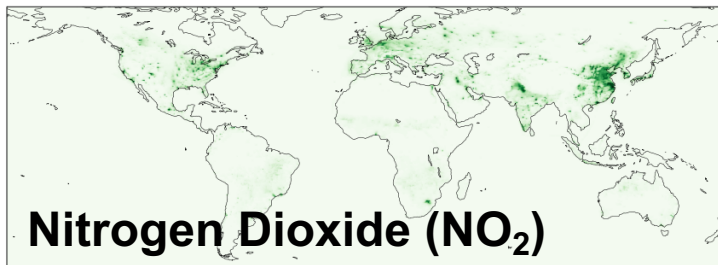
GEOS FPIT



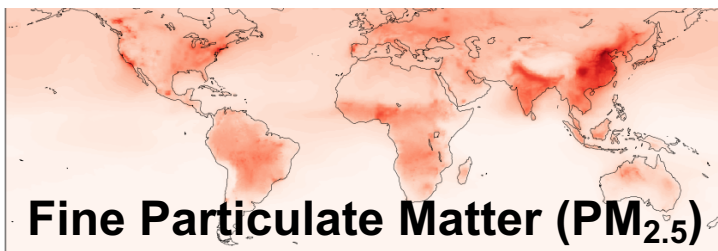
GEOS - Chem



Ozone ( $O_3$ )



Nitrogen Dioxide ( $NO_2$ )



Fine Particulate Matter ( $PM_{2.5}$ )

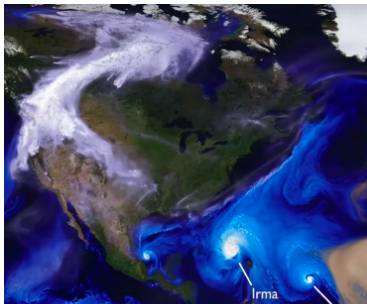
# GEOS-Chem version 12

- Same version as GEOS-Chem Classic

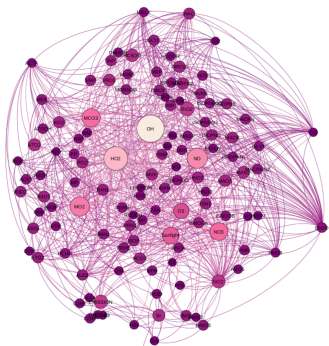
**GE**  **S** - **Chem**

- There are differences for emissions, as GEOS-CF is run in near-real time (e.g., QFED)

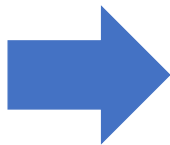
# Daily composition forecast



GEOS FPIT



GEOS - Chem

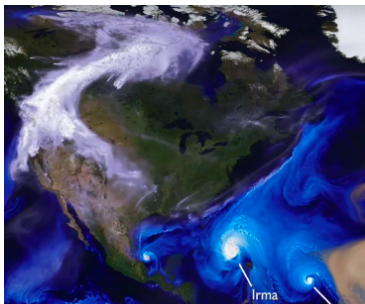


## GEOS - CF

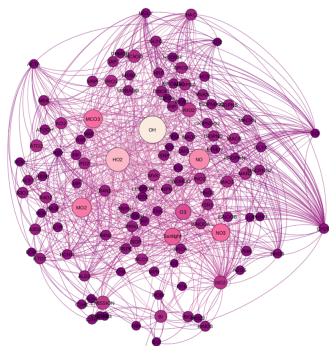
One **5-day forecast** per day

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

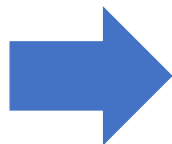
# Daily composition forecast



GEOS FPIT



GEOS - Chem

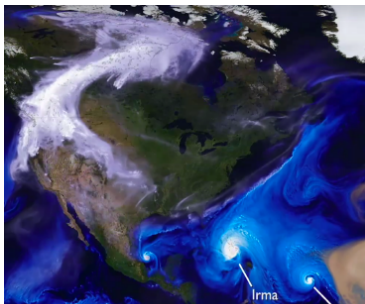


## GEOS - CF

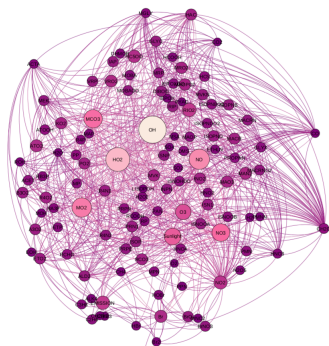
One **5-day forecast** per day

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

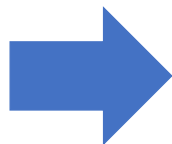
# Daily composition forecast



GEOS FPIT



GEOS - Chem



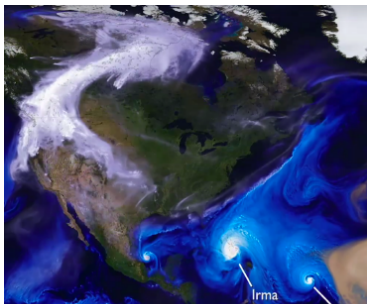
## GEOS - CF

One **5-day forecast** per day

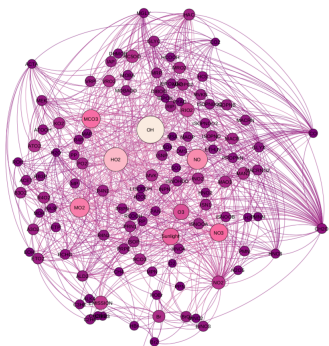
- 1-day hindcast
- 5-day forecast
- c360 ( $0.25^\circ$ ,  $\sim 25 \times 25 \text{ km}^2$ )

➤ **1 January 2018 - NRT**

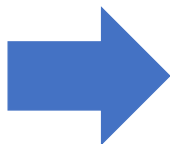
# Daily composition forecast



GEOS FPIT



GEOS - Chem



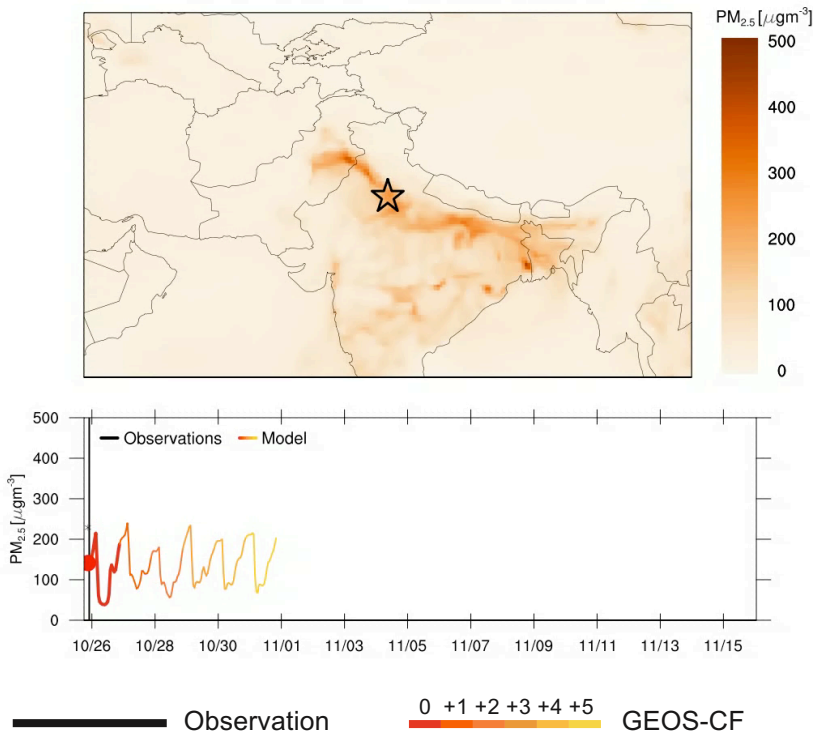
## GEOS - CF

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

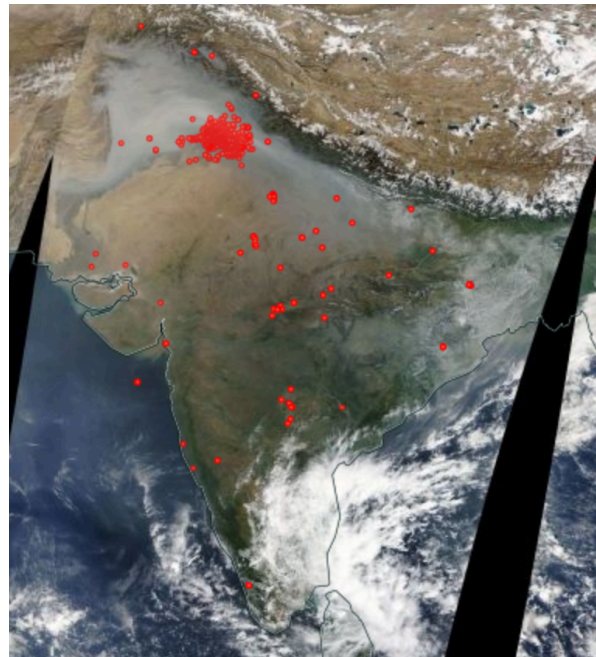


# Case study: agricultural fires in India

Delhi, India, 2017-10-26 00:00 UTC

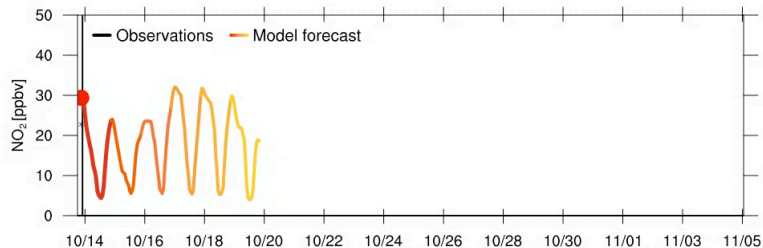
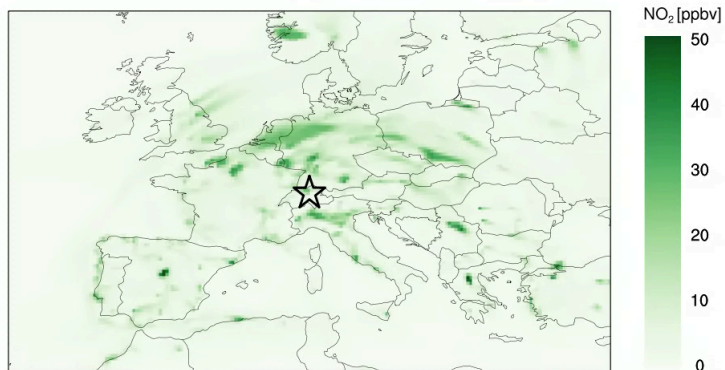


MODIS fires Nov 01, 2017



# Daily composition forecast

Zurich, Switzerland, 2017-10-14 00:00 UTC

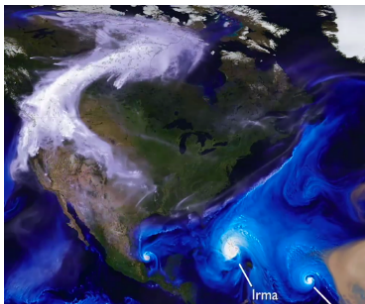


— Observation      0 +1 +2 +3 +4 +5      GEOS-CF

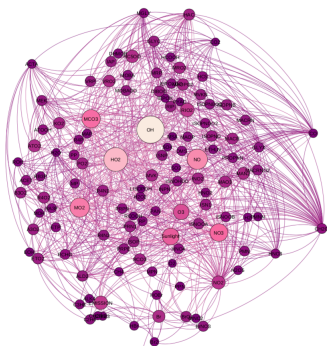
## GEOS - CF

- Currently no direct data assimilation of constituents in GEOS-CF
- Annual emission scale factors based on satellite
- Scale factors applied to emissions for diurnal and weekly variations

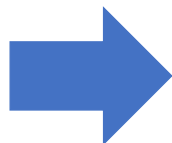
# Daily composition forecast



GEOS FPIT



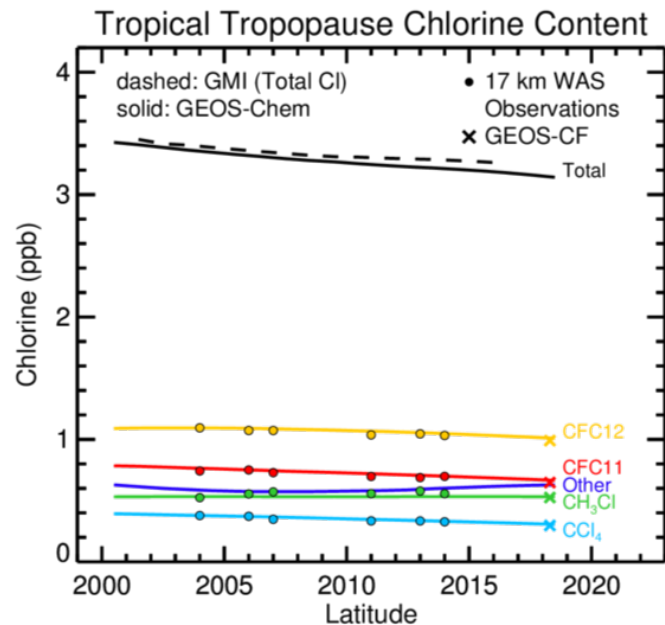
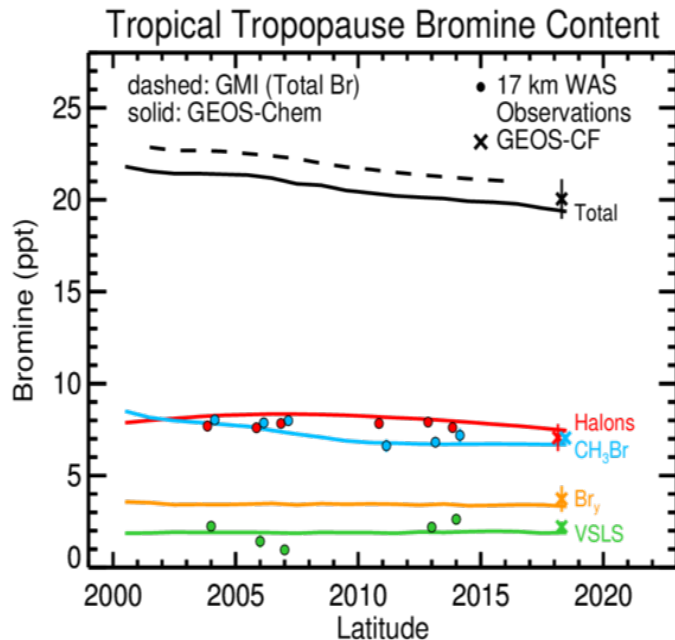
GEOS - Chem



## GEOS - CF

- Currently no direct data assimilation of constituents in GEOS-CF
- **Stratospheric Ozone relaxed to GEOS-FP O3**

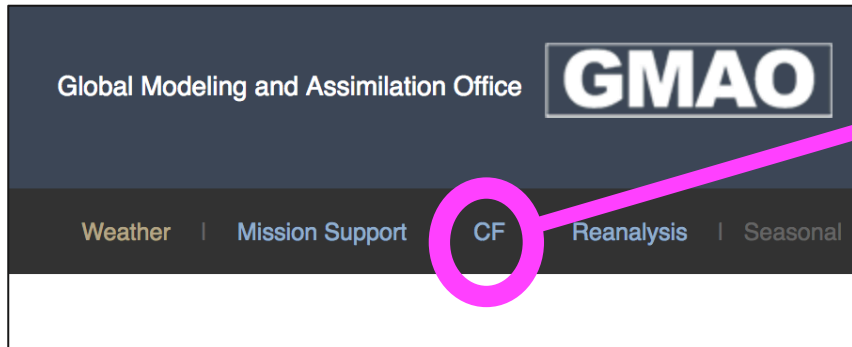
# Stratospheric Composition Evaluation



Zonal means for the Tropics (20°S – 20°N)

# Summary

- GEOS-CF produces daily global air quality forecasts at 25km (16 miles) horizontal resolution since 1 January 2018
- Output available at [fluid.nccs.nasa.gov/cf](https://fluid.nccs.nasa.gov/cf)



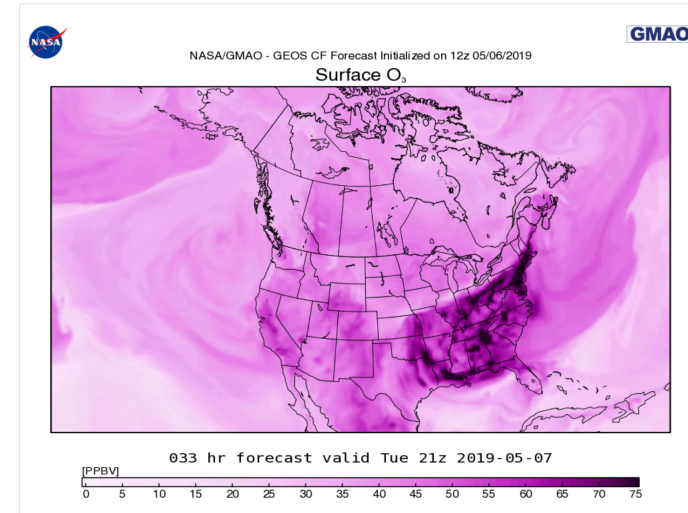
FIELDS	
CO Sfc	NO2 Sfc
<b>O3 Sfc</b>	PM2.5 Sfc
SO2 Sfc	

REGIONS	
North America	

FORECAST INITIAL TIME	
06May2019 12z	

FORECAST LEAD HOUR	
033h 07May2019 21z	

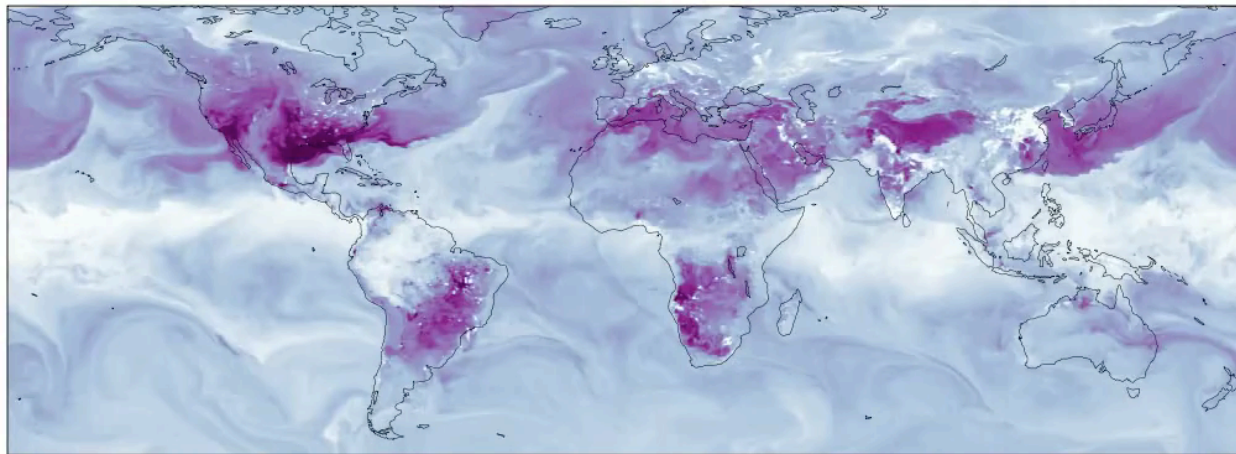
## Composition Forecast Maps



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

# Thank you!

2017-10-01 00:30 UTC



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

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