

Air quality forecasts using the NASA GEOS model

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USRA/GESTAR

NASA Global Modeling and Assimilation Office (GMAO)

In collaboration with:

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Melanie Follette-Cook, Junhua Liu, Julie Nicely

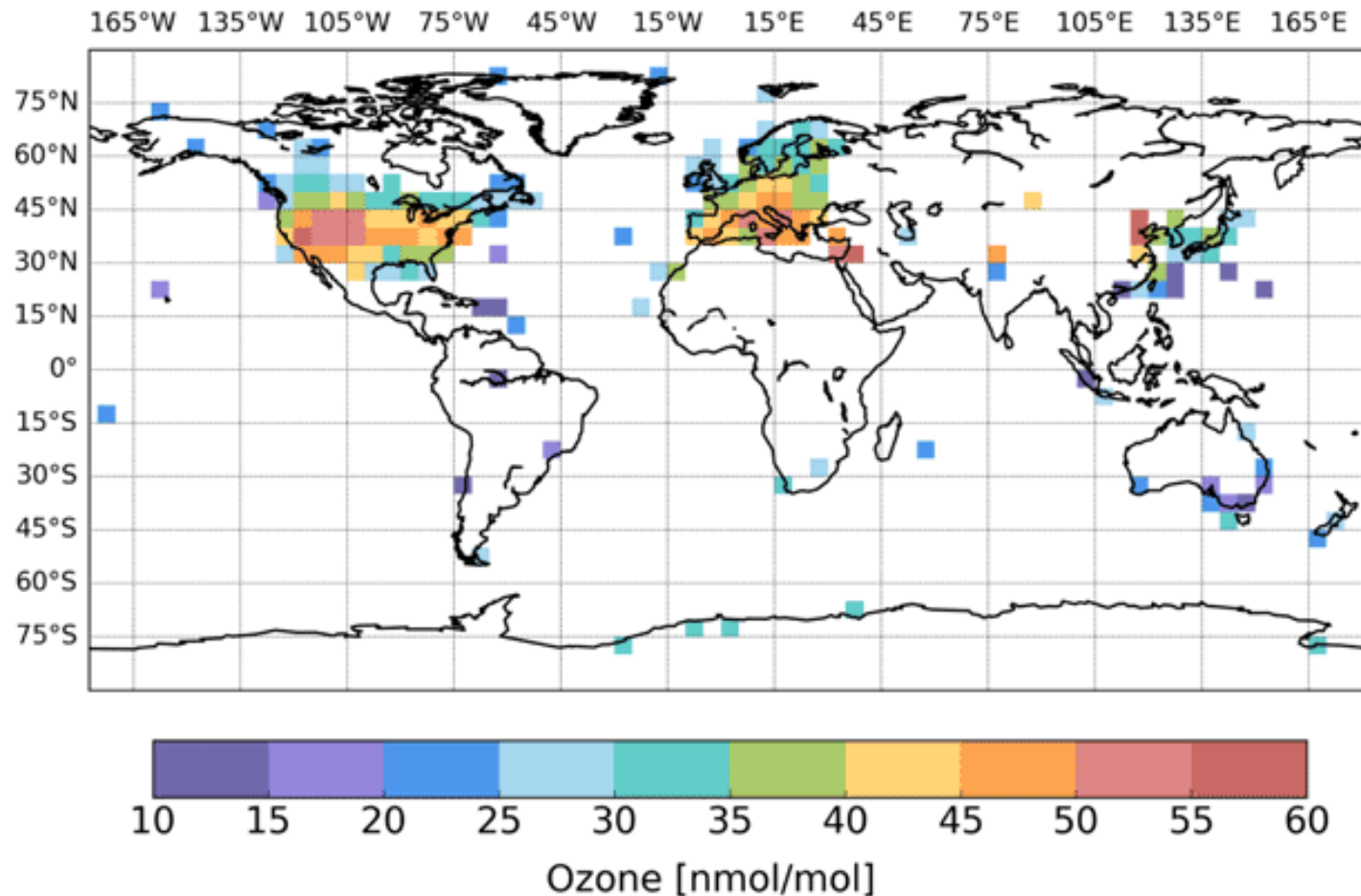


Air quality is a global problem



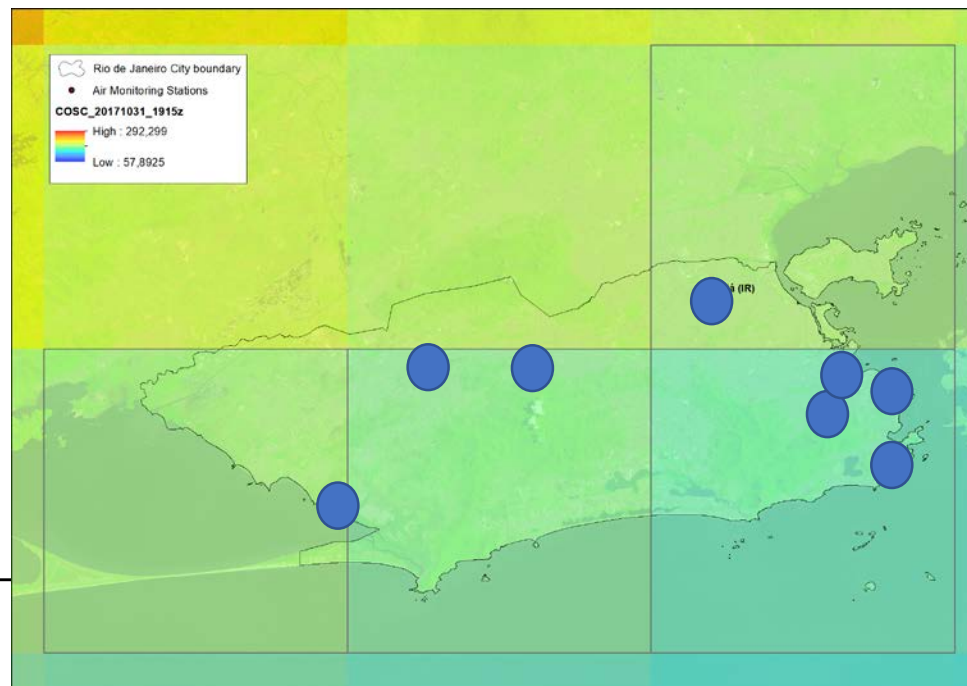
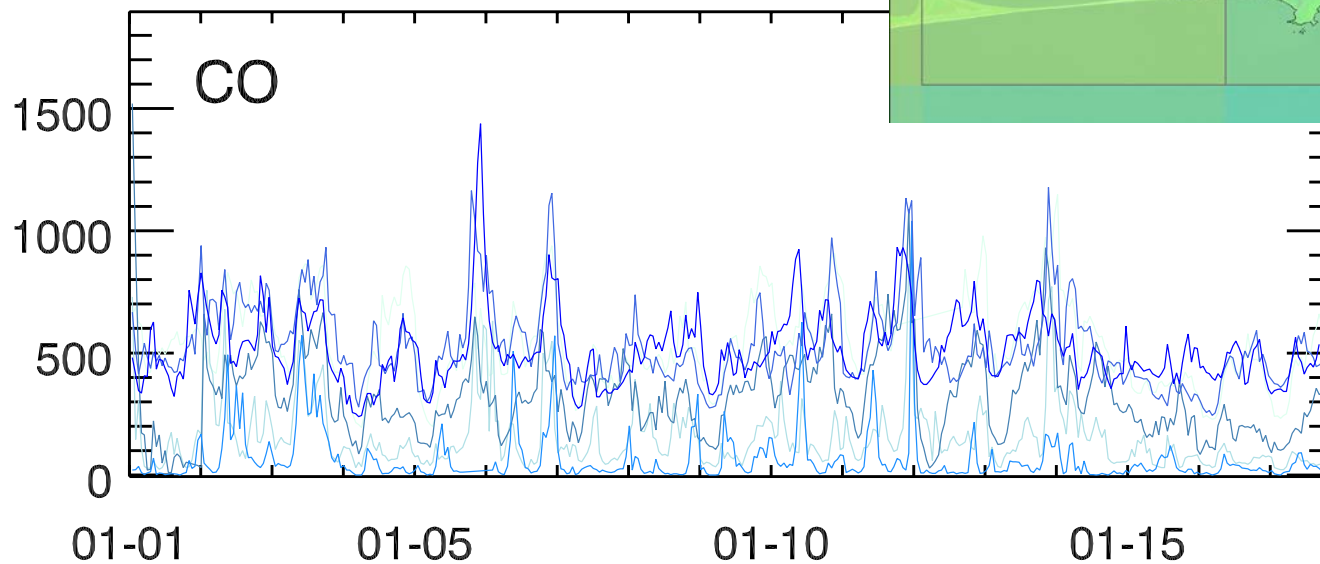
- 1 of every 9 death is related to air pollution (WHO)
- \$5 Trillion in welfare losses every year (World Bank)
- Locally up to 50% crop loss due to ozone

Surface observations are sparse!

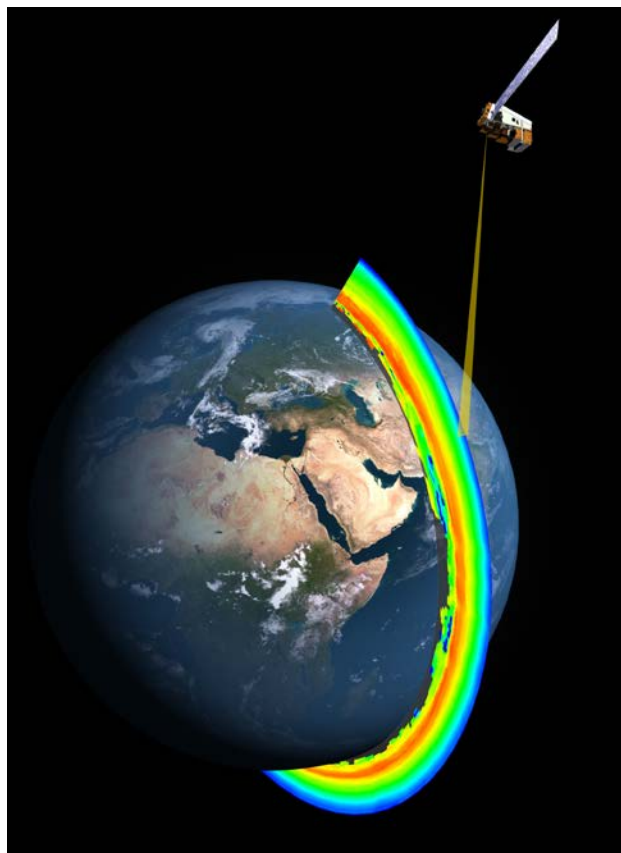


Tropospheric Ozone Assessment Report TOAR (Schulz et al., 2017)

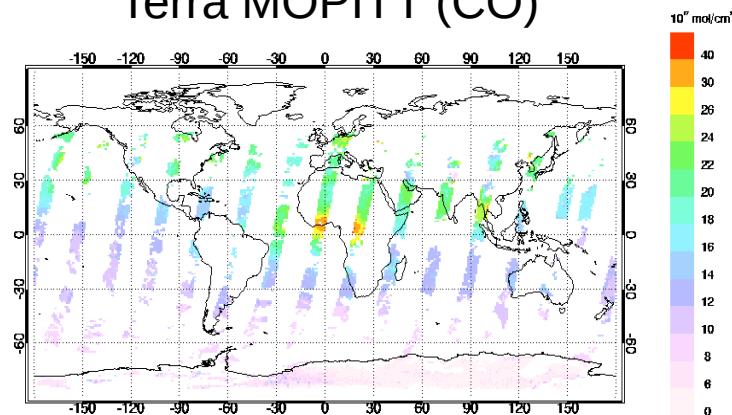
And highly variable!



Current data coverage from space is limited

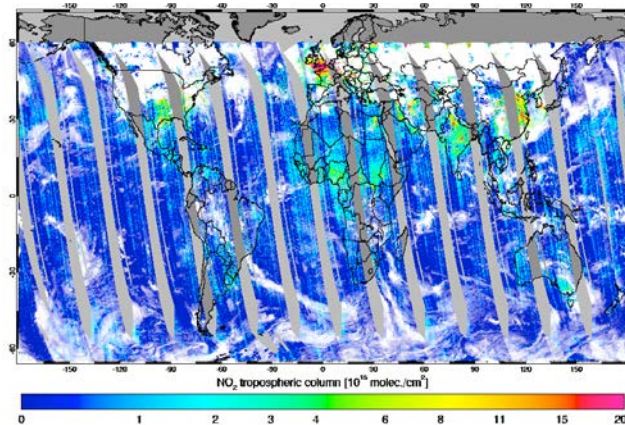


Terra MOPITT (CO)



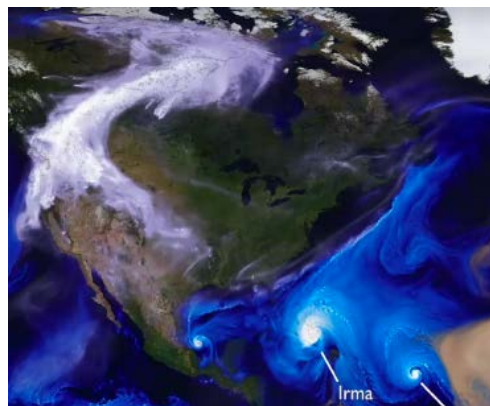
www.aom.ucar.edu

Aura OMI (NO₂, O₃)

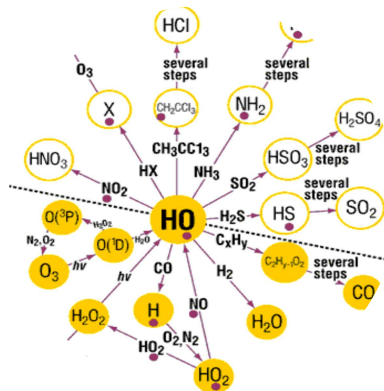


www.temis.nl

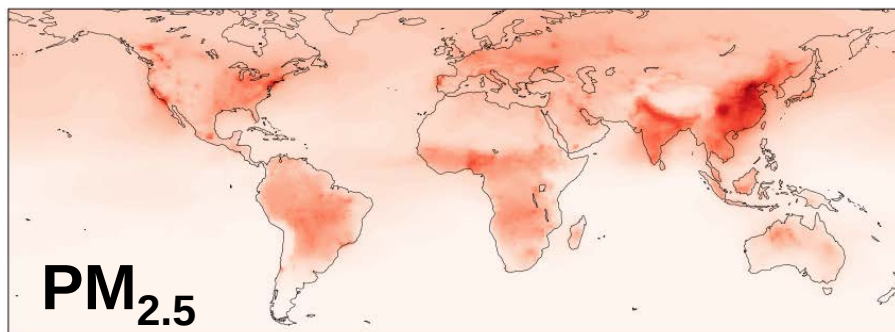
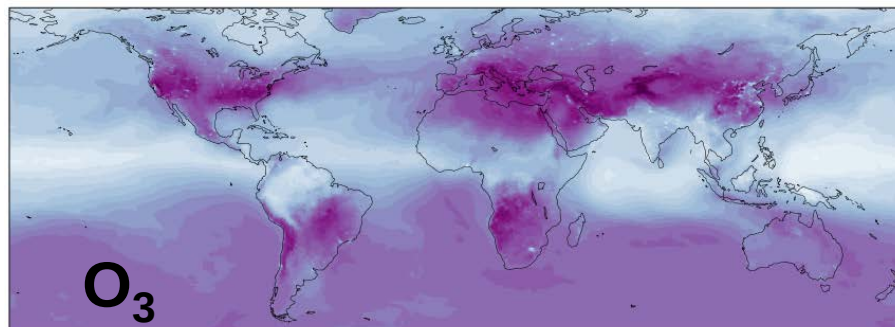
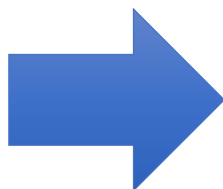
NASA GMAO's Composition Forecast



GEOS - FP



GEOS - Chem

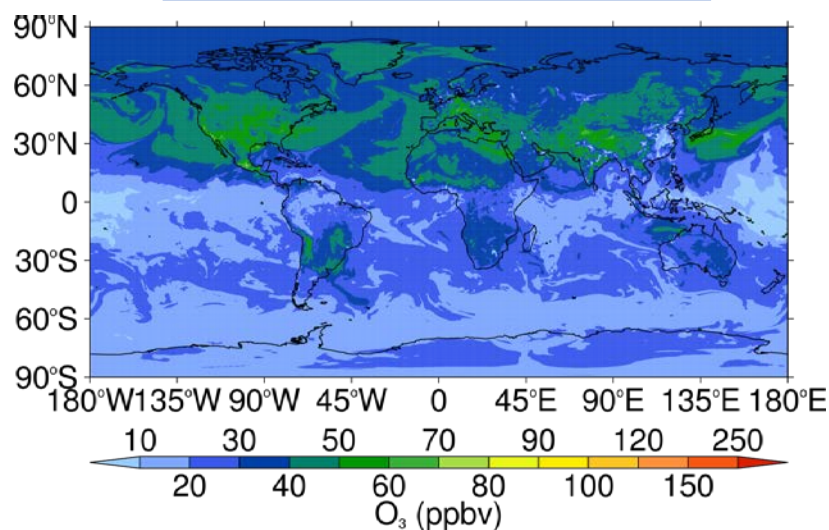


It's a big world out there....are we alone?

GEOS - CF

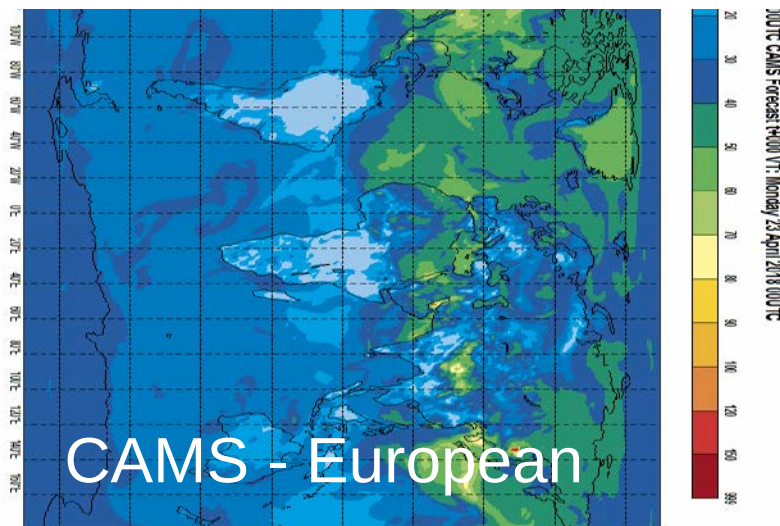
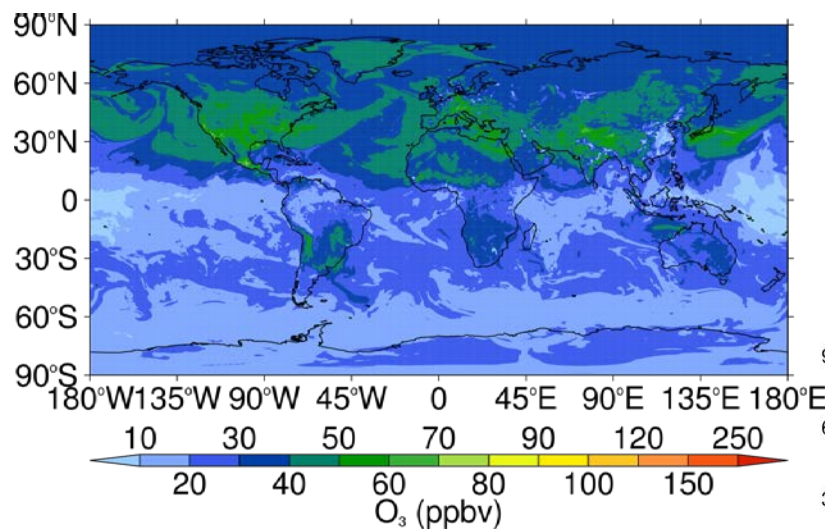
25 km x 25 km (16 miles)

➤ **10 x higher** than
conventional global
atmospheric chemistry
simulations.

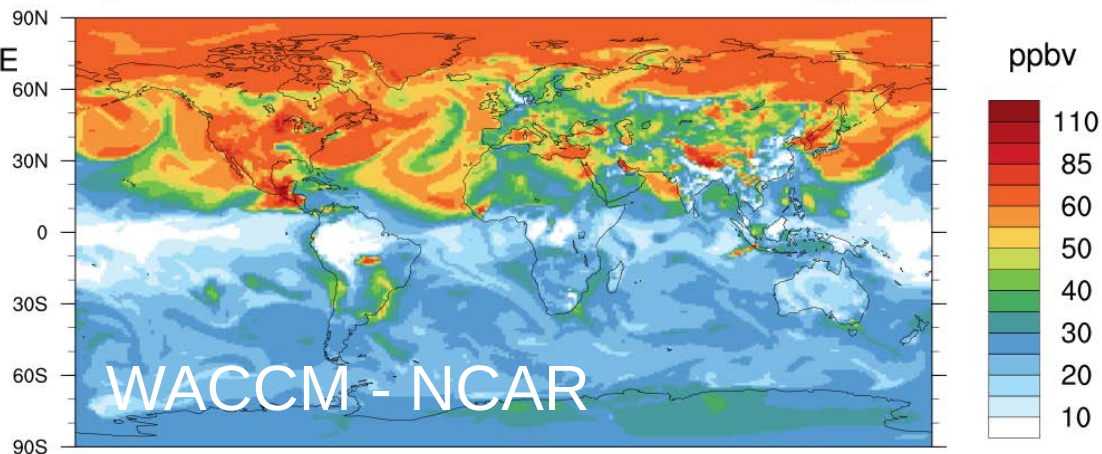


It's a big world out there

GEOS - CF

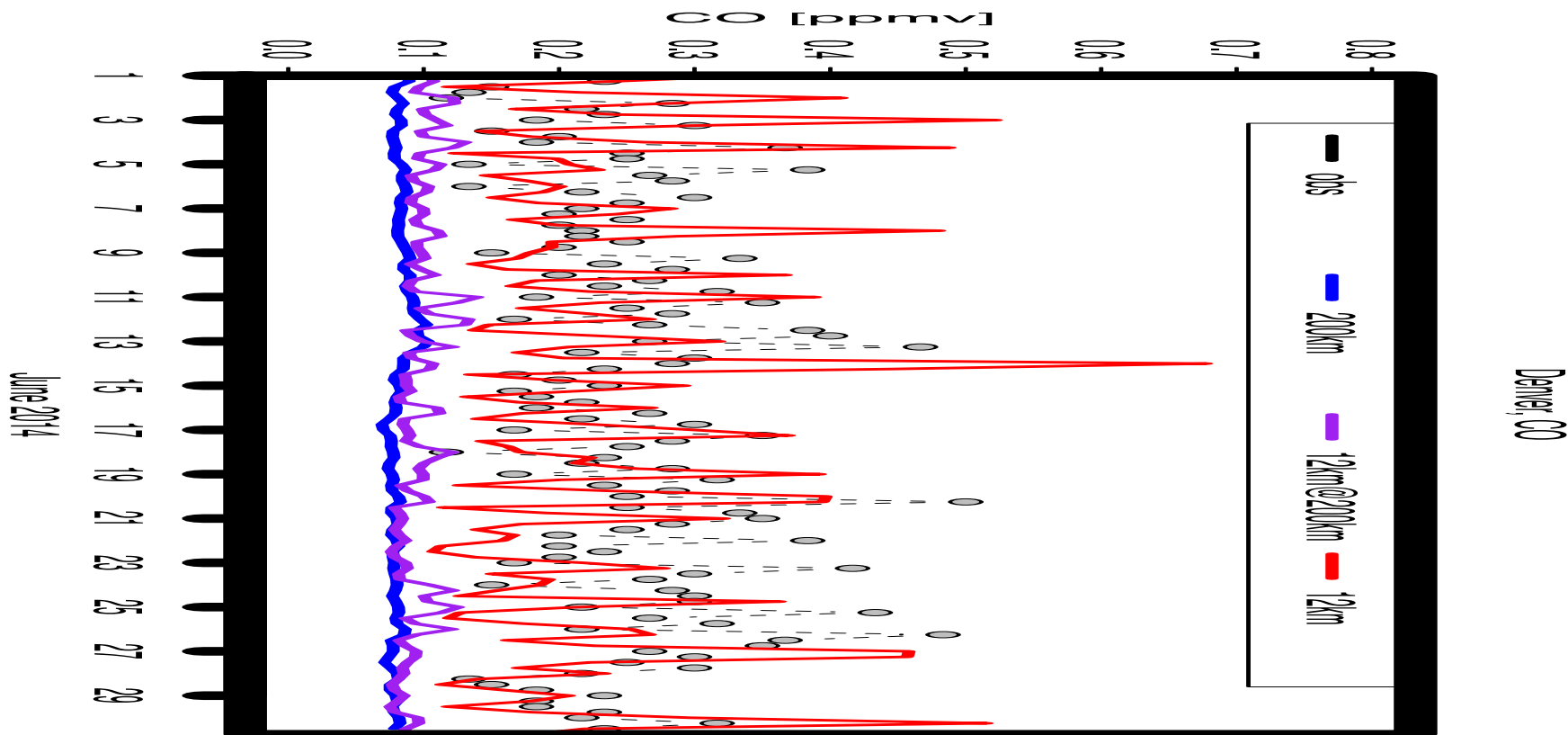


CAMS - European



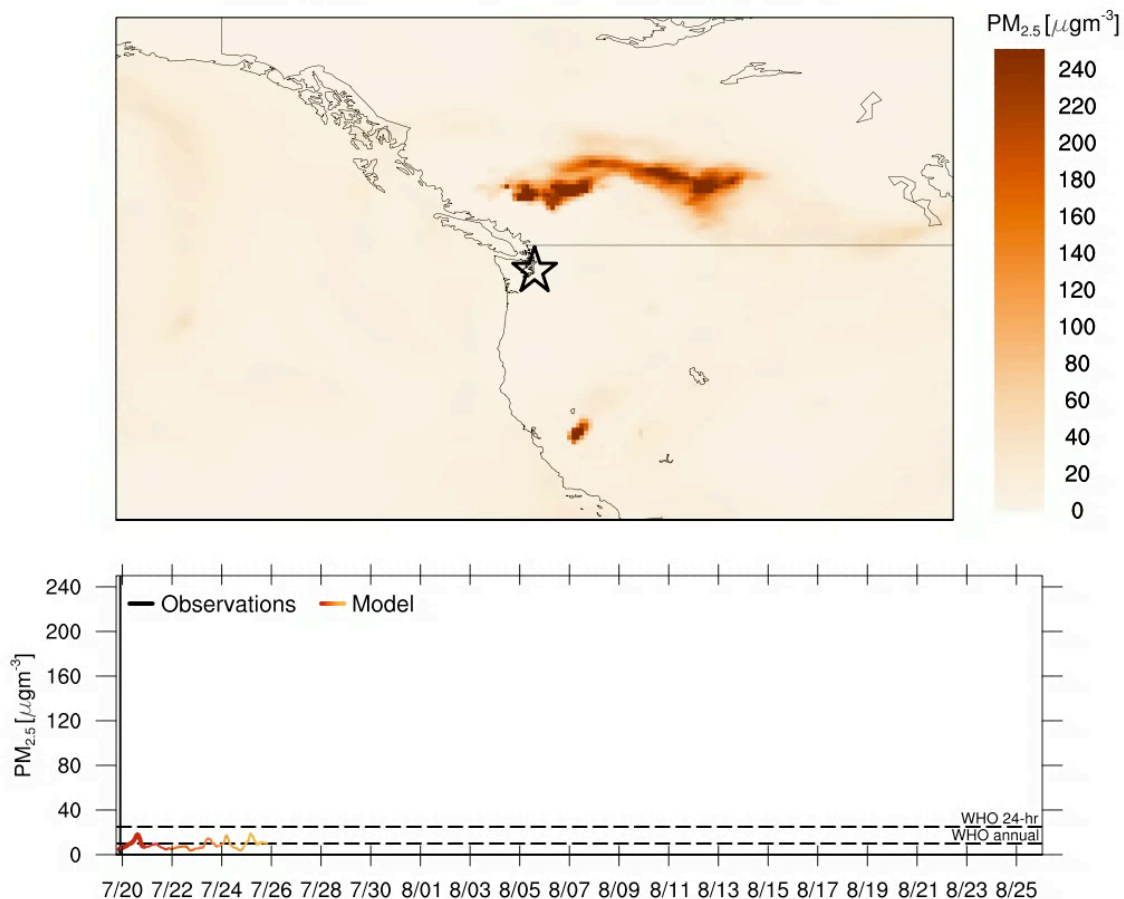
WACCM - NCAR

High resolution critical to resolve features relevant to air quality



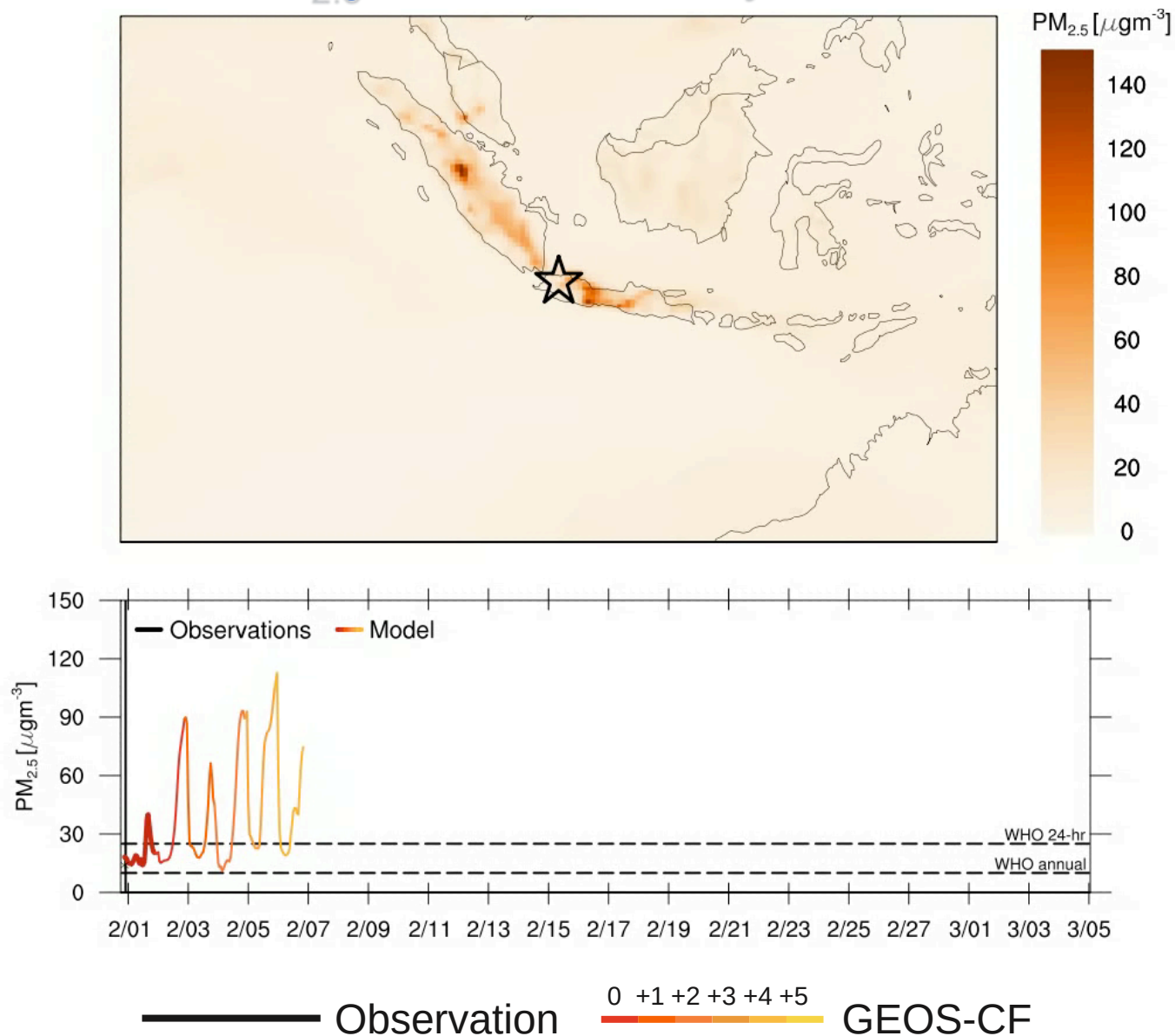
Local evaluation of PM_{2.5} from wildfires

Seattle, WA, 2017-07-20 00:00 UTC



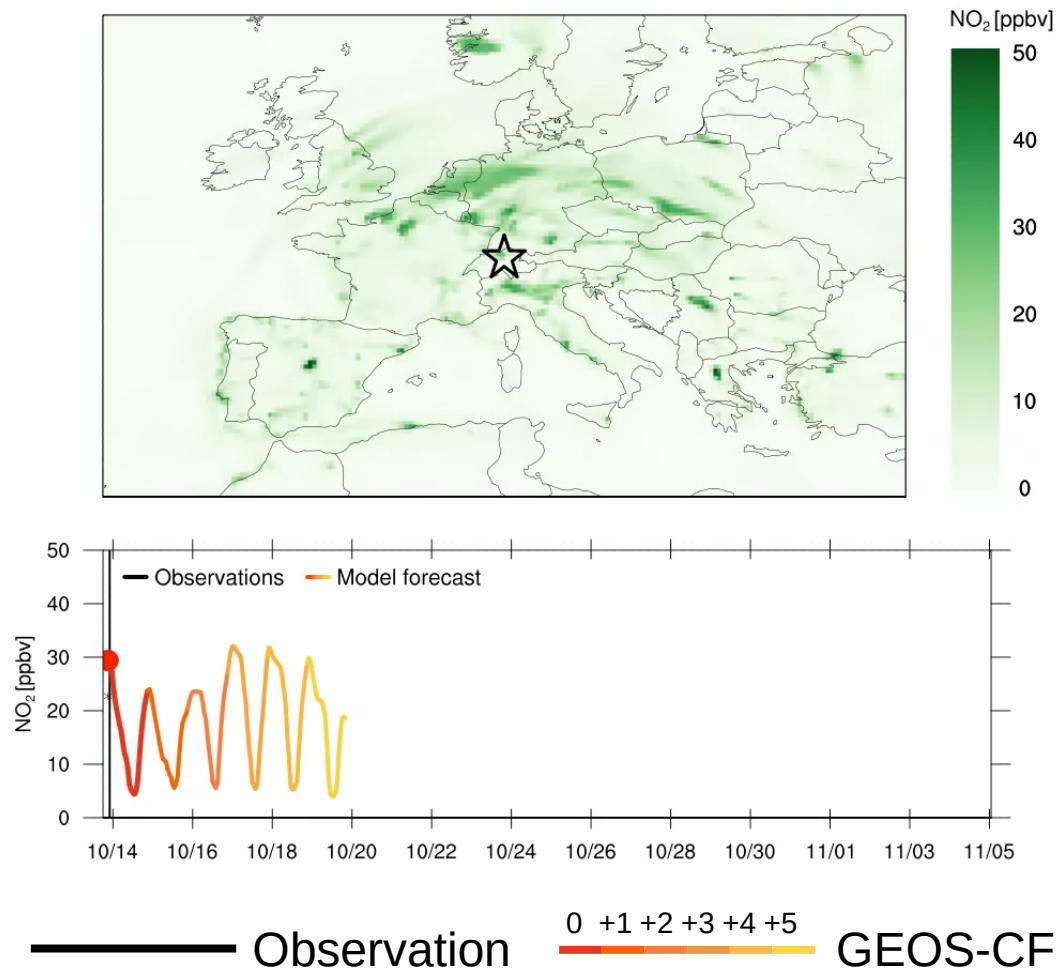
— Observation 0 +1 +2 +3 +4 +5 GEOS-CF

Simulated $\text{PM}_{2.5}$ vs US Embassy Monitor in Jakarta

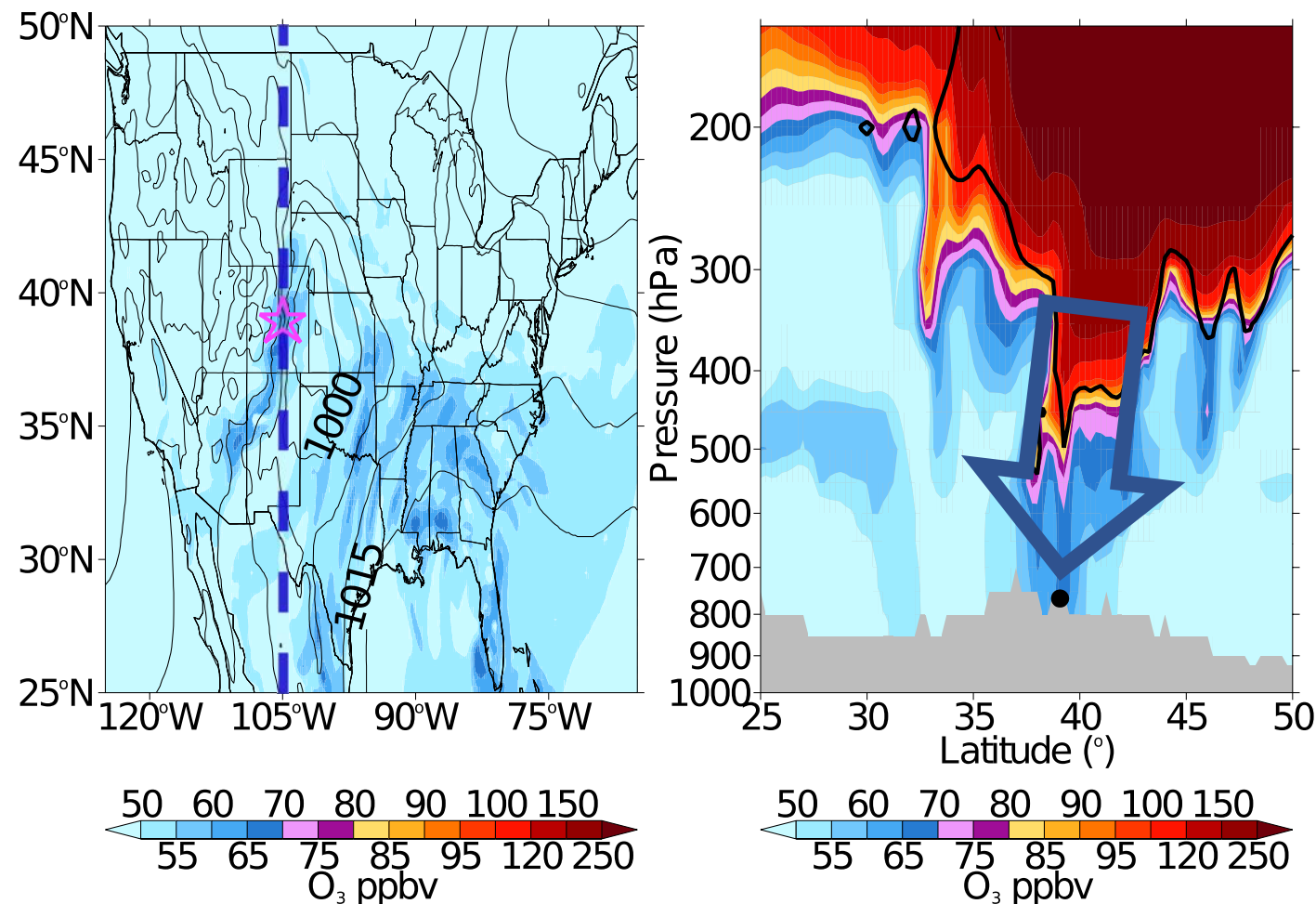


Local evaluation of NO₂: comparison against surface observations (where available)

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



Stratospheric intrusions (SI)



Several **peaks in O₃** at monitoring stations reported in **AZ, CO and MD** April 16-18, 2018, **likely caused by SIs**

With several exceeding the NAAQS O₃ > 70 ppb regulatory limit



Application: Health Air Quality Index (HAQI)

HAQI is a **multi-pollutant** index

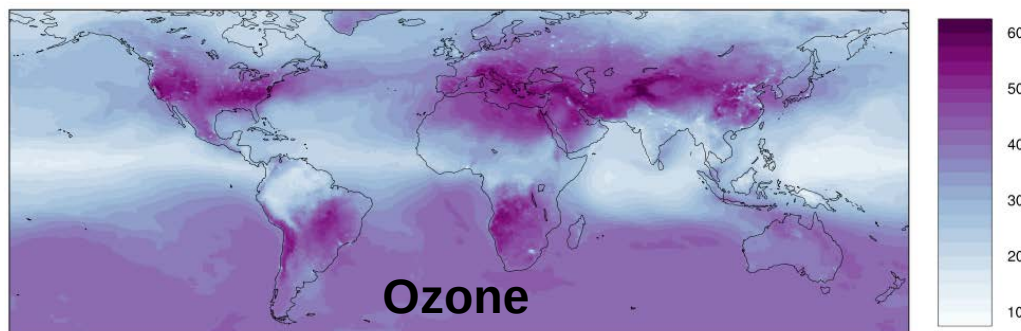
The Canadian HAQI is a function of O_3 , NO_2 , and $PM_{2.5}$

$$AQHI = \left(\frac{1000}{10.4}\right) \times [(e^{0.000537 \times O_3} - 1) + (e^{0.000871 \times NO_2} - 1) + (e^{0.000487 \times PM_{2.5}} - 1)]$$

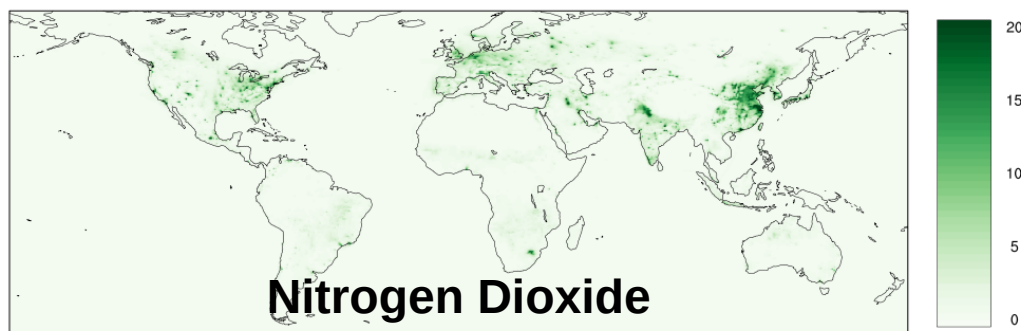
(Stieb et al., 2008, J. Air & Waste Manage. Assoc.)

Application: Health Air Quality Index (HAQI)

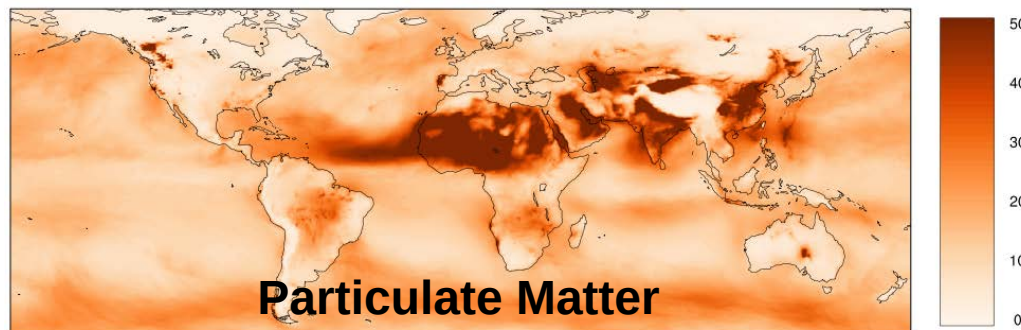
HAQI is a function of O_3 , NO_2 , and $PM_{2.5}$



➤ O_3 influences Background levels



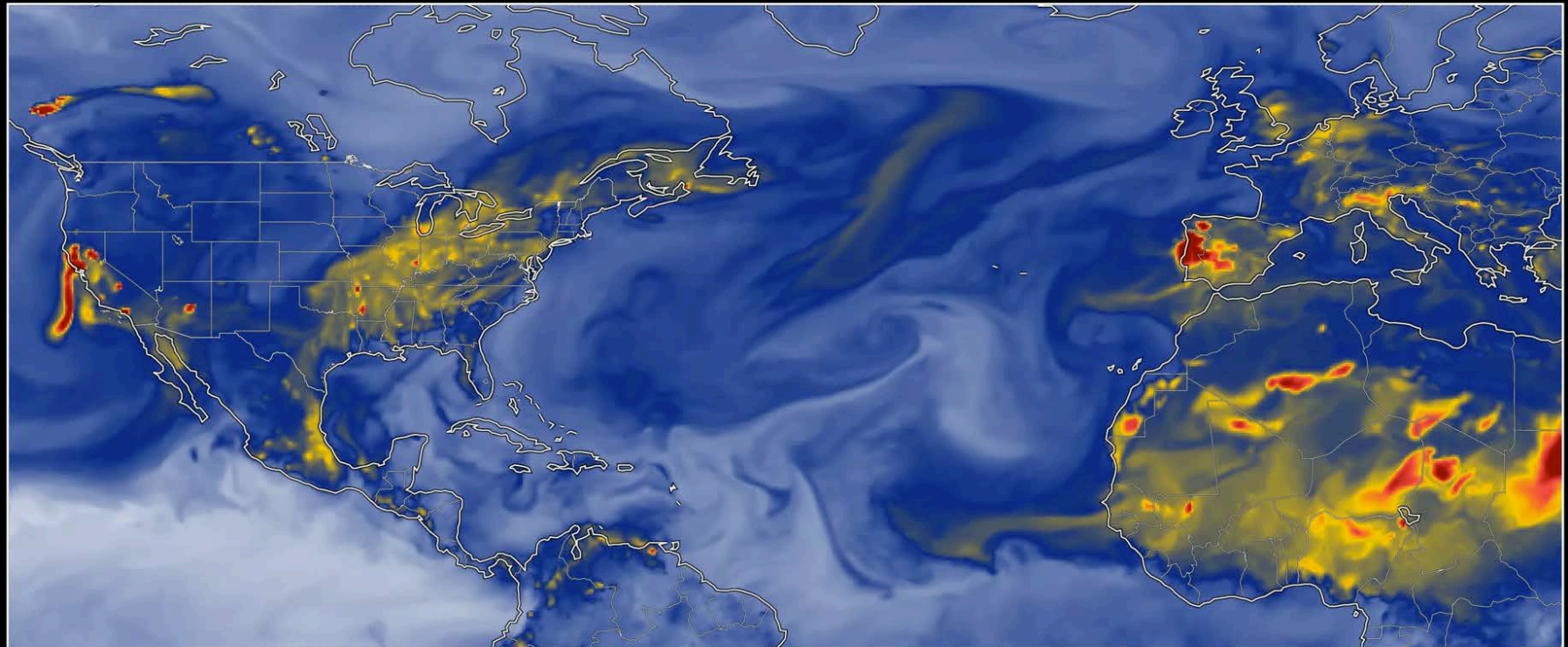
➤ NO_2 is Short-lived
➤ Extreme gradients



➤ $PM_{2.5}$ driver of spatial gradients

Health Air Quality Index

(based on Stieb et al., 2008)



GEOS-5 1/4°



GMAO

Global Modeling and Assimilation Office
NASA Goddard Space Flight Center



Good

Moderate

Unhealthy

Very Unhealthy

GEOS-Chem v11-02



Atmospheric Chemistry Modeling Group
Harvard University

➤ NYU and UNICEF will use GEOS-CF to refine HAQI for children



GMAO

Global Modeling and Assimilation Office
gmao.gsfc.nasa.gov

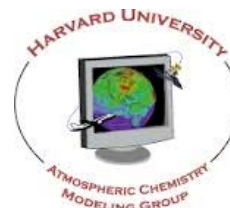
k.e.knowland@nasa.gov
christoph.a.keller@nasa.gov

Collaborations & Opportunities

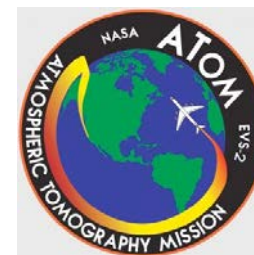
Government,
Public, NGO,
Industry,

Research / Mitigation

Flight campaign
planning



UNIVERSITY
of York



CLIMATE &
CLEAN AIR
COALITION
TO REDUCE SHORT-LIVED
CLIMATE POLLUTANTS

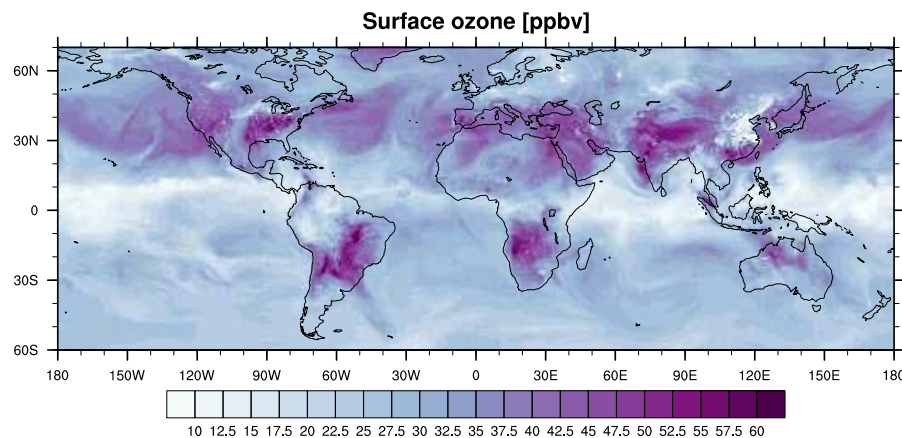


Summary

- GEOS-CF produces daily global air quality forecasts at 25km horizontal resolution
- Output available to public in mid-2018

Under development:

- 2-5 year simulation to collect statistics
- Assimilation system for trace gases (O_3 , NO_2 , CO)



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