Air quality forecasts using the NASA GEOS model

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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
Need global models to fill gaps in observations

Tropospheric Ozone Assessment Report TOAR (Schulz et al., 2017)
GEOS composition forecasting system (GEOS-CF)

- 1-day analysis
- 5-day forecast
- 0.25° resolution
- Aerosols
- Reactive gases

Running since March 2017 – still in test / evaluation mode
GEOS-CF surface ozone

2017-10-01 00:30 UTC

Surface ozone [ppbv]
Contributors to air pollution

- Particulate matter:
  - Organic Carbon
  - Black Carbon
  - Sea salt
  - Nitrate
  - Sulfate
  - Dust

- Reactive gases:
  - Ozone
  - Nitrogen dioxide
  - Carbon monoxide
  - Volatile organic compounds:
    - Formaldehyde
    - Benzene / Toluene
    - And many more!

GOCART
GEOS-Chem
High resolution critical to resolve features relevant to air quality

Denver, CO

![Graph showing CO concentration from June 1 to June 30, 2014, with different resolutions: obs, 200km, 12km@200km, and 12km.](image-url)
Global evaluation of NO$_2$: comparison against surface observations

North America

Europe

Asia

Southern Hemisphere

Day of Year

Nitrogen dioxide [ppbv]

Obs
Model

https://openaq.org
Local evaluation of NO$_2$: good temporal correlation with surface observations (where available)
High bias in surface ozone, but diurnal cycle is well captured

0.25 degrees

2 degrees
Will new chemistry mechanism reduce ozone bias?

v11-02d: updated halogen chemistry

Currently implemented

Sherwen et al., 2017, Faraday Discuss.
Application: Health Air Quality Index (HAQI)

- HAQI is a function of O$_3$, NO$_2$, and PM$_{2.5}$ (e.g. Stieb et al., 2008)
NYU and UNICEF will use GEOS-CF to refine HAQI for children
Summary

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

Under development:
- 2-5 year simulation to collect statistics
- Assimilation system for trace gases (O₃, NO₂, CO)

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