Modeling and forecasting for WINTER

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Mission planning
Mission execution
Post-mission data analysis

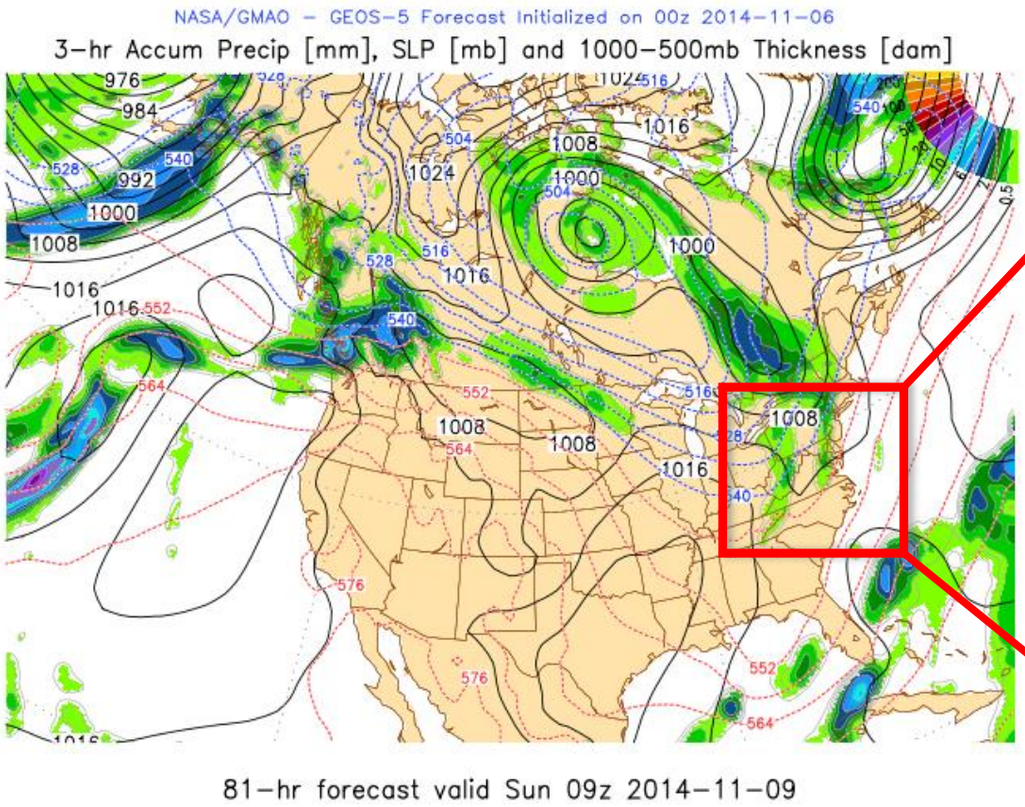
GEOS-5 chemical forecasts
GEOS-Chem chemical transport simulations

GEOS-5 chemical forecasts

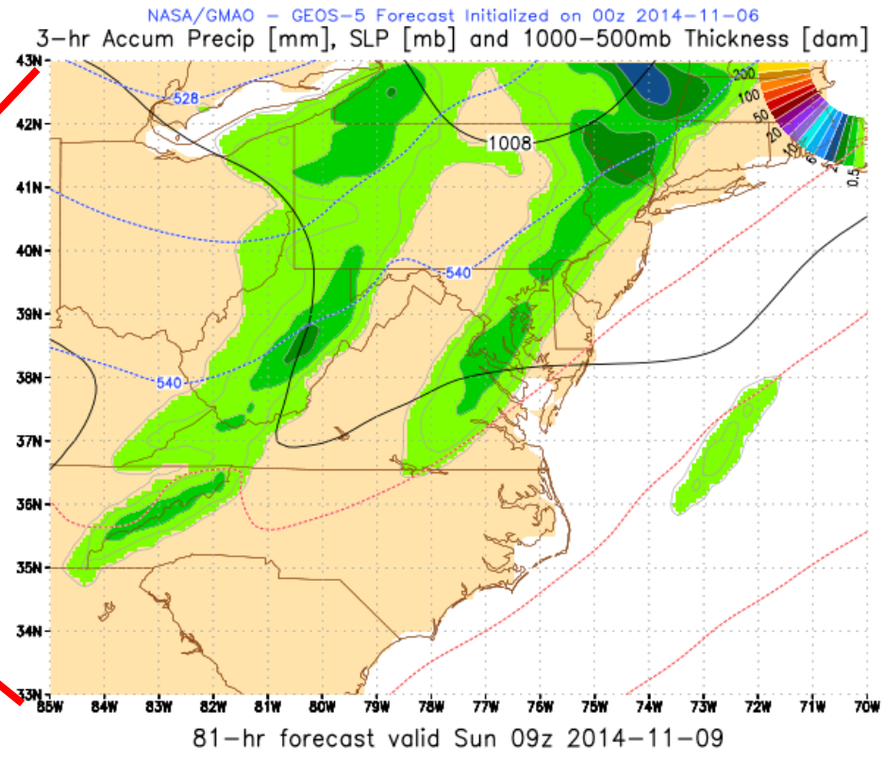
NASA GSFC Code 614 and GMAO forecasts with GEOS-5 model:

- 10-day global forecasts every 12 hours. 1/4º resolution.
- Meteorology: GEOS-5 Atmospheric Data Assimilation System & GEOS-5 GCM. Winds, precip, RH, cloud cover, temp, radiation, etc...
- Assimilation of aerosol optical thickness based on MODIS
- GEOS-5 online Aerosol/Chemistry: 20 tracers

Forecast for Sunday initialized yesterday: Precipitation, SLP



Zoom on Mid-Atlantic region

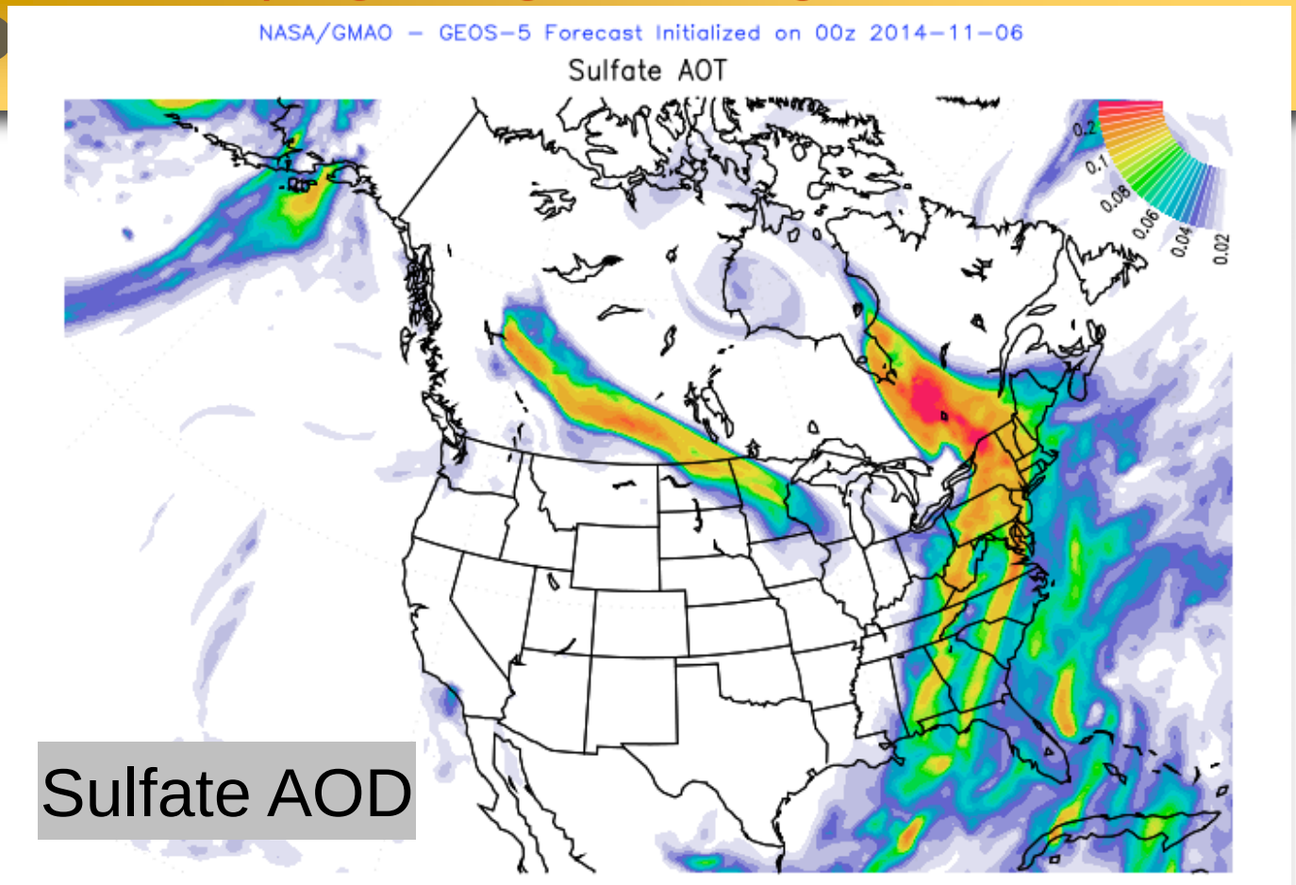


GEOS-5 forecasts

http://gmao.gsfc.nasa.gov/forecasts/

20 Tracers

- Global CO and CO_2 tracers
- 9 tagged CO tracers (N. America FF tracer)
- GOCART aerosols (SO_2, DMS, sulfate, BC, OC, sea salt, dust)
- CFC-12 (trop and strat origin)

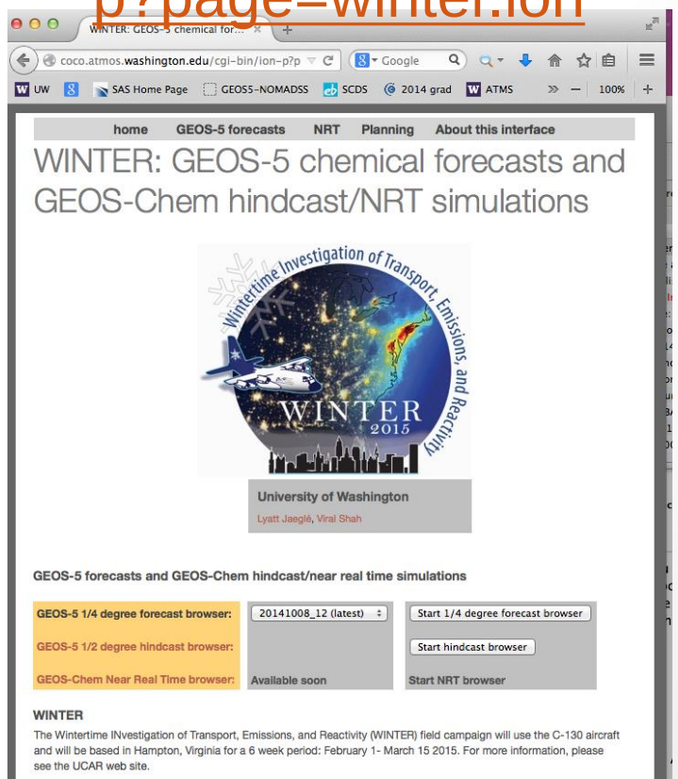


Sulfate AOD

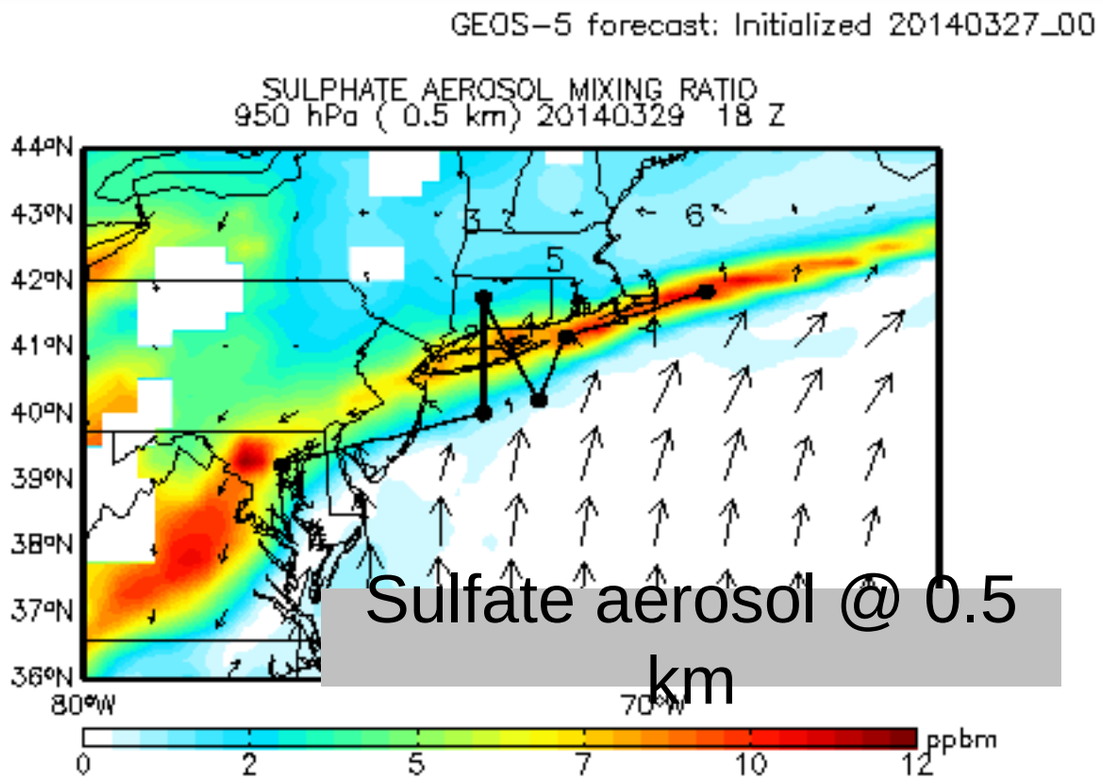
Web-based interactive visualization for WINTER:

http://coco.atmos.washington.edu/cgi-bin/ion-p?page=winter.ion

- server at UW (used for NOMADSS, ARCTAS, INTEX, ITCT2K2)
- maps, cross section, animations for specific regions and tracers
- sample forecasts along planned aircraft flight track

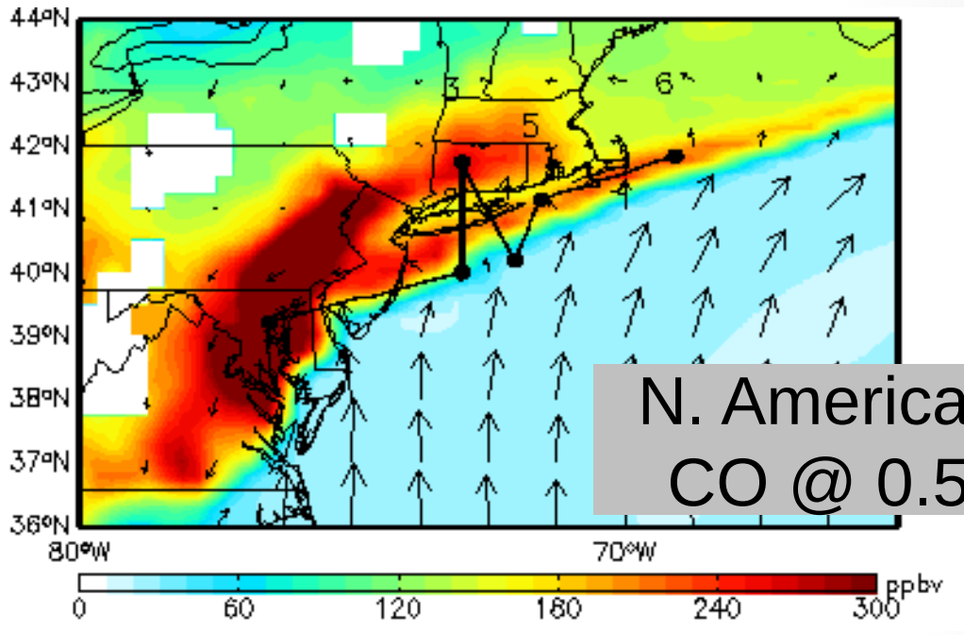


Sample forecasts along flight track



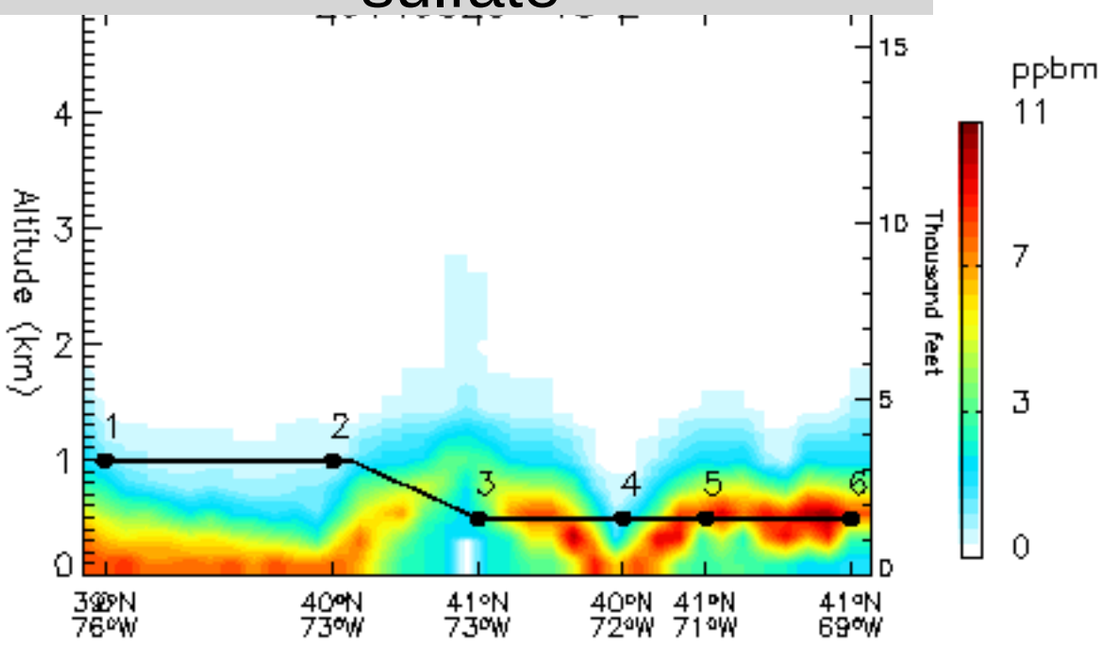
Sulfate aerosol @ 0.5 km

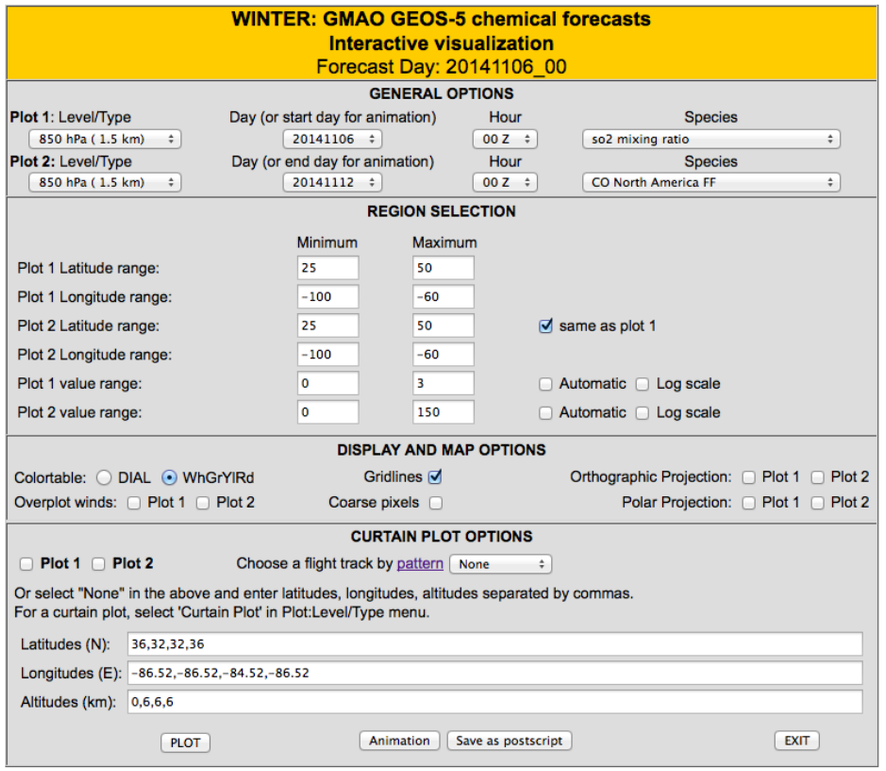
- Example: pollution outflow



N. American FF CO @ 0.5 km

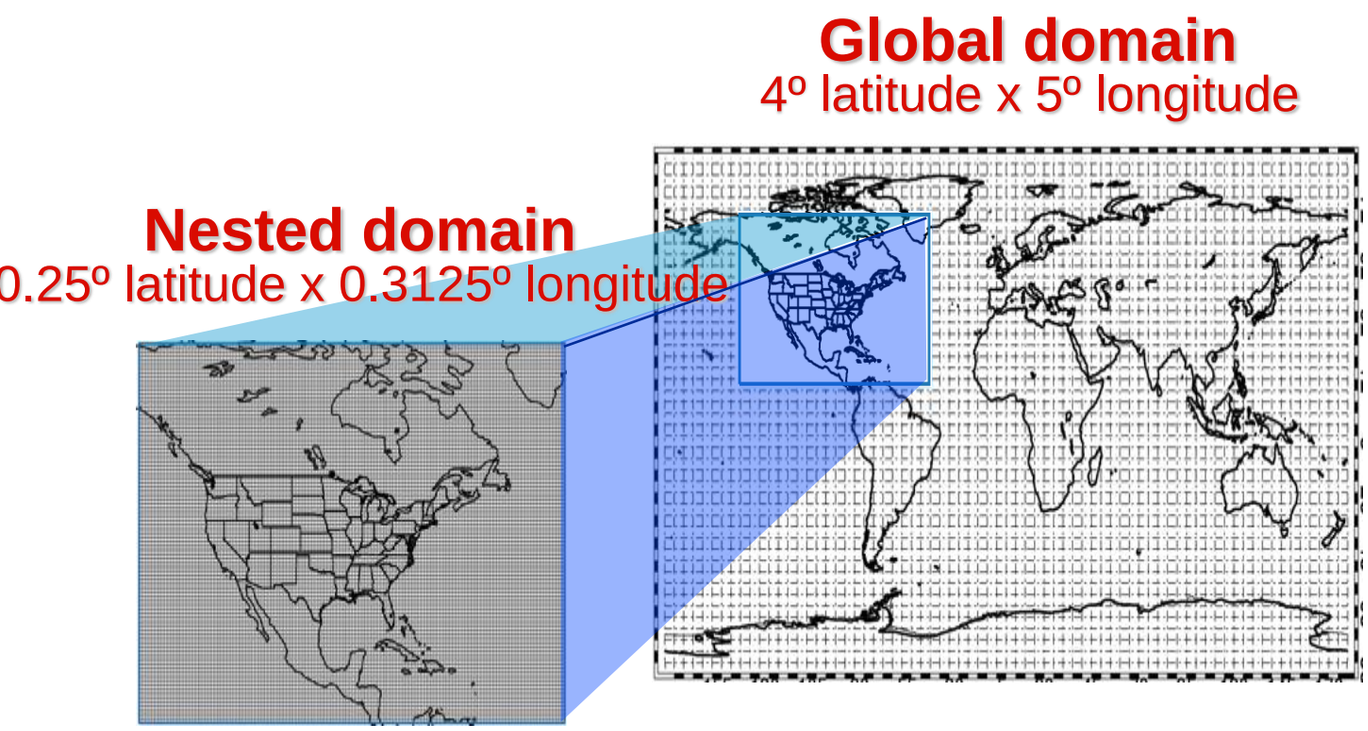
Curtain plot along flight track: sulfate





GEOS-Chem chemical transport model

- Global 3D model 4ºx5º resolution, 47 vertical levels
- Nested grid simulation 0.25º x 0.3125º (~25 km) over N. America
- GEOS-5 assimilated meteorology NASA GMAO
- <u>Aerosol-oxidant simulation</u>
  - Oxidant chemistry: HO_x-NO_x-O_3- VOC-BrO_x
  - Simple $ClNO_2$ scheme from N_2O_5 hydrolysis
  - Aerosols: SO_4^{2-}-NH_4^+-NO_3^-, organic carbon (Hodzic & Jimenez, 2011: primary and secondary OA from FF, BB, + SOA from isoprene, monoterpenes), BC, dust, sea salt
  - Emissions: Anthropogenic (NEI2008), vegetation, soils, fires, lightning

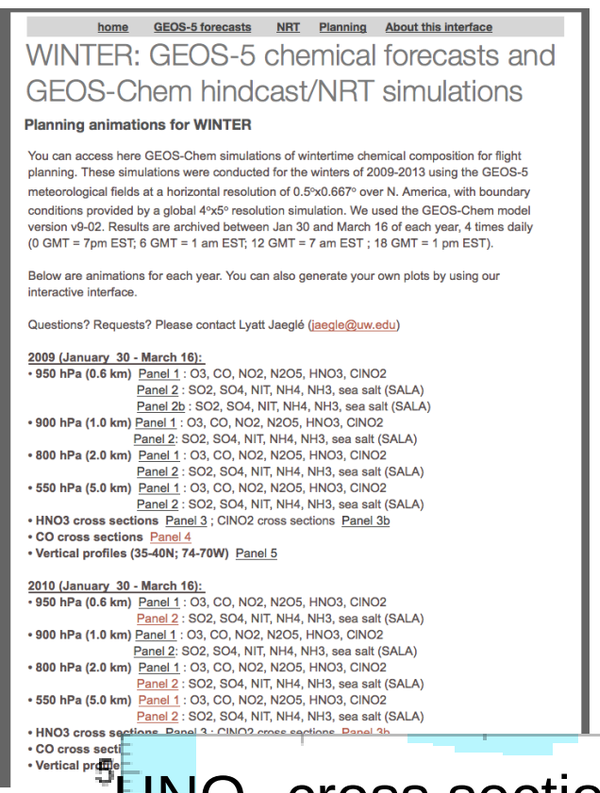


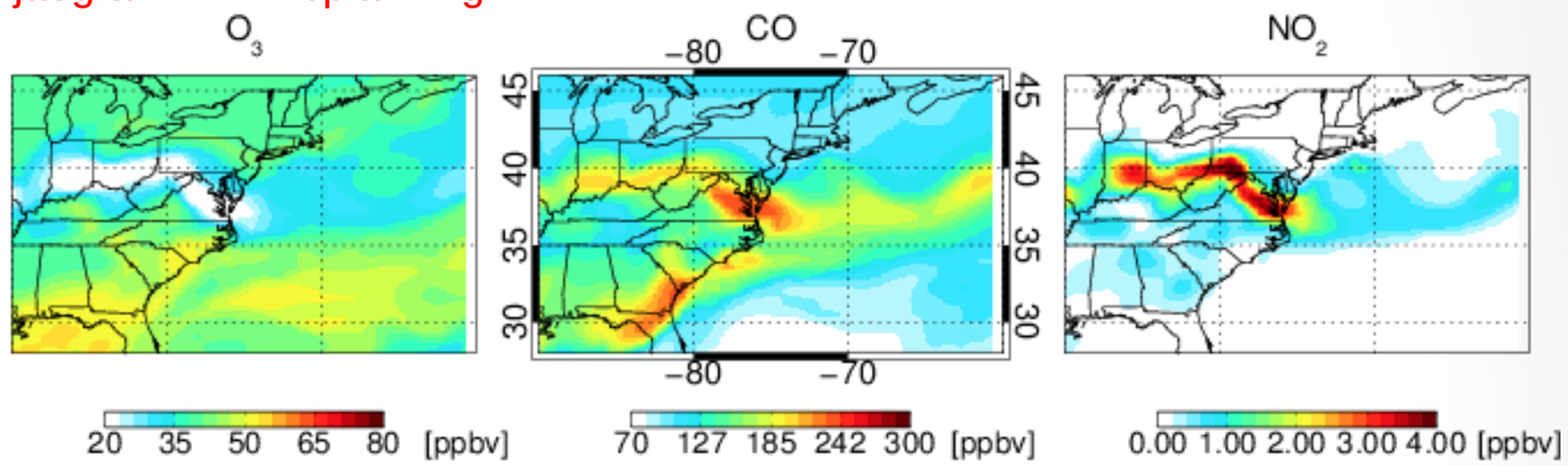
- Before mission: run multi-winter simulation
- During mission: Near-Real-Time (NRT) simulations 2-3 days after flights →quick comparison to obs
- After mission: data analysis

Hindcast simulations with GEOS-Chem

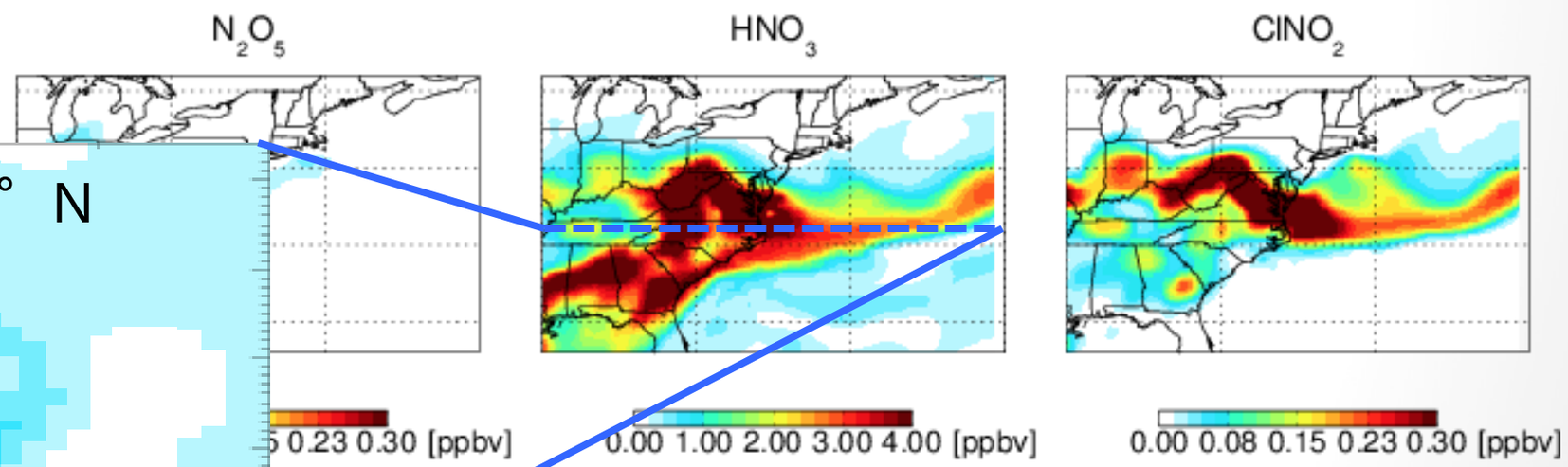
- Hindcast simulations for Feb 1-Mar 15: 2009, 2010, 2011, 2012, 2013
- Animations posted on web site, interactive access

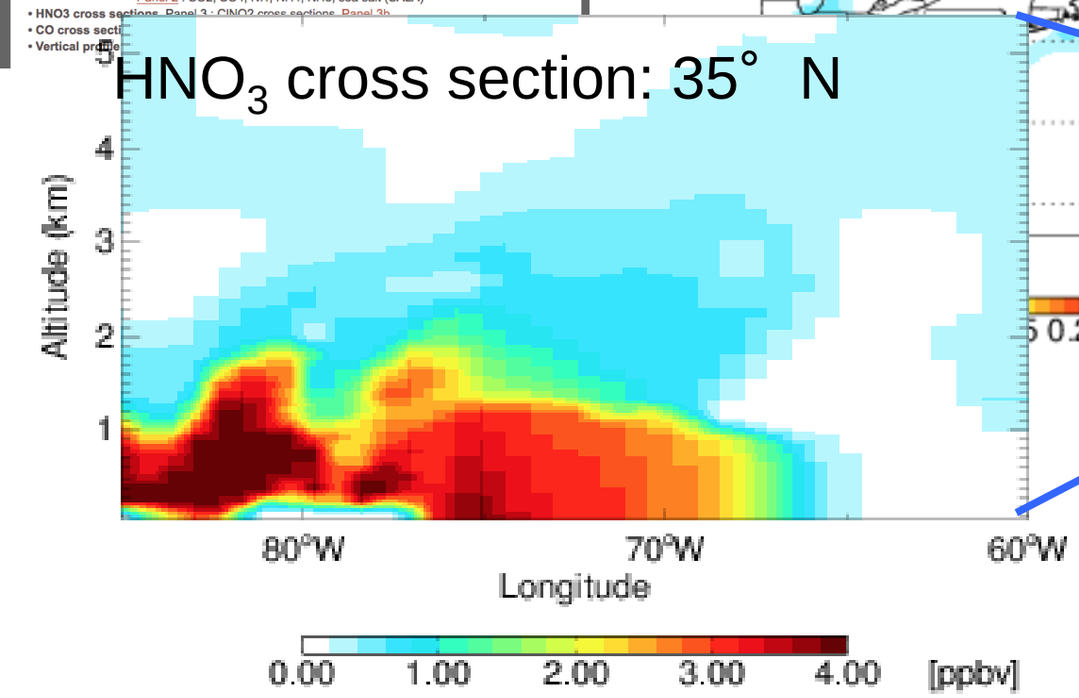
http://www.atmos.washington.edu/~jaegle/WINTER/planning.html





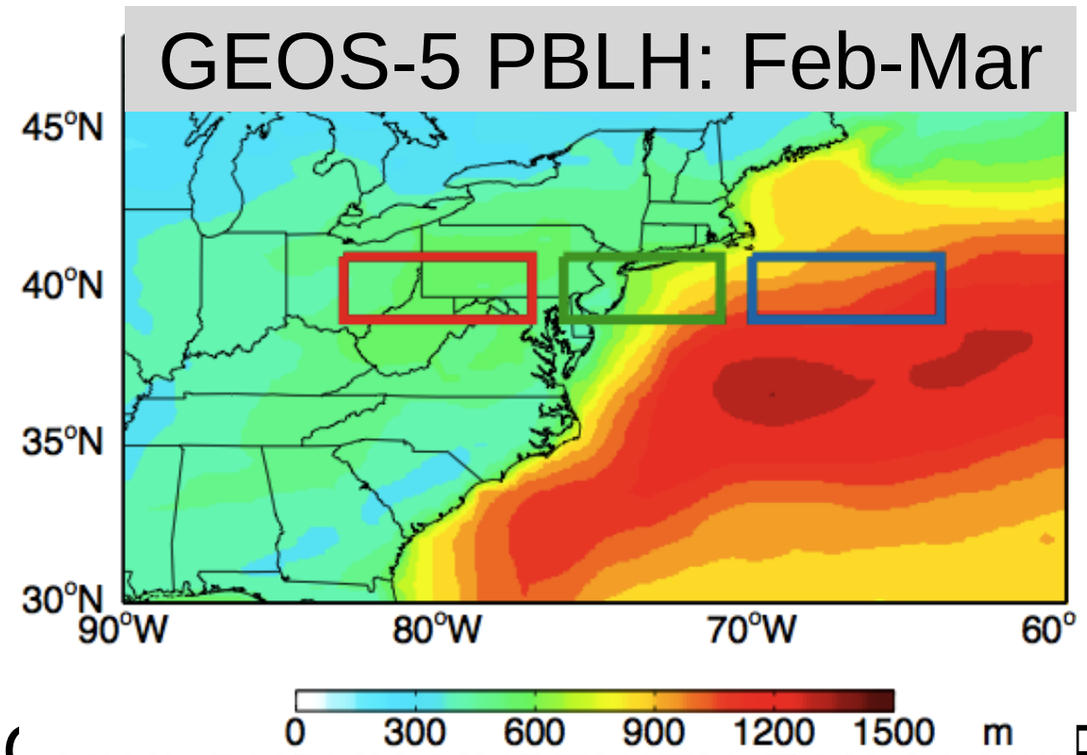
20120208 at 12 GMT (7 am EST), 898 hPa(1.0 km)

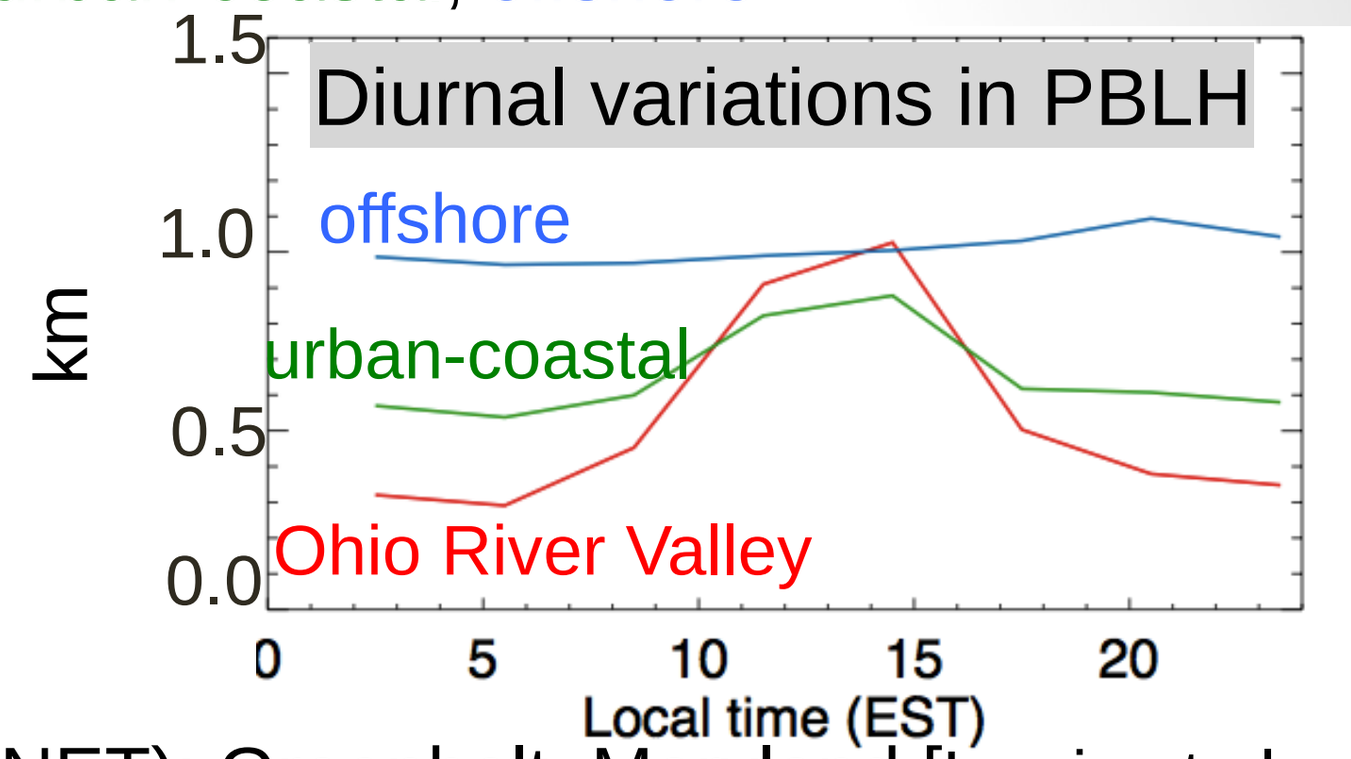




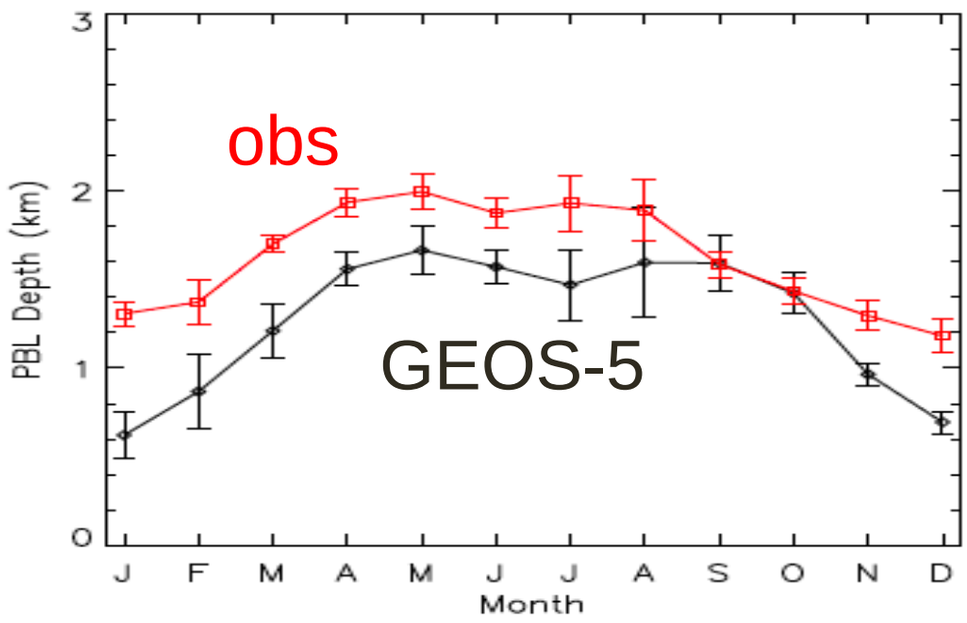
Boundary layer height during Feb-Mar

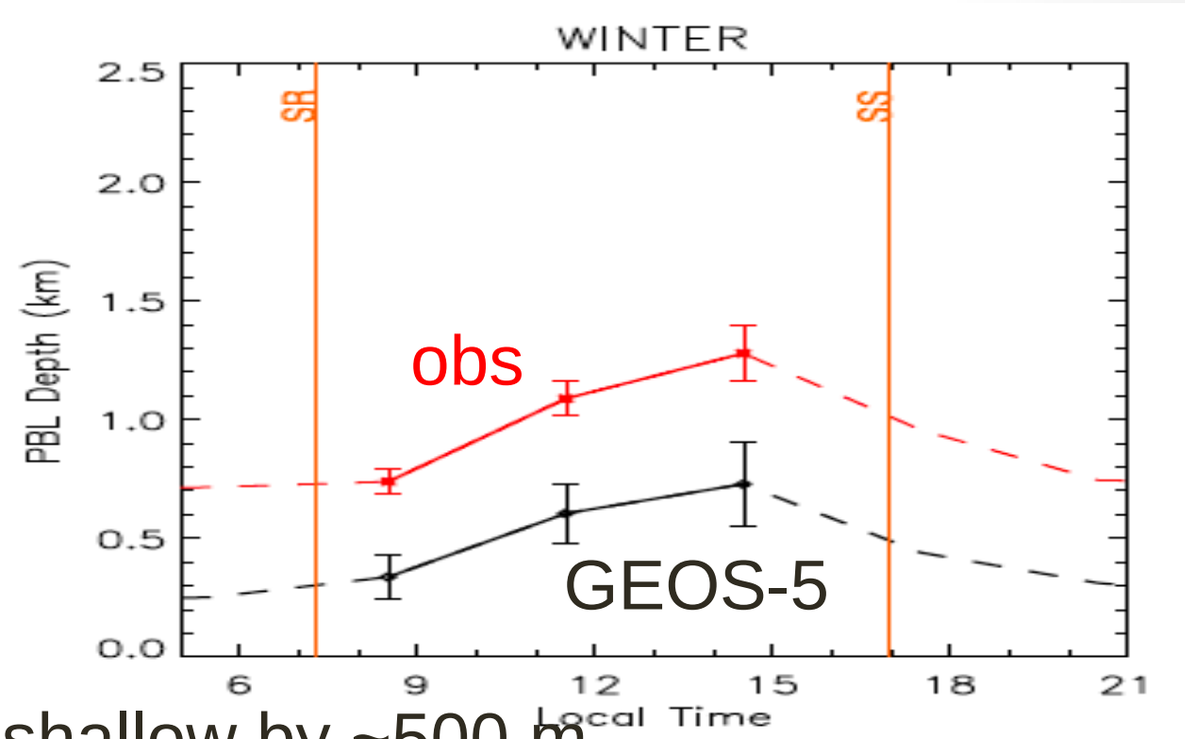
- Three boxes: Ohio River Valley, urban-coastal, offshore





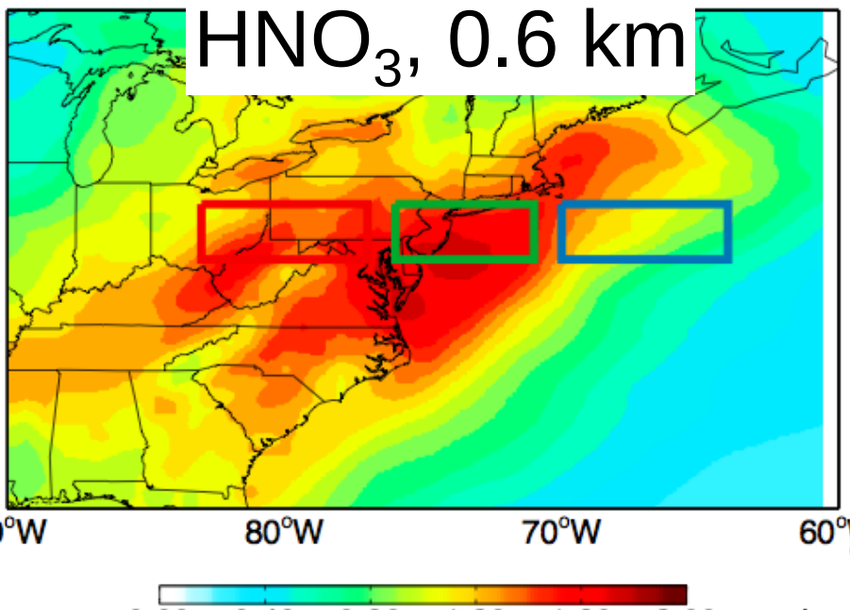
Comparison observed PBLH (MPLNET): Greenbelt, Maryland [Lewis et al., 2013]

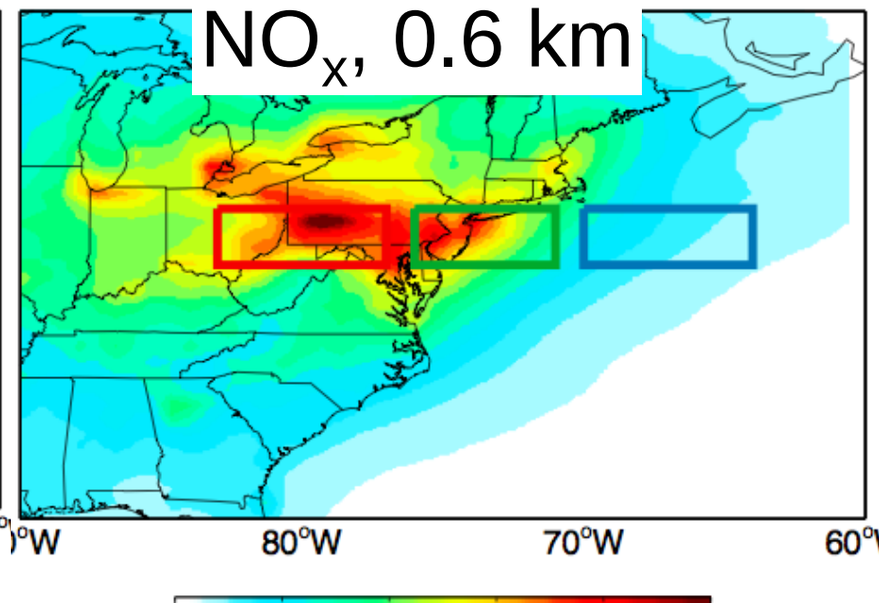


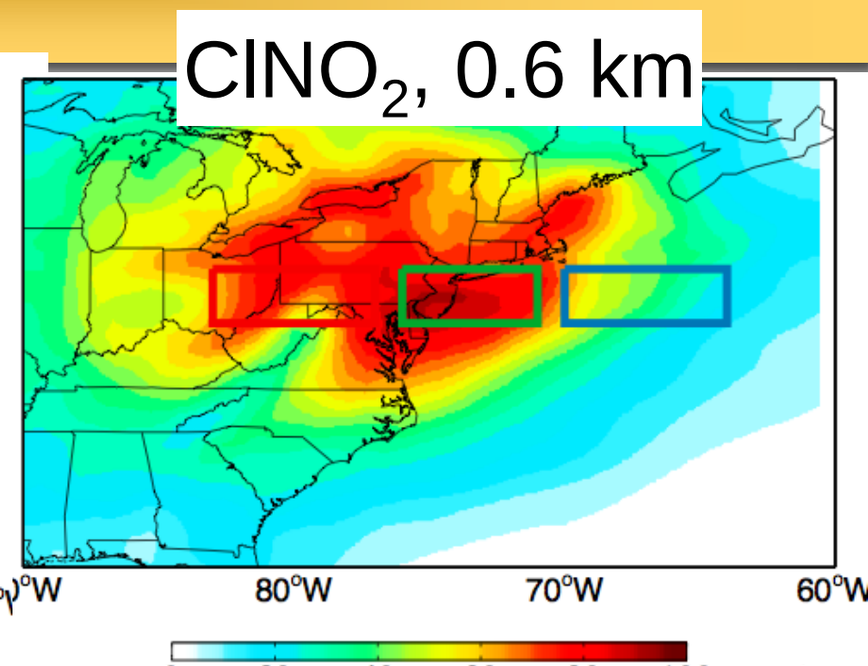


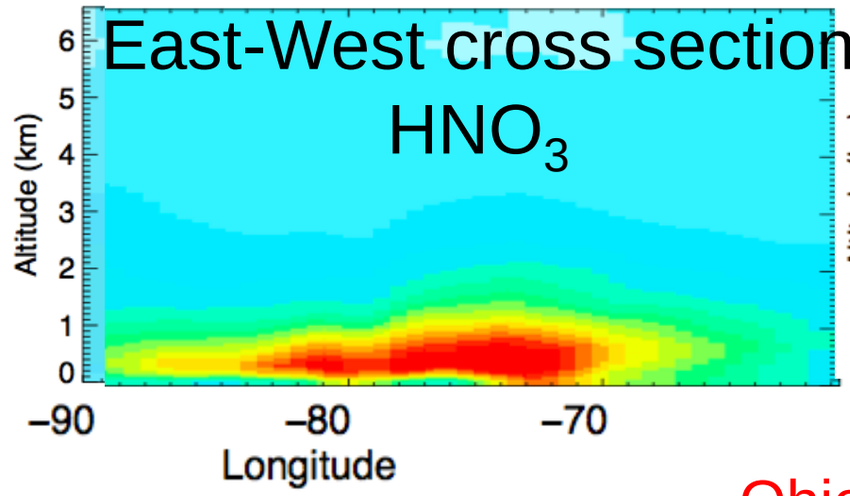
→ GEOS-5 PBL too shallow by ~500 m

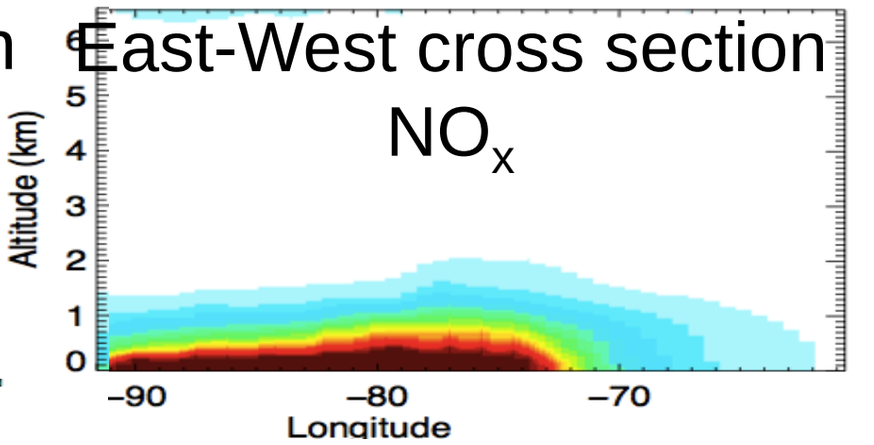
HNO_3, NO_x, $ClNO_2$: Feb-Mar 2012

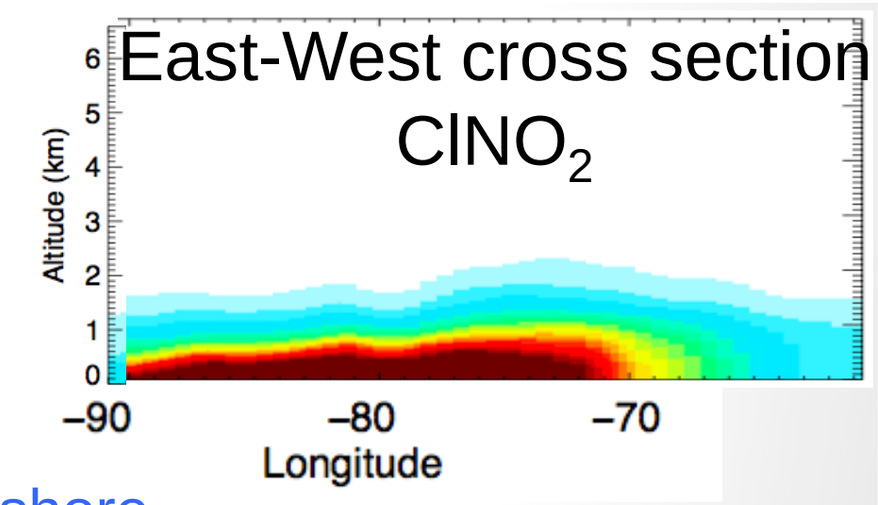




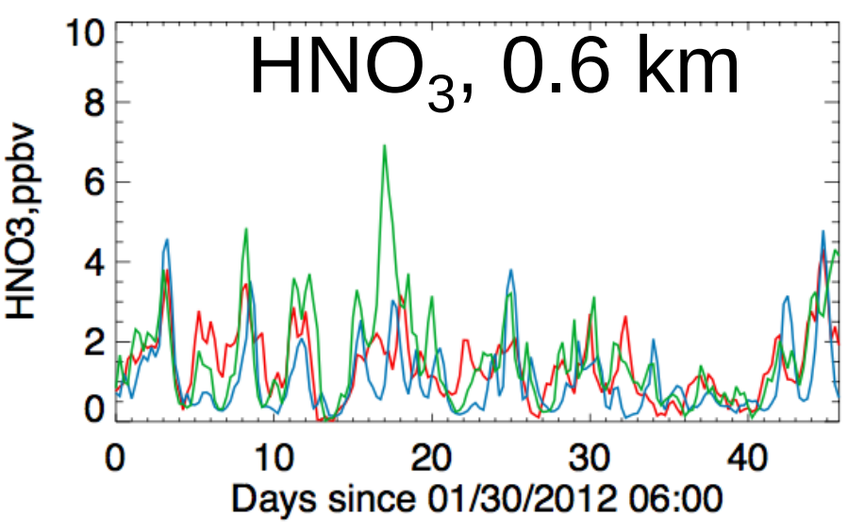


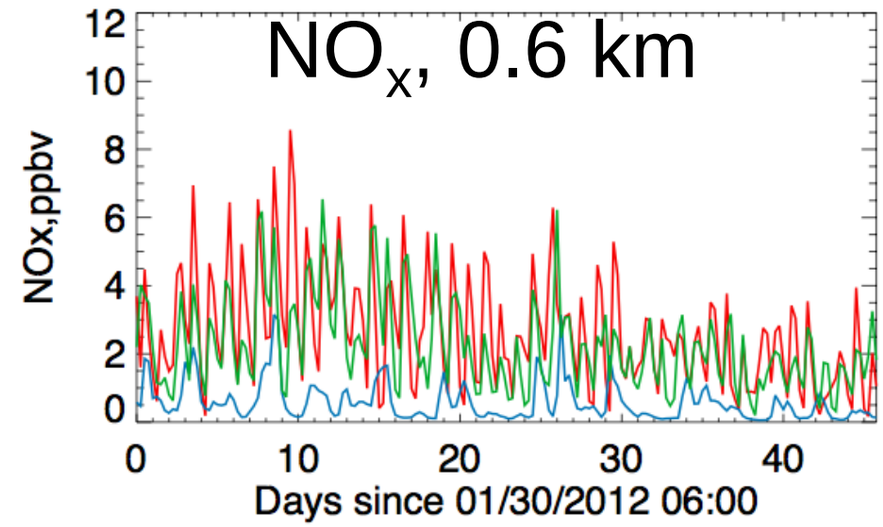


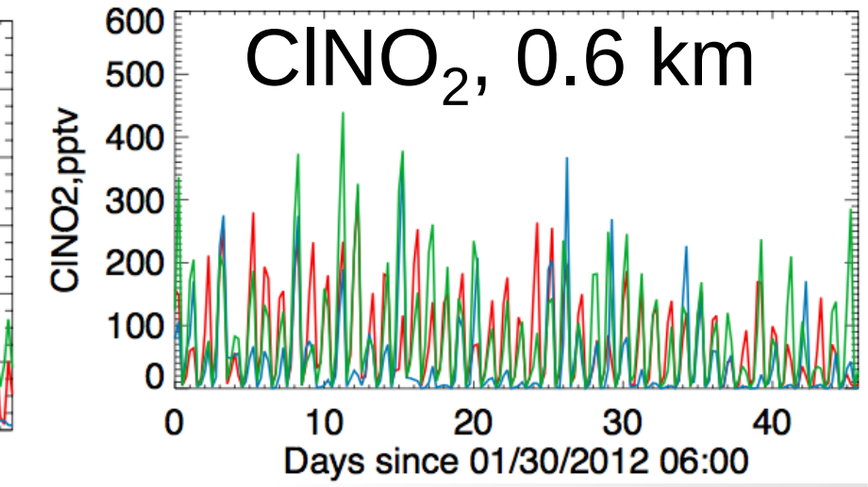




Ohio River Valley, urban-coastal, offshore

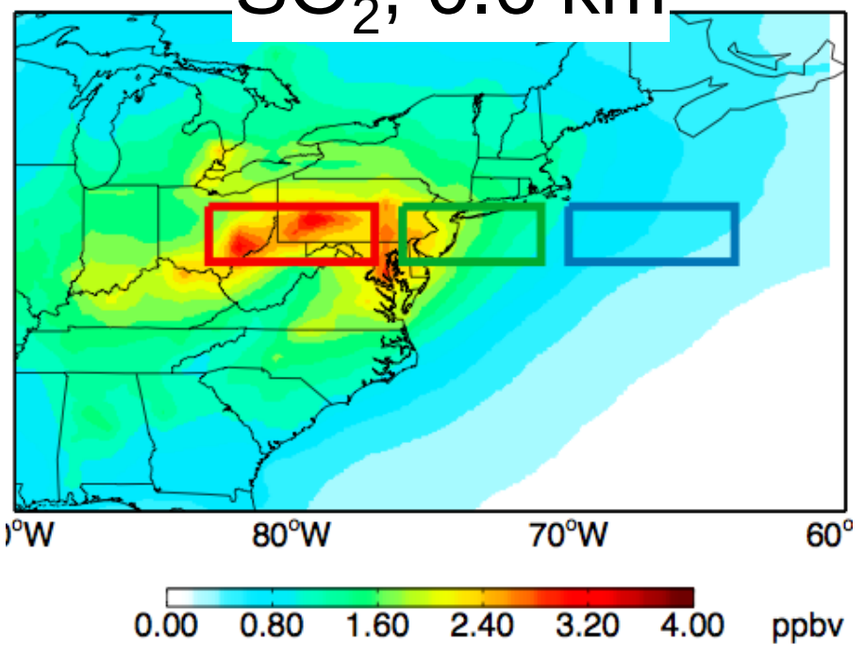




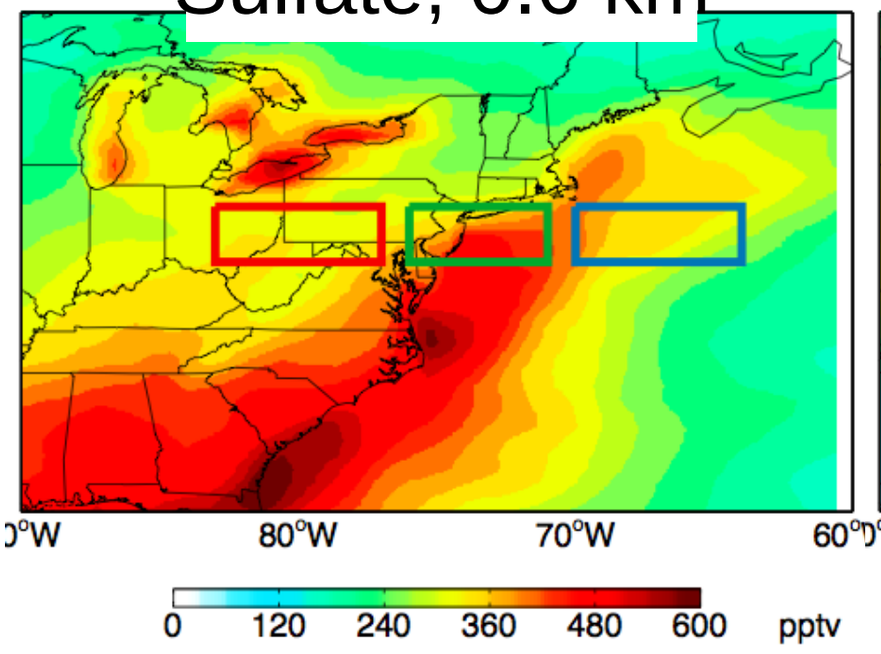


SO_2, sulfate and nitrate: Feb-Mar 2012

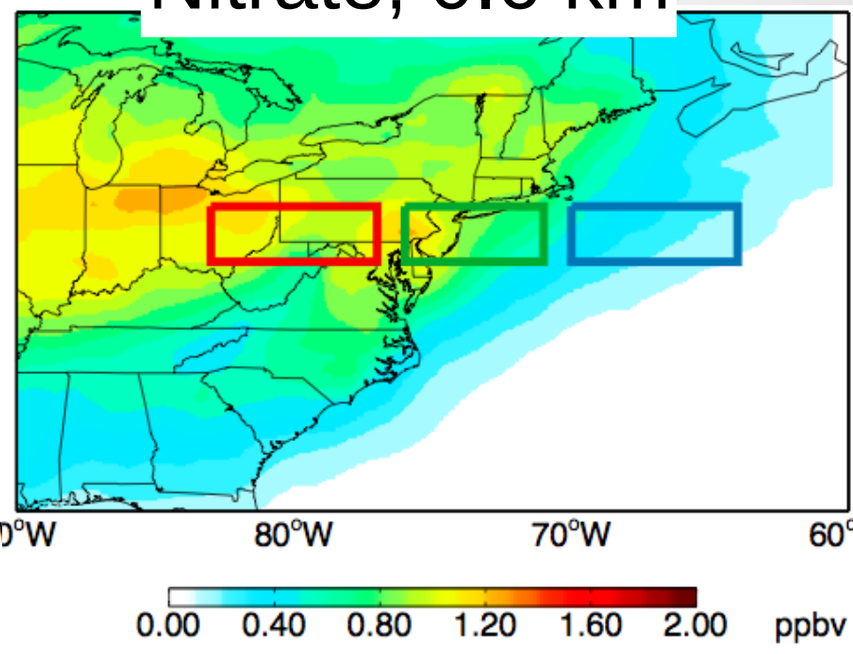
SO_2, 0.6 km



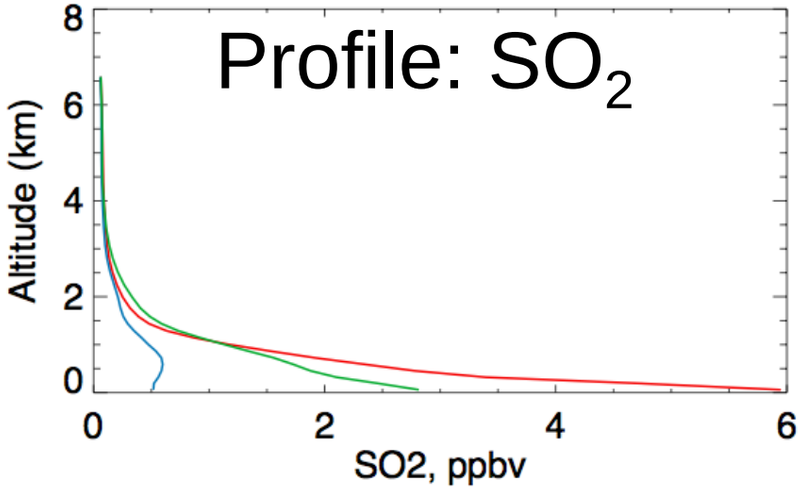
Sulfate, 0.6 km

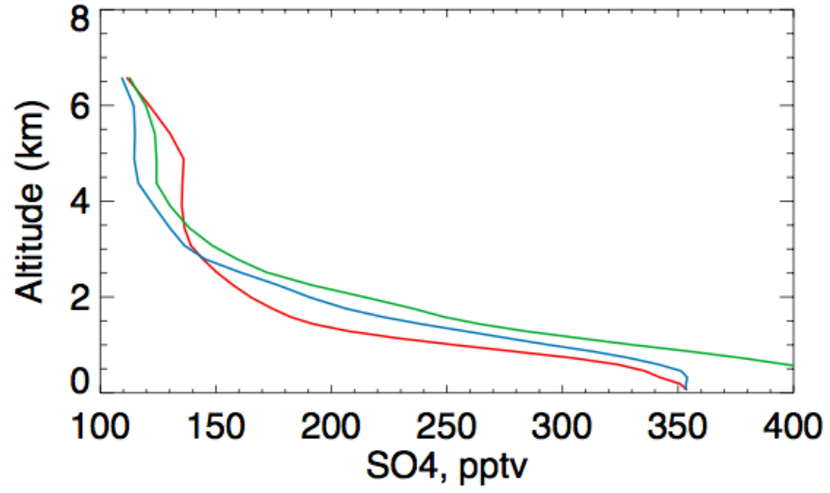


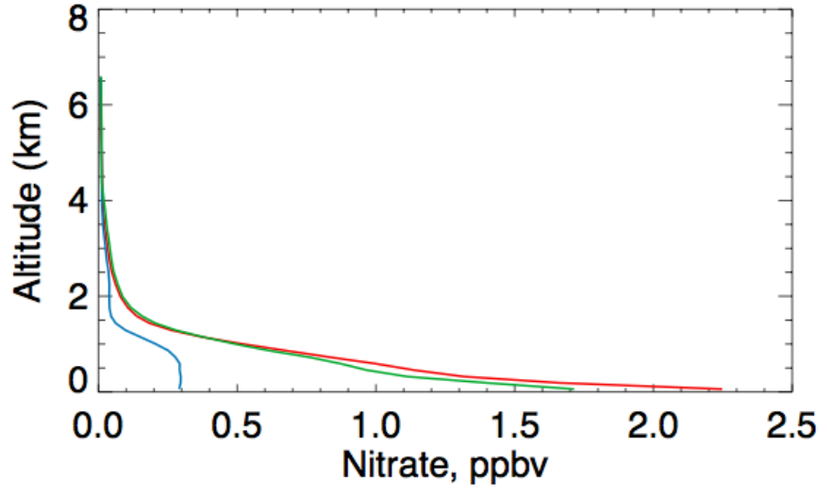
Nitrate, 0.6 km



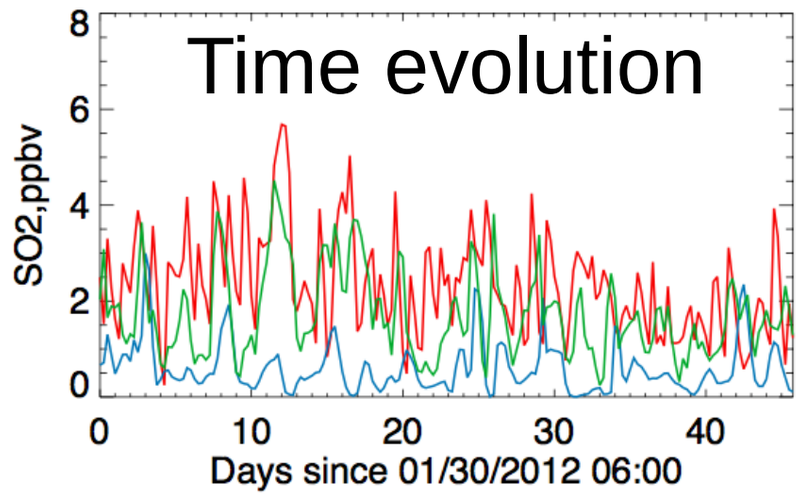
Profile: SO_2

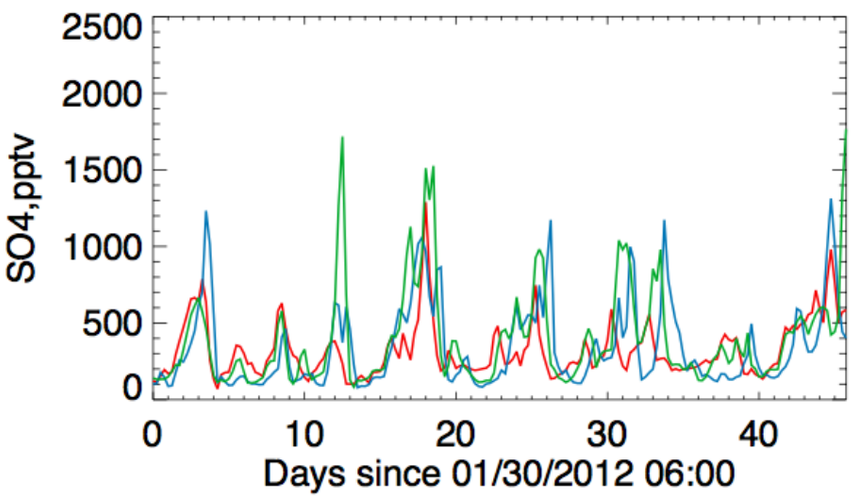


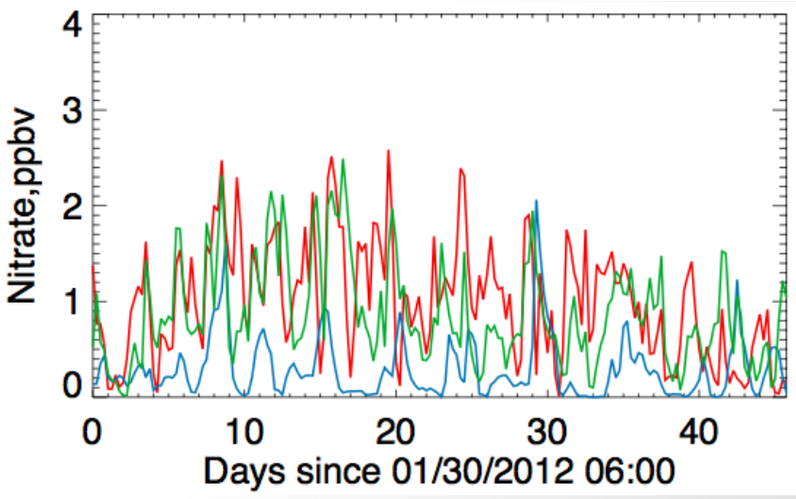




Time evolution

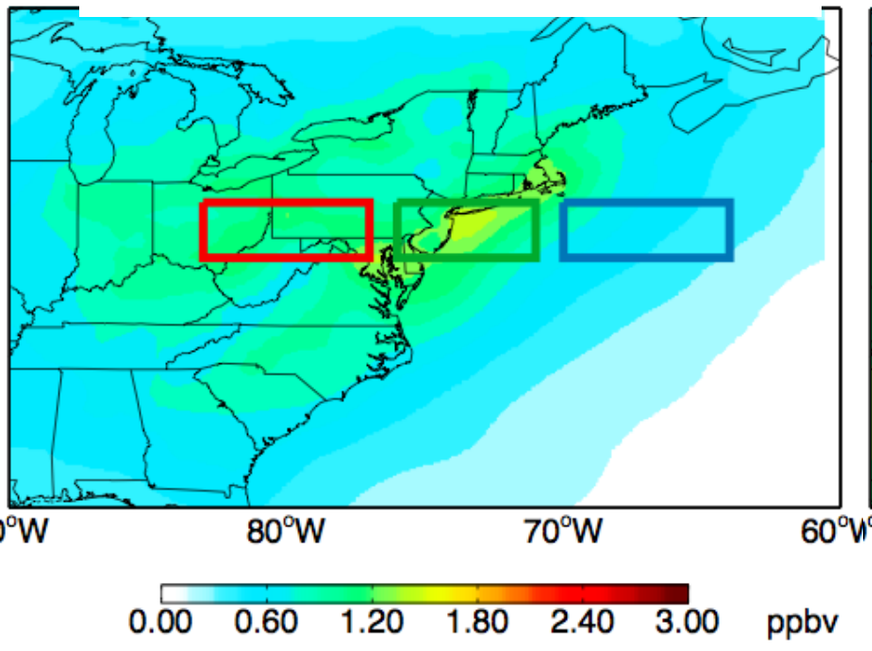




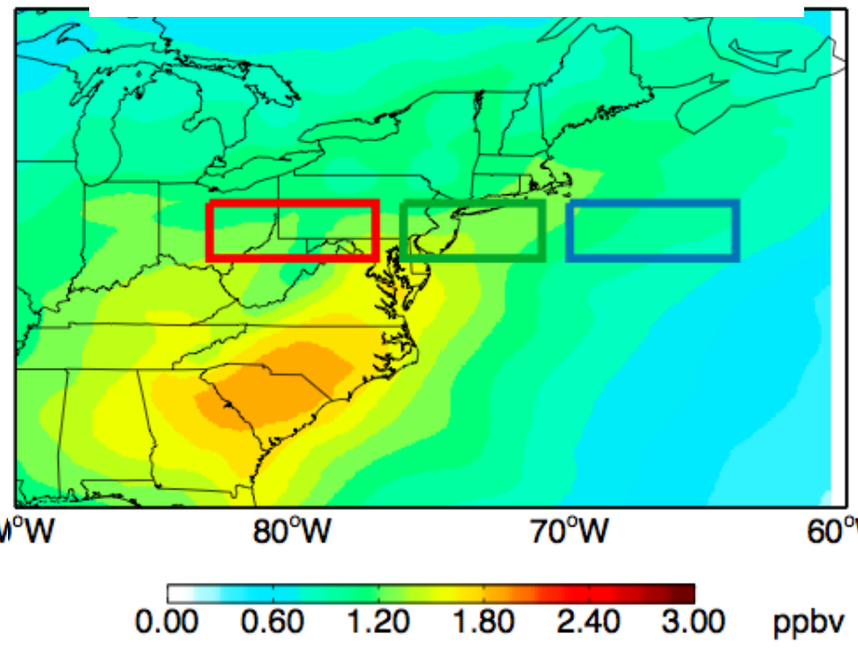


Organic aerosols: Feb 2009

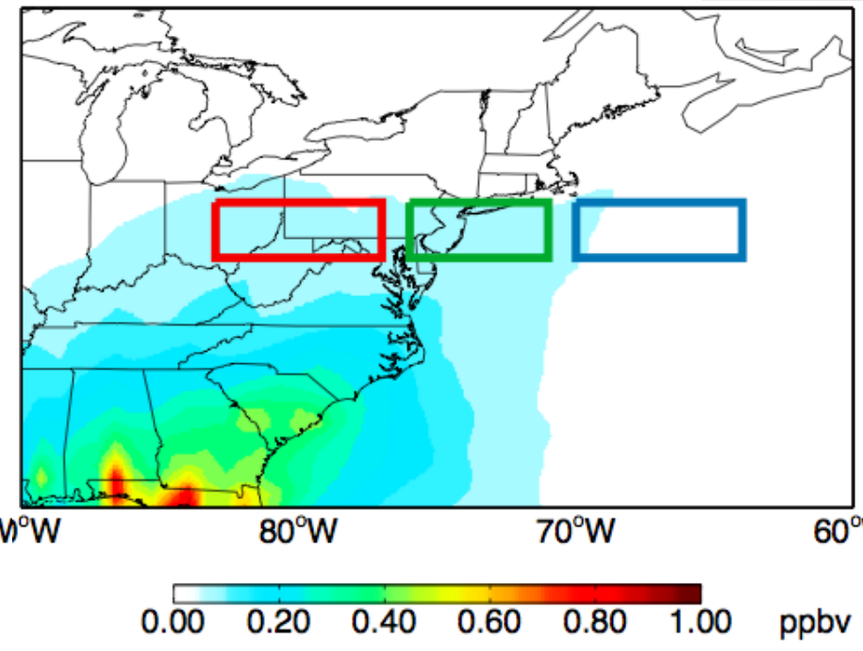
Anthro. POA, 0.6 km



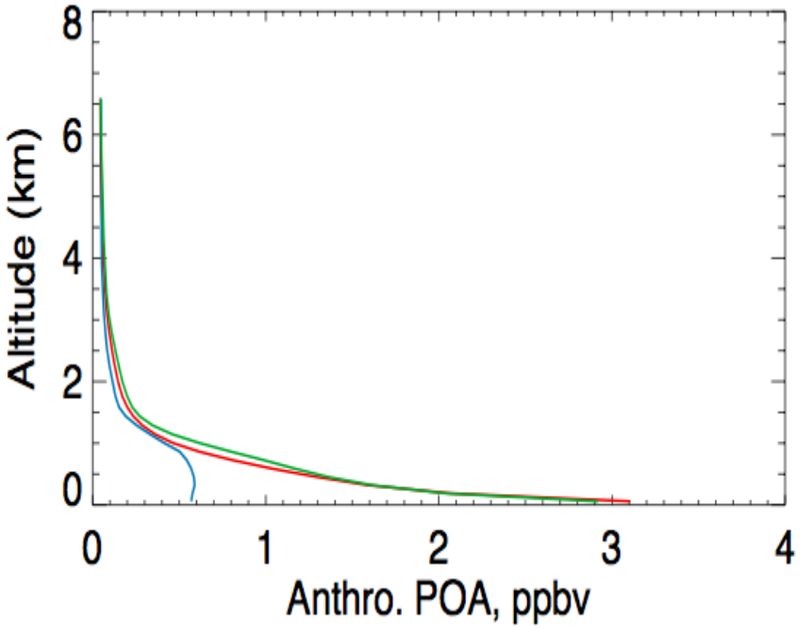
Anthro. SOA, 0.6 km



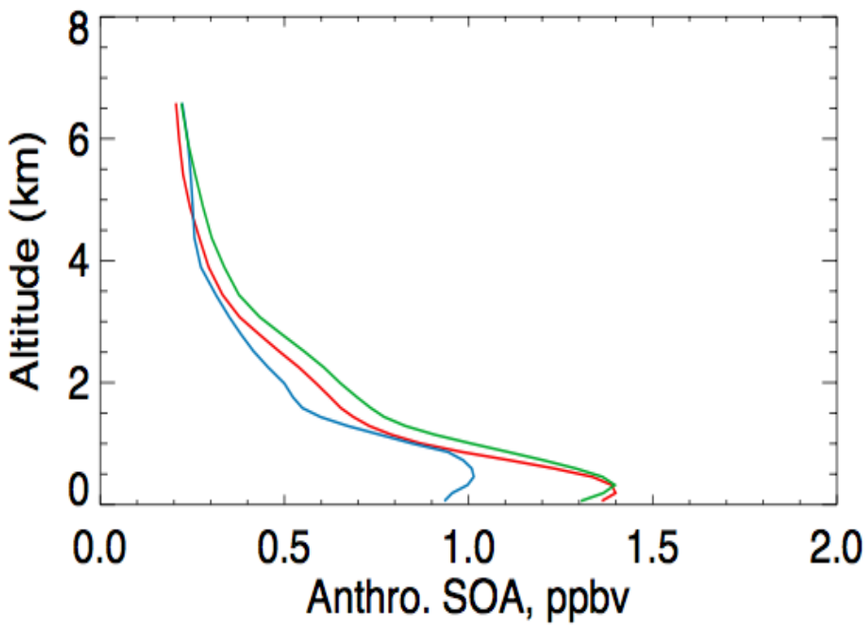
BB POA, 0.6 km



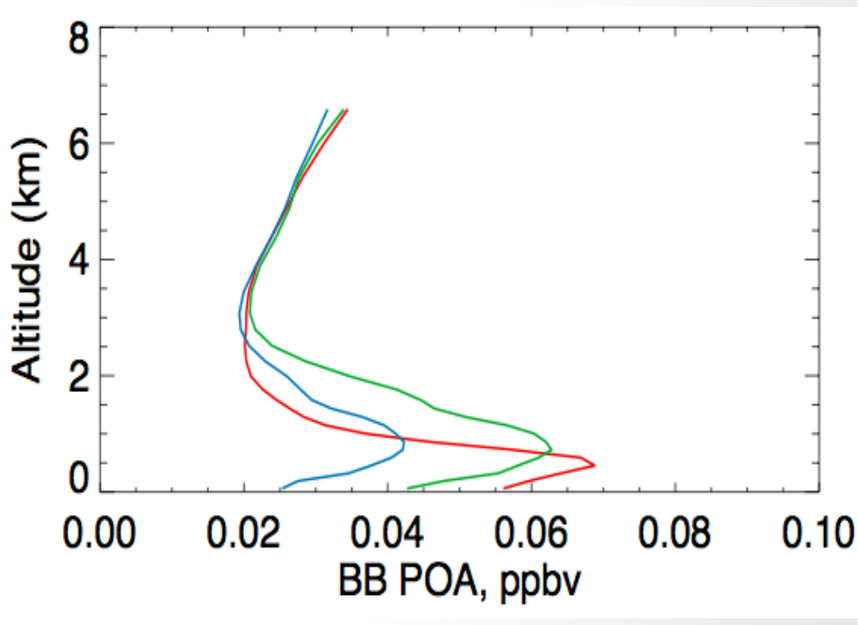
Profiles: Anthr. POA



Profiles: Anthr. SOA



Profiles: BB POA

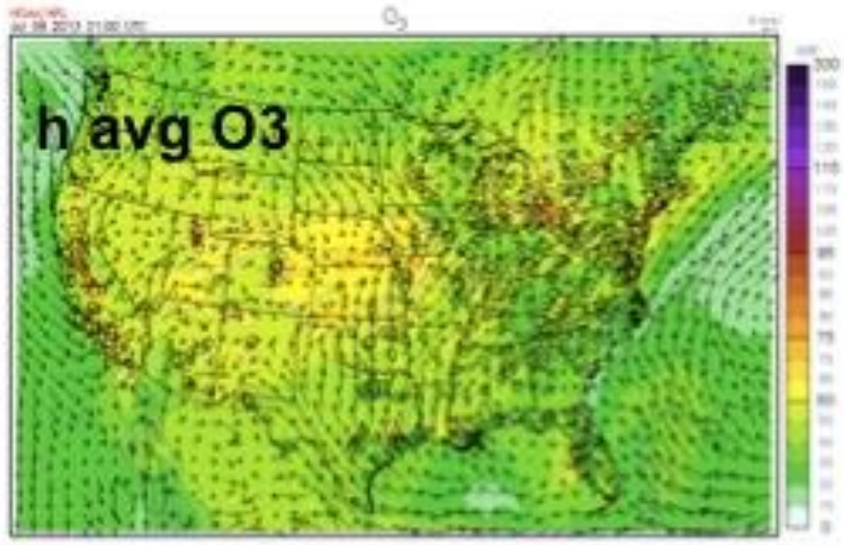


→ dominated by anthropogenic primary and secondary organic aerosols

Slide from Pius Lee and Rick Artz, NOAA ARL

Some resources at ARL to assist O3 and PM forecasting and near real-time verification

http://testbed.arl.noaa.gov/AQ_forecast.php: Sample fields, plots, discussion



NAM AIR QUALITY DIAGNOSTIC DISCUSSION

http://www.hpc.ncep.noaa.gov/discussions/aqm.html