Modeling Support for NOMADSS, SOAS and SENEX

Louisa Emmons, Alma Hodzic, Christoph Knote, Xiaoyan Jiang, Christine Wiedinmyer, Mary Barth

Atmospheric Chemistry Division, NCAR

Lyatt Jaegle, Viral Shah, Yanxu Zhang

University of Washington

Noelle Selin, Shaojie Song, Amanda Giang - MIT

Rob Pinder – EPA

And others ....
Daily fire emissions of trace gases and particles
  – Can include Hg emissions if requested
FINN is run in real-time based on MODIS Rapid Response fire counts
  http://www.acd.ucar.edu/acresp/forecast/fire-emissions.shtml
Plots and data files available for forecasts and hindcasts
MEGAN: biogenic emissions model – offline and online in MOZART, CAM-chem/CLM, WRF-chem
Chemistry Satellite Observations
Louisa Emmons and NCAR/ACD Satellite group

Retrievals produced by NCAR/ACD:
- MOPITT CO – available within a day of overpass
- IASI CO – about 2-day delay, global coverage 2x/day

Helpful for showing influence of western US fires and pollution transport

May 2012:
CO and smoke from the NM Whitewater-Baldy Fire, as well as fires in northern Mexico, were carried to SE U.S.
FLEXPART – planned products
Christoph Knote (ACD/NCAR)

- Driven by GFS forecasts (0.5°)
- Back trajectories from all ground sites
- Forward trajectories from major pollution sources
- Back trajectories from aircraft tracks

Residence time in 0-100m of 4000 particles in back trajectories from Centreville
WRF-chem forecasts
Alma Hodzic, Mary Barth (ACD/NCAR)

- WRF forecasts – 4-10 km horizontal resolution over SE U.S.
- 2-day forecasts
- Full-chemistry with SOA, along with tracers

**WRF/Chem model configuration for BEACHON**

- Coarse domain: 30km horizontal resolution
  - Fine domain: 4km horizontal resolution
  - Top of domain: 10hPa
- WRF/Chem WRFV3.3 with modifications

**Physics/Dynamics**
- Single moment cloud physics (Lin et al., 1983)
- Convective parameterization for coarse domain
- YSU PBL parameterization with the minimum height set to 50m
- NOAH land surface model
- Rapid Radiative Transfer Model for long wave radiation
- Goddard scheme for short wave radiation
- Runge-Kutta time integration method
- Positive definite and monotonic advection for water, scalars, and chemistry species

**Chemistry**
- SAPRC99 gas-phase chemistry
- MOSAIC aerosols - 4bins sectional approach
- Anthropogenic emissions: U.S. EPA NEI05
- Biogenic emissions: Guenther scheme
- Photolysis rates: fast
- Wet deposition not included
- Dry deposition (Wesely, 1989)
- Aerosols feed back to radiation heating in meteorology

**Tracers of anthropogenic emissions of CO**
- for the Denver metropolitan area (tracer=1)
- for the Colorado Springs (tracer=2)
- for the Four corners area (tracer=3)
- for the Manitou local site (tracer=4)
- for the West Coast (tracer=5)
MOZART-4 driven by GEOS-5
Louisa Emmons (ACD/NCAR)

Full chemistry at 1.9°x2.5°

http://www.acd.ucar.edu/acresp/forecast/

5-day forecasts, hourly output, currently operational
MOZART-4 Tracers
Louisa Emmons (ACD/NCAR)

Forecasts of tracers at 0.5° horizontal resolution
- Isoprene-like tracer based on MEGAN isoprene emissions
- Anthropogenic NOx tracer from individual cities and/or regions
- Fire CO tracer for various regions
- Similar to forecasts for DC3 (http://www.acd.ucar.edu/acresp/dc3/), will be run specifically for NOMADSS
Lyatt Jaeglé, Viral Shah, Yanxu Zhang  
University of Washington  
Department of Atmospheric Sciences, Seattle  
Noelle Selin, Shaojie Song, Amanda Giang  
MIT

Mission planning  
Mission execution  
Post-mission data analysis
GEOS-Chem chemical transport model

★ Global 3D model 2ºx2.5º resolution, 47 vertical levels
★ GEOS-5 assimilated meteorology NASA GMAO
★ Aerosol-oxidant simulation
  - Oxidant chemistry: $\text{HO}_x\text{-NO}_x\text{-O}_3\text{- VOC-BrO}_x$
  - Aerosols: $\text{SO}_4^{2-}\text{-NH}_4^+\text{-NO}_3^-$, BC, organic carbon, dust, sea salt
  - Anthropogenic, vegetation (MEGAN v2.1), soils, fires, lightning
★ Mercury simulation (Selin et al., 2007; Holmes et al., 2010; Amos et al., 2012)
  - Anthropogenic, biomass burning, gold mining
  - 2-D surface ocean and 2-D soil/vegetation model
  - Archived oxidants: Br or O$_3$/OH

![Mercury cycle diagram]

Fluxes in Mg/year

- Anthropogenic
- Biomass burning
- Vegetation, soil, snow
- Geogenic
- Wet & dry deposition
- Ocean
Nested-grid simulations

- 0.5° latitude x 0.667° longitude (~50 km) over N. America
- Global simulation provides boundary and initial conditions
- Same emission, chemistry, deposition, transport as global model

Hg wet deposition flux (2008-2009)

Circles = Observations from Mercury Wet Deposition Network (MDN)

Mission execution

• Provide analysis of NASA’s GEOS-5 chemical forecasts:
  ♦ Tracers: CO originating from different sources, O₃ and aerosol species

• Run GEOS-Chem Hg simulation in Near-Real-Time (NRT) 2-3 days after mission, providing quick comparisons to observations

• Tentative: run GEOS-Chem Hg simulation with GEOS-5 met forecasts → Hg forecasts!
NASA GSFC Code 614 and GMAO forecasts with GEOS-5 model:

- 5-days global forecasts every 12 hours. 1/2° or 1/4° resolution.
- Meteorology: GEOS-5 Atmospheric Data Assimilation System & GEOS-5 GCM. Winds, precip, RH, cloud cover, temp, radiation, etc...
- Ozone assimilation MLS/OMI + simple tropospheric chemistry
- Assimilation of aerosol optical thickness based on MODIS
- GEOS-5 online Aerosol/Chemistry: 20 tracers
  ➡ Real time fire emissions from MODIS imagery and land mapping.

Forecast for today initialized on Monday (4d)
Access to GEOS-5 forecasts

- Real-time data delivery:
  - OPeNDAP server
  - Anonymous FTP
  - Web Map Server with Google Earth capabilities
  - Visualization of Chemical Weather

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

http://acdb-ext.gsfc.nasa.gov/People/Colarco/Mission_Support/

http://coco.atmos.washington.edu/cgi-bin/ion-p?page=hippo.ion
Sample forecasts along flight track

GEOS-5 forecast: 20121112_00z

CO mixing ratio, 3 km

700 hPa (5.0 km) 20121118 01:30Z

Example: Florida/Gulf of Mexico transect and profiling

Curtain plot of N. American FF CO
Other Air Quality forecasts

NOAA Rapid Refresh with Chemistry (WRF/Chem 13km)
http://ruc.noaa.gov/wrf/WG11_RT/

Georgia Tech (CMAQ 4km, 12km)
Contact: Ted Russell, Talat Odman
http://forecast.ce.gatech.edu/

TVA (WRF 9km, 27km)
Contact: Steve Mueller
sfmueller@tva.gov

NOAA RAQMS (WRF/Chem 8km)
Contact: Brad Pierce
Brad.pierce@noaa.gov
Retrospective modeling

• More than 30 groups responded to recent SOAS modeling survey, including
  – Observation-constrained box modeling
  – 1-D Canopy and PBL models
  – Large-eddy simulations
  – Lagrangian / trajectory models
  – Regional and global 3-D models

• Developing a community-based emission inventory
  – Greg Frost is developing a year 2008 inventory, available Summer 2013
  – Updates for year 2013 available in Spring 2014
Latitude 34.72 N, Longitude 86.64 W
The 915 MHz **wind lidar** and **ceilometer** measurements are usually operating here in HSV. They chase tornados and hurricanes occasionally.

New Halo Doppler wind lidar with scanner should be operating in a couple of months.

The **ozonesondes** launch every Saturday at 1330. We could fly some extra ones if someone wanted to fund it.

We can operate the **ozone/aerosol lidar** any time it is not raining. 100m to 10 or 12 km, 1-10 min integration, 30-700m vertical resolution.

Calendar of past obs: click on a date for plots.

[http://nsstc.uah.edu/atmchem/lidar/DIAL_data.html](http://nsstc.uah.edu/atmchem/lidar/DIAL_data.html)
Forecasting Questions for Discussion

• What species or tracers are useful?

• How far in advance?

• Multiple forecasts – how to increase the value?

• Is a meteorological forecast needed?