Recent SMOKE Updates and More

B.H. Baek, Catherine Seppanen, Zachariah Adelman, Carlie Coats, Alejandro Valencia, and Michelle Snyder

UNC at Chapel Hill

Alison Eyth, Madeleine Strum, Jeffrey Vukovich

U.S. EPA

Outlines

- SMOKE version 4.0 Release Updates
- Ongoing SMOKE Updates
- Future Upcoming SMOKE updates
- Q&A

Recent SMOKE Updates and More

- SMOKE v4.0 released on September 2016
- Support California Air Resource Board (CARB) Emissions Modeling
- Support Global Gridded Inventories (i.e., EDGAR, HTAP,,,) Processing
- Parallelization of SMOKE Programs using OpenMP
- Parameterization of MOVES Lookup Tables
- New Link-level Inventory Processor Tool Development
- SMOKE4AERMOD Development for US EPA's NATA Studies

CARB Support

- **New 20-Characters SCC and SIC** Codes
- **New GEOCODE [1-4]**: Geographical Code (12-Characters)
  - New Geographical Code that can replace a current 6-digit FIPS (Country/State/County)
  - GEOCODE1: 3-Character Country Code (Ex: USA, KOR, CHN,,,,)
  - GEOCODE2: 6-Character State Code (Ex: USA037, NY, GA,,,,)
  - GEOCODE3: 9-Character County Code (Ex: USA037001,,,,,)
  - GEOCODE4: 12-Character Trial/District Code (Ex: USA037001001,,,,)

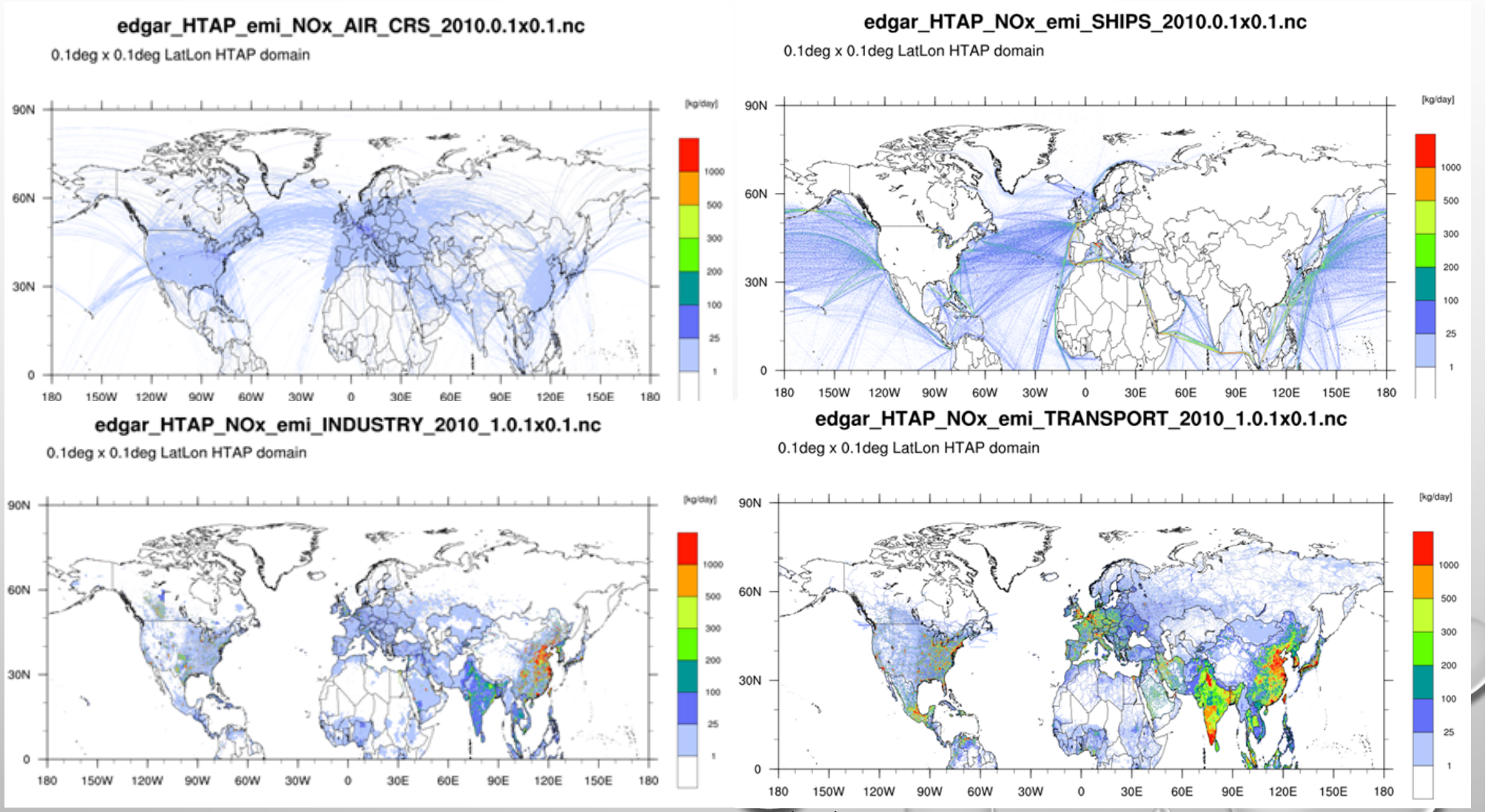
Example of GEOCODE4 Input file:

```
================================================================================
# GEOCODE4, Description, Timezone
NCC006044MBU, "NCC-Santa Cruz-Monterey Bay Unified Apcd",    PST
0SV006045SHA, "SV-Shasta-Shasta County Aqmd",                PST
0MC006046NSI, "MC-Sierra-Northern Sierra Aqmd",              PST
NEP006047SIS, "NEP-Siskiyou-Siskiyou County Apcd",           PST
================================================================================
```

Global Gridded HTAP Emissions

Sectors: aircraft, shipping, industry, energy, transportation, residential, and agriculture

Pollutants: CO, NMVOC, NO_x, SO_2, NH_3, PM_{10}, $PM_{2.5}$,BC and OC

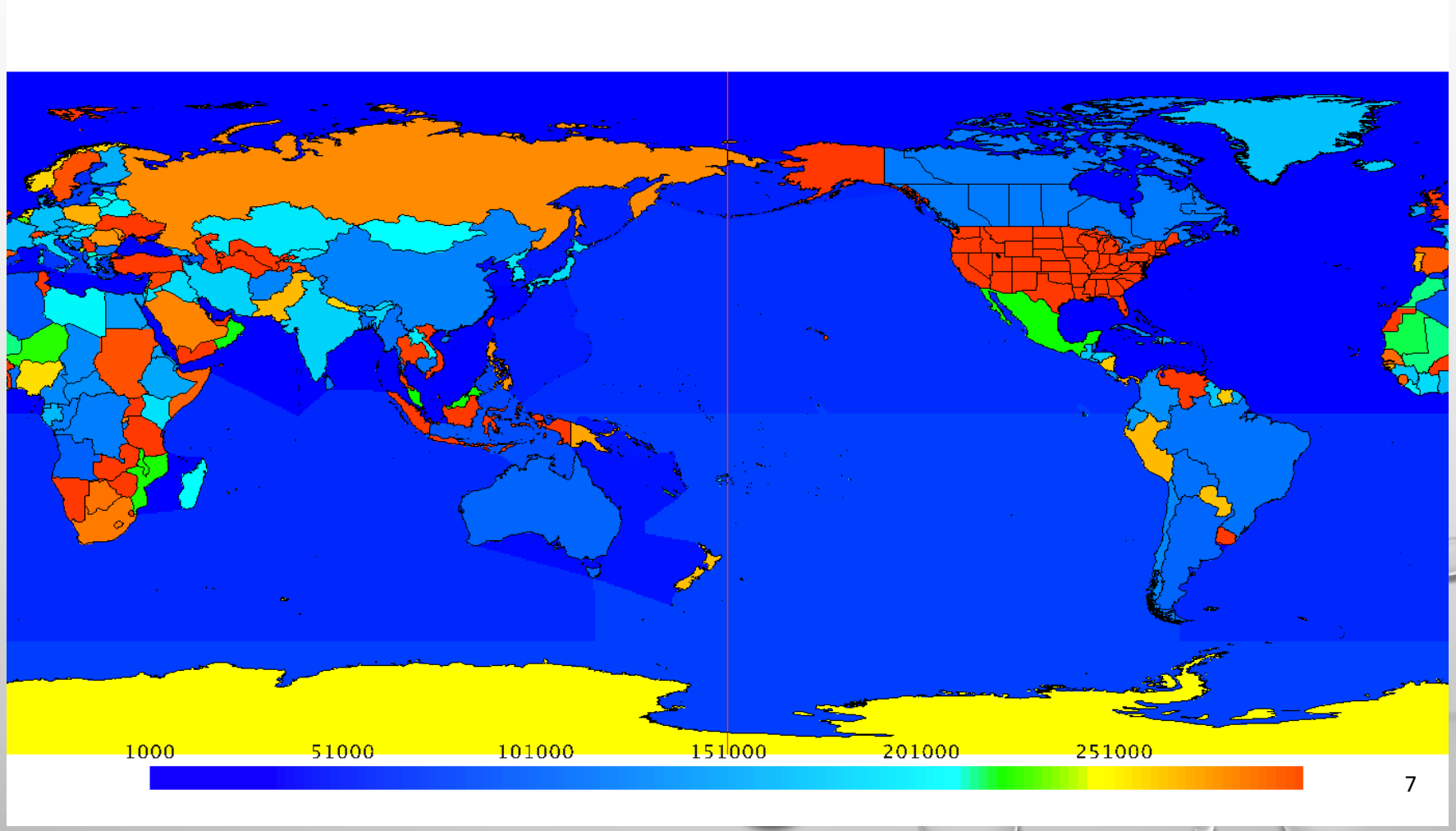


EPA's Hemispheric Modeling Challenges

- Consistent Emissions Processing across various sectors from various sources/countries.
  - Temporal Allocation
  - Horizontal and Vertical Spatial Allocation
- Accurate country-specific Time Zone handling
  - Local time to GMT as well as holidays
- Accurate spatial allocations with and without Surrogates
- Mixing US and Global gridded emissions without double counting

EPA Northern Hemispheric Modeling

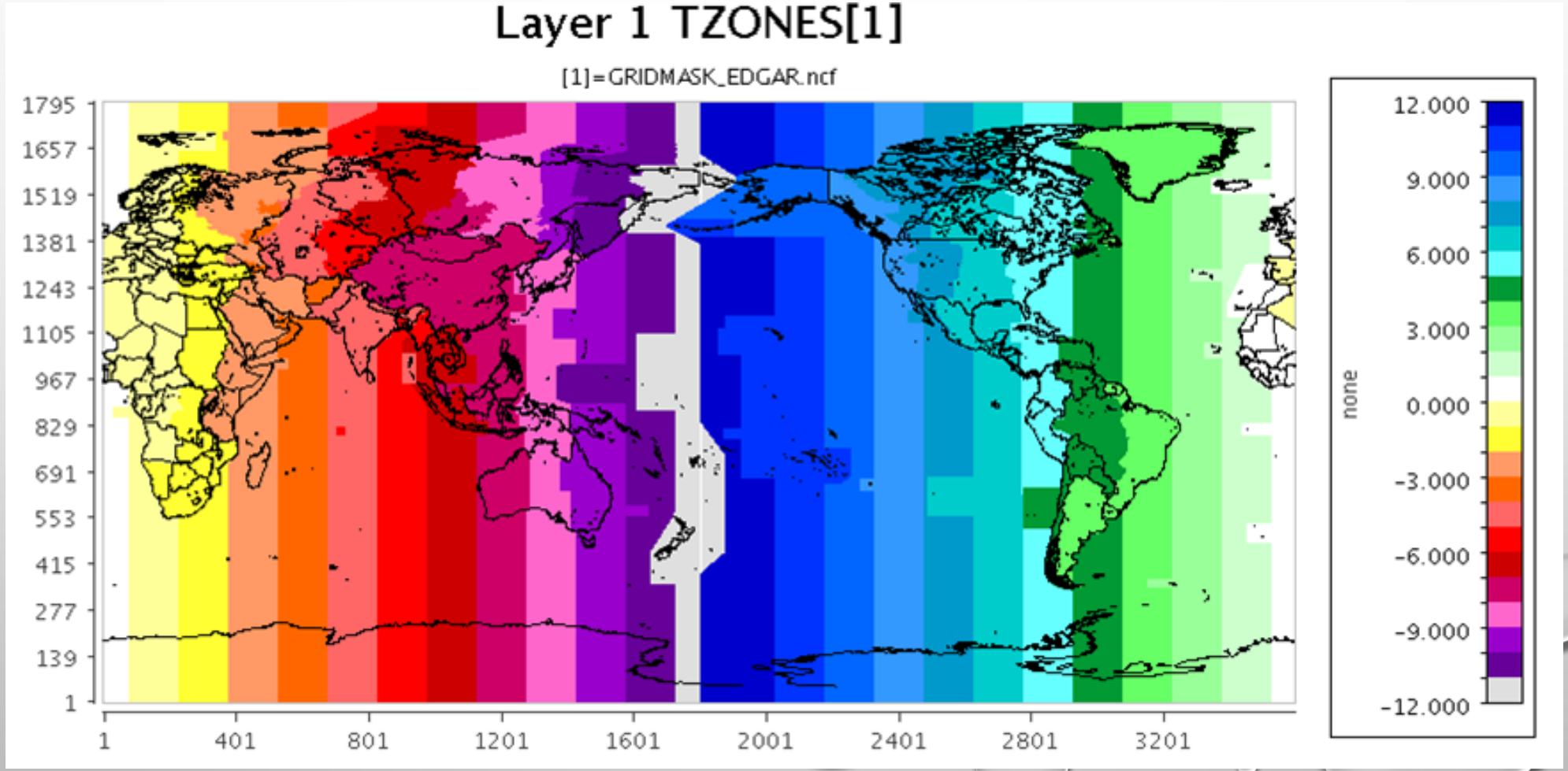
- **GRIDMASK** file that includes both the country and time zone by grid cell : used Arcmap zonal statistics to calculate the majority coverage in the cell



EPA Northern Hemispheric Modeling

- **GRIDMASK** file maps grid cells to time zones

: Finer time zones/country assignment? Required to update the GRIDMASK



SMOKE v4.0 for Hemispheric Modeling

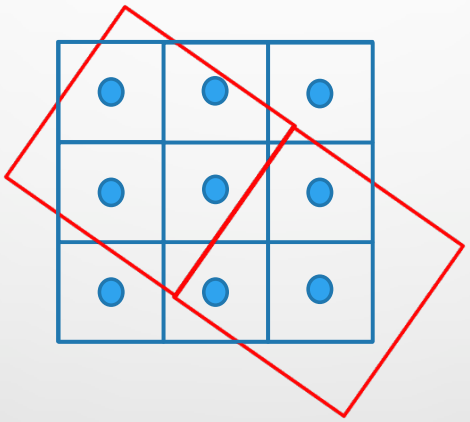
- **Grid Cell = Inventory Source** (6.48 millions sources : 1600*3600)
- **Smkinven** Updates to read and process the native NetCDF-formatted pregridded emissions inventory files (i.e., HTAP, EDGAR,,,,)
  - ***IMPORT_GRDNETCDF_YN*** : Process the native NetCDF pregridded Inventory files
  - ***NETCDF_INV_YEAR*** : Required to provide the year of emissions
  - ***NETCDF_POL_UNIT*** : Required to specify the modeling the unit of each pollutant

ARINV: Area Inventory List File

```
==========================================================
#LIST GRID
#SCC, Pollutant, Variable_Name, Month, File_location_name
SOLVENT,VOC,emis_nmvoc,0,/nas/EDGAR/solvent/nmvoc/v42_2010.nc
SOLVENT,CH4,emis_ch4,0,/nas/EDGAR/solvent/ch4/v42_2010.nc
ENERGY,NOX ,emis_nox,0,/nas/EDGAR/energy/nox/v42_2010.nc
ENERGY,PM25,emis_pm25,0,/nas/EDGAR/energy/pm2.5/v42_2010.nc
ENERGY,NOX,emis_nmvoc,0,/nas/EDGAR/energy/nmvoc/v42_2010.nc
…,…,…,…,…
==========================================================
```

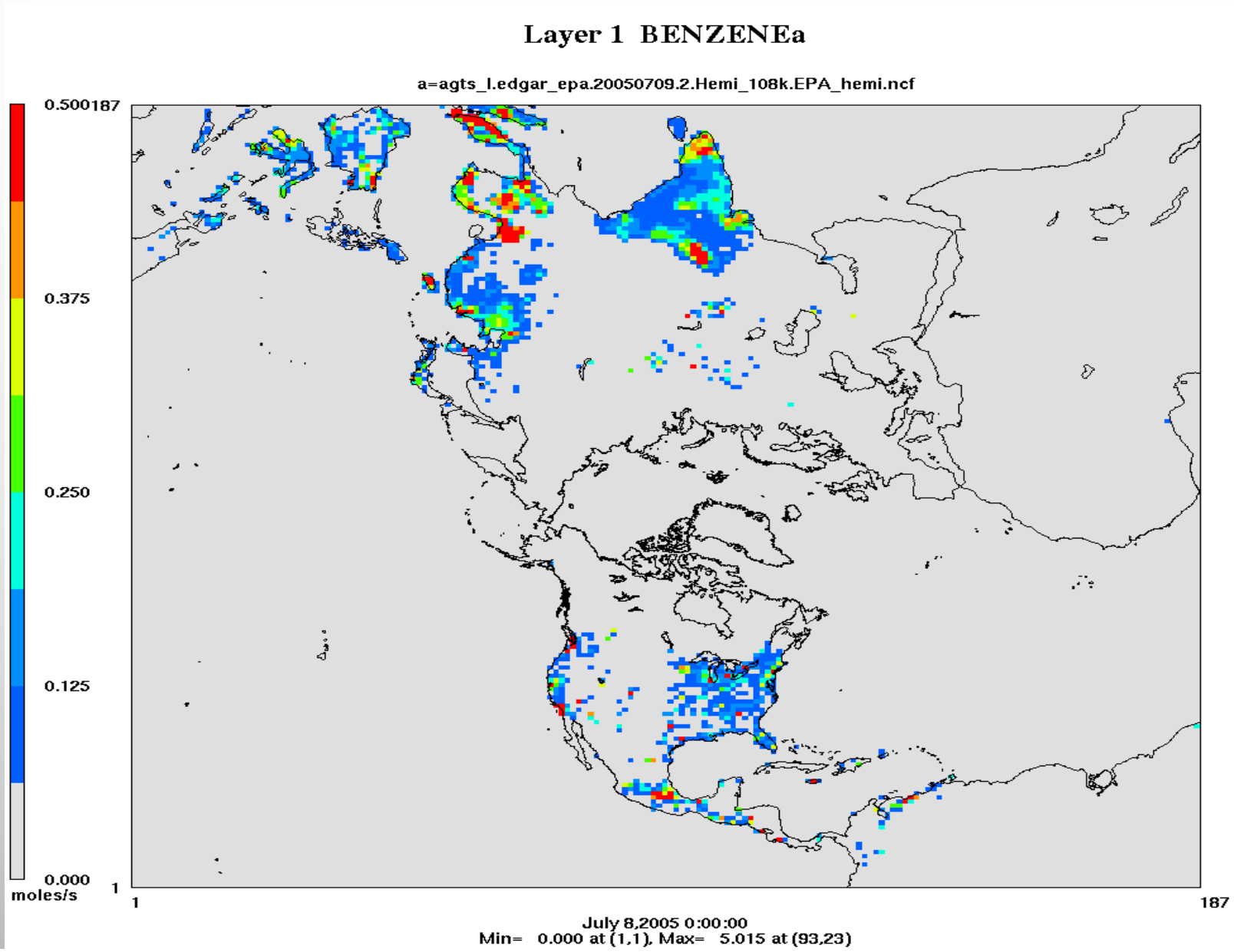
SMOKE v4.0 for Hemispheric Modeling

- **Grdmat** Updates to regrid the pregridded emissions into the output modeling domain without any spatial surrogate.
  - Built a new function to disaggregate the grid cell into multiple point and the regrid them into the new modeling domain.



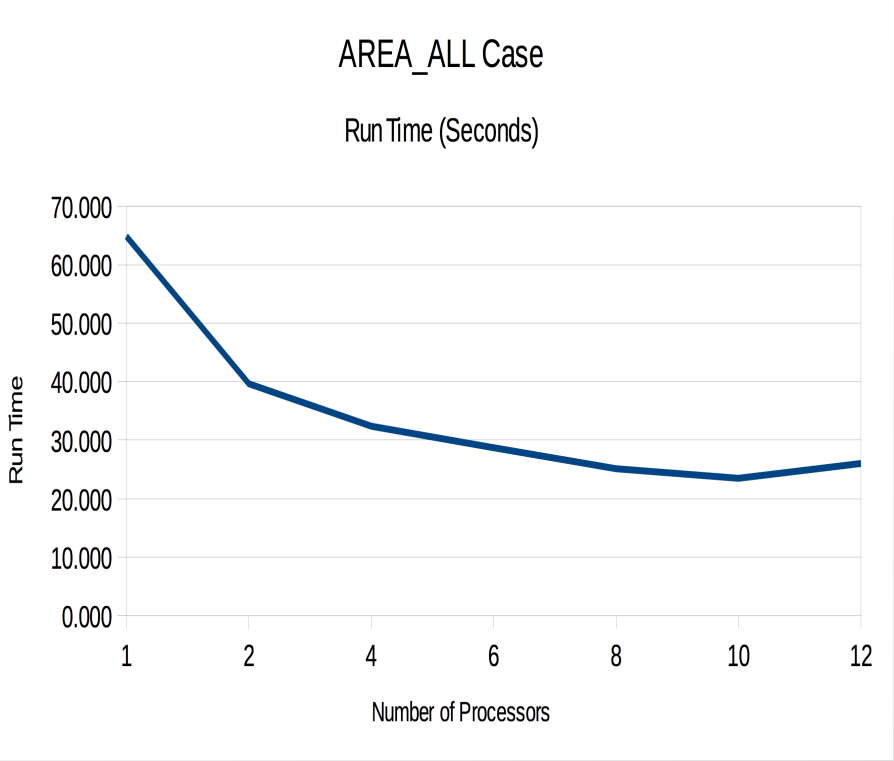
- **Spcmat** used to assign a single chemical speciation profile by grid cell
- **Cntlmat** used to zero-out emissions by regions (defined by GRIDMASK)

Example of Gridded HTAP Emissions



Other Enhancements

- **Open MP Parallelization in SMOKE**
  - Smkreport and Smkmerge
  - Upto 2-2.5x Speed up
  - Requires a complete restructuring



- SMOKE Wiki Page:
  - Based on the EPA's NEI Platform README
  - Added a few tips for SMOKE modeling users

SMOKE4AERMOD Development

- Designed to Support ongoing US EPA NATA 2014 Studies using AERMOD chi/Q mode processing:
  - Point Sources
    - Point-EGU (ptegu)
    - Point-NonEGU (ptnonipm)
    - Airports with Runway (w/o Runway)
  - Nonpoint Sources
    - Nonpoint, NP_oilgas, CMV, and RWC
  - Nonroad Sources
  - Onroad Mobiles Sources:
    - RPD, RPV, RPP, RPH
- Plan to Release in FY 2017 (SMOKE and AERMOD Helper File Scripts)

Parameterization of MOVES Emission Factors Lookup Tables

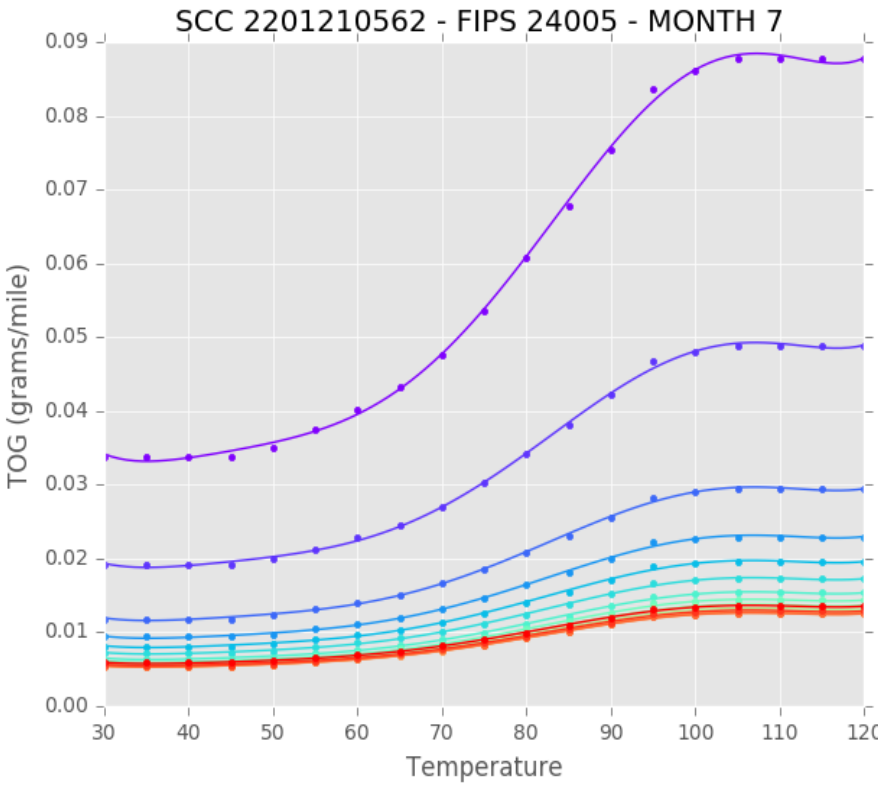
Motivation and Solutions

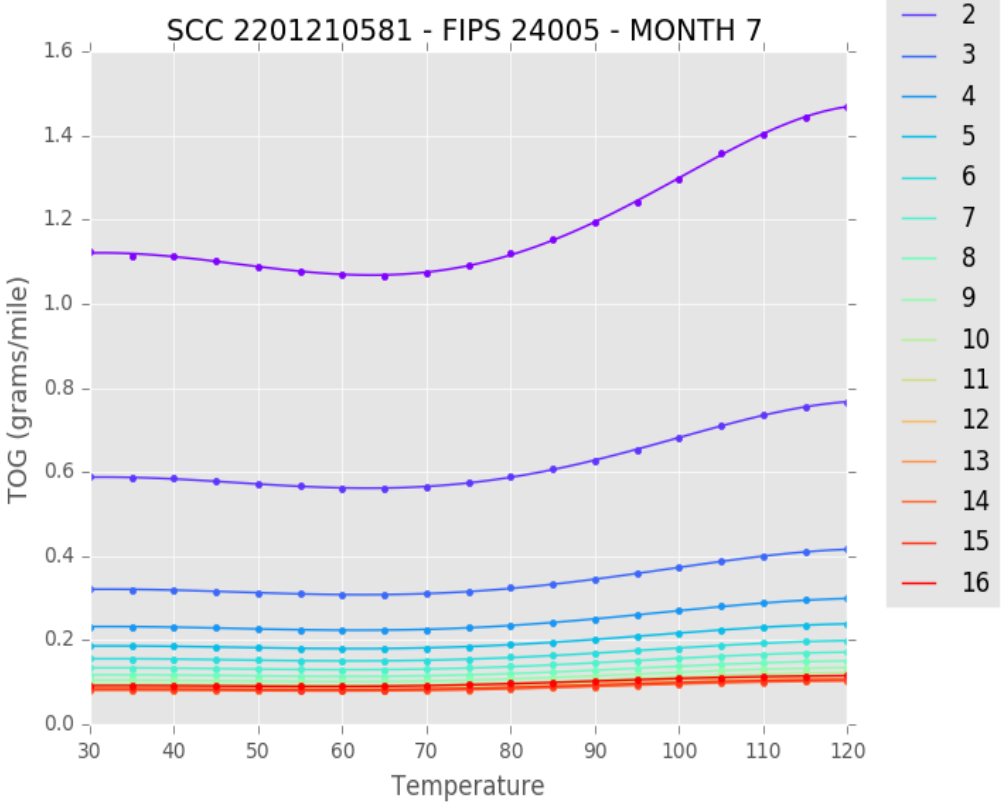
- SMOKE-MOVES Integration Tool Released on 2010
- Main Issues:
  - Very Slow and Most Computationally Expensive Processing Sectors
    - RPD and RPV modes are most slowest sectors
  - Big size of ASCII-format MOVES EF Lookup Tables
  - No of Reference County-specific Lookup Tables
  - Limit us to expand for County-specific MOVES Applications
  - Impossible to couple with AQ models (Inline mode in CMAQ). Especially for forecasting AQ modeling system.
- Solutions:
  - Parameterization of Current MOVES EF Lookup Tables into Polynomial Algorithms using Best-Fitted Curve Algorithms (BFCA)
  - Store the algorithms in NetCDF format to eliminate I/O bottlenecks

Rate Per Distance (RPD)

TOG: Gasoline-Passenger Car: Urban Unrestricted Access

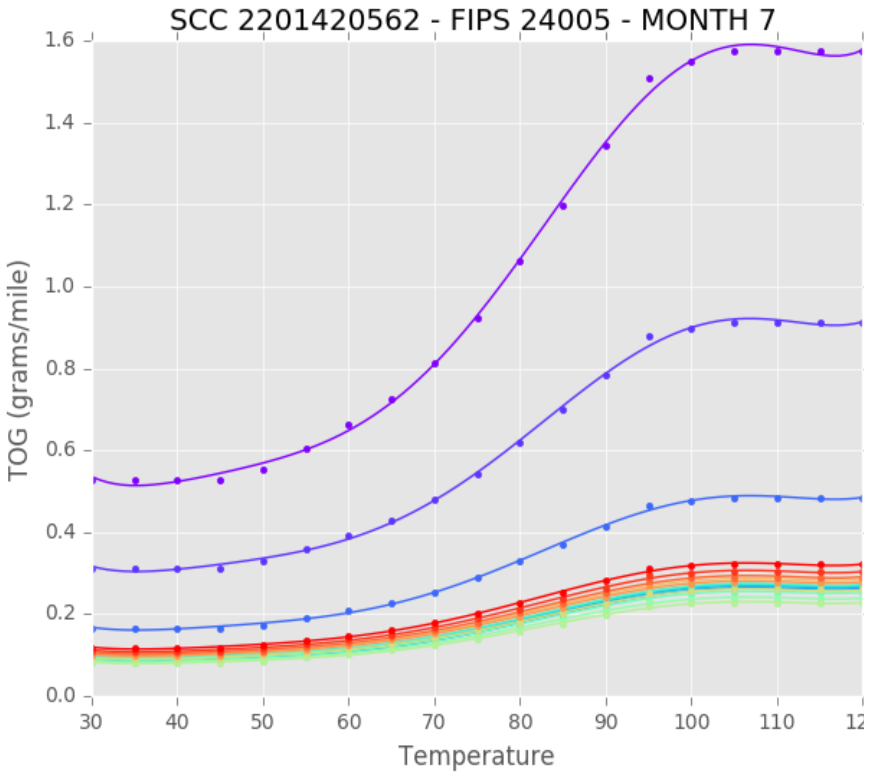
Refueling [62] and All Exhaust, Evaporative, Brake and Tire [81]

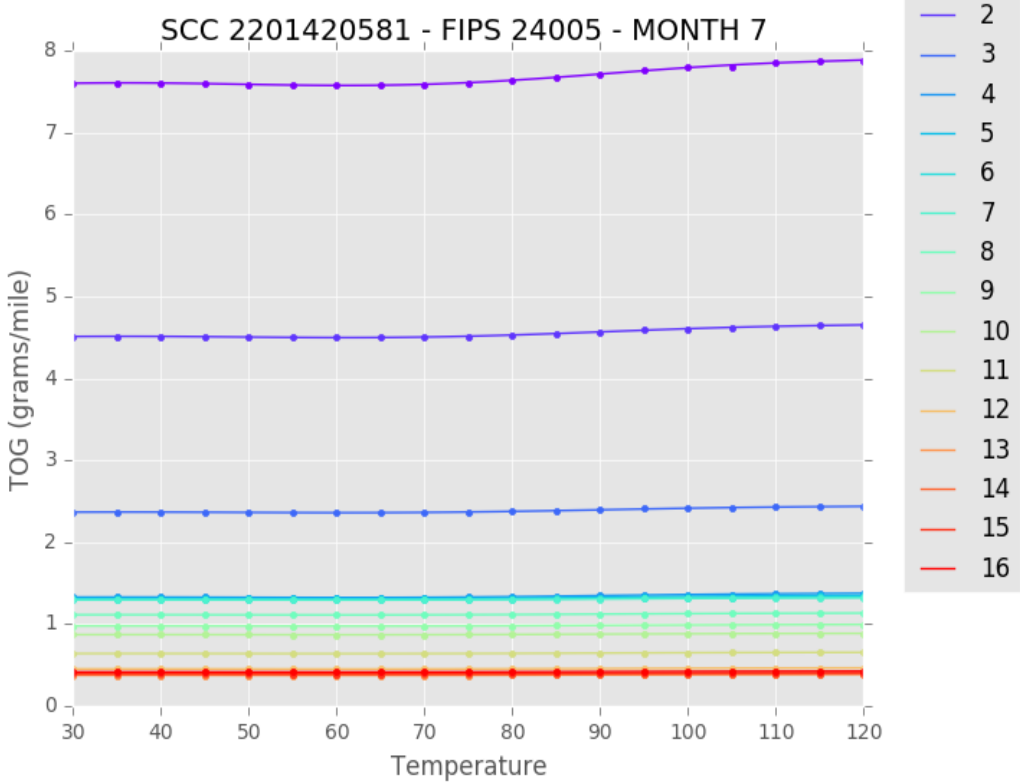




TOG: Gasoline-Transit Buses : Urban Unrestricted Access

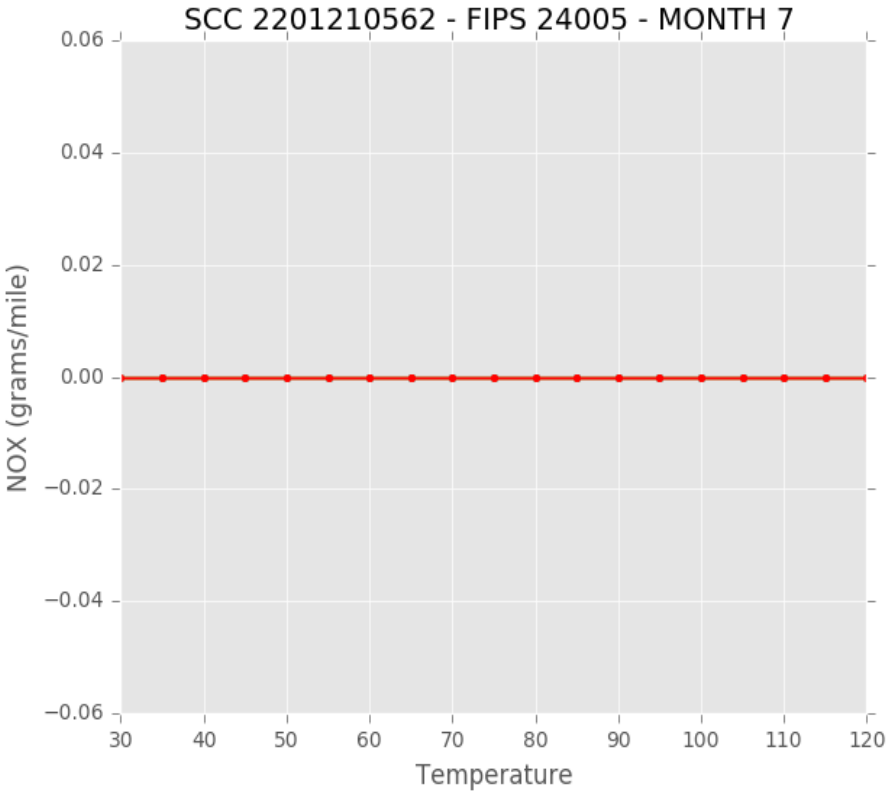
Refueling [62] and All Exhaust, Evaporative, Brake and Tire [81]

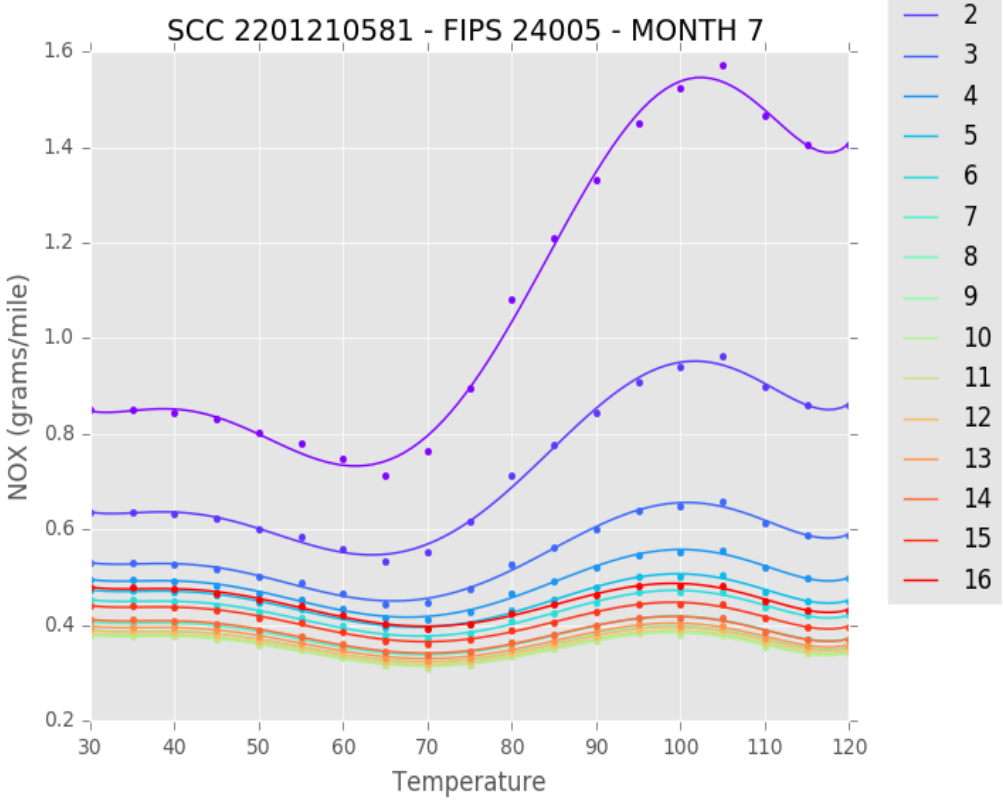




NOx: Gasoline-Passenger Car: Urban Unrestricted Access

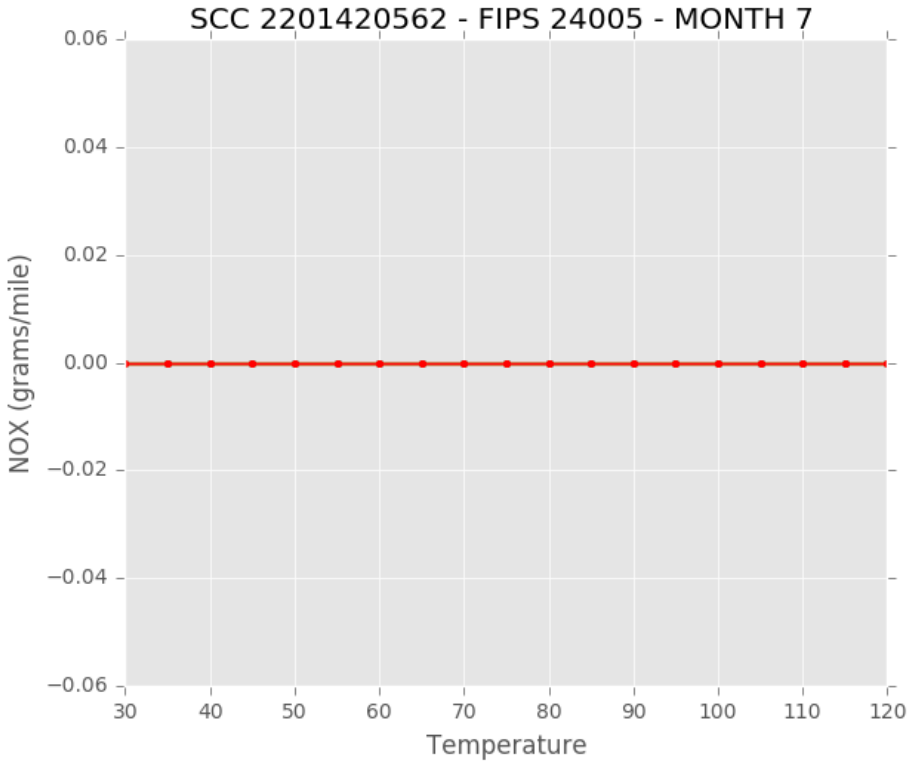
Refueling [62] and All Exhaust, Evaporative, Brake and Tire [81]

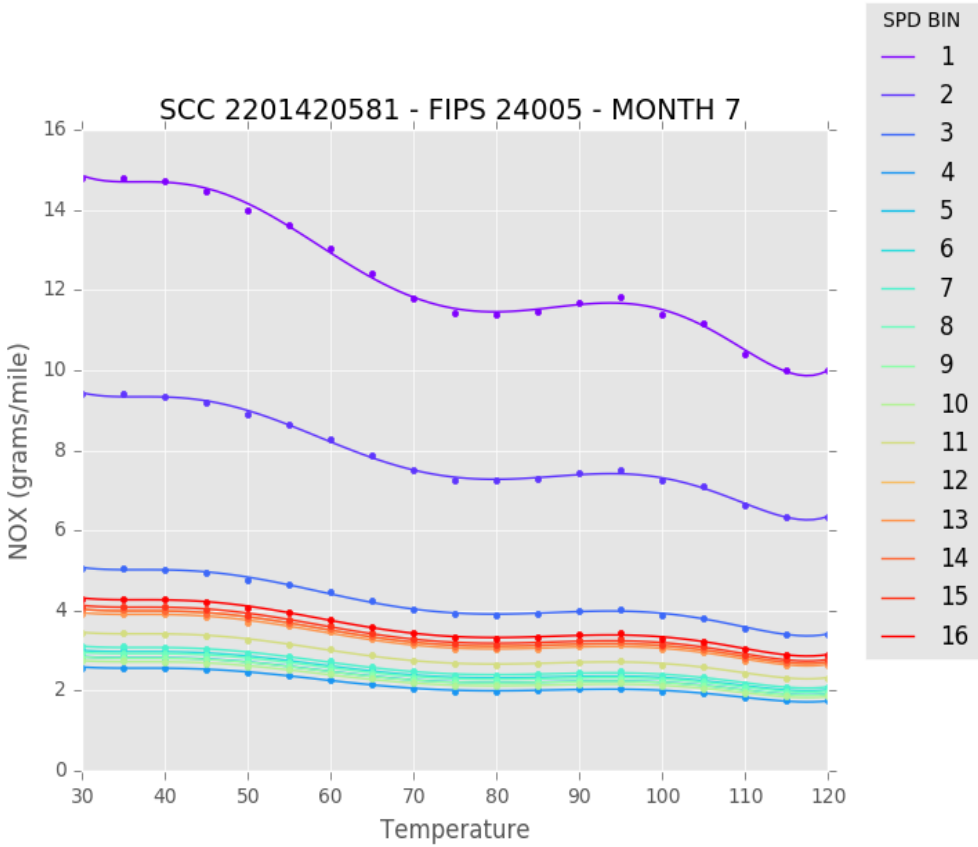




NOx: Gasoline-Transit Buses : Urban Unrestricted Access

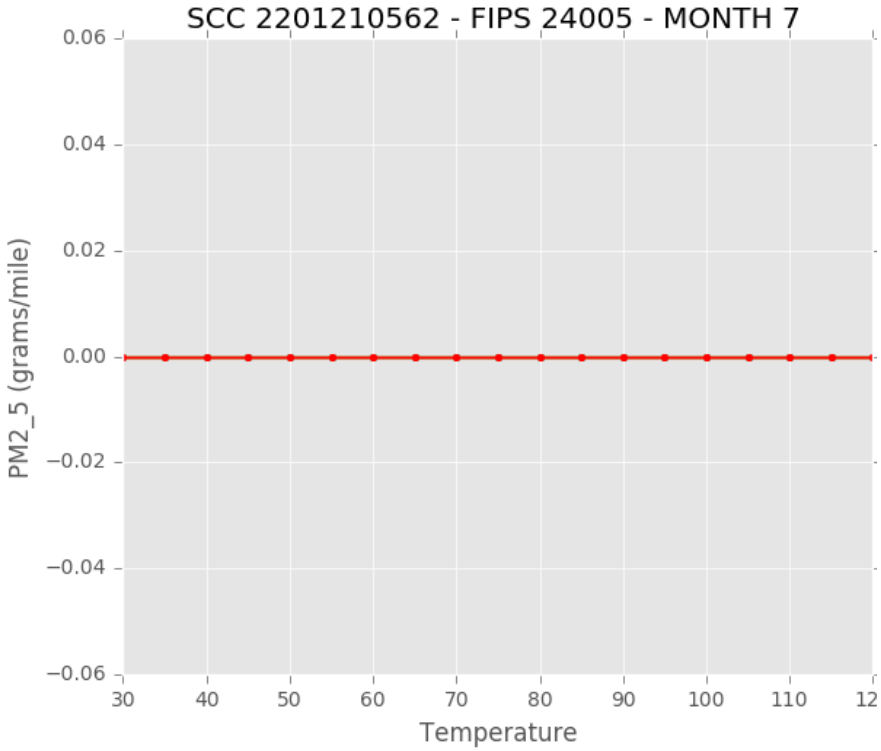
Refueling [62] and All Exhaust, Evaporative, Brake and Tire [81]

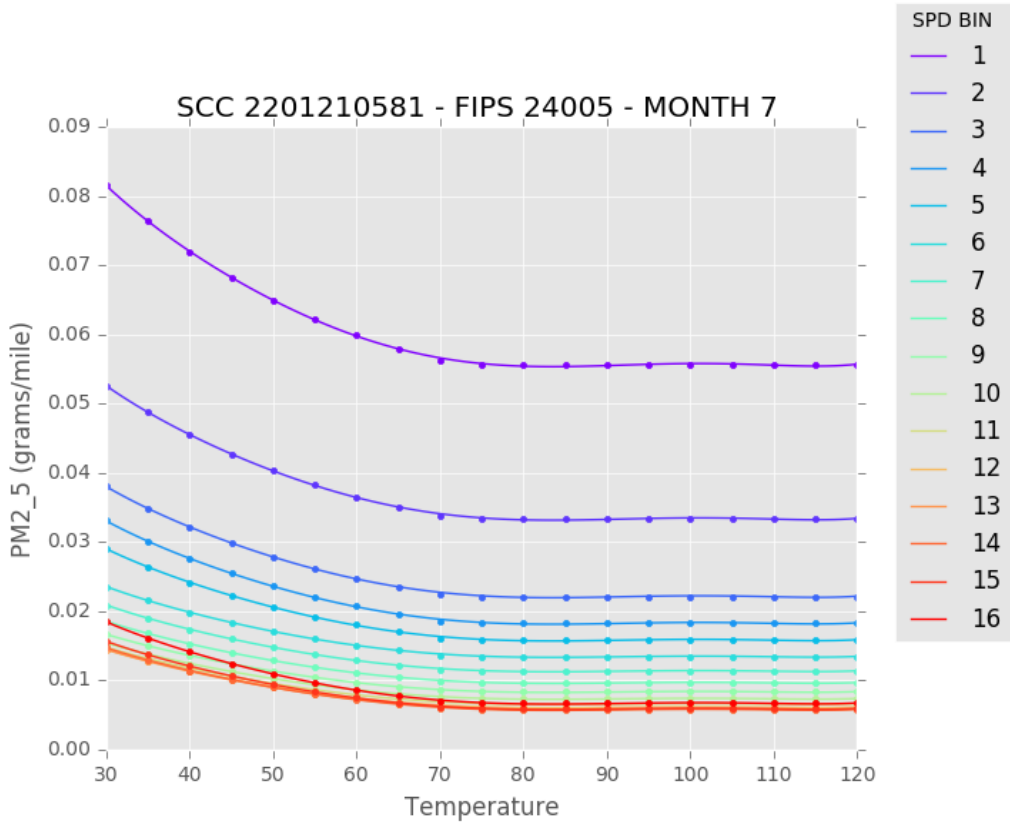




PM2.5: Gasoline-Passenger Car: Urban Unrestricted Access

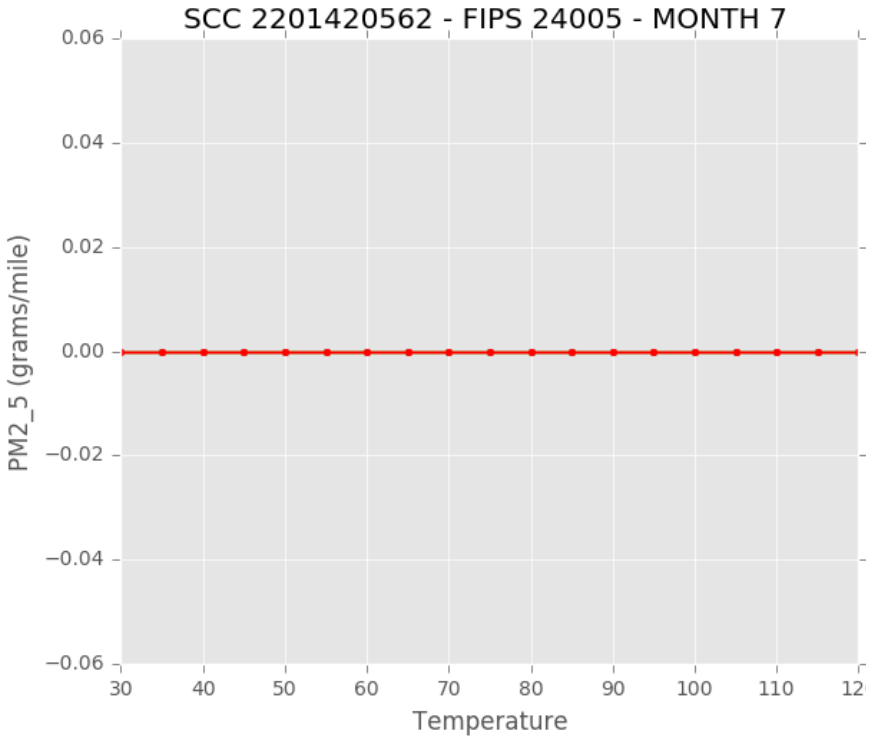
Refueling [62] and All Exhaust, Evaporative, Brake and Tire [81]

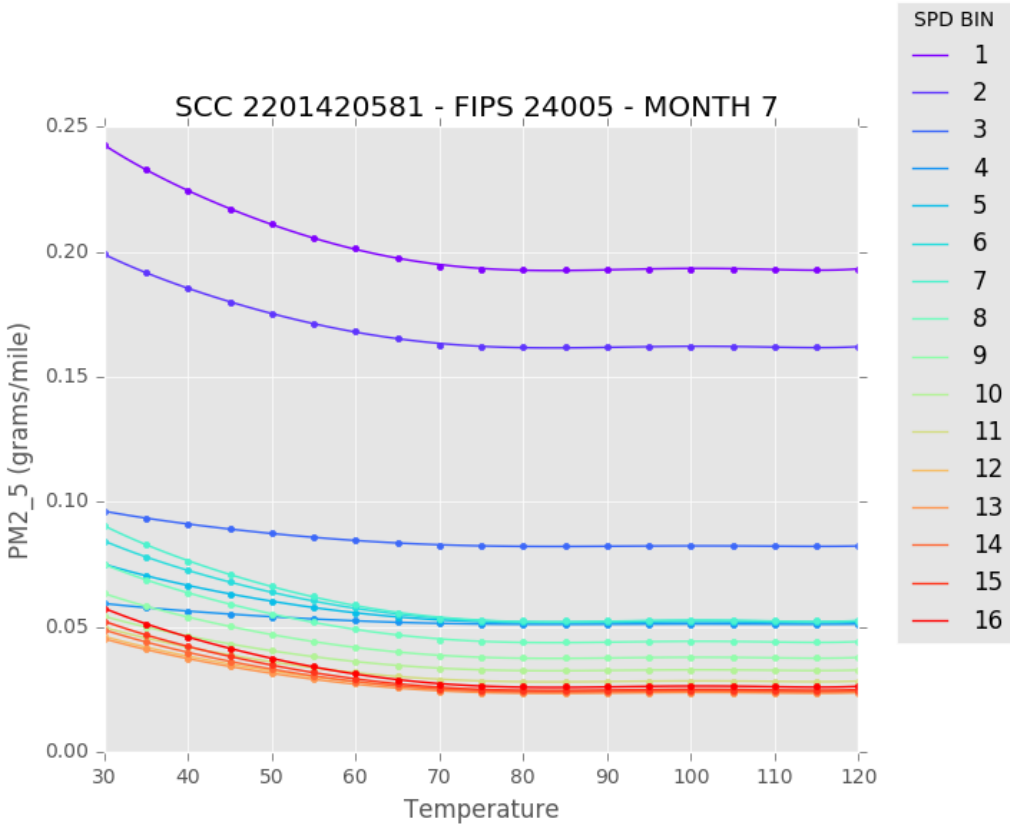




PM2.5: Gasoline-Transit Buses : Urban Unrestricted Access

Refueling [62] and All Exhaust, Evaporative, Brake and Tire [81]

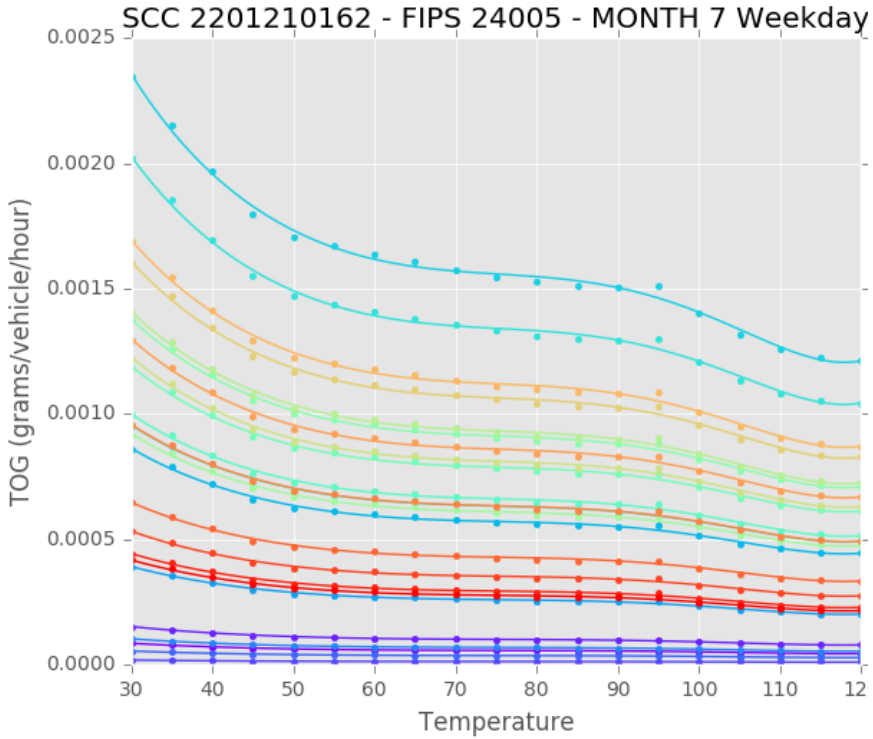


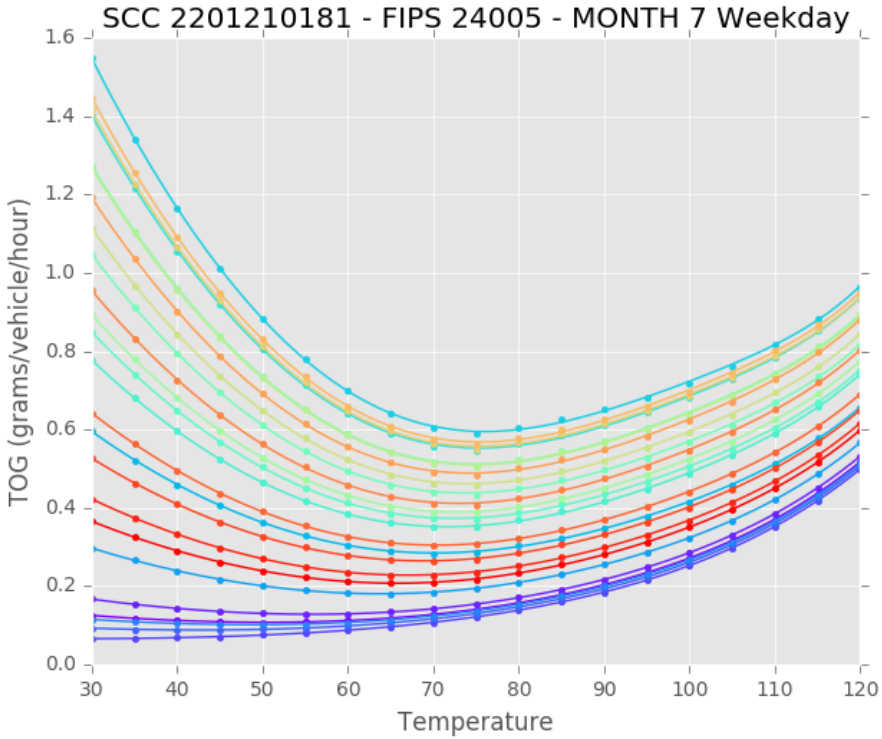


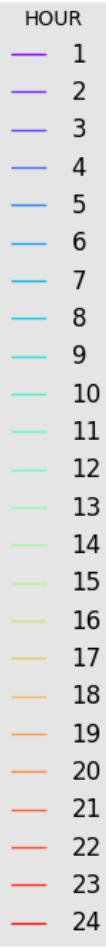
Rate Per Vehicle (RPV)

TOG: Gasoline-Passenger Car : Off-network

Refueling [62] and All Exhaust, Evaporative, Brake and Tire [81]

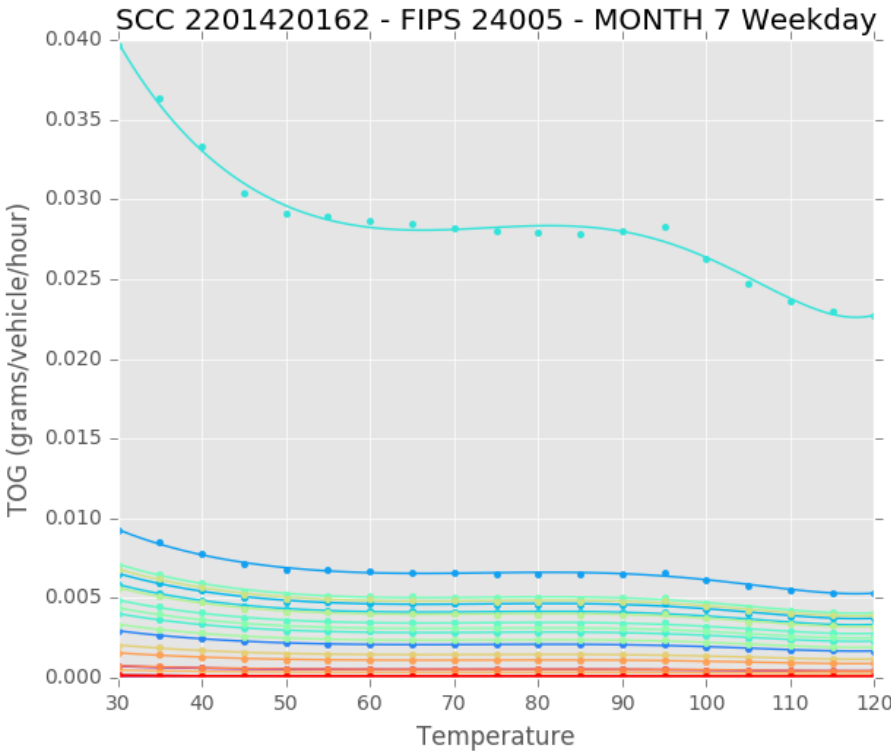


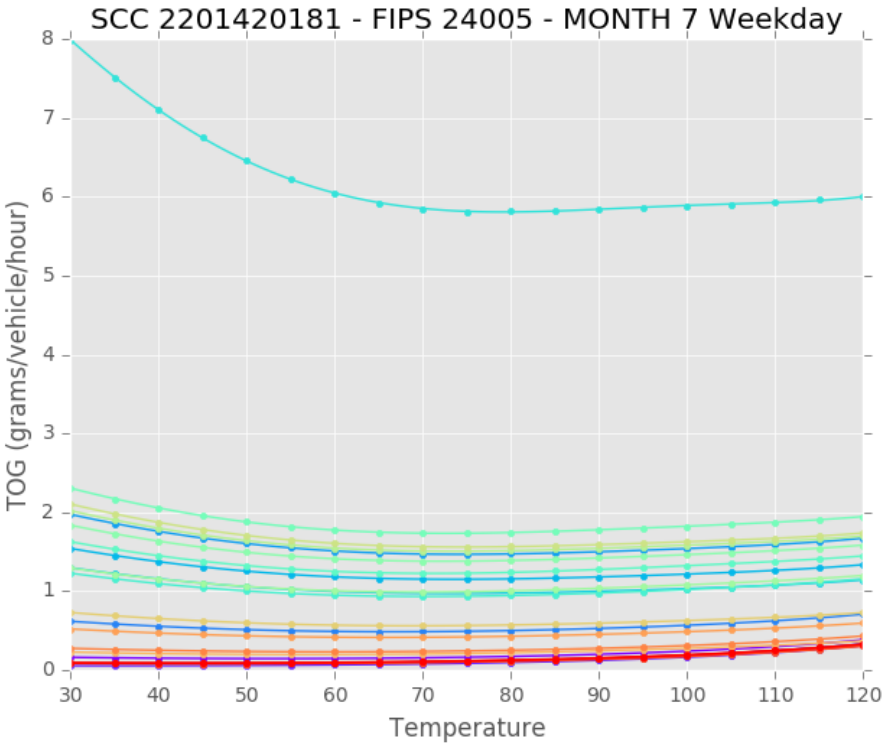


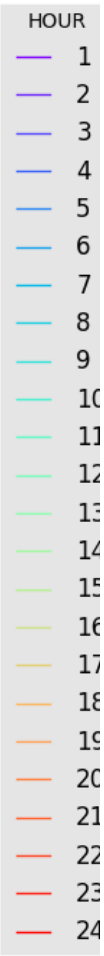


TOG: Gasoline-Transit Buses : Off-network

Refueling [62] and All Exhaust, Evaporative, Brake and Tire [81]

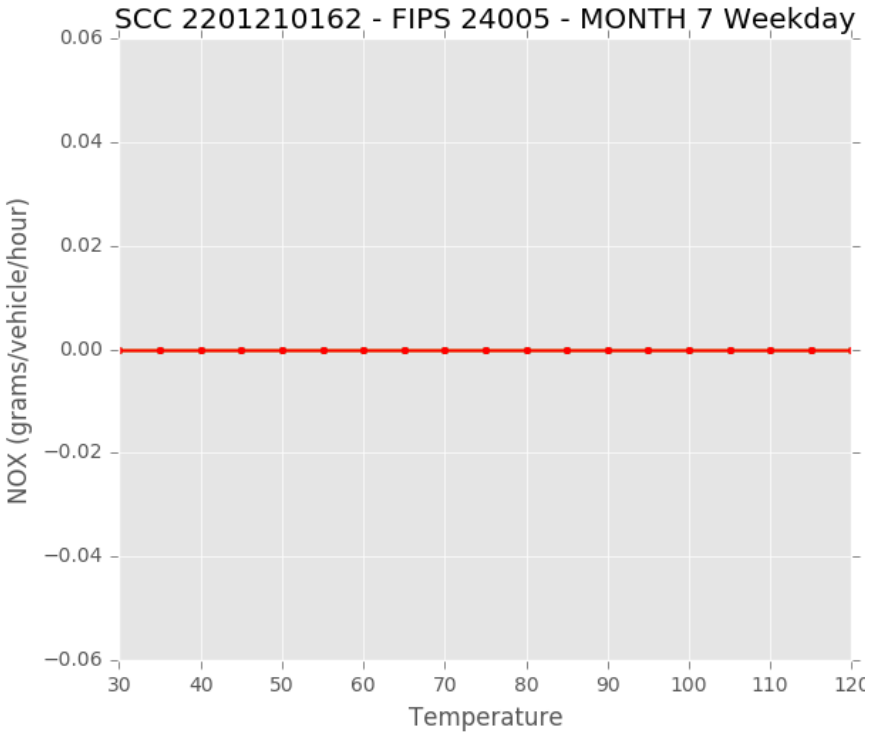


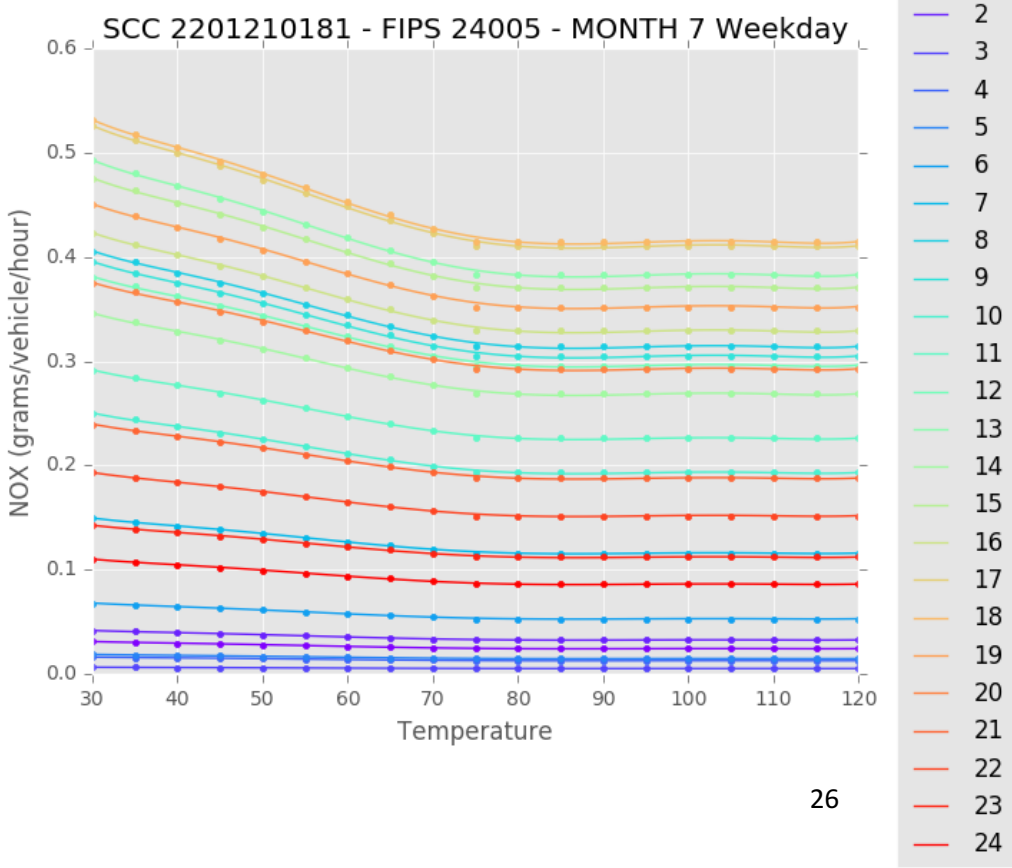




NOx: Gasoline-Passenger Car : Off-network

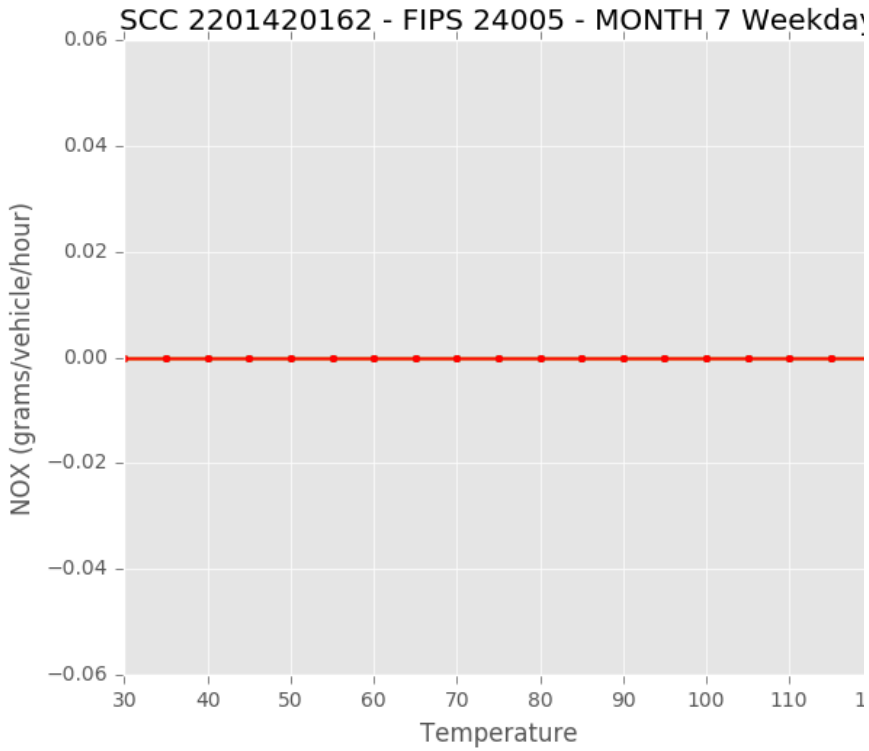
Refueling [62] and All Exhaust, Evaporative, Brake and Tire [81]

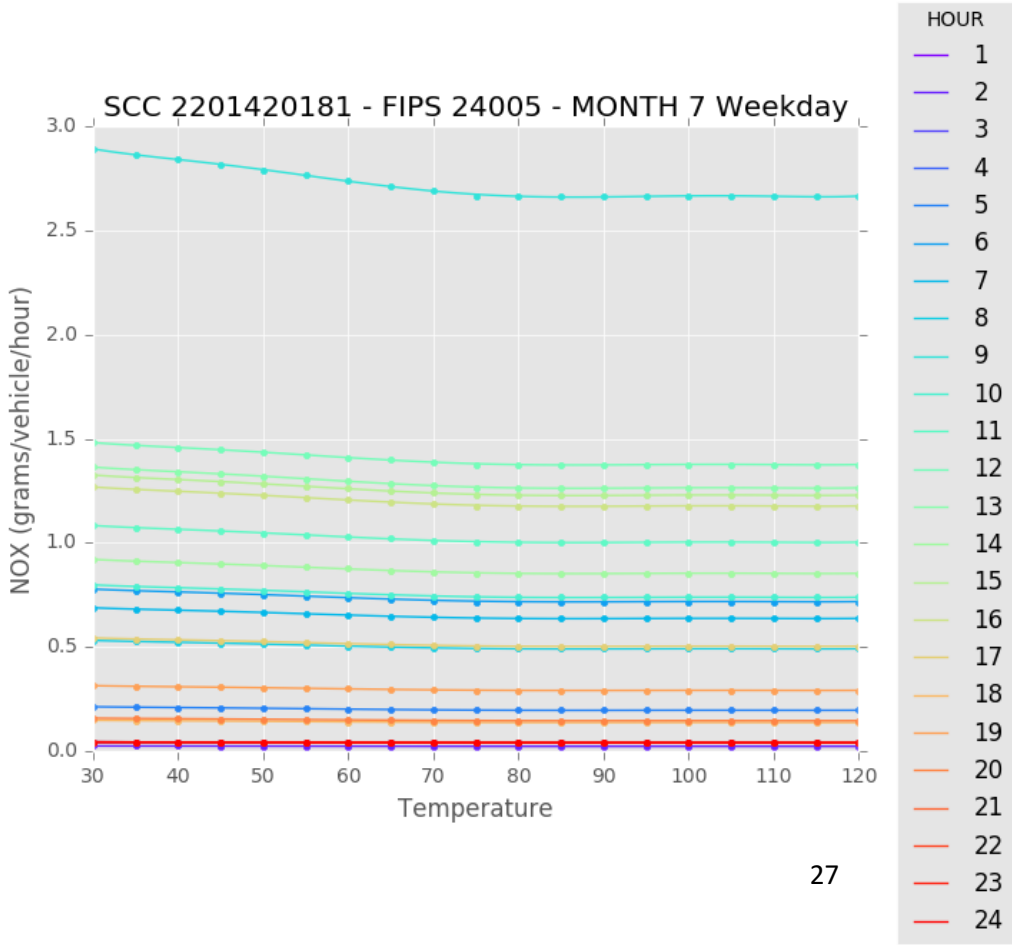




NOx: Gasoline-Transit Buses : Off-network

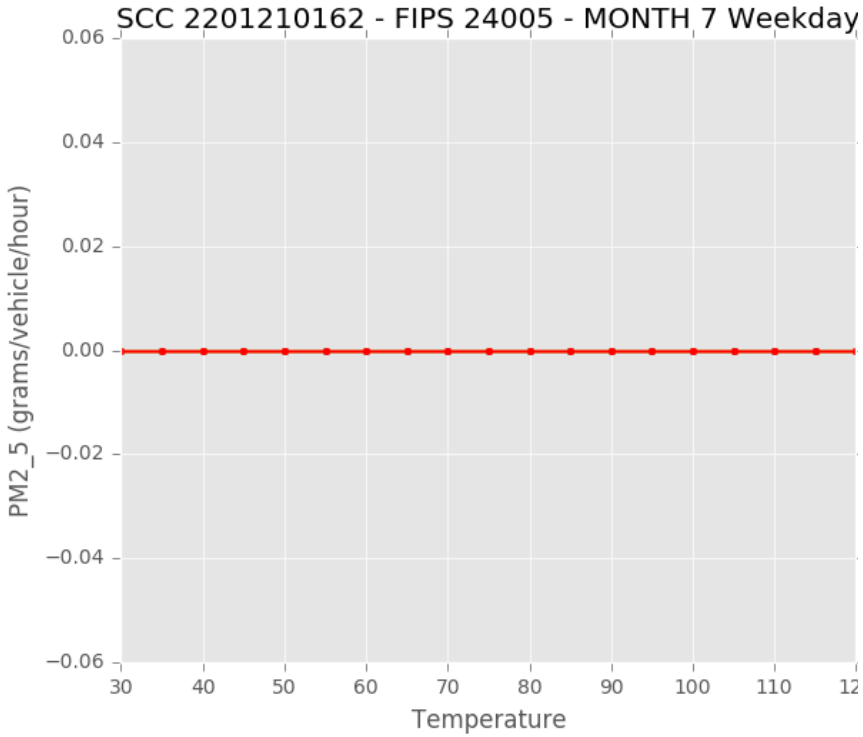
Refueling [62] and All Exhaust, Evaporative, Brake and Tire [81]

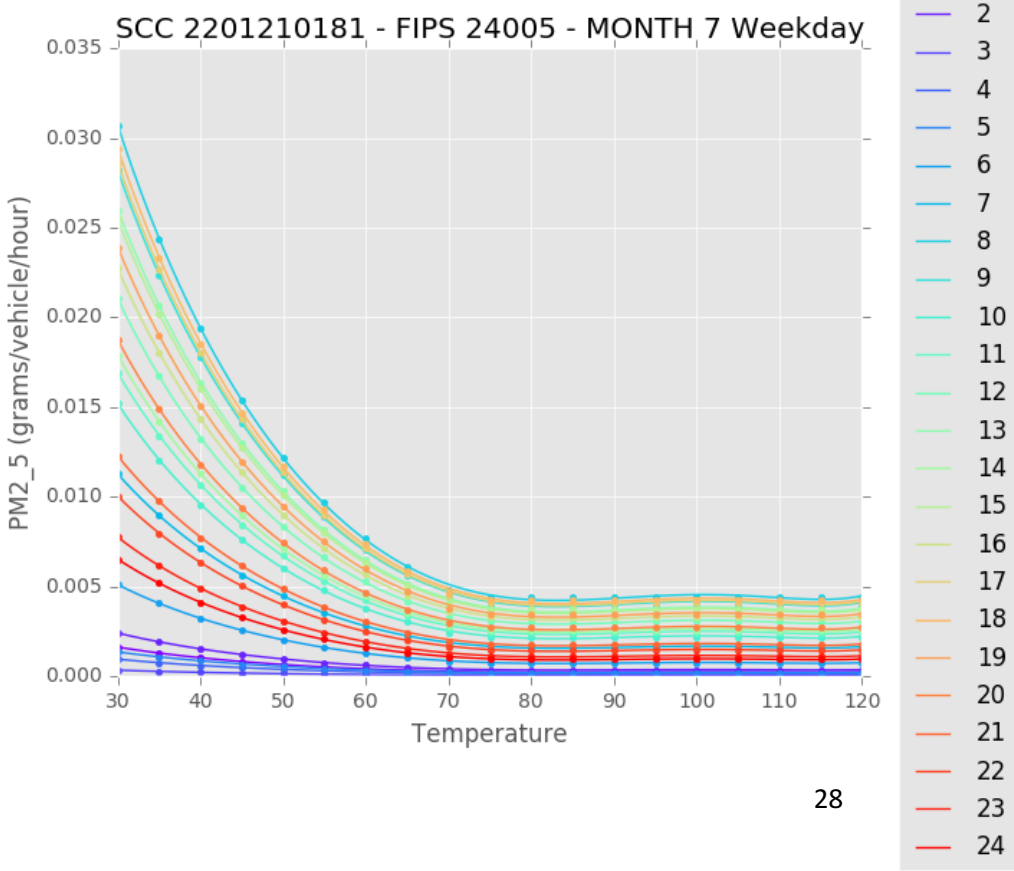




PM2.5: Gasoline-Passenger Car : Off-network

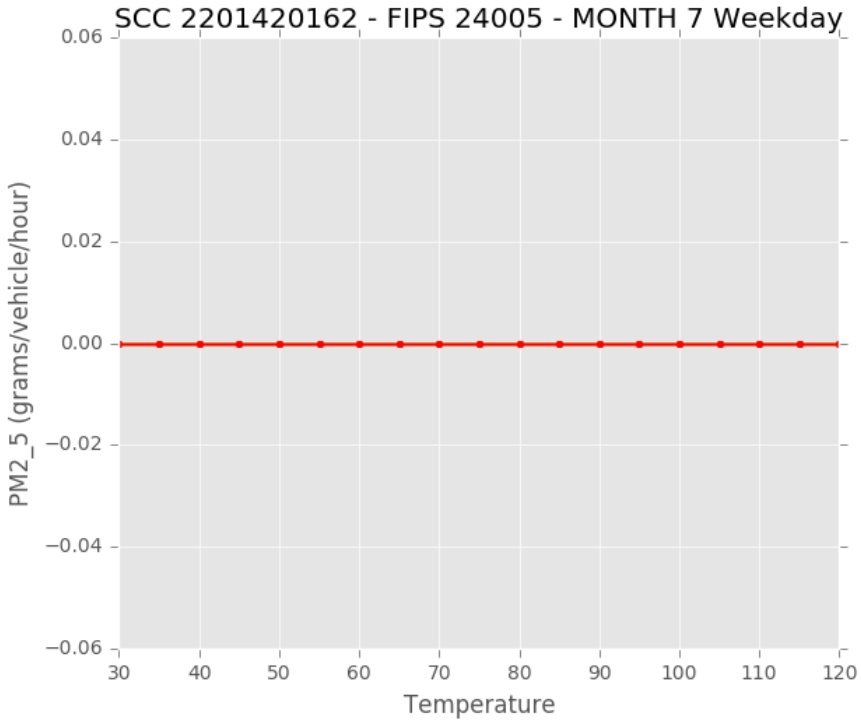
Refueling [62] and All Exhaust, Evaporative, Brake and Tire [81]

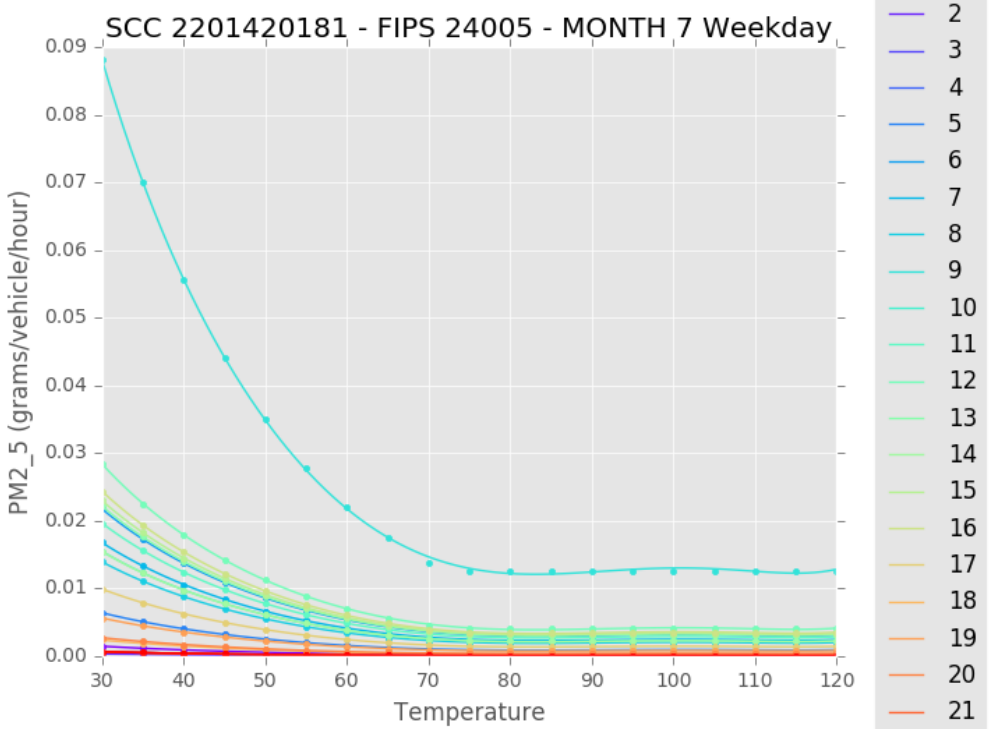




PM2.5: Gasoline-Transit Buses : Off-network

Refueling [62] and All Exhaust, Evaporative, Brake and Tire [81]

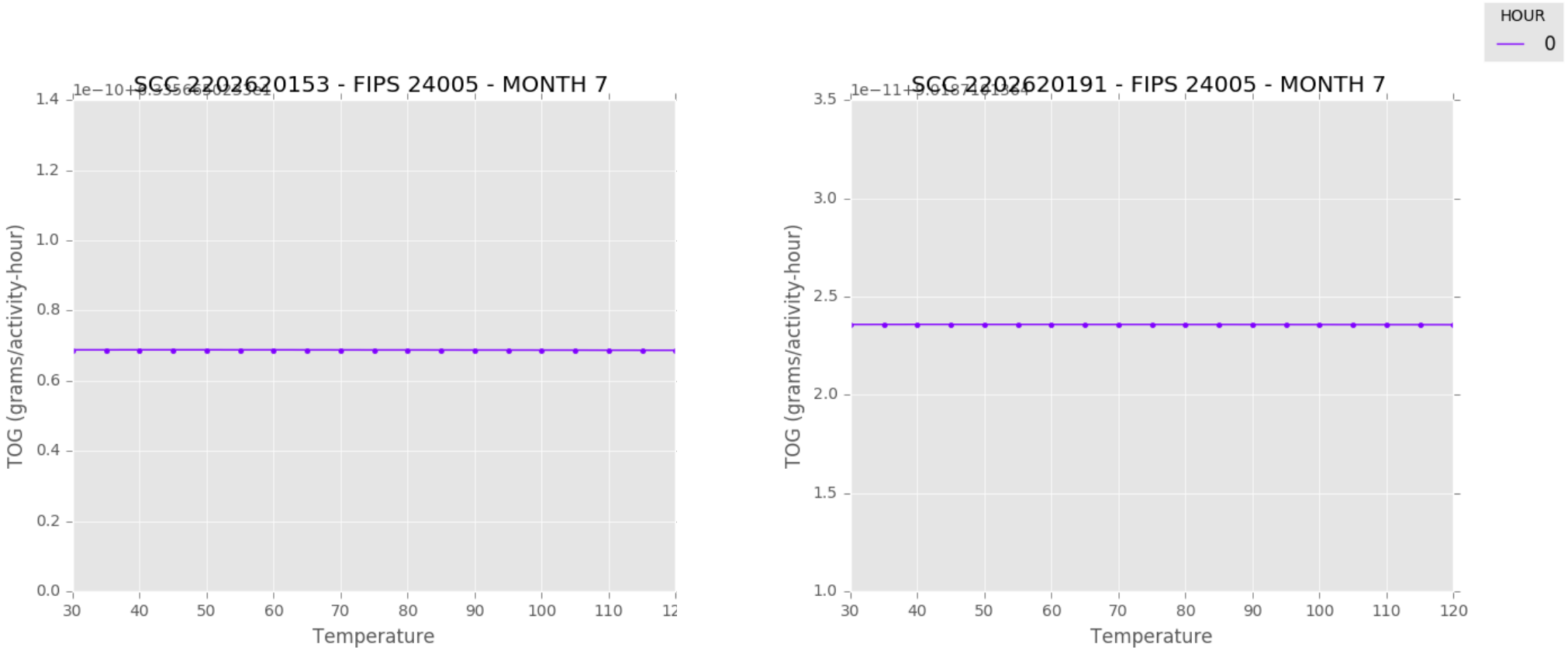




Rate Per Hour (RPH)

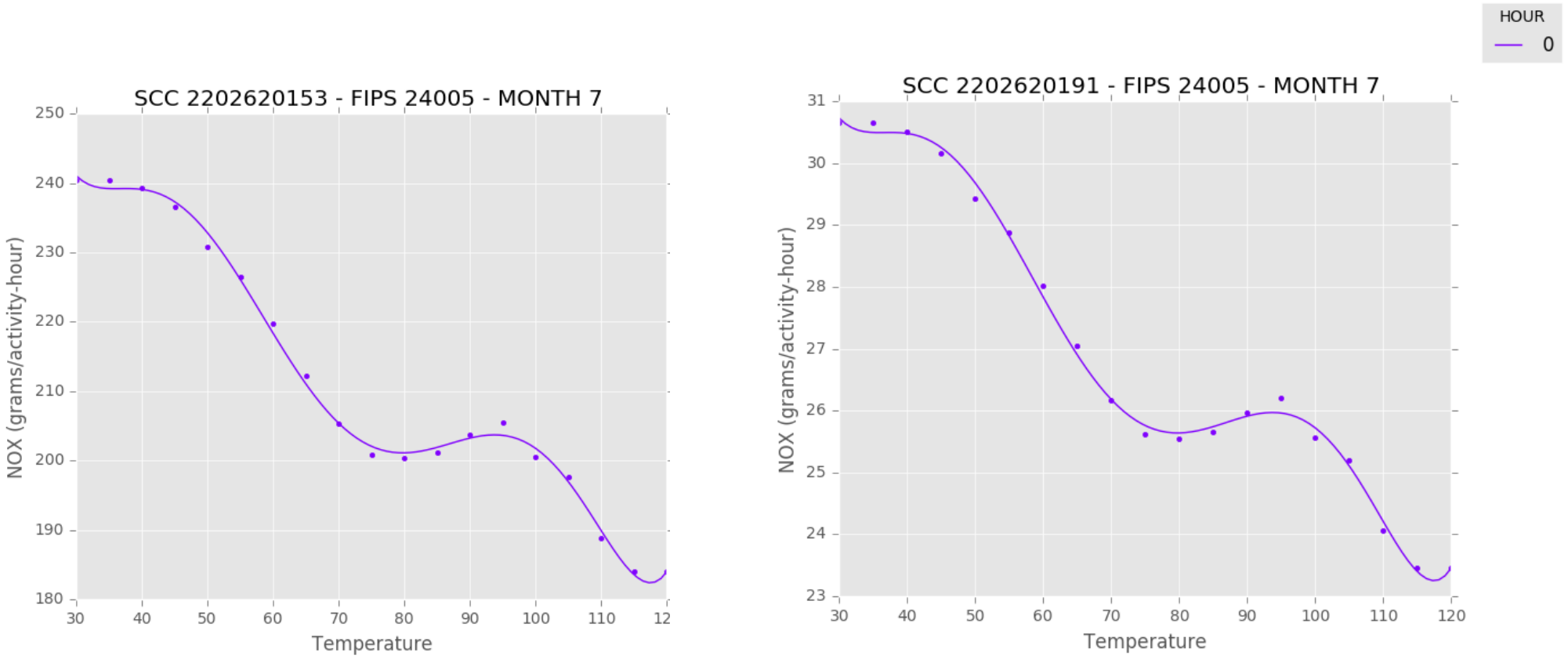
TOG: Diesel Long-haul Truck : Off-network

Extended Idle Exhaust [53] and Auxiliary Power Exhaust [91]



NOx: Diesel Long-haul Truck : Off-network

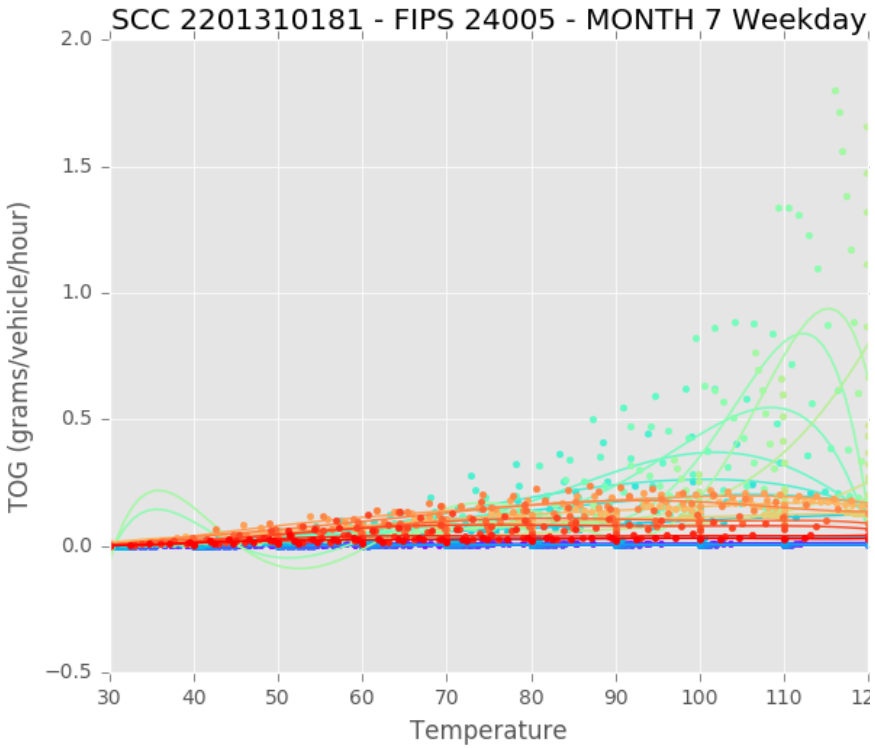
Extended Idle Exhaust [53] and Auxiliary Power Exhaust [91]

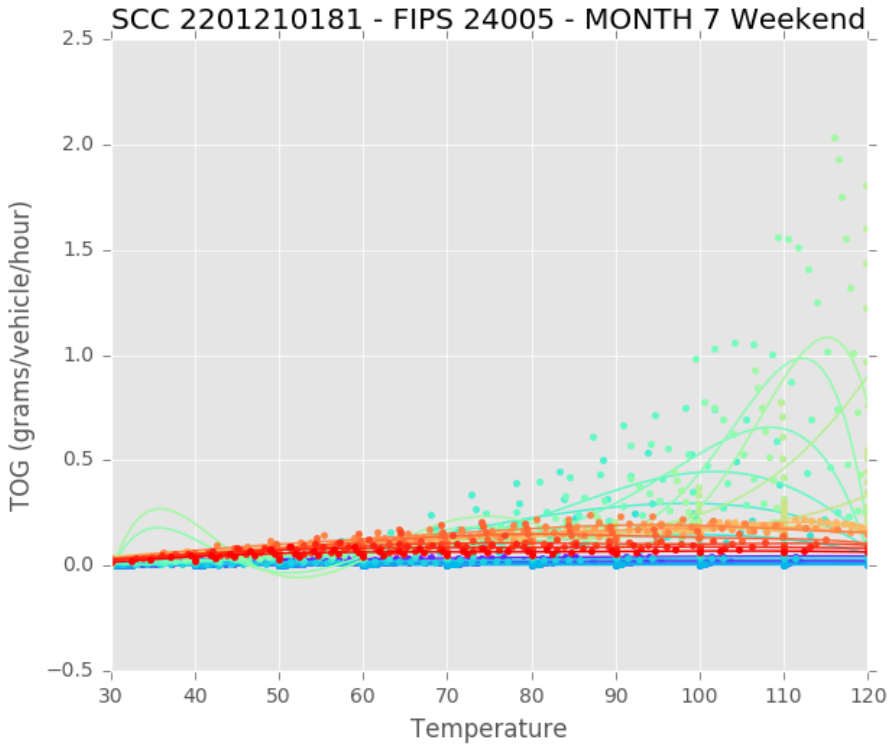


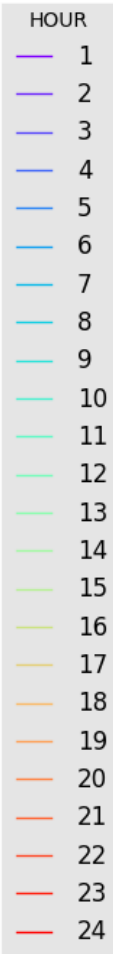
Rate Per Profile (RPP)

TOG: Gasoline-Passenger Cars : Off-network

All Exhaust, Evaporative, Brake and Tire [81] : Weekday vs. Weekend

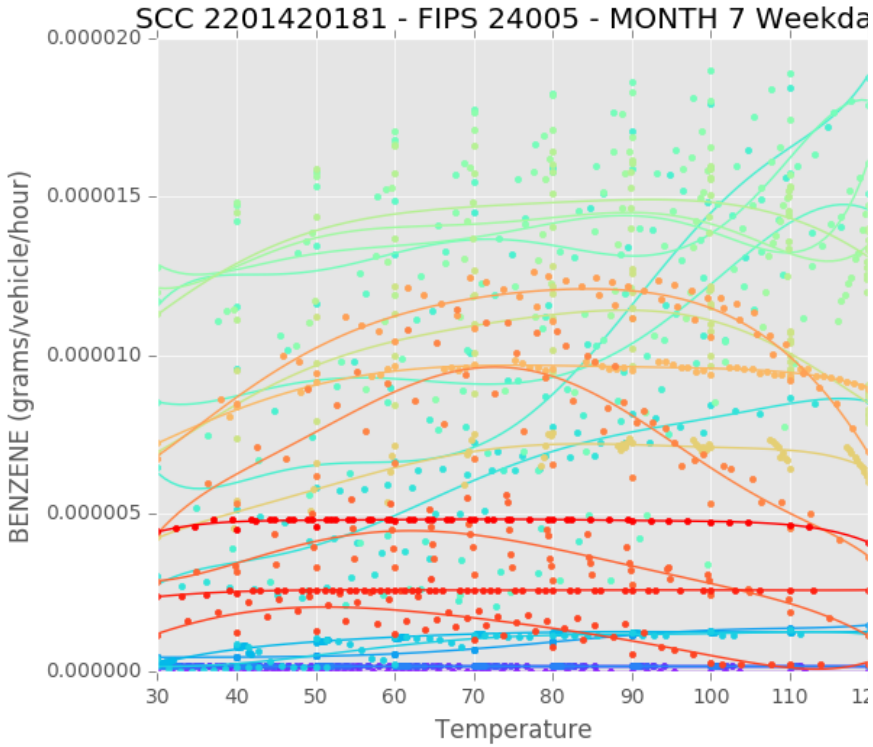


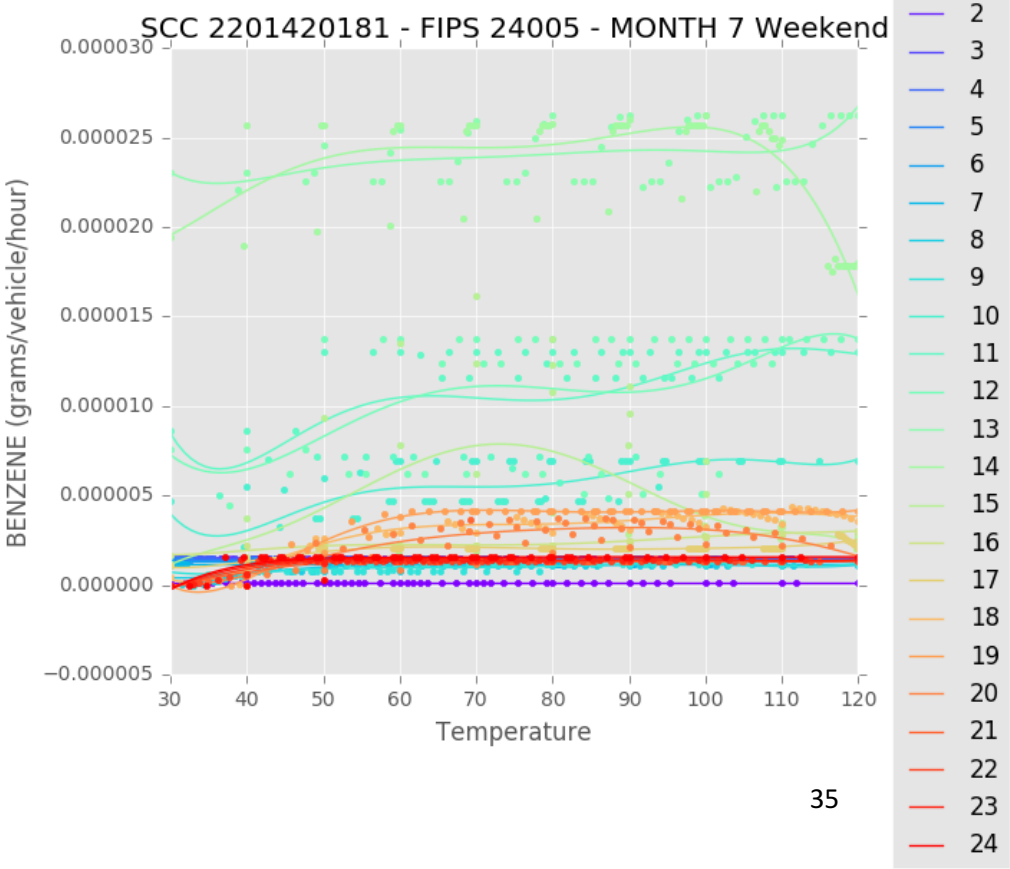




TOG: Gasoline-Transit Buses : Off-network

All Exhaust, Evaporative, Brake and Tire [81] : Weekday vs. Weekend

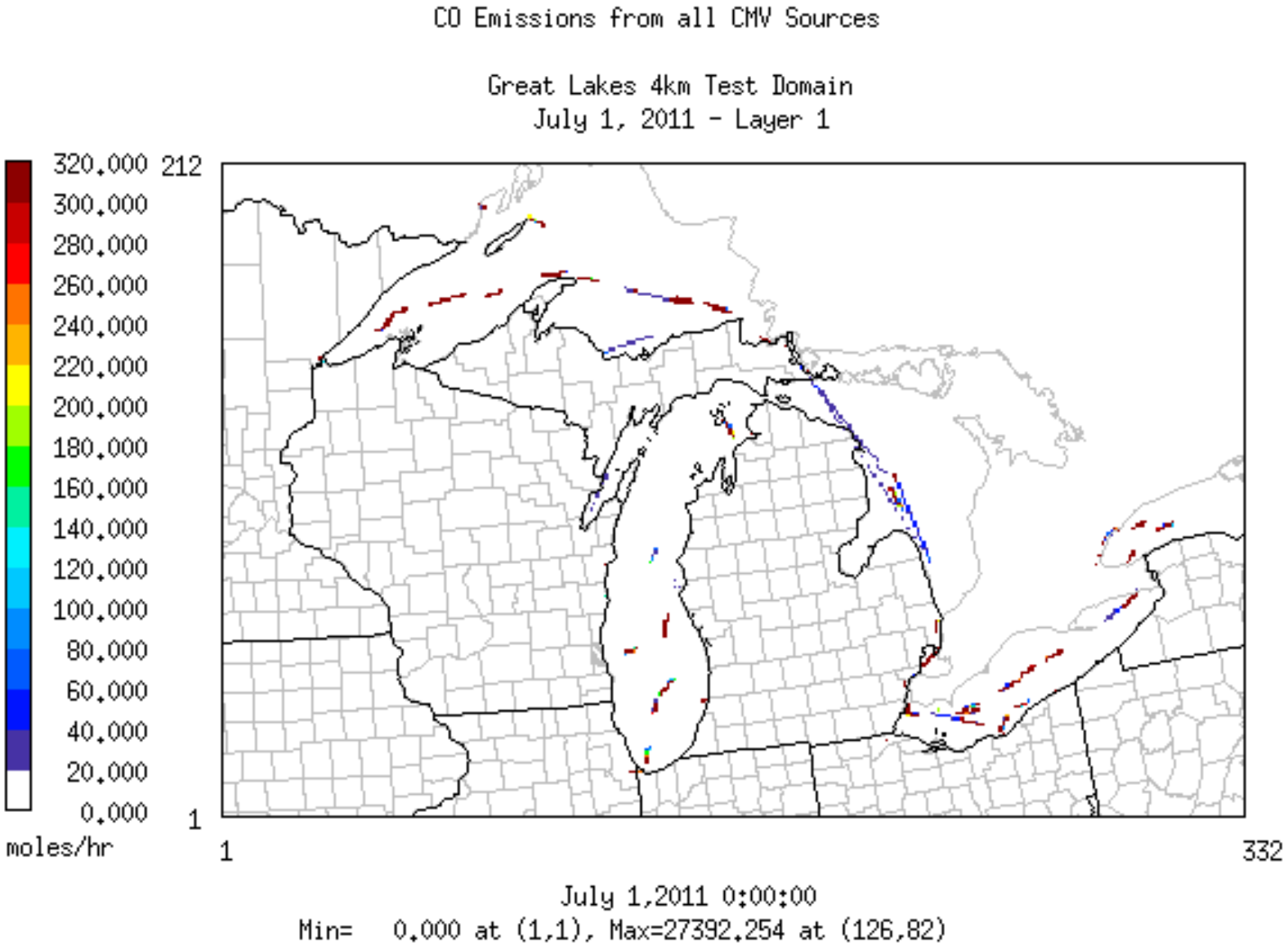




CMV Link-Level Emissions Processing

- LADCO's Commercial Marine Vessels (CMV) Link-Level Emissions
  - Real-time CMV Transponder Data measured by Automatic Identification System (AIS)
    - Vessel identity, type, position, course, speed, navigational status, and other
  - LADCO developed an AIS-based 2014 CMV Inventory
    - Processes: Cruising, Maneuvering and Hoteling
    - Link-level (starting and ending coordinates)
    - Temporal Resolution: Few seconds to Months
- "LinkProc" is a stand-alone Emissions Modeling Processor
  - Generates gridded/speciated/hourly emissions for AQ models
  - No multiple steps like SMOKE programs

LADCO CMV Link-level Emissions



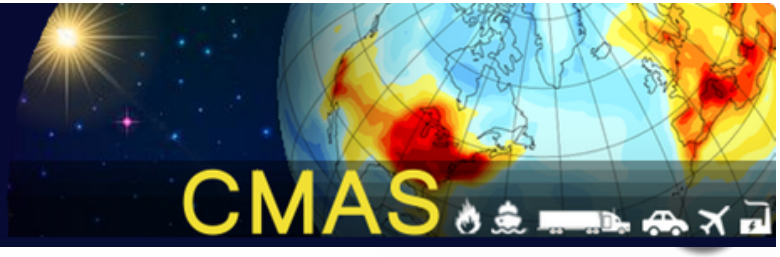
Upcoming SMOKE Updates

- US EPA's Link-Level Aircraft Emissions Processing:
  - Supports from OTAQ and OAQPS offices
  - New NEI platform sector for aircraft with a fully trajectory emissions
  - Based on the previous FAA's AEDTproc and EDMSinv tools
- New Spatial Allocator Based on PostgreSQL/PostGIS
  - Easier, Faster and Simpler
- The Integration of the SMOKE setup structures between NEI Modeling Platform and CMAS SMOKE release versions
  - Restructuring the current CMAS version of SMOKE system
  - NEI platform updates are needed.
- SMOKE version 4.?? Will be available in March 2017

Acknowledgement

- **U.S. EPA**
  - Office of Air Quality Planning and Standards (**OAQPS**)
  - Office of Transportation and Air Quality (**OTAQ**)
  - Office of Research and Development (**ORD**)
- **Korea National Institute of Environment and Research (NIER)**
- **Lake Michigan Air Director Consortium (LADCO)**
- **California Air Resource Board (CARB)**
- **M3users community**

Upcoming CMAS Events



- **Trainings**
  - April 17-19: Introduction to SMOKE (classroom)
  - April 20-21: Introduction to CMAQ (classroom)
  - June 19-23: Introduction to SMOKE (online)
- **Webinars**
  - March 30: Presenting the CMAQv5.2 beta Release
  - April 27: The Spatial Allocator 4.3
  - May 25: Presenting the C-TOOLS
- **Conference**
  - August 28-31: 3rd CMAS Conference South America (Vitória, Brazil)
  - October 23-25: 16th Annual CMAS Conference (Chapel Hill, NC)

For Additional Information
www.cmascenter.org
or email
cmas@unc.edu