For help accessing this document, email NEI_Help@epa.gov.

LADCO | LAKE MICHIGAN AIR DIRECTORS CONSORTIUM

Improving Onroad Freight Emissions Inventories With Satellite And Telemetry Data

Mark Janssen, LADCO Emissions Director

Tom Murtha, Chicago Metropolitan Agency for Planning – CMAP

Dan Goldberg, George Washington University

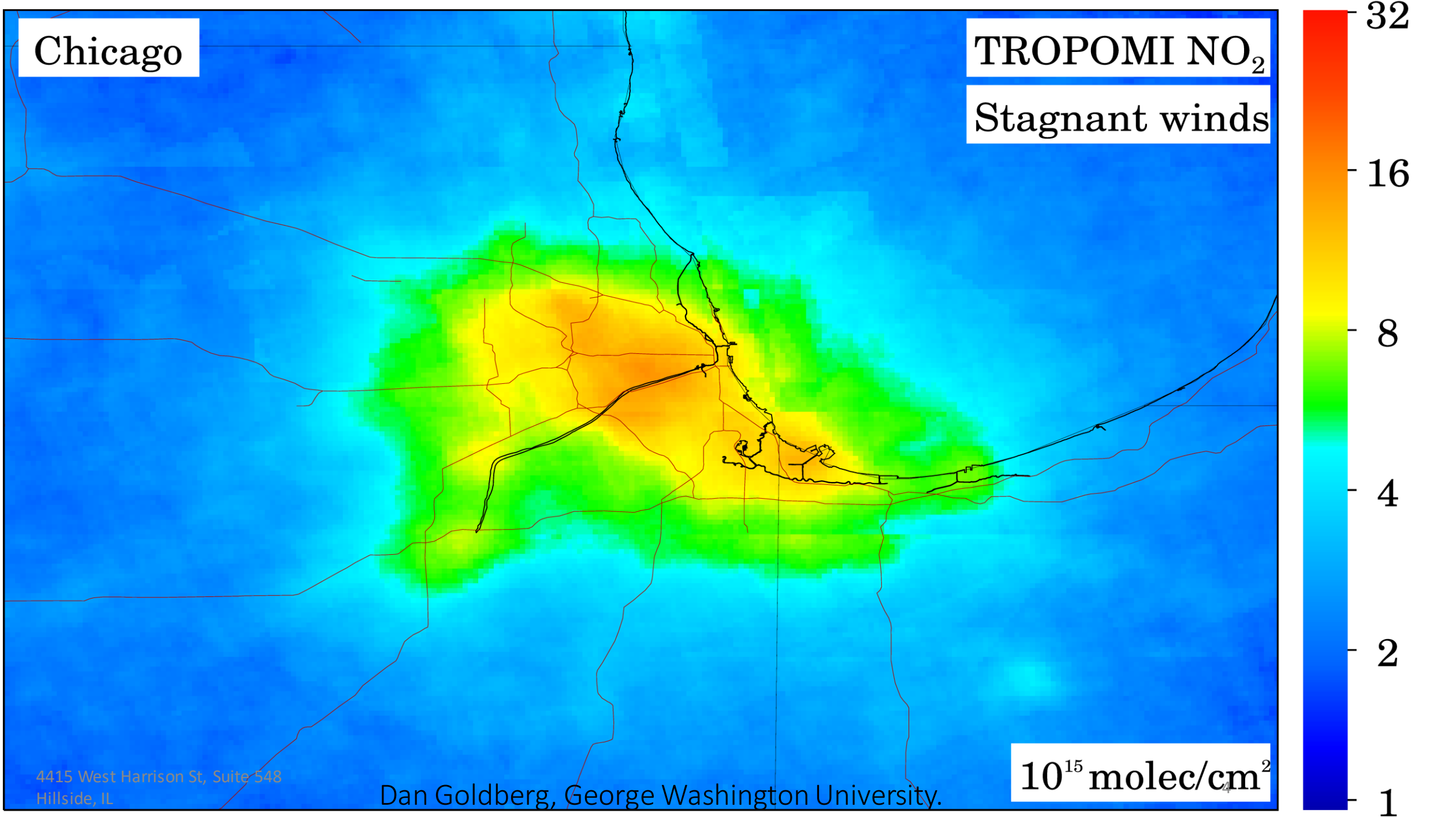
Wednesday, September 27, 2023

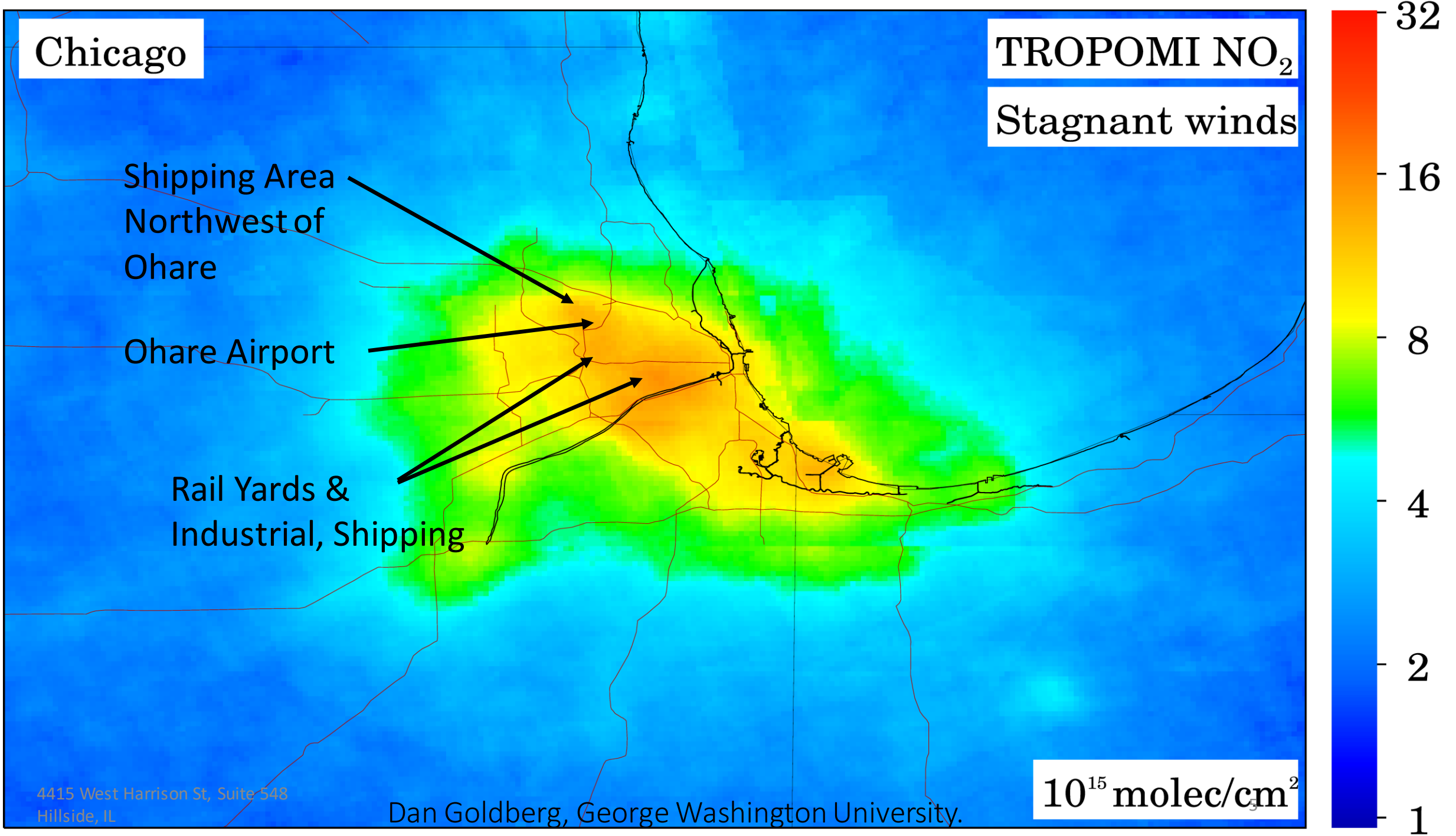
Presentation Content

- Describe emissions inventory improvement: LADCO is pursuing to improve upcoming inventories
- NASA data shows that the emissions inventories we build look different from what satellites see
- CMAP/ATRI truck telemetry data can be used to identify truck idling activity
- CMAP land-use data can be used to better allocate emissions from county to modeling cell

New 2022 Emissions Modeling Platform(EMP)

- LADCO's role is to support the EPA R5 states' State Implementation Plan(SIP) development. Inventory will be delivered in summer of 2024.
- Past work shows there are problems with the freight inventory including defeat devices and long duration idling.
- This is an exploratory project. Conformity and other concerns will impact the eventual incorporation of updated methods.
- Satellite data shows that emissions in Chicago are not concentrated where people live but where warehousing/freight dominate. The southwest side of Chicago is the dominant area for NOX emissions in Chicago.


Chicago
TROPOMI NO_2
Stagnant winds
32
16
8
4
2
1
10^{15} molec/cm^2
4415 West Harrison St, Suite 548
Hillside, IL
Dan Goldberg, George Washington University.



4415 West Harrison St, Suite 548
Hillside, IL

Dan Goldberg, George Washington University.

Problems with Current Idle Inventories

- Idle activity based on registered vehicles which undercounts activity at transportation hubs.
- MOVES has low idle hours(~450 Hrs/Year) while DOT data shows that number is probably closer to 2000 Hrs/Year.
- EPA categorizes activities as off-network idling (ONI) and hoteling.
  - If a vehicle is waiting 8 hours for a load at an intermodal facility is that ONI or Hoteling in MOVES?

Worked with CMAP to use their telemetry database of truck idle durations.

- Data from ATRI is summarized by traffic analysis zone (TAZ), roughly 800m cells.
- Data is in roughly 30 min blocks.
  - They do not count the first 10 minutes because the measurement is from the time the vehicle enters the cell.
  - First 30 minutes are “hot idle”. The engine is warm and the pollution control equipment is operating correctly. This is ONI in MOVES3.
  - All time after 30 minutes is considered cold idle. Pollution control systems are cold/cooling so emissions rates go up. This is hoteling in MOVES3.
  - Example 1-30 min, avg 15 minutes, 10 min thrown out, 5 minutes of hot idle
  - Example 30-60 min, avg 45 minutes, 10 min thrown out, 30 min hot idle, 5 min cold idle/Hoteling.

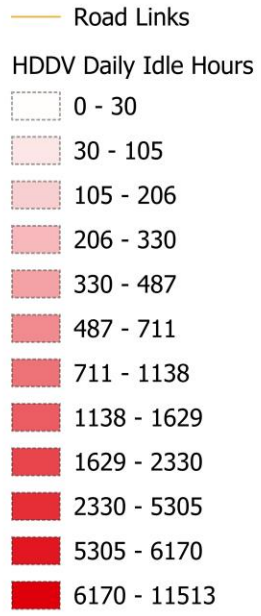
EPA Idling vs LADCO's Updates

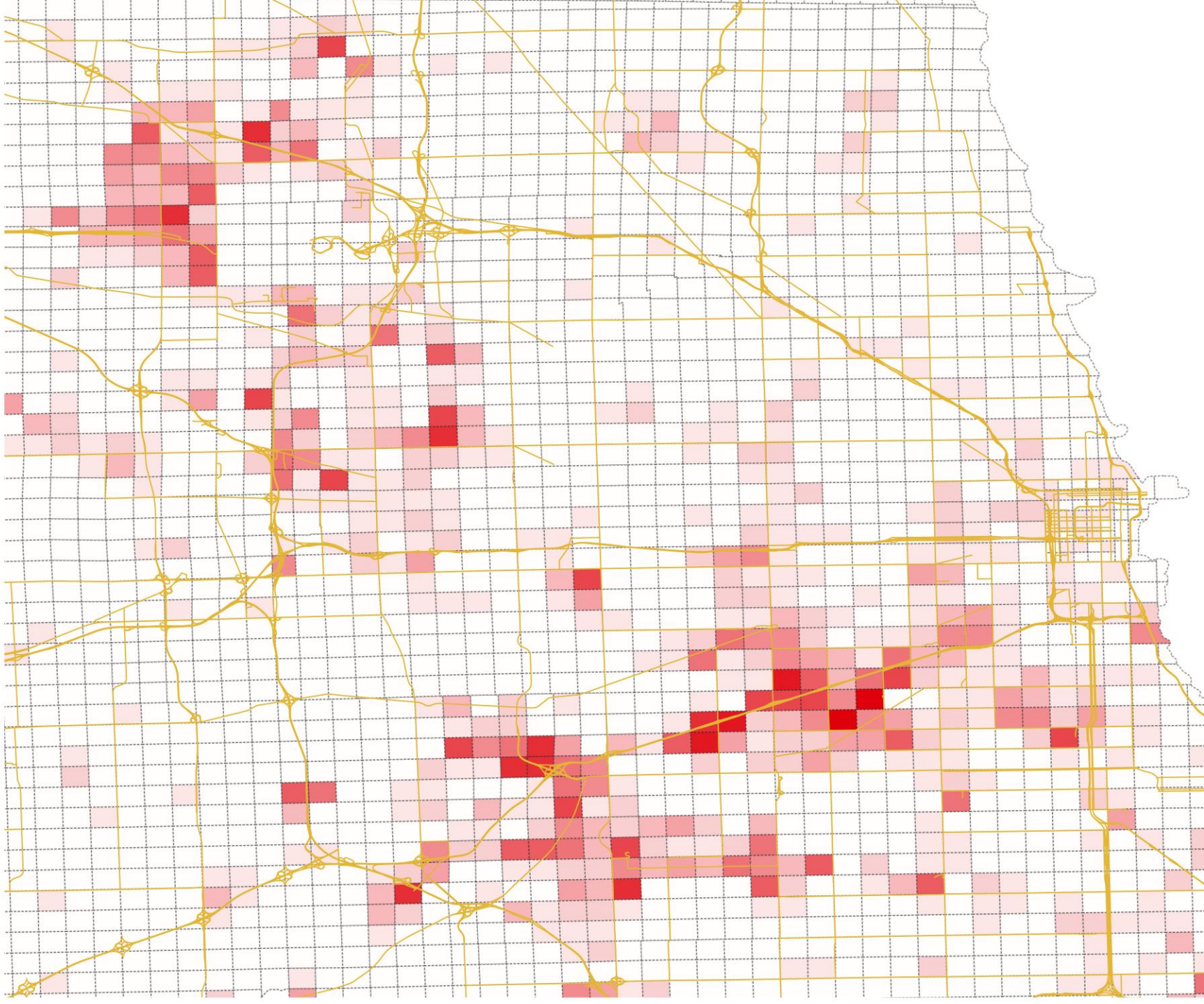
CYNAME	MOVES 2014 ONI Hours	MOVES 2014 Hoteling Hours	CMAP Annual Hot Idle Hours	CMAP Annual Cold Idle Hours	CMAP/MOVES Idling
COOK	2,392,689	3,689,352	18,308,292	108,662,753	20.9
DUPAGE	648,002	1,701,059	3,206,734	19,280,180	9.6
KANE	504,878	1,074,326	1,790,633	11,009,631	8.1
KENDALL	209,134	99,937	431,638	3,017,742	11.2
LAKE	664,396	1,776,422	1,650,640	10,307,700	4.9
MCHENRY	254,070	99,937	465,254	2,351,011	8.0
WILL	1,426,435	3,334,697	6,225,926	45,201,332	10.8
Total	6,099,607	11,775,733	32,079,115	199,830,349	13.0

Comparing HDDV Idle Hours

Country	FIPS	MOVES HDDV POP	CYNAME	CMAP Telemetry Annual Cold Hrs	CMAP Telemetry Annual Hot Hrs	Idle Hours if each vehicle had 2000 Hrs idle	Hot Ratio	Cold Ratio
US	17031	15989	COOK	108,662,753	18,308,292	31,978,231	57%	340%
US	17043	4330	DUPAGE	19,280,180	3,206,734	8,660,533	37%	223%
US	17089	3308	KANE	11,009,631	1,790,633	6,617,941	27%	166%
US	17093	1360	KENDALL	3,017,742	431,638	2,720,607	16%	111%
US	17097	4439	LAKE	10,307,700	1,650,640	8,879,644	19%	116%
US	17111	1697	MCHENRY	2,351,011	465,254	3,395,651	14%	69%
US	17197	9532	WILL	45,201,332	6,225,926	19,064,277	33%	237%
		40658		199,830,349	32,079,115	81,316,884	39%	246%

CMAP Daily Idle Hours





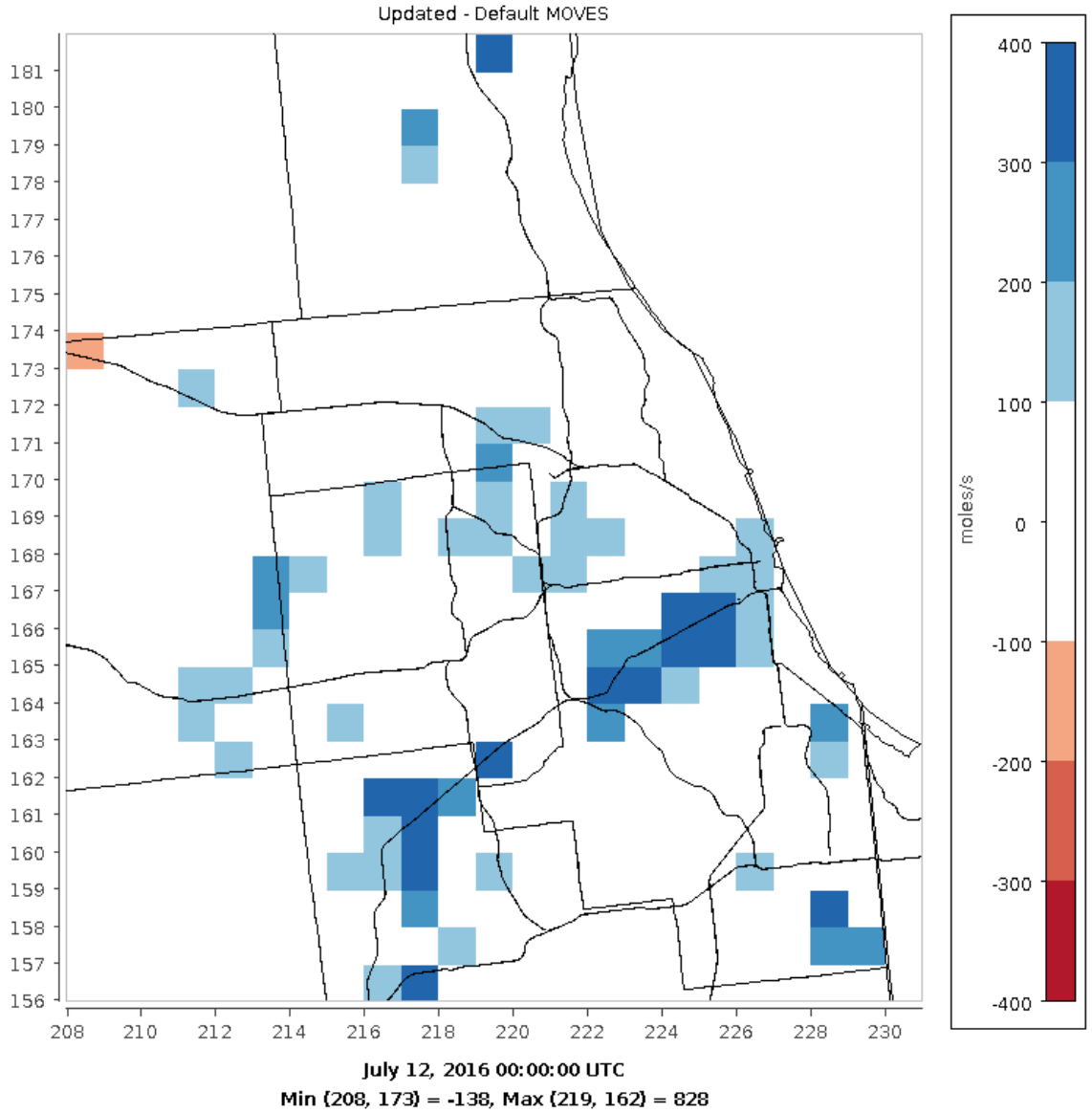
4415 West Harrison St, Suite 548
Hillside, IL

4415 West Harrison St, Suite 548
Hillside, IL

Emissions Modeling

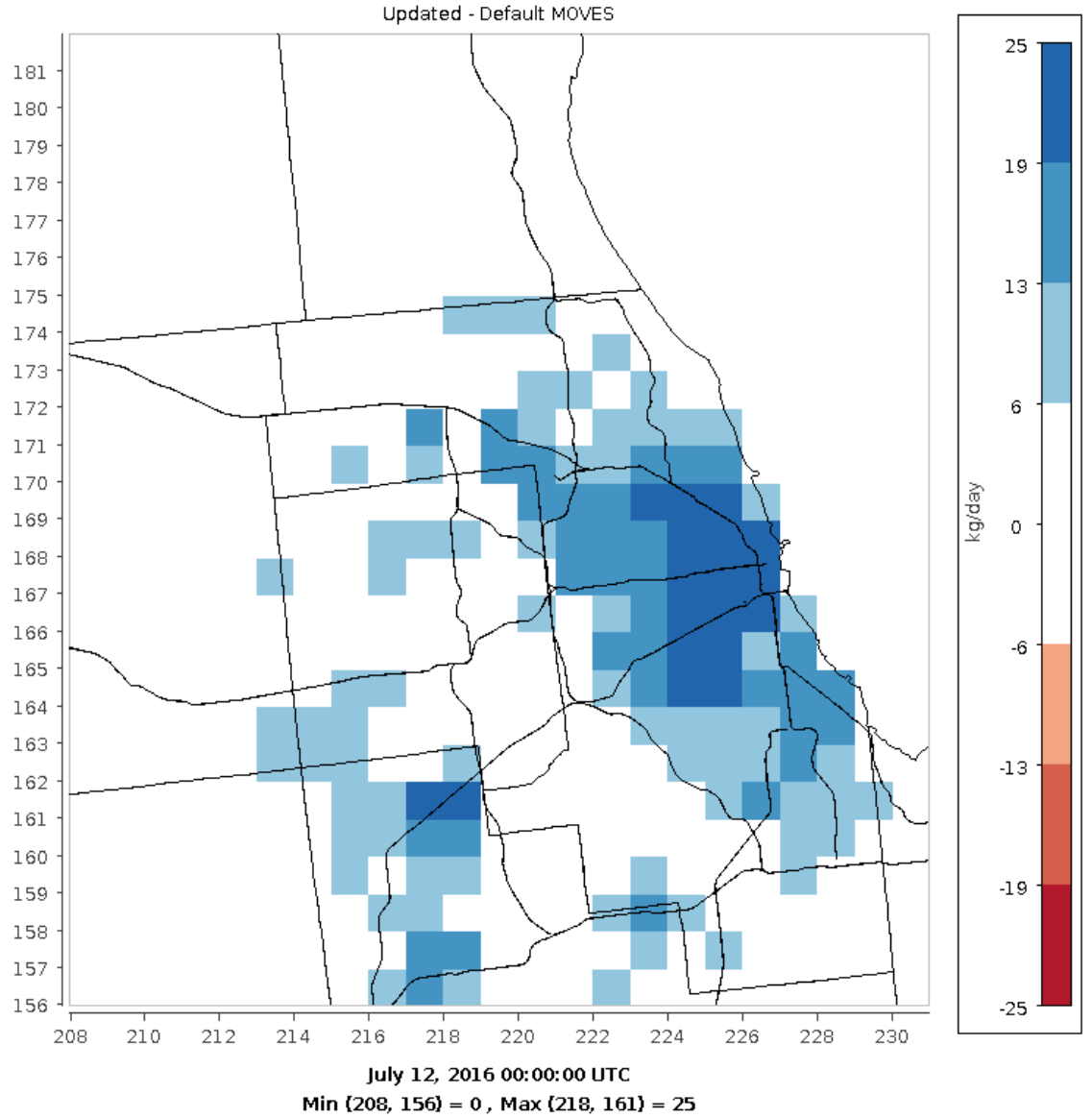
- SMOKE model uses emissions factors from MOVES with gridded activity and day specific meteorology to calculate hour specific, grid cell specific emissions
- LADCO used CMAP TAZ hot/cold activity gridded to LADCO's 4x4 km modeling grid. Created spatial surrogate for both kinds of idle.
- Updated EPA's activity input files and ran MOVES2014.
- Resulted in a 24 Tons/Day NOx increase in emissions in Cook county. Daily NOx from all onroad sources is ~70 Tons/Day. This is a major impact since all anthropogenic sources in Cook county is 190 Tons/Day

Hoteling Difference Daily NOx kg



July 12, 2016 00:00:00 UTC
Min (208, 173) = -138, Max (219, 162) = 828

ONI(Idling) Difference Plot Daily NOx kg



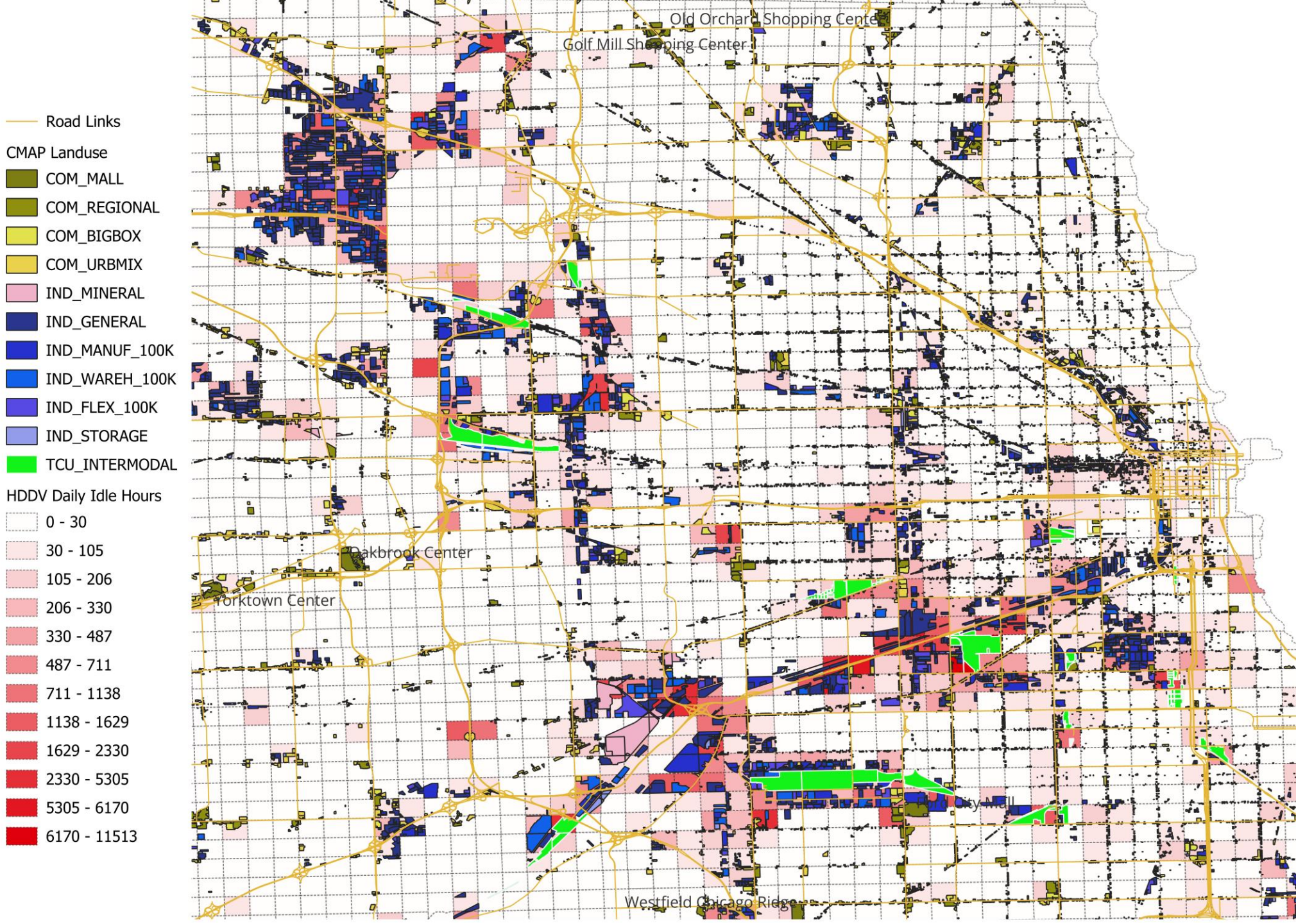
July 12, 2016 00:00:00 UTC
Min (208, 156) = 0 , Max (218, 161) = 25

Updated Spatial Surrogates

- Spatial surrogates are used by emissions models to take countywide emissions and spread them out to the modeling cells.
- Modelers often use “land cover” data, which grouped as high, medium, and low density urban land.
- We worked with CMAP “**land use”** data to understand why specific cells may have large Idling activity. The data showed that the concentrated industrial and commercial activities look different from the “land-cover” data.
- The land-cover data is parcel level activity identified as industrial, commercial, or residential.

CMAP land-use data improved Chicago surrogates.

-- Emissions are concentrated on the southwest
-- Along freight corridors
-- New area Northwest of O'Hare Airport.



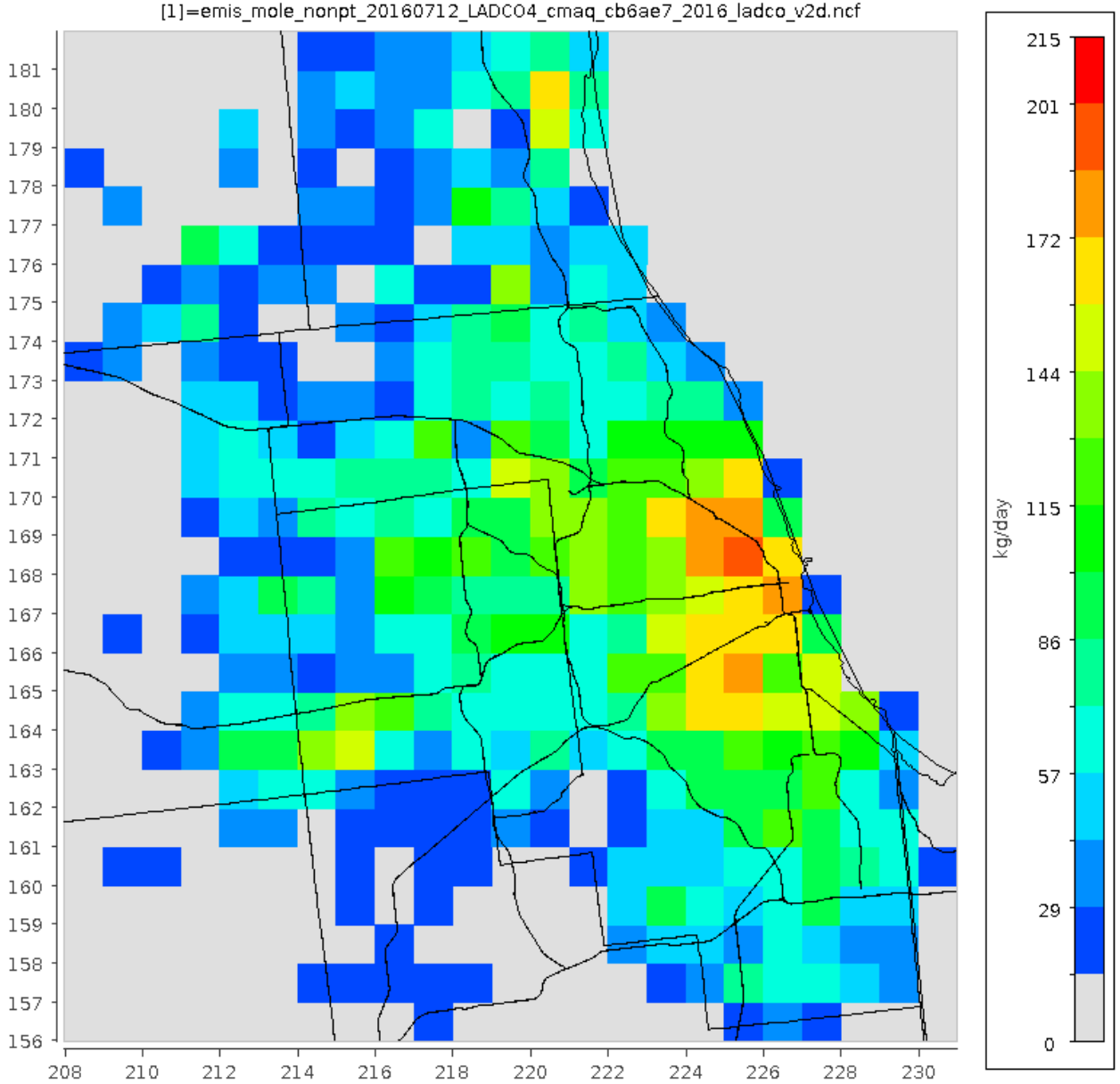
4415 West Harrison St, Suite 548
Hillside, IL

Result of Updated Surrogates in Cook County

- Created 6 new surrogates for Non-Point and Nonroad sectors
  - 1103;CMAP Commercial Industrial
  - 1104;CMAP Commercial Institutional
  - 1105;CMAP Commercial Institutional Industrial
  - 1106;CMAP Industrial
  - 1107;CMAP Residential
  - 1108;CMAP Residential Commercial Institutional
  - 1101;CMAP HOT Idle
  - 1102;CMAP COLD Idle
- 41% of the 34 Tons/Day of nonpoint NOx has new surrogates
- 95% of the 27 Tons/Day of nonroad NOx has new surrogates
- About 36% of the Cook County anthropogenic NOx has new surrogates

NONPOINT Default Surrogates(Daily NOX KG)

[1]=emis_mole_nonpt_20160712_LADCO4_cmaq_cb6ae7_2016_ladco_v2d.ncf

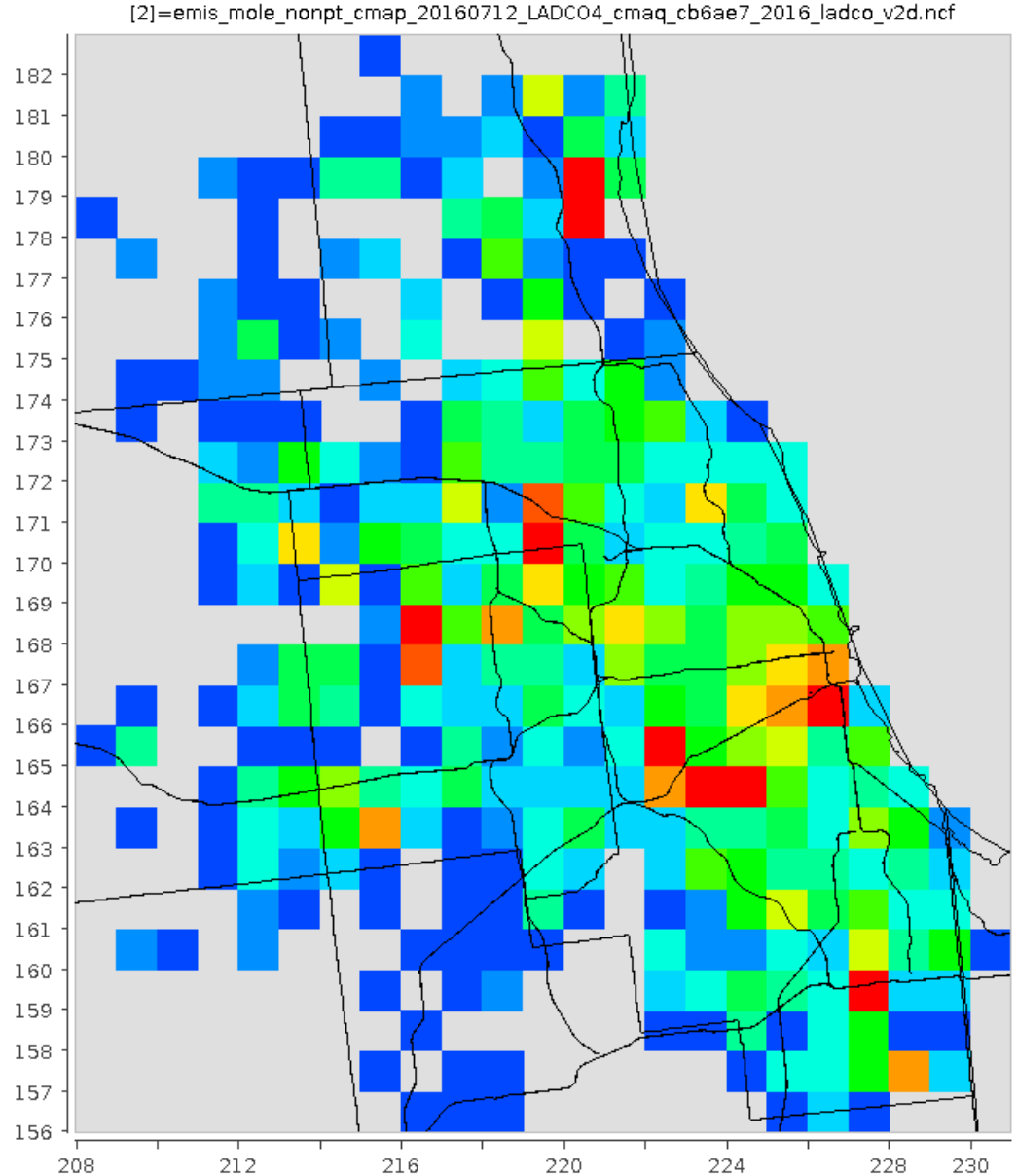


July 12, 2016 00:00:00 UTC

Min (230, 163) = 0 , Max (225, 168) = 188

NONPOINT Updated Surrogates(Daily NOX KG)

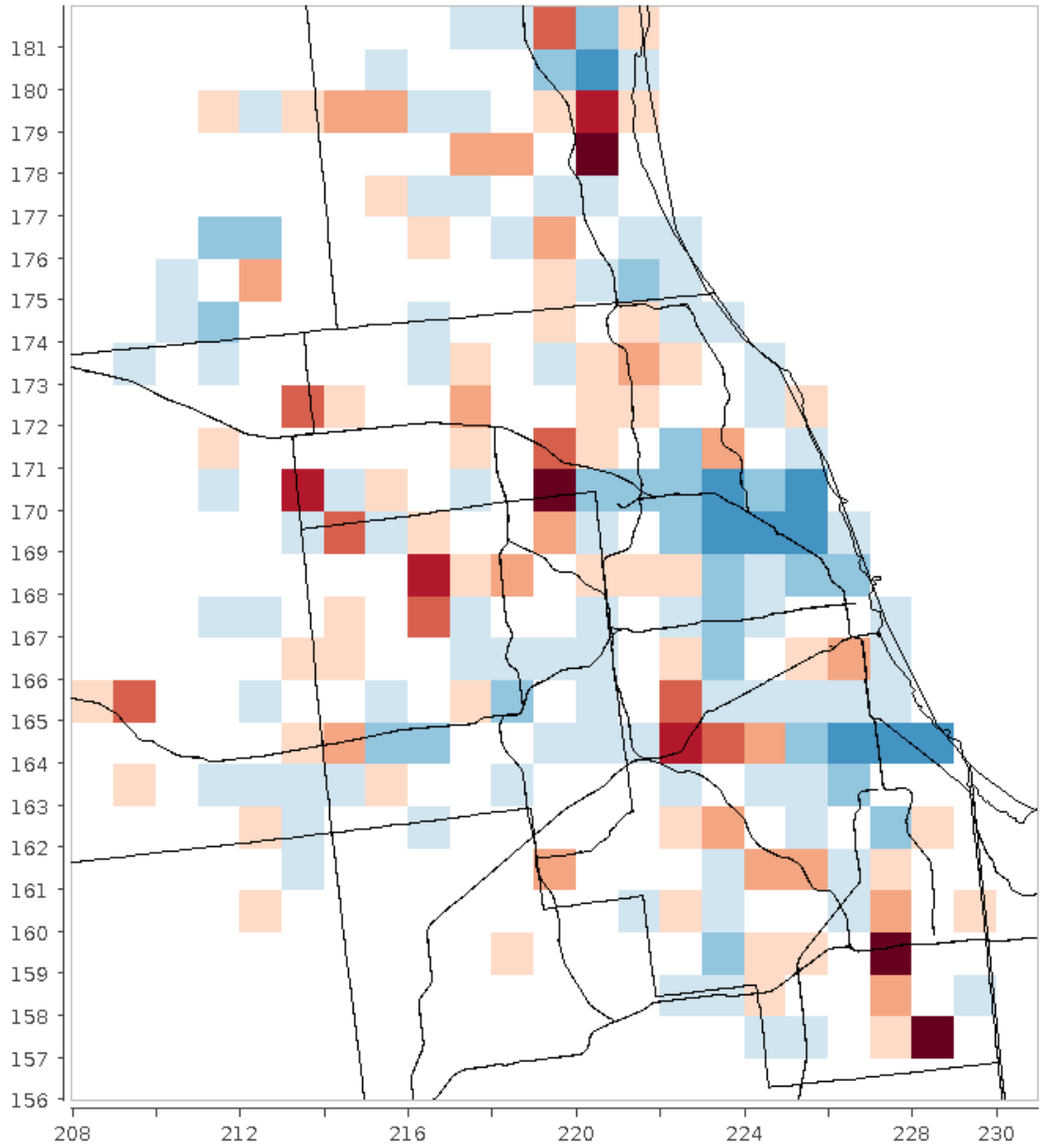
[2]=emis_mole_nonpt_cmap_20160712_LADCO4_cmaq_cb6ae7_2016_ladco_v2d.ncf



July 12, 2016 00:00:00 UTC

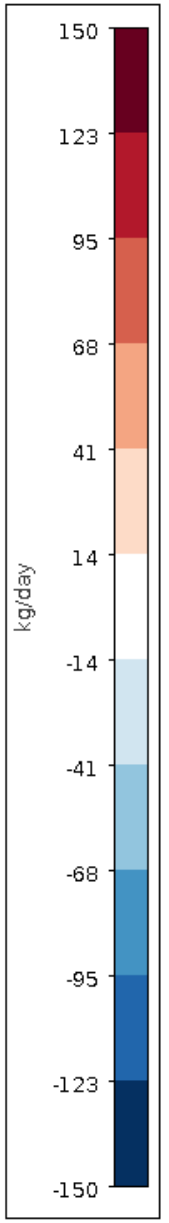
Min (230, 163) = 0 , Max (219, 170) = 387

Difference: Updated Minus Default Nonpoint NOX KG/Day



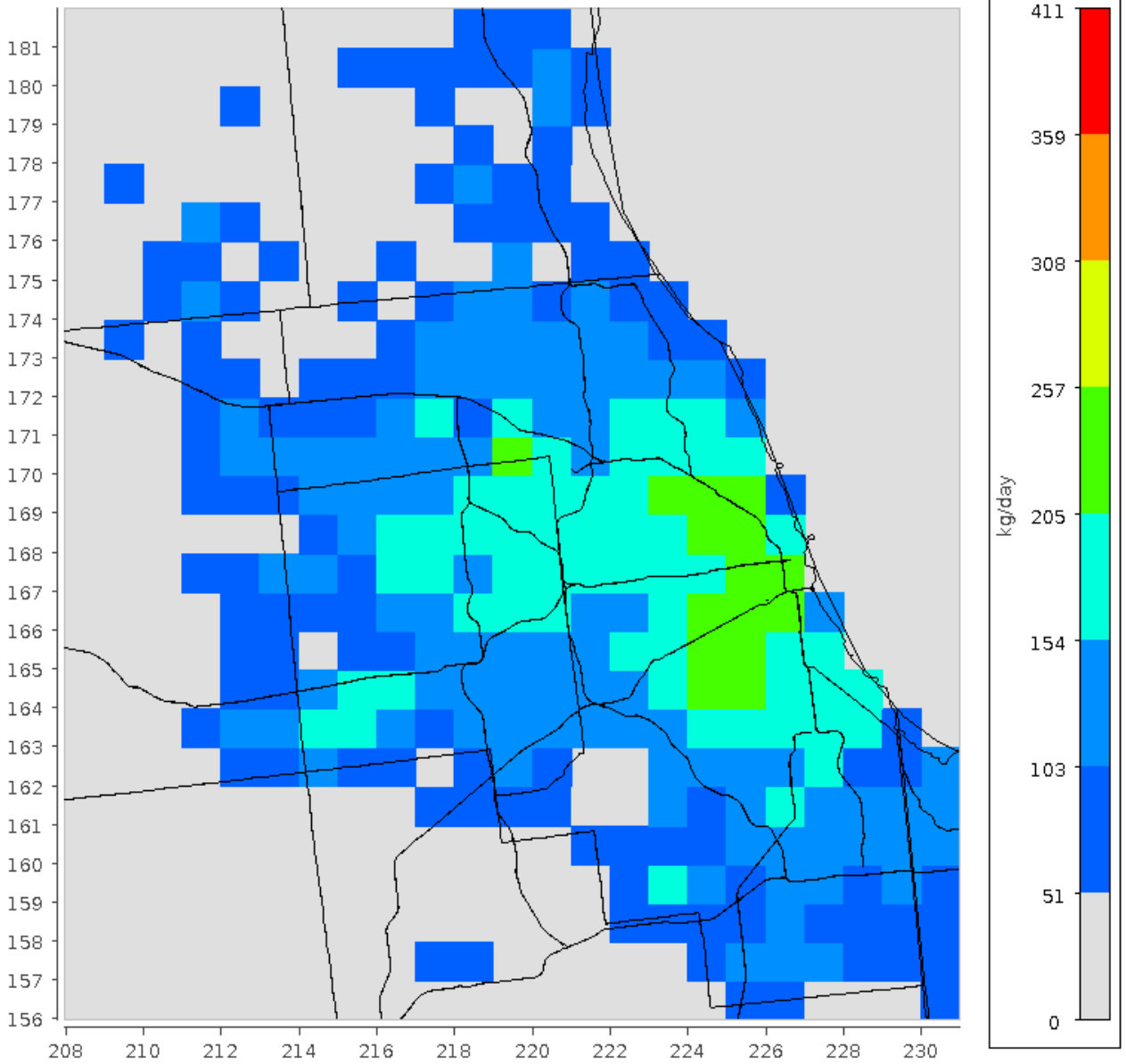
July 12, 2016 00:00:00 UTC

Min (223, 169) = -88, Max (219, 170) = 234



Nonroad Default Surrogates(Daily NOx kg)

[3]=emis_mole_nonroad_20160712_LADCO4_cmaq_cb6ae7_2016_ladco_v2d.ncf

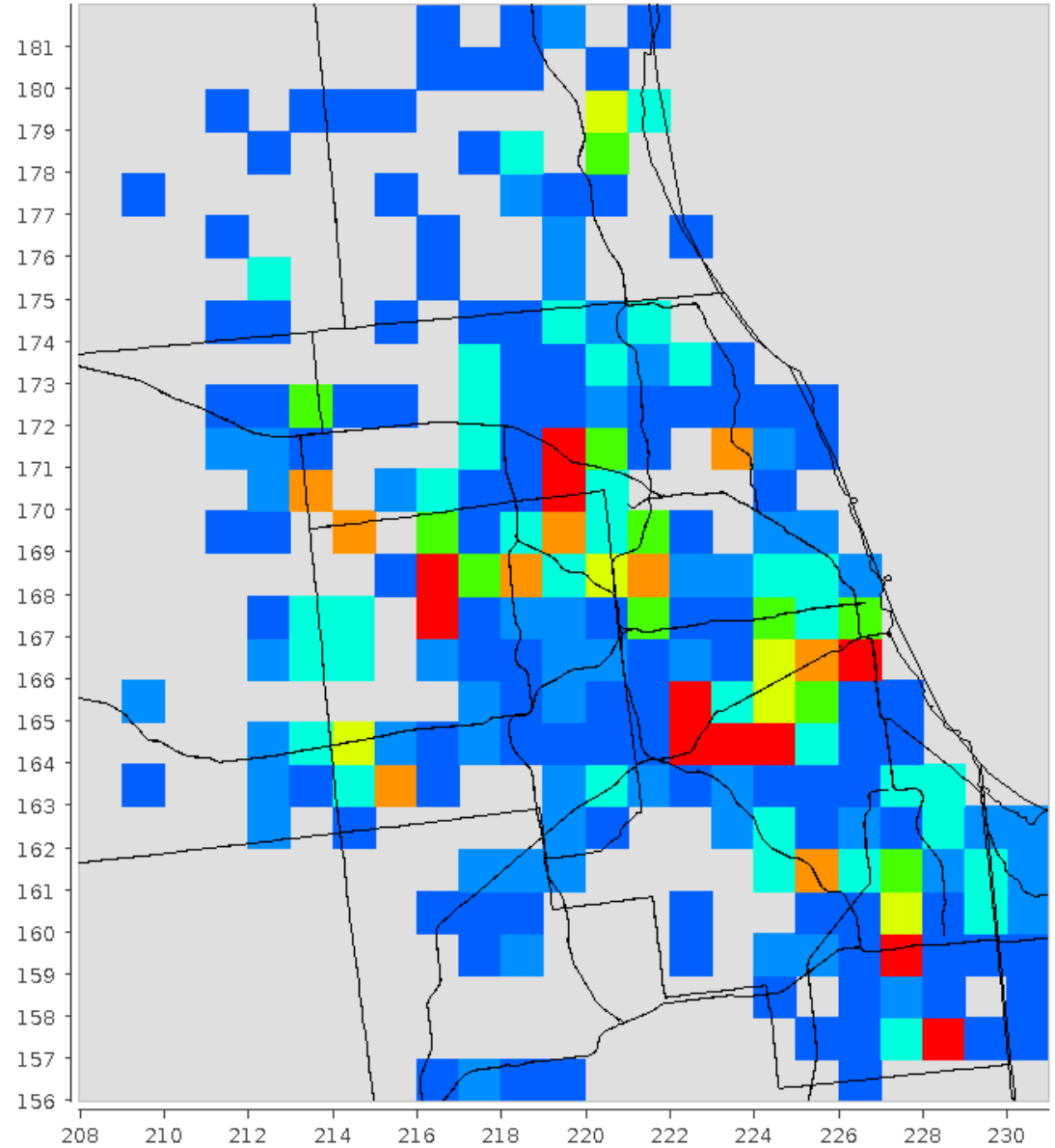


July 12, 2016 00:00:00 UTC

Min (223, 176) = 2 , Max (225, 165) = 226

NONROAD Updated Surrogates(Daily NOx KG)

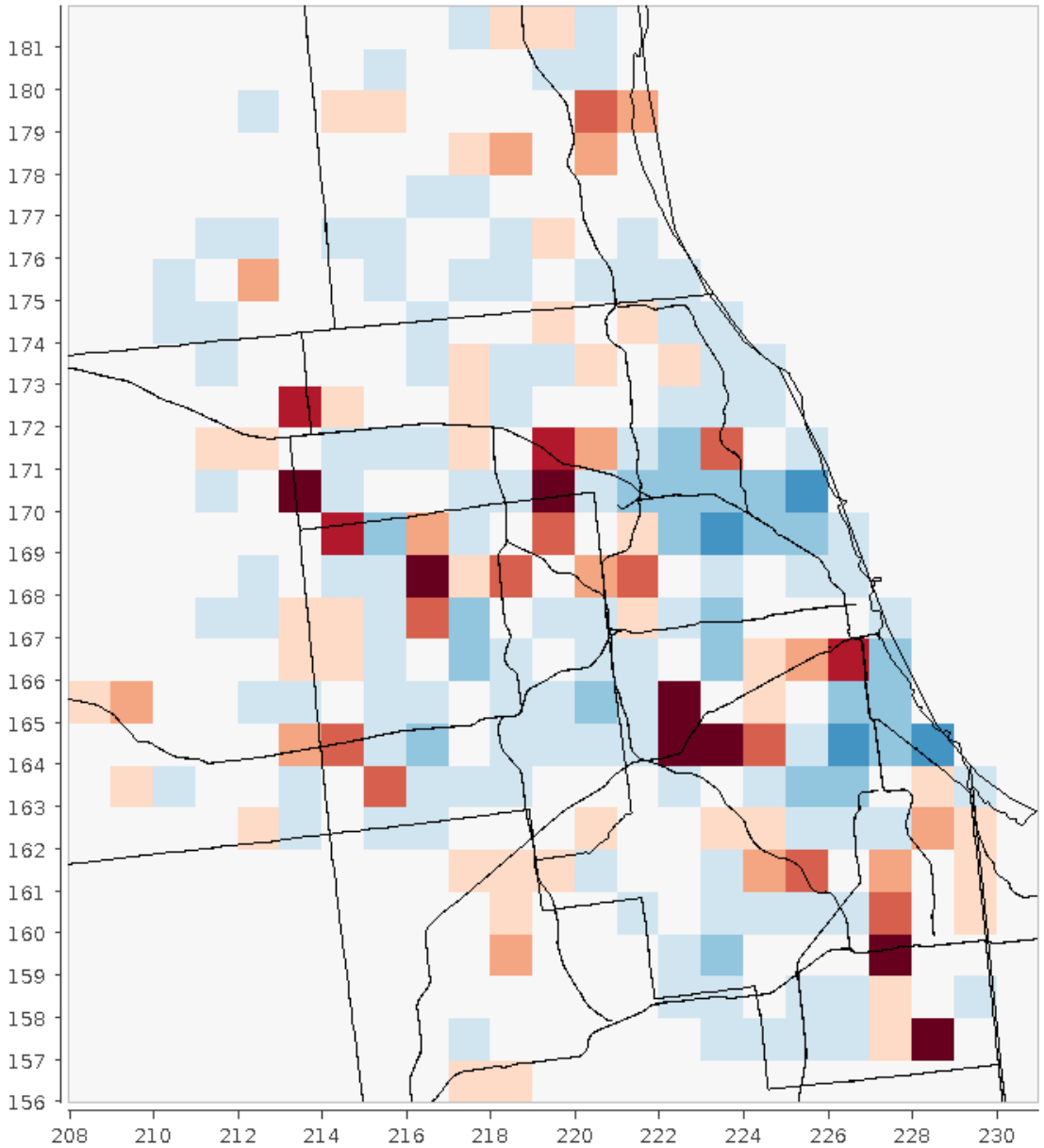
[4]=emis_mole_nonroad_cmap_20160712_LADCO4_cmaq_cb6ae7_2016_ladco_v2d.ncf

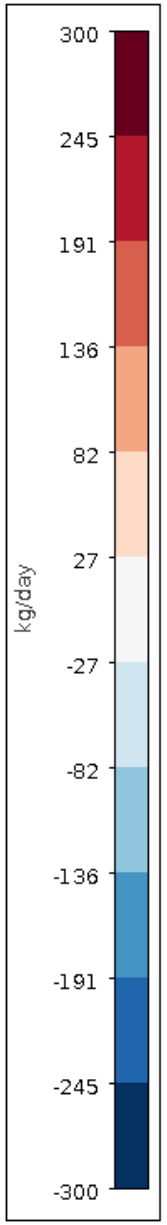


July 12, 2016 00:00:00 UTC

Min (222, 177) = 2 , Max (219, 170) = 883

Difference:Default Minus Updated Nonroad kg/day





July 12, 2016 00:00:00 UTC

Min (223, 169) = -164, Max (219, 170) = 674

ADCO

What's Next if Modeling Shows Impact…

- Run the updated emissions through photochemical model to see the air quality impact.
- We move to 2022 base year run with MOVES4.
- Expand the method to the Midwest beyond Chicago.
  - Create statistical model based on other types of activity. Extrapolate activity on location of freight facilities, industrial sites, intermodal yards, and truck stops.
- Work with States/MPOs to find other sources of idling data/telemetry data.
- Acquire land use data to replace land cover data in as many Midwest cities as possible.