Link-based vs NEI On-road Emissions Impact On Air Quality Model Predictions

Madeleine Strum, Karen Wesson, Sharon Phillips – EPA OAQPS
David Brzezinski, Harvey Michaels, Rich Cook – EPA OTAQ
Alison Pollack, Michele Jimenez, Stella Shepard - ENVIRON
Allan Beidler, Melanie Wilson, Computer Sciences Corporation

2008 Emission Inventory Conference
Session 11- Mobile Sources
Portland, Oregon
June 5, 2008

Purpose

- Compare AQ Model-ready link-based on-road emissions from CONCEPT MV with NEI
  - NEI is county-level, used less accurate data
  - CONCEPT MV is link-based, hourly, gridded
- Quantify/understand differences in VMT, emissions, spatially and temporally using Detroit data
- Determine differences in modeled concentrations and impact of data inputs versus method

Comparison of Emission Estimation Approaches

	NEI	CONCEPT MV	NMIM w/ CONCEPT Inputs
VMT	County-level, monthly, by road type; either provided by State or allocated to county from MSA-level VMT using population	Link-level, hour-specific, from Transportation Demand Model, adjusted using hour/day/month temporal profiles from traffic counter data	Uses CONCEPT daily totals
VMT mix	Uniform across all hours, days. County database: uses national defaults where data not submitted by State.	Detailed temporal profiles by hour/day/month from traffic classification monitoring data	Same as NEI
Temperature	Monthly average 24-hr temperature by county from NWS data	Hour and grid-specific temperatures from 12km met data used for AQ modeling	VMT-weighted by county (across gridded met data within each county)
Speed	County database: uses national defaults where data not submitted by State	Link-specific speeds, by hour	CONCEPT speed bin distribution, VMT weighted by roadway type and hour
Other M6 inputs	County database: uses national defaults where data not submitted by State	Local data from MPO	Local data from MPO as in CONCEPT MV

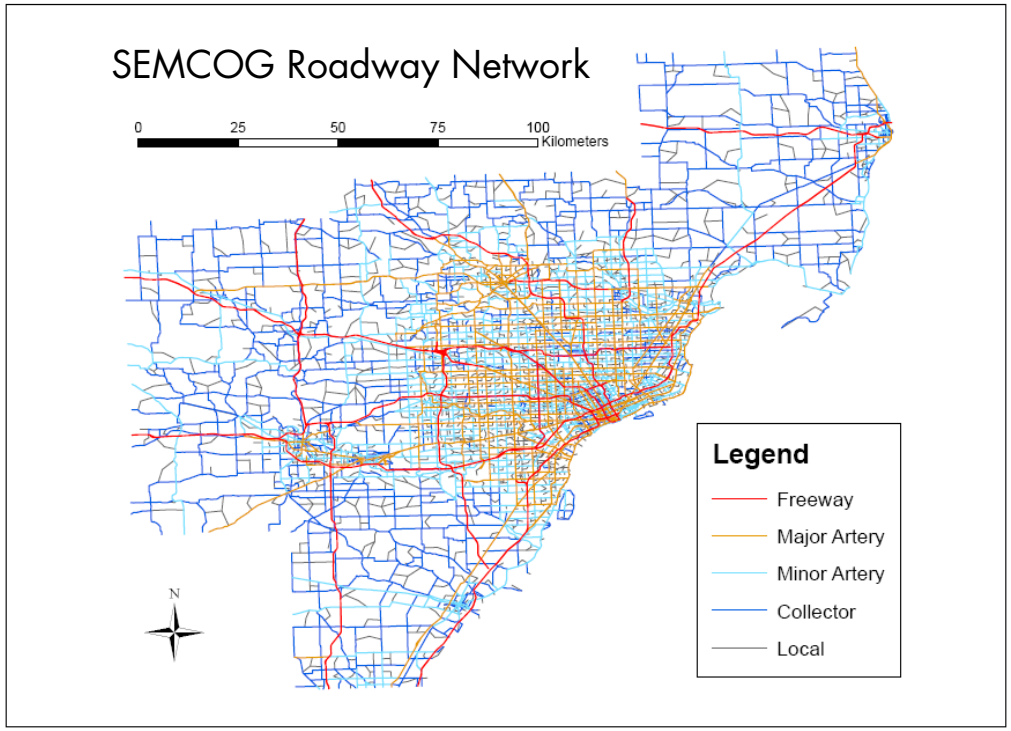
NEI Processing for AQ Modeling

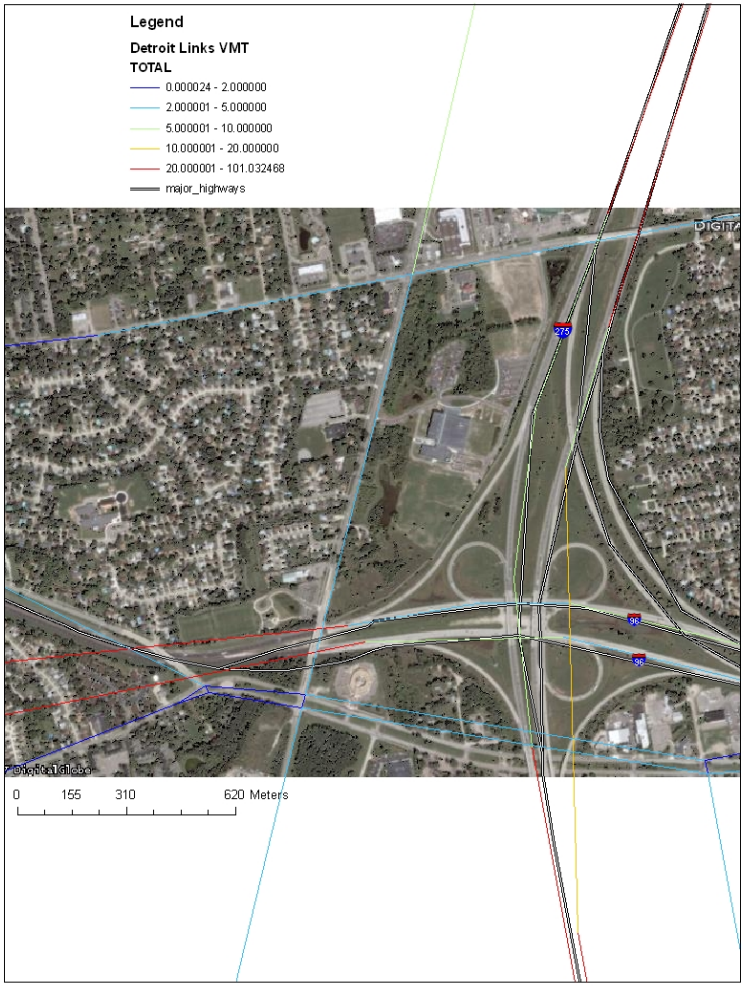
- Processed county-level monthly emissions for AQ modeling using SMOKE:
  - Spatially allocated using miles of roadway (or population for local roads)
    - 12 km grid cells for CMAQ
    - 1 km grid cells for AERMOD
  - Temporally allocated from monthly to day-of-week and hour of day using temporal profiles
  - Speciated emissions for use in photochemical model

CONCEPT MV
Link-Based Method

Link-level VMT and speeds from SEMCOG transportation demand model (TDM)

- VMT and speed on ~15,000 links, by period of day

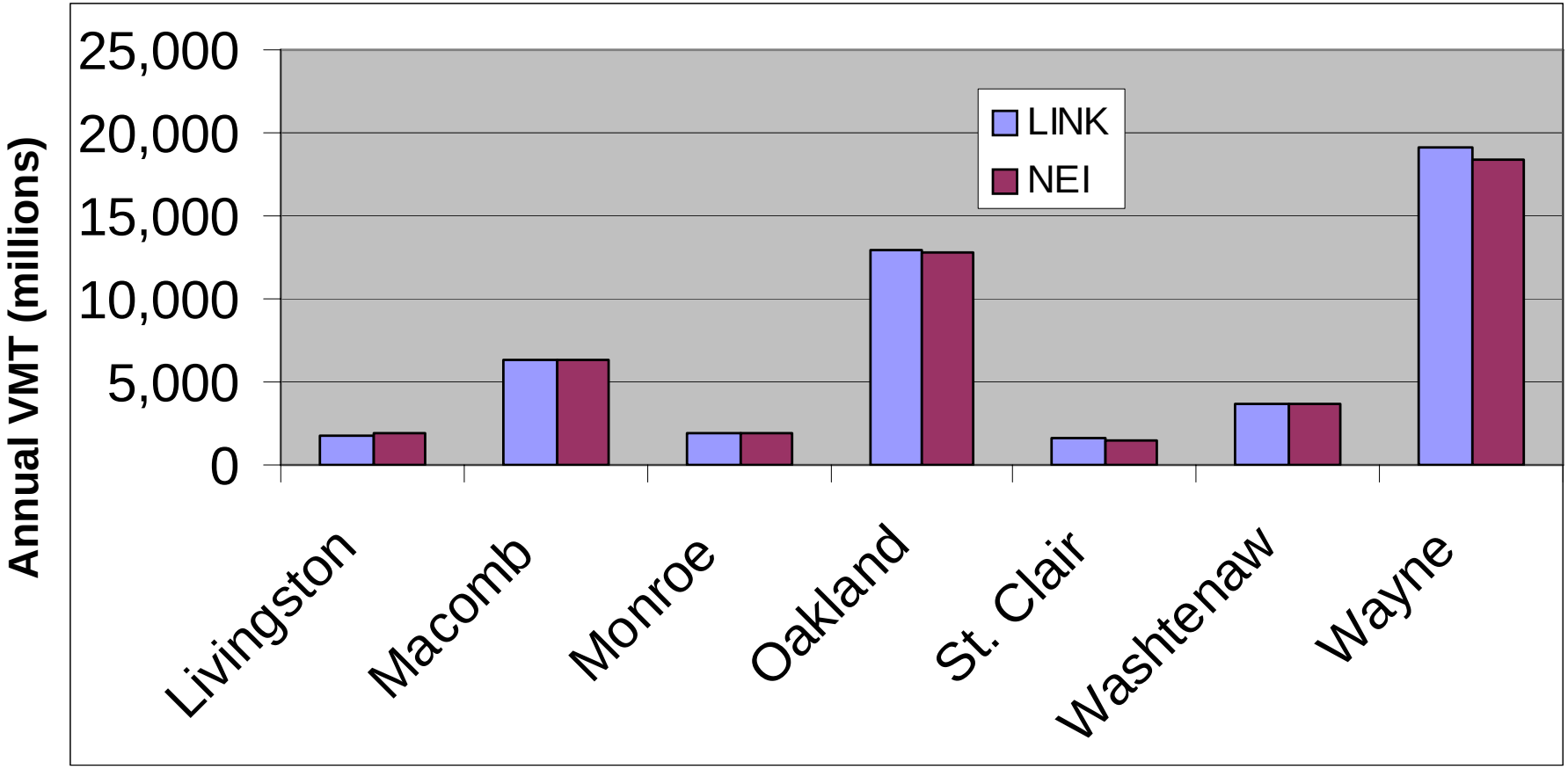




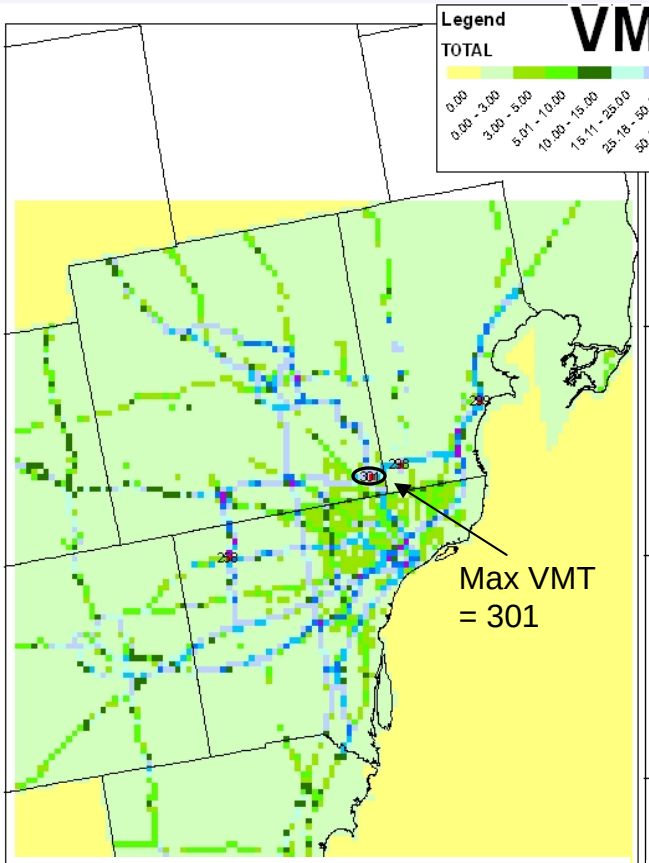
Link vs NEI Comparisons: Detroit

- Link emissions based on CONCEPT MV for comparison to NEI:
  - Estimated for seven-county SEMCOG transportation network
  - One representative week for each of four seasons
    - January, April, July, October 2002
  - Emissions estimated for 8 MOBILE5 vehicle classes
  - Results were used to estimate monthly and annualized emissions

County-level VMT Similar – Michigan Provided VMT Inputs to NEI

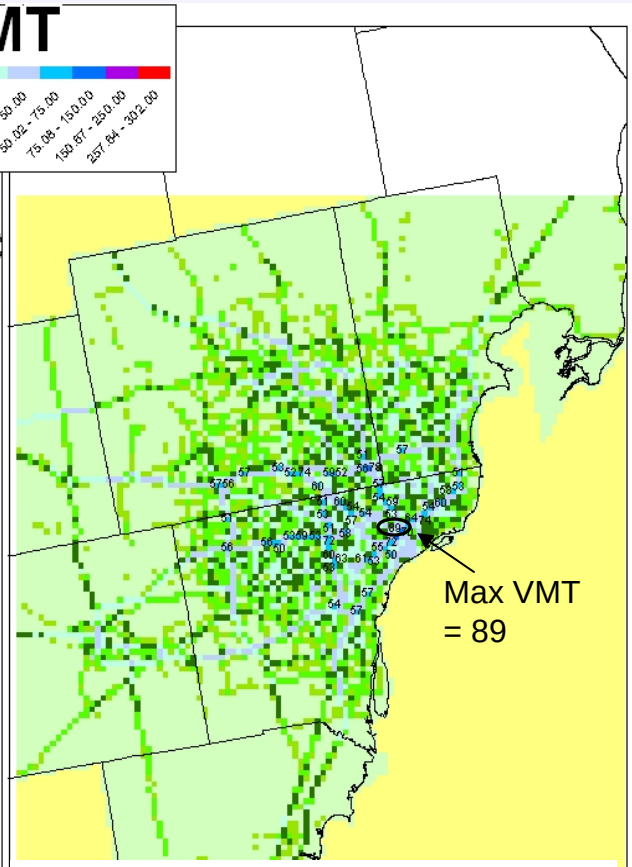


Spatial Distribution of VMT for Grid Modeling is Very Different When Link VMT is Used



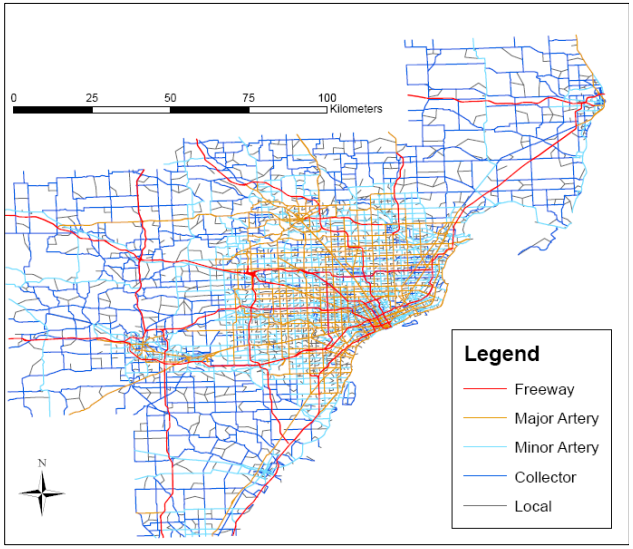
NEI County VMT gridded to 1km

Allocation based on Census TIGER roadway surrogates; creates VMT "hot spots"



Link VMT gridded to 1km

VMT distributed across more roads – more detailed spatial coverage

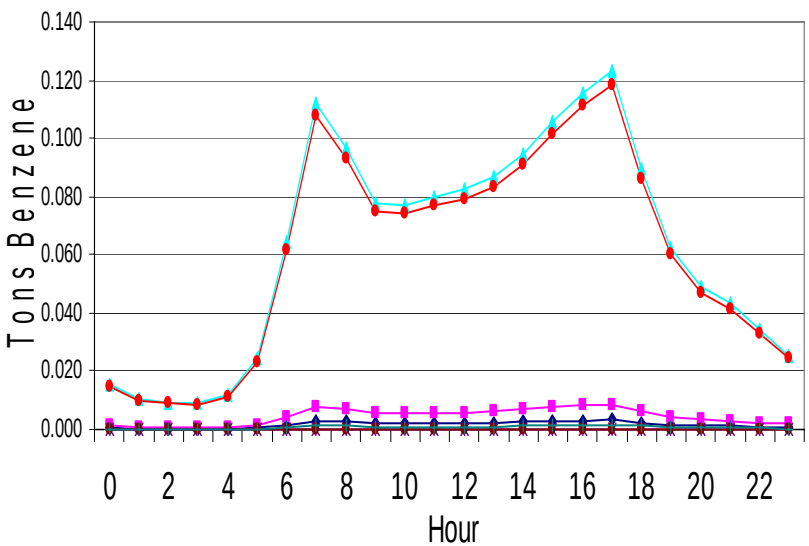


Hourly Temporal Allocation for AQ Modeling is Different

When using the NEI, SMOKE temporally allocates monthly emissions to day-of-week and hour-of-day.

Example:

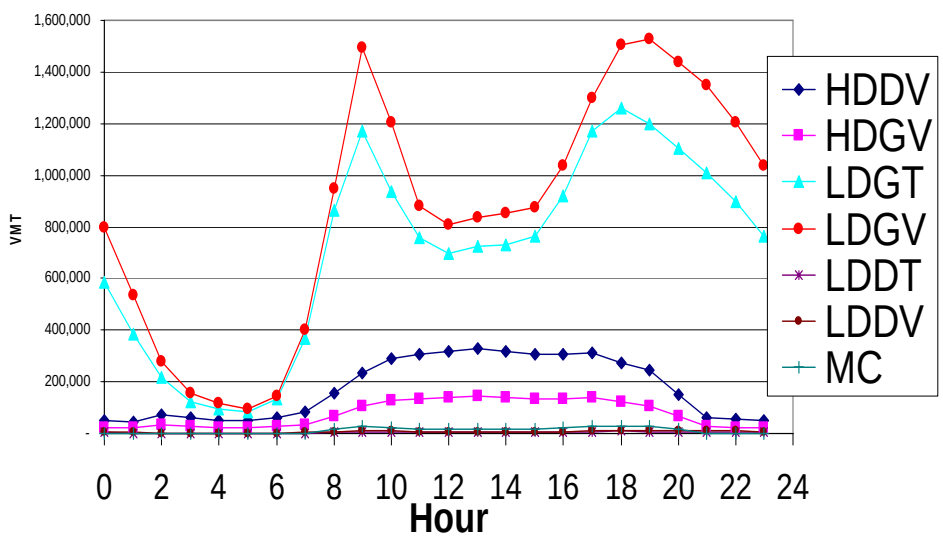
Monday Benzene for Urban Interstates, April



CONCEPT temporally allocates VMT for different time blocks of the day to hourly based on analysis of traffic counter data

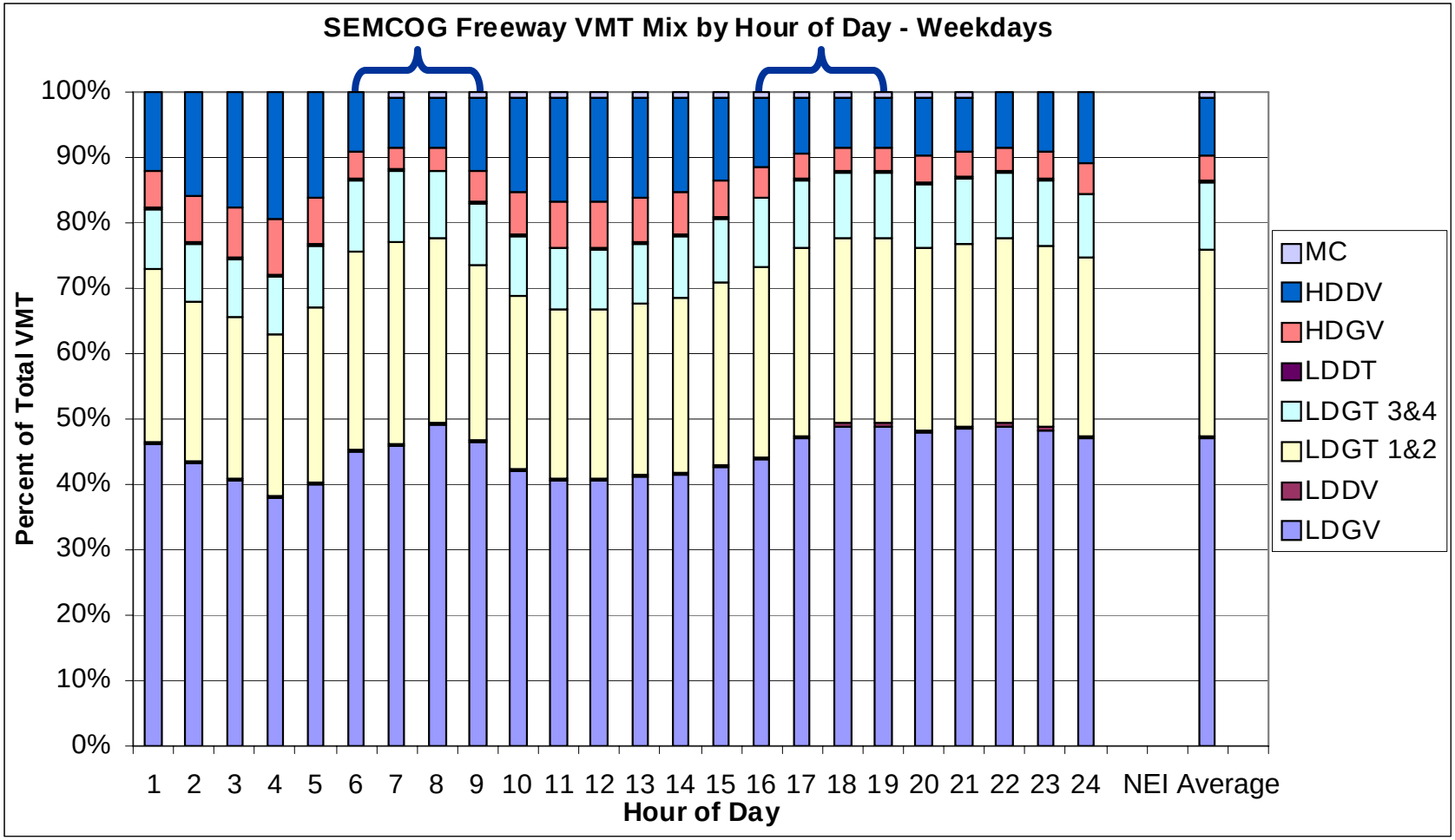
Example:

Monday VMT for Urban Interstates, April

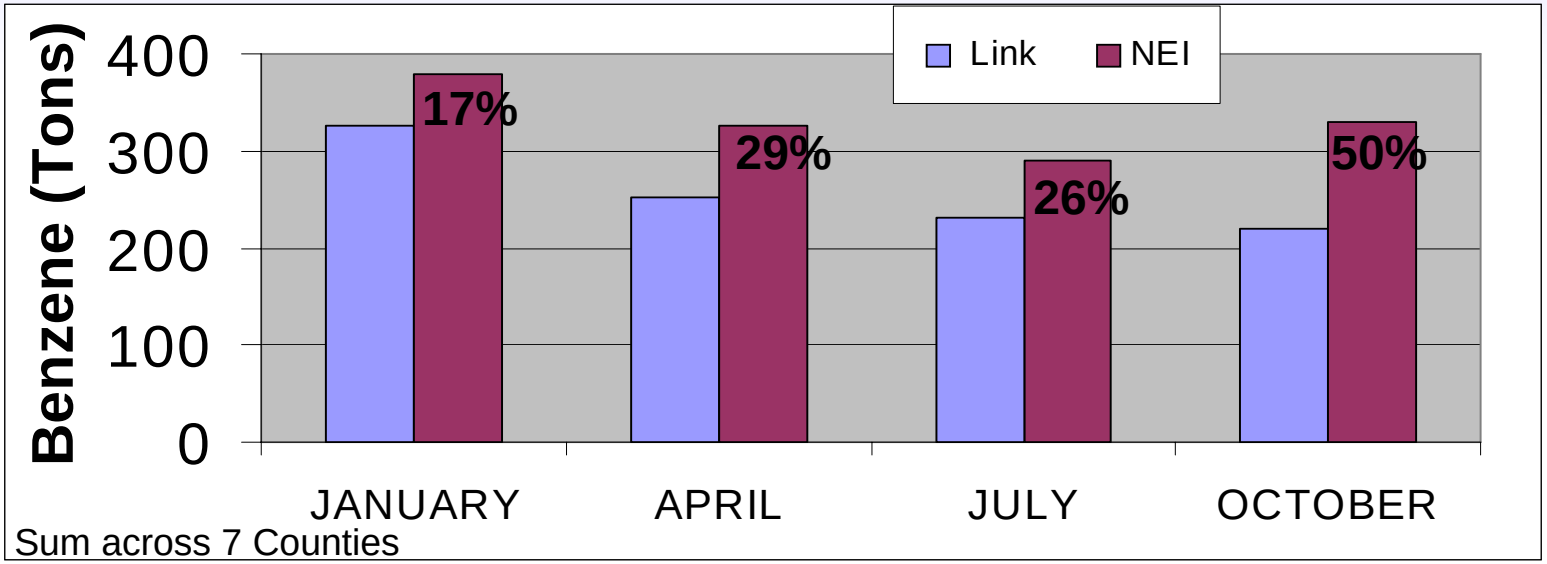


In CONCEPT VMT Mix Varies by Hour

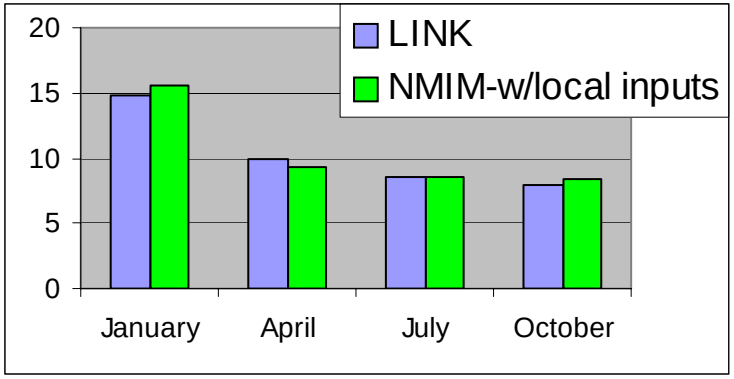
HDDV VMT fraction is lower during am and pm peak traffic hours



NEI Benzene Emissions Higher Than Link



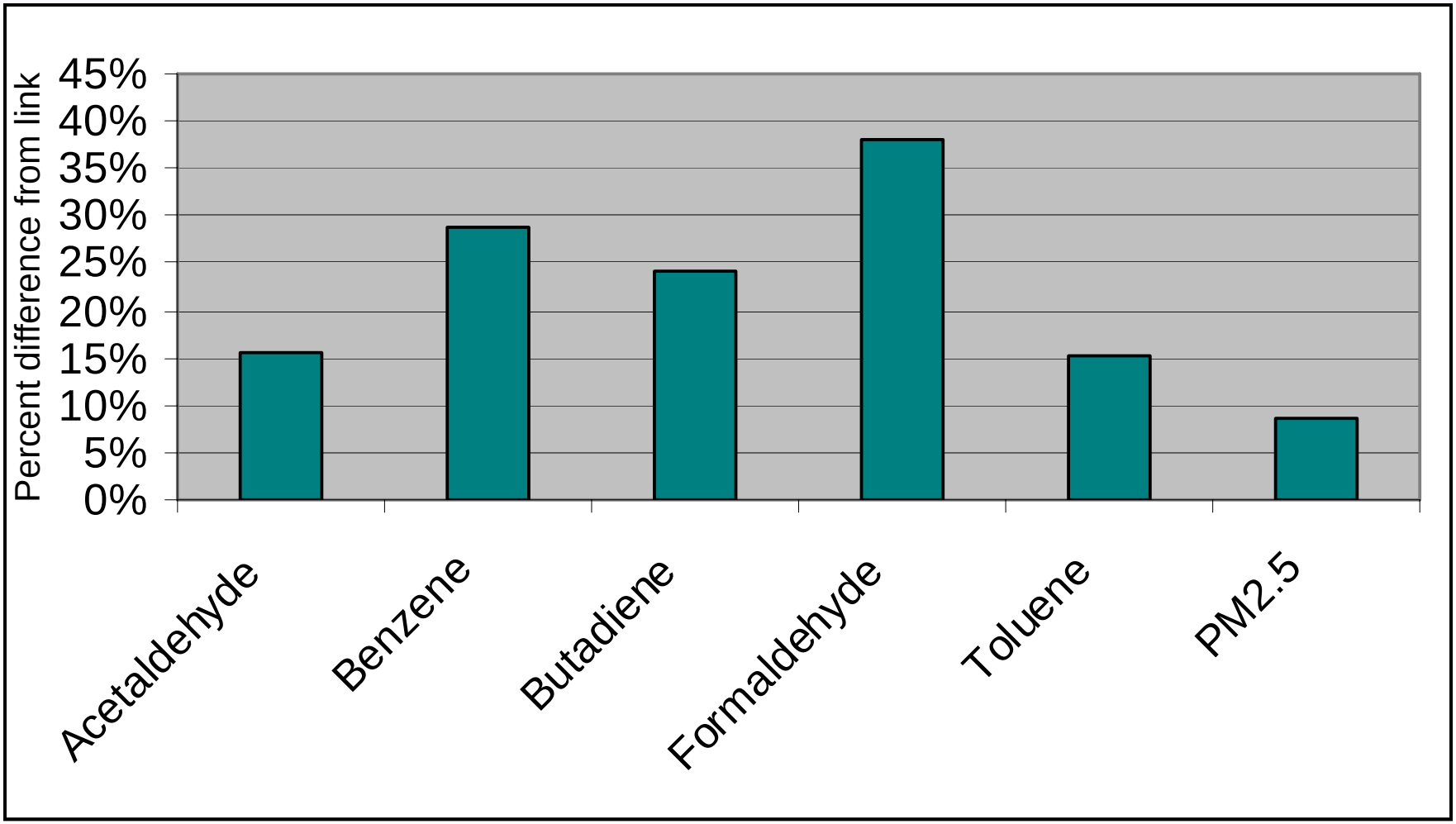
Much closer when NMIM is run with Local Inputs



One day/month

Differences most likely dominated by differences in the MOBILE6 inputs. Differences due to methodology appear to be small.

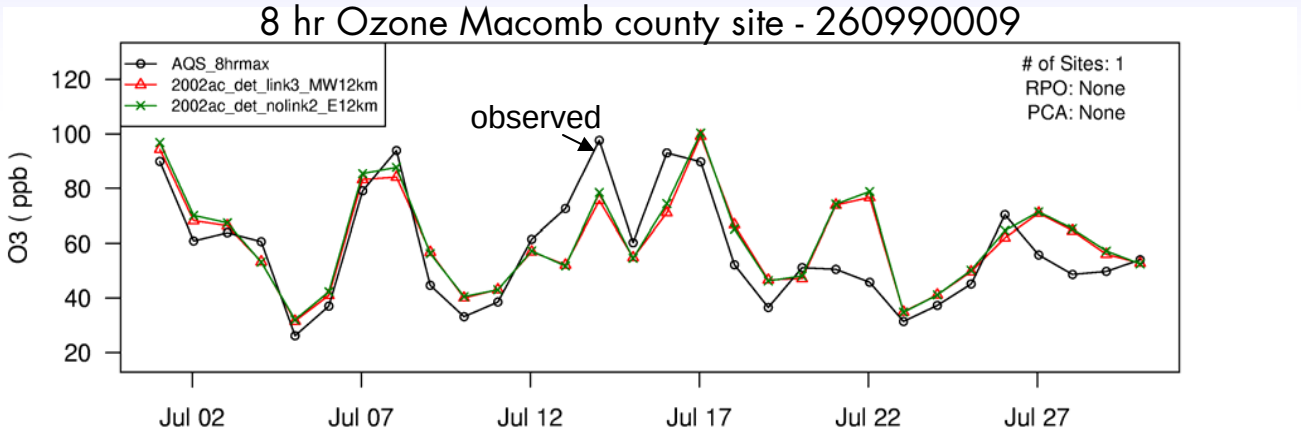
Other Pollutants Emissions – NEI Greater Than Link

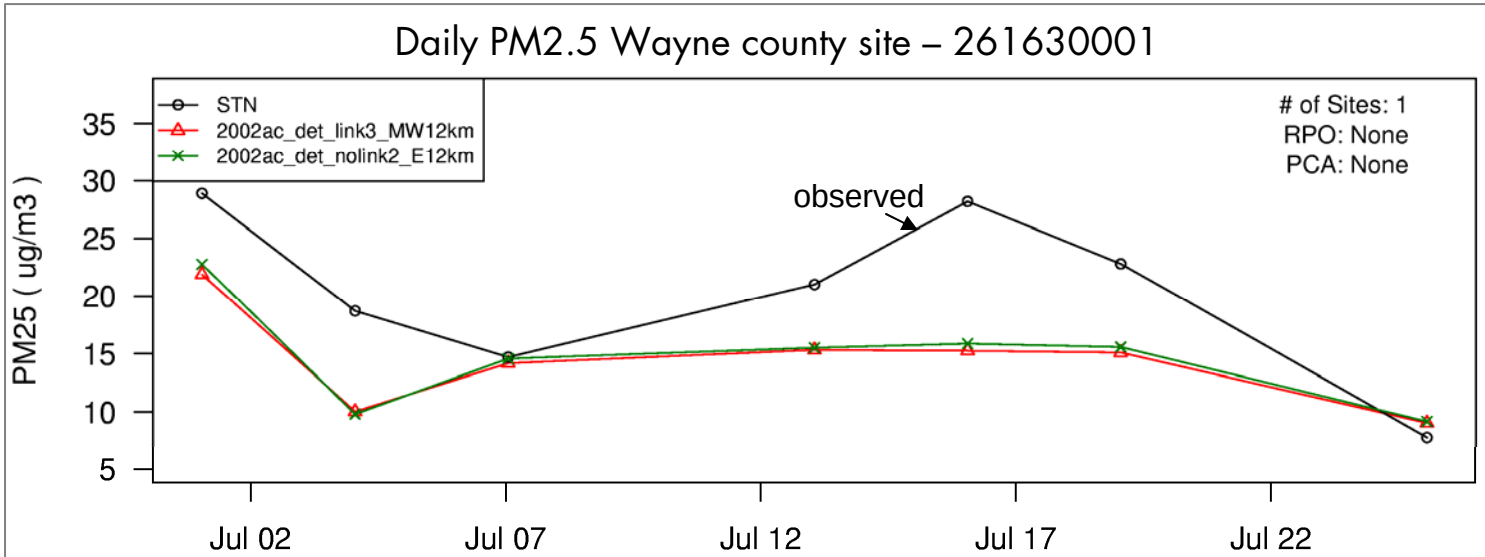


Reasons for Higher Emissions

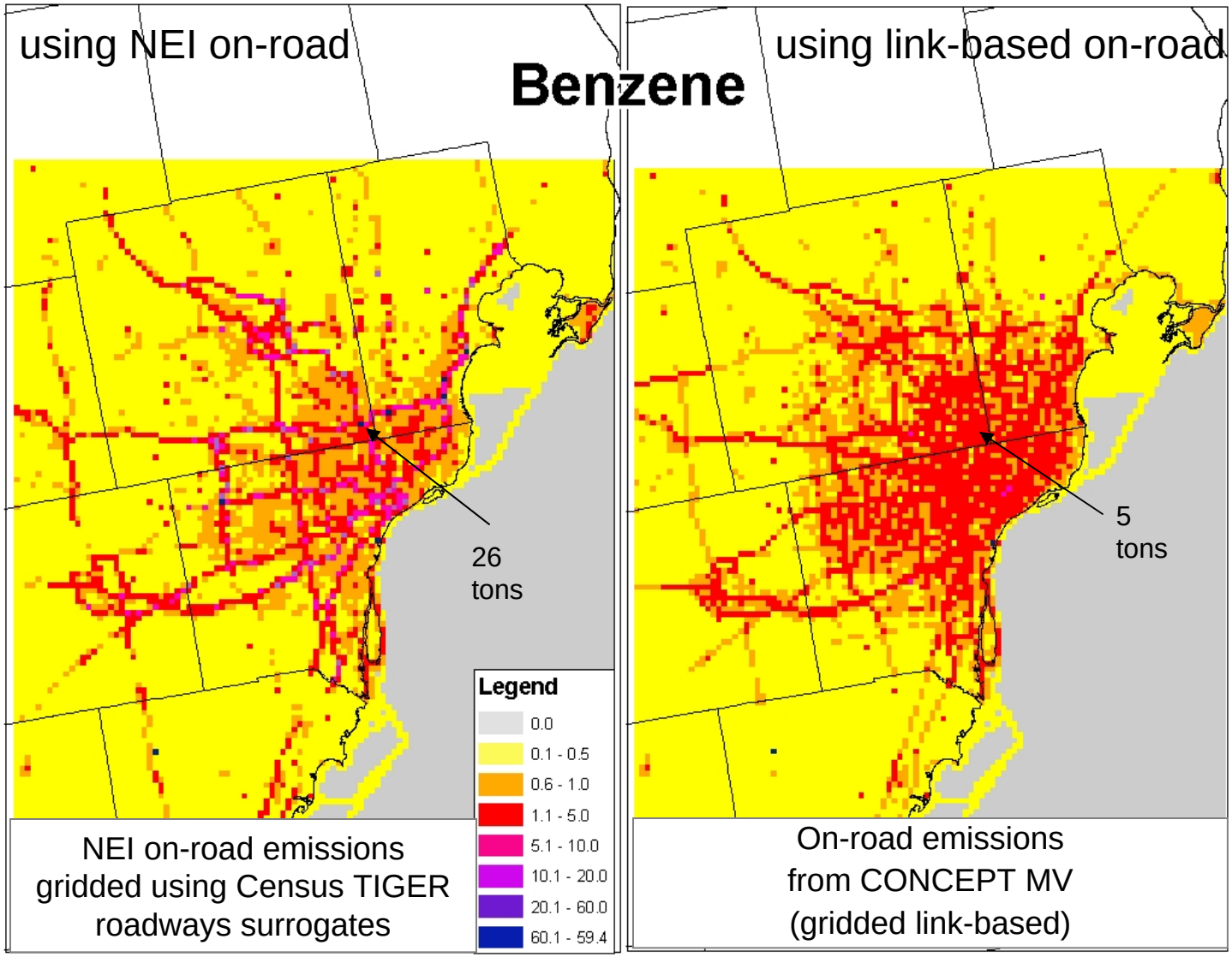
- Other than VMT, inputs to NEI were national defaults and didn't match the local inputs used in the link based approach
- Speeds – speed values and spatial distribution
- Temperatures – County/monthly average profiles versus day-hour and grid cell-specific
- These and further differences (e.g., age distribution) are currently being investigated

Link Based Emissions Have Little Impact on 12 km Model Evaluation



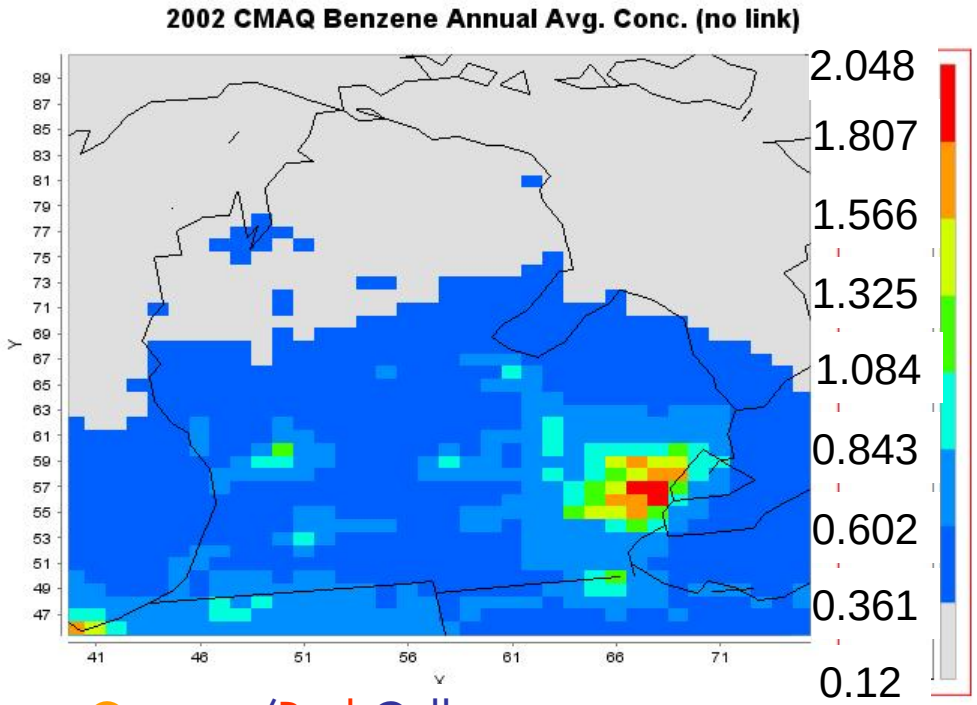


Total Benzene Gridded to 1 km
(On-road Sector is 66% of Total Emissions)



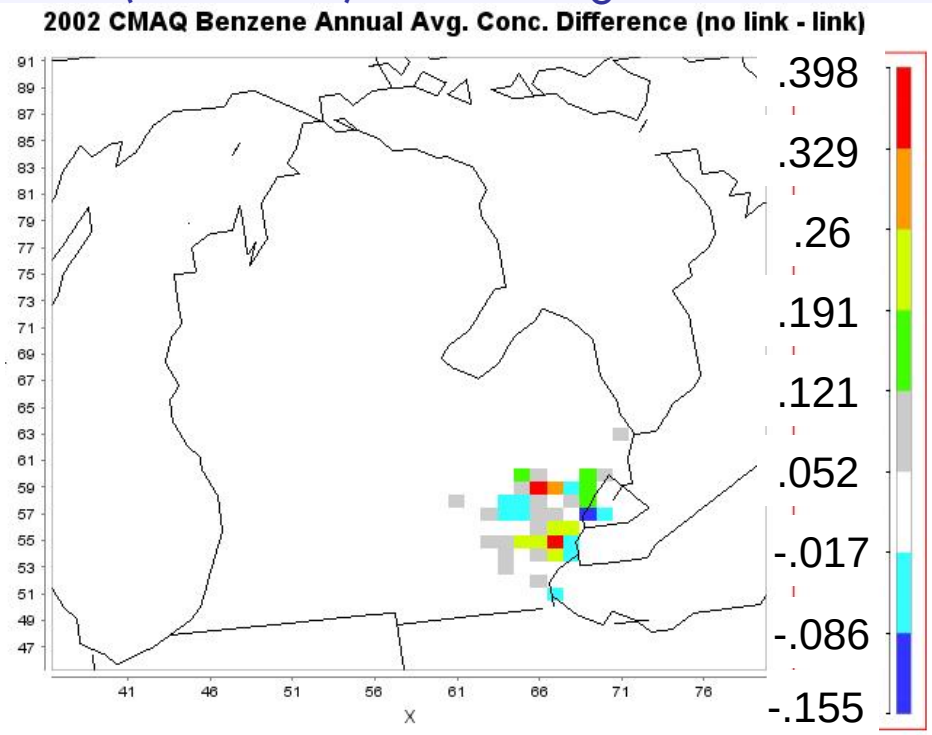
CMAQ results Benzene 12 km Annual Average

NEI Benzene ug/m3



Differences vary across grid cells

(NEI – Link) Benzene ug/m3



Orange/Red Cells:
Risk is 12-16 in a million

Risk computed based on concentration * Unit Risk Estimate (URE)

Benzene URE =0.0000078 (1/[ug/m3])

Largest Negative Difference relates to the NEI underestimating risk by 1 in a million (NEI 16; Link 15)

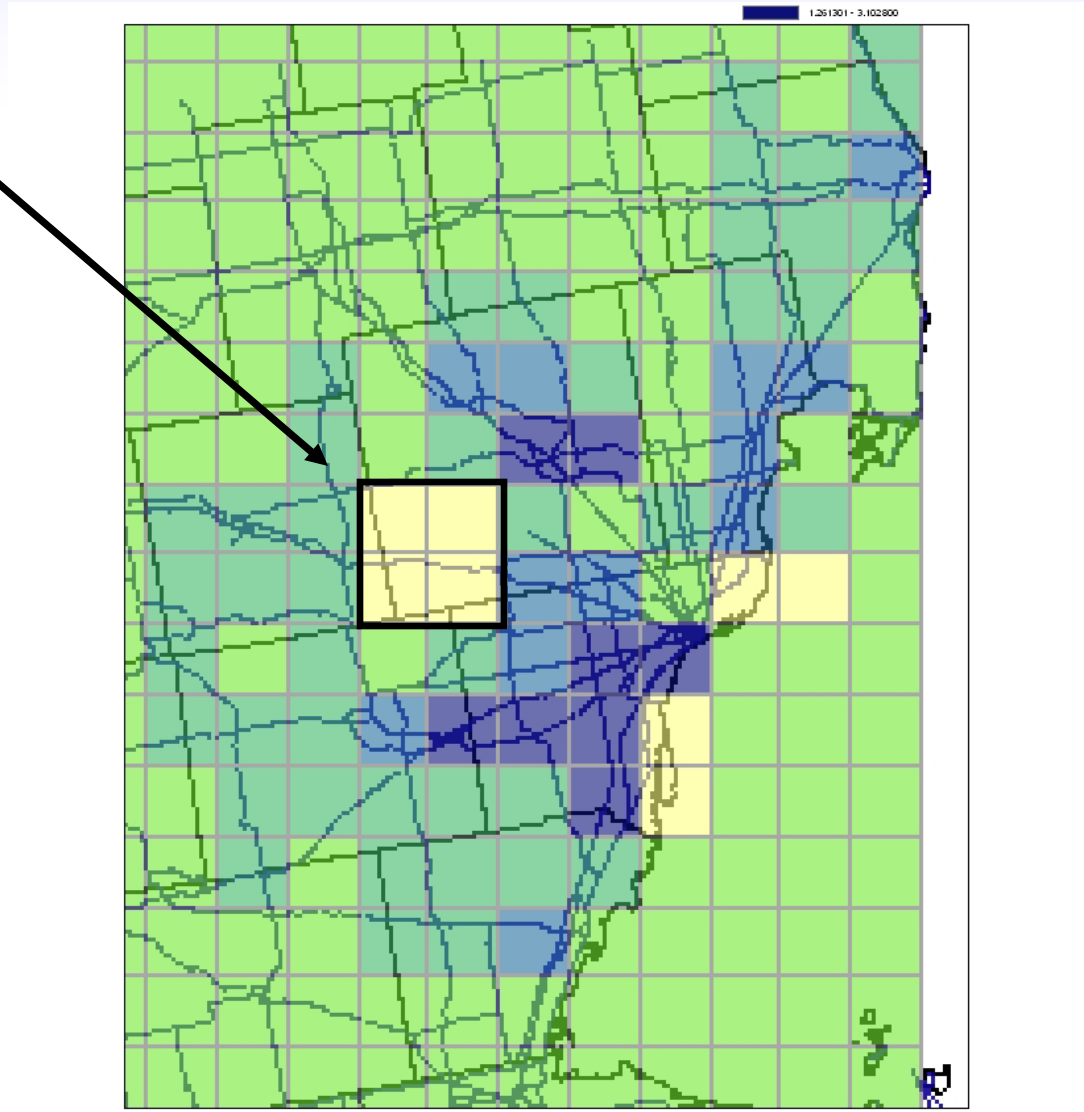
Largest Positive Difference relates to the NEI overestimating risk by 3 in a million (NEI 14; Link 11)

Link Concentrations Are Higher Than NEI for Cells with Few Major Roads

Benzene

risk differences:
NEI – link

- -1.2 to -.255
- -.255 to -.17
- -.17 to .529
- .529 to 1.26
- 1.26 to 3.1



Conclusions

- Compared NEI to CONCEPT/TDM (link) for Detroit Area:
  - VMT: totals are similar
  - Emissions: NEI benzene roughly 20% higher (across 7-county area)
  - Concentrations: vary over geographic regions, maximum benzene differences caused 1-3 in a million change in risk (from NEI base of roughly 12-16 in a million)
- Differences in aggregate emissions are primarily due to inputs, not methods
- Use of NEI could result in inaccurate representation of spatial distribution of certain pollutants due to the spatial allocation approach for the emissions
- No significant differences in model performance between no link and link methods at 12 km resolution for ozone, PM2.5, toxics. Expect to see differences at finer resolution.

Next Steps

- Perform analyses for more pollutants
- Isolate MOBILE6 input parameters of importance
- Run AERMOD at1 km resolution and compare fine scale modeling results
- Run 1 km resolution through exposure and benefits models and compare results to 12 km