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Estimating Link-Level Mobile Source Emissions – CONCEPT Model Updates and Applications

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Overview

- CONCEPT Overview
- CONCEPT MV TDM Pre-Processor
- CONCEPT MV Emissions Procedures
- Example Applications
- Current CONCEPT MV Updates

CONCEPT Overview

- **Consolidated Community Emissions Processing Tool**
  - Open Source
  - Freely Available
  - Community Support & Enhancements
  - Balance Transparency and Performance
  - Database Management System
  - Integration with GIS/Spatial Tools
  - Quality Assurance – Intermediate Output

CONCEPT Overview

- **Includes All Major Emissions Sources**
  - Point Sources
  - Area Sources
  - On-road Mobile Sources
  - Non-road Mobile Sources
  - Biogenic Emissions
- **Supporting Modules**
  - Spatial Allocation
  - Speciation
  - CEM Emissions Processing
  - Growth & Control

CONCEPT MV

- Uses output from transportation demand models (TDM)
- Generates gridded, hourly link-level emissions by vehicle class
- Uses 8 MOBILE5 vehicle classes
- Uses trip data to estimate starts and hot soaks
- Detailed temporal resolution of traffic volume, speeds, and VMT mix
- Uses gridded met data
- Stores many intermediate emissions tables for QA and data review

TDM Transformation Tool (T3)
CONCEPT MV Pre-processor

- **Needed for processing output from a variety of Transportation Demand Models**
- **Generates RPO Data Exchange Protocol Format**
  - Network Definition, Link Coordinates
  - Activity Data (VMT, Speeds, Trip Starts/Ends)
  - Speed Adjustment Instructions
  - Similar to NEI

TDM Inputs to T3

- **Link Characteristics**
  - Endpoint coordinates and projection definition
  - Link volumes
  - Link capacities
  - Link lengths
  - Link speeds or free flow speeds
  - Link facility class
- **Vehicle Trip Starts and Ends by Traffic Analysis Zone (TAZ)**

Volume Data

- **Daily Average or Intra-Day Periods**
  - Off-peak, morning peak, mid-day, pm peak
  - Partial hours (e.g., 7:30am to 9:15am)
  - Overnight (e.g., 9:00pm to 6:00am)
- **All Vehicles or by TDM Vehicle Class**
  - T3 passes through vehicle class details
  - CONCEPT converts to eight MOBILE5 vehicle classes

Speed Data

- **TDMs rarely output calculated speeds**
- **Generally have free flow speeds**
- **TDMs adjust free flow speeds**
  - Volume/capacity ratio
  - Queuing algorithm
- **Adjustment must be done hourly (i.e., after temporal allocation)**
- **T3 passes speed adjustment instructions to CONCEPT**

T3/CONCEPT Speed Adjustments

- **Three Options**
  - Volume-delay function (BPR curve)
  - Lookup tables by speed and volume/capacity ratio
  - Directly input post-processed speeds
- **BPR curves and lookup tables require capacities, free flow speeds, and hourly volumes**
- **CONCEPT generates hourly volumes using temporal profiles**

T3/CONCEPT Speed Adjustments

Most common adjustment is BPR curve:

$$S_a = \frac{S_{ff}}{1 + \left[A * \left(V / C \right)^B \right]}$$

S_a	=	actual link speed (mph)
S_{ff}	=	reported link free flow speed (mph)
V	=	total link volume (vehicles OR vehicles per hour)
C	=	total link capacity (vehicles OR vehicles per hour)
A, B	=	curve calibration coefficients

Additional Options

- Volume/capacity ratio upper limit
- Minimum speeds
- A, B coefficients by speed buckets
- Lookup tables by speed bucket and V/C ratio

T3 Transformations

- **Map Facility Types**
  - Map TDM to HPMS facility types
  - CONCEPT maps HPMS to MOBILE6 facility types
- **Apply HPMS Scaling Factors**
- **Apply VMT Growth Factors**
- **Include/Exclude Counties**
- **Develop TAZ to County Cross-Reference**
  - Or treat TAZs as pseudo-counties in CONCEPT

T3/CONCEPT Temporal Allocation

- CONCEPT disaggregates T3 data (volume, VMT, capacities) for multi-hour periods into hourly volumes
- Requires hourly total volume profiles by HPMS facility class, month, day of week
- Develop profiles from analysis of automated traffic recorder (ATR) data

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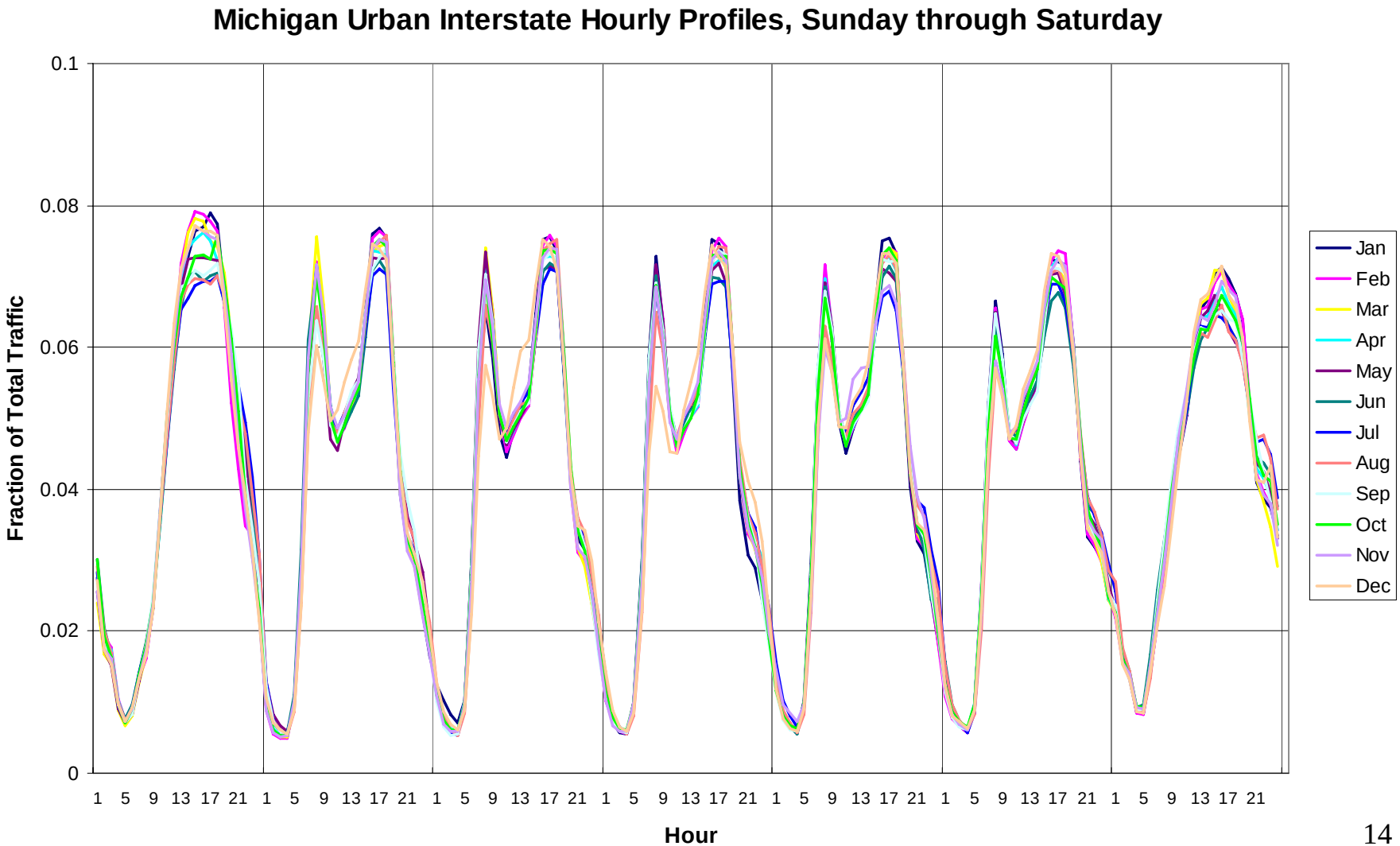
Example Temporal Profiles for Total Vehicle Count



T3/CONCEPT Vehicle Mix Disaggregation

- CONCEPT disaggregates T3-formatted TDM vehicle classes into eight MOBILE5 vehicle classes
- Requires hourly VMT mix profiles by HPMS facility class, month, day of week, hour of day
- Develop hourly VMT mix profiles from analysis of vehicle classification recorder data

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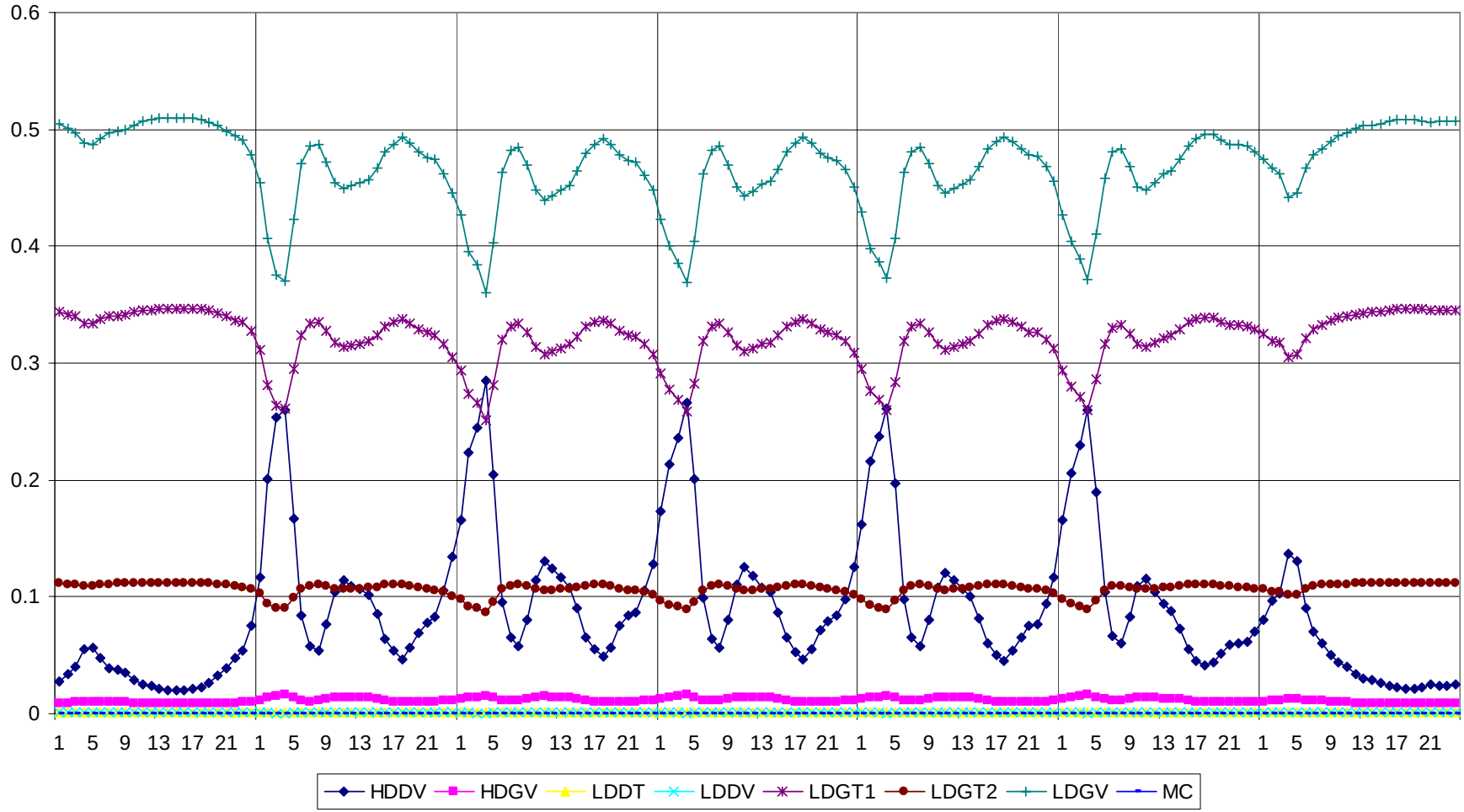
Example Vehicle Mix Temporal Profile

Michigan Urban Interstate Hourly VMT Mix Fractions, Sunday through Saturday



CONCEPT Estimation of On-Road Motor Vehicle Emissions

- Temporally allocate VMT to hours
- Adjust speeds
- Spatially allocate links to grid cells
- Allocate VMT to 8 MOBILE5 vehicle classes
- Run MOBILE6 with grid-specific meteorology
- Apply MOBILE6 Emission Factors
- Speciate emissions for air quality modeling

CONCEPT MOBILE6 Runs

- **Representative county inputs**
  - Fuel parameters
  - Control programs
- **Representative grid cell meteorology**
- **Year, Season**
- **Δ Temperature Bins**
- **Δ Speed Bins**
- **Road Type**
  - Ramps and locals
  - Freeways and arterials by speed bin

Start Emissions

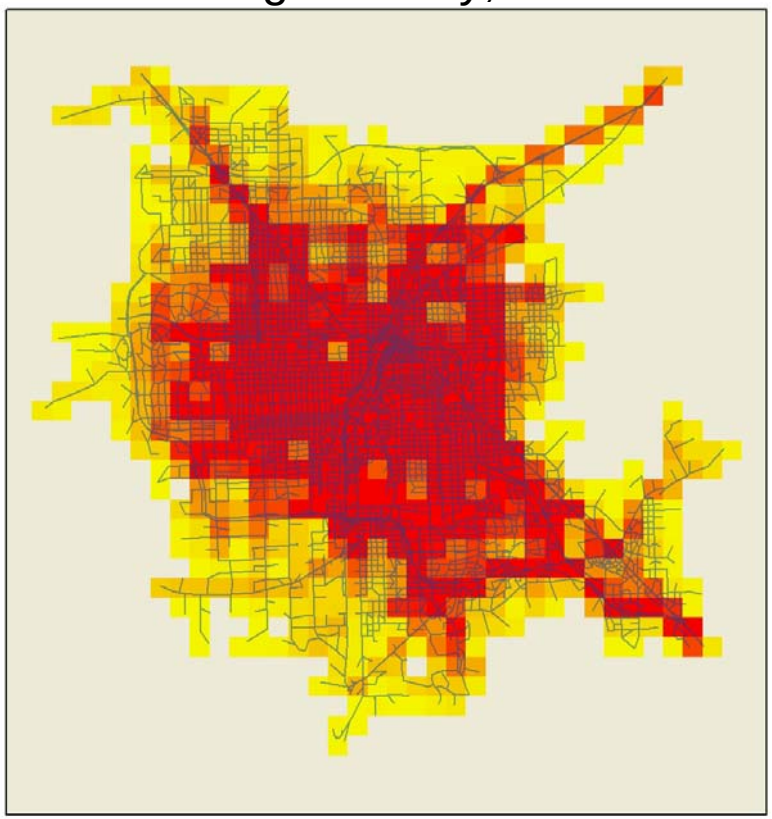
- T3 processes number of vehicle origin trip starts by Traffic Analysis Zone (TAZ)
- CONCEPT uses composite (start + running) exhaust emission factor if trips not available
- Trips are totaled by county and passed to CONCEPT (spatial surrogates are currently only at county level)
- CONCEPT can process trips data at the TAZ level using pseudo-counties
- Start emissions = # trip starts * MOBILE6 start emissions factor

Hot Soak Emissions

- T3 processes number of vehicle origin trip ends by Traffic Analysis Zone (TAZ), if available
- Hot soak emissions = # trip ends * MOBILE6 hot soak emissions factor
- CONCEPT uses trip starts if trip ends not available
- CONCEPT uses composite (start + running) exhaust emission factor if trip starts/ends not available

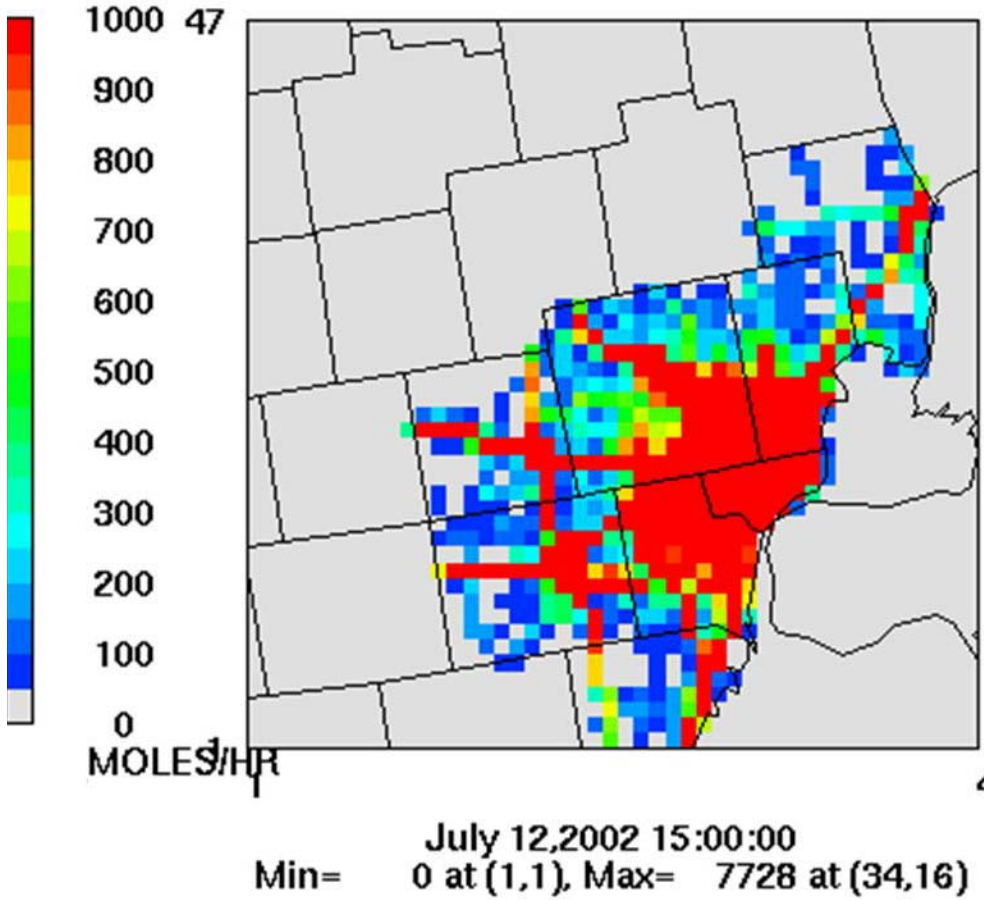
Urban-Scale Applications

Las Vegas Valley, Nevada

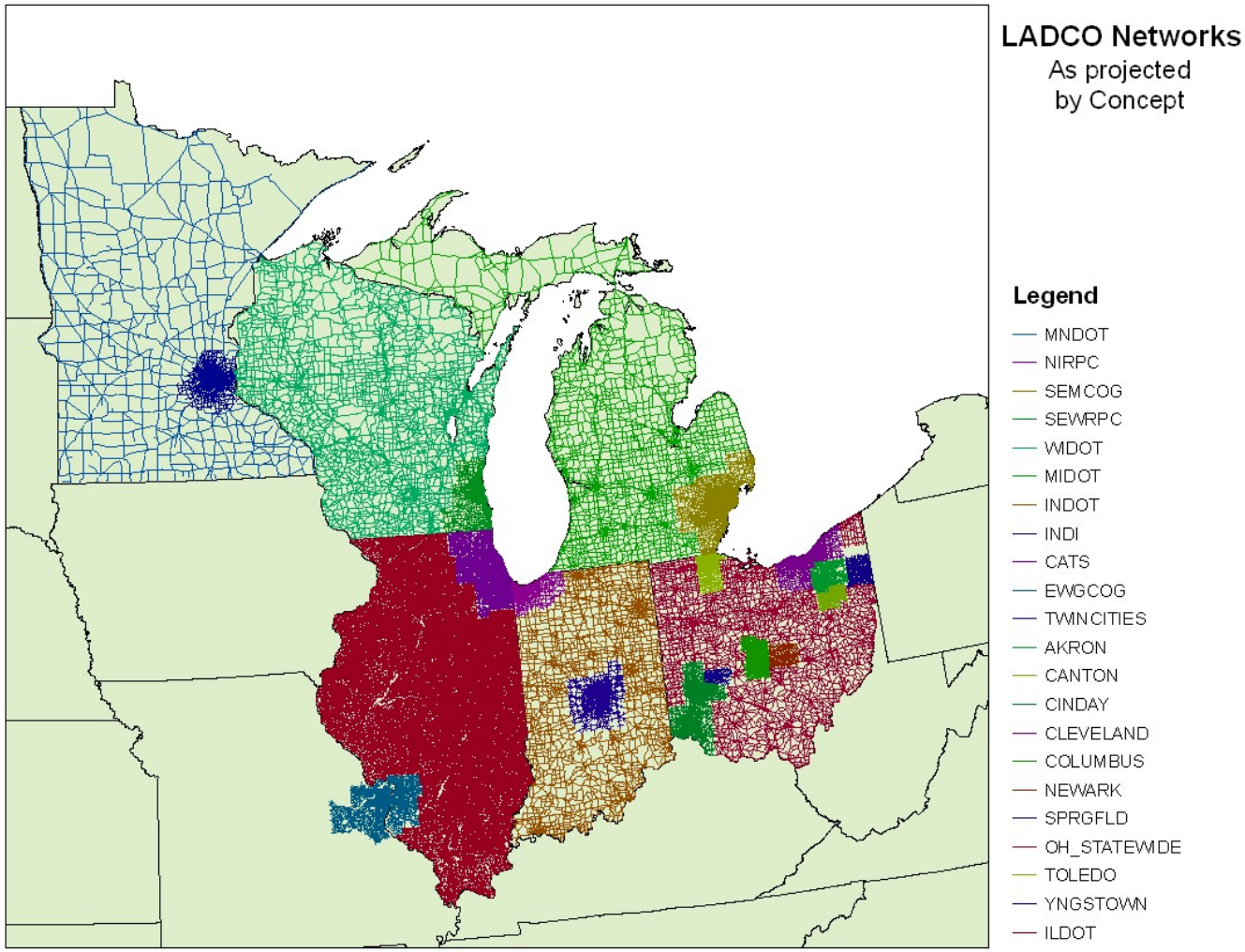


Las Vegas TransCAD
CONCEPT MV
Gridded TOG Emissions - 1k

Detroit, Michigan Metro Area



Regional Application: LADCO States Combination of 22 State and Local Networks



LADCO 2002 Networks Data Processed

State	Network	TDM	# Links
Illinois	CATS - Chicago Area	EMME2	33,774
Illinois	ILDOT Statewide	Generated from Observed	303,297
Indiana	MPO - Indianapolis	TransCAD	7,599
Indiana	NIRPC - Northwest Indiana	EMME2	9,023
Indiana	INDOT Statewide	TransCAD	31,181
Michigan	SEMCOG - Detroit Area	TransCAD	14,985
Michigan	MIDOT Statewide	TransCAD	9,227
Minnesota	MMC - Minneapolis St. Paul Area	TP+	20,898
Missouri	EWGCOG – St. Louis Area	CUBE - TP+/Voyager	40,394
Minnesota	MNDOT Statewide	Generated from Observed	4,402
Ohio	Nine Urban Areas	CUBE-TRANPLAN	3,723 to 29,796
Ohio	OHDOT Statewide	TransCAD	50,644
Wisconsin	SEWRPC - Milwaukee Area	TRANPLAN	17,054
Wisconsin	WIDOT Statewide	TP+/VIPER	143,327
		Total Links	**801,467**

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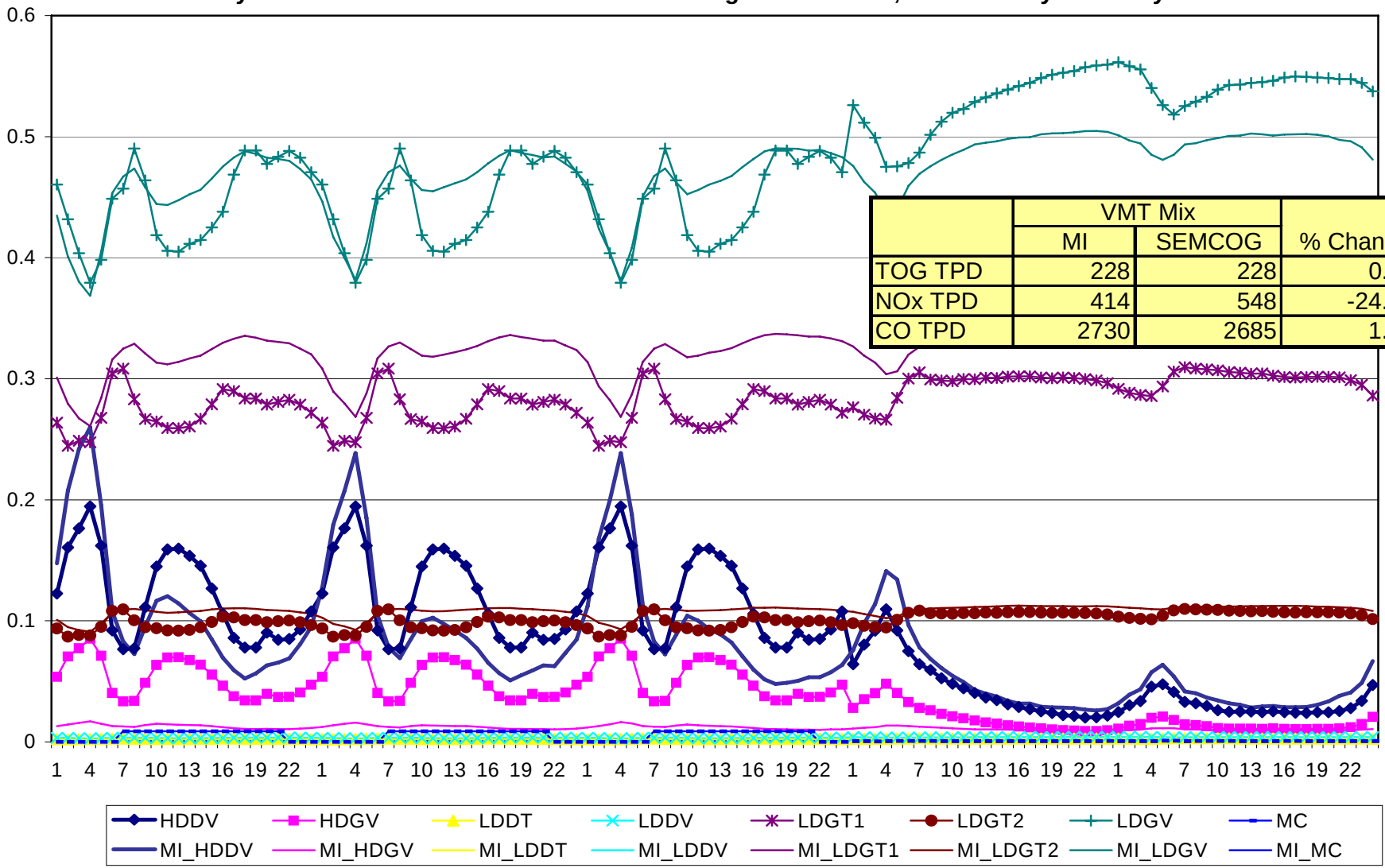
Importance of VMT Mix Profiles

Urban Freeway Vehicle Mix: SEMCOG Profiles vs Michigan Statewide, Wednesday - Sunday



	VMT Mix		
	MI	SEMCOG	% Change
TOG TPD	228	228	0.3%
NOx TPD	414	548	-24.5%
CO TPD	2730	2685	1.7%

Current CONCEPT MV Update: Toxics

- **Six MOBILE6 toxics**
- **Additional HAPs using factors developed by EPA OTAQ**
- **CONCEPT will generate**
  - Link-specific hourly toxics emissions – mass emissions
  - Gridded toxics emissions – molar emissions for air quality modeling