ENVIRON

Development of Link-Level Mobile Source Emission Inventories

Stella Shepard

John Haasbeek

Alison K. Pollack

ENVIRON International Corporation

Mark Janssen

Lake Michigan Air Directors Consortium (LADCO)

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Overview

- CONCEPT Emissions Model
- TDM Transformation Tool (T3)
- Networks Processed with T3
- CONCEPT Emissions Estimates

CONCEPT Overview

- **CONsolidated Community Emissions Processing Tool**
  - Open Source
  - Freely Available
  - Community Support & Enhancements
  - Balance Transparency and Performance
  - Database Management System
  - Quality Assurance – Intermediate Output

CONCEPT Overview

- **Includes 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 Overview

- **Unique Features**
  - Database Approach
  - Open Source
  - Tribal Processing
  - On-road Motor Vehicle Processing
  - Integration with GIS/Spatial Tools

TDM Transformation Tool (T3): What it Does

- **Transforms Transportation Demand Model (TDM) Outputs for Input to CONCEPT**
- **Generates Emissions Modeling Inputs**
- **Outputs in RPO Data Exchange Protocol Format**
  - Network Definition, Link Coordinates
  - Activity Data (VMT, Speeds, Starts)
  - Speed Adjustment Instructions

T3 Technical Approach

- **Follows CONCEPT Open Source Approach**
  - PostgreSQL Database
  - PL/pgSQL and perl Languages
- **Easy-to-Read XML Control File**
- **Accepts Various Input Formats**
- **Flexible Transformation Definition Files**
- **Simple to Add New Network Formats**

T3 Data Inputs

- **Link Characteristics**
  - Endpoint coordinates and projection definition
  - Link volumes
  - Link speeds or free flow speeds
  - Facility class
- **Vehicle Trips 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**
- **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

T3/CONCEPT Speed Adjustments

- **Additional Options**
  - Volume/capacity ratio cap
  - Minimum speeds
  - A, B coefficients by speed buckets
  - Lookup tables by speed bucket and V/C ratio

Facility Types

Urban/Rural		Roadway Type		Combinations		HPMS	MOBILE6
1	Rural	A	Interstate	1A	Rural Interstate	01	Freeway
2	Rural	B	Other Expressway	1B	N/A		
3	Rural	C	Ramp	1C	Rural Ramp	03	Ramp
4	Rural	D	Principal Arterial	1D	Rural Principal Arterial	02	Arterial
5	Rural	E	Major Arterial	1E	N/A		
6	Rural	F	Minor Arterial	1F	Rural Minor Arterial	06	Arterial
7	Rural	G	Major Collector	1G	Rural Major Collector	07	Arterial
8	Rural	H	Minor Collector	1H	Rural Minor Collector	08	Arterial
9	Rural	I	Collector	1I	N/A		
10	Rural	J	Local	1J	Rural Local	09	Local
2	Urban	A	Interstate	2A	Urban Interstate	11	Freeway
3	Urban	B	Other Expressway	2B	Urban Other Expressway	12	Freeway
4	Urban	C	Ramp	2C	Urban Ramp	13	Ramp
5	Urban	D	Principal Arterial	2D	N/A		
6	Urban	E	Major Arterial	2E	Urban Major Arterial	14	Arterial
7	Urban	F	Minor Arterial	2F	Urban Minor Arterial	16	Arterial
8	Urban	G	Major Collector	2G	N/A		
9	Urban	H	Minor Collector	2H	N/A		
10	Urban	I	Collector	2I	Urban Collector	17	Arterial
11	Urban	J	Local	2J	Urban Local	19	Local

T3 Transformations

- **County Codes**
  - Include/exclude counties
- **TAZ to County Cross-Reference**
- **Facility Types**
- **HPMS Scaling**
- **Growth**
- **Flexible Dimensions**
  - By State, County, and/or Link

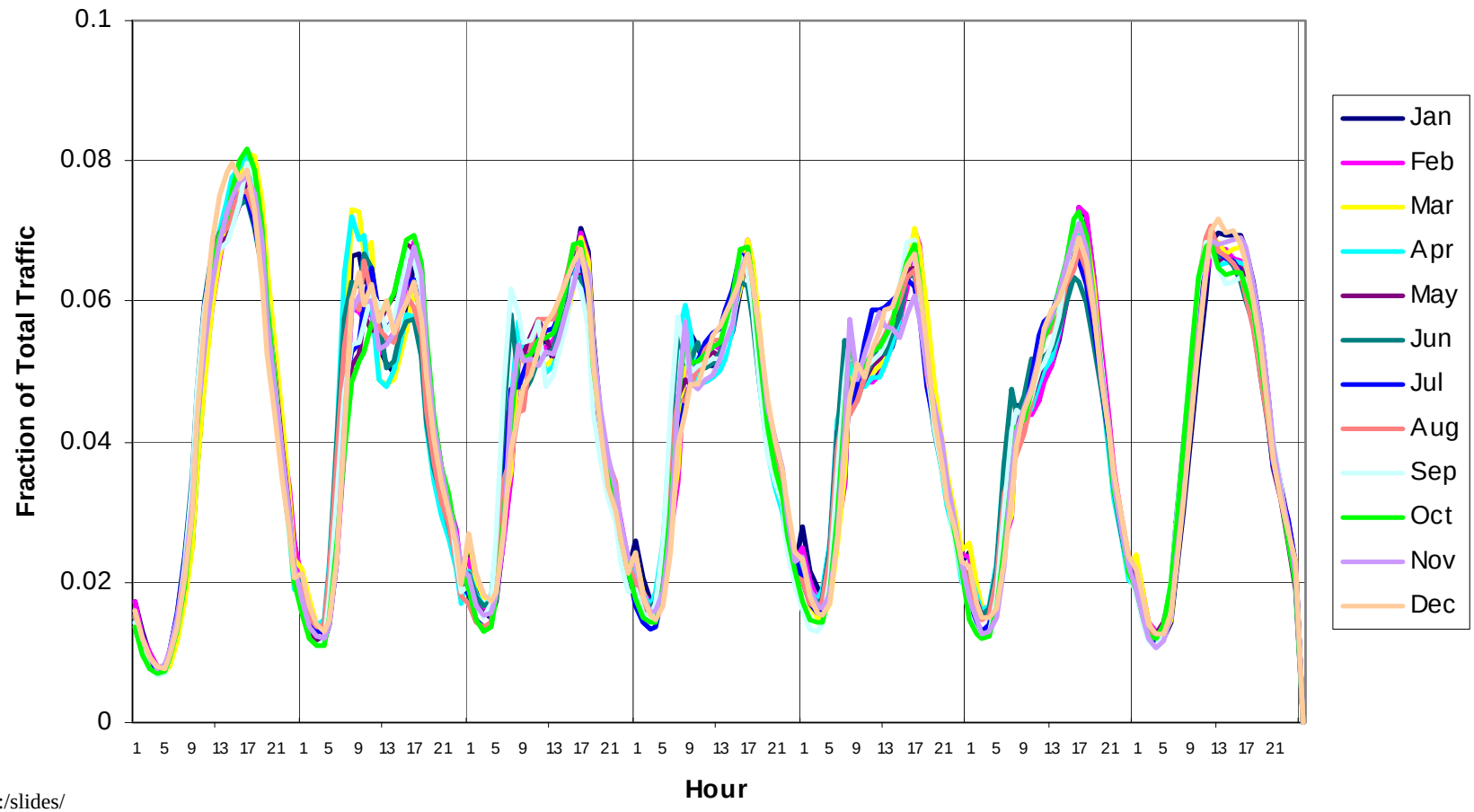
Network Data Processed

State	Network	TDM	# Links
Illinois	CATS - Chicago Area	EMME2	32,341
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	15,021
Michigan	MIDOT Statewide	TransCAD	9,227
Minnesota	MMC - Minneapolis St. Paul Area	TP+	20,898
Minnesota	MNDOT Statewide	Generated from Observed	4,402
Ohio	Nine Urban Areas	CUBE-TRANPLAN	3,723 to 25,424
Ohio	OHDOT Statewide	TransCAD	50,644
Wisconsin	SEWRPC - Milwaukee Area	TRANPLAN	17,054

T3/CONCEPT Temporal Allocation

- T3/CONCEPT disaggregates volumes for multi-hour periods into hourly volumes
- Based on analyses of CY2002 automated traffic recorder (ATR) data
- Hourly total volume profiles developed by HPMS facility class, month, day of week
- Analyses performed for IL, MI, MN, and WI

Example Temporal Profiles for Total Vehicle Count

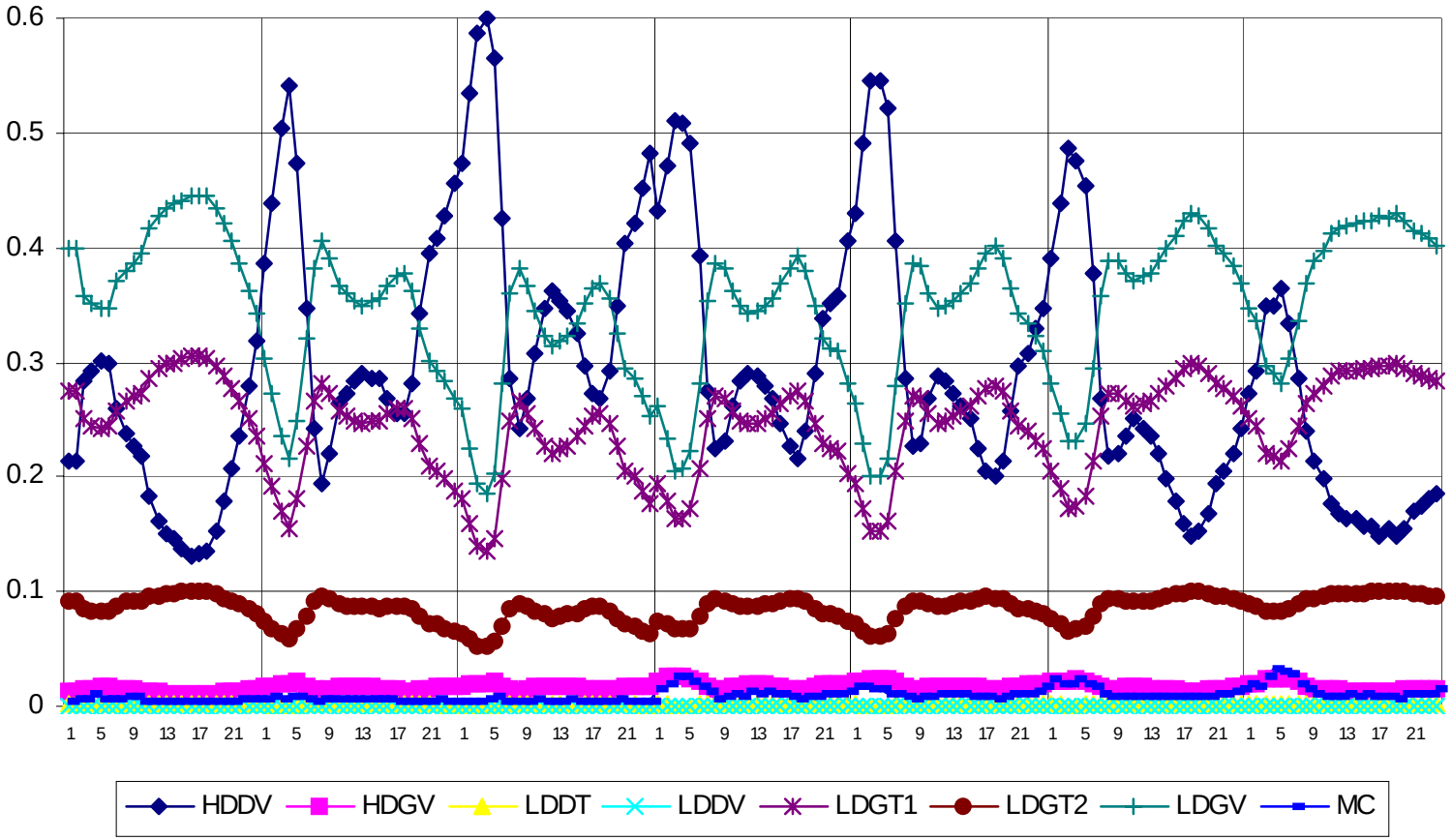


T3/CONCEPT Vehicle Mix Disaggregation

- T3/CONCEPT disaggregates grouped vehicle classes into eight MOBILE5 vehicle classes
- Based on analyses of CY2002 vehicle classification recorder data
- Hourly VMT mix profiles developed by HPMS facility class, month, day of week, hour of day
- Analyses performed for IL, MI, MN, and WI

Example Vehicle Mix Temporal Profile

Illinois Function Class 1, February
Hourly Class Fractions Sunday through Saturday



CONCEPT Estimation of On-Road Motor Vehicle Emissions

- Temporal Allocation
- Speed Adjustment
- Spatial Allocation
- Vehicle Mix Profile Assignment
- Run MOBILE6
- Apply MOBILE6 Emission Factors
- Speciation

CONCEPT MOBILE6 Runs

- Representative County
- Year, Season
- Δ Temperature (Bins)
- Road Type (Freeway and Arterial)
- Speed Bin

Diurnal Emissions

- Pick common Δ temperatures within representative county
- Use single actual hourly temperature profile to represent all cells with same Δ temperature
- Correctly calculates diurnal emissions for that temperature profile
- Variation in temperature profile (wrt diurnals) likely small
- Use humidity profile for same cell

Start Emissions

- T3 reads number of vehicle origin trips by Traffic Analysis Zone (TAZ)
- Trips are totaled by county and passed to CONCEPT (spatial surrogates are currently only at county level)
- Future versions of T3/CONCEPT will handle trips data at the TAZ level
- Start emissions = # trip starts * MOBILE6 start emissions factor

Michigan Statewide roadway network and gridded NO_2 link-level exhaust emissions for July 6, 2002, 8am-9am