MOVES Data Development and Application in Indiana

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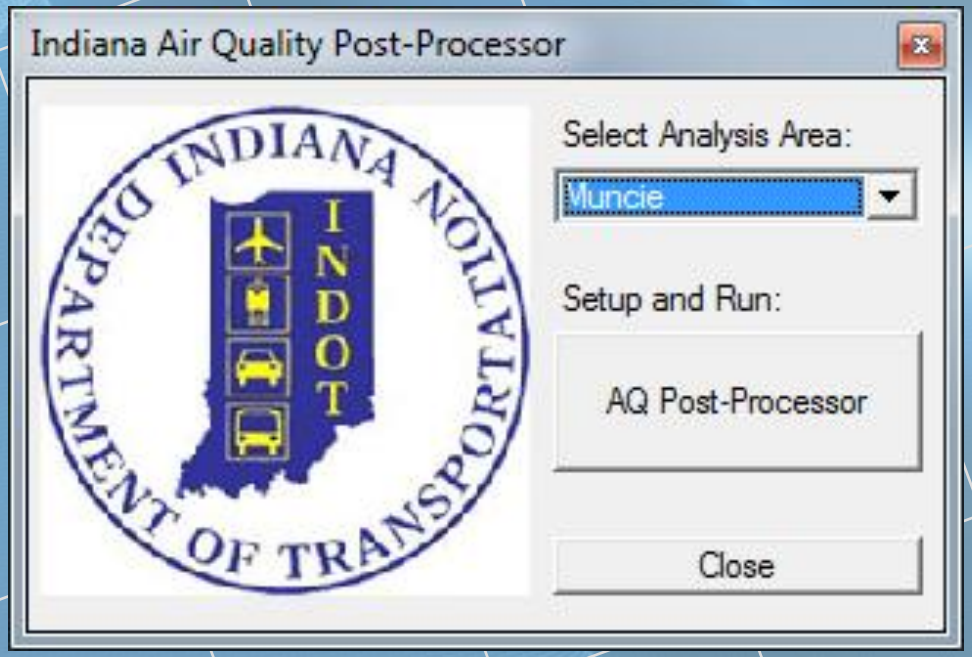


CDM Smith

Acknowledgements

- Indiana Department of Transportation

- Bernardin Lochmueller and Associates

- Indiana's MPOs

Agenda

- Background
- Interagency Consultation
- MOVES Data Development
  - Traffic
  - Vehicle Population
  - Fuel
  - Other data
- Post-Processor
  - Hourly Traffic
  - Peak Spreading
  - Hourly Speeds
  - Speed Bin Interpolation

Background

- Indiana has twelve air quality maintenance or non-attainment areas
- Ozone, PM 2.5, or both depending on area
- Transition to MOVES from MOBILE proving to be very daunting for many regions across the country
- There is a history of some of the smaller regions in Indiana failing to successfully complete the conformity determination process
- INDOT in cooperation with FHWA decided to coordinate the MOVES transition process

Background (continued)

- Goal of the effort was to ensure a successful completion of SIP and conformity determination process
- Desire to develop default data and methods for use throughout the state
- Interagency coordination vital to achieving buy-in
- Project would develop the following products:
  - MOVES input data
  - MOVES emission rates
  - Air Quality post-processor that would apply the emission rates to travel demand model outputs

Interagency Consultation

- Interagency consultation is a vital part of all air quality endeavors
- In order for the products of the project to be of actual use, the interagency consultation group process had to be engaged from the begin
- Consensus was sought for each piece of data developed and each method proposed
- In addition to INDOT, interagency consultation engaged:
  - FHWA
  - US EPA
  - Indiana Department of Environmental Management (IDEM)
  - MPOs

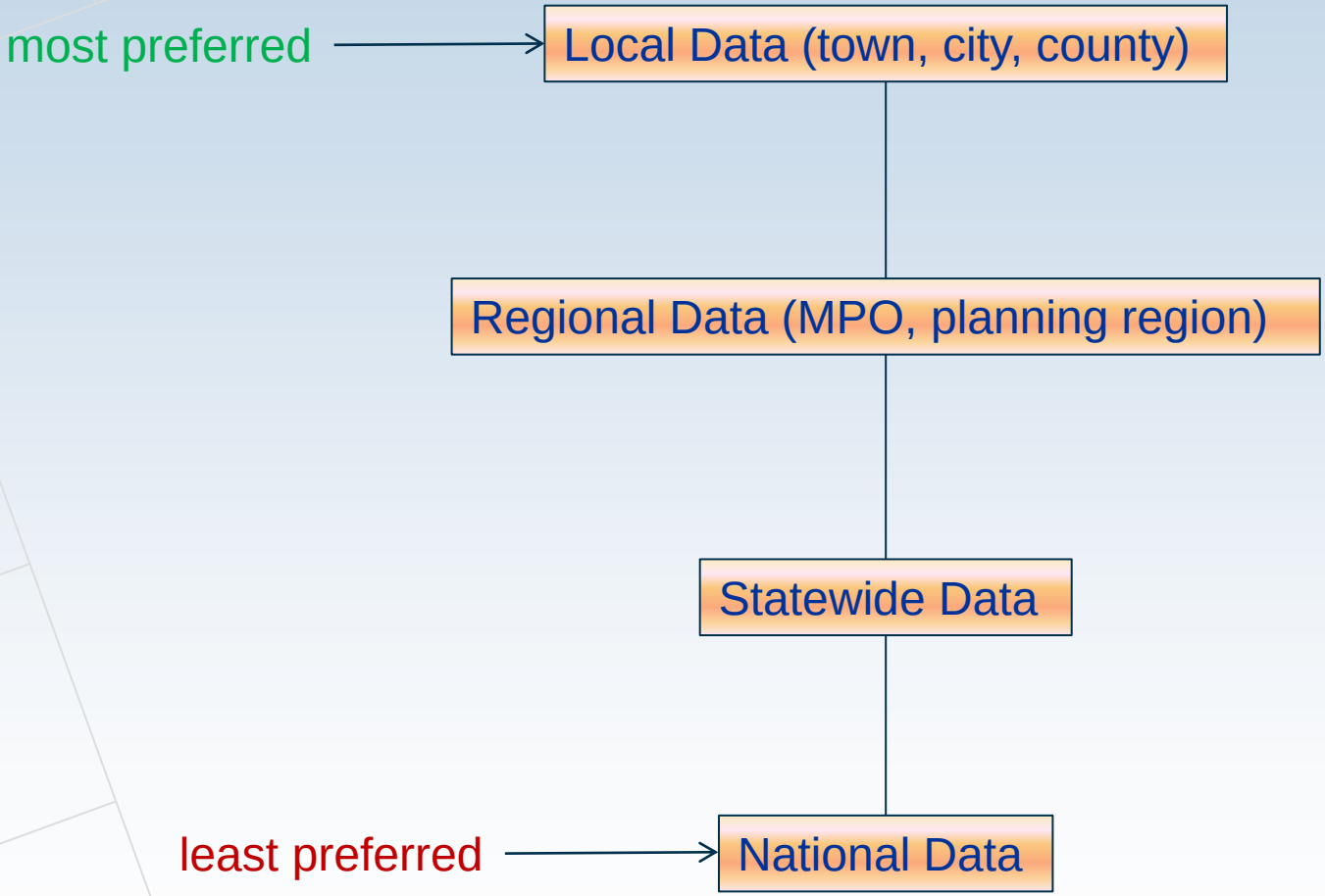
Interagency Consultation (continued)

- Agreement on the general approach to data and methods was sought from the state and federal partners first
- Hesitation from the MPOs on adopting this process was ameliorated on learning that the state and federal agencies were involved and on-board
- Ultimately, most MPO non-attainment and maintenance areas in Indiana adopted the INDOT data and methods
- Exceptions were:
  - Indianapolis (work was begun prior to the INDOT effort and served as a template for other areas in the state)
  - OKI (Cincinnati MPO with multi-state jurisdiction)
  - KIPDA (Louisville MPO with multi-state jurisdiction)

MOVES Data

- MOVES requires a number of data inputs not previously required by MOBILE
- Many areas are having problems generating the data required by MOVES
- EPA is aware of the issue and has generally been very cooperative with regions supposing a good faith effort is being made
- In general, locally developed data is preferred to national default data, but not always available
- Default state data can represent a comfortable middle ground, especially for resource strapped air quality areas

MOVES Data (continued)



Traffic

- Traffic data are a critical input to MOVES
- Data are used to develop vehicle-miles-traveled (VMT)
  - Annual
  - Monthly
  - Daily
  - Hourly
- Traffic data were also used to disaggregate traffic from travel demand models

Traffic (continued)

- MOVES recognizes 13 source types (vehicle types)
- These are represented by two digit codes
- Tens digit corresponds to the six basic HPMS vehicle types
  - 1x: Motorcycles
  - 2x: Cars
  - 3x: Light trucks
  - 4x: Buses
  - 5x: Single-unit trucks
  - 6x: Combination trucks
- Ones digit represents use type (not vehicle size or engine displacement)

Traffic (continued)

sourcetypeid	Description
11	Motorcycles
21	Passenger Car
31	Passenger Truck
32	Light Commercial Truck
41	Intercity Bus
42	Transit Bus
43	School Bus
51	Refuse Truck
52	Single Unit Short-haul Truck
53	Single Unit Long-haul Truck
54	Motor Home
61	Combination Short-haul Truck
62	Combination Long-haul Truck

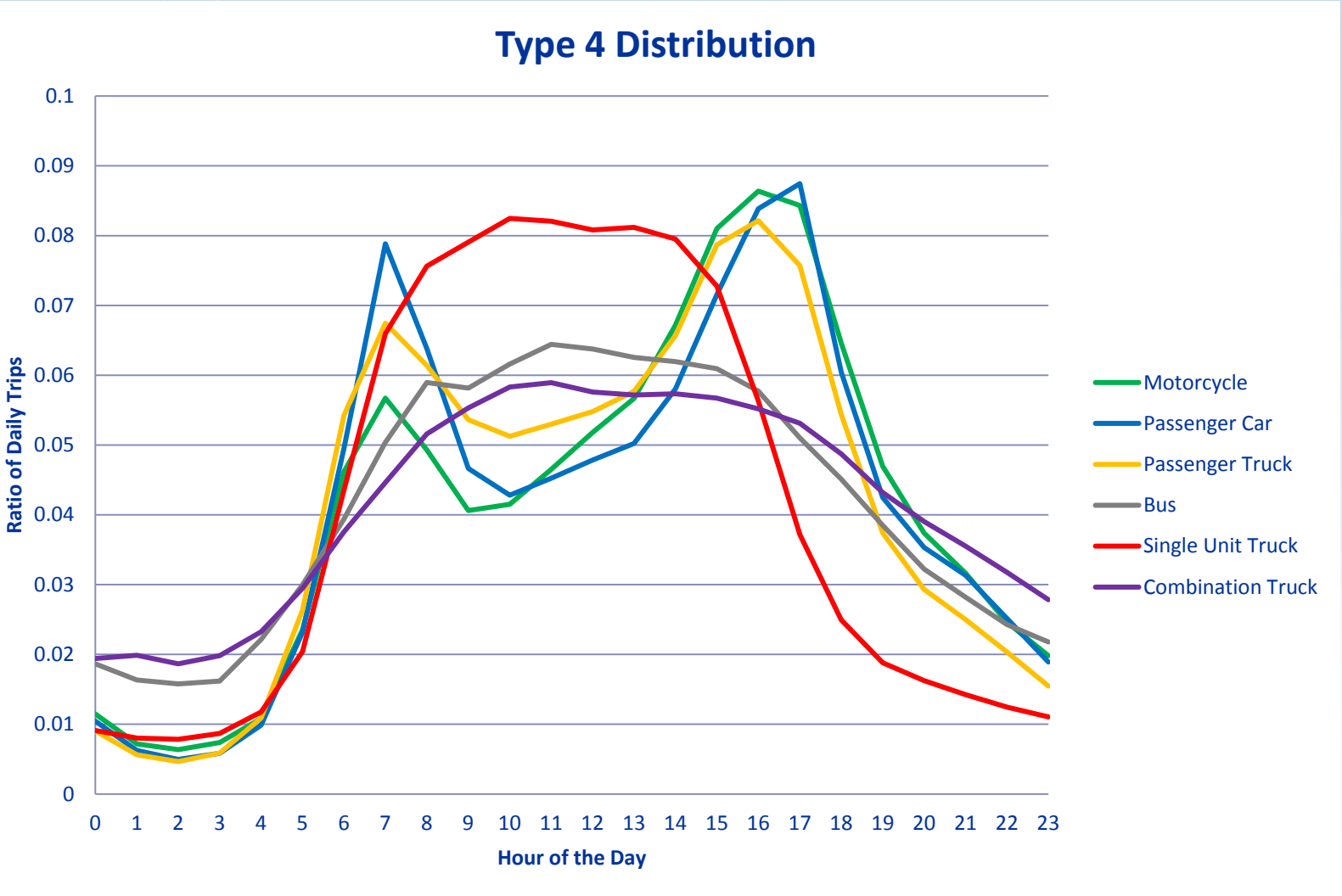
Traffic (continued)

- Monthly and daily factors were developed from INDOT statewide data on seasonal factoring
- Hourly factors were developed by analyzing permanent automatic traffic recorder (ATR) site data
  - 20 sites were selected from across the state
  - Sites covered the spread of four road types analyzed by MOVES
  - 4 years of continuous vehicle classification count data provided by INDOT
  - Data QA/QC to determine data usability
  - Some data were discarded due to quality issues

Traffic (continued)

- All valid data for each site aggregated to create hourly curves for the six primary vehicle types
- Hourly curves developed for each of four MOVES road types
- These hourly curves used as defaults for entire state of Indiana
- MOVES national default hourly curves do not distinguish by vehicle type (heavy trucks do not show mid-day hump)
- Vehicle type curves then applied to the 13 source types
  - Same curves for source types 31 and 32
  - Same curves for source types 41, 42, and 43
  - Same curves for source types 51, 52, 53, and 54
  - Same curves for source types 61 and 62

Traffic (continued)



Vehicle Population

- INDOT had access to vehicle registration data for cars and light trucks
- Data processed from VIN codes
- Motorcycle VIN code formats were not present in the contractor's VIN decoding software
- Heavy vehicle VIN data were unreliable
- Deriving heavy vehicle populations from registration data is questionable since many heavy vehicles are long distance trip makers and may not be registered in the air quality area

Light Vehicles (Cars and Trucks)

- Age distribution curves were developed by a contractor using a VIN decoder and 2009 vehicle registration data
- These curves were developed for every county in Indiana and for several multi-county regions
- Vehicle populations for cars and light trucks were developed from this analysis
- Resulting populations were increased by 5.8% to account for errors in the VIN decoding process
- Light truck disaggregation into source types 31 and 32 used factors recommended by EPA and based on fuel type
- Extensive QA/QC of the vehicle registration data was performed

Heavy Vehicles and Motorcycles

- Vehicle registration data not available
- Statewide default approach was desired, so extensive local data collection was not conducted
- In the absence of better data, used Mileage Accumulation Rates (MARs) method

Mileage Accumulation Rates

- MOVES has built-in default assumptions on the relationship between VMT and vehicle population
- MOVES activity outputs reports population and VMT data, but these are based on defaults from the national database
- Need to apply this default relationship to VMT data provided by MPOs to produce more locally specific vehicle populations
- Divide default populations by default VMT for any given MOVES run in inventory mode to get the appropriate rate
- Multiply rate by local VMT to get local vehicle population for any given source type

Mileage Accumulation Rates (continued)

- Must run a single inventory run in MOVES to get the default activity outputs
- For fastest runtimes, choose a single pollutant without any required constituents
- MARs are not geographically specific, but are temporally specific (county does not matter but year does)
- Run MOVES for a year consistent with the base year VMT data provided by MPO

Future Year Population

- Future year vehicle populations needed for all scenarios (8 scenarios per analysis area)
- Base year vehicle population grown at a rate consistent with growth in human population and employment
- Light vehicle growth was dependent on human population
- Heavy vehicle growth was dependent on employment

Fuel

- Default fuel from MOVES
- After 2012, subsequent years use same fuel formulation as 2012
- Fuel supply varies by month of year
- Ozone was run using July conditions
- PM 2.5 used an average annual condition; fuel supply was weighted throughout the year based on monthly VMT fractions

Other Data

- Ramp fractions calculated by analyzing freeway vehicle-hours-traveled (VHT) from MPO models
- Default speed data from MOVES was used to generate emission rates
  - Even though emission rates are applied to model output data (including speeds) to estimate emissions, MOVES still requires a valid speed input
- Road type VMT distribution was calculated by comparing INDOT traffic count data and MPO model VMT estimates
- Meteorological data were converted from preexisting MOBILE input files using EPA's converters

Post-Processor

- Post-processor needed to apply MOVES emission rates to travel demand model output data
- A single tool that could be used with any model in Indiana
- Initial work started by reviewing the post-processor that had been developed for Indianapolis
- The Indianapolis post-processor was designed to be an integral part of the Indianapolis travel demand model
- Significant changes had to be made to the structure of the post-processor to make it applicable to any model in Indiana and to include additional features that added to the precision of the post-processor

Post-Processor (continued)

- Post-processor developed in GISDK (most models in Indiana (but not all) use TransCAD
- Interface allows user to select which analysis area to run and includes options for year, pollutant, and whether or not to execute the peak spreading model
- Post-processor reads emission rates file output from MOVES exported as CSV directly without additional formatting of the data

Hourly Traffic

- Post-processor starts with model daily volumes
- Daily volumes are disaggregated into hourly volumes using the same default Indiana hourly traffic fractions used as an input into MOVES
- Does **not** use model period volumes from time-of-day models since,
  - Most models in Indiana are daily models and the post-processor had to be universally applicable; and,
  - There is a question as to the validity of time-of-day model volumes (not all time-of-day models validate well to the period)
- The post-processor also starts with total volumes and uses vehicle type fractions to disaggregate traffic into source types

Hourly Traffic (continued)

- Hourly traffic is critical since MOVES emissions are calculated at an hourly level
- Speeds, temperature, humidity, and traffic volumes in MOVES are all at an hourly scale

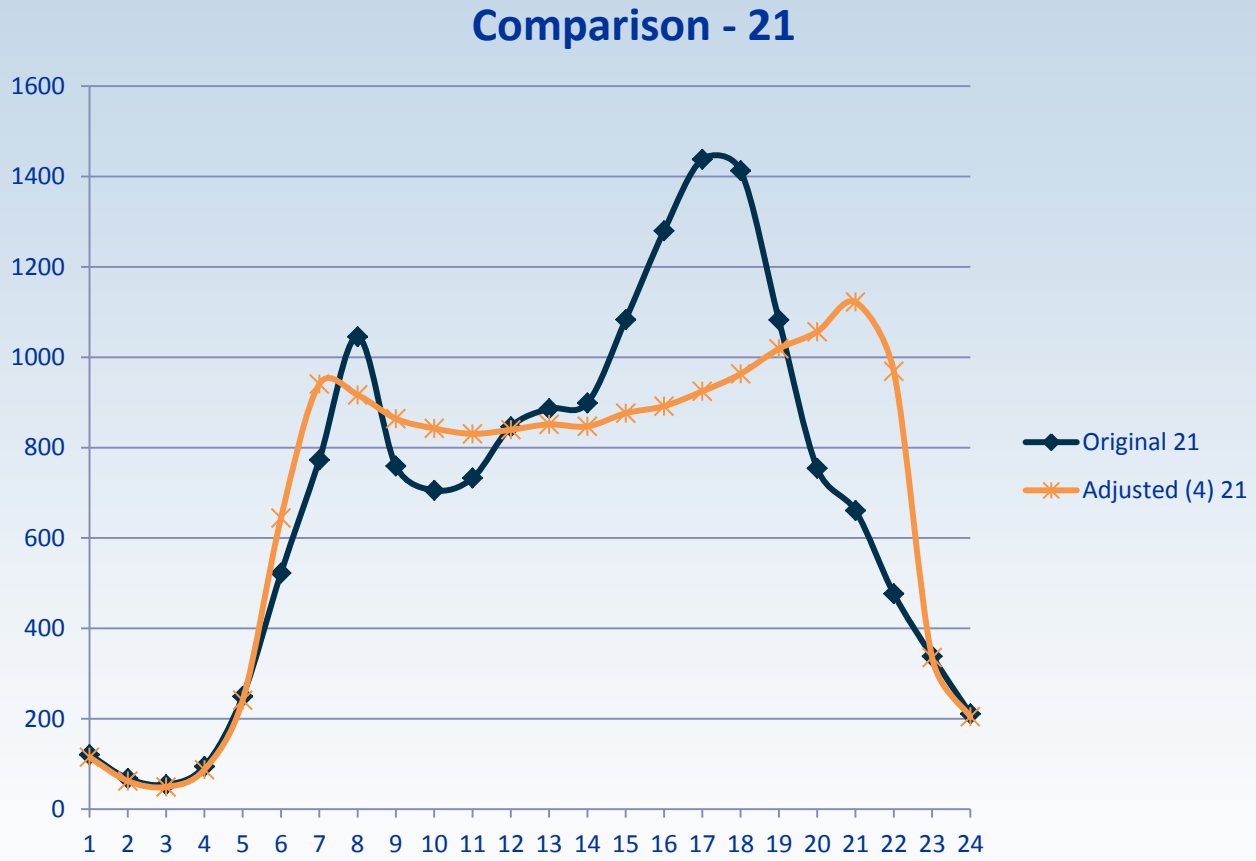
Peak Spreading

- There was some concern that in highly developed areas, particularly in the future, peak spreading may occur
- Peak spreading currently manifests in Gary, Indiana due to traffic related to Chicago
- Post-processor adapts the peak spreading methodology used by ODOT for their air quality purposes
- Traffic in over capacity hours are shifted onto the shoulder hours in an iterative process until all hours are at or under capacity
- Over capacity traffic is shifted half to the preceding hour and half to the following hour

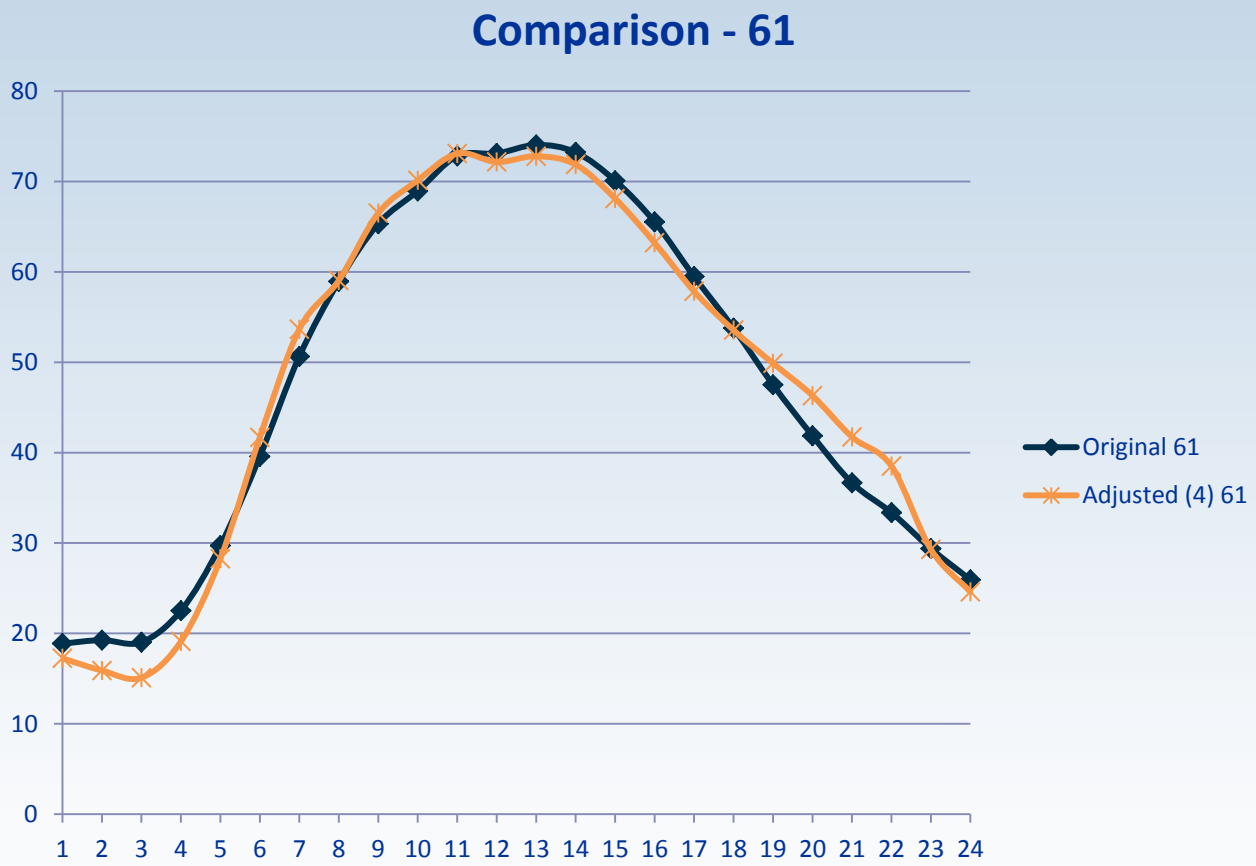
Peak Spreading (continued)

- Light vehicles are more sensitive to displacement from peak spreading
- Heavy vehicles are less sensitive

Peak Spreading (continued)



Peak Spreading (continued)



Hourly Speeds

- Hourly speeds are required by MOVES
- Emission rates are provided at an hourly scale
- BPR volume delay function used to calculate travel times, and subsequently, speeds using:
  - Hourly volumes
  - Hourly capacities
  - Alpha and Beta parameters from each travel demand model
- Hourly speeds are then associated with one of 16 MOVES speed bins

Speed Bin Interpolation

- MOVES Users Guide recommends interpolating emissions rates between speed bins as opposed to just using the rate directly associated with a single speed bin
- Otherwise, emissions estimates may be too sensitive to minute changes in speed
- Post-processor assigns two speed bins for every hourly speed, one high, and one low
- The resulting emission rate is interpolated based on the relative position of the hourly speed to the average speeds of the high and low speed bins

Conclusions

- Emissions rates developed late 2011 early 2012
- Post-processor finished late 2011
- INDOT training occurred in early 2012
- At least one MPO that began developing an independent approach to regional air quality analysis later adopted the INDOT approach after they compared their work to the final INDOT product

Questions?

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