MAKING USE OF MOBILE6'S CAPABILITIES FOR MODELING START EMISSIONS

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Overview

- Why Start Emissions Are Important
- Overview of MOBILE6 Capabilities for Handling Start Emissions
- Methods for Accounting for Start Emissions in SIP and Conformity Analyses
- Conclusions & Recommendations

Introduction

- Start emissions are a significant portion of total on-highway vehicle emissions in MOBILE6
- Although MOBILE6 offers new and improved capabilities for handling start emissions, most model users don't take advantage of them

Why Start Emissions Are Important

- Starts account for 28% of *total* on-road VOC emissions (exhaust and evaporative combined), 31% of CO exhaust emissions, and 20% of NOx exhaust emissions in a typical 2001 summertime model scenario
- Under wintertime conditions, start emissions can comprise up to 50% of total CO exhaust emissions

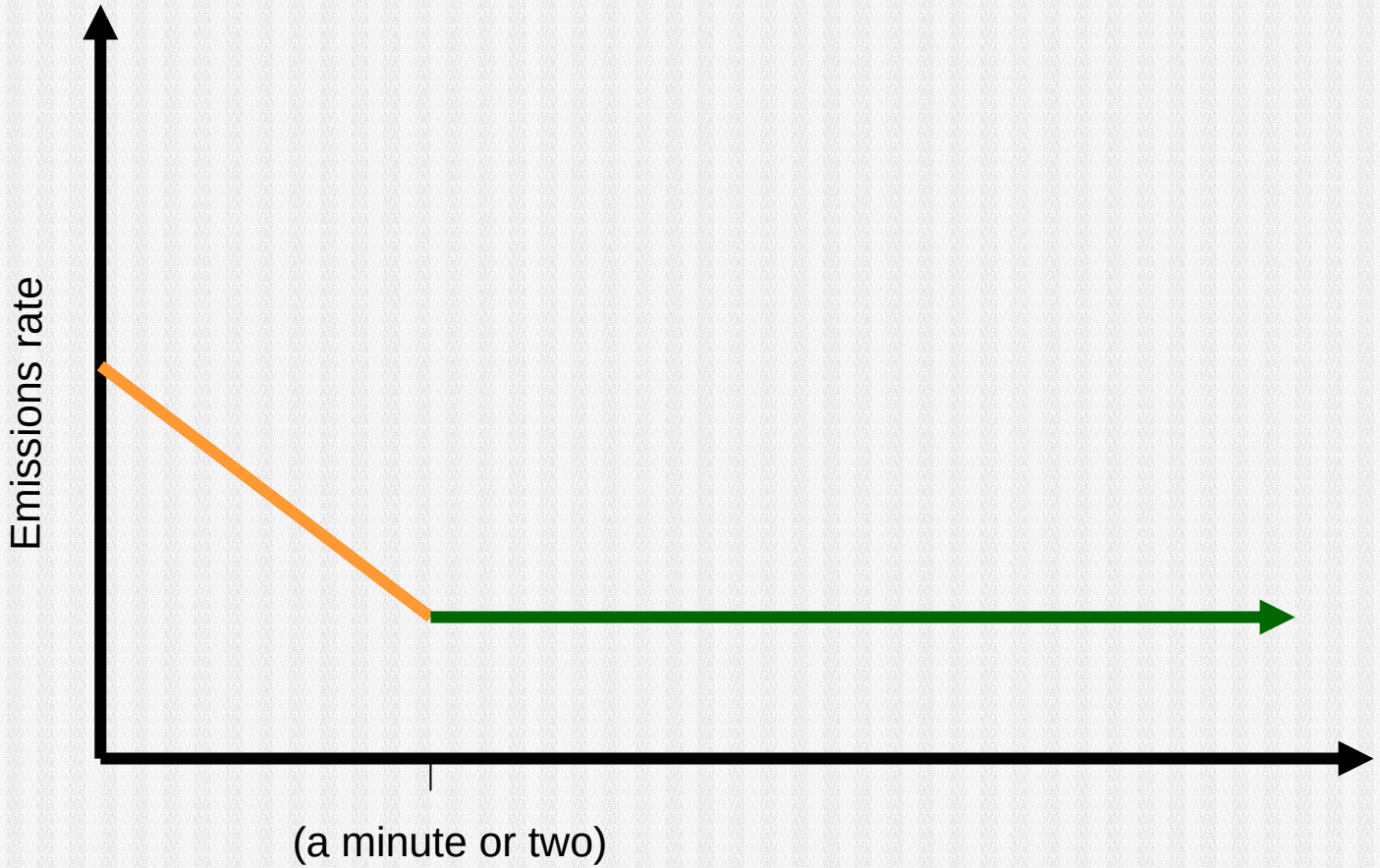
Start Emissions in MOBILE5

- In MOBILE5, as in the Federal Test Procedure, VMT in the cold start (Bag 1) and hot start (Bag 3) modes were weighted (43% cold, 57% hot)
- MOBILE5 combined the weighted start mode emissions with hot stabilized operation to produce emission rates
- Users could modify the cold start, hot start, and hot stabilized percentages

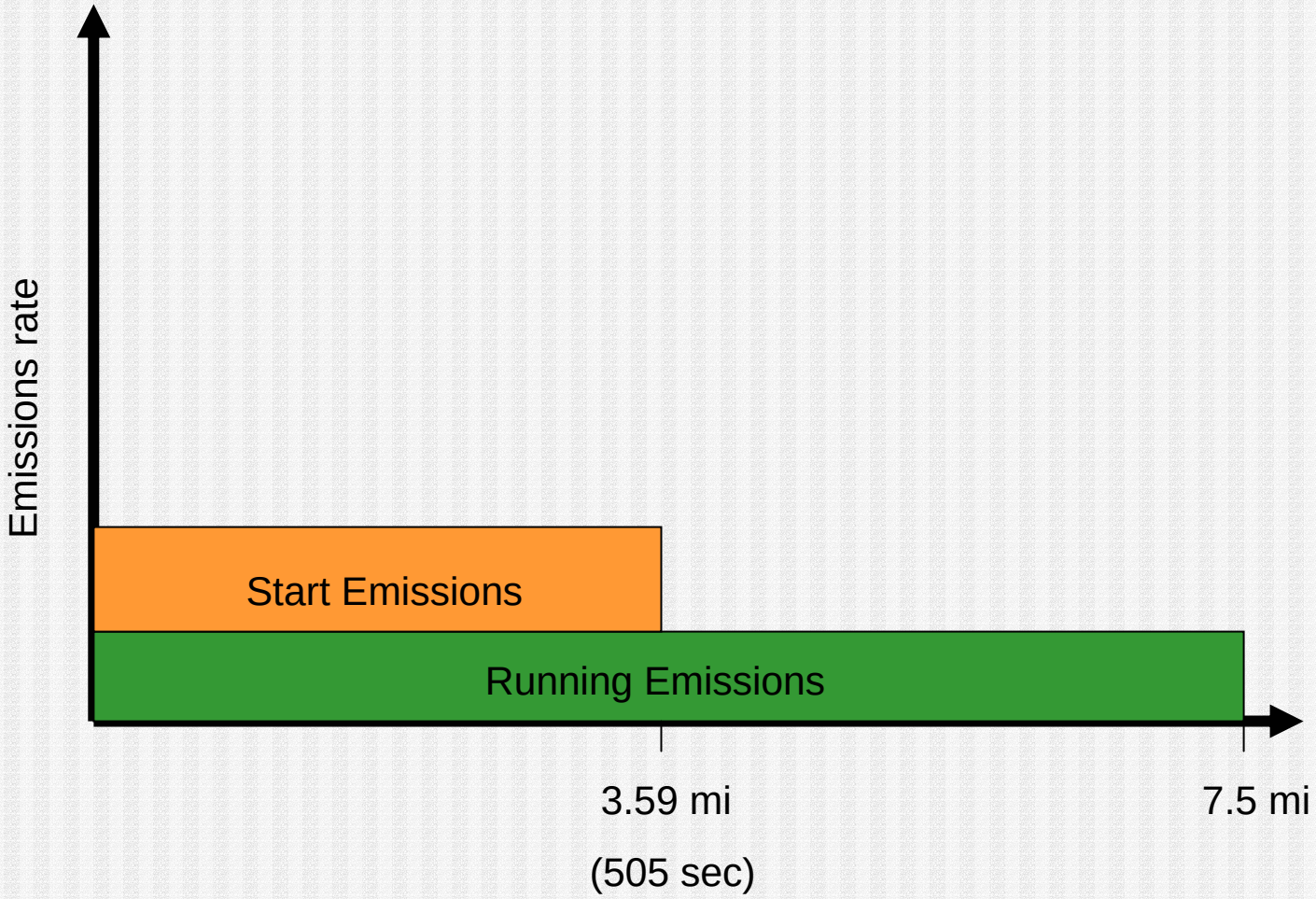
Start Emissions in MOBILE6

- MOBILE6 calculates start emissions separately, as a start “offset”
- Starts are not either hot or cold, but vary based on the *soak distribution* (length of time parked before the start)
- Unless instructed otherwise, MOBILE6 combines the weighted start mode emissions with hot stabilized (running) emissions to produce combined emission rates (just like MOBILE5)

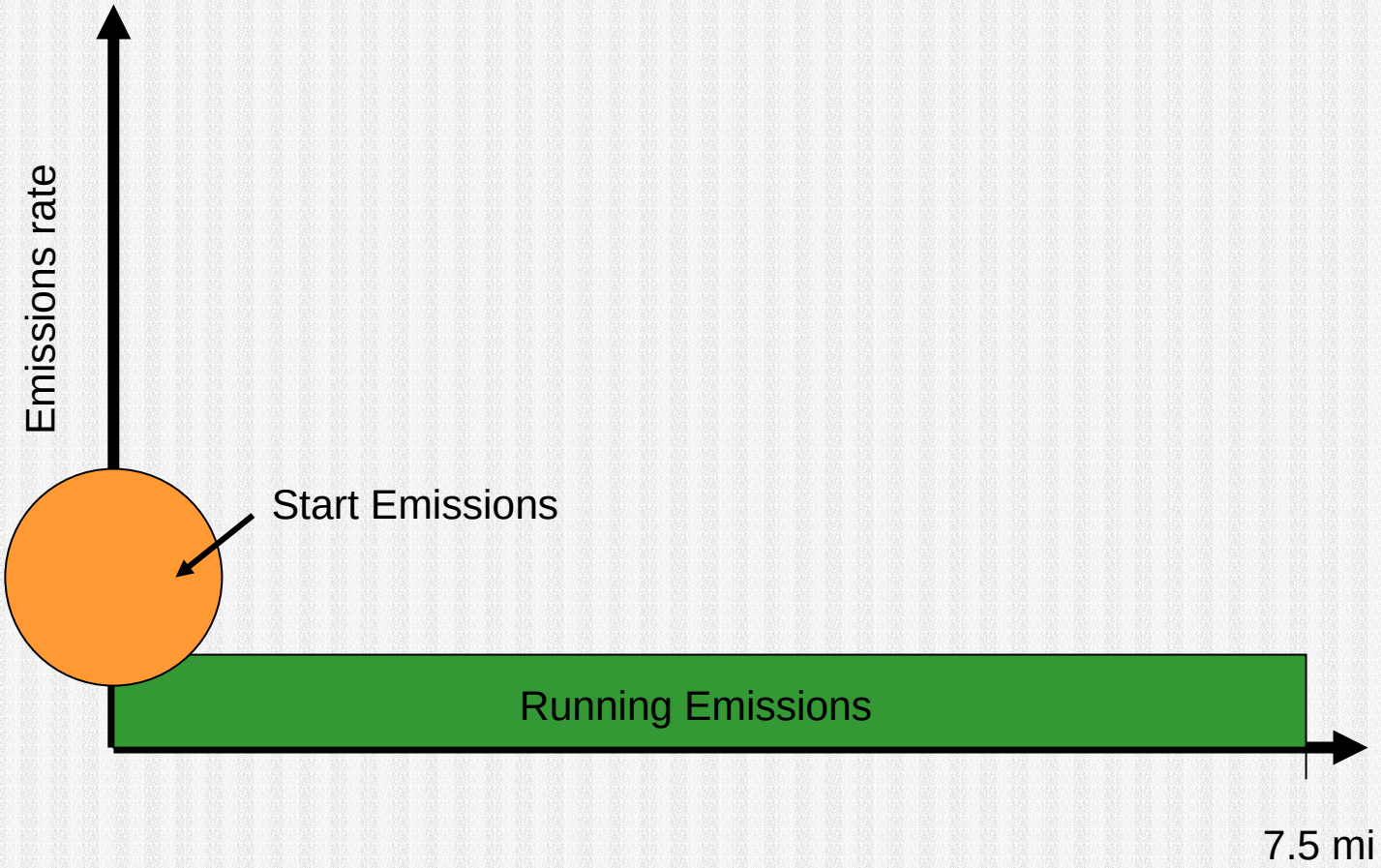
Real World Start & Running Emissions



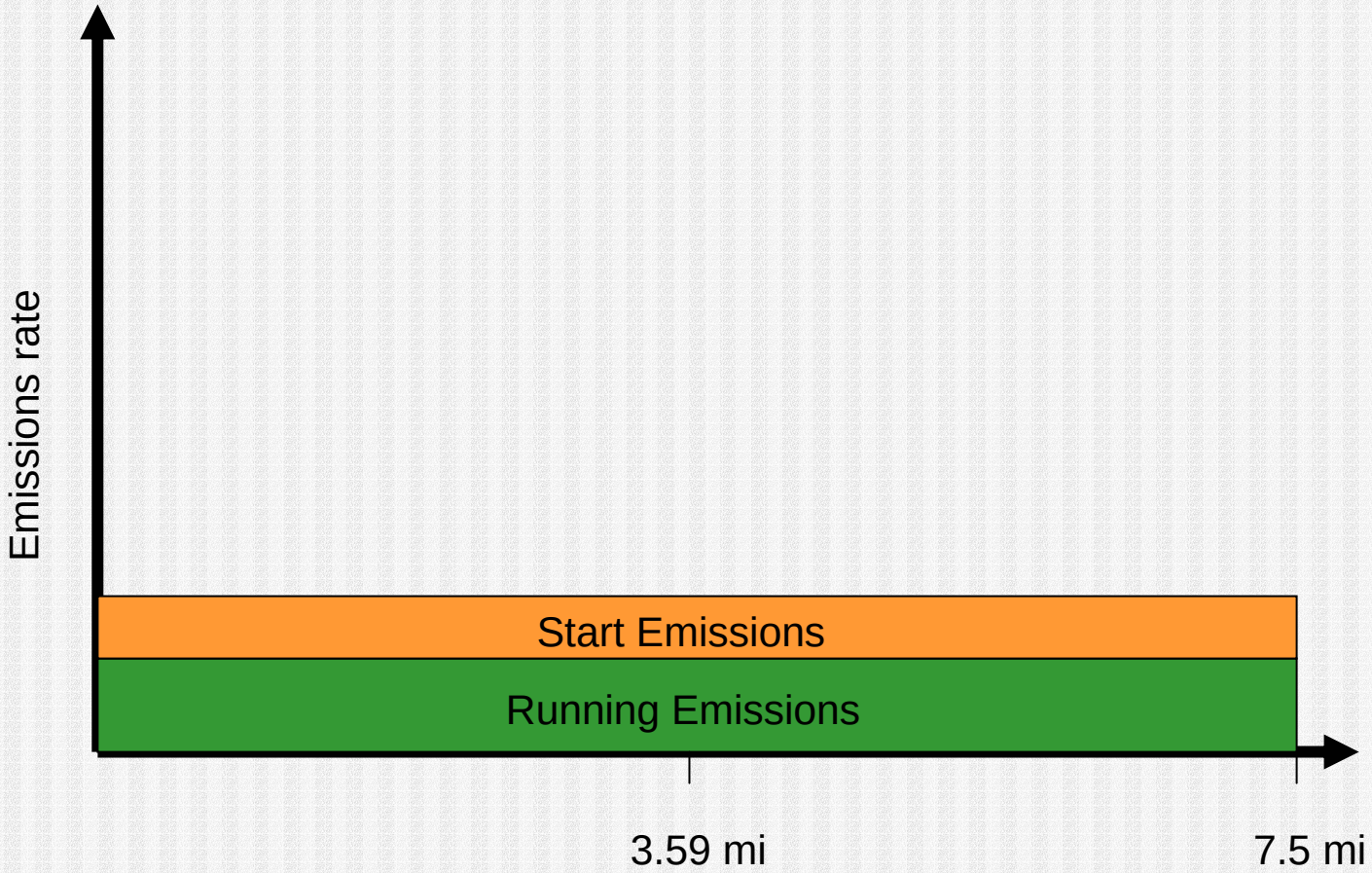
MOBILE5 Start Calculations



MOBILE6 Start Calculations



MOBILE5 & MOBILE6: Default Reporting Method



Start Emissions in MOBILE6

- Rather than rely on MOBILE's default mode of reporting emissions, users now have new flexibility:
  - Users can report start and running emissions separately
  - Users can modify the various distributions that affect start emission rates

Reporting Start Emissions Separately in MOBILE6

- Use the EXPAND EXHAUST command in the descriptive output
- Using the database output, emissions can be calculated in terms of grams per hour, grams per day, grams per mile, or grams per start (note: this generates a lot of data!)

Modifying the Distributions

- STARTS PER DAY
  - Allows users to specify the average number of starts (trips) per day by vehicle class
- START DIST
  - Allows users to allocate engine starts (trips) by hour of day
- SOAK DISTRIBUTION
  - Allows users to modify the default soak distribution, which defines, by hour of day, how long vehicles have been parked prior to an engine start

STARTS PER DAY Default Values

Vehicle Type	Weekday	Weekend
Light Duty Car	7.28	5.41
Light Duty Truck	8.06	5.68
Motorcycle	1.35	
Heavy Duty Gas Vehicle and Bus	6.88	
Heavy Duty Diesel Vehicle and Bus	6.65	

Some Notes . . .

- Start emissions are not reported separately in MOBILE6 for heavy duty gas or HD diesel vehicles, or buses
- Start emissions are not reported separately for particulate matter
- Users may modify the starts per day and soak distributions, but EPA recommends that an instrumented vehicle study be conducted

New Methods for Handling Start Emissions

- Addressing the impact of MOBILE6's default mileage accumulation rates on calculated grams per mile start emission factors
- Modifying the default hourly start distribution to reflect local travel patterns

New Methods for Handling Start Emissions

- Modifying the default starts per day for trips that are not started or completed within the urban area (external/internal and external/external (through) trips)
- Using travel model trips as a surrogate for MOBILE model starts

New Methods for Handling Start Emissions

- Assigning starts to travel model zones
- Considering starts for purposes of project-level analysis

1. MOBILE6's MAR and start emission factors

- MOBILE6 calculates total daily start emissions and then divides by miles/day to estimate grams/mile
- Miles/day comes from default or user-supplied mileage accumulation rate (MAR)
- Default daily weighted MAR for LDV/LDT/MC is 31.24 miles/day: is this appropriate for your area?

MOBILE6's MAR and start emission factors

- Example for Denver:
  - Default MAR: 31.24 mi/day
    - MOBILE6 CO start emissions: 387.4 gm/day
    - Start emission rate = 12.4 gm/mi
  - Denver MAR: 35.87 mi/day
    - MOBILE6 CO start emissions: 387.4 gm/day
    - Start emission rate = 10.8 gm/mi

MOBILE6's MAR and start emission factors

- Apply these emissions rates to Denver VMT (51,300,000 for LDV, LDT, MC):
  - CO start emissions using default MAR = 700 tons/day
  - CO start emissions using Denver MAR = 610 tons/day

MOBILE6's MAR and start emission factors

- Solutions:
  - Use National Household Travel Survey data (if available for your area) to adjust MOBILE6 emissions based on default MAR
  - Use local MAR data in MOBILE6
    - Note: using local MAR data has other effects in the model: MAR is used to "age" the fleet, so changing the MAR will change more than just start emissions rates.

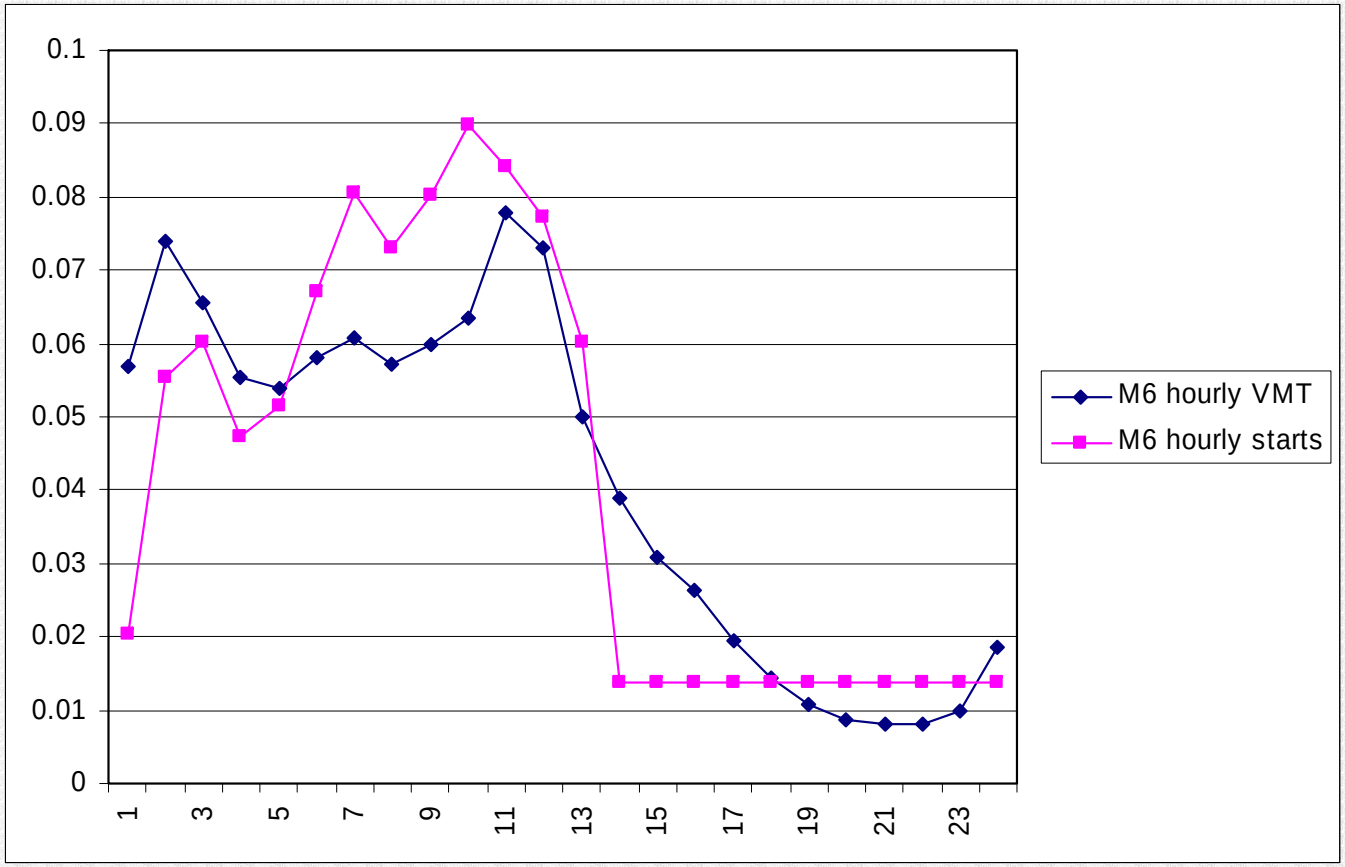
2. Modifying the Start Distribution with Local Data

- Users can modify the model's default distribution of trips by hour of day (instrumented vehicle study not required)
- This has a smaller impact on total emissions (0% - 3%) but is easy to do.
  - Sometimes a 3% difference is significant for an attainment demonstration or conformity determination

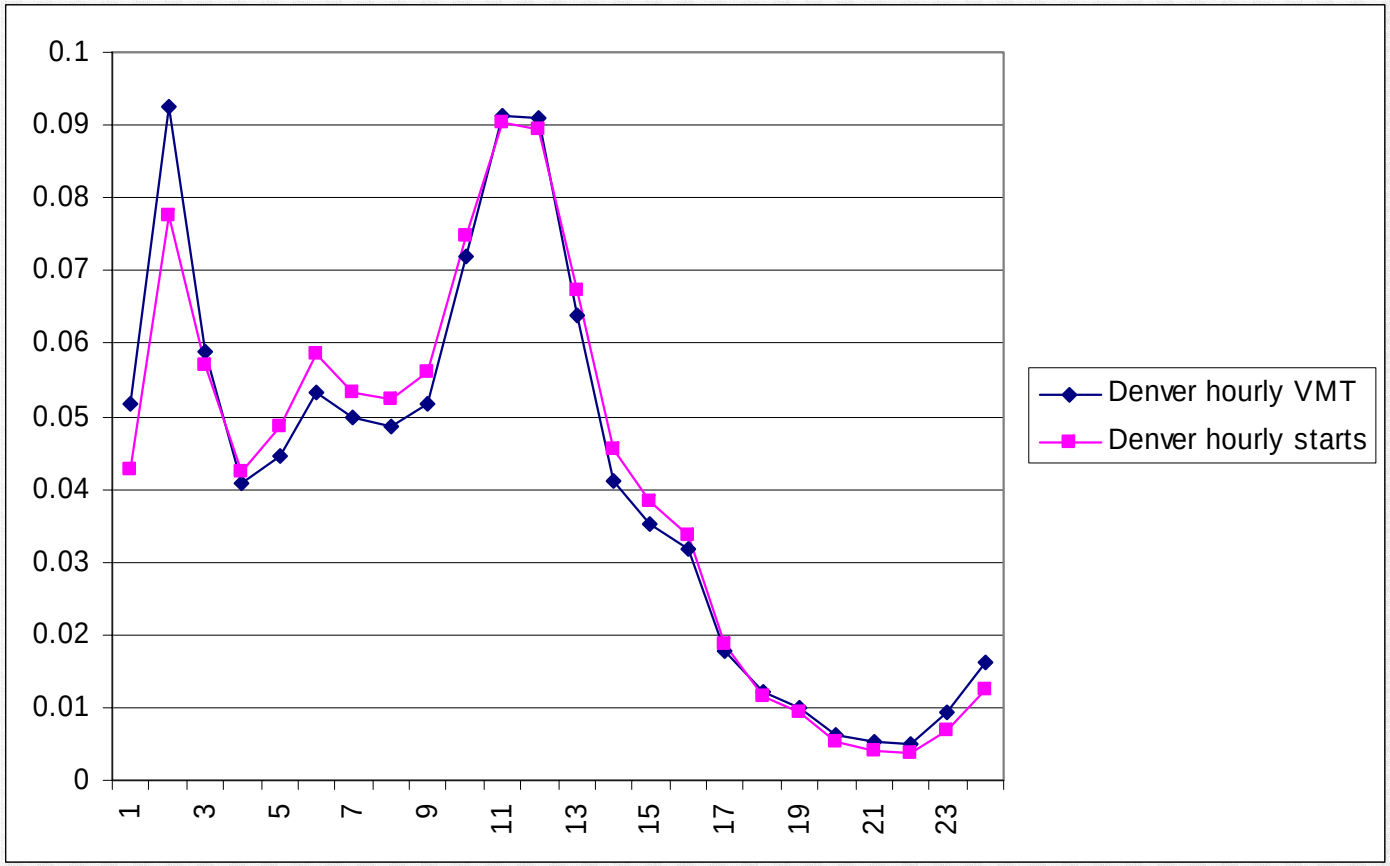
Modifying the Start Distribution with Local Data

- Options:
  - Use hourly VMT distribution (obtained from traffic recorders or other source) as a surrogate for hourly start distribution
  - Use hourly trip distribution from the travel model to represent the hourly start distribution

Modifying the Start Distribution with Local Data



Modifying the Start Distribution with Local Data



Modifying the Start Distribution with Local Data

Comparison of defaults, local HVMT, and local HVMT plus start distribution based on HVMT for Galveston, Texas					
	Defaults	Local HVMT	Percent Difference	Local HVMT & Starts	Percent Difference
VOC, gm/mi	1.75	1.763	0.74%	1.801	2.91%
CO, gm/mi	20.925	21.074	0.71%	21.669	3.56%
NOx, gm/mi	2.933	2.933	0.00%	2.939	0.21%

3. Dealing with Trips that Begin/End Outside the Area

- In most areas, some portion of VMT is made up of trips that don't start within the modeling area (external/internal and through trips)
- If MOBILE6 start emissions rates are applied to all regional VMT, which is common practice, start emissions will be overcounted

Dealing with Trips that Begin/End Outside the Area

- Example for Denver
  - 60,600,000 total daily VMT
    - 800,000 due to through trips
    - 5,300,000 due to external-to-internal trips
    - 6,100,000 daily VMT does not have a start in the modeling area
  - Applying start emissions rates to all VMT would overestimate start emissions by about 10%
  - In the winter, would overestimate total CO emissions by about 5%

Dealing with Trips that Begin/End Outside the Area

- Solutions
  - Model emissions for VMT from through and external-to-internal trips separately, with STARTS PER DAY set to zero (or with just running and evap emissions)
  - Modify the default starts per day estimate to account for VMT without an associated start

Dealing with Trips that Begin/End Outside the Area

- Notes
  - This issue is especially important for rural/fringe counties, with large amounts of through VMT, to consider.
  - Changing starts/day also changes hot soak activity. External-to-internal trips don't have a start in the area, but there will still be a hot soak at the end of the trip; be careful not to undercount these emissions.

4. Using Travel Model Trips for MOBILE6 Starts

- Travel models are not a good source of information for the number of starts per day; they are not good at capturing trip chaining
  - A quick stop at the coffee shop on the way to work usually isn't reported as a separate trip, but it does result in an additional start

Using Travel Model Trips for MOBILE6 Starts

- Can get around this by calculating a ratio of travel model trips to MOBILE default starts, and using this as an adjustment factor
- Travel model outputs can then be used to develop inventories, without the risk of undercounting start emissions

5. Assigning Starts to Travel Model Zones

- Start emissions can be calculated in terms of grams/start (either on a daily average or hourly basis)
- Start emissions can be assigned to the travel model zones where trips originate
  - Result: better definition of the geographic and temporal distribution of emissions for photochemical modeling

6. Considering Starts for Project-Level Analysis

- EPA recommends that in most cases, start emissions should not be included in the CO emissions rates used in CAL3QHC intersection modeling
- MOBILE6 capabilities facilitate this, along with specialized consideration of start impacts for some projects (park & ride lots and other TCMs, sports arenas)

Conclusions & Recommendations

- If local MAR is very different than local defaults, use local MAR data or calculate start emissions separately
- Use a local hourly start distribution, or use the hourly VMT distribution as a surrogate
- Factor out start emissions for VMT on trips that don’t have a start in the modeling area

Conclusions & Recommendations

- For photochemical modeling applications, refine the inventory by assigning start emissions to the zones where they occur
- For project-level analysis, don't include start emissions for most hotspot analysis; for analysis of TCMs and other special projects, consider how the project will affect start activity

For Further Information . . .

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- Paper posted at www.fhwa.dot.gov/resourcecenter/teamaq_pubs.htm