SACSIM Speed Calibration and Validation Using NPMRDS Speed Data

# Acknowledgements

<blurb about ARC’s help, link to their GH repos>

# Conflation

Conflation describes the process by which we tag NPMRDS TMC codes to SACSIM model segments, in turn allowing us to add NPMRDS speed data onto model segments for a variety of purposes with the general goal of having the model’s travel speeds better match real-world speeds.

## Conflating to SACSIM facility types not in the NPMRDS data

NPMRDS data, based on its f\_system field, cover the following facility types:

* General-purpose (GP) freeway lanes
* HOV lanes *if* the HOV facility is physically separated from the GP lanes
* Freeway-freeway connector ramps
* *Some* freeway-to-arterial on/off ramps
* Arterial and collector roads

Non-separated HOV lanes and auxiliary lanes are noticeably from this list. But SACSIM19 does represent them as separate links due to their operational characteristics being significantly different from GP lanes. E.g., compared to GP lanes, aux lanes have lower speeds and capacity due to weaving/merging, while HOV lanes in theory have more reliable travel times due to experiencing less peak-period demand than GP lanes.

With this in mind, we needed to figure out how, or whether, to conflate NPMRDS data to HOV lanes and aux lanes while capturing these facilities’ operational differences.

## Conflation process

### Automated component

<Insert flow diagram>

### Manual component

While the automated process described above successfully conflated the majority of TMC IDs to model links, the geometry differences between the two layers required some manual post processing. Among the most common issues that required manual correction included:

* Model link centroid was too far away from a TMC.
* On longer, curvy model links, the angle of the model link was too different from the end-to-end angle of the TMC.
* Model link conflated to the wrong TMC.
* Other issues?

# Validation and Calibration

*Validation* compares the model’s estimated speeds against observed speeds to see how different they are, while *calibration* makes adjustments to the model, where necessary and possible, so that modeled speeds are closer to observed speeds.

## Observed Validation Data

### Data Source

National Performance Measurement Research Data Set (NPMRDS). NPMRDS has separate speed files for just passenger vehicles, just trucks, and combined speeds of trucks plus passenger vehicles. For our validation we used the combined car plus truck speeds, given that the speeds assumed by the model are supposed to reflect all vehicle types.

#### COVID-19 and Data Year Selection

While 2020 speed data were available at the time of this writing, we decided to use 2019 speed data for all analyses because shelter-in-place orders resulting from the COVID-19 epidemic drastically altered travel patterns and travel speeds during 2020 and beyond. We cannot determine the extent to which travel patterns will return to pre-pandemic levels, but for planning and calibration purposes we are, both for travel modeling and all other aspects of our 2024 MTP-SCS, assuming base year conditions that reflect pre-pandemic conditions.

### Outlier analysis and removal

While NPMRDS data come somewhat pre-cleaned of outliers(e.g. speeds of <2mph or >100mph are removed), we want to come as close as possible to an “apples to apples” comparison with the model. NPMRDS speeds pick up all time periods and all hours, including extreme events like multi-lane closures, or if the only vehicle traveling a section of road was, for example, a slow-moving farm implement. In contrast, the model focuses on what is “typical” travel, not accounting for unusual events that, while rare, can be significant enough to affect average speeds.

## Free-flow speed

### Estimation from observed data

Free-flow speed is supposed to represent the speed at which cars travel when unimpeded by the presence of other cars on the road.

Our free-flow speeds consider all days of the week, for the calendar year 2019.

TASK – compare the 85th percentile overnight speed to the 3am-6am “average” speed, which is what ARC used. Is it slower or faster than the 85th percentile speed? Which one should we use?

### Free-flow Speed Calibration

#### Model Links with Observed Speed Data

Free-flow speed calibration was straightforward on model links for which observed speed data were available, involving little more than simply setting the model link’s free-flow speed to be equal to the observed free-flow speed.

#### Model Links without Observed Speed Data

A large share of SACSIM’s model links do not overlap the NPMRDS TMC network and thus have no observed speed on which to base their free-flow speed.

TASK – more relevant to doing capclass examination, but should look at free-flow speed variation by capclass (after getting full conflation done). If high variation in free-flow speed for a particular capclass, that implies there is not a good enough definition, or a poorly applied definition, of that capclass. Of course capacity class is more about capacity rather than speed. But if we want to have a method for applying speeds to links off the TMC network, capclass might be a good basis on which to do so.

TASK – need to know if we want to use a similar approach to ARC for applying free-flow speeds to links without TMCs (based on capclass and area type, latter of which we don’t have). And if not, how we want to do this.

* Issue with ARC approach is that it is too coarse, plus SACOG doesn’t have defined area types that would be good for speed setting (maybe PPA versions of community types?)
* This step will probably need to come after rejiggering capclass definitions for arterials.

<INSERT scatterplot charts comparing free-flow speed validation before and after updating the network>

## Congested speeds

Validating congested speeds is inherently difficult to do on an apples-to-apples bases between the model, for which the sole determinant of congested speed is volume/capacity ratio (V/C), and observed speeds, which in addition to being affected by V/C are significantly influenced by operational factors like traffic signals, merging and weaving movements, as well as events like collisions or construction that affect vehicle flow.

< Possible task Intriguing check of VDF that SACOG could replicate: for each link, plot its VDF curve overlaid on a scatter plot comparing V/C to NPMRDS congested speed.>