Greenhouse Gas Emission Scenarios of Land Use Change Using a Large Scale Continuous-Time Activity-Based Microsimulation Model System in Southern California: Design, Implementation, Preliminary Findings, and Future Plans

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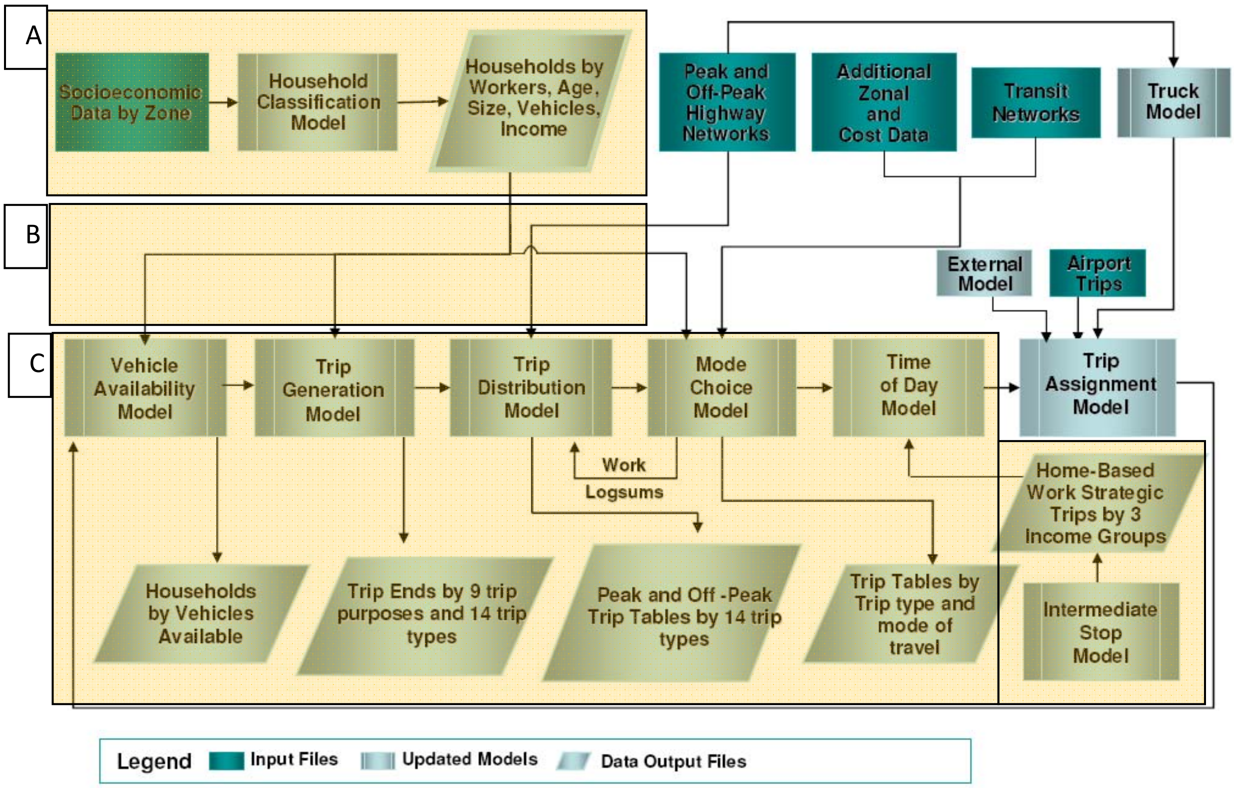
The State of California has recently embarked on an aggressive movement towards reducing greenhouse gas emissions that contribute to global climate change, promoting sustainability, and better managing vehicular travel demand. The recent California State Senate Bill 375 explicitly calls for major metropolitan areas in the state to meet ambitious greenhouse gas emission reduction targets within the next several years. Metro areas are considering a range of policies to meet the emission reduction targets including land use strategies, pricing mechanisms, managed lanes, telecommuting and flexible work hours, enhancement of transit and pedestrian/bicycle modes, and use of technology to better utilize existing capacity. The analysis of these policies, and responding to the mandates of legislative actions such as Senate Bill 375 in California, calls for the adoption of model systems that are able to accurately represent activity-travel patterns of humans in a fine-resolution time-space continuum. The Southern California Association of Governments (SCAG), the metropolitan planning agency for the Southern California region, is moving forward with the development of a comprehensive activity-based microsimulation model system of travel demand to enhance its ability to estimate the impacts of a range of policy measures in response to Senate Bill 375 (http://www.scag.ca.gov/sb375/index.htm). The modeling region, including a population of 19 million people, offers an extremely complex multimodal and diverse planning context in which to develop, implement, and test activity-based microsimulation model systems.

This paper describes the first phase of the development and application of an activity-based microsimulation model system called SimAGENT (Simulator of Activities, Greenhouse Emissions, Networks, and Travel) that has been specified and calibrated to the Southern California region. The model uses CEMDAP (Comprehensive Econometric Microsimulator of Daily Activity-travel Patterns) as its modeling engine and simulates activity-travel patterns of all individuals in the region for a 24 hour period along the continuous time axis. In the paper, the authors describe how the original version of CEMDAP, estimated and calibrated to the Dallas-Fort Worth region in Texas, is adapted, modified, and calibrated to the Southern California region context (see also http://www.ce.utexas.edu/prof/bhat/CEMDAP.htm).

The sheer size of the region and the magnitude of the population results in high computational burden and prohibitively high model run times that require the use of parallel computing capabilities and simulation of activity-travel patterns for a sample of the synthetic population and expansion to the entire population. This model includes the explicit accounting for interactions among household members and time-space interactions in the patterns of activities and travel.

Figure 1 shows the four-step model used by SCAG currently. It also shows three model groups that replace model components in the overall regional model system labeled as A, B, and

FIGURE 1
SCAG REGIONAL TRAVEL MODELING PROCESS



Component A is a PopGen application tailored to the SCAG region and creates a synthetic population using zonal control distributions at the household and person levels jointly (Figure 2 provides an example of the joint distribution of race and age). The detailed procedures, algorithms, and data requirements are documented on the urban model web site (http://urbanmodel.asu.edu/popgen.html). In Phase 1 the entire population of the SCAG region was generated for the years 2003 and 2008 and its output is used in Component B which a modified version of CEMSELTS. This component generates and assigns for each household a set of spatial choice attributes including school and employment locations, residential tenure and type, income and car ownership, as well as work flexibility and duration for the simulation day. The combined input of Components A and B is used in Component C, which is CEMDAP estimated in Dallas-Fort Worth and slightly modified to match modal split in the SCAG region. Detailed description of CEMSELTS and CEMDAP are available at (http://www.caee.utexas.edu/prof/bhat/FULL_CEMDAP.htm).

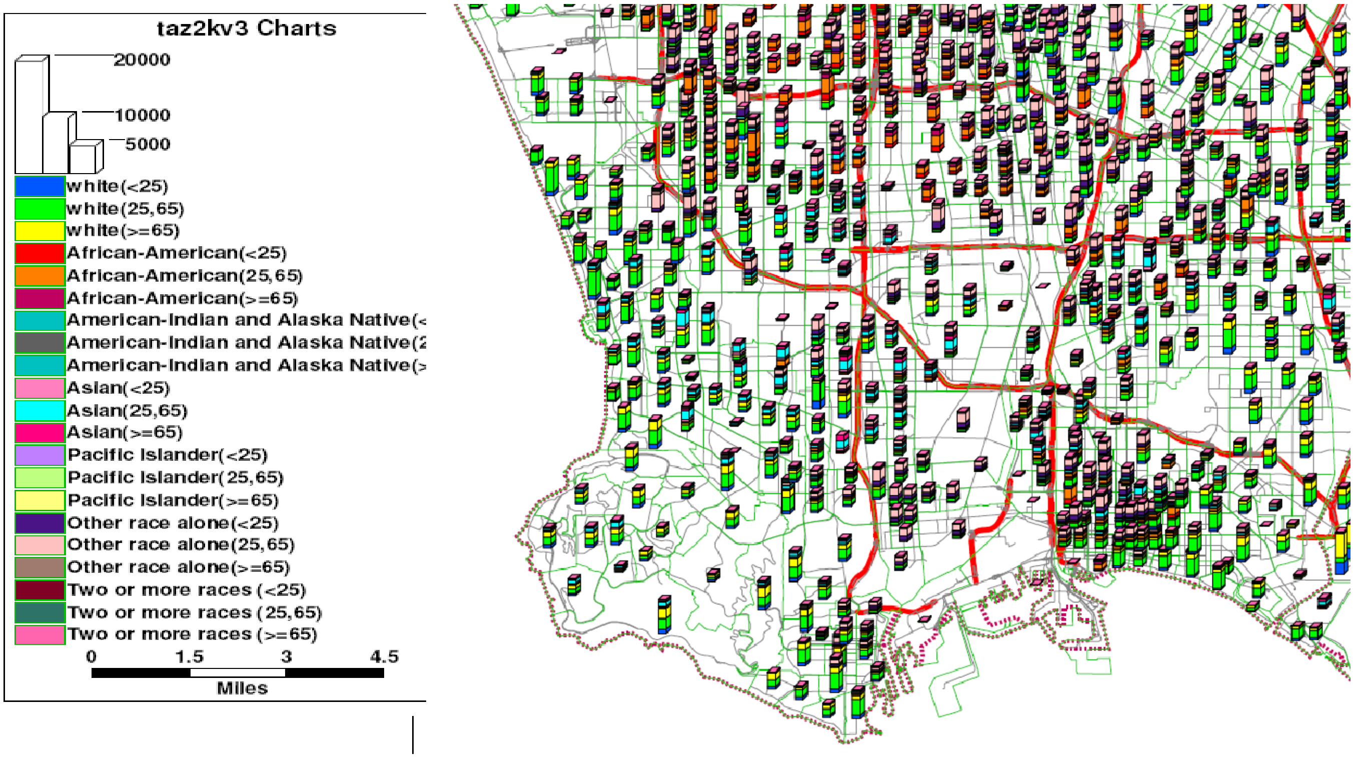


Figure 2 Example Output from PopGen for the SCAG Region

The outputs of the A-B-C are daily synthetic schedules of all the persons in the region. Scenarios can be created either by changing zonal attributes and/or the combination of characteristics within zones, a subset of zones, or even a portion of the residents and workers of a zone. Moreover corridors can be identified and changes imposed on zones that are impacted by corridor specific policies. All these changes are simulated using all three components. The output again will be a complete set of synthetic schedules followed by the synthetic population. This same output is also used to create Origin-Destination (OD) matrices to match the OD matrices used by the other SCAG model components (Truck, External, and Airport Trips) and are employed in the four time-period static assignment of the four-step regional model. This model system is designed to pilot test a variety of model components in CEMSELTS and CEMDAP for SCAG and to examine if transferability using a combination of local data with models and processes from another region is feasible at all. This is accomplished with a variety of land use and pricing scenarios, one output of which is provided in Figure 3, which shows the shifts in work end time of increased population density and different pricing schemes. The figure shows the type of analysis that can be done with synthetic schedule based policy analysis. It also shows the lack of dramatic shifts in time allocation of the policies tested, which is due to a combination of transferability error, rigidity of work scheduling, as well as the aggregate level (across all workers) at which the results are presented.

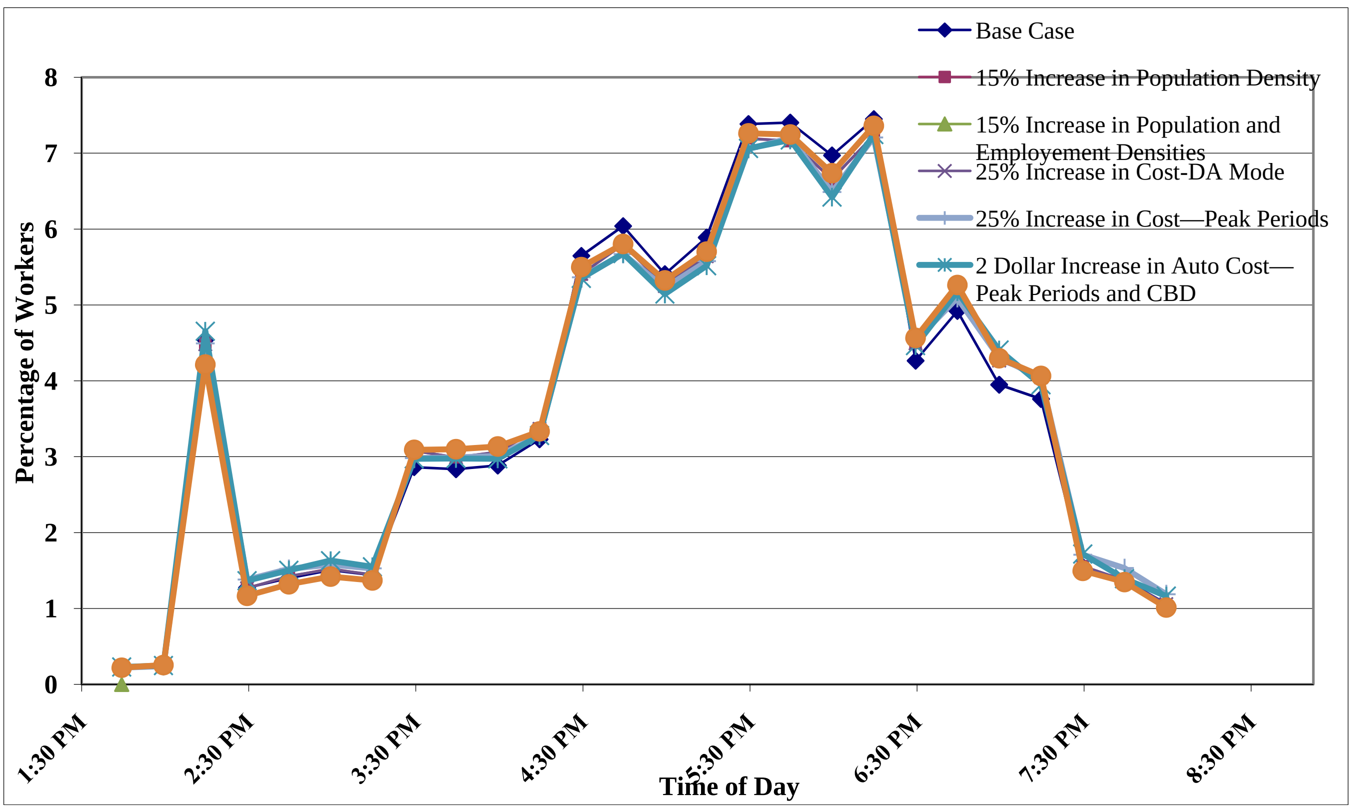
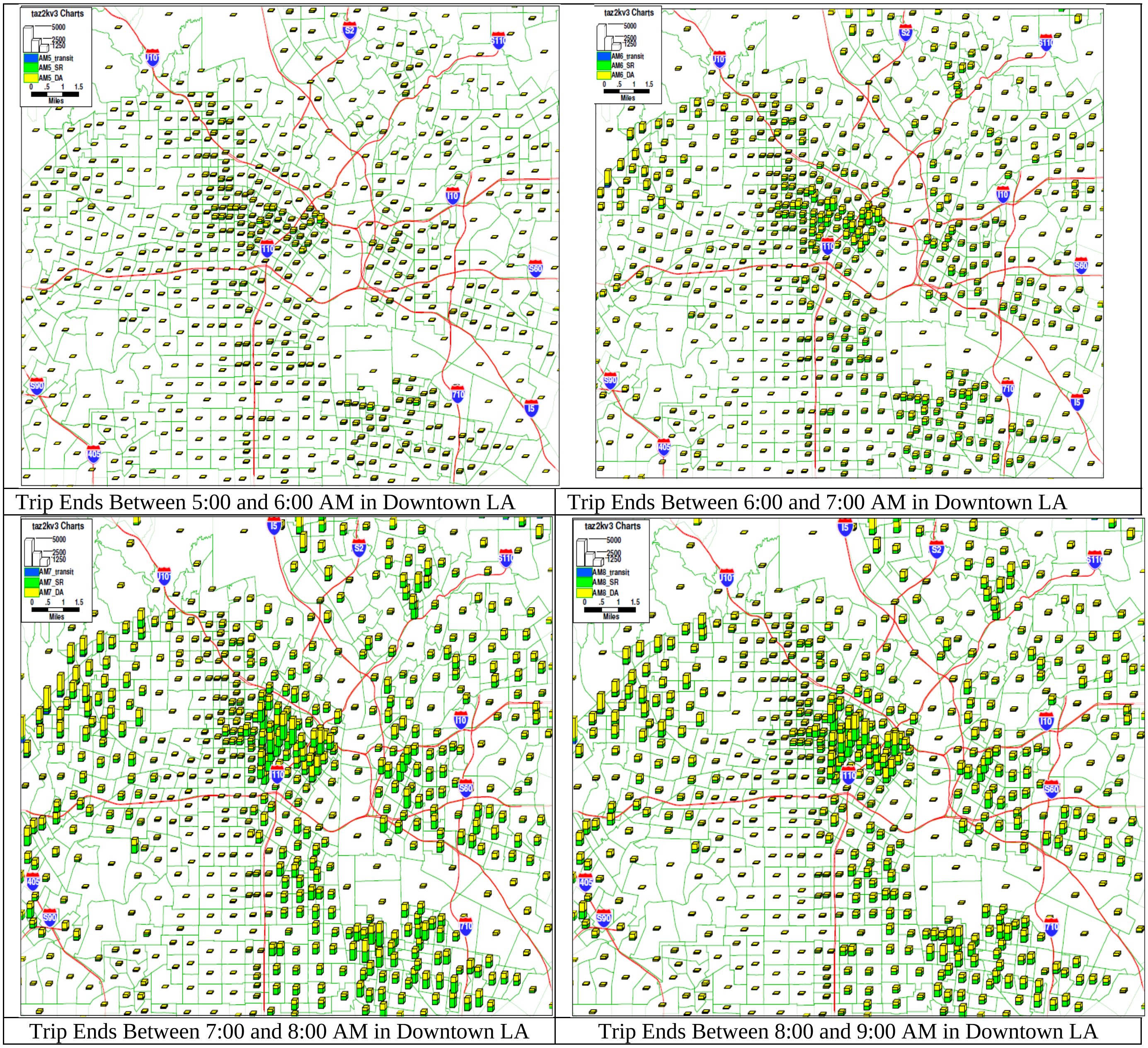


Figure 3 Base Case vs. Policy Case - Work End Time (after 1:30 PM to 8:00 PM only)

Figure 4 illustrates the hour by hour trip ends per square mile by each mode produced by this model system. Although this is an experimental model in its phase 1 it already produces reasonable estimates of travel demand on the existing network that has comparable characteristics to the four step. However, there are many improvements that are required to make this model a replacement for the four-step and to give it all the capabilities required for a well calibrated model system.



Trip Ends Between 5:00 and 6:00 AM in Downtown LA

Trip Ends Between 6:00 and 7:00 AM in Downtown LA

Trip Ends Between 7:00 and 8:00 AM in Downtown LA

Trip Ends Between 8:00 and 9:00 AM in Downtown LA

Figure 4: Hour by Hour Trip Ends Arriving in Downtown Los Angeles based on SimAGENT Estimates

At the time of writing this short communication comparisons between the four-step model and the Phase 1 model system are complete, offering reasonable closeness between the two model systems when evaluated in terms of cordon station traffic counts and aggregate trip rates at the county level. The phase 1 model starts with PopGen synthetic population and ends with EMFAC outputs of emissions. Moreover, experiments with sampling of the population to test scenarios are also complete and testing of computational times using two multi-core servers (SUN 24 core and SUN 16 core) give us a general idea of running times required for each model component. A variety of computationally efficiency gaining schemes are also studied and they include the usual multithreading and parallel processing but also population sampling.

By the time of the conference we will have completed strategic modifications of the Phase 1 model system and a first pass calibration and comparison with the existing four-step model including assessments based on Greenhouse gas emissions for year 2035. We will also present the model system architecture details of Phase 2, which will replace the CEMDAP models with SCAG tailored statistical models that more closely map the relationship between land use and travel behavior. Policy scenarios will be examined in terms of activity-travel behavioral response (at the individual-level, corridor-level, and regionwide level), assigned traffic, and GHG emissions. In addition, we will also provide a variety of recommendations that can be used by other model development teams on accessibility measurement, intra-household interactions, models that can be transferred and models that should be redesigned, as well as computational efficiency schemes.