Integration of Land Use into Travel Demand Modeling

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Outline

- Introduction
- UrbanSim
- Simulation Design
- Application
  - Study Area
  - Simulation Results
- Findings

Introduction

- Transportation and land use interact each other
  - As accessibility improves, the land will become more attractive to developers
  - Induced activities will influence transportation facilities through travel behavior
- TRB Special Report 245:

"the state of knowledge and modeling practice are not adequate for predicting with certainty the impacts of highway capacity additions"

What is UrbanSim?

- Land use microsimulation model
- Developed by the University of Washington
- Provide new land use forecasting and analysis capabilities
  - Based on economic theories
  - Model the interactions of markets and policies
  - Design to interface activity-based models
- Open source software – source code free to use, modify, and redistribute (available at www.urbansim.org)

Input Information

- Population and employment estimates
- Regional economic forecasts
- Land use plans
- Land development policies such as density constraints, environmental constraints, and development impact fees

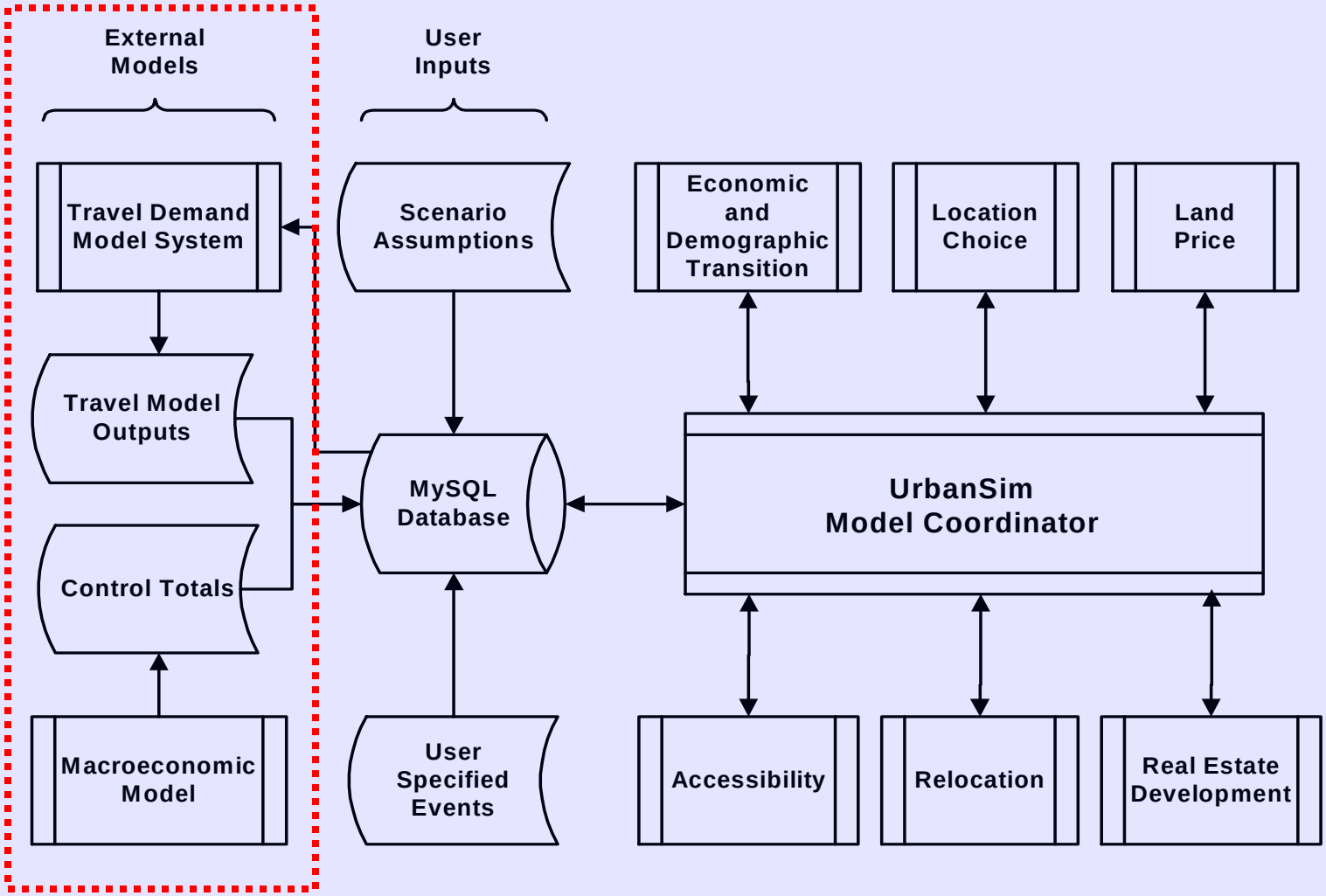
Output Information

- Future year distributions of population
- Households by type (e.g. income, age of head, household size, presence of children, and housing type)
- Businesses by type (e.g. industry and number of employees)
- Land use by type (user-specified)
- Units of housing by type
- Square footage of nonresidential space by type
- Densities of development by type of land use
- Prices of land and improvements by land use

UrbanSim Users

- **US Users**: Seattle, Eugene-Springfield, Houston, Honolulu, Salt Lake City, Phoenix, Detroit
- **Europe Users**: Amsterdam, Paris, Zurich
- **Middle East Users**: Tel Aviv
- **Potential Users**: Downloaded from 80 Different Countries

UrbanSim Model Structure



Sub-Models

- accessibility-model
- household-transition-model
- employment-transition-model
- household-relocation-choice-model
- employment-relocation-choice-model
- household-location-choice-model
- employment-non-home-based-location-choice-model
- employment-home-based-location-choice-model
- scaling-procedure-for-jobs-model
- land-price-model
- real-estate-development-model

Land Price Model

- Linear Regression
- Dependent Variable – natural logarithm of the total land value within a grid cell
- Independent Variables
  - Development type
  - Land use plan
  - Environmental constraints
  - Access to population and employment
  - Land use mix and density
  - Proximity to highways and arterials

Household Location Choice Model

- Applies to new and moving households
- Multinomial Logit Specification
- Variables used
  - Housing cost to income ratio
  - Income * improvement value/unit
  - Trip-weighted utility for HBW by SOV
  - Near arterial road
  - Housing density within walking distance
  - Development types (density, land use mix)
  - Housing age
  - Job accessibility by auto-ownership group
  - Travel time to CBD and airport
  - Neighborhood land use mix and density
  - Neighborhood employment

Employment Location Choice Model

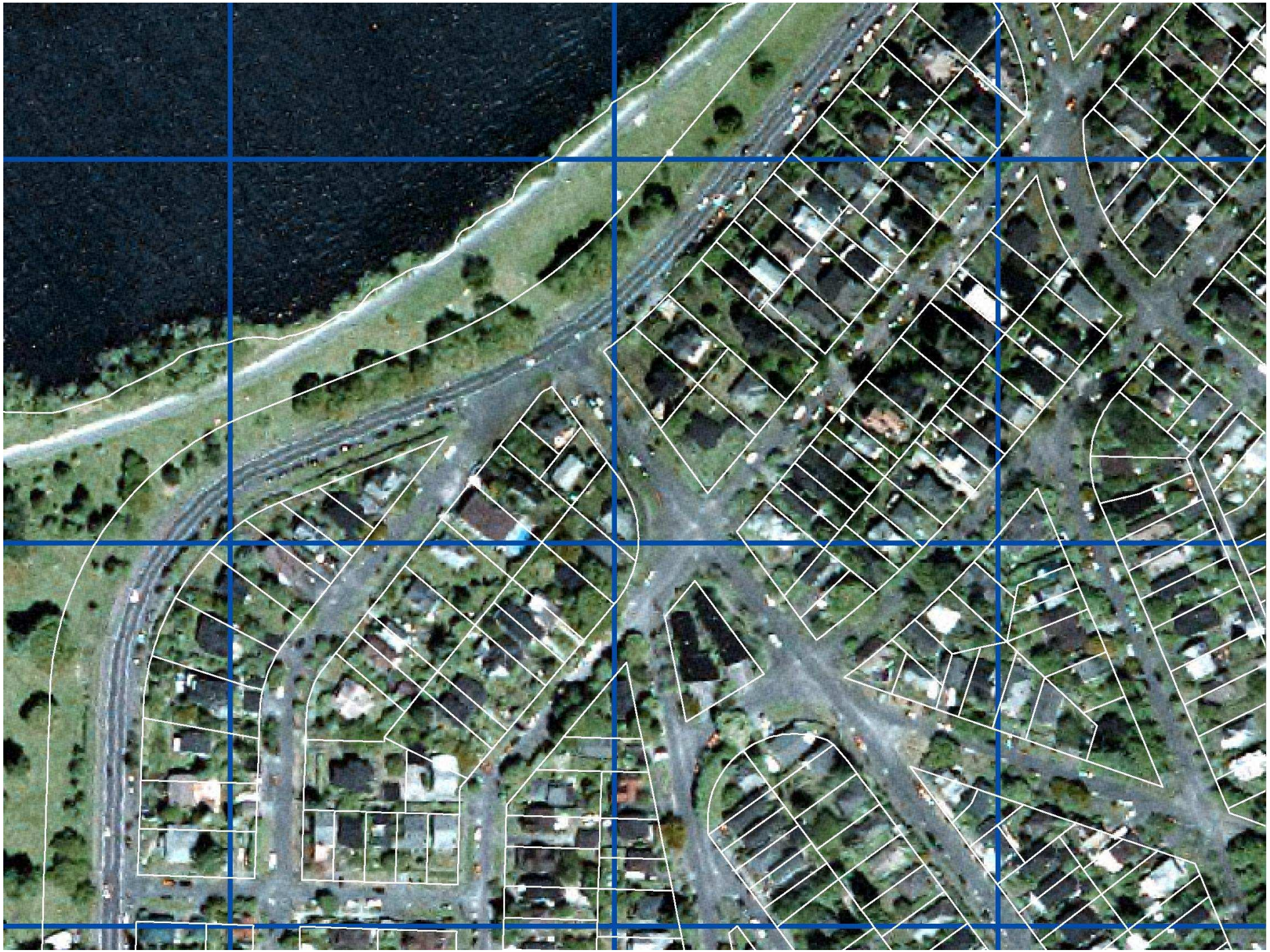
- Applies to new and moving jobs
- Multinomial Logit Specification
  - Employment Home-Based Location Choice Model
  - Employment Non-Home-Based Location Choice Model
- Variables used
  - Total value of land and improvements
  - Trip-weighted (destination) utility for HBW by SOV
  - Travel time to CBD
  - Employment by sector in area
  - Industrial, commercial sqft
  - Proximity to highways and arterials
  - Housing density in area
  - Percent low income in area; mid-income
  - Building age

Real Estate Development Model

- Predicts grid cell development events
- Multinomial Logit Specification
- Variables used
  - Value of land and improvements
  - Land value per acre in area
  - Employment by sector in area
  - Housing units in area
  - Proximity to existing development
  - Development composition in area
  - Recent development events in area
  - Travel time to CBD and airport
  - Trip-weighted travel utility
  - Highway adjacency and distance from
  - Percent: floodplain; water; wetland; stream buffer; steep slope

Data Required

- Grid Cells
- Parcel Data
- Property Tax Data
- Employment Data (Info/USA)
- Environmental Layers: Water, Wetlands, Floodplains, Parks and open space, National forests, Steep slopes (DEM), Stream buffers (riparian areas)
- Planning and Political Layers: Traffic Analysis Zones (TAZs), Cities, Urban growth boundaries, Military, Major public lands, Tribal lands
- Streets



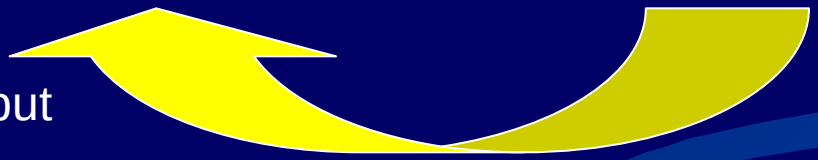
Simulation Process

1 Households
Employment

2 ZDATA1
ZDATA2

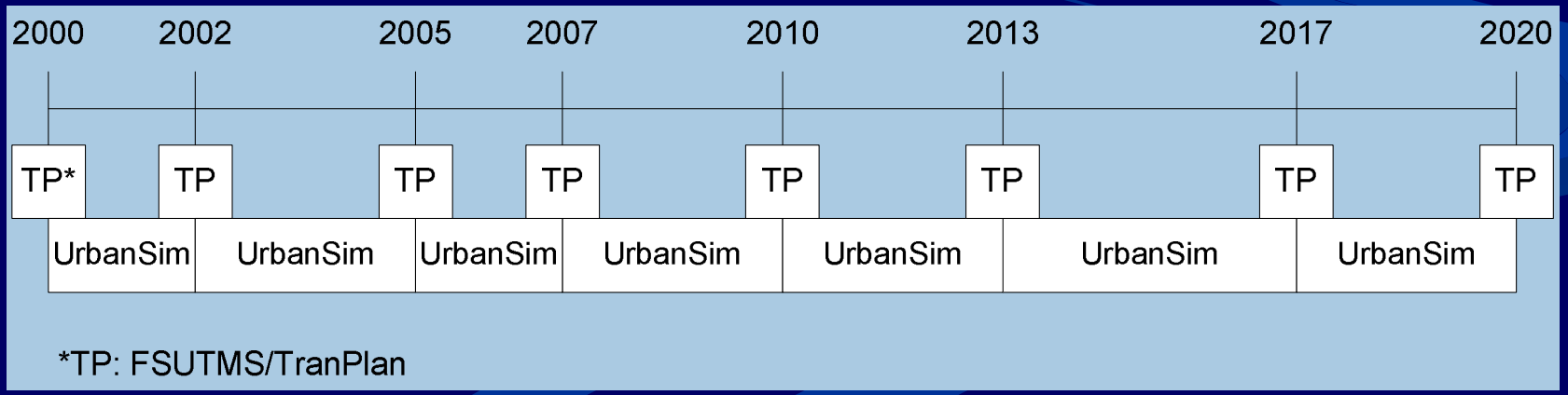
UrbanSim

FSUTMS



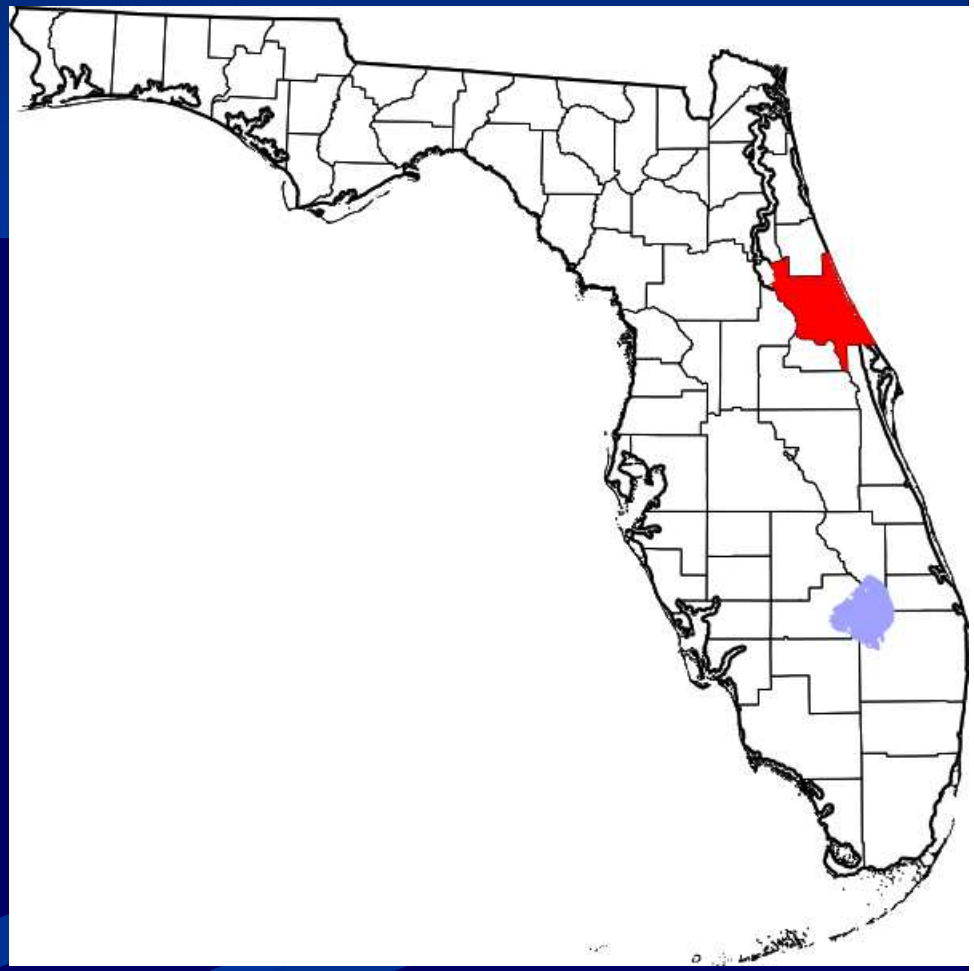
4 Accessibility_Input
Travel_Data
Zones

3 Composite Utility by Auto Ownership
Highway Travel Times



Volusia County

- 1,263 square miles
- Population – 443,343 in 2000
- Surrounded by Flagler, Marion, Lake, Seminole, and Brevard counties (most rural)

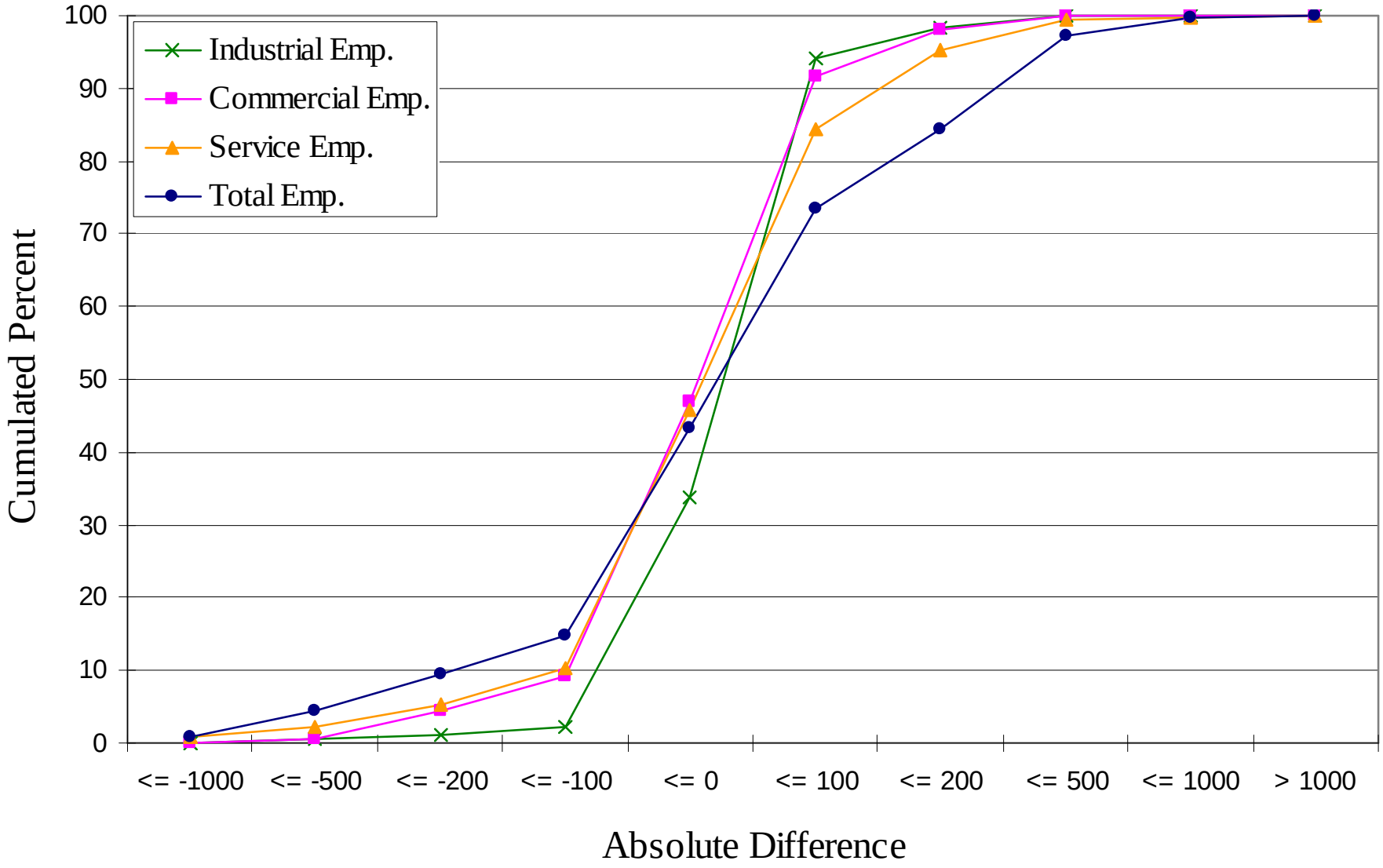


Simulation Results

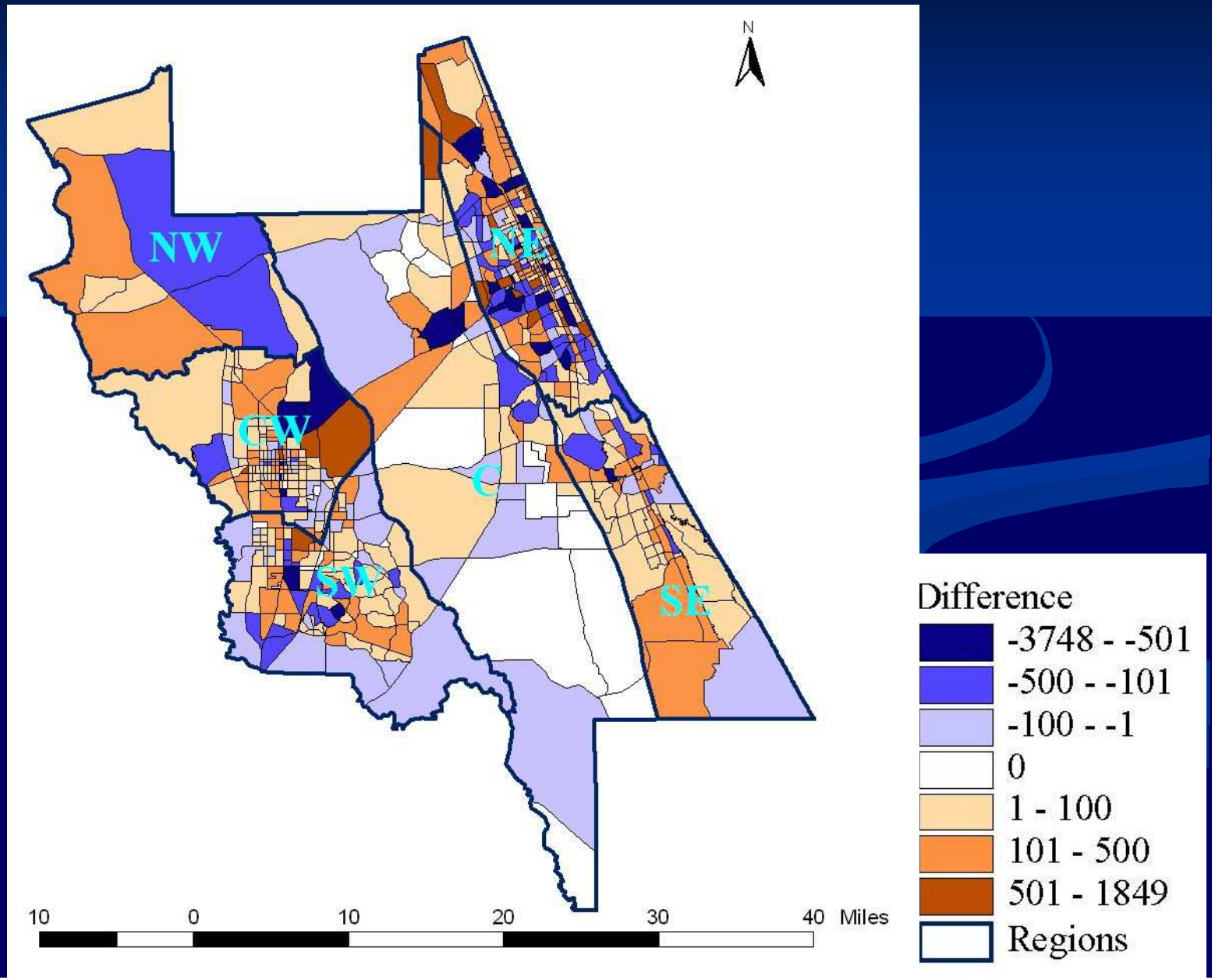
Compared with

- 2005 InfoUSA Employment Data
- 2020 Long Range Transportation Plan

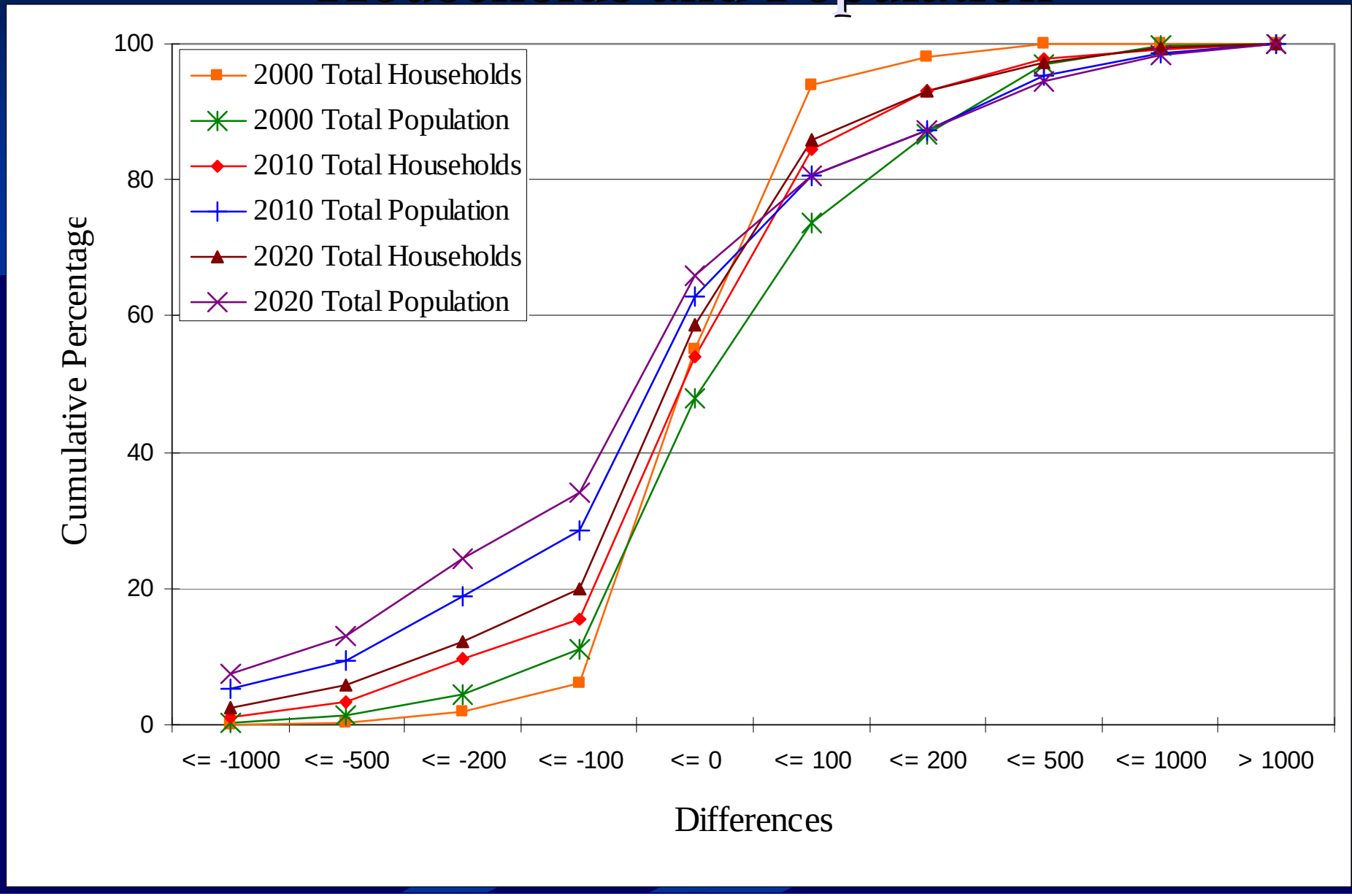
Cumulative Percent of TAZs by Differences between UrbanSim and the 2005 InfoUSA Data



Spatial Distribution of Differences between UrbanSim and 2005 InfoUSA Data



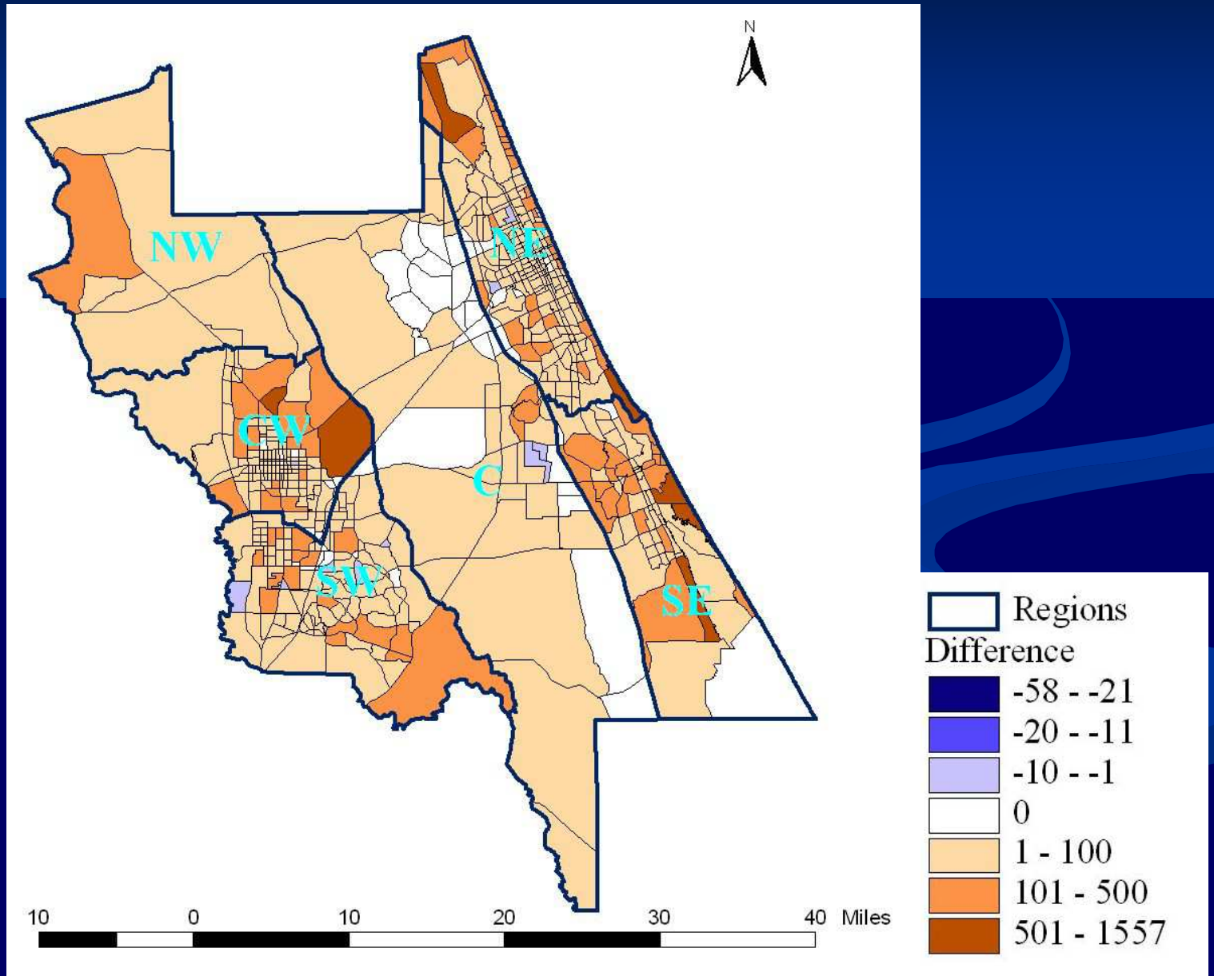
Cumulative Percent of TAZs by Differences of Households and Population



Households Comparison
LRTP vs. UrbanSim

Planning Region	1997	2000	2010		2020	
	LRTP	UrbanSim	LRTP	UrbanSim	LRTP	UrbanSim
Northeast	84,022	80,899	106,863	96,383	119,592	97,987
Southeast	23,846	22,116	31,880	30,424	35,437	32,410
Central	5,689	6,754	18,312	8,087	29,739	8,505
Northwest	2,288	2,176	2,855	2,741	3,255	2,842
Central-west	19,178	19,145	24,590	25,992	27,705	28,937
Southwest	36,300	40,492	40,950	47,198	44,648	49,367

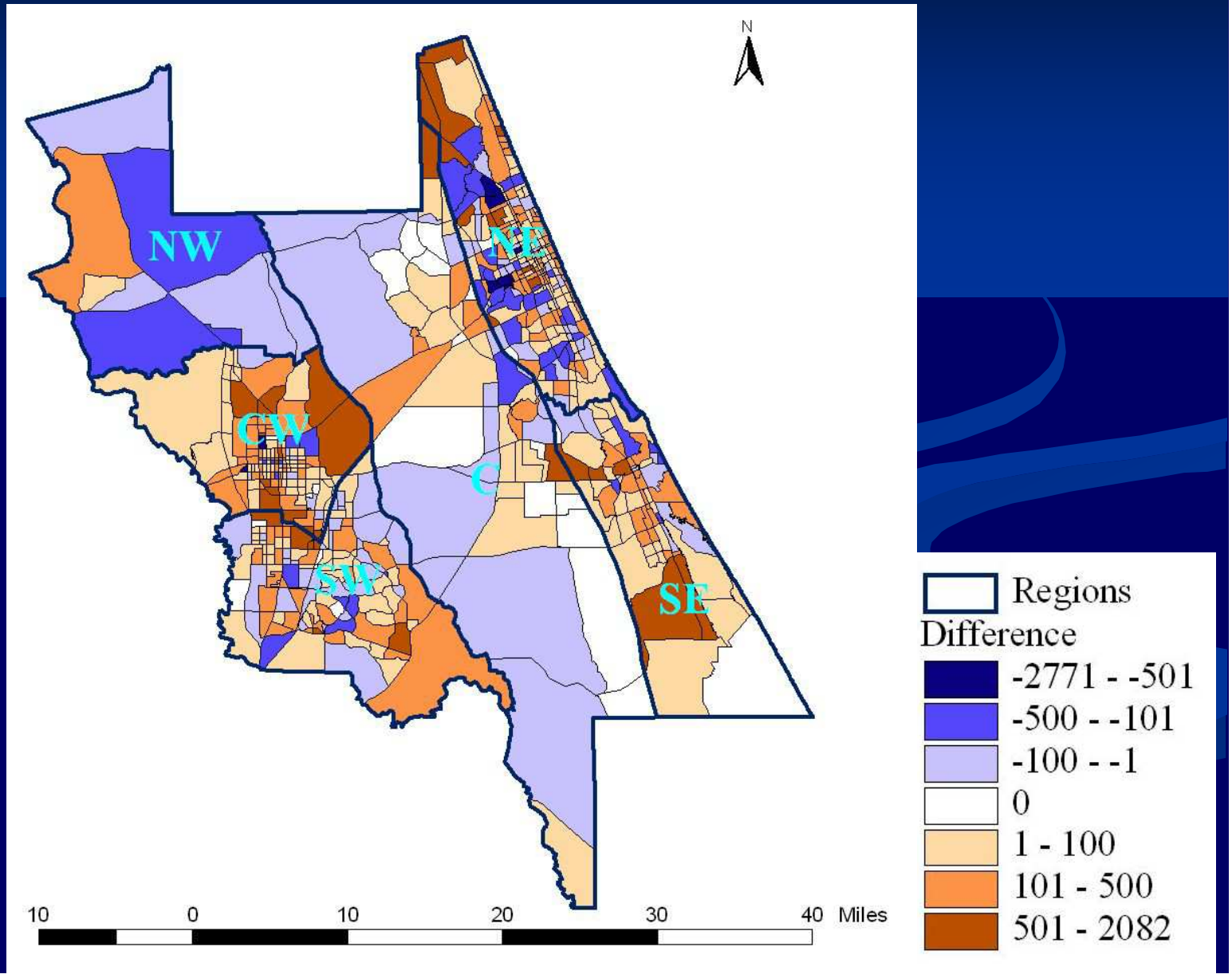
Spatial Distribution of Household Growth from Base Year to 2020



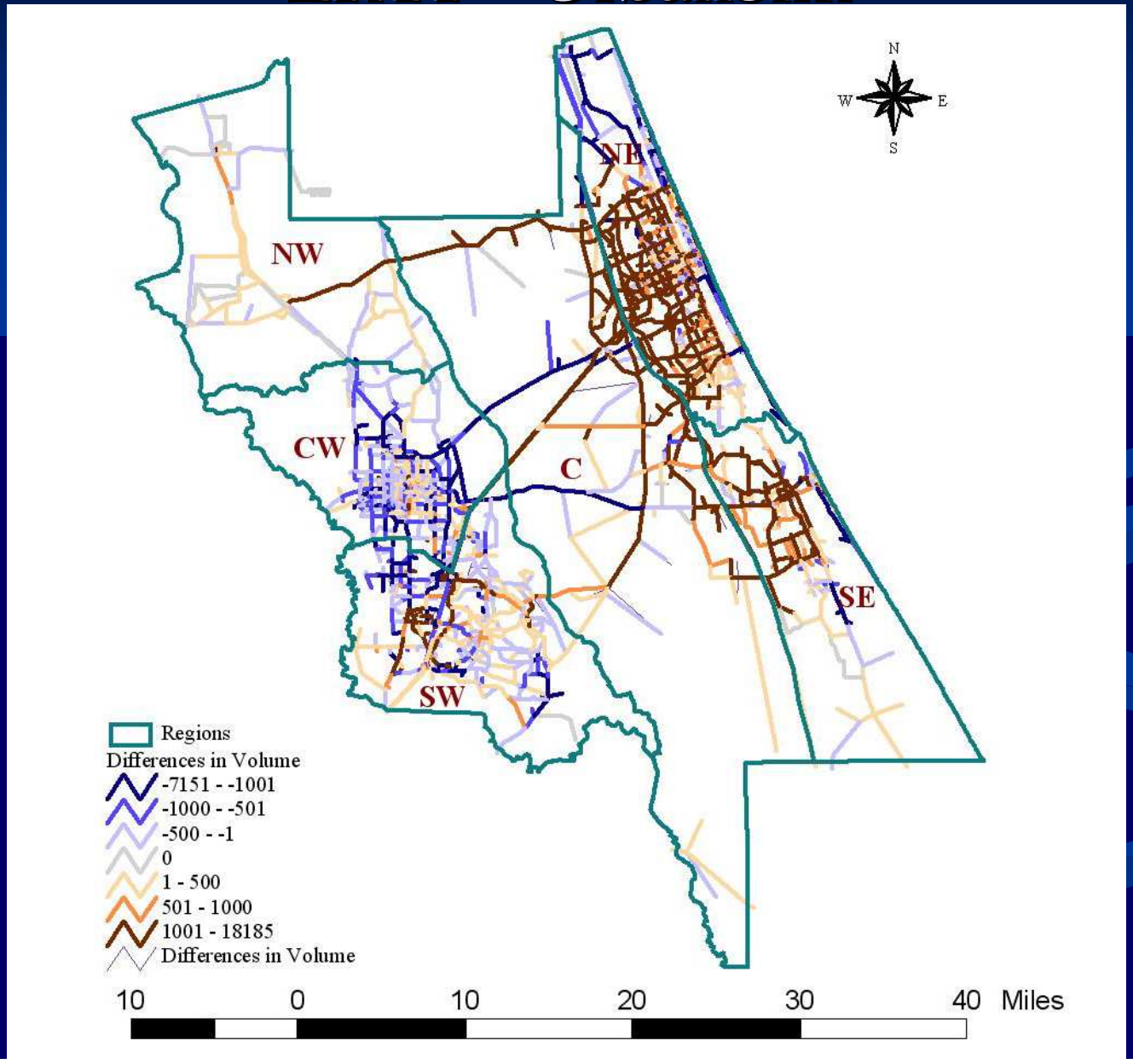
Employment Comparison
LRTP vs. UrbanSim

Planning Region	1997	2000	2010		2020	
	LRTP	UrbanSim	LRTP	UrbanSim	LRTP	UrbanSim
Northeast	100,648	101,315	130,583	106,643	130,583	118,548
Southeast	16,220	15,103	28,919	19,039	28,919	23,803
Central	2,626	6,778	9,761	8,369	9,761	10,565
Northwest	3,789	3,602	3,809	2,927	3,809	3,055
Central-west	20,434	25,440	30,587	36,443	30,587	46,432
Southwest	17,340	20,591	24,984	26,049	24,984	31,969

Spatial Distribution of Employment Growth from Base Year to 2020



Comparison of Traffic Volumes in 2020 LRTP - UrbanSim



Findings

- High data requirements
  - Impute missing data
  - Join property TAX data with parcel layer
  - Join employment data with parcel layer
- Data mining and synthetic data cleaning tools will facilitate working with messy data
- Model estimation requires knowledge of multinomial logit model
- Consultations with local government agencies are desirable in developing model specifications and estimating model parameters