

Web-based Interactive Visualization of Reconstructed Cognized Spaces: The Case of U.S. Migration

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Introduction

- Space: “A relation on a set of objects.”
- Conceptualization of space
 - Physical space
 - Functional spaces (constructed spaces)
 - Time space
 - Cost space
 - Cognized/mental space
 - etc.



FIG. 5.6 New Zealand in geographical space.

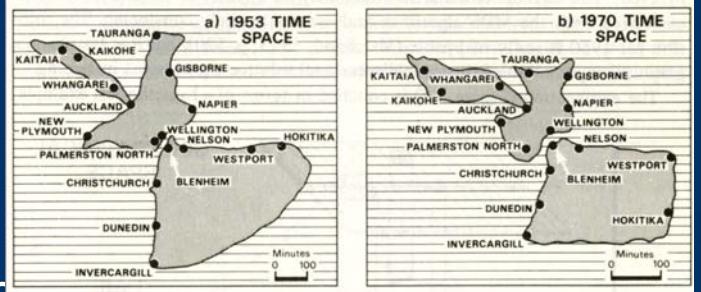


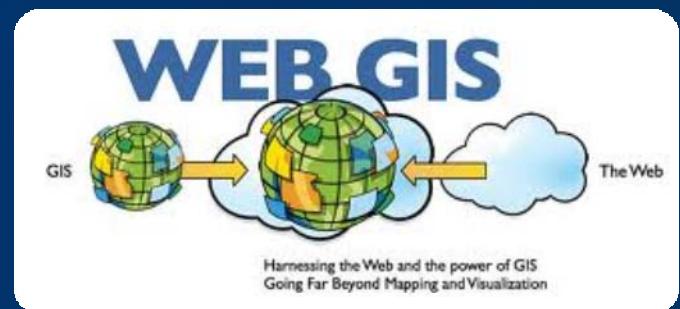
FIG. 5.7 New Zealand in time space (modified from figures in Forer, 1973).



* Anthony C. Gatrell, Distance and Space: A Geographical Perspective

Objectives

- We propose web-based geospatial visualization technology to address the challenges of visualization and analytics of functional spaces (human migration) through automation, interactivity, and the integration of multiple local views with global
- Visualizing & mapping
- Understanding
- Spatial process of phenomena



$$\hat{m}_{ij} = A_i O_i B_j I_j f(d_{ij})$$

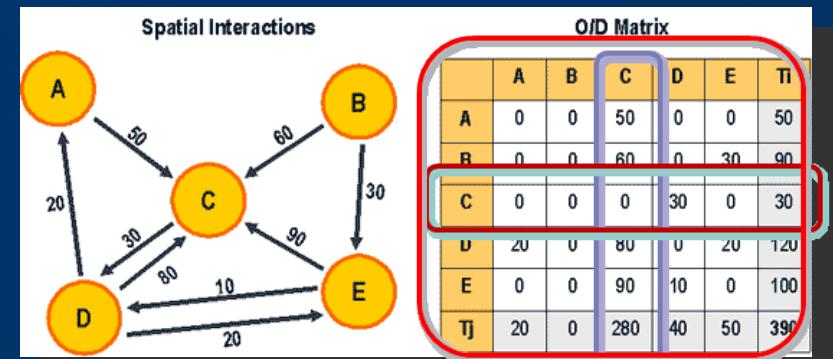
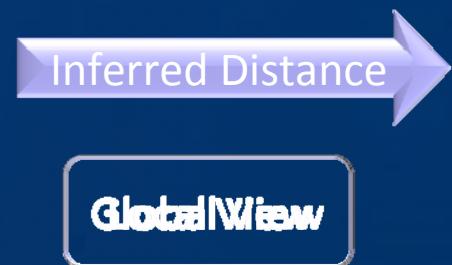
$$\hat{m}_{ij} = A_i O_i B_j I_j f(d_{ij})$$

Theoretical Grounding

- Spatial Interaction Modeling
 - Derived from Gravity Model
 - Posits an influence of both origin region and destination region mass variables and of interregional separation on the magnitude of interactions
- Study of migration flow pattern (Plane, 1984)
 - Reverse estimation of doubly-constrained model

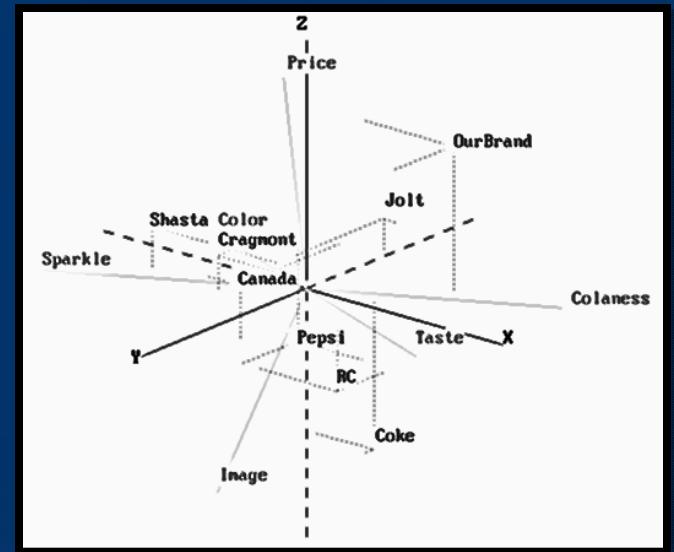


$$\hat{m}_{ij} = A_i O_i B_j I_j f(d_{ij})$$



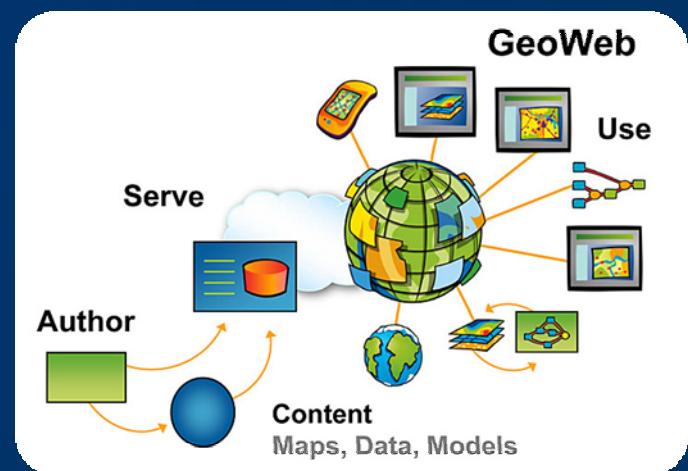
Methodology

- Linear cartogram – Create Local View
 - Visual ways of depicting attributes of geographic objects as the object's length
- Multi-Dimensional Scaling (MDS) – Create Global View
 - A dimension reduction method used in Information visualization for exploring similarities or dissimilarities in data



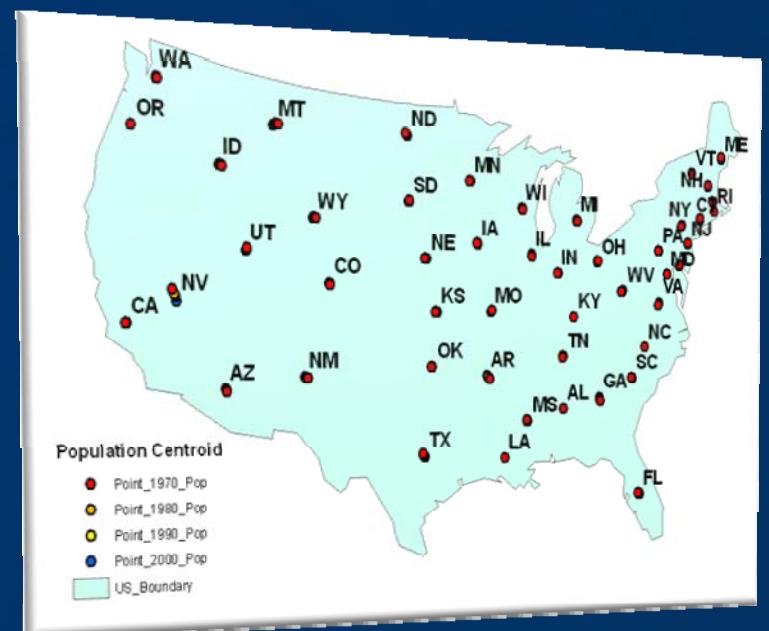
Web GIS Technology

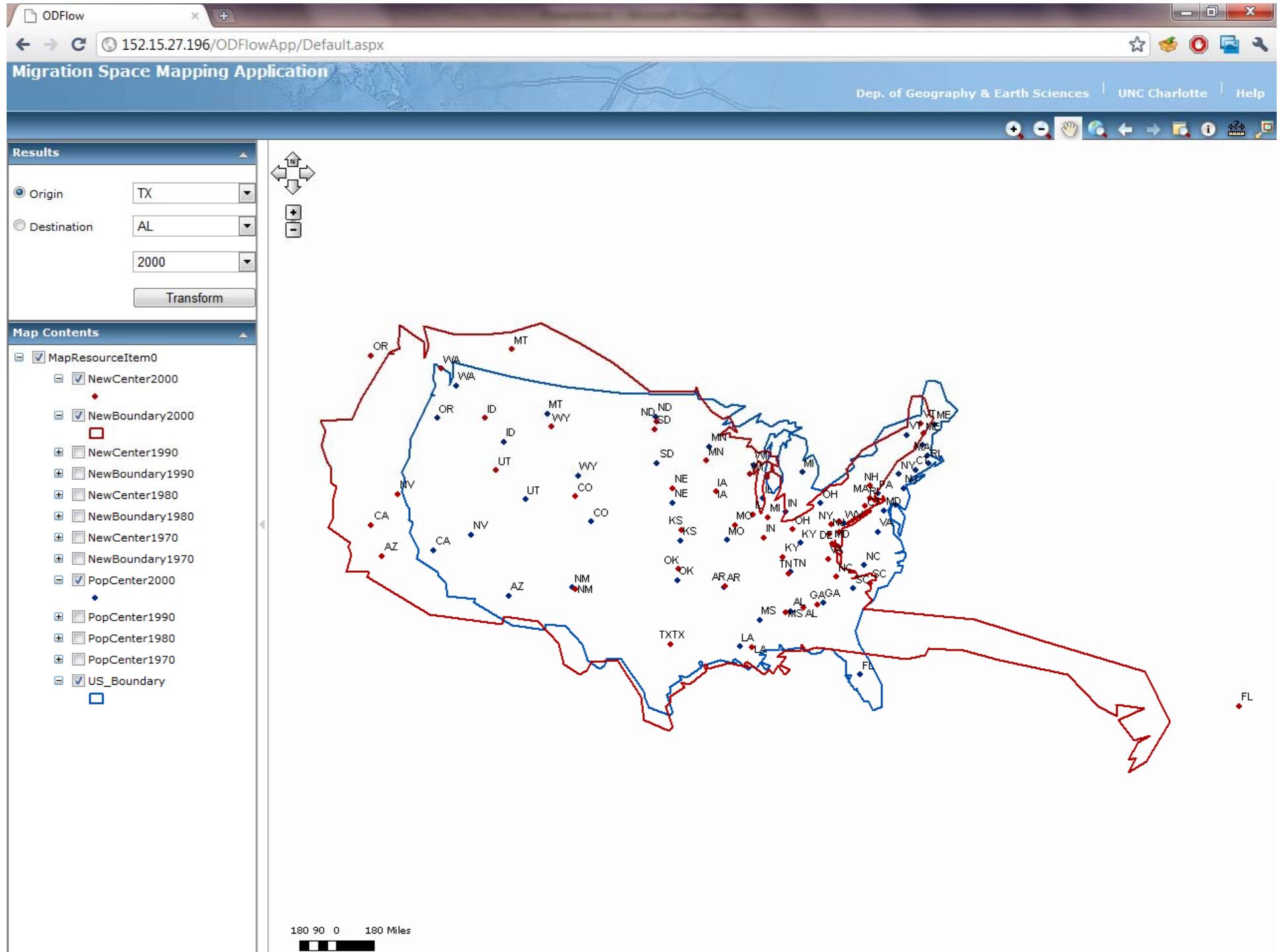
- Client Side (browser)
 - Web application (map display, user interactivity)
 - ASP.NET & AJAX
- Server Side
 - Web service (map creating)
 - ArcGIS Server .NET Web ADF & Visual C#



Data

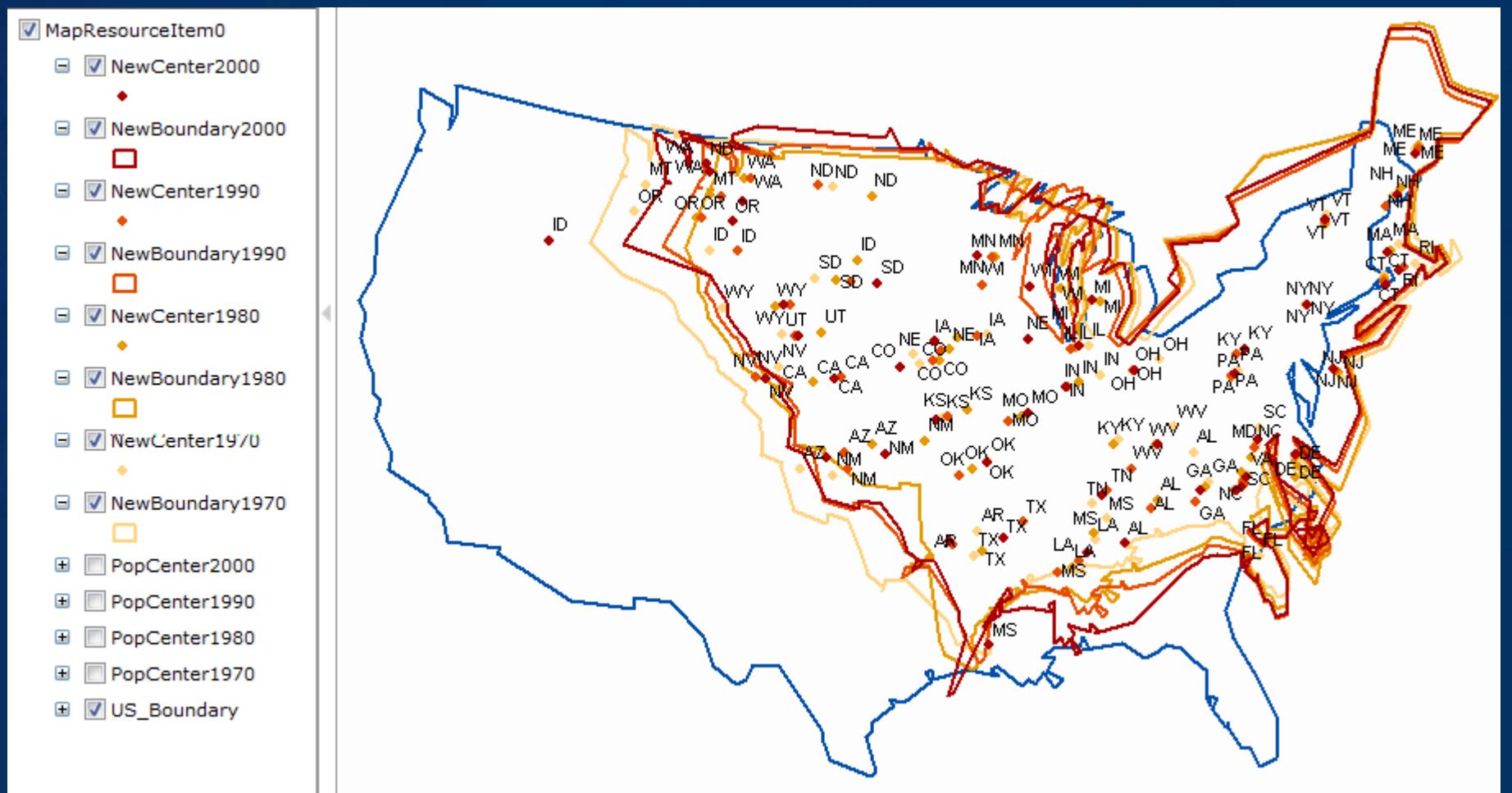
- U.S. population centroids of the 48 contiguous states
 - Vincenty's formula to compute geodesic distances between lat/long pairs on ellipsoid
- Migration flows (Bureau of the Census): 1965-70, 1975-80, 1985-90, 1995-2000
- U.S. boundary data





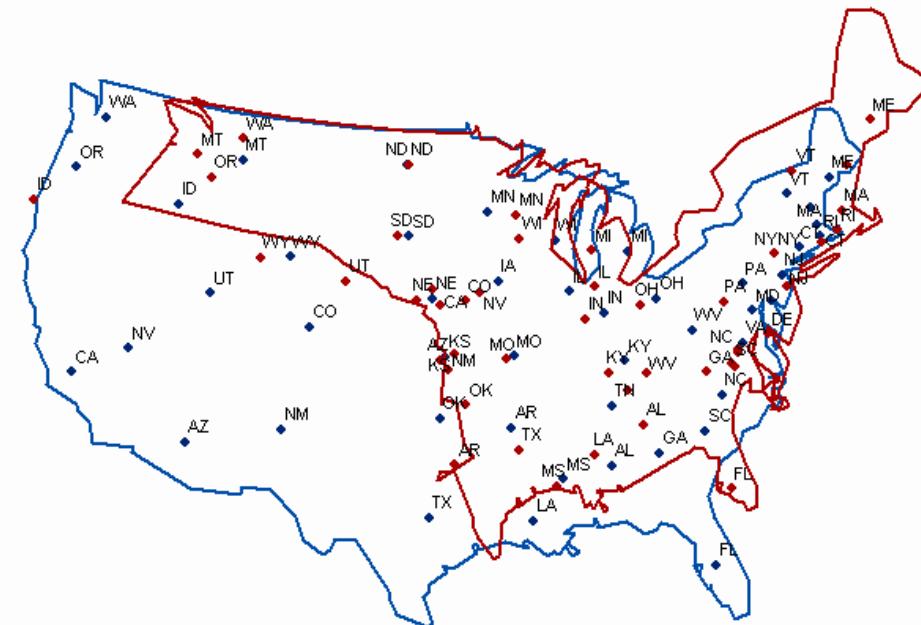
Local Views

Time series comparison: New York In-Migration



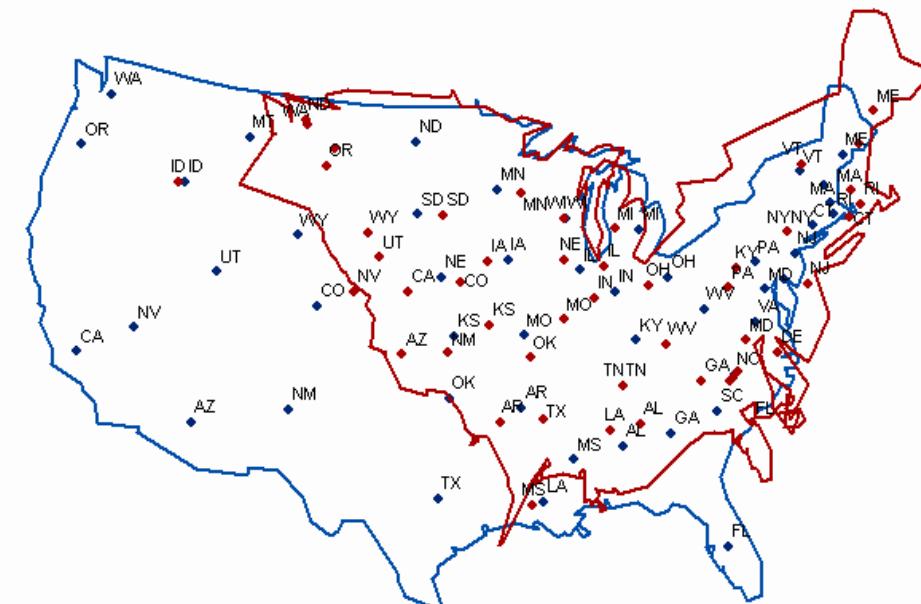
1995-2000

New York Out-Migration



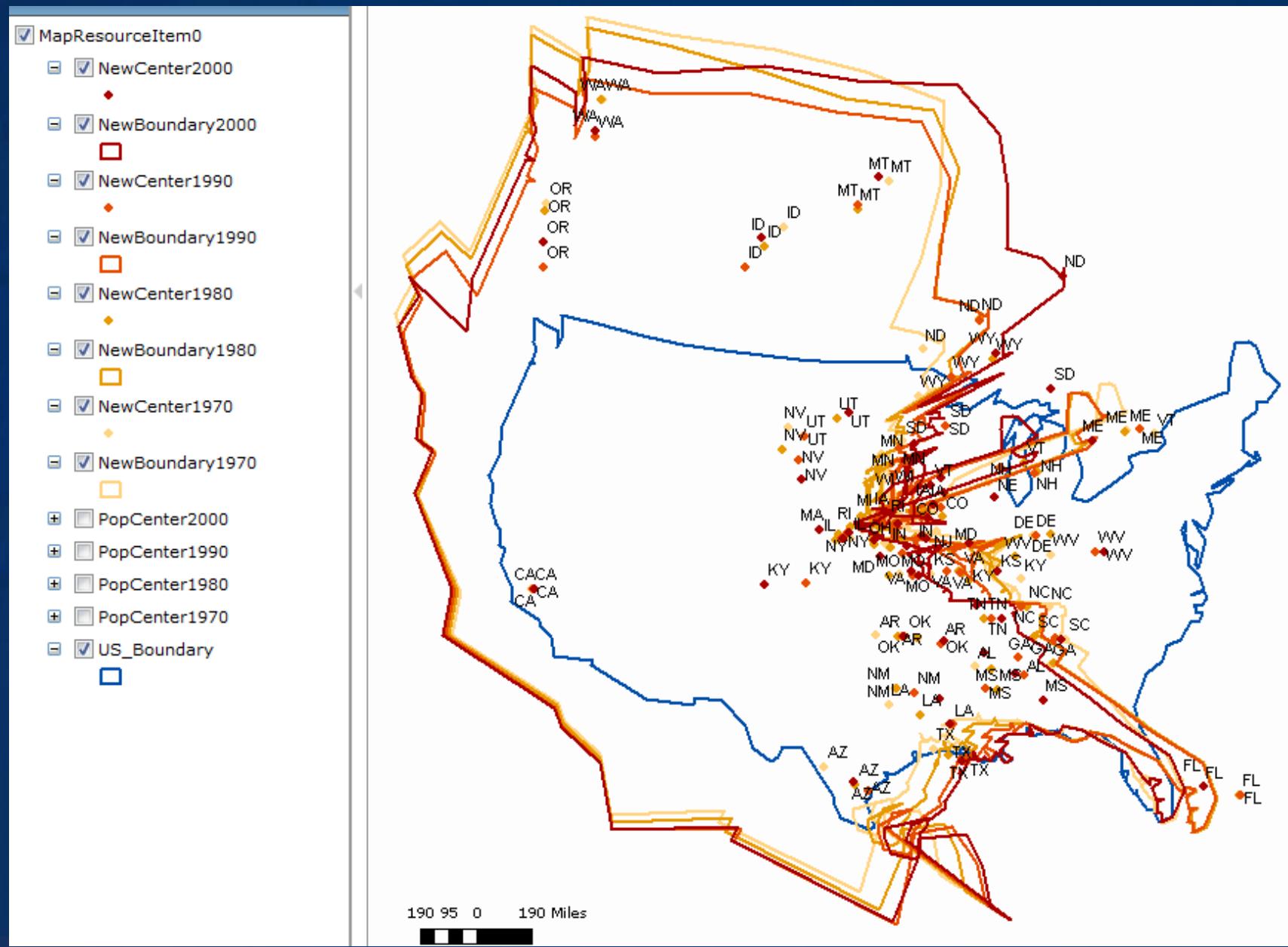
- MapResourceItem0
 - NewCenter2000
 - NewBoundary2000
 - NewCenter1990
 - NewBoundary1990
 - NewCenter1980
 - NewBoundary1980
 - NewCenter1970
 - NewBoundary1970
 - PopCenter2000
 - PopCenter1990
 - PopCenter1980
 - PopCenter1970
 - US_Boundary

- MapResourceItem0
 - NewCenter2000
 - NewBoundary2000
 - NewCenter1990
 - NewBoundary1990
 - NewCenter1980
 - NewBoundary1980
 - NewCenter1970
 - NewBoundary1970
 - PopCenter2000
 - PopCenter1990
 - PopCenter1980
 - PopCenter1970
 - US_Boundary

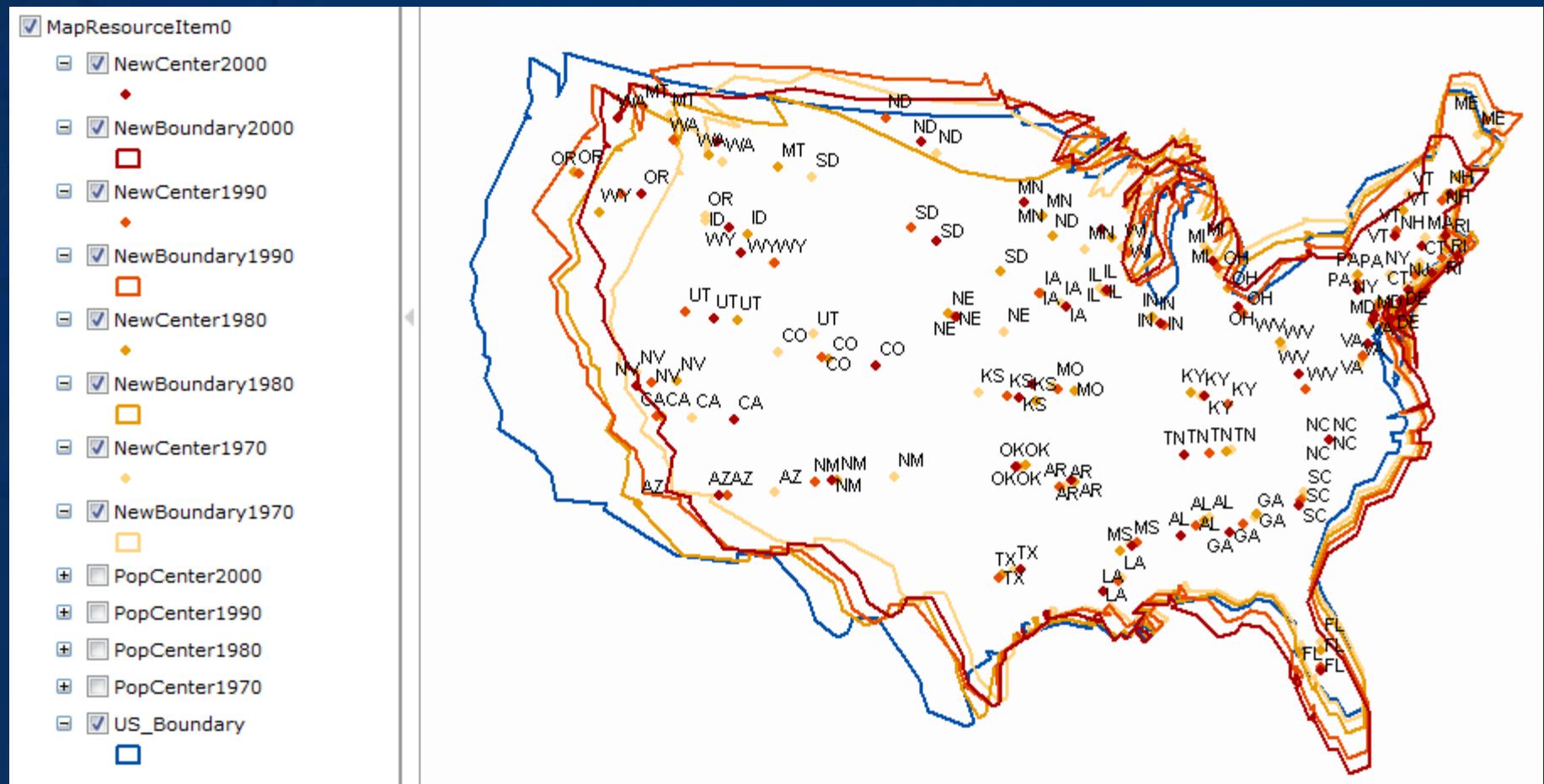


New York In-Migration

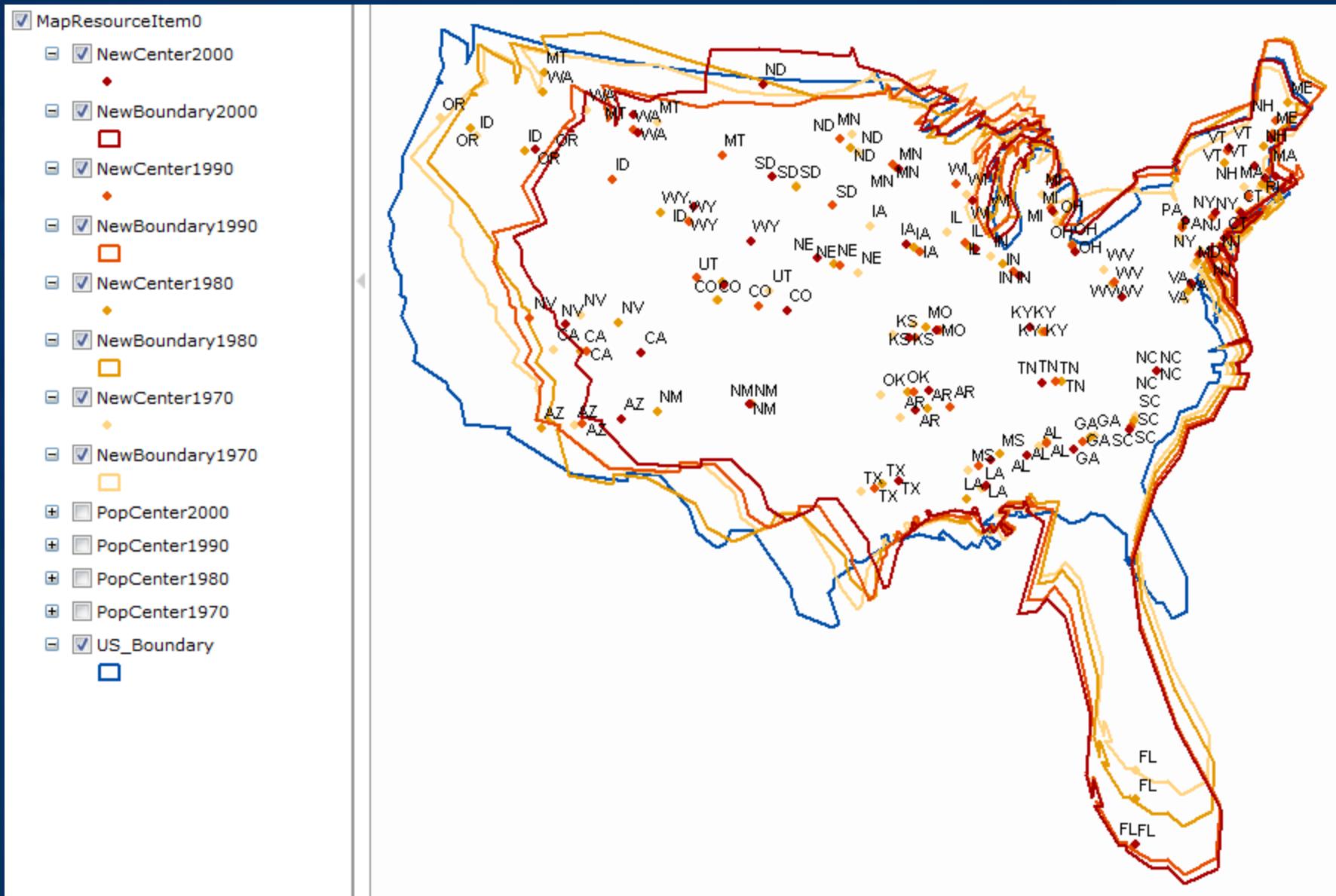
Time series comparison: California In-Migration



Time series comparison: North Carolina In-Migration



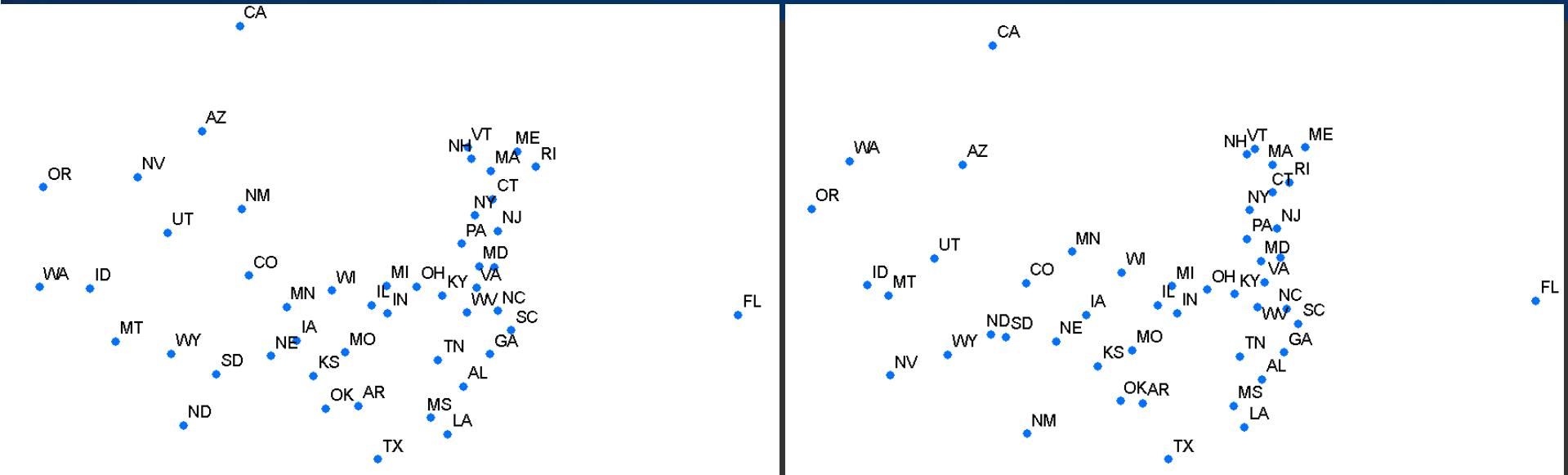
Time series comparison: North Carolina Out-Migration



2D Global View

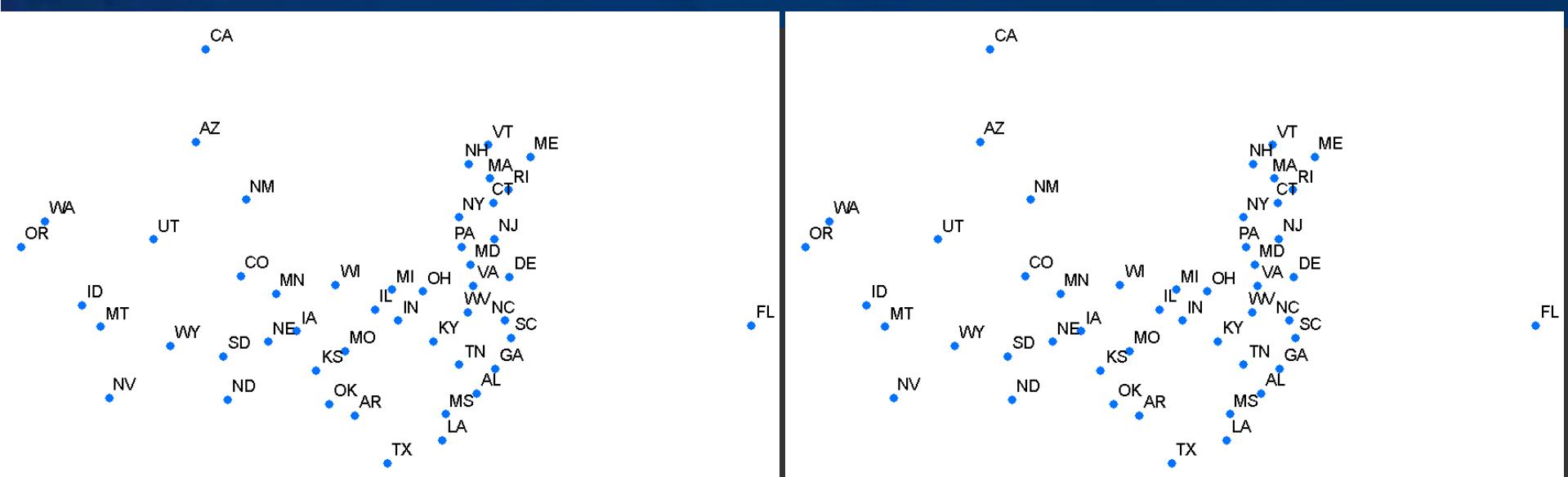
2000

1990



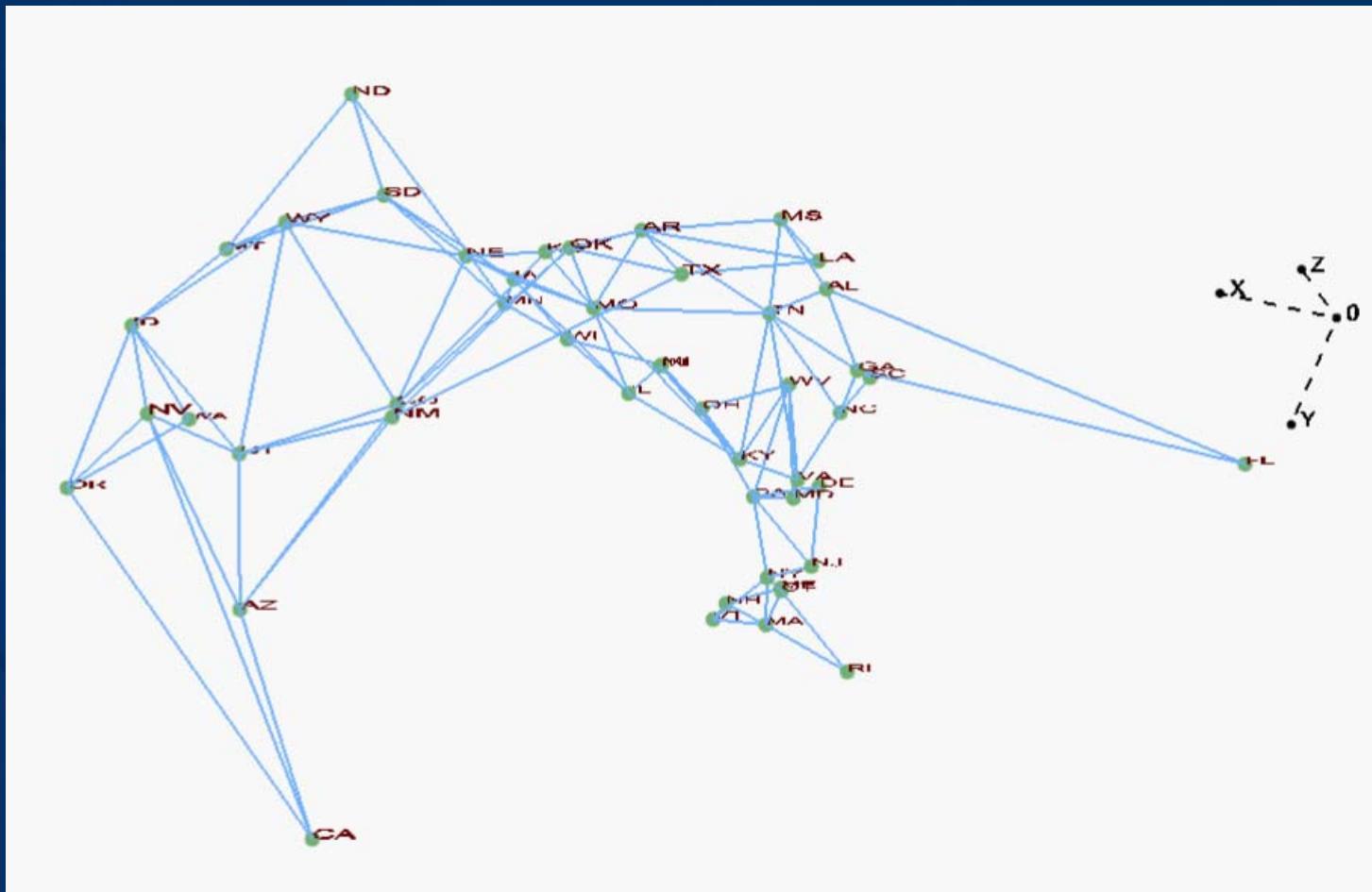
1980

1970



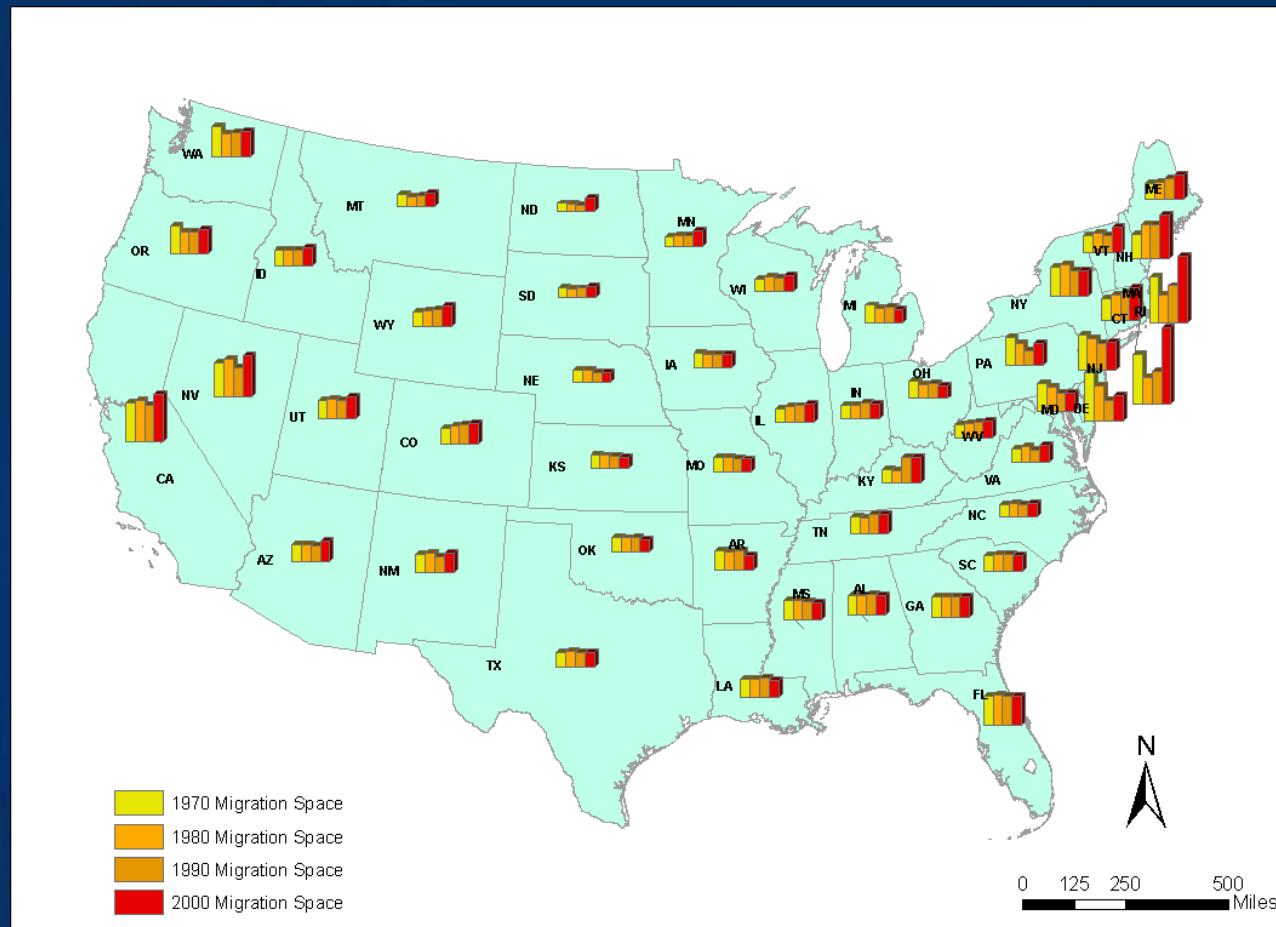
3D Global View

- See animations

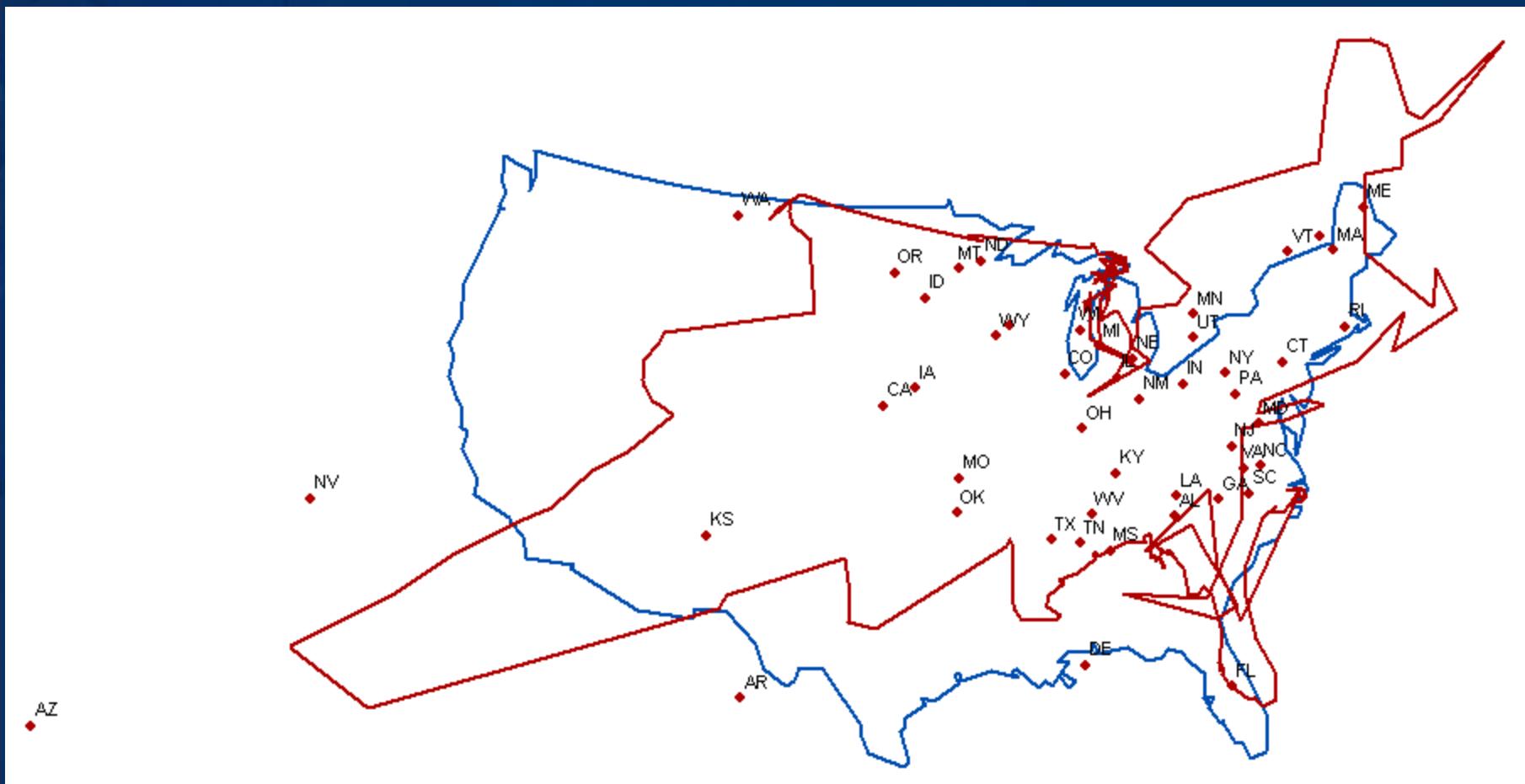


Global View

- Measuring space warping
 - For each i , standard error of cognized d_{ij} / physical d_{ij} , where cognized d_{ij} is in MDS space



Rhode Island - Origin



Conclusions & Future Work

- An intuitive way for exploring functional spaces embedded in flow data via automation and interactivity
- Integration of local views into global views reveals multi-perspective information facilitating knowledge discovery
- Appropriate visualization of functional space is still a challenge regarding to how to make sense and represent the “distortion” (distorted map – rubber sheet?)
- Possible application of visual analytics approach to metropolitan commuter flows

Thank you!

Questions?

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