



NEW ENGLAND COMPLEX SYSTEMS INSTITUTE
solving problems of science and society

Geographical Social Interaction Patterns and their Usage

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www.endcoronavirus.org

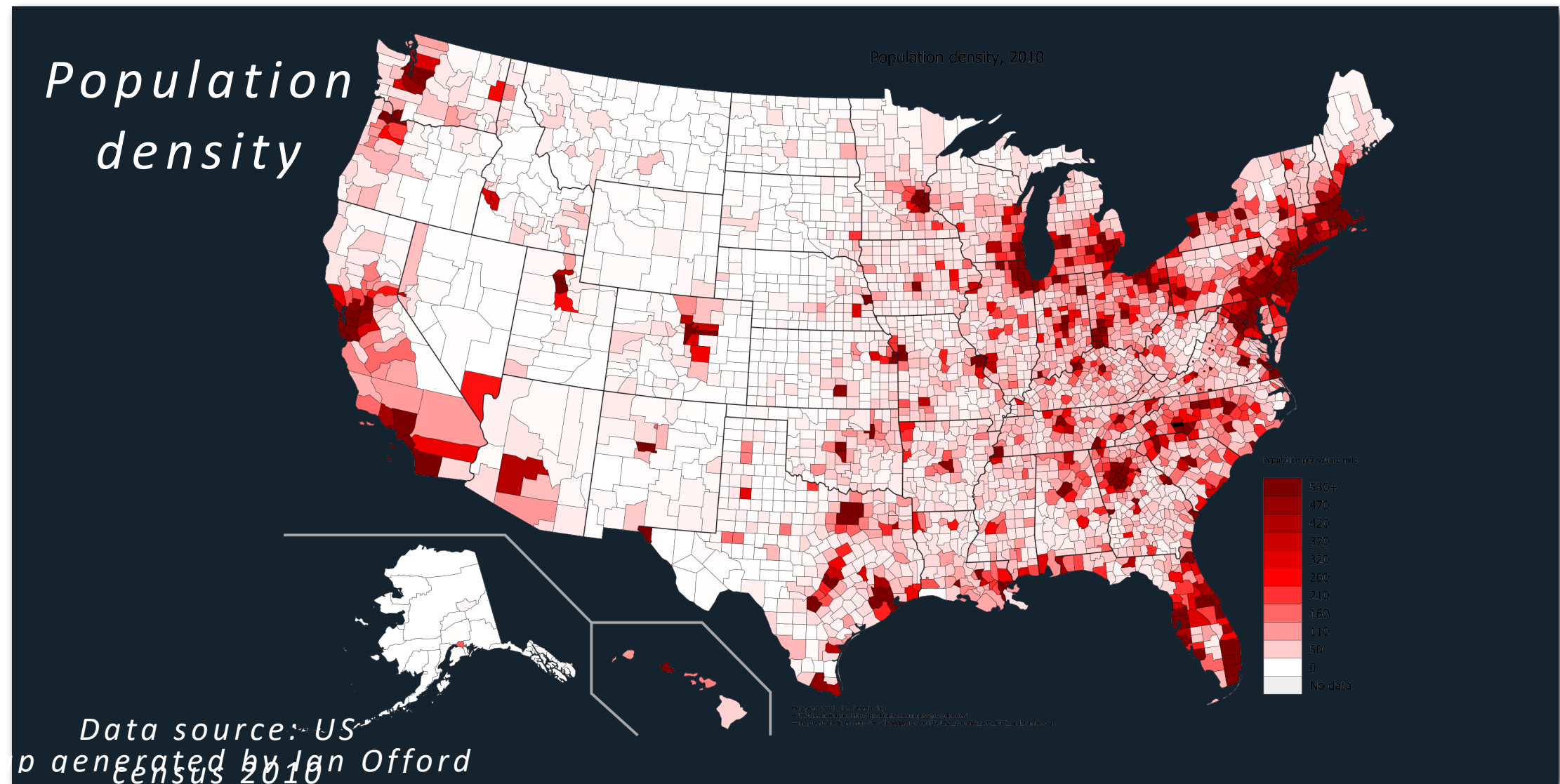
Societies are highly connected



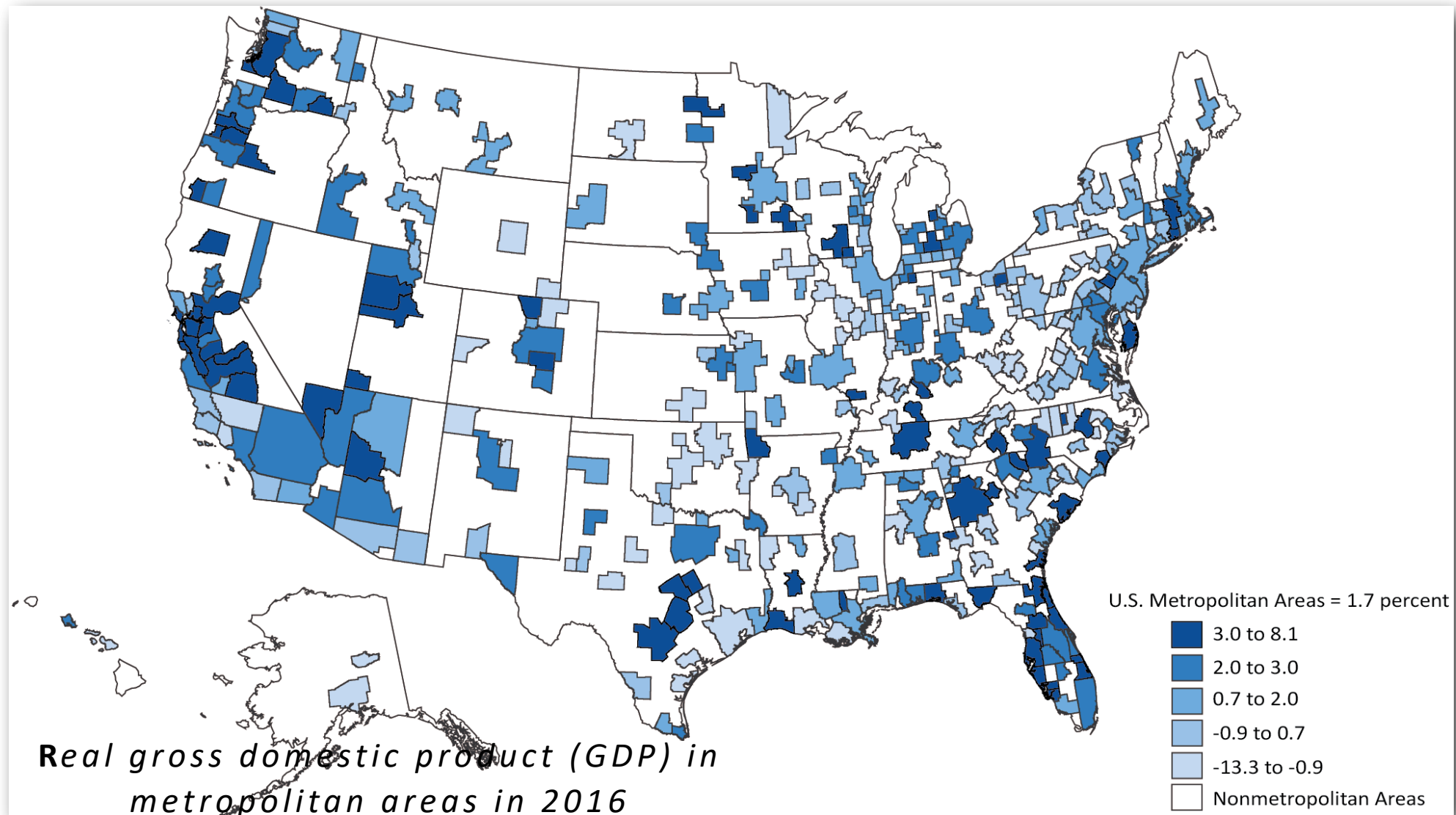
Created by Alfredo J. Morales

Societies are polarized and fragmented

Structure of societies is heterogeneous



Structure of societies is heterogeneous



<https://howmuch.net/articles/gdp-by-metro-2017>

https://www.bea.gov/newsreleases/regional/gdp_metro/2017/gdp_metro0917.htm

Importance of Geographical Social Patterns

- Spread of innovation
- Changes in business and culture
- Development of regional and national events
- Flow of information
- Spread of disease

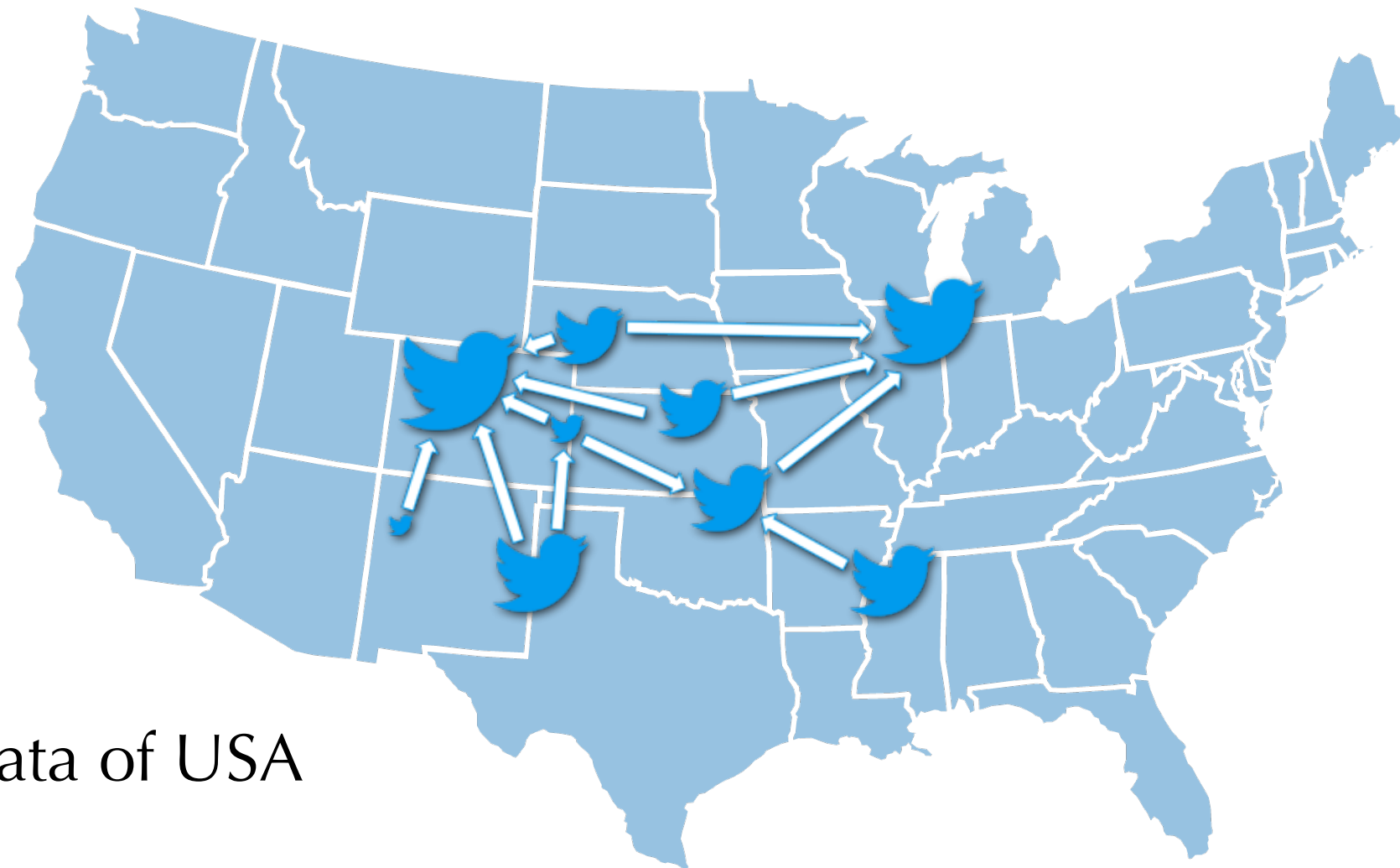
Mobility Patterns

Mobility patterns can be characterized in three overarching concepts:

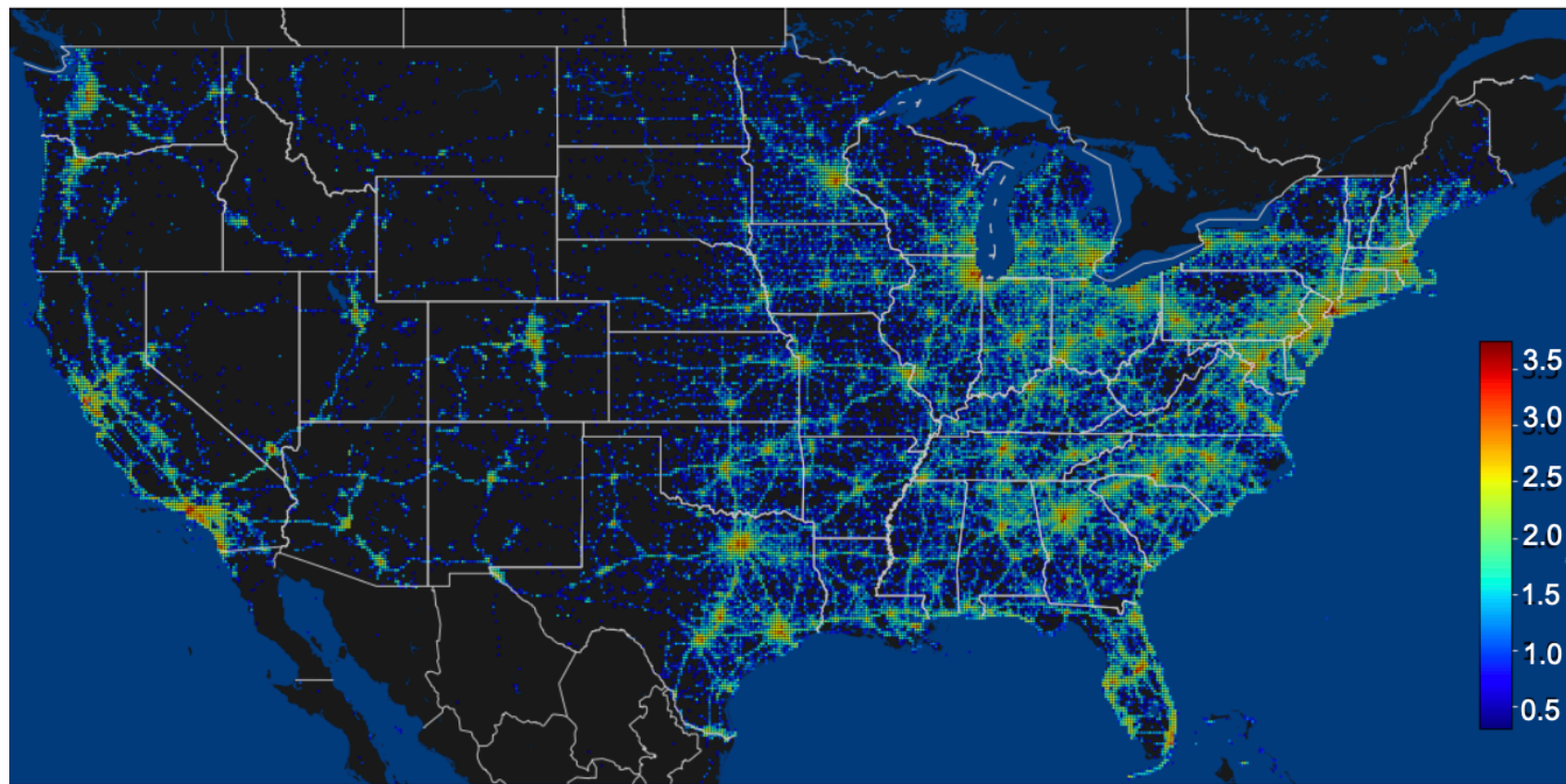
- **Short distance movements** (grocery shopping, walking)
- **Medium distance movements** (travel to neighborhood cities for job or fun)
- **Long distance movements** (travel to other cities for vacation or visiting families).

Combination of these habits in a **self-organized manner** form multi-scale movement patterns.

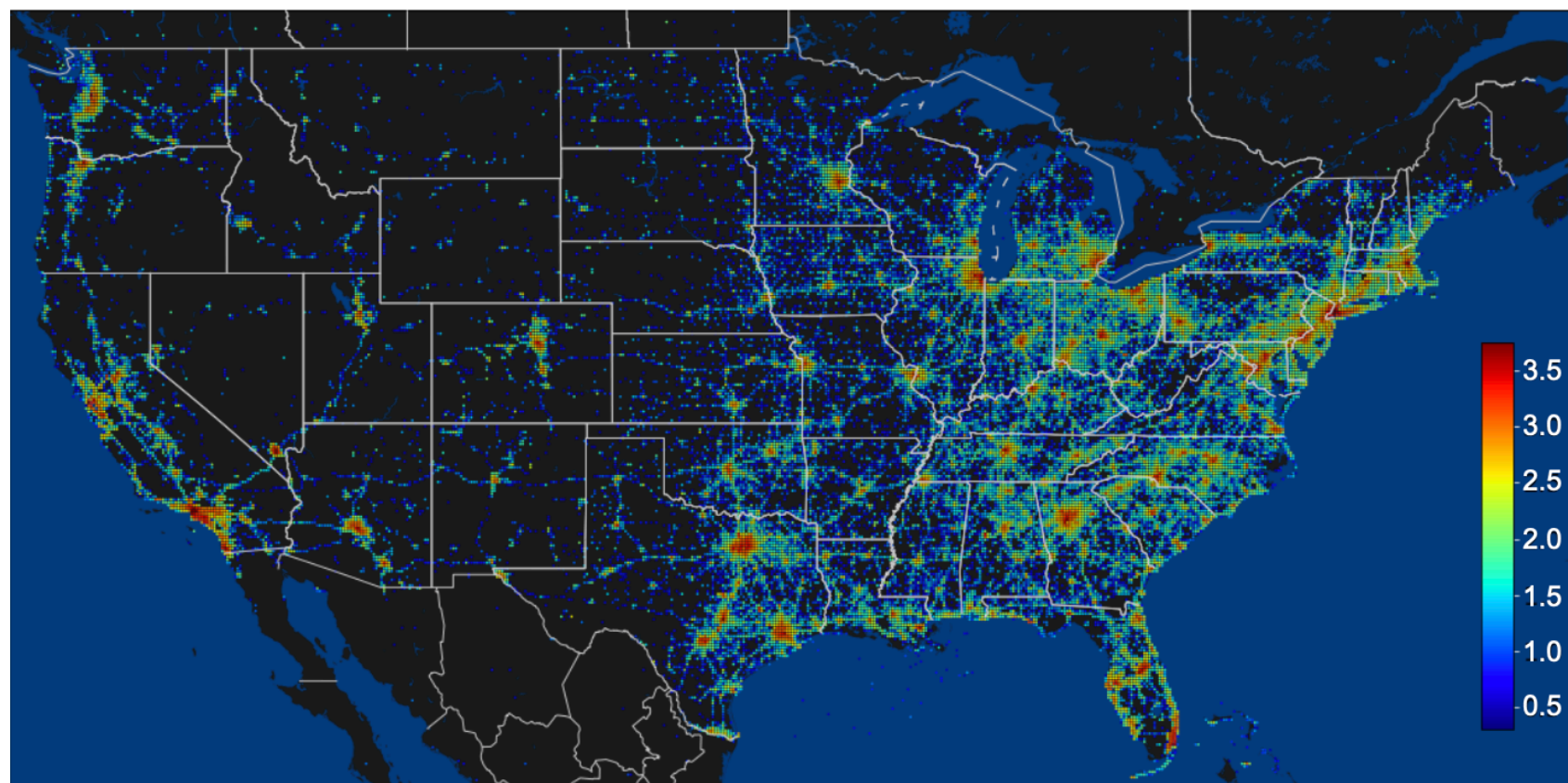
Adaptability of communication and mobility patterns



Twitter Data of USA

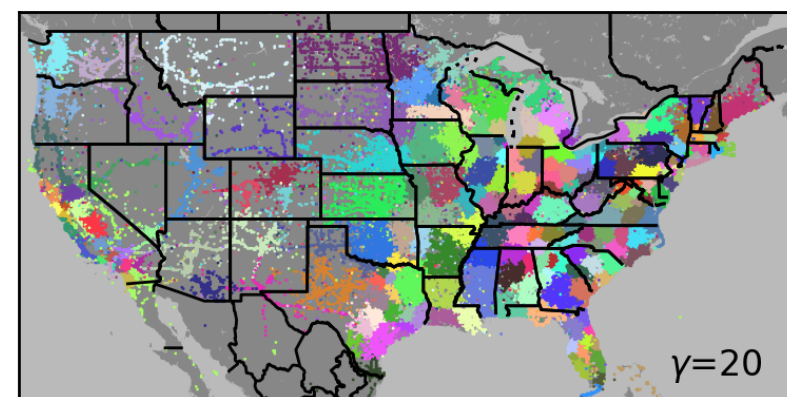
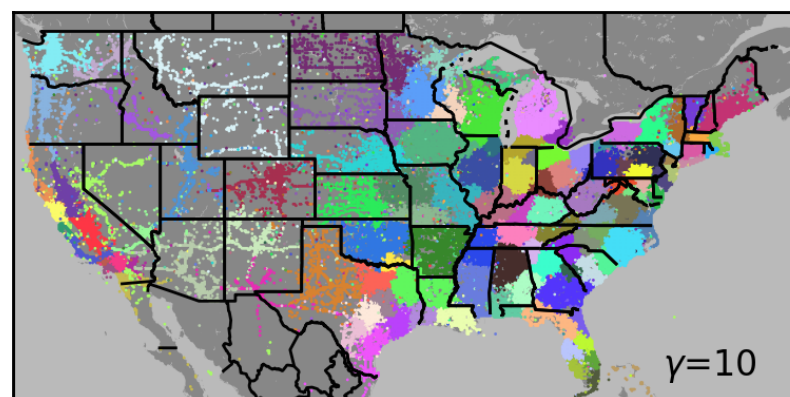
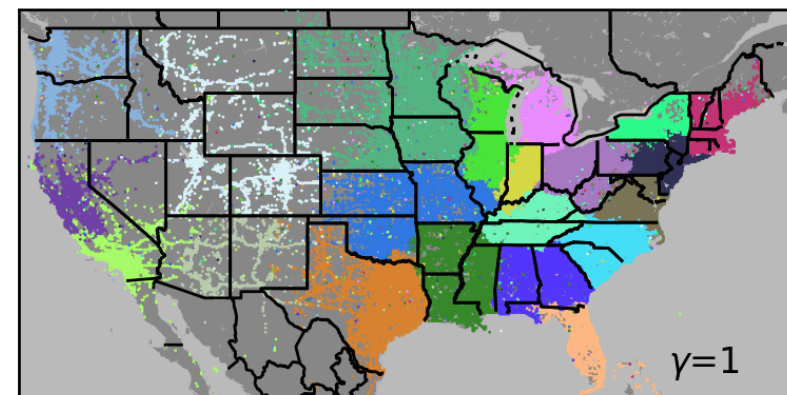
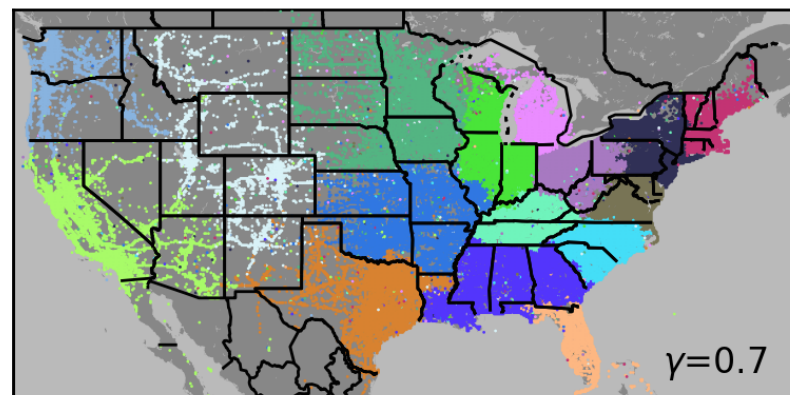
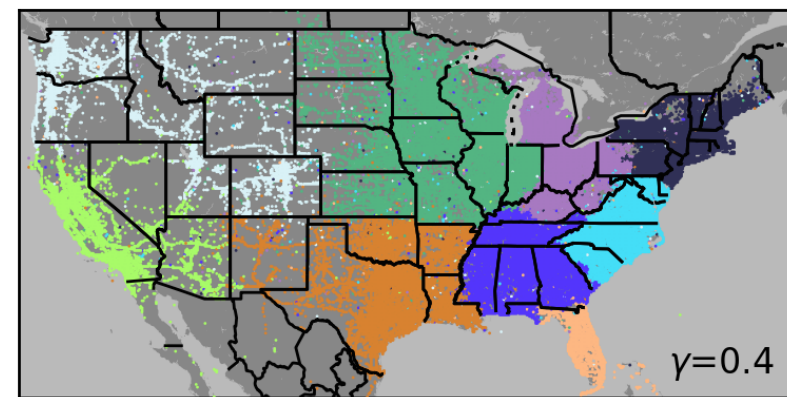
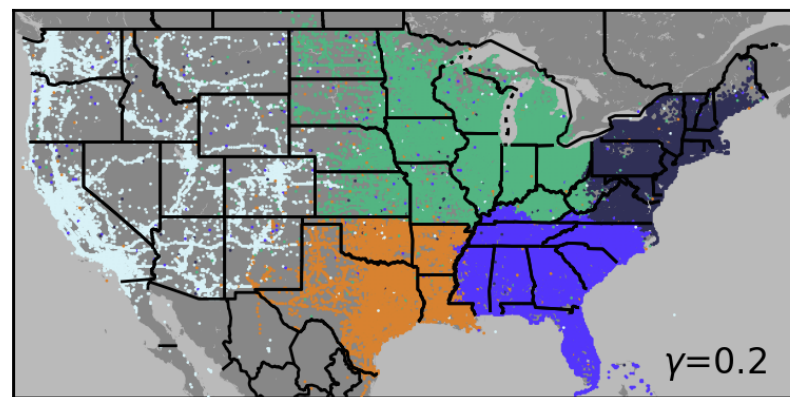
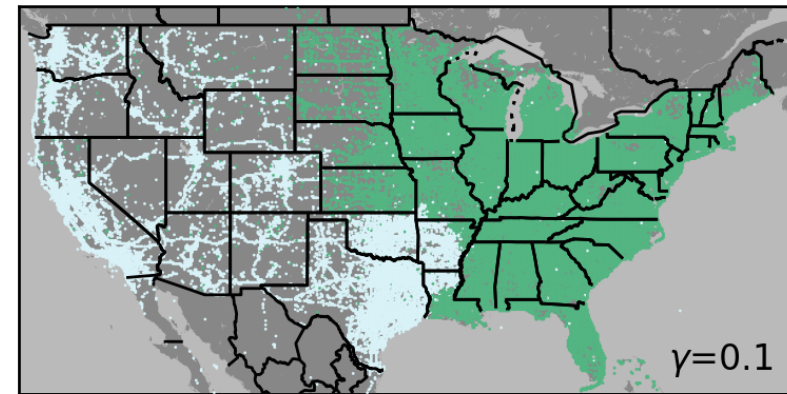
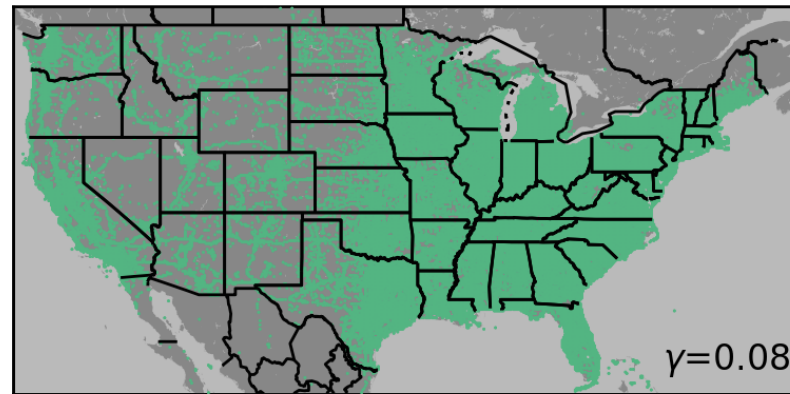


Mobility network

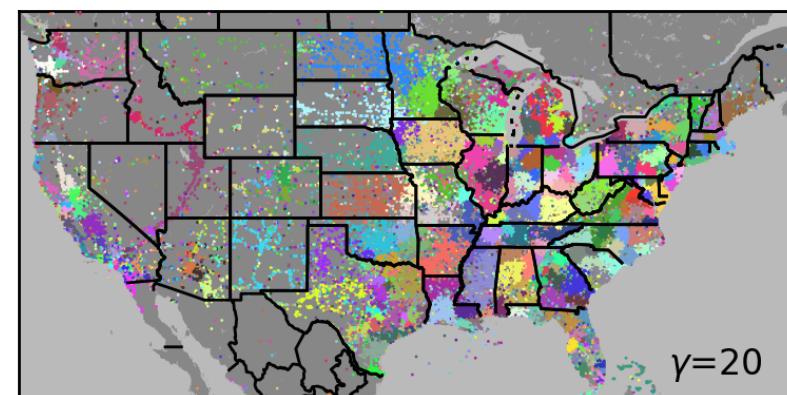
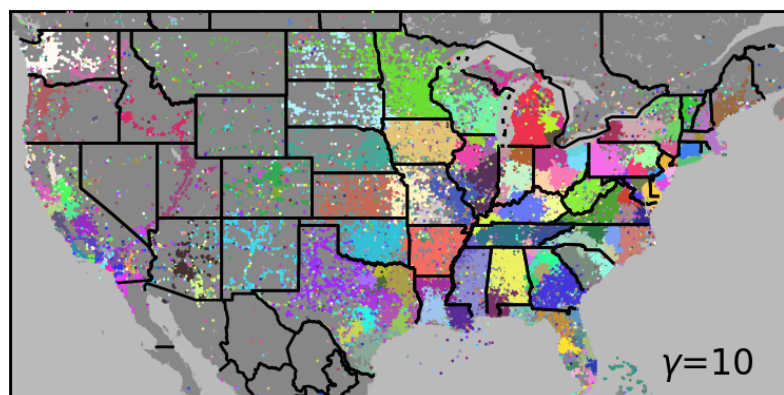
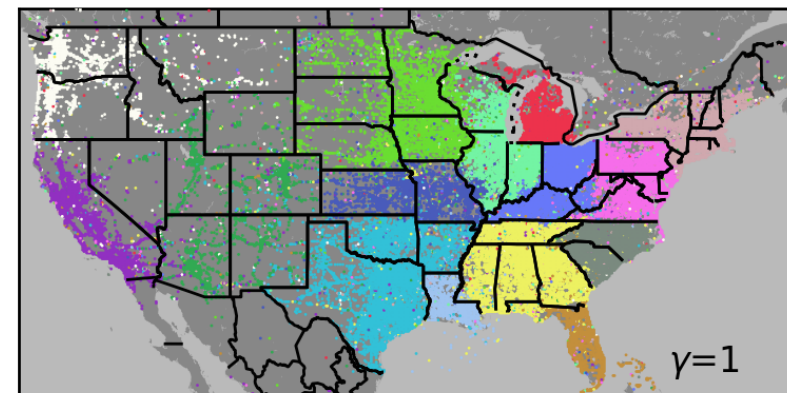
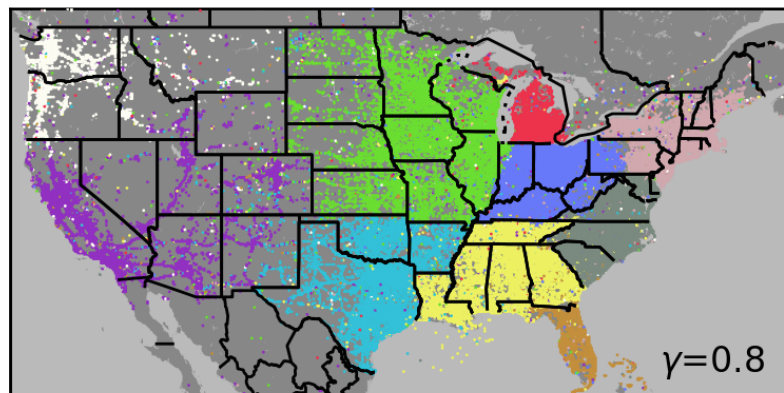
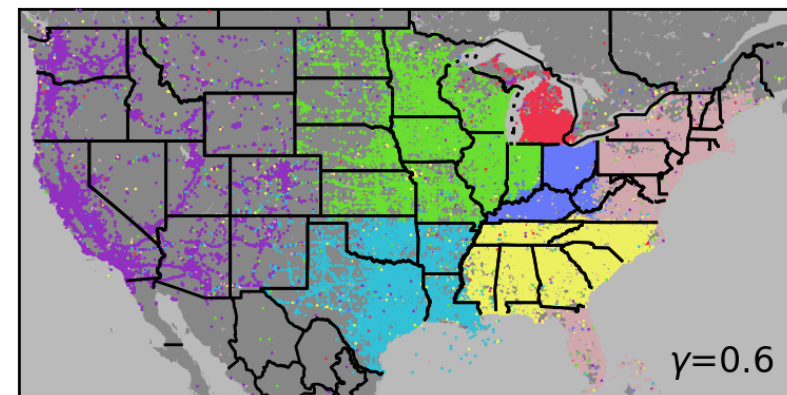
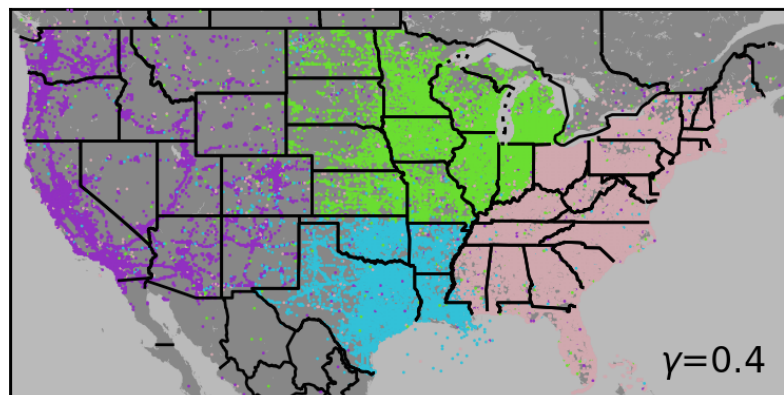
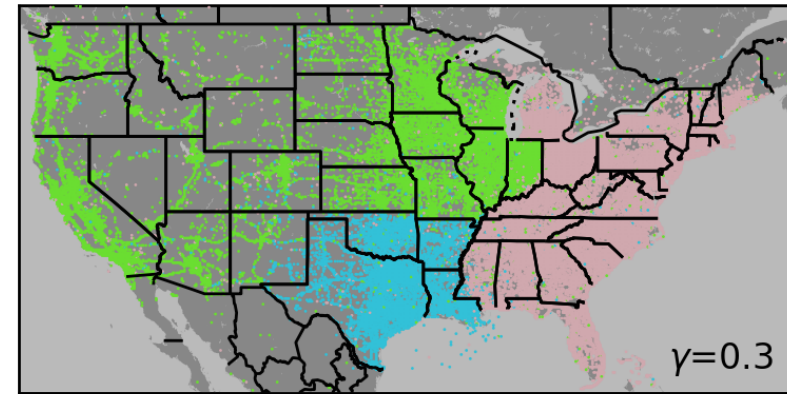
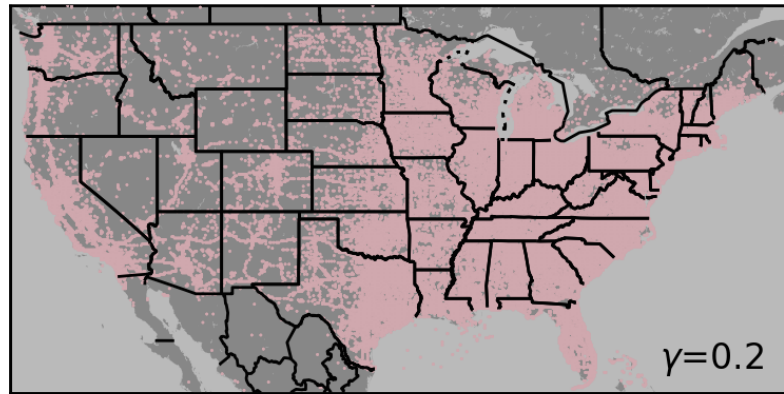


Communication network

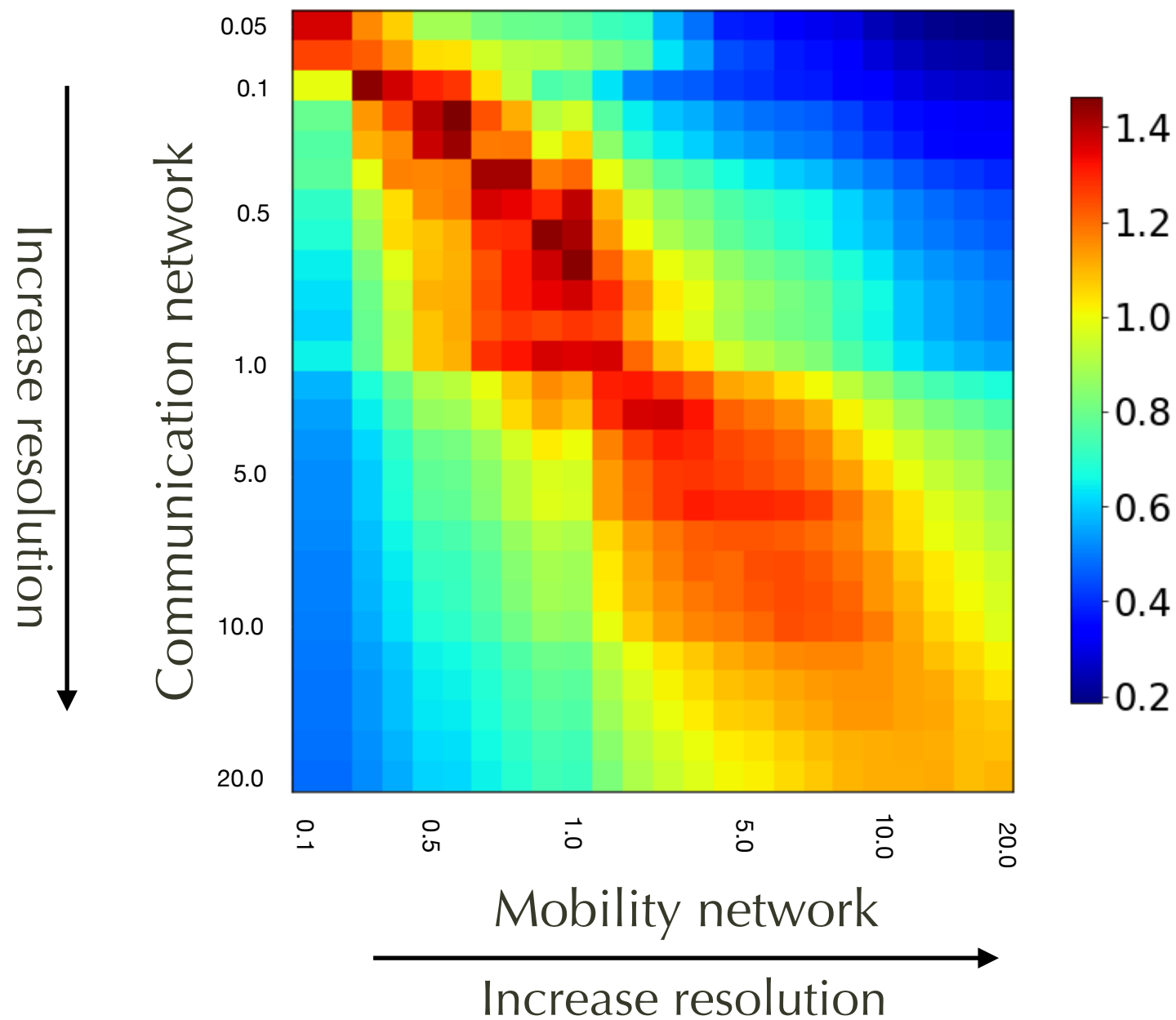
Mobility Network



Communication Network



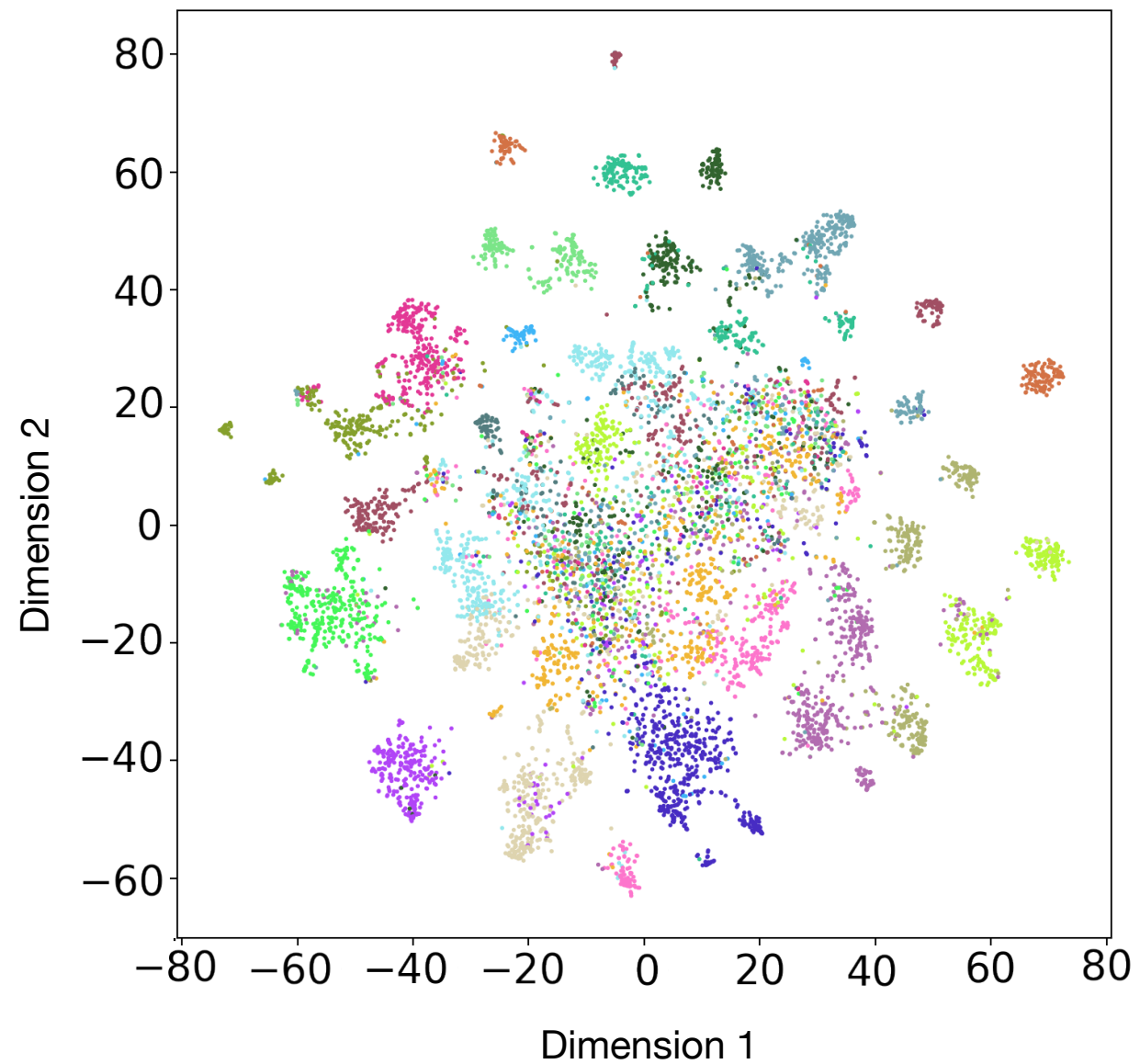
Similarity of the Networks by Communities



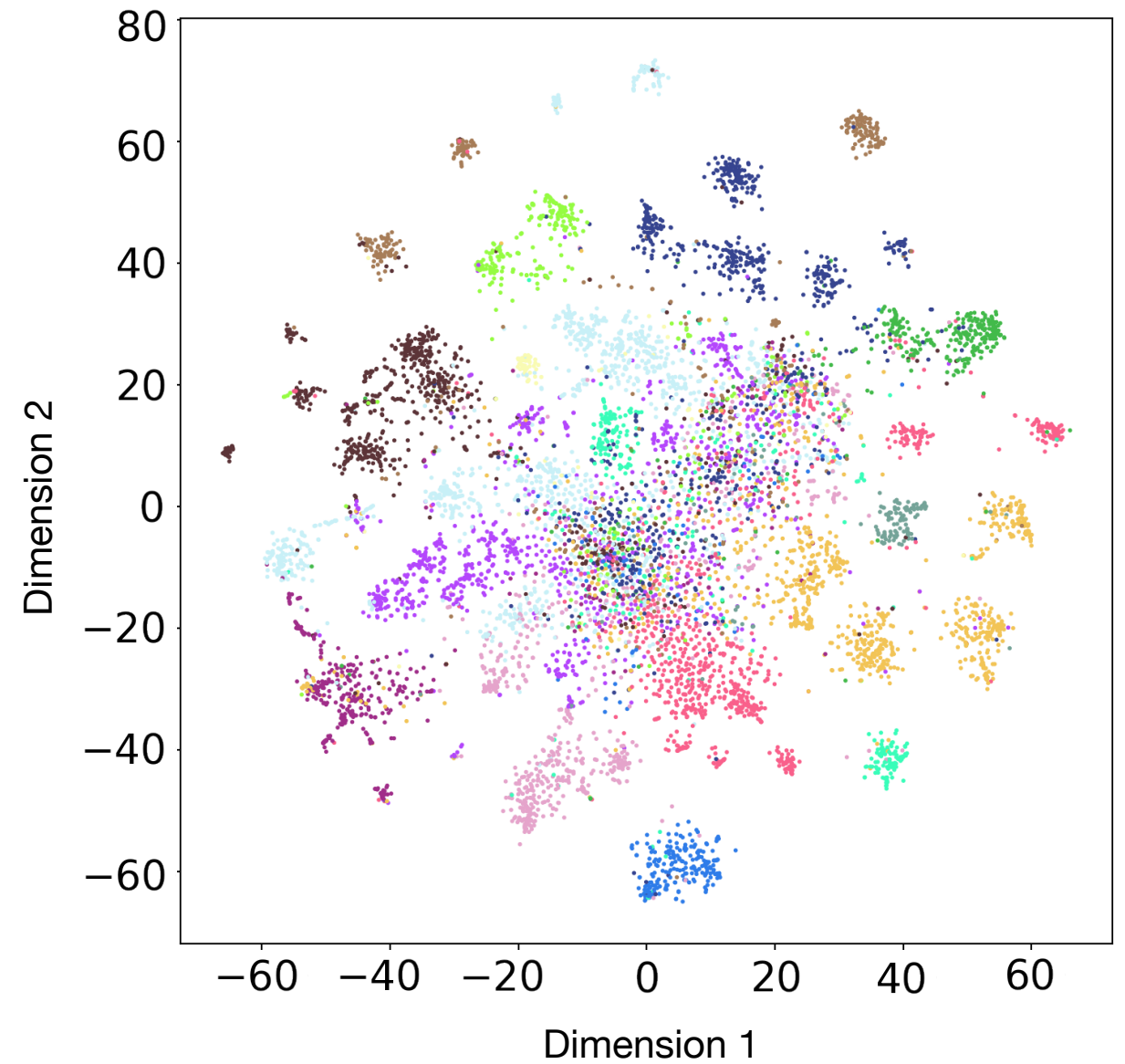
Average of three scores (Purity, Adjusted_Rand and Fowlkes_Mallows) for different values of resolution parameter in both networks.

Content Similarity of Communities

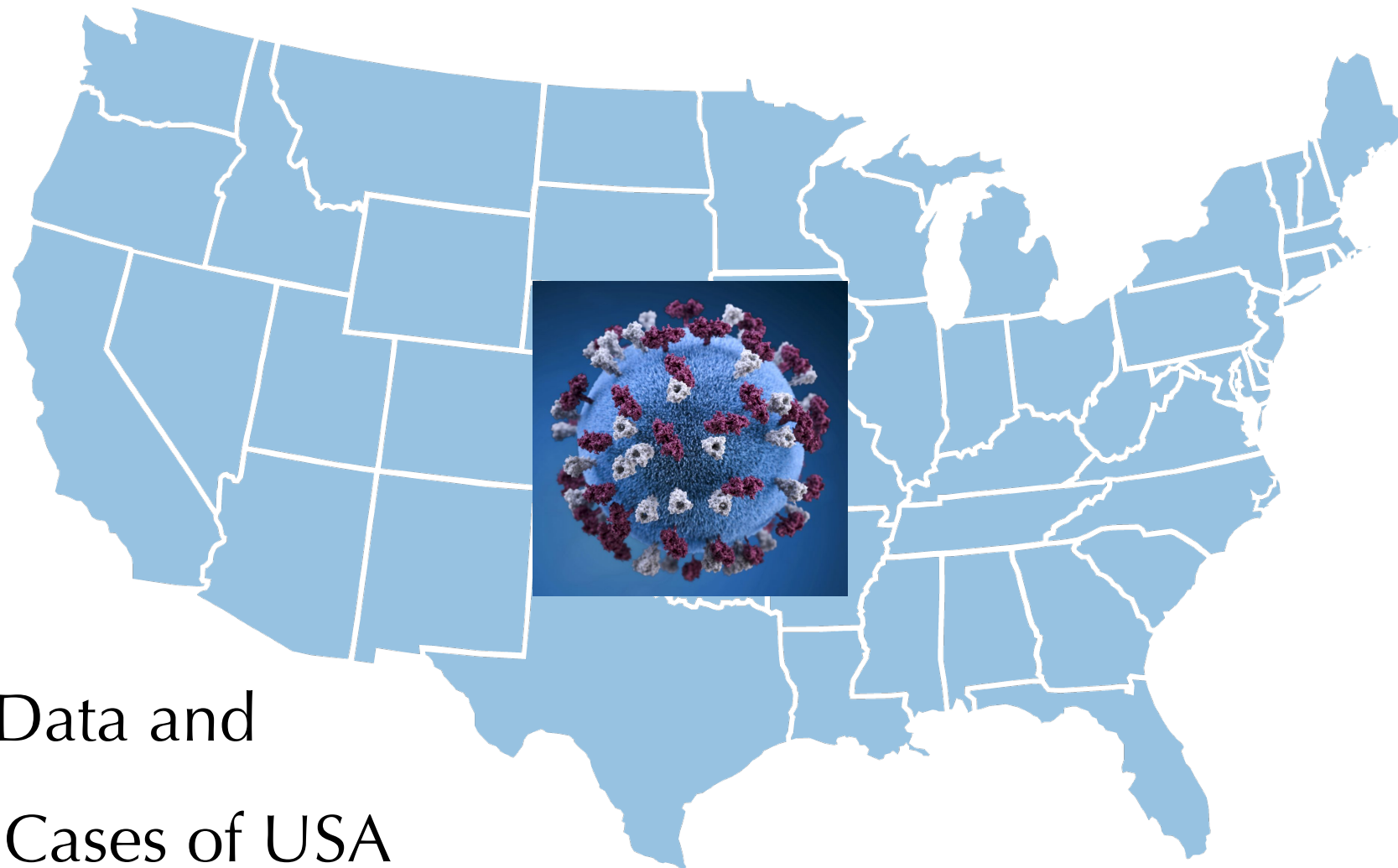
Mobility Network



Communication Network



Strategizing COVID-19 Lockdowns Using Mobility Patterns



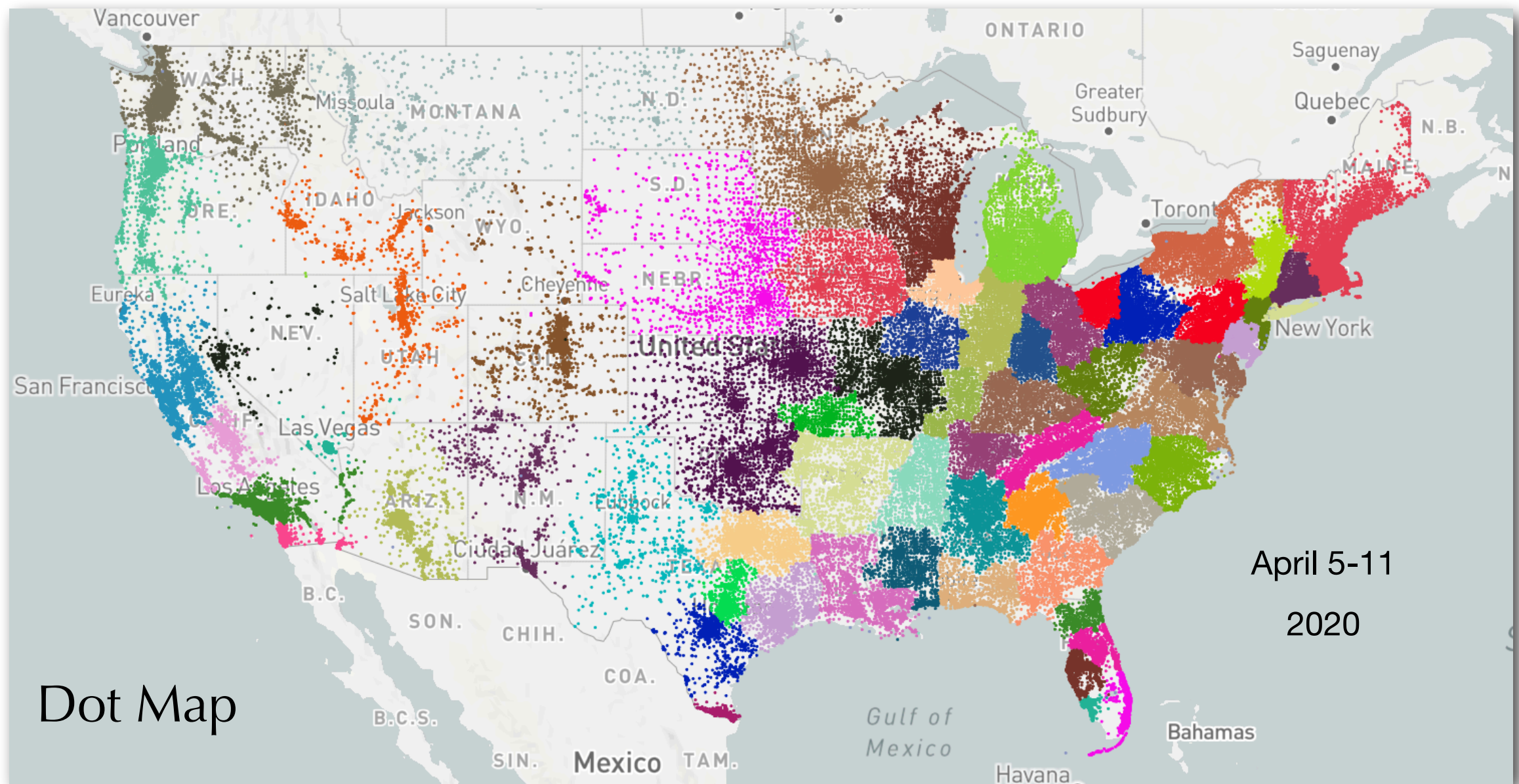
CellPhone Data and
COVID-19 Cases of USA

<https://www.endcoronavirus.org/mobility-maps>

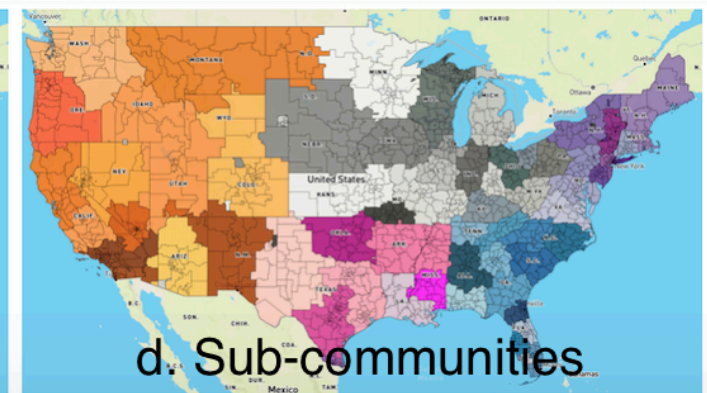
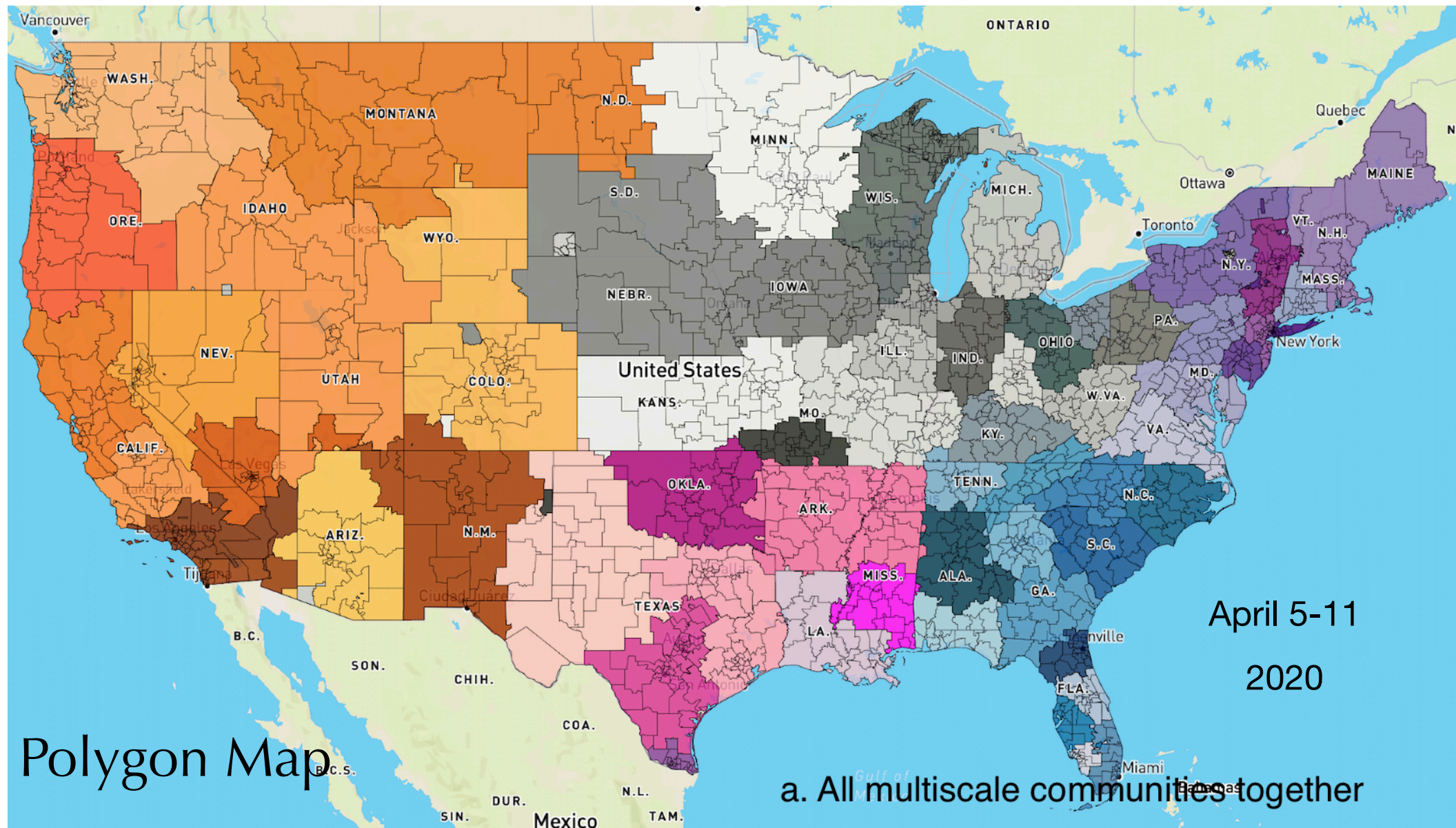


NSF Award Number: 2032536

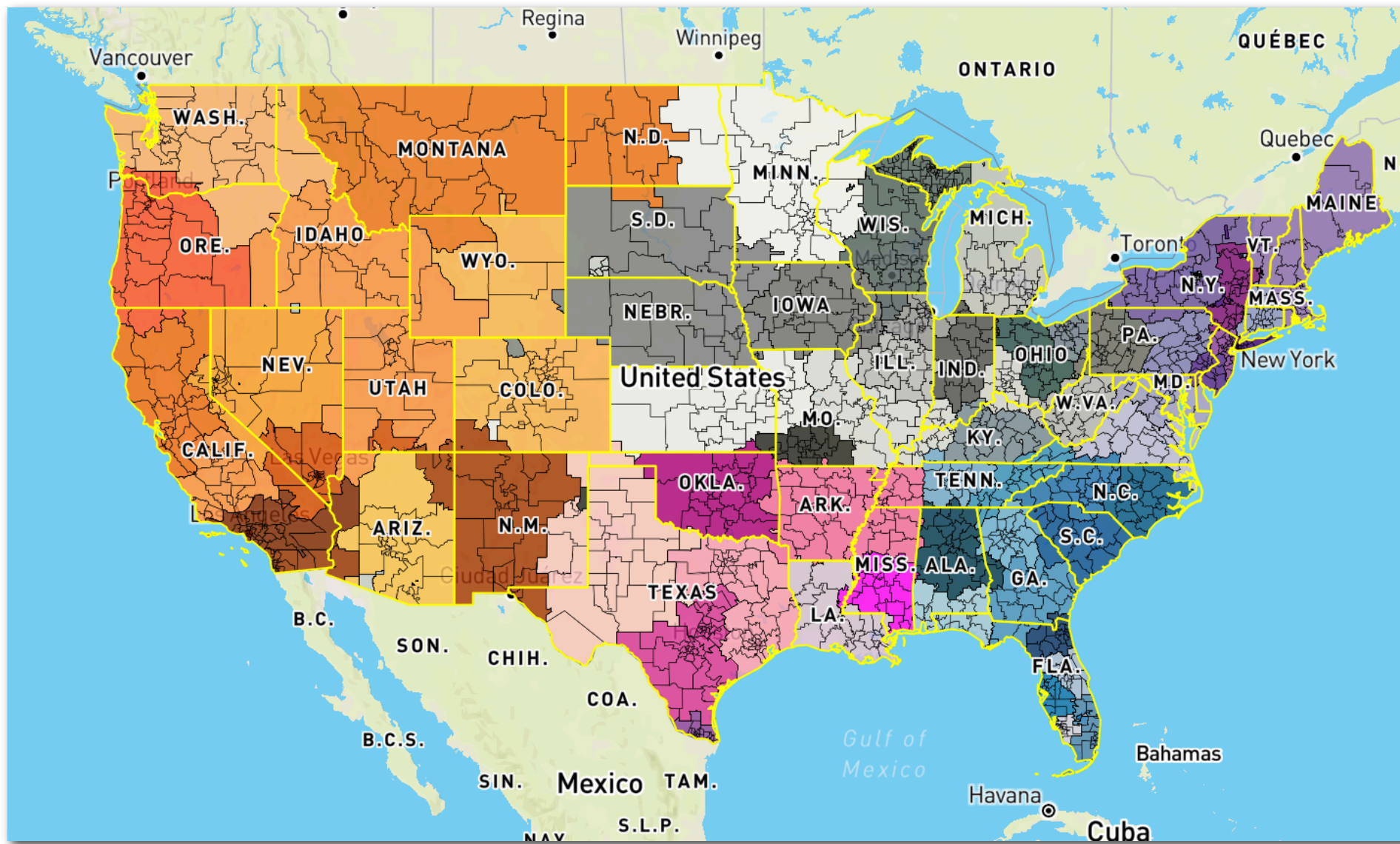
US Mobility Maps



Multi-scale Mobility Patterns

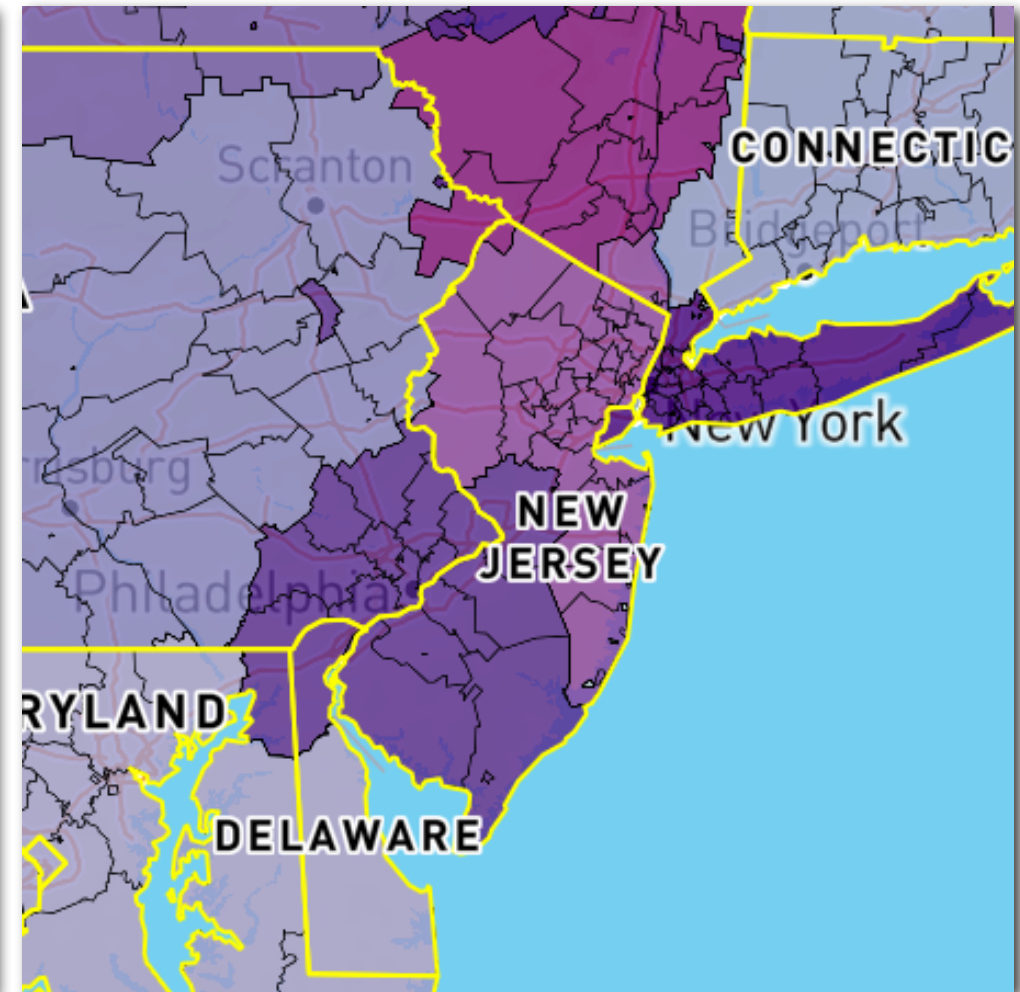
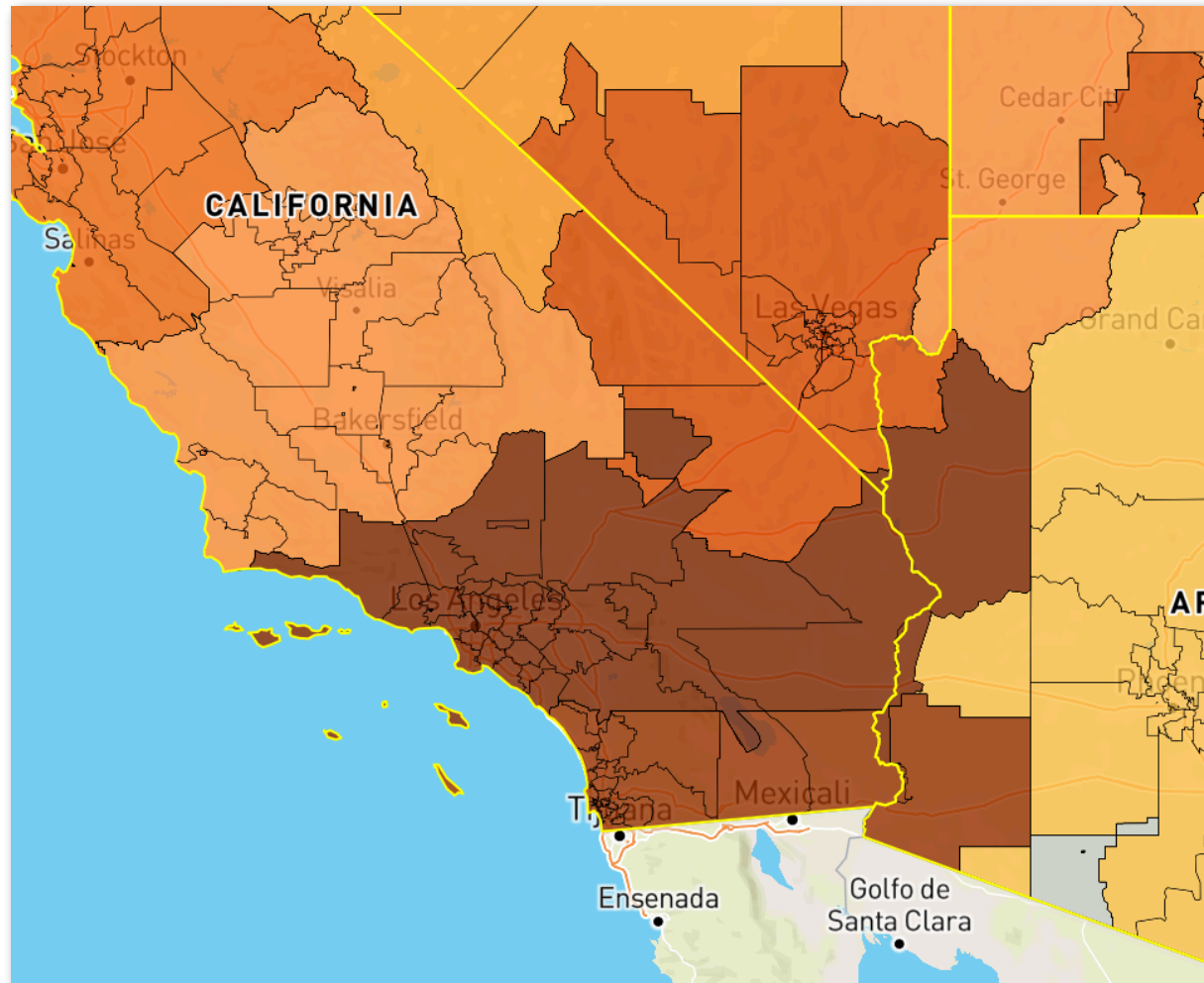


Interesting Facts About the Maps



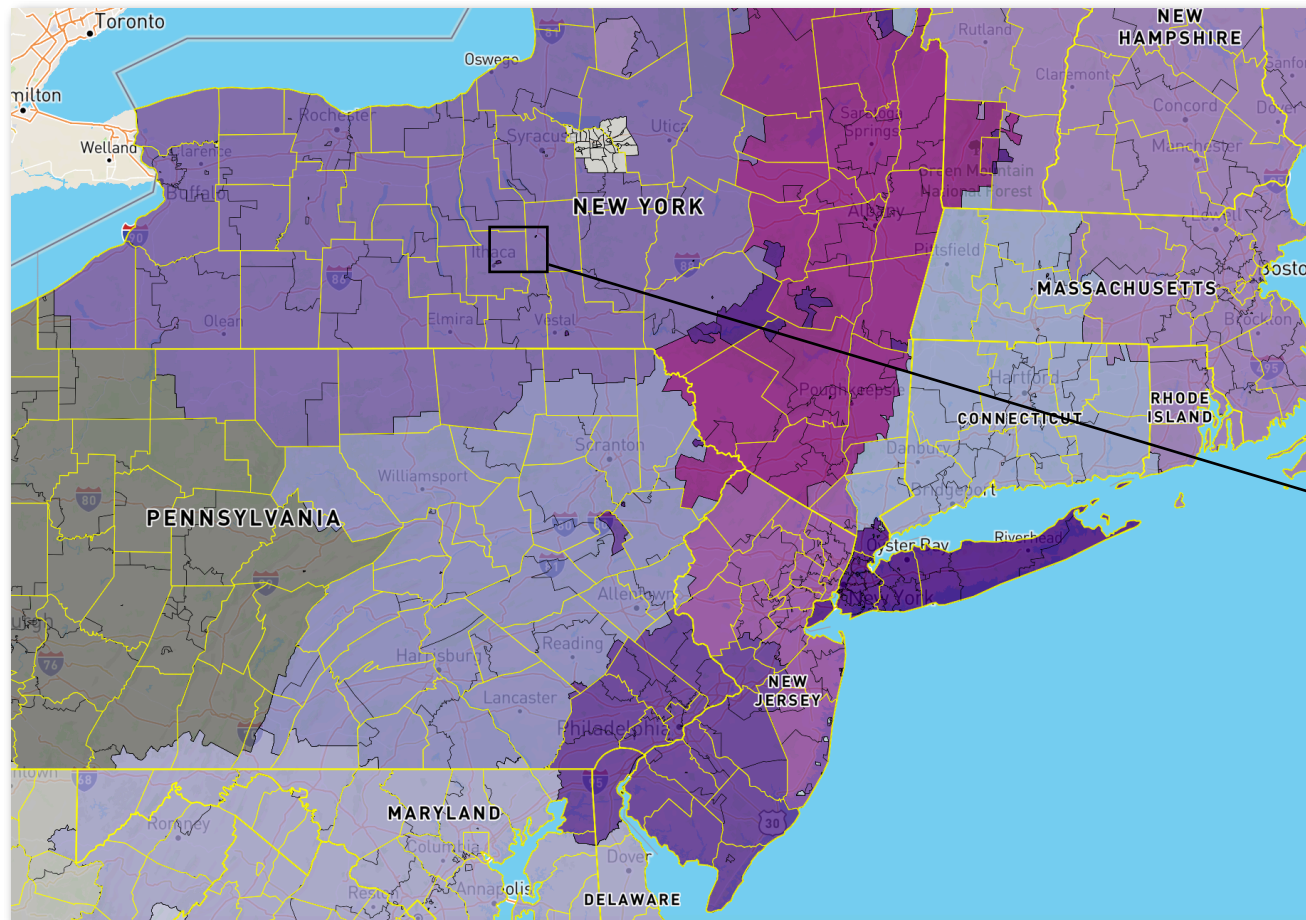
Deviation from administrative borders

Interesting Facts About the Maps



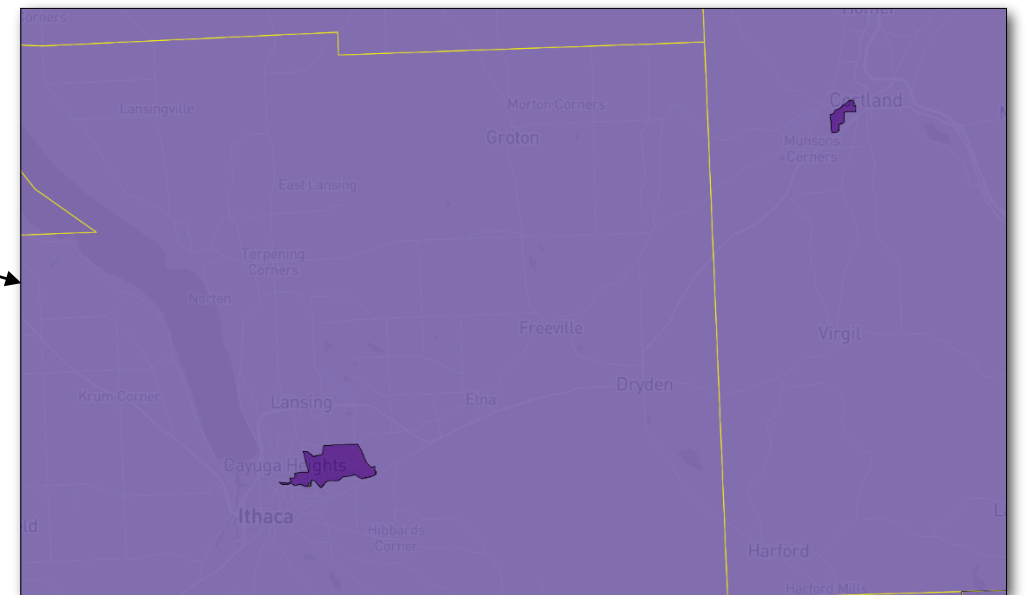
Deviation from administrative borders

Interesting Facts About the Maps



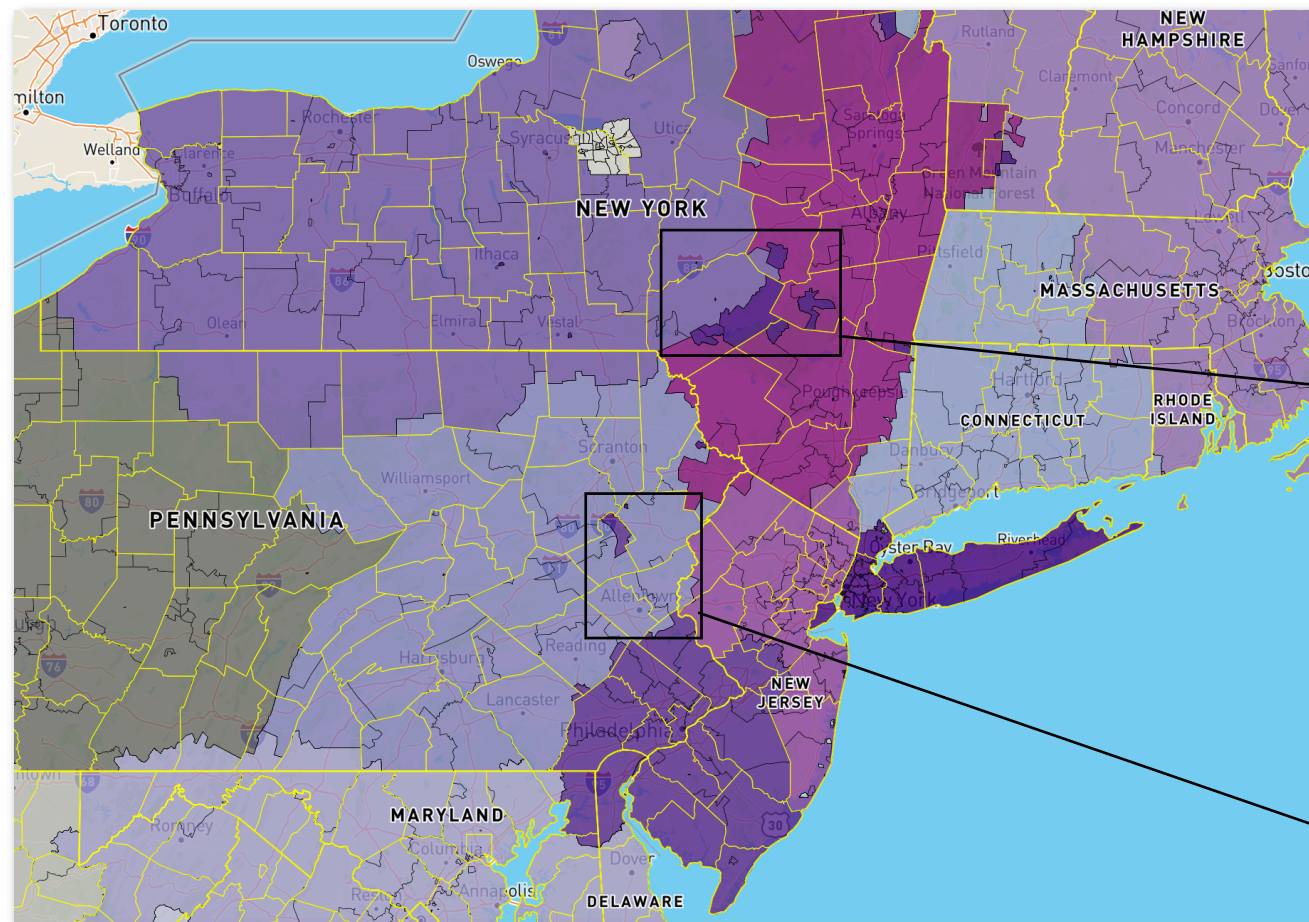
Isolated Communities

Universities

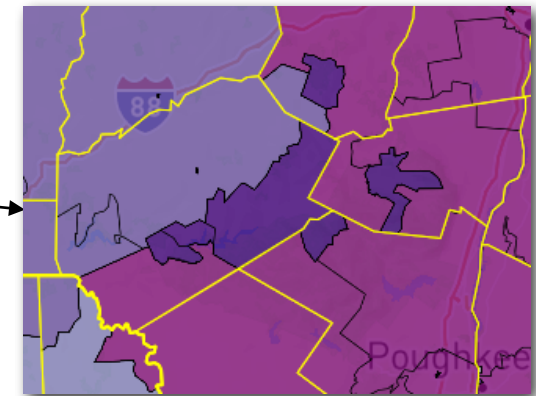


Cornell and SUNY Cortland Universities

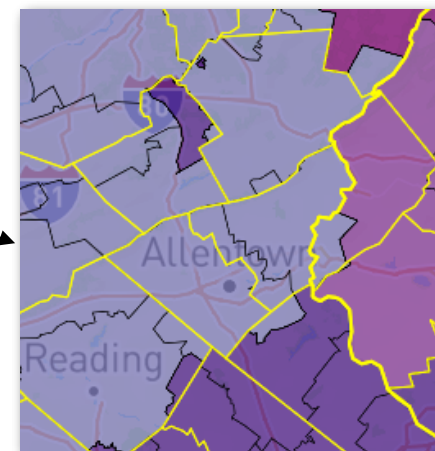
Interesting Facts About the Maps



Vacation spots



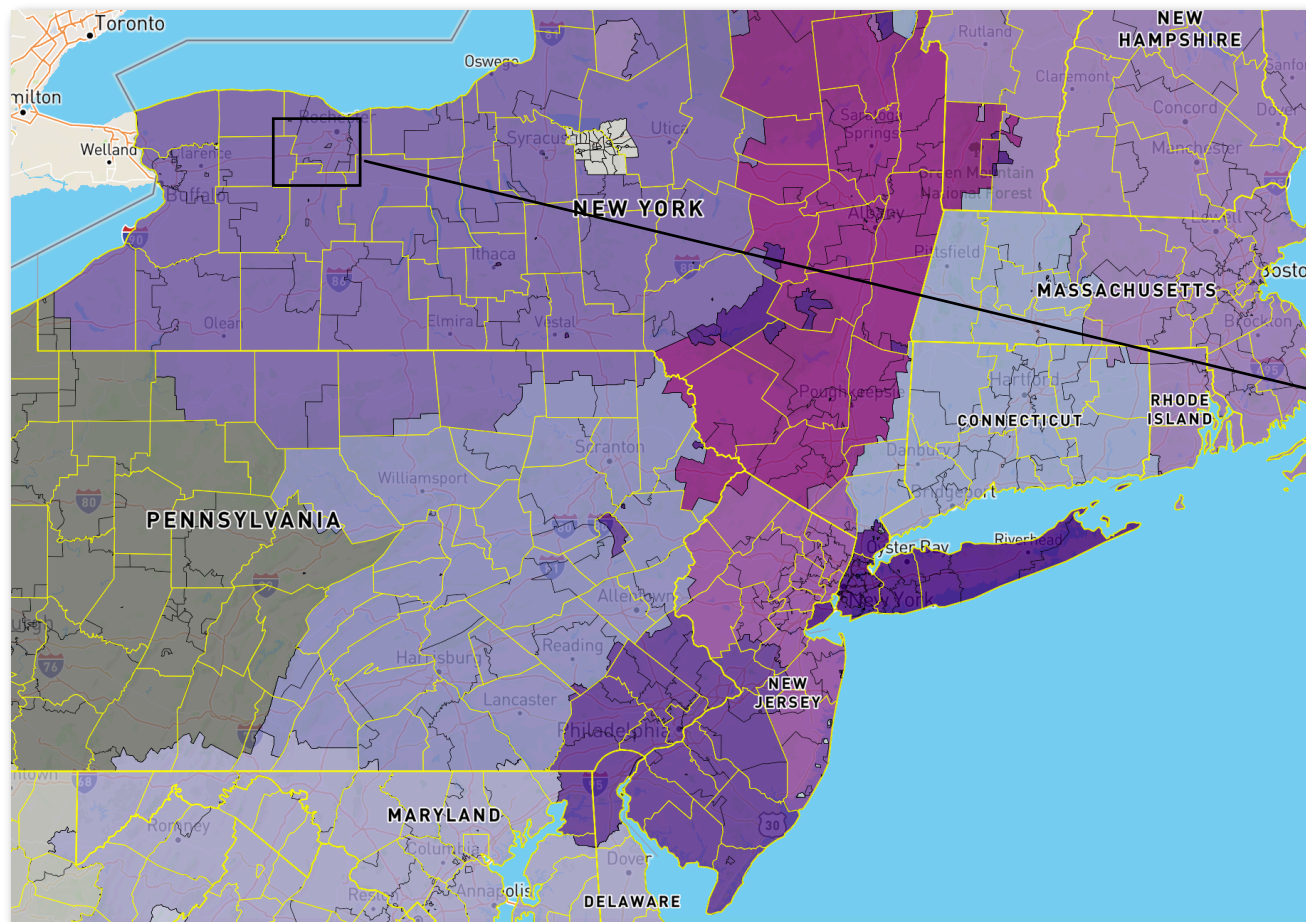
Catskill
Mountains



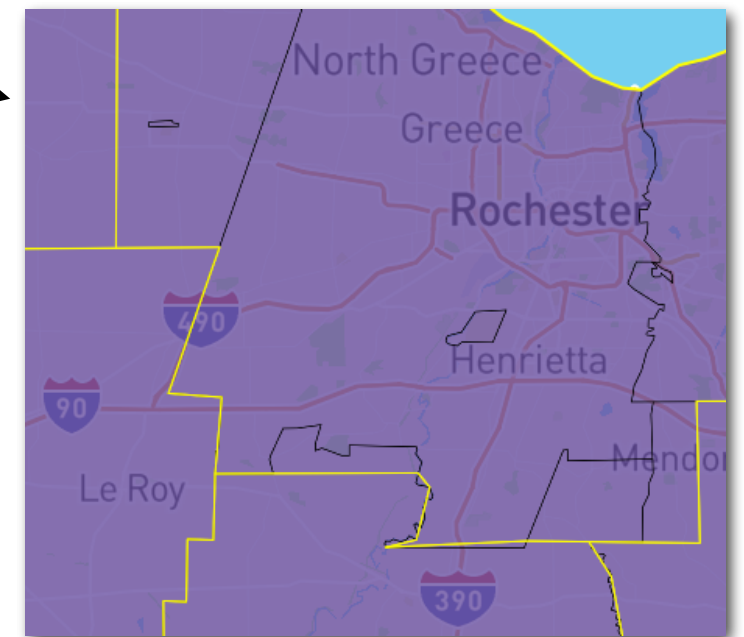
Poconos

Isolated Communities

Interesting Facts About the Maps

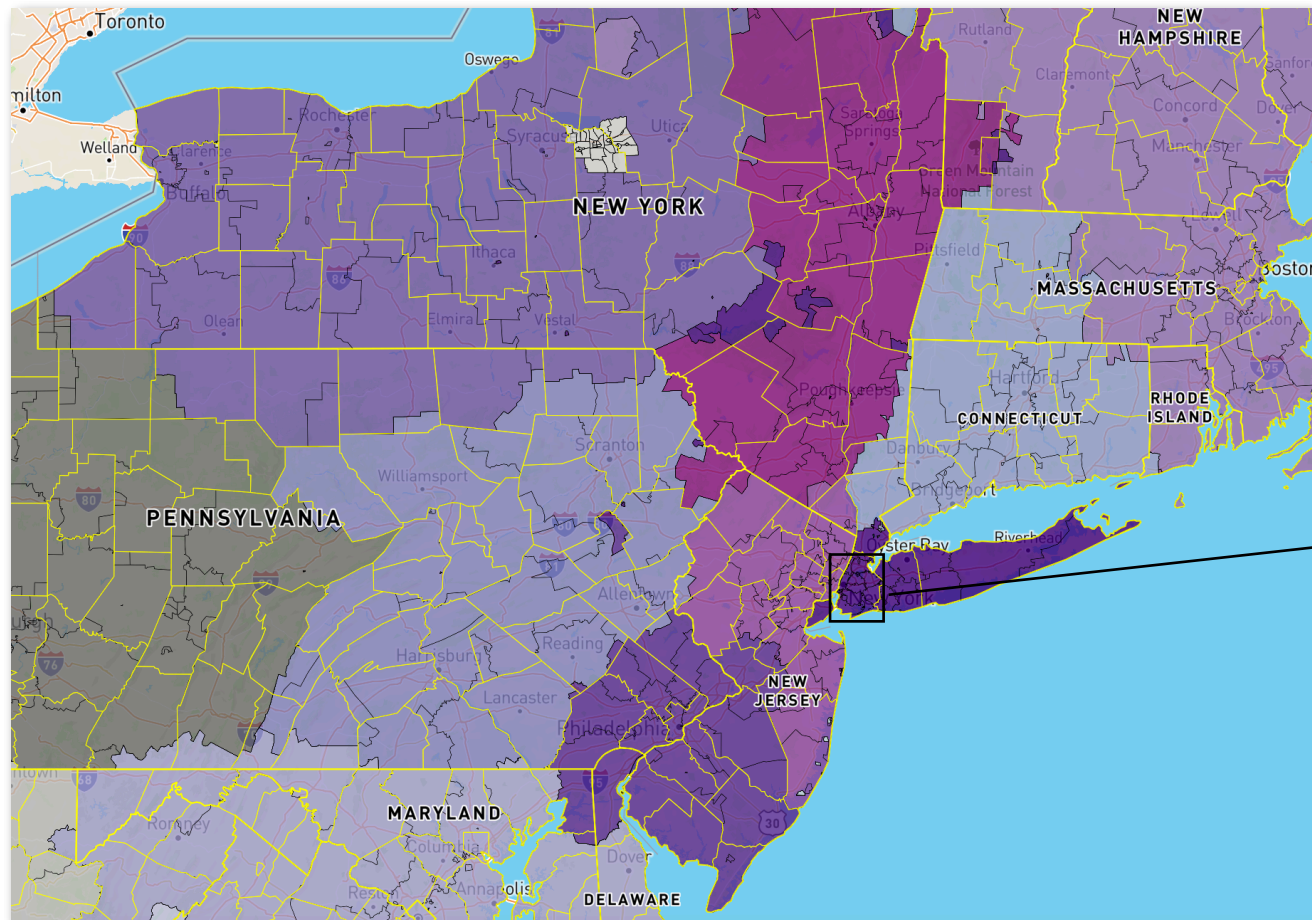


Rochester Institute of Technology

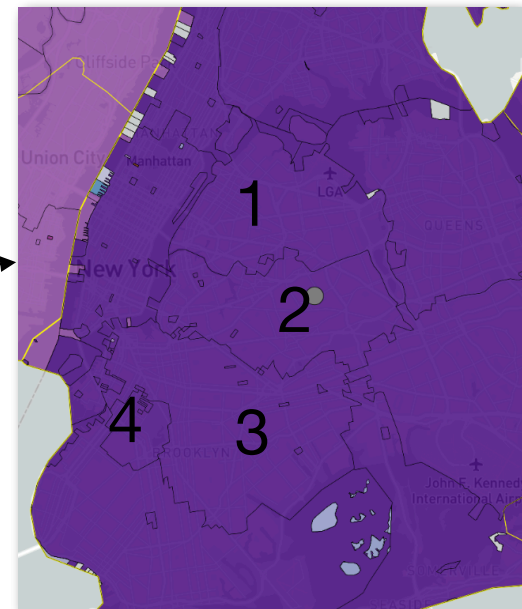


Sub-Communities within Other Sub-Communities

Interesting Facts About the Maps

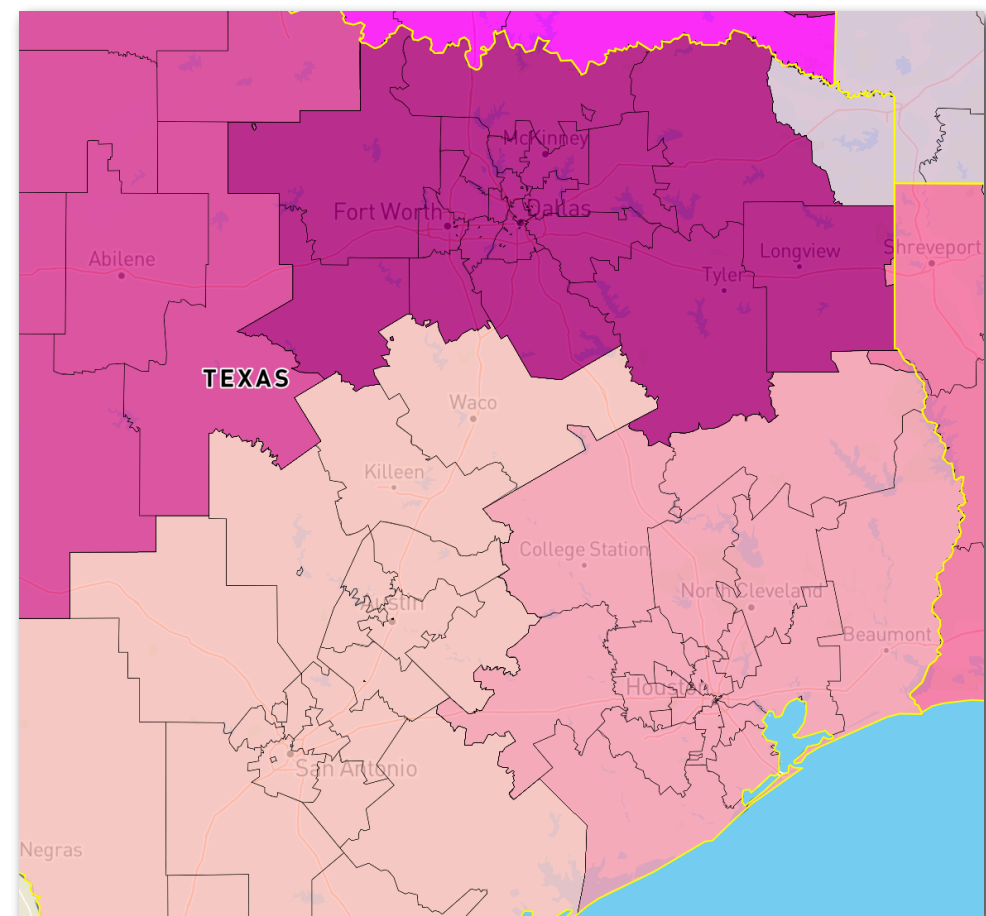
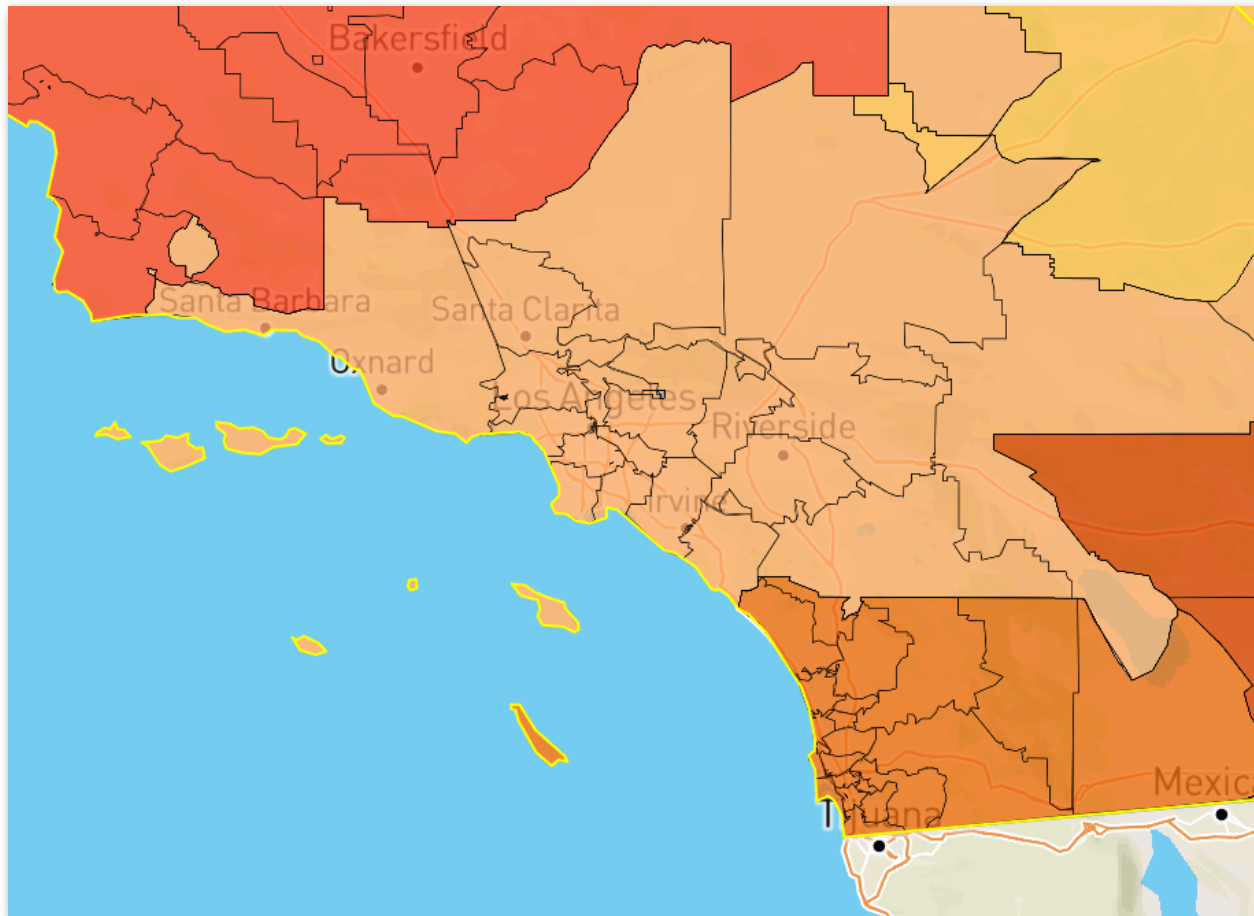


Sub-communities in City areas



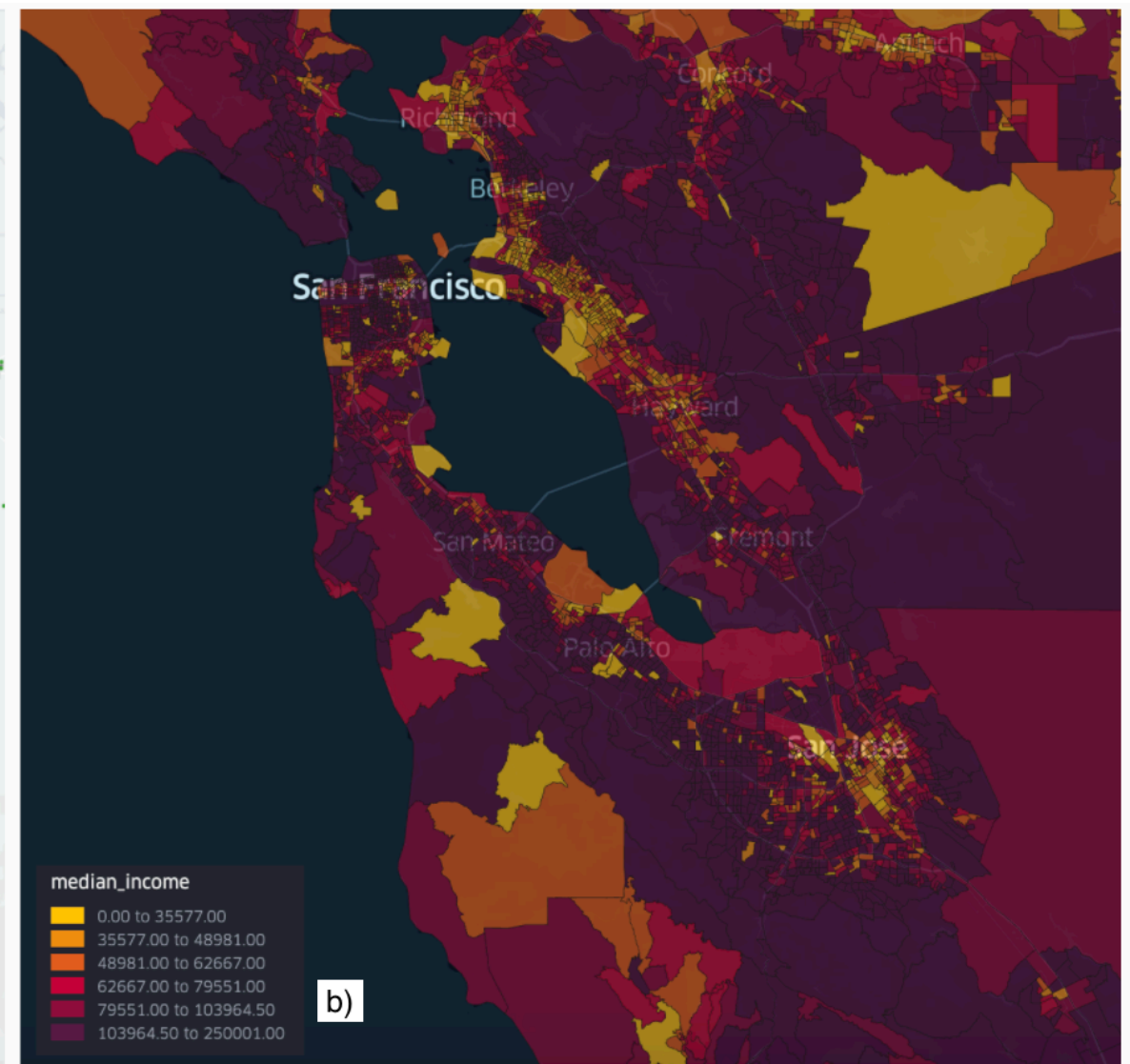
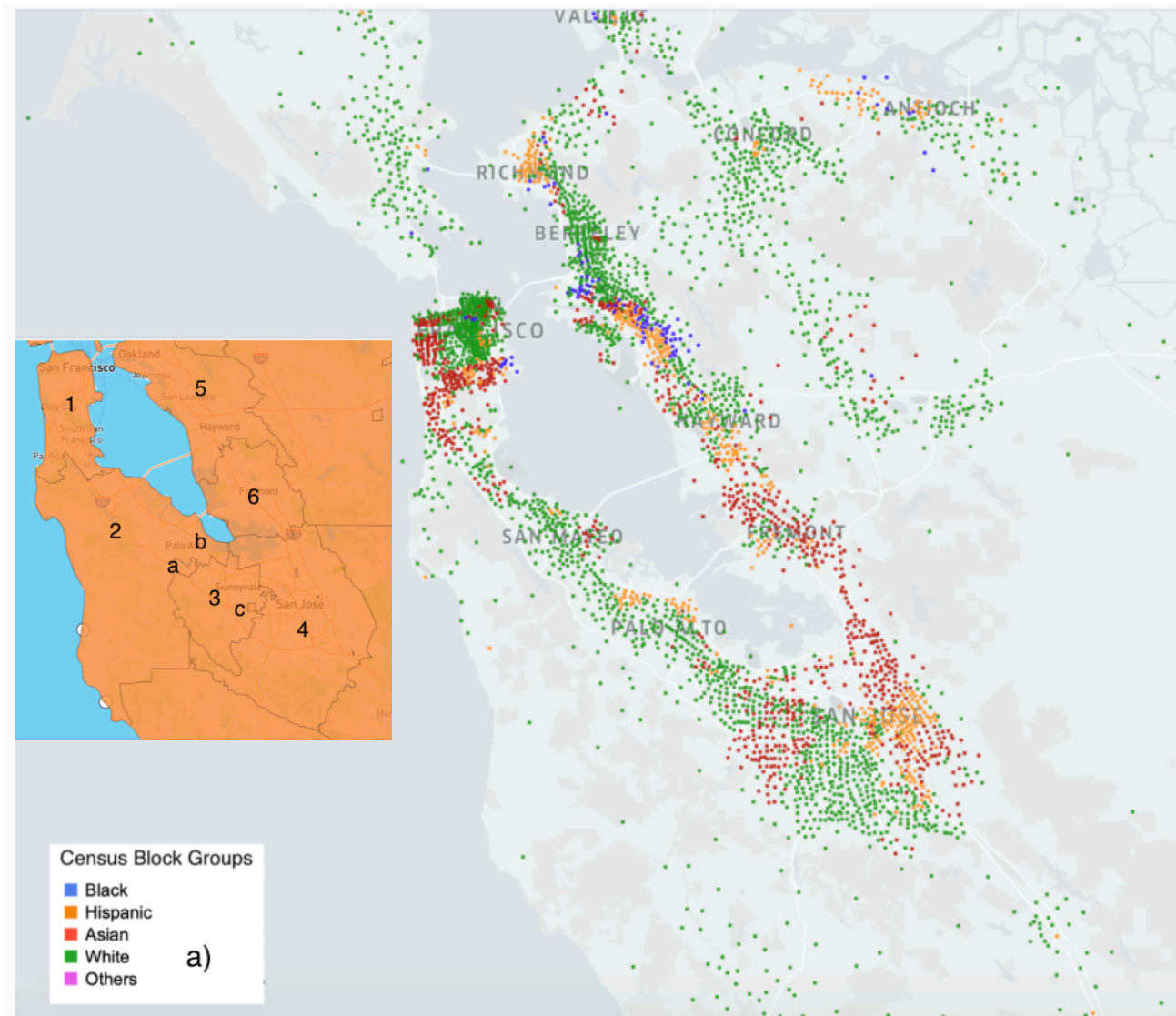
- 1) Areas of Queens
- 2) Northern Brooklyn
- 3) Central Brooklyn
- 4) Around Prospect Park

Interesting Facts About the Maps

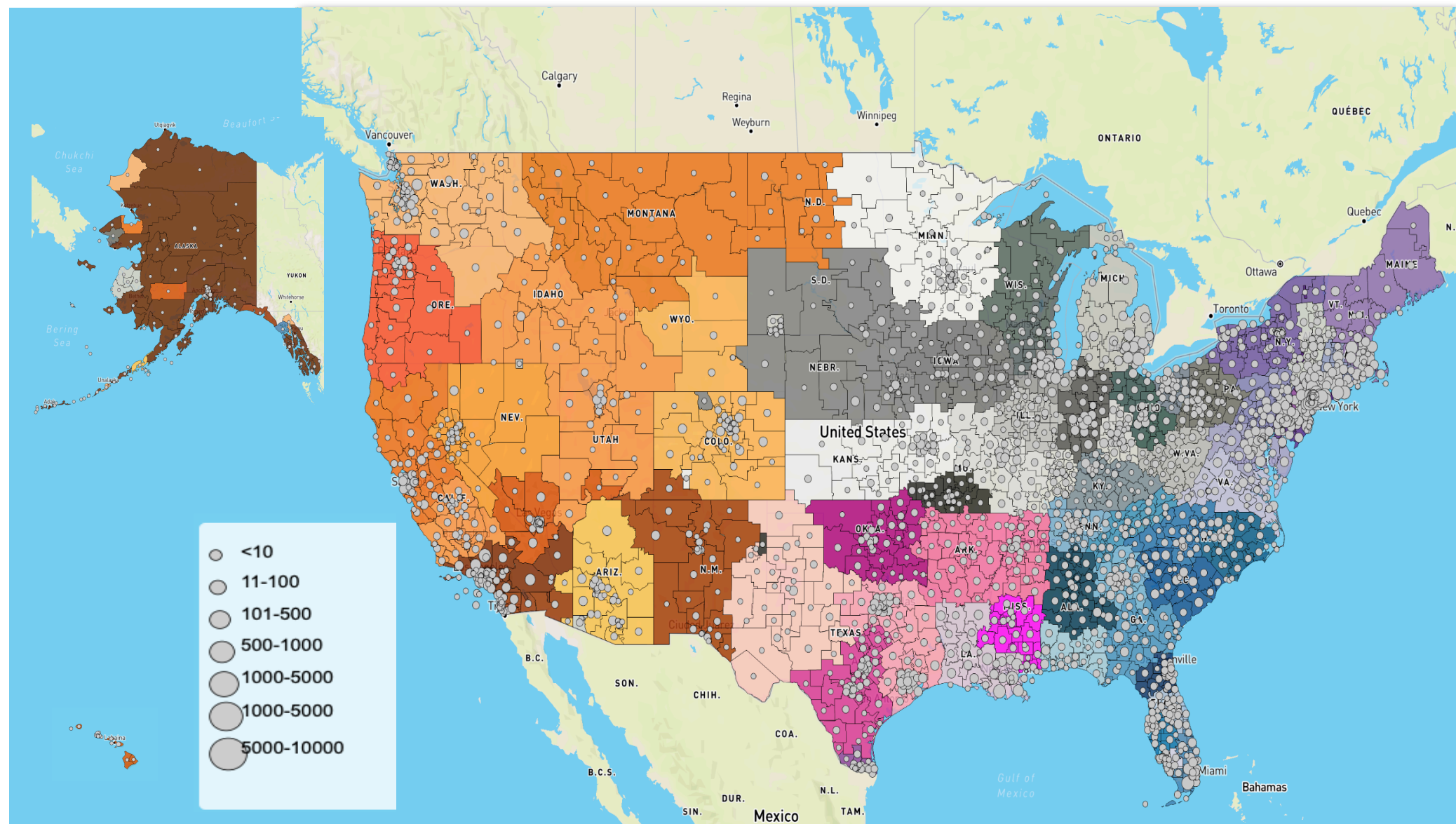


Sub-communities in City areas

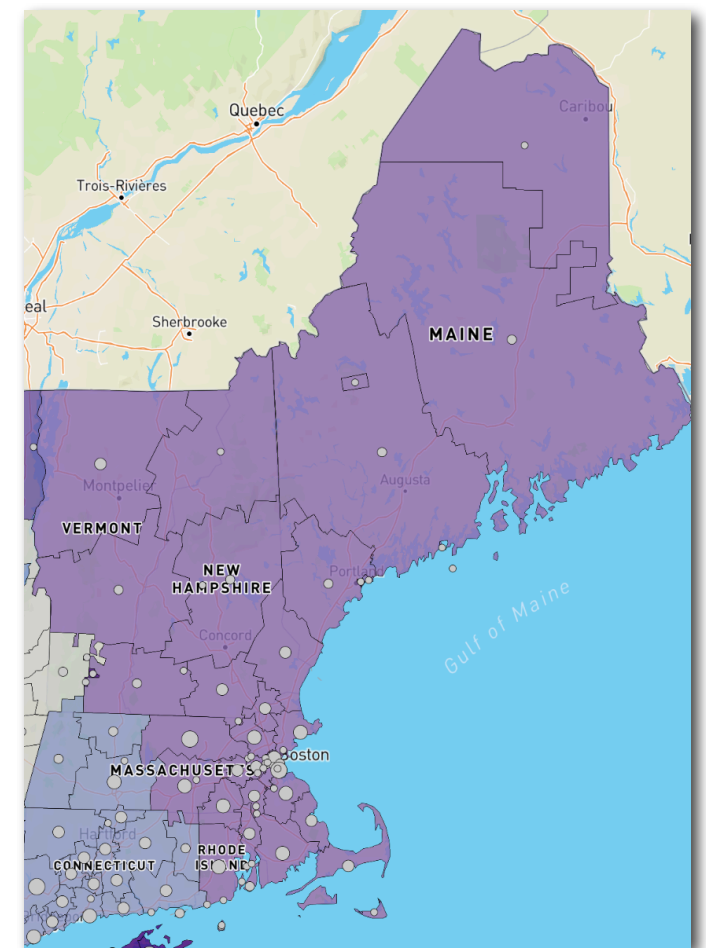
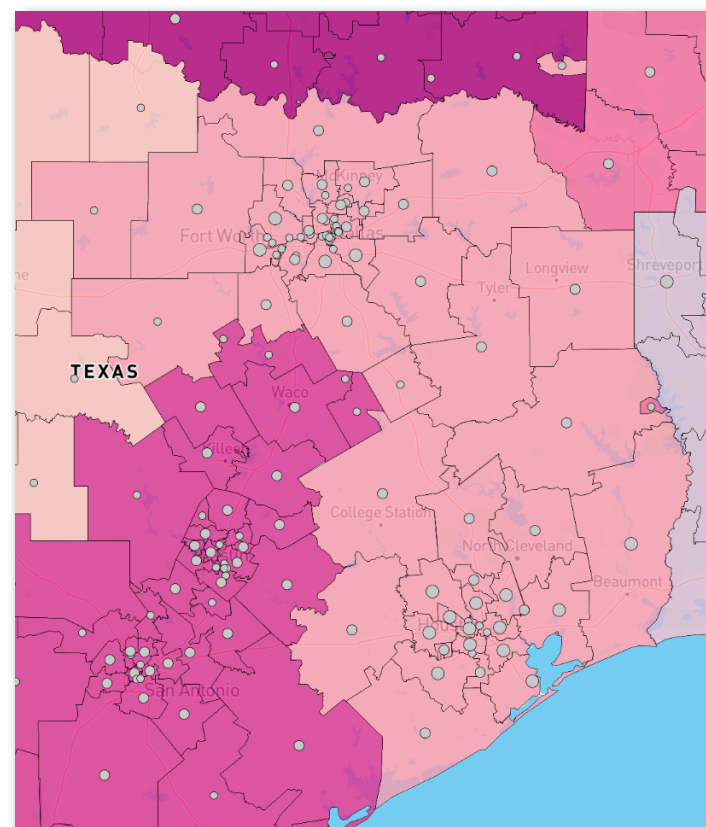
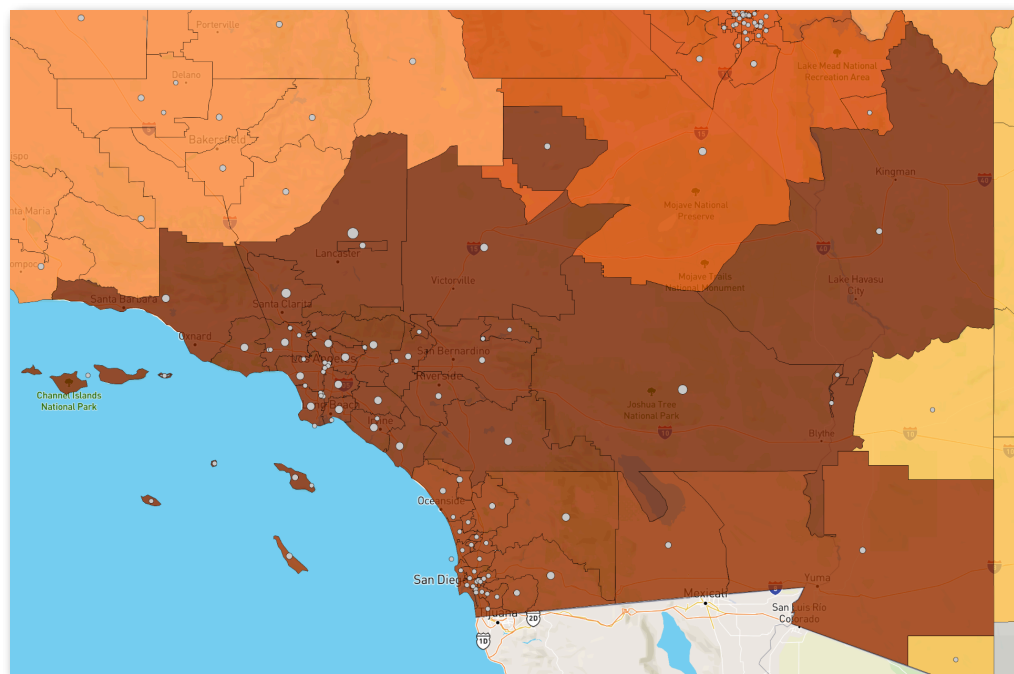
Socio-Economic Characteristics of Communities



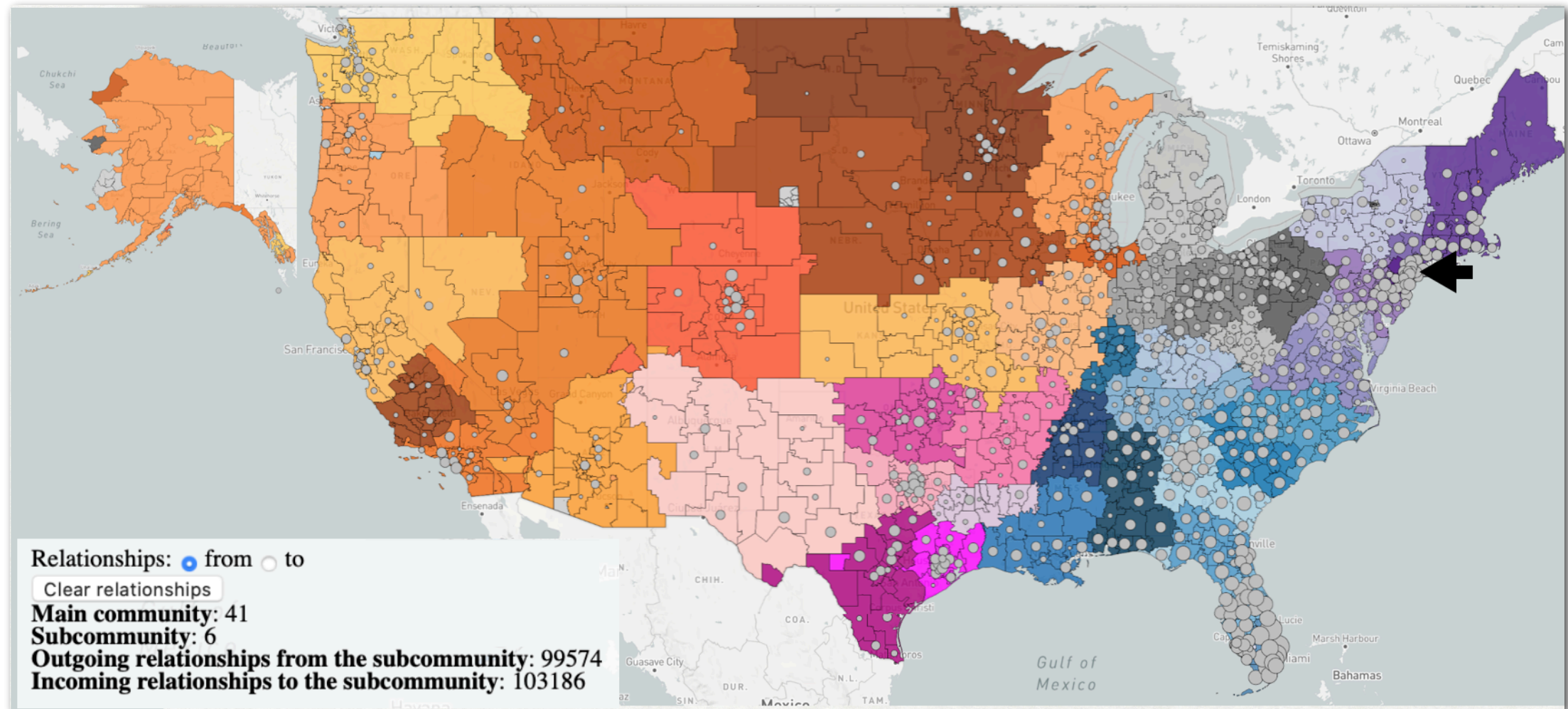
COVID-19 Risk Exposure in Mobility Patches



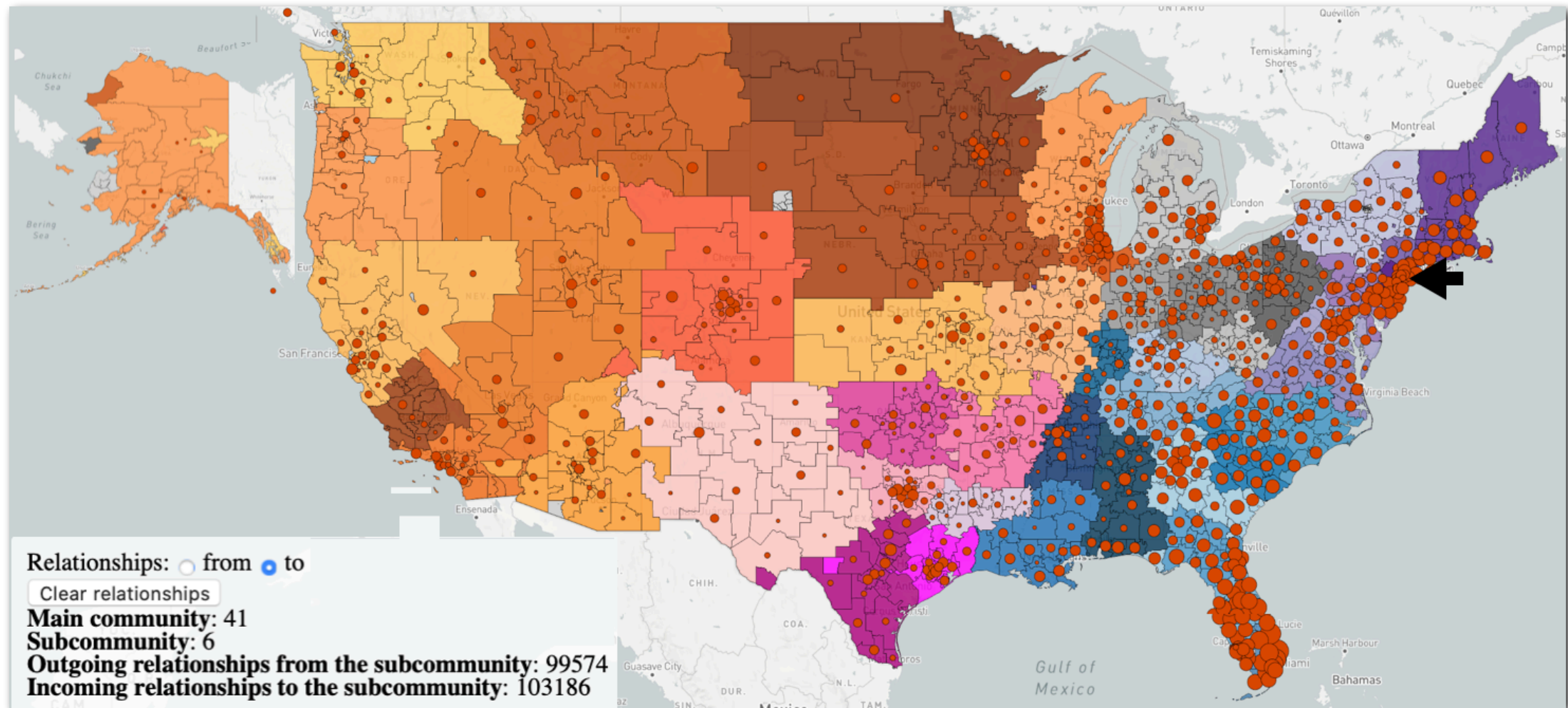
COVID-19 Risk Exposure in Mobility Patches



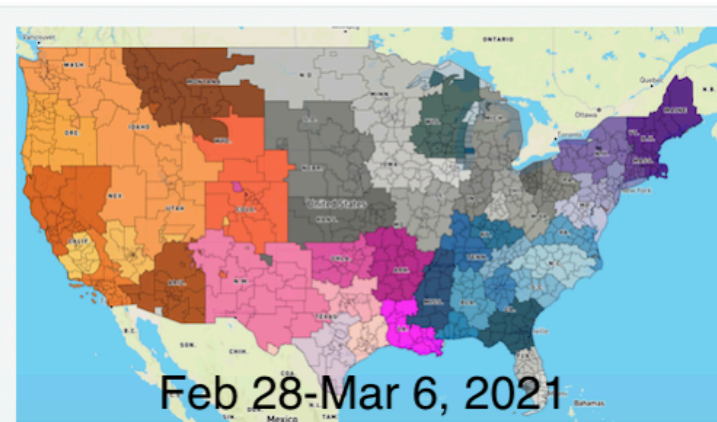
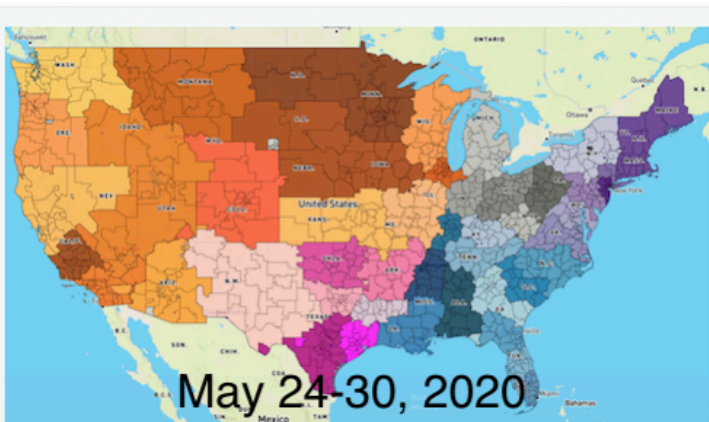
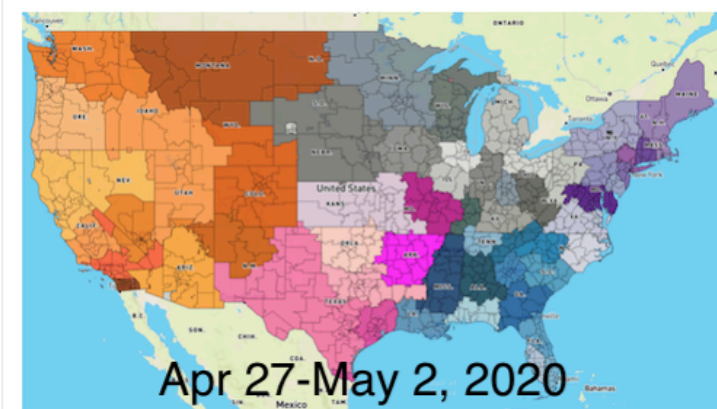
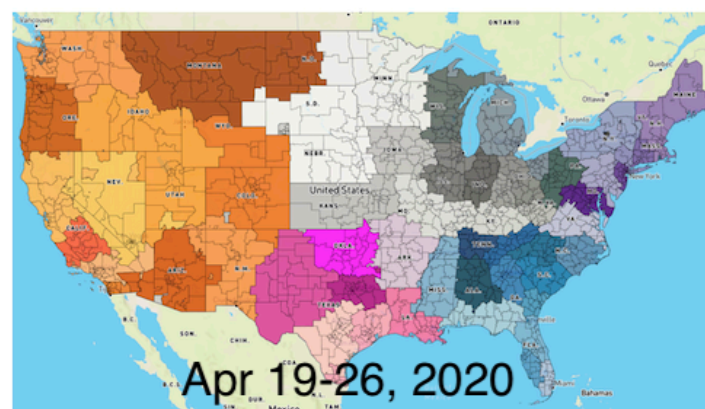
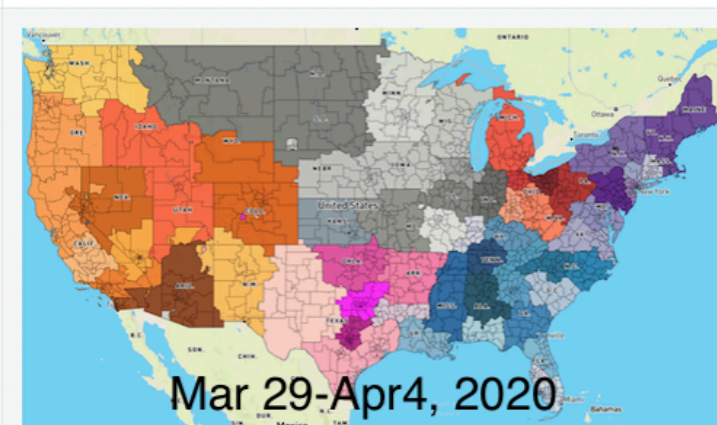
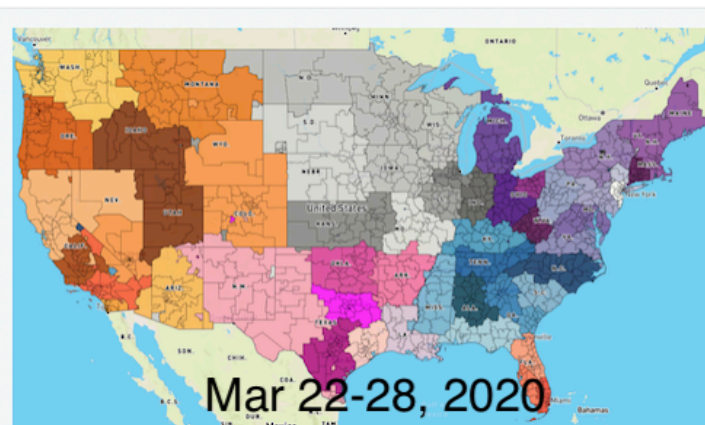
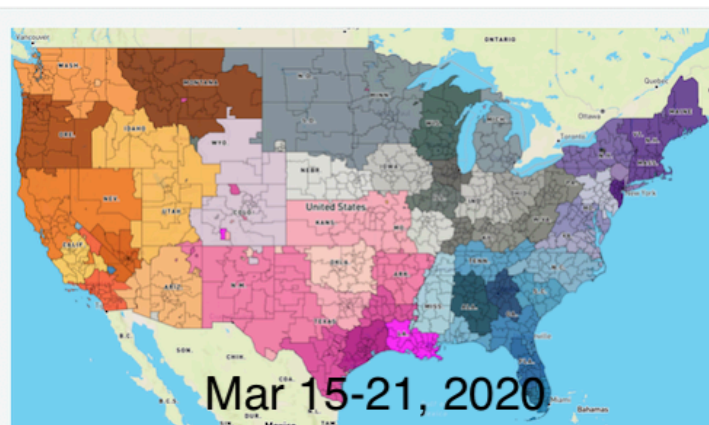
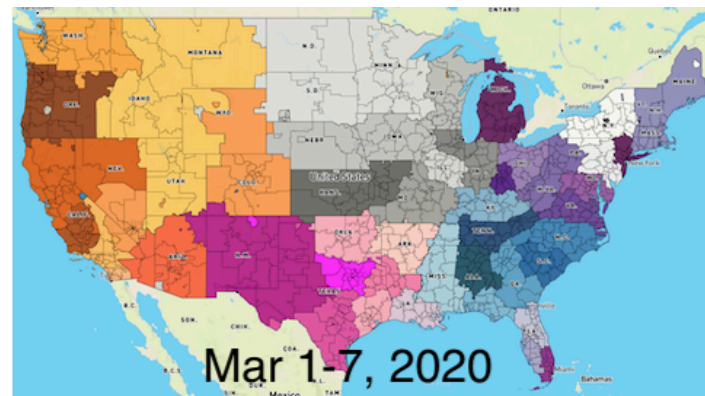
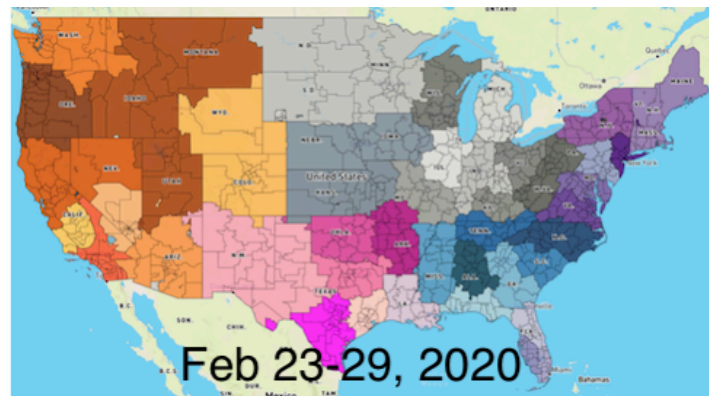
Relationships between Communities



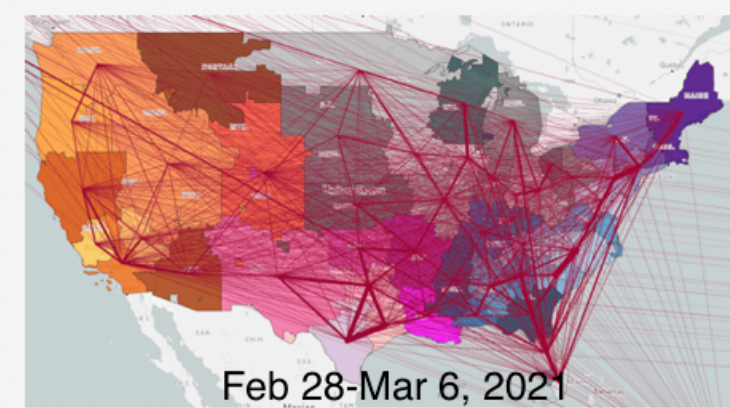
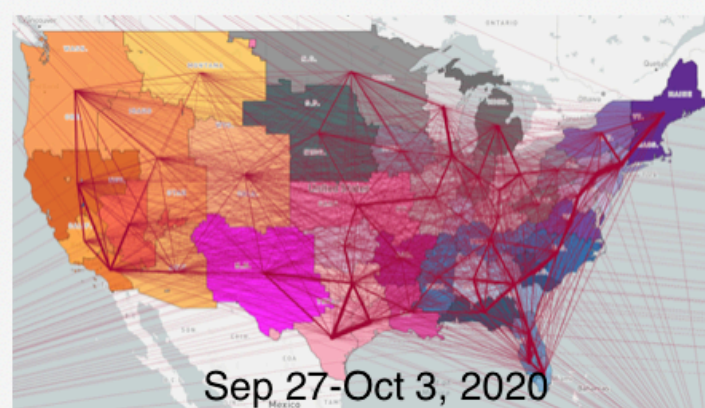
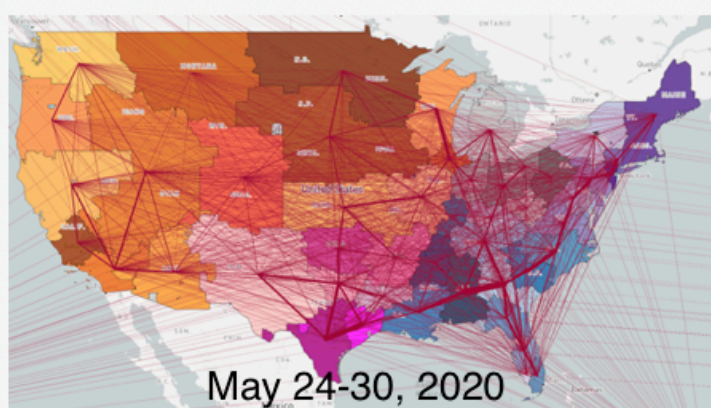
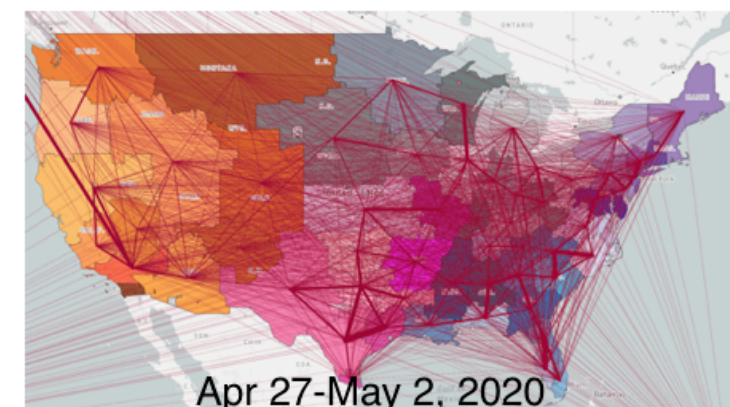
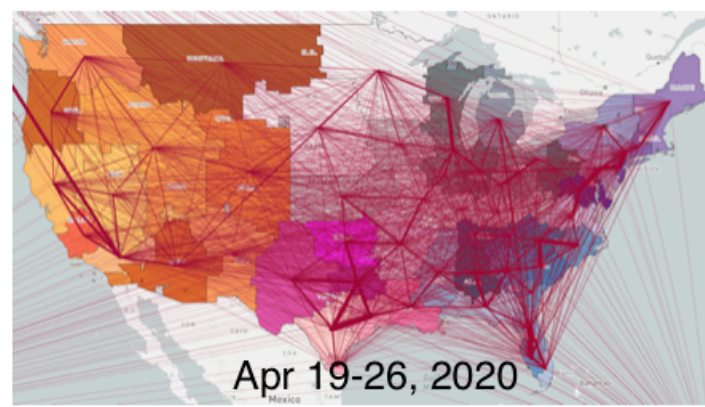
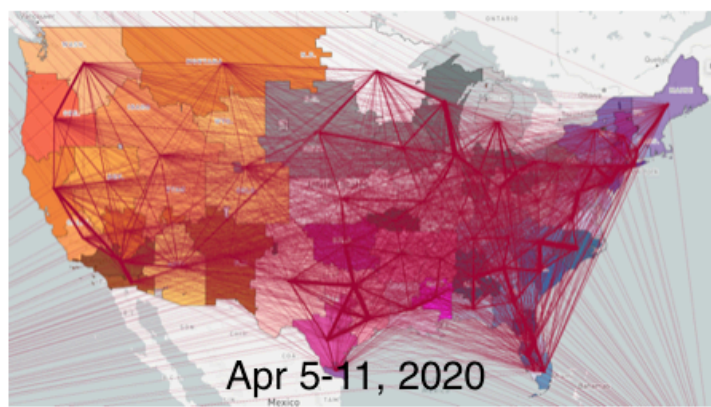
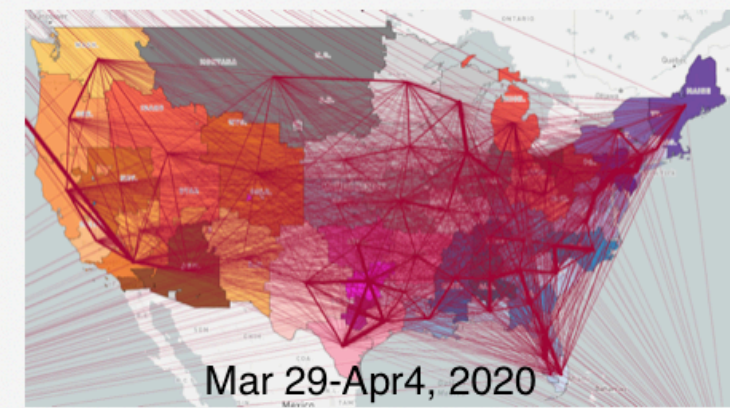
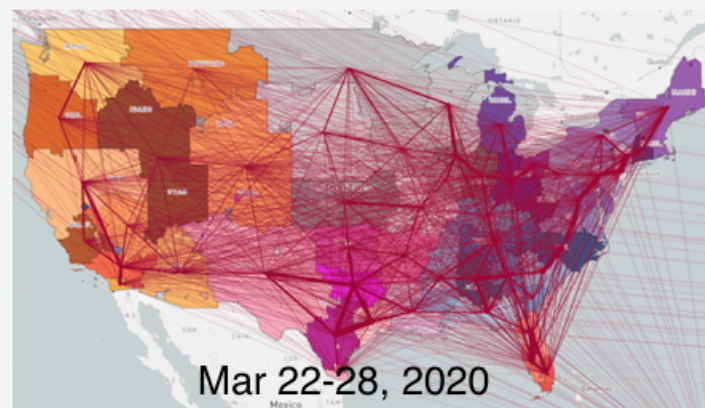
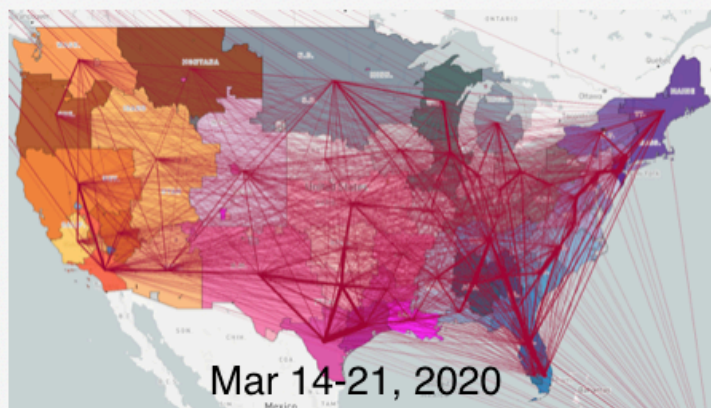
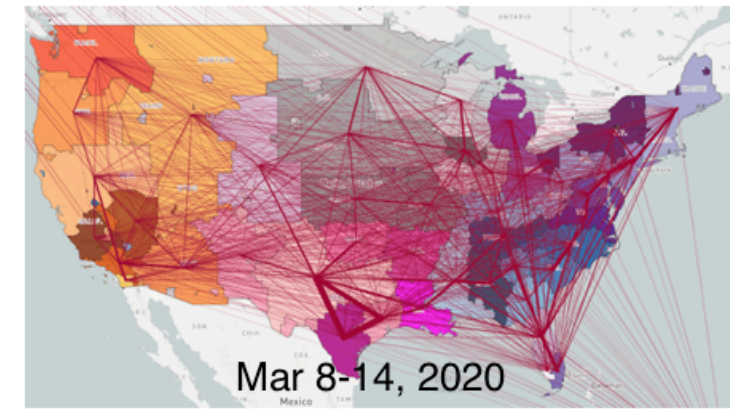
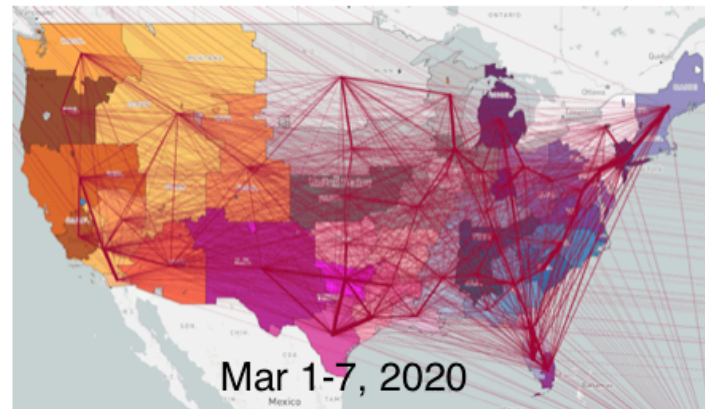
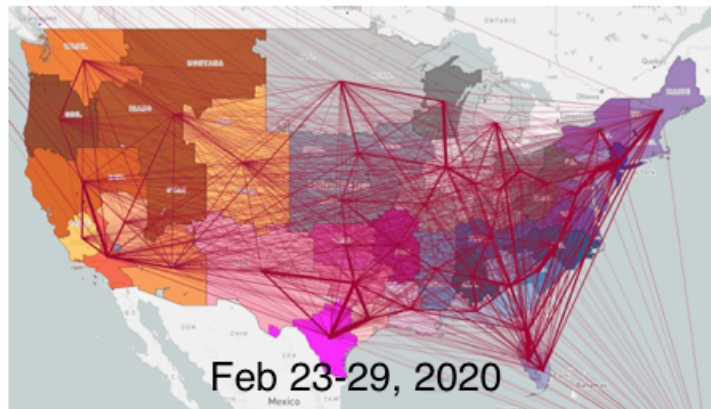
Relationships between Communities



Dynamics of Mobility Patterns

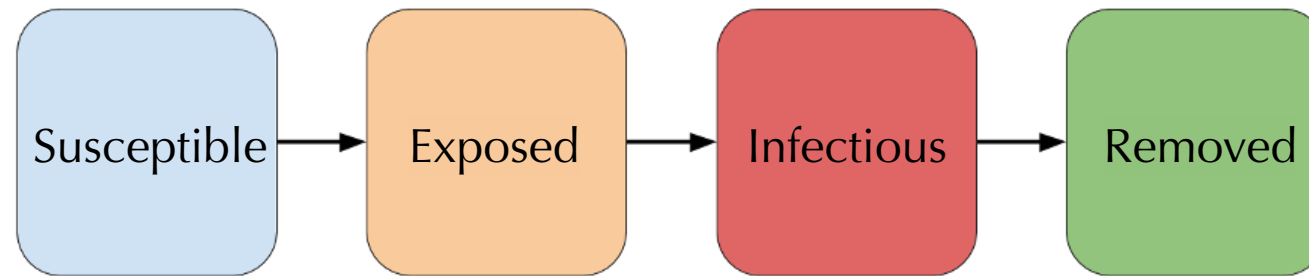


Movements between Communities



COVID-19 Spreading Simulation

SEIR model:



$$\frac{dS_i}{dt} = -\beta \frac{S_i I_i}{N_i} - \eta_i S_i + \sum_j \frac{A_{ij} \eta_j}{k_j} S_j$$

$$\frac{dE_i}{dt} = \beta \frac{S_i I_i}{N_i} - \alpha E_i - \eta_i E_i + \sum_j \frac{A_{ij} \eta_j}{k_j} E_j,$$

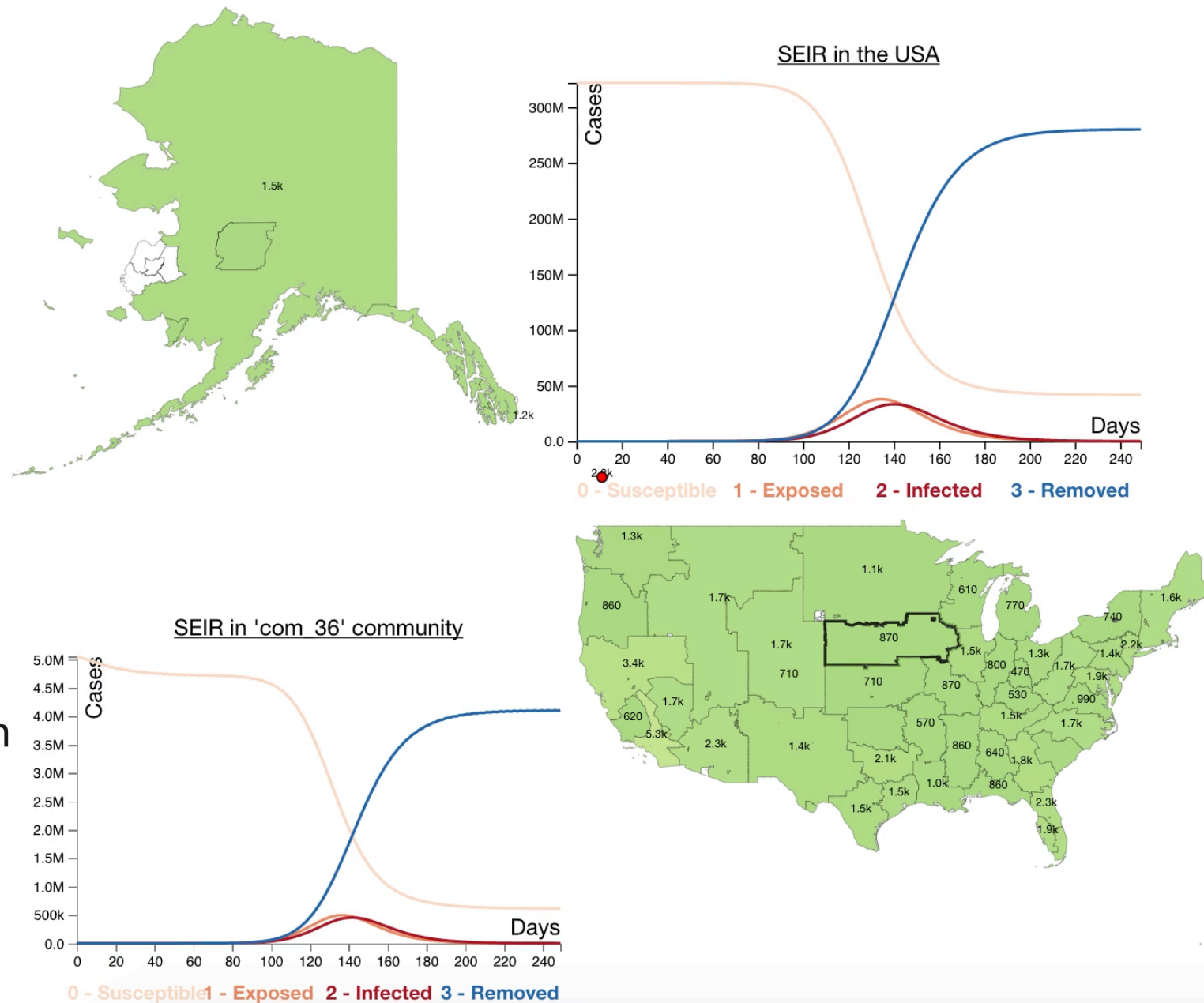
$$\frac{dI_i}{dt} = \alpha E_i - \gamma I_i - \eta_i I_i + \sum_j \frac{A_{ij} \eta_j}{k_j} I_j,$$

$$\frac{dR_i}{dt} = \gamma I_i - \eta_i R_i + \sum_j \frac{A_{ij} \eta_j}{k_j} R_j,$$

$$\frac{dN_i}{dt} = -\eta_i N_i + \sum_j \frac{A_{ij} \eta_j}{k_j} N_j,$$

COVID-19 Spreading Simulation

com_4

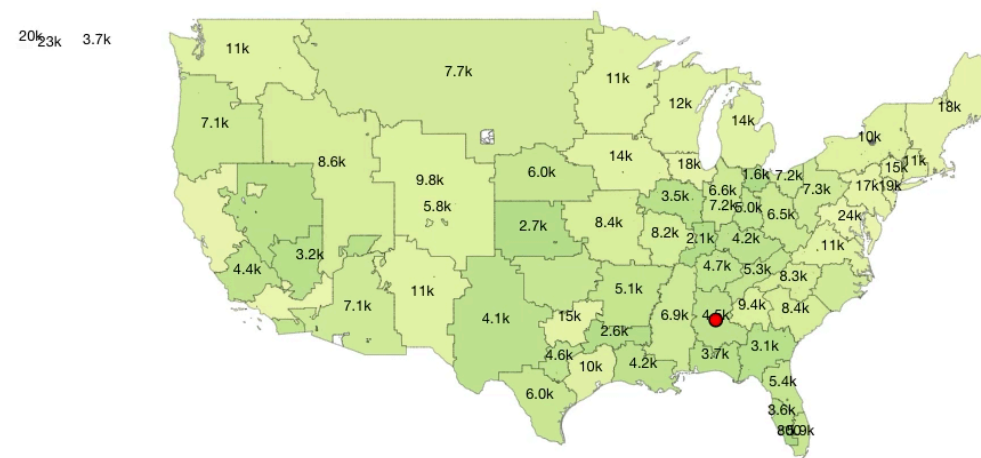
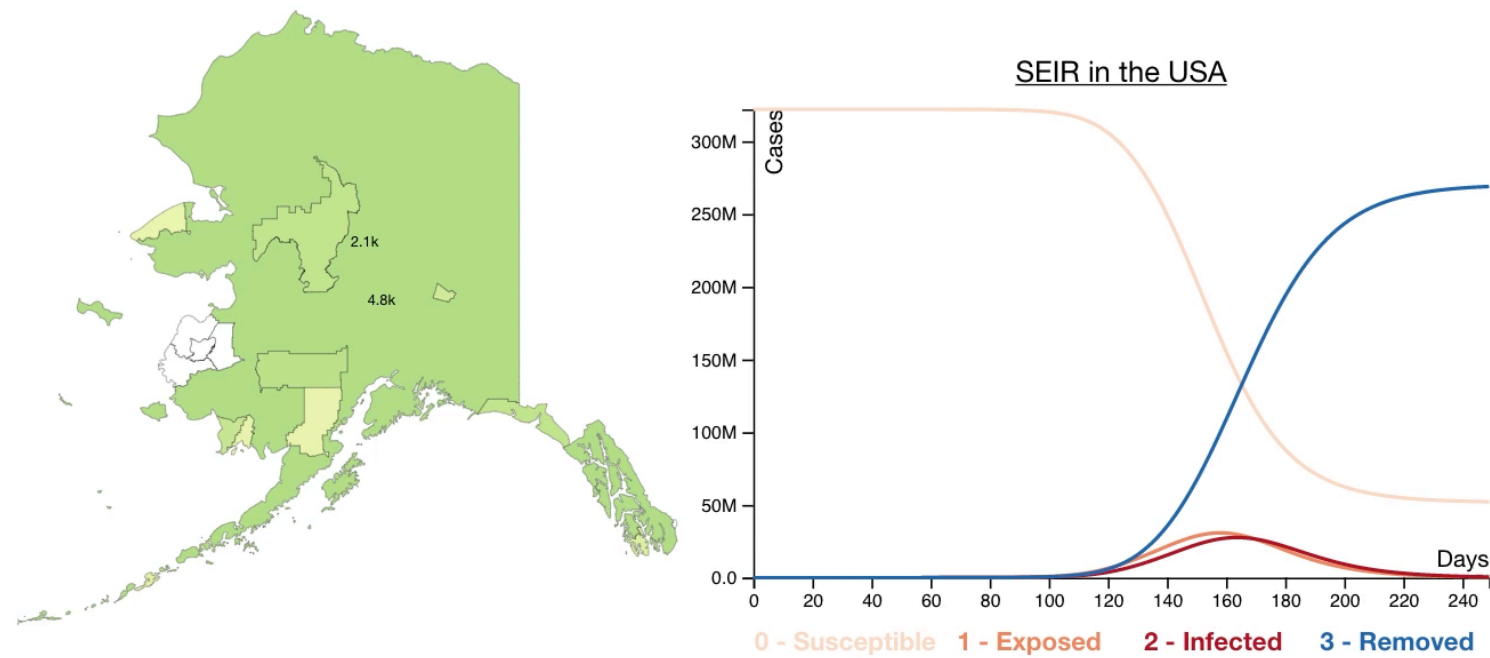


Before Lockdown

Feb 23- Feb 29

COVID-19 Spreading Simulation

com_0



During national Lockdown

March 29-April04

2.0k

820



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solving problems of science and society

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Thanks!

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