

# Spatial synchrony of seasonal influenza epidemics in Norway

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Sinead Morris

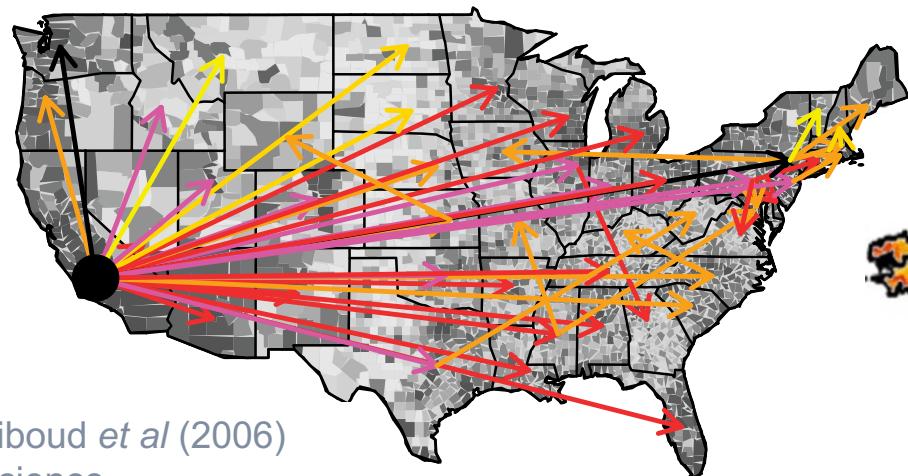
*PhD candidate*

*Princeton University*



Norwegian Institute of Public Health

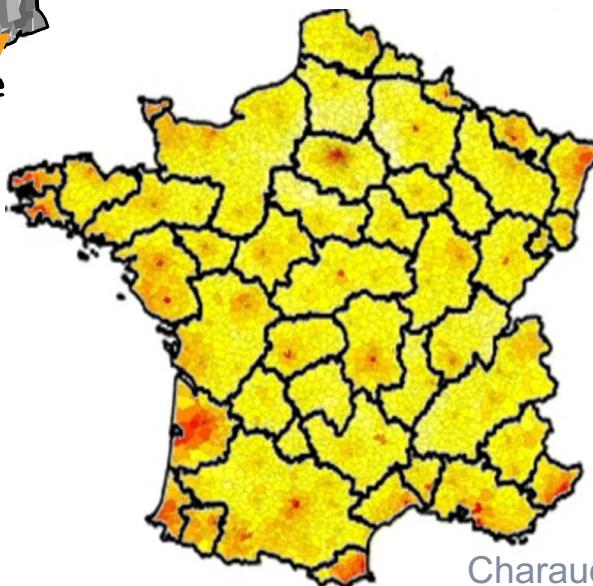
# Why Norway?



Viboud et al (2006)  
Science

Gog et al (2014) PLoS  
Comp. Bio

Stark et al (2012)  
PLoS One

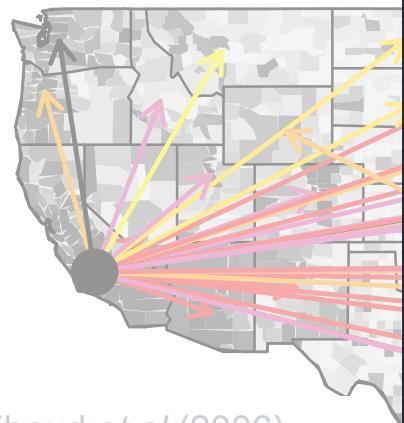


Charaudeau et al (2014)  
PLoS One

Crepey et al (2007)  
Am. J. Epid.

Bonabeau et al (1998)  
Proc B.

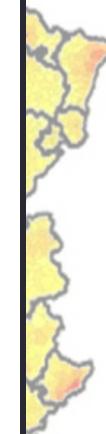
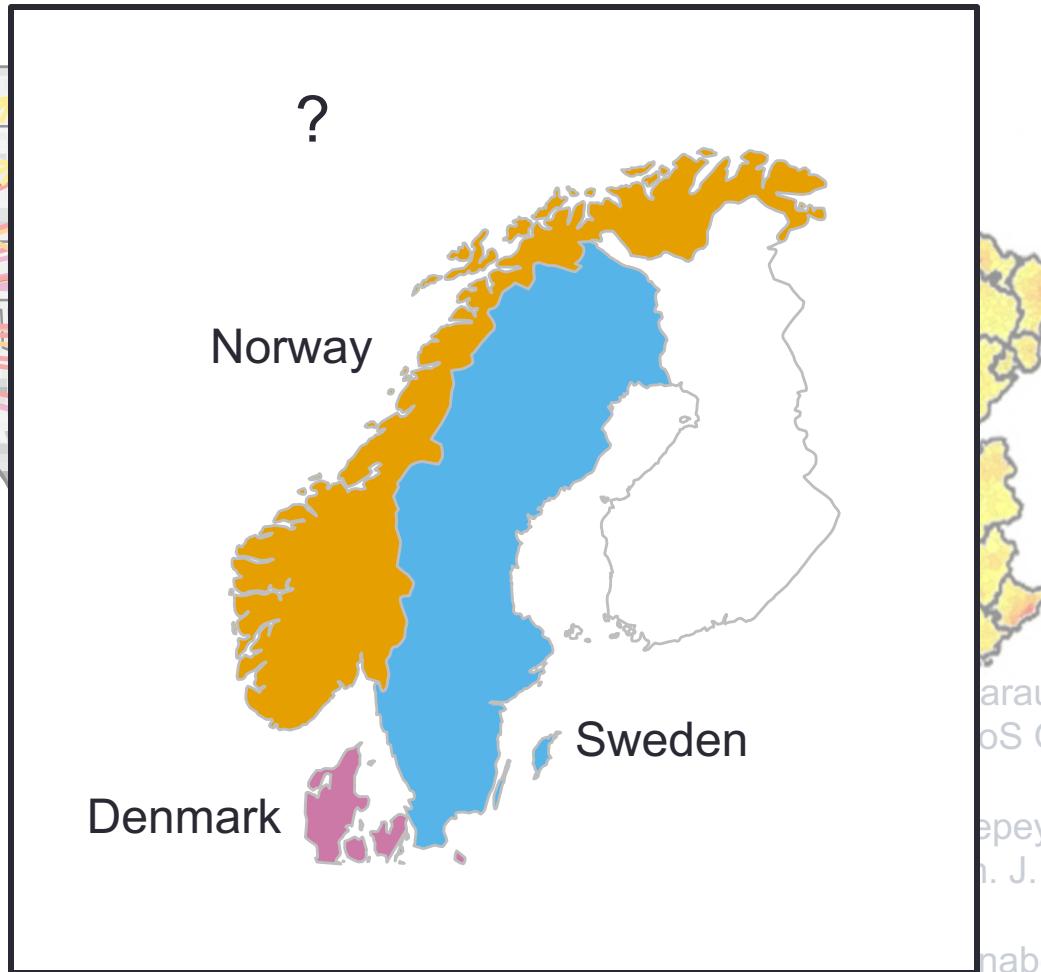
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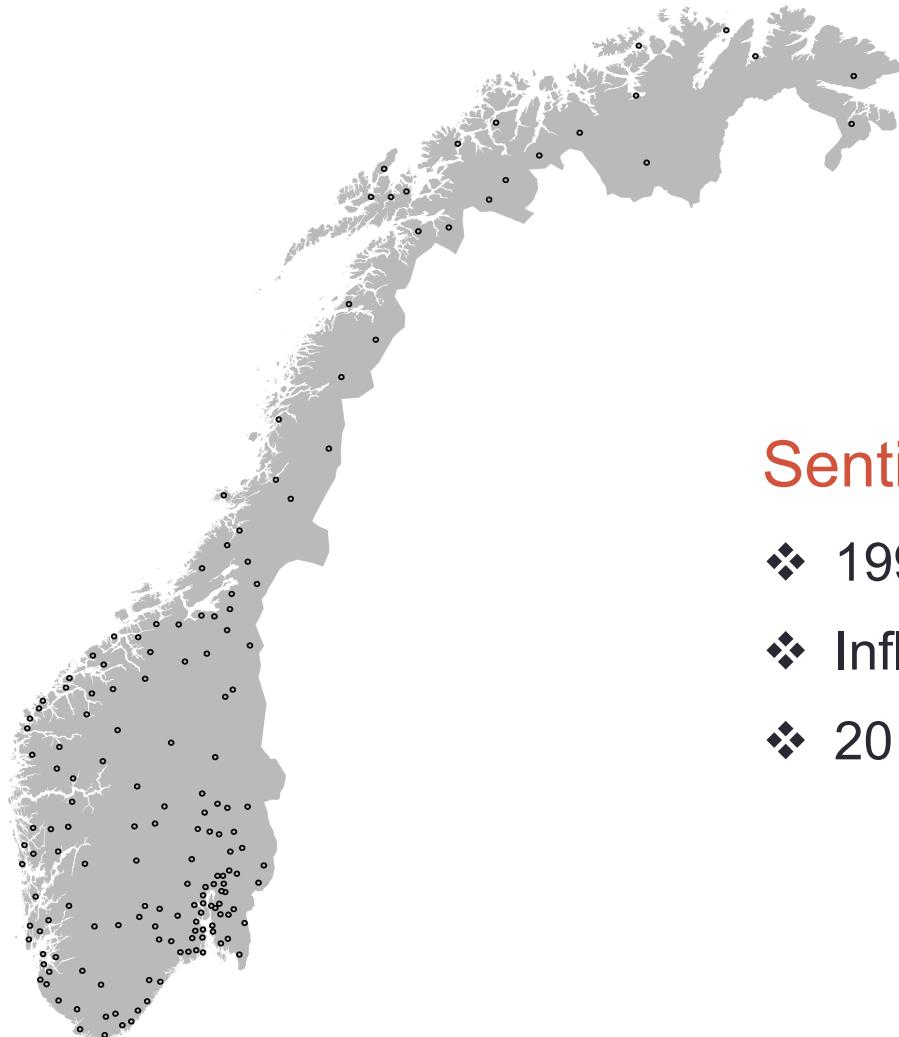
# Outline

1. Data & levels of aggregation
2. Synchrony within Norway
3. Synchrony at a larger spatial scale
4. Future work: comparison with the US

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# Norwegian Data

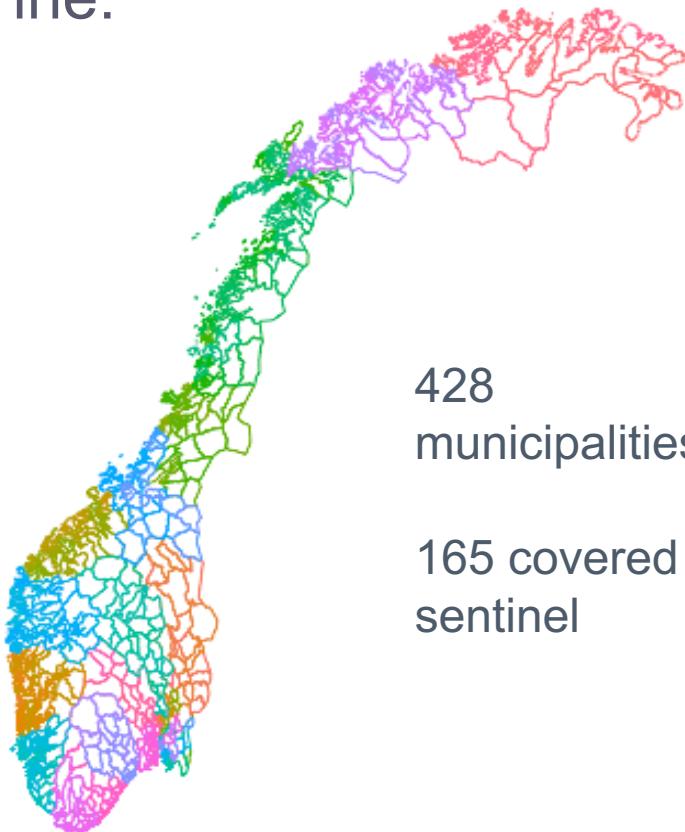


## Sentinel surveillance:

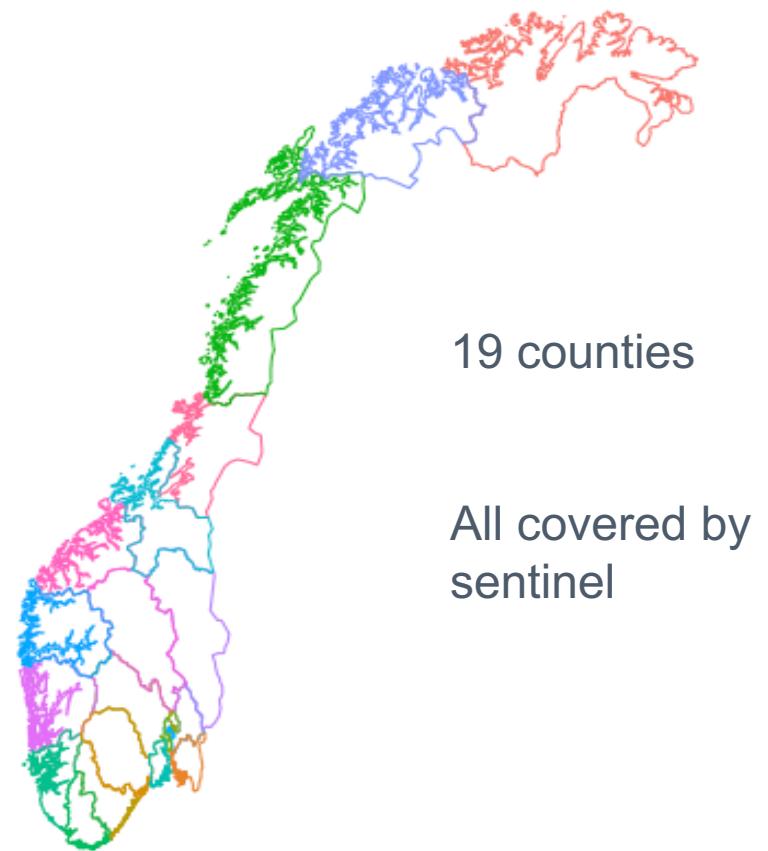
- ❖ 1998 – 2014
- ❖ Influenza-like-illness (ILI)
- ❖ 201 health clinics

# Spatial resolution

Fine:

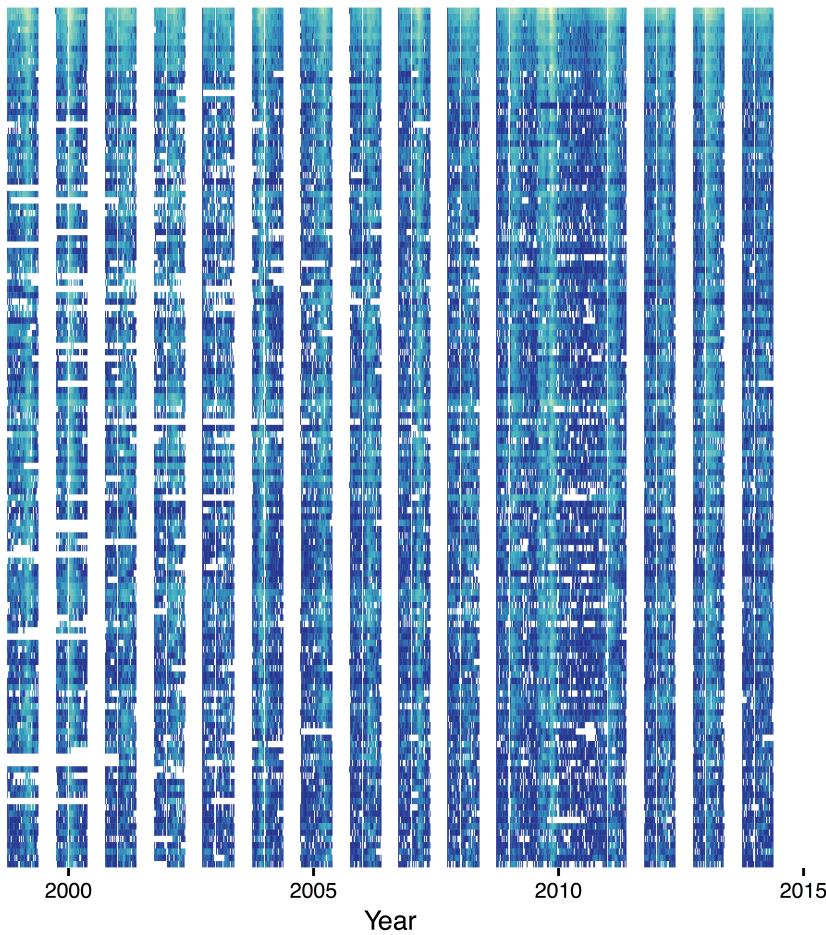


Coarse:

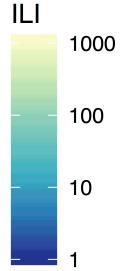
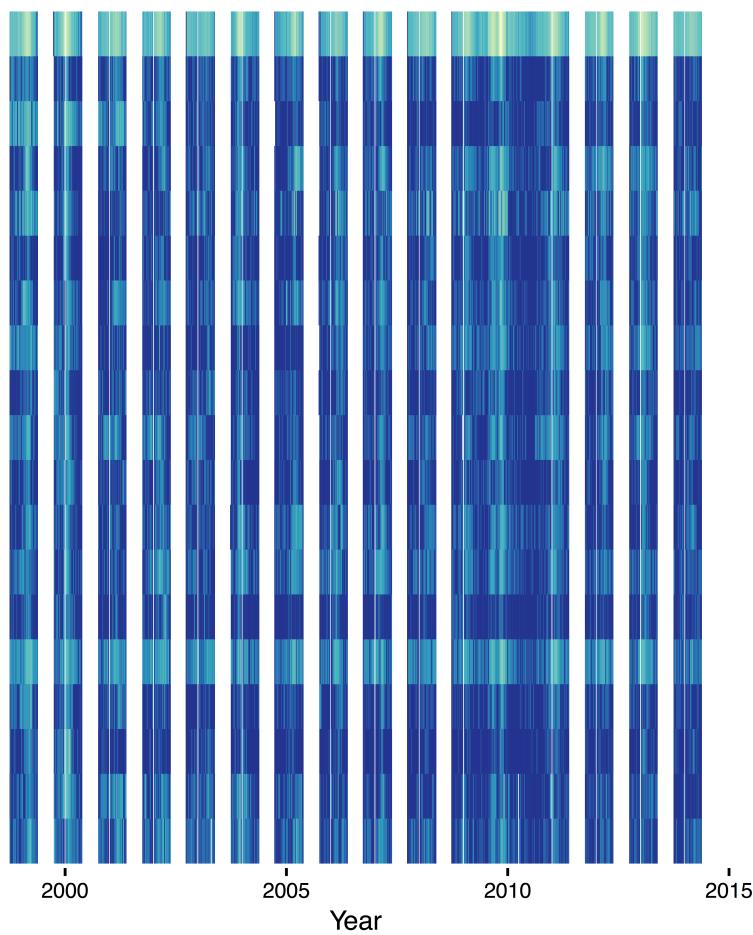


# Spatial resolution

Municipality level (fine)



County level (coarse)



# Wavelet analysis of epidemic timing

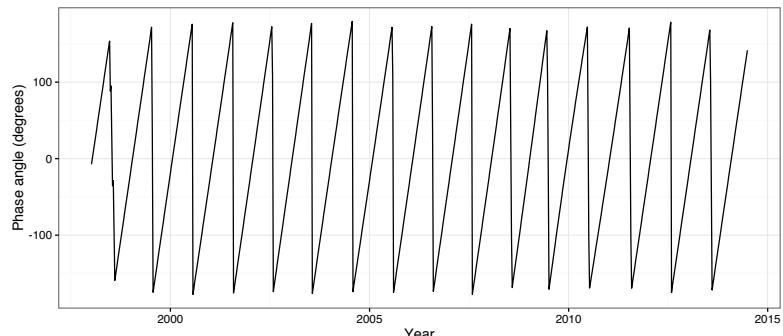
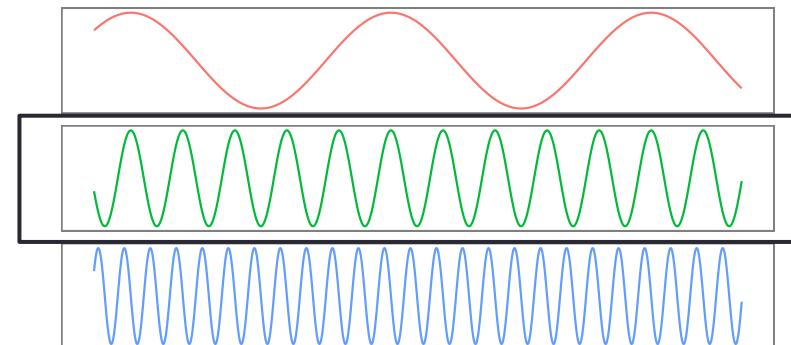
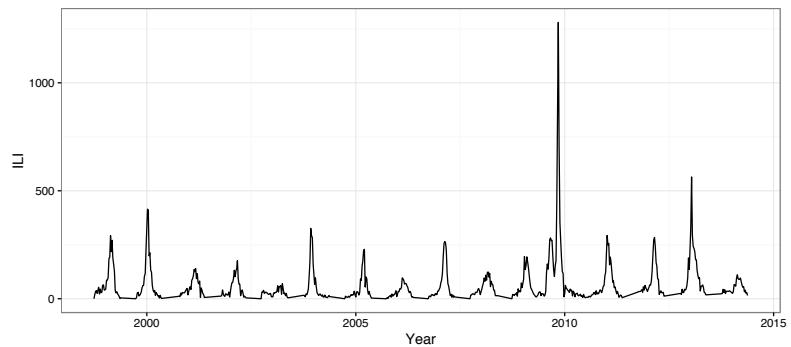
ILI time series



Annual component

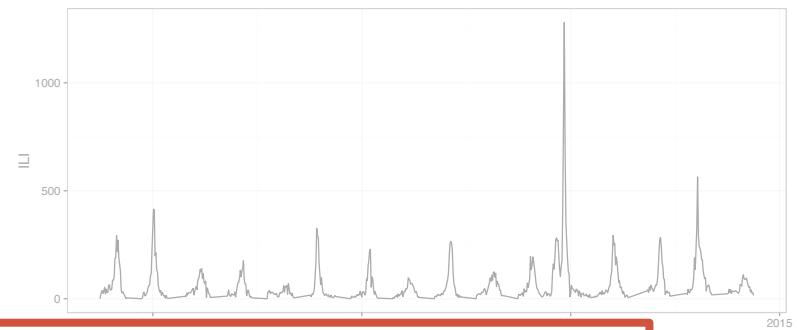


Phase angle time series



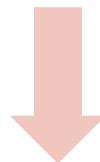
# Wavelet analysis of epidemic timing

ILI time series

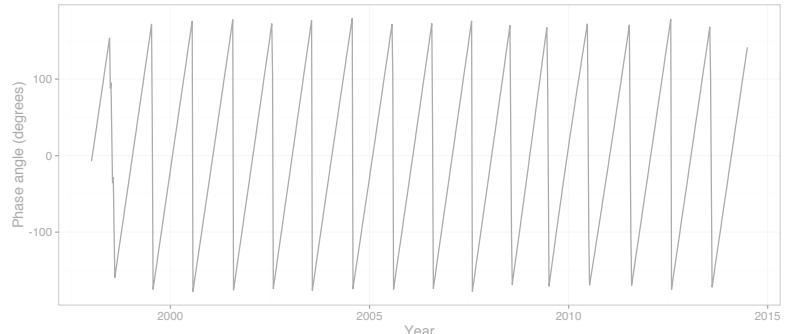


Annual

Compare phase angles for  
differences in epidemic timing



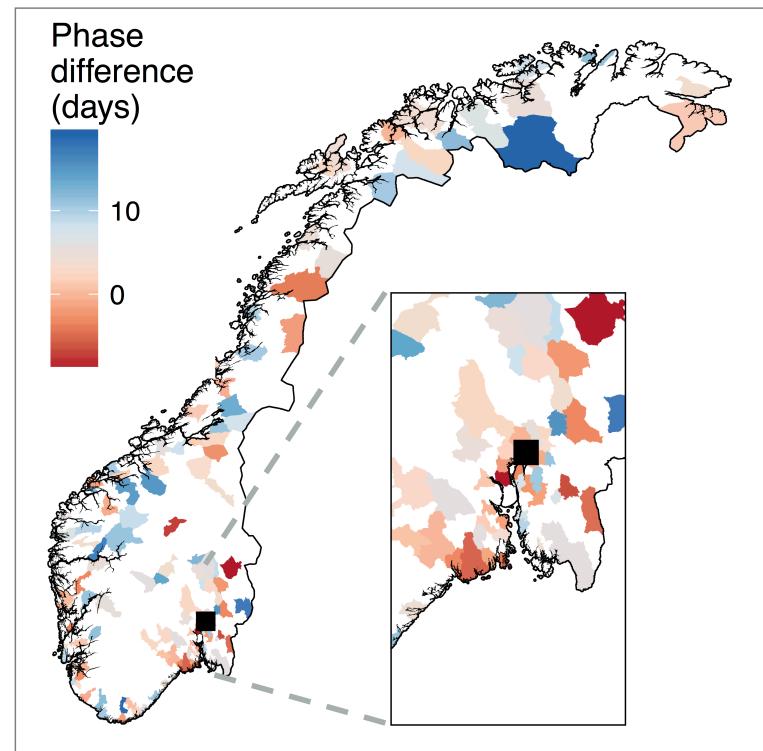
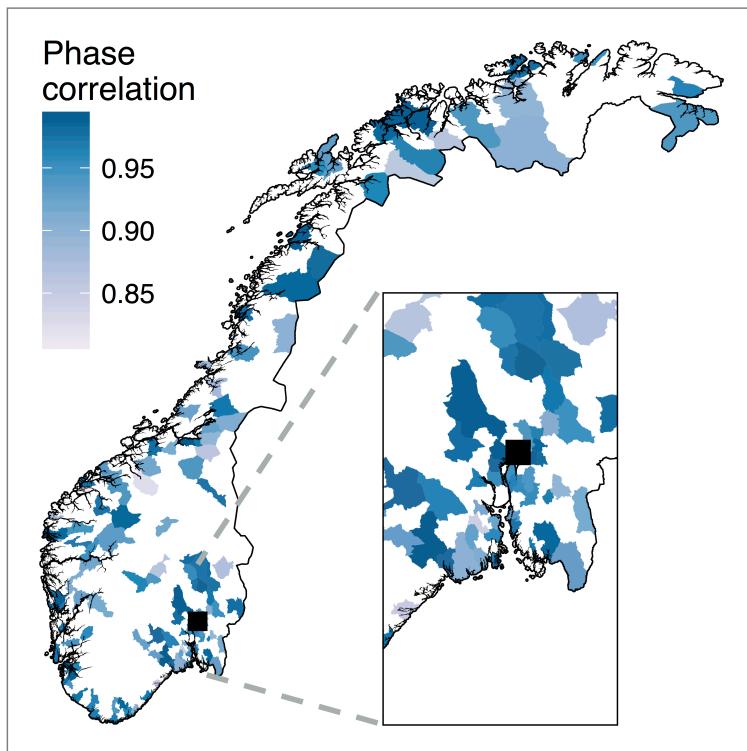
Phase angle time series



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# Synchrony at fine resolution



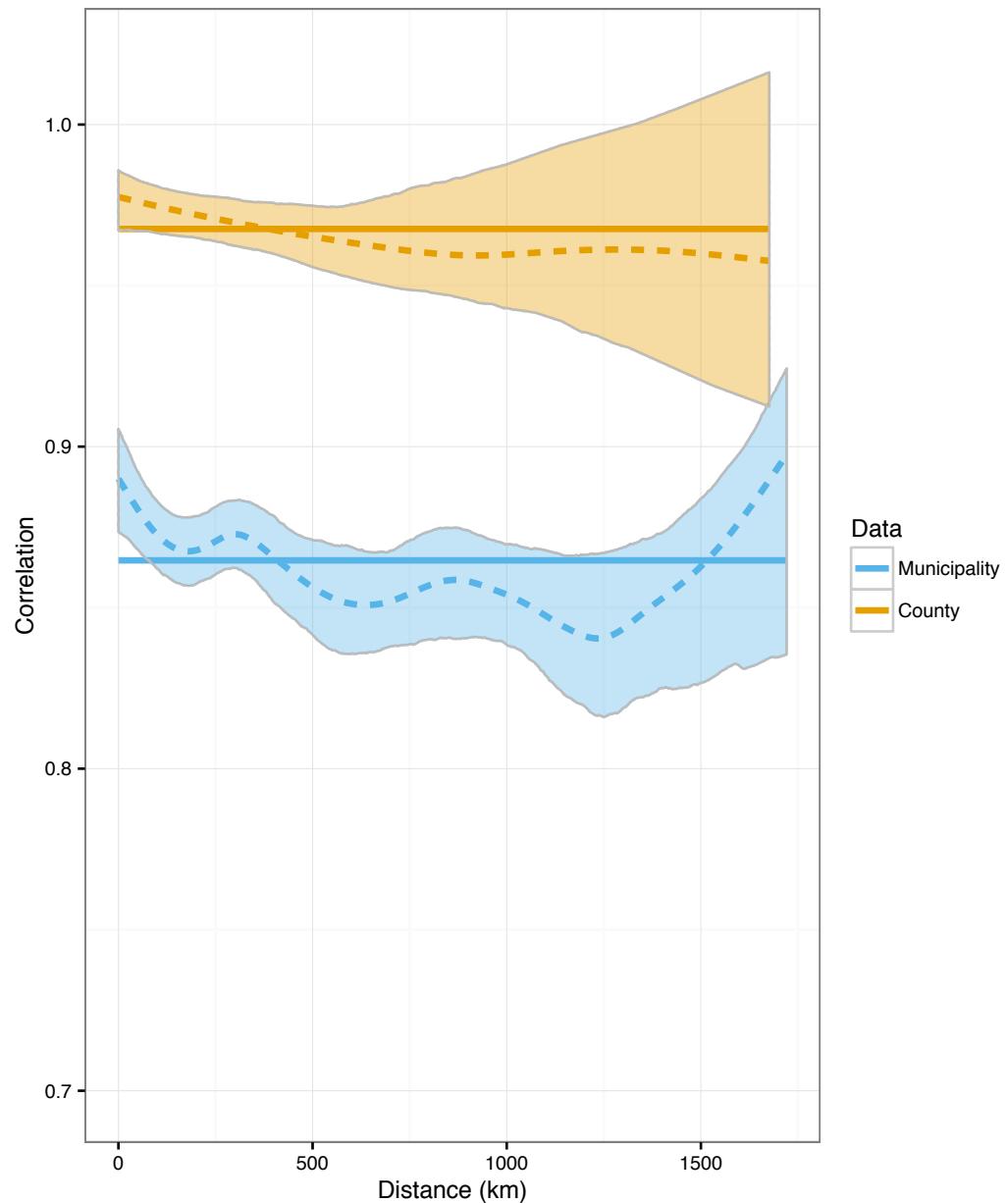
# How does synchrony change with distance?

Non-parametric spline



Correlation between regions vs. distance

Bjørnstad *et al* (1999) TREE  
Grenfell *et al* (2001) Nature  
Viboud *et al* (2006) Science



Epidemics are highly synchronized,  
with distance gradient at fine resolution

...is this synchrony preserved at larger spatial scales?

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# Expanding geographic scale



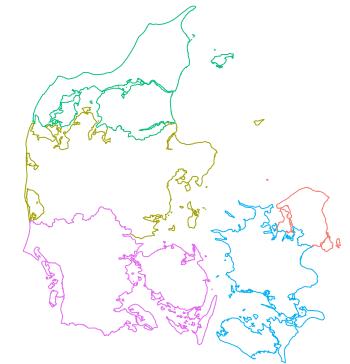
Norwegian data

- ❖ 1998 – 2014
- ❖ 19 counties
- ❖ ILI



Swedish data

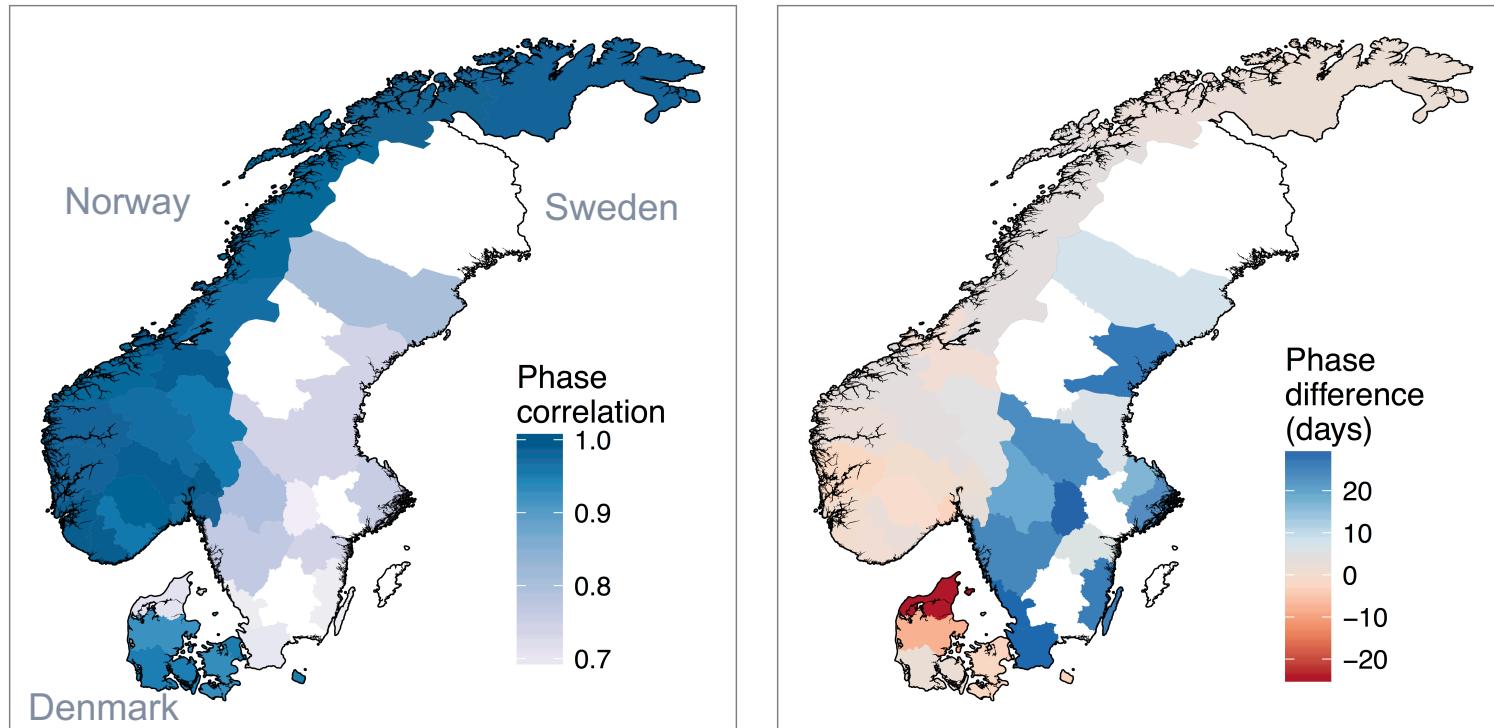
- ❖ 2001 – 2015
- ❖ 21 counties
- ❖ Lab confirmed cases



Danish data

- ❖ 2000 – 2014
- ❖ 5 counties
- ❖ ILI

# Synchrony at larger scales



Previous work: Sweden lags 2wk behind Norway & Denmark

Alonso *et al* (2015) Nature Scientific Reports

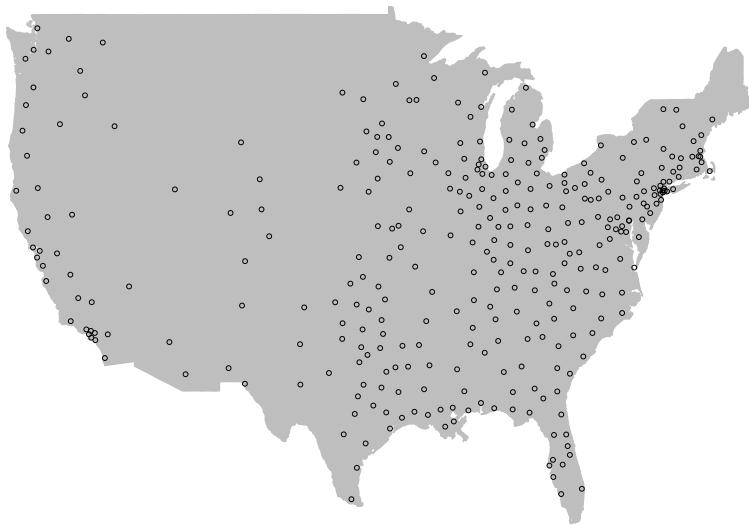
Influenza epidemics are still highly synchronized  
at larger geographic scales

What is driving this synchrony?

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# Future work: comparison with the US

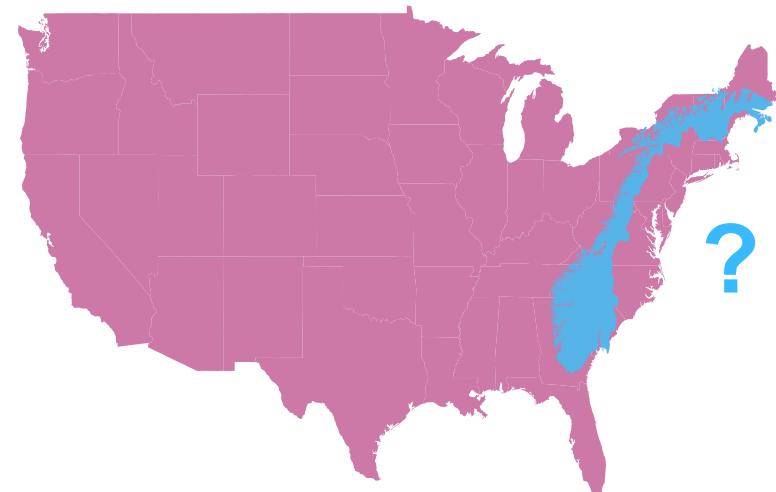


Pros:

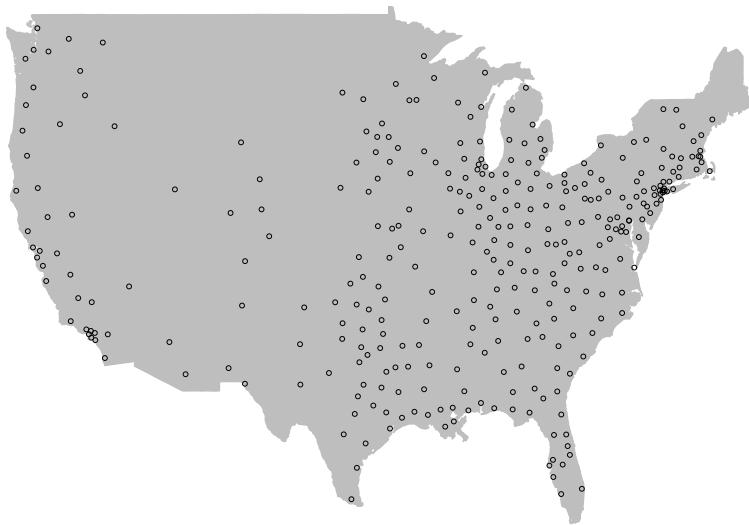
1. Temperate climate with winter epidemics
2. ILI data (2002 – 2010)
3. City level ~ Norwegian counties

Major difference:

Geographic scale...



# Future work: comparison with the US

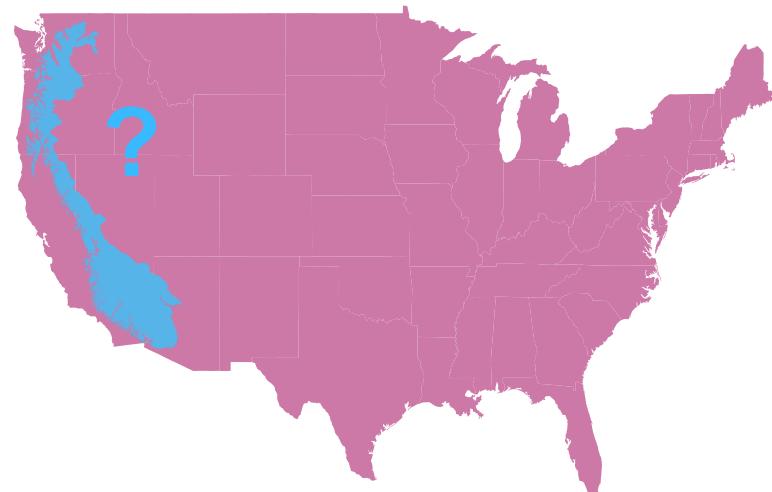


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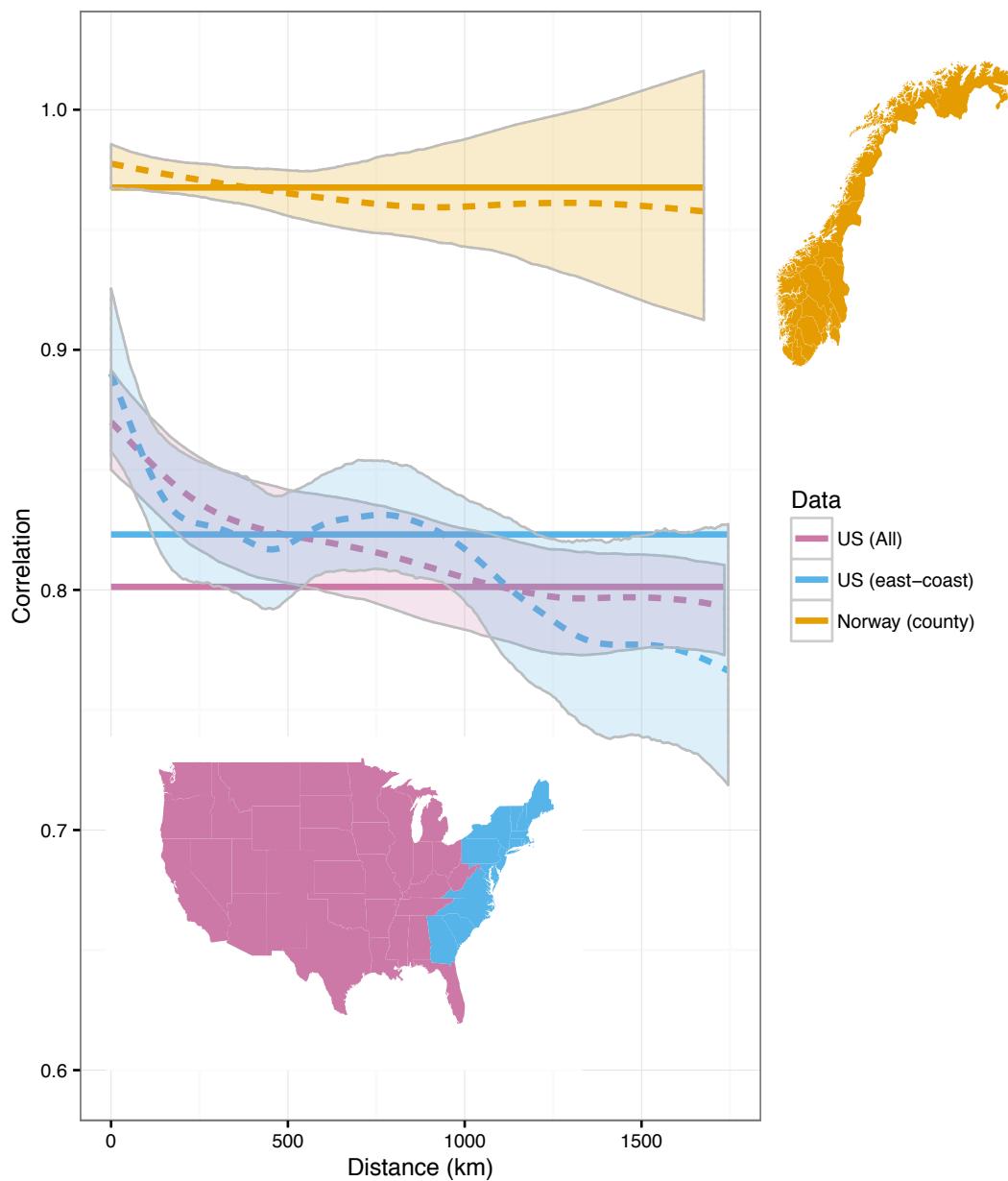
# Difference in synchrony

Norway:

- Highly synchronized
- Weak spatial gradient

US:

- Less synchronized
- Stronger gradient



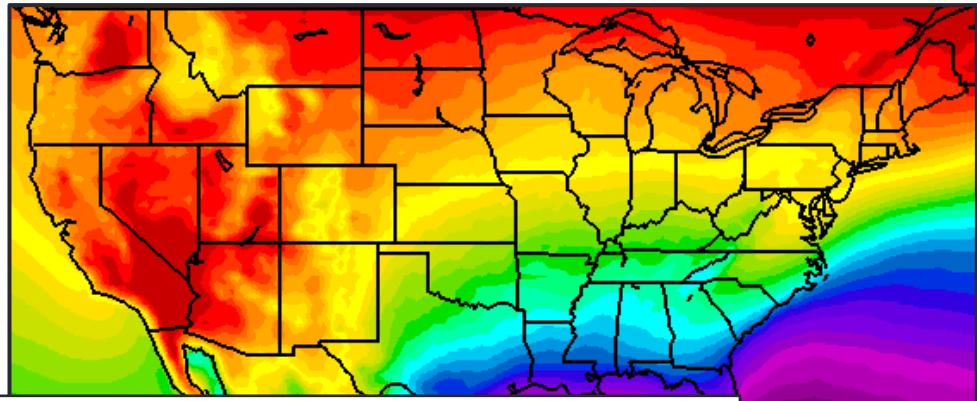
# Potential drivers

## 1. Climate e.g. specific humidity

Shaman & Kohn (2009) PNAS

Shaman *et al* (2010) PLoS Bio

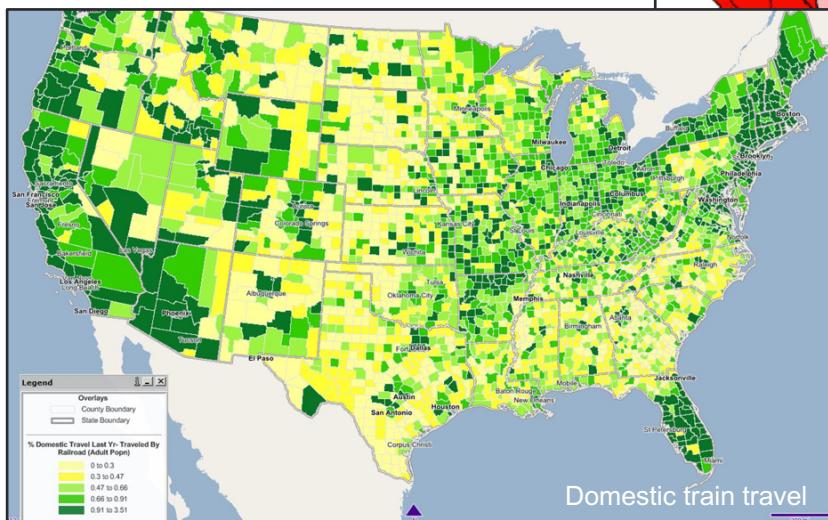
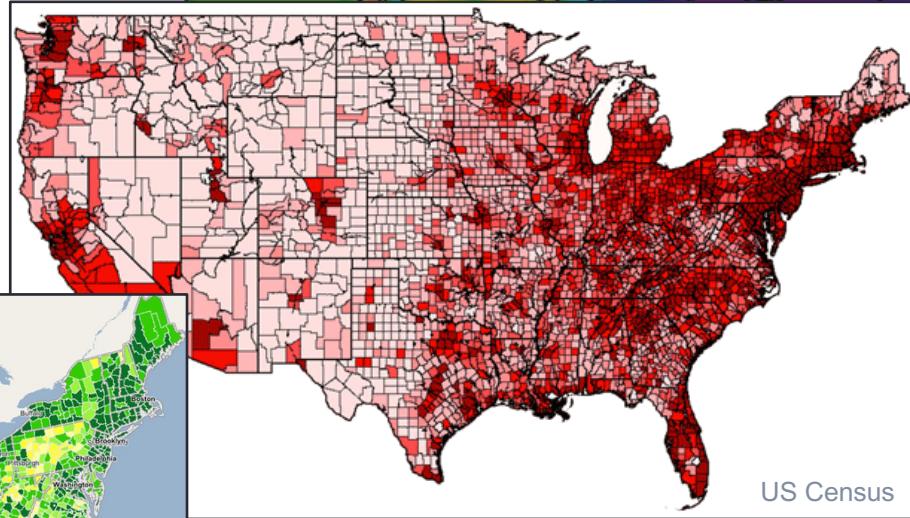
Gog *et al* (2014) PLoS Comp Bio



## 3. Connectivity e.g. commuting, air travel, ...

Stark *et al* (2012) PLoS One

Viboud *et al* (2006) Science



## 2. Population size/density

Viboud *et al* (2006) Science

# Questions?

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Ottar Bjørnstad, Penn State University



STATENS  
SERUM  
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Norwegian Institute of Public Health