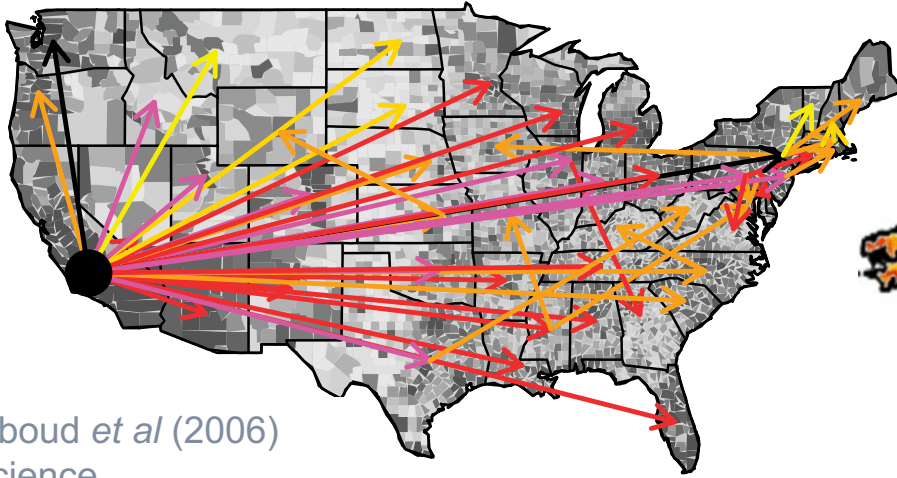


Spatial synchrony of seasonal influenza epidemics in Norway

Sinead Morris
PhD candidate
Princeton University



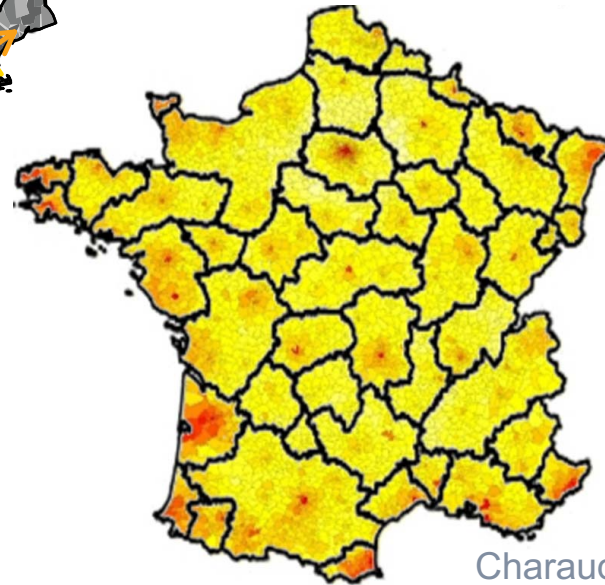
Why Norway?



Viboud *et al* (2006)
Science

Gog *et al* (2014) PLoS
Comp. Bio

Stark *et al* (2012)
PLoS One

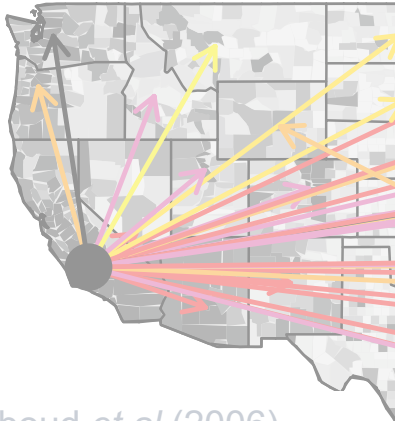


Charaudeau *et al* (2014)
PLoS One

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

Bonabeau *et al* (1998)
Proc B.

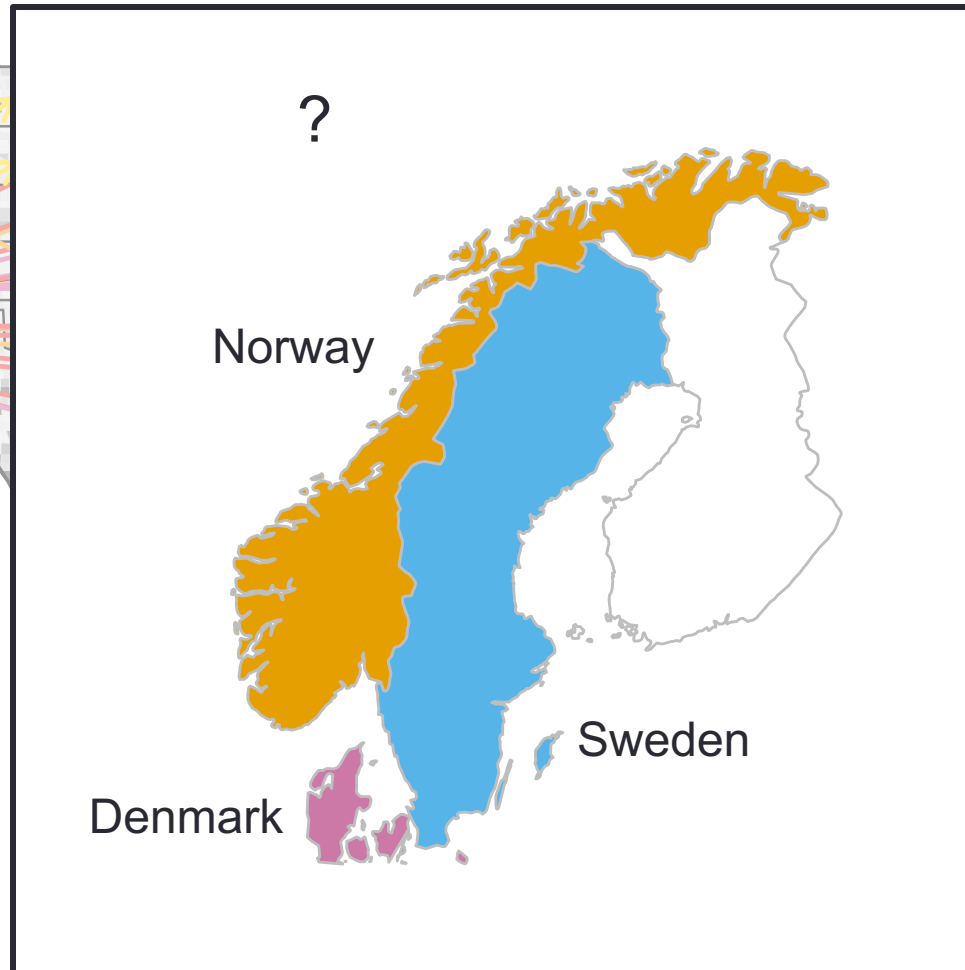
Why Norway?



Viboud *et al* (2006)
Science

Gog *et al* (2014) PLoS
Comp. Bio

Stark *et al.* (2012)
PLoS One



Paradeau *et al* (2014)
PLoS One

Lepey *et al* (2007)
Am. J. Epid.

Chabeau *et al* (1998)
Proc B.

Outline

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

Outline

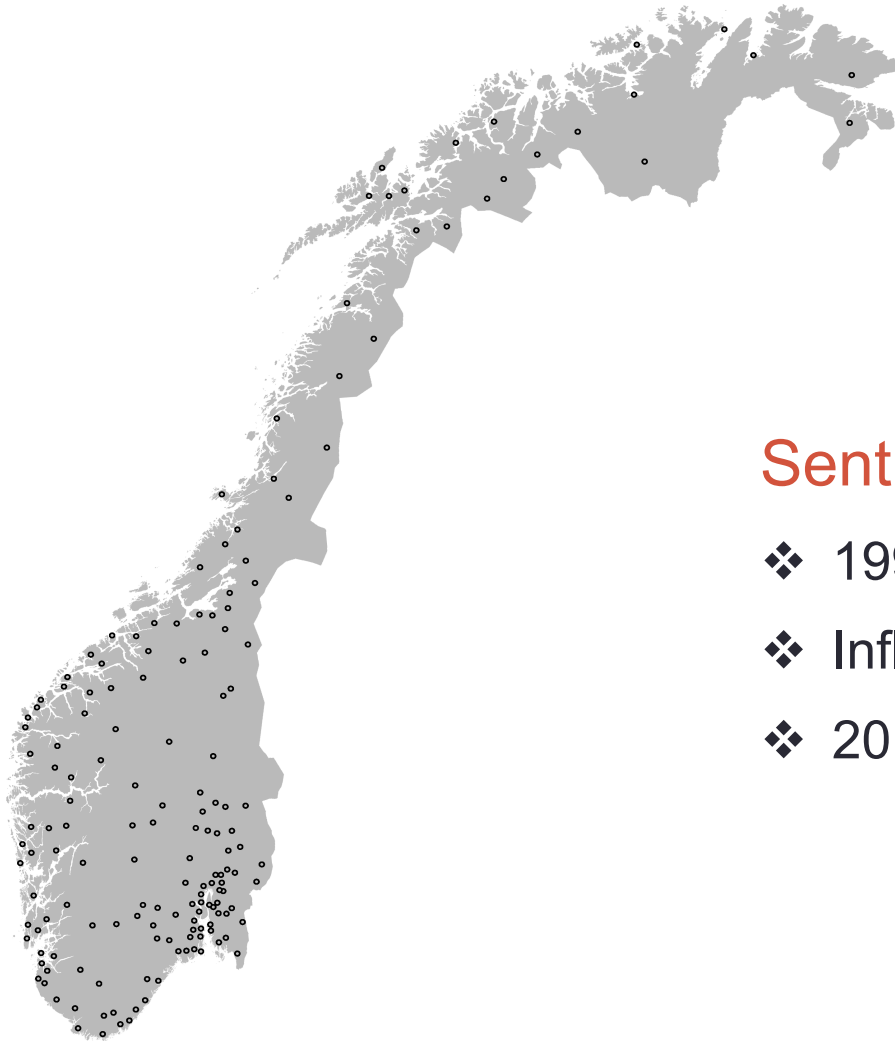
1. Data & levels of aggregation

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Norwegian Data

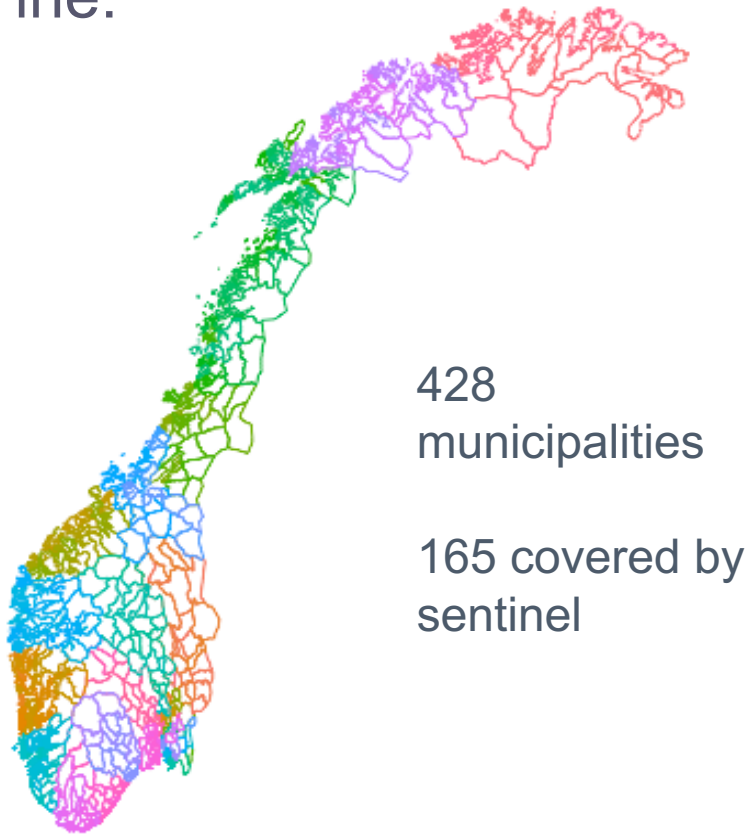


Sentinel surveillance:

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

Spatial resolution

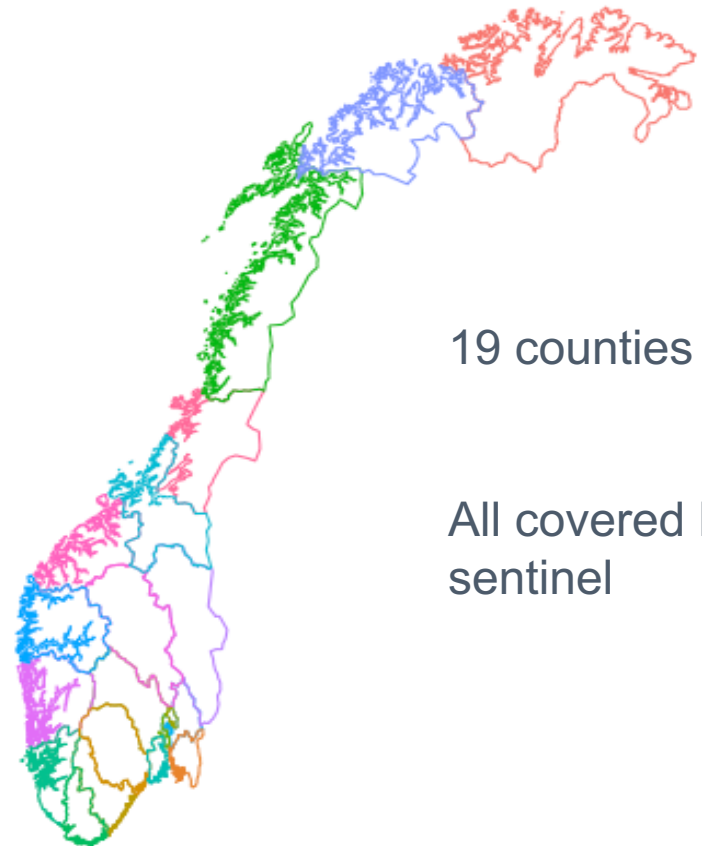
Fine:



428
municipalities

165 covered by
sentinel

Coarse:

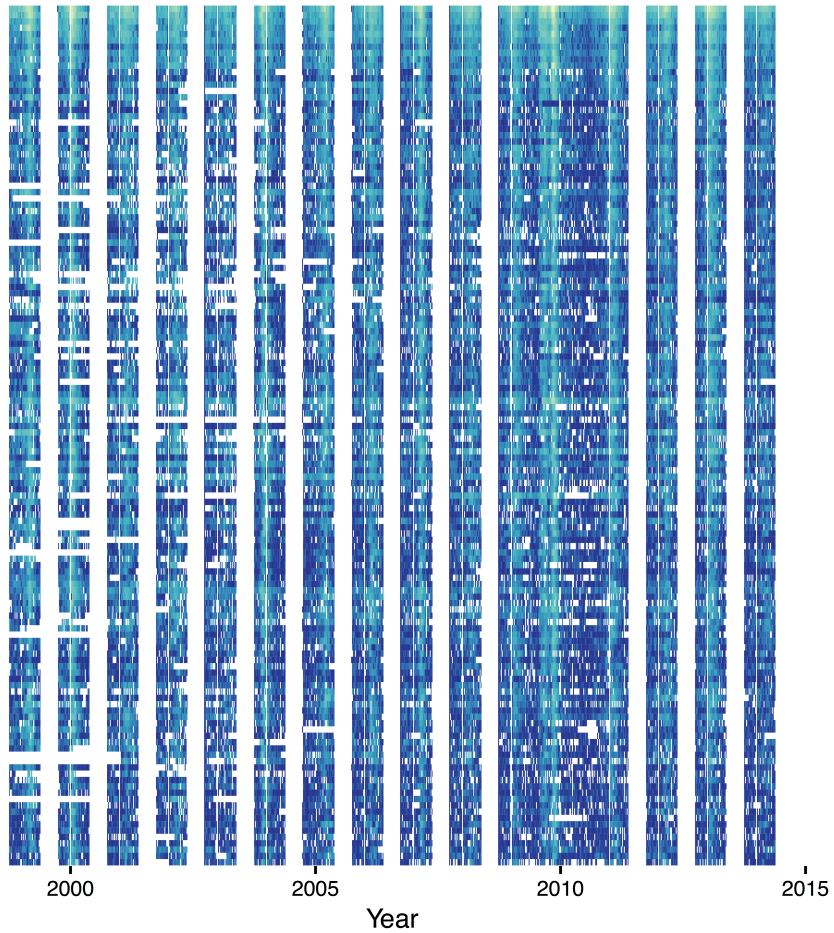


19 counties

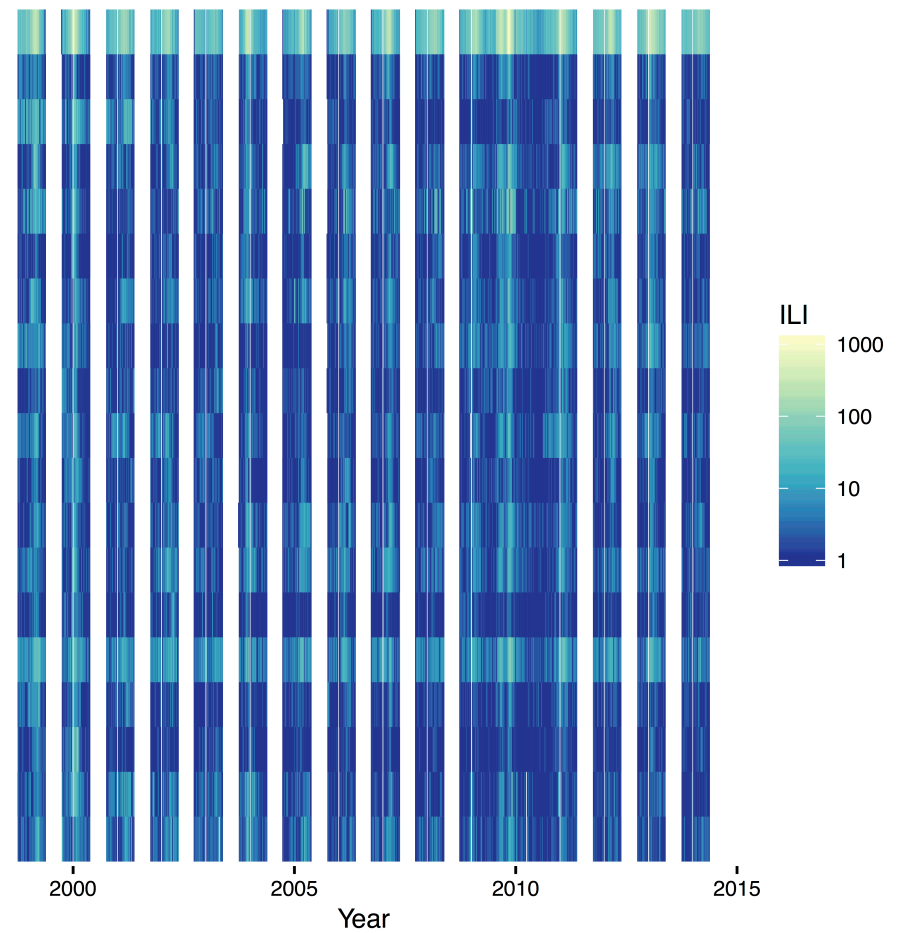
All covered by
sentinel

Spatial resolution

Municipality level (fine)



County level (coarse)



Wavelet analysis of epidemic timing

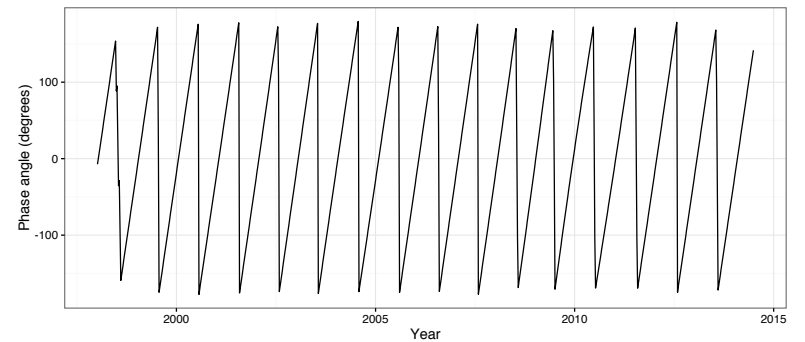
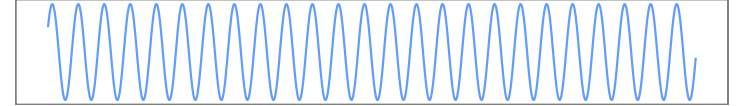
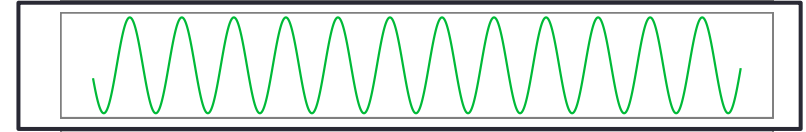
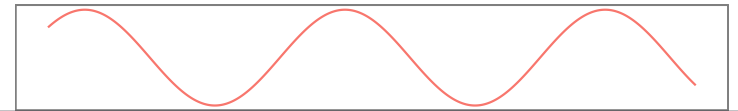
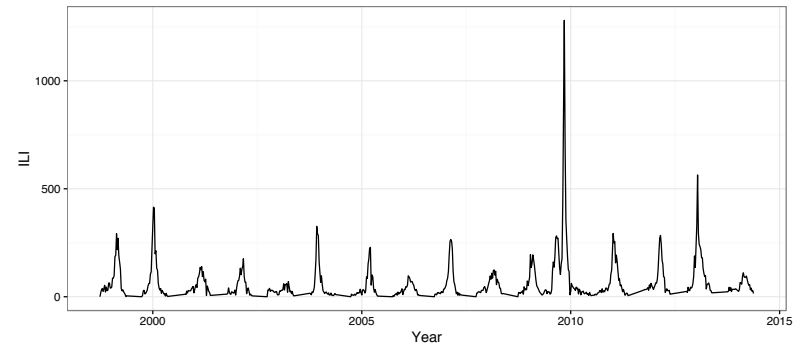
ILI time series



Annual component

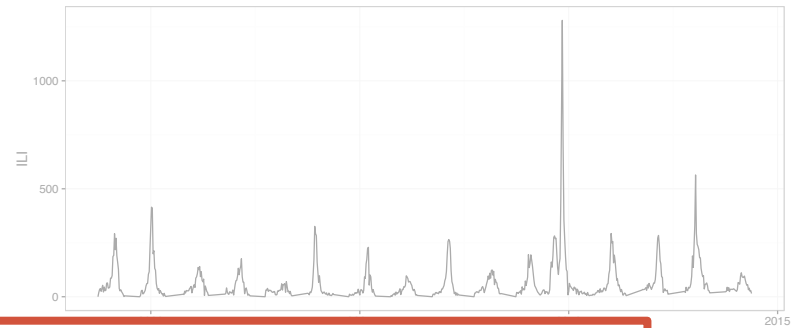


Phase angle time series



Wavelet analysis of epidemic timing

ILI time series

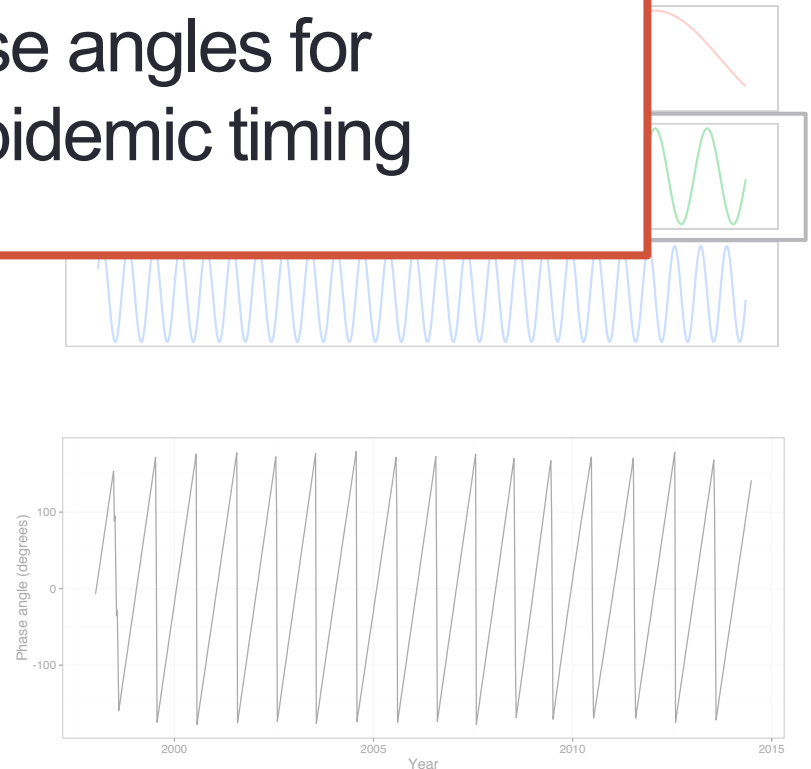


Compare phase angles for differences in epidemic timing

Annual



Phase angle time series



Outline

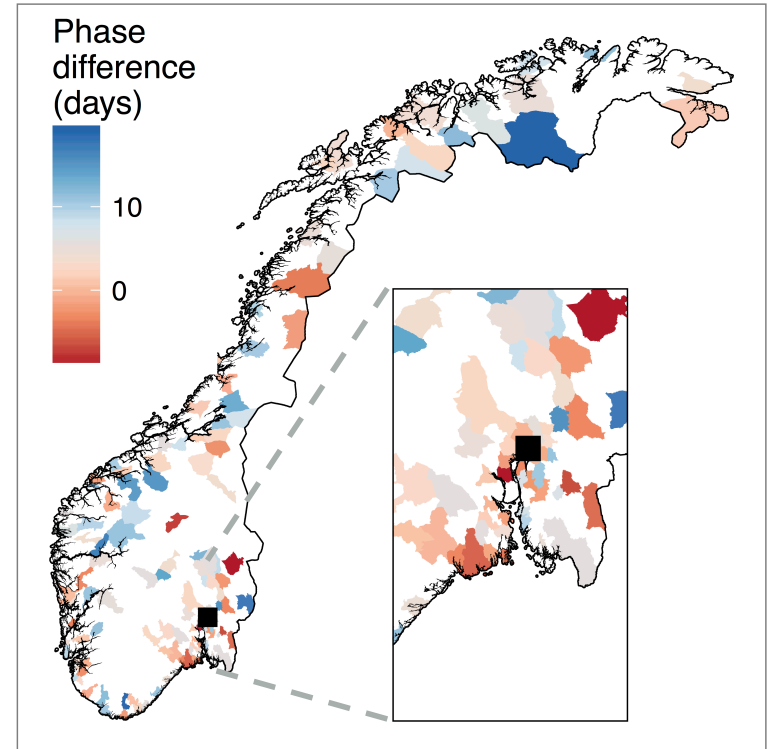
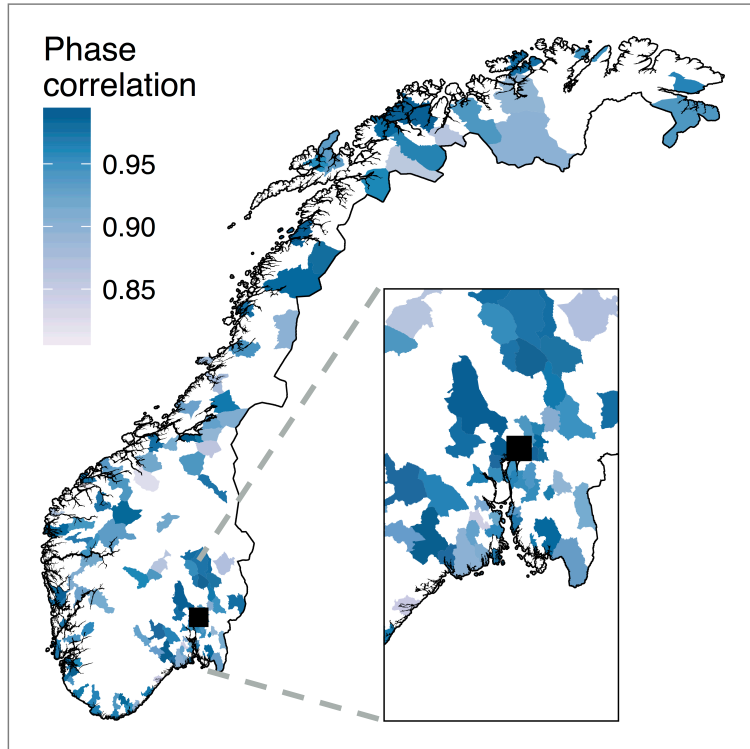
1. Data & levels of aggregation

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Synchrony at fine resolution



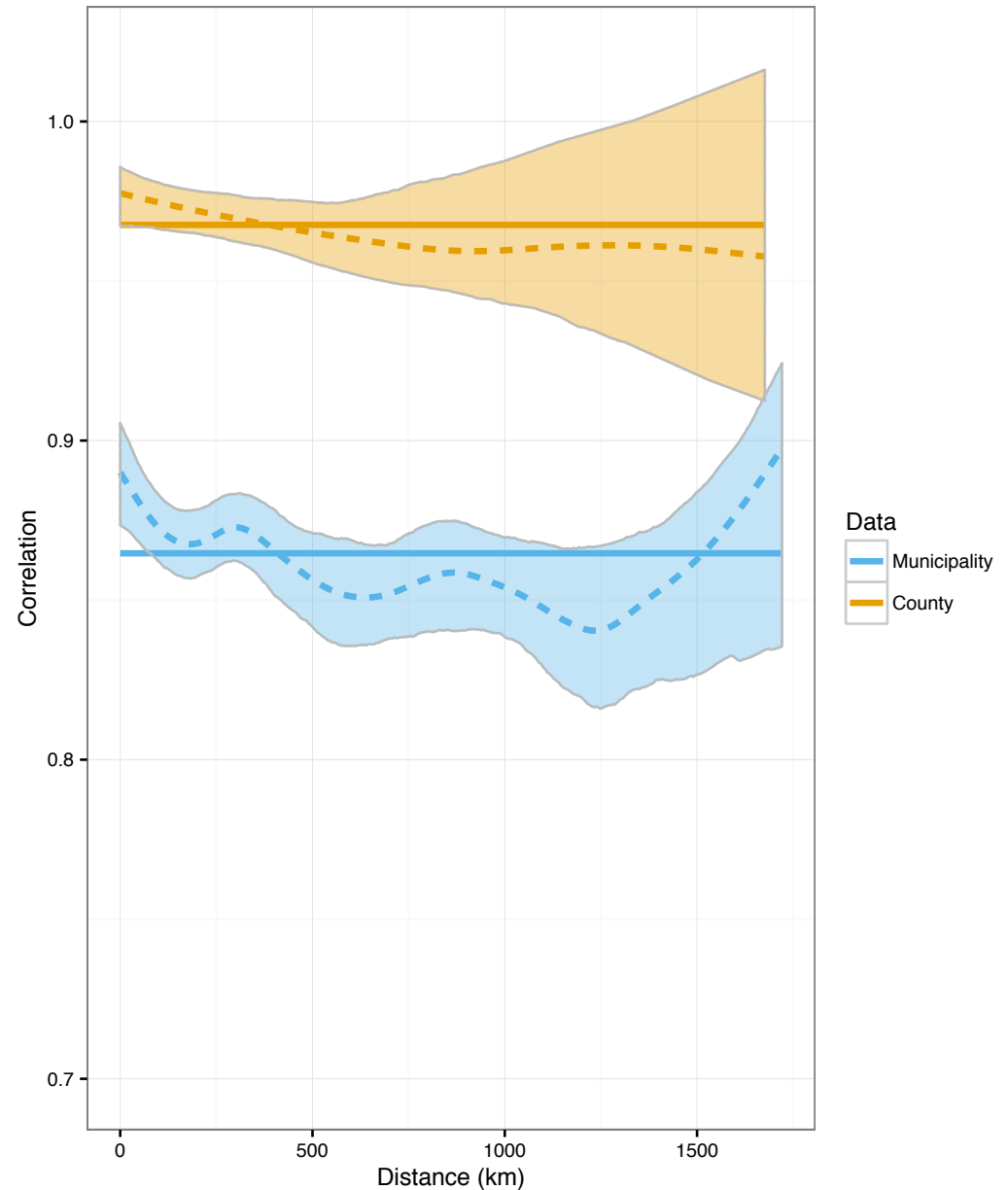
How does synchrony change with distance?

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?

Outline

1. Data & levels of aggregation

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Expanding geographic scale



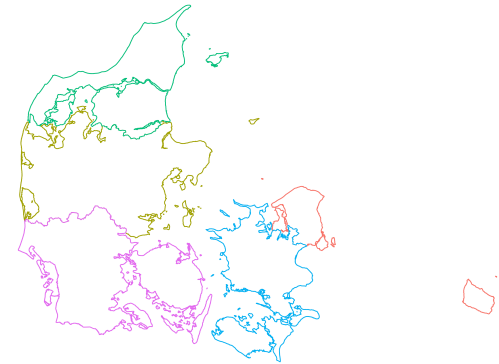
Norwegian data

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



Swedish data

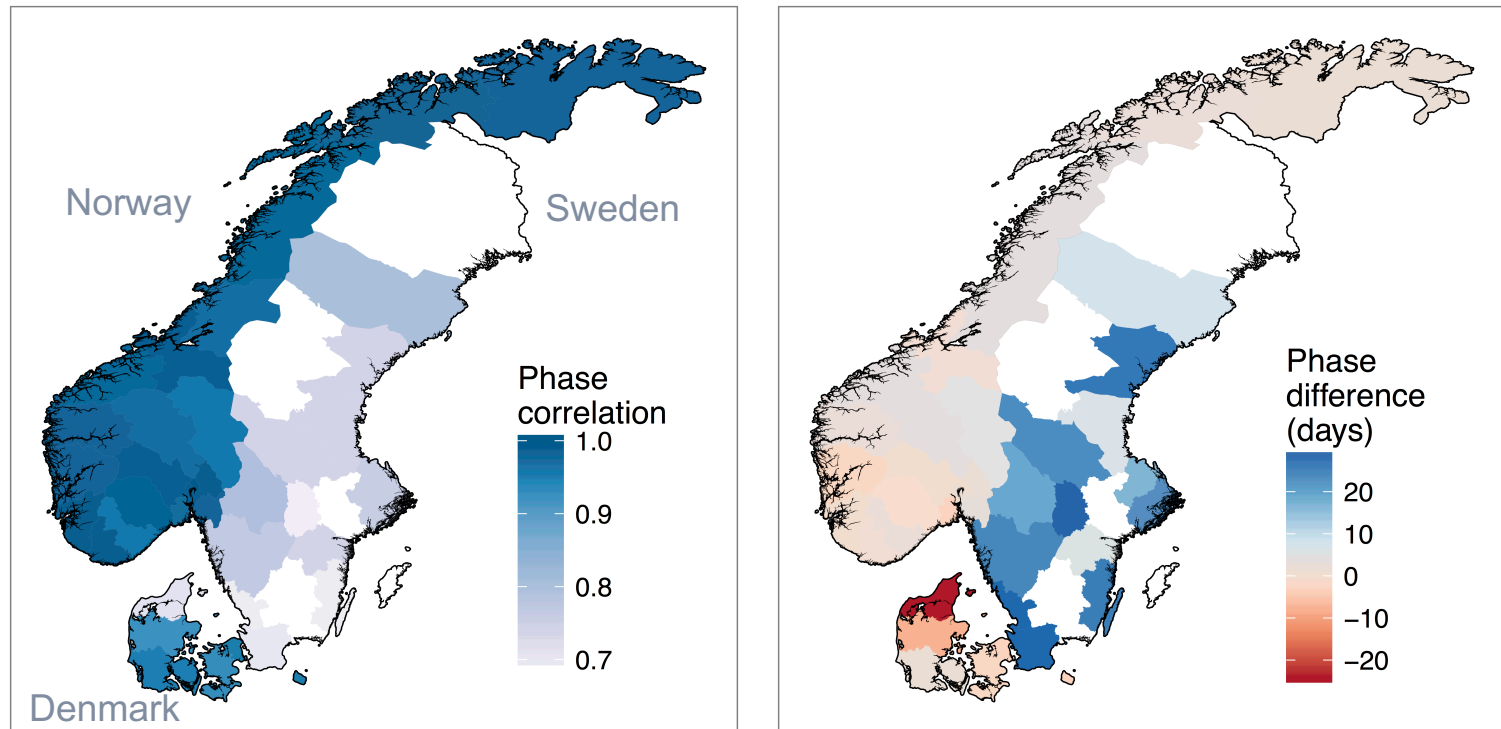
- ❖ 2001 – 2015
- ❖ 21 counties
- ❖ Lab confirmed cases



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

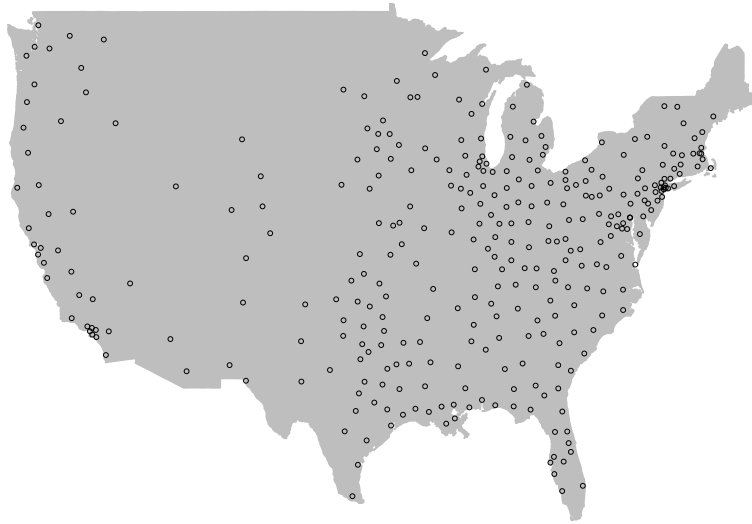
Influenza epidemics are still highly synchronized
at larger geographic scales

What is driving this synchrony?

Outline

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

Future work: comparison with the US

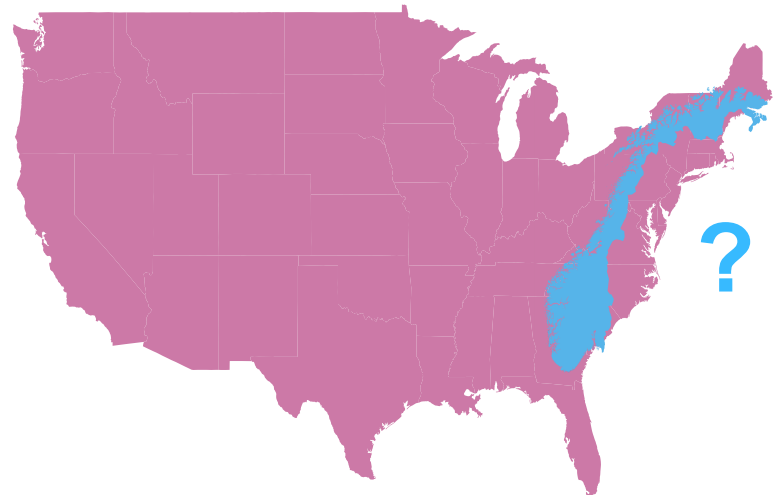


Pros:

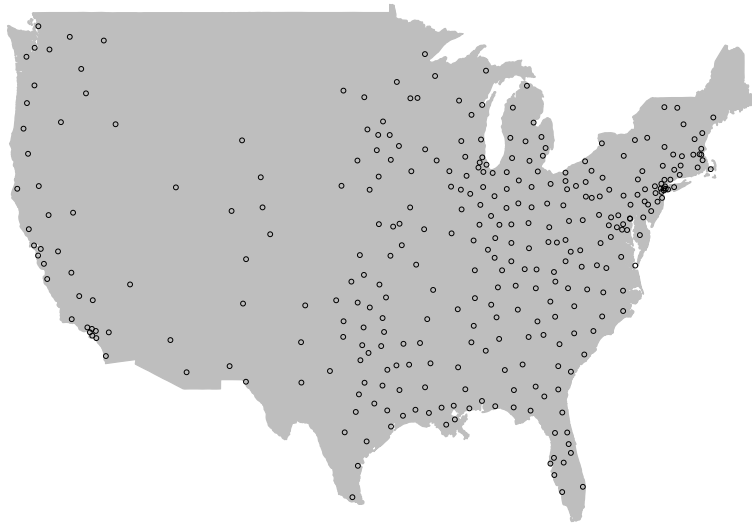
1. Temperate climate with winter epidemics
2. ILI data (2002 – 2010)
3. City level ~ Norwegian counties

Major difference:

Geographic scale...



Future work: comparison with the US

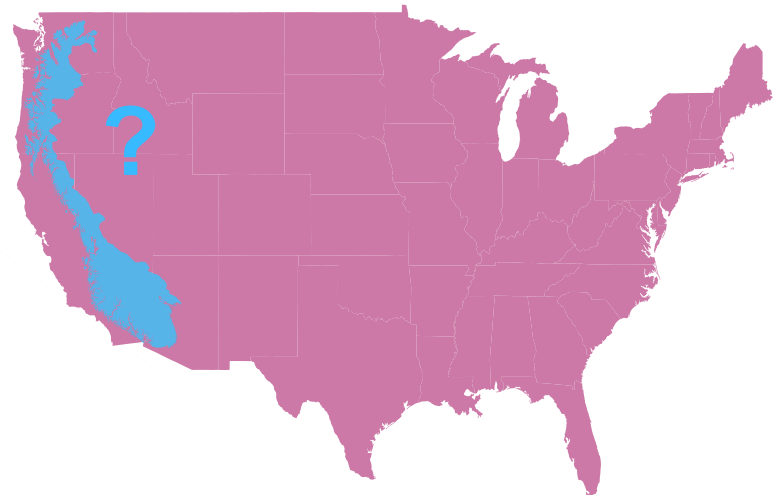


Pros:

1. Temperate climate with winter epidemics
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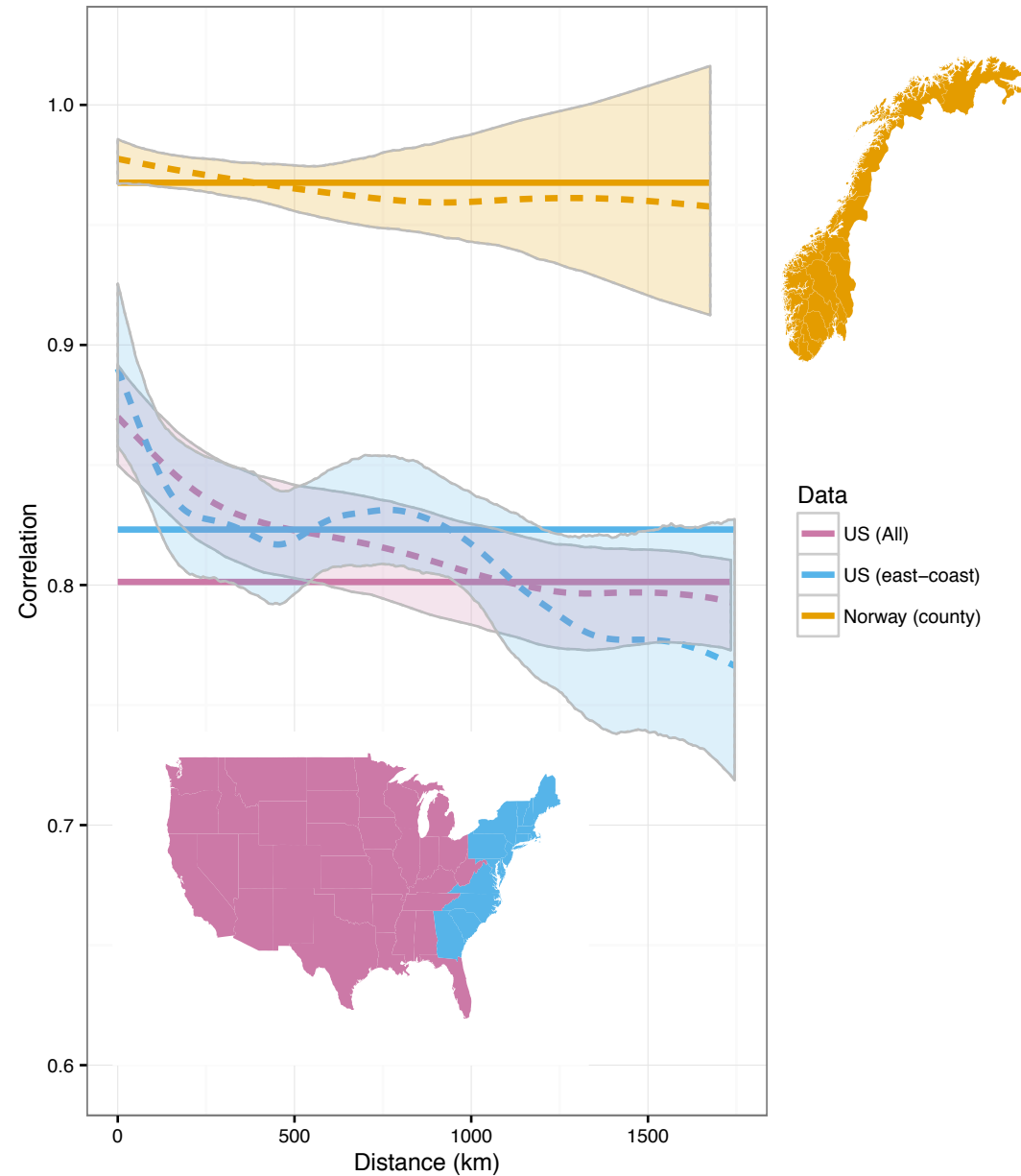
Difference in synchrony

Norway:

- Highly synchronized
- Weak spatial gradient

US:

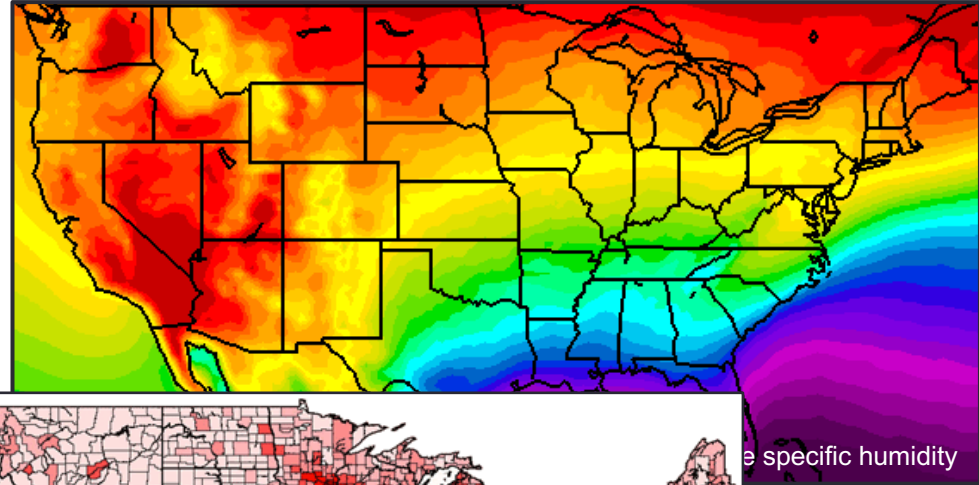
- Less synchronized
- Stronger gradient



Potential drivers

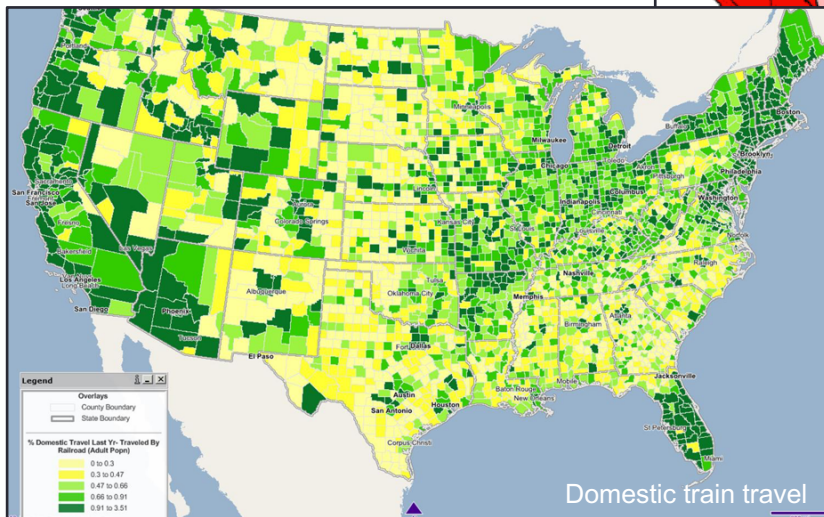
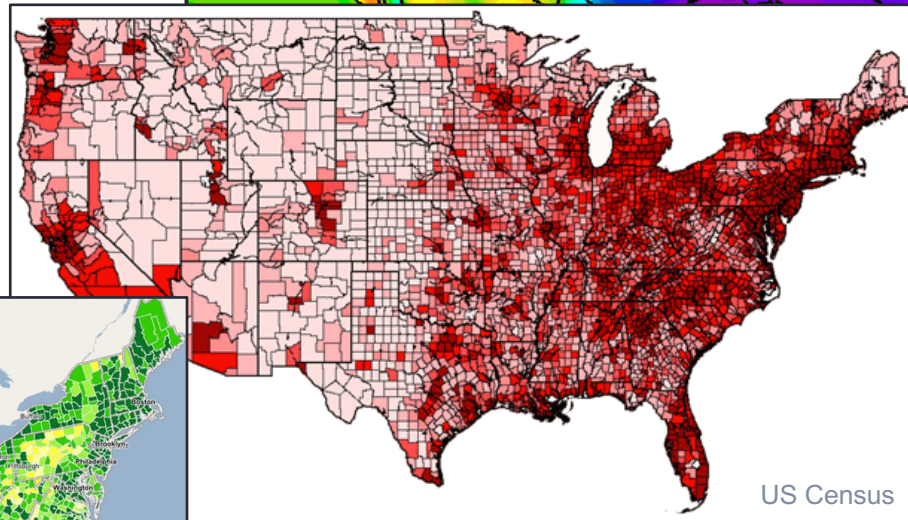
1. Climate e.g. specific humidity

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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Andrea Graham, Princeton University

Cécile Viboud, FIC



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Ottar Bjørnstad, Penn State University

