

**GEIG**

Groupe d'expertise  
et d'information sur la Grippe



**Mercredi 24 octobre 2012**

Salons de l'Aéro-Club de France  
6, rue Galilée, 75116 Paris

**25<sup>e</sup>**  
**RENCONTRES**  
**SUR LA GRIPPE ET**  
**SA PRÉVENTION**

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# influenza models: values & limits

Vittoria Colizza

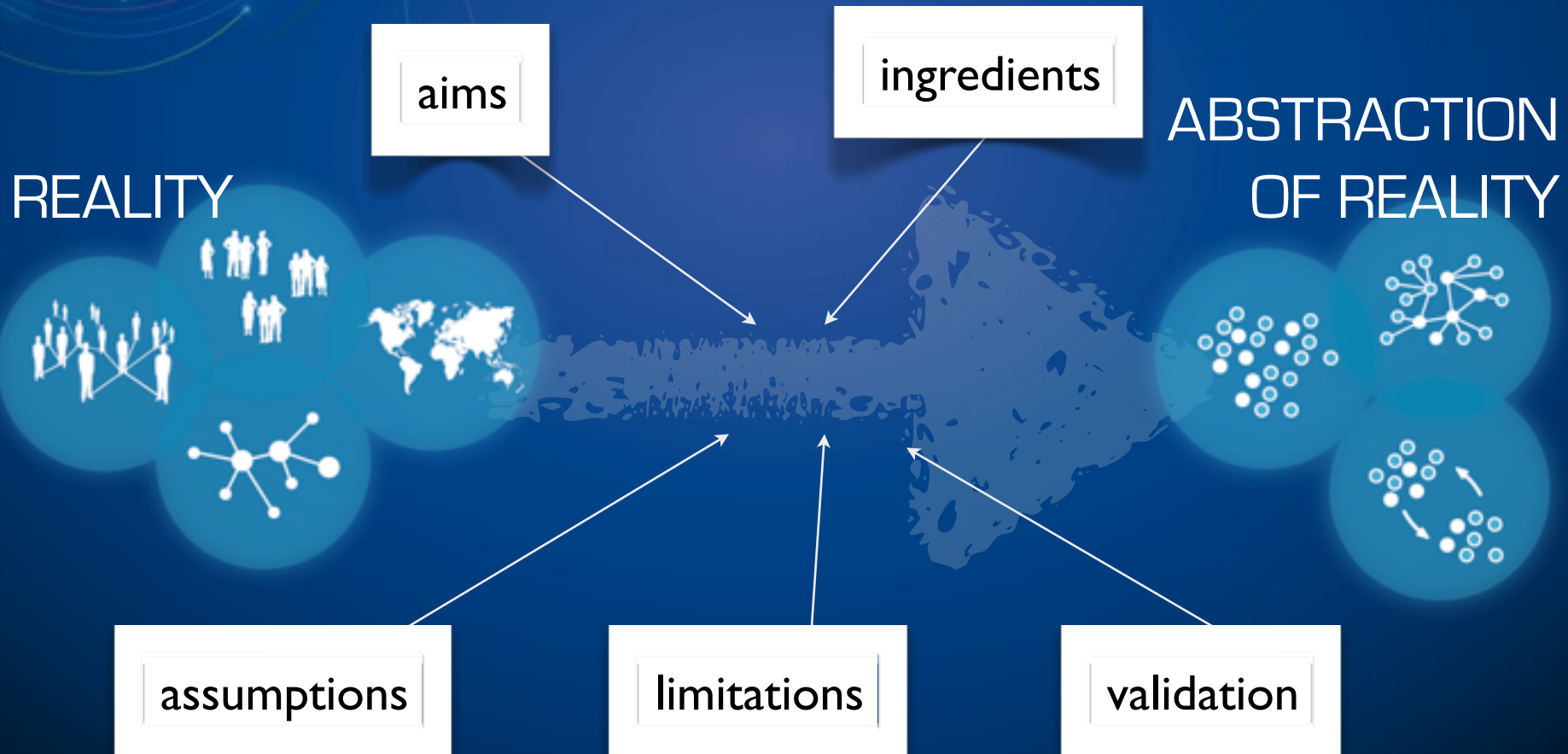
INSERM

U Pierre et Marie Curie

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# [dynamical] modeling 101





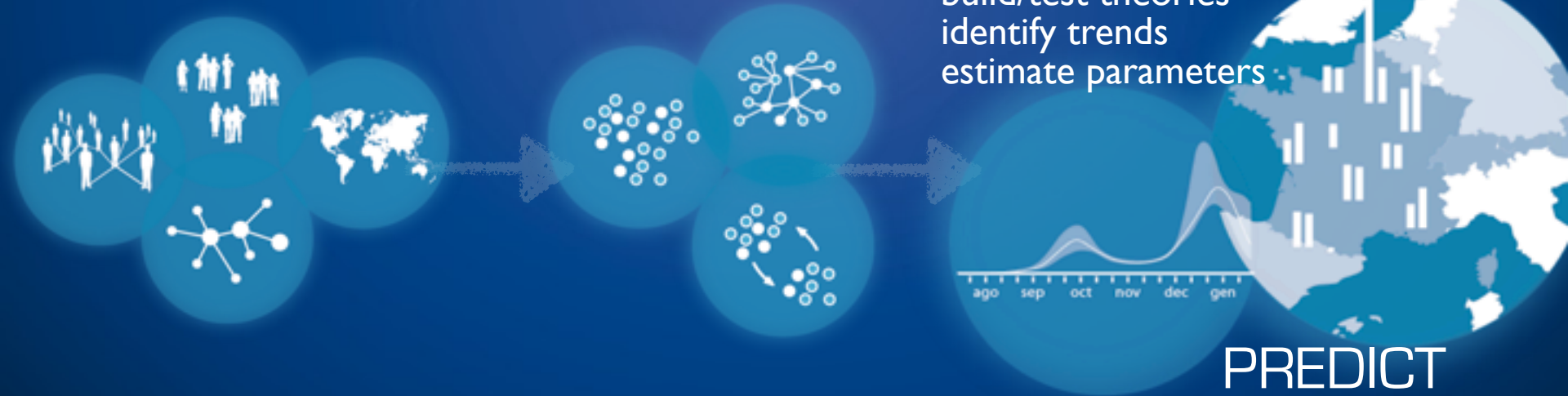
# aims

## UNDERSTAND

- identify key mechanisms
- obtain basic conceptual results
- build/test theories
- identify trends
- estimate parameters

## PREDICT

- explore scenarios
- test/evaluate/compare interventions
- answer specific questions
- provide forecasts (?)



# ingredients



PEOPLE

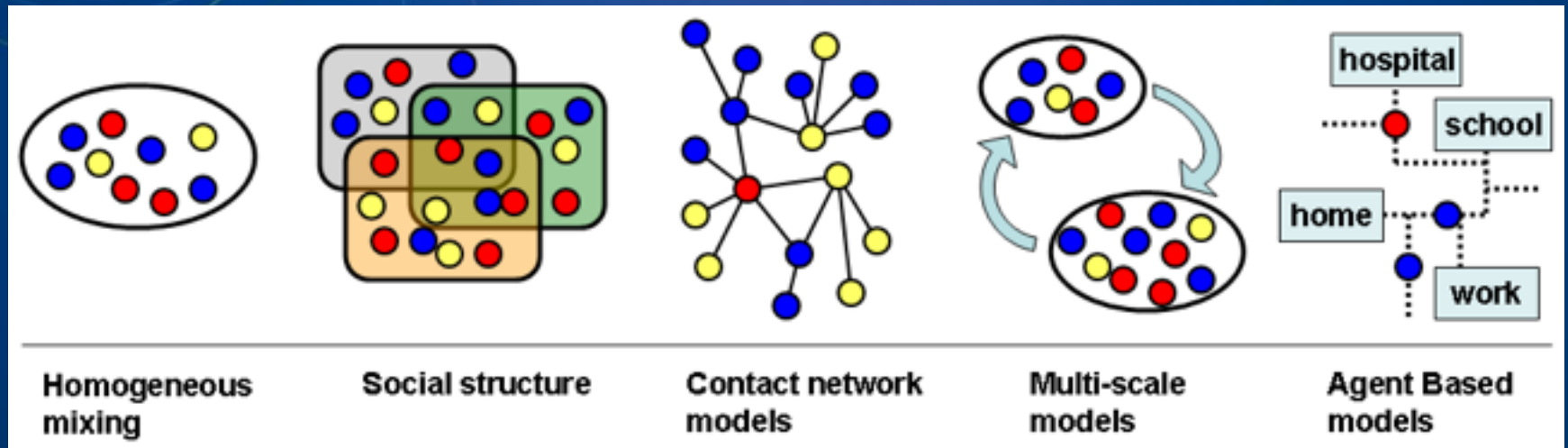


INTERACTIONS  
/MOBILITY



DISEASE

# models' complexity



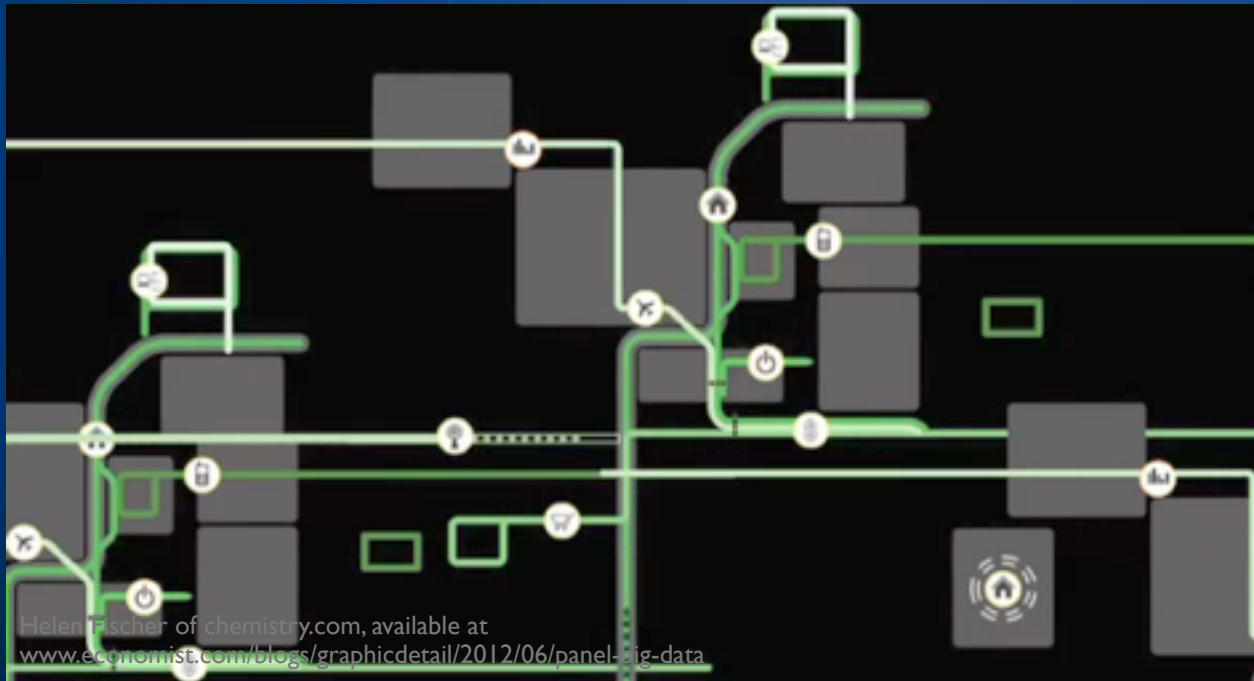
low moderate high REALISM

>> DATA...

# riding the data tsunami...



2008



Helen Fischer of chemistry.com, available at  
[www.economist.com/blogs/graphicdetail/2012/06/panel-big-data](http://www.economist.com/blogs/graphicdetail/2012/06/panel-big-data)



2010

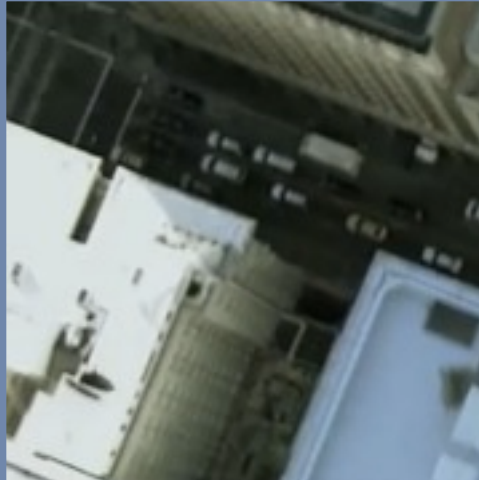


2011

90% of the world's digital data has been created in just the last two years (source: IBM)

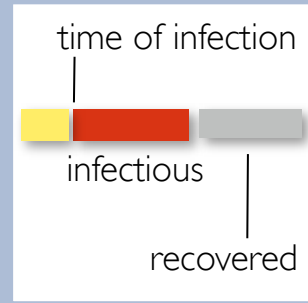
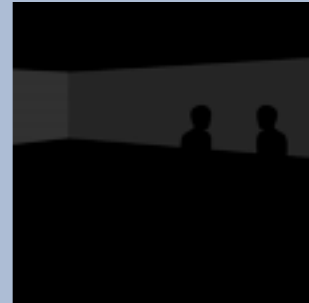
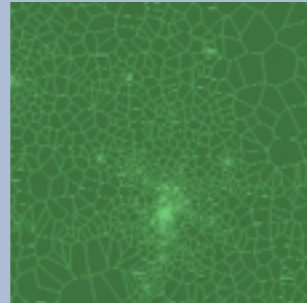


# data

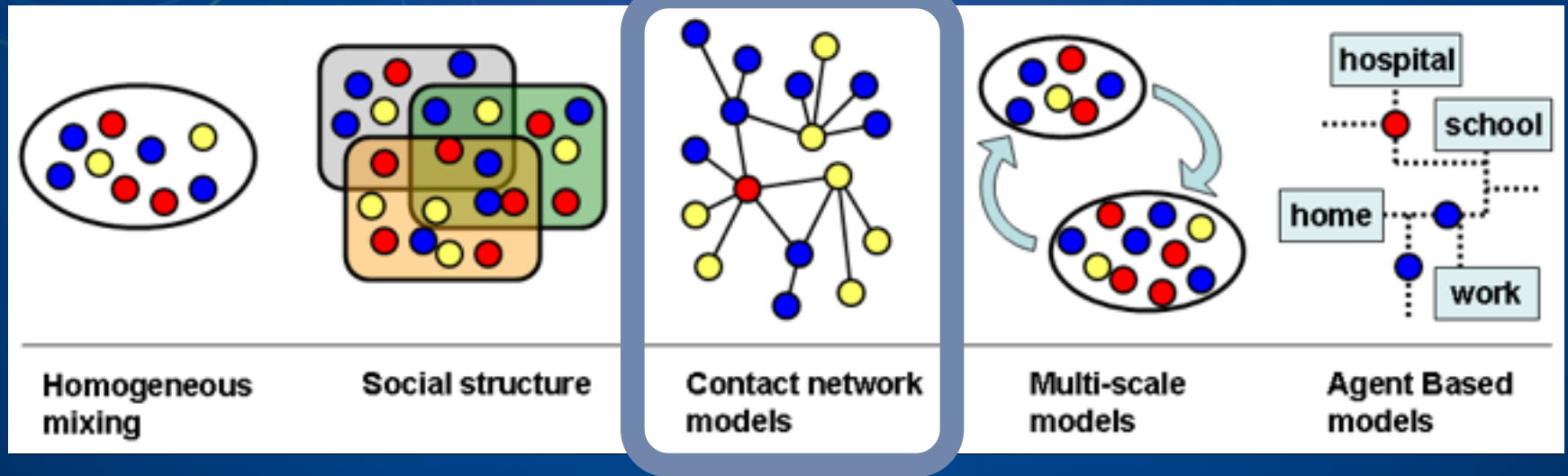




# data



# 3 applications to H1N1 pandemic



Carrat et al.: Planning for the next influenza H1N1 season: a modelling study.  
BMC Inf Dis (2010)

# Carrat et al. study

# THE PROBLEM

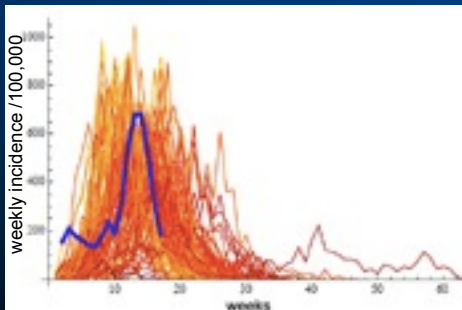
use the RS data of the first pandemic season in France to:

- ▶ estimate attack rates, rates of pre- and post-exposure immunity
- ▶ explore hypothetical scenarios of virus reintroduction with varying levels of cross-immunity

# THE APPROACH

- ▶ individual-centered model
- ▶ demographic characteristics and household sizes
- ▶ network of contacts
- ▶ detailed description of health-care seeking behavior, treatment

## RESULTS



pre-exposure immunity:	young adults	36%
	elderly	85%

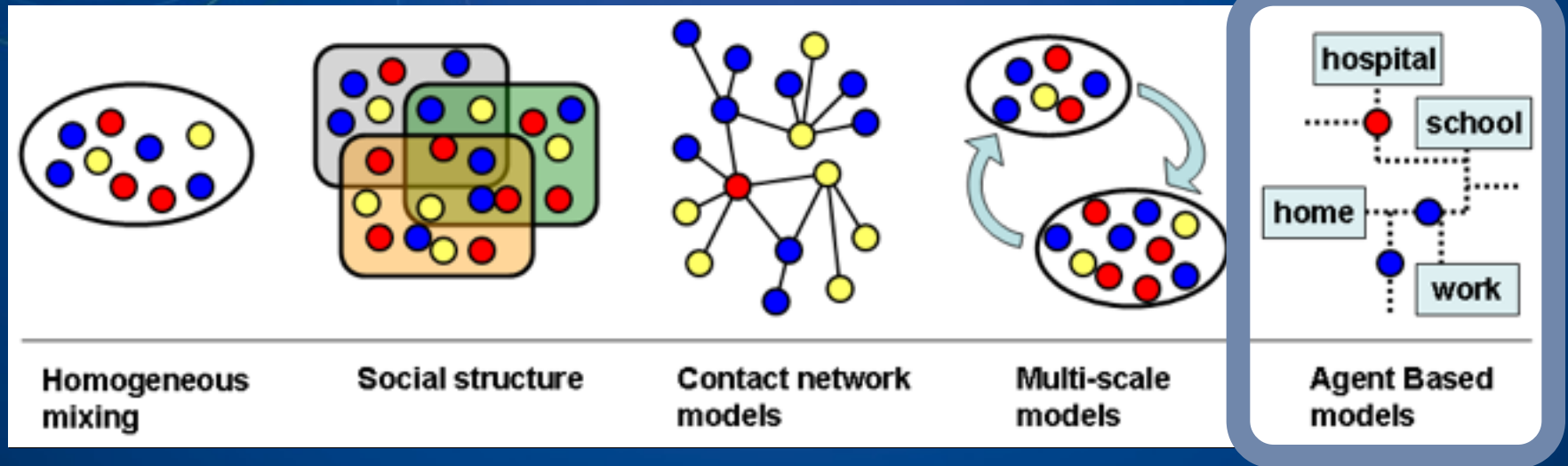
second pandemic	70%	small epidemic size
season, with	50%	disease burden ~ 1st season
cross protection:	30%	substantial burden



# some limitations...

- ▶ difficult to parameterize in real-time
- ▶ highly detailed for single population,  
but *space is missing*

# 2<sup>nd</sup> application to H1N1 pandemic



Determinants of the spatiotemporal dynamics of the 2009 H1N1 pandemic in Europe: implications for real-time modelling.  
PLOS Comp Biol (2011)

Merler et al.

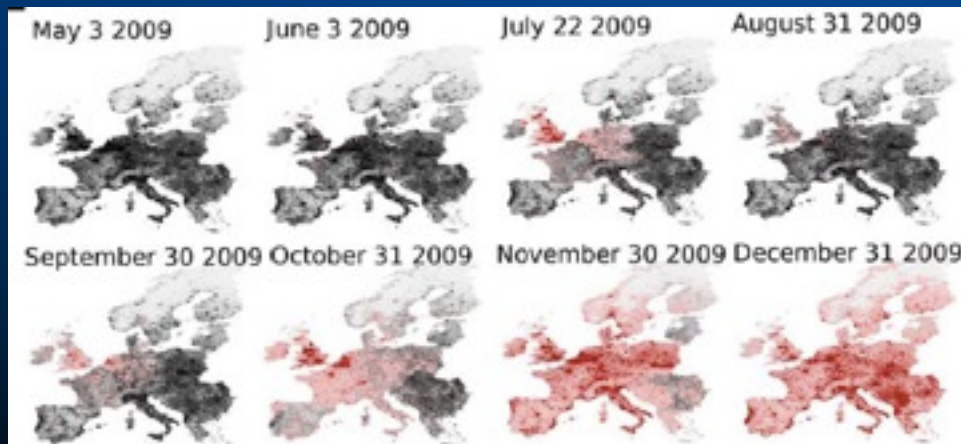
# Merler et al. study

## THE PROBLEM

use epidemic data and available estimates up to June 2009 to:

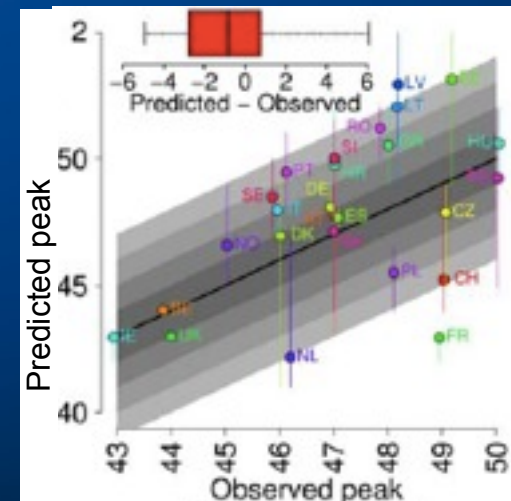
- ▶ evaluate the role of EU socio-demographic structures, school calendars, intra-EU mobility in shaping the spatio-temporal spread

## RESULTS



## THE APPROACH

- ▶ agent-based model informed with EU synthetic population
- ▶ explicit spatial structure restricted to EU + model for seeding events
- ▶ school calendars
- ▶ available epidemic estimates

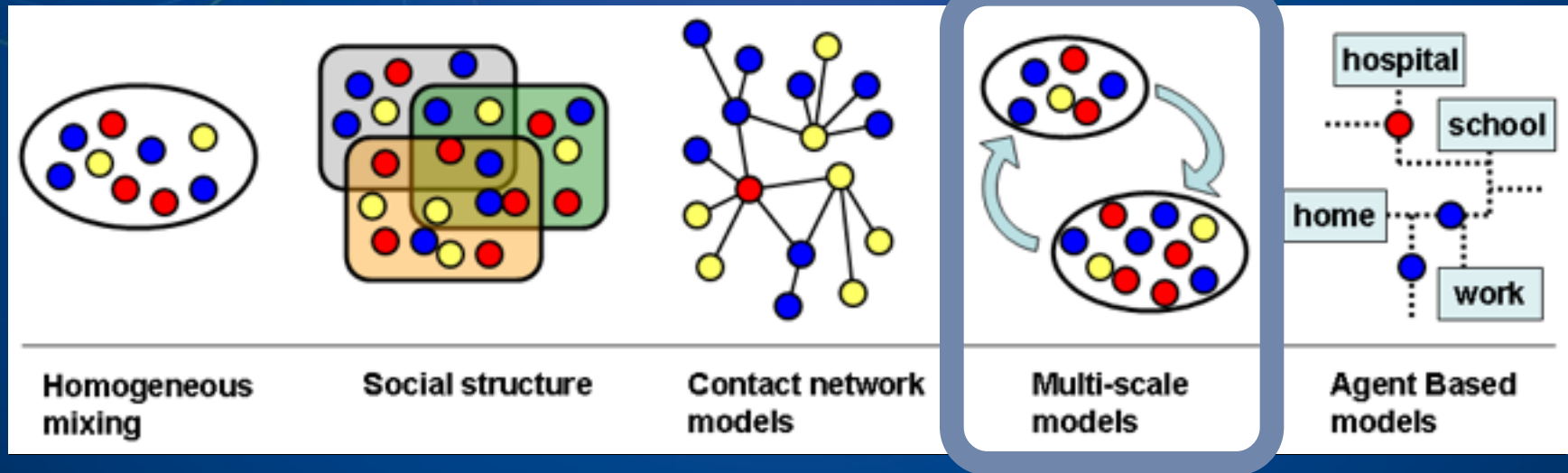




# some limitations...

- ▶ *difficult to parameterize in real-time*
- ▶ high resolution data available for few developed countries

# 3<sup>rd</sup> application to H1N1 pandemic



Seasonal transmission potential and activity peaks of the new influenza A/H1N1: a Monte Carlo likelihood analysis based on human mobility. *BMC Med* (2009)

Balcan et al.

Real-time numerical forecast of global epidemic spreading: case study of 2009 A/H1N1pdm. *BMC Med*, in press.

Tizzoni et al.

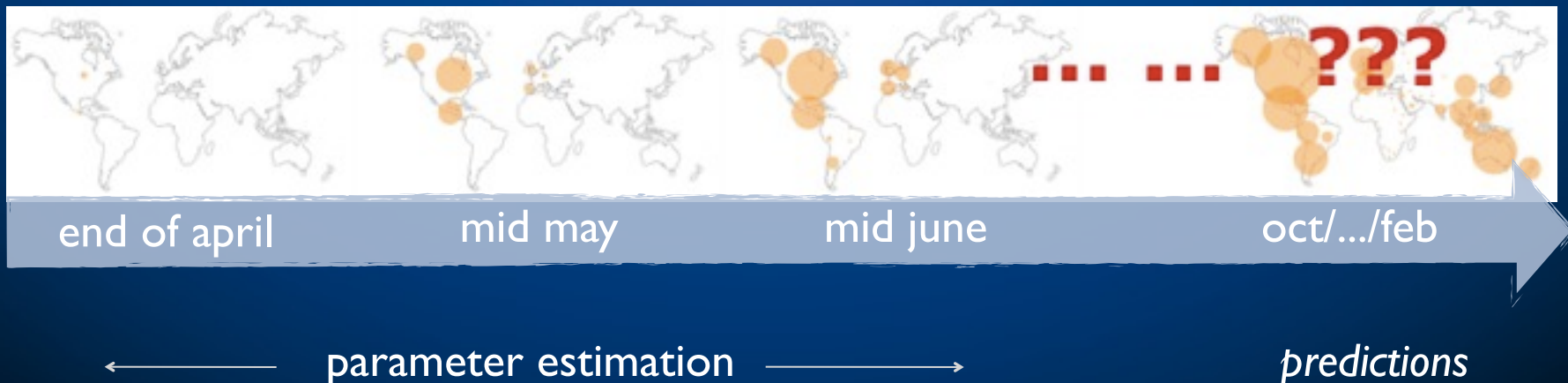
# the GLEAM study

## THE PROBLEM

use the epidemic data up to June 2009 to:

► estimate the seasonal transmission potential of the pandemic

► predict in *real-time* the future spatio-temporal propagation at the *global level* and in particular the peak timing for the upcoming winter season

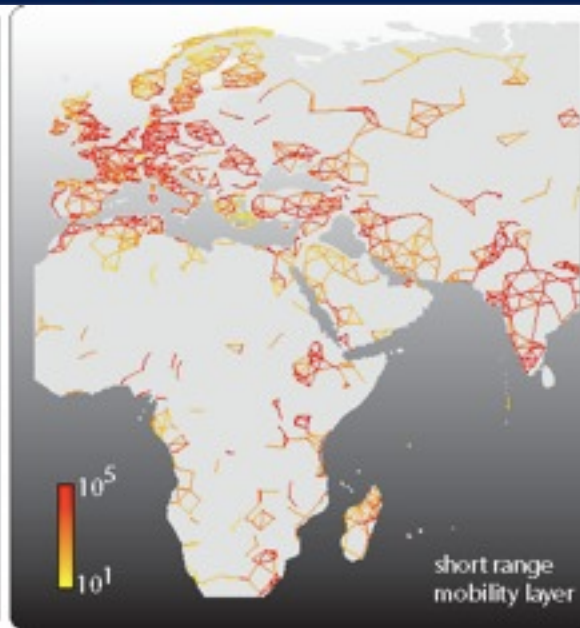




# the approach



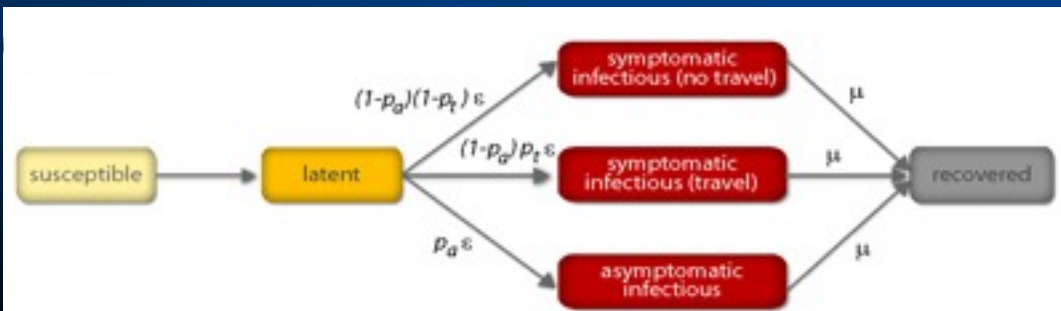
- population data in cells  $1/4^\circ \times 1/4^\circ$



- daily commuting data

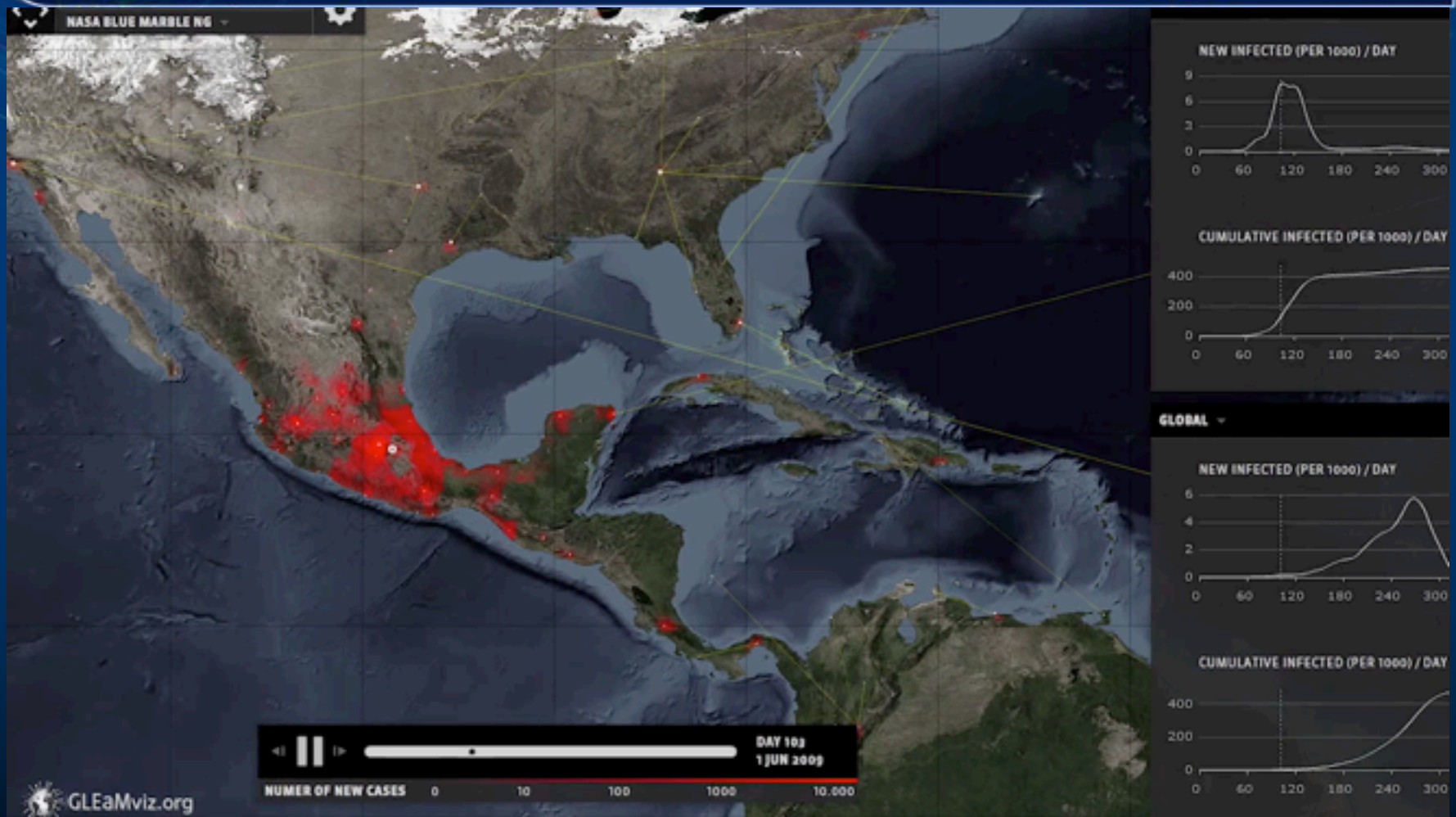


- 3400 airports in 220 countries
- 20,000 connections
- traffic data (IATA, OAG)
- >99% commercial traffic



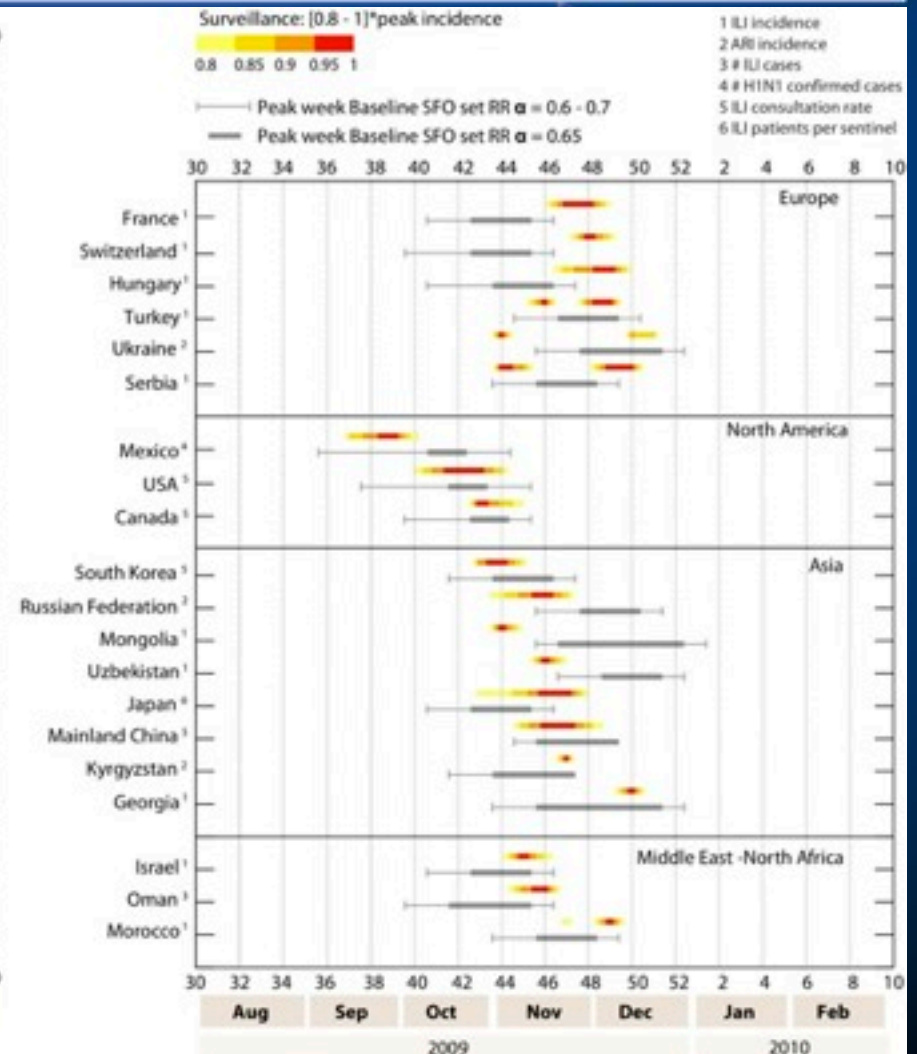
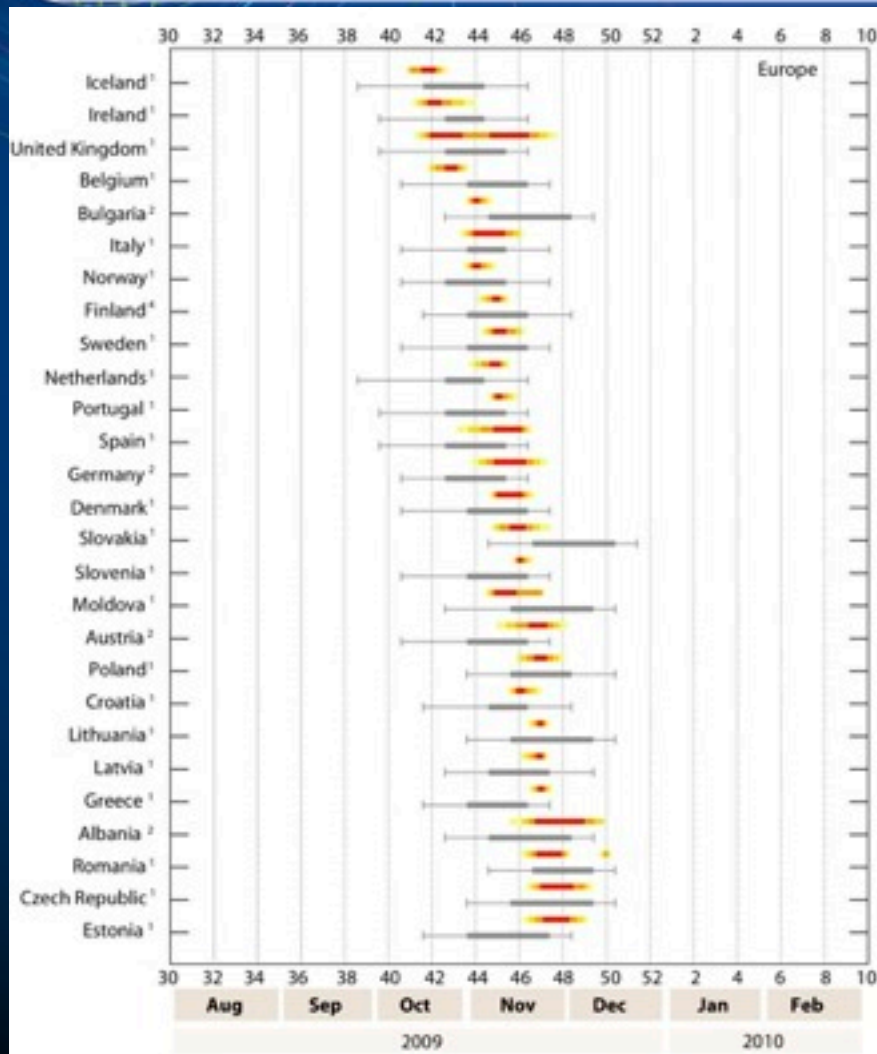
customizable  
compartmental model

# GLEAM: H1N1 output example



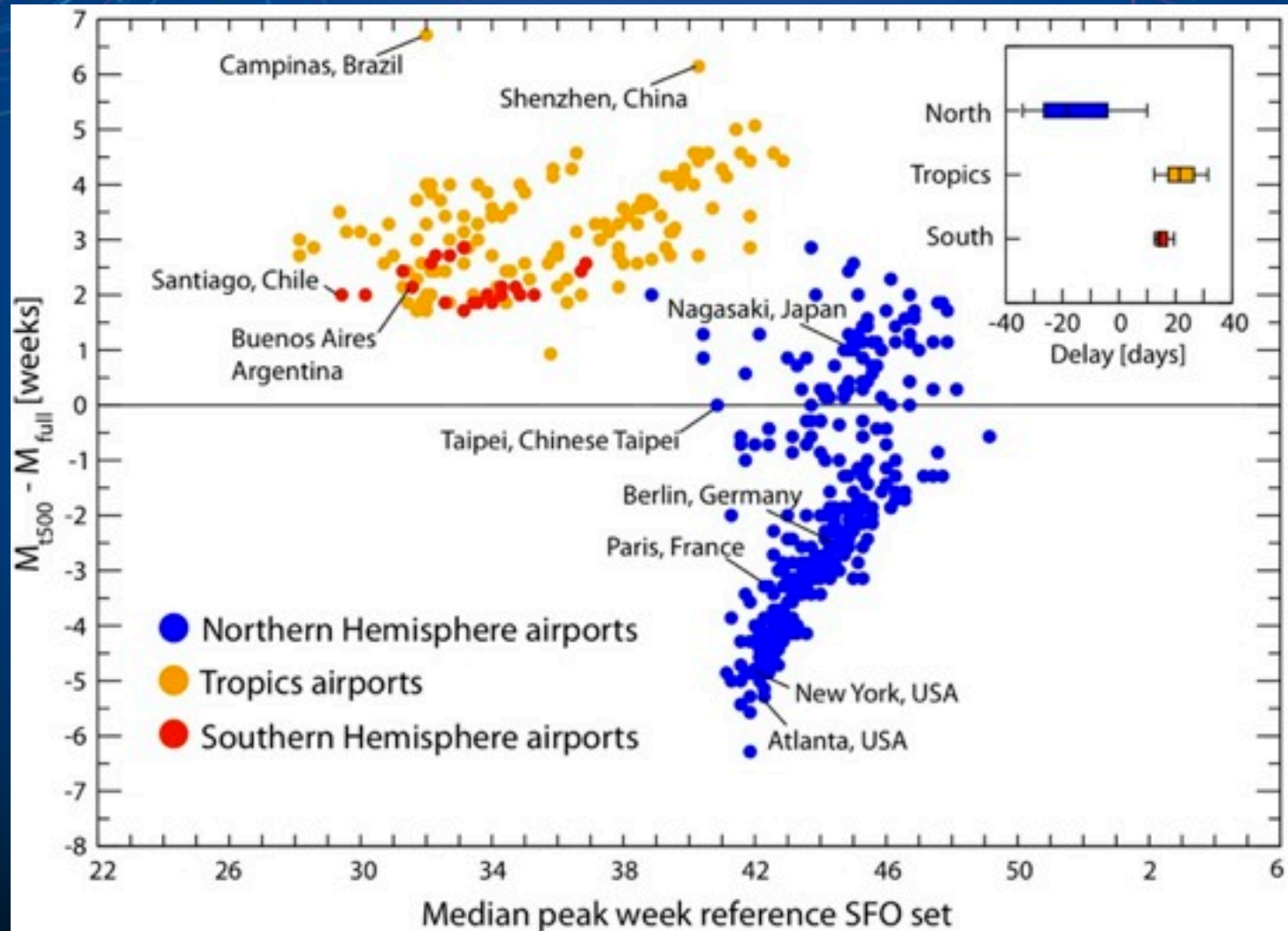


# predictions and assessment





# importance of mobility





some limitations...

▶ lack of high resolution description  
of socio-demographic structures

# remaining challenges

- ➡ data to inform models
  - ▶ social, behavioral, demographic, mobility...
  - ▶ underdeveloped countries?
- ➡ models: integrating different approaches
- ➡ sharing
- ➡ preparedness for emergency (building up collaborative workflows in peacetime)
- ➡ surveillance: high resolution, same case-definition, health-seeking behavior, ...

# influenzaneet.org

 **grippenet**.fr

Un commentaire, un problème ?

4521 Inscrits (actualisé toutes les 5 min.)

Accueil

Le projet

Actualités

La grippe

Résultats

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## Les dernières actualités

Lancement de la nouvelle saison de GrippeNet.fr le 15 novembre !

[Pour en savoir plus ...](#)

24/09/2012

Vous pouvez télécharger la deuxième newsletter estivale de GrippeNet.fr !



[Pour en savoir plus ...](#)

12/09/2012

La première newsletter estivale de GrippeNet.fr est en ligne !



[Pour en savoir plus ...](#)

04/07/2012

Fin du recueil de données de GrippeNet.fr

## Bienvenue sur GrippeNet.fr !

### La nouvelle saison de GrippeNet.fr démarrera le 15 novembre 2012 !

GrippeNet.fr est un projet de recherche portant sur la grippe, mis en place par l'Inserm et l'Université Pierre et Marie Curie, en coordination avec l'Institut de Veille Sanitaire et le consortium [Epiwork](#).

GrippeNet.fr permet à chacun de participer à la surveillance de la grippe en France, de façon volontaire, anonyme et bénévole. Les données recueillies permettent de connaître en temps réel la situation de la grippe en France, et d'étudier la façon dont la maladie se propage.

### Carte de répartition des participants à GrippeNet.fr



S'inscrire

Se connecter

Remplir un questionnaire

Mot de passe oublié ?

Suivre @grippenet

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 **Inserm**

 **UPMC**  
SORBONNE UNIVERSITÉS

 **InVS**  
INSTITUT DE VEILLE SANITAIRE



# acknowledgments & refs

EPICX lab  
U707 INSERM & UPMC  
[www.epicx-lab.com](http://www.epicx-lab.com)

[www.gleamviz.org](http://www.gleamviz.org)  
[www.epifore.eu](http://www.epifore.eu)



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