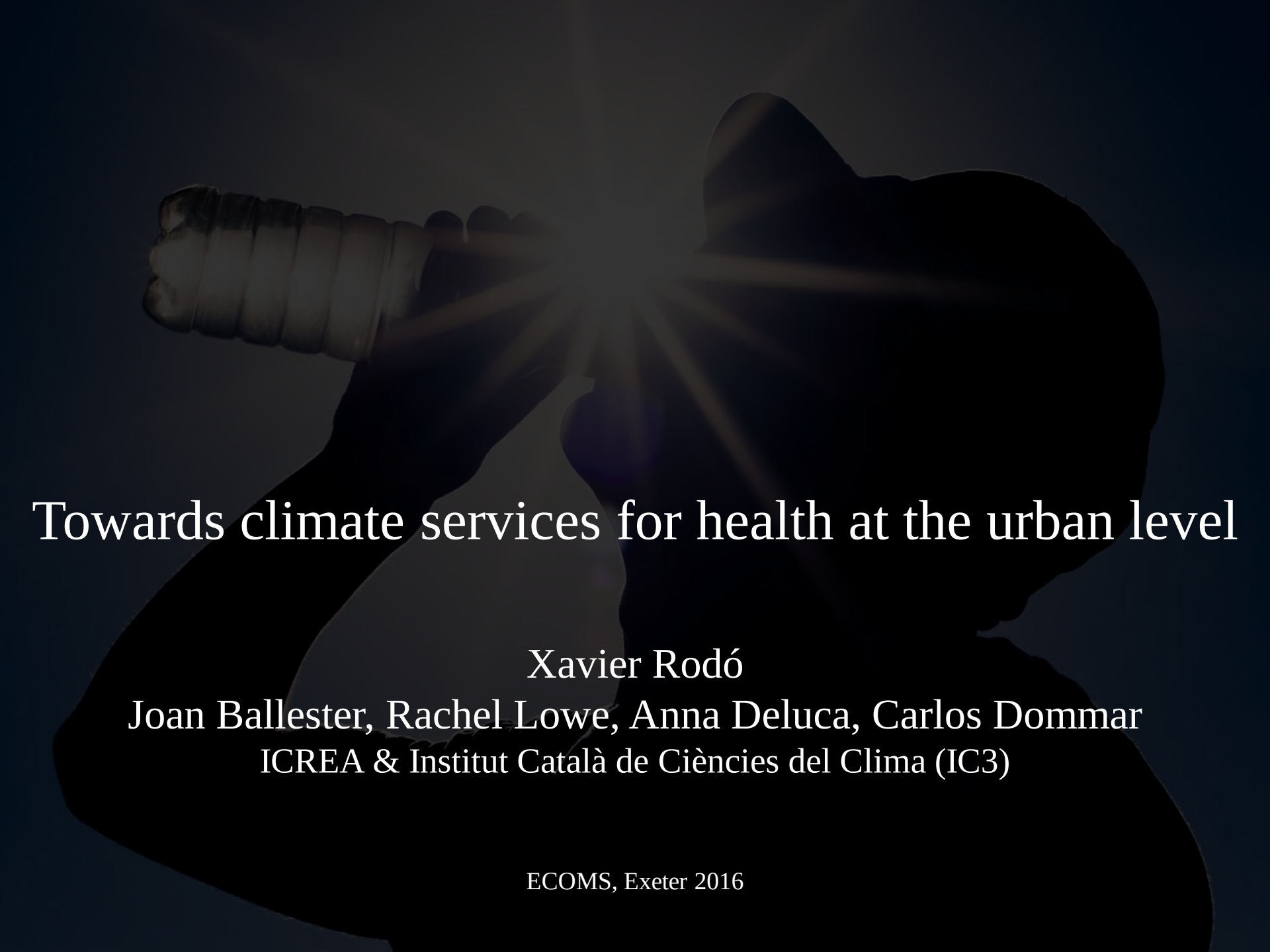


Towards climate services for health at the urban level

Xavier Rodó
Joan Ballester, Rachel Lowe, Anna Deluca, Carlos Dommar
ICREA & Institut Català de Ciències del Clima (IC3)

ECOMS, Exeter 2016

IC3's brief record on climate impacts

Temperature-Related Mortality (TRM):

– Ballester et al. (2011) Nature Communications 2, 358 –

– Ballester et al. (2016) Nature Climate Change, doi:10.1038/nclimate3070 –

Dengue:

– Lowe et al. (2014) The Lancet Infectious Diseases 14, 619-626 –

-Lowe et al (2016) eLife, 1, 18-24

Cholera:

– Pascual, Rodó et al. (2000) Science 289, 1766-1769 –

– Rodó et al. (2002) PNAS 99, 12901-12906 –

– Koelle, Rodó et al. (2005) Nature 436, 696-700 –

-Barachini et al., (2016) ADWR, in press

Malaria:

– Cash, Rodó, Ballester et al. (2013) Nature Climate Change 3, 502-507 –

-Pascual, Rodó et al., (2010) PNAS, 17, 246-249.

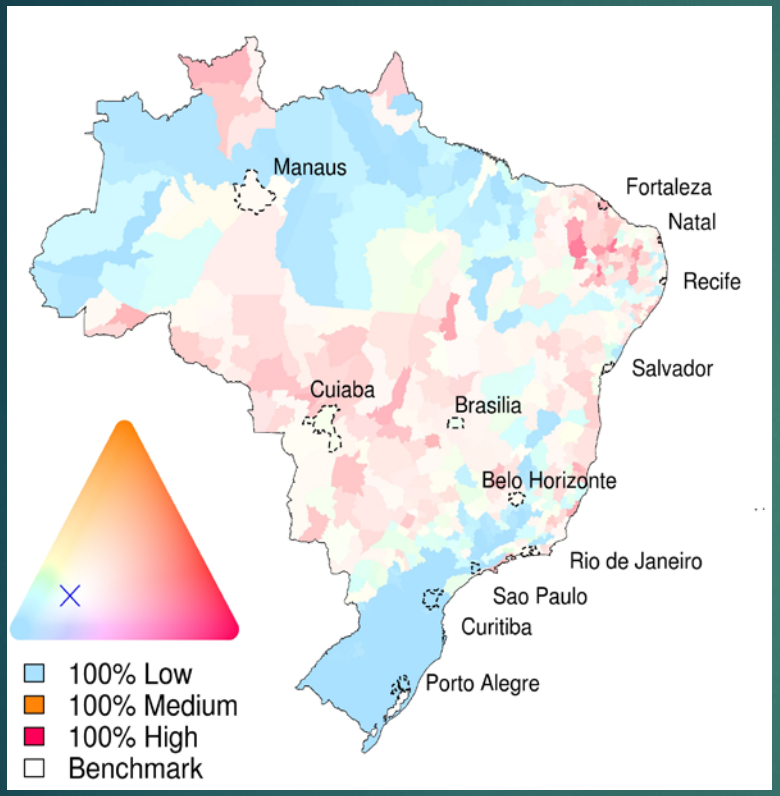
-Bouma et al. (2016) TMIH 9, 213-216

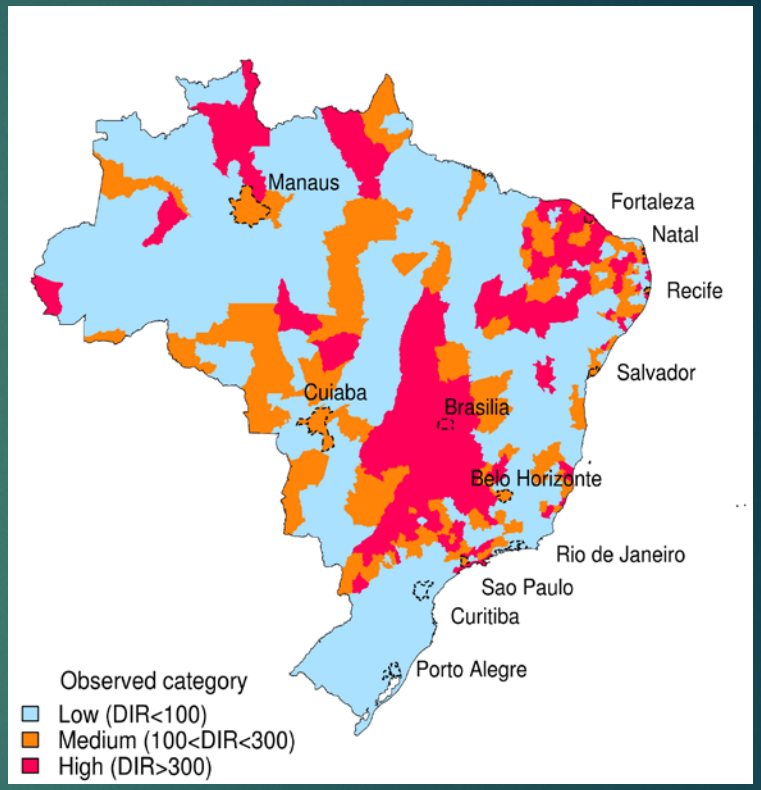
Kawasaki Disease:

– Rodó, Ballester et al. (2011) Nature Scientific Reports 1, 152 –

– Rodó, Curcoll, Robinson, Ballester et al. (2014) PNAS 111, 7952-7957 –

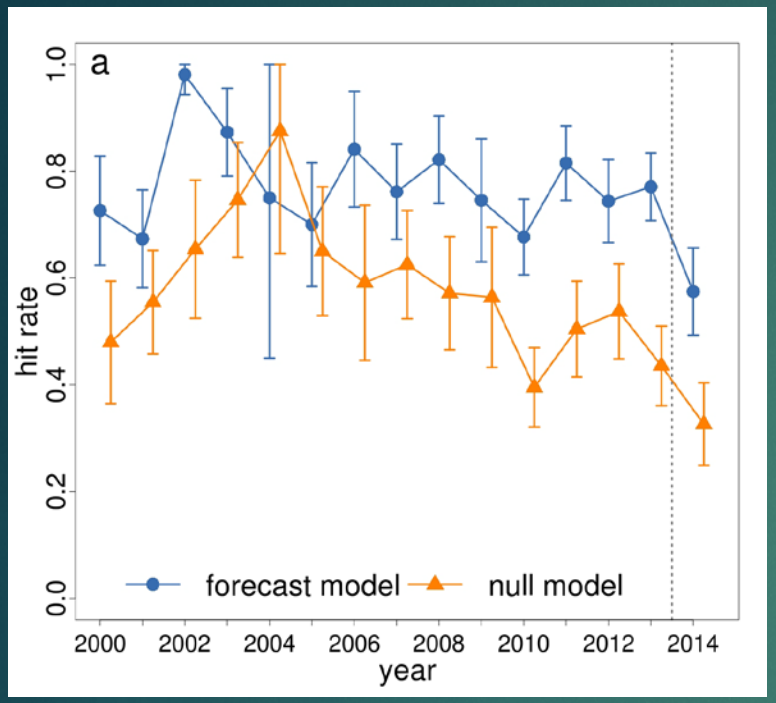
Dengue forecast and observed risk levels

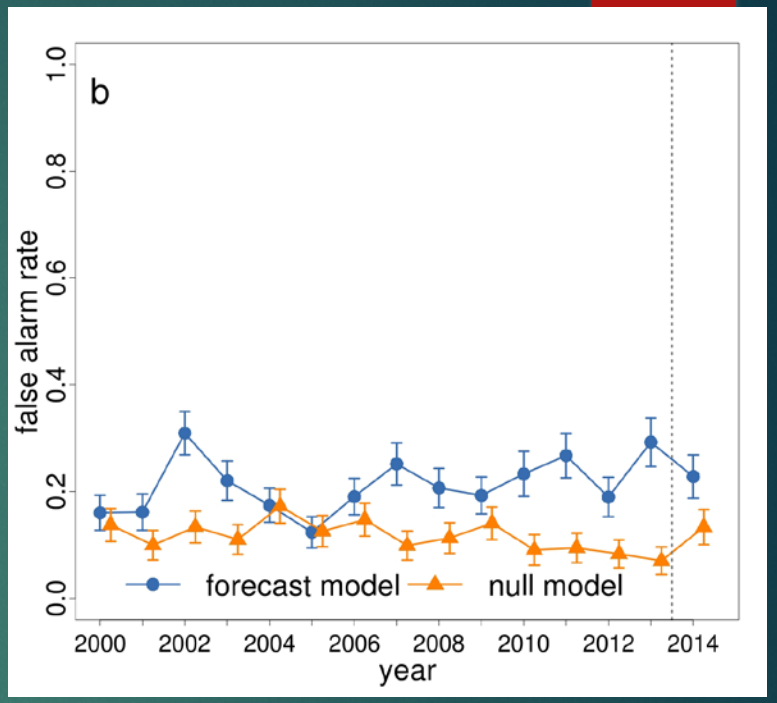




Framework applied to predict dengue risk for June 2014 during the World Cup in Brazil, a mass gathering of more than 3 million local/international spectators.

Comparison of forecast model to null model





Comparison of hit rate and false alarm rate for forecast model (blue) and seasonal average null model (orange) for June 2000-2014.

2014 event
hit rate: 57% (33%)
false alarm rate (type I error rate): 23% (13%)
miss rate (type II error rate): 43% (67%)

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Outline

1. The importance of human adaptation to environmental temperatures
2. Use of climate forecasts for the operational prediction of TRM in Europe
3. Exploration of TRM at new spatial scales: the basis for a case-study of Barcelona

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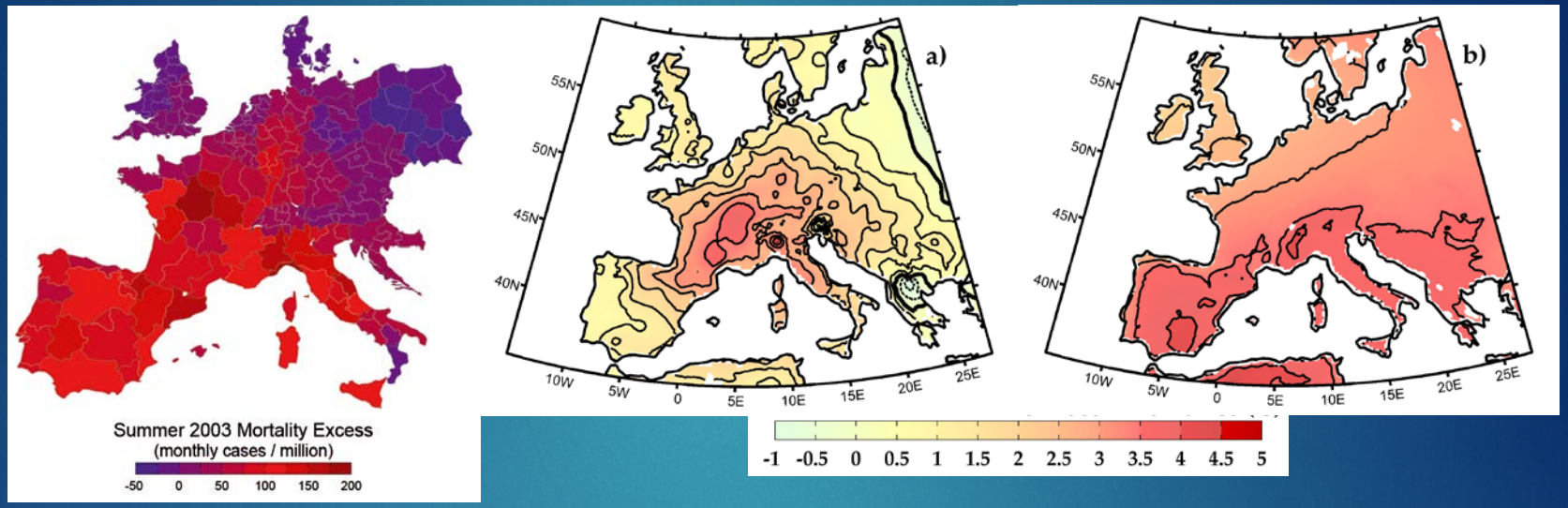
The Summer 2003 Heat Wave

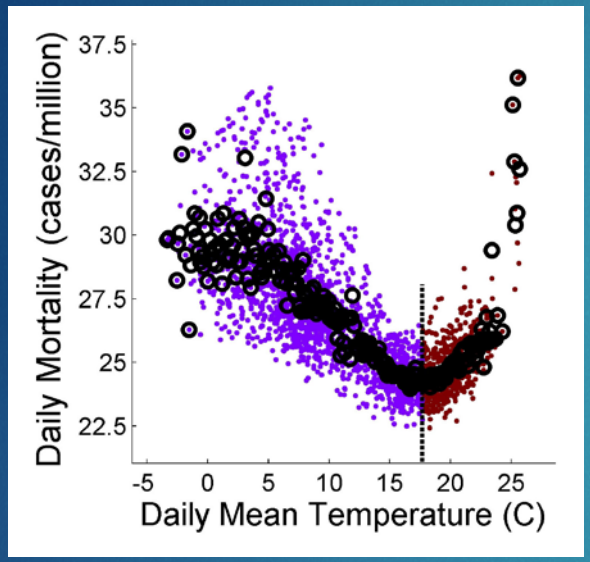


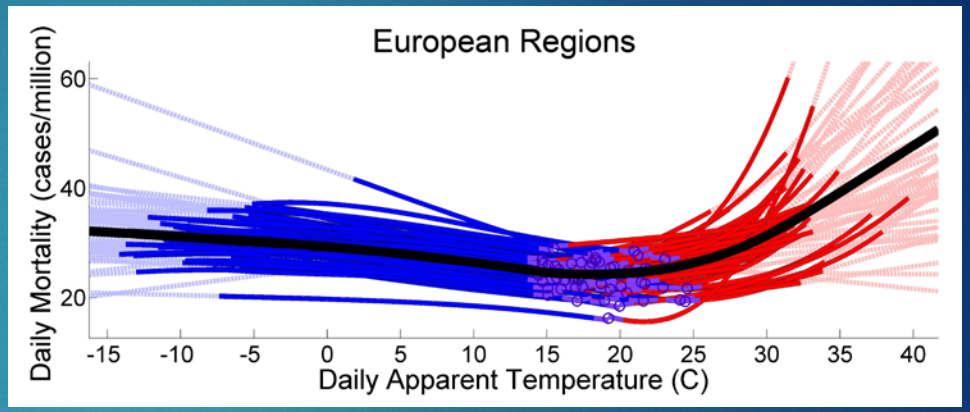
The record-breaking 2003 summer heat wave caused more than 70,000 additional deaths in western Europe.

The centre of the heat wave was in France and Switzerland, but most of the excess mortality occurred in Spain (13.7%), France (11.8%) and Italy (11.6%).

The temperature anomaly was weaker than the projected for the end of the century.

Temperature-Mortality Relationship

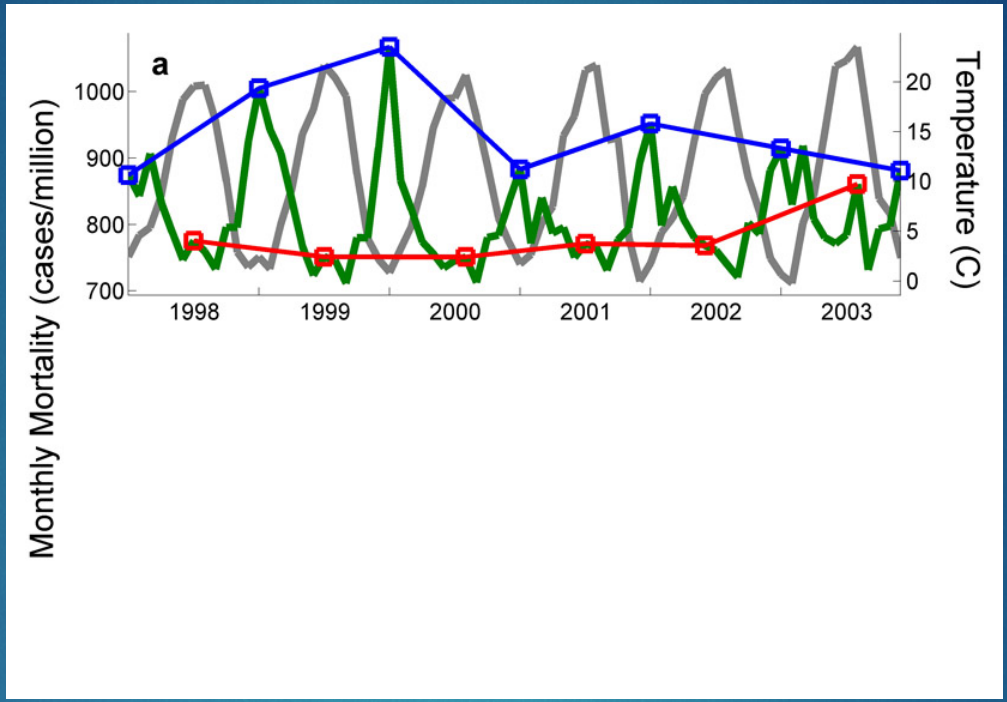




Mortality linearly increases for temperatures colder than the comfort temperature, non-linearly for warmer temperatures.

The sensitivity to temperatures is larger
in the Mediterranean (warm and cold), the UK (cold) and France (warm).

Seasonal Evolution of Mortality

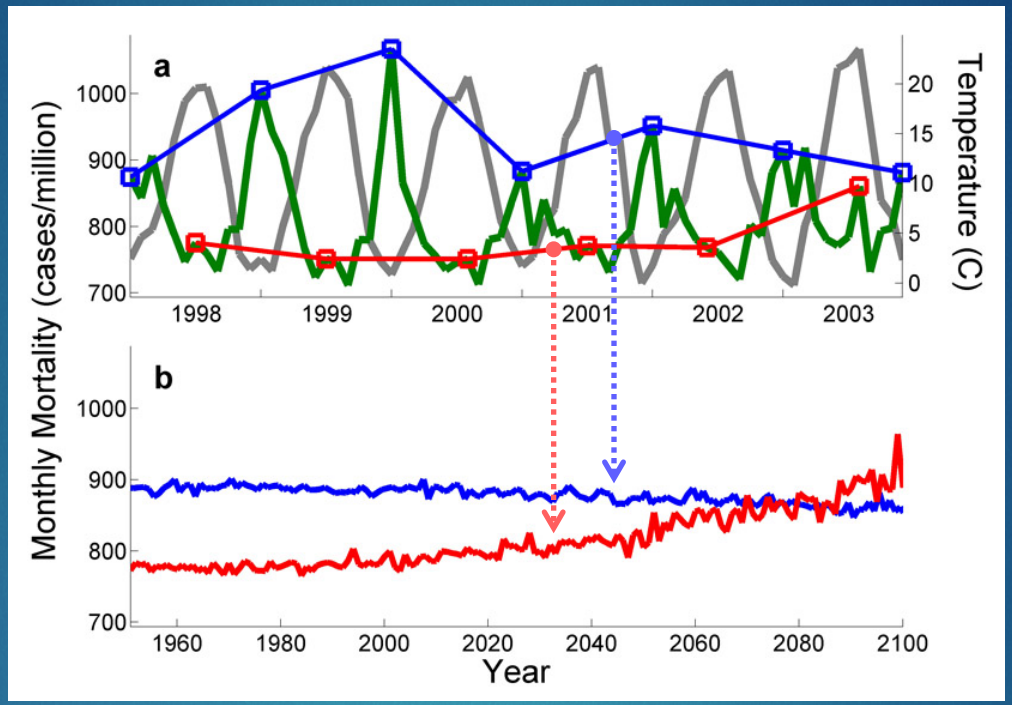


1998-2002: winter mortality peak clearly larger than in summer.

2003: winter and summer peaks of similar magnitude.

21st century: the summer peak will steadily increase and become larger.

Seasonal Evolution of Mortality



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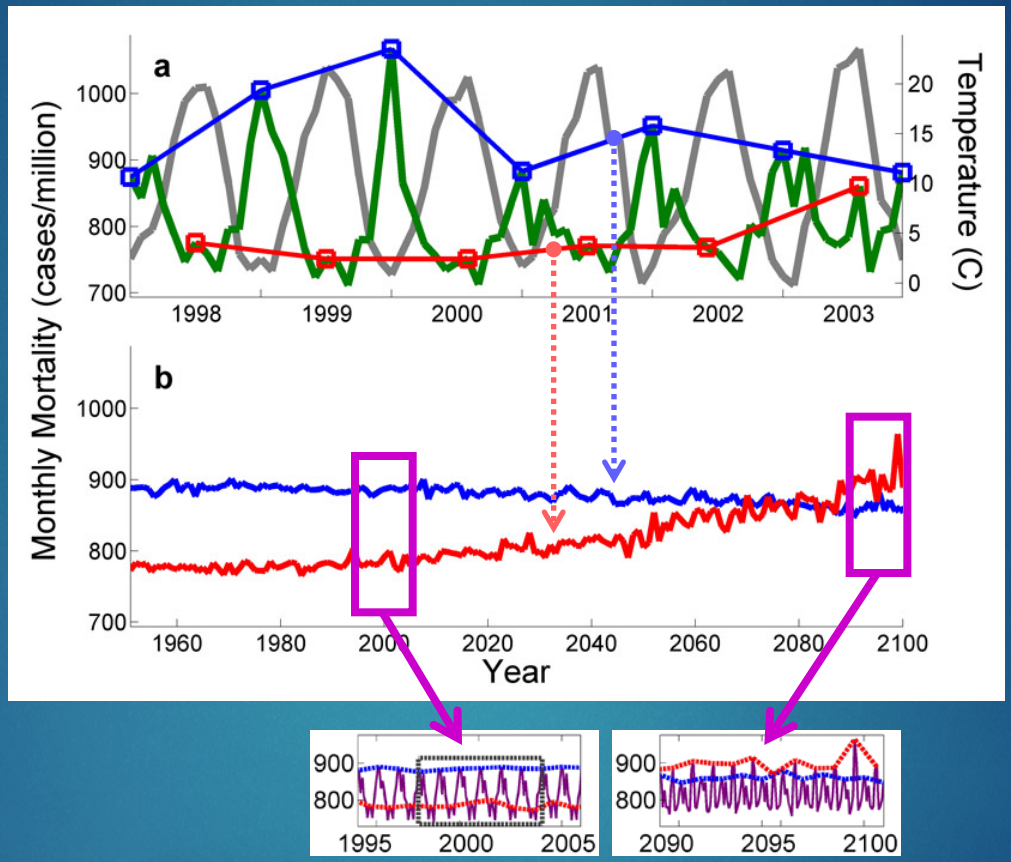


1998-2002: winter mortality peak clearly larger than in summer.

2003: winter and summer peaks of similar magnitude.

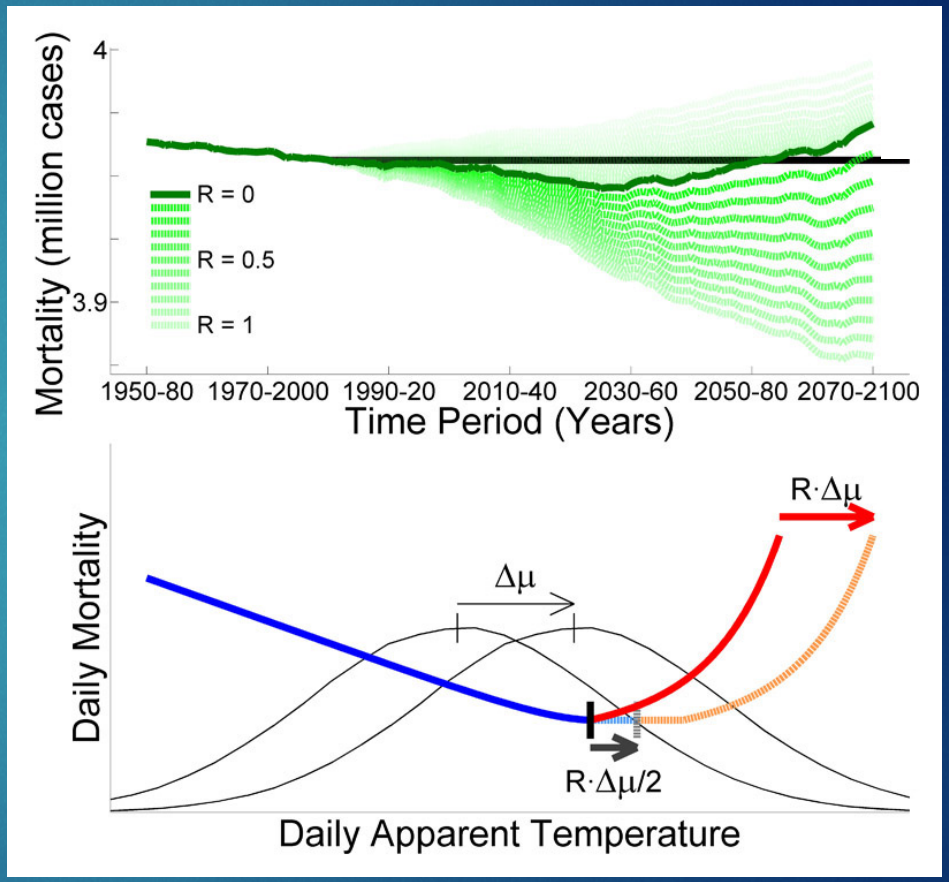
21st century: the summer peak will steadily increase and become larger.

Mortality Evolution and Adaptation

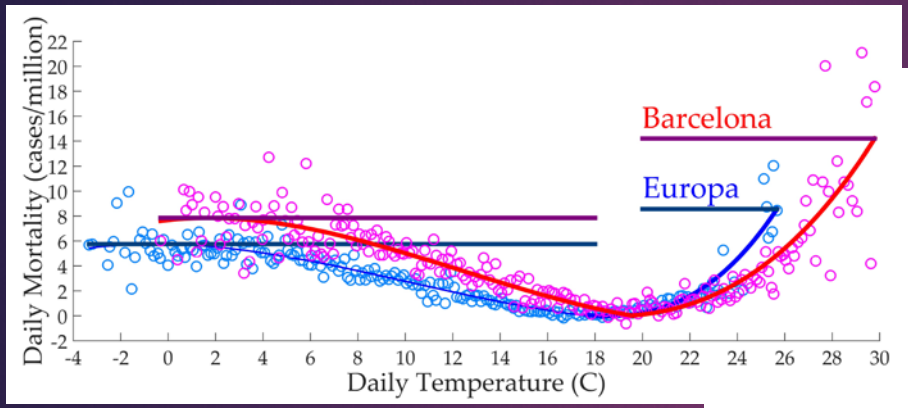
Adaptation scenario:
the warm transfer function is shifted to warmer temperatures ($R \cdot \Delta\mu$) by a fraction ($0 \leq R \leq 1$) of temperature rise ($\Delta\mu$).

No adaptation ($R = 0$):
summer mortality will offset winter deaths in 2045.

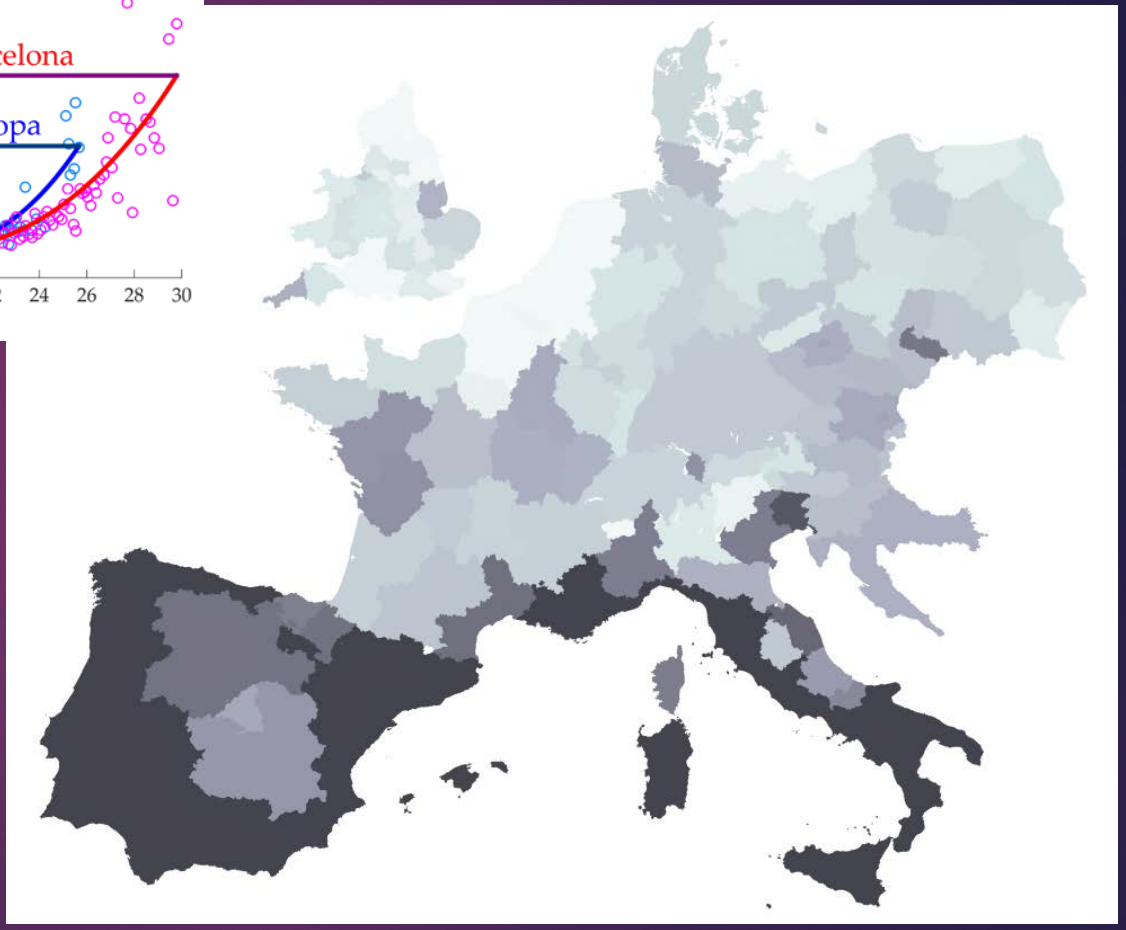
Fast gain of adaptation ($R = 1$):
there is room for a large decrease in human mortality.



Vulnerability inequalities



Temperature vs. Mortality
in Europe and Barcelona



Vulnerability index
to extreme temperatures

Comparison at the Country Level

High vulnerability
Low adaptation

Low vulnerability
Large adaptation

Country	Day-to-day regression coeff.
Portugal	-1.13
Spain	-0.67
Italy	-0.52
United Kingdom	-0.38
France	-0.26
Czech Republic	-0.25
Austria	-0.24
Croatia	-0.23
Belgium	-0.22
Denmark	-0.21
Slovenia	-0.20
Poland	-0.18
Luxembourg	-0.17
Germany	-0.16
Switzerland	-0.15
Netherlands	-0.14

Country	Year-to-year correlation
Portugal	-0.97
Croatia	-0.97
Italy	-0.96
Austria	-0.96
Slovenia	-0.93
Switzerland	-0.88
Spain	-0.88
Czech Republic	-0.88
Germany	-0.85
France	-0.83
Luxembourg	-0.81
Poland	-0.70
Denmark	-0.60
United Kingdom	-0.12
Netherlands	0.08
Belgium	0.38

Spatial correlation:
$r = 0.16$
(not signif.)

No spatial relation between regressions and correlations, suggesting two types of acclimatization processes.

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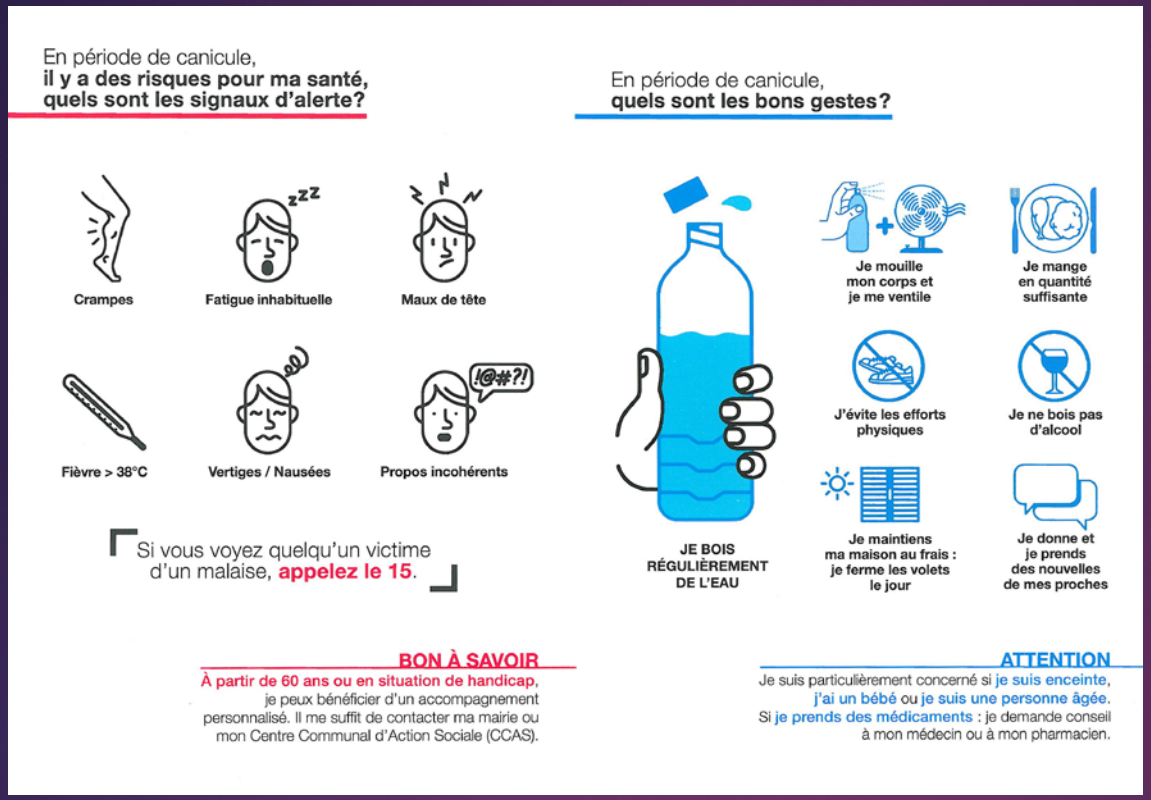
The Importance of Preventive Plans



Global warming and changes in extreme events challenge public health services.

Seasonal climate forecasts provide an opportunity to anticipate TRM.

Preventive plans do save lives: up to 4400 deaths in France during the 11-26 July 2006 heat wave (Fouillet et al. 2008).

Skill of the Observation-Driven Model

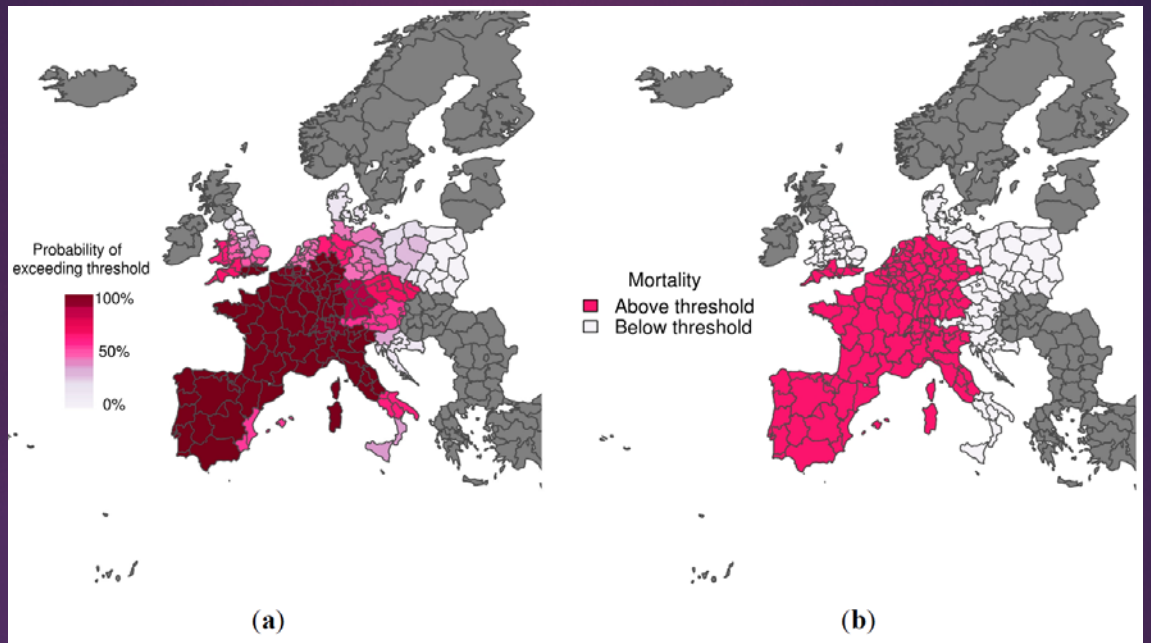


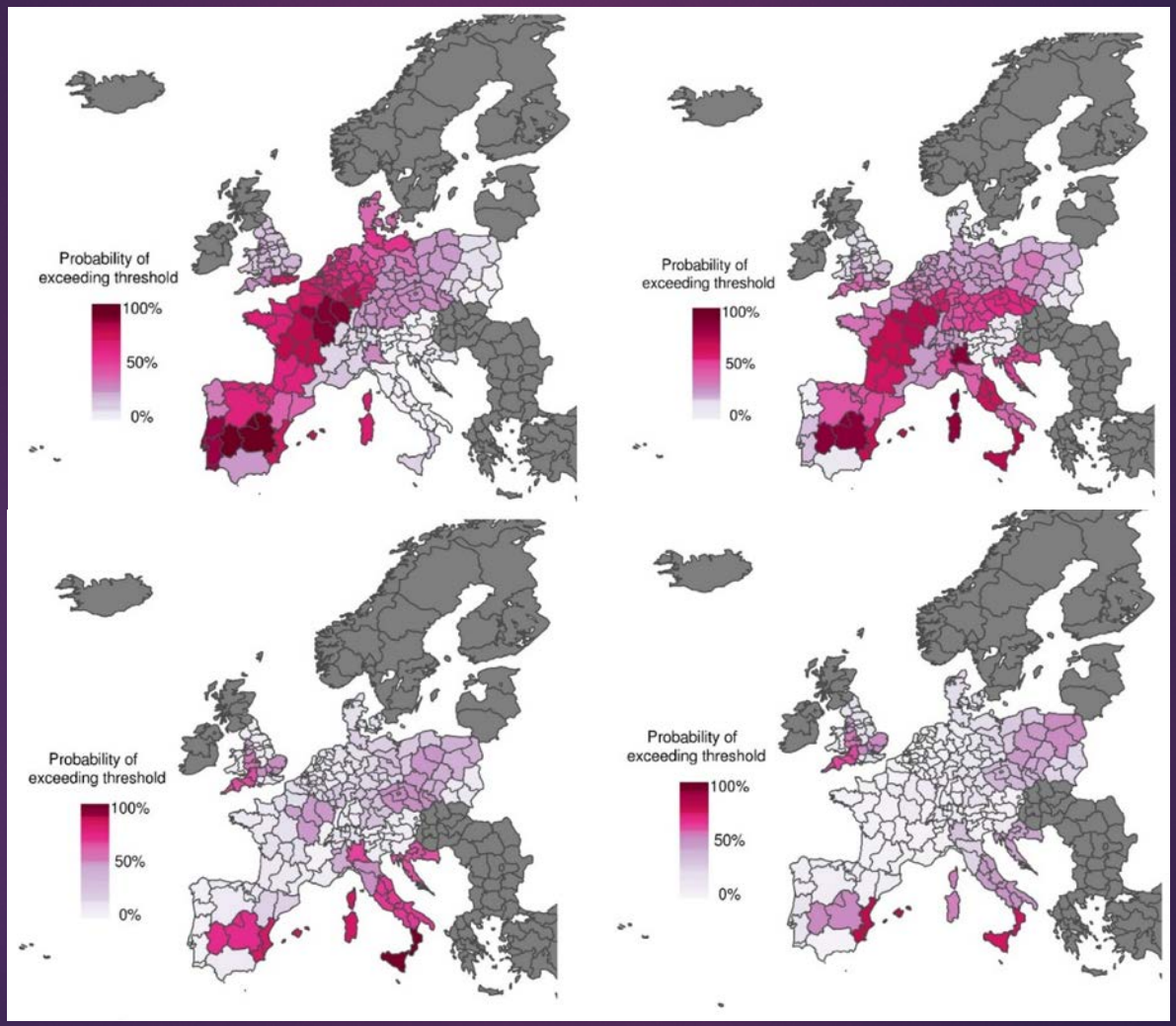
Figure 2. (**a**) Probabilistic map of exceeding emergency daily mortality thresholds (75th percentile of daily mortality distribution in the warm tail); (**b**) Corresponding observations during a heat wave scenario (1–15 August 2003). The graduated colour bar represents the probability of exceeding the mortality threshold (ranging from 0%, pale colours, to 100%, deep colours).

Mortality predictions for the most extreme heat wave: August 1-15, 2003.

The predicted probabilities approach the observations.

Skill of the Forecast-Driven Model

1-day lead time

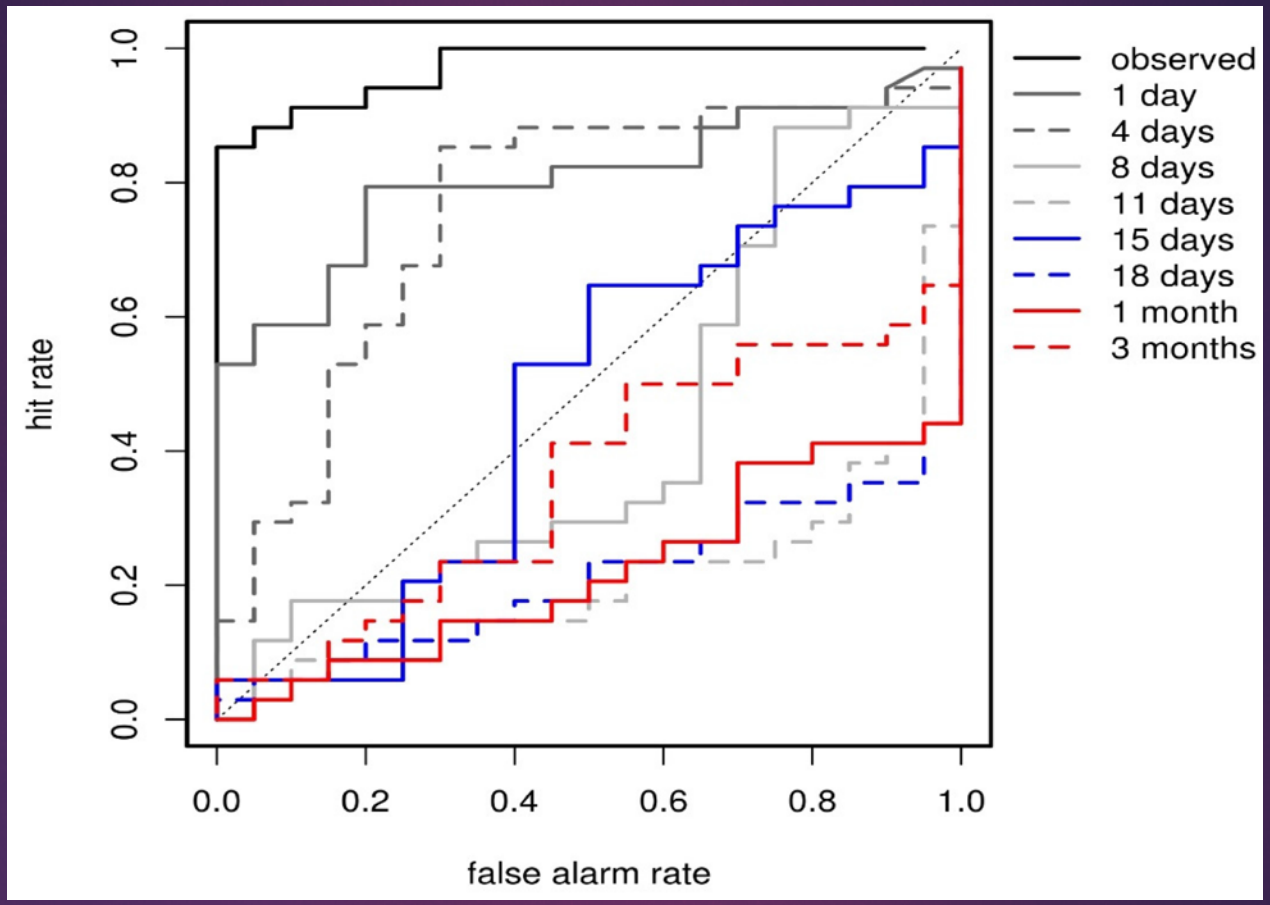


4-day lead time

8-day lead time

11-day lead time

Summary of Results



We found a decreasing transition in skill between
excellent predictions when using observed temperature
to no skill when using forecasts with lead times greater than one week.

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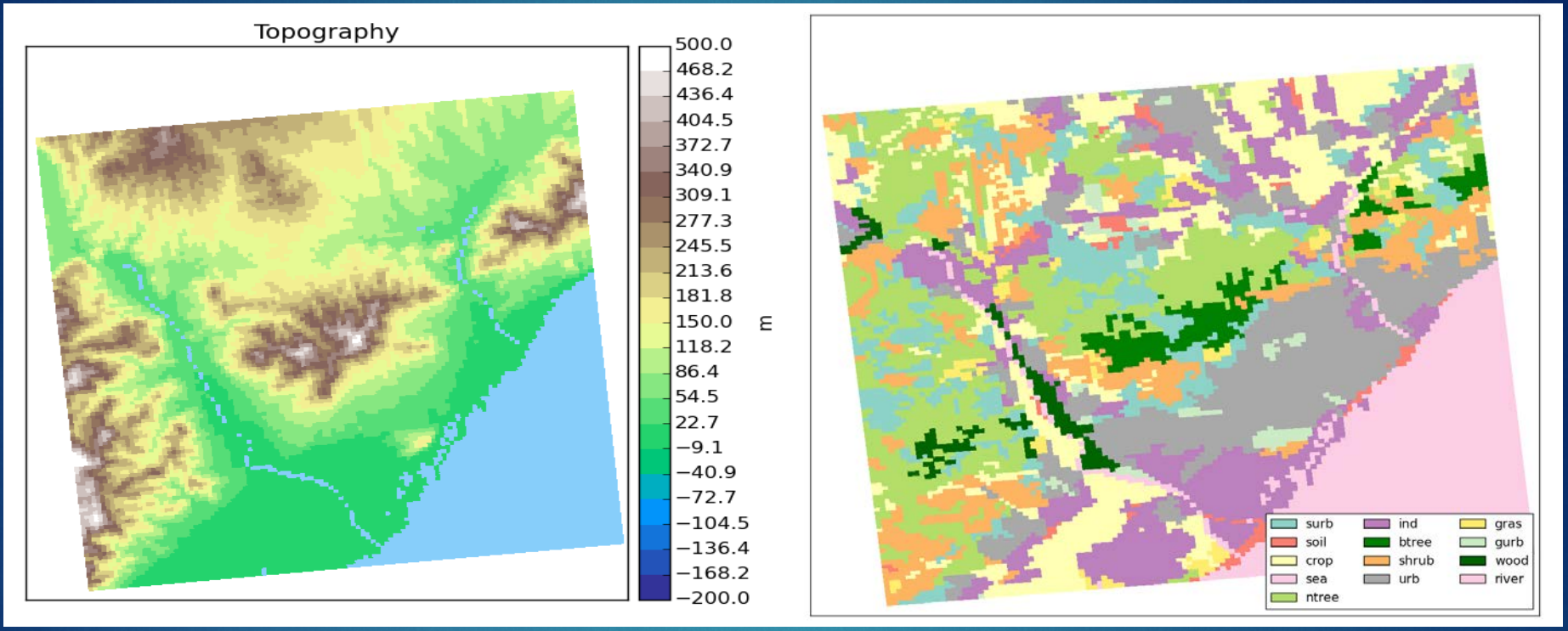
UrbClim: Topography and Land-use



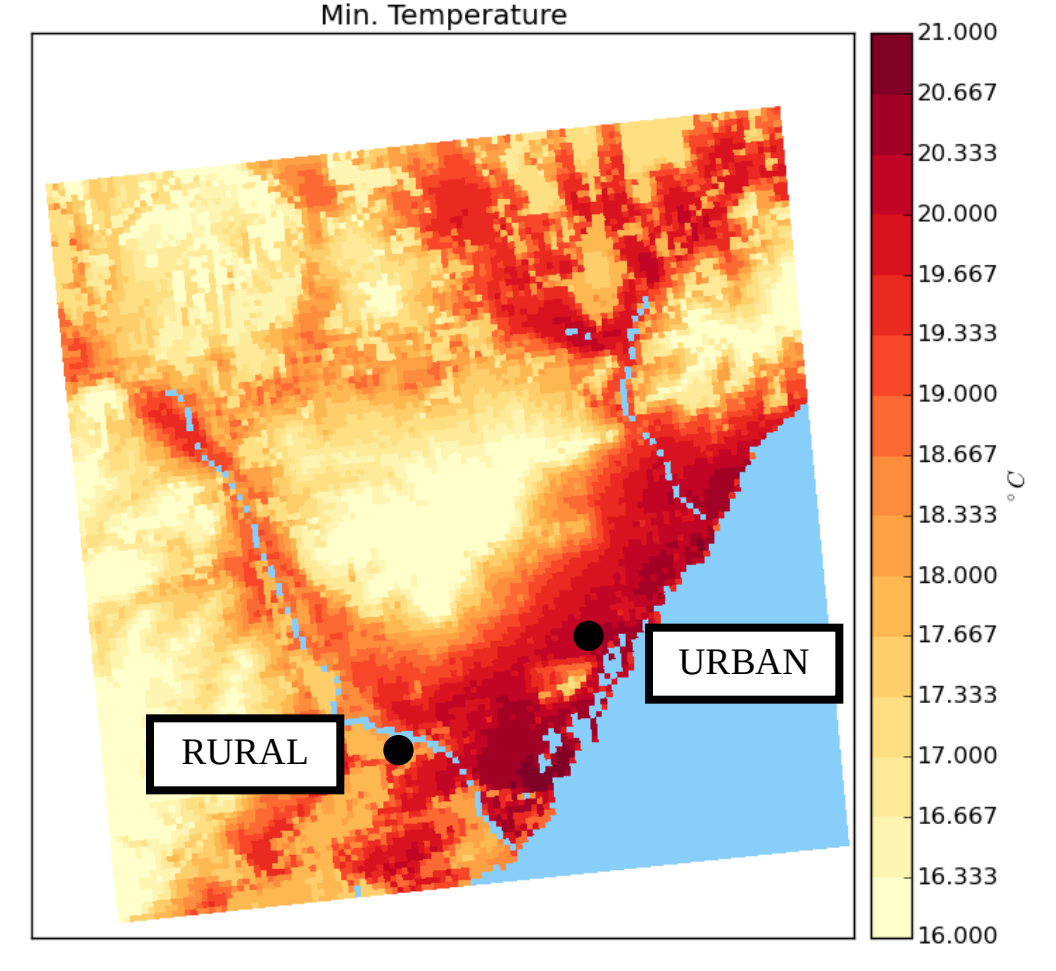
Collaboration with VITO (EUPORIAS-NACLIM)

The city is surrounded by the Mediterranean sea, a mountain range and two rivers.

Summer days are characterized by clockwise rotating breezes and high humidity.

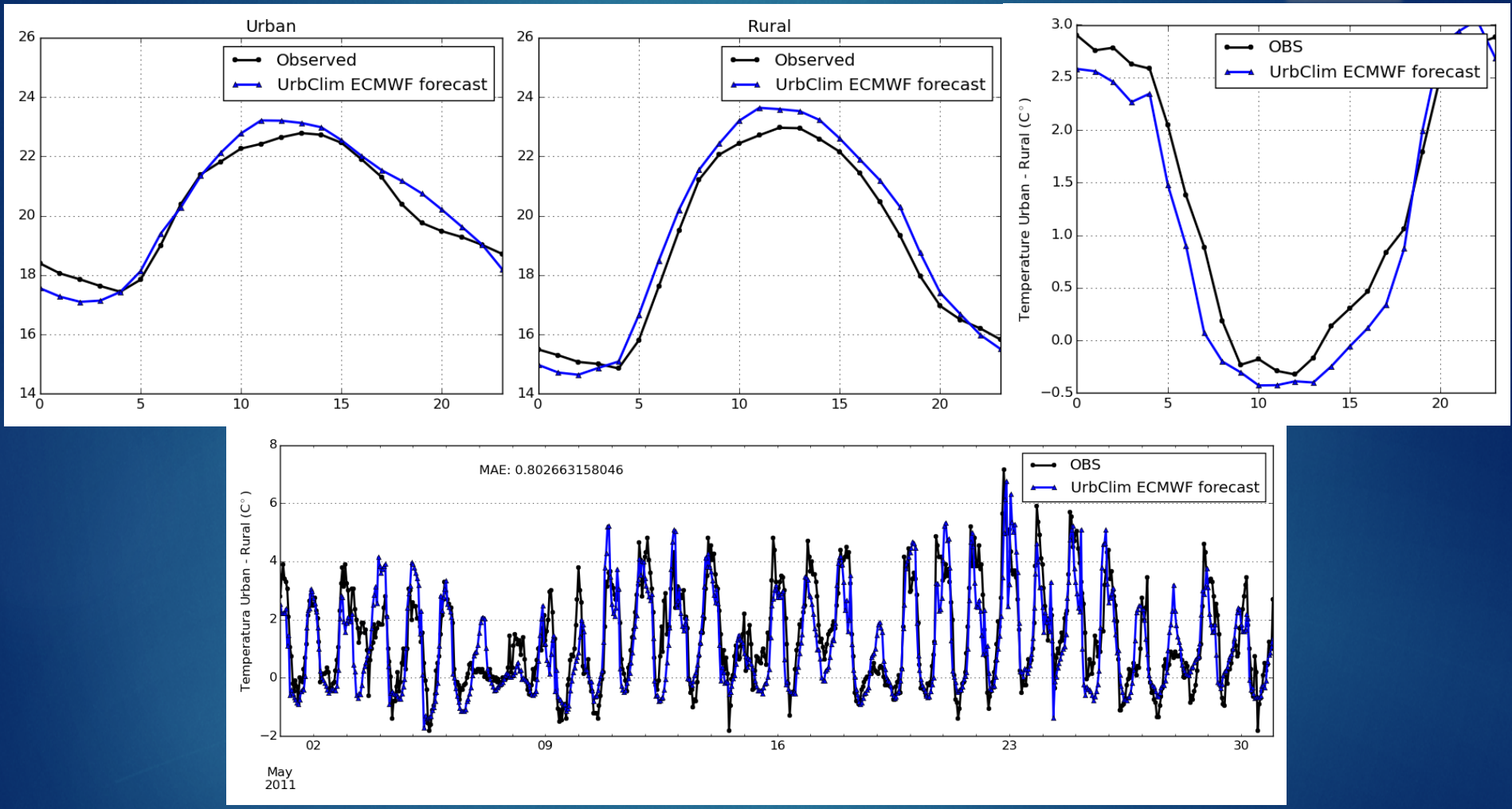
The urban area expands in this area, except near the airport with crop fields.

Urban Heat Island (UHI)



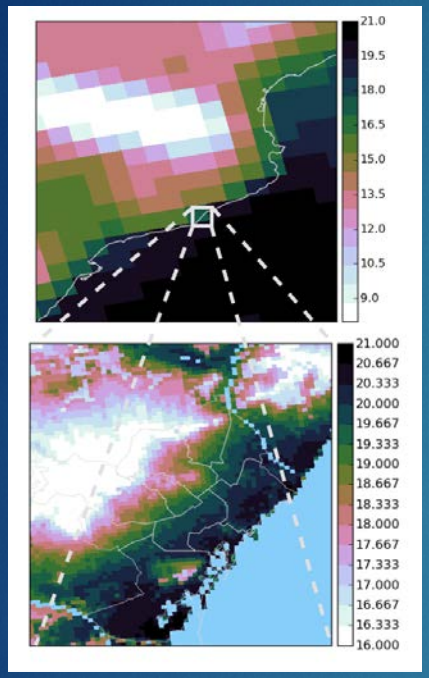
The river delta is a good site with observational data for the evaluation of the UHI.

The UHI effect in Barcelona



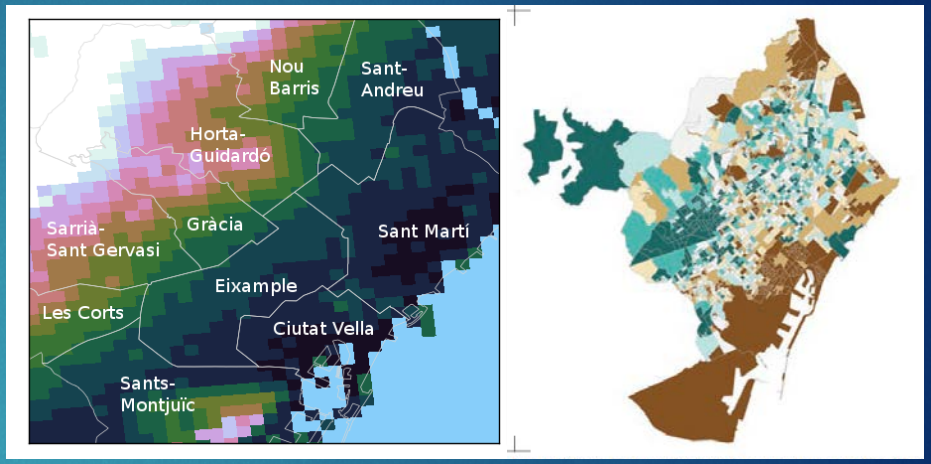
The magnitude of the UHI reaches 3ºC at midnight, and 7ºC in some nights.

What is next?



BEFORE

NOW



Temperature + Mortality

=

Early warning system
of heat stress risk

We plan to study the relationship between urban climate and mortality.
Emphasis will be put on sociodemographic factors, which are key at the city level.
This study could be generalized to other cities in Spain and Europe.

Future Perspectives

TRM is a growing line of research at IC3.

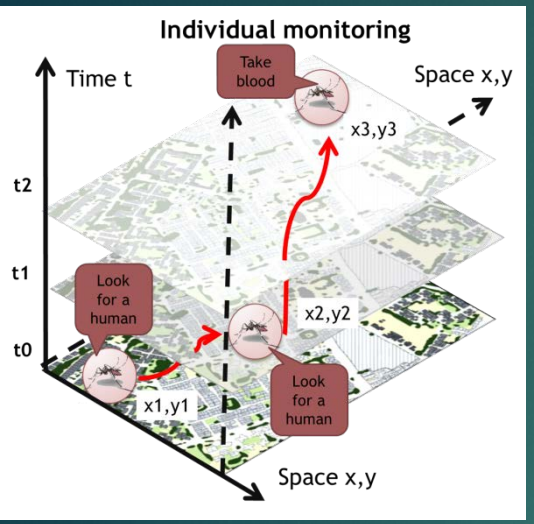
We are willing to expand our current network of collaborations, emphasizing the collaboration with VITO and to participate in new European and national projects.

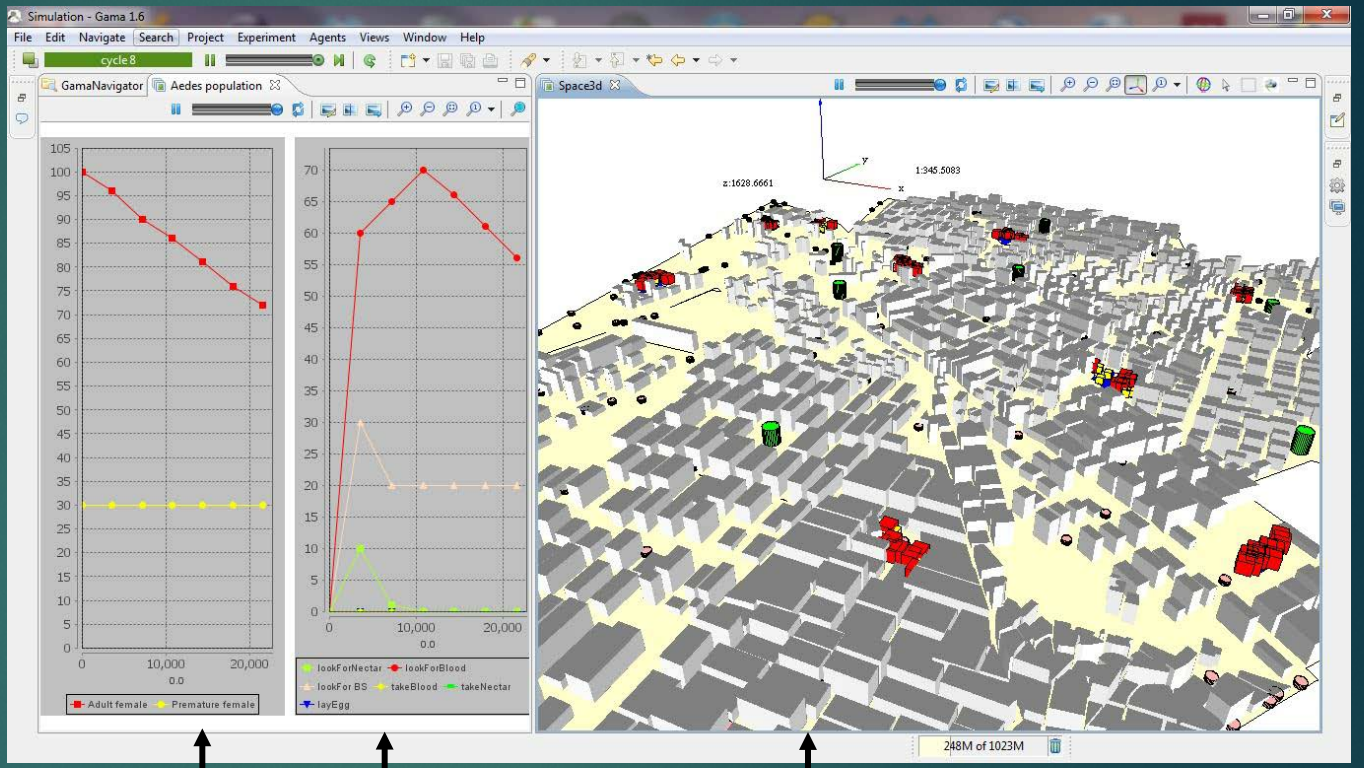
We have access to different types of disease datasets, and TRM data at continental and local scales.

Our main goal is to couple climate forecasts with climate-driven disease models to derive useful information to end-users.

What are the relevant scales for health climate services?

City monitoring





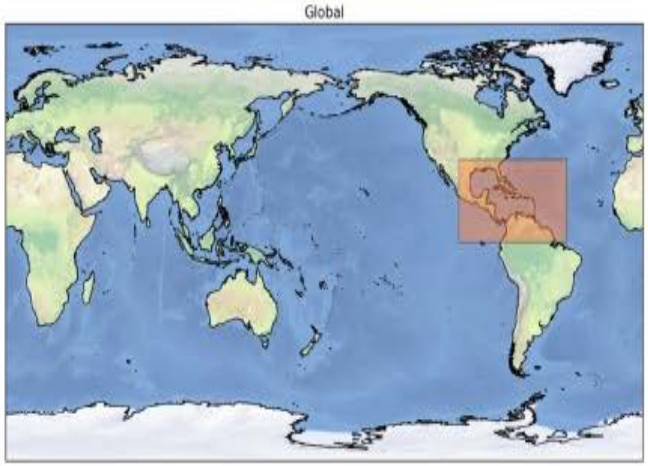
Stages' evolution

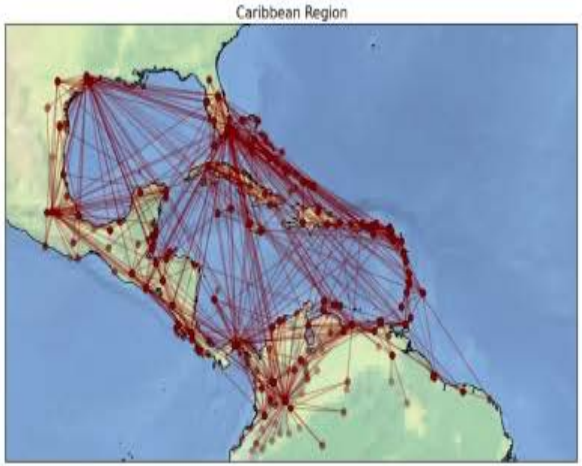
Mosquitoes Activities

Spatial distribution of dengue cases

Daudé et al., in press

The area considered for the flight connection model.



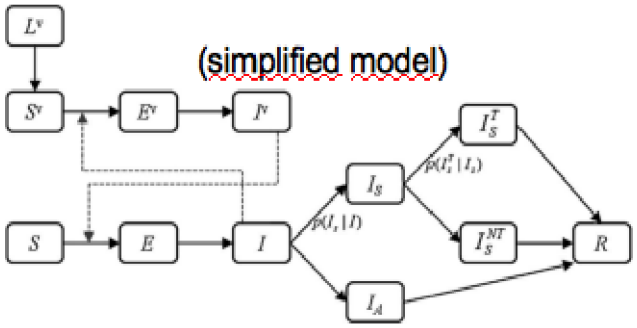


Chikungunya outbreaks

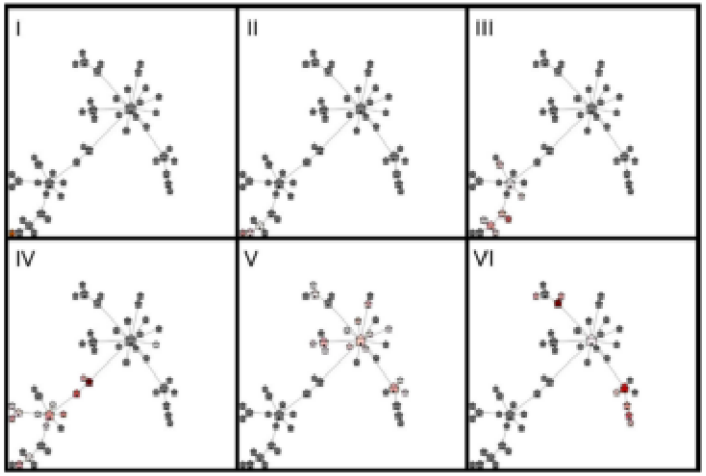
* Use Case example: **Chikungunya epidemic driven by precipitation in urban and sub-urban regions** (Dommar et al, 2014)

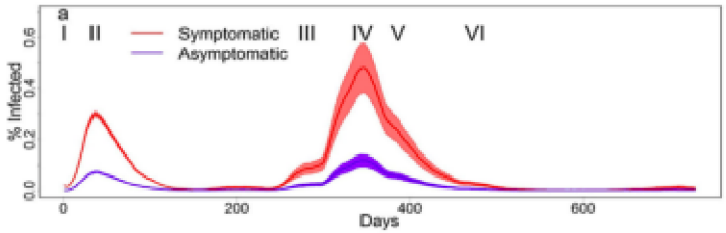
precipitation

(simplified model)

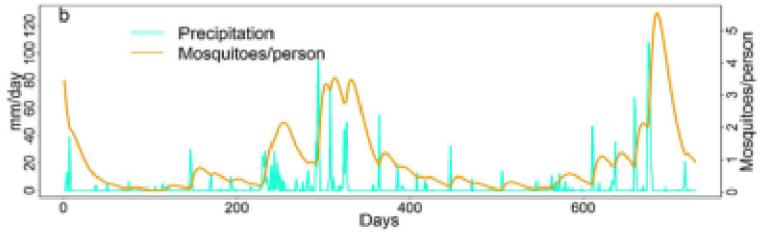


(computational implementation)





CHIKV incidence prediction



The flight network model

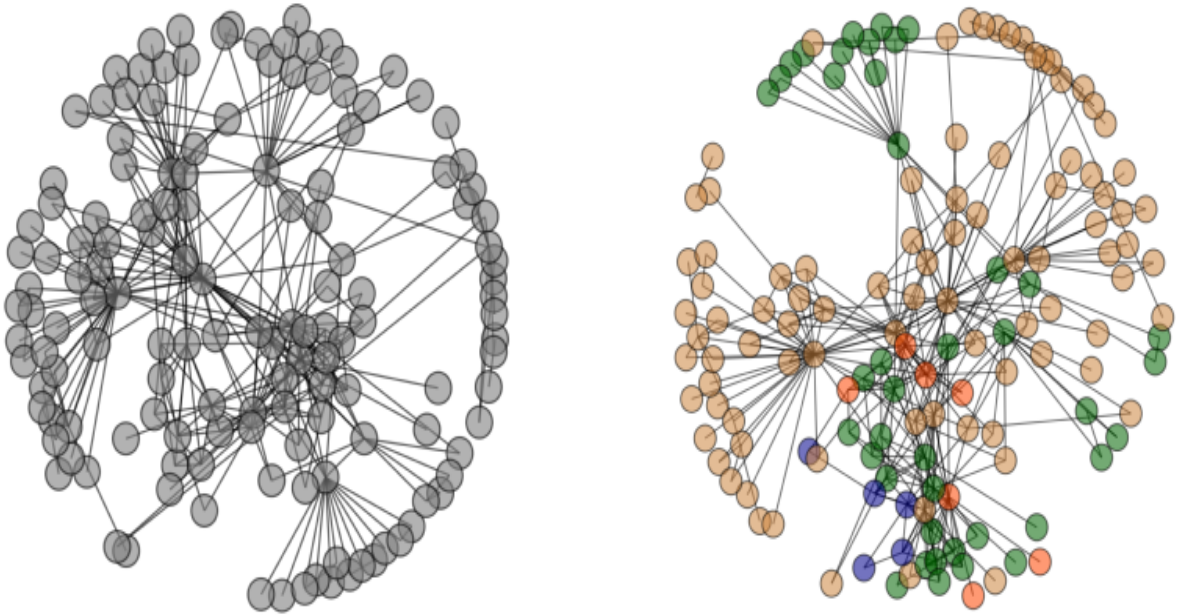
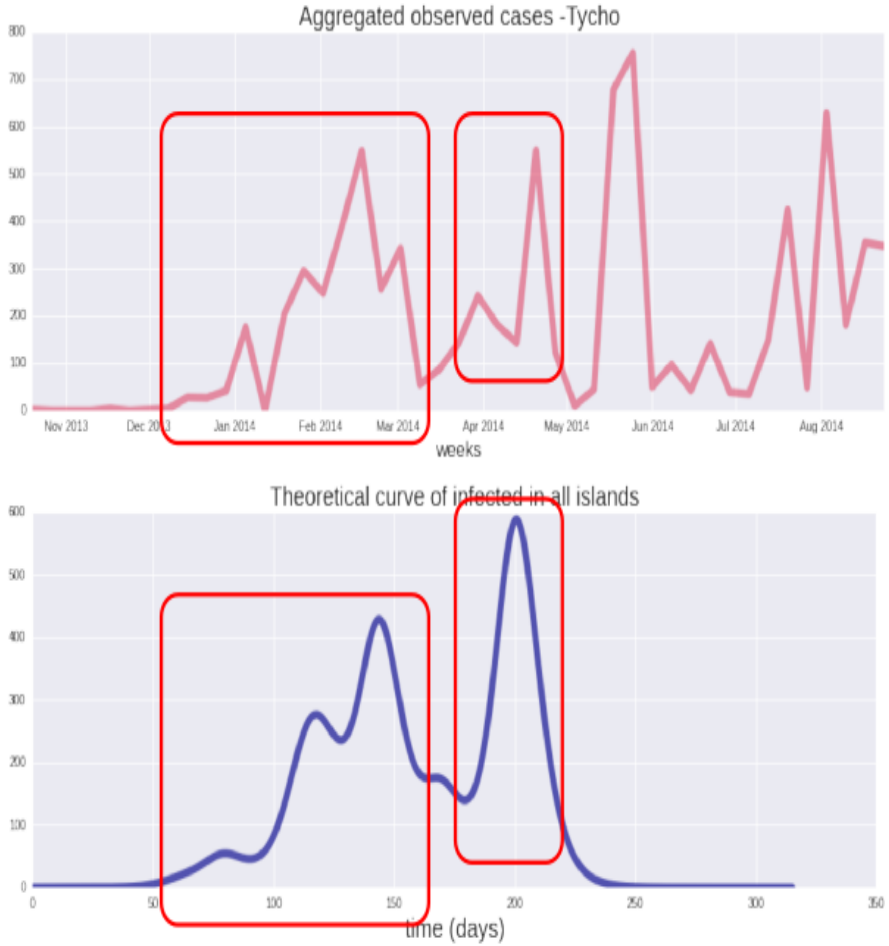


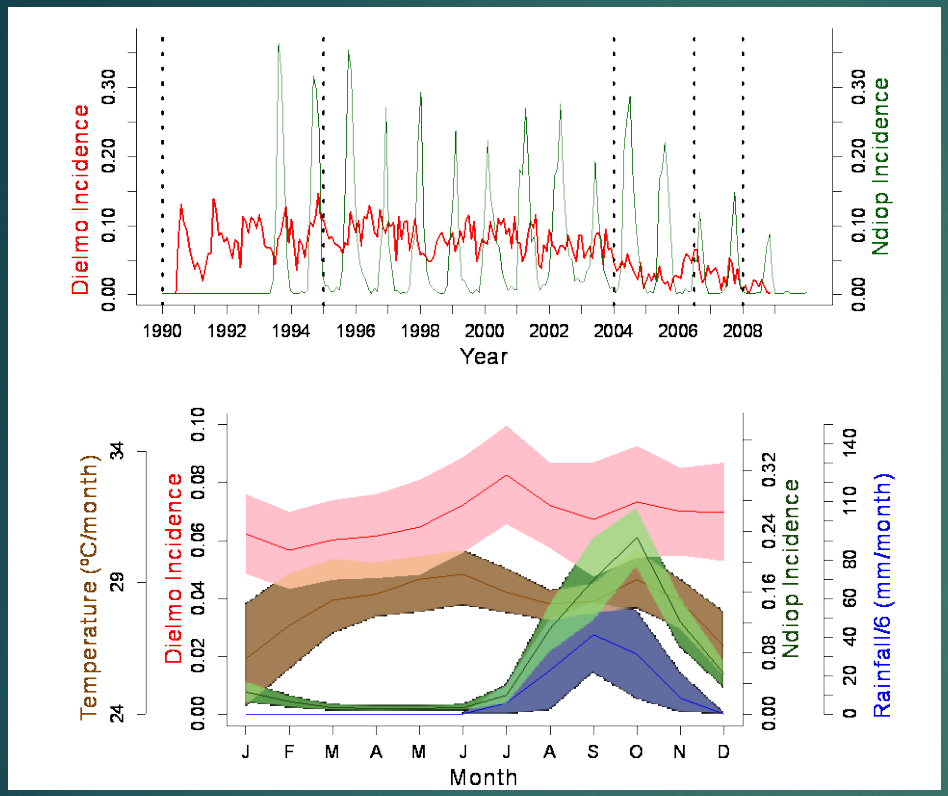
Figure : Network model representing flight connections in the Caribbean - node colors represent four different languages spoken in the region: English (green), Dutch (orange), French (blue), and Spanish (beige)

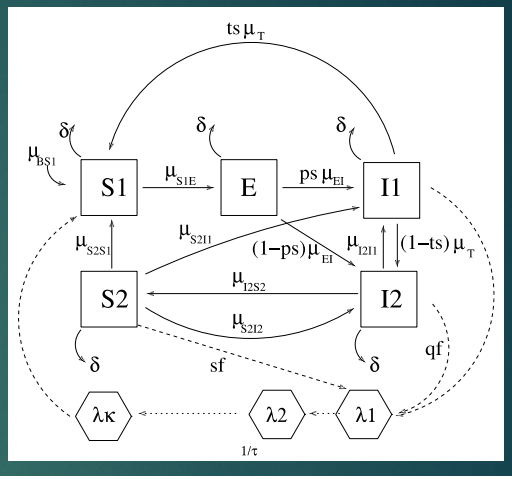
Fitted SEIR + Mobility Network

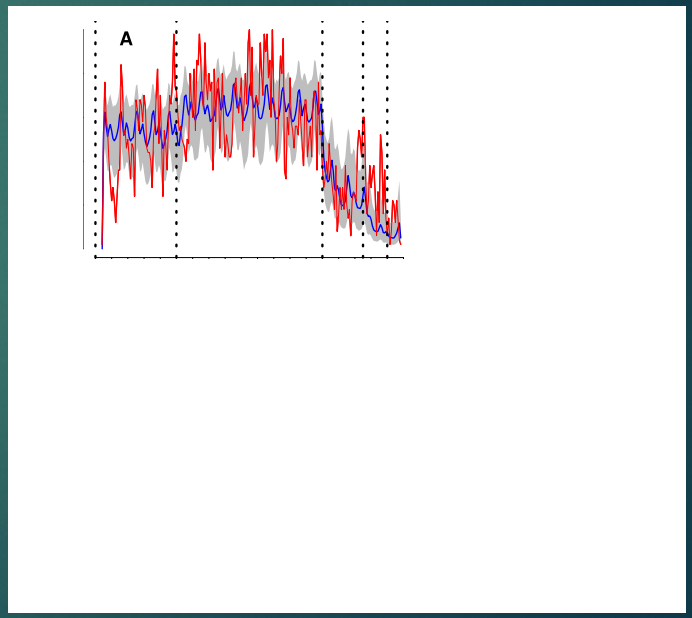


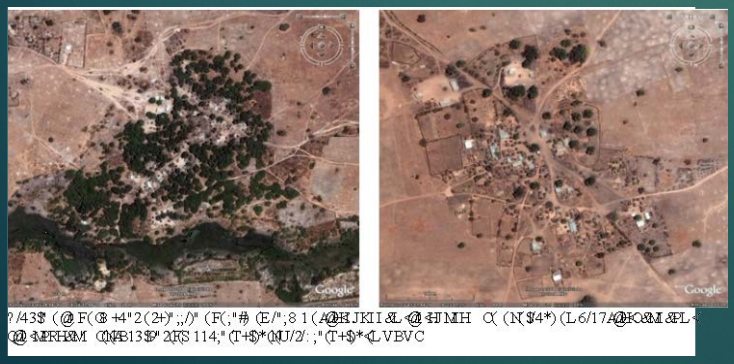
Initial chikungunya outbreak Dec 2013

The climate/Immunity interplay in Malaria forecast









Laneri et al., 2015

SECTEUR

Sector Engagement for the Copernicus Climate Change Services: Translating European User Requirements

SECTEUR is a EU Copernicus Climate Change Service project led by the Institute for Environmental Analytics

Copernicus Europe's eyes on Earth

Copernicus Climate Change Service

SECTEUR works with private and public sector organisations to understand their requirements, in terms of weather and climate data, aiming to deliver better-tailored **information to support decision-making**.

Out Team:
11 organisations across 6 countries

Health Sector Users

IC3 INSTITUT CATALÀ DE CIÈNCIES DEL CLIMA

Together with our Sector Champion: the **European Centre for Disease Prevention and Control (ECDC)**, the Catalan Institute for Climate Sciences (IC3) work with end-users of the Health Sector to analyse their r**equirements** and recommend future research to **support better decision-making**.

ecdc EUROPEAN CENTRE FOR DISEASE PREVENTION AND CONTROL

Why should your organisation engage with us?

Organisations need to plan for the impacts and opportunities that our **changing climate** will bring.

SECTEUR will translate your requirements into tailored products that could help you make better decisions in an uncertain climate future.

Out Approach:
surveys, workshops and interviews across 6 sectors.

Find out more in: http://www.the-iea.org/secteur

Gràcies !!!

Websites: www.icrea.cat and www.ic3.cat/people/xavierrodo
Email: xavier.rodo@ic3.cat