

# On the Use of the Climate Twins Approach to Pose the Challenges of Urban Adaptation

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## Introduction

Despite growing climatic threats and scientific consensus, 72% of the 200 main European cities do not have implemented a climate adaptation plan yet<sup>1</sup>.

- This paucity of political investment can be associated with a lack of understanding from both civil society and decision-makers, because typical scientific statements are usually out of reach and inapplicable for most of the non-specialists.
- There is a need to develop innovative tools which provide intuitively understandable climate information.

→ The Climate Twins approach<sup>2</sup>, by matching the future climate of a city A with the current climate of a city B, might address this need<sup>3</sup>.

- 1) How to efficiently match current and future European cities' climates together?
- 2) How and to which extent this approach can be used as a raise-awareness tool and climate adaptation tool in urban areas?
- 3) What are the uncertainties associated with this concept?

## Methodology

### Climatic Data and Statistics

- 2 periods of 30 years, daily data:
  - Current climate → 1961-1990
  - Future climate → 2071-2100
- Data from outputs of 10 RCMs' simulations, A2 SRES, 50km-resolution, from the PRUDENCE Project<sup>4</sup>.
- Calculation based on 8 climate statistics
  - Monthly mean temperature (°C)
  - Monthly mean max summer temperature (°C)
  - Monthly mean min winter temperature (°C)
  - Monthly temperature standard deviation (°C)
  - Monthly mean precipitation (mm/day)
  - Annual mean precipitation (mm/year)
  - Annual mean snowfall (mm(w.e)/year)
  - Monthly mean 10-m wind (ms<sup>-1</sup>)

### Climatic Twinning

The following method is used to determine all the climate analogues of a city (called « City of Interest » - COI):

- For all the climate statistics:
  - Calculation of the Euclidean distances between the future climate of the COI and the current climate of all other grid points.
  - Establishment of distances thresholds under which the grid points are considered analogous, for each climate statistics.
- If a grid point has all its associated Euclidean distances under the thresholds for all the climate statistics → Climate analogue
- If the climate analogue is located near (<50km) a main European city → City Climate Twin
- Use of different RCMs / scenarios to assess the uncertainty.

## Results

- The Climate Twins approach has been conducted over 100 European cities → 70 cities were found to have at least one climate analogue and 39 were found to have a city climate twin (Fig. 1 and Fig. 2 provide several examples).
- There is a great climatic proximity between the COI's future climate and its city climate twin's current climate for the variables of temperatures and a low climatic proximity for precipitation variables (Fig. 3).

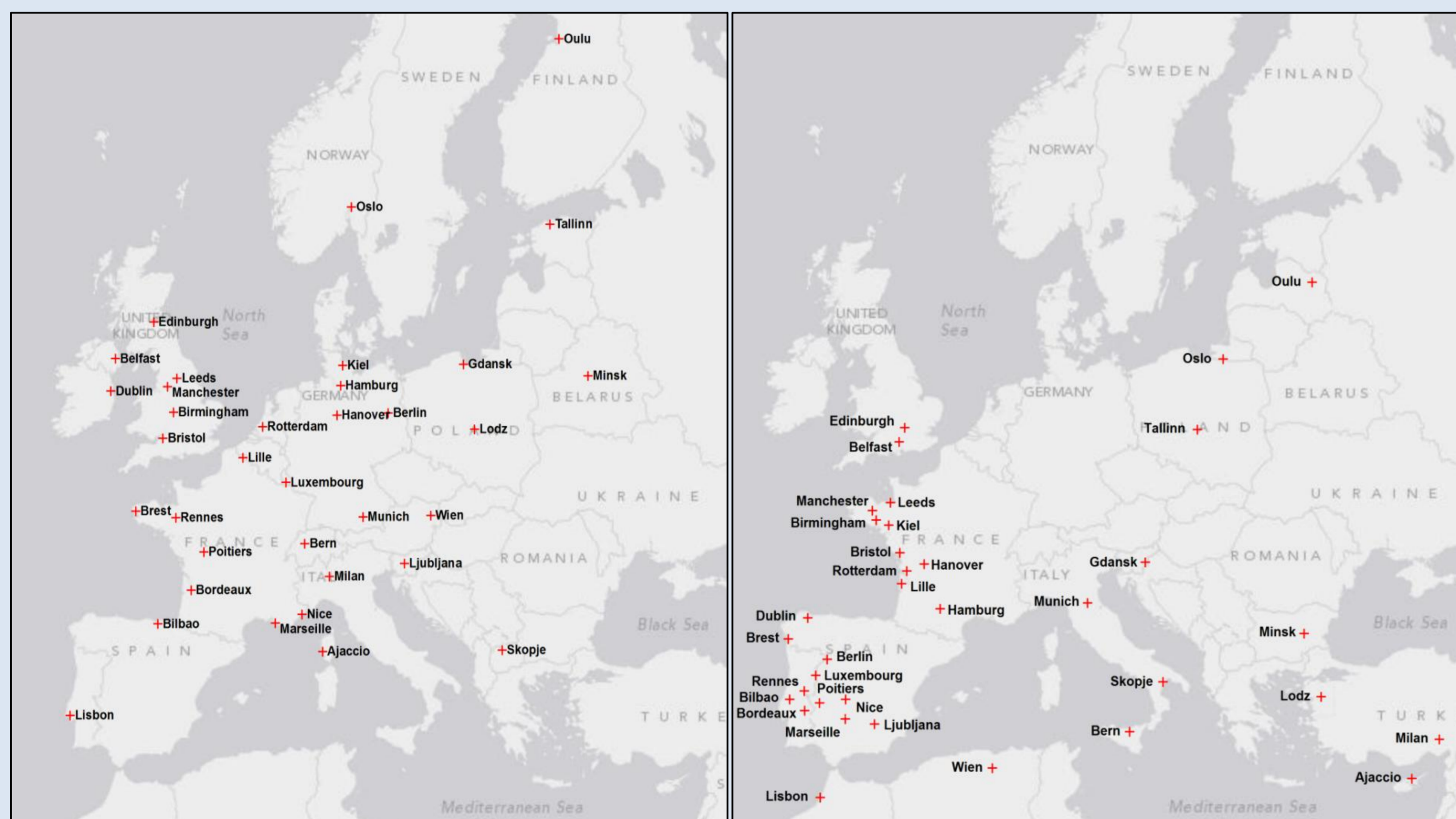


Fig. 1 – Current location of 36 main European cities (left) and location of these cities' best climate analogue (right), representing the current location of their future (2071-2100) climate

Future climate of...	= Current climate of...
Amsterdam	Nantes
Berlin	Saragossa
Brussels	Bordeaux
Edinburgh	London
Hamburg	Toulouse
Leeds	Lille
Liverpool	Plymouth
Ljubljana	Athens
Luxembourg	Saragossa
Milan	Adana
Moscow	Kiev
Nice	Naples
Nuremberg	Marseille
Oslo	Kaliningrad
Prague	Bologna
Rotterdam	Bordeaux
St-Petersburg	Warsaw
Stockholm	Berlin
Stuttgart	Valladolid
Tallinn	Wrocław
Warsaw	Balikesir
Zagreb	Cordoba

Fig. 2 – List of 22 City Climate Twins

### Climatic proximity of the climate twins: case-study with the couple Hamburg - Toulouse

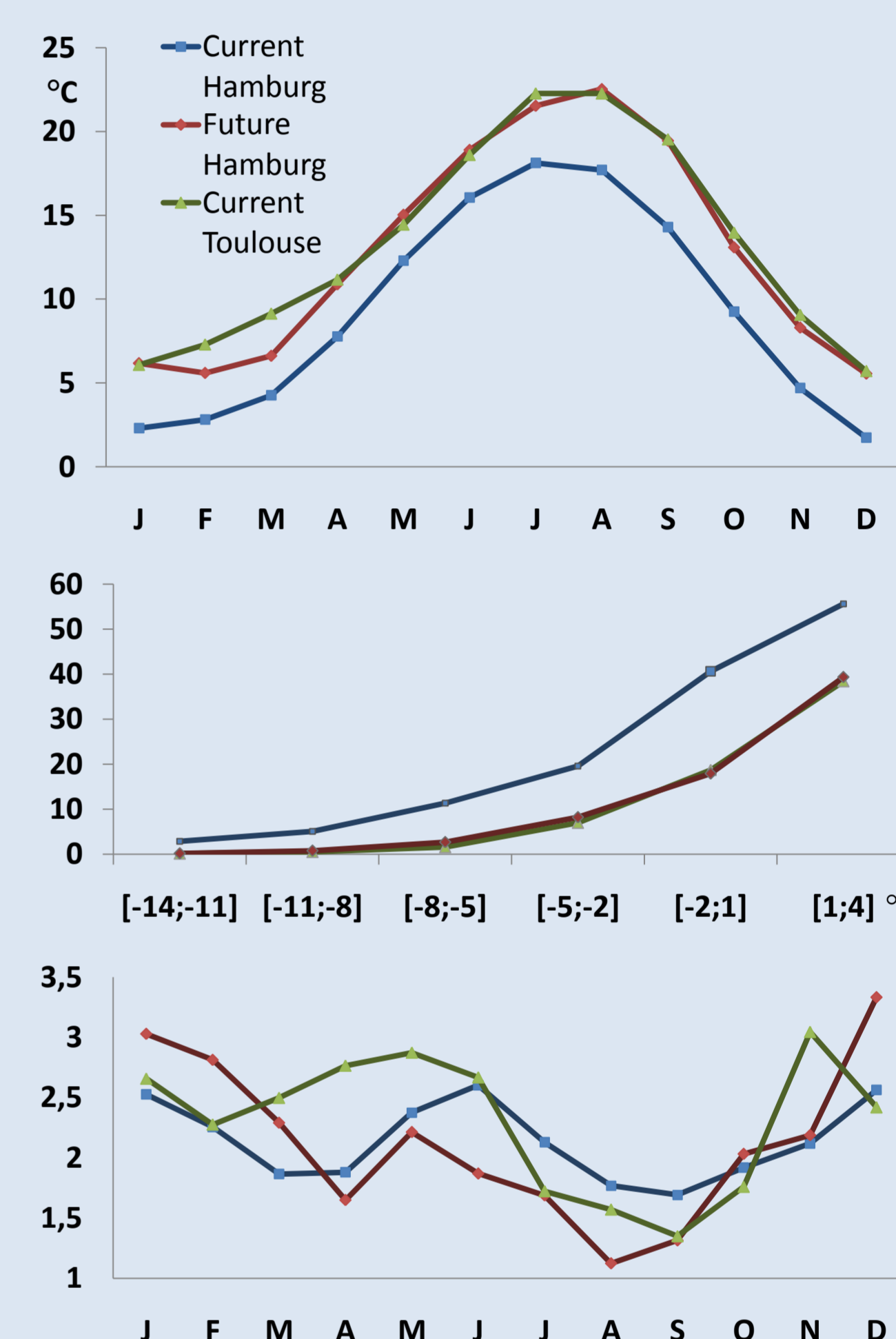


Fig. 3 – Monthly mean temperatures (top); Number of days/year according to the daily min temperatures (middle); Monthly mean precipitation (mm/day) (bottom). All averaged over 30-years periods.

## Applications

### Urban Adaptation Tool

- Because of the great climatic proximity, for temperatures variables, between the COI's future climate and its city climate twin's current climate, this approach could be used as a urban adaptation tool for heat waves management in urban areas.
- Stakeholders from the COI can identify the infrastructures, policies and best practices that are currently implemented in the city climate twin to face its climate and its extreme temperatures events.
- They can then intuitively and immediately envision the changes, in terms of policies and infrastructures, that are required in their own city to better face future impacts of climate change and heat waves.

### Raise-Awareness Tool

- The most obvious use of the Climate Twins approach is to raise awareness of the general public about the impacts of a changing climate on the cities they live in.
- Through a freely-accessible and user-friendly tool (Fig. 4) users can immediately visualize the current location of any European city's future climate (represented by its climate analogues).
- Through this visualization, users can intuitively envision the main changes – in terms of climate – that their city will have to face in the 21<sup>st</sup> century.

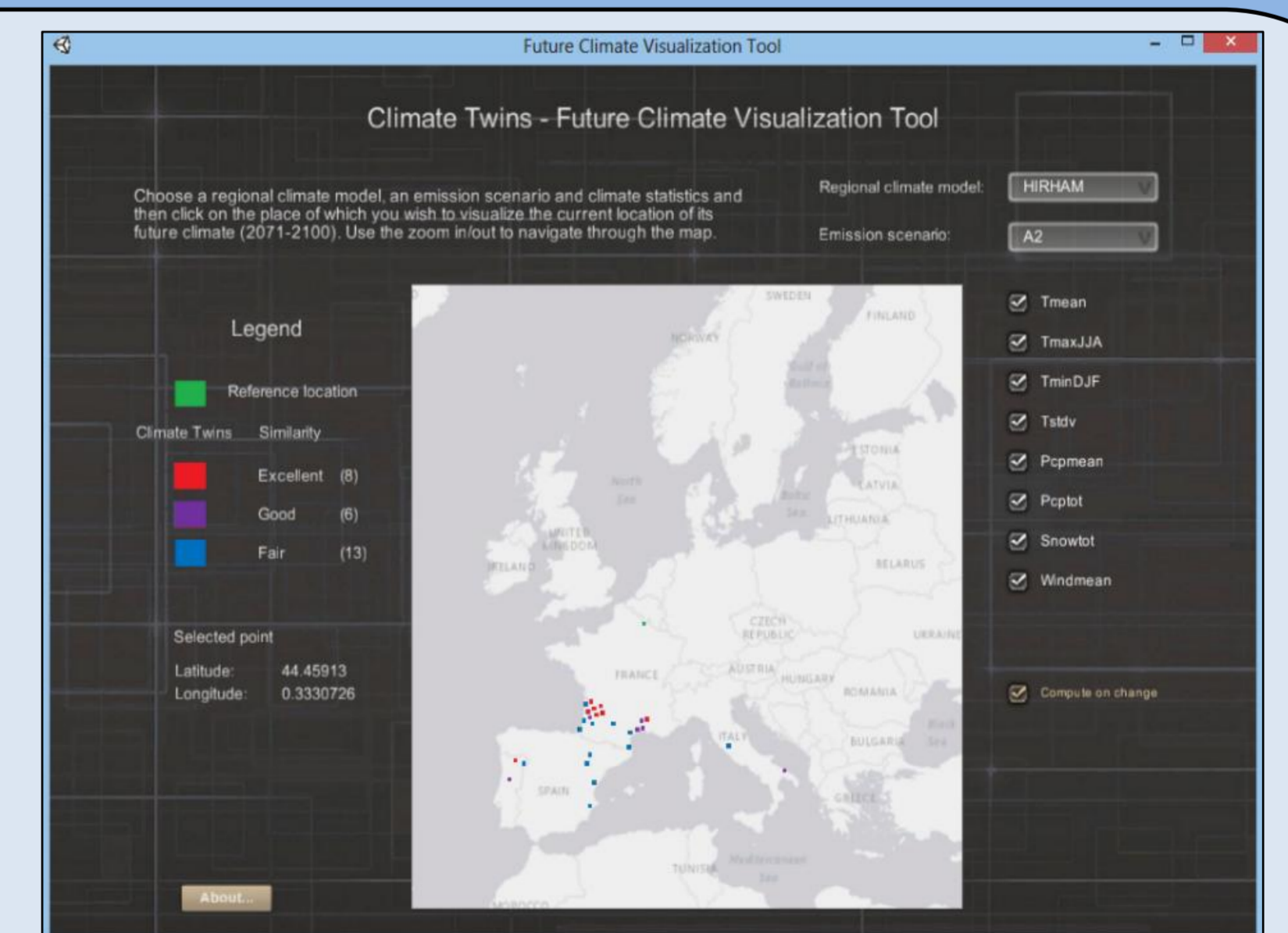


Fig. 4 – User-interface of the Climate Twins Tool

## Uncertainties

The number and the location of climate analogues greatly differ depending on:

- The RCMs that are used: Fig. 5 shows the results' differences for Hamburg's climate analogues, with two different RCMs: HIRHAM (left) and ARPEGE (right).
- The SRES that are used: climate analogues are located more southwards with A2 scenario than with B2 scenario.
- The thresholds that are chosen for each climate statistics: the climatic proximity between two climate twins strongly relies on these thresholds.

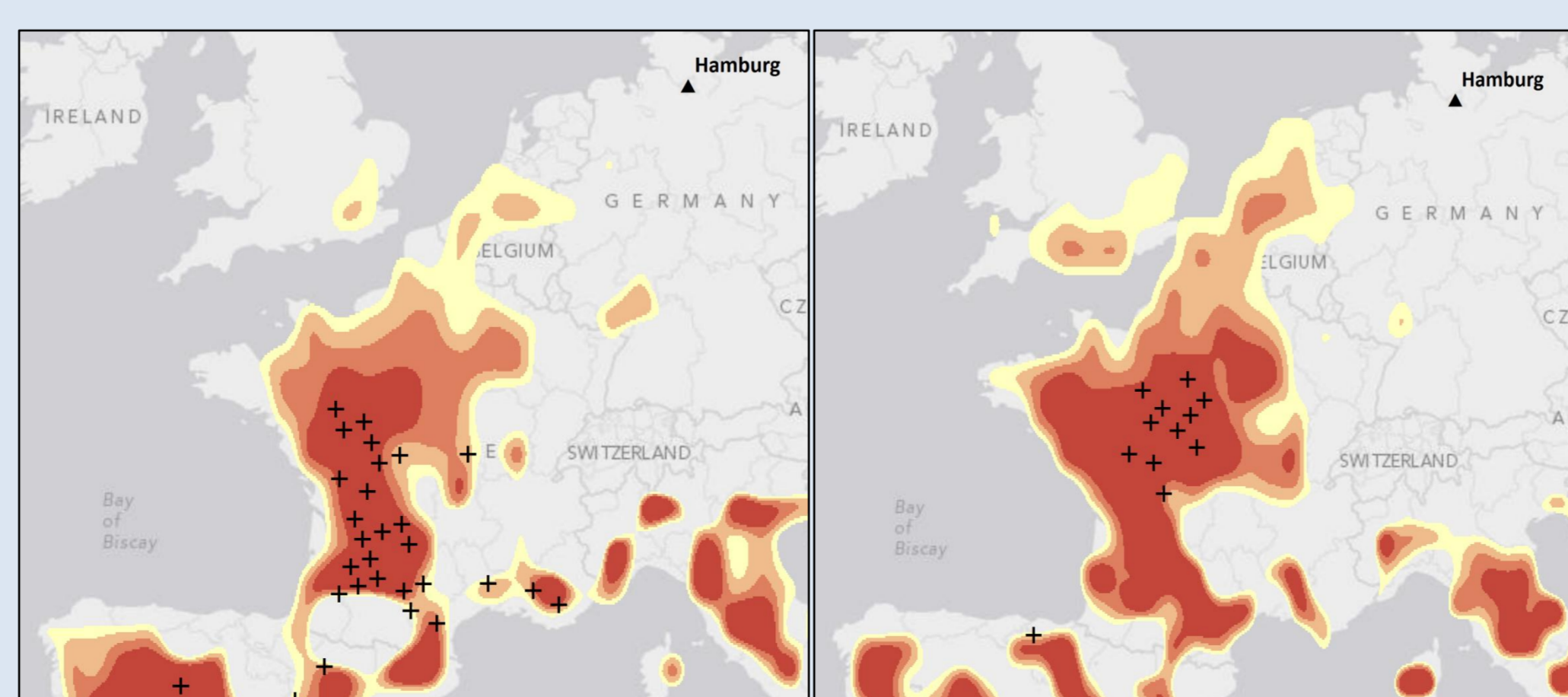


Fig. 5 – Hamburg's climate analogues location, for two different RCMs

## Conclusions

- Despite several limitations, principally due to the uncertainties in climate projections, the use of climate twins appears to be efficient to raise-awareness about the forthcoming impacts of climate change and to readily and intuitively identify the policies, infrastructures and best practices that must be implemented in a city to be well-adapted to climate change.
- The main advantage of this approach is that it can be easily used and understood by urban stakeholders and decision-makers.
- The Climate Twins approach, by its innovativeness, its ease of use and its scientific legitimacy, is a useful and promising tool to address the challenges of urban adaptation in a climate change context.