Urban heat island and inertial effects : analyse from field data to spatial analysis

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[(1)] IRSTV / CRENAU

Context

Observation : behaviour differences between several temperature signals ⇒ Inertial effects

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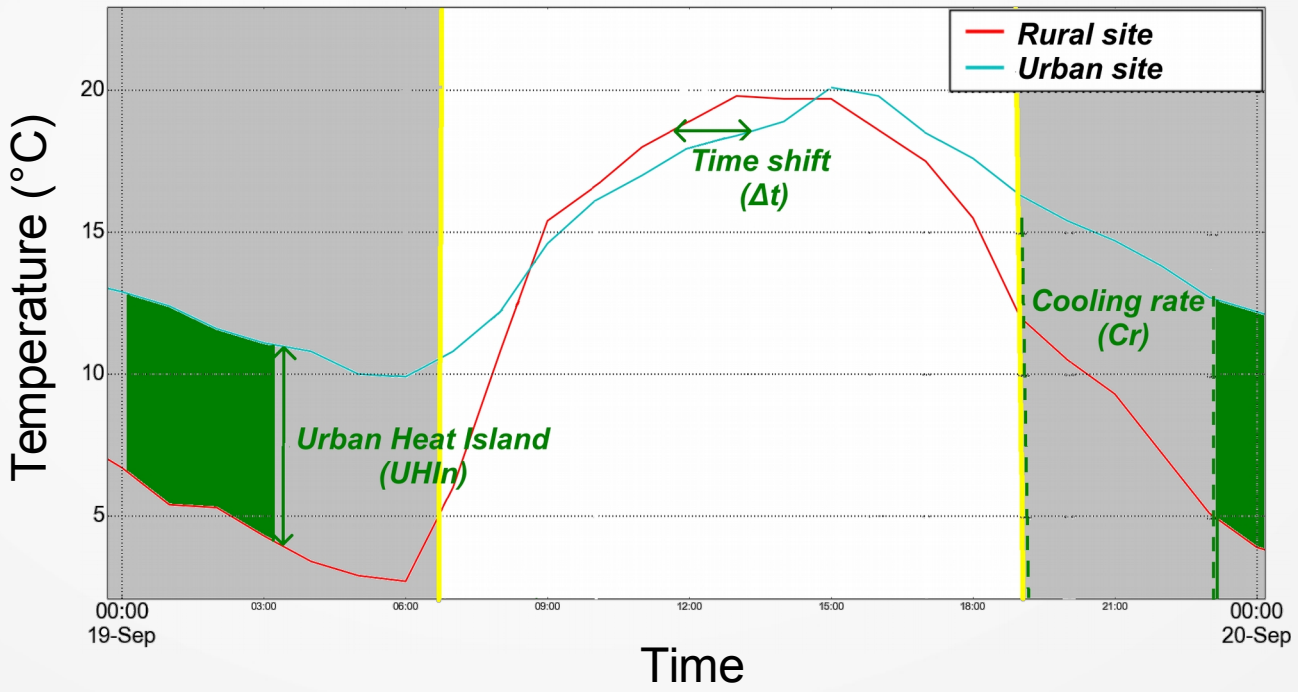

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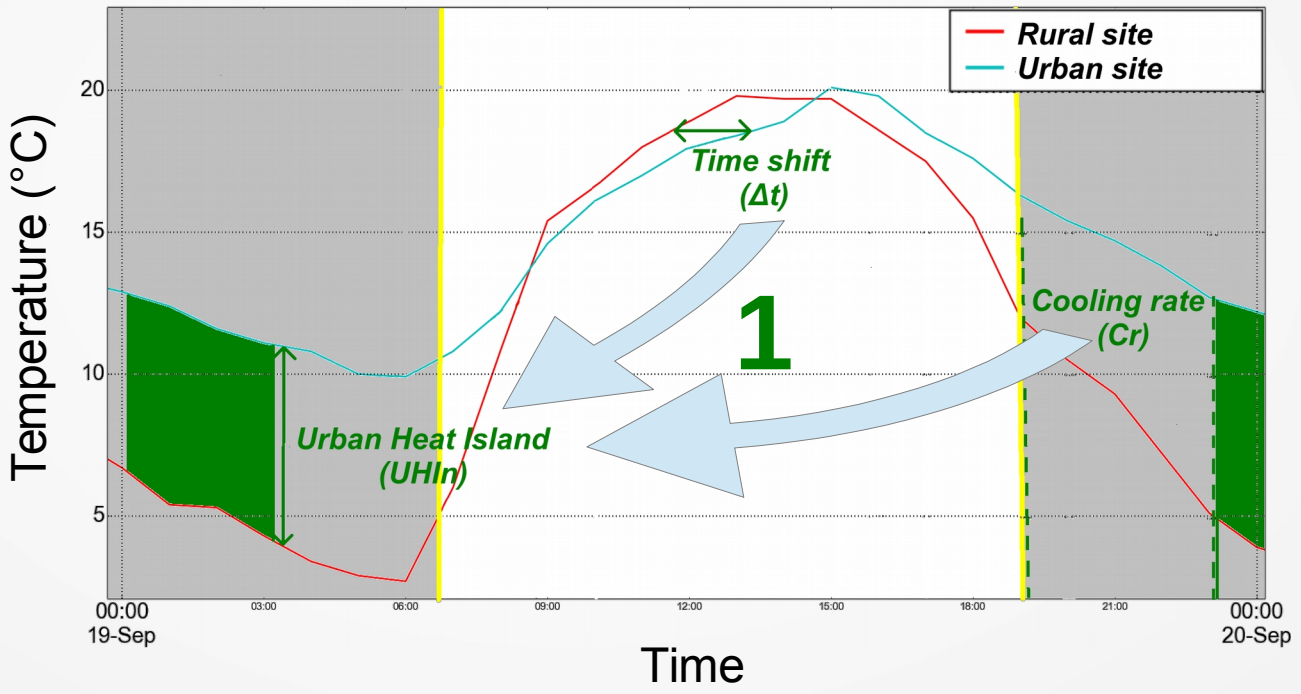

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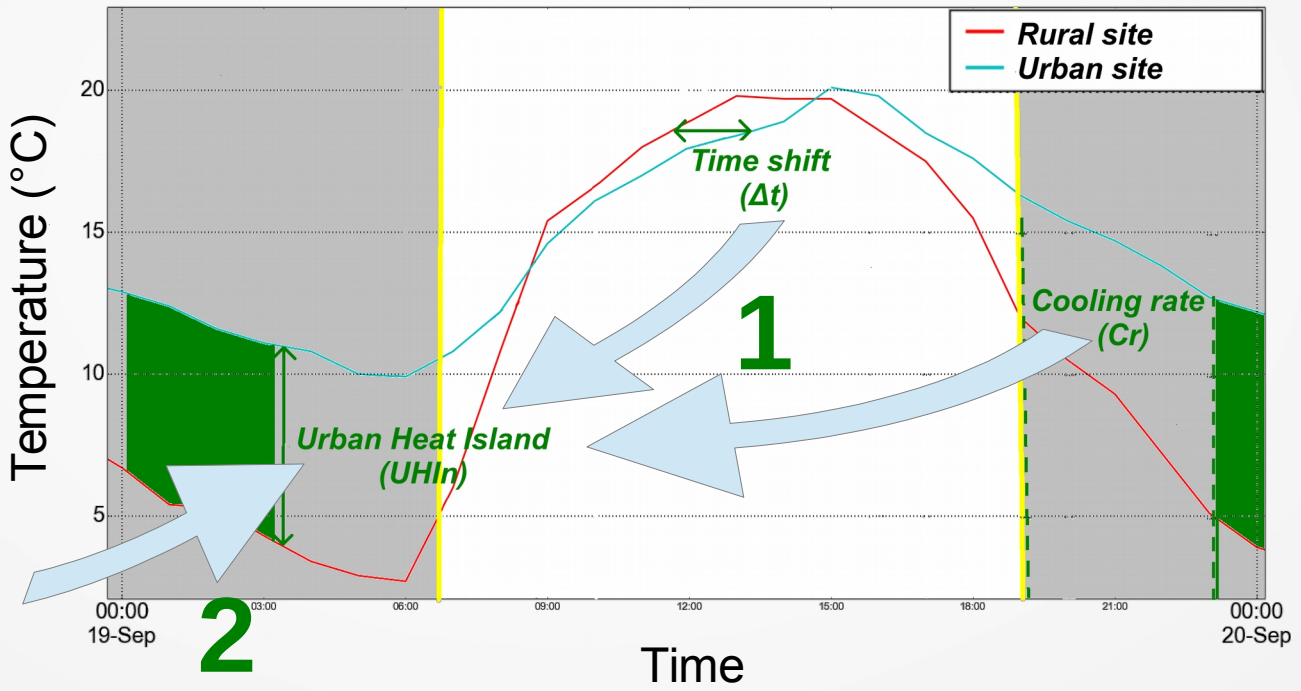
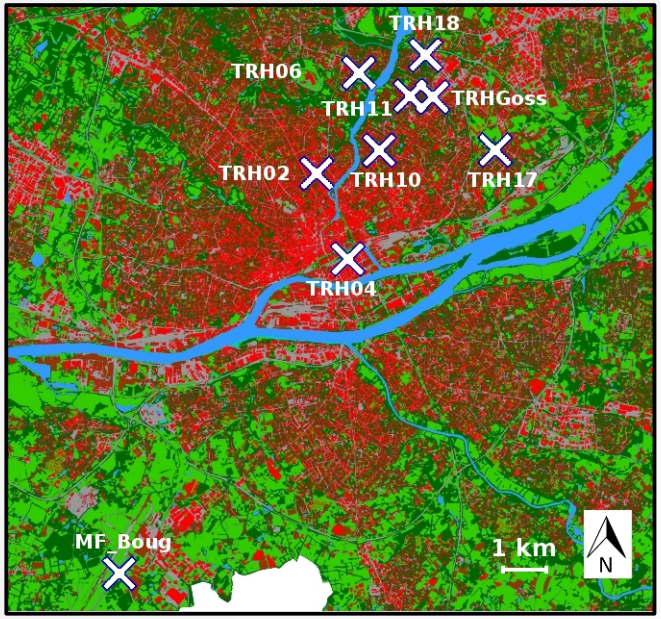


Geographical indicators

Study area and equipment



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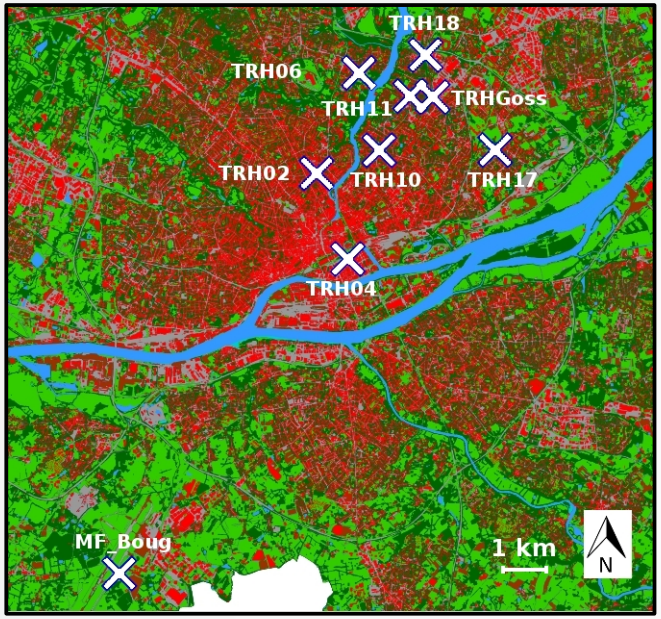

Data are recorded for 4 years

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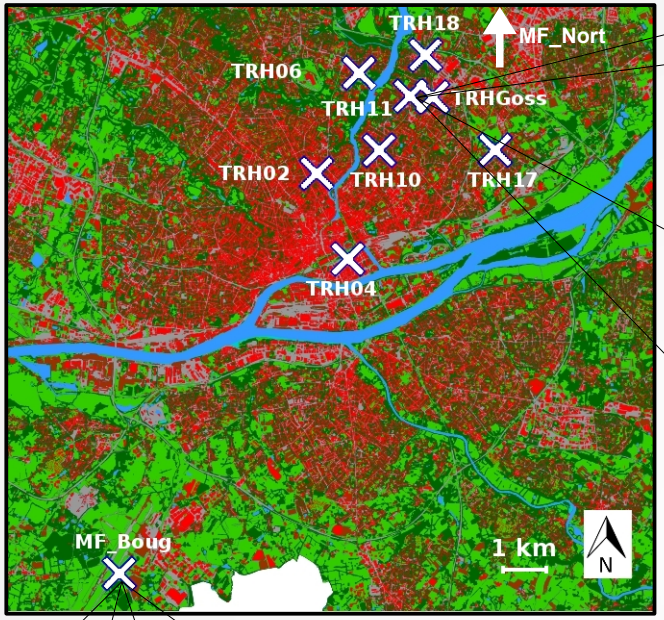

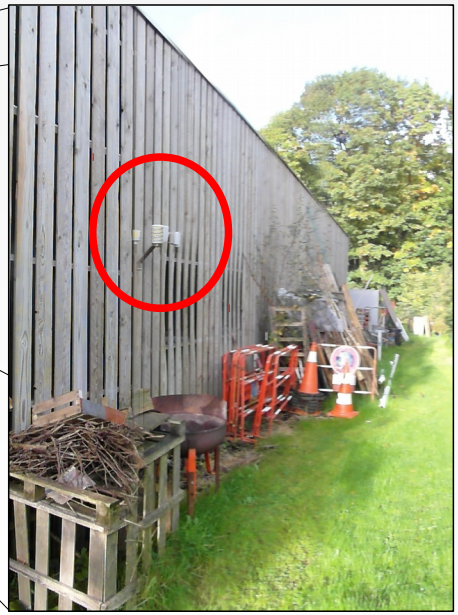

8 TRH stations

2 Meteo-France (MF) stations

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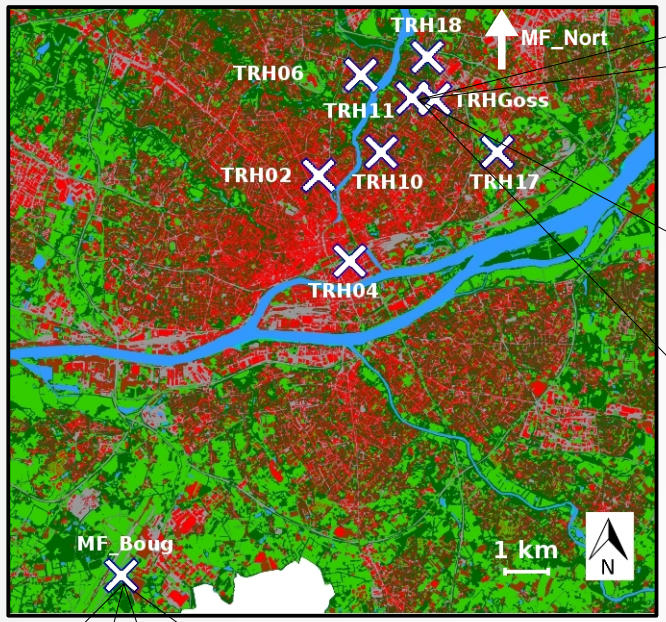

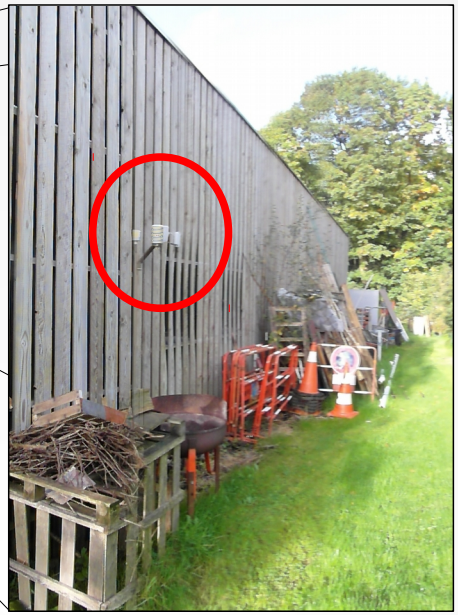

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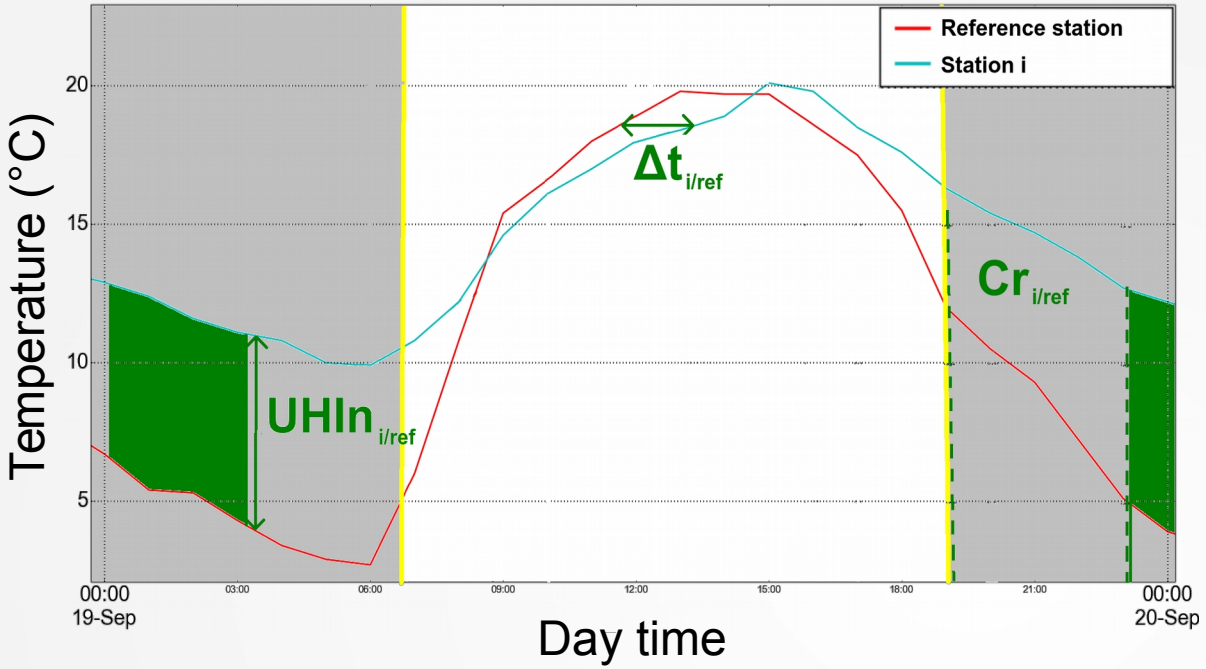
8 TRH stations

2 Meteo-France (MF) stations

Station	location	sampling time	sensor accuracy
TRH	mostly on walls	15 mins	+- 0,3 K
MF	open sites	1h – linear interpolation every 15 mins	+- 0,1 K

Climate indicators calculation



Symbol	**Indicator name**	**Unit**	Time period	Equation
Δt	**Time shift**	**mins**	sunset+4h → sunset+8h	Index when the cross-correlation function is maximum
Cr	**Cooling rate**	**°C/h**	sunset → sunset+4h	mean temperature derivative difference
UHIn	**Night-time Urban Heat Island**	**°C**	all day	mean temperature difference

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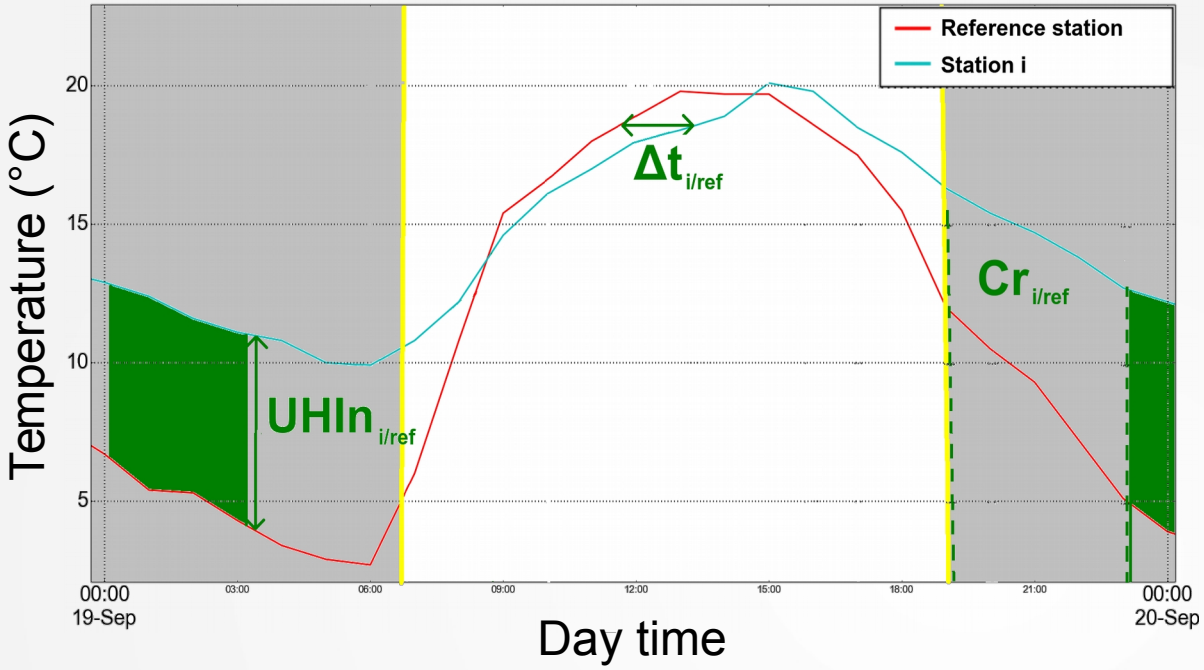

- A reference is used for each indicator calculation : **"MF_Boug"**
- Calculations are performed for each day

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Season / weather conditions filtering

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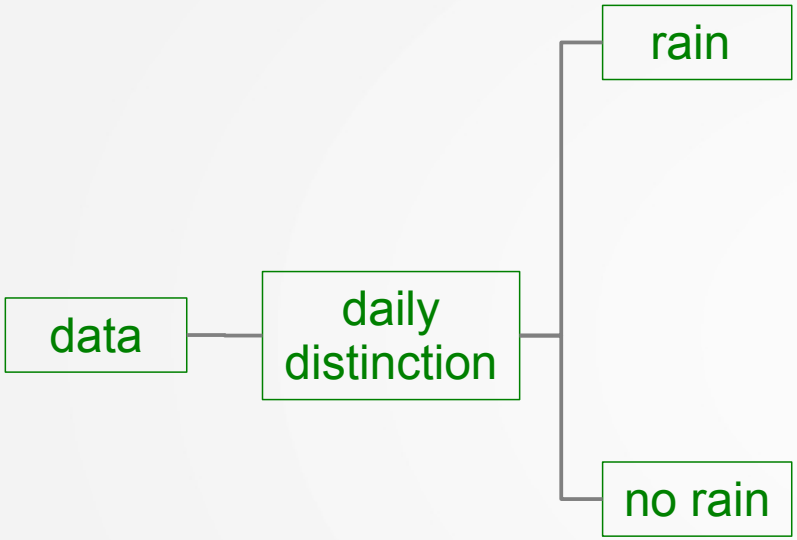
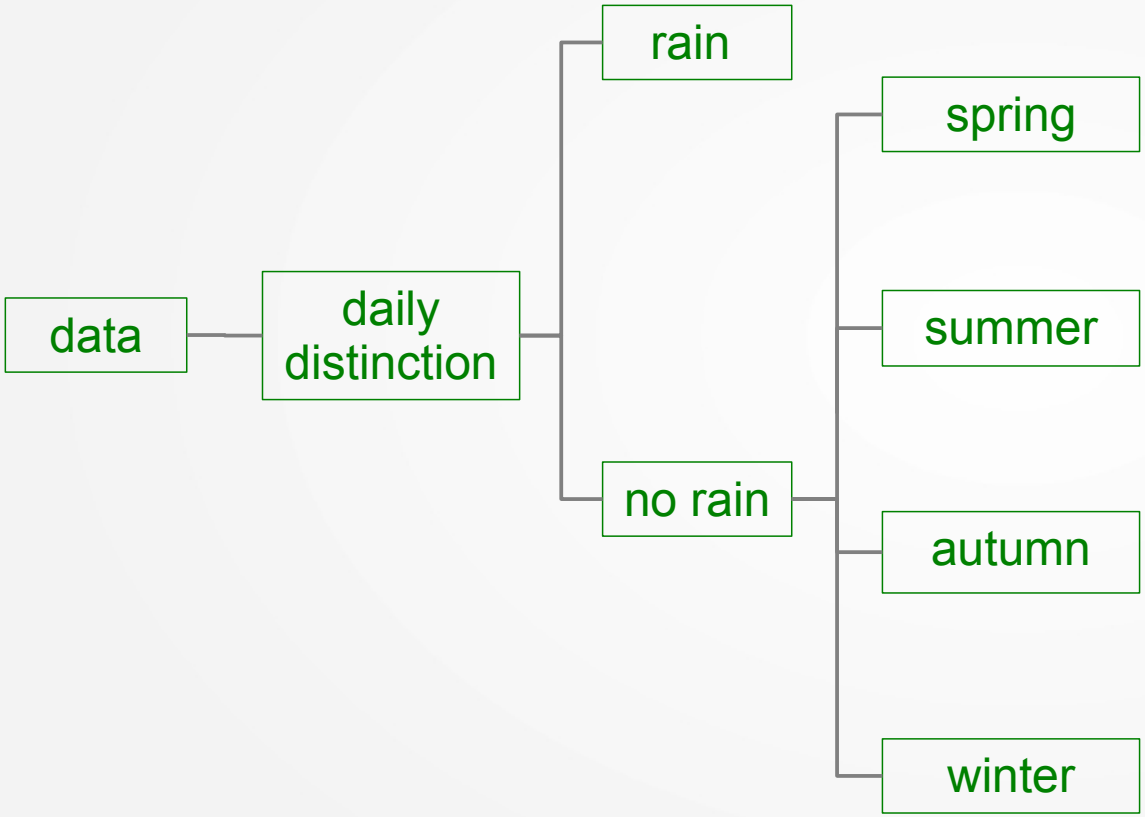
Filtering



Season / weather conditions filtering

Filtering **Sorting**



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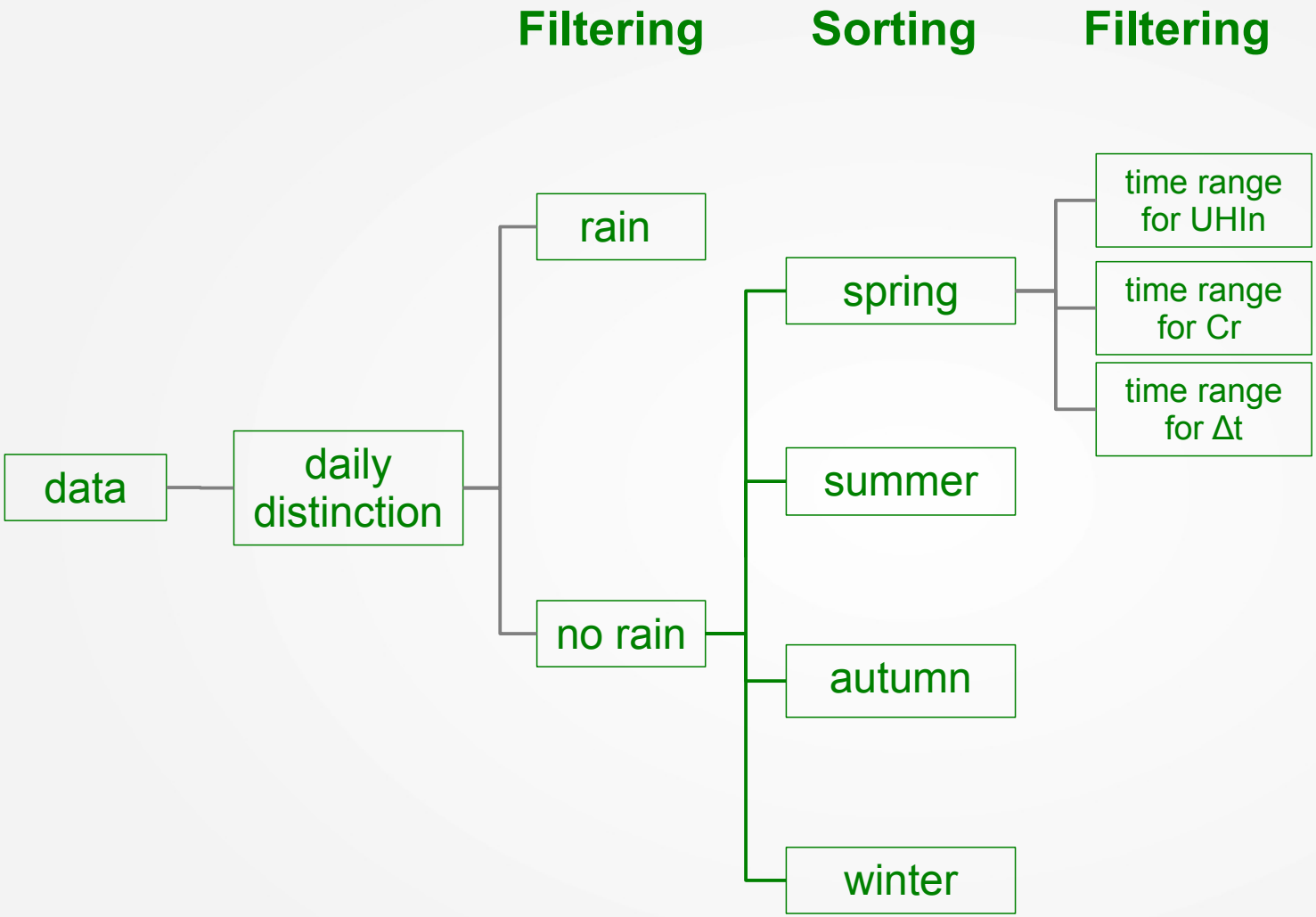

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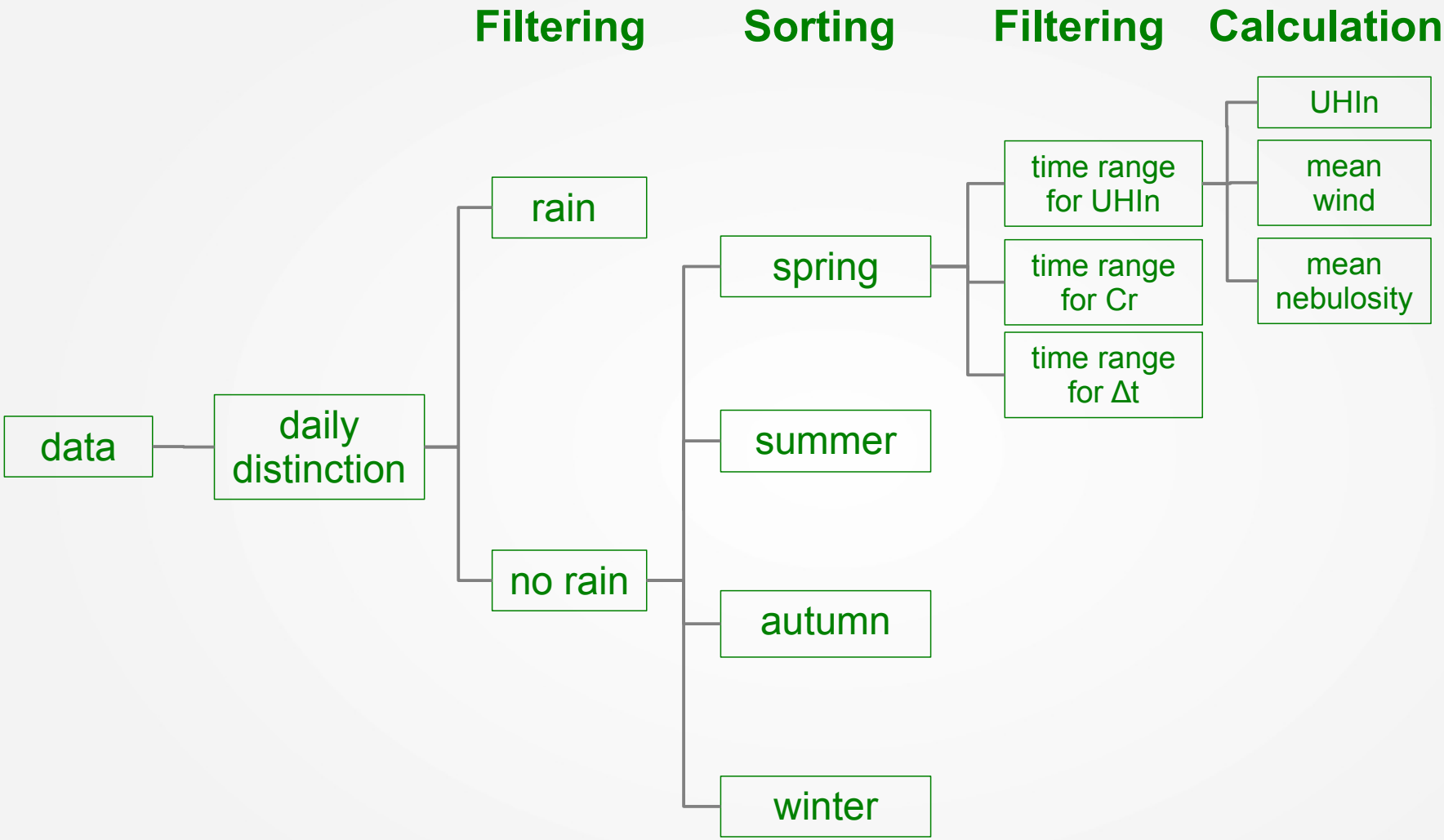

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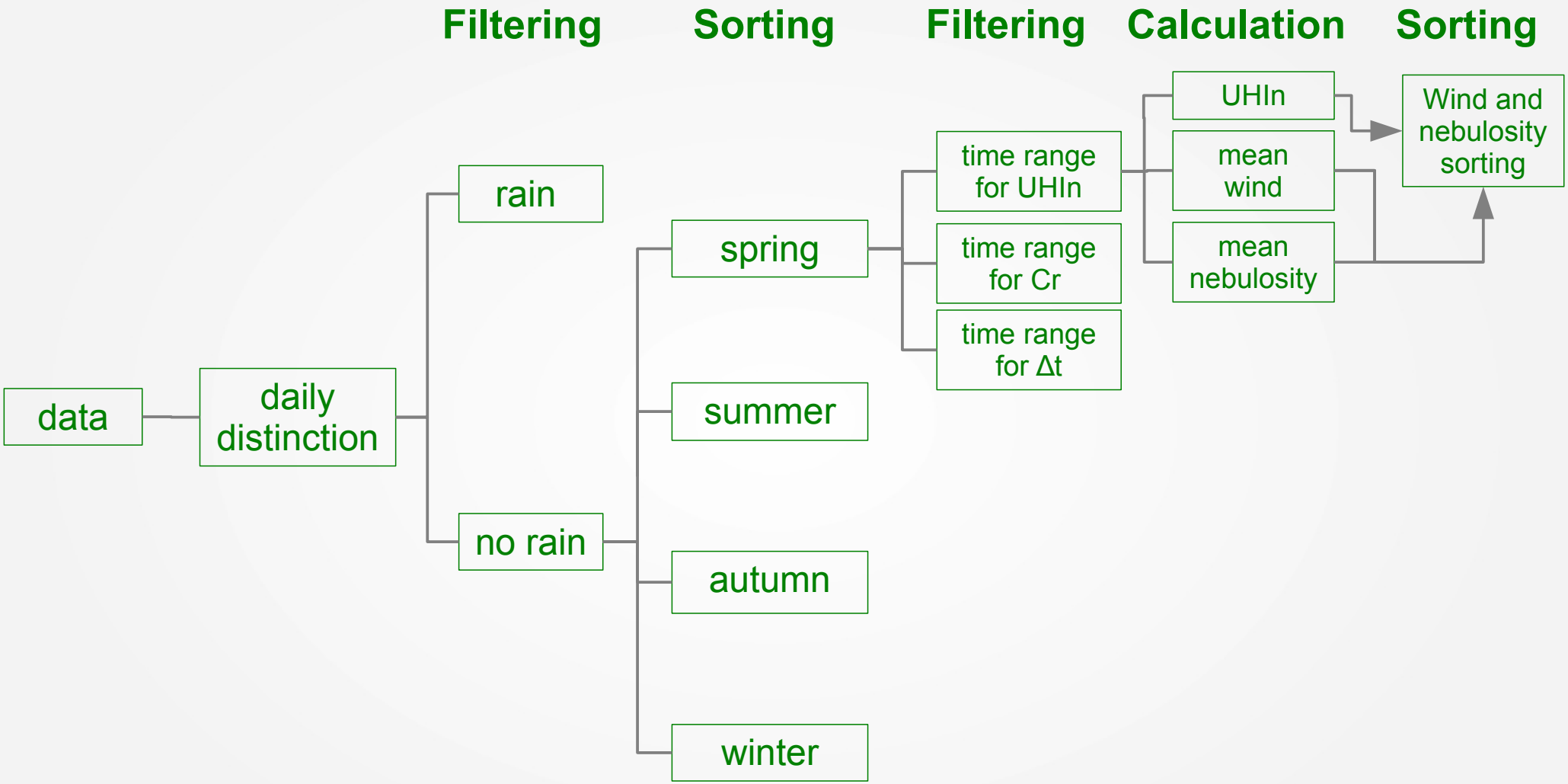

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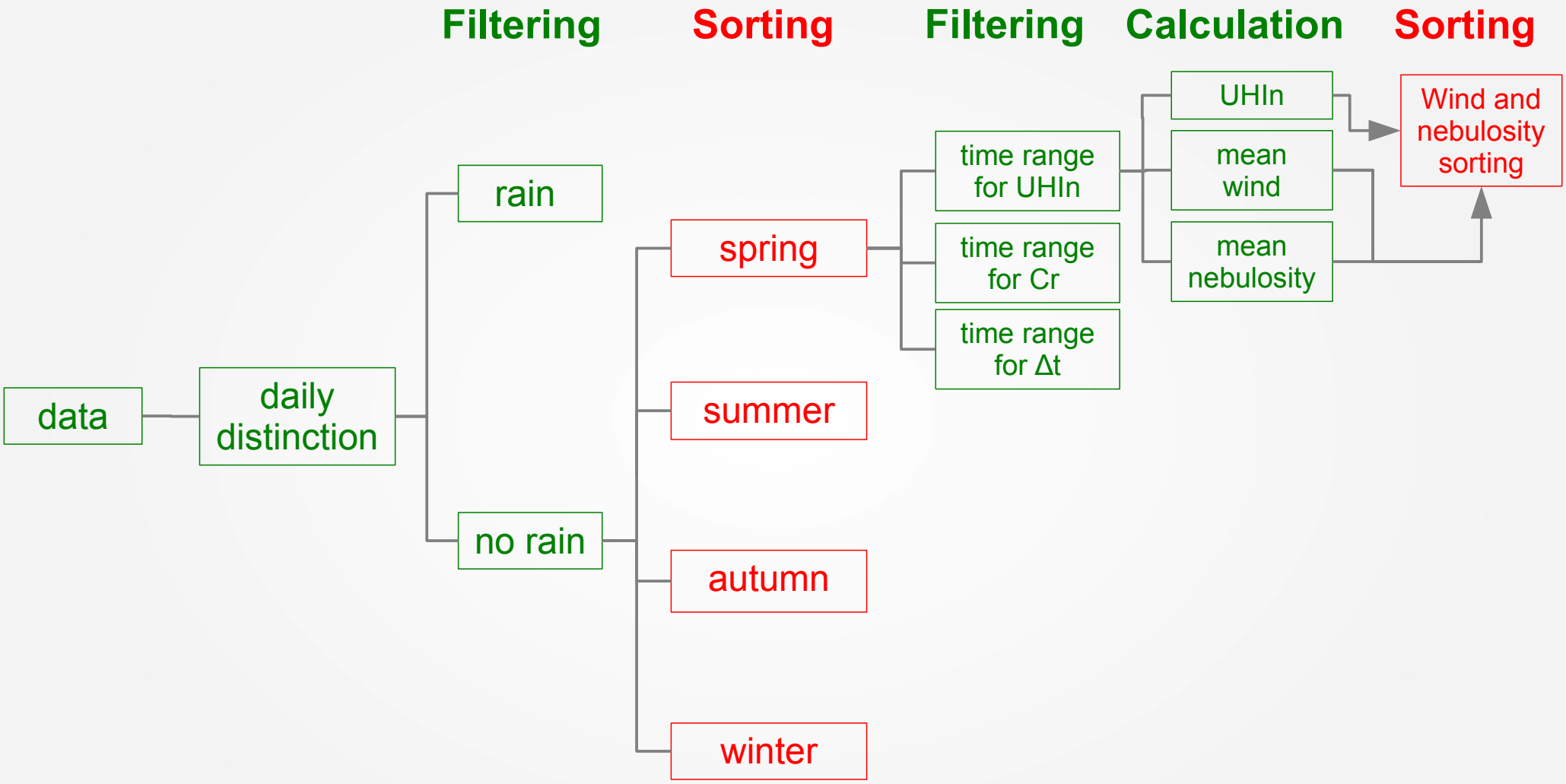
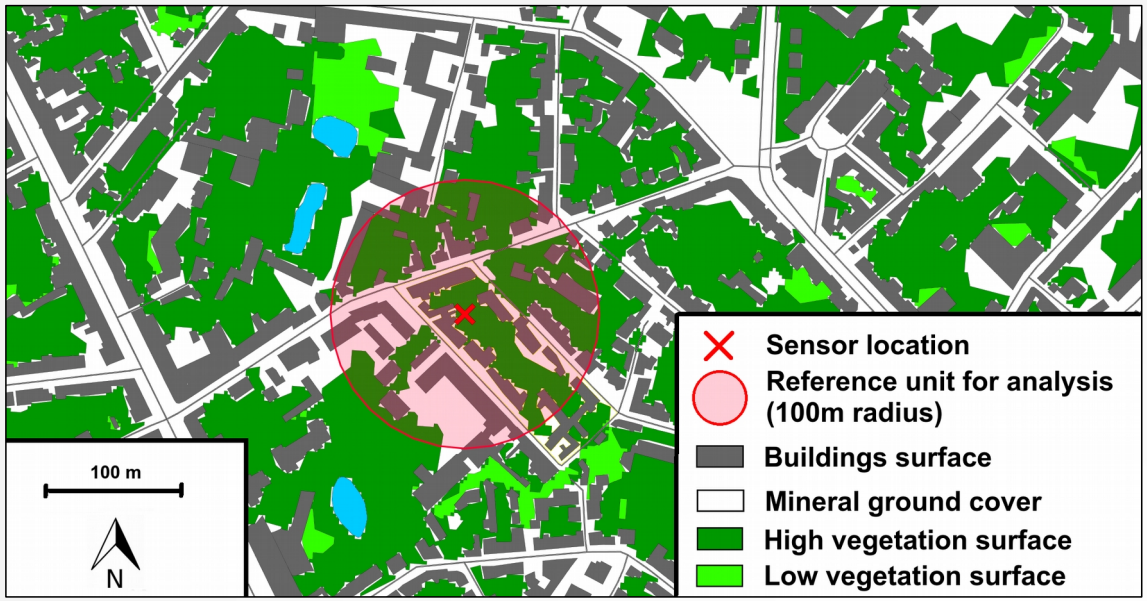


Geographical indicators calculation



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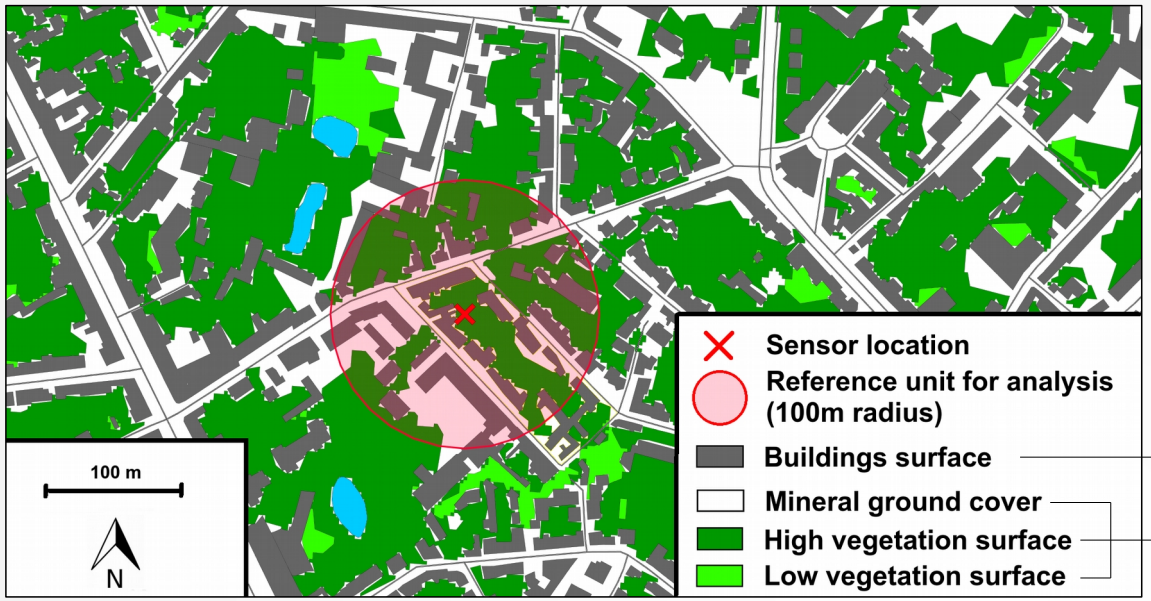

BD TOPO - IGN - 2013

SPOT image - 2.5 m resolution - 2004

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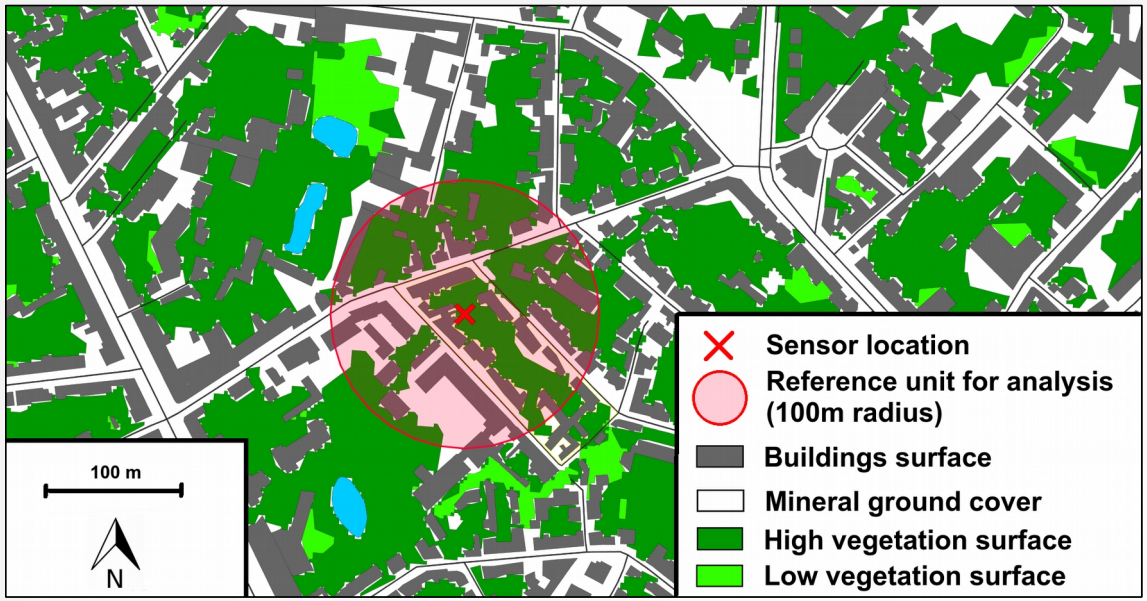

Calculated indicators:

- *Average building height*
- ***Linear of facade density***
- *Open space area*
- *Building volume density*
- *Facade density*
- *Vegetation density*
- ***Equivalent admittance***

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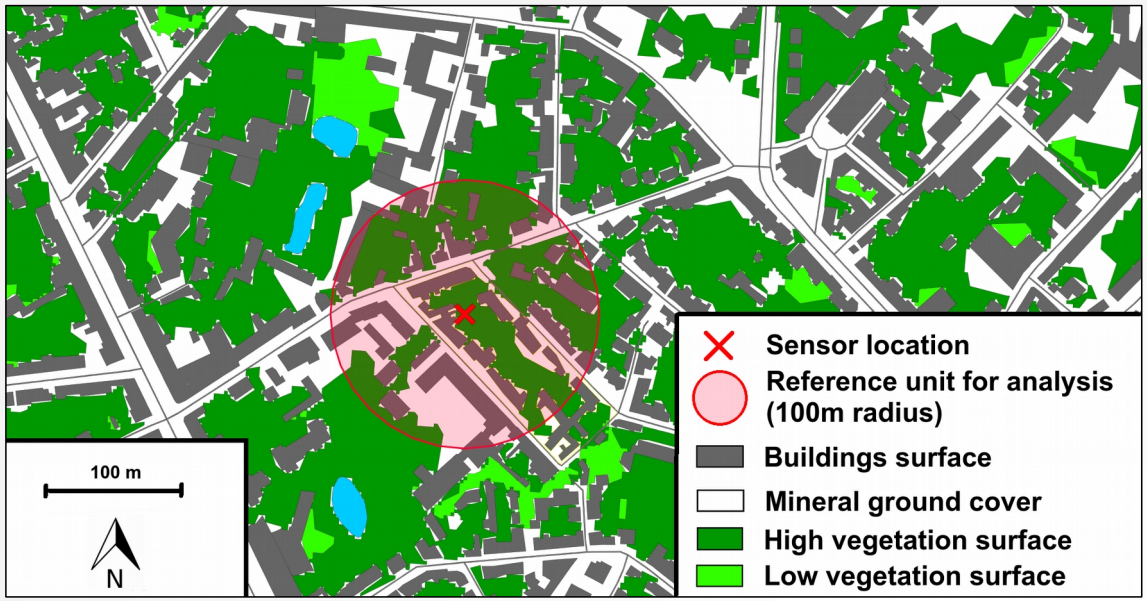

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Symbol	Name	Formula
D_{Flin}	Linear of facade density	$\frac{\sum_i p_i}{A_{ref}}$
ADM	Equivalent admittance	$\mu_a \cdot (D_{Flin} \cdot h_w + \frac{a_{ai}}{A_{ref}}) + \mu_{vh} \cdot \frac{a_{vhi}}{A_{ref}} + \mu_{vl} \cdot \frac{a_{vli}}{A_{ref}}$

A_{ref} : buffer circle area (m^2)

p_i : perimeter of the building i

a_{vh_i} : area taken by the high vegetation i

a_{vl_i} : area taken by the low vegetation i

a_{bg_i} : area taken by the bare ground i

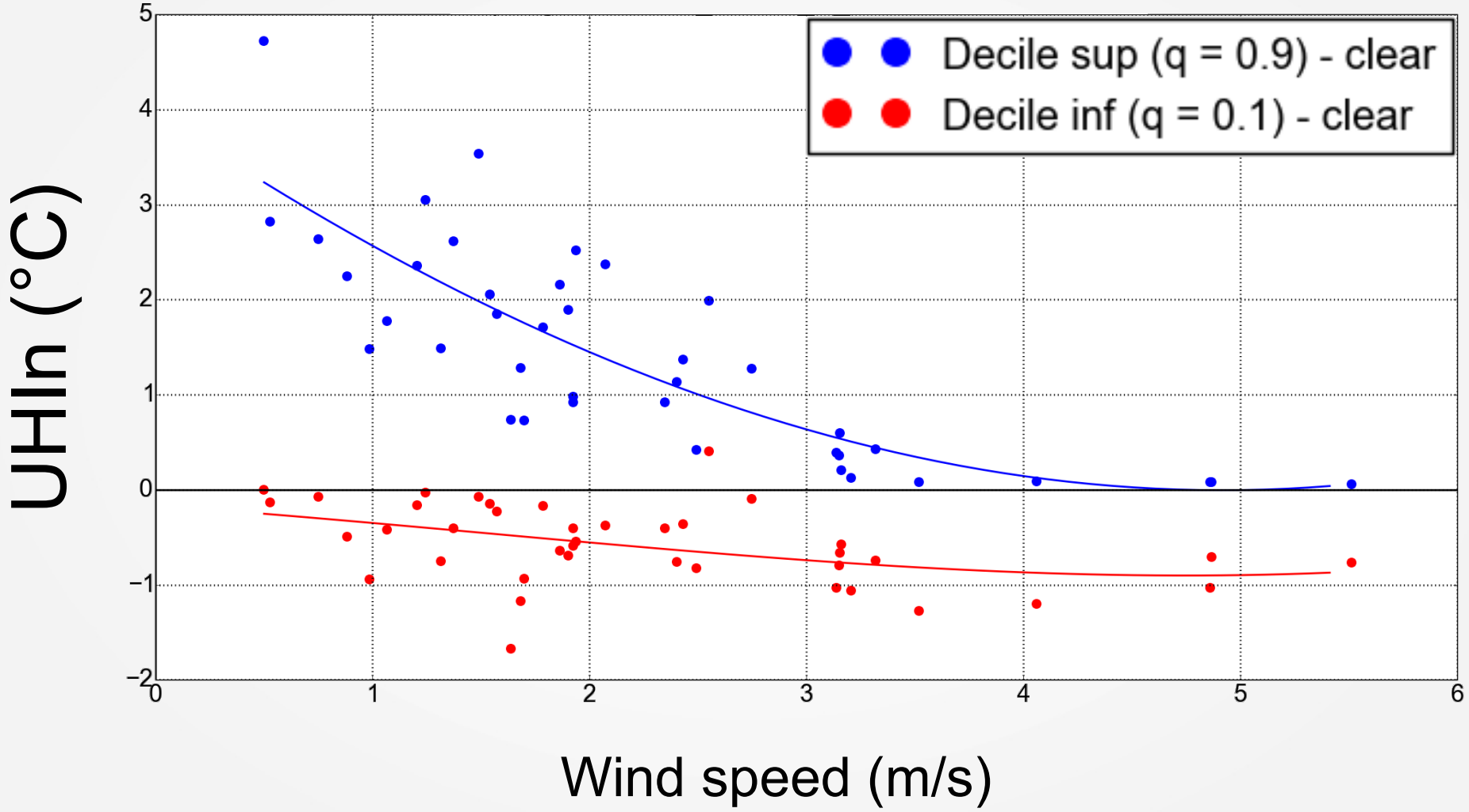
a_{a_i} : area taken by the artificial surface i

μ_a = 700, μ_{vl} = 175, μ_{vh} = 350 :
thermal admittance for artificial surfaces, low vegetation and high vegetation ($J.m^{-2}.s^{-1/2}.K^{-1}$)

h_w = 3 : wall height to consider as influent on the air temperature at screen height

Wind speed classification

(Spring)



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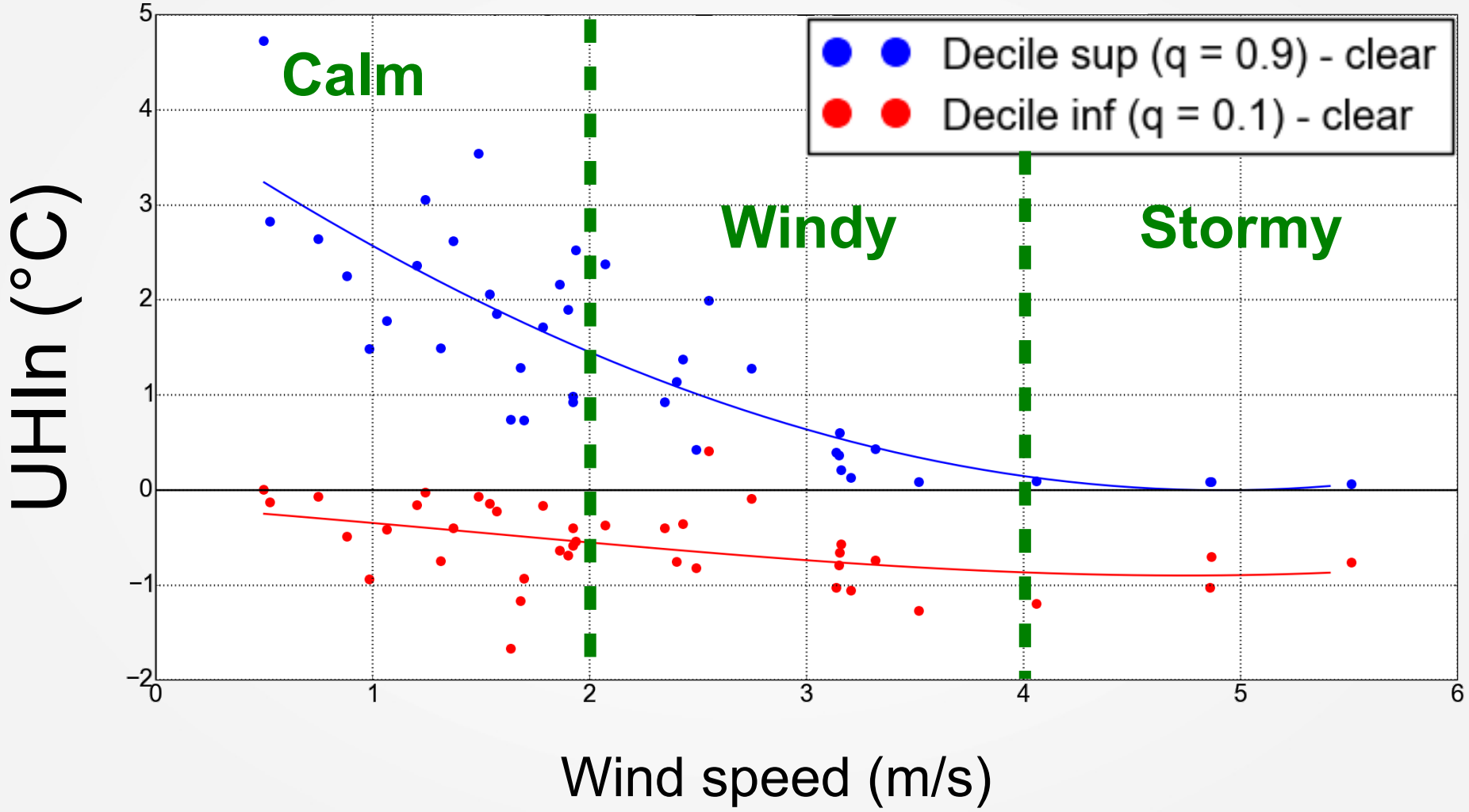

Nebulosity classification

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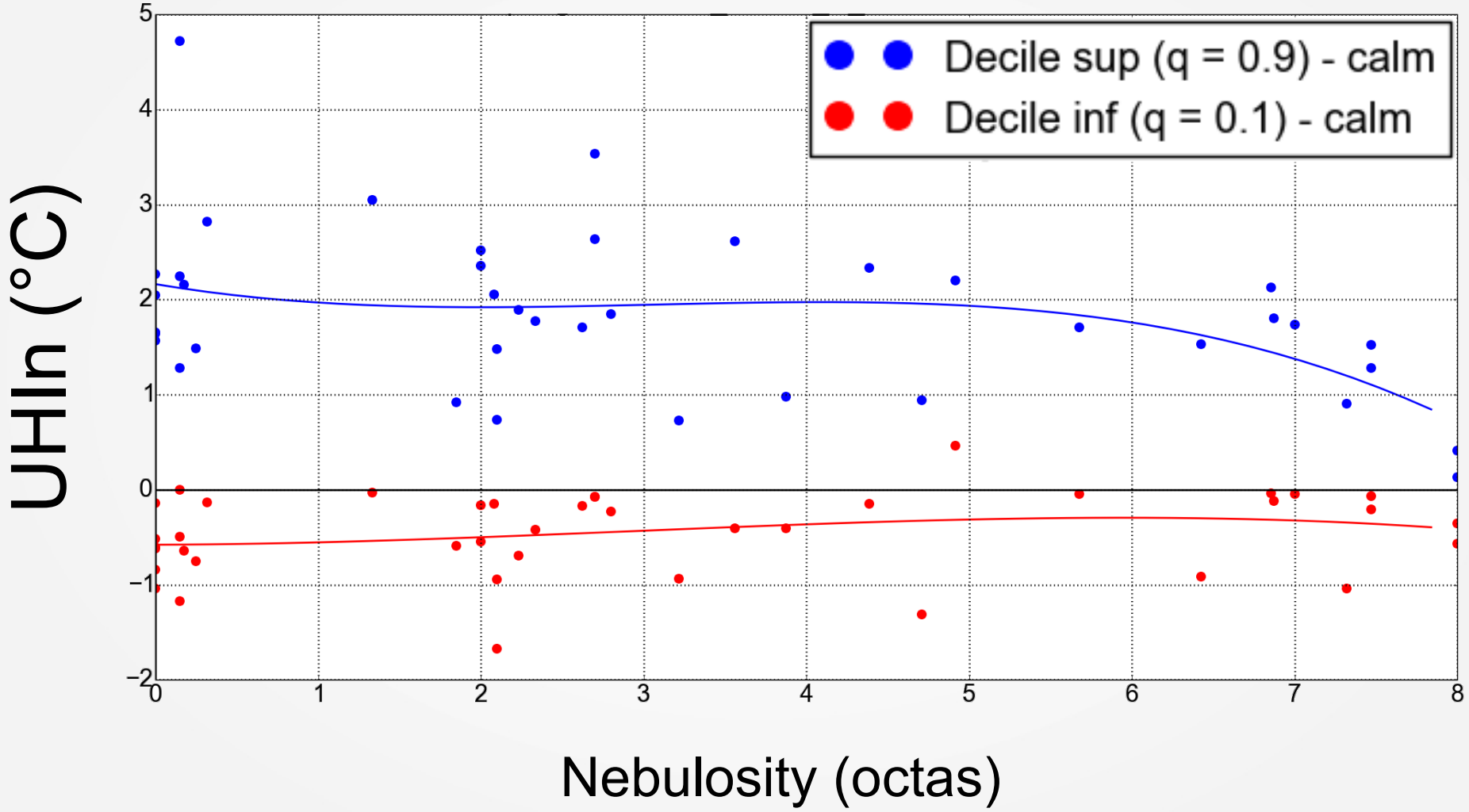

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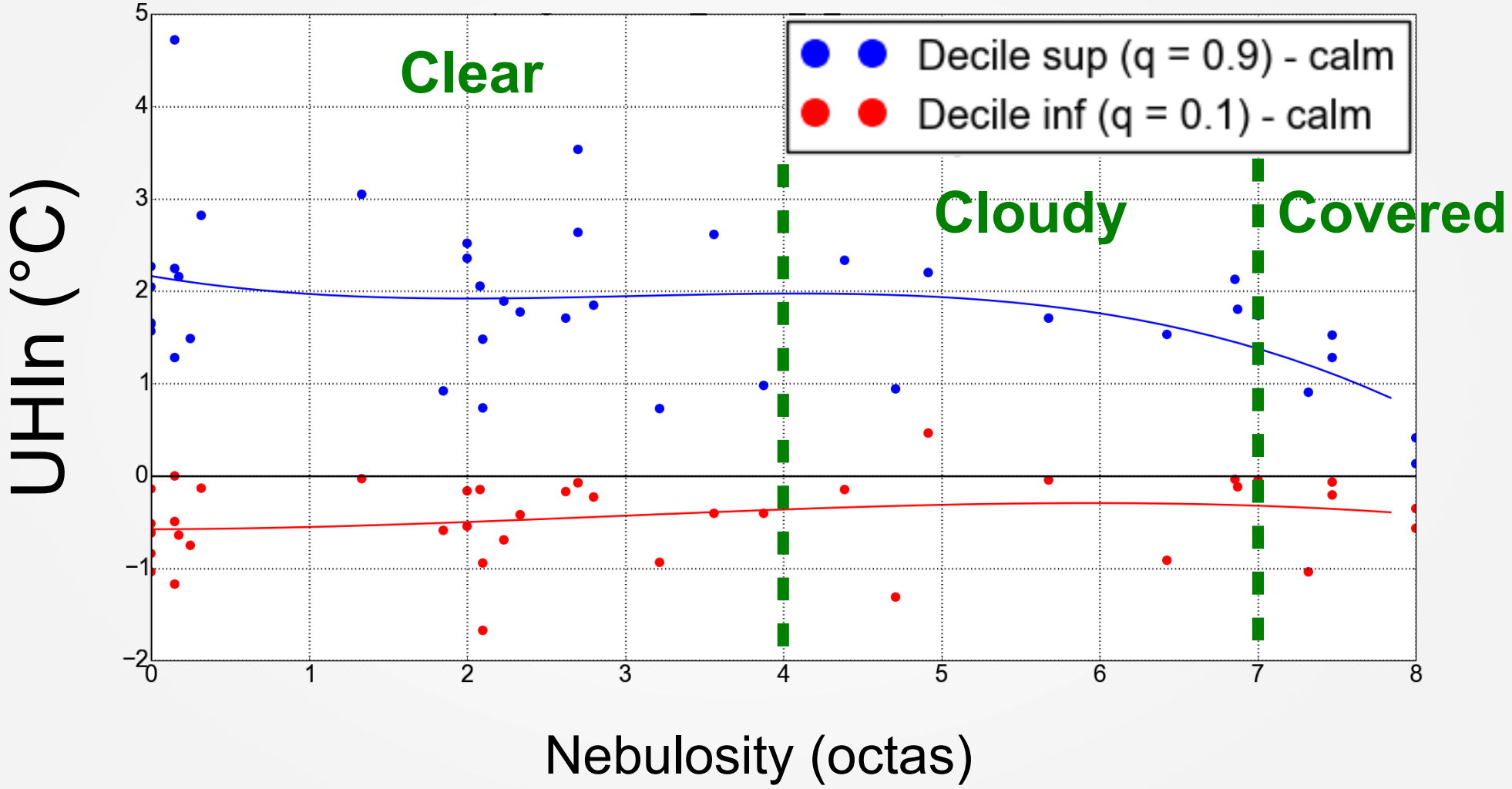
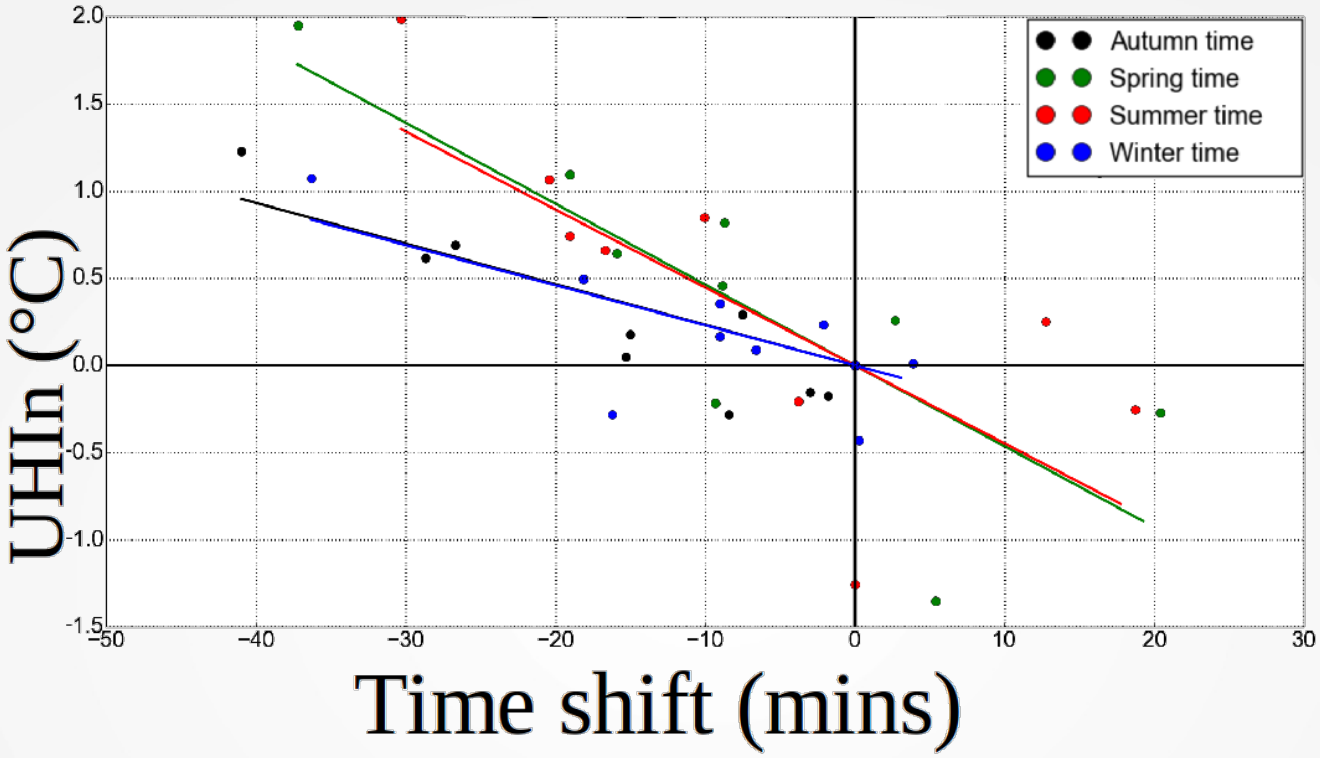


Interclimatic indicators regression



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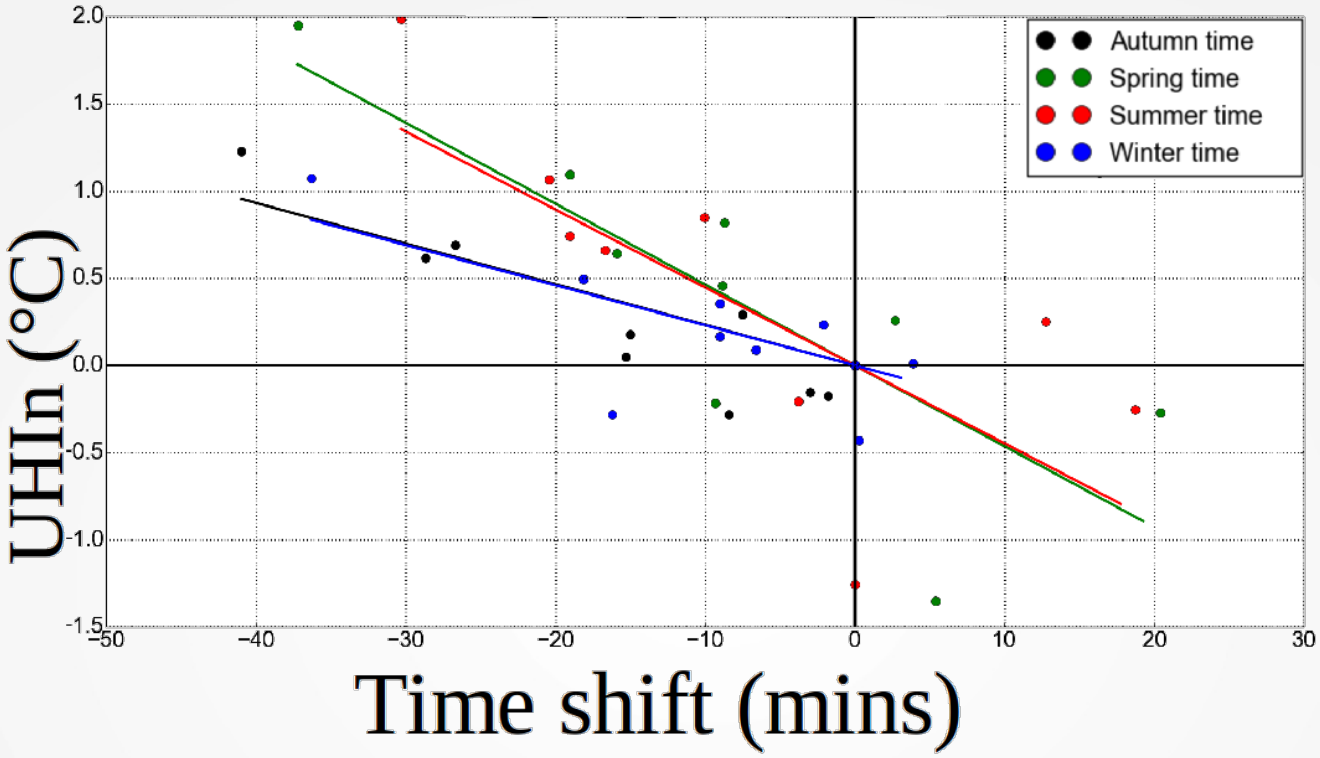
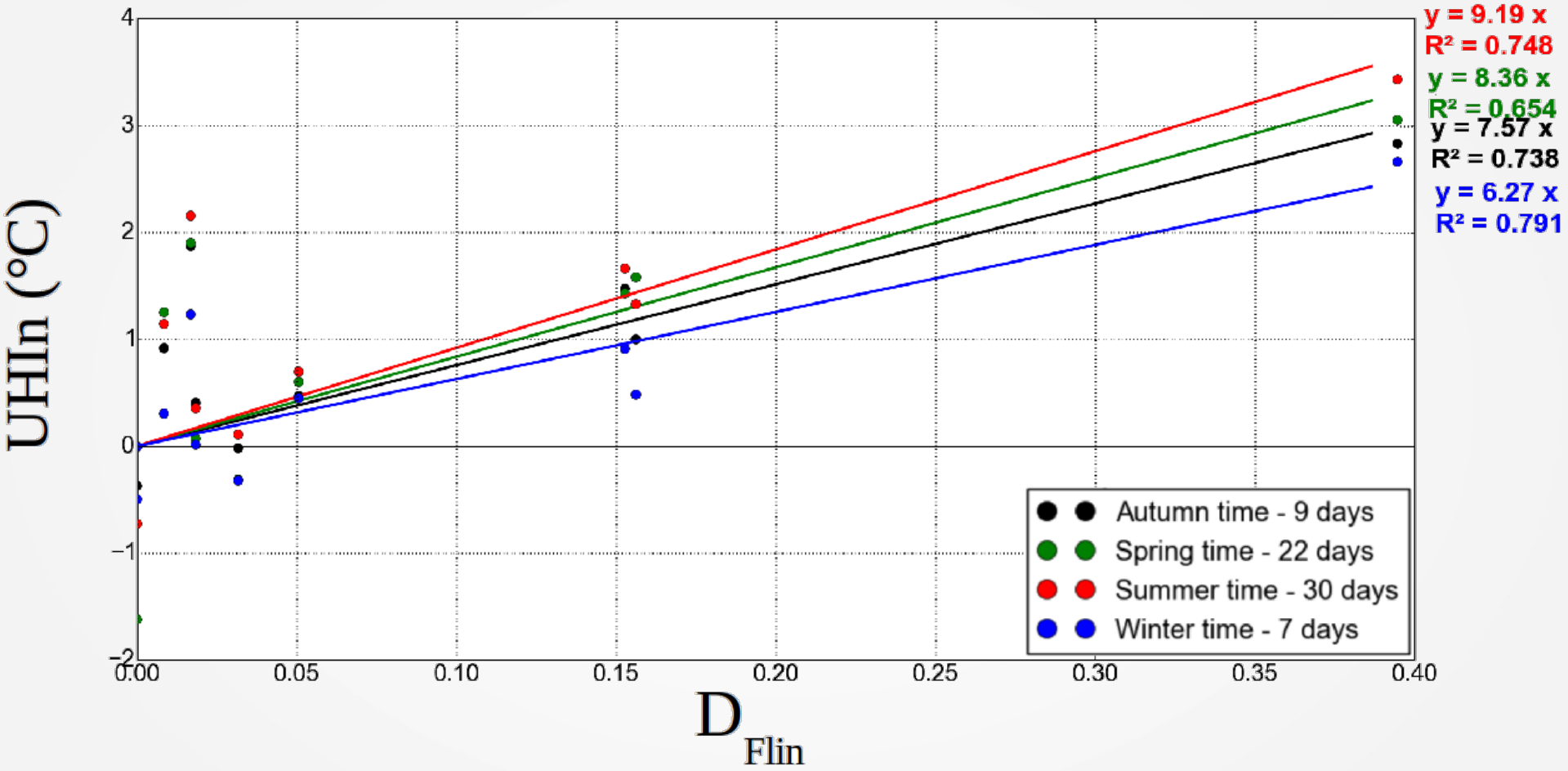


- *The slope of the regression is modified by the season and the weather conditions*
- ***R²** is good (most of the time **> 0,6**) – 0,94 and 0,90 between UHIn and Cr respectively for summer and autumn time (clear and calm conditions)*
  ⇒ the 4 hours after sunset seem decisive for UHI formation

UHIn versus geographical indicators



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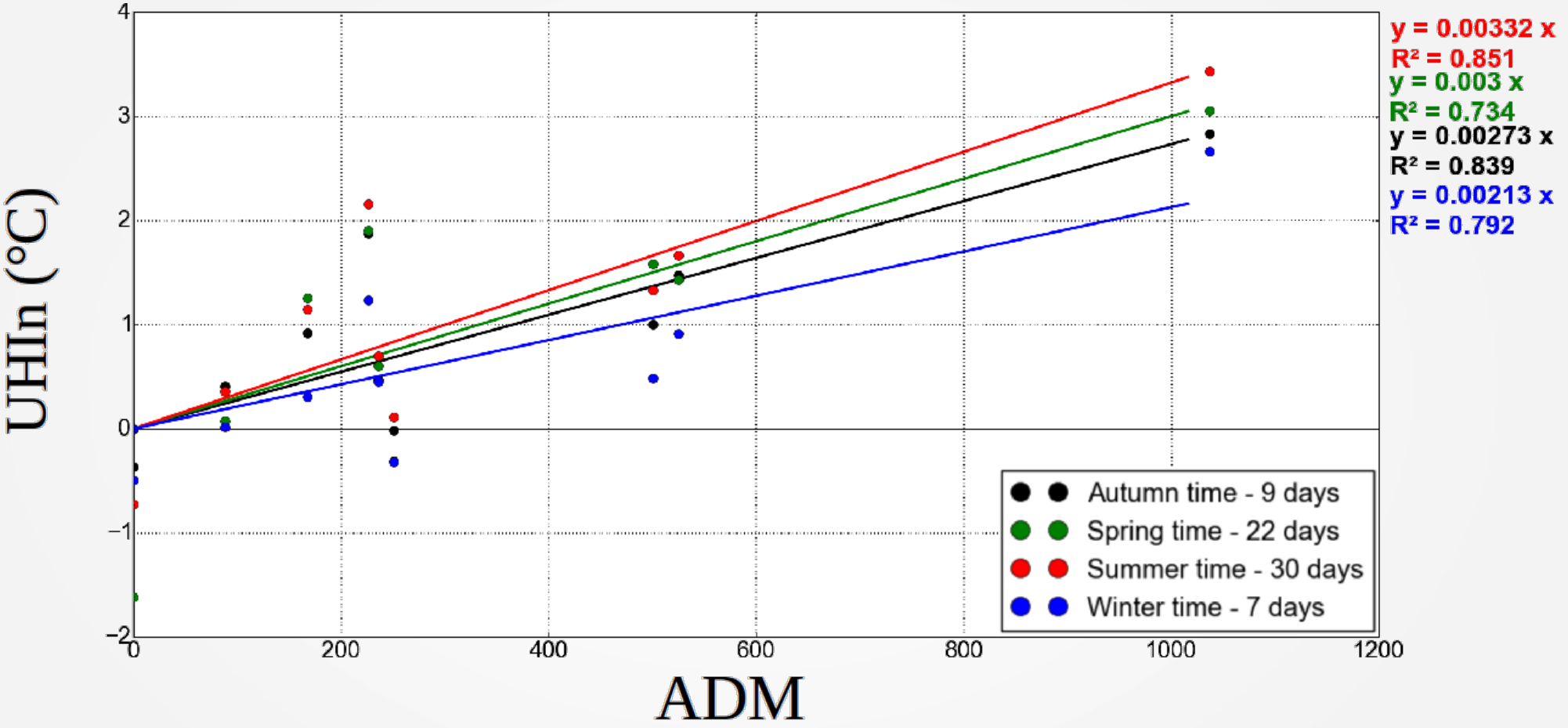
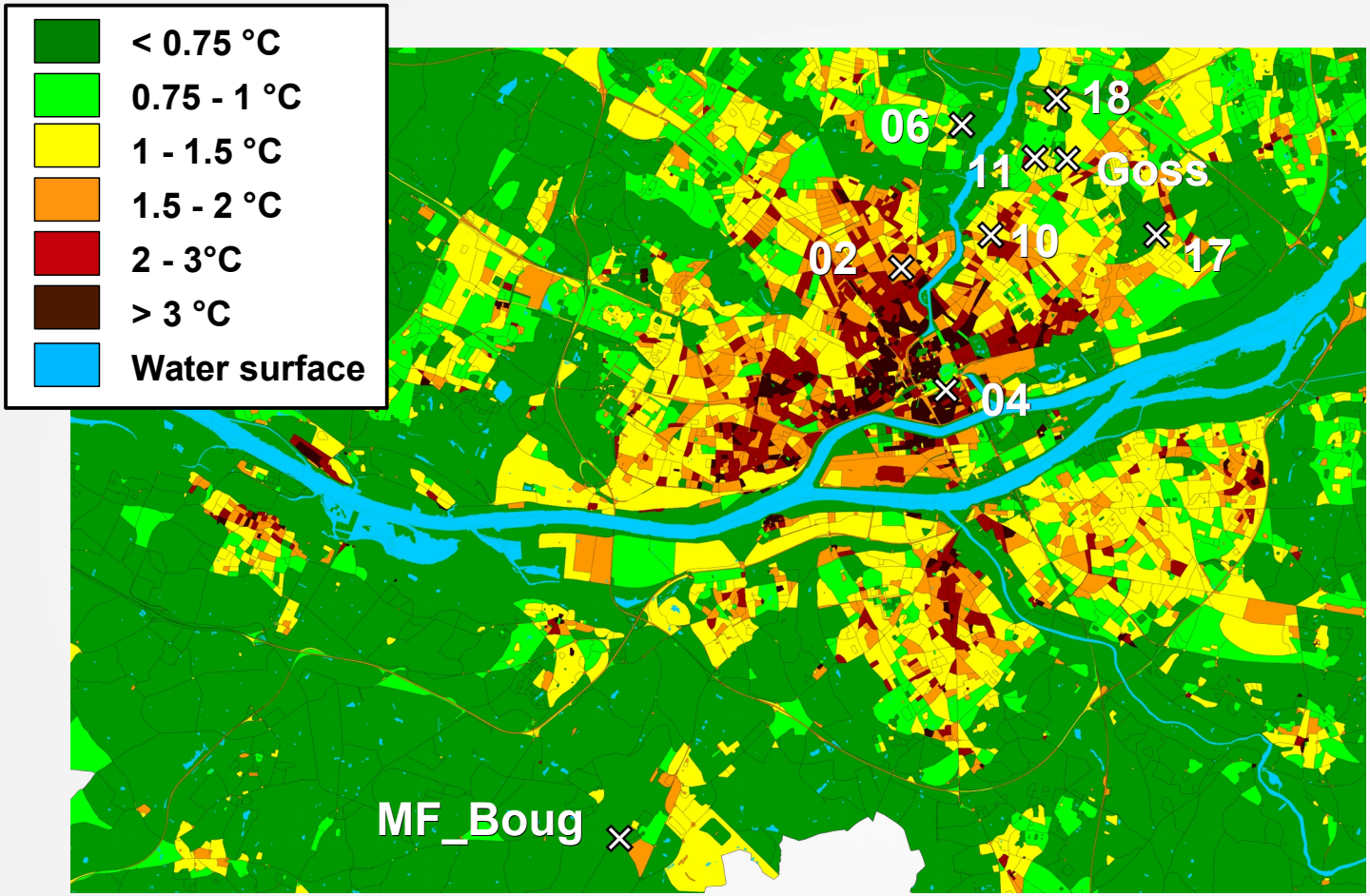


Application of the results on Nantes



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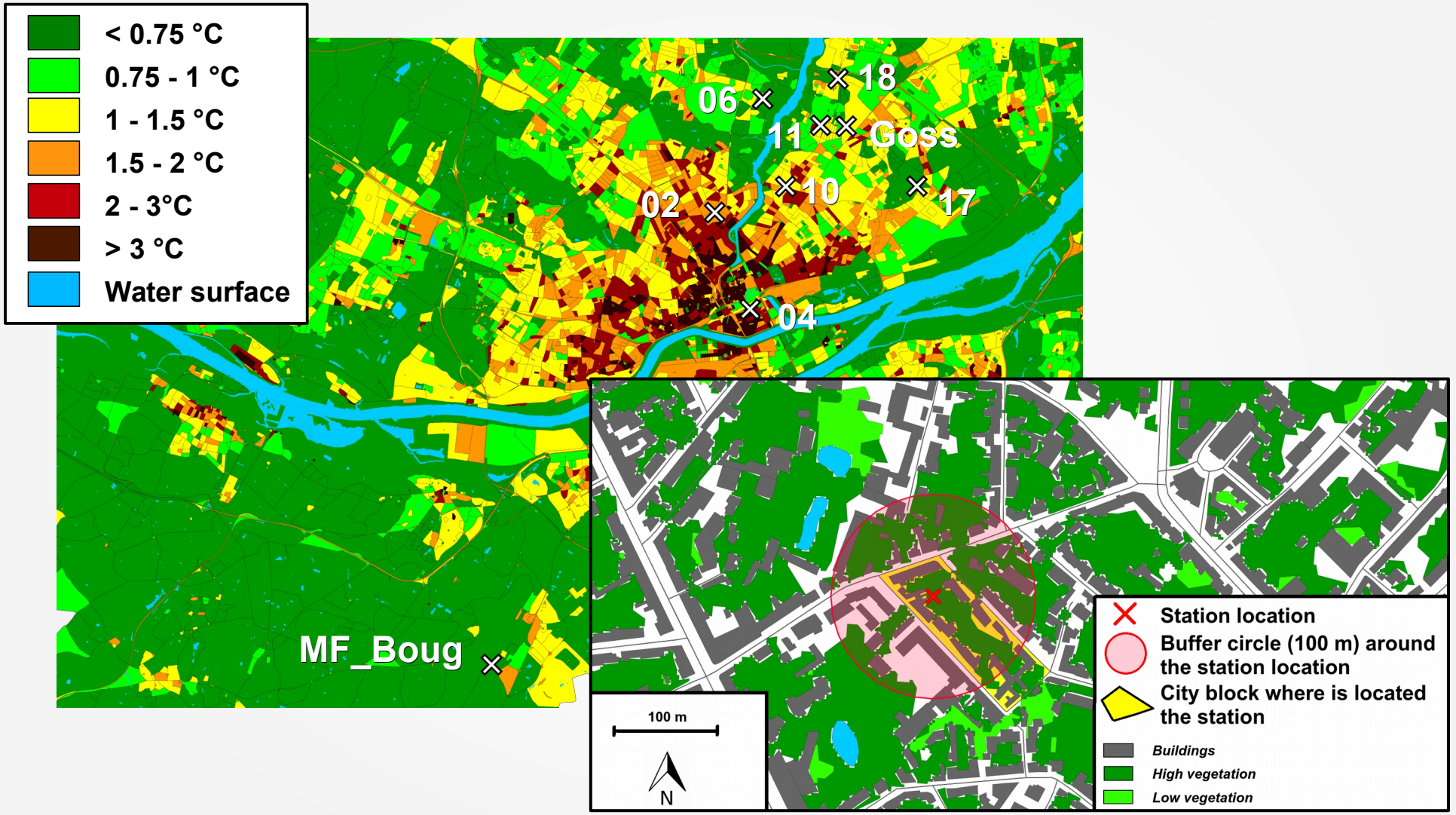

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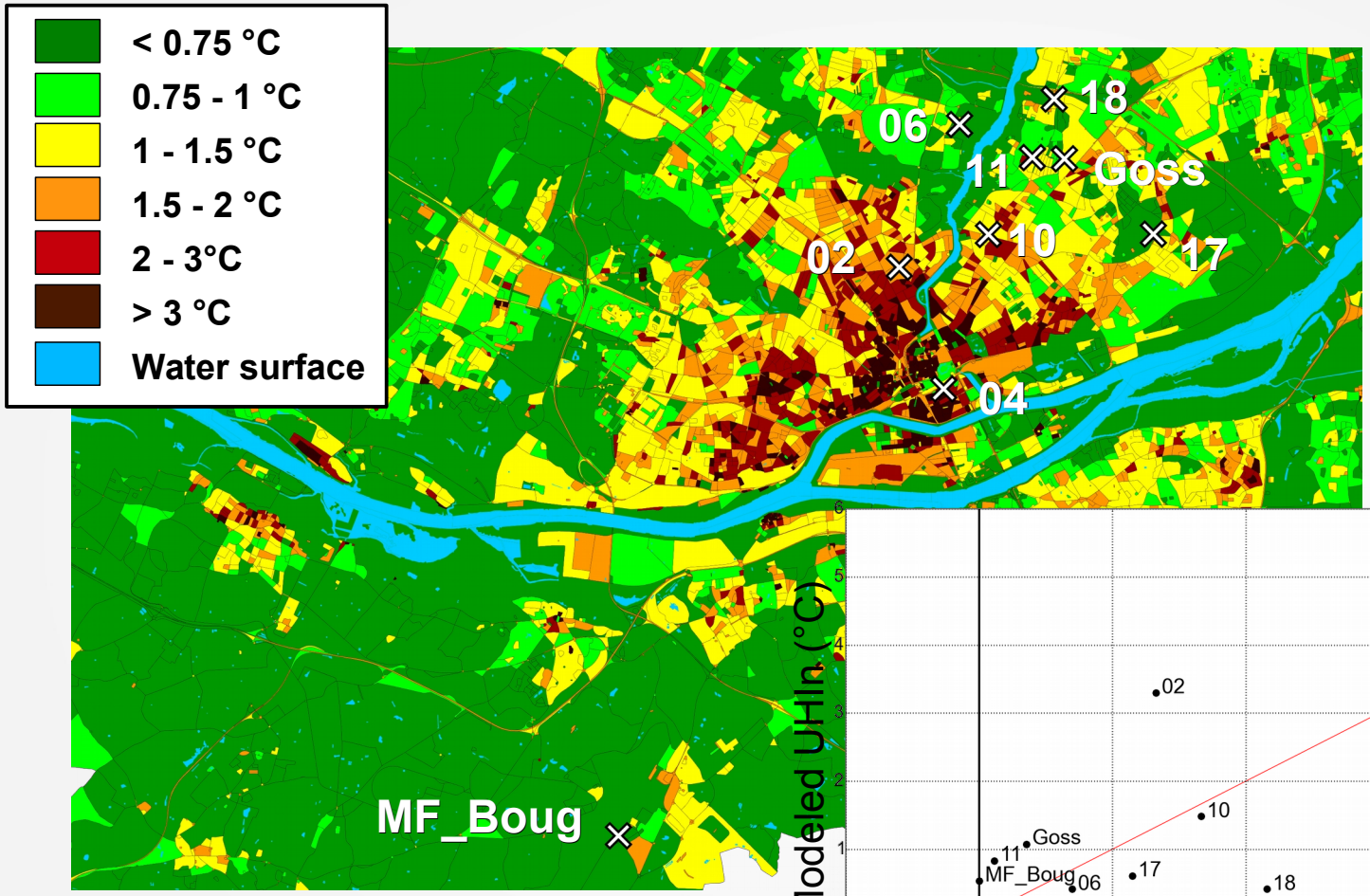

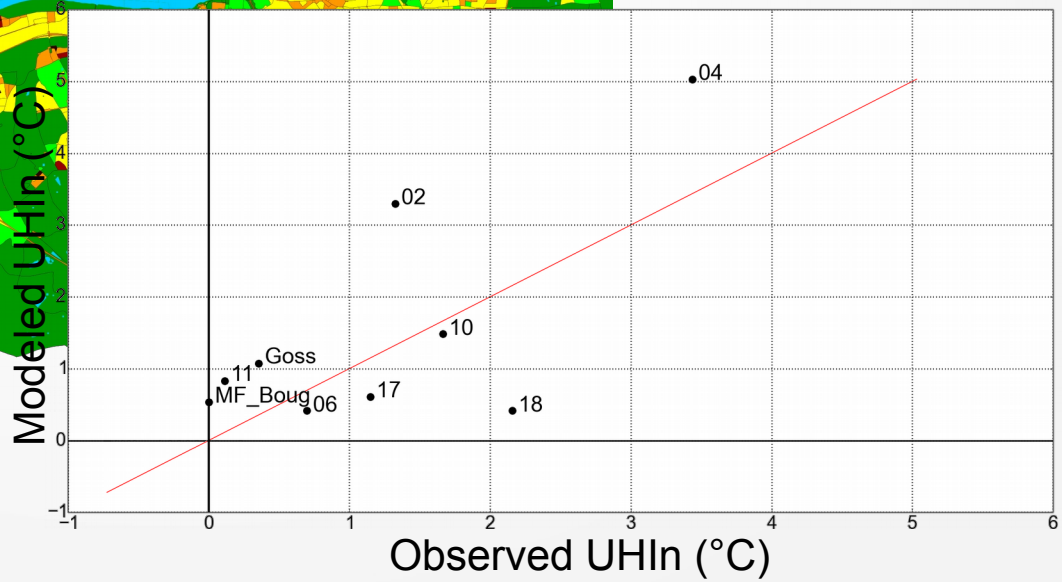

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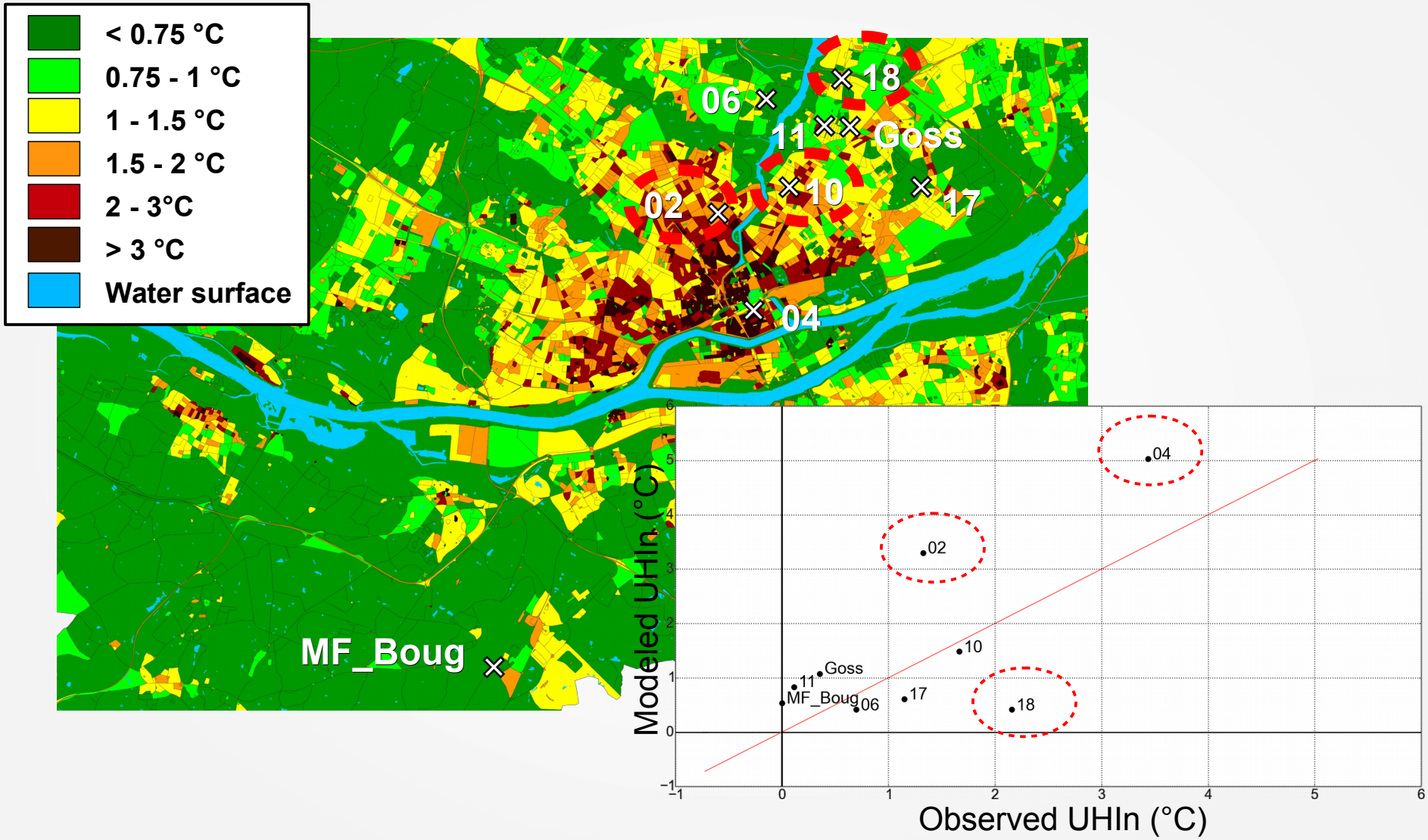

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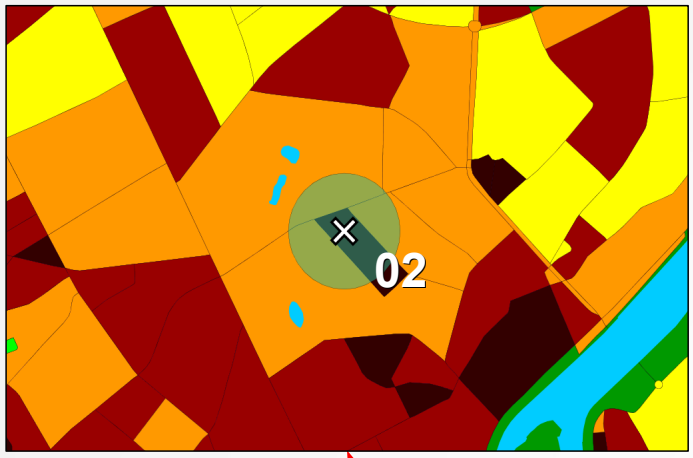
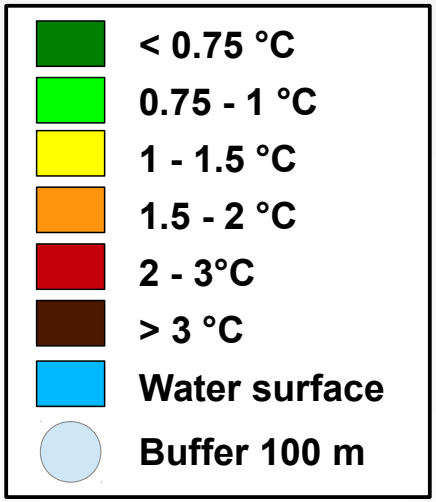
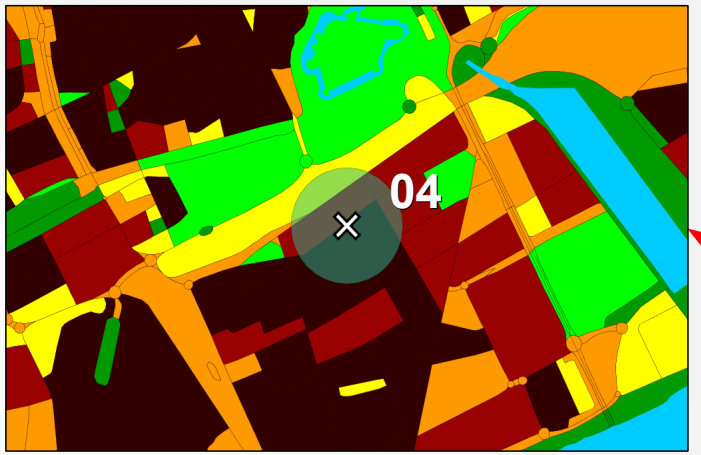
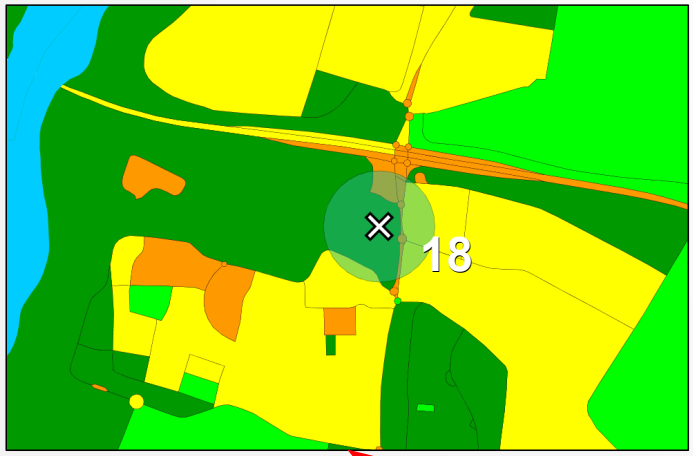
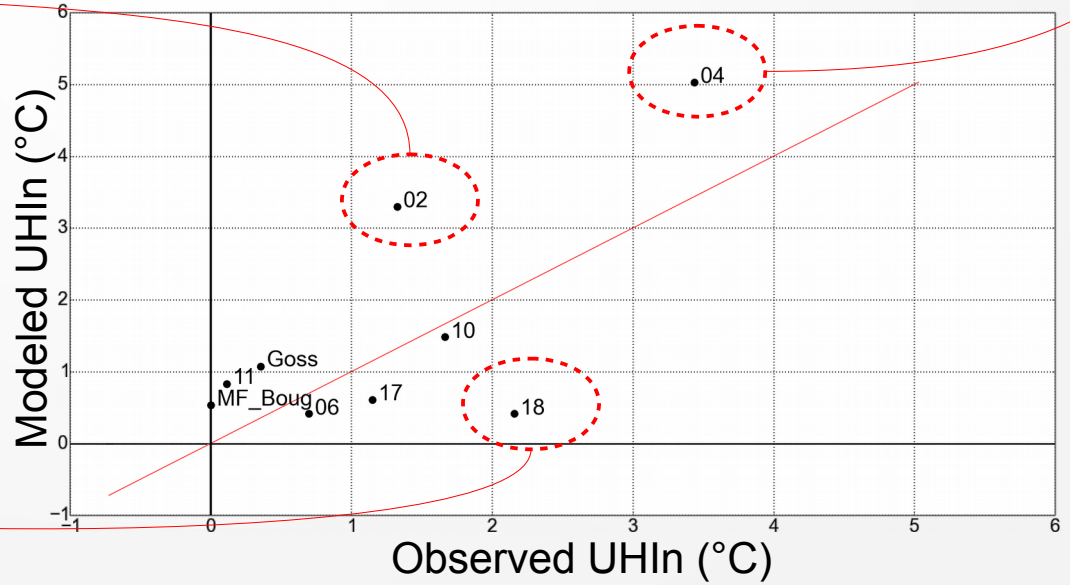




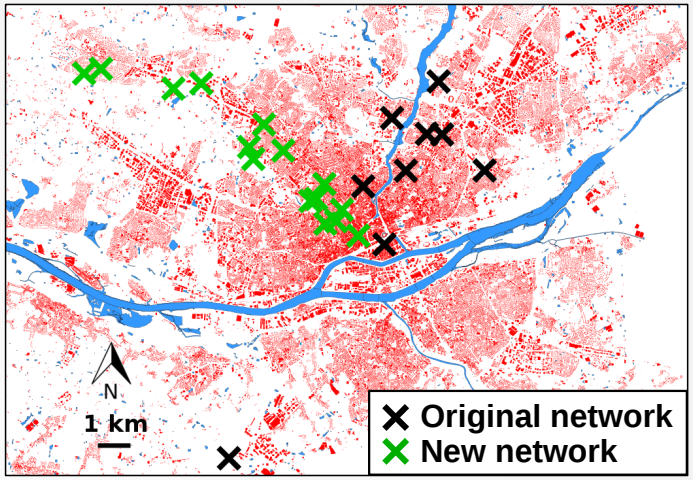






Further improvements

- **Climatic measurement :**
  - Increase the number of measurement sites (currently too low for good regression analysis)



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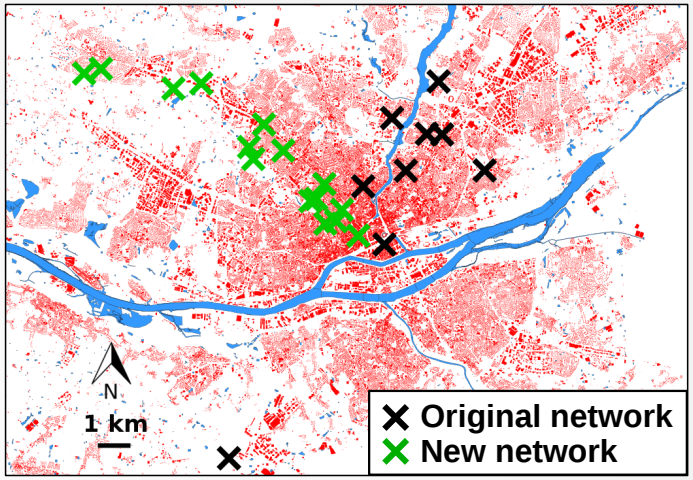
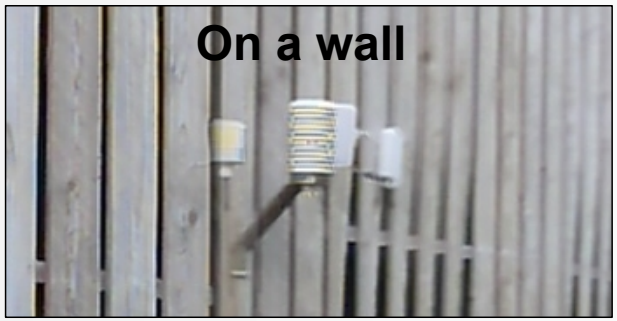
  - Improve the knowledge about shield issues





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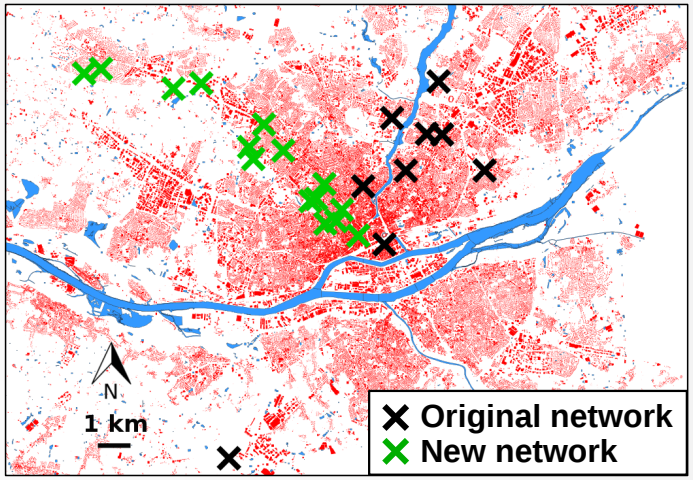
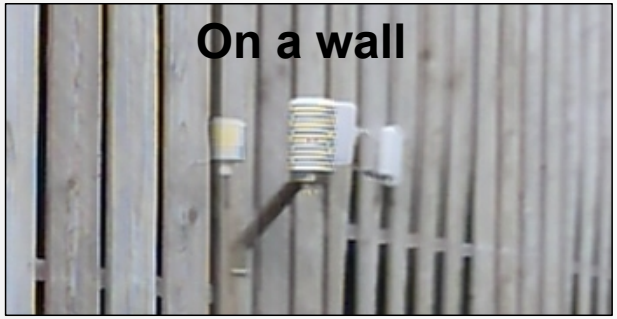




- **Geographical part :** evaluate the influence on the results of :
  - The size and the shape (LCZ, buffer circle, city block defined from road network) choice of the spatial reference unit;
  - The accuracy of the data (remote sensing image resolution) and the errors led by the use of different sources of data

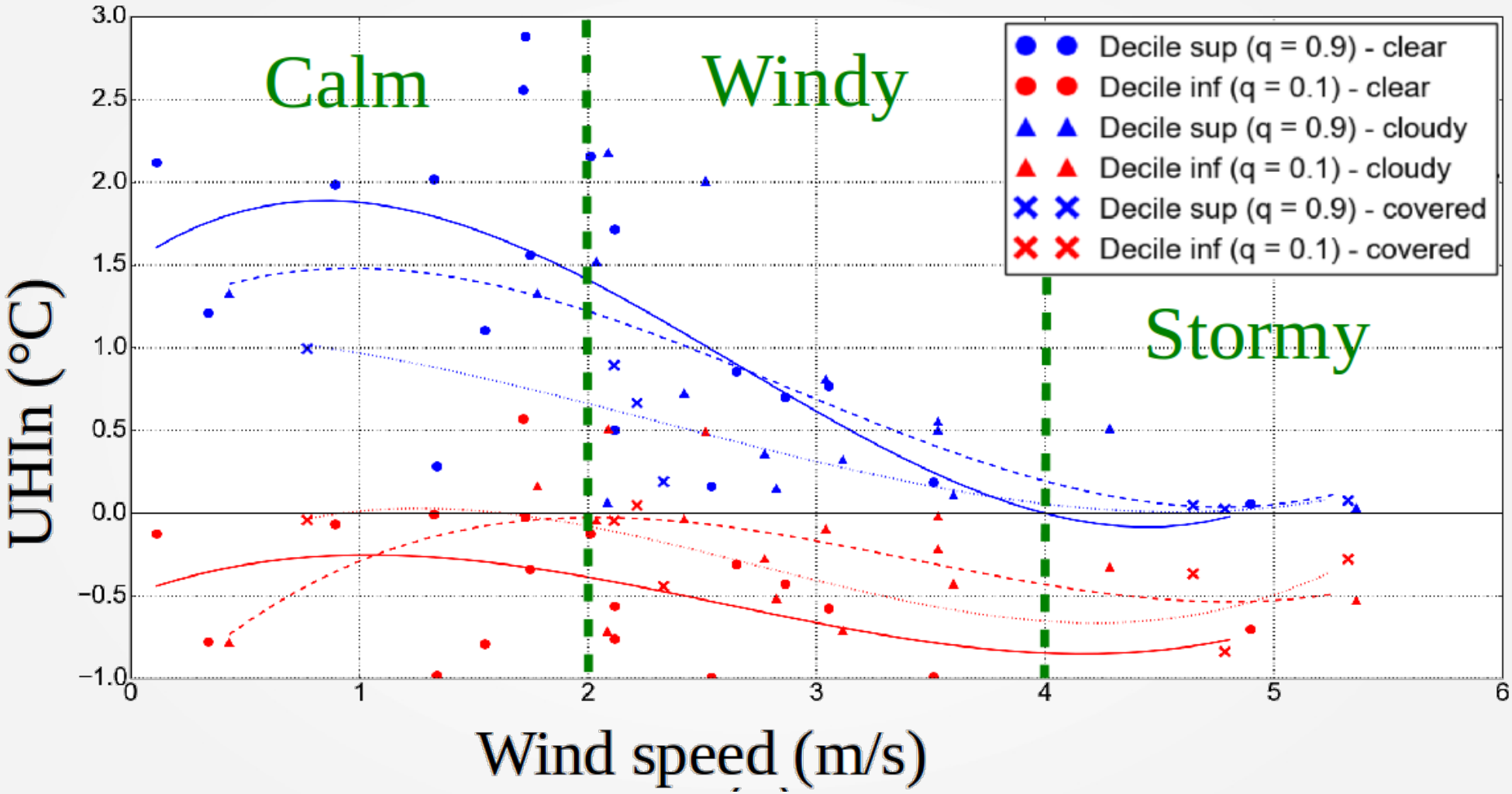
Acknowledgements

Thank you for your attention !

- **Work supported by**
  - French Environment and Energy Management Agency (ADEME)
  - AgroCampus Ouest (ACO) school
  - Region des Pays de la Loire

- **Special thanks to :**
  - OrbisGIS team for their technical support (http://www.orbisgis.org/about/the-team/)
  - Meteo-France for the availability of their measurement data

Wind speed classification



Nebulosity classification