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Estimation of spatial air temperature distribution at sub-mesoclimatic scale using the LCZ scheme and mobile measurements

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Introduction

Background

 Take into account urban climate and urban heat island phenomenon for urban planning operations

Local Climate Zone scheme

 Suitable to provide quantitative climatic data to urban planners and institutional stakeholders



Introduction

Definition

- Local Climate Zone
 - Specific screen-height thermal behavior
 - Minimum diameter of 400 m

Recent research topics...

- Spatial homogeneity of urban indicators vs. Spatial homogeneity of air temperature
- Thermal comparison between LCZ types

Aim of the study

How the relative position of a given Local Climate Zone within the conurbation influences their thermal features?



Summary of the study

Step 1 : Local Climate Zones in the Nancy Area

Step 2 : Mobile measurements within Local Climate Zones

Step 3 : Distance to conurbation's center and thermal behavior

Introduction

LCZ in the Nancy Area

Mobile measurements

Distance to center

Conclusion

Step 1 : Great Nancy Area

286,000 inhabitants Temperate climate, warm summer, without dry season (Köppen-Geiger: "Cfb") July mean air temperature: maxima 25.1°C, minima 13.7°C











Step 1 : Local Climate Zones building process





Step 1 : Issues on residential areas



F. Leconte, J. Bouyer, R. Claverie, M. Pétrissans. 2015. Using Local Climate Zone scheme for UHI assessment: evaluation of the method using mobile measurements. *Building and Environment* 83 : 39-49



Step 1 : Local Climate Zones in the Nancy Area





Step 2 : Mobile measurements within LCZ





Step 2 : Mobile measurements within LCZ

- Measurement hours
 - Middle of afternoon, from 2 pm to 5 pm
 - 3 hours after sunset, from 12 am to 3 am
- Meteorological conditions
 - Anticyclonic conditions
 - Nebulosity below 2 octas
 - ► Low wind speed (below 9 m.s⁻¹, wind speed at 10 meters high)
 - 24 hours free of precipitation, dry road
- Vehicle features
 - Probe installed inside a ventilated cylinder
 - Response time < 100 ms, Accuracy ± 0.2°C
 - Car speed above 15 km.h⁻¹
 - Air temperature recorded every 3 m





Nocturnal air temperature amplitude within LCZ



Amplitude mostly below 2°C Thermal homogeneity of LCZ acceptable

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Mean air temperature difference between LCZ types

Nocturnal, row - column

LCZ Type	Compact	Open	Open Lowrise /	Large	Low
	Midrise	Midrise	Sparsely Built	Lowrise	Plants
Compact Midrise		0.2 (0.5)	1.8 (0.6)	1.5 (0.6)	4.4 (1.0)
Open Midrise	0.4 (0.3)		1.5 (0.6)	1.3 (0.7)	4.2 (1.0)
Open Lowrise /	0.3 (0.3)	-0.1 (0.4)		-0.3 (0.4)	2.4 (0.7)
Sparsely Built					
Large Lowrise	0.0 (0.3)	-0.3 (0.3)	-0.2 (0.3)		2.9 (0.7)
Low Plants	0.8 (0.5)	0.5 (0.4)	0.6 (0.4)	0.8 (0.4)	
Diama La construction de la constru					

Diurnal, column - row

- Air temperature difference
 - Within 1°C at daytime
 - Over 4°C at nighttime

F. Leconte, J. Bouyer, R. Claverie, M. Pétrissans. 2015. Using Local Climate Zone scheme for UHI assessment: evaluation of the method using mobile measurements. *Building and Environment* 83: 39-49









LCZ types matter, independently of the distance to center





- Similar distance to center
 - Air temperature gap due to LCZ type





- Residential areas (Open Lowrise / Sparsely Built)
 - Larger distance to center = lower air temperature





 Mean relative temperature expressed regarding the coldest area of the route (150 m)







LCZ Compact Midrise





LCZ Open Midrise





LCZ Large Lowrise





- LCZ Open Lowrise / Sparsely Built
 - Within the conurbation + reduced distance to the center = relative temperature above Low Plants temperature





- LCZ Open Lowrise / Sparsely Built
 - Outside the conurbation + significant distance to the center = relative temperature similar to Low Plants temperature



Conclusion and ongoing work

Conclusion

- Within the conurbation:
 - LCZ type influential
 - Distance to center significant for Open Lowrise / Sparsely Built : Necessity to take into account this parameter

• Open Lowrise / Sparsely Built outside the conurbation:

- Negligible thermal influence from the conurbation
- Relative temperature similar to the non urbanized LCZ nearby : because of their small size?
- How to perform temperature extrapolation based on LCZ types outside the conurbation?

Ongoing work

- Automatic LCZ building (using GIS)
- Semi-empirical modeling of LCZ's nocturnal cooling



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Air temperature distribution regarding wind direction



Wind direction : North East



Wind direction : South East



Air temperature distribution regarding wind direction



Mean speed : 1.1 m/s^{-1}



Mean speed : 3.1 m/s^{-1}



Diurnal air temperature amplitude within LCZ

