BSA 2017 Building Simulation Applications

unibz Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Measurement of the impact of buildings on meteorological variables

BSA 2017 – Building Simulation Applications
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Dr. D. Mauree, L. Deschamps, P. Bequelin, P. Loesch, Prof. J-L. Scartezzini

LESO-PB Laboratoire d'Energie Solaire Physique du Bâtiment
EPFL École Polytechnique Fédérale de Lausanne
MoLUS
sccer future energy efficient buildings & districts
In cooperation with the CTI
Energy Swiss Competence Centers for Energy Research
Schweizerische Eidgenossenschaft
Confédération suisse
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Swiss Confederation
Commission for Technology and Innovation CTI
IBPSA Italy
International Building Performance Simulation Association

Introduction

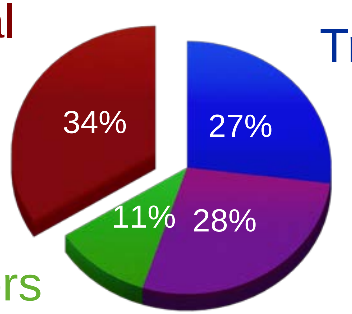
Building energy use

Residential

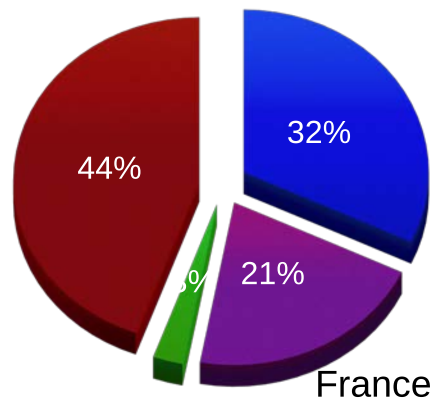
Transport

Other sectors

Industries



World (IEA, 2012)



France (ADEME, 2013)

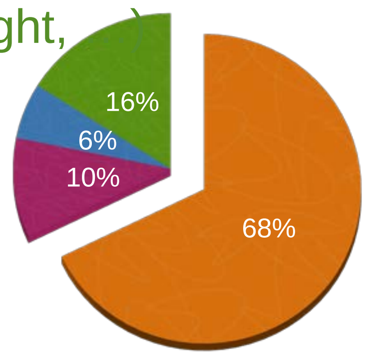
Energy use inside buildings

Specific electricity (light,

Cooking

Sanitary hot water

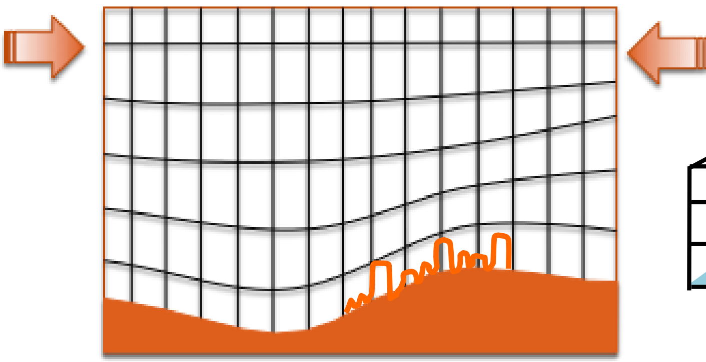
Heating/ Air conditioning

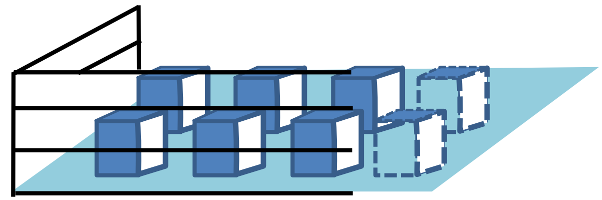


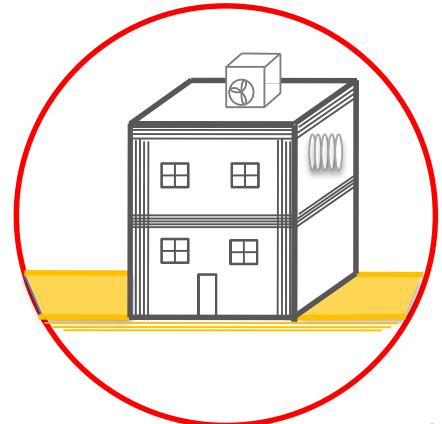
France (ADEME, 2013)

Introduction

Urban climate: Meso-scale models







Courtesy of N. Blond

WRF (Skamarock et al., 2008)
Meso-NH (Lafore et al., 1997)
FVM (Clappier et al., 1996)

Rugosity
Influence of obstacles
- Additional term in equations

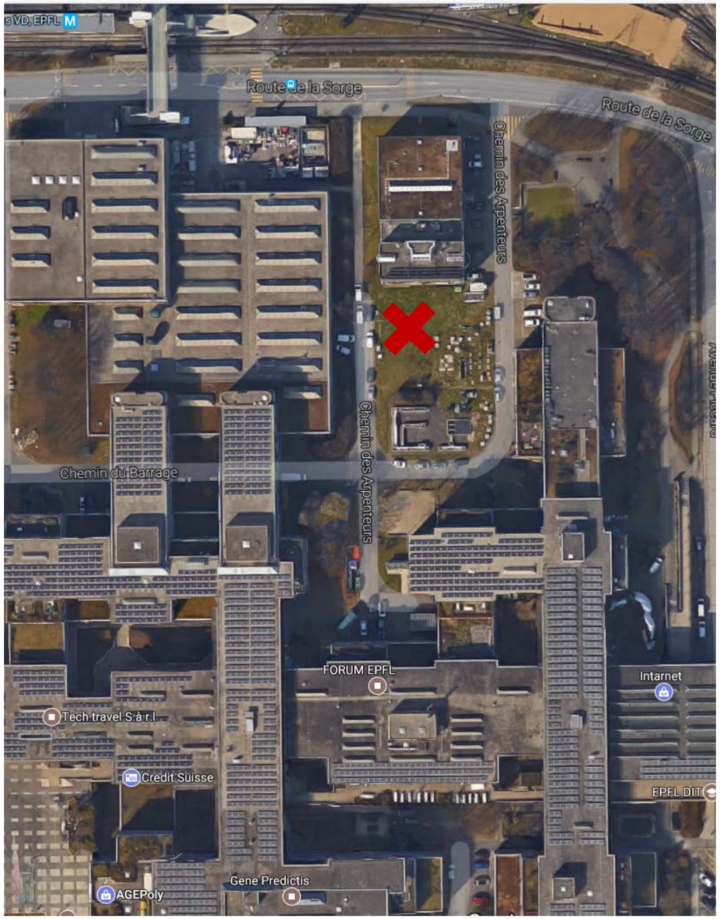
BEP (Martilli et al., 2002)
UCM (Kusaka et al, 2001)
TEB (Masson, 2000)

Buildings / Streets
Solar radiation

BEM (Krpo et al., 2010)
(Kikegawa et al. 2003)

Walls, roofs & streets
Window
Cooling/ Heating

Experimental setup



EPFL Campus, Lausanne, Switzerland

Semi-urban setup

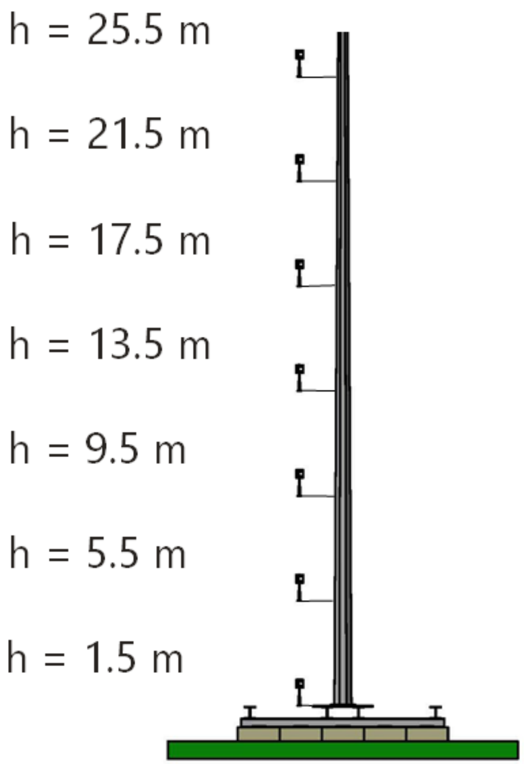
- different from BUBBLE experiment

Instruments

Instrument	Brand	Type
3D sonic anemometers	Gill	WindMaster
Meteorological station	Gill	GMX 300
Surface temperature sensor	Optris	OPTCSLT15K

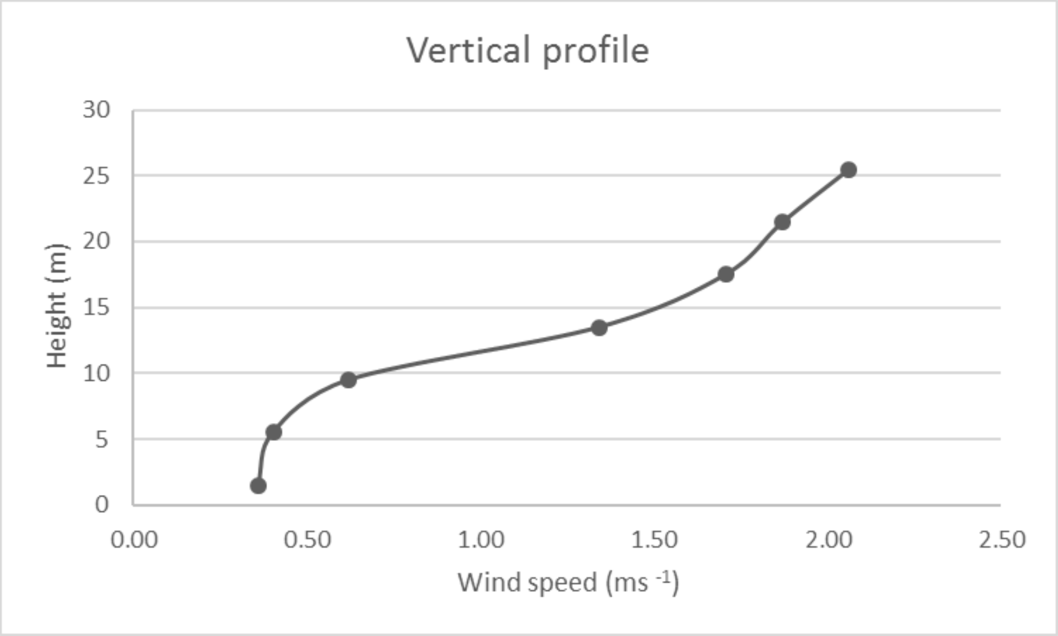
Table 1 – List of instruments

MoTUS



Results

Wind speed profile



Highly impacted vertical wind profile

Air temperature calculation

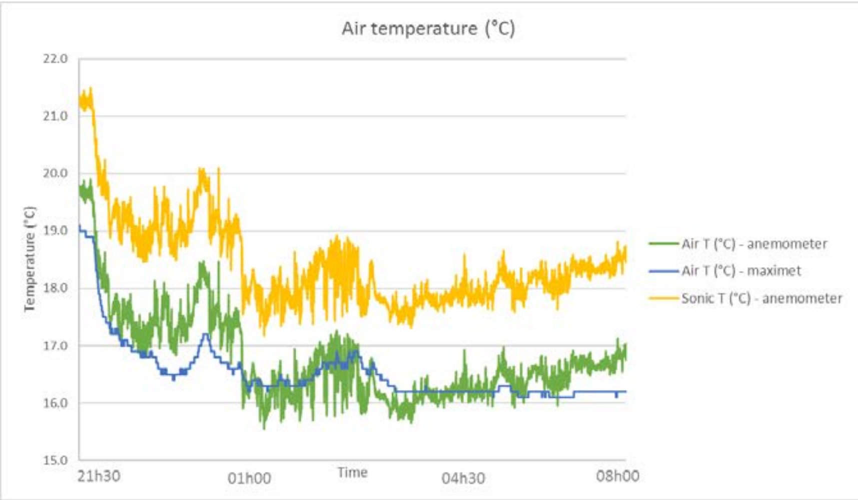
$$\theta_a = \frac{\theta_s}{1 + 0.32\left(\frac{e}{P}\right)}$$

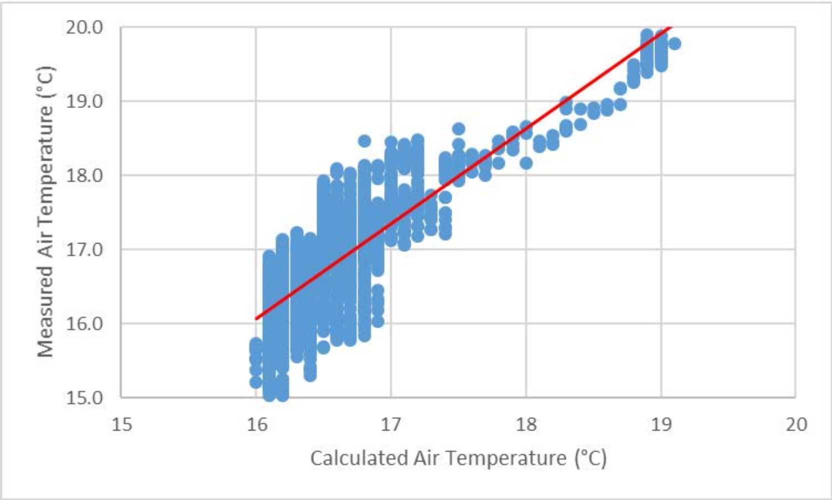
$$e = RH * 100 * \left(6.11 * 10^{\left(\frac{7.5\theta_m}{237.3+\theta_m}\right)}\right)$$

'θ_a'	– Air temperature corrected (K)
'θ_s'	– Sonic temperature (K)
'θ_m'	– Air temperature Maximet (K)
'e'	– Vapor pressure (Pa)
'P'	– Air pressure (Pa)
'RH'	– Relative humidity

Results

Air temperature





Very good agreement between corrected air temperature and measured one

Convective heat transfer coefficient

$$h_c = 5.678\left[m + n\left(\frac{U}{0.3048}\right)\right]$$

$$h_c = 2.8 + 3U$$

'h_c'	– convective coefficient
'U'	– wind speed (ms^{-1})
'm , n'	– Constants

Results

Heat transfer coefficient

Floor	h_c (W/m².K)	Relative difference
1st	7.0	35%
2nd	7.2	34%
3rd	8.1	26%

$$h_c = 5.678\left[m + n\left(\frac{U}{0.3048}\right)\right]$$

Floor	h_c (W/m².K)	Relative difference
1st	3.9	43%
2nd	4.0	41%
3rd	4.7	32%

$$h_c = 2.8 + 3U$$

Table 2 – Heat transfer coefficients

Results

Energy calculation over EPFL campus.

But how useful are localized data ?

Real consumption	30,000 MWh	**% difference**
Localized data	32,600 MWh	8%
Meteonorm	34,400 MWh	15%

Table 3 – Comparison of energy consumption

Conclusions and Perspectives

MoTUS – Measurements

- High frequency measurement over vertical axis
- Long term monitoring of meteorological variables
- Preliminary results confirms previous findings
- Aim is to improve energy consumption calculation

Future steps:

- Develop new parameterization schemes for models
- Inclusion of radiation measurement and surrounding surface temperatures.

Thank you for your attention!

dasaraden.mauree@gmail.com
dasaraden.mauree@epfl.ch
@D_Mauree

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