

Improving local wind estimation for the automated control of blinds

BSA 2017 – Building Simulation Applications
3rd IBPSA-Italy Conference, Bozen-Bolzano 8.2.2017 – 10.2.2017

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Introduction

Building automated controls

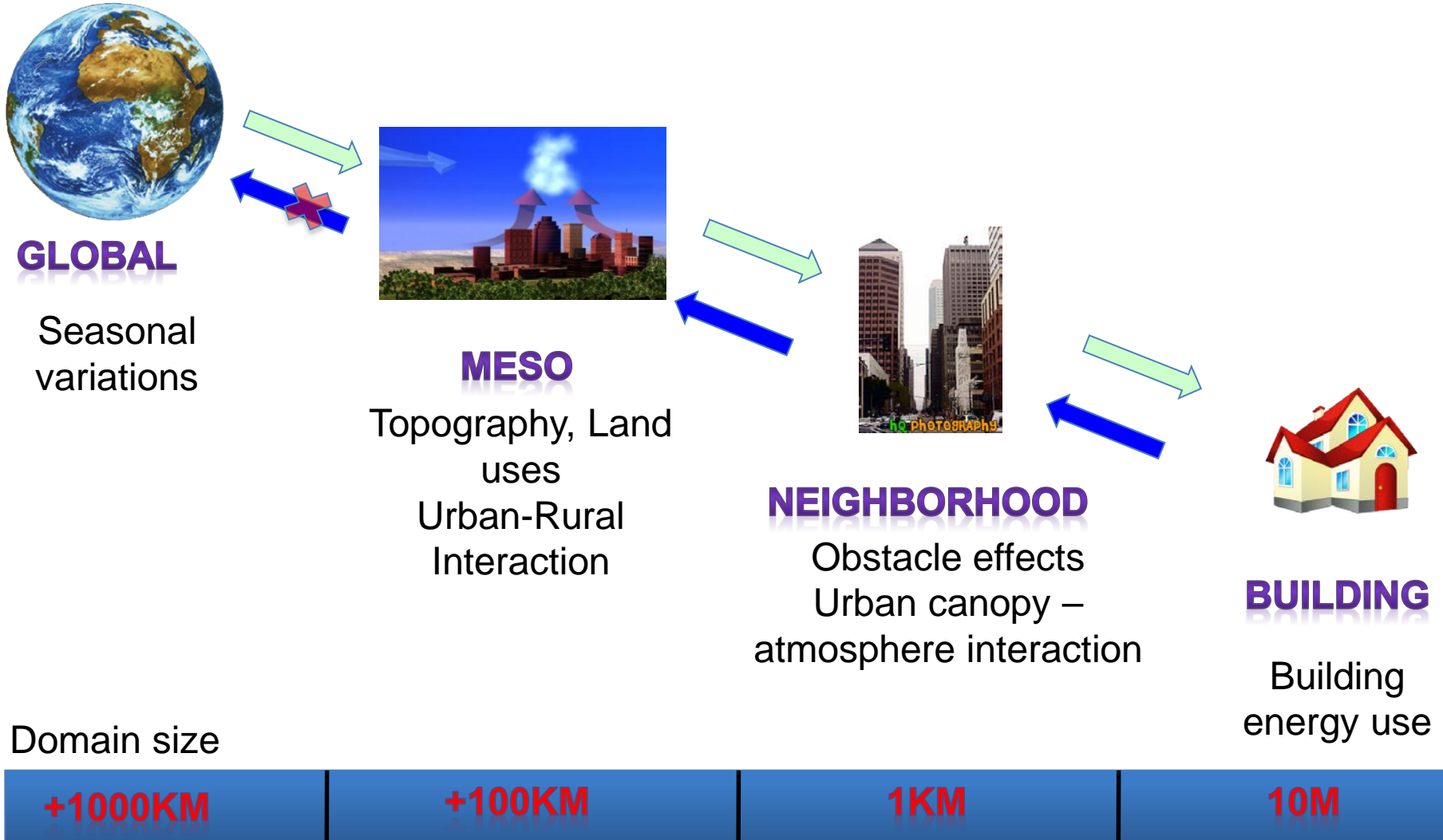
Automated systems installed in buildings:

- Improve user comfort (daylight, glare,...)
- Ameliorate solar heat gains (passive gains)
- Reduce damage to building systems (blinds)

Adoption of installation of automated systems have increased in recent years



Introduction Urban climate: interactions at different scales



Problems and Objectives

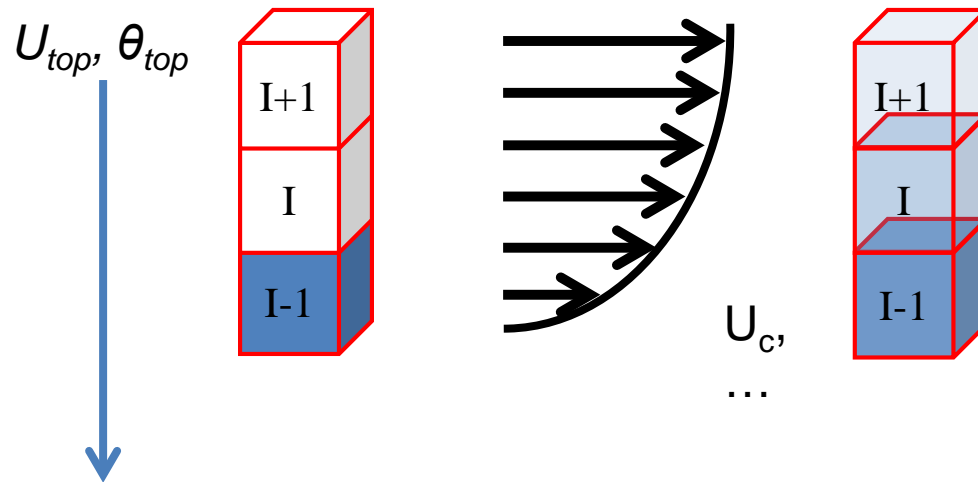
From users perspectives:

- Perception of erratic behaviour from such automated systems
- High maintenance cost due to damage of blinds

Need to improve the reliability of information transmitted.

- How to control blind systems?
- What is the priority (glare, solar gains, blinds protection,...)?
- How do we reduce frequency blind movements?
- How to reduce damages caused to blinds from strong gusts in urban areas?

Canopy Interface Model (CIM)



'I' – variable at centre
'c' – canopy values
'U' – wind speed (ms^{-1})

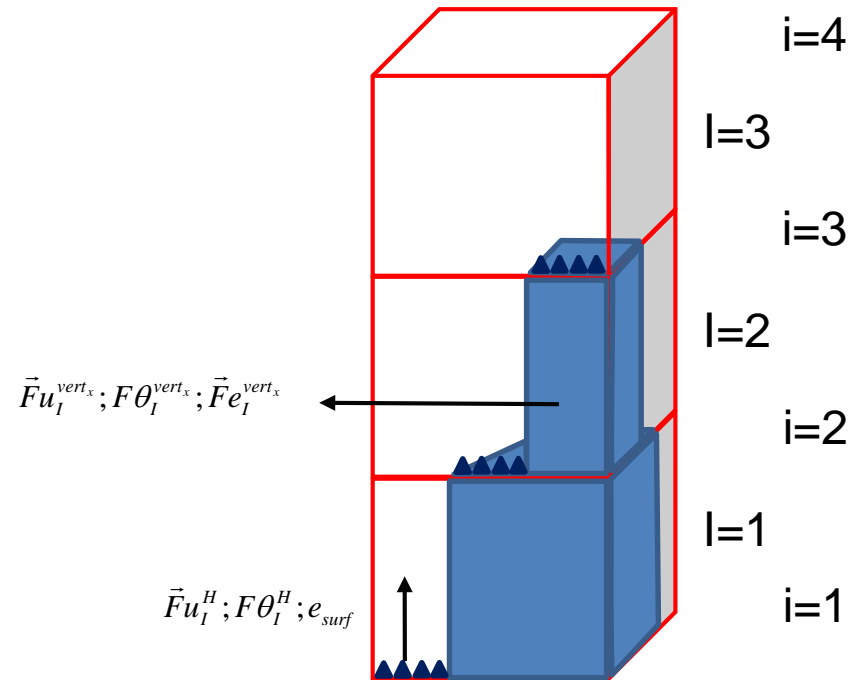
Boundary conditions from:

- Actual data
- Averaged dataset (Meteonorm)
- Models

Canopy Interface Model (CIM)

$$\frac{du}{dt} = \frac{d}{dz} \left(\mu_t \frac{du}{dz} \right) + f_u^s$$

$$\frac{d\theta}{dt} = \frac{d}{dz} \left(\kappa_t \frac{d\theta}{dz} \right) + f_\theta^s,$$



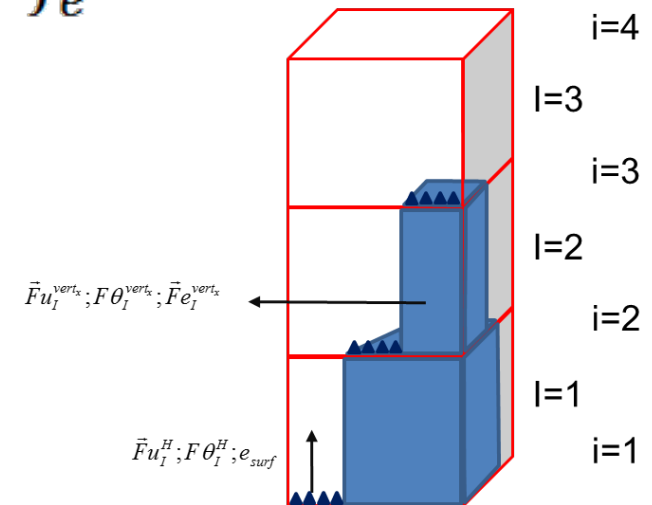
Mauree et al., 2017

Canopy Interface Model (CIM)

$$\mu_t = C_e \sqrt{e} l$$

$$\kappa_t = \text{Pr} \mu_t$$

$$\frac{de}{dt} = \frac{d}{dz} \left(\lambda_t \frac{de}{dz} \right) + C_\varepsilon \frac{\sqrt{e}}{l} (e_\infty - e) + f_e^s$$



Mauree et al., 2017

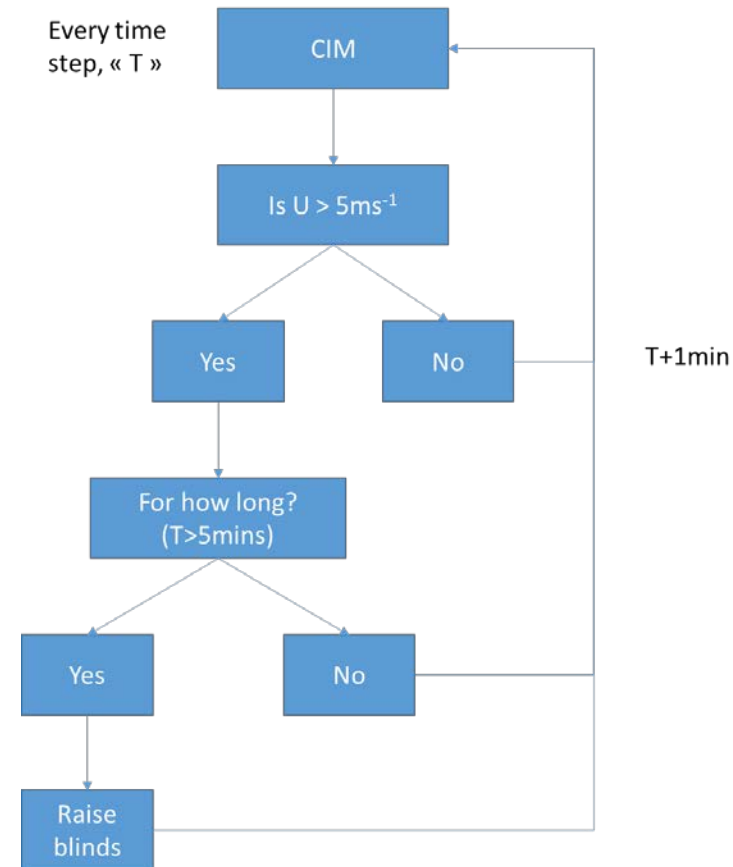
Control Algorithm

Wind speed

- CIM used to calculate vertical profile
- Individual response for each set of blinds
- Define limit

Erratic behaviour

- Additional control to limit movement of blinds
- Possibility to adjust the time constraint
- Use the maximum force the blind can sustain



Experiment

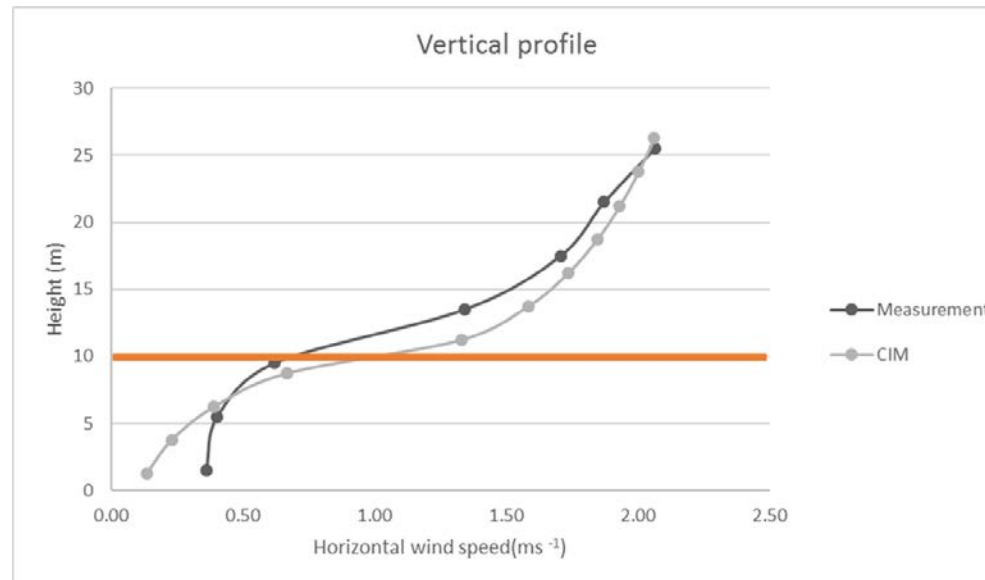
LESO Façade

- 3 floors (10 m high building)
- Each floor separated in two: one with windows and one for the daylight.



Results

Wind speed profile



Good agreement between measurement and simulated profiles

Results

Difference in wind speed calculation

| Floor | U (ms^{-1}) | Relative difference |
|-----------------|-------------------|---------------------|
| 1 st | 0.36 | 73% |
| 2 nd | 0.40 | 71% |
| 3 rd | 0.62 | 54% |

Table 1 – Wind speed measured at each floor v/s at top

Conclusions and Perspectives

MoTUS – Blind controls

- Use of a 1D canopy model
- Good agreement between model and measurements
- Low computational time : easy to implement in the control algorithms

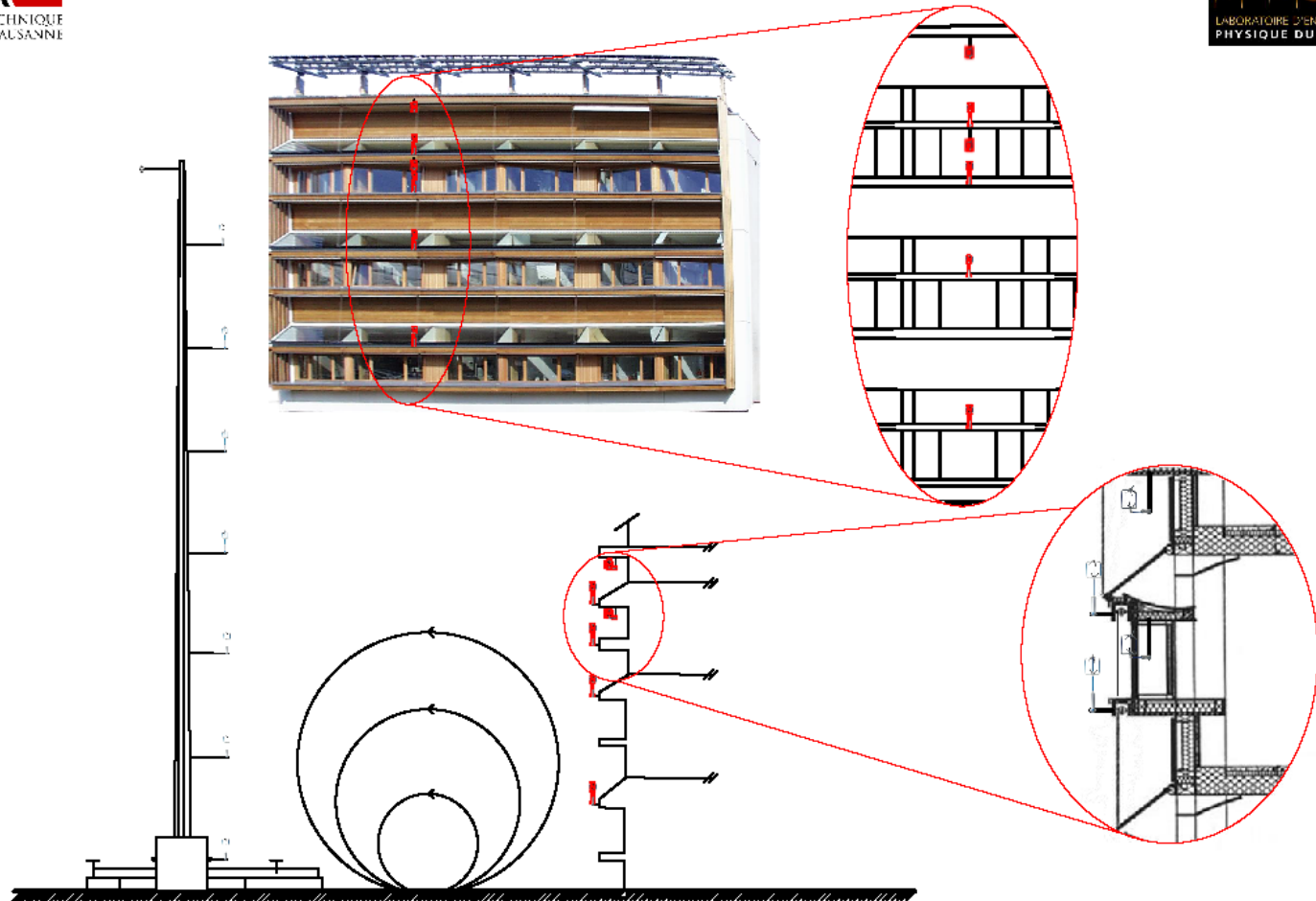
Implementation of controls – future steps:

- New system already being tested at LESO
- Control solar gains as well to improve thermal comforts.

Conclusions and Perspectives



Installation d'anémomètre sur la facade du LESO-PB



Thank you for your attention!




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In cooperation with the CTI

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