Influence of buildings on the urban atmosphere: need to couple CFD simulations with a building model

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Context
• Important impacts of urban phenomena such as air pollution or urban heat island.
• CFD: anticipate these phenomena for the populations and the environment.
• Difficulty to model the urban atmosphere, especially the building thermal influence.

Wall models in Code_Saturne
Two current wall models in Code_Saturne:
• “Force Restore” model
  ∂Tse
  ∂t
  = \sqrt{2\omega \mu}(L^* + S^* + h_{ext}(T_{ext} - Tse))
  - \omega(Tse - T_{int})
  (1)
  \omega: Earth angular frequency (Hz); \mu: thermal admittance (J.m^{-2}.s^{-0.5}.K^{-1}); T_{int}: indoor temperature (K).
• “Wall Thermal” model
  \lambda(e(T_{se}-T_{int}) + h_{ext}(T_{se}-T_{ext})) = L^* + S^*
  (2)
  \lambda: mean thermal conductivity of the wall (W.m^{-1}.K^{-1}); e: wall thickness (m); T_{int}: indoor temperature; h_{ext}: outdoor convection coefficient (W.K^{-1}.m^{-2}).

BuildSysPro
• Objective: use it as a wall model in Code_Saturne (coupling).
• Building modelling software developed by EDF R&D EnerBat in Modelica language.
• Can return the matrices A, B, C and D containing the building informations:
  \{ ˙T = AT + BU 
  Y = CT + DU \}
  (3)

The EM2PAU field campaign
• IFSTTAR, LHEEA, CSTB and Université du Maine.
• Street canyon modeled with containers.
• Important data base.
• Radiation, wind and thermal measurements around the modelled street canyon.

Dynamical effects of the buildings on the airflows

Influence of the temperature in the simulations

Conclusion and Acknowledgements
• Influence of temperature in the simulation of winds (with forced surface temperatures according to observed temperatures).
• Noised and weak thermal effects that are, so far, difficult to isolate from the preponderant dynamic effects.
• Next step: implementation of Osmosys building model in Code_Saturne.

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