Computational Building Physics

Pioneering Computational Models

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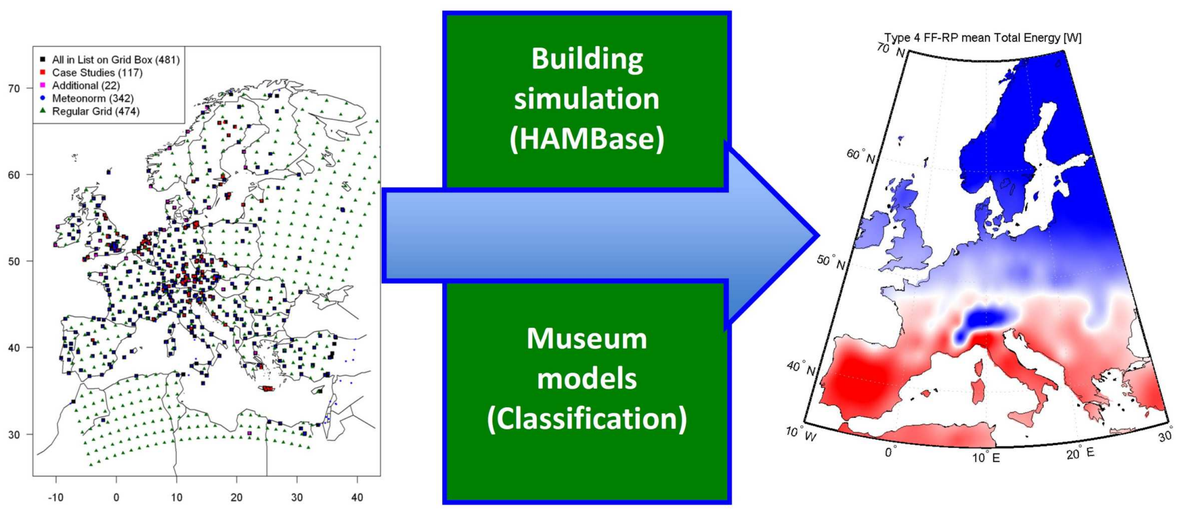
Maps of the expected future energy performances of museums

EU scale: ~Mm

The EU-FP7 project Climate for Culture provided us the opportunity to be first one (worldwide) to produce detailed simulated energy demand maps of museums for the near and far future, using HAMBase and MatLab [1].

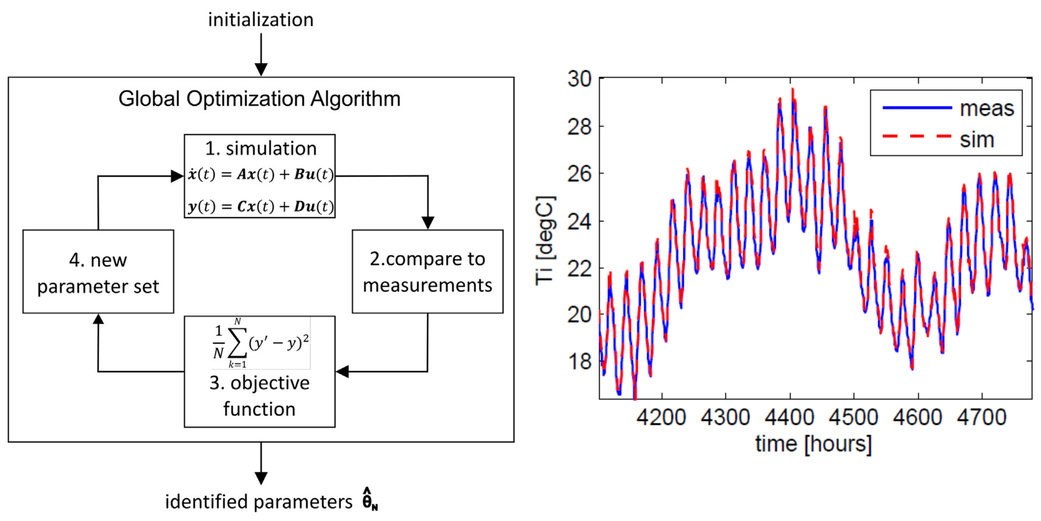


Impression of the methodology, using future external climate data form locations within the EU (Left) and simulated future indoor energy demand of a specific building for each location visualized in a map (Right).

Inverse modeling of thermal-hygric indoor climates using State-Space models

Human scale: ~m

We used measured time series of the indoor climates (temperature and relative humidity) several buildings, to derive the best parameters of thermal-hygric physics-based State-Space models. This model was in turn used to optimize the climate control [3].

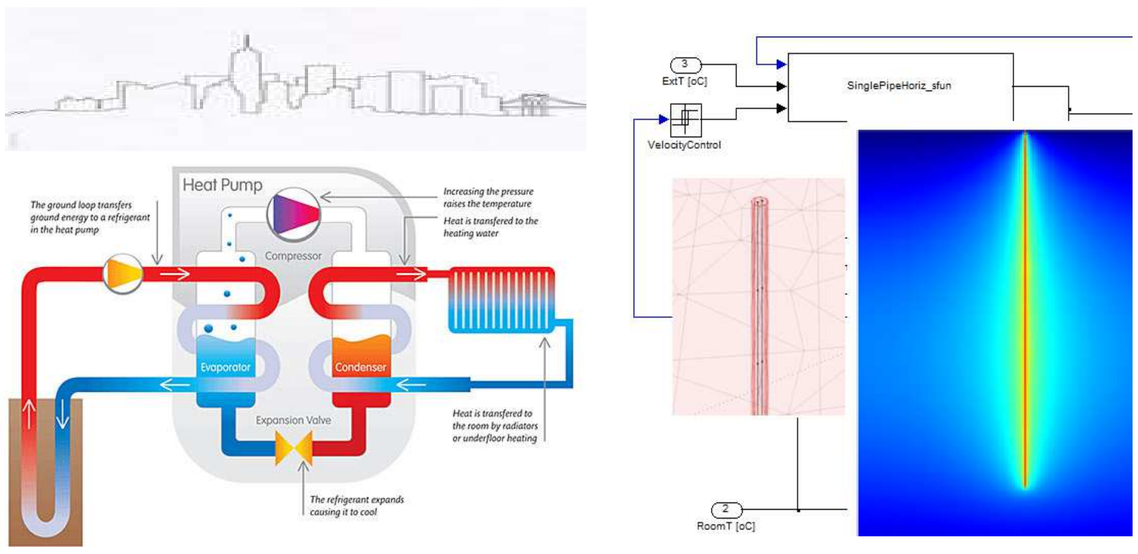


The methodology (Left) and the comparison of the measured and simulated temperatures of an indoor climate.

Integrated PDE (Comsol) and ODE (SimuLink) modeling of an aquifer, building and systems

Urban scale: ~km

In this international MSc research project, for the first time, a 2D PDE Comsol model of an aquifer with a heat pump and building model were integrated into SimuLink. [2]



Impression of modeling: The heat pump and heat exchangers (Left) and the Comsol model of the bore hole integrated and controlled in SimuLink (Right)

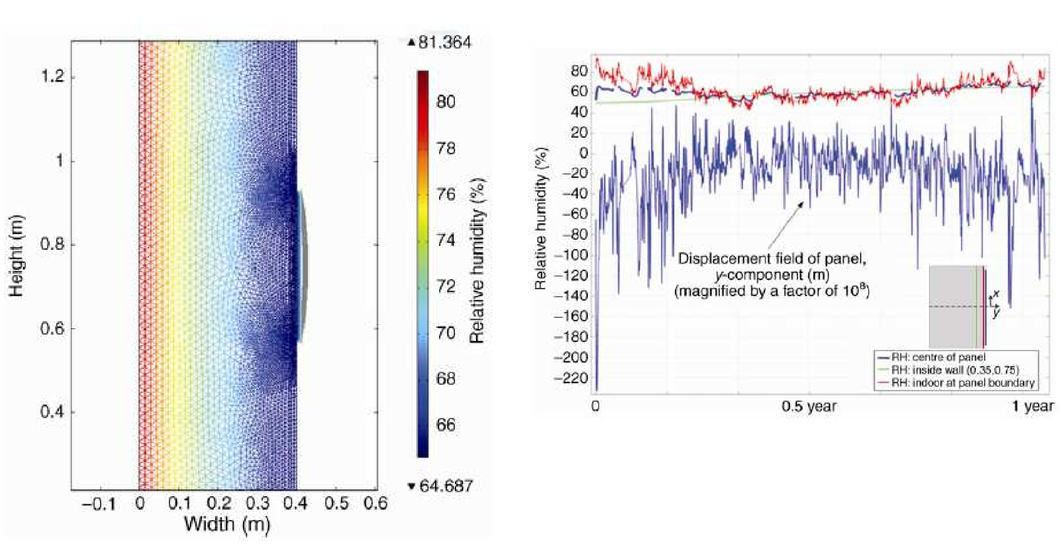
[1] Schijndel, A.W.M. van ,Schellen, H.L. (2015). Climate for Culture, Built Cultural heritage in times of climate change , **ISBN 978-3-00-048328**. Chapter 2.3

[2] Reenen, D. van, supervisors: Schijndel, A.W.M. van , Sasic Kalagasidis, A. (2011). Modeling the performance of underground heat exchangers and storage systems, **MSc Thesis Chalmers**

Multiphysics heat and mass transport and induced stress/strain in artifacts

Material scale: ~mm

We modeled and simulated the effect of temperature and humidity fluctuations on the heat-moisture-induced stress/strain of paintings inside monumental buildings [4].



The relative humidity (RH) distribution of a wall and painting at a specific moment (Left). The displacement of the panel i.e. painting ,due to RH fluctuations.

[3] Kramer, R.P., Schijndel, A.W.M. van & Schellen, H.L. (2013). Inverse modeling of simplified hygrothermal building models to predict and characterize indoor climates. **Building and Environment**, 68, 87-99.

[4] Williams Portal, N.L., Schijndel, A.W.M. van & Sasic Kalagasidis, A. (2014). The multiphysics modeling of heat and moisture induced stress and strain of historic building materials and artefacts. Building Simulation: An International Journal, 7(3), 217-227..

Excerpt from the Proceedings of the 2015 COMSOL Conference in Grenoble