Energy**P**lus **Lab**oratory for Sensitivity and Uncertainty Analysis in Building Energy Modeling : The EPLab Software

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Abstract

The sensitivity and uncertainty analysis in building energy modeling is a relevant topic for improvement of the buildings, the simulation models and their results.

The building physics modeling must be a tradeoff between the accuracy and a growing number of uncertain inputs. Moreover, it is a multiphysics simulation and a wide range of aspects and kind of results can be obtained in the same simulation. There is a need of reliability and transparence of the building performance simulation.

The software EPLab (**E**nergy**P**lus **Lab**oratory for Sensitivity and Uncertainty Analysis in Building Energy Modeling) has been develop to apply uncertainty and sensitivity analysis in building performance simulation and allows wide possibilities of adaptability according to the definition of the study. The EPLab Software is coded in Matlab, it consists of the generation of sample, then the creation of idf file in order to propagate the sample by the automated call of EnergyPlus and finally the extraction and shaping of the results from the EnergyPlus outputs. The Figure 1 presents the architecture of the EPLab software.

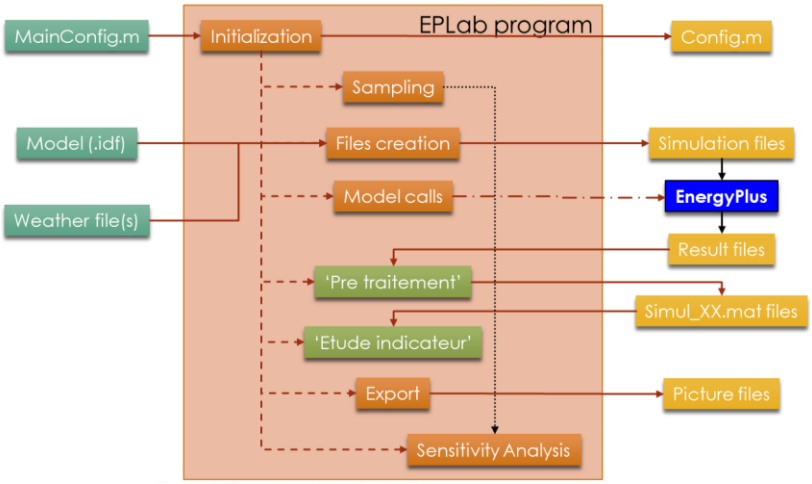

Figure 1: EPLab sotware architecture

The inputs can be fixed or statistically defined as Uniform, Gaussian with mean and variability or Discrete uniform. To evaluate the different inputs combinations, various sampling strategy can be used, the user can choose among the simple Monte-Carlo, the more relevant LHS with minimax or minimean strategies or the semi-random sequences like Halton and LP-π.

Then according to the base EnergyPlus model definition file, EPLab produces a new building model version (.idf file) for each combination of the input values from the sample. This base file is a fully functional EnergyPlus model with additional comment lines the user can produce a complex modification according to the specific inputs values for this simulation. Then the EP engine is called with the desired number of CPU core for parallel computing with one or several computers.

A verification of the completion of each simulation is made and the results are extracted and saved in a MatLab formatted file. A shaping procedure analyses in different ways the building behavior (time range, surface type, orientation, boundary condition, …) and produces scalar or time dependent results. Finally, the results can be saved and analyzed with graphical or sensitivity methods like RBD-FAST or other sensitivity methods implemented.

The aim of the contribution is to present the ability of the EPLab software dedicated to one of the most used building performance simulation software: Energyplus. EPLab is open source and available in Github repository (Rabouille et al., 2015). Two applications of the software will be presented. The First application is about an uncertainty and sensitivity analysis applied to hygrothermal simulation of a brick building in the hot and humid climate of Singapore (J. Goffart et al. 2015). The outputs of interest are the cooling energy demand and the temporal profile of indoor humidity and temperature, the results are obtained with the four levels of wall transfer model and two assumptions for the most complex model HAMT (see Figure 2). Then another application is exposed about the uncertainty and sensitivity analysis of the calculation of the solar incident radiation on the building exterior surfaces (A.P. Almeida Rocha et al. 2016). The output of interest is the solar fraction of the south facade (see Figure 3).

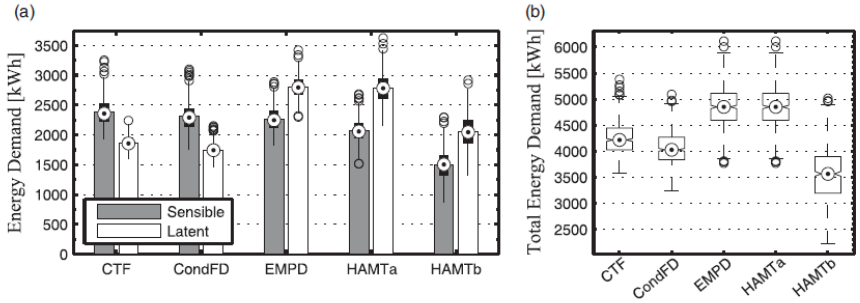

Figure 2: Box plot of the dispersion of the 600 simulations for the study on the annual results of cooling energy demand for the five cases: (a)sensible and latent cooling loads and (b) total cooling energy demand.

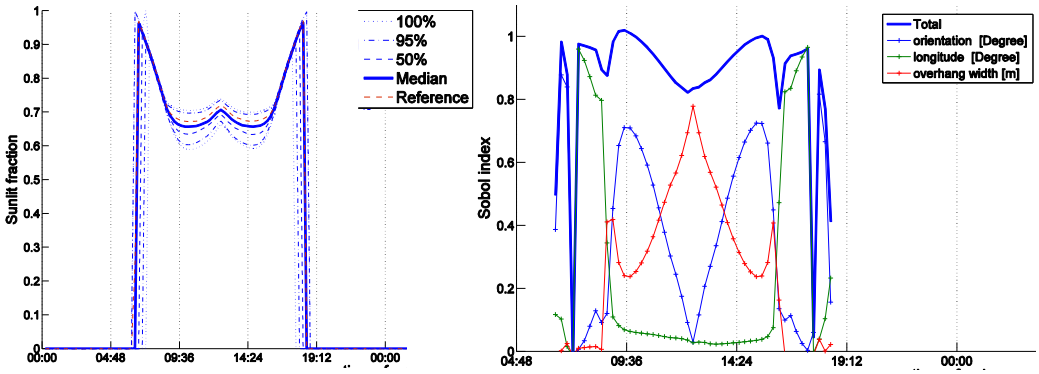

Figure 3: Solar fraction and distribution of uncertainties for the 21 march in New York at left and at right sensitivity index of the temporal profile associated with the solar fraction uncertainties (A.P. Almeida Rocha et al. 2016).

Currently an automated call of DAYSIM program is under progress, in order to perform uncertainty and sensitivity analysis combined with EnergyPlus and DAYSIM for both common natural lighting and energy performance issues.

References:

M. Rabouille, J. Goffart, EPLab: Sensitivity and Uncertainty Analysis in Building Energy Modeling, GitHub repository, V1.8 (2015). https://github.com/mrabouille/EPLab/releases.

J.Goffart, M. Rabouille, N. Mendes. « Uncertainty and sensitivity analysis applied to hygrothermal simulation of a brick building in a hot and humid climate », Journal of Building Performance Simulation, December 2015, http://dx.doi.org/10.1080/19401493.2015.1112430

A.P. Almeida Rocha, J. Goffart, N.Mendes « Uncertainty assessment of the calculation of the solar incident radiation on the building exterior surfaces» Energy and Buildings , under review