



**HAL**  
open science

# THE INFLUENCE OF THERMOCHROMIC GLAZING PARAMETERS ON ENERGY SAVING AND COMFORT CRITERIA USING MOMENT-INDEPENDENT MEASURE

Arthur Ah-Nieme, Bruno Malet-Damour, Dimitri Bigot, Stéphane Guichard, Harry  
Boyer

► **To cite this version:**

Arthur Ah-Nieme, Bruno Malet-Damour, Dimitri Bigot, Stéphane Guichard, Harry Boyer. THE INFLUENCE OF THERMOCHROMIC GLAZING PARAMETERS ON ENERGY SAVING AND COMFORT CRITERIA USING MOMENT-INDEPENDENT MEASURE . Assemblée Générale du laboratoire PIMENT 2017, Nov 2017, Petite-île, Réunion. <hal-01654443>

**HAL Id: hal-01654443**

**<https://univ-reunion.hal.science/hal-01654443v1>**

Submitted on 4 Dec 2017

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

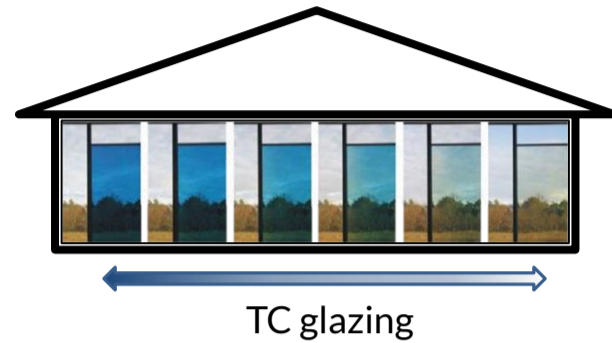
# THE INFLUENCE OF THERMOCHROMIC GLAZING PARAMETERS ON ENERGY SAVING AND COMFORT CRITERIA USING MOMENT-INDEPENDENT MEASURE

## AIM OF THE STUDY

Identify the influence of thermochromic glazing parameters for office buildings in hot climates using dynamic building simulations and sensitivity analysis techniques

## BACKGROUND

**Thermochromic glazing (TC):**  
Has the capability to modulate its thermo-optical properties dynamically and reversibly when a change in its temperature occurs

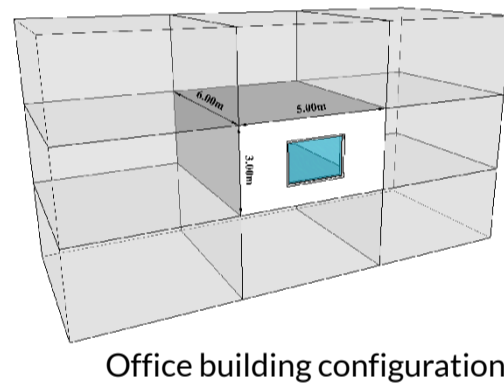
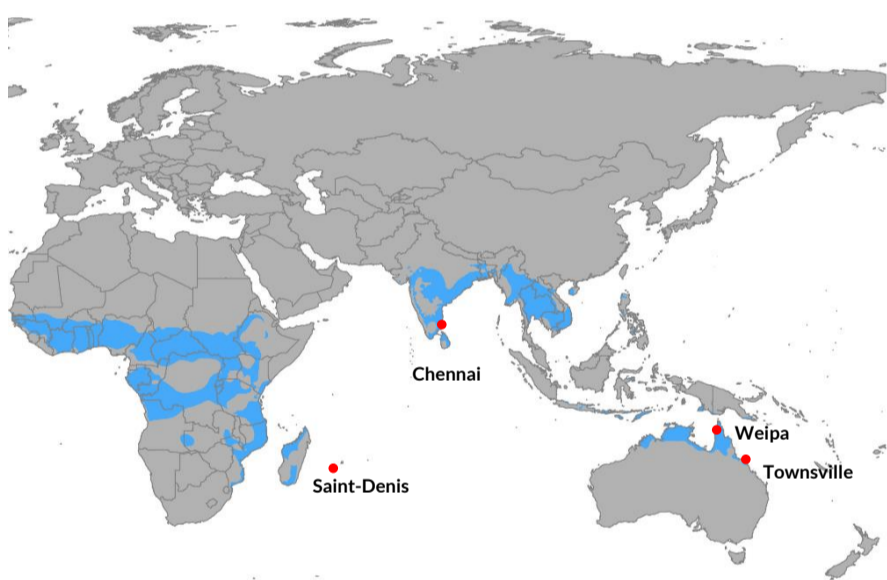




### TC glazing for building application

- Has to be doped with other metals to improve its properties: (Li and al., 2012)
  - Transition temperature
  - Visible Transmittance
  - Solar modulation
- Has a potential to:
  - Reduce energy consumption (Hoffmann et al., 2014)
  - Improve thermal and visual comfort (Costanzo and al., 2016)
- Has a greater efficiency for hot climates (Saeli and al., 2010)



## METHODOLOGY



- Thermal and daylighting simulations with EnergyPlus 
- Sensitivity analysis method with a Python code with the SALib 
- Analysis on several indexes and on 4 locations (hot tropical climates)

## SENSITIVITY ANALYSIS

### Moment-Independent Measure (Borgonovo, 2007):

The assessment of “the influence of the entire input distribution on the entire output distribution without reference to a particular moment of the output”

INPUT VARIABLES	SYMBOL	RANGE	UNIT	PROBABILITY
Building Orientation	BO	0-360	°	Continuous; Uniform
Window to Wall Ratio	WWR	5-99	%	Continuous; Uniform
Insulation Thickness	$\theta_{ins}$	0.01-0.7	m	Continuous; Uniform
Weather File	wea	1-4	-	Discrete; Uniform
Switching Temperature	$T_s$	5-70	°C	Continuous; Uniform
Switching Temperature range	$\Delta T_s$	1-50	°C	Continuous; Uniform
Solar Transmittance Max	$\tau_{sol,max}$	0.3-0.9	-	Continuous; Uniform
Solar Transmittance range	$\Delta \tau_{sol}$	0.01-0.5	-	Continuous; Uniform
Visible Transmittance Max	$\tau_{vis,max}$	0.3-0.9	-	Continuous; Uniform
Visible Transmittance range	$\Delta \tau_{vis}$	0.01-0.5	-	Continuous; Uniform
Number of states	state	2-20	-	Discrete; Uniform

4096 simulations were performed

## MODEL OUTPUTS

### Normalized output indexes

Energy consumption index ( $I_{ec}$ ):

- Sum of the final energy consumed in one year
- Cooling and artificial lighting



Thermal comfort index ( $I_{th}$ ):

- % of time when the operative temperature is below 26°C

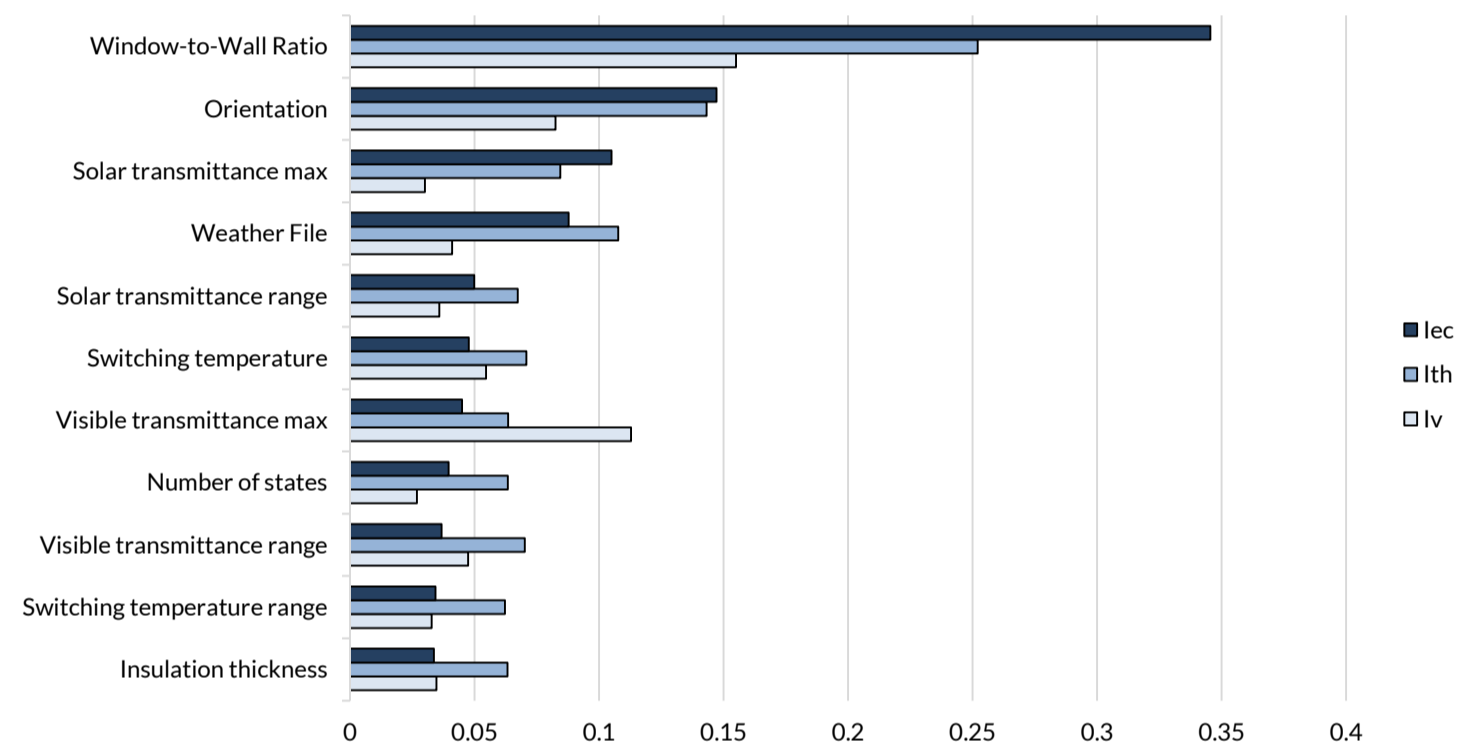
Visual comfort index ( $I_v$ ):

- % of time when the illuminance reference points are between 300 and 2000 lux



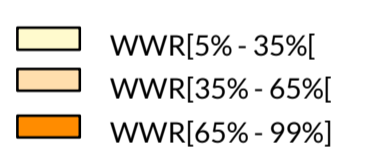
## RESULTS

### Delta

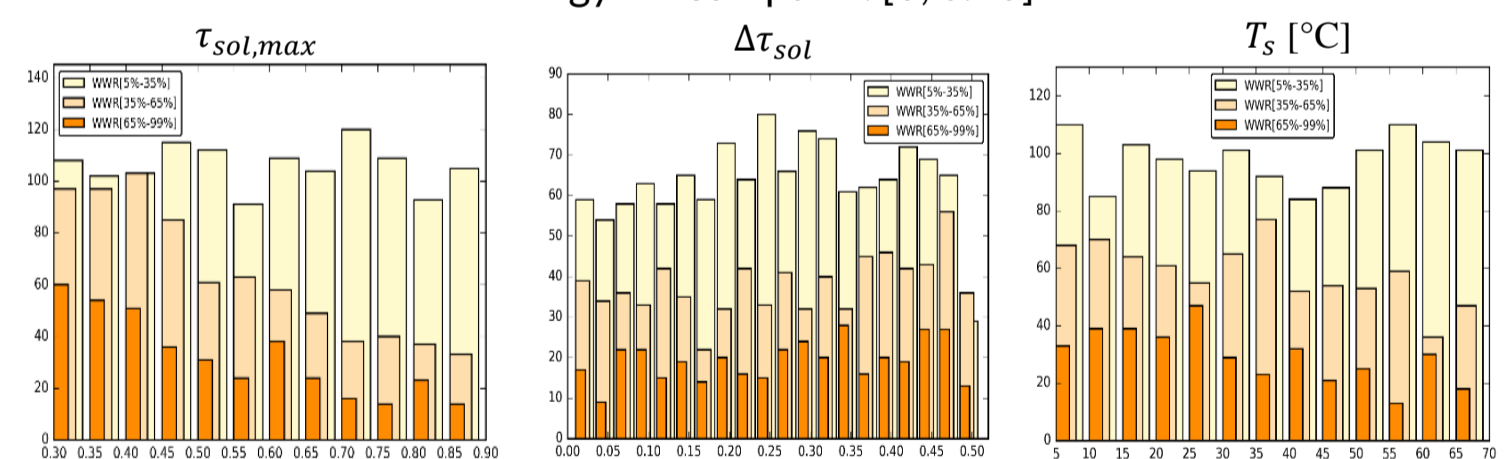


### Distribution of input parameters

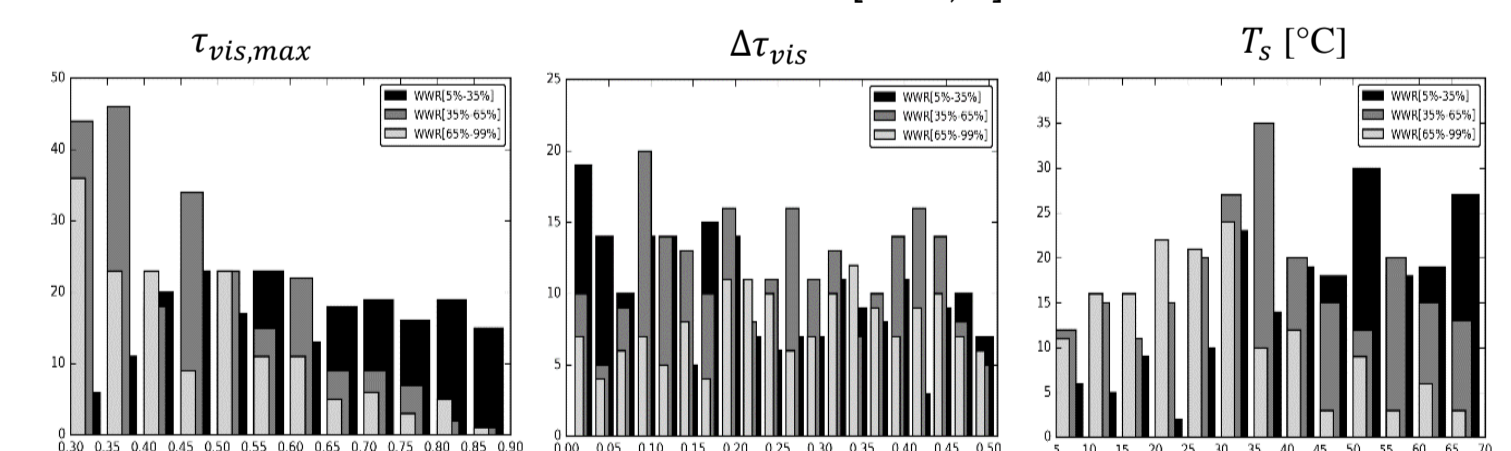
- Filtering model outputs according to a criteria
- Sorting given inputs by glazing size (small, medium, large)



Energy consumption: [0; 0.40]



Visible comfort: [0.70; 1]



## REFERENCES

- Borgonovo, E., 2007. A new uncertainty importance measure. Reliab. Eng. Syst. Saf. 92, 771–784.  
 Costanzo, V., Evola, G., Marletta, L., 2016. Thermal and visual performance of real and theoretical thermochromic glazing solutions for office buildings. Sol. Energy Mater. Sol. Cells 149, 110–120.  
 Hoffmann, S., Lee, E.S., Clavero, C., 2014. Examination of the technical potential of near-infrared switching thermochromic windows for commercial building applications. Sol. Energy Mater. Sol. Cells 123, 65–80.  
 Li, S.-Y., Niklasson, G.A., Granqvist, C.G., 2012. Thermochromic fenestration with VO<sub>2</sub>-based materials: Three challenges and how they can be met. Thin Solid Films, 7th International Symposium on Transparent Oxide Thin Films for Electronics and Optics (TOEO-7) 520, 3823–3828.  
 Saeli, M., Piccirillo, C., Parkin, I.P., Binions, R., Ridley, I., 2010. Energy modelling studies of thermochromic glazing. Energy Build. 42, 1666–1673.



Arthur J.P. Ah-Nieme

B. Malet-Damour, D. Bigot, S. Guichard, H. Boyer

✉ arthur.ah-nieme@univ-reunion.fr

Article accepted in the Australasian Building Simulation Conference

15 – 16 November 2017 – Melbourne

