

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

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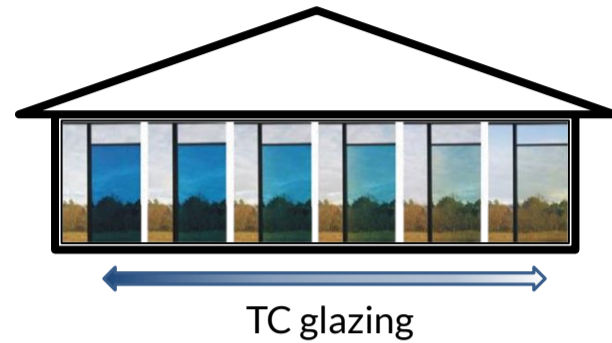
THE INFLUENCE OF THERMOCHROMIC GLAZING PARAMETERS ON ENERGY SAVING AND COMFORT CRITERIA USING MOMENT-INDEPENDENT MEASURE

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

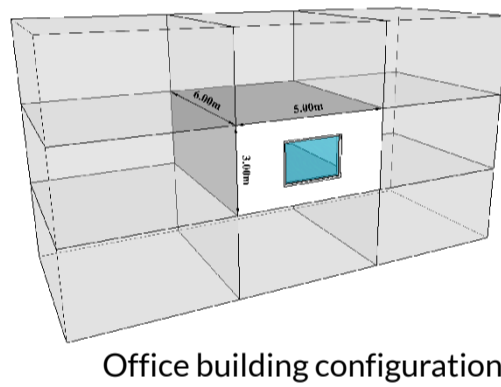
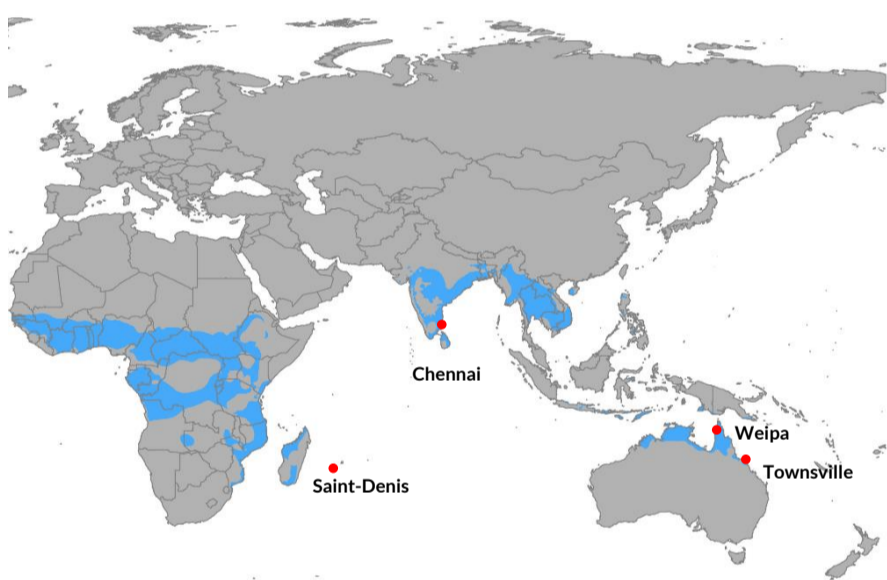




TC glazing for building application

- 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 | θ_{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 | ΔT_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

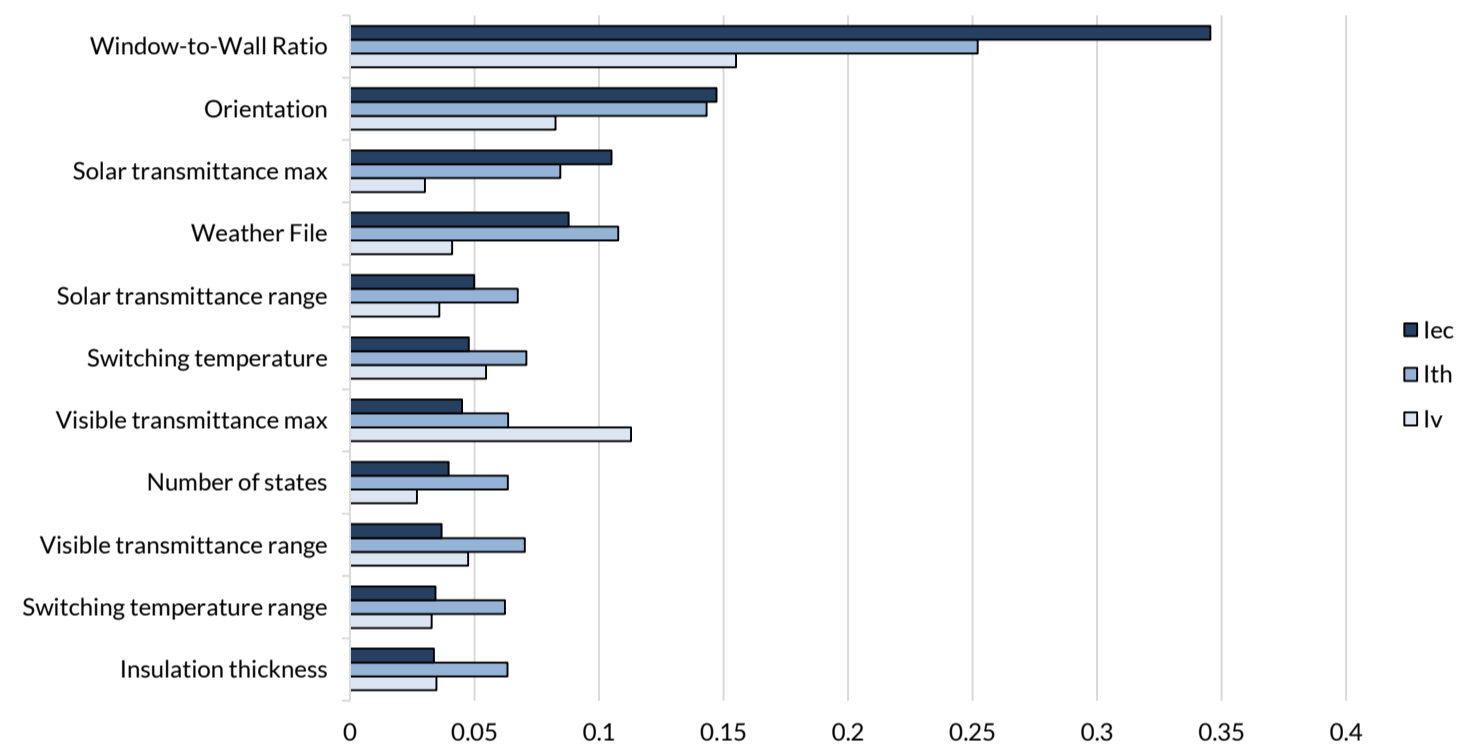
Visual comfort index (I_v):

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



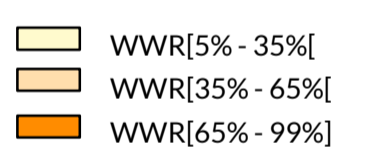
RESULTS

Delta

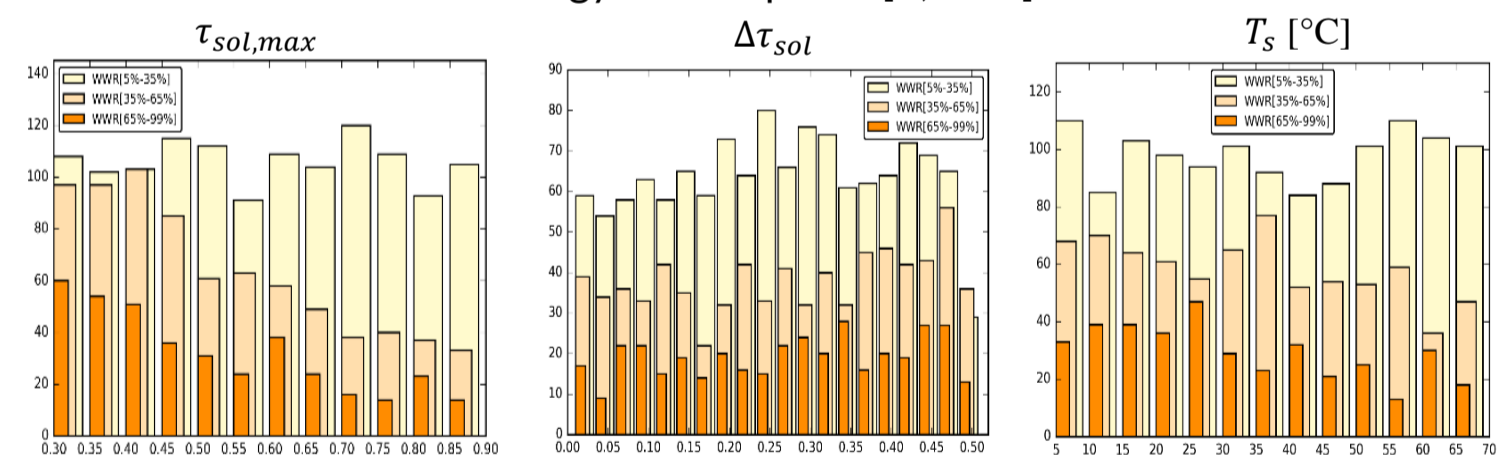


Distribution of input parameters

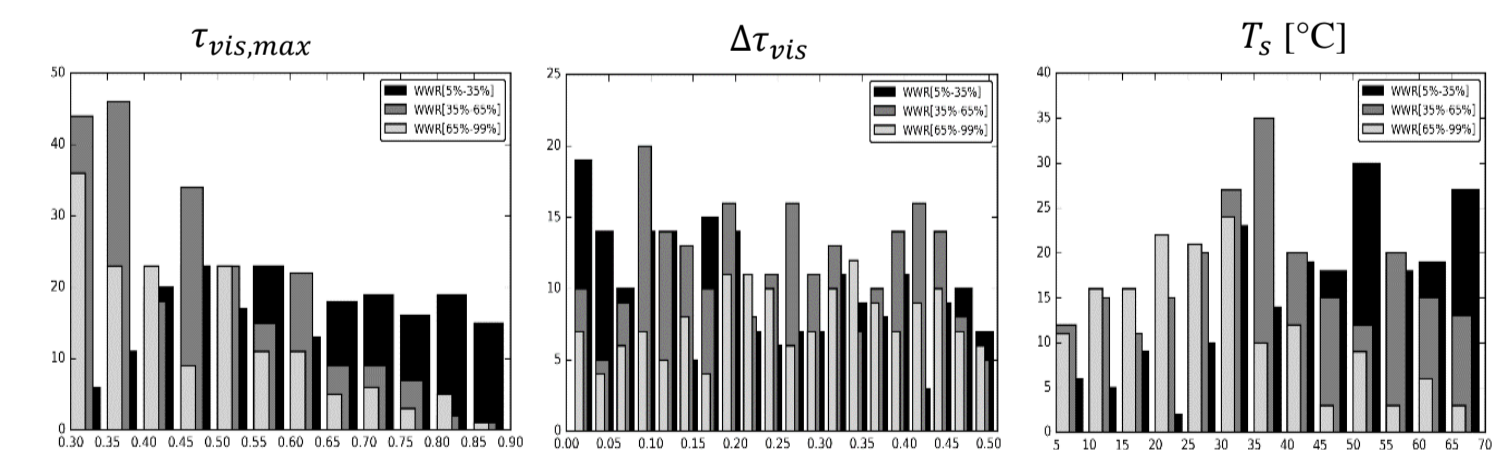
- Filtering model outputs according to a criteria
- Sorting given inputs by glazing size (small, medium, large)



Energy consumption: [0; 0.40]



Visible comfort: [0.70; 1]



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