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## **Thermal comfort analysis: comparison between model and experimental data in tropical climate**

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# Thermal comfort analysis: comparison between model and experimental data in tropical climate

## Introduction

Thermal Comfort means two things:

1. No physiological thermo-regulation
2. Hedonic feeling through thermal perception

### How do we predict thermal comfort?

By choosing the **right model**  
 By **experimental validation**

For the **right people** and  
 the **right environment**

**Aim:** to show that there is a need to promote the studies of thermal comfort for the Reunion context

## Experimental & Numerical set-up

Subjects	Age	Activity	BMI	Clothing
Students	20 to 30 years old	Desk work	16.3 to 32.7	Everyday wear

The highest response rate to the comfort questionnaires was obtained on two particular days:

April 26, 2021	April 29, 2021
Overcast Light ambiance: intermediate "Active" porosity: 13%	Clear sky (morning); overcast sky (afternoon) Light ambiance: bright (morning); intermediate (afternoon) "Active" porosity: 13%

### Questionnaire

Scale	Thermal sensation	Visual sensation
+3	Hot	Glare
+2	Warm	Bright
+1	Slightly warm	slightly bright
0	Comfortable, neutral	Comfortable, neutral
-1	Slightly cool	Slightly dark
-2	Cool	Dark
-3	Cold	Very dark

The questionnaire was answered through **online forms** according to a **normalized scale (ASHRAE)**



### Measurement

The apparatus gathered all **physical parameters** proper to the room and **physiological parameters** for each participant through **sensors**



Parameters
$T_{a,ind}$ , $RH_{ind}$
$T_{sk}$ , $T_{scl}$
$T_g$
$v_a$
$T_a$ , $RH$



### Spreadsheet

The spreadsheet was used to **calculate models results** with the variables measured **in situ**. Three types of data were obtained:

Temperature	Thermal Perception Index	Portion of Population
in [°C]	According to ASHRAE scale	in [%]

## Conclusion & Perspectives

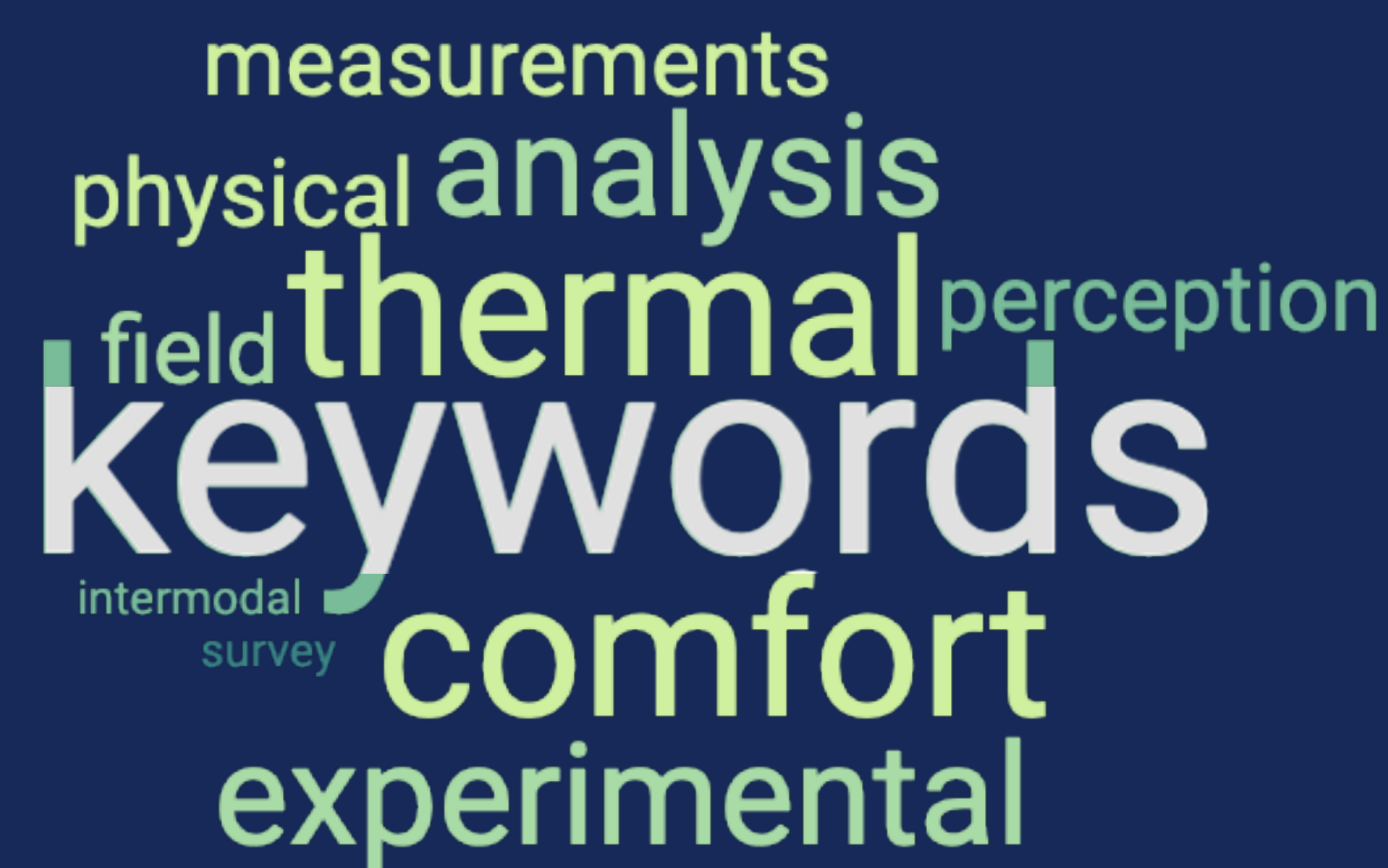
**Modeling**  
**Marked discrepancy : unsuitable approaches for the survey conditions**

**Experiment**  
**Identify the least intrusive perception assessment techniques possible**

**Consistent results**  
**Highlighting the inadequacy of temperate climate studies in the tropical climate context**

Perspectives in modeling  
**Create a generic model**  
**Build a numeric model generator**

Perspective for experiment  
**Develop a field survey combining physics-physiology-psychology**



## Methods

### Indoor thermal comfort models

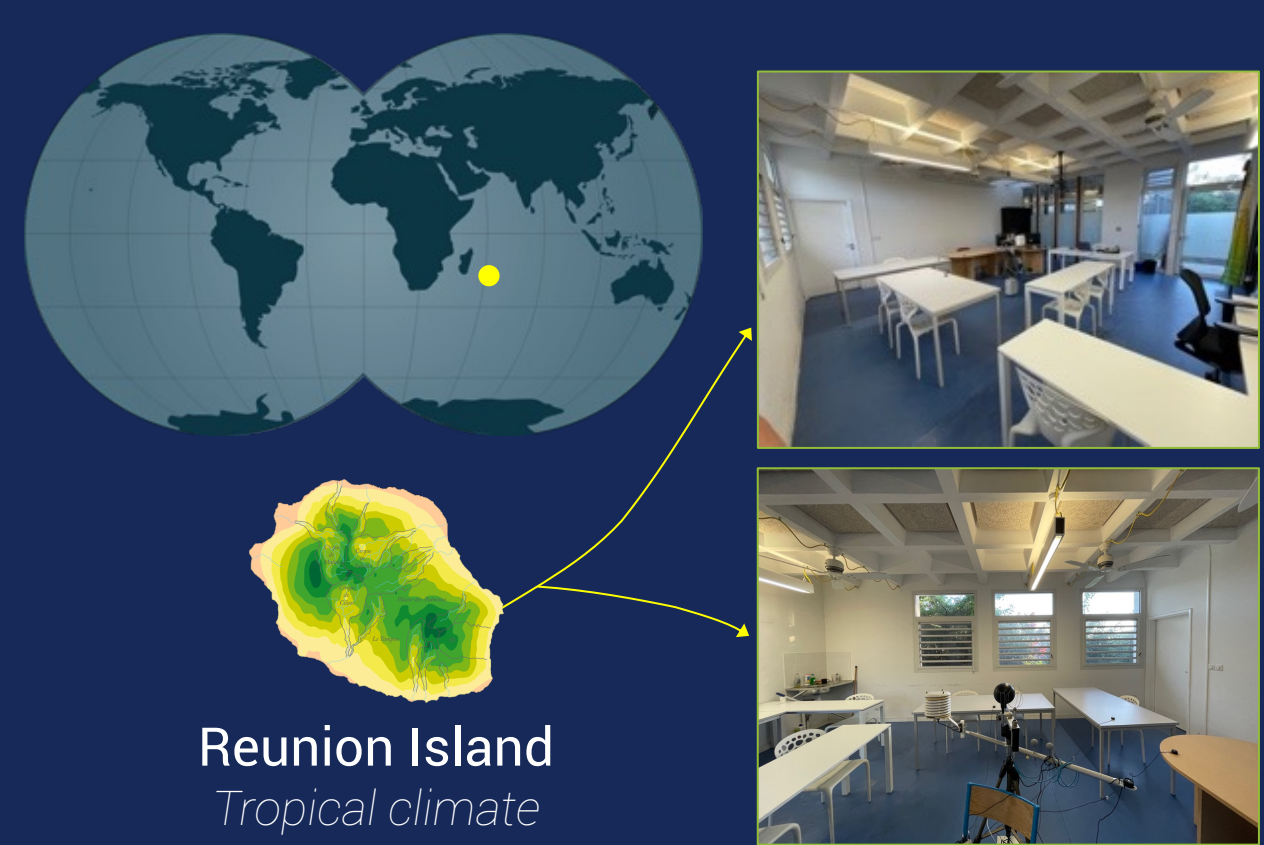
Identification of **models** in the literature  
 Implementation of the models in a spreadsheet

Classes	Output type	Designation
Analytical models	Index	PMV
	Rate	PPD
	Index	TS
	Rate	RSI
	Temperature	$T_{sub}$
Empirical models	Temperature (comfort temperature)	$T_{CBrager \& De Dear}$
		$T_{rSI}$
		$T_{CAuliciens}$
		$T_{CHumphreys}$
Adaptative models	Temperature (neutrality temperature)	$T_{BBrager \& de Dear}$
		$T_{DAuliciens}$
		$T_{BGriffiths}$
		$T_{BGriffiths}$
		$T_{BNicol \& Roof}$

### Experiment on thermal perception Measurement & field survey

Realization of online **questionnaires** on **thermal perception (ASHRAE scale)**

Physical measurements of the **thermal environment** and **skin temperatures** of the occupants

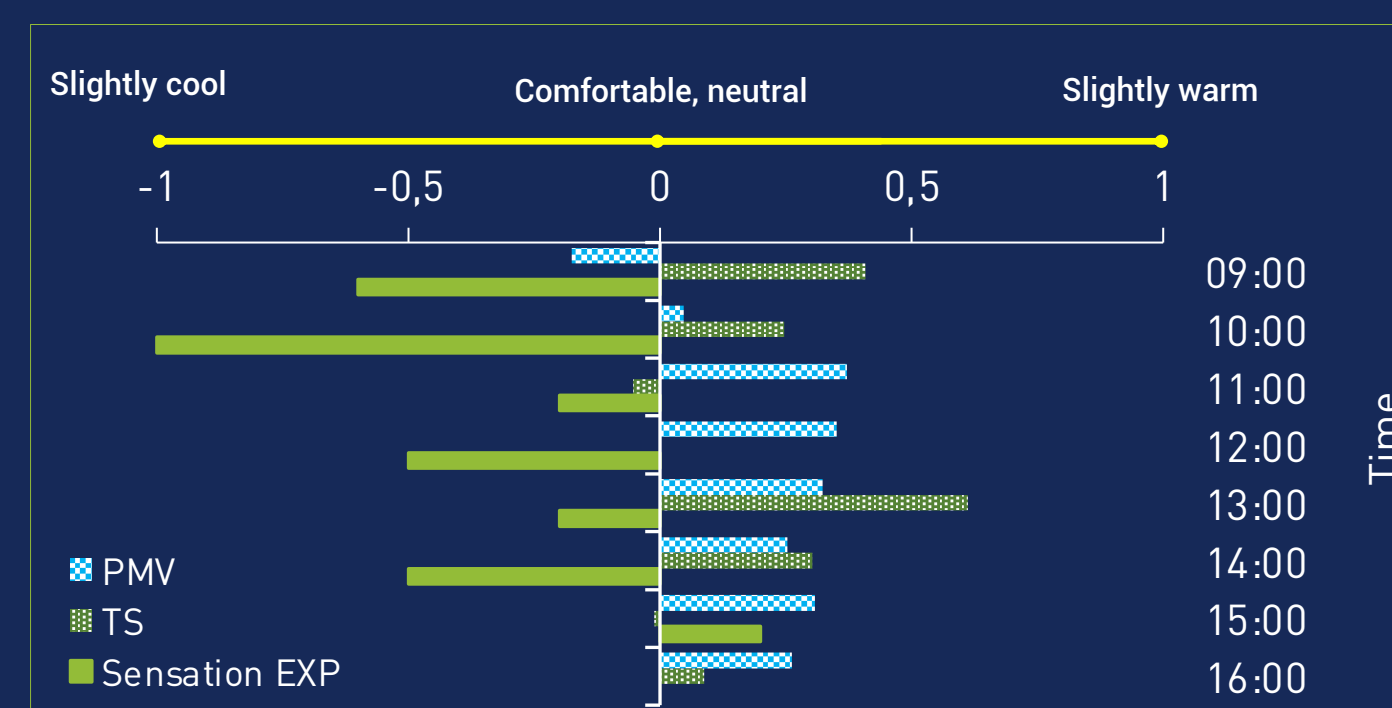


Comparative analysis between **Modeling & Experiments results**

## Results

### Comfort indexes

Hourly evolution of the average comfort index (over the group)



### Experiment analysis

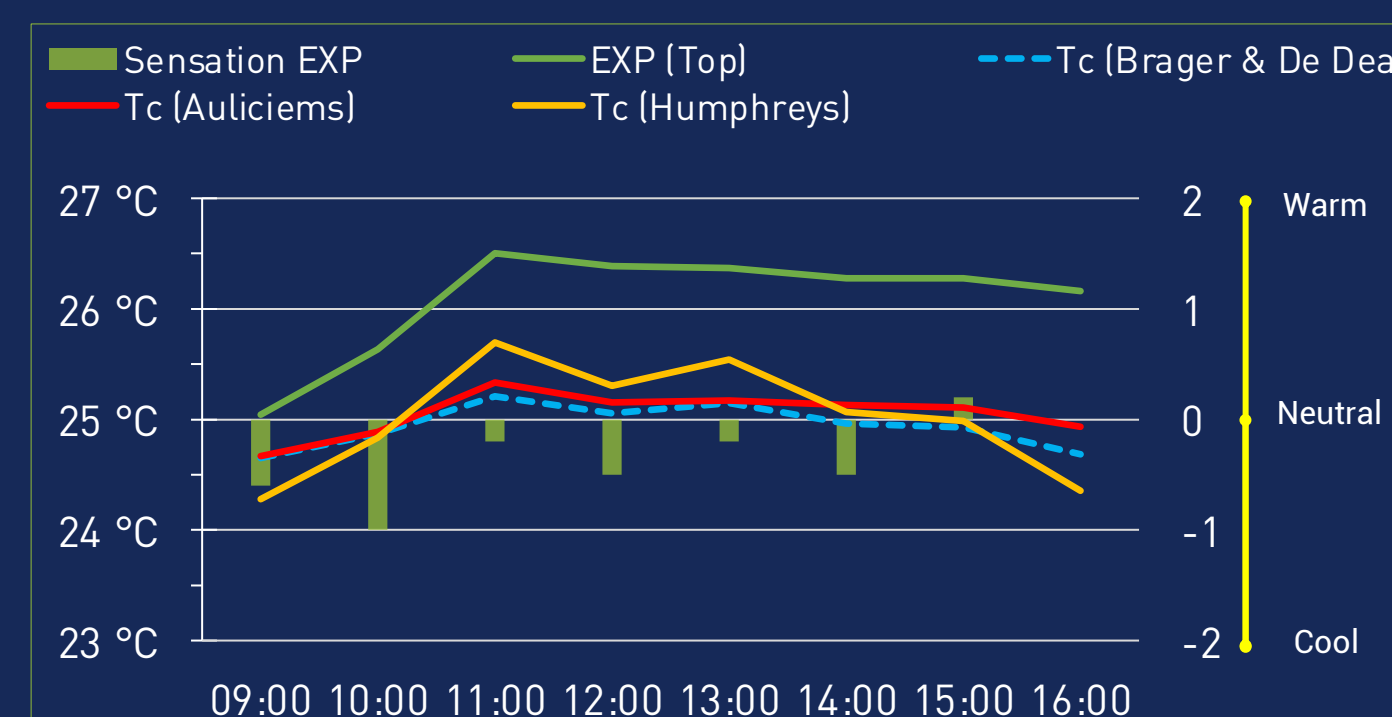
- Sensations between "slightly cold" and "slightly warm"

### Indexes analysis

- PMV (Fanger): inappropriate (temperate climate; AC building)
- TS (Rholes and Nevins): inappropriate (temperate climate; climatic chamber)

### Comfort temperatures

Comparative analysis of average results of  $T_{c,average}$  with  $T_{op,average}$  and occupant perception



### Experiment analysis

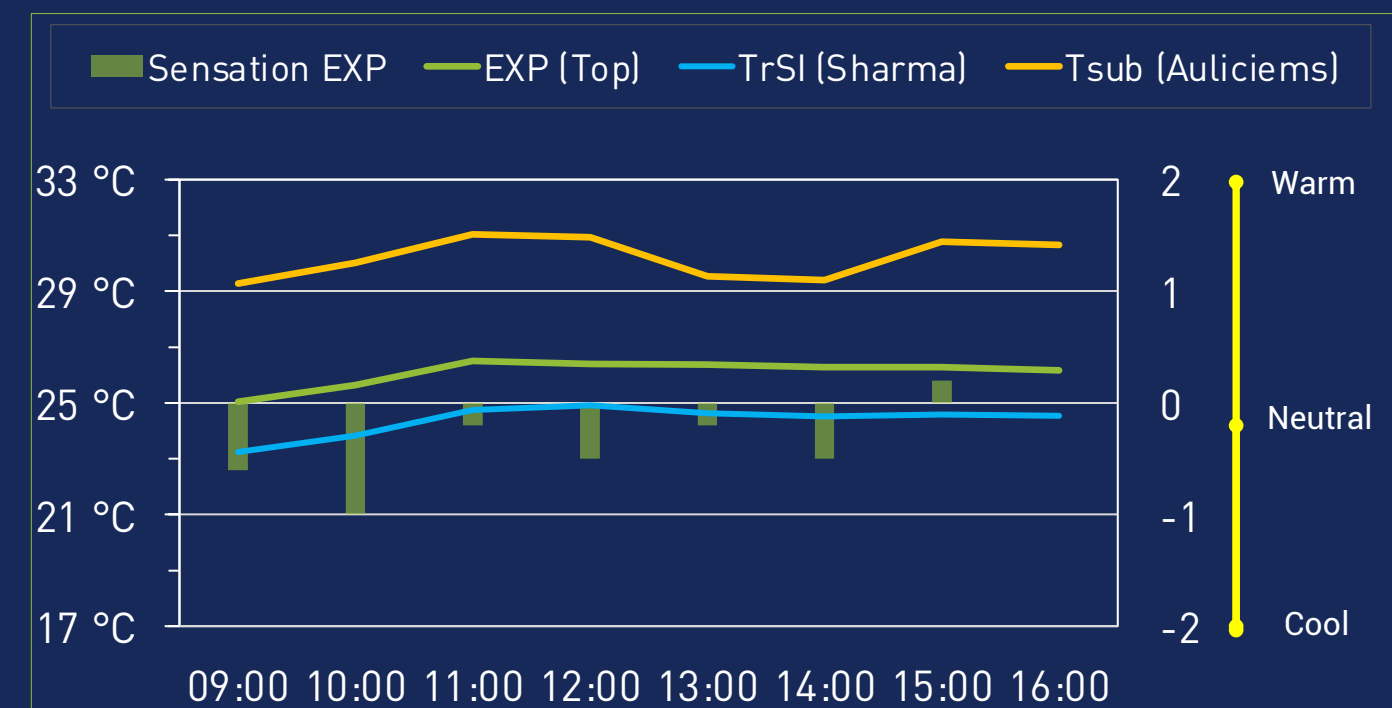
- Neutral situation = thermal comfort
- $T_{op,neutral} = 26.3 \text{ } ^\circ\text{C}$

### Comfort temperatures analysis

- Brager and De Dear + Auliciens: inappropriate
- Humphreys: most efficient, but insufficient
- Possible origins of bias: physical (relative humidity or airspeed) Or physiological (clothing, metabolic level, acclimatization) parameters: not considered

### Neutrality temperatures

Evolution of  $T_{rSI}$ ,  $T_{sub}$  and  $T_{op,average}$  and occupant perception



### Comfort temperatures analysis

- Auliciens: overestimation ( $\approx 4^\circ\text{C}$ , different trend) probably due to relative humidity (76% in the room // 50%)
- Sharma: same trend with a difference of  $1.5 \text{ } ^\circ\text{C}$  due to the climatic conditions under which this approach was developed (hot and humid climate of India)

... more results are available in the article (ID: 209) !

