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A central air conditioning control strategy to enhance thermal comfort in library buildings

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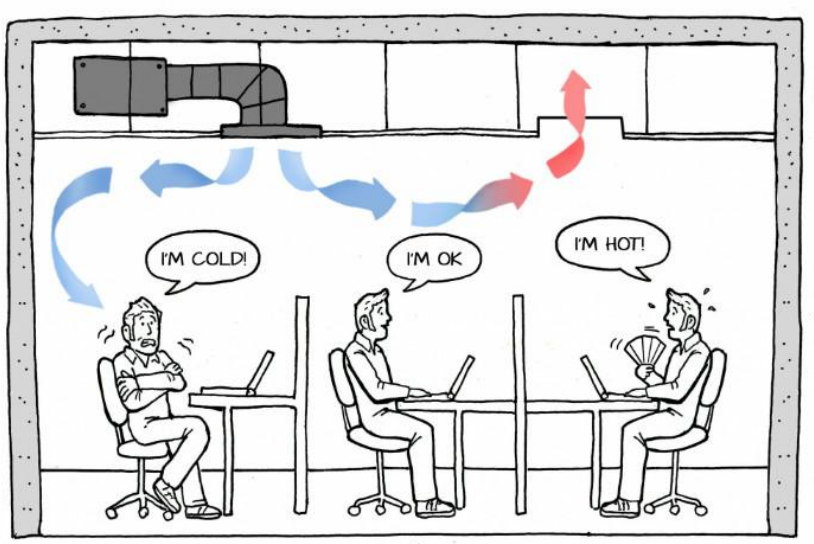
ISHVAC 2019

Issue

Indoor air temp often too cold

Important drivers

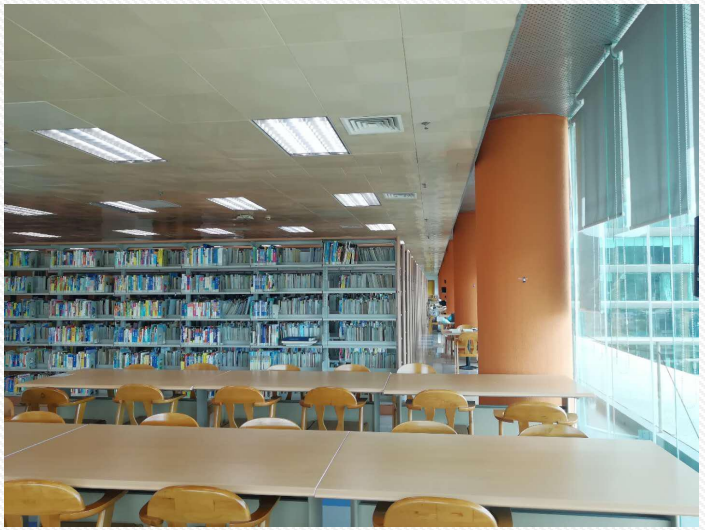


Spatio-temporal distribution of indoor thermal environment

Outdoor weather condition

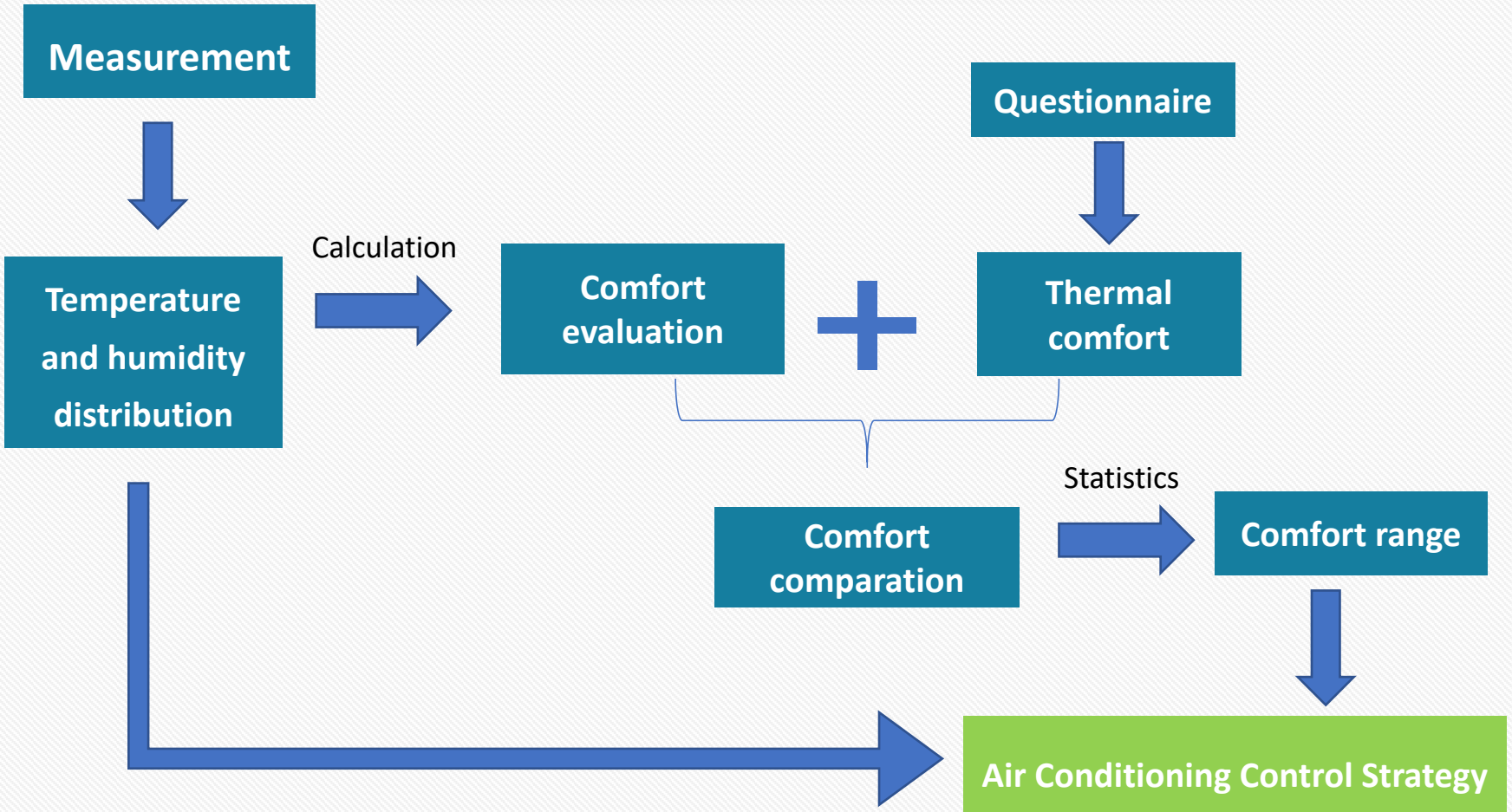
Study sites

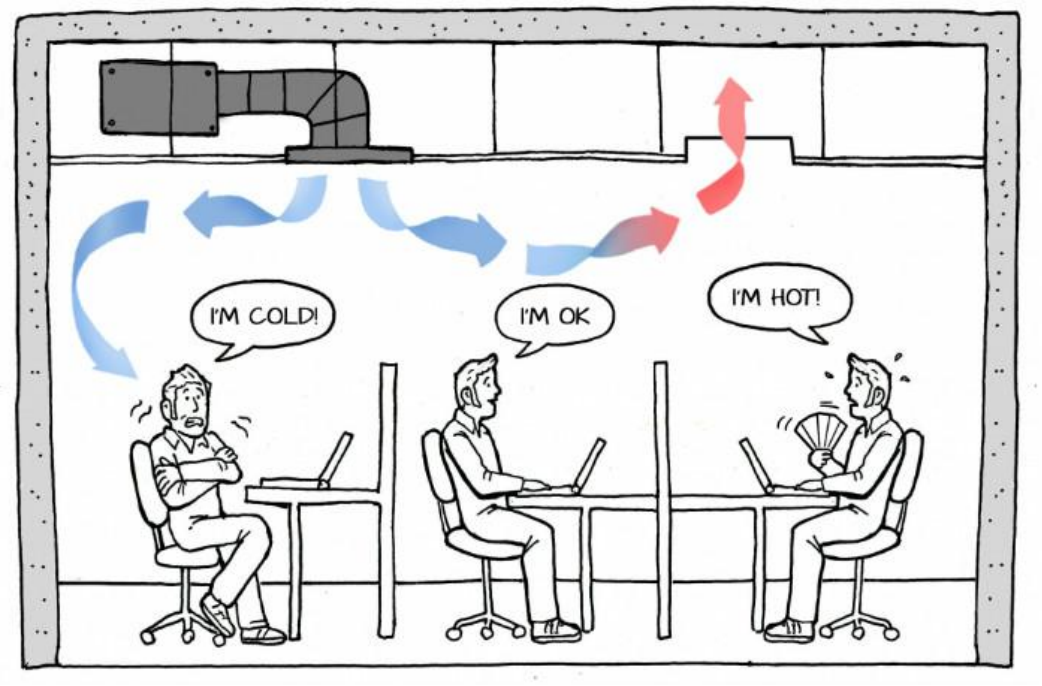
Sun Yat-sen University Library, Zhuhai



8th floor, library

Research flow





1. Indoor environment measurement
2. Subjective thermal comfort
3. Air-con adjustment strategies

2 Methods

Indoor environment measurement

01

HOBO Temp/RH logger

02

iButton Temp logger

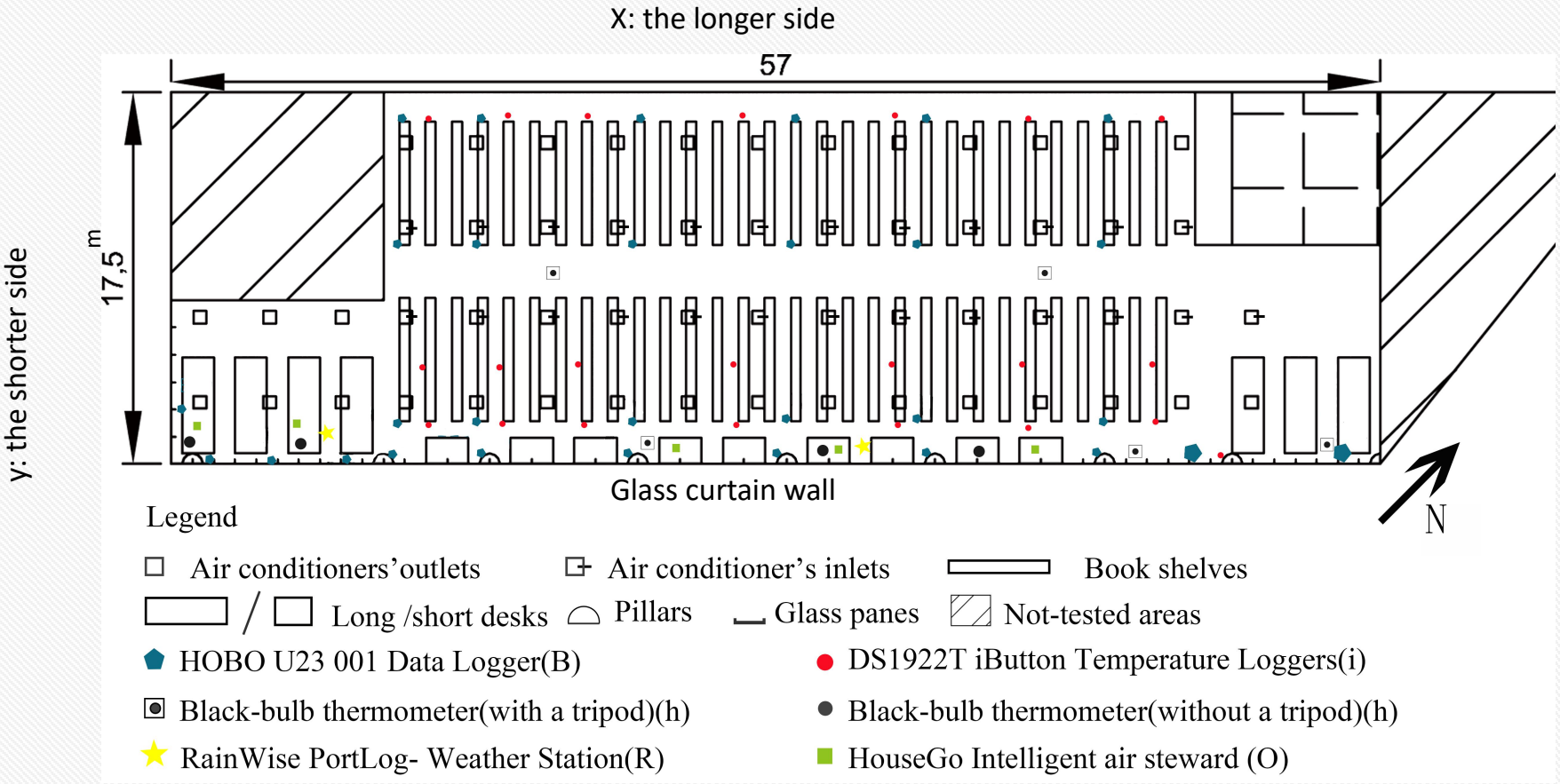
03

- HouseGo smart air housekeeper
- Black globe thermometer

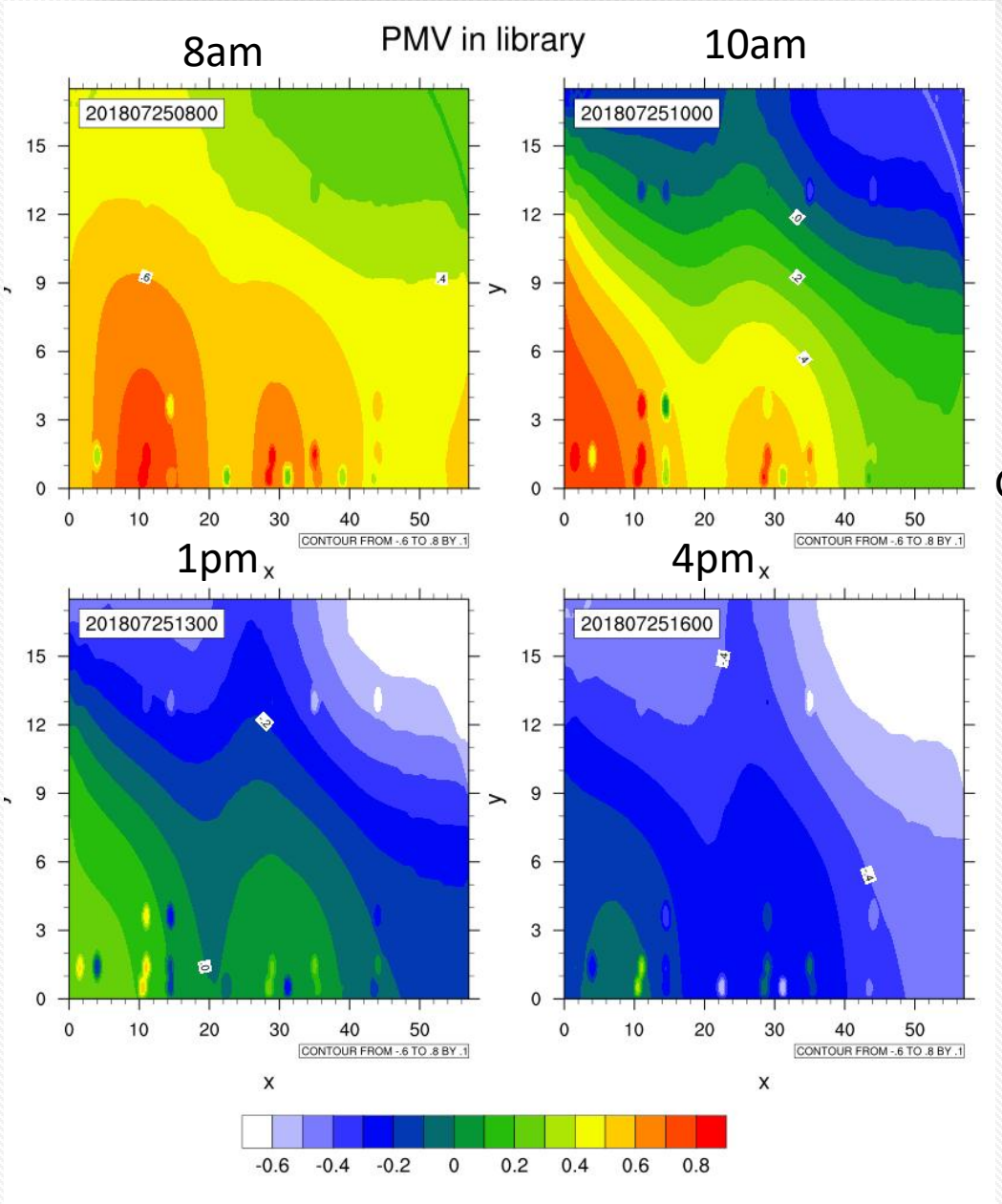
Study period:
25 – 27 July, 29 Aug – 2 Sep 2018

3 Results

Spatio-temporal distribution of PMV in the library

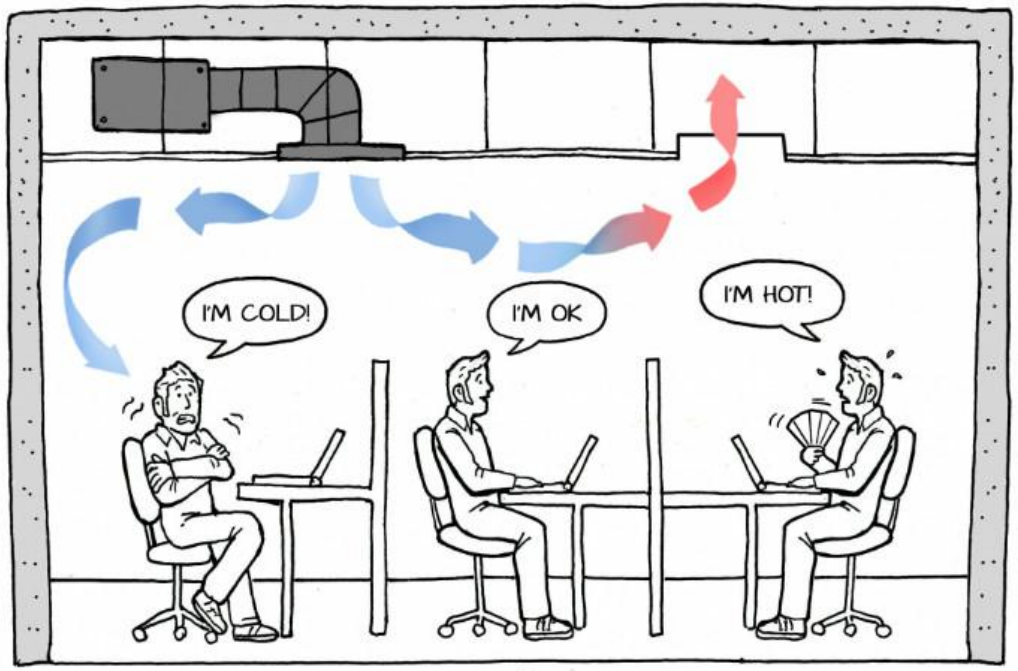


Spatio-temporal distribution of PMV in the library



Glass curtain wall

Glass curtain wall



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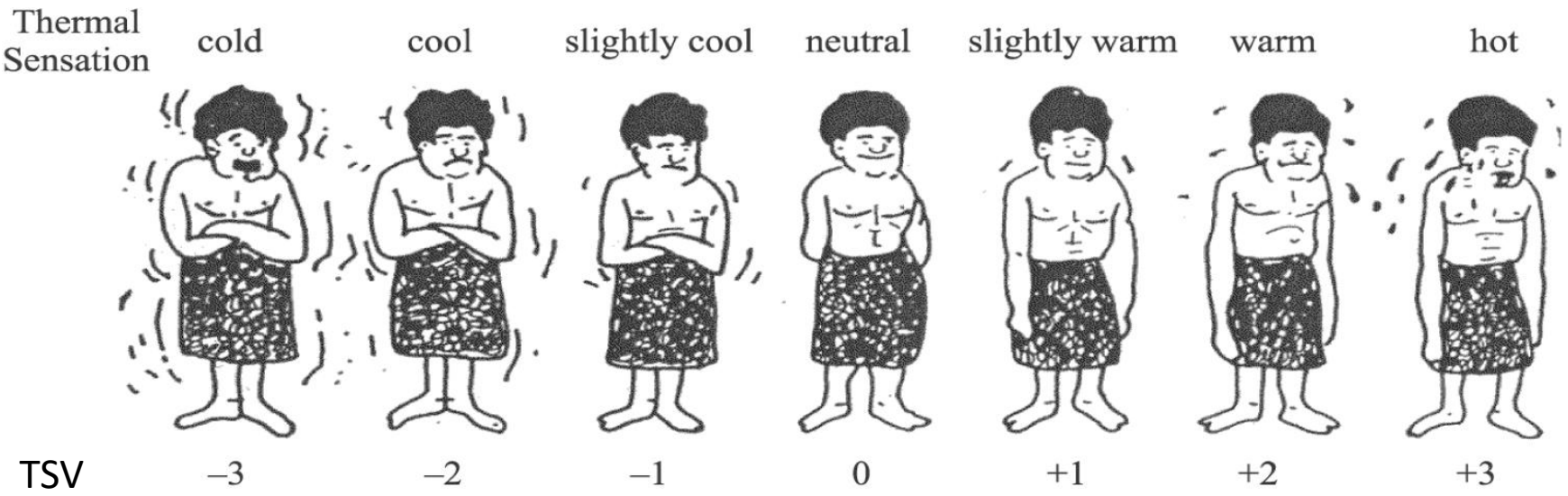
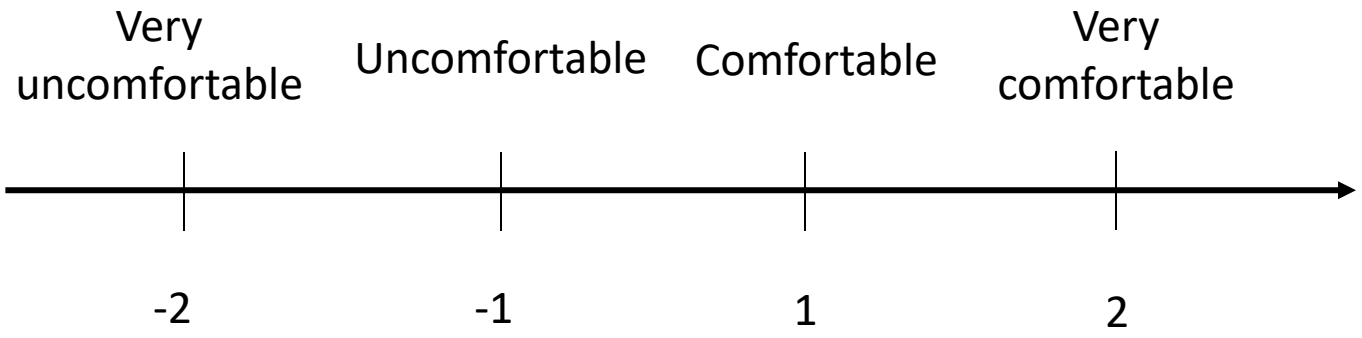
Questionnaire





Thermal comfort evaluation

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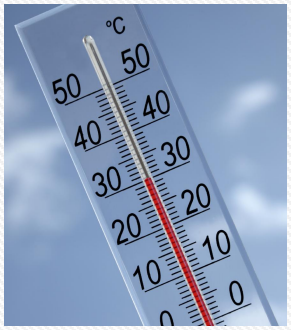
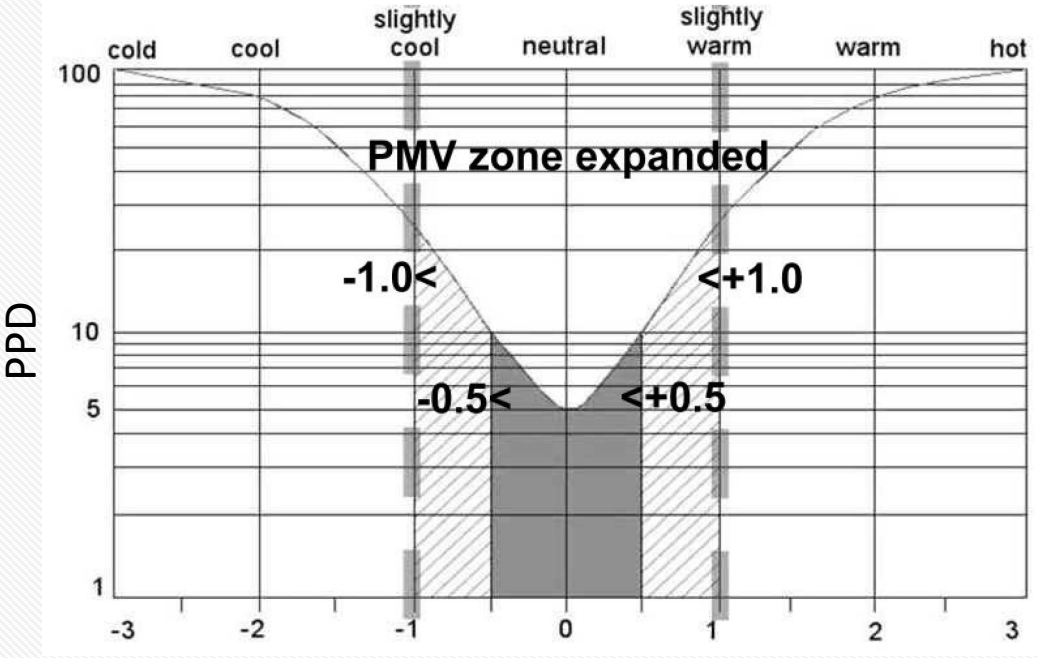
Apparent temperature



Air temperature

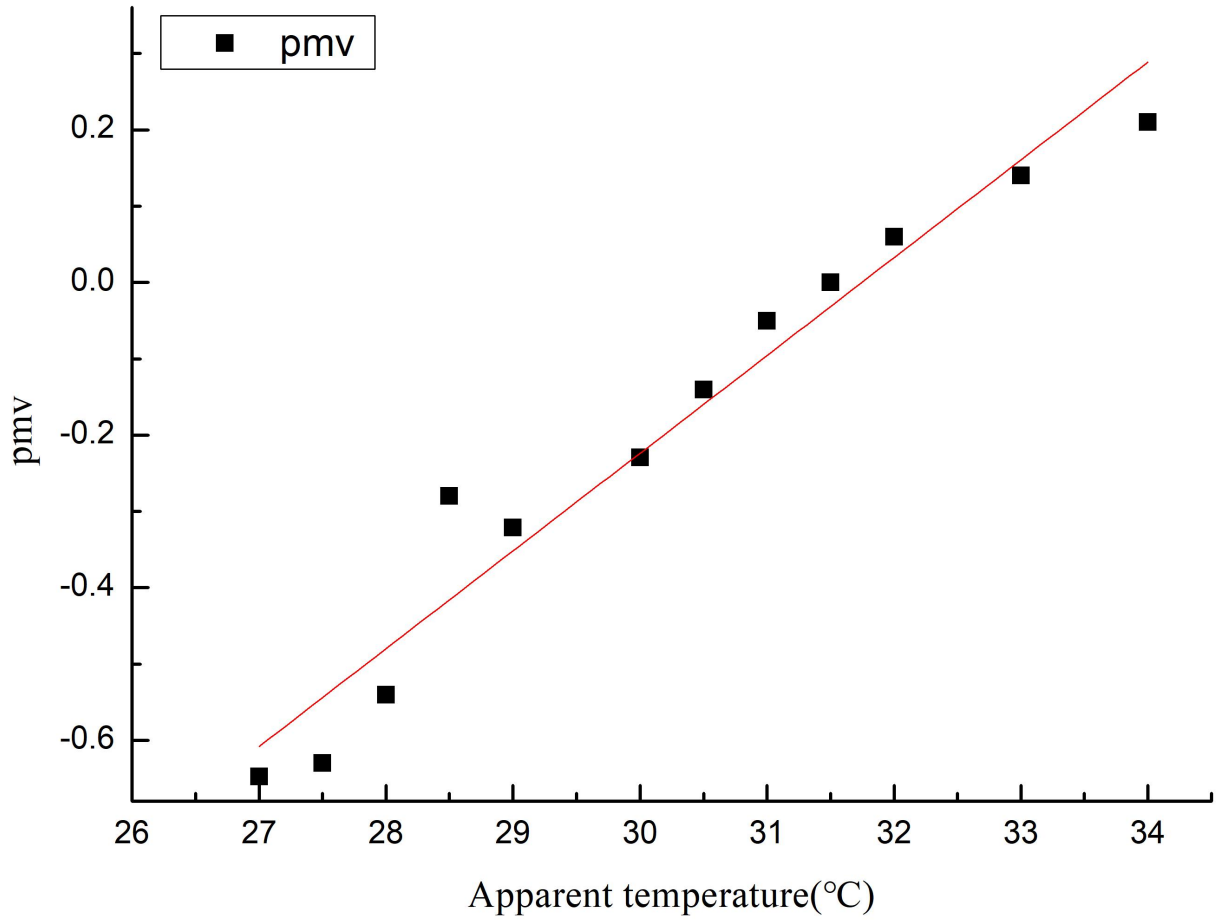
Dew point temperature

Kalkstein & Valimont 1986



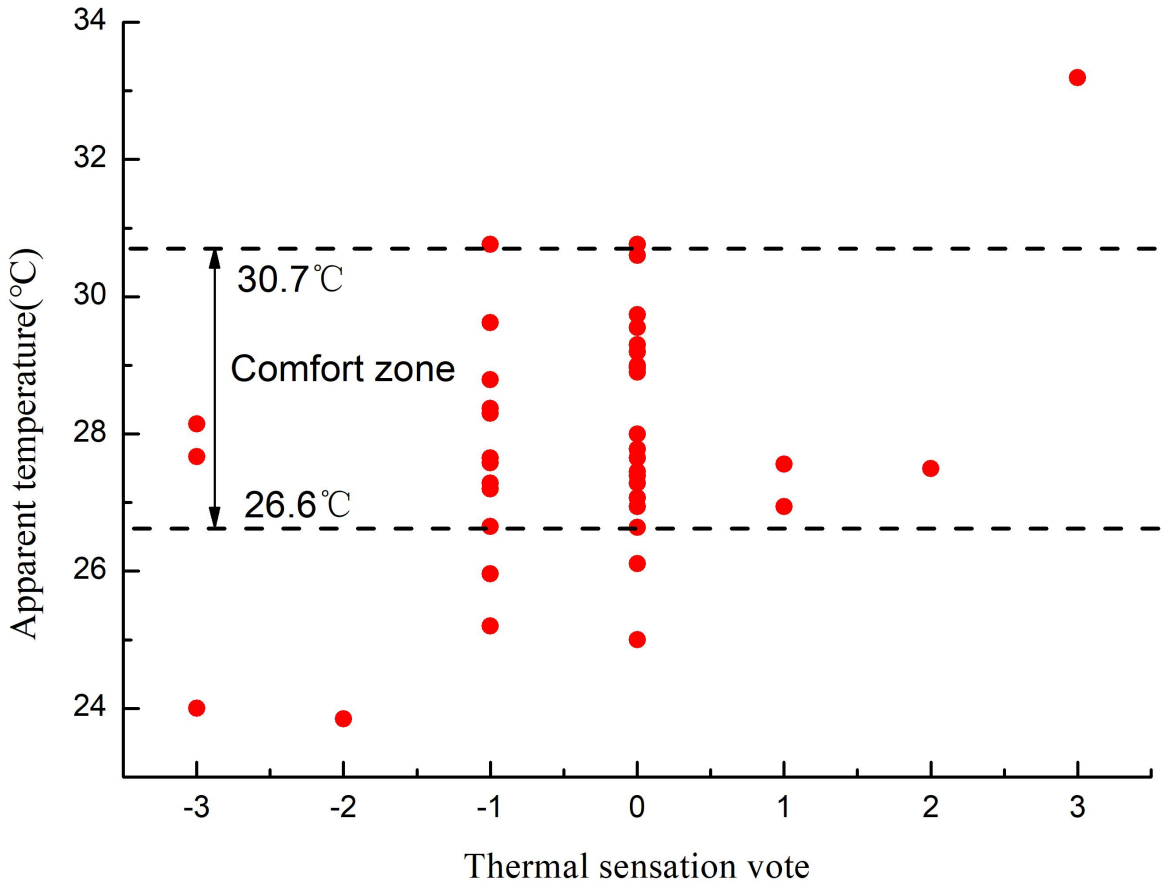
Pitts 2013

Adjustment interval according to apparent temperature



3 Results

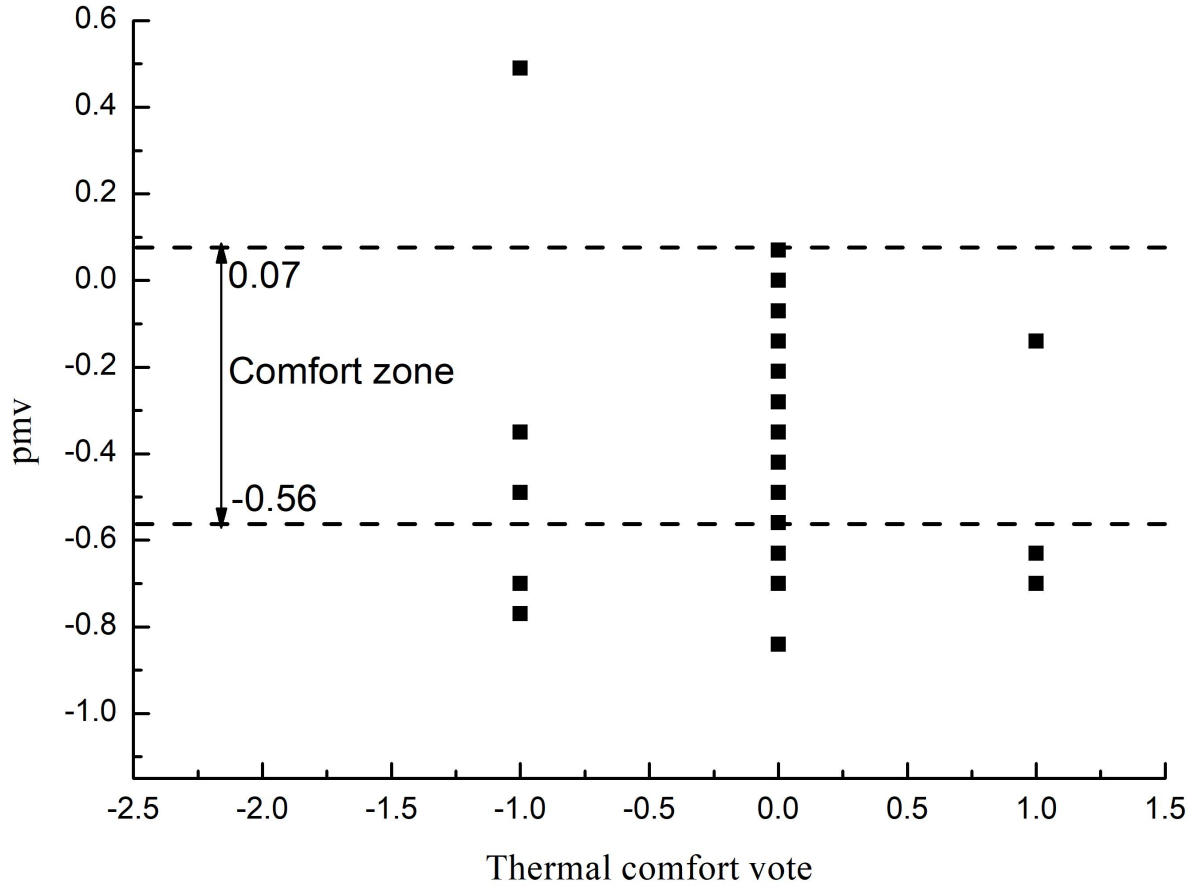
Thermal comfort range of library occupants



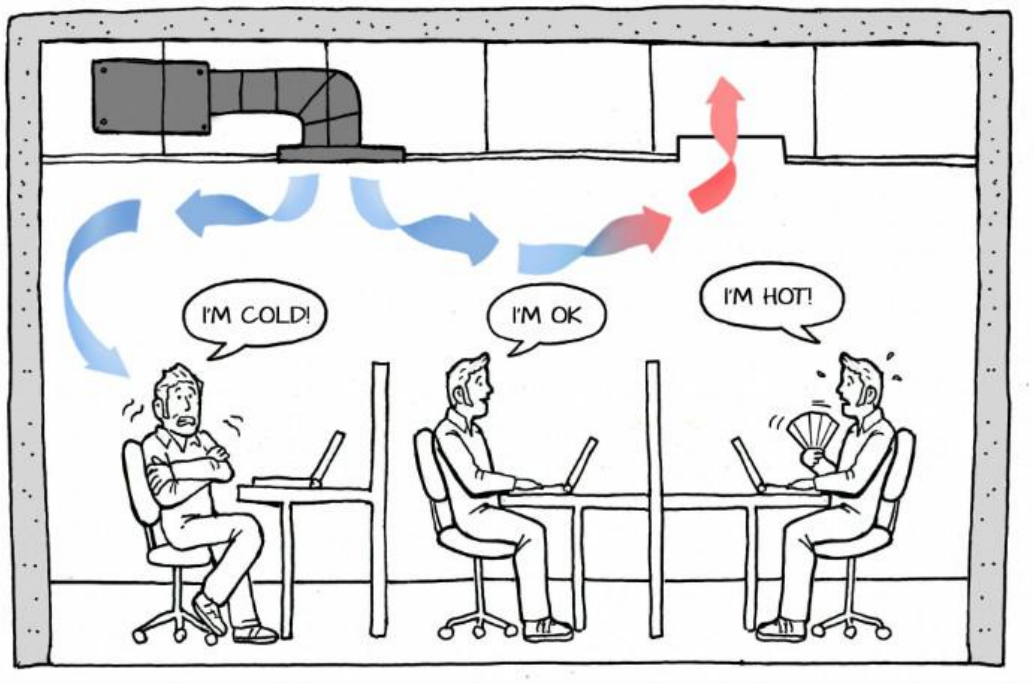
Comfort zone based on apparent temperature: 26.6-30.7 ℃

3 Results

Thermal comfort range of library occupants



Comfort zone based on PMV: -0.56-0.07



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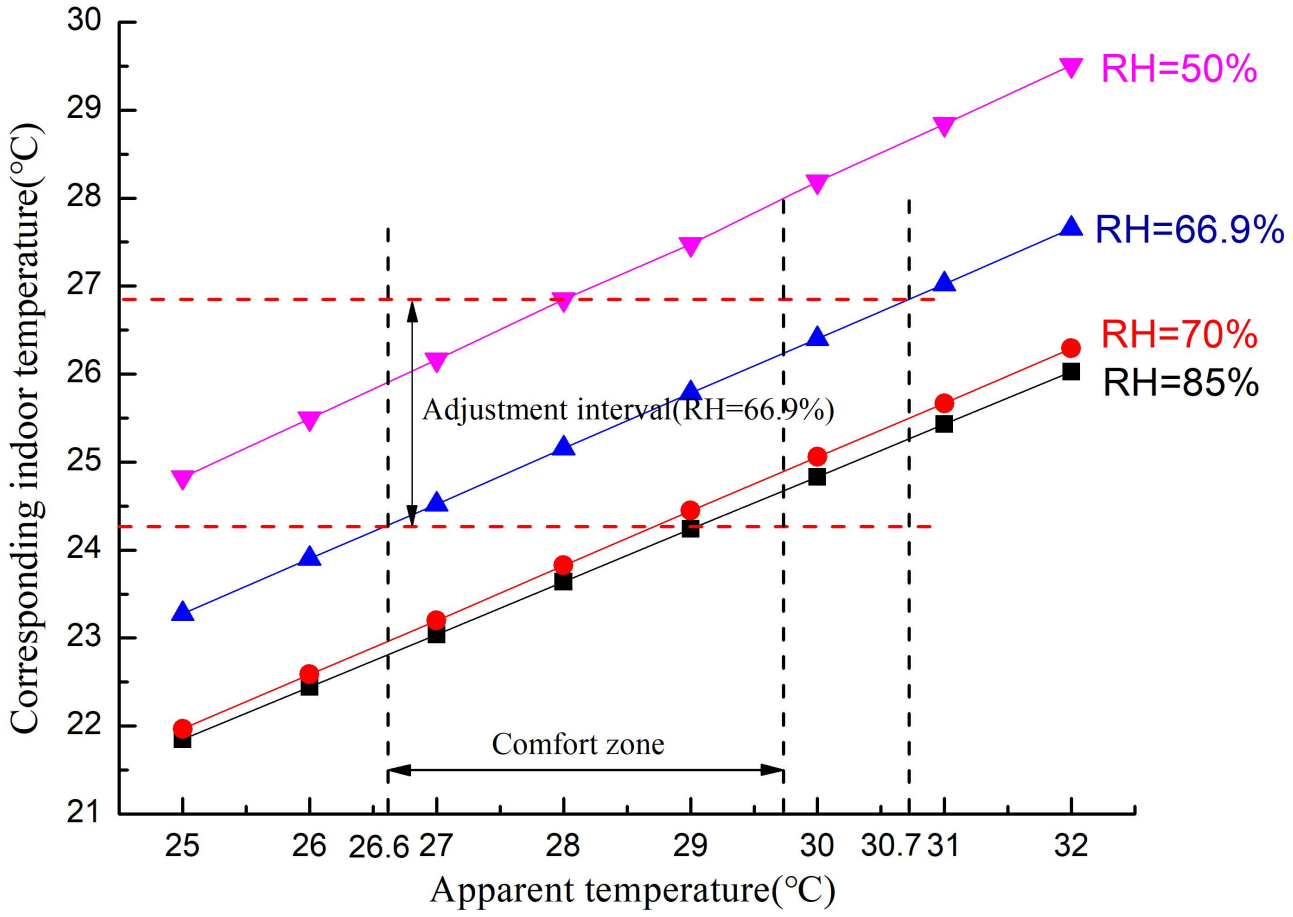
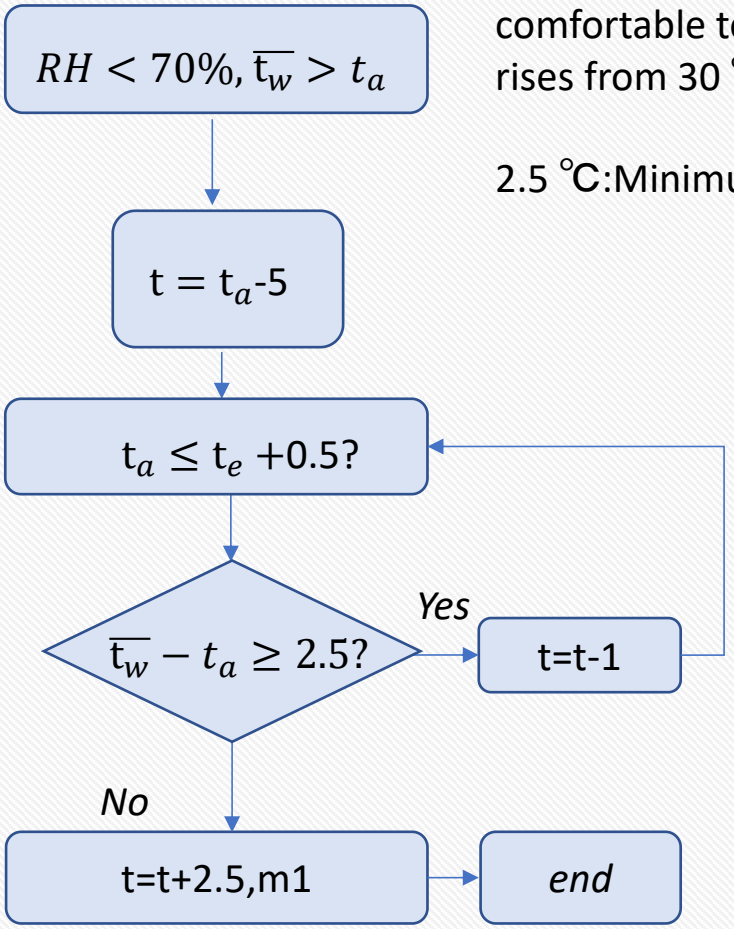
Adjustment interval according to apparent temperature



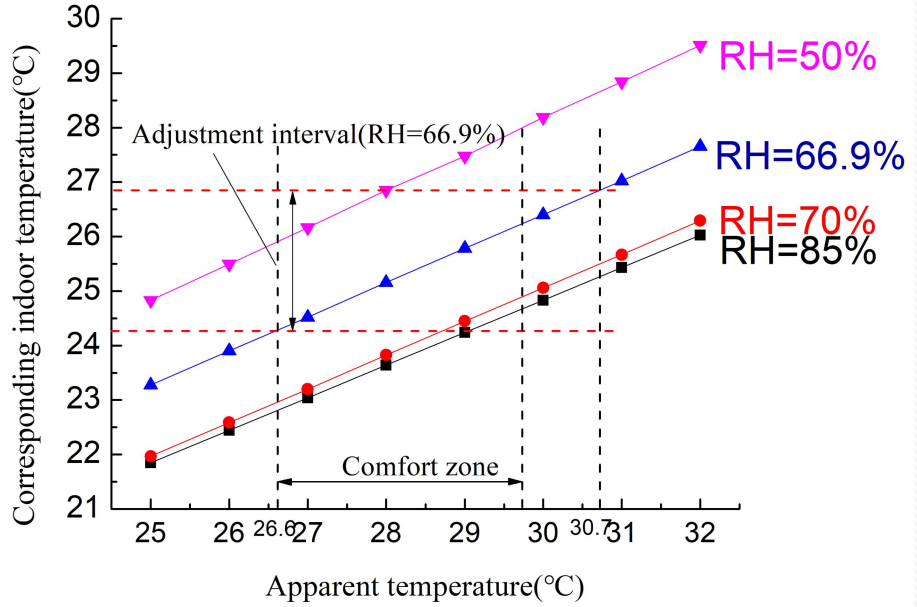
3 Results

Adjustment strategy



Example:
Sunny outdoor, RH : 50%, Indoor temperature :28 ℃,
comfortable temperature:26.6 ℃, and during t to t0, outside temperature rises from 30 ℃ to 31 ℃.

2.5 ℃:Minimum air supply temperature difference(of the system in library)



Adjustment strategy

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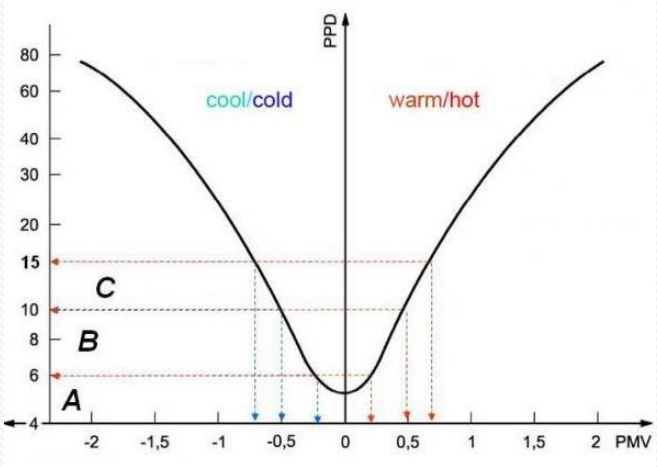
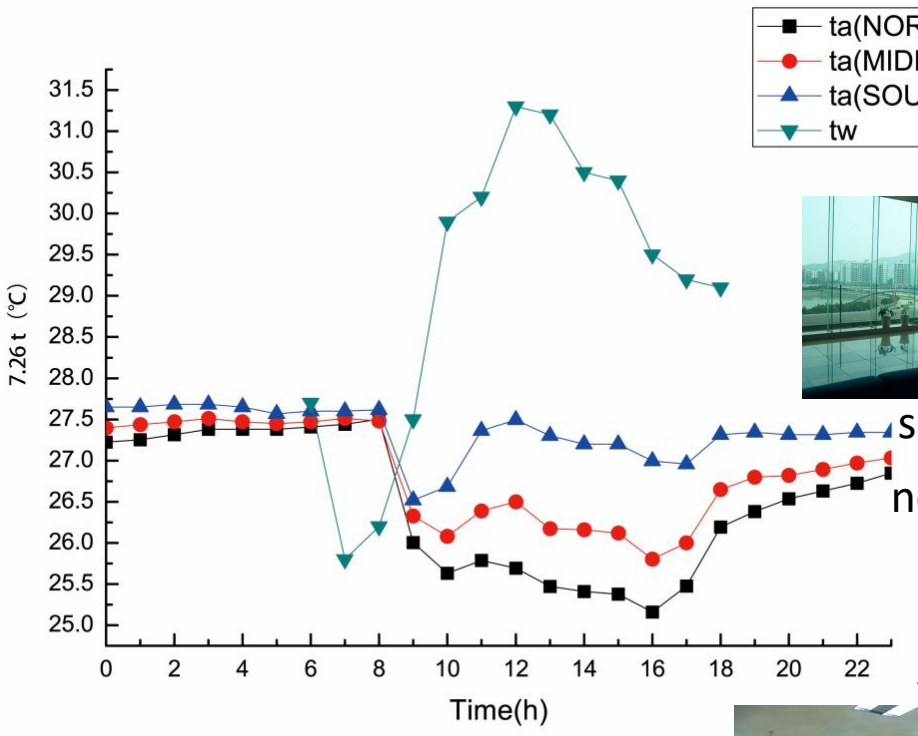


PMV & individual comfort zone

Outdoor weather conditions



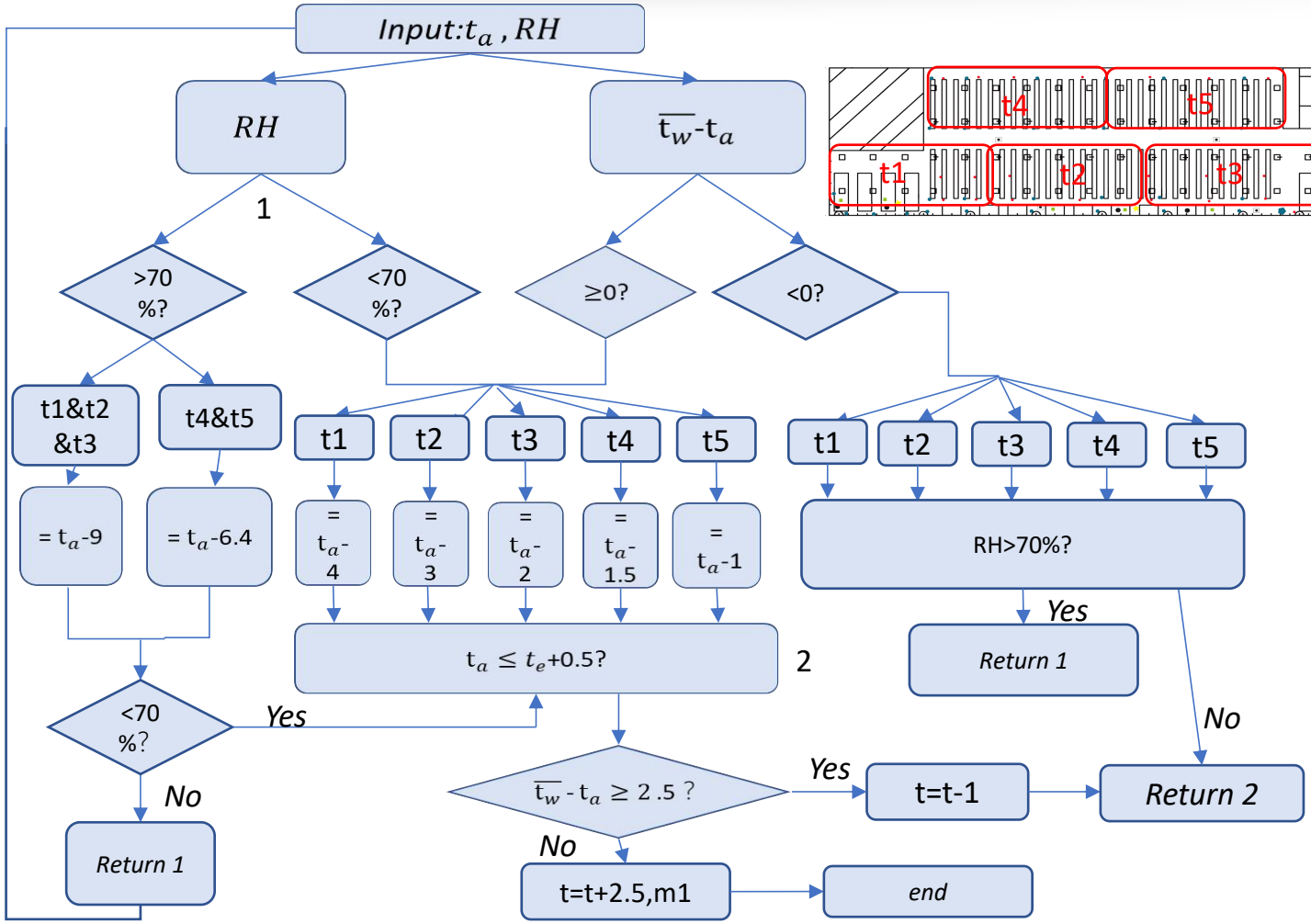
south

north

Spatio-temporal distribution of indoor thermal environment

3 Results

Adjustment strategy



2 Methods

Comfort evaluation calculation

We adopted the PMV and apparent temperature model for Comfort evaluation calculation.

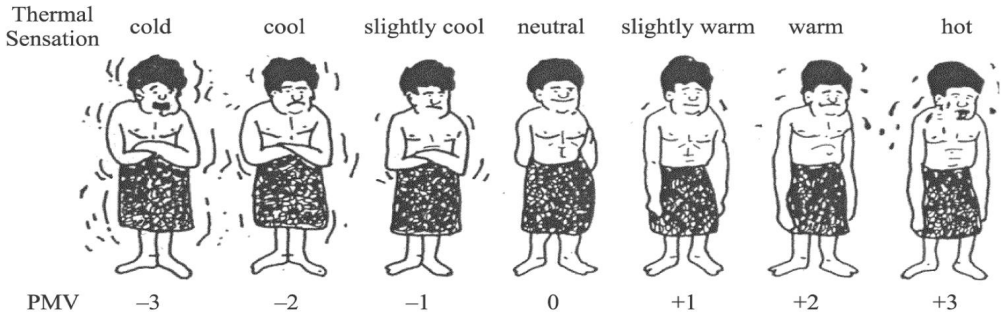
Tc

$$T_c = -2.653 + (0.994 \times T_a) + (0.0153 \times T_d{}^2) \quad (1)$$

$$T_d = \frac{243.04[\ln\left(\frac{rh}{100}\right) + \frac{17.625T_a}{243.04+T_a}]}{17.625 - \ln\left(\frac{rh}{100}\right) - \frac{17.625T_a}{243.04+T_a}} \quad (2)$$

T_c the apparent temperature (°C),
T_d dew point temperature (°C),
T_a air temperature (°C),
rh the indoor relative humidity

PMV(Predicted mean vote)



PMV parameters

Meteorological data

- Air temperature,℃
- Relative humidity,% RH
- Average Radiation Temperature,℃
- Wind speed, m/s VEL
- Water vapor pressure, Pa

China Regional Correction Coefficient=0.7

+ Clothing insulation ,clo&
  Metabolic rate,met