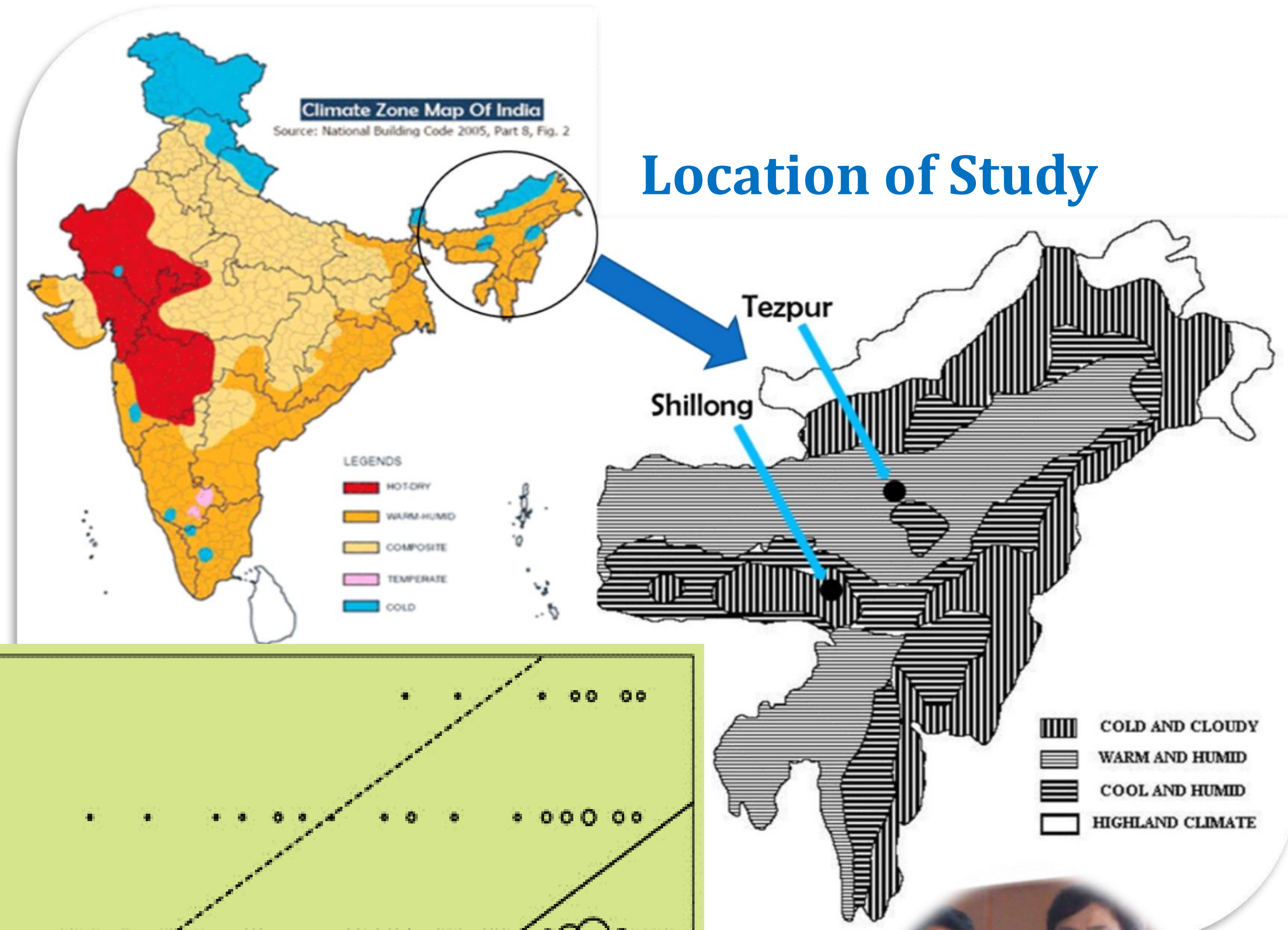
Adaptive thermal comfort in offices of North-East India

Introduction

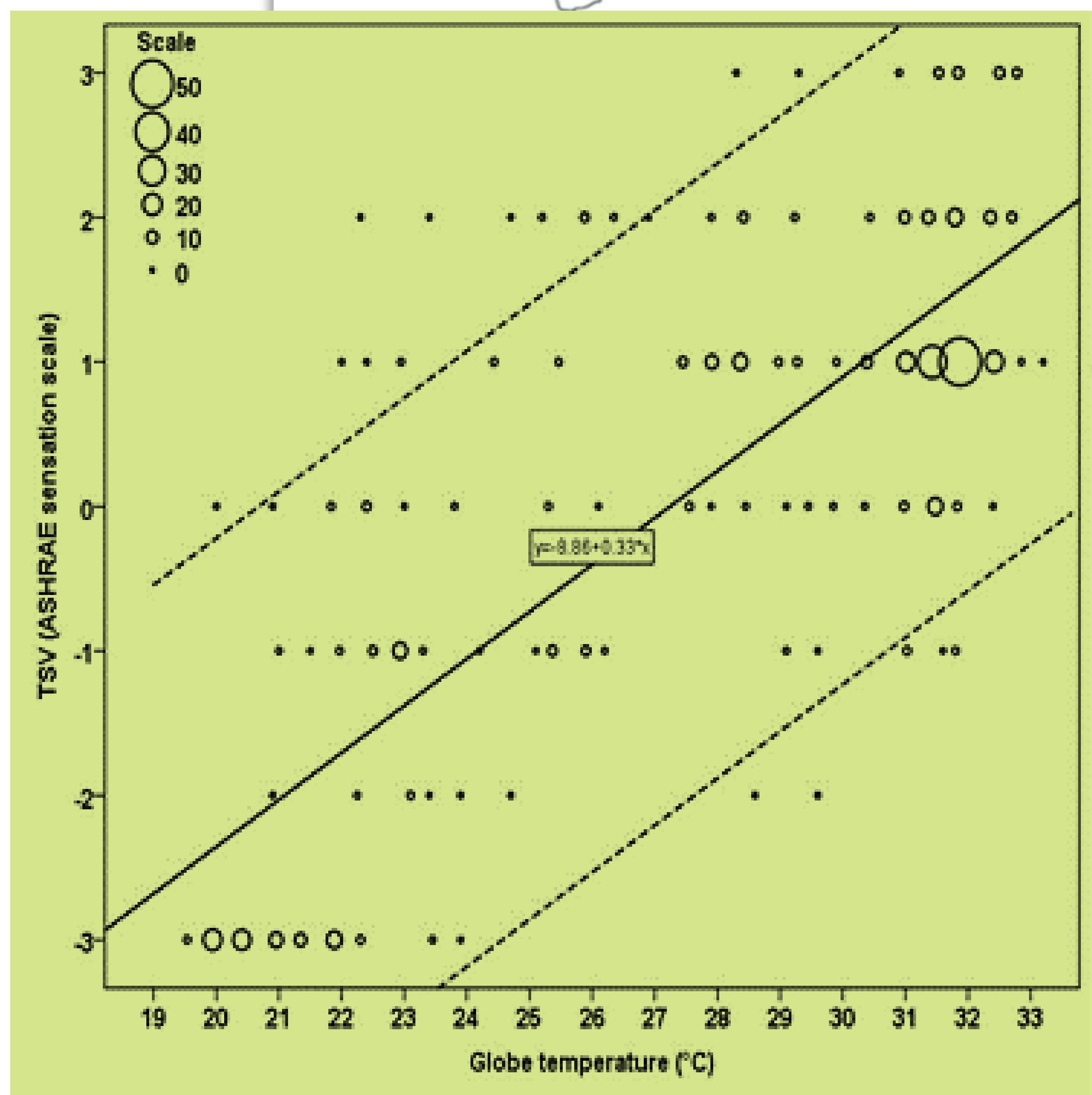
- India is a large country with vast climate, social cultural and economic diversity.
- India rapid growth is creating huge demand for infrastructure.
- The climate of North-East (NE) India as well as office buildings construction and operation is quite different compared to rest of India.
- Literature survey shows that no studies done on the assessment of thermal comfort in the offices of North-East India.
- Studies showed that a more balanced approach is "Adaptive thermal comfort" which integrate subject's thermal preferences in deciding the thermal environment



Objective

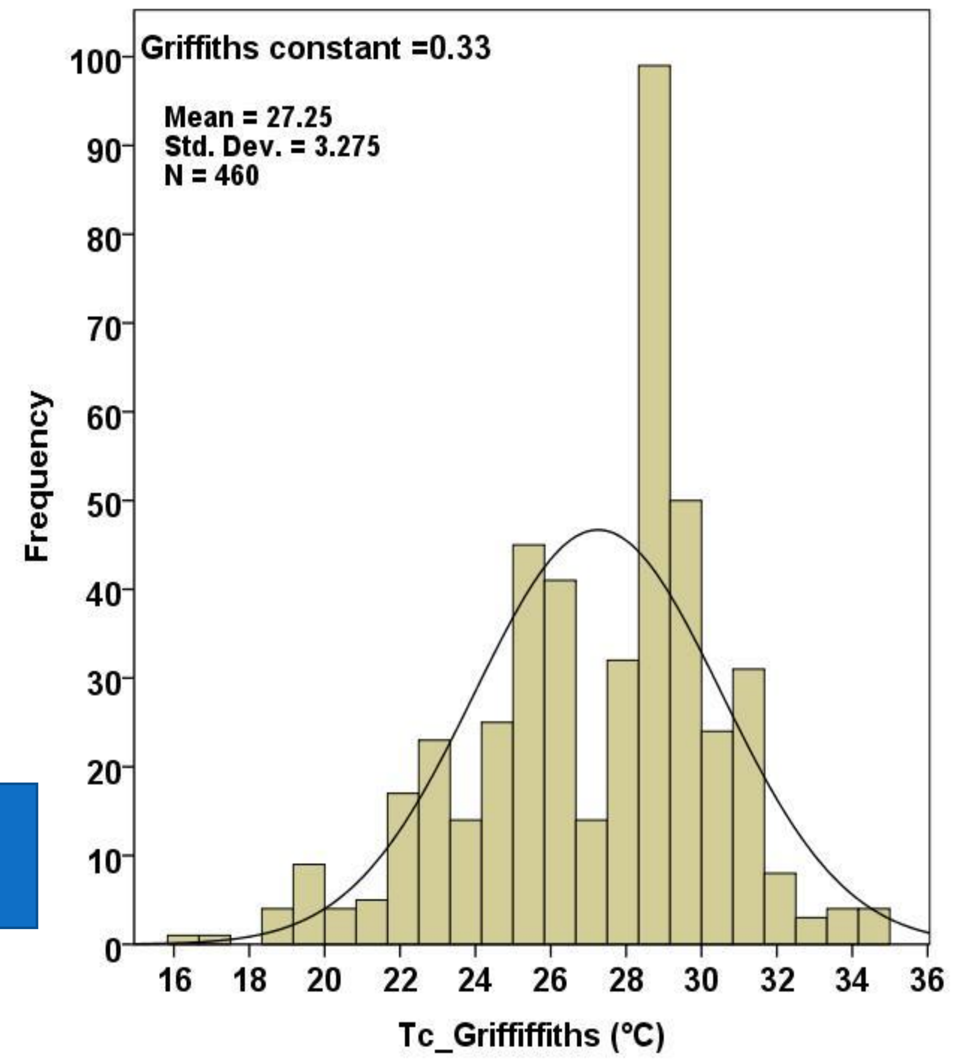
- To assess thermal comfort, thermal preferences and behavioural adaptations in the offices of NE India.

Figure shows naturally ventilated office setting, sitting arrangement and furniture in NE India. .



Regression analysis of thermal sensation votes w.r.t. globe temperature with 95% confidence line shows slope of 0.33 and comfort temperature at 27.2 ° C. It means that approximately 3° C change in indoor globe temperature will lead to shift in one thermal sensation.

Traditional dressing patterns of women in the offices of Shillong. Clothing insulation value of these ensembles are not defined in ASHRAE Standard 55.



Griffiths comfort temperature is calculated by applying following equation to every TSV.

$$T_c = T_{globe} + (0 - TSV)/G$$

Figure shows the distribution of Griffiths comfort temperature corresponding to constant 0.33. Comfort temperature corresponding to Griffiths constant 0.33 is ≈ 27.3 ° C.

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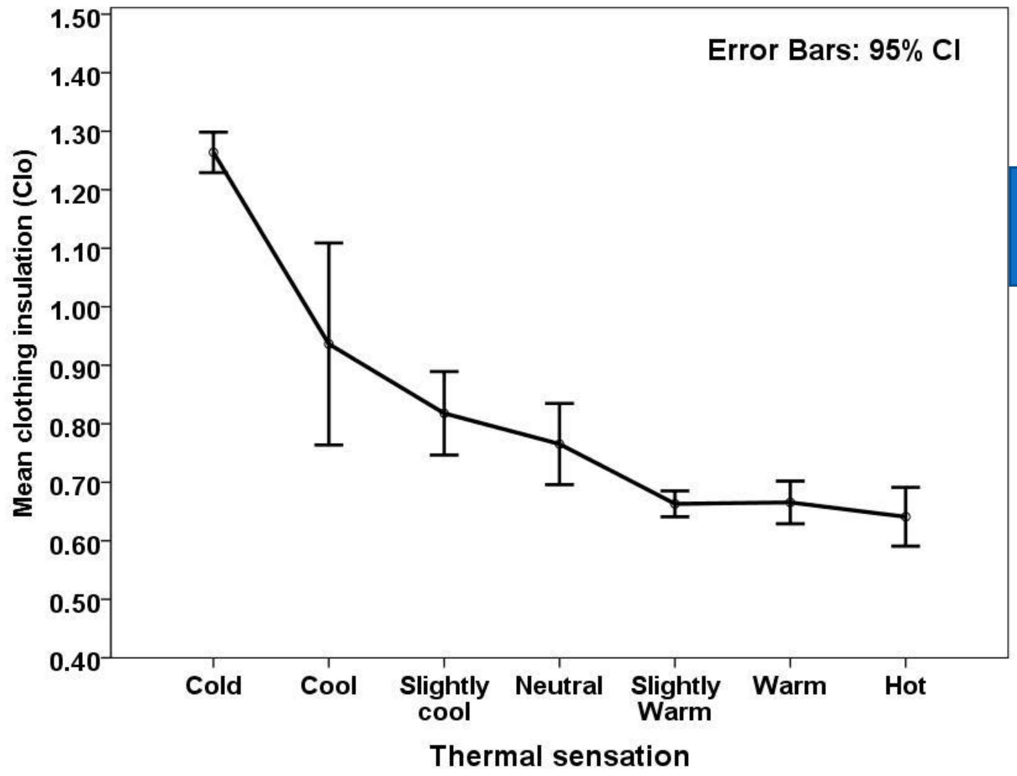
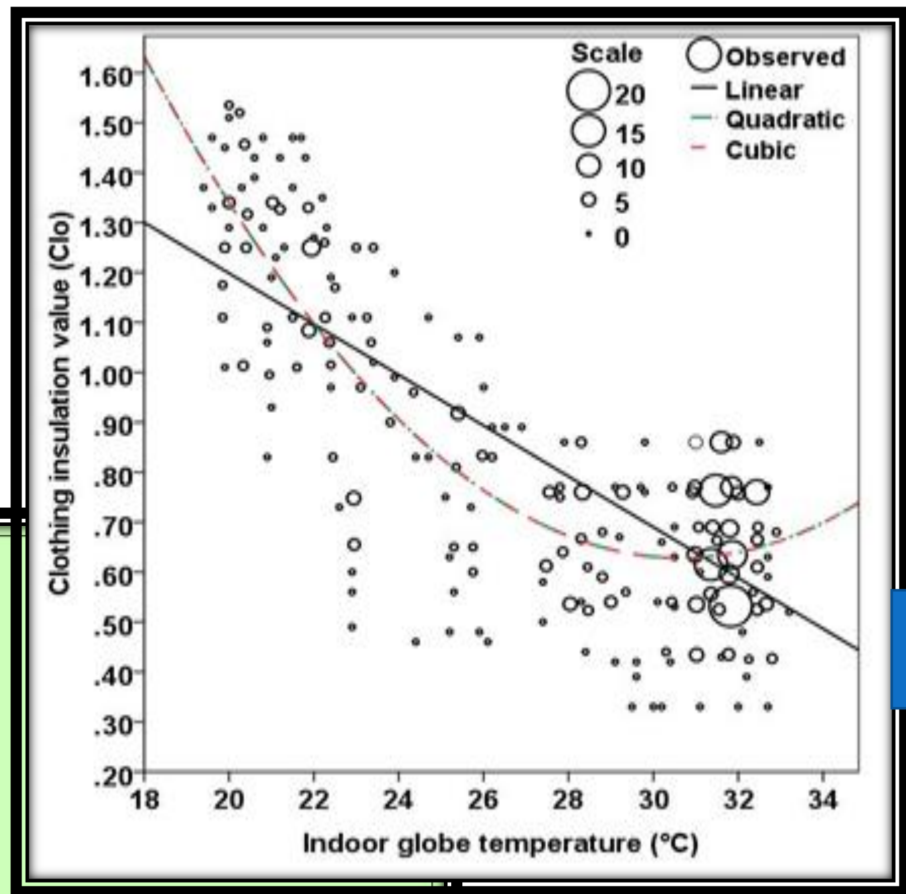
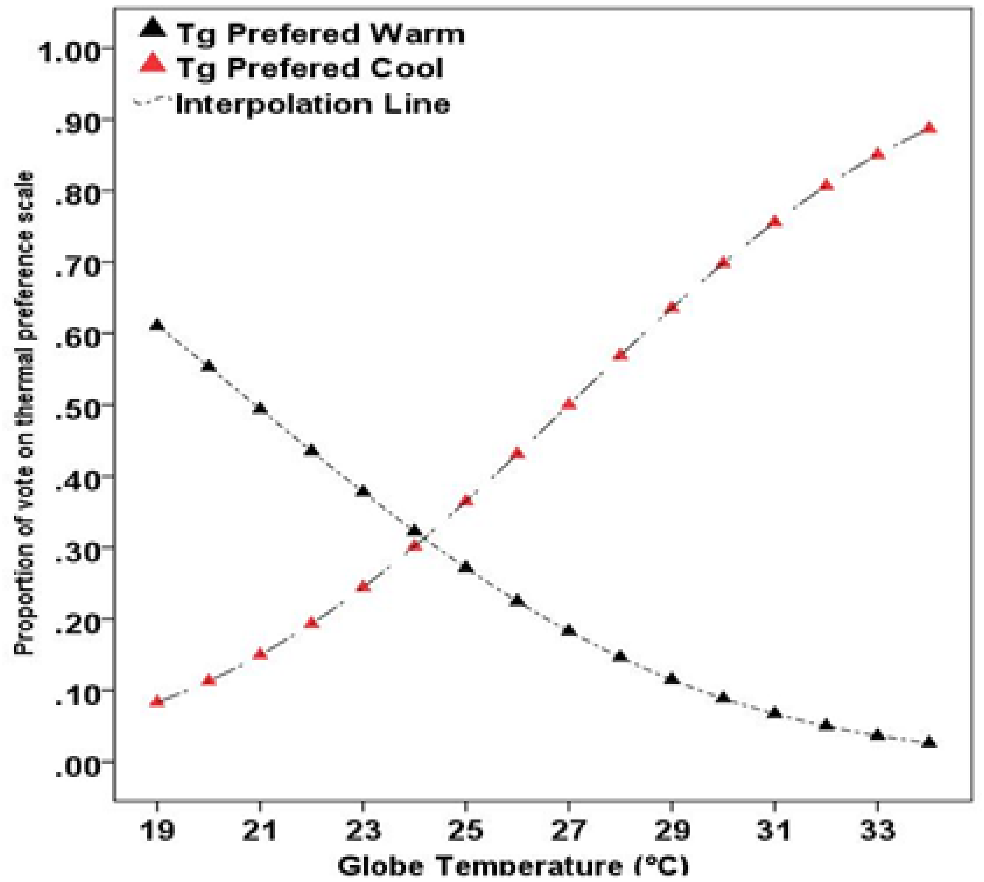


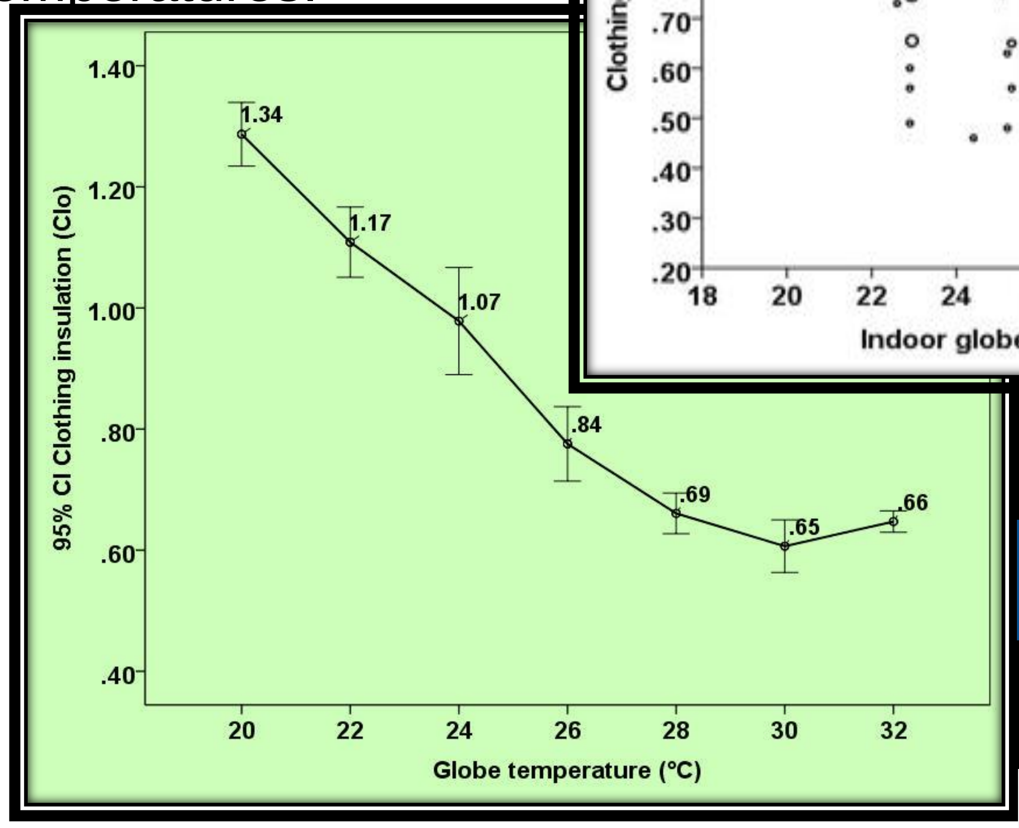
Plot of clothing insulation value against thermal sensation shows that deviation in clothing insulation level is higher towards cooler side of the thermal sensation scale. In other words we can also say that subjects do more adjustment or clothing related adaptation at cooler temperatures compared to warmer temperatures.



Plot of clothing insulation value against indoor globe temperature shows that cubic regression line bends inwards at temperature at low and high temperature showing clothing adaptation.

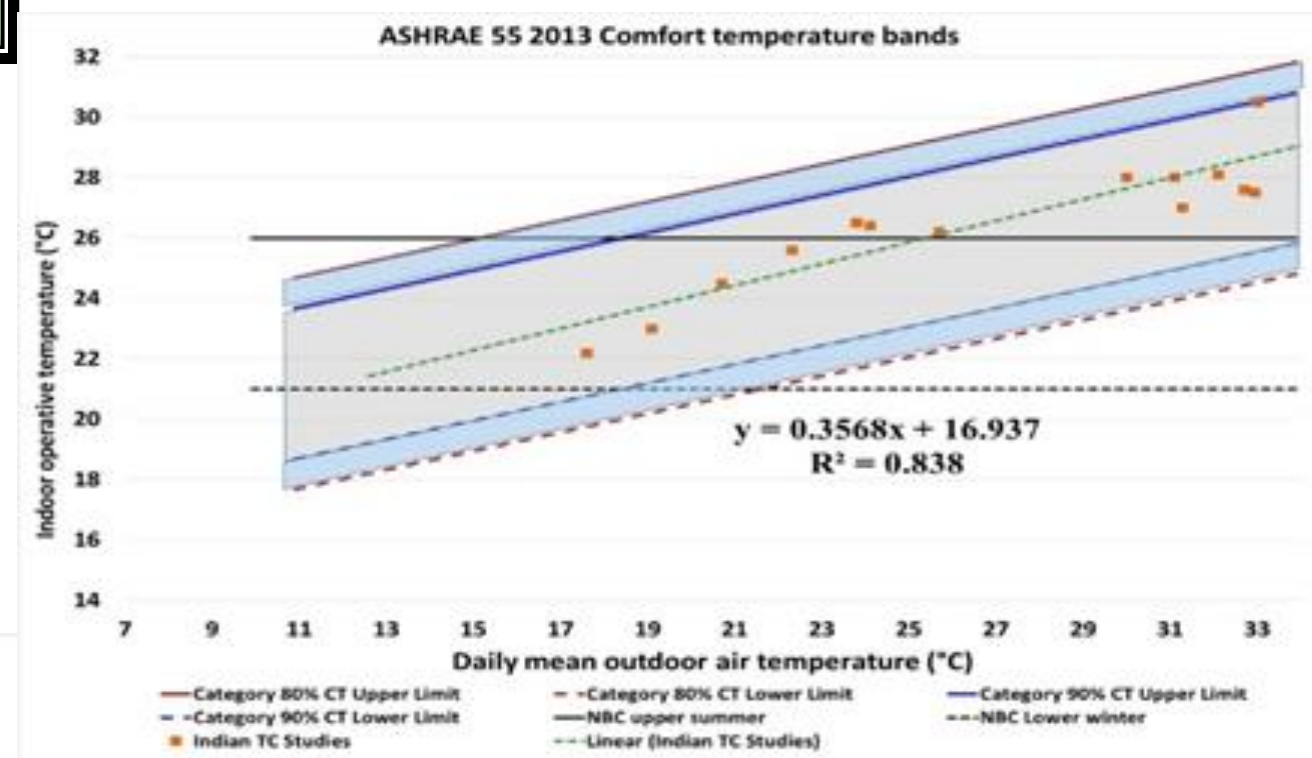
Preferred temperature is calculated by carrying out ordinal regression and probit as linked function after converting thermal preferences votes to binary form. thermal preference votes converted to binary form. It can be seen that both lines intersect at 24.5° C. Preferred temperature is 2.8° C lower than comfort temperature.





This Figure shows the combined information presented by above two figures (far left and right). Clothing value cannot go very low and very high because of physical and social-cultural limitation.

Entire North-East India has high relative humidity and increasing air velocity is the only remedy left with subjects in naturally ventilated offices to restore comfort. Logistic regression analysis on proportion of fan use shows that at 33° C almost all the fans in the offices are operating. It is interesting to see that up to 22.5° C almost no fan is in use.



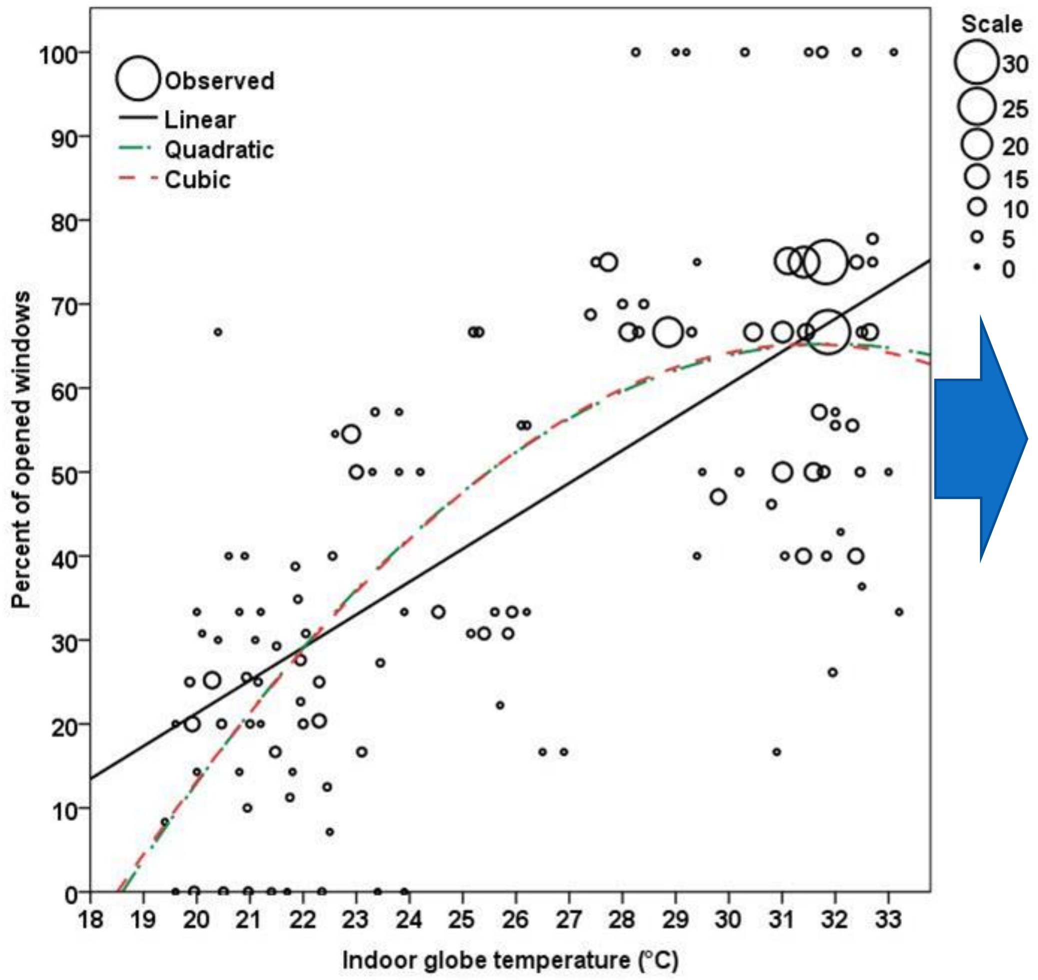
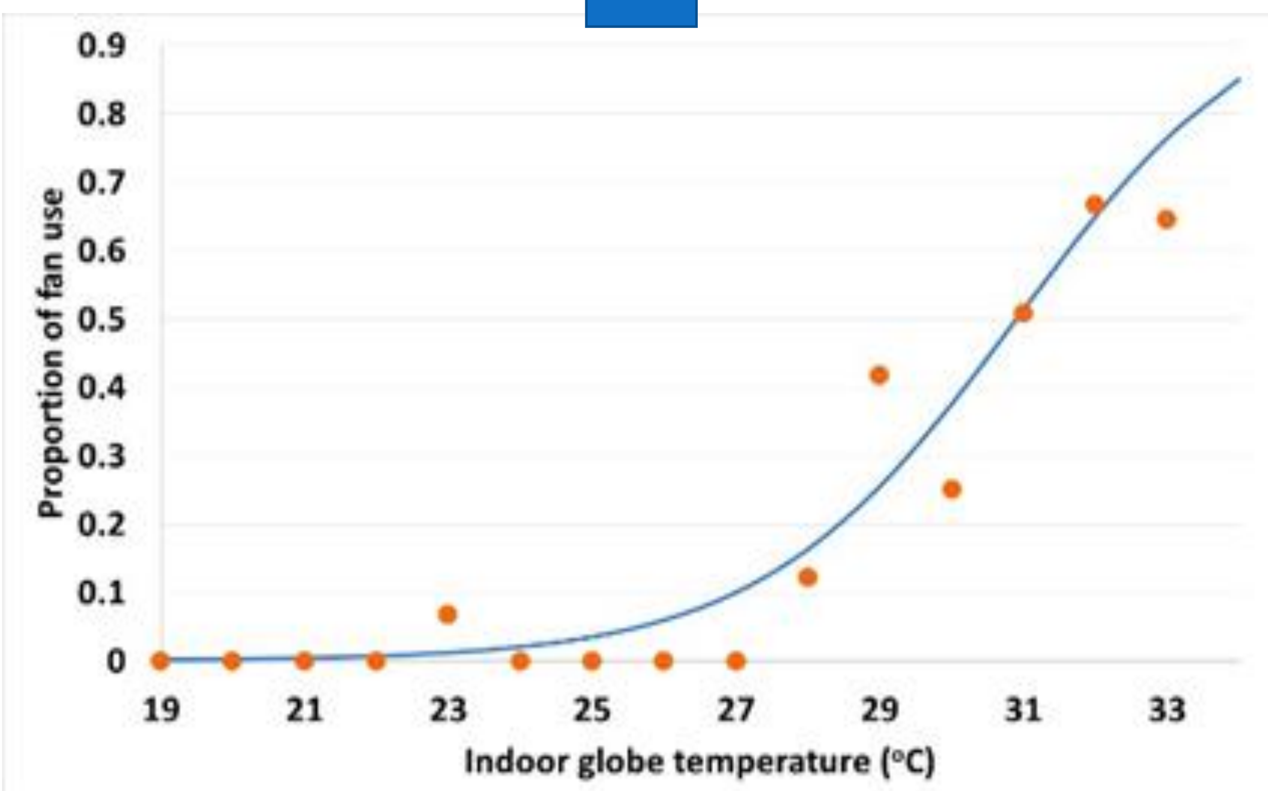


Figure shows the percent of opening windows w.r.t. indoor temperature. We see an adaptive behaviour as windows start closing at low and high temperature. From 22 - 31° C percentage of windows opening increases.



Analysed the comfort temperature proposed by studies done in India and develop a regression equation. Comfort temperature proposed for NV buildings and plotted them against daily mean outdoor temperature. Regression line shows the slope of 0.37, which is close to the slope proposed by in SCATS project. all comfort temperature falls under 80% comfort band limit but not under Indian National building code 2005.

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