

# Passive Design in the Pacific Environment

PASSIVE DESIGN FOR THERMAL COMFORT IN A TROPICAL ENVIRONMENT

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## Thermal Modelling and Intuitive Experience

- Understanding of heat transfer mechanism
- Predicts internal temperatures
- Uses real weather data (Guam)
- Two software methods (ECOTECH & IES)
- Verified by data loggers in Samoa
- Actual building Faiaii exceeds predicted performance

## Typical P Series Meeting House

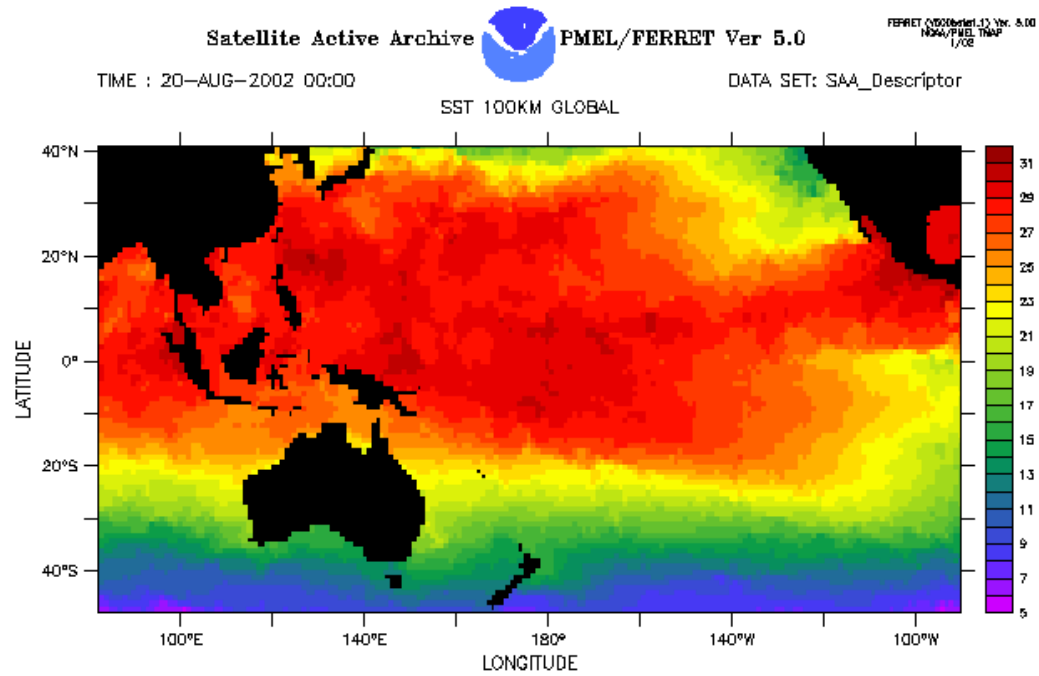


## The Pacific Region

Between Tropic of Cancer (20°N) and Tropic of Capricorn (20°S)



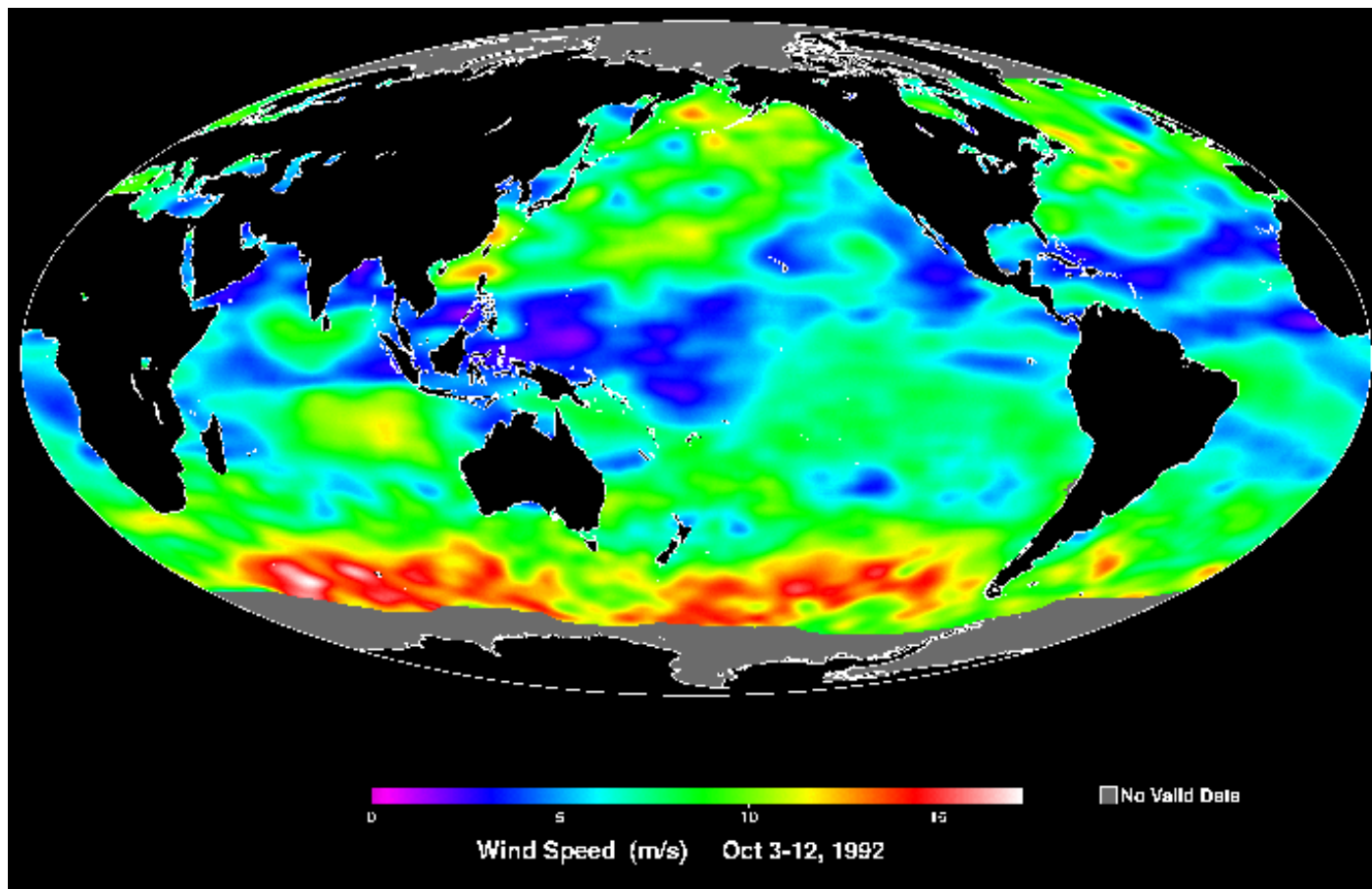
# Ocean Surface Temperatures



Analysis Temperature (Deg. C)



## Wind Speeds



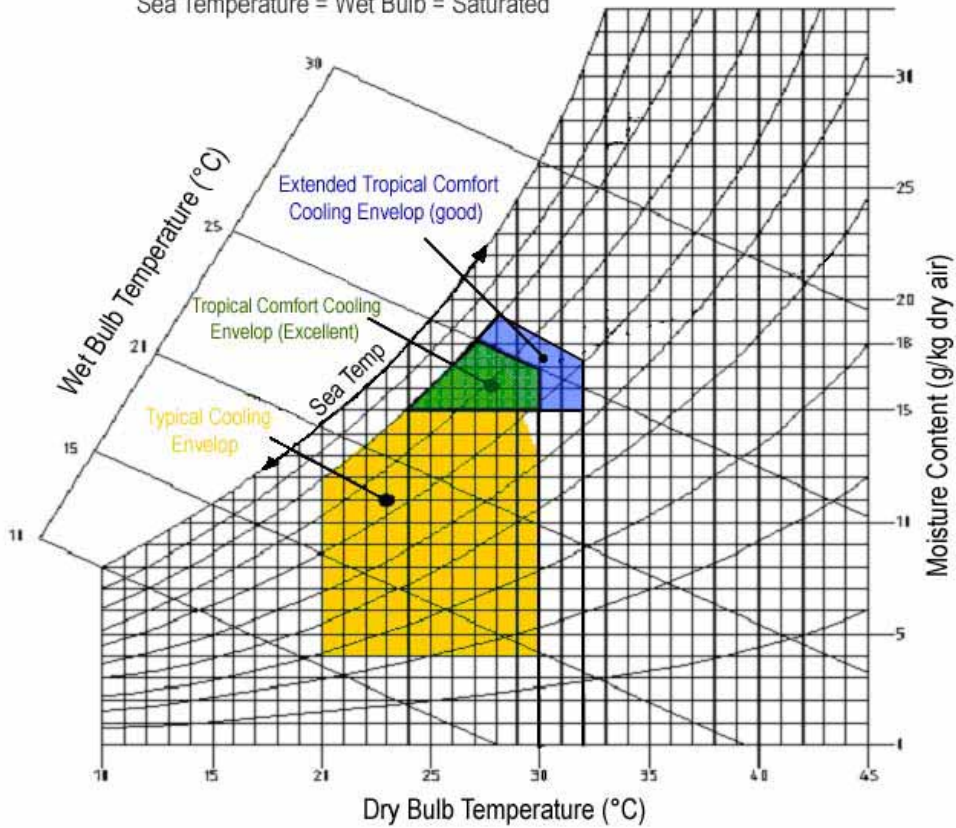
## Sustainability vs Sacred Cows:

- Comfort Envelope ( what will you accept?)
- Natural Ventilation vs Thermal Mass
- Ceiling Fans vs Openable Windows
- Occupancy (Transient or continuous)
- Accurate Modelling of temperatures
- Acceptance by occupants of wider envelope

# Thermal Comfort Envelopes

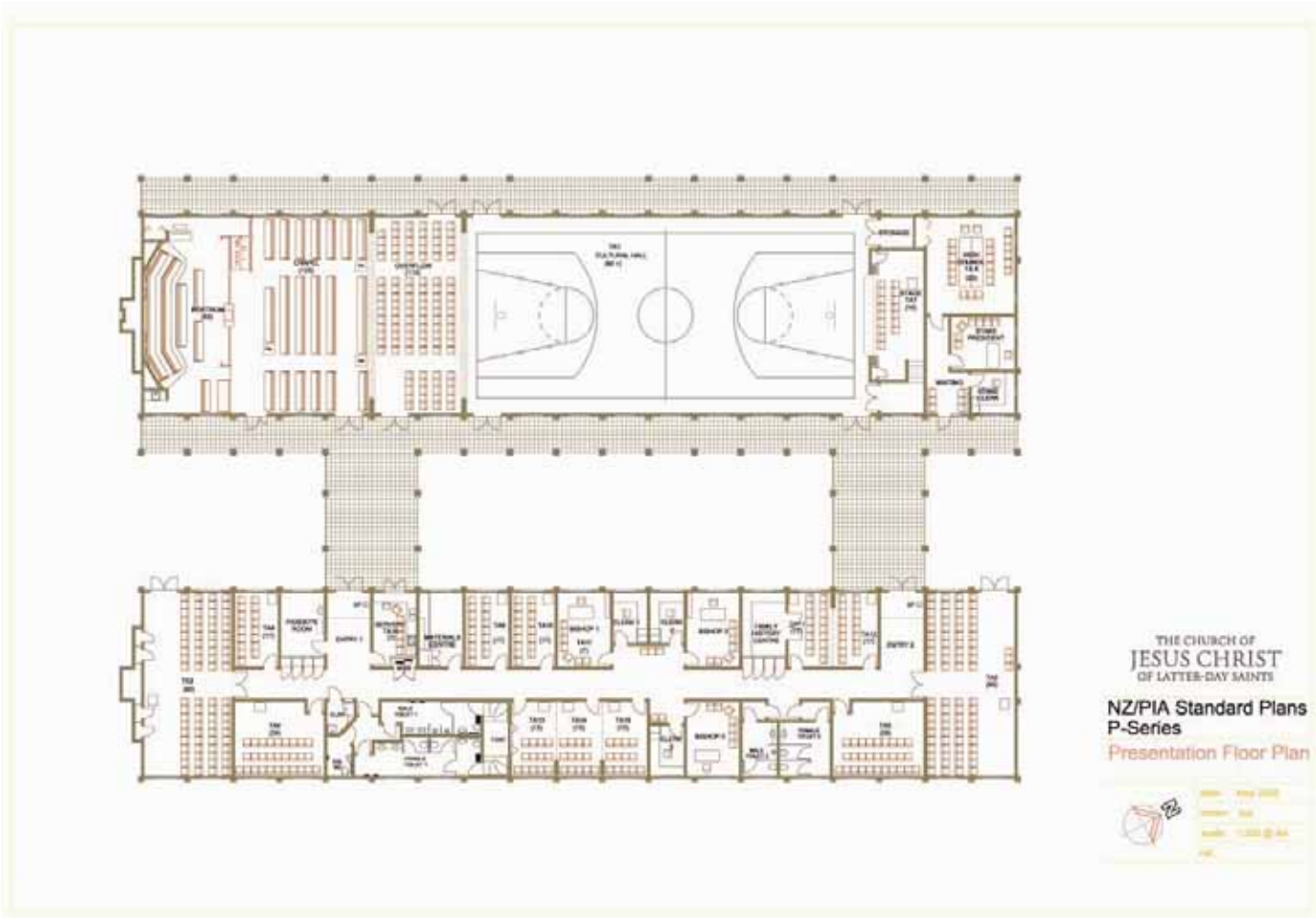
Comfort Cooling Envelopes For Passive Climate Control

Sea Temperature = Wet Bulb = Saturated

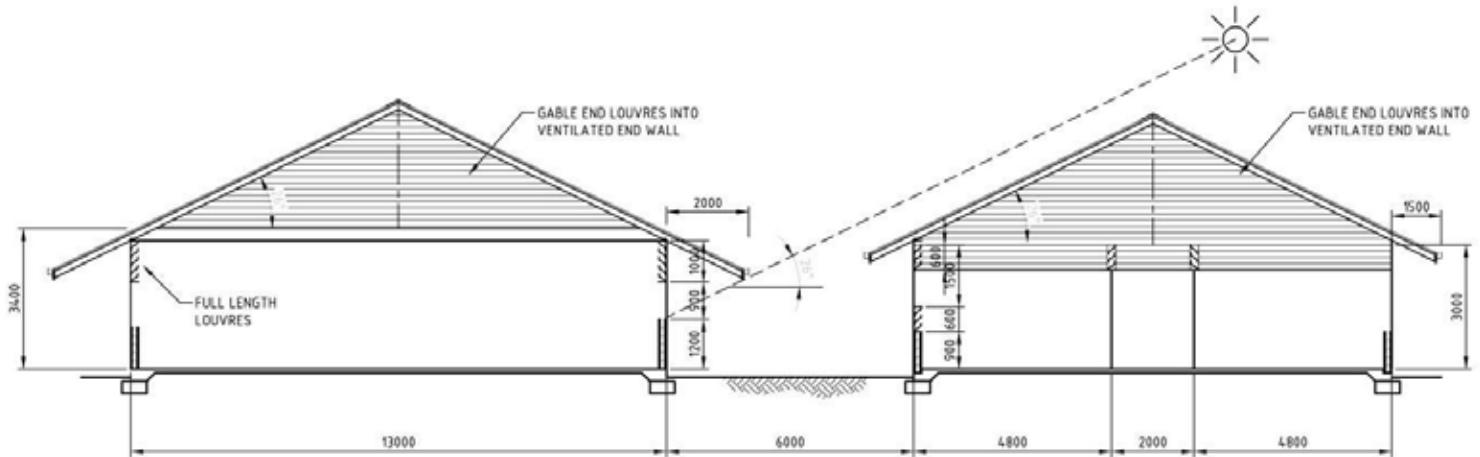


Psych Chart For Comfort Cooling

## P Series P 230 -17SC

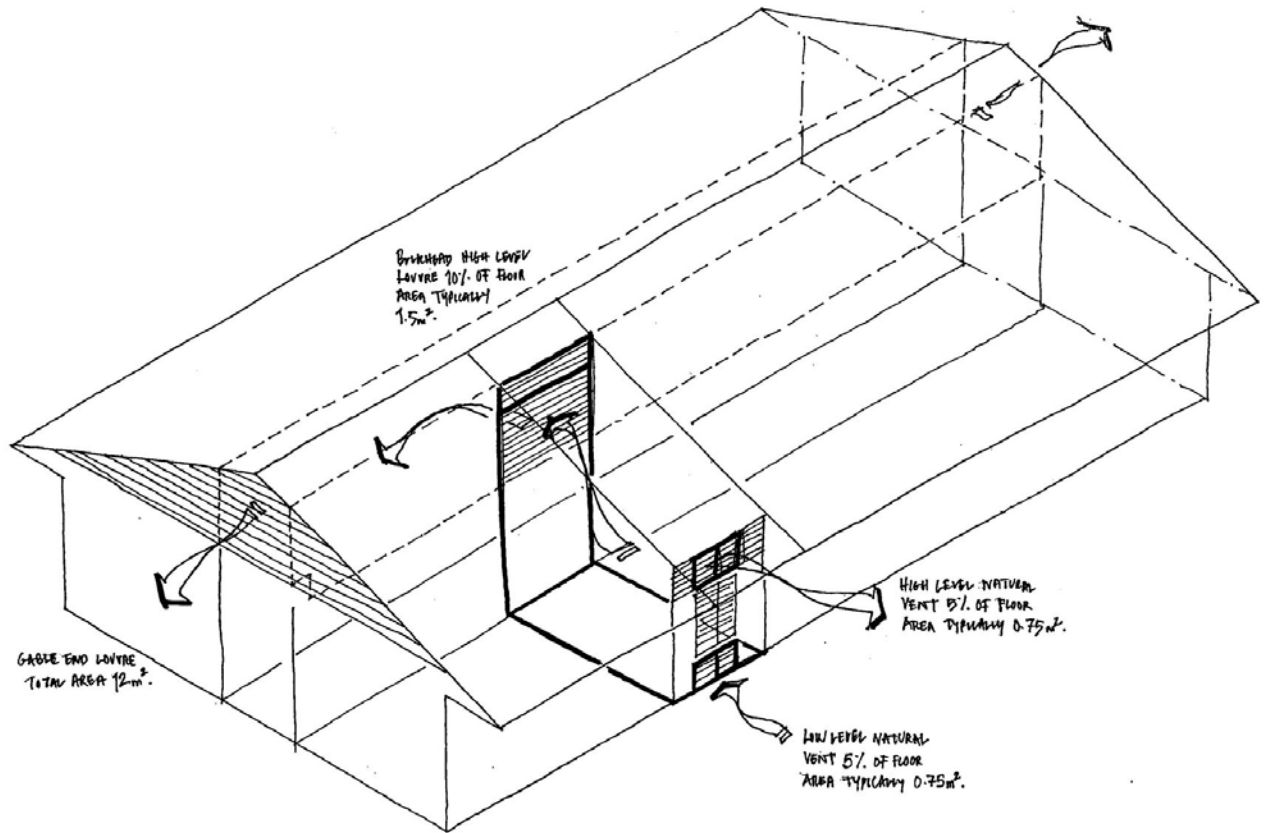


# Shading of Thermal Mass



ASSEMBLY BLOCK / CLASSROOM CROSS SECTION

# Passive Vent provides equilibrium

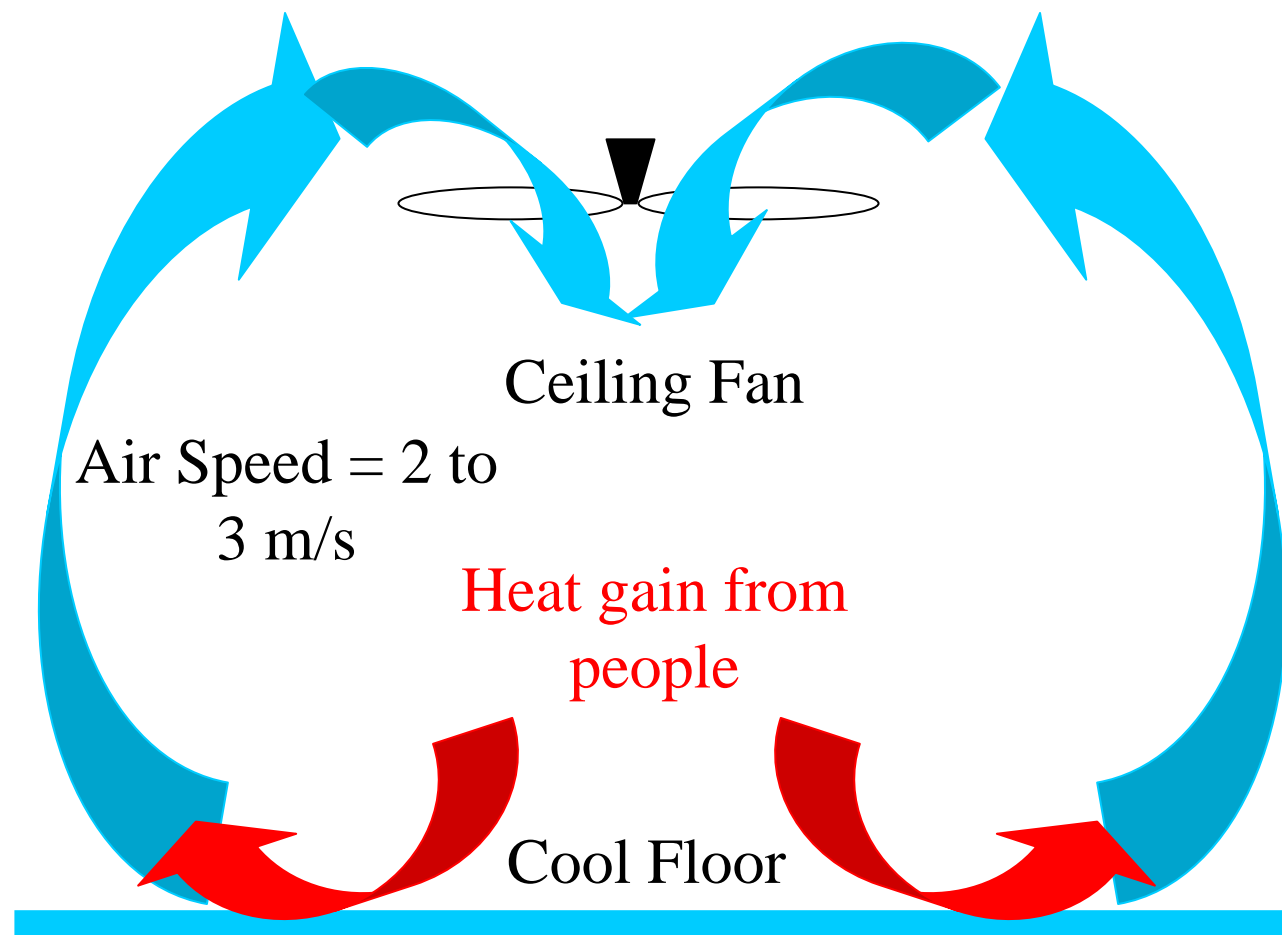


P SERIES CLASSROOM BLOCK PASSIVE VENTILATION

## Effective cooling from fans

- Ceiling fans create air movement
- Velocity of 2 – 3 m/s
- Air movement transfers heat to floor
- Air movement cools skin (evaporation)
- Combined effect of air movement over skin is a perceived temperature drop of 1°C even though air temperature has not dropped.

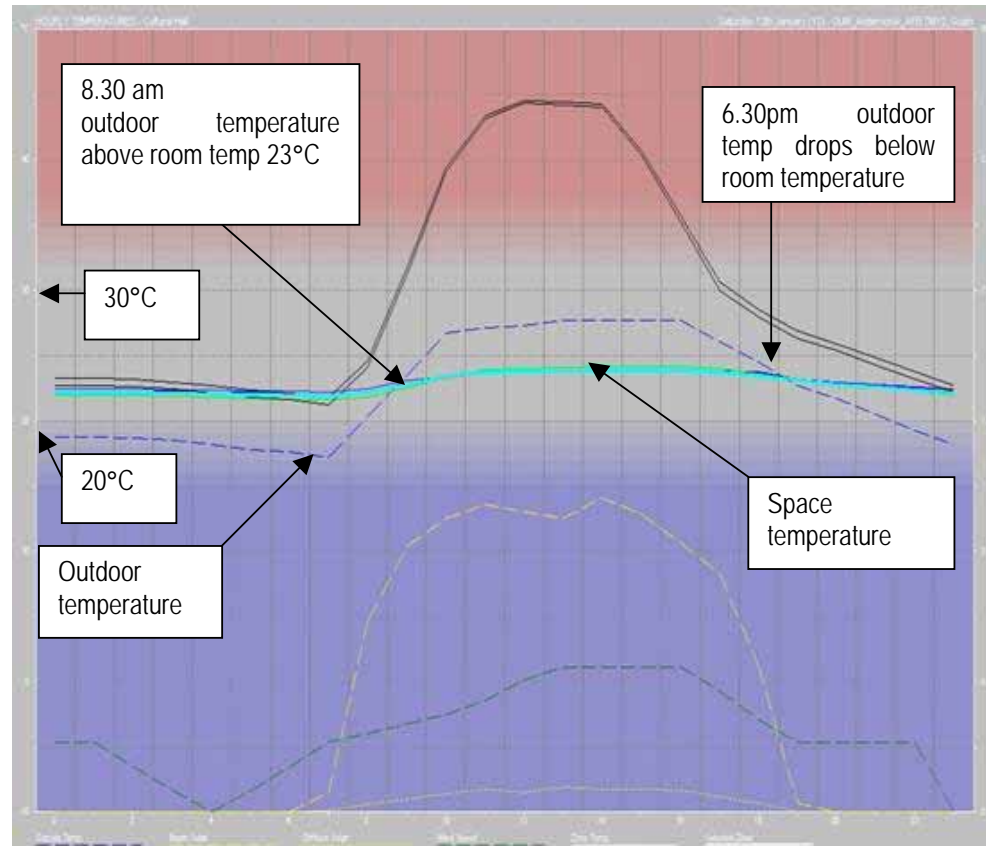
## Effective cooling from fans



## Thermal mass

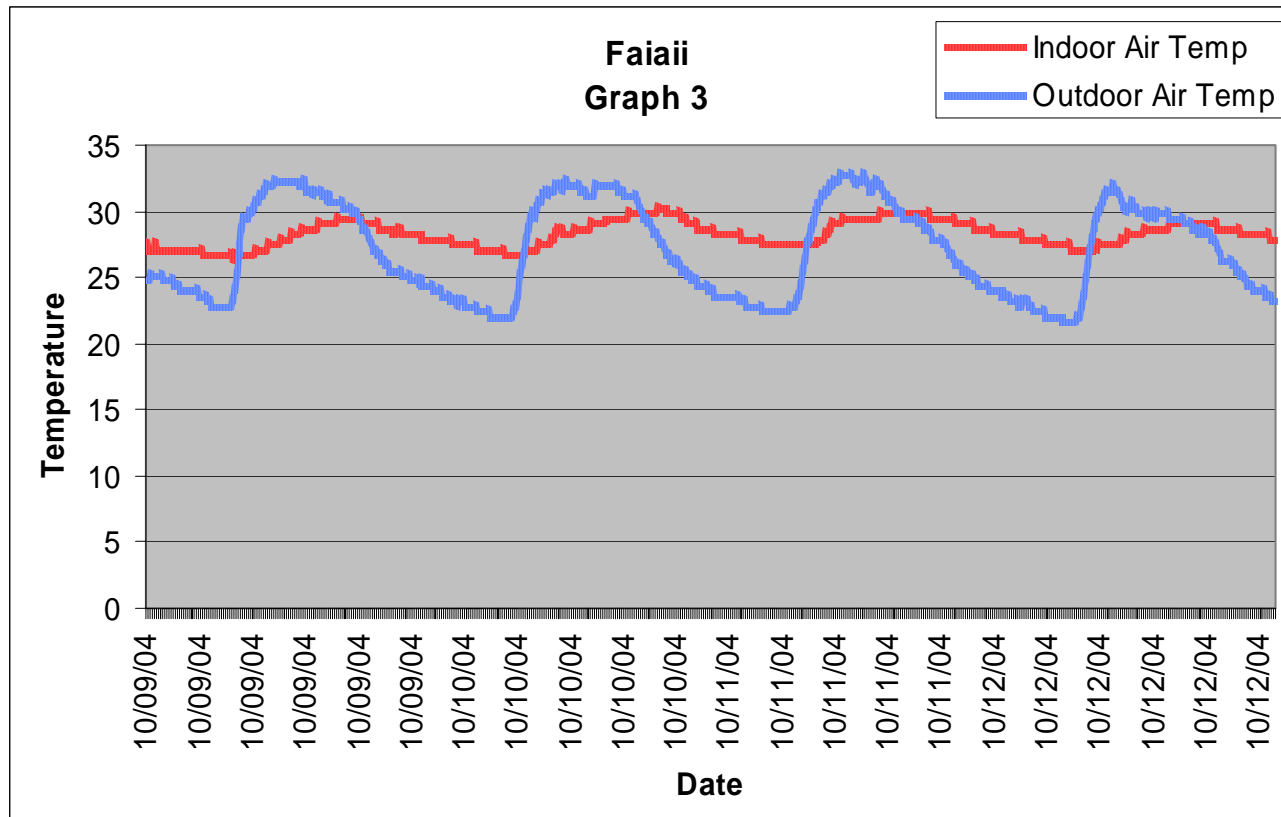
- Heavy weight concrete structure.
  - Thick concrete slab on grade.
  - Thick heavyweight concrete block wall.
- Slab on grade allows heat to be transferred into ground
- Thermal Mass only works if cool. Therefore must be shaded from external gains to be effective.

## Internal temperature profiles



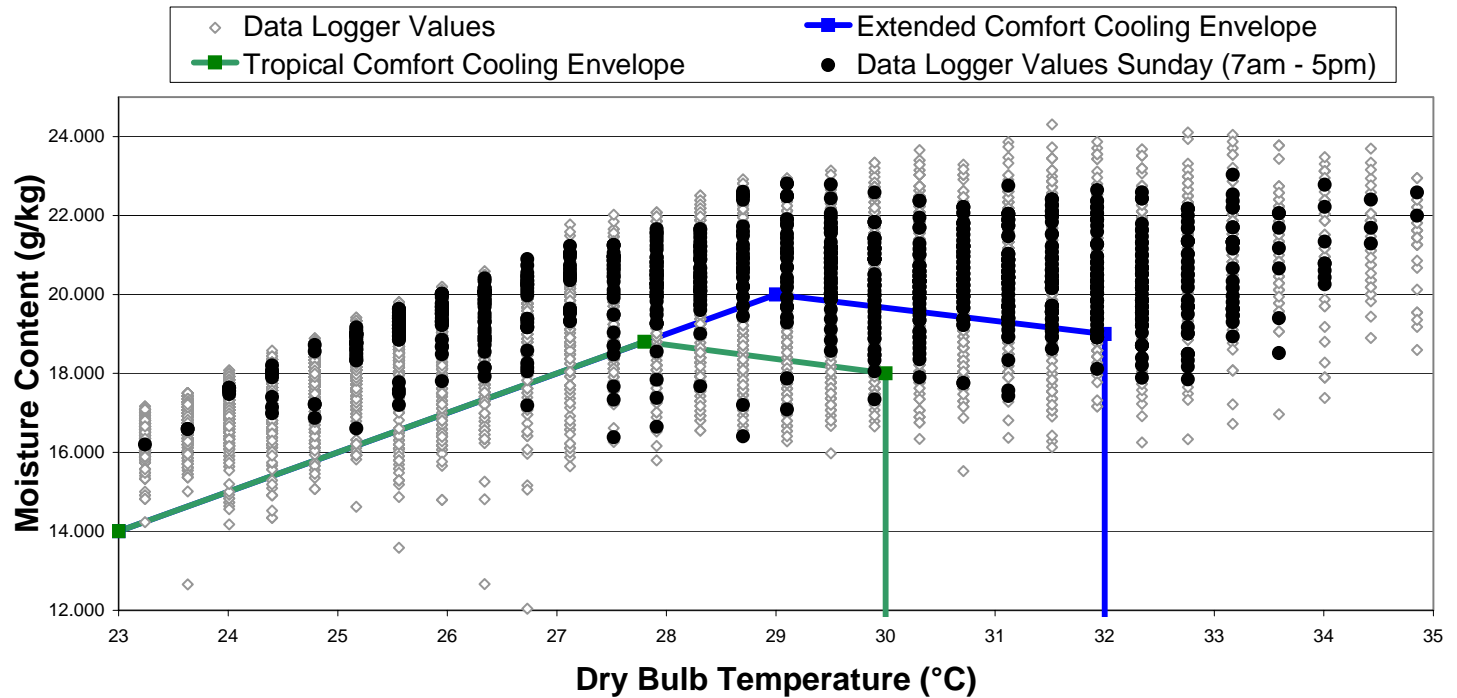
*Shows how internal temperatures vary across a particular day of the year.*

# Actual Thermal Profile



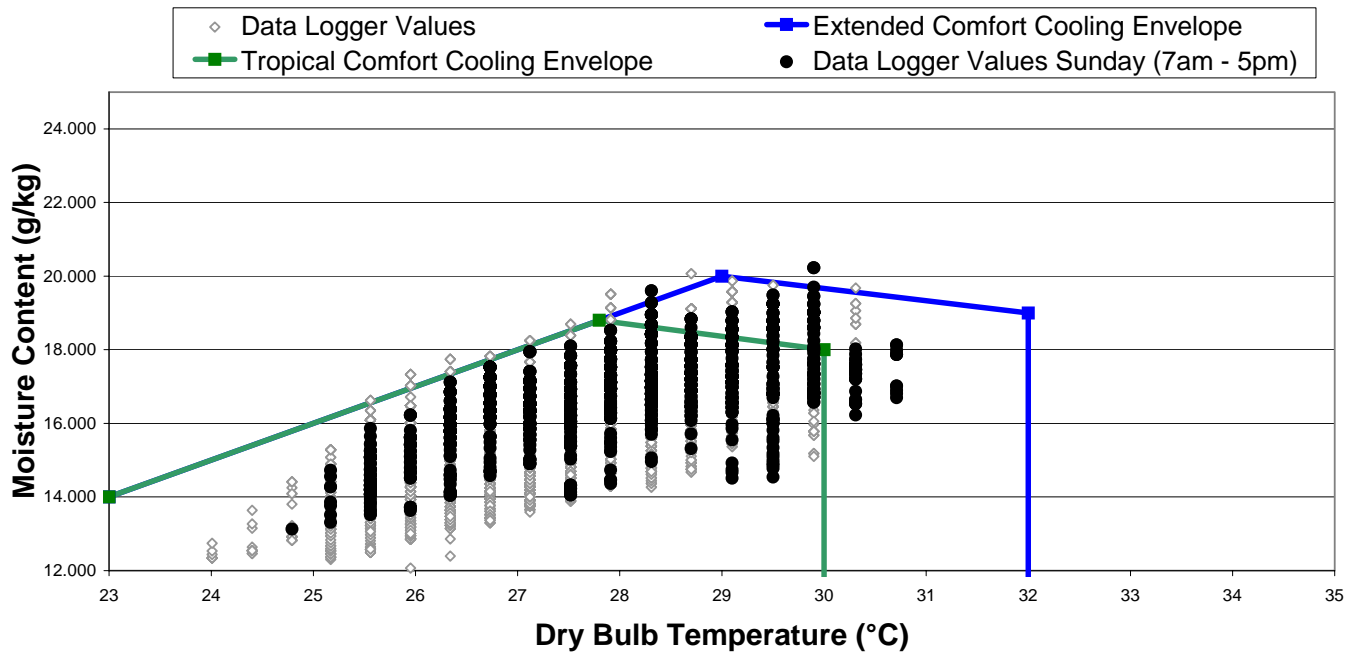
# Outdoor Temperature and Humidity

Faiii Outside (2 Oct 2004 to 13 Jan 2005)



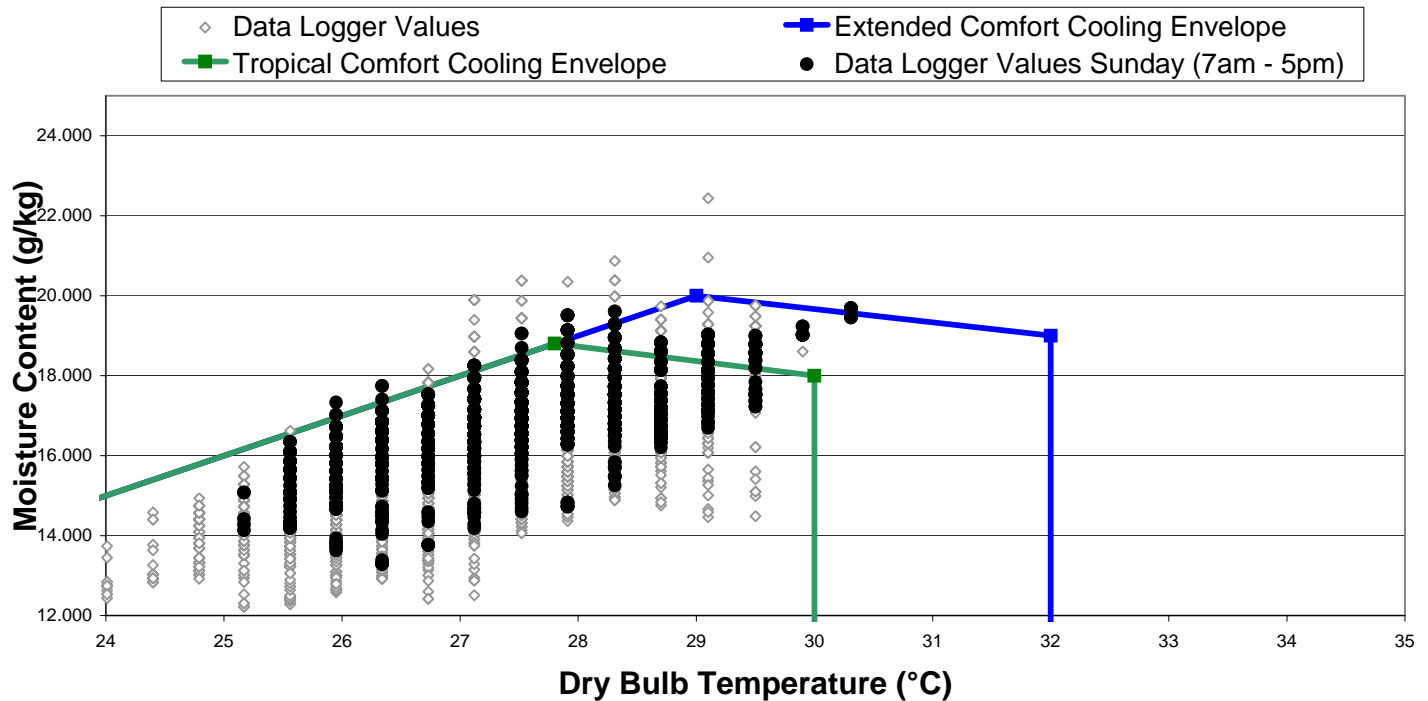
# Indoor Temperature and Humidity(Chapel)

Faiii 3 (available readings between 2 Oct '04 and 30 Nov '05)



# Indoor Temperature and Humidity (Classroom)

**Faiii 8 (available readings between 2 Oct '04 and 30 Nov '05)**



## Recommendations to maximise thermal comfort

- Shaded Thermal Mass
- Light coloured insulated roof
- Ceiling fans evenly distributed
- Internal flow of air for equilibrium
- Transient occupancy

## Conclusions/ Application to New Zealand

- Acceptance of expanded comfort envelope (18°C to 26°C )
- Acceptance of shaded thermal mass ( say NO to glass boxes)
- Acceptance of ceiling fans
- Heat and cool floor slabs for thermal comfort