HUMIDITY ISSUES IN AUSTRALIAN CLIMATES
WORKSHOP
Sydney 2016

AIRAH

# Condensation risks in bulk insulation in hot and mixed climates

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# Acknowledgements


- The research presented here shows some interim insights into a project entitled "Bulk insulation in hot and mixed climates" being undertaken for ICANZ http://icanz.org.au
- Our research and simulation team includes:
  - Exemplary Energy
    Chun Yin Wu, Zhongran (Talent) Deng
  - University of Tasmania
    Thomas Chandler, Johann Potgieter and Abdel Soudan
- Specialised climate data is supplied by our Bureau of Meteorology, selected and formatted by Exemplary Energy www.exemplary.com.au

# Presentation Outline

- Methodology and Problems Encountered
- Climate analysis
- Component analysis
- Component simulation – THERM
- Component simulation – JPA and WUFI
- Conclusions and Progress
- Questions

# Methodology and Problems Encountered

- Variations between AS and ISO Standards and industry practice
- Software limitations for simulations (e.g. assumption of still, trapped air in all voids when cavities are often well ventilated)
- Climate data with unhelpful units of humidity measurement (e.g. Relative Humidity in % and Absolute Moisture Content in g/kg dry air)
- Uncertainties and imprecisions in long term measurement of humidity; generally as Wet Bulb Temperature unadjusted for measured wind speed
- Internal temperatures for Regulation purposes and actual values in practice

# Climate Analysis

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- The research covers three specific climates
  - Darwin (hot humid monsoonal)
  - Brisbane (subtropical, coastal)
  - Eastern Sydney (warm temperate, coastal)
- Climate files selected were RMY-C
- RMY = Reference Meteorological Year
- C = indicative months selected with a strong weighting for temperature and humidity (over solar and wind speed)

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# Climate Analysis

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Eastern Sydney (warm temperate, coastal)

- Used RMY-C climate file but could use immediate past weather data
- Real Time Years (RTYs) to end of last month
- RTYs for Sydney (Macquarie University or CBD) and associated Weather and Energy Index published monthly by Exemplary Energy (http://www.exemplary.com.au/solar_products/EWE%20indices.php)

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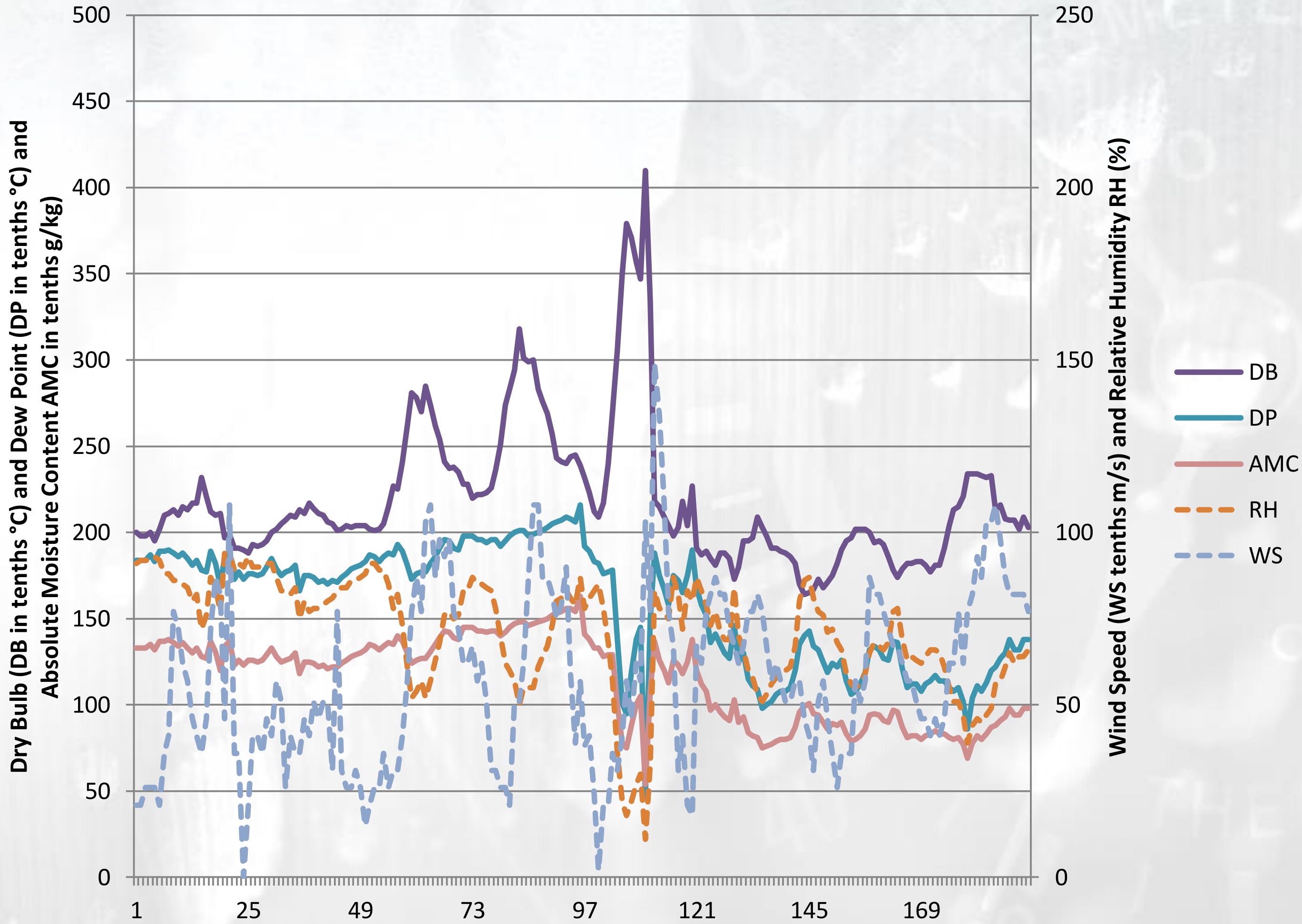
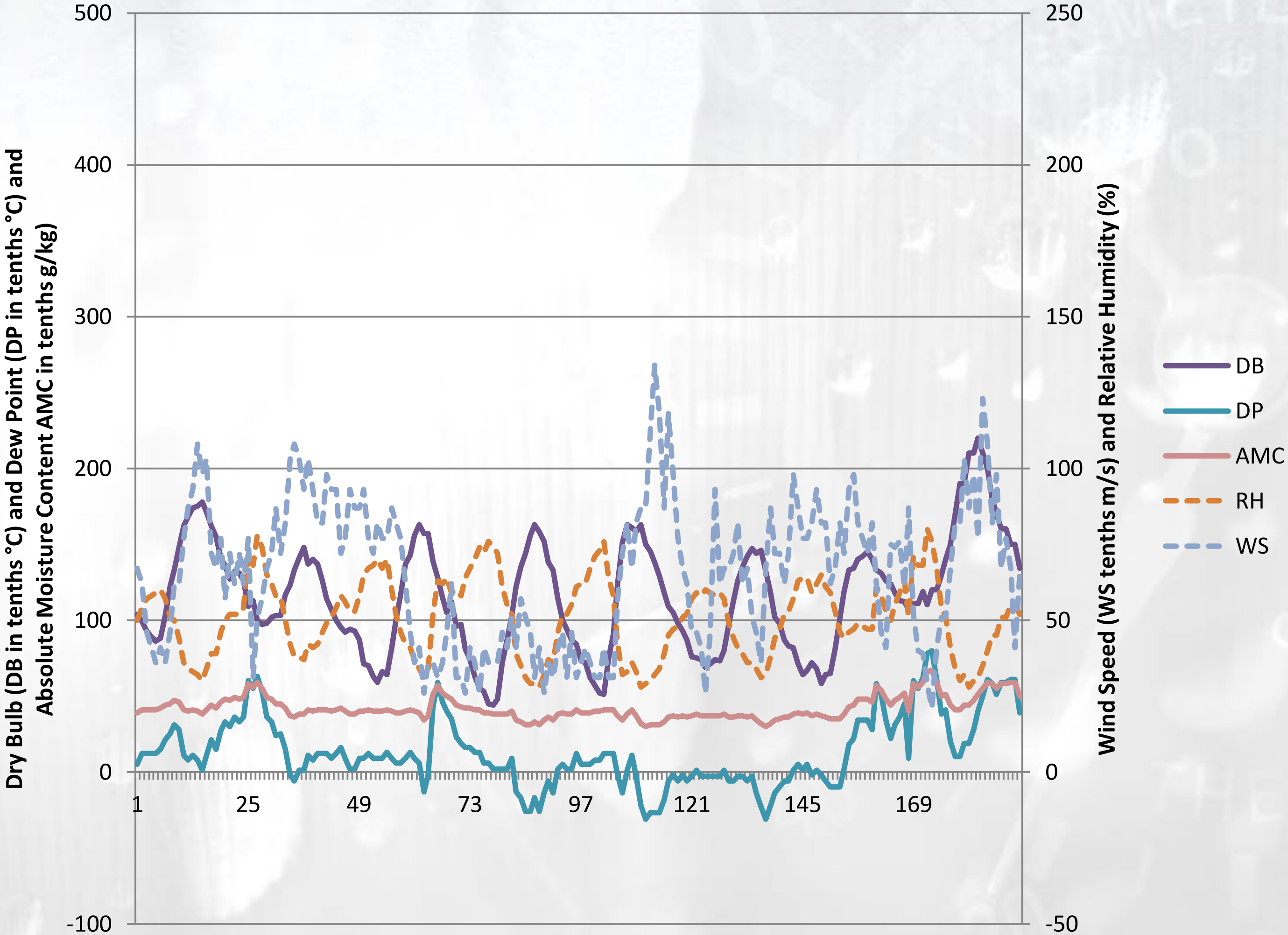
# Climate Analysis - Eastern Sydney

## Summer week around the hottest day



# Climate Analysis - Eastern Sydney

## Winter week around the coldest morning



# Climate Analysis - Internal

- Internal conditions are indicated in the National Construction Code (NCC) and mandatory for compliance simulations
  - Residential – NatHERS (www.nathers.gov.au)
  - Section J – JV3 Energy Verification
    NCC Section J - Verification Methods JV3 (d)(i)(D)
- Actual internal conditions vary widely with occupant and management preferences

# Climate Analysis - Internal

- Darwin (hot humid monsoonal)
  - – NatHERS - Heating: 20.0°C, Cooling: 26.5°C
  - – NCC - Heating: 18.0°C, Cooling: 26.0°C
- Brisbane (subtropical, coastal)
  - – NatHERS - Heating: 20.0°C, Cooling: 25.5°C
  - – NCC - Heating: 18.0°C, Cooling: 26.0°C
- Eastern Sydney (warm temperate, coastal)
  - – NatHERS - Heating:20.0°C, Cooling 24.5°C
  - – NCC - Heating: 18.0°C, Cooling: 26.0°C

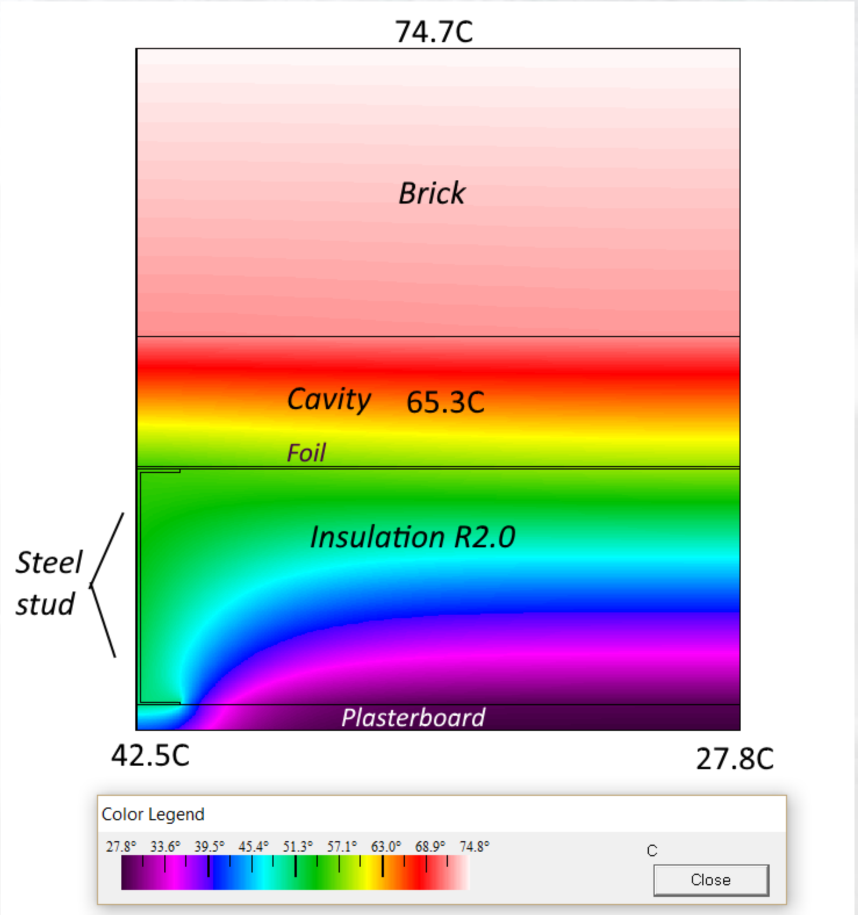
# Component analysis

- Australian Standards
  - AS/NZS 4859.1:2002 - Materials for the thermal insulation of buildings - Part 1: General criteria and technical provisions
- International Standards
  - ISO 6946:2007, Building components and building elements - Thermal resistance and thermal transmittance - Calculation method
  - ISO 10211 (2), Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations
  - ISO 13789 - Thermal performance of buildings - Transmission and ventilation heat transfer coefficients - Calculation method
  - ISO 14683 (4), Thermal bridges in building construction — Linear thermal transmittance — Simplified methods and default values
  - ISO 15242:2007 - Ventilation for buildings - Calculation methods for the determination of air flow rates in buildings including infiltration
  - ISO 15927-1:2003 - Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 1: Monthly means of single meteorological elements

# Component simulation – THERM

## What is THERM?

- thermal modelling software for walls, roofs, window frames…in fact anything solid, plus entrapped gases such as air
- Public domain, free, developed and supported by Lawrence Berkeley National Laboratory, University of California
- At the heart of 10 million window energy ratings in USA, Canada, Australia and many other countries
- *windows.lbl.gov/software*



# Modelling walls and roofs with *THERM 7.4.3*



**THERM capabilities:**

- 2-D heat transfer calculation using 'finite element' method
- Calculate overall R-values, U-values, surface and interstitial temperatures and temperature gradients, condensation risk (provided dew point of the air is known separately)
- One layer or many
- Conduction, convection and radiation
- Computational algorithms are compliant with ISO 15099:2003 (international heat transfer standard)

# Modelling walls and roofs with *THERM 7.4.3*

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**THERM limitations:**

- Steady state analysis, *i.e.* a snapshot in time (not dynamic) and not accounting for thermal mass effects
- Does not evaluate moisture transfer
- Does not calculate wind-driven or fan-forced air flows
- But *does* calculate buoyancy-driven air movement and circulation caused by temperature differences

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# Modelling walls and roofs with *THERM 7.4.3*

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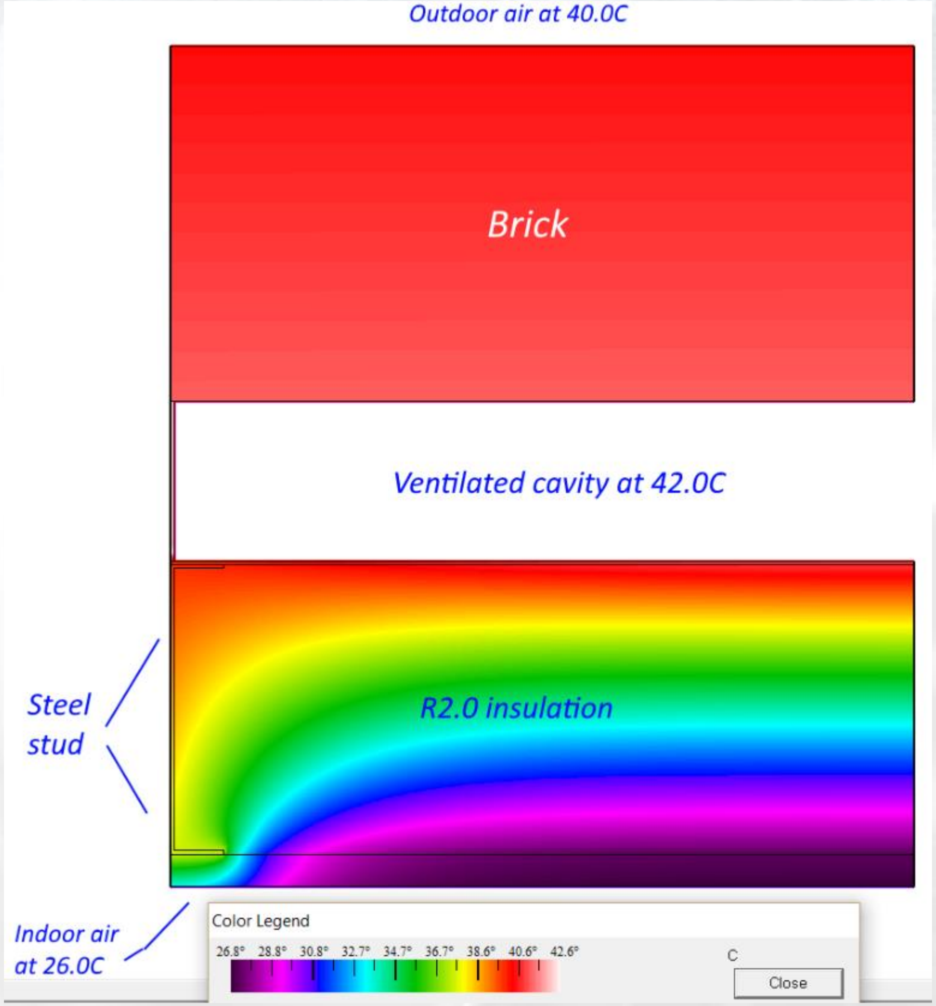
## ***However…***

- THERM *can* be used in situations of wind-driven or thermally forced air flow *IF* those characteristics are known and can be pre-calculated and input to THERM as 'special' boundary conditions.

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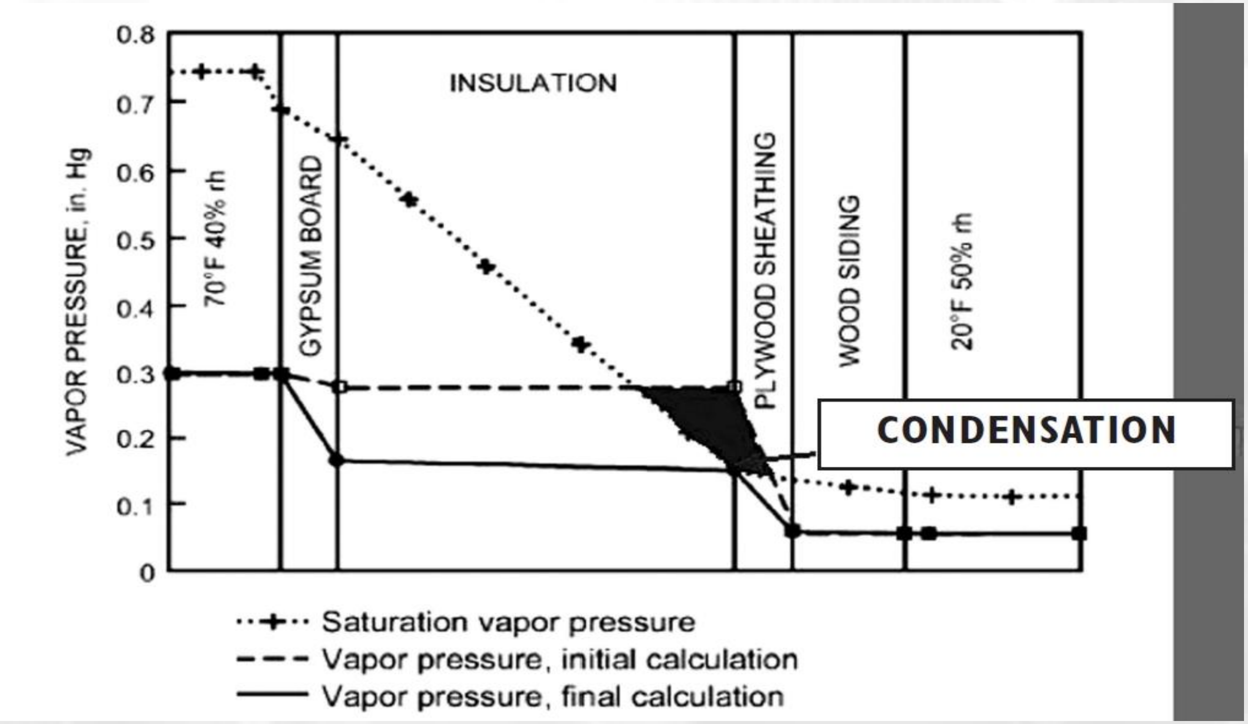
# Component simulation – JPA

- JPA Designer SAP 2012 (9.92) www.techlit.co.uk
- Like THERM, Steady State is assumed; but
- Water vapour transmission and condensation is accounted for; and
- The analysis can include thermal bridging.



# Component simulation – JPA



**Environmental Conditions**

External Conditions

Building location: BOM_Mean 9am_Product_IDCJCM0036

Risk level: Average

- Average
- 1 in 5 years
- 1 in 10 years
- 1 in 20 years
- 1 in 50 years

Internal Condition

Source of intern

Use design

Climate

(•) Maritime ( ) 'Continental' or tropical

Internal humidity class: 4 - Dwellings with high occupancy, spor

Internal temperature (°C): 20.0

| | Int T | Int RH | Ext T | Ext RH |
|---|---|---|---|---|
| Jan | 18.0 | 50.0 | 25.7 | 67.0 |
| Feb | 18.0 | 50.0 | 25.4 | 70.0 |
| Mar | 18.0 | 50.0 | 24.1 | 71.0 |
| Apr | 18.0 | 50.0 | 21.5 | 70.0 |
| May | 18.0 | 50.0 | 18.0 | 71.0 |
| Jun | 18.0 | 50.0 | 15.1 | 70.0 |
| Jul | 18.0 | 50.0 | 14.1 | 68.0 |
| Aug | 18.0 | 50.0 | 15.5 | 63.0 |
| Sep | 18.0 | 50.0 | 18.9 | 60.0 |
| Oct | 18.0 | 50.0 | 21.9 | 60.0 |
| Nov | 18.0 | 50.0 | 23.9 | 60.0 |
| Dec | 18.0 | 50.0 | 25.3 | 63.0 |

OK

**Results Table**

Results to show: ( ) Winter (•) Summer

[ ] Always on top

Close

Description:

- Outside surface resistance
- Steel
- Airspace, heat flow upwards
- Reinforced concrete (1% ste
- Inside surface resistance

| Interface Temperature (°C) | Dewpoint Temperature (°C) | Vapour Pressure (kPa) | SVP (kPa) | Summer Buildup (g/m²) | Annual Buildup (g/m²) | ISO - Winter Worst Buildup (g/m²) (Month) | ISO - Winter Peak Buildup (g/m²) (Month) |
|---|---|---|---|---|---|---|---|
| 25.7 | 19.1 | 2.211 | 3.300 | 0.0 | 0.0 | | |
| 24.8 | 19.1 | 2.211 | 3.134 | 0.0 | 0.0 | n/a | n/a |
| 24.8 | 7.4 | 1.032 | 3.134 | 0.0 | 0.0 | n/a | n/a |
| 21.4 | 7.4 | 1.032 | 2.540 | 0.0 | 0.0 | n/a | n/a |
| 20.2 | 7.4 | 1.031 | 2.362 | 0.0 | 0.0 | n/a | n/a |
| 18.0 | 7.4 | 1.031 | 2.063 | 0.0 | 0.0 | n/a | n/a |

**Results Table**

Results to show: (•) Winter ( ) Summer

[ ] Always on top

Close

Description:

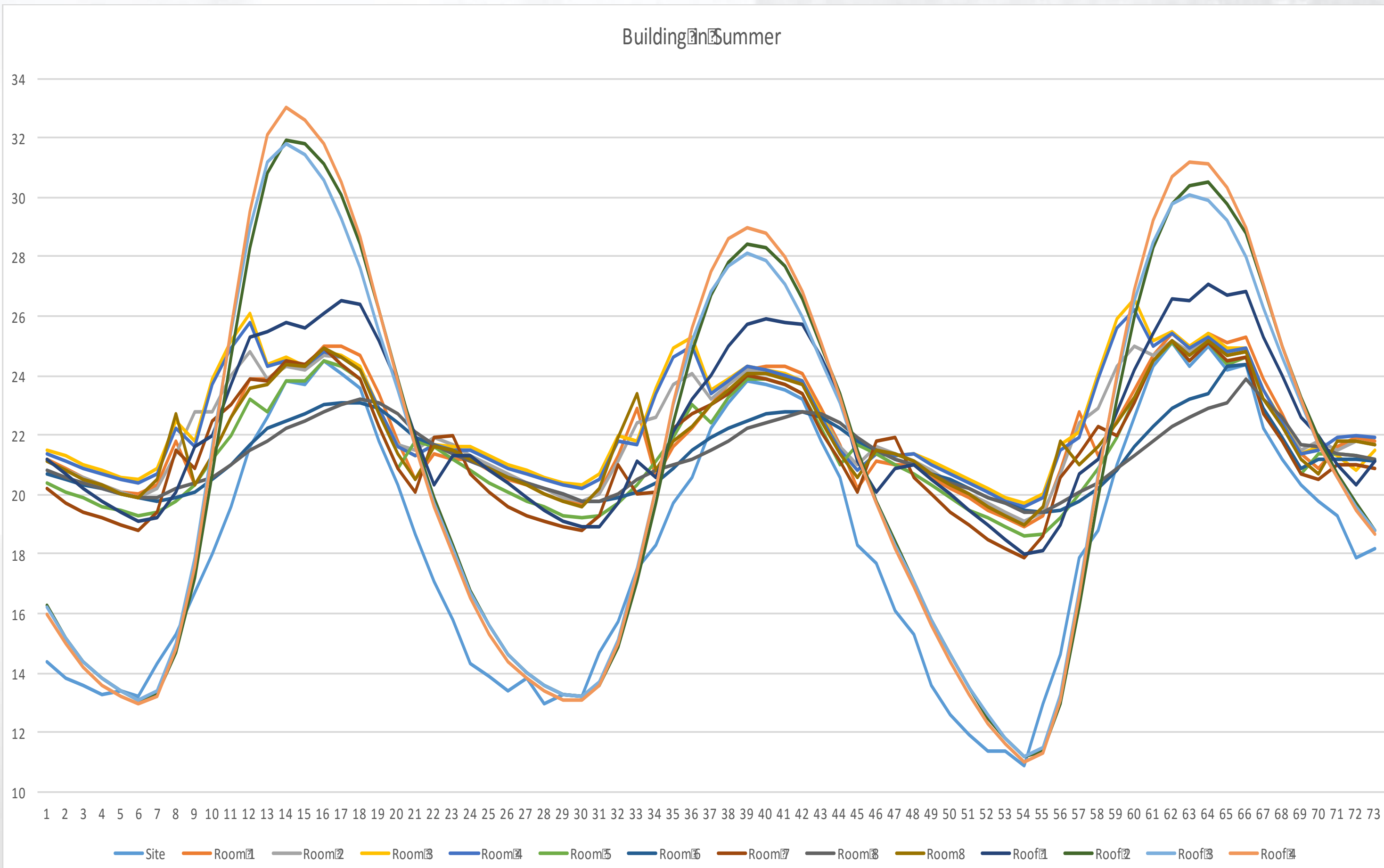
- Outside surface resistance
- Steel
- Airspace, heat flow upwards
- Reinforced concrete (1% ste
- Inside surface resistance

| Interface Temperature (°C) | Dewpoint Temperature (°C) | Vapour Pressure (kPa) | SVP (kPa) | Winter Buildup (g/m²) | Annual Buildup (g/m²) | ISO - Winter Worst Buildup (g/m²) (Month) | ISO - Winter Peak Buildup (g/m²) (Month) |
|---|---|---|---|---|---|---|---|
| 14.1 | 8.3 | 1.094 | 1.608 | 0.0 | 0.0 | | |
| 14.5 | 8.3 | 1.094 | 1.655 | 0.0 | 0.0 | n/a | n/a |
| 14.5 | 7.4 | 1.031 | 1.655 | 0.0 | 0.0 | n/a | n/a |
| 16.3 | 7.4 | 1.031 | 1.853 | 0.0 | 0.0 | n/a | n/a |
| 16.9 | 7.4 | 1.031 | 1.924 | 0.0 | 0.0 | n/a | n/a |
| 18.0 | 7.4 | 1.031 | 2.063 | 0.0 | 0.0 | n/a | n/a |

# Component simulation – JPA



In real buildings, short term transient effects are significant and need to be accounted for.

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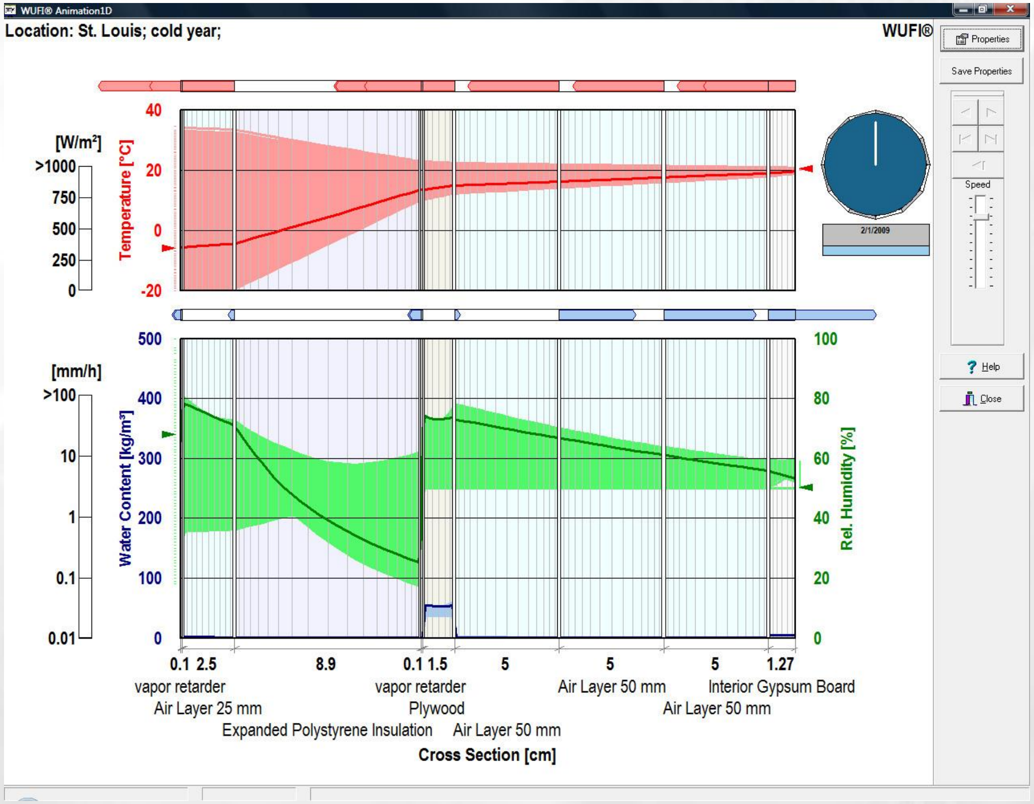
# Component simulation – WUFI

- Considers transient and seasonal effects; but
- It is also 1-Dimensional; but
- It has a high-end 2 Dimensional option.



# Component simulation – Ideal

The ideal software will account for:

- Roof Spaces and Envelope Components;
- Northern Spaces and Envelope Components;
- Eastern Spaces and Envelope Components;
- Western Spaces and Envelope Components;
- Southern Spaces and Envelope Components;
- Façade Systems;
- Passive Ventilation Systems; and
- Passive and wind-driven aspiration of air spaces within Components (e.g. the cavity in brick veneer construction).

# Conclusions and Progress

- Analysing condensation risks in bulk insulation in hot and mixed climates on a theoretical basis has its challenges.

- Studying moisture and condensation issues in buildings by simulation alone has its limitations; but we anticipate overcoming them as a part of this study.

# Questions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