

# The Bed Environment

Results of laboratory and field studies

Ian Ridley

# Introduction

*Is the bed Micro-climate very different from the Bedroom?*

Measurement in an instrumented test bed:

- Determine relationship between room and bed conditions
- Examine spatial variation of conditions in bed
- Examine transient nature of bed conditions

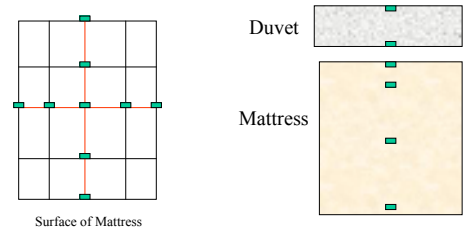
Measurements in test houses

- Seasonal variations in bed and bedroom conditions

# Measurements in test bed



# Sensors in bed

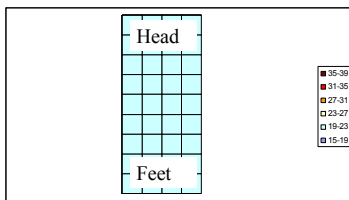


75 RH and Temp Sensors – Multi Channel data-logger

# Temperature on the mattress surface

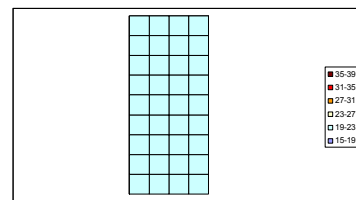


Readings taken every 10 secs  
1 hour average

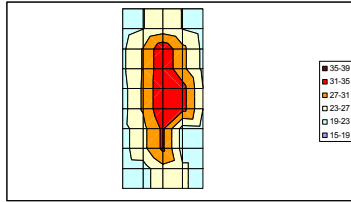


Cold  Hot

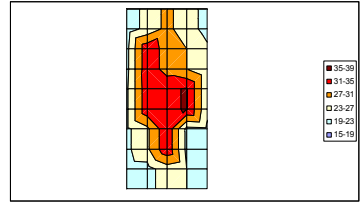
# Surface temperature: 10 PM



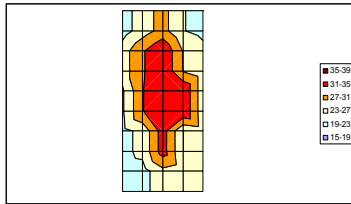
Surface temperature: 11 PM



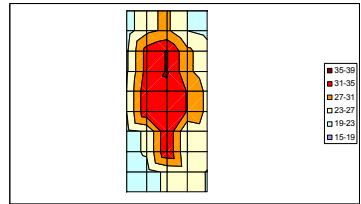
Surface temperature: 12 PM



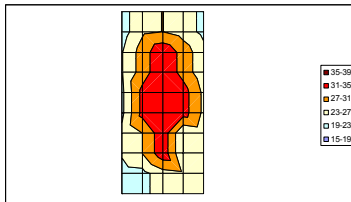
Surface temperature: 1 AM



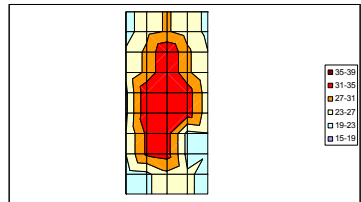
Surface temperature: 2 AM



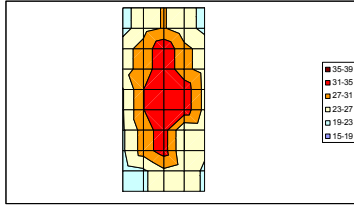
Surface temperature: 3 AM



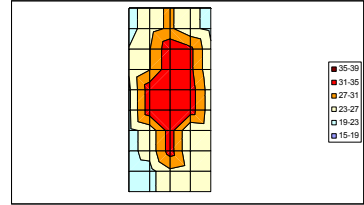
Surface temperature: 4 AM



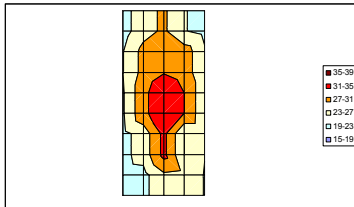
Surface temperature: 5 AM



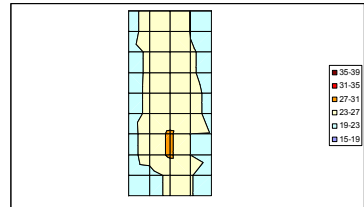
Surface temperature: 6 AM



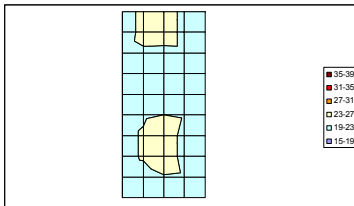
Surface temperature: 7 AM



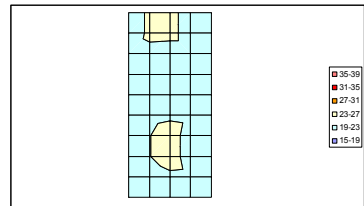
Surface temperature: 8 AM



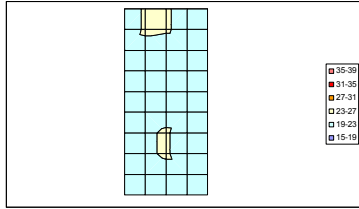
Surface temperature: 9 AM



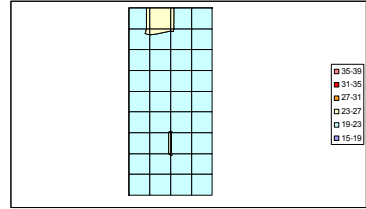
Surface temperature: 10 AM



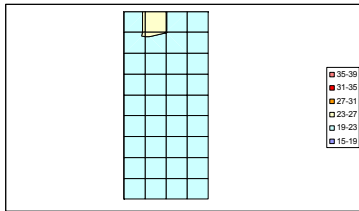
### Surface temperature: 11 AM



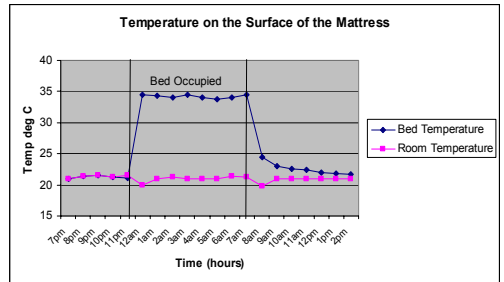
### Surface temperature: 1 PM



### Surface temperature: 2 PM

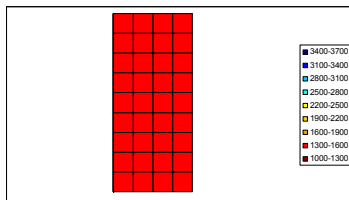


### Temperature on the surface of mattress below occupant

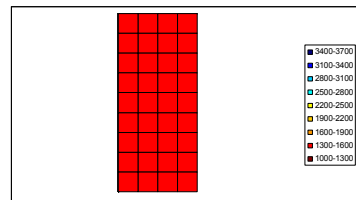


### Vapour pressure on the mattress surface

Vapour pressure/  
absolute humidity  
1000 Pa = 6.2g/kg

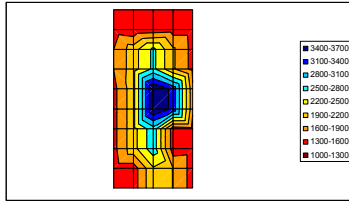


### Surface vapour pressure: 10 PM

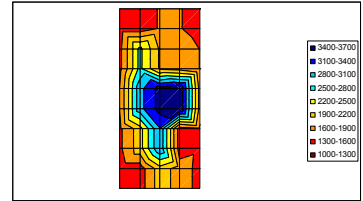


Dry  Wet

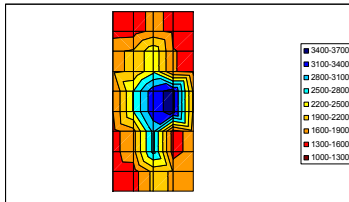
Surface vapour pressure: 11 PM



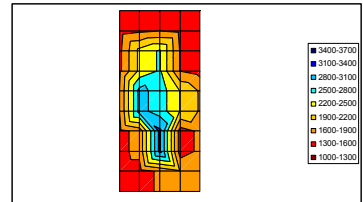
Surface vapour pressure: 12 PM



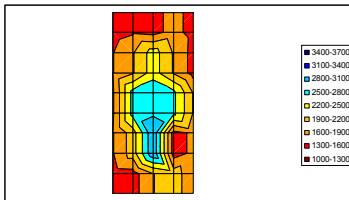
Surface vapour pressure: 1 AM



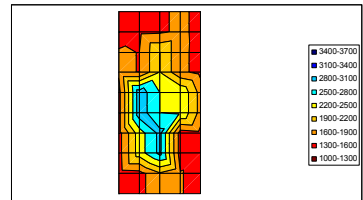
Surface vapour pressure: 2 AM



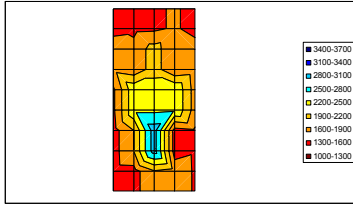
Surface vapour pressure: 3 AM



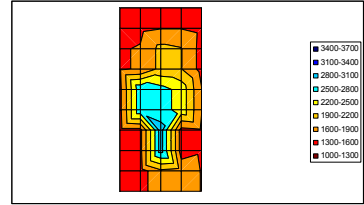
Surface vapour pressure: 4 AM



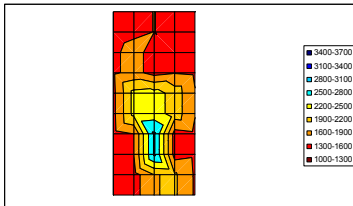
Surface vapour pressure: 5 AM



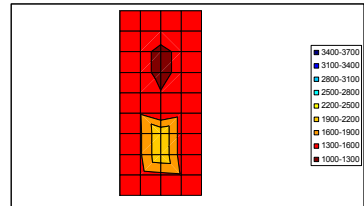
Surface vapour pressure: 6 AM



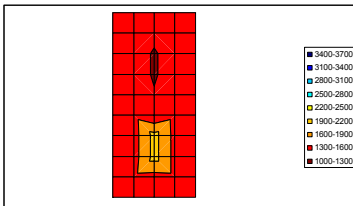
Surface vapour pressure: 7 AM



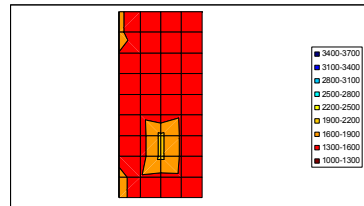
Surface vapour pressure: 8 AM



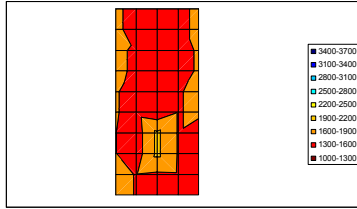
Surface vapour pressure: 9 AM



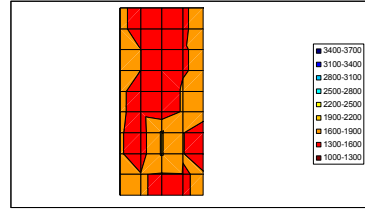
Surface vapour pressure: 10 AM



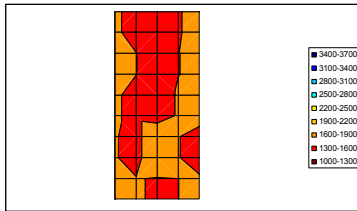
## Surface vapour pressure: 11 AM



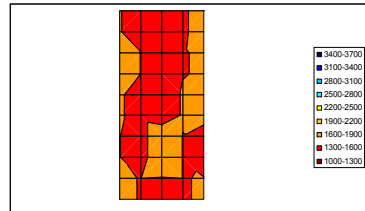
## Surface vapour pressure: 12 AM



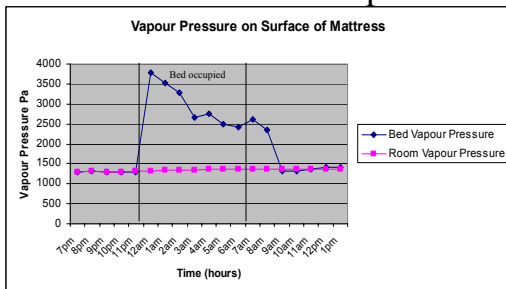
## Surface vapour pressure: 1 PM



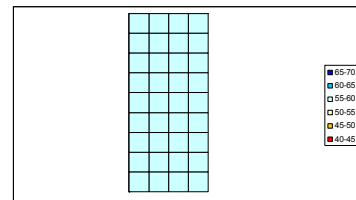
## Surface vapour pressure: 2 PM




## Vapour pressure on surface of mattress below occupant

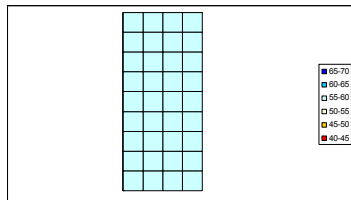


## Relative humidity on the mattress surface

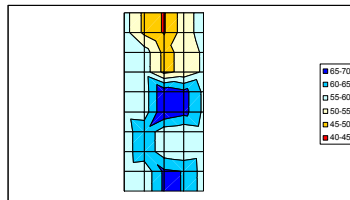


Dry  Wet

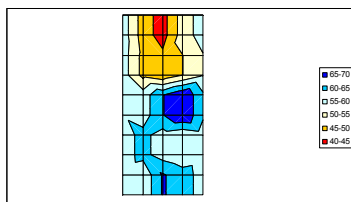
Surface relative humidity: 10 PM



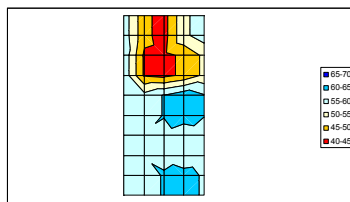
Surface relative humidity : 10 PM



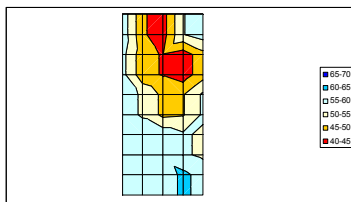
Surface relative humidity : 12 PM



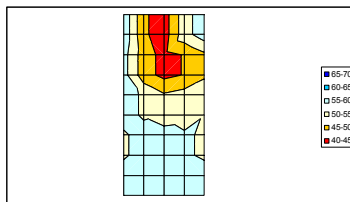
Surface relative humidity : 1 AM



Surface relative humidity : 2 AM

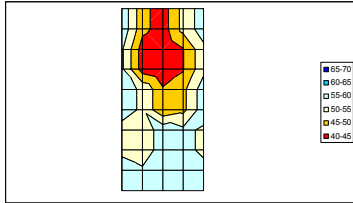


Surface relative humidity : 3 AM

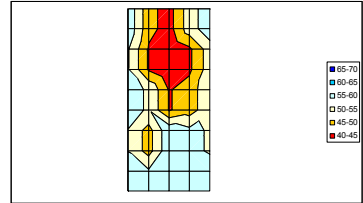




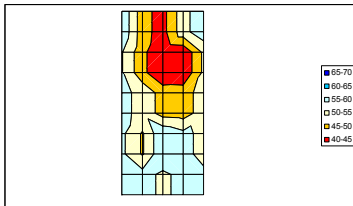
Surface relative humidity : 4 AM



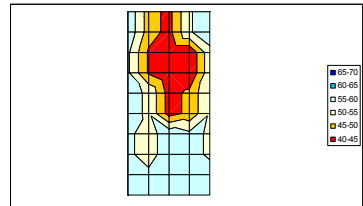
Surface relative humidity : 5 AM



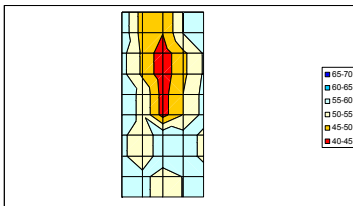
Surface relative humidity : 6 AM



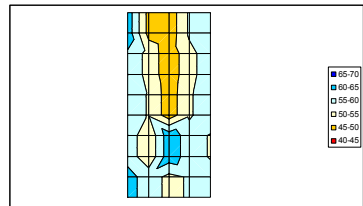
Surface relative humidity : 7 AM



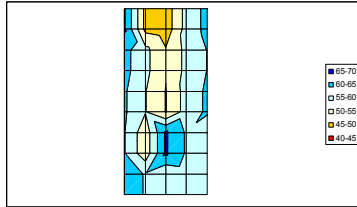
Surface relative humidity : 8 AM



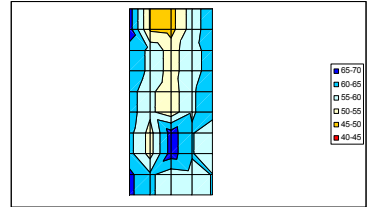
Surface relative humidity : 9 AM



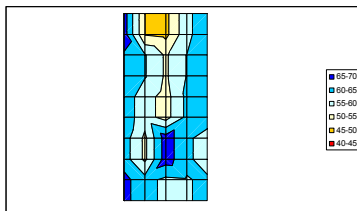
Surface relative humidity : 10 AM



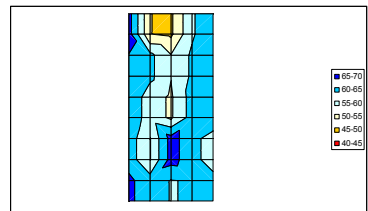
Surface relative humidity : 11 AM



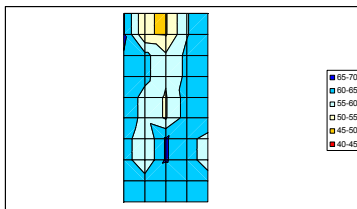
Surface relative humidity : 12 AM



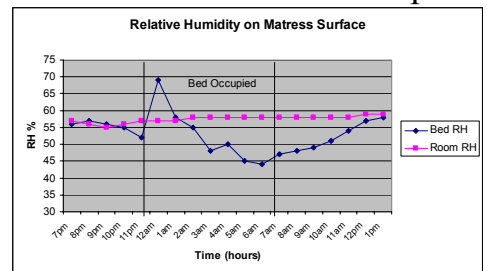
Surface relative humidity : 1 PM



Surface relative humidity : 2 PM



Relative humidity on the surface of the mattress below occupant

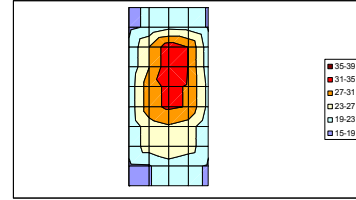


# Does relative humidity under occupant go up or down?

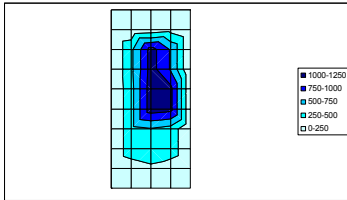
- Occupant inputs both Heat and Moisture into Bed
- Directly under Occupant Temperature is 34 deg C
- Input of Moisture approx 1200 Pa

	30	35	40	45	50	55	60	65	70
15	29.54243	31.00417	32.4659	33.92763	35.38937	36.8511	38.31284	39.77457	41.23631
16	30.12429	31.683	33.24171	34.80042	36.35913	37.91784	39.47655	41.03526	42.59397
17	30.73972	32.401	34.06228	35.72356	37.38484	39.04612	40.70741	42.36869	44.02997
18	31.39035	33.16007	34.92979	36.69951	38.46923	40.23895	42.00867	43.77839	45.54811
19	32.07788	33.96219	35.8465	37.7308	39.61511	41.49942	43.38373	45.26904	47.15235
20	32.80406	34.8094	36.81474	38.82008	40.82541	42.83075	44.83609	46.84143	48.84677
21	33.57072	35.70383	37.83694	39.97006	42.10317	44.23629	46.3694	48.50252	50.63563
22	34.37974	36.64769	38.91564	41.16359	43.45154	45.71949	47.98744	50.25539	52.52335
23	35.23308	37.64336	40.05343	42.46381	44.97379	47.28395	49.89413	52.10431	54.51446
24	36.13278	38.6929	41.26303	43.81316	46.37328	48.93341	51.49353	54.05369	56.61379
25	37.08094	39.79909	42.51724	45.23539	47.95354	50.6717	53.38985	56.108	58.82615
26	38.07973	40.96435	43.84897	46.73359	49.61821	52.50282	55.38744	58.27206	61.15688
27	39.13142	42.19132	45.25122	48.31112	51.37102	54.43092	57.49082	60.55072	63.61062
28	40.23834	43.48273	46.72711	49.9715	53.21588	56.46027	59.70476	62.94904	66.19343
29	41.4029	44.84138	48.27986	51.71833	55.15681	58.59529	62.03377	65.47225	68.91073
30	42.62759	46.27019	49.91278	53.55538	57.19797	60.84057	64.48316	68.12576	71.76835

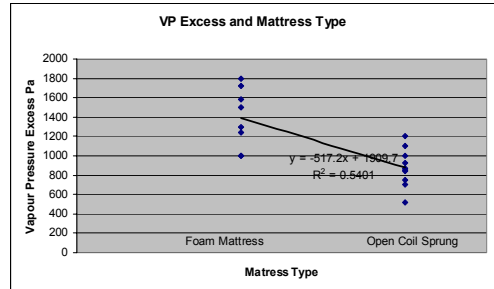
# Average surface temp of bed when occupied



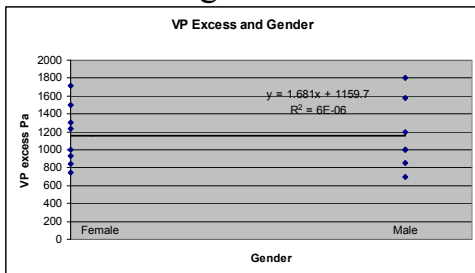
# Average surface vapour pressure excess on bed when occupied



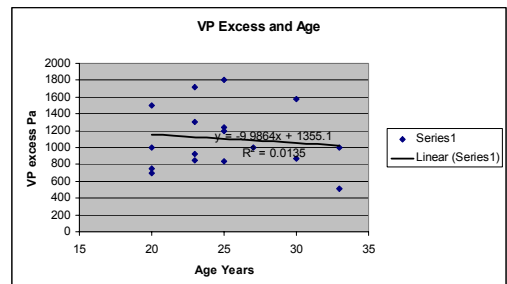
# Variation of VP excess with mattress type



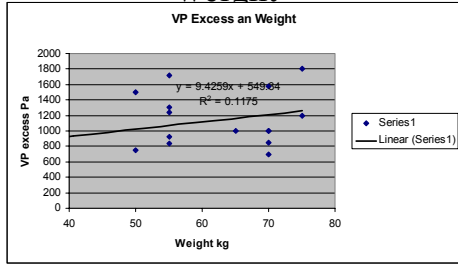
# Variation of VP excess and gender



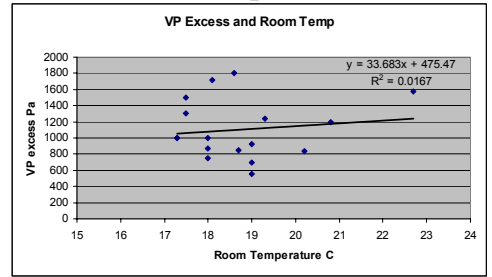
# Variation of VP excess and age



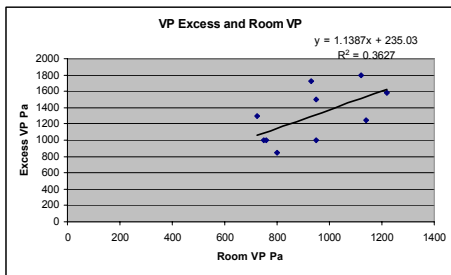
## Variation of VP excess and body weight



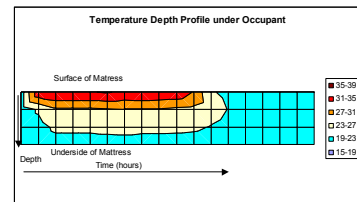
## Variation of VP excess and room temp



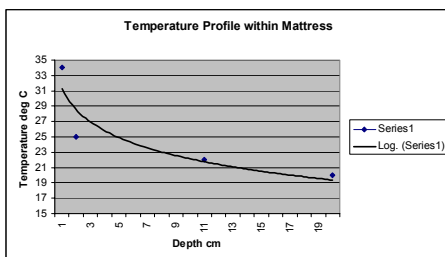
## Variation of VP excess and room VP



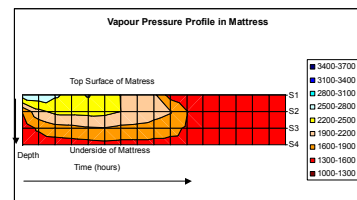
## Temperature inside the mattress



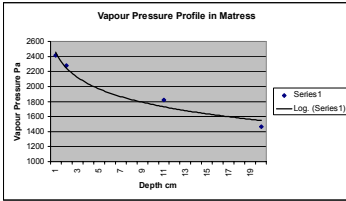
## Temperature at depth



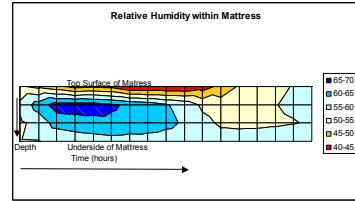
## Vapour pressure inside mattress



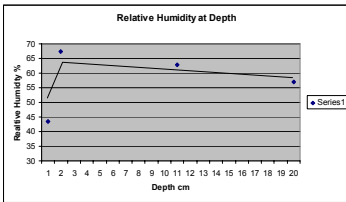
## Vapour Pressure at depth



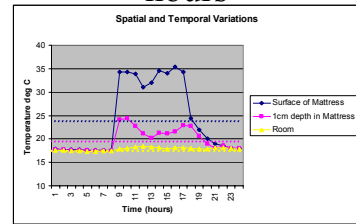
## Relative humidity inside mattress



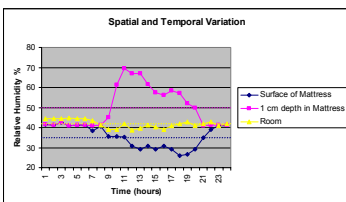
## Relative humidity at depth



## Variations in temperature over 24 hours



## Variations in RH over 24 hours

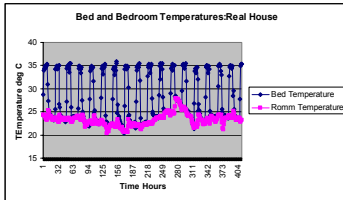


## Experimentation in real beds

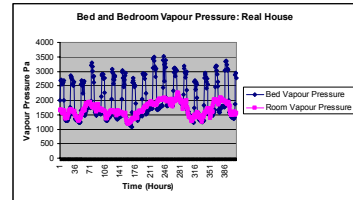
- 3 Houses monitored for 1 year
- Hobo Loggers in:
  - Bedroom,
  - Under Bed,
  - Mattress Surface, under occupant
  - External



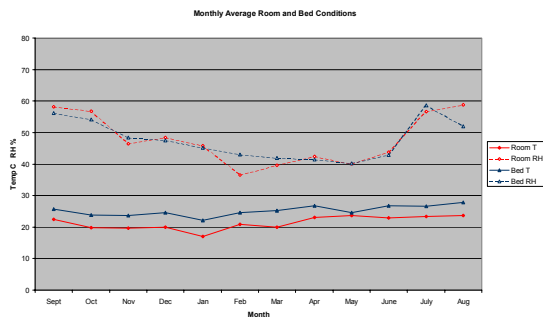
## Bed and bedroom temperatures



## Bed and bedroom vapour pressure



## Monthly average bed and room conditions



## Summary of experimental results

- When unoccupied the bed follows room conditions
- When occupied different parts of the bed have very different conditions
- When occupied the bed condition is different to the room
- The 24hour average bed condition is not equal to 24 hour room condition
- On “getting up” bed returns to equilibrium with room (4-6 hours)