ROGER BULLIVANT

Monitoring of the ground temperature of a piled foundation heat exchanger system for a residential building over two heating seasons

Chris Wood

christopher.wood@nottingham.ac.uk

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The problem:

- Heating, lighting and running the current UK building stock amounts to 50% of the total UK energy consumption. 28% is the domestic sector.
- Heating amounts to over 4/5th of the domestic energy requirement
- 1/3 of the housing stock required by 2050 is still to be built.

The requirement:

- To find methods of reducing carbon emissions of new build residential –

  The Answer: GROUND SOURCE!

- To find cost effective methods of installing ground loops!

  The Answer: To incorporate the loops into the foundations –ENERGY PILES!.

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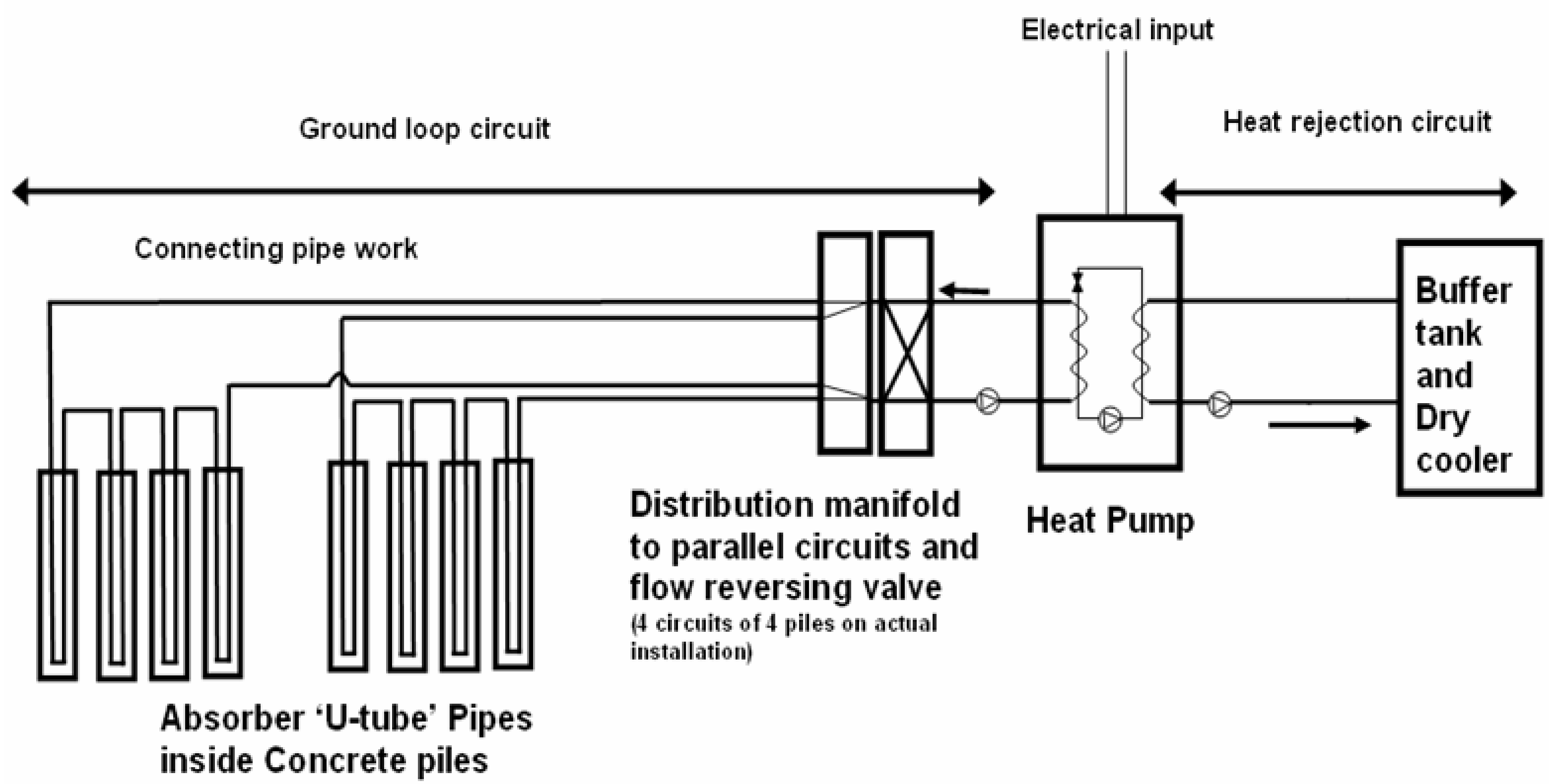
Primary research – ground temperature effects

- Plot equivalent to two semi detached starter homes or one larger 72sqm detached.
- 21 piles to 10m. 300mm diameter. 1 x 32mm OD pipe U tube in each pile. Pile separation 1.86 to 2.46m
- No building – heat rejection system built. Heat loading equivalent to a low energy house of today. Approx 27W/sqm peak
- Testing to date over two heating seasons and two summer seasons
- 16 perimeter piles used for heat extraction
- Maximum heat output from heat pump approximately 5.6kW. At a COP of 3.6, the resultant heat extraction per linear meter of pile is 25W/m.

Test setup



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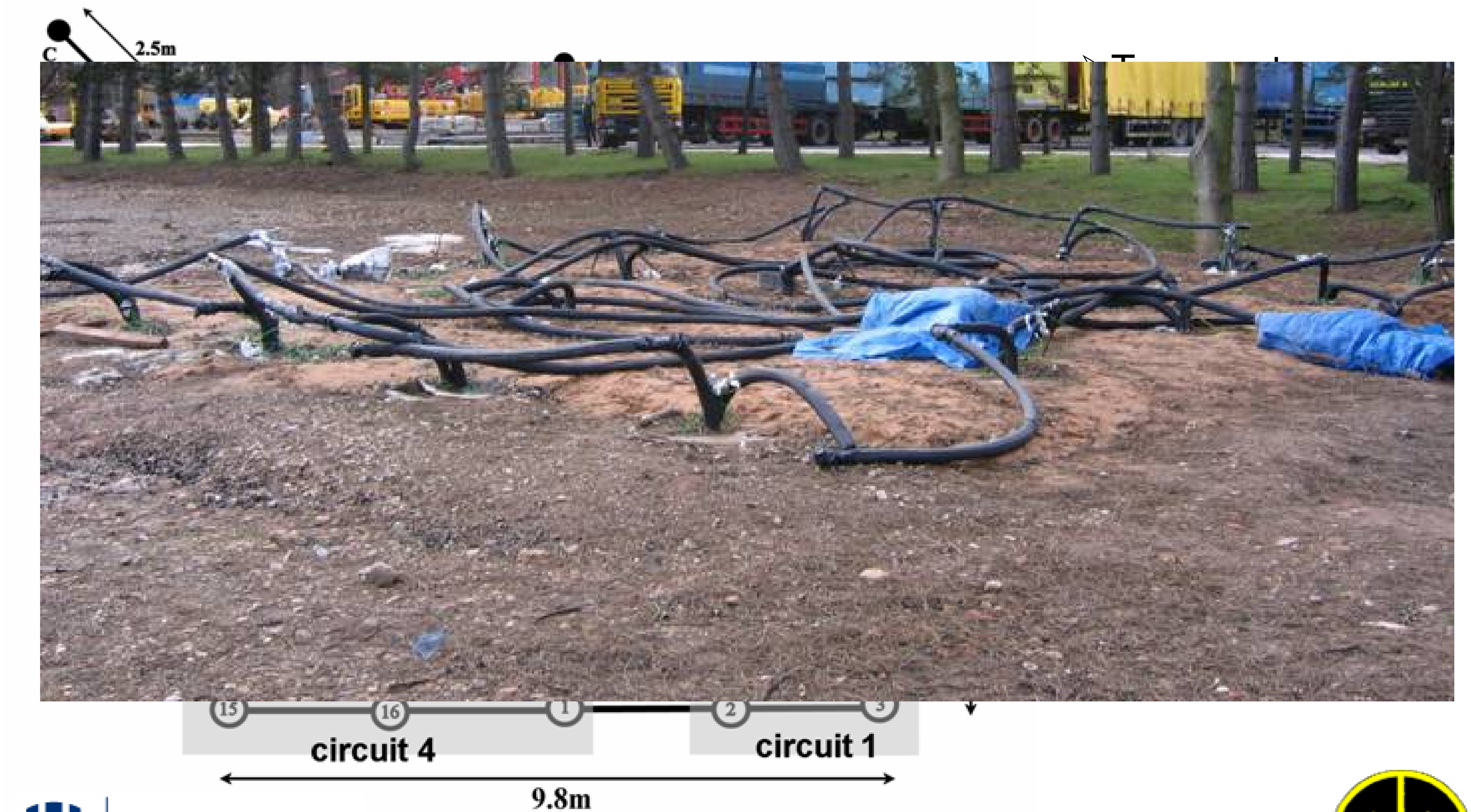
Pile and array sensing locations



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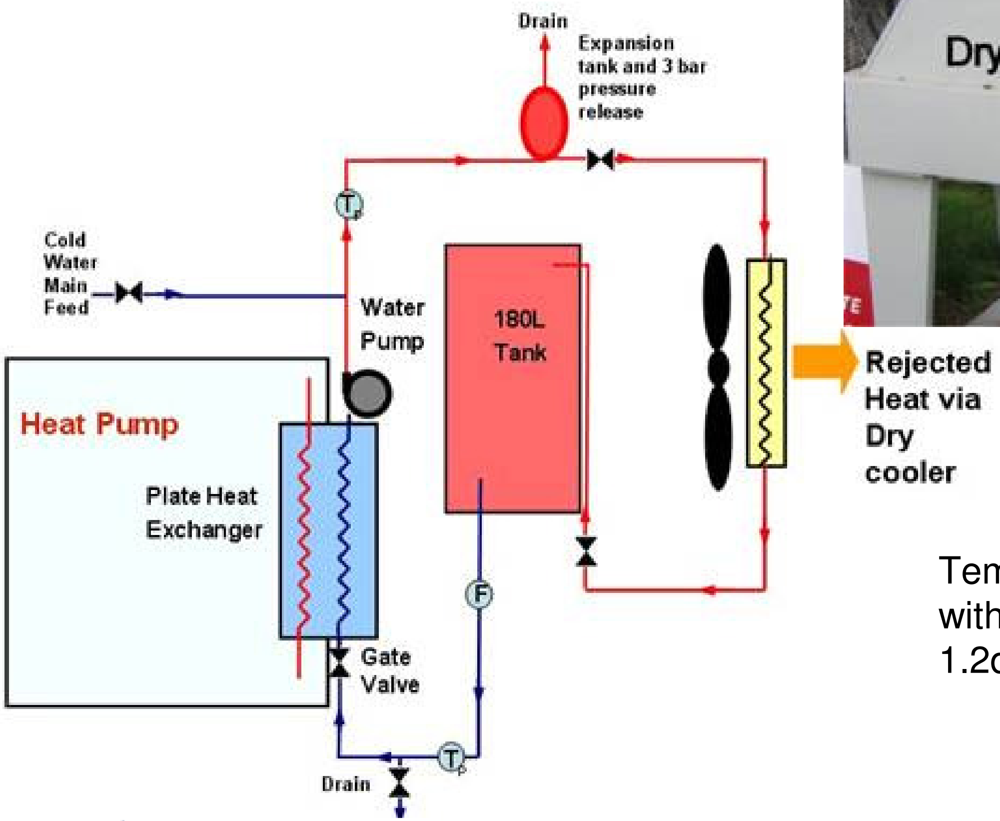
Heat Rejection apparatus



Temperature of water to the heat pump is stable within +/- 0.6deg C i.e. differential range of 1.2degC

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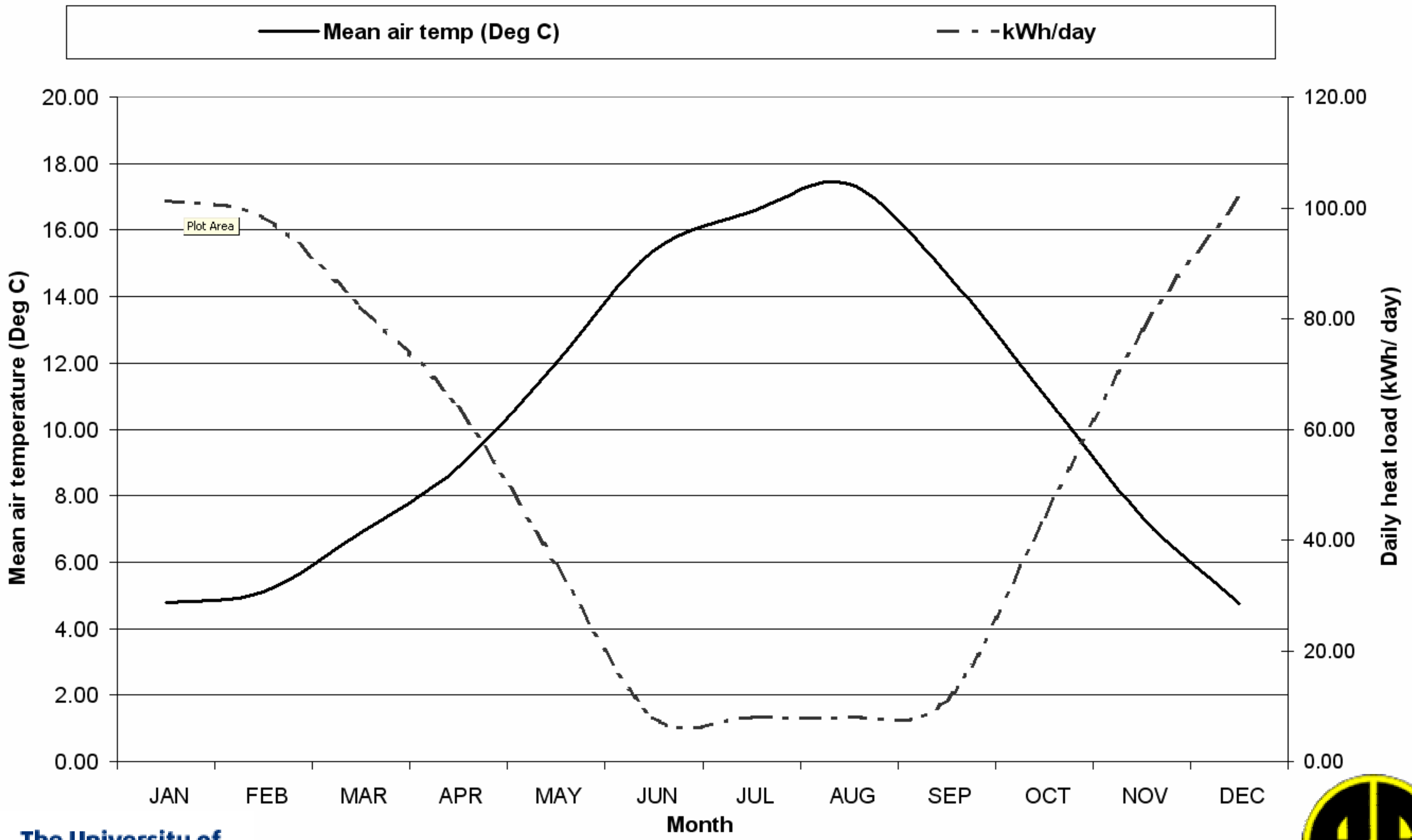
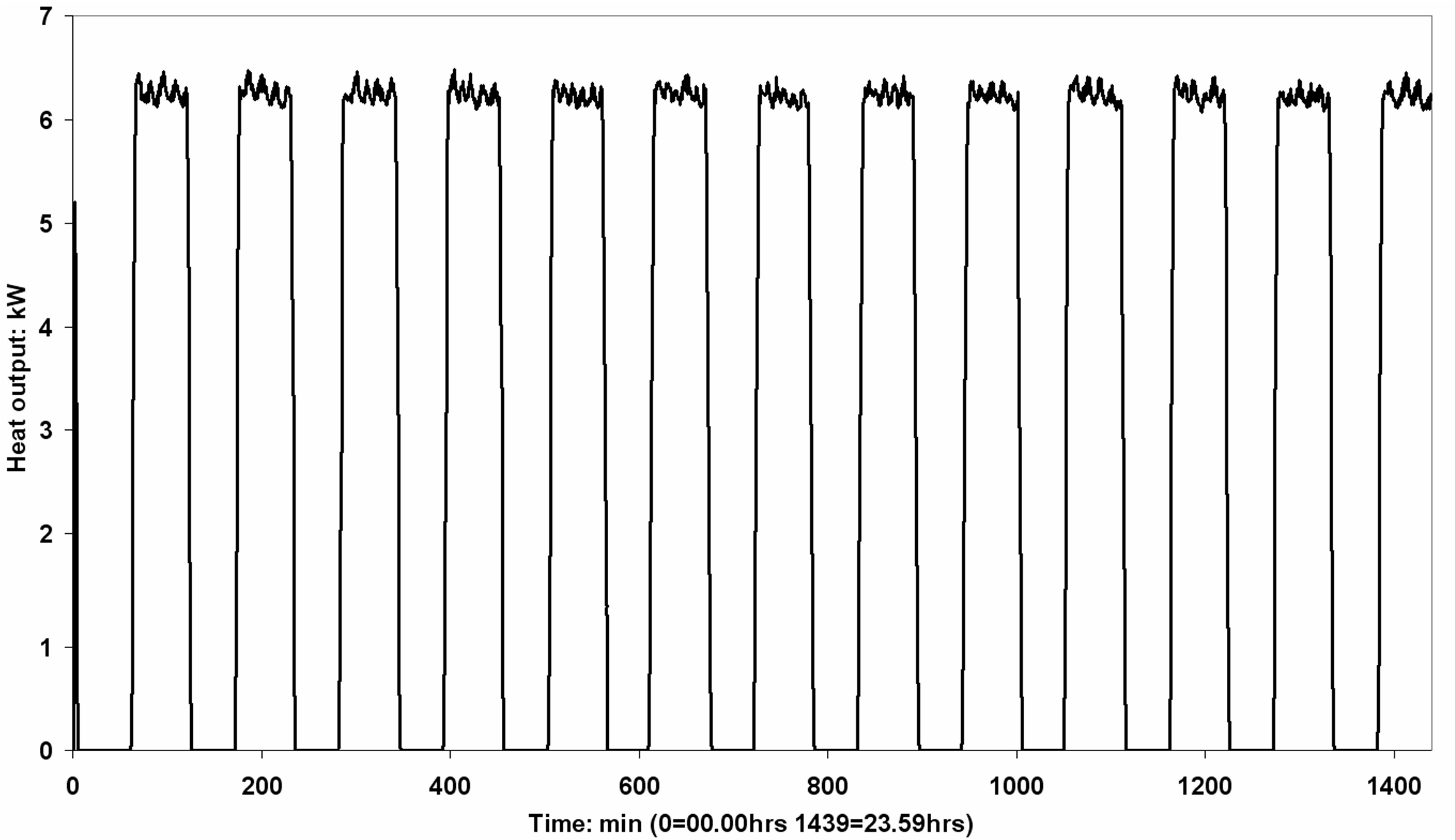
Heat loading

- **27W/sqm at 4.8deg C**
- **Heat load per month calculated by interpolation with respect to the average outside air temperature**





Typical heat pump loading of 50% for a day in November = 78kWh/ day

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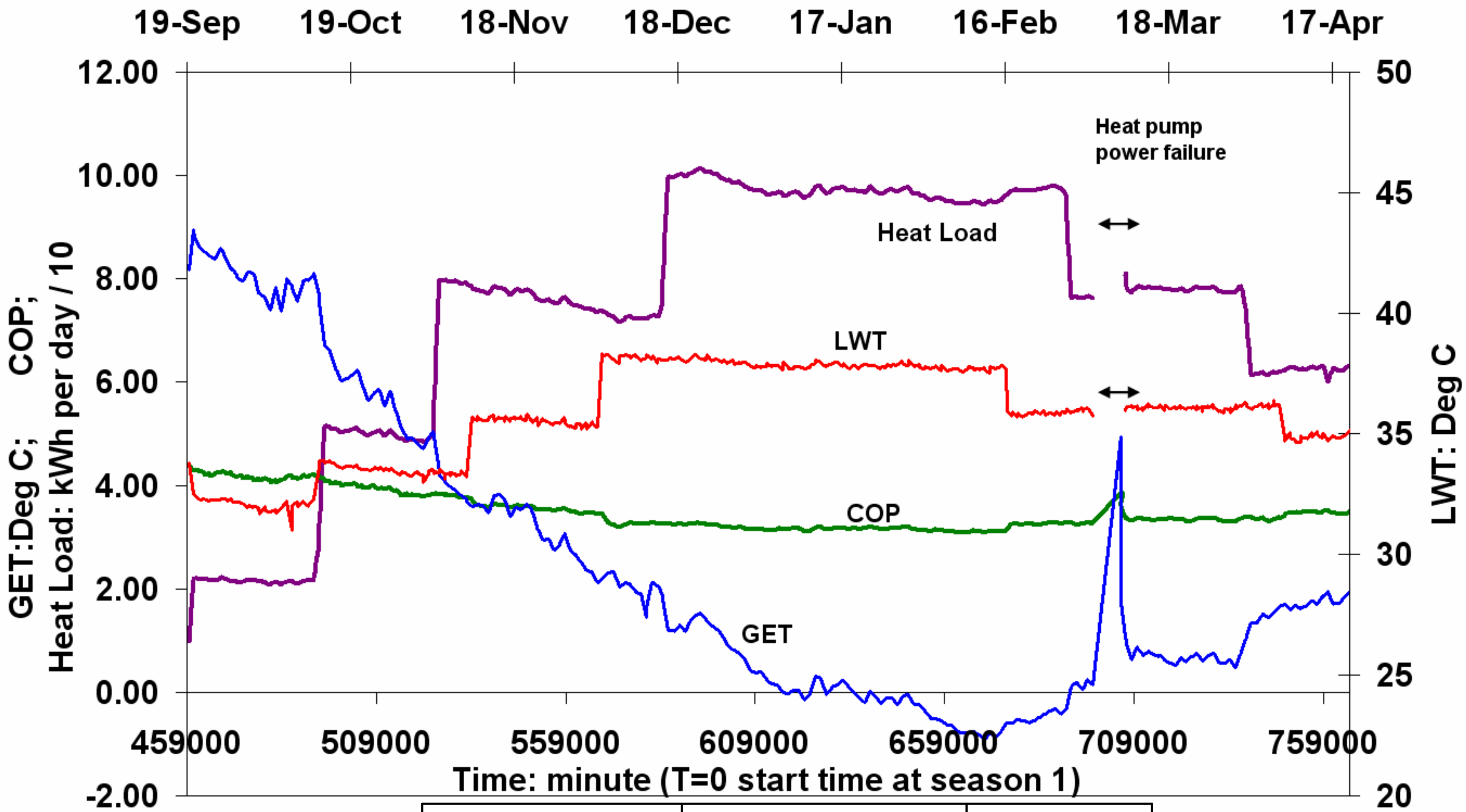
Heat pump monitored parameters



Period (Date)	Seasonal Performance factor	Heat output (MWh)
04/11/07 to 22/05/08	3.62	17.24
22/05/08 to 19/09/08	3.54	0.80
19/09/08 to 22/04/09	3.40	15.15

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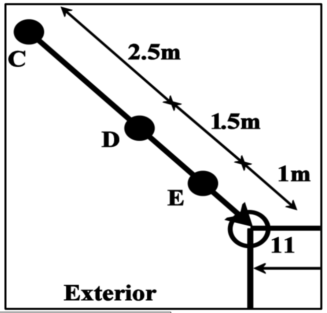
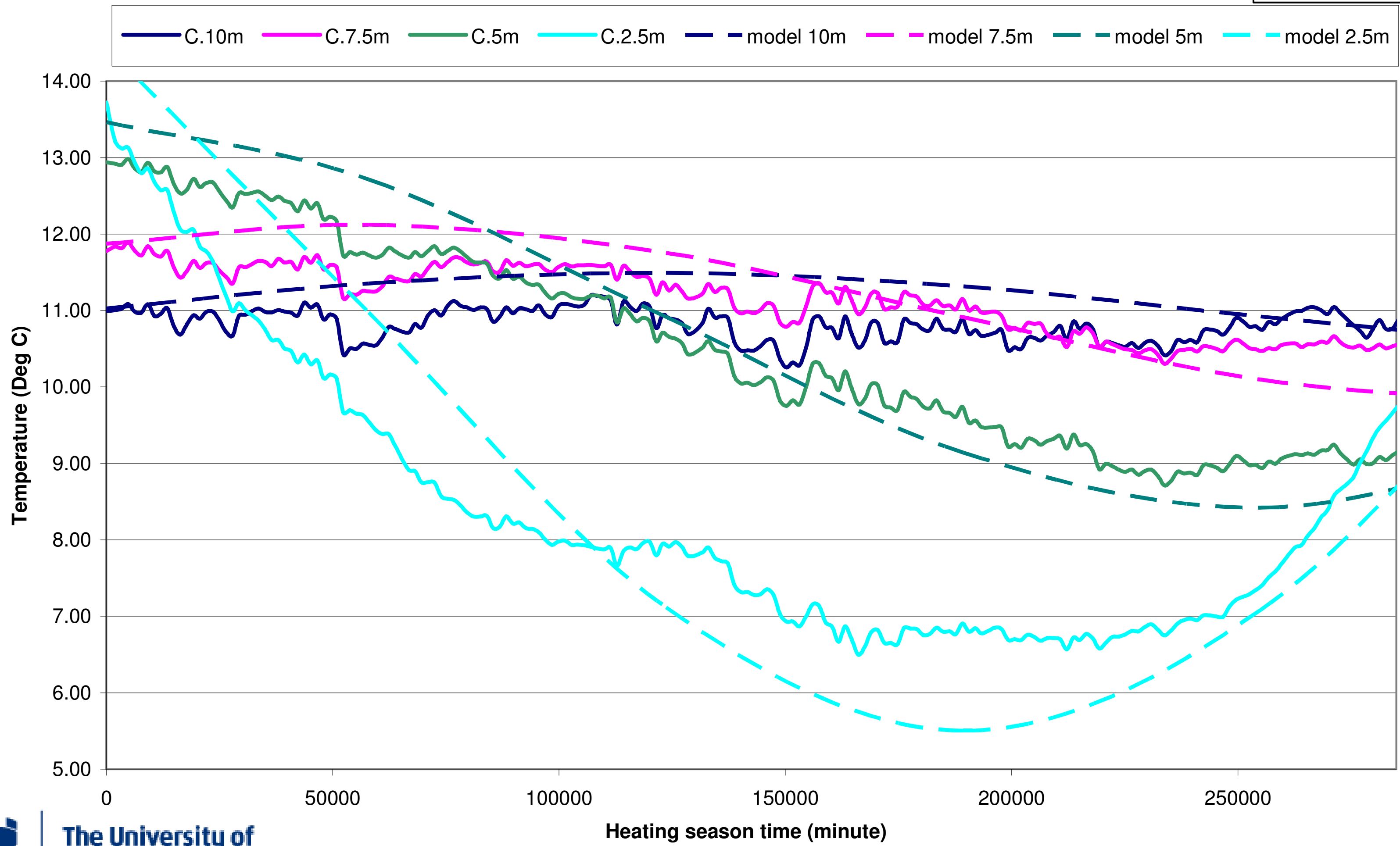
Far field recorded and model calculated ground temperatures across the first heating season

(Array location C – far field)





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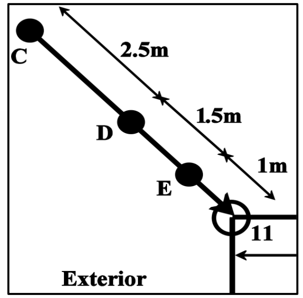
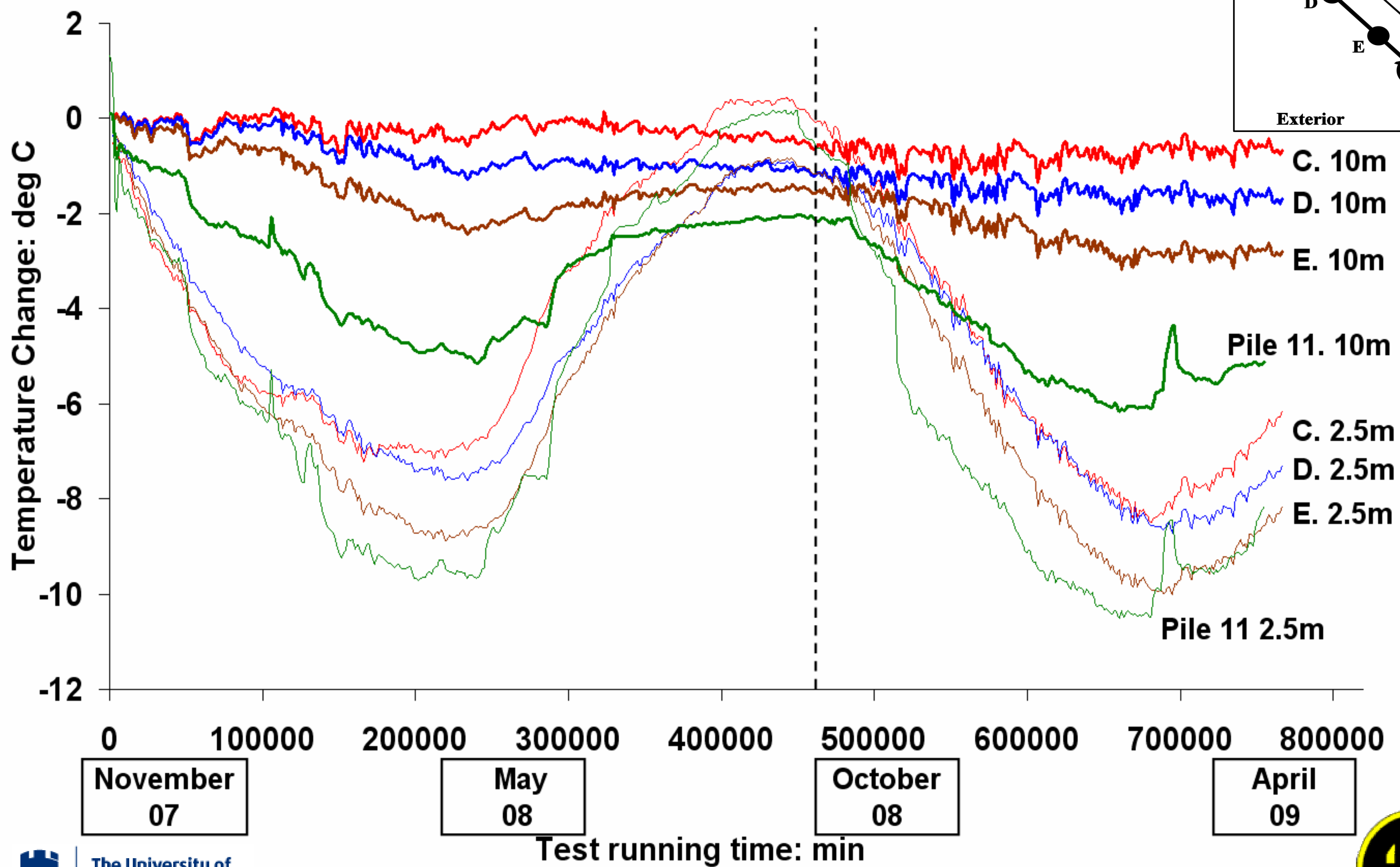
Change in temperature of the ground (from initial temperature) at sensing locations from pile 11 to far field array location C





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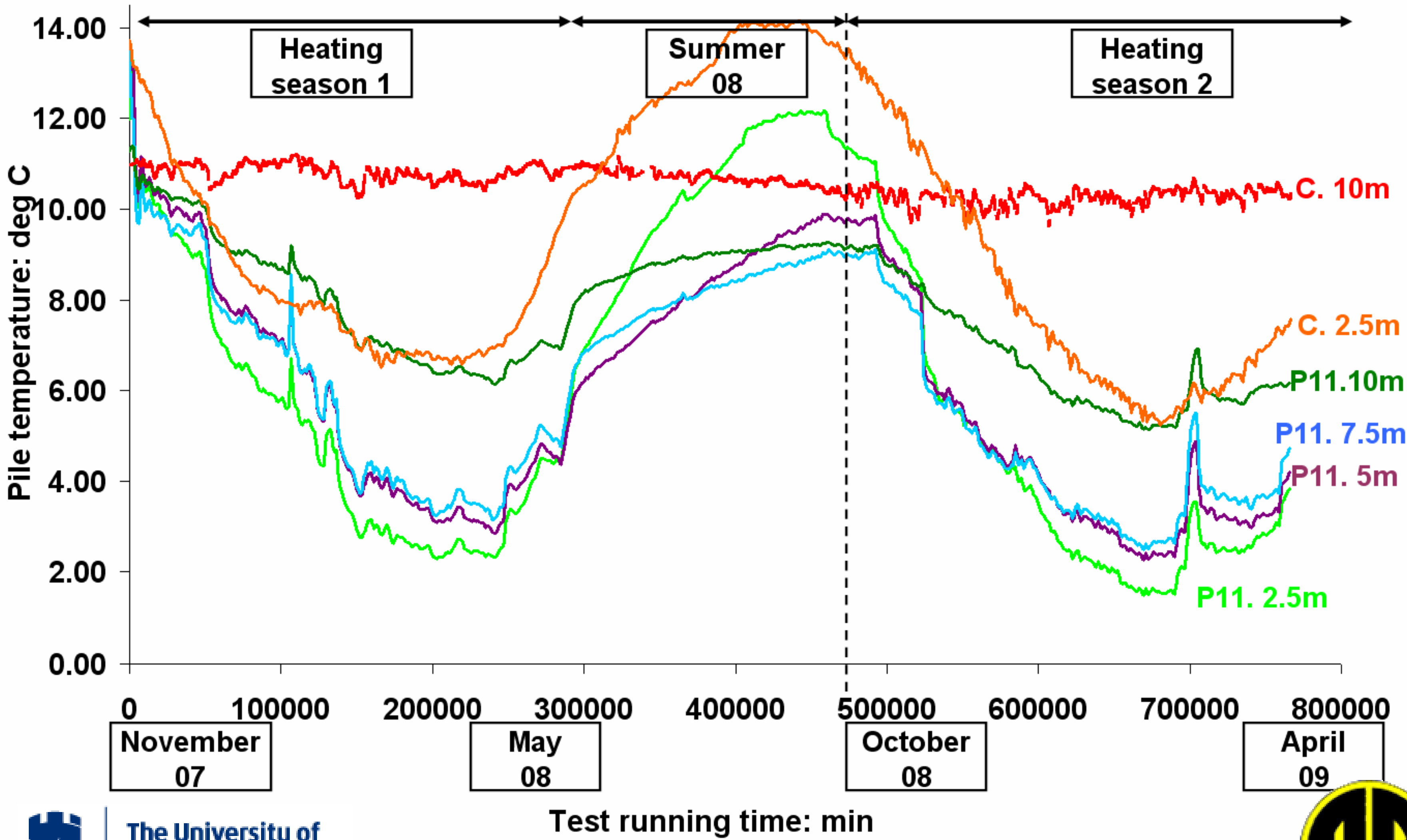
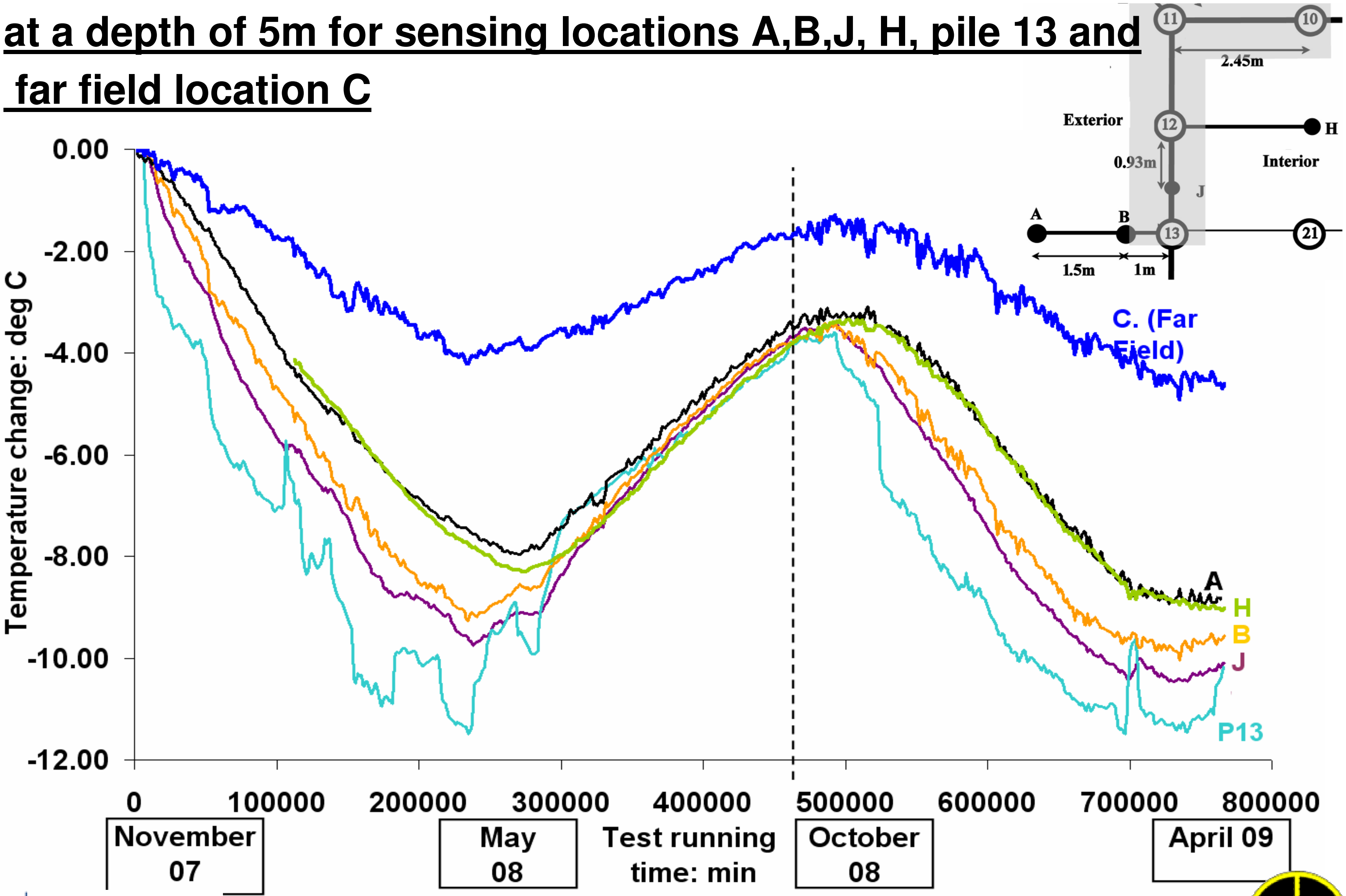
Temperature of pile 11 and far field array location C at various depths



Change in temperature of the ground (from initial temperature) at a depth of 5m for sensing locations A,B,J, H, pile 13 and far field location C



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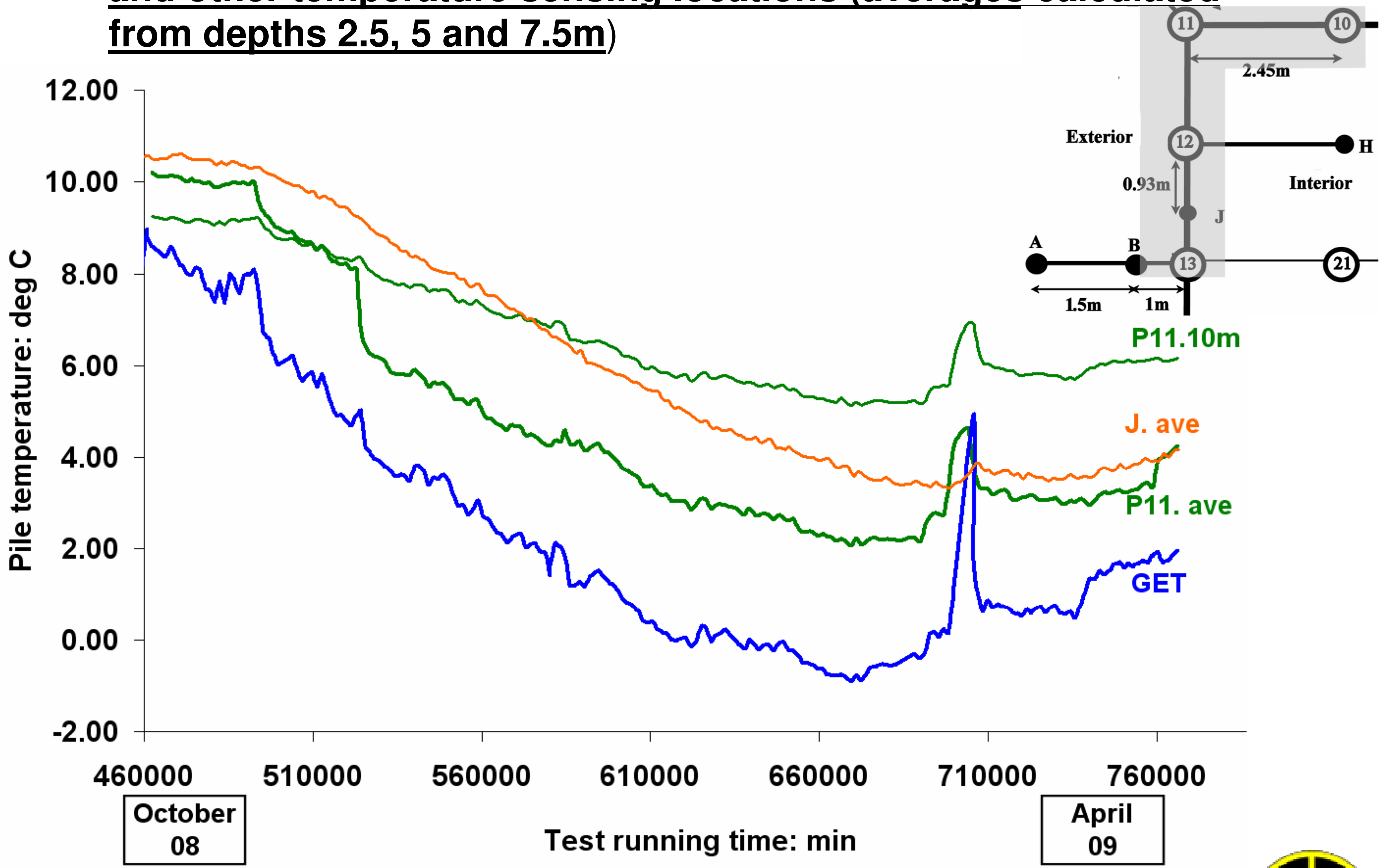
Average temperature of the centre of pile 11 in relation to GET and other temperature sensing locations (averages calculated from depths 2.5, 5 and 7.5m)



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What happens next?

- Important point is how does the ground recover year on year – tests are now into the third heating season

- This summer: Investigations into ground heat recharging utilising summer heat from the roof building fabric:

  Seasonal Heat energy storage within the ground around the energy piles

▪UK Residential buildings – high density of dwellings = lack of ground volume = temperature year on year fall = system efficiency reduction (reducing heat pump COP).

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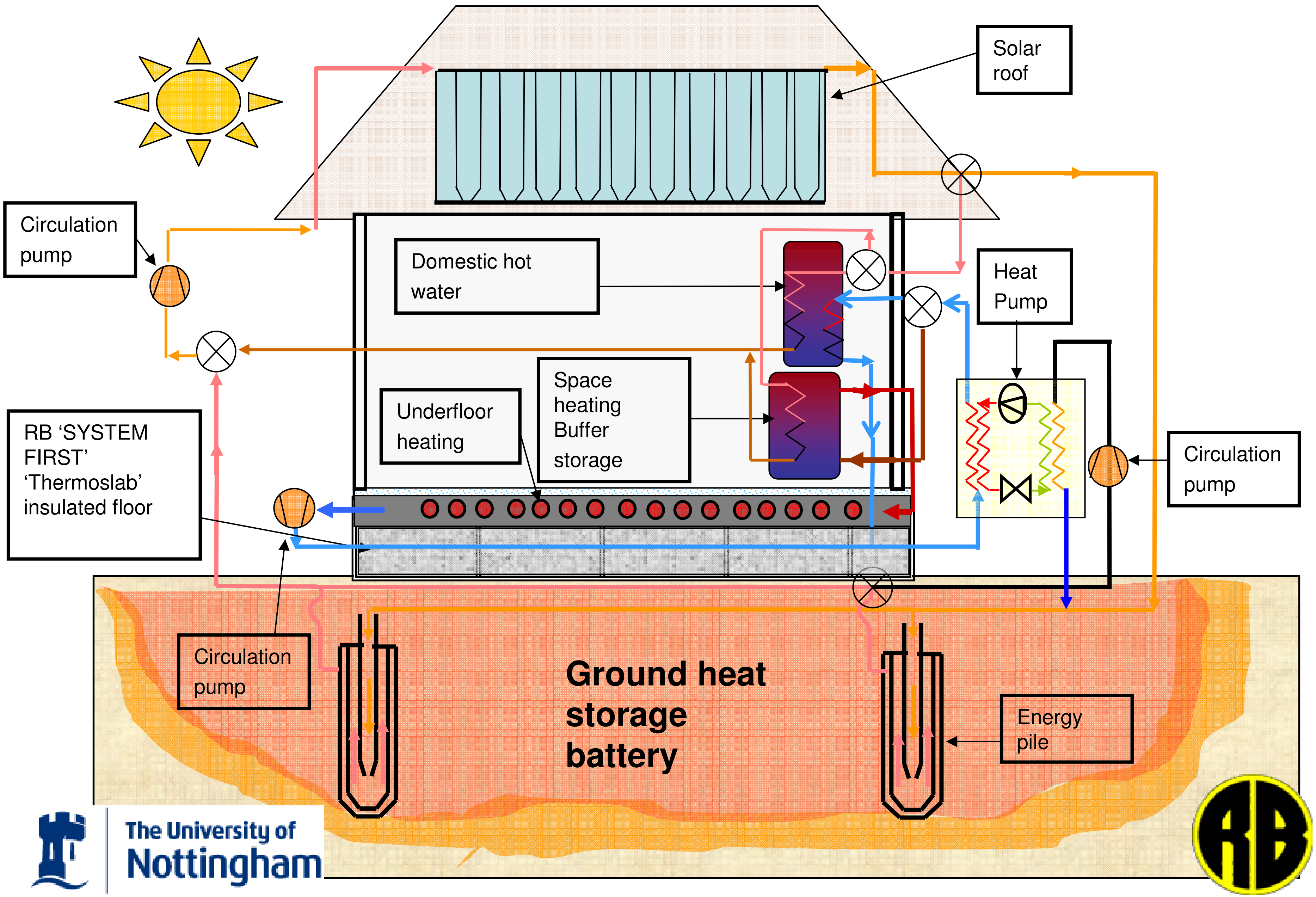
•Energy Pile Ground Heat Storage Battery



Thank you for listening!

Email:
christopher.wood@nottingham.ac.uk