PREDICTING OVERHEATING RISK IN HOMES

Susie Diamond – Inkling

Anastasia Mylona – CIBSE

Simulation for Health and Wellbeing

27th June 2016 - CIBSE

About Inkling

- Building Physics Consultancy
  - Susie Diamond
  - Claire Das Bhaumik
- Services
  - Design stage overheating risk assessments
  - Part L2A/CO2 emissions calculations
  - Massing and orientation advice
  - Daylight, sunlight and overshadowing reports
  - EPC predictions
  - Thermal performance and TM54 analyses
  - CFD modelling

Domestic overheating

Article by Liza Young
CIBSE Journal August 2014

CIBSE JOURNAL

NEWS CIBSE NEWS TECHNICAL CPD JOBS CASE S

Using weather data to make buildings climate proof

Climate change means CIBSE's updated weather files are imperative for building energy and overheating risk analysis. Liza Young explains the new data sets and finds out whether the methodology for applying them is up to the task

Posted in May 2016

Two summers ago, *CIBSE Journal* received a memorable letter from Ben Cullen about life in his sweltering flat in Milton Keynes. He described how his single-aspect apartment became so hot that the 'killer views' alluded to in the sales brochure were more likely to come from his lack clothing, which consistently breached broadcasting standards. (See '**Tickled pink**', *CIBSE Journal*, September 2014).

Article by Liza Young
CIBSE Journal May 2016

HOUSING OVERHEATING

HOME IS WHERE THE HEAT IS

As global temperatures rise, overheating is becoming an urgent problem for the residential sector. With no government-enforced sanctions on maximum temperatures and little incentive for developers, **Liza Young** finds out what can be done to keep cool

The consequences of climate change are not a problem for future generations – they are an immediate threat. Already, there is growing evidence of overheating in homes. According to the Committee on Climate Change (CCC), one fifth of domestic properties could be overheating, even during a cool summer. Flats, which make up 40% of new dwellings, are especially vulnerable.[1]

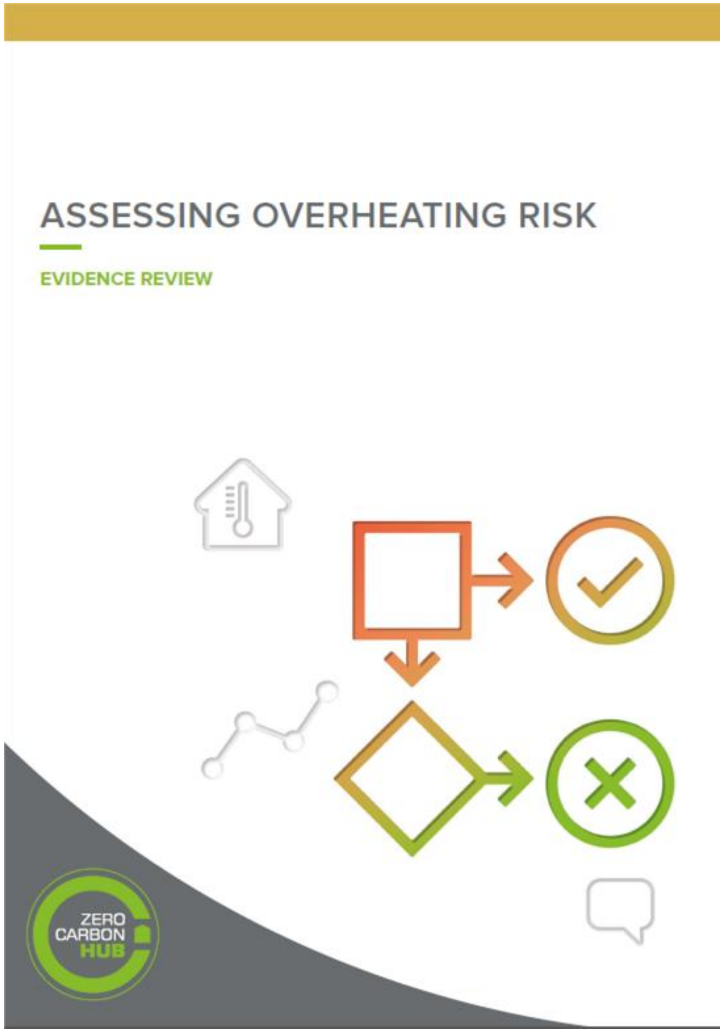
By the 2040s, half of all summers are expected to be as hot, if not hotter, than in 2003, when temperatures of up to 38°C led to more than 2,000 excess deaths in the UK. A recent CCC adaptation sub-committee report predicts that annual deaths caused by high UK temperatures will triple to 7,000 on average by the 2050s.[2]

Yet at the same time, we are designing and building for winter energy efficiency,

"We've forgotten how to design for natural ventilation in dwellings – we've lost the art
Michael Swainson

Assessing Overheating risk

- Zero Carbon Hub publication
- Co-authored by Inkling and Anastasia Mylona (ARCC and CIBSE)
- Part of report series and ongoing research



What is overheating?

- No one definition fits all
- Comfort is subjective
- Depends on both environmental and human factors
- Duration/ timing of high temperatures is important
- Very high temperatures > 35°C lead to **Heat stress**
- High bedrooms temperatures (>26°C) can impair sleep

Image from ZCH *Overheating in homes - Where to Start - An introduction for planners, designers and property owners*, 2013

Key overheating risk factors in homes

- Single aspect
- Large areas of glazing
- Limited ventilation
  - Restricted openings
- City centre locations
  - Noise and/or air pollution limiting natural ventilation
  - UHI effects
- Community heating

Higher overheating risk in city centres

Image from ZCH publication: *Overheating in homes - Where to Start - An introduction for planners, designers and property owners*, 2013

Existing Methodologies

- SAP (Appendix P)
  - Single calculation for June, July and August using monthly averages for weather data
  - Single zone model
  - Easy to fudge
- CIBSE Guide A 2015
  - Follows TM52 – adaptive thermal comfort
  - Based on commercial buildings - advice for dwellings is limited
- PHPP
  - Passive House Planning Package
  - Spreadsheet based
  - Uses bespoke internal gains but similar calc to SAP
- Dynamic Thermal Simulation
  - Powerful software, but inconsistent application as no defined methodology

Evidence?

What do we need?

- A stakeholder agreed methodology to follow that is:
  - Reliable
  - Cost-effective
  - Flexible
  - Understandable
- Not as easy as it first appears, but do-able

CIBSE TM52

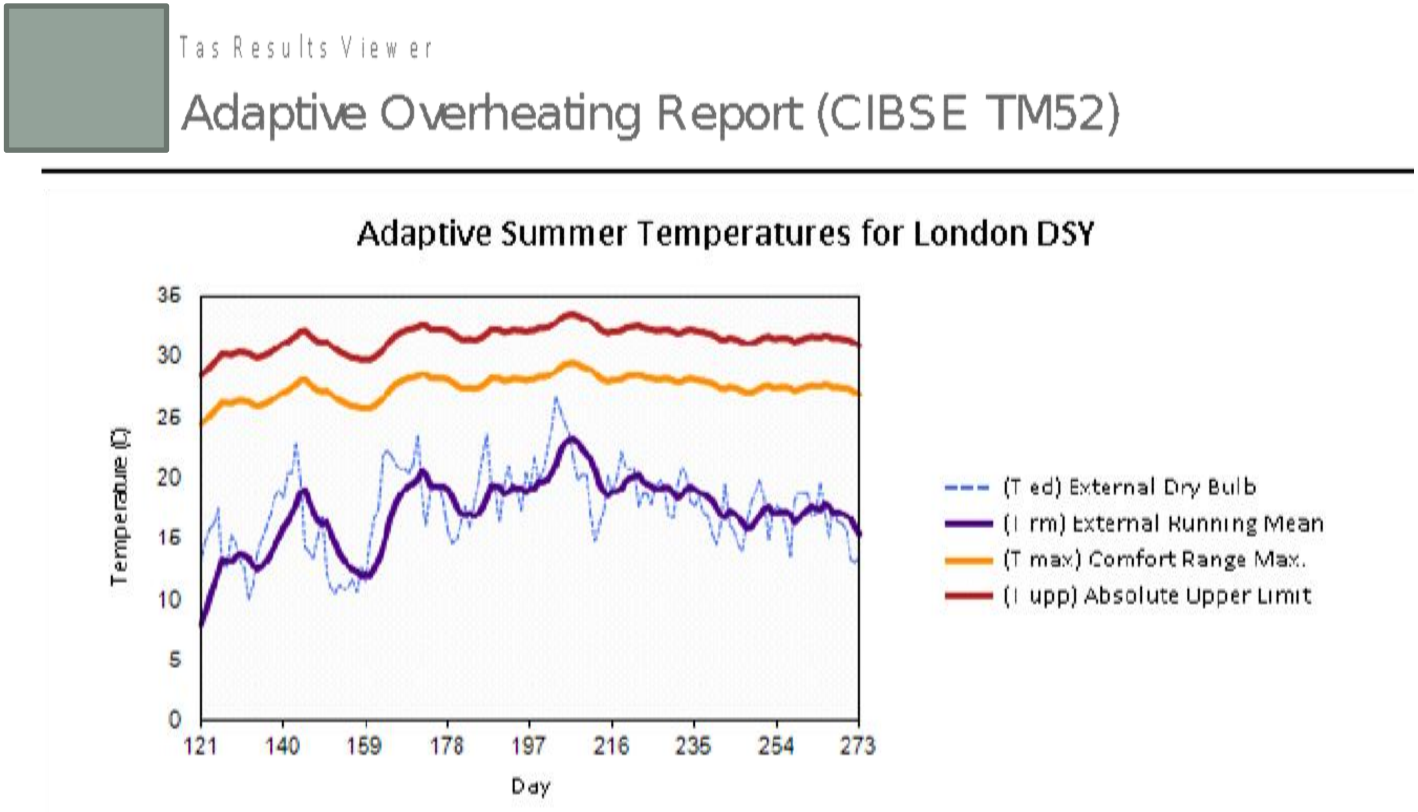
- Developed for ‘free-running’ commercial buildings
- Provides a definition of overheating and pass/fail criteria
- Based on BS EN Standard 15251:2007
- Sets three criteria against which designs should be assessed:
  - Criterion 1: Hours of Exceedance
  - Criterion 2: Daily Weighted Exceedance
  - Criterion 3: Upper Limit Temperature

TM52 – How it works

1. The first criterion sets a limit for the number of hours that the operative temperature can exceed the threshold comfort temperature (upper limit of the range of comfort temperature) by 1 K or more during the occupied hours of a typical non-heating season (1 May to 30 September). **3%**
2. The second criterion deals with the severity of overheating within any one day, which can be as important as its frequency, the level of which is a function of both temperature rise and its duration. This criterion sets a daily limit for acceptability. Weighted exceedance **≤6**
3. The third criterion sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable. It requires the internal operative temperature not to exceed the external running mean by more than 4 degrees. **ΔT≤4K**

TM52 – variable threshold

- DTM results – Threshold temperature graph



TM52 – results presentation

- DTM results – zones results for each criteria

Results

Zone Name	Occupied Summer Hours	Max. Exceedable Hours (3%)	#Hours Exceeding Comfort Range	Peak Daily Weighted Exceedance	#Hours Exceeding Absolute Limit	Result
Teaching_G22	456	13	25	11.0	0	Fail
Teaching_G22_P	456	13	35	14.0	1	Fail
Teaching_G21	456	13	24	10.0	0	Fail
Teaching_G21_P	456	13	35	14.0	1	Fail
Teaching_G20	456	13	25	11.0	0	Fail
Teaching_G20_P	456	13	37	14.0	2	Fail
Teaching_F20	456	13	16	12.0	0	Fail
Teaching_F20_P	456	13	18	12.0	0	Fail
Teaching_F21	456	13	16	12.0	0	Fail
Teaching_F21_P	456	13	19	13.0	0	Fail
Teaching_F22	456	13	18	13.0	0	Fail
Teaching_F22_P	456	13	20	13.0	0	Fail

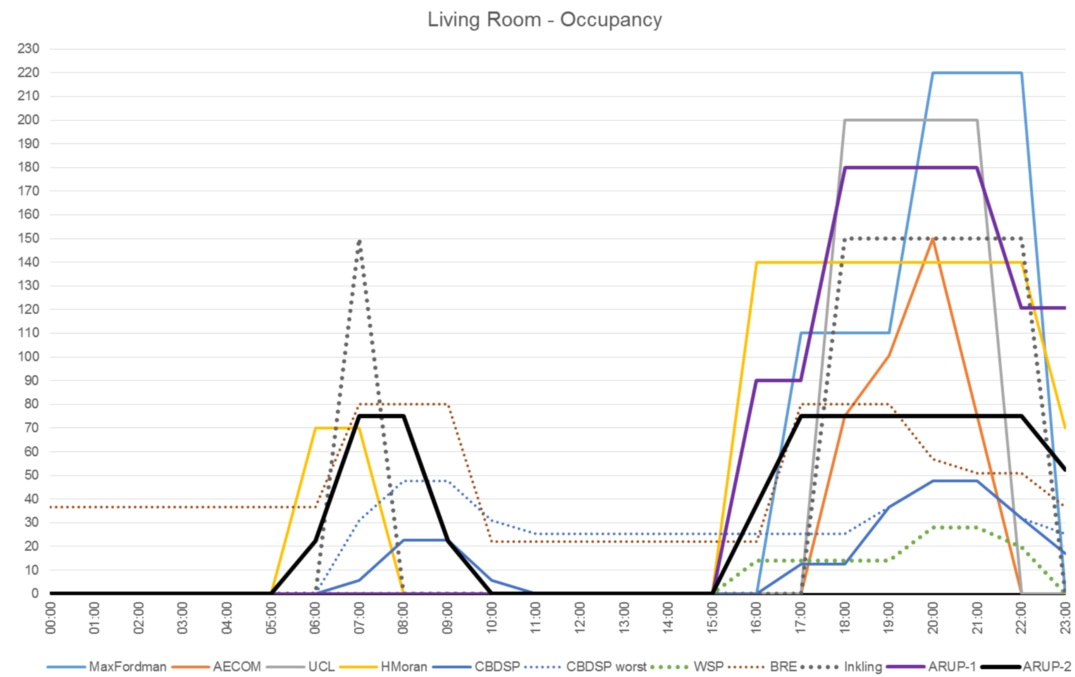
Adapting TM52 for homes

- Occupancy profiles are required (not easy)
  - Domestic occupancy very variable
  - To test design need ‘worst case’ scenario, but too ‘worst case’ is excessive and might force mechanical cooling
  - Focusing on occupied hours for bedrooms can have unintended consequences
  - More robust to include all hours i.e. 24/7
- TM52 thresholds – are these suitable for homes where occupancy hours are longer?
  Do we need to adapt them?

Domestic profiles

- Inkling working with Arup and CIBSE to compile profiles based on suggestions from range of sources
- Lighting and equipment gains linked back to annual electrical consumption for homes

This image shows the collated profile for living room occupancy gains. There is significant correlation, but also variation..



Limitations

- Cannot guarantee that people will always be comfortable, regardless of how they act
- Will need to consider different sizes of unit
- Exceptions - should DTM be required on low risk units?

Guidance needed

Advice will be required to cover:

- Recommended sample size
- Choice of sample - aim for worst case or a varied selection?
- Weather file selection including when/how to use future weather
- Use of blinds
- Modelling window openings

Start somewhere

CIBSE Weather datasets

- Dynamic thermal simulation building models require external climate inputs.
- Annual observed weather data at hourly intervals supplied from the Met Office.
- Weather variables include air temperature, solar radiation and wind.
- Formats available EPW, TAS, .csv

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
5	Site	Belfast														
6	Latitude	54.663	Longitude	-6.222	Altitude	63										
7																
8	Notation and units															
9	Column	Variable	Description	Units	Notes											
10	1	Year														
11	2	Month														
12	3	Date														
13	4	Hour														
14	5	PWC			(on hour GMT)											
15	6	CC	Cloud amou	oktas	(on hour GMT)											
16	7	DBT	Dry Bulb Ter	degrees Celc	(on hour GMT)											
17	8	WBT	Wet Bulb Te	degrees Celc	(on hour GMT)											
18	9	RH	Relative Hur	% (on hour GMT)												
19	10	Press	Mean Sea Le	hPa	(on hour GMT)											
20	11	WD	Wind Directi	degrees	(average over previous hour GMT)											
21	12	WS	Wind Speed	knots	(average over previous hour GMT)											
22	13	GSR	Global Irradi	W/m^2	(average over next hour in LAT)											
23	14	DSR	Diffuse Irrad	W/m^2	(average over next hour in LAT)											
24	15	Alt	Solar Altitud	degrees	(calculated on next half-hour in LAT)											
25	16	Dec	Solar Declin	degrees	(calculated on next half-hour in LAT)											
26	17-22	Missing Dat	see accompanying documentation for description													
27																
28	Model parameters															
29																
30																
31																
32	Year	Month	Day	Hour	PWC	Cloud	DBT	WBT	RH	Press	WD	WS	GSR	DSR	Alt	Dec
33	2003	1	1	1	-999	7	6.7	6.2	93.4	1000.3	110	13	0	0	-58.4	-23
34	2003	1	1	2	-999	8	6.8	6.2	92.1	998.6	110	15	0	0	-56.3	-23
35	2003	1	1	3	-999	8	6.8	6.3	93.4	996.9	110	17	0	0	-51.1	-23
36	2003	1	1	4	-999	7	6.7	6.2	93.4	995.3	110	19	0	0	-43.8	-23
37	2003	1	1	5	-999	8	6.4	5.9	93.3	993.9	110	18	0	0	-35.6	-23
38	2003	1	1	6	-999	8	6.3	5.7	92	992	100	17	0	0	-26.9	-23
39	2003	1	1	7	-999	8	6.4	5.9	93.3	991.4	110	12	0	0	-18.4	-23
40	2003	1	1	8	-999	8	6	5.5	93.2	990.2	110	16	0	0	-10.2	-23

TRYs and DSYs

Test Reference Years (TRYs)

- The TRY weather file represents a typical year and is used to determine average energy use within buildings.
- It consists of average months selected from an historical baseline.
- Previous release in 2006 used a baseline from 1984 to 2004.

Design Summer Years (DSYs)

- The DSY represents a warmer than typical year and is used to evaluate overheating risk within buildings.
- The previous methodology for selecting the DSY released in 2006 involved calculating the mean temperature over the period April to September for each year in an observational dataset.
- The DSY was then chosen as the third hottest year.
- Previous release in 2006 used a baseline from 1984 to 2004.

New TRYs and DSYs

Baseline dataset is being updated, both TRY and DSY are selected from 1984 – 2013 baselines.

TRY – same methodology, but with updated baseline, any effects of observed changes in climate are now included.

DSY – methodology for selecting candidate years has changed, based on that used in TM49:

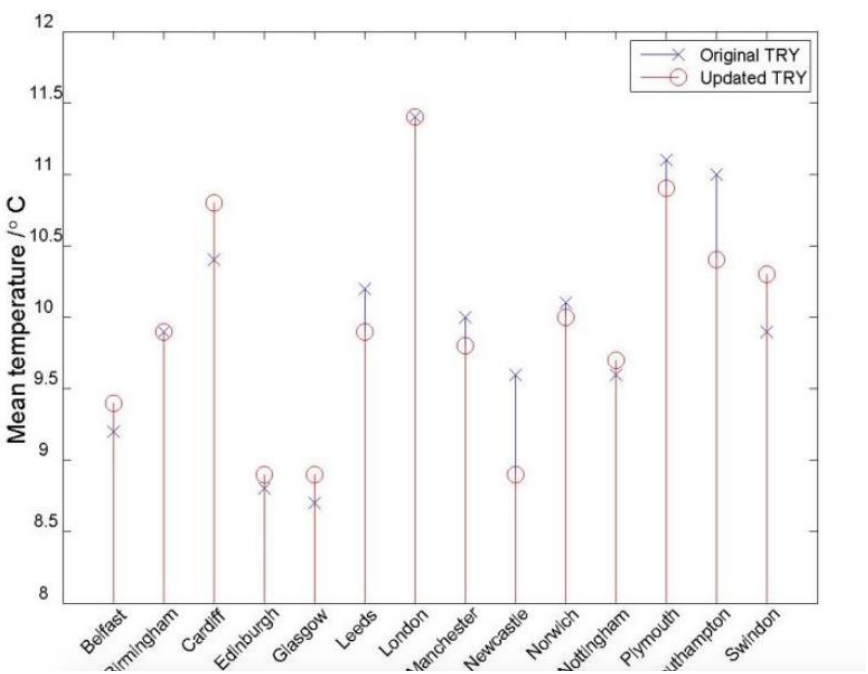
- New files are selected using new metrics based on interrelations between external temperatures and internal comfort temperatures.
- Better description of overheating events, their relative severity and their expected frequency.

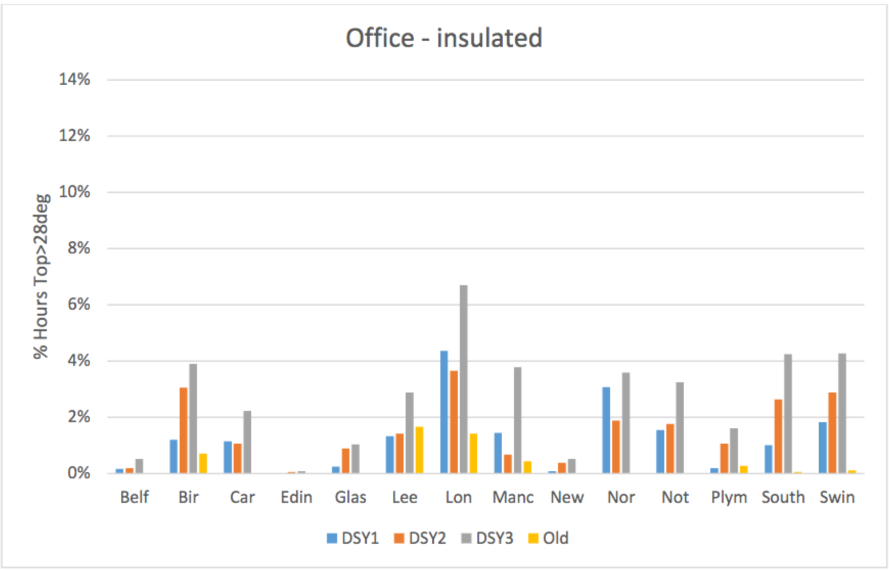
New TRYs and DSYs

Available for 14 locations. For each of 14 locations there are:

- Current TRY
- Current DSY1 – featuring moderately warm summer
- Current DSY2 – featuring short intense warm spell
- Current DSY3 – featuring long, less intense warm spell

Note: three new DSYs to replace the single old one per location.





London DSYs

The set also includes the TM49 data made available for London last year with three different London locations:

- London Gatwick (rural) – LGW
- London Heathrow (sub-urban) – LHR
- London Weather station (inner urban) – LWC

Including these three sites allows for different degrees of urban heat island (UHI) effect to be included within the data. This effect is known to increase night-time temperatures significantly in built up areas. The advice is to use the data most appropriate to the project site.

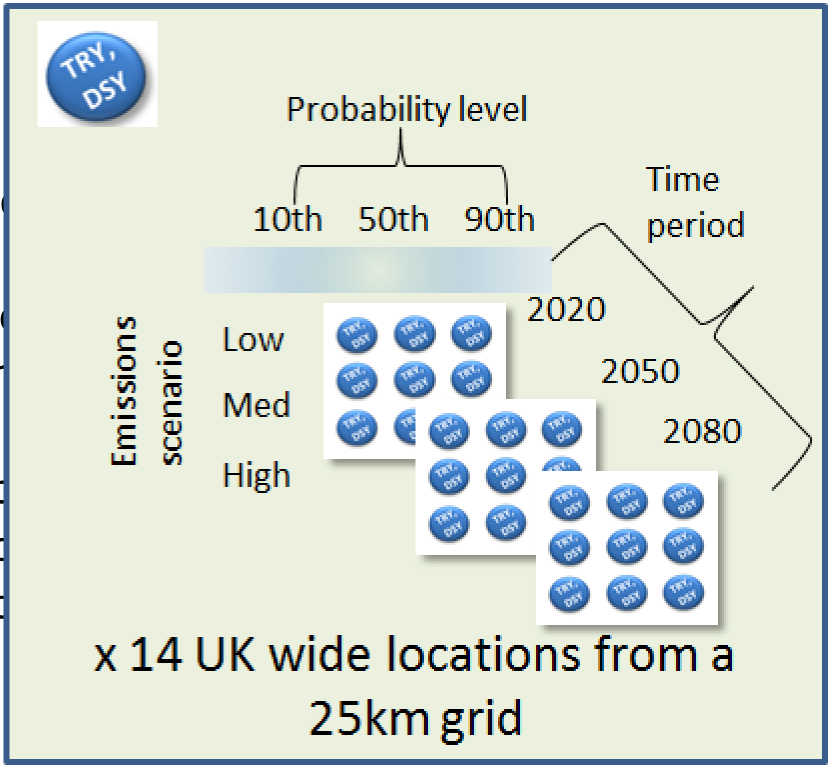
Typical urban heat island profile

This diagram shows a typical urban heat temperature profile. At night, temperatures in dense urban city centres may be up to 4°C higher than those measured in rural areas. The effects can be reduced by the integration of parks, lakes and green spaces into urban areas.

New Future TRYs and DSYs

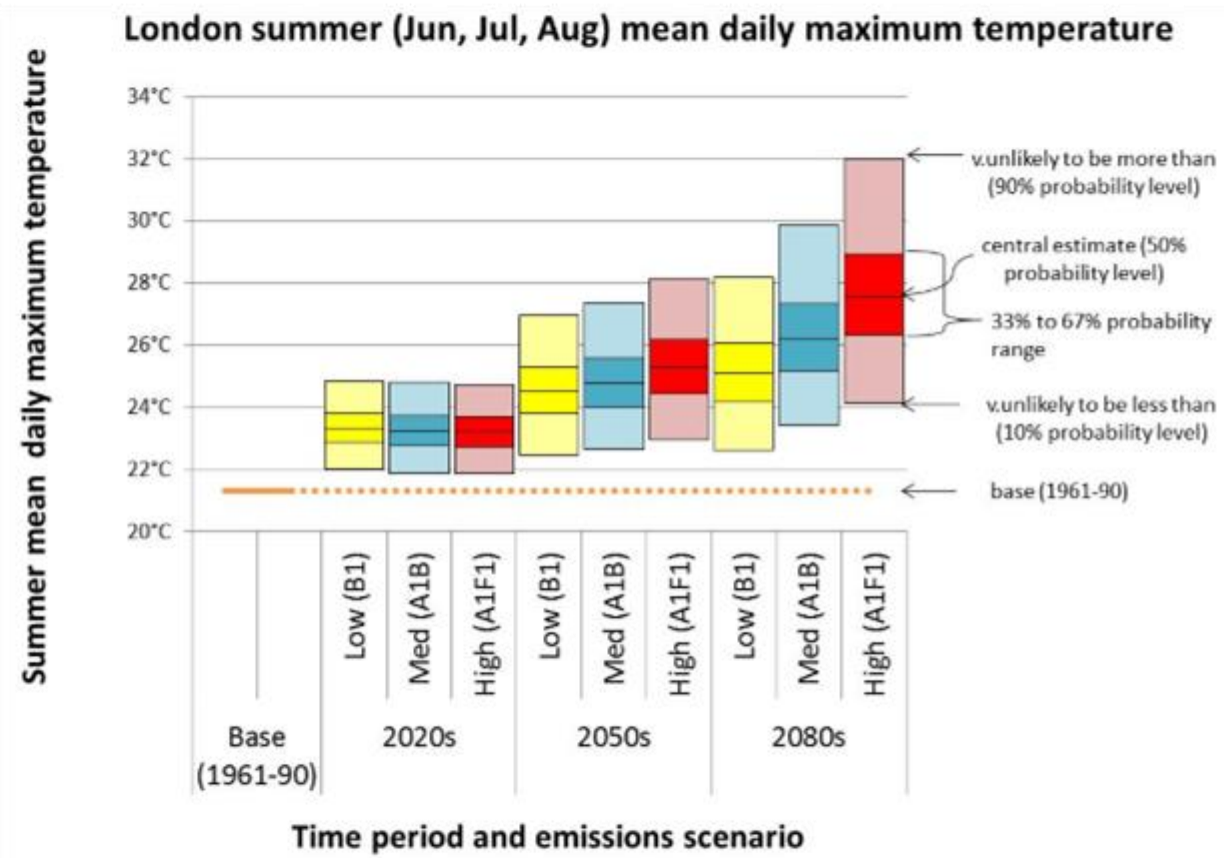
The future weather files have been morphed based on the UKCIP09 projections and include the following options for each location:

> Future TRY
v Future DSY
> DSY1
> DSY2
v DSY3
> 2020s (only for high)
> 2050s (only for medium an
v 2080s
> Low emissions sc
> Medium emissio
v High emissions scenario
10th perc
50th perc
90th perc



Probabilistic Climate Profiles

The Probabilistic Climate Profiles (or ProCliPs) were developed by CIBSE to assist the selection of future files appropriate for each project. These charts, available for all 14 locations, are available for free on the CIBSE Knowledge Portal.



- Seasonal mean air temperature (Winter, Spring, Summer Autumn)
- Daily minimum temperatures for winter
- Daily maximum temperatures for summer
- Seasonal daily precipitation (Winter, Spring, Summer Autumn)

The End

Thank you for listening!

Find us at www.inklingllp.com

@InklingLLP