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Centre for Energy and the Environment

Prometheus: Built to Stand the Test of Time

Adapting our Built Environment - ARCC Contributions and Challenges

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The Context

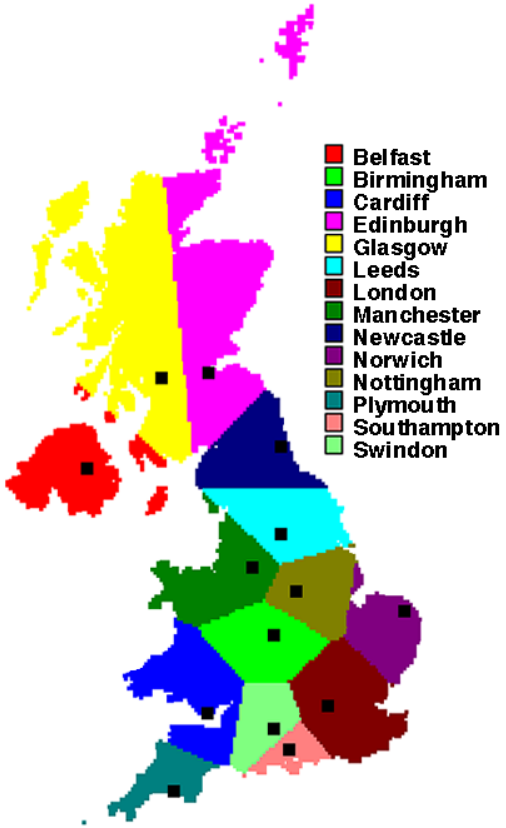
- UK Building Regulations
- Energy Policy
- Design Weather Data
- Sustainable Compliance
- Mitigation / Adaptation
- Sustainable Design Life … 100+ years?
- Risk Assessment / Investment

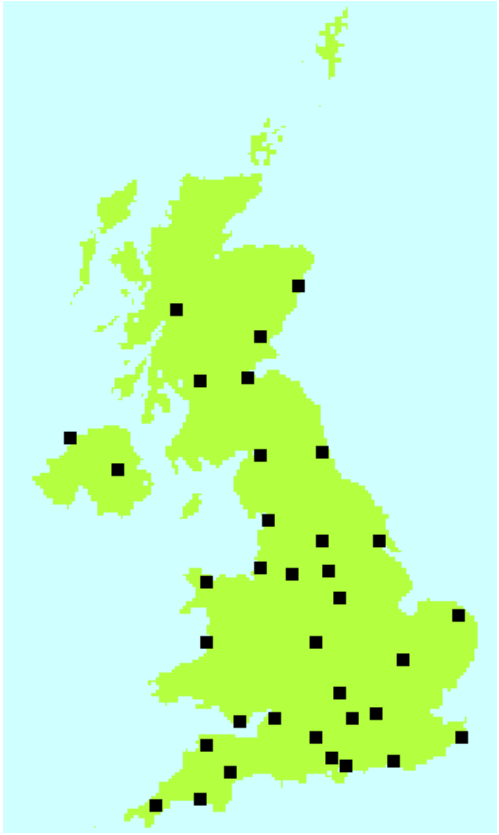
Perceptions of climate change within the building industry

- Surveys of several architectural and engineering firms.
- General concern about climate change and inadequacies of current practices. Very few (~6%) actively denied climate change.
- Greater seniority ⇒ greater satisfaction with current practices.
- Participants focused almost exclusively upon mitigation rather than adaptation options when listing current practices.
- Most common reactions to climate change were to reduce CO_2 emissions, increase sustainability and longevity of building design.
- When asked about possible alternatives to current practices only 5% of responses listed adaptation options, the rest were exclusively mitigation based.
- Main barrier to change was time / money.

Published in Building and Environment

Prometheus weather files





CIBSE files:14 sites
Exeter files: 35 sites

- 3 time periods
- 5 probability levels
- Medium and high emission scenarios
- Both TRY and DSY type files

Method peer reviewed and published.
Building Serv. Eng. Res. Technol.

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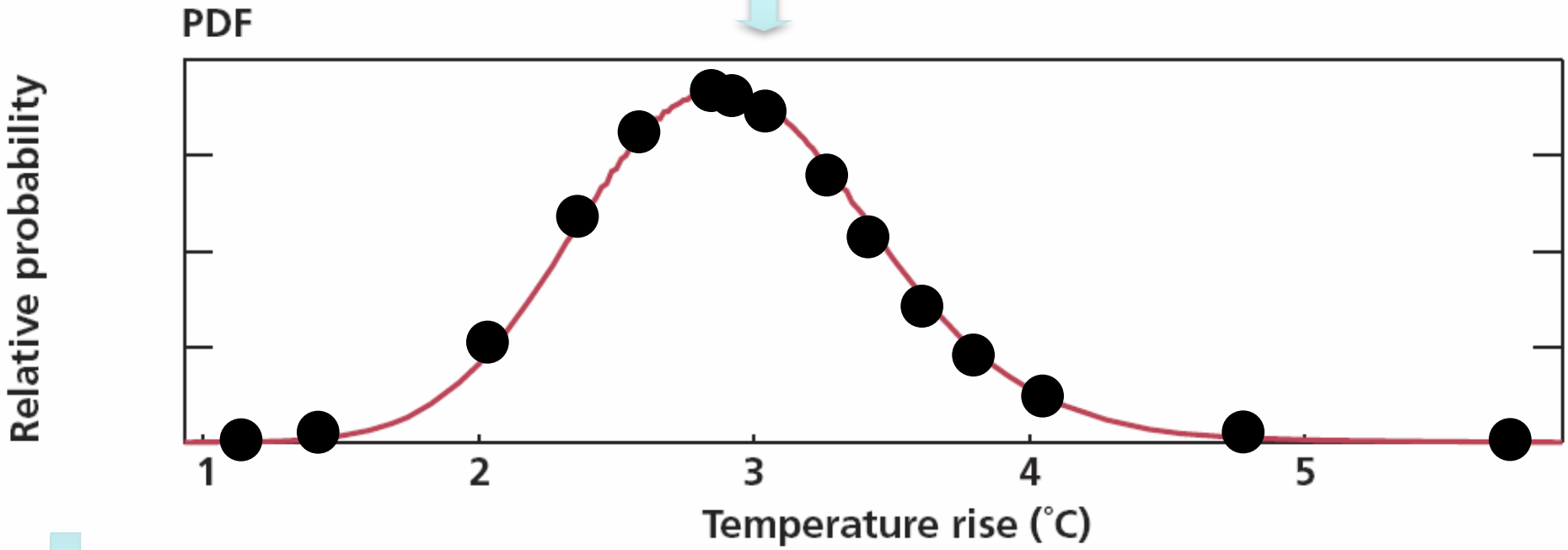
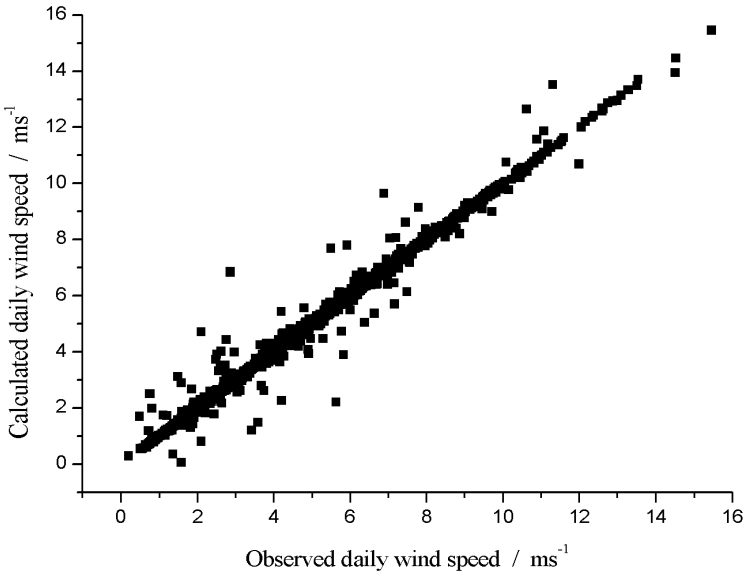
Weather generator → Emissions, time period, location

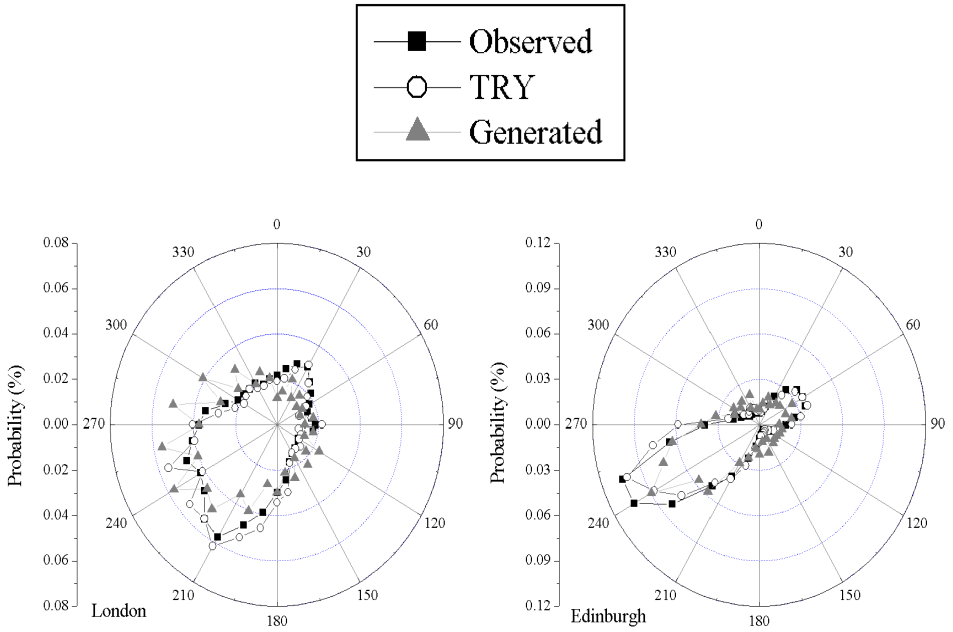


3000 weather years → IES

TRY (10%)
TRY (33%)
TRY (50%)
TRY (66%)
TRY (90%) → IES

Including wind speed and wind direction

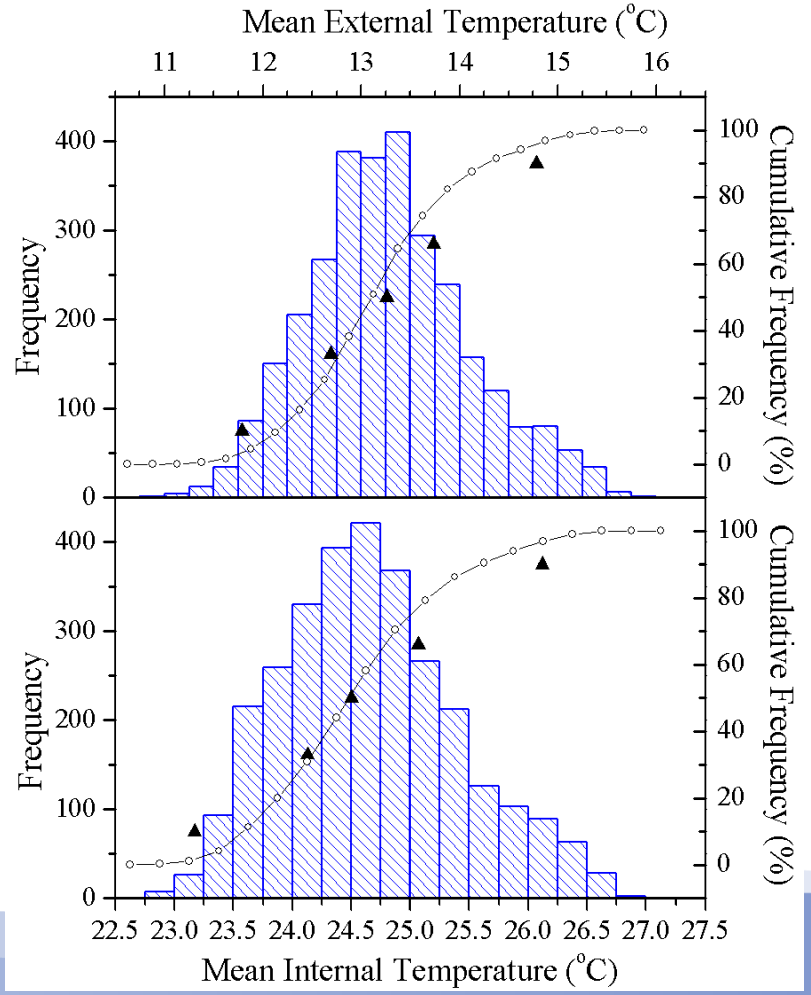




Published in BSER&T

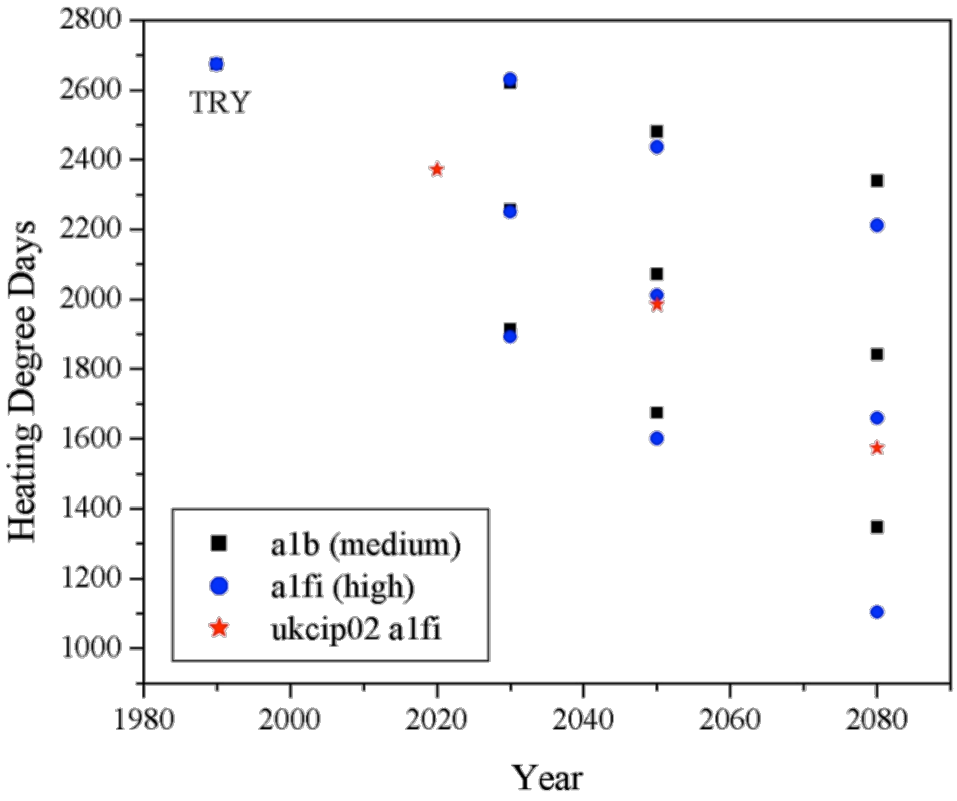
Comparing files: CDFs

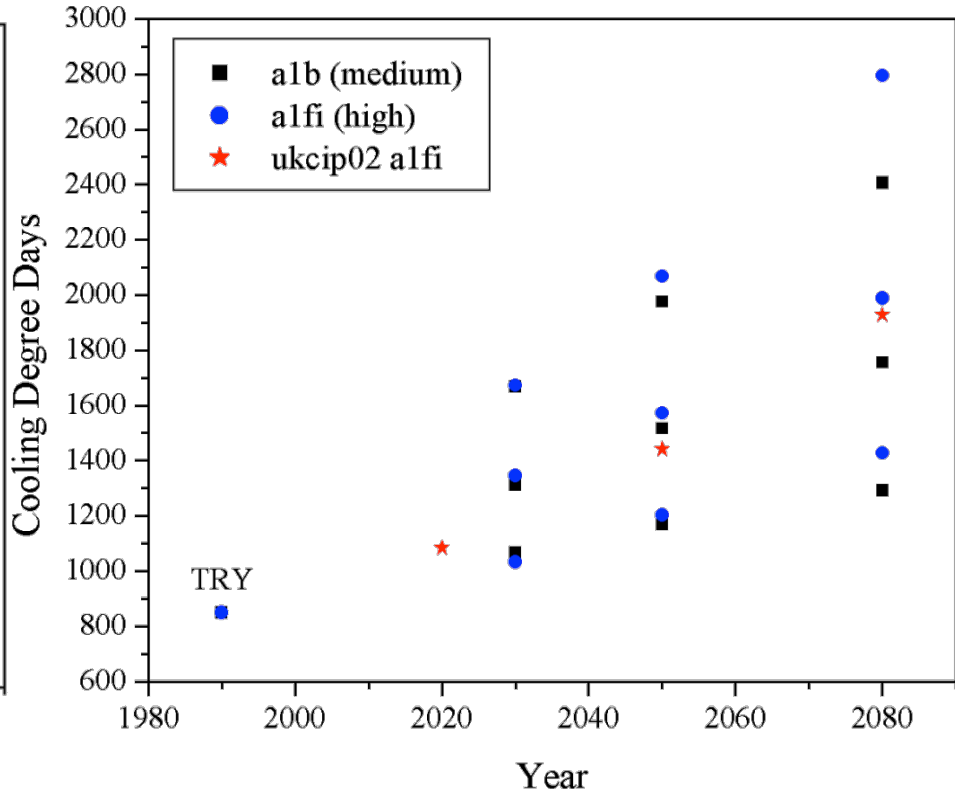
- The UKCP09 weather generator produces 3000 years of weather from which we assemble our probabilistic files.
- The five probabilistic files map well the distribution of the whole set.



Published in Building and Environment

Comparing files: Cooling Degree Days and Heating Degree Days





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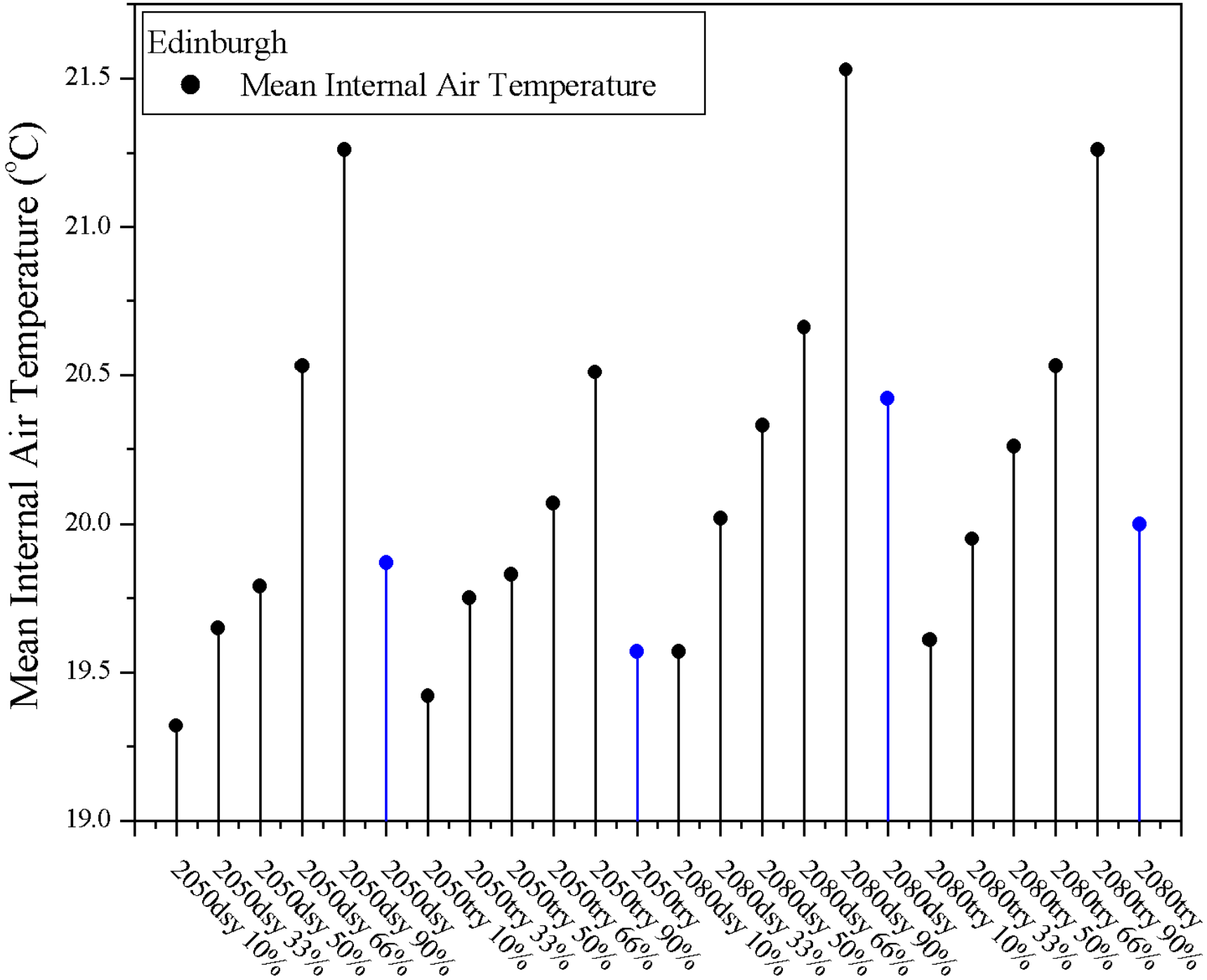
Edinburgh
Mean Internal Air Temperature
Mean Internal Air Temperature (°C)
21.5
21.0
20.5
20.0
19.5
19.0
2050dsy 10%
2050dsy 33%
2050dsy 50%
2050dsy 66%
2050dsy 90%
2050dsy
2050try 10%
2050try 33%
2050try 50%
2050try 66%
2050try 90%
2050try
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2080try

Web centres.exeter.ac.uk/cee/prometheus/

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PROMETHEUS

The Use of Probabilistic Climate Change Data to Future-proof Design Decisions in the Building Sector

Our Project Partners

Jacobs Engineering UK

The Met Office

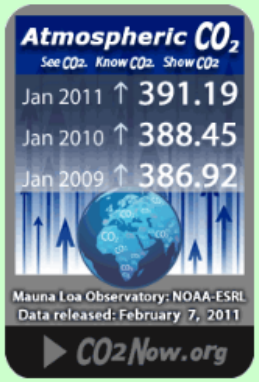
Royal Institute of British Architects

Chartered Institution of Building Services Engineers

Building Research Establishment

Department for Children, Schools and Families

Integrated Environmental Solutions



Download the new CRED guide

What is PROMETHEUS?

PROMETHEUS is a cross-disciplinary EPSRC funded project. The main aims of the project are:

- Create a methodology for the creation of probabilisitic future reference years using the output of UKCP09.
- Using physics based models identify the problems new buildings face as a result of climate change.
- Help the building sector adapt to the challenges of climate change.

Based in the Centre for Energy and the Environment at the University of Exeter PROMETHEUS is one of the Climate Change and Sustainable Futures projects.

We are a member of the ARCC (Adaptation & Resilience to a Changing Climate) co-ordinated research network.

The outputs will be used for projects such as the Montgomery Primary School Project, the first zero-carbon climate change ready school in th UK

Climate Change

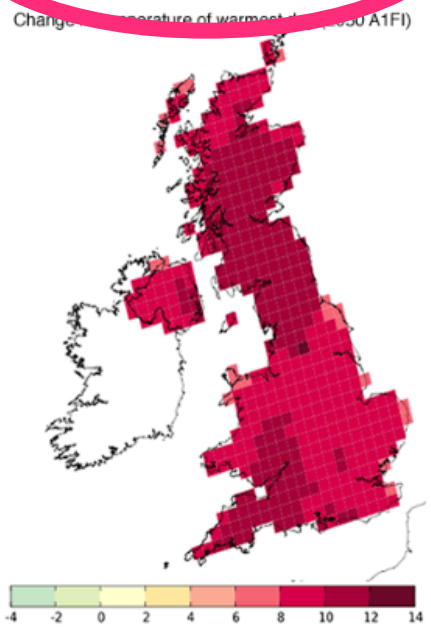
Whether you believe that it is man-made or a natural process there is overwhelming evidience that the climate is changing.

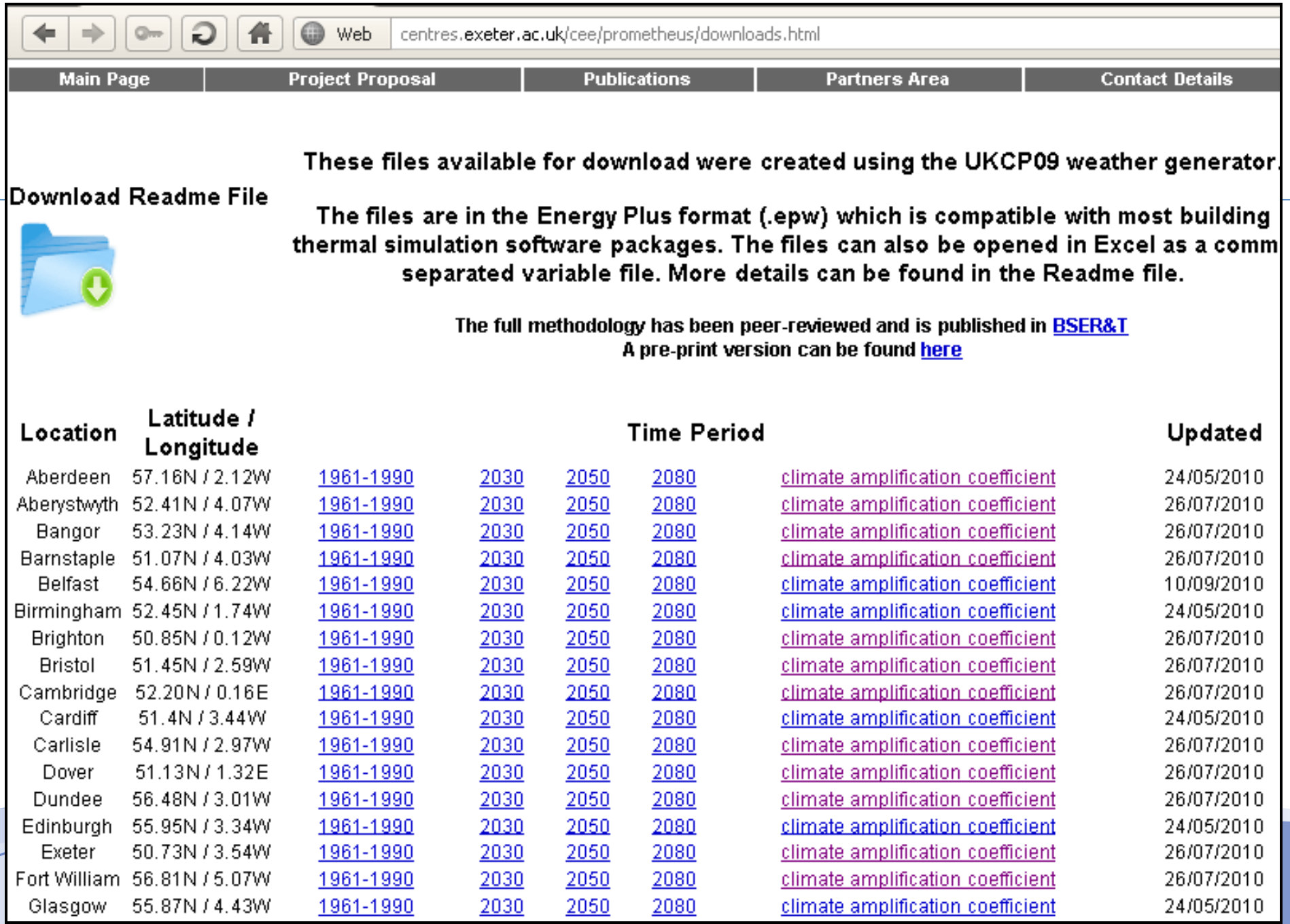
The work of John Tyndall showed that CO2 is almost opague to thermal radiation. Increasing the concentration of this green house gas and others in the atmosphere can only lead to warming of the climate system.

The IPCC's fourth assessment report shows significant warming over land for diferent socio-economic projections of CO2 emissions. The widget on the left shows the trend and current concentration of atmospheric CO2.

For the UK, the latest climate projections based upon these emissions scenarios, UKCP09 incorporates climate models from the Met Office and others. The projections are probabilistic in nature instead of deterministic so as to allow users to assess the level of risk. For example the figure on the right shows the increase in temperature of the warmest day in summer. The data shown is the A1FI emissions scenario for 2050 at the 90th percentile. This means that within this model there is a 90% chance that the increase will be less than this value, but also a 10% chance that it will be greater!

NEWS: *FREE Probabilistic future weather files now available for download Here*





Location	Latitude / Longitude	Time Period					Updated
Aberdeen	57.16N / 2.12W	1961-1990	2030	2050	2080	climate amplification coefficient	24/05/2010
Aberystwyth	52.41N / 4.07W	1961-1990	2030	2050	2080	climate amplification coefficient	26/07/2010
Bangor	53.23N / 4.14W	1961-1990	2030	2050	2080	climate amplification coefficient	26/07/2010
Barnstaple	51.07N / 4.03W	1961-1990	2030	2050	2080	climate amplification coefficient	26/07/2010
Belfast	54.66N / 6.22W	1961-1990	2030	2050	2080	climate amplification coefficient	10/09/2010
Birmingham	52.45N / 1.74W	1961-1990	2030	2050	2080	climate amplification coefficient	24/05/2010
Brighton	50.85N / 0.12W	1961-1990	2030	2050	2080	climate amplification coefficient	26/07/2010
Bristol	51.45N / 2.59W	1961-1990	2030	2050	2080	climate amplification coefficient	26/07/2010
Cambridge	52.20N / 0.16E	1961-1990	2030	2050	2080	climate amplification coefficient	26/07/2010
Cardiff	51.4N / 3.44W	1961-1990	2030	2050	2080	climate amplification coefficient	24/05/2010
Carlisle	54.91N / 2.97W	1961-1990	2030	2050	2080	climate amplification coefficient	26/07/2010
Dover	51.13N / 1.32E	1961-1990	2030	2050	2080	climate amplification coefficient	26/07/2010
Dundee	56.48N / 3.01W	1961-1990	2030	2050	2080	climate amplification coefficient	26/07/2010
Edinburgh	55.95N / 3.34W	1961-1990	2030	2050	2080	climate amplification coefficient	24/05/2010
Exeter	50.73N / 3.54W	1961-1990	2030	2050	2080	climate amplification coefficient	26/07/2010
Fort William	56.81N / 5.07W	1961-1990	2030	2050	2080	climate amplification coefficient	26/07/2010
Glasgow	55.87N / 4.43W	1961-1990	2030	2050	2080	climate amplification coefficient	24/05/2010

The range of possible climate change is large. So which files should I be using?

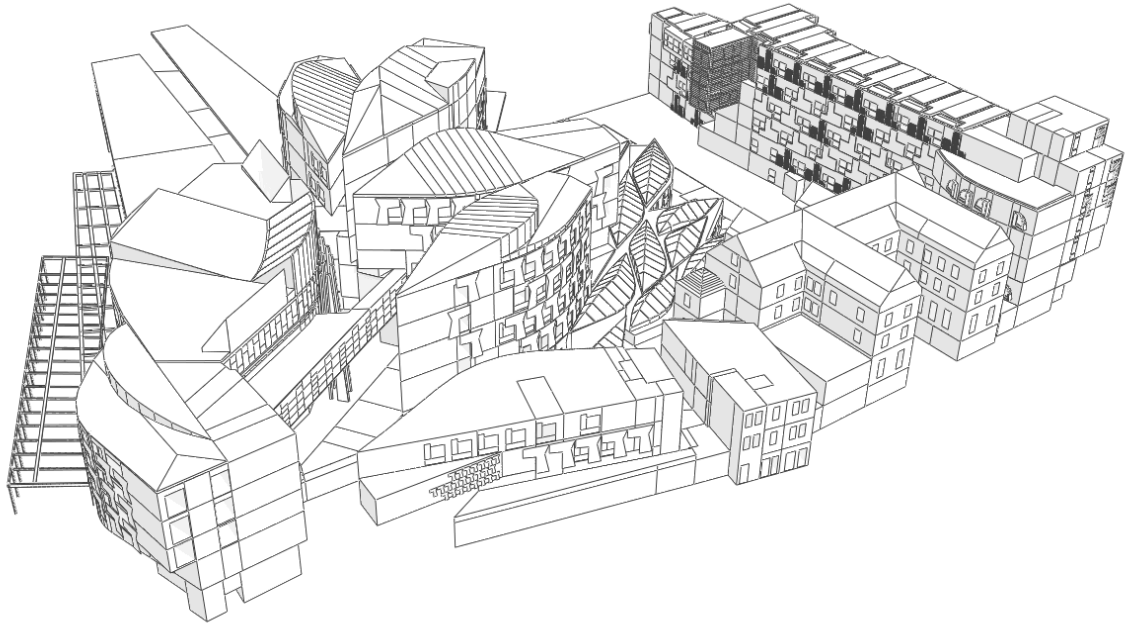
Things to consider:

•Risk to occupants, vuln
groups.

•Cost benefit analysis

•Dialogue with client

•Buildings last 100+ years
HVAC lasts ~25 years



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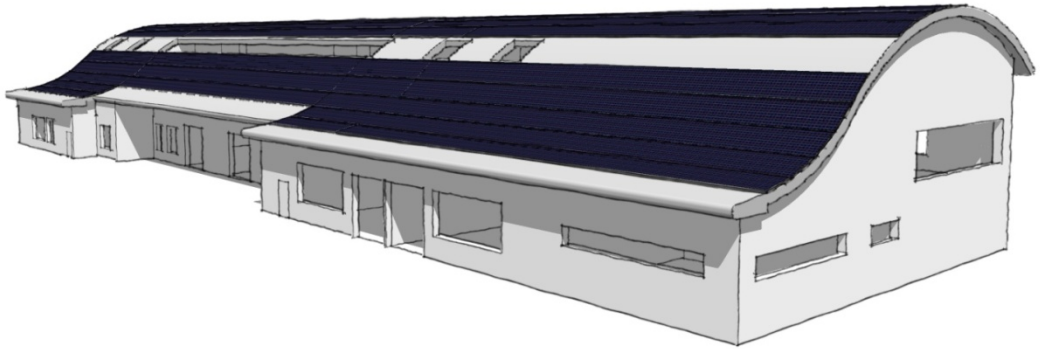
Adaptation of Buildings Montgomery School (Exeter)



Scope: 450 pupil zero-carbon passivhaus design school. Designed to have minimal heating and energy requirements and to be adapted to the effects of climate change

- **Project value** £9m
- **Building size** ~2500m^2
- **Additional cost of alterations** £1m

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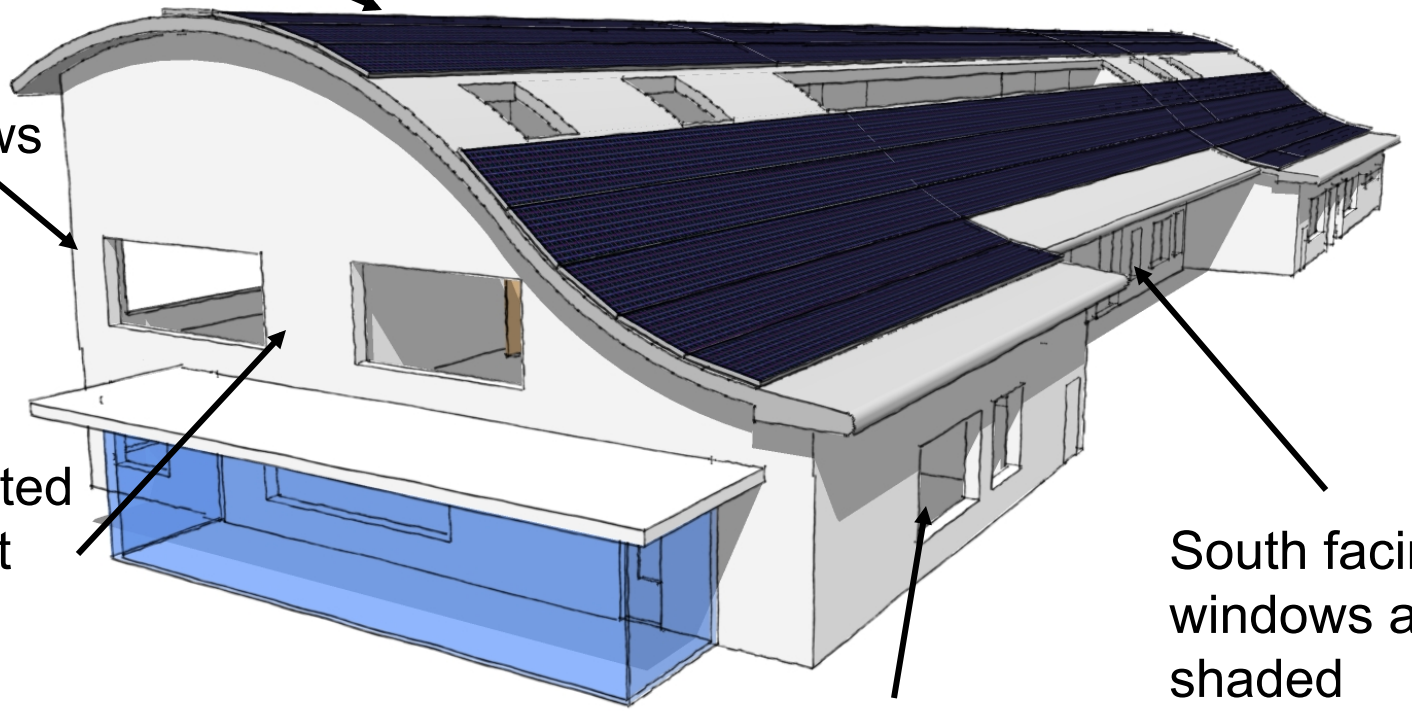
The Building

- Passivhaus design
- Reduced heating requirement
- Increased Air tightness
- Mech Vent with heat reclamation



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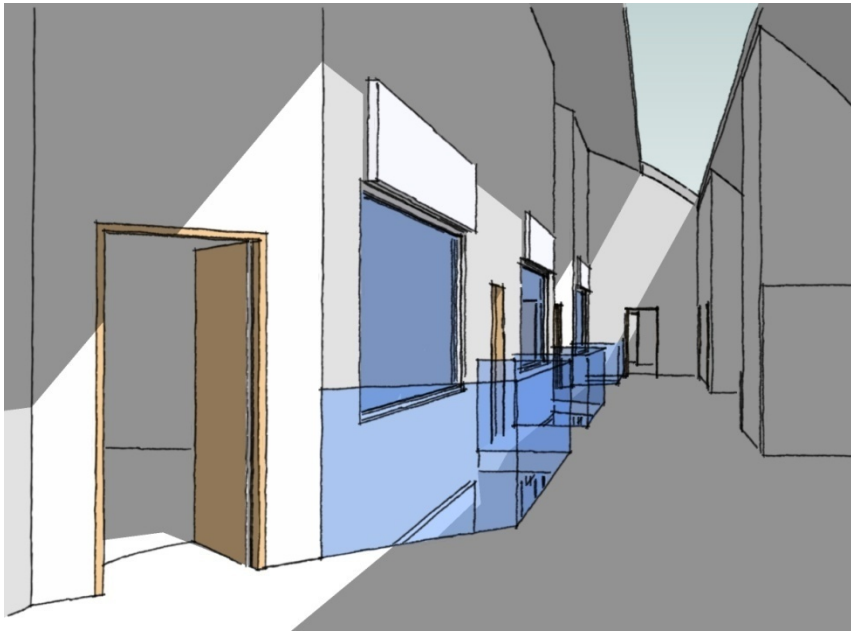
Considered Adaptation

- Increased shading
- Increased thermal mass
- Small windows on southern façade
- Changes to occupant behaviour
- Increased lighting and equipment efficiency
- Provision for increased natural and stack ventilation during summer months
- Inclusion of an early morning cooling strategy.



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Montgomery Primary School

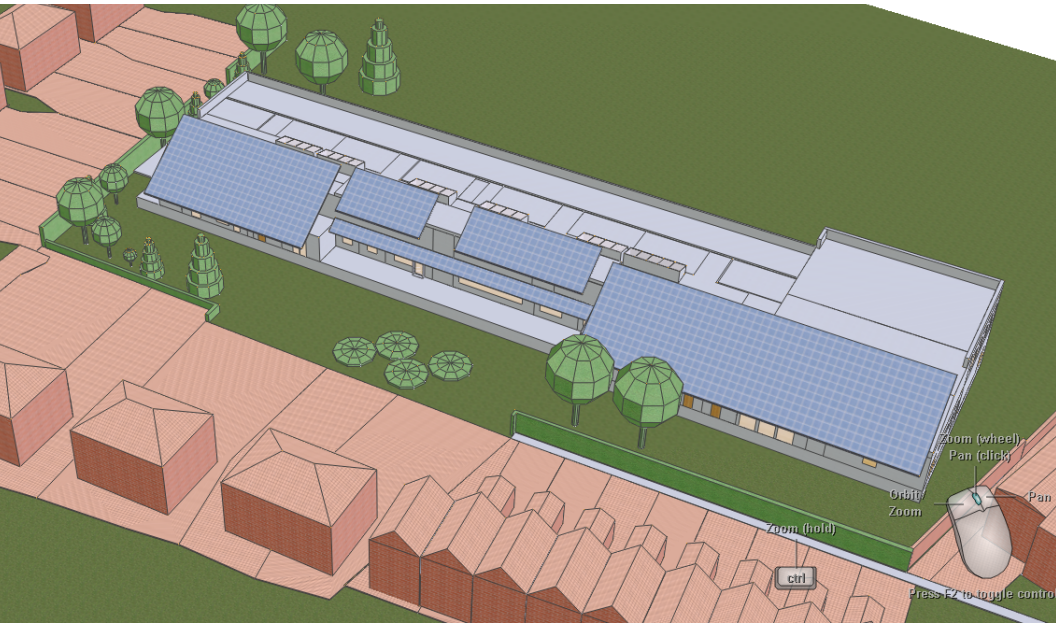
Design modifications: adaptation to future climate

Change occupant behaviour: allow both internal and external doors to open during occupied periods when the internal temperature is greater than 26°C.

Include cooling strategy: Increase summertime ventilation rate from 6.30am until 9am each day when the room temperature is greater than 23°C.

Summary

Design now finalised and construction has begun



Building still on target to pass passivhaus accreditation.

Simulations show that school will pass current overheating criteria in 2080 under high emissions scenario.

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11.02.2011 14:26

Adaptation of Buildings Cornwall County Council Offices

Scope: Refurbishment of 1960's office block. Provision for increased occupancy density in a modern office environment.

- **Project value** £4m
- **Building size** 4800m^2

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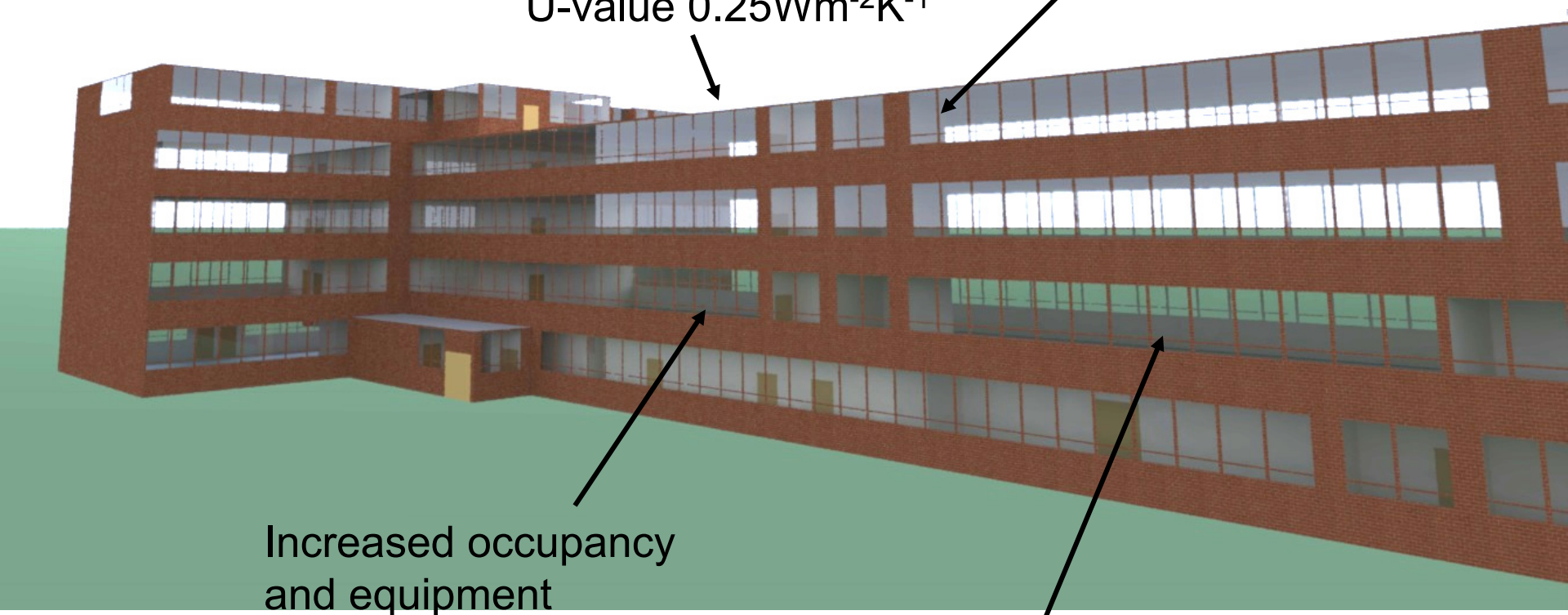
The Building



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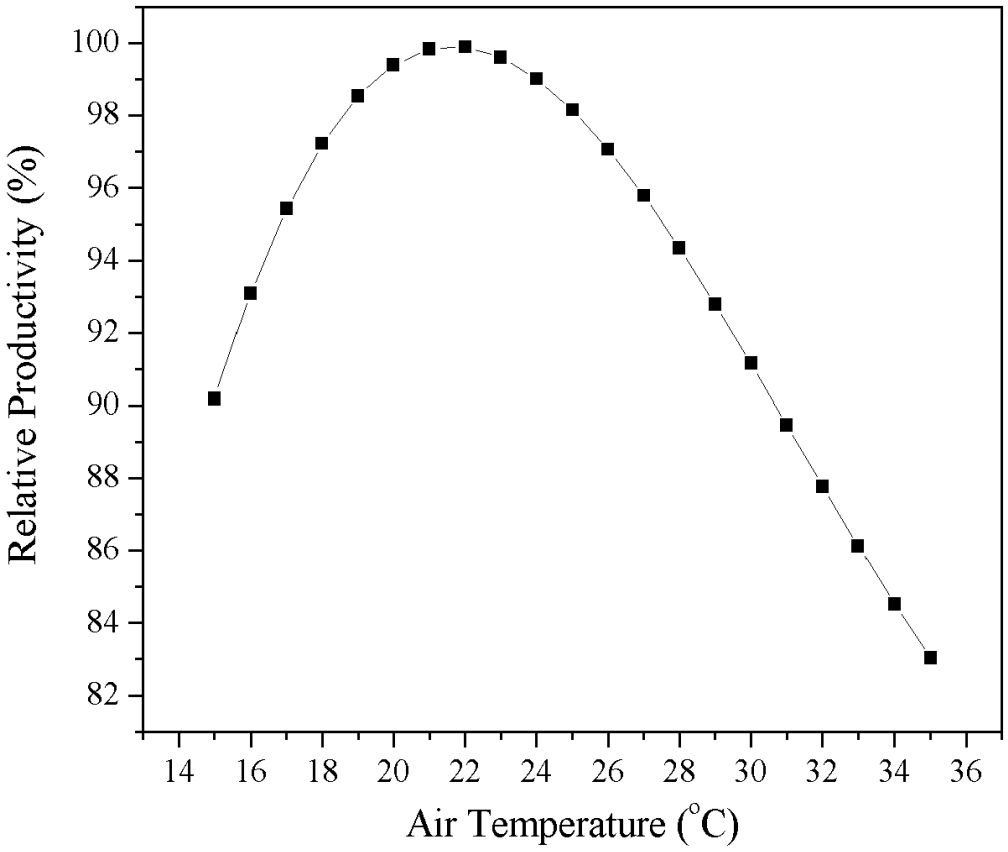
Adaptation Summary



Adaptation strategy for:

- Increased occupancy
- Modern office environment
- Possible future changes in use
- Overheating and productivity
- Aim to create an adaptation future refurbishment schedule

Proposed solutions:

- Increased cross ventilation
- Access to thermal mass via ceiling perimeter gaps
- Solar film on windows
- Reduction in lighting and equipment gains
- Brise soleil
- Changes in working hours

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Prometheus:

The Use of Probabilistic Climate Change Data to Future-proof Design Decisions in the Building Sector

www.ex.ac.uk/cee/prometheus