Department for Environment Food & Rural Affairs | Department for Business, Energy & Industrial Strategy | Met Office Hadley Centre | Environment Agency

Working together on UK Climate Projections

Thermal performance of buildings

Providing future weather files to building professionals to assess thermal comfort and energy performance

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- UKCP09 and its weather generator are being used by building professionals and architects to assess future climate change impacts in the built environment and evaluate adaptation options.
- The UKCP18 probabilistic projections provide variability through time rather than average "weather" allowing the timing of adaptation options to be explored.
- The weather generator is not being updated but daily data (and sub-daily for the 2.2km model) from the global and high resolution datasets will be provided. Further investigation is required to understand how to use the small ensemble of global/high resolution projections alongside the probabilistic projections.

The decision context

The Chartered Institution of Building Services Engineers (CIBSE) and University of Exeter are collaborating in the development of climate change information to enable the building industry to assess resilience across the built environment. The two partners have been working together over the past 10 years to develop resources based on previous climate projections (UKCIP02, UKCP09) which have been used in the assessment of climate change impacts in the built environment and evaluation of adaptation options. These outputs are critical for building professionals and architects to see how their building designs will perform in a changing climate.

CIBSE is the standard setter and authority on building services engineering. It publishes guidance and codes which are internationally recognised as authoritative, and sets the criteria for best practice in the profession. As part of this role, it provides general advice on the use of climate change information[1], produced its own guidelines for the use of UKCP09 in the form of the Probabilistic Climate Profiles (ProCliPs) - see Figures 1 and 2. CIBSE also collaborated with members to understand the practicalities of including climate change adaptation in building design[2].

Our data needs

To assess the performance of buildings, our models require present and future weather data, i.e. hourly information for temperature, dew point temperature, relative humidity, atmospheric pressure, solar radiation, wind direction and wind speed, cloud cover and precipitation.

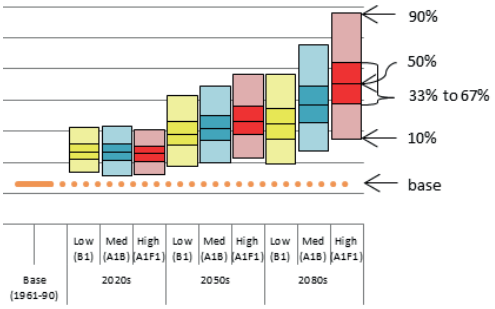

Figure 1. Schematic of probabilistic climate profile graph from UKCP09 data. From Shamash et al (2014)[3].

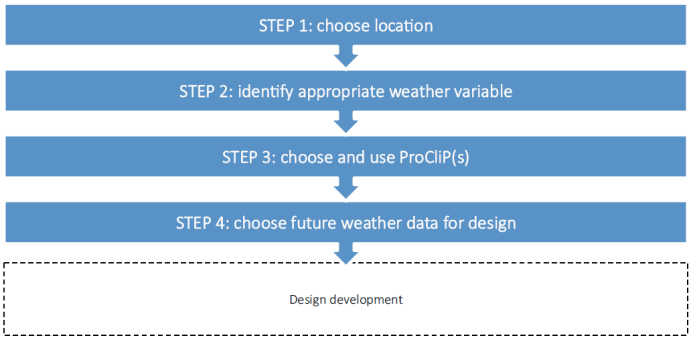

Figure 2. Framework for selection of future weather data. From figure 4 of Shamash et al (2014)[3].

[1] *TM48 Use of climate change data in building simulation, CIBSE, 2009* [2] *TM55: Design for future climate: Case studies, CIBSE, 2014*

[3] *Shamash et al, (2014) Probabilistic Climate Profiles, The effective use of climate projections in building design), CIBSE.*

Find out more

This project is part of a portfolio of demonstration projects that have worked with the UKCP18 team to understand the implications of the next set of UK Climate Projections for their sector.

To find out more about the UKCP18 project and other demonstration projects, please visit https://www.metoffice.gov.uk/research/collaboration/ukcp

Exploiting UKCP18 data

The imminent release of the new climate projections provides an opportunity to use UKCP18 information to assess how our existing methodologies and resources will be affected by the new projections. We will assess the new products offered within the UKCP18 information with the view to identify opportunities to develop new resources and tools for the building industry. The approaches will follow those previously developed by the building industry (see Previous studies using UKCP09). The potential opportunities for the new data are set out below:

Probabilistic projections

The monthly projections will allow us to create 'average' weather which evolves over time. The continuous time series will allow us to explore variability and adaptation options through time. Temperature is the biggest driver of how we use buildings, e.g. we adjust heating and cooling to improve our comfort levels.The addition of wind speed as an output for the probabilistic projections is welcomed as only a subset of the variables were provided coincidently with the UKCP09 dataset. However, various building components rely on the secondary variables to work adequately. UKCP18 provides an opportunity to design building systems better like natural ventilation strategies where coincident temperature and wind are important and its provision crucial if we are going to avoid the use of air conditioning.

Global Climate Model

CIBSE has members from many countries but only has hourly weather datasets for the UK. This product could potentially allow us to expand the methodology to the rest of the world. Previously, only low resolution global climate model data was available. The variables included are also more comprehensive than the UKCP09 probabilistic dataset, so comparisons could also be made to see how the extra information translates into building design options. Our current methodologies would need to be reviewed and expanded so that they are suitable for all variables.

High Resolution Downscaling

This is a novel output from the point of view of building simulation and risk management not available in any previous projections. The present-day period (1981-2000) would provide realistic weather outputs at a high resolution and continuous over space. This is not available for the weather station data that is typically used. This would allow us to test the resolution and spatial coherence problems (occurring at the boundary of two weather files based on weather station data) we have with our current weather data based on observations. From a research point of view this might prove to be one of the more interesting investigations as it will again allow a new avenue of research.

Generating weather files

The approach using the UKCP09 PDFs relied on fitting daily data (or morphing) to the UKCP09 monthly probabilistic data for each time horizon. The approach for the Weather generator (WG) used daily output to generate the DSY and TRY[5, 6, 7]. For those variables not available through the WG (wind speed, wind direction, air pressure), probabilistic values were generated from observations. These were then tested for future time horizons. The WG will not be updated in UKCP18 and instead, daily output will be provided by the global and high resolution models for variables that were available in the WG as well as wind speed/direction and air pressure. Investigation into how the data from a small ensemble of models can be used alongside the probabilistic information will be required.

Previous studies using UKCP09

Two approaches were developed by the building industry to use the UKCP09 information: one based on the probabilistic distribution functions (PDFs) and the other on the weather generator[5]. Both methods sought to produce weather files for a design summer year[4] (DSY) and a test reference year (TRY). The DSY is used to assess the summertime thermal performance and TRY for energy performance of buildings. See Figure 3 for a comparison of the approaches (WG TRY versus CIBSE future TRY). Please note that the comparison refers to older CIBSE weather files prior to their update with UKCP09 data.

Impacts were investigated using UKCP09 climate change projections over land and the UKCP09 weather generator. These sets provided higher resolution and probabilistic data that was previously unavailable. The files generated from UKCP09 projections are at very discrete time horizons (i.e. 30-year averages for 2020s, 2030s, 2040s, etc) with relatively large jumps and potential discontinuities, and ignore the possibility of variability between time horizons.

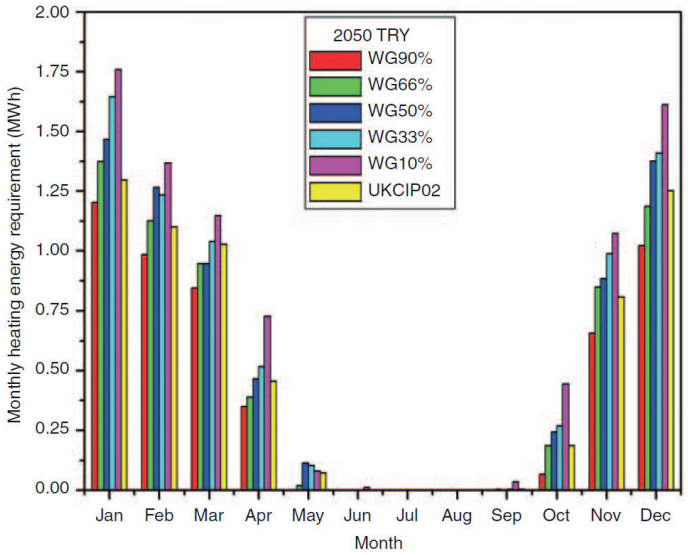

Figure 3. Plot of the monthly heating energy requirement of the building for the different WG Test Reference Year (TRY) files at a number of different probability levels and the CIBSE's future TRY (UKCIP02). Data shown is for London in 2050s (from Eames et al[6], 2011).

[4]*See www.cibse.org/knowledge/cibse-weather-data-sets for more details on DRY and TRY.*

[5]*See PROMETHEUS project at http://emps.exeter.ac.uk/engineering/research/cee/research/prometheus/ for more details about the UKCP09 weather generator approach.*

[6]*Eames M, Kershaw T, Coley D. (2011) On the creation of future probabilistic design weather years from UKCP09, BUILDING SERVICES ENGINEERING RESEARCH & TECHNOLOGY, volume 32, no. 2, pages 127-142.*

[7]*Kershaw T, Eames M, Coley D. (2011) Assessing the risk of climate change for buildings: A comparison between multi-year and probabilistic reference year simulations, BUILDING AND ENVIRONMENT, volume 46, no. 6, pages 1303-1308, DOI:10.1016/j.buildenv.2010.12.018.*