UNIVERSITY OF EXETER

Research Briefing

Built to Stand the Test of Time

Using PROMETHEUS weather files to adapt building designs to climate change

By Dr David Coley and Dr Matt Eames

Innovative research that predicts future weather up to 2080 could transform the capacity of the UK building industry to adapt to climate change in the face of rising temperatures, which threaten to cause buildings to breach regulatory standards and endanger occupants.

Scientists at the University of Exeter's Centre for Energy and the Environment (CEE) have created probabilistic weather files for 35 locations across the country that enable building professionals to design new buildings and formulate retrofit solutions to meet the challenges posed by changing local climates.

The files, which are free to download, are based on the latest UK Climate Projections (UKCP09), and are the product of the CEE's PROMETHEUS project — The Use of Probabilistic Climate Change Data to Future-proof Design Decisions in the Building Sector. The files are presented in the EnergyPlus Weather format (EPW) and are compatible with common building simulation software.

The creation of the PROMETHEUS weather files was inspired by the need to end the flawed practice of modelling buildings using historic weather data, academics say. The current standard test reference year and design summer year are calculated only using data up to 2004 for 14 locations and fail to offer an accurate representation of even the current UK climate.

The European heat wave in 2003 served as a stark reminder that the overheating of buildings can have severe consequences for human health and productivity. About 35,000 deaths across Europe – mostly among the elderly – were attributed to heat stress in buildings. Although these extreme temperatures are currently estimated to be a 1-in-1,000 year event, they are expected to constitute an average summer by the 2040s, while in 2080 it could be anomalously cold, Met Office research shows.

As building projects will be affected by climate change in varying ways, the probabilistic PROMETHEUS files cover a range of common weather variables, such as mean temperatures and wind speed, and carbon emissions scenarios on hourly time steps for the years 2030, 2050 and 2080.

The files have guided the design of the UK's first zero-carbon school, Montgomery Primary School in Devon, and the refurbishment of a 1960s office building for Cornwall Council. The files have also been used to test the resilience of the designs of, among others, Myplace Youth and Community Centre and Blackfriars train station in London, Leeds Arena and Bilston Leisure Centre in Wolverhampton.

Key findings

- The building industry can use PROMETHEUS weather data to adapt new and existing building designs to climate change.
- The freely available files cover a range of weather and emissions scenarios up to 2080.
- PROMETHEUS has influenced the design of a zero-carbon school and the refurbishment of existing council offices.
- PROMETHEUS has tested the resilience of a stadium, a community centre and a train station under climate change.
- Designers can use climate change amplification coefficients to measure the resilience of a specific building design to climate change.

CEE academics applied the PROMETHEUS data to a thermal model of a school and examined 252 building design and weather scenario combinations. Crucially, the academics discovered a direct, quantifiable link between rises in external temperatures due to climate change and increases in internal temperatures of buildings.

They were able to derive a set of climate change amplification coefficients that describe the expected response of any building design to any reasonable amount of climate change. The building industry can use these coefficients to measure the resilience to climate change of a particular design, to set minimum performance standards within building regulations and codes and to cost design options rationally, researchers said.

However, CEE academics said that a cultural shift was needed within the building industry to give equal emphasis to adaptation and mitigation in the face of climate change.

In a study of attitudes to climate change among employees of a large engineering firm, respondents focused on reducing energy consumption and the need to improve efficiency, rather than the need to design buildings for a very different climate.

Comments and implications

Dr David Coley, Senior Research Fellow at the CEE, said: "Estimates of overheating and energy use in buildings will be dramatically wrong if buildings continue to be modelled using weather data that ignores climate change.

"Many of the deaths during the 2003 heat wave were caused by a failure of buildings to moderate the external climate. Given these extreme temperatures are set to become common, we must ask ourselves: is it acceptable that we are designing buildings around the world that will kill people?"

The PROMETHEUS projections are probabilistic in nature so as to allow users to assess the level of risk.

He said: "If you were thinking of expanding your ice cream production, you might base your design on the lowest possible increase in temperature of the warmest day in summer in 2050; if you were designing a flood defence barrier you are more likely to use the highest potential temperature increase."

Dr Matt Eames, Associate Research Fellow at the CEE, stressed the importance of the climate change amplification coefficients for the building industry.

He said: "The estimation of these coefficients for new or existing buildings will allow more rapid thermal modelling of buildings, the design of more resilient buildings, cost-benefit analysis of refurbishment options and the rational assembly of at-risk registers of building occupants.

"We should not expect that we will get away with temperature rises of 2C. We should plan for 4C. It is vital that issues of adaptation become more prominent in the consciousness of building industry representatives when thinking about climate change, alongside the ongoing importance of mitigation."

About the University of Exeter's Centre for Energy and the Environment and the PROMETHEUS project

The Centre is an interdisciplinary team of consultants and research scientists specialising in issues surrounding sustainable buildings, energy and transport. It has a 30-year history of working with both local and national government and the commercial sector.

PROMETHEUS is one of the university's Climate Change and Sustainable Futures projects and is funded by the Engineering and Physical Sciences Research Council.

The PROMETHEUS future weather files are freely available for download from the project website. The files are in .epw format but can also be opened in Excel once the files are extracted. If you experience any difficulty in downloading the files please contact either of the CEE academics below.

http://centres.exeter.ac.uk/cee/prometheus

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David Coley is a Senior Research Fellow at the Centre for Energy and the Environment. He specialises in sustainable building design (particularly for schools), embodied energy, global climate change, renewable energy technologies and energy in the National Curriculum. He was the first to define and apply the climate change amplification coefficient.

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