Potential Impacts of Climate Change on the Built Environment: ASHRAE Climate Zones, Building Codes, and National Energy Efficiency

Joshua R. New, PhD, CEM
Jitendra Kumar, PhD
Forrest M. Hoffman, PhD
Oak Ridge National Laboratory, Oak Ridge, TN, USA

Abstract

Statement of the Problem: ASHRAE releases updates to 90.1 "Energy Standard for Buildings Except Low-Rise Residential Buildings" every 3 years resulting in a 3.7%-17.3% increase in energy efficiency for buildings each release. This is adopted or informs building codes in nations across the globe, is the National Standard for the U.S., and individual states elect which release year of the standard they will enforce. These codes are built upon Standard 169 "Climatic Data for Building Design Standards," the latest 2017 release of which defines climate zones based on 8,118 weather stations throughout the world and data from the past 8-25 years. This data may not be indicative of the weather new buildings built today will see during their 30-120 year lifespan.

Methodology & Theoretical Orientation: Using more modern, high-resolution datasets from climate satellites, IPCC climate models (PCM and HadGCM), high performance computing resources (Titan), and new capabilities for clustering and optimization, the authors briefly analyzed different methods for redefining climate zones using bottom-up analysis of multiple meteorological variables subject matter experts selected as being important to energy consumption, rather than the heating/cooling degree days currently used.

Findings: We analyze the accuracy of redefined climate zones compared to current climate zones, how the climate zones move under different climate change scenarios, and quantify the accuracy of these methods on a local level at a national scale for the U.S.

Conclusion & Significance: There is likely significant annual, national energy and cost (billions USD) savings that could be realized by adjusting climate zones to take into account anticipated trends or scenarios in regional weather patterns.

Image

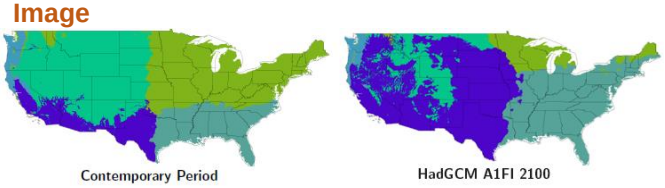

Figure 1. Supercomputer-enabled analysis of high-resolution (4 km² grid) weather data for the current time period (LEFT) and aggressive climate change scenario Hadley GCM A1FI (RIGHT) shows significant changes in climate zones over the next 80 years. This could impact energy efficiency of new buildings, but is not captured by current building codes based on historical weather.

Recent Publications (minimum 5)

1. Edwards, Richard E., New, Joshua R., Parker, Lynne E., Cui, Borui, and Dong, Jin (2017). "Constructing Large Scale Surrogate Models from Big Data and Artificial Intelligence." In *Journal of Applied Energy*, volume 202, pp. 685-699, September 2017. [Applied Energy] [PDF]
2. New, Joshua R., Chen, Yixing, Choi, Joon-Ho, and Bass Abushakra *(Seminar Chair)* (2017). "Seminar 28 - Urban-Scale Energy Modeling, Part 5" presenting "Automatic Building Energy Model Creation (AutoBEM)." To appear in *Proceedings of the ASHRAE Annual Conference*, Long Beach, CA, June 26, 2017. [ORNL] [LBNL] [USC]
3. Bhandari, Mahabir, Shrestha, Som, New, Joshua R., and Allen, Melissa (2017). "Comparison of Microclimate Simulated Weather Data to ASHRAE Clear Sky Model and Measured Data." ORNL internal report ORNL/TM-2016/81, April 2017, 27 pages.
4. Pallin, Simon, Boudreaux, Philip, Shrestha, Som, Adams, Mark, and New, Joshua R. (2017). "State-of-the-Art Hygrothermal Simulation Tools." ORNL internal report ORNL/TM-2017/92, March 30, 2017, 22 pages.
5. New, Joshua R. (2016). "How to use DOE's Roof Savings Calculator." Presented at the International Radiant Insulation Manufacturers' Conference (I-RIM) pre-show event. Hollywood, FL, May 31, 2016. [PPT]

Dr. Joshua New is a computer scientist serving as full-time R&D staff at Oak Ridge National Laboratory, Joint Faculty at The University of Tennessee, and Founder & CEO of Tunation, LLC. He received his Ph.D. in Computer Science at the University of Tennessee in 2009. Dr. New serves at Oak Ridge National Laboratory's Building Technology Research Integration Center (BTRIC) as subprogram manager for software tools and models. He has over 95 peer-reviewed publications and has led more than 45 competitively-awarded projects in the past 5 years involving websites, web services, databases, simulation development, visual analytics, supercomputing using the world's #1 fastest supercomputer and artificial intelligence for big data mining. He is a voting member of ASHRAE TC4.2 and SSPC-169 which define the climate data and HVAC design conditions for international building codes.

Email: newjr@ornl.gov