# **Studying the Impacts of Climate Change on Building Specifications**



# Center for Sustainability and the Global Environment NELSON INSTITUTE

UNIVERSITY OF WISCONSIN-MADISON

### Motivation

- Building must be designed for local weather conditions
- (roofing, window, heating and air conditioning). Architects rely on climate metrics that are not common in meteorology, such as upper and lower 1% dew point temperature, and heating/cooling degree days and hours. This is challenging for many downscaled products due to requirements of realistic variance.
- The American Society of Heating, Air-conditioning ASHRAE Refrigerating and Engineers (ASHRAE) provides their design metrics for the U.S. counties and global locations.
- ASHRAE metrics are based on 25 years historical data from the Integrated Surface Database (ISD). However, building today must endure the climate and weather of the future.
- Our work uses future climate model projections to recalculate the ASHRAE metrics for future conditions.



### **Climate model projection**

We use the UW Probabilistic Downscaling (UWPD) Data (Lorenz, 2015), which determines a daily varying probability distribution of maximum and minimum temperature and precipitation based on large-scale conditions. The advantage of this technique is that it retains extremes, and as such can be used to reliably rescale future hourly variations.

CMIP5 Climate Models (24 for RCP8.5 and 22 for RCP4.5):

ACCESS1-0. ACCESS1-3. CMCC-CM. CMCC-CESM. CMCC-CMS. CNRM-CM5. GFDL-CM3. GFDL-ESM2G. IPSL-CM5A-MR. Inmcm4. CanESM2. MPI-ESM-MR. CSIRO-Mk3-6-0.

**UWPD Estimated** Local Scale Variables

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# Trend of Cooling Degree Hours

- demand for energy needed to cool buildings.
- CDH is defined as the number of hours that the temperature exceeds a base threshold (23.3deg C)



Cooling degree hours (CDHs) increase under both scenarios, especially under RCP 8.5 (high emission scenario), CDHs will double by 2050 and triple by 2090. Under moderate emissions, Madison, WI will be similar to St. Louis, MO by 2090; under high emissions, Madison, WI will resemble Birmingham, AL by 2070.







Cooling degree hours (CDH) is a metric that quantifies the



Fractional difference between T<sub>max</sub>, T<sub>min</sub> and hourly temperature  $a_{ih} = (T_{ih} - T_{minid}) / (T_{maxid} - T_{mini})$ 

Maintain the historical diurnal cycle fraction  $(a_{ih})$ 



Although metrics depend on all temperature, different metrics exhibit different levels of sensitivity to warming. Cooling degree days/hours with high base temperature values have higher sensitivity to warming.

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ASHRAE. (2009). Climatic Design Information. ASHRAE Fundamentals Handbook, 128. https://doi.org/10.1016/0140-7007(79)90114-2 Lorenz, D. J. (2015). Downscaled climate projections. Retrieved from http://djlorenz.github.io/downscaling2/main.html





### **OFFICE OF SUSTAINABILITY**

# Sensitivity of Building Metrics

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6.9	6.5	11.8	17.5	23.5	27.1	28.5	28.3	25.9	20.6	14.4	8						
8.3	8.2	15.1	22.4	27.9	31.8	32.5	31.9	29.6	24.5	17.1	9.7						
6.9	7.9	10.3	12.2	11.9	11.2	9.7	9.7	11.7	11.7	9.5	7.1						
8.1	10.5	15.1	15.6	14.4	13.3	11.6	11	13.3	15.4	13.3	9.6						
6.5	7.4	9.4	8.4	6.9	5.9	4.9	4.7	6	8.7	9.6	7.6						
7	9.7	13.3	13.7	11.7	11	9.6	9.3	10.6	12.7	12.1	8.8						
6.2	7.3	9.4	8.6	6.7	6.1	5.2	4.7	6.3	8.8	10.5	7.7						

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### References