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A novel preparation procedure of future weather datasets for building performance simulation

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The concern on climate change leads to growing demand for countermeasures against its impact on building performance. The aspects of building performance study includes the analysis of indoor thermal environment, building energy use, and energy efficiency design of building envelope. It enables and facilitates the evaluation of a building's performance during the design phase for adjusting the proposed architectural design to meet the expected performance criteria. The assessment of a building's performance is often done by hourly or sub-hourly computer dynamic simulation software with local weather datasets. These weather datasets, which are termed typical meteorological years (TMYs), are selected from long-term observed historical weather by means of Sandia method to ensure their representatives of local climate. Each TMY contains hourly values of observed data of a 1-year period. For the reason of longevous building lifespan and on-going climate change, one might ask how well the building is able to cope with future climate and what kind of countermeasure we should implement in advanced in face of climate change. However, the results obtained from the simulation with TMY couldn't forecast a building's performance in a future climate context without future climate is concerned. In this regard, future climate responsive meteorological data is needed for future climate impact study. From previous studies, as Belcher proposed, the future responsive weather data could be constructed by morphing existing TMY with future weather predicted by general circulation models (GCMs), which could substantially alleviate efforts from spatial and temporal downscaling processes. Consequently, choosing an adequate GCM that fits well with local climatic change pattern is in crucial need.
The objective of the study is to develop a new GCMs selection method for generating future meteorological data. During TMY morphing procedure, monthly changes of a certain meteorological element in a given future period under certain climate change scenarios should be identified. The GCMs provided by the World Climate Research Program's (WCRP) Coupled Model Intercomparison Project Phase 3 (CMIP3) were used to calculate these changes of every accounted meteorological elements that need to be morphed. Since these GCMs may deviates substantially, one might choose an appropriate GCM prior to the morphing procedure. Therefore, to identify the GCM that project well against actual local climate trends, principle component analysis (PCA) was introduced. First principle component of each GCM predicted weather data as well as the observed data from the same period were obtained by PCA. Afterwards, root mean square deviation (RMSD) was used to identify the GCM that suits local trends. The results show that the morphed TMYs agree well with the observed data during the validation process, revealing that the proposed procedure of future weather preparation for building simulation is reliable and also feasible. Hourly future weather datasets for the purpose of building performance simulation for northern and southern Taiwan with two greenhouse gas emission scenarios covering three future timeframes (i.e. 2030s, 2050s, 2080s) were established and discussed herein.