

# 1 epwshiftr: Create future EnergyPlus Weather files using 2 CMIP6 data

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## Software

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## 6 Summary



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8 Building energy simulation (BES) has become increasingly applied to assess building perfor-  
9 mance under climate changes and yield a more sustainable and resilient design ([Yassaghi &](#)  
10 [Hoque, 2019](#)). Multiple morphing-based weather-file modification tools have been developed  
11 to integrate climate change predictions ([Troup, 2016](#)). Most of the widely adopted weather  
12 generators, including CCWorkdWeatherGen ([Jentsch et al., 2008](#)), Meteonorm ([Remund et](#)  
13 [al., 2020](#)), and WeatherShift ([Dickinson & Brannon, 2016](#)), use GCM (Global Climate Mod-  
14 els) data from the CMIP (Coupled Model Intercomparison Project) that covers worldwide  
15 locations.

16 Currently, the CMIP project is in its sixth phase (CMIP6) ([Eyring et al., 2016](#)), which has  
17 developed new emission scenarios that have a similar range as its fifth phase (CMIP5) but fill  
18 critical gaps for intermediate forcing levels ([O'Neill et al., 2016](#)). It will be used in the Sixth  
19 IPCC (Intergovernmental Panel on Climate Change) Climate Assessments Reports ([IPCC,](#)  
20 [2021](#)). However, existing tools based on the previous CMIP were unable to utilize the data  
21 from the latest climate change research. Currently, there are no tools available that could  
22 process user-defined climate simulations in an automated way and allow further statistical  
23 analysis.

24 The epwshiftr package bridges these gaps. It is a free, open-source R package for adapting  
25 a whole-building energy simulation EnergyPlus ([Crawley et al., 2001](#)) Weather (EPW) files  
26 to incorporate climate change predictions using the morphing statistical downscaling method  
27 ([Belcher et al., 2005](#)). The primary goal is to automatically process large amounts of climate  
28 change prediction outputs from the CMIP6 (CMIP Phase 6) GCMs and create future climate  
29 data for BES across worldwide locations in a user-friendly and flexible way.

## 30 Epwshiftr R package

31 Epwshiftr is capable of processing multiple GCM outputs at various spatial and temporal  
32 resolutions. Additionally, the package is designed in a modular manner for flexibility and

33 extensibility. There are five modules in total, and the table below lists their corresponding  
34 names and functionalities.

**Table 1:** The modules designed in the epwshiftr package

Module name	Description
Query module	Query and store metadata of online CMIP6 GCM outputs via the ESGF (Earth System Grid Federation) Search RESTful API. Meta includes the name of GCM, the institution that developed the GCM, emission scenarios, output interval, nominal resolution, output variable, output unit, etc.
Database module	Create and manage a local database of GCM outputs using NetCDF files downloaded in the ESGF portal.
Data Extraction Module	Extract climate variable data of desired temporal domain and specified grid distances to the input baseline EPW file
Morphing Module	Calculate future weather data under the latest CMIP6 emission scenarios using the morphing method
EPW Generation Module	Create future EPW files using various data aggregation strategies using the eplusr package (Jia & Chong, 2021)

35 Each module stores climate data in a consistent Tidy (Wickham, 2014) data format, allowing  
36 exploring a considerably broad pool of ready-to-use methods available in R for customized  
37 statistical analysis. Computational-intensive processes have been designed to run in parallel  
38 for speed-up.

39 The epwshiftr is distributed via CRAN (The Comprehensive R Archive Network). The source  
40 code is available on GitHub at <https://github.com/ideas-lab-nus/epwshiftr> and released under  
41 the MIT license.

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