ASIA-PACIFIC SOLAR RESEARCH CONFERENCE

29 Nov - 1 Dec 2022, Newcastle, Australia

Improving Australian Weather and Climate Data Services

Dario Tarquini[1], Trevor Lee[1], David Ferrari[1]

[1]*Exemplary Energy, 32 Fihelly St, Fadden, Australian Capital Territory 2904, Australia*
E-mail: trevor.lee@exemplary.com.au

Abstract

A Real-Time Year (RTY) file is a compilation of real-time meteorological data formatted for application to engineering and architectural simulations.

RTYs are used in a variety of applications, including calibrated simulation for building commissioning and in the production of benchmarking simulations. The authors have found the latter application particularly valuable for monitoring systems by tracking their recent weather-dependent performance as compared to the performance simulated using historic average climate conditions.

This paper examines a series of recent improvements to weather and climate data services which increase their accuracy and usefulness for most applications:

- Combining satellite-derived estimates of solar resources from a commercial partner with terrestrial observations of other weather elements obtained from the Australian Bureau of Meteorology (BOM), providing users with the latest weather data.
- Undertaking benchmarking simulations to provide valuable insights into the performance of commercial buildings and PV and other solar systems to owners and facility managers including those managing Green Star, SmartScore and NABERS rated buildings.
- Including coincident precipitation data to assist modellers' and designers' consideration of tightened requirements for moisture management under the National Construction Code (NCC) 2019.
- Characterising eXtreme Meteorological Years (XMY) for solar PV generation, HVAC energy use and moisture management simulations.
- Improving estimates of cloud cover.

These enhancements will support modellers to provide more reliable and timely results to aid the efficient design and management of both thermal and hygrothermal systems.

Introduction

An RTY data set is a 12 month collection of historical real-time weather data acquired from the BOM and/or other sources, which includes hourly values of meteorological elements and solar radiation such as Global Horizontal Irradiation (GHI), Direct Normal Irradiation (DNI), Diffuse Horizontal Irradiation (DIF), Relative Humidity (RH), Wind Speed, Wind Direction, Cloud Cover, Temperature, and Pressure. These files can be utilised for building performance simulations (like energy and peak load analyses) and solar and other renewable energy system output simulations.

These data sets come in at least three different formats – Typical Metrological Year (TMY2, TMY3), Energy Plus Weather (EPW), and Australian Climate Data Bank (ACDB). The ACDB data set, originally developed by the CSIRO, in collaboration with the BOM and in consultation with ACADS-BSG which became the distributor, consists of an hourly record of 60-character columns produced in the specific format required for Nationwide House Energy Rating Scheme (NatHERS) software. Because the last 5 of the columns are currently left blank, it has been concurred by CSIRO that we may use them for precipitation data—mostly rainfall—even though there is no current plan for NatHERS to make use of that potential. The EPW data set was developed for use with simulation programs such as EnergyPlus and ESP-r and has since then been adopted as a quasi-standard format by many other building and solar system simulation tools. The format is a text-based comma separated value (CSV), based on data available in other weather format datasets such as TMY2, which contains time-series meteorological measurements and modeled or measured solar radiation values, with occasional inferred and/or interpolated data when satellite or terrestrial observations are missing from the data source. While the TMY2 format uses columnar or positional formats, which enhance data storage optimisation to the detriment of visual inspection ease, the CSV format of the EPW facilitates visual inspection and analysis with simple spreadsheet software such as Microsoft Excel (whereas the ACDB and TMY2 datasets need to be parsed into Excel with the user indicating the breaks between adjacent values).

New Real-Time Data Sources

Following the suspension of the dissemination of satellite solar data from BOM in August 2019, timely data from terrestrial observations was made available to us for Brisbane, Canberra, Perth, and Sydney by arrangements with QUT, CSIRO, Murdoch University and the NSW Department of Planning and Environment. Nevertheless, at the start of 2022 we have subscribed to new sources for terrestrial observations and solar satellite data, in order to provide the latest weather data to our clients and allow extension of the Exemplary Weather and Energy (EWE) Index to all 8 capital cities.

For solar observations, we now access Solcast's global solar database, which they produce using high-resolution (1-2km) imagery from a range of geostationary meteorological satellites. Utilising observations from the advanced imager onboard the Himawari-8 satellite, Solcast produces the gridded solar data utilising their in-house radiation model. This real time service has been successfully integrated into our products since May 2022.

For other less time-sensitive applications, we use BOM's terrestrial observations and QA'd gridded solar data for over 250 Australian locations, which allows us to produce weather data time series in various formats to cover the period 1990-2021 in these locations, and also create Reference Meteorological Year (RMY) climate data files.

Exemplary Weather and Energy Index

Since November 2014, the Exemplary Weather and Energy (EWE) Index has been published through the monthly e-newsletter, which has recently been converted into a blog where analysis highlighting interesting results for any of the 8 capital cities are presented. This helps the FMA industry understand how the RTY weather compares to the long-term average and the medium-term future climates.

Appropriately formatted RMY data is utilised each month to compare with the long-term average climate condition for those cities. RMYs (designated as RMY-A, B, or C depending on the weighting provided to the weather elements, with A having the maximum weighting given to solar irradiation) reflect the entirety of the weather data in a single synthetic year and offer a practical method for modelling building and energy systems (Lee, 2011). These RMY data are then used to calculate the EWE index for each specific location, comparing the performance of three archetypical buildings and a 5kW domestic solar PV system under these RTY weather conditions with the long-term average RMY and future climate EFMY conditions.

Archetypes shown in Figure 1, simulated in EnergyPlus™ to assess the building services energy consumptions, comprise a 3-storey office, a 10-storey office and a ground-level supermarket complying with the proposed Deemed to Satisfy measures of the NCC 2019 Section J. The EWE Index offers comment on peak loads, sensible and latent load and consumption distinctions, and N-E-S-W perimeter and central zone distinctions.

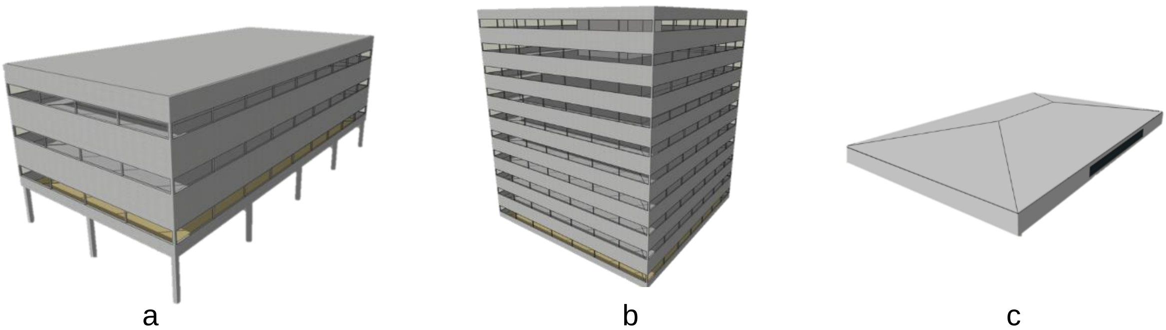

Figure 1. Graphical models of the archetypical buildings used in EWE simulations – a: 3-storey office building, b: 10-storey office building, c: Supermarket.

Further Enhancements - Precipitation

Precipitation data is important for a wide variety of applications. In this context, the AIRAH DA07 (AIRAH, 2020), Criteria for Moisture Control Design Analysis in Buildings, provides specifications for predicting, mitigating, or reducing moisture damage to buildings, and requires detailed consideration of wind-driven precipitation. In 2019, condensation minimum requirements were incorporated into the NCC, designed to control moisture impacts on occupant health, and enhanced in the NCC 2022.

Interestingly, several applications in the design and simulation of built environments require input of historical weather data, and the accuracy of these models increase proportionally with the resolution of the input weather data. Unfortunately, while verification by simulation is possible using accredited software such as WUFI®, there are no reliable datasets which include precipitation in Australia in a recognised format and adequate temporal resolution. The most significant challenge is that these types of tools require hourly or half-hourly datasets, but the historic observation data from the BOM's network only reported daily total of precipitation prior to the early 2000s, when more frequent data became more widely available (Kodagoda et al, 2021).

Nevertheless, utilising older data can be arguably less representative of the current and evolving climate, which suggest that focus on more recent years will improve relevance - suggesting discarding the data before the early 2000's, characterising the climate utilising only the period for which half-hourly data is available.

Furthermore, we want to describe the eXtreme Meteorological Years (XMY) in precipitation in the same way we are characterising XMYs for building HVAC (APSRC, 2022), to better understand moisture management under acute circumstances. Preliminary analysis of the data used by LAROS Technologies on the recommendation of WUFI® (sourced from Meteonorm) showed a wide variance in the data that is currently used for this purpose, thus further justifying our work – apparent characteristics of this data are shown in the following table

Table 1 Precipitation Data for Canberra – Meteonorm cf BOM.

Meteonorm		**BOM (1990 – 2015)**	
Rain Days	Annual Precipitation	Mean Rain Days	Mean Annual Precipitation
161	494 mm	101.2	592.8 mm

Further developments aim to delve into the historic data in order to develop analytical techniques for precipitation XMY, working with colleagues from University of Tasmania, AIRAH and LAROS Technologies.

Further Enhancements – Cloud Cover

Lastly, while cloud cover data is already in ACDB, TMY2 and EPW files, these values are often estimated utilising the satellite-derived solar data and the ASHRAE clear sky model, thus inferring the cloud cover in oktas[1], based on the resulting clear sky index. To improve on these, we are comparing different estimates of cloud cover (e.g., manual observations, ceilometer observations, clear-sky inferred values) to provide more reliable cloud cover data for the whole range of weather and climate data services.

References

Lee T., 2011, 'Climate data for building optimisation in design and operation in Australia', *Proceedings of Building Simulation 2011: 12th Conference of International Building Performance Simulation Association*, 14-16 November, Sydney

Kodagoda C, Mahmoodi M, Hameed N and Lee T, 2021, 'Updating Australia's Reference Meteorological Years with the Addition of Hourly Precipitation Data', *Asia-Pacific Solar Research Conference 2021,* 16-17 December, Sydney

APSRC, 2022, Tan H. J., Lee T. and Ferrari D., *'Extreme Climate Data Files for Design Resilience', unpublished article.*

AIRAH, August 2020, *'DA07 Criteria for Moisture Control Design Analysis in Buildings',* Design Application Manual.

ASHRAE, 2021, *'Handbook of Fundamentals'*, American Society of Heating, Refrigeration and Airconditioning Engineers, Atlanta, USA.

[1]The cloud cover is estimated in terms of how many eights of the sky are covered in cloud, where 0 is referred to a complete clear sky and 8 to a completely overcast sky