Enhancing Australia's Weather and Climate Data for Benchmarking Simulations

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Enhancing Australian Weather and Climate Data Services

In this presentation:

- Background: available climate and weather data sets
- Recent improvements: real-time data sources, inclusion of precipitation, and enhanced cloud cover estimates
- Applications: real-time years and benchmarking simulations

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Background: Weather and Climate Data

- **Weather** is what you actually get, got or are forecast to get
- **Climate** is what you expect to get, inferred from a long enough record of actual weather
- Our climate data is inferred from the 33 years 1990 to 2022, or
- Our “Industry Standard” climate data is inferred from the 26 years 1990 to 2015, or
- Our current climate data is inferred from the 15 years 2007 to 2022
- See Ferrari et al for a discussion of these three options

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Background: Weather and Climate Data Tools for Design Resilience and Facility Management

- Historical weather and the Australian Climate Data Bank (ACDB)
- Reference Meteorological Years (RMY)
- Typical Meteorological Years (TMY)
- Real-Time (meteorological) Years (RTY)
- The Exemplary Weather and Energy (EWE) Index
- eXtreme Meteorological Years (XMY)
- Ersatz Future Meteorological Years (EFMY)
- Industry Standard Meteorological Years (ISMY)

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Background: Weather and Climate Data Tools for Design Resilience and Facility Management

- Data sets include weather elements solar (GHI, DNI, DIF), Humidity, Wind Speed and Direction, Cloud Cover, Temperature and Pressure; can be provided in at least 3 formats for over 250 locations:
  - TMY2 - columnar format which contains time-series meteorological measurements and modelled or measured solar radiation values
  - EPW - text-based comma separated value (CSV) developed for use with simulation programs such as EnergyPlus and ESP-r.
  - ACDB - hourly record of 60-character columns produced in the specific format now only used for the Nationwide House Energy Rating Scheme (NatHERS).
- TMY2 and EPW record solar, cloud and precipitation 60 minutes before the time stamp
- ACDB records solar, cloud and precipitation 60 minutes centred on the time stamp

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Background: Weather and Climate Data Tools for Design Resilience and Facility Management

- Applications: estimating future energy performance, building tuning and commissioning, monitoring and verification of performance, estimating peak load and modelling moisture flows in building components
- Our work in developing XMY_{HVAC} datasets showed a clear trend of increasing average cooling load over 33 years – indicative of a warming climate
- It is imperative to incorporate likely future increase in cooling loads due to climate change into building energy simulations, highlighting the need for accurate and up-to-date weather and climate files

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Recent Improvements (One): Real-Time Data Sources

- To provide the latest weather data to clients, we subscribe to two sources for terrestrial observations and solar satellite data:
  - Solcast's global solar database is utilised for solar satellite data, which uses high-resolution (1-2 km) imagery from a range of geostationary meteorological satellites.
  - the BOM's terrestrial observations and gridded solar data are accessed for other less time-sensitive applications, allowing us to produce weather data time series in various formats to cover the period 1990-2022 for over 250 Australian locations and to create Reference Meteorological Year (RMY) climate data files

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Recent Improvements (One): Real-Time Data Service

- All eight capital cities
- All three data formats: ACDB, TMY2 and EPW
- Trailing 12 months updated monthly:
  - Available for just the immediate past 12 months, or
  - As a discounted annual subscription for 12 monthly updates
- Discounts available for all weather and climate data:
  - for academic and unfunded research work – 50%
  - for members of kindred organisations (e,g. SUHO, APVI) 10%
- Sales portal at https://exemplary.energy/data-purchase/

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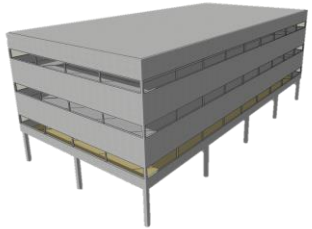
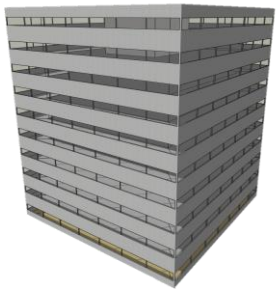
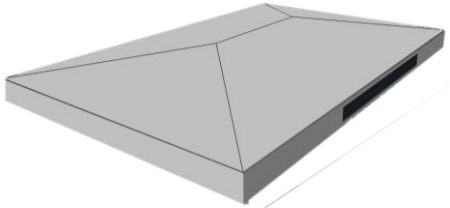
RTY Applications: EWEI
Exemplary Weather and Energy Index

- A monthly free public service published through the “Exemplary Advances” e-newsletter since November 2014 and on our blog since October 2021, to understand how the RTY weather compares with the long-term average (RMY) and the medium-term future (EFMY-2050) climates.
- This service benchmarks three archetype commercial buildings compliant with the current NCC (a 3-storey office building, a 10-storey office building and a ground-level supermarket) and a 5kW solar PV system all compared with RMY conditions.







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RTY Applications: EWEI
Exemplary Weather and Energy Index

- Building services energy consumptions (primarily heating and cooling) are compared by simulating these building models in EnergyPlus.
- Current PV owners can monitor their system performance against our benchmark to identify underperformance and take early corrective actions
- Prospective PV owners can get an idea of how much energy production they can expect to help in making a better-informed decision.
- Similarly, Green Star, SmartScore, NatHERS and NABERS rated building owners can also compare their heating and cooling energy utilisations against our simulated benchmarks or their own specific simulations and conduct corrective actions if their building is underperforming

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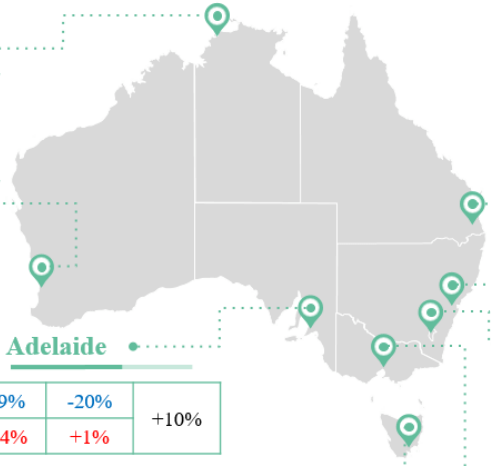
Applications: the Exemplary Weather and Energy Index – Results for all 8 Capitals

Energy index– actual October relative to climate-file October



Darwin

	10-storey	3-storey	S'market	Solar PV
Cooling	+13%	+13%	+3%	+1%
Heating	N.A.	N.A.	N.A.	

Perth

+62%	+52%	+83%	+12%
-92%	-91%	-75%	

Adelaide

-34%	-29%	-20%	+10%
+12%	+24%	+1%	

Hobart

+25%	+24%	+5%	+2%
-55.0%	-52.7%	-3.2%	

Brisbane

+16%	+14%	+19%	+0.0%
-54%	-75.0%	-51%	

Sydney

+37%	+37%	+23%	+17%
-18%	-28%	-10%	

Canberra

+35.5%	+30.0%	+13%	+7%
-13%	-7%	-7.0%	

Melbourne

-11%	-13%	-62%	-4%
+10%	+4%	+78%	

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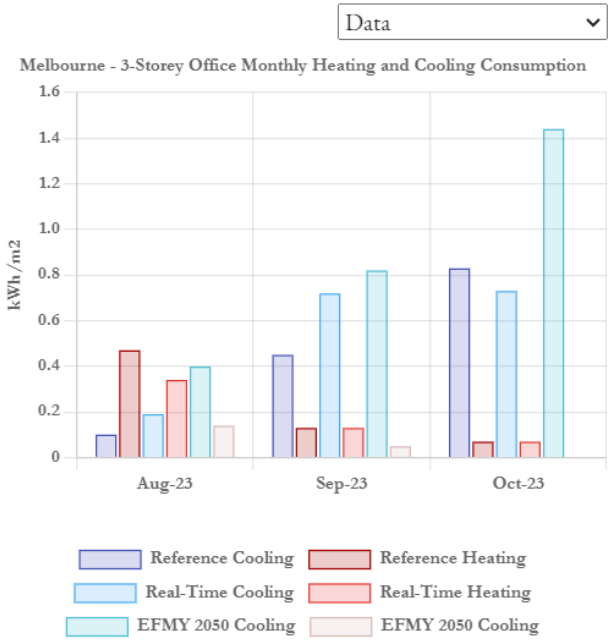
Applications: the Exemplary Weather and Energy Index – Results (continued)

MELBOURNE

Energy Index (%)

10-storey		3-storey		Supermarket	
Heating	Cooling	Heating	Cooling	Heating	Cooling
+10.2	-11.3	+3.8	-12.7	+77.8	-62.4
Solar PV					
-3.5%					

The solar PV simulation output results were 3.5% lower than the long-term average. For the supermarket archetype, cooling and heating energy consumptions were 62.4% lower and 77.8% higher respectively.



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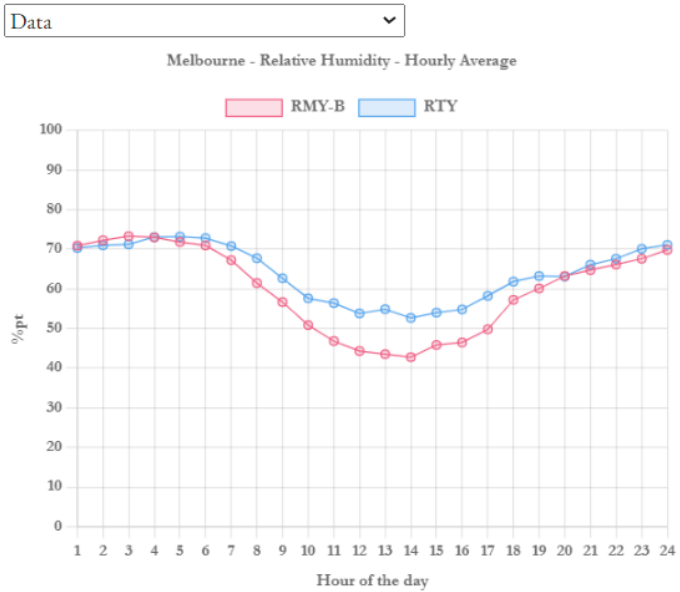
Applications: the Exemplary Weather and Energy Index – Results (continued)



Melbourne experienced a more humid and warmer October compared to the long-term average. The GHI was slightly higher than average in the afternoons only.

Weather Index

Temperature (°C)		
Mean Min	Mean Avg	Mean Max
-0.8	-0.5	-0.8

Relative Humidity (%pt)		
Mean Min	Mean Avg	Mean Max
+7	+4.2	+4.9

Daily Solar Irradiation (GHI %)		
Cloudiest	Mean	Sunniest
-59.9	+0.8	+1.6

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Recent Improvements (Two): Precipitation

- Accurate precipitation data is important across a wide range of applications:
  - The Australian Institute of Refrigeration, Airconditioning and Heating (AIRAH) provides specifications for predicting, mitigating and reducing moisture damage to buildings
  - Minimum condensation-prevention requirements designed to control moisture impacts on occupant health and building durability were incorporated into the National Construction Code (NCC) in 2019
- No prior datasets which include actual precipitation in Australia in a recognised format and adequate resolution; values from the BOM were mostly observed and reported as daily totals prior to early 2000s
- Collaboration with University of NSW, University of Tasmania and AIRAH to estimate half-hourly precipitation data in our weather and climate data sets

Recent Improvements (Three): Cloud Cover

- Values of cloud cover in ACDB, TMY2 and EPW files are often estimated by utilising the satellite-derived solar data and the ASHRAE clear sky model (inherently unreliable through the night)
- We compared 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
- Our in-house software "ClimateCypher" now utilises half-hourly ceilometer data from the BOM for cloud cover in eighths of the sky (oktas) and in Meteorological Aerodrome Reports (MetAR)
- Rigorous QA process to ensure accuracy and reliability of our weather data, and also allows for peer review and feedback to our data providers (in this case, the BOM)

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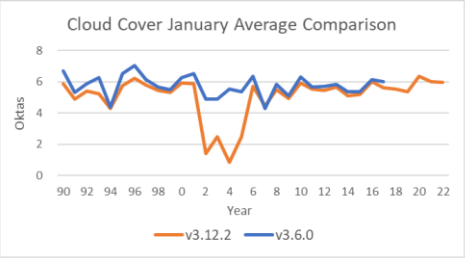
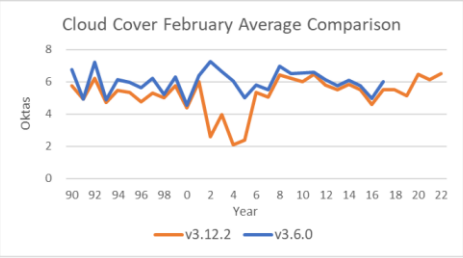
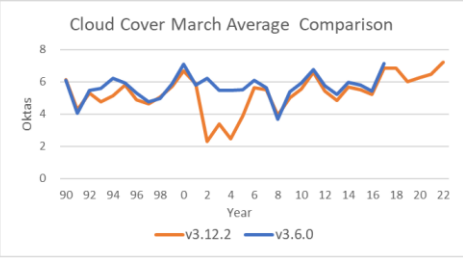
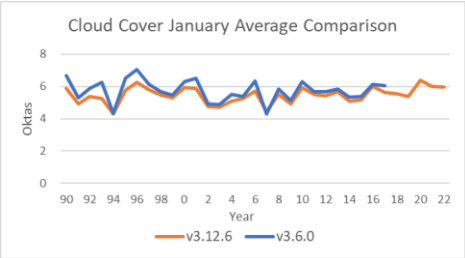
Recent Improvements (Three): Cloud Cover

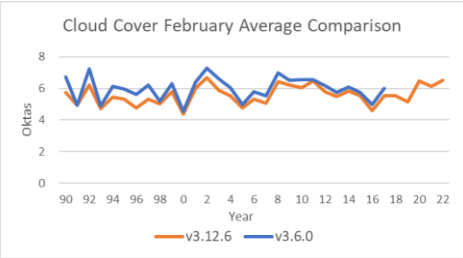


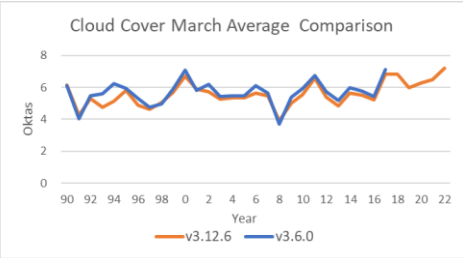




Comparison of cloud cover output data for Sydney from 1990-2022 with the version of our software used for the 2017 production run revealed aberrant cloud cover estimates originating from the raw data obtained by the BOM







The improved cloud cover output for Sydney for the 1990-2022 period after adjustment to our code to work around the problem in the raw data

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Thank You!

Questions?

Please send additional questions, feedback or comments to:

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