



# THE **FUTURE** OF **HVAC** 2013

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*Developing HVAC Design Conditions for  
Australian Locations with Hourly  
Meteorological Data*

**by Eric L. Peterson and J. Ben Liley**

# Developing HVAC Design Conditions for Australian Locations with Hourly Meteorological Data

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Funded by the Commonwealth Department of Resources, Energy and Tourism (DRET)

# mid-20th-century design temperatures

## AIRAH DA09 Load Estimation *update*

- Australian HVAC system design data website

***<http://uq.id.au/e.peterson/>***

increases coverage of HVAC design data by exploiting the Australian Climate Data Bank (ACDB), being a set of 80 high quality annals of hourly meteorological data spanning 45 years (since 1967) by Liley, Nagle & Grant [1].

1. ***Australian climate data for building energy simulation***, AIRAH Building Simulation Workshop Melbourne April 18, 2013.

# ***Australian HVAC system design data:*** mid-21<sup>st</sup>-century design temperatures

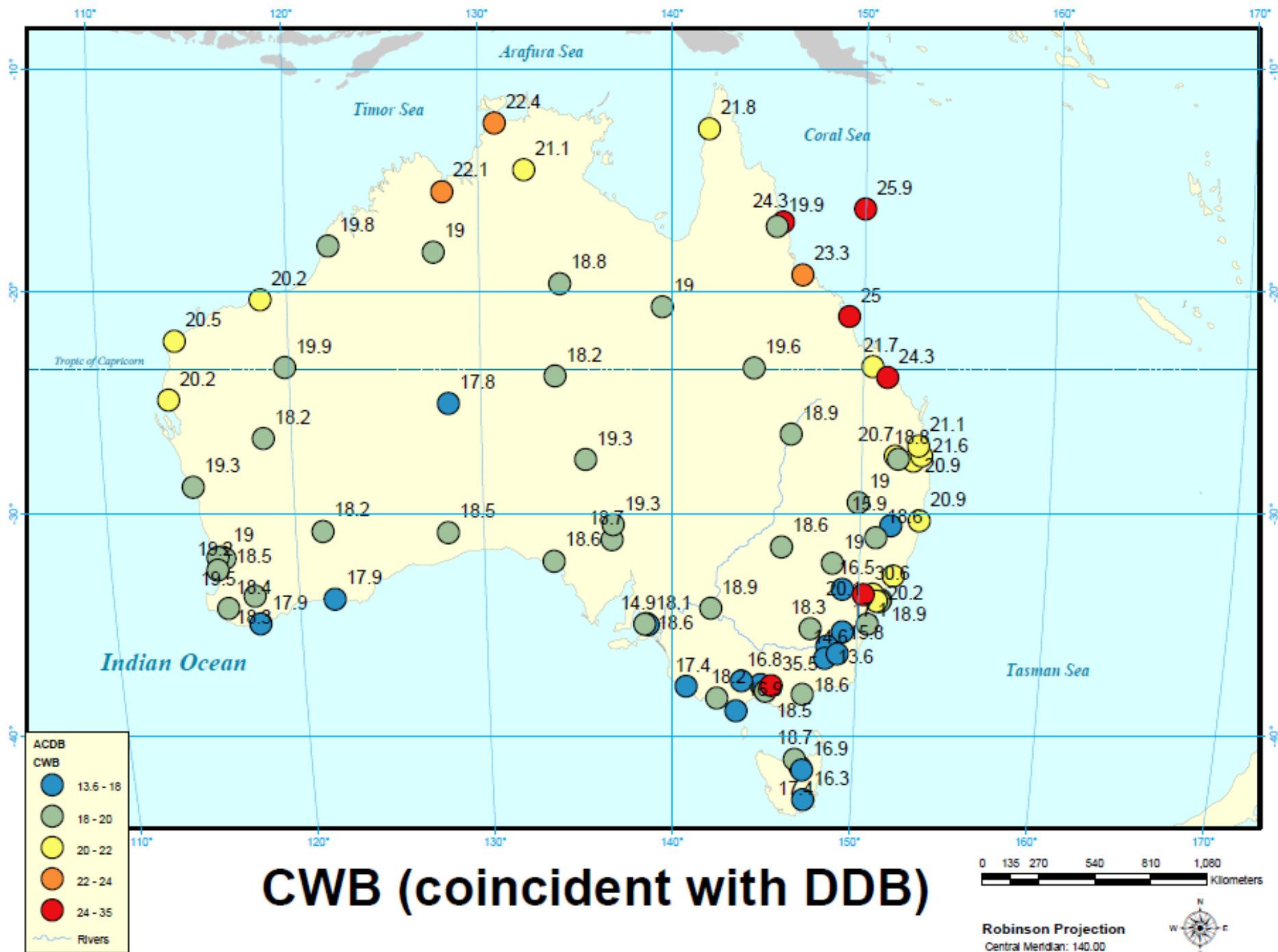
- Provides HVAC Engineers with design data to detail the current climate at 80 key locations, and track local changes with respect to the past 45 years in order to inform likely conditions mid-century-21 (circa year 2050).
- Method could be adapted to increase coverage to 540 locations with Bureau of Meteorology automatic weather station data since 2000 and patched point dataset (PPD) since 1889.

# Key gains from the ACDB

- DA9 includes 46 hourly stations that are covered by the ACDB (providing validation).
- ACDB adds the most recent 25 years since the Australian Bicentennial (climate change).
- ACDB adds 34 hourly stations to the set established by DA9 (greater spatial span).
- ACDB provides coincident solar radiation data as well as wet and dry bulb values.







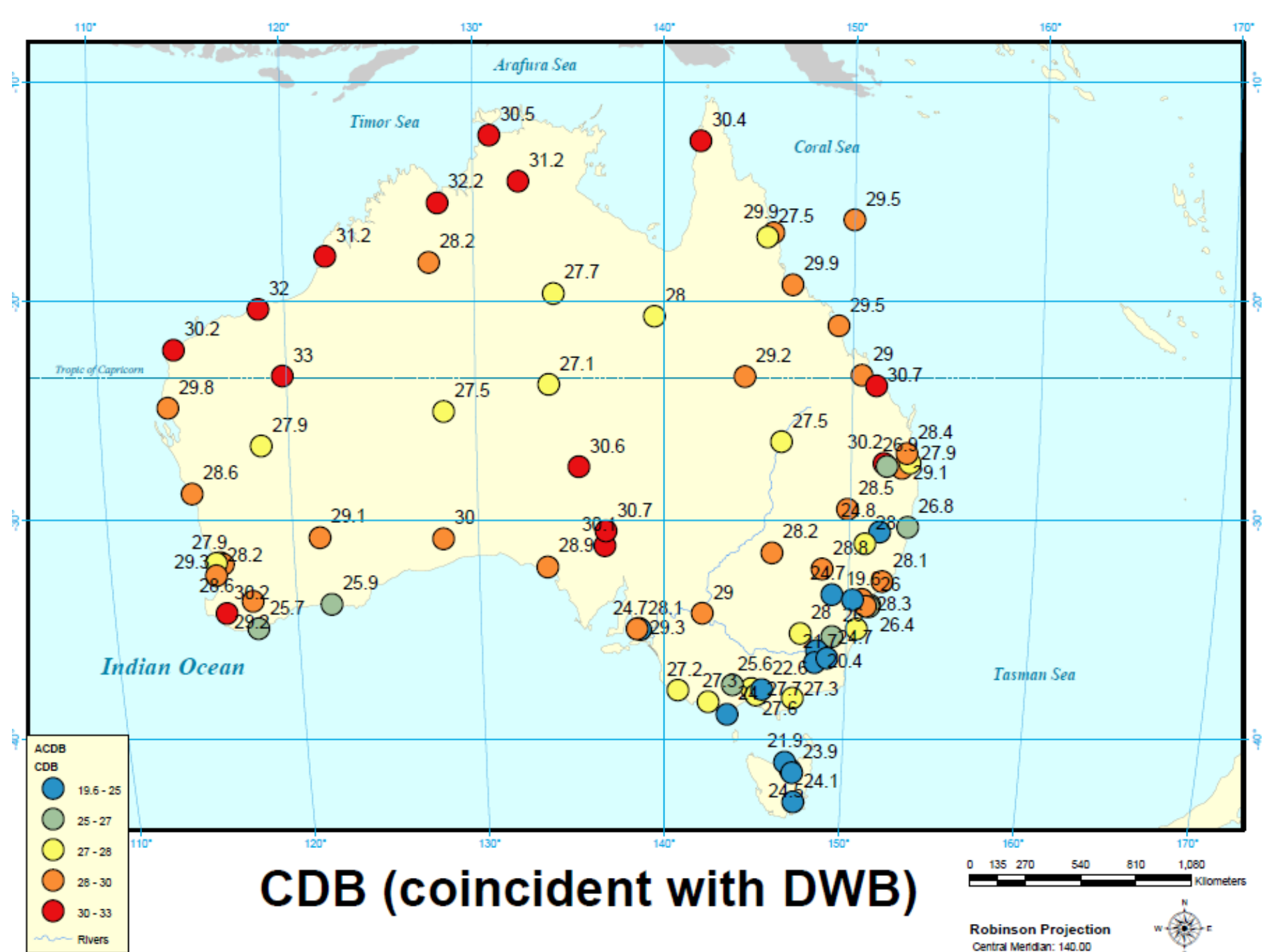
# Abridged results from

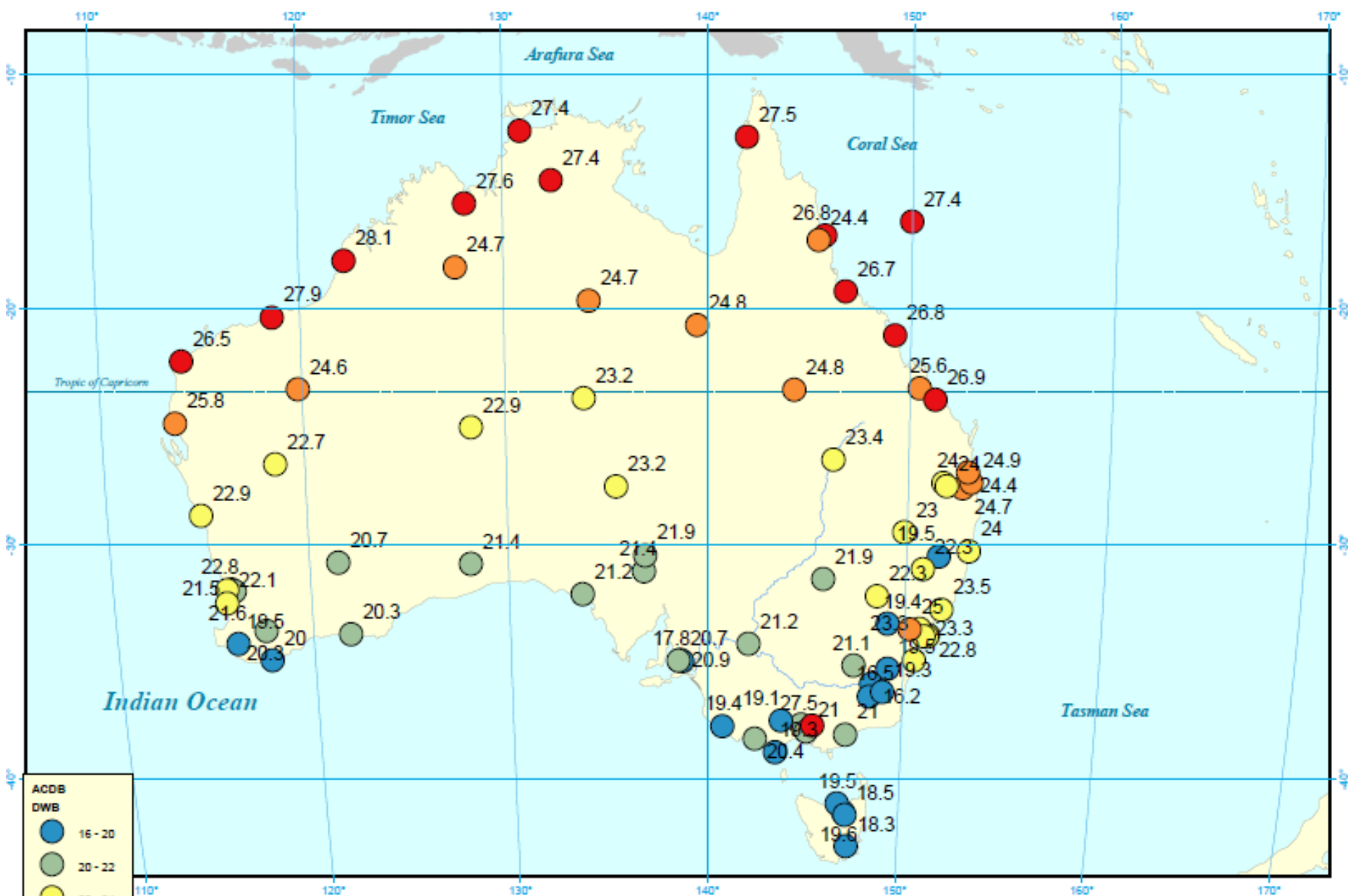
<http://uq.id.au/e.peterson/>

> link to “ACDB Table 1”

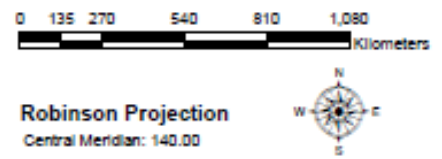
| LOCATION              | Opt 1 Dry   | Opt 2 Wet   | 24 hour   | 8am-6pm   |
|-----------------------|-------------|-------------|-----------|-----------|
|                       | DDB / CWB   | CDB / DWB   | DB / WB   | DB / WB   |
| Darwin (airport) DA   | 34.7 / 22.4 | 30.5 / 27.4 | 34.3/27.2 | 34.8/27.3 |
| Brisbane (airport) BR | 31.6 / 21.6 | 27.9 / 24.9 | 31.6/25.1 | 32.8/25.4 |
| Perth (airport) PE    | 38.2 / 19.0 | 29.3 / 21.5 | 38.3/21.9 | 39.8/22.3 |
| Adelaide (CBD) AD     | 38.0 / 18.6 | 29.3 / 20.9 | 38.3/21.4 | 39.7/21.8 |
| Sydney (Obs Hill) SY  | 31.9 / 19.1 | 26.0 / 22.6 | 32.6/23.0 | 34.7/23.3 |
| Melbourne (CBD) ME    | 35.5 / 18.2 | 27.5 / 20.3 | 36.0/20.7 | 37.7/21.0 |
| Canberra (airport) CA | 34.6 / 17.1 | 26.0 / 19.5 | 34.5/19.8 | 35.9/20.2 |
| Hobart (CBD) HO       | 28.3 / 16.3 | 24.1 / 18.3 | 29.5/18.7 | 31.6/19.1 |
| Tullamarine (MEL) TU  | 35.4 / 17.8 | 27.6 / 20.4 | 36.0/20.5 | 38.0/20.9 |
|                       | comfort     | comfort     | critical  | critical  |







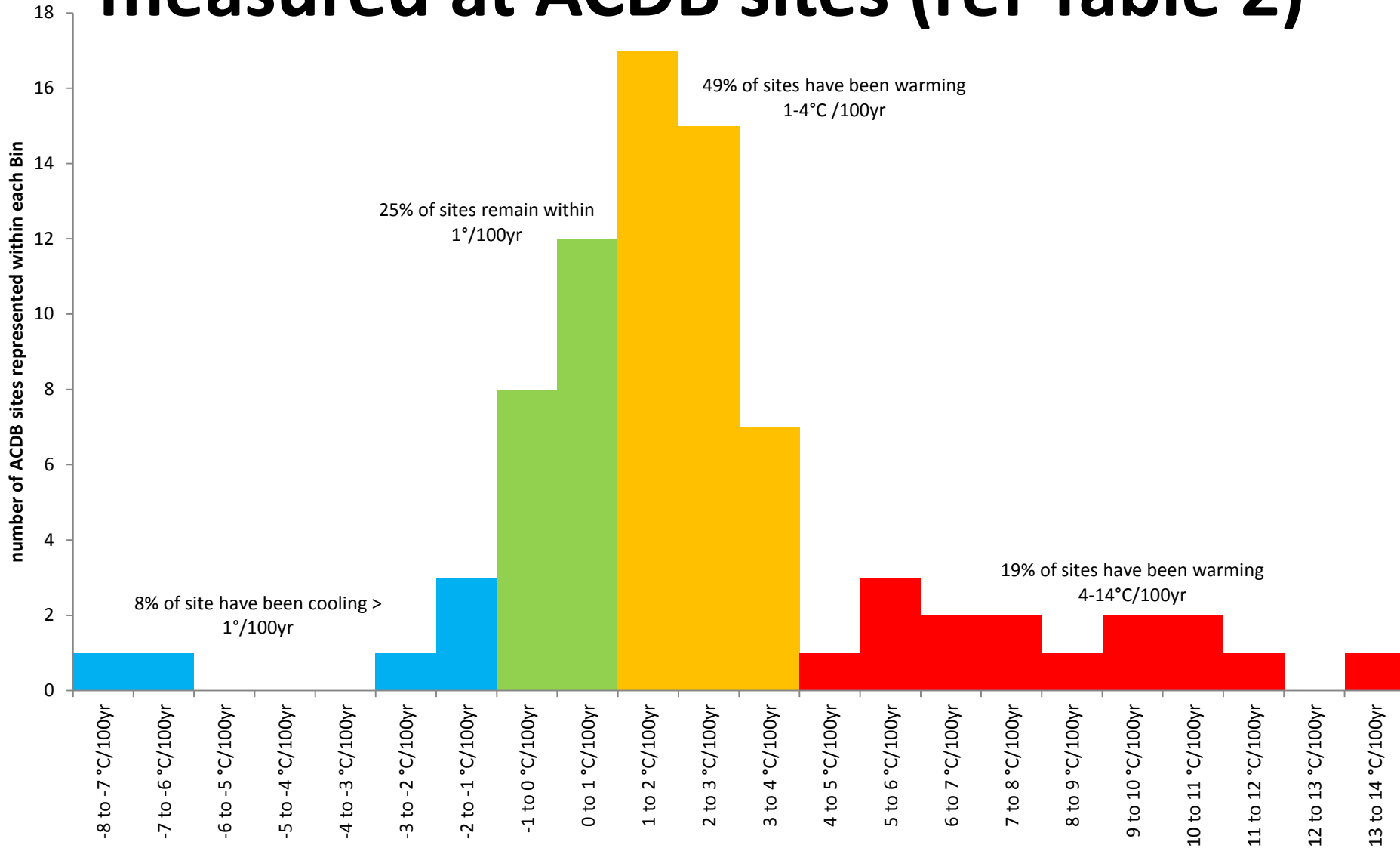
**DWB (10 days pa incl std dev)**

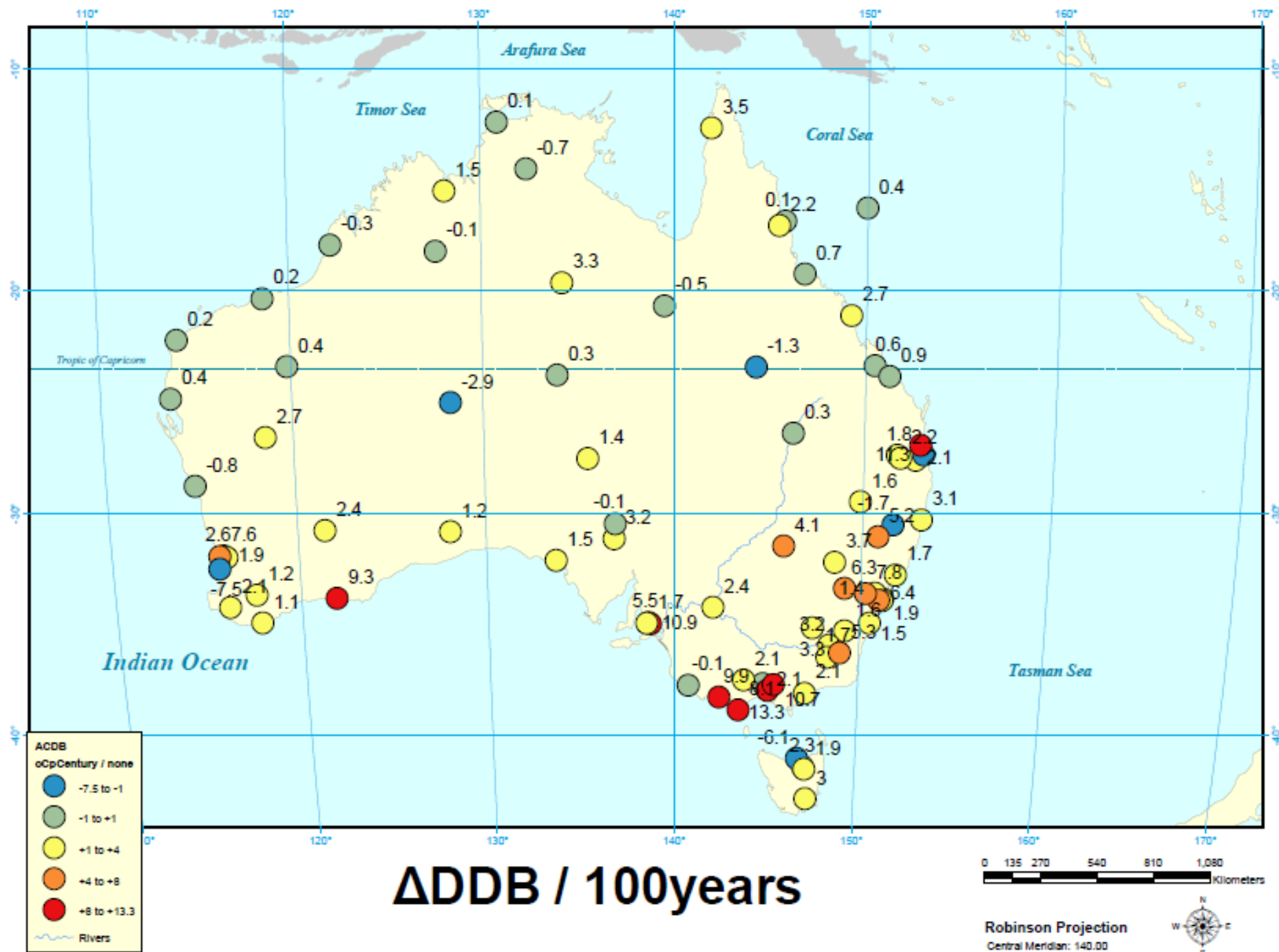


# Table 1: ACDB output in DA9 format

| ID | LOCATION                     |       | Option 1 Dry summer  |  | Option 2 Wet summer  |  | 24 hour<br>0.25% | 8AM-6PM<br>0.25% | Winter(8AM) | 24 hour<br>0.25% | 8AM-6PM<br>0.25% | Elev   | Lat    | Long   | Daily   | Yearly  | Data      |
|----|------------------------------|-------|----------------------|--|----------------------|--|------------------|------------------|-------------|------------------|------------------|--------|--------|--------|---------|---------|-----------|
|    |                              |       | design DB / coinc WB |  | coinc DB / design WB |  | DB / WB          | DB / WB          | comfort     | critical         | critical         | (m)    | (o)    | (o)    | Range   | Range   | Years     |
| 1  | Darwin                       | DA    | 34.7 DDB / 22.4 CWB  |  | 30.5 CDB / 27.4 DWB  |  | 34.3/27.2        | 34.8/27.3        | 16.8 DB     | 16.7 DB          | 18.3 DB          | 35.0   | -12.42 | 130.89 | 6.9 DB  | 17.9 DB | 1967-2011 |
| 2  | Pt Hedland                   | HE    | 42.0 DDB / 20.2 CWB  |  | 32.0 CDB / 27.9 DWB  |  | 41.5/27.8        | 42.8/28.0        | 11.0 DB     | 9.5 DB           | 15.2 DB          | 8.4    | -20.37 | 118.63 | 14.9 DB | 31.0 DB | 1967-2011 |
| 3  | Longreach                    | LO    | 41.5 DDB / 19.6 CWB  |  | 29.2 CDB / 24.8 DWB  |  | 41.2/24.8        | 42.0/25.1        | 3.5 DB      | 3.1 DB           | 6.8 DB           | 192.5  | -23.44 | 144.28 | 13.7 DB | 38.0 DB | 1967-2011 |
| 4  | Carnarvon                    | CR    | 38.4 DDB / 20.2 CWB  |  | 29.8 CDB / 25.8 DWB  |  | 37.9/25.7        | 39.7/25.9        | 7.8 DB      | 7.6 DB           | 10.9 DB          | 8.0    | -24.89 | 113.67 | 11.3 DB | 30.6 DB | 1967-2011 |
| 5  | Townsville                   | TO    | 33.8 DDB / 23.3 CWB  |  | 29.9 CDB / 26.7 DWB  |  | 33.7/26.7        | 35.0/26.9        | 10.9 DB     | 9.3 DB           | 14.5 DB          | 9.1    | -19.25 | 146.77 | 6.0 DB  | 22.9 DB | 1967-2011 |
| 6  | Alice Springs                | AL    | 41.0 DDB / 18.2 CWB  |  | 27.1 CDB / 23.2 DWB  |  | 40.6/23.3        | 41.4/23.4        | -0.4 DB     | -0.6 DB          | 2.9 DB           | 547.0  | -23.80 | 133.89 | 12.2 DB | 41.4 DB | 1967-2011 |
| 7  | Rockhampton                  | RO    | 36.1 DDB / 21.7 CWB  |  | 29.0 CDB / 25.6 DWB  |  | 35.8/25.6        | 37.1/25.8        | 6.7 DB      | 5.4 DB           | 10.0 DB          | 15.1   | -23.38 | 150.48 | 10.9 DB | 29.4 DB | 1967-2011 |
| 8  | Moree                        | MO    | 37.9 DDB / 19.0 CWB  |  | 28.5 CDB / 23.0 DWB  |  | 37.8/23.1        | 39.0/23.5        | 0.3 DB      | 0.1 DB           | 3.7 DB           | 218.5  | -29.49 | 149.85 | 13.0 DB | 37.6 DB | 1967-2011 |
| 9  | Amberley                     | AM    | 35.7 DDB / 20.9 CWB  |  | 29.1 CDB / 24.7 DWB  |  | 35.4/24.8        | 36.9/25.1        | 1.2 DB      | 0.5 DB           | 5.8 DB           | 31.0   | -27.63 | 152.71 | 11.3 DB | 34.5 DB | 1967-2011 |
| 10 | Brisbane                     | BR    | 31.6 DDB / 21.6 CWB  |  | 27.9 CDB / 24.9 DWB  |  | 31.6/25.1        | 32.8/25.4        | 6.9 DB      | 5.6 DB           | 10.0 DB          | 9.5    | -27.39 | 153.13 | 7.6 DB  | 24.7 DB | 1967-2011 |
| 11 | Coffs Harbour                | CH    | 30.4 DDB / 20.9 CWB  |  | 26.8 CDB / 24.0 DWB  |  | 30.5/24.0        | 32.1/24.3        | 4.7 DB      | 3.4 DB           | 8.3 DB           | 6.0    | -30.31 | 153.12 | 6.6 DB  | 25.7 DB | 1967-2011 |
| 12 | Geraldton                    | GE    | 39.9 DDB / 19.3 CWB  |  | 28.6 CDB / 22.9 DWB  |  | 39.7/23.1        | 41.1/23.3        | 6.3 DB      | 5.0 DB           | 8.6 DB           | 35.0   | -28.80 | 114.70 | 14.9 DB | 33.6 DB | 1967-2011 |
| 13 | Perth                        | PE    | 38.2 DDB / 19.0 CWB  |  | 29.3 CDB / 21.5 DWB  |  | 38.3/21.9        | 39.8/22.3        | 4.4 DB      | 3.5 DB           | 6.9 DB           | 20.0   | -31.93 | 115.98 | 14.1 DB | 33.8 DB | 1967-2011 |
| 14 | Armidale (old Tamworth)      | AA    | 31.2 DDB / 15.9 CWB  |  | 24.8 CDB / 19.5 DWB  |  | 30.9/19.2        | 32.1/19.8        | -0.9 DB     | -2.4 DB          | 1.0 DB           | 1079.6 | -30.53 | 151.62 | 11.2 DB | 32.1 DB | 1967-2011 |
| 15 | Williamstown                 | WE    | 35.4 DDB / 20.3 CWB  |  | 28.1 CDB / 23.5 DWB  |  | 35.7/23.7        | 37.7/24.2        | 4.4 DB      | 3.0 DB           | 6.5 DB           | 8.0    | -32.79 | 151.84 | 12.8 DB | 31.0 DB | 1967-2011 |
| 16 | Adelaide                     | AD    | 38.0 DDB / 18.6 CWB  |  | 29.3 CDB / 20.9 DWB  |  | 38.3/21.4        | 39.7/21.8        | 4.6 DB      | 4.0 DB           | 6.2 DB           | 51.0   | -34.92 | 138.62 | 10.7 DB | 33.4 DB | 1967-2011 |
| 17 | Sydney RO (Observatory Hill) | SY    | 31.9 DDB / 19.1 CWB  |  | 26.0 CDB / 22.6 DWB  |  | 32.6/23.0        | 34.7/23.3        | 6.8 DB      | 6.6 DB           | 7.6 DB           | 40.2   | -33.86 | 151.21 | 9.5 DB  | 25.1 DB | 1967-2011 |
| 18 | Nowra                        | NO    | 33.7 DDB / 19.2 CWB  |  | 27.2 CDB / 22.7 DWB  |  | 34.2/22.9        | 36.5/23.5        | 4.9 DB      | 3.9 DB           | 6.4 DB           | 105.0  | -34.95 | 150.54 | 12.4 DB | 28.8 DB | 1967-2011 |
| 19 | Charleville                  | CV    | 39.8 DDB / 18.9 CWB  |  | 27.5 CDB / 23.4 DWB  |  | 39.6/23.5        | 40.5/23.7        | 0.1 DB      | -0.2 DB          | 4.0 DB           | 303.3  | -26.41 | 146.26 | 12.0 DB | 39.7 DB | 1967-2011 |
| 20 | Wagga                        | WA    | 37.8 DDB / 18.3 CWB  |  | 28.0 CDB / 21.1 DWB  |  | 38.0/21.4        | 39.2/21.8        | -1.0 DB     | -1.0 DB          | 0.6 DB           | 213.0  | -35.16 | 147.46 | 13.9 DB | 38.8 DB | 1967-2011 |
| 21 | Melbourne                    | RO ME | 35.5 DDB / 18.2 CWB  |  | 27.5 CDB / 20.3 DWB  |  | 36.0/20.7        | 37.7/21.0        | 3.9 DB      | 3.3 DB           | 4.3 DB           | 32.2   | -37.81 | 144.97 | 11.6 DB | 31.6 DB | 1967-2011 |
| 22 | East Sale                    | SE    | 33.8 DDB / 18.6 CWB  |  | 27.3 CDB / 21.0 DWB  |  | 34.4/21.0        | 36.6/21.6        | -0.3 DB     | -0.6 DB          | 0.8 DB           | 8.2    | -38.12 | 147.13 | 14.5 DB | 34.1 DB | 1967-2011 |
| 23 | Launceston (Ti Tree Bend)    | LT    | 28.4 DDB / 17.4 CWB  |  | 24.5 CDB / 19.6 DWB  |  | 28.7/19.6        | 30.0/20.3        | -0.6 DB     | -0.7 DB          | -0.3 DB          | 5.0    | -41.42 | 147.12 | 10.2 DB | 29.0 DB | 1981-2011 |
| 24 | Canberra                     | CA    | 34.6 DDB / 17.1 CWB  |  | 26.0 CDB / 19.5 DWB  |  | 34.5/19.8        | 35.9/20.2        | -4.0 DB     | -4.0 DB          | -2.0 DB          | 580.0  | -35.31 | 149.20 | 15.7 DB | 38.6 DB | 1967-2011 |
| 25 | Cabramurra (old Alpine)      | CM    | 25.5 DDB / 13.6 CWB  |  | 20.4 CDB / 16.2 DWB  |  | 25.6/16.2        | 26.9/16.7        | -3.3 DB     | -4.7 DB          | -3.8 DB          | 1482.4 | -35.94 | 148.38 | 7.7 DB  | 28.8 DB | 1967-2011 |
| 26 | Hobart                       | HO    | 28.3 DDB / 16.3 CWB  |  | 24.1 CDB / 18.3 DWB  |  | 29.5/18.7        | 31.6/19.1        | 2.2 DB      | 1.7 DB           | 2.4 DB           | 51.4   | -42.89 | 147.33 | 9.6 DB  | 26.1 DB | 1967-2011 |
| 27 | Mildura                      | MI    | 39.8 DDB / 18.9 CWB  |  | 29.0 CDB / 21.2 DWB  |  | 40.1/21.9        | 41.4/22.2        | 0.7 DB      | 0.7 DB           | 2.0 DB           | 52.8   | -34.24 | 142.09 | 14.9 DB | 39.1 DB | 1967-2011 |
| 28 | Richmond                     | RI    | 37.5 DDB / 20.1 CWB  |  | 29.2 CDB / 23.3 DWB  |  | 37.4/23.4        | 39.0/23.9        | -0.3 DB     | -0.2 DB          | 2.1 DB           | 20.0   | -33.60 | 150.78 | 15.1 DB | 37.8 DB | 1967-2011 |
| 29 | Weipa                        | WP    | 36.5 DDB / 21.8 CWB  |  | 30.4 CDB / 27.5 DWB  |  | 35.9/27.3        | 36.3/27.6        | 16.6 DB     | 16.2 DB          | 19.5 DB          | 19.0   | -12.68 | 141.92 | 10.3 DB | 19.9 DB | 1967-2011 |
| 30 | Wyndham                      | WY    | 41.8 DDB / 22.1 CWB  |  | 32.2 CDB / 27.6 DWB  |  | 41.3/27.5        | 42.0/27.5        | 16.4 DB     | 12.3 DB          | 19.1 DB          | 4.3    | -15.51 | 128.15 | 10.2 DB | 25.4 DB | 1967-2011 |
| 31 | Willis Island                | WS    | 31.9 DDB / 25.9 CWB  |  | 29.5 CDB / 27.4 DWB  |  | 31.6/27.3        | 32.0/27.6        | 21.8 DB     | 20.9 DB          | 21.7 DB          | 8.1    | -16.29 | 149.97 | 3.9 DB  | 10.1 DB | 1967-2011 |
| 32 | Cairns                       | CN    | 33.3 DDB / 24.3 CWB  |  | 29.9 CDB / 26.8 DWB  |  | 33.2/26.6        | 34.2/26.8        | 13.9 DB     | 12.9 DB          | 16.4 DB          | 8.3    | -16.87 | 145.75 | 7.1 DB  | 19.4 DB | 1967-2011 |
| 33 | Broome                       | BM    | 38.6 DDB / 19.8 CWB  |  | 31.2 CDB / 28.1 DWB  |  | 38.1/28.1        | 39.3/28.2        | 12.3 DB     | 9.8 DB           | 16.1 DB          | 9.0    | -17.95 | 122.24 | 10.3 DB | 26.3 DB | 1967-2011 |
| 34 | Learmonth                    | LM    | 42.3 DDB / 20.5 CWB  |  | 30.2 CDB / 26.5 DWB  |  | 41.9/26.2        | 43.0/26.5        | 9.0 DB      | 8.5 DB           | 12.7 DB          | 5.5    | -22.24 | 114.10 | 15.4 DB | 33.3 DB | 1976-2011 |
| 35 | Mackay                       | MK    | 32.4 DDB / 25.0 CWB  |  | 29.5 CDB / 26.8 DWB  |  | 32.1/26.7        | 32.8/27.1        | 10.2 DB     | 9.1 DB           | 12.3 DB          | 36.3   | -21.12 | 149.22 | 5.7 DB  | 22.2 DB | 1967-2011 |
| 36 | Gladstone                    | GL    | 34.0 DDB / 24.3 CWB  |  | 30.7 CDB / 26.9 DWB  |  | 33.4/26.6        | 34.2/27.0        | 10.8 DB     | 10.4 DB          | 11.7 DB          | 75.2   | -23.86 | 151.26 | 8.1 DB  | 23.2 DB | 1967-2011 |
| 37 | Halls Creek                  | HA    | 41.1 DDB / 19.0 CWB  |  | 28.2 CDB / 24.7 DWB  |  | 40.6/24.6        | 41.3/24.6        | 11.9 DB     | 9.8 DB           | 13.8 DB          | 423.9  | -18.23 | 127.66 | 11.4 DB | 29.2 DB | 1967-2011 |
| 38 | Tennant Creek                | TE    | 40.6 DDB / 18.8 CWB  |  | 27.7 CDB / 24.7 DWB  |  | 40.4/24.5        | 41.0/24.5        | 9.0 DB      | 9.0 DB           | 10.3 DB          | 377.1  | -19.64 | 134.18 | 11.4 DB | 31.6 DB | 1967-2011 |
| 39 | Mt Isa                       | IS    | 40.6 DDB / 19.0 CWB  |  | 28.0 CDB / 24.8 DWB  |  | 40.3/24.6        | 41.0/24.6        | 4.9 DB      | 4.4 DB           | 8.9 DB           | 340.9  | -20.68 | 139.49 | 12.2 DB | 35.7 DB | 1967-2011 |
| 40 | Newman                       | NE    | 43.1 DDB / 19.9 CWB  |  | 33.0 CDB / 24.6 DWB  |  | 42.6/24.5        | 43.7/24.7        | 1.9 DB      | 1.3 DB           | 7.3 DB           | 524.5  | -23.42 | 119.80 | 11.8 DB | 41.2 DB | 1967-2011 |
| 41 | Giles                        | GI    | 40.9 DDB / 17.8 CWB  |  | 27.5 CDB / 22.9 DWB  |  | 40.7/23.0        | 41.3/23.0        | 3.9 DB      | 3.7 DB           | 4.9 DB           | 599.0  | -25.03 | 128.30 | 10.7 DB | 37.0 DB | 1979-2011 |
| 42 | Meekatharra                  | MT    | 42.0 DDB / 18.2 CWB  |  | 27.9 CDB / 22.7 DWB  |  | 41.7/23.0        | 42.4/23.0        | 5.0 DB      | 4.6 DB           | 7.4 DB           | 519.0  | -26.61 | 118.54 | 12.4 DB | 37.0 DB | 1967-2011 |
| 43 | Oodnadatta                   | OO    | 42.5 DDB / 19.3 CWB  |  | 30.6 CDB / 23.2 DWB  |  | 46.0/23.7        | 46.4/23.9        | 2.9 DB      | 3.0 DB           | 5.1 DB           | 117.0  | -27.56 | 135.45 | 12.6 DB | 39.6 DB | 1967-2011 |
| 44 | Kalgoorlie                   | KA    | 40.3 DDB / 18.2 CWB  |  | 29.1 CDB / 20.7 DWB  |  | 40.3/21.5        | 41.5/21.7        | 2.3 DB      | 1.5 DB           | 5.1 DB           | 370.1  | -30.79 | 121.45 | 14.8 DB | 38.0 DB | 1967-2011 |
| 45 | Woomera                      | WO    | 41.0 DDB / 18.7 CWB  |  | 30.1 CDB / 21.4 DWB  |  | 41.2/22.3        | 42.2/22.5        | 4.0 DB      | 3.9 DB           | 5.4 DB           | 168.5  | -31.16 | 136.81 | 13.7 DB | 37.0 DB | 1967-2011 |
| 46 | Cobar                        | CO    | 39.5 DDB / 18.6 CWB  |  | 28.2 CDB / 21.9 DWB  |  | 39.7/22.4        | 40.7/22.6        | 2.1 DB      | 2.0 DB           | 3.7 DB           | 263.6  | -31.48 | 145.83 | 12.7 DB | 37.4 DB | 1967-2011 |
| 47 | Bickley                      | BI    | 36.4 DDB / 18.5 CWB  |  | 28.6 CDB / 21.6 DWB  |  | 36.1/21.9        | 37.5/22.6        | 4.0 DB      | 3.5 DB           | 5.3 DB           | 384.0  | -32.01 | 116.14 | 14.5 DB | 32.4 DB | 1994-2011 |
| 48 | Dubbo                        | DU    | 37.9 DDB / 19.0 CWB  |  | 28.8 CDB / 22.3 DWB  |  | 37.7/22.6        | 39.0/23.1        | -0.7 DB     | -1.1 DB          | 1.5 DB           | 285.0  | -32.22 | 148.57 | 13.7 DB | 38.6 DB | 1967-2011 |
| 49 | Katanning                    | KT    | 36.9 DDB / 18.3 CWB  |  | 29.2 CDB / 20.3 DWB  |  | 37.0/20.7        | 38.5/21.2        | 3.1 DB      | 1.5 DB           | 4.6 DB           | 321.0  | -33.69 | 117.61 | 16.1 DB | 33.8 DB | 1967-2011 |
| 50 | Oakey                        | OA    | 35.3 DDB / 20.7 CWB  |  | 30.2 CDB / 24.0 DWB  |  | 34.9/24.0        | 36.1/24.1        | -1.4 DB     | -2.3 DB          | 3.3 DB           | 406.7  | -27.40 | 151.74 | 11.9 DB | 36.7 DB | 1967-2011 |
| 51 | Forrest                      | FO    | 41.4 DDB / 18.5 CWB  |  | 30.0 CDB / 21.4 DWB  |  | 41.6/21.8        | 43.0/22.2        | 3.4 DB      | 1.4 DB           | 6.9 DB           | 160.0  | -30.84 | 128.11 | 18.2 DB | 38.0 DB | 1967-2011 |
| 52 | Swanbourne                   | SW    | 37.3 DDB / 19.5 CWB  |  | 27.9 CDB / 22.8 DWB  |  | 36.6/23.2        | 38.1/23.7        | 6.0 DB      | 5.7 DB           | 7.6 DB           | 41.0   | -31.96 | 115.76 | 12.0 DB | 31.3 DB | 1994-2011 |
| 53 | Ceduna                       | CE    | 40.4 DDB / 18.6 CWB  |  | 28.9 CDB / 21.2 DWB  |  | 40.6/21.6        | 42.2/22.1        | 1.8 DB      | 1.3 DB           | 4.1 DB           | 15.7   | -32.13 | 133.70 | 15.5 DB | 38.6 DB | 1967-2011 |
| 54 | Mandurah                     | MD    | 36.2 DDB / 19.2 CWB  |  | 28.2 CDB / 22.1 DWB  |  | 36.1/22.3        | 37.4/22.6        | 6.5 DB      | 5.2 DB           | 7.9 DB           | 3.5    | -32.52 | 115.71 | 12.6 DB | 29.7 DB | 1988-2011 |
| 55 | Esperance                    | EP    | 35.3 DDB / 17.9 CWB  |  | 25.9 CDB / 20.3 DWB  |  | 35.4/20.6        | 38.0/21.0        | 6.4 DB      | 5.6 DB           | 7.7 DB           | 27.0   | -33.83 | 121.89 | 14.9 DB | 28.9 DB | 1967-2011 |
| 56 | Mascot (Sydney Airport)      | MA    | 33.3 DDB / 18.9 CWB  |  | 26.4 CDB / 22.8 DWB  |  | 34.0/22.9        | 36.0/23.2        | 5.0 DB      | 5.0 DB           | 7.0 DB           | 5.0    | -33.94 | 151.17 | 10.1 DB | 28.3 DB | 1967-2011 |
| 57 | Manjimup                     | MJ    | 33.9 DDB / 18.4 CWB  |  | 30.2 CDB / 19.5 DWB  |  | 34.0/19.2        | 35.6/19.8        | 4.5 DB      | 2.2 DB           | 5.4 DB           | 287.2  | -34.25 | 116.15 | 13.2 DB | 29.4 DB | 1967-2011 |
| 58 | Albany                       | AB    | 31.4 DDB / 17.9 CWB  |  | 25.7 CDB / 20.0 DWB  |  | 32.1/20.2        | 34.7/20.8        | 4.9 DB      | 4.1 DB           | 6.6 DB           | 69.0   | -34.94 | 117.80 | 13.1 DB | 26.5 DB | 1967-2011 |
| 59 | Mt Lofty                     | ML    | 30.9 DDB / 14.9 CWB  |  | 24.7 CDB / 17.8 DWB  |  | 31.6/17.9        | 32.5/18.2        | 2.9 DB      | 2.1 DB           | 2.5 DB           | 685.0  | -34.98 | 138.71 | 5.4 DB  | 28.0 DB | 1988-2011 |
| 60 | Tullamarine (Melbrn Airport) | TU    | 35.4 DDB / 17.8 CWB  |  | 27.6 CDB / 20.4 DWB  |  | 36.0/20.5        | 38.0/20.9        | 2.9 DB      | 2.0 DB           | 3.6 DB           | 118.8  | -37.67 | 144.83 | 12.5 DB | 32.5 DB | 1967-2011 |

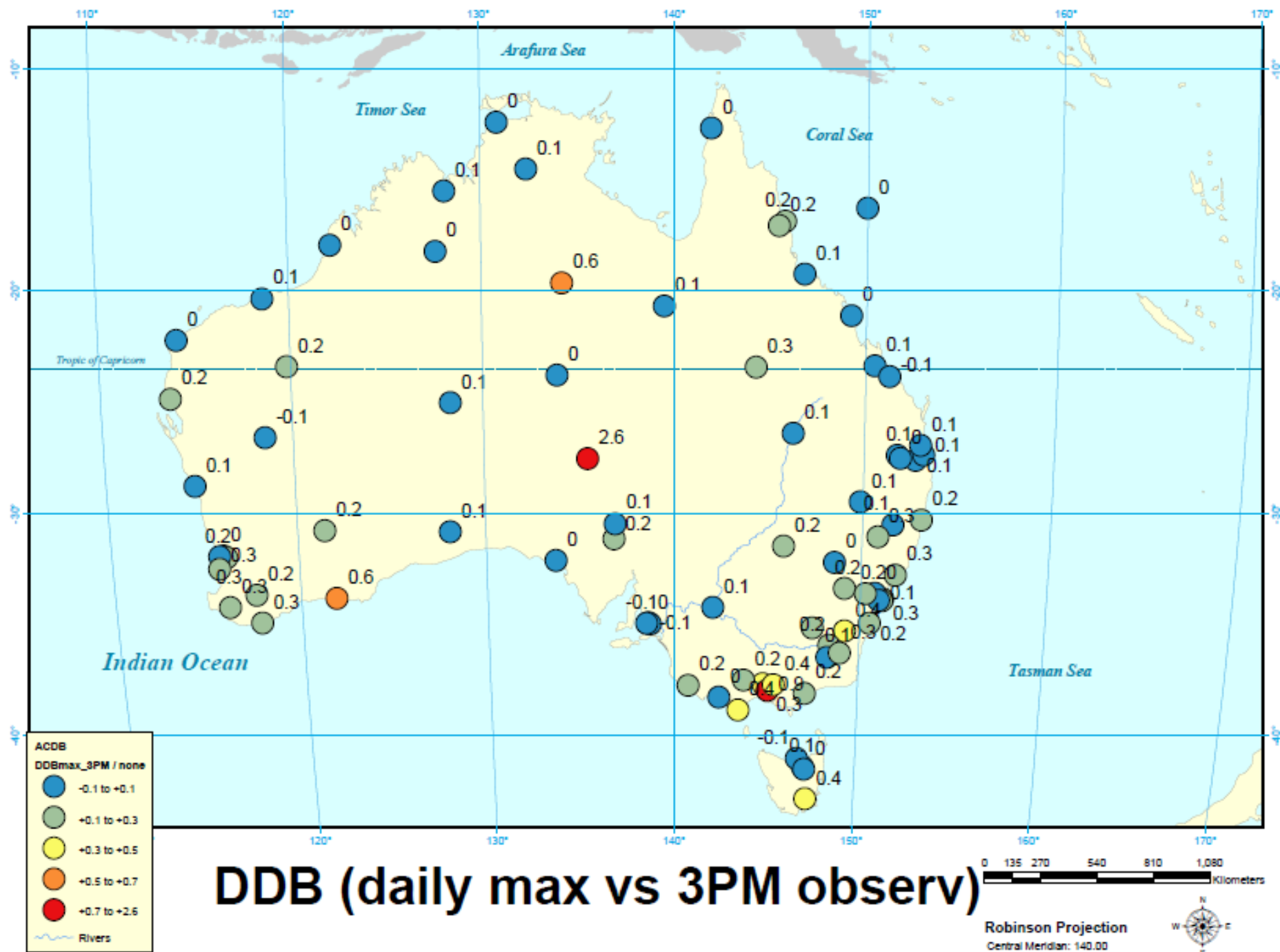
# Histogram of design change trends measured at ACDB sites (ref Table 2)



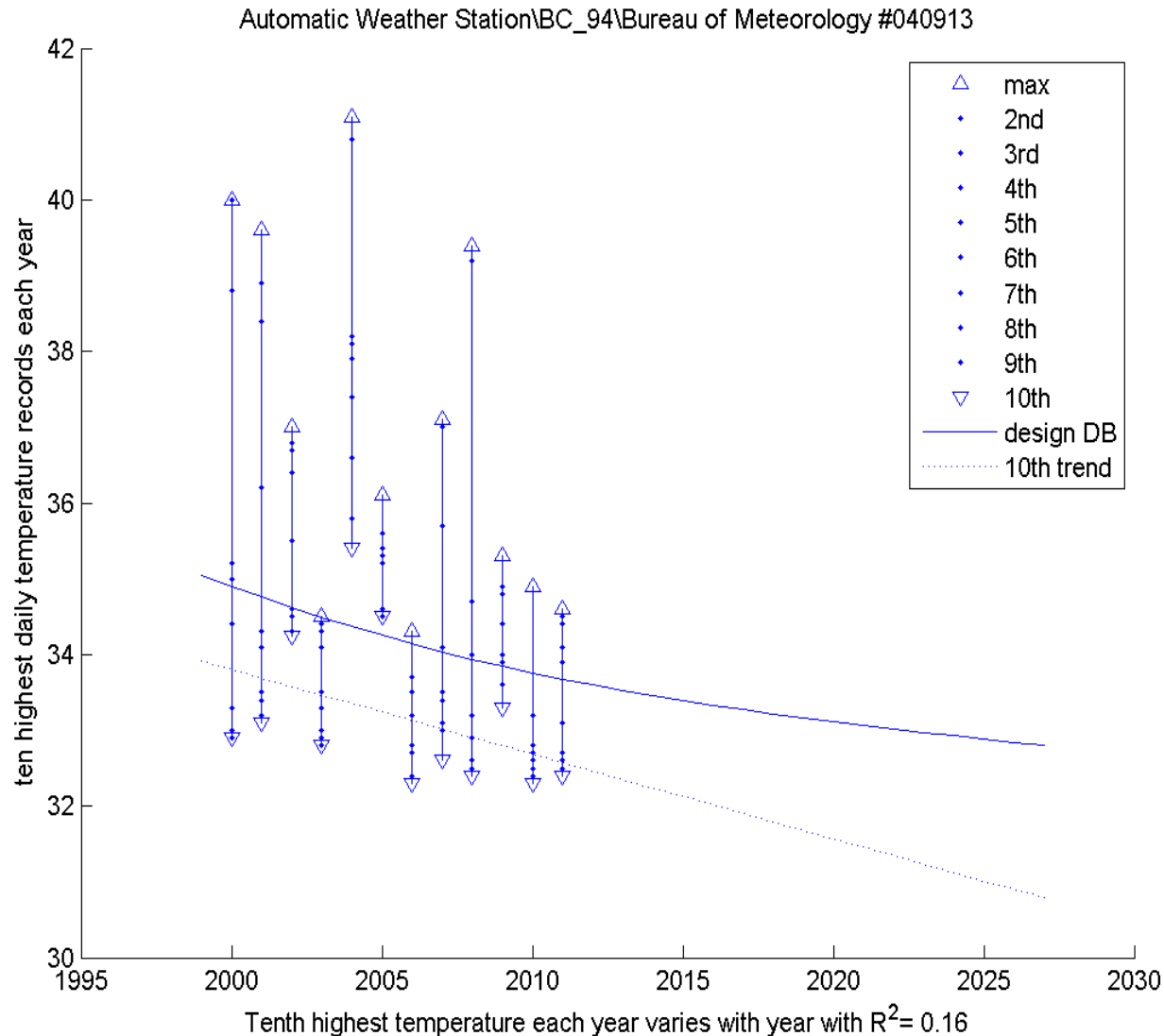


| Coincident conditions of the 3PM design dry bulb |      |              |        |        |          |         |          |         |         |         | Alternative design dry bulb values |        |       |      |                    |              |      |
|--------------------------------------------------|------|--------------|--------|--------|----------|---------|----------|---------|---------|---------|------------------------------------|--------|-------|------|--------------------|--------------|------|
| NatHERS                                          |      | base station |        |        | coinc    | coinc   | coinc    | coinc   | coinc   | coinc   | Table                              | ASHRAE | style | DDB  | alternative design | ~year        |      |
| zone                                             | post | automatic    | stn    | dGHI   | maximum  | minimum | range of | time of | time of | time of | 1                                  | 0.4%   | 1.0%  | 2.0% | design dry bulb    | 2050         |      |
| abbrev                                           | id   | code         | BoM id | WMO id | (wh/sqm) | DB      | DB       | DB      | max DB  | min DB  | DDB                                | DDB    | DDB   | DDB  | DDB                | oC/100y(R^2) | DDB  |
|                                                  |      |              |        |        |          |         |          |         |         |         |                                    |        |       |      |                    |              |      |
| DA                                               | 1    | 800          | 14015  | 94120  | 6908     | 34.4    | 25.4     | 9.1     | 15:18   | 05:58   | 34.7                               | 34.0   | 33.5  | 33.0 | 34.7               | 0.1( 0.04)   | 34.8 |
| HE                                               | 2    | 6721         | 4032   | 94312  | 7893     | 42.5    | 24.8     | 17.7    | 14:12   | 05:30   | 42.0                               | 40.8   | 39.3  | 37.9 | 42.1               | 0.2( 0.03)   | 42.2 |
| LO                                               | 3    | 4730         | 36031  | 94346  | 8198     | 41.6    | 24.2     | 17.4    | 15:36   | 06:11   | 41.5                               | 40.7   | 39.3  | 38.1 | 41.8               | -1.3(-0.14)  | 41.0 |
| CR                                               | 4    | 6701         | 6011   | 94300  | 7612     | 40.0    | 23.7     | 16.3    | 13:48   | 05:04   | 38.4                               | 36.8   | 34.2  | 32.3 | 38.6               | 0.4( 0.03)   | 38.8 |
| TO                                               | 5    | 4810         | 32040  | 94294  | 7338     | 33.8    | 25.0     | 8.8     | 14:30   | 05:43   | 33.8                               | 33.1   | 32.2  | 31.5 | 33.9               | 0.7( 0.10)   | 34.3 |
| AL                                               | 6    | 870          | 15590  | 94326  | 8229     | 41.1    | 23.9     | 17.2    | 15:48   | 06:06   | 41.0                               | 40.0   | 39.0  | 37.8 | 41.0               | 0.3( 0.04)   | 41.1 |
| RO                                               | 7    | 4700         | 39083  | 94374  | 7493     | 36.3    | 22.6     | 13.6    | 15:36   | 05:36   | 36.1                               | 35.1   | 33.7  | 32.5 | 36.2               | 0.6( 0.07)   | 36.5 |
| MO                                               | 8    | 2400         | 53115  | 95527  | 7924     | 38.3    | 22.3     | 16.0    | 16:24   | 05:49   | 37.9                               | 37.0   | 35.4  | 34.0 | 38.0               | 1.6( 0.16)   | 39.0 |
| AM                                               | 9    | 4306         | 40004  | 94568  | 7676     | 36.0    | 19.8     | 16.2    | 15:24   | 05:30   | 35.7                               | 34.7   | 32.9  | 31.5 | 35.8               | 2.1( 0.24)   | 37.1 |
| BR                                               | 10   | 4000         | 40842  | 94578  | 7308     | 31.8    | 21.5     | 10.3    | 14:18   | 05:27   | 31.6                               | 31.0   | 29.9  | 29.0 | 31.7               | -1.6(-0.28)  | 30.8 |
| CH                                               | 11   | 2450         | 59040  | 94791  | 6903     | 31.5    | 20.3     | 11.2    | 14:18   | 04:13   | 30.4                               | 29.6   | 28.0  | 27.1 | 30.6               | 3.1( 0.41)   | 32.5 |
| GE                                               | 12   | 6530         | 8051   | 94403  | 7965     | 40.6    | 21.4     | 19.2    | 14:18   | 02:23   | 39.9                               | 38.7   | 36.4  | 34.0 | 40.0               | -0.8(-0.09)  | 39.5 |
| PE                                               | 13   | 6000         | 9021   | 94610  | 7875     | 38.7    | 21.5     | 17.2    | 15:36   | 03:03   | 38.2                               | 37.4   | 35.3  | 33.4 | 38.5               | 2.6( 0.29)   | 40.1 |
| AA                                               | 14   | 2350         | 56238  | 95773  | 7344     | 31.3    | 17.4     | 13.9    | 15:12   | 04:13   | 31.2                               | 30.2   | 28.6  | 27.1 | 31.3               | -1.7(-0.17)  | 30.3 |
| WE                                               | 15   | 2300         | 61078  | 94776  | 7691     | 35.7    | 18.0     | 17.6    | 15:06   | 05:32   | 35.4                               | 34.4   | 32.0  | 29.8 | 35.7               | 1.7( 0.14)   | 36.7 |
| AD                                               | 16   | 5000         | 23090  | 94675  | 7755     | 38.5    | 23.2     | 15.3    | 15:36   | 03:04   | 38.0                               | 37.3   | 34.9  | 32.8 | 37.9               | 5.5( 0.49)   | 41.2 |
| SY                                               | 17   | 2000         | 66062  | 94768  | 6691     | 32.7    | 20.1     | 12.6    | 14:48   | 04:02   | 31.9                               | 31.4   | 29.0  | 27.3 | 32.1               | 2.7( 0.25)   | 33.7 |
| NO                                               | 18   | 2541         | 68072  | 94750  | 7034     | 34.3    | 16.3     | 18.0    | 15:00   | 03:40   | 33.7                               | 33.0   | 30.3  | 28.2 | 33.9               | 1.5( 0.13)   | 34.8 |
| CV                                               | 19   | 4470         | 44021  | 94510  | 7696     | 40.0    | 24.2     | 15.9    | 16:06   | 06:11   | 39.8                               | 39.0   | 37.6  | 36.2 | 39.9               | 0.3( 0.03)   | 40.0 |
| WA                                               | 20   | 2650         | 72150  | 94910  | 7717     | 38.2    | 20.9     | 17.3    | 15:54   | 05:14   | 37.8                               | 37.0   | 35.0  | 33.0 | 38.0               | 3.3( 0.24)   | 40.0 |
| ME                                               | 21   | 3000         | 86071  | 94868  | 7428     | 36.2    | 18.2     | 18.0    | 16:06   | 02:22   | 35.5                               | 34.9   | 32.2  | 29.7 | 35.8               | 2.1( 0.18)   | 37.1 |
| SE                                               | 22   | 3852         | 85072  | 94907  | 6708     | 34.2    | 13.7     | 20.5    | 14:48   | 05:00   | 33.8                               | 32.9   | 29.6  | 26.8 | 34.0               | 2.1( 0.17)   | 35.3 |
| LT                                               | 23   | 7250         | 91237  | 94969  | 6647     | 28.6    | 14.6     | 13.9    | 15:30   | 05:11   | 28.4                               | 27.9   | 26.1  | 24.6 | 28.5               | 2.3( 0.19)   | 29.7 |
| CA                                               | 24   | 2600         | 70014  | 94926  | 7904     | 35.2    | 15.5     | 19.7    | 15:54   | 05:33   | 34.6                               | 33.6   | 31.4  | 29.3 | 35.0               | 1.6( 0.10)   | 36.0 |
| CM                                               | 25   | 2629         | 72161  | 95916  | 7275     | 25.6    | 16.1     | 9.5     | 15:42   | 03:54   | 25.5                               | 24.9   | 23.2  | 21.7 | 25.7               | 3.2( 0.30)   | 27.6 |
| HO                                               | 26   | 7000         | 94029  | 94970  | 6295     | 28.9    | 14.4     | 14.5    | 15:12   | 02:14   | 28.3                               | 28.2   | 25.4  | 23.4 | 28.7               | 3.0( 0.31)   | 30.5 |
| MI                                               | 27   | 3500         | 76031  | 94693  | 7770     | 40.5    | 22.3     | 18.2    | 16:00   | 04:38   | 39.8                               | 39.2   | 37.0  | 34.9 | 39.9               | 2.4( 0.20)   | 41.4 |
| RI                                               | 28   | 2753         | 67105  | 95753  | 7397     | 38.0    | 17.9     | 20.1    | 15:42   | 05:04   | 37.5                               | 36.1   | 33.6  | 31.3 | 37.5               | 1.4( 0.10)   | 38.4 |
| WP                                               | 29   | 4874         | 27045  | 94170  | 7267     | 36.4    | 23.4     | 13.0    | 15:30   | 06:22   | 36.5                               | 35.4   | 34.6  | 33.8 | 36.5               | 3.5( 0.61)   | 38.6 |
| WY                                               | 30   | 6740         | 1006   | 95214  | 7321     | 41.9    | 29.2     | 12.7    | 15:00   | 04:47   | 41.8                               | 40.9   | 39.8  | 39.0 | 41.9               | 1.5( 0.24)   | 42.9 |
| WS                                               | 31   | 4871         | 200283 | 94299  | 7045     | 31.7    | 27.2     | 4.5     | 14:12   | 04:07   | 31.9                               | 31.4   | 30.9  | 30.4 | 31.9               | 0.4( 0.10)   | 32.2 |
| CN                                               | 32   | 4870         | 31011  | 94287  | 7311     | 33.3    | 24.3     | 8.9     | 14:24   | 05:39   | 33.3                               | 32.7   | 31.9  | 31.2 | 33.5               | 0.1( 0.01)   | 33.5 |
| BM                                               | 33   | 6725         | 3003   | 94203  | 7159     | 38.9    | 24.0     | 14.9    | 14:42   | 05:19   | 38.6                               | 37.3   | 36.0  | 34.7 | 38.6               | -0.3(-0.04)  | 38.4 |
| LM                                               | 34   | 6707         | 5007   | 94302  | 8216     | 42.5    | 23.9     | 18.6    | 15:24   | 05:55   | 42.3                               | 41.1   | 39.4  | 37.9 | 42.3               | 0.2( 0.03)   | 42.4 |
| MK                                               | 35   | 4740         | 33119  | 94367  | 7725     | 32.5    | 24.8     | 7.7     | 14:06   | 05:34   | 32.4                               | 31.7   | 30.8  | 30.1 | 32.4               | 2.7( 0.44)   | 34.0 |
| GL                                               | 36   | 4680         | 39123  | 94380  | 7524     | 34.2    | 24.3     | 10.0    | 14:00   | 05:34   | 34.0                               | 32.9   | 32.0  | 31.1 | 33.9               | 0.9( 0.14)   | 34.5 |
| HA                                               | 37   | 6770         | 2012   | 94212  | 7789     | 41.0    | 27.3     | 13.7    | 15:00   | 05:33   | 41.1                               | 40.1   | 39.2  | 38.2 | 41.1               | -0.1(-0.02)  | 41.0 |
| TE                                               | 38   | 860          | 15135  | 94238  | 8093     | 40.6    | 27.6     | 13.1    | 16:24   | 06:34   | 40.6                               | 40.0   | 39.0  | 38.0 | 41.2               | 3.3( 0.25)   | 43.2 |
| IS                                               | 39   | 4825         | 29127  | 94332  | 8036     | 40.6    | 23.7     | 16.9    | 15:48   | 06:23   | 40.6                               | 39.9   | 38.8  | 37.7 | 40.7               | -0.5(-0.07)  | 40.4 |
| NE                                               | 40   | 6753         | 7176   | 94317  | 7940     | 43.1    | 28.2     | 14.9    | 15:30   | 05:31   | 43.1                               | 42.0   | 40.8  | 39.6 | 43.3               | 0.4( 0.04)   | 43.5 |
| GI                                               | 41   | 6438         | 13017  | 94461  | 8029     | 41.3    | 28.1     | 13.3    | 16:42   | 04:35   | 40.9                               | 40.2   | 39.1  | 38.0 | 41.0               | -2.9(-0.34)  | 39.4 |
| MT                                               | 42   | 6642         | 7045   | 94430  | 8099     | 42.0    | 27.5     | 14.5    | 15:48   | 06:12   | 42.0                               | 41.2   | 40.0  | 38.8 | 41.9               | 2.7( 0.40)   | 43.5 |
| OO                                               | 43   | 5734         | 17043  | 94476  | 7384     | 42.4    | 29.2     | 13.2    | 16:00   | 05:53   | 42.5                               | 45.3   | 44.1  | 42.3 | 45.1               | 1.4( 0.09)   | 45.9 |
| KA                                               | 44   | 6430         | 12038  | 94367  | 7639     | 40.6    | 23.3     | 17.2    | 15:48   | 02:37   | 40.3                               | 39.5   | 37.6  | 35.6 | 40.5               | 2.4( 0.25)   | 41.9 |
| WO                                               | 45   | 5720         | 16001  | 94659  | 8026     | 41.4    | 25.3     | 16.2    | 15:54   | 05:15   | 41.0                               | 40.5   | 38.7  | 37.0 | 41.2               | 3.2( 0.32)   | 43.1 |
| CO                                               | 46   | 2835         | 48027  | 94711  | 7829     | 39.9    | 25.2     | 14.7    | 16:06   | 05:42   | 39.5                               | 39.0   | 37.1  | 35.6 | 39.7               | 4.1( 0.37)   | 42.2 |
| BI                                               | 47   | 6076         | 9240   | 95610  | 8043     | 37.0    | 20.1     | 16.9    | 15:30   | 04:33   | 36.4                               | 35.2   | 33.4  | 31.6 | 36.6               | 1.9( 0.10)   | 37.5 |
| DU                                               | 48   | 2830         | 65070  | 95719  | 8069     | 38.2    | 21.9     | 16.4    | 16:06   | 04:45   | 37.9                               | 36.9   | 35.0  | 33.2 | 37.9               | 3.7( 0.30)   | 40.1 |

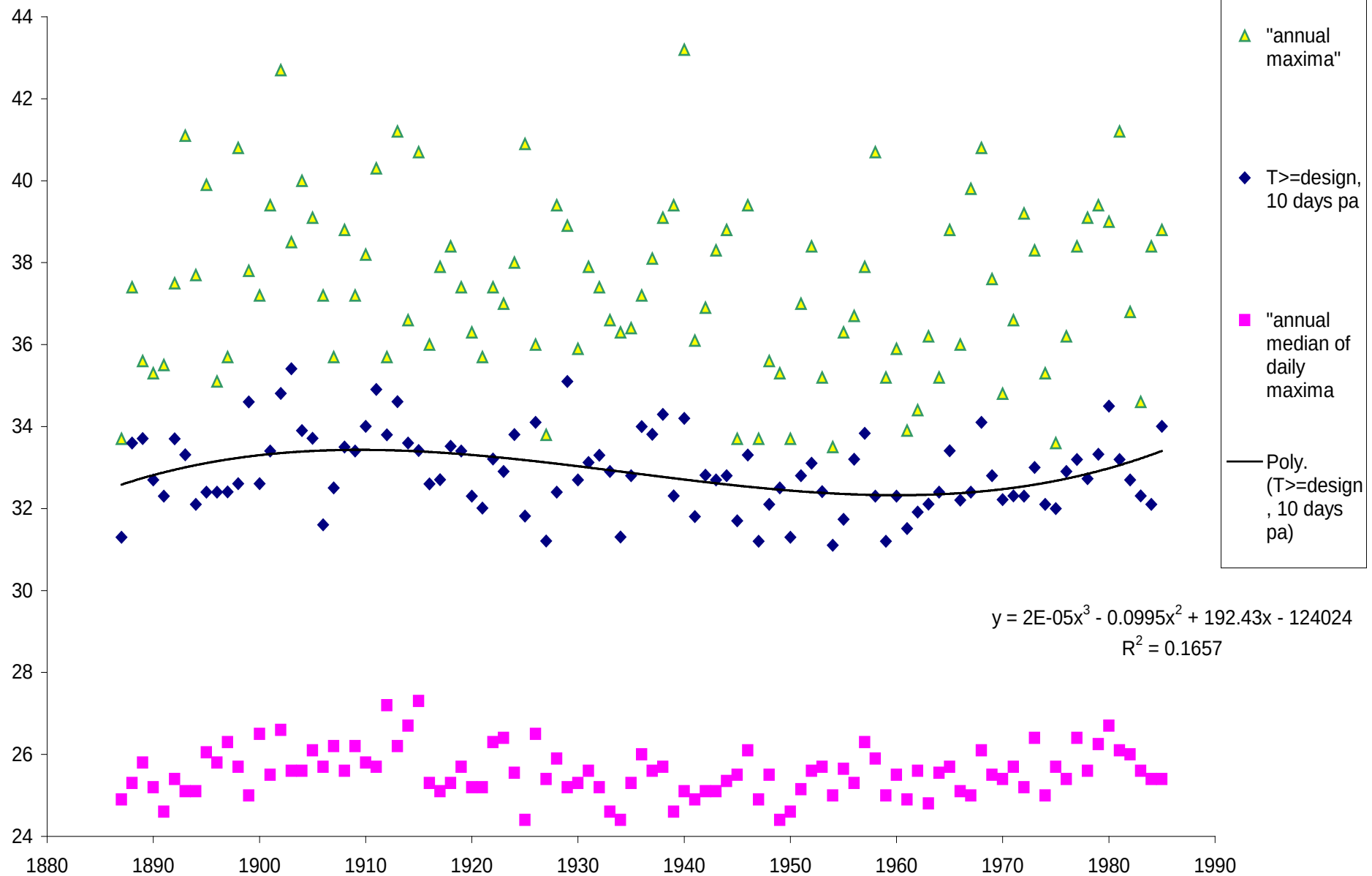




# Further work is required to detail sites not included in ACDB, e.g. Brisbane CBD



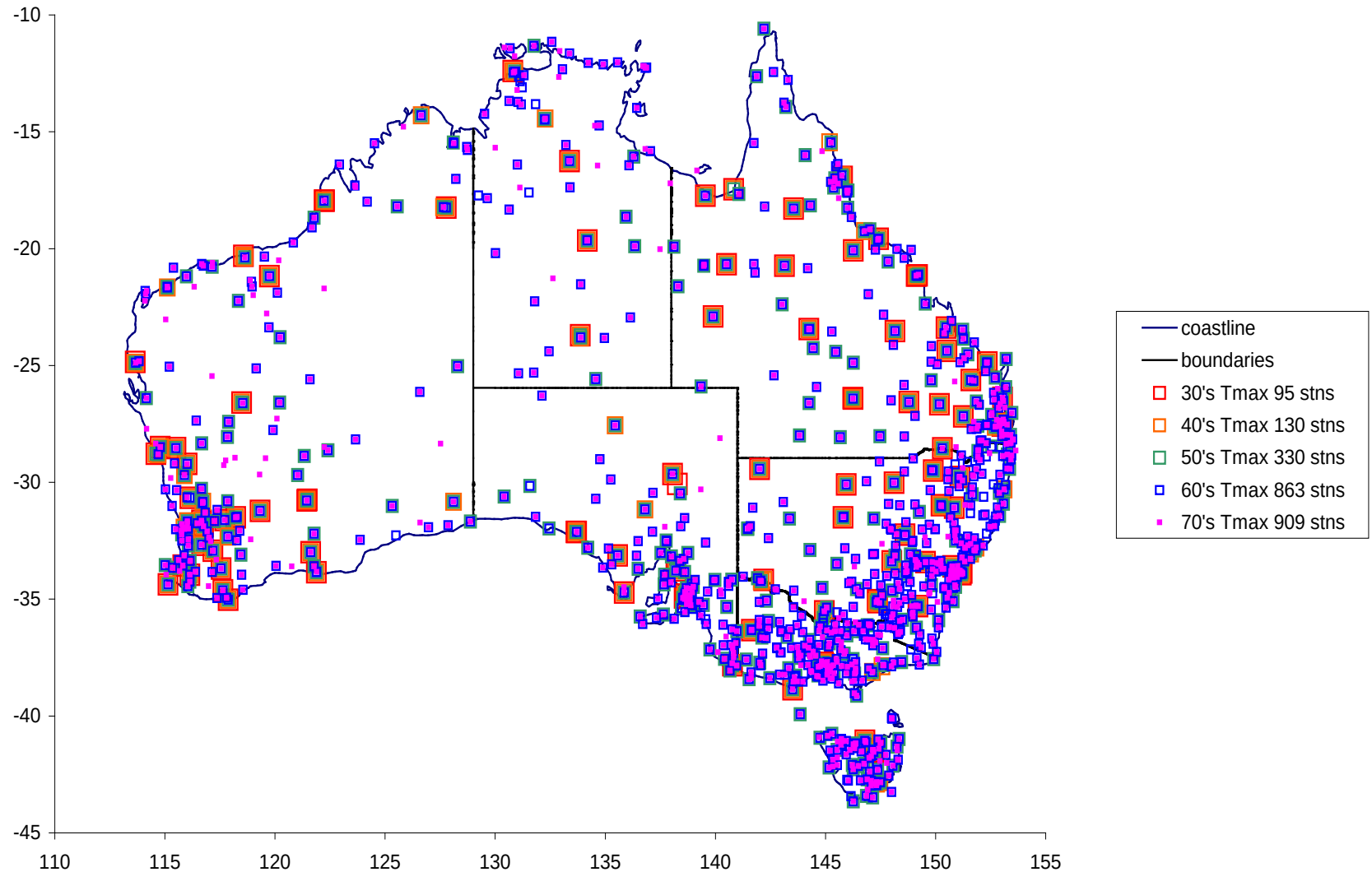
# Brisbane Regional Office BOM (040214) long time scale perspective



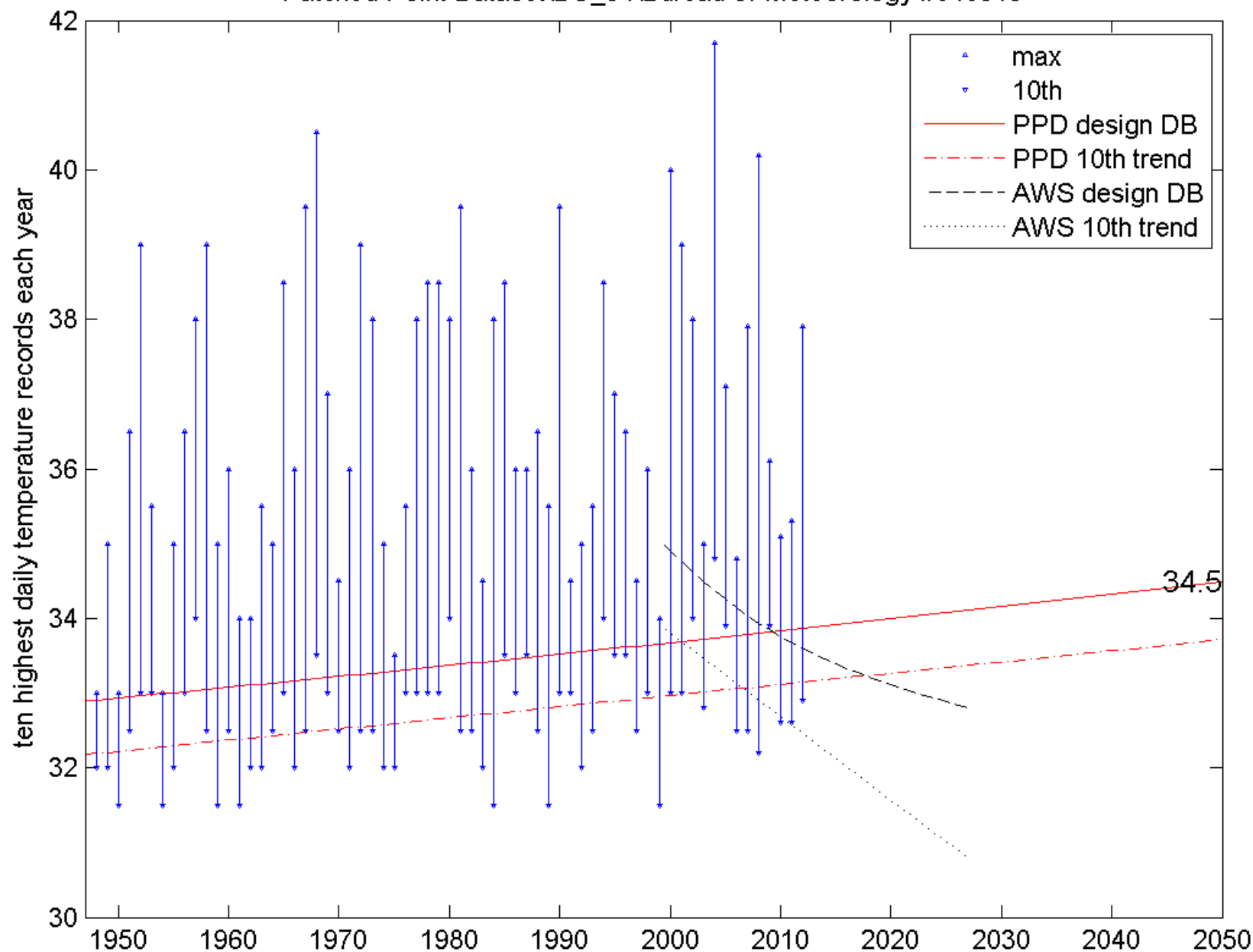
# Nineteenth-Century annals updated daily throughout Australia

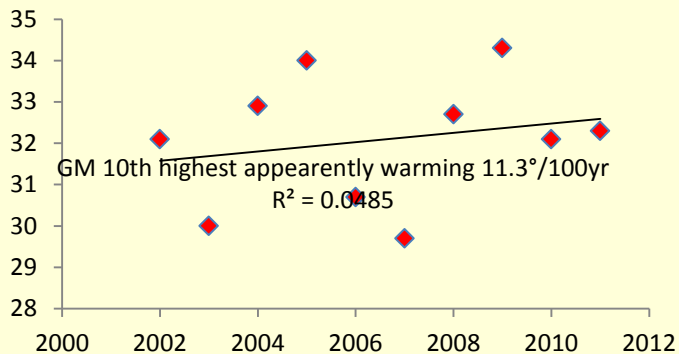
- PPD <<http://www.longpaddock.qld.gov.au/silo/>> annals of daily minimum and maximum temperature, humidity & pressure at 1200 manual observation locations.
  - Records from various colonial meteorologists blended with Commonwealth Bureau of Meteorology observations can be used to estimate HVAC design conditions & trends virtually at any locality within the continent.
  - Finding DA9 design db & wb temperatures not exceeded more than 10 day per year ***including standard deviation*** [2]
2. Peterson, Williams, Gilbert & Bremhost ***New air conditioning design temperatures for Queensland***, AIRAH Ecolibrium, Vol. 5, Feb 2006, pp.26-36

422 evap stns, 1203 temperature stns, 4729 rain stns  
patched point times series interpolated to maps



Patched Point Dataset\BC\_94\Bureau of Meteorology #040913





Glasshouse Mountains GM 11.3°/100yr

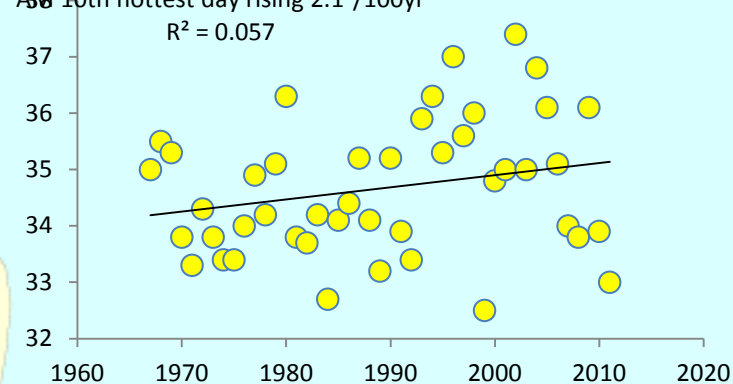
Oakey OA 1.8°/100yr

Brisbane BR -1.6°/100yr

Toowoomba TW 2.2°/100yr

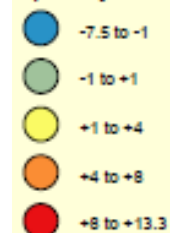
Amberley AM 2.1°/100yr

AM 10th hottest day rising 2.1°/100yr  
 $R^2 = 0.057$



**$\Delta$ DDB / 100years**

ACDB  
 oCpCentury / none

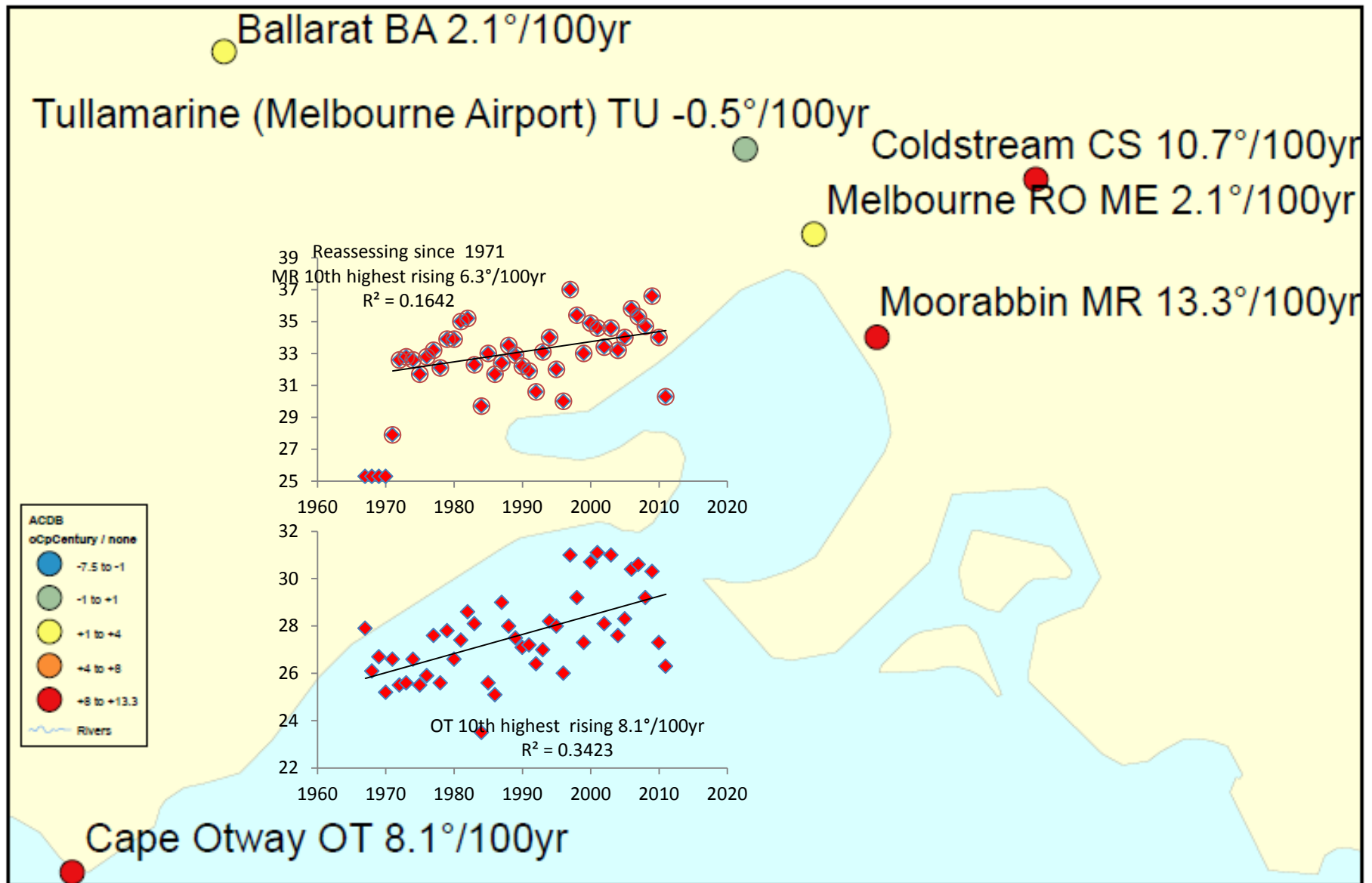


0 5 10 20 30 40  
 Kilometers

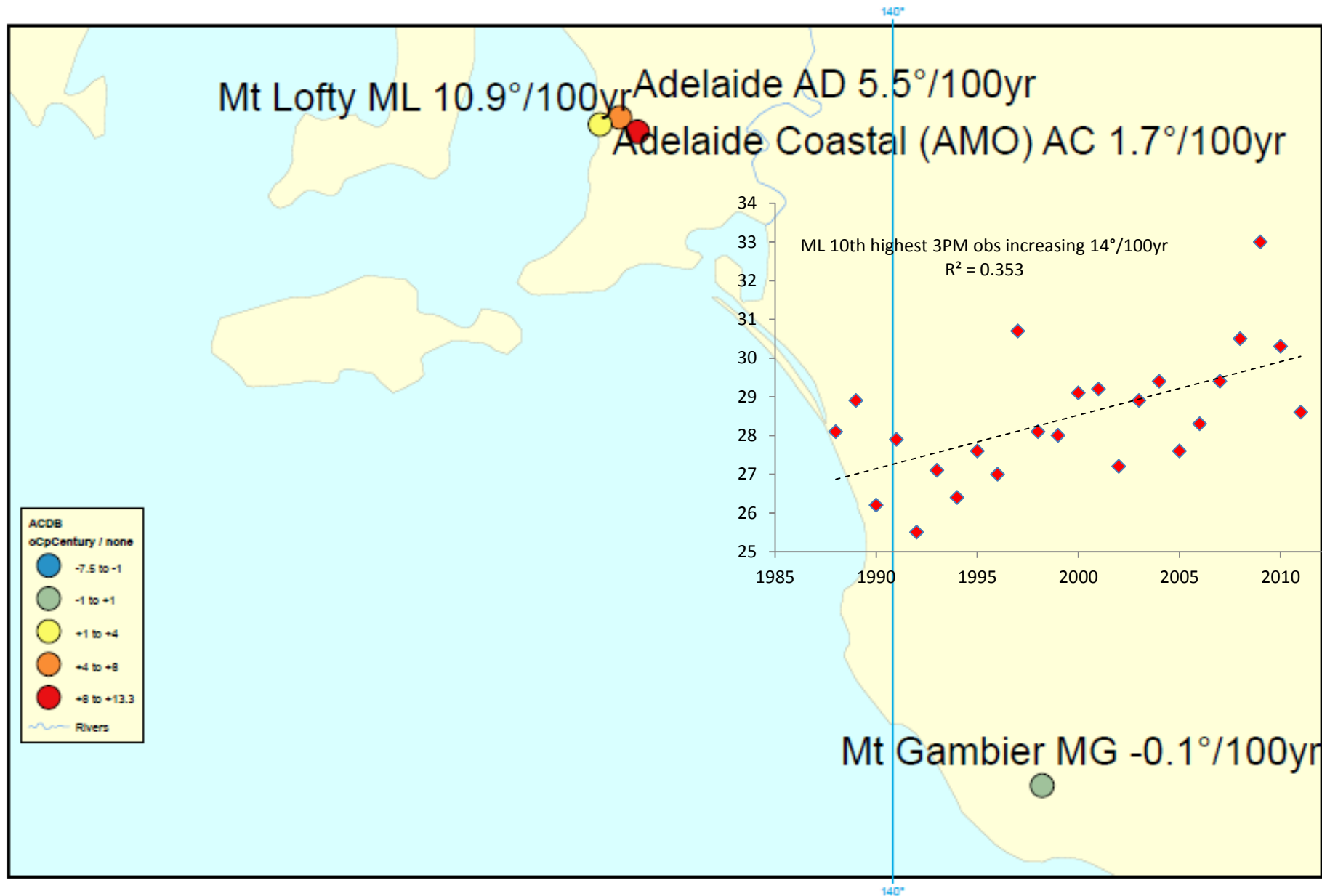
Robinson Projection  
 Central Meridian: 140.00







**$\Delta$ DDB / 100years**



**ΔDDB / 100years**

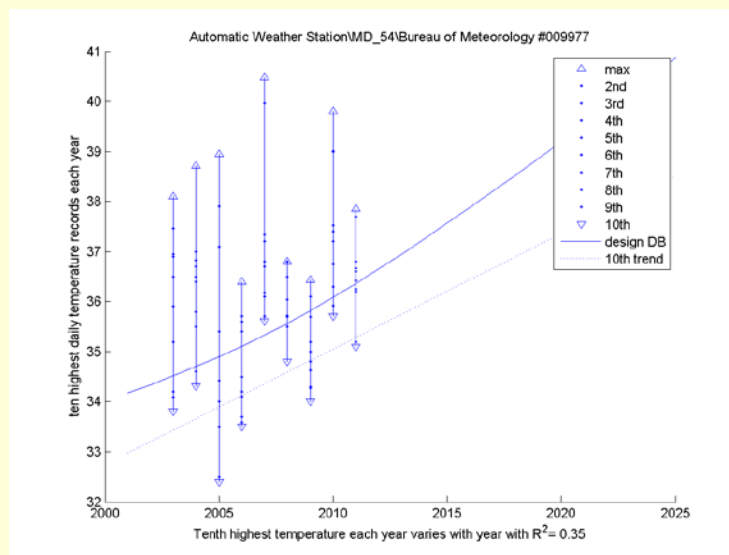
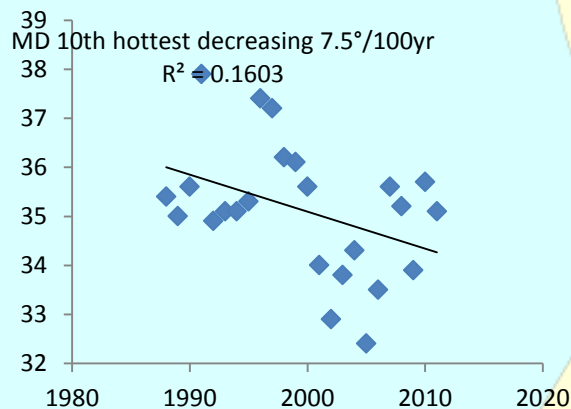
0 12.5 25 50 75 100 Kilometers

Robinson Projection  
Central Meridian: 140.00



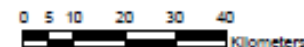
Swanbourne SW 7.6°/100yr Perth PE 2.6°/100yr  
Bickley BI 1.9°/100yr

Mandurah MD -7.5°/100yr



Katanning KT 1.2°/100yr

$\Delta$ DDB / 100years



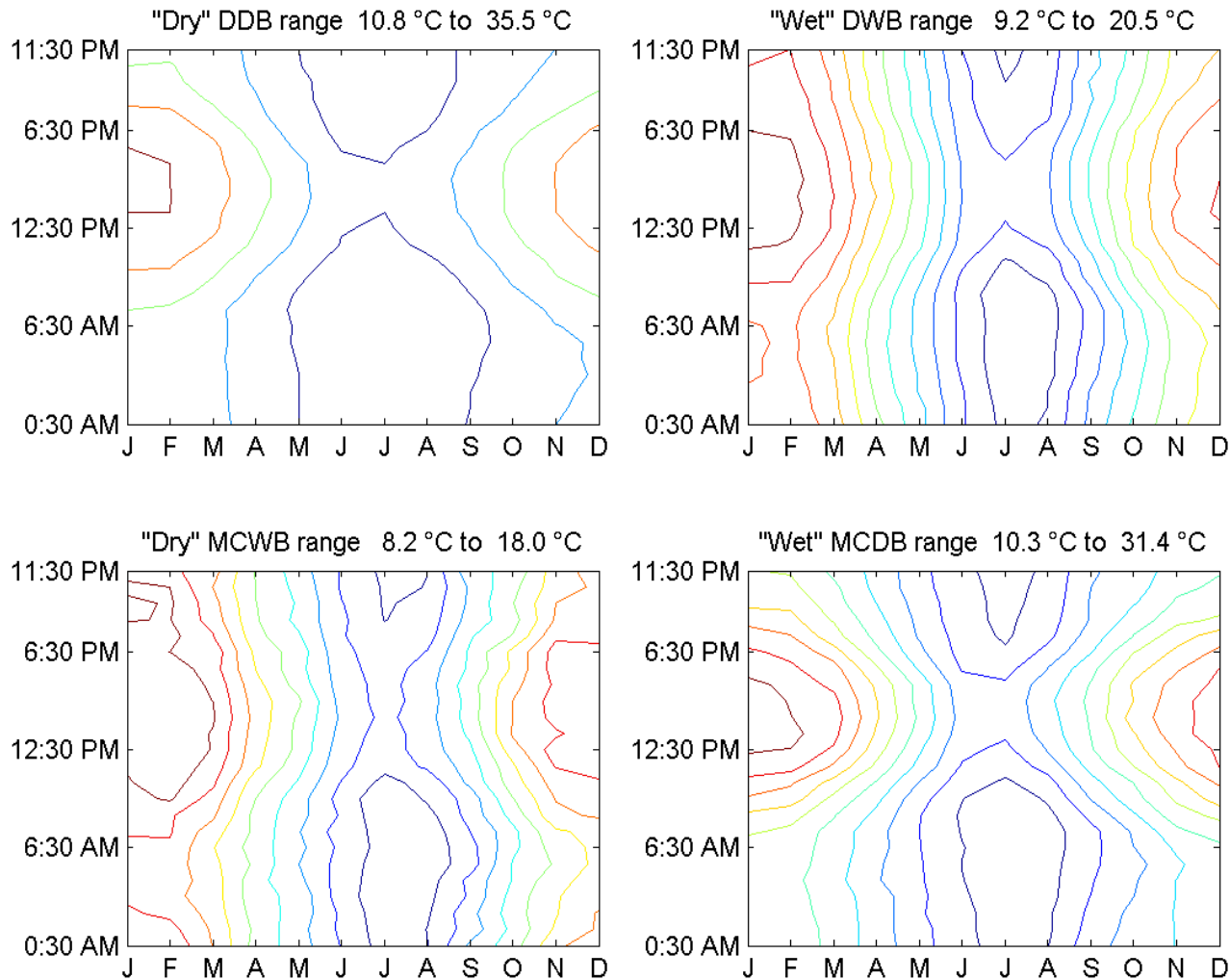
Robinson Projection  
Central Meridian: 140.00



# Additional Outcome – Design Day files

- The Australian HVAC system design dataset <http://uq.id.au/e.peterson/> includes Design Day files in three versions “DB”, “WB” and “CR”, each consisting of 24 hour drybulb-wetbulb pairs for each month (January through December), for each ACDB site.
- Developed for ACADS-BSG CAMEL software, ascii adaptable to serve other HVAC system modelling software such as EnergyPlus.

# Tullamarine airport design wet-bulb and design dry-bulb over mean coincident wet-bulb and mean coincident dry-bulb -used to create *Design Day Files* (24 hour x 12 months)



Australian HVAC system design website serves 3 design-day files for each site, e.g. Tullamarine:

- **TU\_60\_DB** -intended to represent DA9  
“Option 1” Dry summers selected by DB.
- **TU\_60\_WB** -intended to represent DA9  
“Option 2” Wet summers selected by WB.
- **TU\_60\_CR** -intended to represent DA9  
“Design Values” selected for DB and WB.

“CR” files are provided in accordance with AIRAH DA9 “Design Values” - being a synthetic combination of design DB with design WB that is climatologically unlikely or at least very rare and so may be desirable for more critical applications.

# Application of Design Day files

All Design Day files have been tested at the Queensland Department of Housing and Public Works using CAMEL version 5.10.3D software.

CAMEL did not run unless the daily range is at least 10 degrees, which was the case for Tullamarine but apparently must be edited by the user for other locations.

# 158 m<sup>2</sup> demountable metal clad school building assumed veranda facing east

## Assumptions:

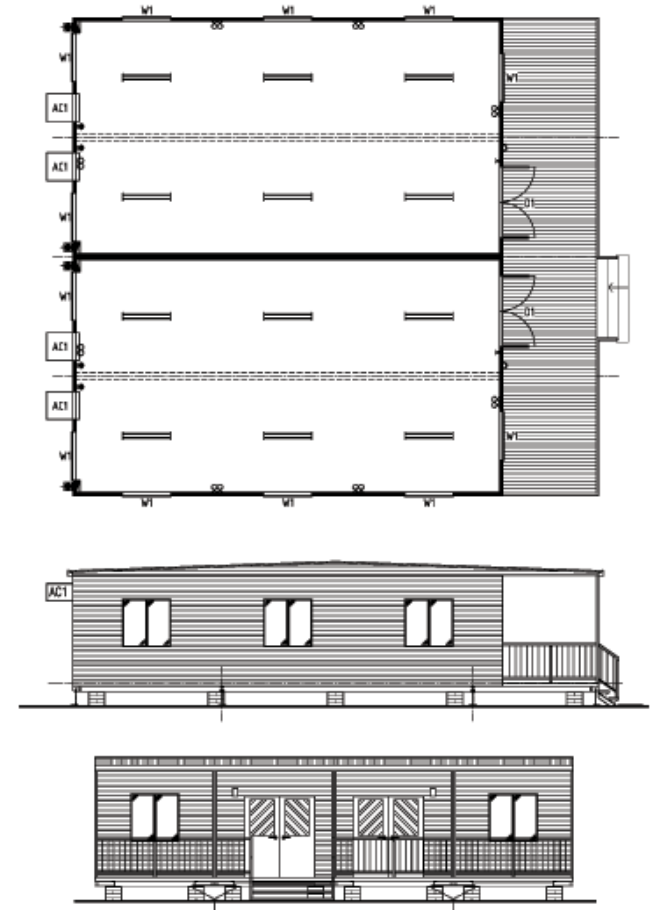
R1.5 insulation, dark colours.

DX cooling coil by-pass factor of 0.15

1.6 kW of lighting and 79 persons.

Primary school occupancy, 5 litres per second conditioned fresh air per student in accordance with QLD Government Policy

Indoor design 24°C at 50% relative humidity.



<http://www.atcosl.com/en-ca/AU/Modular-Buildings/Portable-Schools>



# Tullamarine (TU 60) HVAC system

## Design Day files used in CAMEL

|                                              | CAMEL standard<br>COMFORT<br>Concurrent<br>WB and DB | CAMEL standard<br>CRITICAL<br>24 hr 0.25% | ACDB<br>“Dry Summer”<br>Design DB with<br>mean coincid WB | ACDB<br>“Wet Summer”<br>Design WB with<br>mean coincid DB | ACDB<br>“Design Values”<br>design DB &<br>design WB |
|----------------------------------------------|------------------------------------------------------|-------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------|
| Design conditions                            | 34.3/20.5                                            | 36/21                                     | 35.4/17.8                                                 | 27.6/20.4                                                 | 35.4/20.4                                           |
| Aver. Daily Range                            | 12.9                                                 | ref ACADS-BSG                             | 12.5                                                      | 12.5                                                      | 12.5                                                |
| kW GTH                                       | 27.6                                                 | 32.7                                      | 25.3                                                      | 29.9                                                      | 28.9                                                |
| L/s supply                                   | 1498                                                 | 1729                                      | 1494                                                      | 1289                                                      | 1544                                                |
| peak time                                    | 3 PM January                                         | 3 PM January                              | 4 PM January                                              | 4 PM January                                              | 4PM January                                         |
| On-coil DB/WB                                | 26.8/18                                              | 27.4/18.3                                 | 27.0/17.0                                                 | 26.3/18.1                                                 | 26.9/18                                             |
| Off-coil DB/WB                               | 13.5/12.3                                            | 13.8/12.5                                 | 13.1/11.6                                                 | 13.1/12.0                                                 | 13.6/12.4                                           |
| Apparatus dew pt                             | 11.3°C                                               | 11.3°C                                    | 11.7°C                                                    | 10.8°C                                                    | 11.2°C                                              |
| Luvata Coils ver<br>9.1 cooling<br>selection | 1100 mm x<br>600mm 8-row<br>R134a DX                 | 1200 mm x<br>600mm 8-row<br>R134a DX      | 1100 mm x<br>600mm 8-row<br>R134a DX                      | 1600 mm x<br>500mm 12-row<br>R134a DX                     | 1300 mm x<br>600mm 12-row<br>R134a DX               |

# ASHRAE design data

- ASHRAE publishes design data (-2005) [5] to establish accurate and comprehensive set of design conditions for all parts of the world based on hourly records (not just 3 pm) but did not include solar data included in the ACDB (-2011).
5. Handbook of Fundamentals, Chapter 14 and CDROM Climatic Design Information  
ASHRAE, Atlanta, Georgia, USA 2009.

# ASHRAE 0.4% outdoor design “strict control of indoor environmental parameters”

- DA9 includes reprints from Handbook of Air Conditioning Systems Design, McGraw-Hill 1972. The latest McGraw-Hill Handbook recommends ASHRAE design values with mean coincidence of the other parameters. Wang [11] states “It is not economical to choose the annual maximum or annual minimum values as the design data”.

11. Handbook of air conditioning and refrigeration  
2nd ed. McGraw Hill, New York, 2001



# General Services Administration (US)

## *Design Criteria*



Summer design conditions for sensible heat load calculations shall be based on the 0.4 % dry bulb temperature with its mean coincident wet bulb temperature. Design conditions for the summer ventilation load and all dehumidification load calculations shall be based on the 0.4% dew point with its mean coincident dry bulb temperature.

# Hours exceeding design temperatures at Tullamarine

|                                            |          |                      |           |
|--------------------------------------------|----------|----------------------|-----------|
| Option 1 Dry summer                        |          | Option 2 Wet summer  |           |
| design DB / coinc WB                       |          | coinc DB / design WB |           |
| 35.4 DDB / 17.8 CWB                        |          | 27.6 CDB / 20.4 DWB  |           |
| percentage of hourly data exceeding levels |          |                      |           |
| design DB                                  | coinc WB | coinc DB             | design WB |
| 0.31 %                                     | 2.59 %   | 3.15 %               | 0.27 %    |
| design DB & coinc WB                       |          | coinc DB % design WB |           |
| 2.71 %                                     |          | 3.28 %               |           |
| design DB concurrent with design WB        |          |                      |           |
| 0.56 %                                     |          |                      |           |



# % hours exceeded in Australian capital cities (1967-2011)

| ID | zone | location  | "Option 1"<br>Design DB | Option 2"<br>Design WB | "Design Values"<br>(either exceeded) |
|----|------|-----------|-------------------------|------------------------|--------------------------------------|
| DA | 1    | Darwin    | 0.11%                   | 0.11%                  | 0.22%                                |
| BR | 10   | Brisbane  | 0.25%                   | 0.29%                  | 0.51%                                |
| PE | 13   | Perth     | 0.25%                   | 0.37%                  | 0.61%                                |
| AD | 16   | Adelaide  | 0.28%                   | 0.38%                  | 0.64%                                |
| SY | 17   | Sydney    | 0.33%                   | 0.42%                  | 0.72%                                |
| ME | 21   | Melbourne | 0.30%                   | 0.37%                  | 0.64%                                |
| CA | 24   | Canberra  | 0.23%                   | 0.31%                  | 0.52%                                |
| HO | 26   | Hobart    | 0.38%                   | 0.35%                  | 0.65%                                |

# “Location Summary” for each of the 80 ACDB stations, e.g. TU\_60\_Table.txt

```
| Analysis of Australian Climate Data Bank (ACDB) version from NIWA 2013 |
| ACDB(60) station Tullamarine (Melbourne Airport) 45 years (1967-2011)|
| BoM 86282 (WMO 94866) -37.67° latitude 144.83° longitude 118.8 m alt |
|
| It is now 04-Jul-2013 04:55:59 -> computational time was 7 minutes |
|                               OUTPUTS                               |
| INPUTS                      => NEW33/60/TU_60_Table.txt (this print out)|
| A:          ACDB_in/NatH_CZ.csv => NEW33/60/TU_60_DB.txt (Dry Design Day)|
| B: CZ0607_NatHERS_1967-2011_w.txt => NEW33/60/TU_60_WB.txt (Wet Design Day)|
| C:          ACDB33.m          => NEW33/60/TU_60_CR.txt (Critical D Day)|
|                               => NEW33/ACDB_Table1.txt (compare others)|
```

## ANALYSIS SUMMARY

35.4 °C Design DB = mean of 10th highest 3PM each year + (std dev \* 1.63)  
=> this Design DB was exceeded 10.0 days/year (incl std dev 3.5 days/year).  
35.9 ° alternative Design DB = mean of 10th highest daily maximum each year + (1 std dev)  
=> alternative Design DB was exceeded 9.3 days/year (incl std dev 3.4 days/year).  
Design drybulb changes -0.5 °C per century (linear regression  $R^2$  -0.04) ~> 35.6 °C mid century.

20.4 ° Design WB = mean of 10th highest 3PM each year + (std dev \* 2.00)  
=> this Design WB was exceeded 10.0 days/year (incl std dev 4.5 days/year).  
20.4 ° alternative Design WB = mean of 10th highest daily maximum each year + (1 std dev)  
=> alternative Design WB was exceeded 10.0 days/year (incl std dev 4.5 days/year).  
Design wetbulb changes -1.4 °C per century (linear regression  $R^2$  -0.23) ~> 19.6 °C mid century.

2.9 ° Heating DB = mean of 10th lowest 8AM each year - (std dev \* 0.76)  
=> this Heating DB was insufficient 9.6 days/year (incl std dev 3.7 days/year).  
1.8 ° alternative Heating Design = mean of 10th lowest daily minimum each year - (1 std dev)  
=> alternative Heating Design was insufficient 8.4 days/year (incl std dev 3.6 days/year).  
Design heating changes 2.8 °C per century (linear regression  $R^2$  0.49) ~> 3.5 °C mid century.

# Table 2 (DB) & Table 3 (WB)

Table 2 Coincident conditions of the 3PM design dry bulb Alternative design dry bulb values

| NatHERS |    | base station |           |        | coinc    | coinc   | coinc   | coinc    | coinc   | coinc   | Table | ASHRAE style DDB |      |      |                 | alternative design |      | year |
|---------|----|--------------|-----------|--------|----------|---------|---------|----------|---------|---------|-------|------------------|------|------|-----------------|--------------------|------|------|
| zone    |    | post         | automatic | stn    | dGHI     | maximum | minimum | range of | time of | time of | 1     | 0.4%             | 1.0% | 2.0% | design dry bulb |                    | 2050 |      |
| abbrev  | id | code         | BoM id    | WMO id | (wh/sqm) | DB      | DB      | DB       | max DB  | min DB  | DDB   | DDB              | DDB  | DDB  | DDB             | oC/100y(R^2)       | DDB  |      |
| DA      | 1  | 800          | 14015     | 94120  | 6908     | 34.4    | 25.4    | 9.1      | 15:18   | 05:58   | 34.7  | 34.0             | 33.5 | 33.0 | 34.7            | 0.1( 0.04)         | 34.8 |      |
| HE      | 2  | 6721         | 4032      | 94312  | 7893     | 42.5    | 24.8    | 17.7     | 14:12   | 05:30   | 42.0  | 40.8             | 39.3 | 37.9 | 42.1            | 0.2( 0.03)         | 42.2 |      |
| LO      | 3  | 4730         | 36031     | 94346  | 8198     | 41.6    | 24.2    | 17.4     | 15:36   | 06:11   | 41.5  | 40.7             | 39.3 | 38.1 | 41.8            | -1.3(-0.14)        | 41.0 |      |
| CR      | 4  | 6701         | 6011      | 94300  | 7612     | 40.0    | 23.7    | 16.3     | 13:48   | 05:04   | 38.4  | 36.8             | 34.2 | 32.3 | 38.6            | 0.4( 0.03)         | 38.8 |      |
| TO      | 5  | 4810         | 32040     | 94294  | 7338     | 33.8    | 25.0    | 8.8      | 14:30   | 05:43   | 33.8  | 33.1             | 32.2 | 31.5 | 33.9            | 0.7( 0.10)         | 34.3 |      |
| AL      | 6  | 870          | 15590     | 94326  | 8229     | 41.1    | 23.9    | 17.2     | 15:48   | 06:06   | 41.0  | 40.0             | 39.0 | 37.8 | 41.0            | 0.3( 0.04)         | 41.1 |      |
| RO      | 7  | 4700         | 39083     | 94374  | 7493     | 36.3    | 22.6    | 13.6     | 15:36   | 05:36   | 36.1  | 35.1             | 33.7 | 32.5 | 36.2            | 0.6( 0.07)         | 36.5 |      |
| MO      | 8  | 2400         | 53115     | 95527  | 7924     | 38.3    | 22.3    | 16.0     | 16:24   | 05:49   | 37.9  | 37.0             | 35.4 | 34.0 | 38.0            | 1.6( 0.16)         | 39.0 |      |
| AM      | 9  | 4306         | 40004     | 94568  | 7676     | 36.0    | 19.8    | 16.2     | 15:24   | 05:30   | 35.7  | 34.7             | 32.9 | 31.5 | 35.8            | 2.1( 0.24)         | 37.1 |      |
| BR      | 10 | 4000         | 40842     | 94578  | 7308     | 31.8    | 21.5    | 10.3     | 14:18   | 05:27   | 31.6  | 31.0             | 29.9 | 29.0 | 31.7            | -1.6(-0.28)        | 30.8 |      |
| CH      | 11 | 2450         | 59040     | 94791  | 6903     | 31.5    | 20.3    | 11.2     | 14:18   | 04:13   | 30.4  | 29.6             | 28.0 | 27.1 | 30.6            | 3.1( 0.41)         | 32.5 |      |
| GE      | 12 | 6530         | 8051      | 94403  | 7965     | 40.6    | 21.4    | 19.2     | 14:18   | 02:23   | 39.9  | 38.7             | 36.4 | 34.0 | 40.0            | -0.8(-0.09)        | 39.5 |      |

Table 3 Coincident conditions of the 3PM design wet bulb Alternative design wet bulb values

| NatHERS   |    | base station |           |        | coinc    | coinc   | coinc   | coinc    | coinc   | coinc   | Table | ASHRAE style DWB |      |      | alternative design |              | year |
|-----------|----|--------------|-----------|--------|----------|---------|---------|----------|---------|---------|-------|------------------|------|------|--------------------|--------------|------|
| zone      |    | post         | automatic | stn    | dGHI     | maximum | minimum | range of | time of | time of | 1     | 0.4%             | 1.0% | 2.0% | design wet bulb    |              | 2050 |
| abbrev id |    | code         | BoM id    | WMO id | (Wh/sqm) | WB      | WB      | WB       | max WB  | min WB  | DWB   | DWB              | DWB  | DWB  | DWB                | oC/100y(R^2) | DWB  |
| DA        | 1  | 800          | 14015     | 94120  | 6353     | 27.2    | 23.9    | 3.3      | 15:30   | -3:05   | 27.4  | 30.1             | 29.7 | 29.5 | 27.4               | 0.6( 0.21)   | 27.7 |
| HE        | 2  | 6721         | 4032      | 94312  | 7424     | 27.9    | 23.1    | 4.8      | 15:42   | -4:07   | 27.9  | 31.9             | 31.4 | 30.9 | 27.9               | 0.7( 0.23)   | 28.4 |
| LO        | 3  | 4730         | 36031     | 94346  | 5597     | 25.0    | 21.0    | 4.0      | 16:00   | -1:51   | 24.8  | 29.1             | 29.0 | 29.2 | 24.9               | 3.0( 0.43)   | 26.8 |
| CR        | 4  | 6701         | 6011      | 94300  | 7217     | 25.8    | 21.6    | 4.3      | 16:12   | -4:15   | 25.8  | 29.6             | 29.1 | 28.6 | 25.7               | -0.7( -0.13) | 25.3 |
| TO        | 5  | 4810         | 32040     | 94294  | 6364     | 26.6    | 23.7    | 2.9      | 16:06   | -3:16   | 26.7  | 29.7             | 29.2 | 28.9 | 26.7               | 1.6( 0.43)   | 27.7 |
| AL        | 6  | 870          | 15590     | 94326  | 5221     | 23.5    | 19.9    | 3.7      | 16:54   | -4:33   | 23.2  | 27.1             | 27.2 | 27.6 | 23.3               | 3.2( 0.37)   | 25.2 |
| RO        | 7  | 4700         | 39083     | 94374  | 5836     | 25.7    | 22.5    | 3.1      | 15:42   | -2:12   | 25.6  | 28.7             | 28.2 | 27.9 | 25.7               | 0.9( 0.21)   | 26.2 |
| MO        | 8  | 2400         | 53115     | 95527  | 6504     | 23.3    | 18.9    | 4.3      | 15:54   | -2:59   | 23.0  | 28.5             | 28.1 | 27.7 | 23.0               | 0.1( 0.01)   | 23.0 |
| AM        | 9  | 4306         | 40004     | 94568  | 5921     | 24.8    | 20.8    | 4.0      | 16:18   | -1:53   | 24.7  | 28.7             | 28.0 | 27.4 | 24.7               | -0.7( -0.15) | 24.2 |
| BR        | 10 | 4000         | 40842     | 94578  | 6496     | 25.0    | 21.1    | 3.8      | 16:24   | -3:22   | 24.9  | 27.8             | 27.3 | 26.8 | 24.9               | 0.7( 0.16)   | 25.3 |
| CH        | 11 | 2450         | 59040     | 94791  | 6523     | 24.0    | 19.9    | 4.1      | 15:18   | 00:36   | 24.0  | 26.6             | 26.1 | 25.5 | 24.0               | 0.2( 0.06)   | 24.1 |



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