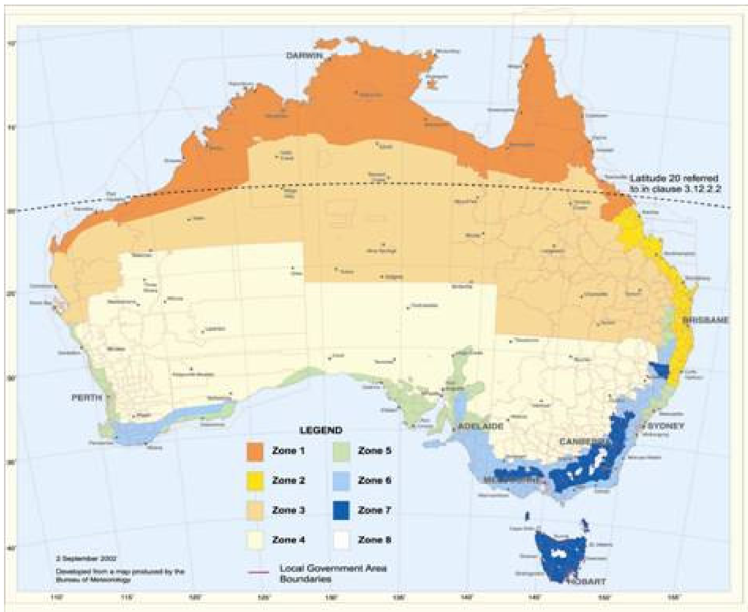
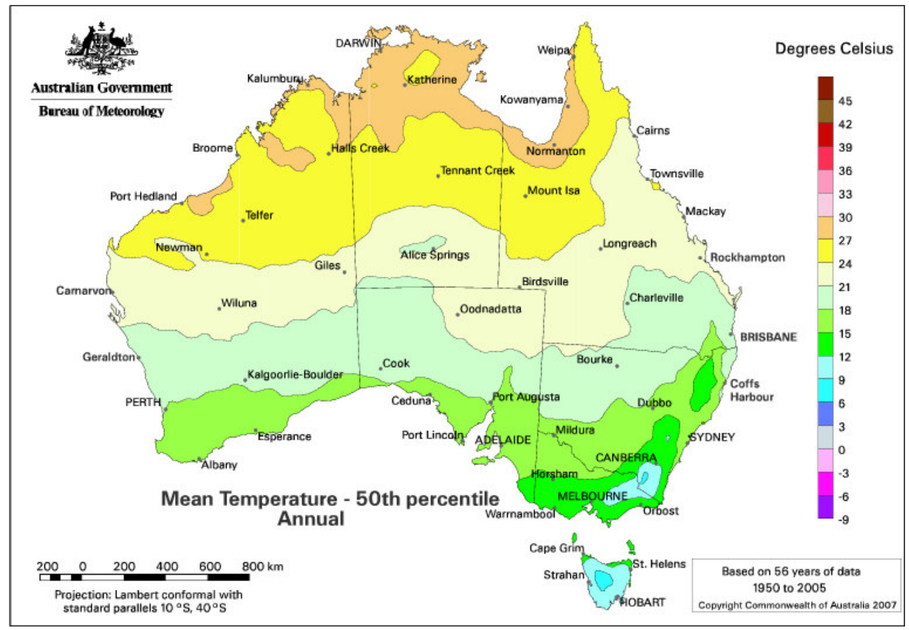
CREATION OF ERSATZ FUTURE WEATHER DATA FILES



Climate zones of the Australian Building Codes Board



50th Percentile Temperatures (Annual)

ENERGY
PARTNERS

Trevor Lee, Director
David Ferrari

Associated Contributions

- "An Assessment of the Need to Adapt Buildings for the Unavoidable Consequences of Climate Change" (BRANZ for AGO)
  - Lynda Amitrano (BRANZ Ltd)
  - Rachel Hargreaves (BRANZ Ltd)
  - Ian Page (BRANZ Ltd)
  - Kevin Hennessy (CSIRO)
  - Les Winton (Artcraft Research)
  - Rosalie Woodruff (ANU-NCEPH)
  - Tord Kjellstrom (ANU-NCEPH)

Unavoidable Climate Change

- Commercial and residential buildings
- 13 sites selected to represent Australia
- Climate change information
  - Temperature
  - Rainfall
  - Wind (including cyclones)
  - Flooding
  - Fire
  - Hail
  - Humidity
  - Radiation

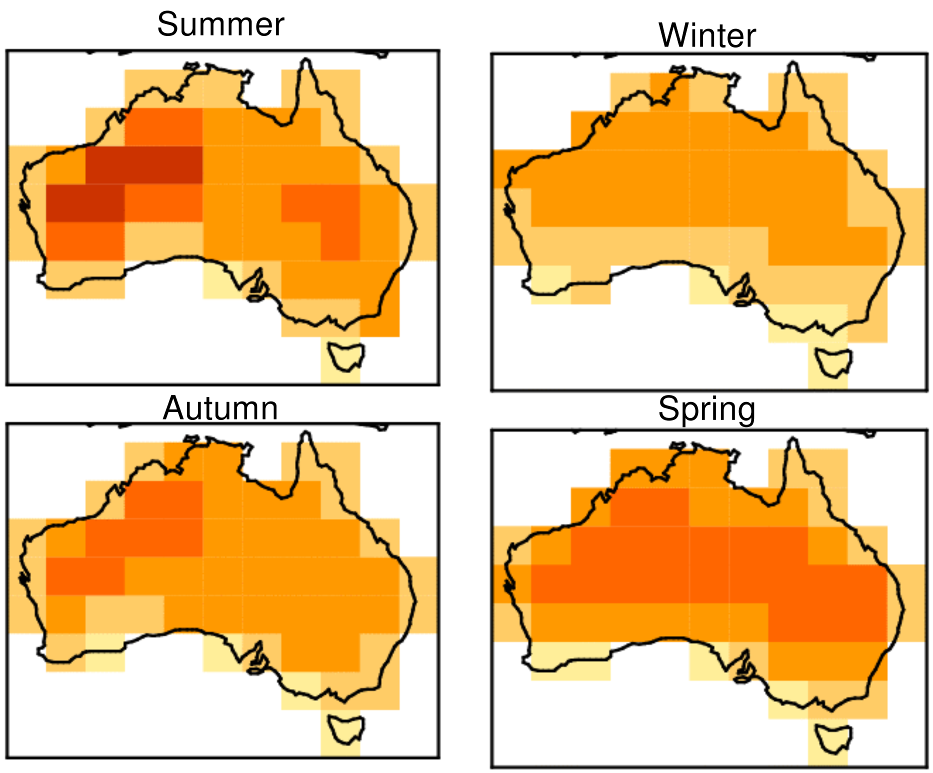
Setting the Climate Baseline

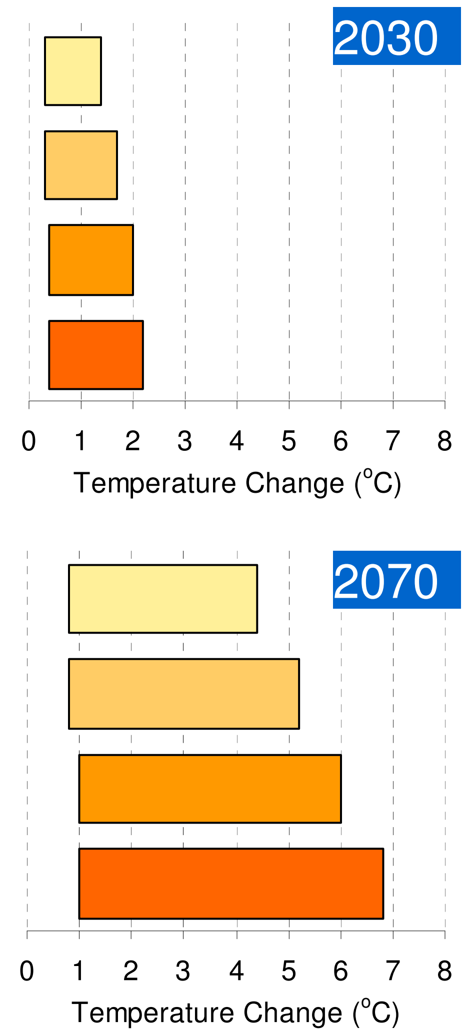
- This work predates ACDB 2006 which processed and archived BOM data from 1967 to 2004 inclusive
- CSIRO used the 4 decades centred on 1984 (ie, 1964 to 2004) as the baseline
- No adjustment for apparent warming over the baseline period

“Forecasting” the Climate

- Weather “forecast” for the 4 decades centred on 2030 and 2070
- Each weather element “forecast” as a wide range of possible values
- No indication of a “most likely” value
- Each element “forecast” independently (eg, higher temperature, lower relative humidity, higher-or-lower insolation, higher-or-lower wind speed)

Previous Climate "Forecast" (Seasonal)

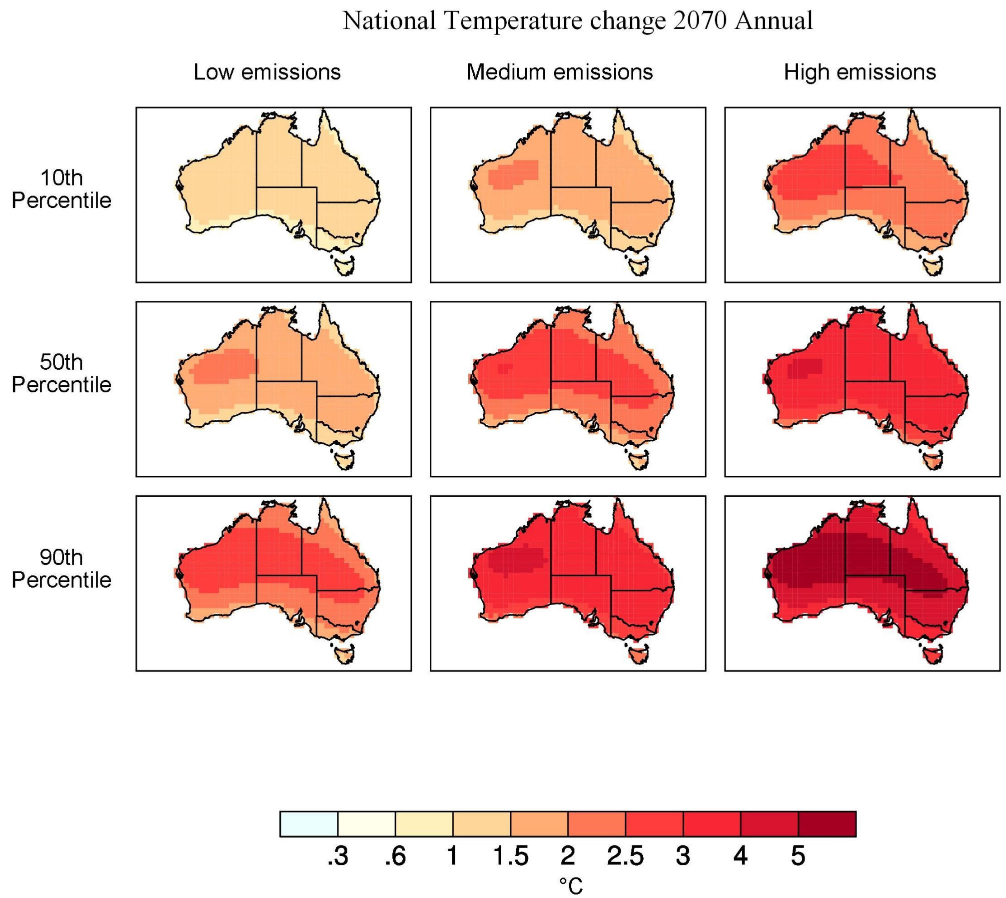




- Baseline of 4 decades centred on 1984
- Most warming spring and summer.
- 10-50% more hot days by 2030.
- Increase in number of hot spells

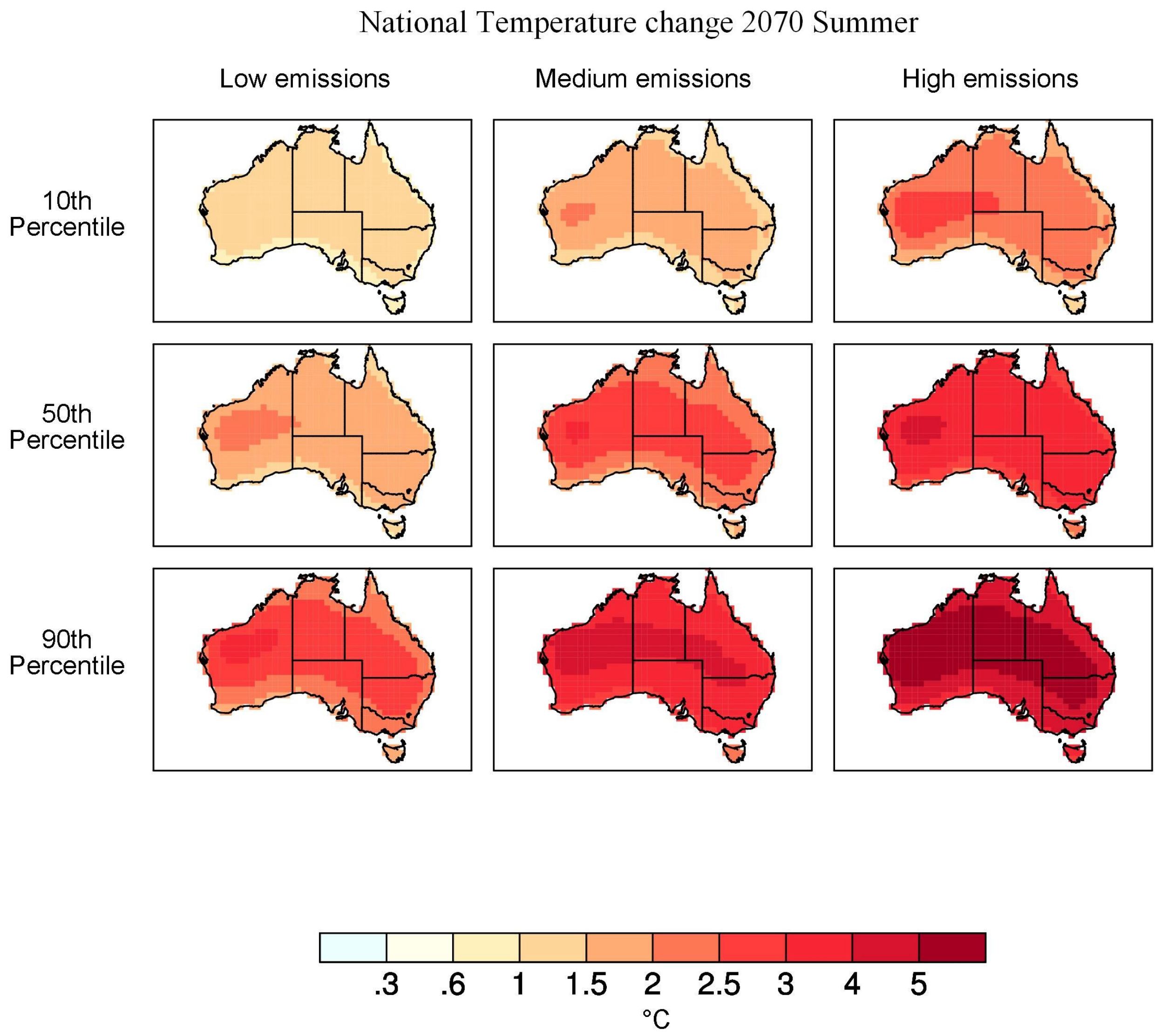
Updated Climate "Forecast" (Annual)

Available at: http://www.climatechangeinaustralia.gov.au

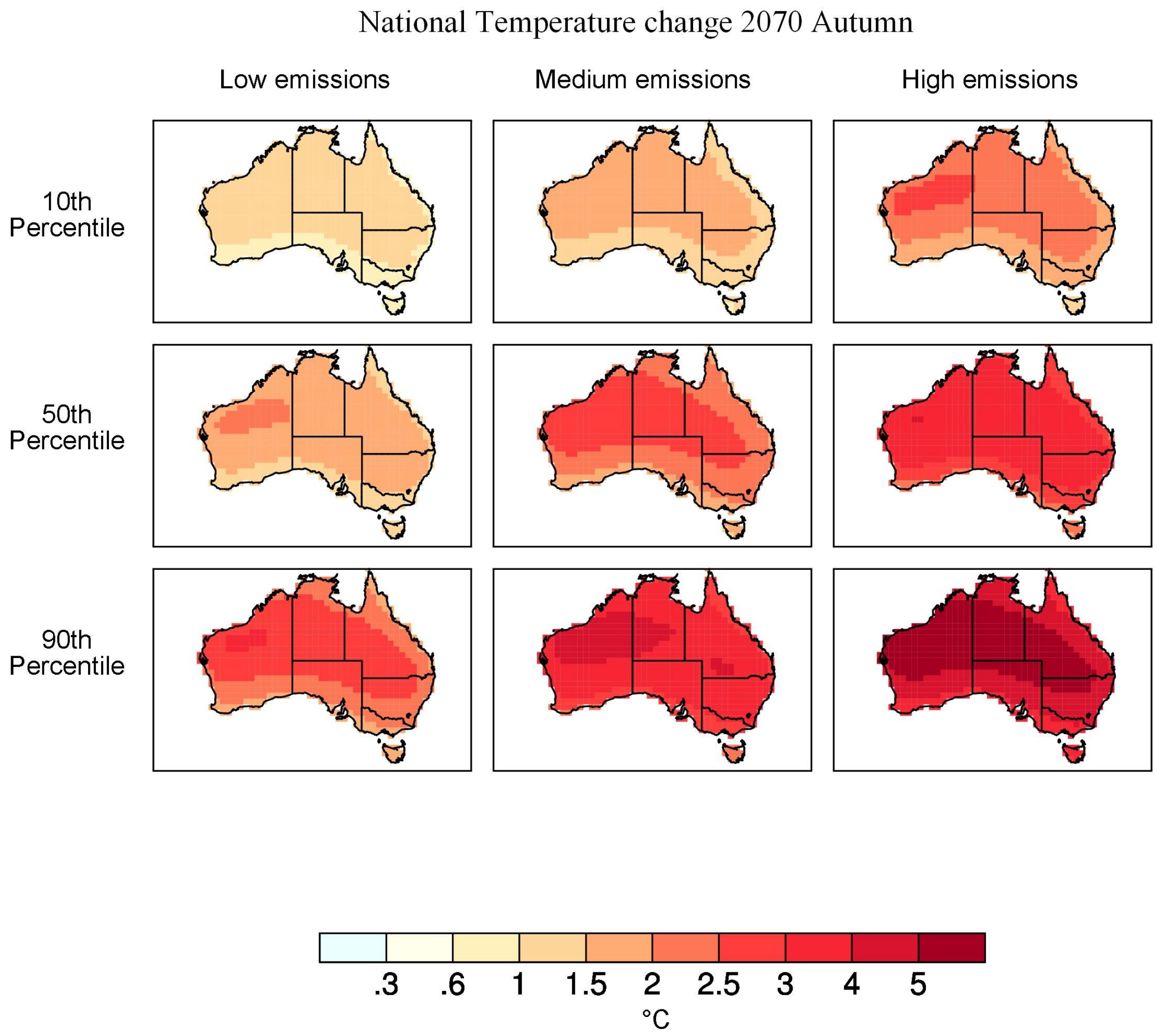


- **More accurate updated projections, at finer resolution**
- **Projections are presented relative to the period 1980-1999 (referred to as the "1990 baseline" for convenience).**
- **The 50th percentile (the mid-point of the spread of model results) provides a best estimate result.**
- **The 10th and 90th percentiles provide a range of uncertainty.**

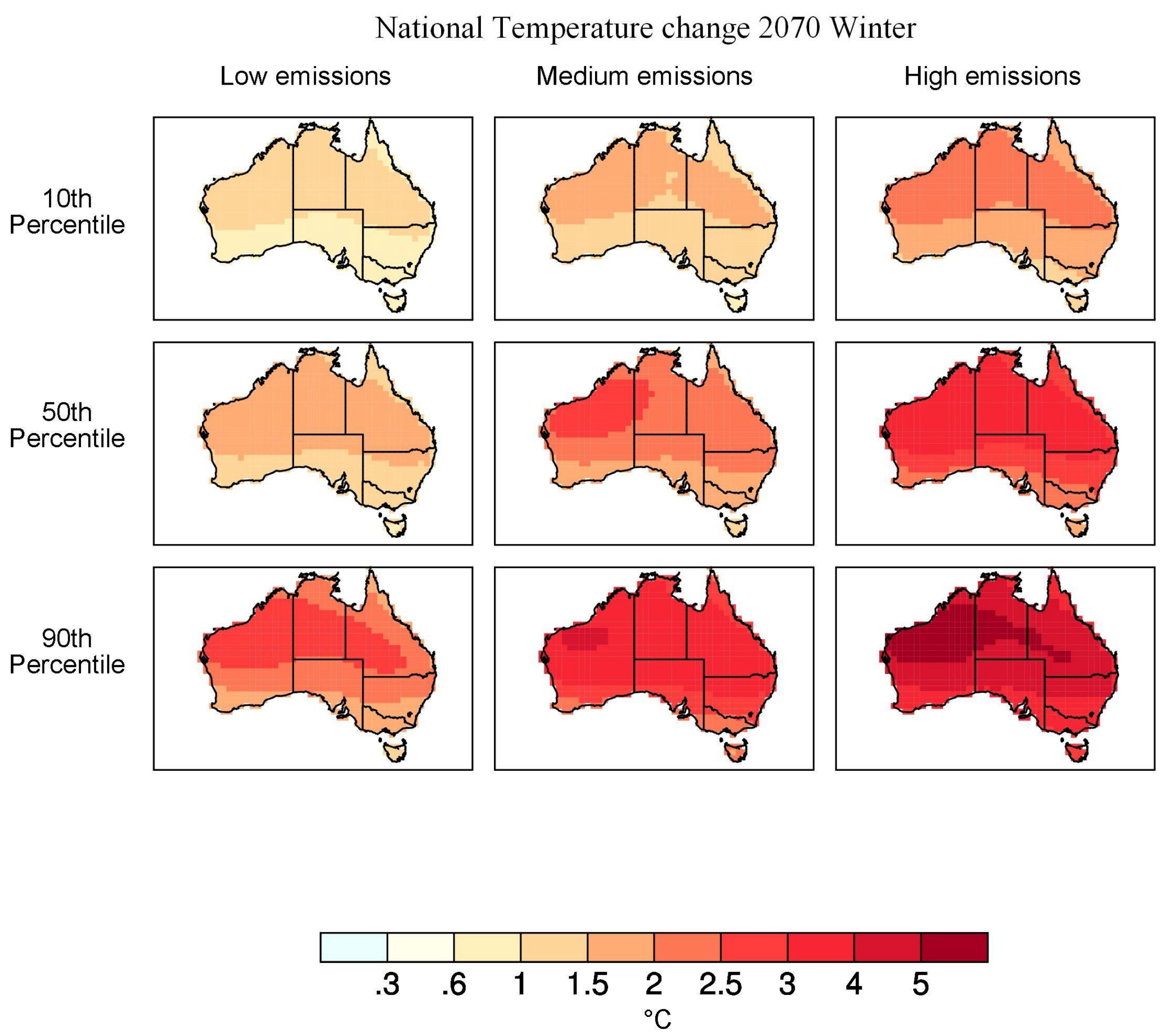
Climate "Forecast" (Summer)



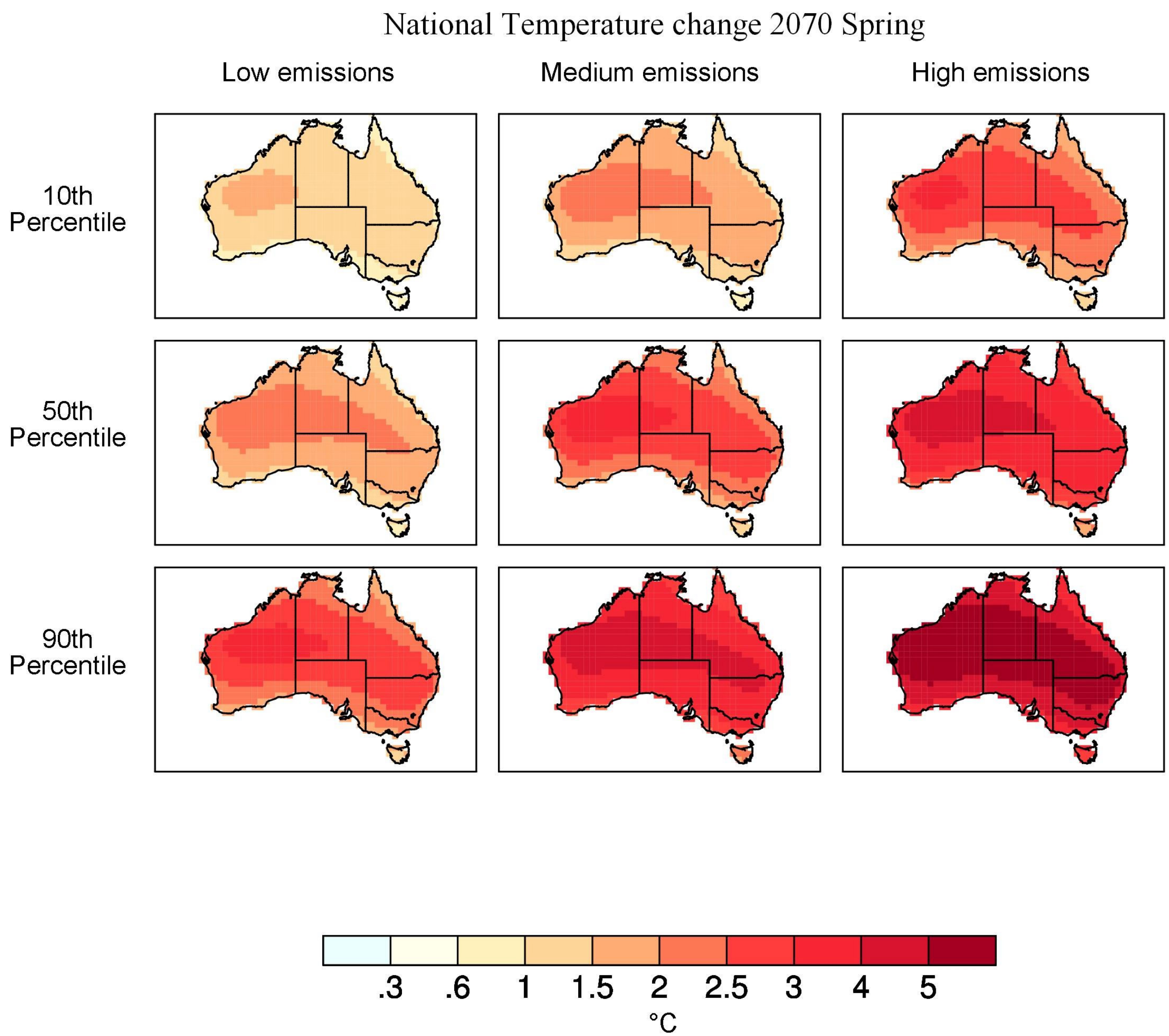
Climate "Forecast" (Autumn)



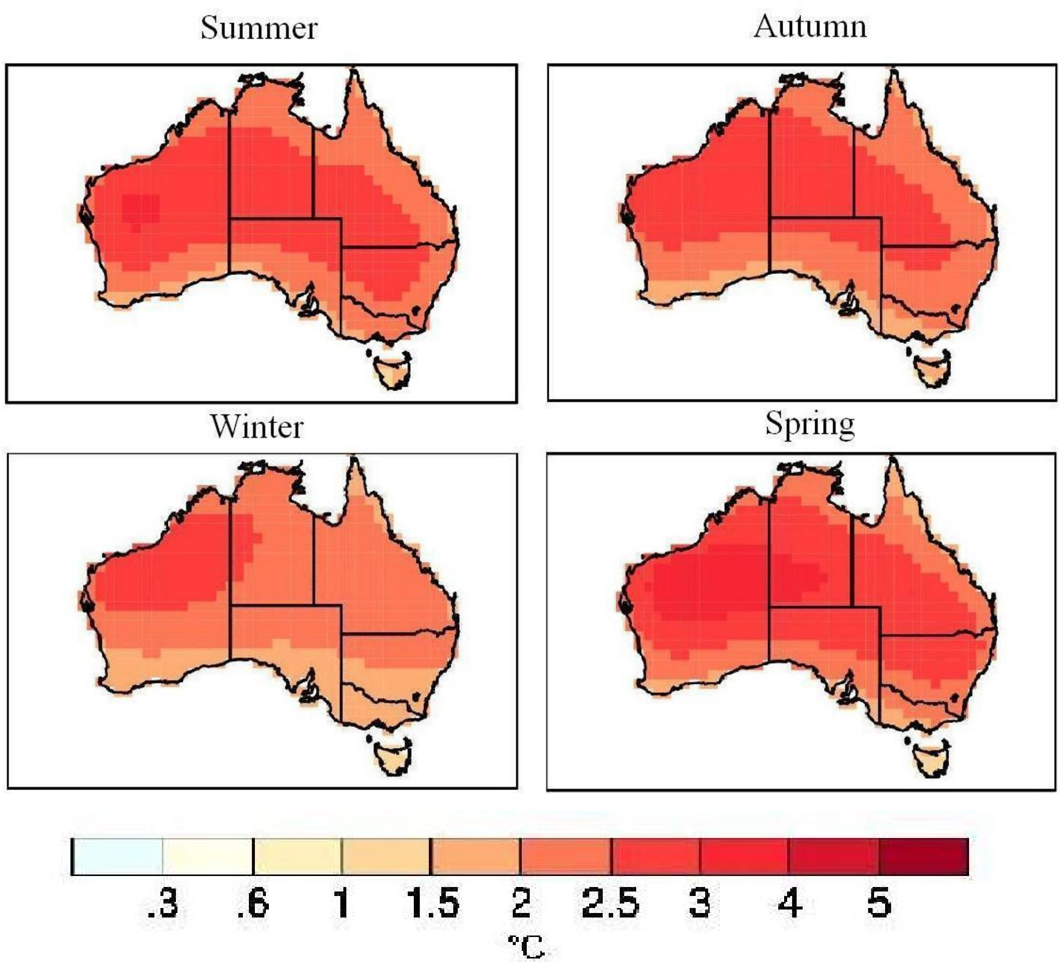
Climate “Forecast” (Winter)



Climate “Forecast” (Spring)

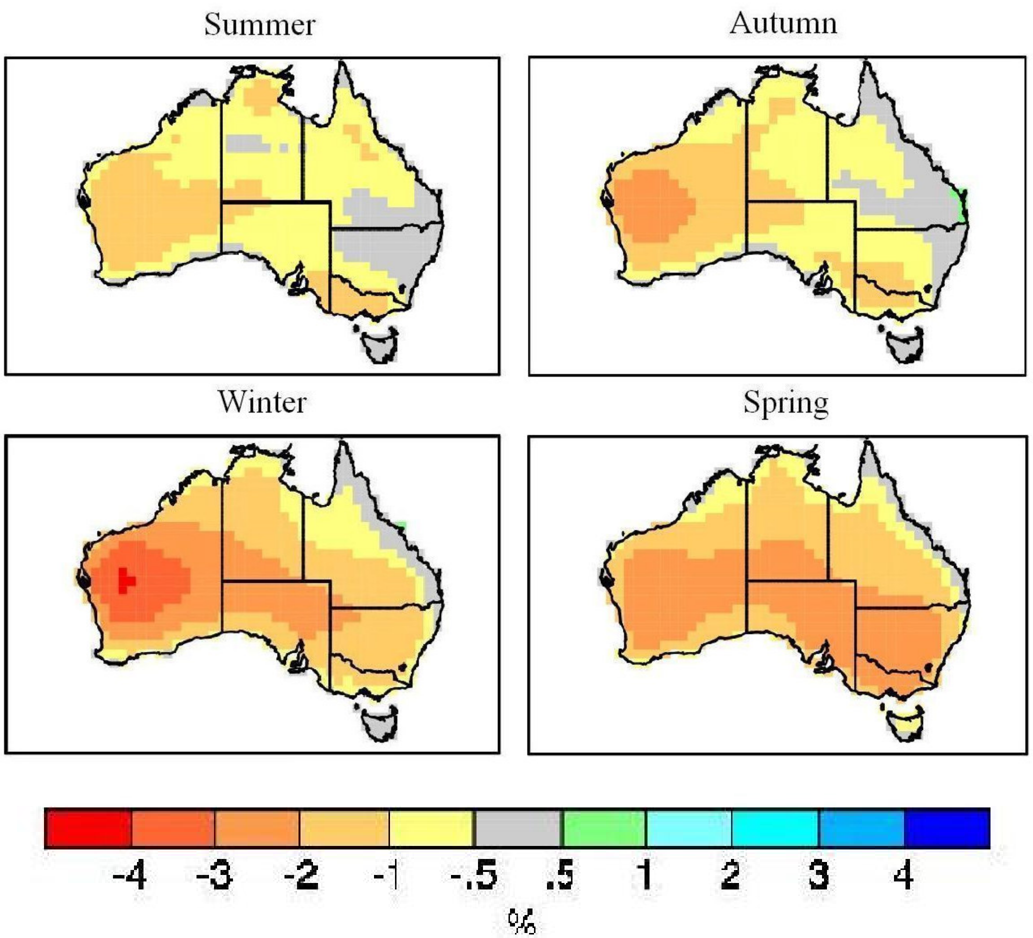


Climate “Forecast” (Seasonal)



- 50th percentile change in dry-bulb temperature

Climate “Forecast” (Seasonal)



- 50^{th} percentile change in Relative Humidity

Setting the Weather Data Baseline

- Based on TRYs created by BOM and CSIRO in 1980s
- Test Reference Year (actual) selected by excluding years of extraordinary dry bulb temperature
- Subsequent “Reference Meteorological Year” (RMY) data (actual months) is selected on the basis of statistical averages. Now marketed by ANZSES and ACADS-BSG for building simulation, but not available at the time of this work
- RMYs for 81 locations now in process for release this year

Creating the Ersatz Weather Data

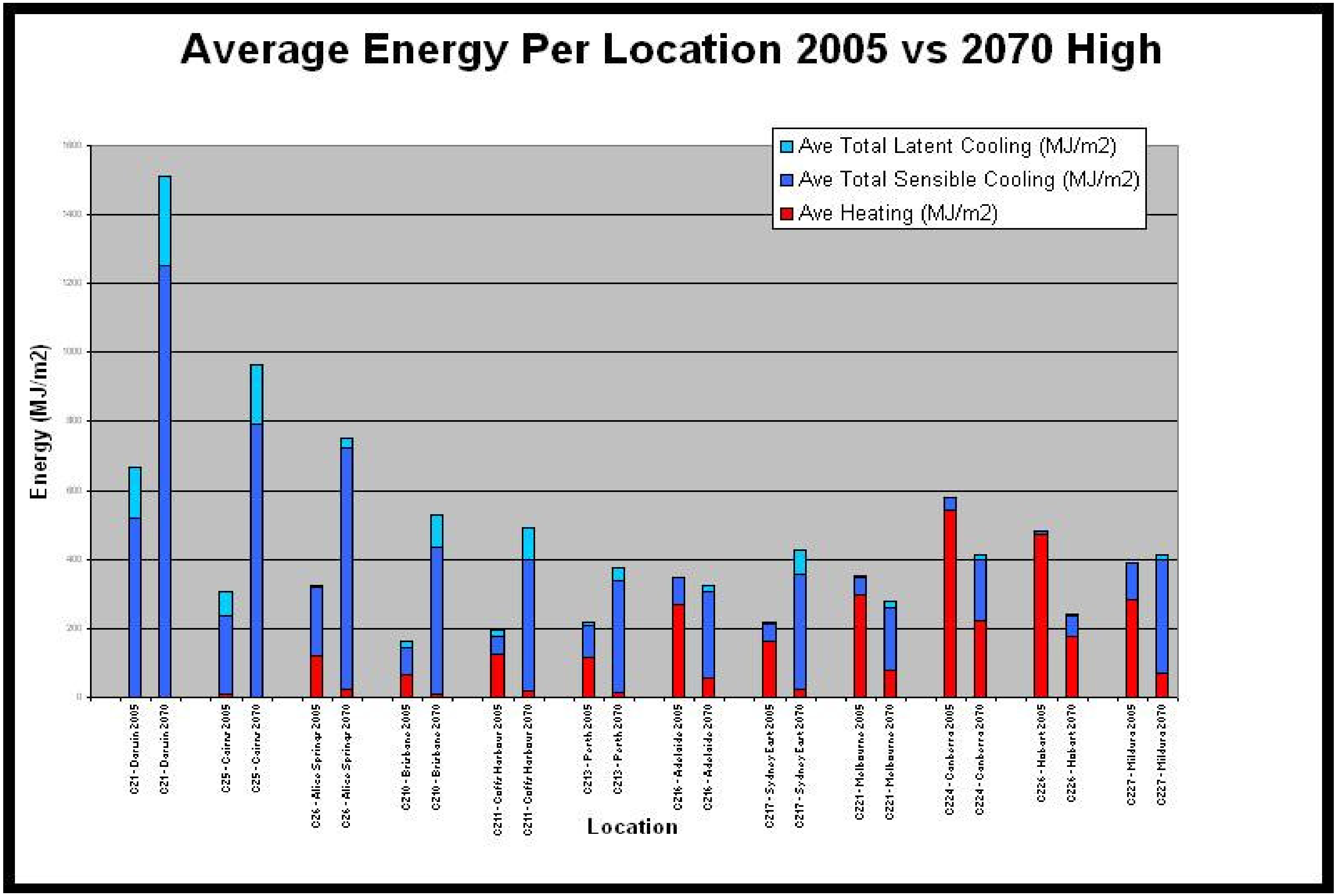
- Only weather files for 2070 created
- Temperature – increment taken as the mid point of the range for the mid point of the season then linearly interpolated for each month

  January+2.0℃, February+1.67℃, March+1.33℃, April+1.0℃
- Humidity – using the same temporal interpolation, applied the mid-point CSIRO increment to the mean RH and mean dry bulb temperature to derive the absolute humidity increment
- Insolation and cloud cover
- Wind

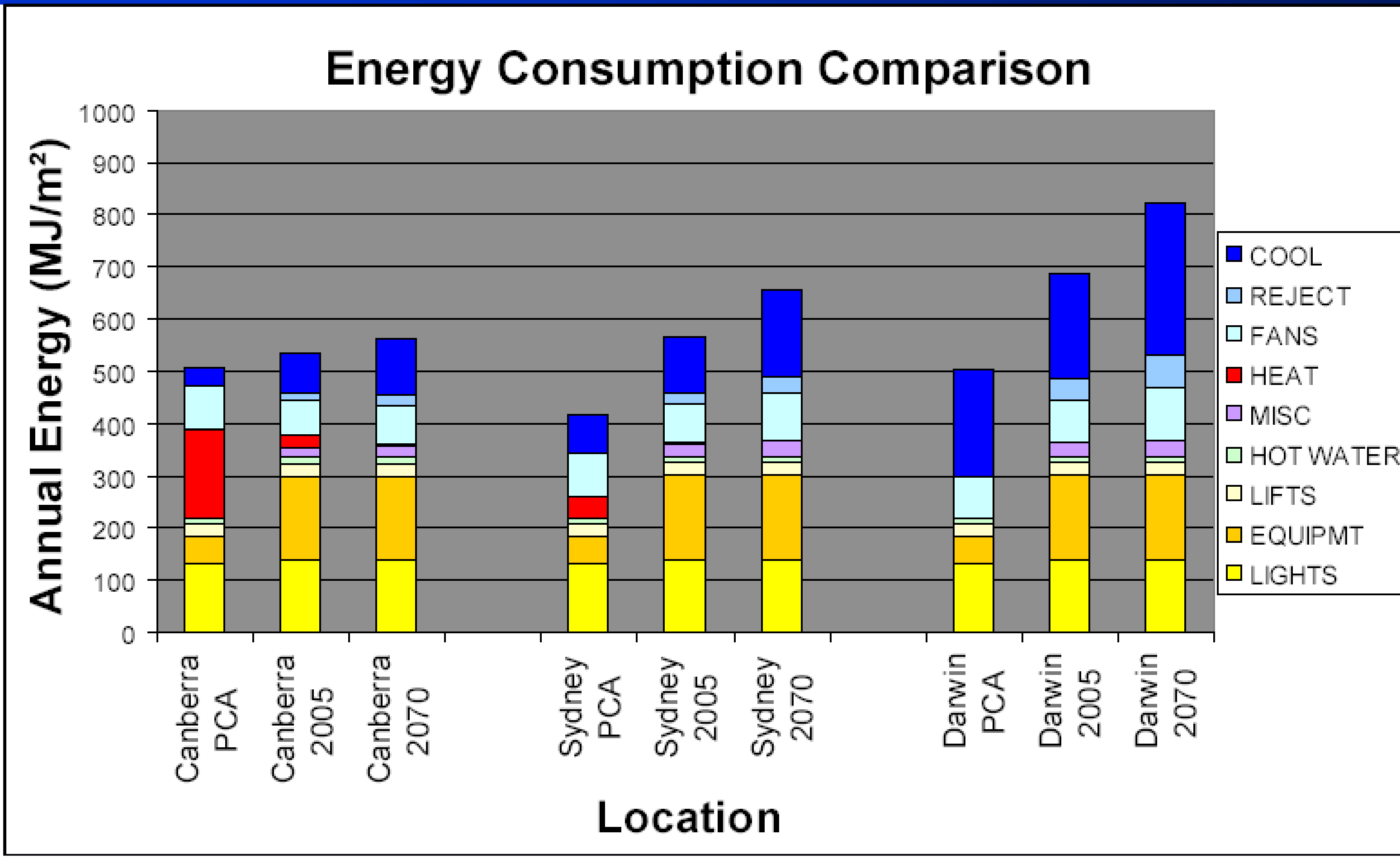
Creating the Ersatz Weather Data

- Insolation and cloud cover
  - irradiance values were retained wherever zero octas (clear sky)
  - total (sum) of global irradiation to be the original level multiplied by the CSIRO increment factor
  - optimisation performed for estimation of “forecast” direct:diffuse ratio
  - for any one hour, direct irradiance was not permitted to increase over TRY levels, while diffuse irradiance was permitted to increase, but restricted to less than double TRY levels
  - cloud cover not incremented due to absence of a technique and it being a second order effect on building energy performance
- Wind
  - keep all wind directions unchanged
  - increase all non-zero wind speeds by the same factor that CSIRO “forecast” for mean wind speeds

Energy Impacts for Dwellings

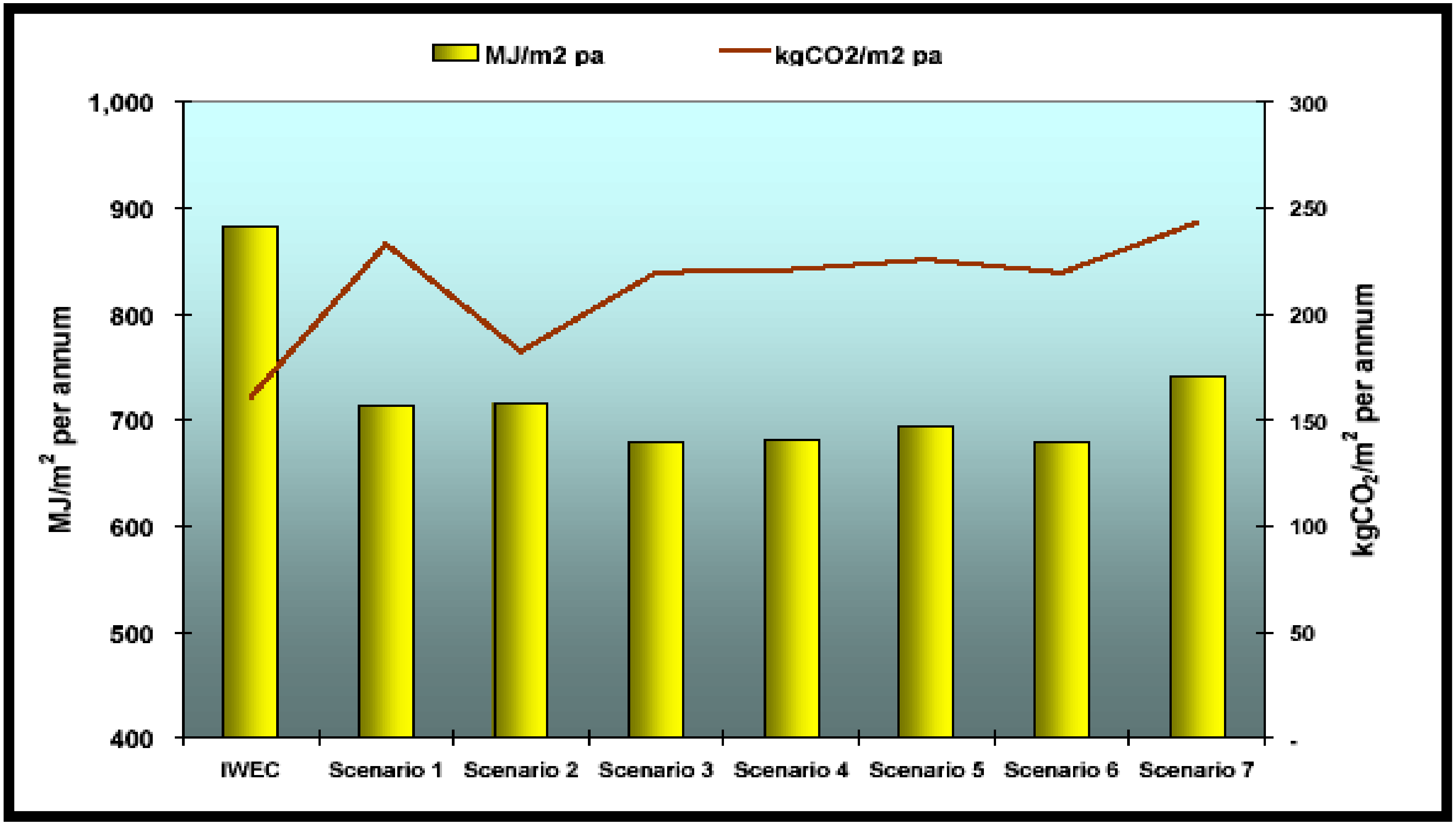


Energy Impacts for Non-residential Buildings



Simulated end-use energy consumption of 10-storey office building

Energy Impacts for Non-residential Buildings



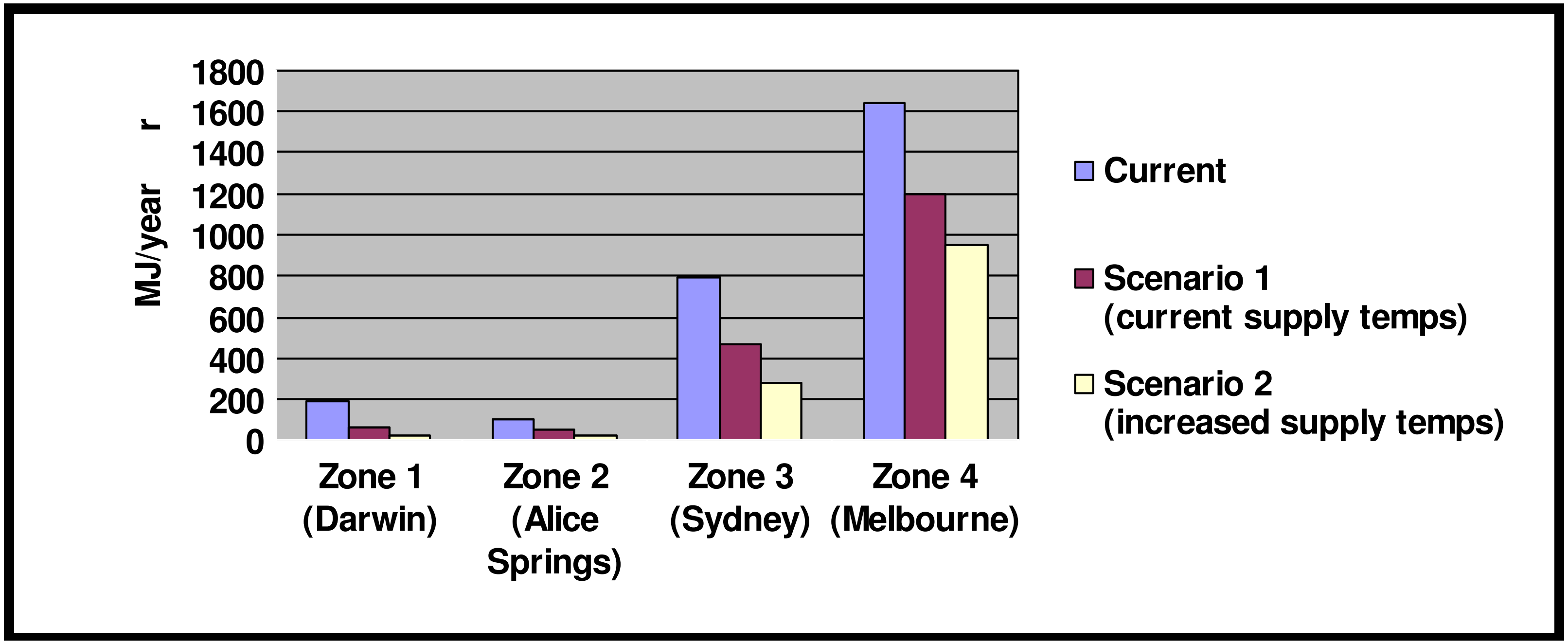
Energy consumption and GHG emissions for Melbourne based hospital

Impacts on plant size

- Residential buildings
  - Average reduction in peak heating loads of 3.66 kW
  - Average increase in peak cooling loads of 4.38 kW
- Office buildings
  - 10-storey office block showed average increase in cooling plant capacity of 17%
  - Reduction in heating plant capacity of 5%
- Melbourne based hospital
  - Average reduction in heating plant capacity of 32%
  - Average increase in cooling plant capacity of 3%

Single Household Solar Water Heating

- Large reductions in auxiliary energy demand
  - Greatest relative improvements in warm climates
  - Greatest absolute improvements in cool climates



Building Integrated Photovoltaics

- Overall improved performance under future climatic conditions
  - Greater improvement in amorphous silicon PV systems compared to mono crystalline silicon PV systems

	Performance Increase (2070)	
	M-si	A-Si
Darwin	4.4%	6.6%
Sydney	3.2%	5.5%
Melbourne	6.9%	8.8%

Limitations of the Ersatz Weather Data

- changes to the four key weather elements of temperature, humidity, solar and wind are <u>not</u> independent of each other but their future values were predicted as though they are
- for worst case scenarios we put together the most challenging values for each in the one "future climate" for each location
- likely to overestimate the impact of climate change

Conclusions in 2005

- a general increase in the energy consumption of air conditioned buildings and a decrease in the heating:cooling ratio for cooler climates as a result of "forecast" climate change
- also a reduction in the size of heating plant (and its obviation in some warmer climates) and an increase in the size of cooling and dehumidifying plant
- review of relevant HVAC sizing guides recommended then is now under active consideration

Current and Future Work

- sensitivity analyses on the impacts of several weather elements in differing combinations
- specific element-inter-related projection scenarios based on climate modelling are needed to improve accuracy (e.g. Mitchell, 2003 as cited by Crawley, below)
- allowance for the projected increased frequency of extreme events (e.g. “heat waves”) needs to be included in these “forecasts”

Current and Future Work

- Re-setting the baseline
  - The 2008 update to the ACDB includes improvements to calculations in several areas
  - New “forecast” RMYs based on data 1967 to 2007 and using these techniques are likely to become available by the end of 2008
  - Ideally, new baseline RMYs would be created for the 1980-1999 period forming the baseline of specific CSIRO projections published by BOM
  - Similarly, harmonisation of baseline periods around the world is needed for direct comparison with similar work elsewhere

Current and Future Work

- "Forecast" XMYs (eXtreme Meteorological Years) are needed for design and evaluation purposes
- other applications of these techniques may include estimation of the effect of urban heat islands, as in the upcoming paper:

  Crawley, D. *"Estimating the impacts of climate change and urbanisation on building performance".* Journal of Building Performance Simulation, yet to be published.

- There is an urgent need for review of sizing guides for HVAC to ensure comfort/control over the full life of new buildings

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