

*DAFF climate discussion*  
*Emerald*  
*30/07/10*

- Our climate is always changing.
- Our climate is influenced by both natural variability and human induced environmental changes on differing time scales

## *Natural Variability Includes*

- The annual cycle
- El Nino/Southern Oscillation, Pacific Decadal Oscillation, North Atlantic Oscillation
- Volcanic eruptions
- Fluctuations in solar output
- Orbital Cycles
- Ocean and Polar Ice Variations

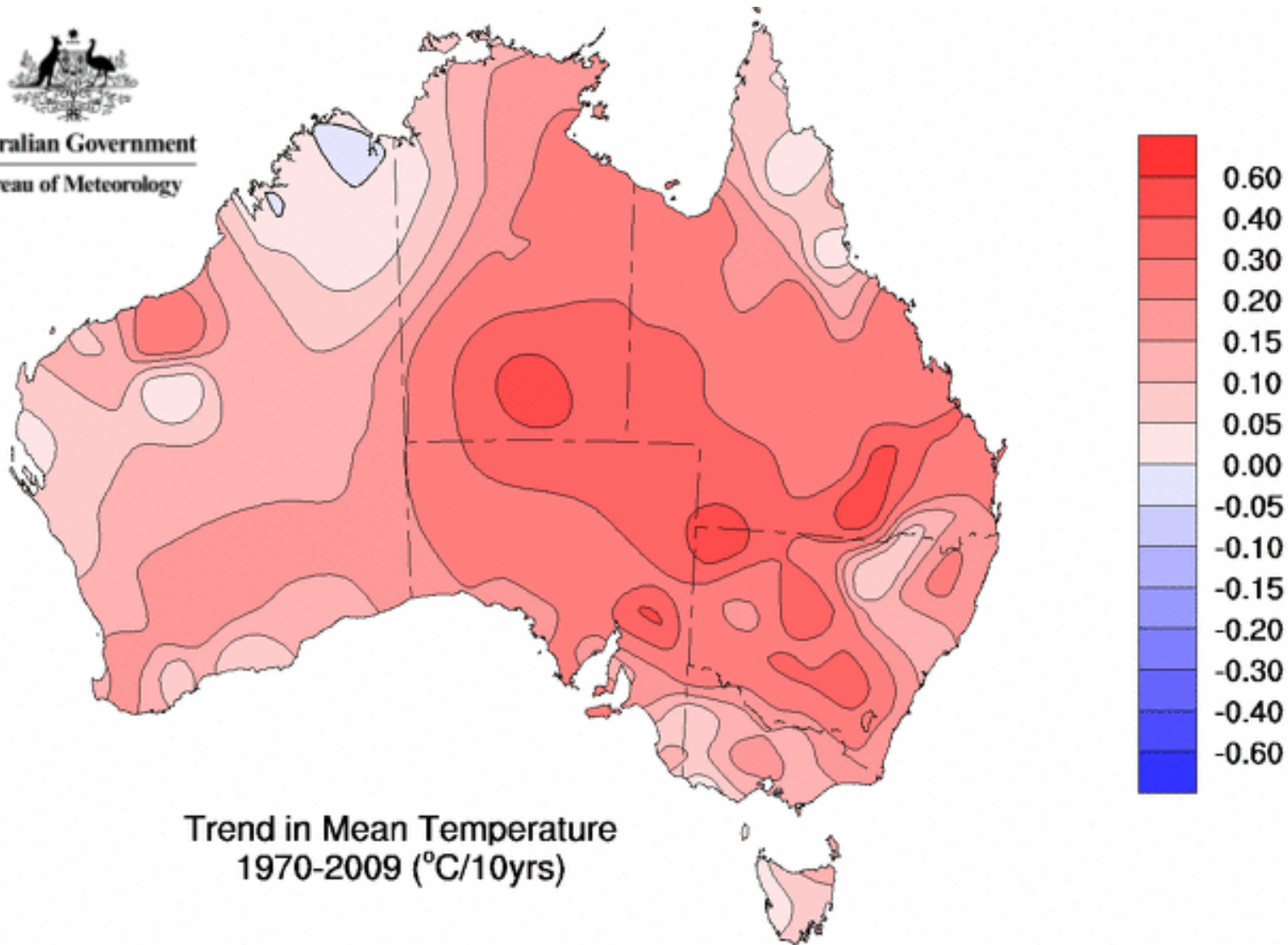
## *Human Influences Include*

- Changing land use
- Changing urban climates
- Anthropogenic sources of greenhouse gases (increase in CO<sub>2</sub>, methane etc = increase in temperature)
- Aerosols and other pollutants

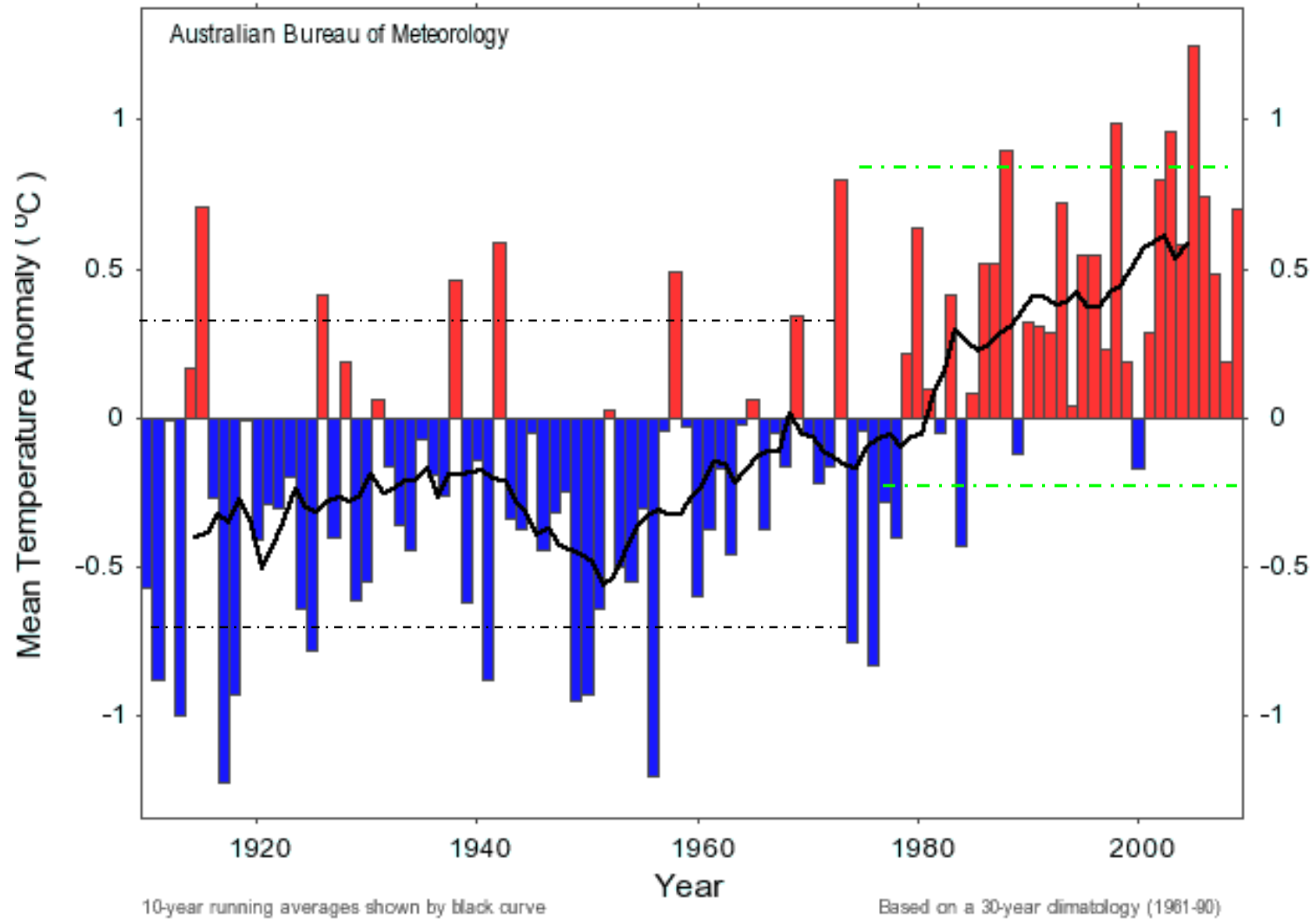
## *Greenhouse gases*

- Did not arrive with the last federal election cycle
- Svante Arrhenius
  - 1903 Nobel Laureate in Chemistry
  - Combined existing research on greenhouse effect (Fourier 1827) with work suggesting the burning of fossil fuels could alter the concentration of carbon dioxide in the atmosphere (Hogbom 1894) to be the first to calculate greenhouse warming associated with carbon dioxide (1896) and predict possibility of man made global warming

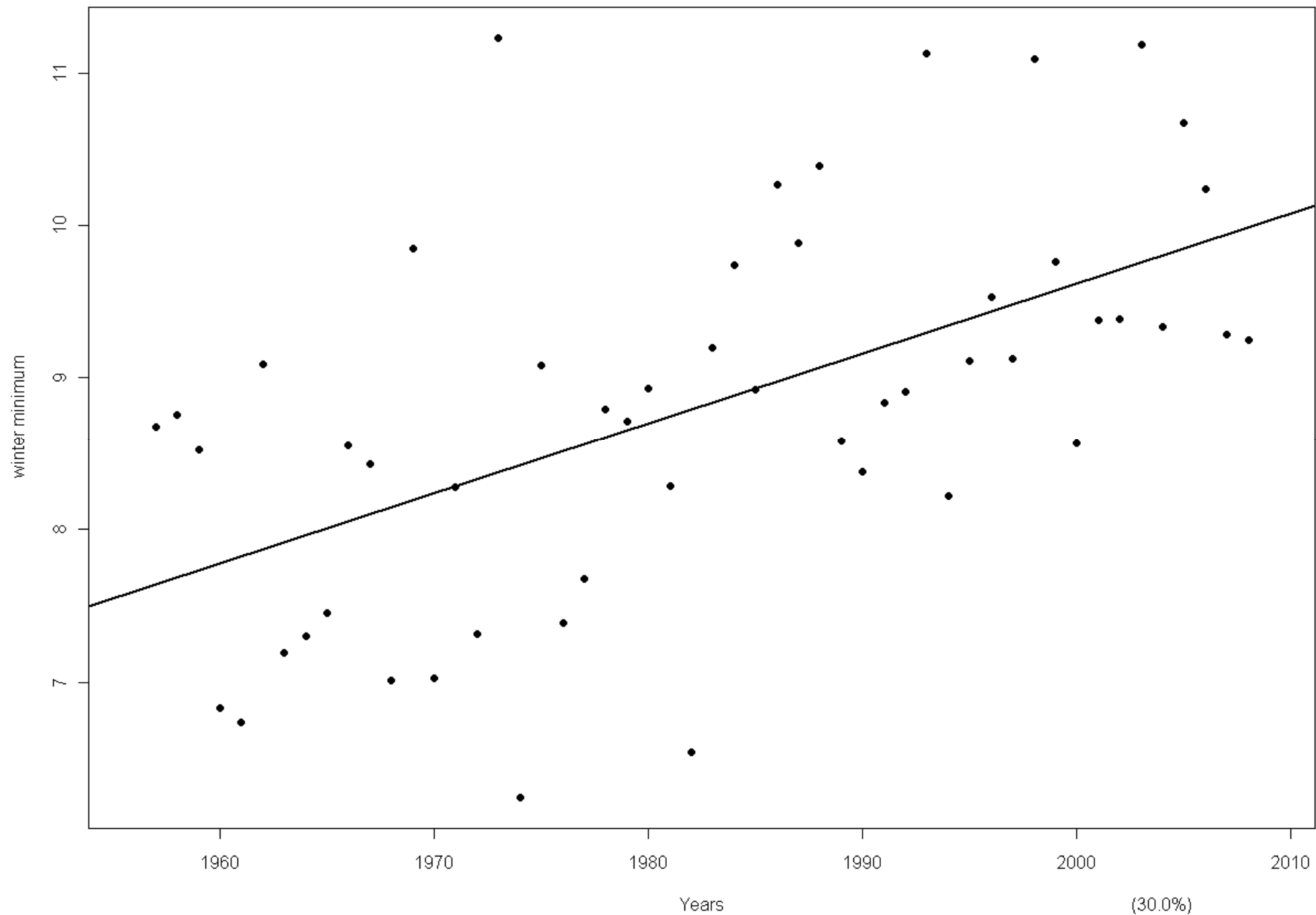
# Observations of recent change



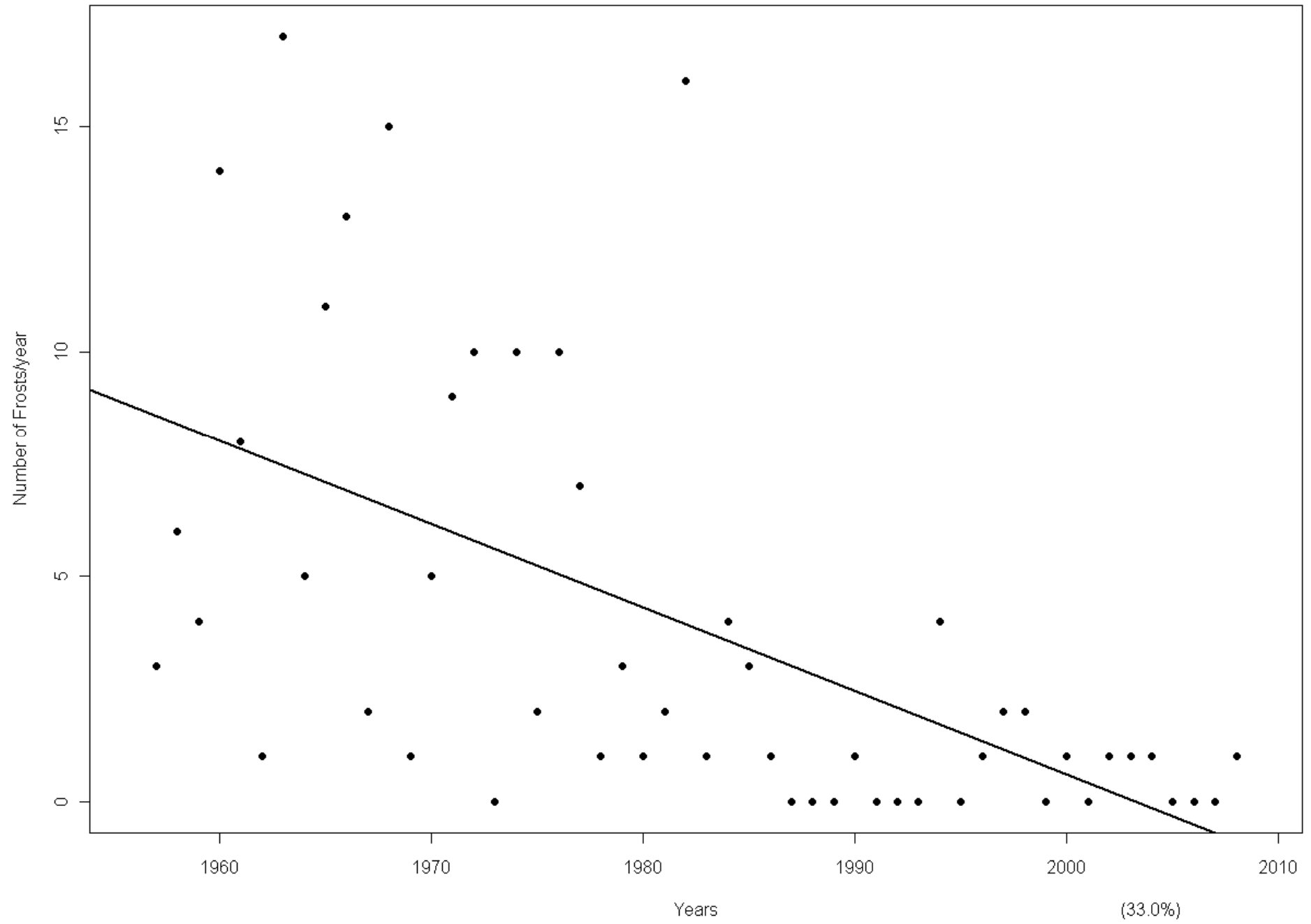
# Annual Mean Temperature Anomaly - Queensland



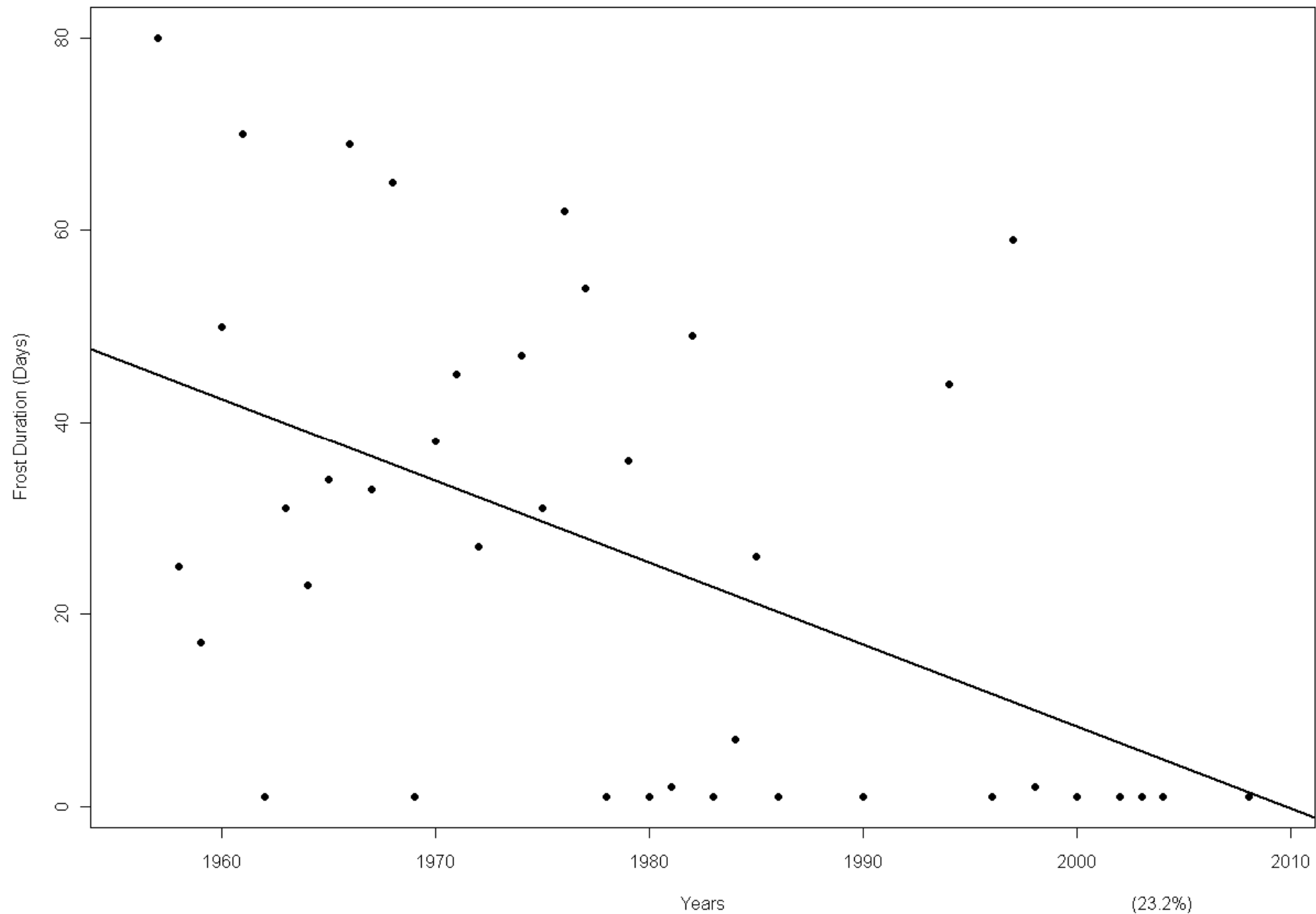
# Emerald



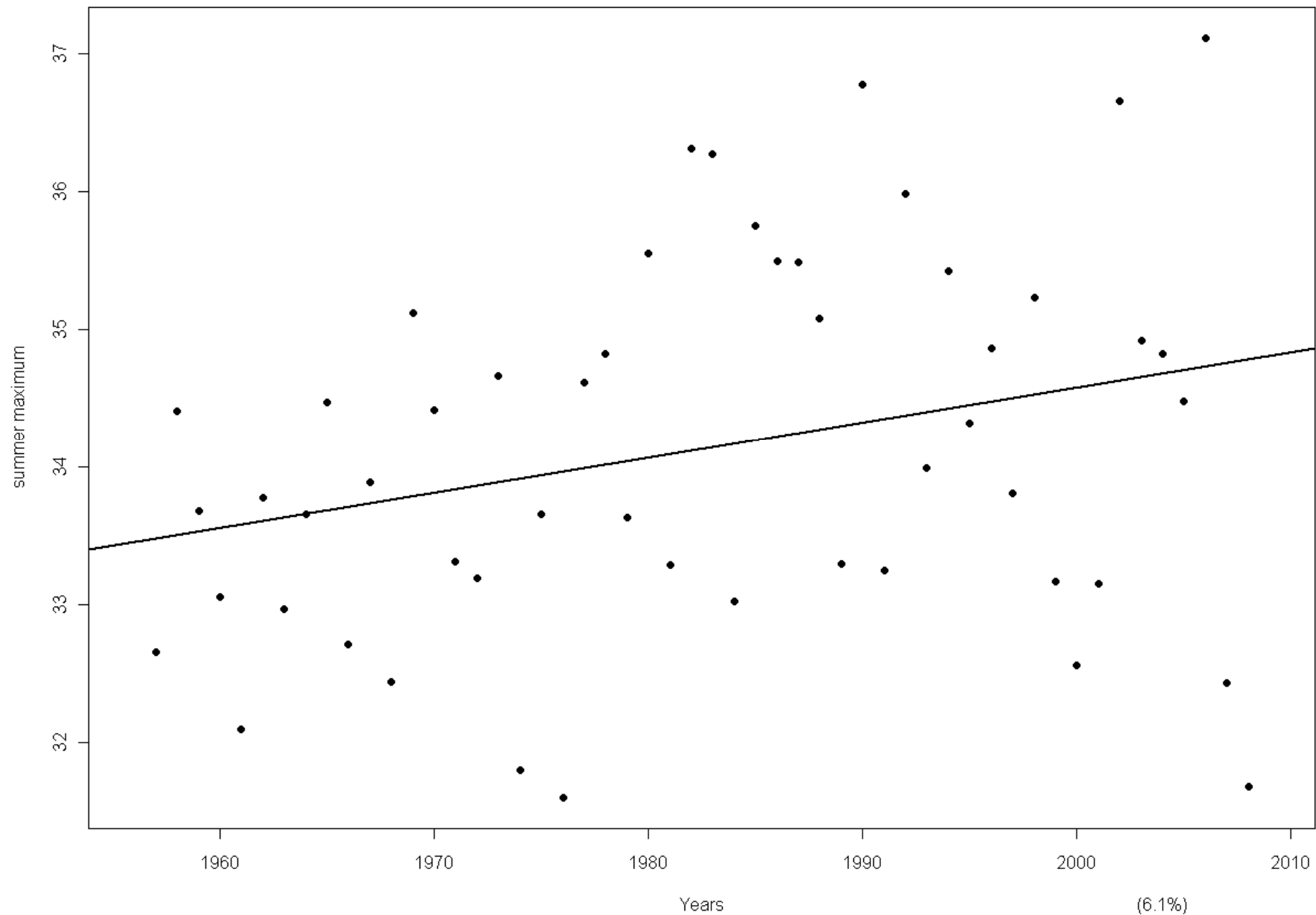
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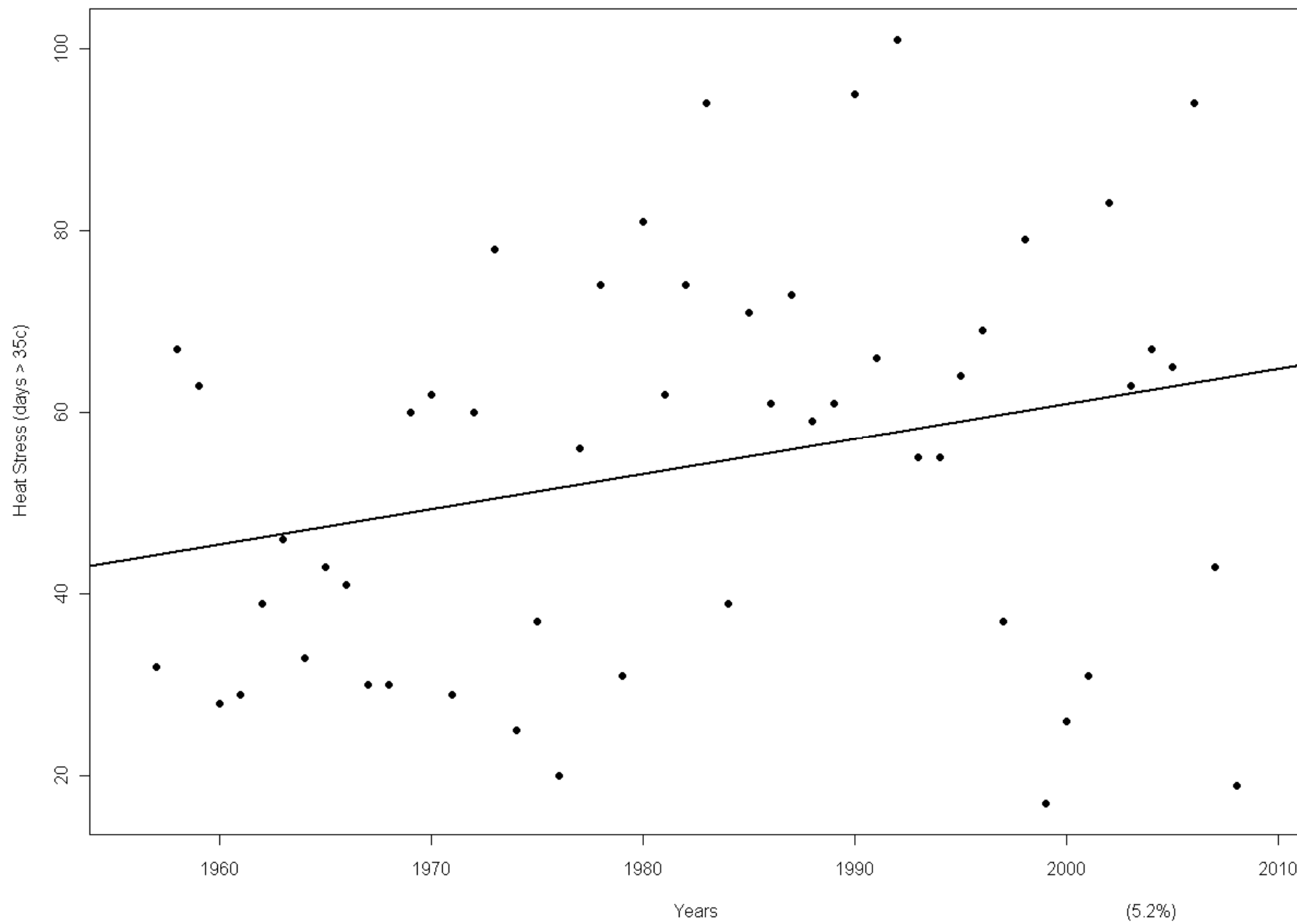
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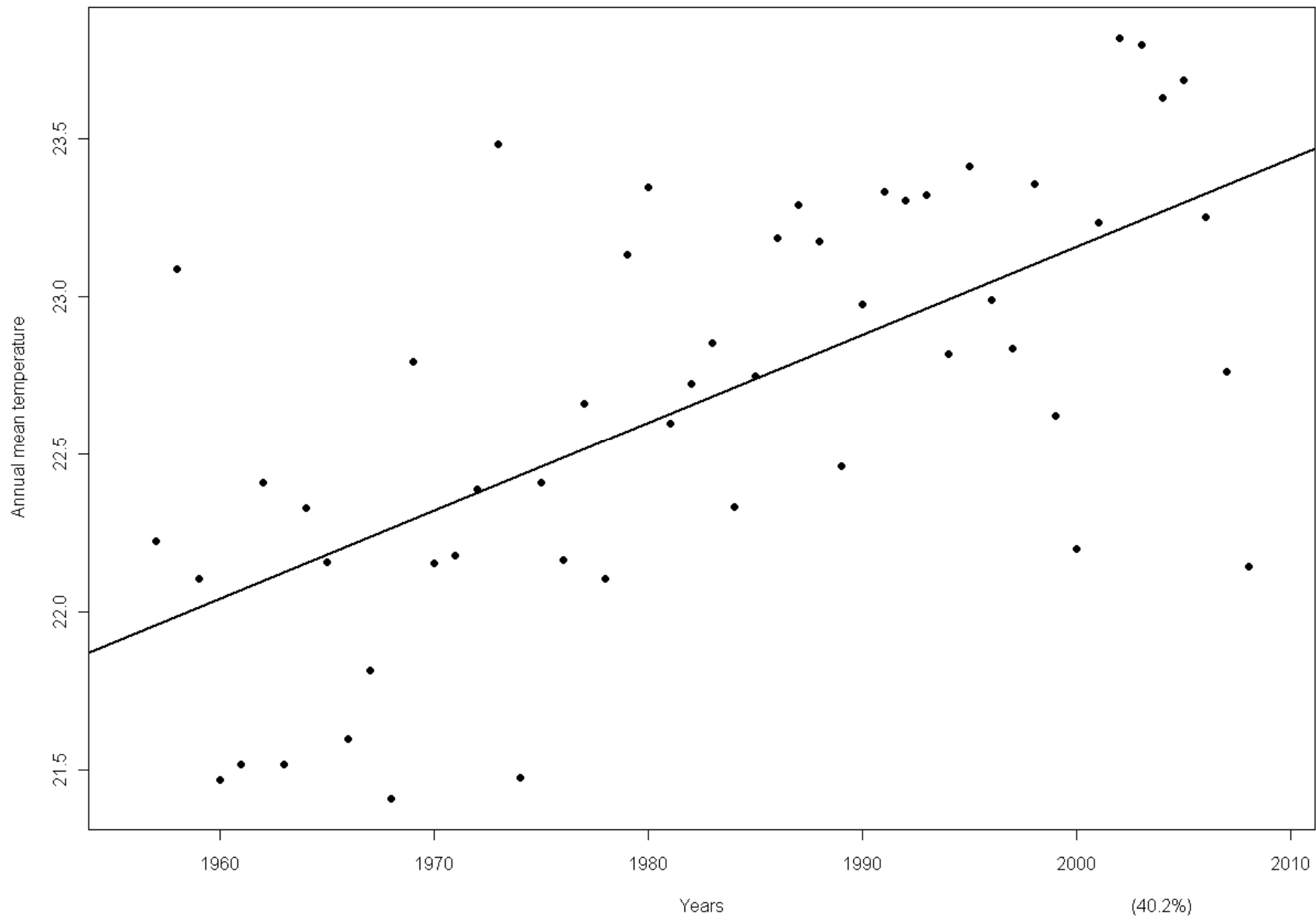
# Emerald



# Emerald



# Emerald



# *Temperature summary*

- All of Australia has experienced warming over past 50 years
- Some areas have experienced warming since 1960 of up to 0.4 degree C per decade – total warming over last 5 decades of 1.5 to 2 degree C
- Number of hot days has increased per decade over past 50 years
- There have been fewer cold days
- 2000 to 2009 was Australia's warmest decade on record

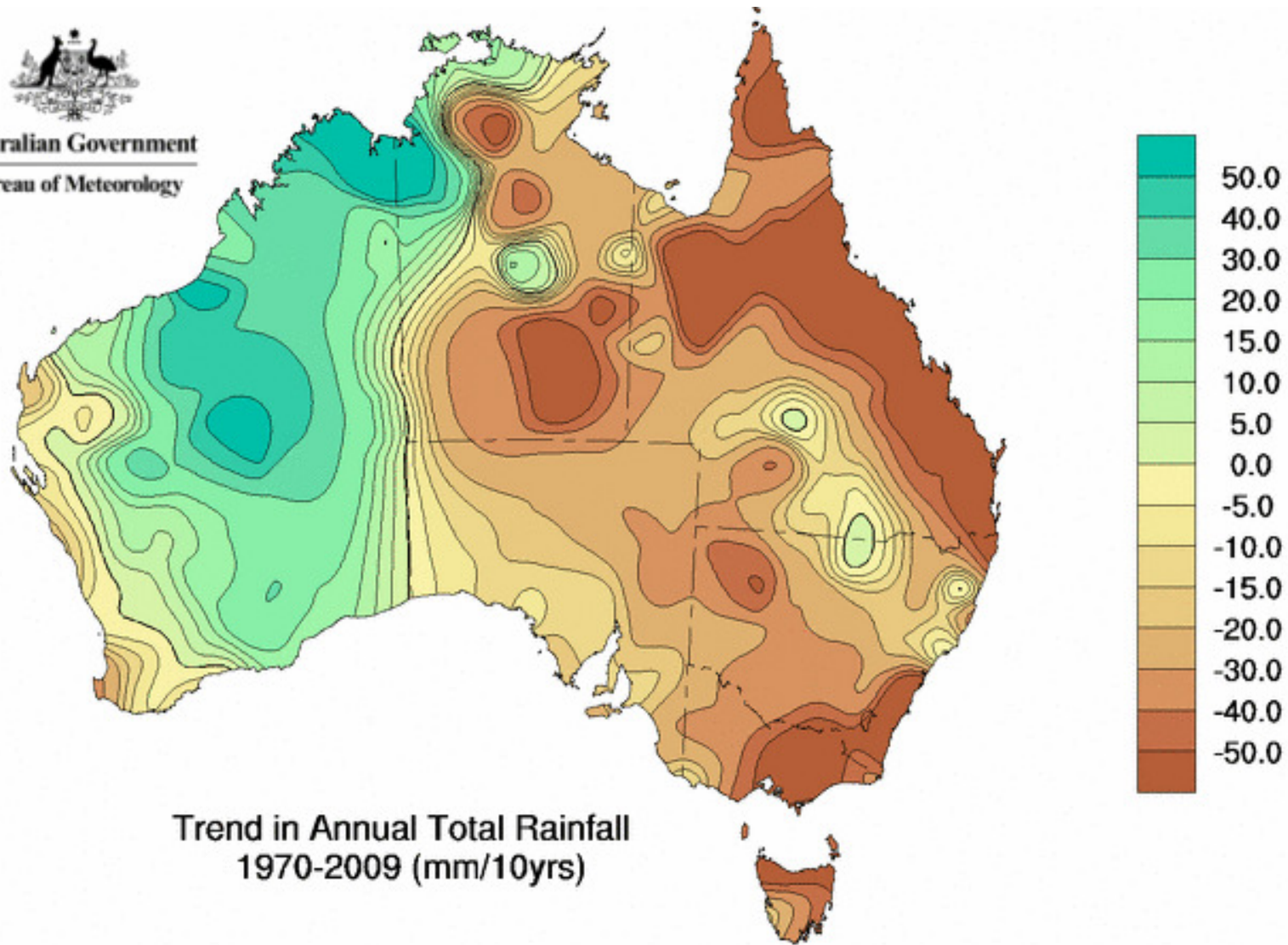
# *Temperature projections*

Department of Environment  
and Resource Management

- Annual mean temperature is projected to increase by further 1.0 degree C by 2030 (by 1.3 to 2.8 degree C by 2050)
- There is little variation in projections between the seasons
- Potential evaporation increase of between 3 to 4% by 2030 (6% increase in winter and spring)

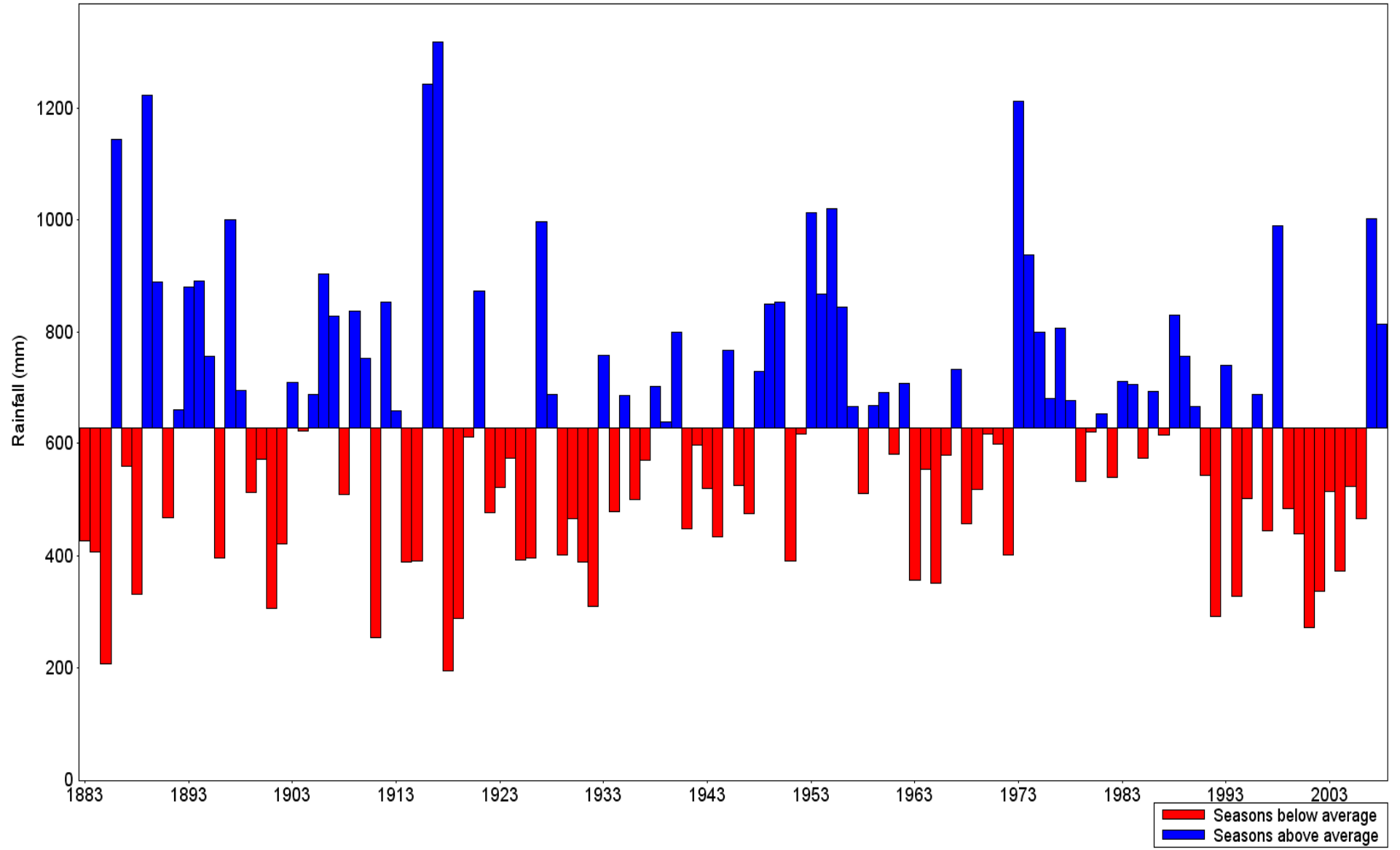
# Observations of recent change

  
Australian Government  
Bureau of Meteorology



### Seasonal rainfall (12 months, May in year 1 to Apr in year 2) at EMERALD AIRPORT COMPOSITE\*

Long-term average rainfall (12 months, May in year 1 to Apr in year 2) is 628 mm

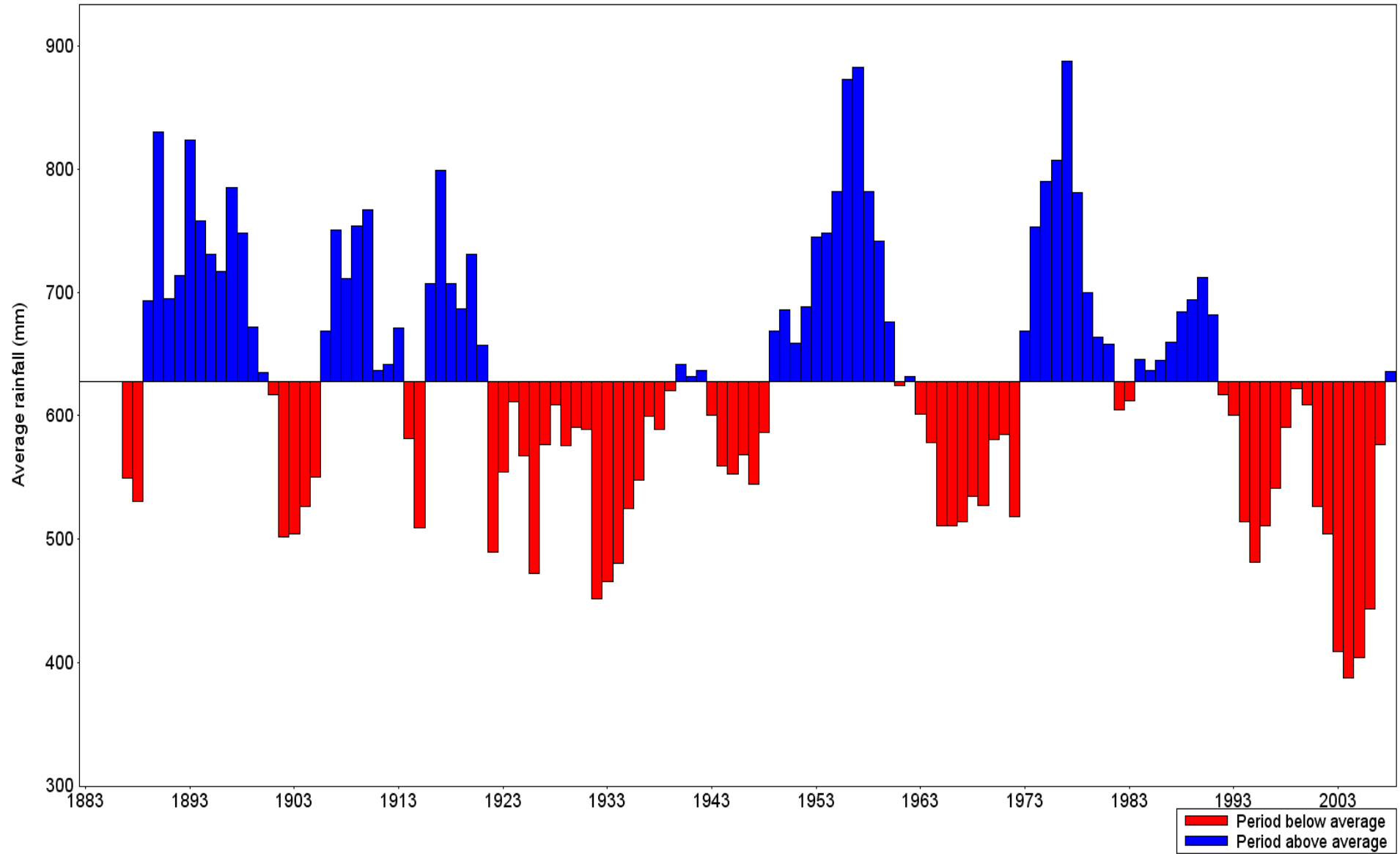


Ending year of rainfall

Source: Rainman StreamFlow

### 5-year moving average rainfall (12 months, May in year 1 to Apr in year 2) at EMERALD AIRPORT COMPOSITE\*

Long-term average rainfall (12 months, May in year 1 to Apr in year 2) is 628 mm

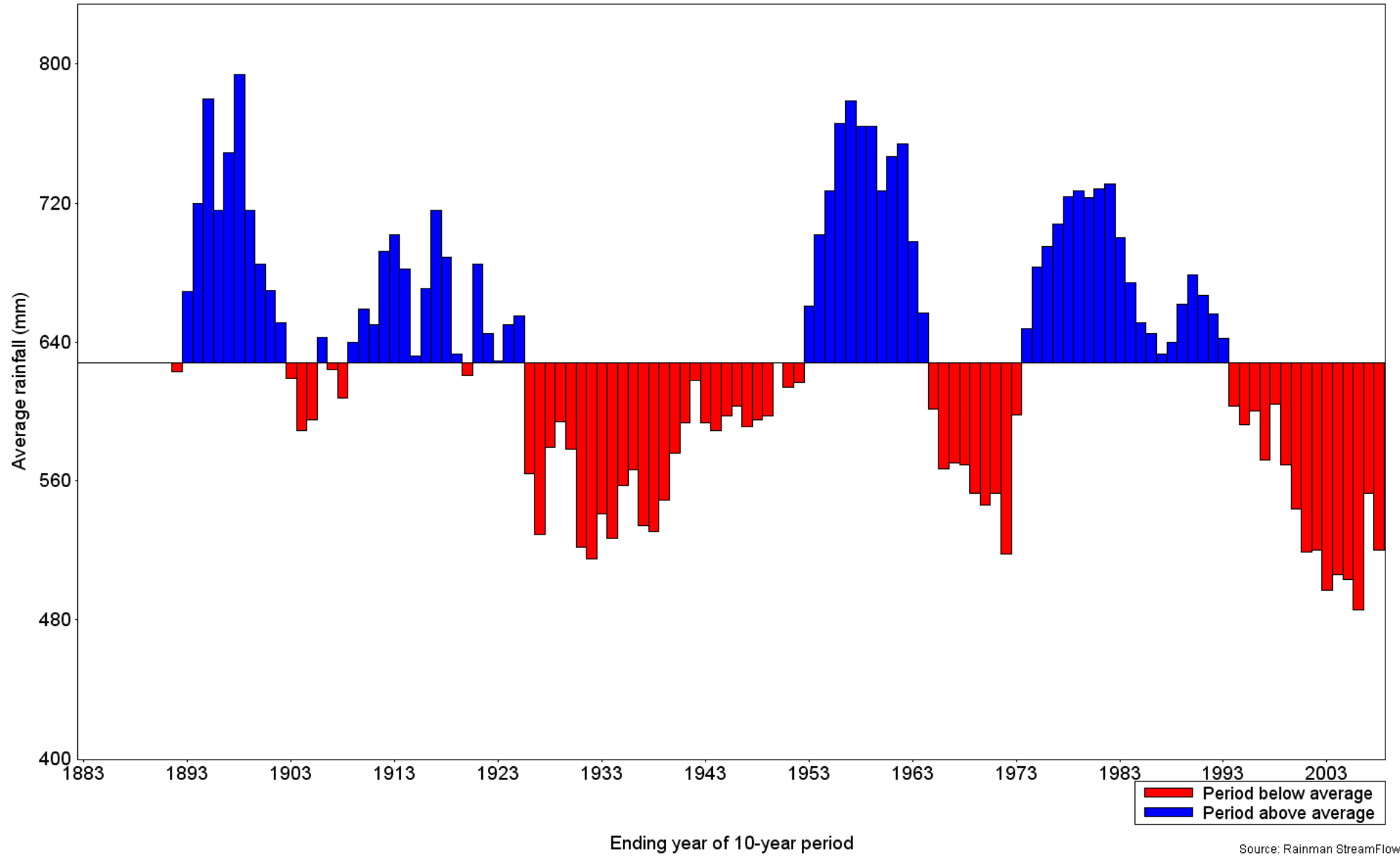


Ending year of 5-year period

Source: Rainman StreamFlow

### 10-year moving average rainfall (12 months, Apr in year 1 to Mar in year 2) at EMERALD AIRPORT COMPOSITE\*

Long-term average rainfall (12 months, Apr in year 1 to Mar in year 2) is 628 mm



## *Rainfall summary*

- Trend over 5 decades of increasing rainfall in many parts of northern and central Australia
- Trend over 5 decades of rainfall decreasing across much of southern and eastern Australia
- Long term rainfall at Emerald is 628mm (using rainfall records 1883 to 2010)
- Last 10 year average is 522mm (-106mm)

# *Rainfall projections*

- CQ average annual rainfall in the last decade fell nearly 14% compared with previous 30 years. This is generally consistent with natural variability
- This makes it difficult to detect any anthropogenic climate change impact
- Annual rainfall is projected to decrease by 3% by 2030 with seasonal decrease of 6% for spring; (7% by 2050, 12% for spring)

## *So what does this mean*

- Australia will likely be hotter. These changes will be through an increase in number of hot days
- Much of Australia will likely be drier (southern Australia during winter, southern and eastern Australia during spring and south west Australia during autumn).
- Likely increase in number of consecutive dry days but likely increase in intensity of rainfall events

# *Change and Adaptation*

Department of Environment  
and Resource Management

- Consequences of climate change are already impacting on agriculture
- Climate change can be viewed as another mode of climate variability
- There will be winners and losers
- Resilience (profitability and sustainability) is the key: by focusing on increasing a business's resilience will ensure that the business can manage changes in it's operating environment (climate, market forces etc) into the future



# *Adaptation strategies*

- **Grazing industry**
  - Changes in grazing systems from set grazing rates to more variable rotational/cell/spell grazing systems
  - Carbon grazing system
  - Changes in production system
  - Change in species
  - Changes in breeding cycles
  - Changes in enterprise structure
  - Improvement in infrastructure

# *Adaptation strategies*

- Crop industries
  - Variety and planting date changes
  - Species change
  - Changes in crop management
  - More opportunity cropping
  - Increase risk of soil erosion due to higher rainfall intensity
  - Improvement in infrastructure

## Feature of climate change

Department of **Environment  
and Resource Management**

1. Elevated CO <sub>2</sub>
2. Increased evaporation
3. Higher minimum temperature
4. Less frost
5. Higher maximum temperature
6. More days over 35°C
7. More droughts
8. Increased rainfall intensity
9. Decrease in winter rainfall
10. Increased coastal erosion/inundation due to sea level rise
11. Increased local flooding
12. More bushfires
13. Higher Peak Wind Speeds

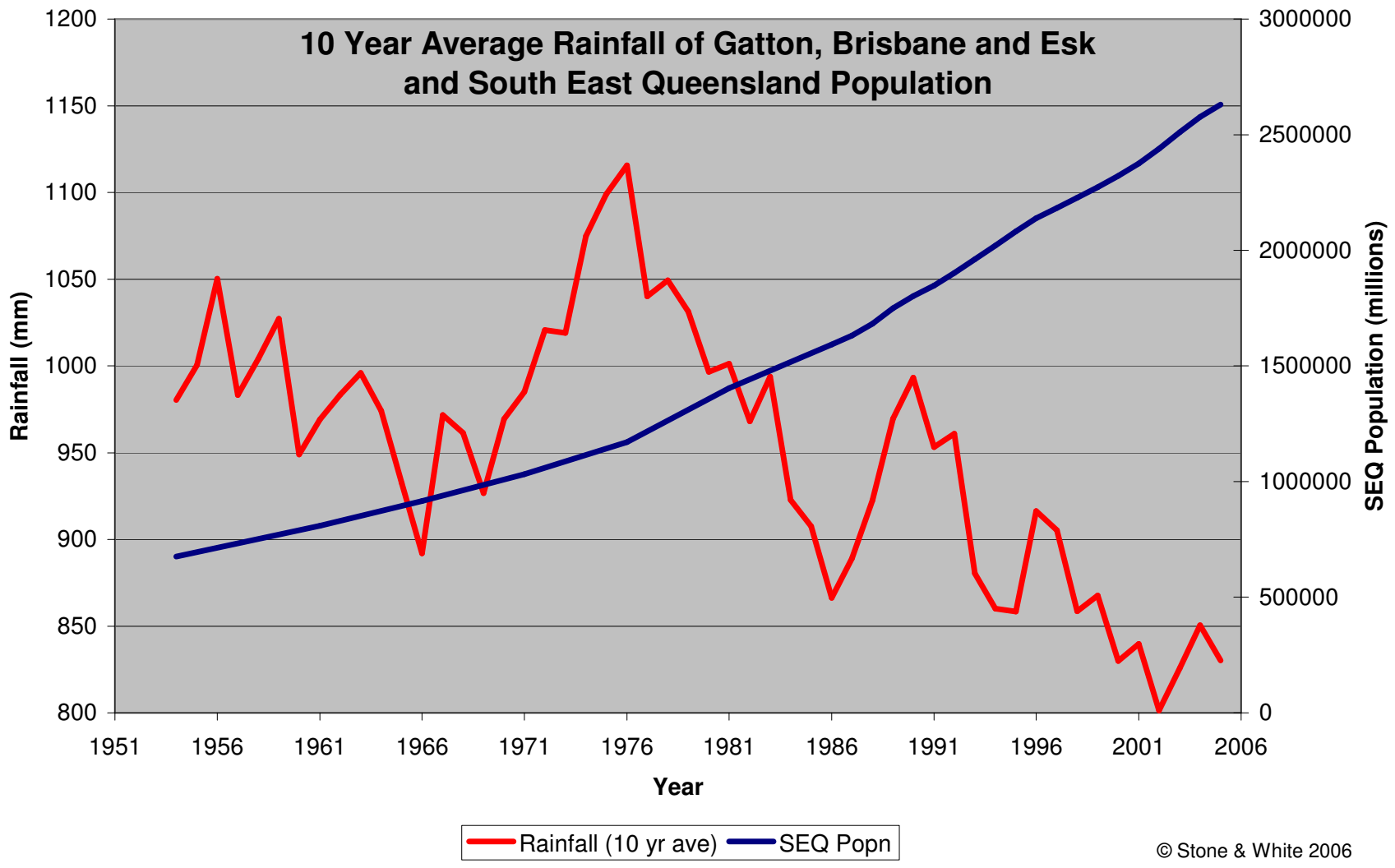
### LEVEL OF CONFIDENCE IN PROJECTIONS


Very high confidence in projections

High confidence in projections

Medium to high confidence in projections

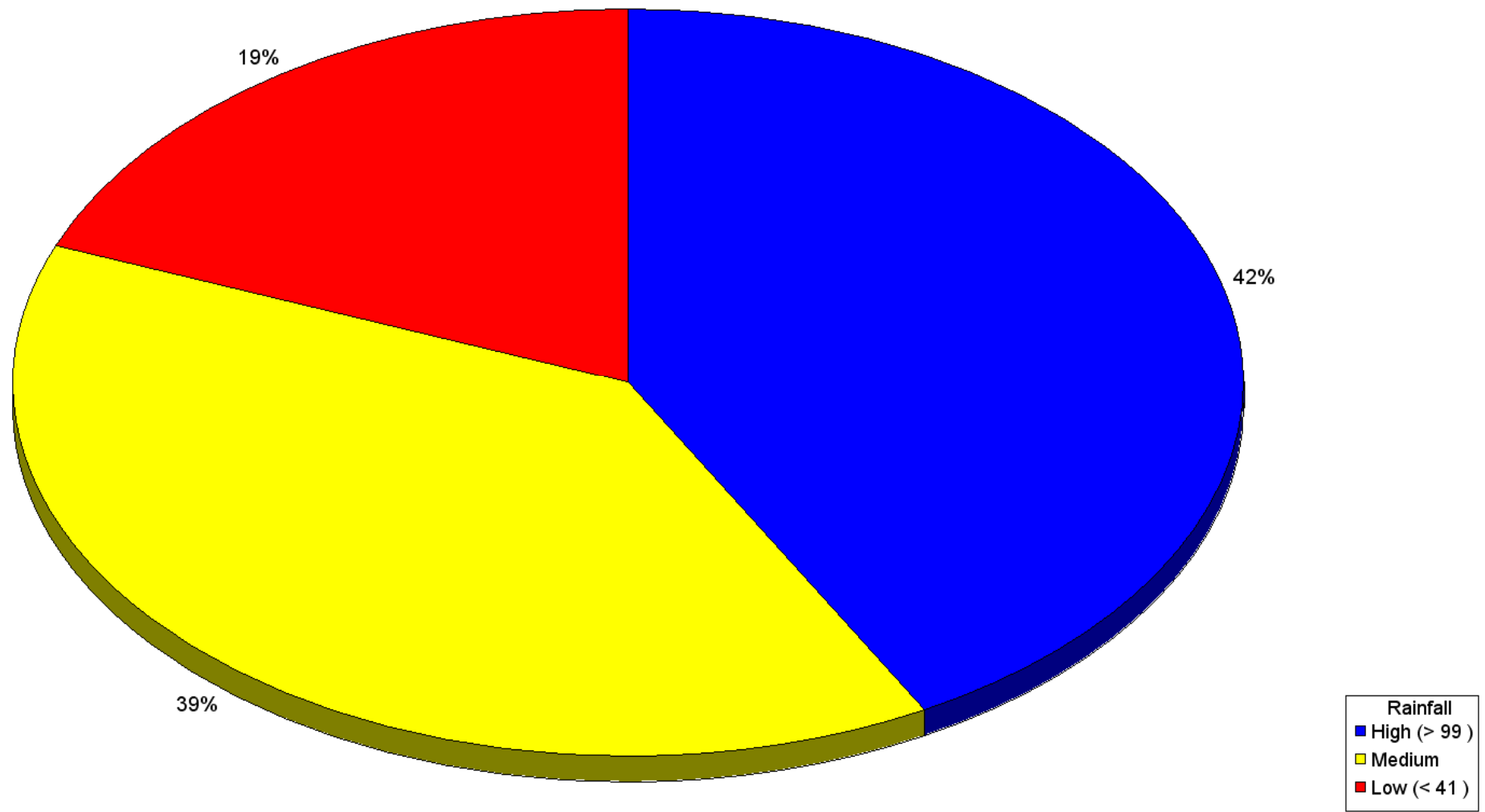
Moderate confidence in projections



Chance of rainfall at EMERALD AIRPORT COMPOSITE*						
Analysis of historical data (1883 to 2010) using SOI Phases: Jun to Jul Leadtime of 0 months						
The SOI phases/rainfall relationship for this season is statistically significant because KW test is above 0.9, and Skill Score (19.0) is above 7.6 (p = 0.996).						
Rainfall period: Aug to Oct	SOI falling	SOI negative	SOI neutral	SOI rising	SOI positive	All years
% yrs with at least 207 mm	0	0	5	8	11	6
140 mm	7	10	13	19	32	17
120 mm	7	14	13	19	36	19
100 mm	29	19	18	38	54	31
60 mm	57	29	50	73	79	58
20 mm	86	67	82	92	100	86
10 mm	100	81	95	96	100	94
% yrs above median 73 mm	43	24	45	62	68	50
KS/KW probability tests	KS=0.05	KS=0.999	KS=0.83	KS=0.77	KS=0.99	KW=0.999
Significance level	Not significant	***	Not significant	Not significant	**	
Years in historical record	14	21	38	26	28	127
Highest recorded (mm)	200	164	219	267	476	476
Lowest recorded (mm)	13	6	1	8	27	1
Median rainfall (mm)	71	30	54	94	108	73
Average rainfall (mm)	72	50	69	98	124	85

### Chance of rainfall at EMERALD AIRPORT COMPOSITE\*

Analysis of historical data (1883 to 2010) using SOI Phases: Jun to Jul Leadtime of 0 months Rainfall period: Aug to Oct  
The SOI phases/rainfall relationship for this season is statistically significant because KW test is above 0.9, and Skill Score (19.0) is above 7.6 ( $p = 0.996$ ).



SOI rising

Source: Rainman StreamFlow