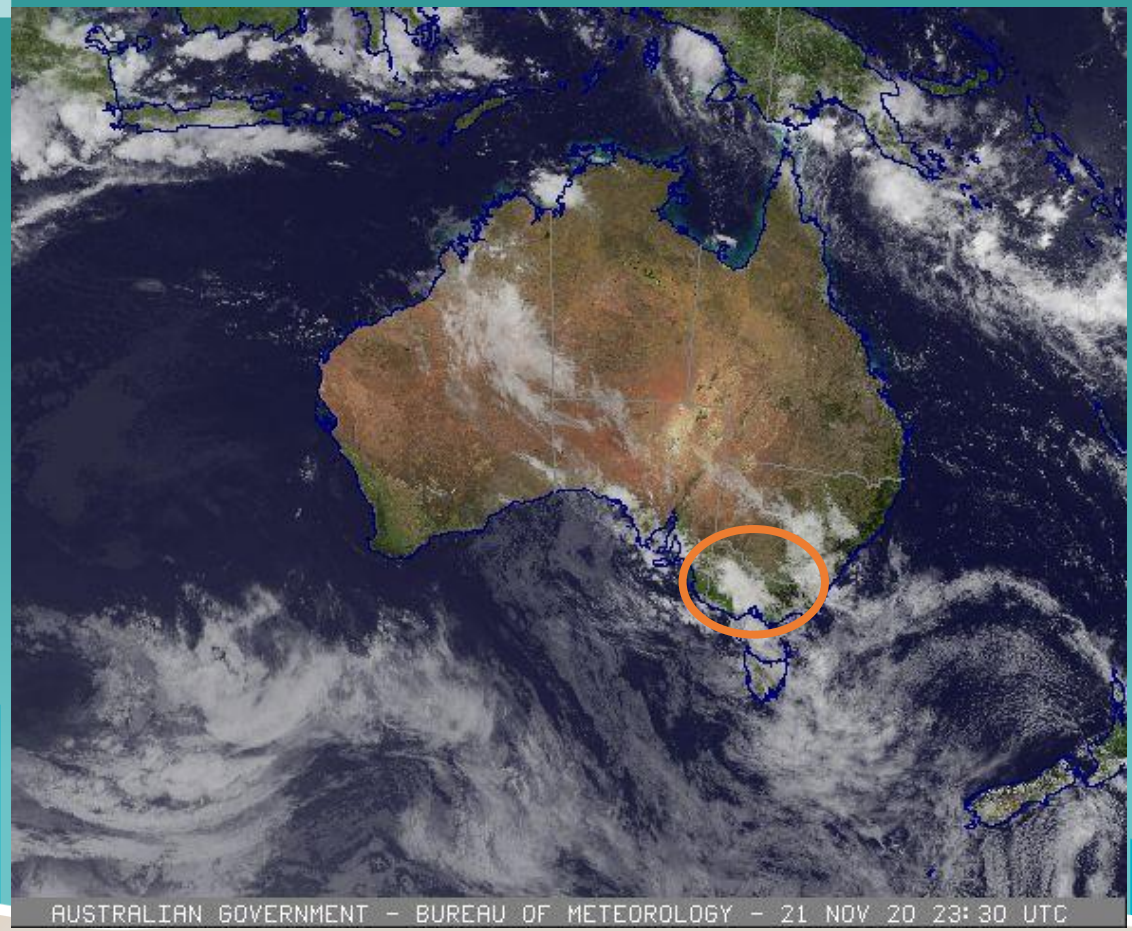
Victorian Water and Climate Initiative

Victorian Rainfall
Past, Present and Future



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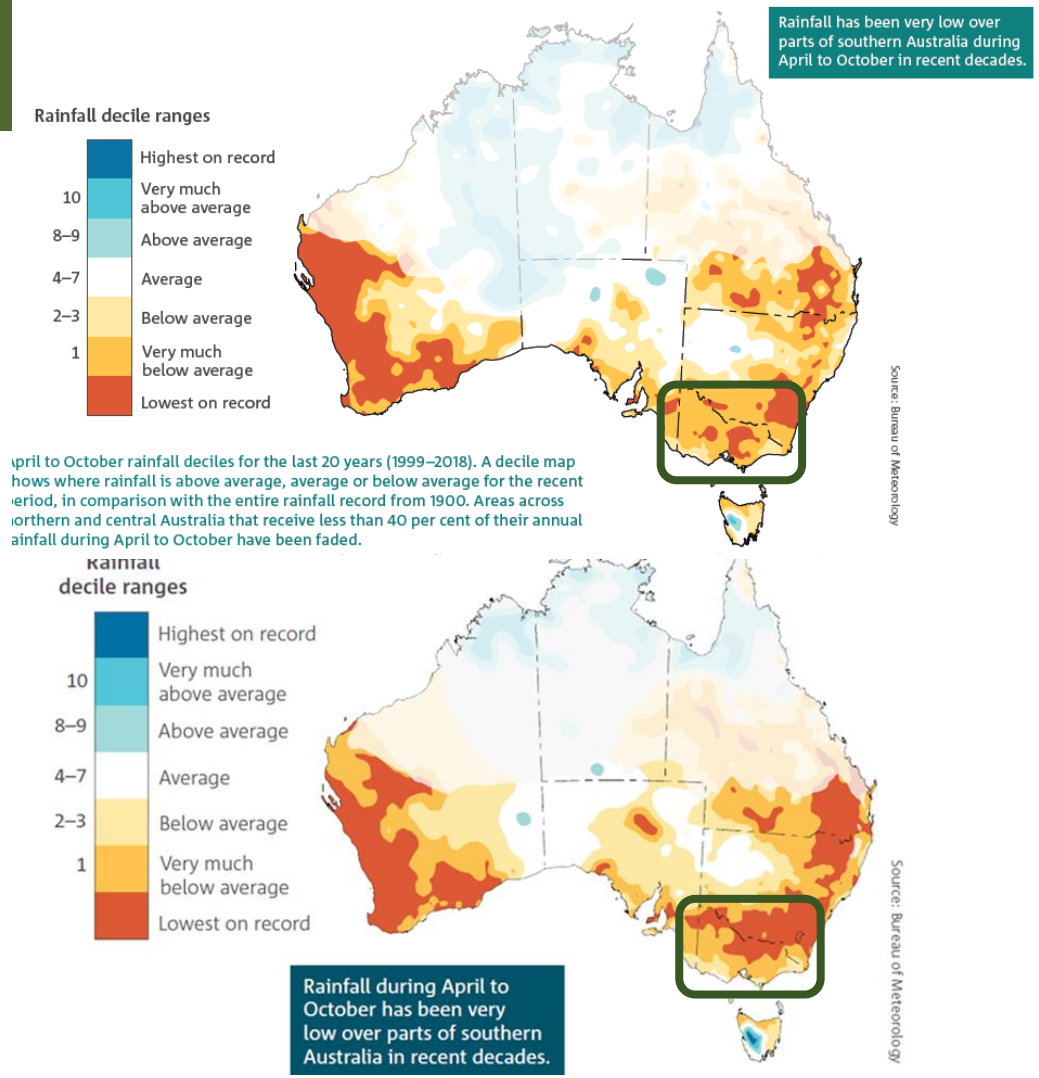
Australian Government
Bureau of Meteorology

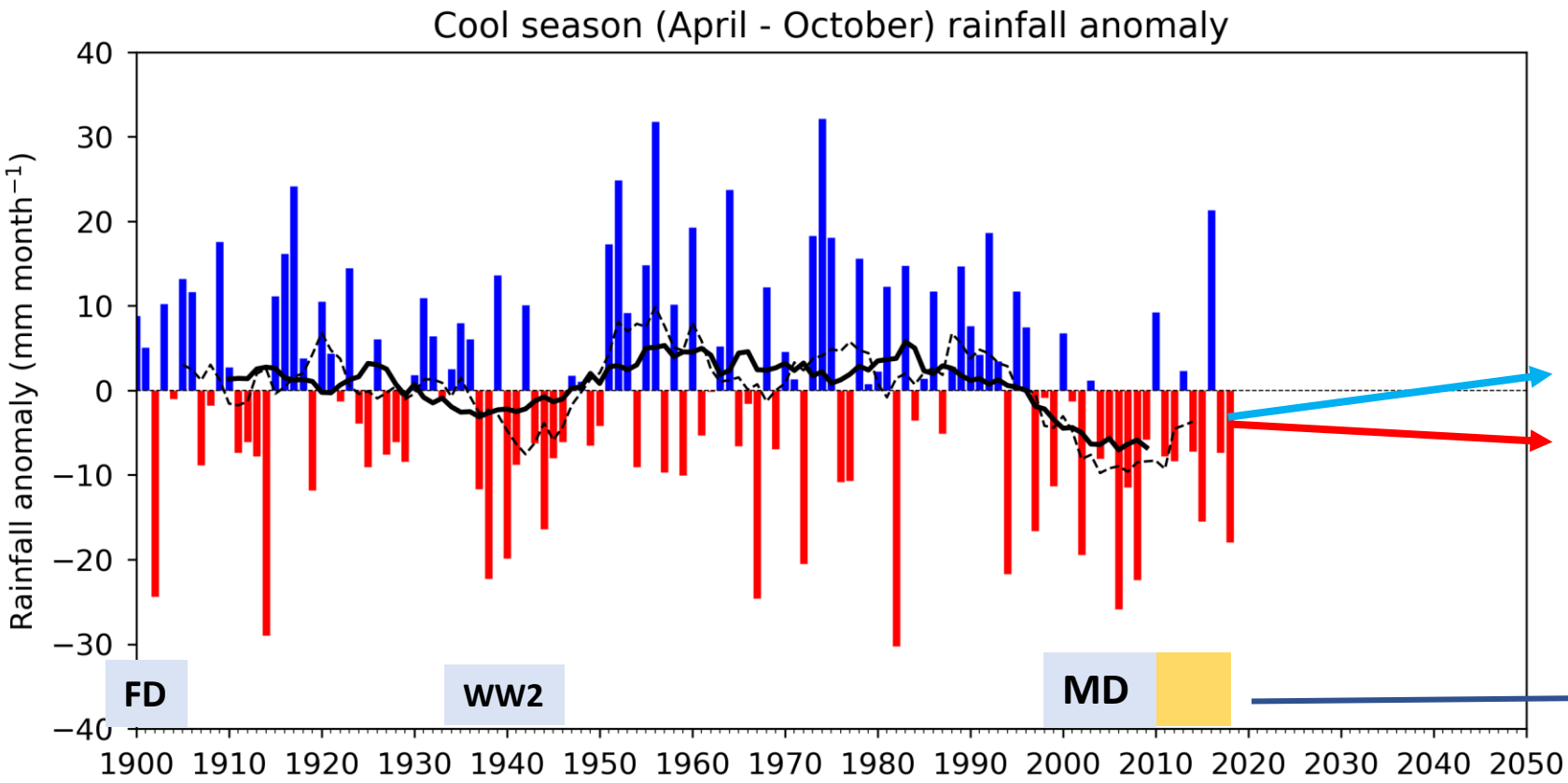
VICTORIA State Government
Environment, Land, Water and Planning

What is happening?



- Cool season rainfall has been very much below average over many parts of southern Australia in recent decades
- Cool season for Victoria accounts for about 2/3rd of Victoria's annual rainfall
- Any change in rainfall during the cool season has a disproportionate impact on water availability across the state.

Victorian Rainfall Variability



Federation Drought (FD: 1896 – 1905)

World War II Drought (WW2: 1935 – 1945)

Millennium Drought (MD: 1997 – 2009)

Decline (~12 %) wrt 1900 – 1959 average

Is any historical period truly representative of the current state of the climate or expected future?

Questions addressed:

How unusual is the observed recent drying?

How much of the recent drying is due to external forcing?

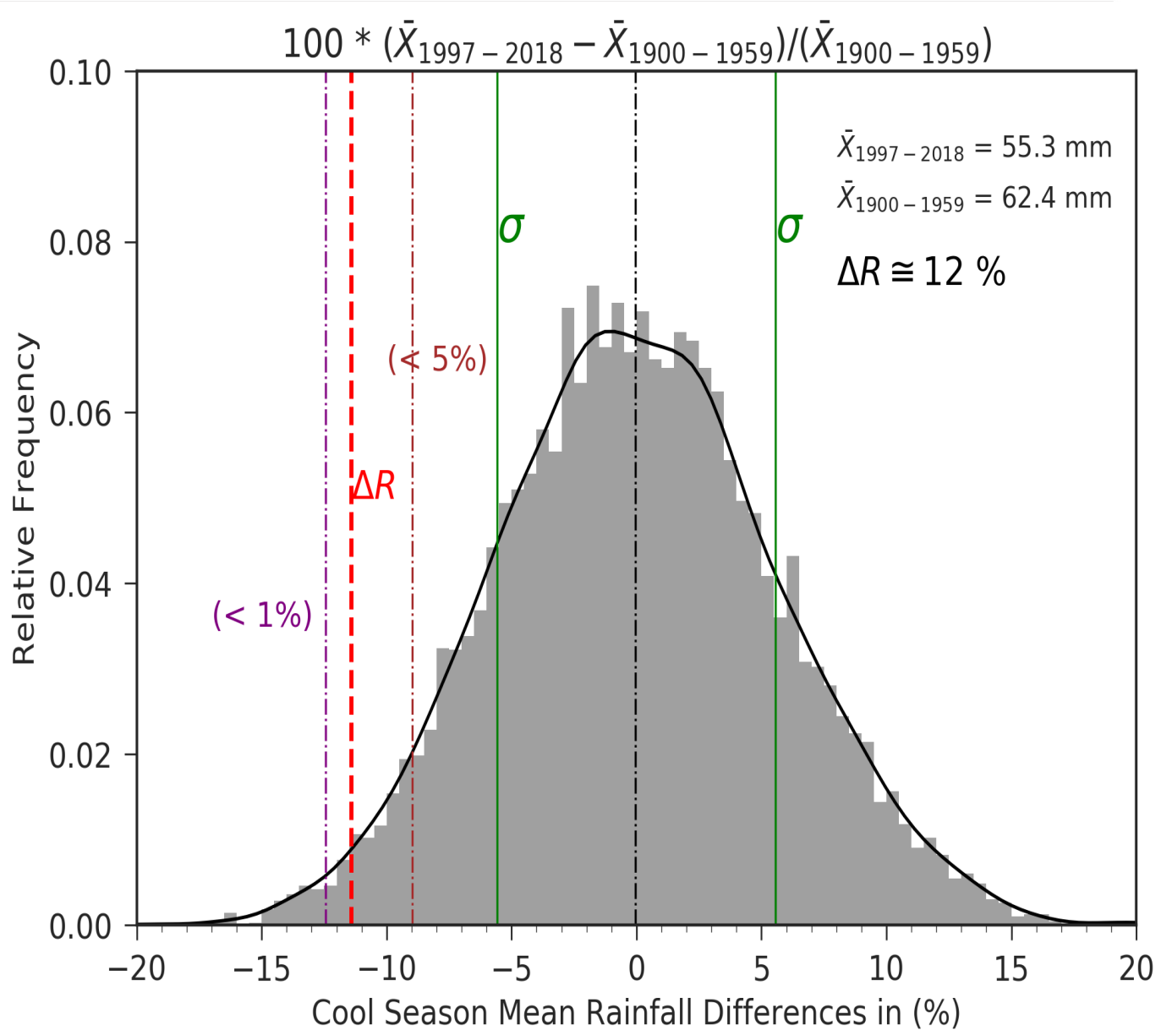
Do models project a decrease in rainfall in future under various scenarios?

When does the impact of global GHG emissions on rainfall become clear?

What is the expected combined impact of both external forcing and internal variability on Victorian rainfall over coming decades?

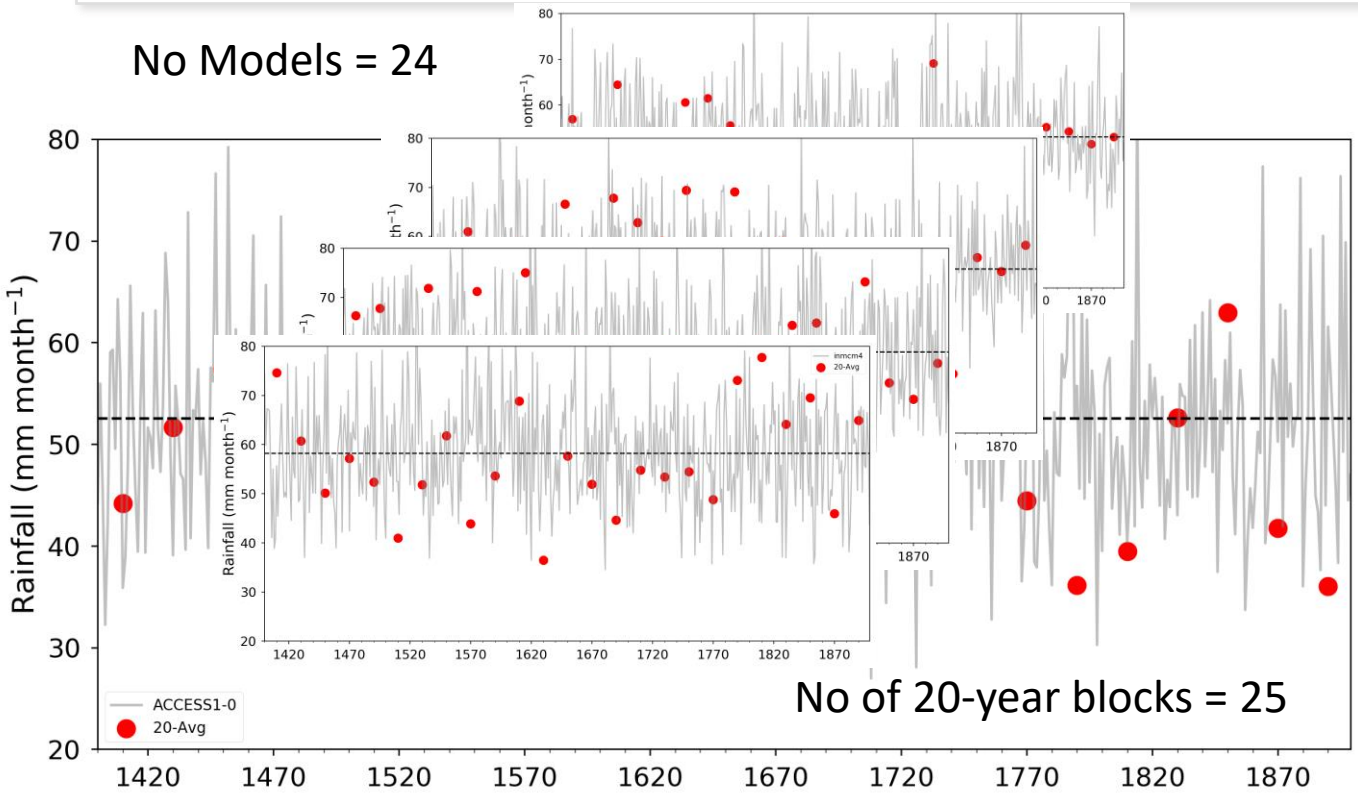
How unusual is the recent decline in rainfall?

- Extremely unlikely
- Not sure how much of the observed decline is due to
  - Natural internal climate variability or
  - External (anthropogenic) forcing

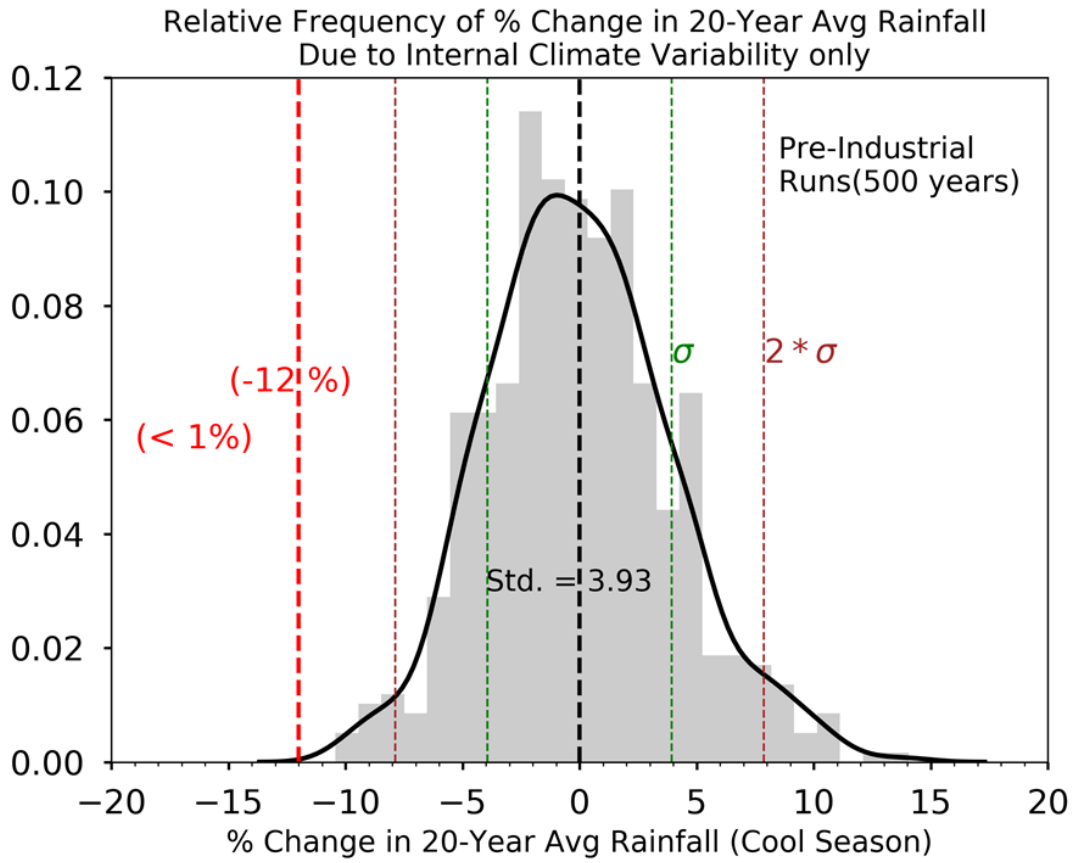


Changes in rainfall due to natural, internal variability

According to models, the probability of having 12% rainfall decline due to natural internal variability alone is less than 1%



Pre-industrial climate runs



Past, Present & Future Decadal Rainfall Changes WRT Preindustrial Climate

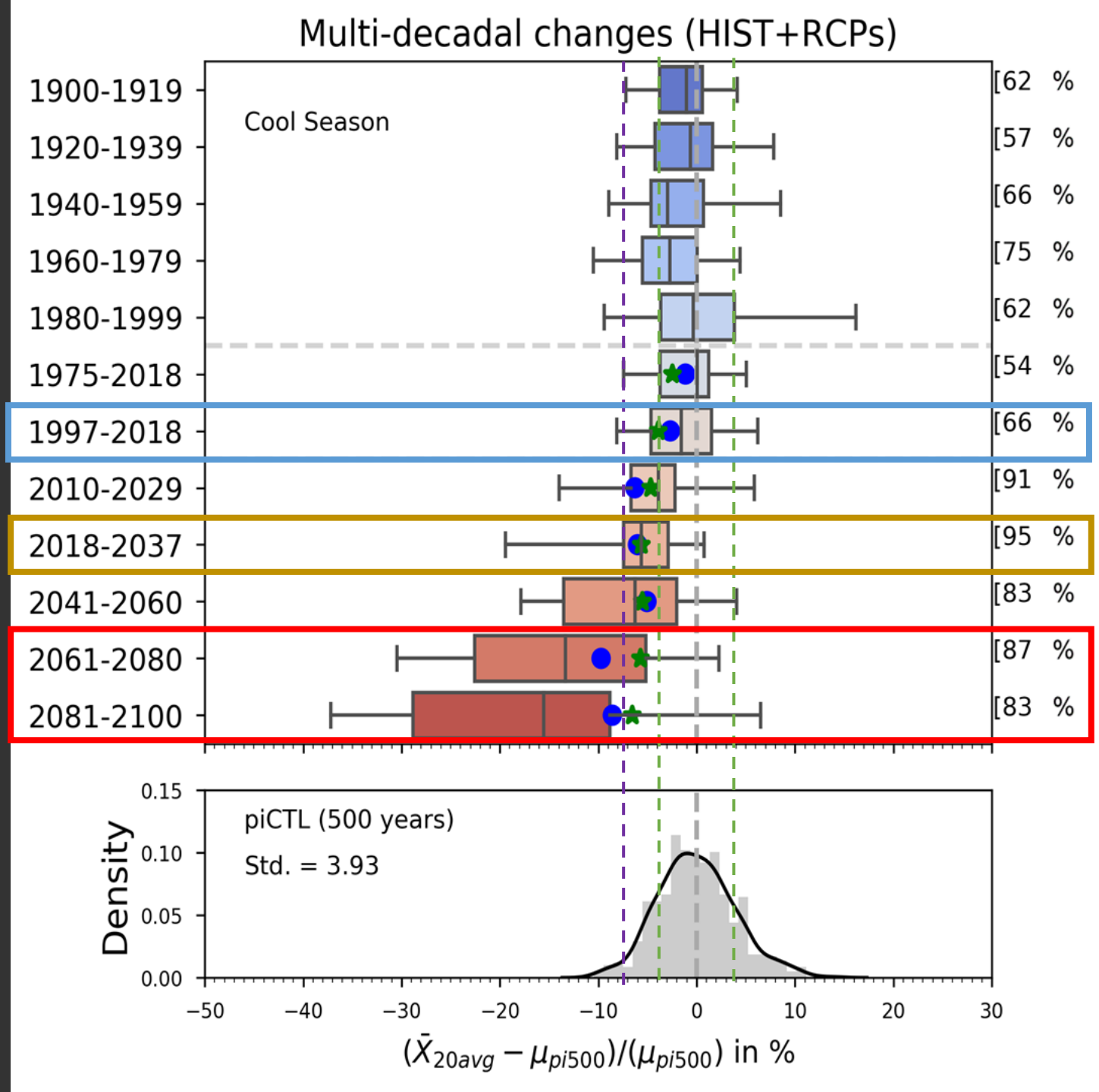
Substantial drying over Victoria appears inevitable after year 2060 under a high emission scenario (RCP8.5)

The impact of emission reduction is not clear until after the mid-21st century in terms of median change

~88% chance that the 2018–2037 will be drier than the preindustrial average

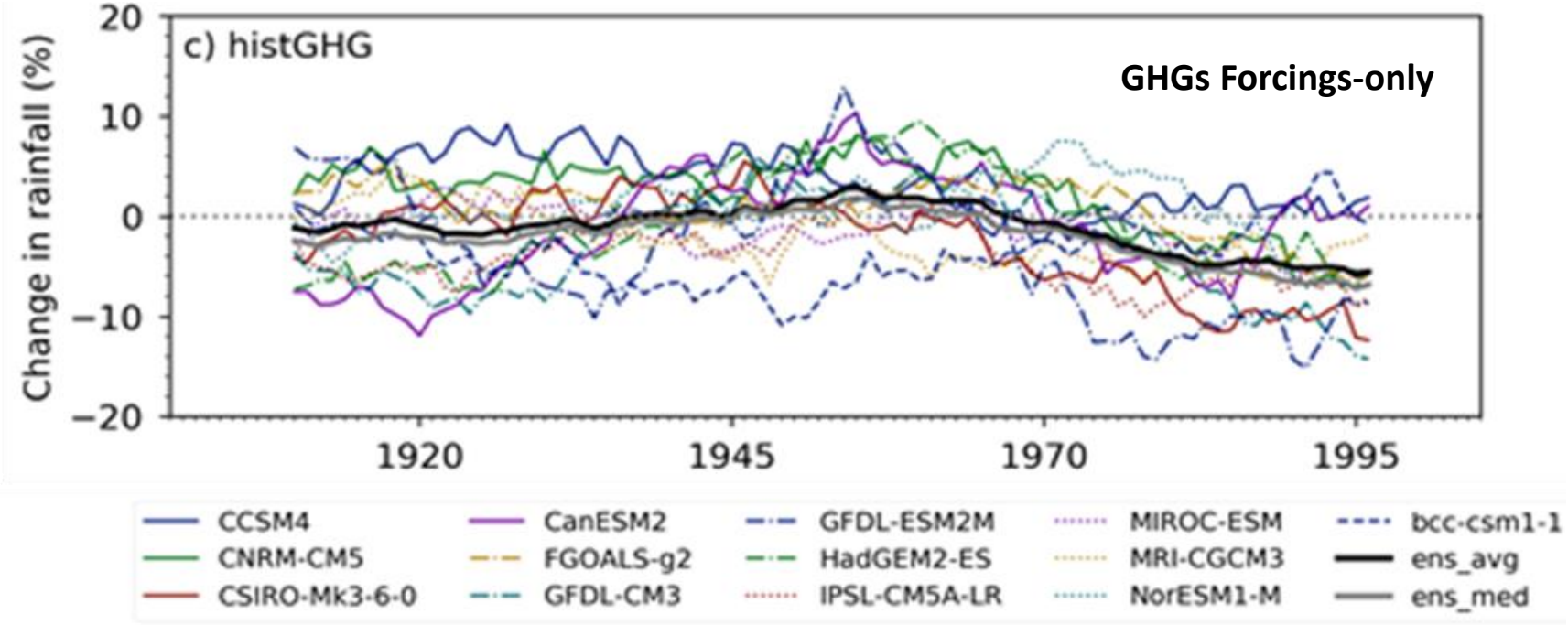
2/3rd of models simulate drying for 1997-2018

No significant climate change signal during the 20th century



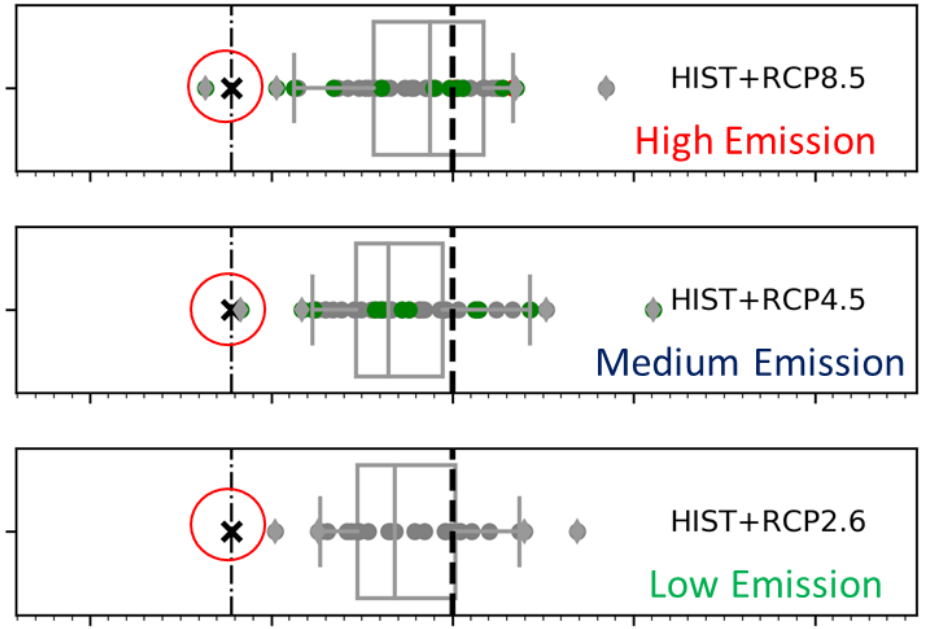
Role of Anthropogenic Forcing

- 10 out of 13 (84 %) models simulate decrease in rainfall post-1970 under histGHG simulations
- This suggests that the increased concentration of GHGs emission generally leads to a drier climate over Victoria



(%) change in rainfall across models with GHGs forcing only, relative to average of 500 years pre-industrial runs.

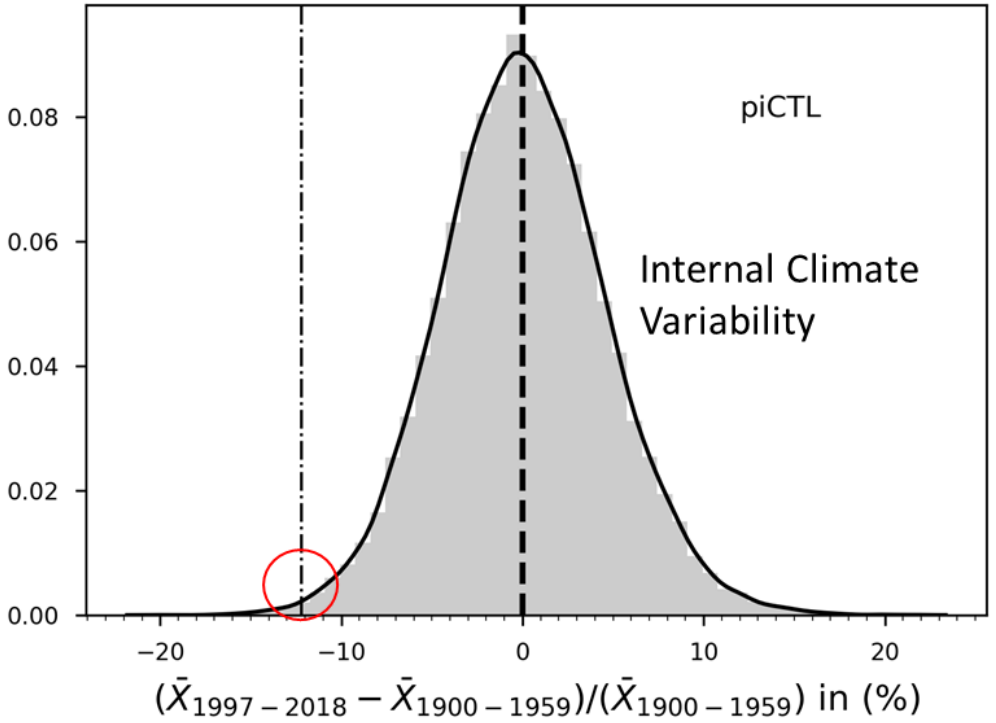
Contribution of Anthropogenic Forcing



Models forced under all three RCP scenarios don't capture the observed change in rainfall

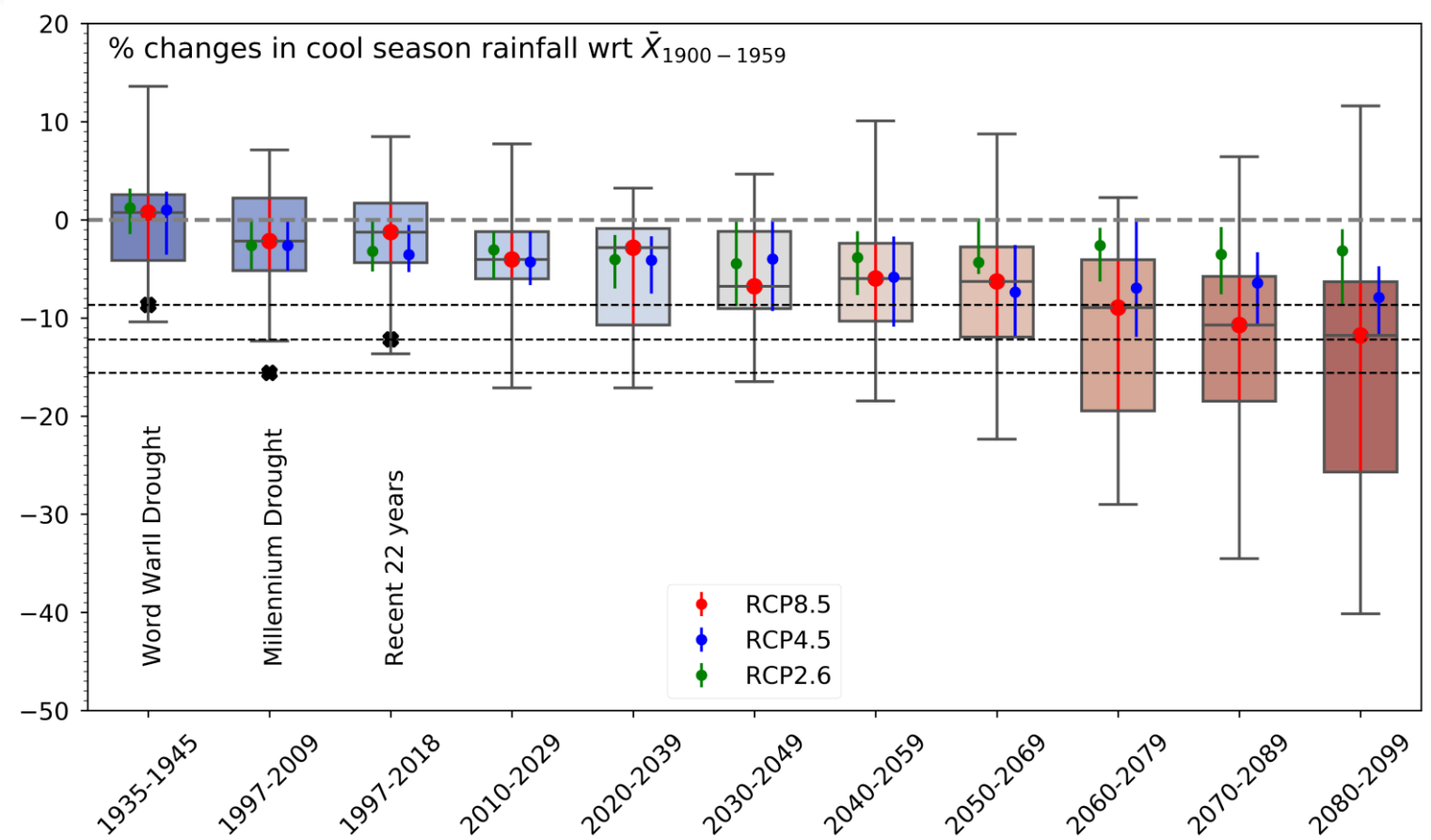
Magnitude of the externally-forced drying in models can be estimated by averaging the median values of all three RCPs

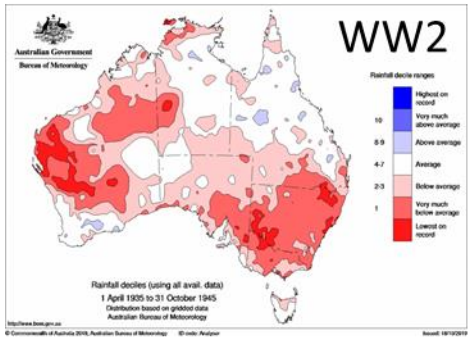
- **The percentage contribution of anthropogenic forcing is 20% with IQR between 40% to -4%**

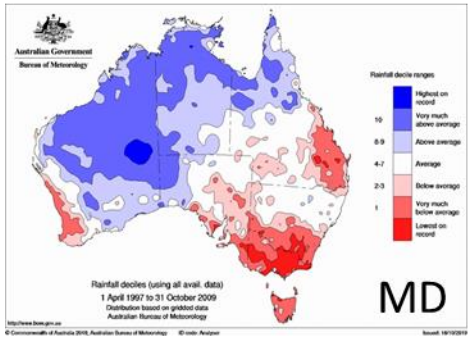


Prospects WRT Observed Droughts

- Global warming will significantly increase the risk of events like the WWII and Millennium droughts
- What rainfall Victoria receive will also be a function of internal variability







Summary

Drying in recent decades is dominated by natural internally-generated rainfall variability. However, it would not have been as large without the influence from increasing levels of atmospheric greenhouse gases

Large proportions of CMIP5 models suggest that increase in the GHGs concentration leads to a drier climate over Victoria

Externally-forced drying becomes dominant from 2010-2029 (relative to pre-industrial), when drying is evident in over 90% of models

For 2018 – 2037, according to models, there is only a ~12% chance that internal rainfall variability could completely offset the externally-forced drying. This means that dry conditions are very likely wrt preindustrial

By the late 21st century, global warming under a high emission scenario (RCP8.5) will significantly increase the risk of events like the WWII and the Millennium droughts

Confidence in the projections is lowered because models have difficulty in simulating the magnitude of the observed decline in rainfall

Victorian Water and Climate Initiative

Thanks for listening

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Rauniyar, S. P., S. B. Power (Under preparation): Estimating future rainfall distributions in a changing climate for water resource planning, to be submitted in Climate Dynamics

Rauniyar, S. P., S. B. Power (2020): The impact of anthropogenic forcing and natural processes on past, present and future rainfall over Victoria, Australia, J. Climate, 33, 8087–8106, https://doi.org/10.1175/JCLI-D-19-0759.1.

Rauniyar, S. P., S. B. Power, and P. Hope (2019): A literature review of past and projected changes in Victorian rainfall and their causes, and climate baselines. 40 pp. http://www.bom.gov.au/research/publications/researchreports/BRR-037.pdf

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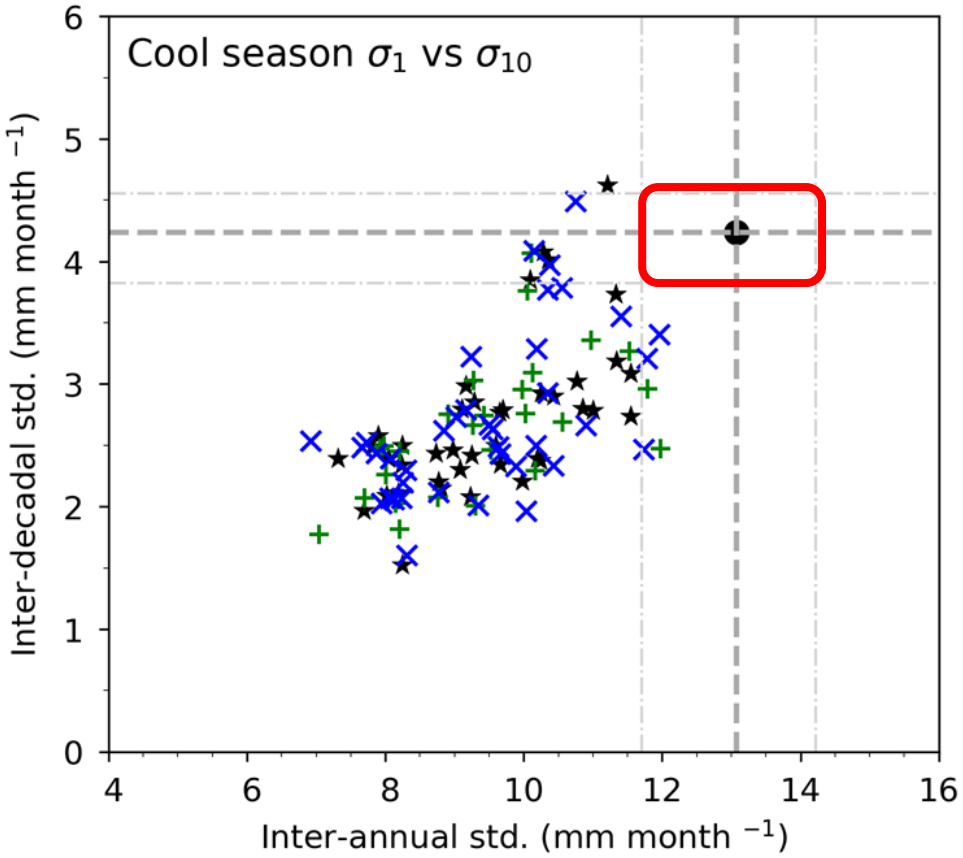
How much confidence we have?

The underestimation of the changes in rainfall by the models can arise, in principle, from one or more of the following reasons:



- Observational error
- The real world exhibited a very unusual and extreme natural internally-generated event
- Models underestimate the forced response
- Models variability is too weak

Key Climate Drivers of Relevance to Victorian Rainfall