Relative Contribution of Anthropogenic Forcing and Natural Processes to Rainfall Variability over Victoria, Australia

Surendra Rauniyar and Scott Power

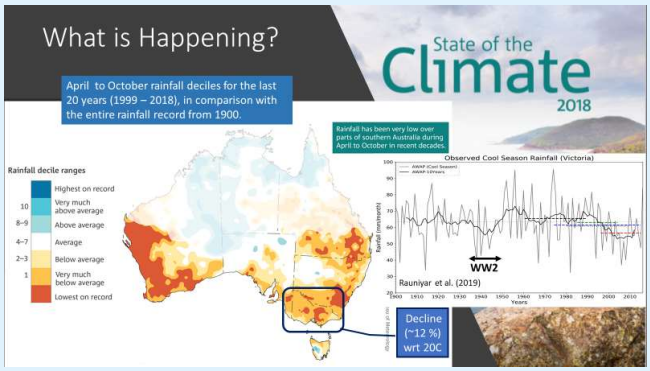
Science to Services, Bureau of Meteorology, Melbourne, Australia

Correspondence Email: surendra.rauniyar@bom.gov.au

Introduction

Rainfall over Victoria occurs predominantly in the cool season (Apr - Oct) compared to the warm season (Nov - Mar). The cool season rainfall contributes ~70% to annual rainfall.

However, Victoria is experiencing decline in its cool season rainfall since the start of the Millennium Drought in 1997. Such changes in rainfall have huge impacts on agriculture, tourism and the environment across the region.



How much of the drying is due to anthropogenic forcing?

Recent decline in rainfall is very unusual in terms of model internal variability.

more than 95% of models underestimate the magnitude of the observed drying

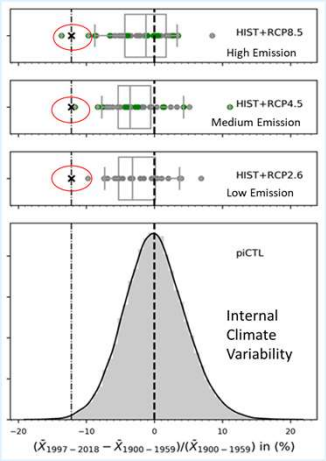
According to models, the recent drying is dominated by internally generated rainfall variability and anthropogenic forcing contributes 20%

Anthropogenic Contribution

(1997 – 2018) wrt (1900 – 1959)

[~= 20%]

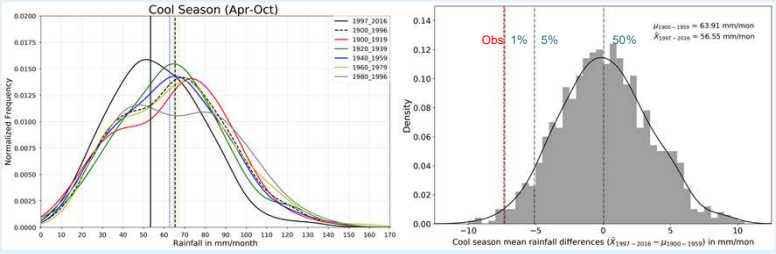
IQR = [40% , -4%]



Research questions we address

1. How unusual is the observed recent drying since 1997 over Victoria, Australia?
2. Do climate models simulate the decrease in rainfall during the recent (1997-2018) period, and if they do, how much of the drying is due to greenhouse gases (GHGs)?
3. How large is the projected decrease in rainfall in the near future (2018 – 2037) and towards the end of the 21st century (2081 – 2100) under three RCP scenarios?
4. How large is the simulated drying relative to preindustrial variability? When do the benefit of reductions in global GHG emissions become clear?
5. What is the expected combined impact of both external forcing and internal variability on Victorian rainfall over coming decades?

Multi−decadal Variability and Recent Decline in Victorian Rainfall



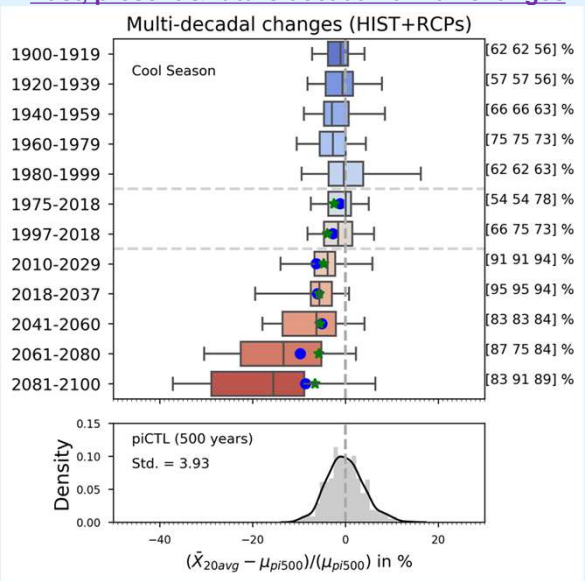
Bootstrapping Method is applied to generate above stats

April to October rainfall deciles for the last 22 years (1997 – 2018), in comparison with the first six decades (1900 – 1959) shows rainfall has been very much below average

Extremely unlikely (< 1%) to obtain the observed change by chance only.

But we don't know for sure how much of the observed decline is due to natural internal climate variability or due to the human activity.

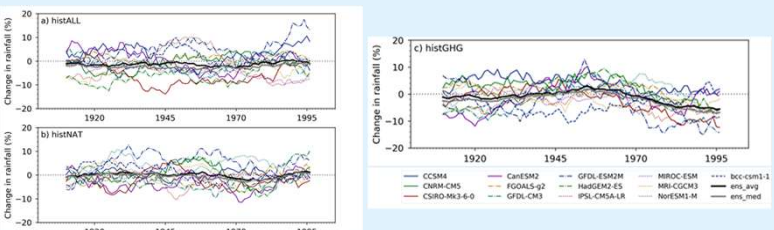
Past, present & future decadal rainfall changes



- No significant CC signal during the 20th century
- ~88% chance that the 2018–2037 will be drier than the preindustrial average
- Substantial drying over Victoria appears inevitable after year 2060 under RCP8.5
- The impact of emission reduction is not clear until after the mid-21st century in terms of median change

Did increases in greenhouse gases cause the drying?

CMIP5 models that provide historical rainfall simulations for the 1900 – 2005 period with all-forcing, natural-only forcing (e.g., Solar, Volcano) and GHG-only forcing are being analysed



10 out of 13 of models simulate decrease in rainfall post-1970 in response to GHGs increases

SUMMARY

- Rainfall during the cool season has been unusually low since 1997 (less than 2% chance of occurrence)
- Taking models at face value, drying is dominated by natural internally-generated rainfall variability: external forcing only caused 20% of the drying
- Externally-forced drying becomes clear from the late 20th century (relative to preindustrial), when drying is evident in over 80% 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 suggests that dry conditions are very likely.
- By the late 21st century the externally-forced drying under RCP8.5 is so large that internal variability appears far too small to be able to offset it.

This research is co-funded by the Australian Bureau of Meteorology and Department of Environment, Land, Water and Planning (DELWP) through the Victorian Water and Climate Initiative (VicWaCI) project

Rauniyar SP and Power SB (Under review) The impact of anthropogenic forcing and natural processes on past, present and future rainfall over Victoria, Australia. Journal of Climate, (revised).