



## **Observed Changes and Projections in Southern Hemisphere Mid-latitude Storms, Rainfall and Circulation**

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Large and continuing reductions, during the last sixty years, in Southern Hemisphere mid-latitude winter rainfall, particularly in the southern Australian region, are shown to be associated with major shifts in the Southern Hemisphere circulation over this period. In particular, these changes have been linked to large reductions in the growth rates of winter storms. These effects have become more pronounced with time.

In this paper, we focus on the observed changes in mid-latitude storm formation and relate them to large scale atmospheric circulation changes and discuss their impact on rainfall. We employ a useful diagnostic of storm development related to baroclinic instability, and encapsulated in the Phillips (1954) criterion. The relationship between changes in the Phillips criterion and changes in rainfall during the twentieth century is discussed. We also consider projected changes and trends in storm formation and rainfall SRES scenarios using results from CMIP3 models. In particular, we focus on changes between the periods (2040 – 2059) and (1980-1999), and (2080-2099) and (1980-1999). We elucidate the roles of anthropogenic forcing and internal variability. Our results show that the impact of further increases in anthropogenic CO<sub>2</sub> concentrations can lead to further large reductions in storm formation, by the end of the 21st century, with trends similar to those simulated by models at the end of the 20th century. Associated reductions in southern Australian rainfall can also be as much as twice those seen at the end of the 20th century.