

The role of ocean variability for multi-year droughts in Australia

*Andrea Taschetto^{1,2}, Alex Sen Gupta^{1,2}, Caroline C Ummerhofer³, Matthew H England^{1,2}

1. Climate Change Research Centre, University of New South Wales, Sydney, Australia, 2. ARC Centre of Excellence for Climate Extremes, University of New South Wales, Sydney, Australia, 3. Department of Physical Oceanography, Woods Hole Oceanographic Institution, Woods Hole, MA, USA

Australian climate is strongly affected by variations in sea surface temperature in the Pacific, Indian and Southern Oceans. Over the northern and eastern regions of Australia, the El Niño –Southern Oscillation (ENSO) is the main phenomenon causing profound impacts in rainfall. On the southern regions, a large proportion of rainfall comes from synoptic weather systems at the mid-latitudes, such as cold fronts and cut-off lows. The interaction between the tropical modes of variability and the atmosphere dynamics at mid-latitudes makes difficult to understand the role of the oceans for droughts relative to the atmosphere internal variability.

The contribution of ocean versus atmosphere variability for Australian rainfall is investigated in this study. Numerical experiments are performed using the National Center for Atmospheric Research (NCAR) Community Earth System Model (CESM). Three multi-century simulations are integrated to address the role of the oceans for rainfall variability: (i) a fully coupled climate system run, (ii) an run forced with climatological cycle of SST, i.e. no SST variability beyond one year, and (iii) a run forced with varying SST, i.e. containing SST variability but no air-sea feedback.

Our results show that interannual variations in sea surface temperature has a significant impact on rainfall variability and extremes, such as multi-year droughts and pluvials. Ocean variability makes droughts more intense and modulates the duration of short-term dry spells. However, interannual variability in the oceans does not significantly affect the duration of droughts longer than 3 years. On the other hand, in a world with no year-to-year ocean variability, multi-year dry spells can last longer than oceanic-driven droughts. This can be explained by the influence that ENSO has over the tropics: ENSO is a crucial phenomenon for restoring droughts and pluvials. In the absence of ocean variability, there is no dominant climate driver that can act to terminate extended dry or wet periods.

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