Observations and simulations of ENSO, the IPO, and rainfall variability in eastern Australia

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Abstract: Understanding changes in past and future rainfall variability can improve societal, environmental and economic decision-making. Global climate models (GCMs) are commonly used to improve our understanding of rainfall variability; however, accurately simulating variability in precipitation is difficult as many processes with different spatial and temporal scales contribute to final precipitation volume. Interactions between climate oscillations, which influence precipitation over wide temporal and spatial scales, often have the greatest impact on rainfall variability. Currently, the ability of GCMs to simulate inter-oscillation processes and teleconnections with rainfall is not well known. This study uses correlation and composite analysis to investigate how the joint interaction between two oscillations, the El Niño Southern Oscillation (ENSO) and the Interdecadal Pacific Oscillation (IPO), influences eastern Australian rainfall variability, and whether or not this relationship is simulated by a GCM. To do this, the Australian Water Availability Project (AWAP, run 26j) gridded observational dataset is compared with the Australian Community Climate and Earth-System Simulator (ACCESS1.3) GCM for the years 1900–2005.

The ENSO–IPO interaction exhibits its strongest influence on eastern Australian rainfall in the austral summer and autumn. The influence of the ENSO–IPO interaction on rainfall reflects the interplay between the inter-annual and inter-decadal scales of the oscillations. Stratification of rainfall according to the phases of the ENSO and IPO reveals that ENSO predominantly determines rainfall variability, but that the IPO modifies this relationship. In the IPO negative phase this relationship is amplified; in the IPO positive phase this relationship is attenuated, and in the IPO neutral phase, a slight decrease in rainfall is observed. In the case of moderately extreme ENSO and IPO events, rainfall variability is once more influenced primarily by ENSO, but in this case, modified by IPO neutral and positive phases. The most extreme IPO events, and, critically, not the most extreme ENSO events, have the greatest influence on rainfall variability. ACCESS1.3 does not simulate the observed ENSO–IPO interaction, nor the observed influence of this interaction on rainfall. The model appears to represent the IPO as an ENSO-like phenomenon, and does not simulate the spatial or temporal features that characterise the IPO. Consequently, ACCESS1.3 fails to spatially or temporally simulate the rainfall associated with extreme rainfall events. This highlights how important incorporating interactions between climate oscillations into GCMs is for increasing the accuracy of modelled precipitation.

Keywords: *Rainfall variability, El Niño Southern Oscillation, Interdecadal Pacific Oscillation, ACCESS1.3*