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Heatwaves intensification in Australia: a consistent trajectory across past, present and future

Ralph Trancoso (1,2) and Jozef Syktus (1,2)
(1) Global Change Institute, University of Queensland, (2) Department of Environment and Science, Queensland Government

Heatwaves are associated with unusually high temperature events that occur for at least three consecutive days with major impacts to human health, economy, agriculture and ecosystems. Heatwaves have increased globally over the last century and are projected to achieve unprecedented levels by the end of the current century in absence of strong mitigation measures. The main reported cause for the widespread heatwaves intensification in the global warming. This research aims to investigate whether heatwaves characteristics such as amplitude, magnitude, frequency and duration have changed over the last 70 years in Australia and are projected to change over the current century in Queensland. We use maximum and minimum daily temperatures from both historical records (5 km pixel size) for Australia from 1945 to 2014 and climate change projections from 11 models from the CMIP5 5 forced under the RCP 8.5 downscaled over Queensland region (10 km pixel size) for the period 1980-2099 followed by bias-correction. We identified heatwaves events using the Excess Heat Factor and then computed eight metrics to represent different characteristics of heatwaves. We computed non-parametric monotonic trends (Mann-Kendall) and slopes (Sen-slope) of heatwave metrics for historical records and future projections as well as shifts in the long-term steady state (10-20 years averages). Results of analysis reveal that heatwaves have increased in intensity, frequency and duration across Australia. Over the past 70 years, the eight heatwave metrics have consistently increased at different rates Australia-wide. Greater increases have been observed in South Australia and Western Australia, whereas the Northern Territory had the lowest trends in heatwave metrics. With regards to climate change projections, all the 11 regional climate models (RCMs) suggested a more acute and consistent increase over the current century with rising atmospheric CO_2 concentrations. Trend slopes had higher magnitude in comparison to historical records and were statistically significant across the entire state. Our projections also highlight that distinct climatic regions within Queensland may have different heatwave response under global warming, where tropical heatwaves appear to be more sensitive to elevated atmospheric CO_2 concentrations in comparison to subtropical and arid regions. Our results offer new insights on Australian heatwaves with major implications for society and environment and may support climate change adaptation and mitigation initiatives at regional scale.