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Modelling Extreme Events in a Changing Climate using Regional Dynamically-Downscaled Climate Projections

Christopher J. White (1), Stuart Corney (1), Michael Grose (1), Greg Holz (1), James Bennett (1,2), Nathaniel L. Bindoff (1,3)

(1) Climate Futures for Tasmania, Antarctic Climate & Ecosystems Cooperative Research Centre, University of Tasmania, Hobart, TAS, Australia (chris.white@acecrc.org.au), (2) Hydro Tasmania Consulting, Cambridge, TAS, Australia, (3) Centre for Australian Climate and Weather Research, CSIRO Marine and Atmospheric Research, Aspendale, VIC, Australia

The ability of regional dynamically-downscaled global circulation models (GCMs) to assess changes to future extreme climatic events and the likely impacts was investigated. A collaborative research initiative generated projections on a high-resolution 0.1° (∼14km) grid across Tasmania, an island state of Australia, using the CSIRO Conformal Cubic Atmospheric Model (CCAM). Two future emission scenarios and multiple GCMs were used for the period 1961-2100. Extreme value methods were employed for the analysis of temperature and precipitation extremes and a bias-adjustment procedure was developed to correct extreme magnitudes against observed data. Changes to the magnitude, intensity, frequency and duration of extreme events were modelled and analysed using a suite of indices to demonstrate evolving changes to extremes. Estimates of precipitation return periods were calculated using events fitted to a Generalized Pareto distribution through a robust extreme value threshold selection procedure developed for gridded precipitation datasets. Results were correlated against mean trends, both seasonally and annually, and compared to station and gridded observations. Future trends in individual and multi-model projections were compared with existing Australia-wide and global scale results calculated from GCMs. Increases in both daily maxima and minima temperature associated with climate change were noted, resulting in fewer cold nights, more heat waves and increased bushfire weather occurrences. Projections of future precipitation extremes were found to correlate closely with changes to regional climate drivers and spatial variance was also found across the state that closely matched observations. Results demonstrate that dynamical downscaling captures regional climate variability (particularly relevant for precipitation) and displays significant ability in modelling future changes to extreme events at the local scale for use in adaptation and emergency planning applications.