

## **Variability and decline in the number of severe tropical cyclones making land-fall over eastern Australia since the late 19th Century**

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Recent studies have raised concerns that tropical cyclones (TCs), particularly severe TCs, have become more frequent in many places in response to global warming. Other studies discuss errors in TC data that can cause large inaccuracies in some of the observed trends. Additional studies conclude that TCs are likely to become more intense in the future in response to global warming, while regional modelling studies for the south-west Pacific near north-eastern Australia project an intensification of TCs and either a decrease or no change in TC numbers. Here we describe and use a new data base of severe land-falling TCs for eastern Australia derived from numerous historical sources, that has taken over a decade to develop. It provides one of the world's longest reliable records of tropical cyclone activity, and allows us to document changes over much longer periods than has been done previously for the Southern Hemisphere. Land-fall numbers are shown to vary a great deal on interannual, decadal and longer time-scales. The interannual variability is consistent with previous studies using much shorter data sets: land-fall numbers are well-simulated as a Poisson process and are modulated by the El Niño-Southern Oscillation (ENSO). Land-falls occurred almost twice as often in La Niña years as they did in El Niño years, and multiple land-falls only occurred during La Niña years. The statistical link between land-falls and pre-season values of the Southern Oscillation Index provides a modest predictive capability. Decadal variability in ENSO drives some of the variability in land-fall numbers. The sign and magnitude of trends calculated over 30yr periods vary substantially, highlighting that caution needs to be taken in making inferences about trends based on e.g. satellite era data only. The linear trend in the number of severe TCs making land-fall over eastern Australia declined from about 0.45 TCs/yr in the early 1870s to about 0.17 TCs/yr in recent times - a 62% decline. This decline can be partially explained by a weakening of the Walker Circulation, and a natural shift towards a more El Niño-dominated era. The extent to which global warming might be also be partially responsible for the decline in land-falls - if it is at all - is unknown.