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A spatial seasonal forecast model of tropical cyclone risk for the Australian region

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The economic importance of skillful seasonal location specific (2.5°x2.5°) forecasting of tropical cyclones (TCs) for the Australian region is indisputable. For example in late December 2010, TC Tasha made landfall on Australia's northeast coast and was accountable for a proportion of the disastrous flooding in Queensland at the beginning of 2011. The Queensland floods have impacted the Australian economy with multi billion dollar losses in damage and export revenues. As many as 40 coal mines in central Queensland's Bowen Basin have been disrupted because of the floods. Crops have been damaged and grazing lands are under water.

Here, we develop and present a forecast model of the seasonal spatial risk of TCs (and intense TCs) for the Australian region. Our model helps us to quantify the upcoming seasonal risk of landfalling TCs, and also the risk for offshore industry in the Indian Ocean regions.
The Australian TC region is in many ways different from other TC basins. For one, there is the high importance of the El Niño-Southern Oscillation on Australian region TCs, but also the fact that two tropical Ocean basins, the eastern Indian Ocean and the western South Pacific bound the Australian continent. This generates multiple climate modes that affect the region and has to be addressed to develop a skillful model for the spatial risk of TC 'hits'. Especially challenging is the current state of knowledge, that the tracks of Australian region TCs are almost unpredictable. That questions the use of Monte Carlo TC track simulations, often used in the insurance sector, for the Australian TC region.

Instead of generating TC tracks via bootstrapping or Monte Carlo methods, we concentrated on a Bayesian inference approach for modeling the seasonal rate a spatial grid point is affected by a TC per season. The statistical forecast model uses the Markov Chain Monte Carlo method via a multivariate slicesampler generating 25,000 synthetic TC climatologies on the basis of the conditional functions between the model predictand (here TC hits per season) and predictors (pre-seasonal values of carefully selected climate indices). A stepwise approach ensures that the best combination of predictors has been chosen, by calculating the probabilistic root-mean-squared error of cross-validated model TCG hindcasts over the period 1968/69-2007/08.
We also have successfully applied this method for seasonal forecasting of the number of Australian region TC counts and the spatial probability of TC development in the Australian region.