Pre-Season Forecast for Australian-Region and Queensland Landfalling Tropical Cyclones in 2000/01

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Produced in collaboration with the Met. Office
by Drs Paul Rockett, Mark Saunders and Tony Hamilton
Benfield Greig Hazard Research Centre, UCL (University College London), UK.

Forecast Summary

Australian region tropical cyclone activity and Queensland landfalling numbers are expected to be slightly above average in the coming 2000/01 season

The *Tropical Storm Risk* (TSR) consortium presents a pre-season forecast for Australian region tropical cyclones and severe tropical cyclones, and for tropical cyclone strike numbers on the populated Queensland coast. Our forecasts span the Australian season from 1st December 2000 to 30th April 2001. They are based on data available through the end of November 2000. Rigorous independent hindcasts for 1985/86-1999/00 show that our early December forecasts have 35% skill (better than chance) in predicting the seasonal basin tropical cyclone and severe tropical cyclone numbers. Our main predictor for Queensland landfalling storms is the forecast Nino 3.4 value for December-March, and our main predictor for basin numbers is the prior October-November ENSO sea surface temperature close to the Date Line.

1. Australian Region Total Numbers in 2000/01

		Severe Tropical Cyclones	Tropical Storms
TSR Forecast (±SD)	2000/01	6.8 (±1.3)	12.4 (±2.5)
Average (±SD)	1975/76-1999/00	6.5 (±2.5)	11.7 (±4.0)
Actual	1999/00	8	13

Key: Severe Tropical Cyclones = 1 Minute Sustained Wind > 63Kts = Hurricane Category 1 to 5
Tropical Cyclones = 1 Minute Sustained Wind > 33Kts
Forecast Error = Standard Deviation of Independent Hindcast Errors for 1985/86-1999/00
Australian Region = Southern Hemisphere 100°E to 170°E (Storm must form as a Tropical Cyclone within to count).

- Tropical storm and severe tropical storm numbers are anticipated to be 5% above average in 2000/01.
- Very severe tropical cyclones (hurricane category 3-5) are not forecast due to data reliability problems in the historical record.

2. Queensland Landfalling Numbers in 2000/01

		Tropical Cyclones
TSR Forecast (±SD)	2000/01	1.4
Average (±SD)	1960/61-1999/00	1.2 (±1.0)
Actual	1999/00	2

Key: Landfalling Region = Northeast Australian Coast from 15°S (Cooktown) to 30°S (Northern New South Wales), and >145°E longitude.

- The risk from tropical cyclone strikes is slightly above average in 2000/01.
- Severe and very severe tropical cyclone strikes are not forecast due to their low occurrence rates (average numbers of 0.4 and 0.1 per year respectively) and their lack of correlation with tropical cyclone strike numbers.

Predictors and Key Influences in 2000/01

Our model exploits the predictability of tropical sea surface temperatures (SSTs). Anomalous patterns of SST are the primary source of tropical atmosphere forcing at seasonal and interannual timescales. The three main predictors in our model are:

1. December-March forecast SST for the El Nino Southern Oscillation (ENSO) region 5°N-5°S, 120°W-177.5°W. (Main predictor for Queensland seasonal landfalling activity).
2. October-November prior SST for the ENSO region 5°N-5°S, 160°E-170°W. (Main predictor for Australian region seasonal tropical cyclone activity).
3. December-March forecast SST for the Coral Sea region 10°S-20°S, 150°E-170°E. (Secondary predictor for Australian region seasonal tropical cyclone activity).

The forecast SSTs come from an in-house statistical model which utilises initial conditions and trends in global SSTs.

The key factors behind our forecast of slightly above average activity in 2000/01 are: (a) the enhancing effect of the cooler than normal projected value for predictor (1) of -0.6°C; the enhancing effect of the slightly cooler than average value for predictor (2) of -0.1°C; and the neutral projected value for predictor (3). All anomalies are with respect to the 1961-1990 climatology. These predictors are expected to lead to slightly lower than normal vertical wind shear over the Coral Sea - thus favouring tropical cyclone formation - and to 925mb east-west ‘steering’ wind anomalies favouring a slightly above average risk of Queensland landfalling storms.

Methodology

The interannual variability in Queensland strike numbers is modelled using a Poisson distribution, while a Gaussian distribution is used to model Australian region tropical cyclone activity. In selecting predictors we apply the Chow parameter stability test, as used in economics, to ensure persistence and stability. This involves running the same regression over subsections of the data to test the hypothesis that the regression parameters obtained for the subsets are not significantly different from those found for the whole regression, against the alternative that one or more are different. This hypothesis must be satisfield at the 95% level for a predictor to prove stable and acceptable.

Forecast skill is assessed by rigorous hindcast testing over the period 1985/86-1999/00. We use only prior years in identifying the predictors and in calculating the regression relationship for each

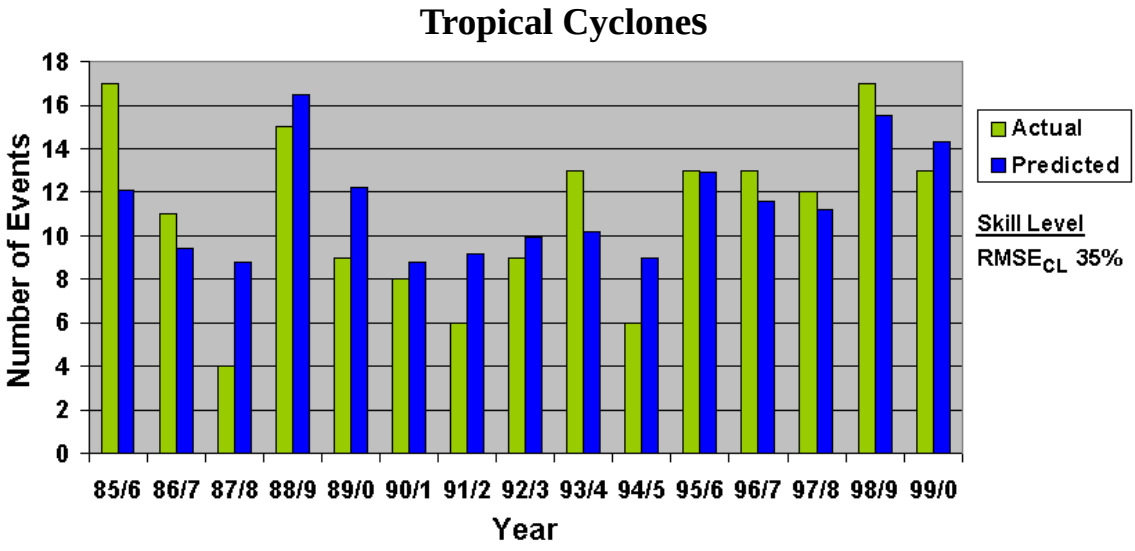
future year to be forecast - ie the hindcasts are performed in strict 'forecast' mode. Thus 1985/86 is forecast using 1960/61-1984/85 data, 1986/87 using 1960/61-1985/86 data, etc. We do not employ the jack-knife method of cross-validation which inflates skill, nor do we identify predictors using the whole data set which again inflates skill. The hindcast values are compared against verification, and the model skill is quantified using the $RMSE_{CL}$ Skill (%) metric defined as the percentage reduction in root-mean-square-error over what one would obtain from climatology forecasts, ie:

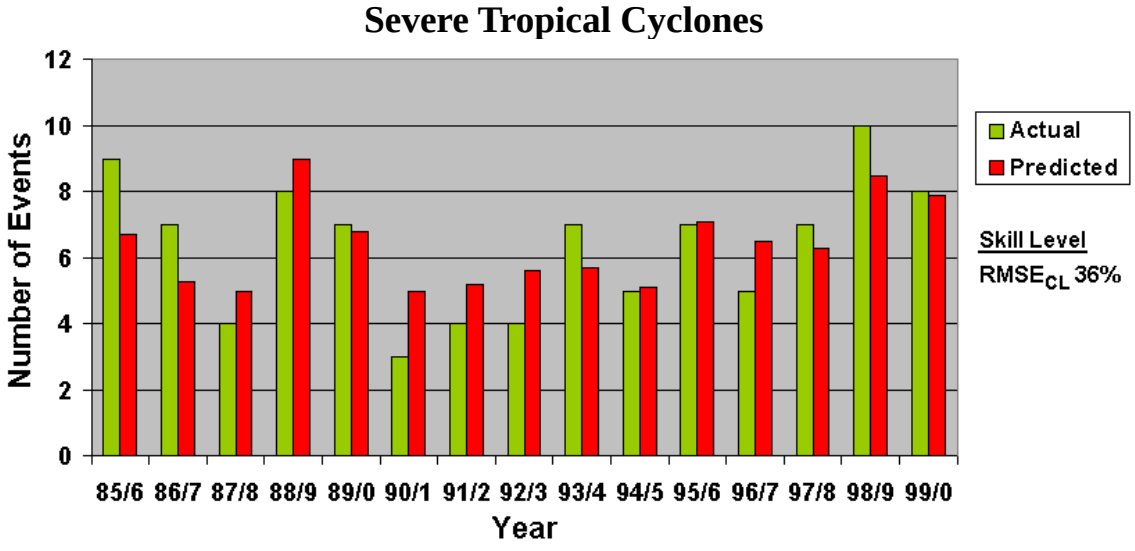
$$Skill\ Score\ =\ RMSE_{CL}(\%)\ Skill\ =\ \left(1-\frac{RMSE_{FORECAST}}{RMSE_{CLIMATOLOGY}}\right)*100\%$$

The skill scores in this document (page 1 and below) all use the $RMSE_{CL}$ skill measure. We feel this is a robust skill score which is immune to the bias problems associated with the Percentage of Variance Explained and Percentage Agreement Coefficient skill measures. The forecast errors in the Table on page 1 are given as the standard deviation of the hindcast errors for 1985/86-1999/00.

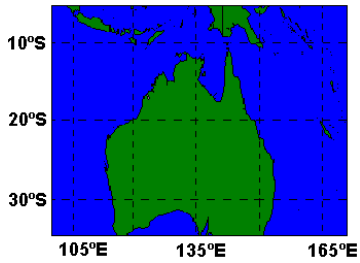
Model Hindcast Performance and Skill 1985/86-1999/00

How would the Australian region pre-season (early December) forecast model have performed had it been available in previous years? The figures below show the model hindcast performance and skill for the last 15 seasons. All forecasts are based solely on prior data.



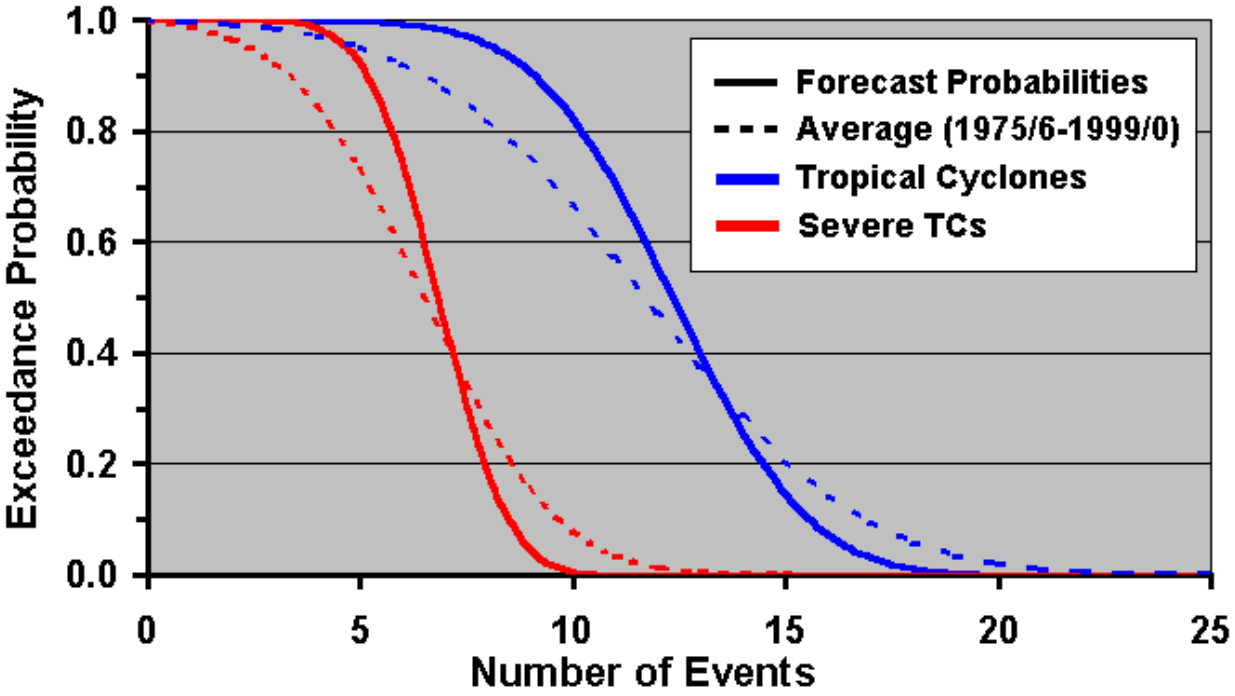


Number of Australian Region Tropical Cyclones in 2000/01

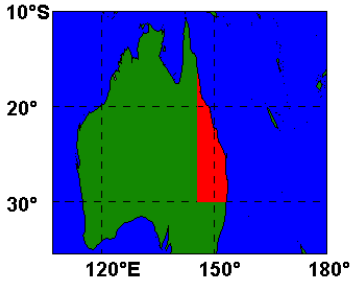


(Southern Hemisphere Region, 100°E to 170°E)

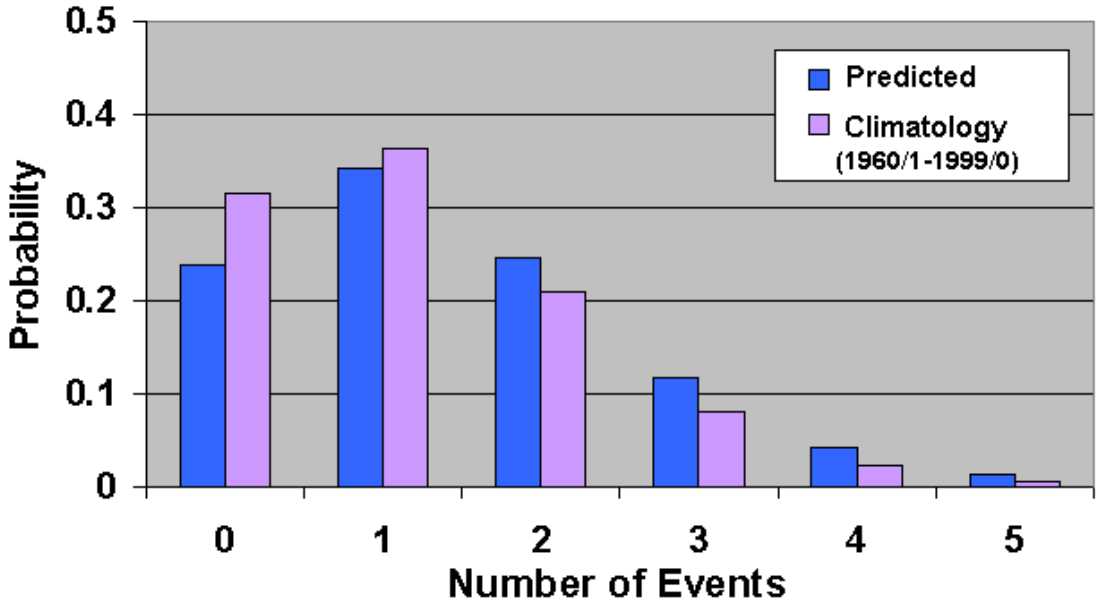
Probability of Exceedance Forecast for 2000/01



Queensland Landfalling Tropical Cyclones in 2000/01



Probability Forecast for 2000/01



Potential Benefits

Tropical cyclones prove a costly and deadly natural disaster for northern Australia and the SW Pacific islands between 10°S and 30°S. In 1999, for example, tropical cyclone John caused insured losses of US $200 million in northwest Australia. With the advent of satellites, numerical models provide warnings of impending landfall up to a week ahead. However, efforts are now being directed towards seasonal probabilistic forecasting of events many months in advance. Such long-range forecasts would benefit society, business and government by reducing - through the available lead-time - the risk and uncertainty inherent to varying active and inactive storm seasons.

Future Forecasts and Verifications

1. End-of-year summaries and forecast verifications for the Atlantic and NW Pacific 2000 seasons will be issued in lateDecember 2000.
2. Extended-range forecast for NW Pacific and Japan landfalling tropical cyclone activity in 2001 will be issued in mid January 2001.

Tropical Storm Risk.com (TSR)

TropicalStormRisk.com (TSR) is a venture which has developed from the UK government-supported TSUNAMI initiative project on seasonal tropical cyclone prediction. The *TSR* consortium comprises leading UK insurance industry experts and scientists at the forefront of seasonal forecasting. The *TSR* insurance expertise is drawn from the UK composite and life company *CGNU Group*, the *Royal and Sun Alliance* insurance company, and *Benfield Greig*, a leading independent global reinsurance and risk advisory group. The *TSR* scientific grouping brings together climate physicists, meteorologists and statisticians at *UCL* (University College London) and the *Met. Office*. *TSR* forecasts are available from http://tropicalstormrisk.com.

Acknowledgements

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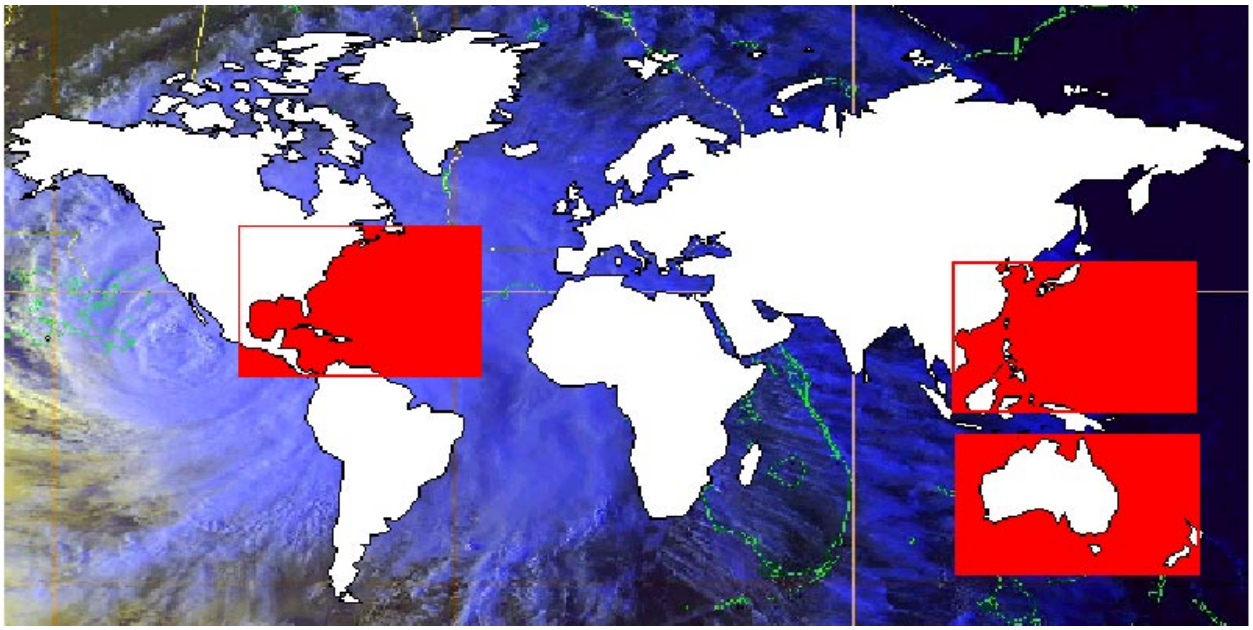

The three basins under research by the TSR Tropical Storm Risk team