Pre-Season Forecast for Australian Region Tropical Storms in 2001/02

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Forecast Summary

Australian region (100°E to 170°E) tropical storm and severe tropical cyclone numbers are expected to be 25-30% below average during the 2001/02 season

The Tropical Storm Risk (TSR) consortium presents a pre-season forecast for Australian-region tropical storm and severe tropical cyclone numbers, and for Queensland strike numbers. Our forecasts span the Australian season from December 2001 to the end of April 2002. They are based on data available through the end of November 2001. Rigorous independent hindcasts for 1986/87-2000/01 show that our pre-season forecast has skill 37% better than climatology in predicting the seasonal number of Australian-region tropical storms. Our main predictor is the observed ENSO sea surface temperature close to the Date Line. We anticipate the 2001/02 season being the quietest since 1994/95.

1a. Australian Region Total Numbers Forecast for 2001/02

		Severe Tropical Cyclones	Tropical Storms
TSR Forecast (±SD)	2001/02	4.5(±1.2)	8.9 (±2.2)
Average (±SD)	1976/77-2000/01	6.5(±2.5)	11.5 (±4.0)
Actual	2000/01	6	10

Key: Severe Tropical Cyclone = 1 Minute Sustained Wind > 63Kts = Hurricane Category 1 to 5
Tropical Storm = 1 Minute Sustained Wind > 33Kts
SD = Standard Deviation
Forecast Error = Standard Deviation of independent hindcast errors for 1986/87-2000/01
Australian Region = Southern hemisphere 100°E to 170°E (Storm must form as a Tropical Cyclone within to count).

- Tropical storm and severe tropical cyclone numbers are expected to be 25-30% below average in 2001/02. It is 85-90% probable that Australian region tropical storm activity will be below average.
- Very severe tropical cyclones (hurricane category 3-5) are not forecast due to data reliability problems in the historical record.
- TSR's extended range forecast for the 2001/02 Australian season, issued in June, called for near average activity. The downward revision of this forecast arises from the ENSO Nino 4 sea temperature prediction for October-November made in June being slightly in error.

1b. Queensland Landfalling Numbers in 2001/02

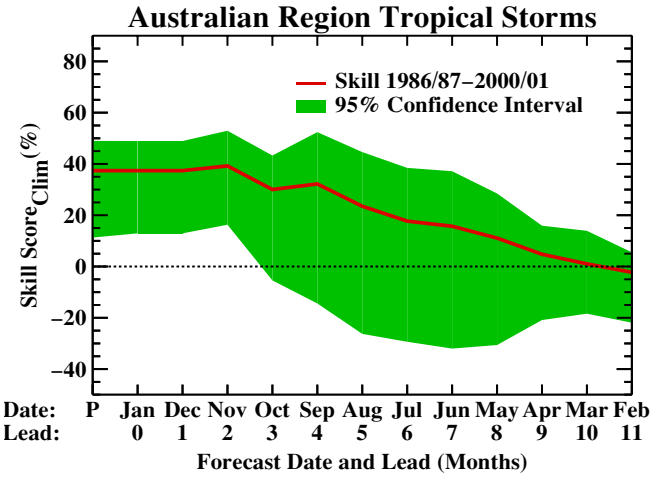
		Tropical Storms
TSR Forecast (±SD)	2001/02	1.1 (±0.8)
Average (±SD)	1976/77-2000/01	1.0 (±0.9)
Actual	2000/01	1

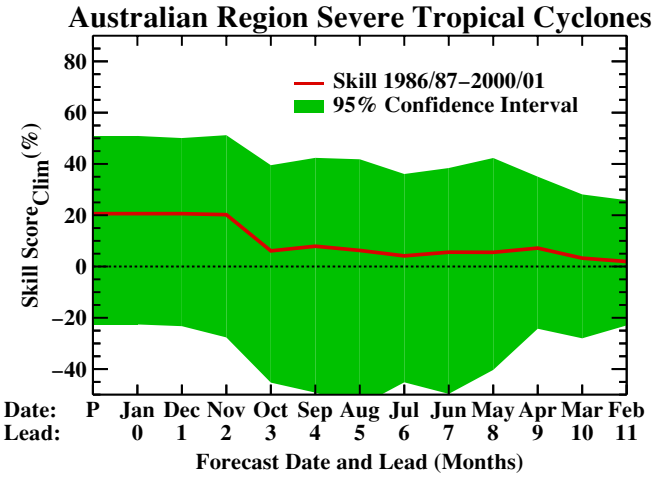
Key: Landfalling Region = Northeast Australian coast from 15°S (Cooktown) to 30°S (northern New South Wales).

- 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 to their lack of correlation with tropical storm strike numbers.

2. TSR Hindcast Skill Versus Lead Time 1986/87-2000/01

How would the TSR Australian-region forecast model have performed as a function of lead time had it been available in previous years? The figures below show the model skill and associated 95% confidence interval for tropical storm and severe tropical cyclone numbers as a function of forecast lead time. Leads extend to 11 months. Skill is assessed over the recent fifteen years 1986/87 to 2000/01. For an early December forecast of tropical storm numbers the mean skill is 37% better than a climatological forecast. For severe tropical cyclone numbers at this lead, model skill is 21% better than a climatological forecast.





3. Skill Score and Uncertainty

Several methods are in use to assess the skill of forecast models (eg Wilks, 1995; von Storch and Zwiers, 1999). We employ the percentage improvement in root mean square error over a climatological forecast ($RMSE_{cl}$). For simplicity we denote this skill measure as 'Skill Score $_{Clim}$ (%)' in the above figures. We consider this is a robust skill measure which is immune to the bias problems associated with the Percentage of Variance Explained and Percentage Agreement Coefficient skill measures. For climatology we employ the running 25-year period prior to each forecast year. Positive skill indicates the model does better than a climatology forecast, negative skill indicates that it does worse than climatology.

We compute confidence intervals on our forecast skill using the bootstrap method (Efron, 1979; also see Efron and Gong, 1983). This tests the hypothesis that the model forecasts are more skilful than those from climatology to some level of significance. We apply the bootstrap by randomly selecting (with

replacement) 15 actual values together with their associated predicted and climatology forecast values to provide a fresh set of hindcasts for which the $RMSE_{cl}$ skill measure can be calculated. This process is repeated many times (2,000 in this case) and the results histogrammed to give the required skill score. Provided that the original data are independent (in distribution and in order), the distribution of these recalculated values maps the uncertainty in the forecast skill about the original value over a 15-year period. 95% two-tailed confidence intervals for this uncertainty are then obtained.

4. Predictors and Key Influences for 2001/02

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 main predictors in our model for tropical storm numbers are:

a) The forecast October-November SST for the El Niño Southern Oscillation (ENSO) Nino 4 region 5°N-5°S, 150°W-160°E. (Main predictor for leads from previous January to October).
b) The observed October Niño 4 SST. (Main predictor for November forecast).
c) The observed October-November SST for the region 5°N-5°S, 170°W-160°E. (Main predictor for December and January forecasts).

Forecasts for severe tropical cyclones numbers are obtained by thinning the forecasts for tropical storm numbers. The January severe tropical cyclone forecast employs SST persistence for the Coral Sea region 15°S-25°S, 150°E-177.5°E from November and December. The predictor for Queensland landfalling numbers is the forecast December-March SST for the extended Nino region 5°N-5°S, 120°W-177.5°W.

The Niño 4 and extended Nino forecast SSTs come from an in-house extension of the Knaff and Landsea (1997) ENSO-CLIPER model.

The main climate factor influencing our forecast for below average activity in 2001/02 is the warmer than average October-November water temperature from the Niño 4 SST region of 0.64°C. Warmer than normal waters in this region lead to increased atmospheric vertical wind shear over the tropical cyclone forming seas around Australia; a condition favouring below average tropical storm activity.

5. Forecast Methodology

Our forecast model is statistical. We model the interannual variability in Australian region tropical storm activity using a Gaussian distribution. 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 5% level for a predictor to prove stable and acceptable.

Forecast skill is assessed by rigorous hindcast testing over the period 1986/87-2000/01. 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 1986/87 activity is forecast using 1960/61-1985/86 data, 1987/88 activity using 1960/61-1986/87 data, etc.

6. Monthly Updated Forecasts

For the 2002/03 Australian-region tropical storm season, TSR will be offering monthly updated forecasts for tropical storm and severe tropical cyclone activity from May through to December. The figures on page 2 show the TSR forecast skill and uncertainty as a function of lead month. Please contact Dr Mark

Saunders (mas@mssl.ucl.ac.uk) if you are interested in the monthly service. A summary and forecast verification for the 2001/02 Australian season will be issued in May 2002.

7. Potential Benefits

Tropical storms are a costly natural disaster for northern Australia and adjacent southwest Pacific islands between latitudes 10°S and 30°S and longitudes 100°E and 170°E. The average storm damage bill per year 1990/1-2000/1 for this region is US $ 55 million (2001 $). By providing a lead time on storm forecasts, TSR helps governments, administrators and businesses plan ahead, thus reducing the risk and uncertainty from varying active and inactive storm seasons.

8. Tropical Storm Risk.com (TSR)

Tropical Storm Risk.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 experts on insurance, risk management and seasonal climate forecasting. The TSR industry expertise is drawn from the *Benfield Group*, the leading independent reinsurance intermediary, *Royal & SunAlliance,* the global insurance group, and from *Crawford & Company*, a global provider of risk management services. The *TSR* scientific grouping brings together climate physicists, meteorologists and statisticians at *UCL* (University College London) and the *Met Offic*e. TSR forecasts are available from http:// tropicalstormrisk.com.

Acknowledgements

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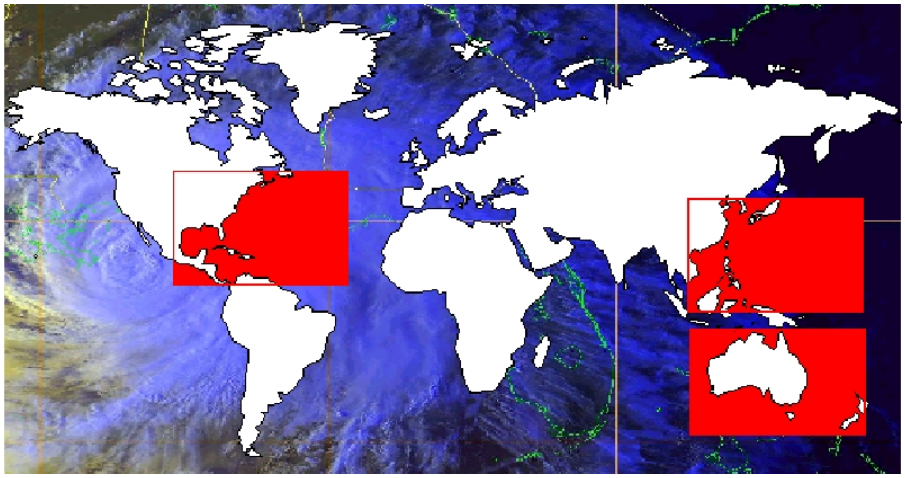

The three tropical cyclone basins under research by the TSR Tropical Storm Risk team.