Long-Range 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 close to 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. Our forecasts span the Australian season from 1st December 2001 to 30th April 2002. They are based on data available through the end of May 2001. Rigorous independent hindcasts for 1985/86-1999/00 show that our extended-range early June forecasts possess skill 12% better than climatology in predicting the seasonal number of Australian-region tropical storms. We present our 15-year forecast skill with 95% confidence intervals as a function of lead month from early January back to the previous January. Our main predictor is the forecast or observed ENSO sea surface temperature close to the Date Line.

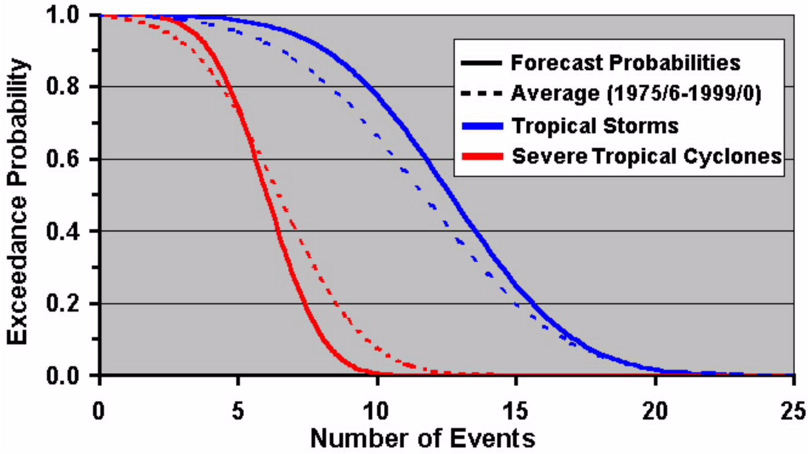
1a. Australian Region Total Numbers Forecast for 2001/02

		Severe Tropical Cyclones	Tropical Storms
TSR Forecast (±SD)	2001/02	6.0 (±1.6)	12.7 (±2.5)
Average (±SD)	1975/76-1999/00	6.5 (±2.5)	11.7 (±4.0)
Actual	2000/01	6	10

Key:
Key:	Severe Tropical Cyclone	=	1 Minute Sustained Wind > 63Kts = Hurricane Category 1 to 5
	Tropical Storm	=	1 Minute Sustained Wind > 33Kts
	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).

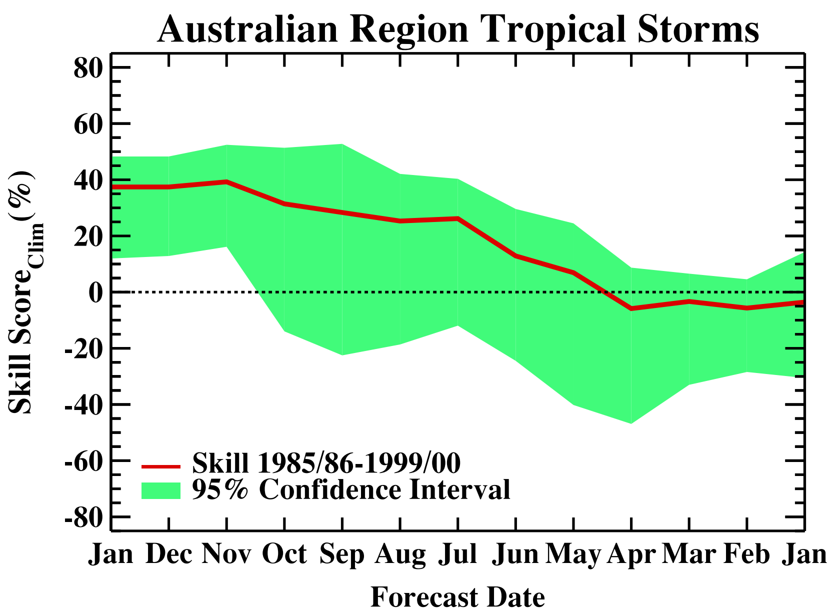
- Tropical storm and severe tropical cyclone numbers are anticipated to be within 10% of average in 2001/02.
- Very severe tropical cyclones (hurricane category 3-5) are not forecast due to data reliability problems in the historical record.
- Queensland landfalling numbers are not forecast as our model does not have skill at this extended 6-month lead.

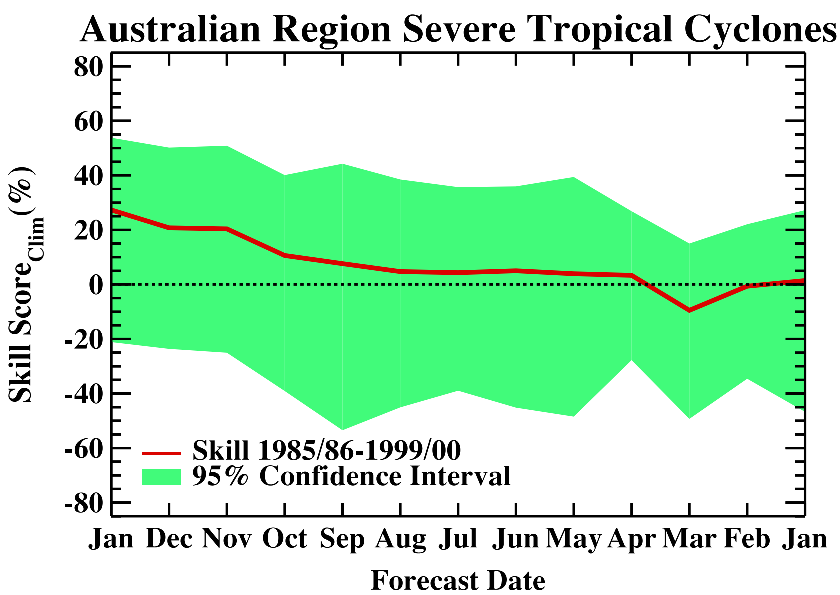
1b. Australian Region Probability of Exceedance Forecast for 2001/02



2. TSR Hindcast Skill Versus Lead Time 1985/86-1999/00

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 12 months. Skill is assessed over the recent fifteen years 1985/86 to 1999/00. For an early June





forecast of tropical storm numbers the mean skill is 12% better than a climatological forecast. For severe tropical cyclone numbers at this lead , model skill is only marginally 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; LePage and Billiard, 1992; Wilks, 1995). 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 predictand (or actual) values from the original 15 hindcast years. This provides a fresh set of hindcasts for which the $RMSE_{cl}$ skill measure can be calculated. This process is repeated many times (10,000 in this case) and the results histogrammed to give the required distributions. Provided that the original data points 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 readily 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, 160°E-150°W. (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, 160°E-170°W. (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 Niño 4 forecast SSTs come from an in-house statistical model which utilises initial conditions and trends in global SSTs.

The key factor behind our forecast for average activity in 2001/02 is the neutral projected value for the October-November Niño 4 SST of 0.32±0.46°C. The $RMSE_{cl}$ model skill for Niño 4 SST at this range is an acceptable 38%. This predictor is expected to lead to neutral vertical wind shear anomalies over the Coral Sea during the main tropical cyclone season thereby favouring average tropical cyclone 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 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 uture year to be forecast - ie the hindcasts are performed in strict 'forecast' mode. Thus 1985/86 activity is forecast using 1960/61-1984/85 data, 1986/87 activity using 1960/61-1985/86 data, etc.

6. Monthly Updated Forecasts

For the 2001/02 Australian-region tropical storm season, *TSR* also offers monthly updated forecasts for tropical storm and severe tropical cyclone activity as the season approaches. 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 this service.

TSR will issue a public pre-season forecast for Australian-region and Queensland landfalling tropical storm activity in early December 2001.

7. Potential Benefits

Tropical cyclones prove a costly and deadly natural disaster for northern Australia and for the southwest 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 the 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.

8. 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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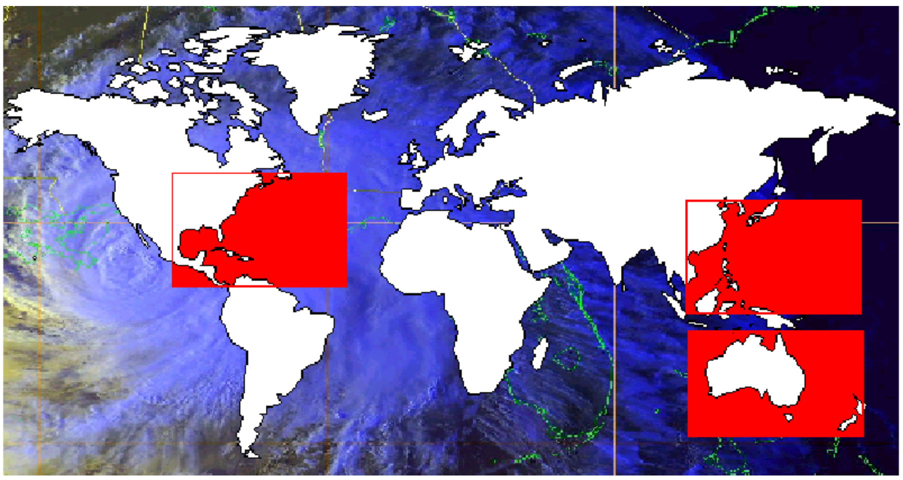

The three tropical cyclone basins under research by the TSR Tropical Storm Risk team.