Atlantic, U.S. and Caribbean Landfalling Tropical Cyclones in 2000

Pre-Season Forecast Issued 26th May, 2000

Produced under contract for TSUNAMI in collaboration with the UK Met. Office
by Drs Mark Saunders, Paul Rockett and Tony Hamilton
Benfield Greig Hazard Research Centre, University College London, UK.

Forecast Summary

Atlantic hurricane activity and US landfall probability are expected to be slightly below average in 2000

We present pre-season forecasts for Atlantic tropical cyclone, hurricane and intense hurricane numbers in 2000, and for hurricane strike numbers on the US East Coast, the US Gulf Coast, and on the Caribbean Lesser Antilles in 2000. These forecasts span the full 2000 Atlantic season from 1st June 2000 to 30th November 2000. They are based on data available through the end of April 2000. Hindcast testing for 1990-1999 shows that our May predictions are able to anticipate around 45% of the year-to-year variance in seasonal basin numbers, and up to 35% of the year-to-year variance in seasonal US strikes. Our predictors are forecast sea surface temperatures and forecast QBO.

1. Atlantic Total Numbers in 2000

		Intense Hurricanes	Hurricanes	Tropical Storms
TSUNAMI Forecast (±SD)	2000	2.1 (±1.4)	5.1 (±2.3)	8.7(±3.0)
NOAA May Forecast	2000	≥3	≥7	≥11
Gray April Forecast	2000	3	7	11
Actual	1999	5	8	12
Average (±SD)	1952-1999	2.3 (±1.5)	5.8 (±2.4)	9.9 (±3.1)

Key: Intense Hurricanes = Sustained Wind > 95Kts = Category 3 to 5
Hurricanes = Sustained Wind > 63Kts = Category 1 to 5
Tropical Storms = Sustained Wind > 33Kts
'Average' refers to the 1952-1999 period.

2. US Landfalling Numbers in 2000

		Intense Hurricanes	Hurricanes	Tropical Storms
Forecast (±SD)	2000	0.7 (±0.8)	1.5 (±1.2)	3.1 (±1.7)
Actual	1999	1	3	5
Average (±SD)	1952-1999	0.8 (±0.9)	1.7 (±1.3)	3.5 (±1.9)

3. US East Coast Strikes in 2000

		Intense Hurricanes	Hurricanes	Tropical Storms
Forecast (±SD)	2000	0.6 (±0.8)	0.8 (±0.9)	1.7 (±1.3)
Actual	1999	0	2	4
Average (±SD)	1952-1999	0.4 (±0.6)	1.0 (±1.0)	2.1 (±1.5)

4. US Gulf Coast Strikes in 2000

		Intense Hurricanes	Hurricanes	Tropical Storms
Forecast (±SD)	2000	0.3 (±0.5)	1.0 (±1.0)	2.3 (±1.5)
Actual	1999	1	2	3
Average (±SD)	1952-1999	0.4 (±0.7)	1.0 (±1.0)	2.5 (±1.6)

5. Caribbean Lesser Antilles Strikes in 2000

		Intense Hurricanes	Hurricanes	Tropical Storms
Forecast (±SD)	2000	0.2 (±0.4)	0.4 (±0.6)	1.2 (±1.1)
Actual	1999	1	2	2
Average (±SD)	1952-1999	0.3 (±0.5)	0.5 (±0.7)	1.3 (±1.1)

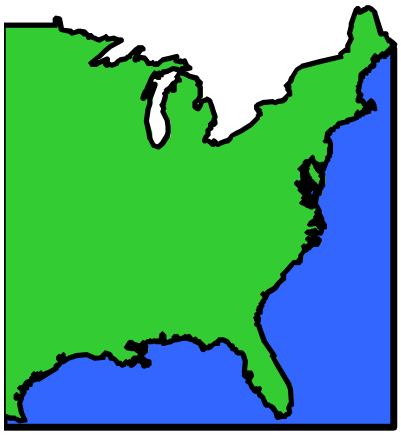
Predictors and Key Influences in 2000

We use a Poisson generalised linear model to describe the year-to-year variability in seasonal incidence rates. As such, the standard error given on all forecasts is the square root of the forecast mean. Mean absolute errors computed from hindcasts over 1990-1999 are typically 30% less than the forecast standard errors (see examples on page 4).

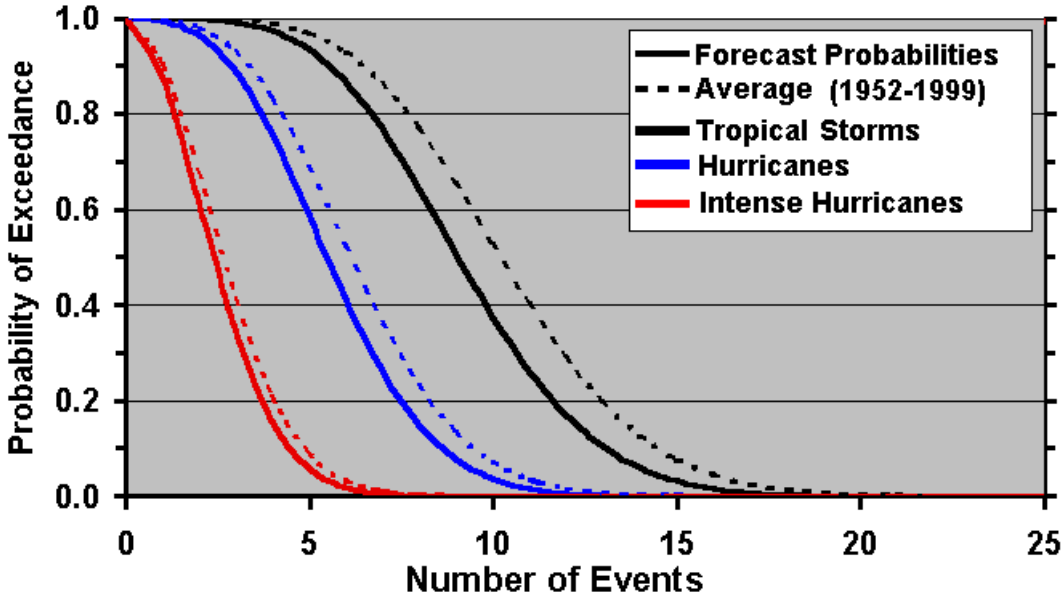
The predictors in our model are forecast sea surface temperatures (SSTs) for Nino 3.4 in August-September 2000, forecast SSTs for five Atlantic regions in the tropics and extra-tropics in August-September 2000, and the forecast QBO for August-September 2000. The forecast Nino 3.4 value we employ is the median of eight leading internatonal ENSO forecasts. The Atlantic SST forecasts we use are developed in-house. These latter can anticipate about 50% of seasonal variance in the required Atlantic August-September SSTs from the end of April.

The strongest factors behind the forecast of slightly below average activity in 2000 are the neutral Nino 3.4 forecast (median value of -0.2°C (1961-1990 climatology), and the forecast neutral SSTs (anomaly of 0.02°C (1961-1990 climatology)) for the Atlantic main development region (10°-20°N, 20°-60°W).

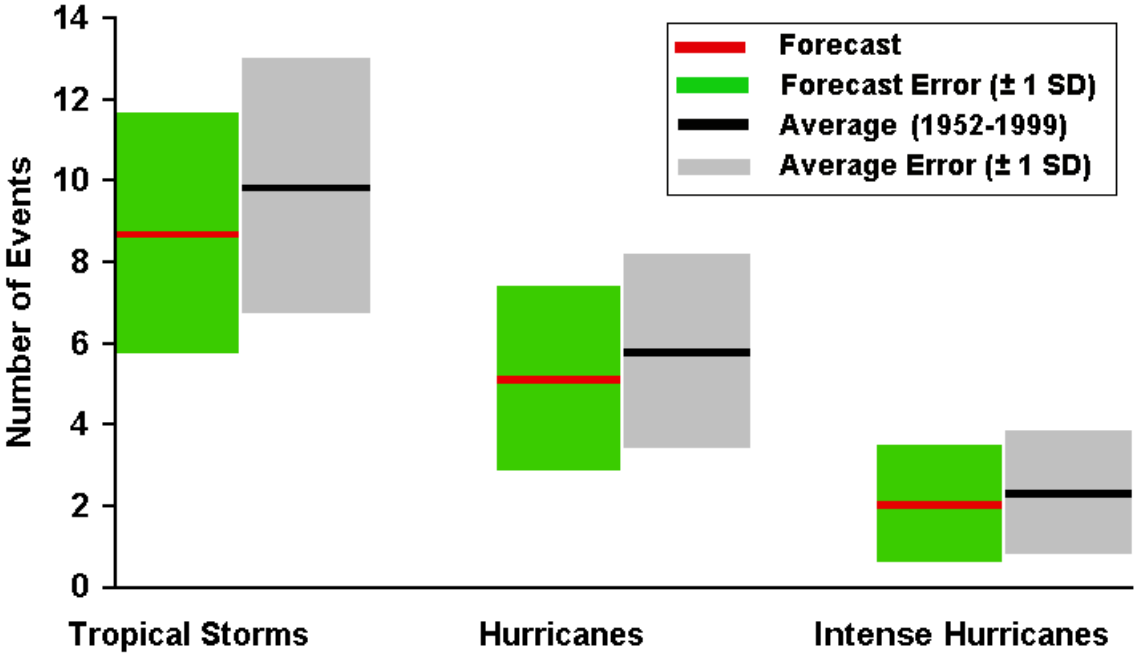
Total Number of Atlantic Tropical Cyclones



Probability of Exceedance Forecast for 2000

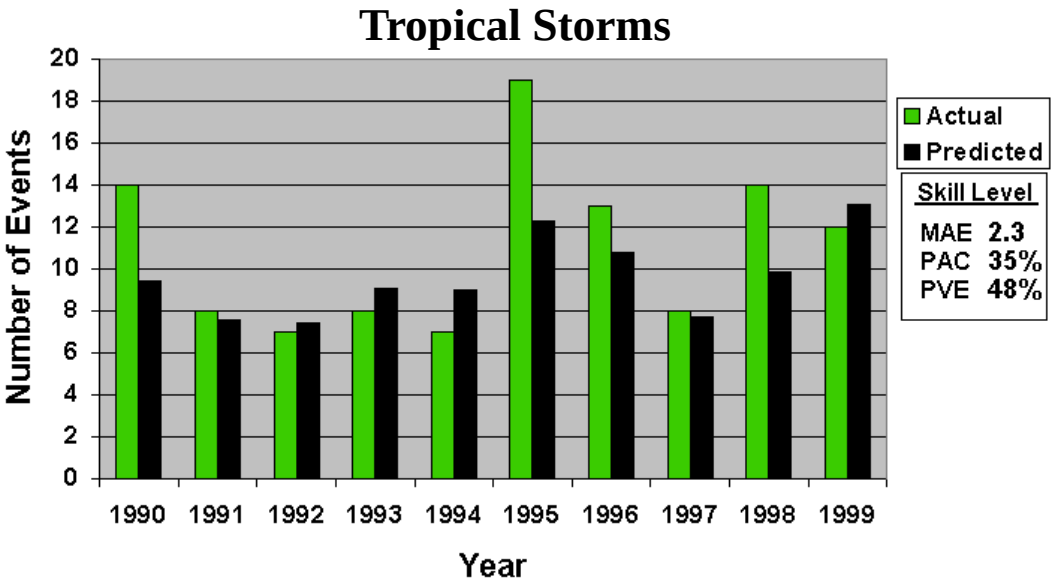


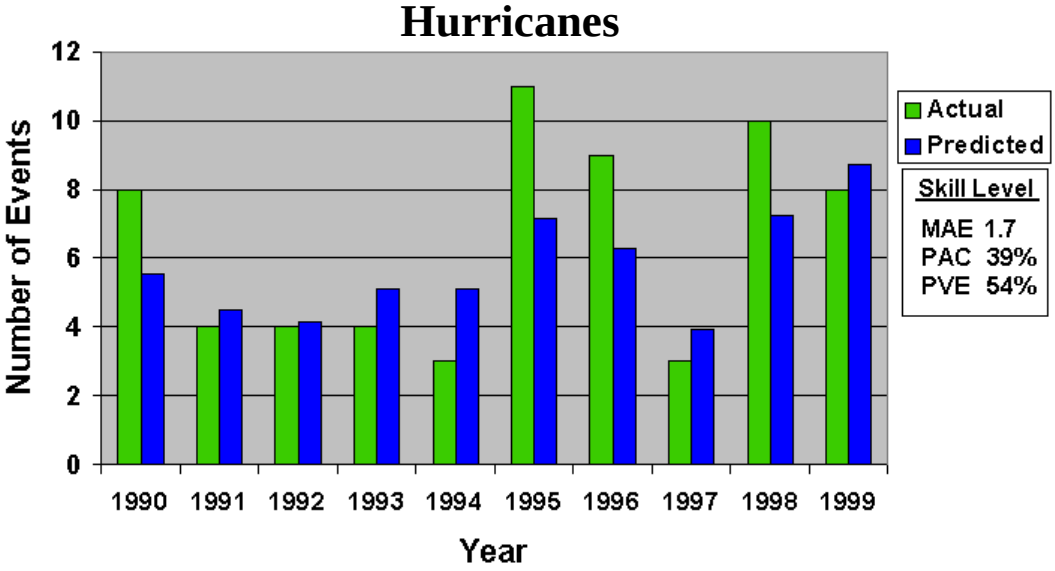
Frequency and Severity Distribution for 2000

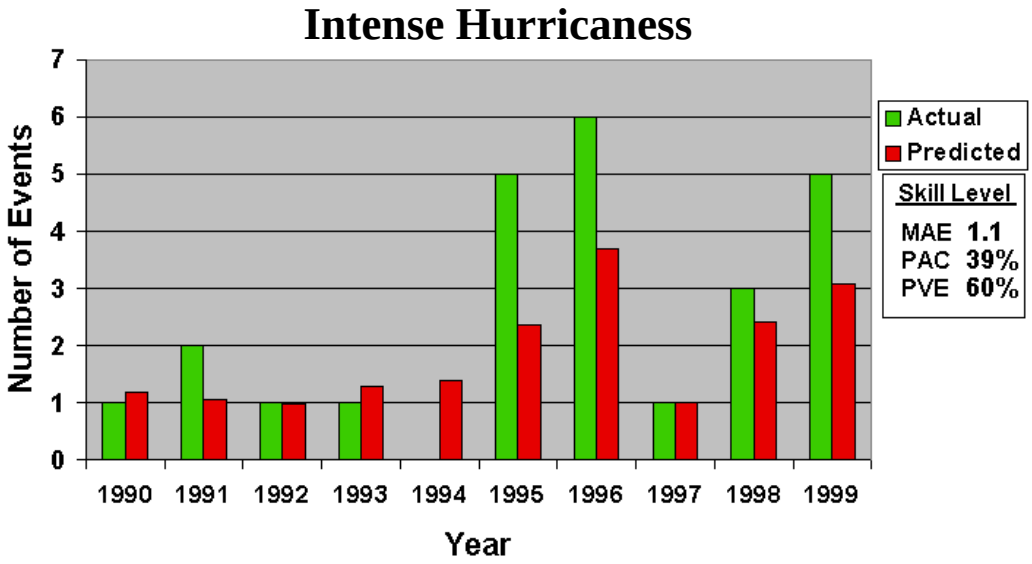


Model Hindcast Performance 1990-1999: Basin Total Numbers

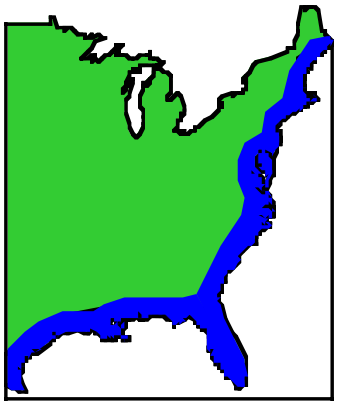
How would the pre-season model (using data up to the end of April) perform had it been available in previous years?



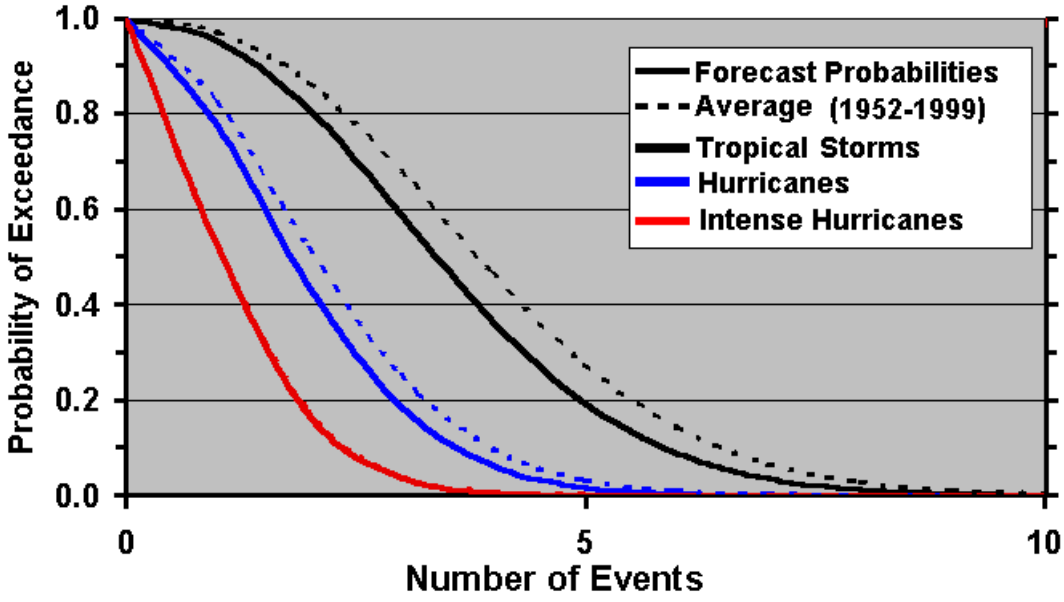




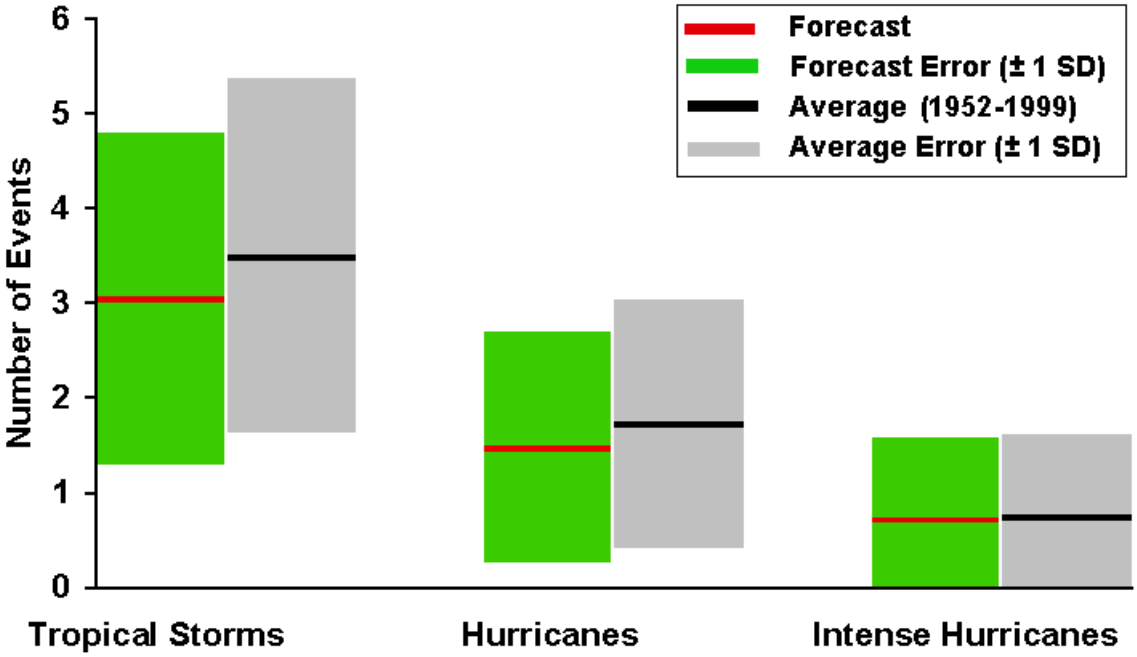
USA Landfalling Tropical Cyclones



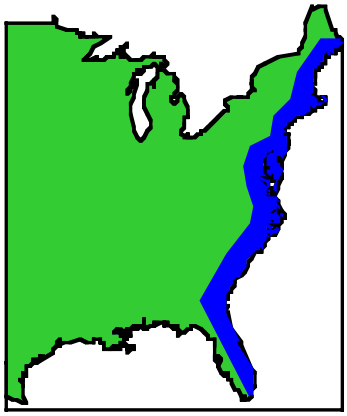
Probability of Exceedance Forecast for 2000



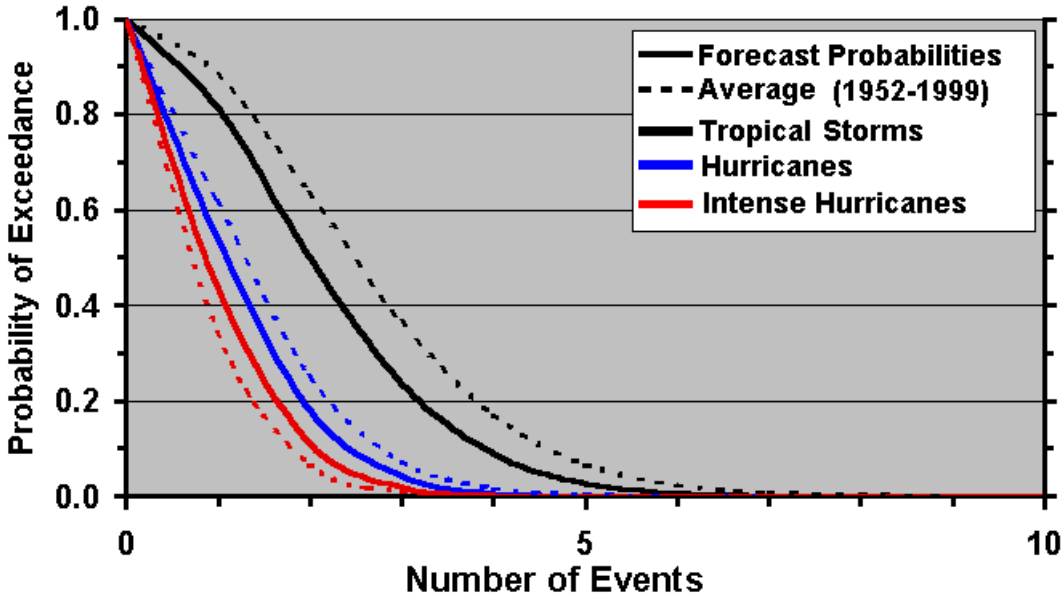
Frequency and Severity Distribution for 2000



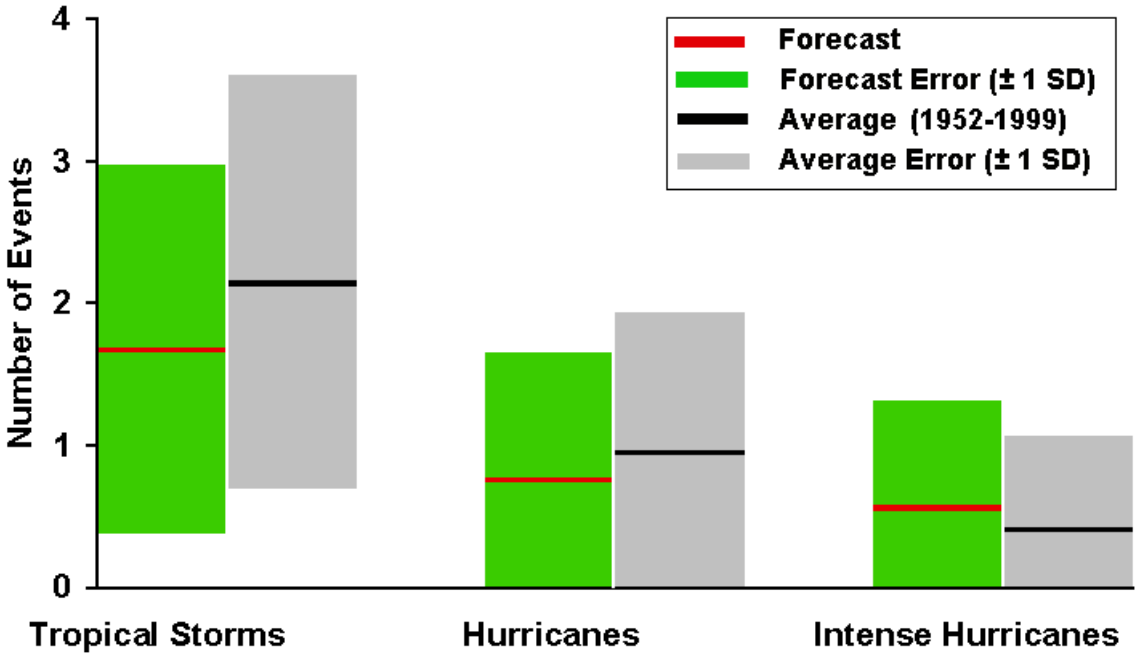
East Coast Landfalling Tropical Cyclones



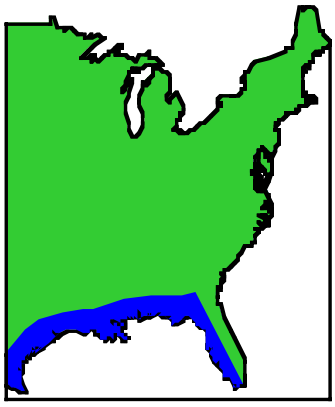
Probability of Exceedance Forecast for 2000



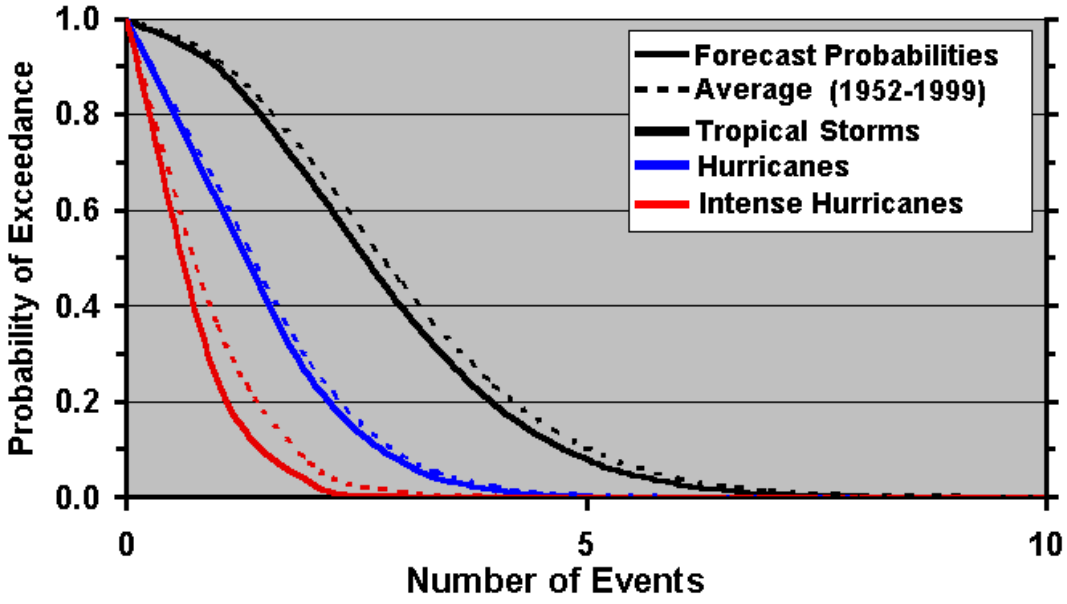
Frequency and Severity Distribution for 2000



Gulf Coast Landfalling Tropical Cyclones



Probability of Exceedance Forecast for 2000



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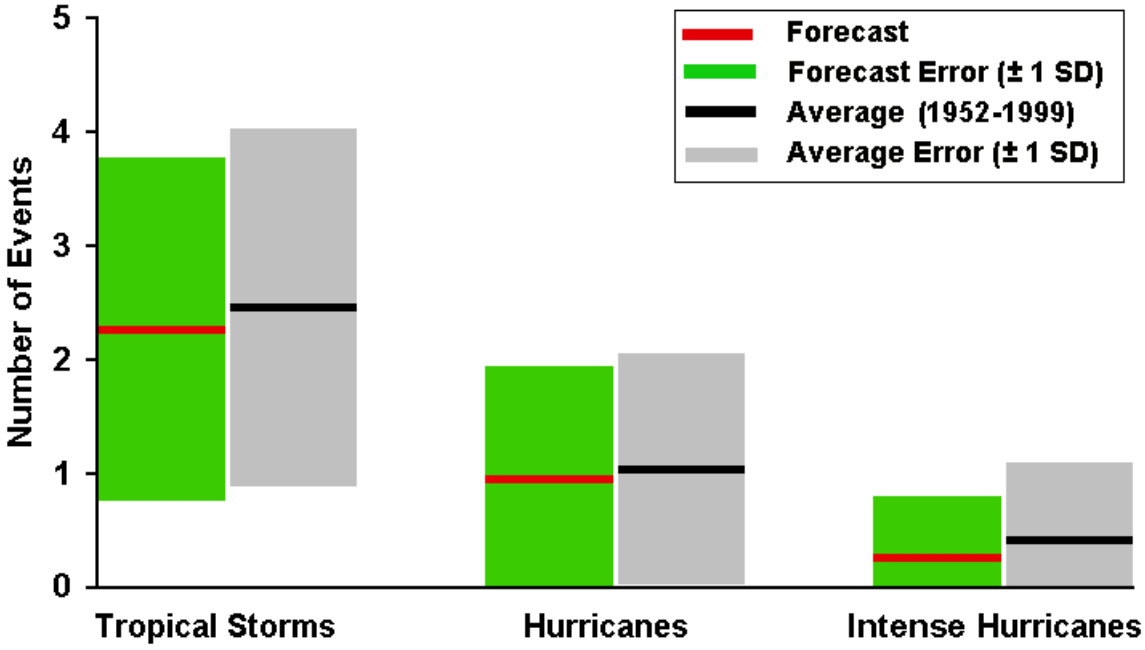
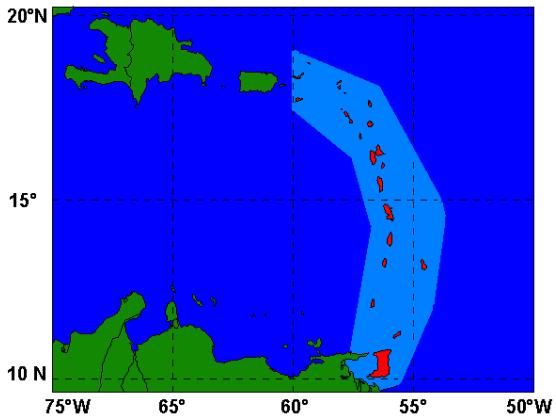
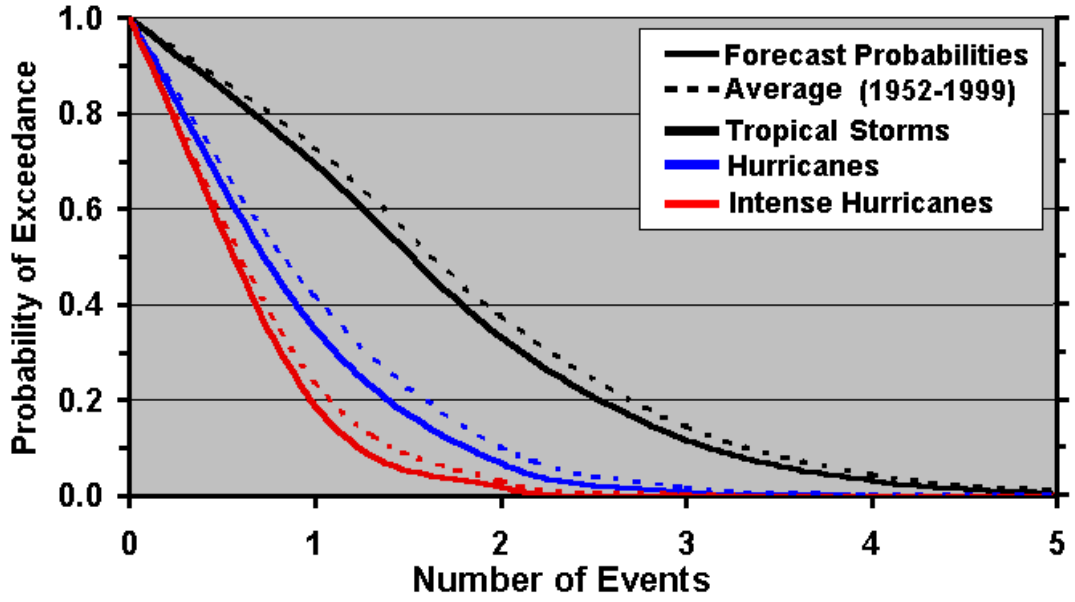


Lesser Antilles Landfalling Tropical Cyclones



Probability of Exceedance Forecast for 2000



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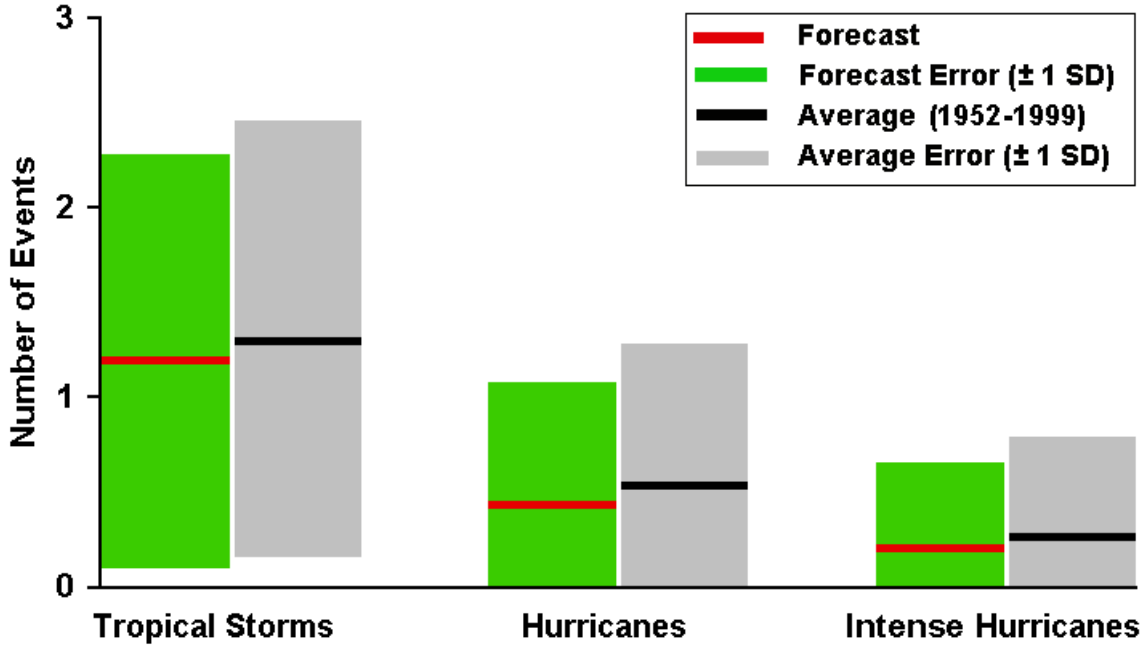


Potential Benefits

Tropical cyclones rank above earthquakes and floods as the major cause of property damage in the United States. The annual hurricane damage bill in the continental US for 1926-1995 is estimated as US $5.0 billion (1997 $) [Pielke and Landsea, 1998]; for the period 1990-1998 the annual figure is US $5.2 billion (1997 $). Intense tropical cyclones - or hurricanes - are responsible for 98% of US damage [Pielke and Landsea, 1998]. With the advent of satellites, numerical models provide warnings of impending landfall up to a week ahead. However, efforts are now being given to the seasonal probabilistic forecasting of these landfalls many months in advance. Such long-range forecasts - if skilful - would benefit a range of industry including insurance, energy and power, and agriculture.

Hindcast Skill Measures

The tropical cyclone and SST forecast skill is assessed by hindcast testing over the period 1990-1999. We use constant predictor sets throughout but only use prior years to calculate the regression relation for each future year to be forecast - ie the hindcasts are performed in 'forecast' mode. Thus 1990 is forecast using 1952-1989 data, 1991 using 1952-1990 data, etc. We do not employ the jack-knife method of cross-validation which inflates skill. The hindcast values are compared against verification, and the model skill is quantified using the following standard measures:

MAE (Mean Absolute Error) defined as the mean absolute difference between the predicted and actual values. The lower this value, the more skilful the model.

PAC (Percentage Agreement Coefficient) defined as the mean absolute difference between the predicted and actual values relative to the level expected under the model. A PAC of 100% indicates perfect skill, a PAC value of 0% indicates no forecast skill.

PVE (Percentage of Variance Explained) defined as the percent of the actual variance explained by the forecast. A PVE of 100% indicates perfect skill, a PVE of 0% indicates no skill.

Future Forecasts

An extended-range forecast for Atlantic seasonal tropical cyclone activity and for US and Caribbean hurricane strike probabilities in 2001 will be issued on 1st October 2000.

End-of-year summaries and forecast verifications for the NW Pacific and Atlantic 2000 seasons will be issued in early December 2000.

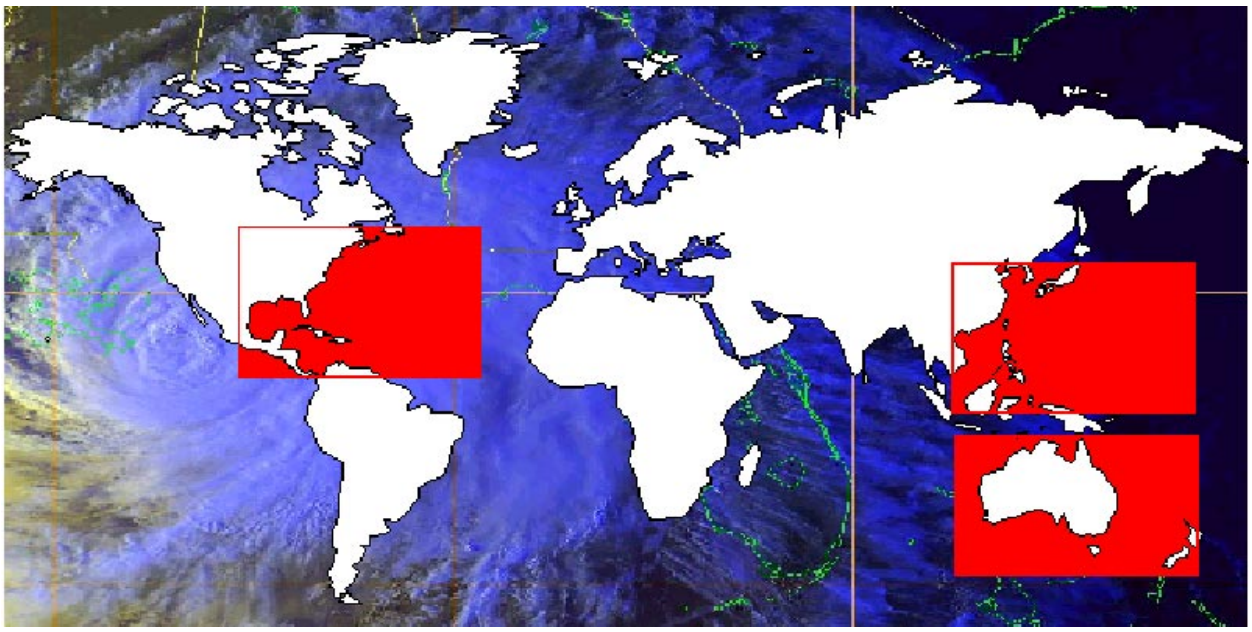
Acknowledgements

The Seasonal Prediction of Tropical Cyclones project is coordinated by the UK Met. Office under the direction of Mrs Alyson Bedford. We wish to thank Lance Garrard (Director, MetRisk Ltd) and Mike Cooper (CGU Group) for industrial liaison, Dr Richard Chandler (Department of Statistical Science, University College London) for statistical advice, Dr Mike Davey (Met. Office) for meteorological expertise, and Frank Roberts and Justin Mansley (UCL) for computing assistance.

The TSUNAMI Initiative

The TSUNAMI initiative was established in response to the Foresight Programme, a UK Government initiative aimed at stimulating improved dialogue between academia and industry. TSUNAMI was formed in September 1997 by Dr Dougal Goodman, Deputy Director of the British Antarctic Survey a component part of the Natural Environment Research Council (NERC). It aims to improve the competitiveness of the UK insurance industry by using UK scientific expertise to improve the assessment of risk. TSUNAMI's three year programme is funded jointly by the Government through the Department of Trade and Industry's Sector Challenge, and by a consortium from the UK insurance industry comprising:

UK Composite Companies:	CGU Group, Royal and Sun Alliance Insurance Group
Lloyd's Reinsurance Brokers:	Benfield Greig Group, Guy Carpenter
Lloyd's Managing Agencies:	Catlin Underwriting Agencies Ltd, DP Mann Ltd, Wren Syndicates Management Ltd.



The three basins under research in the TSUNAMI Seasonal Prediction of Tropical Cyclones project.