

Stormy times ahead

Professor Mark Saunders, tropical storm risk lead scientist and head of seasonal forecasting and meteorological hazards at the Benfield Hazard Research Centre, looks ahead to this year's hurricane season.

CURRENT forecasts indicate that following the ravages of 2004, the maritime world needs to prepare itself for another above-average Atlantic hurricane season in 2005, a factor which underlines the ongoing need for vigilance on the part of governments and individual citizens alike.

Hurricanes rank as the US's most expensive natural disaster and are responsible for eight of the 10 most costly catastrophes to affect the country. The average annual total loss from hurricane strikes on the continental US during the period 1950–2004 is estimated to be US\$5.6bn at 2004 prices and exposures.

There is no doubt that we are witnessing an active period for North Atlantic hurricane activity. Over the last 10 years, from 1995 to 2004, eight Atlantic hurricanes occurred on average each year. This compares to an average of just five hurricanes a year between 1971 and 1994.

Furthermore, 2003 and 2004 saw the third highest two-year total number of US hurricanes making landfalls since 1900, with seven hitting the country during that period.

Based on current and projected climate signals, it seems that this upsurge in activity will continue through 2005 with the current Tropical Storm Risk (TSR) long-range hurricane outlook anticipating that Atlantic basin and US landfalling hurricane activity will be some 160% of the average.

- An 85% probability of an above-average Atlantic hurricane season (which runs from 1 June to 30 November), a 13% probability of a near-average season, and only a 2% chance of a below-average season.
- Forecasts of 14 tropical storms for the Atlantic basin as a whole, with eight of these being hurricanes and four being intense hurricanes.
- A 71% probability of above-average US landfalling hurricane activity, a 21% likelihood of a near-average season, and only an 8% chance of a below-average season.

The two main climate factors influencing the TSR hurricane forecast for 2005 are the expected values in August and September for the speed of the trade winds which blow westward across the tropical Atlantic and Caribbean Sea and the temperature of the sea waters between West Africa and the Caribbean where many hurricanes develop.

The speed of the trade winds influences cyclonic 'vorticity' – the likelihood of storms being spun up – over the regions where hurricanes form. Weaker than normal trade winds enhance the vorticity factor, so leading to more hurricanes being formed, and vice versa when there are stronger than normal trade winds.

At the same time, the temperature of the sea surface water impacts on the amount of heat

incipient storms, with warmer than normal surface waters creating a greater likelihood of storms. Again, when the opposite applies there is a reduced likelihood of storms.

At present TSR is anticipating that in 2005 there will be weaker than normal trade winds and warmer than normal waters; conditions which both favour an above-average hurricane season. However, the possible development of El Niño remains an uncertainty.

The current forecast anomalies (1975–2004 climatology) for these predictors are $0.56 \pm 0.60 \text{ ms}^{-1}$ (down from last month's forecast value of $0.62 \pm 0.68 \text{ ms}^{-1}$) and $0.35 \pm 0.24^\circ\text{C}$ (up from last month's forecast value of $0.24 \pm 0.25^\circ\text{C}$). The forecast skills (1985–2004) for these predictors at this lead are 46% and 35% respectively.

Looking at the figures in more detail, the TSR current forecasts indicate that there is an 85% probability that the 2005 Atlantic hurricane season ACE (Accumulated Cyclone Energy) index will be above average (defined as an ACE index value in the upper tercile), a 13% likelihood it will be near normal (defined as an ACE index value in the middle tercile), and only a 2% chance it will be below normal (defined as an ACE index value in the lower tercile).

From a statistical standpoint, terciles are data groupings of equal (ie 33.3%) probability, and for the purpose of this model correspond to the upper, middle and lower third of historical

CATASTROPHE

Forecast for Atlantic ACE index and system numbers in 2005

		ACE index	Intense hurricanes	Hurricanes	Tropical storms
TSR forecast (\pm FE)	2005	158 (\pm 44)	3.6 (\pm 1.4)	7.8 (\pm 2.1)	13.9 (\pm 2.6)
55yr climate norm (\pm SD)	1950–2004	98 (\pm 57)	2.6 (\pm 1.8)	6.0 (\pm 2.4)	9.9 (\pm 3.3)
Forecast skill at this lead	1985–2004	28%	26%	19%	21%

Key	
ACE index	Accumulated Cyclone Energy Index = sum of the squares of 6 hourly maximum sustained wind speeds (in units of knots) for all systems while they are at least tropical storm strength. ACE unit = $\times 10^4$ knots
Intense hurricane	1 minute sustained wind >95 Kts = hurricane category 3 to 5
Hurricane	1 minute sustained wind >63 Kts = hurricane category 1 to 5
Tropical storm	1 minute sustained wind >33 Kts
SD	Standard deviation
FE (forecast error)	Standard deviation of errors in replicated real time forecasts 1985–2004
Forecast skills	Percentage improvement in mean square error over running 10-year prior climate norm from replicated real time forecasts 1985–2004

Turning to the Atlantic hurricane main development region (MDR) – the region 10° N– 20° N, 20° W– 60° W between the Cape Verde Islands and the Caribbean Lesser Antilles – the TSR models currently indicate there is an 86% probability that in 2005 the MDR, Caribbean Sea and Gulf of Mexico ACE index will be above average, a 13% likelihood it will be near average, and only a 1% chance it will be below average.

In terms of this element of the forecast, it is worth noting that a storm is defined as having formed within this region if it reached at least tropical depression status while in the area.

For the US, current forecasting constraints mean that while it is possible to anticipate the overall number of hurricanes that will make US landfall, it is far more difficult to assess the potential strength and activity of those hurricanes and, therefore, how many will fall into the intense category.

Forecast for ACE index and numbers forming in the MDR, Caribbean Sea and Gulf of Mexico in 2005

		ACE index	Intense hurricanes	Hurricanes	Tropical storms
TSR forecast (\pm FE)	2005	140 (\pm 45)	3.5 (\pm 1.3)	6.0 (\pm 2.0)	10.1 (\pm 2.7)
55yr climate norm (\pm SD)	1950–2004	76 (\pm 58)	2.3 (\pm 1.8)	4.2 (\pm 2.4)	6.9 (\pm 3.2)
Forecast skill at this lead	1985–2004	32%	32%	37%	37%

Accordingly, this factor is not generally forecast, although TSR has recently developed a computer model which significantly improves the ability to predict the strength of hurricane activity striking the US mainland and is hopeful of making further strides on this front in future.

What can be predicted for 2005 from the current forecasts is that there is a 71% probability that the US landfalling ACE index will be above average, a 21% likelihood it will be near normal, and only a 8% chance it will be below normal.

Forecast storm strikes on the Caribbean Lesser Antilles are also predicted to be above average in 2005. Tropical storms and hurricanes striking these islands originate from the Atlantic hurricane main development region so there is a strong link between the number of MDR storms and strikes on the Lesser Antilles. TSR is forecasting two tropical storm hits, one of which will be a hurricane, on the Caribbean Lesser Antilles in 2005. ■

Typhoon warning

Professor Mark Saunders now gives his view of the likely typhoon activity in the Northwest Pacific

THE Northwest Pacific typhoon season lasts from 1 January to 31 December with, historically, 95% of typhoons occurring after 1 May. The current Tropical Storm Risk (TSR) outlook for Northwest Pacific typhoon activity in 2005, which was released on 5 May, points to a close-to-average season.

As forecasts currently stand, TSR is predicting a 30% likelihood of an above-average activity season, a 51% probability of a near-average season and only a 19% chance of a below-average season. More specifically, this translates into an expectation of 28 tropical storms, of which 18 will be typhoons, with nine out of those 18 typhoons being intense typhoons.

This outlook indicates a less active season than in 2004 where activity was 60% above normal with 21 typhoons in total of which 13 were intense typhoons.

The TSR forecast includes deterministic and

probabilistic projections for overall basin activity, and deterministic projections for the numbers of tropical storms, typhoons and intense typhoons at this point in the year.

Its main predictor at this lead time for overall activity is the forecast anomaly in August–September Niño 3.75 sea surface temperature (SST) – ie the temperature of the sea waters in the region 140°W–180°W, 5°S–5°N – which we anticipate will be $0.13 \pm 0.46^\circ\text{C}$ warmer than normal this summer.

Warmer than normal summer waters in this area are linked to Northwest Pacific trade wind speed changes, which enhance cyclonic vorticity (the spinning up of storms). This is due to the fact that above average Niño 3.75 SSTs are associated with weaker trade winds over the region 2.5°N–12.5°N, 120°E–180°E.

By the same token, colder than normal summer waters – or Niño 3.75 SSTs – are associated with stronger trade winds over the

critical region and have the opposite effect, so resulting in below-average activity.

The forecast skill (1965–2004) for this predictor at this lead is 57%.

Following a review of seasonal predictability over the extended 1965–2004 period of reliable data, the TSR predictors that are being used for the 2005 Northwest Pacific typhoon season have changed from recent years.

Tropical storm and typhoon numbers are now forecast before May using the Niño 3 SST from the prior September. From May onwards they are forecast using April surface pressure over the region 17.5°N–35°N, 160°E–175°W.

Intense typhoon numbers and the ACE index are now forecast in March and April using the February surface pressure in the central northern tropical Pacific region 10°N–20°N, 145°W–165°W, while from May they are forecast from the forecast value for the August–September Niño 3.75 index (5°S–5°N; 140°W–180°W). ■

Forecast for Northwest Pacific typhoon activity in 2005					
		ACE index	Intense typhoons	Typhoons	Tropical storms
TSR forecast (\pm FE)	2005	314 (\pm 81)	8.9 (\pm 2.6)	17.5 (\pm 2.9)	27.6 (\pm 3.7)
55yr climate norm (\pm SD)	1950–2004	305 (\pm 99)	0.3 (\pm 3.0)	16.9 (\pm 3.7)	26.8 (\pm 4.5)
Forecast skill at this lead	1985–2004	32%	24%	37%	33%
Key					
ACE index	Accumulated Cyclone Energy Index = sum of the squares of 6 hourly maximum sustained wind speeds (in units of knots) for all systems while they are at least tropical storm strength. ACE unit = $\times 10^4$ knots				
Intense typhoon	1 minute sustained wind >95 Kts = hurricane category 3 to 5				
Typhoon	1 minute sustained wind >63 Kts = hurricane category 1 to 5				
Tropical storm	1 minute sustained wind >33 Kts				
SD	Standard deviation				
FE (forecast error)	Standard deviation of errors in replicated real time forecasts 1965–2004				
Forecast skills	Percentage reduction in mean square error afforded by cross-validated hindcasts 1965–2004 over hindcasts made with the 1965–2004 climate norm				
Northwest Pacific	Northern hemisphere region west of 180°W including the South China Sea. Any tropical cyclone (irrespective of where it forms) which reaches tropical storm strength within this region counts as an event.				