Winds of change

Following a run of forecast successes, outlooks for the 2006 hurricane season proved less impressive. Mark Saunders assesses the precision of such forecasts.

Photodisc

THE 2004 AND 2005 North Atlantic and US landfalling hurricane seasons were both predicted to have 'high activity' — that is, within the top third of years historically — to 'high probability' (65% to 70%) from the previous December. However, forecasts for the 2006 hurricane season have proved less impressive. This raises the following three important questions: what is the precision of seasonal hurricane forecasts when assessed over many years; to what lead times are current seasonal hurricane forecasts useful; and how typical are years such as 2006? These questions are of fundamental importance to risk awareness and decision-making in the insurance and reinsurance industries.

Hurricane forecast precision

There are four main organisations that provide publicly available seasonal outlooks for North Atlantic and US landfalling tropical cyclone activity: Colorado State University, headed by William Gray and Philip Klotzbach; Tropical Storm Risk, led by the Benfield UCL Hazard Research Centre at University College London; the National Oceanic and Atmospheric Administration; and the Meteorological Institute, Cuba.

Each of these organisations varies in terms of the parameters forecast, whether US landfalling activity is predicted, the forecast issue times, the range of years for which forecasts are available, and whether forecasts are issued in deterministic and/or tercile probabilistic format (see table, p29).

The CSU and TSR forecasts are available for the greatest number of years and will, therefore, form the basis of the skills assessment herein.

Forecast accuracy is presented for tropical storm numbers, hurricane numbers, intense hurricane numbers and for the total Atlantic Accumulated Cyclone Energy index. Since the ACE index is sensitive to storm numbers, storm intensity and storm duration, it provides a better indication of overall activity than considering the numbers of tropical storms or hurricanes alone.

Forecast precision is assessed using the Mean Square Skill Score. MSSS is the percentage improvement in mean square error over a climatological forecast. It is also the standard metric recommended by the World Meteorological Organisation for verification of deterministic forecasts. Positive skill indicates the model performs better than a climatology forecast, while negative skill indicates that it performs worse than climatology. A running prior 10-year climate norm is employed for climatology as this forms the 'toughest' skill measure to beat.

The precision of the TSR and CSU forecasts as a function of month of issue from the start of the peak hurricane season in early August back to the previous October is displayed in Figure 1 (below) for the two periods 1984 to 2005 and 1992 to 2005. The second period is included because 1992 marks the introduction of an increased suite of forecasts by CSU, including forecasts of intense hurricane numbers and forecasts from the previous December.

These graphs show that similar precision exists for each hurricane-related parameter at the same lead time. Precision increases slowly from the previous October through to early June and then more rapidly through to early August.

The CSU precision from early June and early August is similar to that of TSR for the period 1984 to 2005. However, TSR slightly outperforms CSU in early December and early August for the period 1992 to 2005. Forecast precision outperforms a prior 10-year climatology at all leads out to the previous November. Taking a 'tough' definition of 'useful' precision as an MSSS greater than 25%, then useful predictive skill exists for the Atlantic ACE index from early May for the years 1984 to 2005.

A positive link exists between the TSR forecasts for the Atlantic ACE index and US hurricane loss. In terms of rank correlation, this link exceeds 0.4 from early July for the period 1984 to 2005, and exceeds 0.4 from early May for the period 1992 to 2005.

So what happened in 2006?

Forecasts for the 2006 hurricane season consistently pointed to another high activity season — although one notably less active than in 2004 and 2005. With this hurricane season now nearly over, and activity so far being below average, many are wondering what happened this year. The unexpected onset and development of El Niño conditions from mid-September is likely to have been a contributory factor, especially for the very quiet second half of the season.

A further significant factor was the presence of considerable African dry air and Saharan dust over the hurricane main development region during August and September, which would have inhibited thunderstorm occurrence and thus tropical storm development. However, many other environmental conditions that have proved reliable indicators of overall activity in previous years were favourable for tropical storm development in 2006; therefore, it is surprising more activity did not occur.

Unusual year

The unusual nature of the 2006 hurricane season is evident from Figure 2. This plots the Atlantic ACE index, colour-coded by tercile against the two environmental fields which underpin the TSR seasonal hurricane forecast model. The data covers the period between 1950 and 2005.

The two environmental fields are the anomaly in August-September trade wind speed, u_T, over the Caribbean and tropical North Atlantic, and the anomaly in August-September sea surface temperature in the hurricane main development region, defined as the area 10-20N, 20-60W. The wind field influences cyclonic vorticity (the spinning up of storms) in the hurricane main track region, while the oceanic thermal field provides heat and moisture to power incipient storms in the main track region.

This illustration shows high hurricane activity (upper tercile ACE index) occurs when u_T is positive (corresponding to trade winds weaker than normal) and the MDR SST is warmer than normal. Also marked on Figure 2 is the point for 2006 and those for the hyperactive hurricane seasons of 2003, 2004 and 2005. It is clear that the u_T and MDR SST fields in 2006 were similar to those that occurred in the previous three years and in other high activity seasons.

Indeed, 2006 had the least activity of any year since 1950 for the observed values for these two fields. Furthermore, the values for these fields in 2006 were well predicted, as demonstrated by the 2006 'forecast point'. Thus, one may conclude that this year's hurricane season is atypical of years since 1950 and should not reflect badly on the general capability of forecasts as shown in Figure 1. **POST**

Mark Saunders is professor of climate prediction in the department of space and climate physics at University College London, and head of weather and climate extremes at the Benfield UCL Hazard Research Centre

Organisations providing publicly available Atlantic hurricane outlooks

Organisation	Parameters forecast	US landfalling	Forecast issue times	Deterministic and/or probabilistic	Available years
Colorado State University	TS, H, IH, NTC, and number of TS, H and IH days	Probablility of at least 1 IH	Dec, Apr, Jun and Aug	Deterministic (except US)	From 1984 (1992 for some leads/parameters)
Tropical Storm Risk	TS, H, IH, ACE (and for sub regions)	TS, H, US ACE	Monthly from Dec to Aug	Deterministic and tercile probabilistic	From 1984
NOAA	TS, H, IH, ACE	—	May/Jun and Aug	Deterministic and tercile probabilistic	From 1988
Meteorological Institute, Cuba	TS, H	—	May and Aug	Deterministic	

TS = tropical storm; H = hurricane; IH = internse hurricane; NTC = net tropical cyclone activity; ACE = accumulated cyclone energy

FIGURE 2. THE UNUSUAL AND ATYPICAL NATURE OF SEASONAL HURRICANE ACTIVITY IN 2006

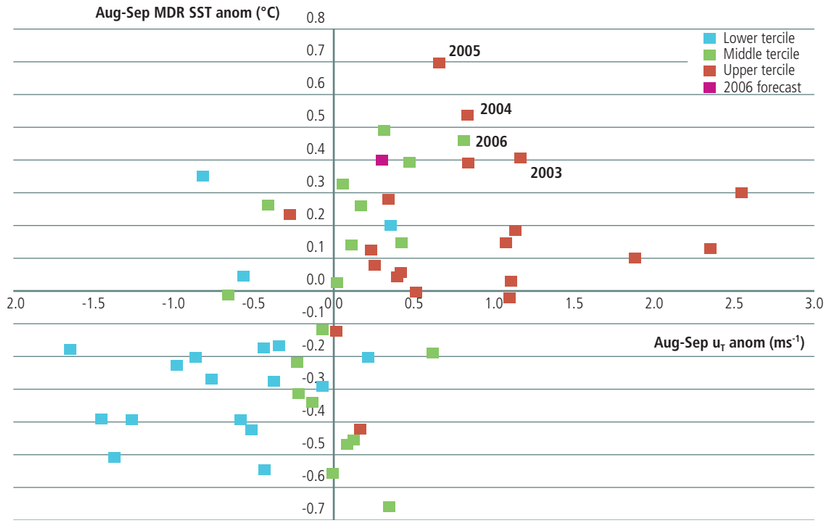


FIGURE 1A: 1984-2005

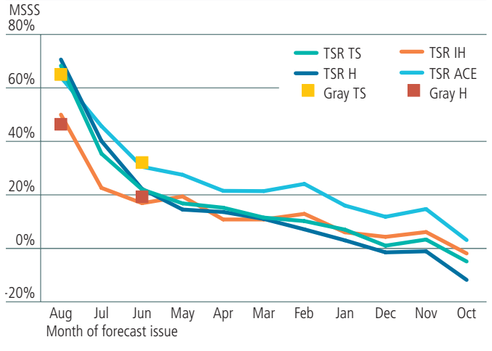
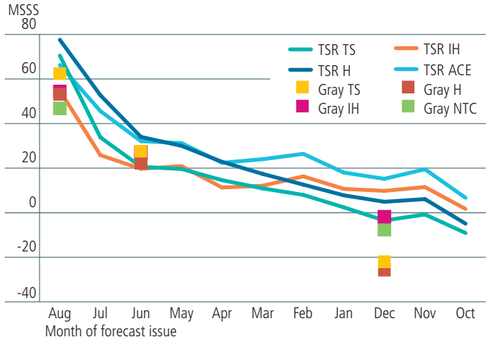


Figure 1. Precision of seasonal outlooks for North Atlantic hurricane activity issued by Tropical Storm Risk and Colorado State University (labelled Gray) for two extended periods. The parameters forecast are the numbers of tropical storms (TS), numbers of hurricanes (H), numbers of intense hurricanes (IH), the ACE index and the Net Tropical Cyclone (NTC) activity.

FIGURE 1B: 1992-2005



USEFUL WEBSITE ADDRESSES:

http://typhoon.atmos.colostate.edu
http://www.tropicalstormrisk.com
http://www.cpc.ncep.noaa.gov/products/outlooks/hurricane.shtml