Storm forecasts look

David Simmons says that the storm prediction consortium TropicalStormRisk can generate real business benefits for (re)insurers.

The consensus of scientific opinion is now that the global climate is changing. That was the conclusion at the recent Shanghai meeting of the Intergovernmental Panel on Climate Change, but the consequences of this change are far from clear.

How predictable are the forces of nature that can wreak havoc on a massive scale? If insurers do not have the best information available on these matters, how can they serve both their shareholders and the world at large? Do we know enough about the risks that threaten both traditional insurance markets and developing economies?

Tropical cyclones provide the majority of catastrophe shocks to developed insurance markets, but they also threaten the stability of the economies of developing countries. TropicalStormRisk (TSR), a consortium of UK-based scientists and insurance experts, aims to improve forecasting in highly insured areas such as the US, the Caribbean and Japan and to develop methodologies that may be transferred to any other tropical cyclone basin.

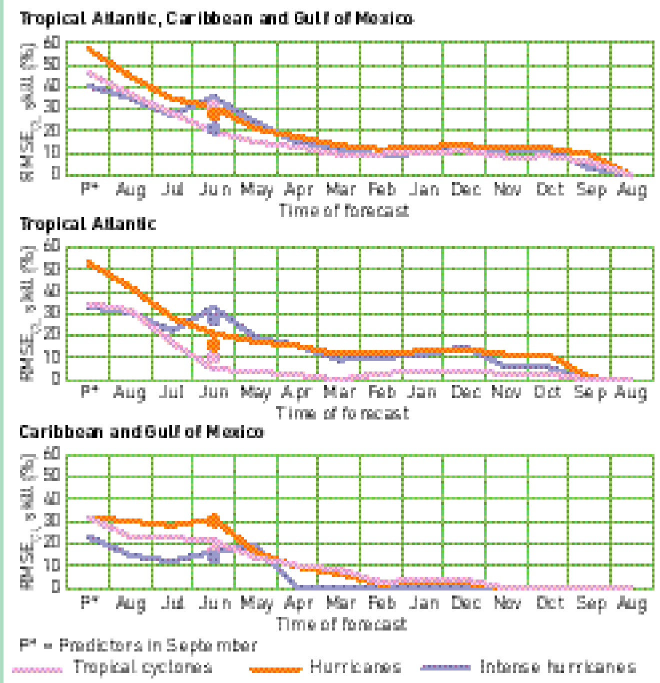
Enter Tsunami

It was in an attempt to wrestle with the risks from the forces of nature that a consortium of seven UK insurance groups, known as Tsunami, funded a tropical cyclone forecasting project in 1998.

Tsunami was originally half-funded by the UK government, with the aim of increasing the competitiveness of the UK insurance industry by investment in cutting-edge scientific research. The tropical cyclone project gained the most support from the consortium and, after a competitive tender, was won by researchers at the Benfield Greig Hazard Research Centre at University College London, backed by the UK's national meteorological office (the Met Office).

Tropical cyclones rank above earthquakes and floods as the US' most costly natural disaster. The annual damage bill in continental US from hurricane landfalls from 1926-99 is estimated to be $5.2bn (at 2000 prices).

Figure 1: TSR seasonal Atlantic hurricane hindcast skill over one year — 1986-2000



Forecasters generally fall into two camps; statistical and dynamical.

For example, Hurricane Floyd, which struck the US east coast in September 1999, killed 70 people and caused $7bn of economic damage and $2.4bn of insured damage. It led to the evacuation of three million people and produced widespread flooding.

Tropical cyclones are also the most expensive and deadly natural disaster affecting much of Japan, South Korea, Taiwan, the Philippines and coastal areas in other South-east Asian countries. The annual damage bill and fatality rate caused by tropical cyclones in South-east Asia from 1990-99 average $3.3bn (at 2000 prices) and 740 deaths respectively.

Tropical cyclone losses can vary greatly from year to year. For example, in 1999 and 1997 the US experienced losses of $8.2bn and just $160m (in 2000 prices) respectively. Skilful long-range forecasts of seasonal tropical cyclone strike numbers will benefit society, businesses and governments by reducing the risk, uncertainty and financial volatility inherent in tropical storm seasons.

Choice of methods

Forecasters generally fall into two camps; statistical and dynamical. Statistical forecasters, such as Professor Bill Gray's group at Colorado State University, acknowledge that the world's climate is a complex system that is far from understood. However, they argue that a partial understanding does not preclude long-term forecasts being made with real skill. Historical records are examined in an attempt to find patterns.

For example, Professor Gray's team found that a number of predictors in combination seems to give a reasonable guide to the intensity of the following year's hurricane season. Predictors used by his group include the El Niño Southern Oscillation (Enso) and West African rainfall during the prior year.

In contrast, dynamical forecasters would argue that such methods, based as they are on limited data, are unreliable. Instead, forecasters should seek to understand fully the processes that determine extreme climatic events.

These are laudable sentiments, but are dynamical modellers yet in a position to forecast general climatic conditions nine months ahead? The accuracy and range of dynamical climate models is undoubtedly increasing, assisted by an exponential growth in computing power. However, even the best modellers, such as the Met Office's Hadley Centre, would not claim to be able to produce seasonal forecasts more than a few months ahead.

Combination approach

The aim of Tsunami was to get the best of both worlds. The team at the Benfield Greig Hazard Research Centre, led by Dr Mark Saunders, had the previous year made news by demonstrating a link between hurricane frequency and Atlantic sea surface temperature. The team was

TropicalStormRisk (TSR)

TSR publishes the following forecasts on its website www.TropicalStormRisk.com:

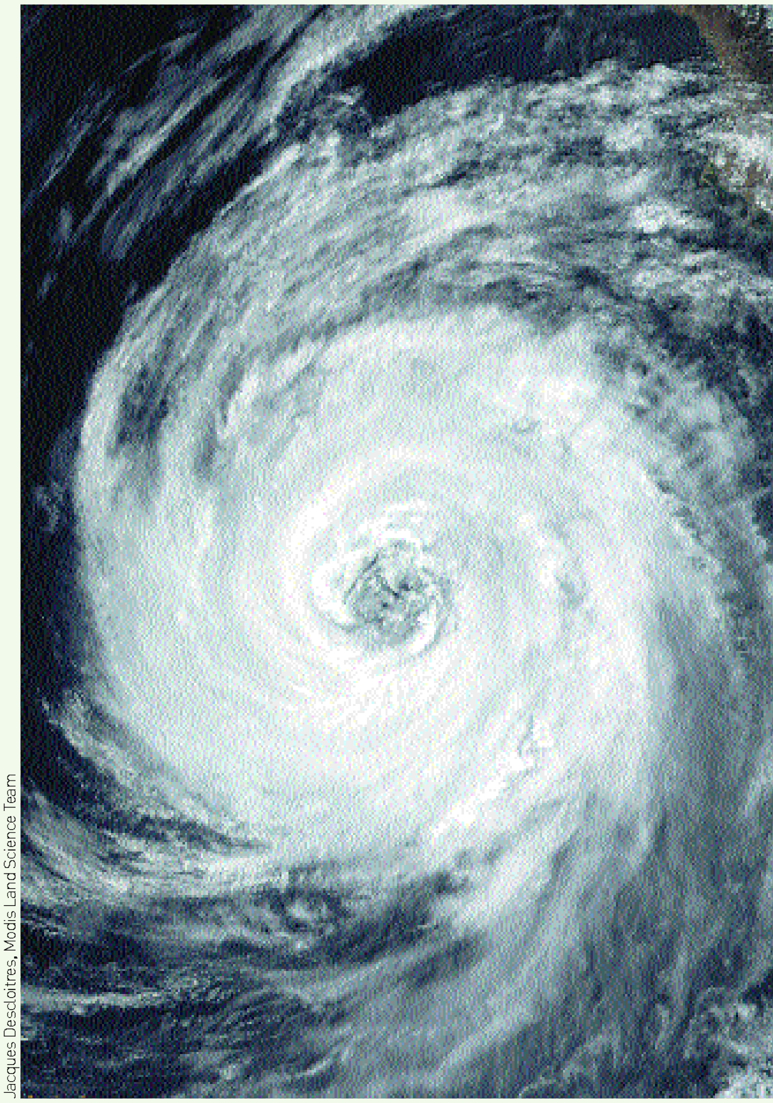
Basins:	Atlantic (ATL), NW Pacific (NWP) and Australian (AUS).
Landfalling cyclones:	US, Caribbean Lesser Antilles, Japan and Queensland.
Intensity forecasts:	Equivalent of tropical storm strength, hurricane strength and intense (Category 3) hurricane strength.
Long-range forecasts:	Issued before start of main renewal season (ATL — October; NWP — January; AUS — April).
Pre-season forecasts:	Issued at the start of each basin's main tropical cyclone season (ATL — June; NWP — June; AUS — December).
Verification:	Post-season verification of forecasts against actual.

The members of the TSR consortium get the benefit of a short lead time before the forecasts are made public.

TSR also offers:

- Monthly updated forecasts for any territory, landfall area and strength category listed above for September to August (ATL), December to August (NWP) and April to February (AUS).
- Specialist consultancy services, including the development and running of forecasts for other areas or basins or with finer geographical focus.

favourable



Jacques Descloitres, Modis Land Science Team

■ The spinning cloud pattern of Tropical Storm Lane is visible in this Modis image.

Table 1: North-west Pacific storm activity — 2000

	Tropical storms	Typhoons	Intense typhoons
Average number (±SD) (1971-2000)	27.2 (±4.6)	17 (±4.1)	8.2 (±3.4)
Actual number 2000	25	14	7
TSR forecast (±SD) 26 May 2000	25.3 (±3.2)	14.1 (±2.5)	7 (±2.2)
Chan* forecast (±SD) end of June 2000	28 (±3)	16 (±2)	n/a

SD = standard deviation n/a = not available
* Professor Johnny CL Chan of the City University of Hong Kong

confident that it could go 'beyond Gray' by using the latest scientific and computational methods to identify new predictors of tropical cyclones.

The plan was to use the Met Office's dynamical climate models to seek to explain how observed predictors influence tropical cyclone activity. It was hoped that from this project consortium members would not only gain access to better long-term forecasts, but also that the work would increase understanding of the cycles and patterns governing tropical cyclone genesis and intensity.

Tsunami breaks up

The Tsunami project ran successfully for 18 months. When funding ended, three of the member companies agreed to continue sponsoring the project.

The major reason that the other companies stopped their funding was certainly nothing to do with concerns about the science, but more because of doubts about the usefulness of any long-term forecast to the insurance industry. It was argued that a single long-term forecast is unlikely to change insurance underwriting policy and core reinsurance purchase decisions.

The companies sticking with the project, later to become the TSR consortium, felt that the forecasts had real value. By sharing forecasts with customers risk awareness increases and risk mitigation strategies can be developed. The core ambition — to increase the understanding of what influences the frequency and severity of tropical cyclones — remains.

The TSR consortium comprises UK insurance industry experts and scientists at the forefront of seasonal forecasting. The insurance expertise is drawn from the UK-based multinational insurers CGNU and Royal & SunAlliance and from reinsurance and risk advisory group Benfield Greig. The TSR scientific grouping brings together climate physicists, meteorologists and statisticians at the Benfield Greig Hazard Research Centre and the Met Office.

TSR aims to: improve the accuracy of seasonal tropical cyclone forecasts at all lead times using new statistical and dynamical model techniques; forecast landfalls in addition to overall basin activity; extend forecasts to new territories (eg South-east Asia and Queensland); and benefit business, government and society by reducing risk and uncertainty.

In an early success TSR predicted accurately in December 1998 that hurricane and tropical storm strikes in the US would be above average in 1999.

Net benefit

The only true proof of a forecast is its long-term track record but how can the potential accuracy and usefulness of a new forecast methodology be judged? One good result does not mean that the method is foolproof any more than one bad result means that it is useless. The only near certainty in forecasting is that the forecast will be wrong.

However, even forecasts with limited skill can have real value. If a forecast is better than climatology (ie long-term averages) only six years out of 10, an investor using the forecasts for a portfolio of weather derivatives should make money.

The skill of a forecasting model can be measured by 'hindcasting', ie computing what the model would have forecast, say, for the 1990 hurricane season based only on data available at that time.

Figure 1 shows that real skill can be demonstrated eight months before the start of the season. Skill is expressed as percentage reduction in root-mean-square-error over what would be obtained from climatology forecasting — $RMSE_{CL}$ skill (%). This robust skill score is immune to bias problems associated with other skill scores. * denotes the model skill obtained by including dynamical forecasts for Caribbean trade wind speed obtained from the Met Office Unified Model (1 June forecasts only).

The vertical scale denotes the skill with perfect model predictors. The TSR model has positive skill (ie better than random chance) as far in advance as the previous September. Skill increases rapidly as lead time falls below four months (ie after 30 April).

The skill levels of the team continue to increase; for example, it accurately predicted the numbers of tropical storms, typhoons and intense typhoons in the north-west Pacific in 2000 (Table 1) and the landfalls in Japan of typhoons and tropical storms (Table 2).

Table 2: Storm landfalls in Japan — 2000

	Tropical storms	Typhoons
Average number (±SD) 1971-2000	4.1 (±1.7)	2.5 (±1.5)
Actual number 2000	4	2
TSR forecast (±SD) 26 May 2000	3.1 (±1.8)	1.8 (±1.4)

SD = standard deviation

TSR has built an enviable reputation for the accuracy of its forecasts and robustness of its methodology in its short life. It is continuing to expand its services and further improve the scientific and technical bases of its forecasts. Improved understanding of these meteorological risks can only enhance the ability of insurers to meet their needs.

During the coming months TSR scientists will be extending their research:

- To incorporate Met Office dynamical weather prediction data into the TSR models at short (less than four months) lead times. This is consistent with the original Tsunami idea of linking the best of statistical and dynamical modelling approaches.
- To use regional TSR forecasts as input to catastrophe models. Most catastrophe models do not explicitly allow for trends and cycles in likely frequency of events. The output of a TSR forecast can be used to demonstrate how the probability of financial loss of any given size in the current year is greater (or less) than the long-term average. re

David Simmons is Benfield Greig's representative in Tropical Storm Risk.