

TROPICAL STORM RISK



Forecasts of Tropical Cyclone Activity to Benefit Business, Industry and Society

Founded in 2000, Tropical Storm Risk (TSR) offers a leading resource for forecasting the risk from tropical storms worldwide. The venture provides innovative forecast products to increase risk awareness and to help decision making within the (re)insurance industry, other business sectors, government and society. The TSR Storm Tracker provides the best available information for assessing the risk from active tropical storms worldwide. The TSR monthly-updated forecasts for seasonal tropical cyclone activity in the Atlantic, NW Pacific and Australian-region basins provide skillful and independent outlooks for assessing the likelihood of upcoming damage and disruption.

TSR Consortium

The TSR venture has developed from the UK government-supported TSUNAMI initiative project on seasonal tropical cyclone prediction which ran from October 1998 to June 2000. The current TSR consortium comprises experts on insurance, risk management and seasonal climate forecasting. The TSR industry expertise is drawn from Benfield, the leading independent reinsurance intermediary, Royal & SunAlliance, the global insurance group, and from Crawford & Company, a global provider of risk management services. The TSR scientific grouping brings together climate physicists, meteorologists and statisticians from the UCL (University College London) Benfield Hazard Research Centre and the Met Office. The TSR sponsorship has been renewed four times.

Access and Further Information

Please visit the TSR web site at www.tropicalstormrisk.com.

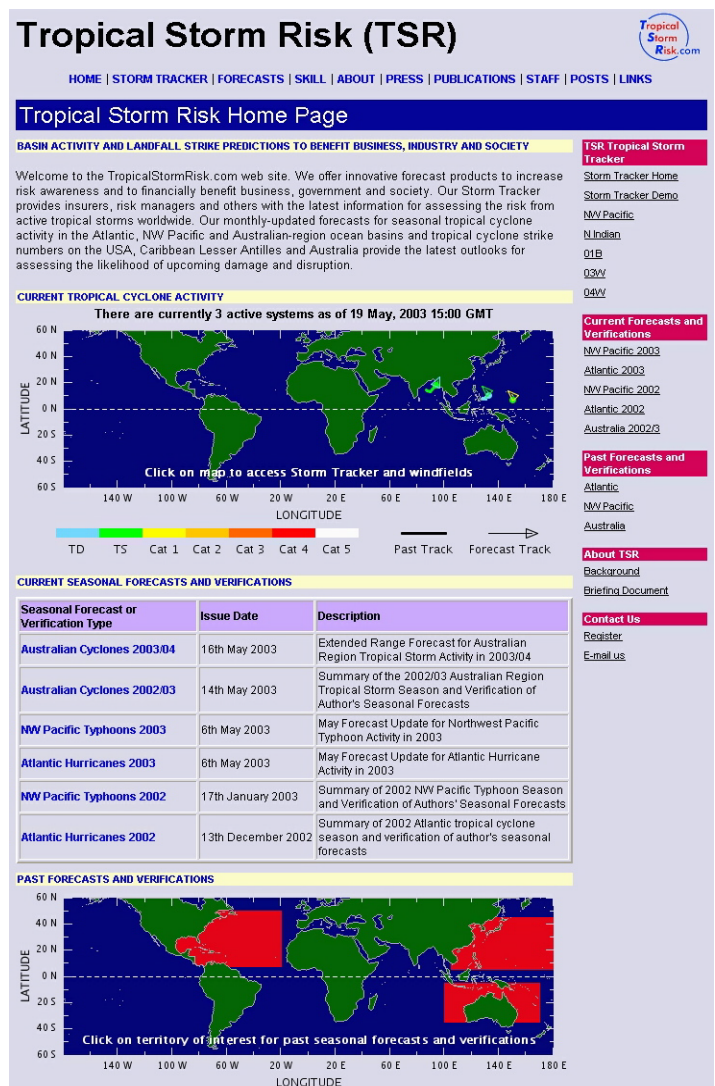


Figure 1. The Tropical Storm Risk (TSR) Home Page



Tropical Storm Tracker

The TSR *Tropical Storm Tracker* is a free to use internet application available through TSR's newly updated website www.tropicalstormrisk.com. It has been developed to allow insurers, reinsurers and risk managers to increase their awareness of tropical storm activities and to enhance their ability to forecast more accurately the risk and loss from tropical storms around the world. The *Tropical Storm Tracker* provides real-time forecasts out to five days lead for all active tropical cyclone systems worldwide. Forecasts are updated every 6-12 hours and offer the best available information on storm position (past, current and forecast), storm strength, track and track uncertainty, all with various levels of zoom.

Features

- The *Tropical Storm Tracker* includes the following features, examples of which appear below:
- Unique current and forecast 2-dimensional windfields (in knots) for all systems of at least hurricane force prior to extra-tropical transition.
 - Forecast windfields out to 120 hours lead.
 - Storm-centred zooms for current and forecast positions out to 120 hours lead.
 - Forecast track uncertainties out to 120 hours lead.

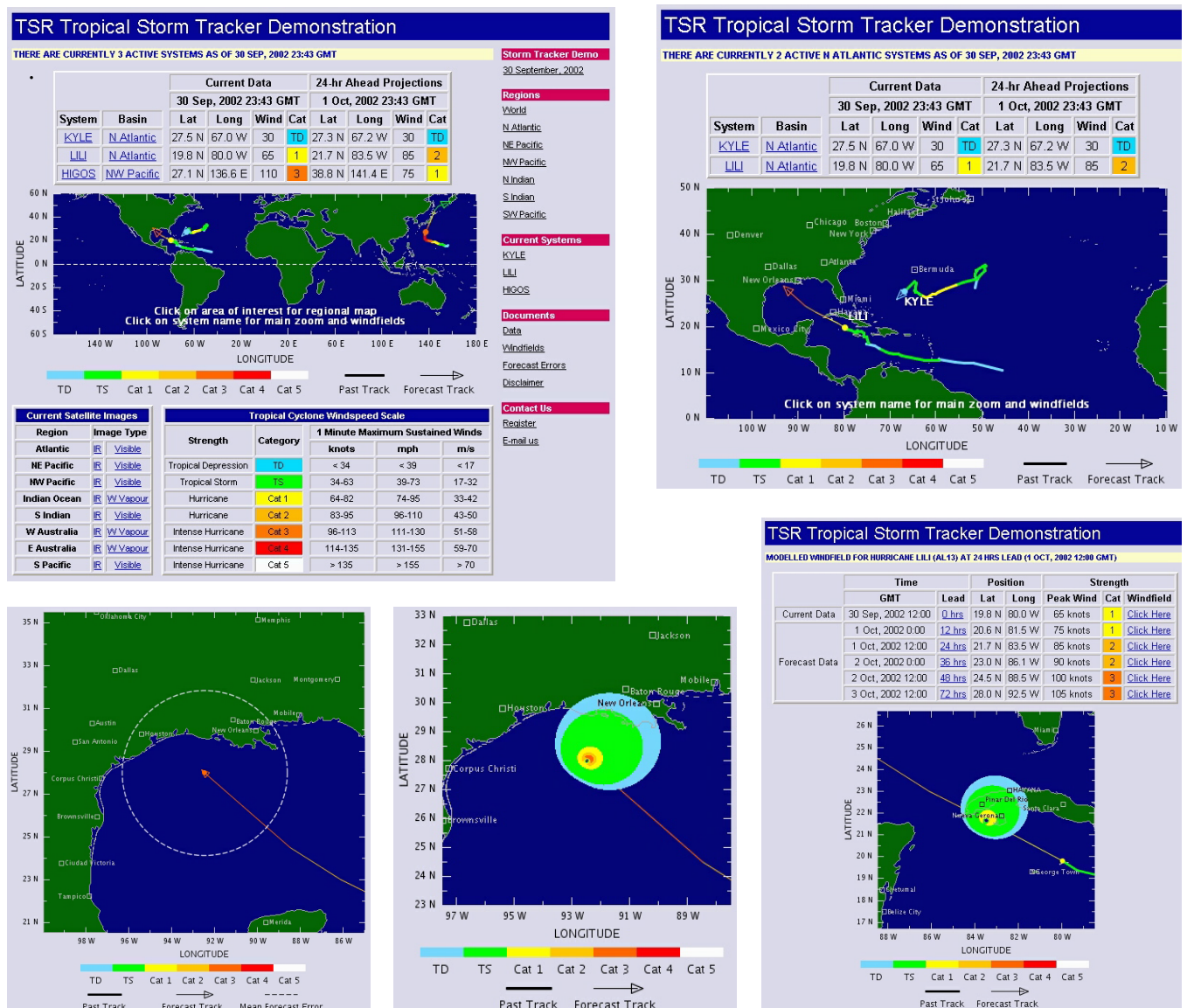


Figure 2. TSR Storm Tracker examples taken at 23:43 GMT 30th September 2002: the Tracker home page (top left), Atlantic basin regional map (top right), forecast windfields for hurricane Lili at 24 hours lead (lower right) and 72 hours lead (lower centre), and forecast track and error information for Lili at 72 hours lead.

Historical Storms

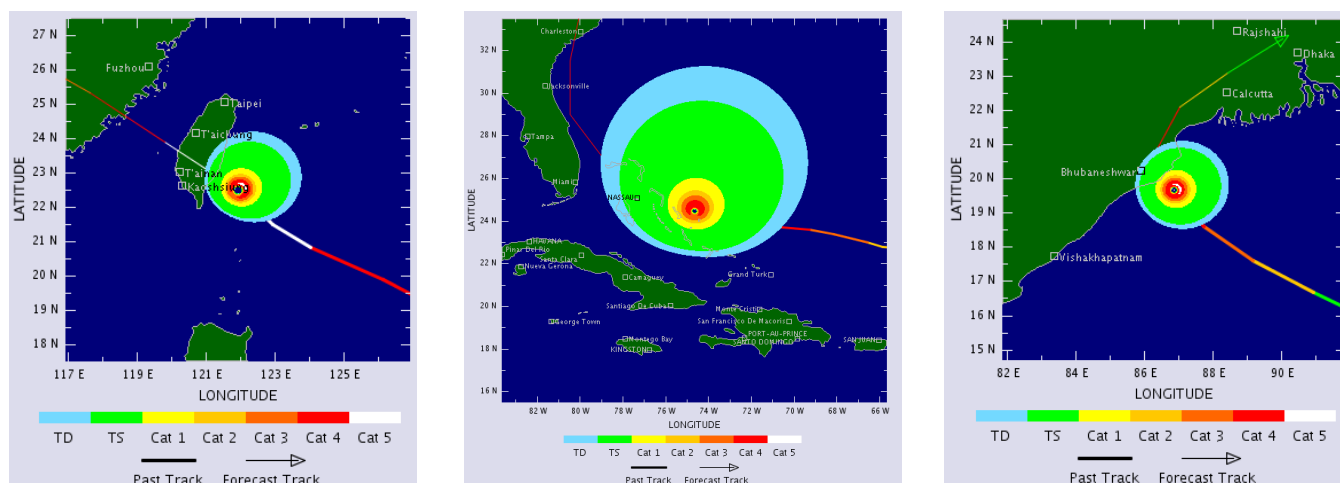


Figure 3. Storm Tracker windfields for historical storms. (Left) Super typhoon Bilis at 12 GMT on 22nd August 2000 prior to striking Taiwan. (Centre) Hurricane Floyd at 00 GMT on 14th September 1999 approaching the Bahamas. (Right) The Orissa Cyclone 05B at 00 GMT on 29th October 1999 prior to striking northeast India.

Seasonal Forecasts

TSR has an impressive forecast track record. Christopher Landsea, co-author of the Gray and NOAA seasonal Atlantic hurricane outlooks, acknowledges that “*the TSR forecasts were certainly the first to correctly anticipate a below normal Atlantic hurricane season in 2002*”. The TSR forecasts predicted the below average activity from early May (which competing forecasts did not anticipate until early August). This success combines with accurate TSR seasonal predictions for the 2002 NW Pacific typhoon season (1.0 standard deviation above average overall activity) and for the 2002/03 Australian cyclone season (0.8 standard deviation below average activity).

Innovative Forecast Products

Innovative forecast products released within the past year to increase risk awareness include:

- Forecasts of the NOAA Accumulated Cyclone Energy (ACE) Index Over Sea and Land.** TSR forecasts values of the ACE Index - a measure of total wind energy — for seasonal basin and landfalling activity. We define the landfalling ACE index as the sum of the squares of 1-hr maximum sustained wind speeds for all systems while they are at least tropical storm strength and over land. Since this index reflects a combination of intensity and duration it should be a better measure of likely damage than the number of tropical storm or hurricane/typhoon landfalls alone.
- Monthly Updated Forecasts.** These are issued for seasonal Atlantic basin, US landfalling and Caribbean Lesser Antilles landfalling activity (and for the ACE values) from early December to early August. For NW Pacific typhoon and Australian-region cyclone activity the monthly updates run from March to August and from May to December respectively. Since climate conditions can change rapidly (eg an abrupt change happened in the North Atlantic between April and May 2002), this product provides business and government with the latest up to date forecast information.

- **Multi-Ensemble Statistical ENSO Forecasts.** TSR has pioneered a multi-ensemble statistical seasonal prediction model for El Niño Southern Oscillation (ENSO). Rigorous hindcasts over the past 50 years shows that this model outperforms (in terms of skill, versatility and speed of operation - and for all ENSO index regions) the leading ECMWF dynamical model ENSO hindcasts from the DEMETER project.

Prediction Skills and Business Application

TSR offers rigour and transparency in forecast skill and significance. TSR employs the standard skill metric recommended by the World Meteorological Organisation for verification of seasonal forecasts, include the 95% confidence interval on all skill scores, and show skill as a function of monthly lead out to ~10 months. TSR issues over 40 seasonal forecast products including predictions for ENSO indices, tropical sea surface temperatures and trade wind speeds. Skill assessments often extend to 50 years to provide optimum confidence in model performance.

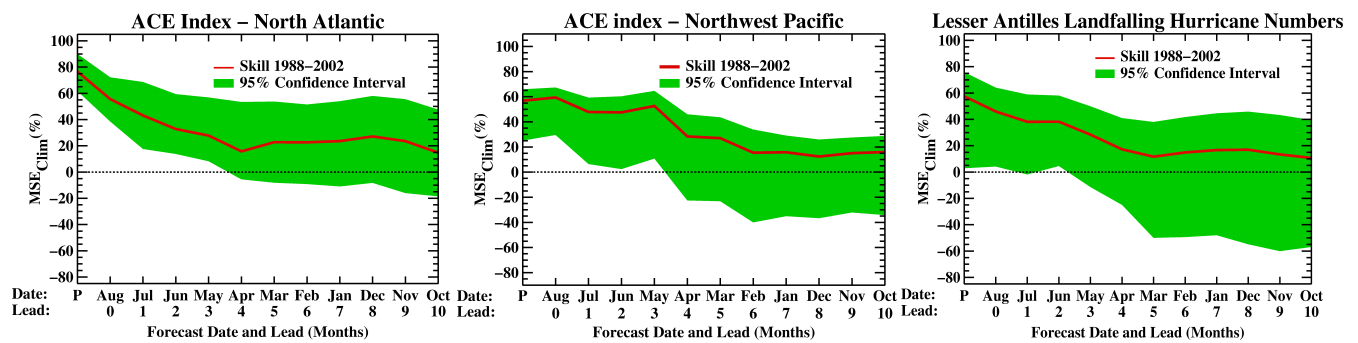


Figure 4. TSR hindcast skills as a function of lead month for (left) Atlantic seasonal ACE Index, (centre) NW Pacific seasonal ACE Index and (right) hurricane strikes on the Caribbean Lesser Antilles. The forecast period is 1988-2002. The skill score is the percentage improvement in mean square error (MSE) over a running prior 10-year climatological forecast. Skill to 95% confidence exists from early May for the Atlantic and NW Pacific ACE Index forecasts, and from early June for Lesser Antilles hurricane hits.

TSR’s recent advances in seasonal forecasting techniques and skill are being integrated into the business process to deliver real value to insurance organisations. In collaboration with the Helvetia Patria Group, TSR is developing a method to simulate 10,000 years of US hurricane landfalls, losses and ACE Index forecasts to examine the business relevance of the TSR US ACE forecasts for reinsurance/retrocession buy and sell strategies. Results show that a *Forecast Strategy* - which uses the TSR forecasts for 1973-2002 to decide whether to buy - outperforms traditional buying strategies by ~10% in terms of protection purchase efficiency.

Summary

TSR offers the best available resource for forecasting the risk from tropical storms worldwide. The *Tropical Storm Tracker* is arguably the leading tracker on the market and will become an industry standard. TSR has developed an impressive seasonal forecast track record and its predictions regularly outperform those from other parties. TSR’s innovative forecast products provide increased risk awareness and enhance the ability of business and government to anticipate losses from tropical storms around the world.

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