P5.22 GRAPHICAL MAPPING OF TROPICAL CYCLONE FORECAST WIND PROBABILITIES WORLDWIDE

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1. INTRODUCTION

The Tropical Storm Risk (TSR) new *'wind speed probability'* graphical product is presented and described. This real-time product has been in routine operation for tropical storms worldwide since July 2005 and may be accessed at www.tropicalstormrisk.com.

2. PRODUCT DESCRIPTION

The product maps the likelihood that a specific point on a map will be struck by hurricane (74 mph) and/or by tropical storm strength (39mph) 1-min sustained winds during different time periods out to 5 days ahead. Probabilities are displayed from 1% to 100% in color-coded 5% bands. A Table relates these probabilities to simple descriptions that the event will happen. For example, a probability of 50% indicates a medium or evens-chance that the event will occur. Major cities are included on the maps to aid risk assessment.

Chance of Happening	Value	Chance of Happening	Value
Extremely low	10%	Medium-high	60%
Very low	20%	High	70%
Low	30%	Very high	80%
Medium-low	40%	Extremely high	90%
Medium	50%	Certain	100%

Table*. Probability Scale relating the forecast probability values of being struck by hurricane (74 mph) and/or by tropical storm strength (39mph) 1-min winds to an equivalent simple description that the event will happen.*

Forecast probabilities are updated every 6 hours, except for systems in the North Indian and Southern Hemisphere regions where updates occur every 12 hours. Separate '*wind speed probability*' maps are provided from the current time to each available forecast lead time at which the storm exists.

3. BENEFITS TO USERS

The *'wind speed probability'* graphical product is designed for clarity and usefulness of information. It offers distinct advantages to users compared to other tropical cyclone forecast products. The product allows decision-makers to tell at a glance the current chance that a location will be hit by damaging tropical cyclone winds. Businesses, industry and the general public can assess better the risk which an active tropical cyclone poses to their specific locations. This quantitative Information will help with better preparedness decisions. Insurers and reinsurers may obtain real-time information on the likelihood of potential loss for their portfolios. Humanitarian relief agencies may obtain more useful advance warning on the likelihood of aid being needed at a given location.

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4. METHODOLOGY

The '*wind speed probabilities'* are computed by modelling and combining the errors in the forecast track position with the errors in the forecast extent of winds in each storm quadrant. Modelling is performed separately for each forecast lead time. The errors are computed from the official forecast advisories issued in 2004. A latitude-longitude grid resolution of 0.2 x 0.2 degree (~22km) is employed throughout.

The forecast track errors are obtained by computing, as a function of lead time, the distribution of along-track and across-track forecast errors (Heming, 1994). These distributions are well-modelled as normal. Probability maps giving the likelihood that the storm centre will be located in a given grid cell are then produced for each forecast lead time.

The error distribution for the forecast extent of winds in the four storm quadrants (NE, NW, SW and SE) is modelled as a function of wind speed threshold (34 or 64 knots) and forecast lead time. These forecast error distributions are well-modelled as normal. These distributions are combined with the real-time forecast values for the four quadrant wind radii to obtain - in a storm-centred framework - the gridded probability that the wind speed will exceed the threshold in question.

As the above gridded probabilities are a function of wind speed threshold, lead time and the four quadrant wind radii it is possible to obtain 30 million unique probability maps. Each of these probability maps is then combined with the corresponding probability map for the error in the storm position to obtain the 'final' *wind speed probability* maps. The contours on these maps are smoothed using the technique of curvature scale space smoothing (Mokhtarian et al., 1998).

5. EXAMPLE – HURRICANE KATRINA

Examples of the '*wind speed probability*' graphical product are shown for hurricane Katrina (2005) in Figures 1 and 2. These probability maps employ as input information from the U.S. National Hurricane Center advisory number 21 (issued at 09:00 GMT on August 28, 2005). They were issued by TSR in real-time at ~09.30 GMT on August 28. Katrina made its first landfall as a strong Cat 3 hurricane near Buras, Louisiana at 11:10 GMT on 29 August 2005. Its final landfall occurred near the Louisiana/Mississippi border at 14:45 GMT.

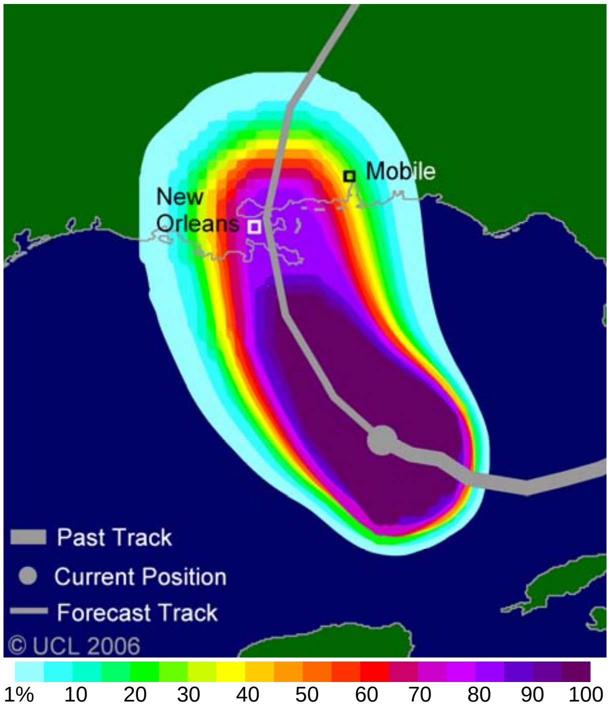

Figure 1. *Probabilities (in percent) of experiencing 1-min sustained wind speeds of at least hurricane Cat 1 strength (64kt or 74 mph) from hurricane Katrina during the 33 hours starting at 09:00 GMT on August 28, 2005*.

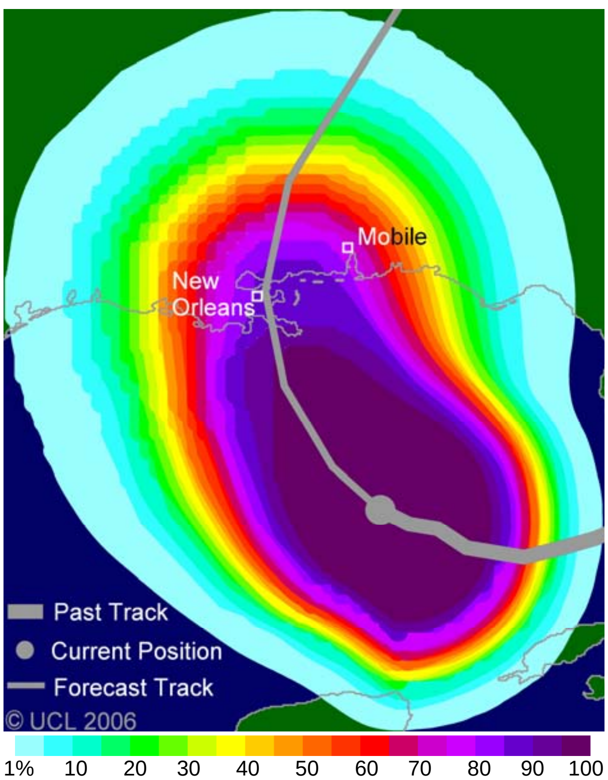

Figure 2. *Probabilities (in percent) of experiencing 1-min sustained wind speeds of at least tropical storm strength (34kt or 39 mph) from hurricane Katrina during the 33 hours starting at 09:00 GMT on August 28, 2005*.

At ~09:30 GMT on August 28 (29 hours before Katrina's final US landfall), the predicted chances of New Orleans being struck by hurricane Cat 1 strength and by tropical storm strength 1-min sustained winds were 80% and 90% respectively (Figures 1 and 2). The probabilities for Mobile were 35% (Cat 1 winds) and 75% (tropical storm strength winds). The real-time verification for the areas Katrina actually affected with Cat 1 and tropical storm strength winds is shown in Figure 3. The windspeed probability forecasts for New Orleans and Mobile proved reliable as did also the forecast areal extent of Cat 1 and tropical storm strength winds. The 50% forecast probability contours in Figures 1 and 2 match well with the verification.

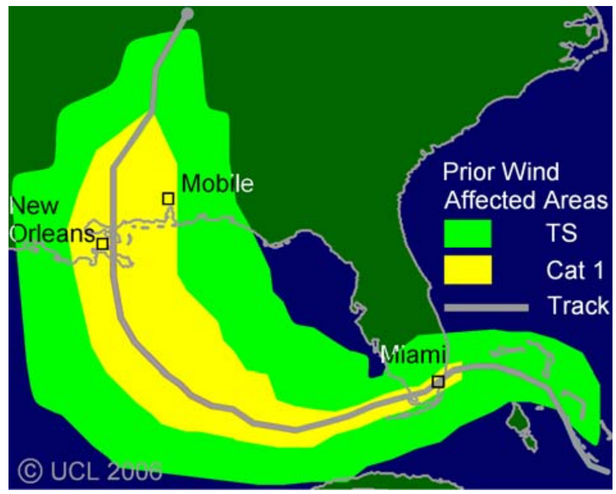

Figure 3. '*Prior wind affected areas*' *graphic for hurricane Katrina as of 15:00 GMT on August 30, 2005. The display plots the regions Katrina affected with 1-min sustained winds of Cat 1 and tropical storm (TS) strength together with the storm's centre track. The Figure verifies qualitatively the precision of the forecast 'wind speed probabilities' displayed in Figures 1 and 2.*

6. SUMMARY

TSR's innovative *'wind speed probability'* graphical product adds a new dimension to tropical storm tracking and risk-assessment. Decision makers could previously only guess at the chance that a given location would be struck by damaging winds from an active tropical cyclone. This new quantitative tool allows users to see this likelihood at a glance out to 5 days lead. The product will reduce the risk and uncertainty associated with active tropical storms worldwide.

7. REFERENCES

Heming, J., Verification of tropical cyclone forecast tracks at the Met Office, NWP Gazette, Vol. 1, No. 2, pp. 2-8, December 1994 (Updated July 2000).

Mokhtarian, F., N. Khalili and P. Yuen, Multi-scale 3-D free-form surface smoothing, Proceedings of the Ninth British Machine Vision Conference, pp. 730-739, 1998.