Objective calibrated wind speed and crosswind probabilistic forecasts for the Hong Kong International Airport

P. Cheung and C. C. Lam
Hong Kong Observatory, 134A Nathan Road, Hong Kong, China

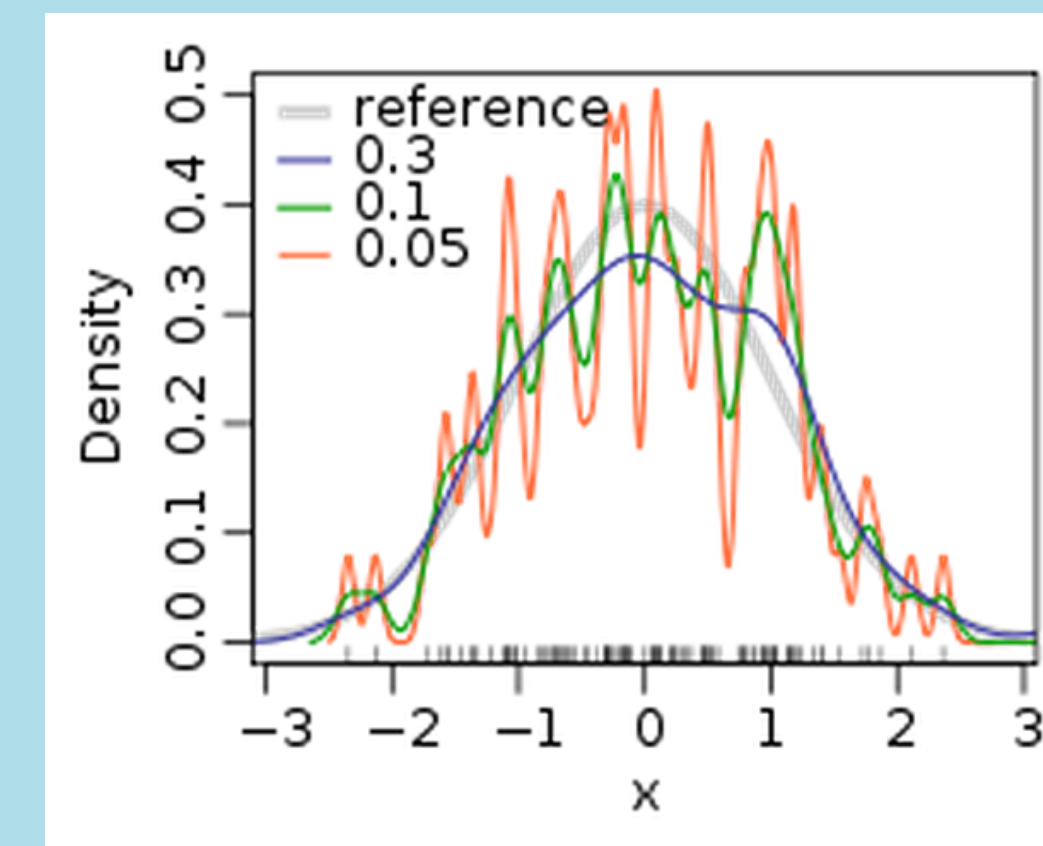## Probabilistic wind speed and crosswind forecasts

Wind, especially crosswind, is one of the major weather factors causing significant flight delay and cancellation at the Hong Kong International Airport (HKIA) in tropical cyclone (TC) situations. To assist aviation forecasters in assessing the possibility of high winds and crosswinds in TC situations, the Observatory developed objective wind speed and crosswind probabilistic forecasts for HKIA based on the European Centre for Medium-Range Weather Forecasts (ECMWF) Ensemble Prediction System (EPS) outputs. The 36-hour probabilistic forecasts are made available to the aviation users twice a day on a trial basis to facilitate their appreciation of the forecast uncertainties.

The probabilistic wind forecasts are made available to aviation users through the Hong Kong Observatory's Aviation Meteorological Information Dissemination System (AMIDS) on a trial basis. The products are generated automatically from the wind forecasts at the model grid point closest to HKIA. These products will be available when tropical cyclone warning signal is in force in Hong Kong and will normally be updated twice a day at around 09 and 21 UTC.

Kernel Density Estimation (KDE)

Kernel density estimation, also known as the Parzen-Rosenblatt window method, is a way of estimating the probability density function of a variable.

$$\hat{f}_h(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x - x_i}{h}\right)$$

Kernel density estimation using different smoothing bandwidths.

On each forecast hour, the method is applied to the 50 members of the ECMWF EPS to obtain the probability density function of wind and crosswind forecasts. The normalized result is then presented in the form of a time series.
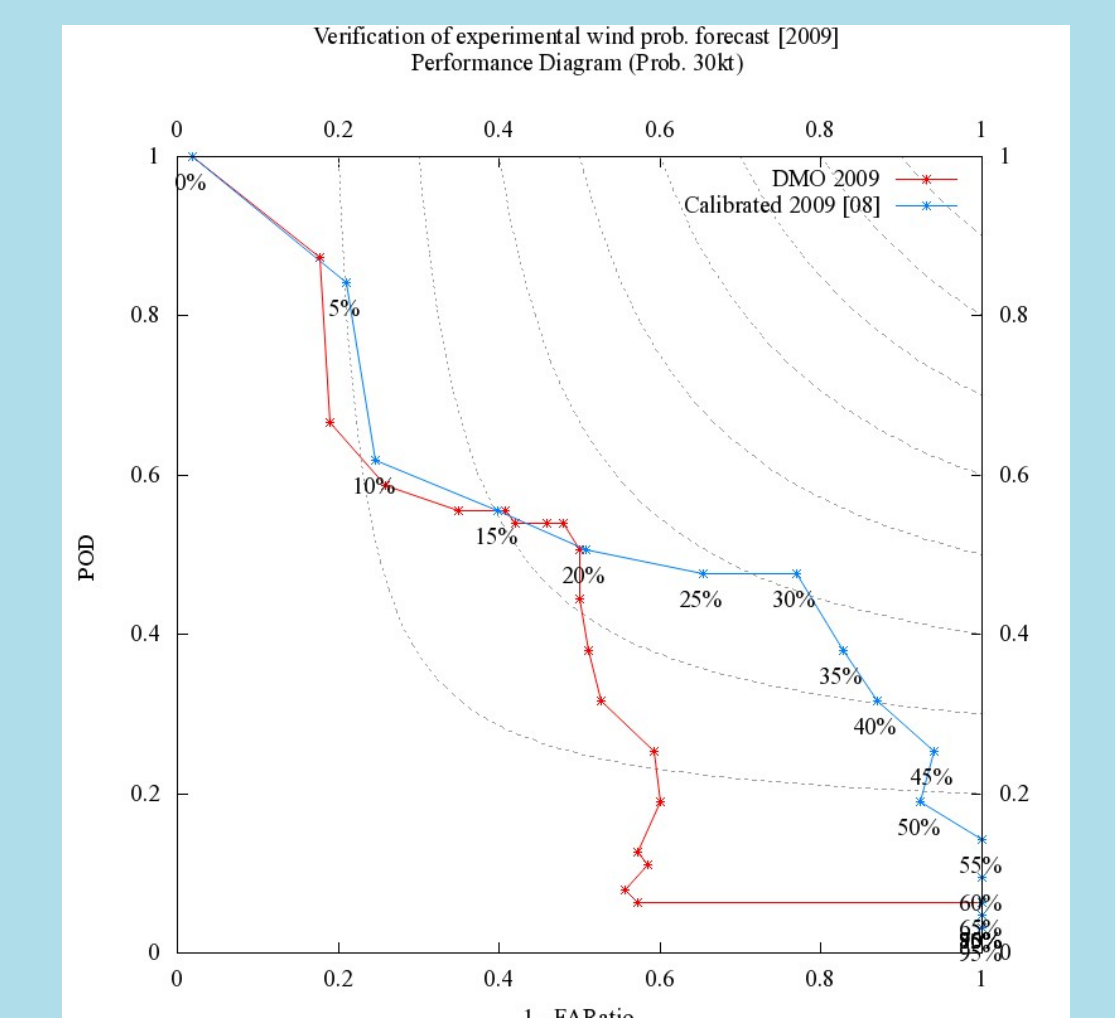
Tropical Cyclone (TC) case

The above example shows the wind speed and crosswind probabilistic forecasts during the passage of Tropical Storm Mujigae in September 2009. The actual 10-minute mean wind observations (denoted by black cross for METAR report and vertical bars spanning the range of wind speed recorded by multi-anemometers on the runways) fell mostly in the range with the highest probabilities and were generally closer to the actual observations as compared with the deterministic model forecast (yellow line).

Recent Developments

To facilitate users' understanding of the spread in the probabilistic wind forecasts, new products including probabilistic forecast of TC distance from HKIA is planned for trial in the 2011 TC season.
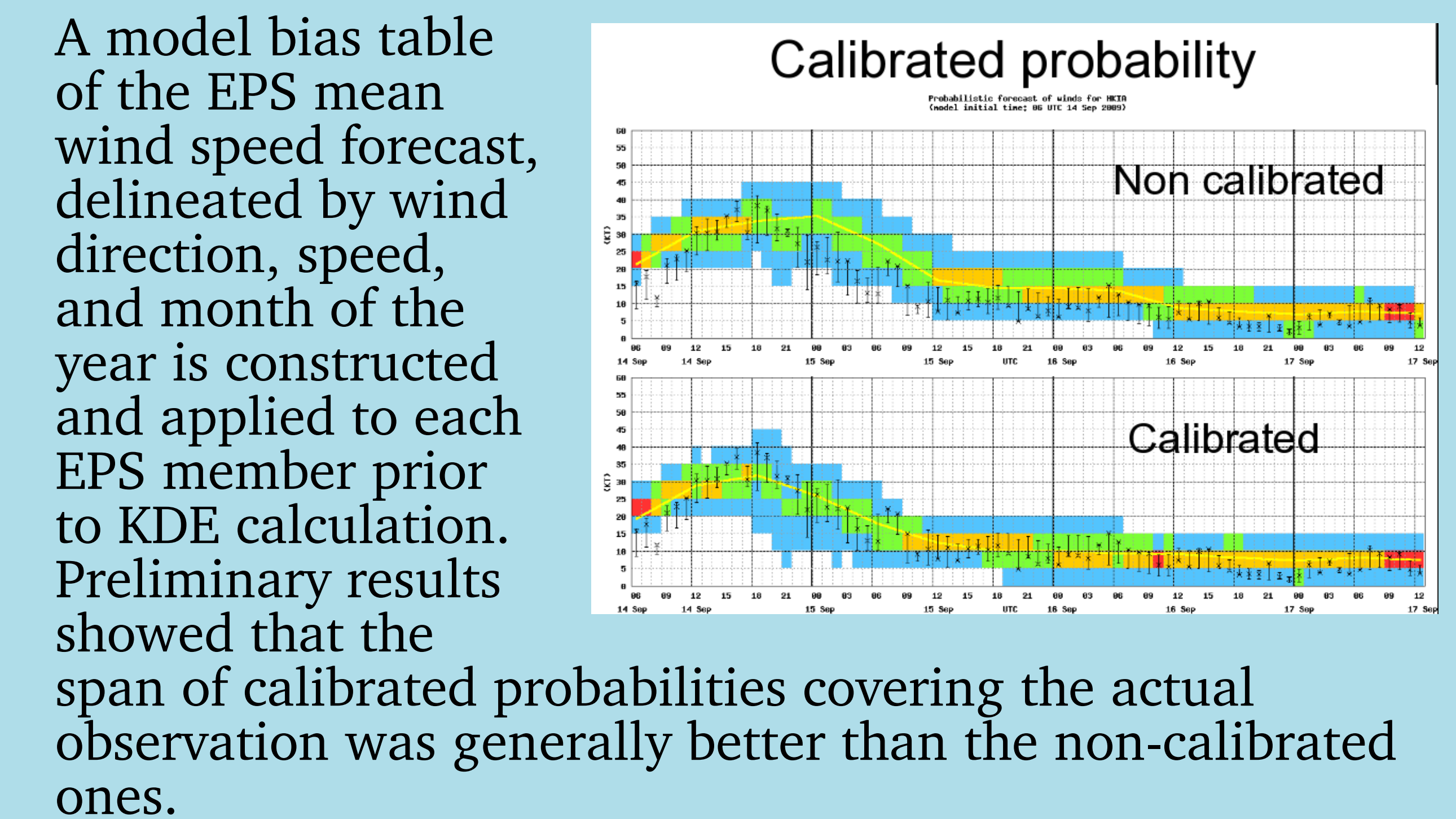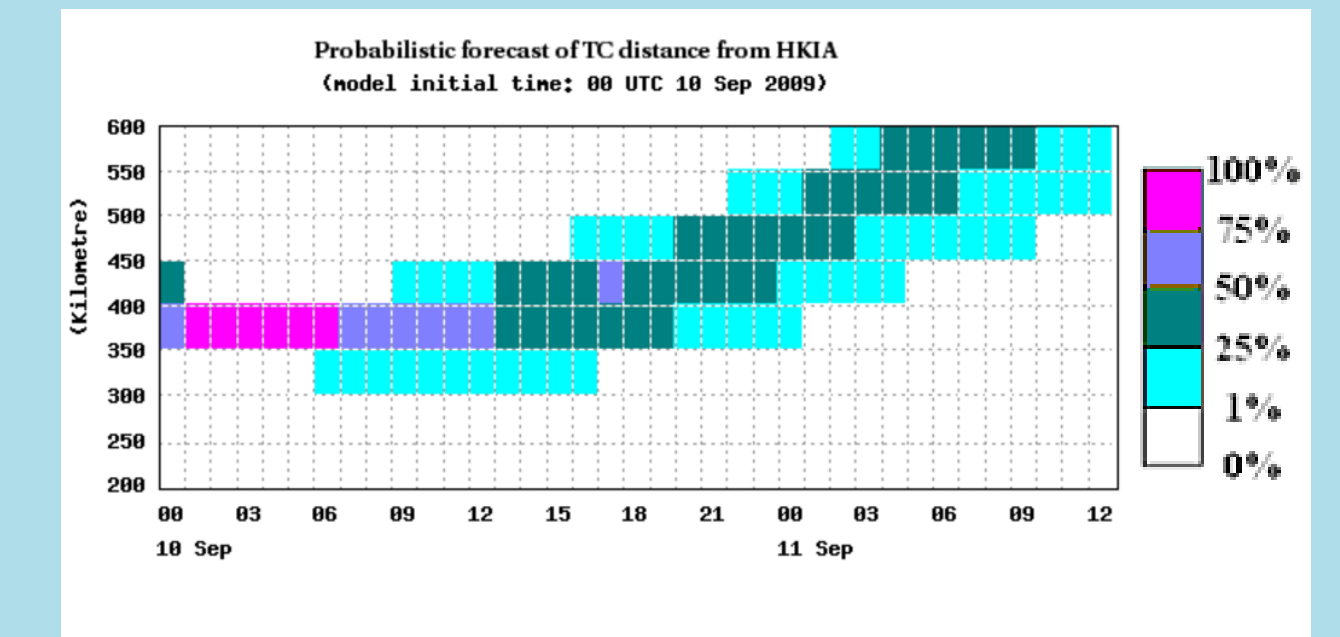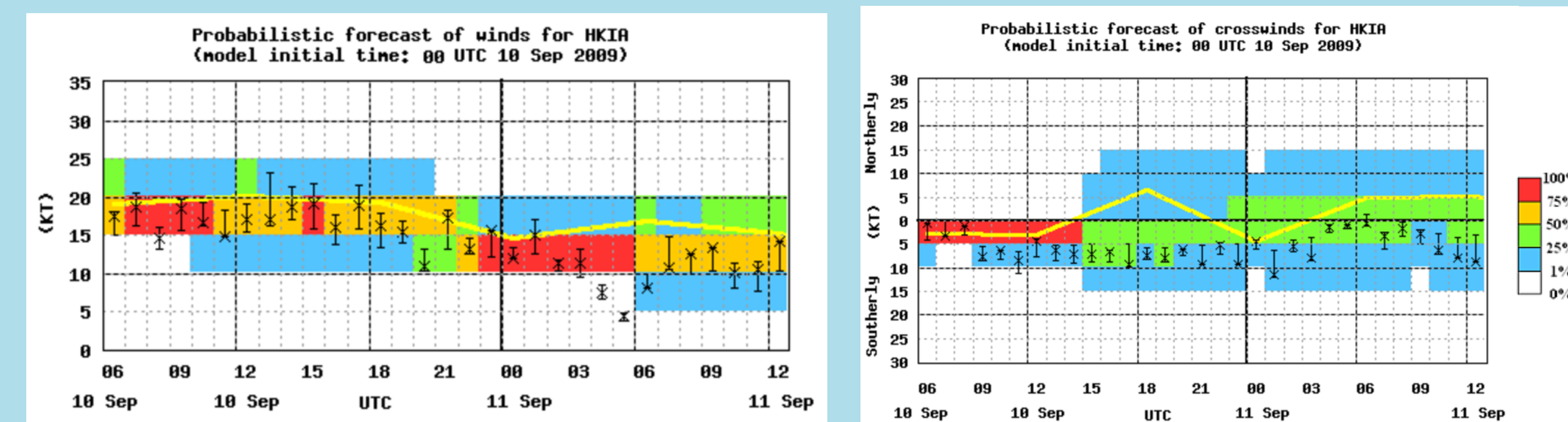

A model bias table of the EPS mean wind speed forecast, delineated by wind direction, speed, and month of the year is constructed and applied to each EPS member prior to KDE calculation. Preliminary results showed that the span of calibrated probabilities covering the actual observation was generally better than the non-calibrated ones.

To verify the product, different probability thresholds have been used to transform the probabilistic forecast into deterministic forecast with respect to a preset wind speed criterion. Comparison with the observation on the hour is then made to derive the POD and FAR.

Verification results based on 30kt wind speed threshold in 2009 TC cases indicated that apparently 30% - 40% probability performed the best. The calibrated probability forecast was also found to outperform direct model output.