Determining Uncertainty in Historical Tropical Cyclone Intensity Analyses

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The intensity of tropical cyclones is unknowable. We need to understand how close we are.

1. Background

The maximum sustained wind (MSW) in tropical cyclones (TCs) is never exactly known, even in well-observed storms. There are several good reasons to be able to characterize the uncertainty of MSW in TC records, such as identifying storms for reanalysis, quantifying error bounds in trend analyses, and risk assessment in catastrophe models.

Previous efforts to characterize uncertainty in historical (best-track) records are limited to the north Atlantic basin where the availability of aircraft data allow for a valid quantitative assessment of uncertainty (Torn and Snyder 2012; Landsea and Franklin 2013). The emerging availability of global TC intensity assessment data through the Cyclone Center crowd sourcing project (Hennon et al. 2015, inset at right) now allow for a global characterization of TC uncertainty.

2. Cyclone Center as a Useful Tool

Cyclone Center (CC) classifications have been shown to comparable in skill to manual and automated Dvorak intensity estimates. Figure 1 shows a time series of intensity estimates for Hurricane Katrina (2005). The red line shows the best-track intensity for only those times Influenced by recon data (within 3 hours) – the blue line shows the crowd-sourced intensity estimate, and the green is the intensity from the Advanced Dvorak Technique applied to the same satellite data set (ADT-HURSAT). Error bars represent 1 standard deviation of CC classifications. The root mean square error (RMSE) of CC intensities (8.3 kt) is about 26% lower than the RMSE for ADT-HURSAT (11.3 kt) for Katrina. Fig. 2 shows that CC does a good job at estimating the MSW across all intensities.

Hennon, C.C., and coauthors, 2015: Cyclone Center: Can Citizen Scientists Improve Tropical Cyclone Intensity Records? *Bulletin of the American Meteorological Society,* **96,** 591-607.
Knapp, K.R., and J.P. Kossin, 2007: New Global Tropical Cyclone Data From ISCCP B1 Geostationary Satellite Observations. *Journal of Applied Remote Sensing,* **1**, 013505.

Period of Record
1978-2009

Satellite Data (IR)
HURSAT-B1

3. Quantifying Uncertainty

The MSW uncertainty can be calculated as a function of the following parameters: aircraft data availability (rare), variance of Cyclone Center classifications, variance of interagency Dvorak estimates, and availability of numerous other satellite intensity estimates. For each TC synoptic time, uncertainty will be calculated using Bayesian Model Averaging, which assigns weights to each source's uncertainty based on pre-determined criteria (e.g. aircraft data = high weight).

Since approximately 70% of all TC best-track times in the north Atlantic (`95% globally) do not have the benefit of aircraft reconnaissance, the intensity uncertainty will be strongly influenced by the Dvorak technique's bias and uncertainty. By augmenting agency estimates with CC's suite of classifications and accounting for known systematic errors,, we believe a useful global intensity data set enhanced with uncertainty information is obtainable.

References

Landsea, C.W., and J.L. Franklin, J.L.,, 2013: Atlantic hurricane database uncertainty and presentation of a new database format. *Monthly Weather Review,* **141**, 3576-3592.

Torn, R.D., and C. Snyder, 2012: Uncertainty of Tropical Cyclone Best-Track Information. *Weather and Forecasting,* **27**, 715-729.

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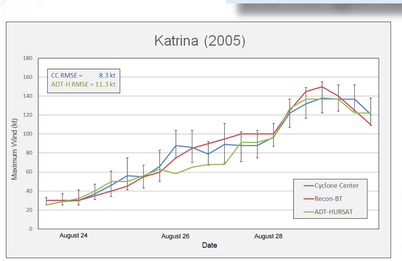

Figure 1. Comparison of CC and ADT-HURSAT intensities to best-track data influenced by recon observation.

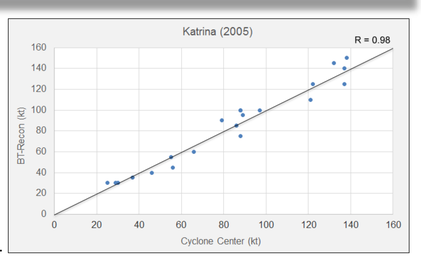

Figure 2. CC vs. recon influenced best-track data.