NOAA Joint Hurricane Testbed Project
Mid-year progress report

A New Secondary Eyewall Formation Index: Transition to Operations and Quantification of Associated Intensity Changes

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Report:

The new PERC (Probability of Eyewall Replacement Cycle) model was installed into the operational SHIPS in time for testing during the 2010 Atlantic hurricane season.

Year-2 goals:

1. Verify the 2010 operational skill of the PERC-model.
2. Utilize our newly-constructed database of low-level aircraft reconnaissance measurements to construct a general climatology of intensity changes associated with eyewall replacement cycles.
3. Apply the new climatology toward constructing new operational tools for forecasting intensity changes associated with eyewall replacement cycles.

Progress by item:

1. Completed. In addition to verifying 2010 performance, we were able to access the operational SHIPS files for the 2008 and 2009 seasons. This allowed us to perform a more through test of the true operational characteristics of the model. Results of the verification follow below.
2. Mostly completed. Results below.
3. Not yet begun.

Results:

The cross-validated Brier Skill Score (BSS) based on the SHIPS developmental dataset, which is based on posterior reanalysis and best track, was found to be 21% for the combined years 1997–2006 with a range of –23% to +33% for the 10 individual years (Fig.1; also shown in Kossin and Sitkowski 2010). The true operational BSS in 2010 verified at 27% at 00–12h lead-time, so 2010 was a good inaugural year for the PERC-model. Things weren't quite so rosy for the 2009 operational test, but the operational BSS for the combined years 2008–2010 was +17%, which is more likely to be representative of longer-

term performance due to increased sample size. The relatively small degradation in skill from cross-validated posterior reanalysis (+21%) to operational analysis (+17%) suggests that the PERC-model is not overly sensitive to operational input errors, and performs skillfully and predictably in an operational setting.

As expected, skill degrades at longer lead-time and the model shows little to no skill past 24h. We suspect that our use of the satellite-based features may be a culprit here; we followed the SHIPS protocol of simply keeping these features fixed for all lead-times. But the SHIPS model does not strongly weight these features, and is less sensitive than the PERC-model to large variations that can occur on timescales relevant to forecasting. In our FY2012 JHT proposal, we propose to address this issue with a simple lead-time-dependent weighting scheme. To complement the operational skill assessment, reliability (attributes) diagrams are shown in Fig.2.

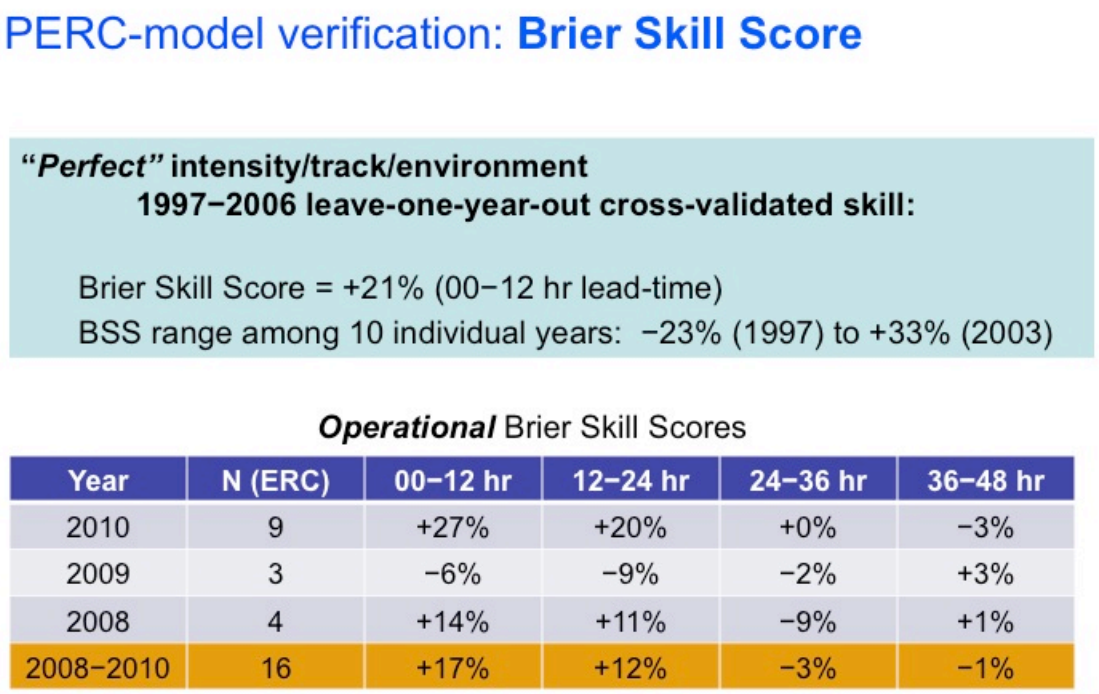

Figure 1: Assessment of PERC-model performance based on Brier Skill Score.

The second Year-2 goal is the construction of a new general climatology of intensity changes associated with eyewall replacement cycles. These changes can be naturally separated into 3 distinct phases: intensification, weakening, and re-intensification (Fig.3). For forecasting purposes then, there are 6 targets that describe the intensity change and the duration of each phase. The average values of these and their standard deviations are shown in Table 1. The mean intensity change during phase I is +14kt over a 9h period. During the weakening

phase, intensity decreases an average of 21kt over 17h, and re-intensification of 6kt over 11h occurs, on average, after that. The total cycle lasts 37h on average, and intensity ends about where it started.

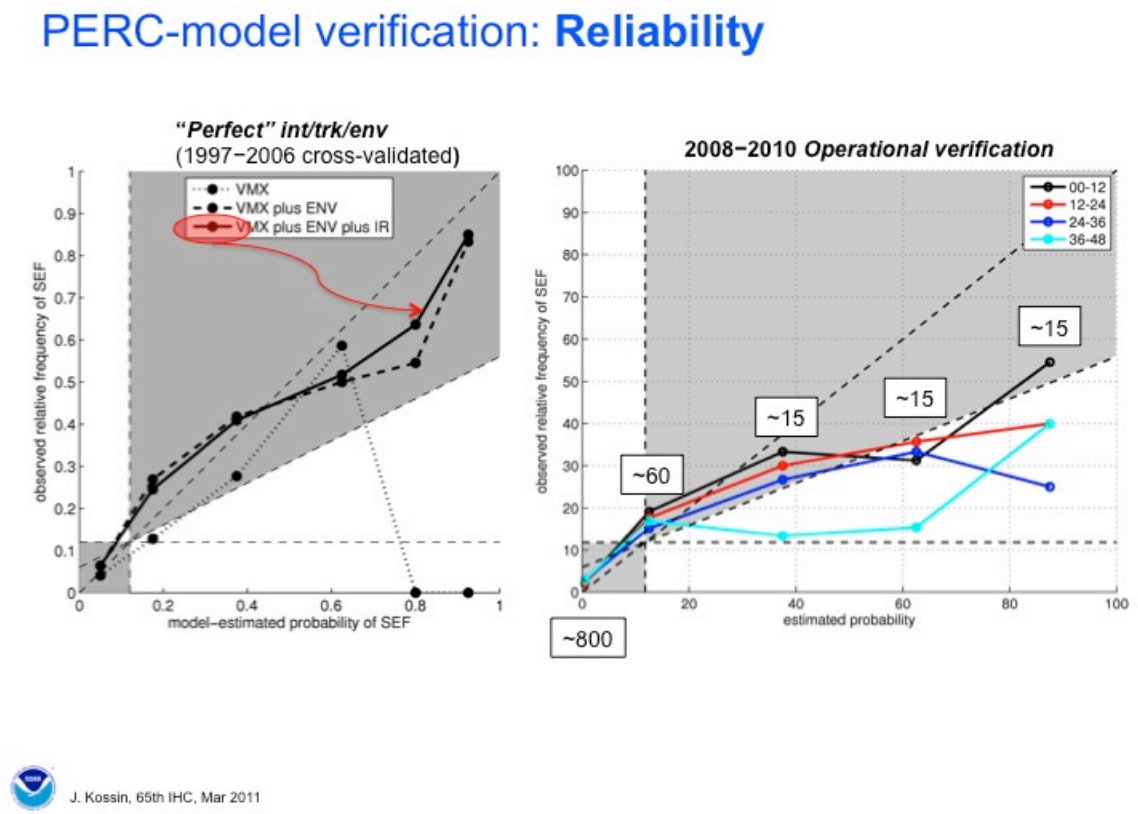

Figure 2: Comparison of cross-validated posterior reanalysis-based reliability (solid line in left panel) and operational reliability at all lead-times (right panel).

The values shown in Table 1 represent the first step toward constructing forecast tools to provide objective guidance for modifying intensity forecasts during eyewall replacements cycles. The large associated standard deviations, however, demonstrate that the utility of the raw climatologies is limited. The next major part of this project will be the identifying of environmental features that can explain some of this large variance.

Most of these results were recently presented by at the 65th Interdepartmental Hurricane Conference in Miami, FL.

In addition to documenting intensity changes associated with eyewall replacement cycles, we have also identified the associated structure changes. Although this is not an explicit JHT proposed task, the information may be useful to forecasters, or in post-season reanalyses of storm characteristics.

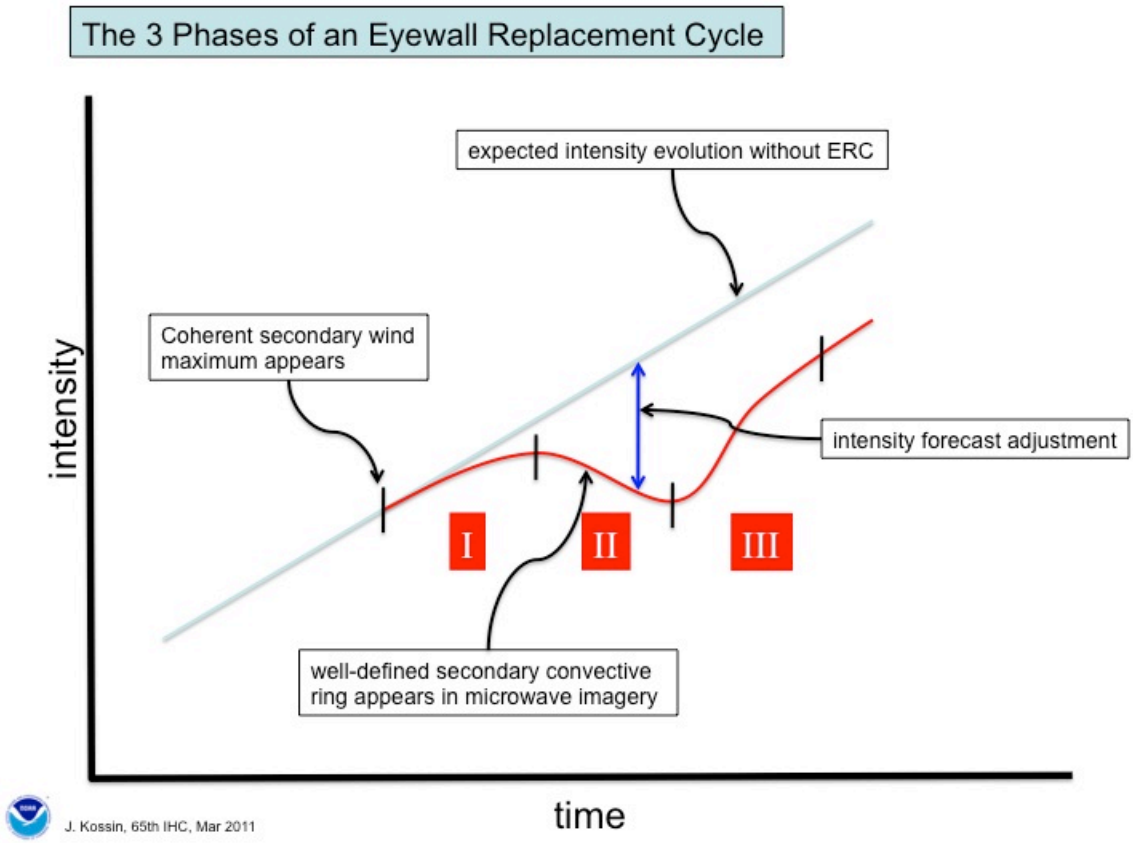

Figure 3: Schematic of the 3 phases of eyewall replacement. Each phase has an associated characteristic intensity change and duration.

	Phase I (intensification)	Phase II (weakening)	Phase III (re-intensification)	Mean Total
ΔV (kt) (intensity change)	$\mu = +14$ $\sigma = 17$	$\mu = -21$ $\sigma = 12$	$\mu = +6$ $\sigma = 8$	−1
Δt (hr) (duration)	$\mu = 9$ $\sigma = 9$	$\mu = 17$ $\sigma = 9$	$\mu = 11$ $\sigma = 13$	37

Table 1: Mean values of the 6 forecast targets and their standard deviations. The rightmost column shown the total mean intensity change and duration for the entire eyewall replacement cycle.