

National Hurricane Center Forecast Verification: Quantifying Forecast Uncertainty

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Acknowledgement to John Cangialosi

2013 National Hurricane Conference

L311 Hurricane Readiness for Coastal Communities

25 March 2013





NHC Forecast Verification

- NHC verifies all official tropical cyclone track and intensity forecasts each year
- Why verify forecasts?
 1. Monitor performance and progress
 - Government Performance and Results Act (GPRA)
 2. Understanding forecast errors help forecasters and modelers to reduce them
 3. Identify critical issues for the research community
 4. Basis for the development of certain products
 - Wind speed and storm surge probabilities
 5. Helps decision makers use NHC products more effectively



NHC Forecast Verification

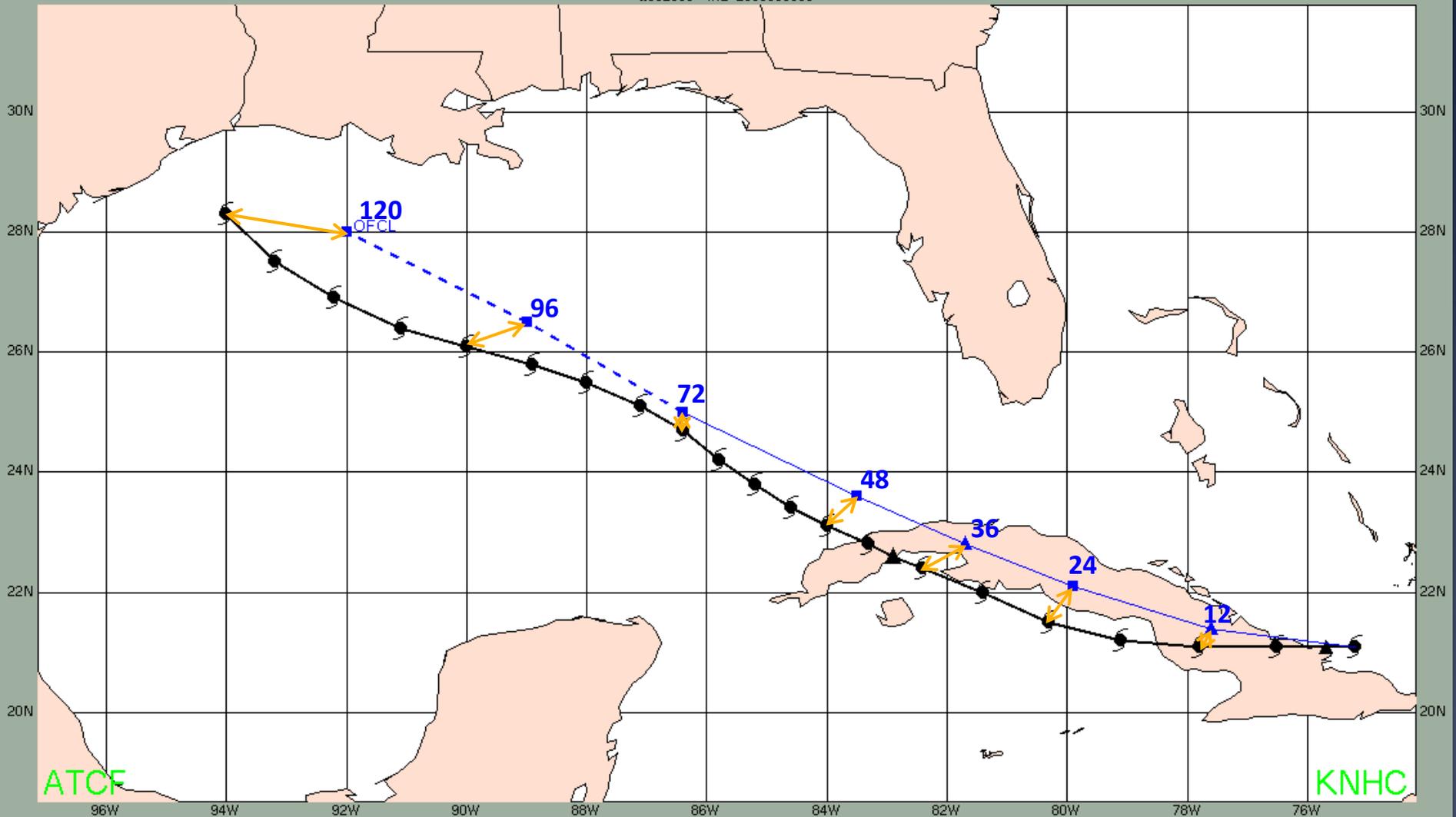
- System must be a tropical or subtropical cyclone at both forecast initial time **and** verification time
- Special advisories ignored (original advisory is verified instead)
- Definitions:
 - Track error: great-circle distance between the forecast location and the actual location of the storm center (n mi)
 - Intensity error: difference between the forecast and actual intensity (kt)
 - Forecast SKILL is computed by comparing forecast error to the error from a Climatology-Persistence model (CLIPER, Decay-SHIFOR)



Track Error Definition

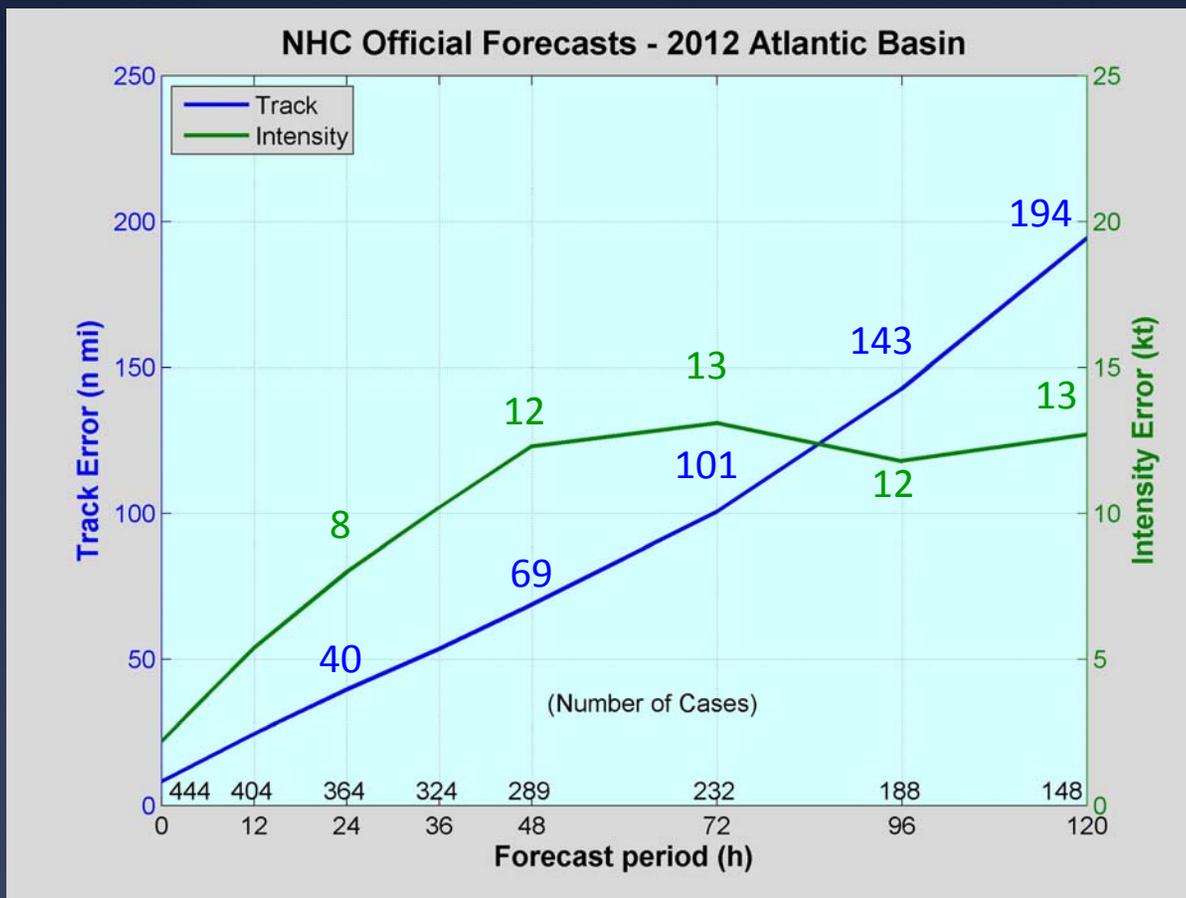


092008 - IKE 2008090800





2012 Atlantic Verification



VT (h)	NT	TRACK (n mi)	INT (kt)
000	444	8.2	2.2
012	404	24.6	5.4
024	364	39.7	8.0
036	324	53.6	10.2
048	289	68.8	12.3
072	232	100.6	13.1
096	188	142.8	11.8
120	148	194.4	12.7

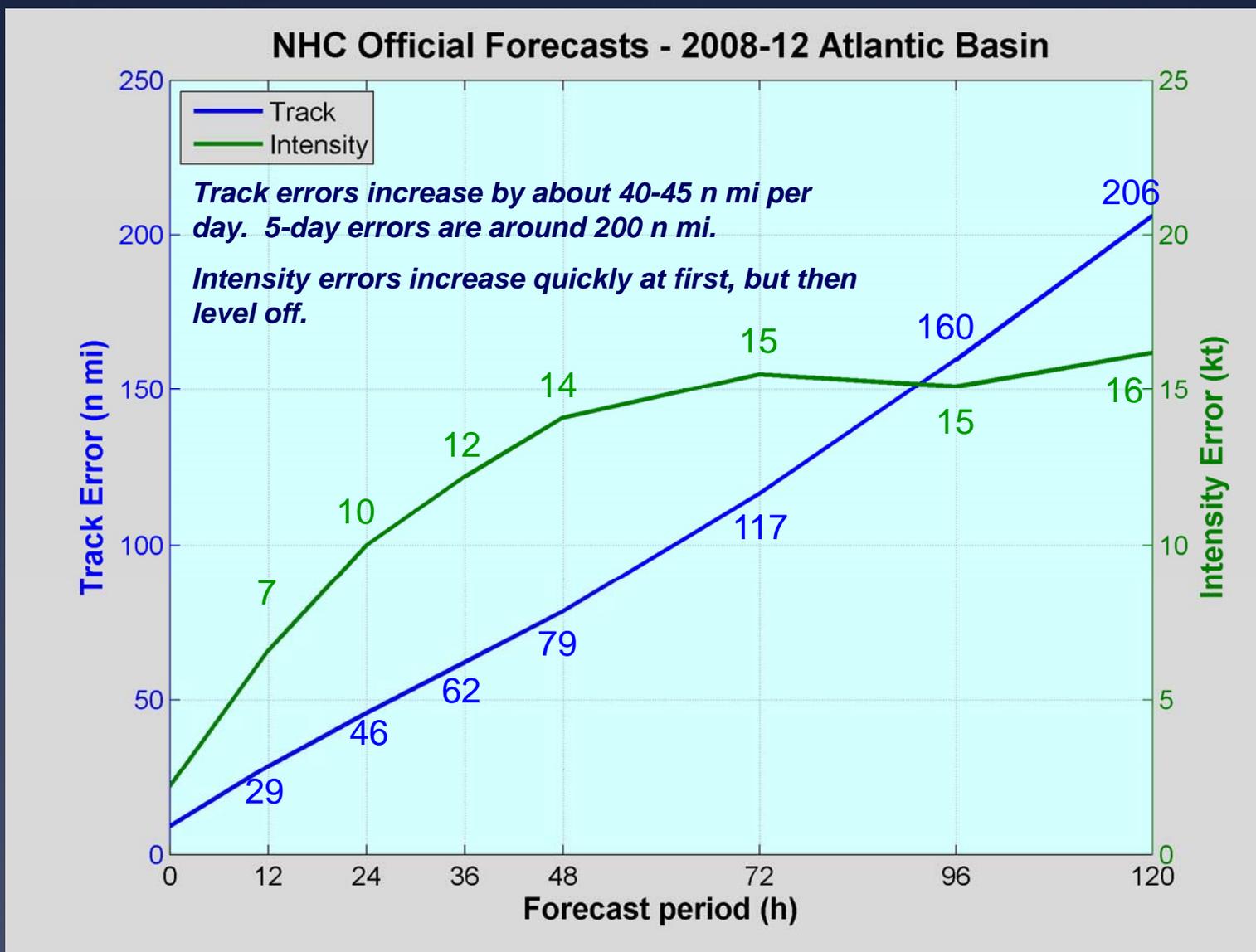
Values in green exceed all-time records.

Track forecast accuracy set records at all lead times except 120 h.

Intensity errors grow rapidly during the first day or two, then level off.



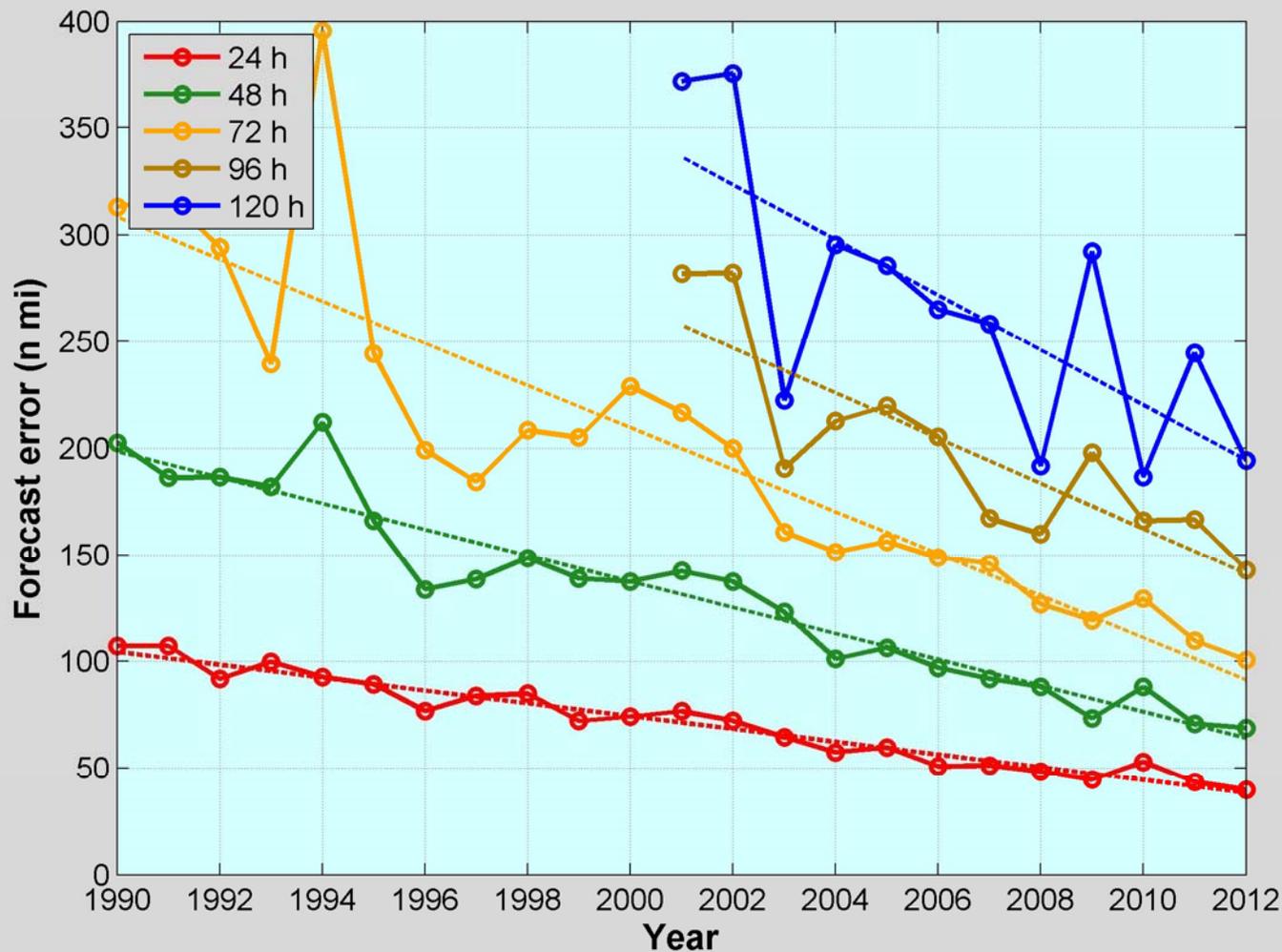
Atlantic 5-year mean errors





Atlantic Track Error Trends

NHC Official Track Error Trend Atlantic Basin



**Error
Reduction
since 1990**

72 h: 67%

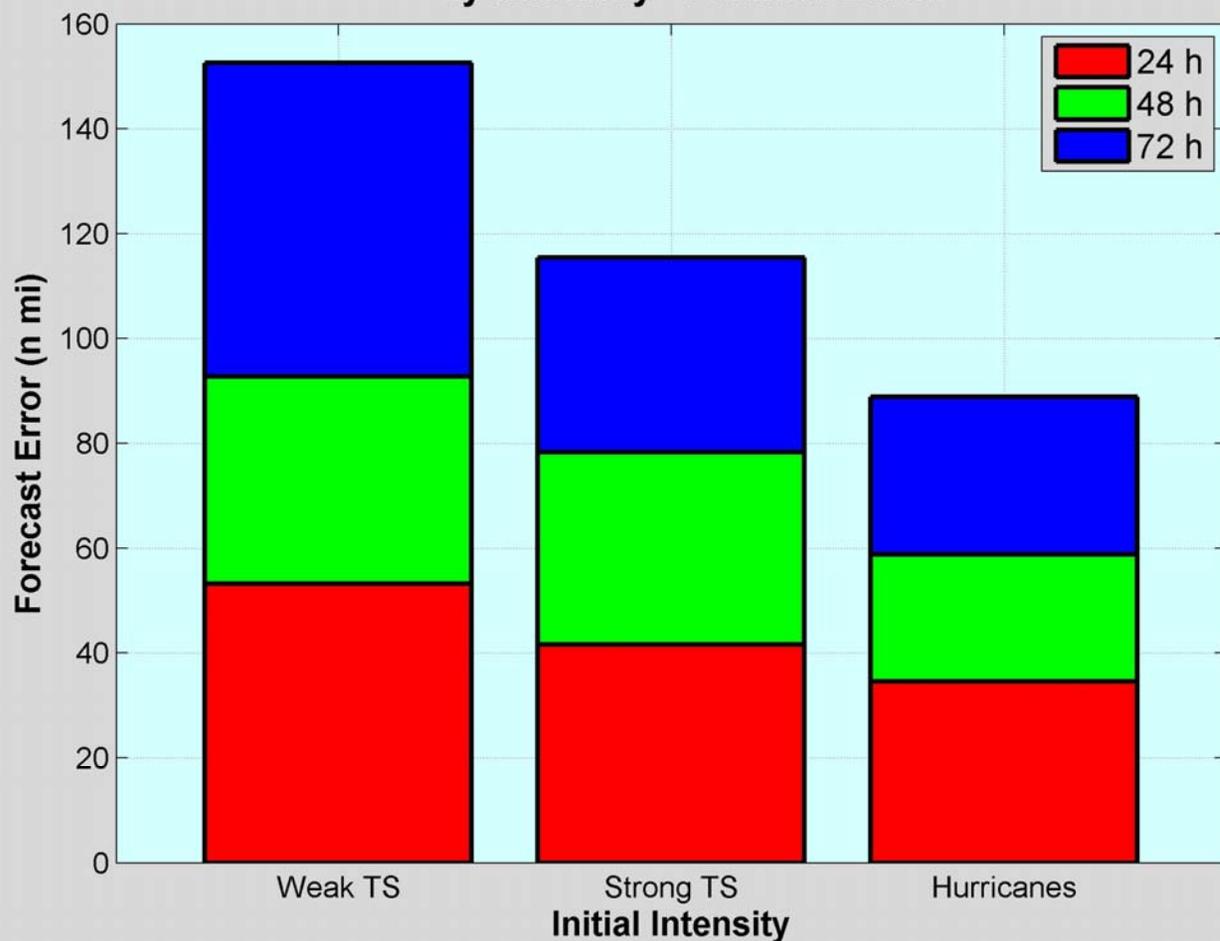
48 h: 65%

24 h: 58%



Track Errors by Intensity

2008-12 NHC Official Track Forecast Errors
by Intensity - Atlantic Basin



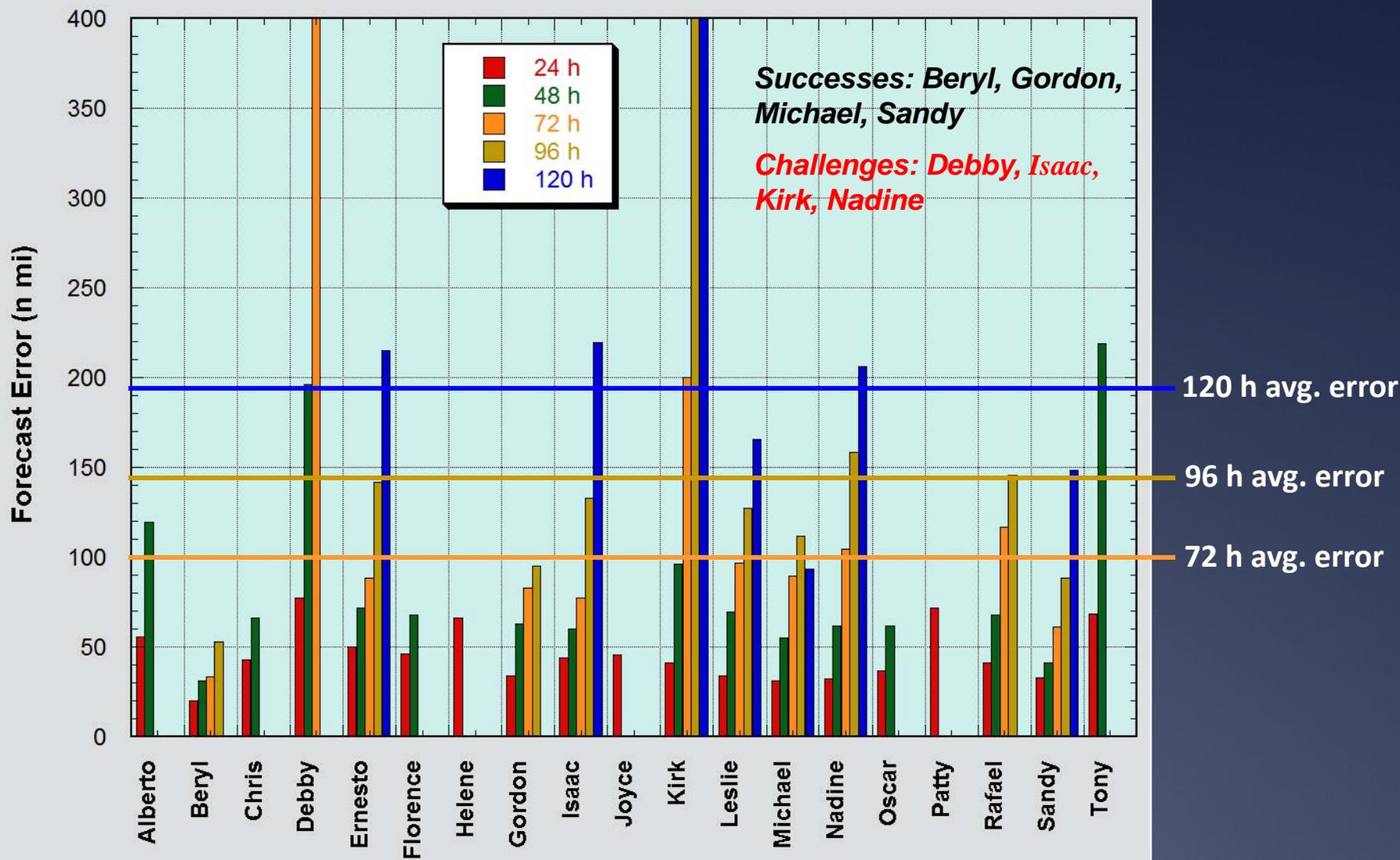
As the initial intensity of the storm increases, NHC track errors on average get smaller.



Still Some Forecast Challenges



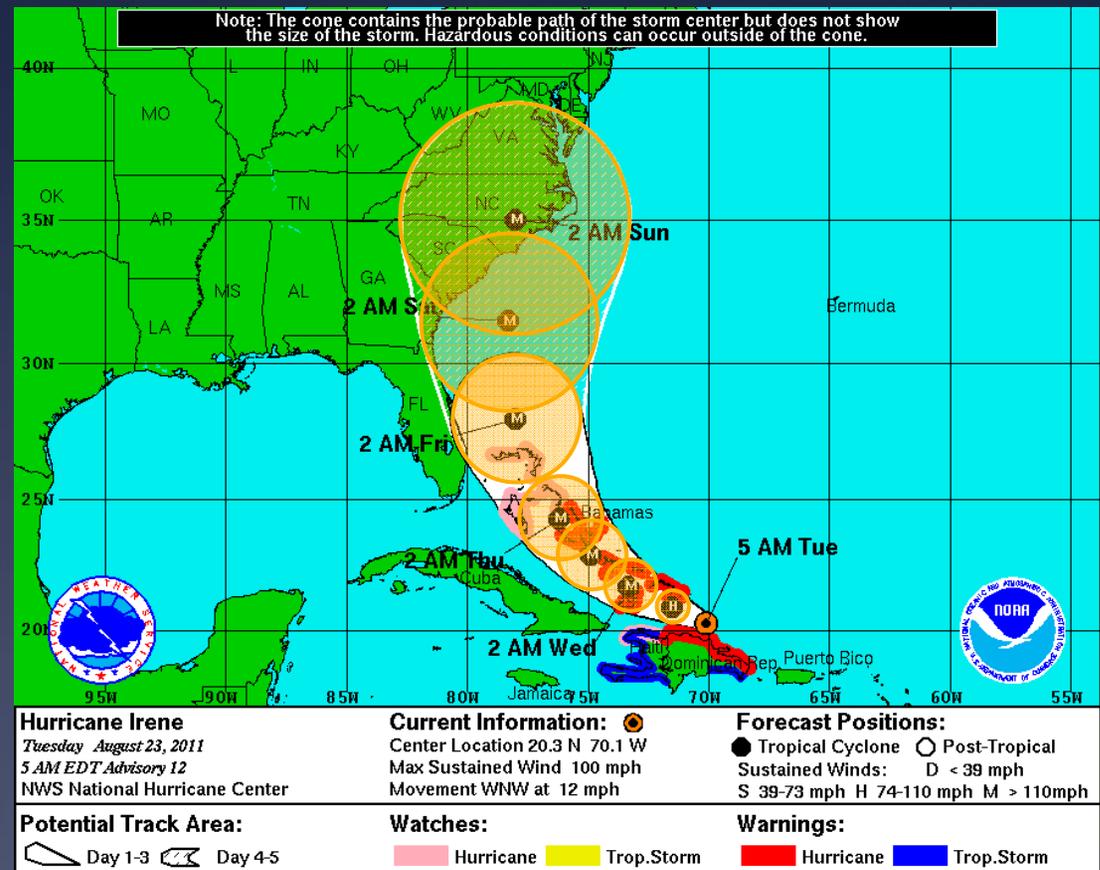
2012 Official Track Errors By Storm - Atlantic





NHC Forecast Cone

- Represents probable track of tropical cyclone center – but does not tell you anything about impacts!
- Formed by connecting circles centered on each forecast point (at 12, 24, 36 h, etc.)
- Size of the circles determined so that, for example, the actual storm position at 48 h will be within the 48-h circle 67% of the time



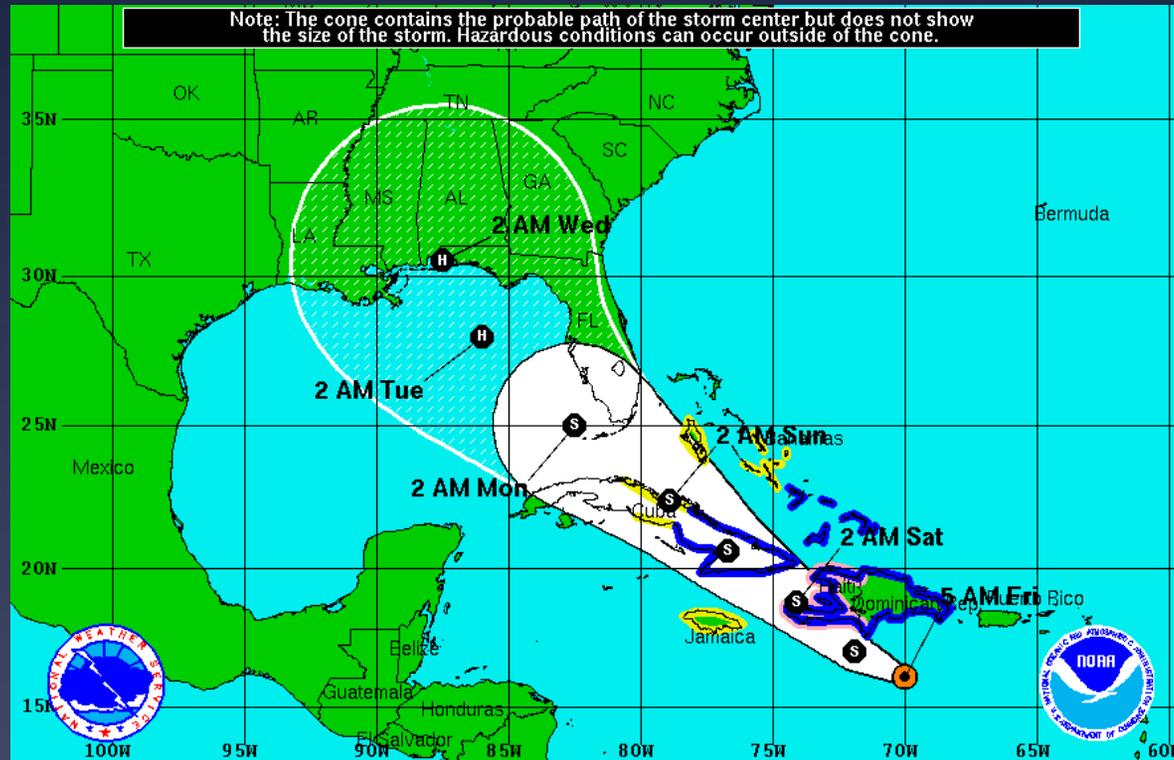


Atlantic Cone Radii – 2013 vs. 2012

Forecast Period (h)	2012 Circle Radius (n mi) ('07 – '11 errors)	2013 Circle Radius (n mi) ('08 – '12 errors)	Percent Change
12	36	33	-8%
24	56	52	-7%
36	75	72	-4%
48	95	92	-3%
72	141	128	-9%
96	180	177	-2%
120	236	229	-3%



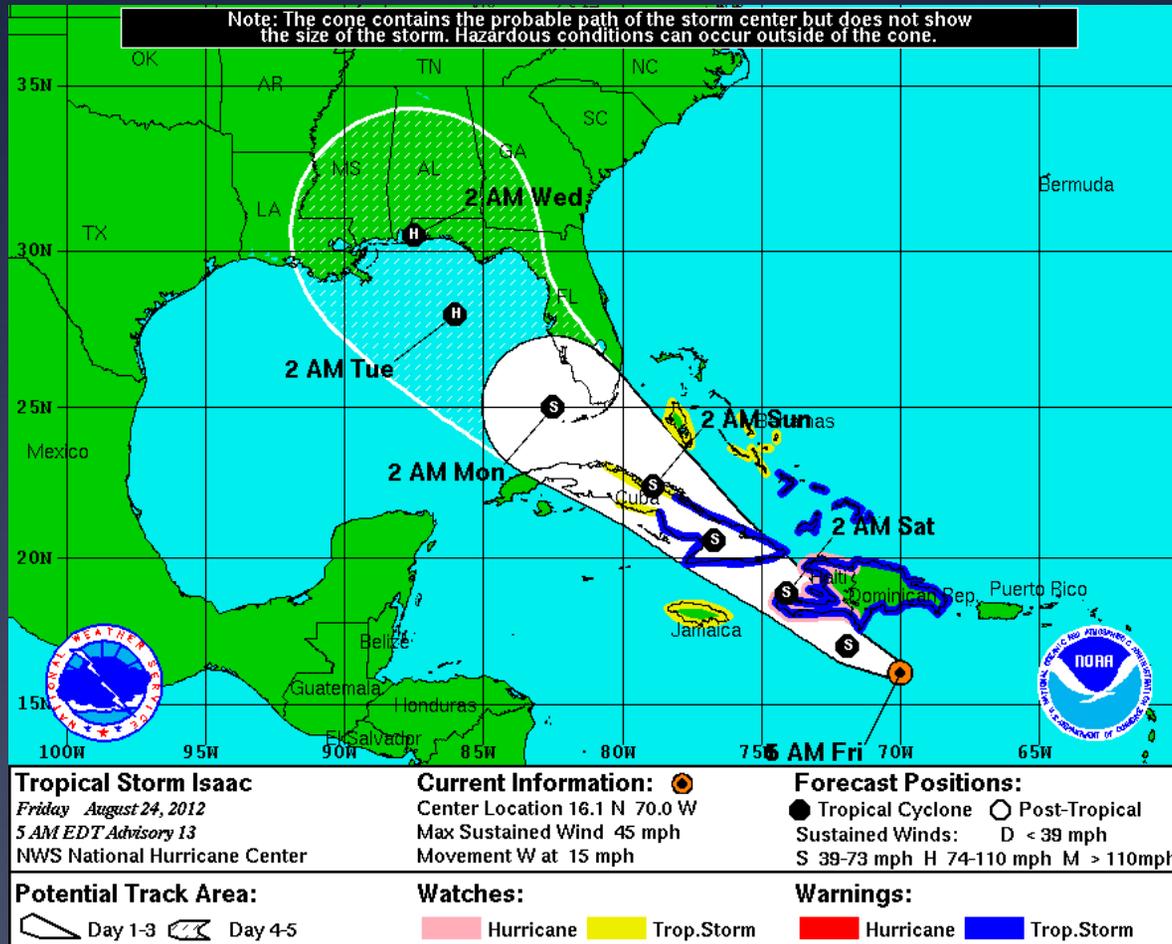
Isaac Advisory 13 with 2008 Cone



Tropical Storm Isaac Friday August 24, 2012 5 AM EDT Advisory 13 NWS National Hurricane Center	Current Information: ● Center Location 16.1 N 70.0 W Max Sustained Wind 45 mph Movement W at 15 mph	Forecast Positions: ● Tropical Cyclone ○ Post-Tropical Sustained Winds: D < 39 mph S 39-73 mph H 74-110 mph M > 110mph
Potential Storm Area: ☐ Day 1-3 ☐ Day 4-5	Watches: ■ Hurricane ■ Trop.Storm	Warnings: ■ Hurricane ■ Trop.Storm

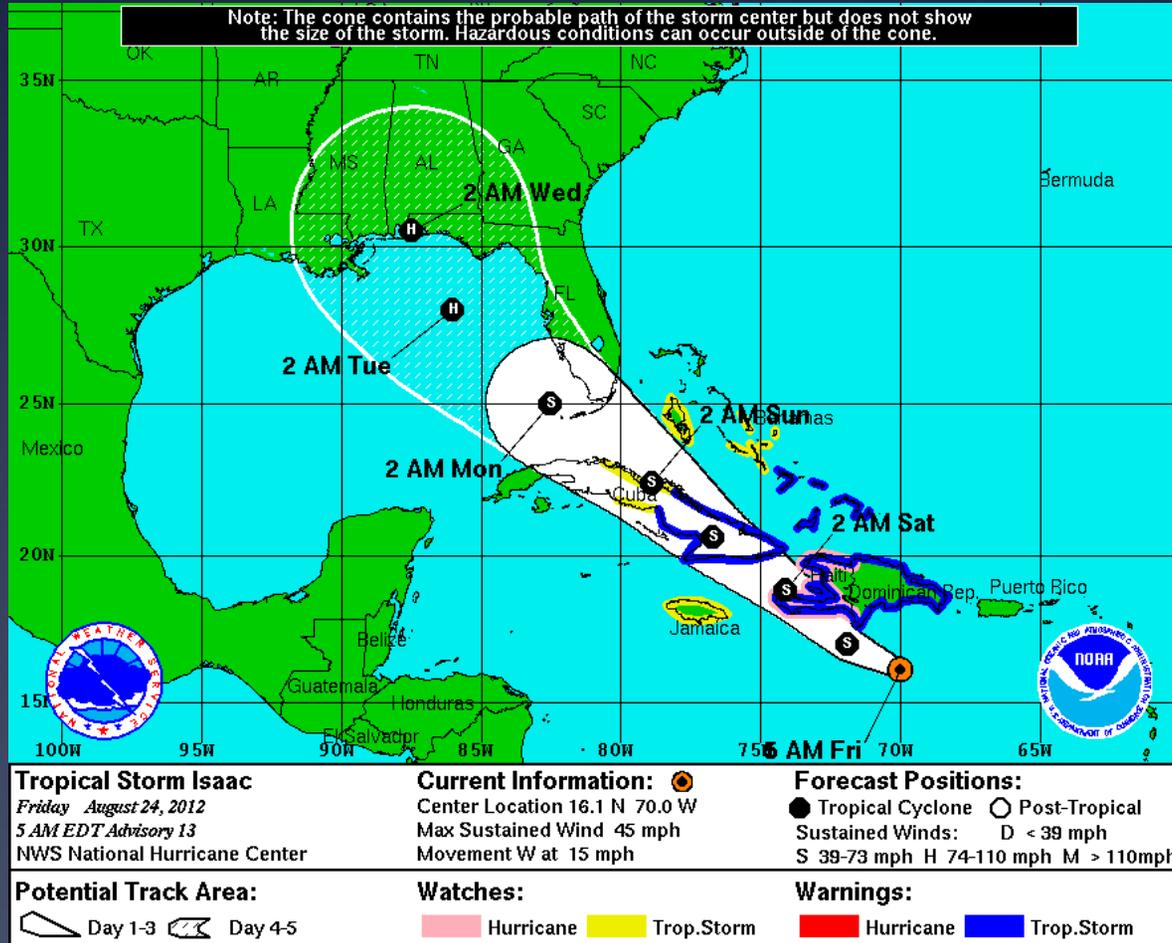


Isaac Advisory 13 with 2012 Cone





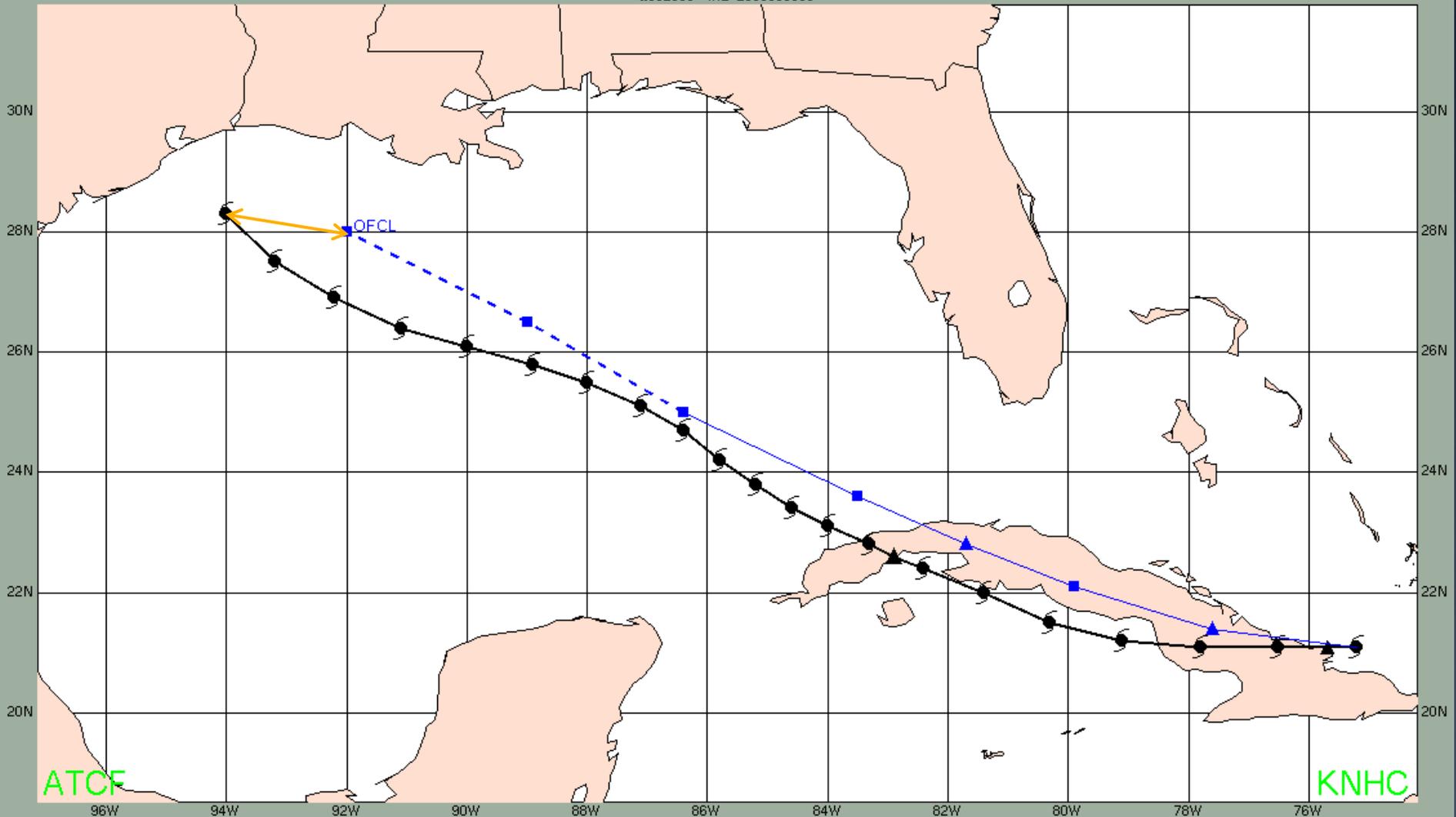
Isaac Advisory 13 with 2013 Cone





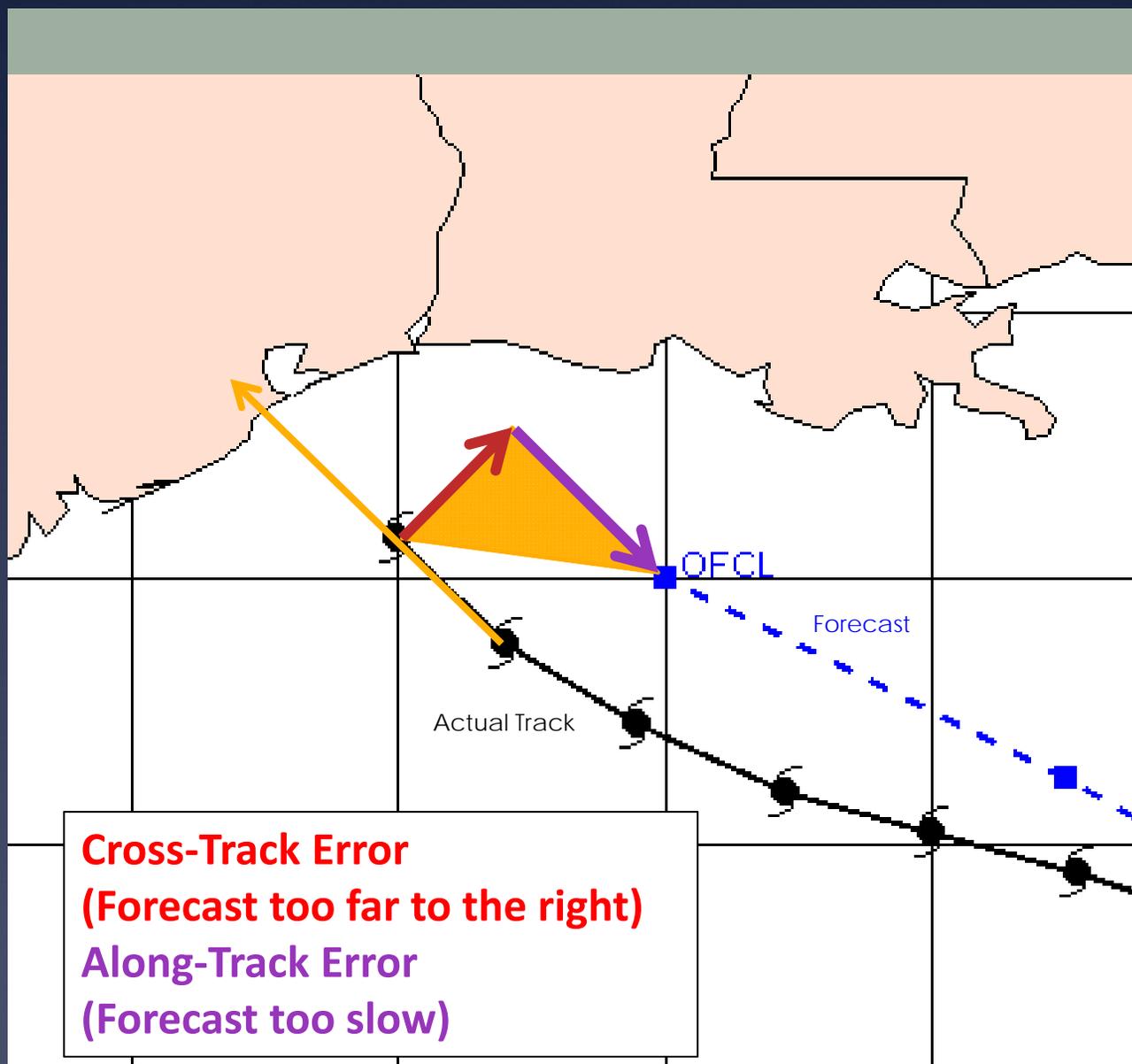
Along- and Cross-Track Errors (Timing vs. Location)

al092008 - IKE 2008090800





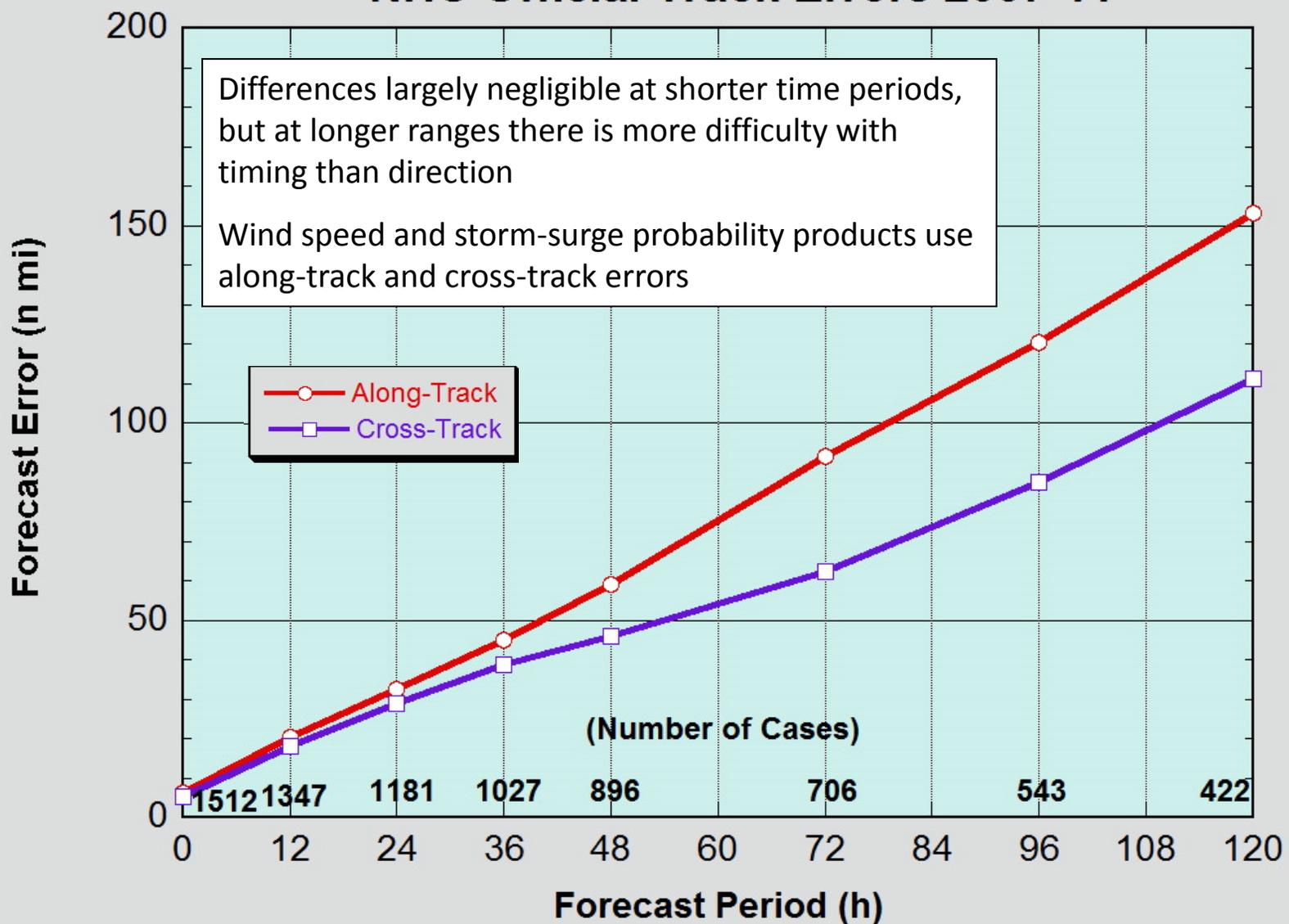
Along- and Cross-Track Errors





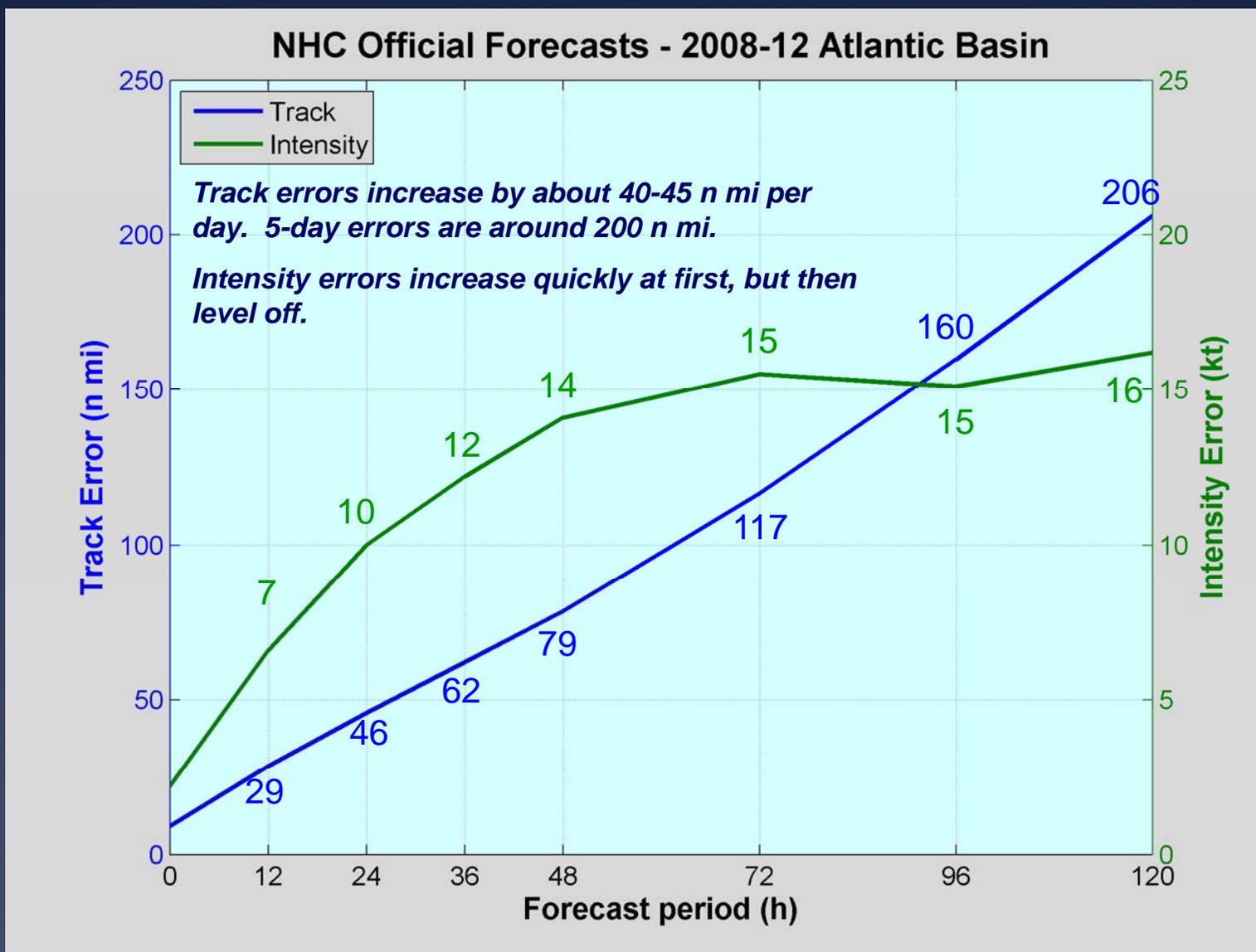
Along- and Cross-Track Errors

NHC Official Track Errors 2007-11



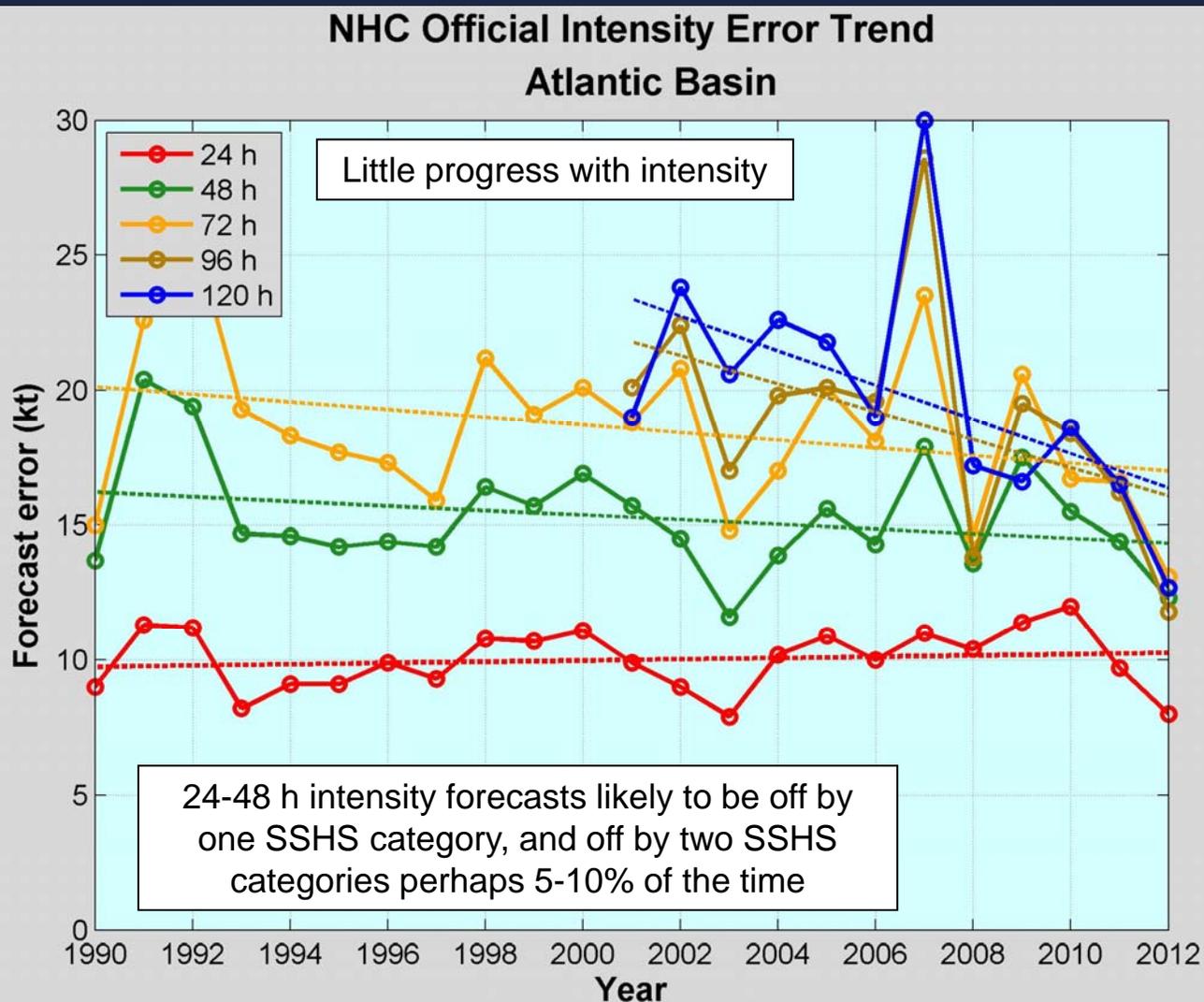


Atlantic 5-year mean errors





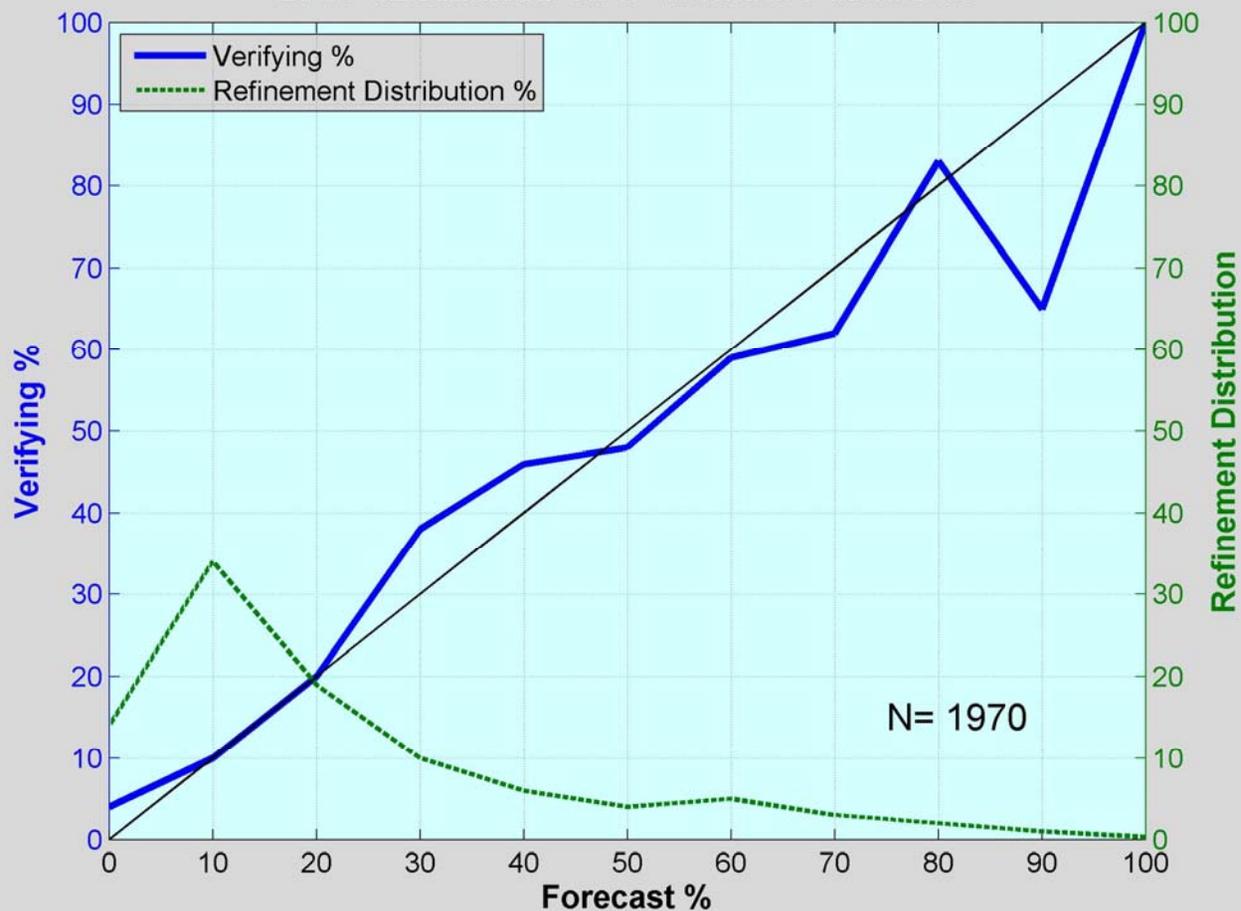
Atlantic Intensity Error Trends





2009-12 Genesis Forecasts

2009-12 Atlantic 48-h Genesis Forecasts



*Although a low bias
Existed in 2012, a 3-yr
Average shows that
The probabilistic forecasts
are well calibrated.*



Verification Web Page



weather.gov

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Tropical Cyclone Reports

The National Hurricane Center's Tropical Cyclone Reports (formerly called Preliminary Reports) contain comprehensive information on each storm, including synoptic history, meteorological statistics, casualties and damages, and the post-analysis best track (six-hourly positions and intensities).

Atlantic, Caribbean, and the Gulf of Mexico

2011

Eastern Pacific (out to 140°W)

2011

* Note: 1958-1994 for the Atlantic, Caribbean, and the Gulf of Mexico and 1988-1994 for the Eastern Pacific are scanned images of the printed reports.

[An XML index file is also available for all the Tropical Cyclone Reports.](#)



Summary

- Atlantic basin track errors increase by 40–45 n mi each day
 - Forecasts have been steadily getting better over the past two decades (and longer)
- NHC uncertainty cone made up of circles that enclose actual storm position about two-thirds of the time
 - Error cone will be only about 3 to 8% smaller in 2013, so little perceivable change
 - However, as the cone has shrunk over the years, impacts become more likely to occur *outside* the cone!
- Actual track forecast errors aren't quite circular about the forecast point
 - Along-track (timing) errors tend to be larger than cross-track (directional) errors at 48 h and beyond



Summary

- Intensity errors 24-48 h in advance are regularly off by one Saffir-Simpson category
- Intensity errors begin to level off around 72 h
- No appreciable change in intensity forecast error over the past two decades
- 48-h genesis forecasts show ability to distinguish between systems that clearly will or will not develop
 - Genesis forecasts struggle with systems in the 30-70% probability ranges, but have shown signs of improvement