

National Hurricane Center Forecast Verification: Quantifying Forecast Uncertainty

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Acknowledgement to James Franklin and John Cangialosi

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21 April 2011



NHC Forecast Verification

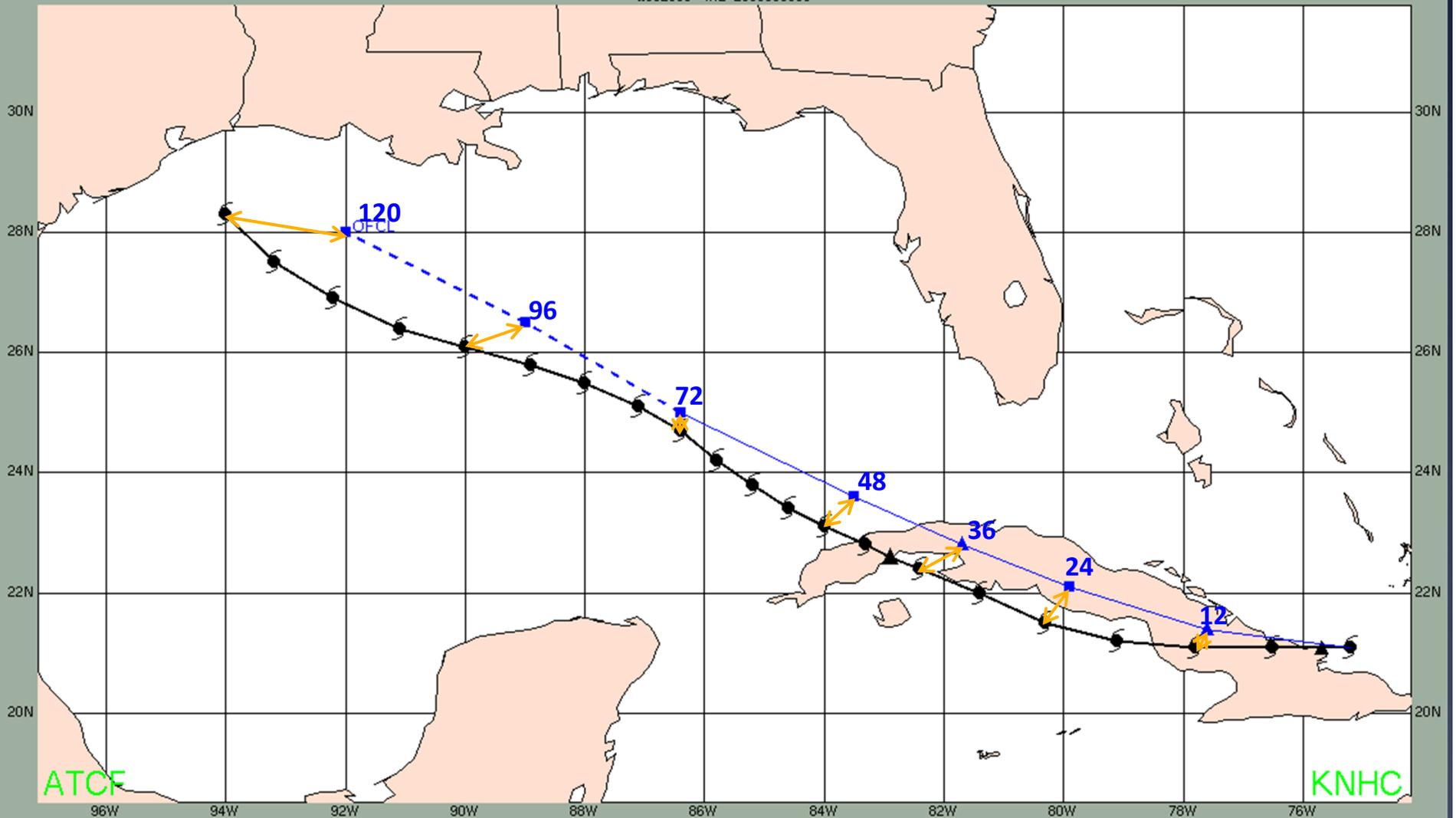
- NHC verifies all official tropical cyclone track and intensity forecasts each year
- Why verify forecasts?
 1. We have to monitor performance and progress
 - Government Performance and Results Act (GPRA)
 2. Understanding forecast errors help forecasters and modelers to reduce them
 3. Identify critical 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

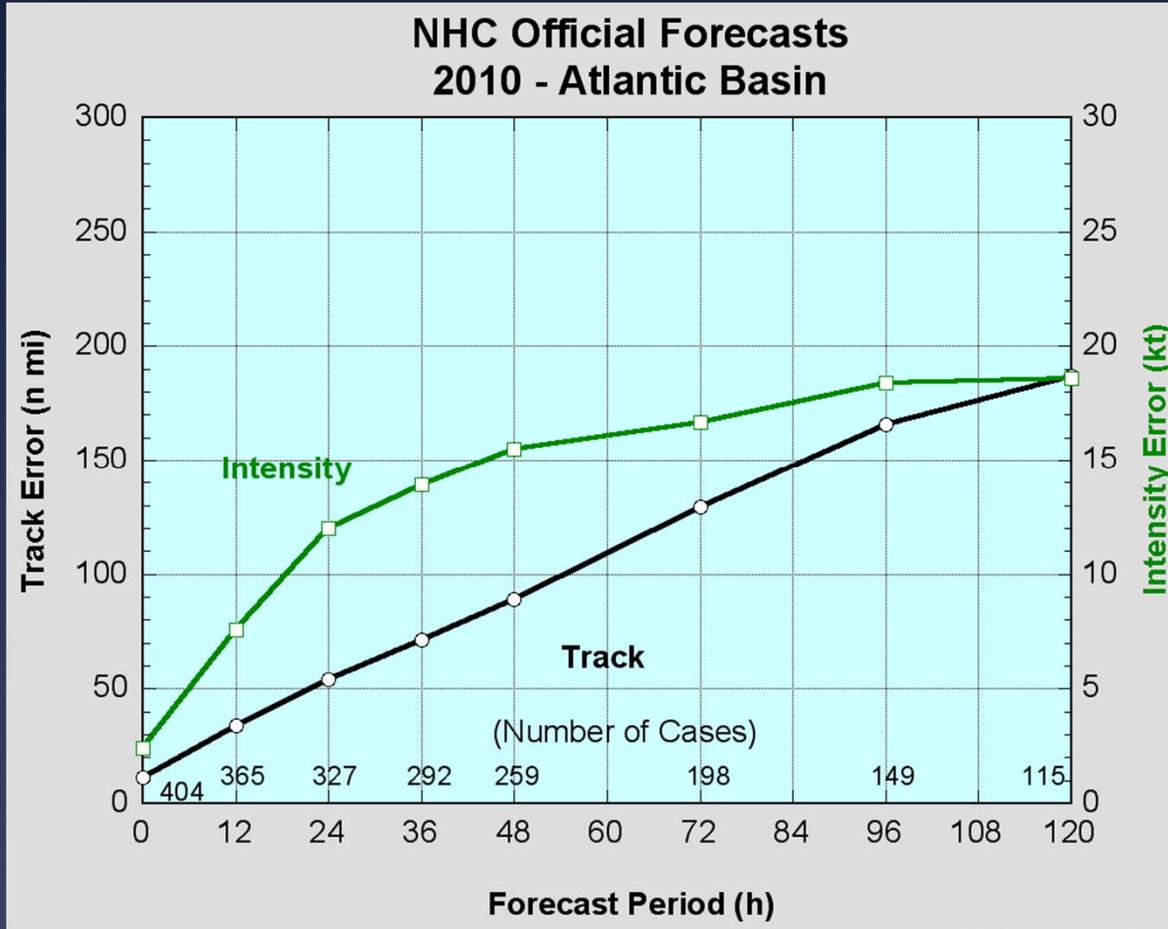
- System must be a tropical or subtropical cyclone at both forecast initial time **and** verification time
- Special advisories ignored (original advisory is verified instead)
- Definitions:
 - Track error: great-circle distance between the forecast location and the actual location of the storm center (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



2010 Atlantic Verification



VT (h)	NT	TRACK (n mi)	INT (kt)
000	404	11.2	2.4
012	365	34.2	7.6
024	327	54.2	12.0
036	292	71.6	13.9
048	259	89.1	15.5
072	198	129.4	16.7
096	149	166.0	18.4
120	115	186.7	18.6

**Values in red exceed
all-time records**

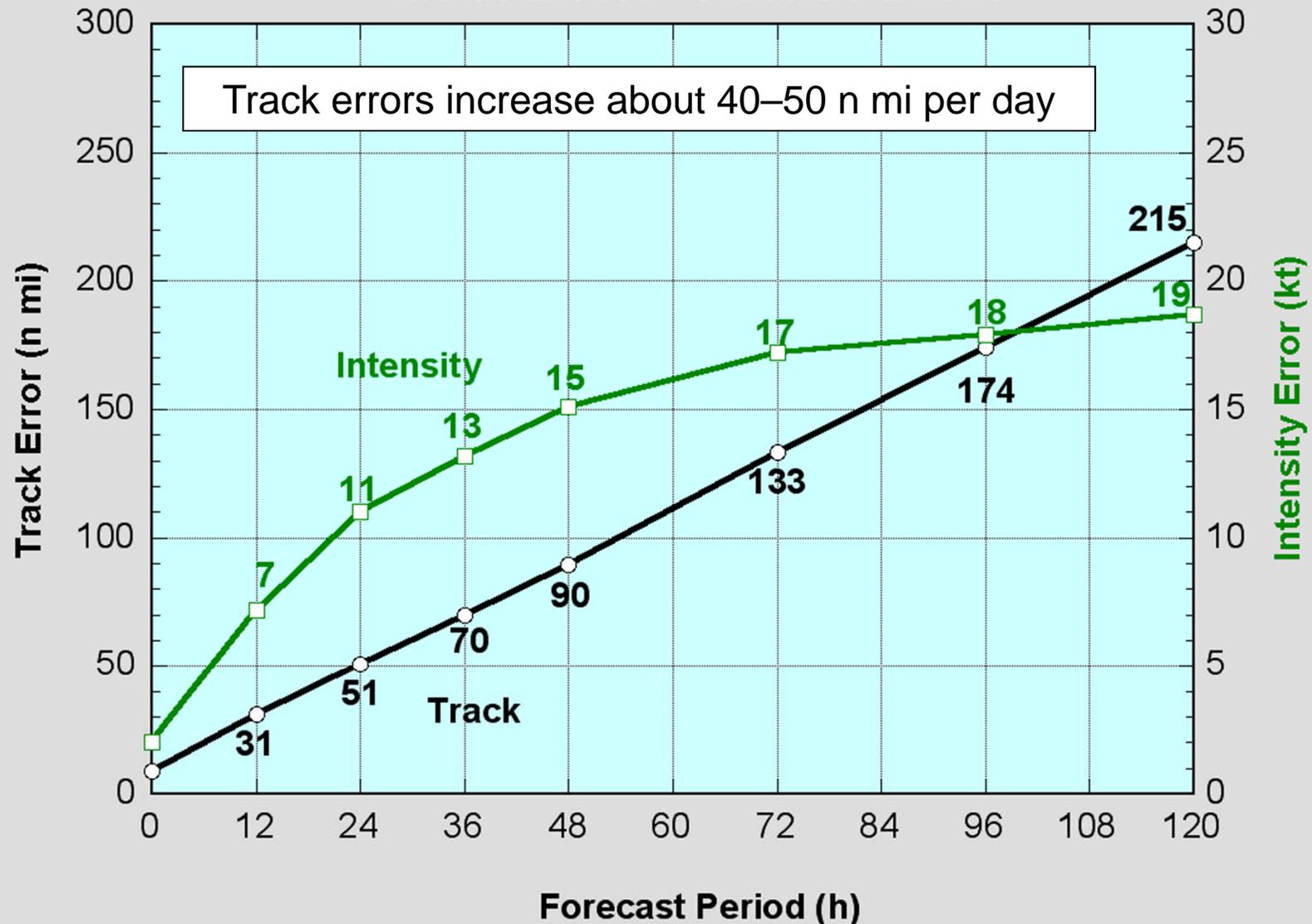
Only one record set for track, but 48-h track error below 90 n mi

No change in intensity error, still grows quickly through 2-3 days and levels off

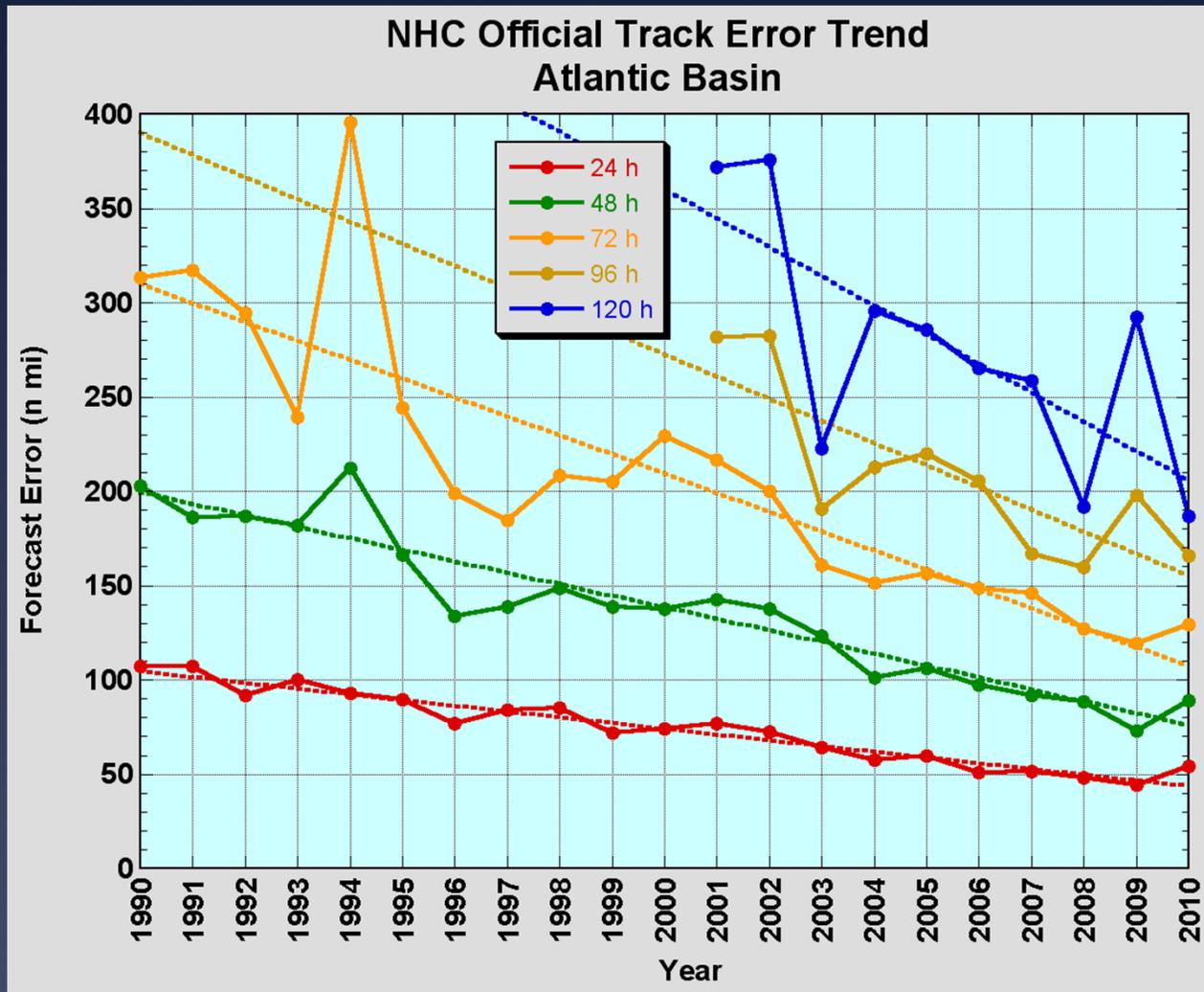
Much larger sample than 2009, especially at days 4 and 5

Atlantic 5-Year Mean Track Errors

NHC Official Five-Year (2006-10)
Mean Errors - Atlantic Basin



Atlantic Track Error Trends (1990-2010)



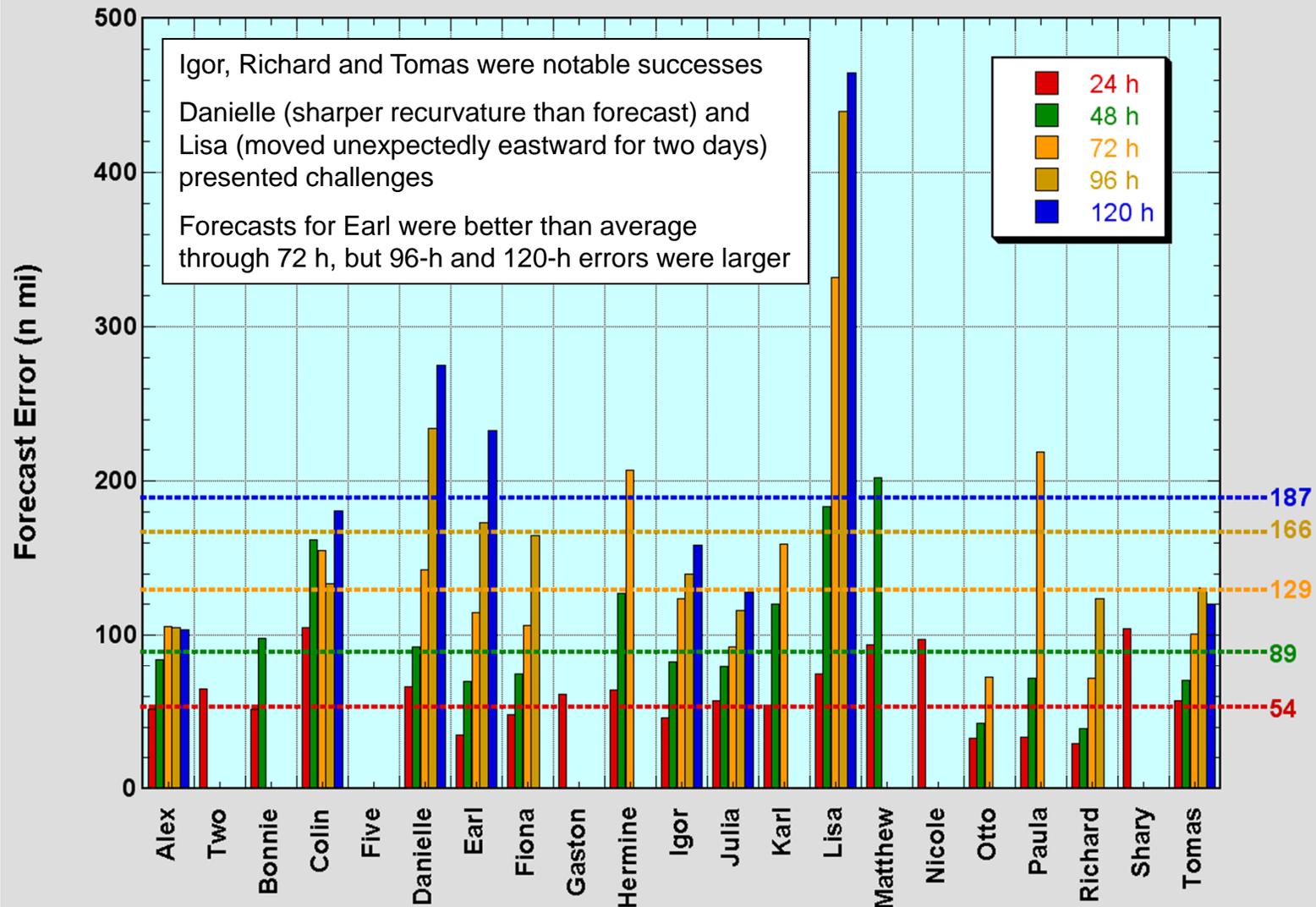
Track errors have decreased by about 60% since 1990

Current 5-day forecast is as accurate as the 3-day forecast was just 10 years ago

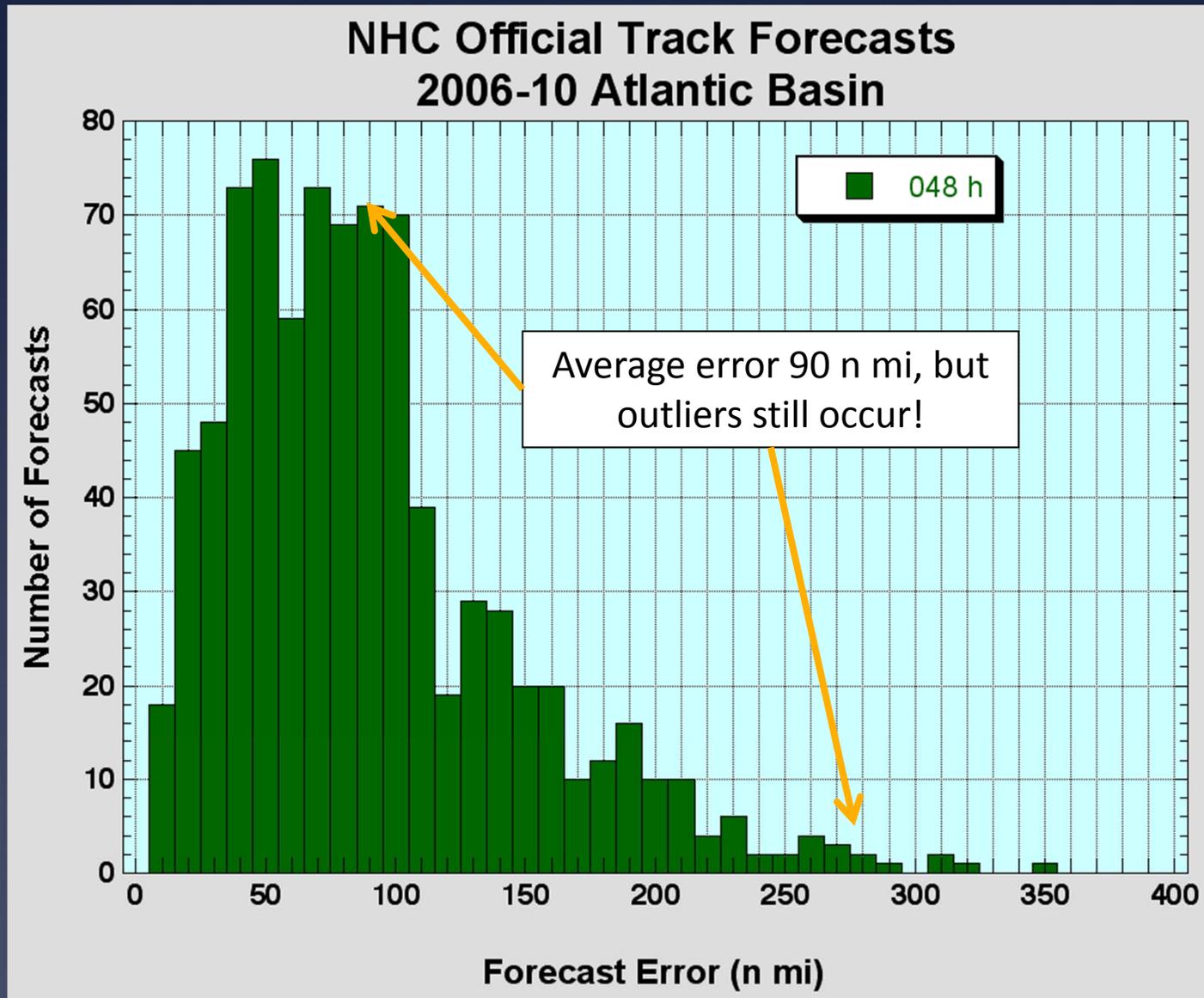
Long-term trend distinctly downward through day 5

2010 Atlantic Track Errors by Storm

NHC Official Track Forecast Error by Storm
2010 - Atlantic Basin

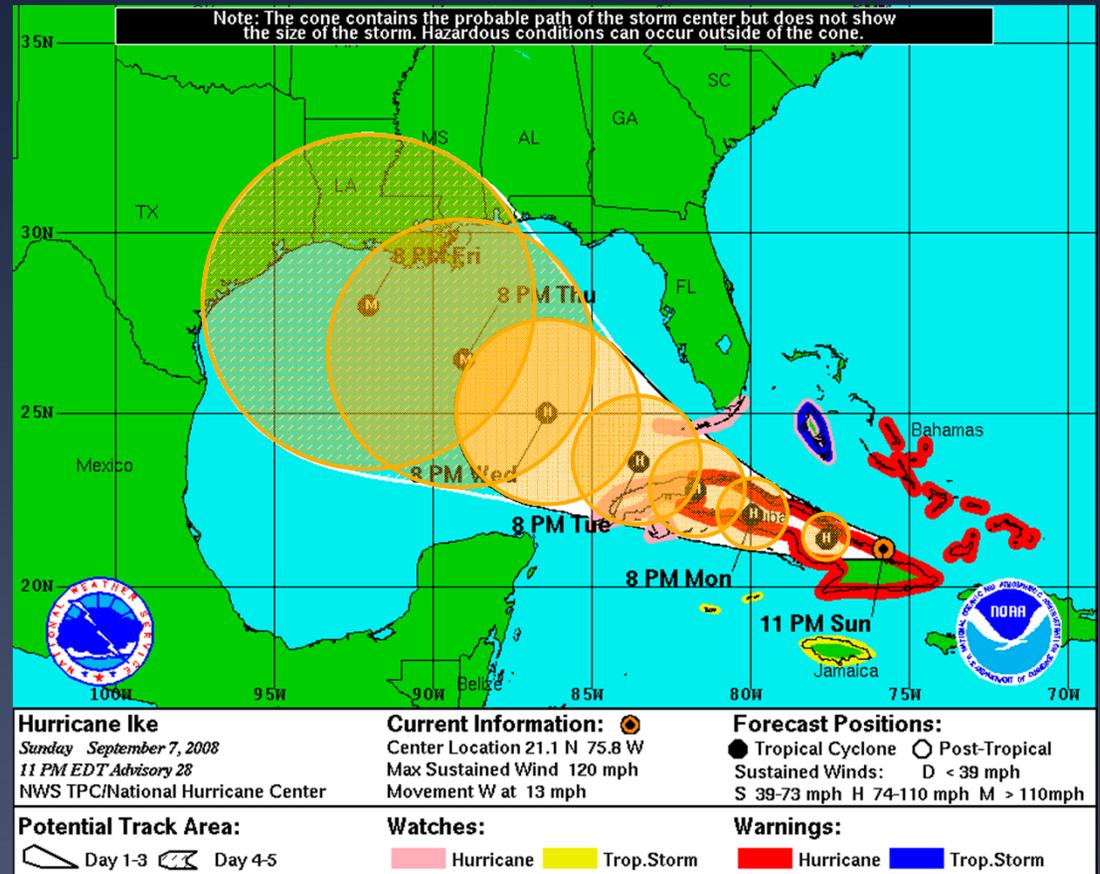


Atlantic Track Error Distribution (48 h)

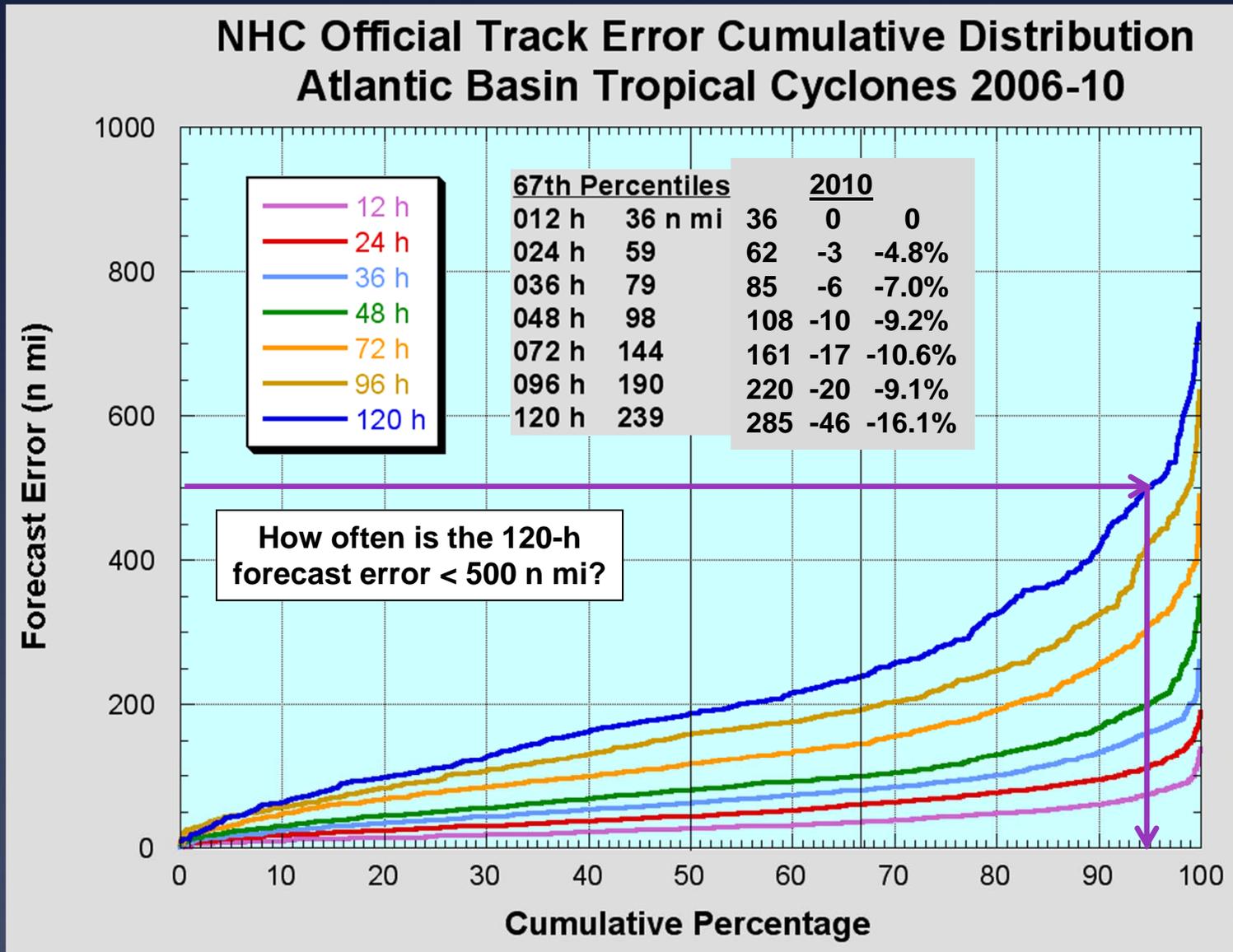


NHC Forecast Cone

- Represents probable track of tropical cyclone center
- 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



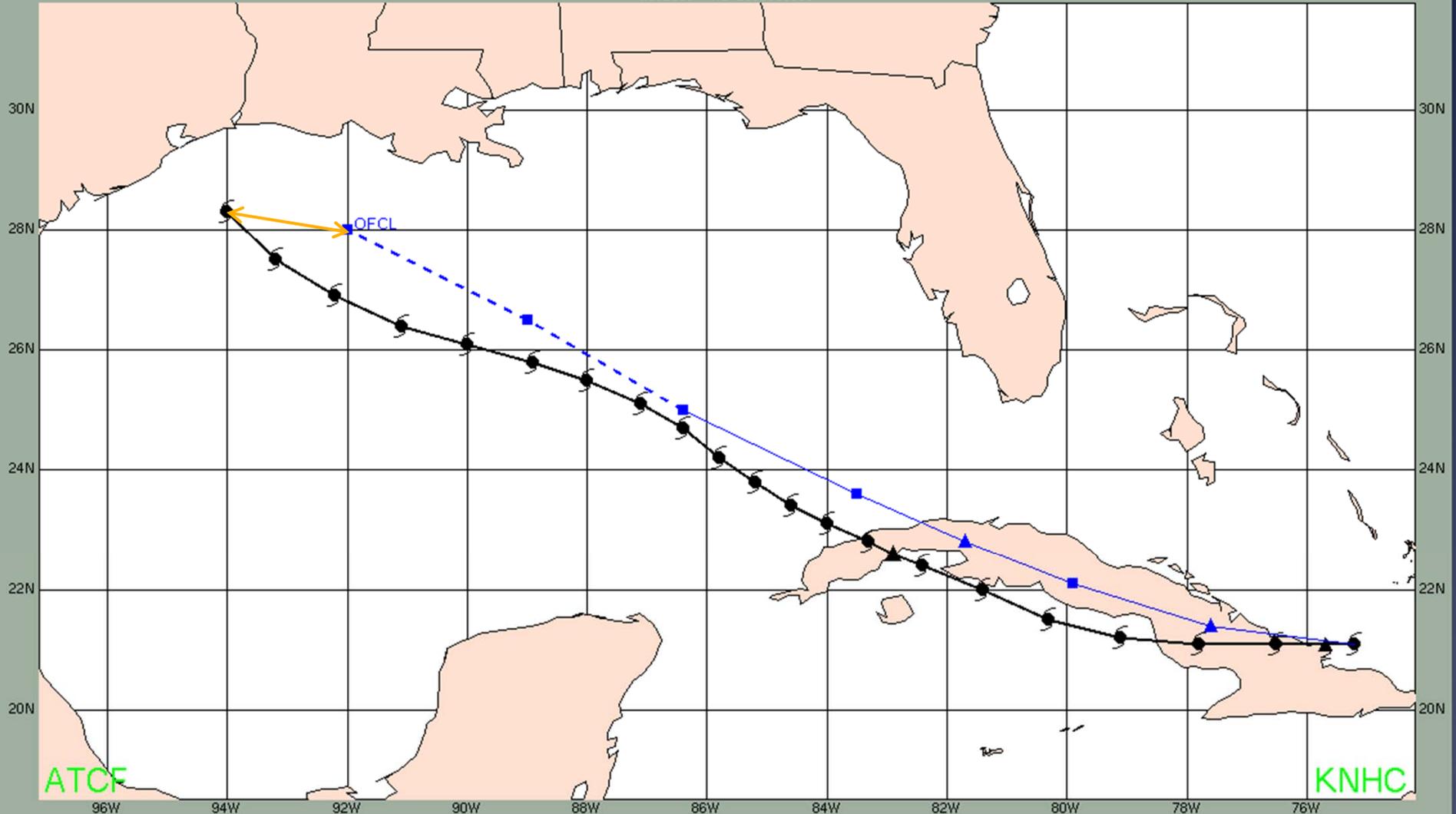
Forecast Error Distributions and Cone Radii



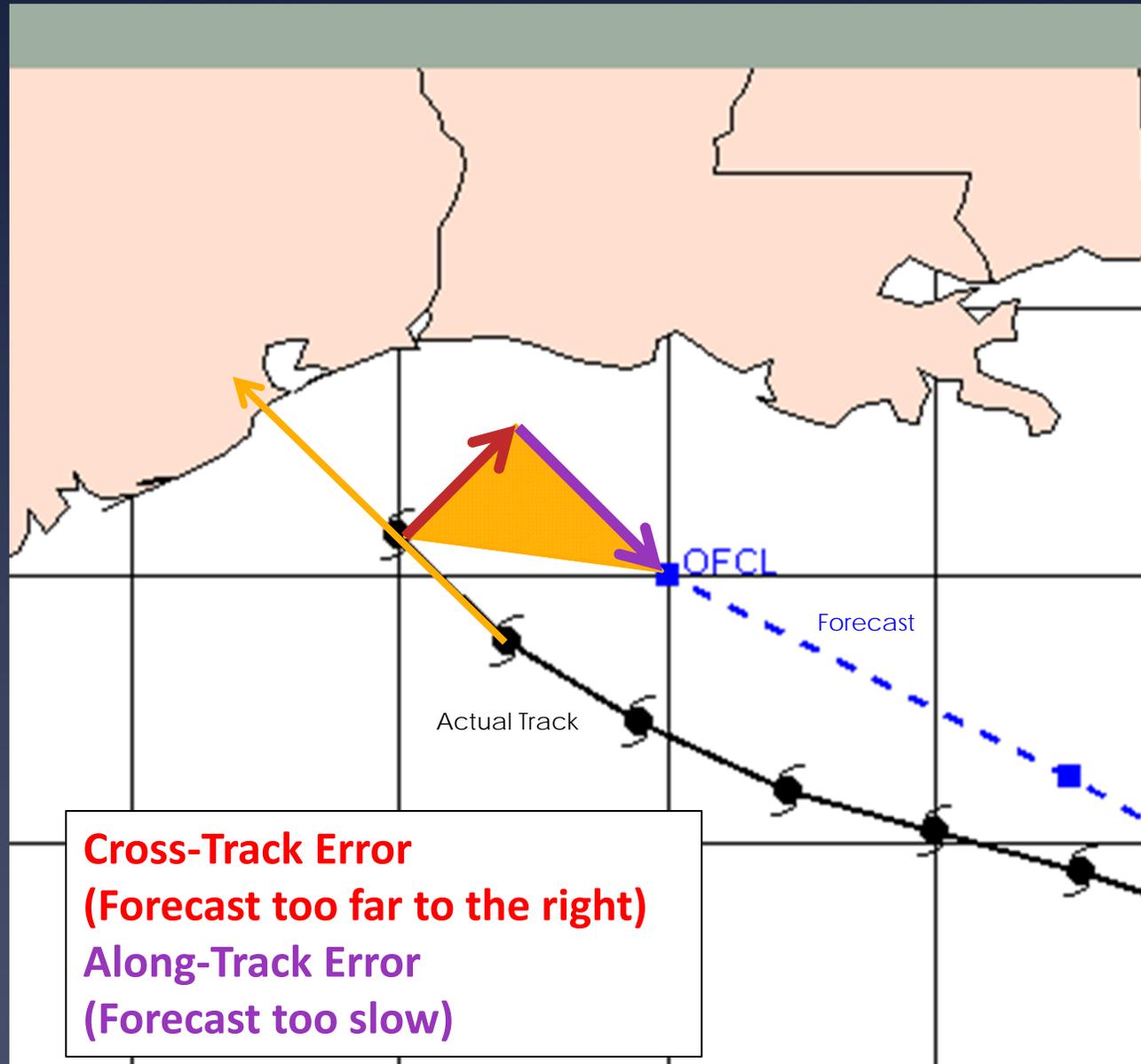
Substantial reduction in track cone size for 2011 due to 2005 season dropping out of the sample

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

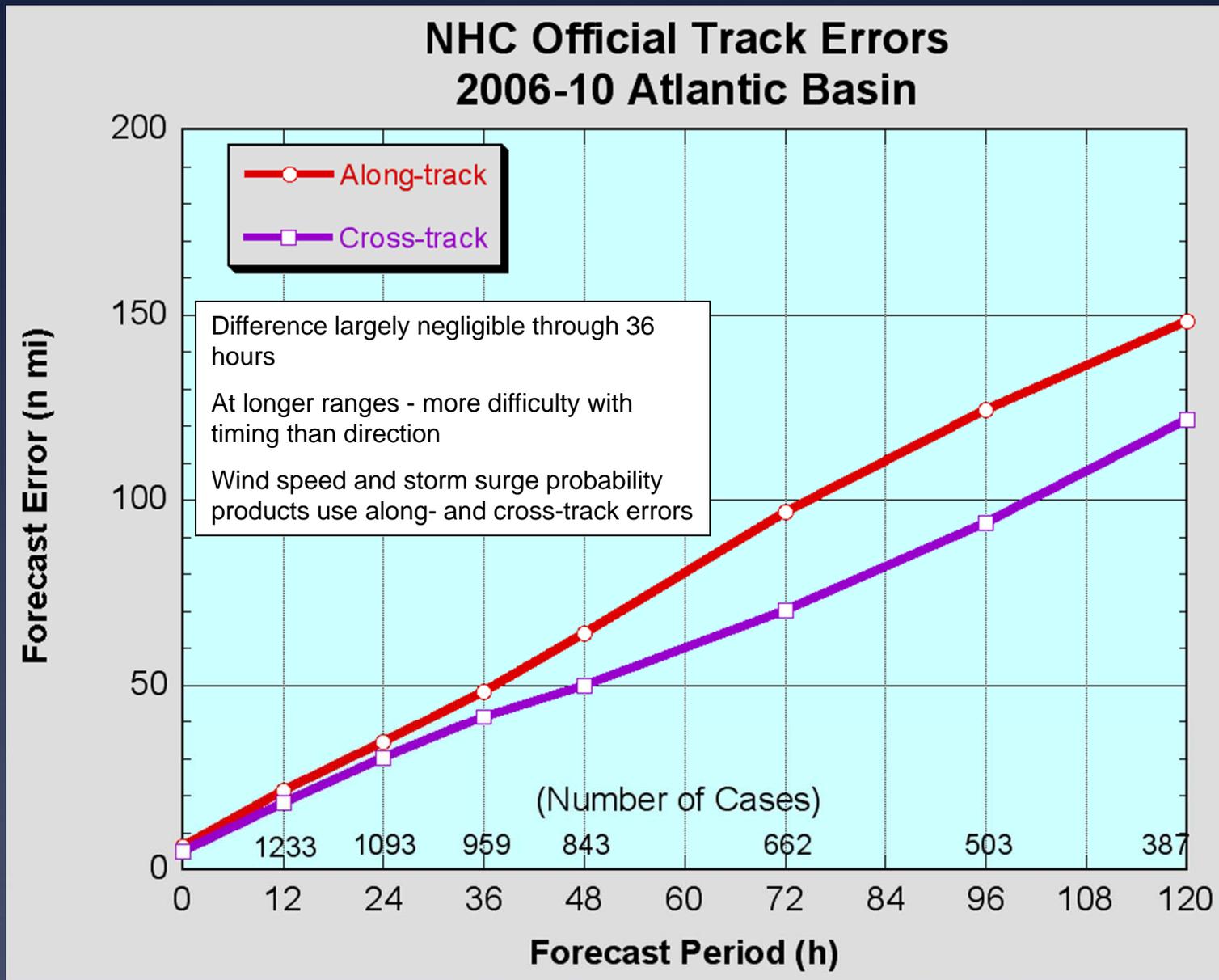
092008 - IKE 2008090800



Along- and Cross-Track Errors

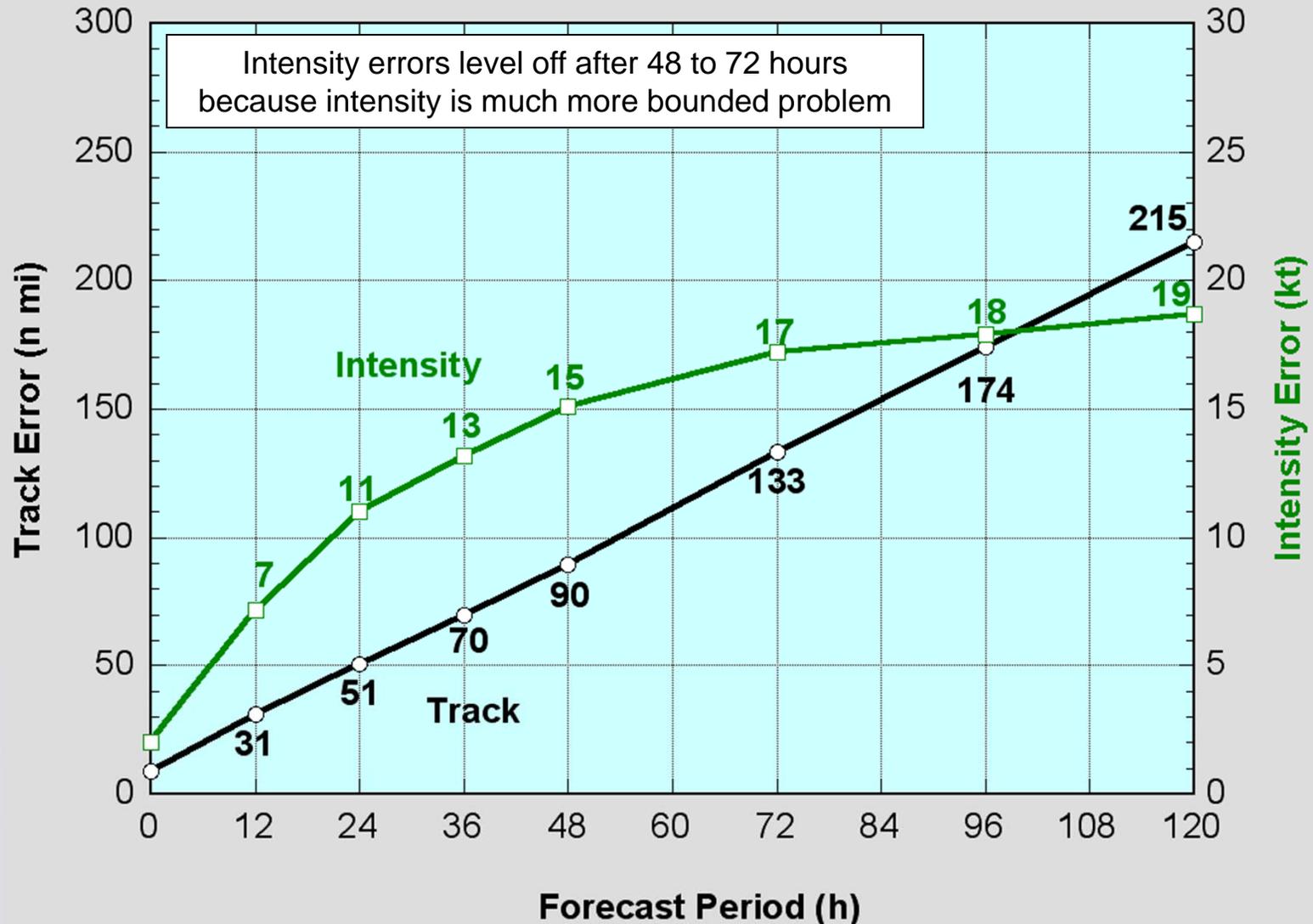


Along- and Cross-Track Errors

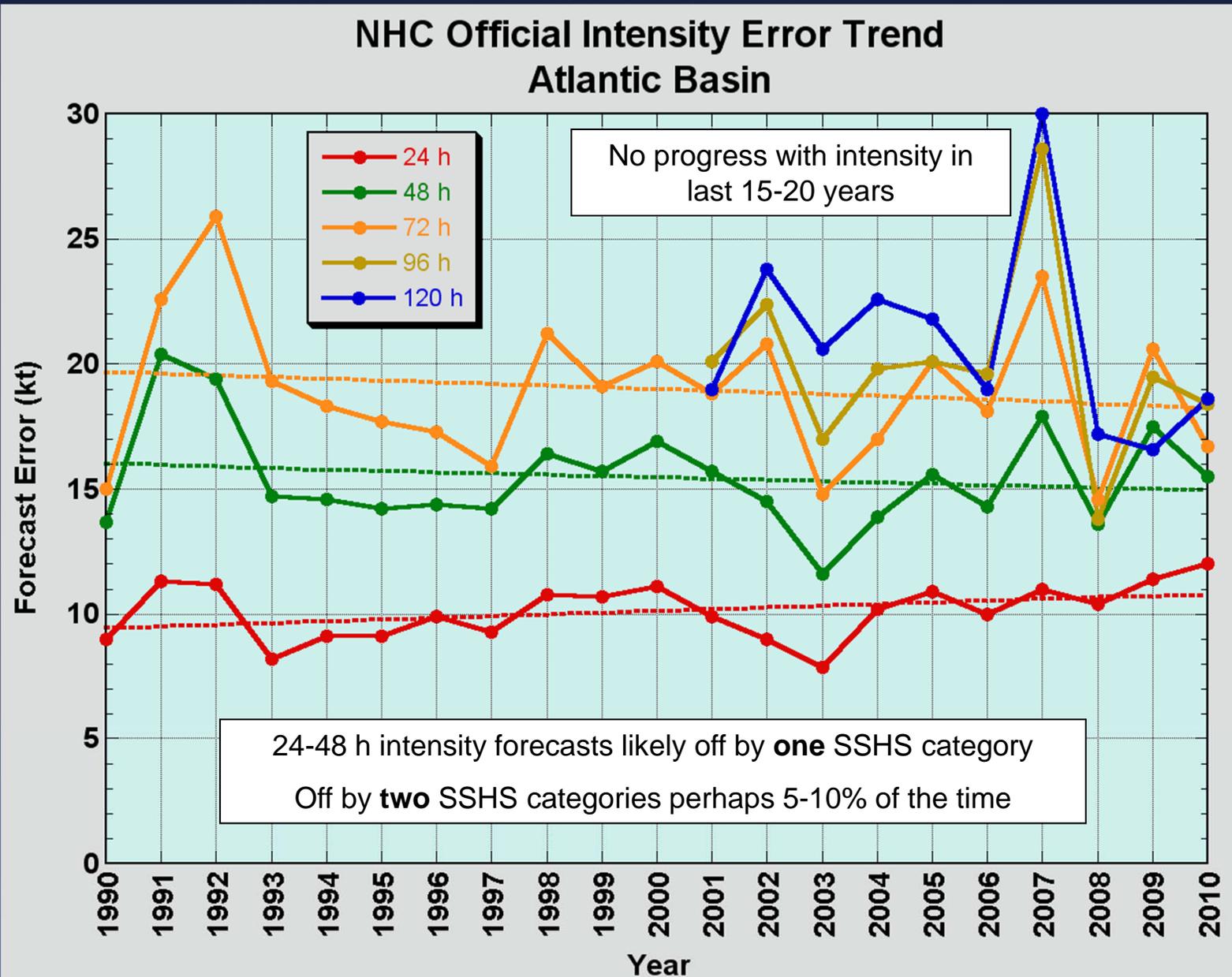


Atlantic 5-Year Mean Errors

NHC Official Five-Year (2006-10)
Mean Errors - Atlantic Basin

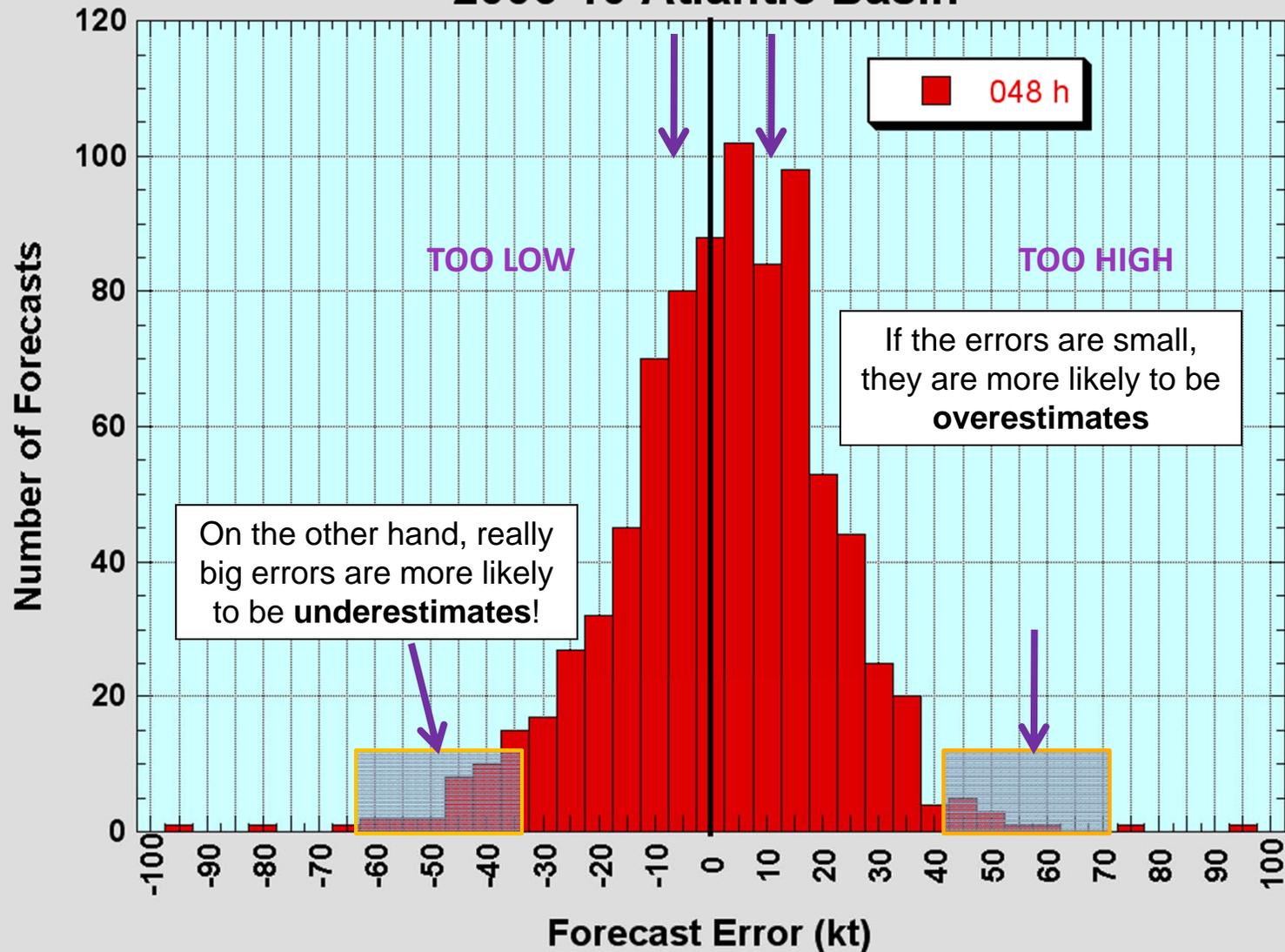


Atlantic Intensity Error Trends (1990-2010)



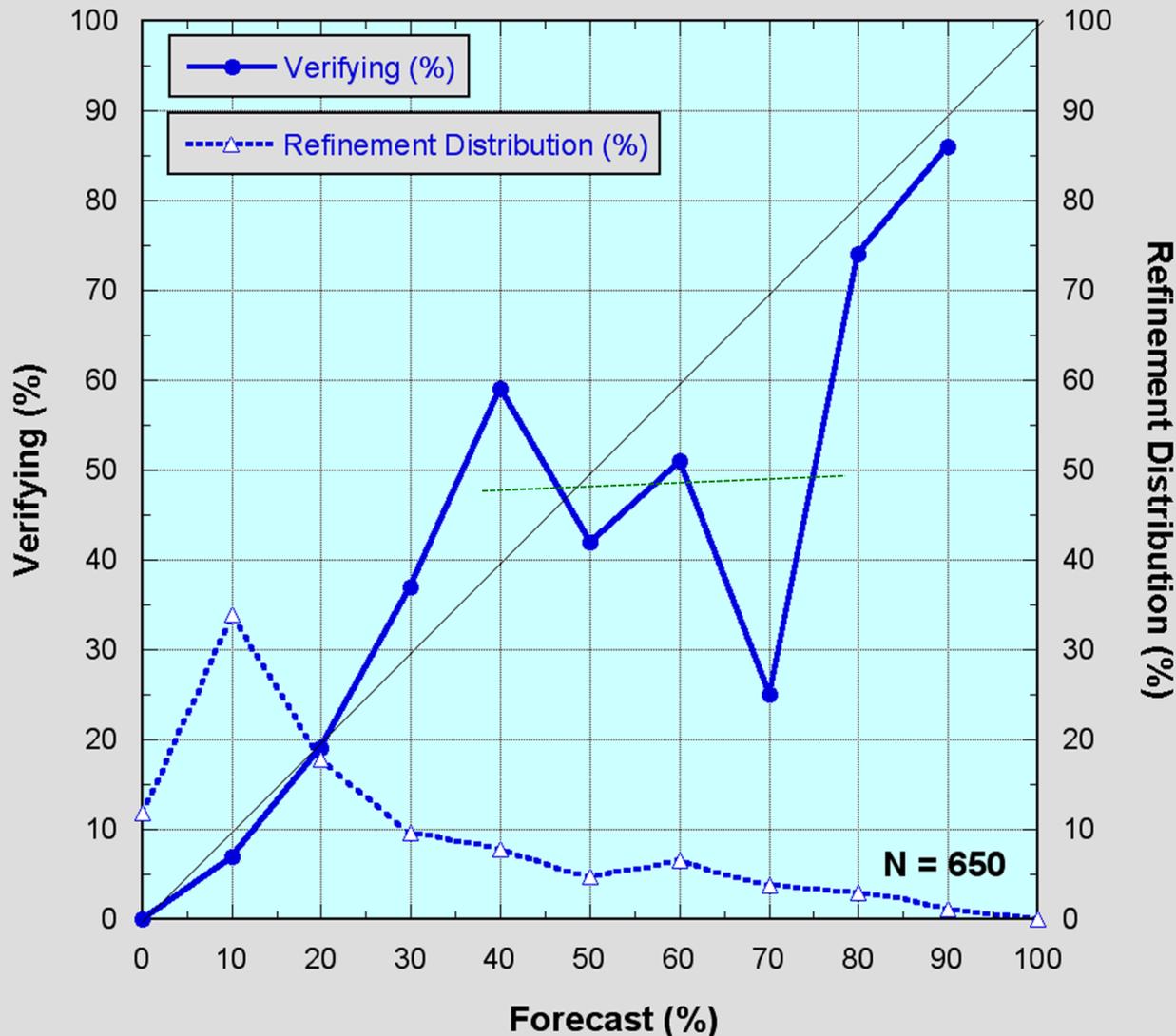
Intensity Error Distribution (48 h)

NHC Official Intensity Forecasts
2006-10 Atlantic Basin



Atlantic Genesis Forecasts

2010 OFCL 48-h Genesis Forecasts
Atlantic Basin

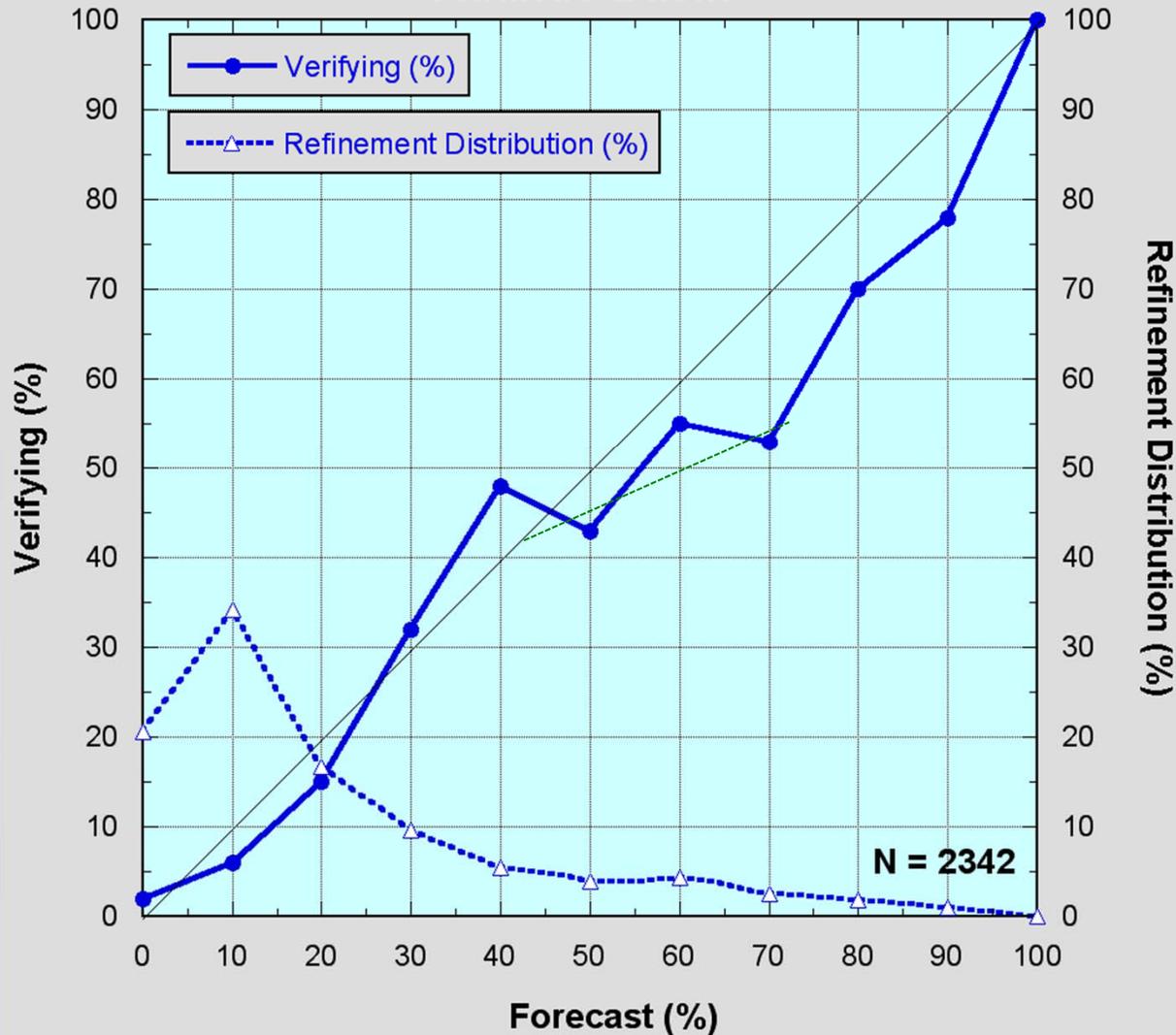


Forecasts at the high end and low end were very well calibrated (reliable) with minimal bias

However, this year's forecasts could not distinguish gradations in likelihood between 30% and 70%

Atlantic Genesis Forecasts

2007-2010 OFCL
48-h Genesis Forecasts
Atlantic Basin



Results for the 2007-2010 sample show some ability in the mid-range, but it's clearly an area that could be improved

Verification Web Page

National Hurricane Center Forecast Verification - Mozilla Firefox

http://www.nhc.noaa.gov/verification/

National Weather Service
National Hurricane Center

Home News Organization Search Go

Local forecast by "City, St" or "ZIP" Go

Alternate versions
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Experimental
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Audio/Podcasts
GIS Data | RSS
Help with Advisories

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Atlantic and E Pacific
Analysis Tools
Gridded Marine
Help with Marine

Hurricane Awareness
Be Prepared | Learn
Storm Surge
Frequent Questions
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Hurricane Hunters
Saffir-Simpson Scale
Forecasting Models
Glossary/Acronyms
Storm Names
Breakpoints

Hurricane History
Seasons Archive
Forecast Accuracy
Climatology
Most Extreme

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National Hurricane Center Forecast Verification

Updated 20 April 2010

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8. Performance measures and goals
9. References

1. Introduction

NHC receives frequent inquiries on the accuracy and skill of its forecasts and of the computer models available to it. To help answer these questions, these verification web pages were established in March 2005. The development of this resource will be completed in stages; ultimately all available records dating back to the earliest NHC forecasts in 1954 will be included. A digital database of NHC official track forecast errors has been constructed for the period 1970 to the present, and it is this period that is presented initially here. A digital database of intensity errors has been constructed dating back to 1990. These pages will be updated as extensions to the database are completed. Questions on NHC forecast verifications may be directed to James.Franklin@noaa.gov.

Note: A number of the documents included here are in PDF format. You may need to install the free [Acrobat® Reader](#) to view and print these documents.

Next: [Forecast verification procedures](#)

Quick Navigation Links:
[NHC Active Storms](#) - [Atlantic and E Pacific Marine](#) - [Storm Archives](#)
[Hurricane Awareness](#) - [How to Prepare](#) - [About NHC](#) - [Contact Us](#)

NOAA/ National Weather Service
National Centers for Environmental Prediction
National Hurricane Center
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Summary

- Atlantic basin track errors increase by 40–50 n mi per 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 substantially smaller in 2011, especially at days 4 and 5, due to 2005 season statistics dropping out of the sample
- Actual track forecast errors aren't quite circular about the forecast point
 - Along-track (timing) errors tend to be larger than the 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, but struggle with marginal systems in the 30-70% probability ranges