

National Hurricane Center Forecast Verification: Quantifying Forecast Uncertainty

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National Hurricane Center
Acknowledgement to James Franklin

Short Course on Tropical Weather
Going Deep into the Tropics and Oceans
23 June 2010



NHC Forecast Verification

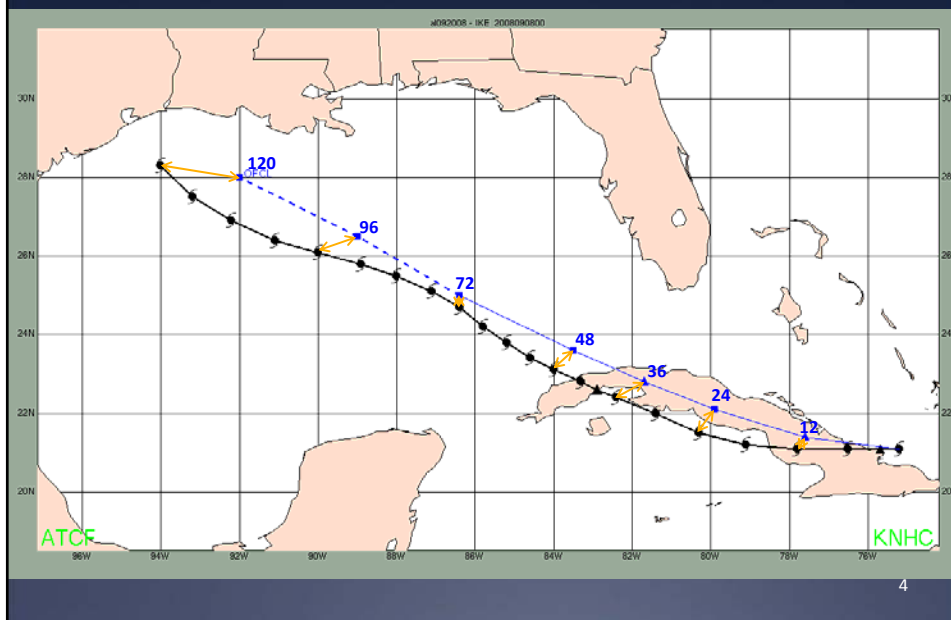
- NHC verifies all official tropical cyclone track and intensity forecasts each year
- Why verify forecasts?
 1. We have to monitor performance and progress
 - Government Performance and Results Act (GPRA)
 2. Understanding forecast errors help forecasters and modelers to reduce them
 3. Identify critical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

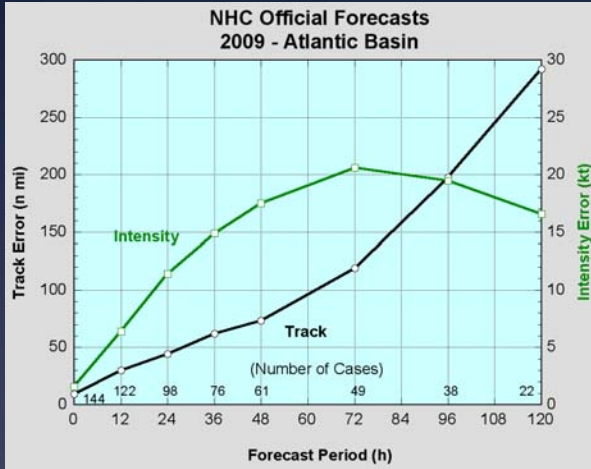
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Track Error Definition



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2009 Atlantic Verification



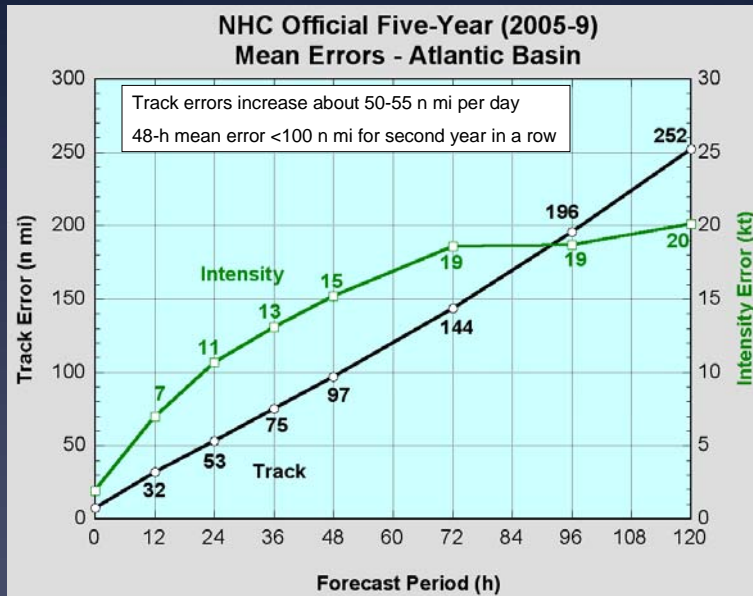
VT (h)	NT	TRACK (n mi)	INT (kt)
000	144	9.6	1.6
012	120	30.1	6.4
024	96	44.5	11.4
036	75	61.8	14.9
048	61	73.2	17.5
072	49	119.2	20.6
096	38	197.9	19.5
120	22	292.3	16.6

Values in red exceed all-time records

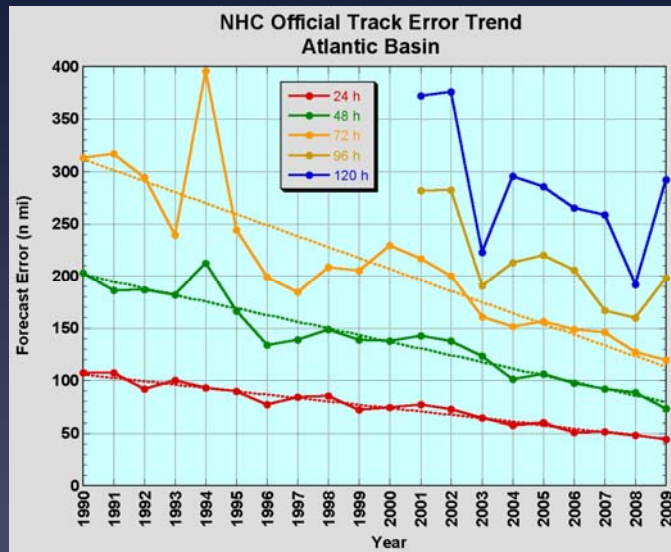
- Four- and five-day track error was almost exclusively along-track (slow)
- Sample was very small (last year 346 forecasts), and five-day sample is the smallest ever

Atlantic 5-Year Mean Track Errors

Track

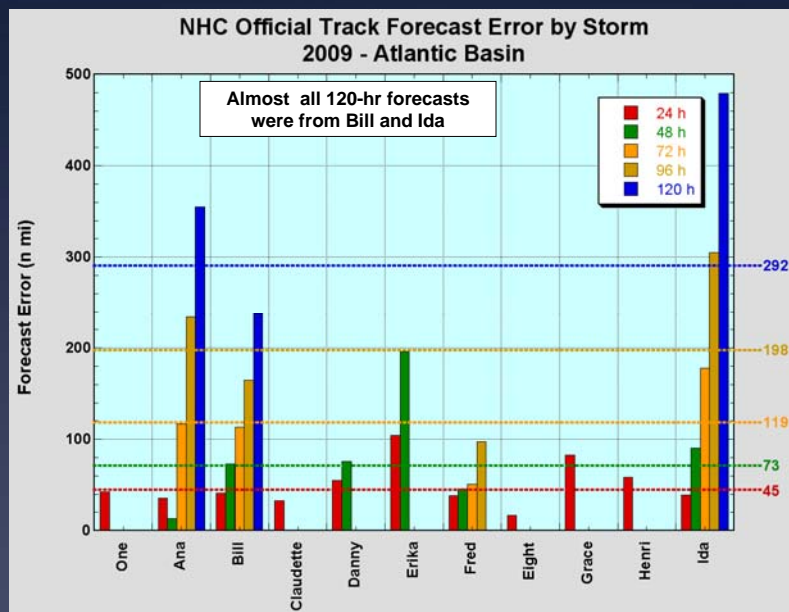


Atlantic Track Error Trends

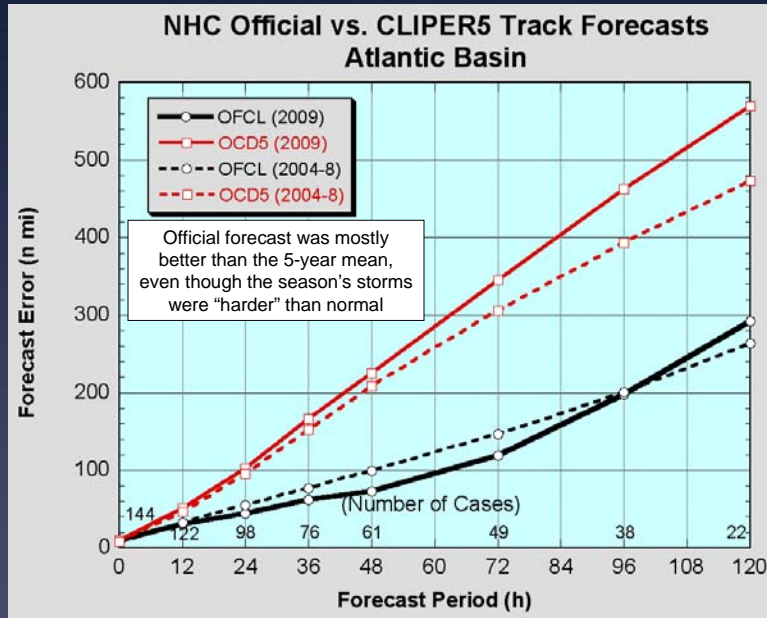


- Errors have been cut in half over the past 15 years
- 2009 was best year ever at 24-72 hours
- Trends more erratic at days 4 and 5 due to smaller samples

Atlantic Track Errors by Storm

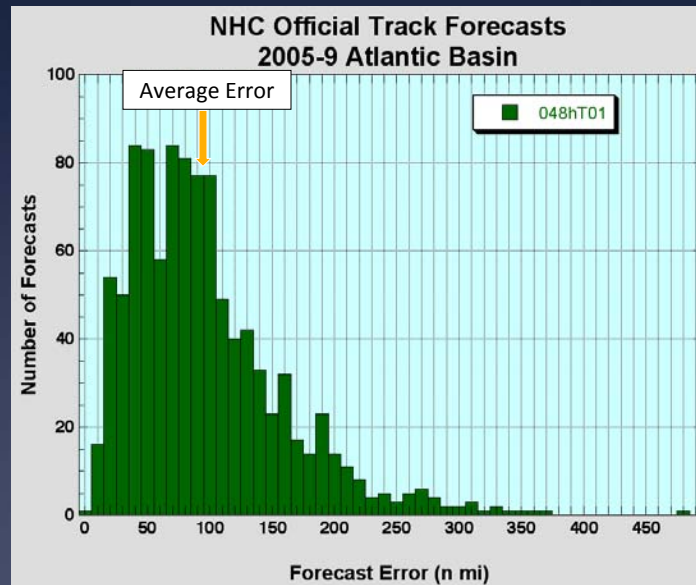


Atlantic Track Errors vs. 5-Year Mean



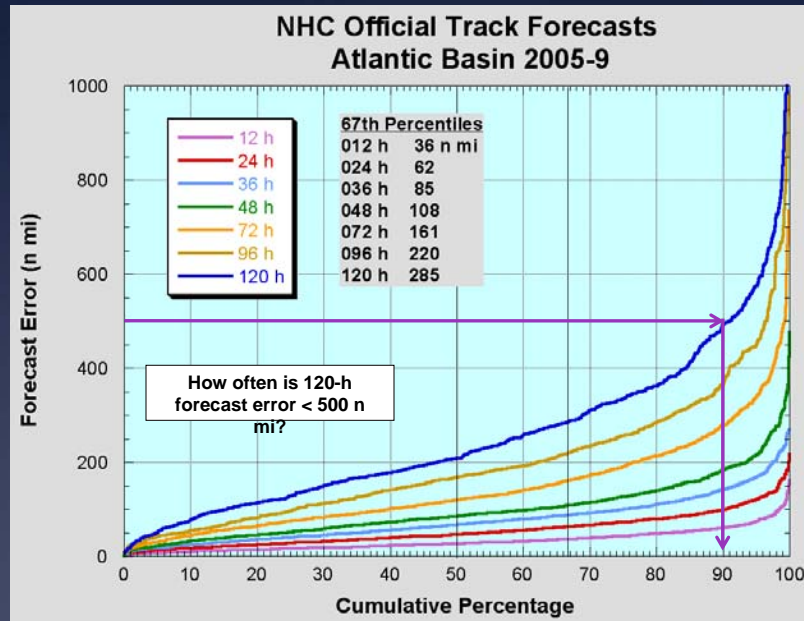
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Atlantic Track Error Distribution 48-hours



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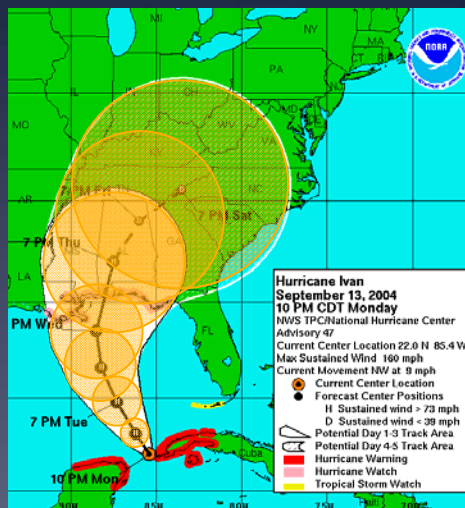
Forecast Error Distributions and Cone Radii



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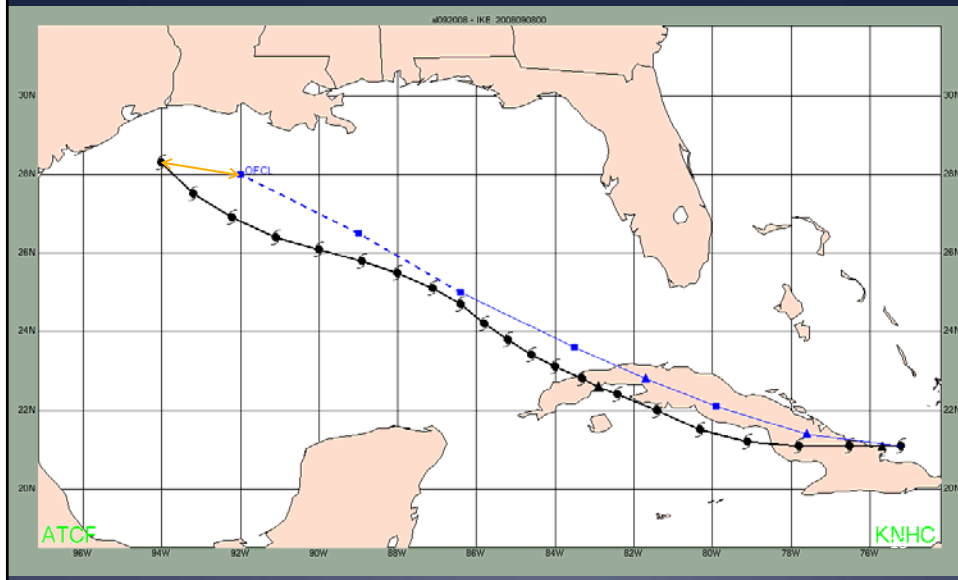
NHC Forecast Cone

- 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

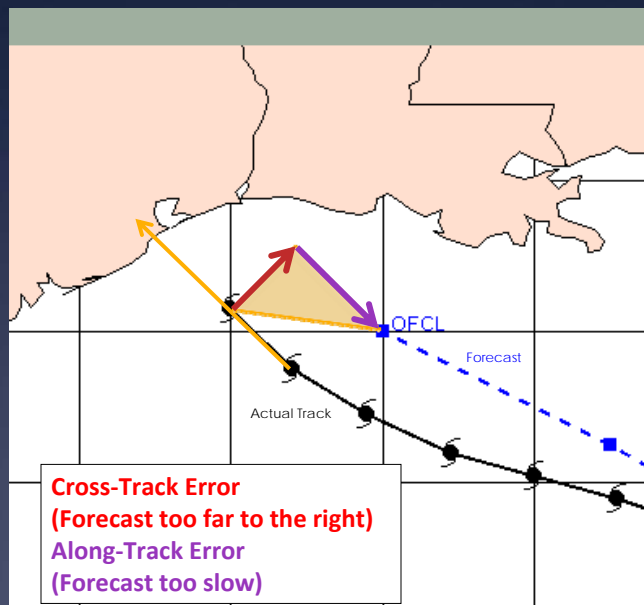


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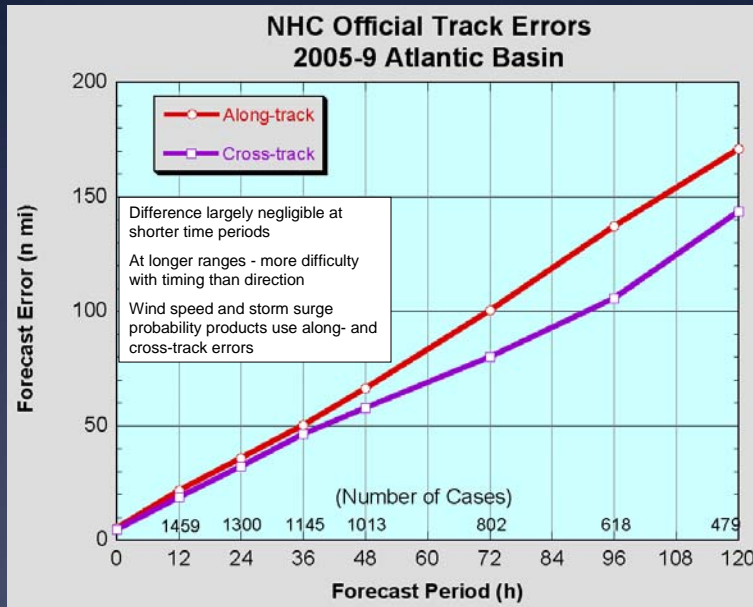
Along- and Cross-Track Errors (Timing vs. Location)



Along- and Cross-Track Errors



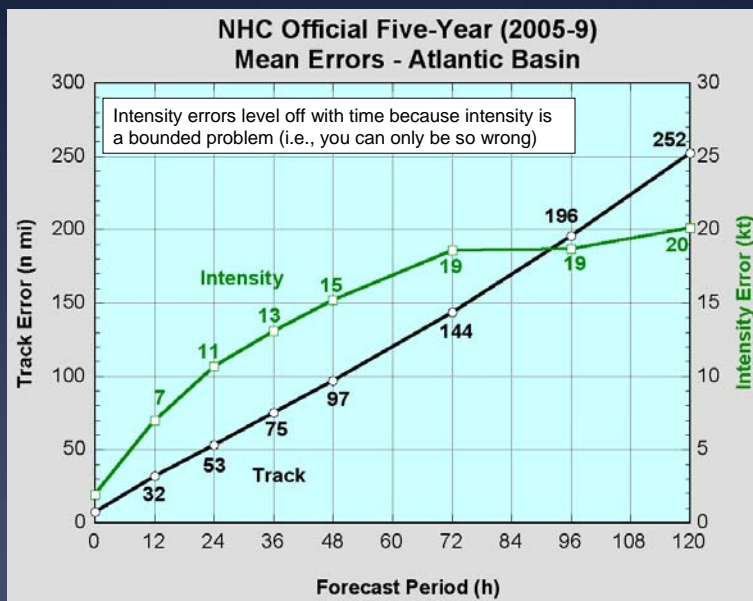
Along- and Cross-Track Errors



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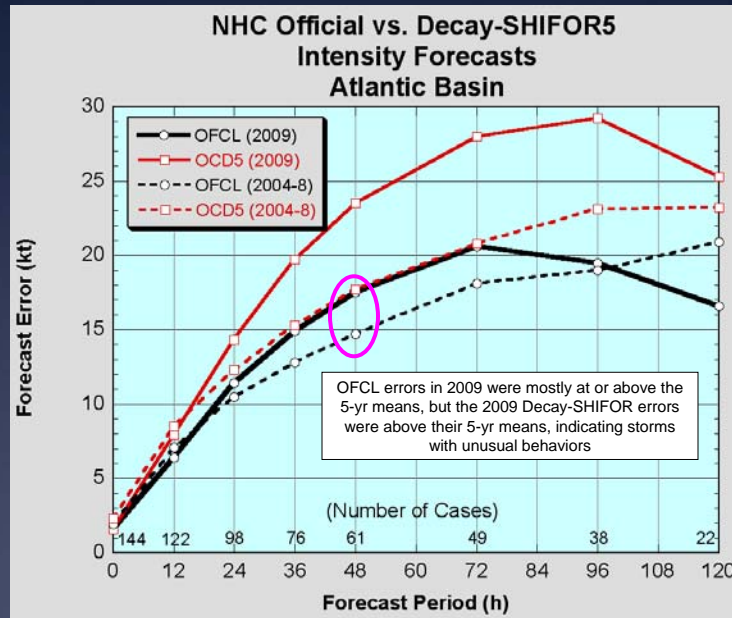
Atlantic 5-Year Mean Errors

Intensity



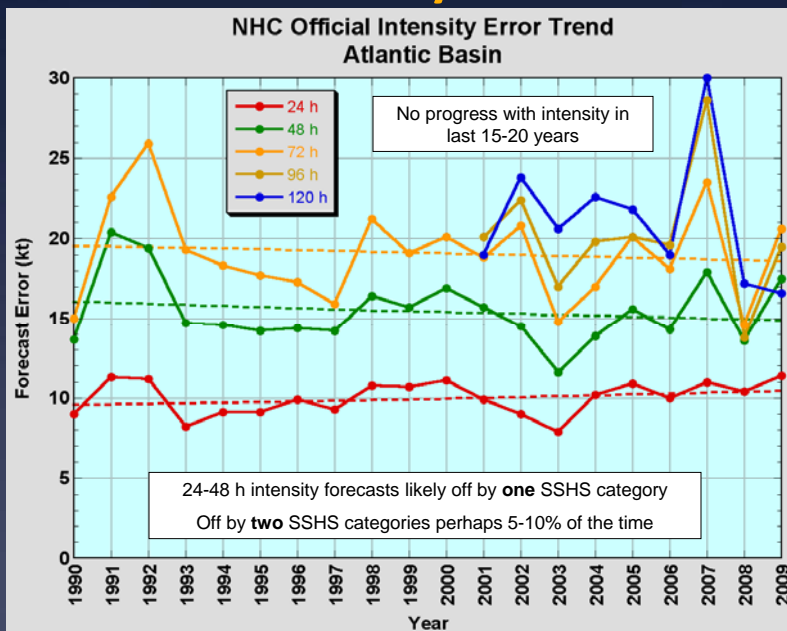
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Atlantic Intensity Errors vs. 5-Year Mean



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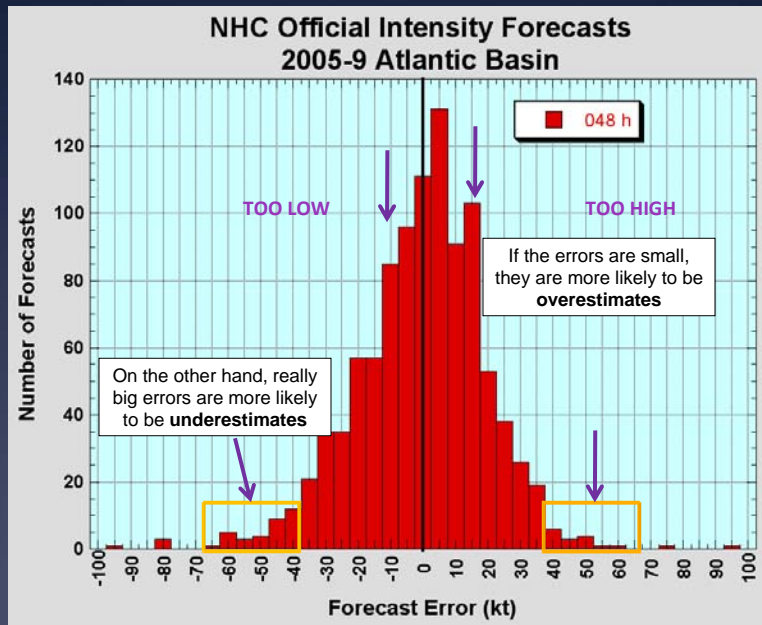
Atlantic Intensity Error Trends



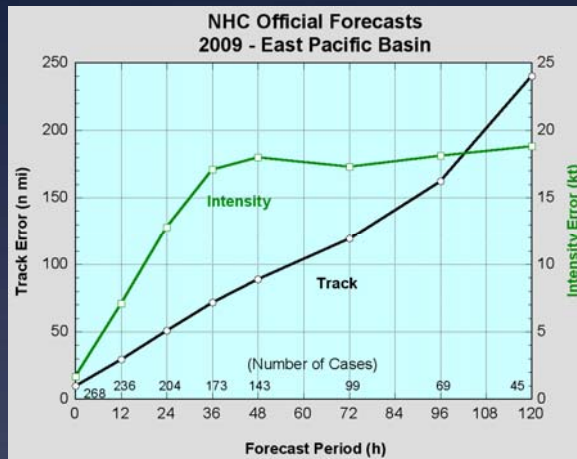
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Intensity Error Distribution

48-hours



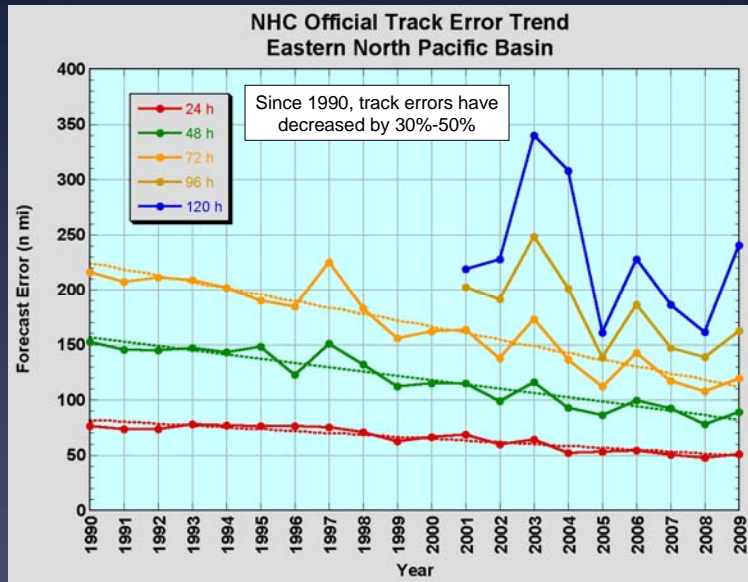
2009 East Pacific Verification



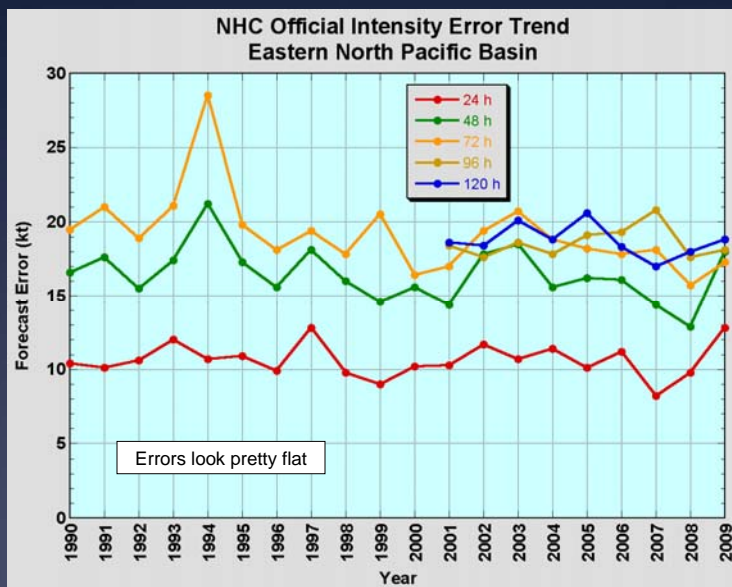
VT (h)	NT	TRACK (n mi)	INT (kt)
000	268	9.7	1.7
012	236	29.5	7.1
024	204	50.9	12.8
036	173	71.9	17.1
048	143	89.0	18.0
072	99	119.2	17.3
096	69	162.5	18.1
120	45	240.4	18.8

Values in red tied or exceeded all-time lows

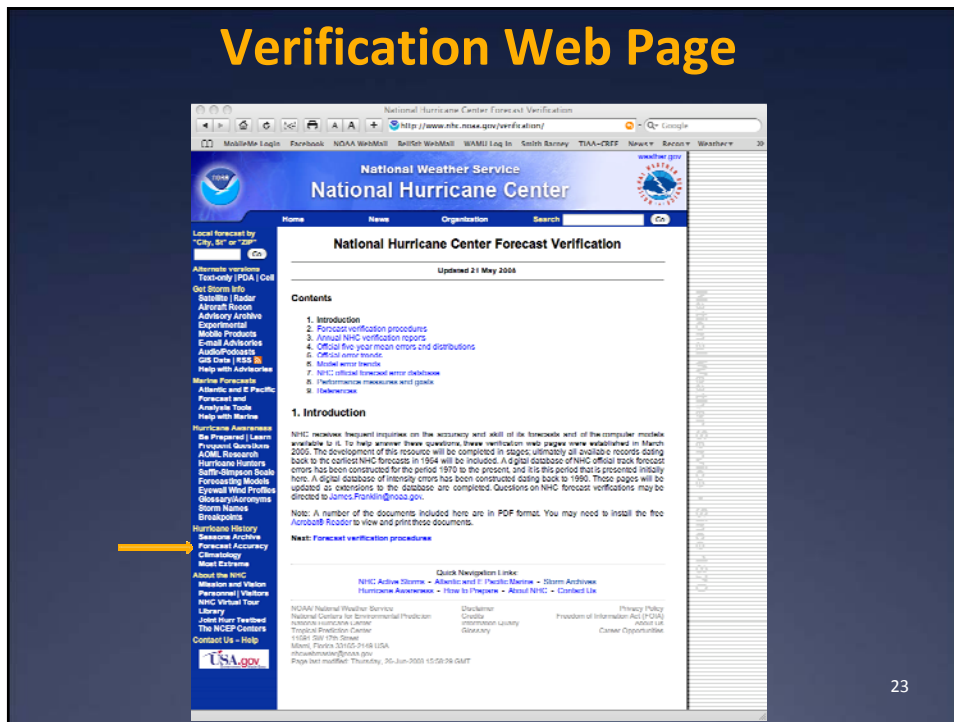
EPAC Track Error Trends



EPAC Intensity Error Trends



Verification Web Page



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Summary

- Atlantic basin track errors increase by about 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
- Actual errors aren't quite circular about the forecast point
 - Along-track (timing) errors tend to be larger than the cross-track (directional) errors

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Summary

- Intensity forecast errors at 24-48 h 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