Have We Reached the Limits of Predictability for Tropical Cyclone Track Forecasting?

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"This massive improvement in tropical cyclone track prediction in one generation is \textbf{the greatest accomplishment in the history of numerical weather prediction.}"

- Mike Fiorino - May 2011

- On reducing the 72 hr forecast error in the Atlantic from 310 down to 130 nm
NHC Official Track Error Trend
Atlantic Basin

- Red circles: 24 h
- Orange circles: 72 h
- Blue circles: 120 h

Forecast error (n mi)

Year

Linear best fit
NHC Official Track Error Trend
Atlantic Basin

Forecast error (n mi)

Year


24 h
72 h
120 h

Linear best fit
Latest five year (2012-2016) trends – Atlantic Basin

*Atlantic Errors*

- 24 hr – Flatter than 19 of previous 23 5-yr periods
- 72 hr – Flatter than 16 of 23
- 120 hr – Flatter than 9 of 12
Latest five year (2012-2016) trends – Northeast Pacific Basin

Northeast Pacific Errors

- 24 hr – Flatter than 13 of previous 23 5-yr periods
- 72 hr – Flatter than 9 of 23
- 120 hr – Flatter than 9 of 12
Latest five year (2012-2016) trends – Atlantic Basin

*Atlantic Skill*

- 24 hr – Flatter than 22 of previous 23 5-yr periods
- 72 hr – Flatter than 17 of 23
- 120 hr – Flatter than 7 of 12
Latest five year (2012-2016) trends – Northeast Pacific Basin

*Northeast Pacific Skill*

- 24 hr – Flatter than 14 of previous 23 5-yr periods
- 72 hr – Flatter than 19 of 23
- 120 hr – Flatter than 10 of 12
Theoretical Limits of Predictability

2.5 Day Timescale for Doubling of Errors
- Aberson (1998)

Fig. 5. The predictability timescale for tropical cyclone tracks in the North Atlantic ($m = 2$ to 14). The values of $1/K$ do not change as $m$ increases, giving the value of the timescale of about 2.5 days.
Theoretical Limits of Predictability

2.5 Day Timescale for Doubling of Errors
- Aberson (1998)

40 hr Timescale for Doubling of Errors
- Plu (2011)

Fig. 5. The predictability timescale for tropical cyclone tracks in the North Atlantic ($m = 2$ to 14). The values of $1/K_2$ do not change as $m$ increases, giving the value of the timescale of about 2.5 days.
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• Using theoretical and empirical evidence, it appears that we may soon be reaching the limits of predictability
• If so, important to convey this expectation to tropical cyclone forecast users
• Going forward, research focus should be on improving forecasts of intensity, structure, and impacts (wind, flooding rain, surge, tornadoes) presented primarily probabilistically