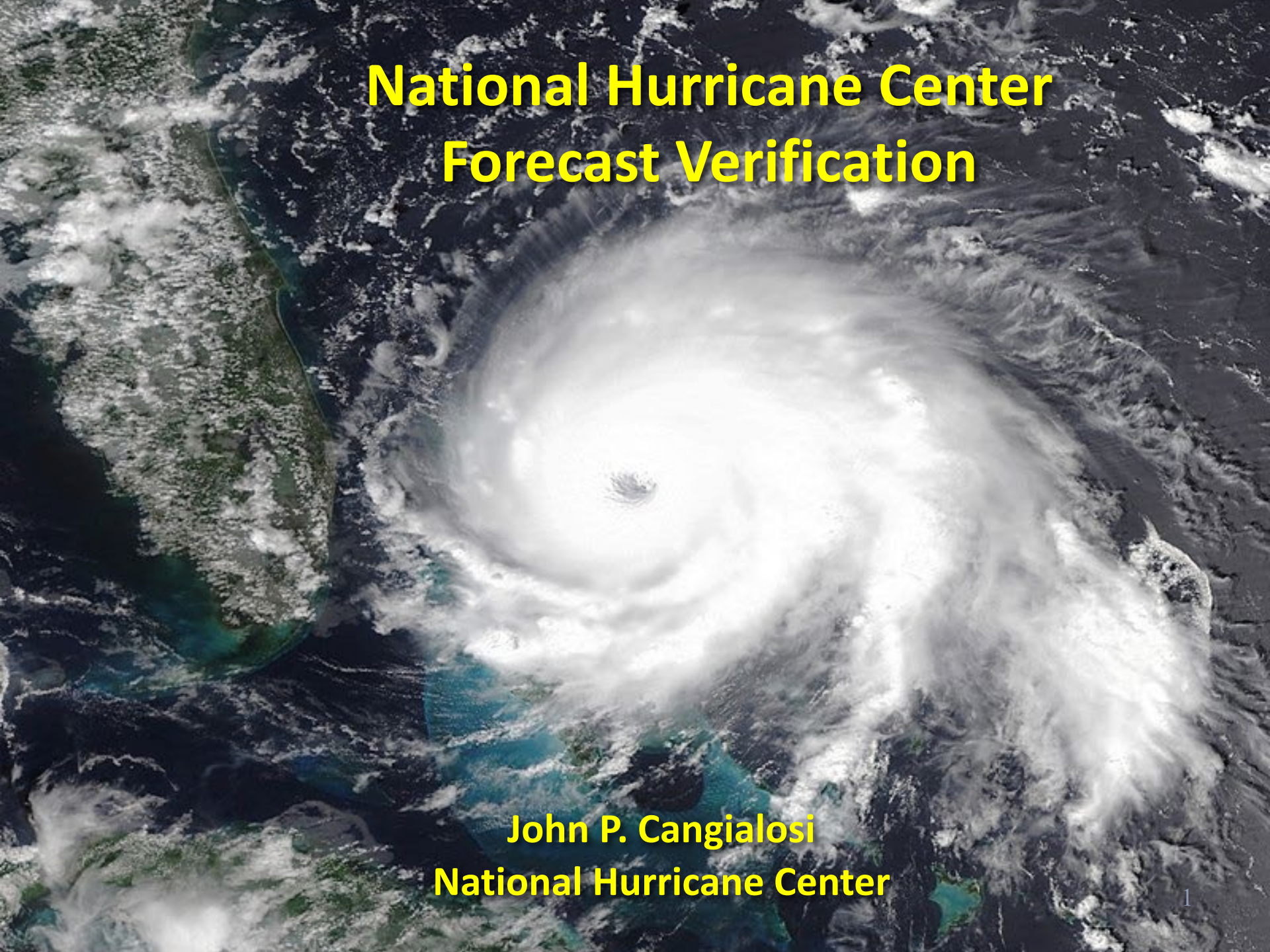


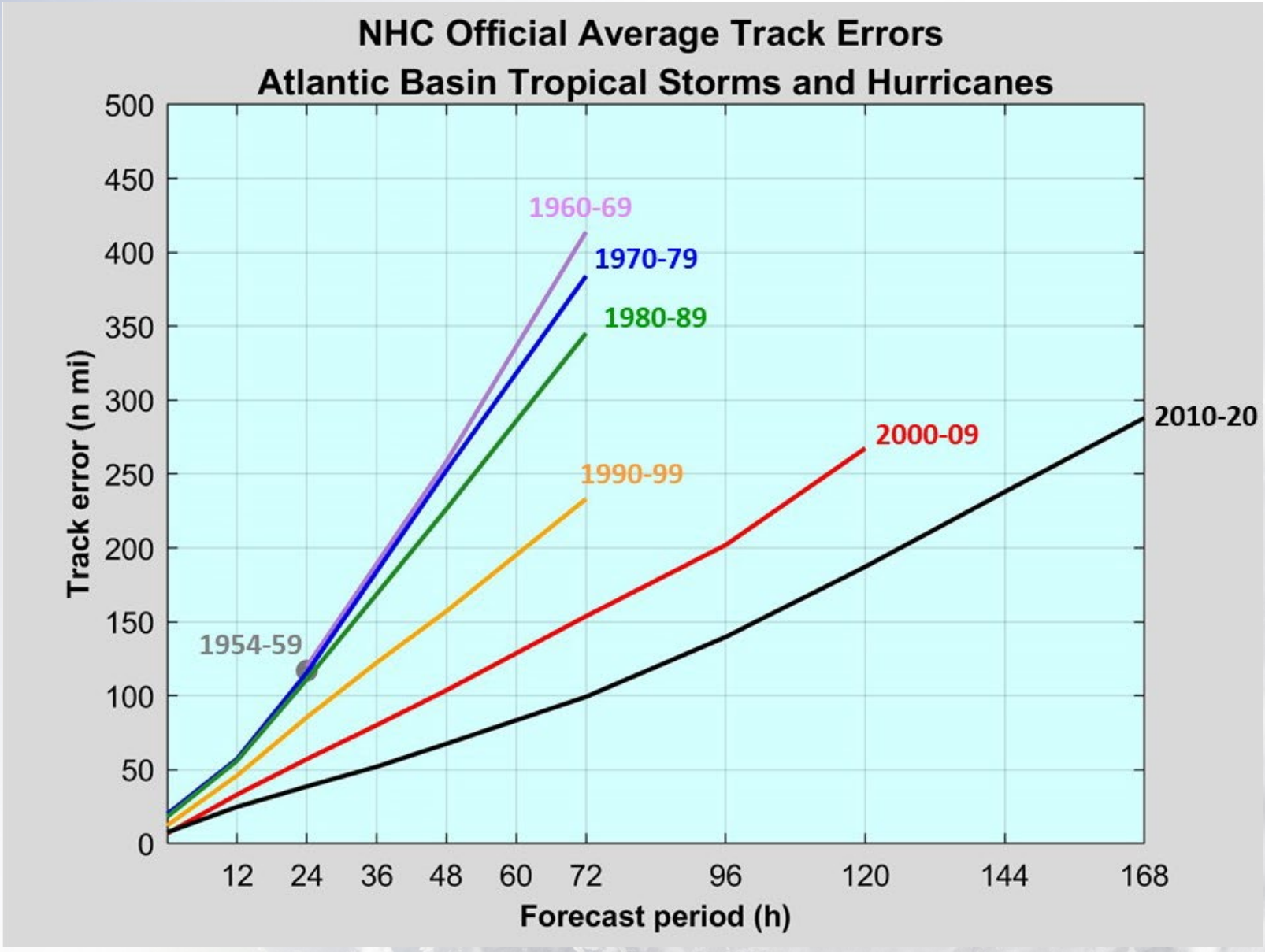
National Hurricane Center Forecast Verification

John P. Cangialosi
National Hurricane Center

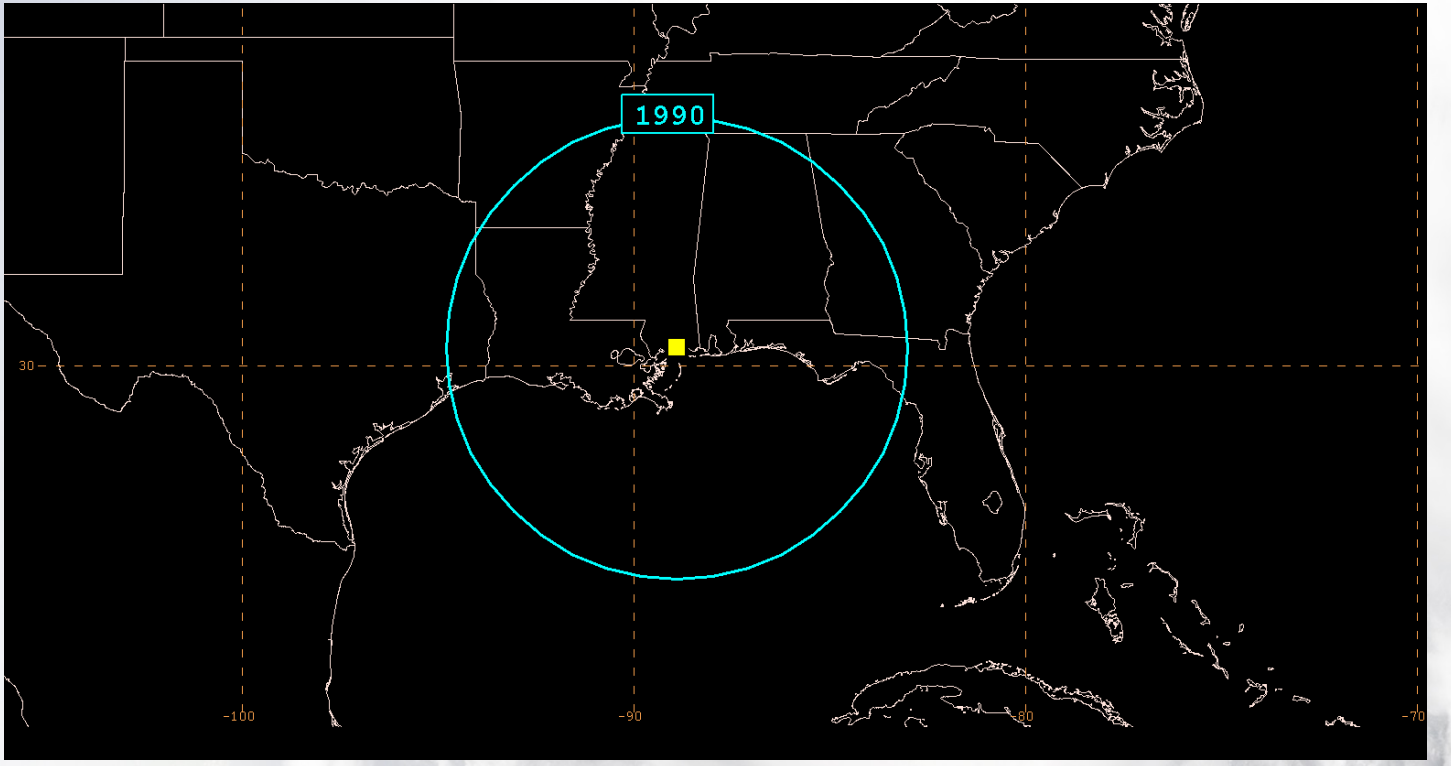
Accuracy of NHC Forecasts

- Track (how far off - east/west, north/south)
- Intensity (was the prediction too strong or too weak)
- Compare NHC forecasts against the models and look at long-term trends.

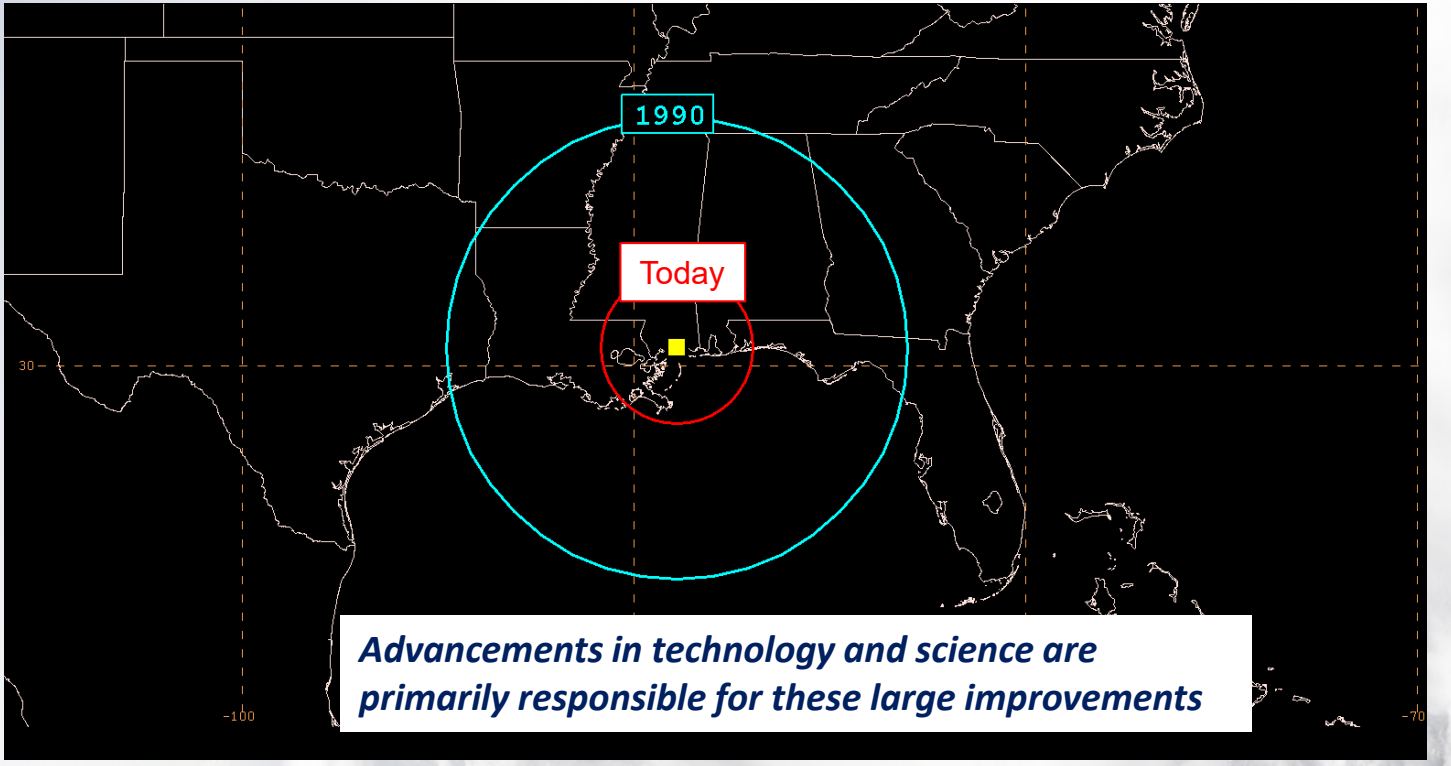
Atlantic Track Error Trends



3-day NHC Average Track Error

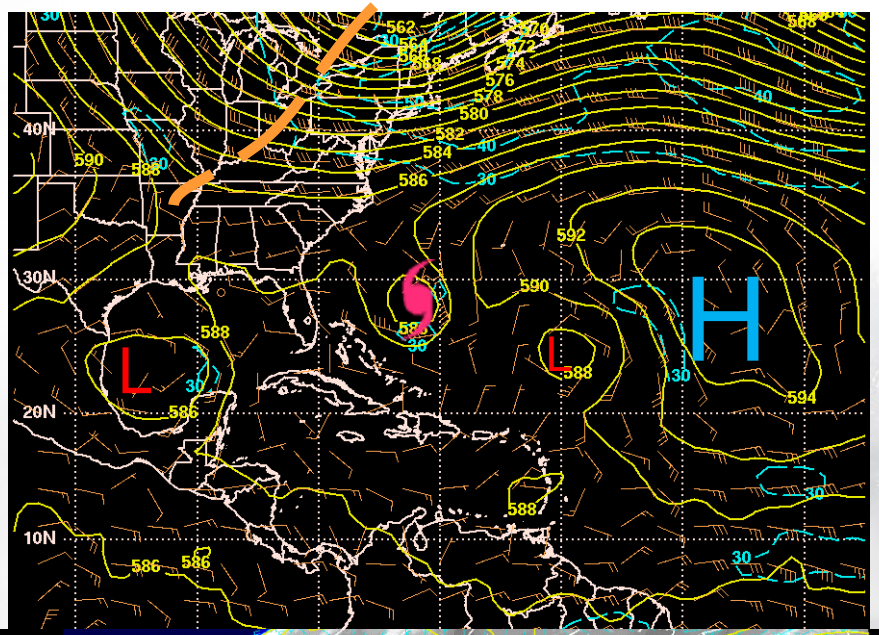


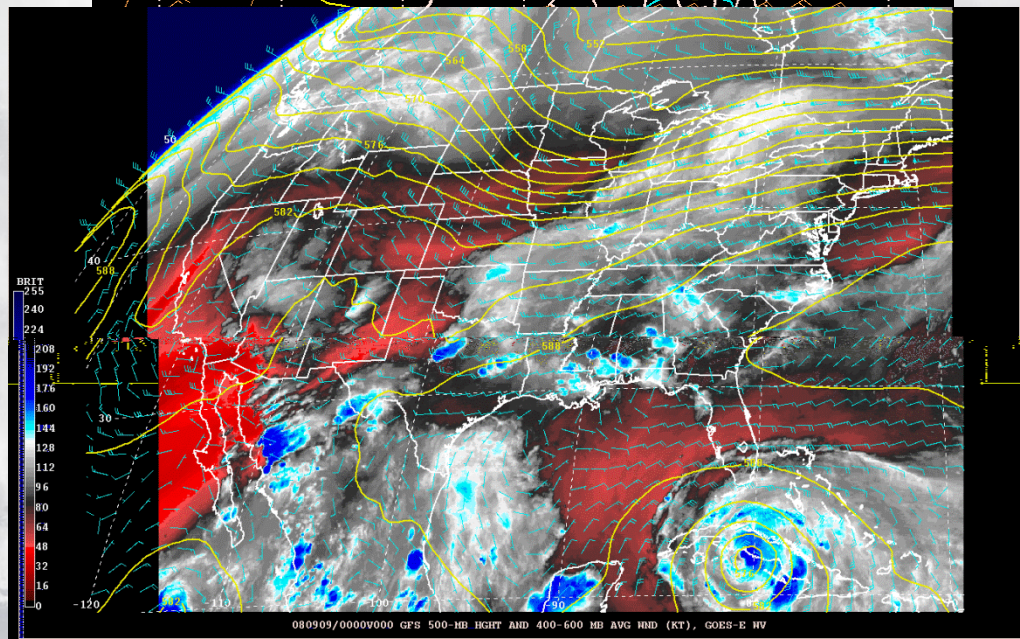
3-day NHC Average Track Error



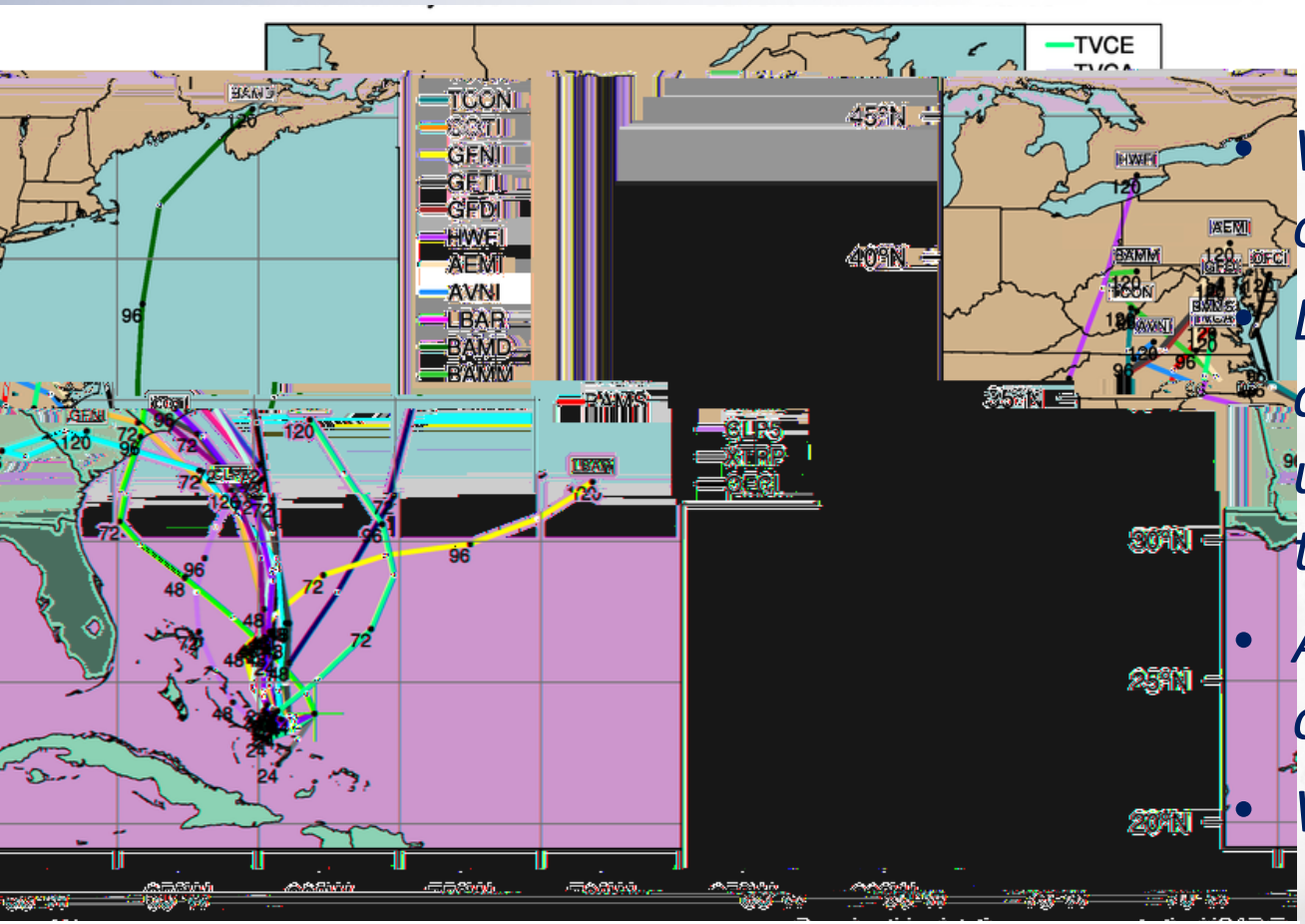
Tropical Cyclone Motion

- Track forecasting is a relatively simple problem with well-understood physics
  - Cork in stream analogy
- Important atmospheric features are relatively large and easy to measure
- Numerical computer models forecast track quite well
  - Constantly improving with upgrades to model physics and resolution
  - Long ago surpassed statistical models in accuracy





Track Models

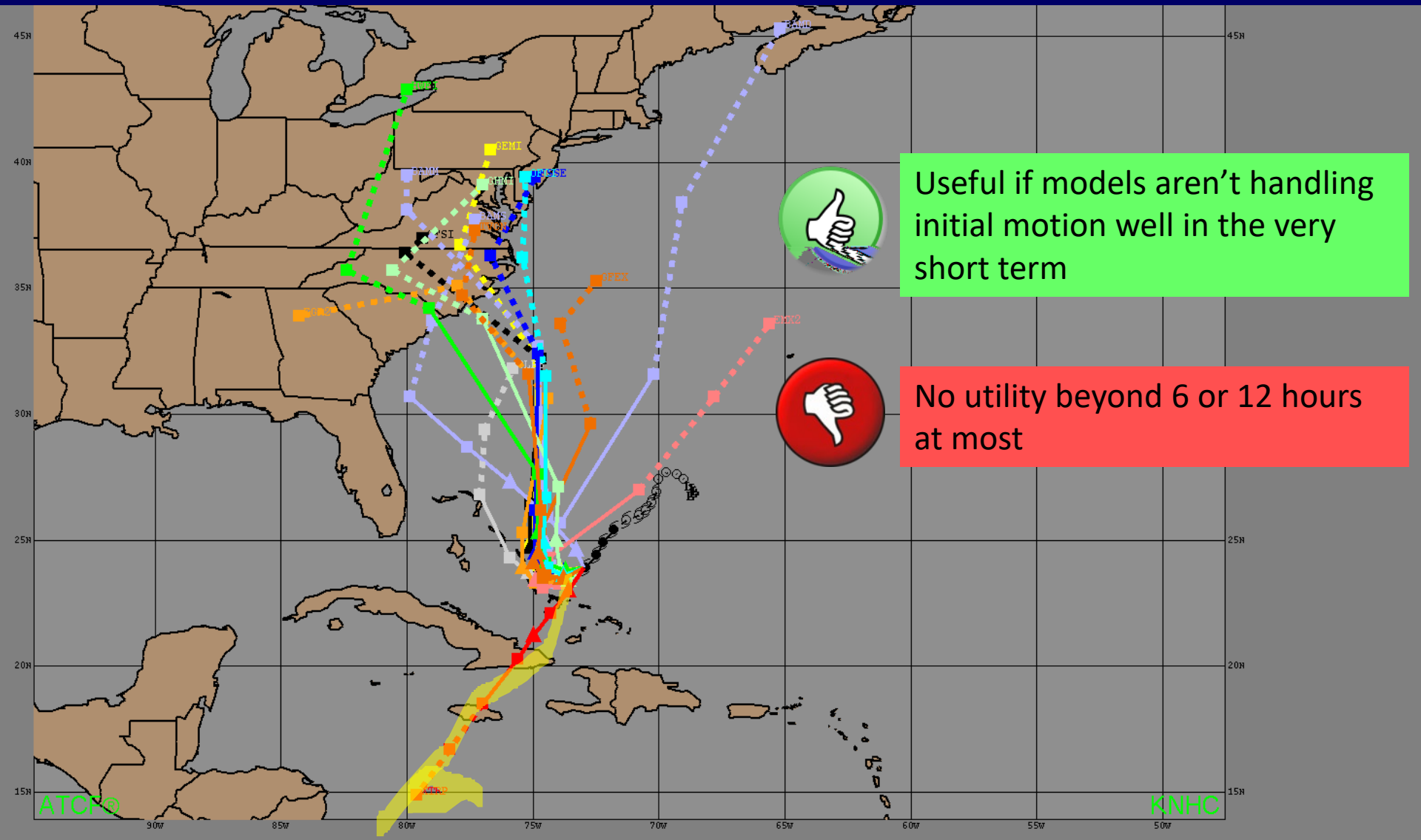


- *What does this set of lines represent?*
- *Do they accurately convey the uncertainty in the track forecast?*
- *Are they all created equal?*
- *What's missing?*

MAJOR HURRICANE JOAQUIN (AL11)

Tropical Cyclone Models

Extrapolated Motion

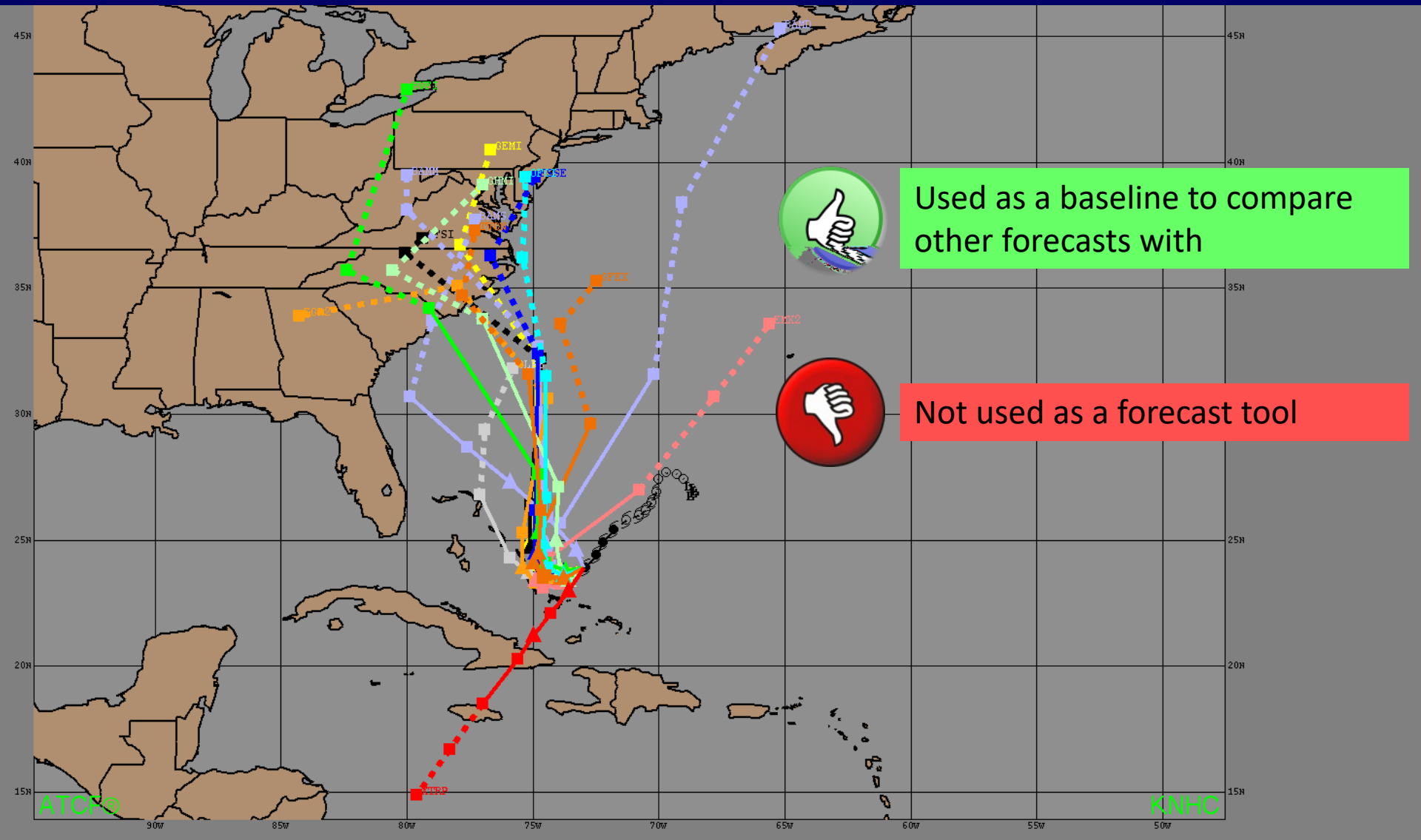


Useful if models aren't handling initial motion well in the very short term

No utility beyond 6 or 12 hours at most

Tropical Cyclone Models

Climatology and Persistence

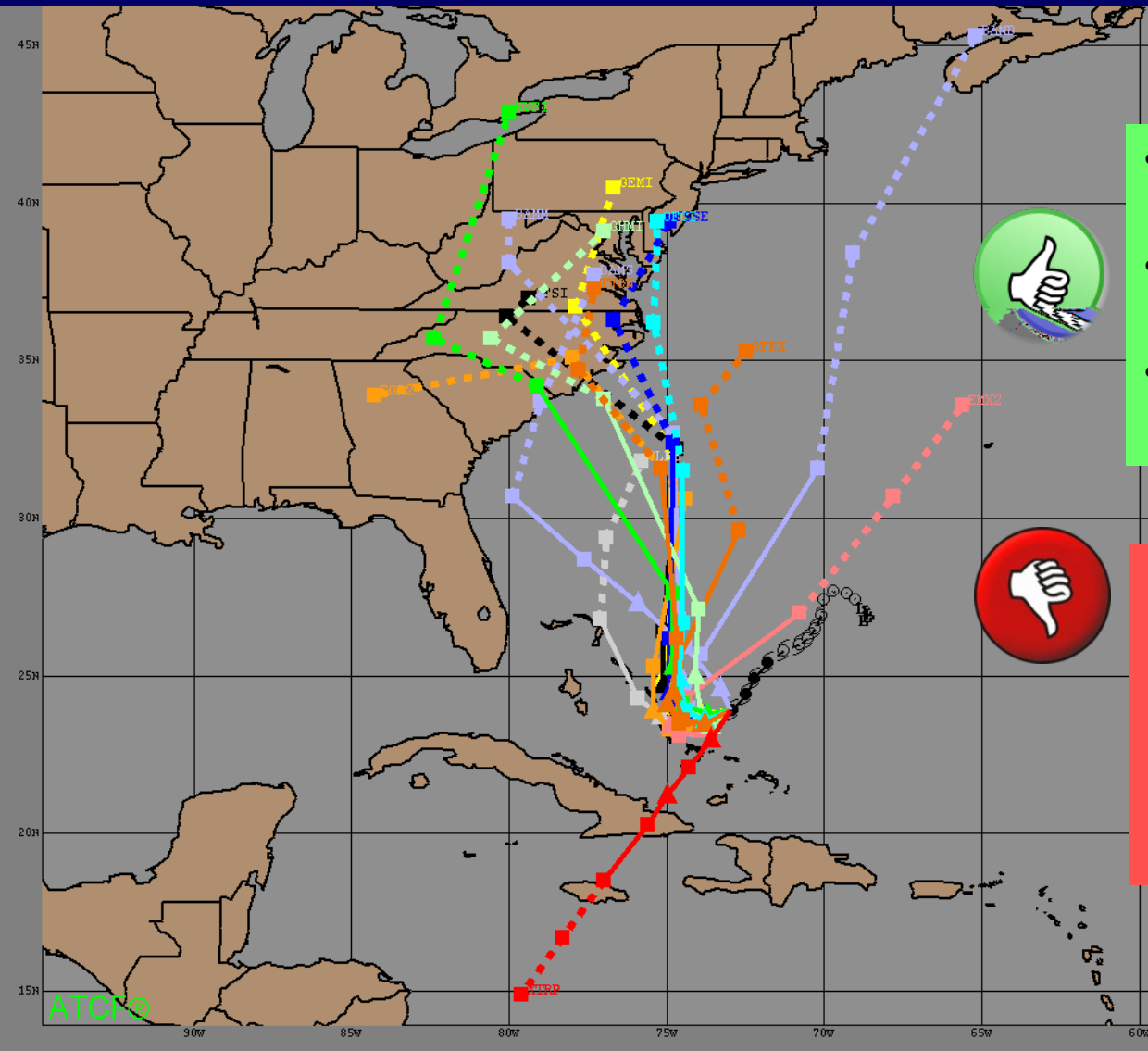


Used as a baseline to compare other forecasts with

Not used as a forecast tool

Tropical Cyclone Models

Global Models

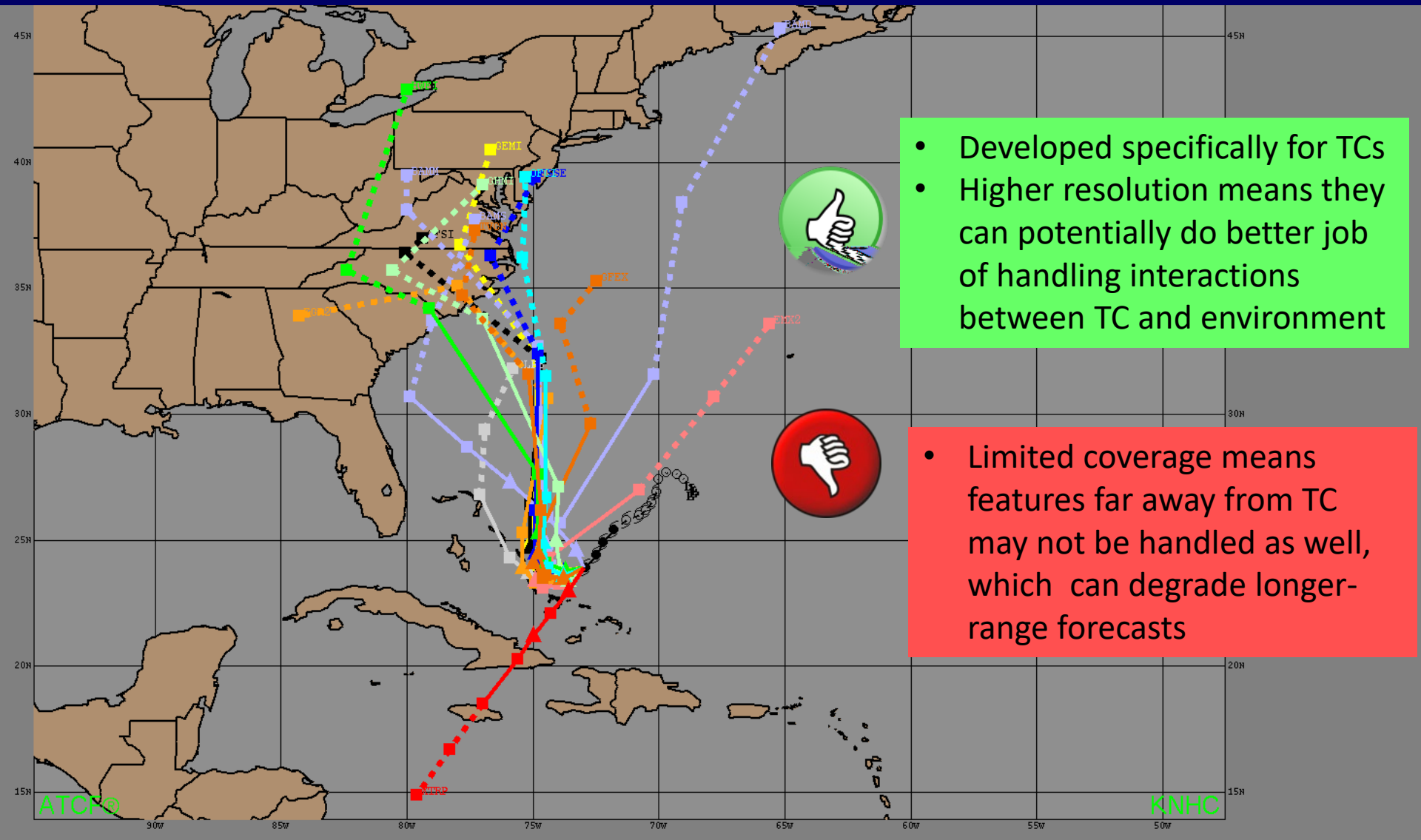


- Best forecast models for TC track
- Developed for general weather forecasting
- Handle large-scale pattern and steering flow well

- Can't see details of TC inner core
- Sometimes struggle with storm structure and intensity, which can affect track forecasts

Tropical Cyclone Models

Regional Hurricane Models

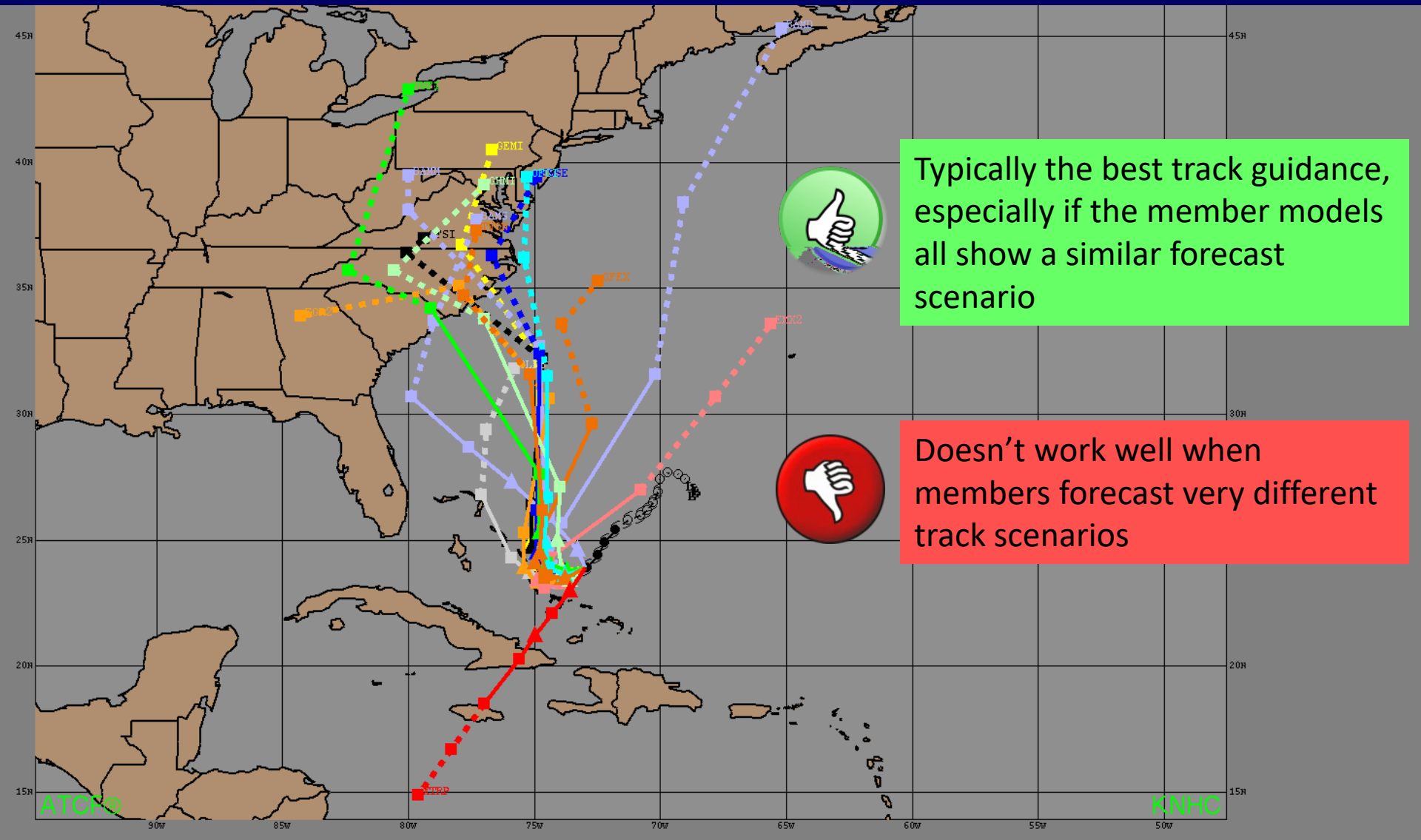


- Developed specifically for TCs
- Higher resolution means they can potentially do better job of handling interactions between TC and environment

- Limited coverage means features far away from TC may not be handled as well, which can degrade longer-range forecasts

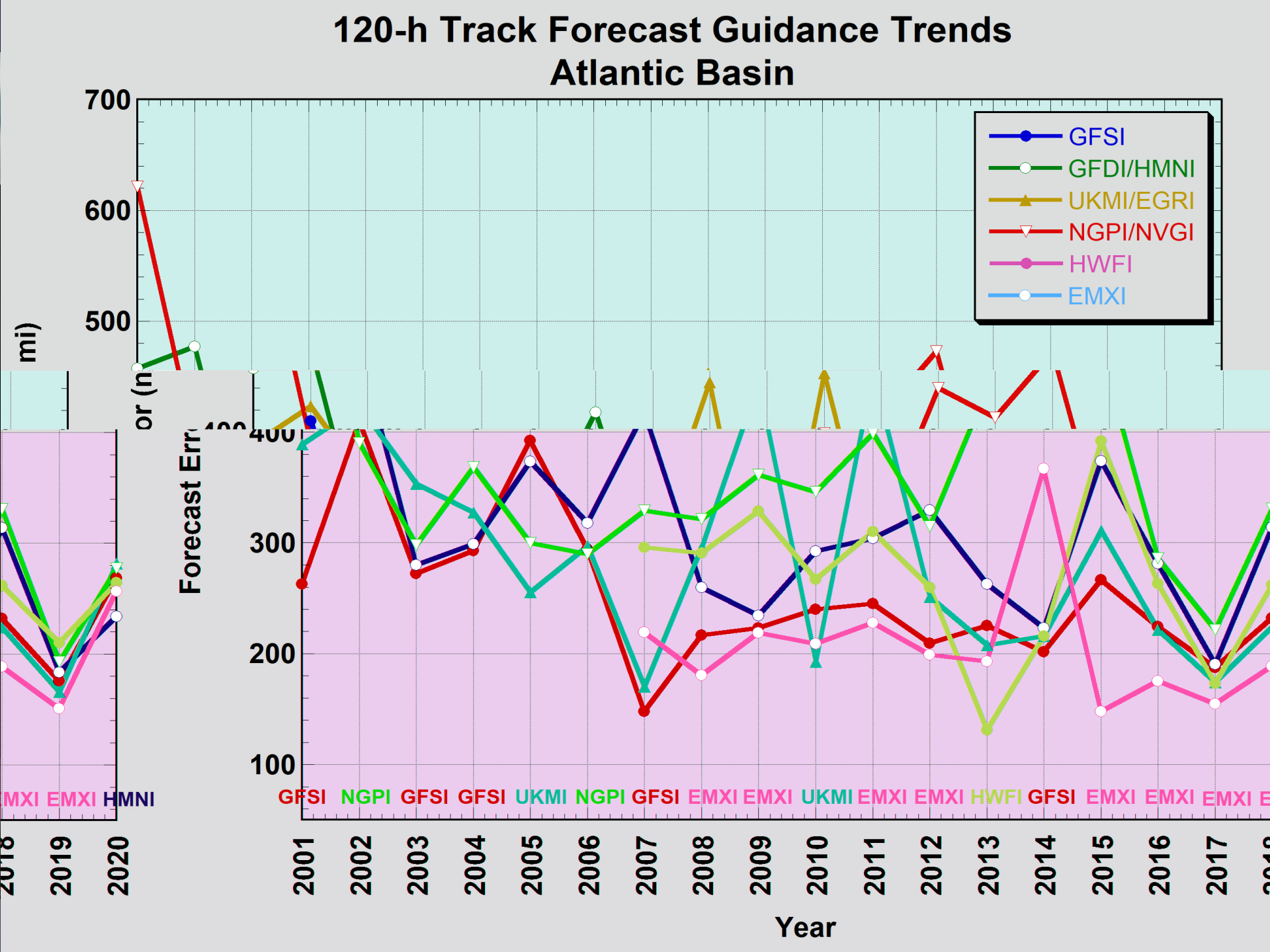
Tropical Cyclone Models

Consensus Models

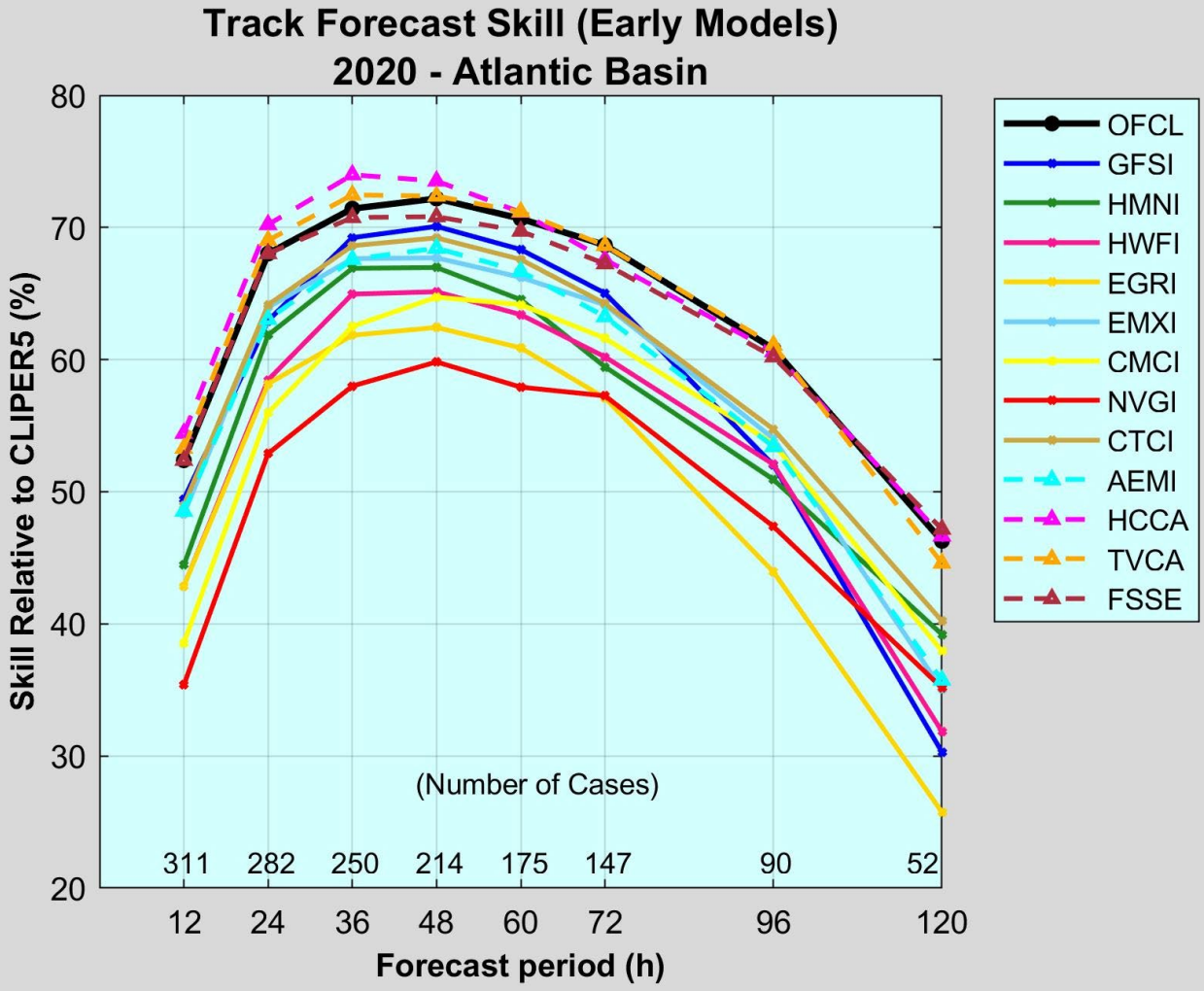


Questions

Which model is the best one?
Which one should you use?


120-h Track Forecast Guidance Trends
Atlantic Basin
GFSI
GFDI/HMNI
UKMI/EGRI
NGPI/NVGI
HWFI
EMXI
Forecast Error (nmi)
700
600
500
400
300
200
100
GFSI NGPI GFSI GFSI UKMI NGPI GFSI EMXI EMXI UKMI EMXI EMXI HWFI GFSI EMXI EMXI EMXI E
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
MXI EMXI HMNI
2018
2019
2020

2020 Track Guidance



Official forecasts were very skillful and were near best performing models, the consensus aids (FSSE, HCCA, TVCA).

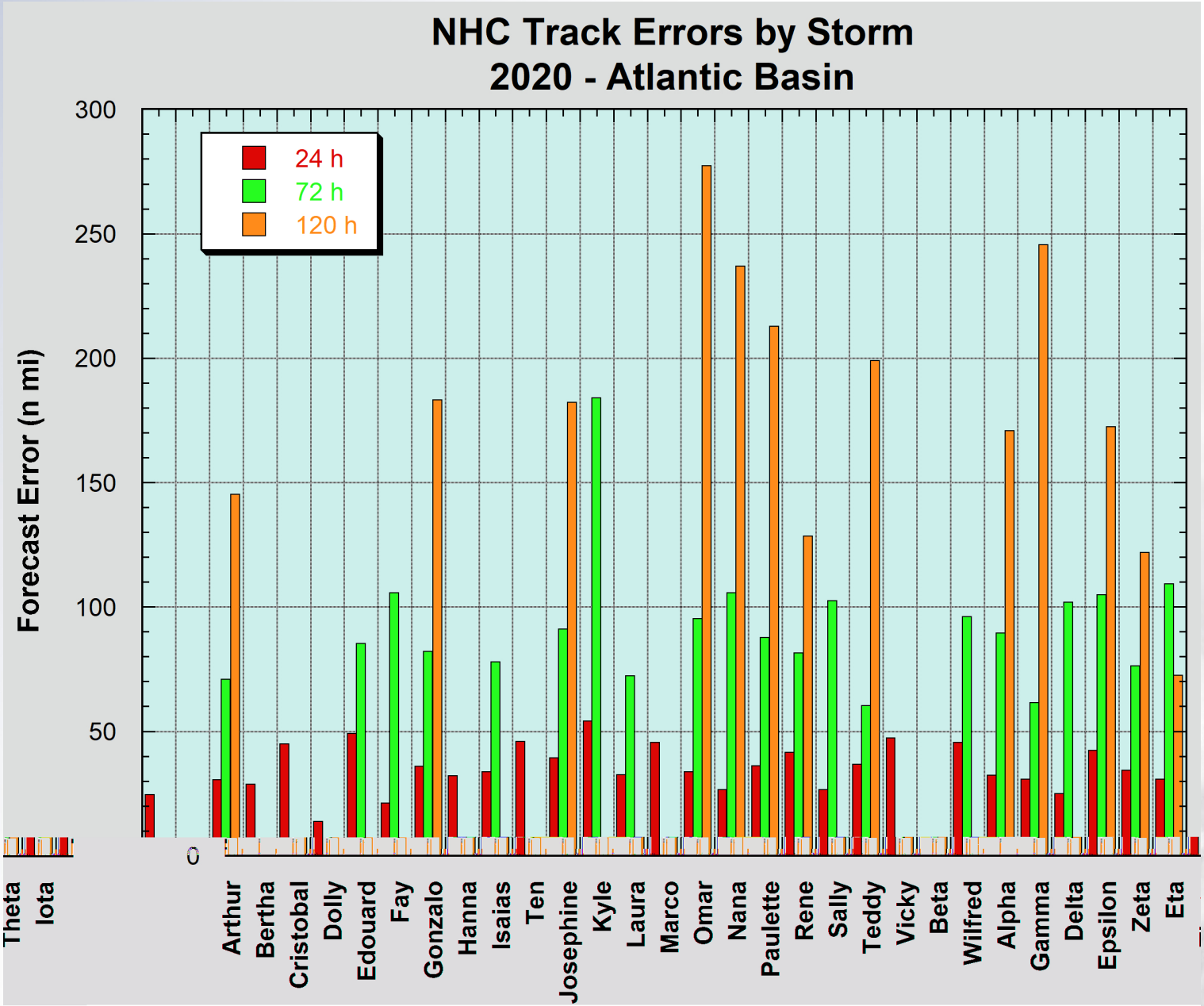
***GFSI** best individual model, from 36 – 72 h.*

AEMI, EMXI, HMNI, CTCI, close to one another.

HWFI and CMCI were next best models.

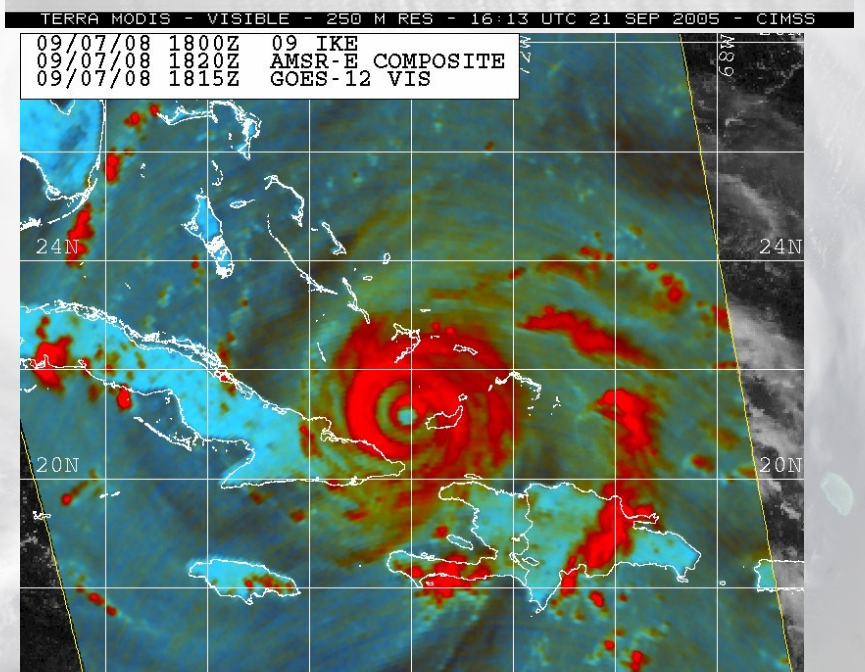
NVGI, EGRI trailed

2020 NHC Track Errors by Storm

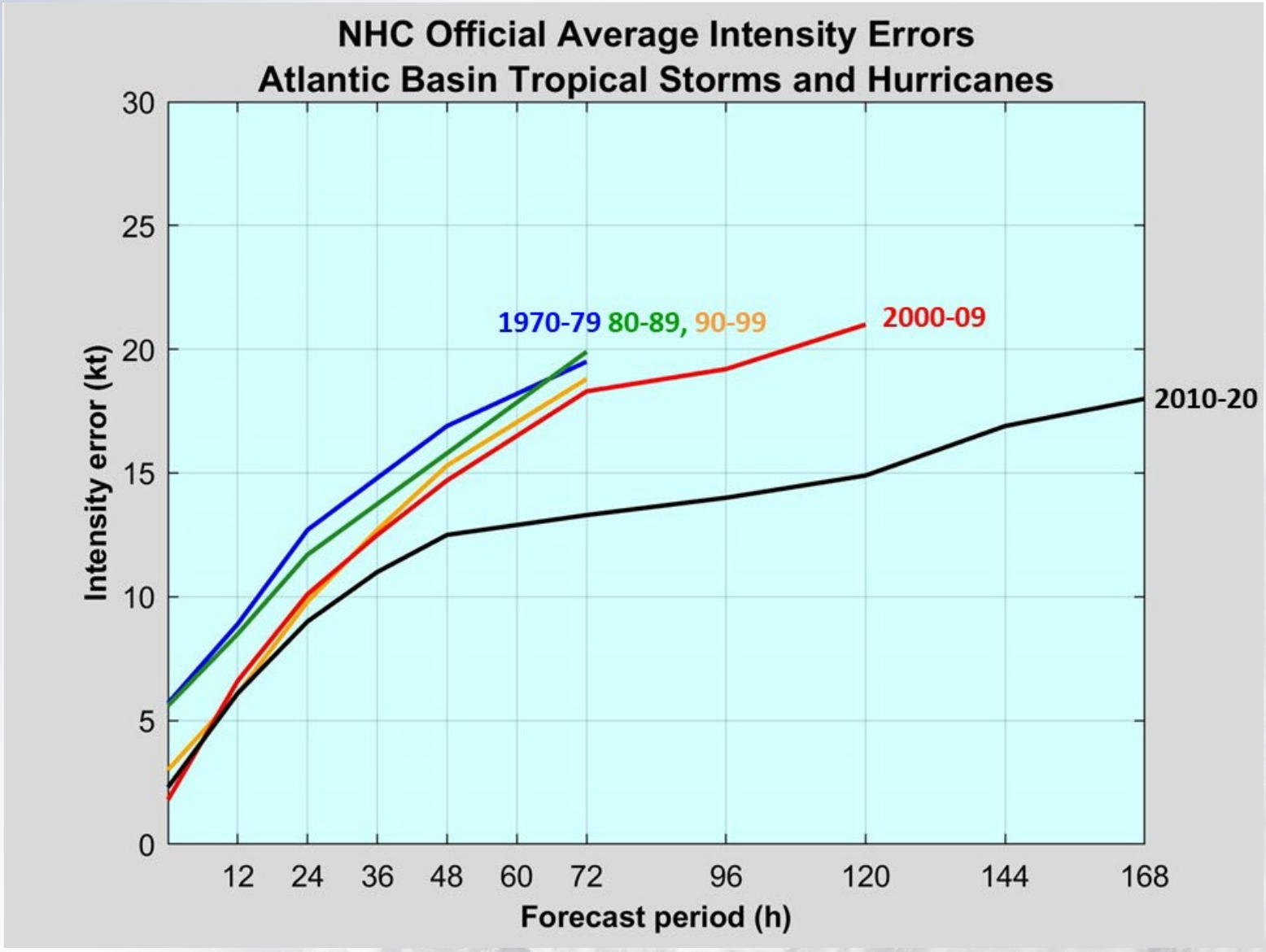


Tropical Cyclone Intensity

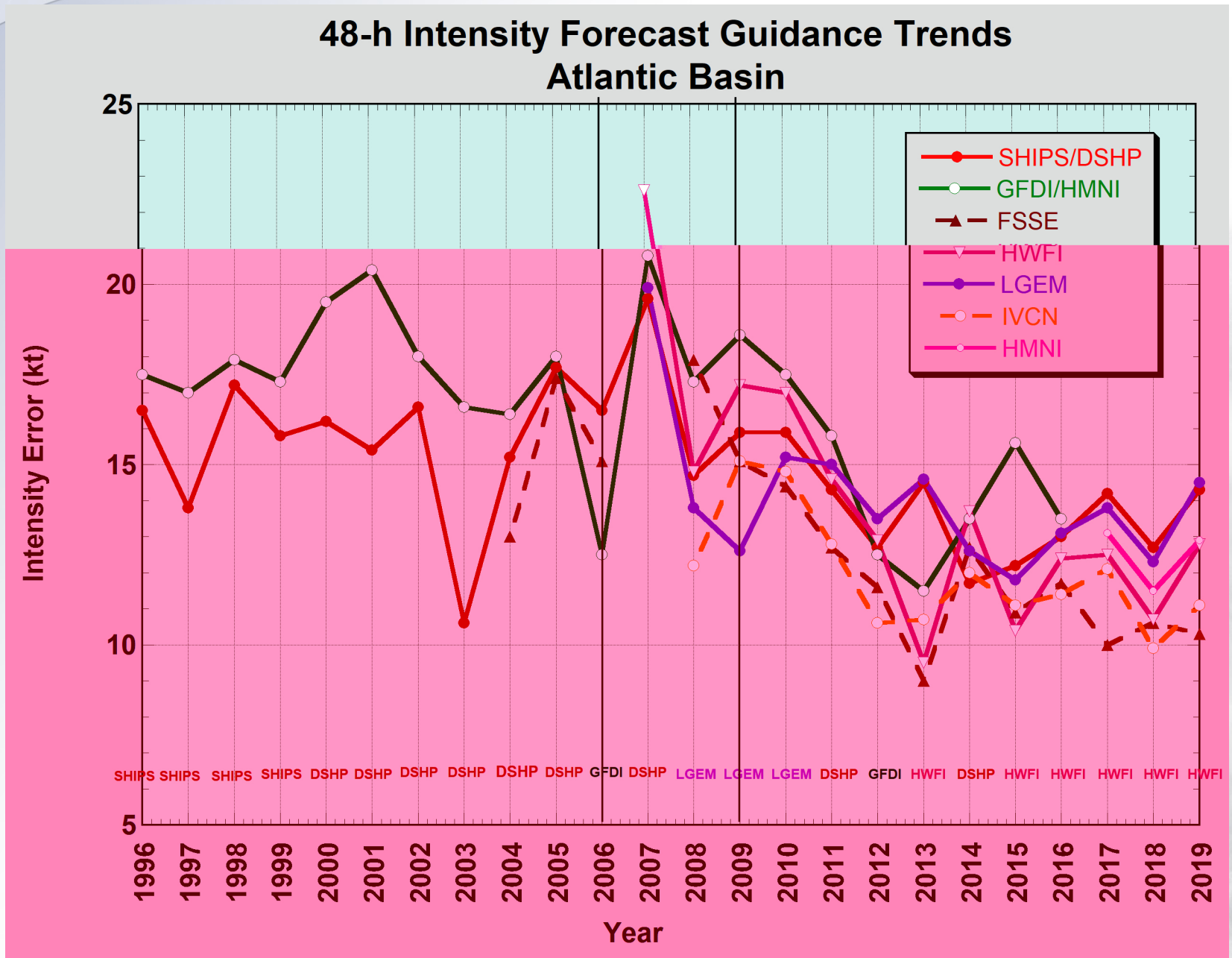
- Multi-scale problem that involves complex interactions between thunderstorms in the core and the environment, as well as atmosphere-ocean interactions
- Depends strongly on track
- Depends critically on wind, temperature, and moisture patterns over the core and near environment
- Depends on internal processes, such as eyewall replacement cycles, that are poorly understood



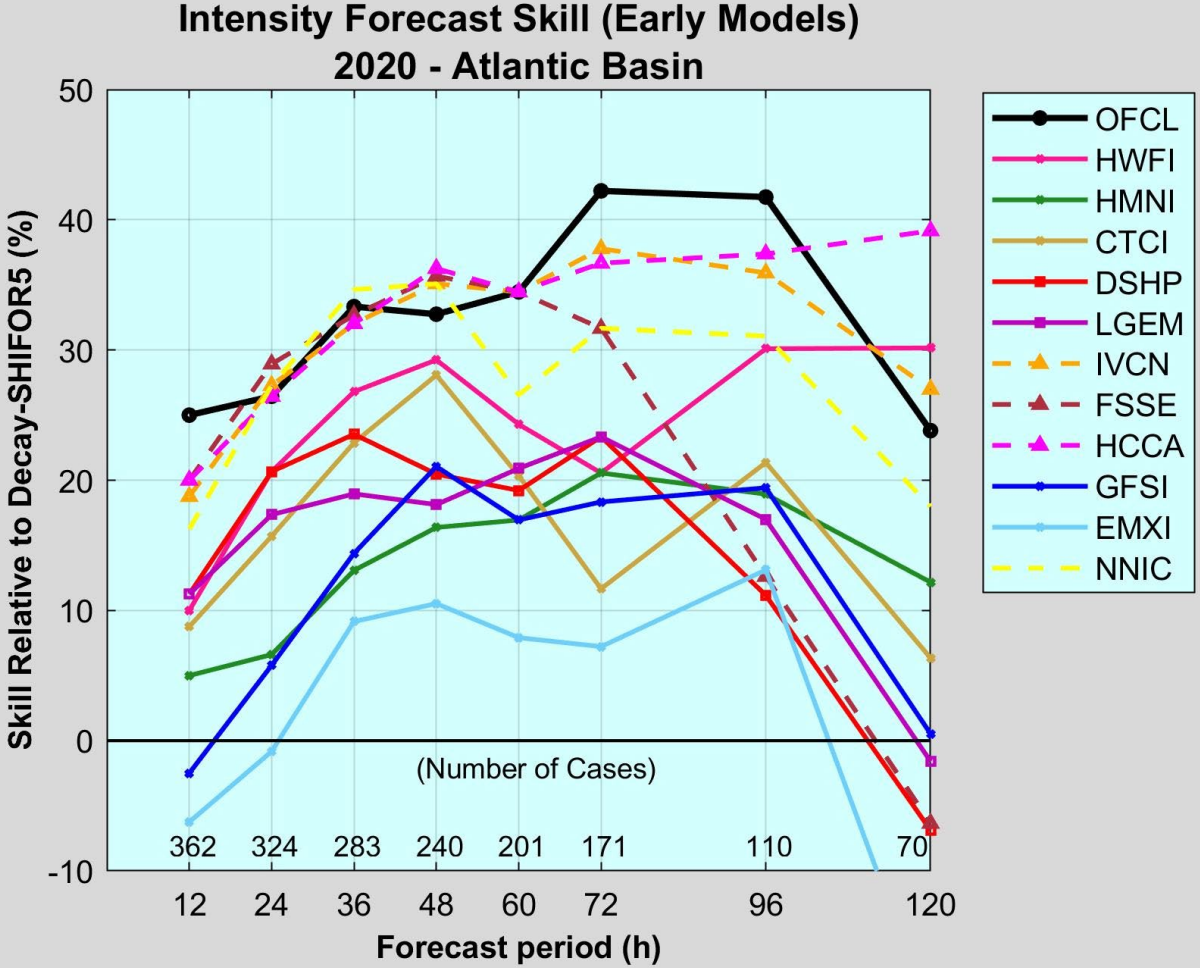
Atlantic Intensity Error Trends



48 h Model Trends



2020 Intensity Guidance



Official forecasts very skillful, as good as or better than the consensus aids.

FSSE trailed with time.

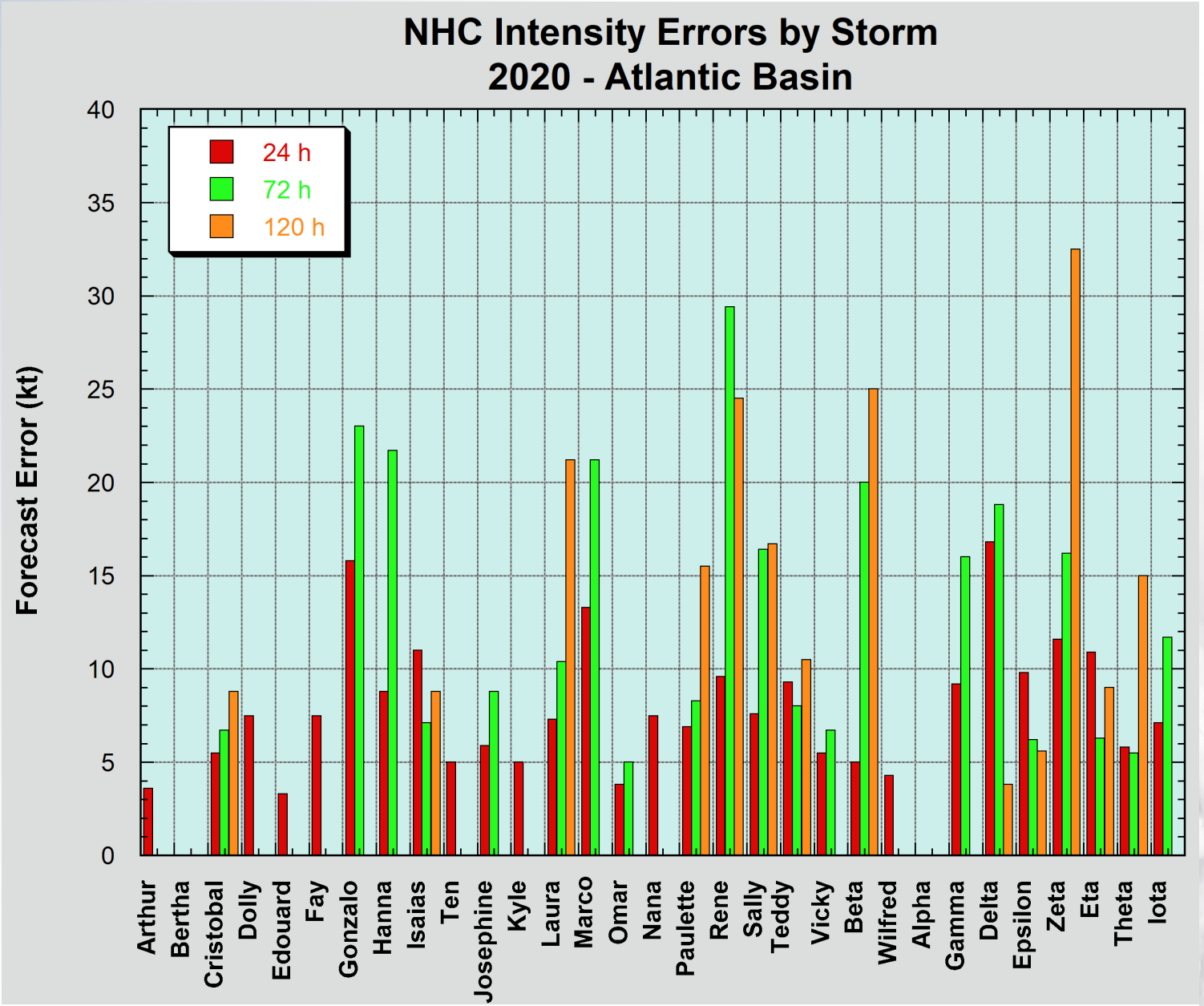
HWFI was a strong performer, best individual model.

CTCI and HMNI not as good as HWFI.

DSHP and LGEM were fair performers, but not as good as HWFI and consensus models.

GFSI somewhat competitive.
EMXI barely skillful.

2020 NHC Intensity Errors by Storm



FORECAST INTENSITY ERRORS
Rapid Strengthening

RAPID INTENSIFICATION

Rapid intensification remains a forecast challenge and often results in very large errors

- Our ability to recognize conditions that favor rapid intensification has improved, however forecasting the extent and timing of that intensification remains difficult.

Example: Iota Advisory 7 (2020)

Initial Intensity:	65 mph	Initial Intensity:	65 mph
24h Forecast:	105 mph	36h Forecast:	120 mph
Actual Intensity:	105 mph	Actual Intensity:	155 mph
24 h Error:	**0 mph**	**36 h Error:**	**35 mph**