NHC's Perspectives on Priorities for the Next Generation Hurricane Model

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Outline

- NHC mission and products
- From hurricane models to watches and warnings
- Brief history of model improvements
- Current limitations
- NHC modeling priorities

National Hurricane Center Mission

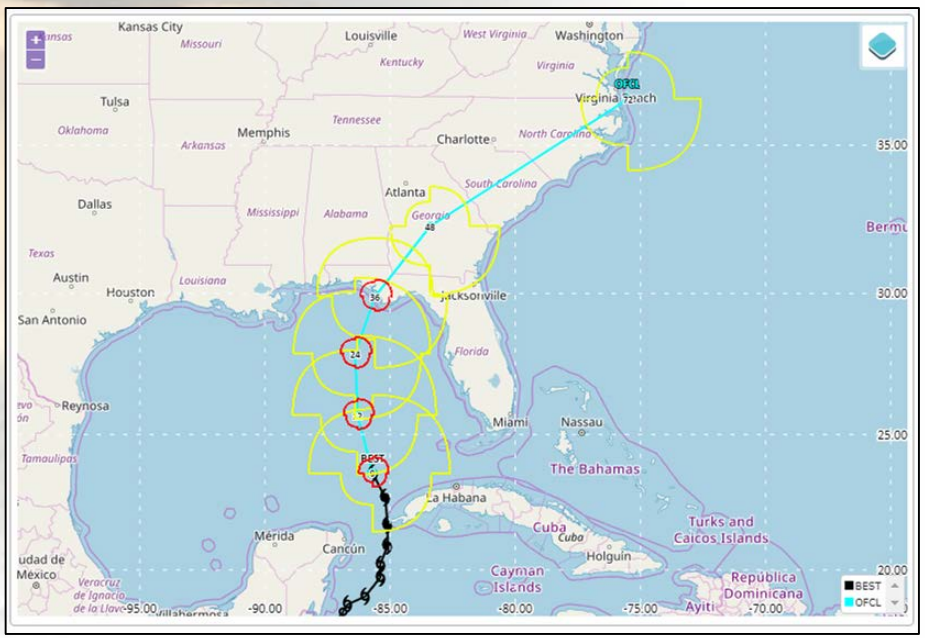
To save lives, mitigate property loss, and improve economic efficiency by issuing the best watches, warnings, forecasts, and analyses of hazardous tropical weather, and by increasing understanding of these hazards.

NHC Products

- TC wind watches/warnings (coastal)
- TC storm surge watches/warnings (U.S. East/Gulf Coast)
- Deterministic track, max wind forecasts to 120 hr
- Deterministic radii of 34, 50 kt wind to 72 hr
- Deterministic radii of 64 kt winds to 48 hr
- Probability of 34, 50 and 64 kt wind to 5 days
- Probabilistic time of arrival of 34 kt winds
- Probability-based potential storm surge flooding map (10% exceedance)
- Probability of TC formation through 2 and 5 days
- Cone and other graphical products
- Text products (Public Advisory, Discussion, TCM)
- Key messages

Hurricane Michael 0900 UTC 9 Oct 2018

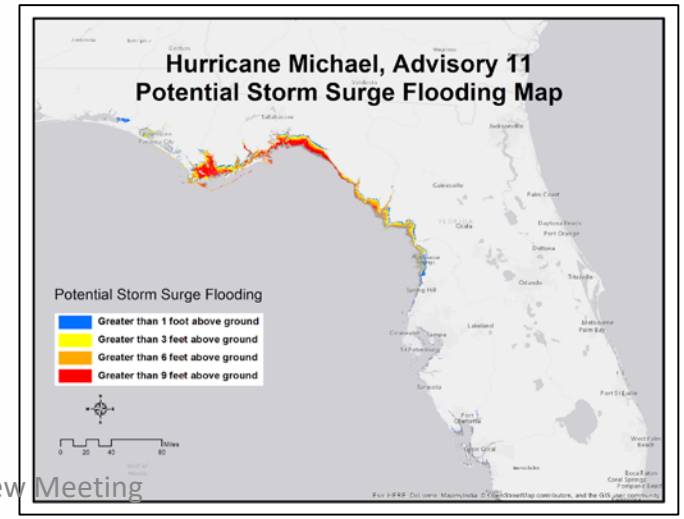
NHC Deterministic Forecast



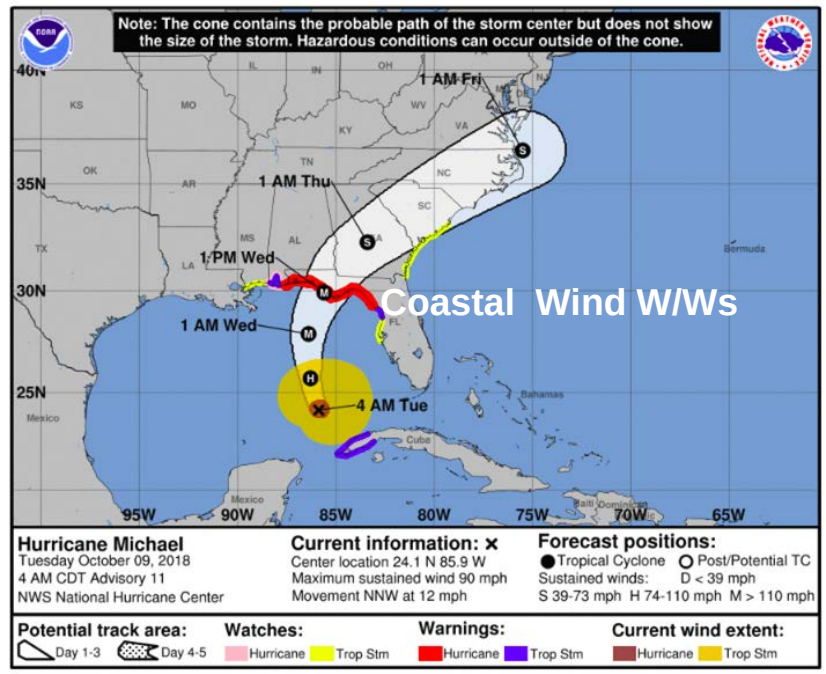
64-kt Wind Speed Probabilities

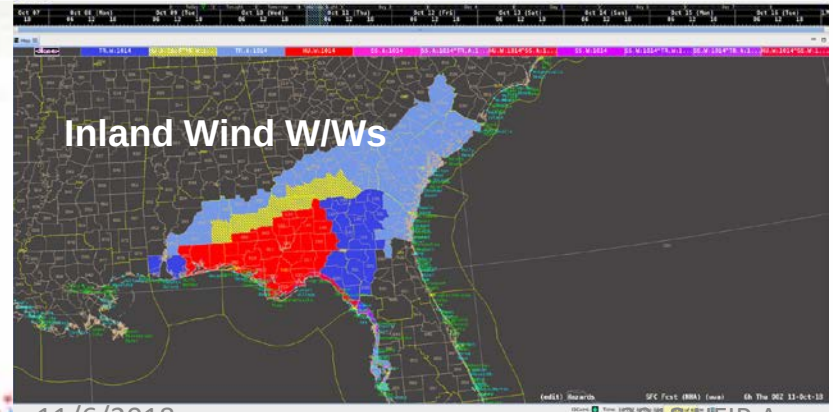
Probability of hurricane-force winds (1-minute average >= 74 mph) from all tropical cyclones
O indicates Hurricane Michael center location at 1 AM CDT TUE OCT 09, 2018 (Forecast/Advisory #11)

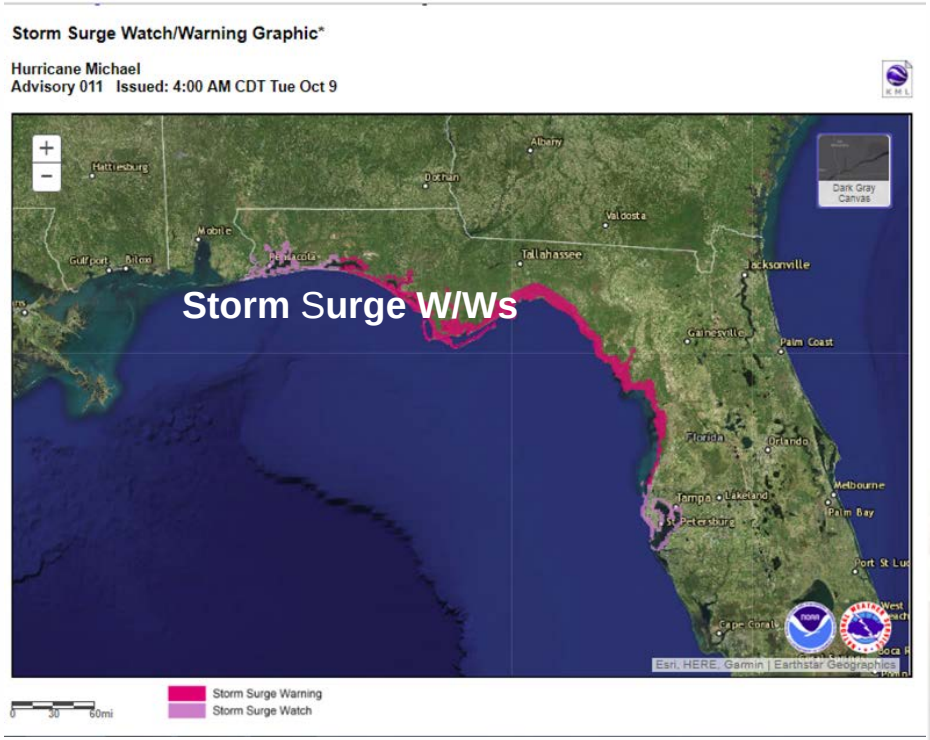
5 10 20 30 40 50 60 70 80 90 %



Wind and Surge Watches/Warnings
Hurricane Michael 0900 UTC on 9 Oct 2018



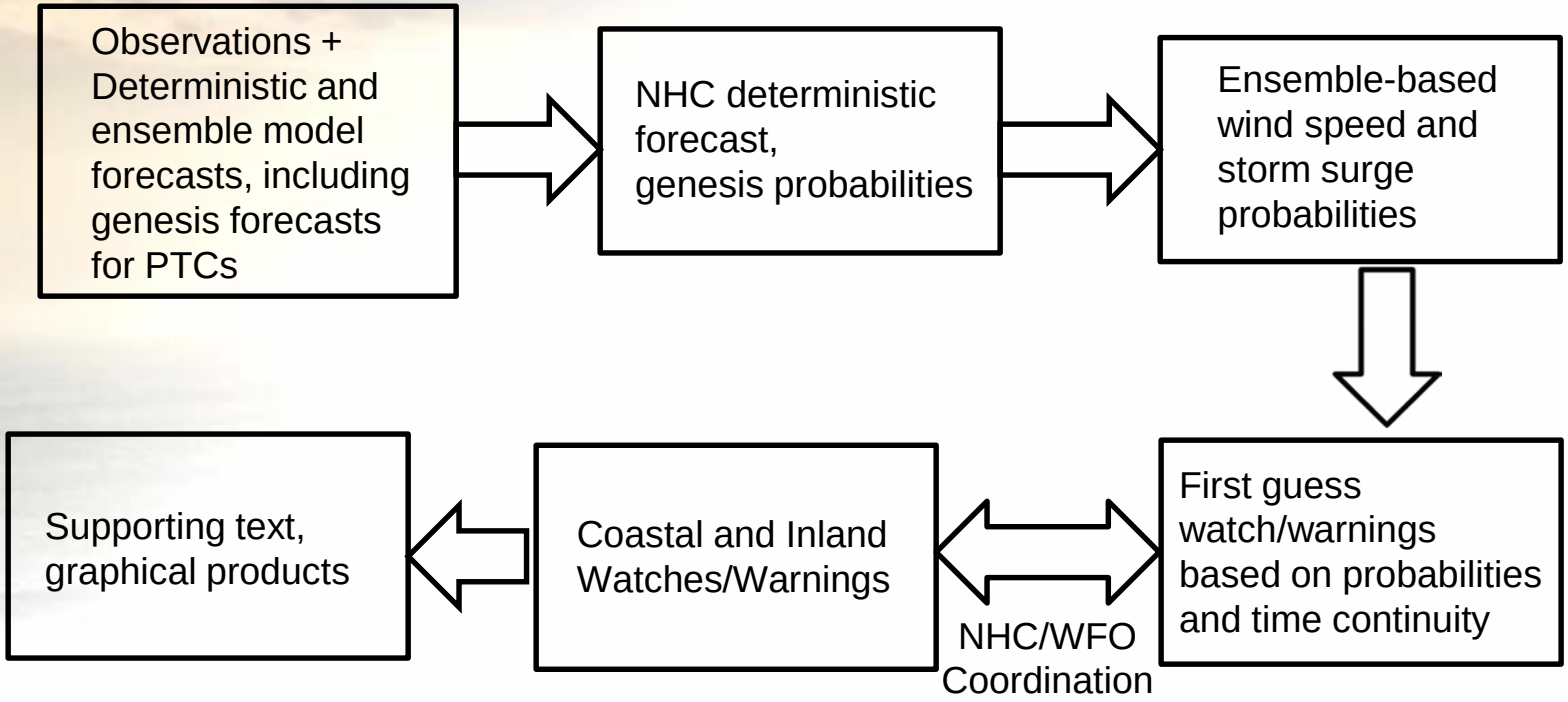




Model Guidance For Watches/Warnings

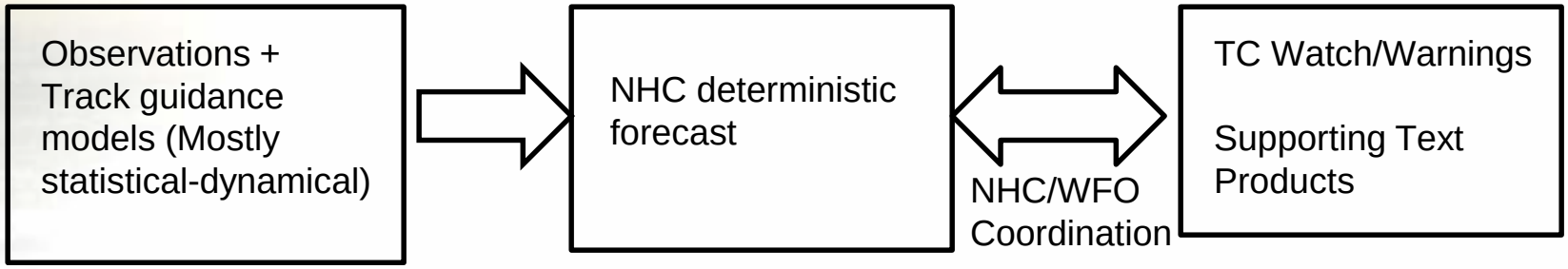
- Surface wind field forecast and its uncertainty
- Accurate ocean elevation (storm surge) model forced by surface wind forecast and its uncertainty
- Ideal modeling system*:*
  - *Well-calibrated coupled ocean-atmosphere-surge ensemble system*

Idealized Model-Based TC Wind Forecast/Warning Process



Real-World TC Wind Forecast/Warning Process

- 1954: First objective 24 hr forecast of lat/lon
  - Objective guidance models soon followed
- 1954-1987: Only track guidance available
- Forecast/Warning Process through 1987:

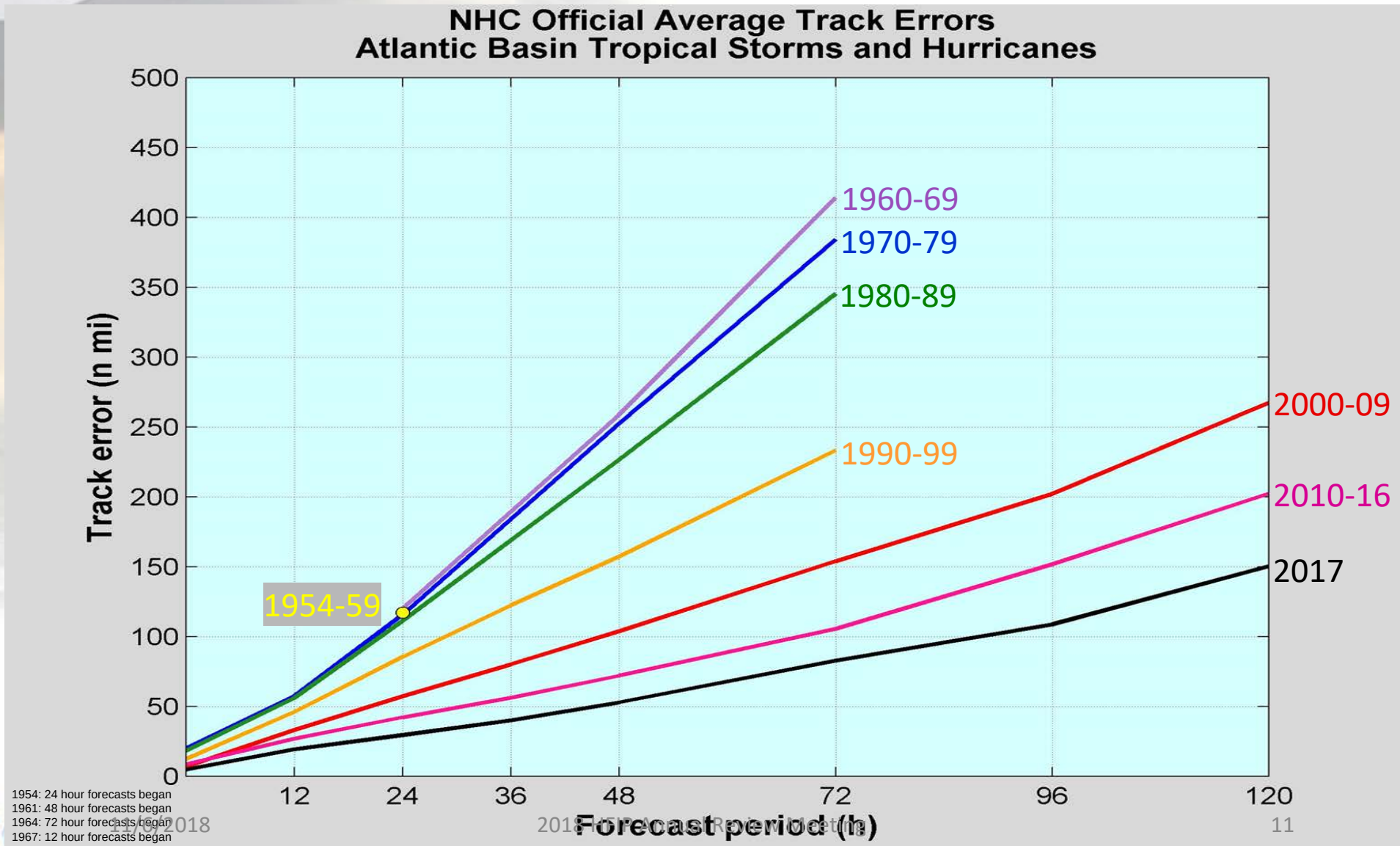


- Required intensity/wind structure, uncertainty info determined subjectively or from statistics

Model and Forecast Product Improvements

- 1980s
  - First NHC probability product (Strike Probabilities)
  - Statistical intensity models
- 1990s
  - Dynamical (GFDL) and statistical-dynamical (SHIPS) intensity models
  - Track forecasts from global models
  - Coupled ocean-atmosphere hurricane models
  - NHC web page, TC graphics
- 2000s
  - Global model ensembles, consensus methods
  - Statistical Rapid Intensification (RI) Index
  - HWRF and HFIP
  - NHC forecasts extended to 5 days
  - NHC wind speed probabilities replace strike probabilities
- 2010s
  - Dynamical intensity models surpass statistical intensity models
  - Genesis forecasts from global models and statistical post-processing (FSU)
  - Probabilistic storm surge models
  - NHC genesis probability product
  - TS/Hurricane Watch/warning lead times increased
  - NHC Storm Surge watches/warnings
  - NHC forecasts for potential TCs

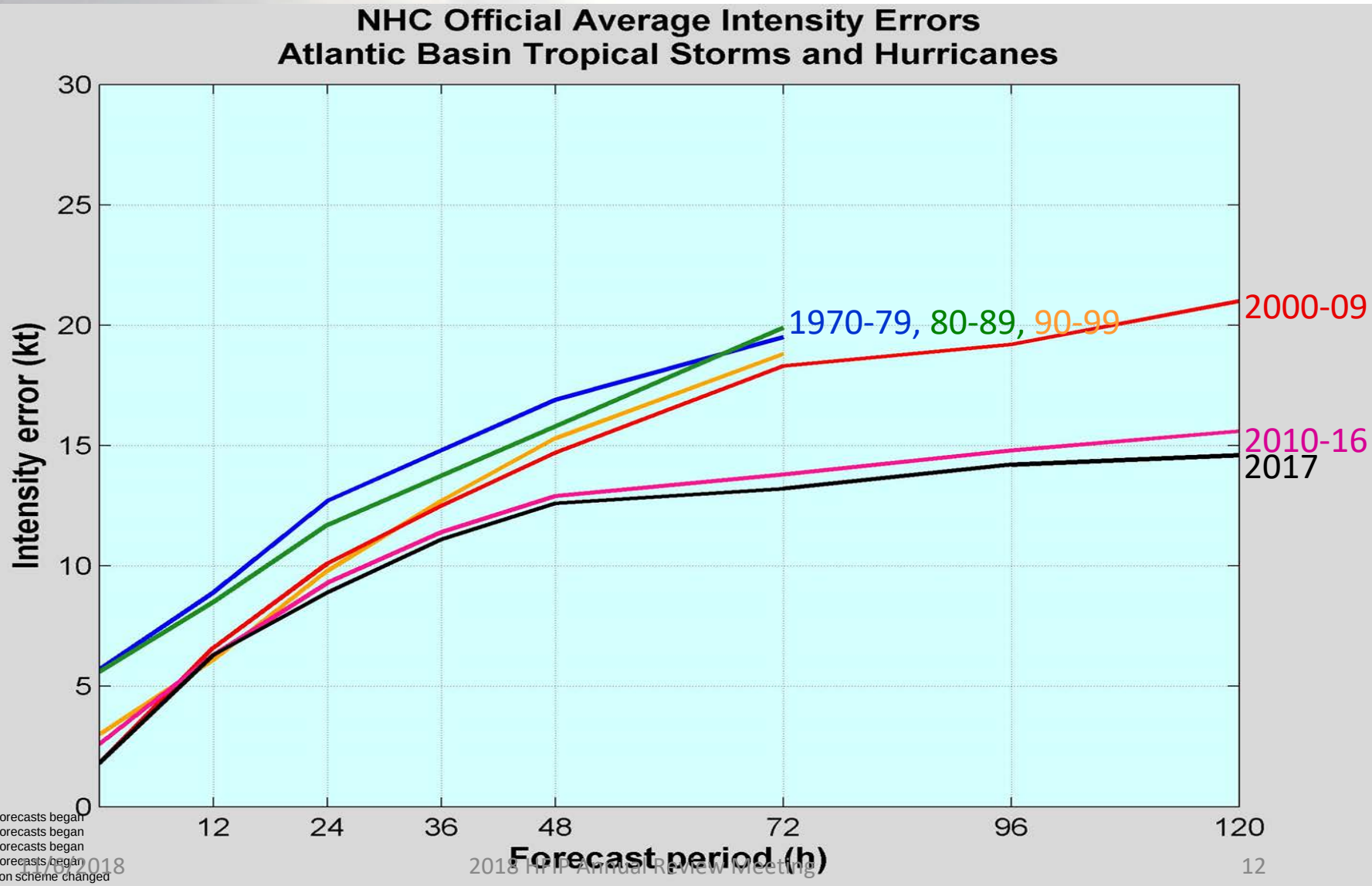
NHC Official Average Track Errors (Atlantic basin)



1954: 24 hour forecasts began
1961: 48 hour forecasts began
1964: 72 hour forecasts began
1967: 12 hour forecasts began
1970: Verification scheme changed
1988: 36 hour forecasts began

Source: NHC ENR/JPC 1/2018

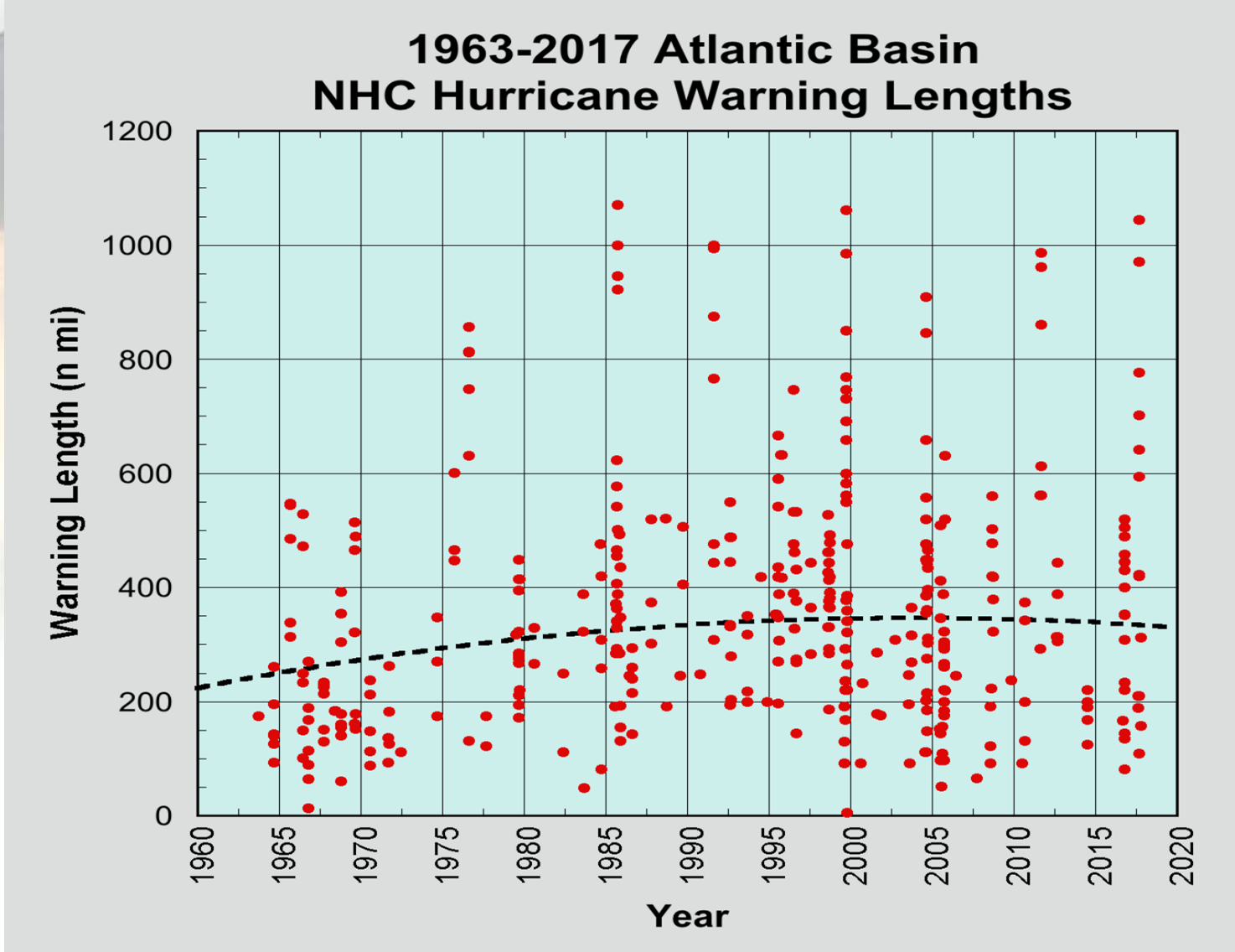
NHC Official Average Intensity Errors (Atlantic basin)



1954: 24 hour forecasts began
1961: 48 hour forecasts began
1964: 72 hour forecasts began
1967: 12 hour forecasts began
1970: Verification scheme changed
1988: 36 hour forecasts began
2001: 96 and 120 hour forecasts began (became public in 2003)

Source: NHC ENR/JPC 1/2018

Evolution of NHC Coastal Hurricane Warnings



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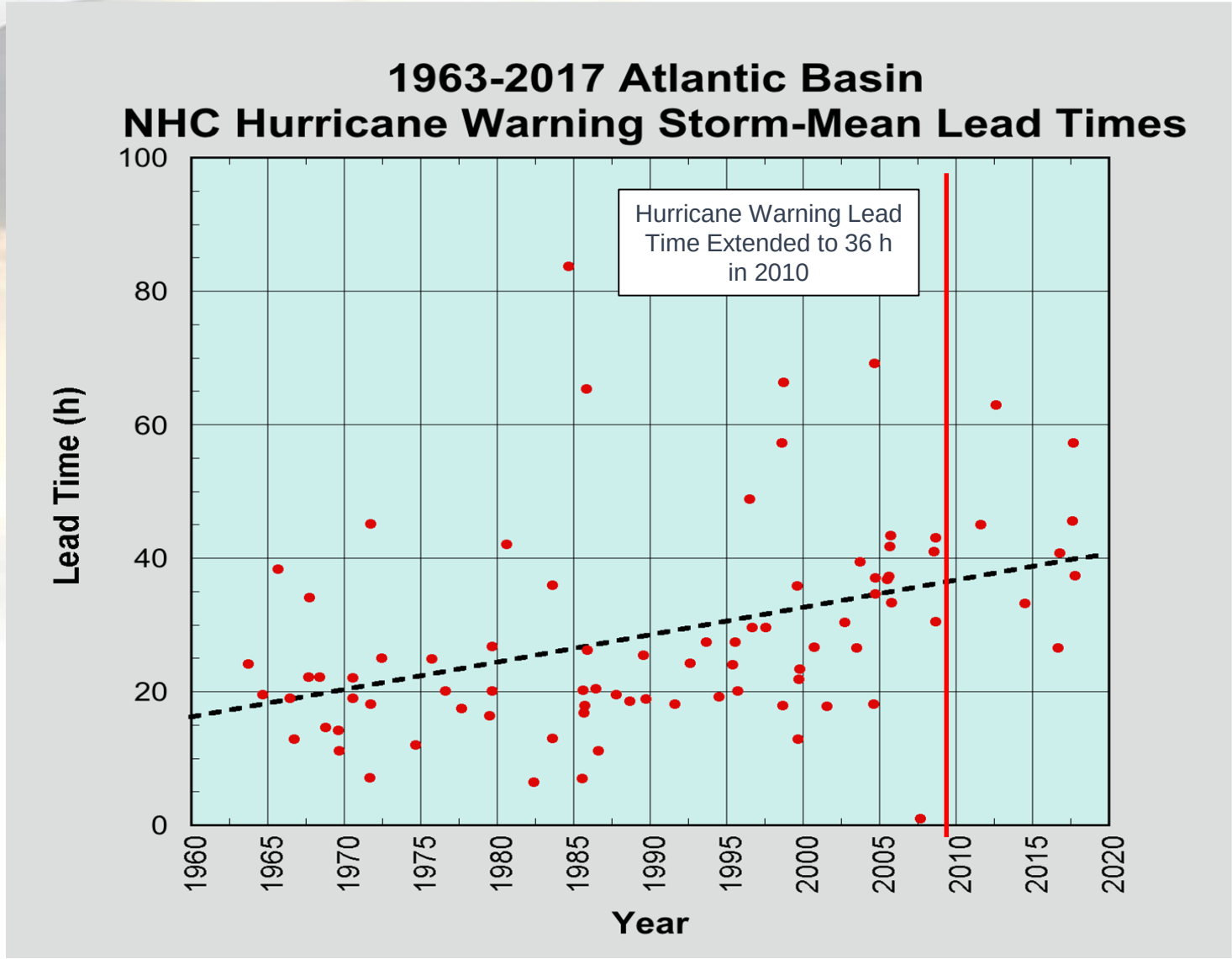

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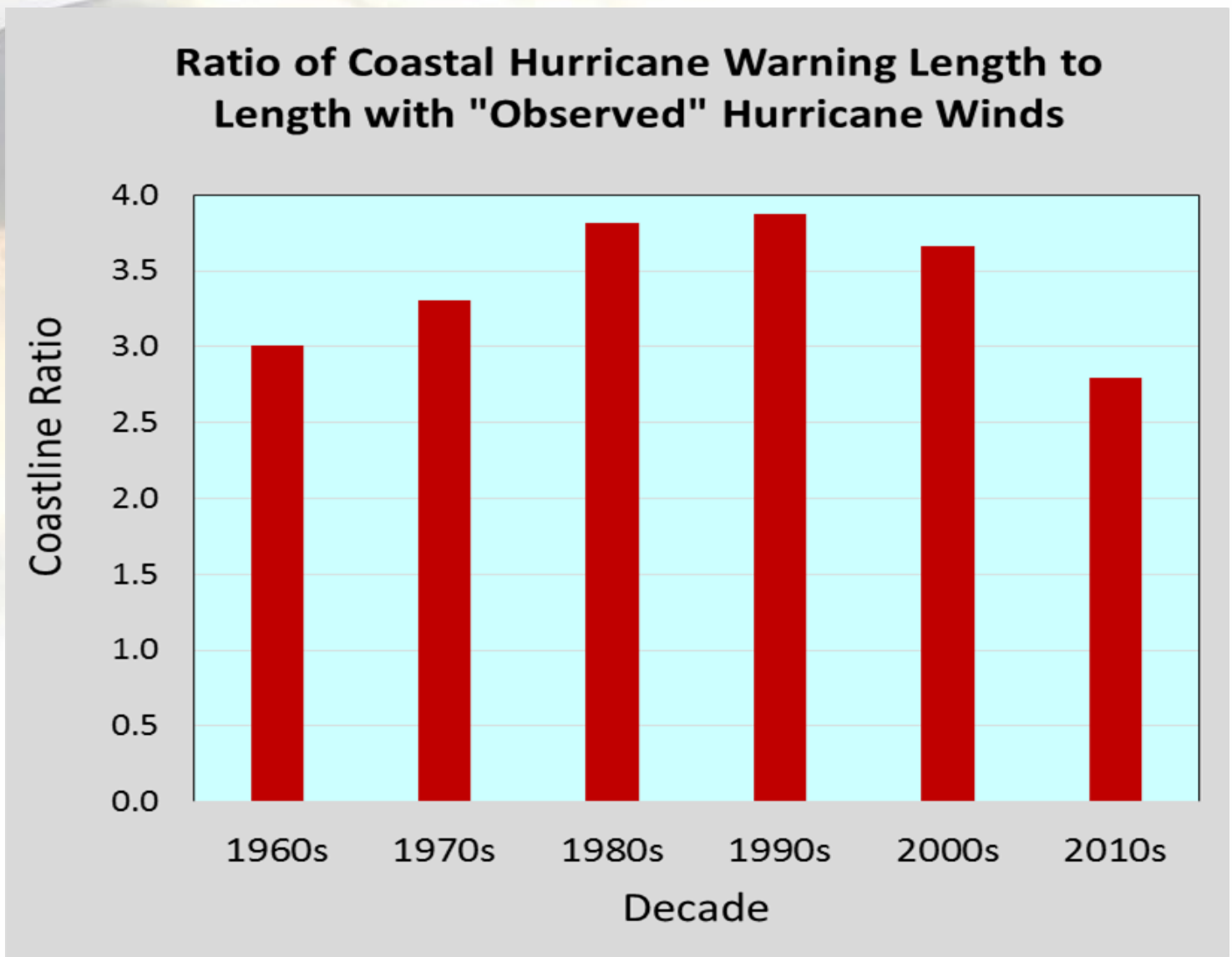
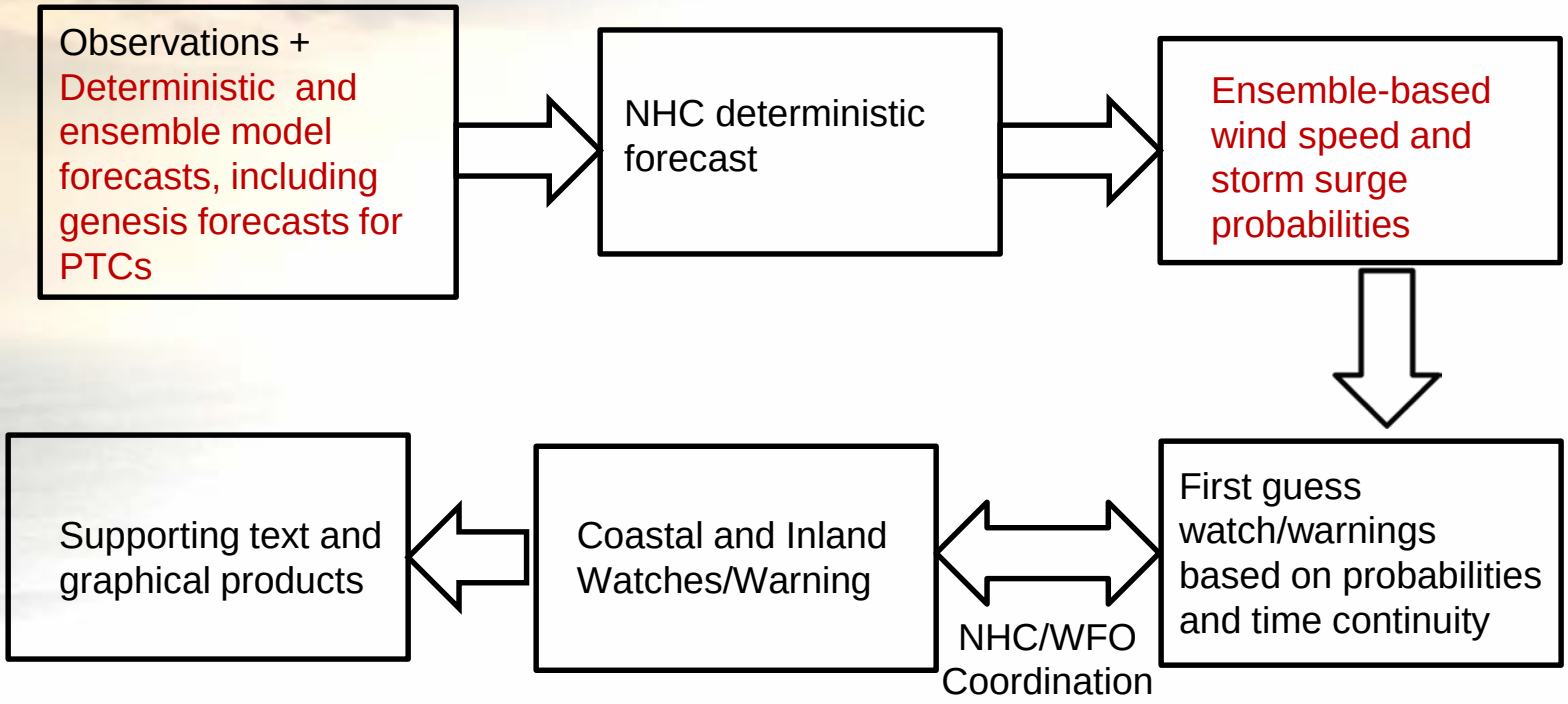


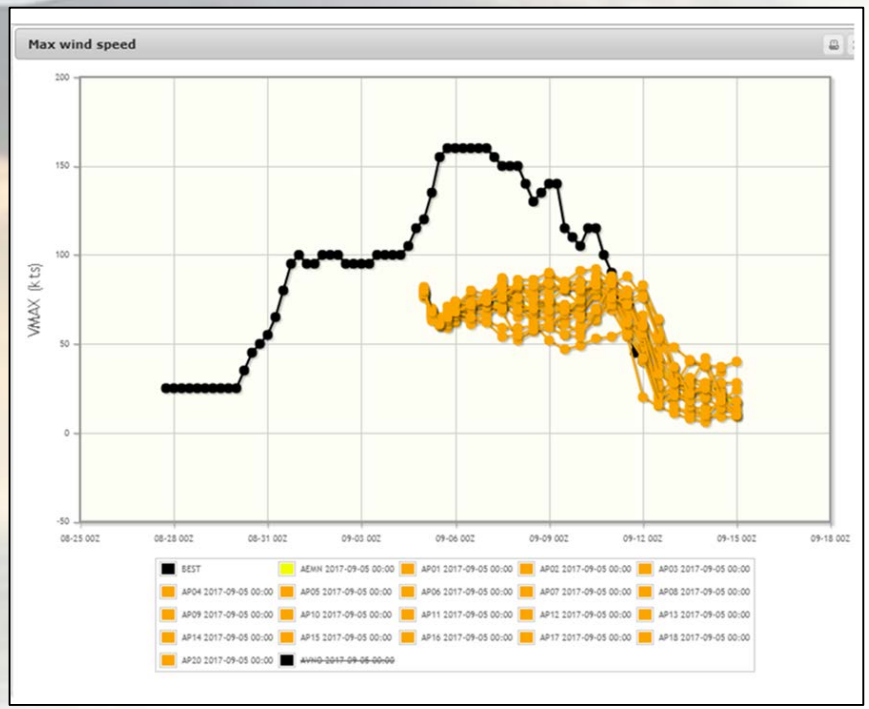
Idealized Model-Based TC Wind Forecast/Warning Process



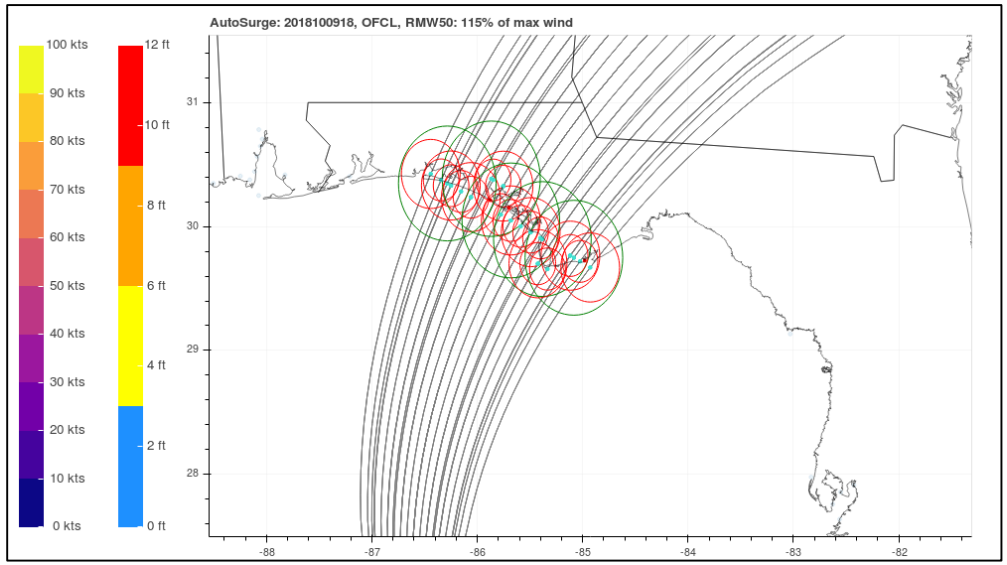
Current Limitations

- Statistical RII methods are better discriminators of rapid intensification than dynamical model forecasts
- Model wind structure forecast skill unclear
  - Radius of max winds, 34, 50 and 64 kt winds
- Ensemble systems biased (especially for intensity) and sometimes under-dispersive
  - NHC wind speed probabilities based mostly on historical error distributions
  - Wind forcing for P-Surge from statistical error distributions
- No information on wind gusts

Ensemble Examples



GEFS Intensity Forecasts for
Hurricane Irma 00 UTC 5 Sept 2017



Track ensembles for Hurricane Michael
P-Surge run determined from
historical error distributions

NHC Priorities for Next Generation Hurricane Model

1. Improved rapid intensification/weakening forecasts
2. Ensemble system that can drive wind speed probability products, storm surge model forcing
3. Improved wind structure analyses and forecasts, including over land
4. Improved genesis forecasts
5. Useful forecasts to 7 days
6. Inclusion of wind gusts

- *Modeling Issues*
  - *Improved data assimilation, Use of all available observations*
  - *Better tools for targeted observations*
  - *Physics that scale to very high spatial, temporal resolution*
  - *How to divide resources between deterministic model and ensemble system?*