The Hurricane Warning Mission Operations & Supporting Research NWS Perspective

Interdepartmental Hurricane Conference
Tropical Cyclone Research Forum

John D. Murphy

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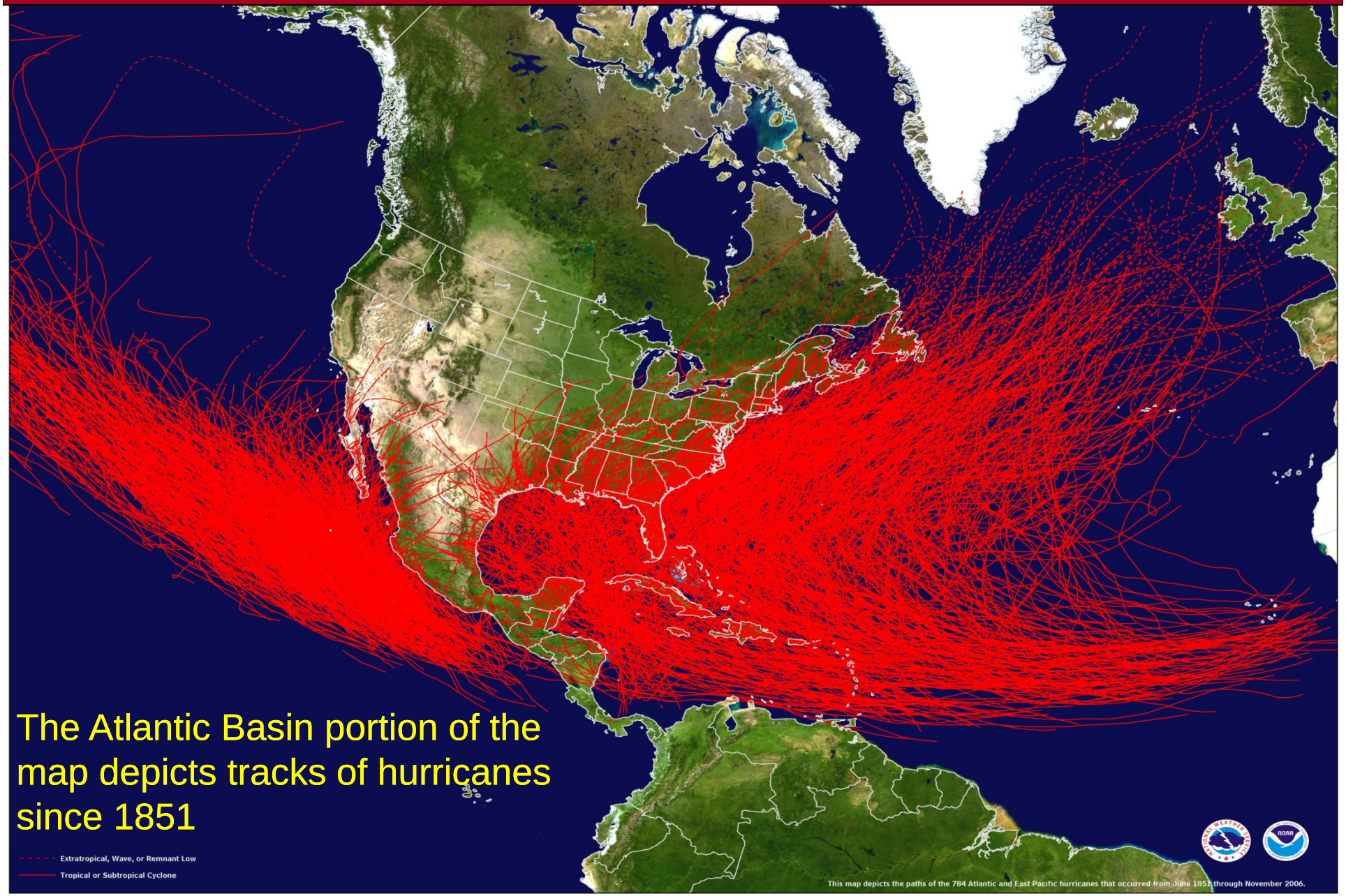
AGENDA

- Drivers
- Progress
- Plan

We are a nation with a vulnerability!



DRIVERS
Need for HFIP (Circa 2008)

- **Lives**: More than 50% of U.S. population lives within 50 miles of coast; Number of people at risk increasing along coast and inland; 180 million people visit the coast annually

- **Property**: Value of coastal infrastructure and economy rising… now > $3 trillion; annual U.S. tropical-cyclone-related damage losses averaged about $10 billion circa 2008; averaged losses double about every ten years

- **Forecasts**: Hurricane track forecasts have improved greatly; intensity forecasts have not


Bolivar peninsula after Ike (2008)

- **Research**: Tropical cyclone research has been under-resourced and not well-coordinated within the meteorological community

Courtesy: Ed Rappaport

DRIVERS

Expected HFIP Outcomes/Benefits

- NOAA outcomes
  - Greatly **improved storm observing strategies** and use of existing and planned data
    - Increases overall return on investment on NOAA observing systems
  - **Improved forecasts**
    - Increased forecast accuracy at longer lead times, especially during periods of rapid intensity changes; raise confidence levels for all forecast periods
    - Reduced over-warning

- Bottom line outcomes
  - More effective emergency management response enabled by more accurate information at longer lead-times
  - Overall reduction in preventable economic losses

DRIVERS

HFIP Performance Goals

- Reduce numerical forecast errors in track and intensity day 1 to day 5
  - 20% in 5 years
  - 50% overall
- Extend forecast guidance to 7 days with today's skill at 5 days
- Increase the probability of detection (POD) for rapid intensity change to 90% at Day 1 decreasing linearly to 60% at Day 5
- Decrease the false alarm ratio (FAR) for rapid intensity change to 10% for Day 1 increasing linearly to 30% at Day 5
- Improve storm surge prediction

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PROGRESS

HFIP After 5 years (2009–2013)

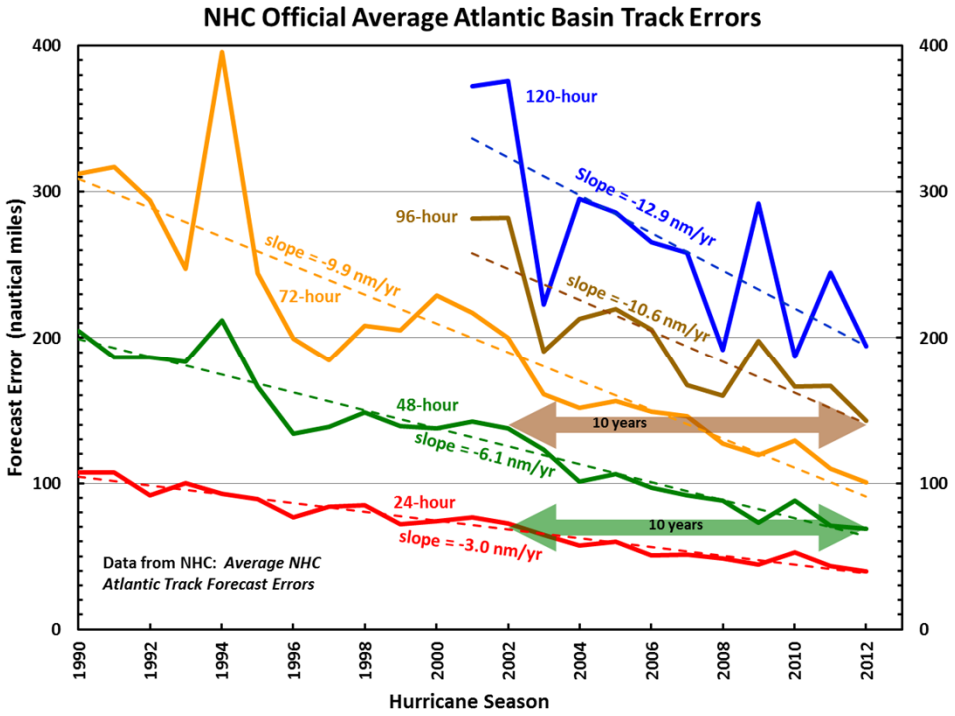
- HFIP 5-year Performance Goals Exceeded (or Within Reach)
  - Operational GFS among best dynamical models for hurricane track prediction
    - New GSI-Hybrid DA Systems went operational in GFS in May 2012
    - Track forecasts exceeded 5-yr goal for Days 1 through Day 4
    - Beating ECMWF at most lead times
    - However, little progress reducing 5 to 7 day track error in numerical guidance
  - A third nest added to operational HWRF allowing an inner core resolution of 3 km. This and other changes led to another 20% improvement in both HWRF track and intensity forecasts over previous year
  - Improvements in Numerical Guidance appear to be showing up in operational guidance

Where will we stand at the end of the 2014 Hurricane Season?

PROGRESS

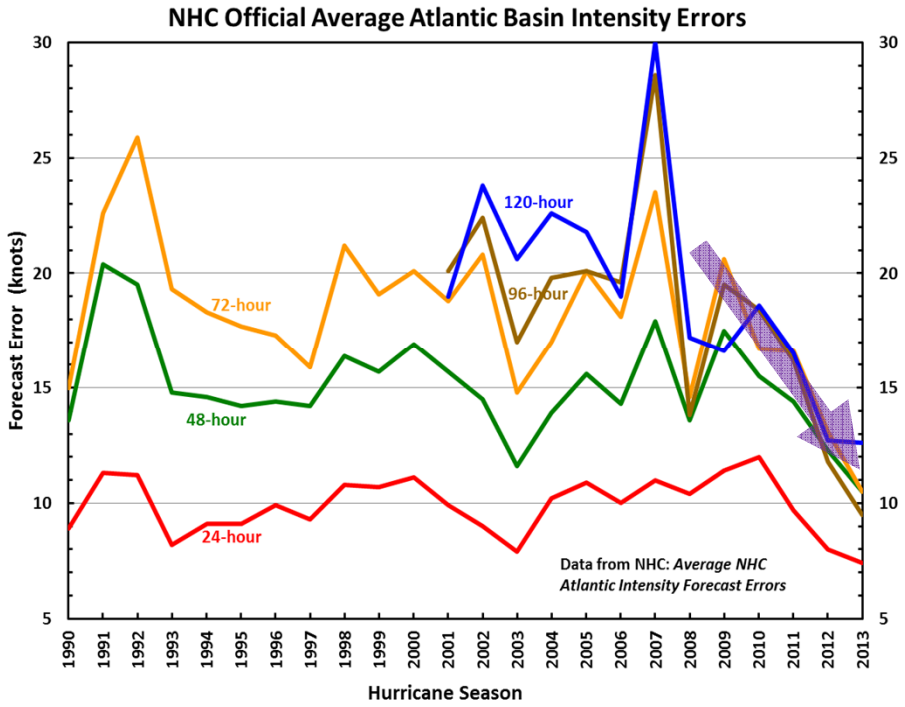
Operational Forecast Performance

Good – track forecast improvements



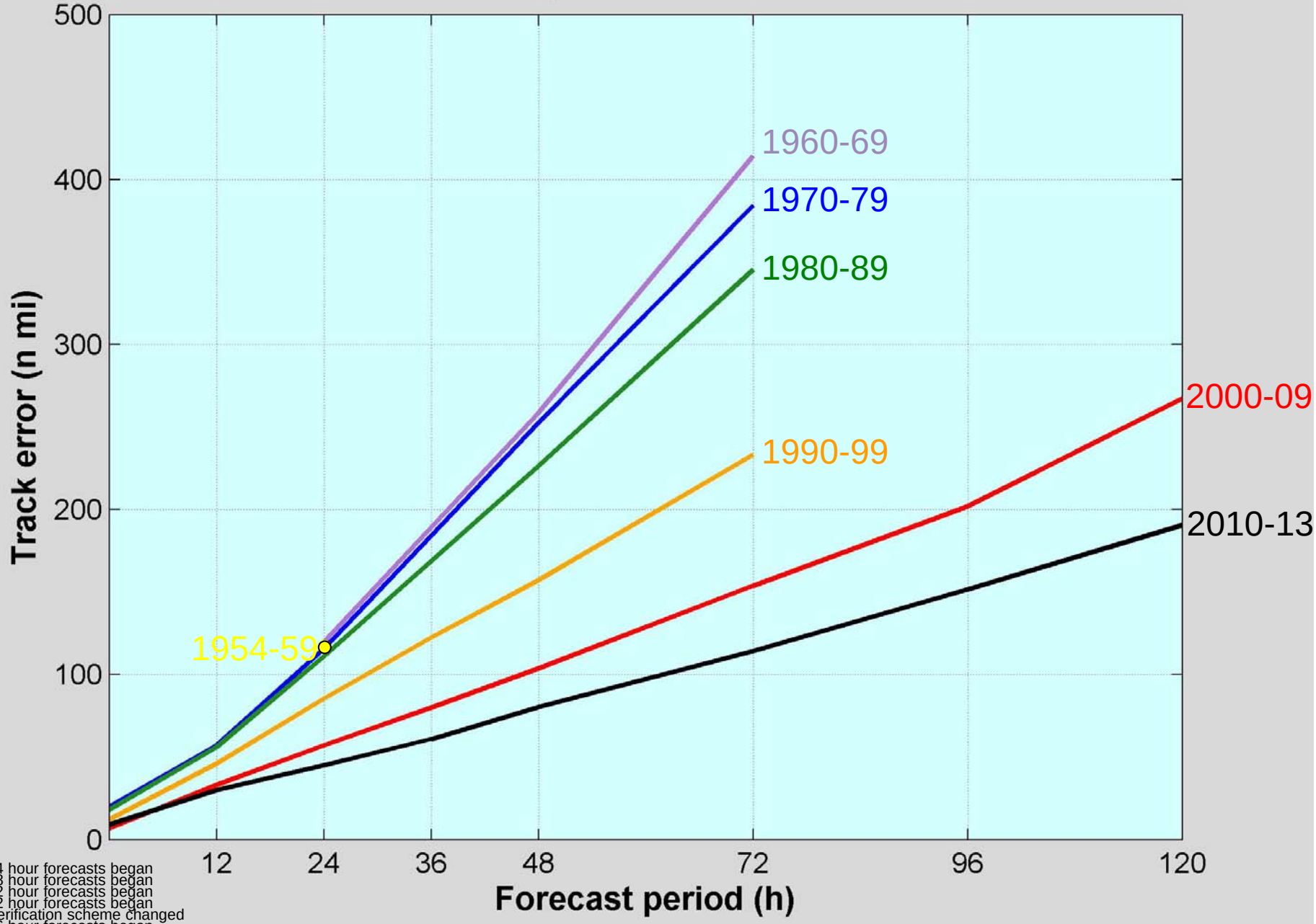
- Errors cut in half over past 15 yrs
- 10-yr improvement - As accurate at 48 hrs as we were at 24 hrs in 2000

Not so Good – however, recent trend hopefully persists



- 24-48h intensity forecast historically off by 1 category (2 categories perhaps 5-10% of time)

NHC Official Average Track Errors
Atlantic Basin Tropical Storms and Hurricanes



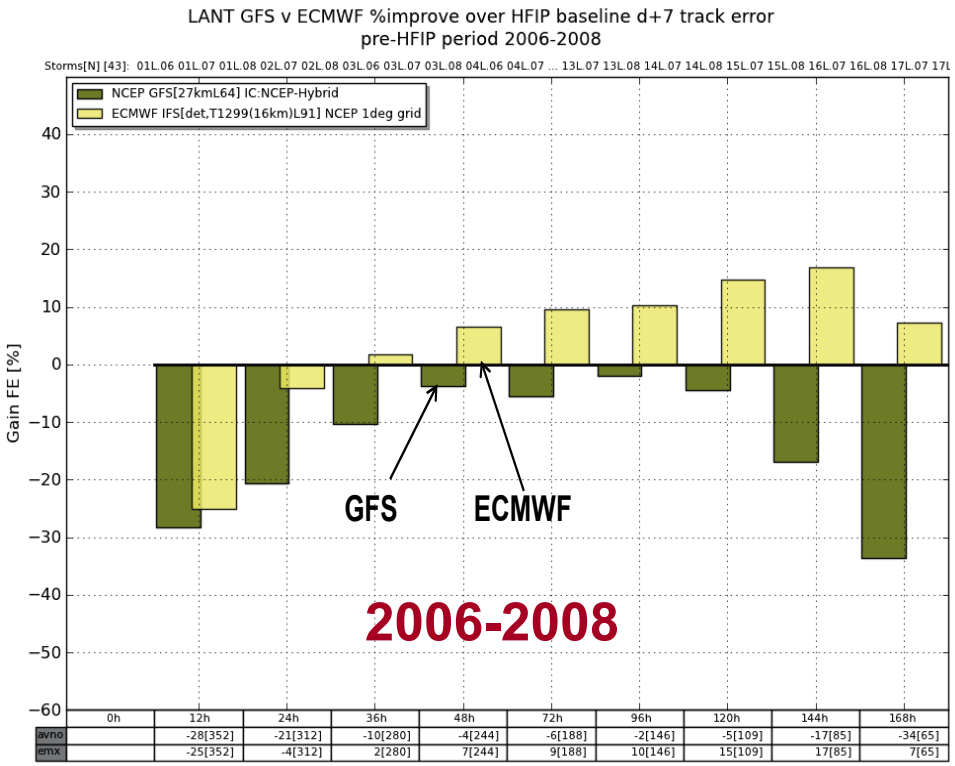
1954: 24 hour forecasts began
1961: 48 hour forecasts began
1964: 72 hour forecasts began
1967: 12 hour forecasts began
1970: Verification scheme changed
1988: 36 hour forecasts began
2001: 96 and 120 hour forecasts began (became public in 2003)

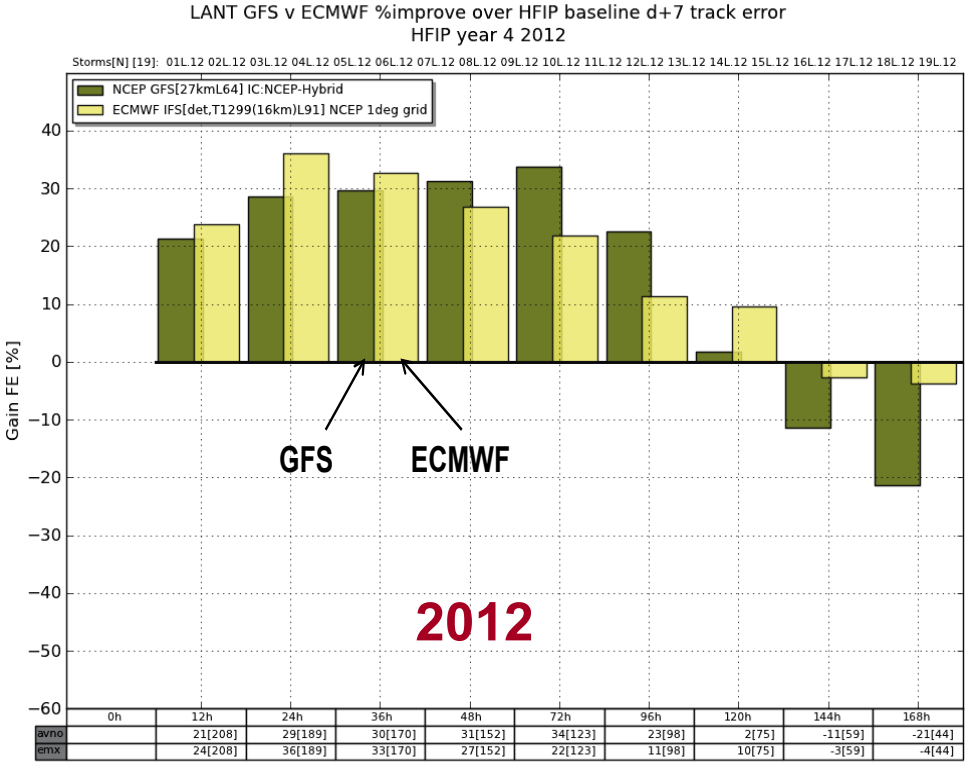
Source: ENR 2/2014

PROGRESS

Operational Global Model

(% Improvement over HFIP baseline)

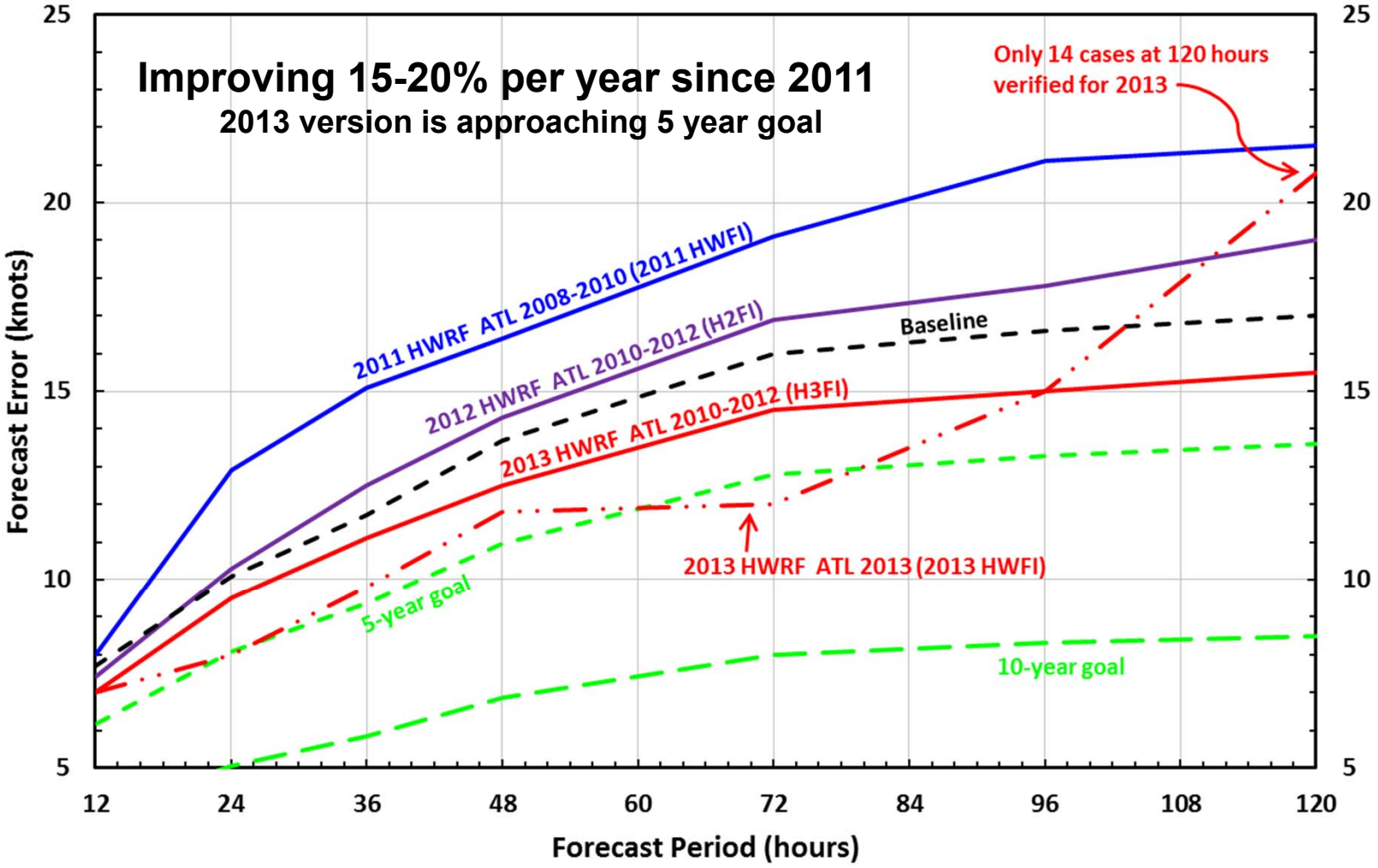




PROGRESS

Operational HWRF ATL Basin

Cumulative Intensity Forecast Improvements

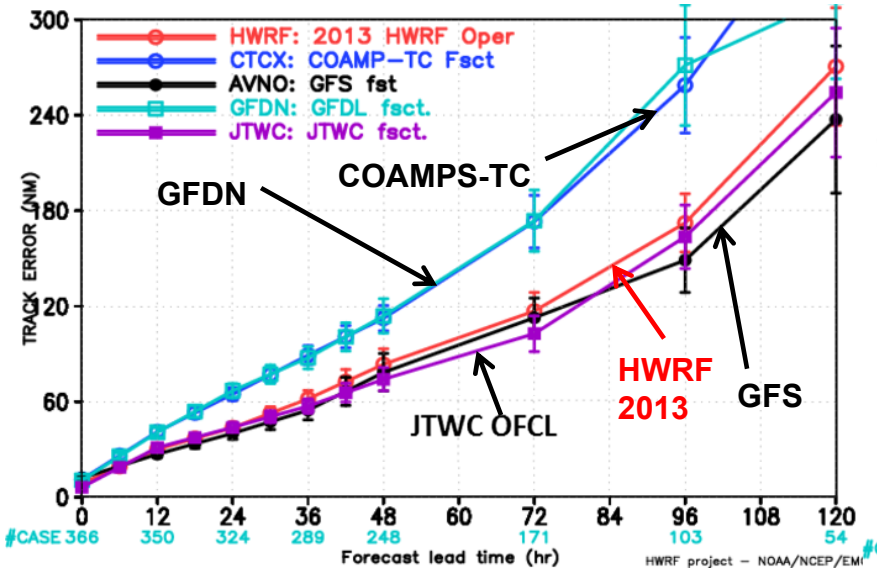


PROGRESS

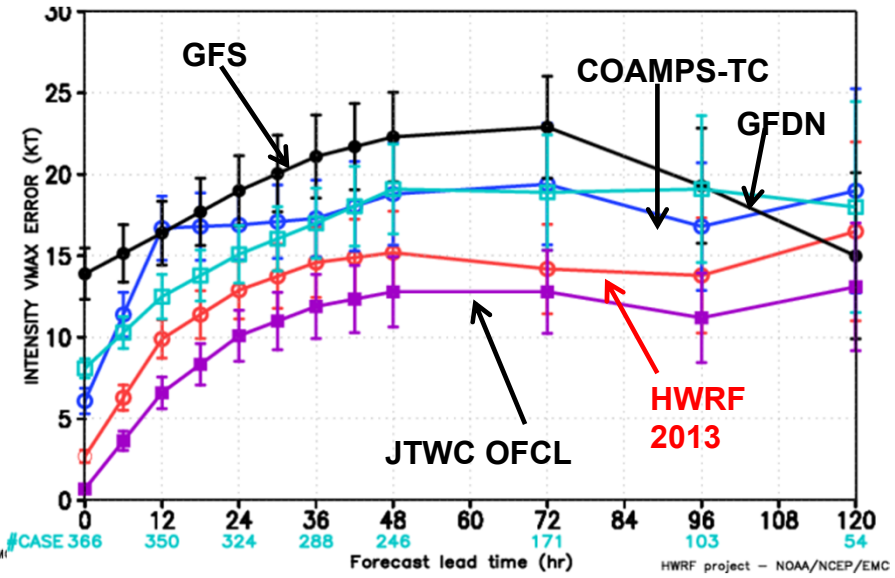
HWRF in WPAC

- HFIP has been running HWRF in the WPAC for JTWC 2-12-2013
- Results shown below indicate that the HWRF track forecasts are comparable to the global model and better than other regional models in the region
- HWRF Intensity forecasts are better that other model guidance in WPAC
- JTWC has been using HWRF model output in their operational **forecasts**

WPAC Track



WPAC Intensity



PLAN

NWS Restructuring/Reorganization

- **Rationale**
  - Many driving forces for NWS change (including NAPA Report)
  - NWS must be adaptable and respond to needs
  - Structure should reflect true cost to run NWS
  - Budget Structure that is transparent and that has a logic flow that maps to the NWS mission
- **Benefits**
  - Aligns budget to function (forecast and warning process) and links to performance
  - Improves budget credibility and transparency
  - Establishes new internal control environment
  - More responsive to stakeholder needs and technology advances
  - More efficient, responsive, and advanced operations directed toward strategic goals
- **Risks/Challenges**
  - Pace of change: orderly process vs. immediate change
  - Culture change for stakeholders - concern regarding fate of specific programs and PPAs
  - Some cost drivers (i.e. ITOs, data center consolidation) require key changes in policies or approaches to control or fix
  - Labor Management Relations partnership requires time and dedication
  - Never under estimate the impact of a move/change

PLAN

NWS Proposed PPA Restructure

PPAs	*Existing Programs*
Observations	Surface, Ocean & Upper Air Observations, Aircraft Obs, Radiosondes, NEXRAD, ASOS, Buoys, Snow Surveys, Profilers, National Mesonet, Observations Support
Central Processing	Data Collection/Display, AWIPS, Model Implementations, Supercomputing, Advanced Hydrologic Prediction System
Analyze, Forecast, Support	WFO Forecasts & Warnings, National Service Centers, River Forecast Centers, CWSUs, Tsunami Services, Decision Support Services, WCM Program
Disseminate	IT & Dissemination Systems; Telecommunications Gateway, NOAA Weather Radio; NEXTGEN, Ground Readiness, NOMADS
Science & Technology Integration	Research/Development/Assess, Environmental Modeling Center, Test and Demonstration, WRN Pilots, Testbeds, Training, CSTAR, Education & Outreach, SOO Program

PLAN

NWS R&D Priorities: Next 3-5 years

- Program drivers:
  1. Rapid intensity forecast accuracy
  2. Continued track forecast accuracy
  3. Continued overall intensity forecast accuracy

- HFIP Components in Priority order:
  1. Evaluation of impact of aircraft inner core data
  2. Minimize intensity and structure initialization problem
  3. Maximize use of satellite data that improve model initialization.
  4. Accurate extended (3-5 day) forecasts of disturbances.
  5. Post-processing of products for users (limited effort within HFIP).
  6. Quantify importance of ocean forecasts (adjust program if necessary)
  7. Develop applications for use of model guidance by forecasters (limited).
  8. Global model work

PLAN

Significance of Rapid Intensity Change

- **Rapid intensity (RI) change (≥30 kt in 24 hours) has significant impact on preparedness & evacuation actions for emergency managers**
  - Greatest forecast challenge for hurricane forecasters
  - Not handled well by current operational models
  - High priority in HIRWG report and past NOAA research solicitations
  - 83% of major hurricanes have at least 1 RI event
    - Major hurricanes are responsible for 80% of all hurricane damage
  - Linked to changes in storm structure and storm surge

Research & operational efforts necessary to improve forecasts of rapid intensity change will also improve intensity & track forecasts