Evaluation of Experimental Models for Tropical Cyclone Forecasting in Support of the NOAA Hurricane Forecast Improvement Project (HFIP)

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With acknowledgment of the rest of the TCMT

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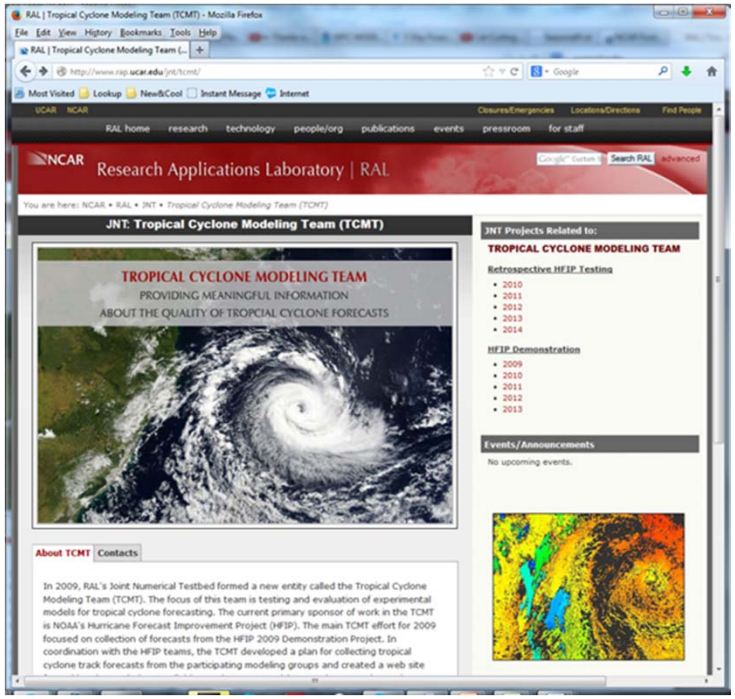
Tropical Cyclone Modeling Team (TCMT)

- Provides independent and consistent evaluations of research and operational model forecasts for tropical cyclones (TC)
- Develops new verification methods and tools for TC forecasts and community evaluation tools
- Designs and implements diagnostic verification experiments to evaluate the performance of TC forecast models
- Developed and maintains HFIP forecast database for comprehensive evaluations by HFIP community
- Developed TC verification guideline document for WMO



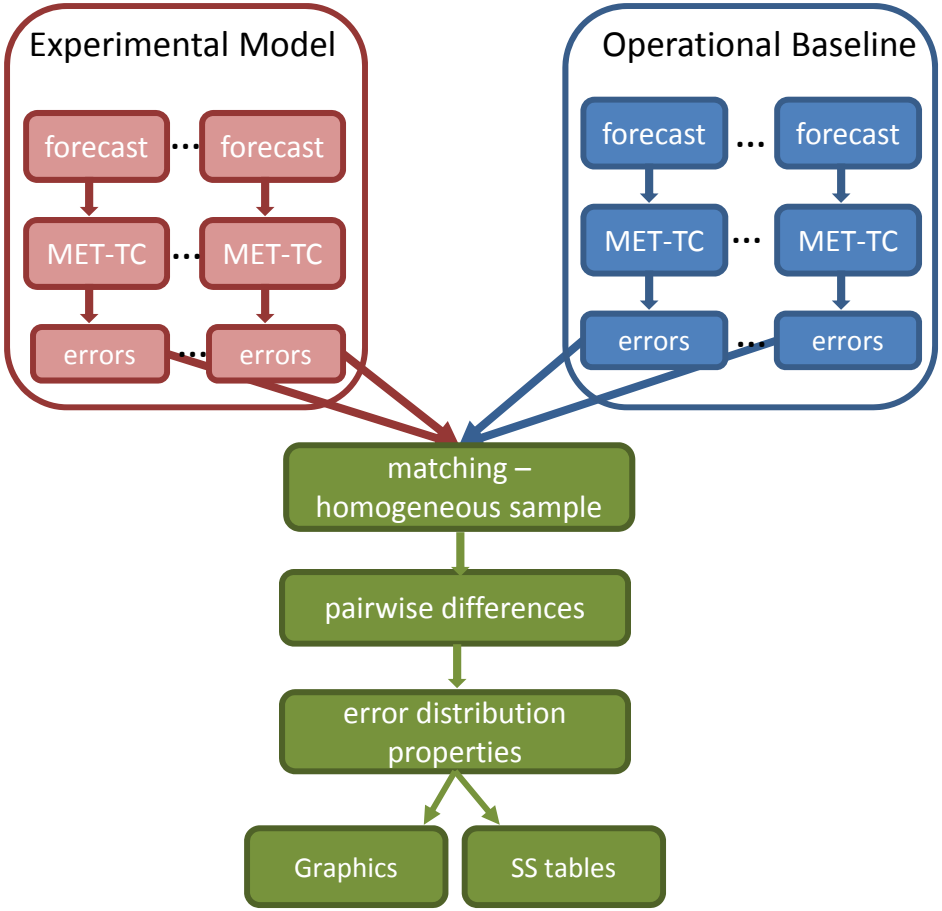
http://www.rap.ucar.edu/jnt/tcmt/

Annual HFIP Retrospective and Demonstration Evaluations

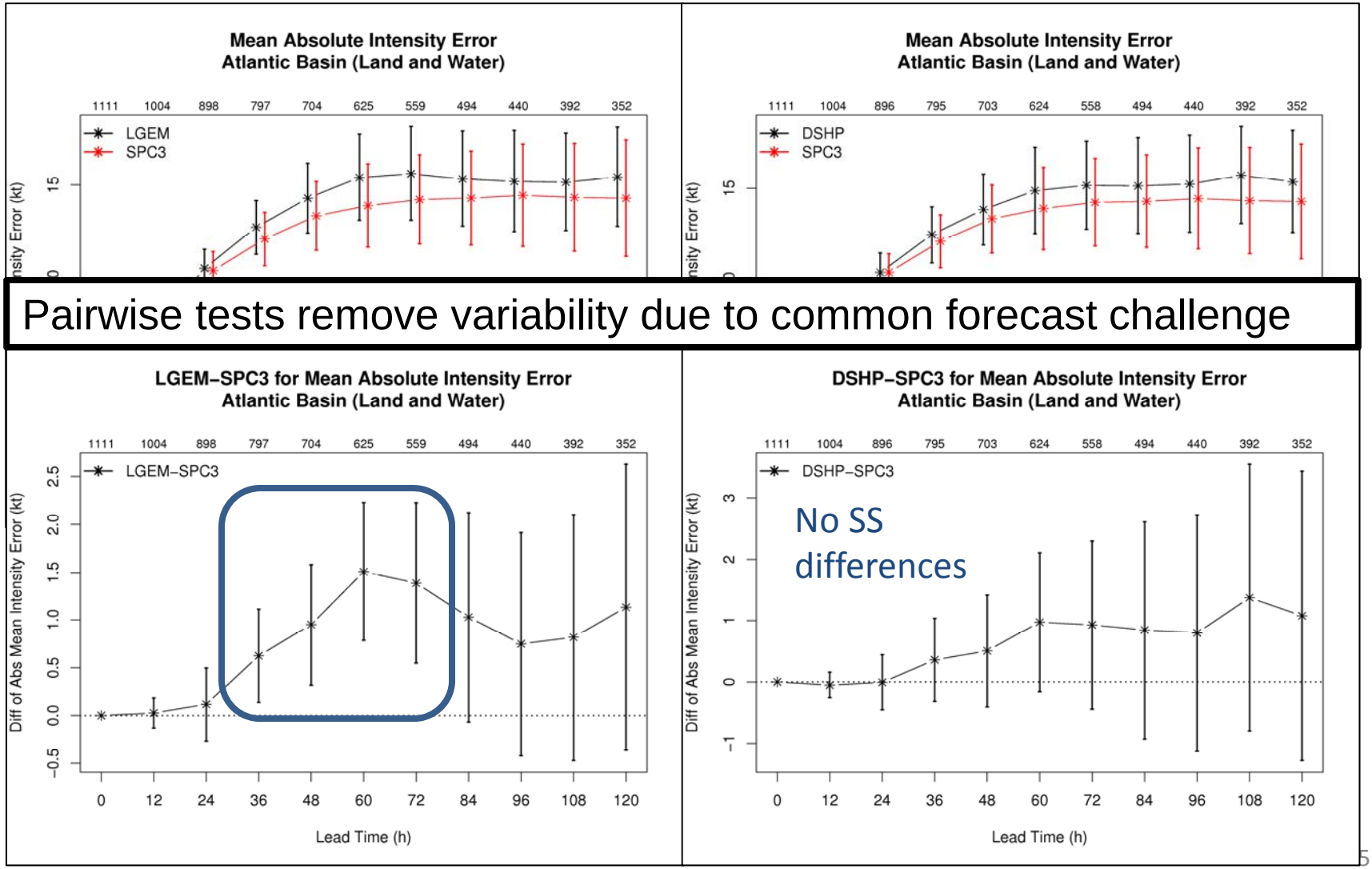
- TCMT leads annual evaluation of experimental TC forecasts for the North Atlantic and Eastern North Pacific Ocean basins
  - Retrospective Testing: Evaluate experimental model performance for past three hurricane seasons
    - Provide guidance on models to be evaluated by NHC forecasters
  - Demonstration: Evaluate model performance for current hurricane season and compare to retrospective performance
- Models evaluated include regional-dynamic-deterministic/ ensemble, global dynamic deterministic, weighted-consensus, and statistical-dynamic-consensus systems
- Evaluations starting in 2009 through 2013

New TC Evaluation Methods

Pairwise Model comparison to explore the distribution of errors and statistical significance



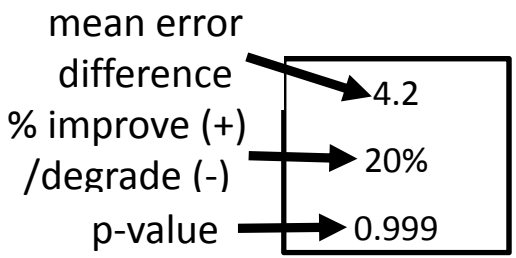
Getting the most out of the statistics…



New TC Evaluation Methods

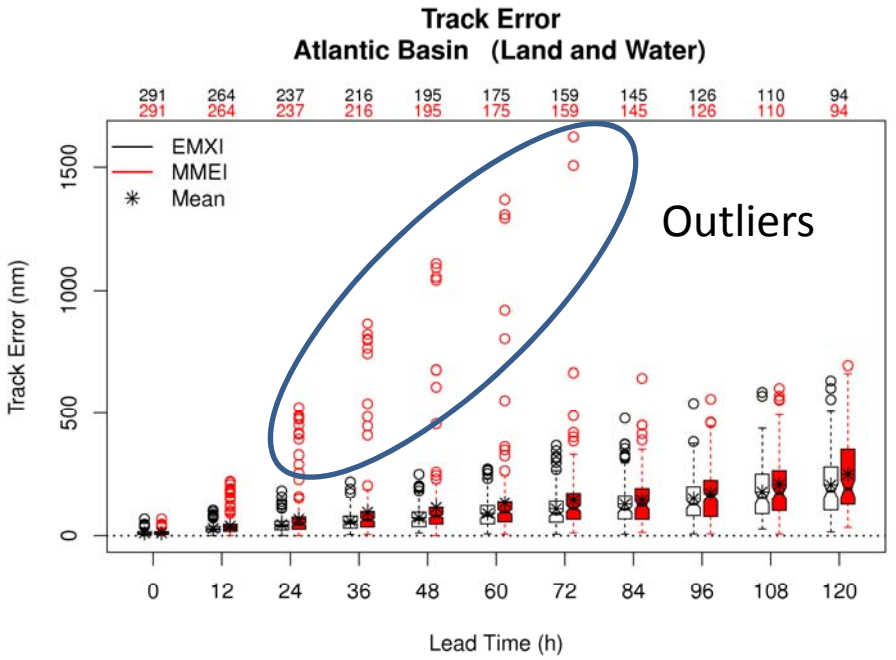
Pairwise Model comparison to explore the distribution of errors and statistical significance

Statistical Significance Tables



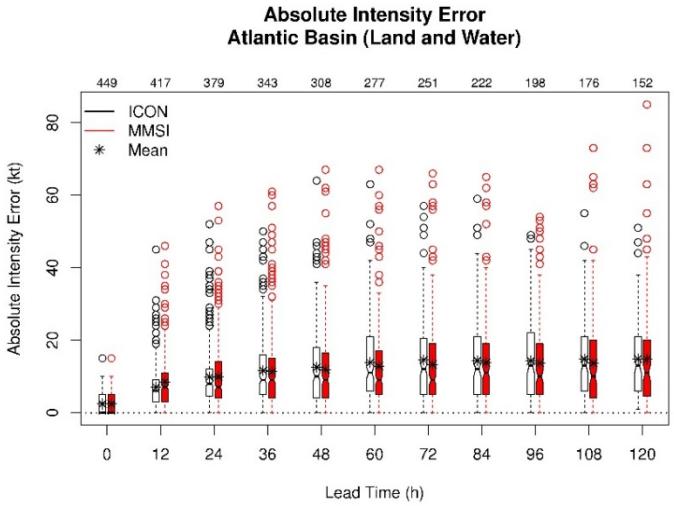
Forecast hour	12	24	36	48	60
GHMI	-5.7	-12.4	-18.2	-21.5	-24.2
Track	-17%	-22%	-23%	-22%	-20%
Land/Water	0.999	0.999	0.999	0.999	0.999
GHMI	-0.5	0.3	0.8	0.8	1.6
Intensity	-6%	2%	5%	5%	9%
Land/Water	0.987	0.546	0.625	0.576	0.954

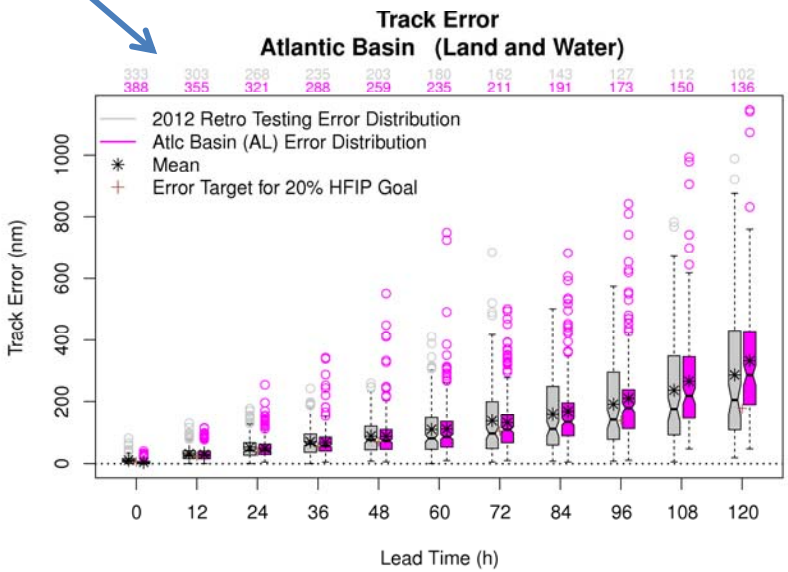
Distribution of errors

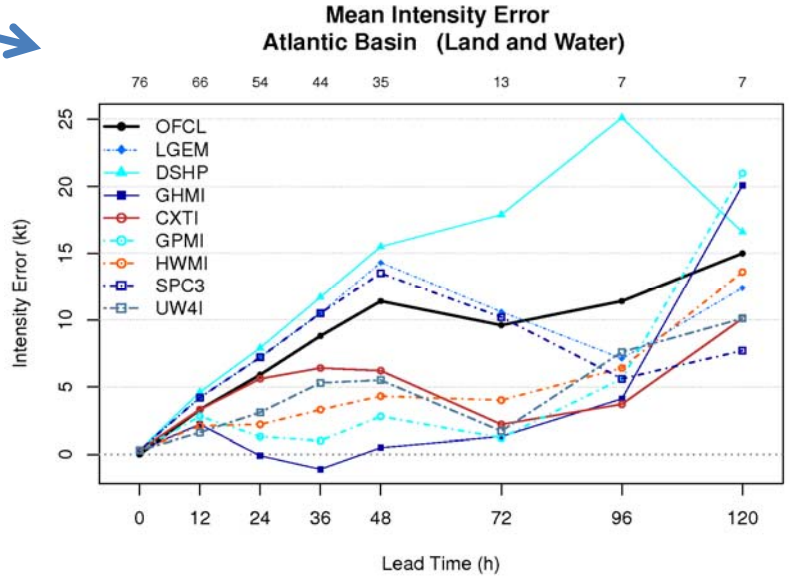


Retrospective and Demonstration Evaluations

- Experimental models compared to operational consensus during the retrospective tests
- Demonstration evaluation includes performance comparisons with operational models and retrospective results





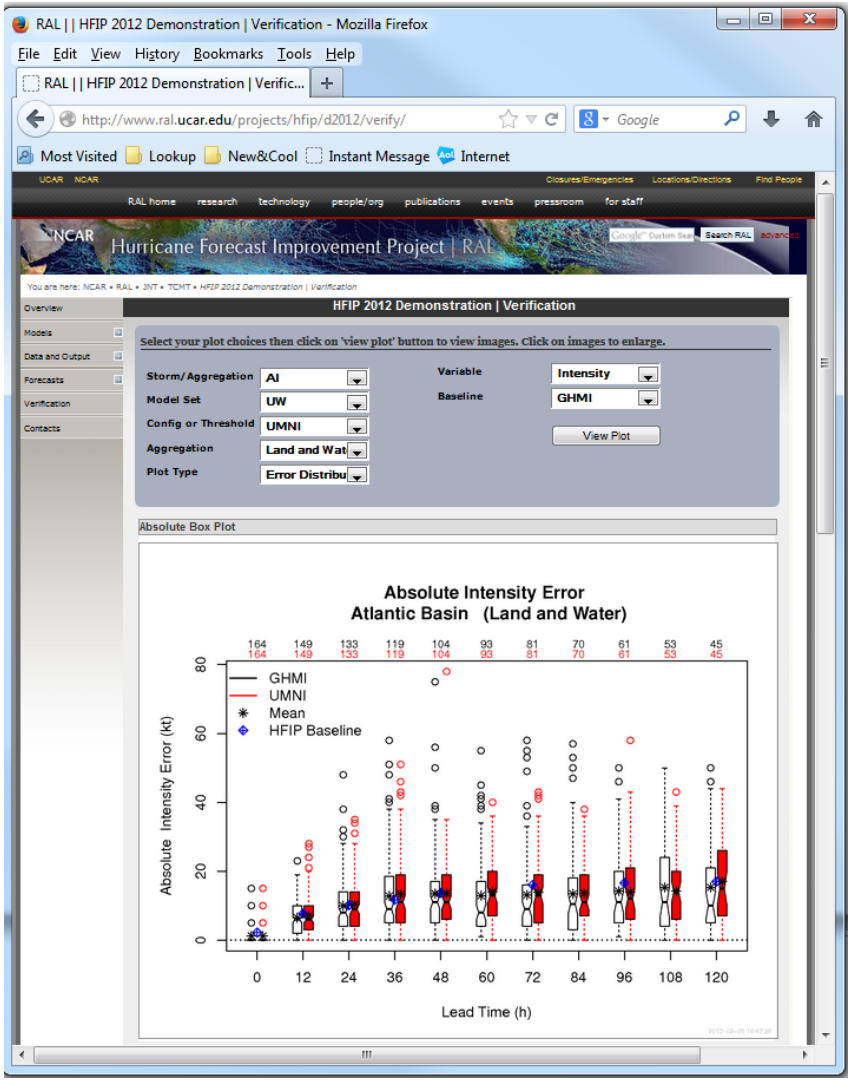


Online Access to HFIP Retrospective and Demonstration Evaluation Results

- Online access to retrospective and demonstration model evaluations to allow wider dissemination to the hurricane community:

  http://www.ral.ucar.edu/projects/hfip/

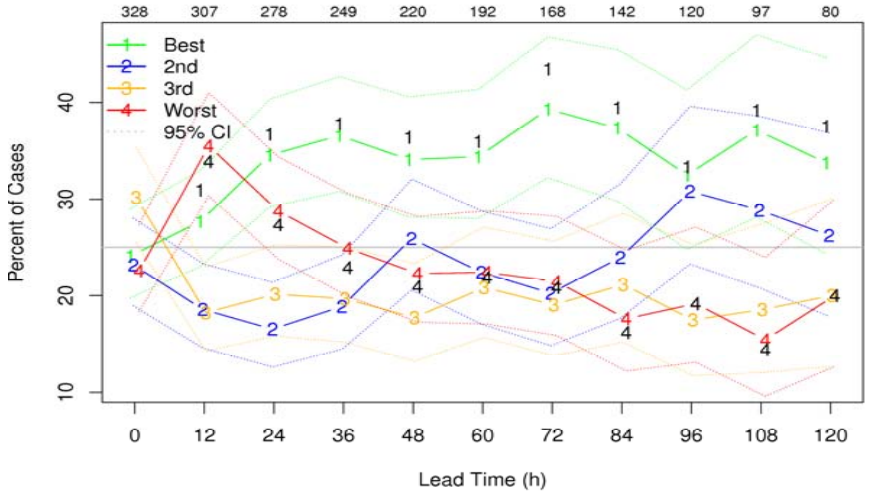
- Wide variety of statistics and evaluations:
  - Aggregations
    - Basin or storm
    - Land/water, or water only
  - Plot types
    - Error distributions
    - Line plots
    - Rank histogram
    - Demo vs. Retro
  - A variety of models, variables, and baselines to evaluate and compare



New TC Verification Tools

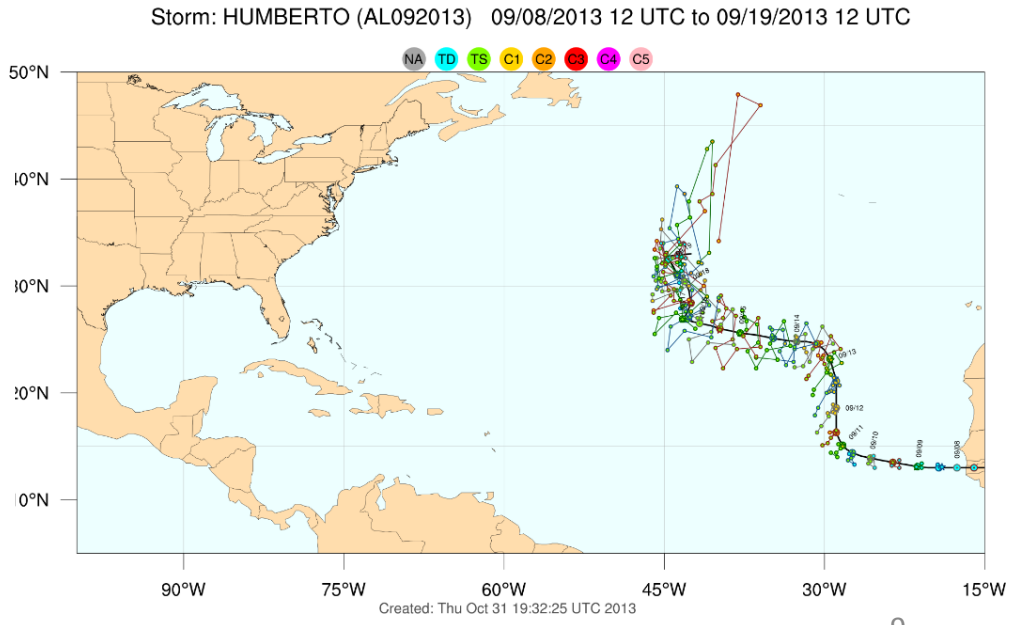
Forecast Model Rankings

- Rankings offer a comparison of an experimental model with a group of operational models
- Ranks look at percent of cases for which experimental model has smallest to largest errors – does not reflect size of differences between the errors.



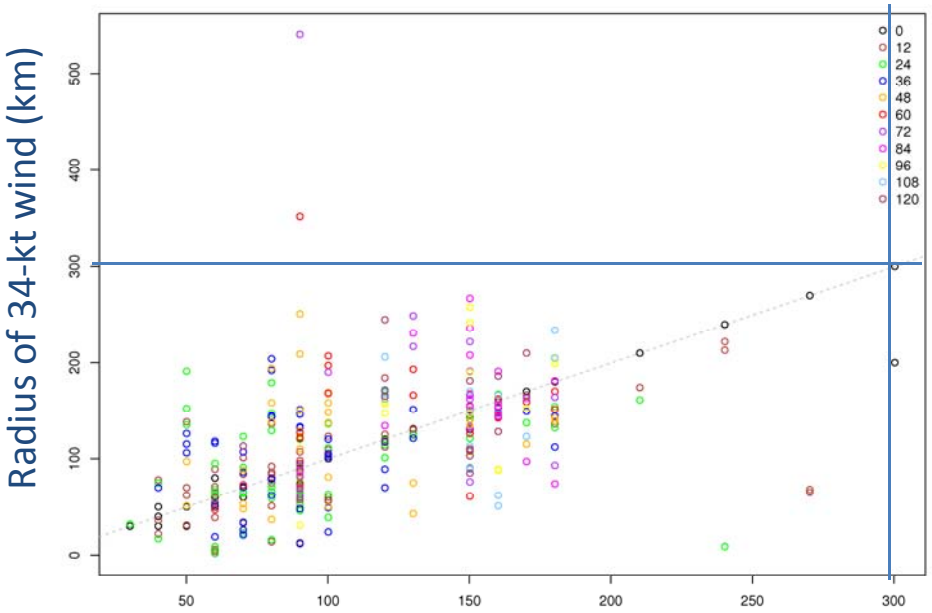
Forecast Revision Series

- Provides a method to examine forecast consistency between forecast cycles
- Summary measures being developed

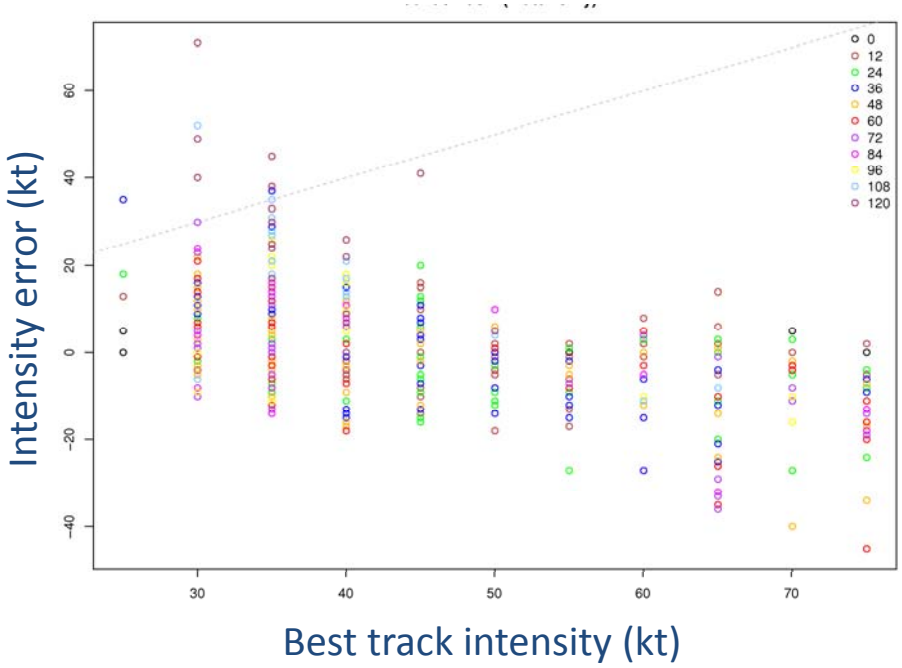


Diagnostic Evaluation of Wind Fields

Goal: examine relationships (e.g., wind quadrant radii, intensity errors) that provide more diagnostic information about forecast performance



Radius of 34 kt wind in the NE quadrant as a function of best track radius (color coded by lead time)



Intensity errors as a function of best track intensity (color coded by lead time)

Diagnostic Evaluation of Wind Fields

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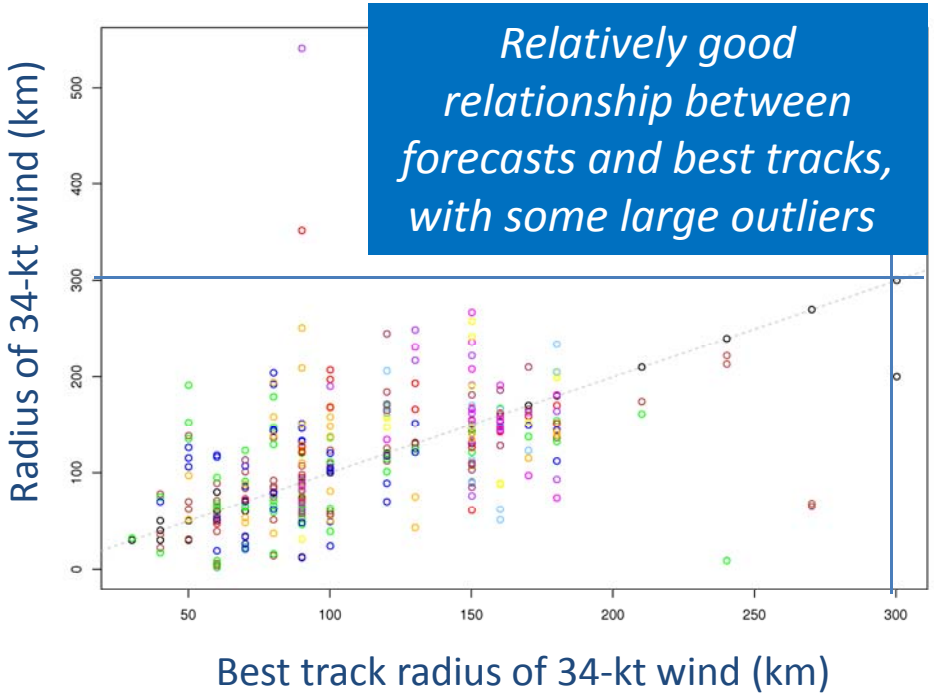
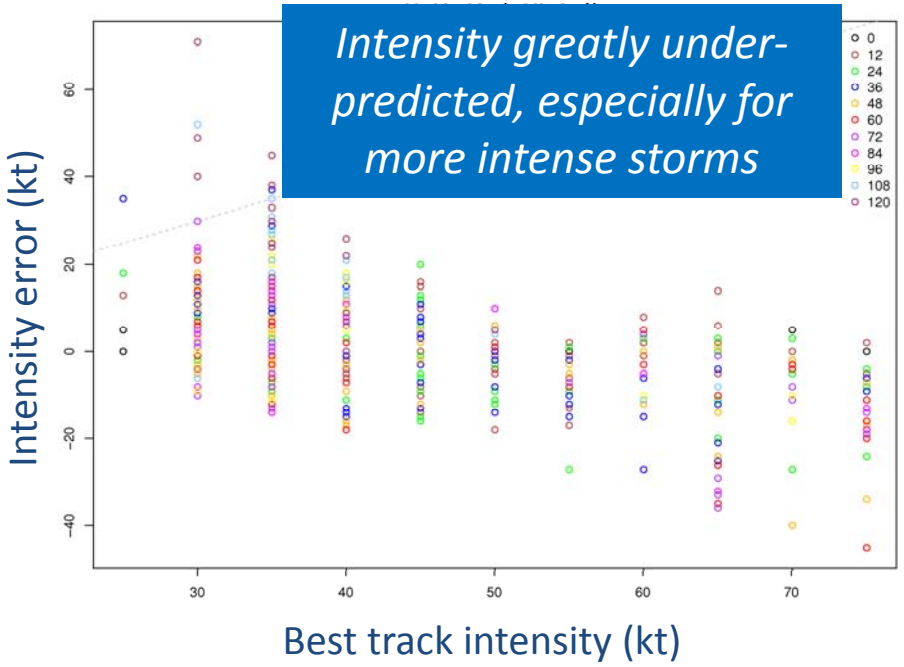




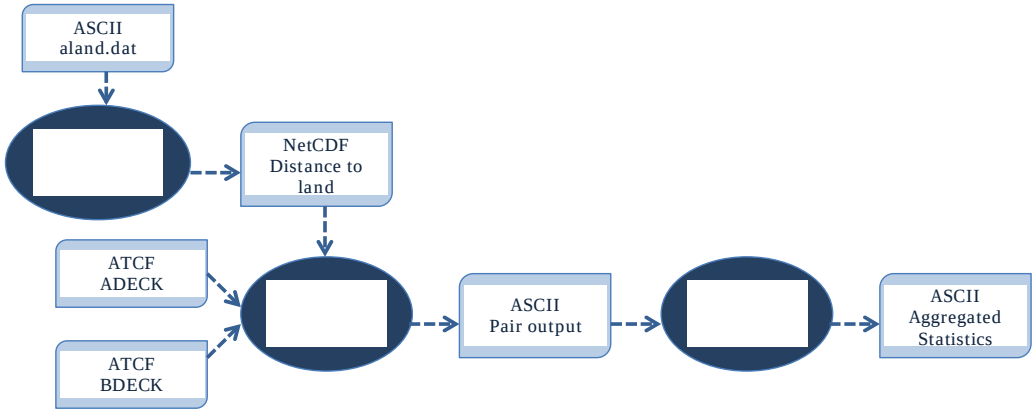
Radius of 34 kt wind in the NE quadrant as a function of best track radius (color coded by lead time)

Intensity errors as a function of best track intensity (color coded by lead time)

MET-TC: New Tropical Cyclone Verification Toolkit

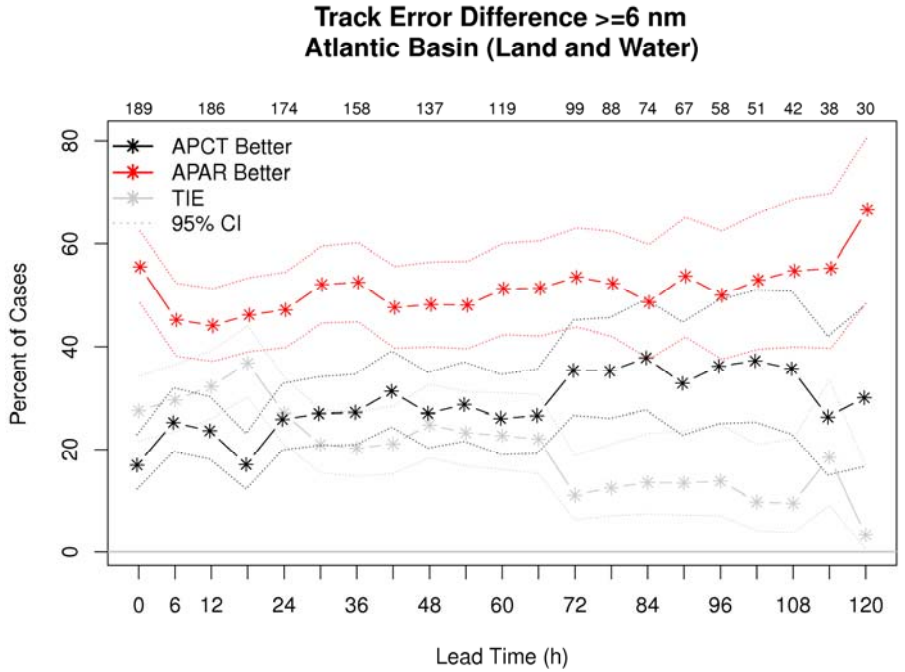
- Replicates functionality of the current NHC verification software
- Provides flexible framework for performing evaluations without needing to reprocess data for different aggregations
- Modular set of tools that utilize the MET software framework
  - Allows for additional capabilities and features to be added in future releases
- MET-TC is available as an open source community verification package through the Developmental Testbed Center (DTC):

  http://www.dtcenter.org/met/users/



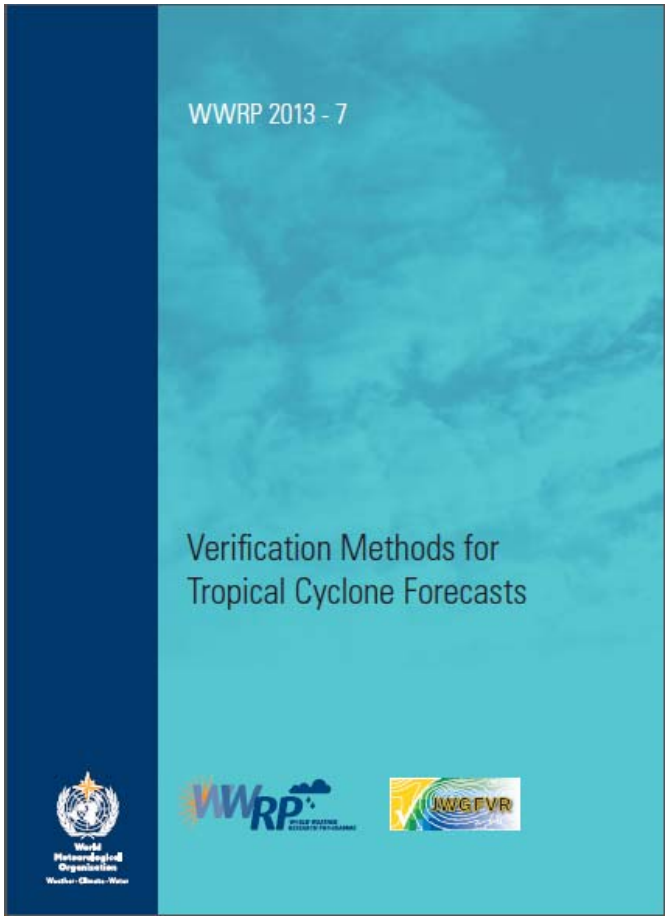
HFIP Aircraft Reconnaissance Data Impact Studies

- Conduct systematic investigation of the impact of aircraft reconnaissance data from the inner core of tropical cyclones on numerical guidance provided by regional tropical cyclone models
- Provides a framework to conduct consistent observing system evaluations.
- Methodology can be applied to evaluating the impact of other datasets such as satellite & other aircraft observations



WMO Hurricane Verification Document

- Comprehensive document on TC verification methods
- Developed by WMO verification working group
  - Reviewed by many members of this community



Available at
http://www.wmo.int/pages/prog/arep/wwrp/new/Forecast_Verification.html

Summary

- TCMT provides consistent evaluations of the TC forecasting performance of experimental models for HFIP
- A rigorous verification approach has been implemented for these evaluations, which leads to consistent and comparable analyses
- New tools and guidelines have been made available for the community