HFIP Diagnostics and Verification Workshop
4 May – 6 May, 2009

HFIP Verification Team

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HFIP Goals

- 20% Forecast improvement in 5 years
- 50% Forecast improvement in 10 years

The role of the verification team:

- Assessing the progress towards those official HFIP goals.

- Assisting other teams in model development by developing and providing a "verification toolkit" for modelers to use.

Responsibilities of the Verification & Diagnostics Teams

Verification: Was the forecast right or wrong?

Diagnostics: **WHY** was the forecast right or wrong?

For example….

• Mean track forecast error at 72h = 230 n mi.

Steering flow analysis

Strength & timing of large-scale environmental features

Was the storm consistently initialized too strong? Too weak?

Functions of the Verification Team

- Define a set of metrics that will be used when validating forecasts in order to determine progress towards HFIP goals (Initially: Current NHC metrics).

- Develop and maintain a group of verification tools that can be used by all teams to validate various metrics from model forecasts.

- Perform annual forecast verifications and report the results to HFIP management so that progress towards HFIP goals can be assessed.

Current NHC Forecast Verification Metrics

1. Track position forecast errors
(up to 5 day lead time)

2. Maximum wind forecast errors
### (up to 5 day lead time)
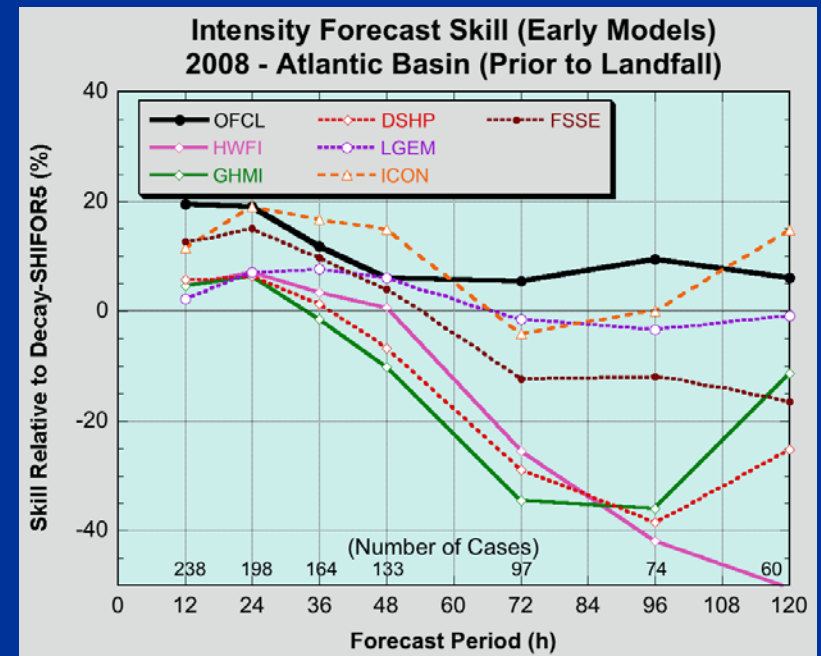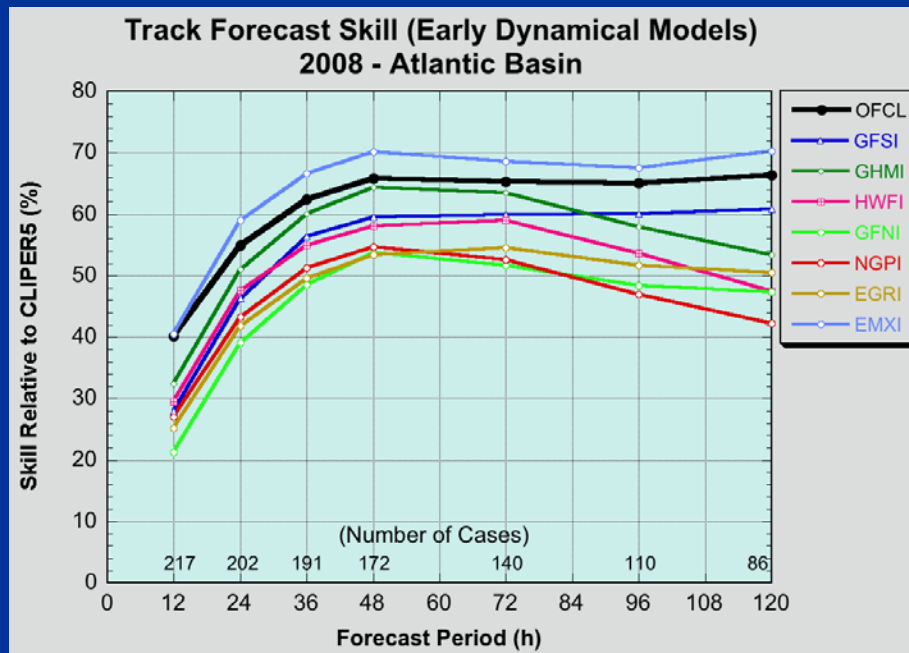
(Courtesy: James Franklin)

Potential new verification metrics...

## ...but the tools either do not exist or are not yet 100% portable

- RI / RW forecasts (POD & FAR stats, timing of onset errors)

- Track forecasts (out to 7-day lead time)

- Wind structure forecasts (RMW, vertical structure, surface wind profiles, fractional wind coverage, IKE and related storm damage potential variables)

- Rainfall forecasts (pattern-matching, mean/volume, extreme amounts, feature-based / spatial verification)

- Ensemble-based probabilistic guidance

- Ocean response guidance (Taylor diagrams)

- Consistency of forecasts from one cycle to the next

Vortex-scale diagnostics: Wind field size & structure

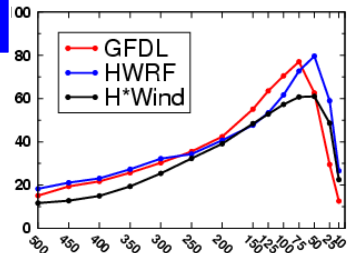## Time-radius Hovmoller of axisymmetric 10-m wind from H*Wind and HWRF-x
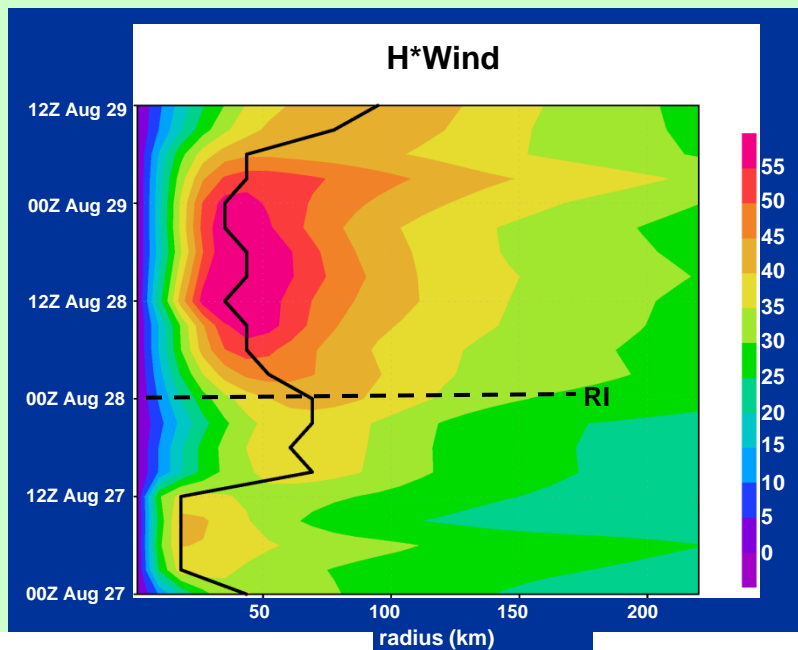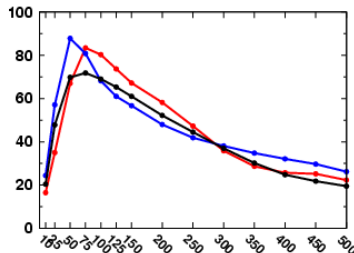

Courtesy: Rob Rogers
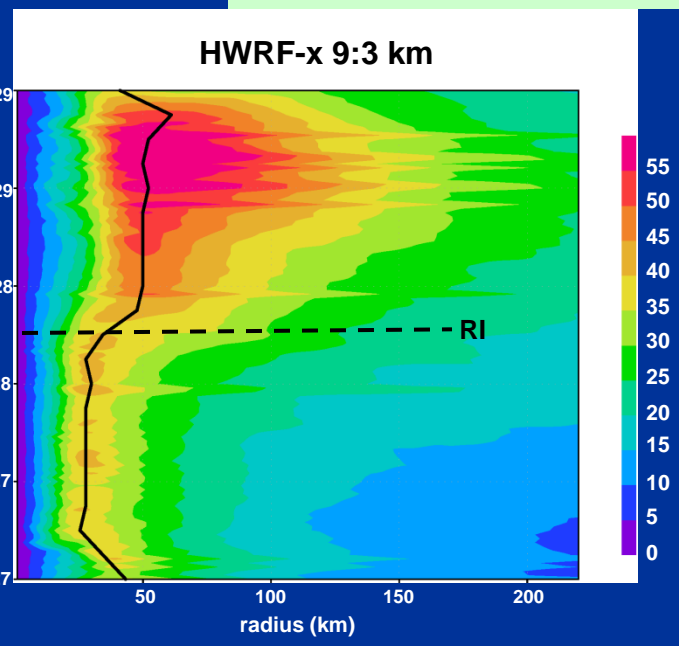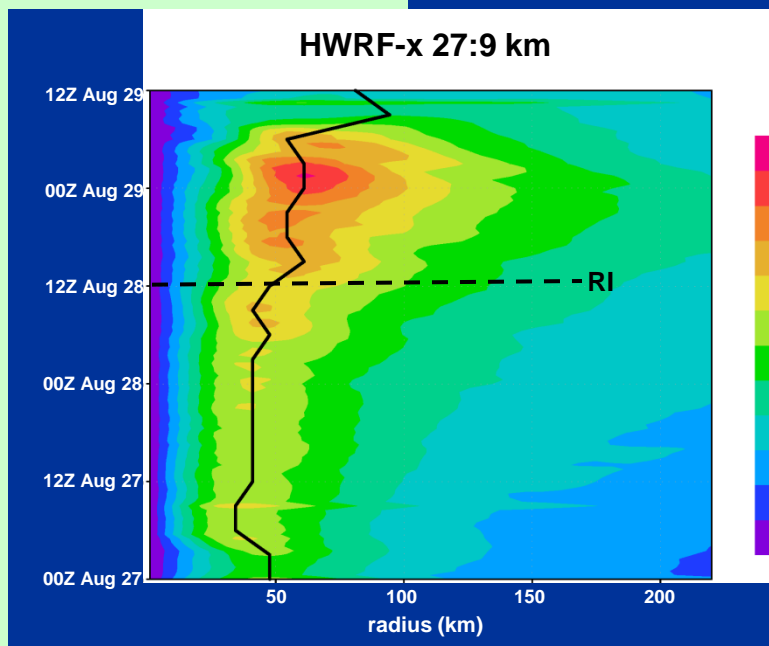
10-m Wind Structure

Profiles of 10-m Wind Speed (kts) by Quadrant
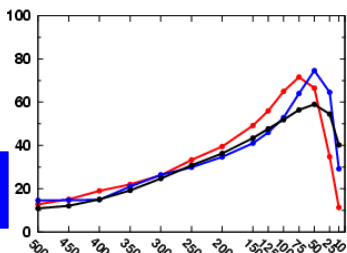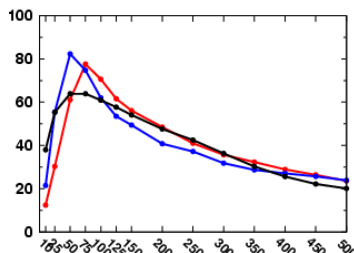2008 Atlantic TCs (Init Vmax > 64 kts),   tau=48h
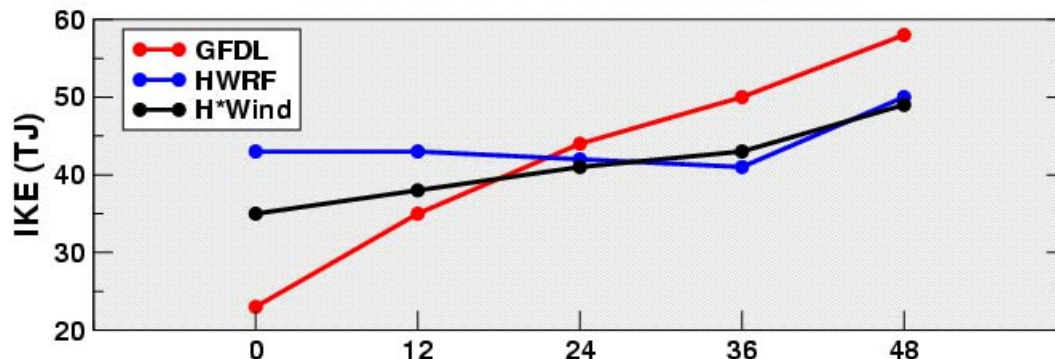
NW NE SW SE

Radial profiles of the tangential wind, compared against H*Wind

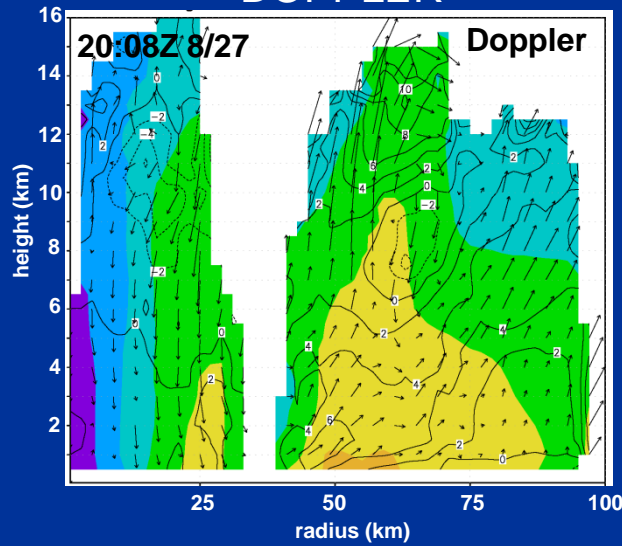Forecasts of Integrated Kinetic Energy, compared against H*Wind

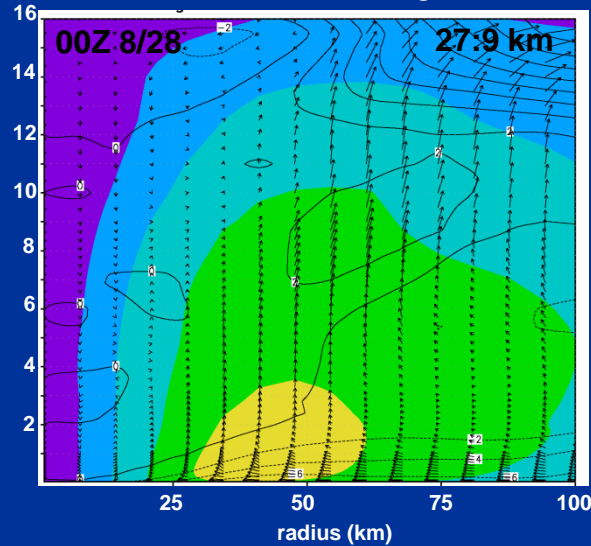Forecast and Observed IKE (for winds >18 m/s)
Subset of Atlantic Storms, 2008

Vortex-scale diagnostics: Vertical structure of axisymmetric vortex

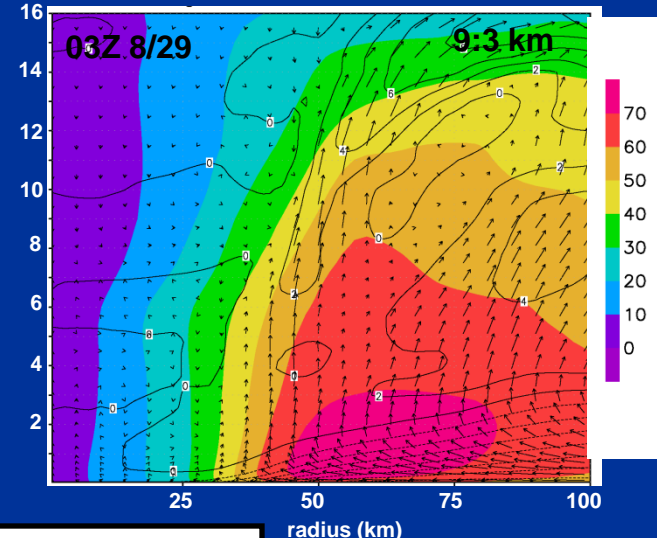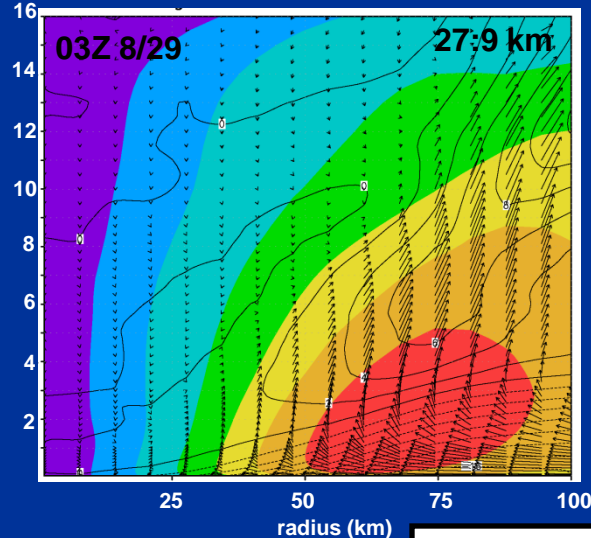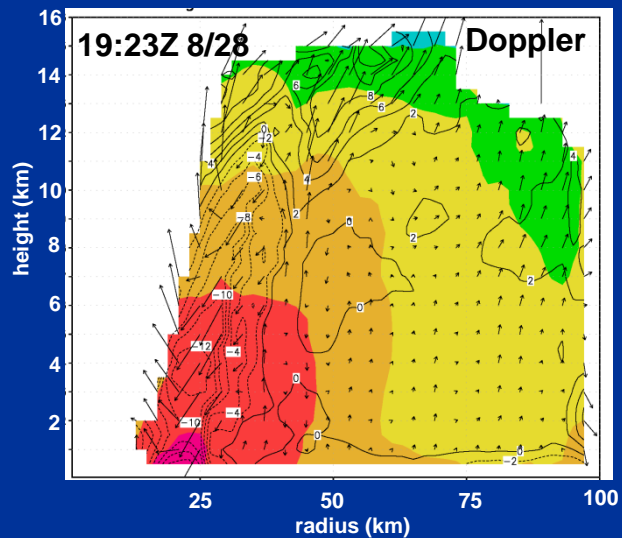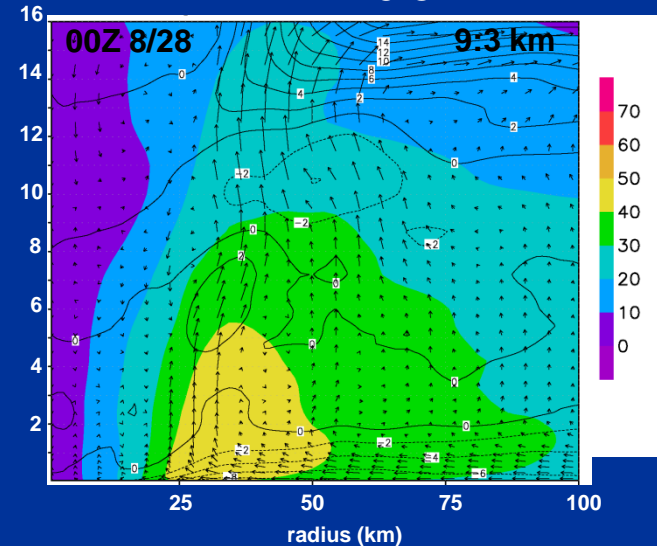## Axisymmetric tangential (shaded, m s⁻¹) and radial wind (contour, m s⁻¹) for Doppler and HWRF-x

Courtesy: Rob Rogers

Track-relative rainfall verifications

0-100 km
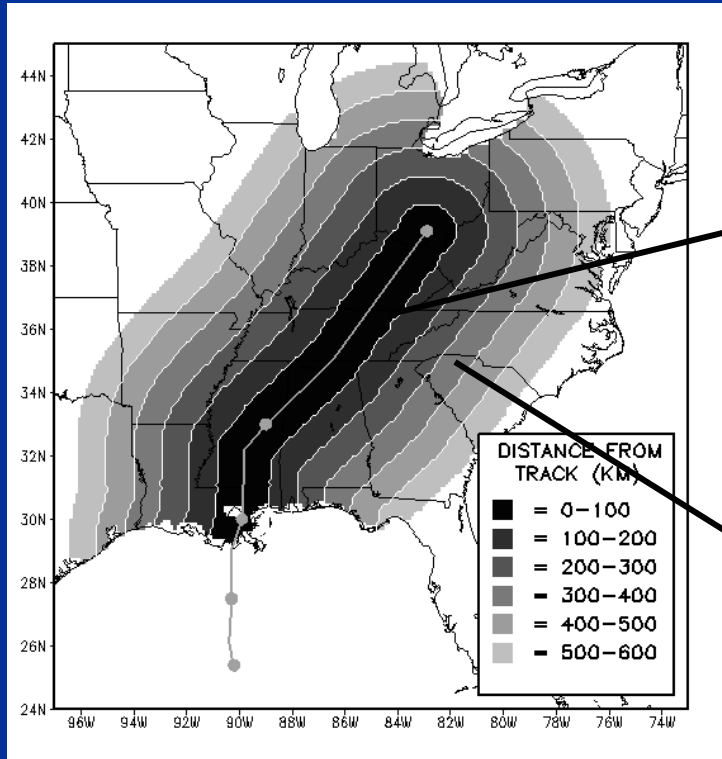
300-400 km

Marchok et al., 2007
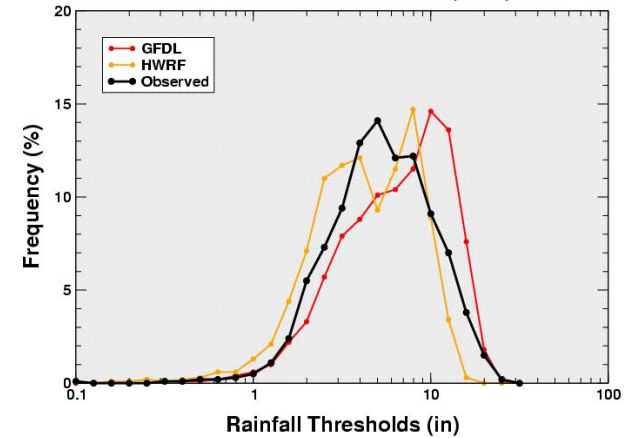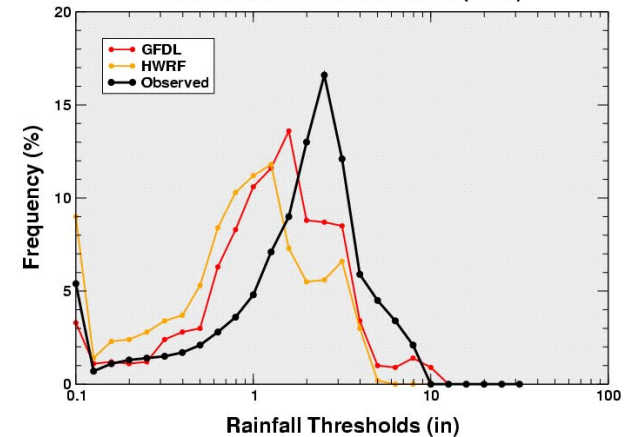
Spatial verification approaches

Filtering

1. Neighborhood
2. Scale separation

Displacement

3. Feature-based
4. Field deformation

Courtesy: Barb Brown

Assessing the ocean response to hurricane forcing

Taylor Diagram: simulations vs. baseline:

SST

Taylor Diagram: simulations vs. Observations:

SST

Courtesy: Nick Shay

Discussion items…

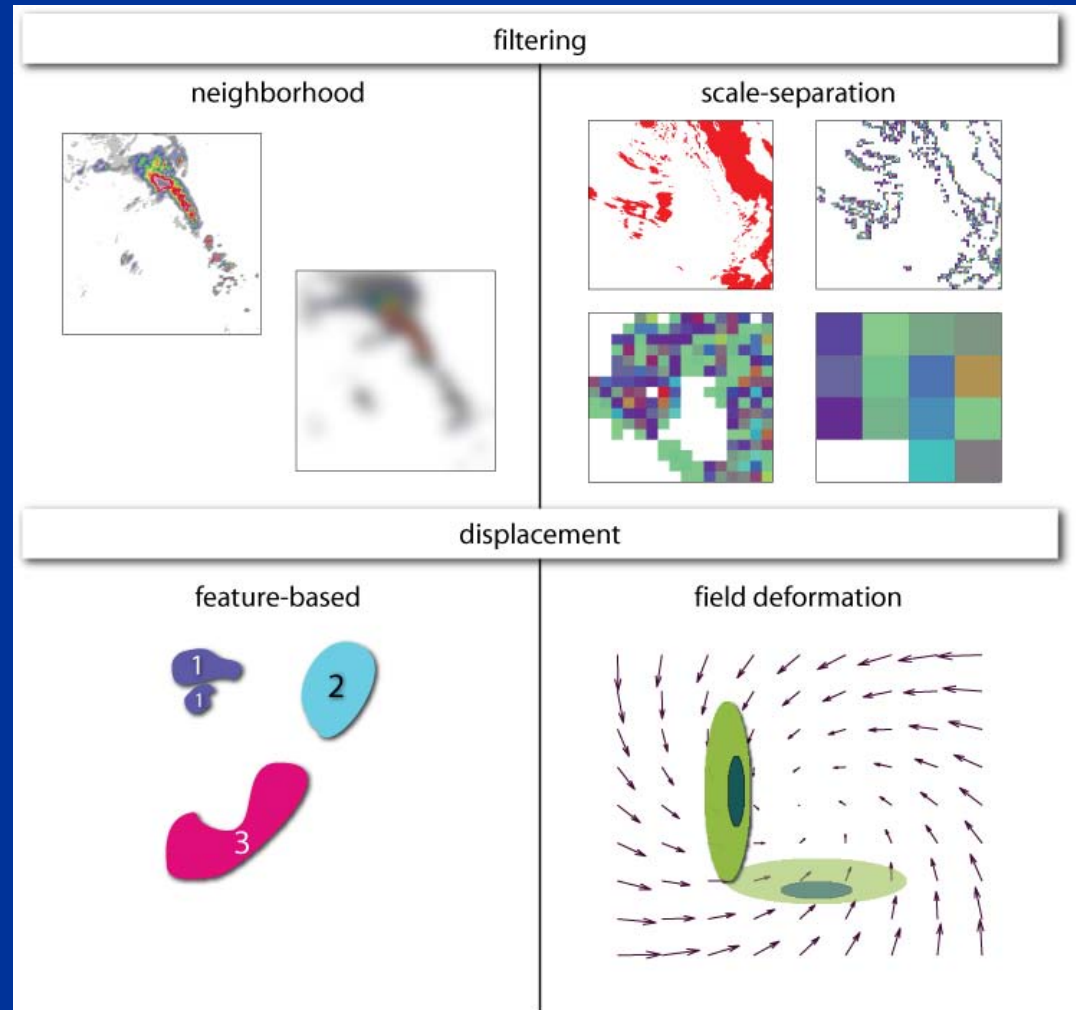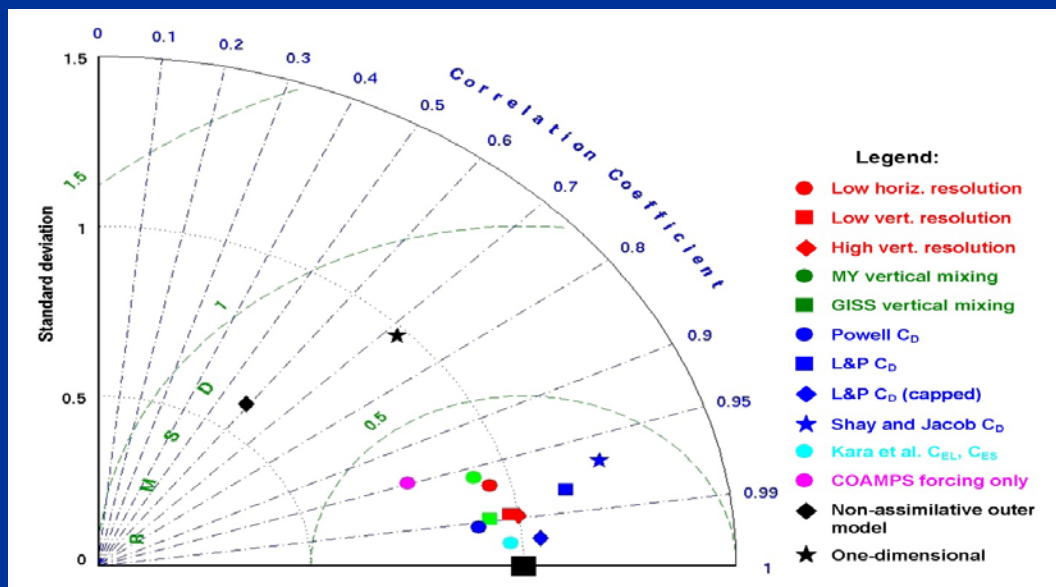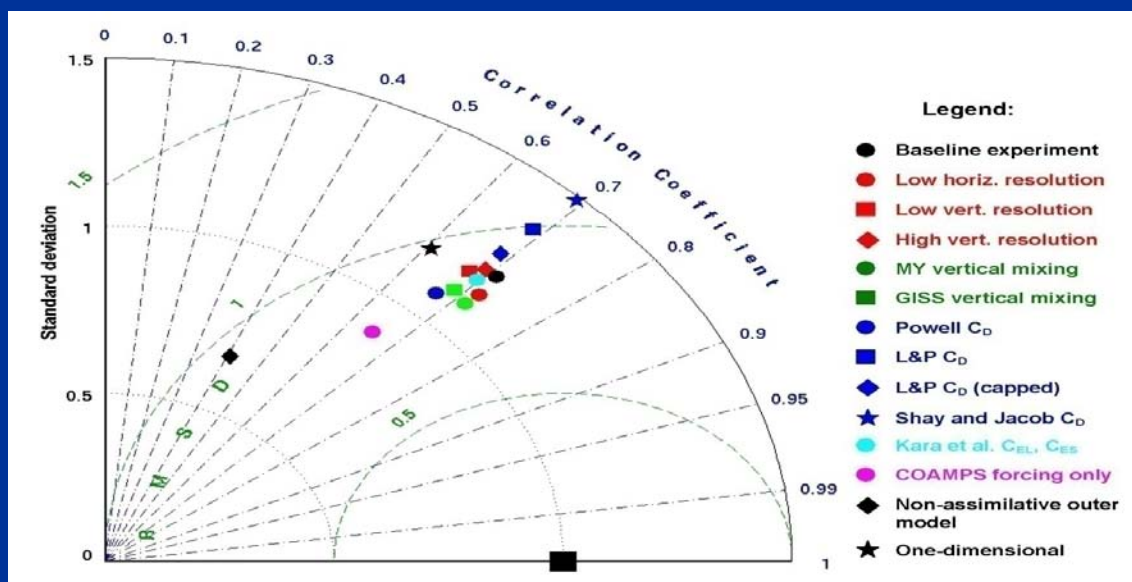- For assessing our progress towards HFIP 5- and 10-year goals, should any metrics other than these four be verified and tracked year to year: (1) 5-day track forecast errors; (2) 5-day intensity forecast errors; (3) RI/RW forecast statistics; (4) Skillful 7-day forecasts?

- Should forecasting of tropical cyclogenesis be an area addressed by the verification team?

- Verification team Year 1 milestone #5: *"Perform baseline verification for existing HFIP models and provide annual report to HFIP management and other HFIP teams."* Which models should be in that group for this first (baseline) year?

Discussion items...

- How can the verification team best interact with the various modeling & diagnostic teams?

- How and when will verification tools be made available to the modeling groups for development use?

- Regarding submission of verification tools to the "verification toolbox" by the modeling groups: Will developers be willing to submit any verification packages they have, and will they be willing to offer support?

Discussion items…

- DTC is collecting an invaluable suite of model forecast data. What happens after June with this data, and should more be done in terms of diagnostics and verification than simply track, intensity, and RI/RW?

- If we would ever do another high res test again, would we do anything differently? What did we miss on this test?

Discussion items...

- A major thrust of HFIP is the utilization of ensemble forecasts. Besides ensemble <u>mean</u> track & intensity forecasts, what ensemble-based guidance can we envision that is directed towards the primary HFIP goals, and what methods, algorithms and software are available for verification?

  - ➤ One guidance possibility: Wind speed probability guidance, mimicking the DeMaria product, but derived instead from dynamical models.