Validation of HWRF forecasts with satellite observations

Project team

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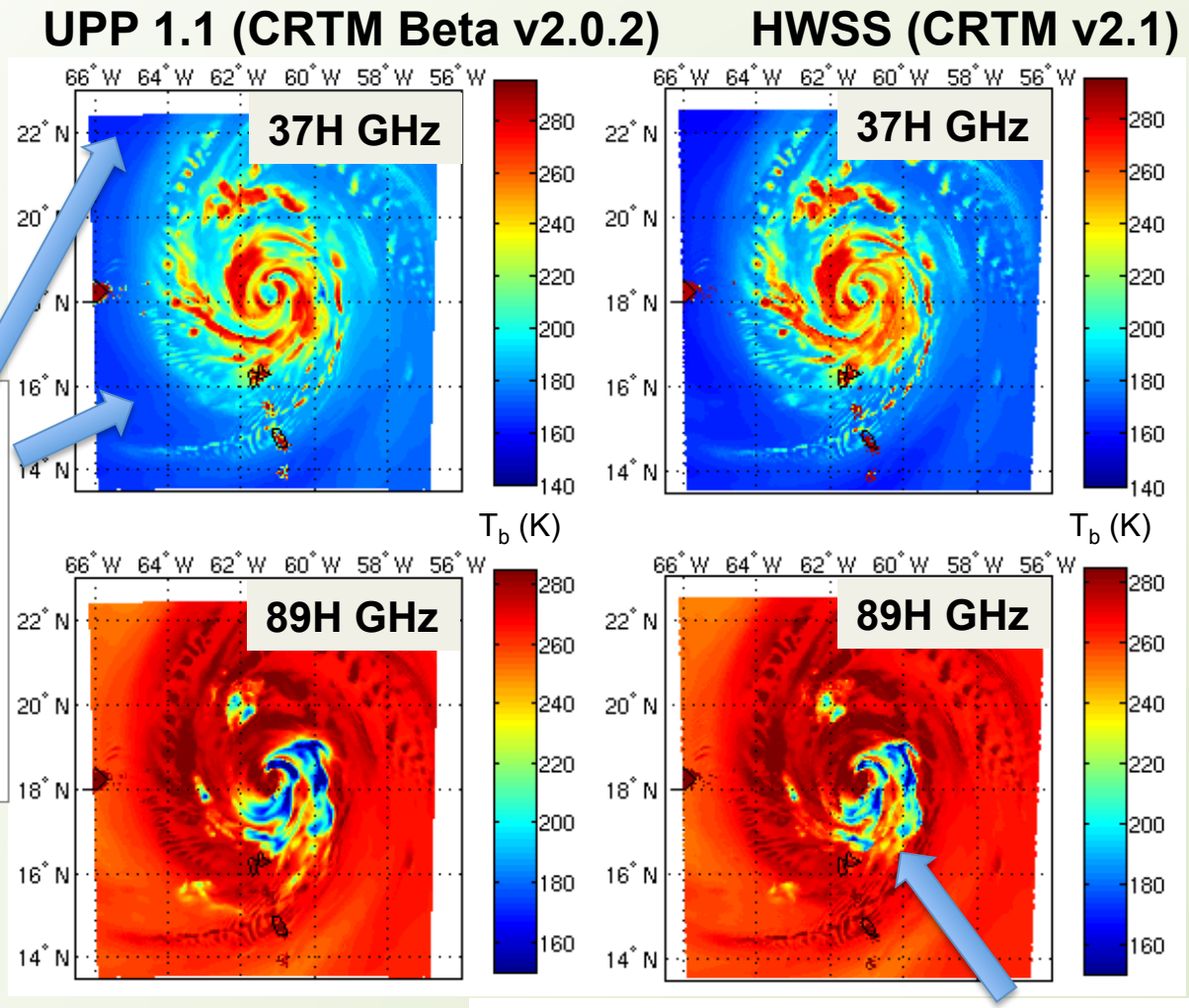
Background

- **Goals**
  - ➢ Develop satellite instrument simulator (HWSS) for generating satellite equivalent observations using HWRF forecasts
  - ➢ Transition HWSS capabilities into HWRF operational post-processing environment
  - ➢ Develop satellite-data-specific diagnostics for validation of HWRF forecasts
- **Project time line**
  - – September 2011 – August 2013

Summary of accomplishments Year 1-second ½, Year 2-first ½

- HWSS development
  - New features
    - Storm relative analysis; requires observed storm center (e.g., ARCHER)
    - Ferrier ice microphysics; in collaboration with B. Ferrier
    - QuickBeam; simulates CloudSat CPR and TRMM PR
    - Remapping tool; coarsens model grid data using instrument antenna pattern (microwave sensors only)
    - Slant path radiative transfer; modified CRTM v2.1
  - Comparison to UPP

UPP/HWSS AMSR-E comparison

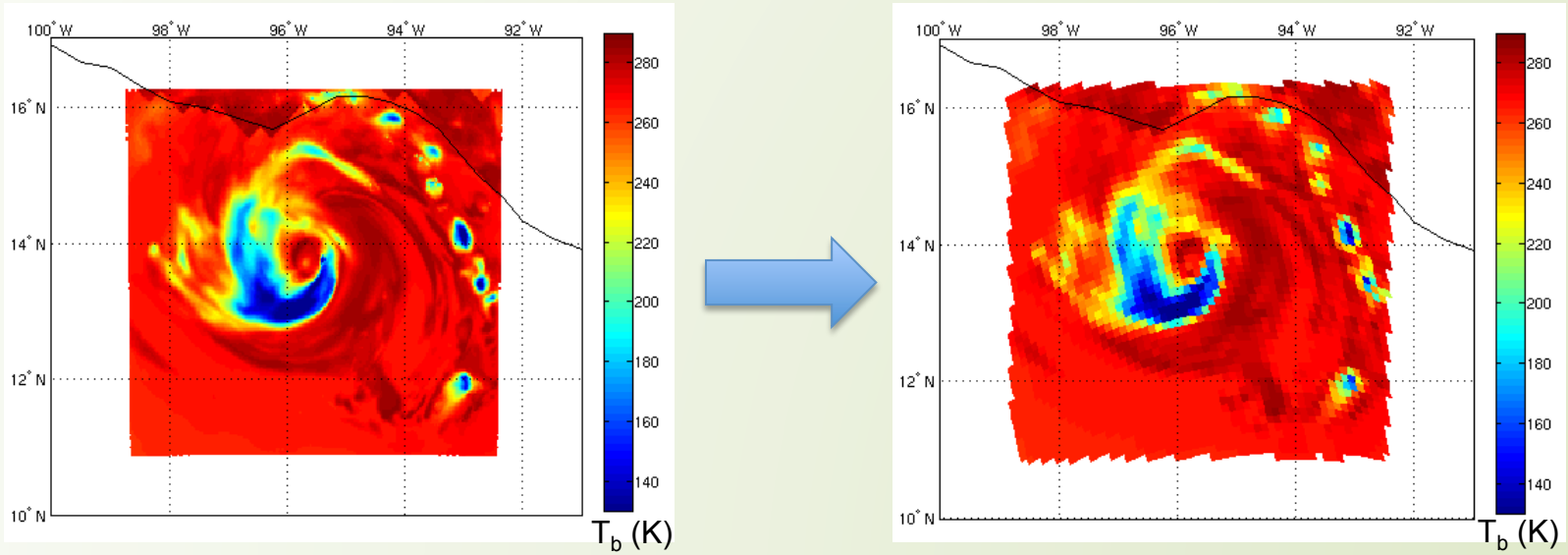


Differences in cloud free areas likely due to differences in sea surface emissivity models at 37 GHz

Cause of differences in ice scattering regions is unclear

Transition to operations

- Data remapping
  - Provide forecast SSMIS 91H GHz T_b fields that mimic the observations and allow for "apples-to-apples" ARCHER analysis
  - Code delivered to Dave Zelinsky (NHC)



Transition to operations

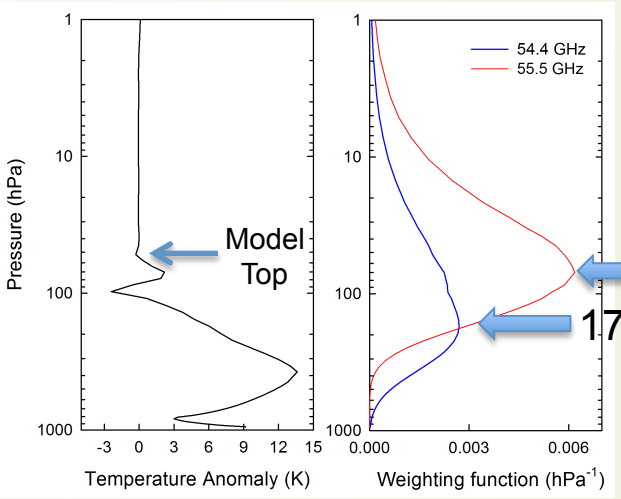
- Warm core anomaly products
  - UPP code modified to output SSMIS channel 4 (54.4 GHz) data to provide information about upper tropospheric warming (courtesy of Sam Trahan, EMC)
  - Although code has yet to be tested, plans are to generate products similar to those available from SSMIS observations

Hurricane Earl example

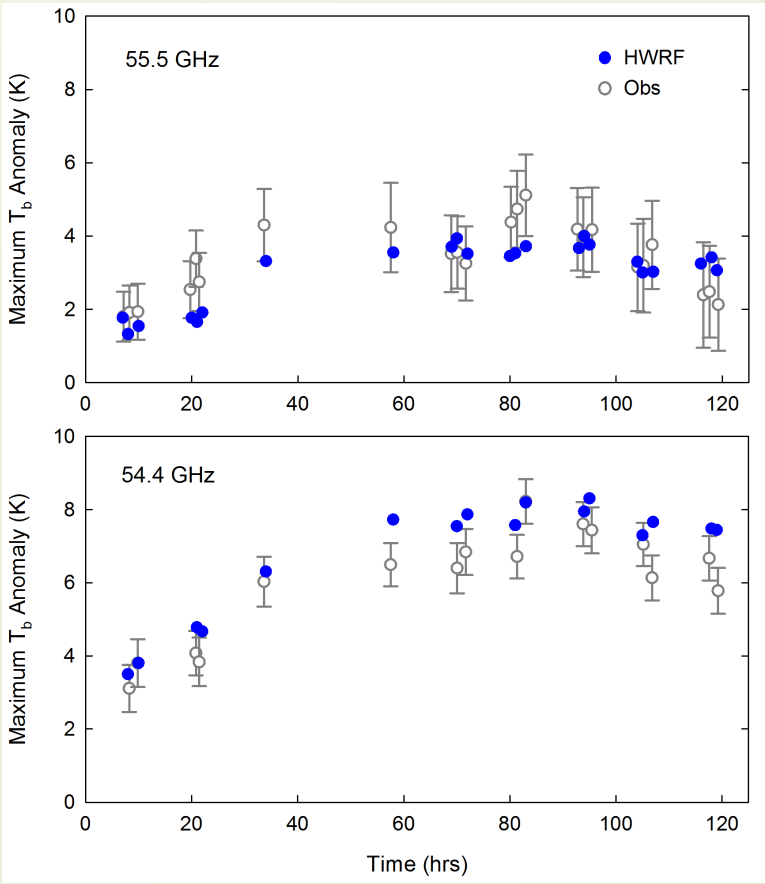
- Hurricane Earl: 29 Aug – 3 Sep 2010
- New DA system (HEDAS) at AOML/HRD was used with latest version of HWRF (the operational version)
- 124-hr run initialized at 14 UTC 29 Aug 2010
- Innermost nested grid domain at 3 km grid spacing
- Explicit convection

Validation: Warm core anomaly

- **How well does HWRF predict upper tropospheric warming?**
- Matching criteria:
  - Forecast within ½ hr of SSMIS obs
  - Storm center must be away from edge of satellite swath

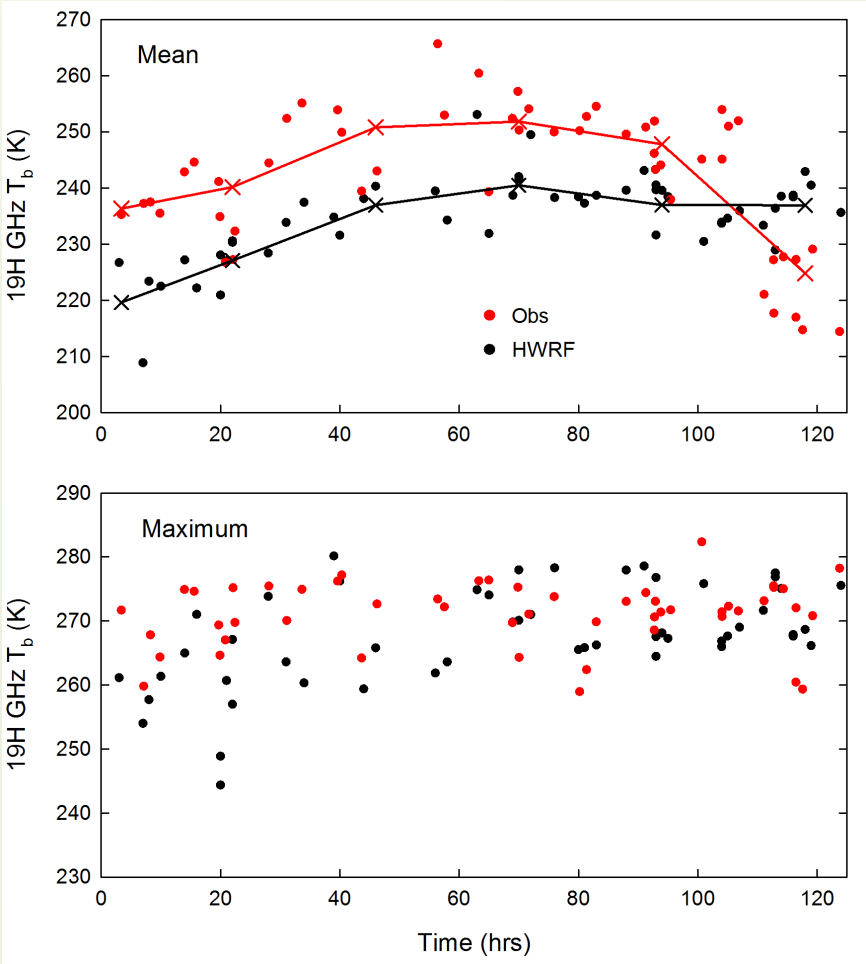


Maximum warm core anomalies:



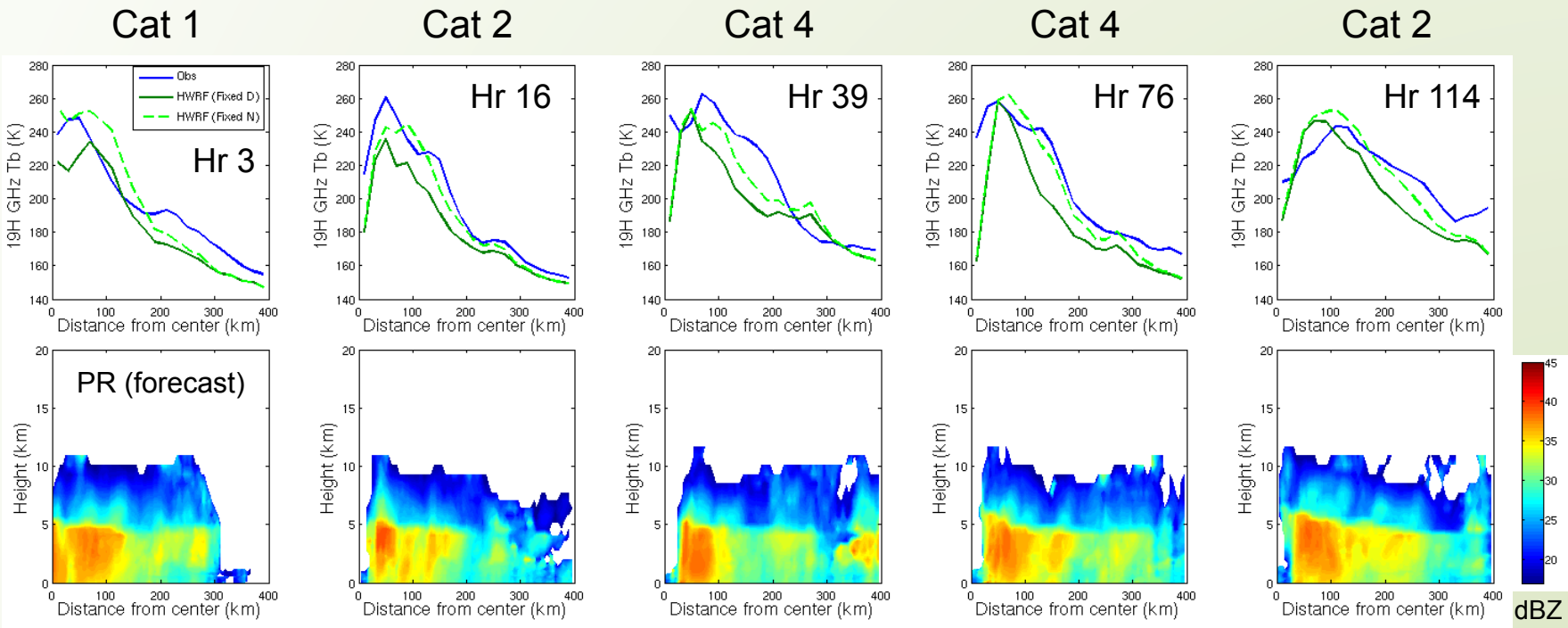
Validation: Inner core rain

- **How well does HWRF predict the inner core (< 100 km) rain field intensity?**
- Source of 19H GHz obs:
  - SSMI F-15
  - SSMIS F-16/17/18 (courtesy of Wesley Berg, CSU)
  - TMI
  - AMSR-E
- Matchup criteria:
  - Within ½ hr of obs
  - Data remapped



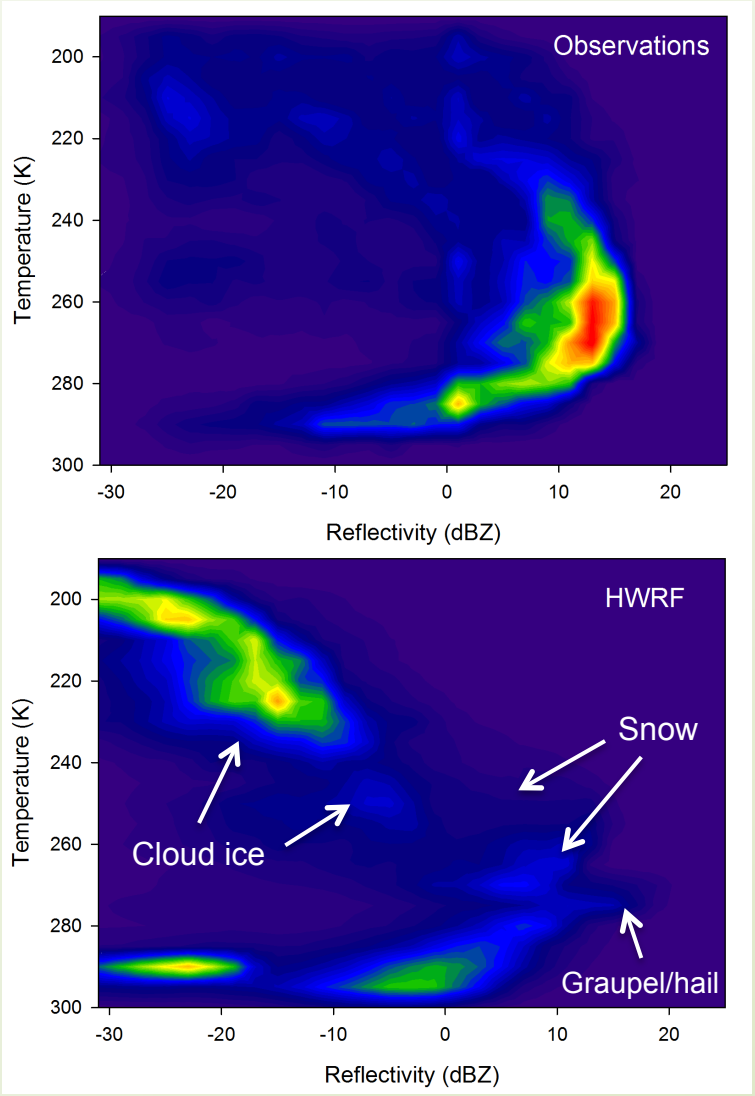
Validation: Rain structure

- Time evolution of the horizontal structure of rain using 19H GHz data



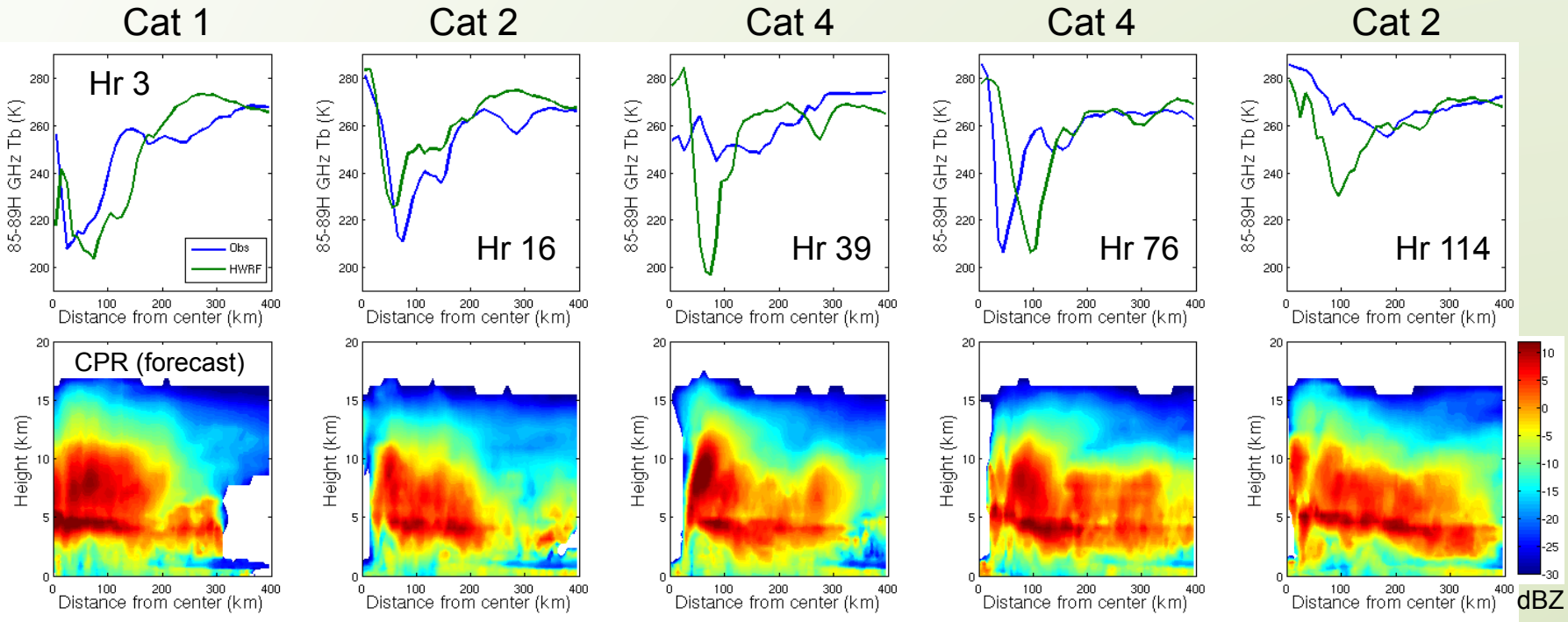
Validation: Ice microphysics

- CloudSat CPR validation
  - One CloudSat overpass at 0610 UTC on 31 Aug 2010
  - Fixed particle sizes assumed
- Characteristic features of joint PDFs (T vs reflectivity)
  - Cloud ice (240-200 K) more frequent in simulation than obs
  - Simulation lacks frequent large reflectivities at colder temps (220-250 K)

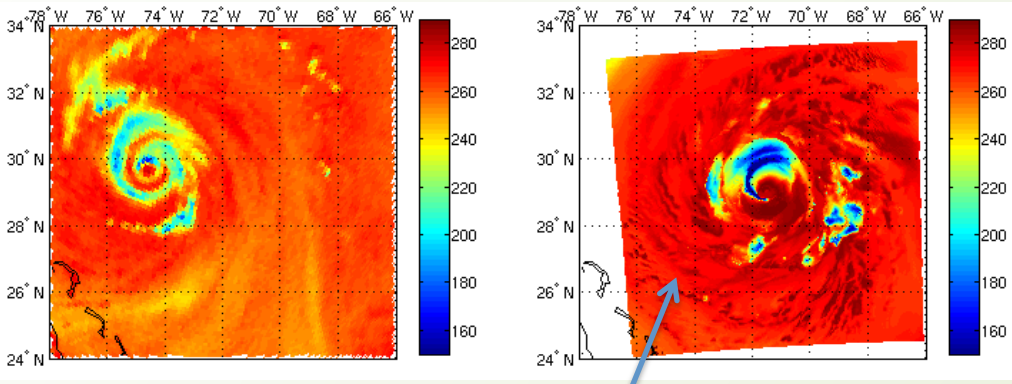


Validation: Ice structure

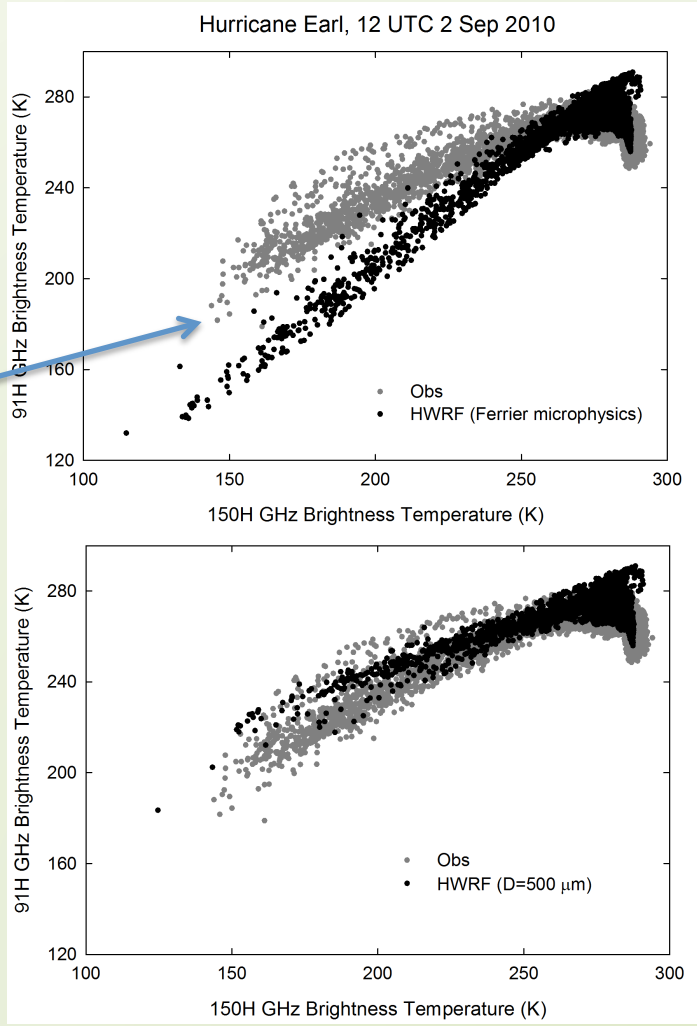
- Time evolution of the horizontal distribution of large ice associated with strong convection using 85-89H GHz data



Validation: 85-91 GHz cold biases



Biases in HWRF simulated 85-91 GHz T_bs are often 20-40 K in convective areas



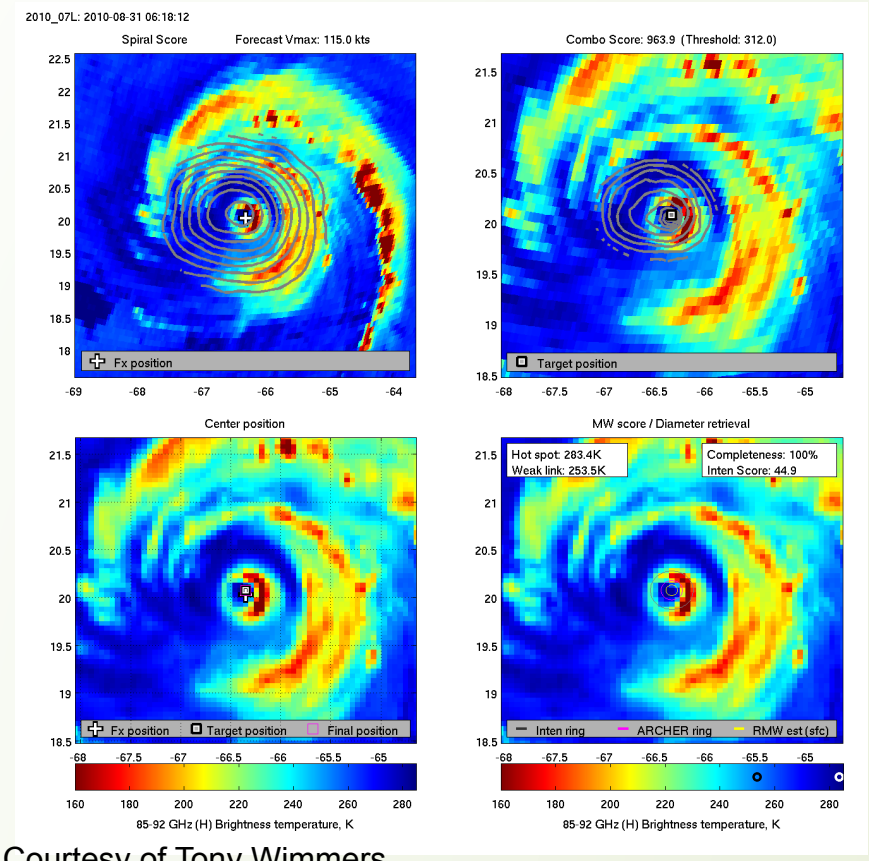
Assigning a fixed snow particle size (D_e = 500 μm) brings the simulation into better agreement with observations. However, more work is needed to determine whether the ice microphysical parameters and/or CRTM scattering properties are the cause of the disagreement

Validation: ARCHER analysis

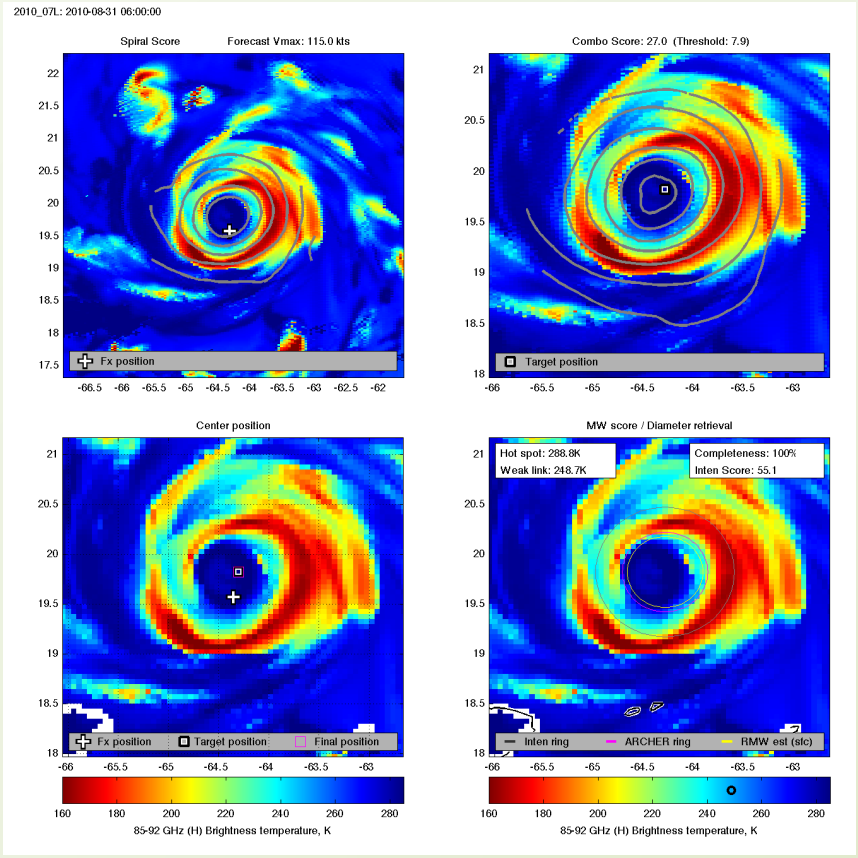
- ARCHER is an algorithm developed by UWisc-CIMSS that operates on multi-spectral satellite imagery and objectively analyzes structure to estimate TC storm center, eyewall diameter, and spiral banding structure/organization.
- From this analysis, ARCHER also provides an intensity score, which is then related to thresholds of maximum winds (but only meant for intensifying storms).
- Currently applied to 85-91H GHz satellite obs, but has great promise as a new tool for evaluating HWRF forecasts.
- This work is being done in collaboration with Tony Wimmers and Chris Velden (UW-CIMSS), and Dave Zelinsky (NHC).

Validation: ARCHER example

AMSR-E Observations



HWRF forecast at 40 hrs



Courtesy of Tony Wimmers

The ARCHER spiral and ring analyses can be used to compare and quantify the integrity of the HWRF forecasts to the verifying microwave imagery. However, ARCHER score and intensity thresholds used for HWRF data purposes may require calibration adjustments.

Future steps

- Test modified UPP code to output SSMIS channel 4 data and generate warm core anomaly products in GRIB
- Explore options for obtaining microwave satellite observations in real-time to compare directly to HWRF forecasts
  - Convert GDAS satellite observation files from BUFR to GRIB
  - New NASA portal
- Apply validation techniques to other storms