Lessons Learned from HWT-DTC Interactions: SPC Perspective

Steven Weiss and Russell Schneider

HWT-DTC Collaboration Meeting

Boulder, CO

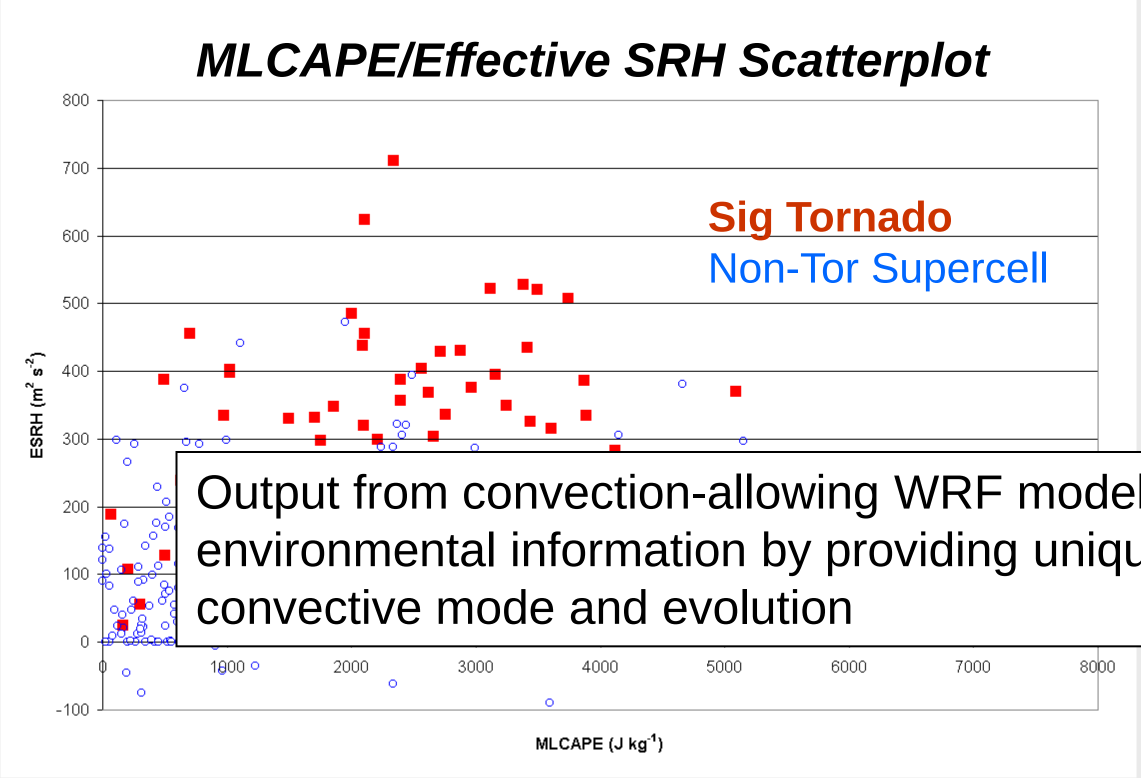
September 25, 2009

Background

- Traditional synoptic and mesoscale NWP model forecasts do not predict explicitly convective scale phenomenon
  - Thunderstorms, severe thunderstorms, tornadoes, etc.
- SPC forecasters focus on diagnosing and predicting **pre-convective and near-storm environments** to assess questions such as:
  - *Will thunderstorms develop?*
  - *Where and when will storms occur?*
  - *What convective modes are possible?*
  - *How they will evolve over time?*
  - *What severe threats are most likely?*
- Accurate prediction of the mesoscale environment is critical to convective forecasting

The "Environment" is One of the Keys

- Improved predictions of the mesoscale environment are the first step to improving severe weather forecasts
  - But environment info. (CAPE/shear, etc.) may not be sufficient
    - *Similar environments can produce different convective weather*
    - *Different environments can produce similar convective weather*



Many non-tornadic supercells share parts of parameter space with supercells producing significant tornadoes

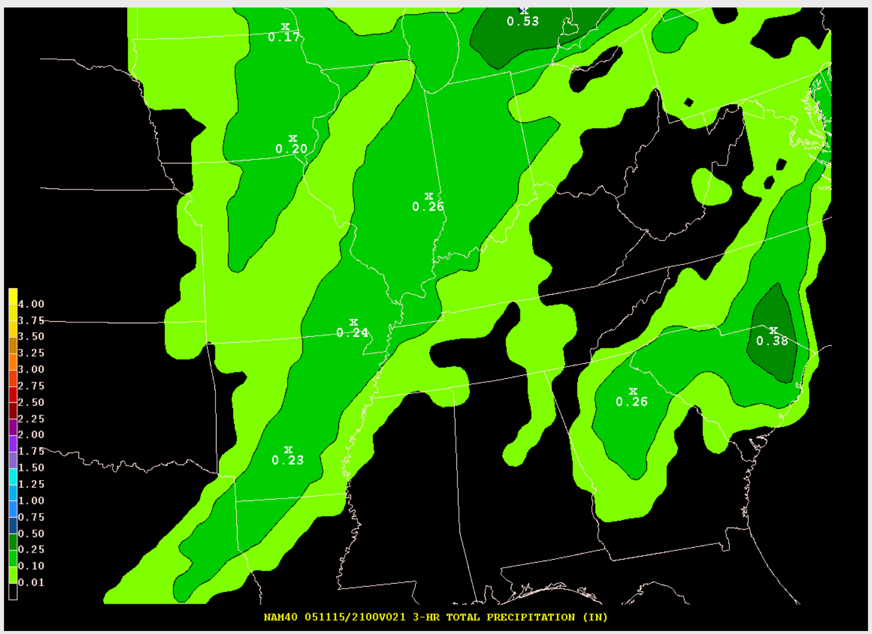
(From Thompson et al. 2007)

Output from convection-allowing WRF models complements environmental information by providing unique details about convective mode and evolution

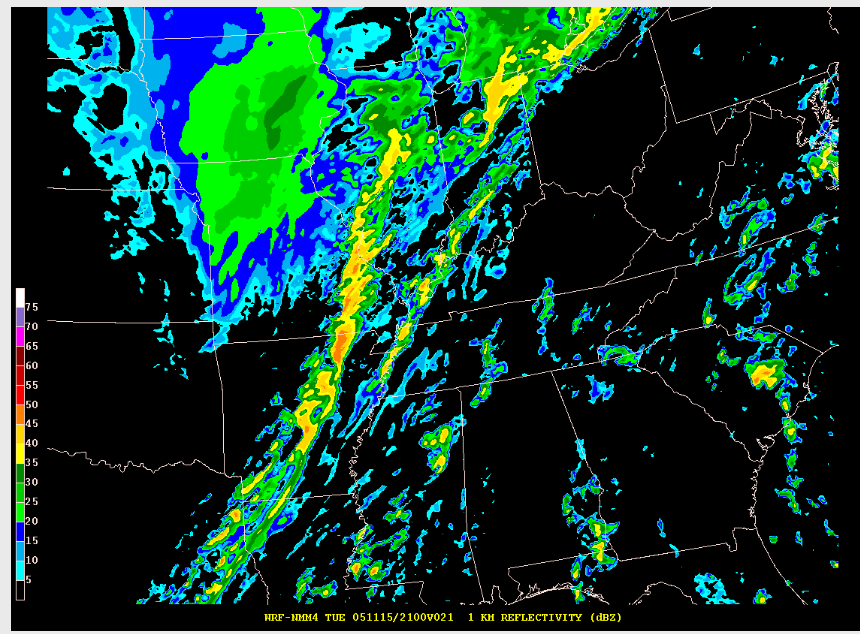
Simulated Reflectivity in WRF Output

- **Convection-allowing WRF model reflectivity can provide mesoscale and near stormscale details not seen in traditional output**

21 hour forecasts valid 21 UTC 15 Nov 2005

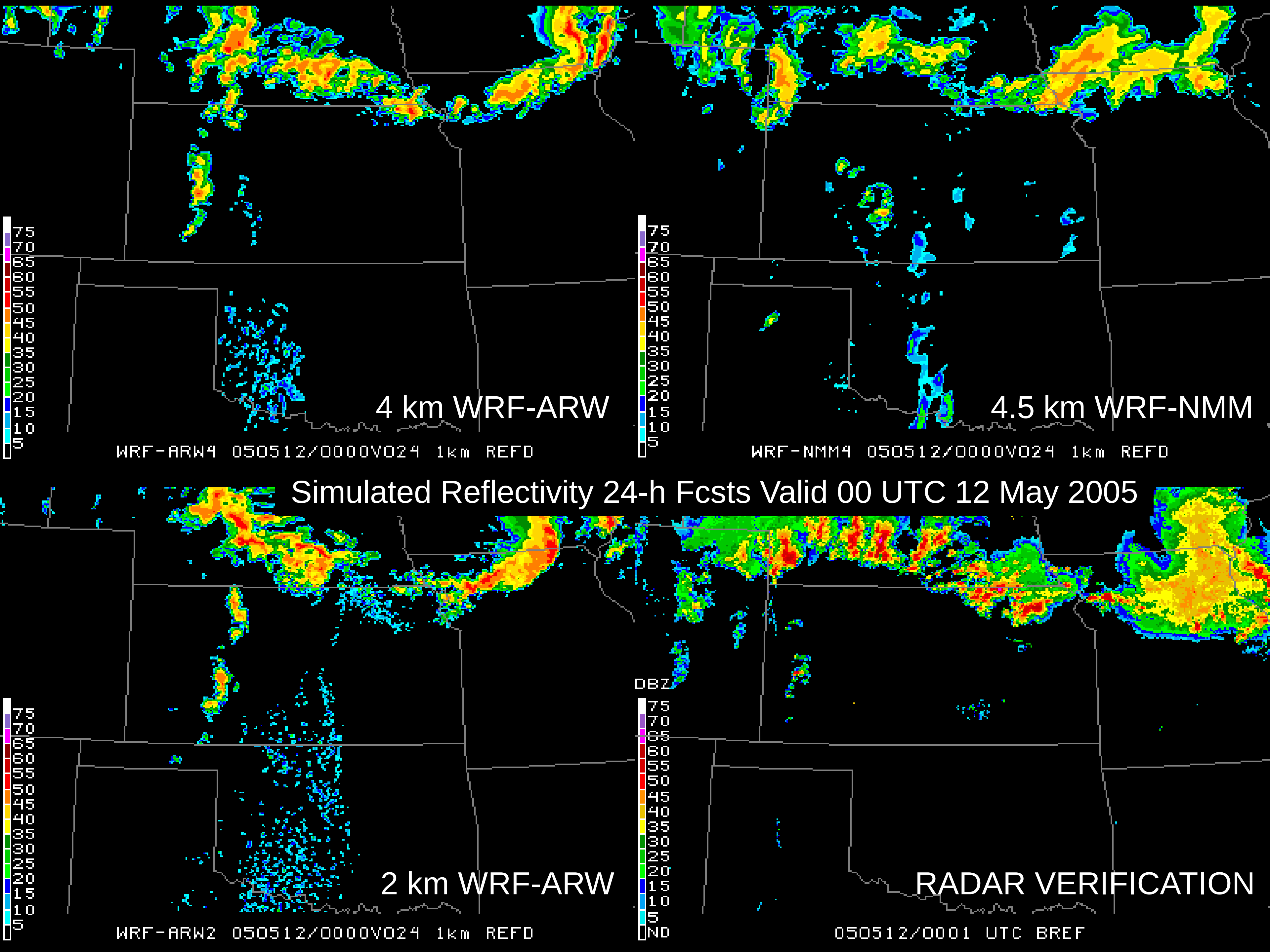


NAM 3h Pcpn



4.5 km WRF-NMM Reflectivity

Simulated Reflectivity 24-h Fcsts Valid 00 UTC 12 May 2005

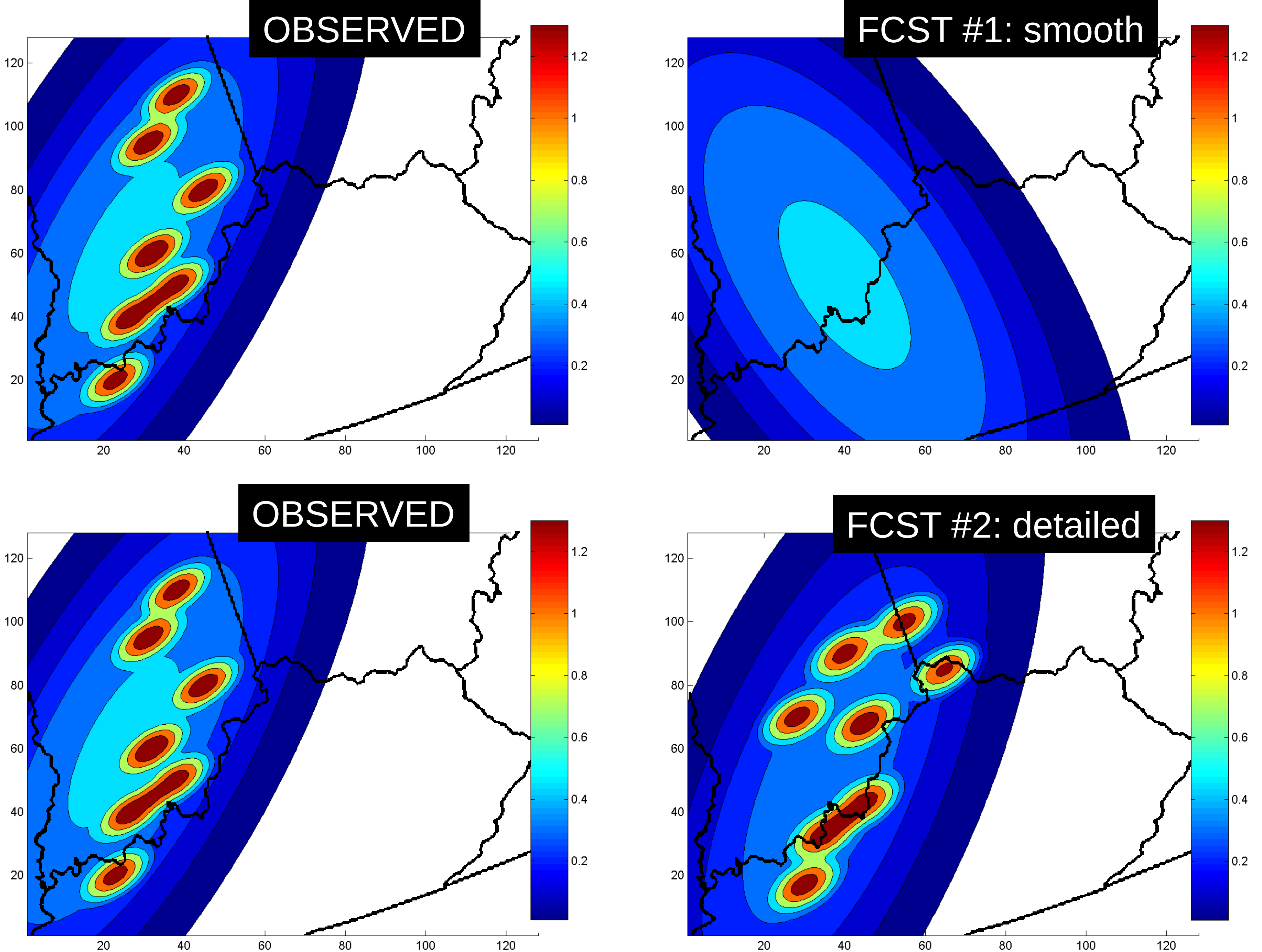


Evaluation of WRF Models

- Verification of WRF model predictions of convective storms is necessary to provide:
  - **Feedback to model developers** on model performance
    - What is impact of changes to data assimilation, physics, numerics, etc. (Is model better, worse, unchanged)?
  - **Information to forecasters** so they can use model guidance in a more informed way
    - What are strengths and weaknesses of model performance (e.g., are there situations or regions where it is more/less accurate)?
- Subjective evaluation of WRF models has been a cornerstone of HWT Spring Forecasting Experiment activities (Kain et al. 2003)
- But objective verification is also needed

Evaluation of WRF Models

- Traditional statistical measures were formulated for synoptic scale model verification
  - AC, MAE, RMSE, ETS (aka GSS), Bias
- EMC routinely computes and closely examines these types of metrics when evaluating candidate data assimilation and model physics upgrades
  - QPF metrics are critical when deciding if changes increase or decrease overall “model accuracy”
- However, metrics such as ETS and Bias have well known limitations at CAM resolutions



Courtesy: Mike Baldwin

Traditional “Measures-Oriented” Approach to Verifying These Forecasts

(Almost all favor the smooth, less detailed forecast)

Verification Measure	Forecast #1 (smooth)	Forecast #2 (detailed)
Mean absolute error	***0.157***	0.159
RMS error	***0.254***	0.309
Bias	0.98	0.98
Threat score	***0.214***	0.161
Equitable threat score	***0.170***	0.102

Courtesy: Mike Baldwin

HWT-DTC Interactions 2008-2009

- Recognition that new objective measures are needed to properly evaluate WRF forecasts of QPF and reflectivity
  - Objective measures needed to apply to large sample sizes and to provide community-wide standards of comparison
  - Systematic improvements in WRF models will be hindered unless meaningful verification measures are developed, tested, evaluated, and utilized
- DTC is ideal partner to help address these issues during Spring Experiments

HWT-DTC Interactions 2008-2009

- From SPC perspective, collaborative partnership with DTC in the HWT will lead to operational benefits
  – Ability to explore model forecast skill at multiple scales
  – Mesoscale: MCSs (including QLCS)
  – Stormscale: Bow echoes and supercells
- 2008 - EMC and NSSL WRF models used by forecasters all year
- 2009 - Radar assimilation impact – CAPS and HRRR verification
  – Special HWT web page graphics plus traditional and object-based scoring
  – Proof-of-Concept testing (multiple scales)
  – Still learning utility of different measures and applications