Model Development at NCEP

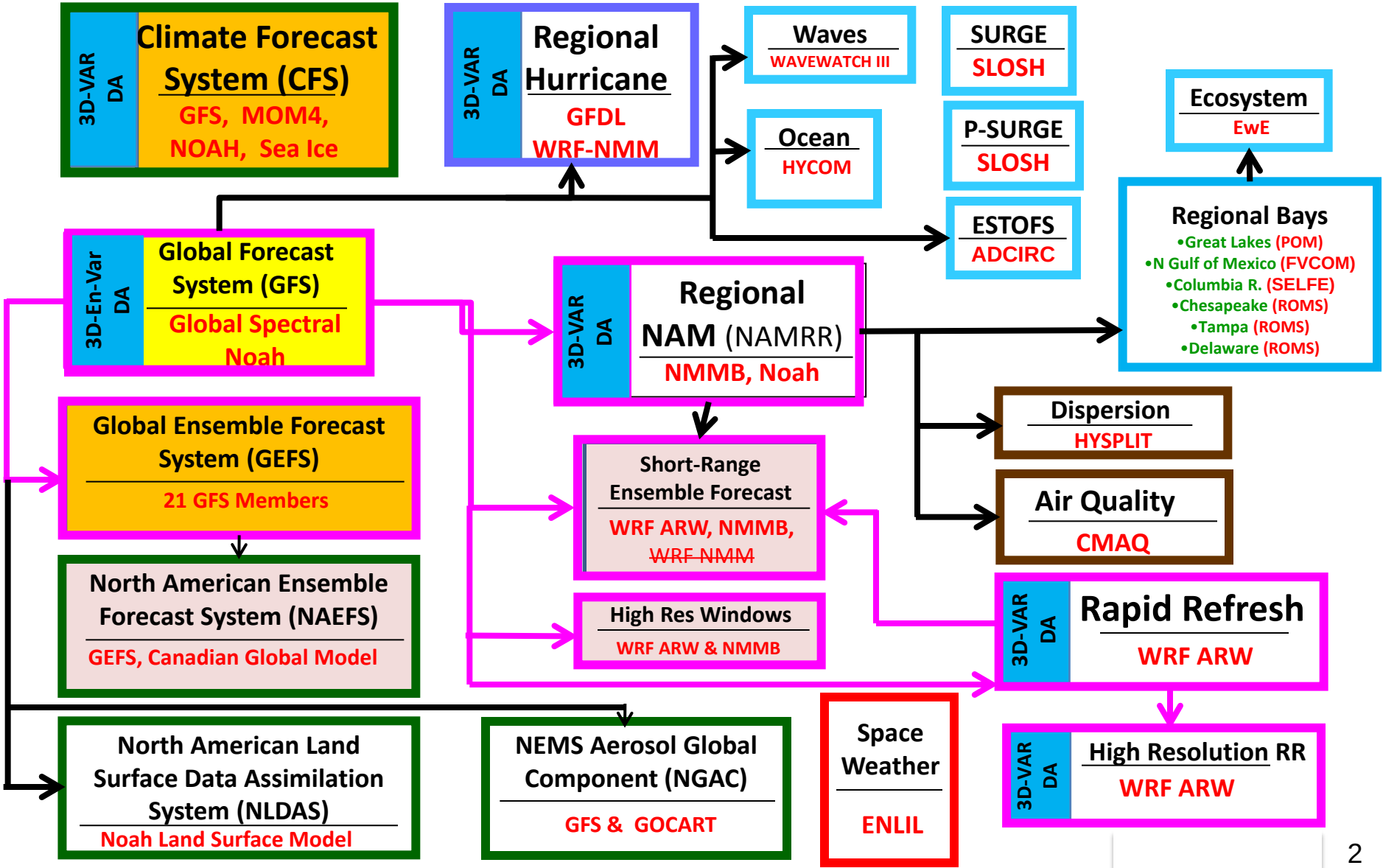
Brad Ferrier[1,2]
[1] NOAA/NWS/NCEP/EMC
[2] I.M. Systems Group, Inc. (IMSG)
(+ Geoff Manikin[1], Geoff DiMego[1], Eric Aligo[1,2])

NCAR & FAA In-Flight Icing Users Technical Interchange Meeting (TIM)

25-26 February 2015
UCAR Office
Washington, DC

NOAA's Operational Production Suite (2014)

(Systems in magenta will be discussed in this presentation)

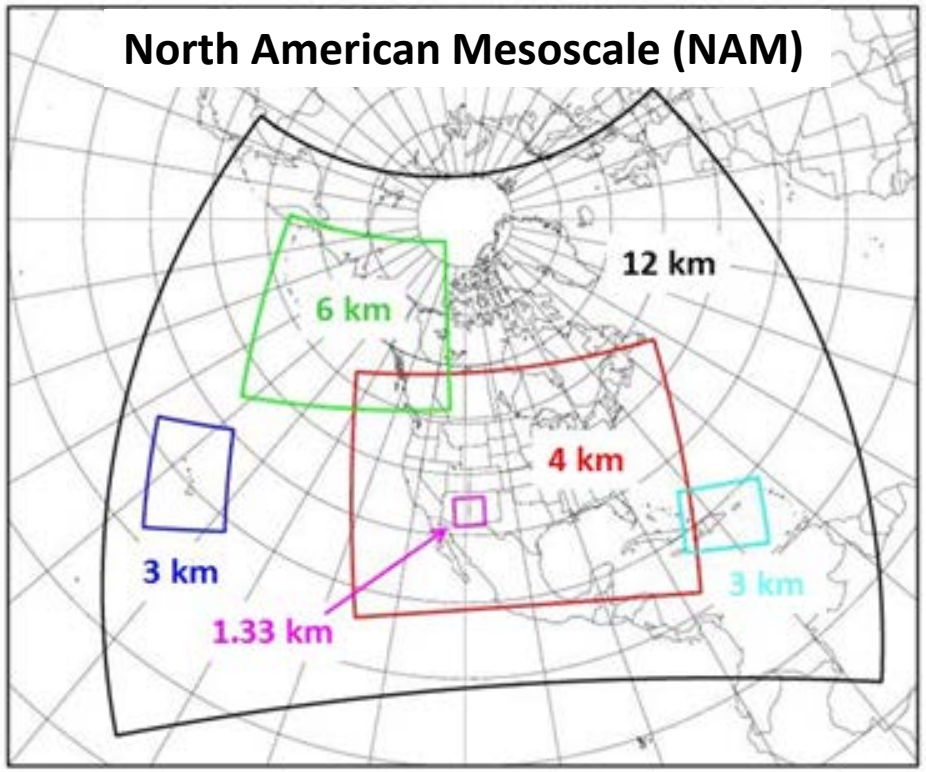


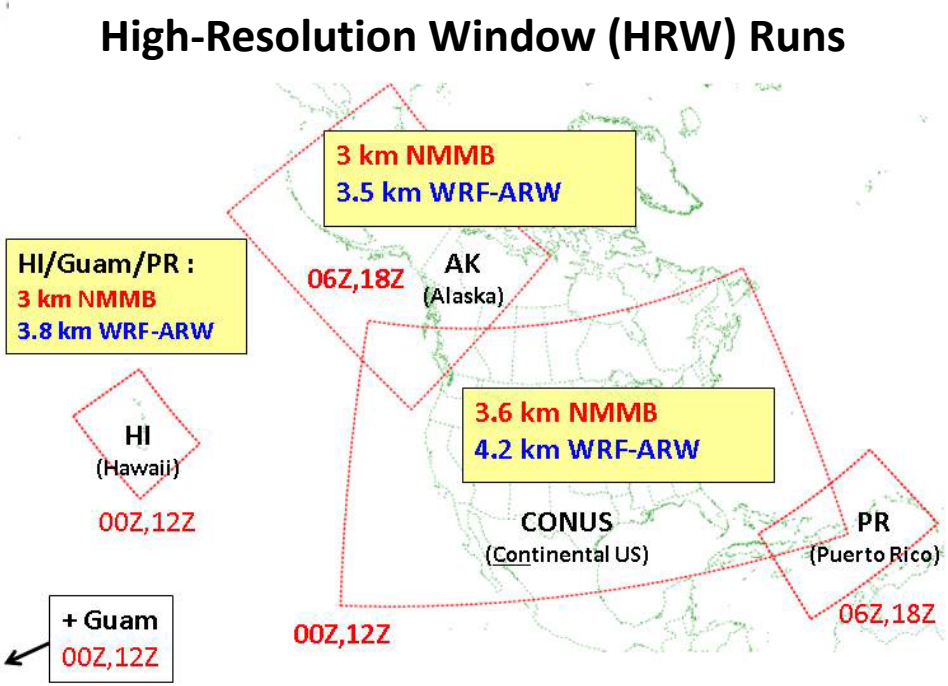
Road Map and Themes

- Where we are and where do we want to go
  - Short-range regional (mesoscale) modeling
  - Current & future global prediction systems
- Evolution over the next 5 years
  - From current “model of the day” thinking
  - To probabilistic guidance from ensemble systems

(Limited discussion on aircraft icing)

Regional Systems (4/day)



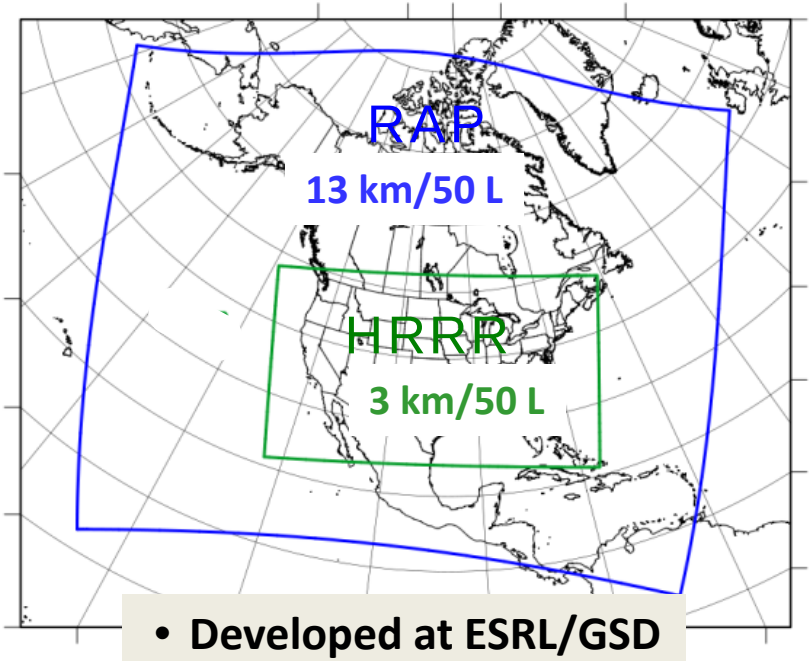


- 12 km/60L to 84 h (SREF, 16 km/35-40L)
- Nests (60L) to 60 h, except 1.33 km fire weather to 36 h (relocatable)
- 1-way nesting
- Runs @ 00, 06, 12, 18 UTC

- NMMB & WRF ARW (40L) to 48 h
- 00, 12 UTC - CONUS, Hawaii, Guam
- 06, 18 UTC – AK, PR
- Initialized from Rapid Refresh (RAP)

Rapid Refresh Systems (24/day)

RAP = Rapid Refresh
HRRR = High-Resolution Rapid Refresh

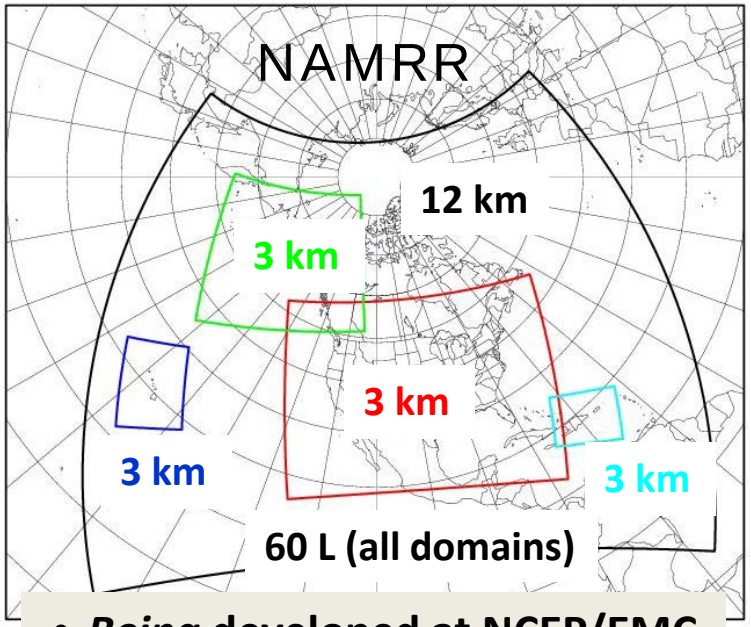


- Developed at ESRL/GSD
- WRF ARW model

- RAP - hourly to 18 h
- HRRR –hourly to 15 h
- LH T tendencies from radar data

+

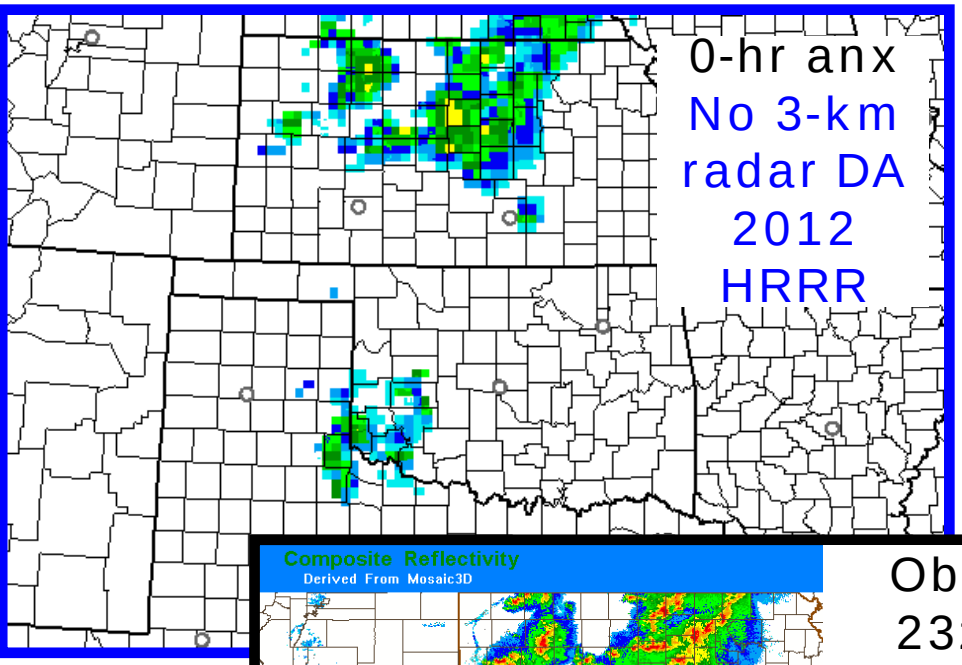
NAMRR = NAM Rapid Refresh
(to be implemented in Q1FY16)

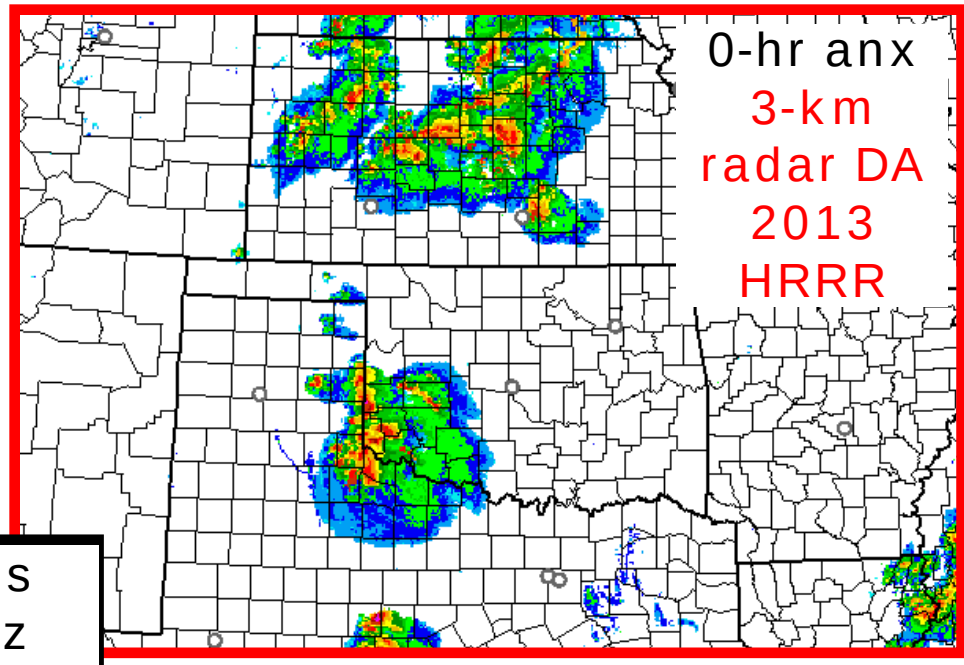


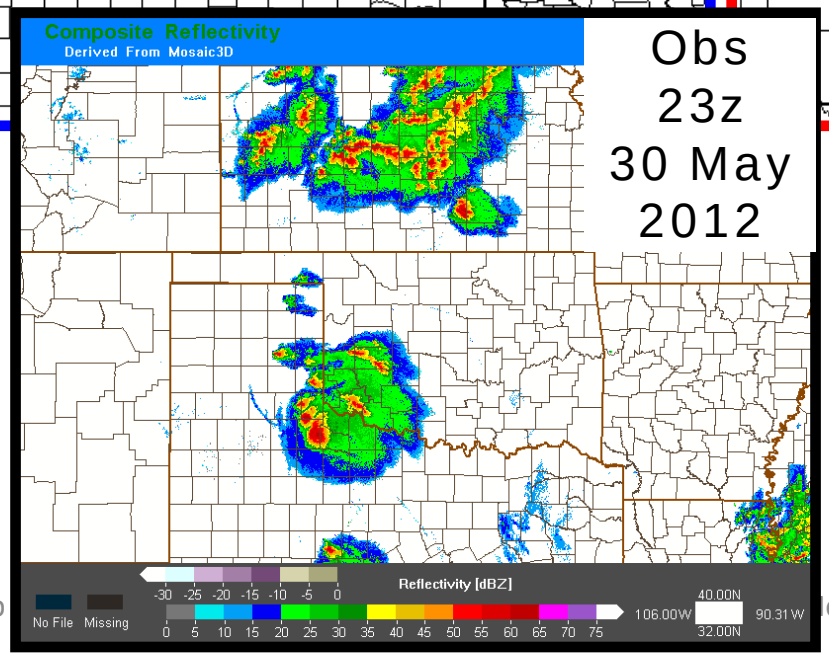
- *Being* developed at NCEP/EMC
- NEMS/NMMB model

- Similar to NAM at 00, 06, 12, 18Z
- Hourly runs to 18 h at other times
- LH T tendencies from radar data

Benefits of radar data assimilation







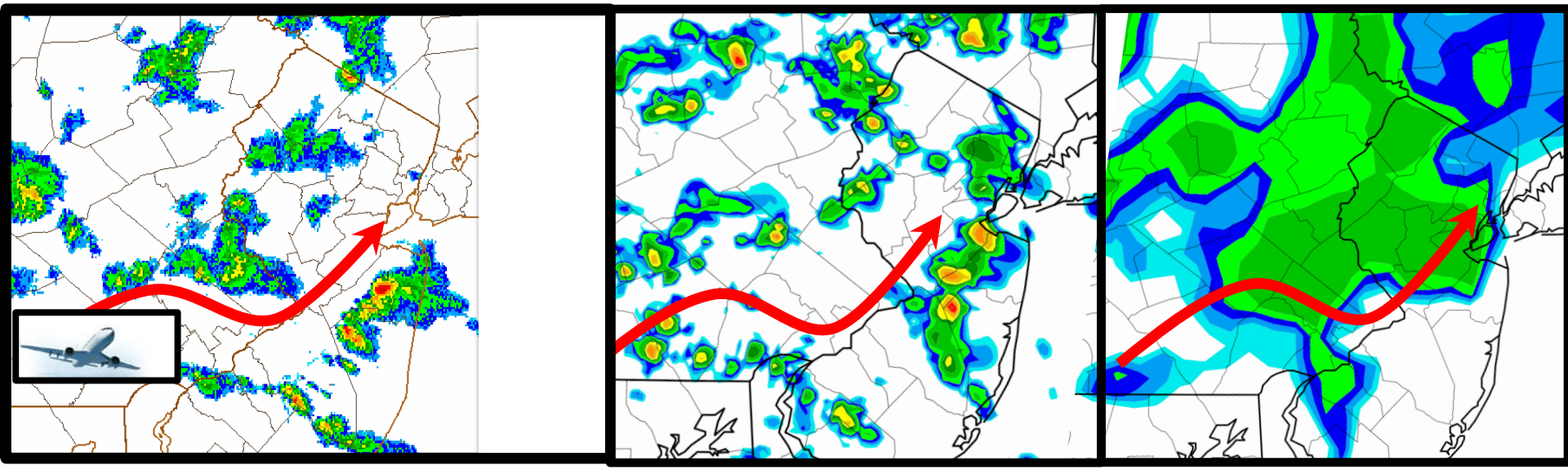
From G. Manikin
(NCEP HRRR Briefing)

Benefits of High-Res Models for Aviation

07 June 2012 5 PM EDT
Reality

3-km HRRR
Explicit
Convection 6 hr forecast

13-km RAP
Parameterized
Convection 6 hr forecast



Aircraft must Navigate Around Thunderstorms

From G. Manikin (NCEP HRRR Briefing)

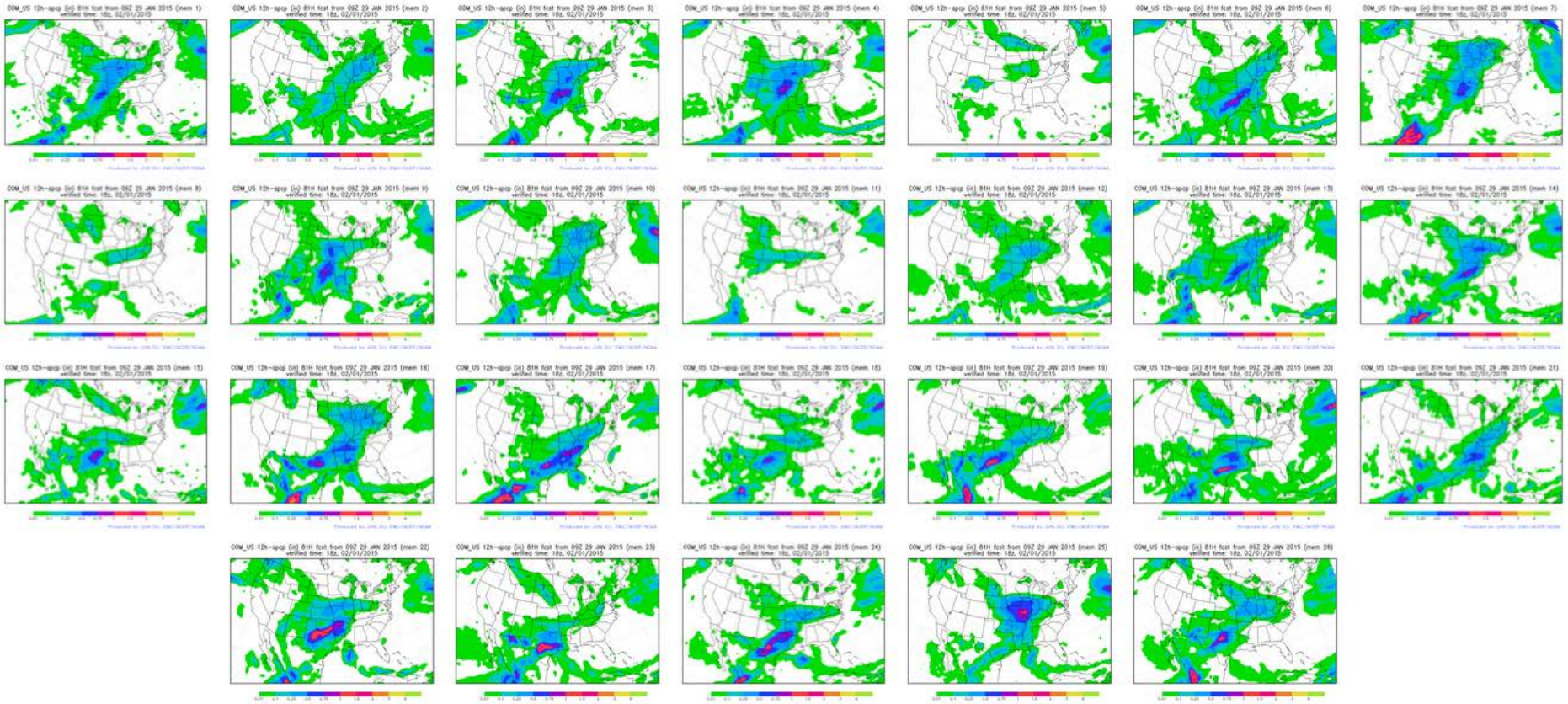
Accurate Storm Structure

Accurate Estimate of Permeability

No Storm Structure

No Estimate of Permeability

Short-Range Ensemble Forecast (SREF)



(Sample 84-87 h QPF for all 26 members from the parallel SREF)

Ops vs Parallel SREF Systems

Operational SREF

- 16 km, 35 L -- 21 members
- 3 dynamic cores / ICs
  - NEMS/NMMB from NAM
  - WRF NMM from GFS
  - WRF ARW from RAP
- Limited physics diversity
- **Some clustering by core/IC**

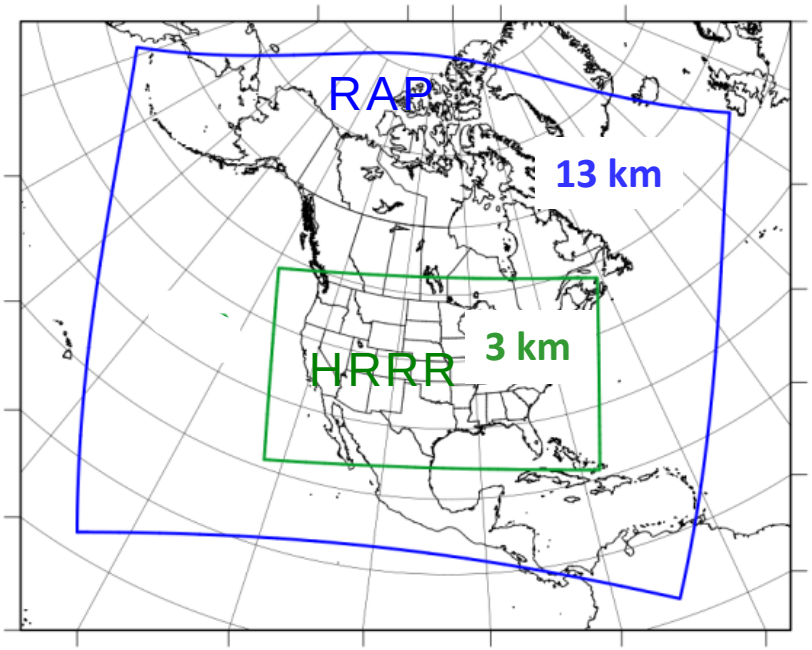
Parallel SREF (being tested)

- 16 km, 40 L -- 26 members
- 2 dynamic cores / ICs
  - NEMS/NMMB (ctl + 12 perts)
  - WRF ARW (ctl + 12 perts)
  - Even mix of NAM, GFS, RAP in perts
- More physics diversity in NMMB & WRF ARW
- **Reduced clustering by cores**

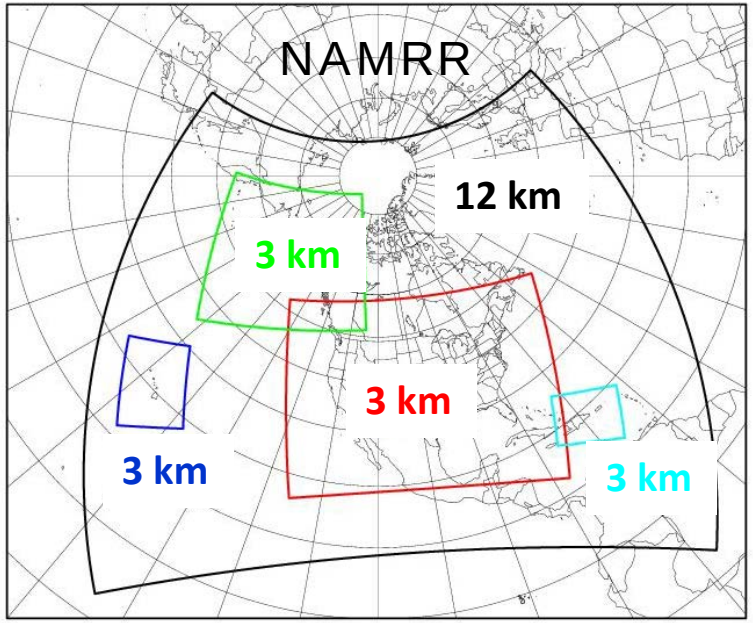
Both versions of SREF have

- ICs: a mix of GEFS and regional perturbations
- LBCs: from different GEFS (global ensemble) members

Future Plans: Combine All Systems



+



=

Longer-range guidance at 00, 06, 12, 18 UTC

- **High Resolution Ensemble Forecast (HREF) = multiples of HRRR + NAMRR nests (60 h?)**
- **Short Range Ensemble Forecast (SREF) = multiples of RAP + NAM parent (84 h?)**

Shorter-range guidance at more frequent intervals (≤ 1 h)

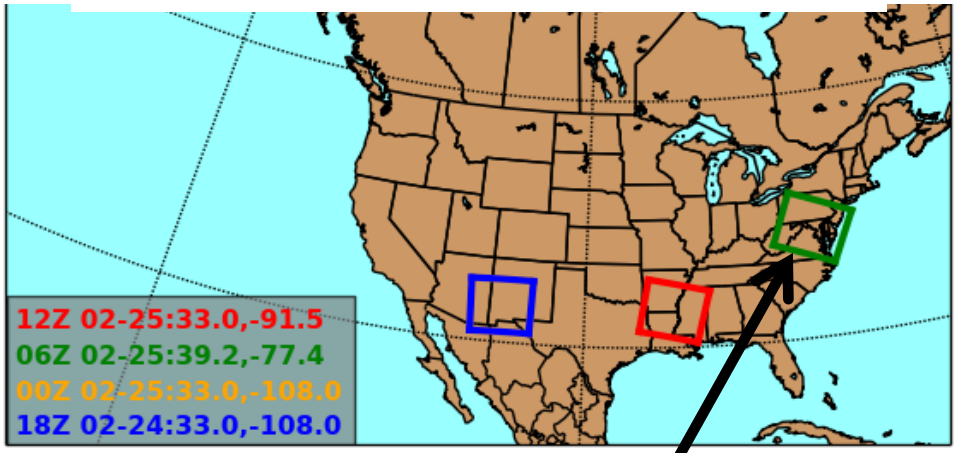
- **HREF Rapid Refresh (HREF-RR) = HREF run at hourly intervals or less (18 h?)**
- **SREF Rapid Refresh (SREF-RR) = SREF run at hourly intervals (24 h?)**

(? - forecast ranges are TBD)

Improved Aviation Products

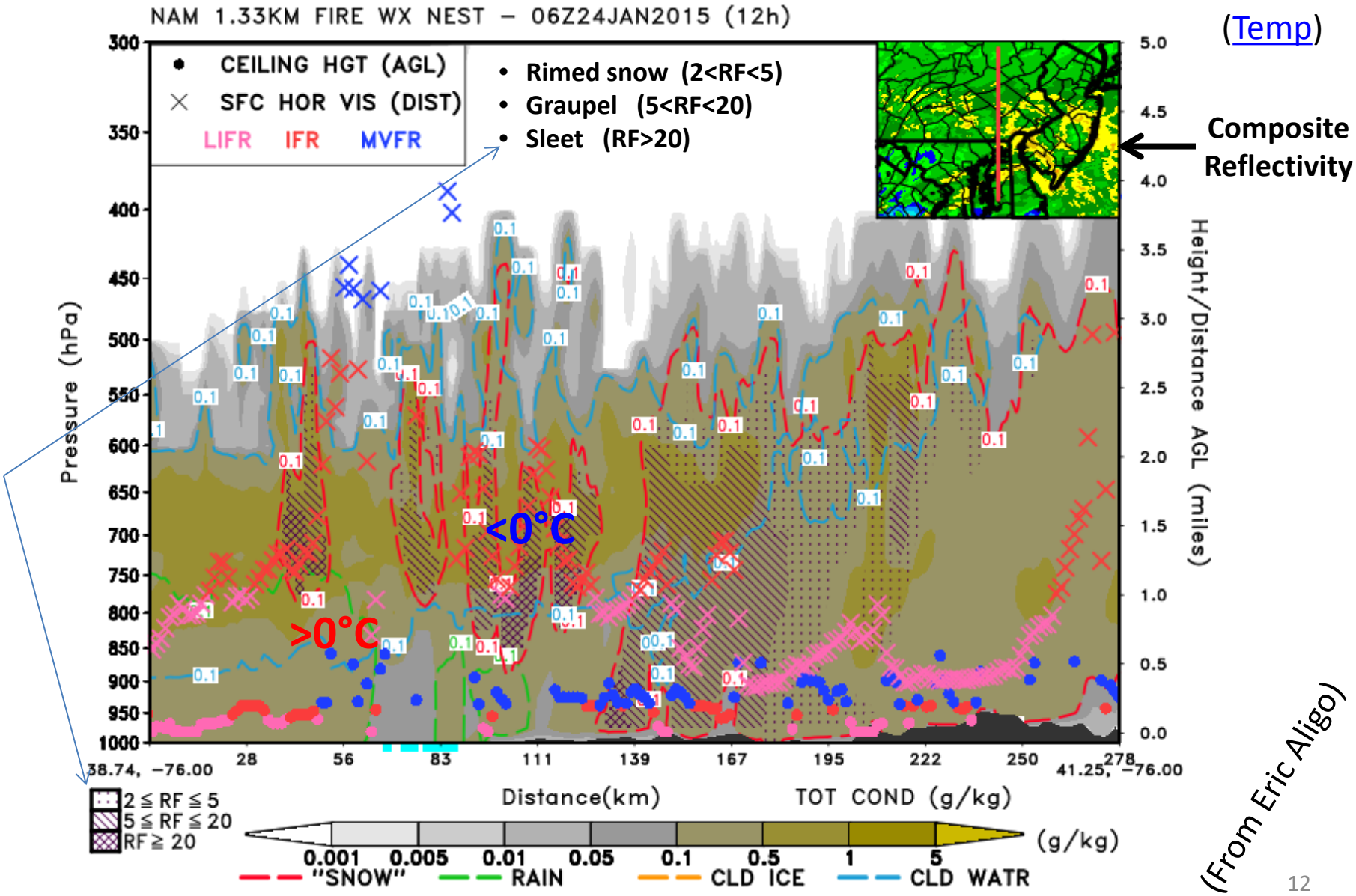
- Aircraft icing (see next slide)
- Flight restrictions (with AWC)
  - Cloud ceiling heights
  - Visibilities
- Low-level wind shear
- Turbulence
- Precipitation type (rain, snow, freezing rain, sleet)
- Simulated radar structures of severe local storms (with SPC; see 2 slides later)
  - Mode (discrete cells vs lines)
  - Cellular structure (supercellular or not)
  - Evolution

Relocatable 1.33-km Fire WX Nests



(Next slide shows a N-S cross section of clouds & precipitation from a recent winter storm)

Cross Section from 1.33-km Fire WX Nest



(From Eric Aligo)

Improved Simulated Radar Reflectivity Structures of Severe Local Storms (NAM nests)

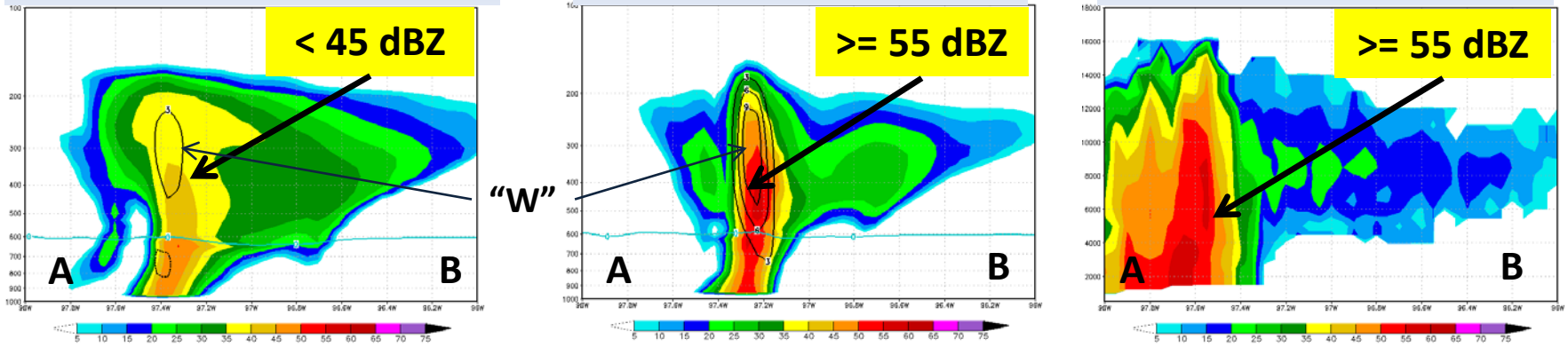
22 h Forecasts at 20 May 2013 - Moore, OK Tornado Outbreak

Vertical Cross Sections

Old NAM Microphysics

New Ferrier-Aligo Microphysics

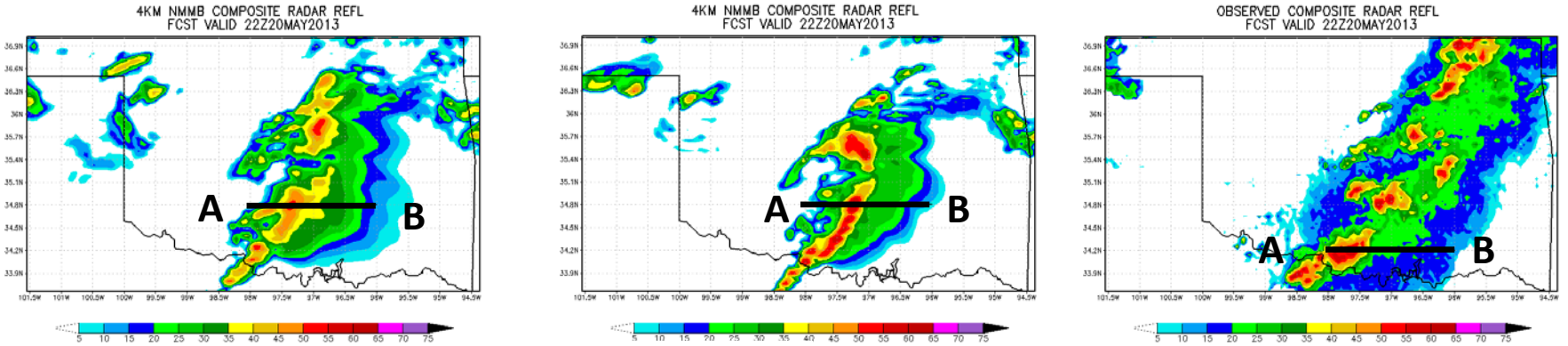
Observed Reflectivity



Weaker Storm

Stronger Storm (Improved)

Horizontal Maps



← 4-km NMMB Forecasts →

(From Eric Aligo)

NCEP Global Models

- Recent Global Forecast System (GFS) upgrade
  - ~13 km, 64 L, 0 to 10 days
  - ~33 km, 64 L, 11 to 16 days
- Upcoming Global Ensemble Forecast System (GEFS) upgrade (~20 members)
  - ~27 km, 64 L, 0 to 8 days
  - ~33 km, 64L, 9 to 16 days

Next Generation Global Prediction System (NGGPS)

(Replace GFS In 2019?)

- **Requirements**
  - Provide skillful forecasts out to 30 days
  - Match the computational efficiency of the GFS
  - Include advanced data assimilation & physics
  - Be flexible to meet future demands
- Models under consideration
  - GFS Global Spectral Model (GSM @ NCEP)
  - Non-hydrostatic Multiscale Model (NMM @ NCEP)
  - Non-hydrostatic Flow Following Icosahedral Model (NIM @ ESRL)
  - Cubed-Sphere Finite Volume (HiRAM @ GFDL)
  - Model for Prediction Across Scales (MPAS @ NCAR)
  - Navy's Non-hydrostatic Unified Model (NEPTUNE @ NRL)