Evaluation of the RUC-initialized WRF for application in the Rapid Refresh at NCEP

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The Joint WRF/MM5 User's Workshop
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FORECAST
SYSTEMS
LABORATORY

BOULDER, COLORADO

GOALS:

- Use WRF model at ~13 km horizontal resolution in the Rapid Update Cycle (RUC) at NCEP in 2007 - Rapid Refresh (RR)

- Achieve improved performance of WRF in RR compared to RUC on the same horizontal resolution

- Test WRF model against current RUC hydrostatic model using RUC initial conditions (WRFRUC – WRF initialized with RUC)

WRFRUC model configurations:

- NCAR Eulerian mass-coordinate dynamic core - (ARW – Advanced Research WRF) using 35 and 50 vertical sigma-p levels
- WRF-NMM to be added in near future
- Initial conditions – from RUC**20**/RUC**13** cycles using RUC 3DVAR
- Lateral boundary conditions - from the same FSL RUC20/RUC13 (~ ETA) 48h forecast
- RUC post-processing adapted to WRF output to produce RUC look-alike GRIB output

Two WRFRUC systems run at FSL in real time:

1. WRFRUC with 20-km horizontal resolution on CONUS domain
   - 48-h forecasts twice a day (00 and 12 UTC)

2. WRFRUC with 13-km horizontal resolution on CONUS domain
   - 48-h forecasts twice a day (00 and 12 UTC)

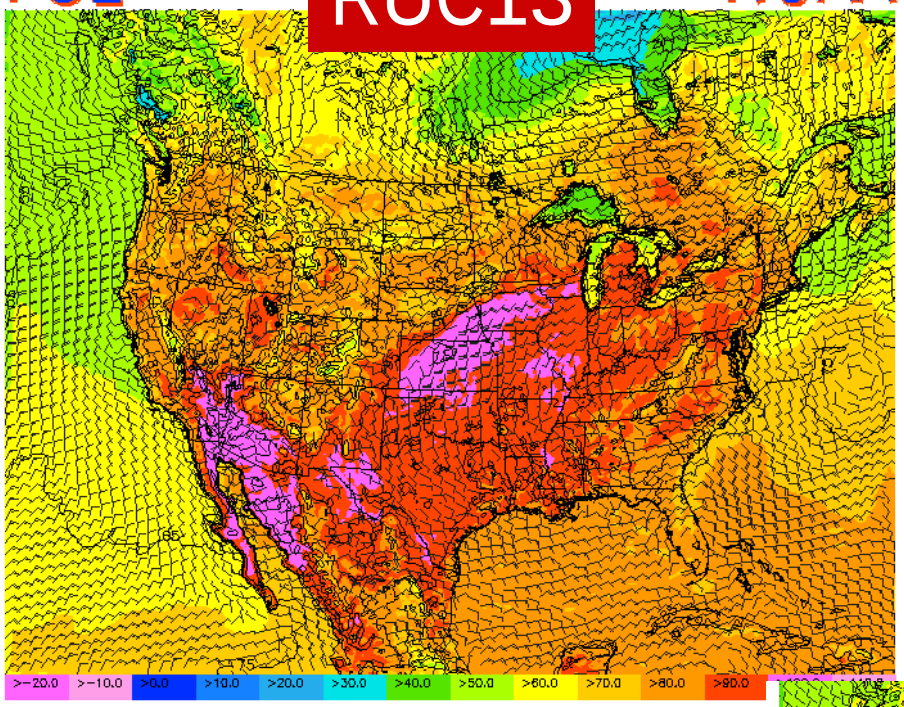
http://ruc.fsl.noaa.gov

Physics options used in WRFRUC :

- WSM (WRF Single-Moment) 5-class microphysics scheme (option 4)
- RRTM longwave radiation (option 1)
- Dudhia shortwave radiation (option 1)
- Janjic surface layer (Eta) scheme (option 2)
- RUC land-surface model (option 3)
- Mellor-Yamada-Janjic (Eta) TKE scheme (option 2)
- Grell-Devenyi ensemble cumulus scheme (opt.3)

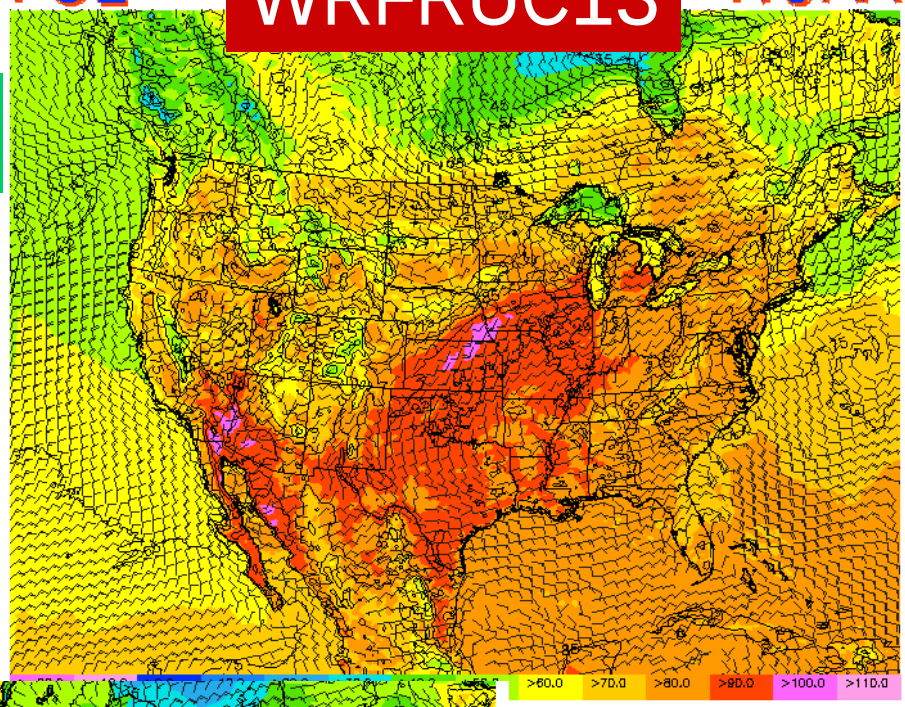
[also in current RUC model]

FSL RUC13 NOAA

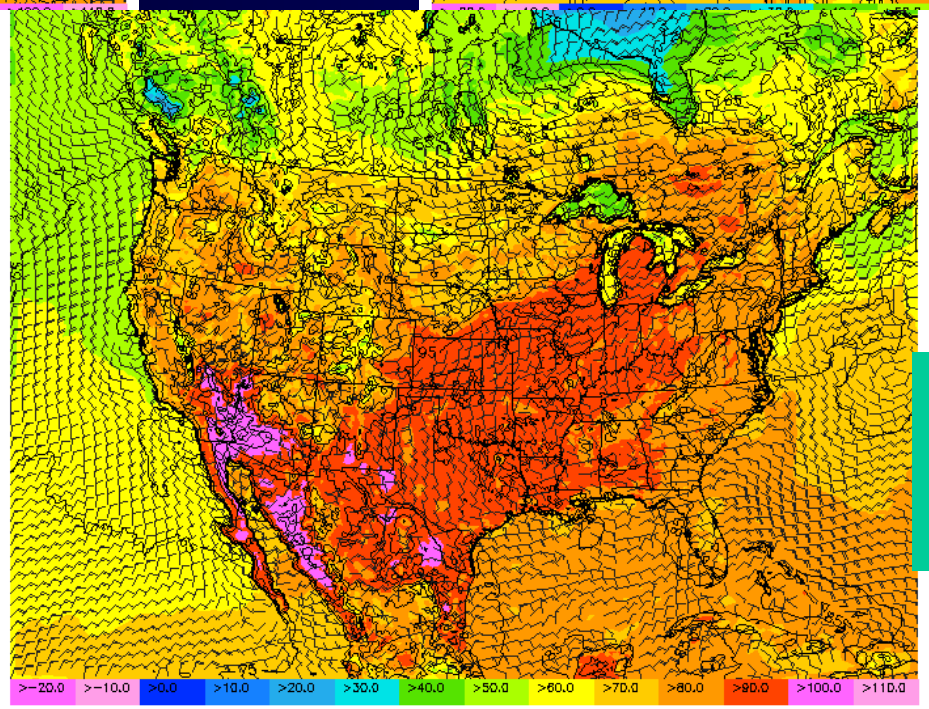


9h fcst

FSL WRFRUC13 NOAA



2-m temperature valid at 2100 UTC 24 June 2005



RUC13 analysis

12-h surface forecasts verified vs. METAR obs

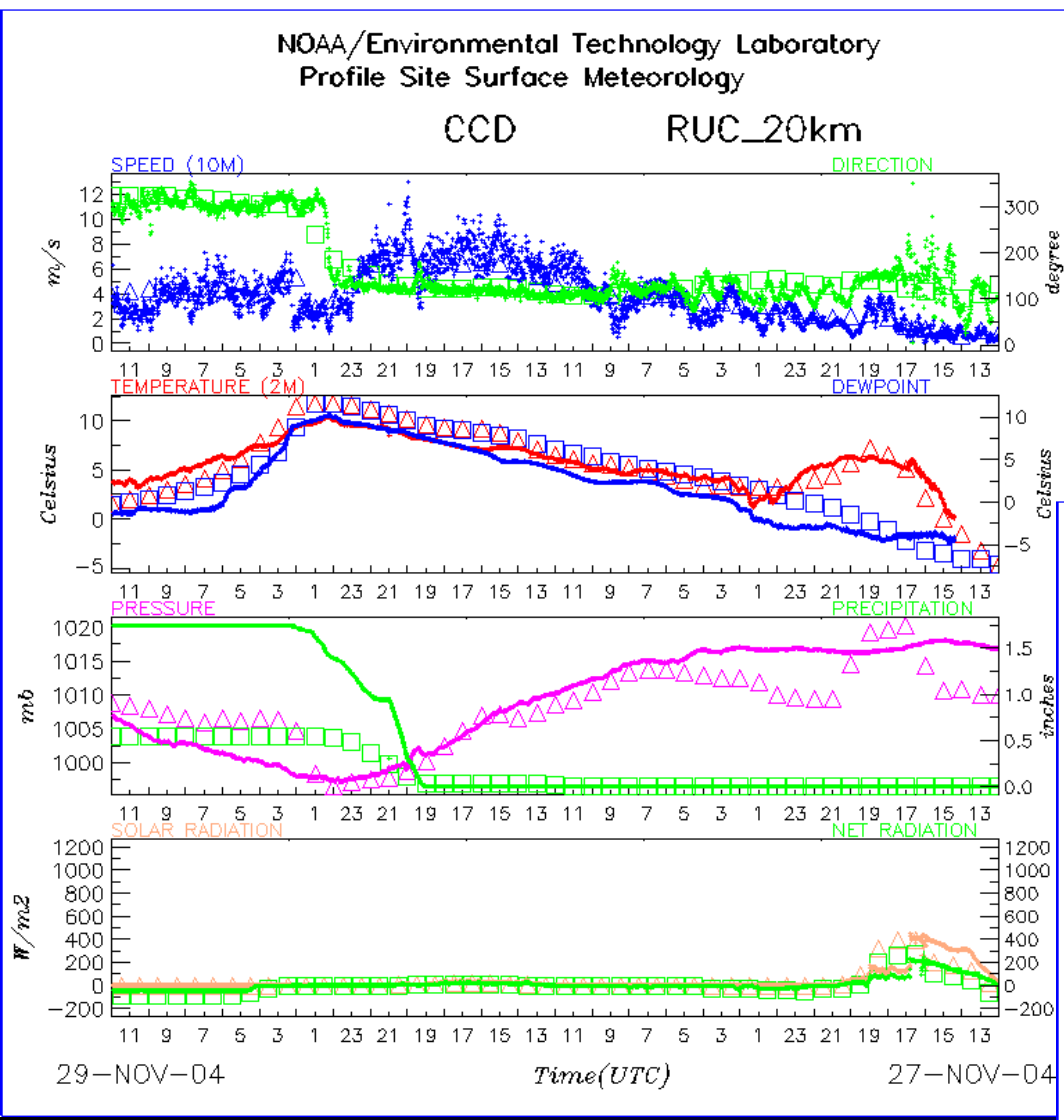
10 March – 21 June 2005

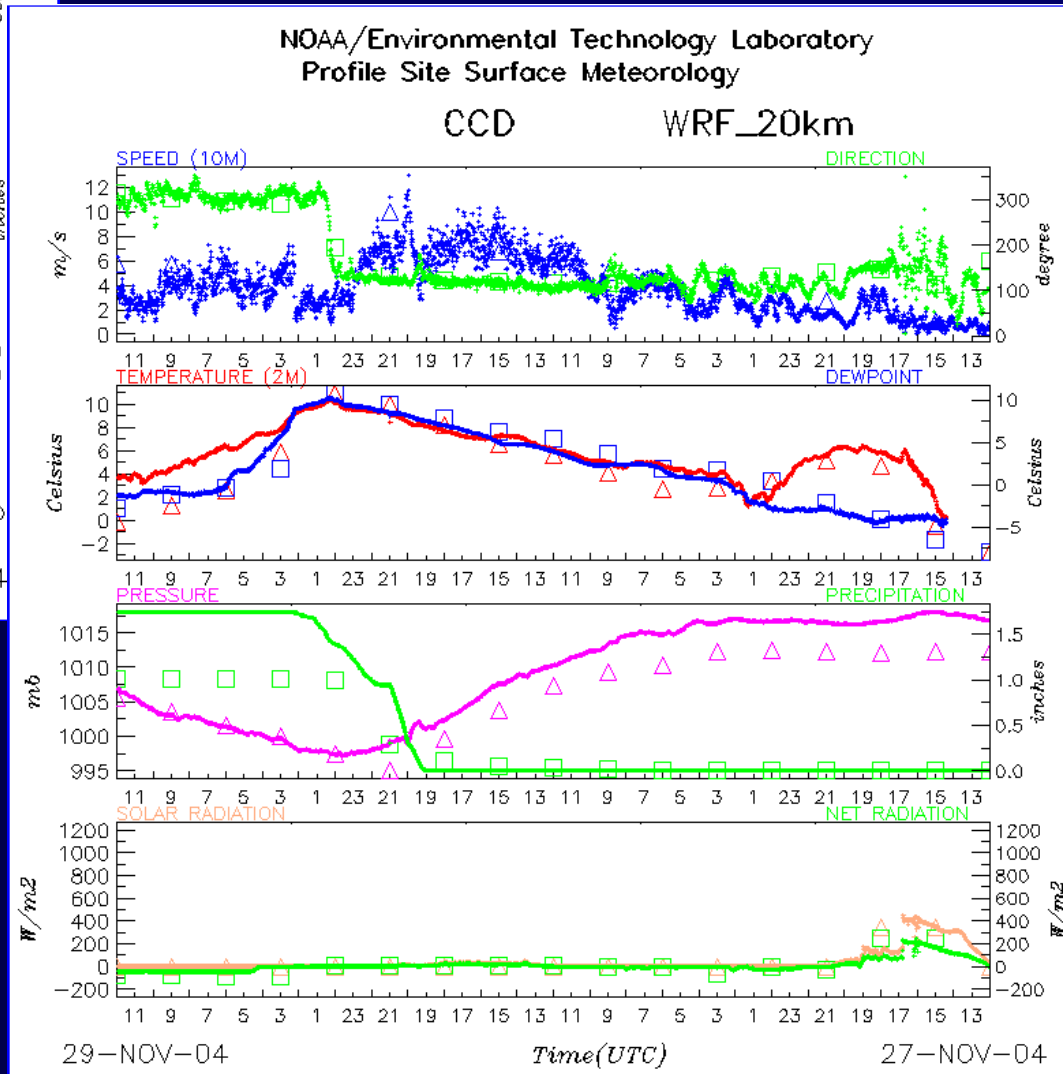
RUC vs. WRFRUC –

all METARs in domain

Variable	RUC20	WRF20	RUC13	WRF13
Wind spd – s.d.	2.01	2.03	1.98	1.98
Wind spd - bias	-0.04	0.20	0.07	0.16
Temp –s.d.	2.62	2.52	2.55	2.59
Temp – bias 12z	-0.31	-0.34	-0.10	-0.13
Temp – bias 00z	-1.43	-1.58	-0.26	-1.65
Dewpoint – s.d.	2.81	2.84	2.98	2.91
Dewpoint – bias 12z	0.89	0.10	0.88	0.13
Dewpoint – bias 00z	1.61	0.73	1.32	0.11

NOAA New England High Resolution Temperature Program (NEHRTP)





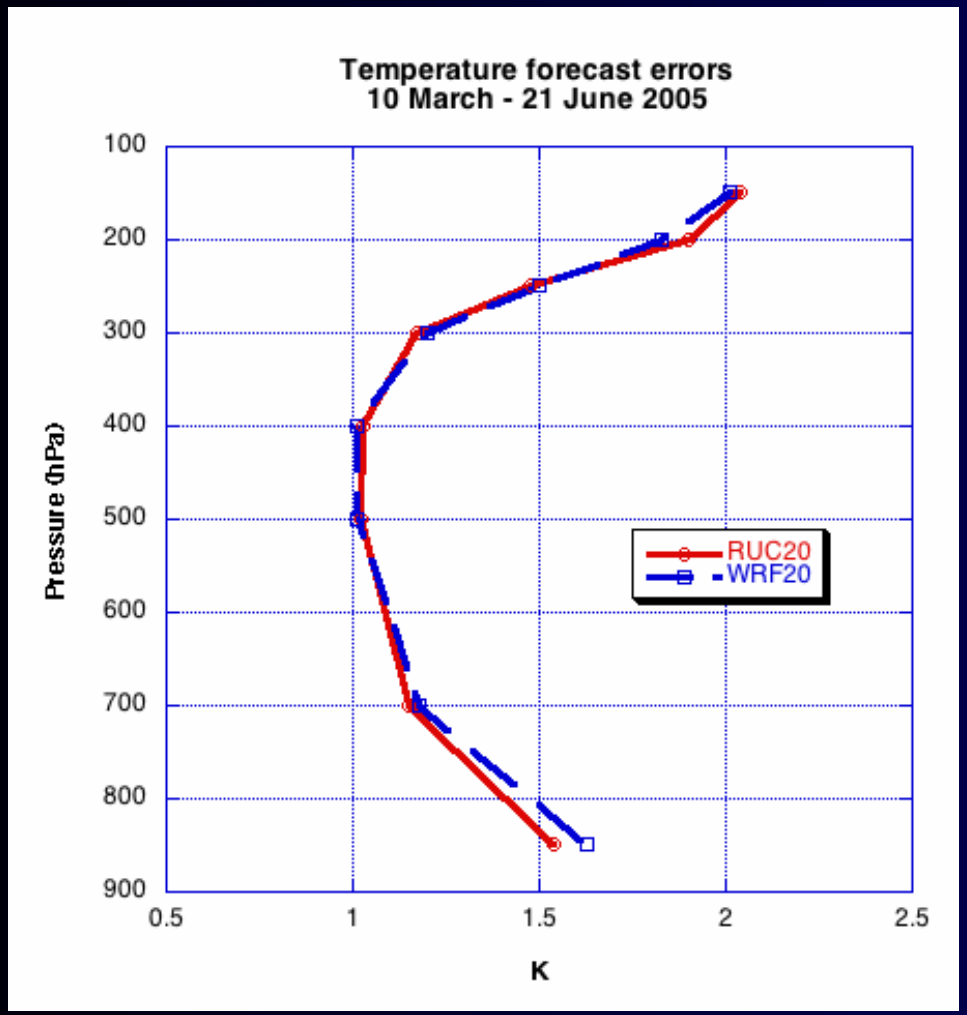
Concord, NH

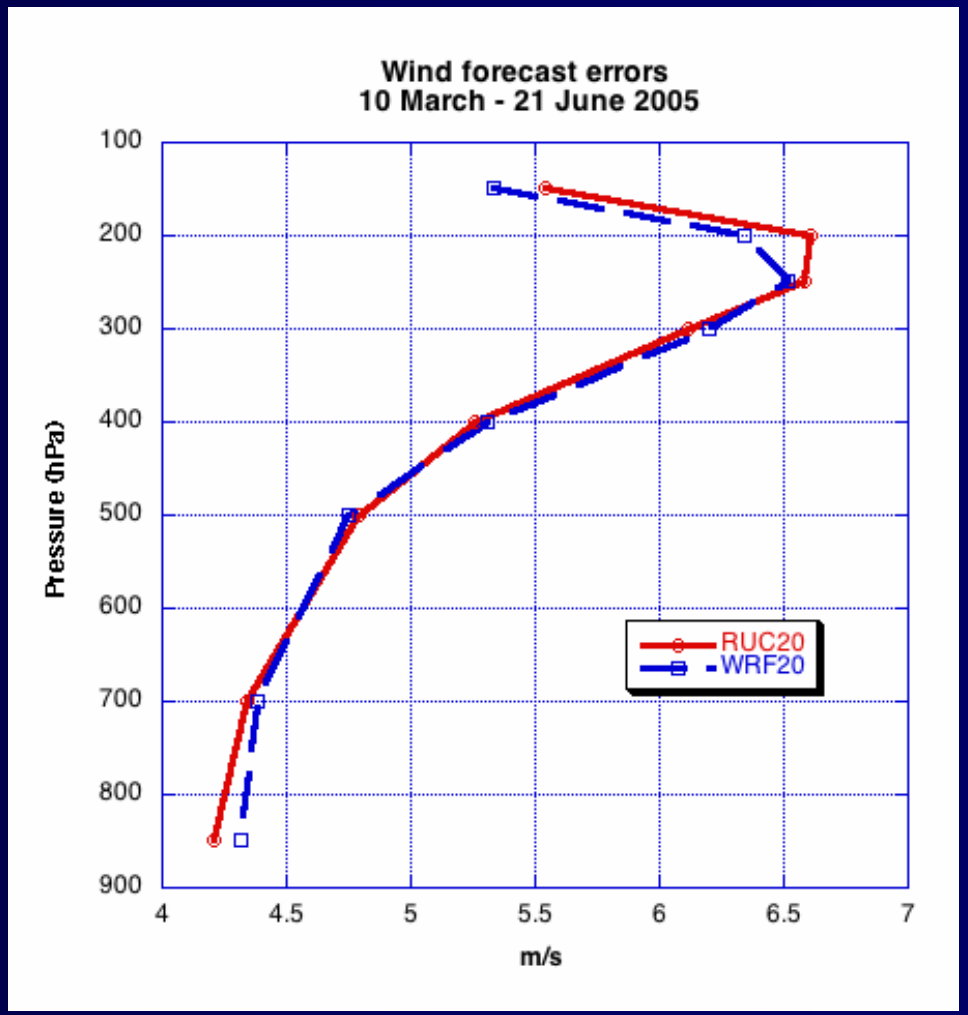
27-29 November 2004 (12 UTC)

12-h temperature and winds aloft forecasts – verified against rawinsonde (92 stations)

20-km RUC vs. 20-km WRFRUC

10 March – 21 June 2005

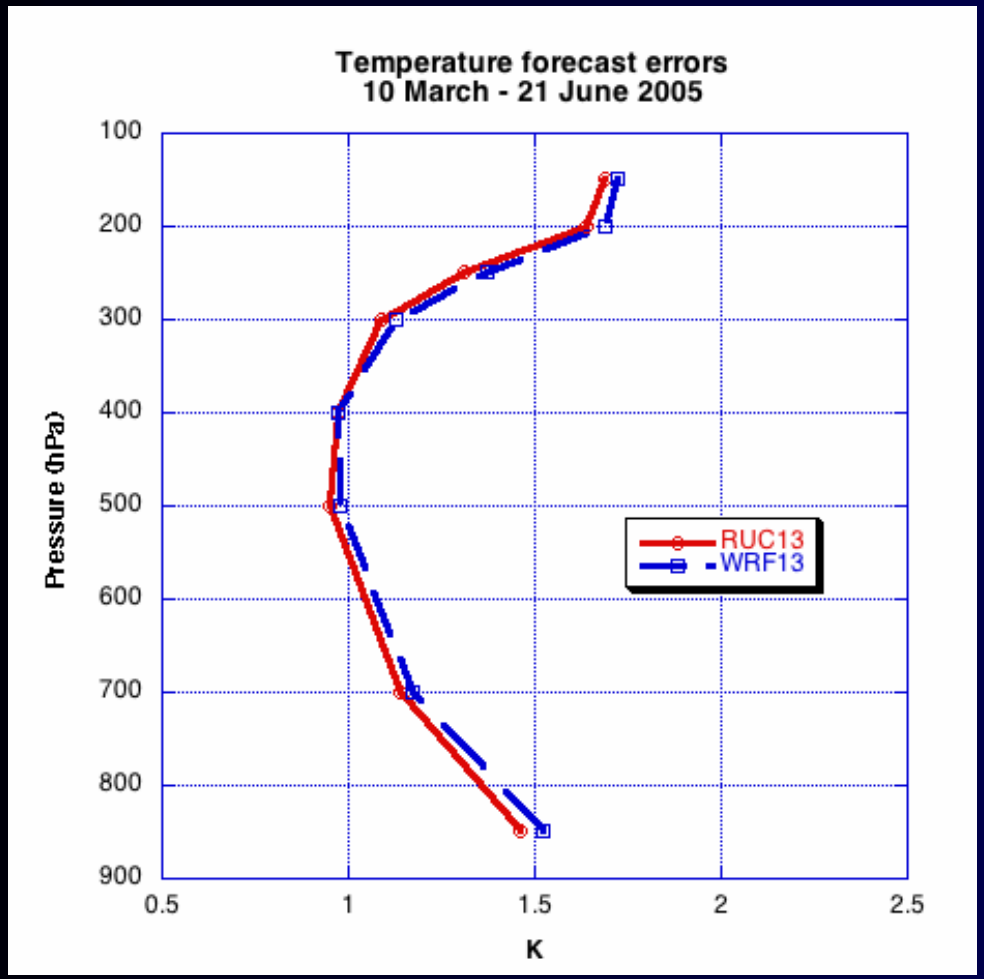


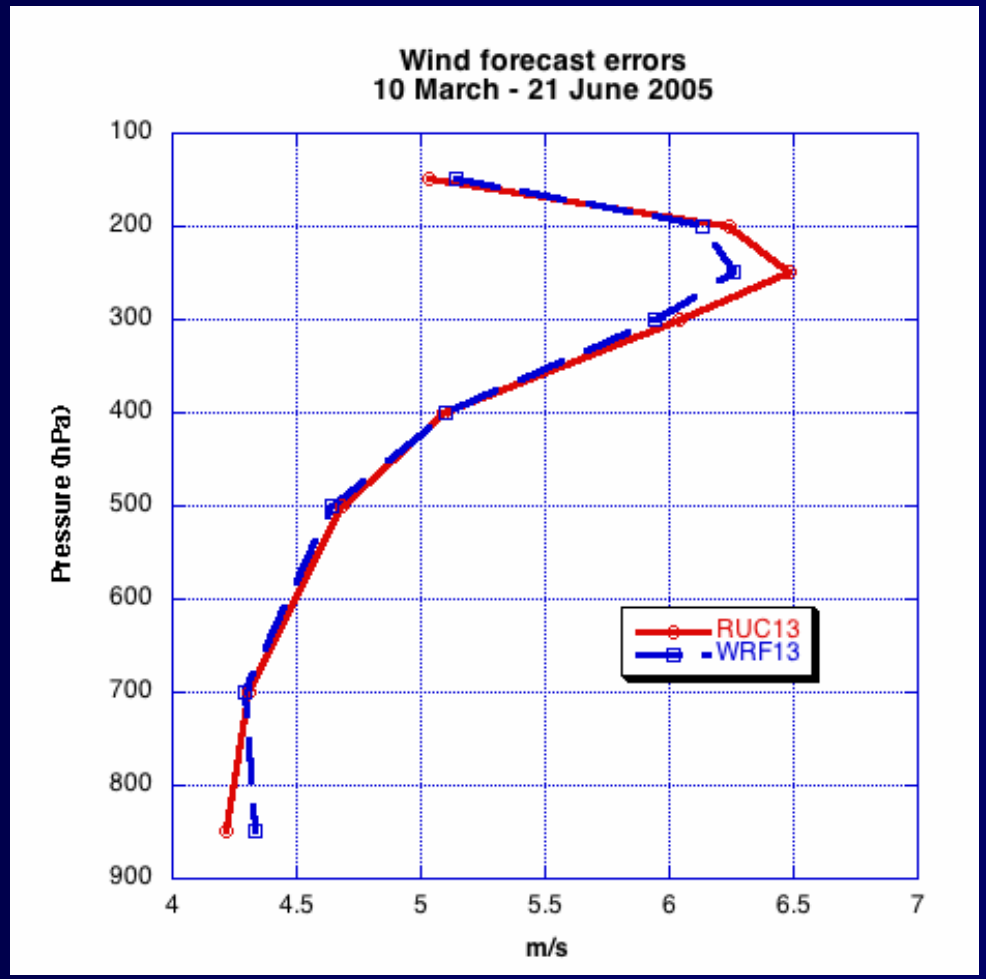


12-h temperature and winds aloft forecasts – verified against rawinsonde (92 stations)

13-km RUC vs. 13-km WRFRUC

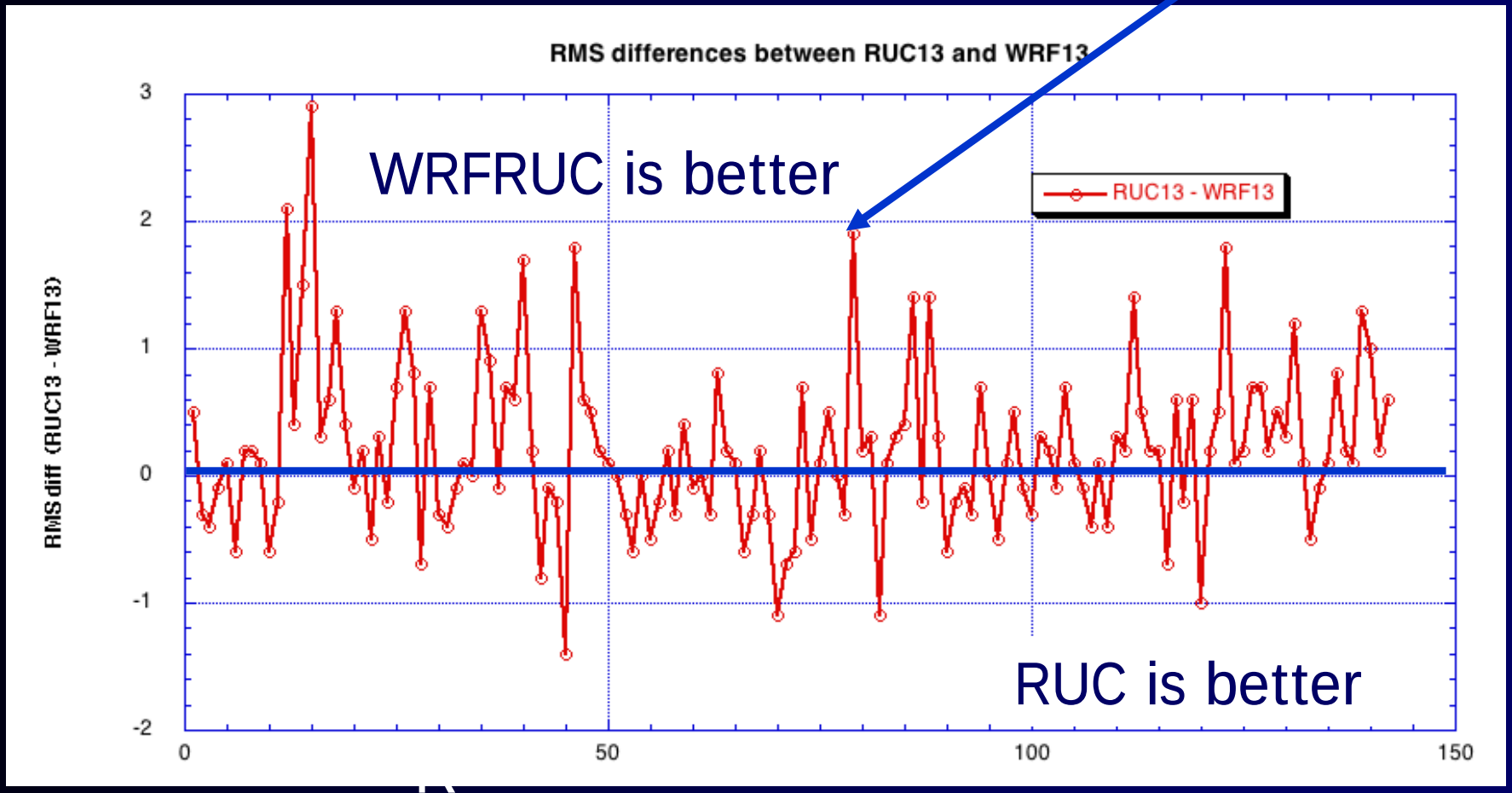
10 March – 21 June 2005

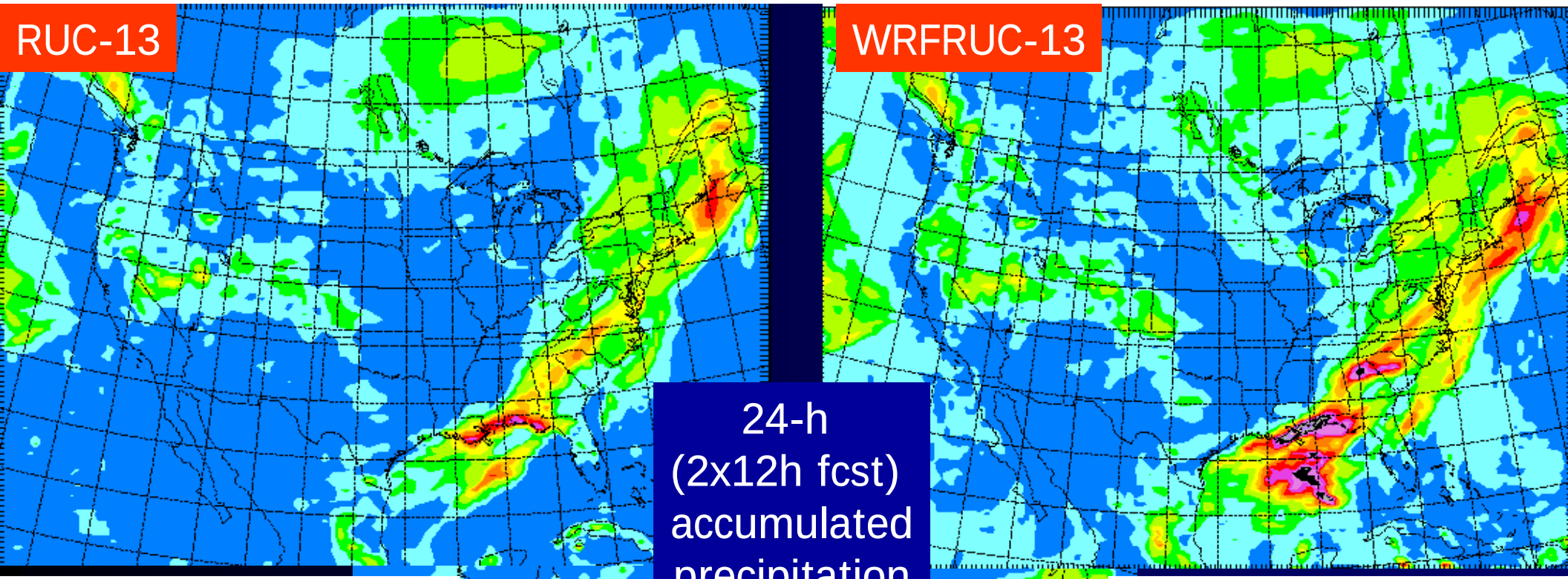




Differences of 250mb wind 12-h forecast RMS vector error (RUC13 minus WRFRUC13)

1 May 2005



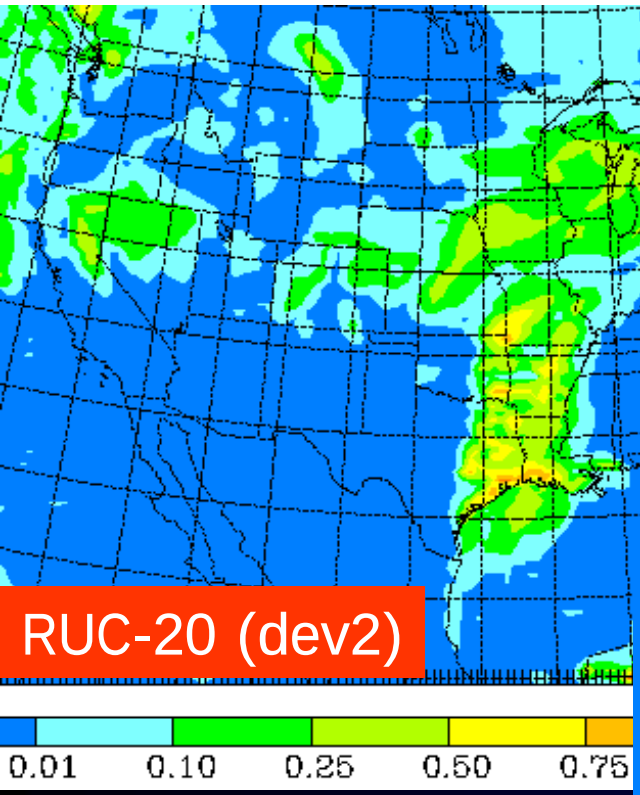


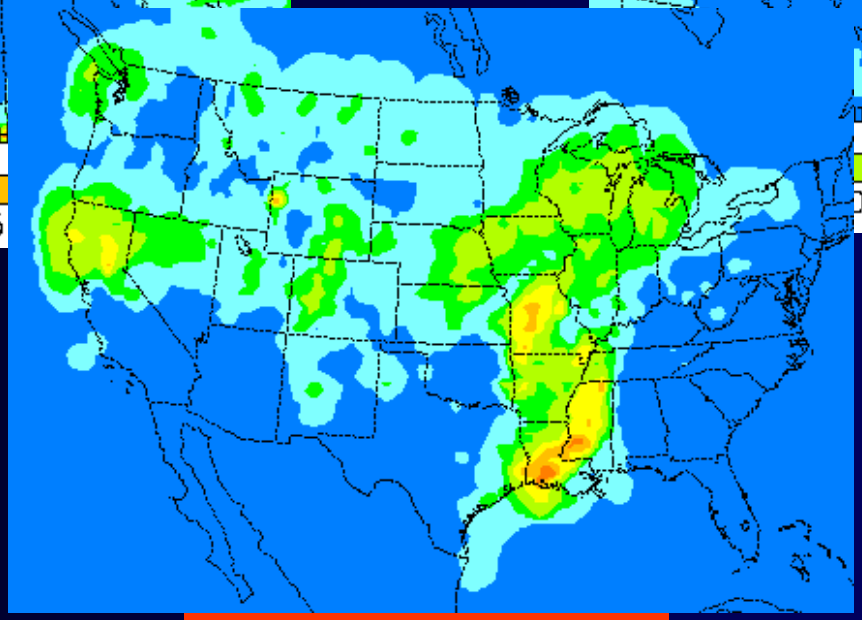
thrsh	eqts	bias
0.01	0.369	1.093
0.10	0.492	0.809
0.25	0.440	0.709
0.50	0.340	0.601
1.00	0.195	0.392
1.50	0.182	0.362
2.00	0.092	0.250
3.00	0.200	0.200

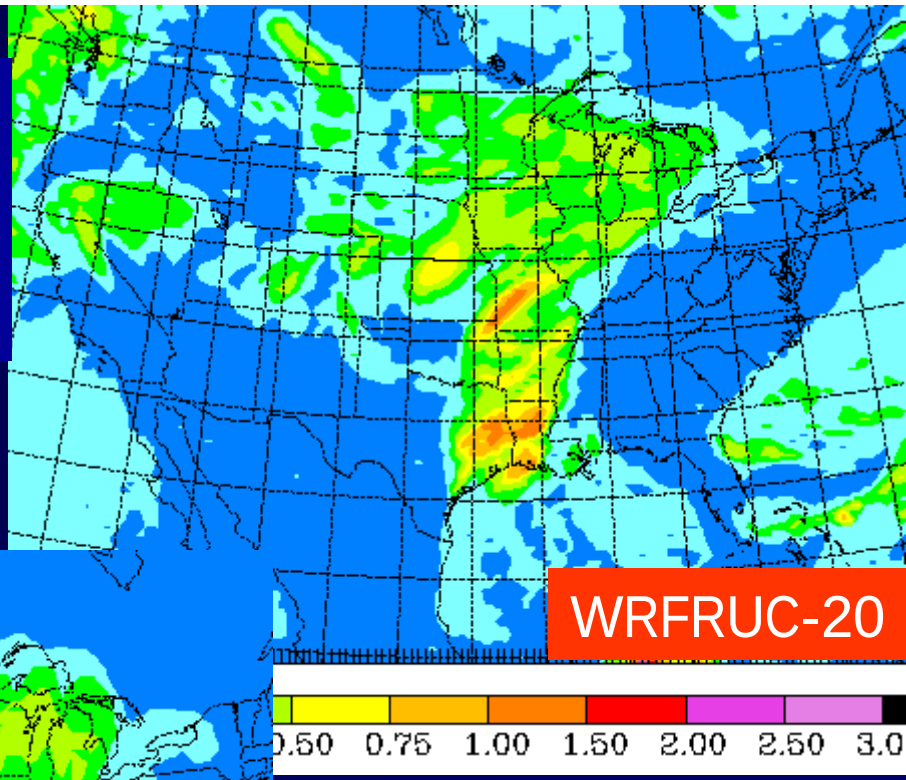
thrsh	eqts	bias
0.01	0. 279	1.380
0.10	0.471	1.076
0.25	0.475	0.901
0.50	0.375	0.786
1.00	0.243	0.922
1.50	0.249	1.191
2.00	0.276	1.286
3.00	0.066	2.200

Valid at 1200 UTC 1 May 2005

24-h (2x12h fcst) accumulated precipitation





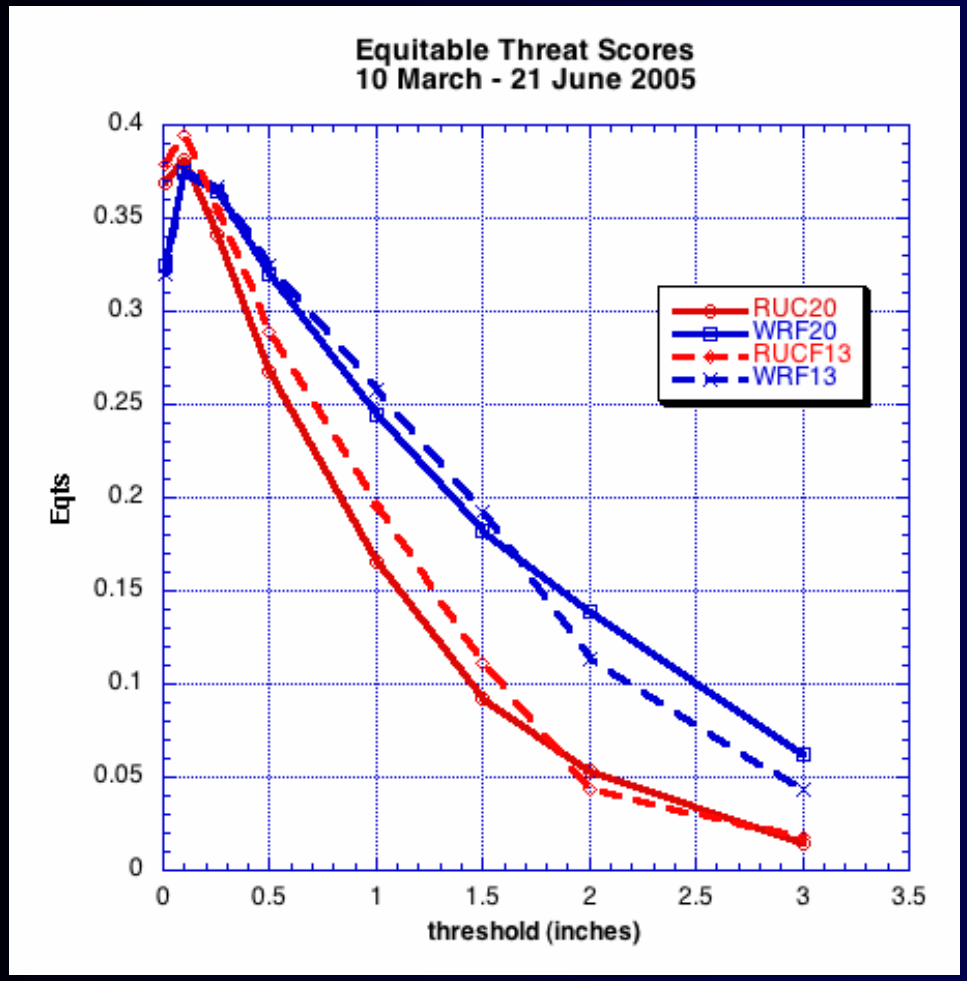


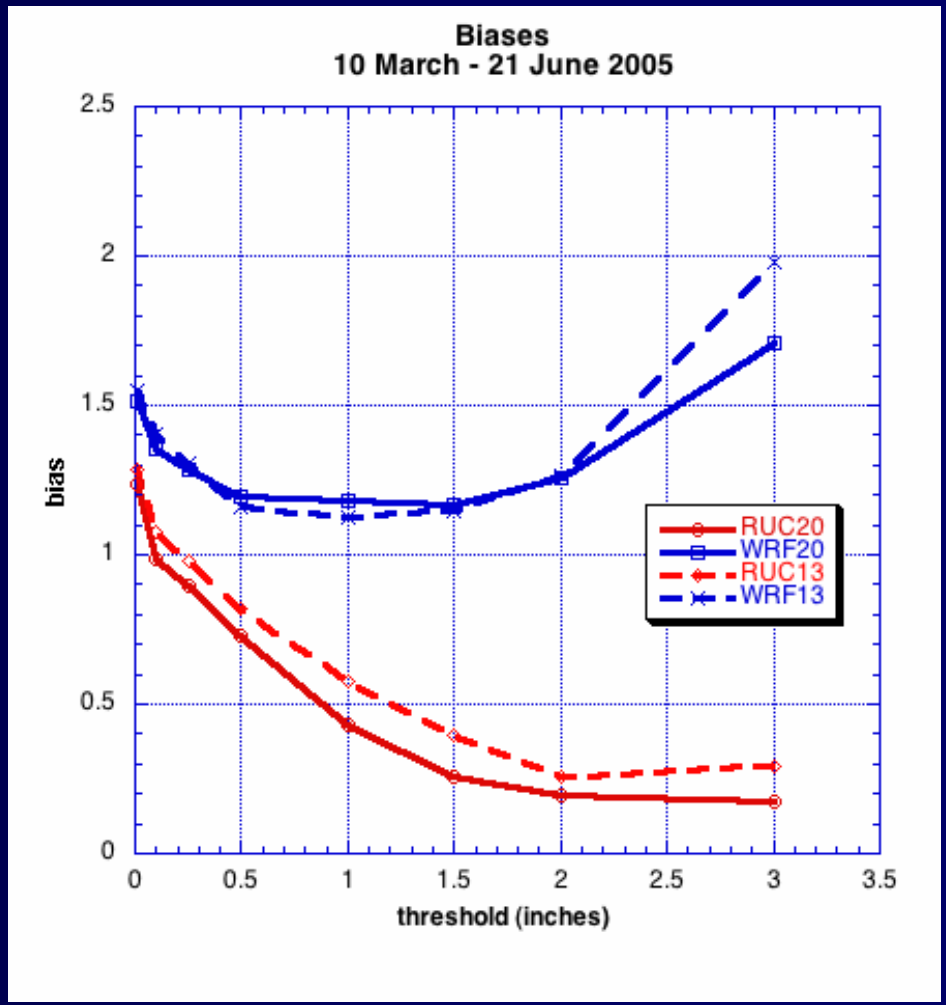
thrsh	eqts	bias
0.01	0.492	1.069
0.10	0.371	0.920
0.25	0.159	0.597
0.50	0.075	0.335
1.00	0.000	0.000

thrsh	eqts	bias
0.01	0.451	1.220
0.10	0.398	1.093
0.25	0.200	1.021
0.50	0.100	0.709
1.00	0.022	0.424

Valid at 1200 UTC
28 November 2004

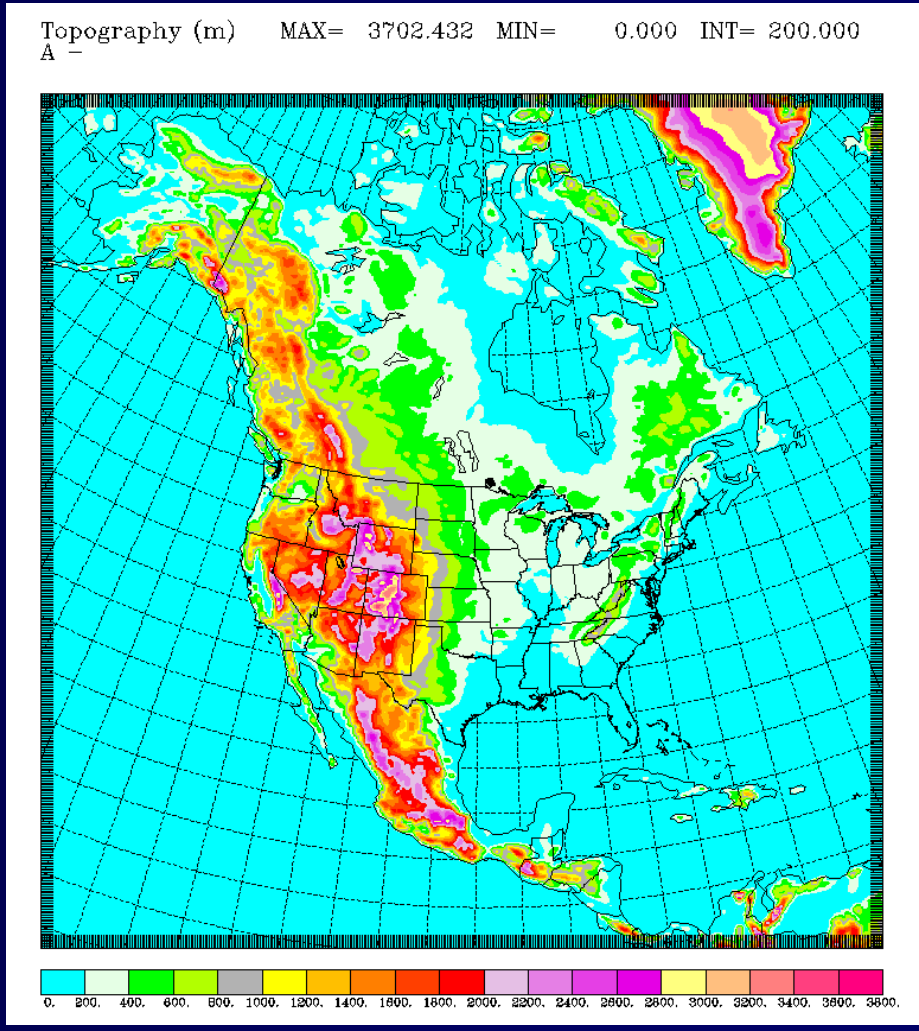
Averaged equitable threat scores and biases for **24-h** (2x12h fcst) accumulated precipitation from RUC and WRFRUC 10 March – 21 June 2005

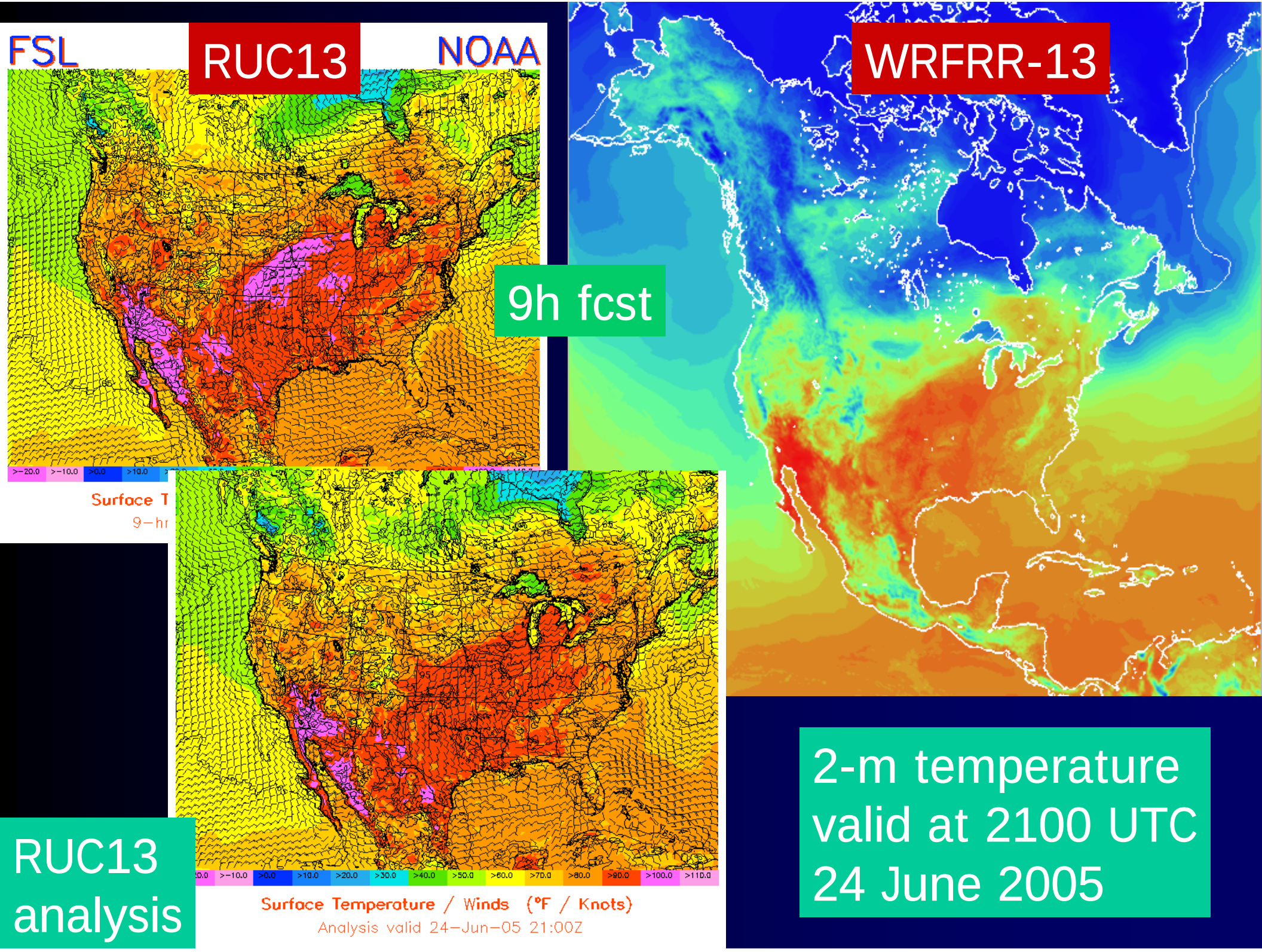


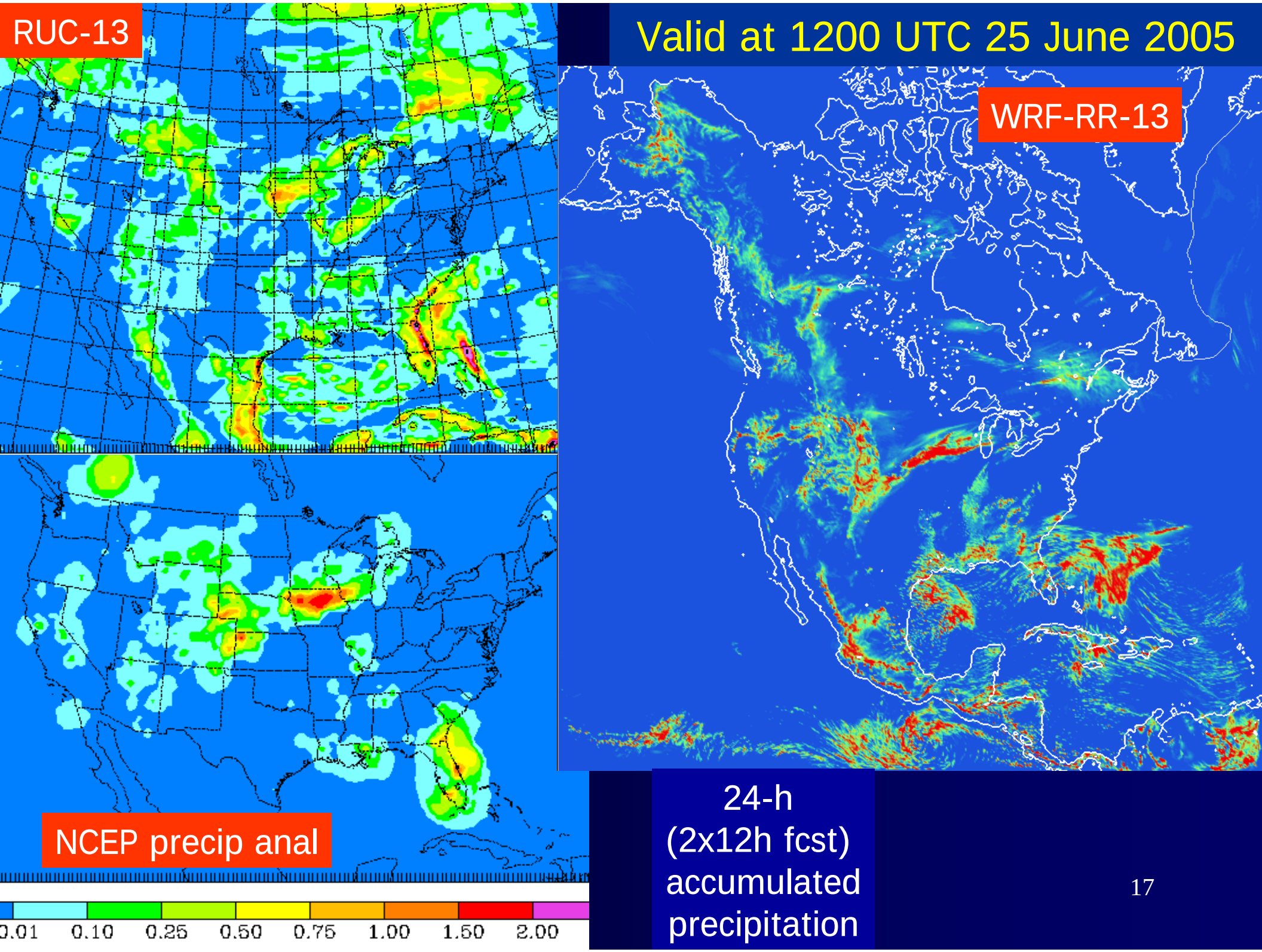


Rapid Refresh on expanded domain

- GSI (Gridpoint Statistical Interpolation) for data assimilation
- Boundary conditions from GFS (currently also initialized from GFS in initial testing)
- WRF model
  - selection of dynamical core (ARW or NMM)
  - selection of model physics
  - development of digital filter initialization - DFI




FSL
RUC13
NOAA
WRFRR-13
9h fcst
Surface T
9-hr
>-20.0 >-10.0 >0.0 >10.0
>0.0 >10.0 >20.0 >30.0 >40.0 >50.0 >60.0 >70.0 >80.0 >90.0 >100.0 >110.0
Surface Temperature / Winds (°F / Knots)
Analysis valid 24-Jun-05 21:00Z
RUC13 analysis
2-m temperature valid at 2100 UTC 24 June 2005


RUC-13
Valid at 1200 UTC 25 June 2005
WRF-RR-13
NCEP precip anal
0.01
0.10
0.25
0.50
0.75
1.00
1.50
2.00
24-h
(2x12h fcst)
accumulated
precipitation

Summary

- 13-km and 20-km WRFRUC (ARW) on CONUS run in real time
- Results of WRFRUC surface verifications - generally reasonable, daytime cold bias
- Precipitation verification - overall improved in WRFRUC compared to RUC at both 20-km and 13-km resolutions

Future plans

- Test WRFRUC (ARW and NMM) in parallel cycles on CONUS domain with different physics options to
  - reduce temperature and wind errors aloft
  - reduce day-time cold bias at the surface
  - evaluate performance of aviation impact variables (ceiling, visibility, etc.)
- Determine the optimal WRF model configuration for application in the Rapid Refresh at NCEP