Realtime 3 km explicit convective forecasts with WRF-ARW during Spring 2007*

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Joseph Klemp (NCAR/MMM)

(8th WRF Users Workshop)

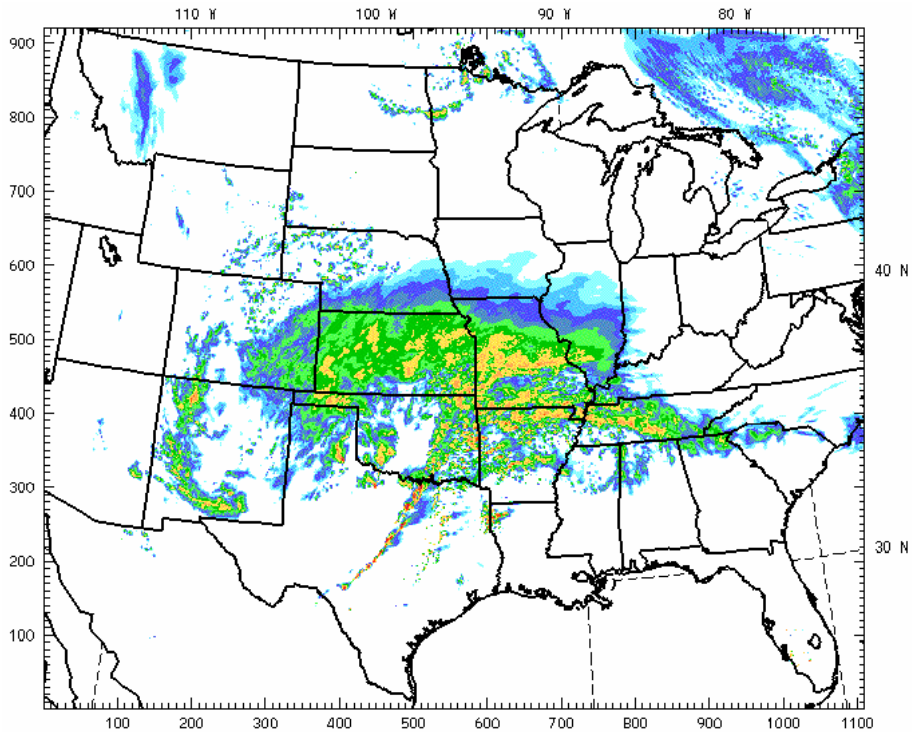
*SPC/NSSL Spring Program:

- 4 km ARW, NMM (NCAR/NSSL/NCEP)
- 3 km ARW (NCAR)
- 2 km ARW (CAPS)
- 10 member 4 km ARW ensemble (CAPS)

2007 WRF-ARW Realtime Forecasts:

24 h ARW Forecast

Valid 00 UTC 4/14/07



- 36 h, 3 km resolution
- WPS, 40 km NAM initial/boundaries

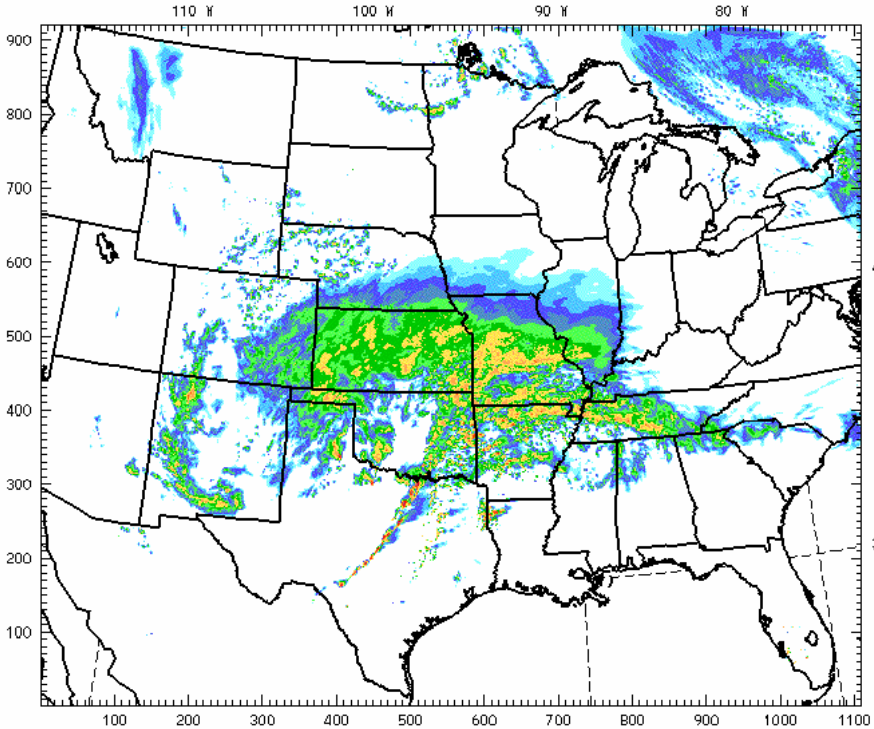
✞ - Thompson microphysics

- MYJ (YSU) PBL

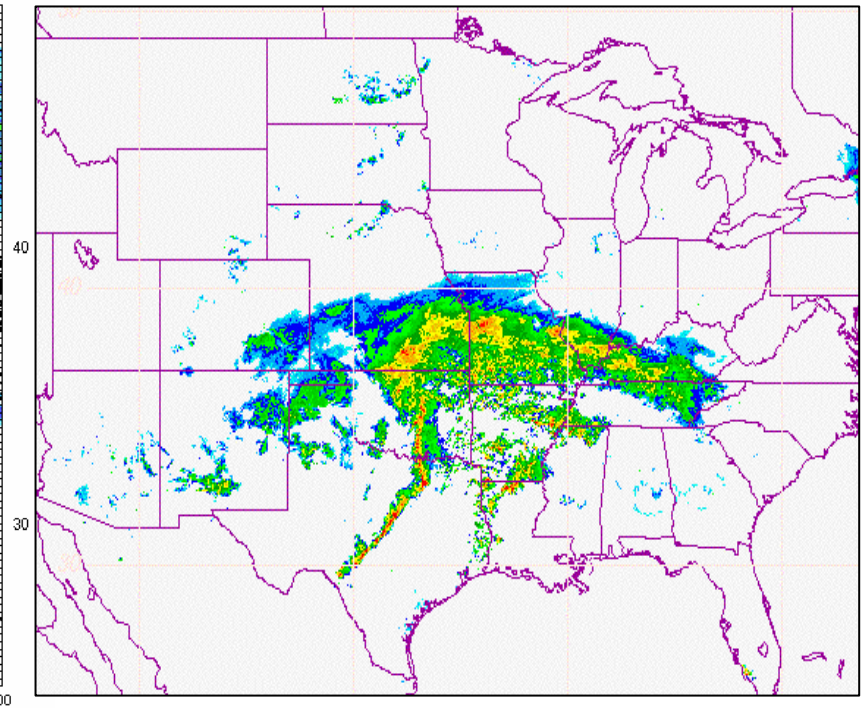
✞ - Positive-definite advection for moisture

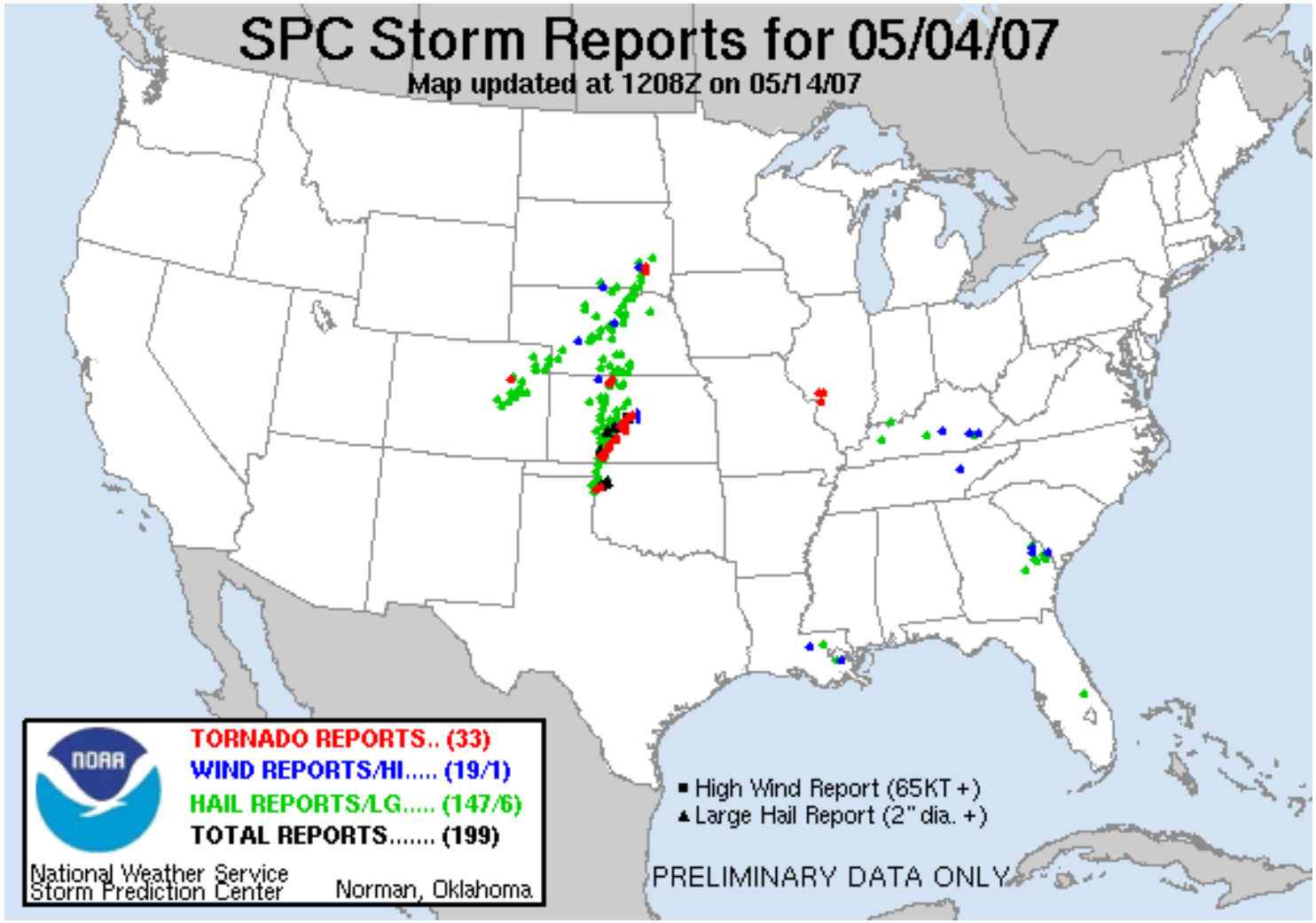
3 km ARW Forecast: 00 UTC 04/14/07

24 h ARW Reflectivity



Observed Reflectivity




SPC Storm Reports for 05/04/07
Map updated at 1208Z on 05/14/07
TORNADO REPORTS.. (33)
WIND REPORTS/HI..... (19/1)
HAIL REPORTS/LG..... (147/6)
TOTAL REPORTS..... (199)
National Weather Service
Storm Prediction Center
Norman, Oklahoma
High Wind Report (65KT+)
Large Hail Report (2" dia. +)
PRELIMINARY DATA ONLY

3 km ARW Forecast: 05/04/07

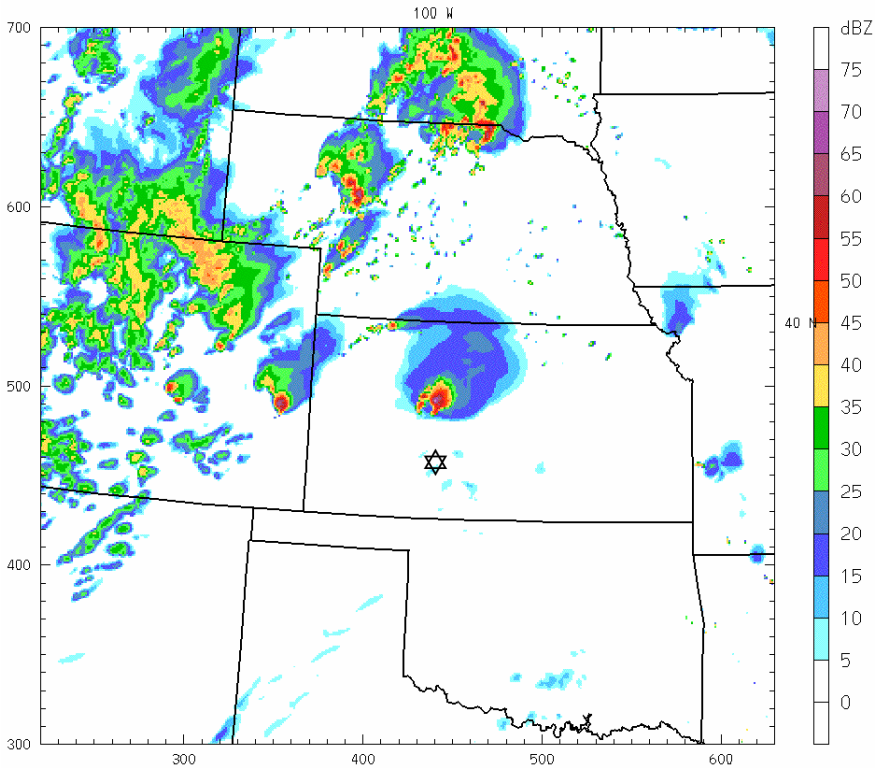
ARW Reflectivity

Observed Reflectivity

QuickTime™ and a
BMP decompressor
are needed to see this picture.

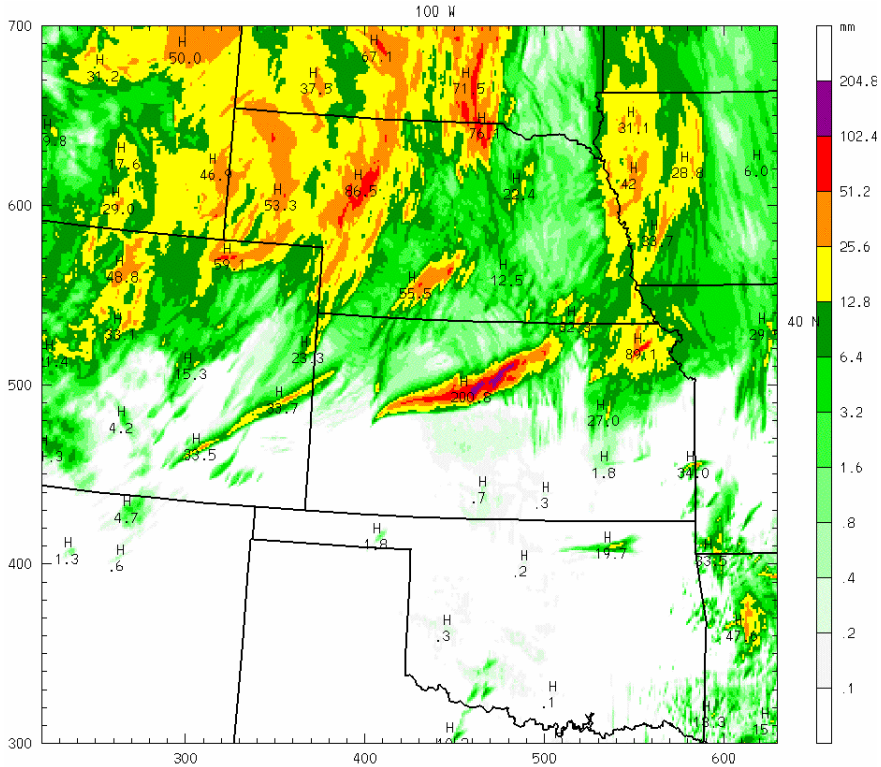
ARW Forecast: 05/05/07

24 h ARW Reflectivity (00 UTC)



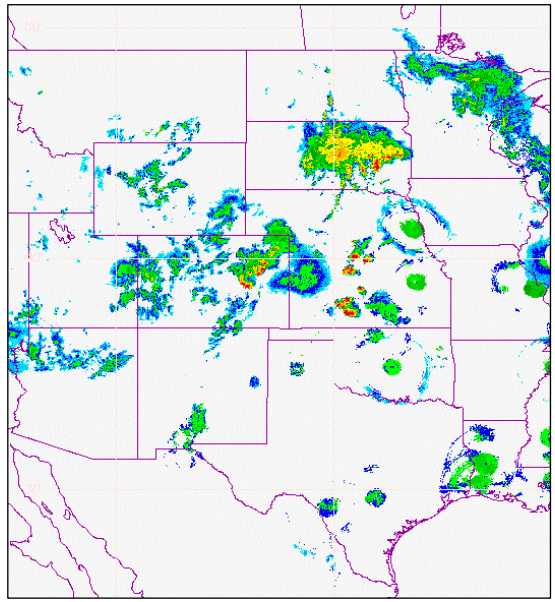
✡ Greensburg, Kansas

30 h ARW Precipitation (06 UTC)



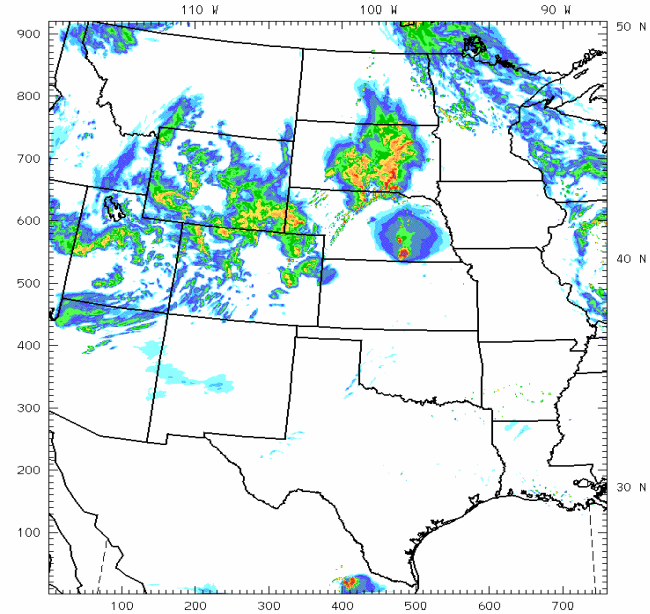
5 May 2007 03 UTC

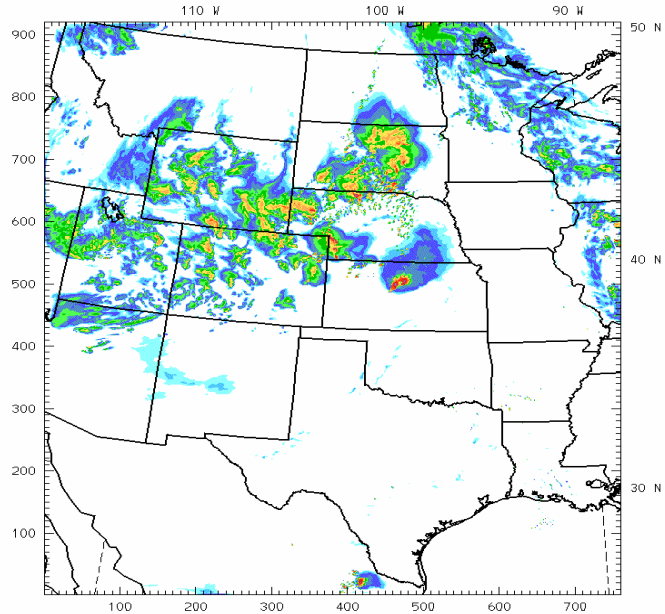
Radar



YSU PBL

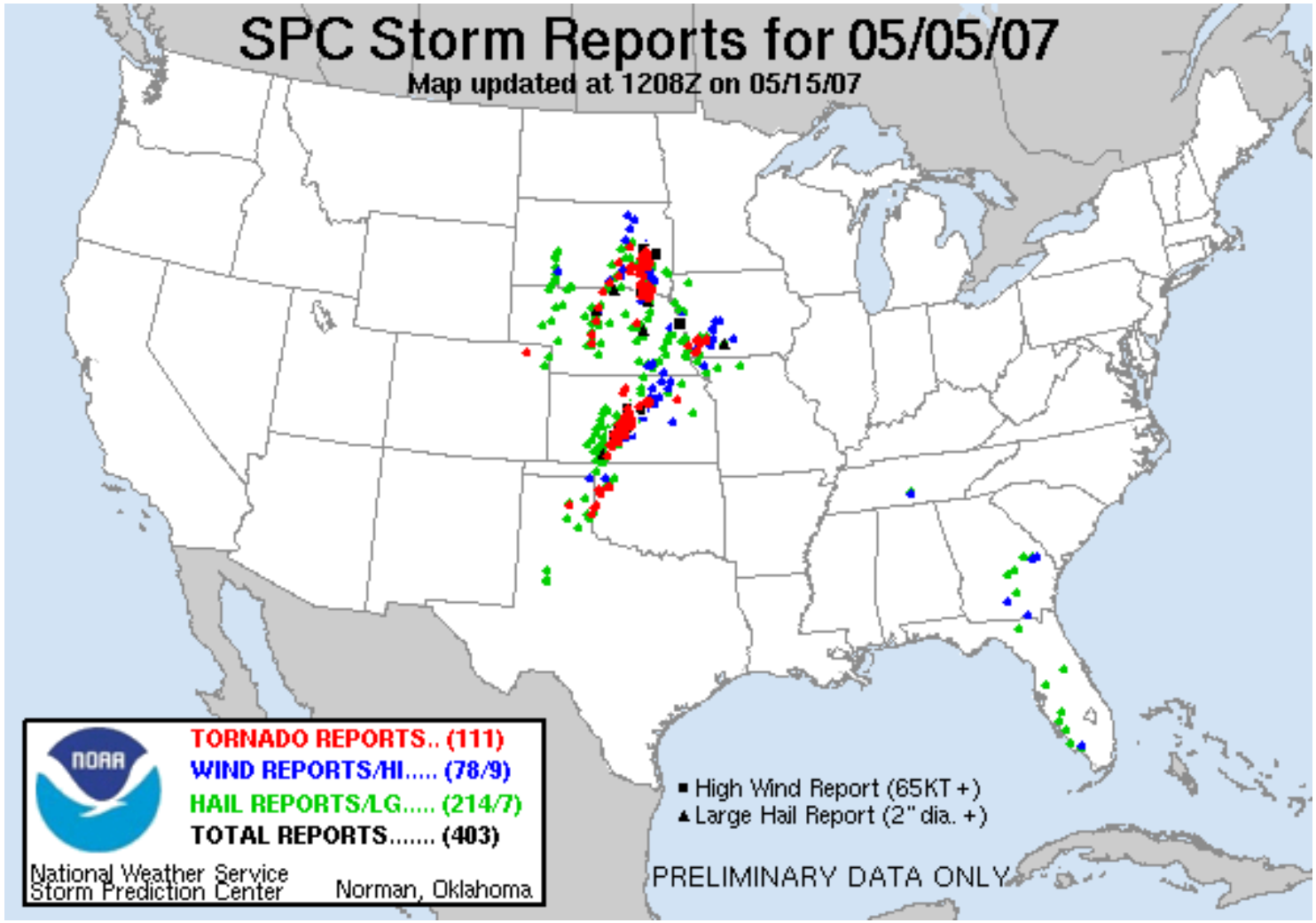
(27h)





MYJ PBL

(27h)


SPC Storm Reports for 05/05/07
Map updated at 1208Z on 05/15/07
TORNADO REPORTS.. (111)
WIND REPORTS/HI..... (78/9)
HAIL REPORTS/LG..... (214/7)
TOTAL REPORTS..... (403)
National Weather Service
Storm Prediction Center
Norman, Oklahoma
High Wind Report (65KT+)
Large Hail Report (2" dia. +)
PRELIMINARY DATA ONLY

3 km ARW Forecast: 05/05/07

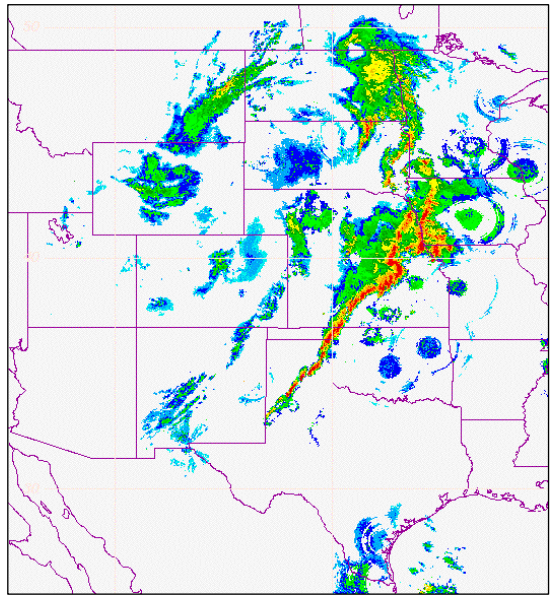
ARW Reflectivity

Observed Reflectivity

QuickTime™ and a
BMP decompressor
are needed to see this picture.

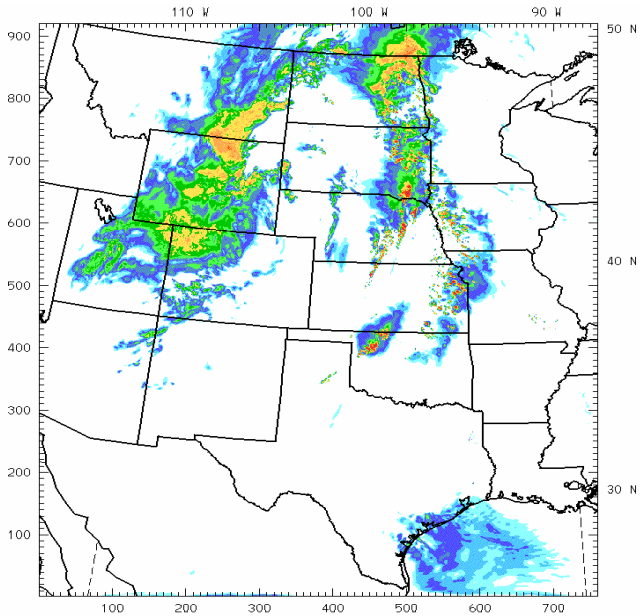
6 May 2007 06 UTC

Radar



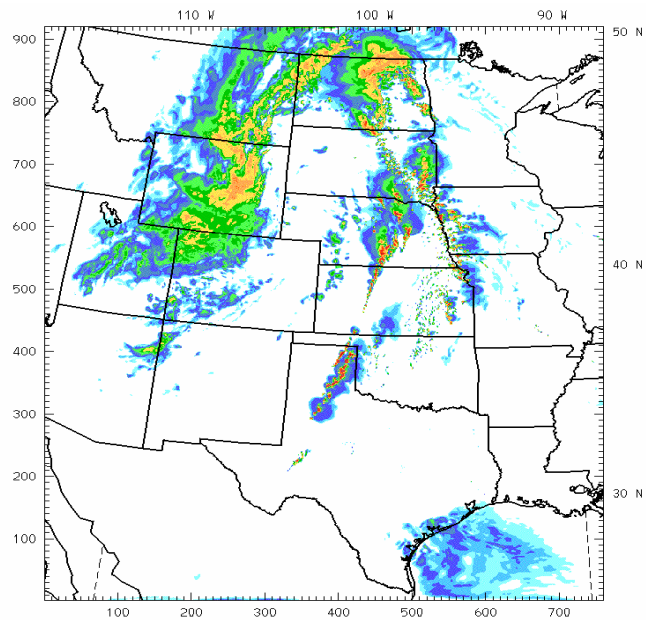
YSU PBL

(30h)



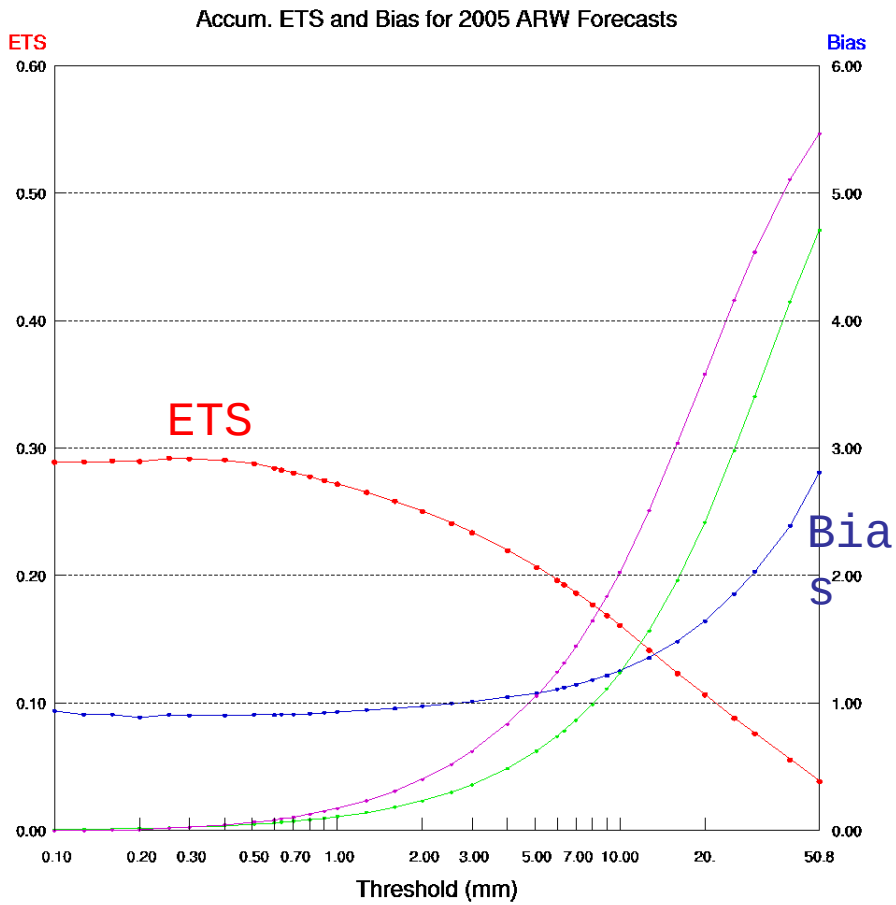
MYJ PBL

(30h)



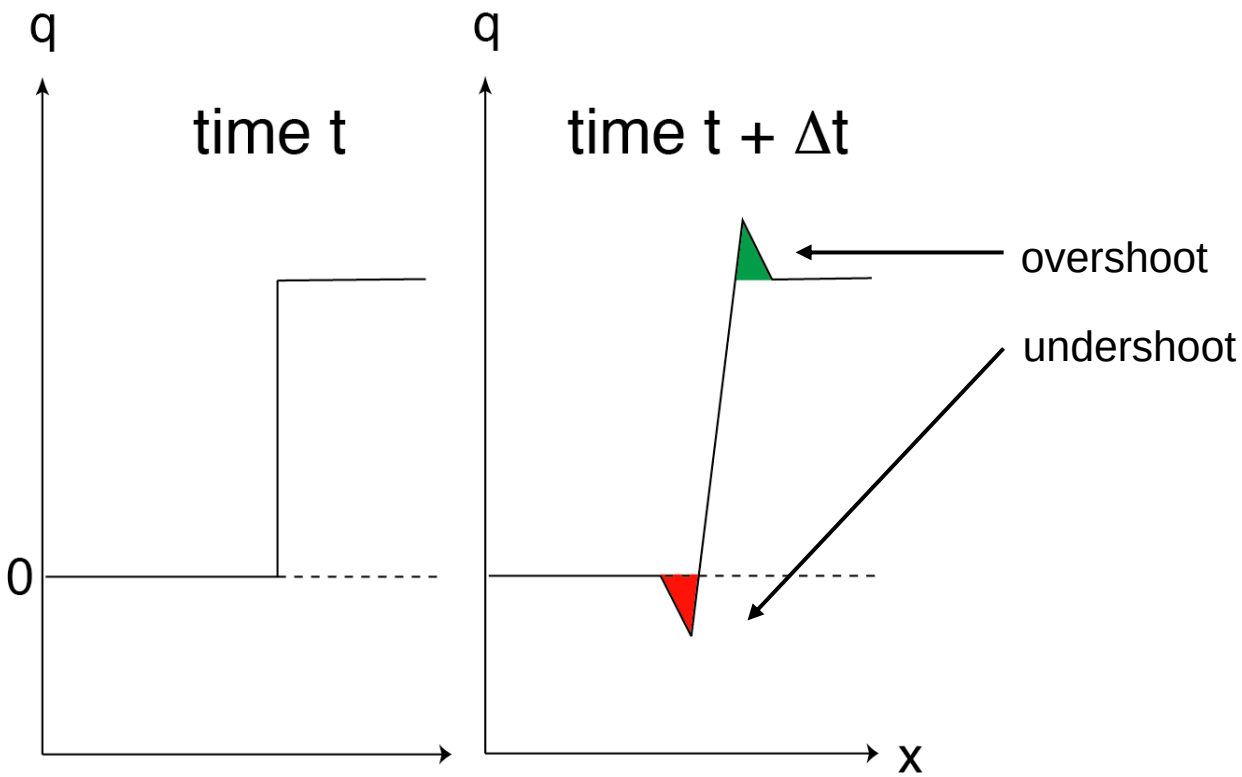
Ongoing Problem: High Precipitation Bias

2005 ARW 4 km Forecasts:



Moisture Transport in ARW

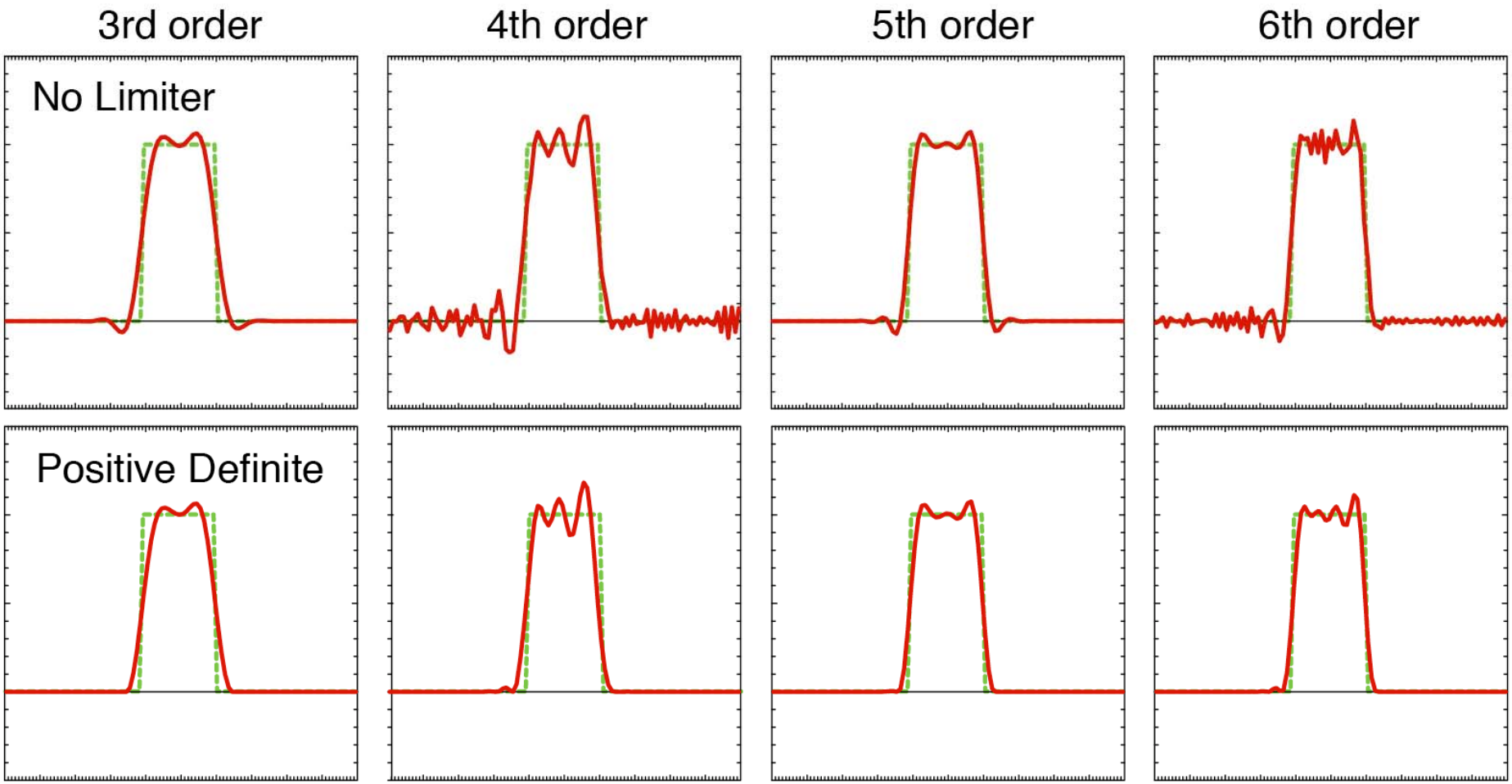
1D advection



ARW scheme is conservative,
but not positive definite nor monotonic.
Removal of negative q
results in spurious source of q .

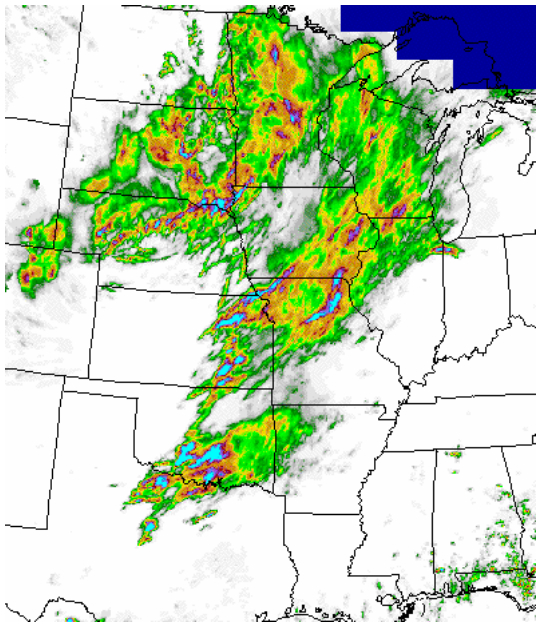
PD Limiter in ARW - 1D Example
Top-Hat Advection

Cr = 0.5, 1 revolution (200 steps)

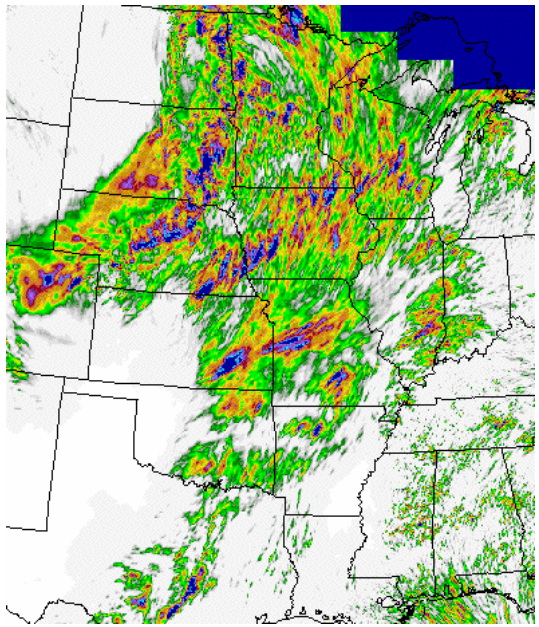


24 h Precipitation 06/05/05

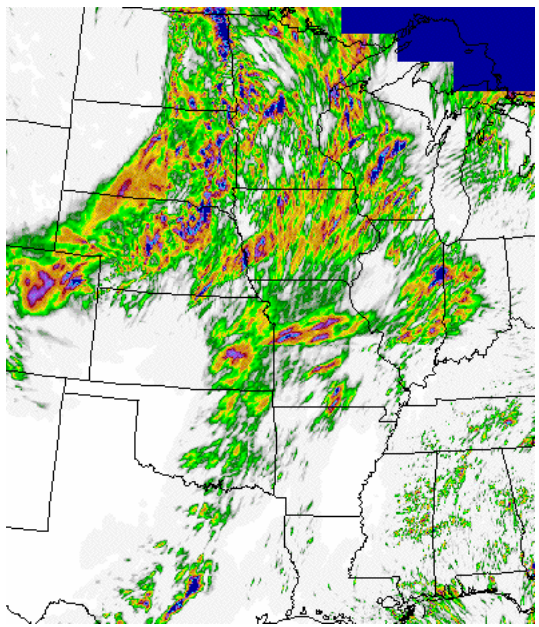
Observed (ST4)

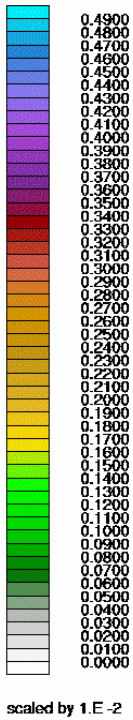


ARW Standard



ARW Positive-Definite

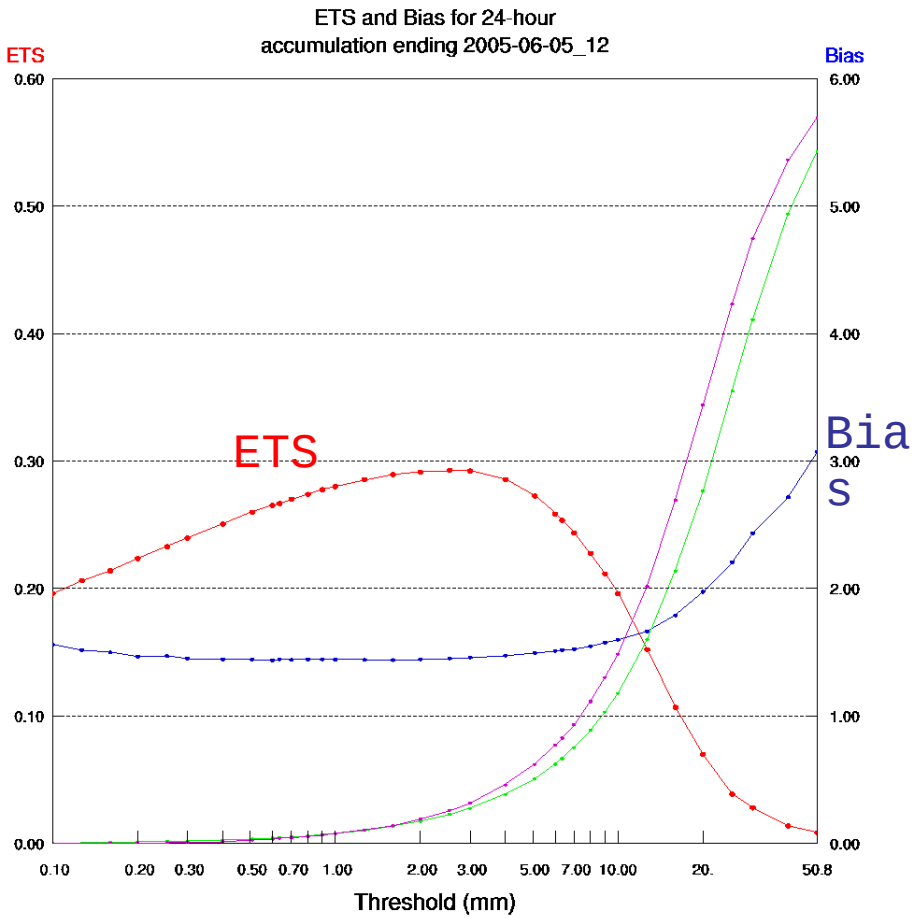




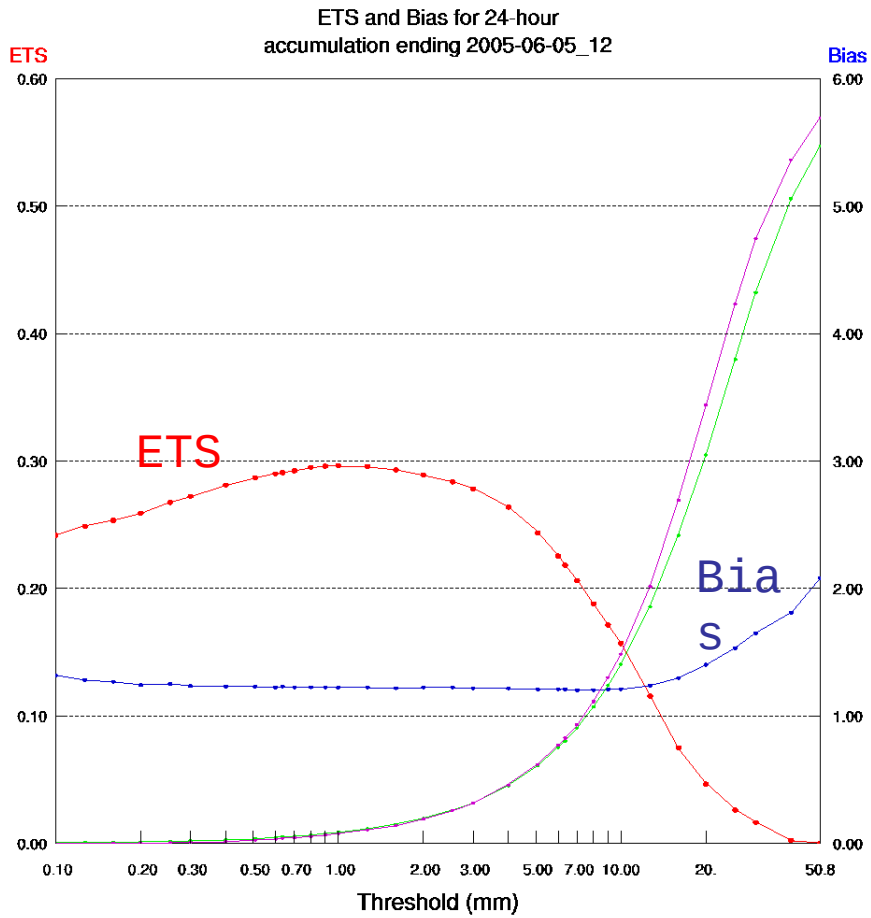
scaled by 1.E -2

24 h ETS and BIAS: 06/05/05

Standard advection

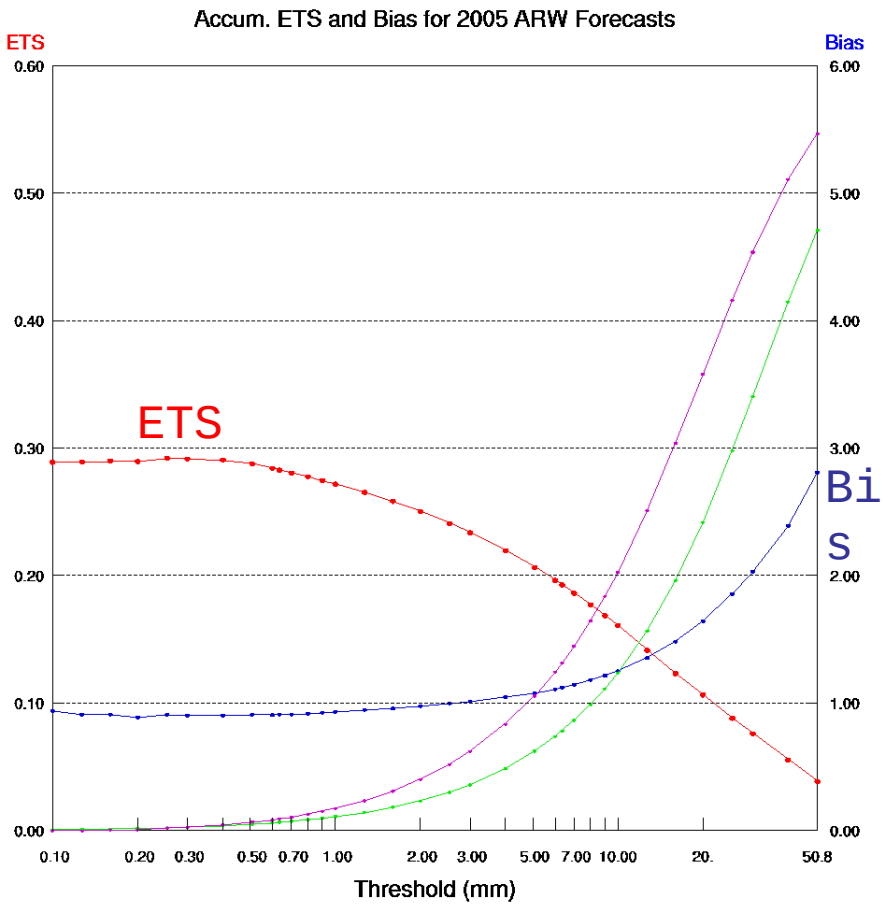


Positive-definite advection

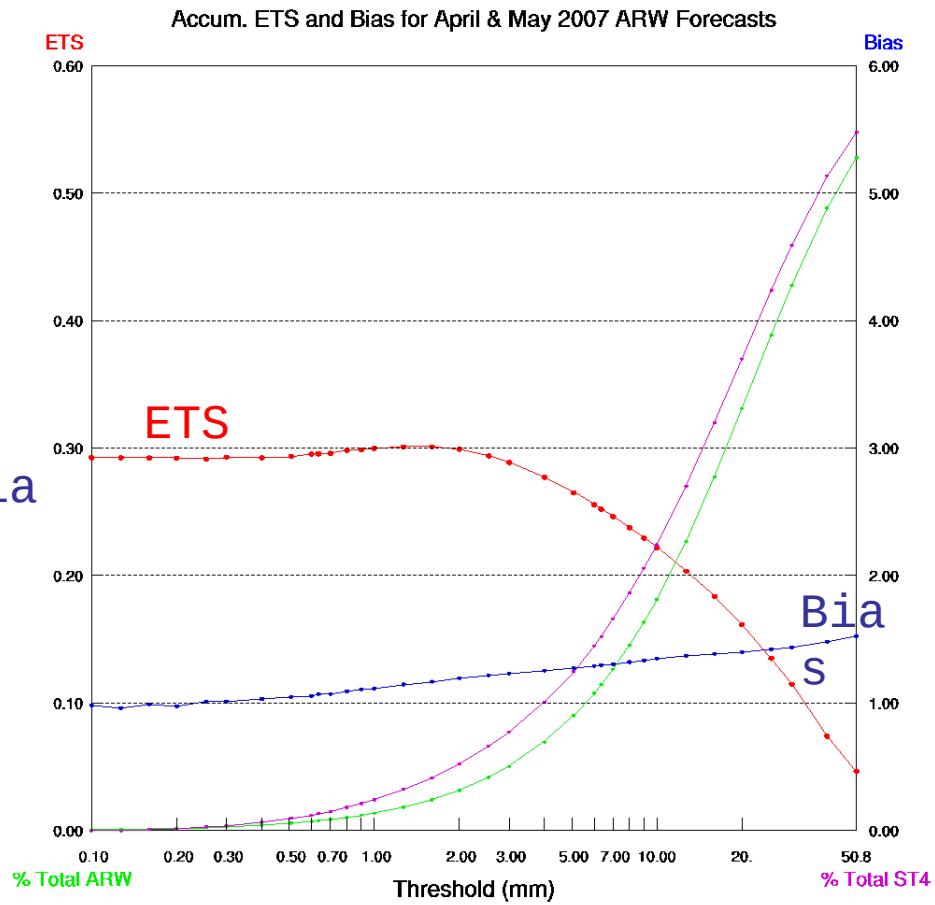


Accumulated ETS and BIAS: 2005,2007

2005: Standard advection



2007: Positive-definite advection



Summary:

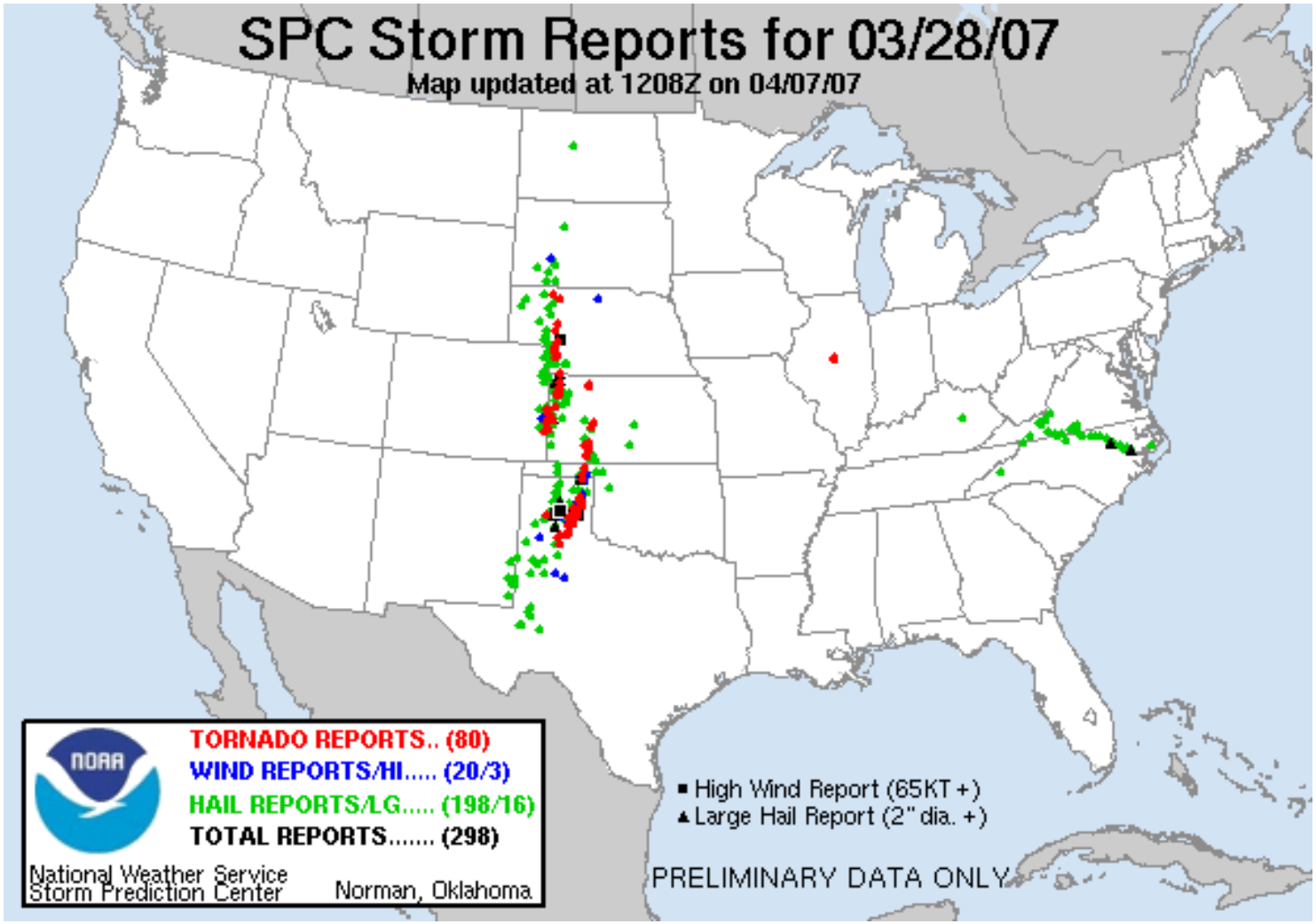
- More realistic convective system/cell structure with 3 km resolution and Thompson microphysics

  * Supercells now more viable

- Improved ETS/BIAS scores with positive-definite advection

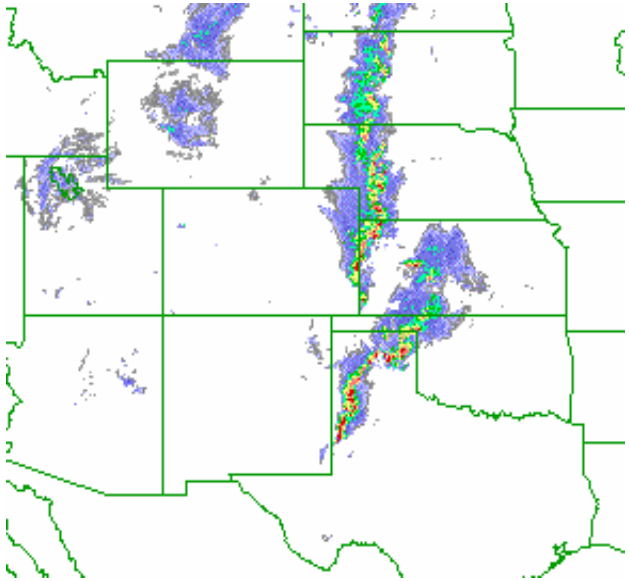
  * High bias for convective precipitation much reduced

``Positive definite is definitely a positive''


SPC Storm Reports for 03/28/07
Map updated at 1208Z on 04/07/07
TORNADO REPORTS.. (80)
WIND REPORTS/HI..... (20/3)
HAIL REPORTS/LG..... (198/16)
TOTAL REPORTS..... (298)
National Weather Service
Storm Prediction Center
Norman, Oklahoma
■ High Wind Report (65KT +)
▲ Large Hail Report (2" dia. +)
PRELIMINARY DATA ONLY

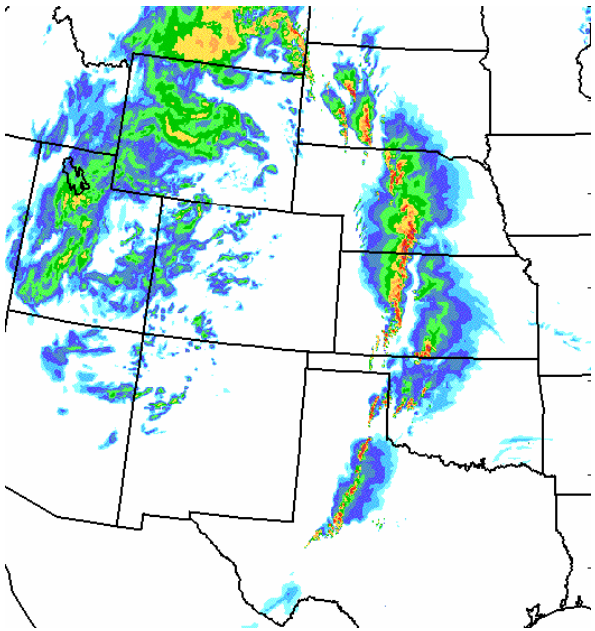
29 March 2007 03 UTC

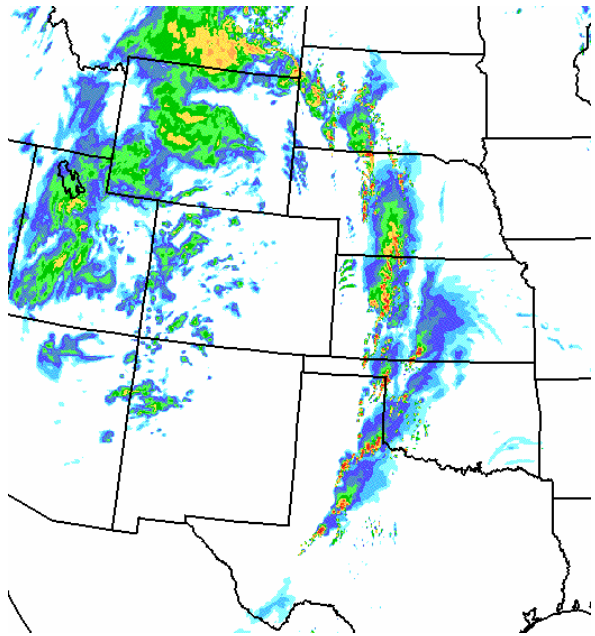
Radar



YSU PBL

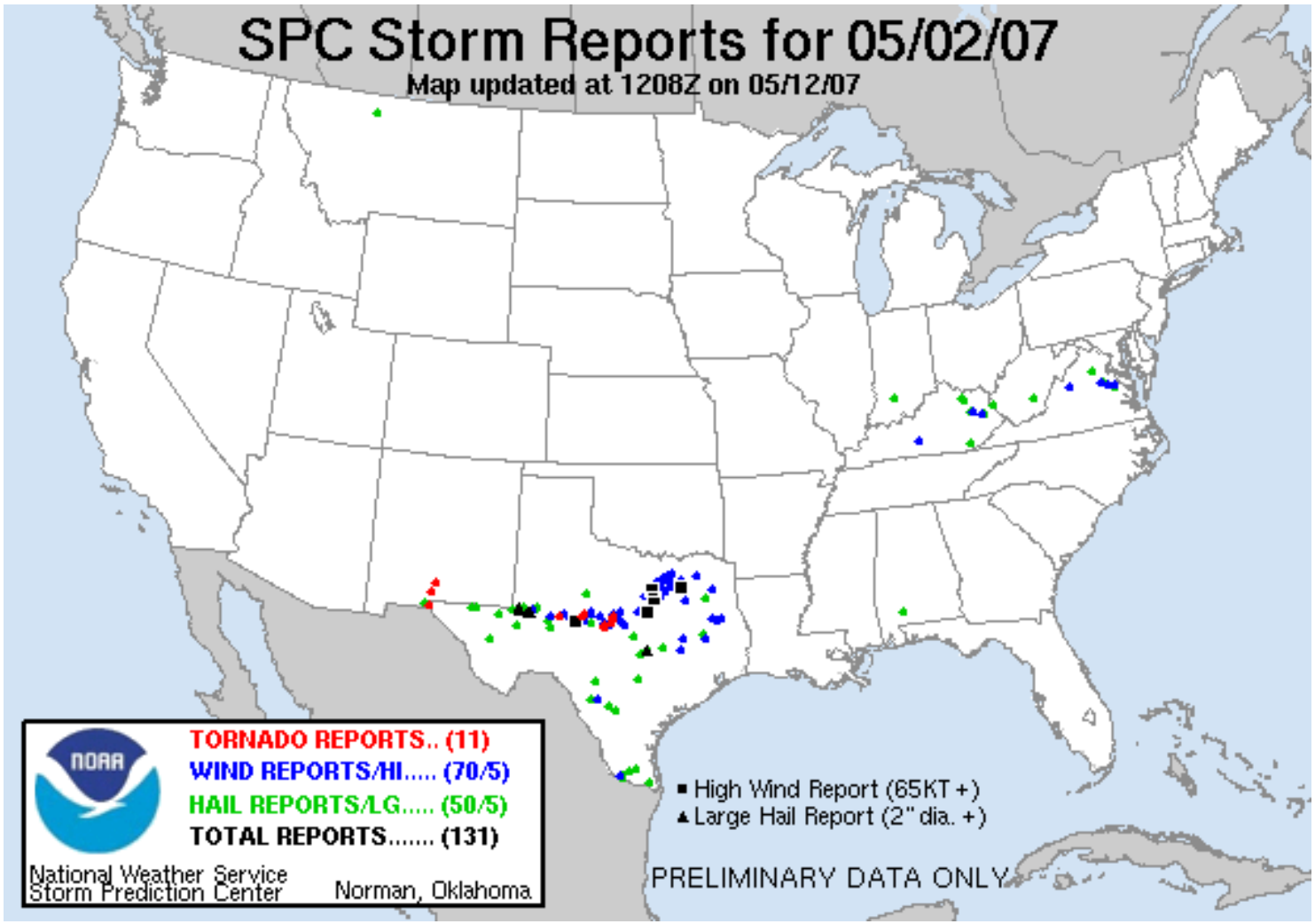
(27h)





MYJ PBL

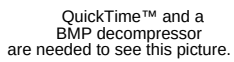
(27h)


SPC Storm Reports for 05/02/07
Map updated at 1208Z on 05/12/07
TORNADO REPORTS.. (11)
WIND REPORTS/HI..... (70/5)
HAIL REPORTS/LG..... (50/5)
TOTAL REPORTS..... (131)
National Weather Service
Storm Prediction Center
Norman, Oklahoma
High Wind Report (65KT+)
Large Hail Report (2" dia.+)
PRELIMINARY DATA ONLY

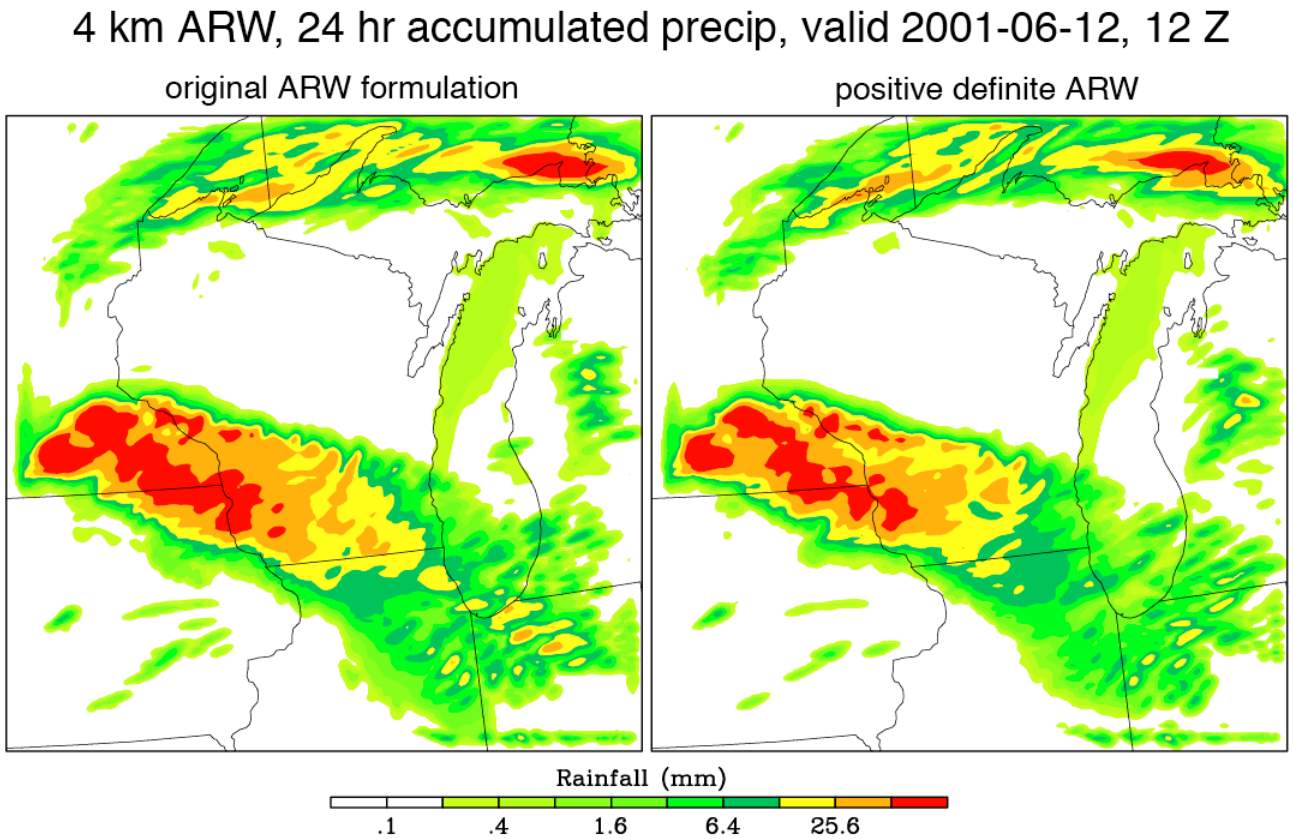
3 km ARW Forecast: 05/02/07

ARW Reflectivity

Observed Reflectivity



ARW test with PD scheme (24 h forecast)



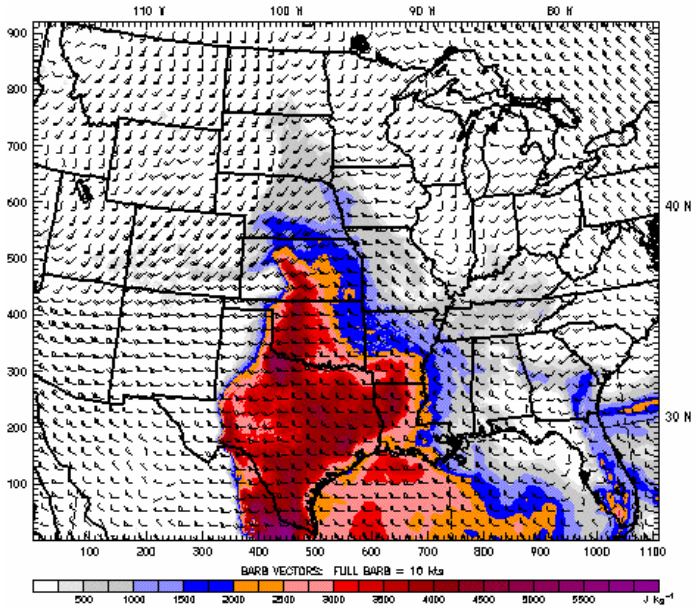
Non-PD ARW sets any negative q to zero each step: spurious water source

Total 24 h precip:
PD-ARW: 2.15 x 10^{10} m^3
Non-PD: 2.58 x 10^{10} m^3

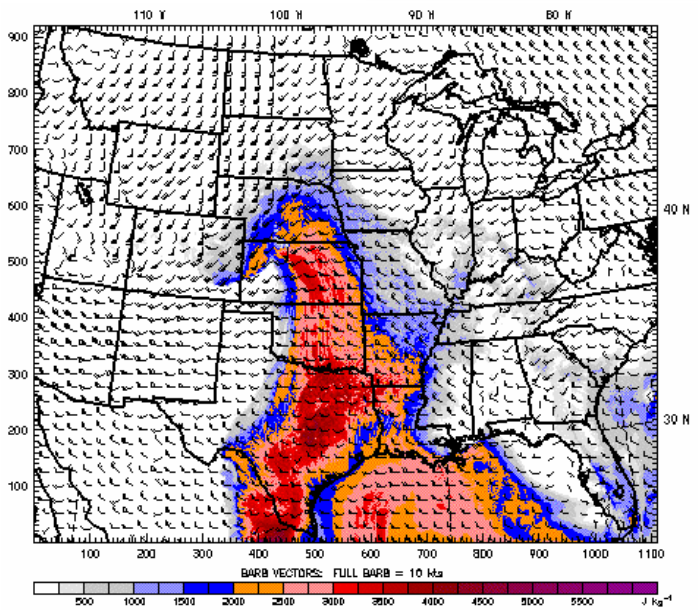
Non-PD added mass: 0.65 x 10^{10} m^3
Non-PD additional precip: 0.43 x 10^{10} m^3

CAPE 05 May 2007 00 UTC

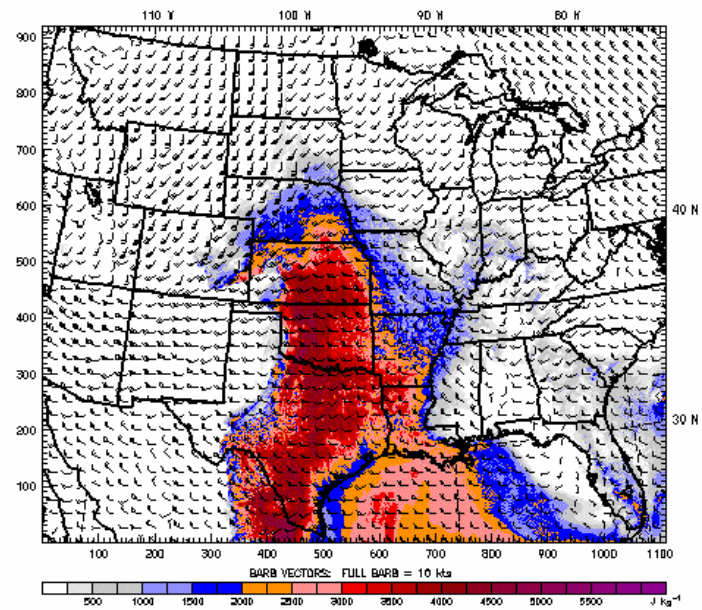
NAM Analysis



YSU PBL (24h)

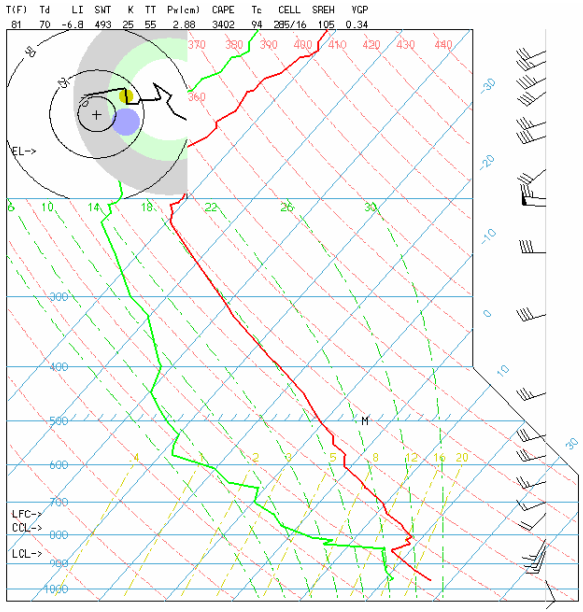


MYJ PBL (24h)



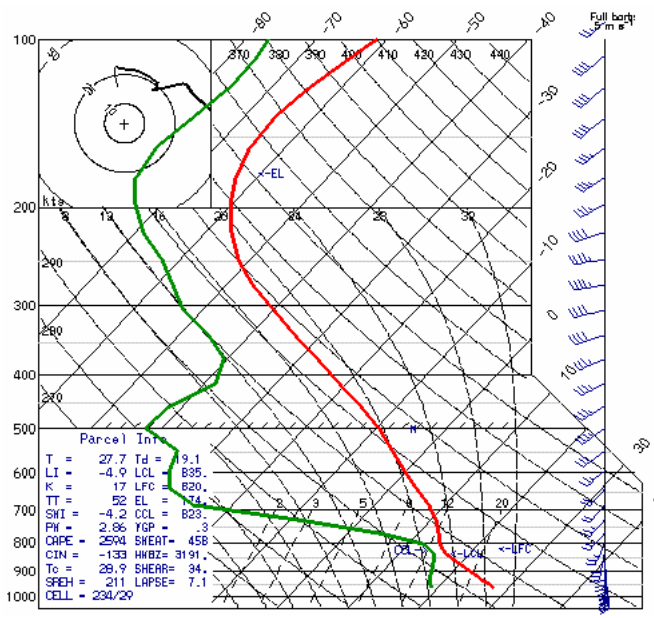
OUN 05 May 2007 00 UTC

OBS



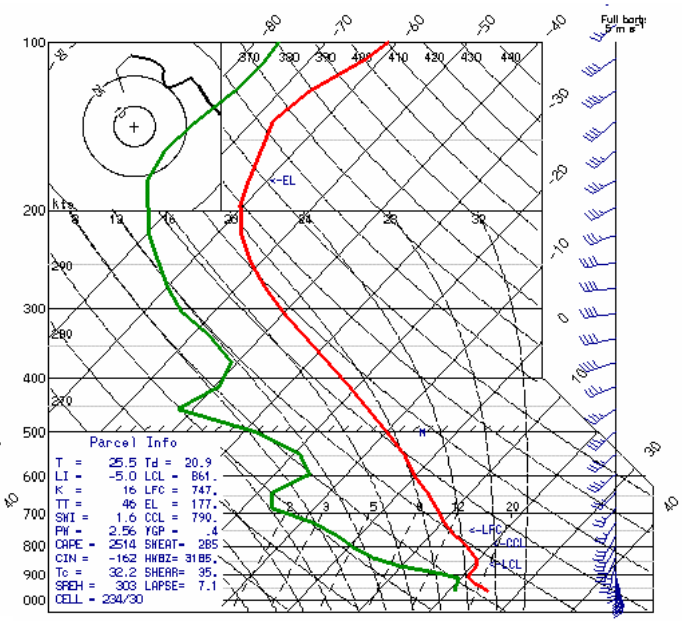
YSU PBL

(24h)



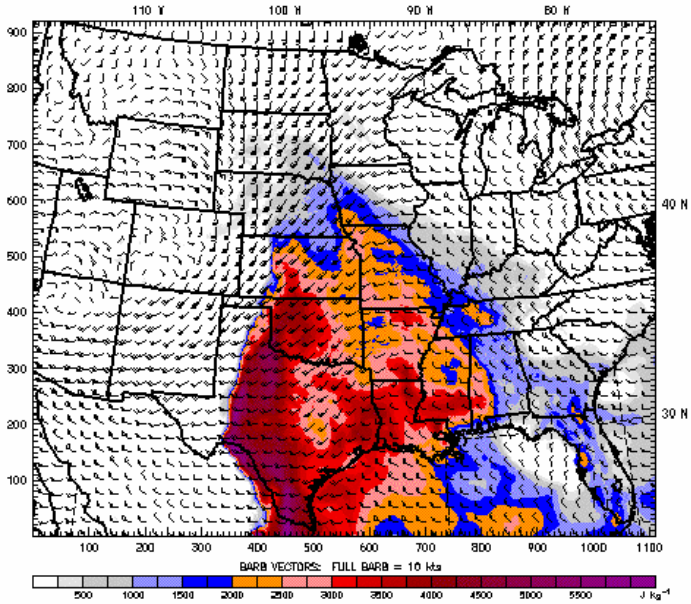
MYJ PBL

(24h)

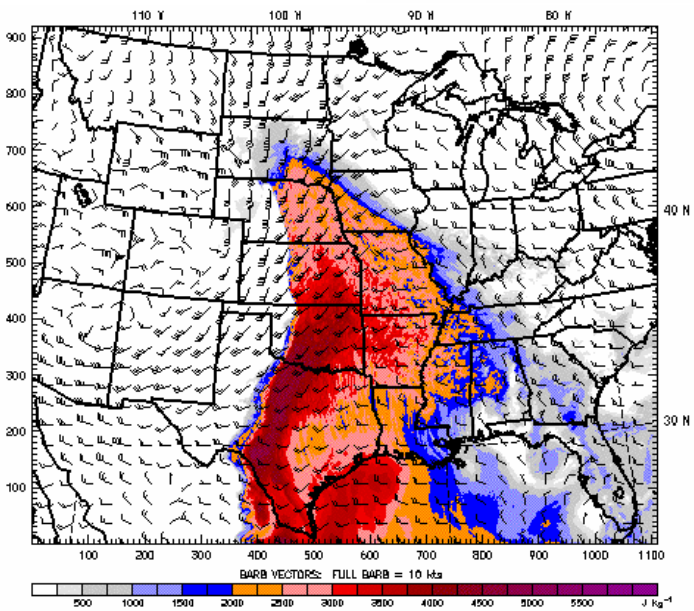


CAPE 06 May 2007 00 UTC

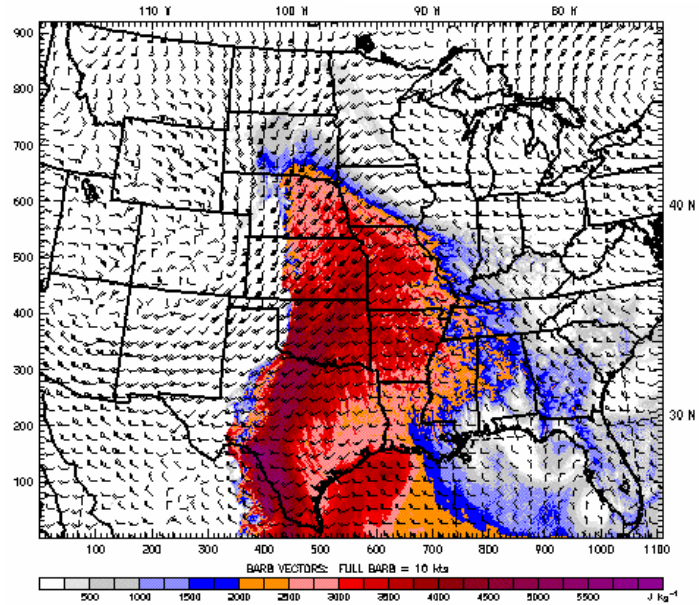
NAM Analysis



YSU PBL (24h)

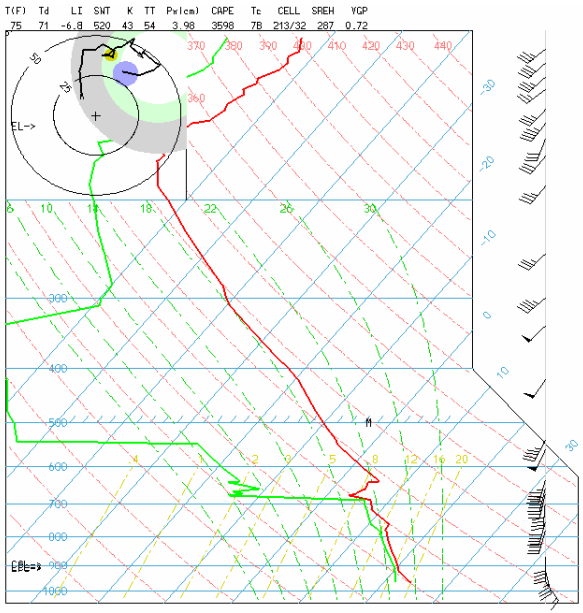


MYJ PBL (24h)



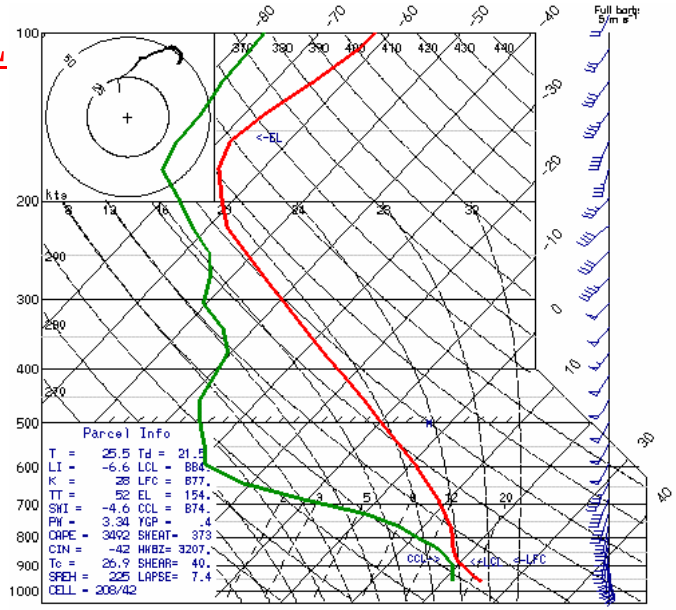
OUN 06 May 2007 00 UTC

OBS



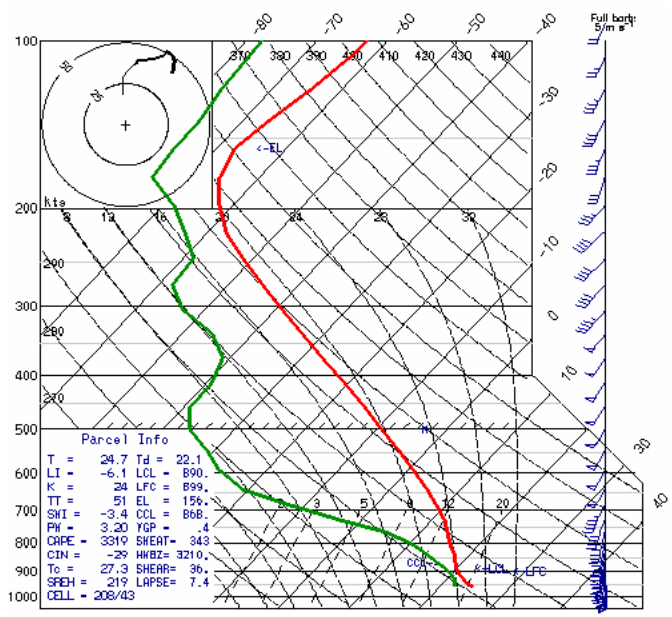
YSU PBL

(24h)



MYJ PBL

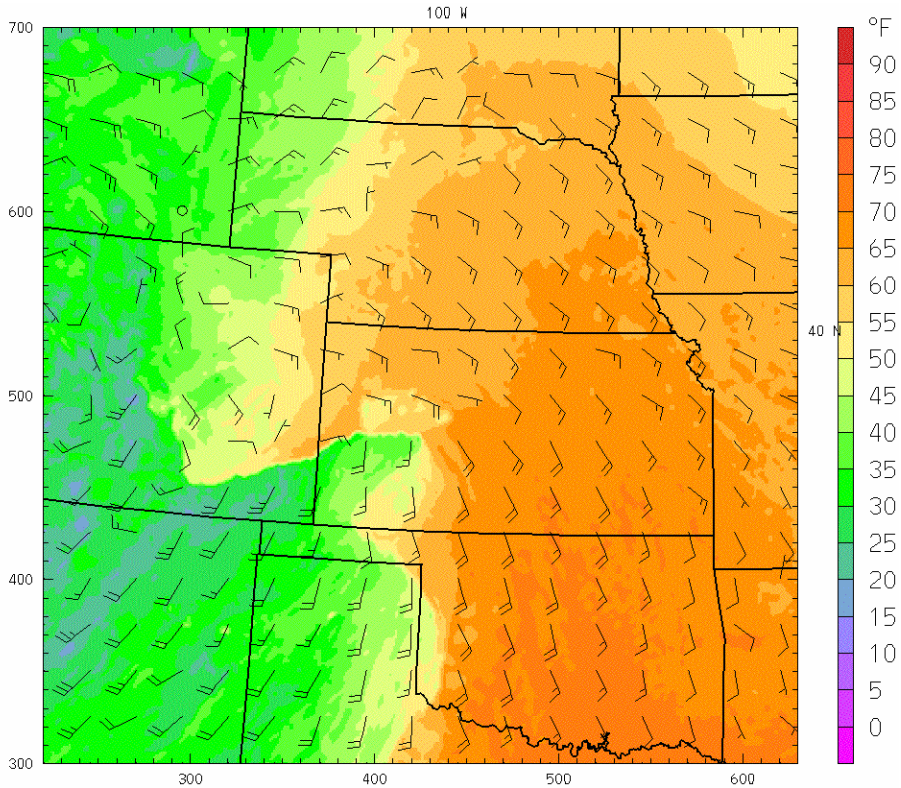
(24h)



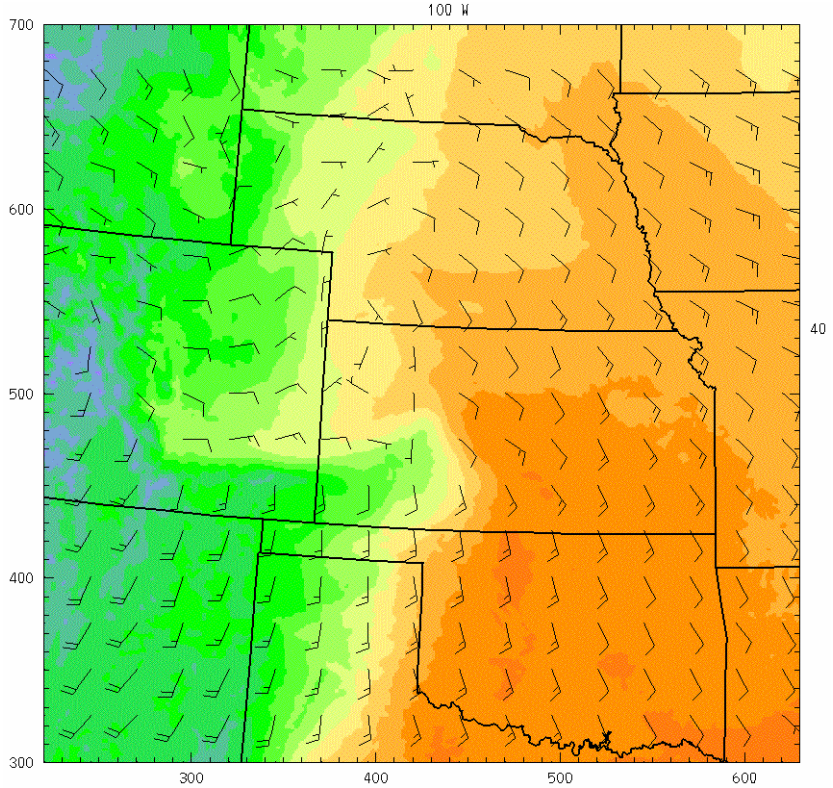
ARW Forecast: 00 UTC 05/05/07

Surface dewpoint, winds

24 h Forecast



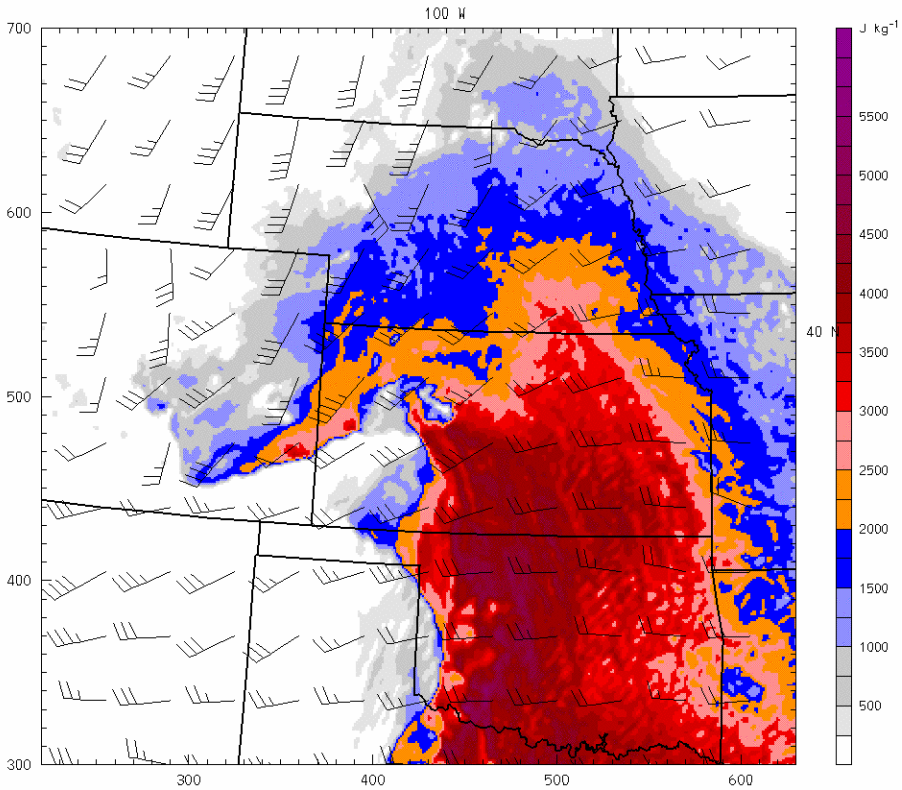
00 h Analysis



ARW Forecast: 00 UTC 05/05/07

CAPE, 6 km shear

24 h Forecast



00 h Analysis