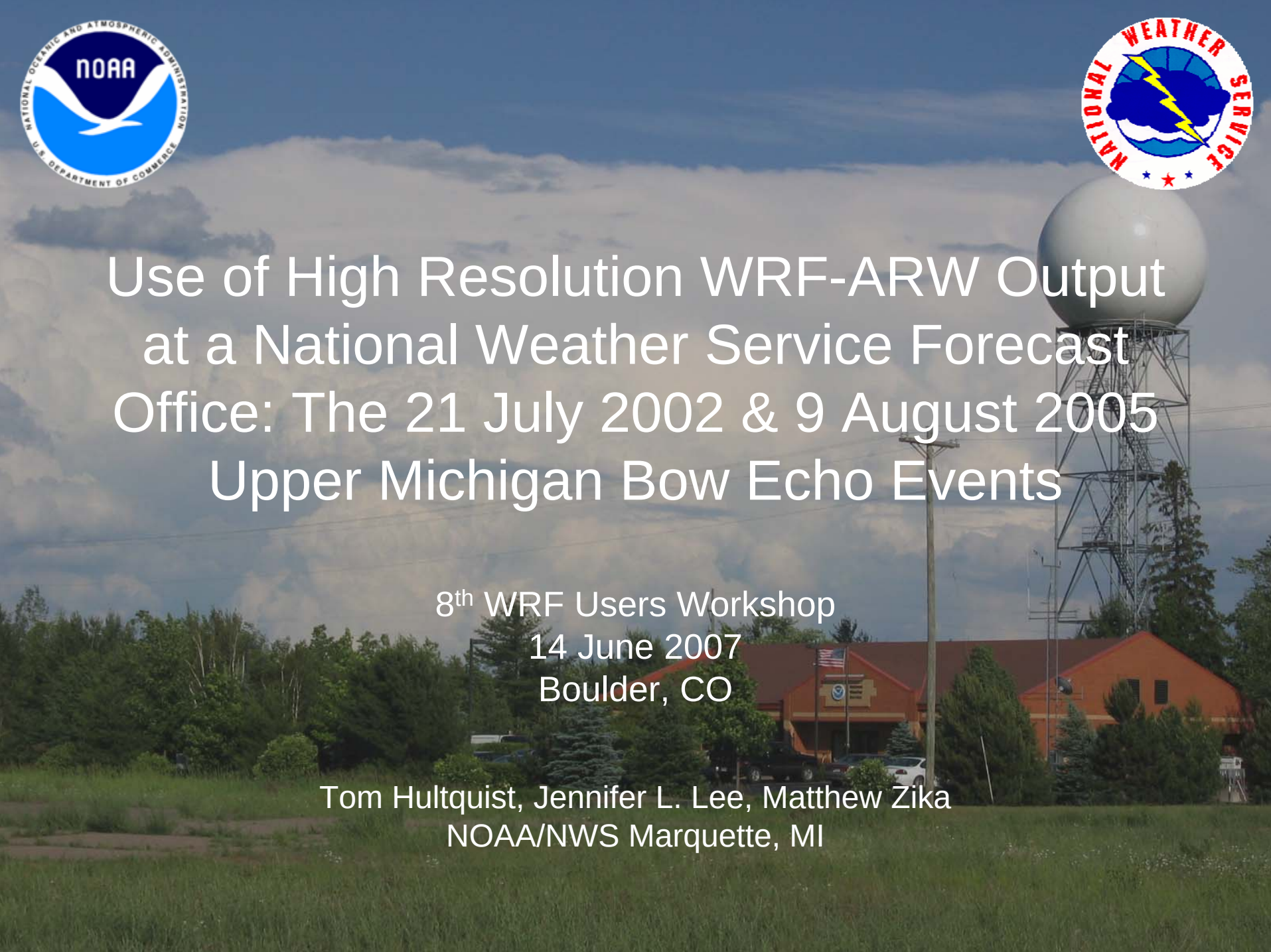


Use of High Resolution WRF-ARW Output at a National Weather Service Forecast Office: The 21 July 2002 & 9 August 2005 Upper Michigan Bow Echo Events

8th WRF Users Workshop
14 June 2007
Boulder, CO

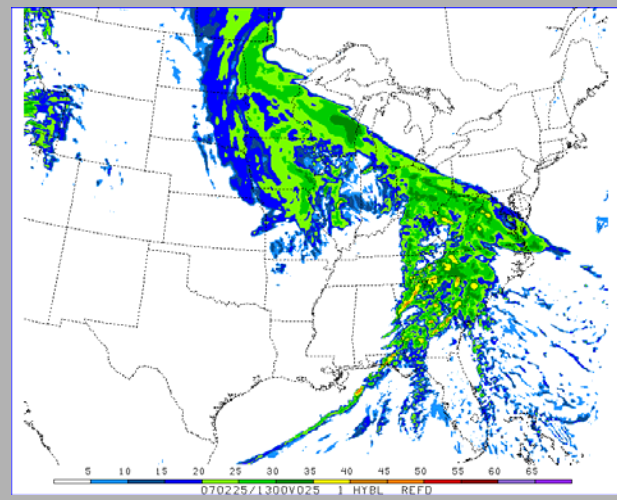
Tom Hultquist, Jennifer L. Lee, Matthew Zika
NOAA/NWS Marquette, MI

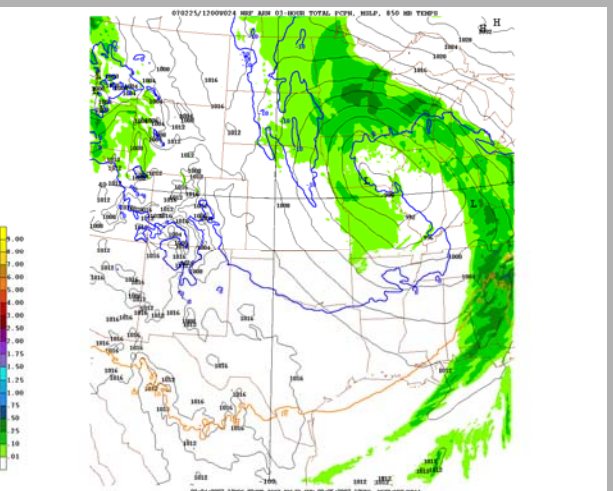
Operational NWP Output

- Allows for assessment of synoptic- and meso-scale features to help determine potential for convective initiation, mode, and evolution.
- Various stability and shear parameters are utilized by forecasters to infer probable convective mode and evolution.
- Very little “explicit” information in the raw model output.
- Convective parameterizations are a necessity, but their results can obscure the details.

High Resolution NWP in the WFO

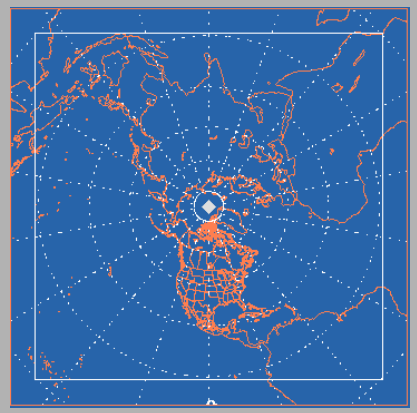
- Exposure to output from “explicit” model runs has increased dramatically over the past several years.
  - NCAR BAMEX, DTB, NCEP High Resolution Windows, NCEP “SPC” run, etc
- Deployment of STRC WRF EMS (developed by Bob Rozumalski) has made it possible for WFOs to easily run the WRF ARW and/or NMM locally



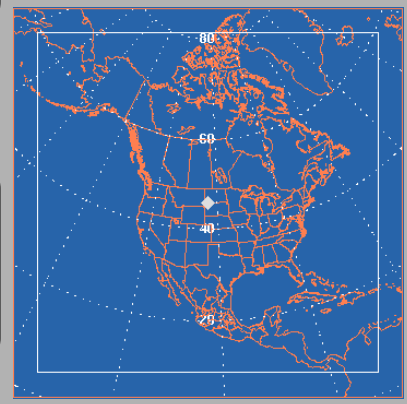


- Very high resolution output has been incorporated into numerous research articles over the past few years.

WFO Marquette Local Modeling System



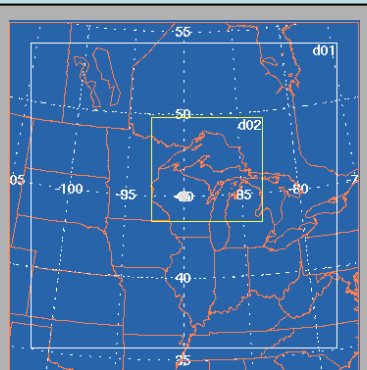
HemiWRF-ARW (260x260x31)
Run – 00 & 12Z to 180-hrs
IC – 00-hr GFS
BC – 180-hr GFS
HGS – 80 km



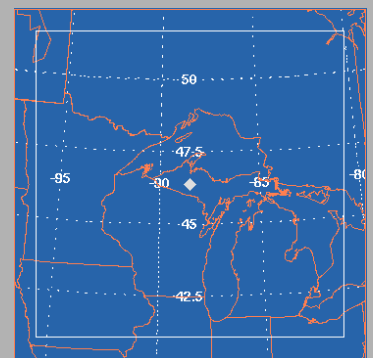
NoAmWRF-ARW (214x214x40)
Run – 00, 06, 12, 18Z to 72-hrs
IC – 00-hr GFS
BC – HemiWRF-ARW
HGS – 40 km

RegWRF-ARW (104x104x31)
Run – 00 & 12Z to 48-hrs
IC – LAPS (non-AWIPS)
BC – NoAmWRF-ARW
HGS – 20 km

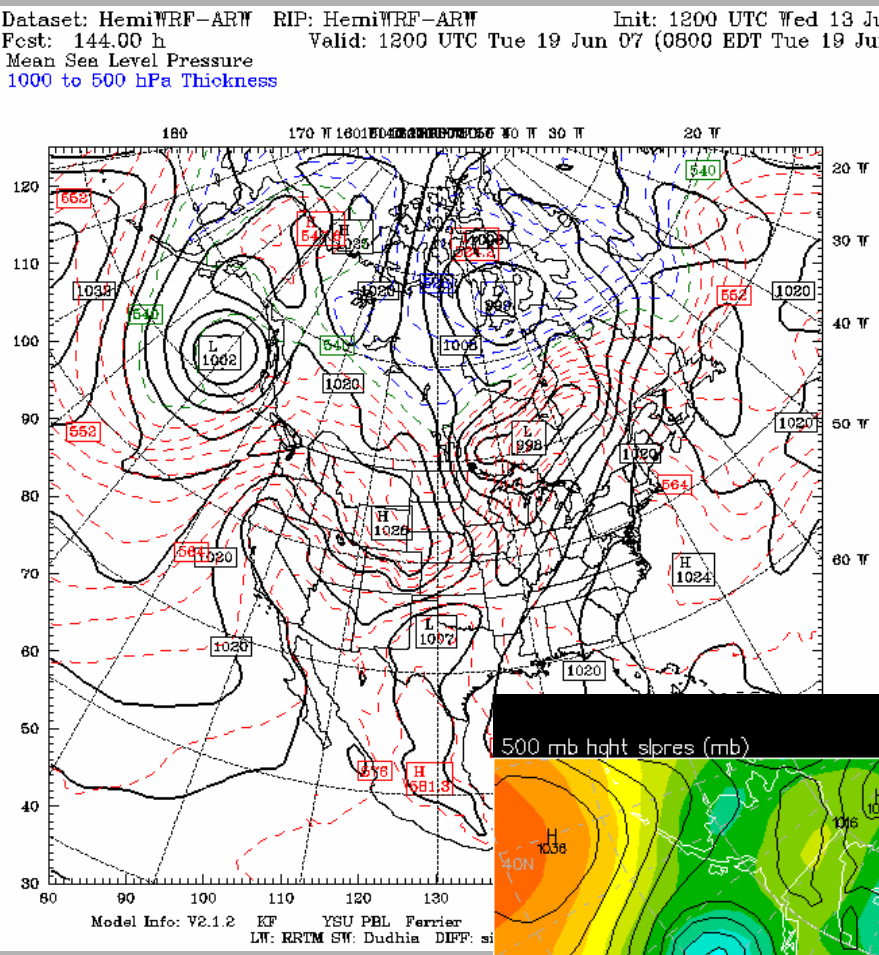
LAPSWRF-ARW (251x251x45)
Run – every hr to 2-hrs, every 3-hrs to 12-hrs
IC – LAPS (non-AWIPS)
BC – NoAmWRF-ARW
HGS – 5 km

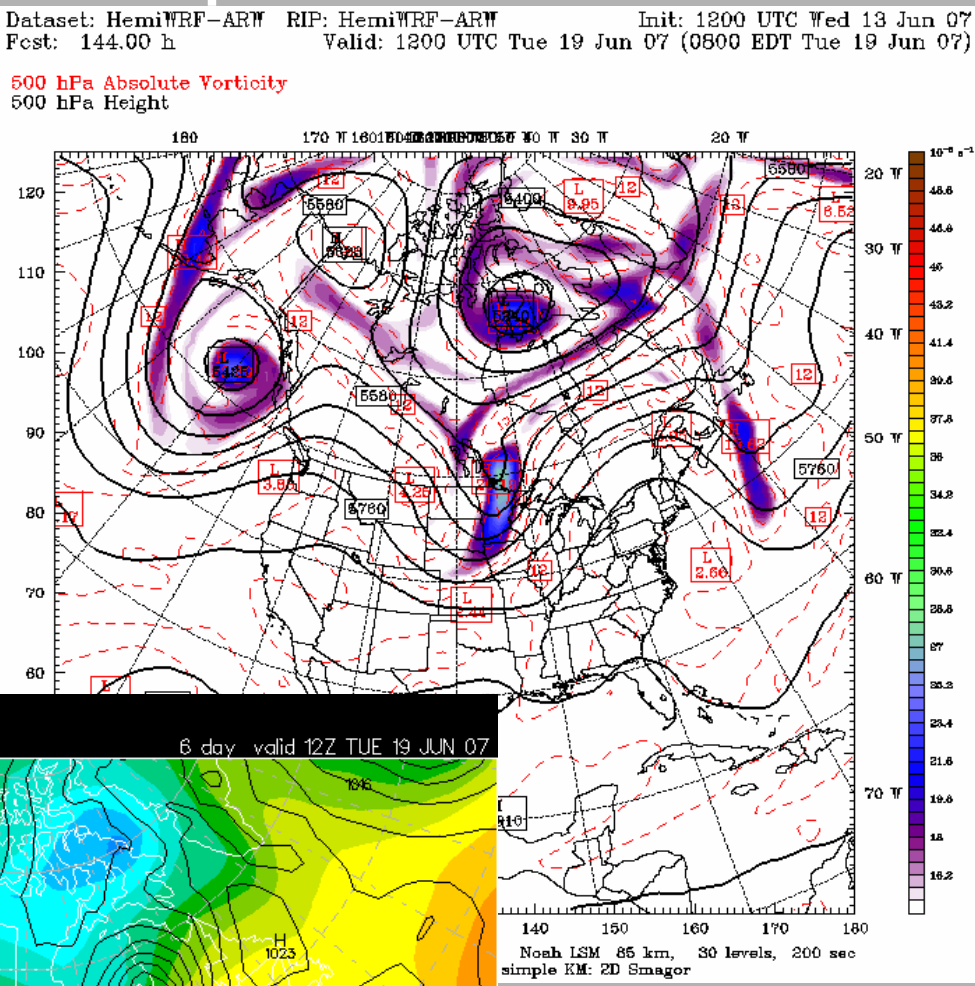


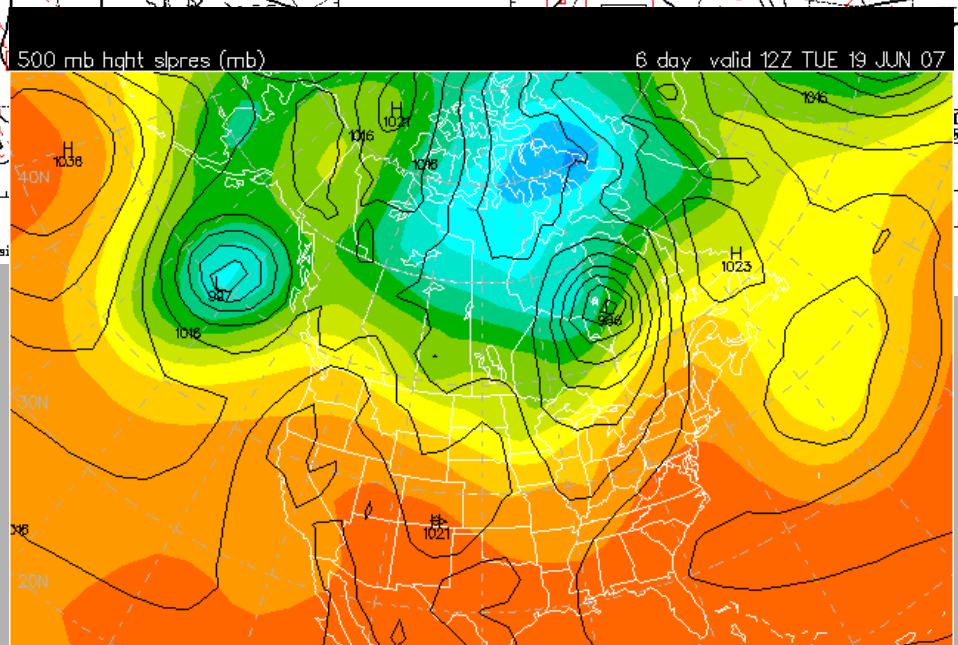
HiResWRF-ARW (152x144x31)
Run – 00 & 12Z to 48-hrs
IC – LAPS (non-AWIPS)
BC – RegWRF-ARW (two-way concurrent nest)
HGS – 5 km



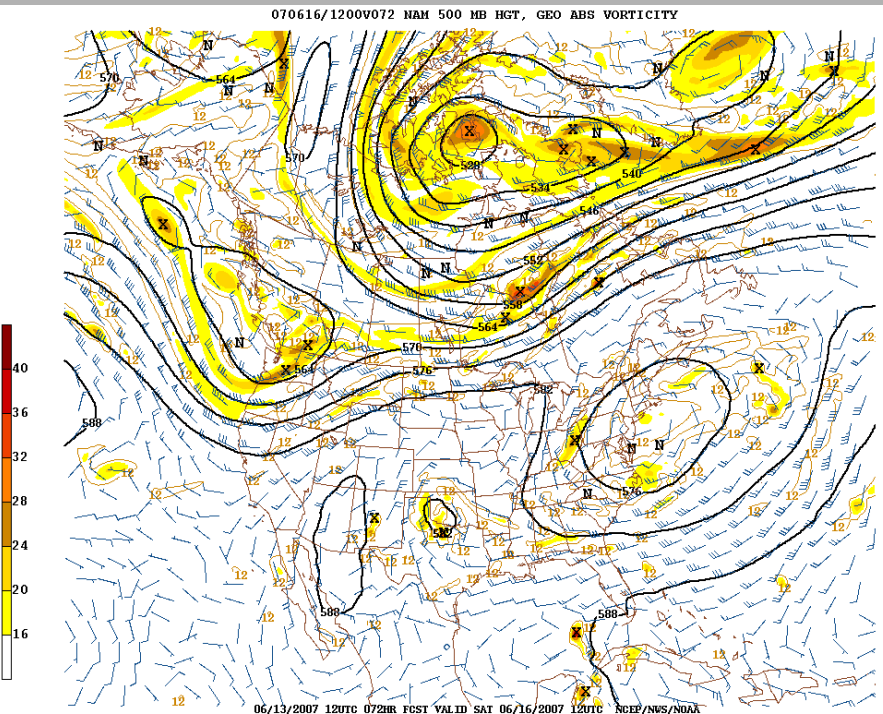
A Few Examples

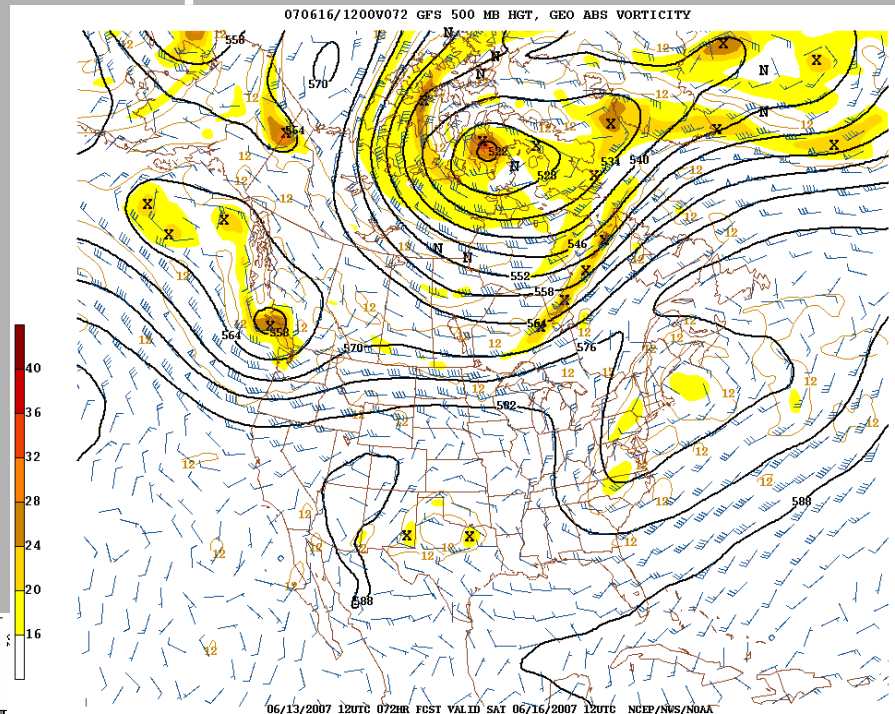


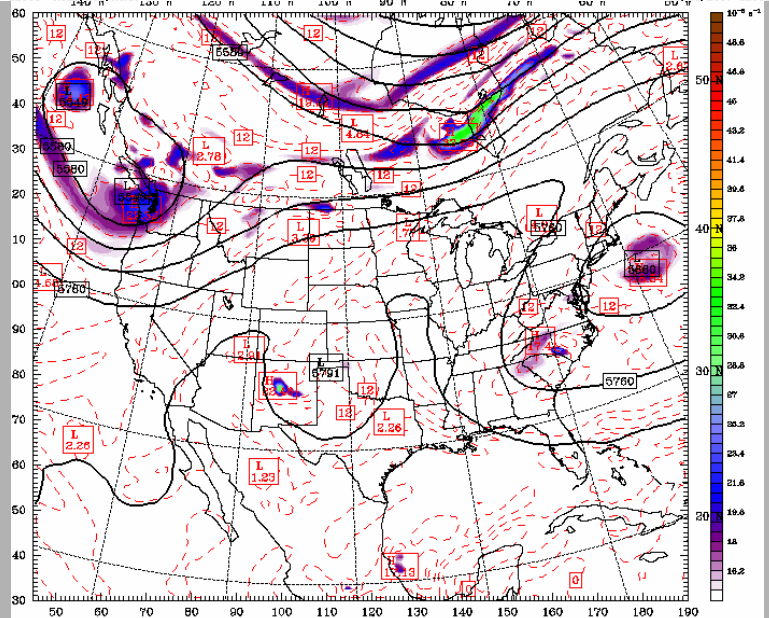


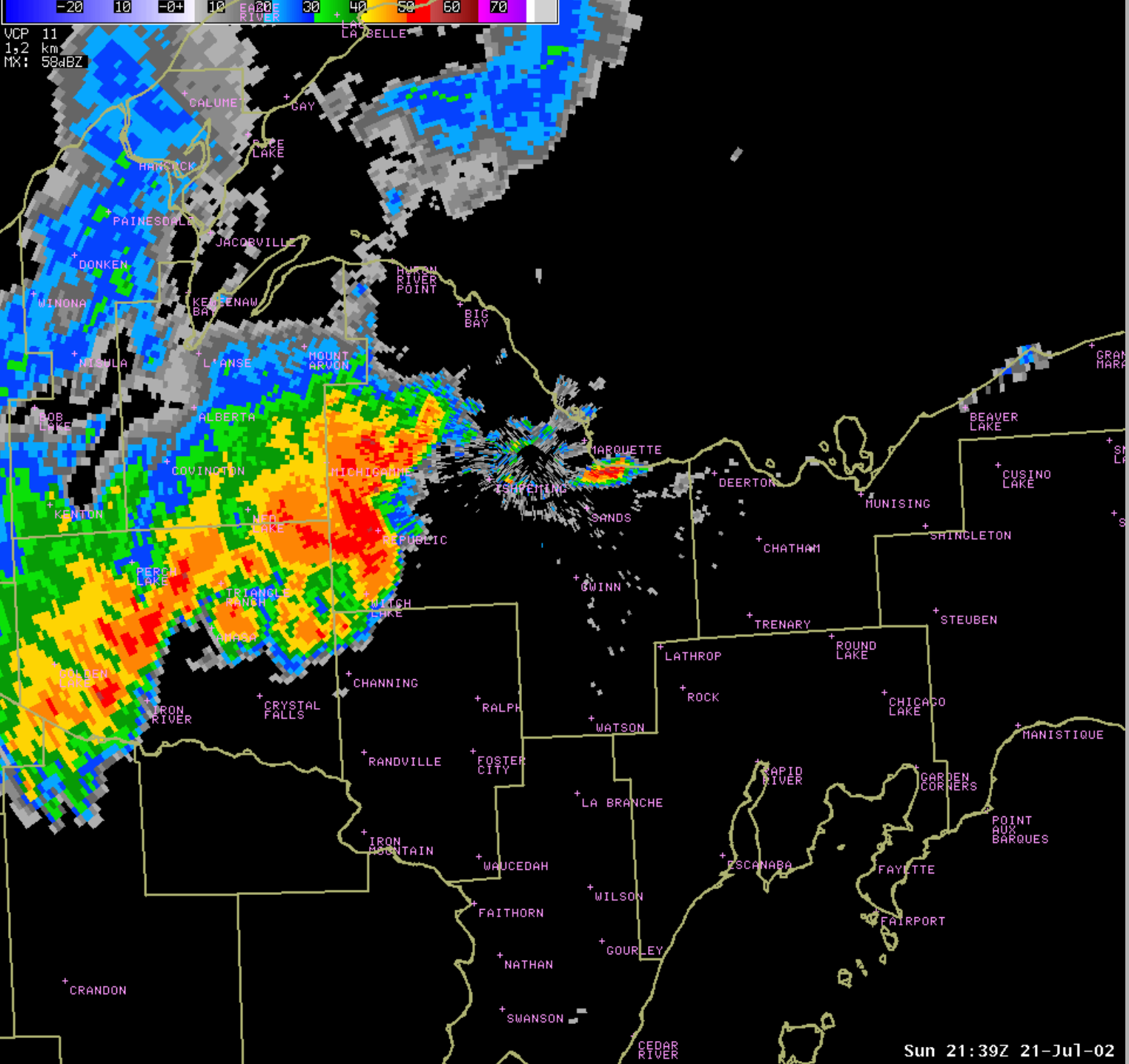


A Few Examples





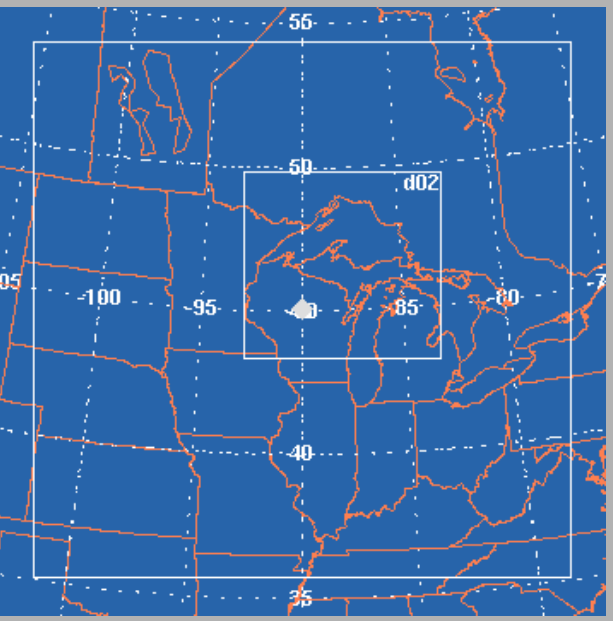




21 July 2002 Bow Echo Event

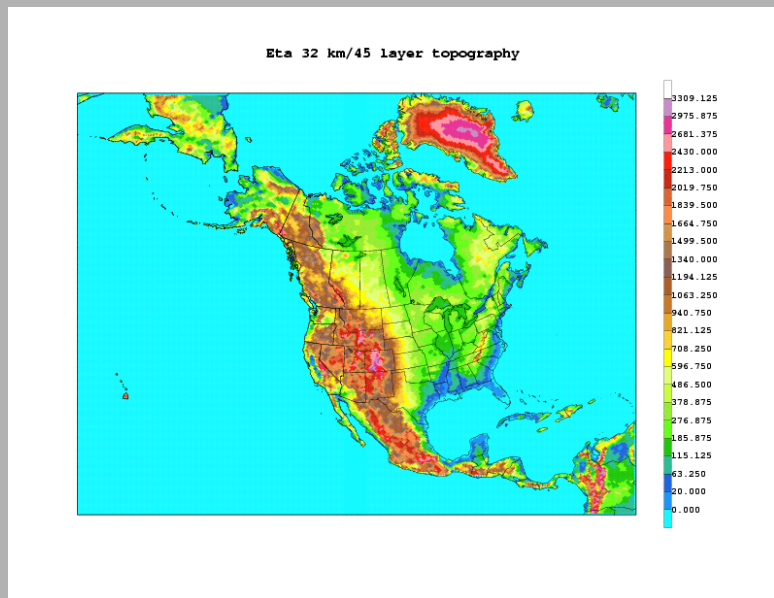
KMQT .5 Reflectivity 21:39Z to 00:00Z

Simulating the 21 July 2002 Bow Echo Event



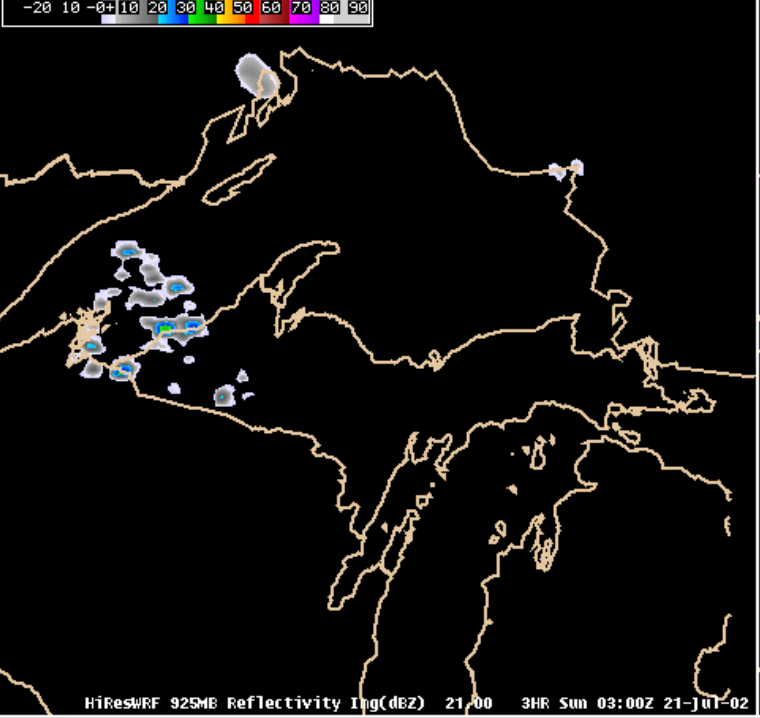
- Model: WRF-ARW 2.1.2
- Initial/Boundary Conditions: North American Regional Reanalysis (32 km)
- 20 km outer nest, 5 km inner nest (two-way nesting)
- 31 vertical levels

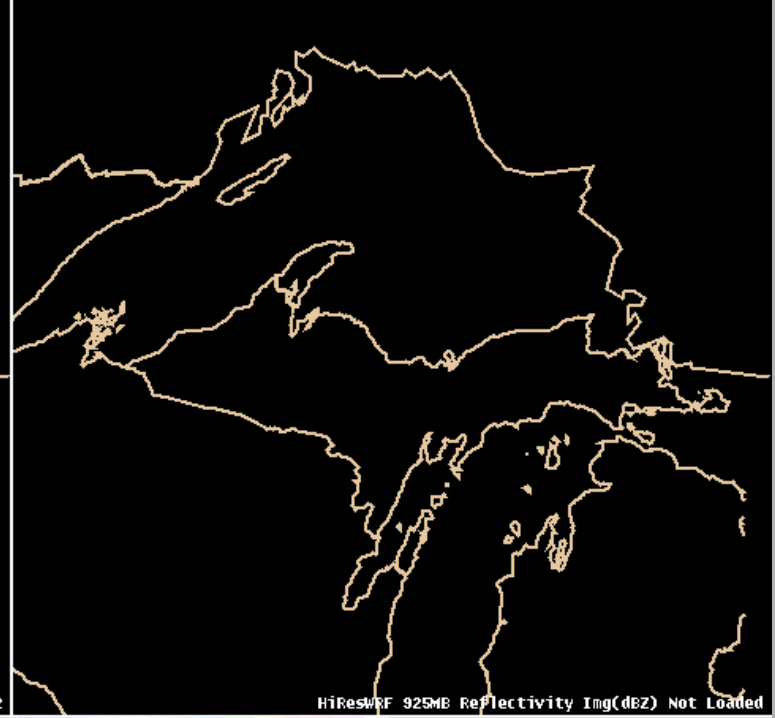
- Kain-Fritsch CP scheme (outer nest), no CP scheme (inner nest)
- Lin et al. microphysics
- RRTM longwave radiation scheme
- Dudhia shortwave radiation scheme
- Noah land surface model
- YSU PBL scheme

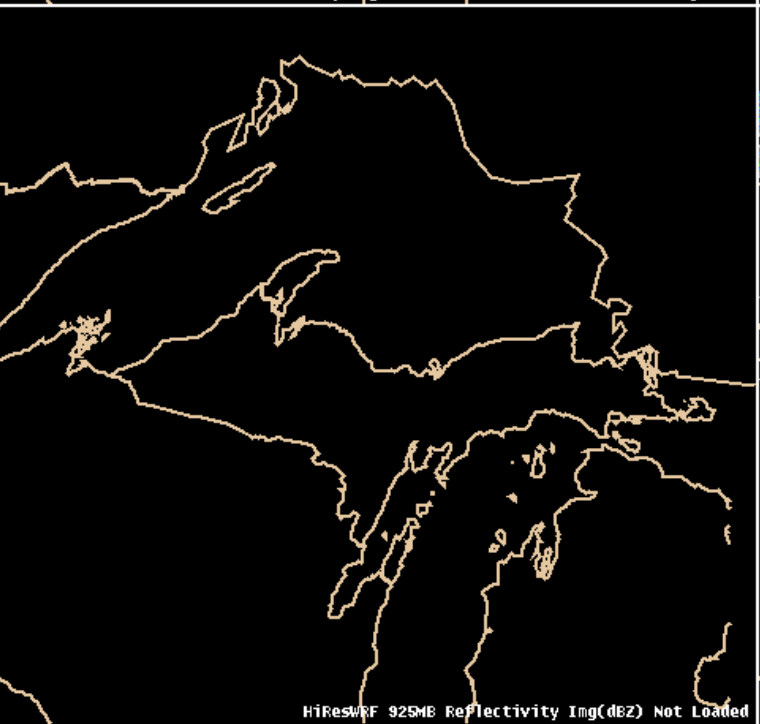


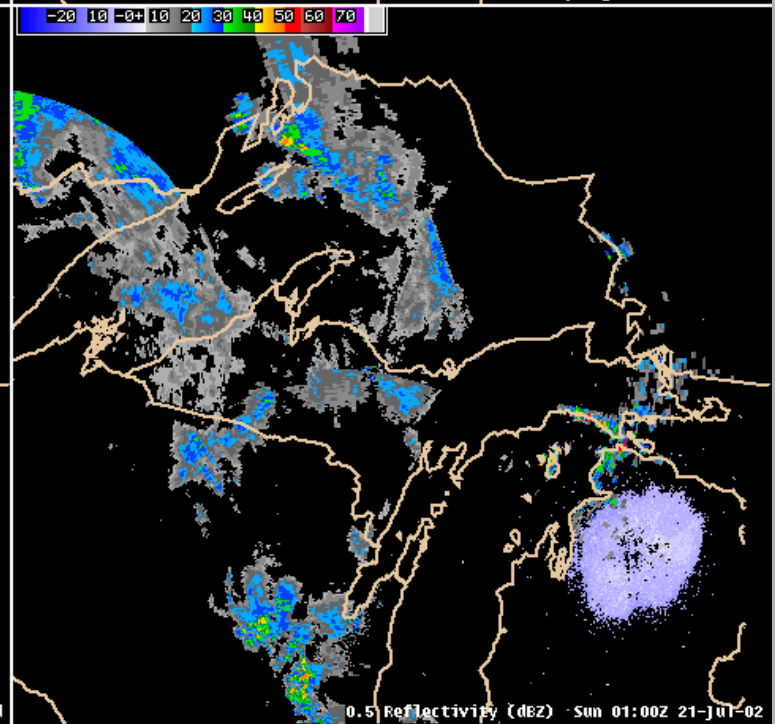
Simulating the 21 July 2002 Bow Echo Event

- Ran three simulations, altering the start time of the runs.
  - 00Z 21 July 2002
    - least “successful”
  - 06Z 21 July 2002
  - 12Z 21 July 2002
    - most “successful”
- All three simulations developed convection over the area of interest during the late afternoon, with similar evolution of features.
- The 12Z simulation captured the timing and location of convection best.







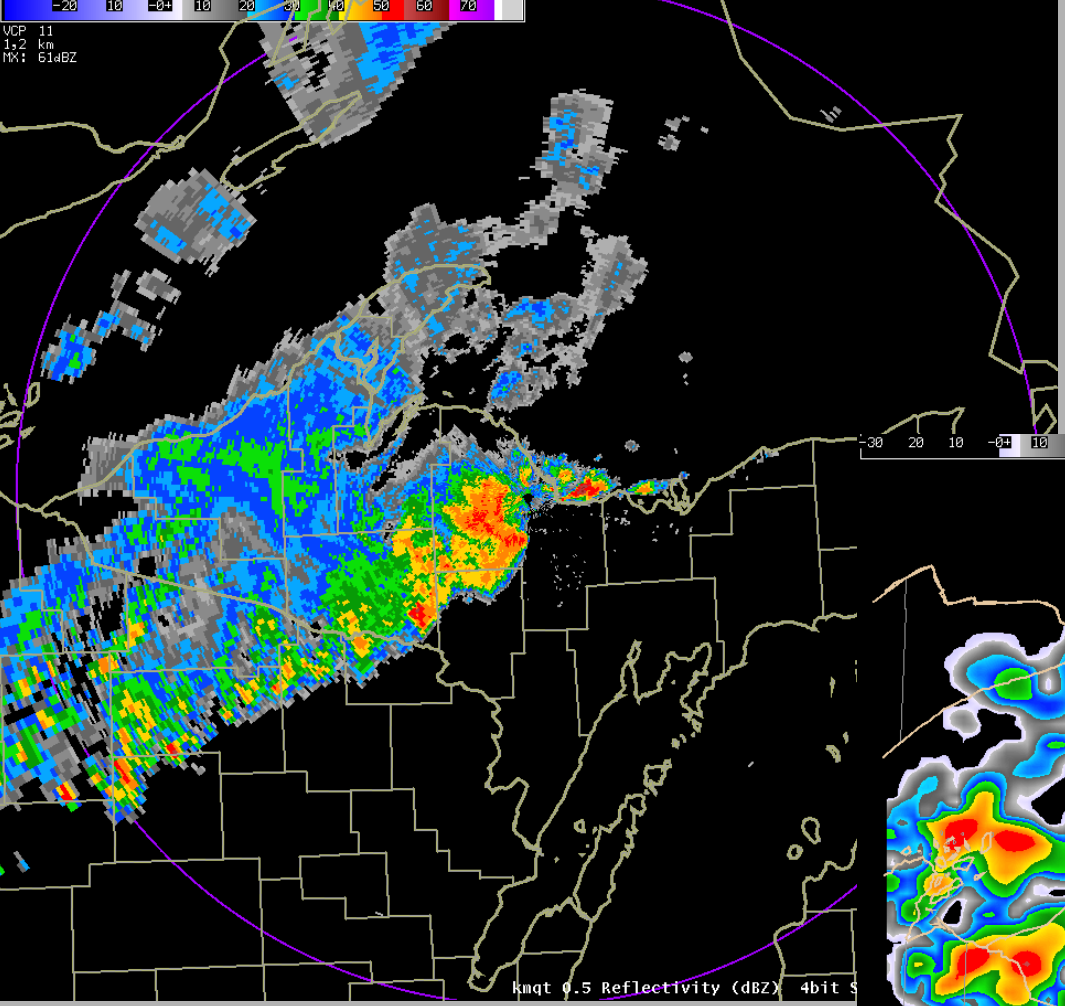


01Z 21 July 2002 – 04Z 22 July 2002

Reflectivity (925 hPa for 5km WRF, 0.5° for Radar Mosaic)

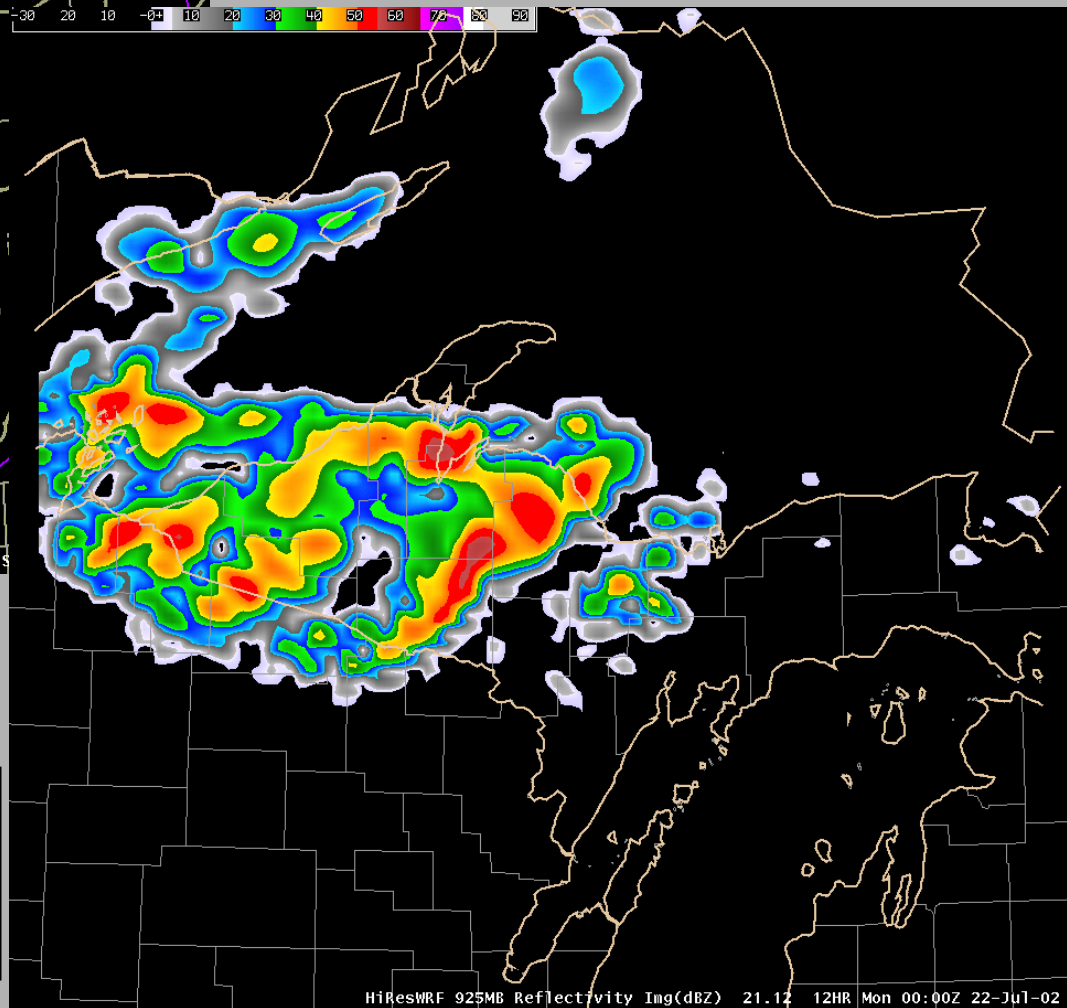
00Z 5km WRF (upper left)
06Z 5km WRF (upper right)
12Z 5km WRF (lower left)
Radar Mosaic (lower right)

Note: 2-hour offset between model forecasts and radar imagery



2159Z 21 July 2002

0.5° Reflectivity

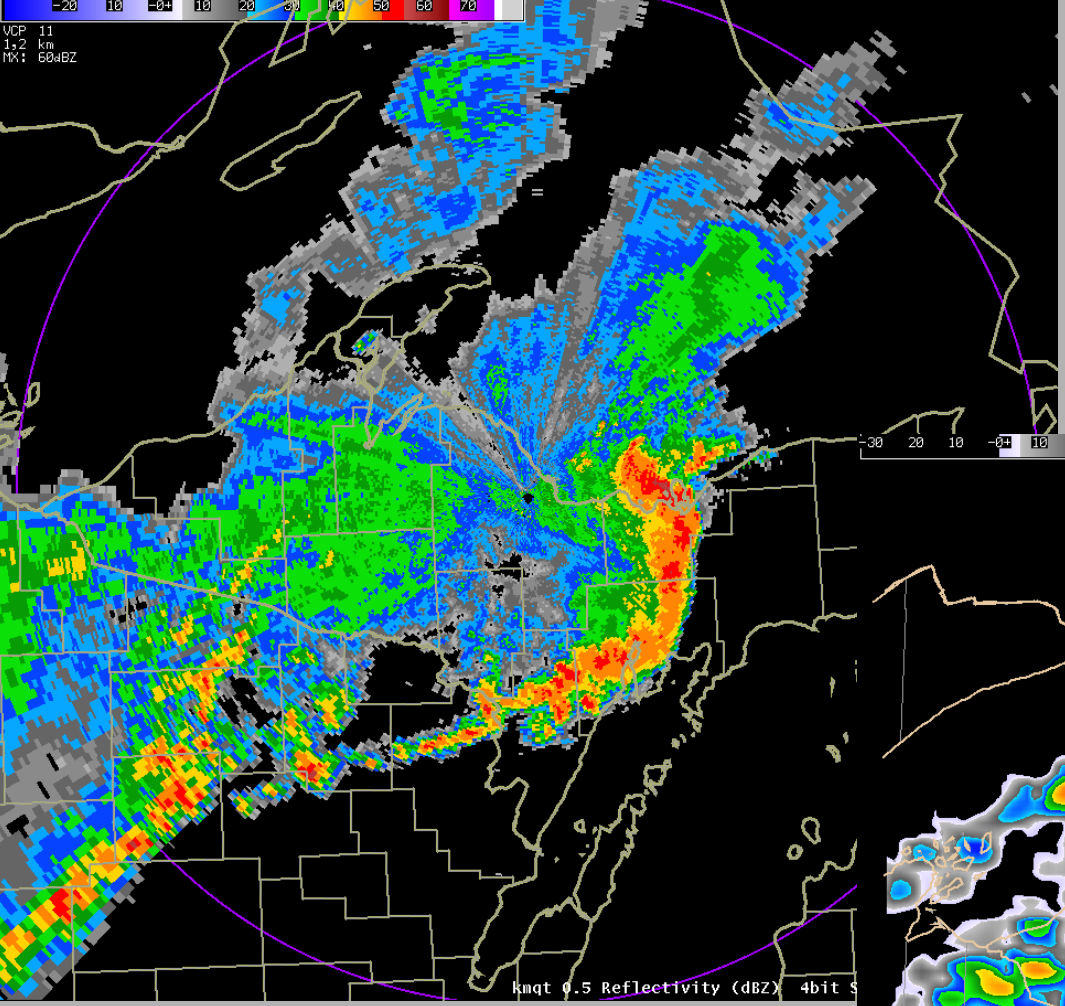


00Z 22 July 2002

5km WRF 925 hPa Reflectivity

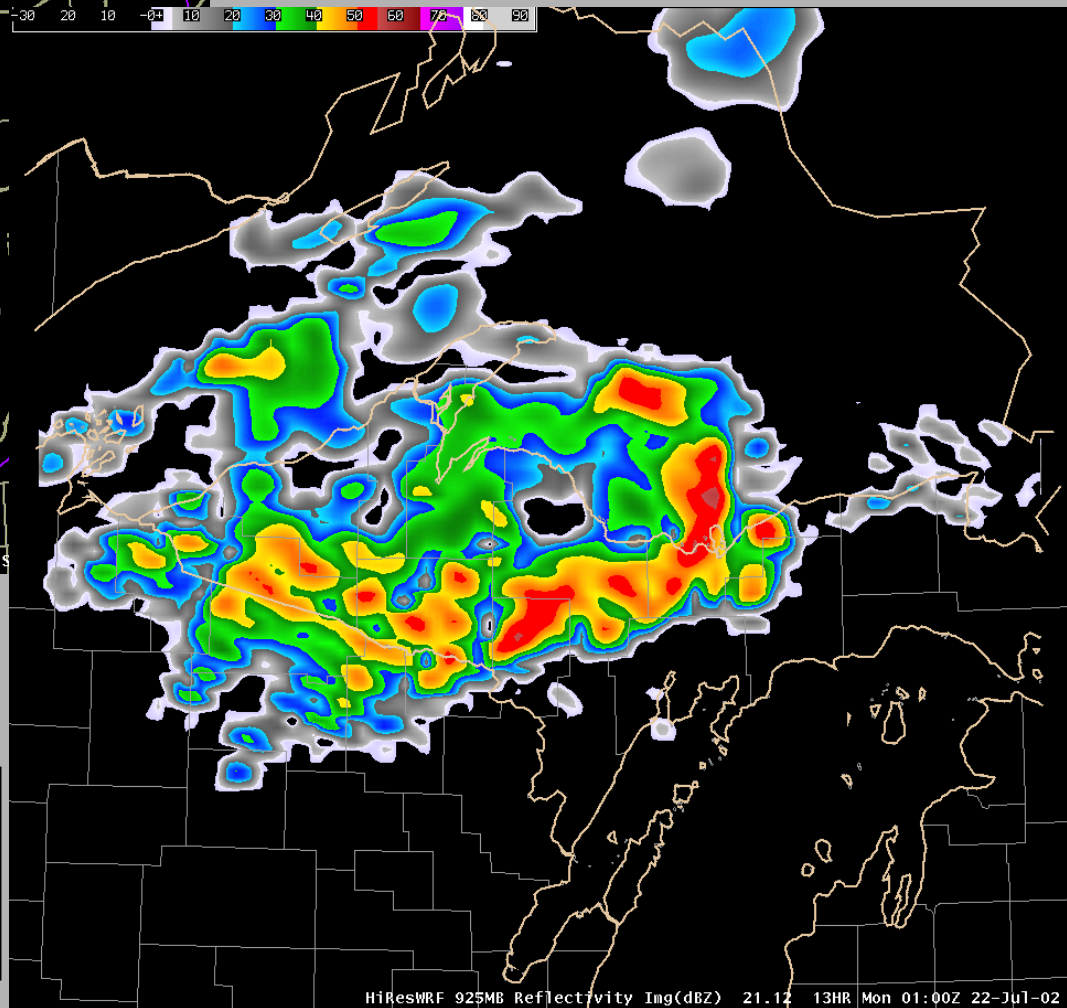
2259Z 21 July 2002

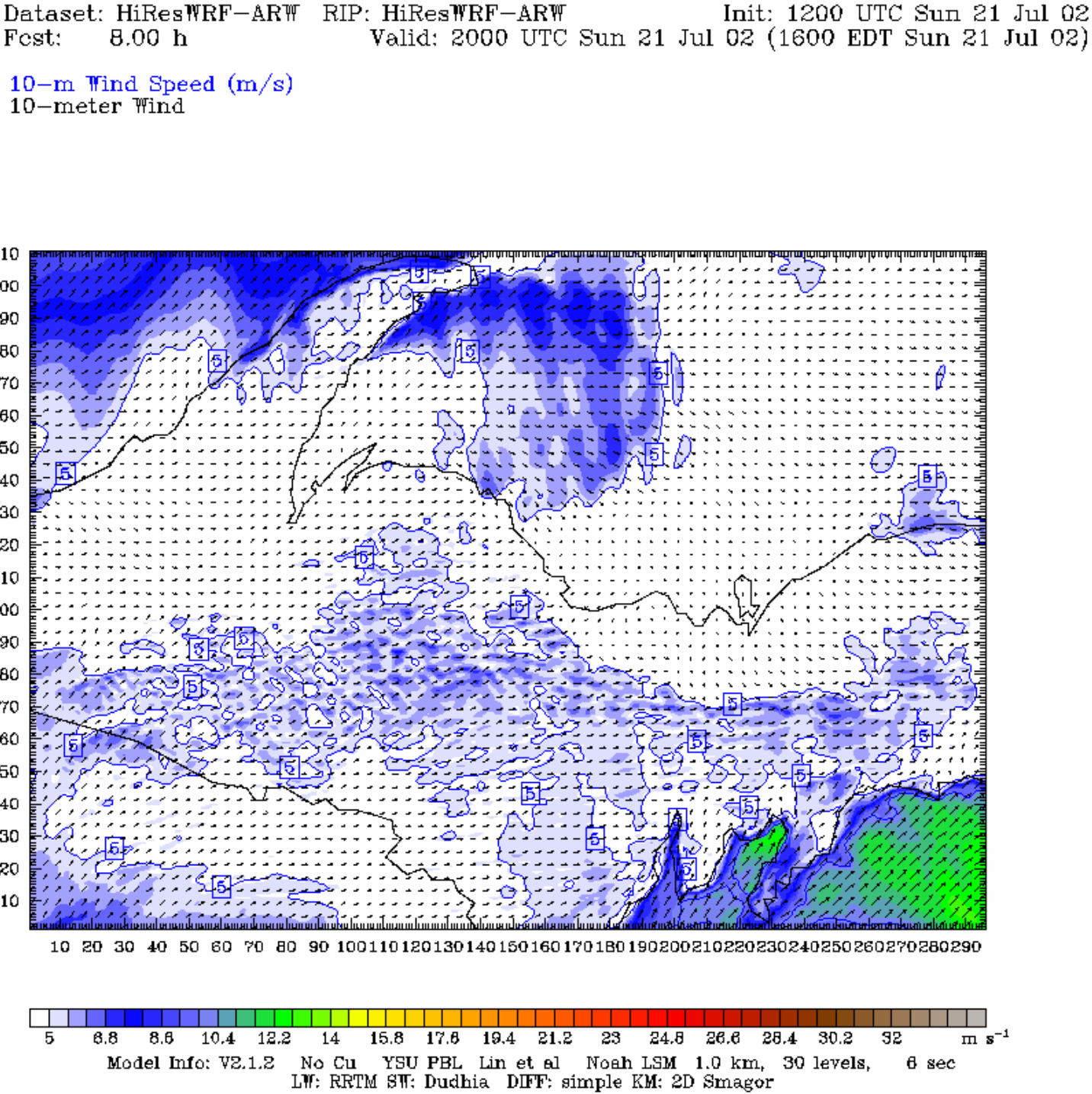
0.5° Reflectivity



01Z 22 July 2002

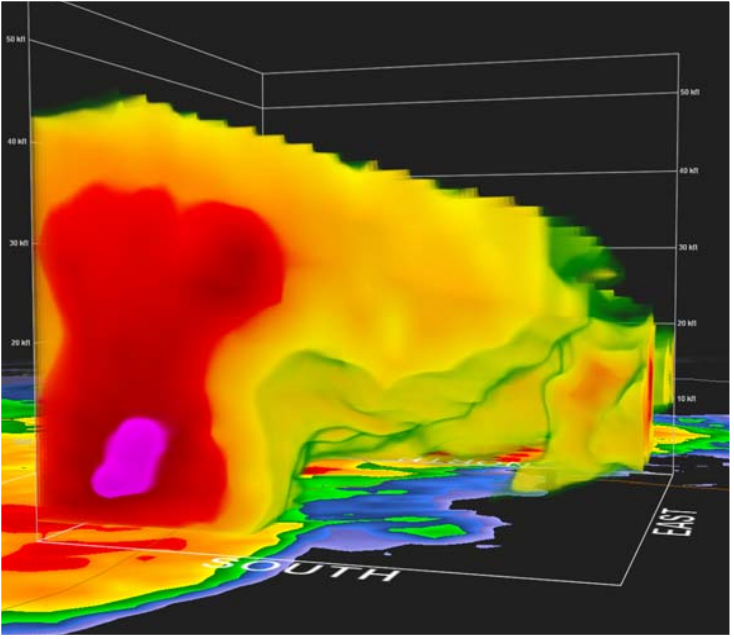
5km WRF 925 hPa Reflectivity

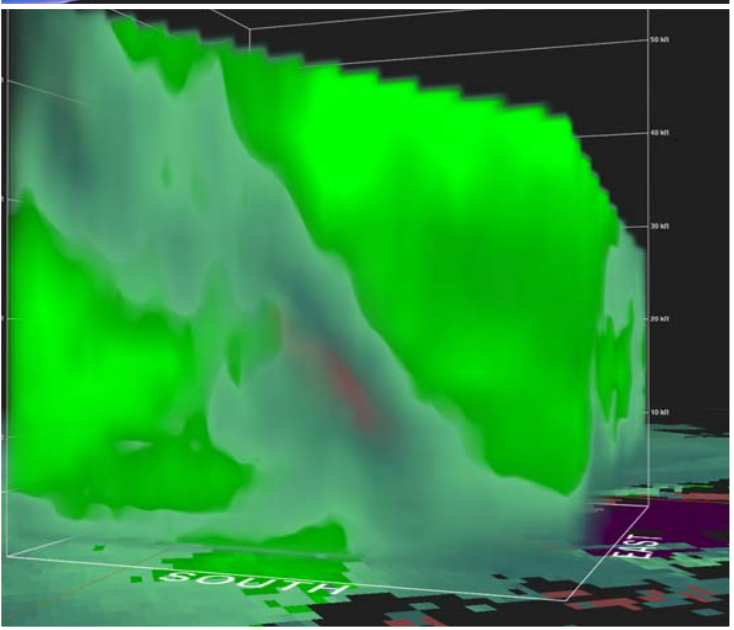




20Z 21 July 2002 – 04Z 22 July 2002

1km WRF 10-m Winds





00Z 22 July 2002

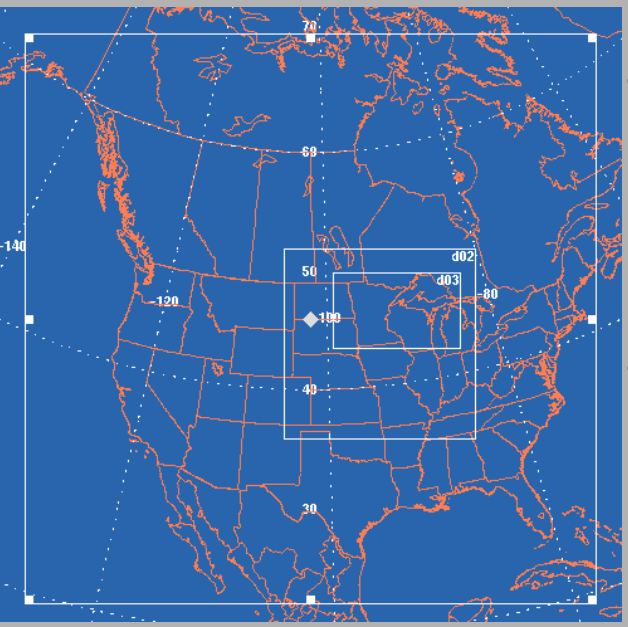
1km WRF Reflectivity & Wind Speed (along cross-section)

60S CMX MI | 70SSE CMX MI | 86SSE CMX MI | 88NNW ESC MI | 70NNW ESC MI

Distance (km)

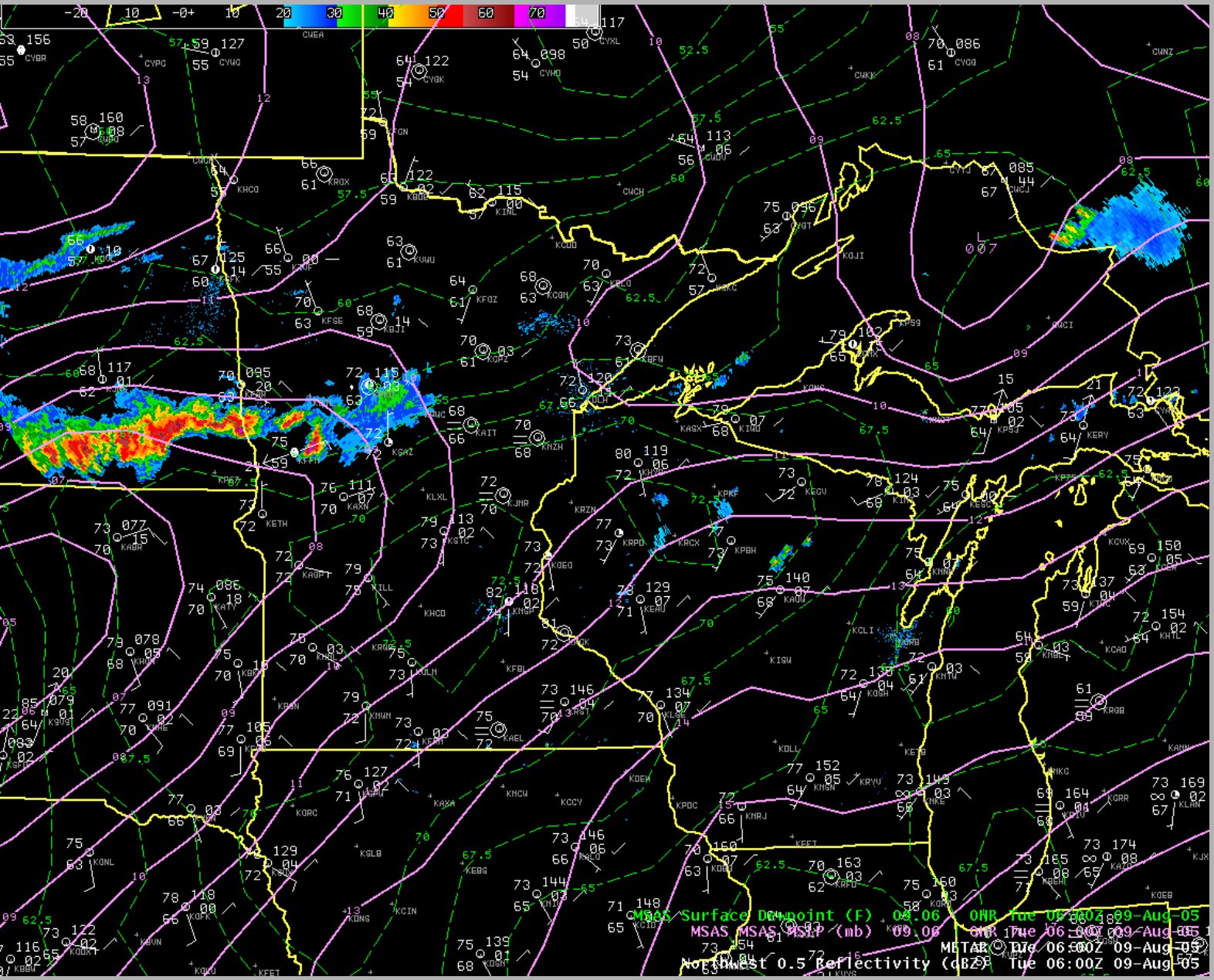
SuperHiResWRF lineE Ageo Vert Circ () 21.12 12HR Mon 00:00Z 22-Jul-02
SuperHiResWRF lineE Component Along (kts) 21.12 12HR Mon 00:00Z 22-Jul-02
SuperHiResWRF lineE Reflectivity Img(dBZ) 21.12 12HR Mon 00:00Z 22-Jul-02

A Similar Event – 9 August 2005



- Bow echo moves through Upper Michigan during the morning hours of 9 August 2005.
- Evolved into a bow just prior to entering area, moved through just south of the 21 July 2002 event.

- Three-way nest from 60 > 20 > 4 km, 31 vertical levels
- GFS initial/boundary conditions
- 30-hour simulation from 18Z 8 August 2005 – 00Z 10 August 2005
- d03 “explicit” convection, d01 & d02 varied between KF & BMJ, microphysics varied between Lin et al. and Ferrier, 1- and 2- way nesting, no nesting

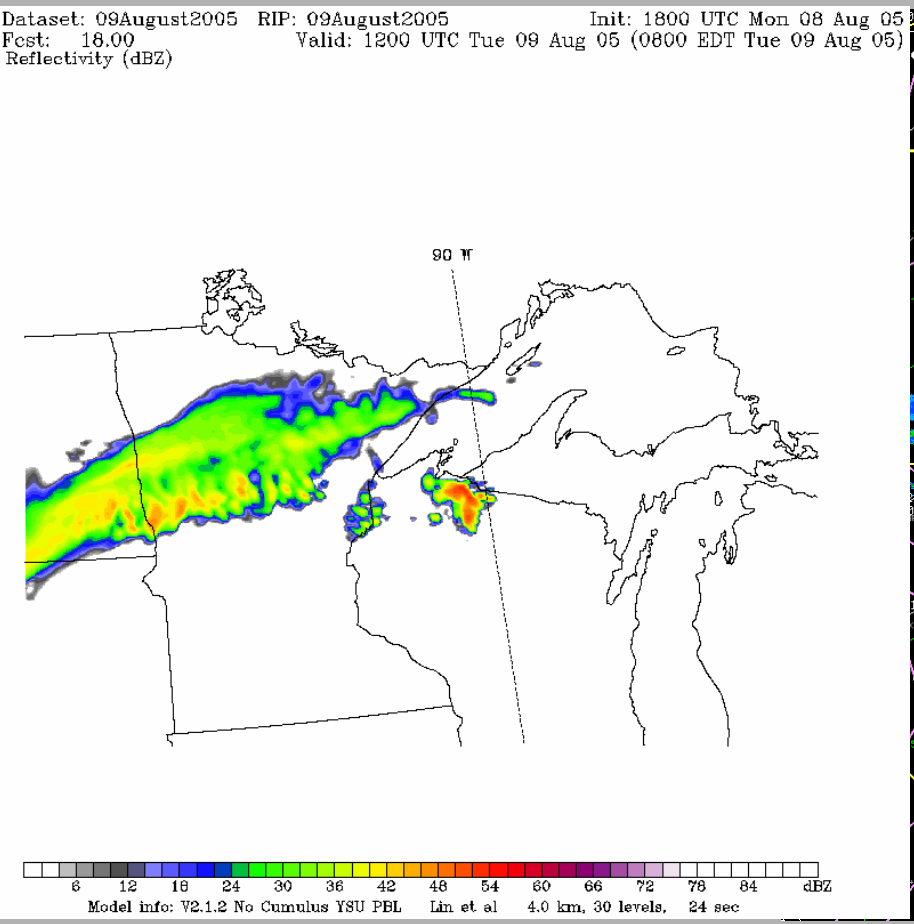


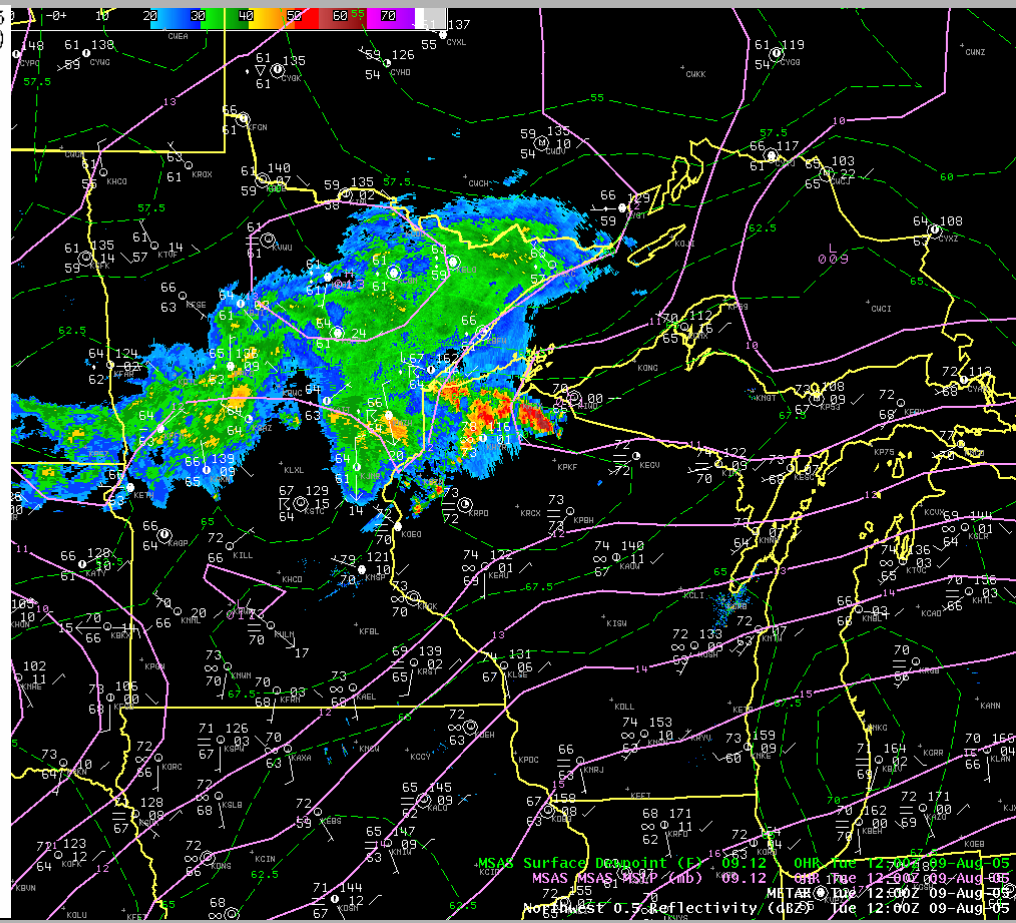
06Z 9 August 2005 – 00Z 10 August 2005

0.5° Reflectivity Mosaic, MSAS MSLP (magenta), MSAS Dewpoint (green), METARs (white)

12Z 9 August 2005

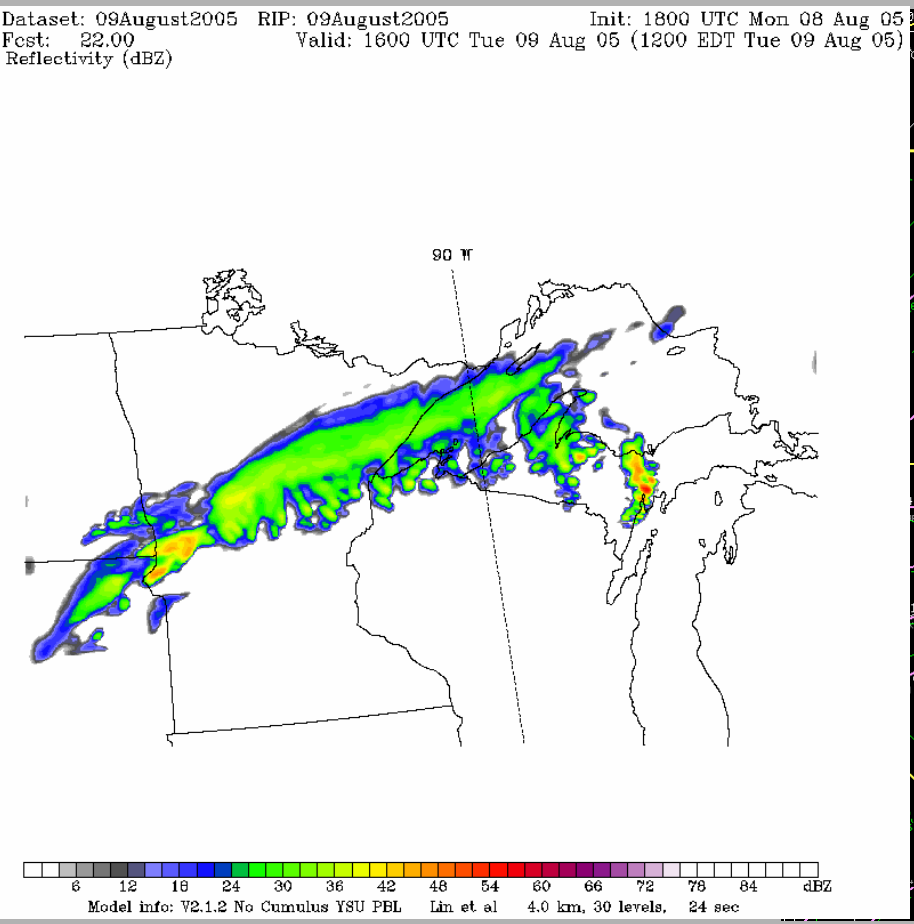
0.5° Reflectivity Mosaic (right)
4km WRF (KF, Lin et al.)
Reflectivity (left)

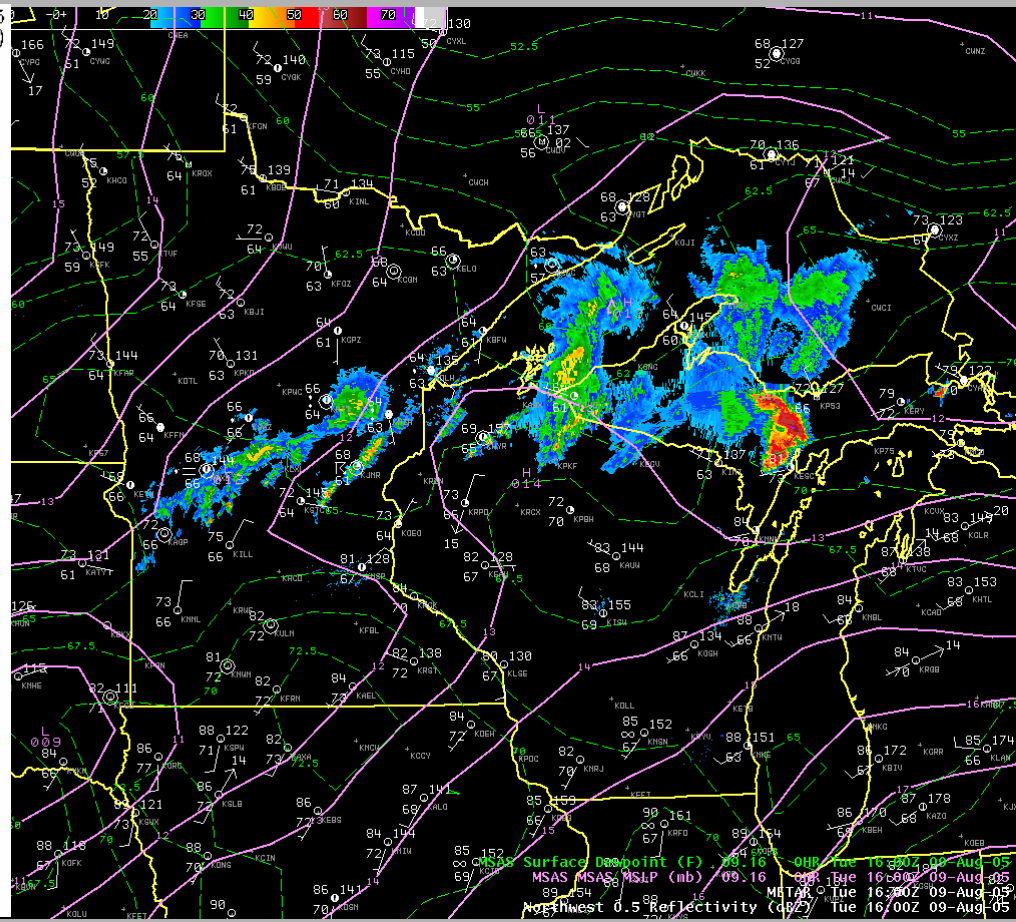




16Z 9 August 2005

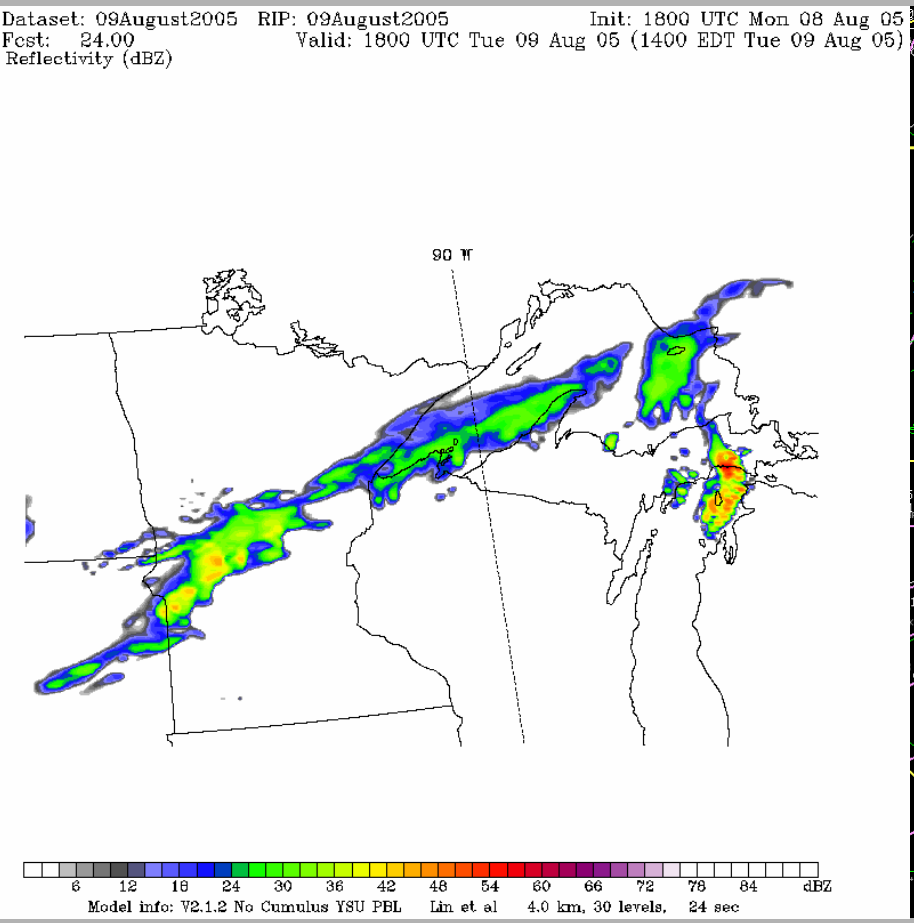
0.5° Reflectivity Mosaic (right)
4km WRF (KF, Lin et al.)
Reflectivity (left)

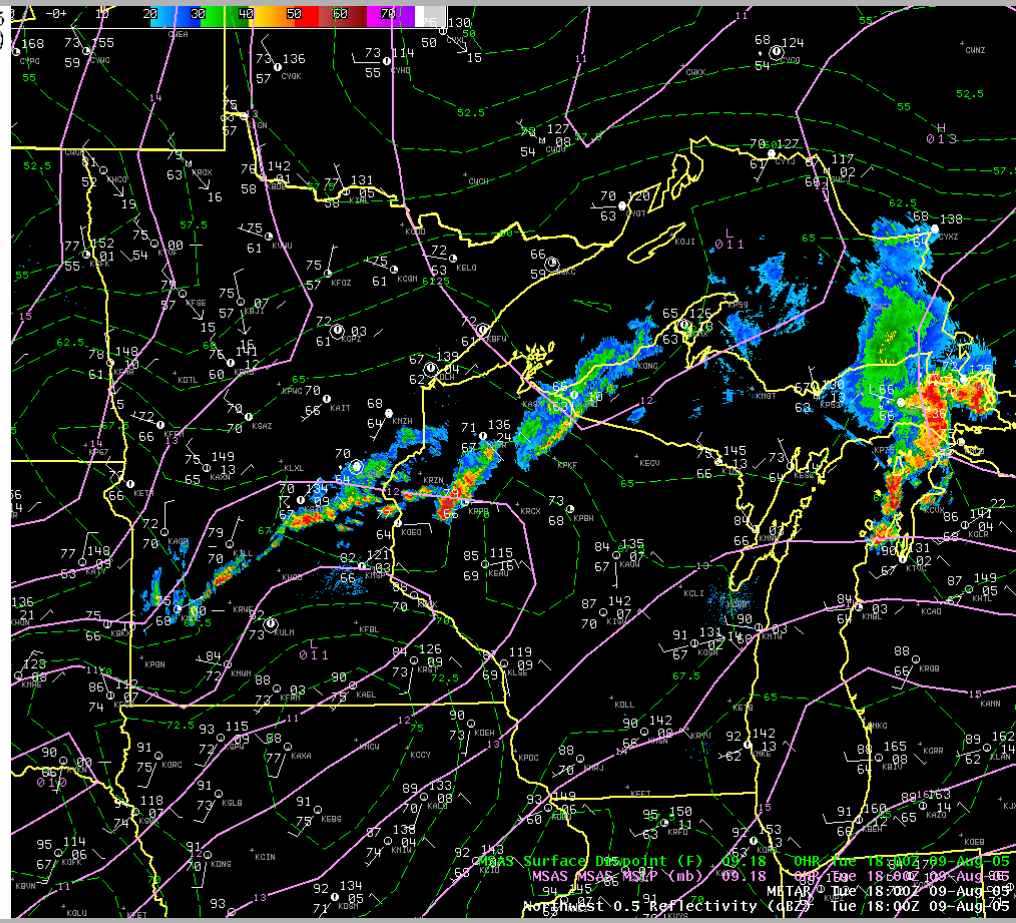




18Z 9 August 2005

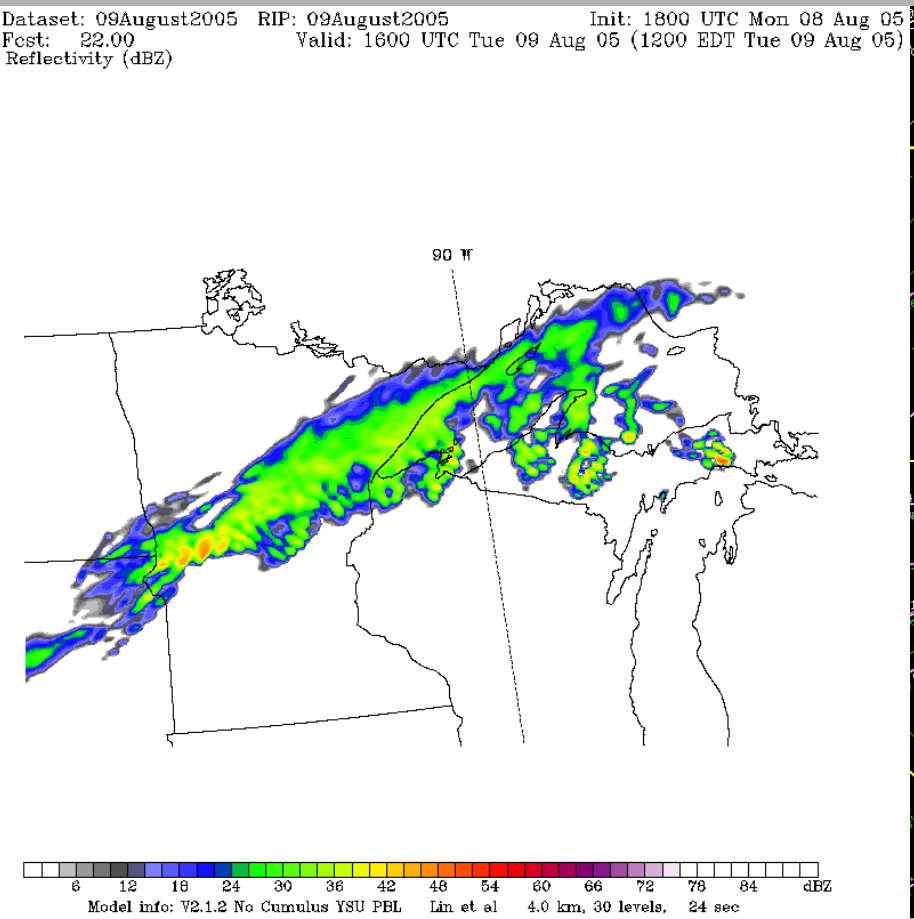
0.5° Reflectivity Mosaic (right)
4km WRF (KF, Lin et al.)
Reflectivity (left)

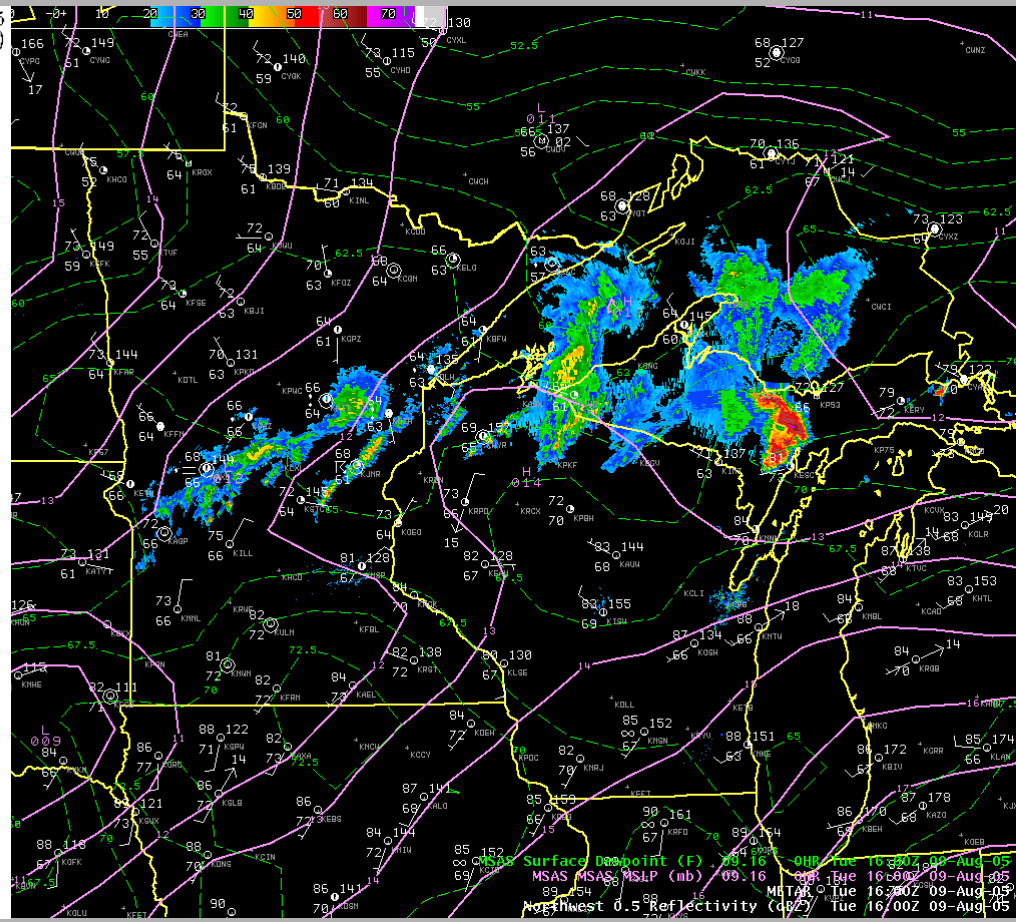




16Z 9 August 2005

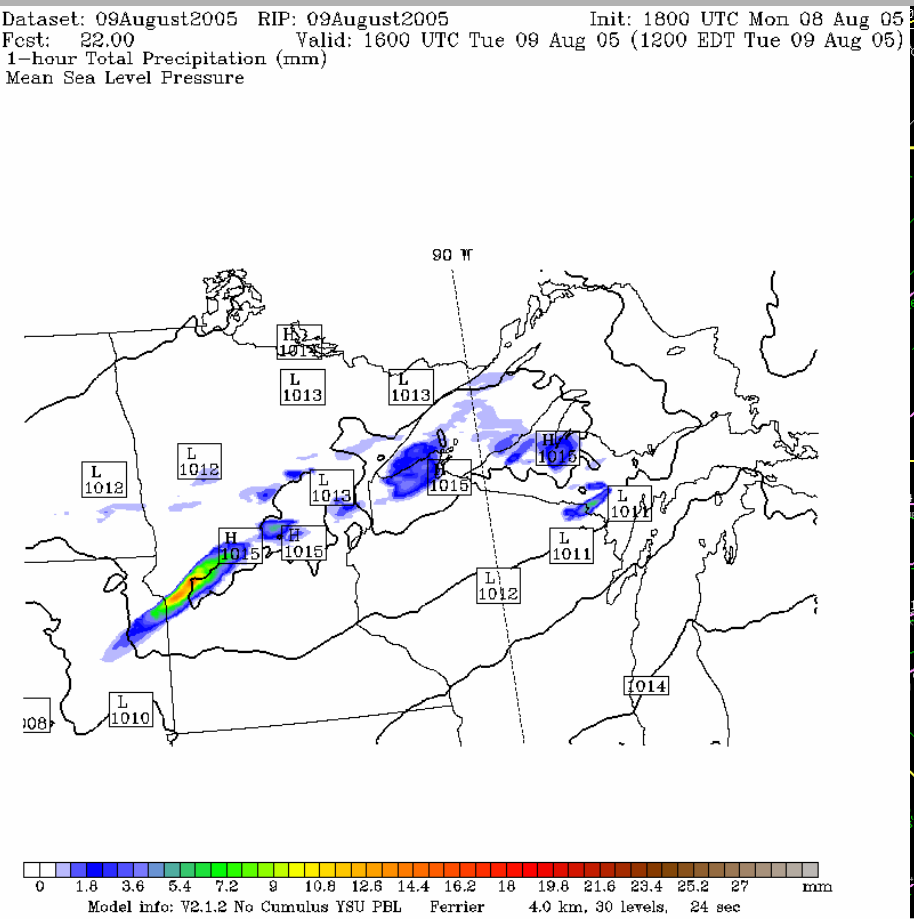
0.5° Reflectivity Mosaic (right)
4km WRF (BMJ, Lin et al.)
Reflectivity (left)

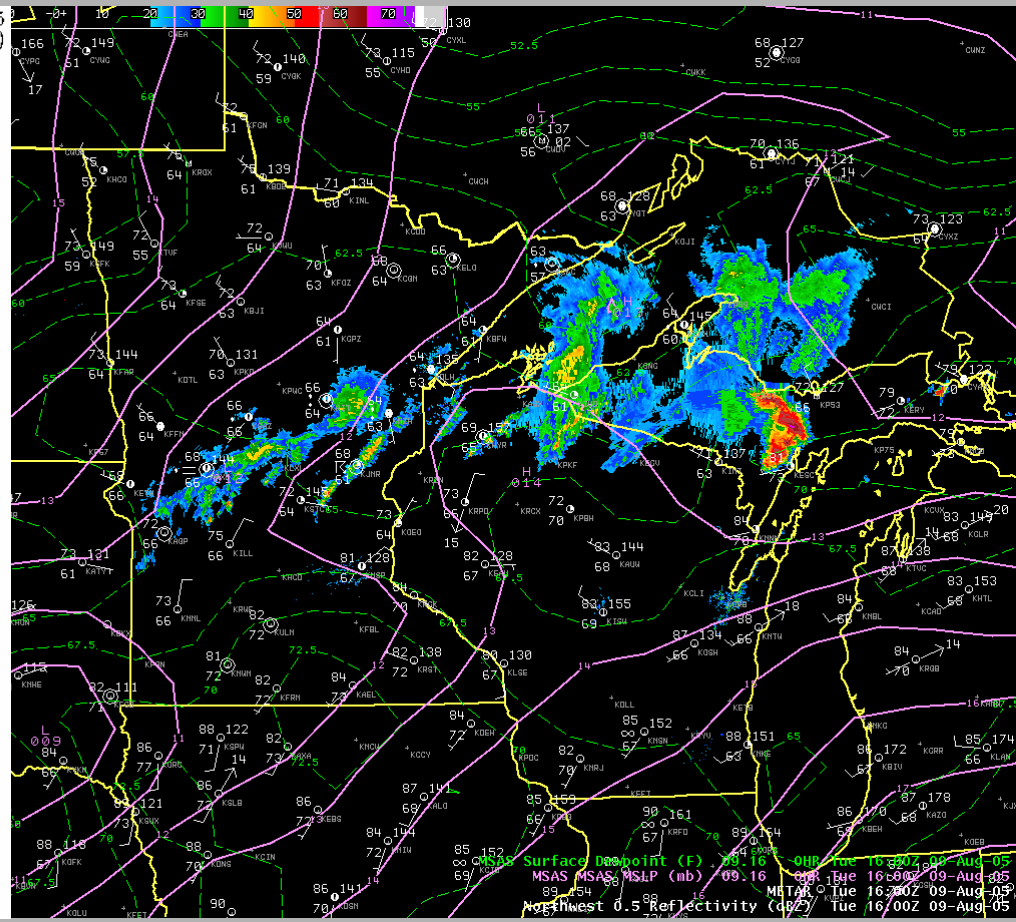




16Z 9 August 2005

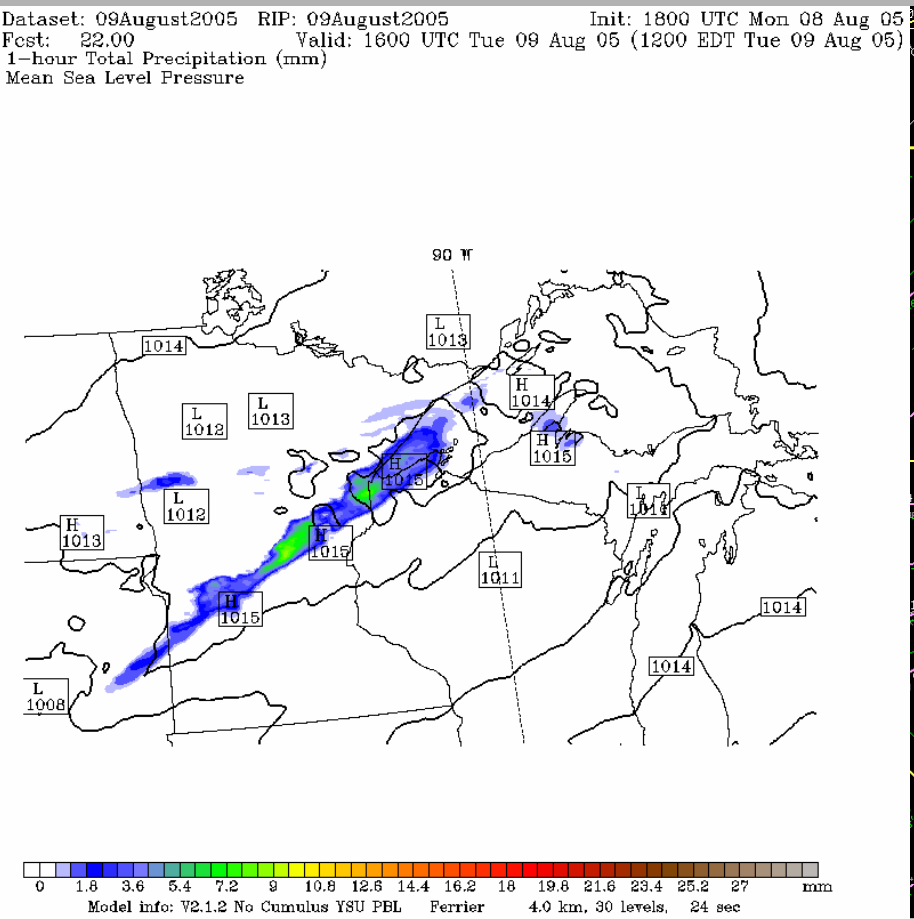
0.5° Reflectivity Mosaic (right)
4km WRF (KF, Ferrier) 1-hour Precipitation (left)

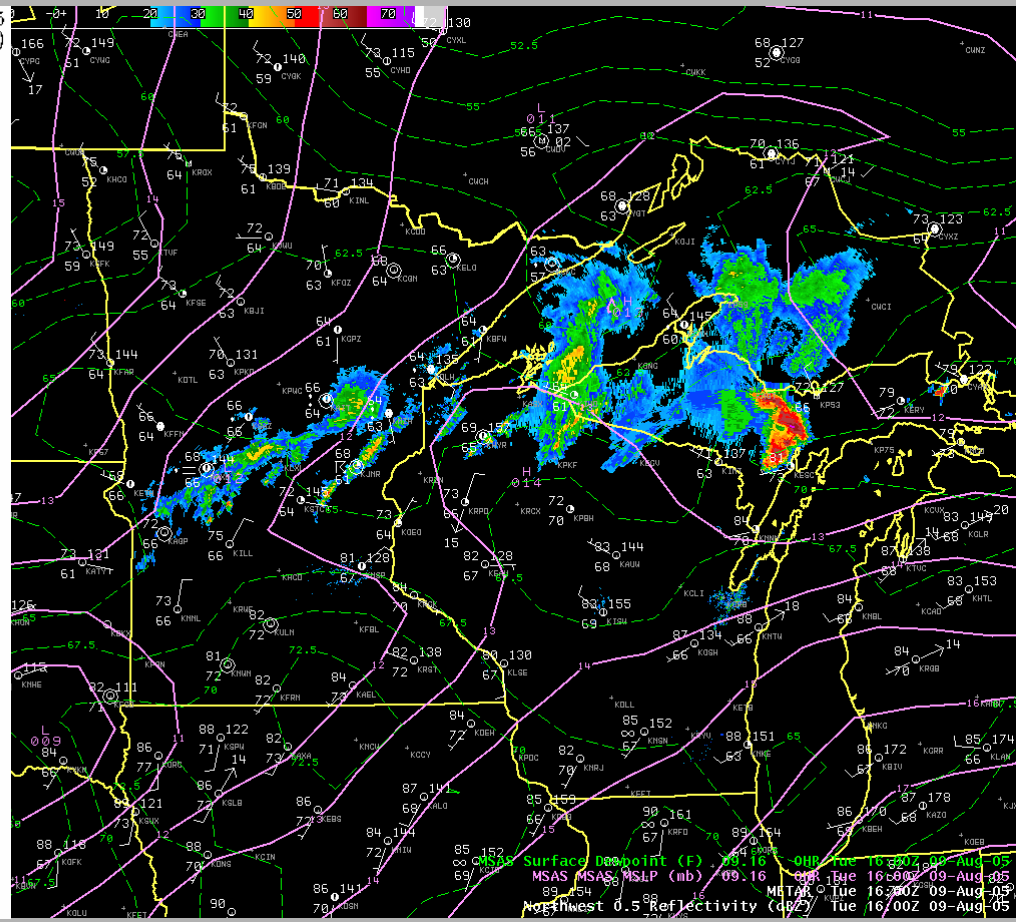




16Z 9 August 2005

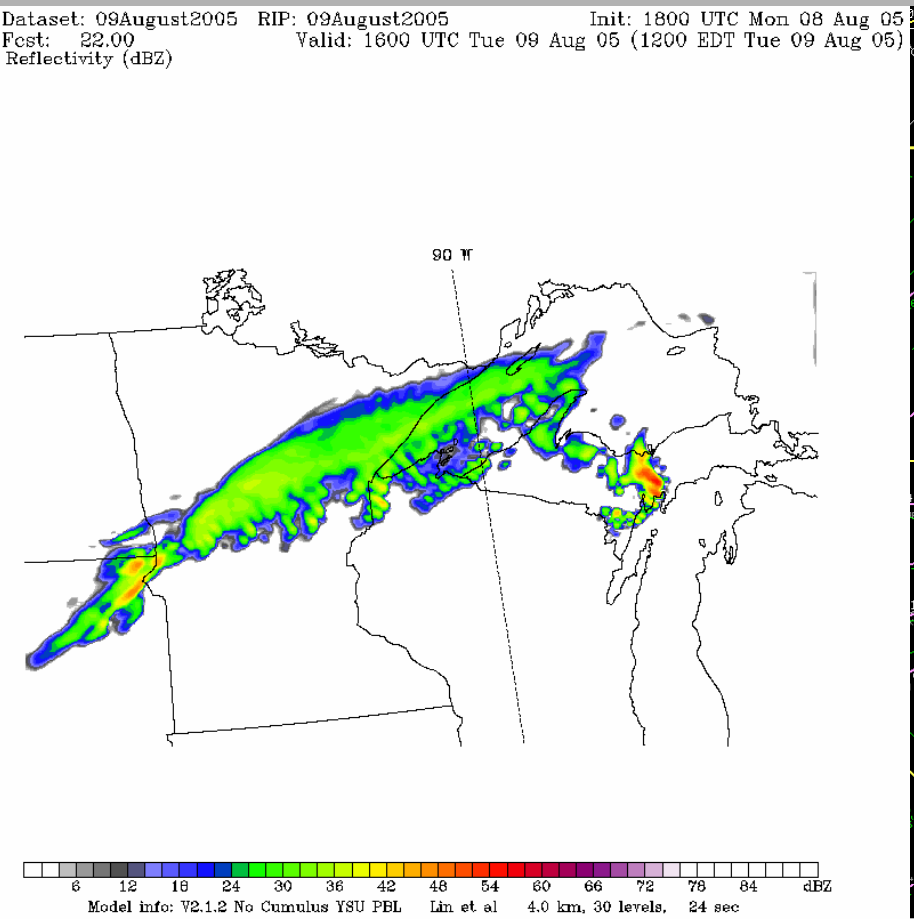
0.5° Reflectivity Mosaic (right)
4km WRF (BMJ, Ferrier) 1-hour Precipitation (left)

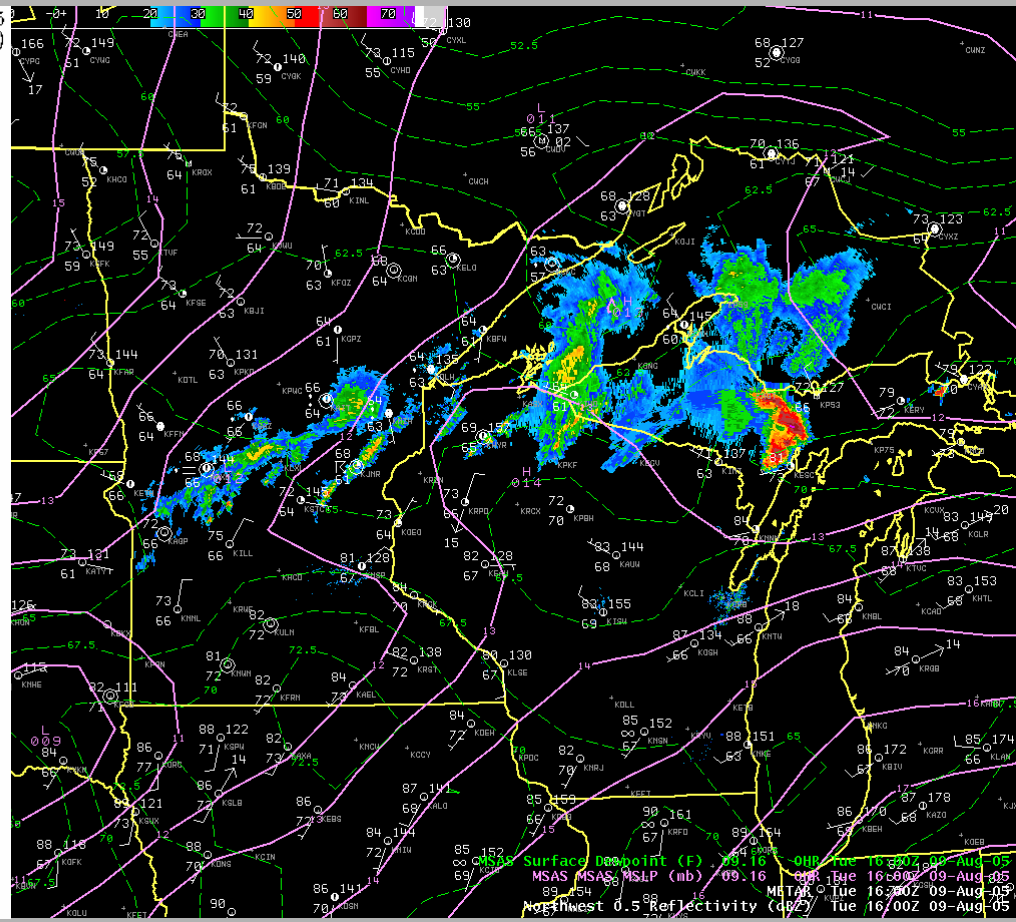




16Z 9 August 2005

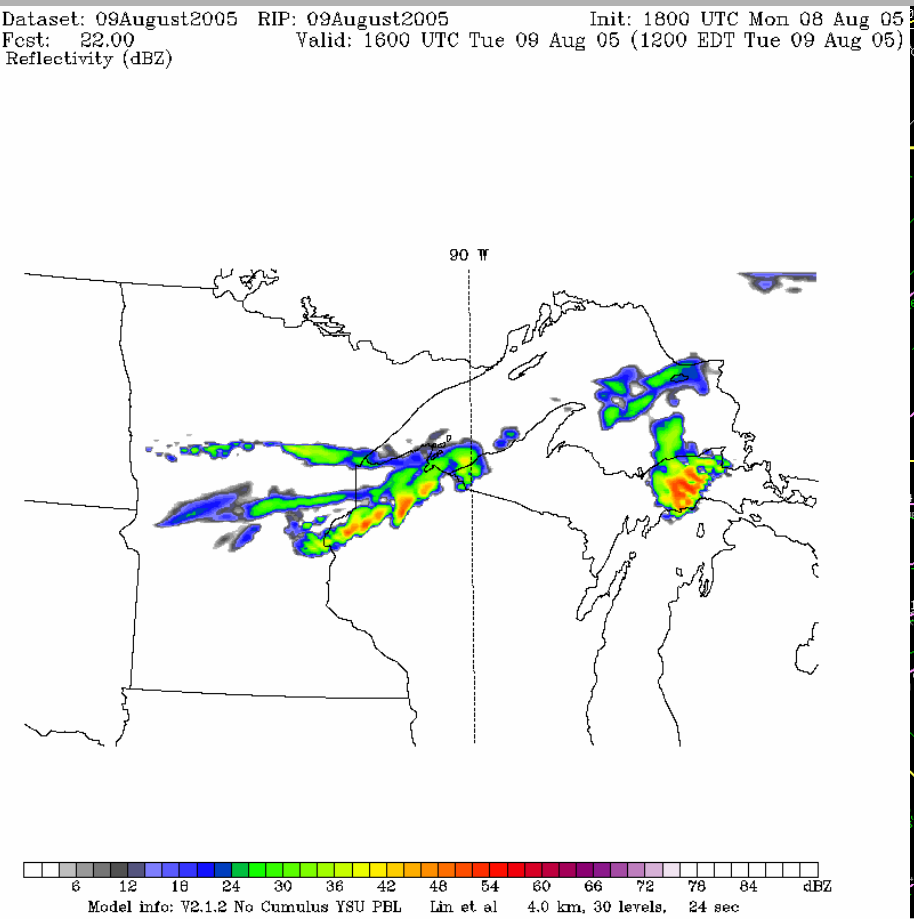
0.5° Reflectivity Mosaic (right)
4km WRF (KF, Lin et al., 1-way nest) Reflectivity (left)

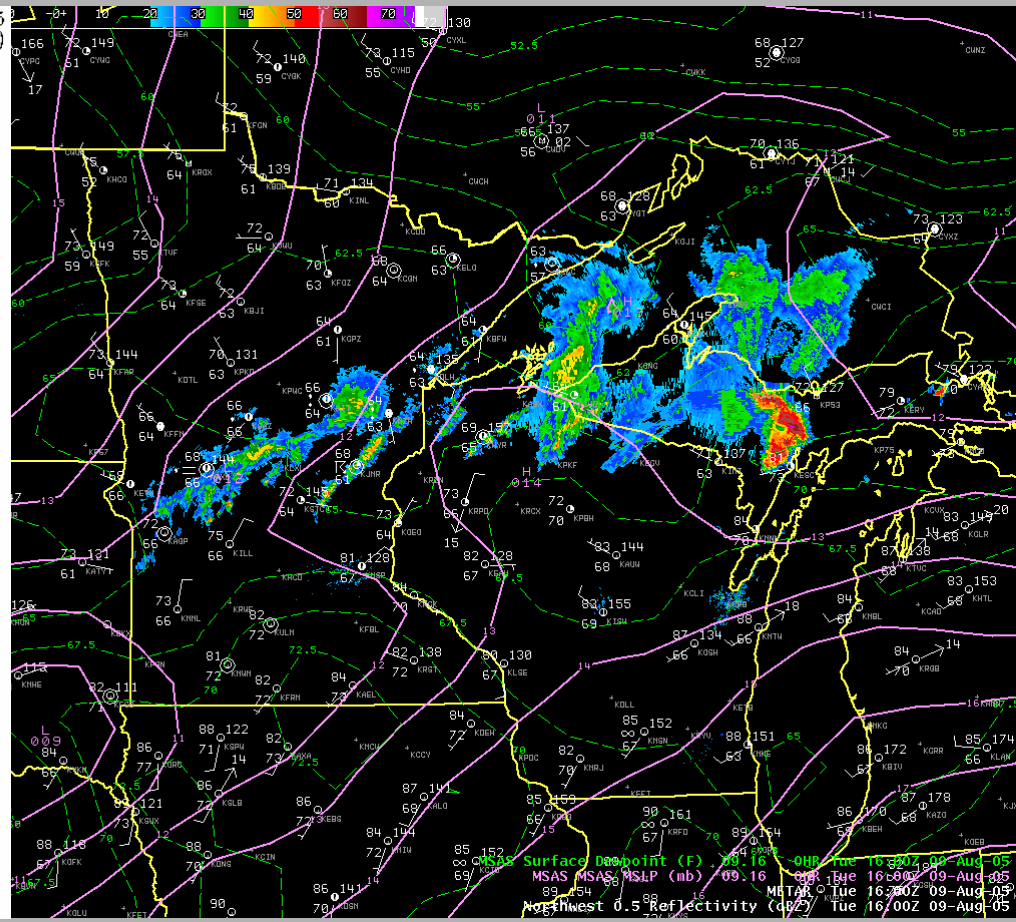




16Z 9 August 2005

0.5° Reflectivity Mosaic (right)
4km WRF (KF, Lin et al., single domain) Reflectivity (left)





Questions?

Photo by Don Rolfson