



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

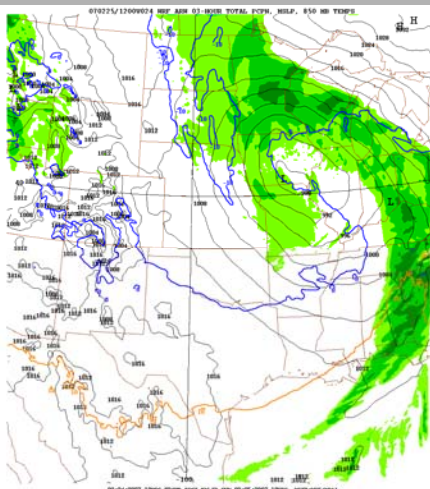
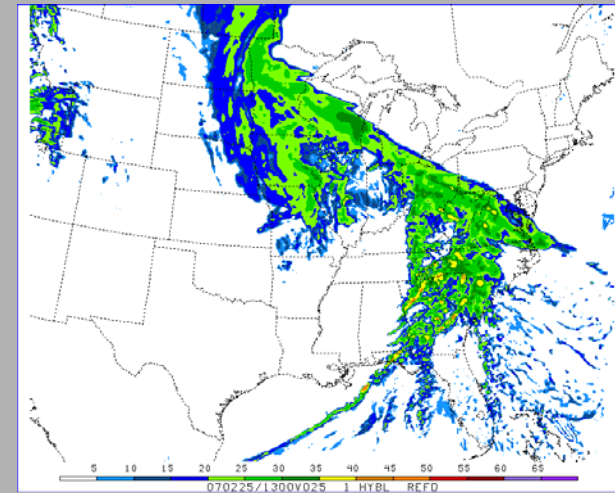
Tom Hultquist, Jennifer L. Lee, Matthew Zika
NOAA/NWS Marquette, MI

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

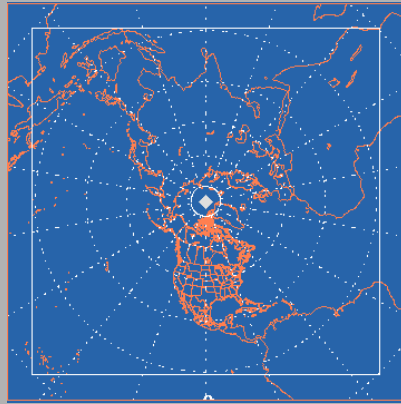
- Exposure to output from “explicit” model runs has increased dramatically over the past several years.
 - NCAR BAMEX, DTB, NCEP High Resolution Windows, NCEP “SPC” run, etc
- Deployment of STRC WRF EMS (developed by Bob Rozumalski) has



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)

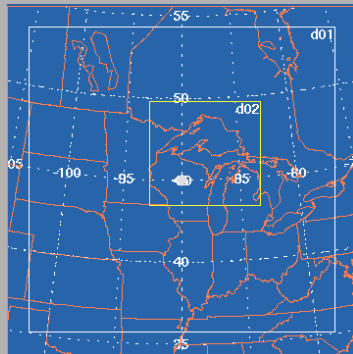
Run – 00, 06, 12, 18Z to 72-hrs
IC – 00-hr GFS
BC – HemiWRF-ARW
HGS – 40 km

RegWRF-ARW (104x104x31)

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

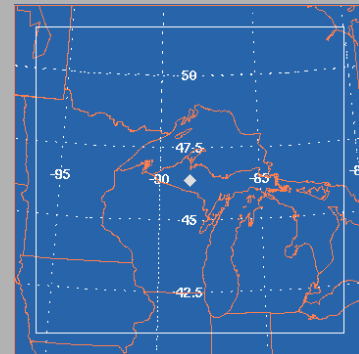
LAPSWRF-ARW (251x251x45)

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

Dataset: HemiWRF-ARW RIP: HemiWRF-ARW

Fest: 144.00 h

Mean Sea Level Pressure

1000 to 500 hPa Thickness

Init: 1200 UTC Wed 13 Jun 07 Dataset: HemiWRF-ARW RIP: HemiWRF-ARW

Valid: 1200 UTC Tue 19 Jun 07 (0800 EDT Tue 19 Jun 07)

Fest: 144,00 h

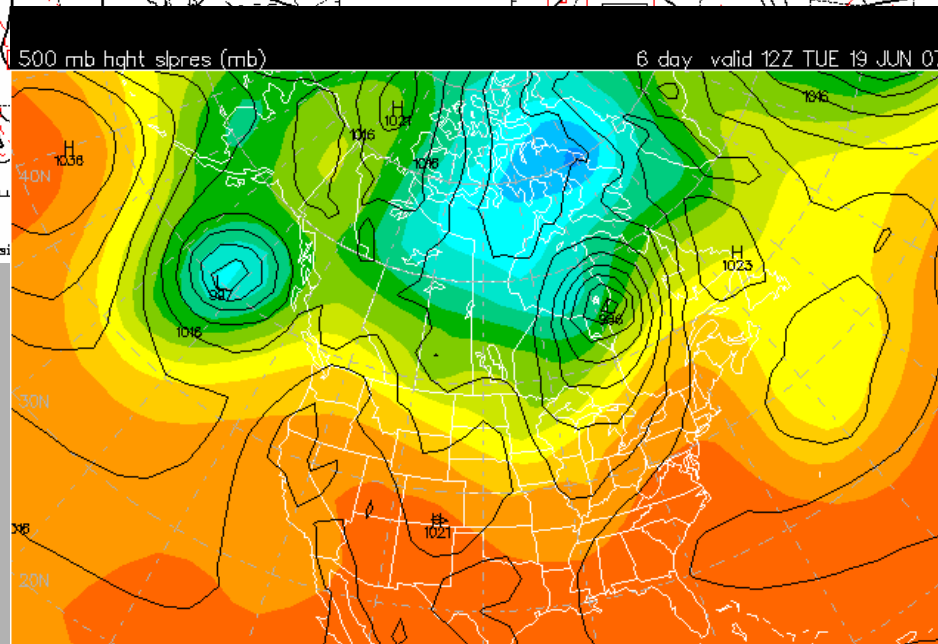
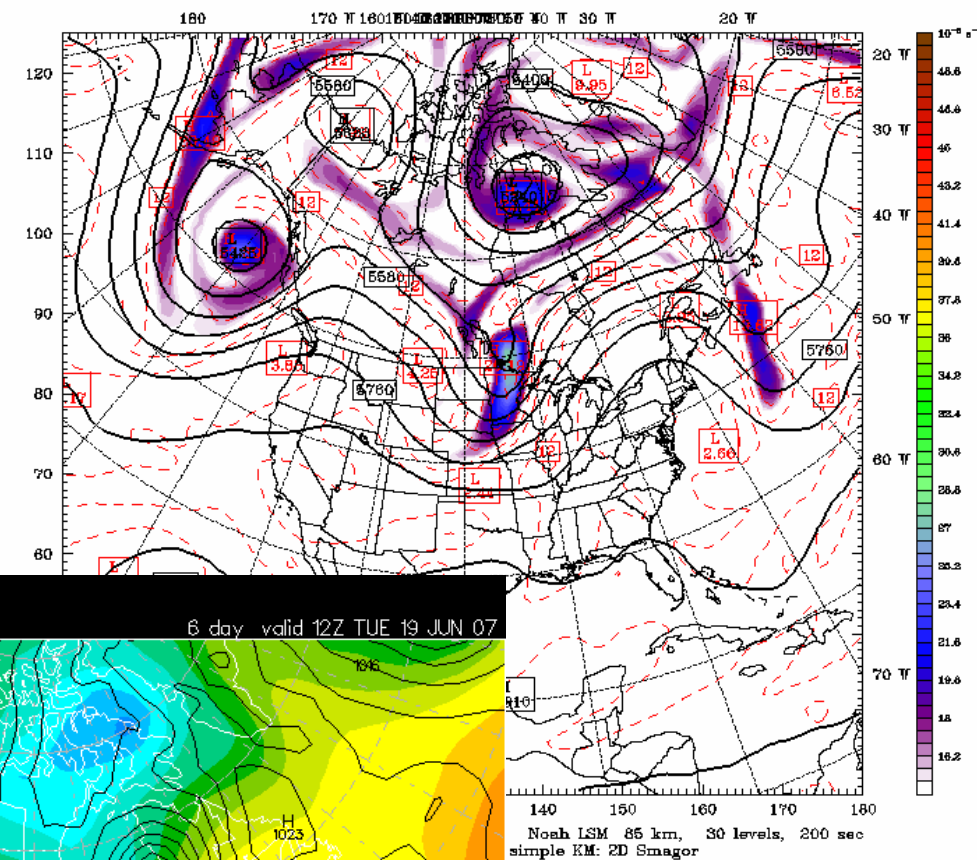
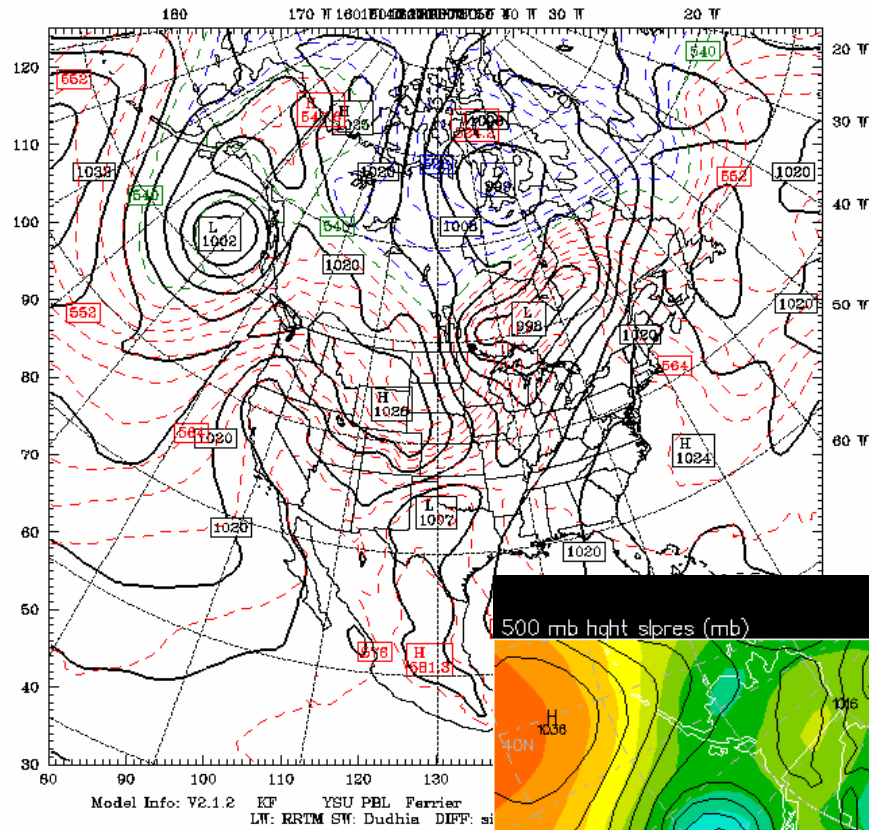
RIP: HemiWRF-ARW

Valid: 1200 UTC Tue 19 Jun 07 (0800 EDT Tue 19 Jun 07)

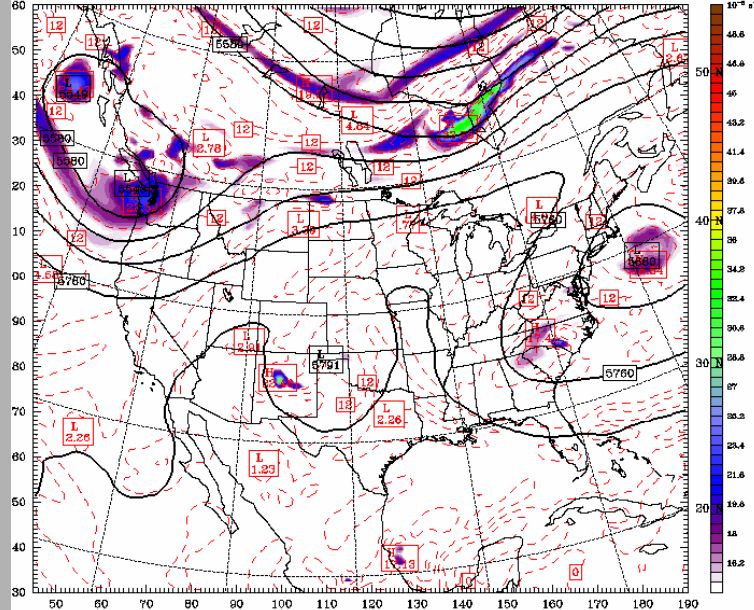
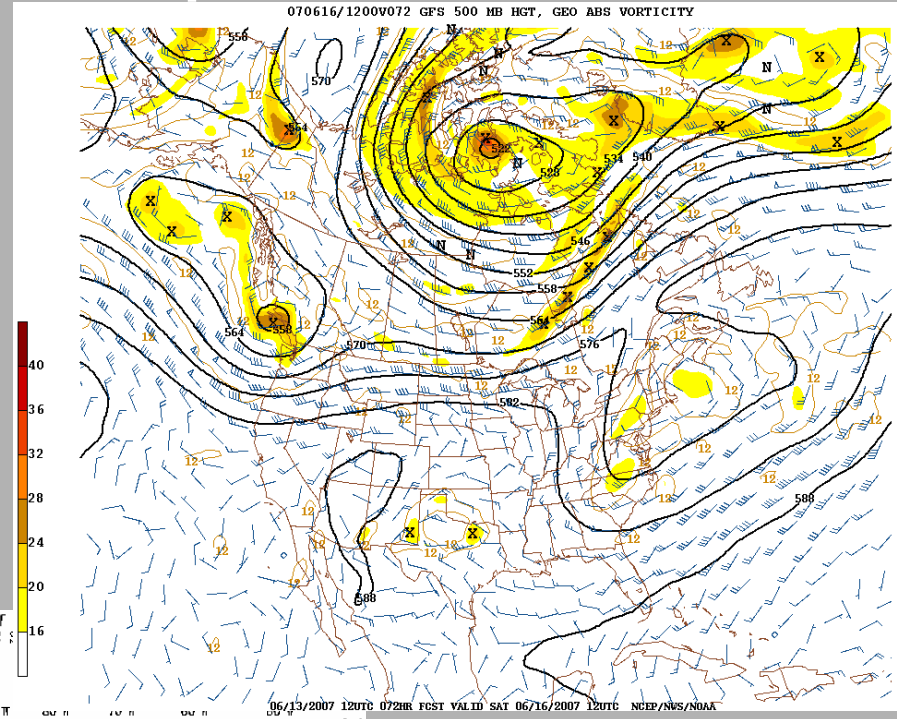
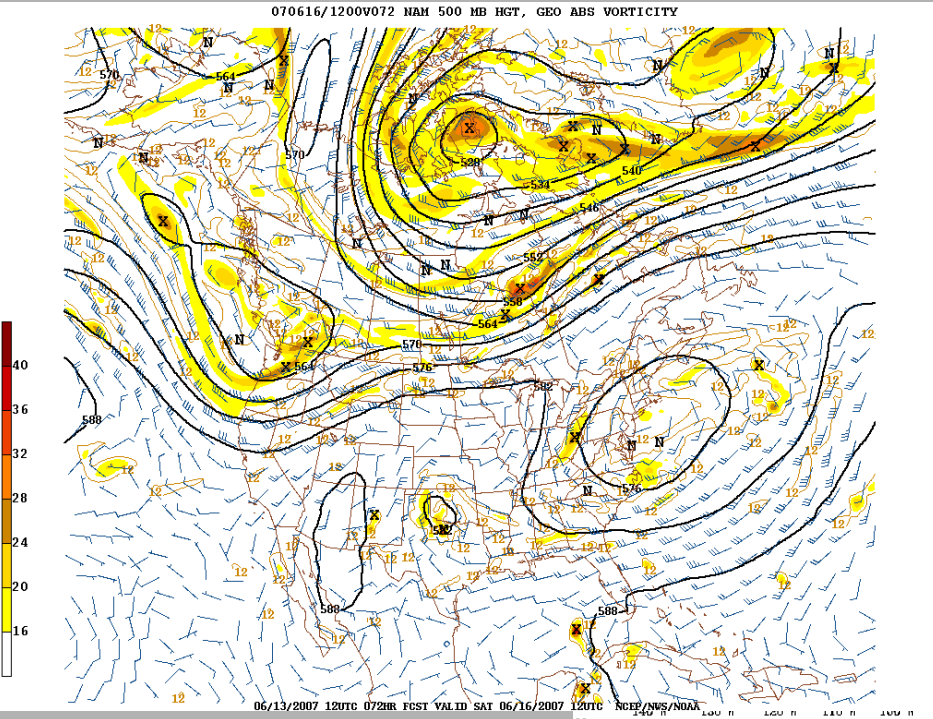
10/22/97 14:00 010 100 10 0000 01 0000 220 100 10 0000 01

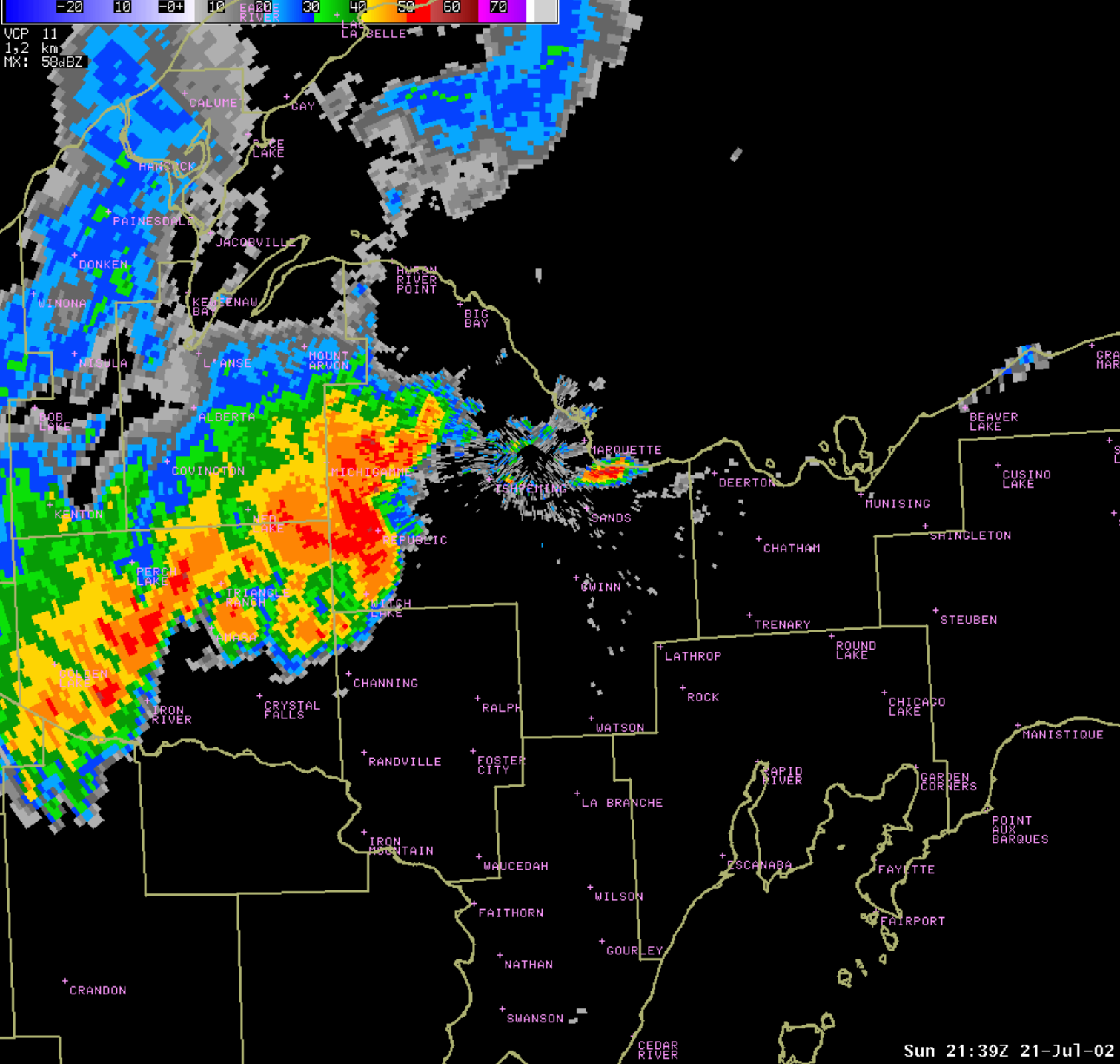
500 hPa Absolute Vorticity

500 hPa Height



A Few Examples



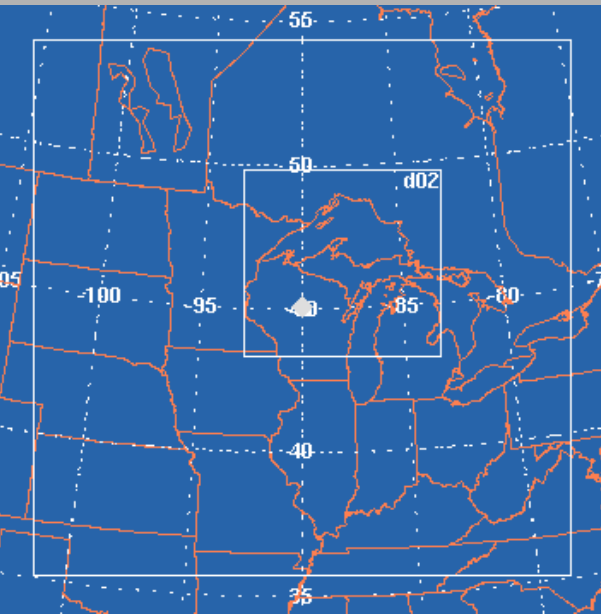


21 July 2002
Bow Echo
Event

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

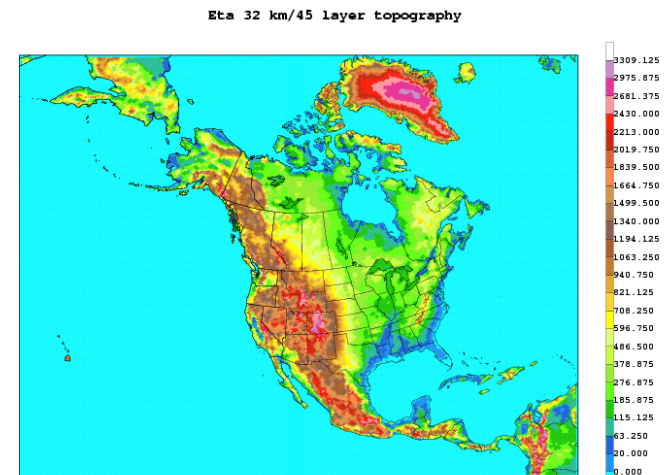
Sun 21:39Z 21-Jul-02

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

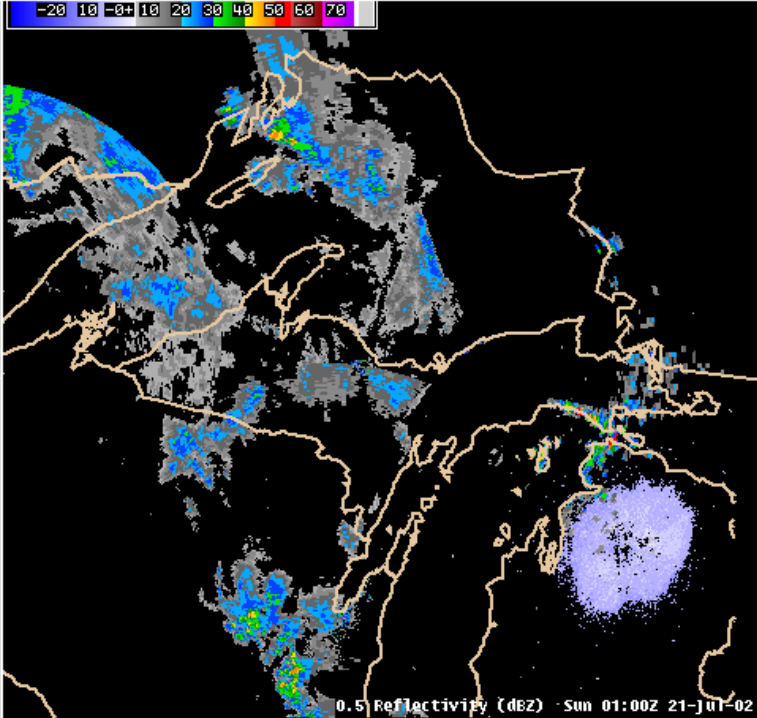
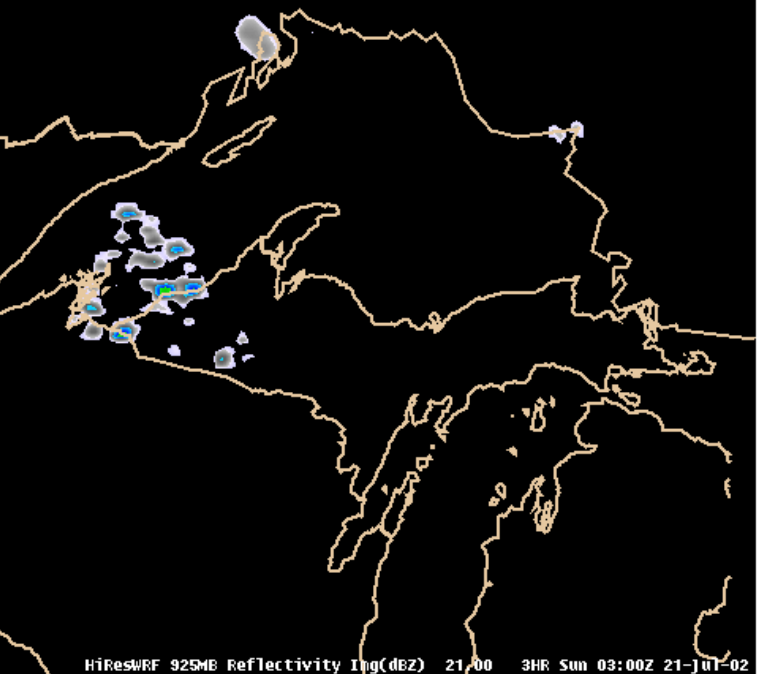
- Kain-Fritsch CP scheme (outer nest), no CP scheme (inner nest)
- Lin et al. microphysics
- RRTM longwave radiation scheme
- Dudhia shortwave radiation scheme
- Noah land surface model
- YSU PBL scheme



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.

-20 10 -0+10 20 30 40 50 60 70 80 90



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)

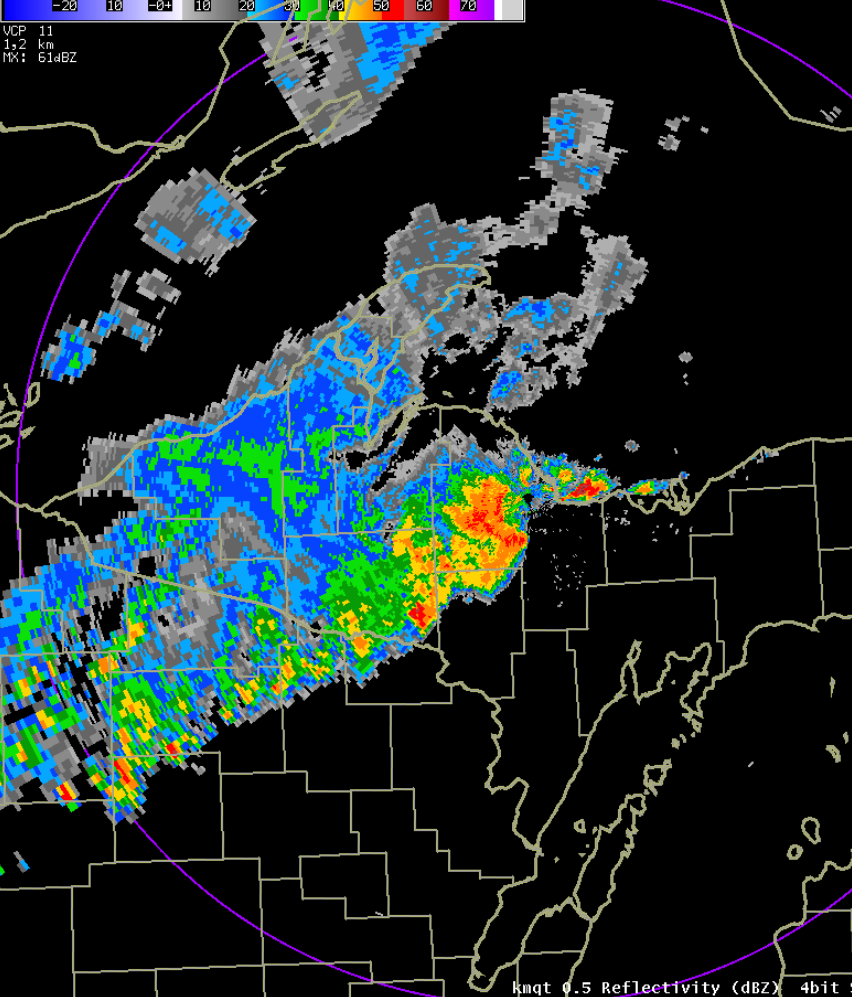
12Z 5km WRF

(lower left)

Radar Mosaic

(lower right)

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



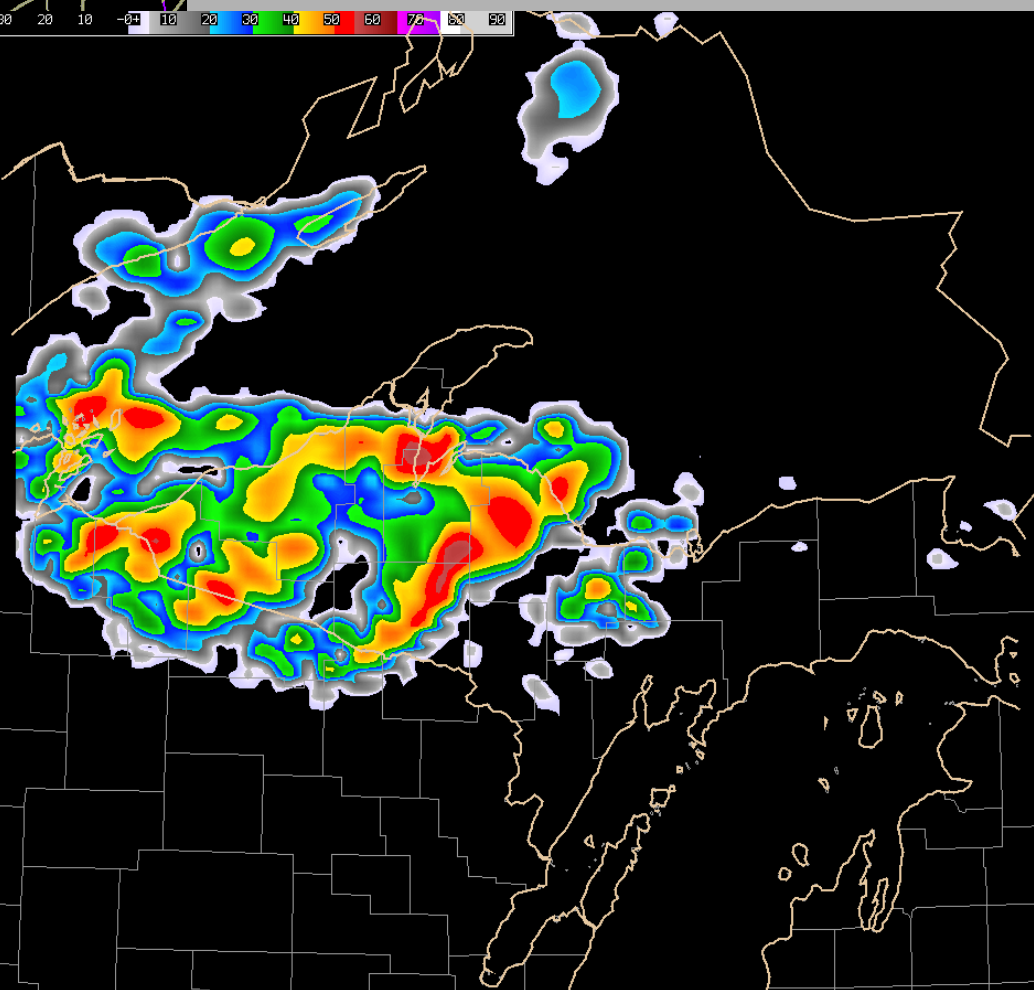
2159Z 21 July 2002

0.5° Reflectivity

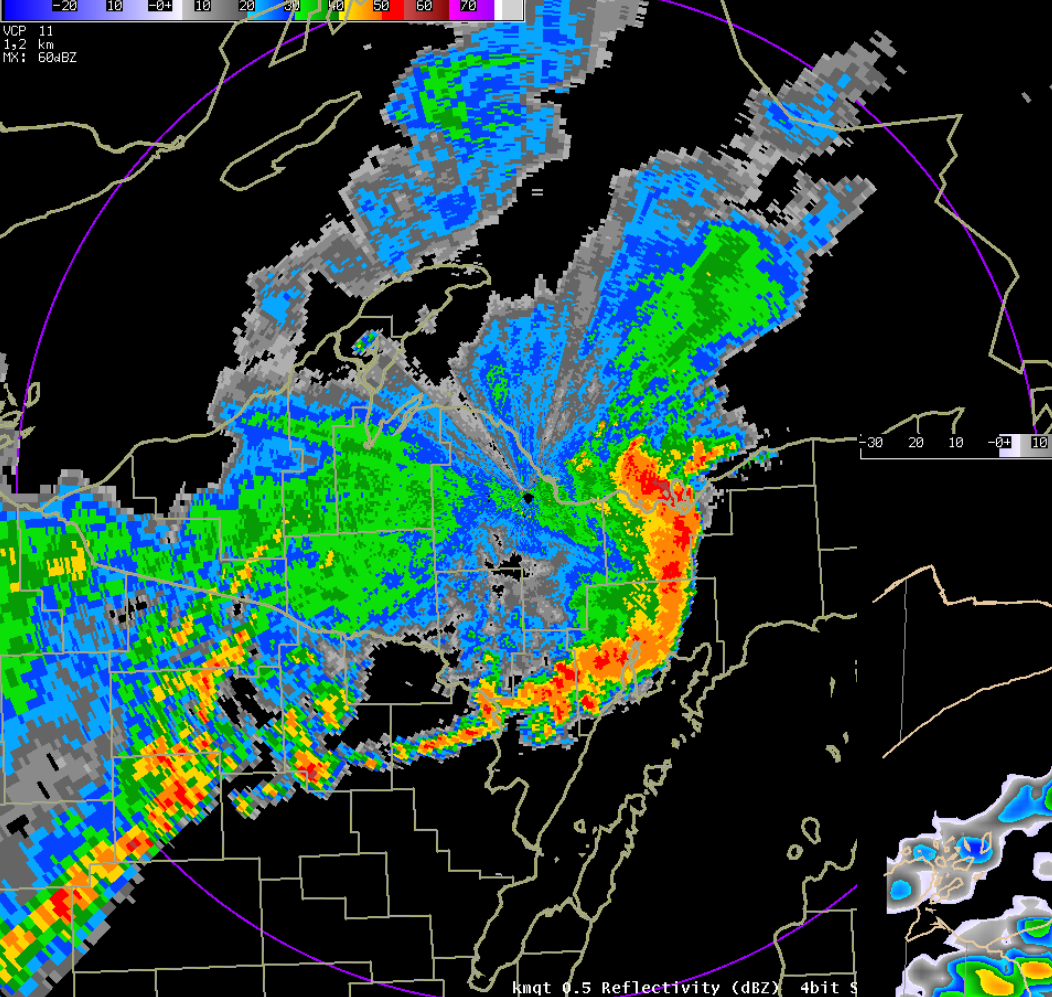


00Z 22 July 2002

5km WRF 925 hPa
Reflectivity



VCP 11
1.2 km
MK: 60dBZ



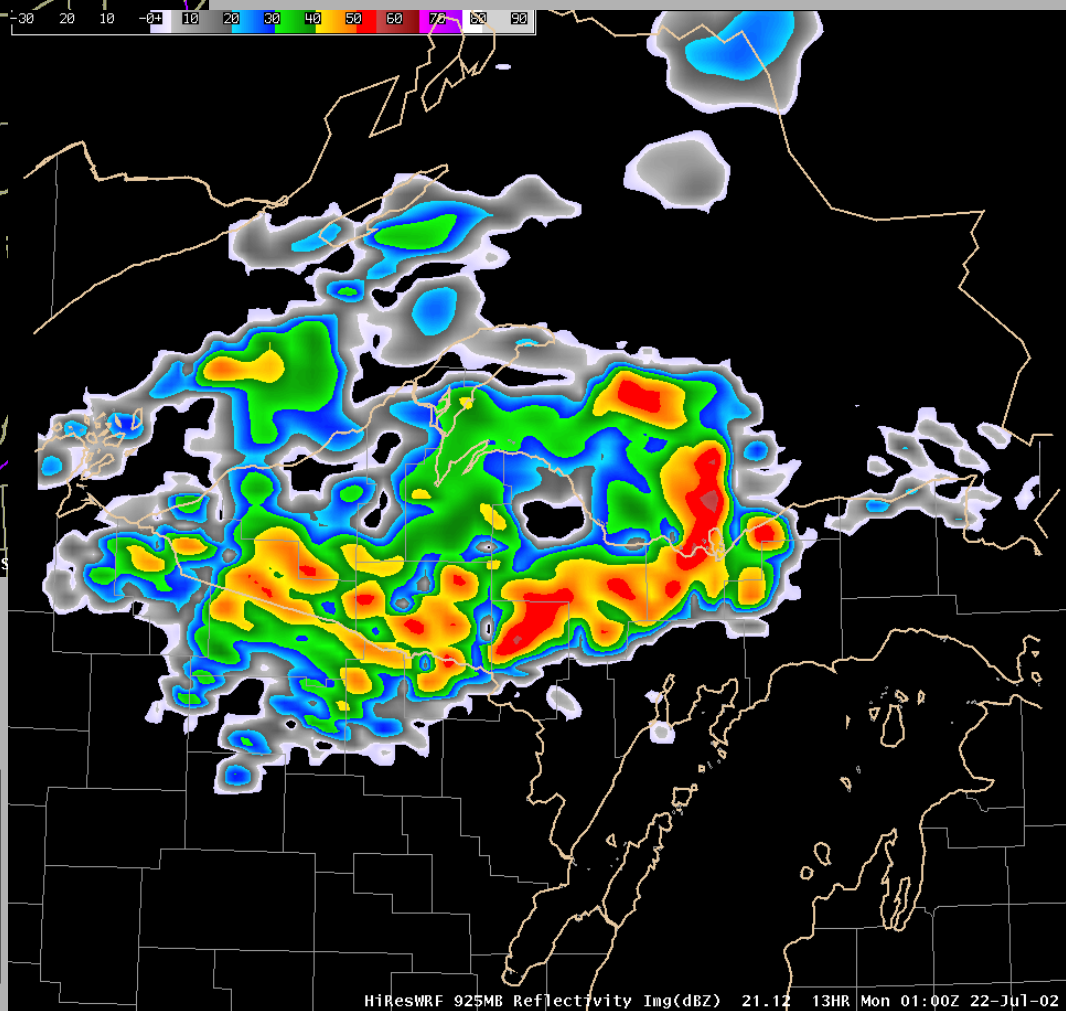
2259Z 21 July 2002

0.5° Reflectivity

kmqt 0.5 Reflectivity (dBZ) 4bit S

01Z 22 July 2002

5km WRF 925 hPa
Reflectivity



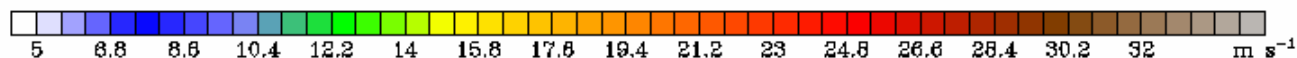
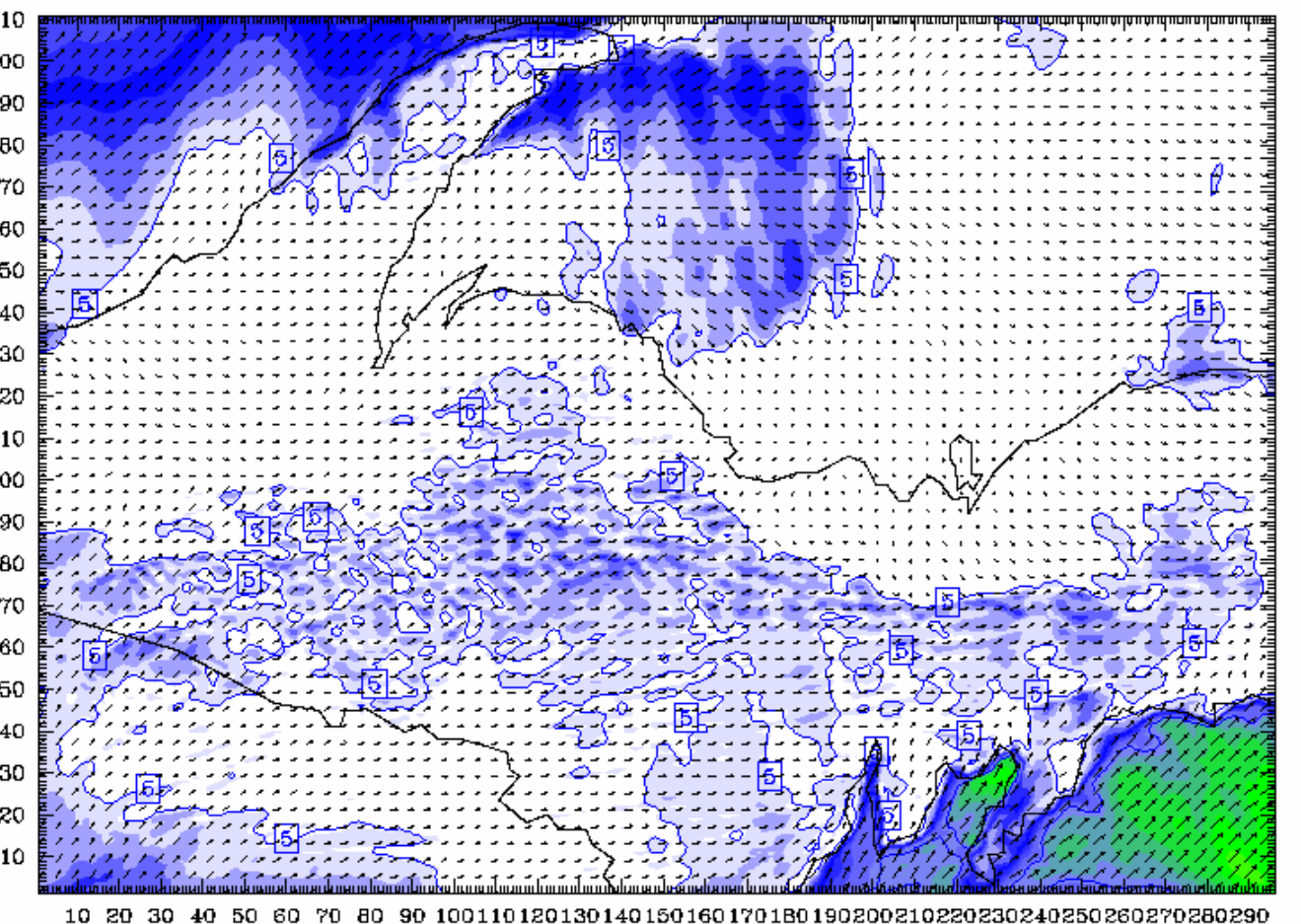
HiResWRF 925MB Reflectivity Inq(dBZ) 21.12 13HR Mon 01:00Z 22-Jul-02

Dataset: HiResWRF-ARW RIP: HiResWRF-ARW Init: 1200 UTC Sun 21 Jul 02
Fest: 8.00 h Valid: 2000 UTC Sun 21 Jul 02 (1600 EDT Sun 21 Jul 02)

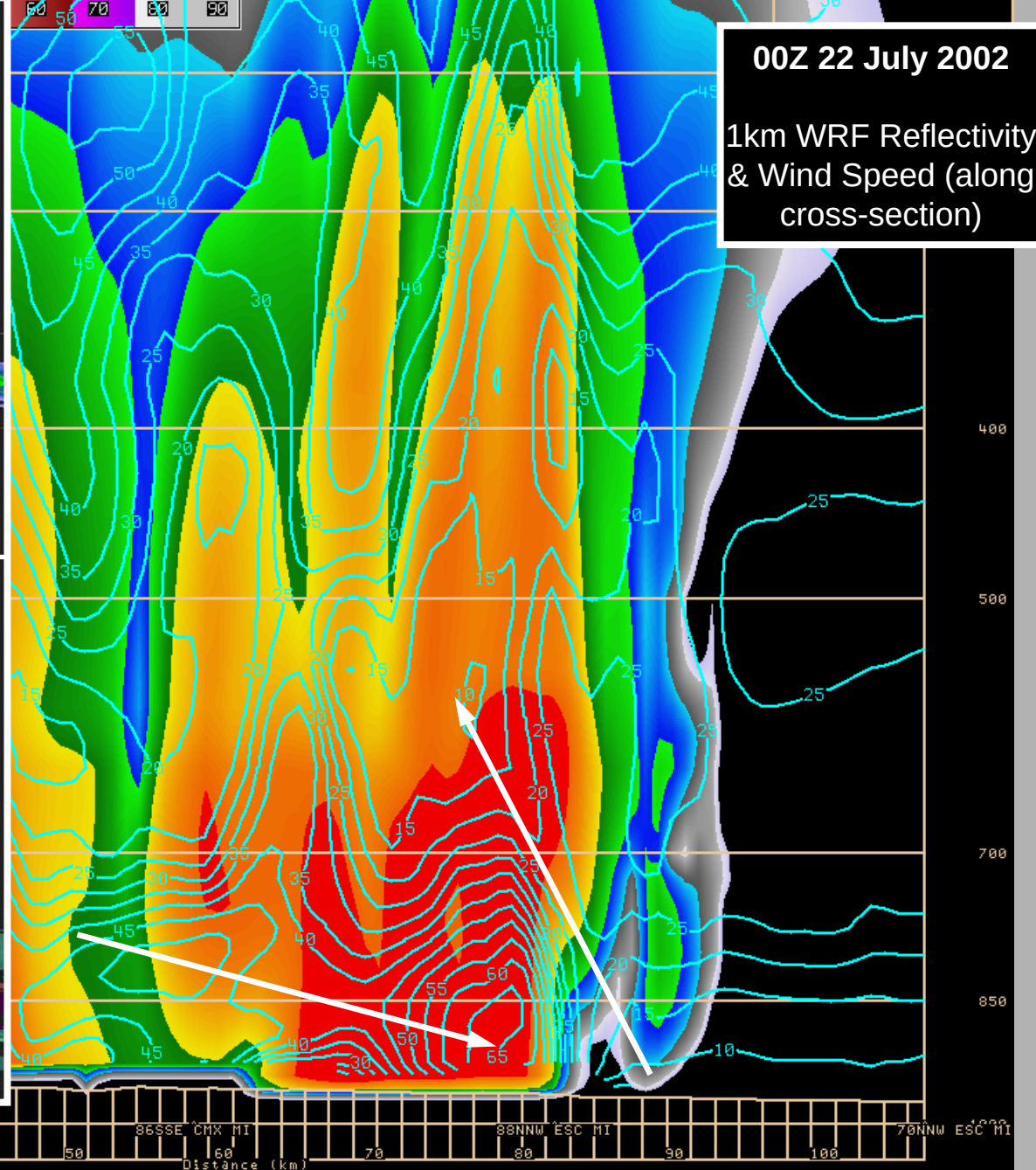
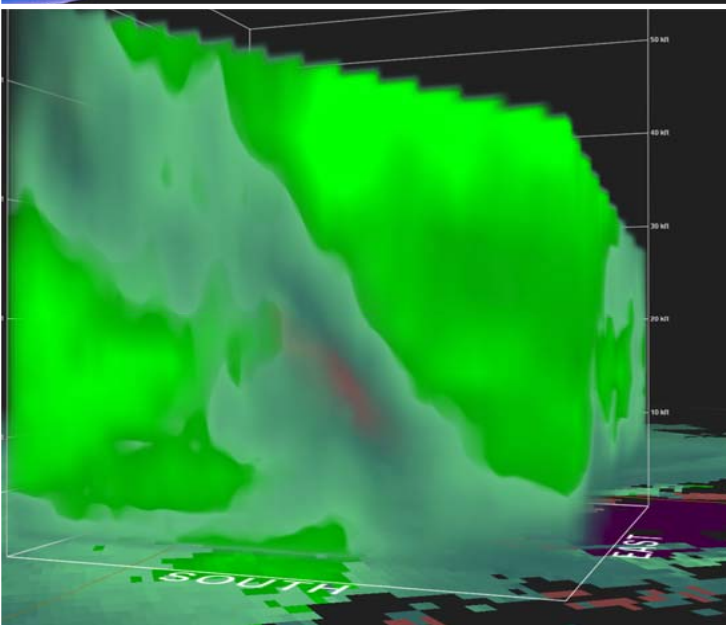
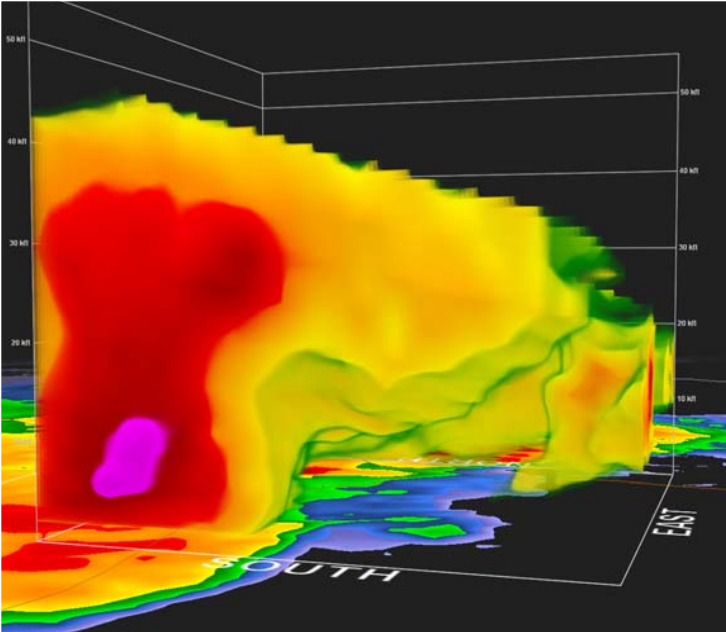
10-m Wind Speed (m/s)
10-meter Wind

20Z 21 July 2002 – 04Z
22 July 2002

1km WRF 10-m Winds

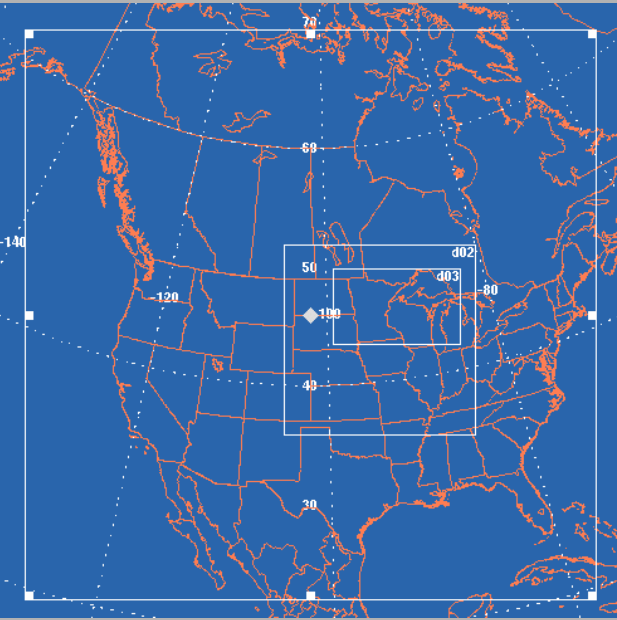


Model Info: V2.1.2 No Cu YSU PBL Lin et al Noah LSM 1.0 km, 30 levels, 6 sec
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor



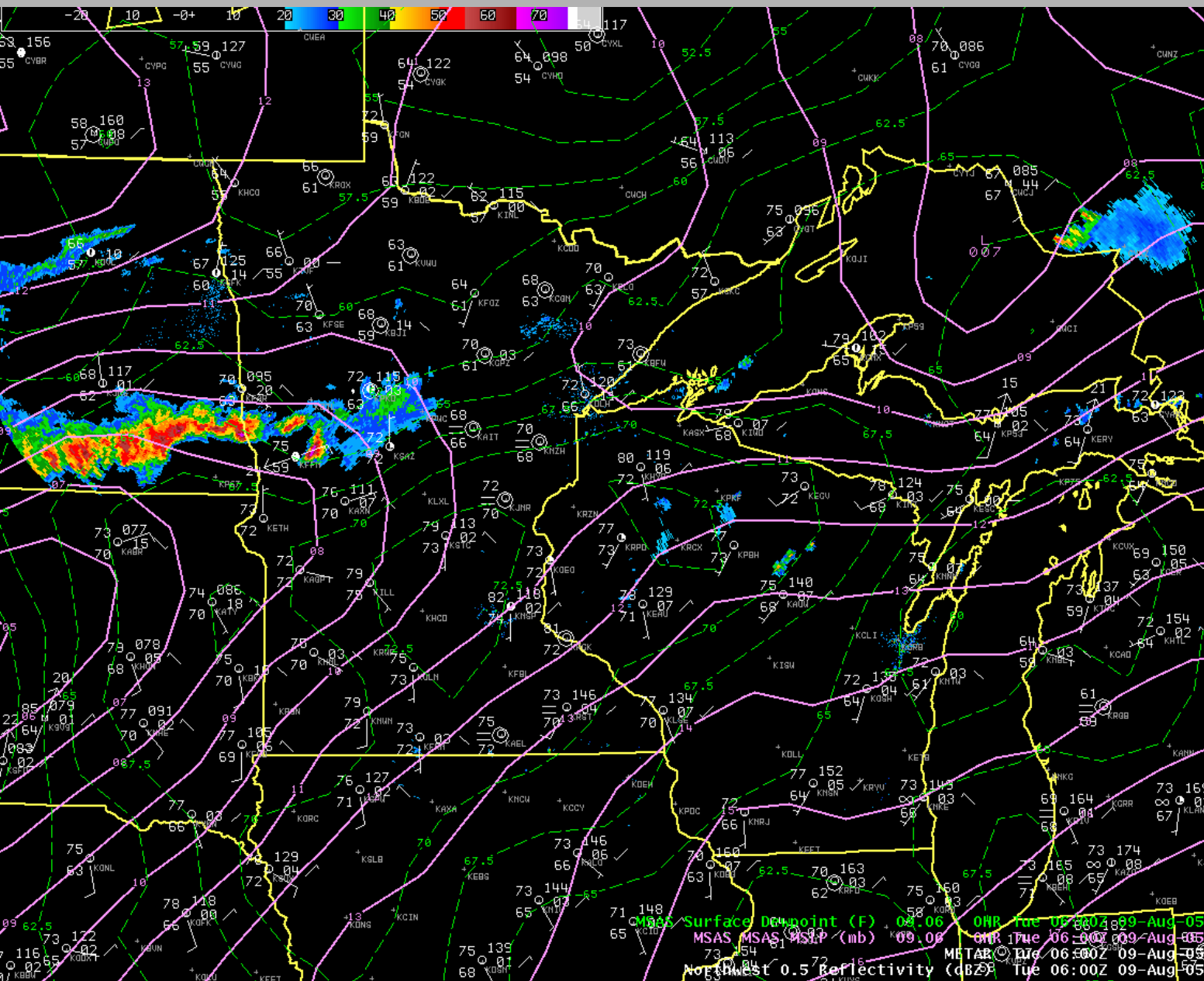
SuperHiResWRF lineE	Ageo Vert Circ ()	21.12	12HR	Mon	00:00Z	22-Jul-02
SuperHiResWRF lineE	Component Along (kts)	21.12	12HR	Mon	00:00Z	22-Jul-02
SuperHiResWRF lineE	Reflectivity Img(dBZ)	21.12	12HR	Mon	00:00Z	22-Jul-02

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

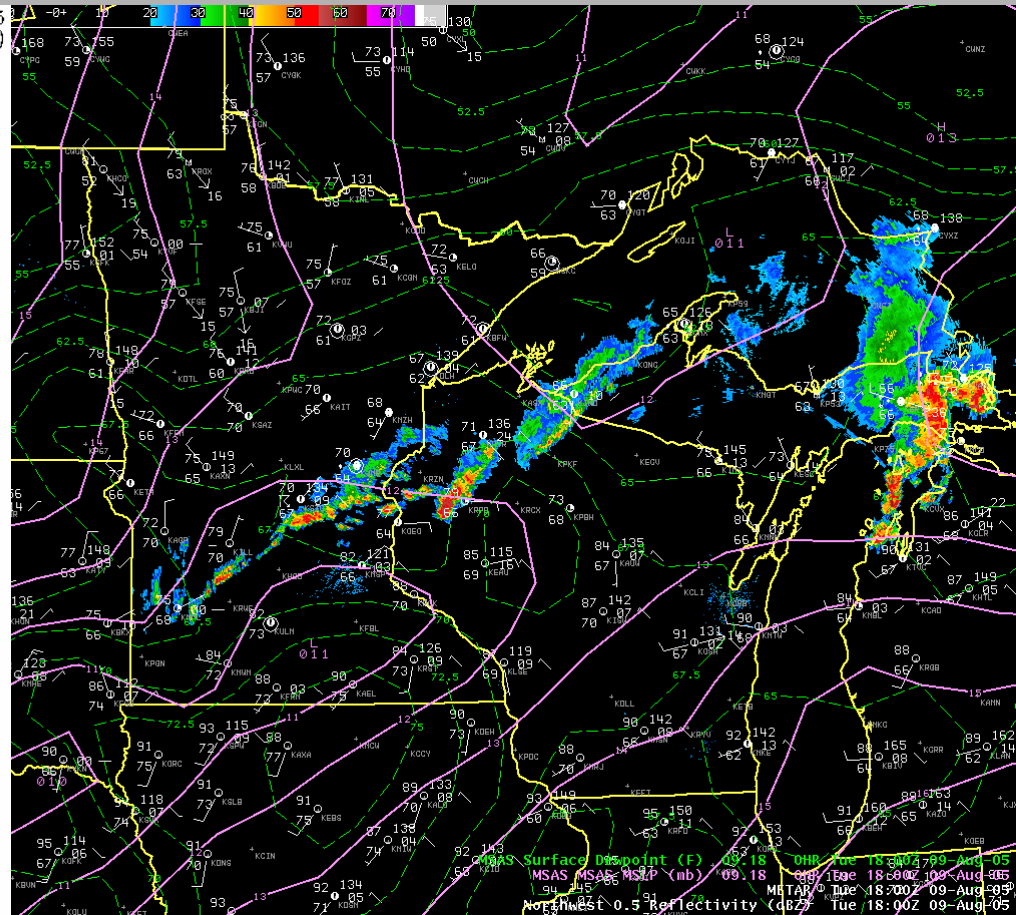
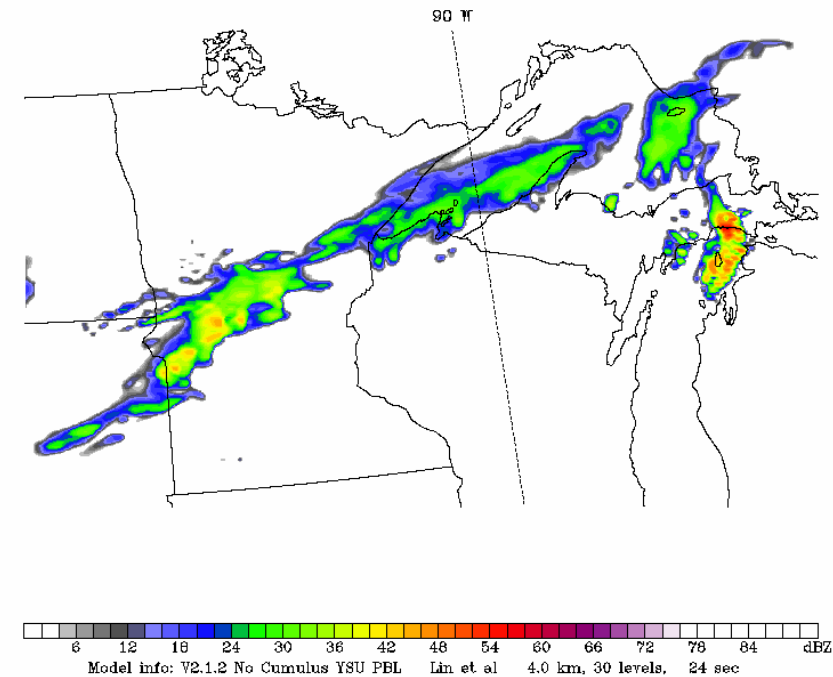
0.5° Reflectivity
Mosaic, MSAS
MSLP (magenta),
MSAS Dewpoint
(green), METARs
(white)

0.5° Reflectivity Mosaic, MSAS MSLP (magenta), MSAS Dewpoint (green), METARs (white)
MSAS Surface Dewpoint (F) 08.06
MSAS MSLP (mb) 09.06
METAR Tue 06:00Z 09-Aug-05
Tue 06:00Z 09-Aug-05

18Z 9 August 2005

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

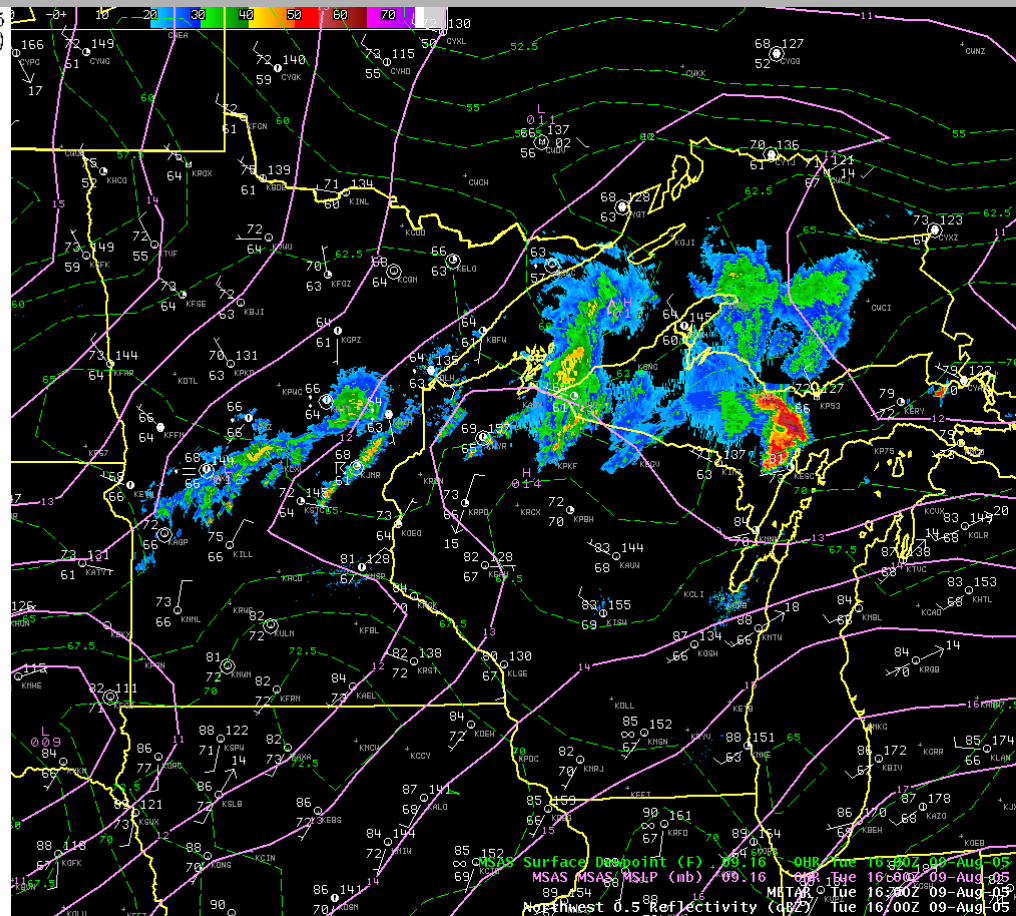
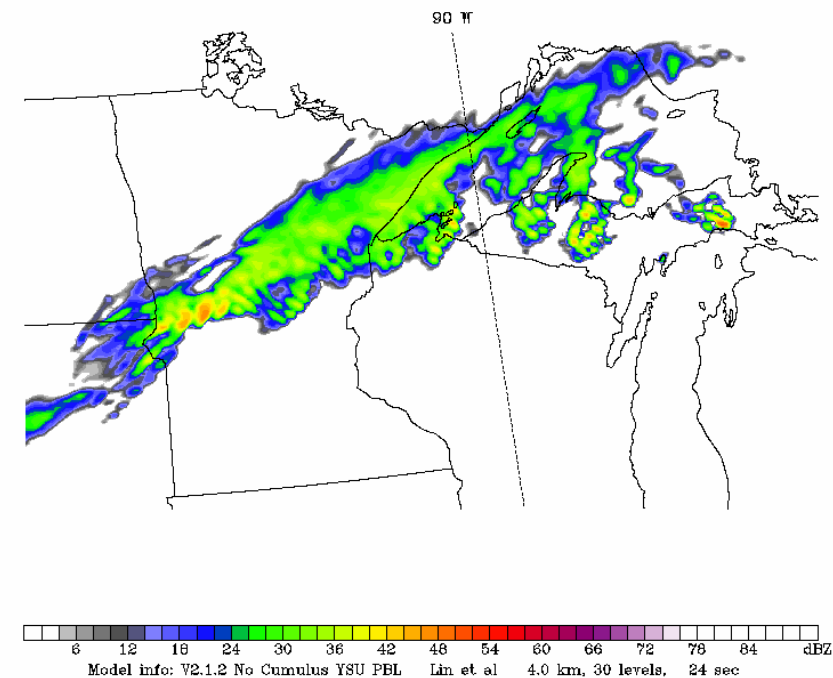
Dataset: 09August2005 RIP: 09August2005 Init: 1800 UTC Mon 08 Aug 05
Fcst: 24.00 Valid: 1800 UTC Tue 09 Aug 05 (1400 EDT Tue 09 Aug 05)
Reflectivity (dBZ)



16Z 9 August 2005

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

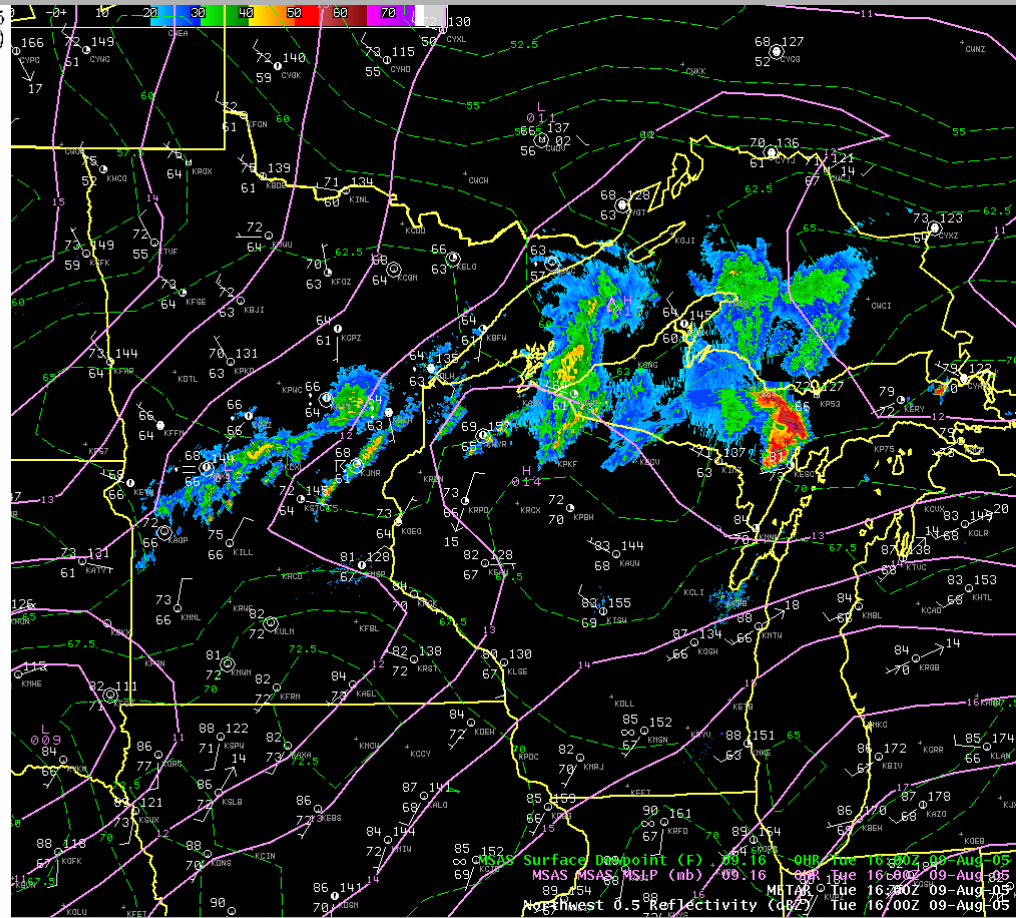
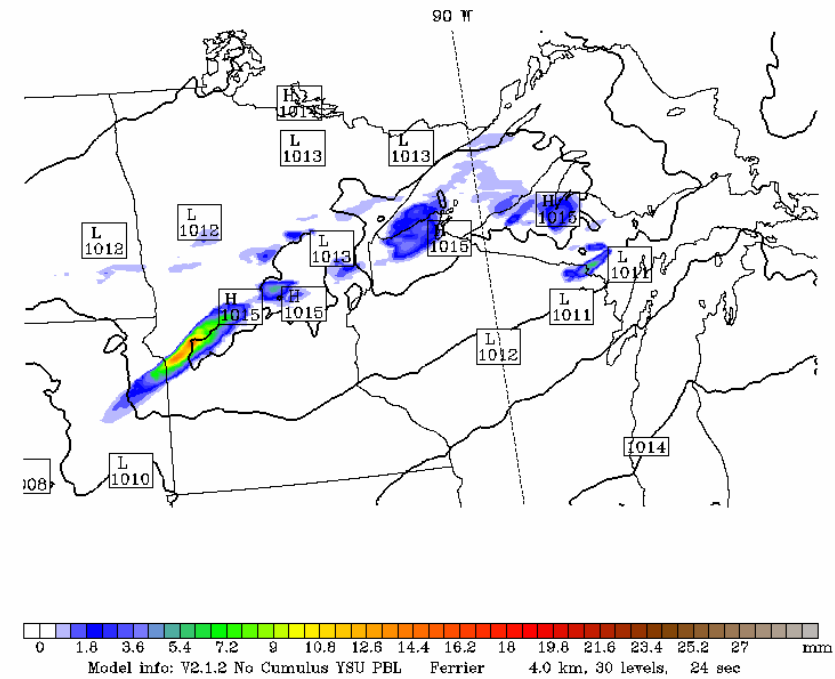
Dataset: 09August2005 RIP: 09August2005 Init: 1800 UTC Mon 08 Aug 05
Fcst: 22.00 Valid: 1600 UTC Tue 09 Aug 05 (1200 EDT Tue 09 Aug 05)
Reflectivity (dBZ)



16Z 9 August 2005

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

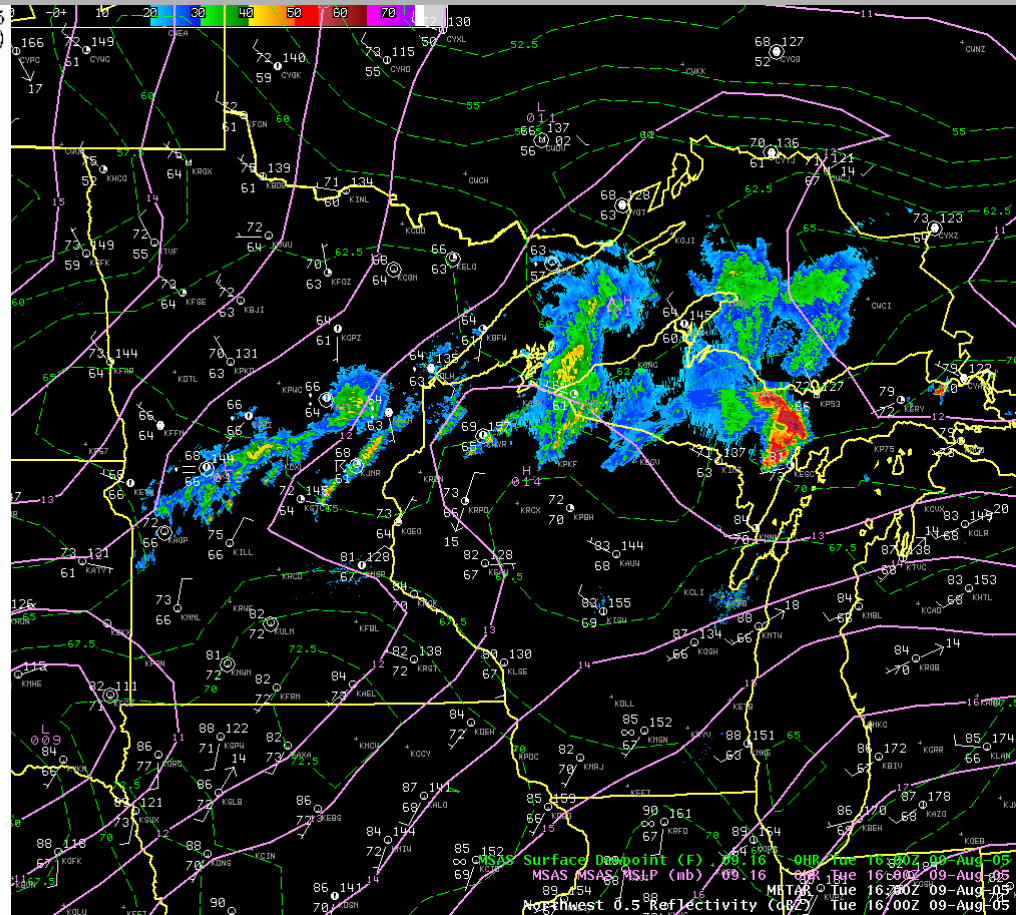
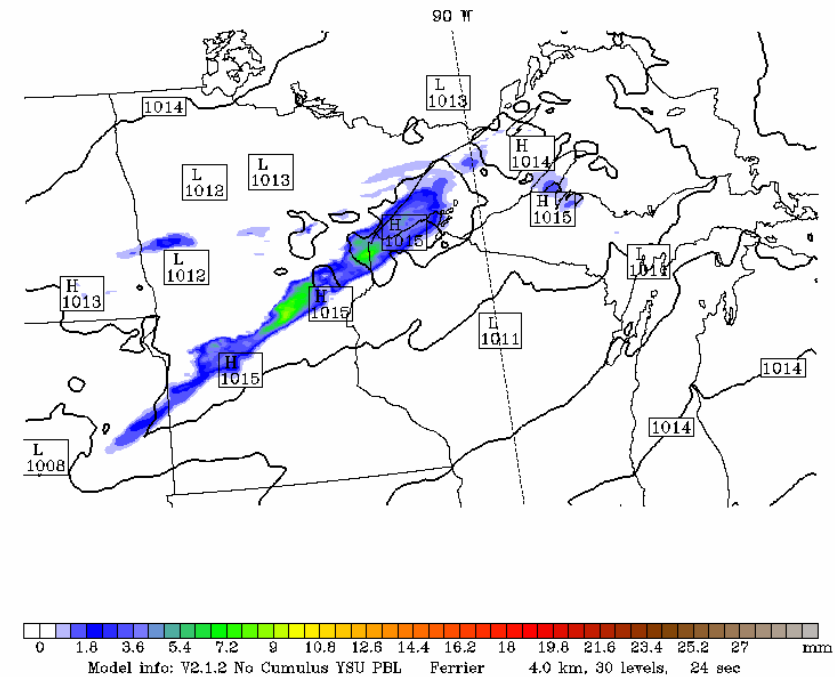
Dataset: 09August2005 RIP: 09August2005 Init: 1800 UTC Mon 08 Aug 05
Fcst: 22.00 Valid: 1600 UTC Tue 09 Aug 05 (1200 EDT Tue 09 Aug 05)
1-hour Total Precipitation (mm)
Mean Sea Level Pressure



16Z 9 August 2005

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

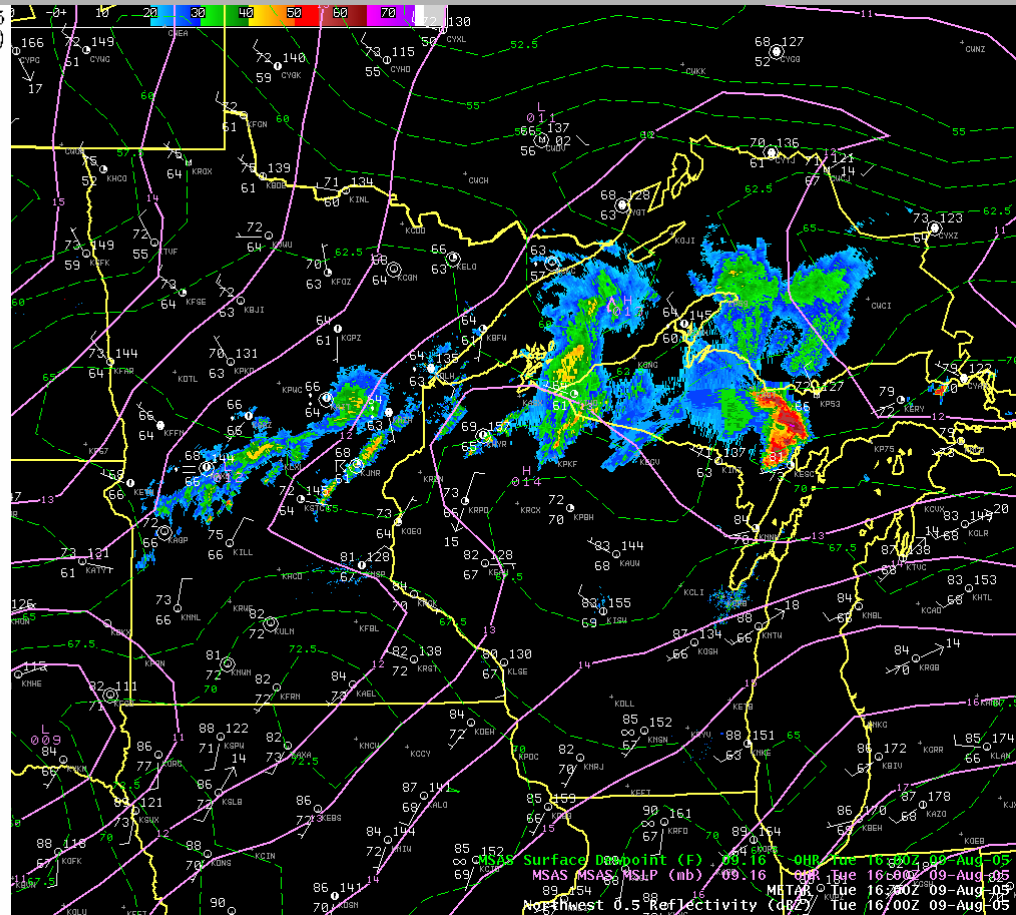
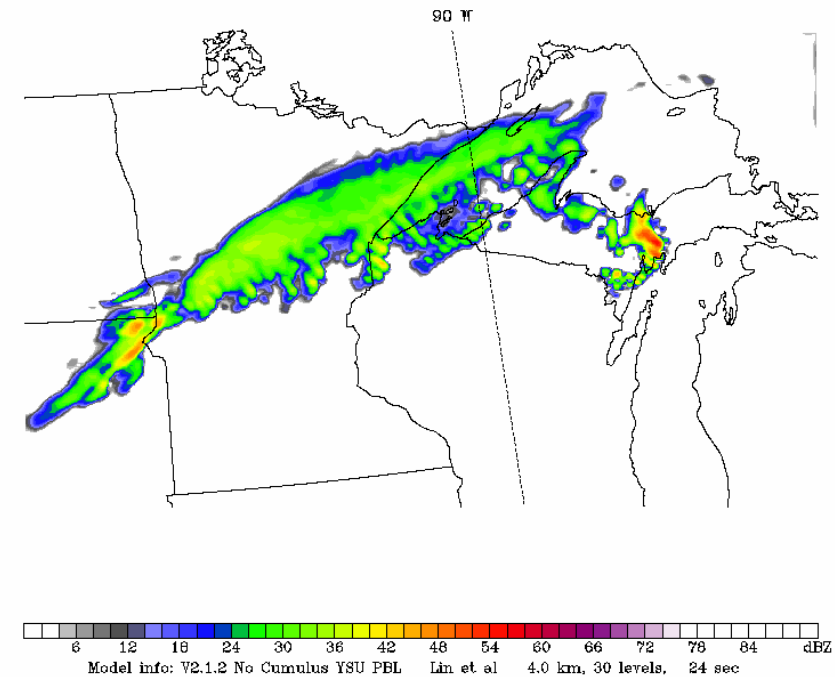
Dataset: 09August2005 RIP: 09August2005 Init: 1800 UTC Mon 08 Aug 05
Fcst: 22.00 Valid: 1600 UTC Tue 09 Aug 05 (1200 EDT Tue 09 Aug 05)
1-hour Total Precipitation (mm)
Mean Sea Level Pressure



16Z 9 August 2005

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

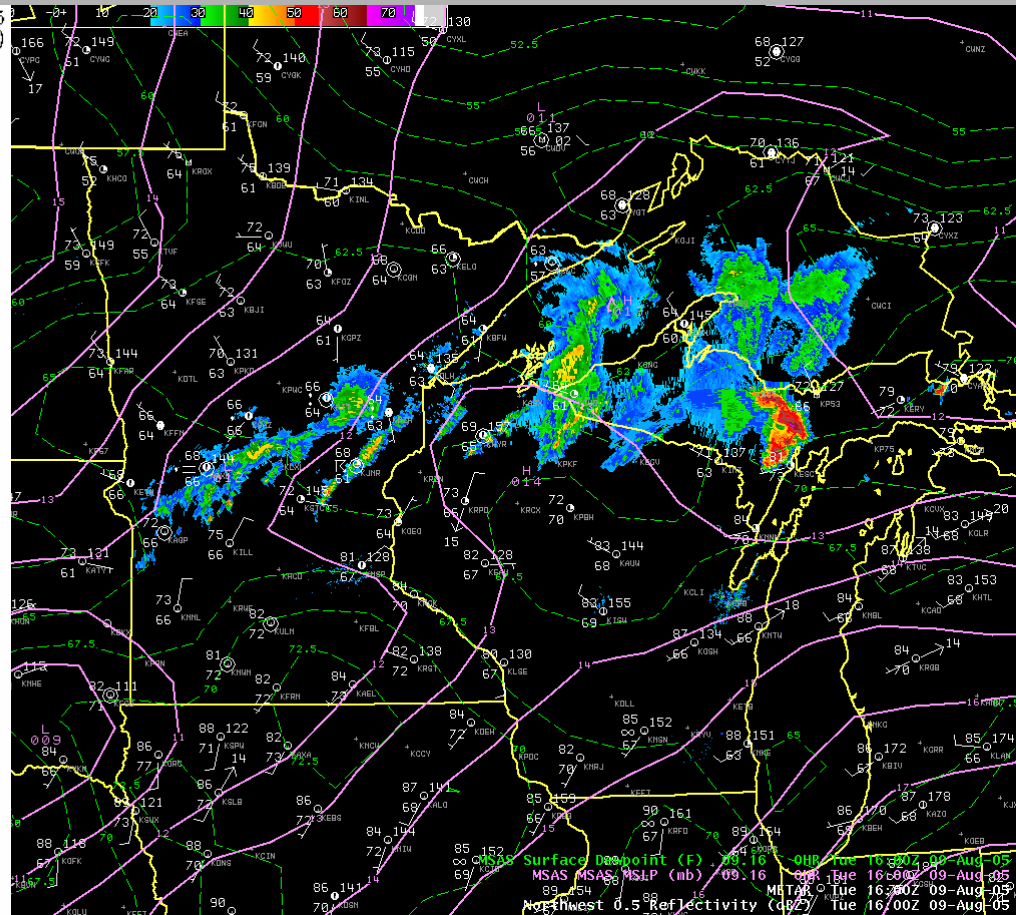
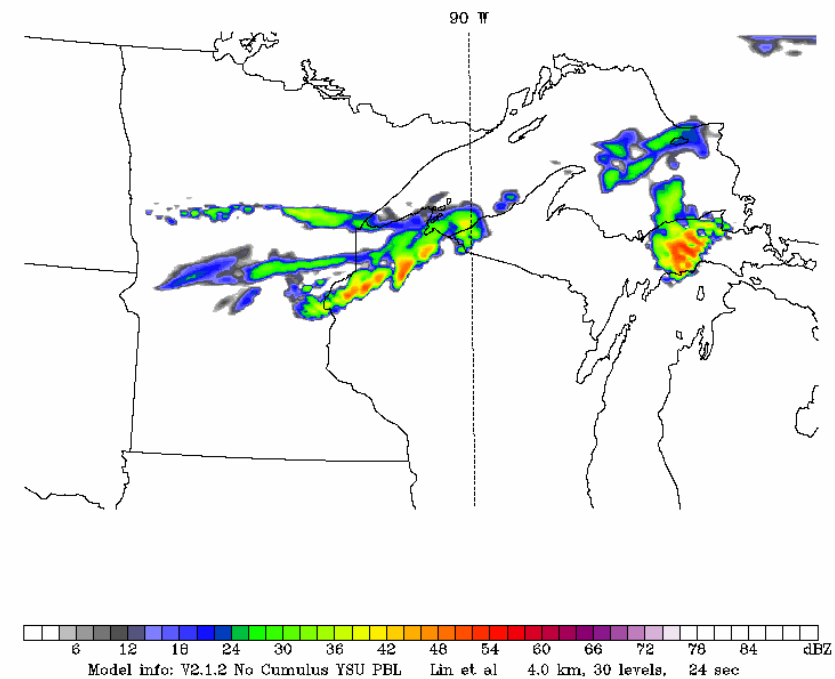
Dataset: 09August2005 RIP: 09August2005 Init: 1800 UTC Mon 08 Aug 05
Fcst: 22.00 Valid: 1600 UTC Tue 09 Aug 05 (1200 EDT Tue 09 Aug 05)
Reflectivity (dBZ)



16Z 9 August 2005

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

Dataset: 09August2005 RIP: 09August2005 Init: 1800 UTC Mon 08 Aug 05
Fcst: 22.00 Valid: 1600 UTC Tue 09 Aug 05 (1200 EDT Tue 09 Aug 05)
Reflectivity (dBZ)



Questions?



Ice ridge just offshore on Lake Superior

Photo by Don Rolfson