

# Simulating Beaufort Sea Coastal Wind Events Using MM5 and WRF

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Great Alaska Weather Modeling Symposium  
March 13-15, 2007, Fairbanks, Alaska

# Motivation

*Beaufort Sea Mesoscale  
Meteorology Model Study ----- funded by MMS, DOI*

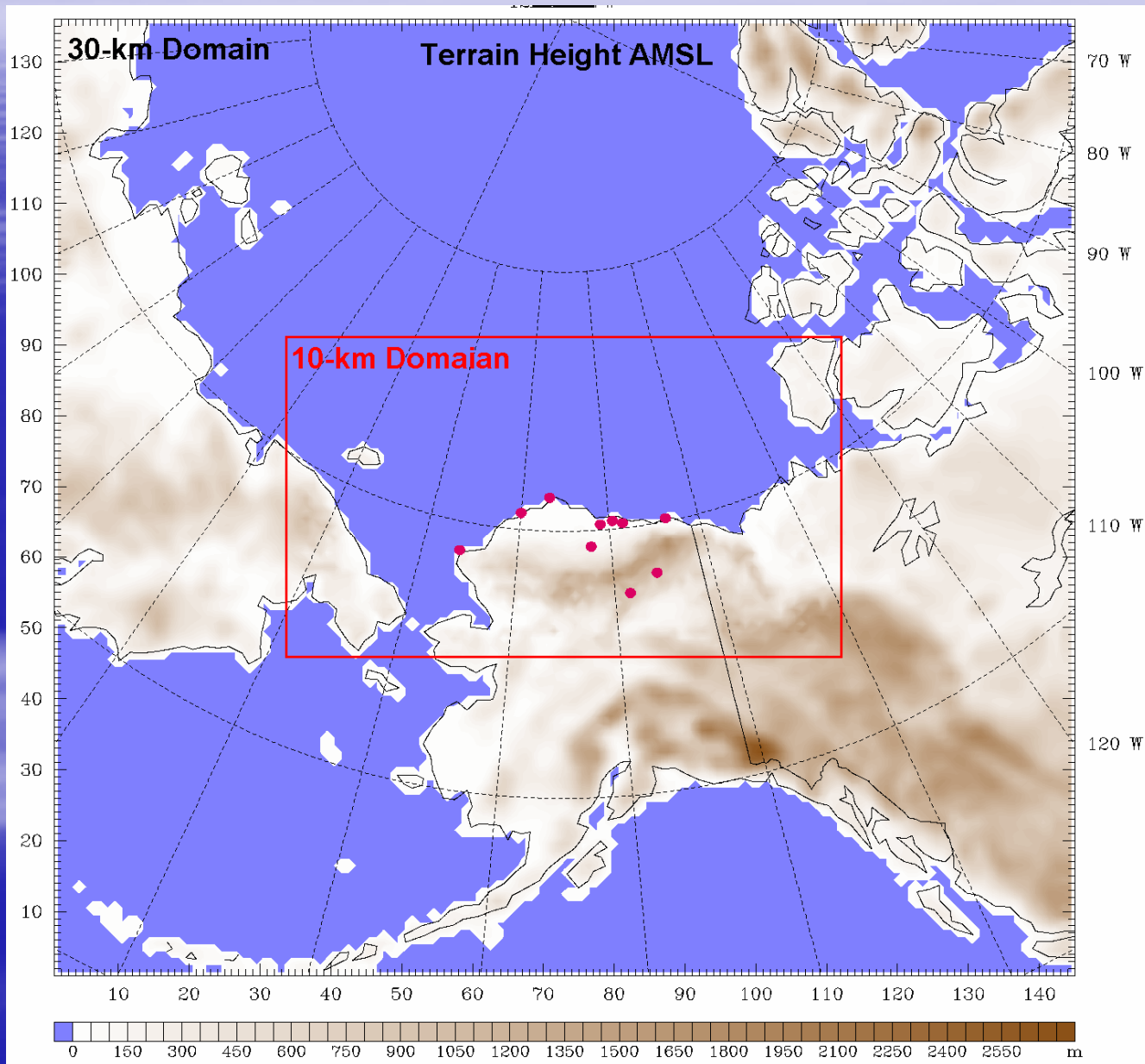
- Surface wind simulation
- Impacts of terrain and land-ocean-ice
- MM5, WRF?
- Their capability?



# Objectives

- Test the two models, MM5 and WRF, on their capability and performance in simulating wind events along the Beaufort Sea coastal region.
  - High resolution: 10-km
  - Different driving data sources: NARR (North America Regional Reanalysis), ERA-40 reanalysis
  - Nesting: (e.g., ERA-40 is 1.125 degree resolution)
  - FDDA (Four dimensional data assimilation): Nudging

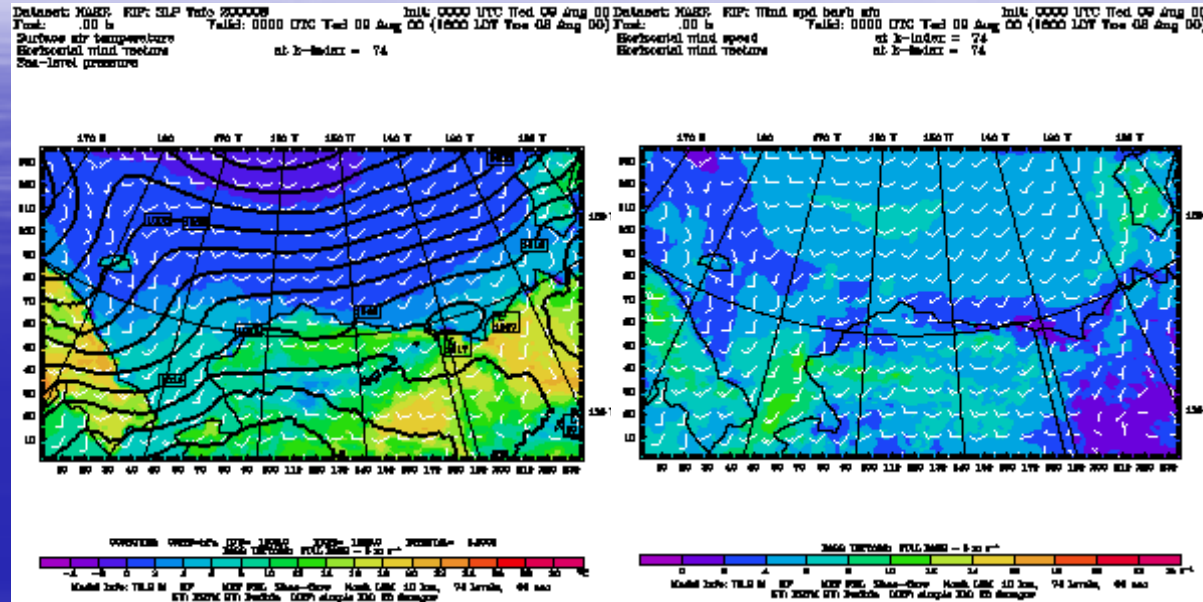
# Domain & Resolution



# Two Extreme Wind Events

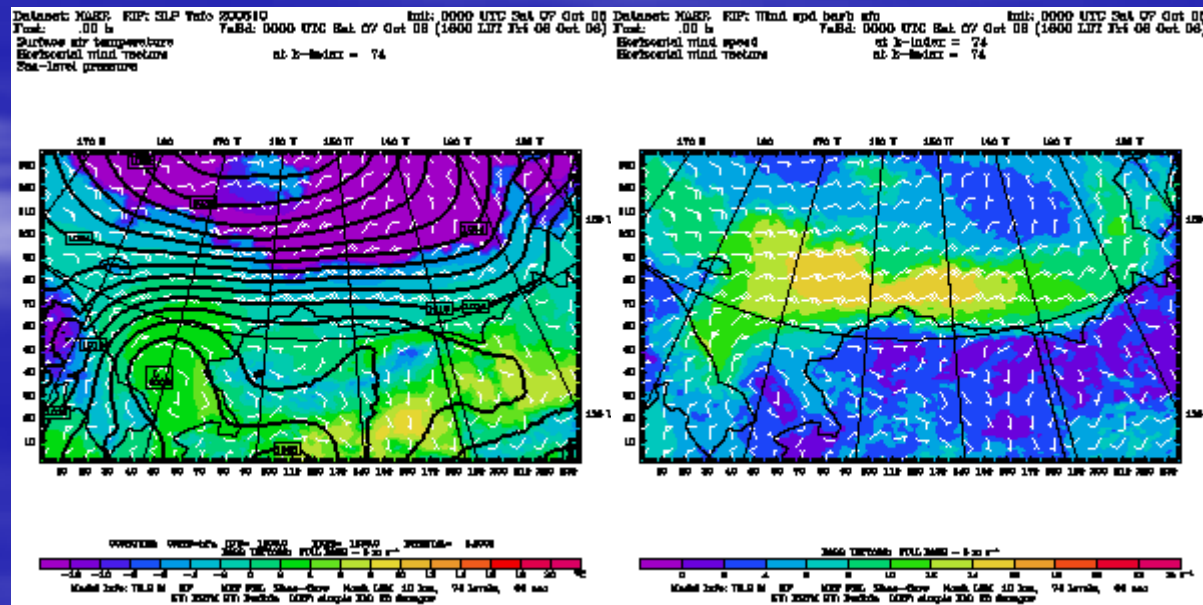
## August 09-13, 2000

- Max daily average wind speed: 25 m/s at Deadhorse
- Low pressure system



## October 07-11, 2006

- Max daily average wind speed: 20 m/s at Deadhorse
- High pressure system



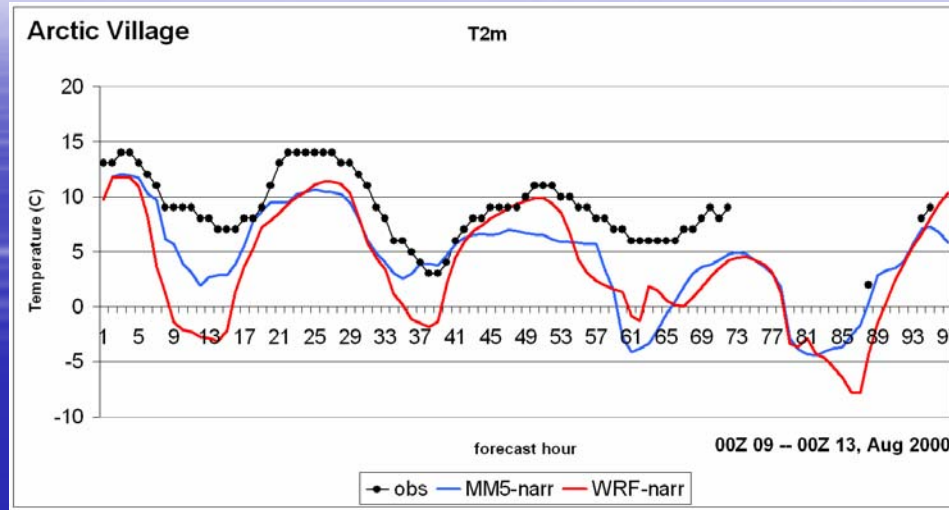
# Modeling Configuration

- MM5 v3.7
    - LW Radiation: RRTM
    - (SW Radiation: Dudhia)
    - Cumulus: Kain-Fritsch2
    - Microphysics: Reisner1
    - NOAH land surface model
    - PBL: MRF
  - WRF v2.2
    - LW Radiation: RRTM
    - SW Radiation: Dudhia
    - Cumulus: Kain-Fritsch (new)
    - Microphysics: NCEP 5-class
    - NOAH land surface model
    - PBL: MRF
- 
- Experiments
    - NARR driven, 10-km
    - NARR driven, 10-km, nudging
    - ERA40 driven, nested 10-km
    - ERA40 driven, nested 10-km, nudging

(NCEP/NCAR reanalysis is not as good as ERA-40, at least for Arctic, proved from our one-year Arctic reanalysis experiments)

# Results & Problems

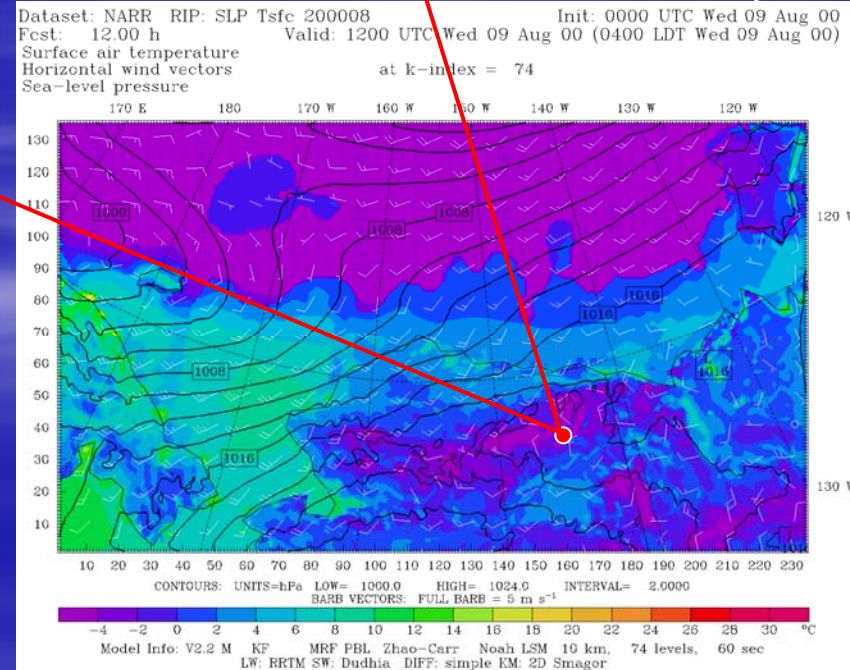
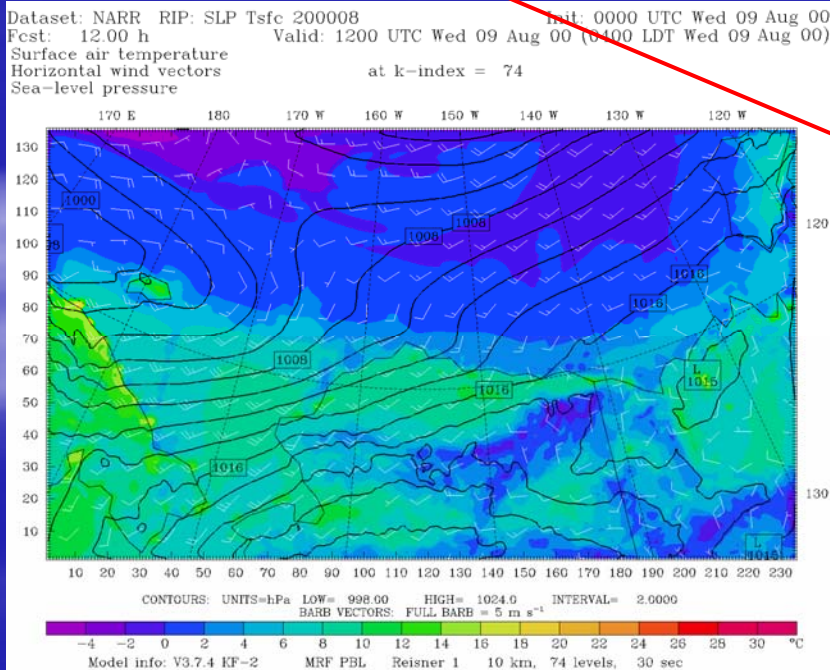
August  
2000



Cold surface at night time.

MM5 (ref)

WRF



# Problems

- Problems with the new release WRF v2.2 pre-processing system (WPS)
- Three major problems found:
  - (Jeremy Krieger has reported to NCAR 2 days ago)
  - Bugs in sea ice processing
  - Bugs in soil T and M processing – missing value
  - Humidity initialization (when using NARR data)



# Sea-Ice Problem

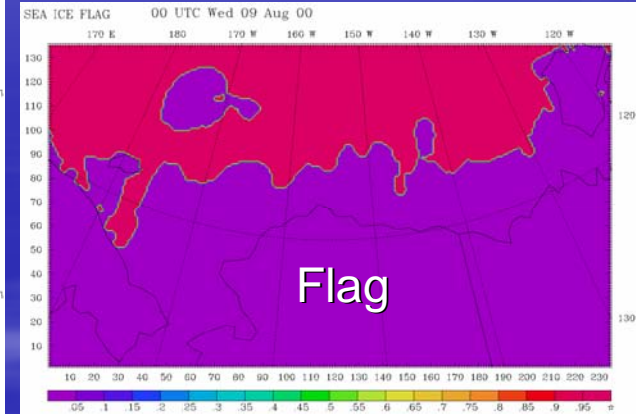
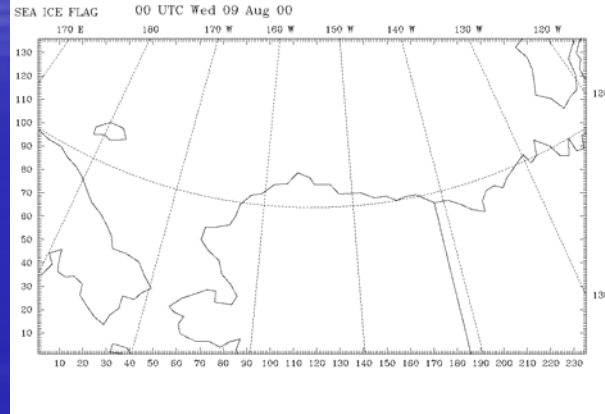
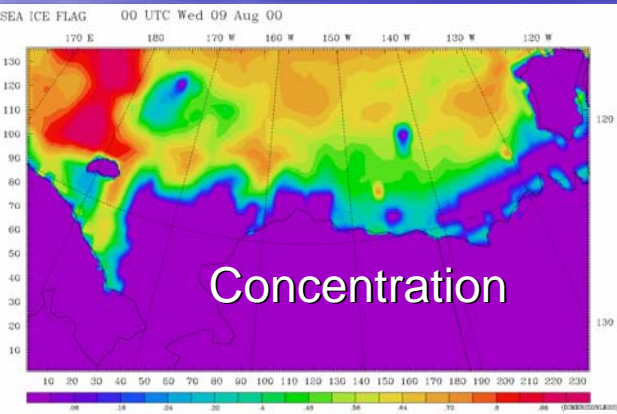
MM5

WRF

August 2000

?

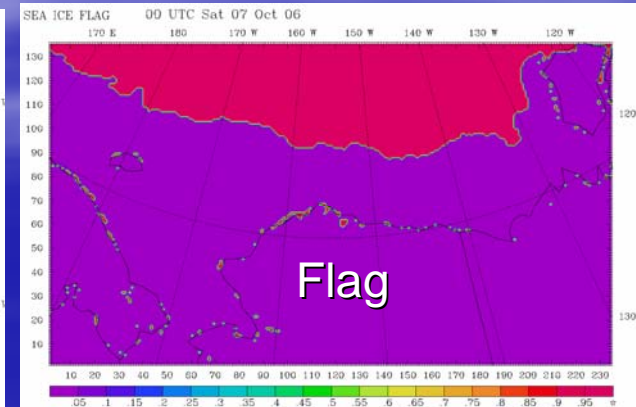
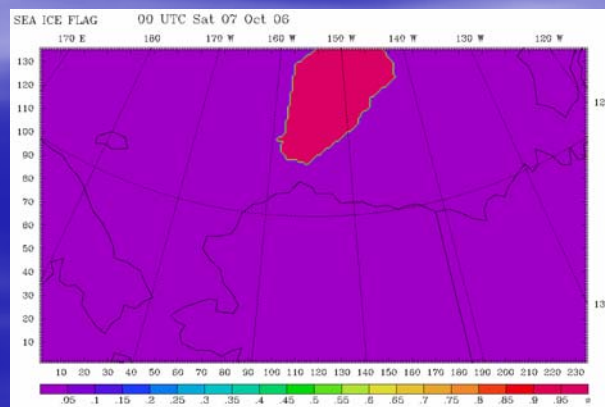
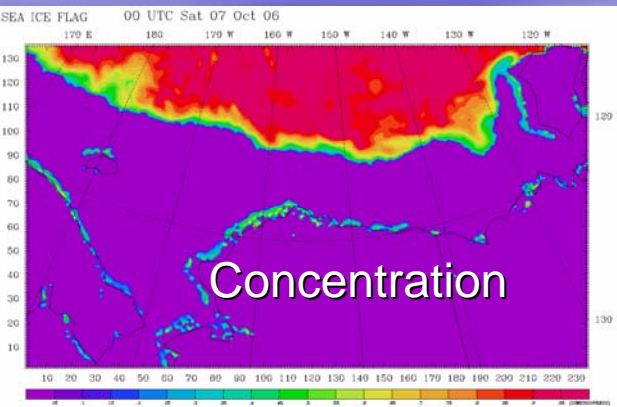
Fixed



October 2006

?

Fixed



# Humidity Initialization Problems with NARR

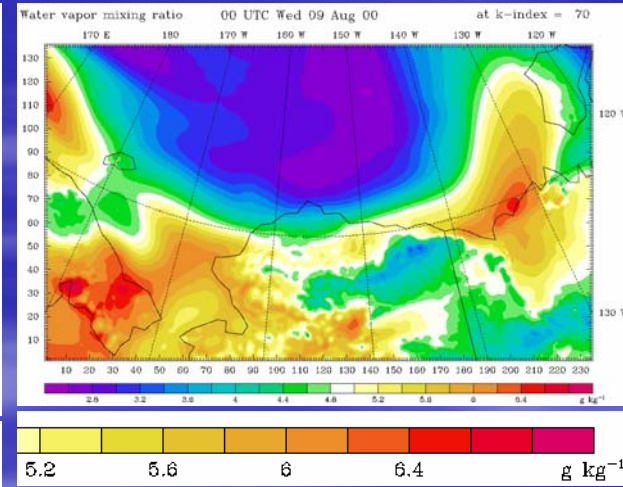
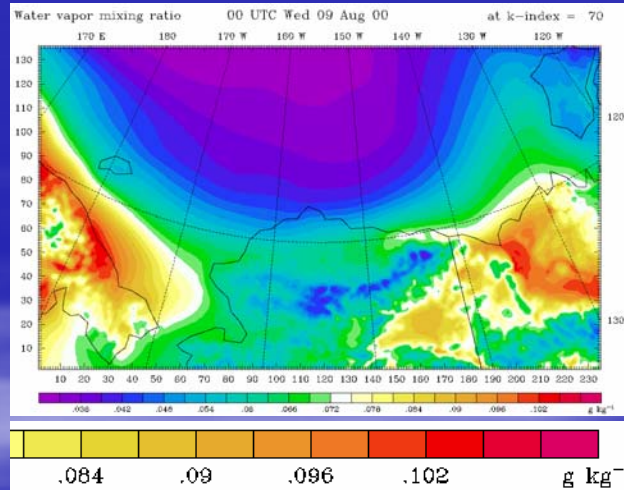
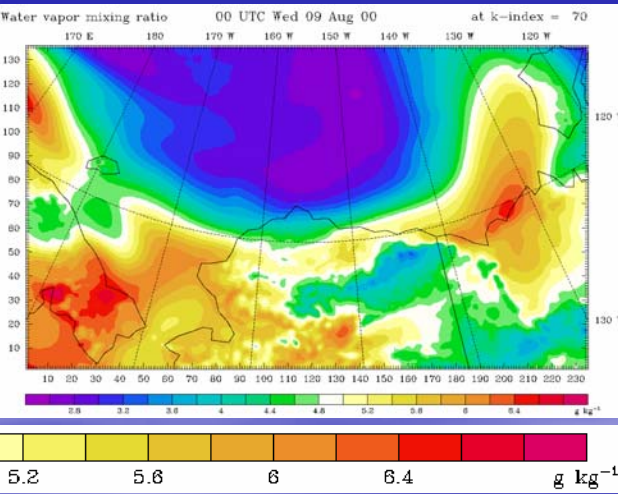
MM5

WRF

August 2000

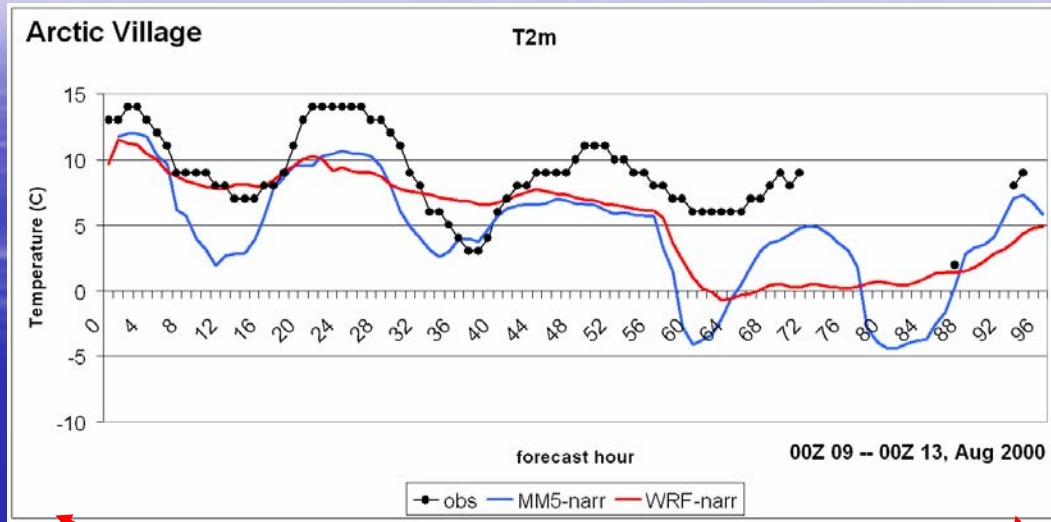
?

Fixed



# New WRF output

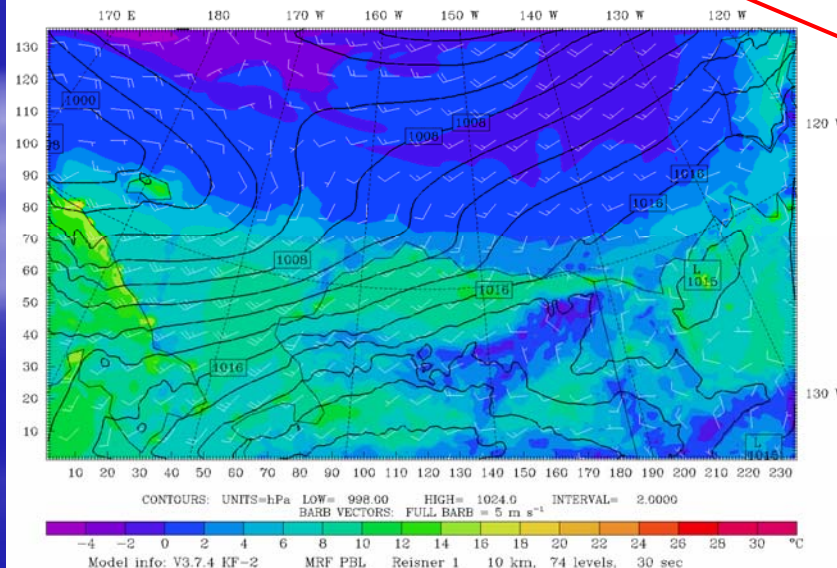
August  
2000



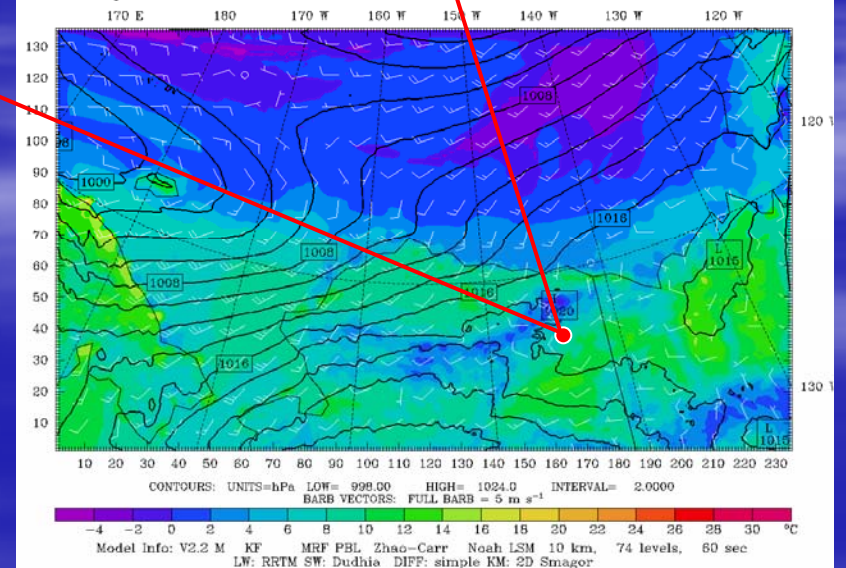
MM5 (ref)

WRF

Dataset: NARR RIP: SLP Tsfc 200008 Init: 0000 UTC Wed 09 Aug 00  
 Fcst: 12.00 h Valid: 1200 UTC Wed 09 Aug 00 (0400 LDT Wed 09 Aug 00)  
 Surface air temperature  
 Horizontal wind vectors  
 Sea-level pressure  
 at k-index = 74



Dataset: NARR RIP: SLP Tsfc 200008 Init: 0000 UTC Wed 09 Aug 00  
 Fcst: 12.00 h Valid: 1200 UTC Wed 09 Aug 00 (0400 LDT Wed 09 Aug 00)  
 Surface air temperature  
 Horizontal wind vectors  
 Sea-level pressure  
 at k-index = 74



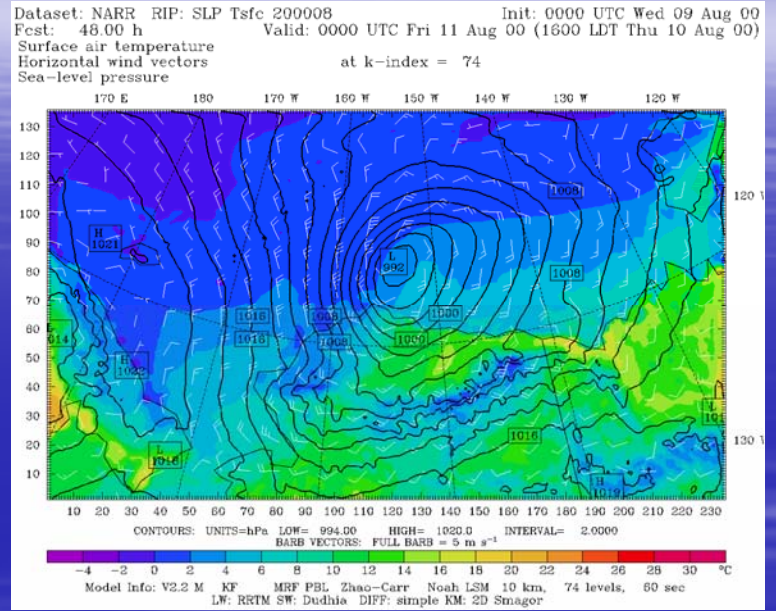
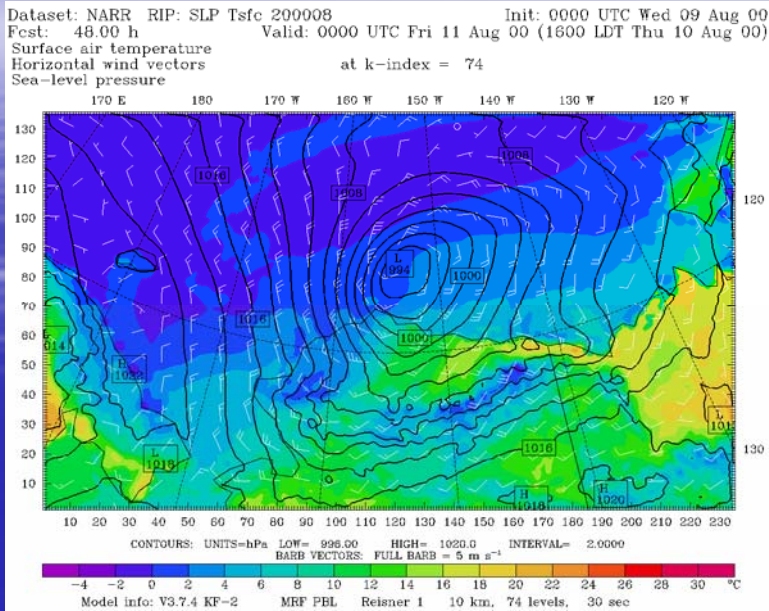
48-hr  
SLP, T 2-m  
Fcst:

# MM5

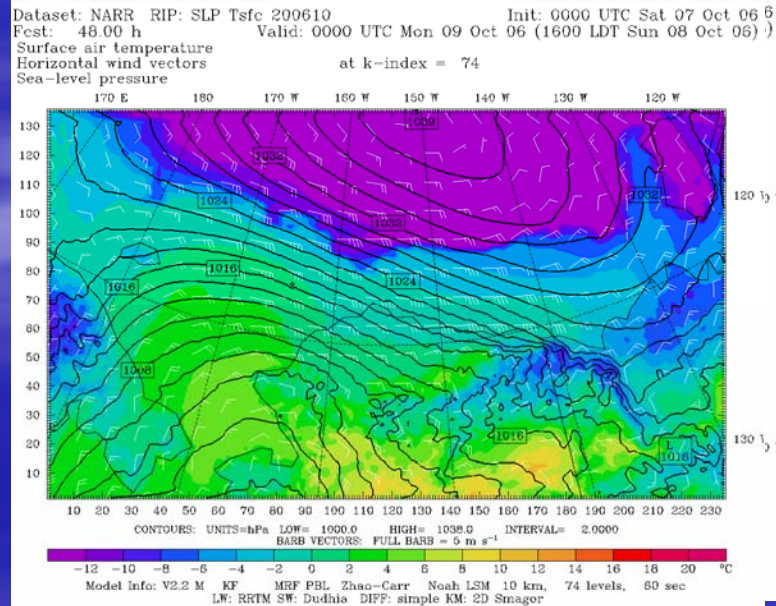
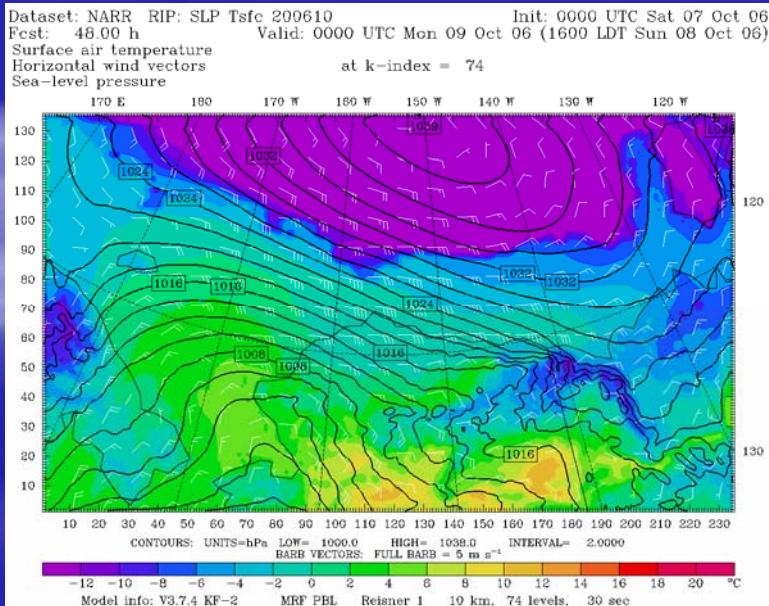
# vs.

# WRF

August 2000



October 2006



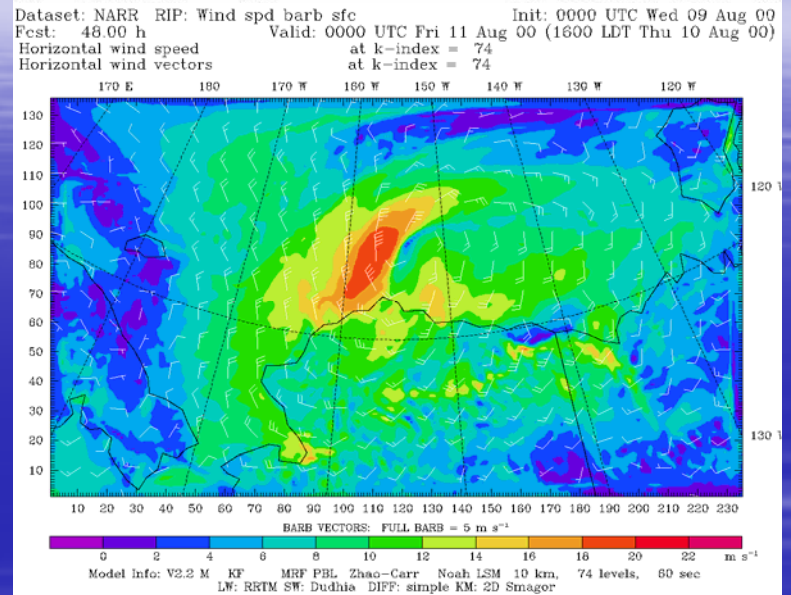
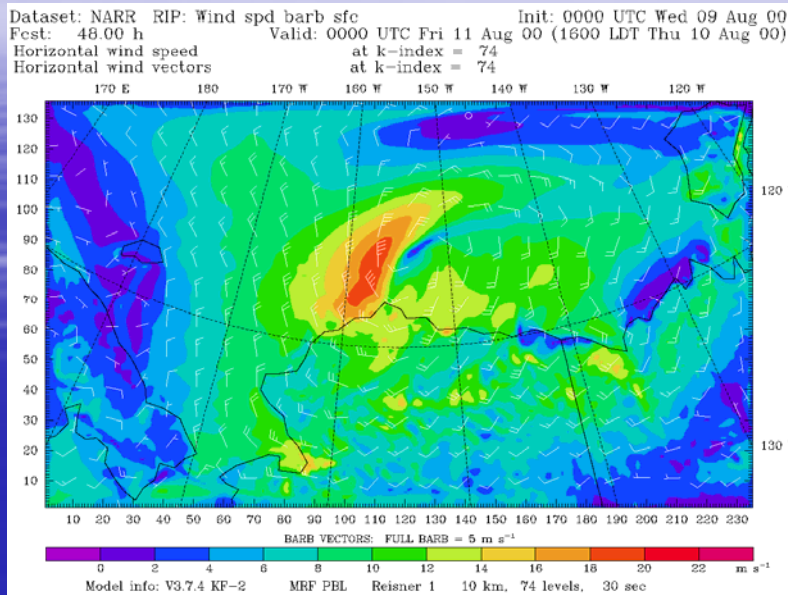
48-hr  
Sfc Wind  
Fcst:

# MM5

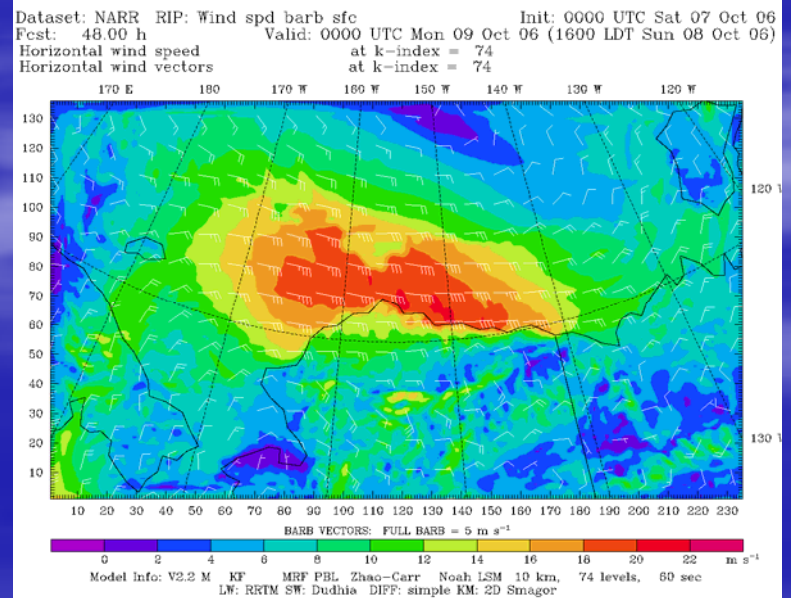
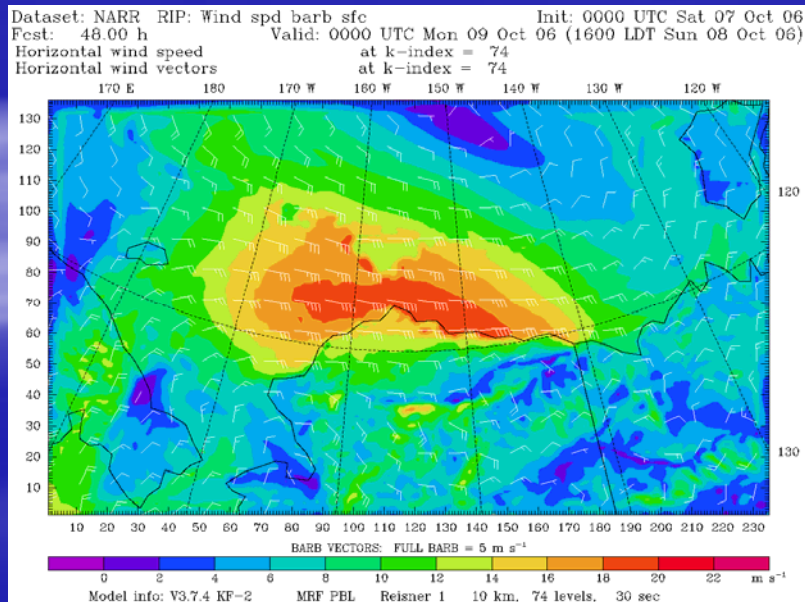
# vs.

# WRF

August 2000



October 2006

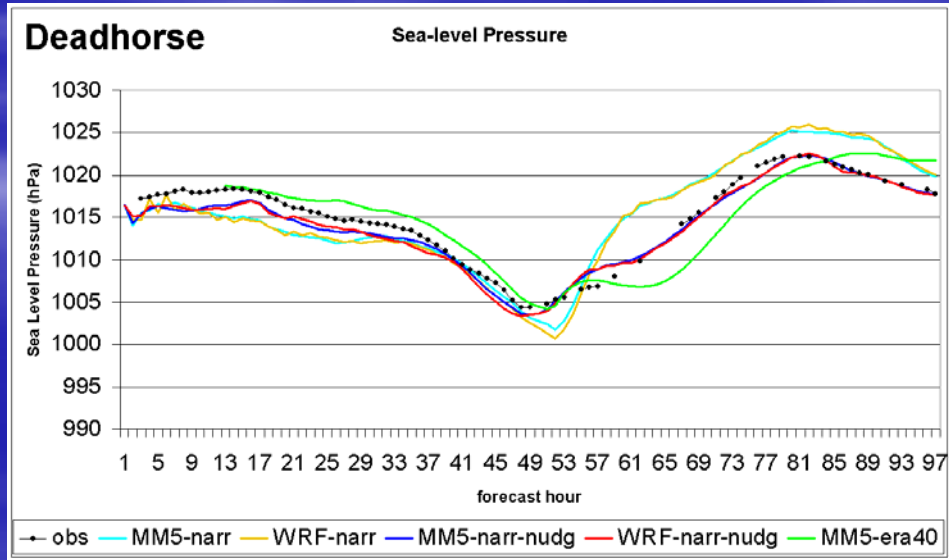
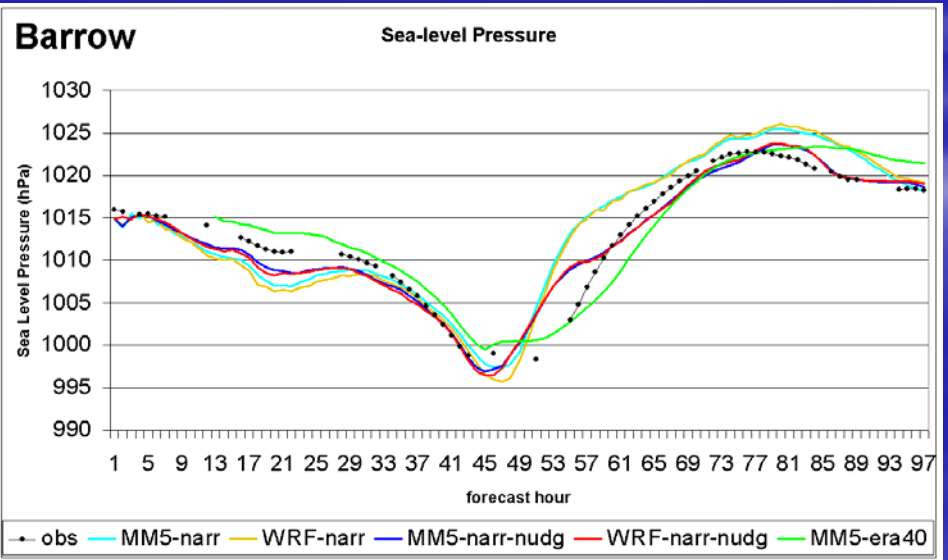
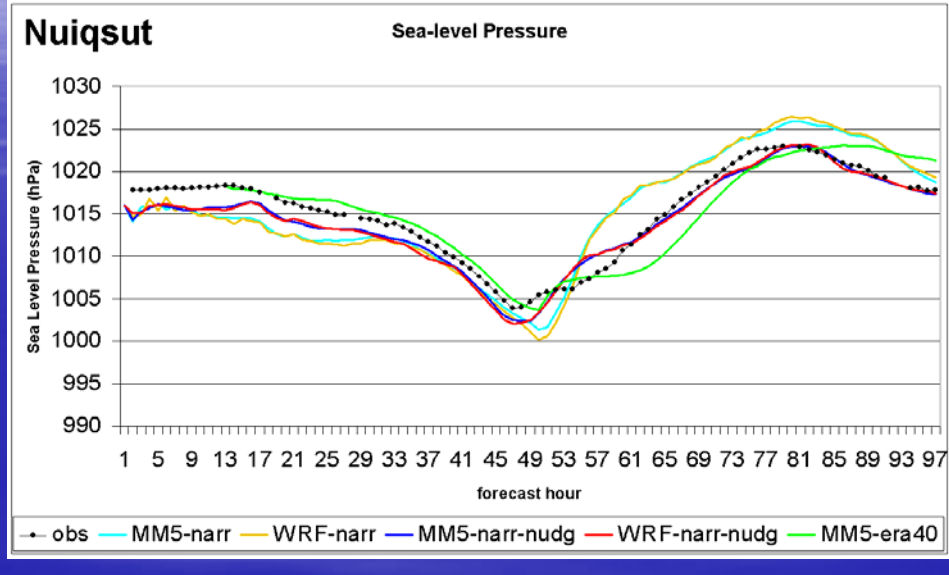
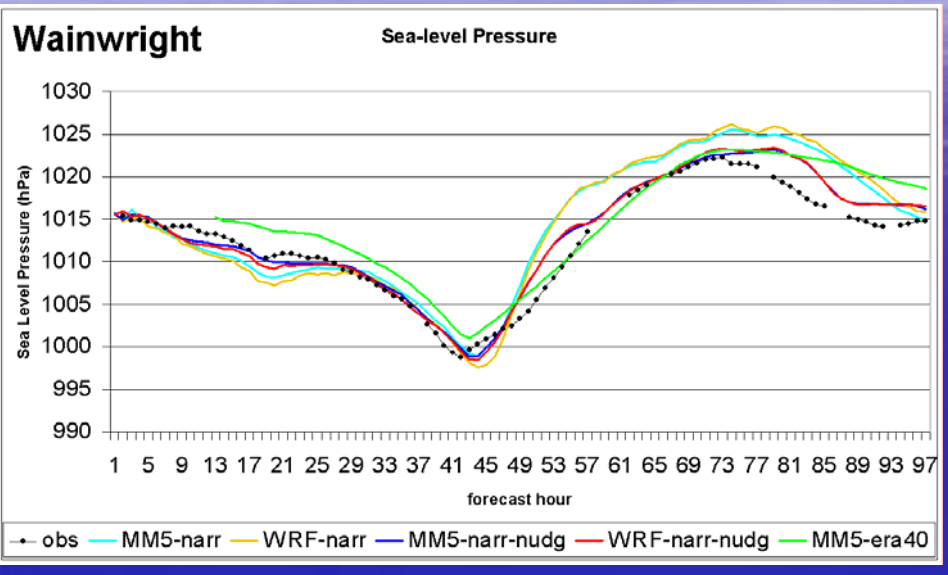


# Station Verification



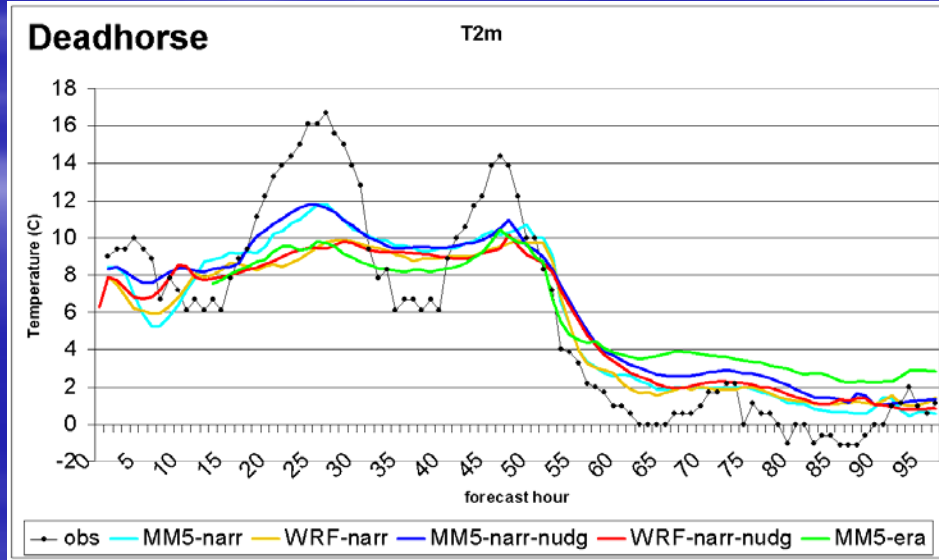
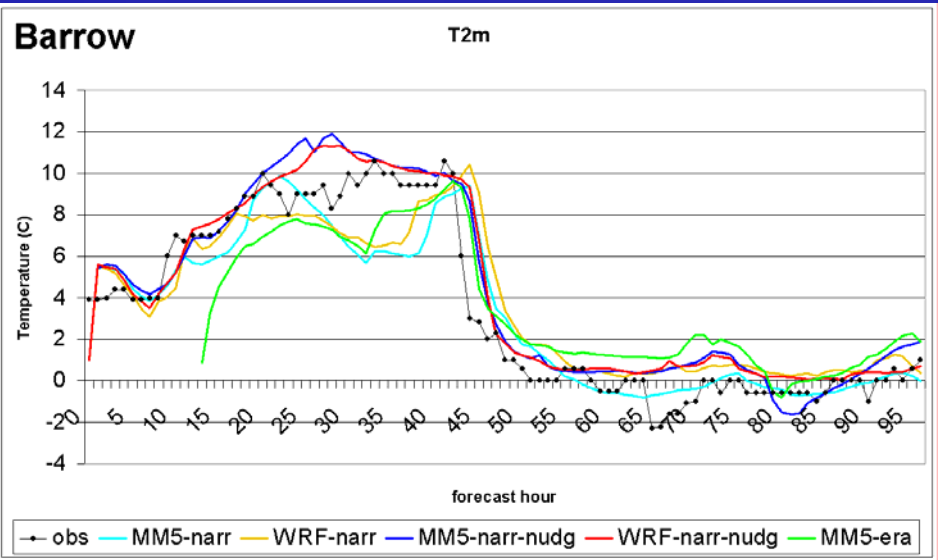
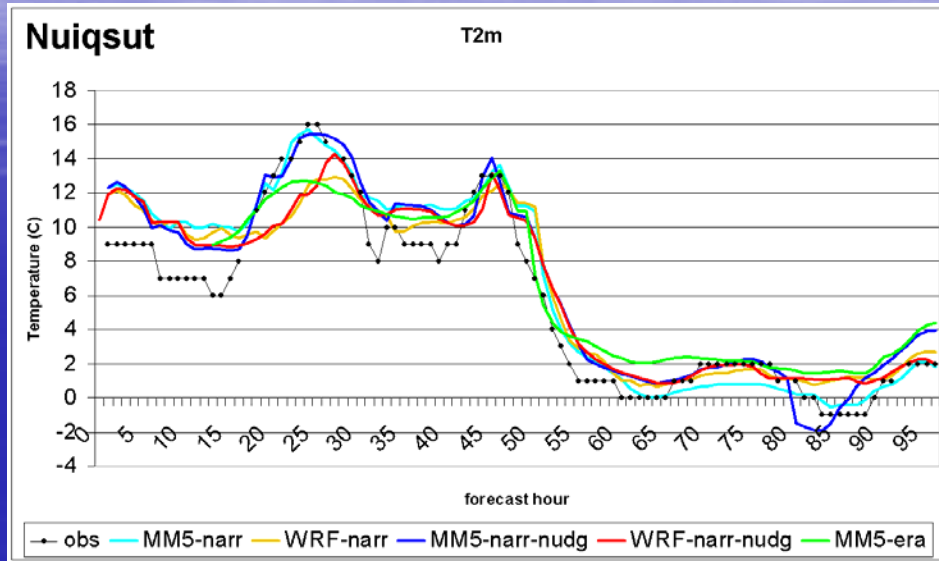
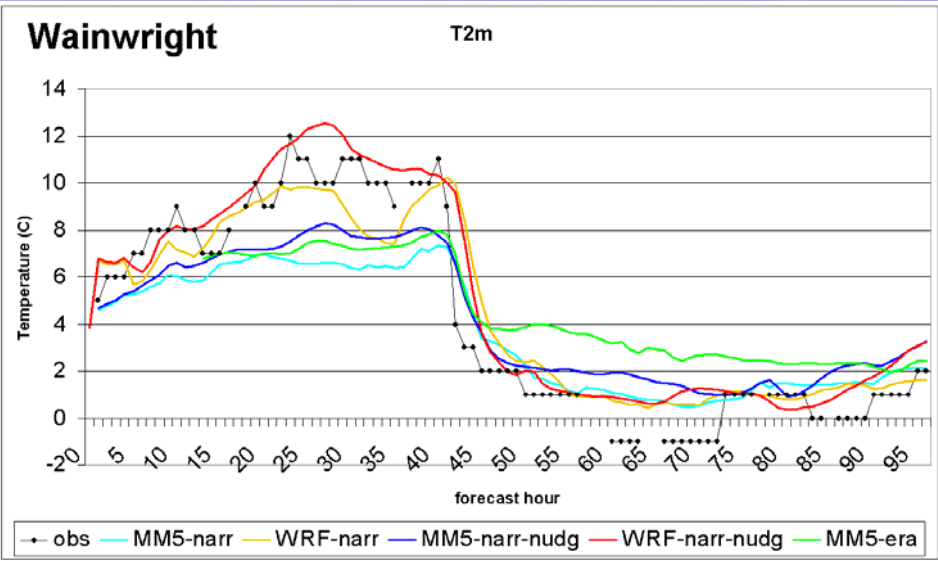
August 2000

# Sea Level Pressure



August 2000

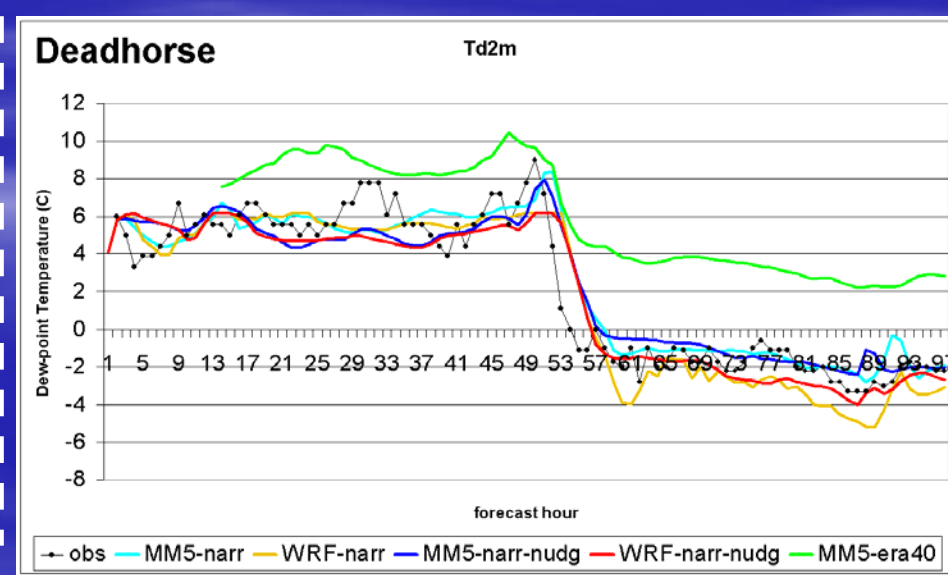
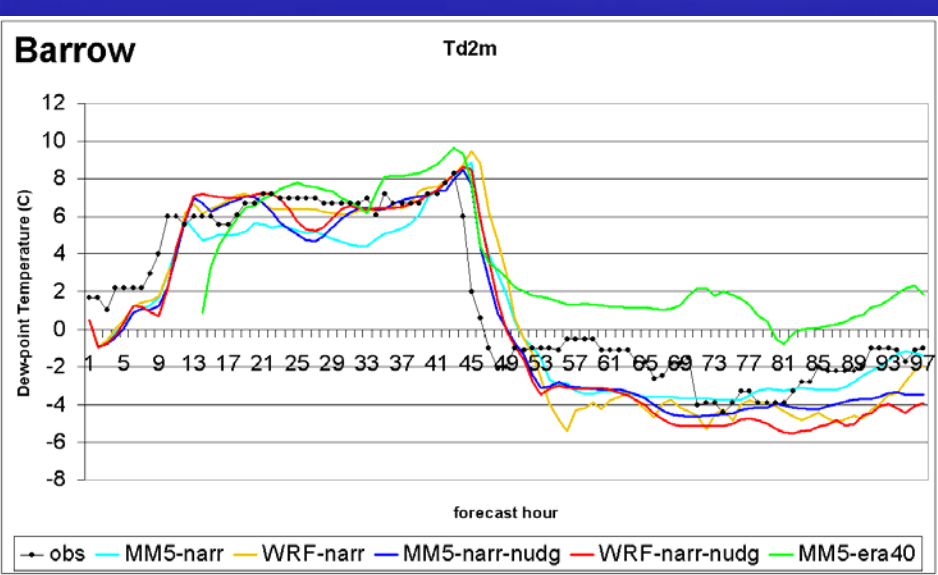
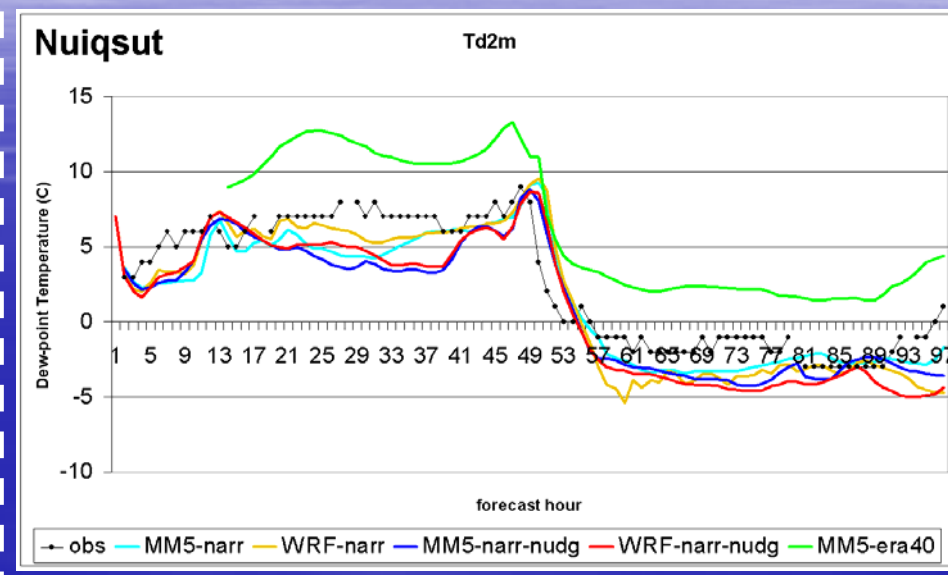
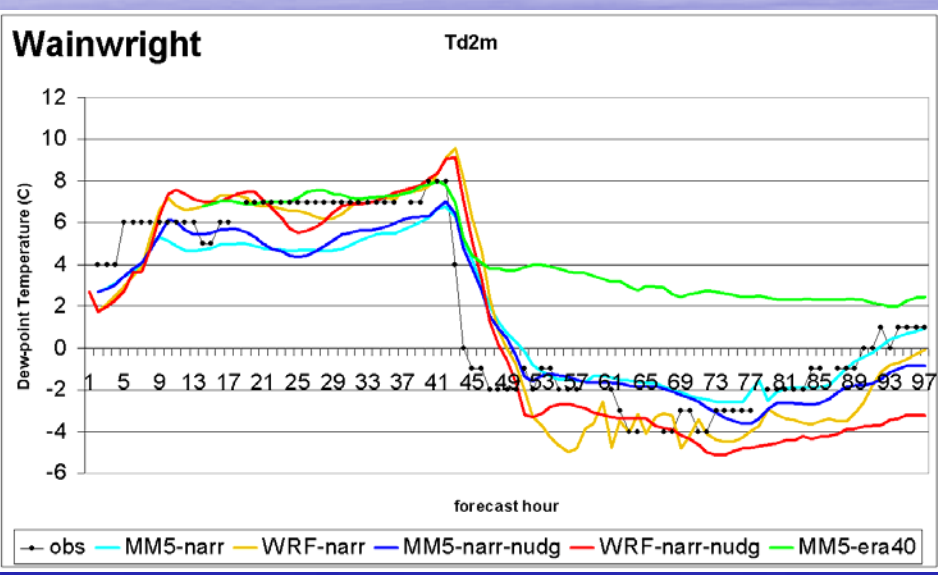
# 2-m Temperature





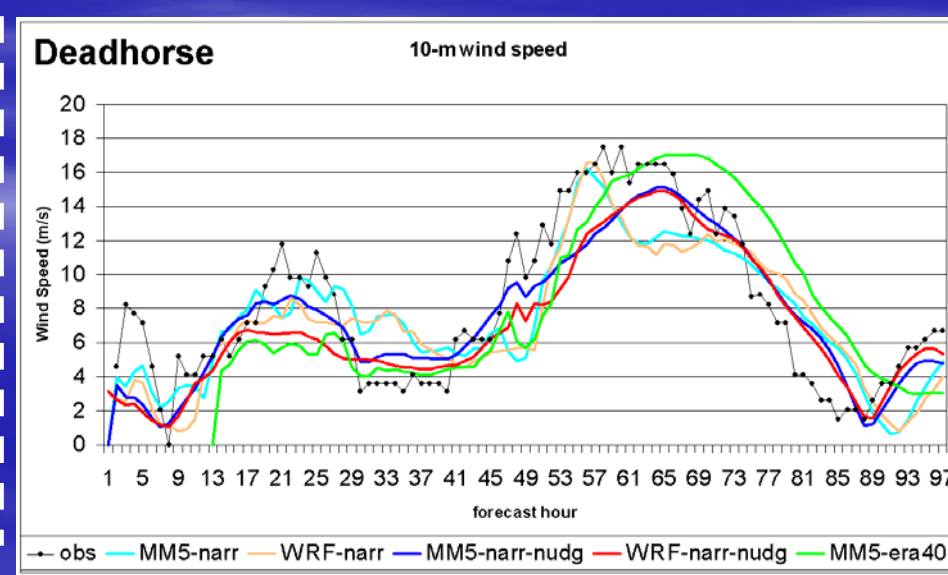
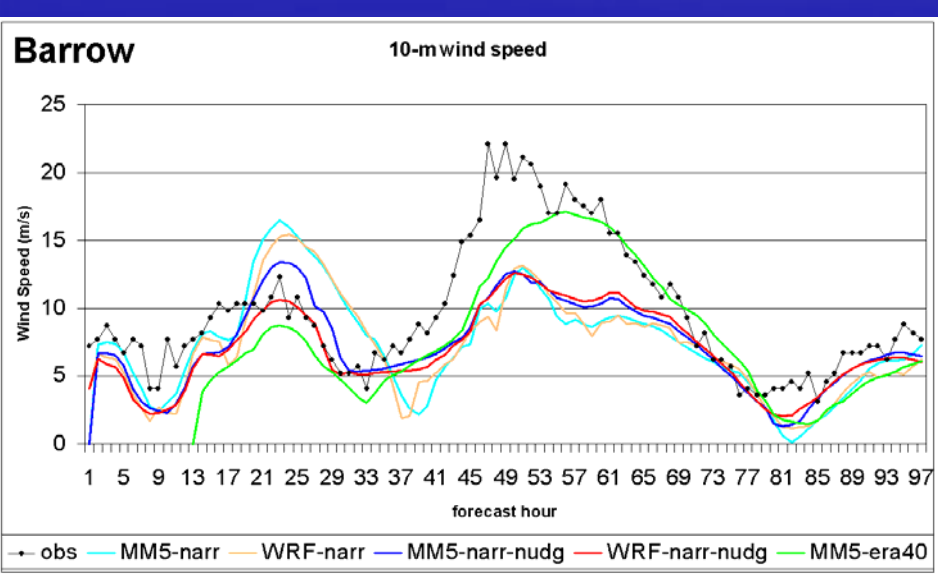
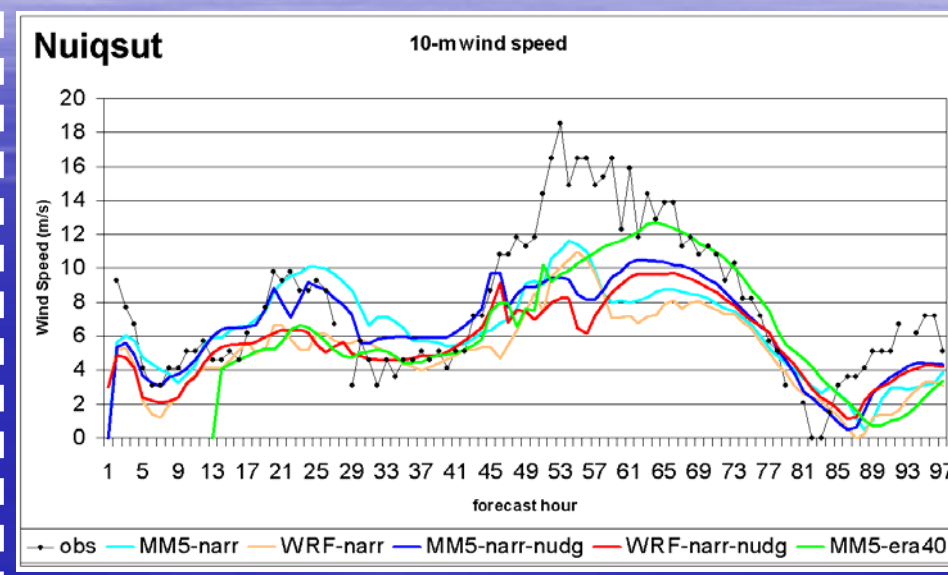
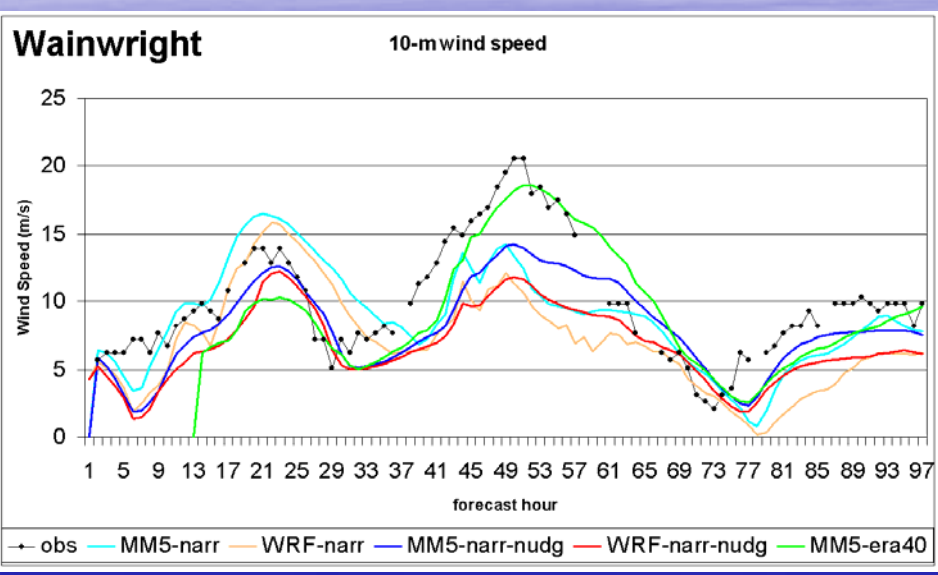
August 2000

# 2-m Dew Point



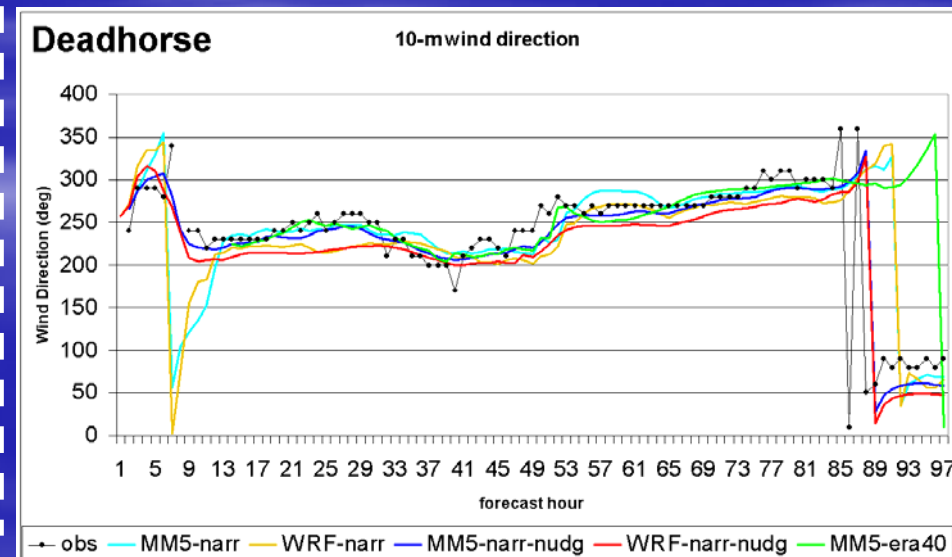
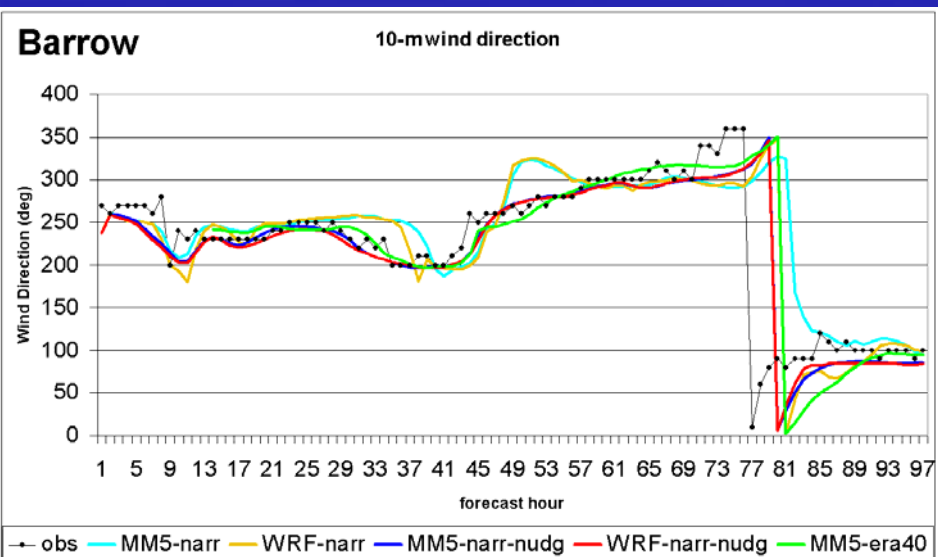
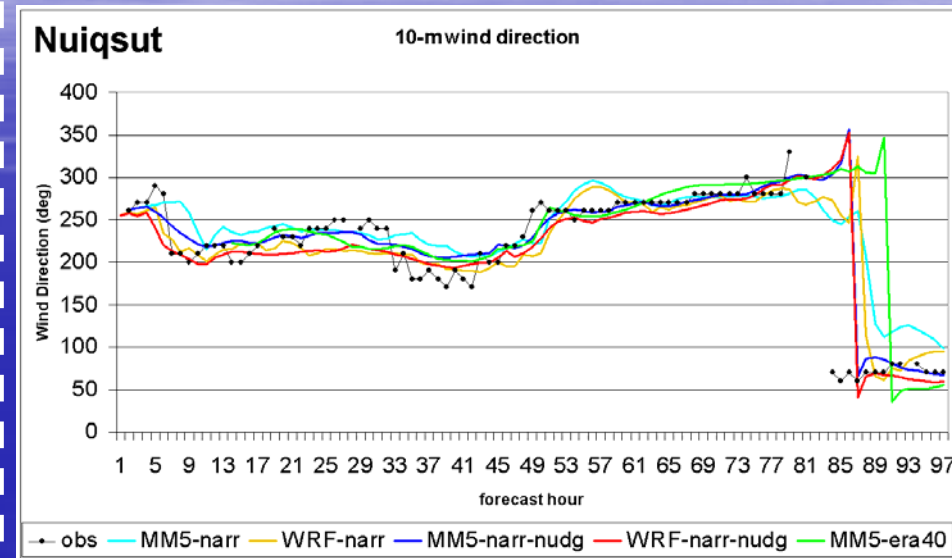
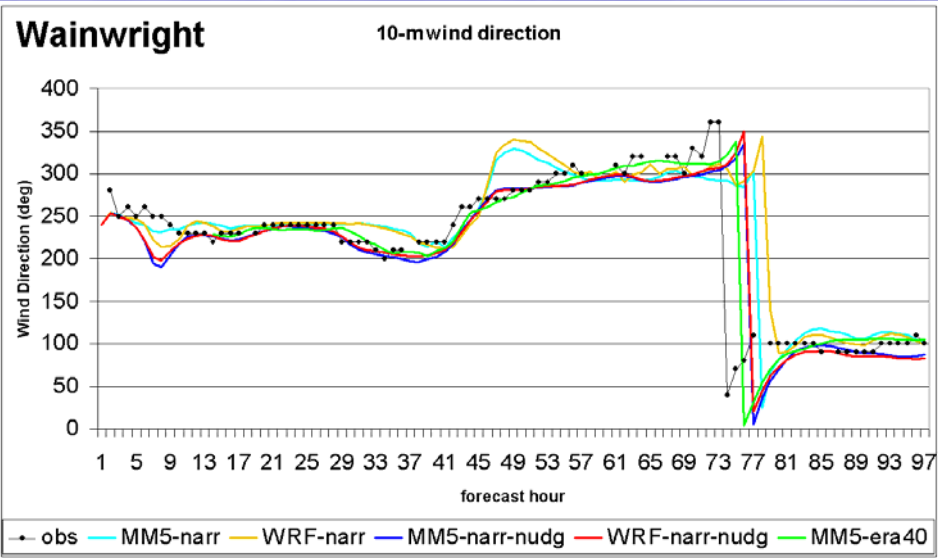
August 2000

# 10-m Wind Speed



August 2000

# 10-m Wind Direction



August 2000

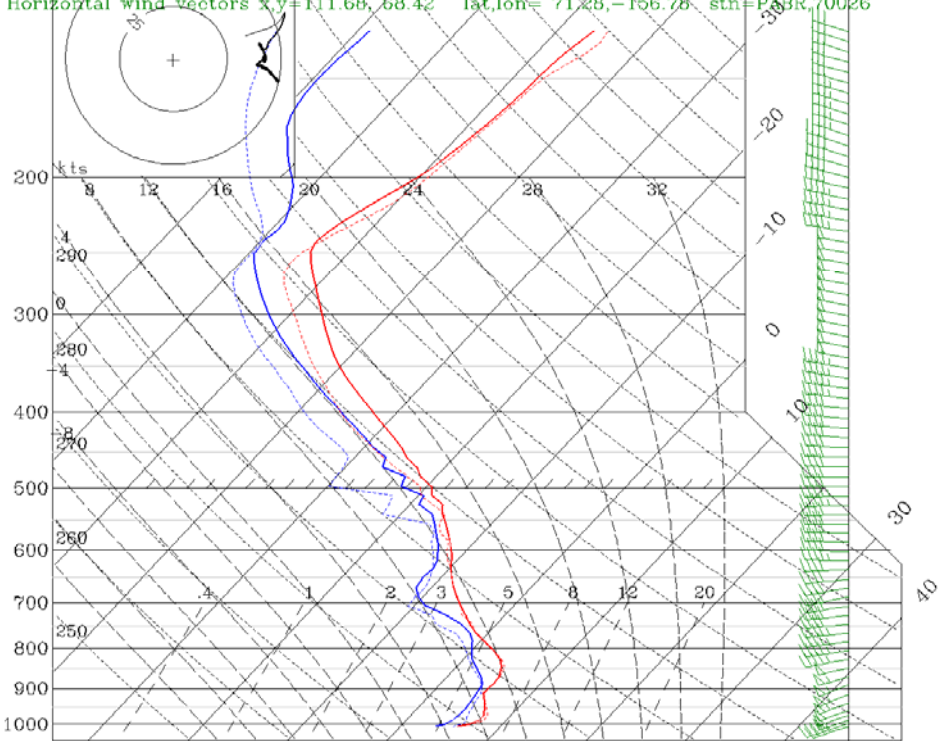
# Temperature Profile – Barrow

24 hr 00Z 08/10/2000

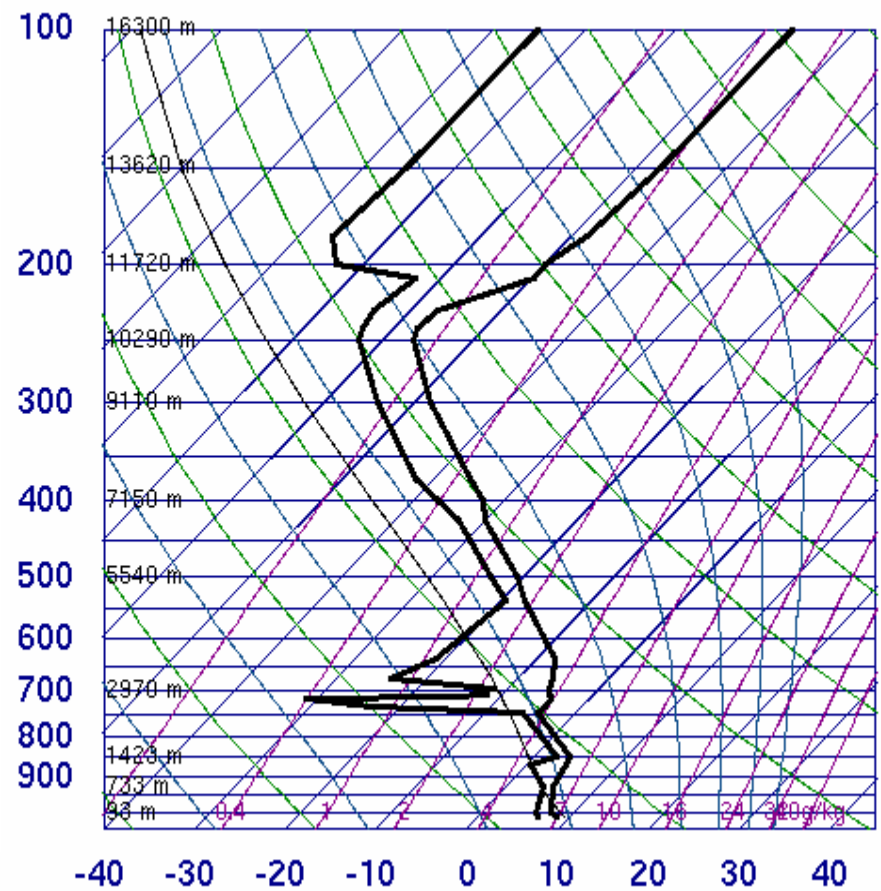
Rawinsonde

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Fcst: 24.00 h Valid: 0000 UTC Thu 10 Aug 00 (1600 LDT Wed 09 Aug 00)

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 Dewpoint temperature x,y=111.68, 68.42 lat,lon= 71.28,-156.78 stn=PABR,70026  
 Temperature x,y=111.68, 68.42 lat,lon= 71.28,-156.78 stn=PABR,70026  
 (diff. from case=NARR, time= 24.00)  
 Temperature x,y=111.68, 68.42 lat,lon= 71.28,-156.78 stn=PABR,70026  
 Dewpoint temperature x,y=111.68, 68.42 lat,lon= 71.28,-156.78 stn=PABR,70026  
 (diff. from case=NARR, time= 24.00)  
 Dewpoint temperature x,y=111.68, 68.42 lat,lon= 71.28,-156.78 stn=PABR,70026  
 (diff. from case=NARR, time= 24.00)  
 Dewpoint temperature x,y=111.68, 68.42 lat,lon= 71.28,-156.78 stn=PABR,70026  
 Horizontal wind vectors x,y=111.68, 68.42 lat,lon= 71.28,-156.78 stn=PABR,70026



70026 PABR Barrow



MM5 T ——— WRF T .....  
 Td ——— Td .....

00Z 10 Aug 2000

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August 2000

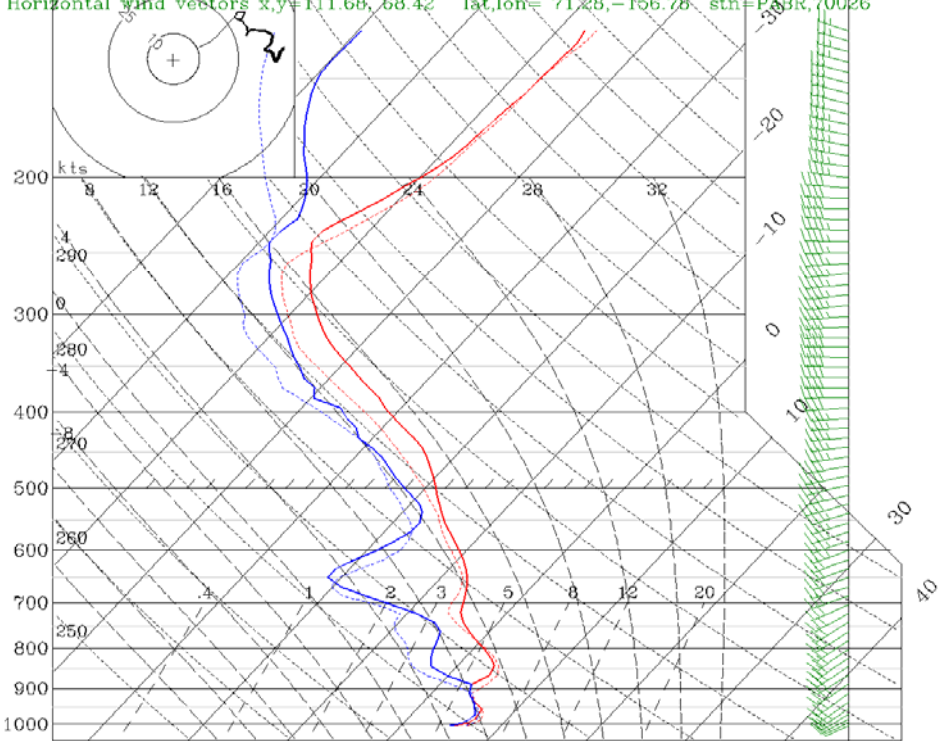
# Temperature Profile – Barrow

36 hr 12Z 08/10/2000

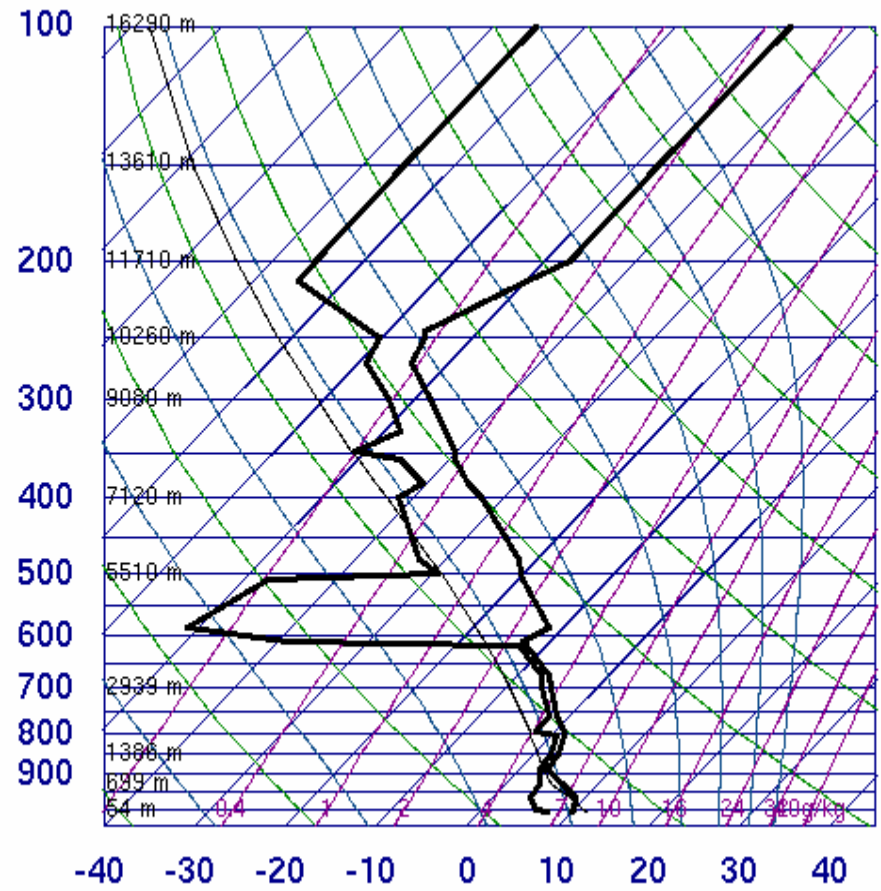
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 Dewpoint temperature (diff. from case=NARR, time= 36.00) x,y=111.68, 68.42 lat,lon= 71.28,-156.78 stn=PABR,70026  
 Horizontal wind vectors x,y=111.68, 68.42 lat,lon= 71.28,-156.78 stn=PABR,70026



70026 PABR Barrow



MM5 T ——— WRF T .....  
 Td ——— Td .....

12Z 10 Aug 2000

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August 2000

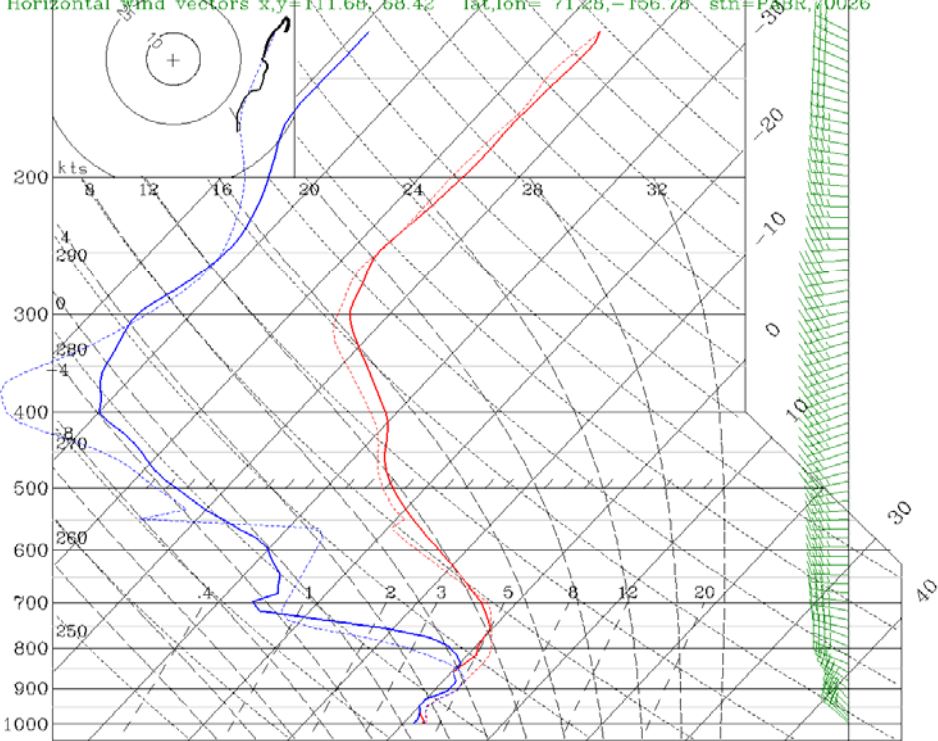
# Temperature Profile – Barrow

48 hr 00Z 08/11/2000

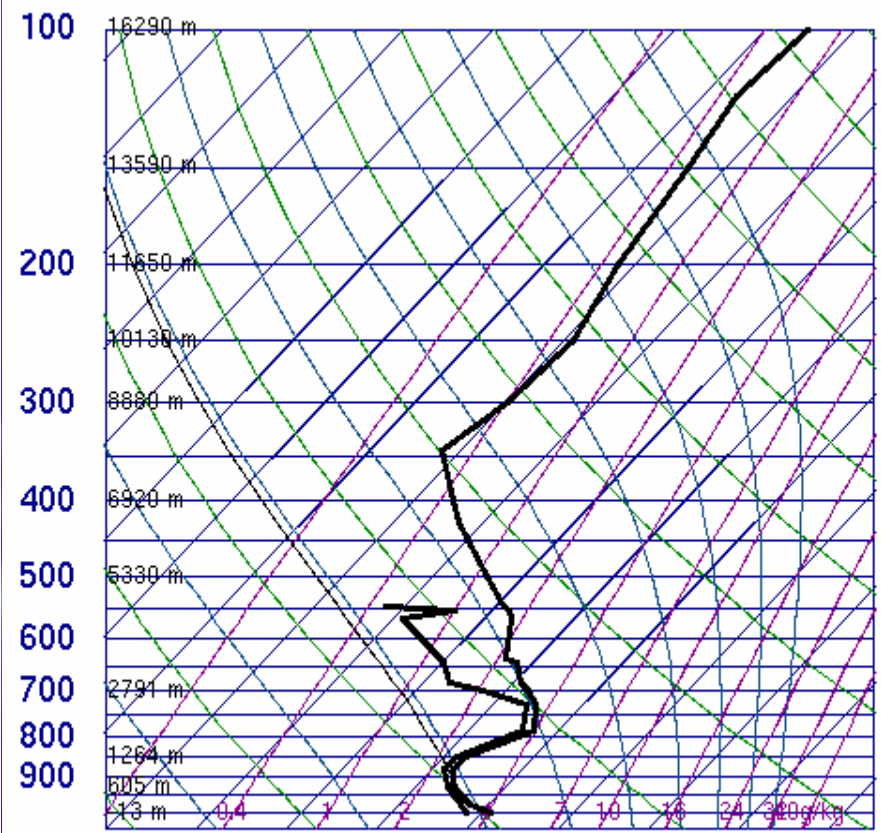
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 Horizontal wind vectors x,y=111.68, 68.42 lat,lon= 71.28,-156.78 stn=PABR,70026



70026 PABR Barrow



MM5 T ——— WRF T .....  
 Td ——— Td .....

00Z 11 Aug 2000

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August 2000

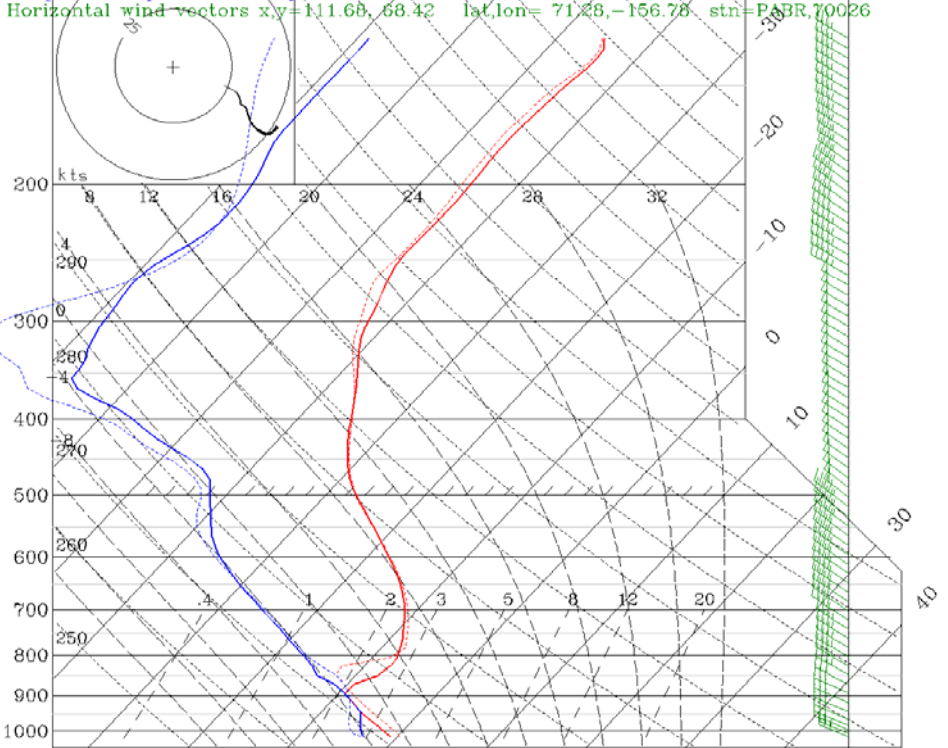
# Temperature Profile – Barrow

60 hr 12Z 08/11/2000

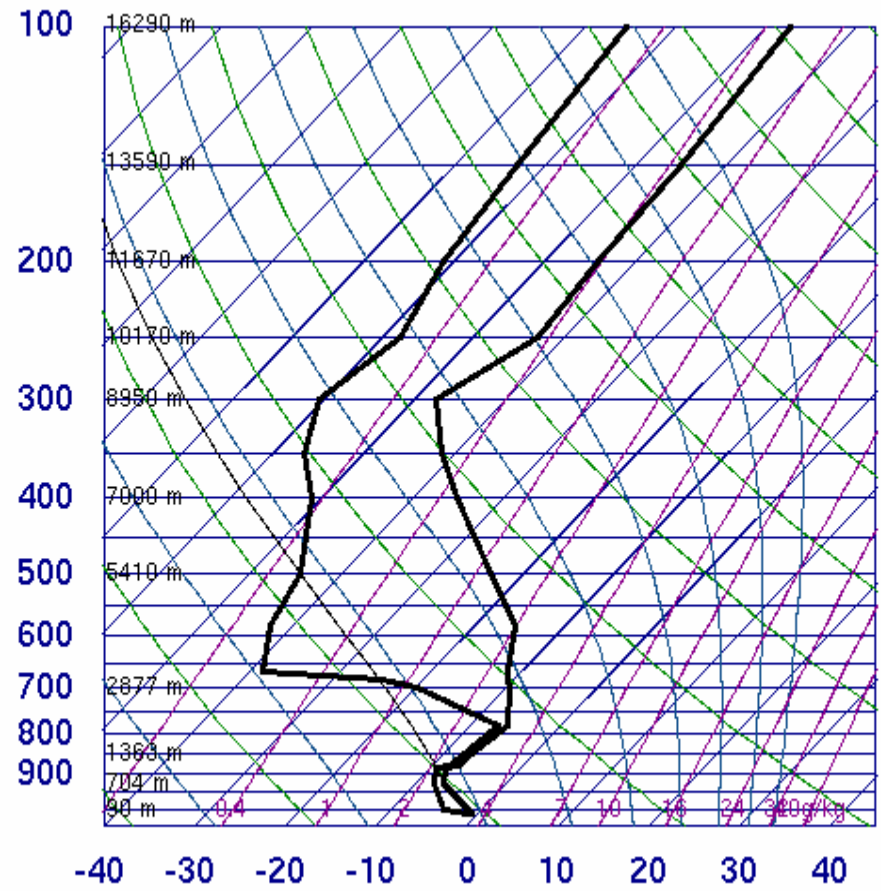
Rawinsonde

Dataset: NARR RIP: mw diff 1 Init: 0000 UTC Wed 09 Aug 00  
 Fcst: 60.00 h Valid: 1200 UTC Fri 11 Aug 00 (0400 LDT Fri 11 Aug 00)

Temperature x,y=111.68, 68.42 lat,lon= 71.28,-156.78 stn=PABR,70026  
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 Horizontal wind vectors x,y=111.68, 68.42 lat,lon= 71.28,-156.78 stn=PABR,70026



70026 PABR Barrow



MM5 T ——— WRF T .....  
 Td ——— Td .....

12Z 11 Aug 2000

University of Wyoming

# Summary

- WRF new release problem fixes, works well with NARR and ERA-40 reanalyses;
- Humidity initialization affects the simulation badly, esp. obvious on surface temperature;
- High-resolution modeling produces more short-range variations, while
- Nudging (to a coarse-resolution field) is helpful for simulating SLP and synoptic variations of other variables;
- Extreme wind speed is not well captured by mesoscale models, but is seen in ERA40 driven run for the synoptic scale pattern;
- WRF simulation results are encouraging for surface and upper-air variables, compared to MM5.



**This study is funded by the Minerals  
Management Service, U.S.  
Department of Interior, under  
contract number 0106CT39787**