Update on the Regional Modeling System

David Ovens, Cliff Mass, Phil Regulski, Jeff Baars, Richard Steed, Mark Albright, David Carey

Northwest Weather Workshop
March 1, 2008

Supported by the Northwest Modeling Consortium…the regional modeling effort centered at the UW has been

- Running the MM5 at 36, 12, and 4 km resolution twice day
- Running the new WRF model at 36, 12 km resolution twice a day and 4-km once a day.
- Running TWO high resolution regional ensemble systems to provide probabilistic forecasts and data assimilation
- Gathering all local weather observations from dozens of networks. Plus quality control.
- Running a wide range of weather applications dealing with air quality, hydrology, transportation weather and fire weather.

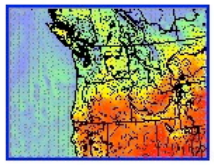
Pacific Northwest Environmental Forecasts and Observations

Supported by the Northwest Modeling Consortium

High Resolution Model Forecasts
More Information
Forecast Graphics Description

MM5-GFS
36km 12km 4km
Past Runs
Status
complete through forecast hour 32 for the 36 and 12 km domains 4km not begun

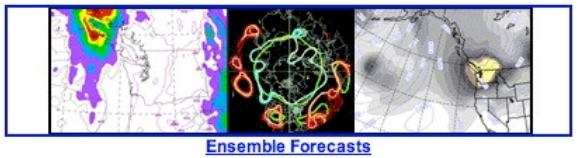
MM5-NAM
36km 12km
Past Runs
Status
complete



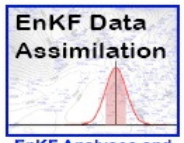
WRF-GFS
36km 12km 4km
Past Runs
Status
not yet begun

Extended MM5-GFS
36km 12km
Past Runs
Status
complete through forecast hour 32

UW Ensemble Forecast System
More Information

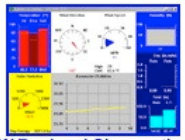


Ensemble Forecasts



EnKF Analyses and Forecasts

NW Regional Observations and Real Time Verification
More Information



NW Regional Observations

Observation Quality Control

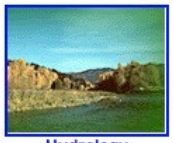
Verification

Regional Applications
More Information

Transportation

Air Quality

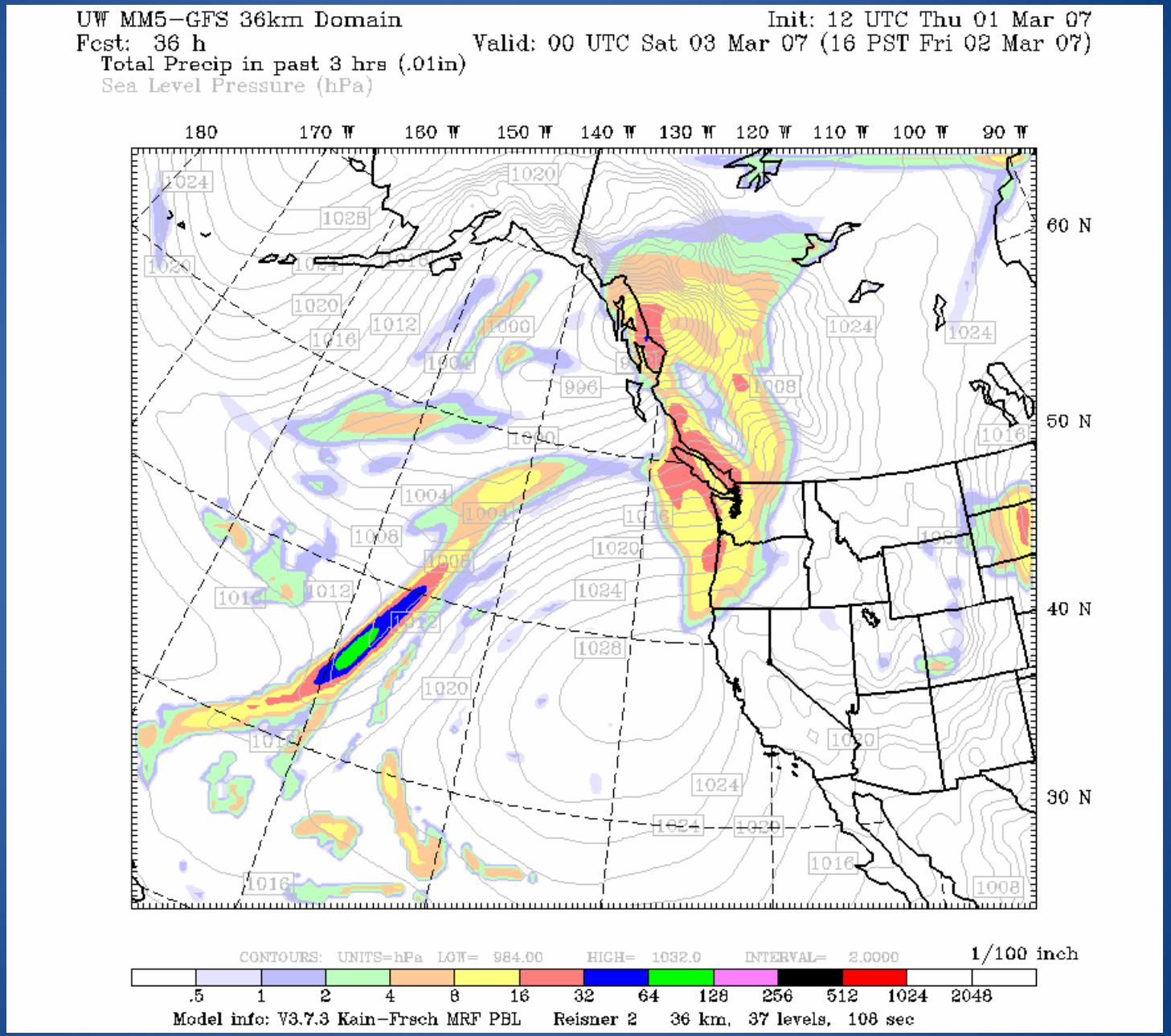
Fire Weather



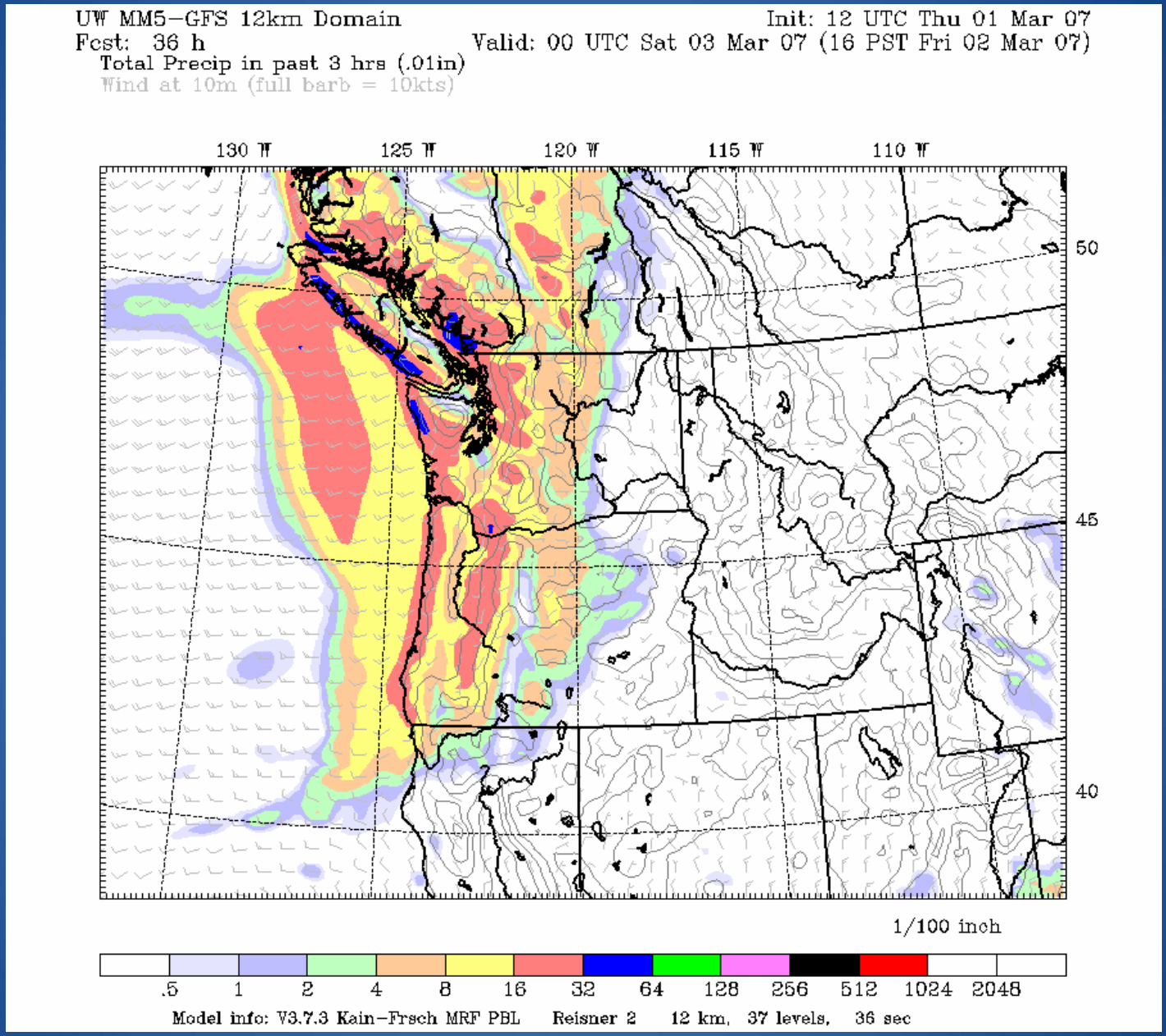
Hydrology

Updated: Wed Feb 27 10:02:02 PST 2008

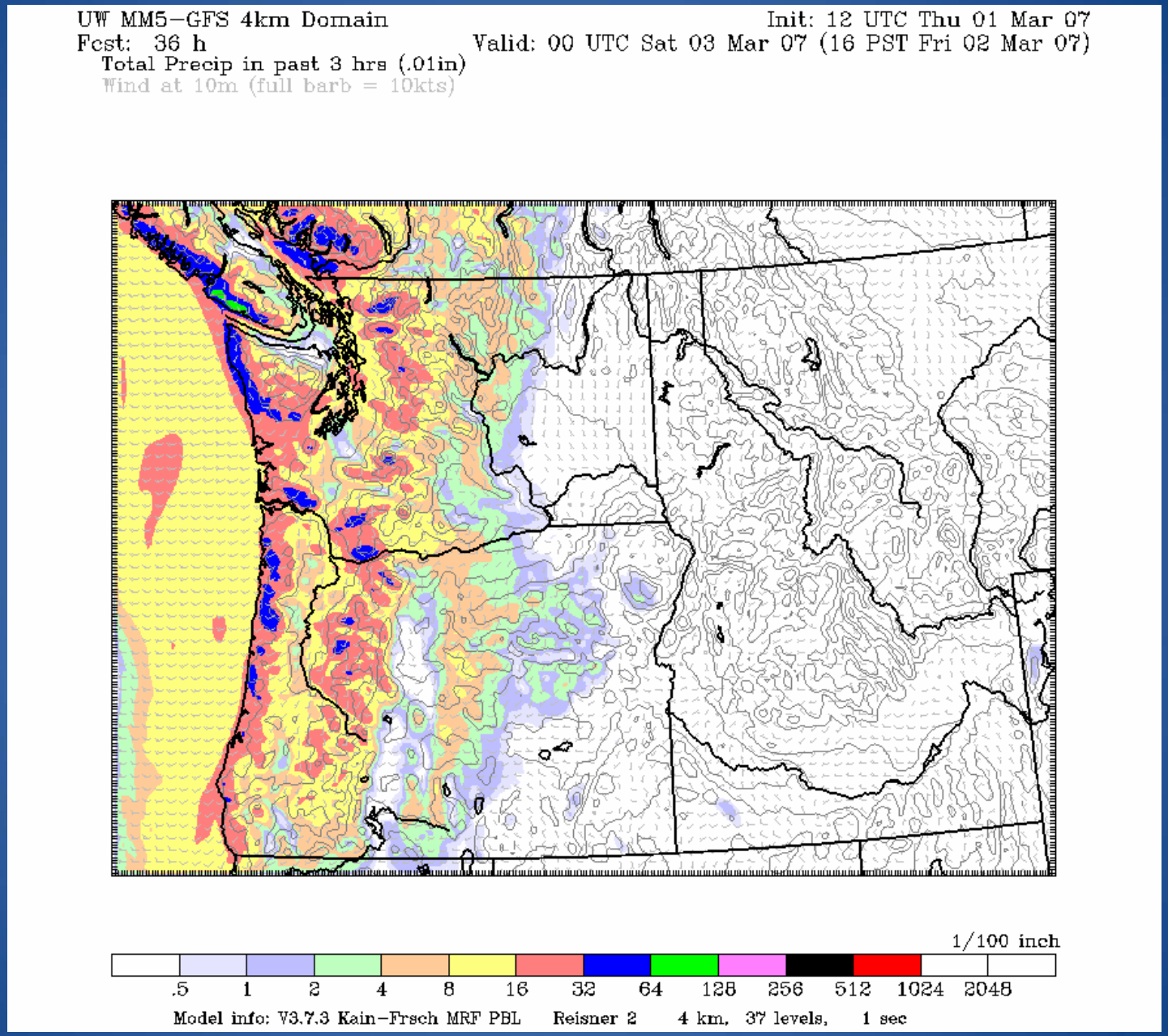
36 km


UW MM5-GFS 36km Domain
Init: 12 UTC Thu 01 Mar 07
Fcst: 36 h
Valid: 00 UTC Sat 03 Mar 07 (16 PST Fri 02 Mar 07)
Total Precip in past 3 hrs (.01in)
Sea Level Pressure (hPa)
180
170 W
160 W
150 W
140 W
130 W
120 W
110 W
100 W
90 W
60 N
50 N
40 N
30 N
CONTOURS: UNITS=hPa LOW= 984.00 HIGH= 1032.0 INTERVAL= 2.0000
1/100 inch
.5
1
2
4
8
16
32
64
128
256
512
1024
2048
Model info: V3.7.3 Kain-Frsch MRF PBL Reisner 2 36 km, 37 levels, 108 sec

12 km


UW MM5-GFS 12km Domain
Init: 12 UTC Thu 01 Mar 07
Fcst: 36 h
Valid: 00 UTC Sat 03 Mar 07 (16 PST Fri 02 Mar 07)
Total Precip in past 3 hrs (.01in)
Wind at 10m (full barb = 10kts)
130 W
125 W
120 W
115 W
110 W
50
45
40
1/100 inch
.5
1
2
4
8
16
32
64
128
256
512
1024
2048
Model info: V3.7.3 Kain-Frsch MRF PBL Reisner 2 12 km, 37 levels, 36 sec

4 km


UW MM5-GFS 4km Domain
Init: 12 UTC Thu 01 Mar 07
Fcst: 36 h
Valid: 00 UTC Sat 03 Mar 07 (16 PST Fri 02 Mar 07)
Total Precip in past 3 hrs (.01in)
Wind at 10m (full barb = 10kts)
1/100 inch
.5 1 2 4 8 16 32 64 128 256 512 1024 2048
Model info: V3.7.3 Kain-Frsch MRF PBL Reisner 2 4 km, 37 levels, 1 sec

2008 is the Year for the Major WRF Transition

- During the past ten years we have mainly used the MM5—the Penn. State/NCAR mesoscale model version 5.
- During the past two years we have run the replacement model—the Weather Research and Forecasting Model--WRF—in parallel.

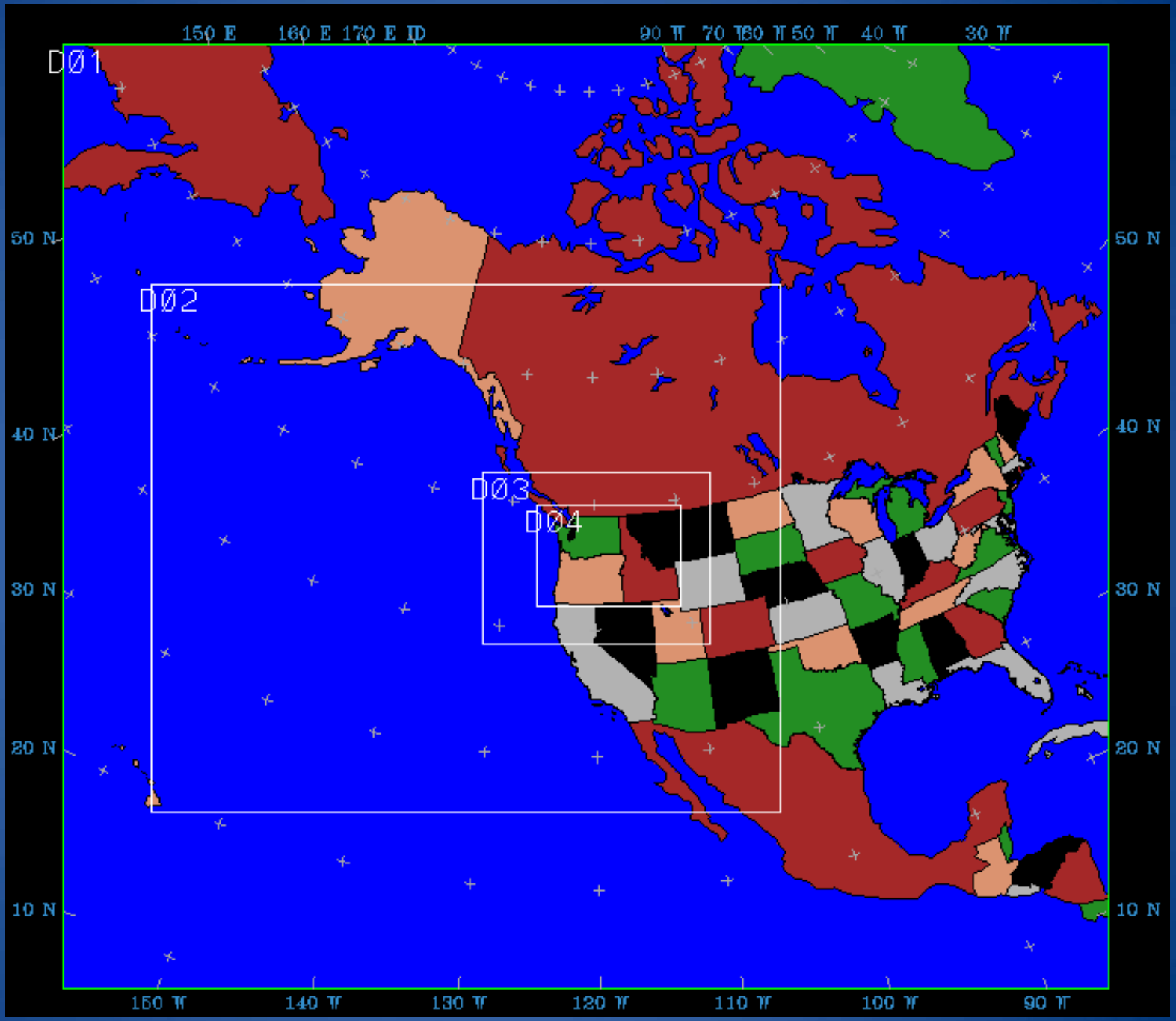
WRF Model

- The MM5 model is frozen and all new developments going into WRF
- WRF is less diffusive and provides more detail and structure at the same resolution
- WRF parallelizes better on large number of processors
- After a year of verification and comparison with MM5, it appears that WRF improves a number of fields and is equivalent in others.
- The NW modeling consortium, which sponsors and controls the local modeling, voted to switch the high resolution regional runs to WRF starting in March

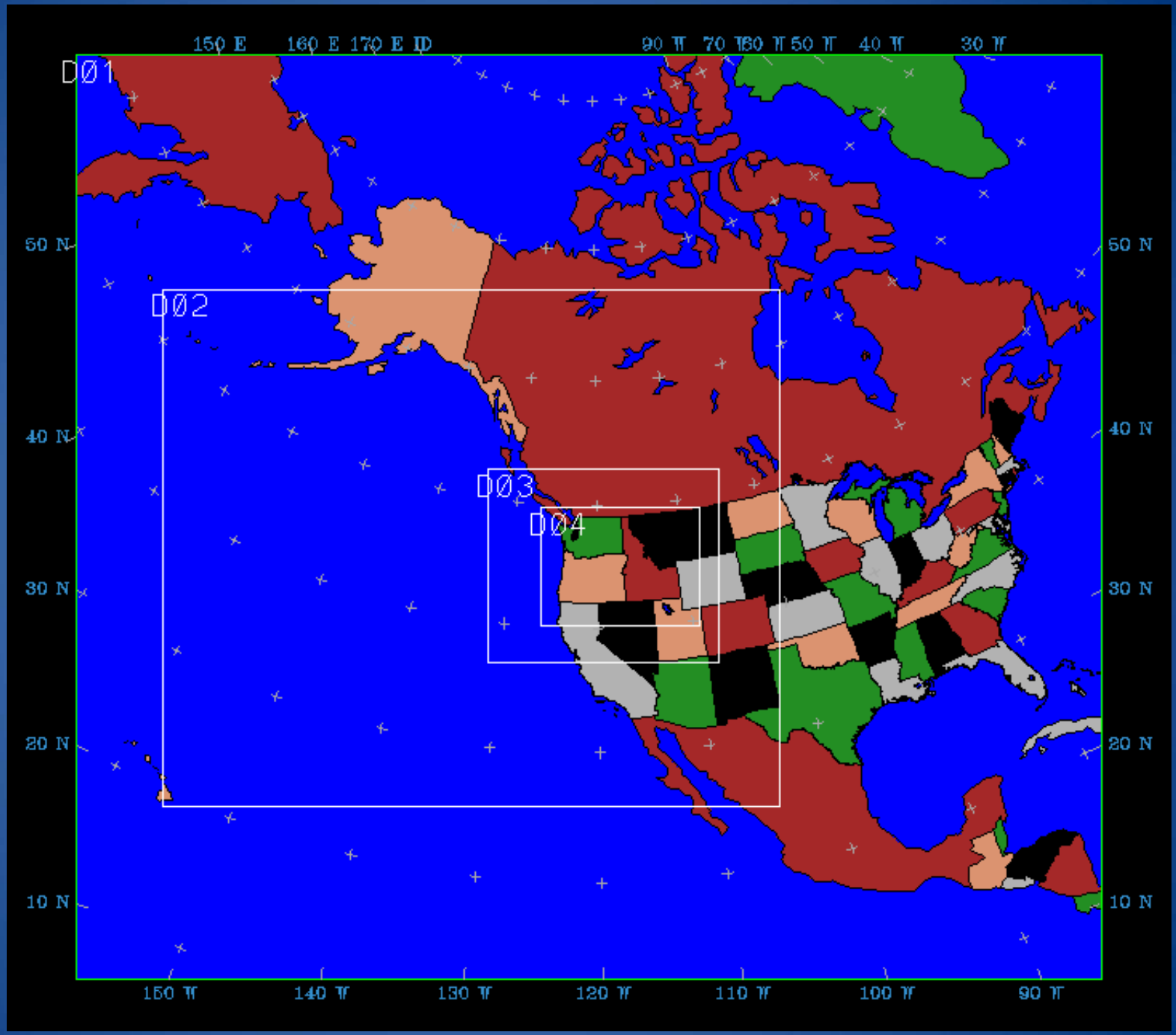
Major Changes

- The 12-km domain is expanded both westward and to the south (includes SF Bay area)
- A major expansion of the 4-km domain to include Yellowstone and Northern California.
- Doubling the number of processors and earlier availability.
- The NW WRF is forced by the National Weather Service GFS model…and thus will be referred to as GFS-WRF. GFS-MM5 will be dropped.
- The extended (180 hr) run of MM5 will be switched to WRF.

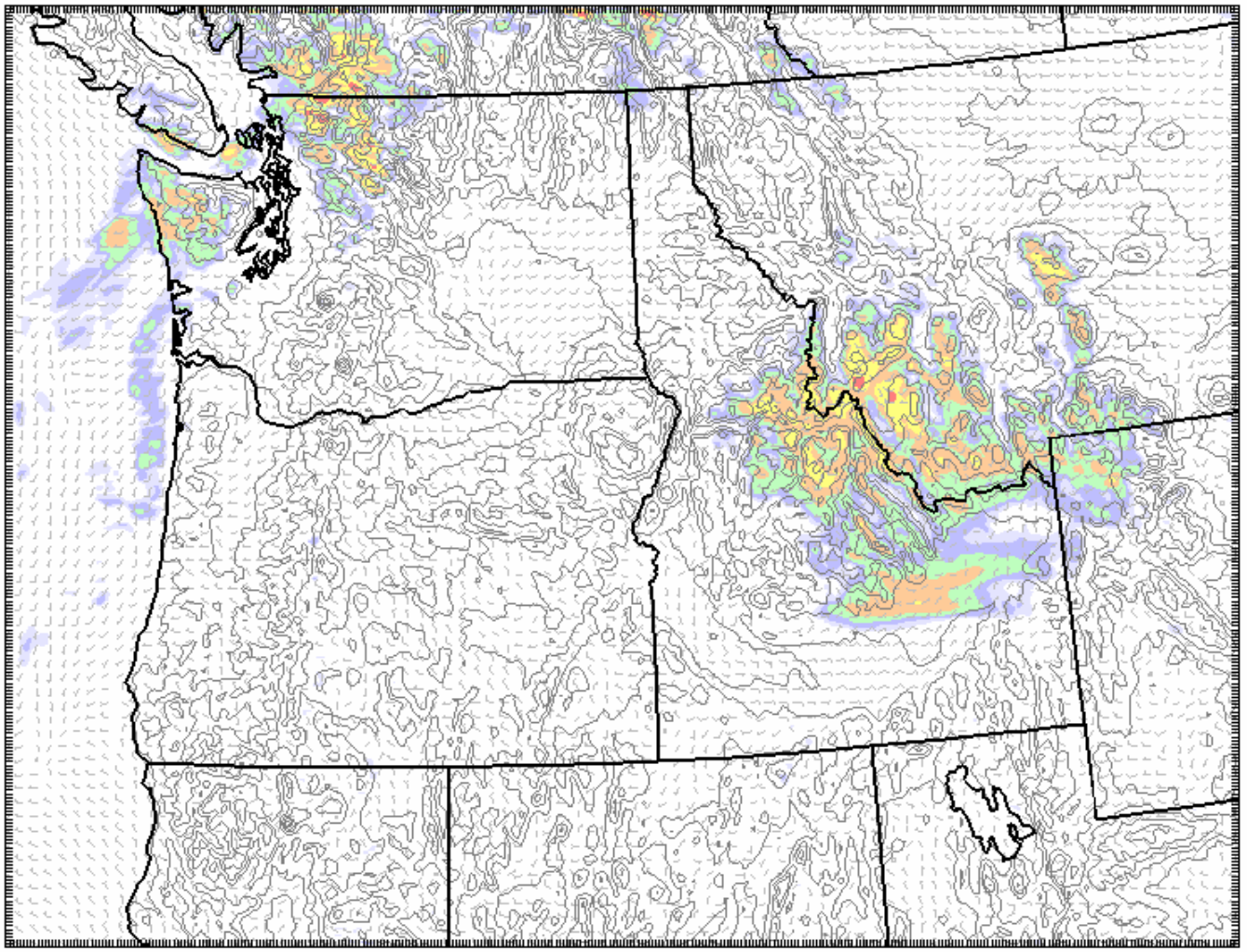
OLD


150 E
160 E
170 E
180
90 W
70 W
60 W
50 W
40 W
30 W
D01
D02
D03
D04
50 N
40 N
30 N
20 N
10 N
150 W
140 W
130 W
120 W
110 W
100 W
90 W

New


150 E
160 E
170 E
180
90 W
70 W
60 W
50 W
40 W
30 W
D01
D02
D03
D04
50 N
40 N
30 N
20 N
10 N
150 W
140 W
130 W
120 W
110 W
100 W
90 W

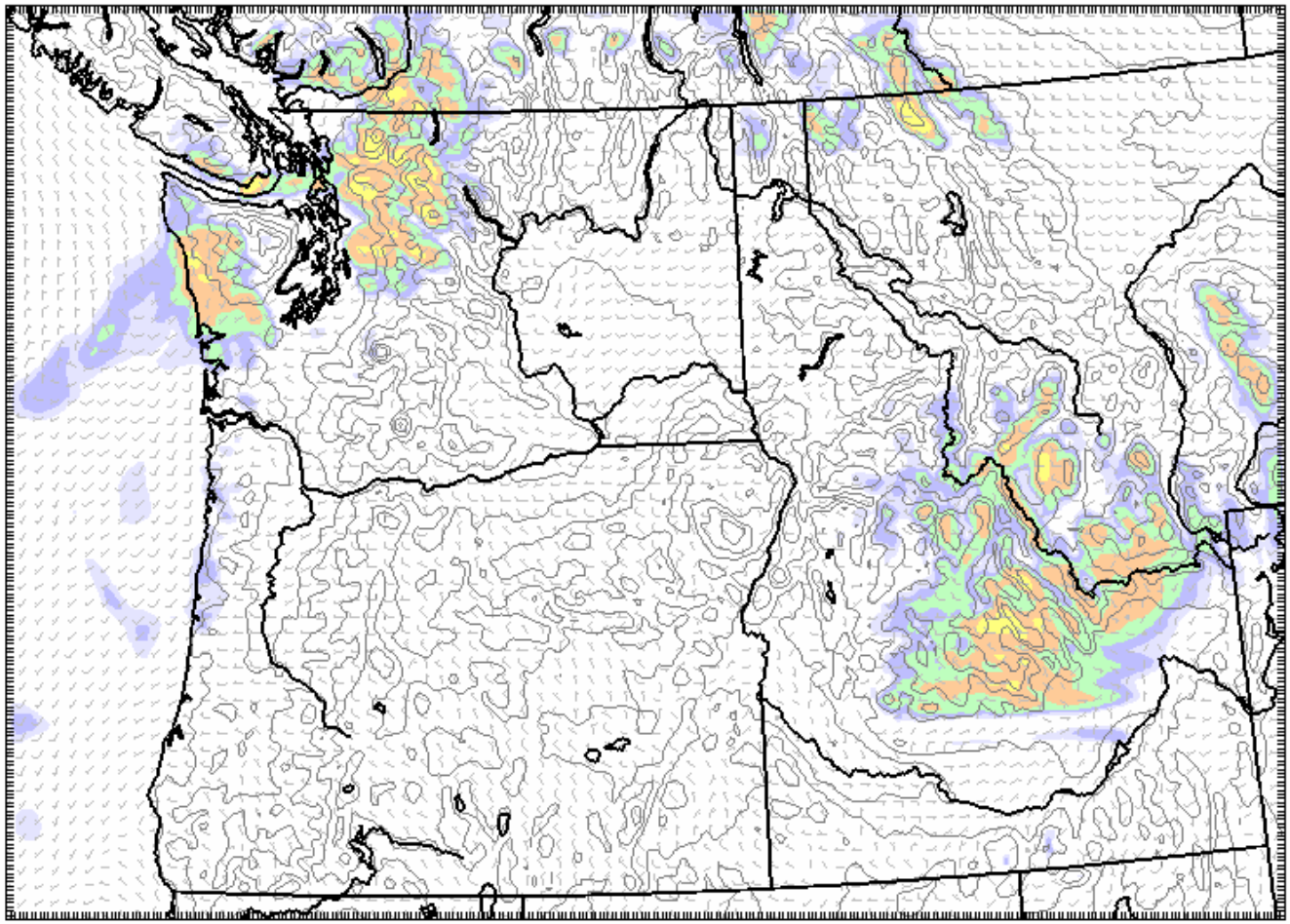
UW WRF-GFS 4km Domain
Init: 00 UTC Wed 27 Feb 08
Fcst: 24 h
Valid: 00 UTC Thu 28 Feb 08 (16 PST Wed 27 Feb 08)
Total Precip in past 3 hrs (.01in)
Wind at 10m (full barb = 10kts)



.5 1 2 4 8 16 32 64 128 256 512 1024 2048 mm

Model Info: V2.2 M KF YSU PBL Thompson Noah LSM 4.0 km, 37 levels, 24 sec
DIFF: simple KM: 2D Smagor

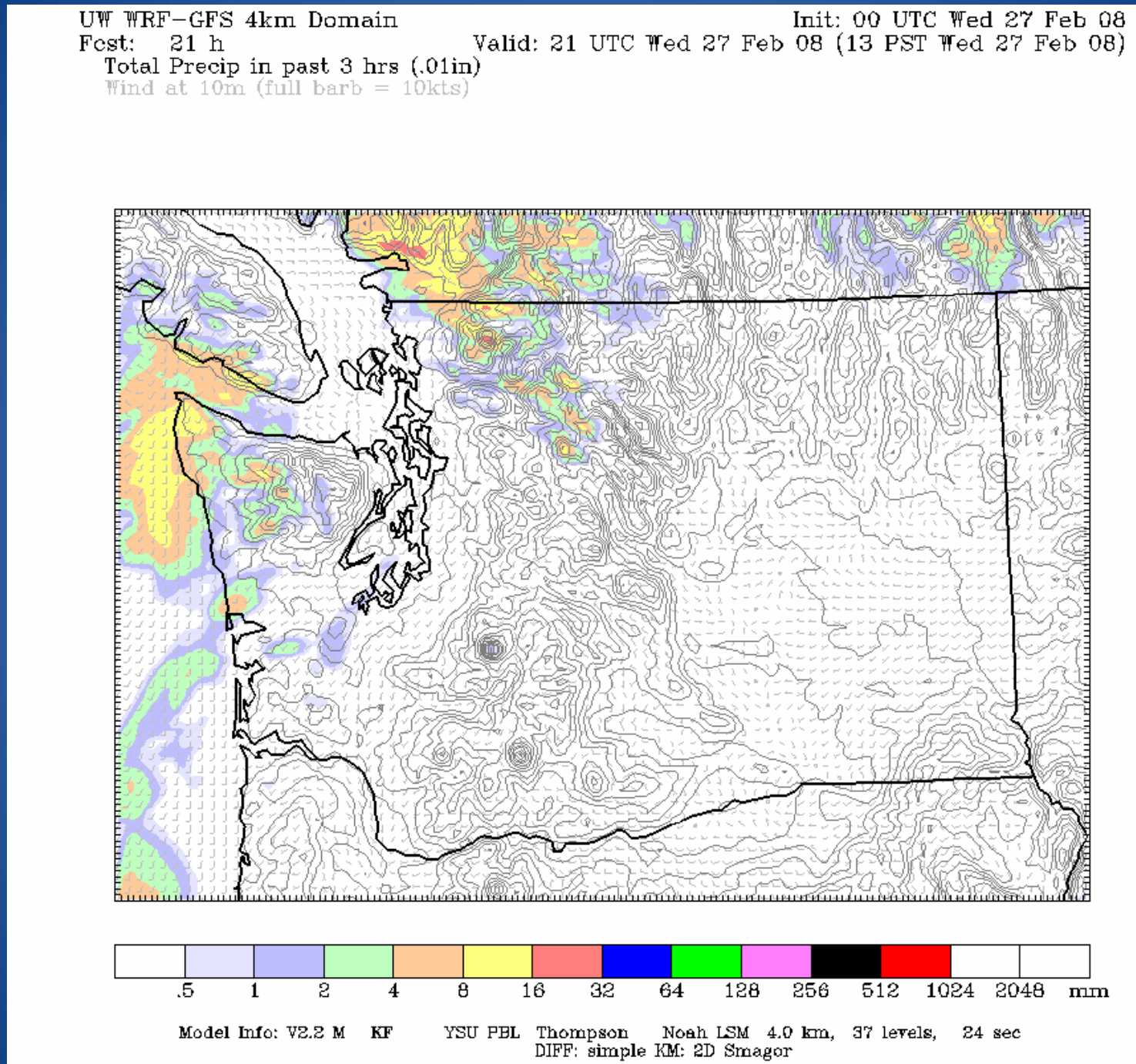
UW MM5-GFS 4km Domain
Init: 00 UTC Wed 27 Feb 08
Fcst: 24 h
Valid: 00 UTC Thu 28 Feb 08 (16 PST Wed 27 Feb 08)
Total Precip in past 3 hrs (.01in)
Wind at 10m (full barb = 10kts)



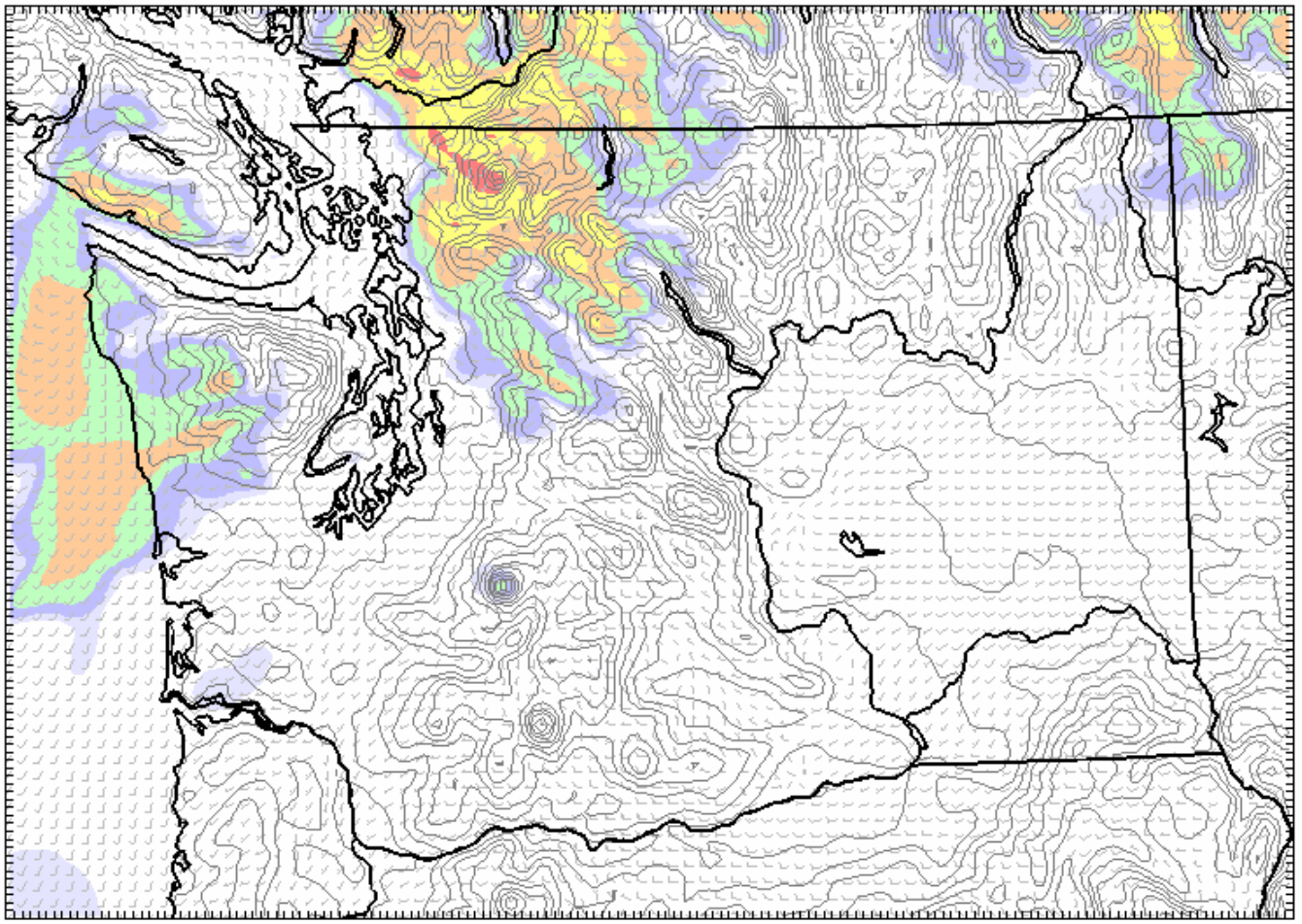
1/100 inch

.5 1 2 4 8 16 32 64 128 256 512 1024 2048

Model info: V3.7.4 Kain-Frsch MRF PBL Reisner 2 4 km, 37 levels, 1 sec


UW WRF-GFS 4km Domain
Init: 00 UTC Wed 27 Feb 08
Fcst: 21 h
Valid: 21 UTC Wed 27 Feb 08 (13 PST Wed 27 Feb 08)
Total Precip in past 3 hrs (.01in)
Wind at 10m (full barb = 10kts)
.5 1 2 4 8 16 32 64 128 256 512 1024 2048 mm
Model Info: V2.2 M KF YSU PBL Thompson Noah LSM 4.0 km, 37 levels, 24 sec
DIFF: simple KM: 2D Smagor

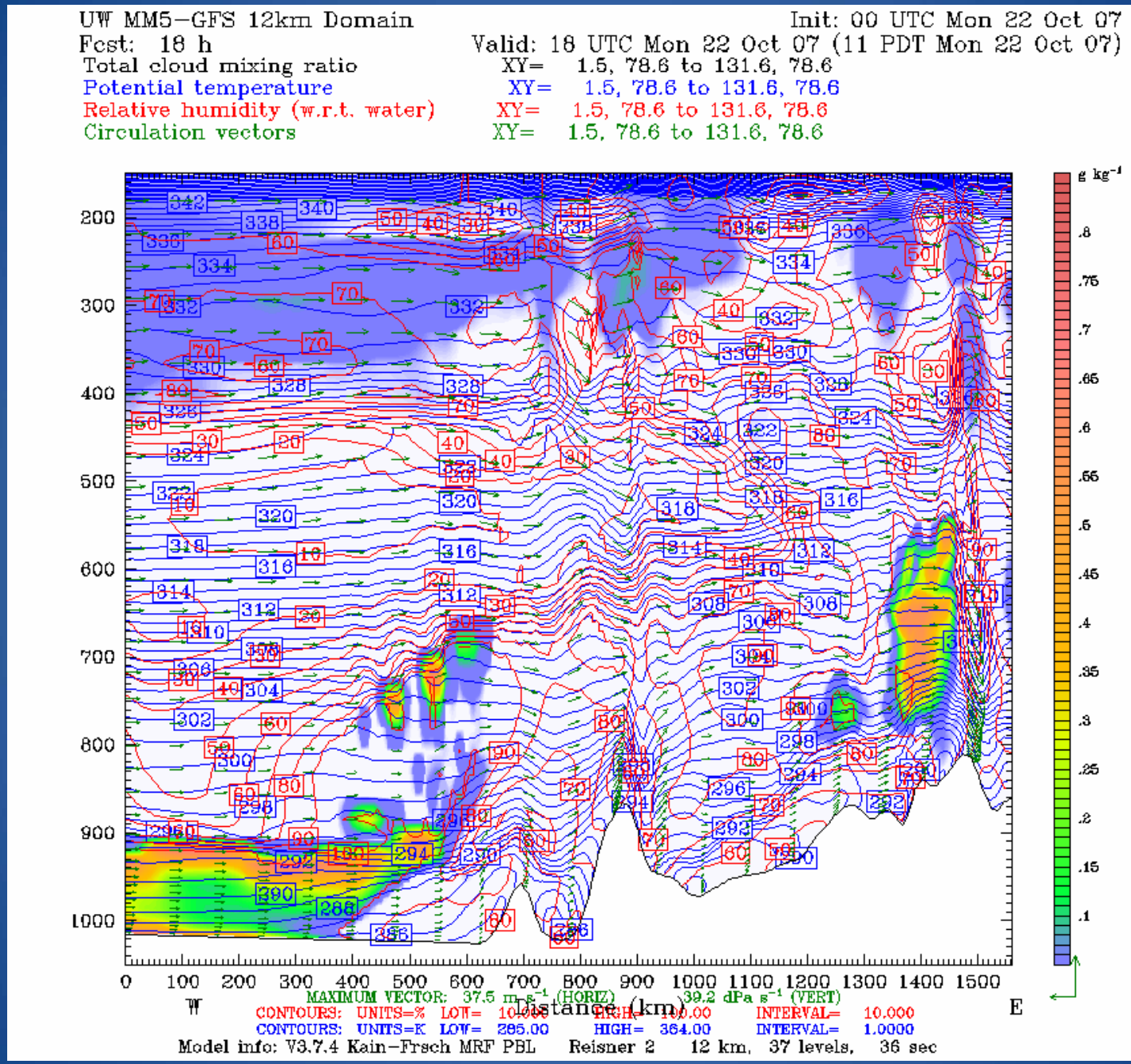
UW MM5-GFS 4km Domain
Init: 00 UTC Wed 27 Feb 08
Fcst: 21 h
Valid: 21 UTC Wed 27 Feb 08 (13 PST Wed 27 Feb 08)
Total Precip in past 3 hrs (.01in)
Wind at 10m (full barb = 10kts)

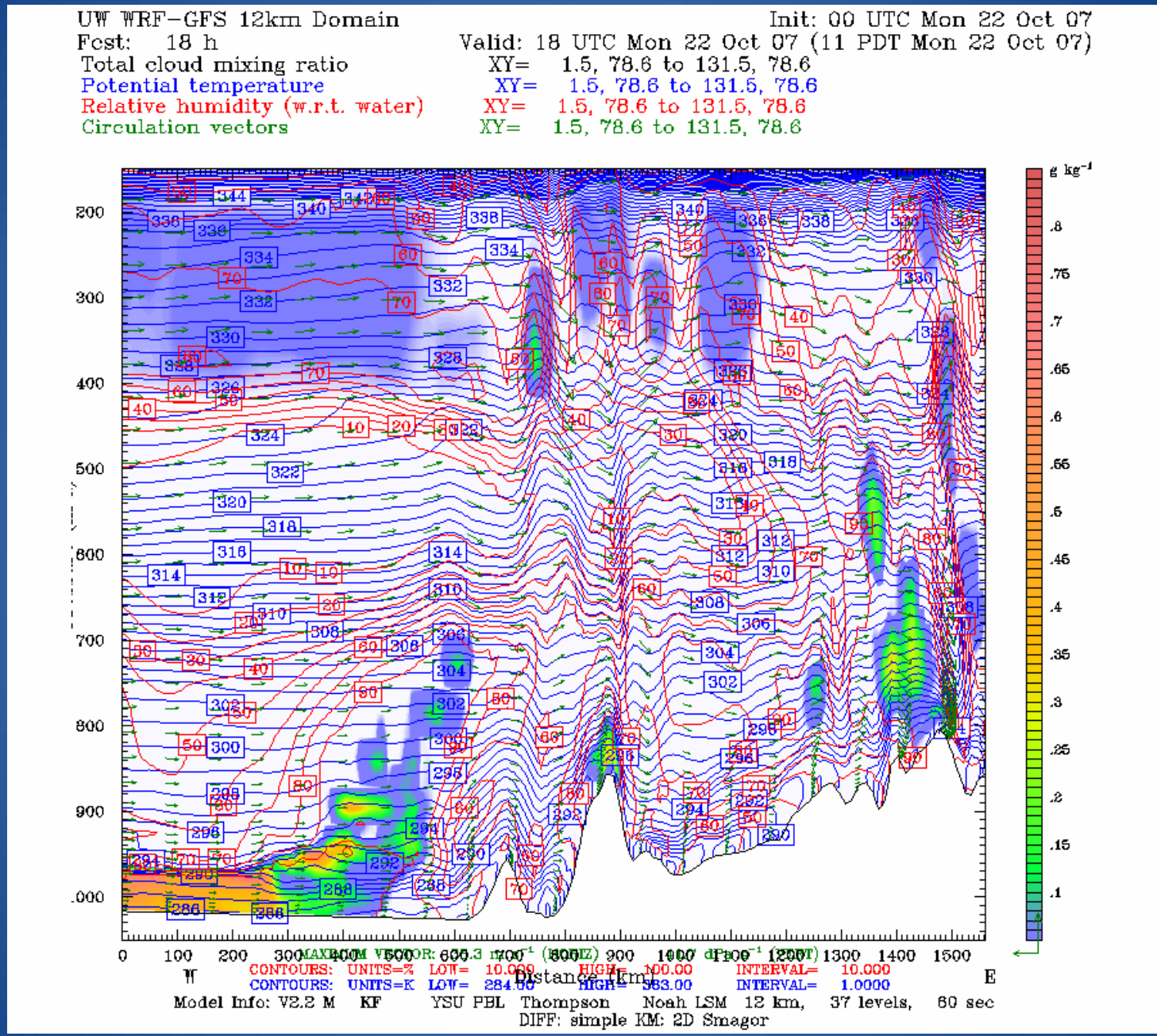


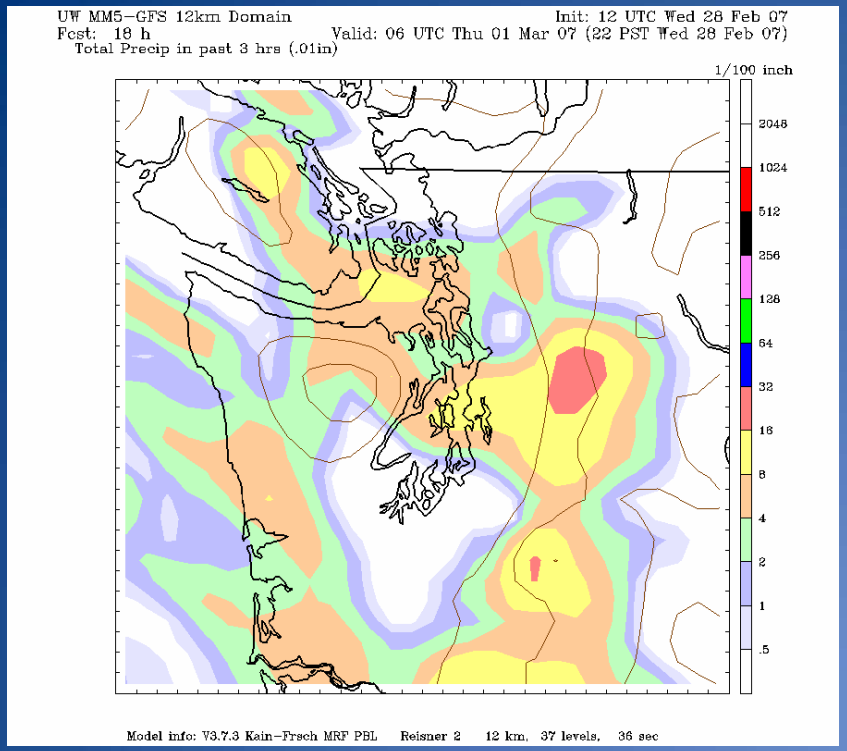
1/100 inch

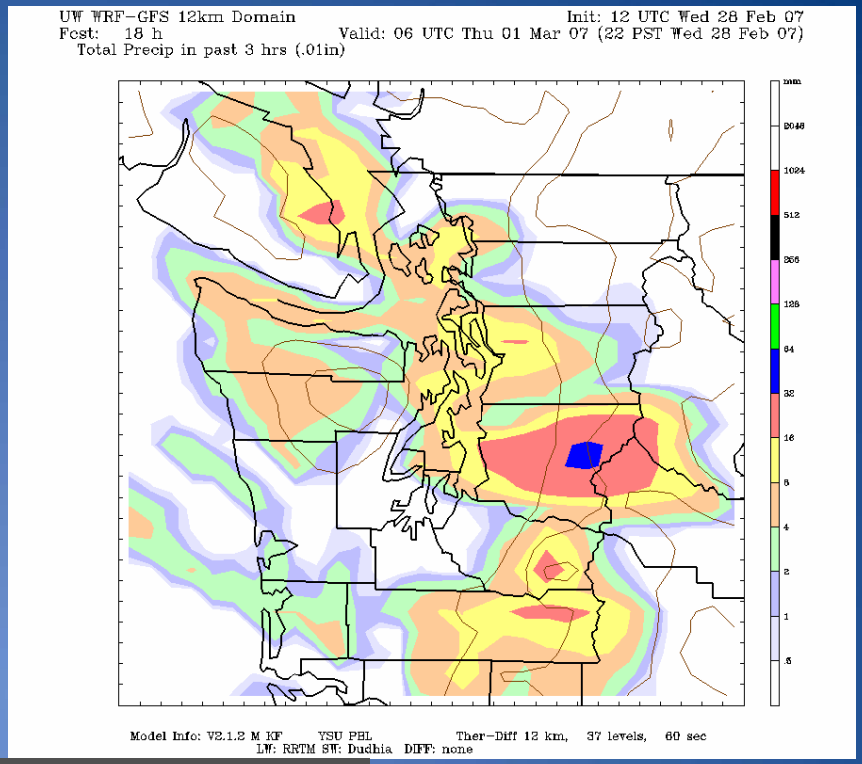
.5 1 2 4 8 16 32 64 128 256 512 1024 2048

Model info: V3.7.4 Kain-Frsch MRF PBL Reisner 2 4 km, 37 levels, 1 sec

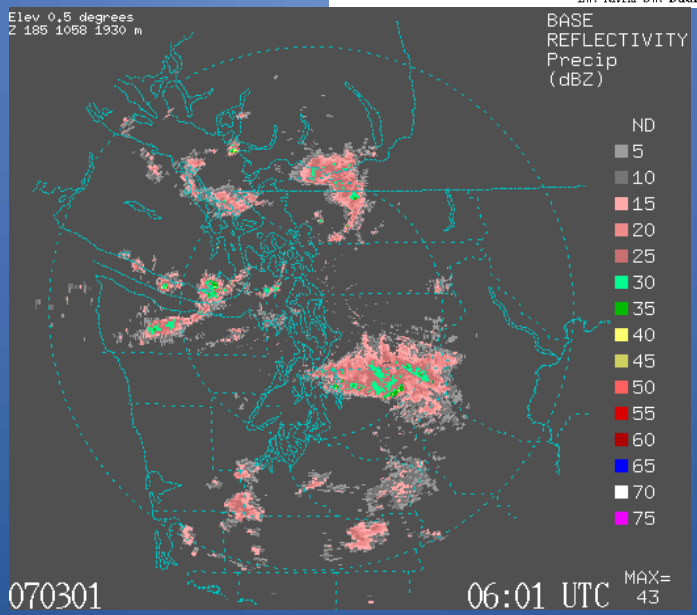

UW MM5-GFS 12km Domain
Init: 00 UTC Mon 22 Oct 07
Fcst: 18 h
Valid: 18 UTC Mon 22 Oct 07 (11 PDT Mon 22 Oct 07)
Total cloud mixing ratio XY= 1.5, 78.6 to 131.6, 78.6
Potential temperature XY= 1.5, 78.6 to 131.6, 78.6
Relative humidity (w.r.t. water) XY= 1.5, 78.6 to 131.6, 78.6
Circulation vectors XY= 1.5, 78.6 to 131.6, 78.6
g kg-1
Distance (km)
W
E
MAXIMUM VECTOR: 37.5 m s-1 (HORIZ) 39.2 dPa s-1 (VERT)
CONTOURS: UNITS=% LOW= 10.000 HIGH= 100.00 INTERVAL= 10.000
CONTOURS: UNITS=K LOW= 285.00 HIGH= 364.00 INTERVAL= 1.0000
Model info: V3.7.4 Kain-Frsch MRF PBL Reisner 2 12 km, 37 levels, 36 sec

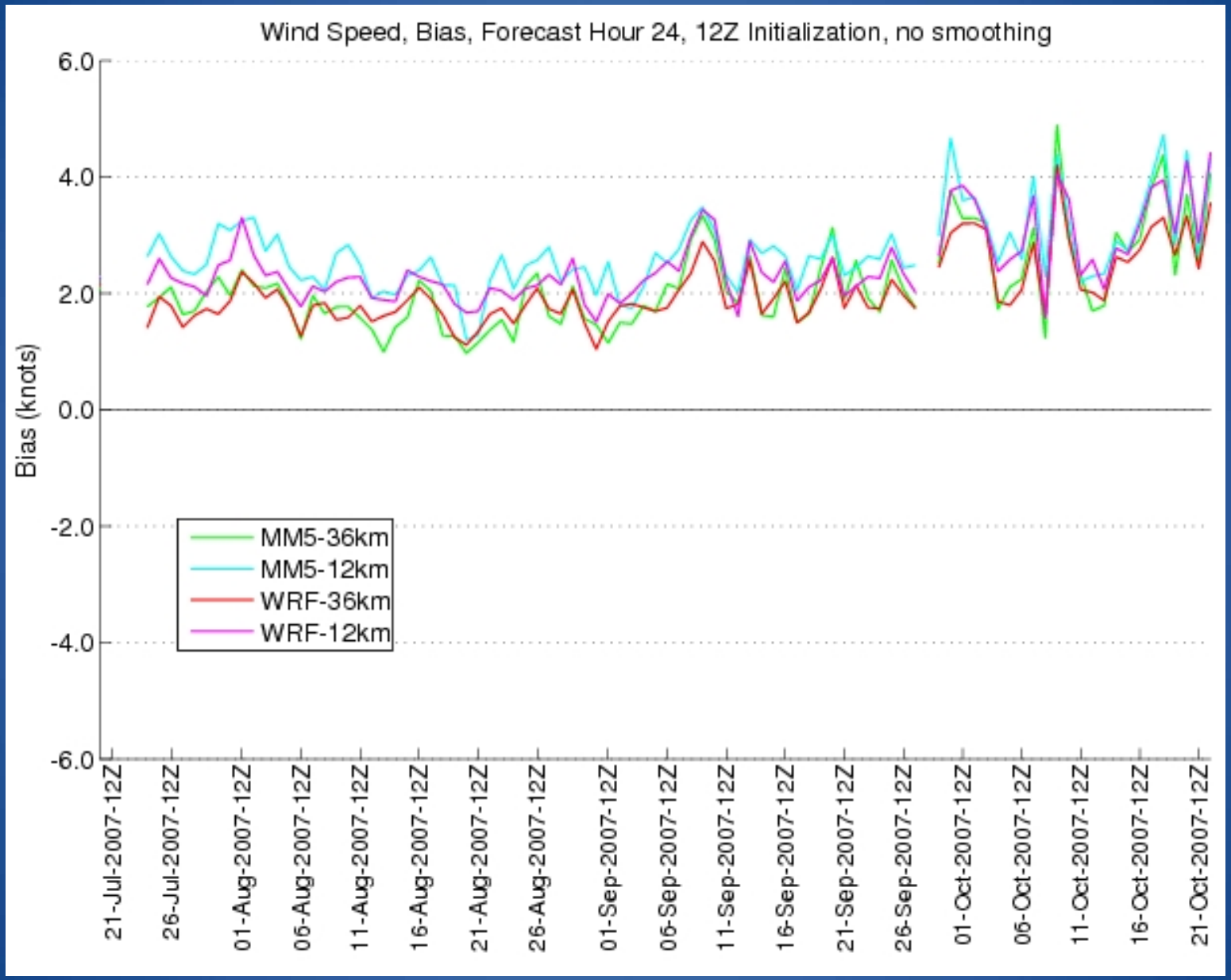

UW WRF-GFS 12km Domain
Init: 00 UTC Mon 22 Oct 07
Fcst: 18 h
Valid: 18 UTC Mon 22 Oct 07 (11 PDT Mon 22 Oct 07)
Total cloud mixing ratio XY= 1.5, 78.6 to 131.5, 78.6
Potential temperature XY= 1.5, 78.6 to 131.5, 78.6
Relative humidity (w.r.t. water) XY= 1.5, 78.6 to 131.5, 78.6
Circulation vectors XY= 1.5, 78.6 to 131.5, 78.6
g kg-1
Distance (km)
W
E
CONTOURS: UNITS=% LOW= 10.000 HIGH= 100.00 INTERVAL= 10.000
CONTOURS: UNITS=K LOW= 284.00 HIGH= 363.00 INTERVAL= 1.0000
Model Info: V2.2 M KF YSU PBL Thompson Noah LSM 12 km, 37 levels, 60 sec
DIFF: simple KM: 2D Smagor

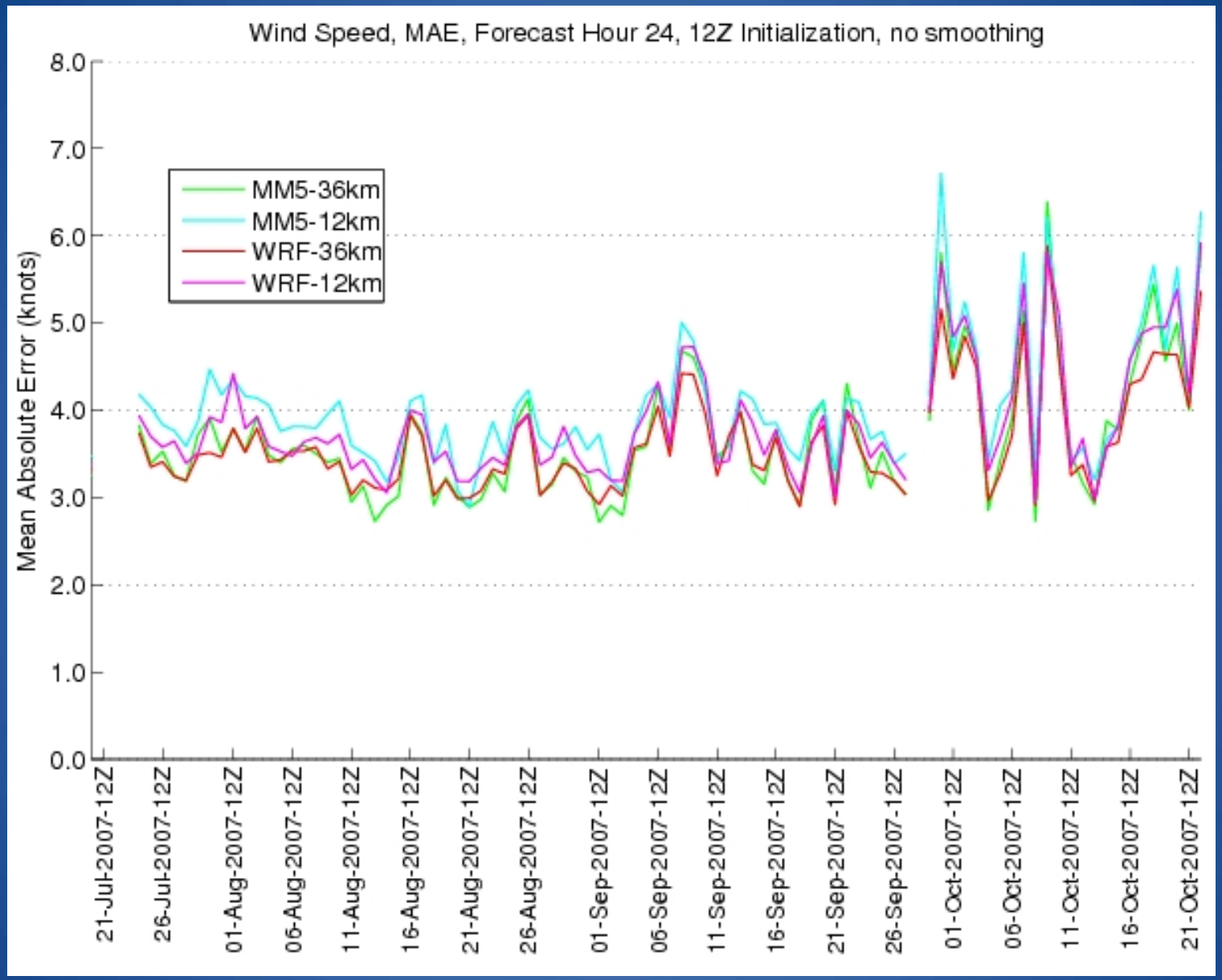




March 1 Convergence Zone Event




Wind Speed, Bias, Forecast Hour 24, 12Z Initialization, no smoothing
Bias (knots)
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
MM5-36km
MM5-12km
WRF-36km
WRF-12km
21-Jul-2007-12Z
26-Jul-2007-12Z
01-Aug-2007-12Z
06-Aug-2007-12Z
11-Aug-2007-12Z
16-Aug-2007-12Z
21-Aug-2007-12Z
26-Aug-2007-12Z
01-Sep-2007-12Z
06-Sep-2007-12Z
11-Sep-2007-12Z
16-Sep-2007-12Z
21-Sep-2007-12Z
26-Sep-2007-12Z
01-Oct-2007-12Z
06-Oct-2007-12Z
11-Oct-2007-12Z
16-Oct-2007-12Z
21-Oct-2007-12Z


Wind Speed, MAE, Forecast Hour 24, 12Z Initialization, no smoothing
Mean Absolute Error (knots)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
MM5-36km
MM5-12km
WRF-36km
WRF-12km
21-Jul-2007-12Z
26-Jul-2007-12Z
01-Aug-2007-12Z
06-Aug-2007-12Z
11-Aug-2007-12Z
16-Aug-2007-12Z
21-Aug-2007-12Z
26-Aug-2007-12Z
01-Sep-2007-12Z
06-Sep-2007-12Z
11-Sep-2007-12Z
16-Sep-2007-12Z
21-Sep-2007-12Z
26-Sep-2007-12Z
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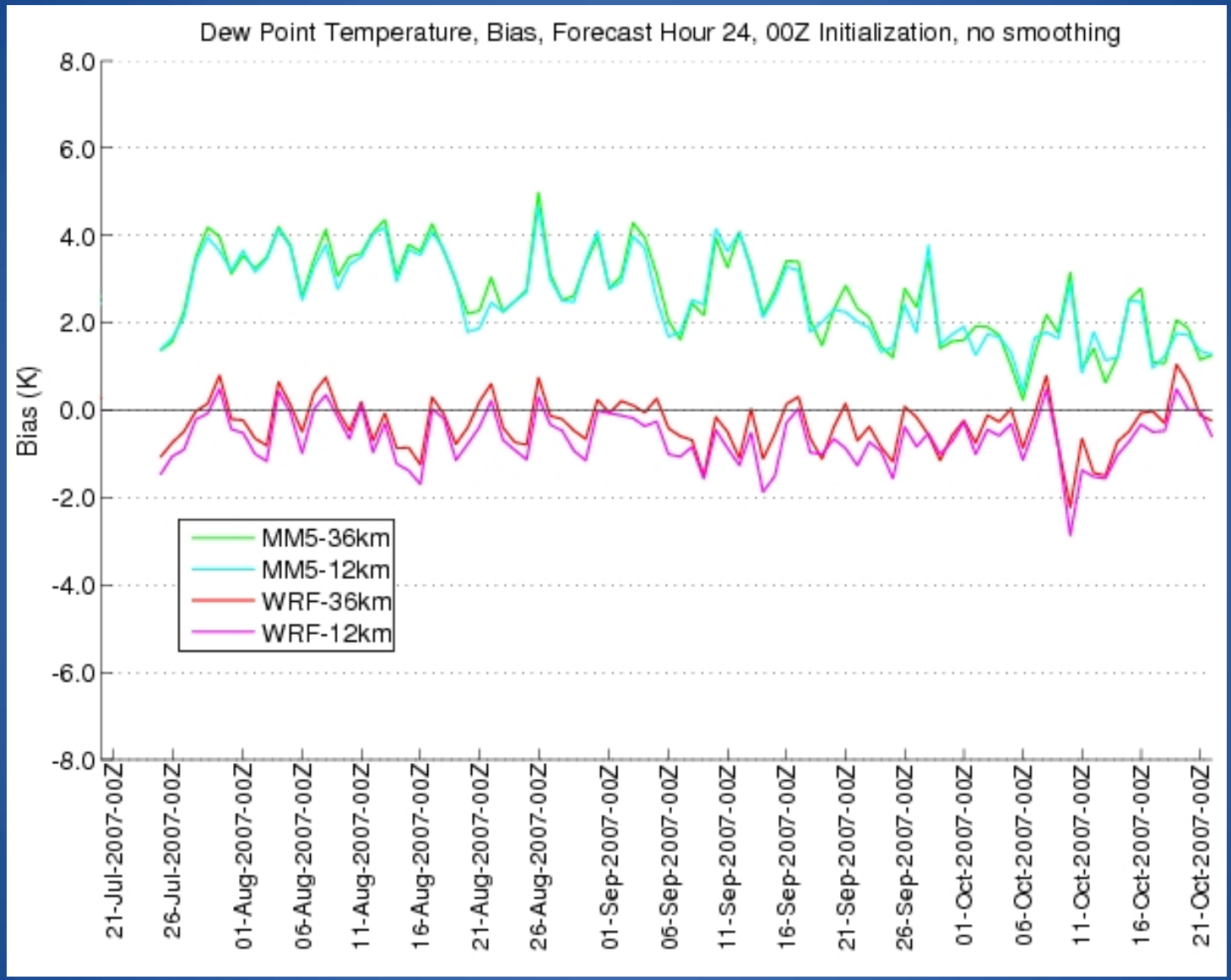
06-Oct-2007-12Z
11-Oct-2007-12Z
16-Oct-2007-12Z
21-Oct-2007-12Z


Dew Point Temperature, Bias, Forecast Hour 24, 00Z Initialization, no smoothing
Bias (K)
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
MM5-36km
MM5-12km
WRF-36km
WRF-12km
21-Jul-2007-00Z
26-Jul-2007-00Z
01-Aug-2007-00Z
06-Aug-2007-00Z
11-Aug-2007-00Z
16-Aug-2007-00Z
21-Aug-2007-00Z
26-Aug-2007-00Z
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21-Sep-2007-00Z
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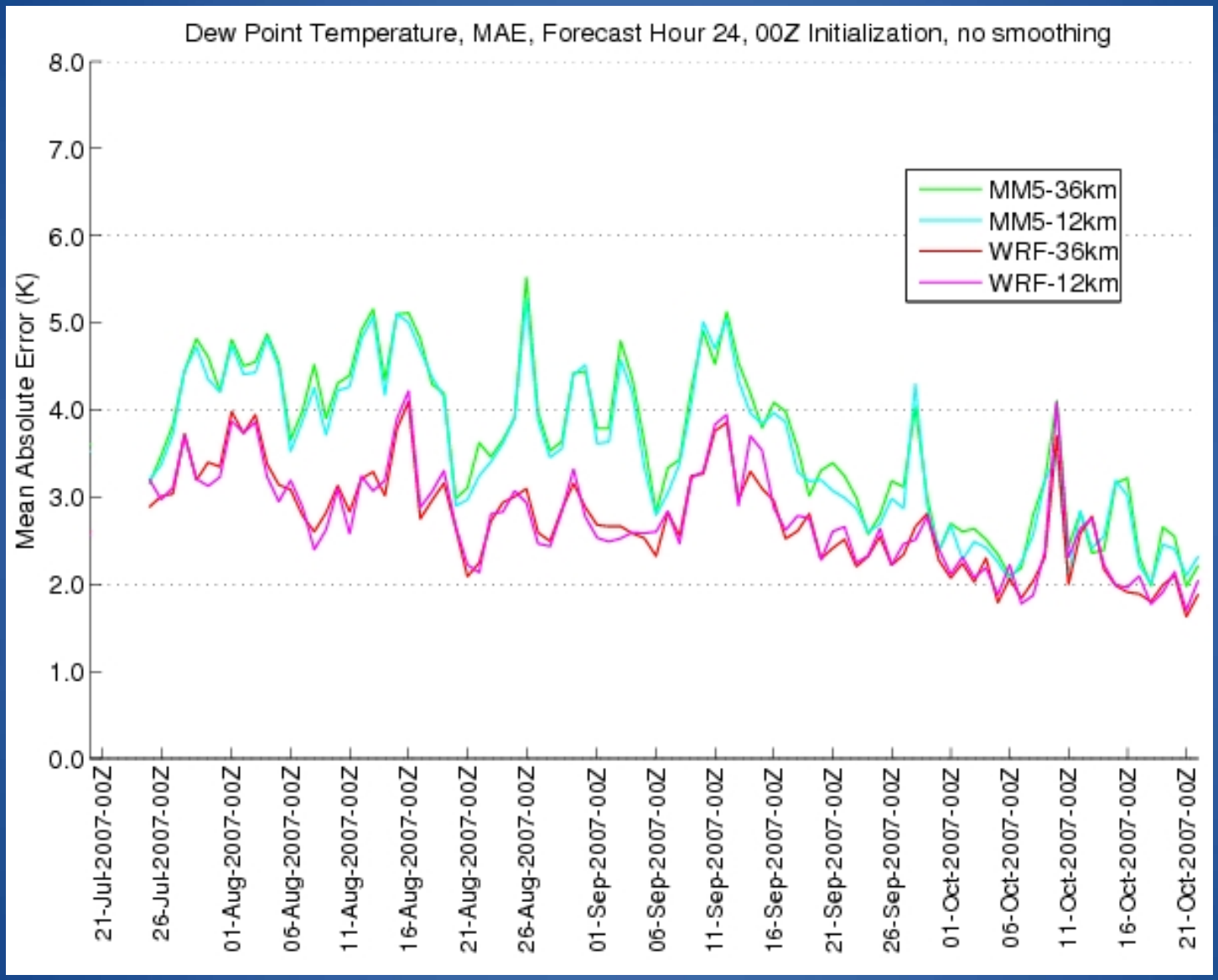
Dew Point Temperature, MAE, Forecast Hour 24, 00Z Initialization, no smoothing
Mean Absolute Error (K)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
MM5-36km
MM5-12km
WRF-36km
WRF-12km
21-Jul-2007-00Z
26-Jul-2007-00Z
01-Aug-2007-00Z
06-Aug-2007-00Z
11-Aug-2007-00Z
16-Aug-2007-00Z
21-Aug-2007-00Z
26-Aug-2007-00Z
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21-Sep-2007-00Z
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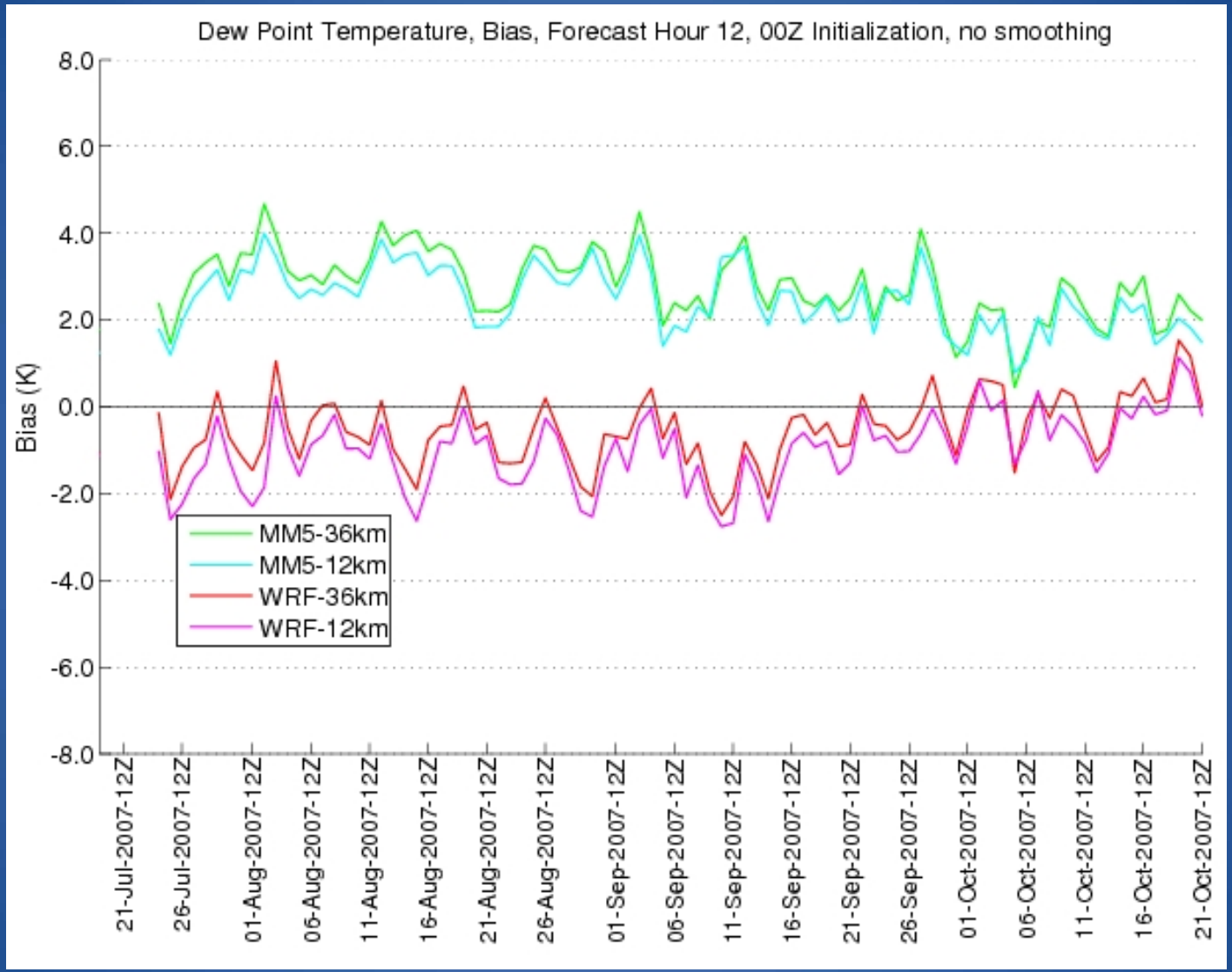
Dew Point Temperature, Bias, Forecast Hour 12, 00Z Initialization, no smoothing
Bias (K)
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
MM5-36km
MM5-12km
WRF-36km
WRF-12km
21-Jul-2007-12Z
26-Jul-2007-12Z
01-Aug-2007-12Z
06-Aug-2007-12Z
11-Aug-2007-12Z
16-Aug-2007-12Z
21-Aug-2007-12Z
26-Aug-2007-12Z
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11-Sep-2007-12Z
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21-Sep-2007-12Z
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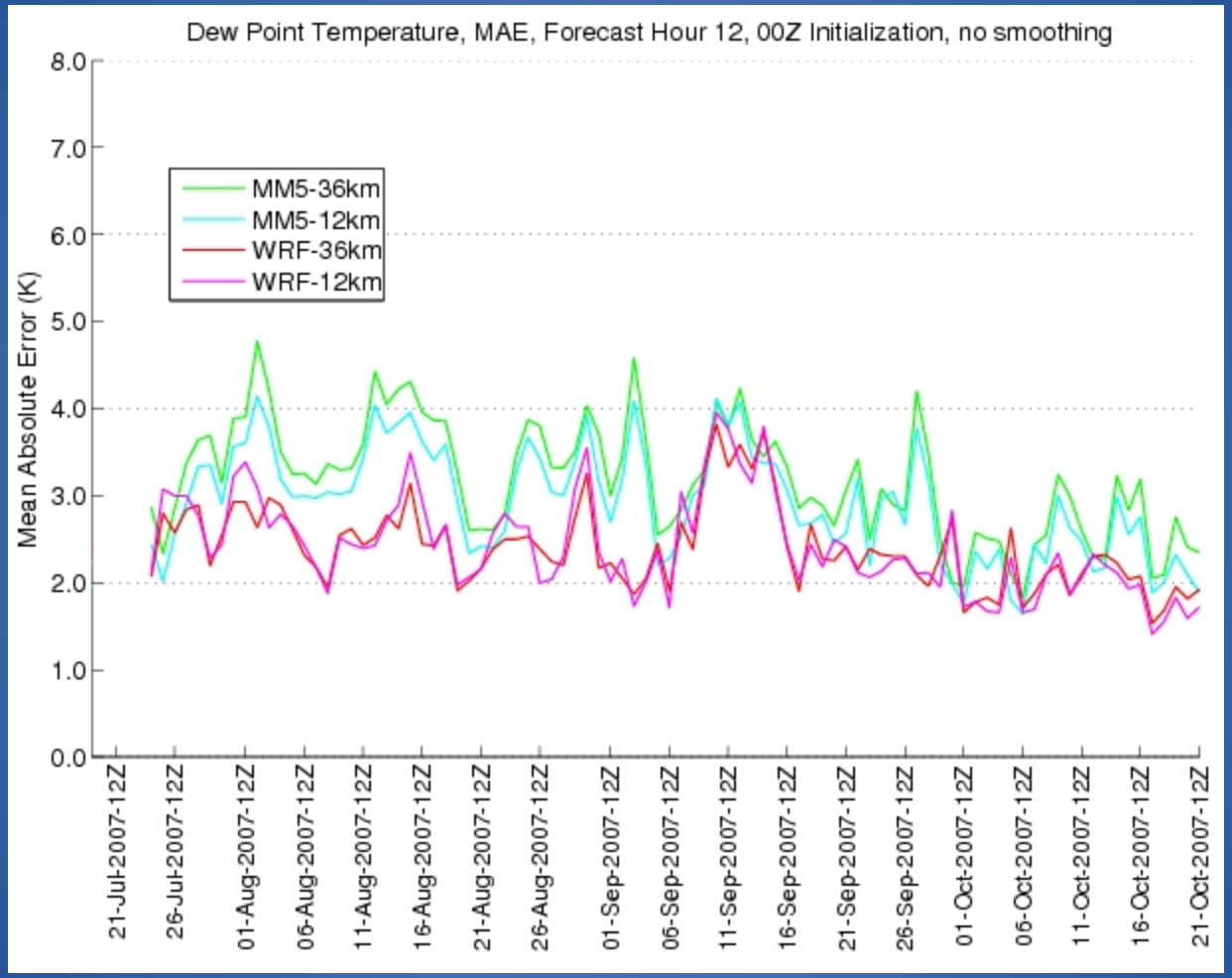
Dew Point Temperature, MAE, Forecast Hour 12, 00Z Initialization, no smoothing
Mean Absolute Error (K)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
MM5-36km
MM5-12km
WRF-36km
WRF-12km
21-Jul-2007-12Z
26-Jul-2007-12Z
01-Aug-2007-12Z
06-Aug-2007-12Z
11-Aug-2007-12Z
16-Aug-2007-12Z
21-Aug-2007-12Z
26-Aug-2007-12Z
01-Sep-2007-12Z
06-Sep-2007-12Z
11-Sep-2007-12Z
16-Sep-2007-12Z
21-Sep-2007-12Z
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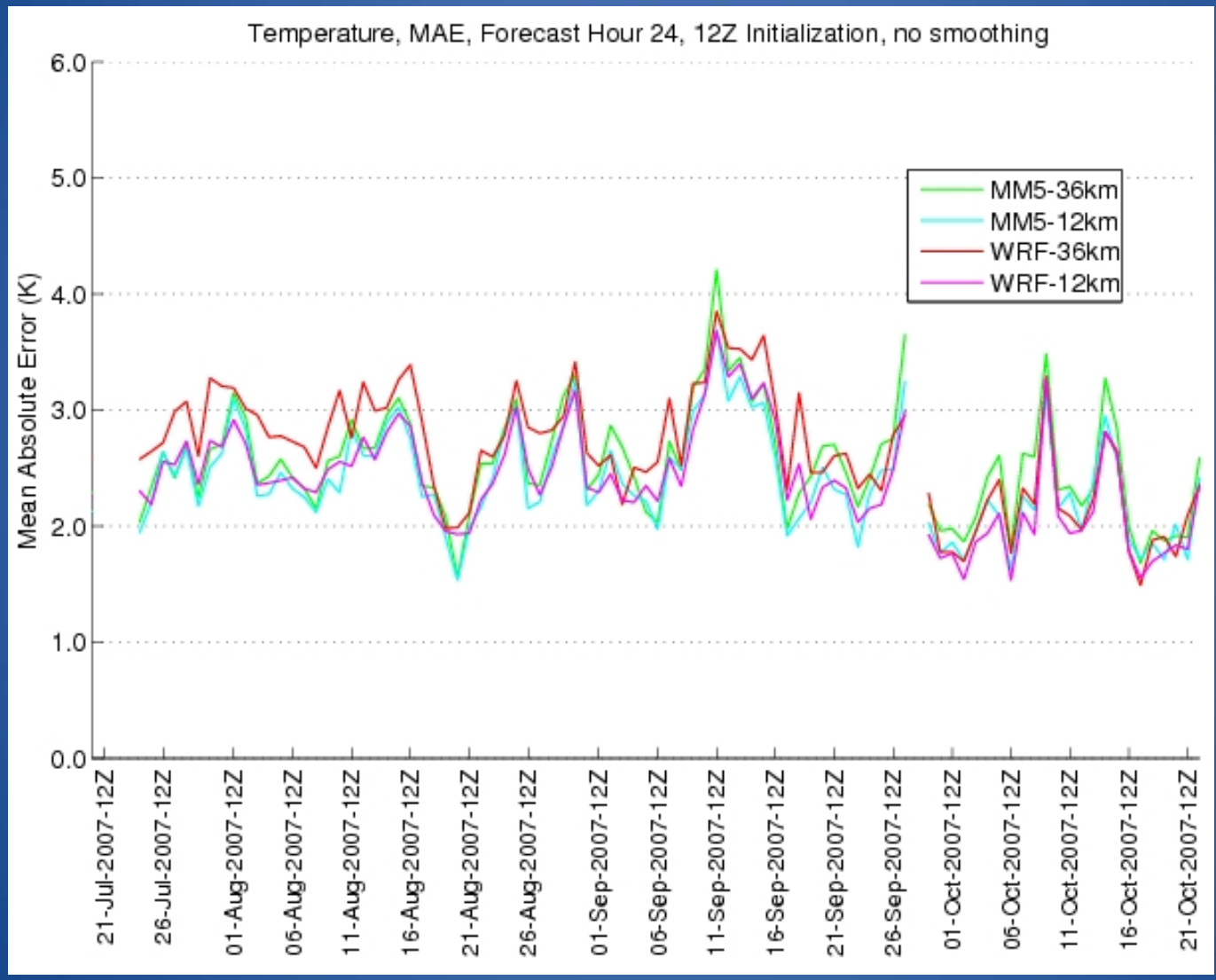
21-Oct-2007-12Z


Temperature, MAE, Forecast Hour 24, 12Z Initialization, no smoothing
Mean Absolute Error (K)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
MM5-36km
MM5-12km
WRF-36km
WRF-12km
21-Jul-2007-12Z
26-Jul-2007-12Z
01-Aug-2007-12Z
06-Aug-2007-12Z
11-Aug-2007-12Z
16-Aug-2007-12Z
21-Aug-2007-12Z
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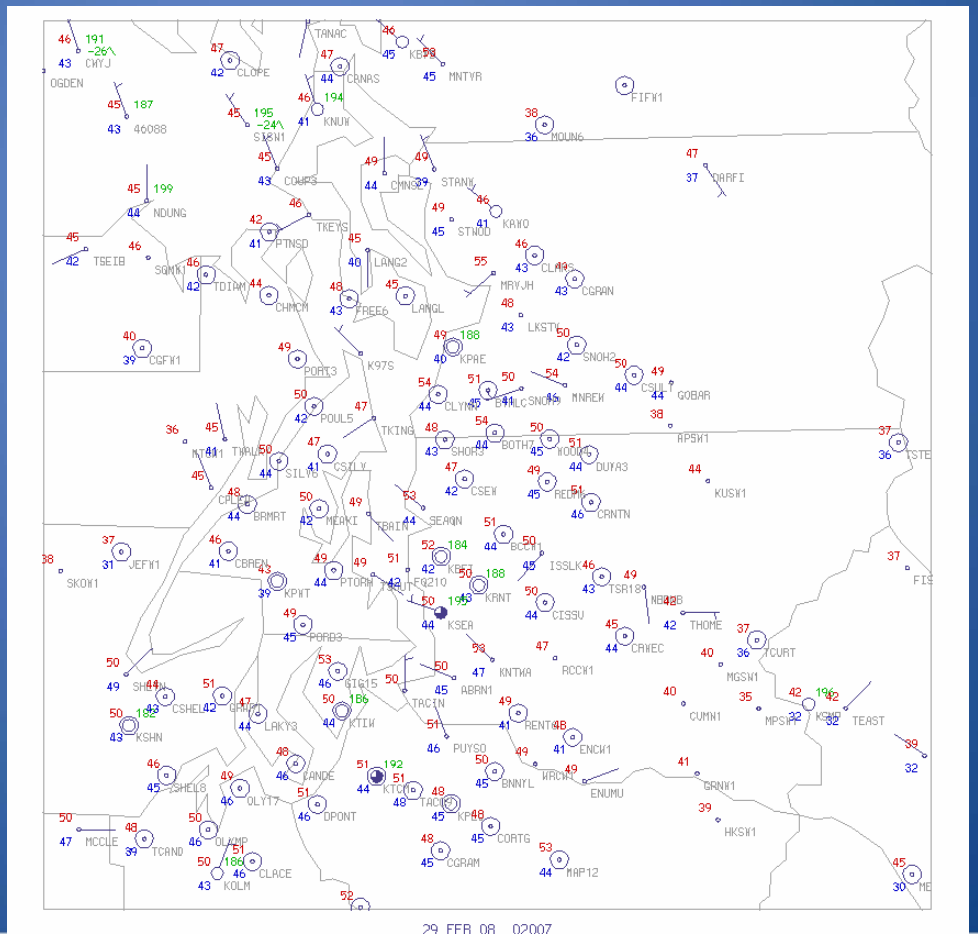
21-Sep-2007-12Z
26-Sep-2007-12Z
01-Oct-2007-12Z
06-Oct-2007-12Z
11-Oct-2007-12Z
16-Oct-2007-12Z
21-Oct-2007-12Z

Data Assimilation Using Ensembles

Creating a Quality Analyses and Short Term Forecasts

- Right now there are thousands of real-time surface observations in the Northwest every hour
- Plus, many other types of reports (e.g. ACARS aircraft obs)

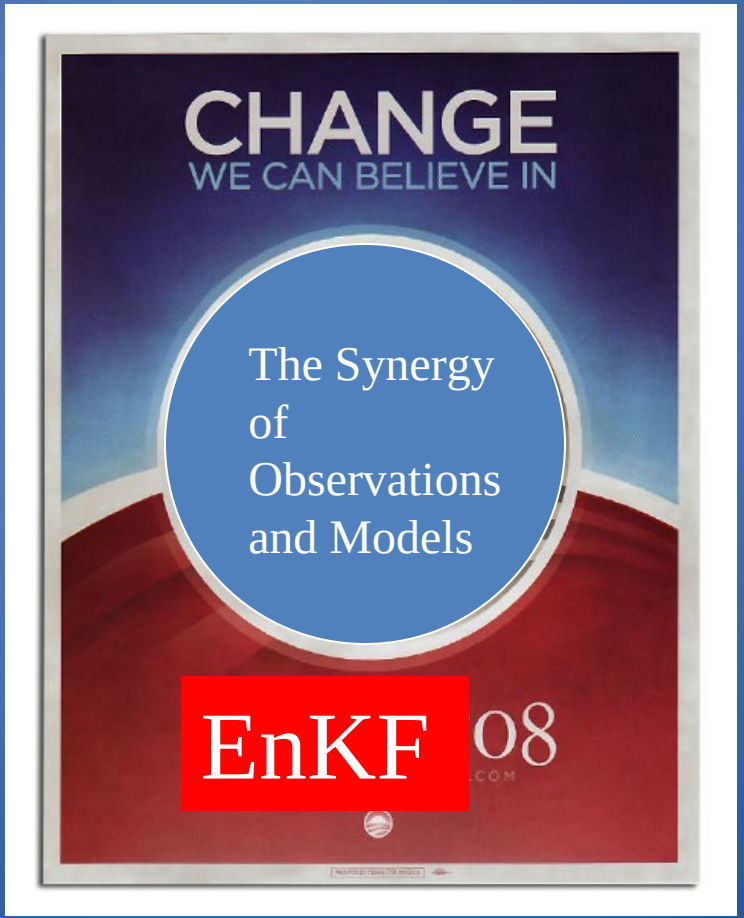


Regional Analysis

- How can we use all these observations to produce a high quality three-dimensional analysis?
- How can we use forecast models to spread the observations in a physically consistent way?
- Can we someday combine prediction and analysis in a seamless way?
- And even compute the uncertainty in both?

YES WE CAN!

- There is great HOPE for this CHANGE in 2008!



Ensemble Kalman Filter

- By running a large high resolution ensemble of forecasts it is theoretically possible to do this.
- Each ensemble member uses slightly different observations, based on typical errors.
- A series of short-term forecasts (for six hours in our current system).
- The differences in the forecasts not only provide uncertainty information but provide information on how to spread observations in space.

UW EnKF Data Assimilation System

- Now running in real time.
- Uses WRF model.
- 36 and 12-km grid spacing
- 90 members
- Analyses and six hour forecast every six hours.
- Every twelve hours there is a 48-h forecast.
- Has own web site. Greg Hakim and Brian Ancel are leading this.

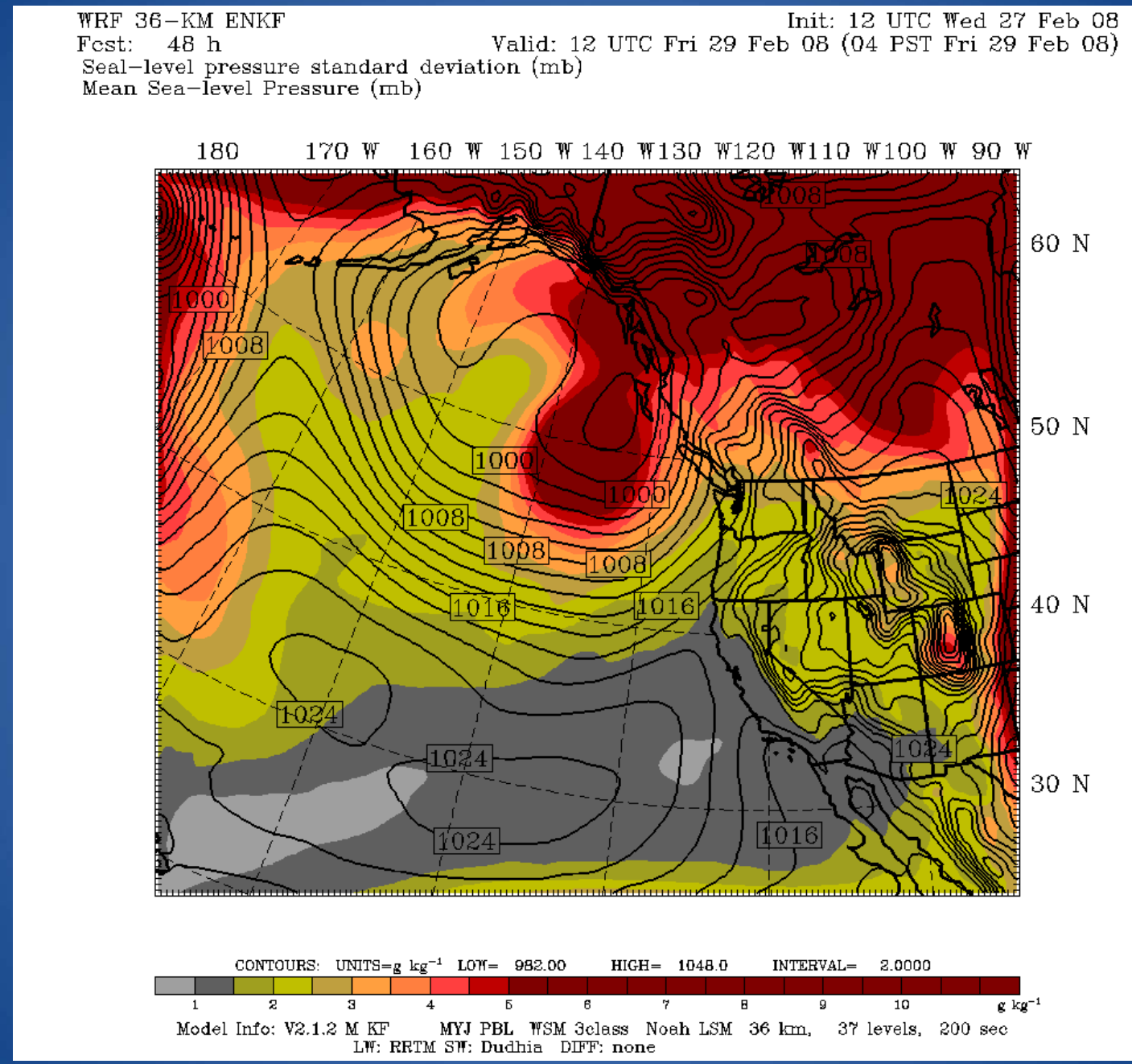
Pacific Northwest WRF Ensemble Kalman Filter (EnKF) Weather Analyses and Forecasts

Updated: 20070607 00:17 UTC Next Update: 20070607 20:17 UTC

Available Initialization Times			
20070523 12:00 UTC	20070527 06:00 UTC	20070531 00:00 UTC	20070603 18:00 UTC
20070523 18:00 UTC	20070527 12:00 UTC	20070531 06:00 UTC	20070604 00:00 UTC
20070524 00:00 UTC	20070527 18:00 UTC	20070531 12:00 UTC	20070604 06:00 UTC
20070524 06:00 UTC	20070528 00:00 UTC	20070531 18:00 UTC	20070604 12:00 UTC
20070524 12:00 UTC	20070528 06:00 UTC	20070601 00:00 UTC	20070604 18:00 UTC
20070524 18:00 UTC	20070528 12:00 UTC	20070601 06:00 UTC	20070605 00:00 UTC
20070525 00:00 UTC	20070528 18:00 UTC	20070601 12:00 UTC	20070605 06:00 UTC
20070525 06:00 UTC	20070529 00:00 UTC	20070601 18:00 UTC	20070605 12:00 UTC
20070525 12:00 UTC	20070529 06:00 UTC	20070602 00:00 UTC	20070605 18:00 UTC
20070525 18:00 UTC	20070529 12:00 UTC	20070602 06:00 UTC	20070606 00:00 UTC
20070526 00:00 UTC	20070529 18:00 UTC	20070602 12:00 UTC	20070606 06:00 UTC
20070526 06:00 UTC	20070530 00:00 UTC	20070602 18:00 UTC	20070606 12:00 UTC
20070526 12:00 UTC	20070530 06:00 UTC	20070603 00:00 UTC	20070606 18:00 UTC
20070526 18:00 UTC	20070530 12:00 UTC	20070603 06:00 UTC	
20070527 00:00 UTC	20070530 18:00 UTC	20070603 12:00 UTC	

WRF-ENKF 36km Domain
Initialized 20070606 18:00 UTC

Product		Loop By Type	Forecast Hour
Ensemble Members	SLP, loop all members	LOOP	00 06
	850mb temperature, loop all members	LOOP	00 06
	SLP, 10m winds, 925mb temp	LOOP	00 06 12 18 24
	Sea-level pressure with observations	LOOP	00
	1000 - 500mb thickness	LOOP	00 06 12 18 24
	1000 - 850mb thickness	LOOP	00 06 12 18 24
	Surface dewpoint temperature	LOOP	00 06 12 18 24
	Surface temp, 10m winds	LOOP	00 06 12 18 24

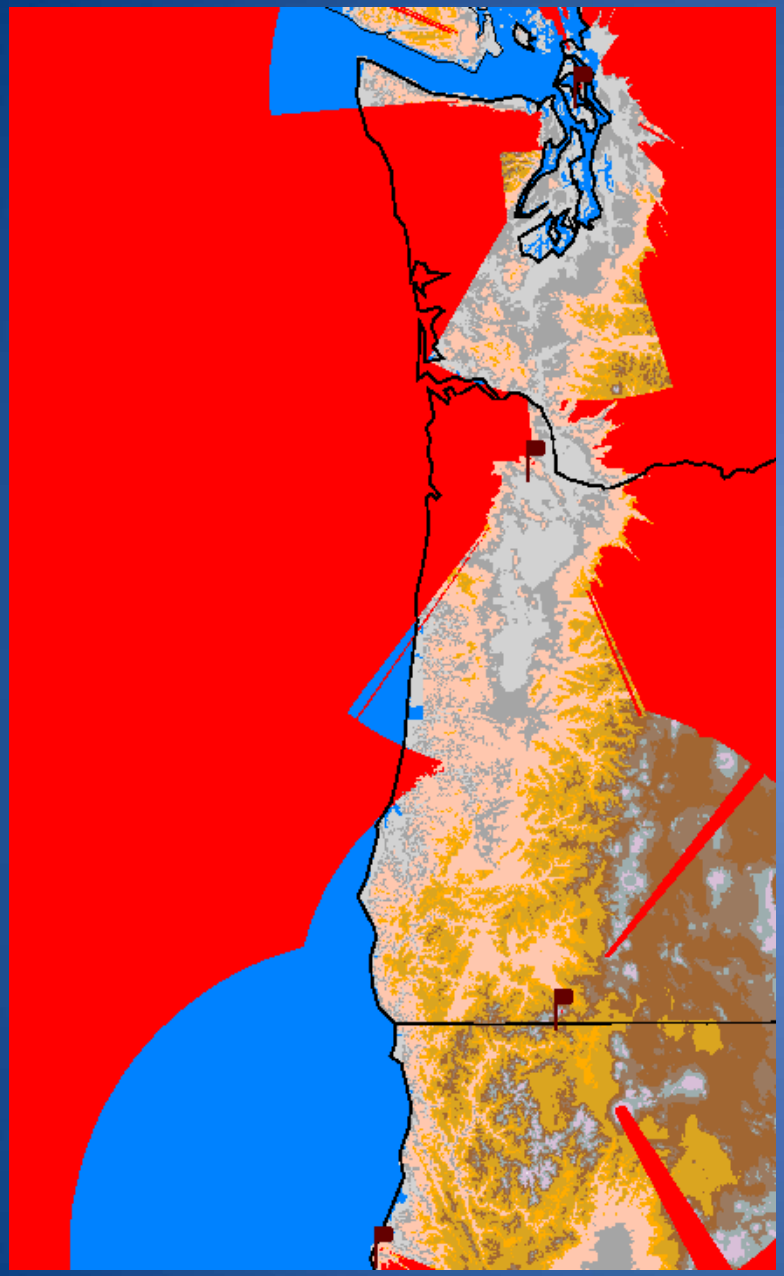

WRF 36-KM ENKF
Init: 12 UTC Wed 27 Feb 08
Fcst: 48 h
Valid: 12 UTC Fri 29 Feb 08 (04 PST Fri 29 Feb 08)
Seal-level pressure standard deviation (mb)
Mean Sea-level Pressure (mb)
180
170 W
160 W
150 W
140 W
130 W
120 W
110 W
100 W
90 W
60 N
50 N
40 N
30 N
1000
1008
1016
1024
CONTOURS: UNITS=g kg-1 LOW= 982.00 HIGH= 1048.0 INTERVAL= 2.0000
1 2 3 4 5 6 7 8 9 10 g kg-1
Model Info: V2.1.2 M KF MYJ PBL WSM 3class Noah LSM 36 km, 37 levels, 200 sec
LW: RRTM SW: Dudhia DIFF: none

Much more next year….

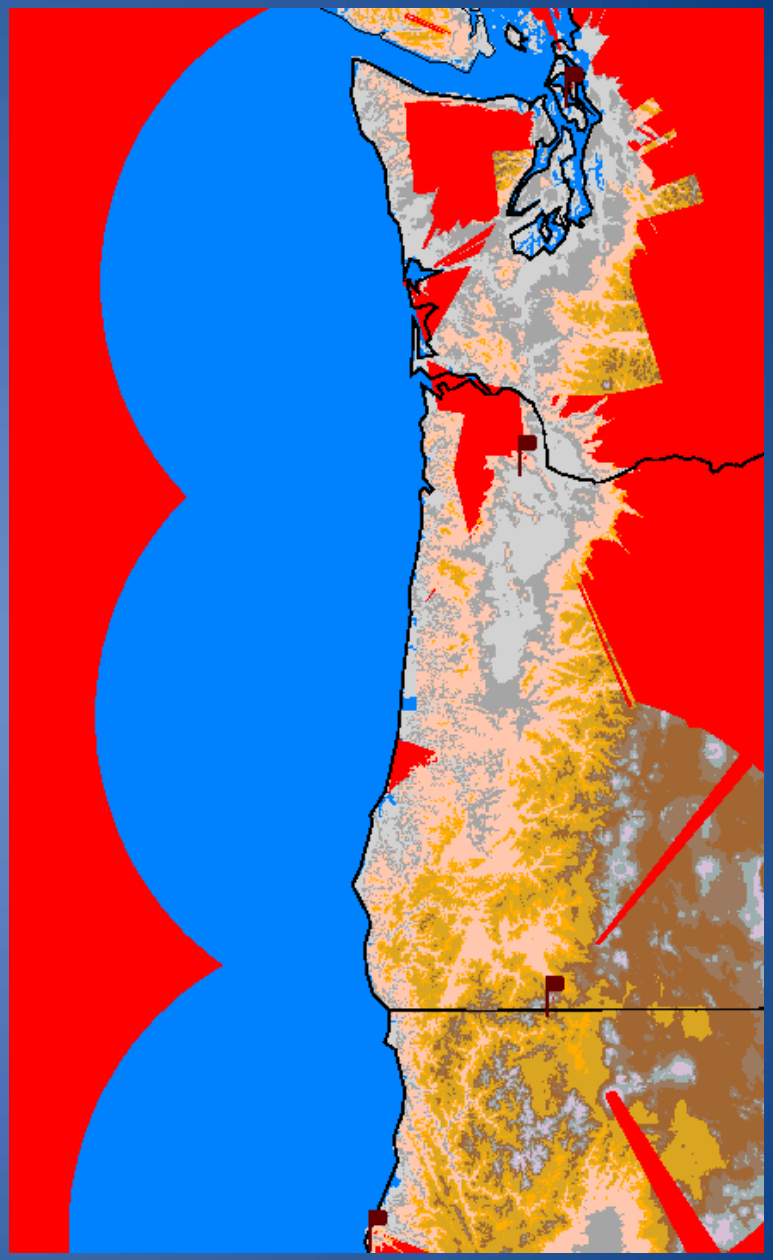
Weather Radar on the Washington Coast: An Update

More at:

http://www.atmos.washington.edu/~cliff/coastalradar.html



Now



With Two New Radars

The Year

- Increasing interest by WA Congressmen and Senators (Norm Dicks, Jay Inslee, Senators Cantwell and Murray).
- Senator Cantwell's office has called a major meeting on March 6th in Aberdeen (Grays Harbor Community College) to coordinate the effort. She is very serious about pushing it this year.
- Local communities along the coast are interested and lobbying. So are weather sensitive businesses.
- Local meteorologists should write and email and use their influence. NOW!

The END