Grid-Based Bias Removal
of Surface Parameters

By Garrett Wedam, Atmospheric Sciences,
University of Washington

Co-authors: Garrett Wedam, Clifford Mass, Richard Steed

Gridded Bias Removal

of Surface Parameters

- Why attempt to remove bias from forecast grids?
  - Systematic bias accounts for a significant portion of model error
  - NWS and others now use gridded graphical forecasts
  - People and applications need forecasts everywhere…not just at MOS sites
- In the past, the NWS has attempted to remove these biases only at observation locations (MOS, Perfect Prog)

About Grid-Based

Grid-based bias removal could be used actively by operational centers.

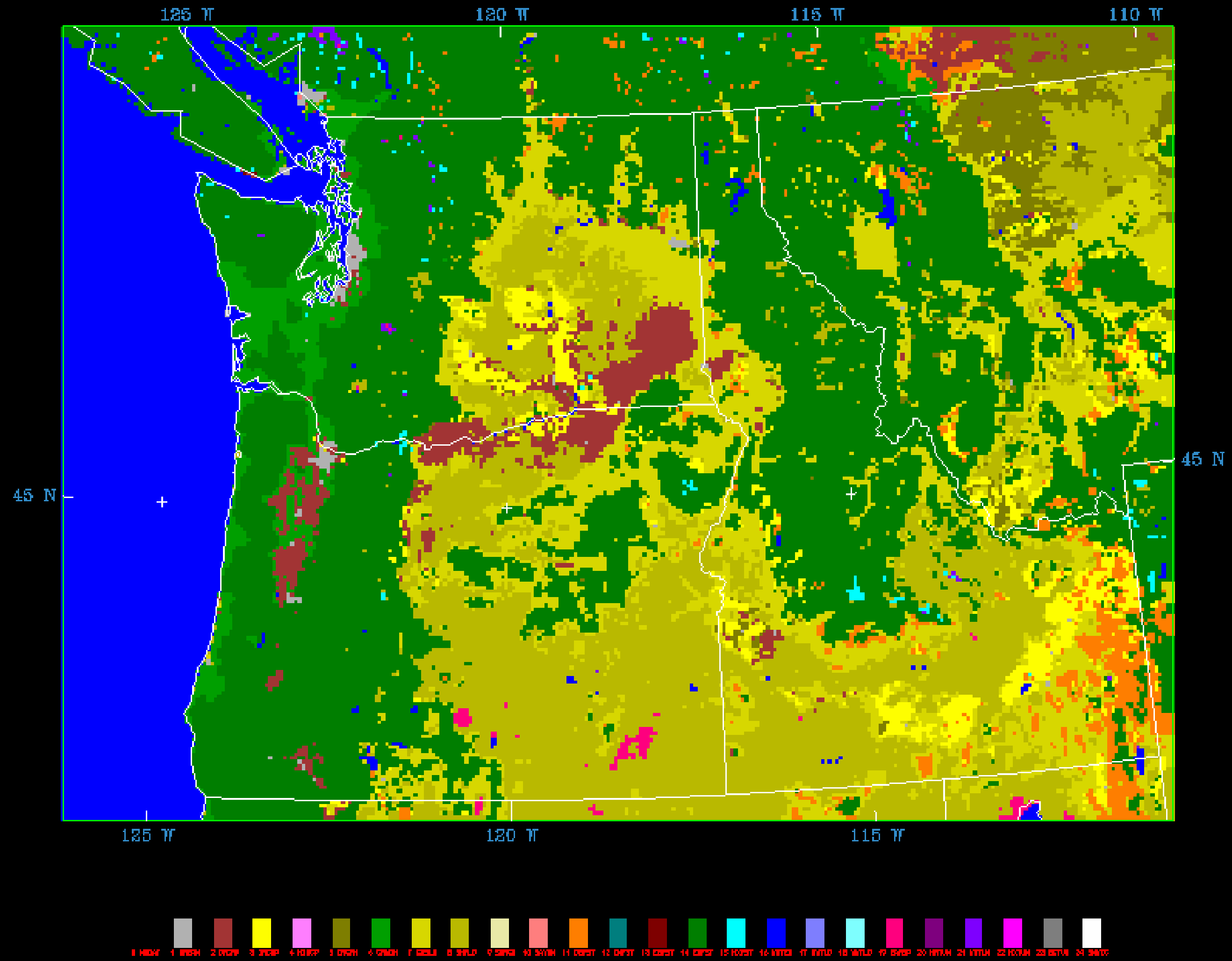
Bias-corrected observation locations cannot simply be interpolated to grids, because individual sites frequently have non-representative and non-systematic biases.

Obs-Based Gridded Bias Removal

- A method that uses gridded analyses (i.e. RUC) as truth was found to be helpful, but limited due to limited resolution. Model predictions need to be supported at fine resolution (few km's).

- The Solution: Use observations. Land use and elevation are the key parameters that control physical biases. So base the bias removal on station land use category and elevation along with proximity.

DOMINANT VEGECAT/NEW LANDUSE TYPE



Obs-Based Gridded Bias Removal: First Try

- Determine model biases at observation locations by interpolating model forecasts to observation sites, then calculating the errors.
- Identify a land use, elevation, and lat-lon for each observation site.
- Calculate average biases at these stations hourly for the past two weeks.
- For every forecast hour: At every forecast grid point search for nearby stations of similar land use and elevation. Collect enough stations (using closest ones first) to average out local effects (~five). Average the biases for these sites and apply the bias correction to the forecast.

Grid-Base Bias Removal

- Why is this approach good?
  - Takes out diurnal bias
  - Takes in consideration land use (e.g., land versus water and generally will only use stations from right side of mountains)
  - Does not spread the non-representative error particular to given sites
  - Based on recent biases so adaptive for time of year and model changes
  - Can be used in areas of relatively sparse data (just have to look further).

This Approach: Not Enough

- BUT… This approach can degrade the forecasts when the weather changes: e.g., forecasts for warm days may not have biases similar to forecasts for cool days.

- So we need a new method that calibrates each parameter to its current regime, and thus does not experience problems at regime changes.

New Method

- As with the previous method, at each grid point search for 5 similar nearby observation stations.
- The new part: Compare the current forecast for each station to previous forecasts, and calculate the station’s bias from just the dates with similar parameter values. E.g., if KSEA’s interpolated forecast temperature was 60, calculate the bias just from dates when KSEA’s forecast was between 55 and 65. Go back in time only far enough to get a certain number of matches…say 4-7.
- As with the previous method, the average of those 5 stations’ biases is used to calculate the bias-corrected forecast at the grid point

Bias at the Station

- So does this method accurately determine the bias at each station before it is applied to the grid point?
  - If so, the mean error over time at a given station should be near zero.
  - Also, removing the calculated bias from each station should result in a better forecast; the mean squared error should be less than the raw forecast's mean squared error.

Relative Humidity (%)

36-hour forecast from 12Z
8/23/04 to 01/23/05

mean absolute error **bias: "mean" and "(standard deviation)"**

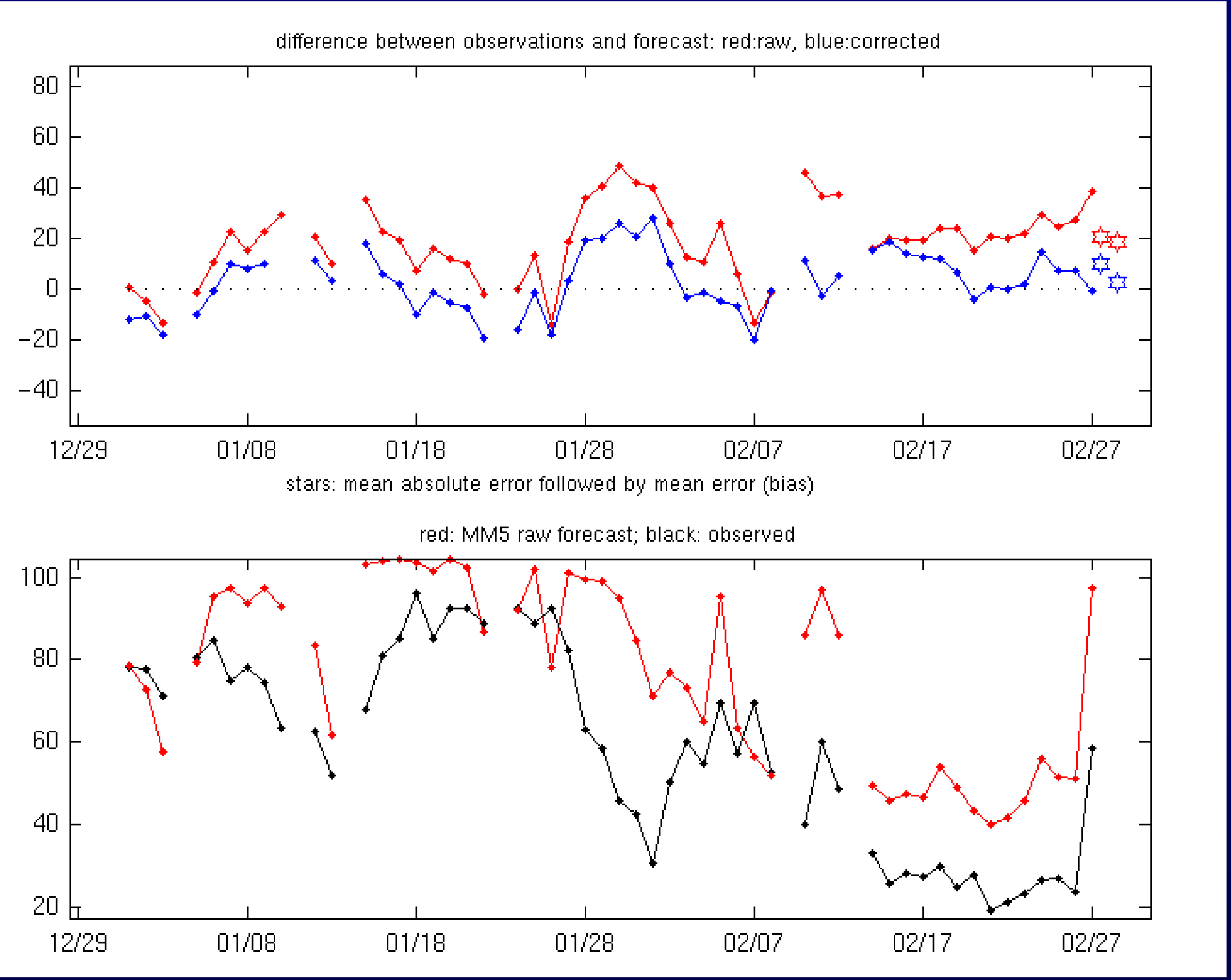
sites	NEW	OLD	RAW	NEW	OLD	RAW
KBFI	9.5	10.4	12.2	-0.1 (12)	2.8 (13)	6.6 (13)
KOLM	8.7	10.2	10.0	-0.8 (12)	0.2 (13)	2.0 (13)
KGEG	11.6	12.6	12.3	0.5 (15)	2.7 (15)	6.5 (14)
KSEA	9.2	9.8	10.3	-0.2 (12)	-0.6 (12)	3.1 (13)
KBNO	10.7	9.7	17.1	0.5 (14)	0.4 (13)	15.9 (13)
KSLC	11.5	13.3	18.3	-0.1 (15)	5.9 (15)	16.1 (15)
KBZN	13.4	13.9	19.9	-0.1 (18)	-2.1 (18)	17.2 (17)
KELN	10.0	12.0	17.0	0.0 (13)	6.9 (13)	15.2 (14)
KKLS	7.9	11.5	11.0	-0.6 (11)	2.3 (14)	1.8 (14)
KYKM	10.1	11.3	15.3	0.7 (14)	4.7 (15)	13.2 (14)

combined mean absolute error:
NEW: 10.3; OLD: 11.5; RAW: 14.3

Relative Humidity (%)

Shorter Term

36-hour forecast from 12Z



Temperature (C)

36-hour forecast from 12Z

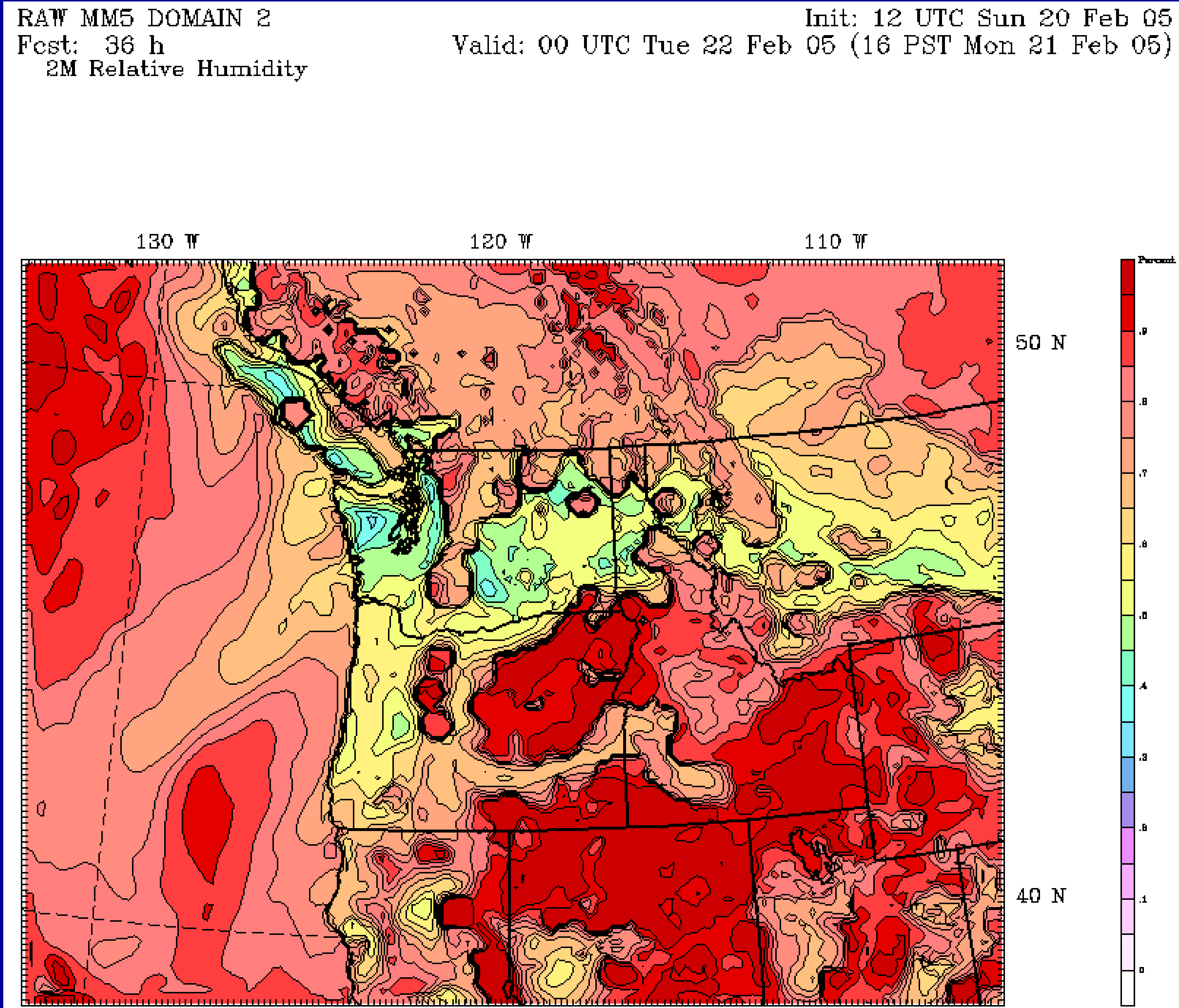
mean absolute error | **bias: "mean" and "(standard deviation)"**

sites	NEW	OLD	RAW	NEW	OLD	RAW
KEPH	1.9	2.0	2.0	0.22 (2.3)	0.02 (2.4)	-0.57 (2.4
KOLM	1.5	1.7	1.6	0.15 (2.0)	-0.46 (2.1)	0.65 (2.1)
KGEG	1.6	1.8	1.6	0.08 (2.1)	0.46 (2.2)	-0.28 (2.0)
KSEA	1.5	1.6	1.7	0.00 (2.0)	0.43 (2.1)	0.90 (2.2)
KBNO	2.0	2.1	2.6	0.17 (2.6)	-0.08 (2.7)	-1.43 (2.9)
KKLS	1.7	1.7	1.7	0.24 (2.2)	-0.10 (2.2)	0.10 (2.2)
KYKM	2.2	2.4	2.2	-0.14 (2.9)	0.15 (3.1)	-0.67 (2.7)
KEUG	1.9	1.7	1.8	0.19 (2.5)	0.20 (2.3)	0.72 (2.3)

combined mean absolute error:
NEW: 1.8; OLD: 1.9; RAW: 1.9

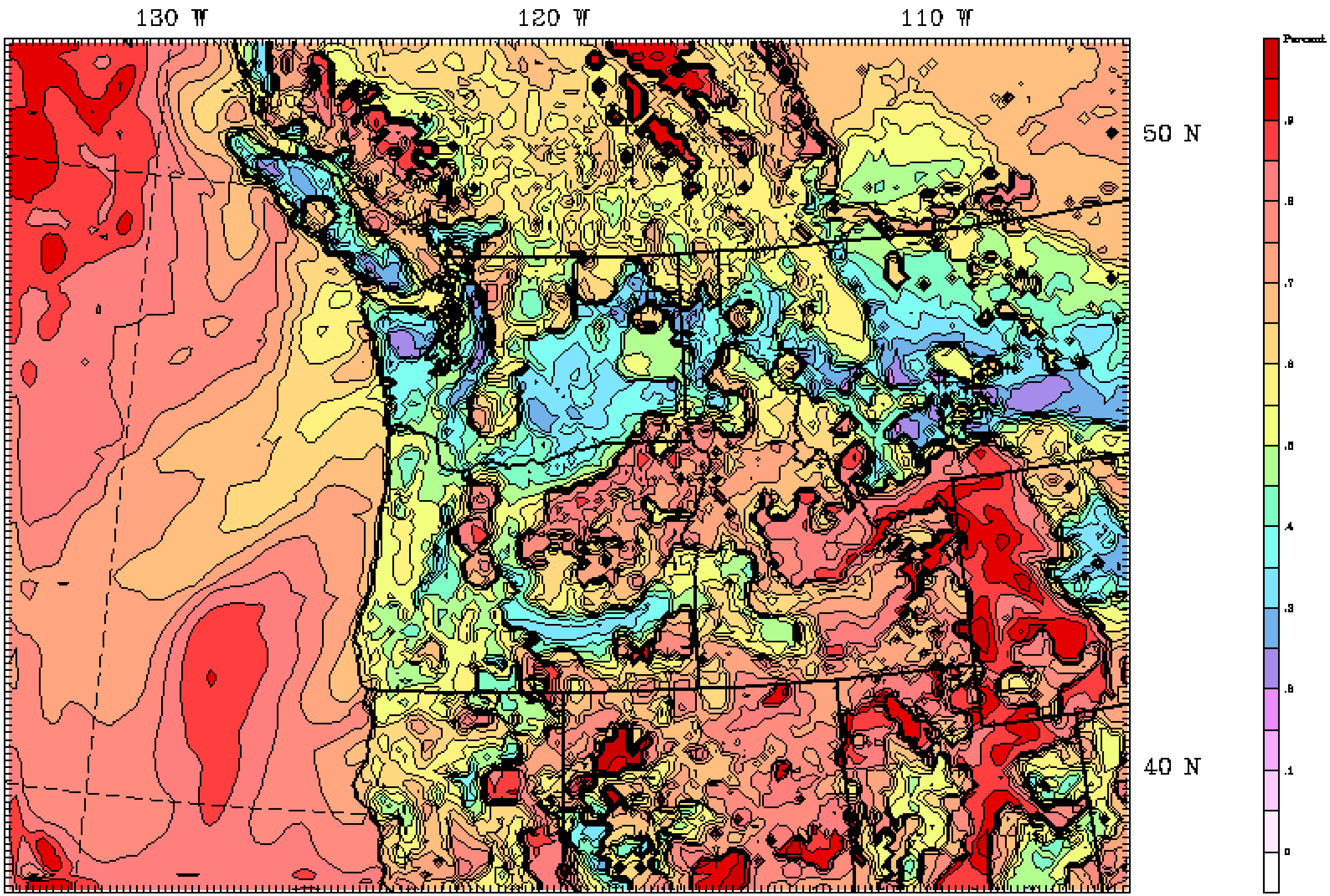
Apply to the Grid

- Now we know that the method accurately calculates bias for the stations, but is it useful when averaged and applied to a grid?
  - Next: case analyses for Relative Humidity and Temperature.


RAW MM5 DOMAIN 2
Fcst: 36 h
2M Relative Humidity
Init: 12 UTC Sun 20 Feb 05
Valid: 00 UTC Tue 22 Feb 05 (16 PST Mon 21 Feb 05)
130 W
120 W
110 W
50 N
40 N
Percent

WC TEST DOMAIN 2
Fcst: 36 h
2M Relative Humidity

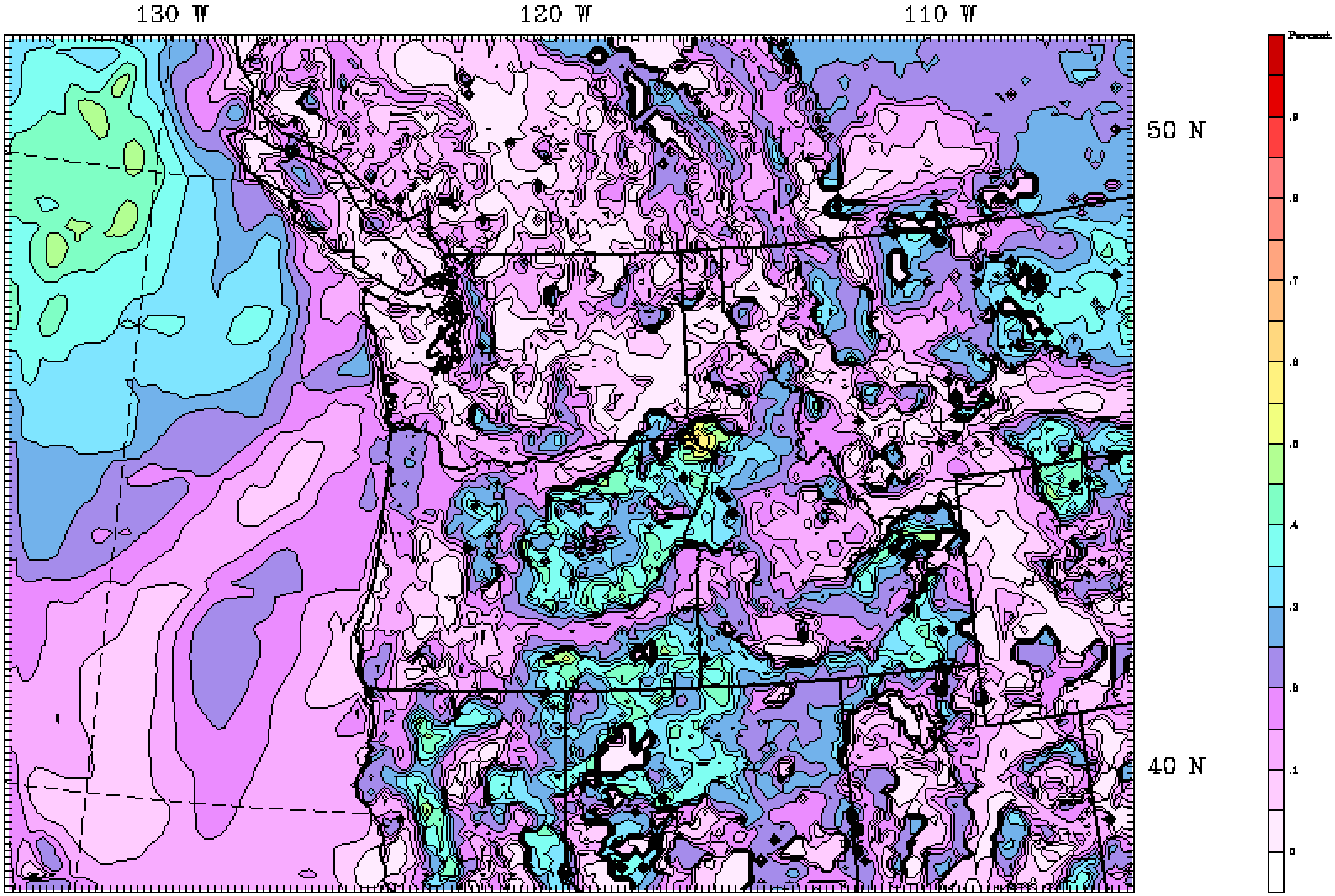
Init: 12 UTC Sun 20 Feb 05
Valid: 00 UTC Tue 22 Feb 05 (16 PST Mon 21 Feb 05)



MM ERR DOMAIN 2
Fcst: 0 h
2M Relative Humidity

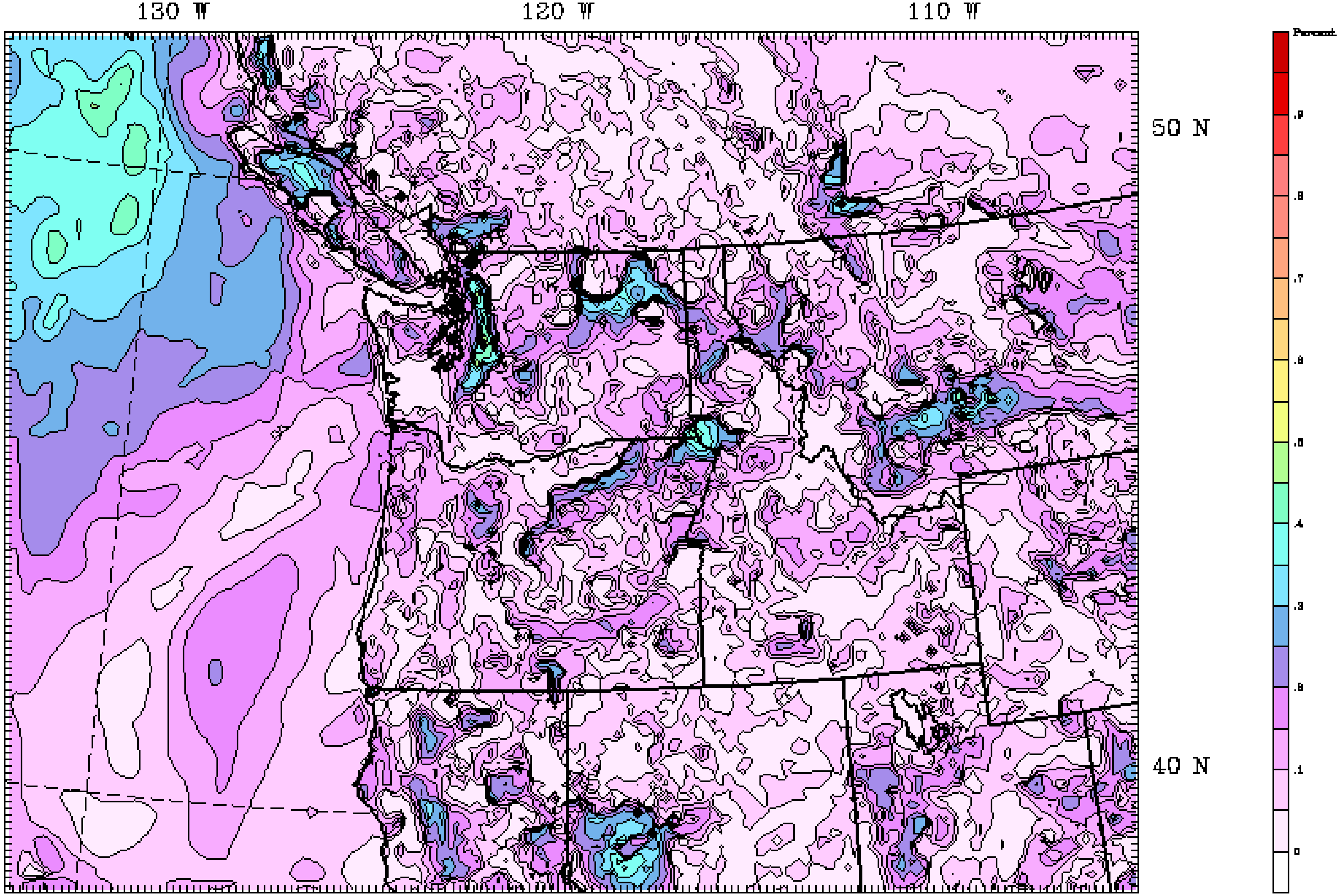
Init: 00 UTC Tue 22 Feb 05
Valid: 00 UTC Tue 22 Feb 05 (16 PST Mon 21 Feb 05)

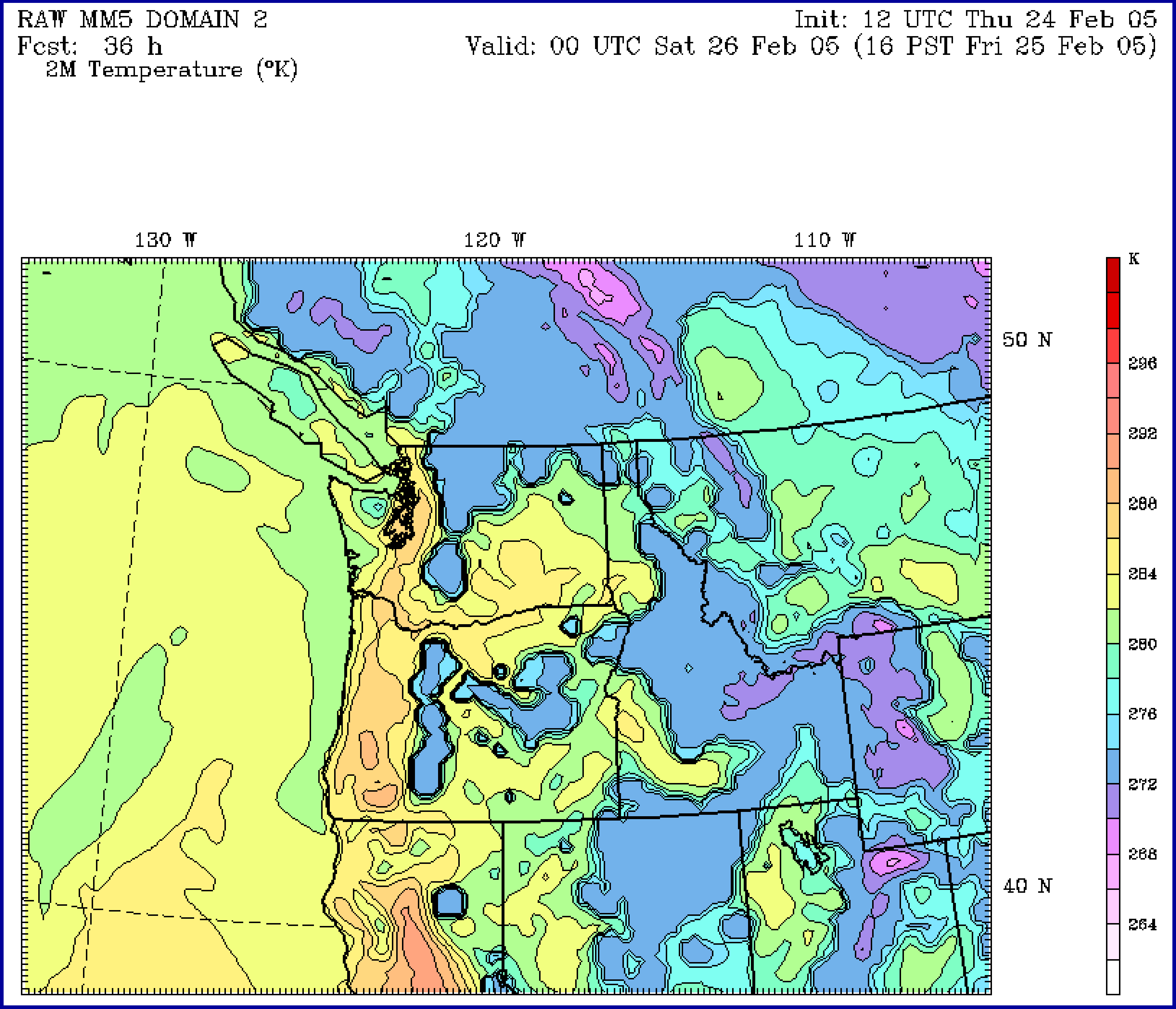
Mean Bias: 12.8 %
Mean Abs. Error: 16.7 %



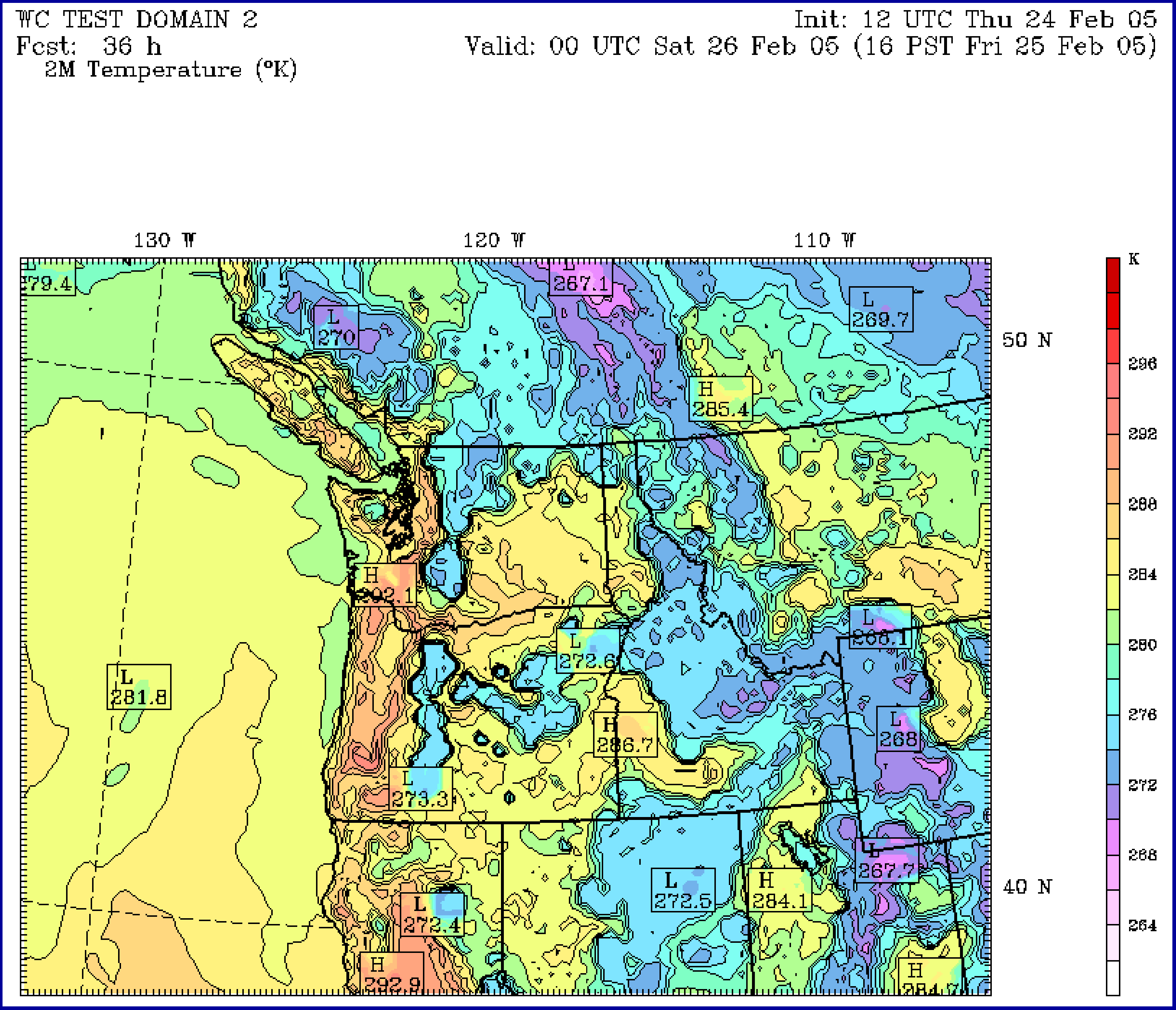
BC ERR DOMAIN 2 Init: 00 UTC Tue 22 Feb 05
Fcst: 0 h Valid: 00 UTC Tue 22 Feb 05 (16 PST Mon 21 Feb 05)
2M Relative Humidity

Mean Bias: 1.1 % (Raw: 12.8 %)
Mean Abs. Error: 11.3 % (Raw: 16.7 %)





RAW MM5 DOMAIN 2
Fcst: 36 h
2M Temperature (°K)
Init: 12 UTC Thu 24 Feb 05
Valid: 00 UTC Sat 26 Feb 05 (16 PST Fri 25 Feb 05)
130 W
120 W
110 W
50 N
40 N
K
296
292
288
284
280
276
272
268
264

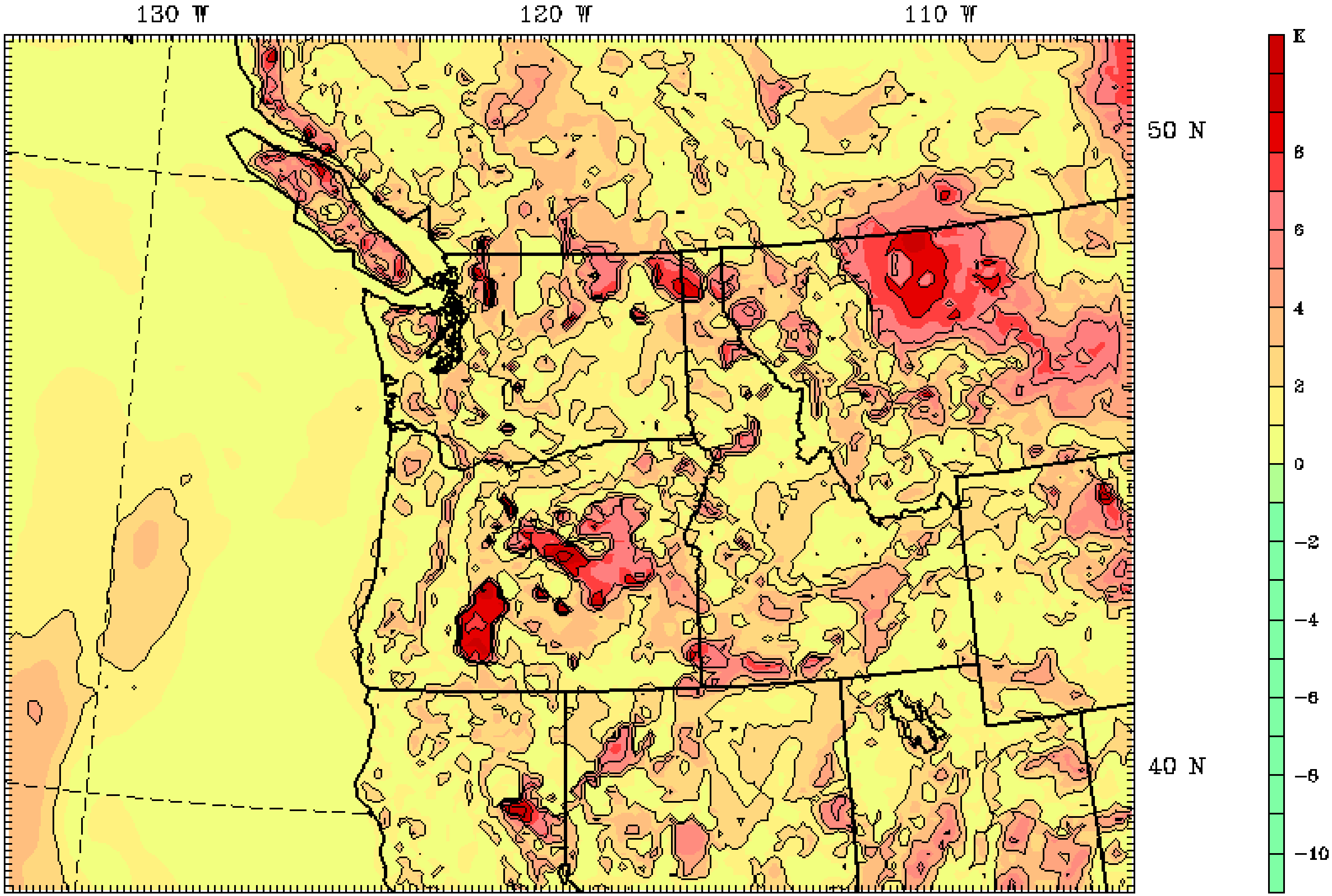


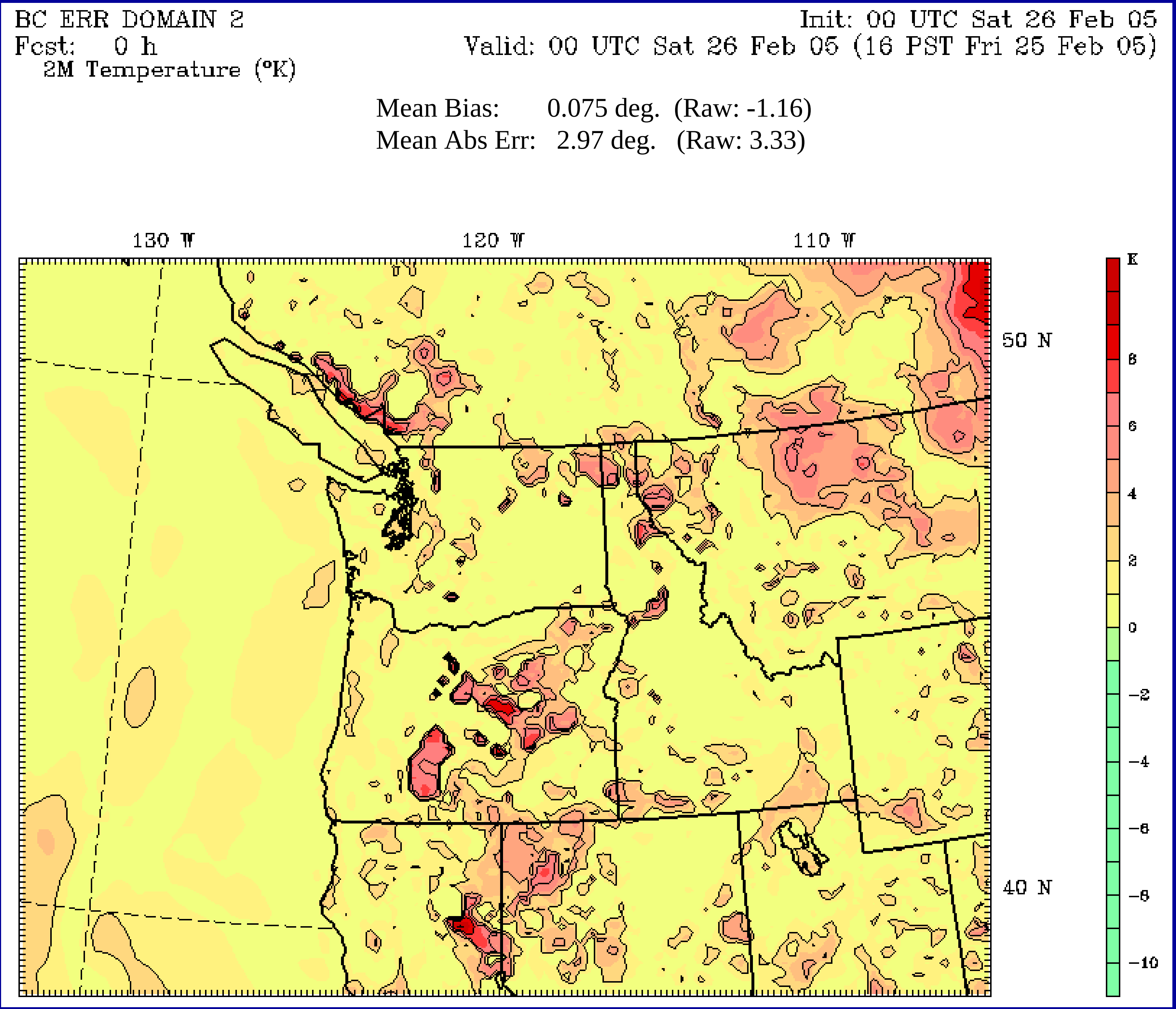
WC TEST DOMAIN 2
Fcst: 36 h
2M Temperature (°K)
Init: 12 UTC Thu 24 Feb 05
Valid: 00 UTC Sat 26 Feb 05 (16 PST Fri 25 Feb 05)
130 W
120 W
110 W
50 N
40 N
L 270
267.1
L 269.7
H 285.4
H 292.1
L 281.8
L 272.6
H 286.7
L 268
L 273.3
L 272.5
H 284.1
L 267.7
L 272.4
H 292.9
K
296
292
288
284
280
276
272
268
264

MM ERR DOMAIN 2
Fcst: 0 h
2M Temperature (°K)

Init: 00 UTC Sat 26 Feb 05
Valid: 00 UTC Sat 26 Feb 05 (16 PST Fri 25 Feb 05)

Mean Bias: -1.16 deg.
Mean Abs Err: 3.33 deg.




BC ERR DOMAIN 2
Fcst: 0 h
2M Temperature (°K)
Init: 00 UTC Sat 26 Feb 05
Valid: 00 UTC Sat 26 Feb 05 (16 PST Fri 25 Feb 05)
Mean Bias: 0.075 deg. (Raw: -1.16)
Mean Abs Err: 2.97 deg. (Raw: 3.33)
130 W
120 W
110 W
50 N
40 N
K
8
6
4
2
0
−2
−4
−6
−8
−10

Haves, Will Haves, and Plans

- Currently, we have a grid-based bias correction and verification system for RH and T.
- WSP is being implemented, with promising preliminary outlook, W-dir is next.
- Plans are to complete testing through producing and verifying gridded forecasts, then make the system available to consortium