

June 20, 2010

Tornadoes in Wyoming

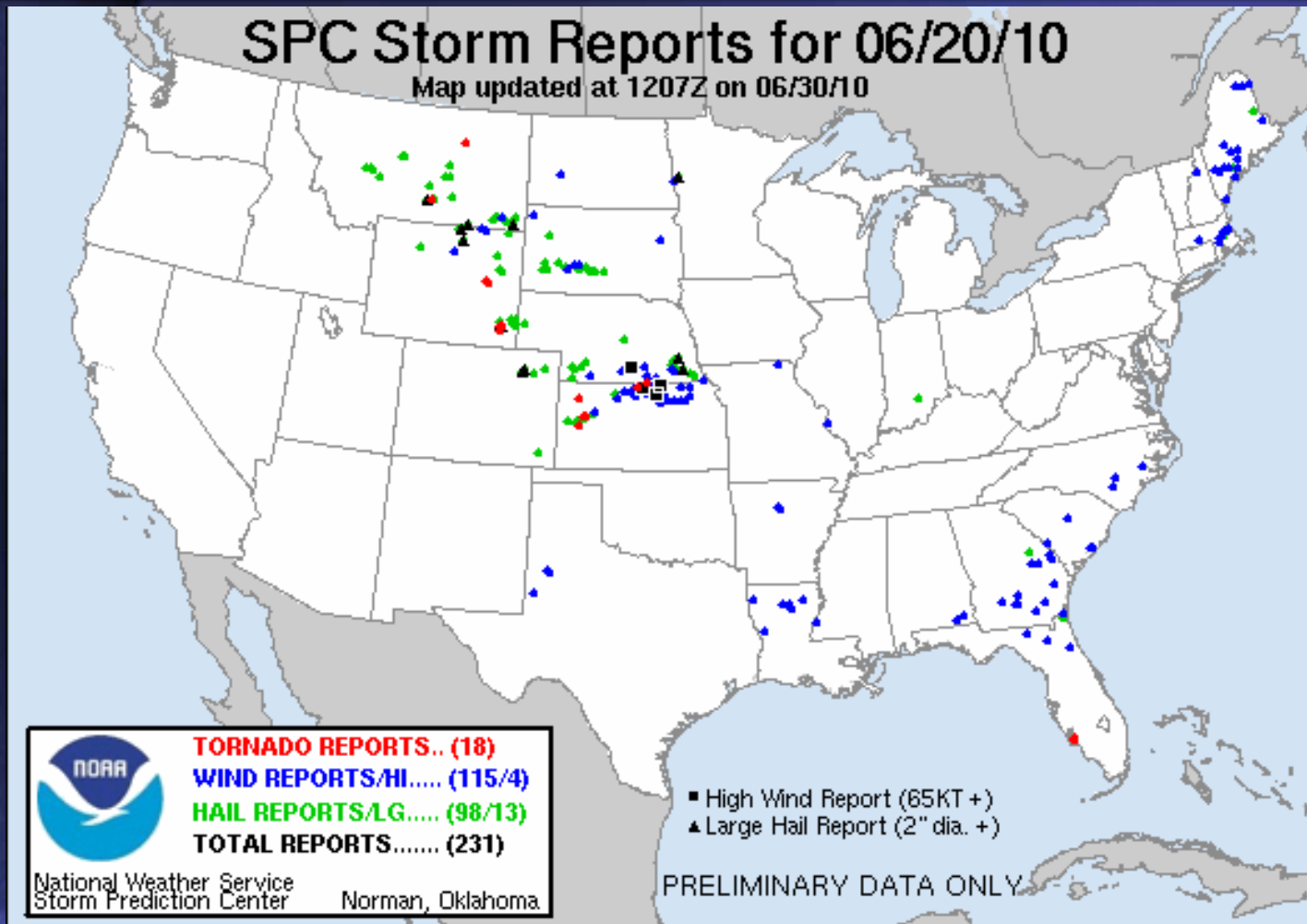
Jonathan Finch – National Weather Service, Dodge City

Dan Bikos – Cooperative Institute for Research in the
Atmosphere, Fort Collins, CO

Morning Thoughts from Cheyenne

"I've looked at many eastern WY tornado cases dating back to 1940s and today's parameters are on the extreme side of what is typically associated with tornado events."

Storm Reports



Initial Chugwater Storm

Michael Carlson

<http://michaelcarlsonphoto.com/>



Chugwater Tornado

Michael Carlson

<http://michaelcarlsonphoto.com/>



Chugwater Tornado

Michael Carlson

<http://michaelcarlsonphoto.com/>



Chugwater Hailstones

Tony Laubach



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www.tornadoeskick.com

Chugwater Hailstones

Tony Laubach



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www.tornadoeskick.com

Chugwater Hail Victims



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Converse County Storm

After the initial storms weakened, we became worried about the high CIN east of I-25. So we headed north to Converse county hoping a storm would develop in the clear air.

Jonathan Finch
&
Dan Bikos



Converse County Storm

Jonathan Finch
&
Dan Bikos



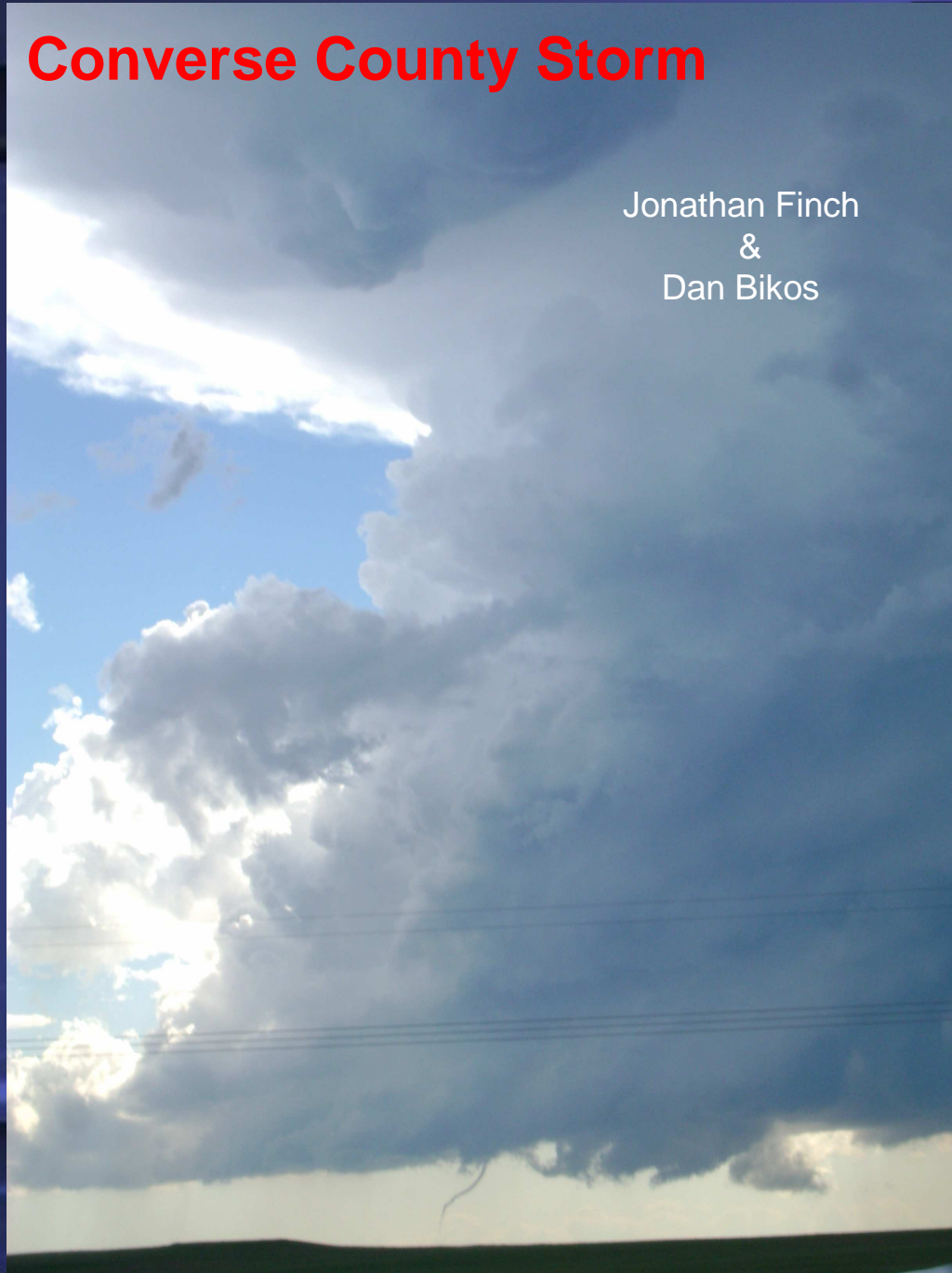
Converse County Storm

Jonathan Finch
&
Dan Bikos



Converse County Storm

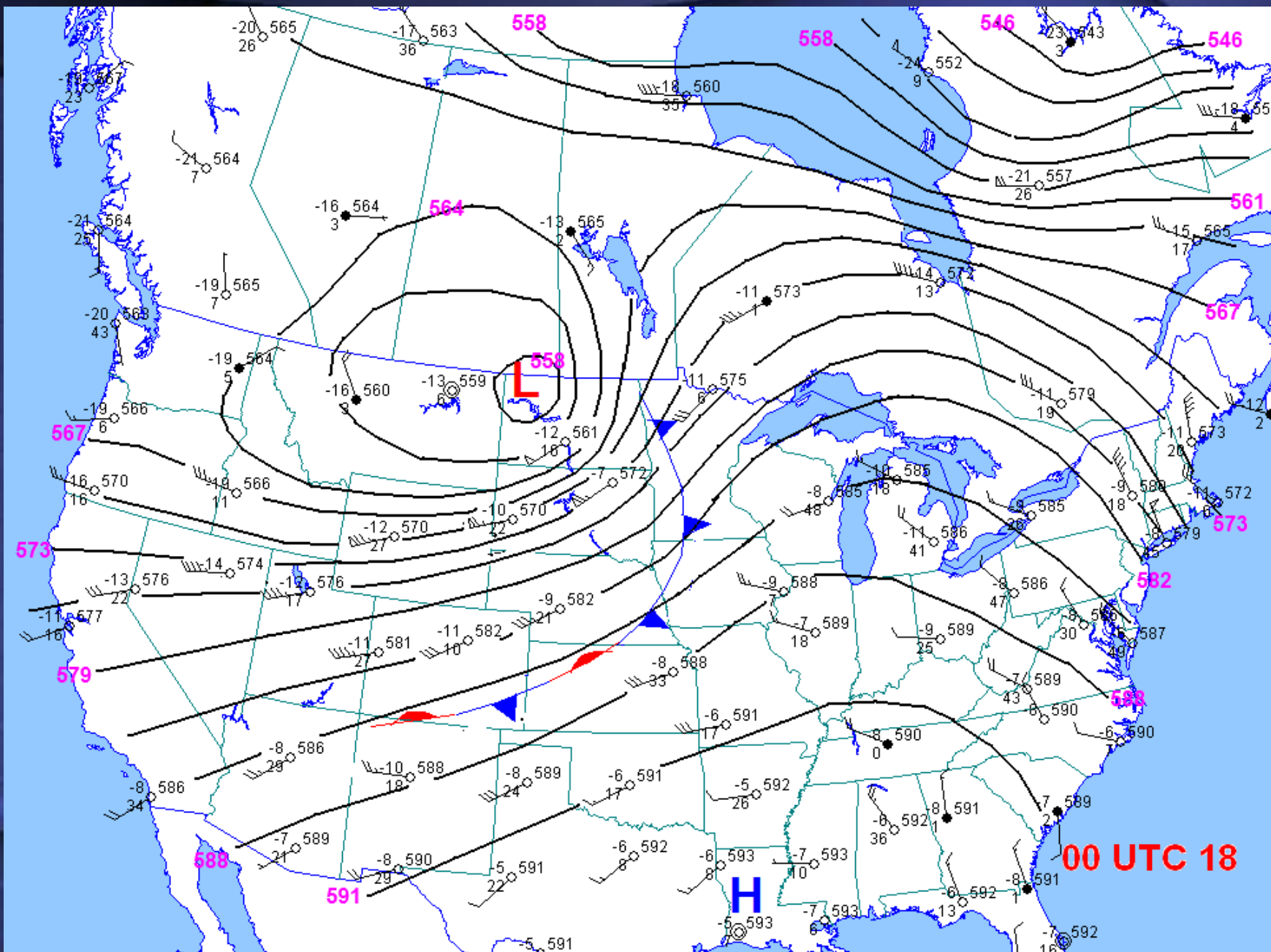
Jonathan Finch
&
Dan Bikos



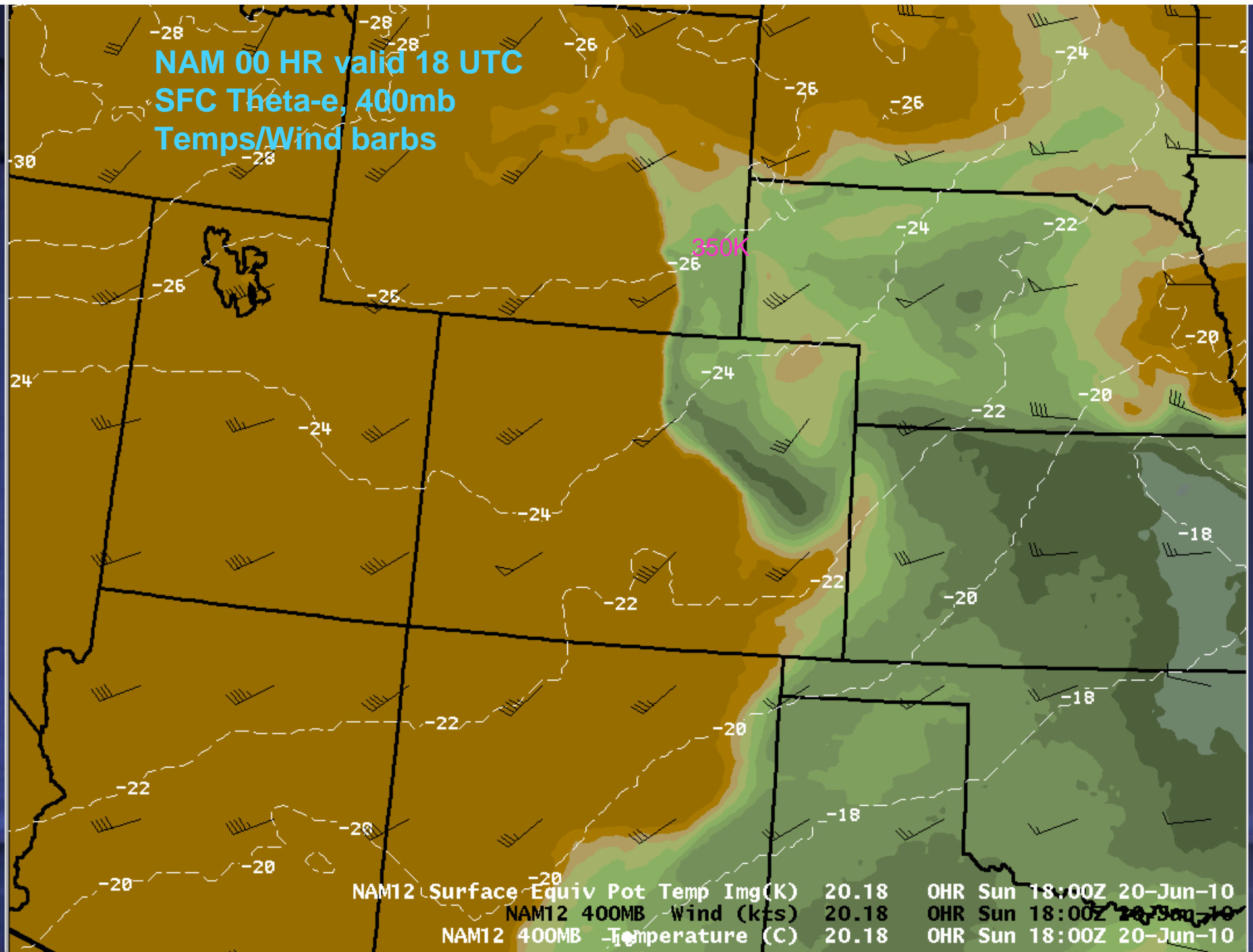
**Converse County Storm
(courtesy Douglas Budget)**



500 mb Progression with Primary Surface Front

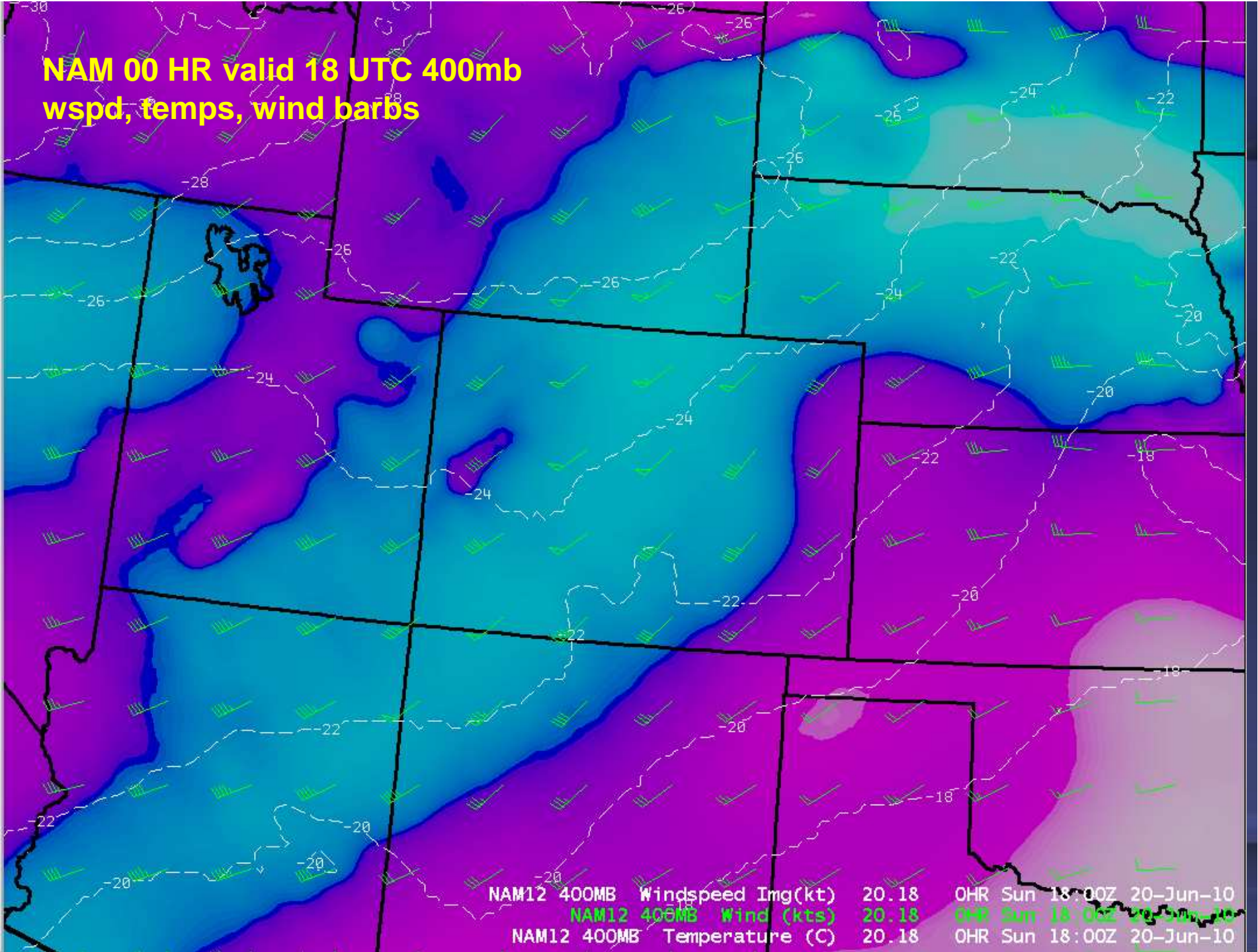


NAM 00 HR valid 18 UTC
SFC Theta-e, 400mb
Temps/Wind barbs



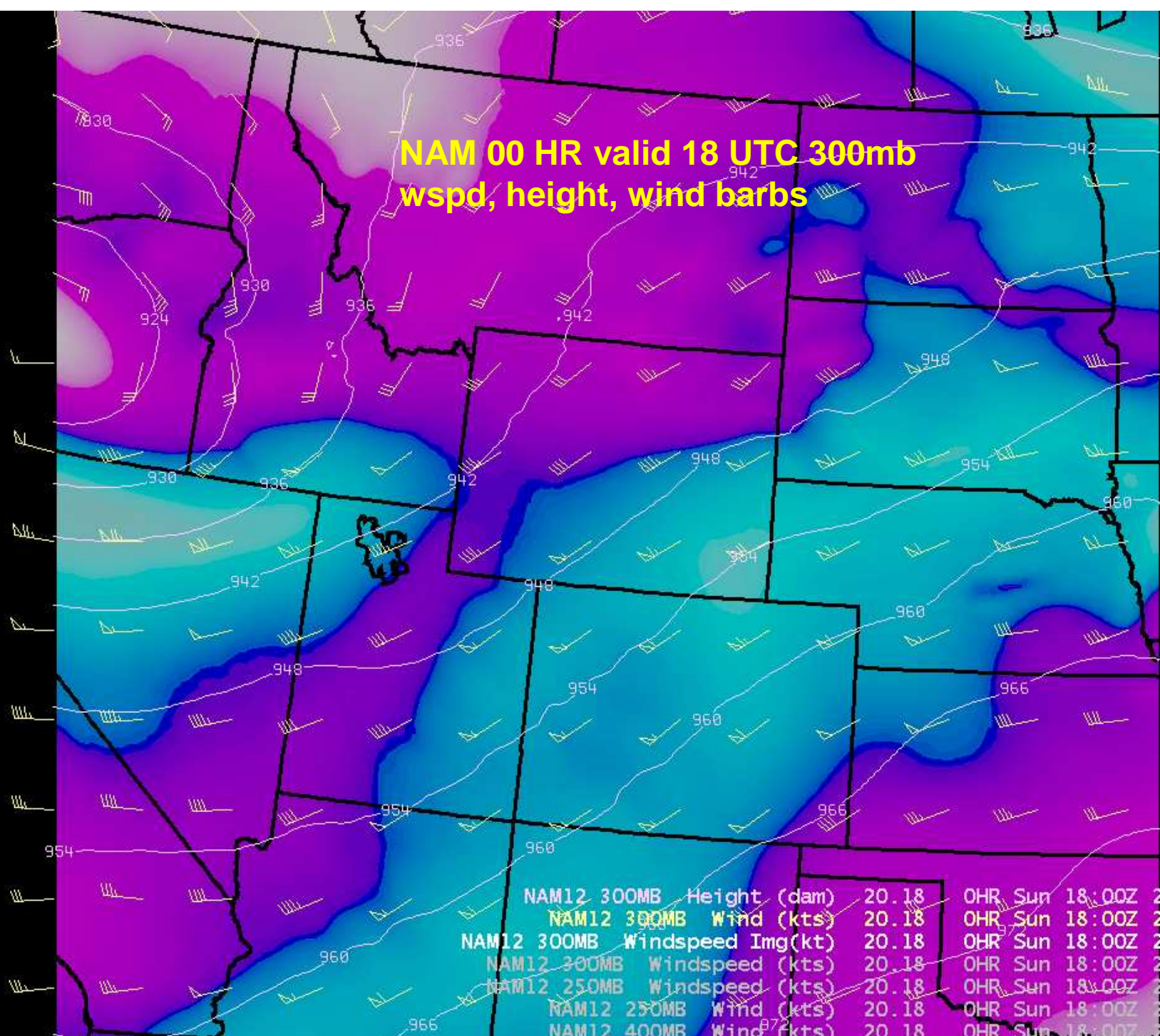
NAM12 Surface Equiv Pot Temp Img(K)	20.18	OHR Sun 18:00Z 20-Jun-10
NAM12 400MB Wind (kts)	20.18	OHR Sun 18:00Z 20-Jun-10
NAM12 400MB Temperature (C)	20.18	OHR Sun 18:00Z 20-Jun-10

**NAM 00 HR valid 18 UTC 400mb
wspd, temps, wind barbs**

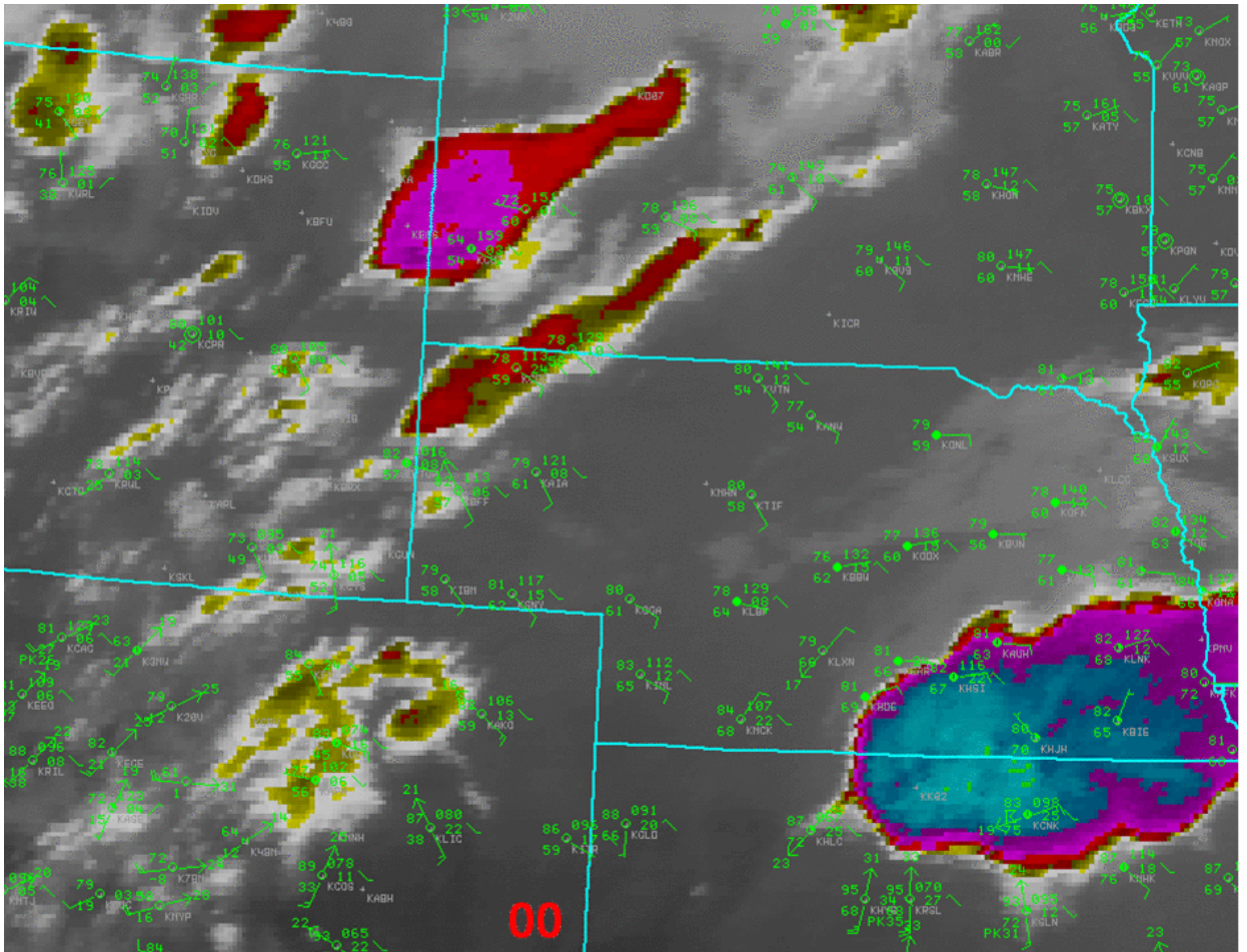


NAM12 400MB Windspeed Img(kt)	20.18	OHR Sun 18:00Z 20-Jun-10
NAM12 400MB Wind (kts)	20.18	OHR Sun 18:00Z 20-Jun-10
NAM12 400MB Temperature (C)	20.18	OHR Sun 18:00Z 20-Jun-10

**NAM 00 HR valid 18 UTC 300mb
wspd, height, wind barbs**



NAM12 300MB Height (dam)	20.18	OHR Sun 18:00Z	20-Jun-10
NAM12 300MB Wind (kts)	20.18	OHR Sun 18:00Z	20-Jun-10
NAM12 300MB Windspeed Img(kt)	20.18	OHR Sun 18:00Z	20-Jun-10
NAM12 300MB Windspeed (kts)	20.18	OHR Sun 18:00Z	20-Jun-10
NAM12 250MB Windspeed (kts)	20.18	OHR Sun 18:00Z	20-Jun-10
NAM12 250MB Wind (kts)	20.18	OHR Sun 18:00Z	20-Jun-10
NAM12 400MB Wind (kts)	20.18	OHR Sun 18:00Z	20-Jun-10



Outflow Surging Westward

23Z 98/69 19016KT
00Z 78/66 04020KT

Hill City, KS after 23 Z 19th

01Z 88/65 05003KT
02Z 78/66 33006KT
03Z 76/67 07015KT

Goodland, KS after 01 Z 20th

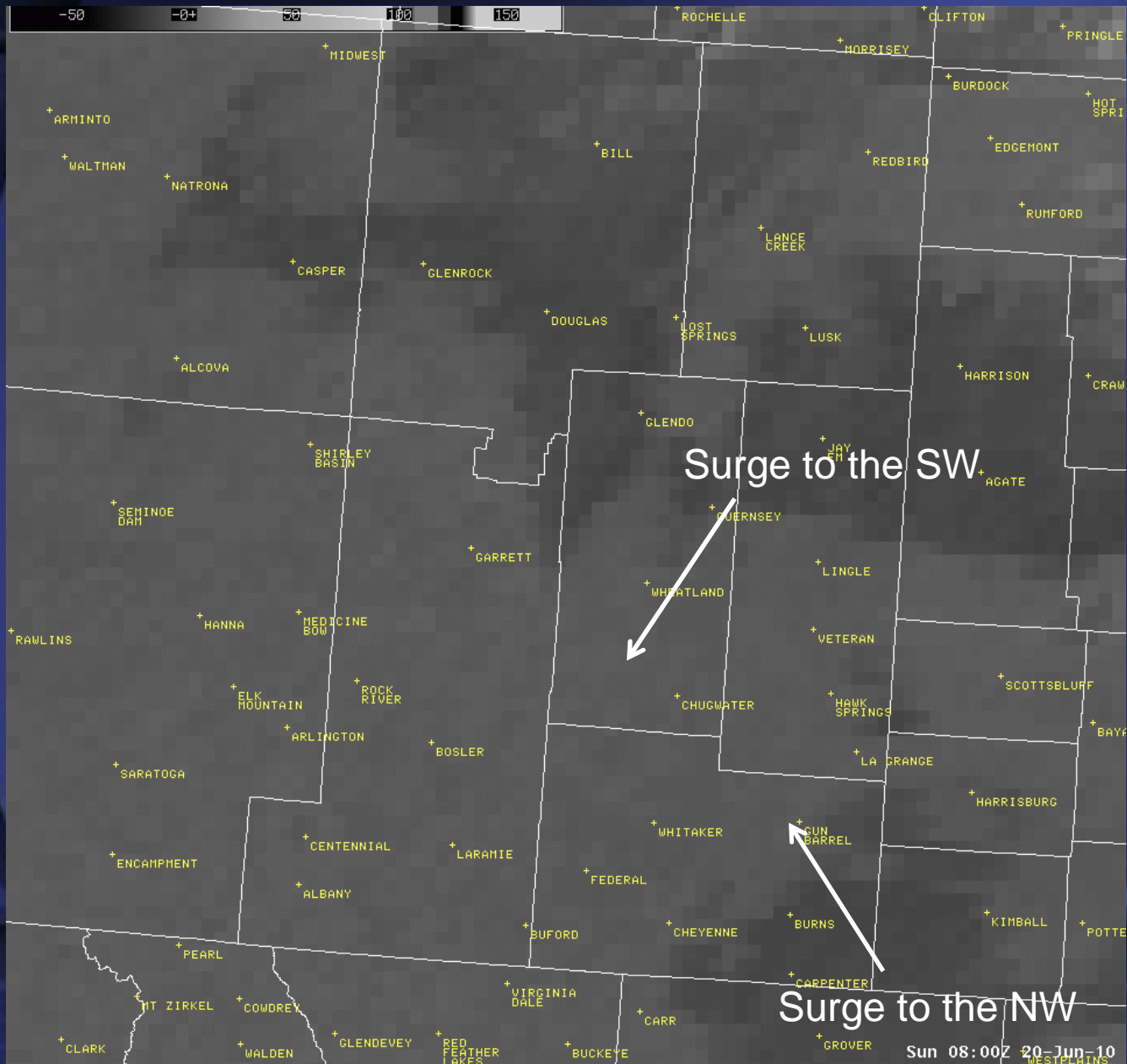
04Z 65/49 05003KT
05Z 64/59 33006KT
06Z 66/63 07015KT

Limon, CO after 04 Z

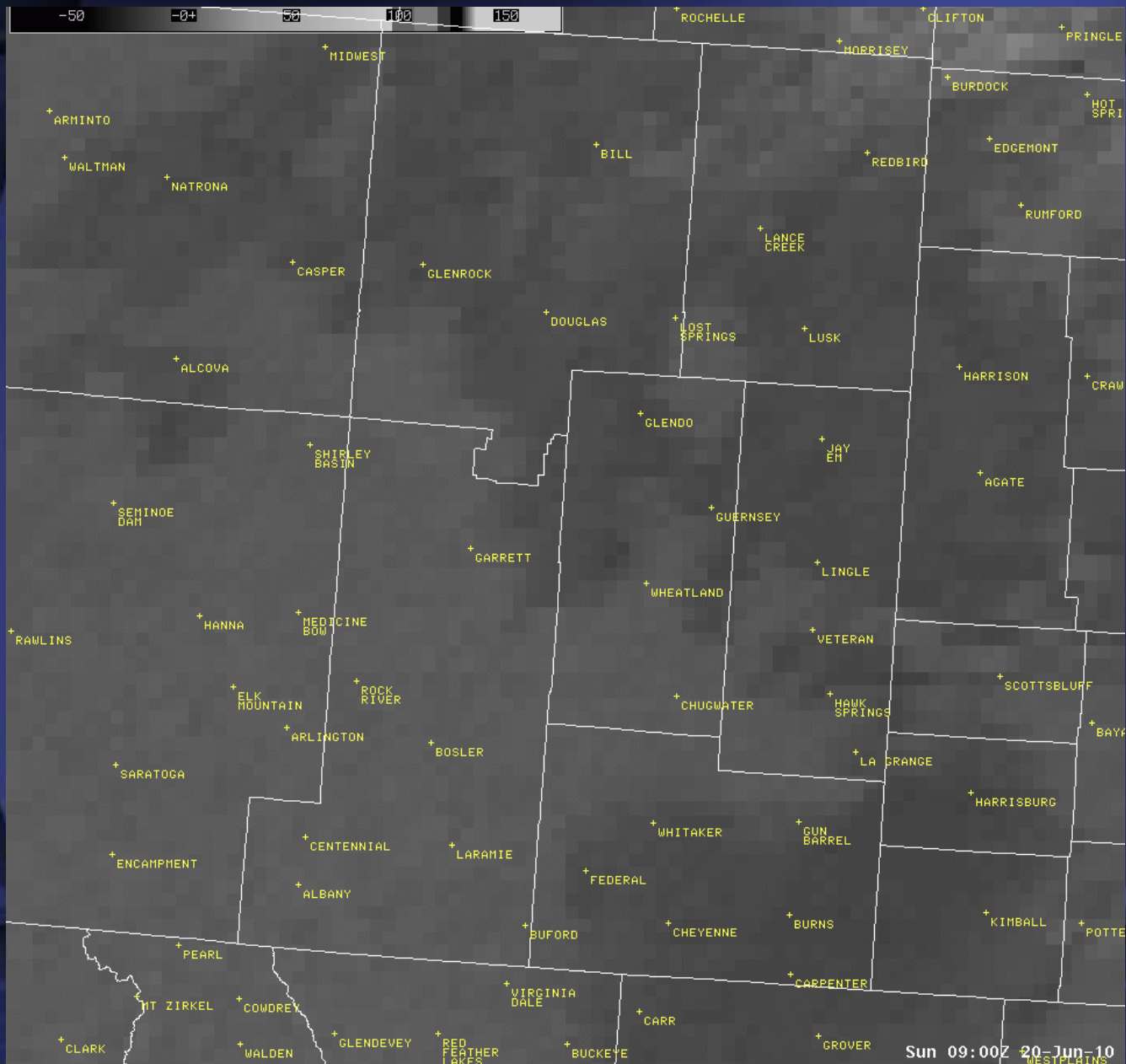
04Z 70/60 00000KT
05Z 70/61 09021KT
06Z 67/64 10021KT

Akron, CO after 04 Z

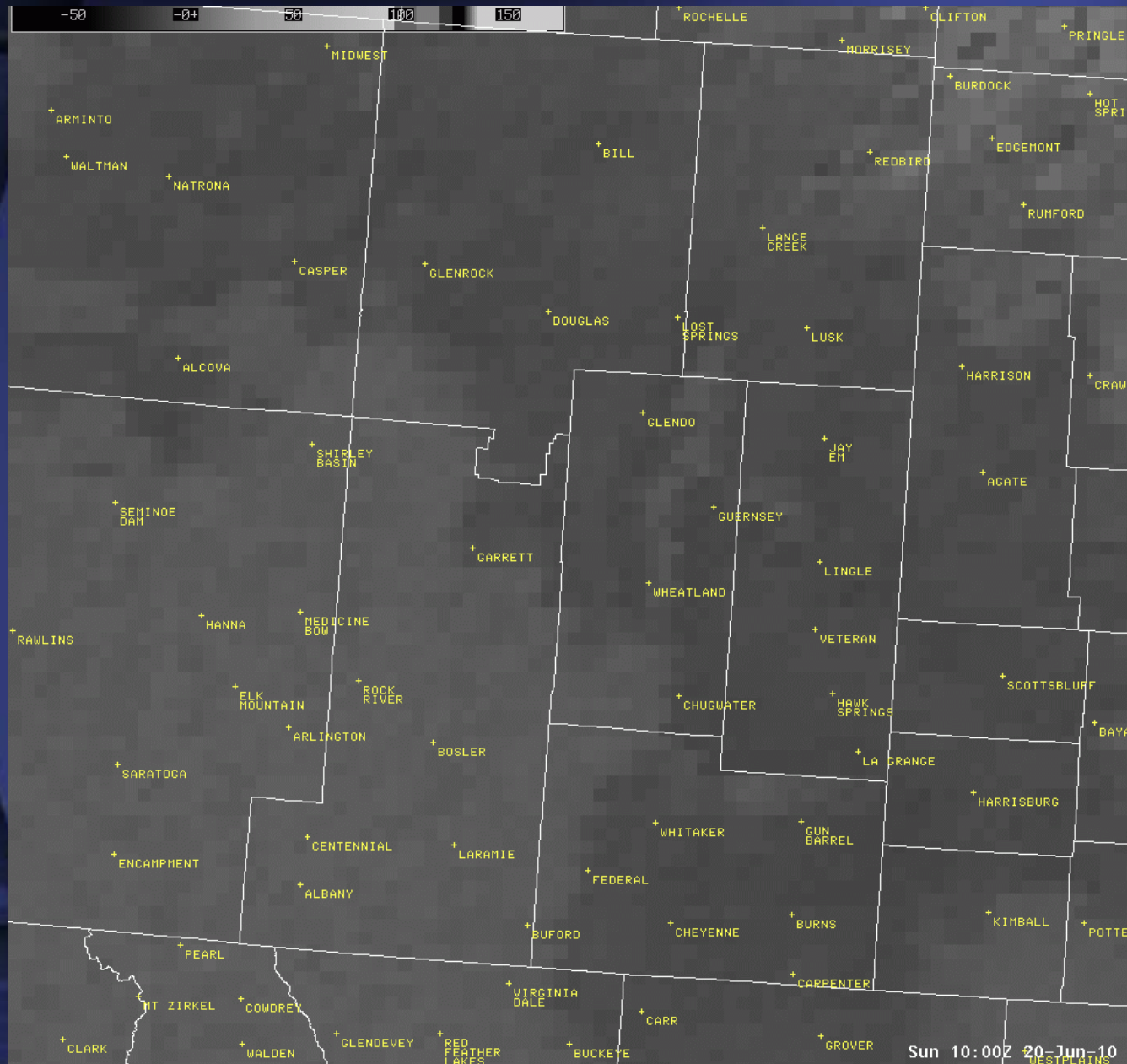
Morning Moist Surge - 08 UTC



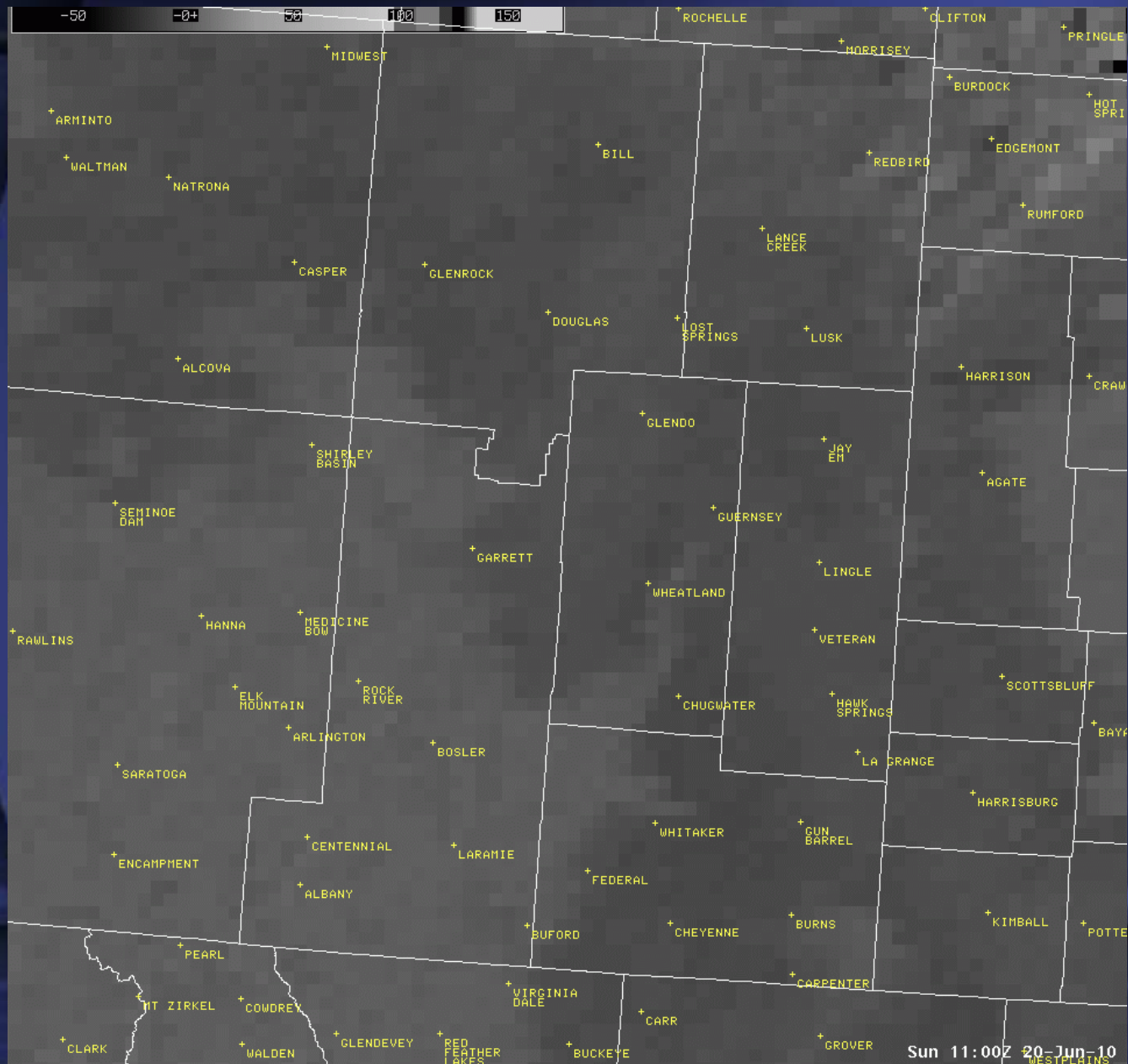
Morning Moist Surge – 09 UTC



Morning Moist Surge – 10 UTC

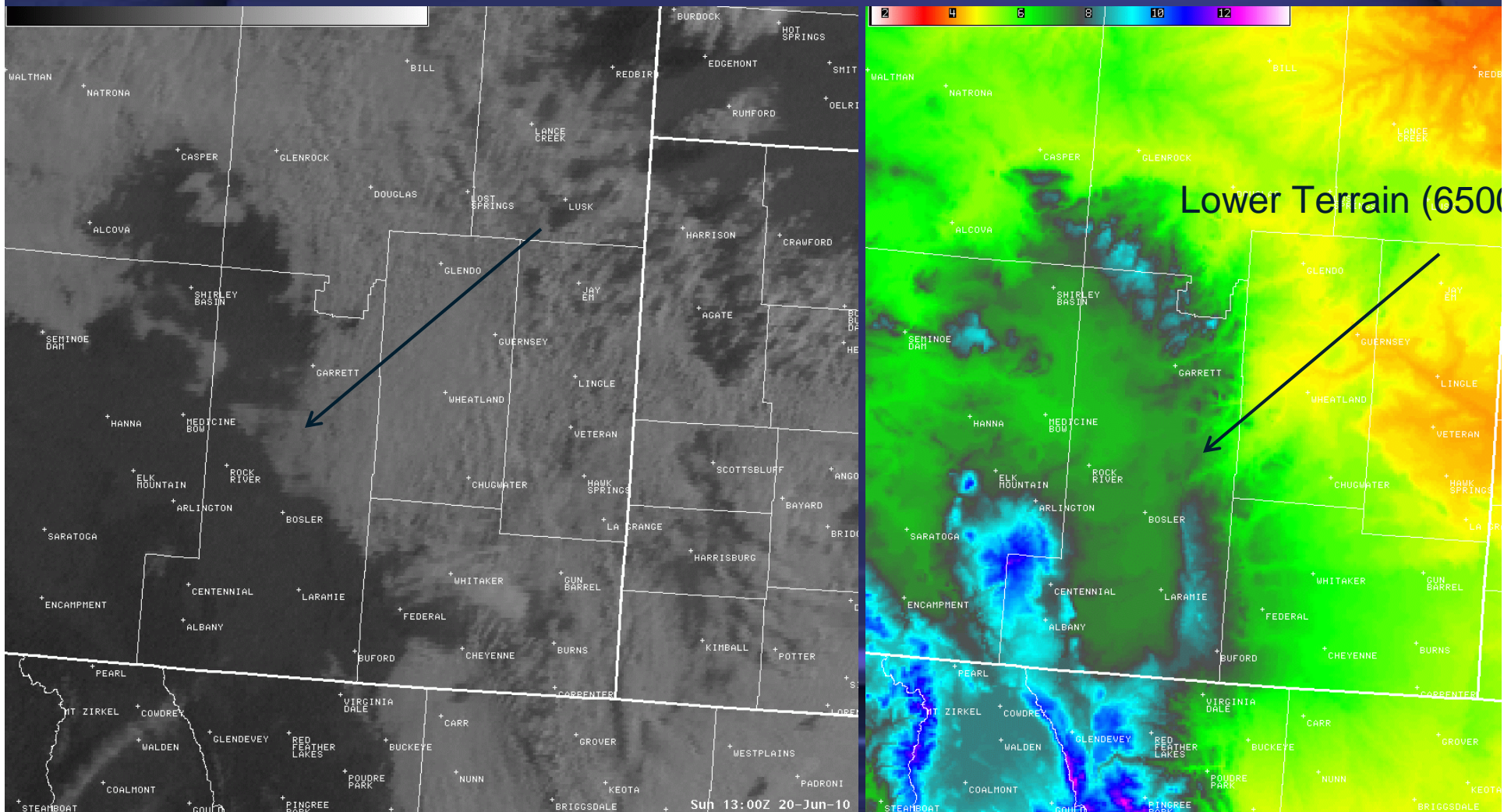


Morning Moist Surge – 11 UTC

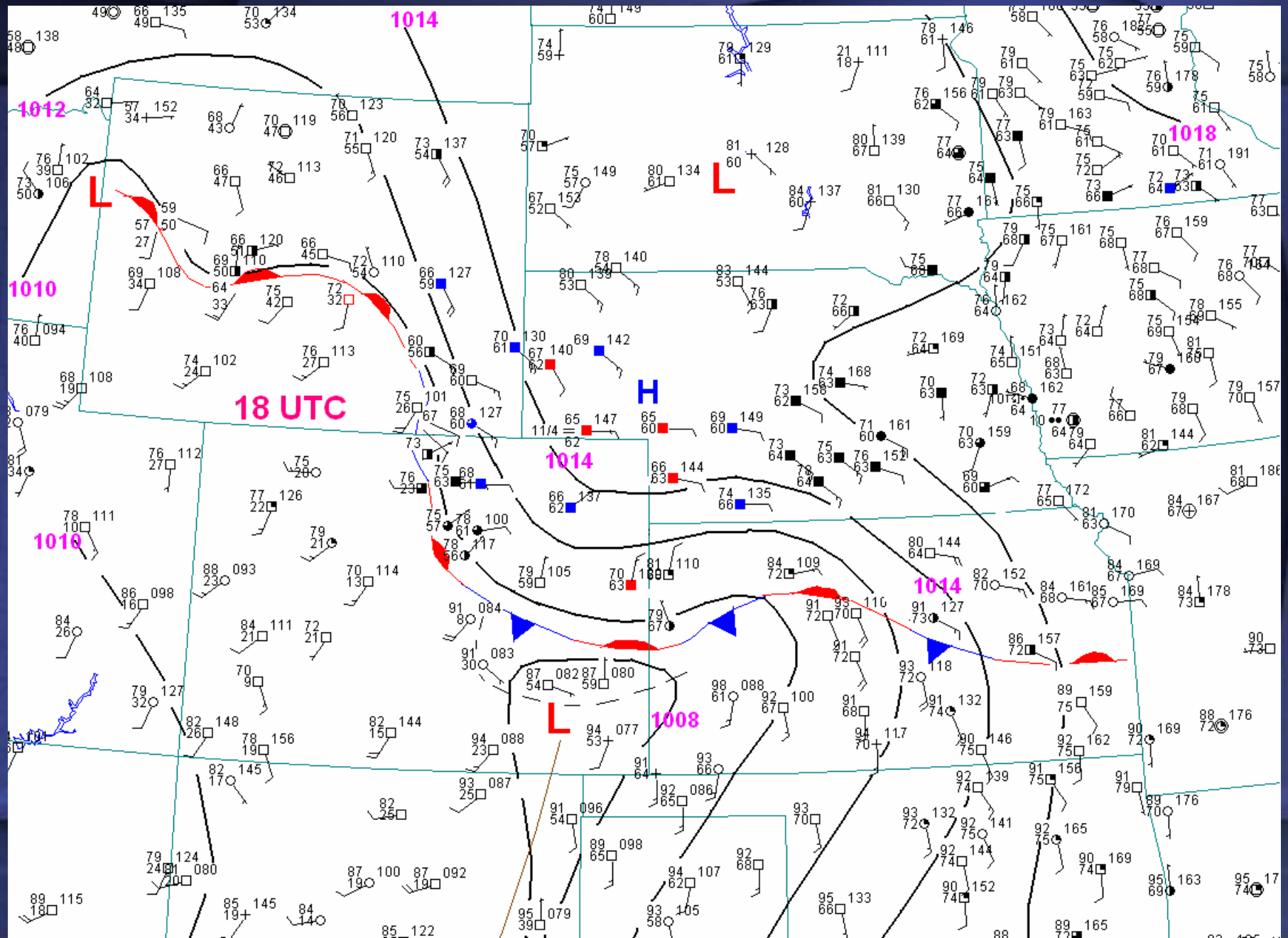


Morning Visible Image at 13 UTC Alongside Terrain Map

Note westward Buldge in Stratus between Mountain Ranges



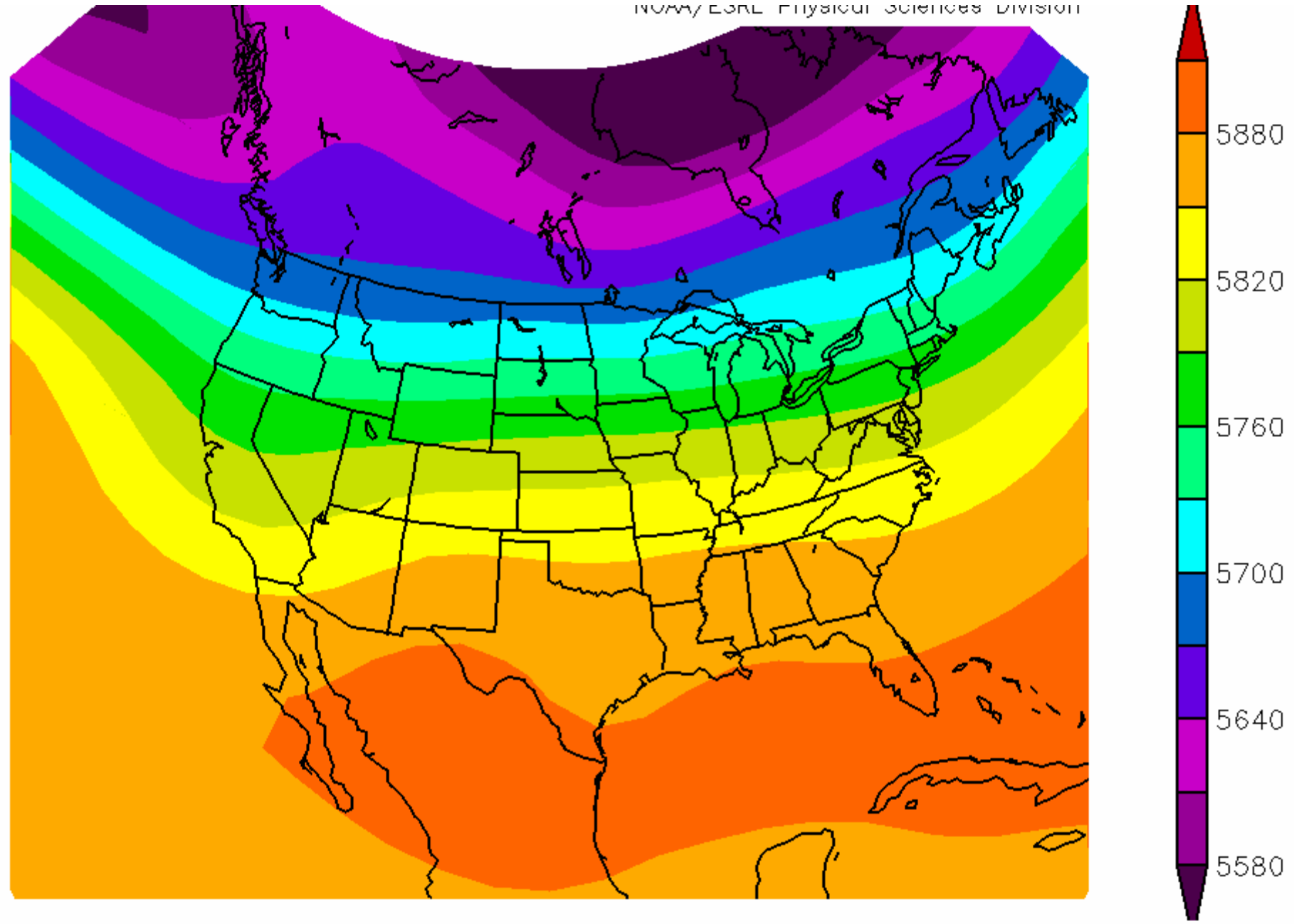
Unusually High Dewpoints in Southeastern Wyoming!



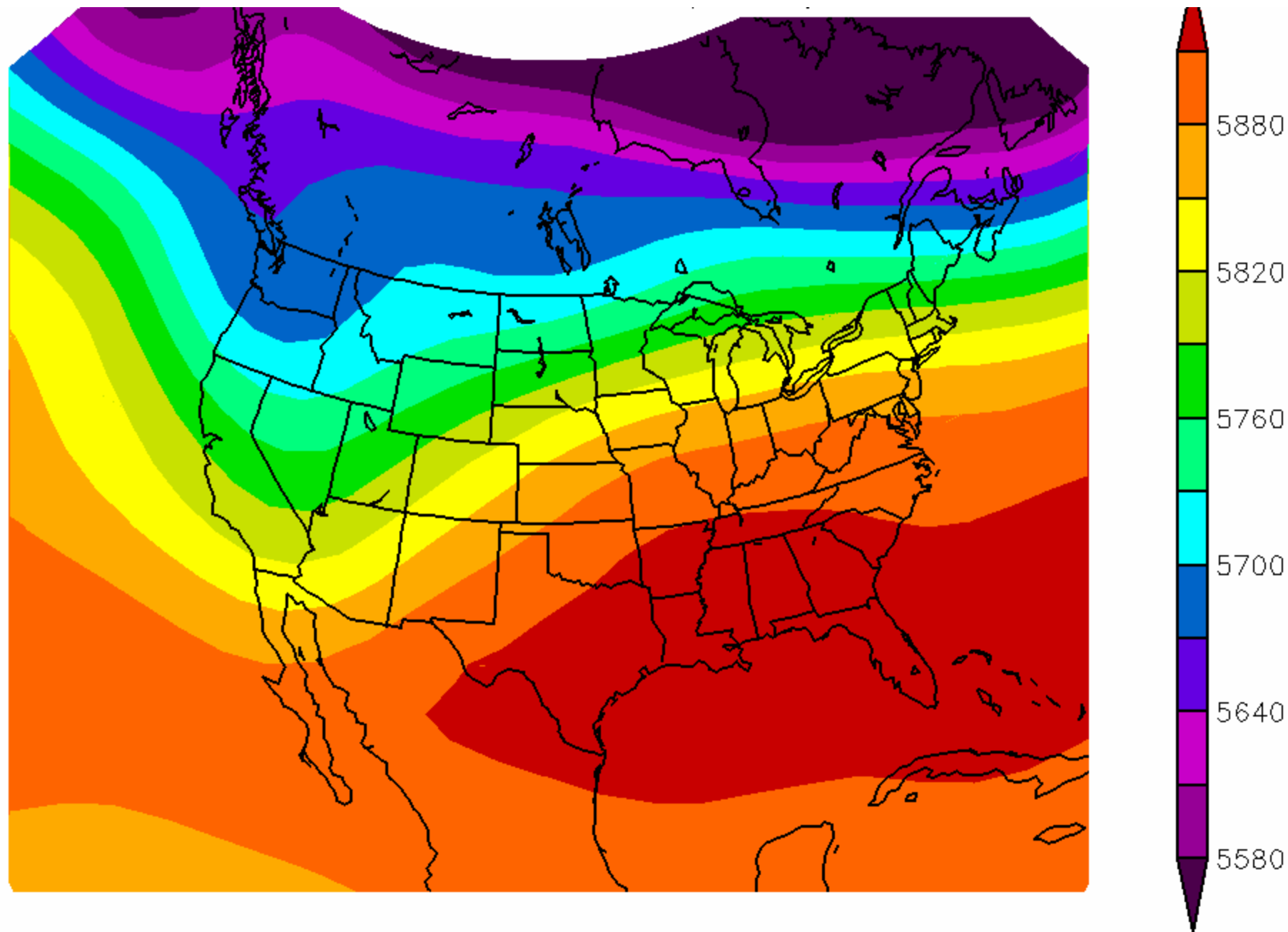
Unusually Moist Below and Cold aloft!!

- From 1942 to 2010, there has only been 1 instance of 60F or > surface dewpoints at Cheyenne in June at 18 UTC and this was on June 20, 2010.
- There have been 15 instances in 69 years during June at 18 UTC when the theta-e was higher than on June 20, 2010. But the average 400mb temperature for these 15 cases was -19.3C compared to -24C on June 20, 2010.
- For the 42 July-September instances when the dewpoint was 60F or greater, the average 400mb temperatures was -17.5C.

Why Was It So Moist???

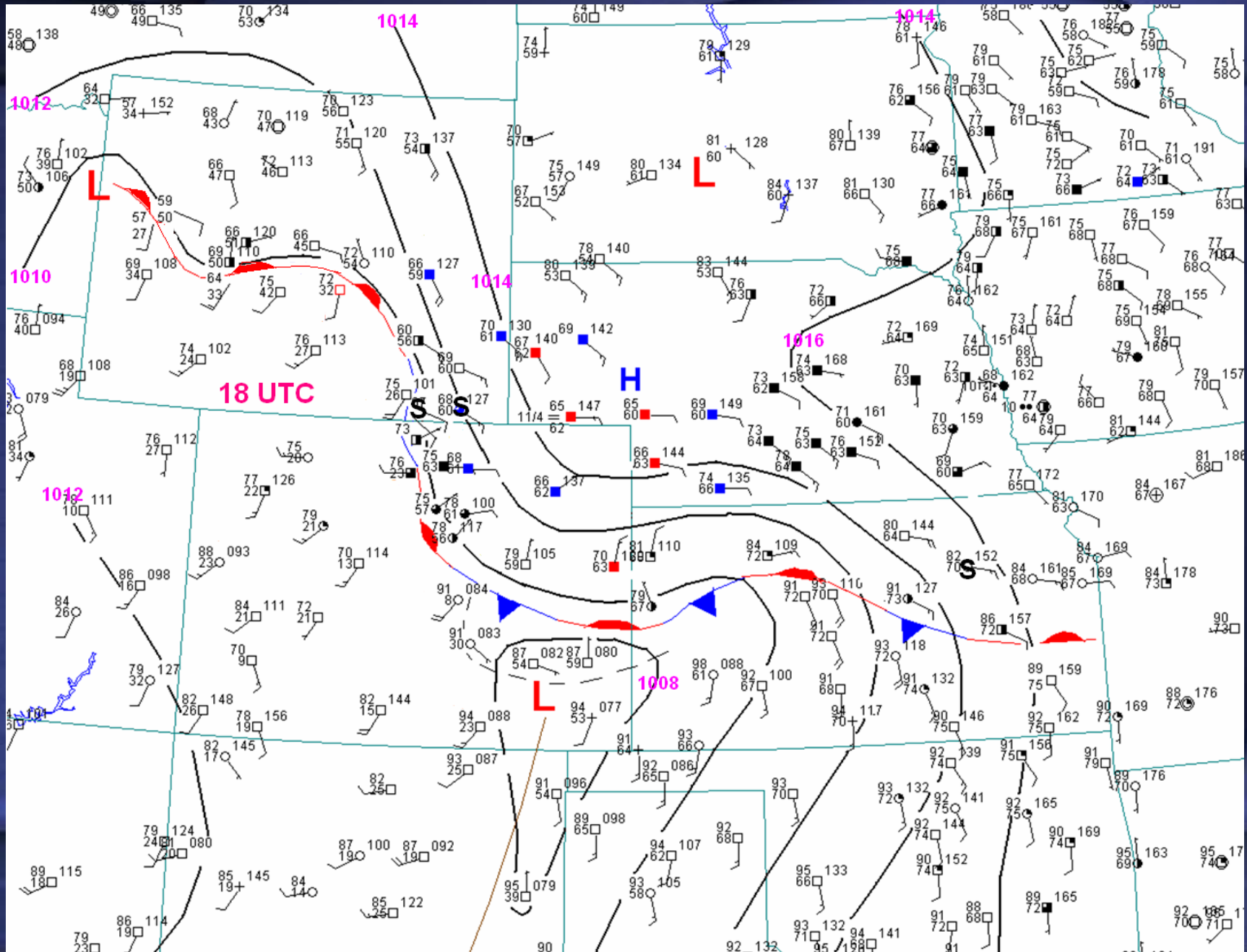


500mb Height Composite for June 16 (1990 to 2009)

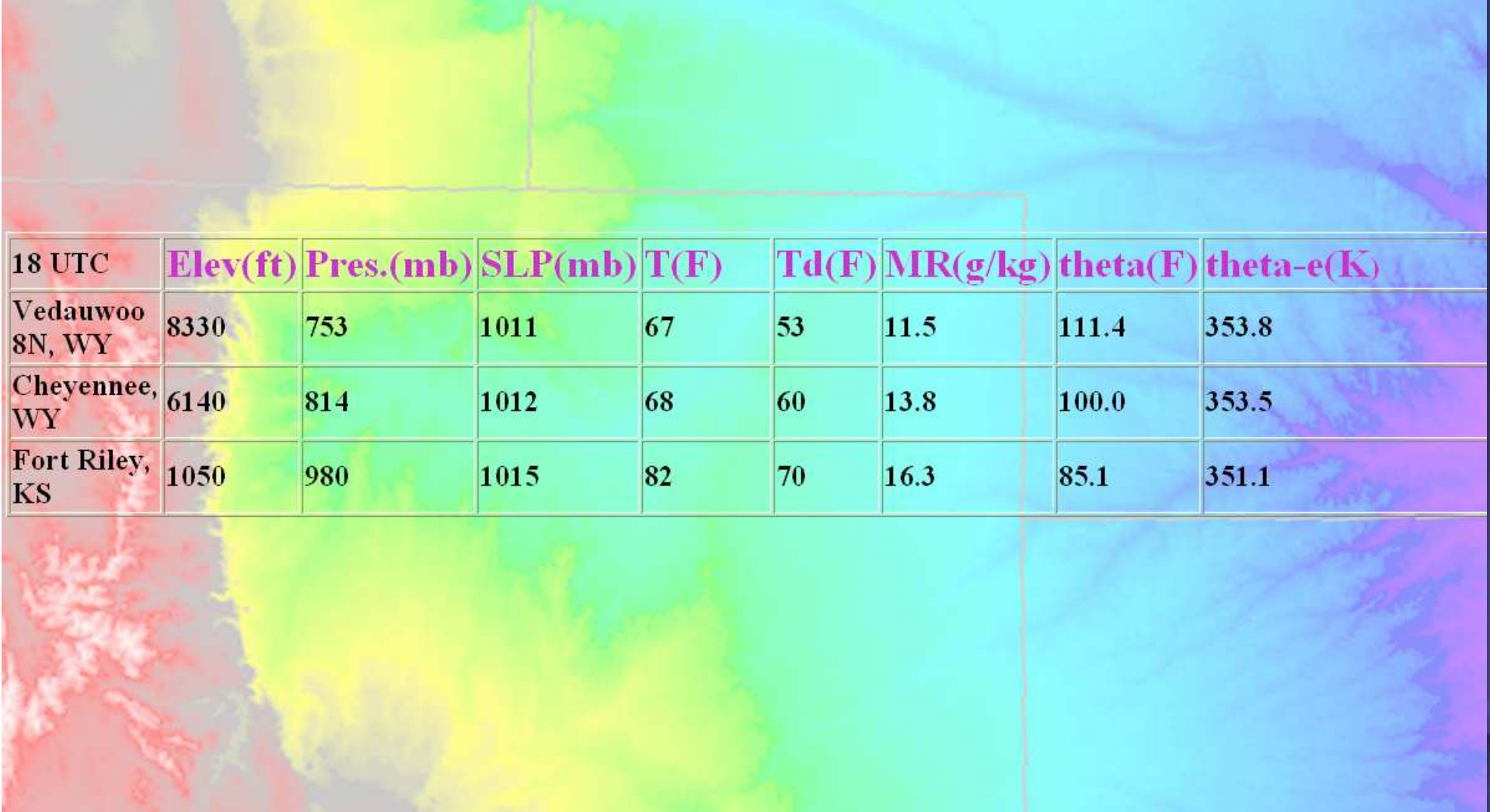


**500mb Heights--Composite Mean
June 14-20 (00 UTC) 2010**

High vs Low Plains Thermodynamic Comparison



Theta-e Comparison at 18 UTC High Elevation vs Low Plains



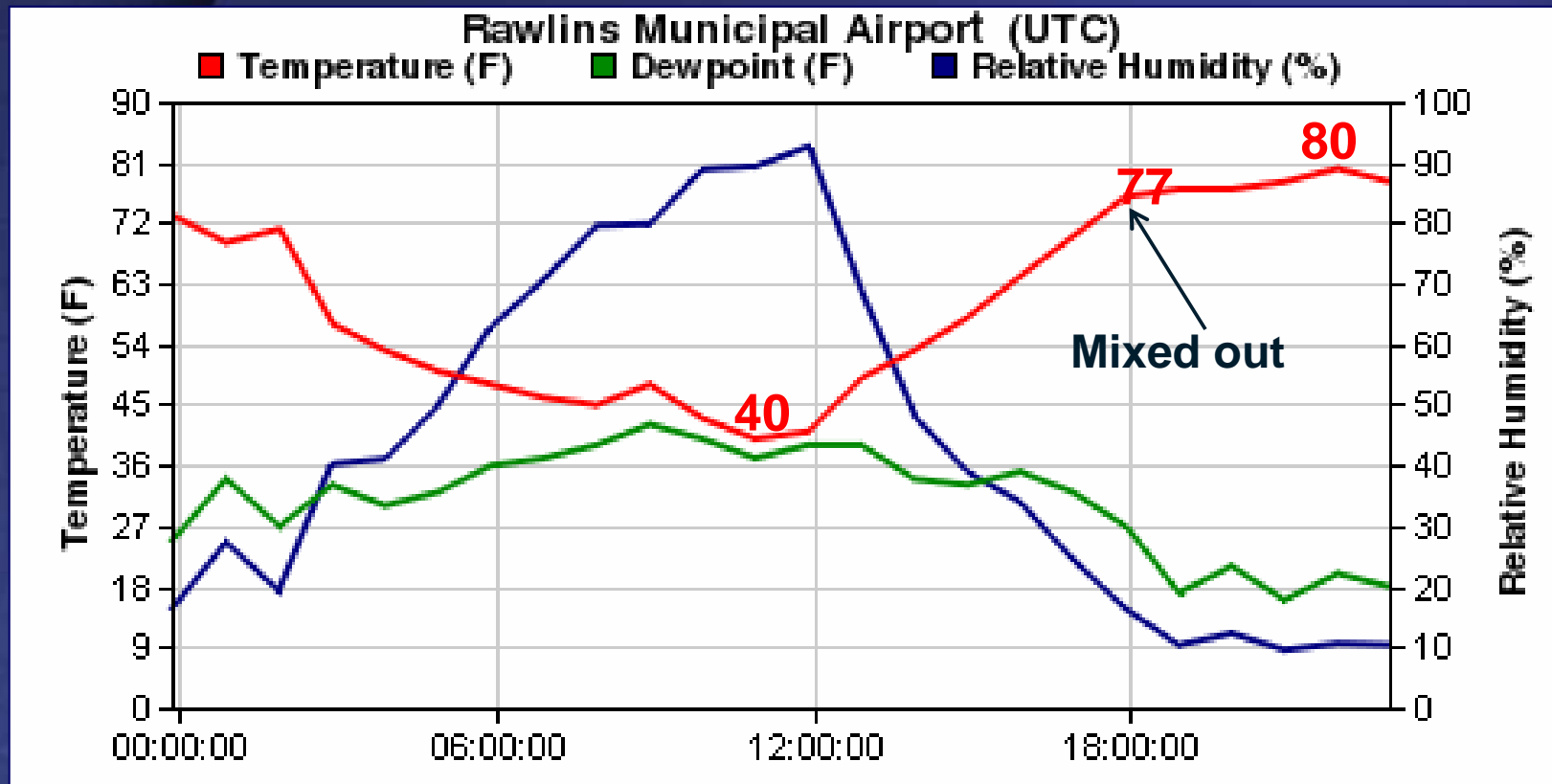
18 UTC	Elev(ft)	Pres.(mb)	SLP(mb)	T(F)	Td(F)	MR(g/kg)	theta(F)	theta-e(K)
Vedaauwo 8N, WY	8330	753	1011	67	53	11.5	111.4	353.8
Cheyenne, WY	6140	814	1012	68	60	13.8	100.0	353.5
Fort Riley, KS	1050	980	1015	82	70	16.3	85.1	351.1

Estimation of 500mb Temps and Lifted Index Without Upper Air Data

- Interrogating raw observations as opposed to exclusively fixating on NWP analyses can help the forecaster heighten situational awareness.

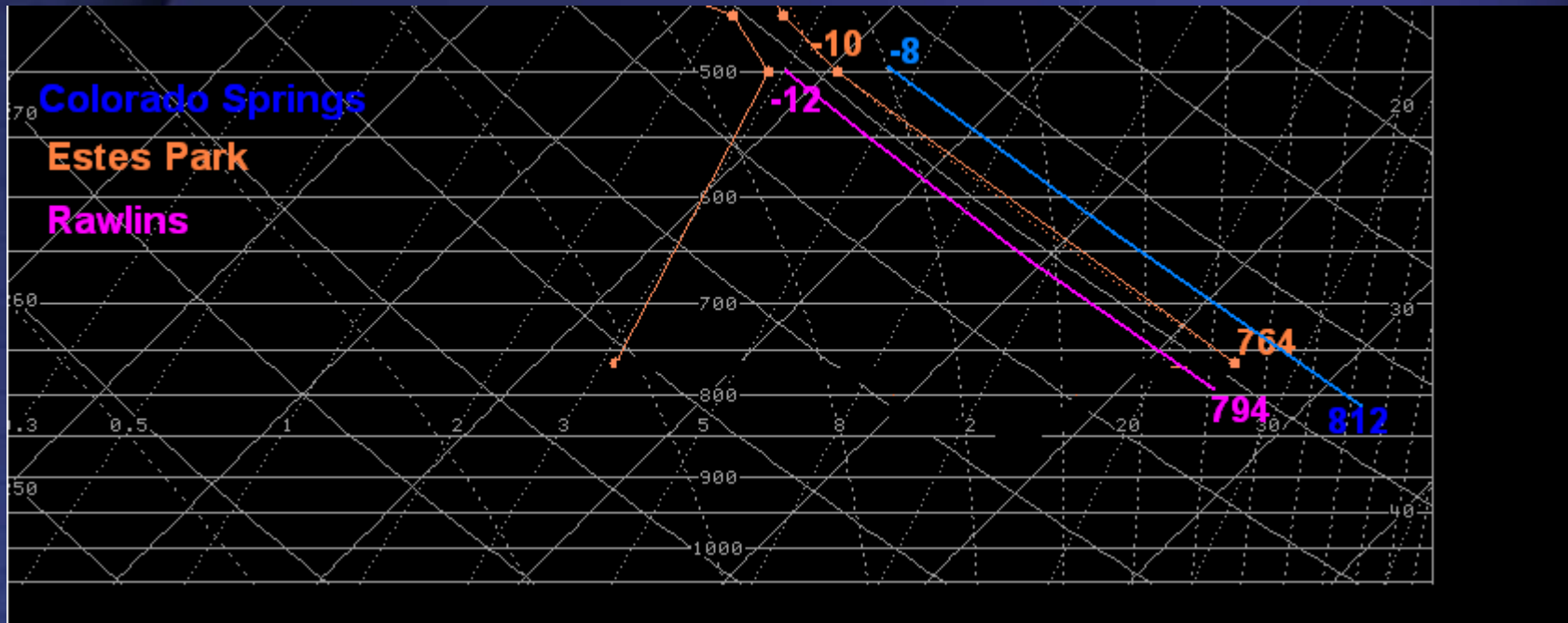
Find Mixout Temperature for Selected Stations

Rawlins, WY Surface Pressure ~ 794 mb



Estimating 500mb Temperature

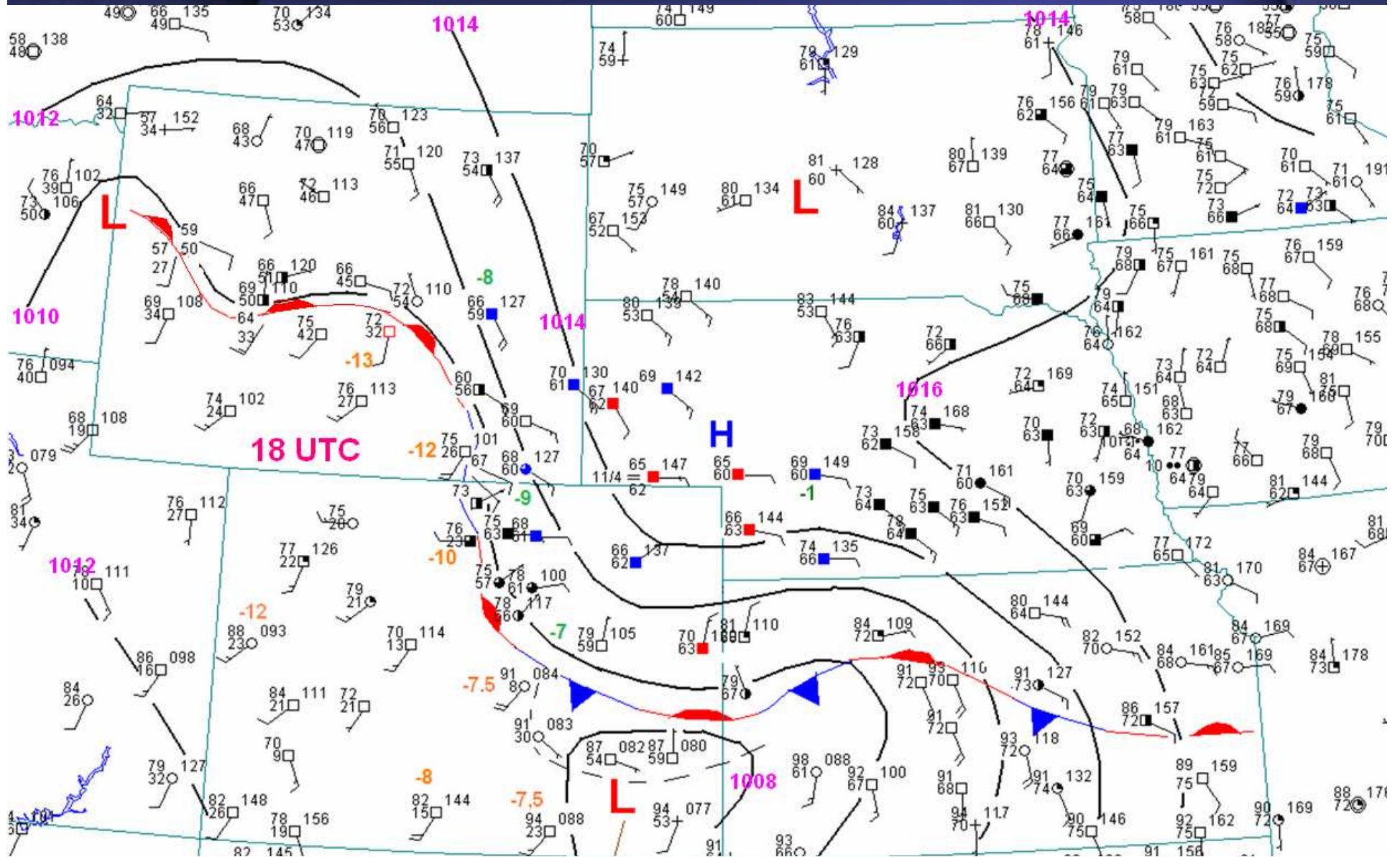
Lift Surface Parcels up to 500mb

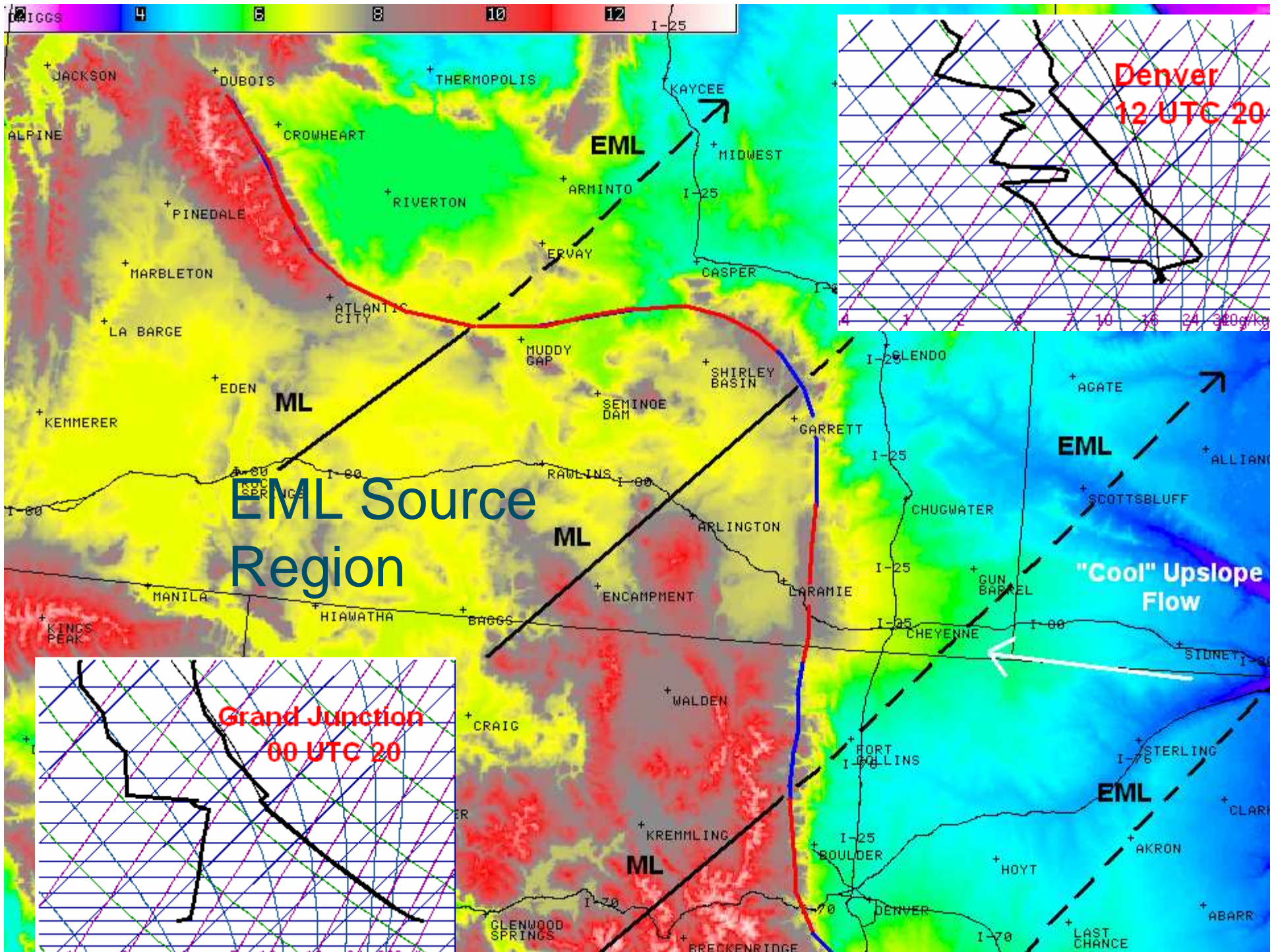


Inferring Upper Air Information

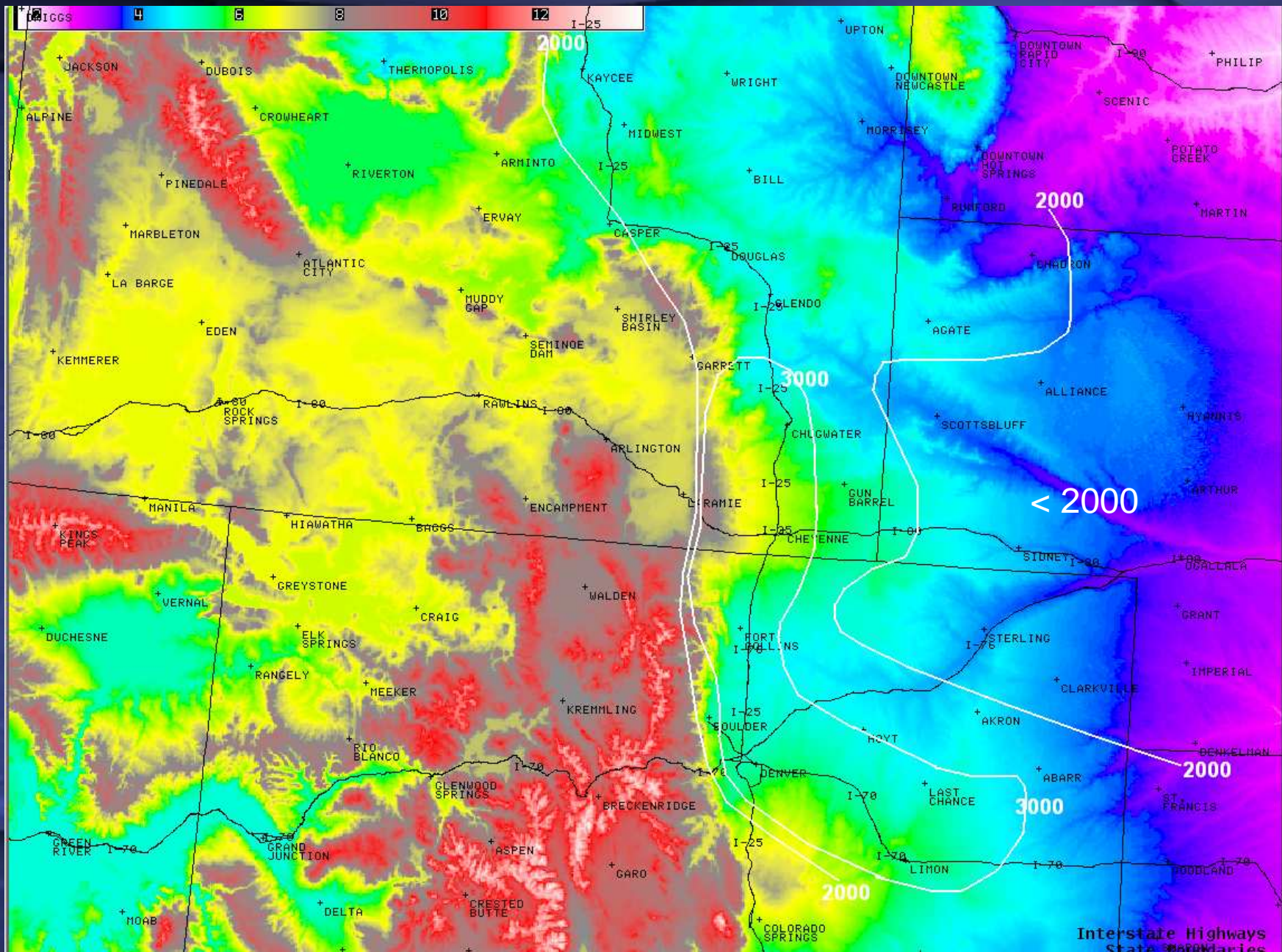
500mb Temperature Estimates

Lifted Index Approximations (500mb)

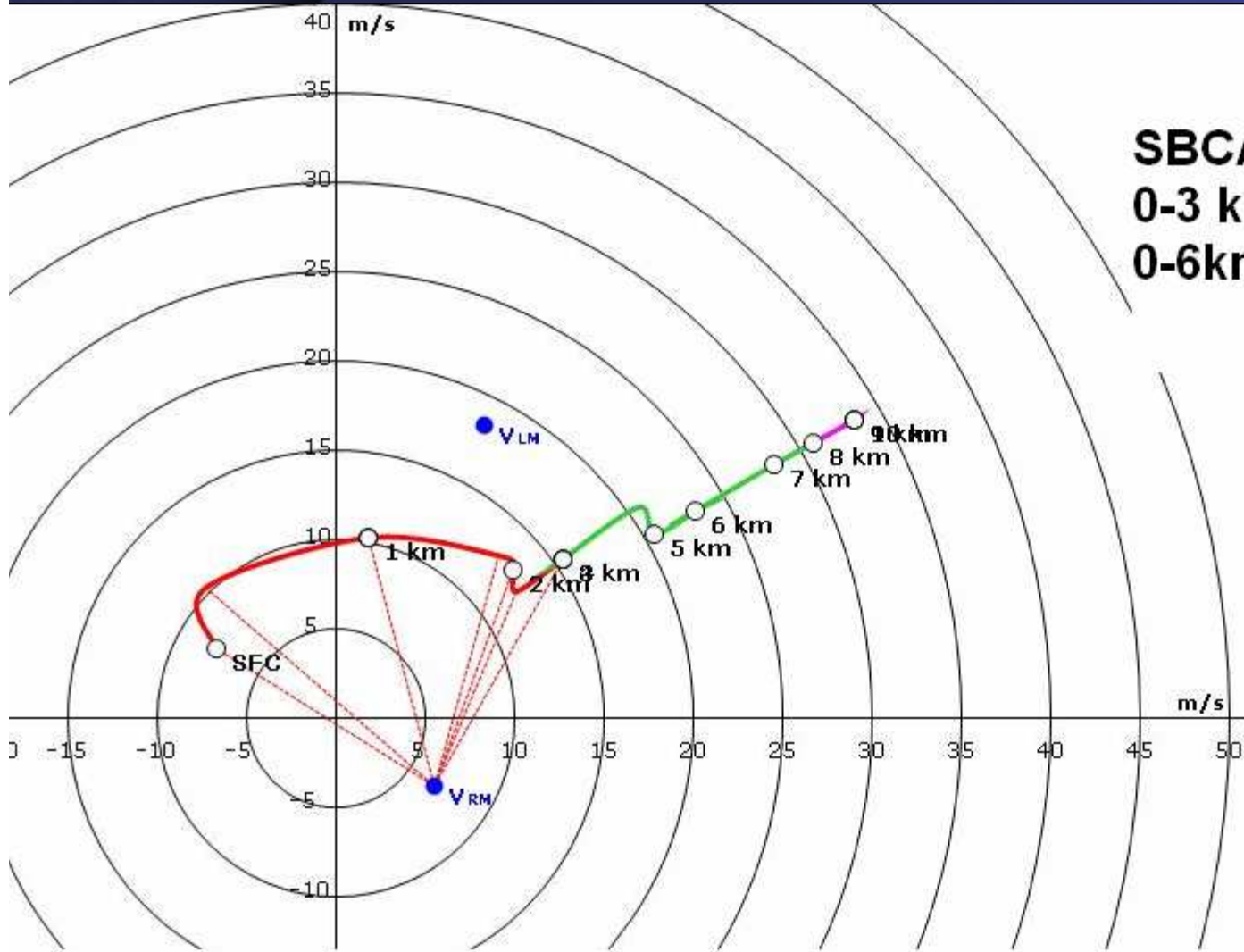




18 UTC Cape Analysis (modified from RUC 18 UTC)

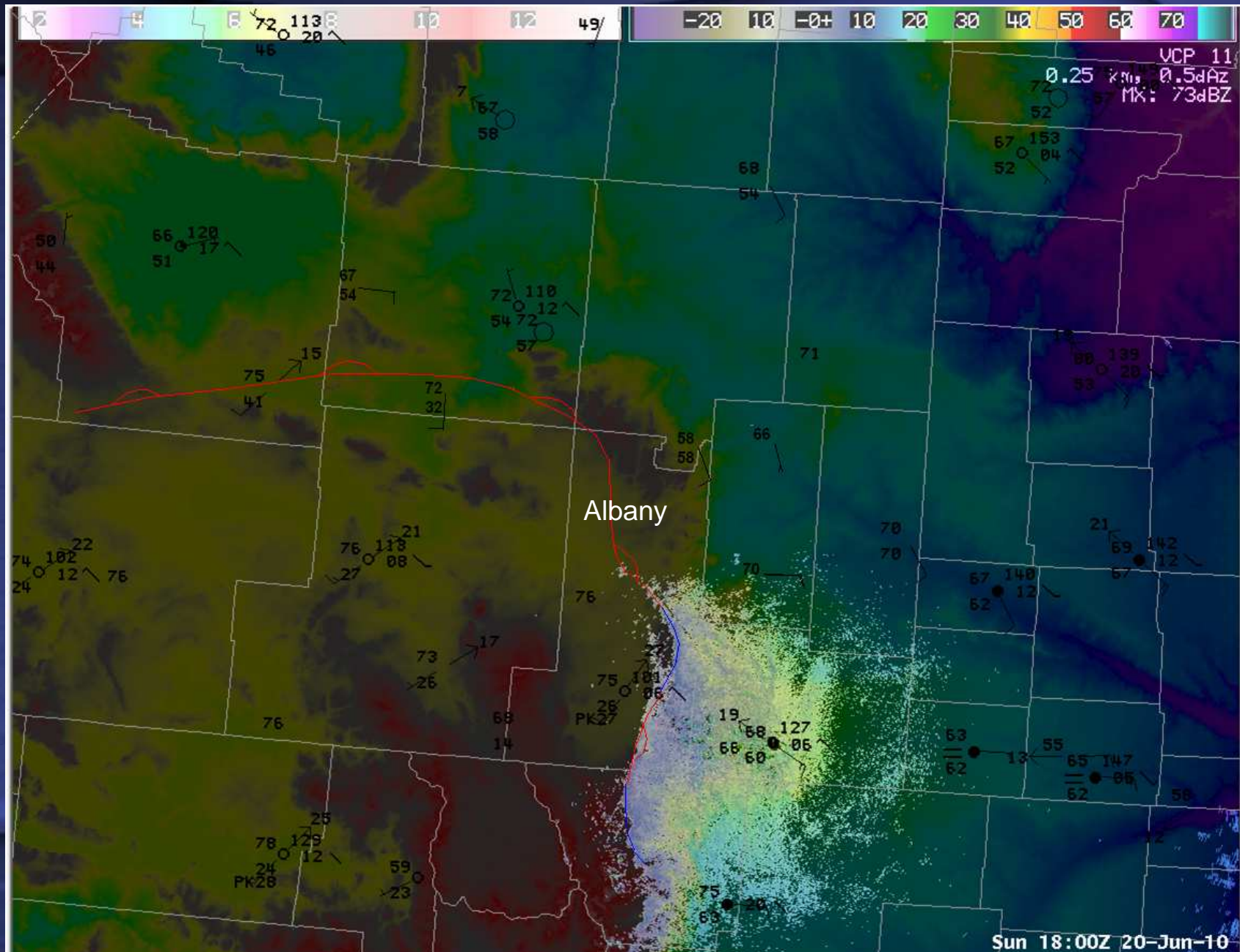


CAPE & Shear Parameters for Chugwater Storm

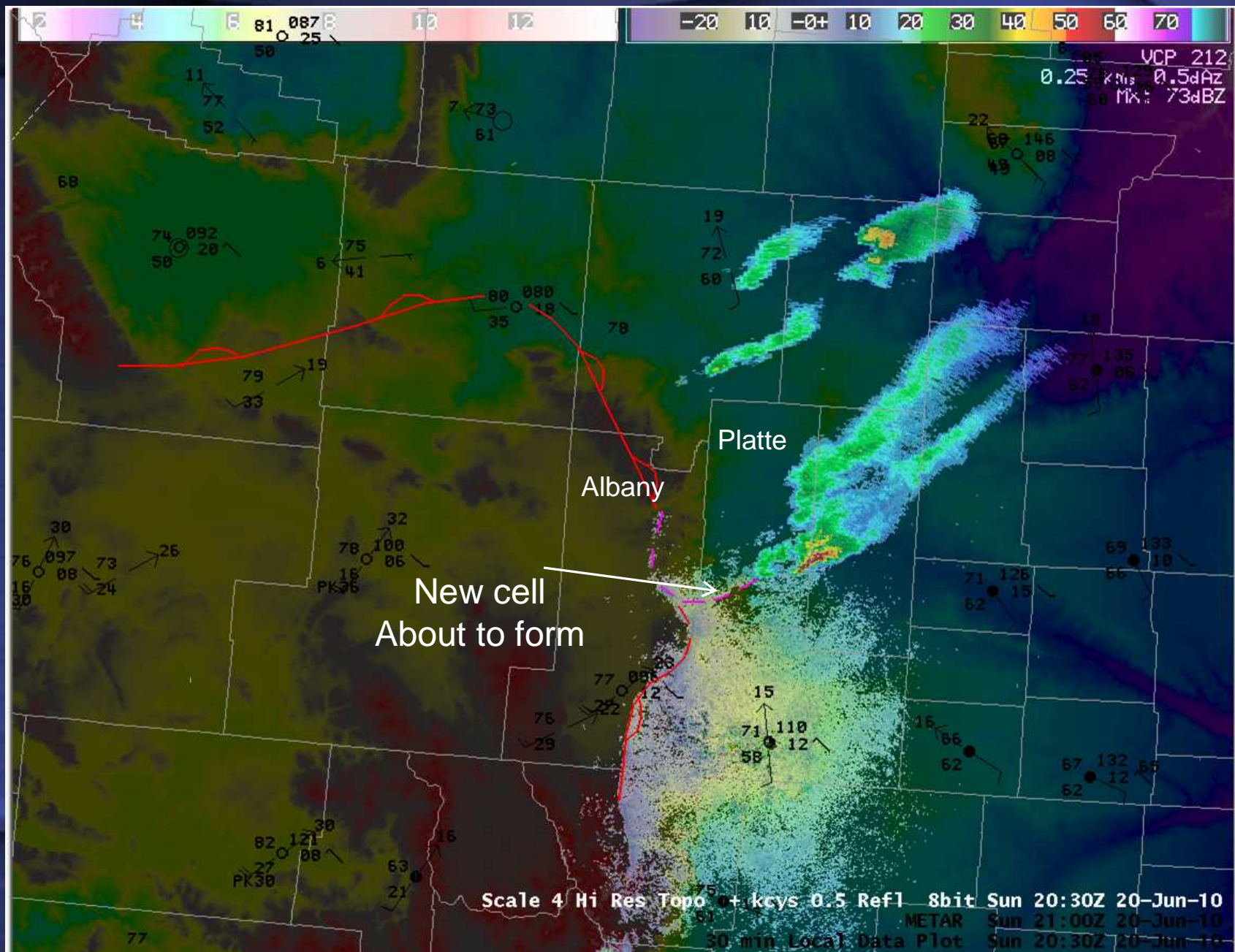


SBCAPE = 3400 j/kg
0-3 km srh = 313 m²/s⁻²
0-6km shear = 55 kts

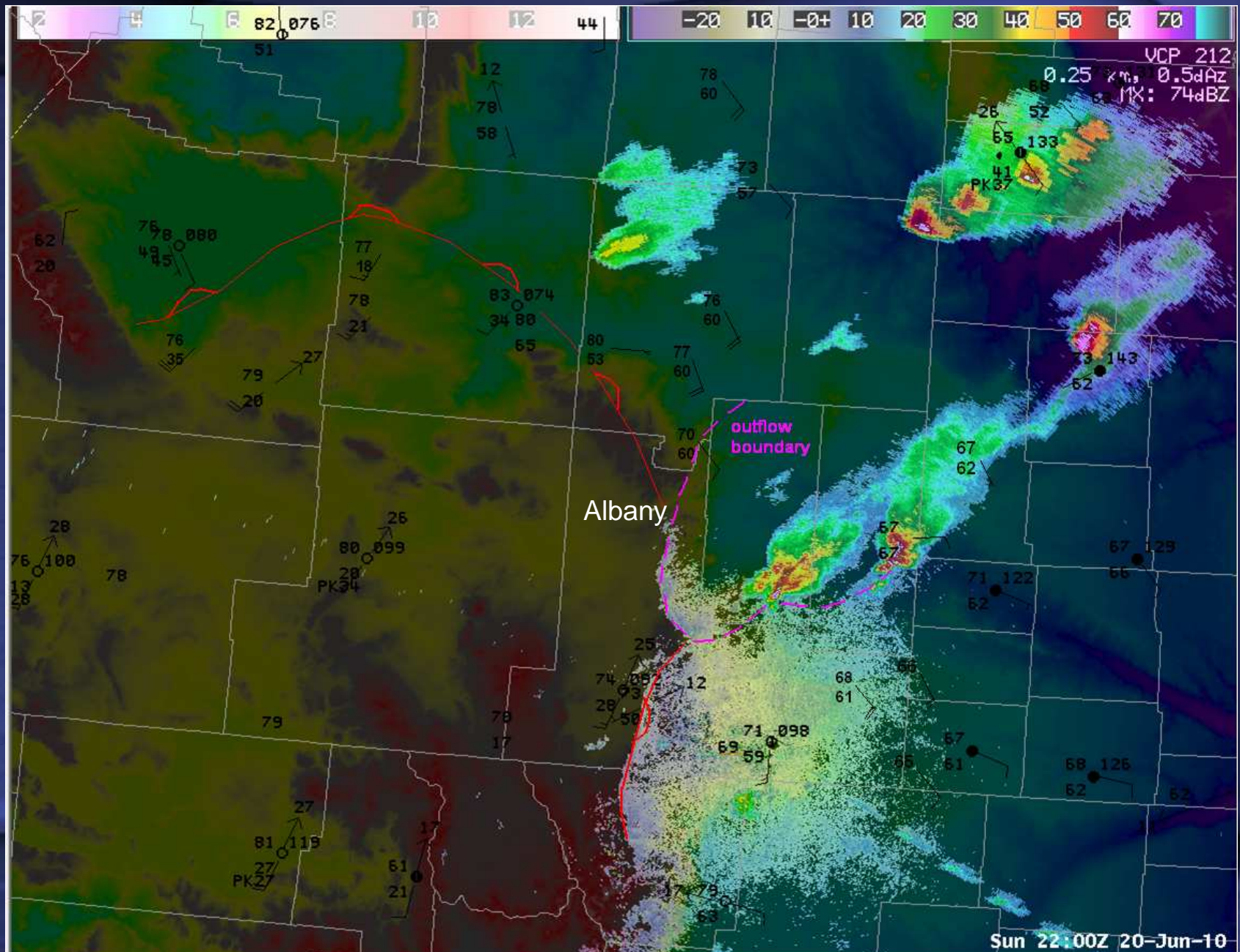
18 UTC Mesoanalysis with Radar



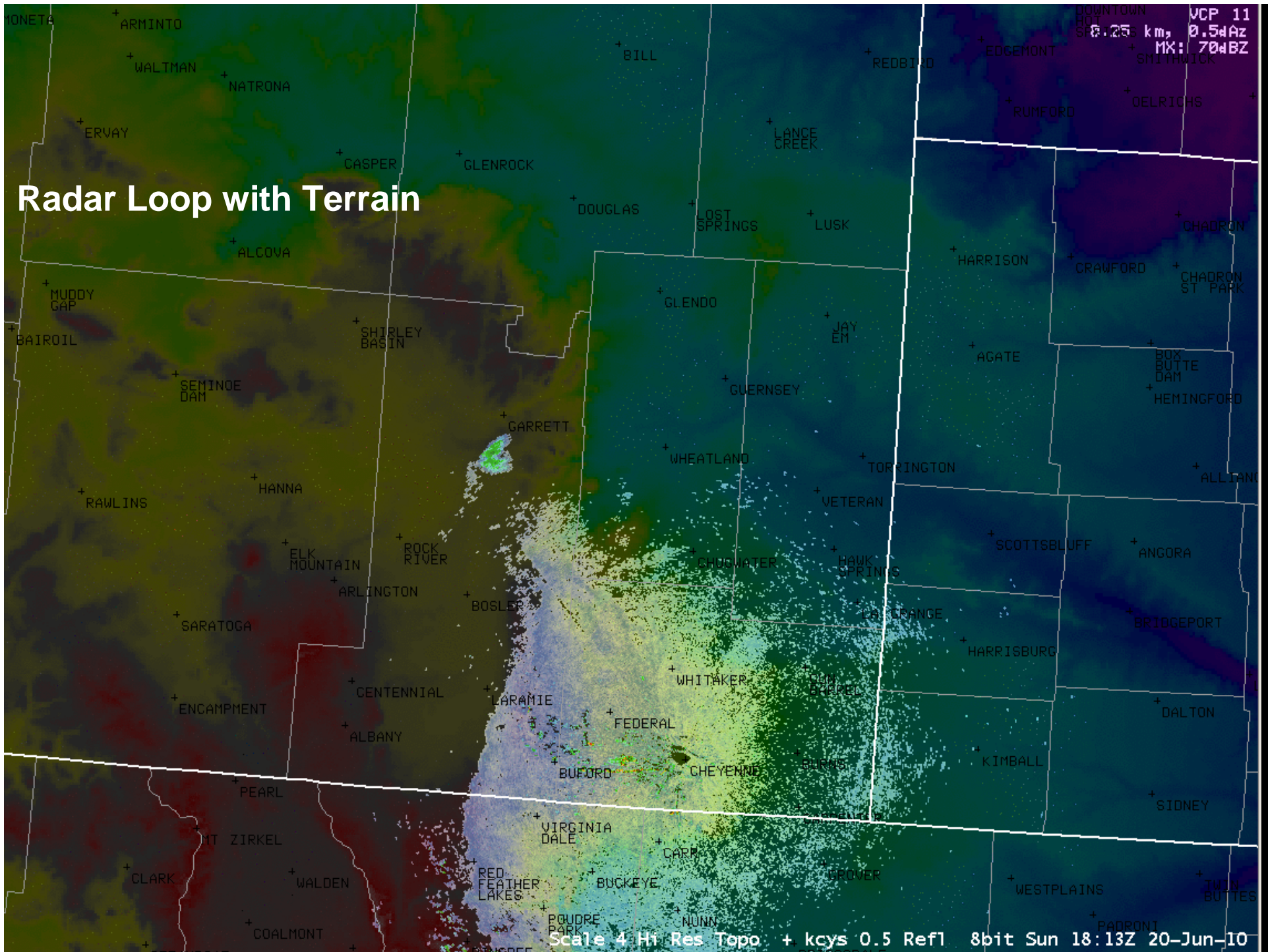
2030 UTC Mesoanalysis with Radar



22 UTC Mesoanalysis with Radar

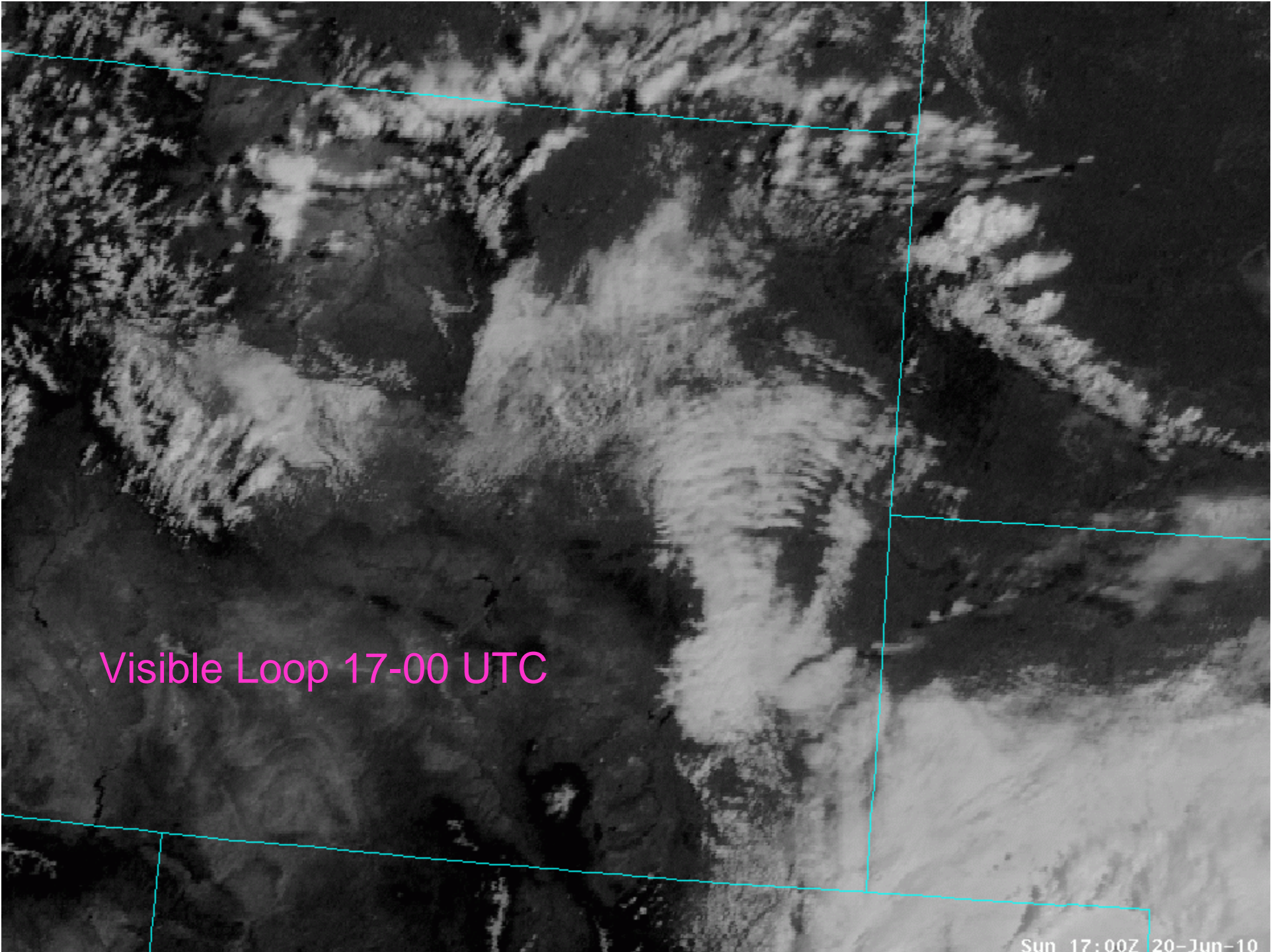


Radar Loop with Terrain



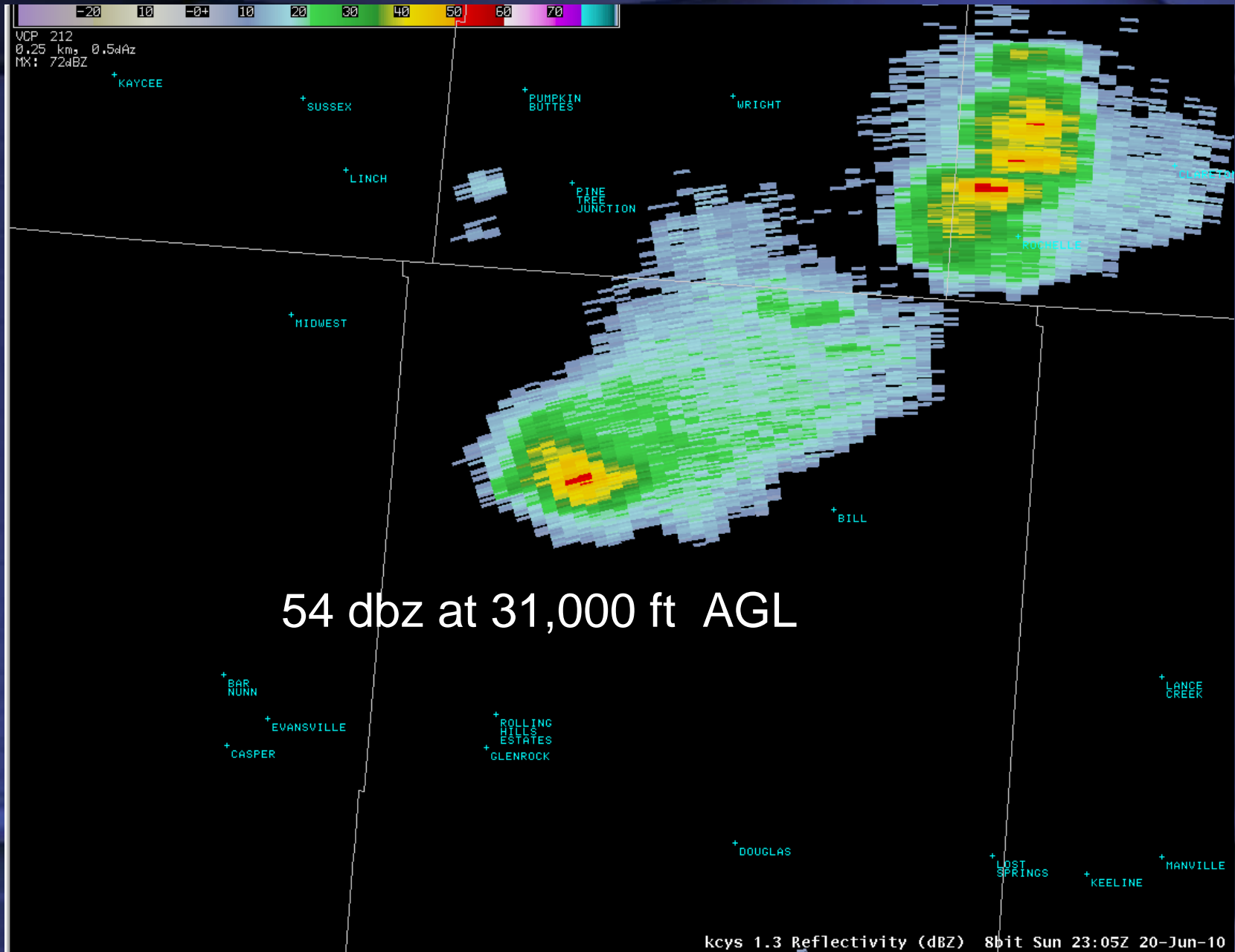
VCP 11
0.5 km, 0.5 deg Az
MK: 70 dBZ

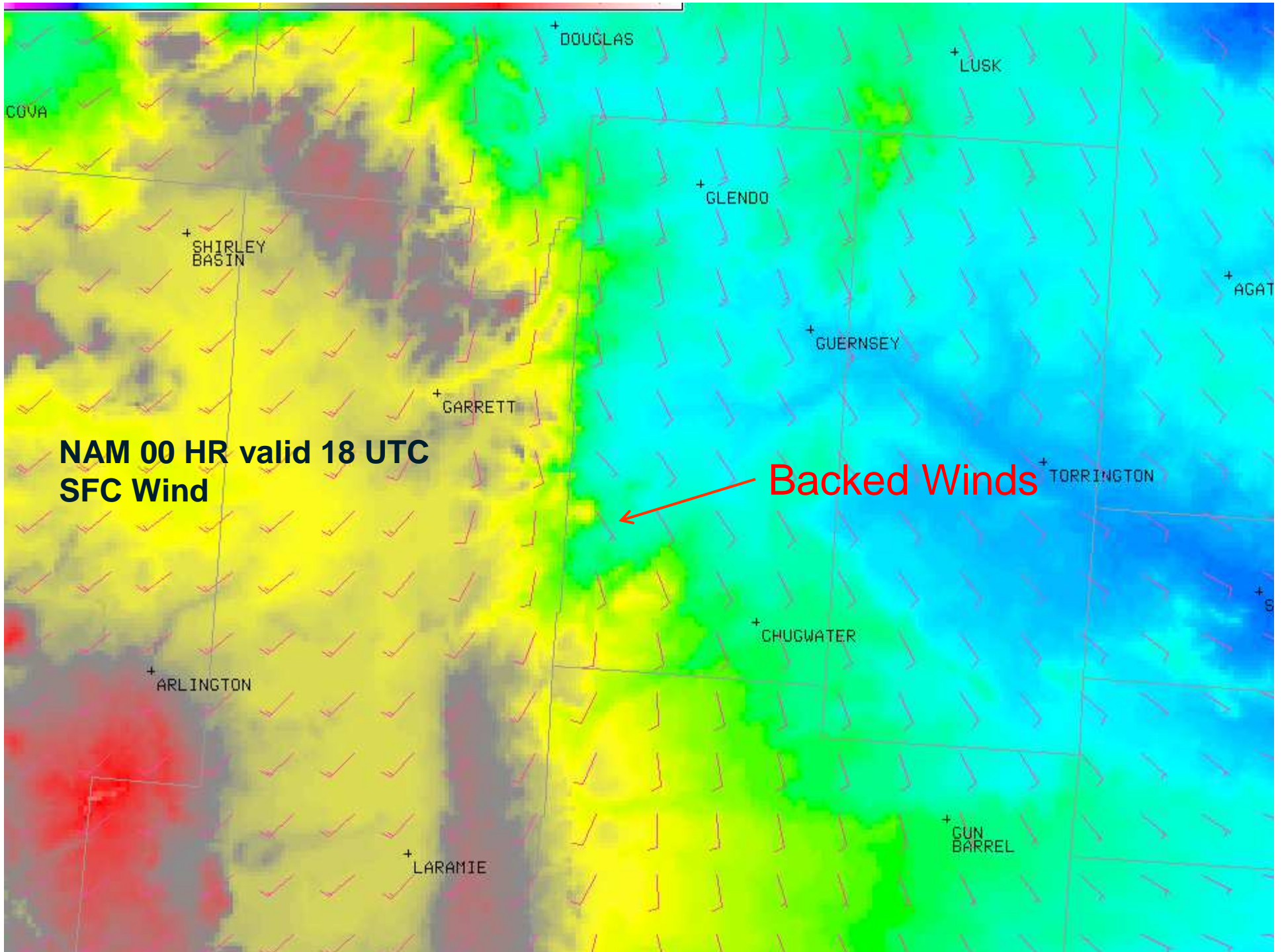
Scale 4 Hi Res Topo + kcys 0.5 Ref1 8bit Sun 18:13Z 20-Jun-10

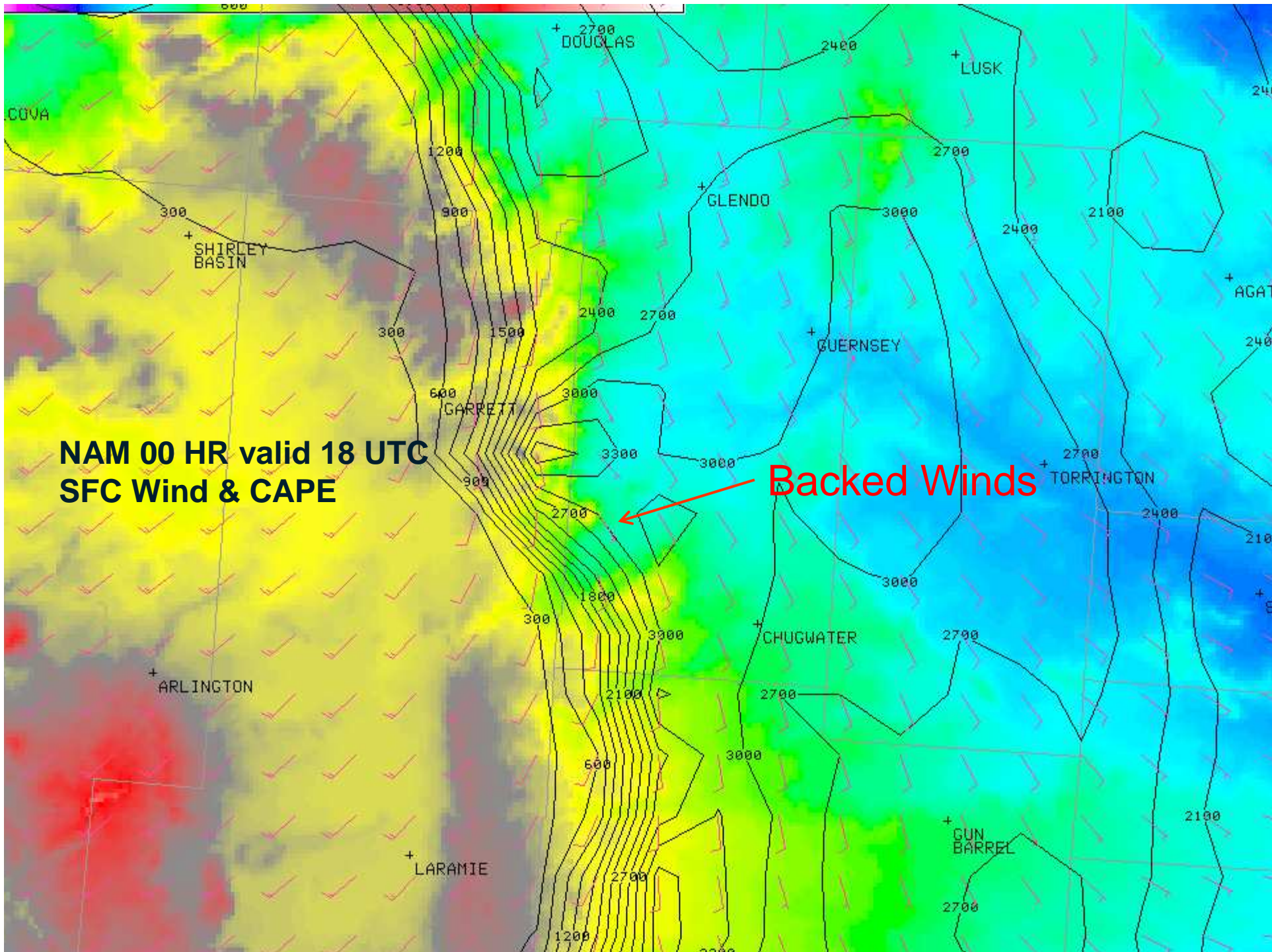


Visible Loop 17-00 UTC

Core of Converse County Storm (1.3 deg)







**NAM 00 HR valid 18 UTC
SFC Wind & CAPE**

Backed Winds

Future Research

- The “Chugwater-Wheatland Convergence Zone” (we are calling CWCZ) focused convective initiation in a localized area. Is this a regular occurrence in southwest flow regimes with upslope flow? This will be the focus of our future research.
- Is storm back-building a regular occurrence in the CWCZ? We have personally witnessed this on several occasions during our storm chases in the Chugwater-Wheatland area.

Conclusions/Thoughts

- The rare combination of extreme mixing ratios and cool mid-level temperatures lead to unusually high CAPE values in the lee of the Laramie Range.
- Overnight MCS clusters aided in shunting moisture westward up the higher terrain.
- The sharp gradient in CIN and mesoscale boundaries were important with respect to convective evolution.
- A convergence zone west of the Chugwater-Wheatland area (CWCZ) may have encouraged storm formation in a localized area. Is this a regular occurrence? This will be our focus of future research.
- Is storm backbuilding a regular occurrence in the CWCZ?
- The Converse county supercell developed just ahead of the surface warm front.