Supporting MATERHORN-Fog: Climatology, Synoptic Conditions, High-resolution WRF Forecasting

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MATERHORN Investigator Meeting – IV
09-10 October 2014
University of Utah

Outline

- **Climatology**

  Fog distribution and frequency over the Salt Lake and Heber Valleys

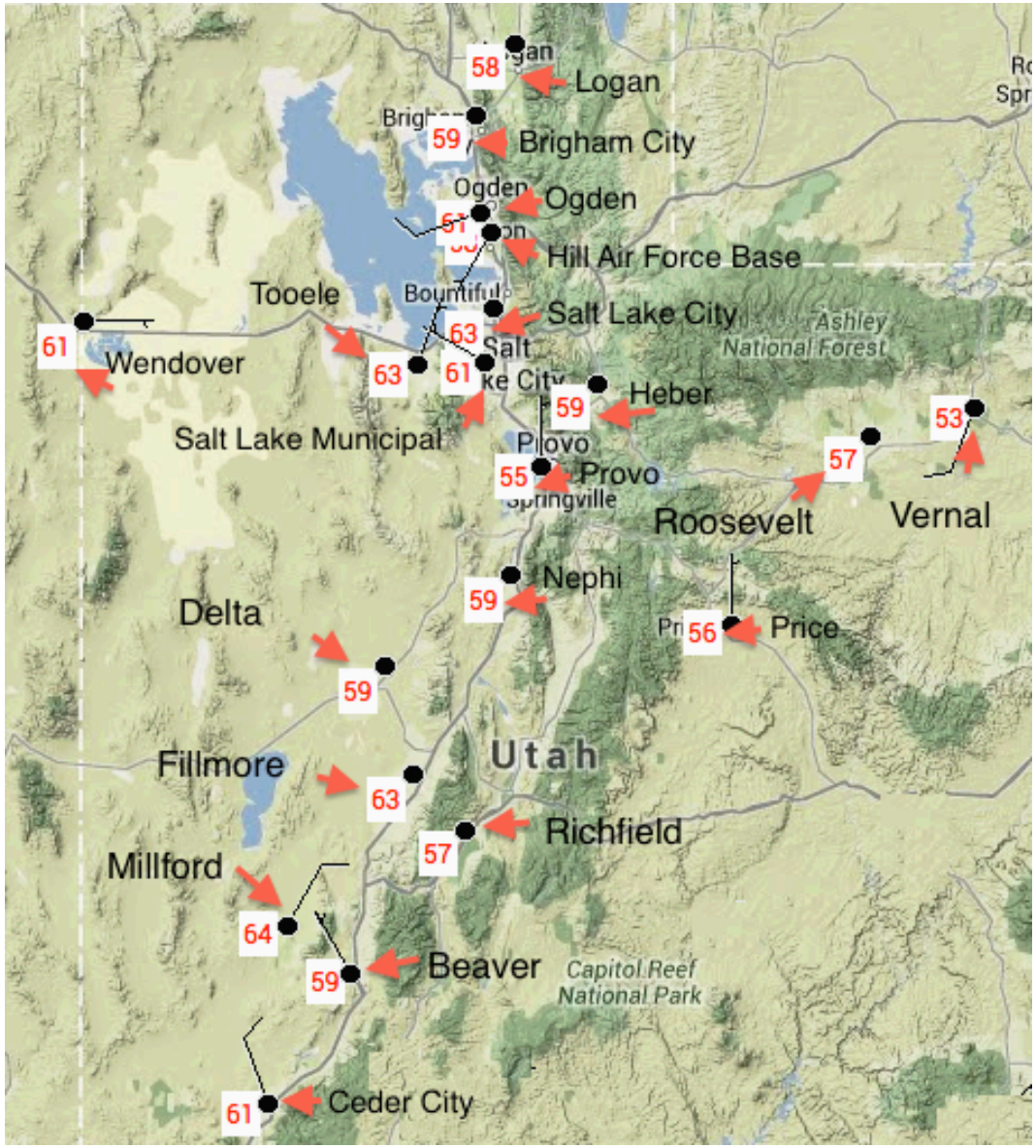
- **Synoptic conditions**

  An examination of synoptic conditions during the winter of 2013-2014

- **Real-time high-resolution WRF forecasting**

  Set-up and plan for the real-time forecasting

Fog distribution and frequency over the Salt Lake and Heber Valleys


58
Logan
59
Brigham City
Ogden
Ogden
Hill Air Force Base
Tooele
Salt Lake City
Ashley
National Forest
61
Wendover
63
63
61
59
Heber
Salt Lake Municipal
53
57
55
Provo
Roosevelt
Vernal
Nephi
59
Delta
56
Price
59
Utah
Fillmore
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Richfield
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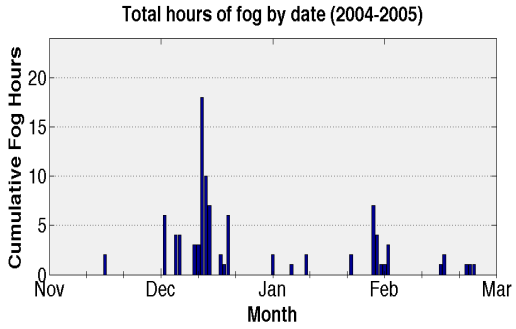
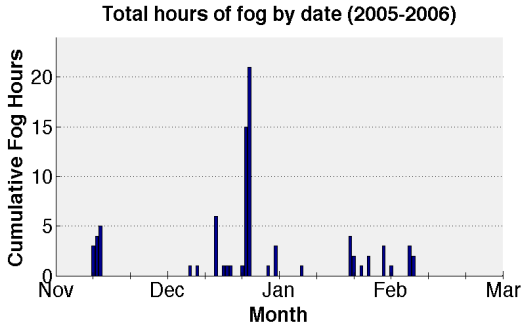
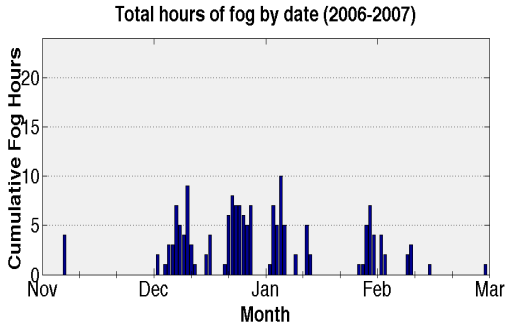
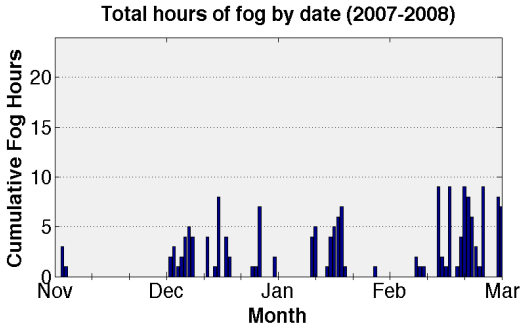
Millford
64
59
Beaver
Capitol Reef
National Park
61
Ceder City

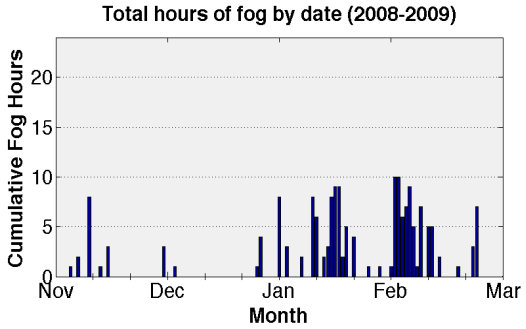
Fog frequency by year/month (Heber Valley)

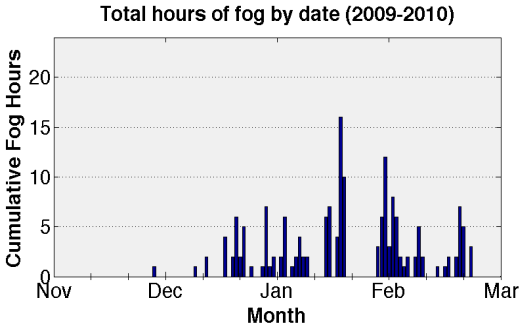


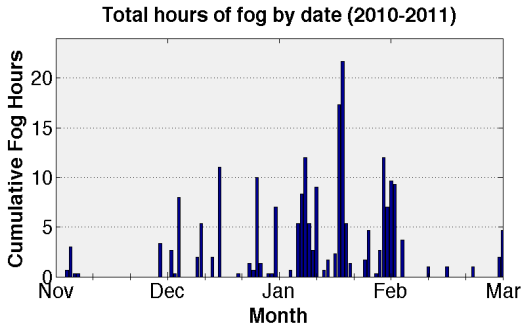


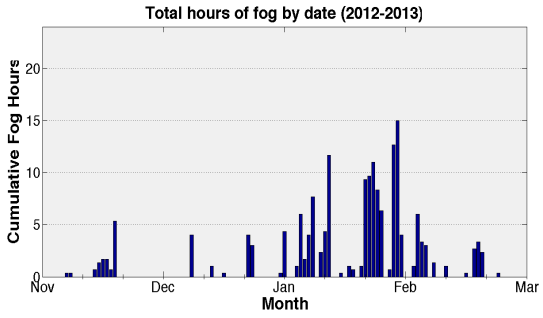


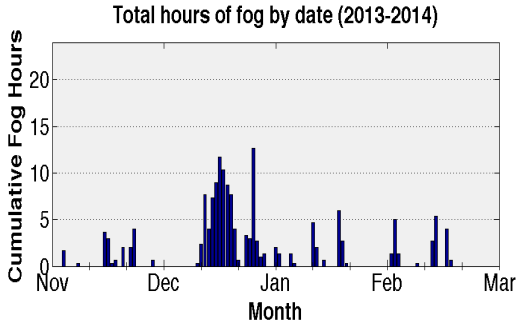




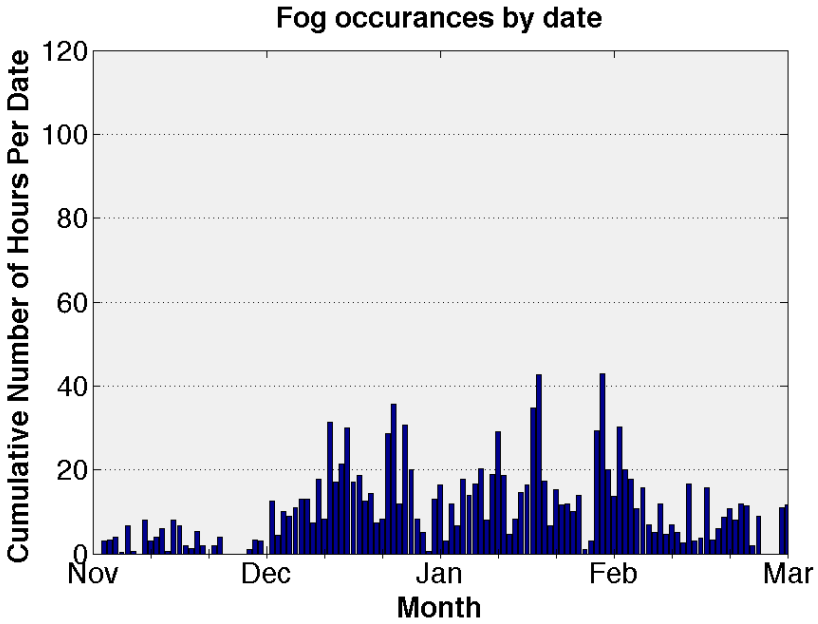


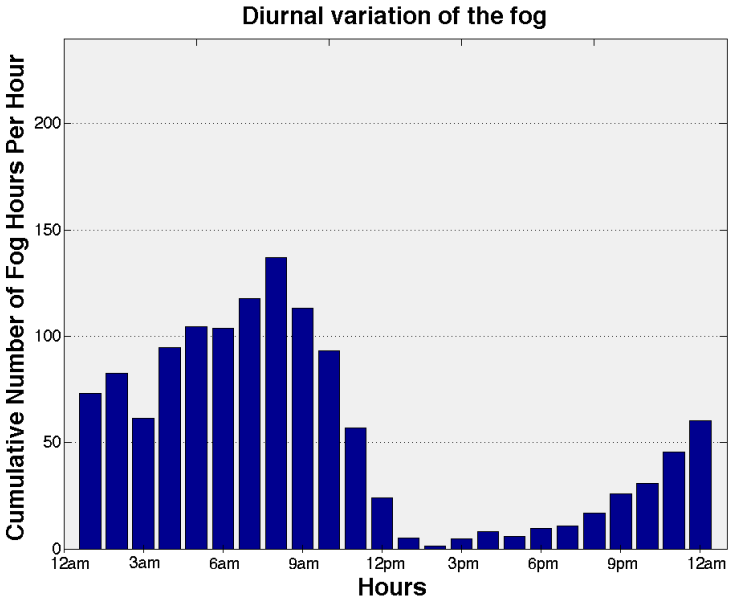






Fog frequency (Heber Valley) 2004-2014 - Summary





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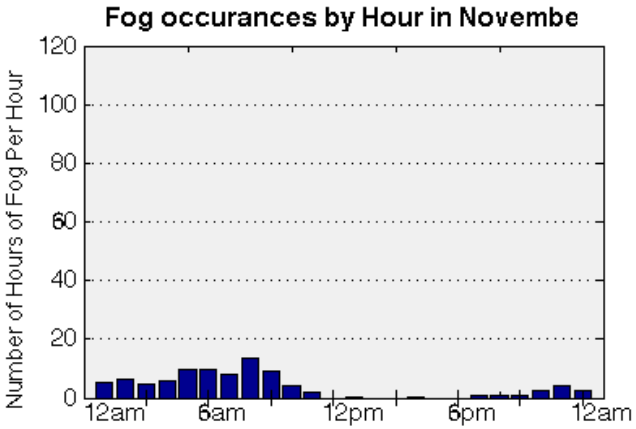
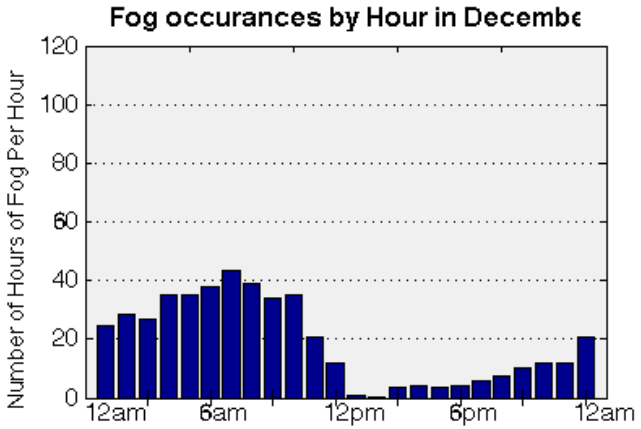
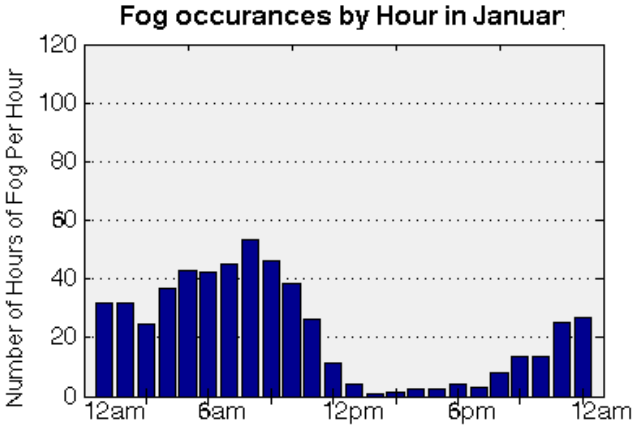
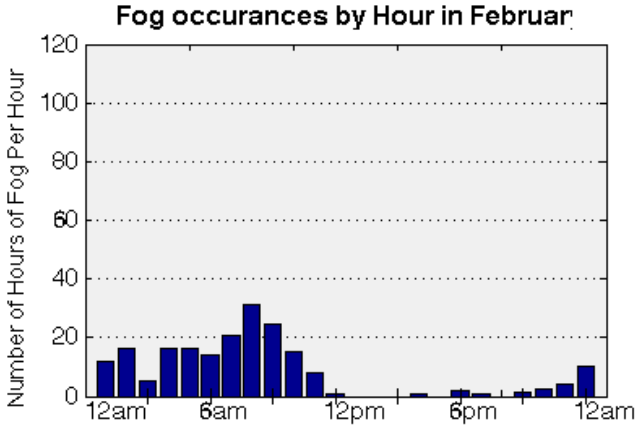
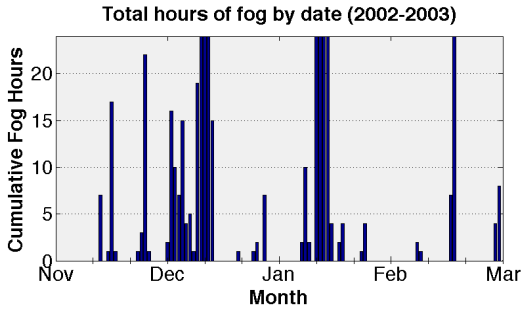


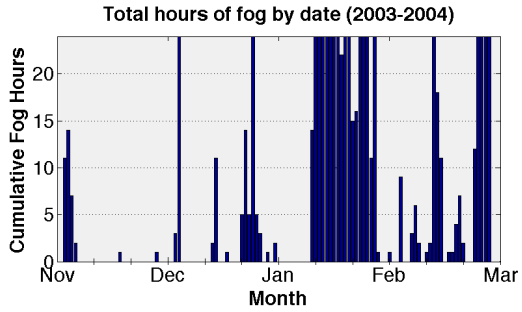


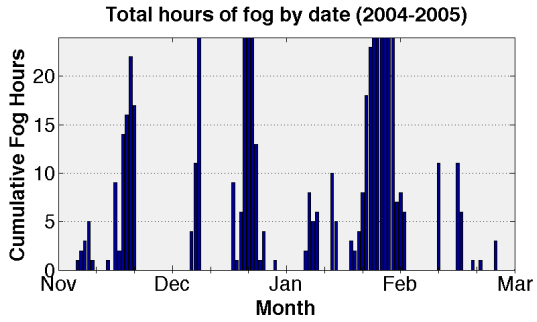


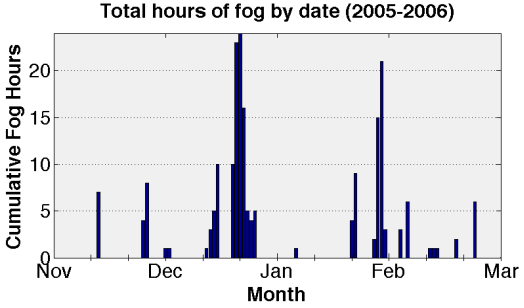


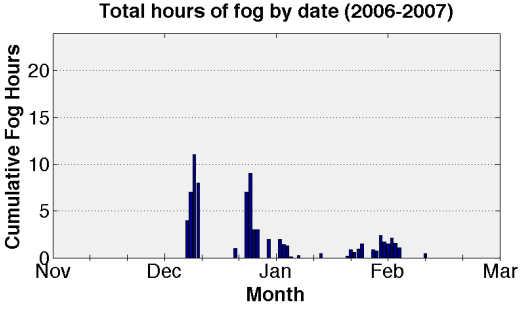
Fog frequency by year/month (Salt lake Valley)

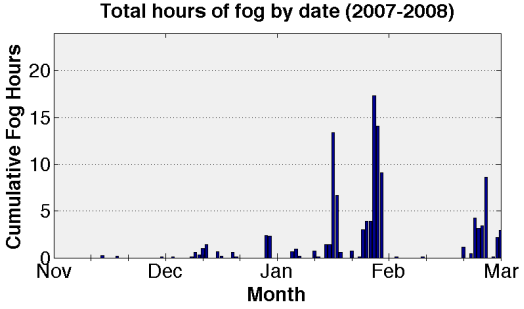


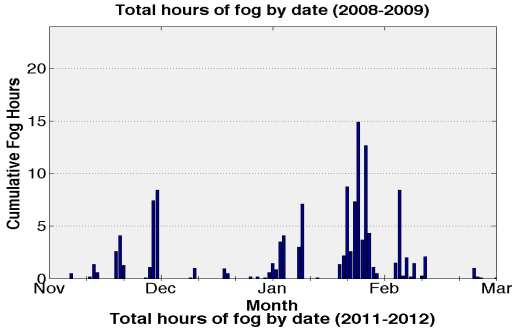


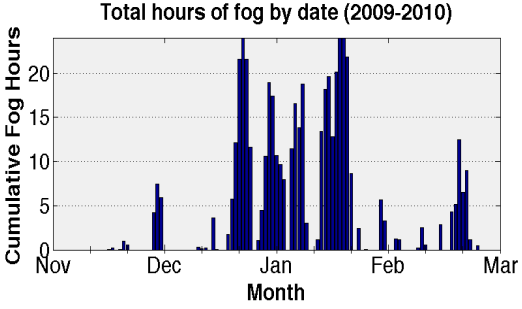


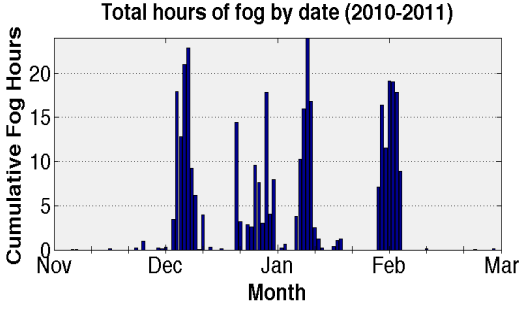


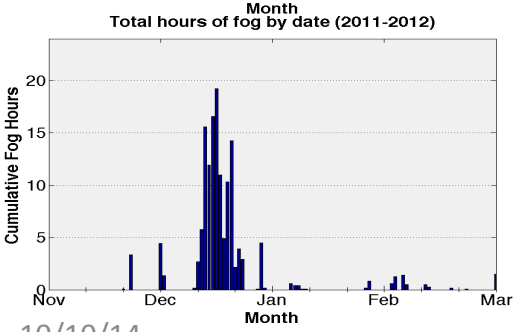


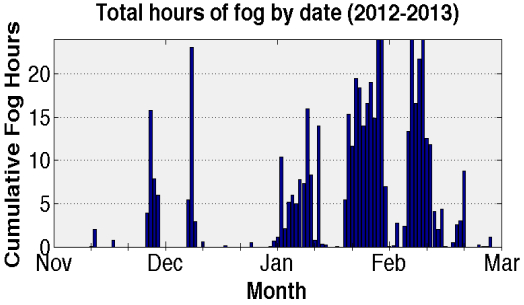


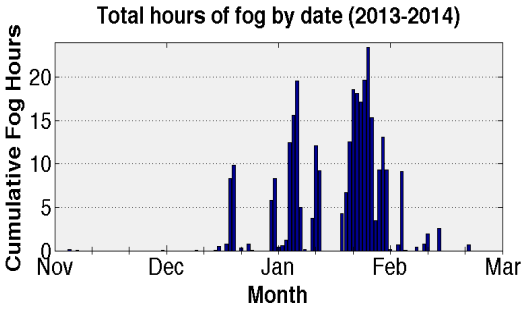




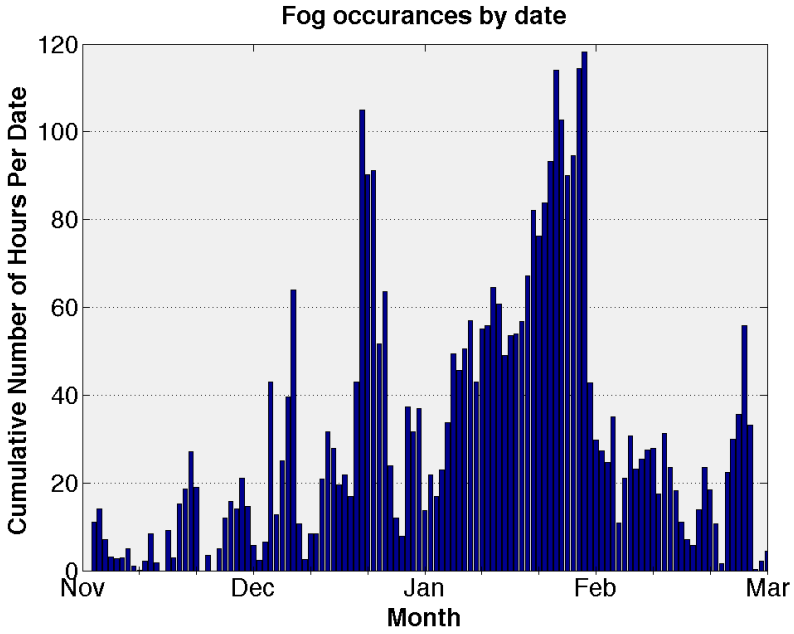


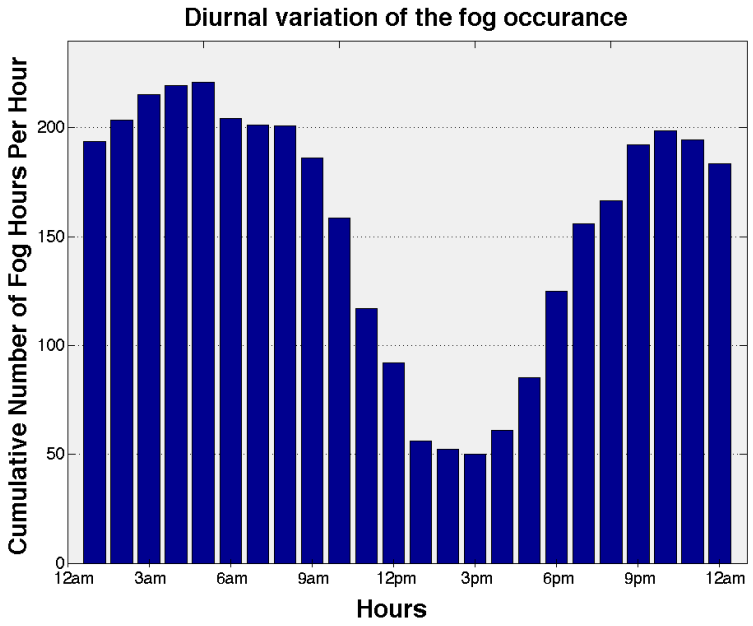






Fog frequency (Salt Lake Valley) 2002-2014 - Summary





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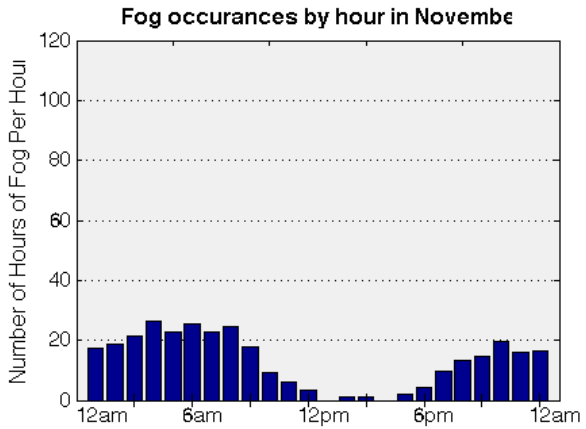
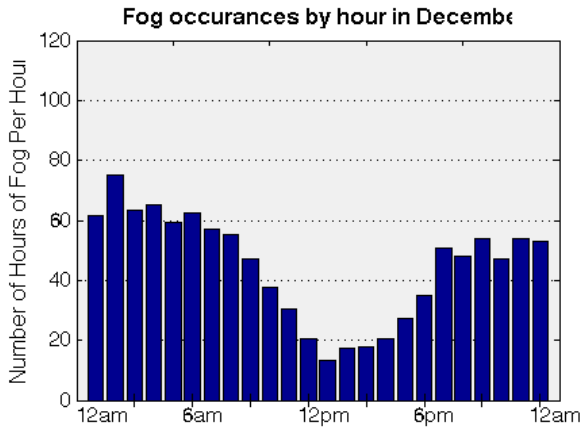
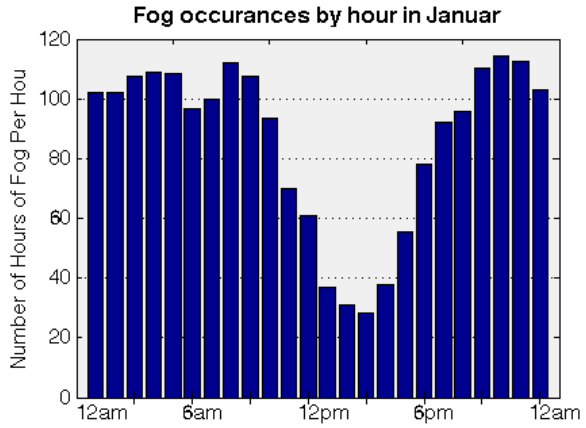
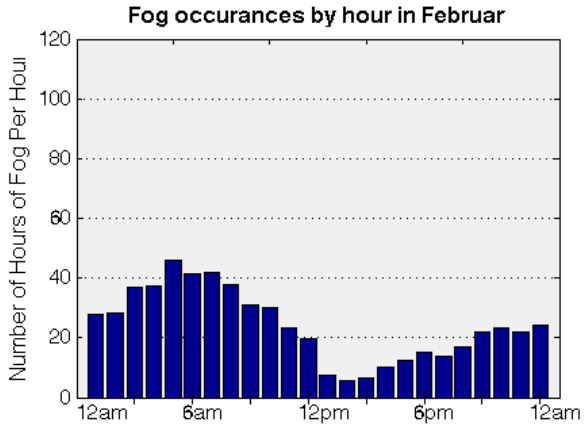








Averaged days of fog events (2002-2014)

City	Nov.	Dec.	Jan.	Feb.	Total
Salt Lake City	5.5	14.25	17.75	8.75	46.25
Heber City	3.55	13.11	14.22	7.77	38.66
Tooele	2.2	12.1	14.9	6.1	35.3
Fill Air Base	1.66	10	13.08	7.	31.75
Provo	0.33	5.66	10.55	6.0	22.55
Logan	8.25	18.66	22.58	18.16	67.66
Ogden	2.75	13.25	17.0	10.16	43.16

Summary - Climatology

Salt Lake Valley

- Fog formation is common during November 25 – February 25 with the peak occurrence between December 5 to January 30.

- On average, the nighttime is significantly foggier than the daytime with the peak occurrences near 9pm-4am local time.

- The months of December and January contain a significantly higher number of inversion-based fog events, compared with November and February. With absolute peak in middle of January. This can be attributed to the snow on the ground, available cold air and lower sun angle.

Heber Valley

- Compared with the Salt Lake Valley, the Heber Valley has higher ratio of fog events in November and especially in February, although during the December and February it has a slightly lower ratio of fog events. Its fog season is boarder and less peaked than the Salt Lake Valley.

- Most fog is radiation fog, with strong peak around 6-9 am local time, which coincides with sunrise.

Synoptic conditions:
An Examination from the winter of 2013-2014

FOG CONDITIONS:
SALT LAKE AND HEBER VALLEYS

AN EXAMINATION OF SYNOPTIC-SCALE SETUPS FROM THE WINTERS OF 2013-2014

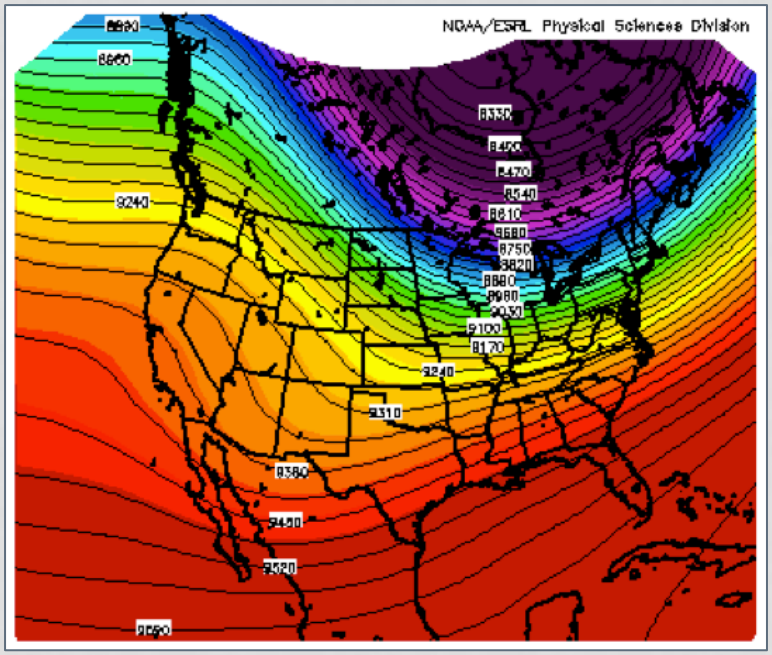
DATES USED

January 2013						
Su	M	Tu	W	Th	F	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

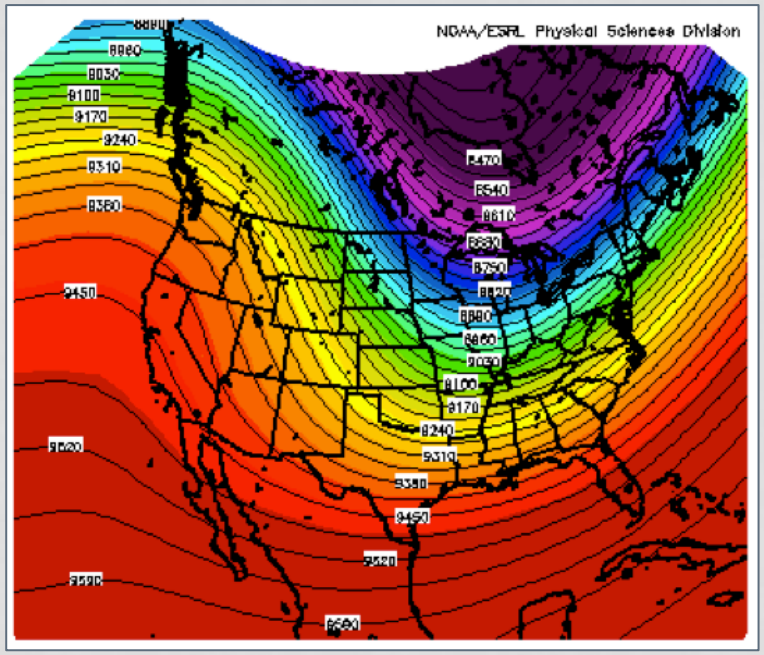
December 2013						
Su	M	Tu	W	Th	F	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

January 2014						
Su	M	Tu	W	Th	F	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

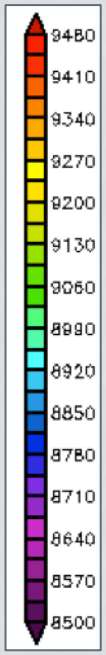
300 MB GEOPOTENTIAL HEIGHT



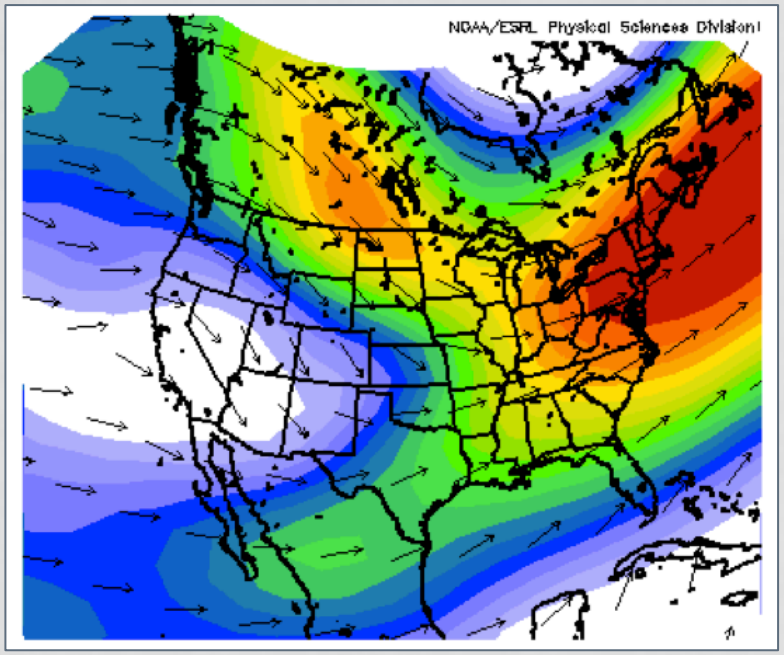
2013 Winter



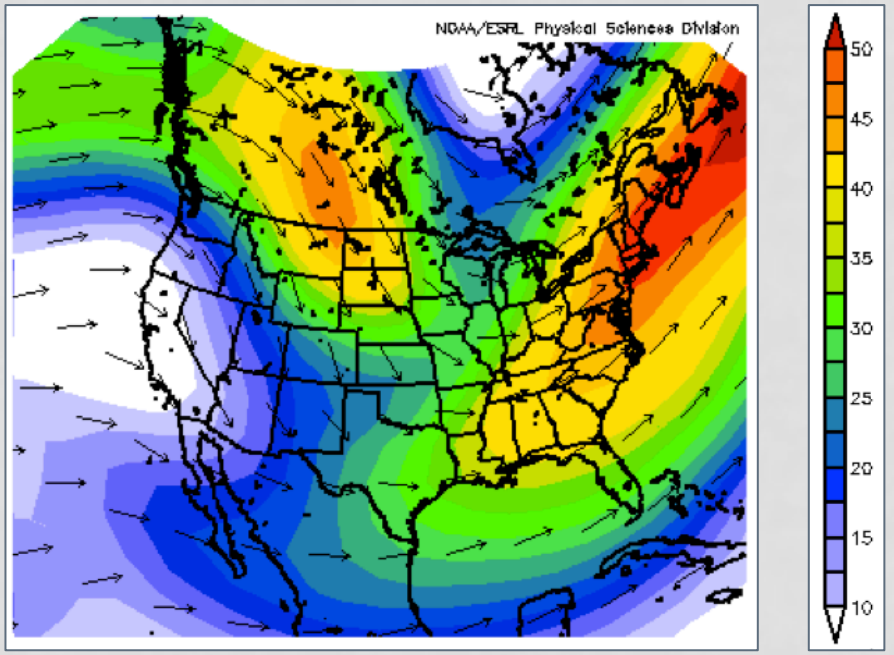
2014 Winter



300 MB WIND

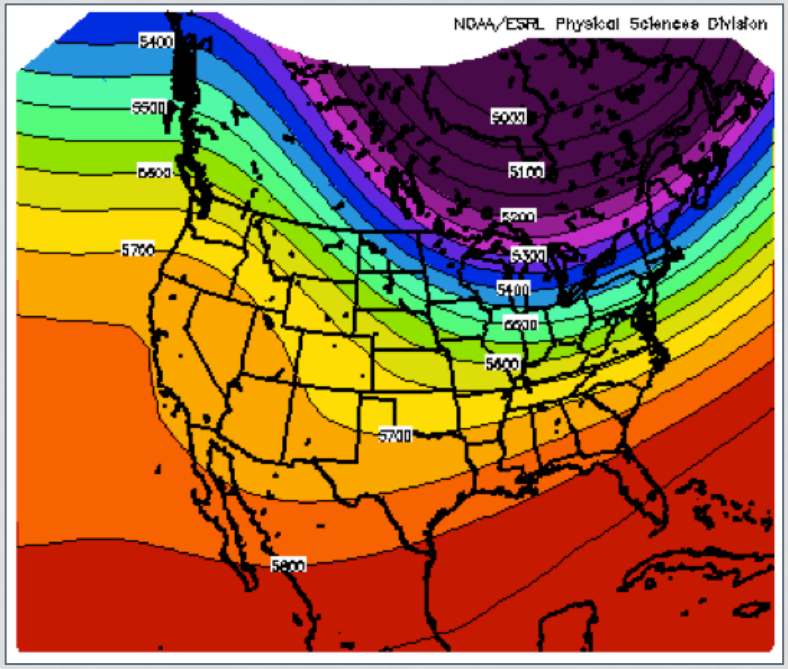


2013 Winter

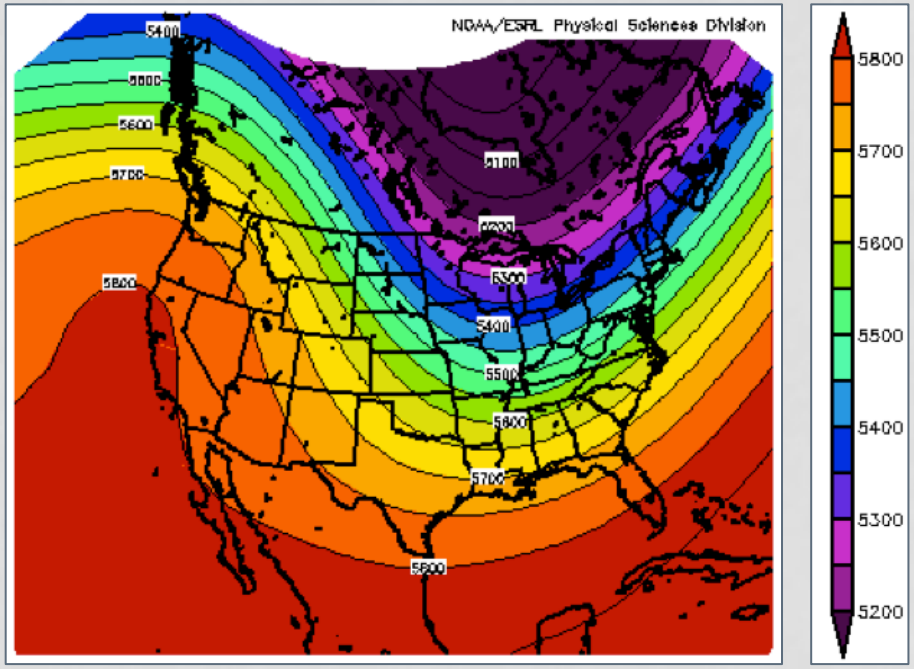


2014 Winter

500 MB GEOPOTENTIAL HEIGHT

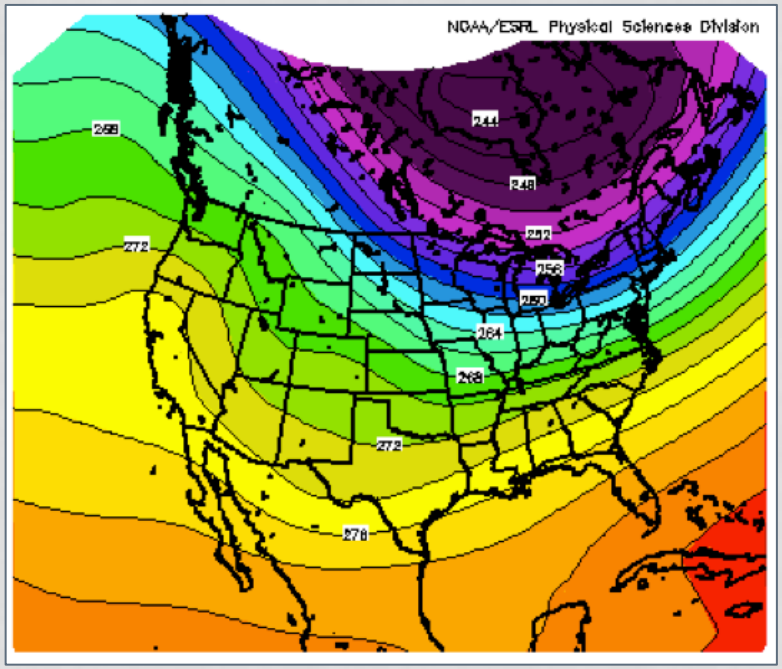


2013 Winter

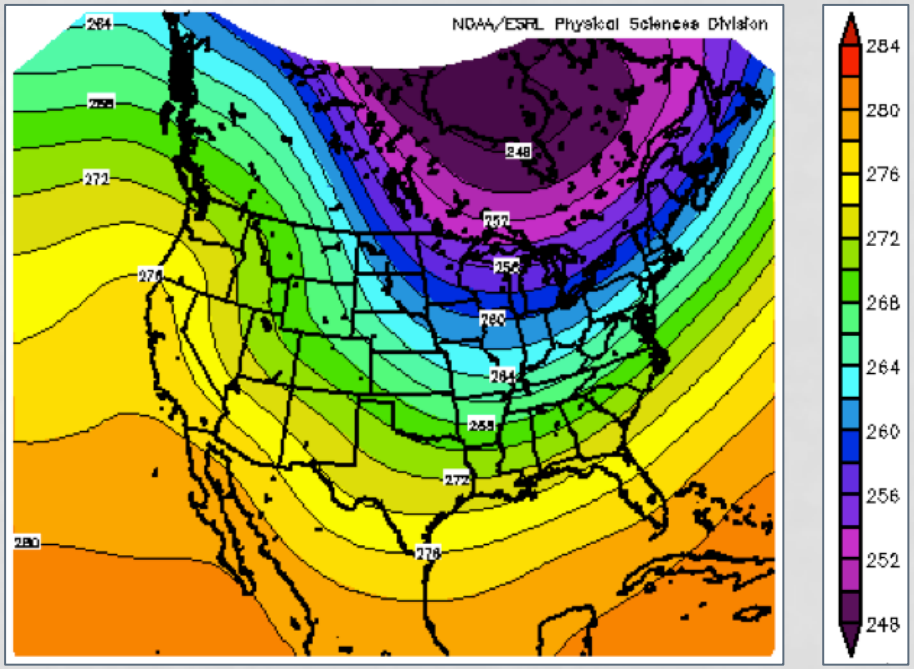


2014 Winter

700 MB TEMPERATURE

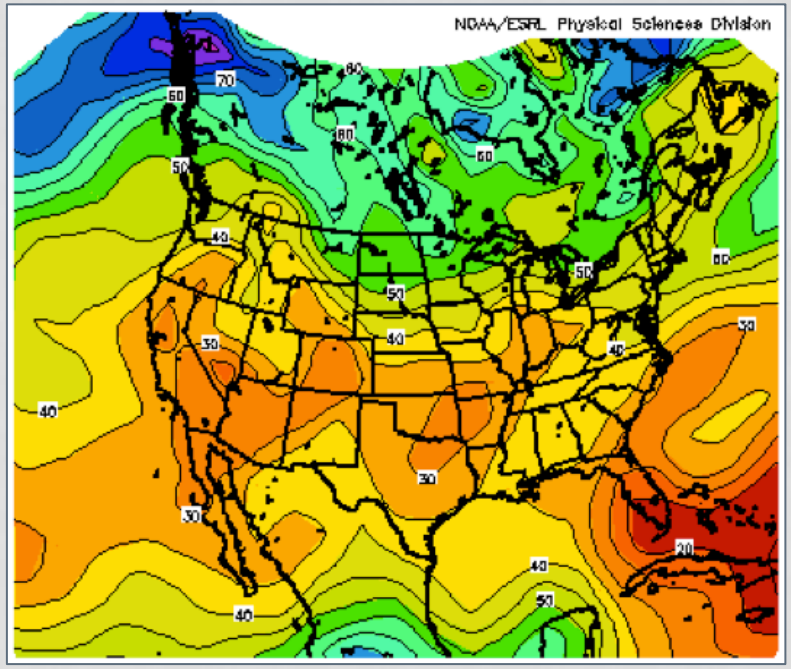


2013 Winter

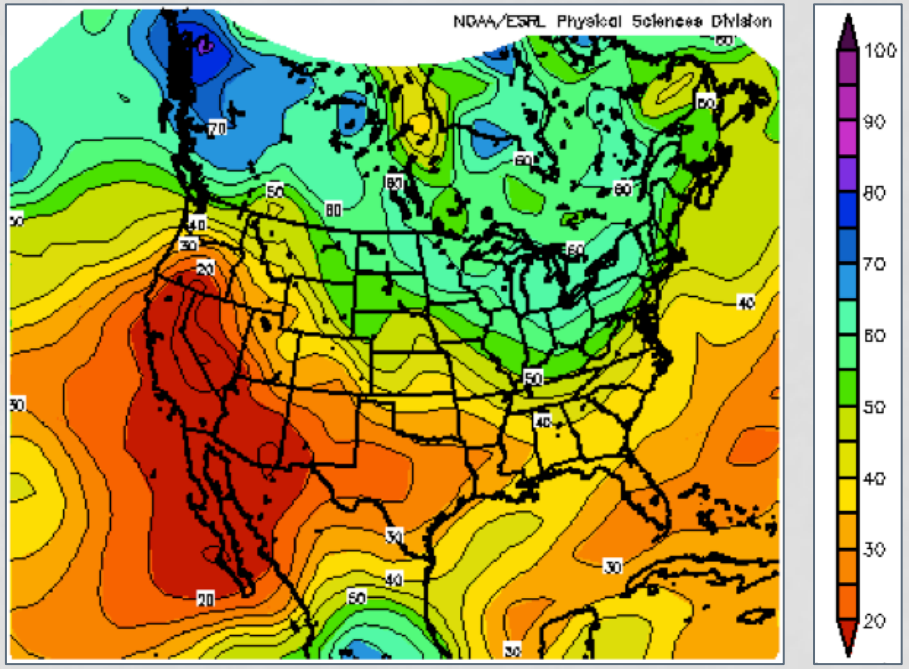


2014 Winter

700 MB RELATIVE HUMIDITY

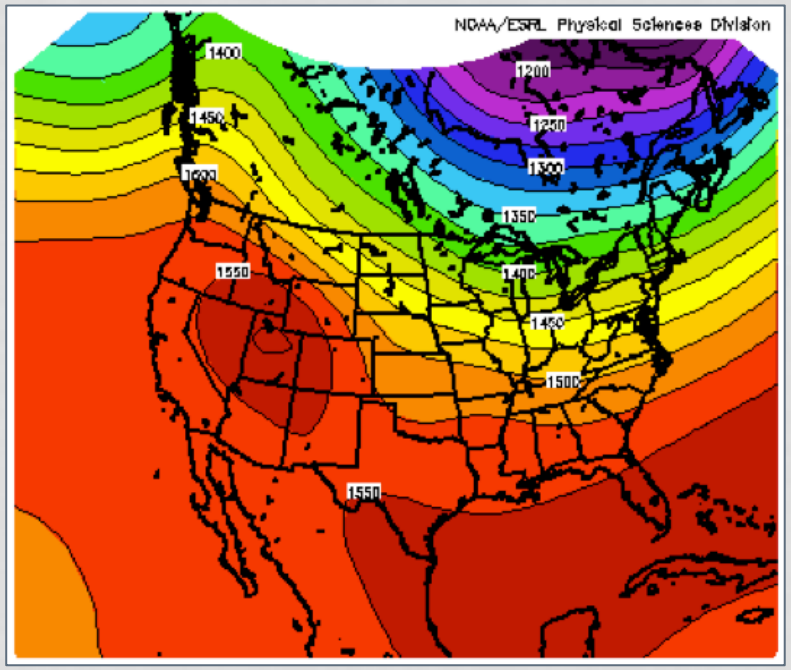


2013 Winter

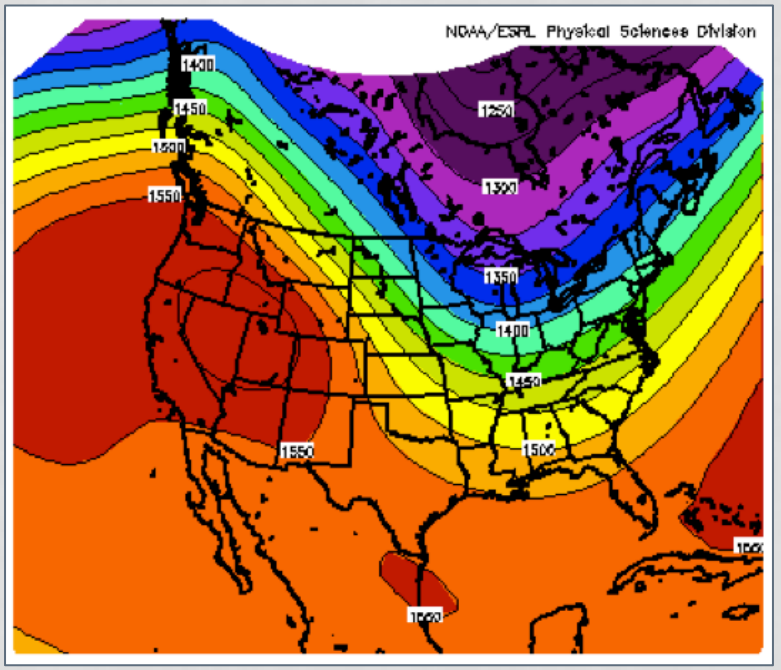


2014 Winter

850 MB GEOPOTENTIAL HEIGHT (M)

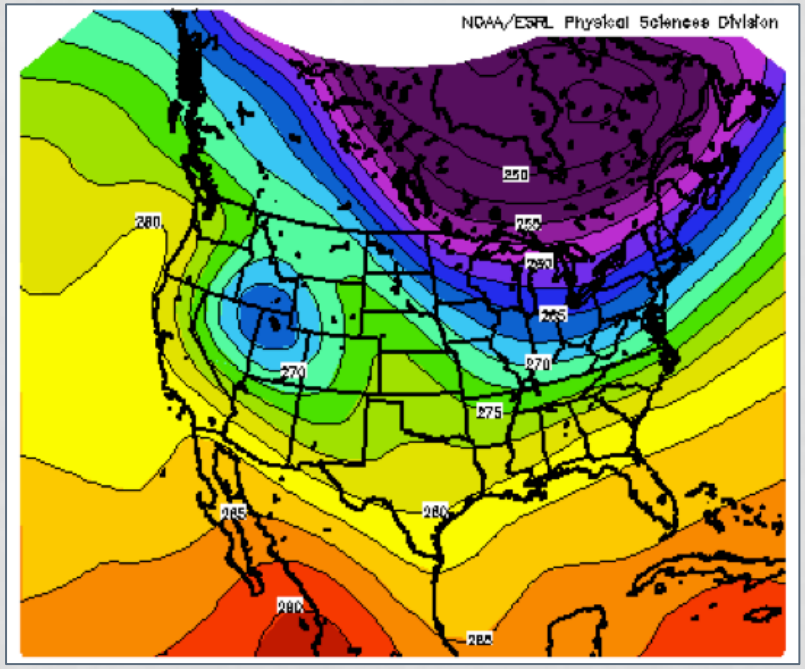


2013 Winter

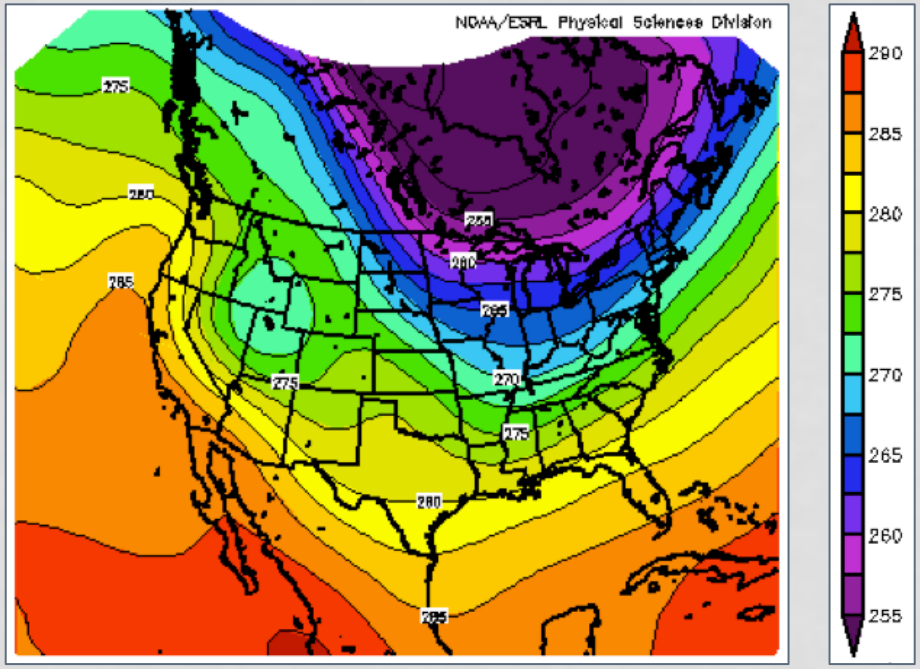


2014 Winter

850 MB TEMPERATURE

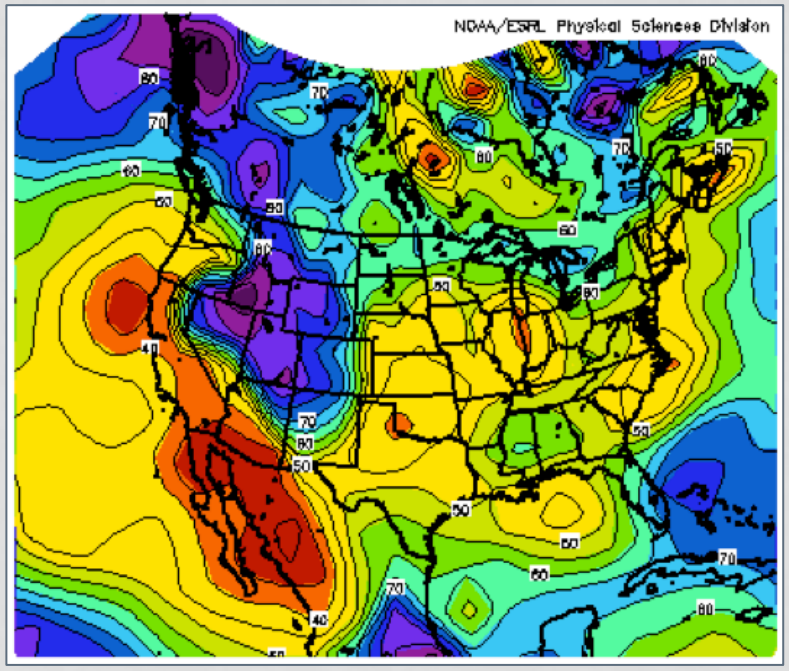


2013 Winter



2014 Winter

850 MB RELATIVE HUMIDITY



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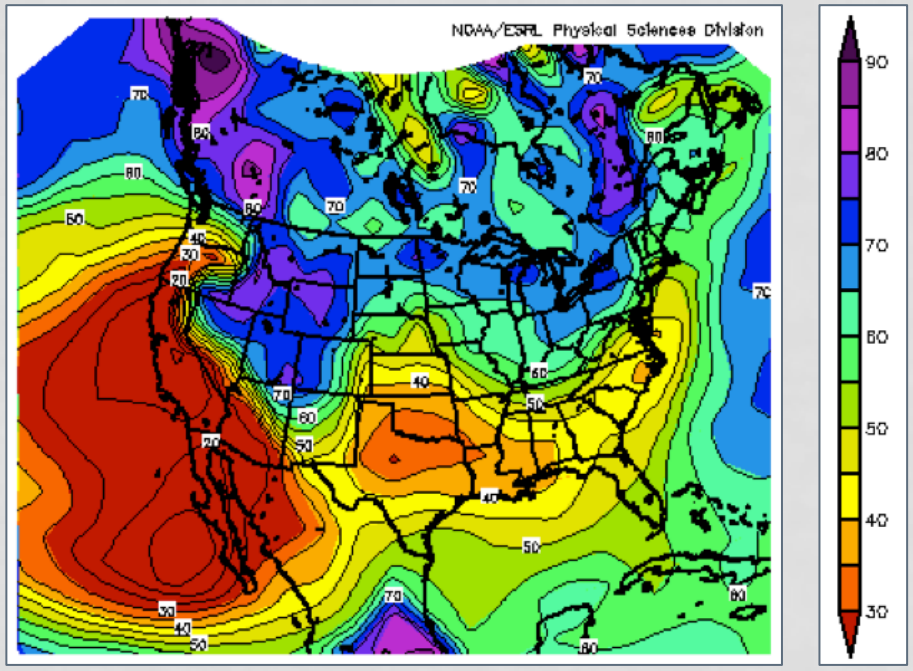
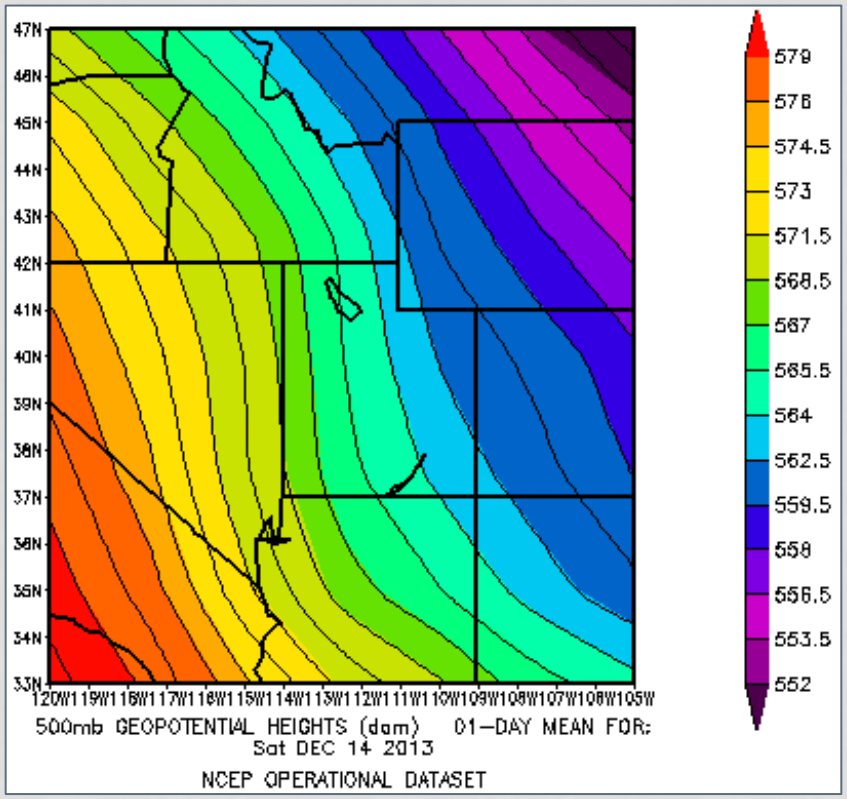


2014 Winter

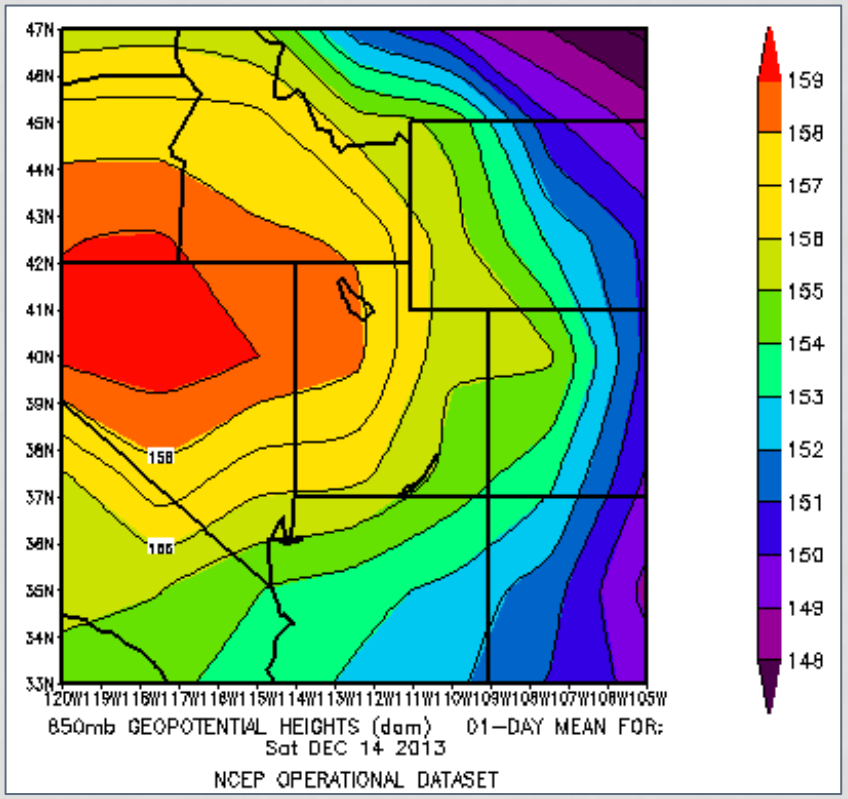
CONCLUSIONS

- 300 mb
  - Further ridging support
  - Relatively low wind speeds (<20 kts) at jet level
- 500 mb
  - Upper-level support for western CONUS ridging
- 700 mb
  - Cold air advection, with mean 270 K (-3 °C) temperature
  - Shallow capped layer, (inversion present at 700 mb)
- 850 mb (Surface)
  - Ridging along the western CONUS
  - Cold air pooling and low-level moisture transport in the Great Basin

DECEMBER 14, 2013

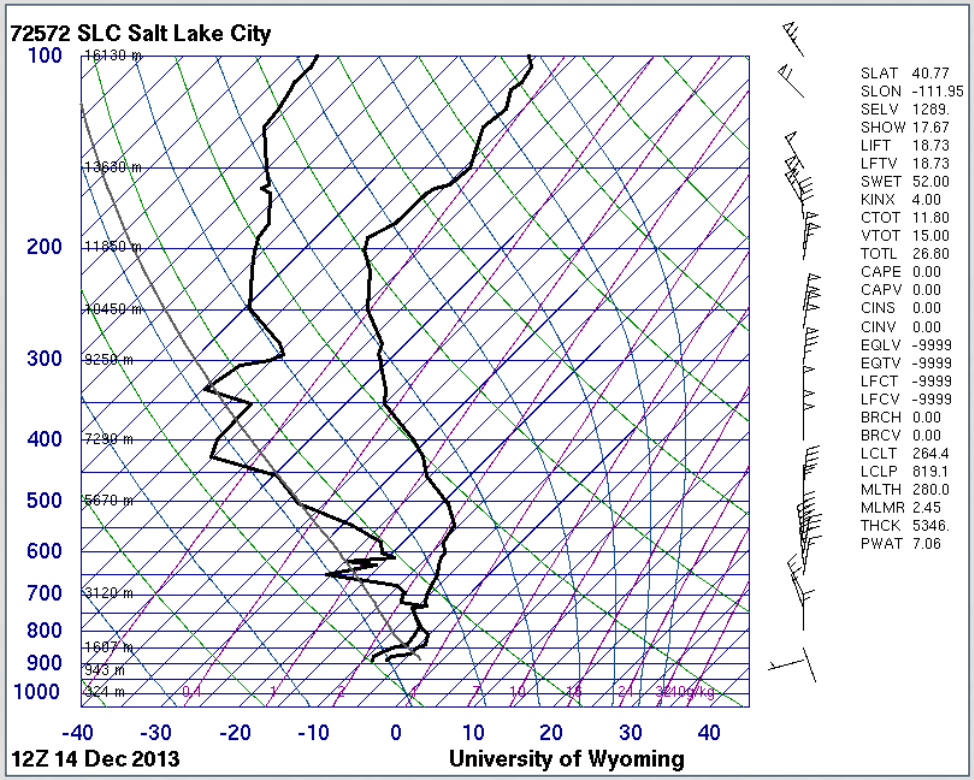


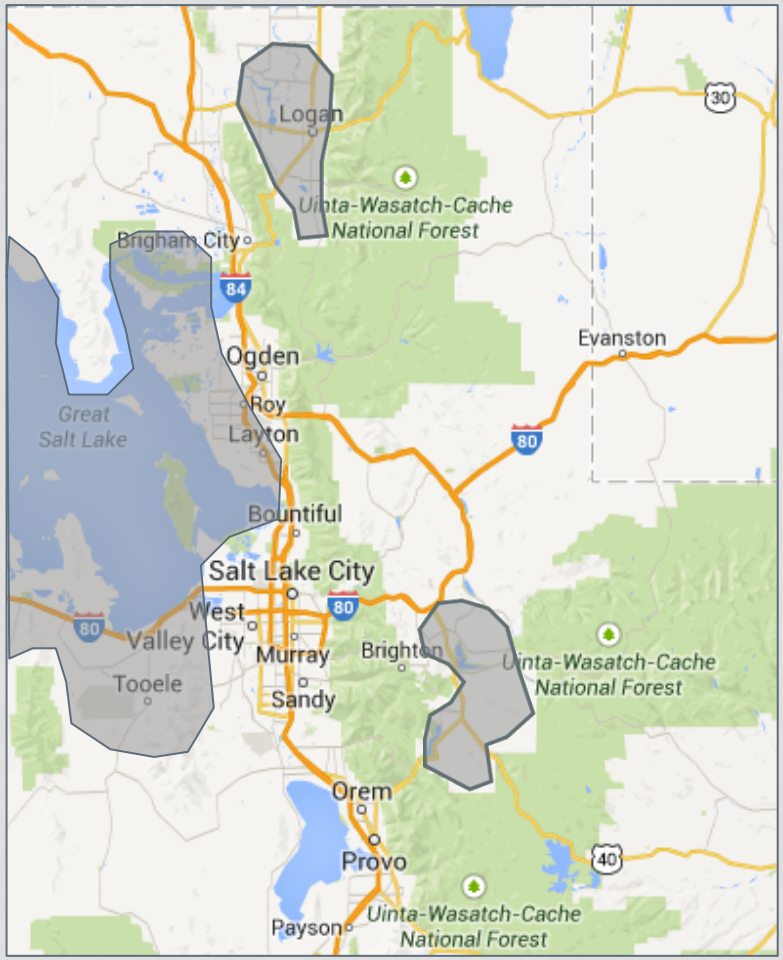
500mb Geopotential Height



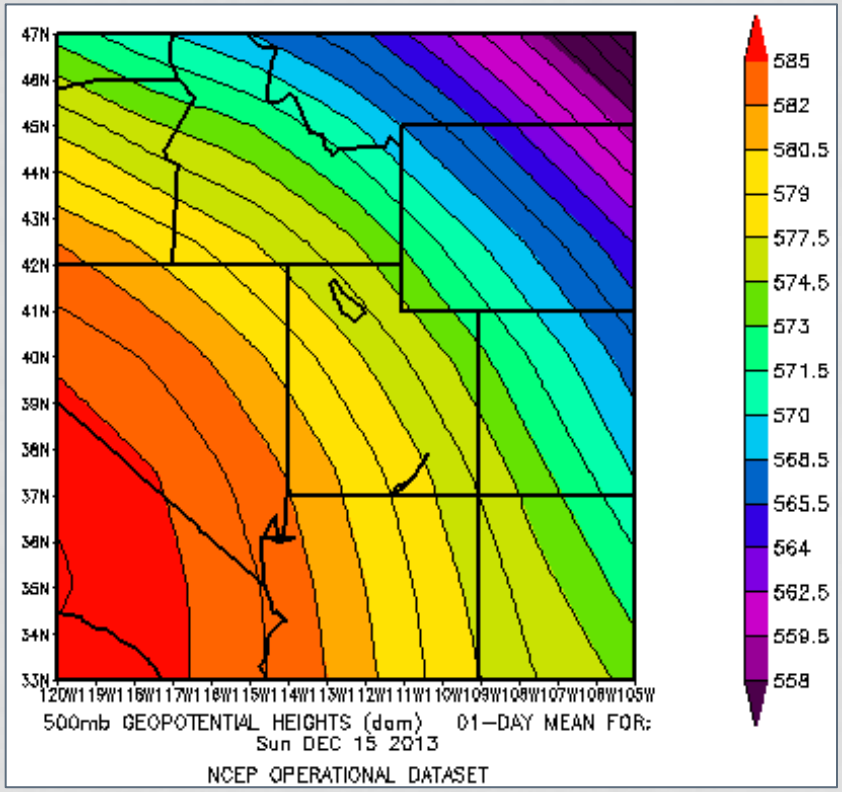
850mb Geopotential Height

DECEMBER 14, 2013

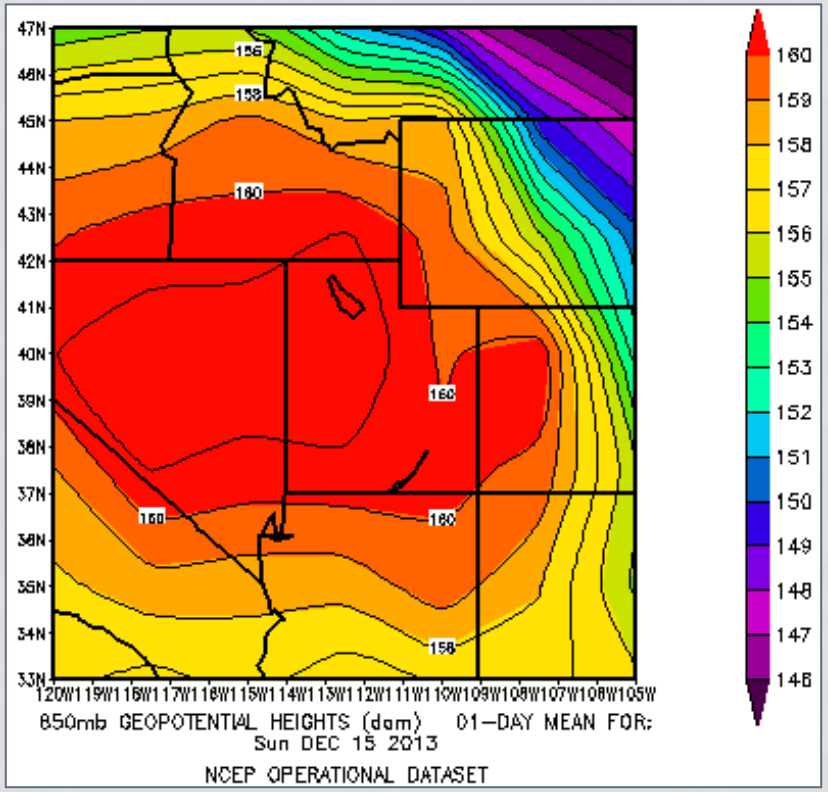




DECEMBER 15, 2013

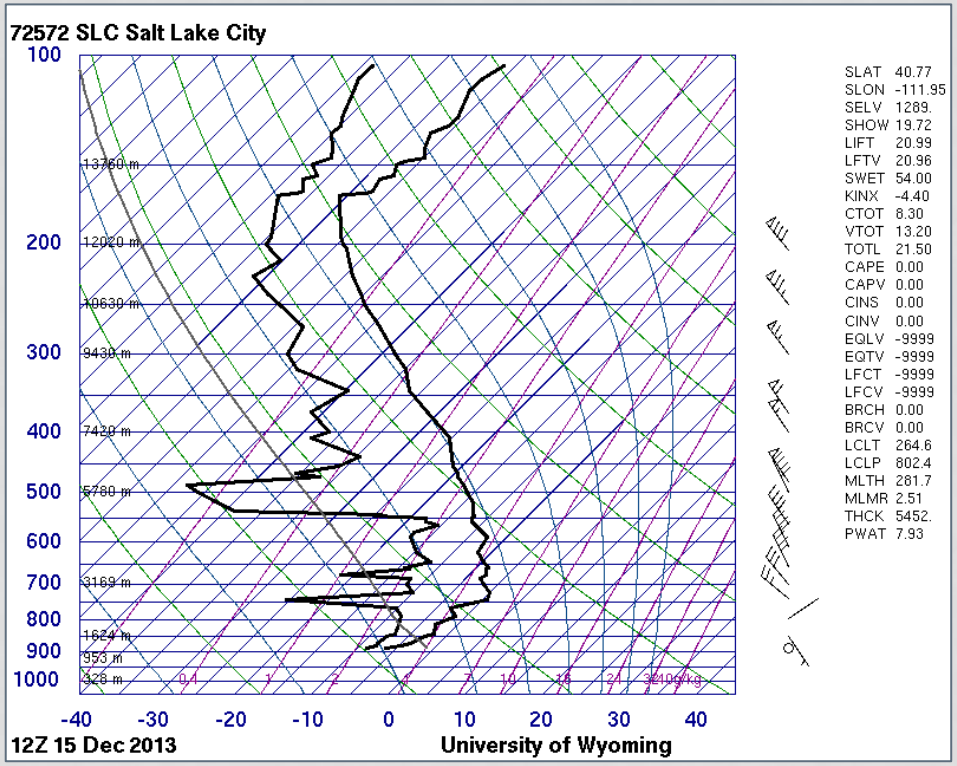


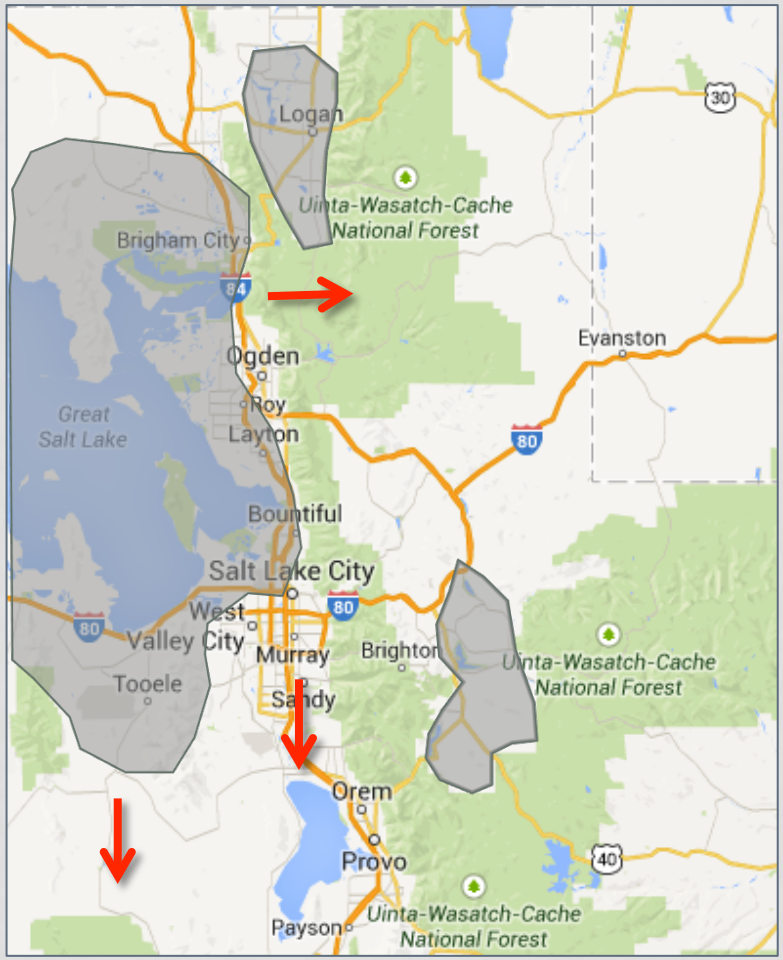
500mb Geopotential Height



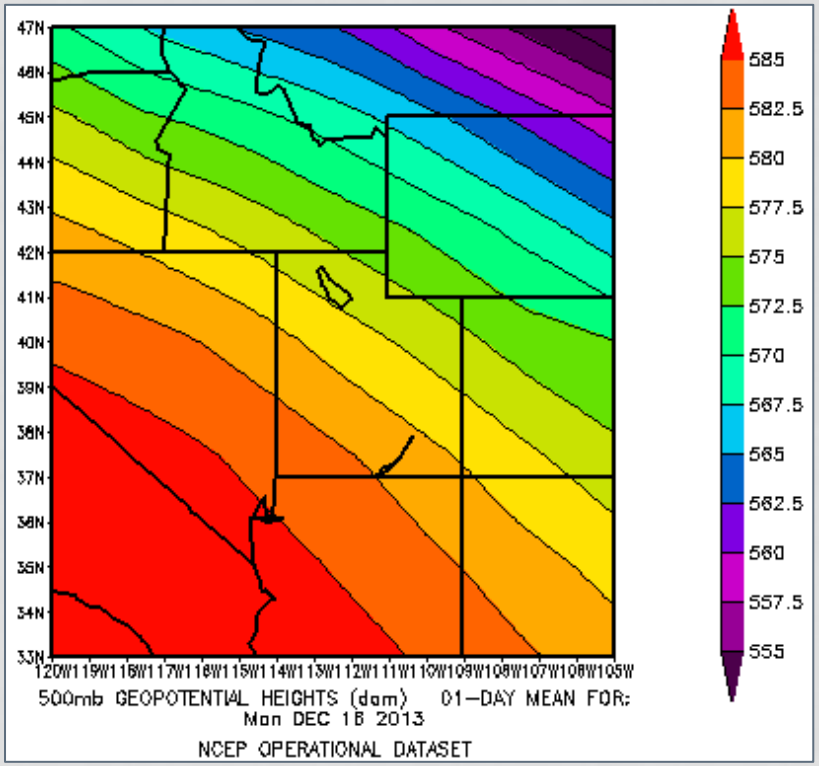
850mb Geopotential Height

DECEMBER 15, 2013

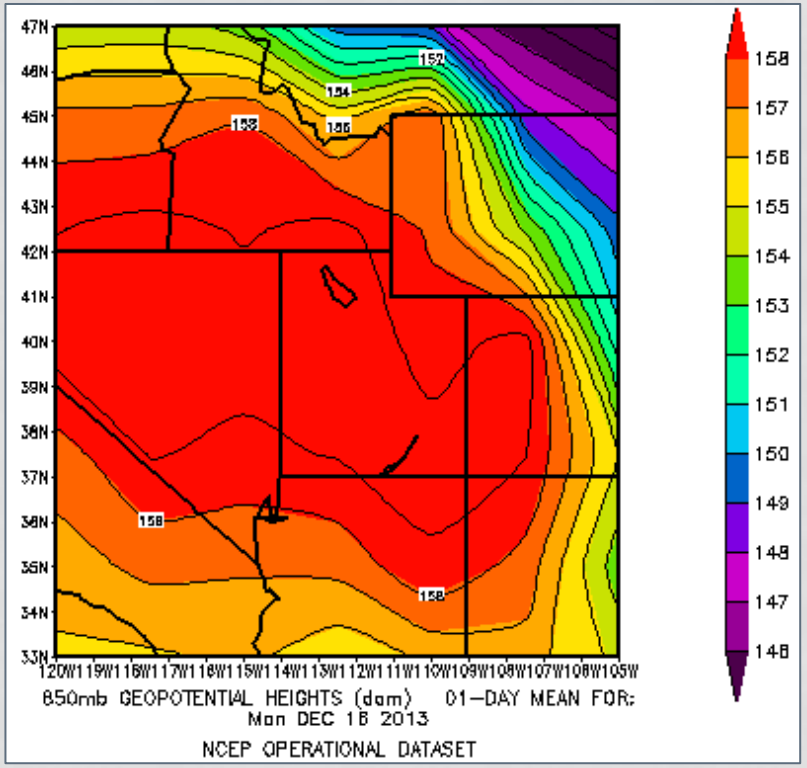




DECEMBER 16 – 17, 2013

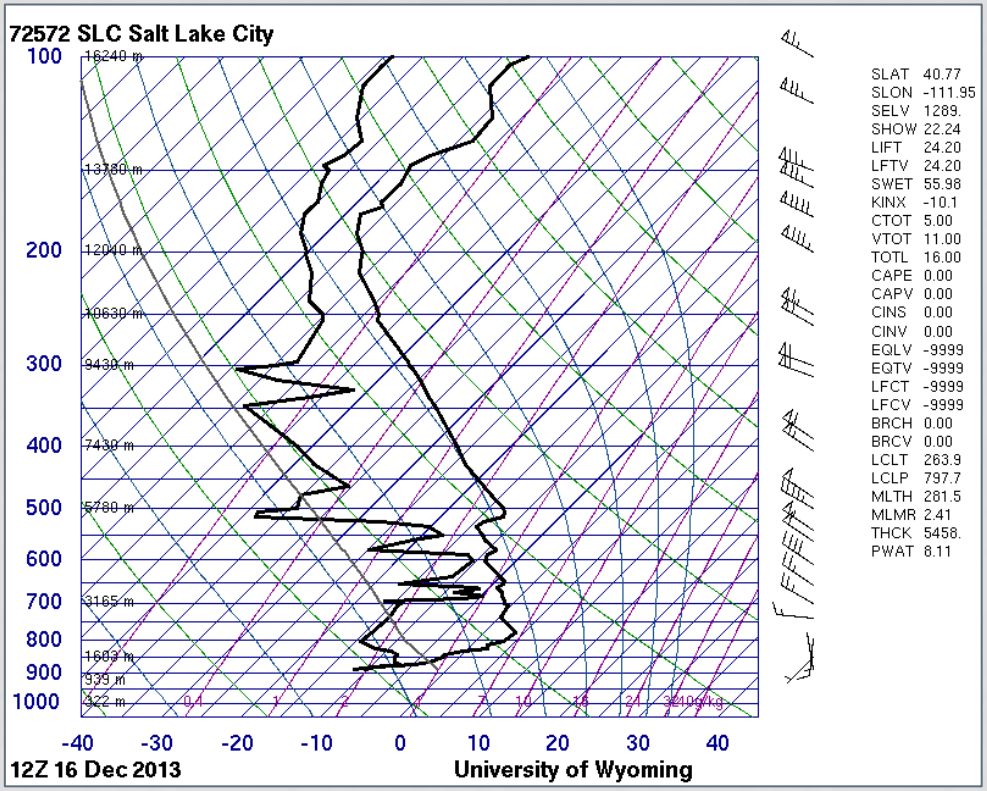


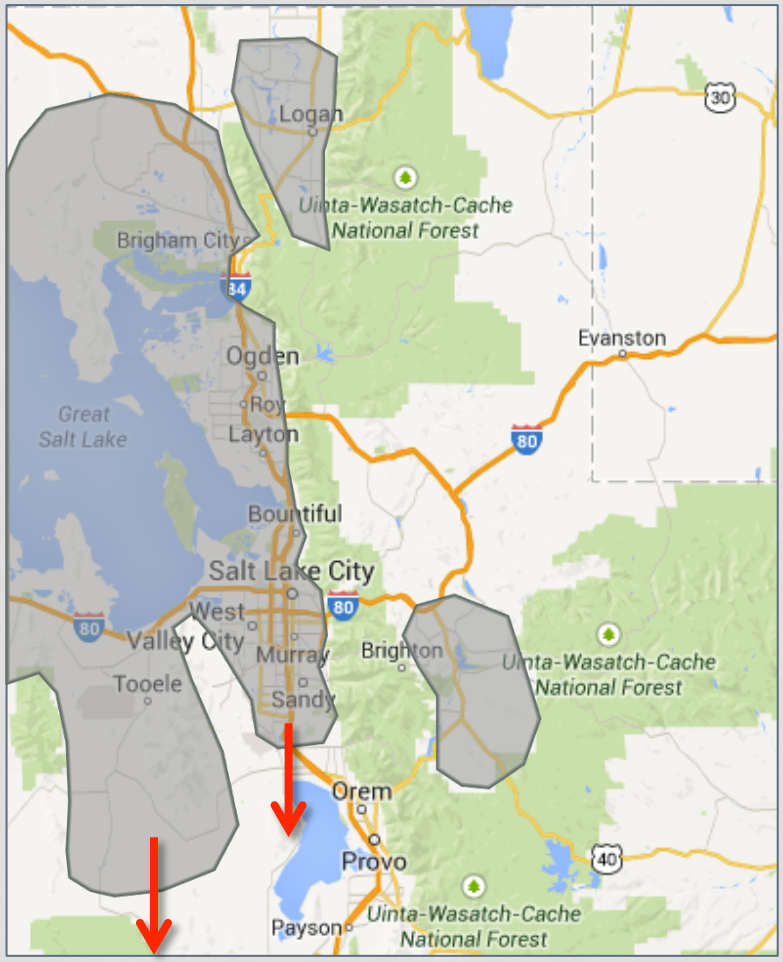
500mb Geopotential Height



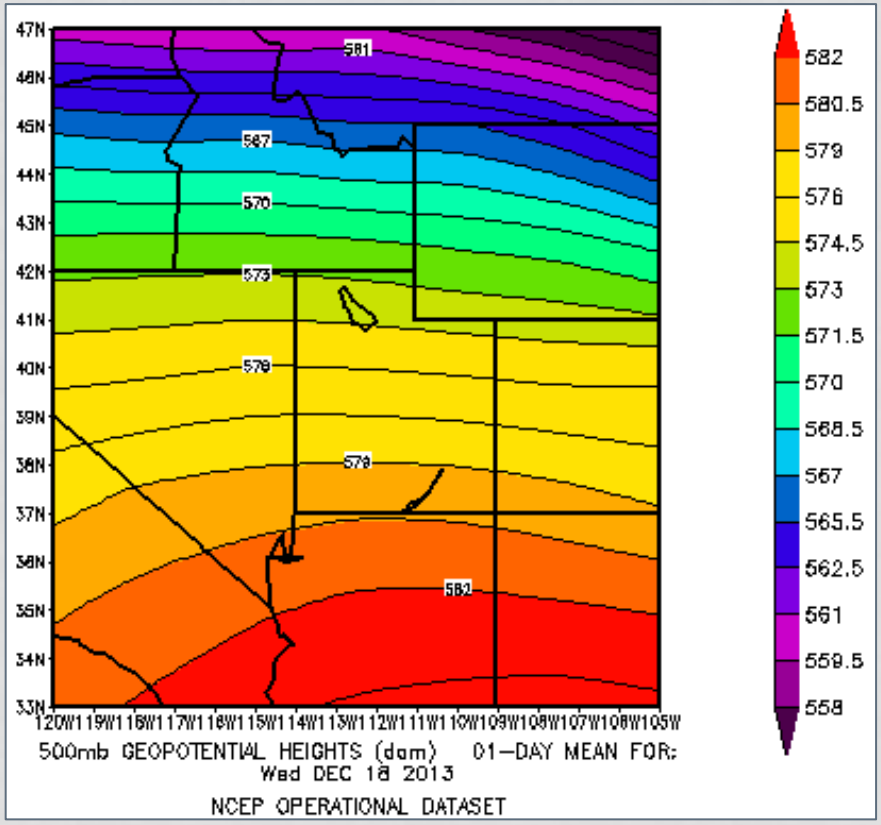
850mb Geopotential Height

DECEMBER 16 - 17, 2013

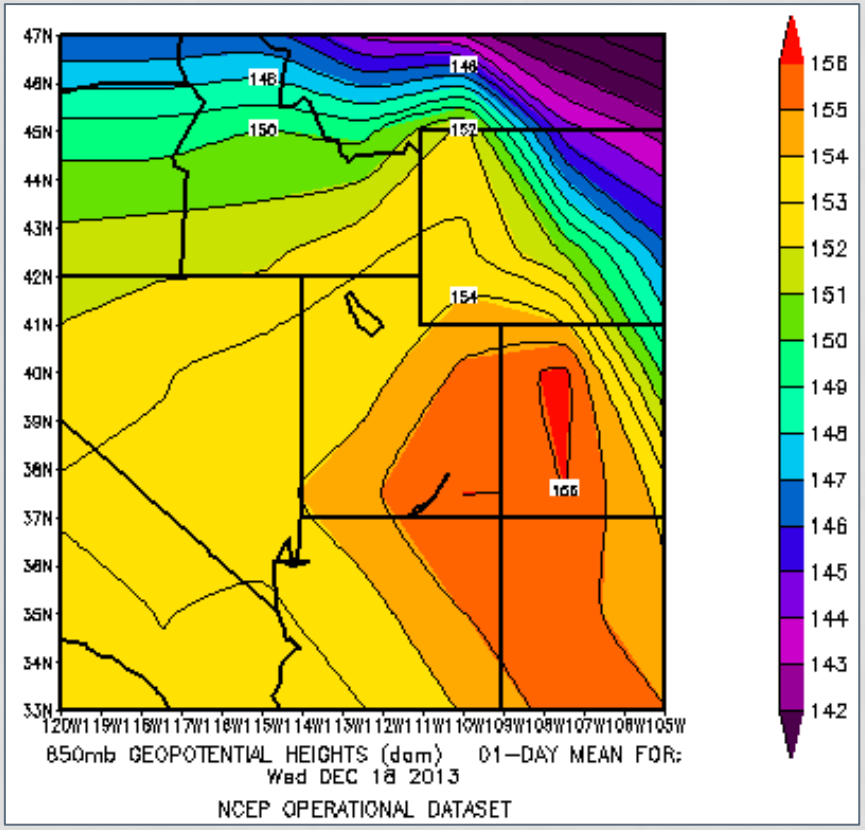




DECEMBER 18, 2013

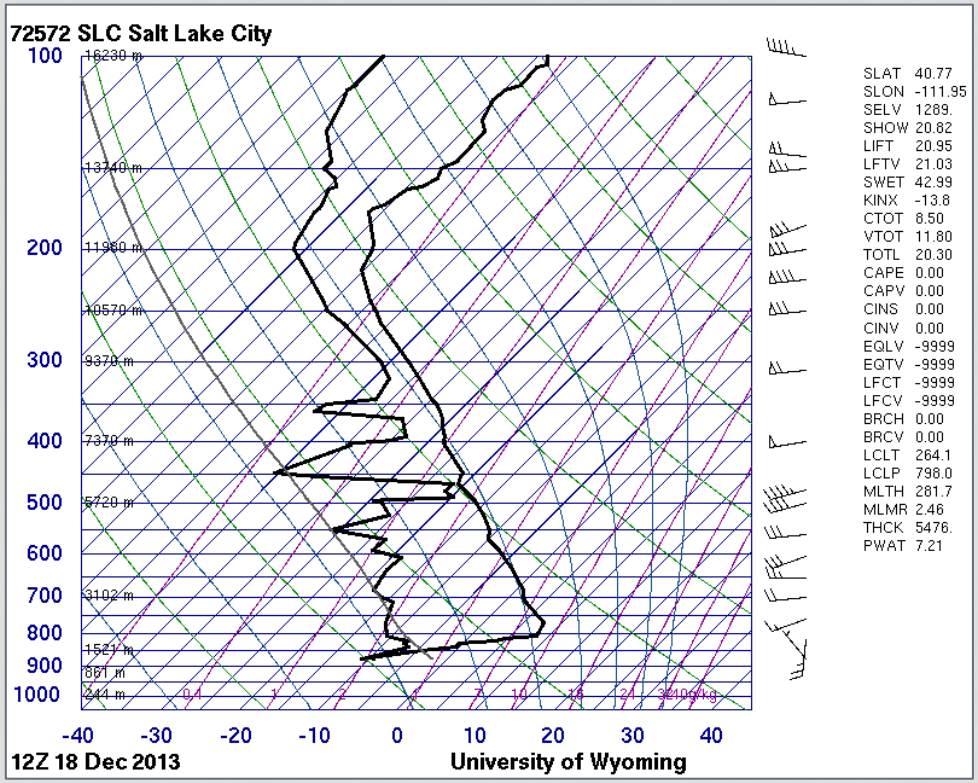


500mb Geopotential Height

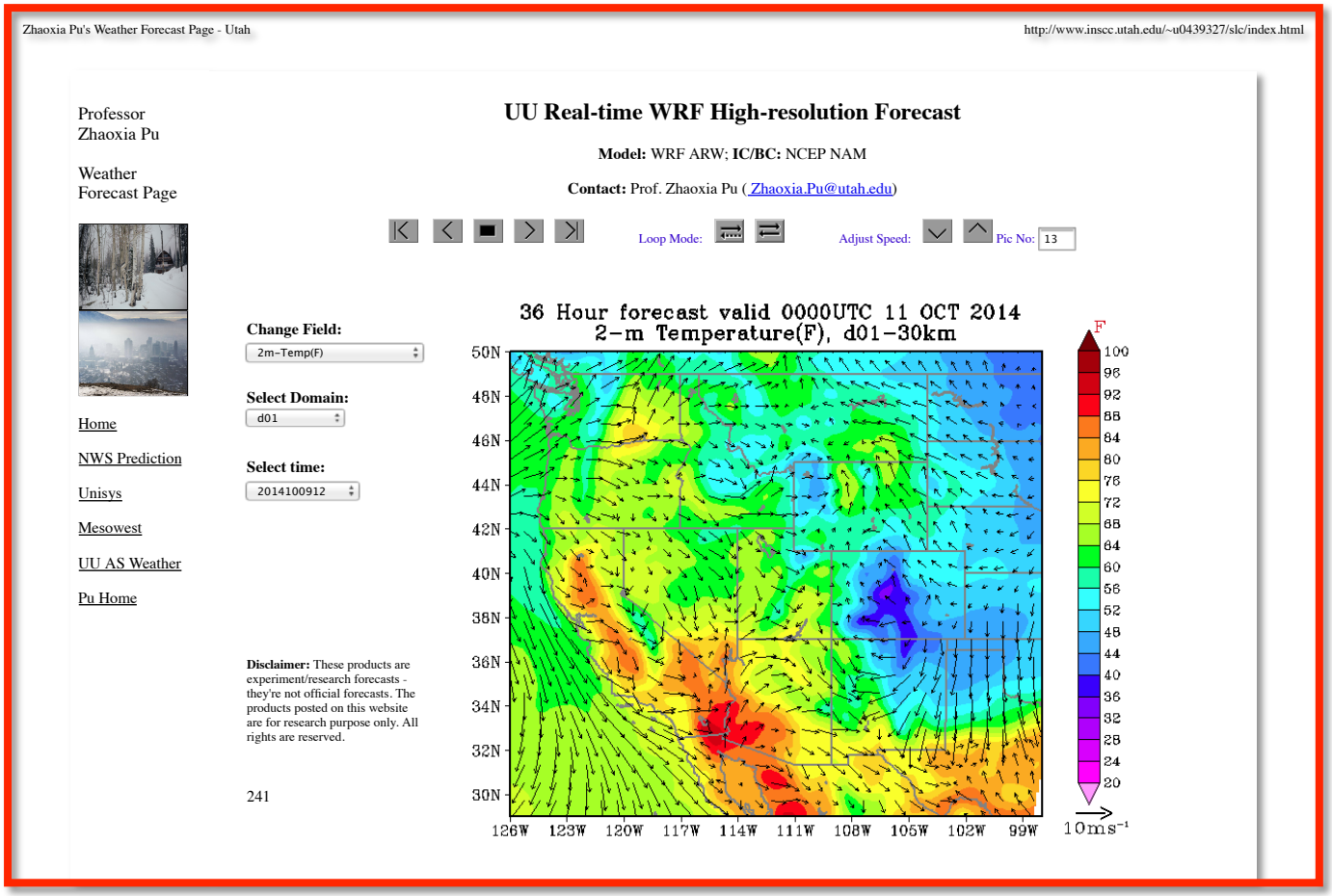


850mb Geopotential Height

DECEMBER 18, 2013



Near-real Time WRF High resolution forecasting

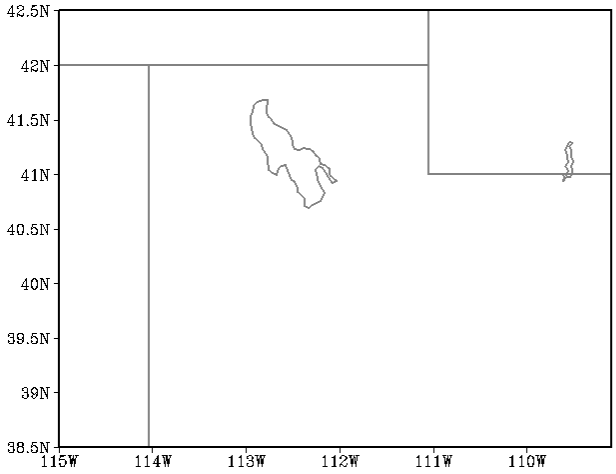


http://www.inscc.utah.edu/~pu/slc/

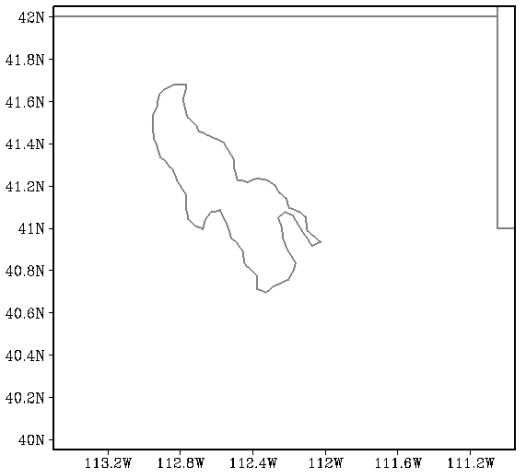
Model Setup (Following MATERHORN Fall and Spring Exps.)

- WRF / ARW Version 3.5
- 30/10/3.3/1.1km

D03



D04



- IC/BC: NCEP NAM
- Forecast: Twice daily at 00 UTC and 12 UTC

Sample Products

- Near surface wind/temperature/ Dewpoint Temperature
- PBL Height
- Rainfall
- SkewT – LnP
- Surface and middle to upper level atmospheric conditions

- Visibility (under development) - will make available during the MATERHORN-Fog

Science questions - Modeling/Forecasting

- Model validation
- Microphysical parameterization
- Boundary layer processes
- Radiation processes
- Visibility calculation
- Data assimilation and impact
- Predictability