Using the Ensemble Situational Awareness Table:

How I Learned to Stop Worrying and Love the Global Ensembles

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February VLab Forum – 19 Feb 2014

Providing Tools for DSS

- Using good science, our goal is to objectively answer these questions for the forecaster:
  - What is significant in the forecast?
  - How likely is it to happen?
  - What are the potential impacts?

- "Better living through verification"
  - There's a lot of guidance out there, but *should I believe it?*

Climatological Perspectives

- "R-Climate": reanalysis-climate
  - How does the model forecast compare to typical conditions at this time of year?
  - "You don't usually get a trough this deep in September"

- "M-Climate": model-climate
  - How does the model forecast compare to what is typically forecast at the same lead time, and this time of year?
  - "The model rarely shows precipitable water this high, 5 days out"

R-Climate Calculations

- Goal: quickly identify where/when the forecast departs significantly from climatology.

- NAEFS ensemble mean is compared to the 1979-2009 Climate Forecast System Reanalysis.
  - 1.0x1.0-degree NAEFS interpolated to 0.5 deg
  - Forecast is compared the CFSR for a 21-day window centered on the valid time.
  - 00Z compared only to 00Z analyses, 06Z to 06Z, etc.

User Interface

National Weather Service
Ensemble Situational Awareness Table

Help | Archive | Horizontal Tables | Verification | Permalink

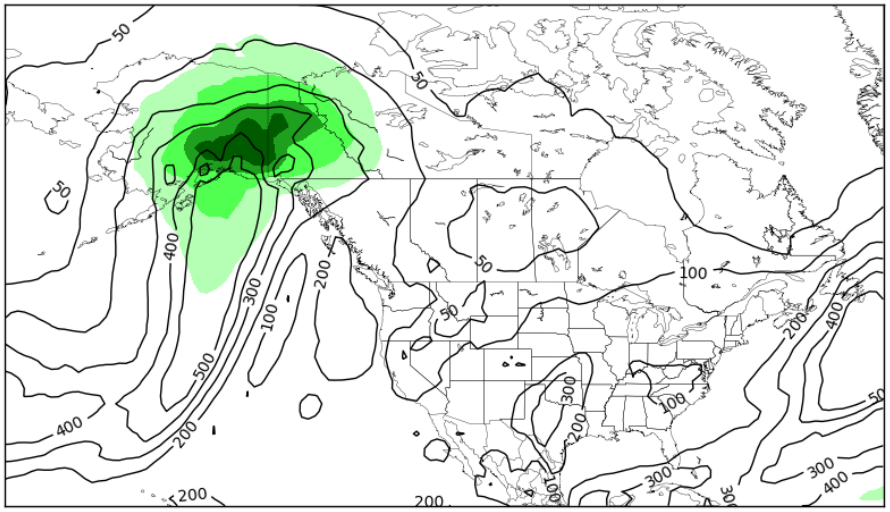
Model Run: Oct 23, 2013 00Z | Table Region: North America | Plot Region: North America | Output: NAEFS Standardized Anomaly | View Table

Fcst Hr: 132 Valid: Mon Oct 28 6:00 AM MDT

WFO North America Table Oct 23, 2013 00Z Run

			Z	T	U	V	WSP	SLP	Q	PW	IVT
6	Wed 23rd	06Z	-3.0	3.5	-3.4	3.5	3.5	-3.0	3.7	3.0	4.3
12		12Z	-3.2	3.4	-3.4	3.7	3.5	-3.1	3.8	3.2	5.0
18		18Z	-3.3	3.4	-3.5	4.1	5.5	-3.2	3.7	2.9	5.8
24	Thu 24th	00Z	-3.4	3.2	-4.0	4.0	5.5	-3.3	3.4	2.7	5.9
30		06Z	-3.5	-3.2	-4.1	3.7	3.5	-3.4	3.3	2.7	5.6
36		12Z	-3.7	-3.1	-4.0	3.2	4.1	-3.5	3.5	2.9	5.1
42		18Z	-3.5	-3.2	-4.1	-3.5	3.8	-3.3	3.7	2.9	4.8
48	Fri 25th	00Z	-3.5	-3.2	3.3	3.3	3.8	-3.4	4.2	2.8	4.3
54		06Z	-4.2	-3.6	3.4	-3.2	3.7	-4.0	4.2	3.0	3.7
60		12Z	-4.2	-3.8	-4.1	3.3	3.8	-4.1	3.9	3.1	3.6
66		18Z	-4.0	-3.7	-3.9	3.5	3.9	-3.9	3.9	2.9	3.6
72	Sat 26th	00Z	-3.8	-3.8	-3.1	3.2	3.1	-3.4	3.3	2.8	3.4
78		06Z	-4.0	-4.0	3.0	2.9	3.8	-2.8	3.2	2.6	3.8
84		12Z	-3.9	-3.8	3.1	2.8	3.4	-2.9	2.6	2.3	4.4
90		18Z	-3.7	-3.4	3.2	3.1	3.5	-2.8	3.0	2.7	4.5
96	Sun 27th	00Z	-3.3	-3.0	3.2	3.6	3.3	-2.6	3.7	3.6	4.7
102		06Z	-2.9	2.9	4.1	4.0	3.9	2.6	4.4	4.2	5.6
108		12Z	3.2	3.1	4.6	4.3	4.7	2.7	4.7	4.4	6.4
114		18Z	3.4	3.3	5.2	4.3	5.0	2.6	5.5	4.8	7.3
120	Mon 28th	00Z	3.6	3.4	5.5	4.2	5.4	2.4	6.0	4.3	8.3
126		06Z	3.7	3.5	5.2	-4.2	4.9	2.4	5.9	5.5	9.4
132		12Z	3.7	3.2	5.0	-4.2	5.3	-2.8	5.5	4.8	9.7
138		18Z	3.5	3.0	4.6	-4.2	4.7	-3.3	5.2	3.8	9.5
144	Tue 29th	00Z	3.3	3.0	4.3	-4.0	4.1	-3.3	4.7	3.7	8.0
150		06Z	3.1	2.9	3.8	-3.7	3.8	-3.1	3.7	3.1	6.5
156		12Z	2.9	2.8	3.3	-3.3	3.2	-2.6	3.1	2.6	5.5
162		18Z	2.7	2.5	3.2	-2.9	2.8	-2.3	2.7	2.2	4.4
168	Wed 30th	00Z	-2.5	2.3	2.8	-2.6	2.3	-2.4	2.3	1.9	3.4
174		06Z	2.4	2.1	-2.3	-2.2	1.9	-2.4	2.1	1.7	2.9
180		12Z	2.3	2.0	2.0	-1.8	1.7	-2.2	2.0	1.7	2.3
186		18Z	2.3	2.3	2.2	-1.6	1.6	-2.1	2.0	1.7	1.8
192	Thu 31st	00Z	2.2	2.1	2.0	-1.5	1.6	-2.0	1.9	1.6	1.8
198		06Z	2.1	2.1	2.0	-1.4	1.6	-1.9	1.9	1.7	1.7
204		12Z	2.0	2.0	1.8	1.4	1.5	-1.9	1.7	1.5	1.4
210		18Z	1.9	2.1	1.6	-1.3	1.4	-1.9	1.9	1.3	1.1
216	Fri 1st	00Z	-2.2	2.1	1.4	-1.1	1.1	-2.6	1.8	1.3	1.1
222		06Z	-2.2	1.9	1.2	-1.1	1.0	-2.4	1.8	1.2	0.8
228		12Z	-2.5	-1.9	1.2	1.0	0.8	-2.6	1.6	1.2	0.8
234		18Z	-2.5	2.0	1.1	0.9	0.7	-2.6	1.6	1.1	0.8
240	Sat 2nd	00Z	-2.6	1.9	-1.0	-0.9	0.7	-2.9	1.7	1.1	0.6

NAEFS Mean Integrated WV Transport ($kgm^{-1}s^{-1}$) and Standardized Anomaly
HOUR 132 - VALID 12:00 UTC Mon Oct 28 2013

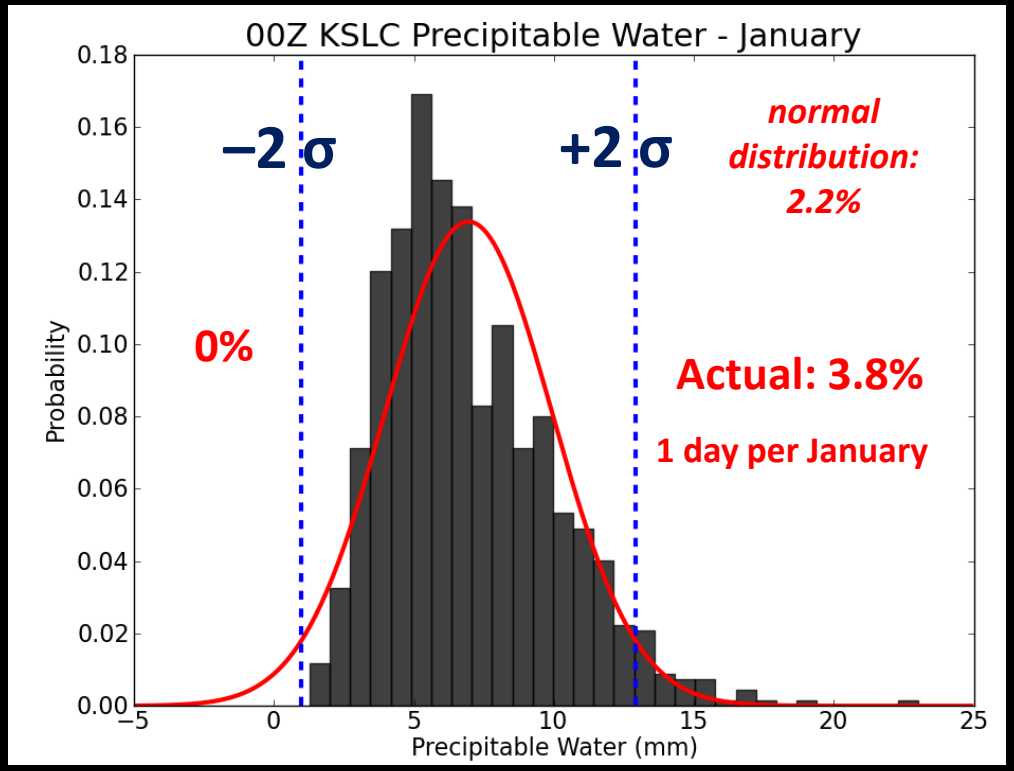


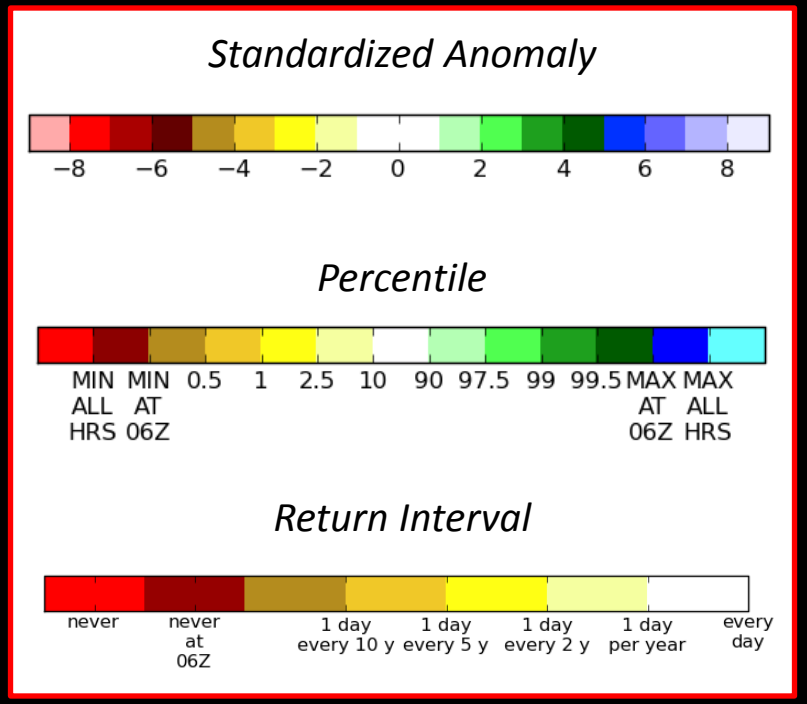
Relative to the 18-Oct to 08-Nov 1979-2009 CFSR climatology

http://ssd.wrh.noaa.gov/satable

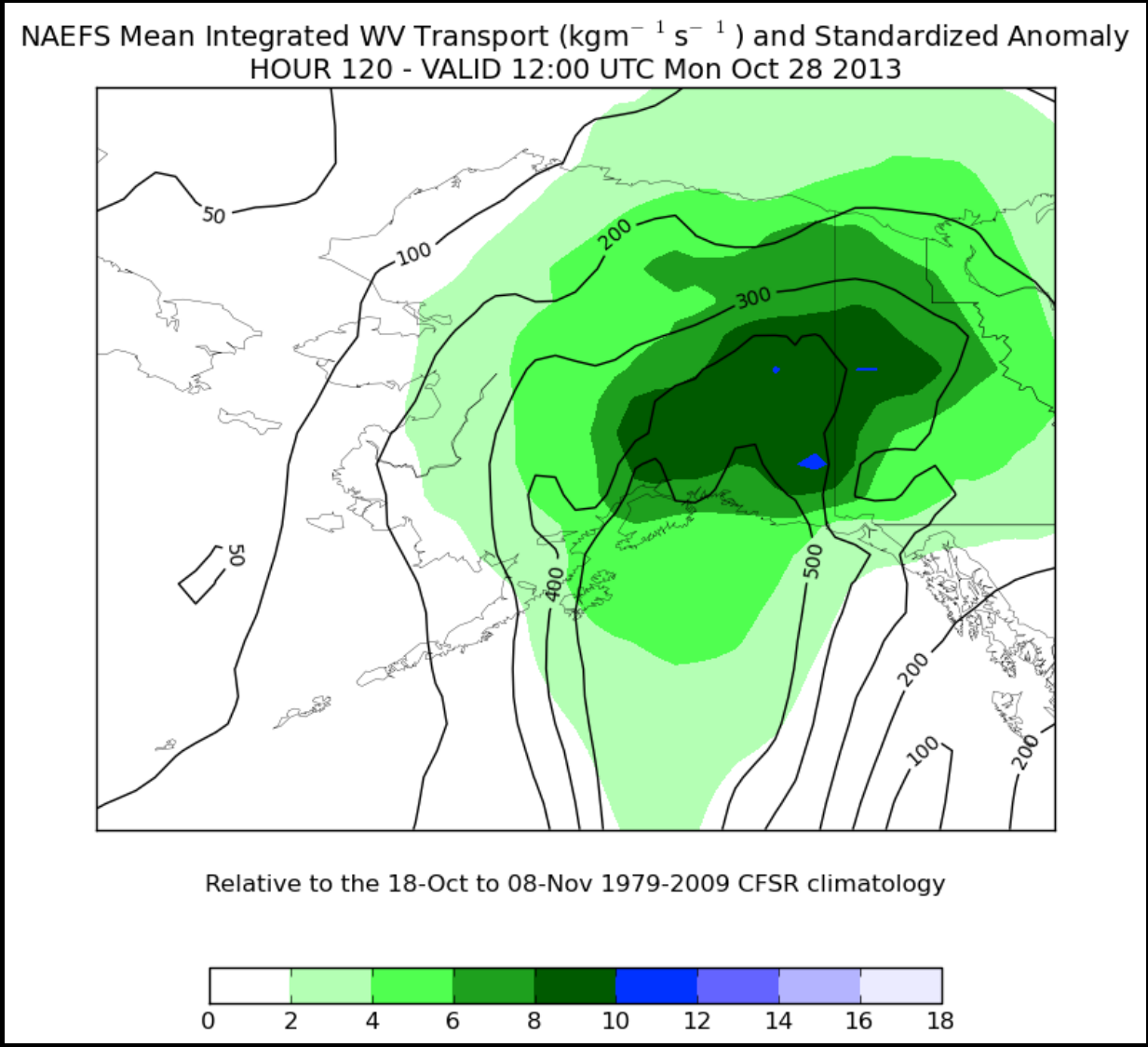
Output Types

- Not all fields are normally distributed
- Percentiles/return intervals help translate standardized anomalies into “where exactly does this event fall relative to climatology?”

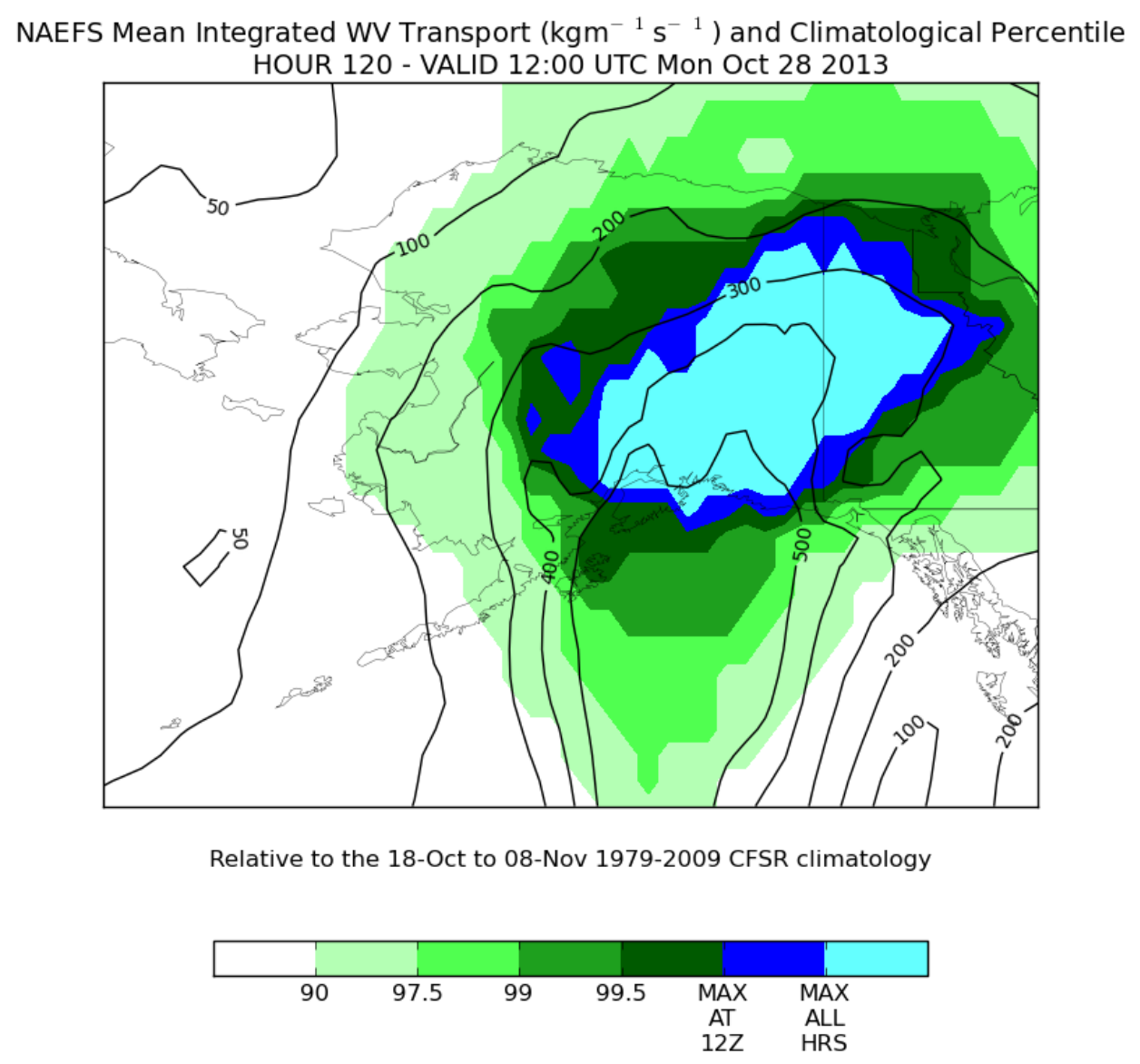




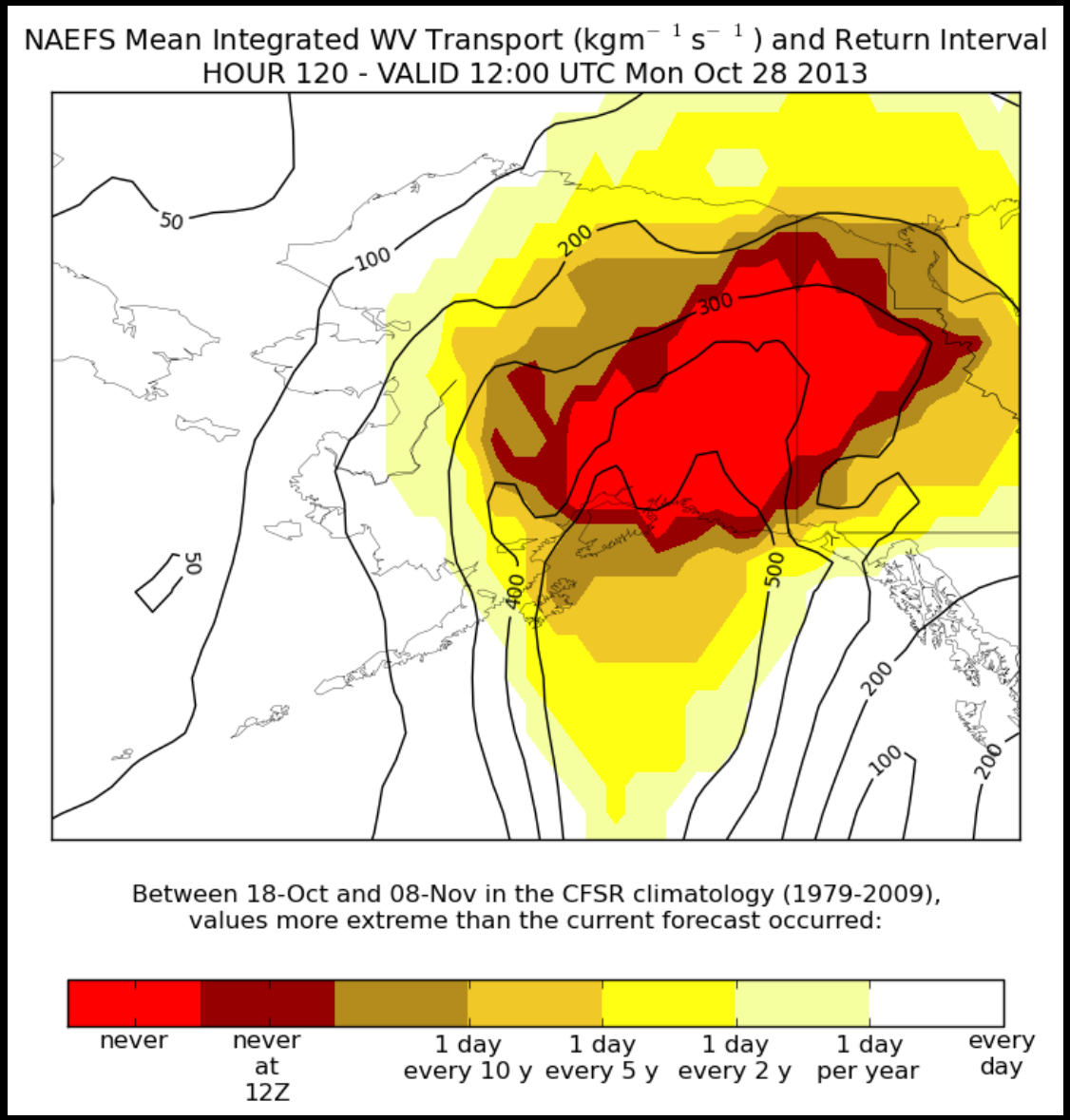
R-Climate: Standardized Anomaly



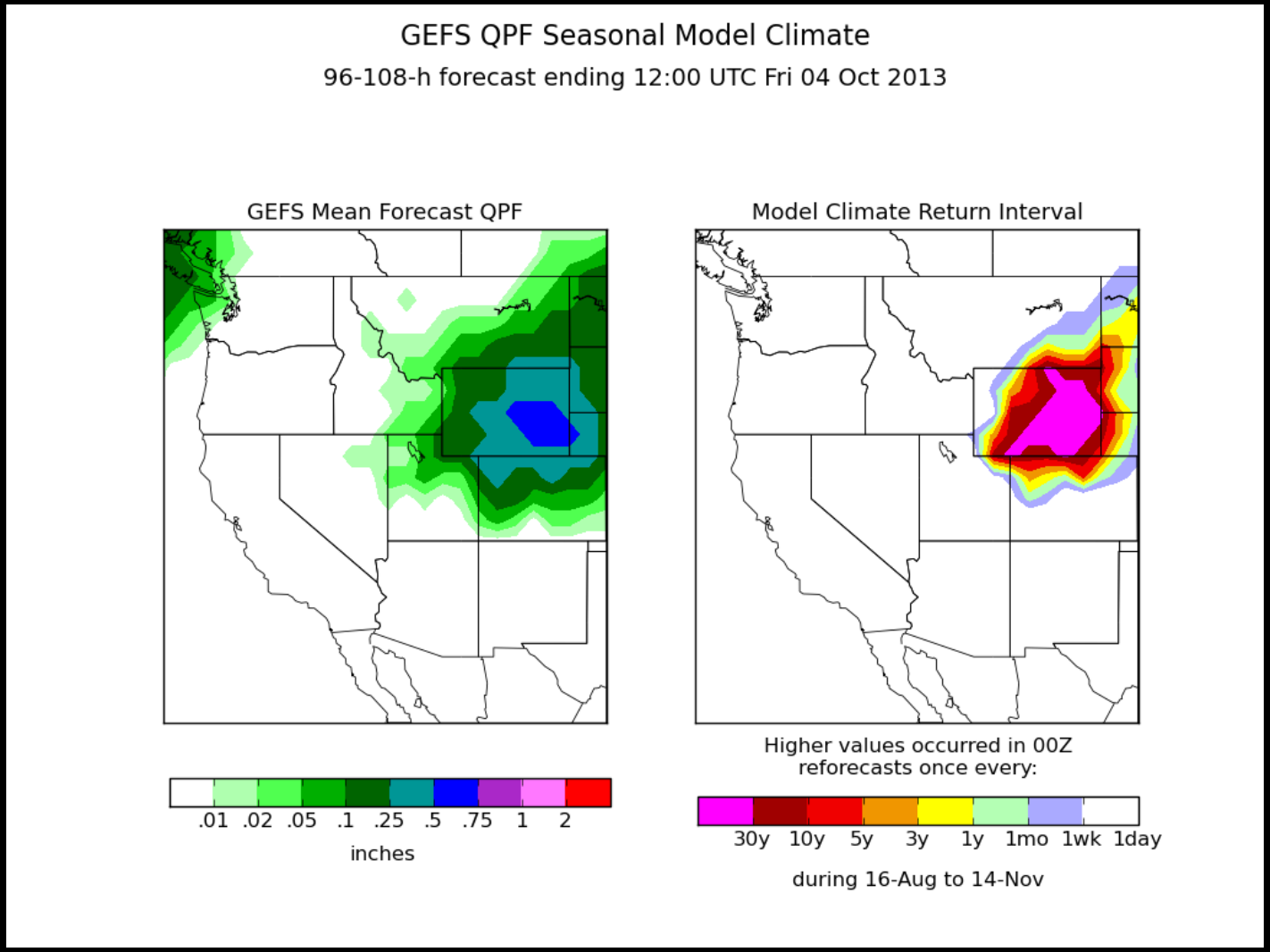
R-Climate: Percentile



R-Climate: Return Interval



M-Climate QPF

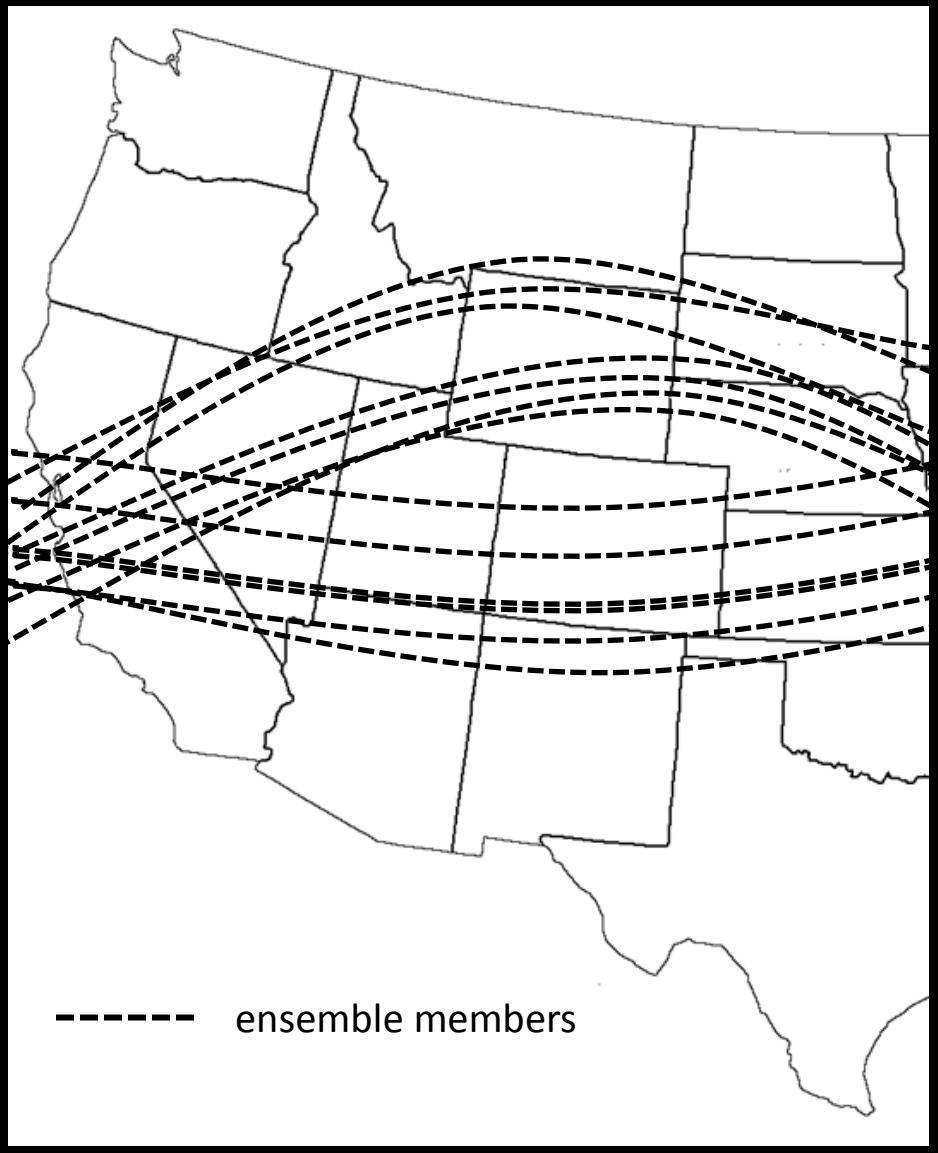


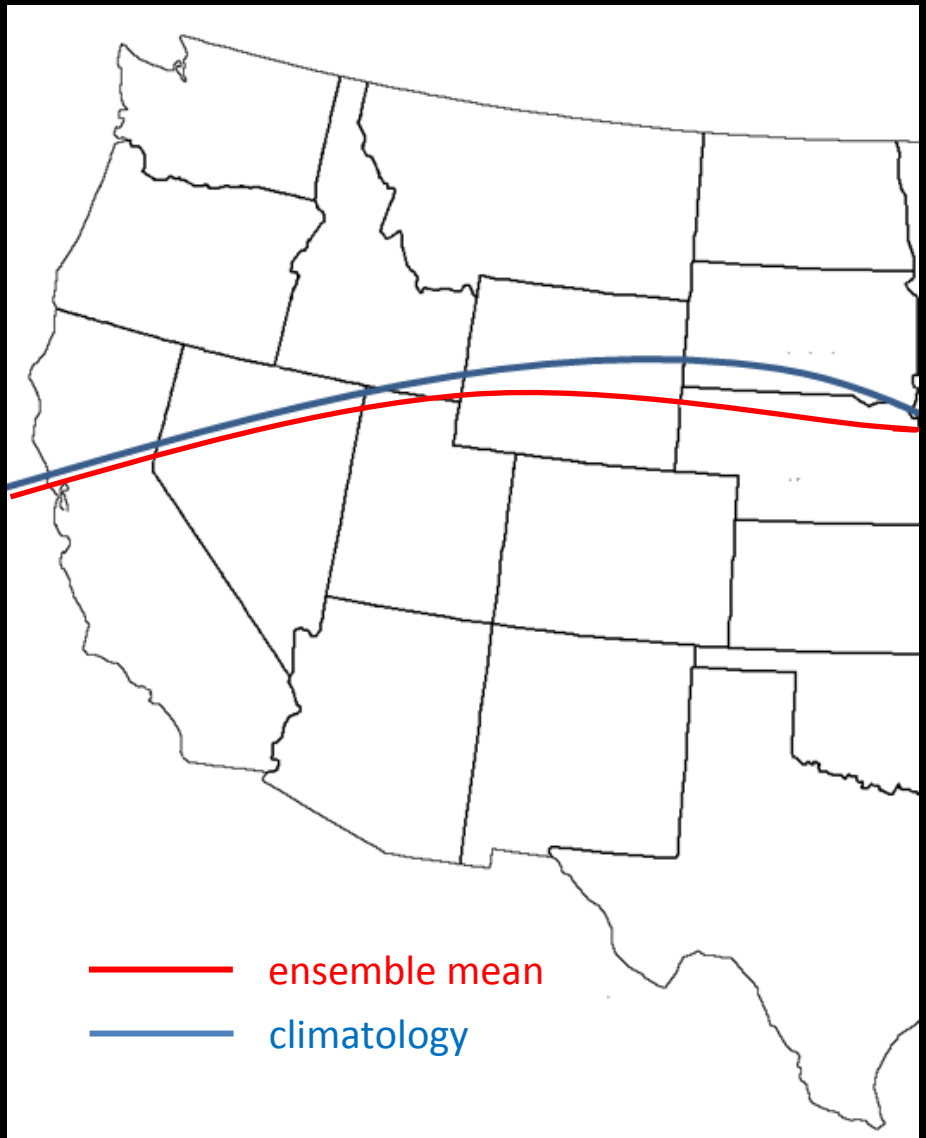
Ensemble Mean as a Confidence Tool

- For a multi-model ensemble mean to depart from climatology requires that most members show a significant feature in the same location at the same time

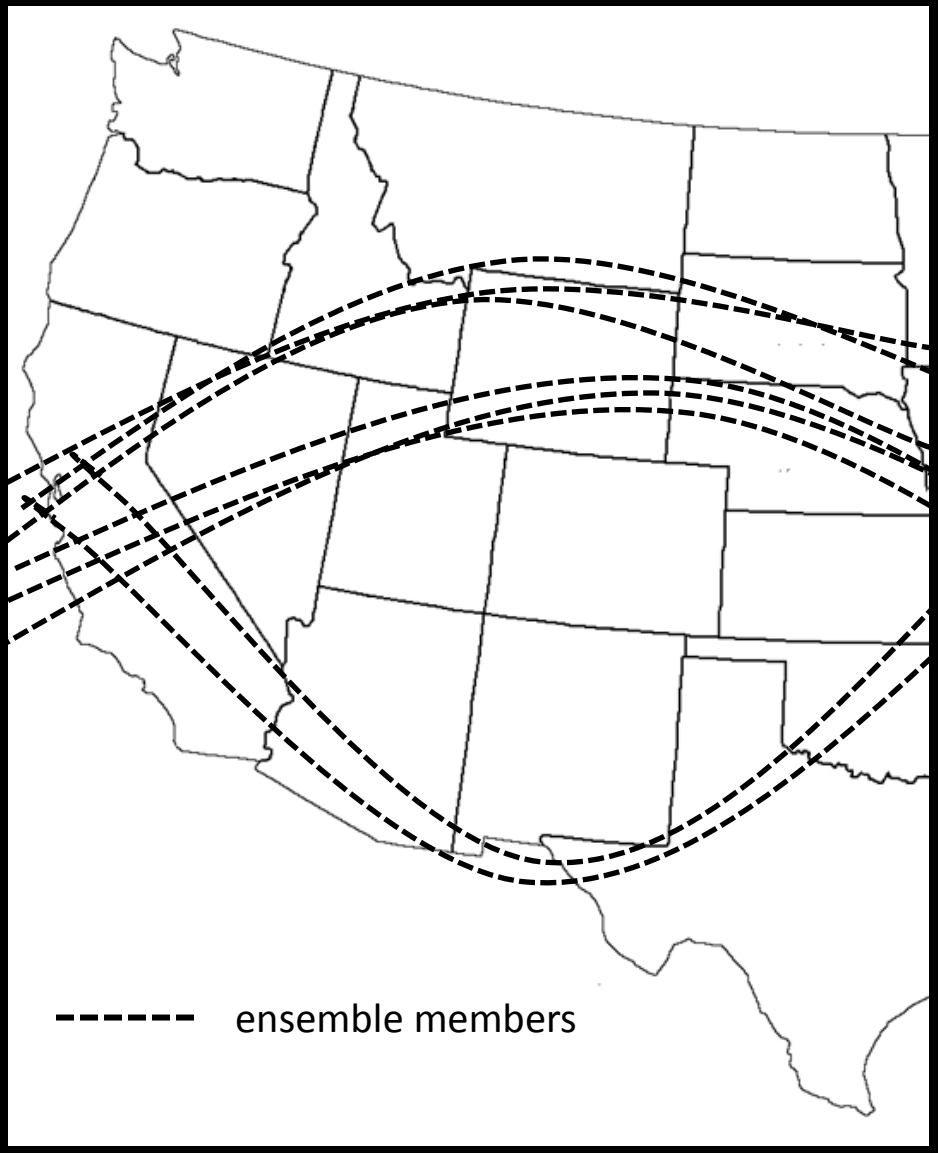
- Hypothesis: using a *multi-model* ensemble mean at medium to long ranges probably misses a lot of extreme events, but when it does “go big”, it’s usually right.

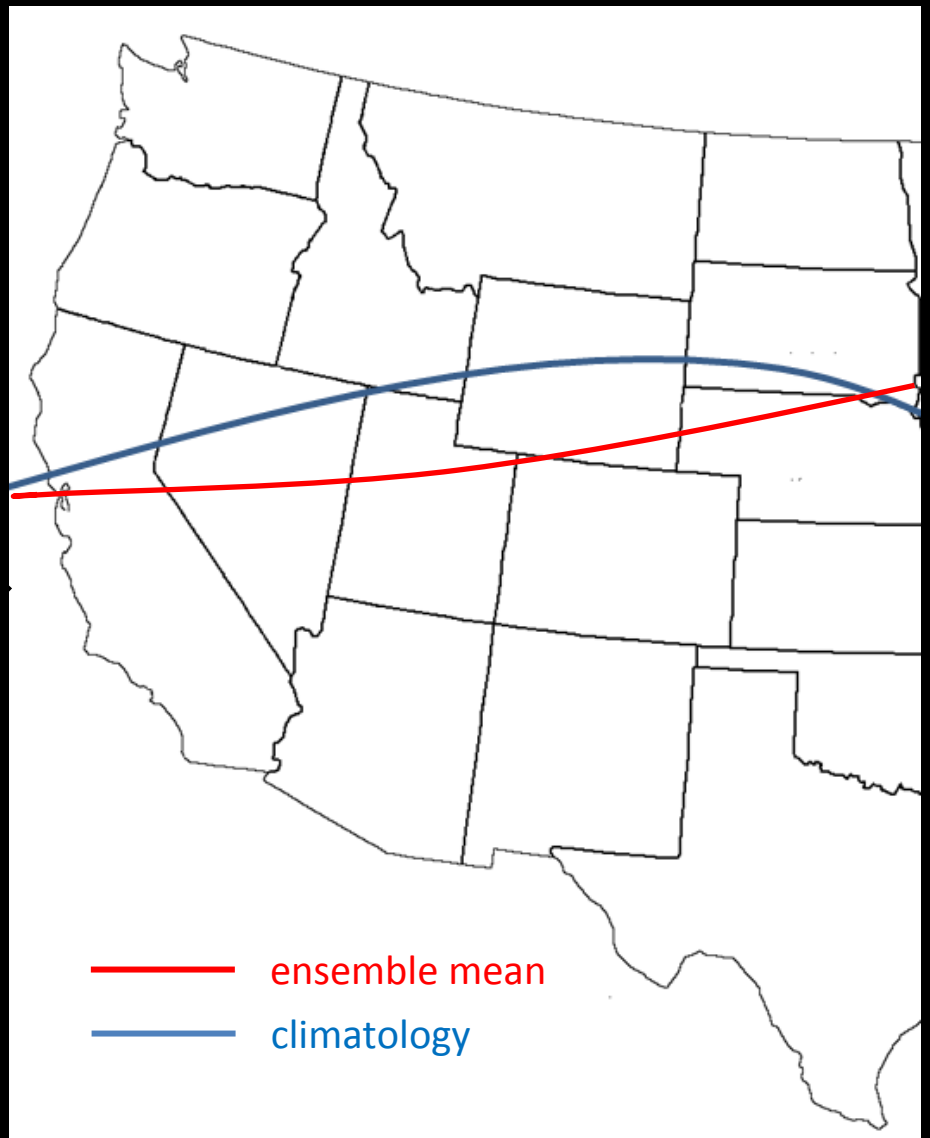
Ensemble Mean as a Confidence Tool



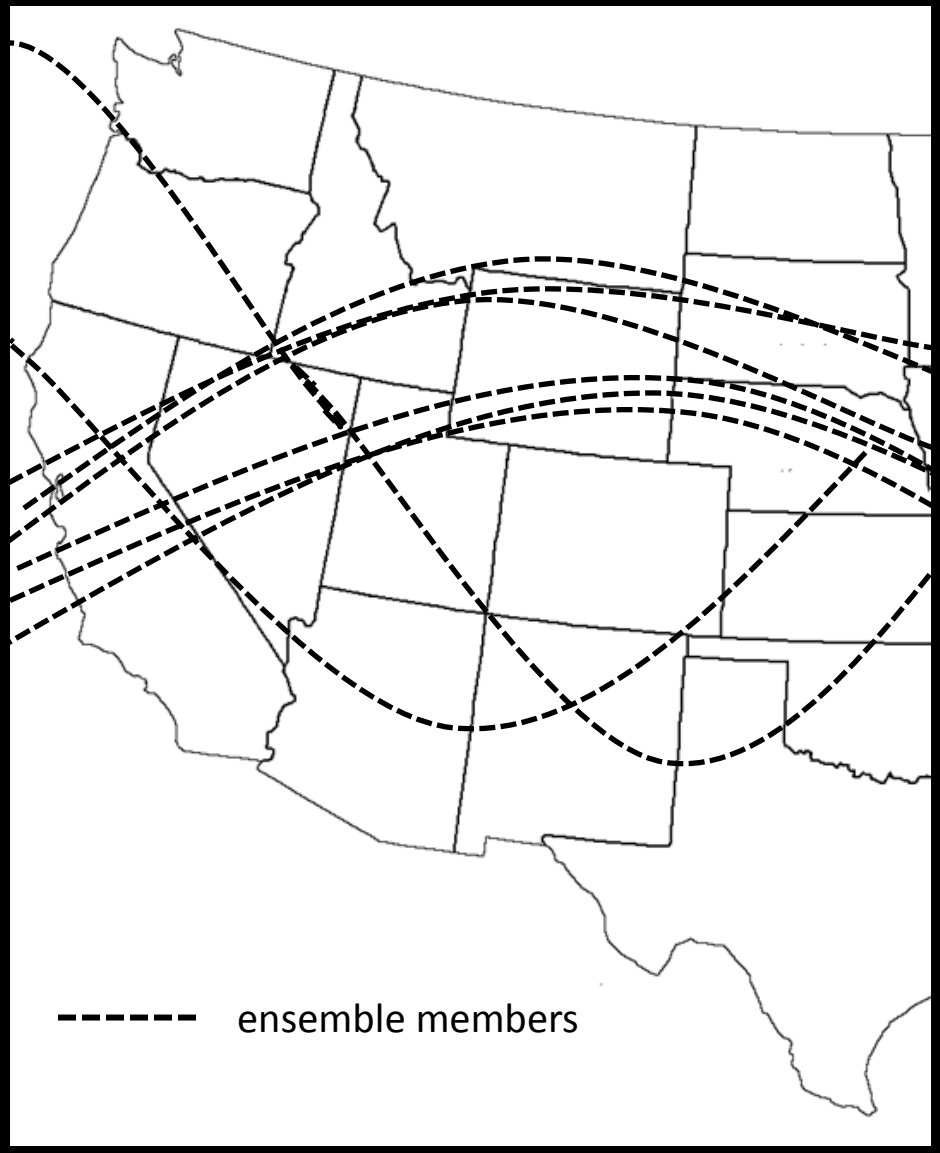


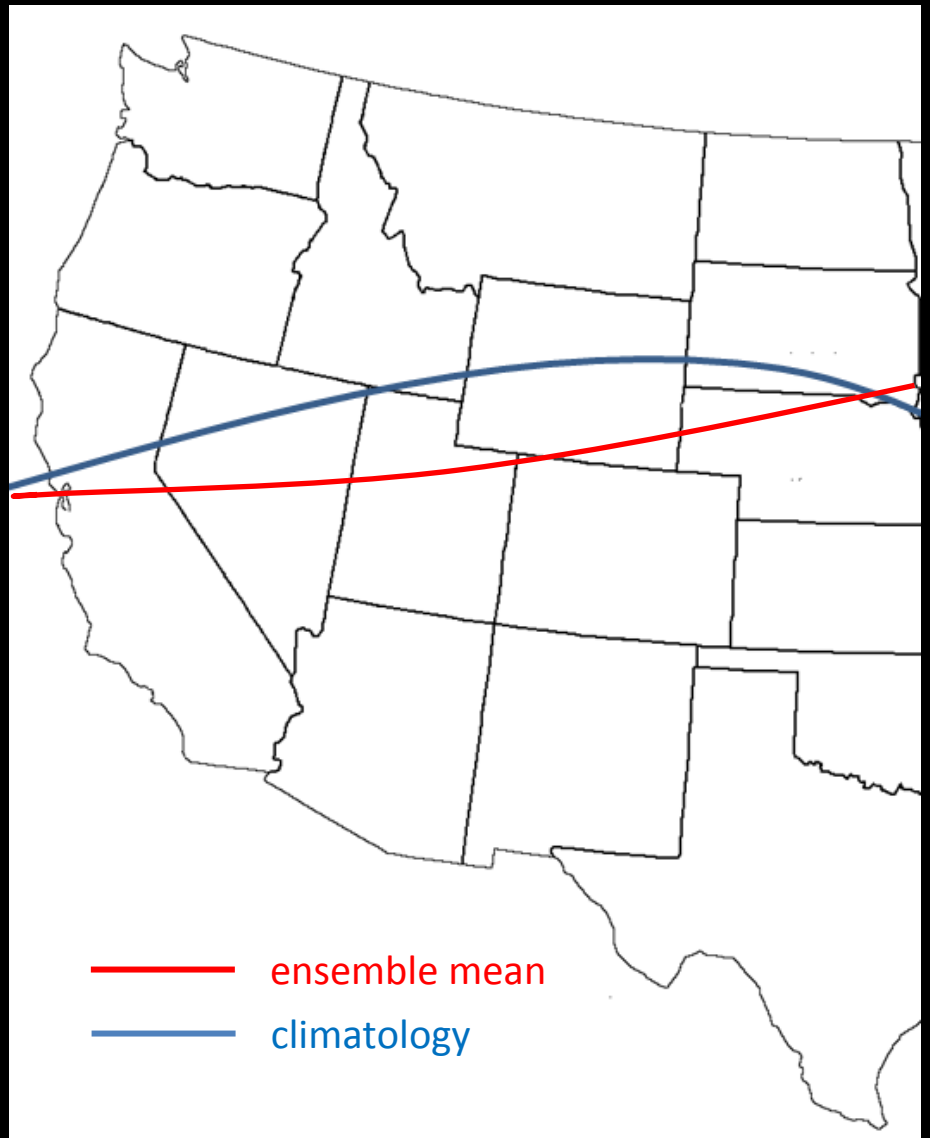
Ensemble Mean as a Confidence Tool



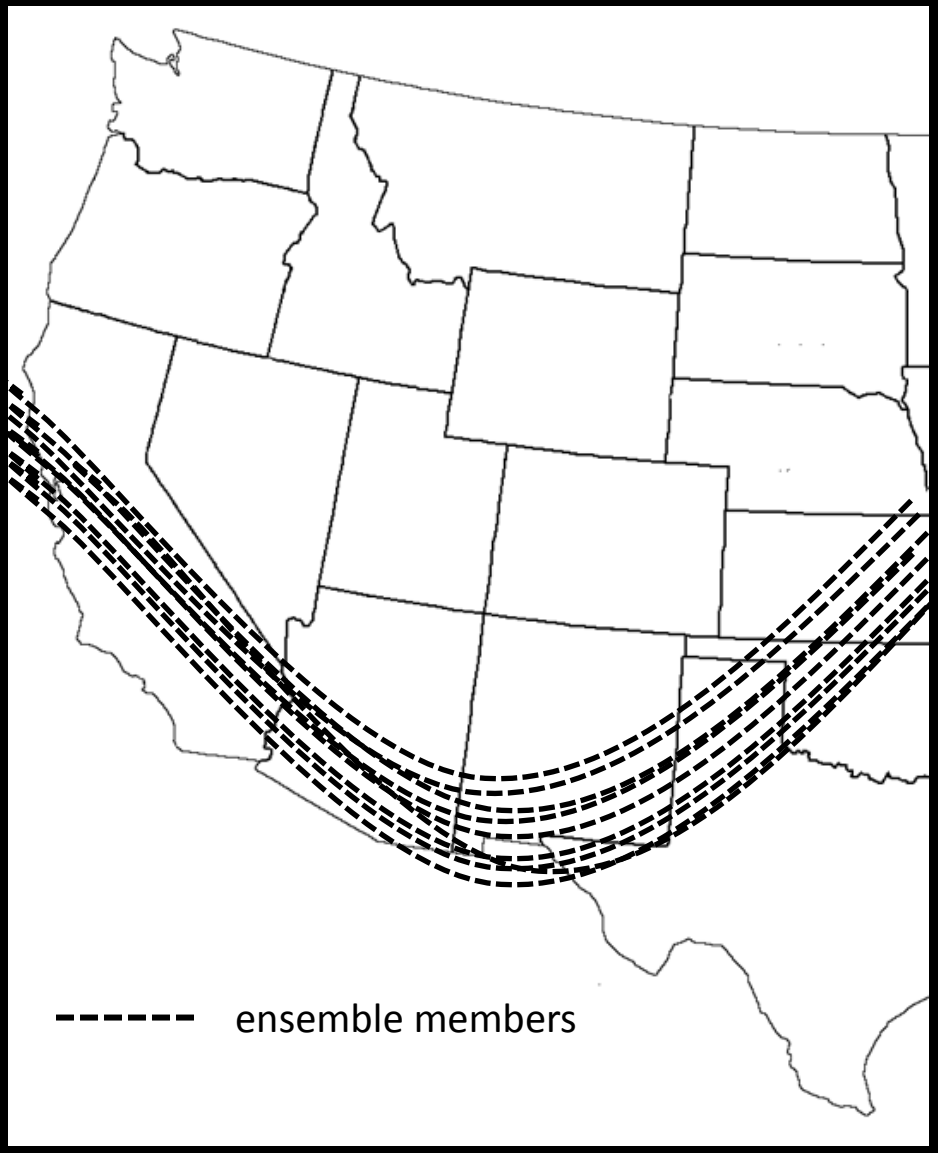


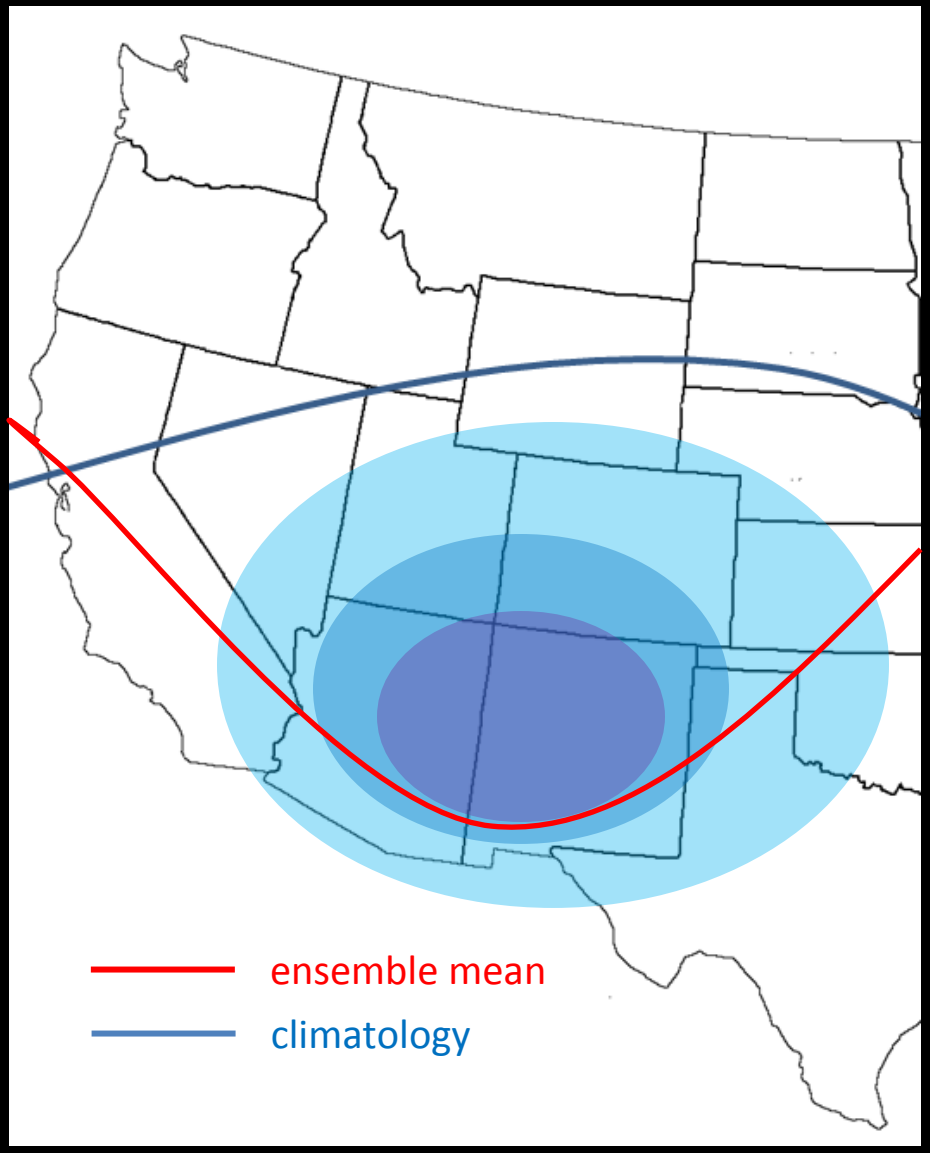
Ensemble Mean as a Confidence Tool



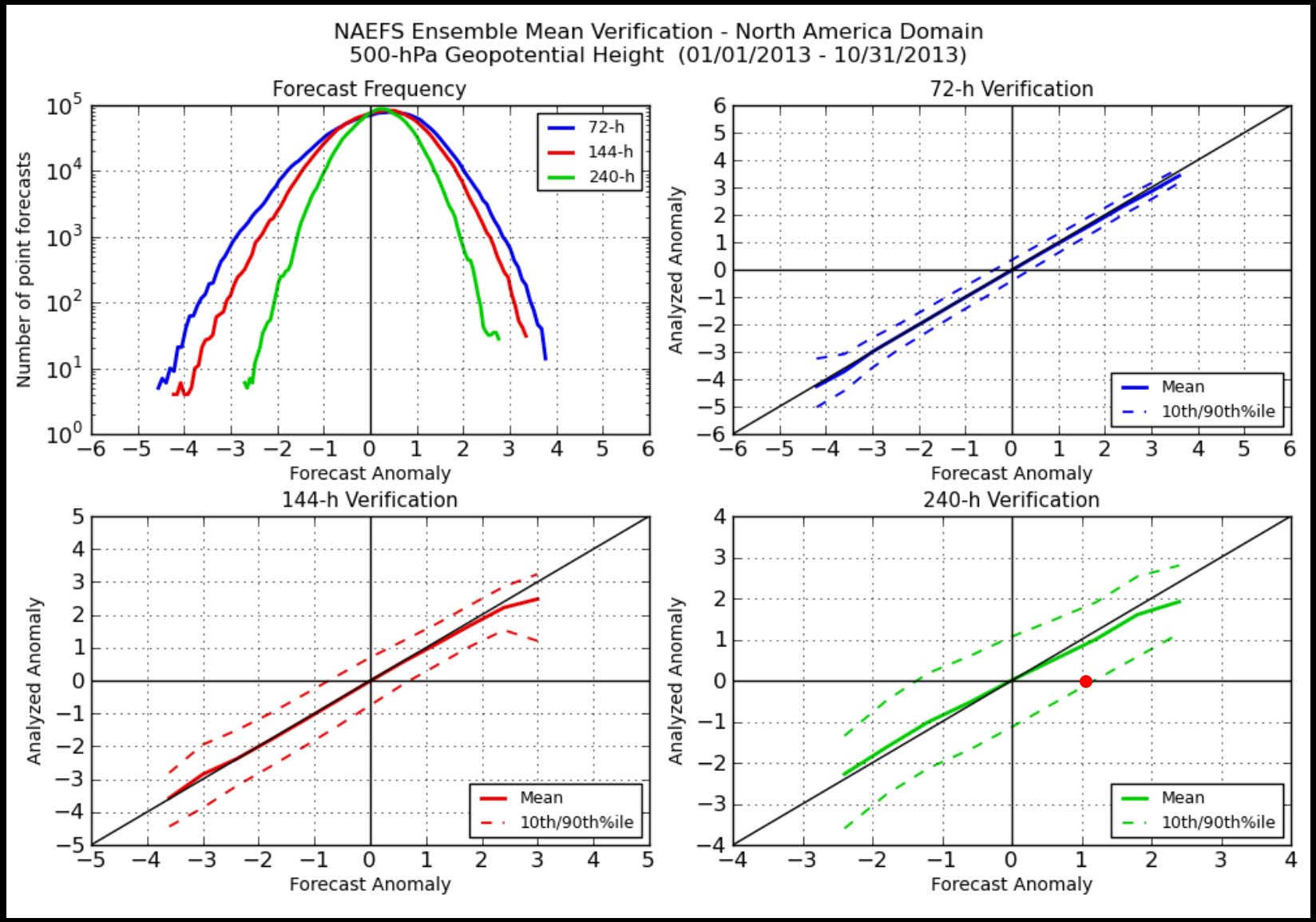


Ensemble Mean as a Confidence Tool

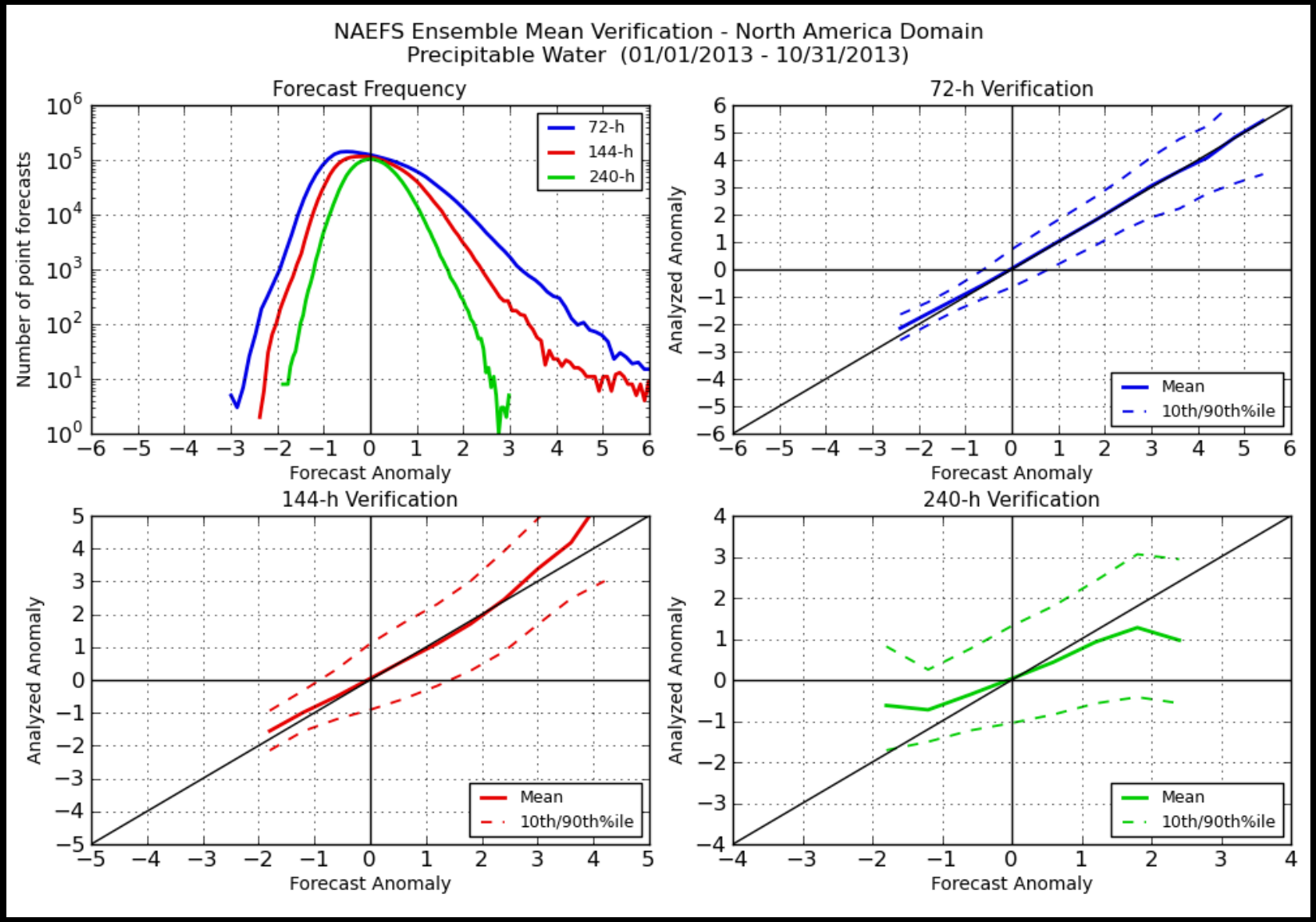




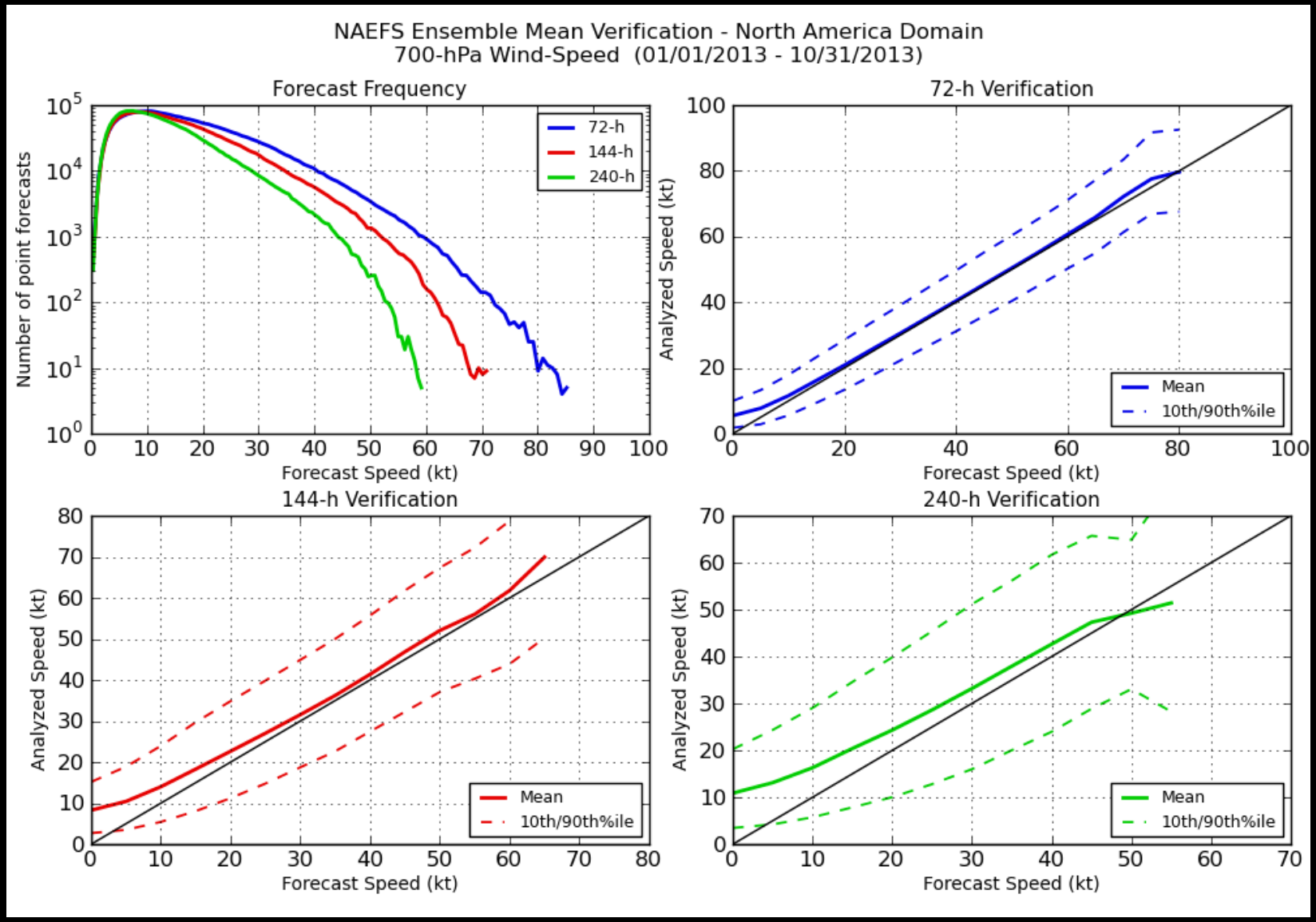
Anomaly Verification: 500-mb Height



Anomaly Verification: PWAT



Verification: 700-mb Wind Speed



Probabilistic Forecasts

- What fraction of NAEFS members produce an "extreme" forecast?

- We are using "extreme" loosely
  - outside the 3-week climatology
  - not necessarily (rarely, in fact) all-time high or low

- 3 weeks is a good balance, because "outside-the-climatology" events are:
  - common enough that we can evaluate forecast skill
  - rare enough to be associated with impacts

Probabilistic Forecasts

National Weather Service
Ensemble Situational Awareness Table

Verification Help Permalink

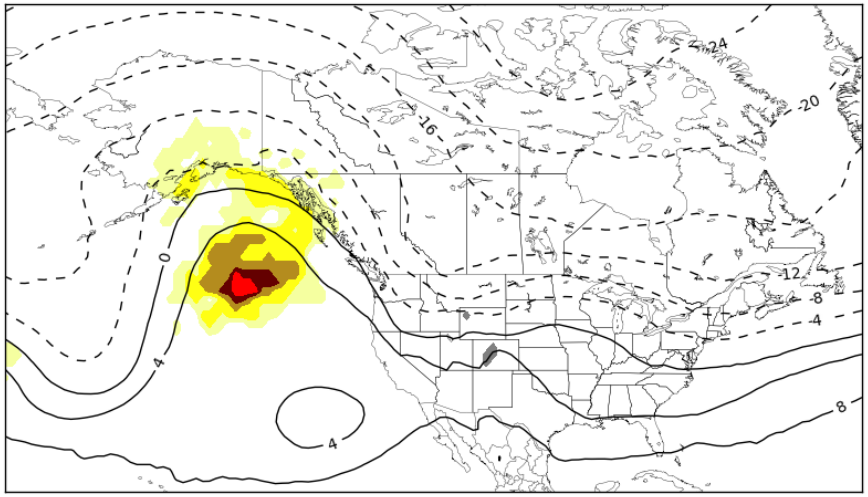
Model Run: Oct 22, 2013 00Z | Table Region: Alaska | Plot Region: North America | Output: NAEFS Probabilities | View Table

Fcst Hr: 144 Valid: Sun Oct 27 6:00 PM MDT

WFO Alaska Table Oct 22, 2013 00Z Run

			Z	T	WSP	SLP	PW
6	Tue 22nd	06Z	0	0	0	0	0
12		12Z	0	2	2	0	7
18		18Z	0	50	0	0	7
24	Wed 23rd	00Z	0	64	0	0	4
30		06Z	0	71	0	0	11
36		12Z	0	83	23	0	4
42		18Z	0	69	14	11	4
48	Thu 24th	00Z	7	54	11	57	4
54		06Z	38	7	14	80	4
60		12Z	23	2	7	80	7
66		18Z	21	9	14	78	2
72	Fri 25th	00Z	2	26	19	47	4
78		06Z	0	11	35	28	4
84		12Z	0	11	19	4	7
90		18Z	2	14	23	0	7
96	Sat 26th	00Z	7	9	16	0	11
102		06Z	9	7	9	0	19
108		12Z	4	9	7	9	14
114		18Z	2	11	9	7	19
120	Sun 27th	00Z	4	28	14	14	33
126		06Z	19	78	9	14	52
132		12Z	35	83	26	28	57
138		18Z	45	95	21	14	52
144	Mon 28th	00Z	54	90	23	14	57
150		06Z	69	97	40	9	52
156		12Z	66	78	47	11	45
162		18Z	52	73	40	4	42
168	Tue 29th	00Z	42	59	33	4	26
174		06Z	33	52	30	7	33
180		12Z	23	35	23	16	11
186		18Z	11	33	21	14	11
192	Wed 30th	00Z	9	30	9	9	14
198		06Z	9	30	9	9	16
204		12Z	14	21	9	9	16
210		18Z	14	19	16	7	11
216	Thu 31st	00Z	4	19	11	7	7
222		06Z	4	11	11	11	7
228		12Z	2	9	9	11	4
234		18Z	2	7	7	9	4
240	Fri 1st	00Z	2	4	4	7	2

NAEFS Mean 700-hPa Temperature (C) and Probability of Extremes
HOUR 144 - VALID 00:00 UTC Mon Oct 28 2013

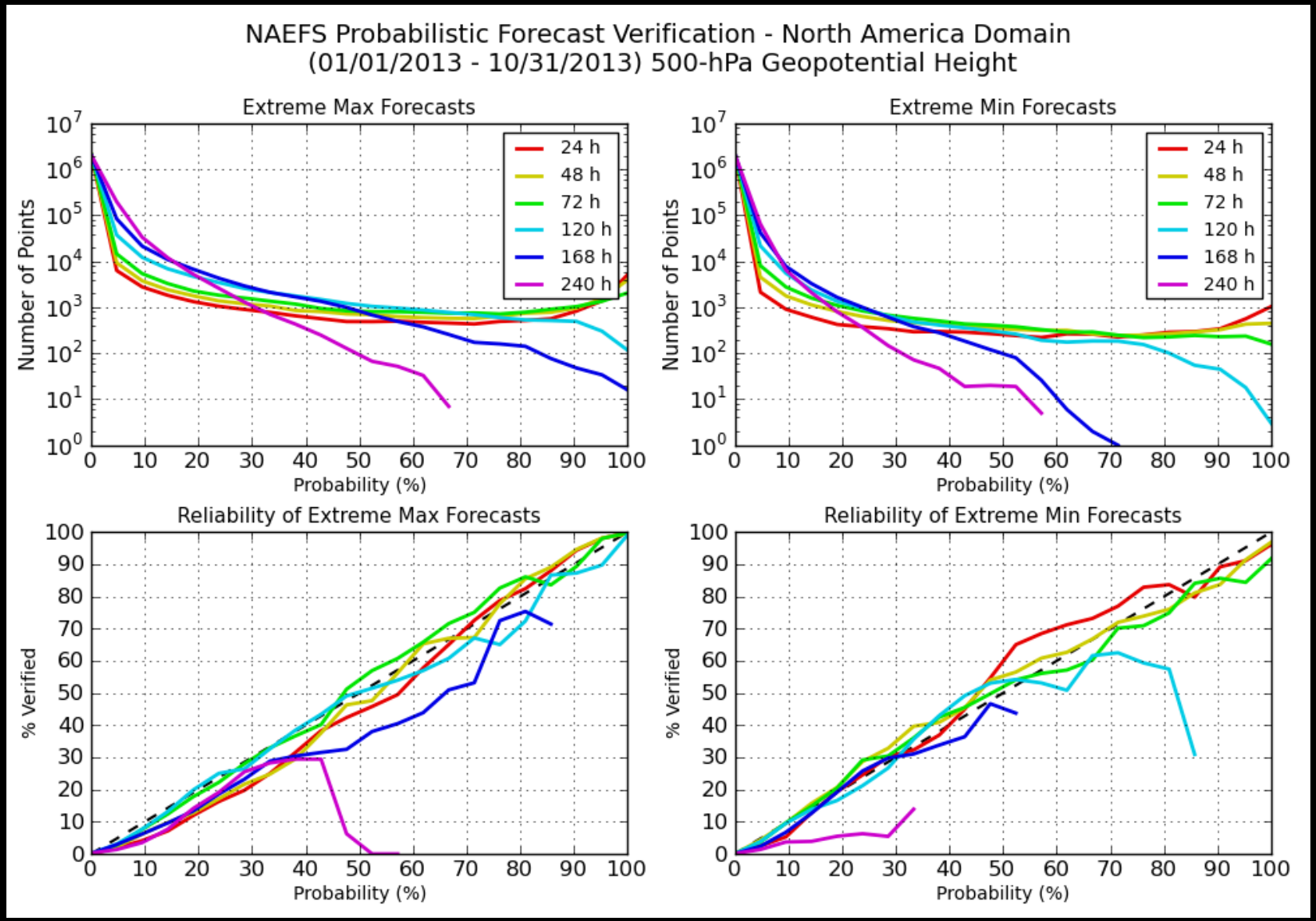


Relative to the 17-Oct to 07-Nov 1979-2009 CFSR climatology
(gray = near or below ground)

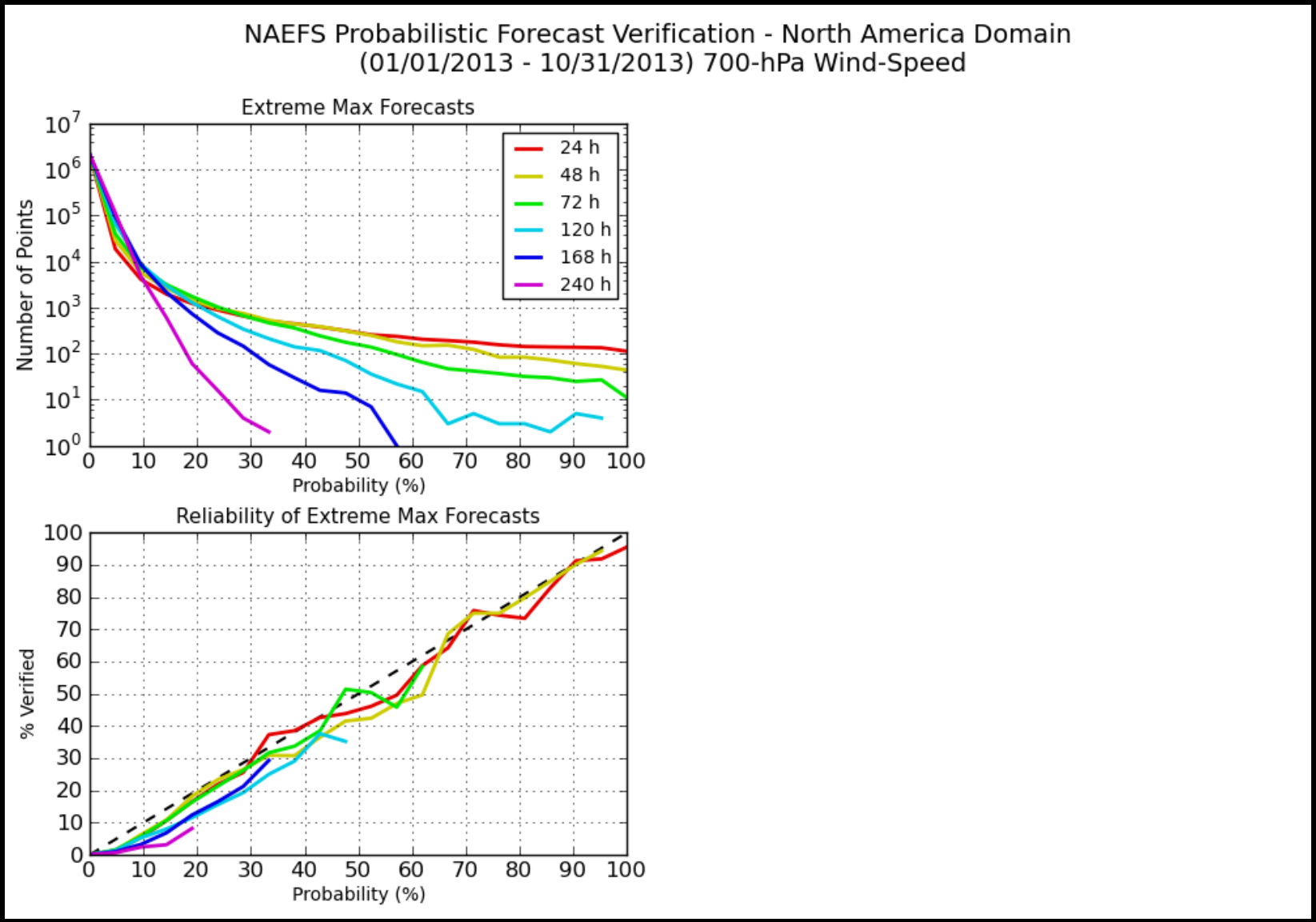
Extreme Minimum Extreme Maximum

90% 75% 50% 25% 10% 0% 10% 25% 50% 75% 90%

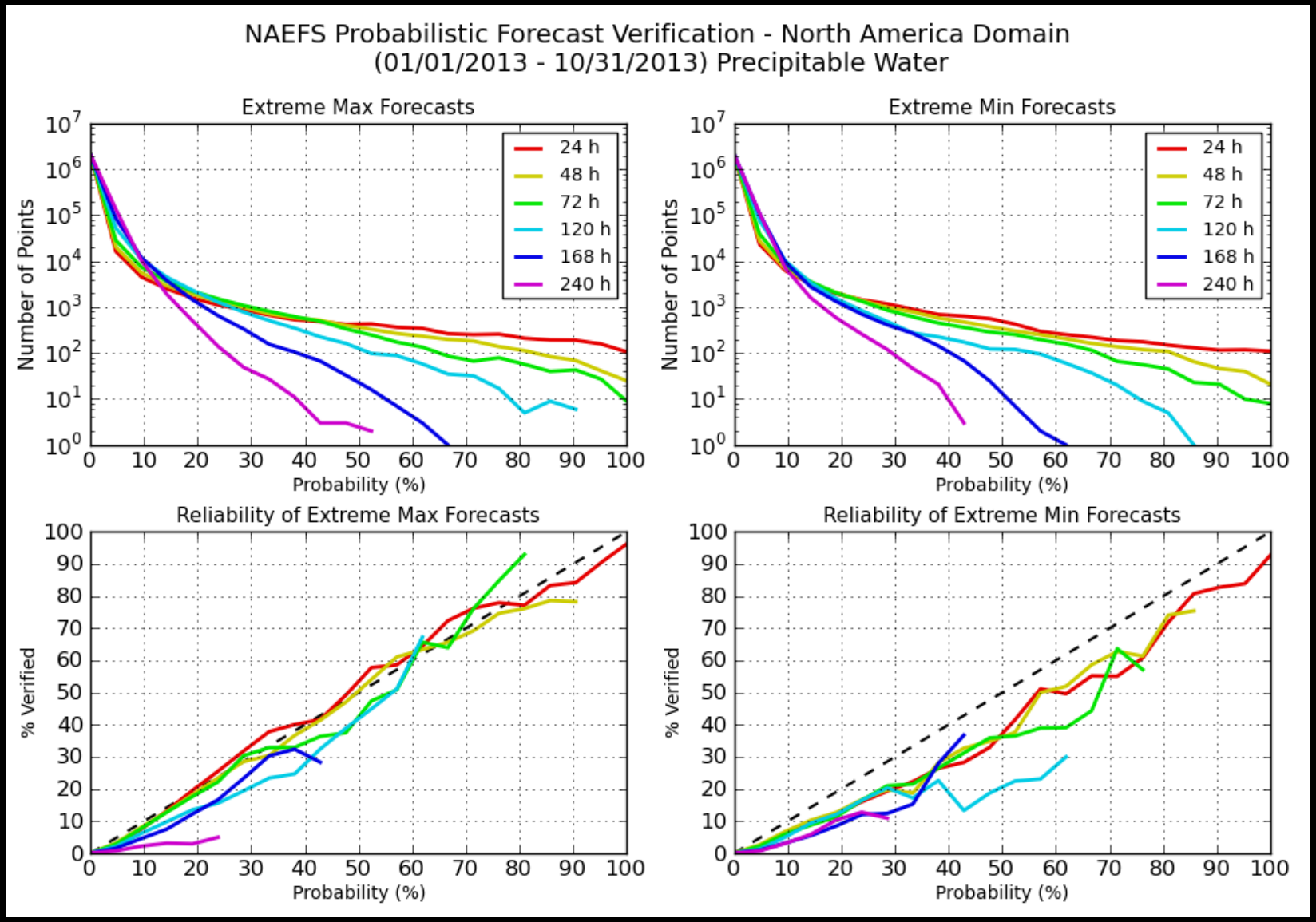
Probabilistic Forecasts: 500-mb Height



Probabilistic Forecasts: 700-mb Wind Speed

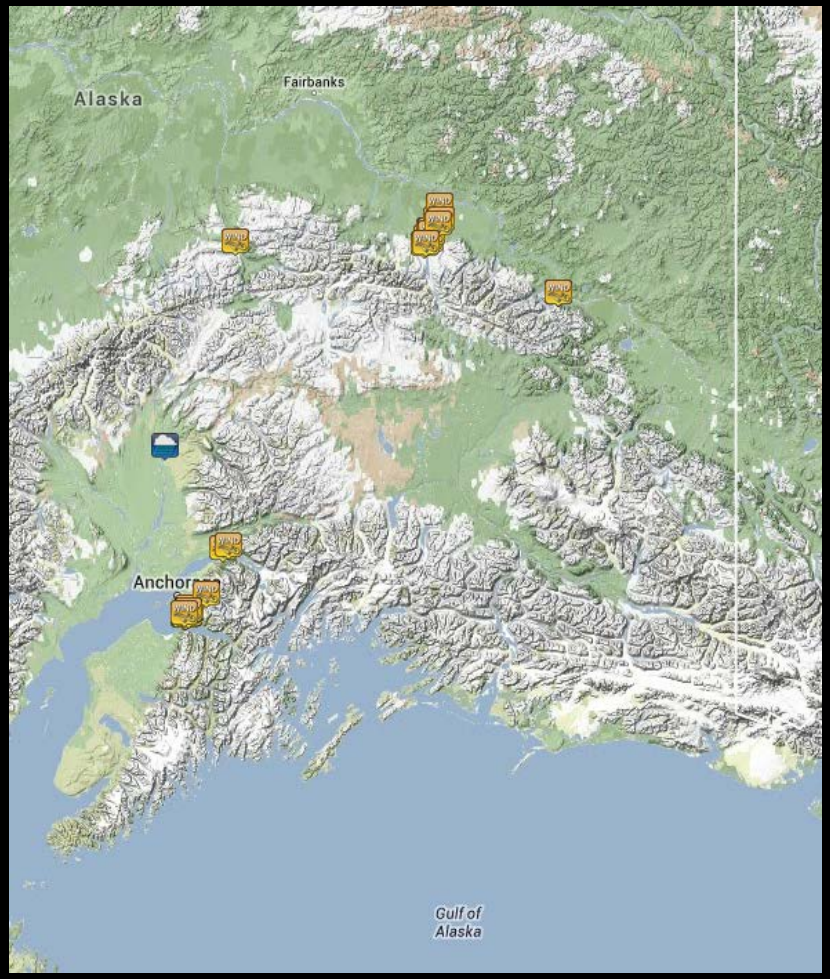


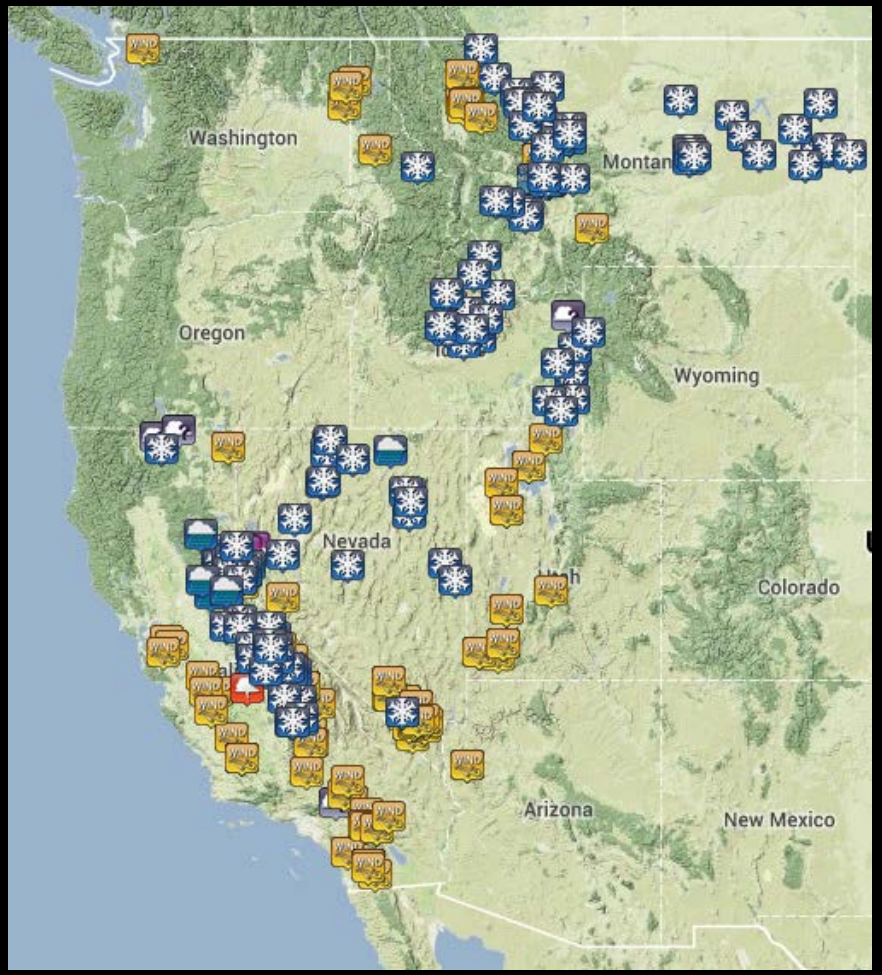
Probabilistic Forecasts: PWAT



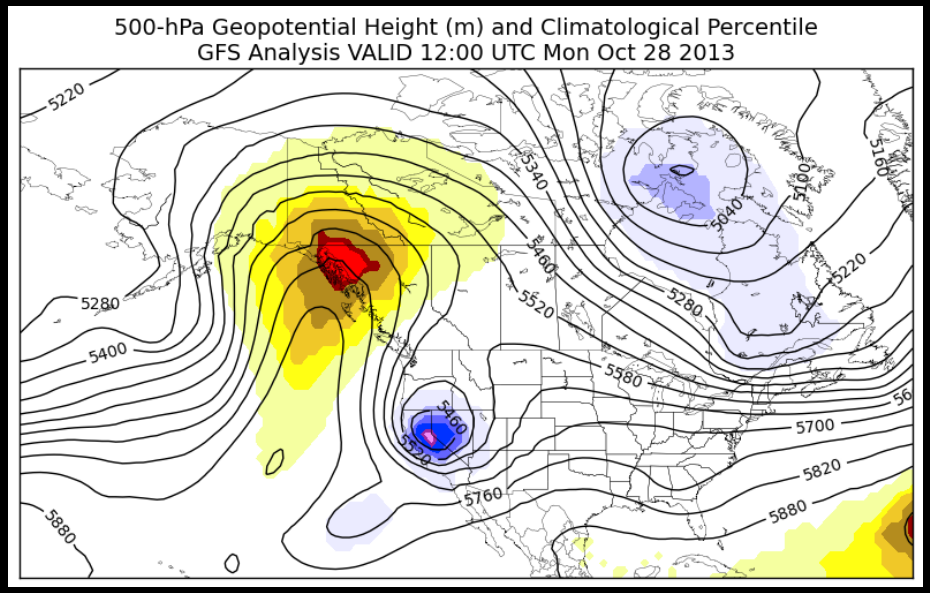
Alaska/Western US Trough

27-30 Oct 2013 Storm Reports

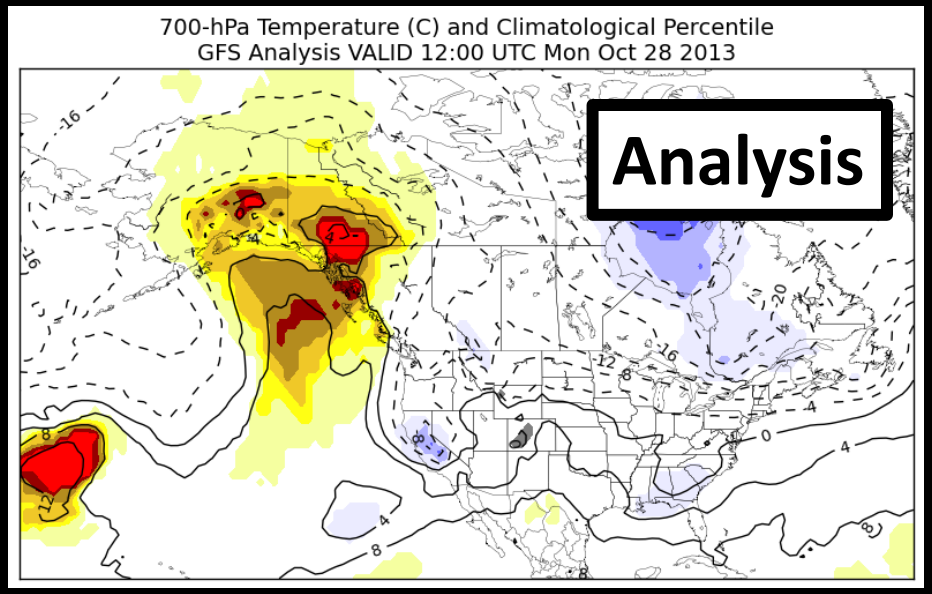


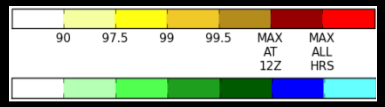


500-hPa Height

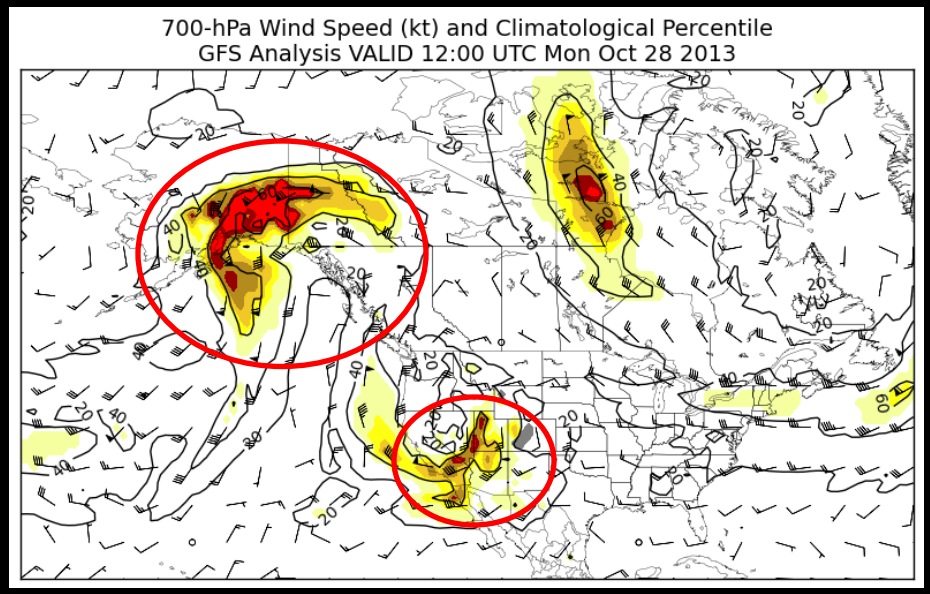


700-hPa Temperature

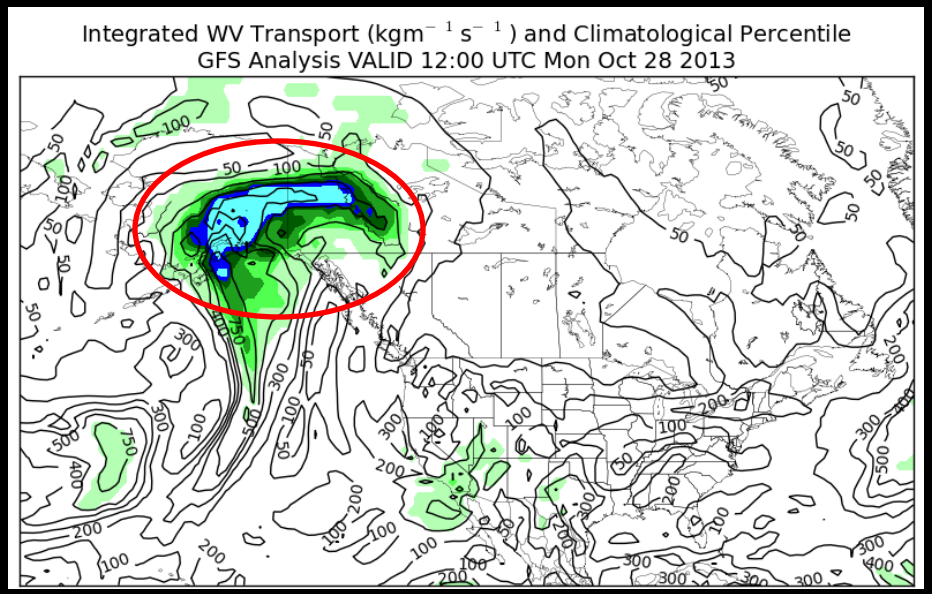




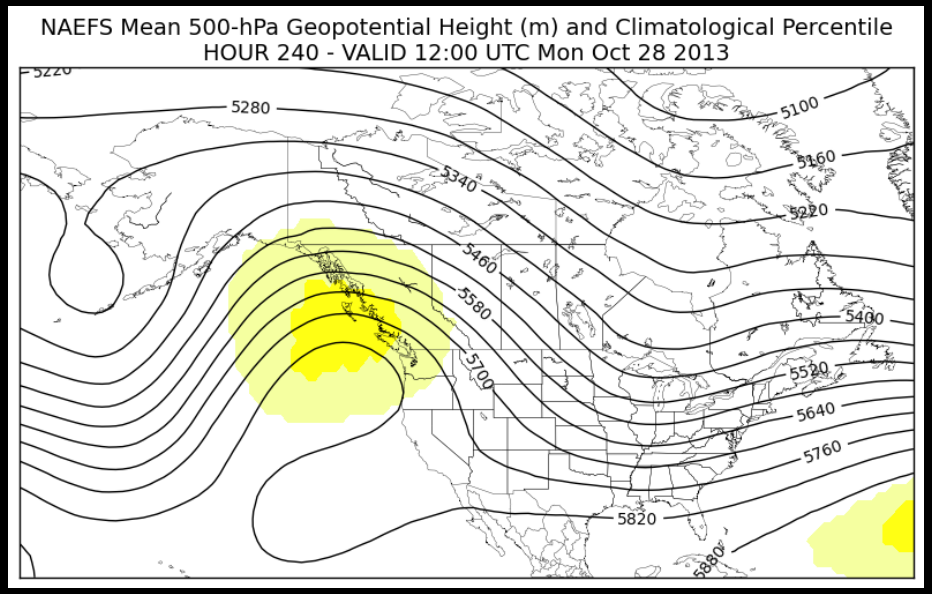
700-hPa Wind Speed



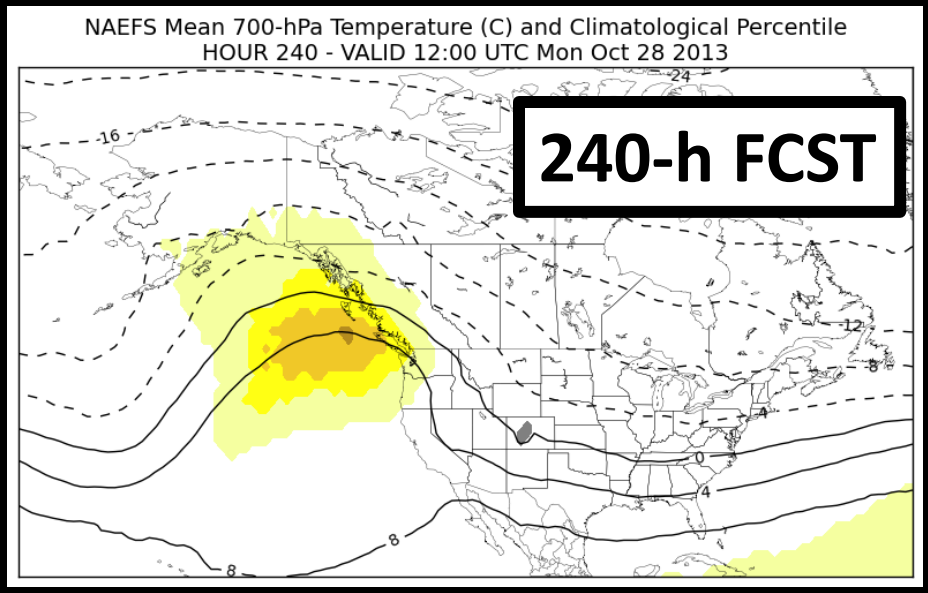
Integrated WV Transport

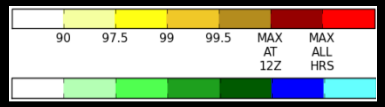


500-hPa Height

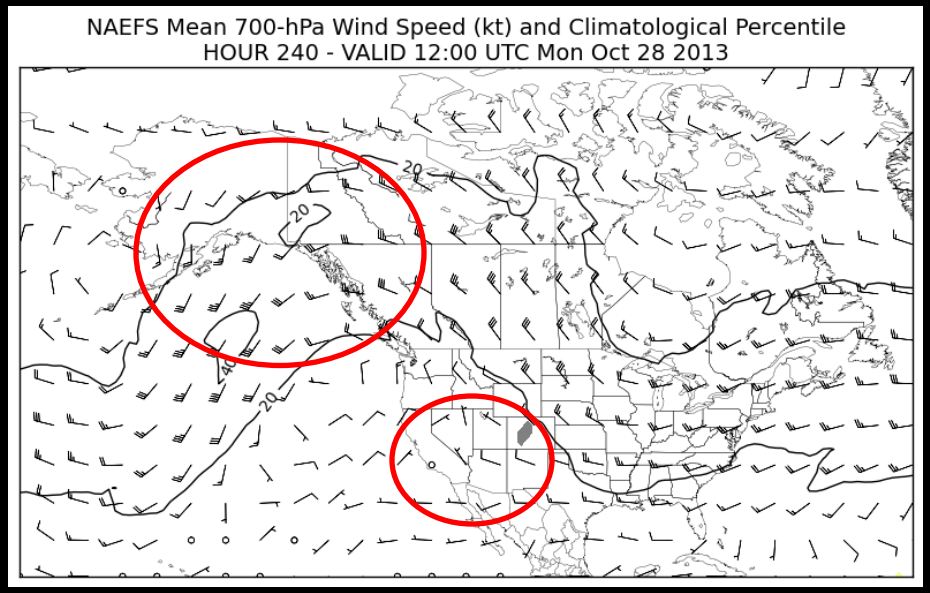


700-hPa Temperature

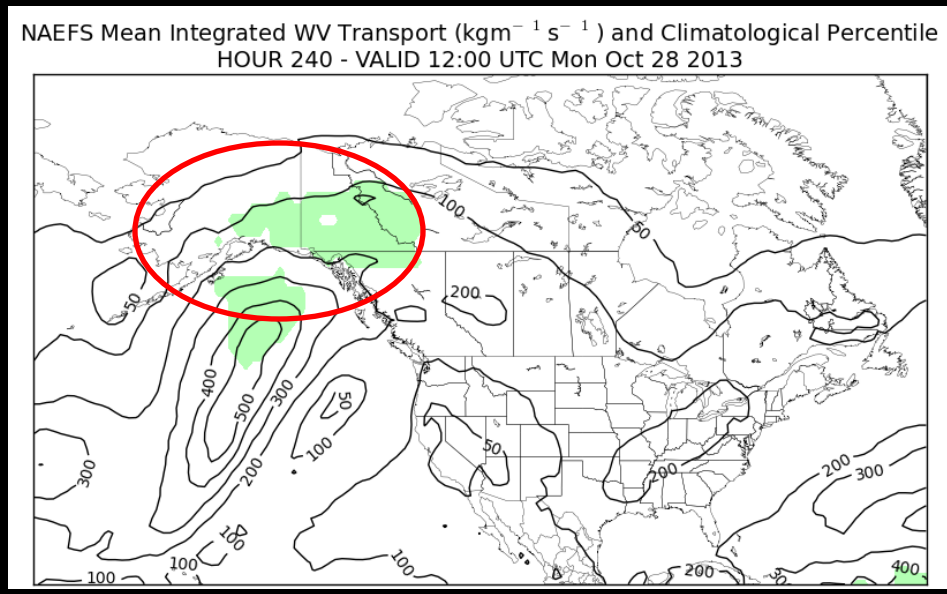




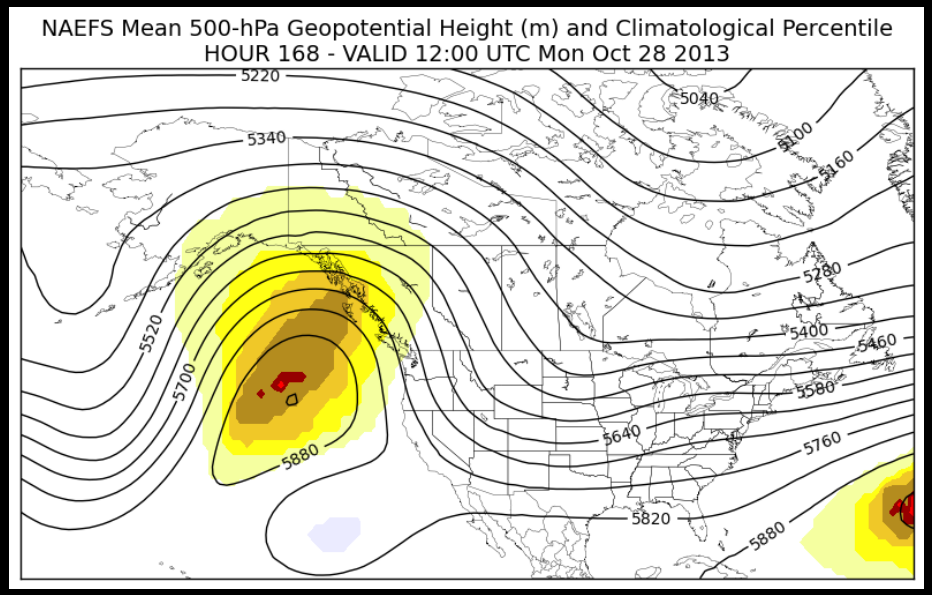
700-hPa Wind Speed



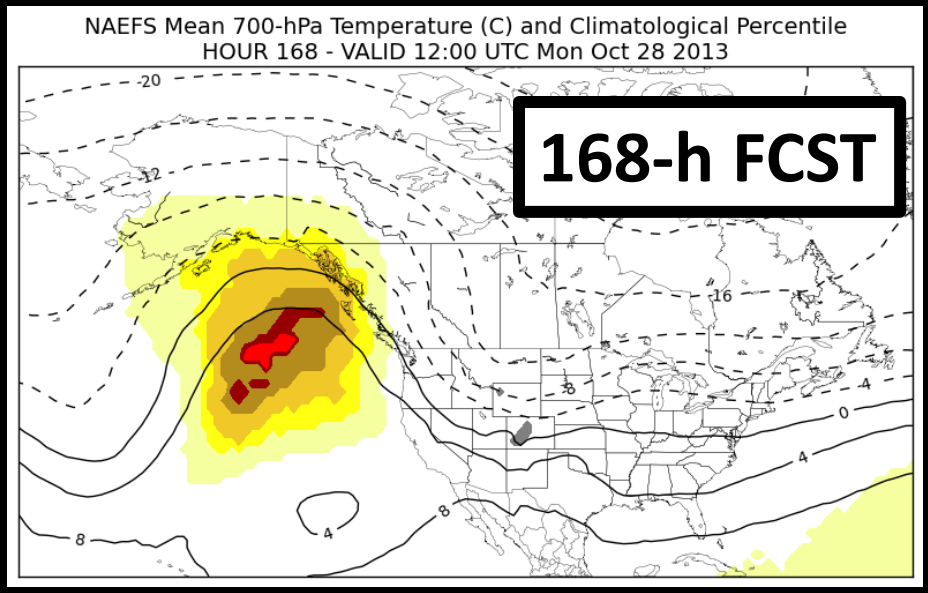
Integrated WV Transport

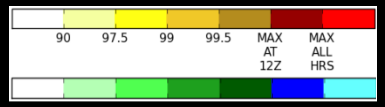


500-hPa Height

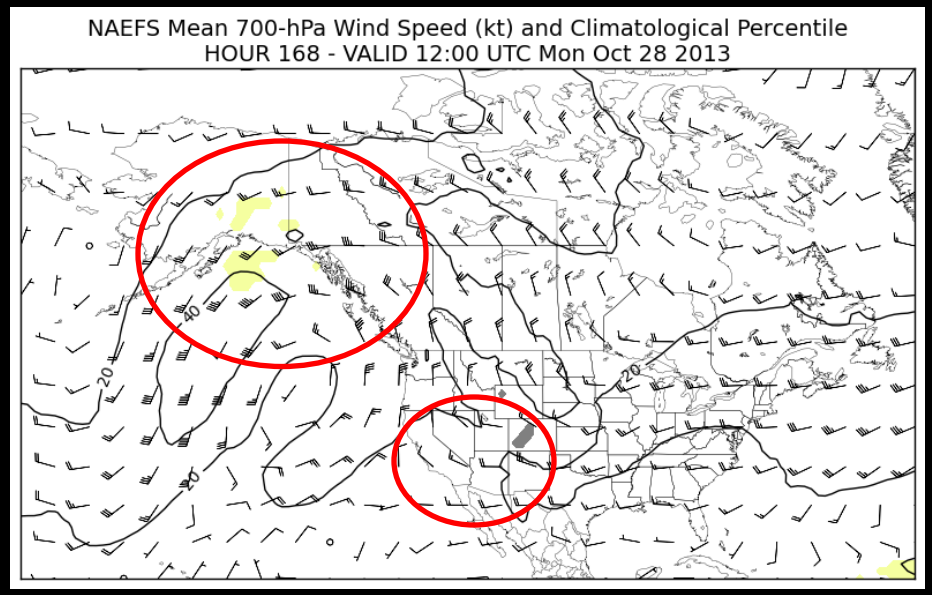


700-hPa Temperature

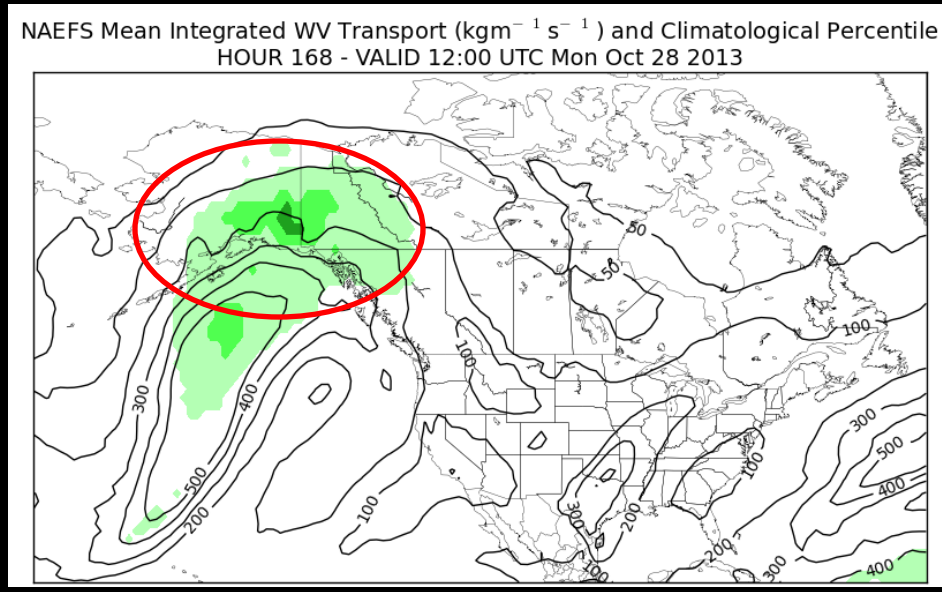




700-hPa Wind Speed



Integrated WV Transport



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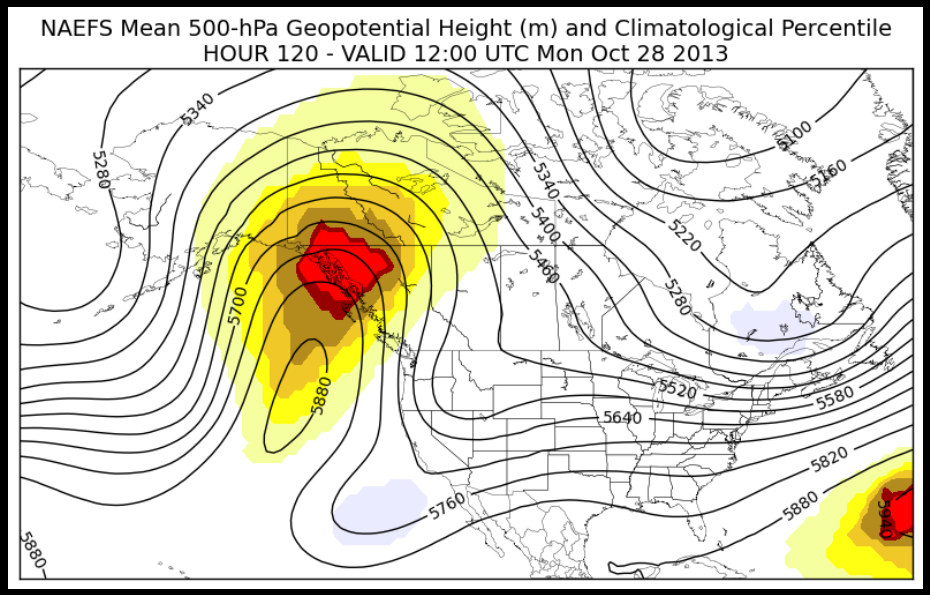

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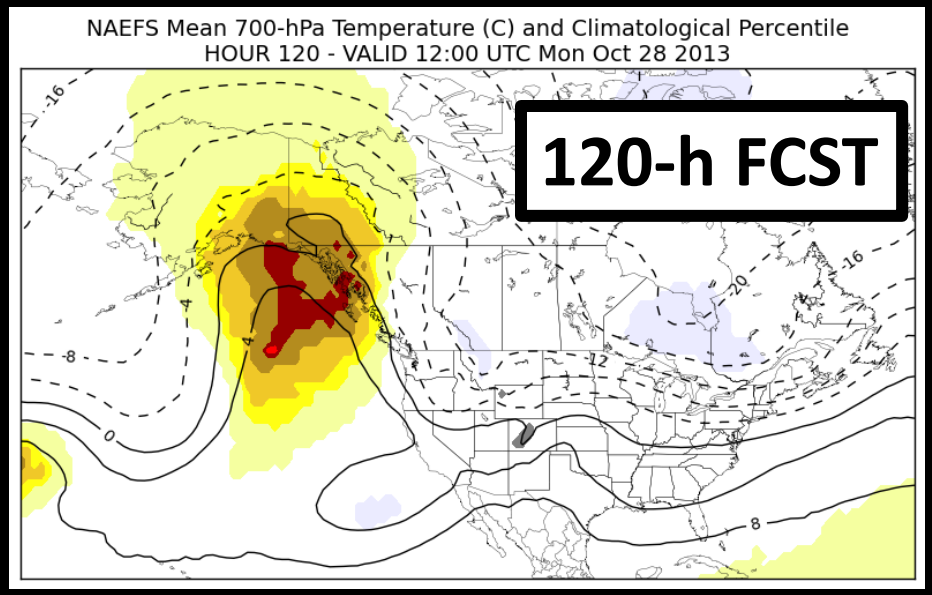

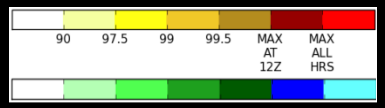

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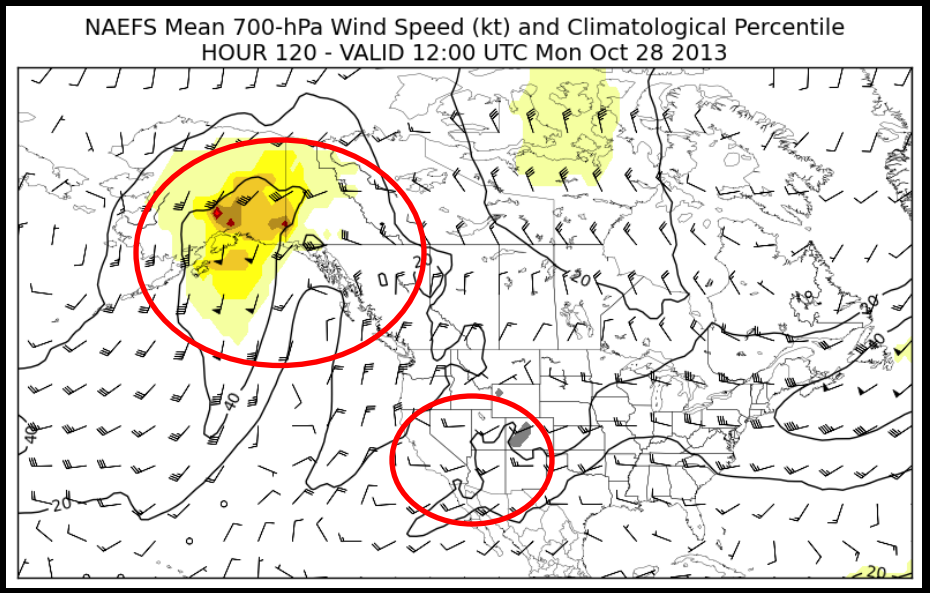
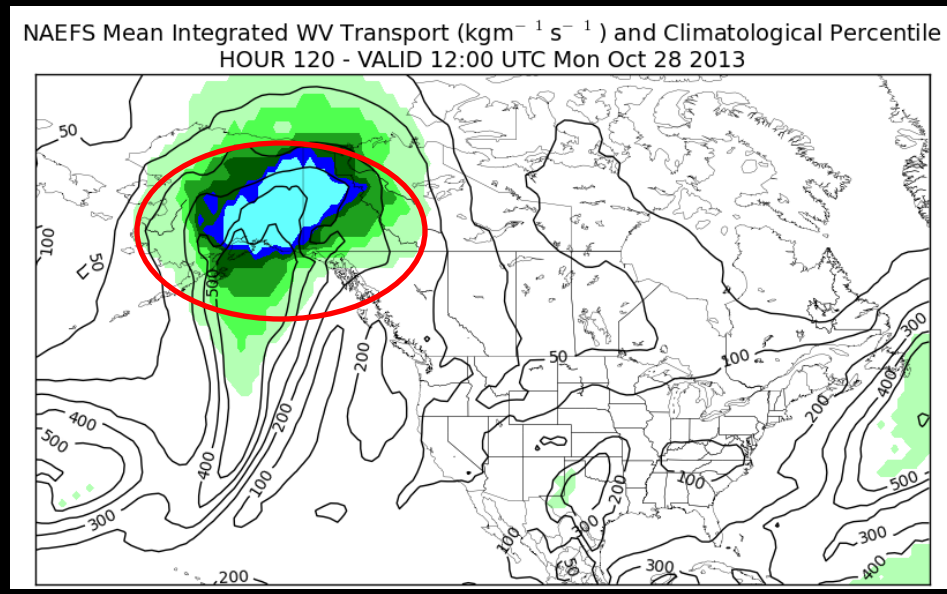


Integrated WV Transport



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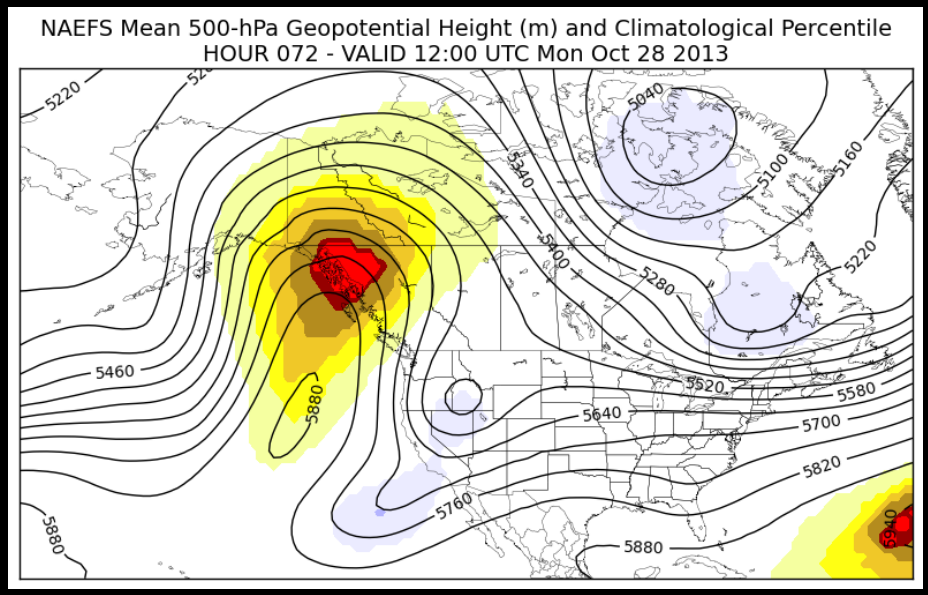
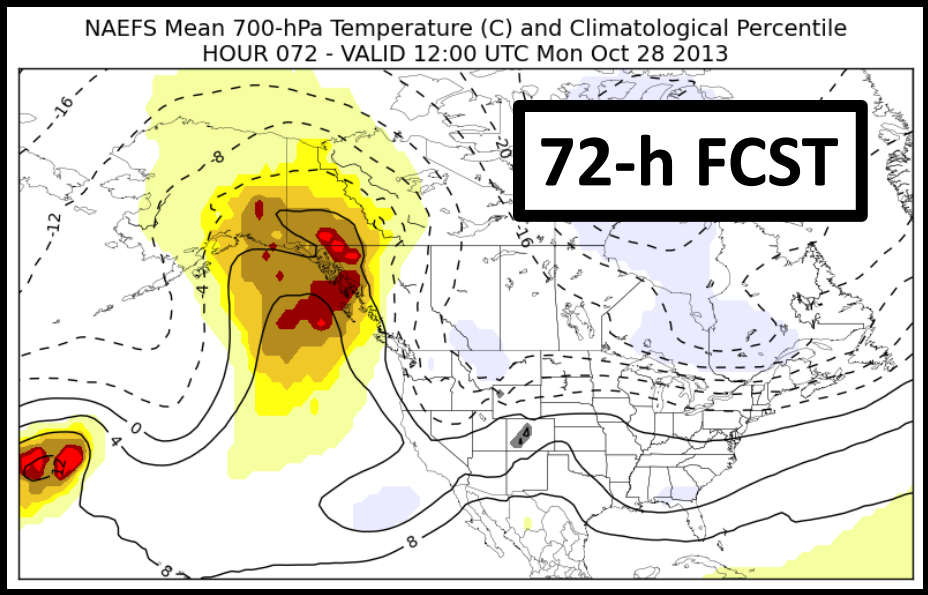
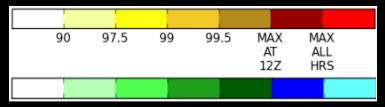
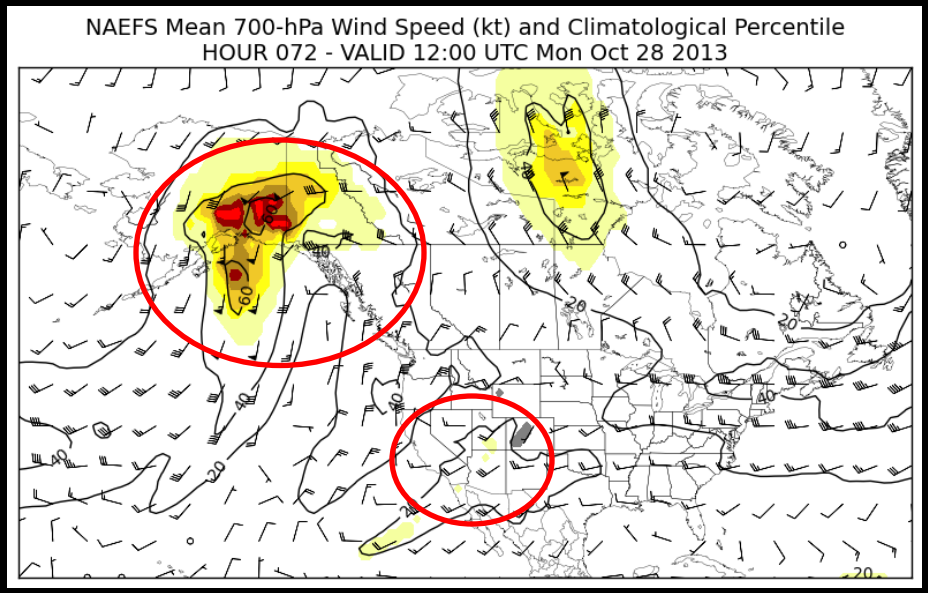


700-hPa Temperature

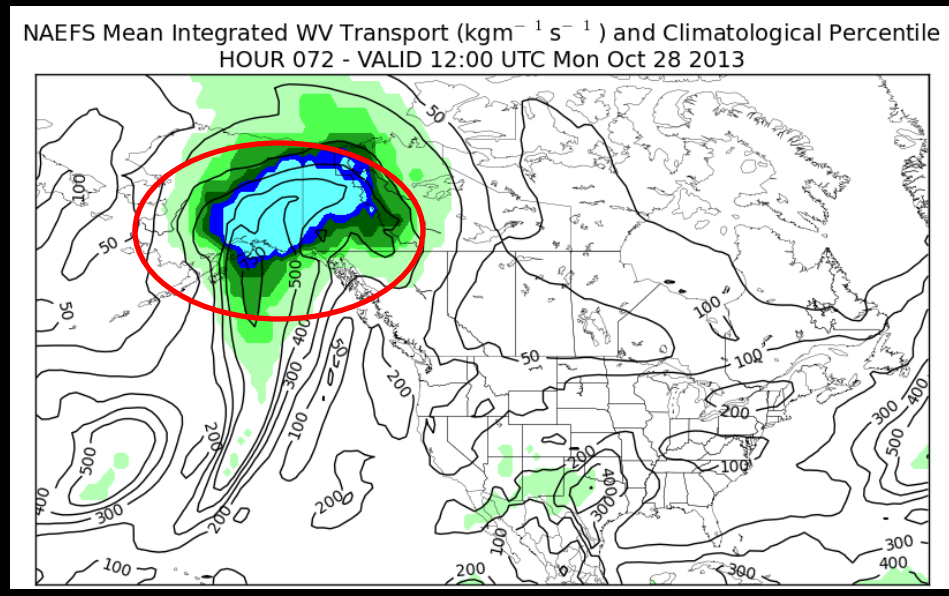




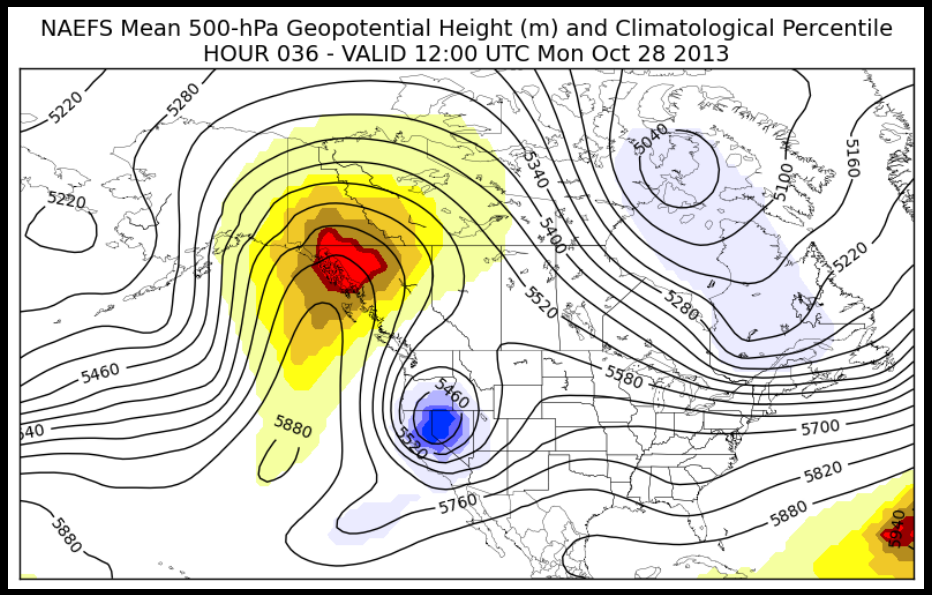
700-hPa Wind Speed



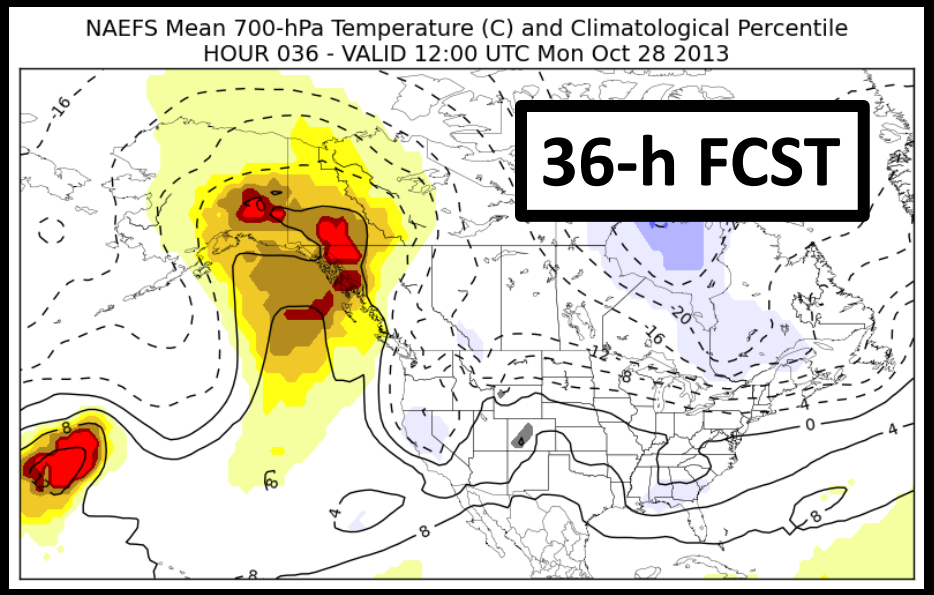
Integrated WV Transport

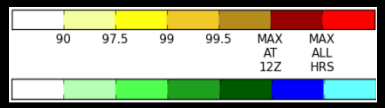


500-hPa Height

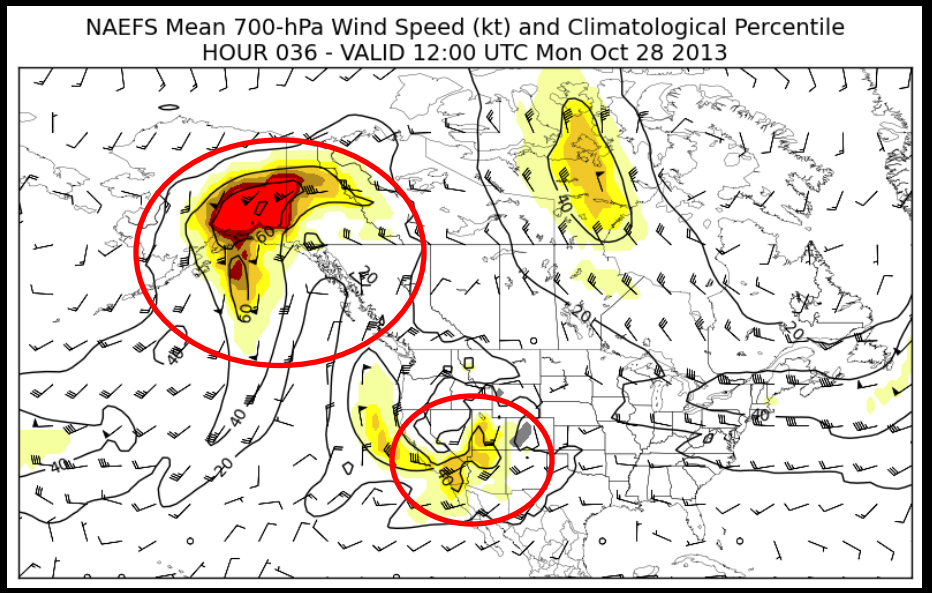


700-hPa Temperature

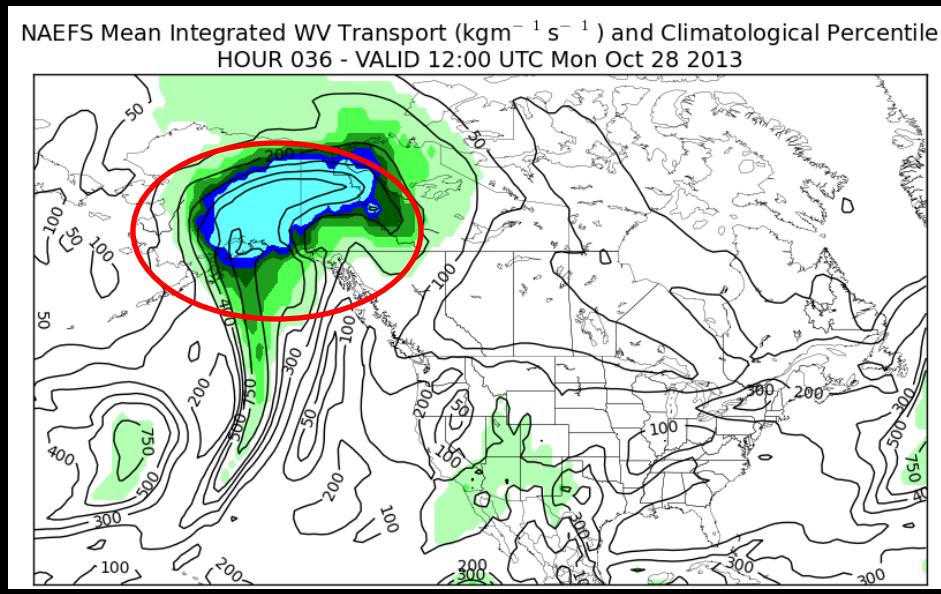




700-hPa Wind Speed



Integrated WV Transport



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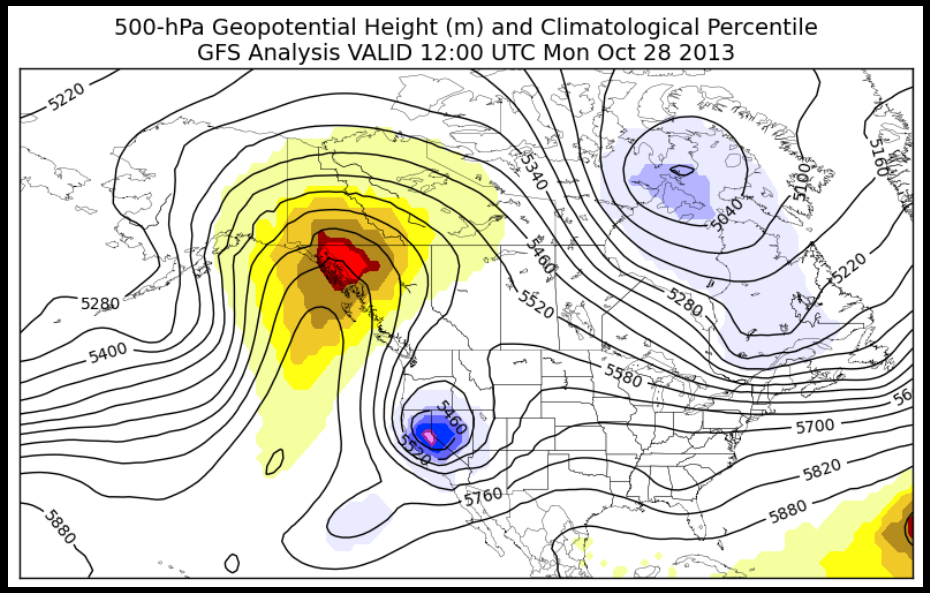
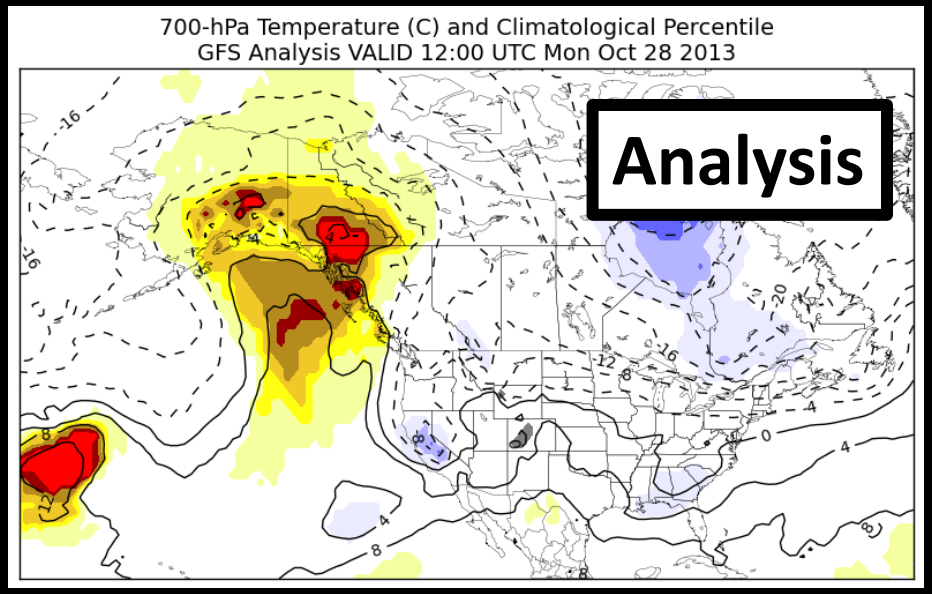
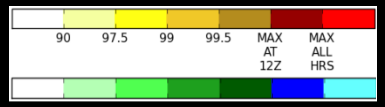
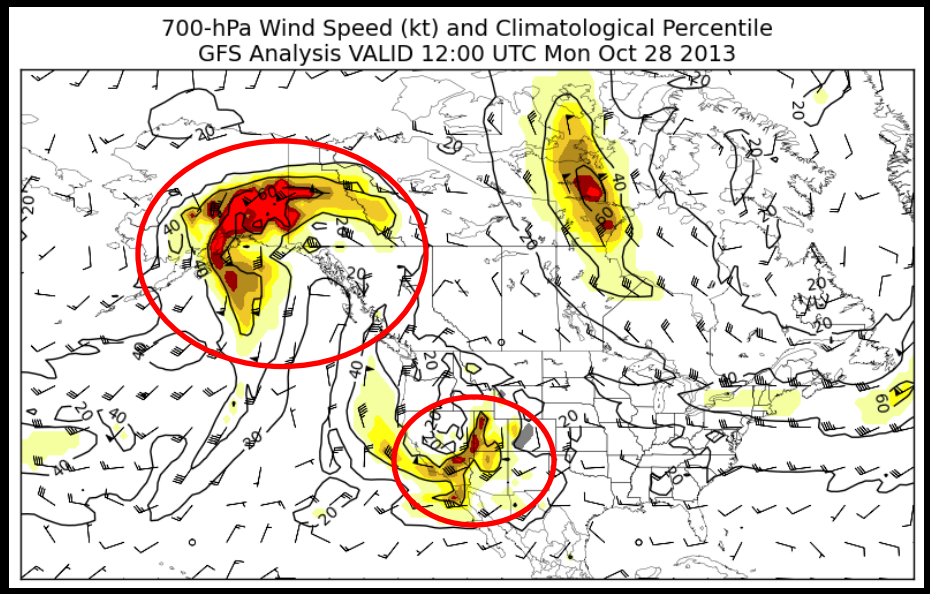


700-hPa Temperature

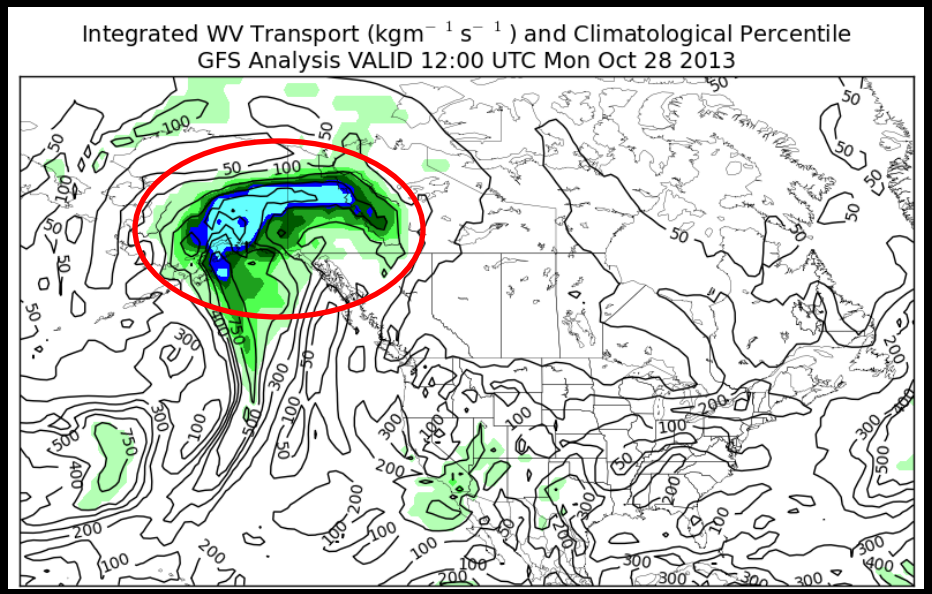




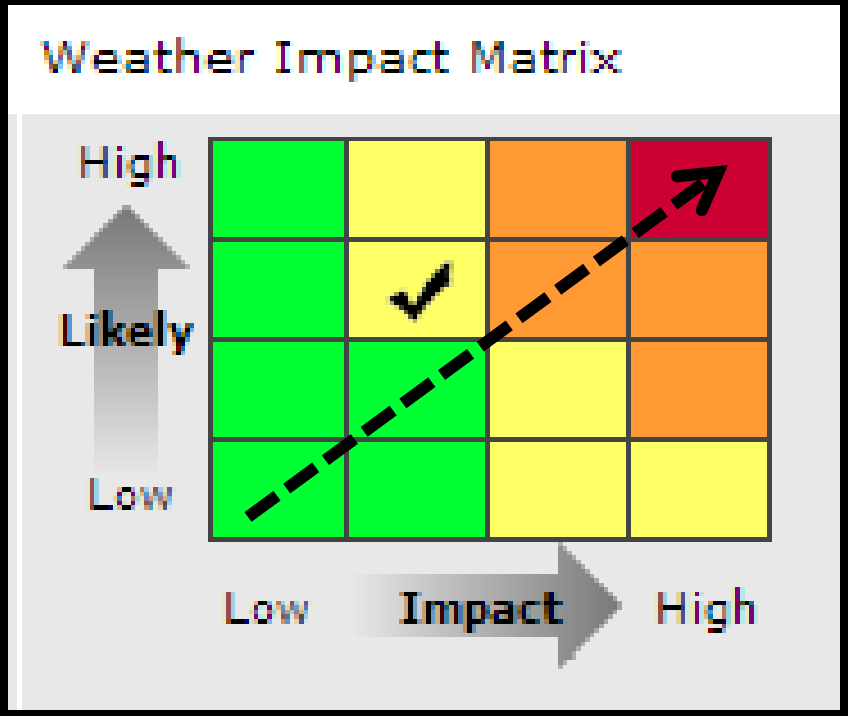
700-hPa Wind Speed

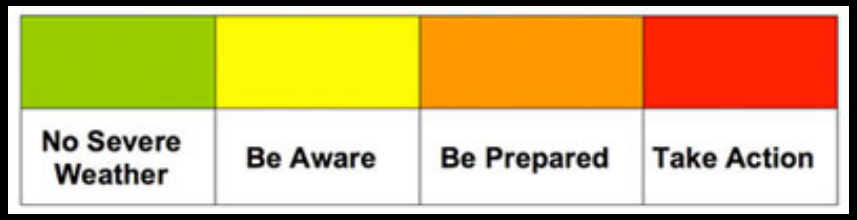


Integrated WV Transport



The Next Step





- UK Met Office “impact matrix”
- Green to red == larger anomalies / percentiles / higher probabilities of extremes
- Danger colors in the SA tables depend on high “impact” and high confidence

- **There’s an avenue here to translate ensemble information into a partner/public message.**

Conclusions

- The smoothing effect of a multi-model ensemble mean can be used to our advantage:
  - the mean only differs significantly from climatology when the bulk of members from both models agree on amplitude, location and timing
  - when an unusual/extreme event does show up, there is typically a high likelihood that it will verify
  - "Slam dunks" may be more common than we think, and may exist at longer lead times than we're used to.

- Probabilistic information is fairly reliable in the medium range
  - When reliability does break down, the ensemble tends to be overconfident.

Conclusions

- A very rough take on NAEFS predictability limits over N America (your mileage may vary):
  - Major upper-level patterns – 8-10 days
  - Major surface highs/lows – 6-8 days
  - Significant warmth/cold – 5-7 days
  - Strong large-scale winds – 5-7 days
  - Significant column moisture – 3-5 days

Caveats

- Caveats:
  - not every high-impact event is associated with anomalous upper-level forecast fields
  - anomalous upper-level fields are not always associated with high-impact weather
  - not every high-impact event is well predicted
  - tools struggle with moderate-impact, low-confidence events

Questions/comments

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