Using Anomaly and Ensemble Data To Forecast Higher Impact Weather

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NOAA/NWS La Crosse WI

December 2012 Media Seminar

Anomalies

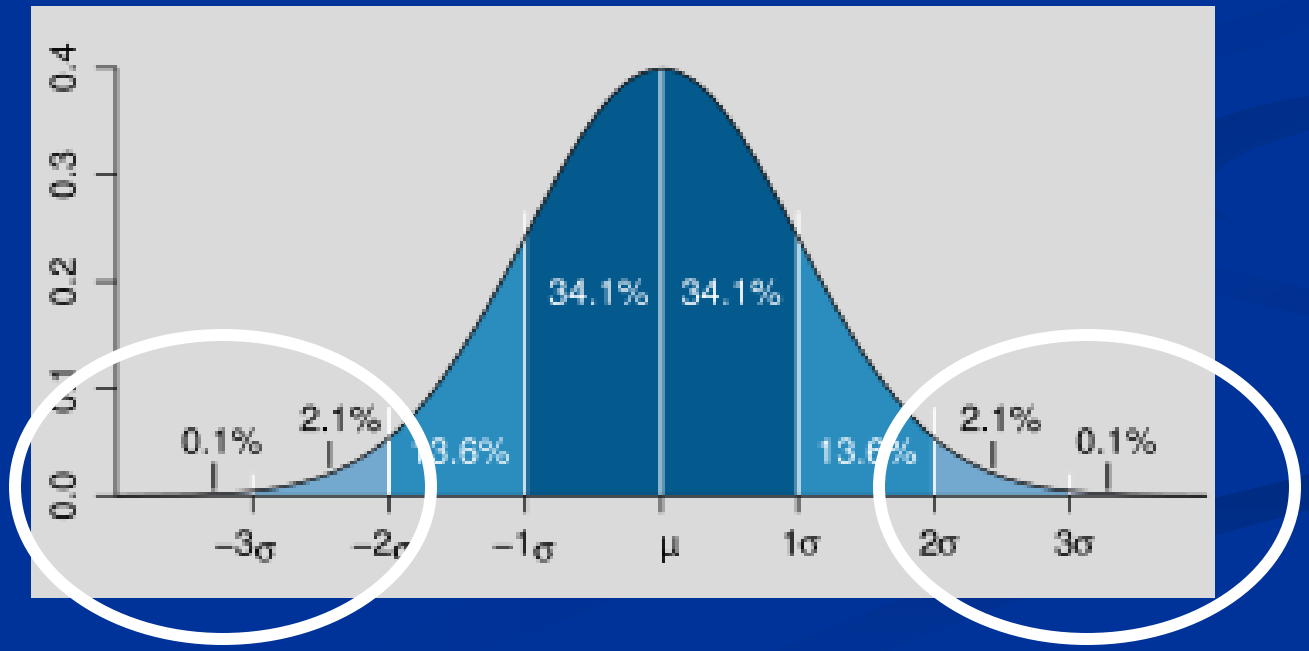
- What is significant weather?
- How do we define significant weather numerically?

- By looking at climatology, we can find the significant events because they deviate from the normal (mean).

Anomalies

- For a normal distribution, recall standard deviation
- The “tails” represent *rarity*: < -2 STD, > +2 STD

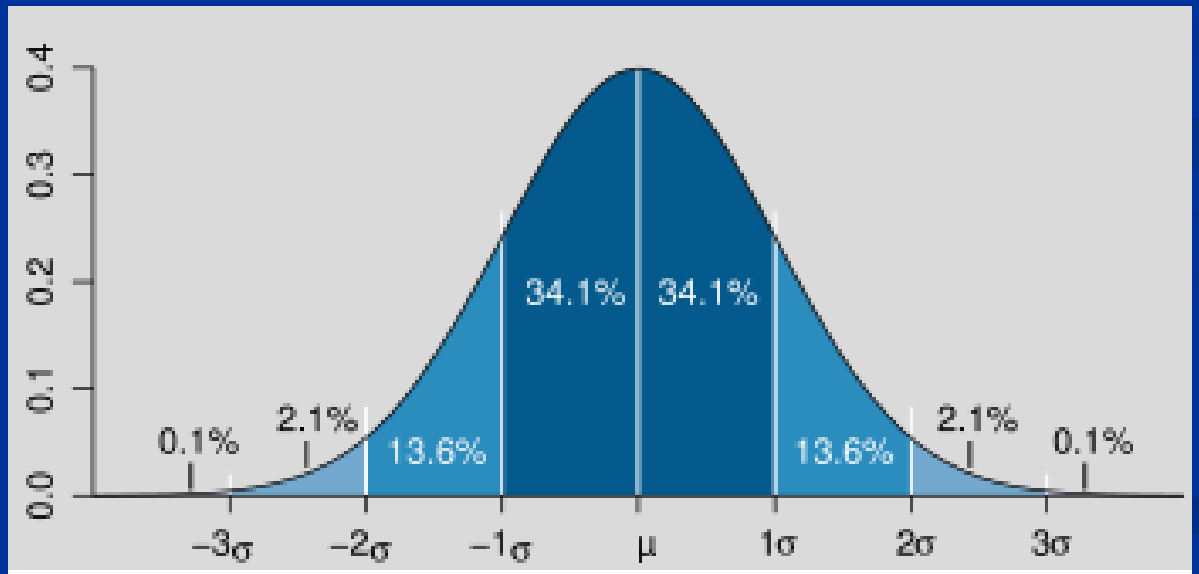
Rare



Rare

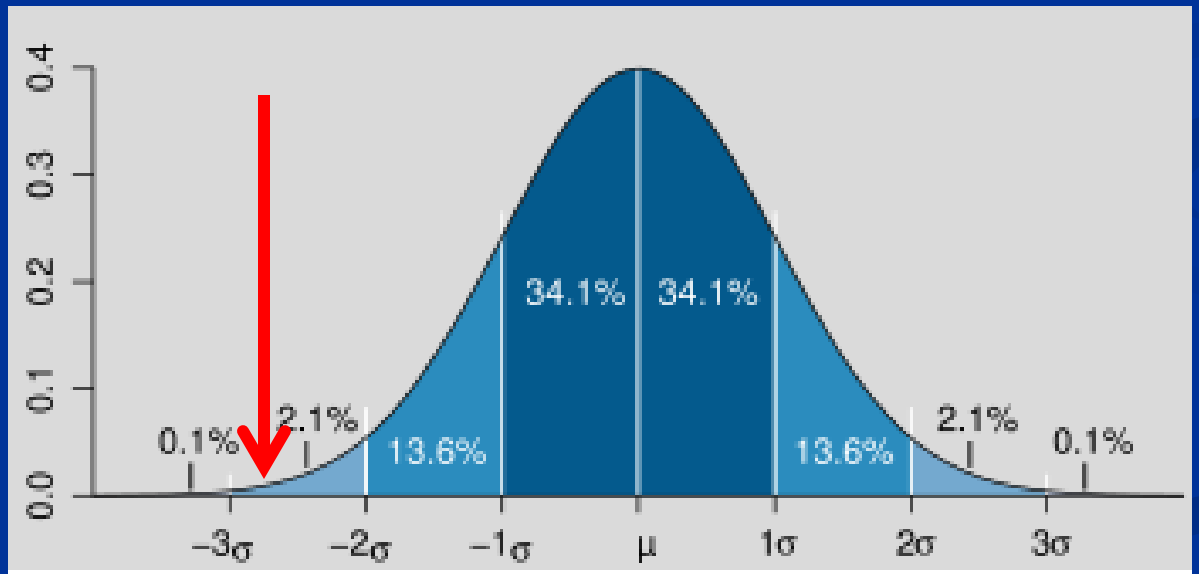
Anomalies

- Example: Minimum Temperature, Dec-Feb
- LSE: 1981-2012: Mean: 13F, Standard Dev: 14F



Anomalies

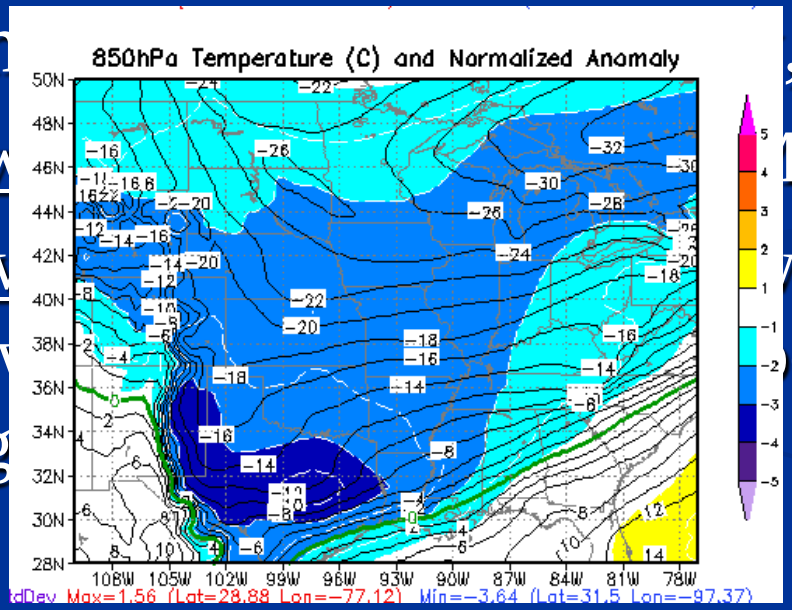
- So, a -25F minT in winter, which has happened only 100 times in the last 136 years, is a -2.6 standardized anomaly



-31F -17F -3F 11F 25F 39F 53F

Anomalies in Forecasting

- So, we assess model anomalies that force a given solution at th, record lows).
  - Record Low ISLP
  - Heavy Snov -level jet strength, lov er jet strength, 500mb heig



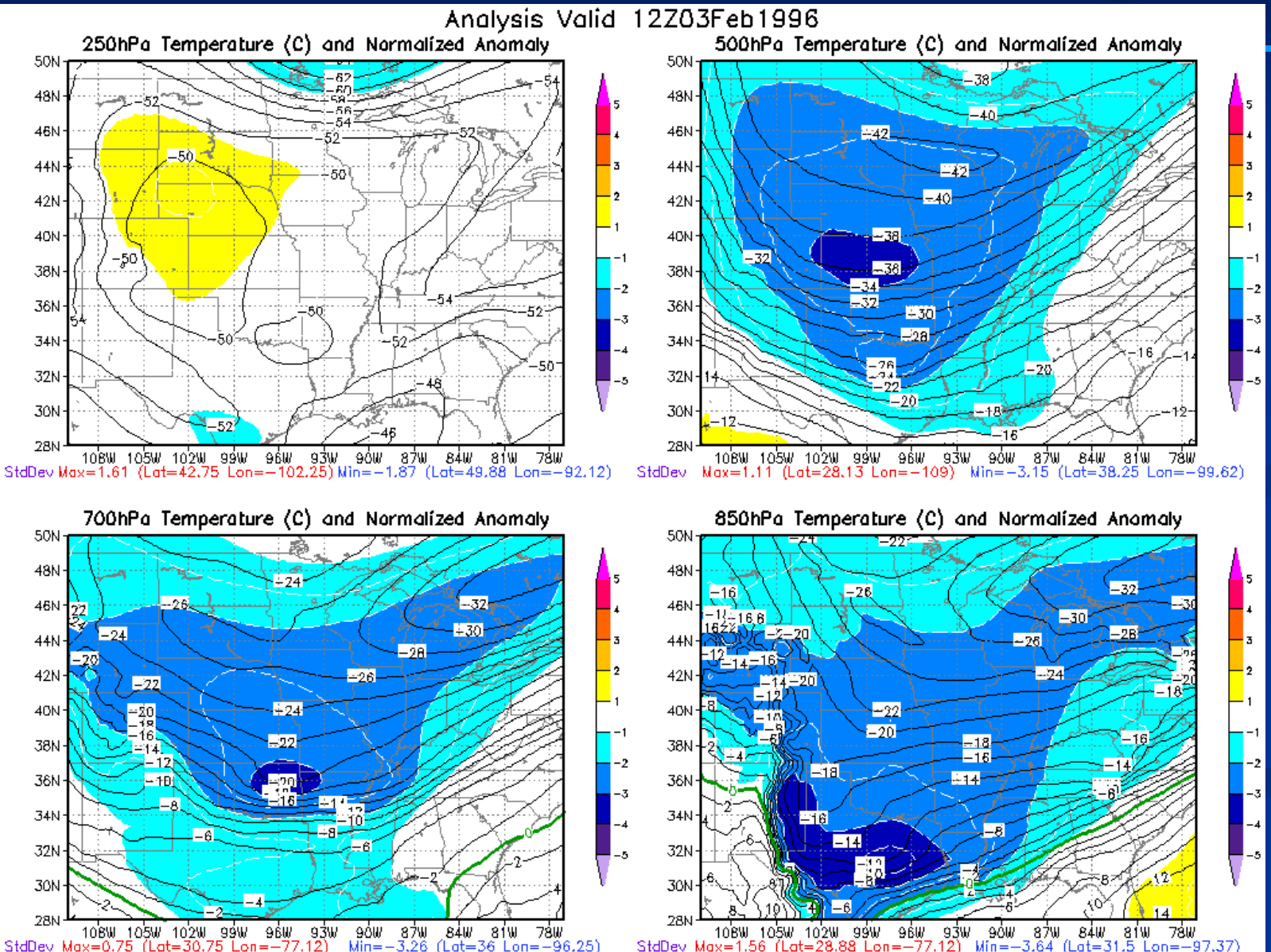
1996 Extreme Cold Event

- Average high temperature was -5.7 degrees
- 3 record low temperatures for February
- 1 record low high temperature for February

- LA CROSSE MUNI AP (KLSE)

Date	MaxT	MinT
1/30/1996	-5	-26
1/31/1996	-1	-28
2/1/1996	-8	-26
2/2/1996	-13	-34
2/3/1996	-9	-35
2/4/1996	0	-31

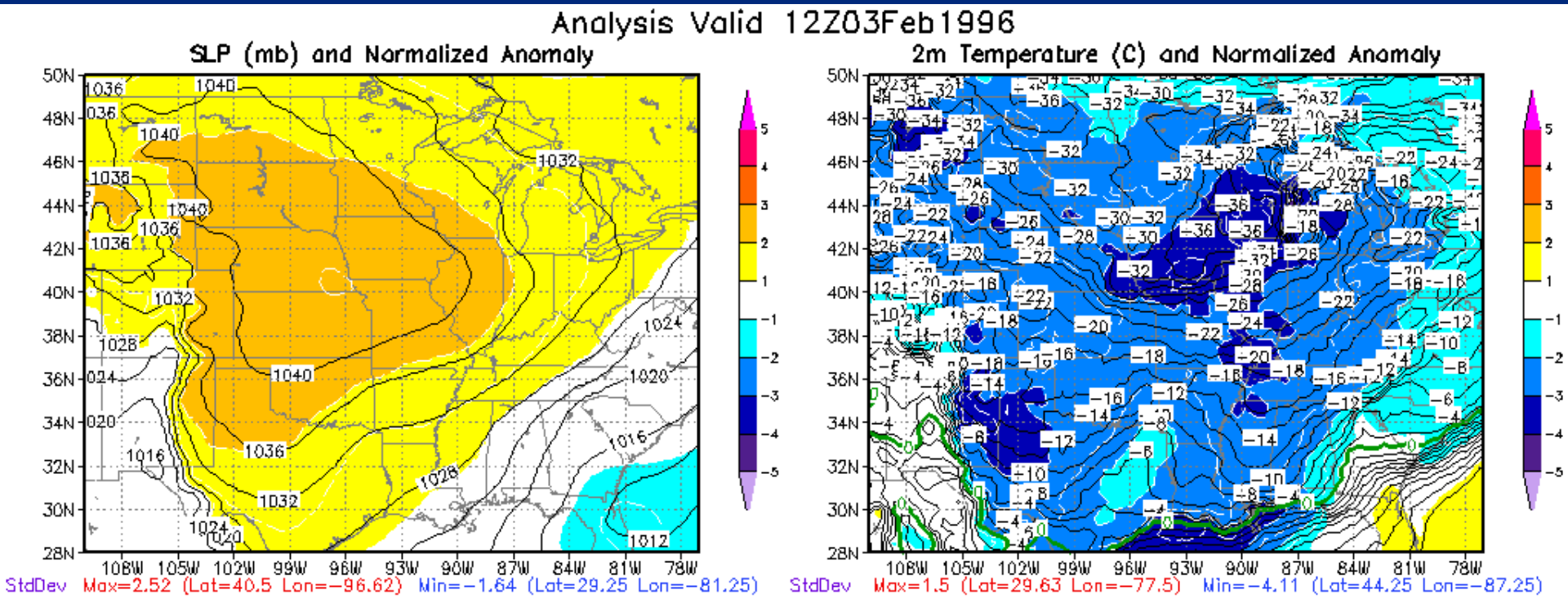
3 Feb 1996: Lo: -35F High: -9F



850mb T: -25C

Std Anom: -2 to -3

3 Feb 1996: Lo: -35F High: -9F



MSLP: 1039mb

Std Anom: +2 to +3

Record Heat: July 2-6, 2012

- A period of 95-105F.
- Dewpoint: 68-75F, not unusually high.
  - Drier soil moisture.
- Heat Index: Afternoons in the 105-110F range.

La Crosse

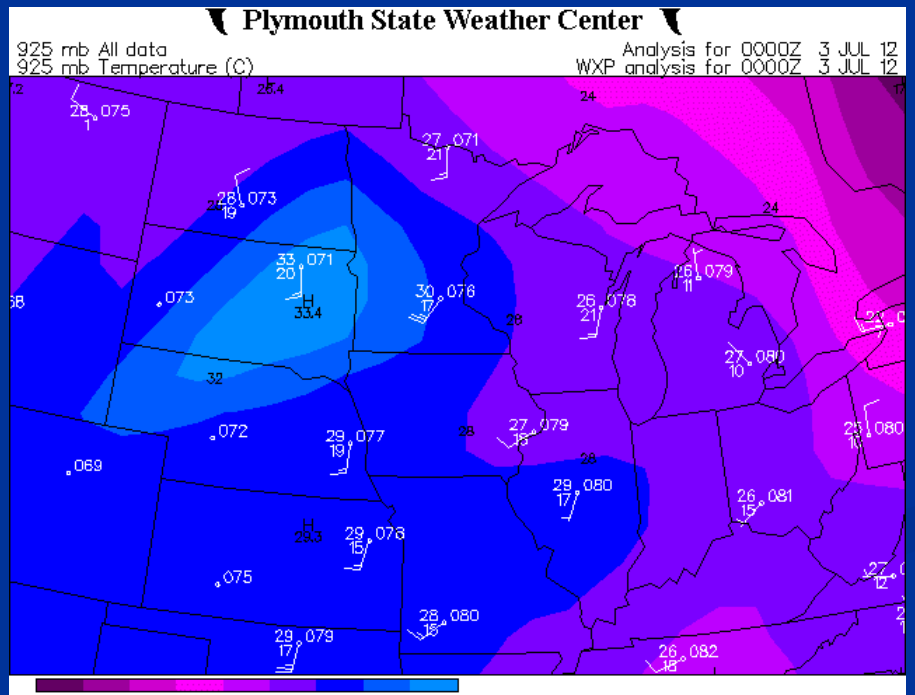
	High	Low	Average	Heat Index
July 2nd	99	73	86	105
July 3rd	99	75	87	105
July 4th	103	81	92	110
July 5th	98	79	89	111
July 6th	103	78	91	109

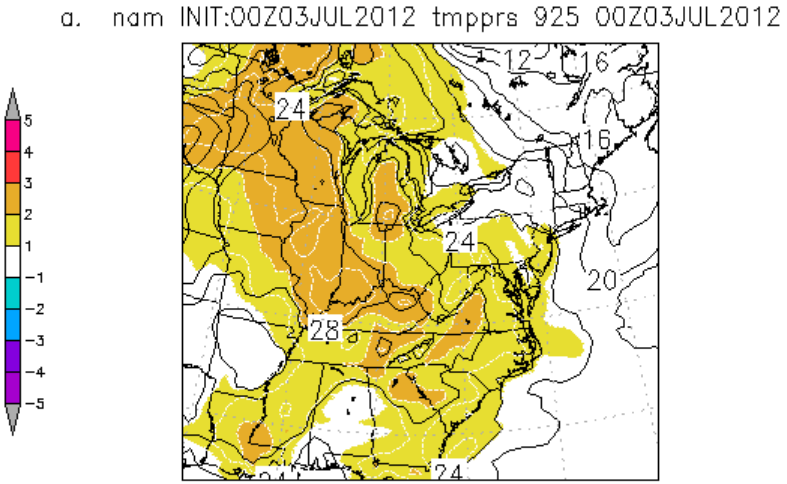
Rochester

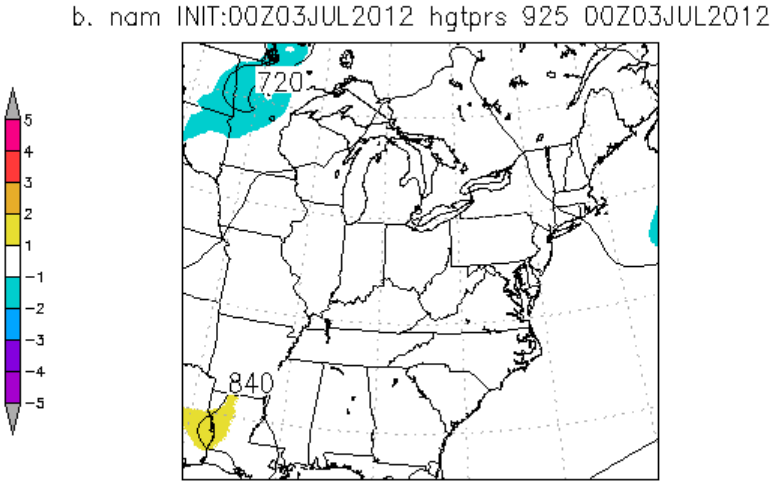
	High	Low	Average	Heat Index
July 2nd	92	73	83	98
July 3rd	93	73	83	102
July 4th	93	75	84	104
July 5th	94	73	84	105
July 6th	96	74	85	103

Anomalies: July 2-6, 2012

- 925 mb Temperature
  - Warmest days clearly seen (July 4,6)
  - > 30C, 3+ standardized anomaly

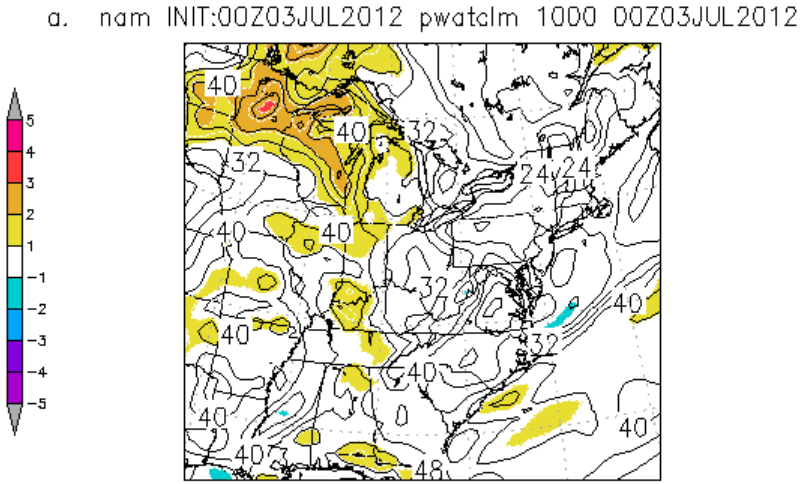


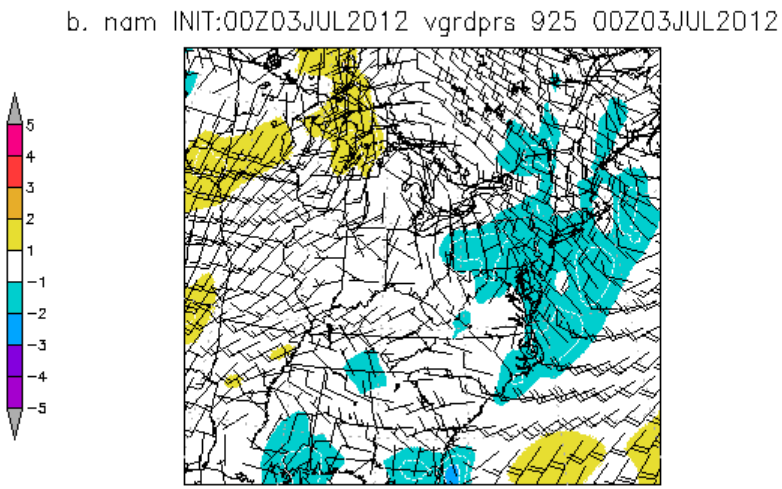




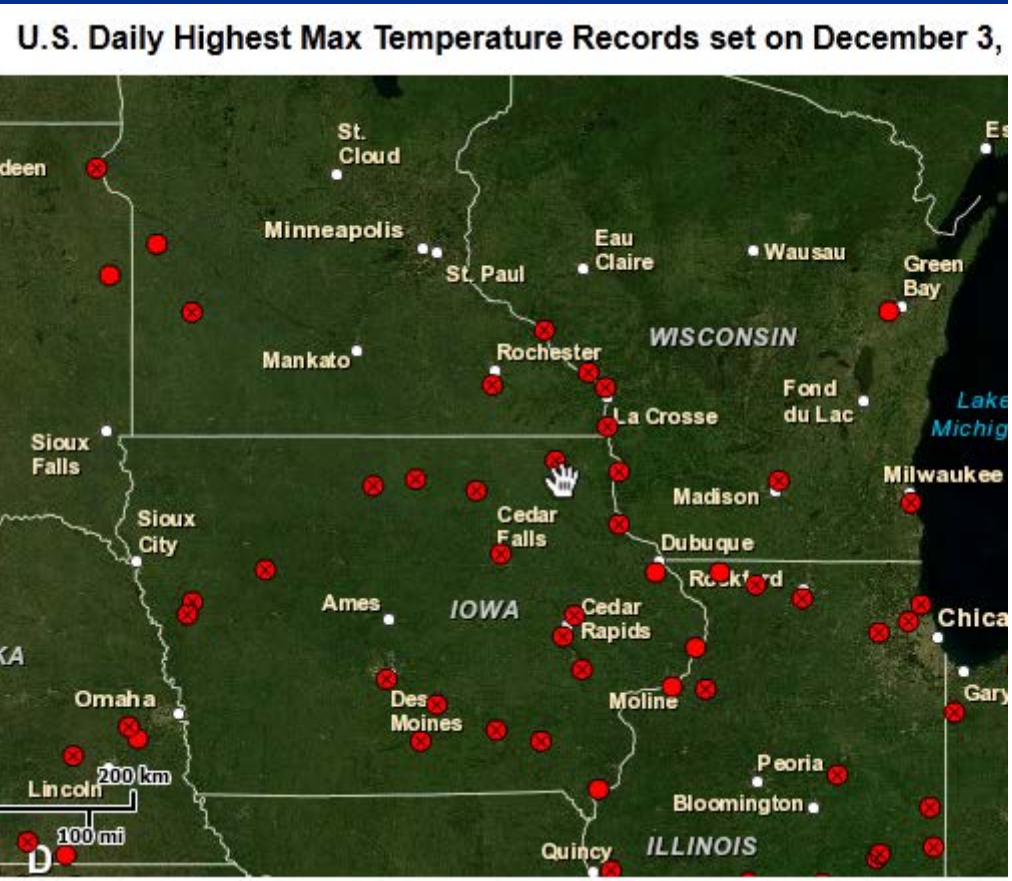
Anomalies: July 2-6, 2012

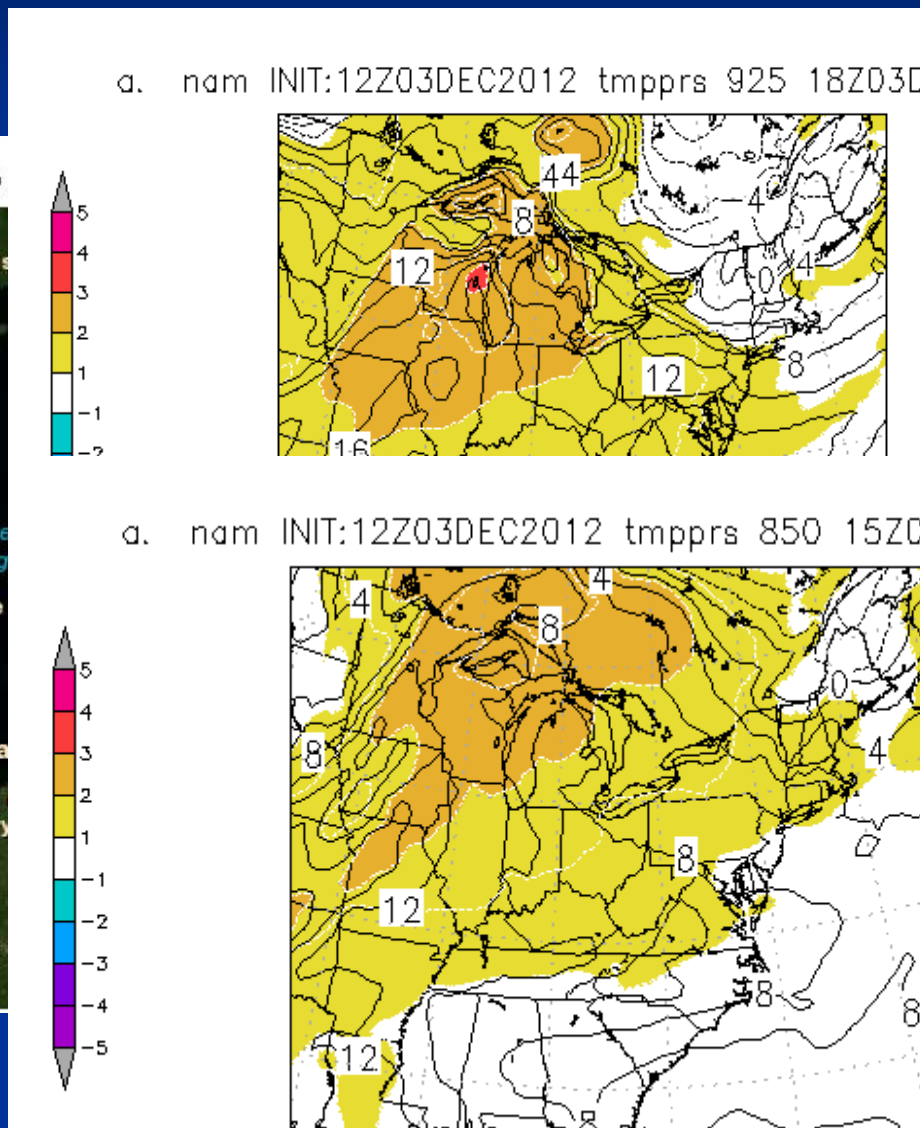
- Precipitable Water
  - Generally unimpressive
  - PW pooling around frontal boundaries and weather
  - ~ 1 inch PW, was not anomalous





From Monday

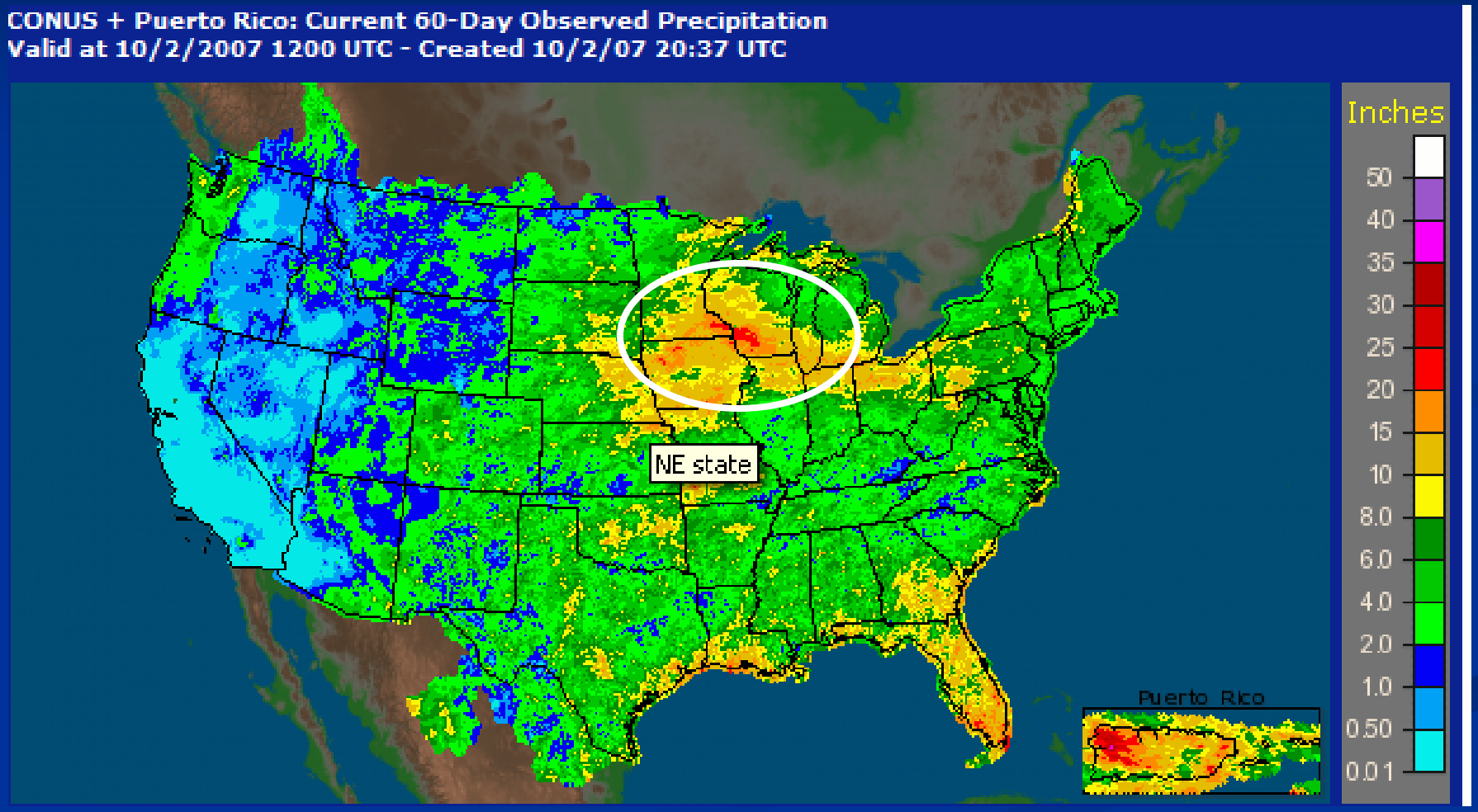

U.S. Daily Highest Max Temperature Records set on December 3,
St. Cloud
Minneapolis
St. Paul
Eau Claire
Wausau
Green Bay
WISCONSIN
Mankato
Rochester
La Crosse
Fond du Lac
Sioux Falls
Sioux City
Cedar Falls
Madison
Milwaukee
Dubuque
Ames
IOWA
Cedar Rapids
Omaha
Des Moines
Moline
Peoria
Bloomington
Lincoln
200 km
100 mi
Quincy
ILLINOIS


a. nam INIT:12Z03DEC2012 tmpprs 925 18Z03D
a. nam INIT:12Z03DEC2012 tmpprs 850 15Z0

The Big Wet

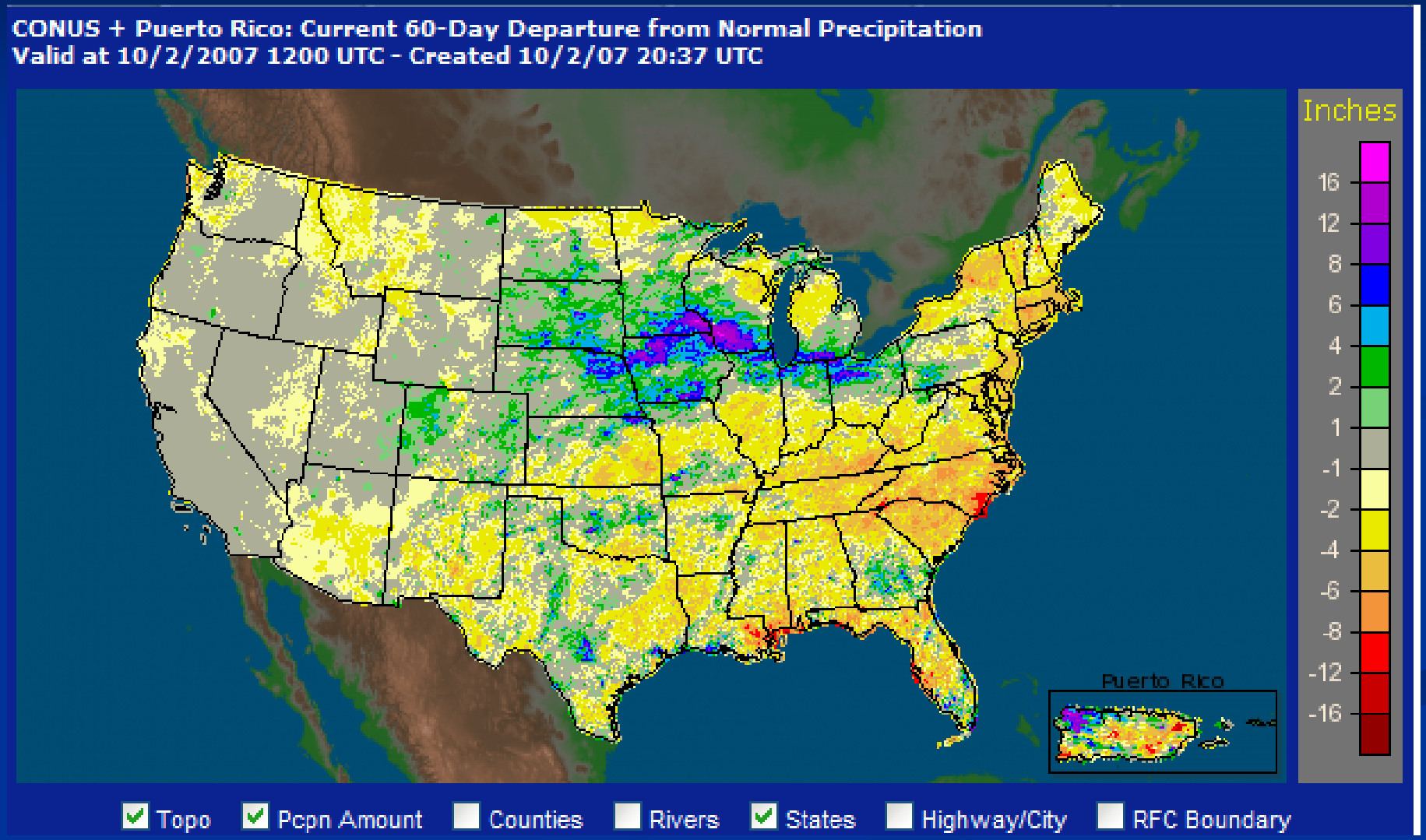
Composite Anomalies Aug-Sep 2007 Depicting an Anomalous Wet Period

Wettest in the Country Last 2 Months?



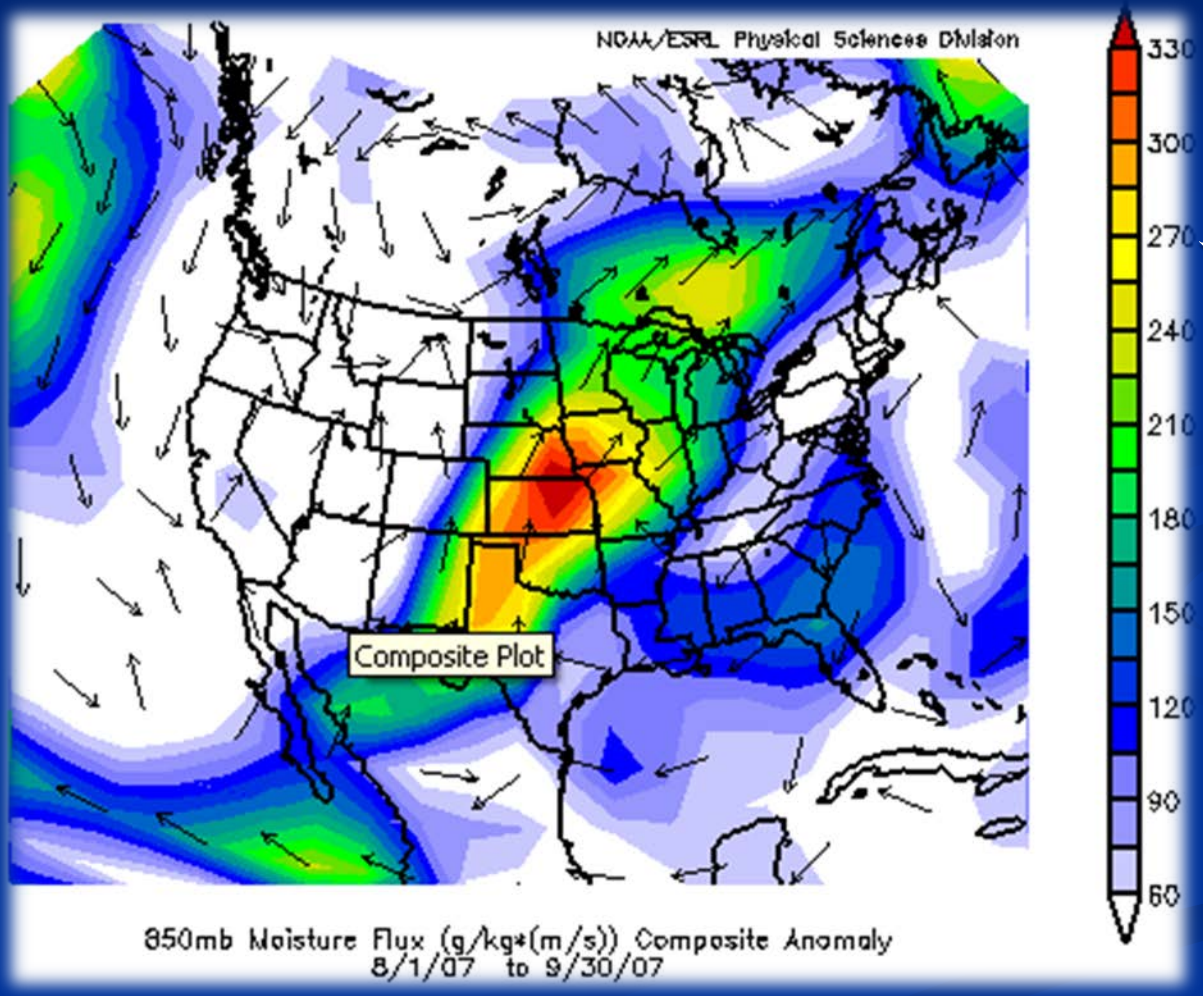
- 60 Day Rainfall Accumulations from NWS

Rainfall Accumulation Departure



- 60 Day Rainfall Departures from NWS

Stronger LLJ + Higher Precip. Water = Anomalous Moisture Flux



Note: Not Standardized

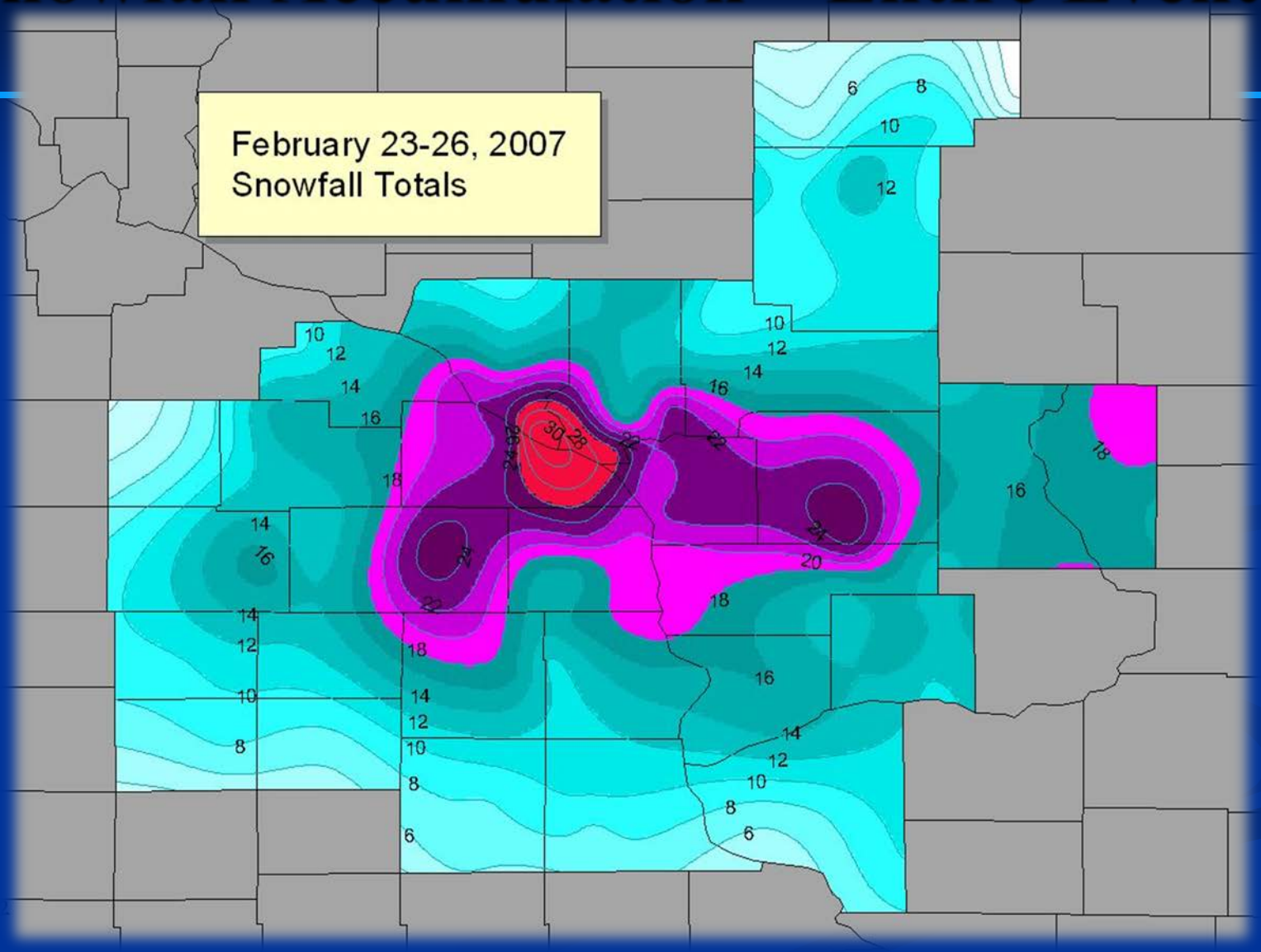
850mb Moisture Flux Anomaly – August through September 2007

February 23-25, 2007

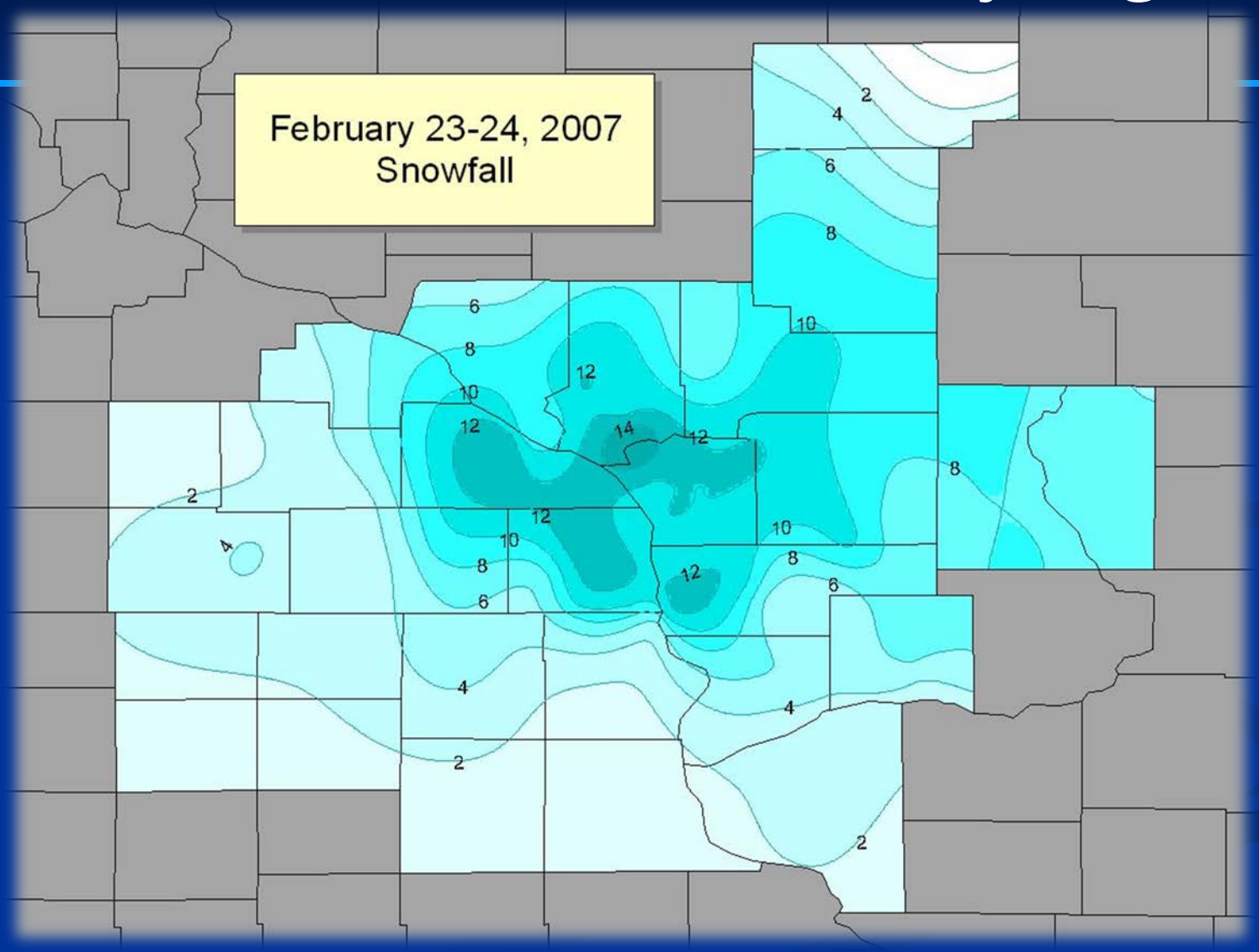
La Crosse's Largest Snow Storms		
Rank	Date/Dates	Snow Total
1	February 23-25, 2007	21.0 inches
2	March 12-14, 1997	19.1 inches
3	January 25-27, 1996	18.8 inches
4	March 5-6, 1959	18.5 inches

Unprecedented Snowfall in LSE

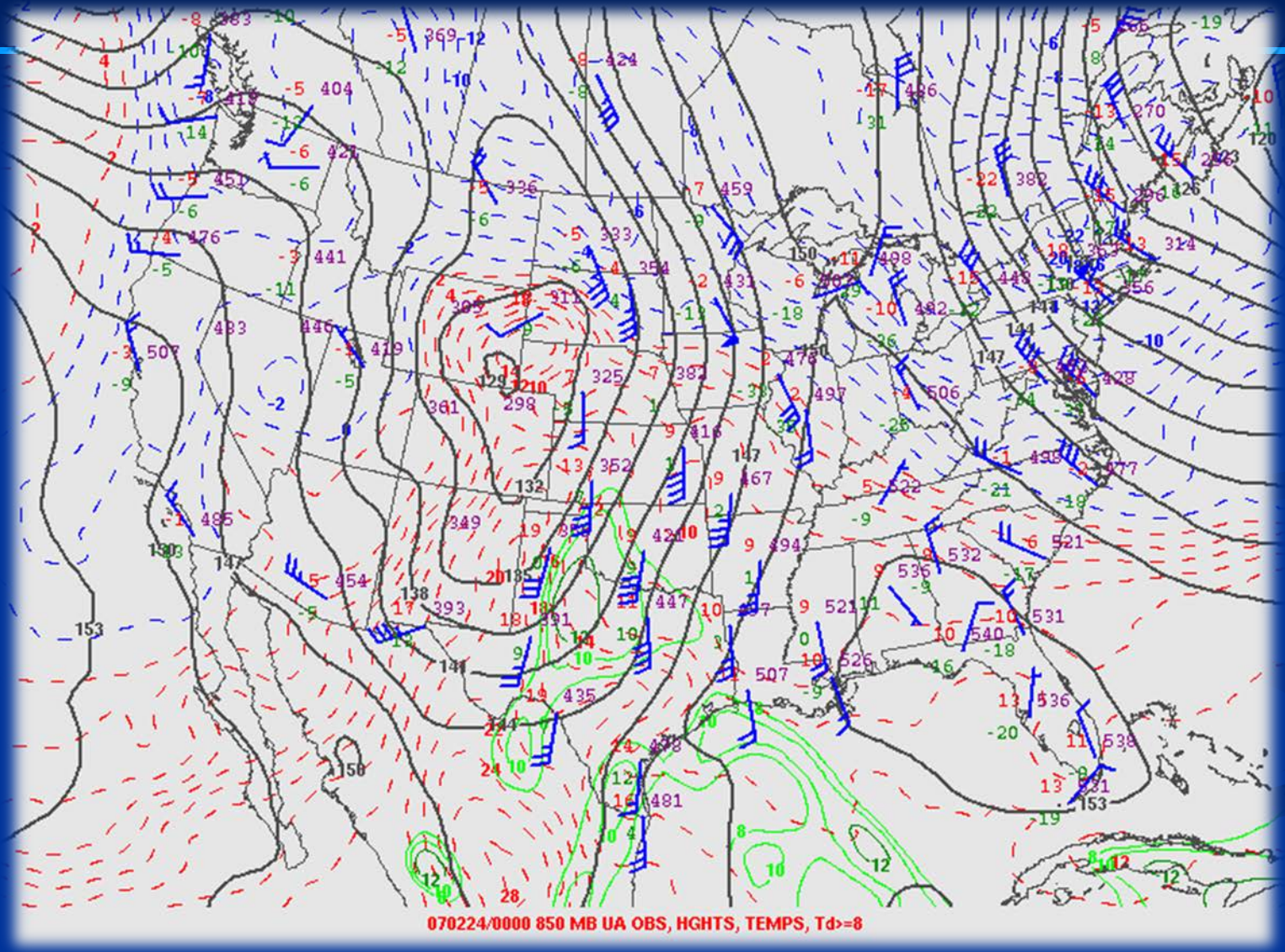
Snowfall Accumulation – Entire Event

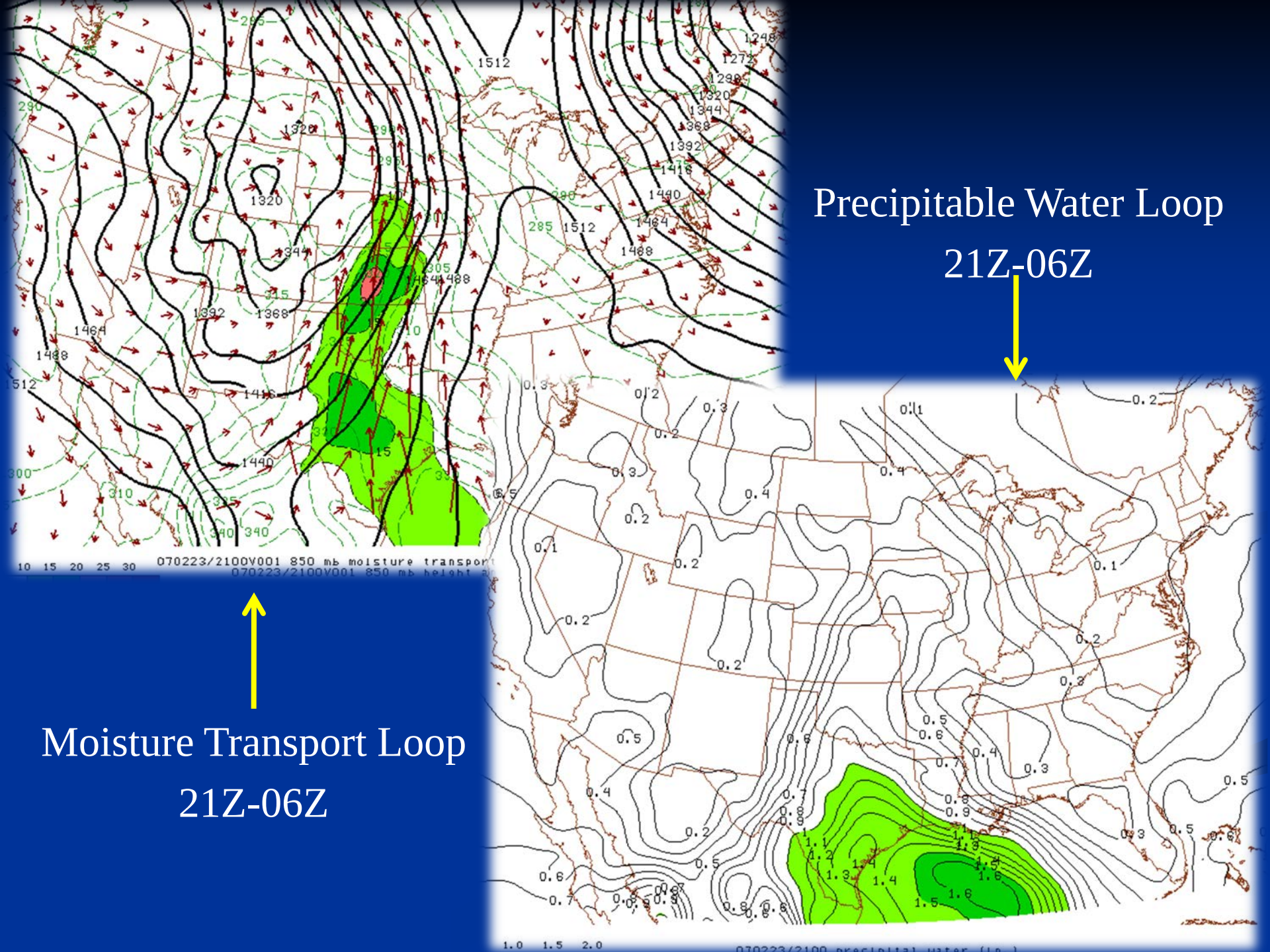


Snowfall Accumulation – Friday Night



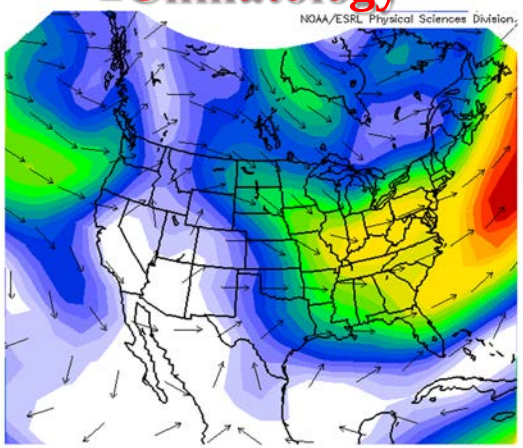
24 February 2007 00Z 850MB Analysis

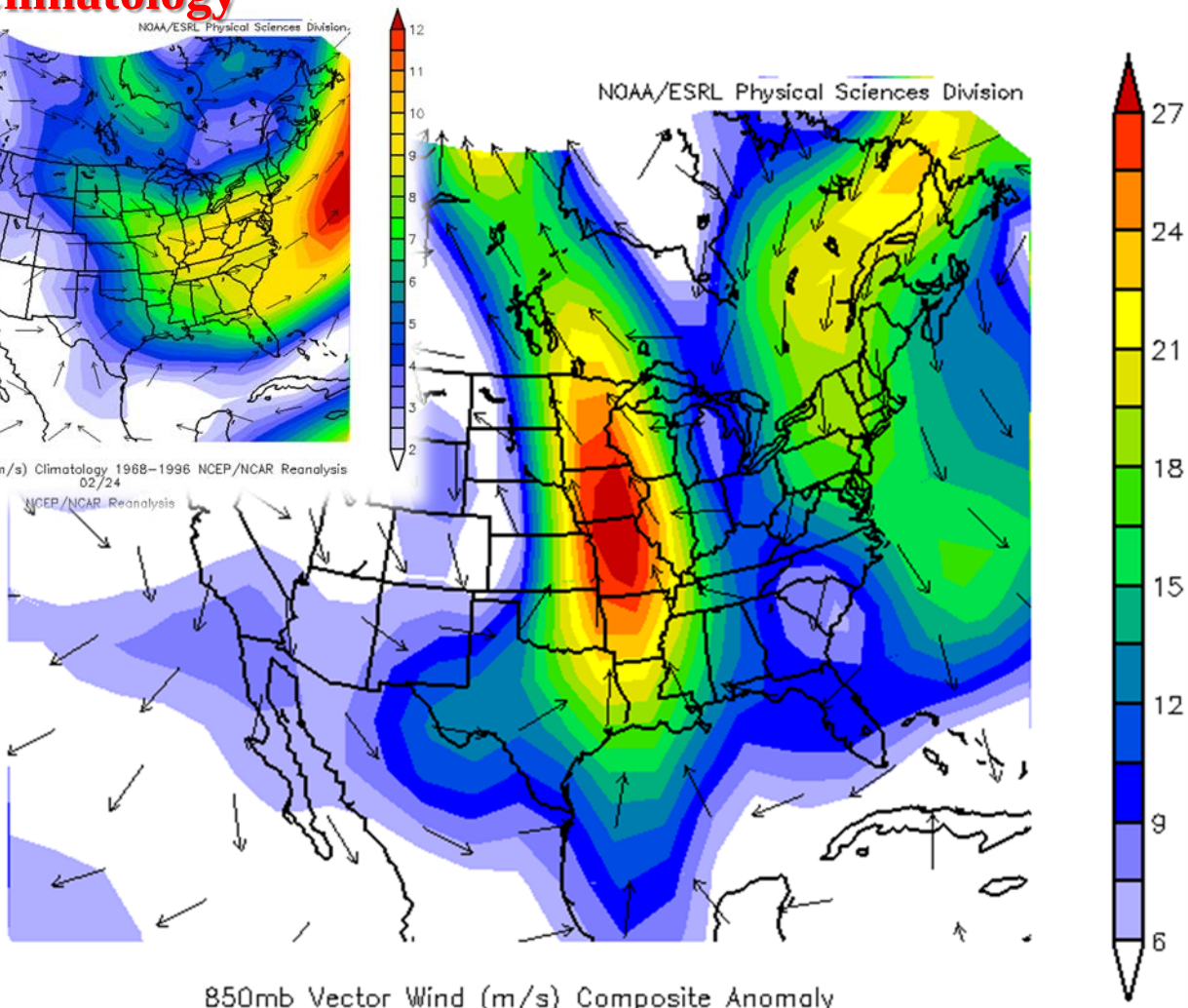



Precipitable Water Loop
21Z-06Z
Moisture Transport Loop
21Z-06Z
070223/2100V001 850 mb moisture transport
070223/2100V001 850 mb height
10 15 20 25 30
1.0 1.5 2.0

24 Feb 07 NCEP Reanalysis – 850MB Wind Anomaly

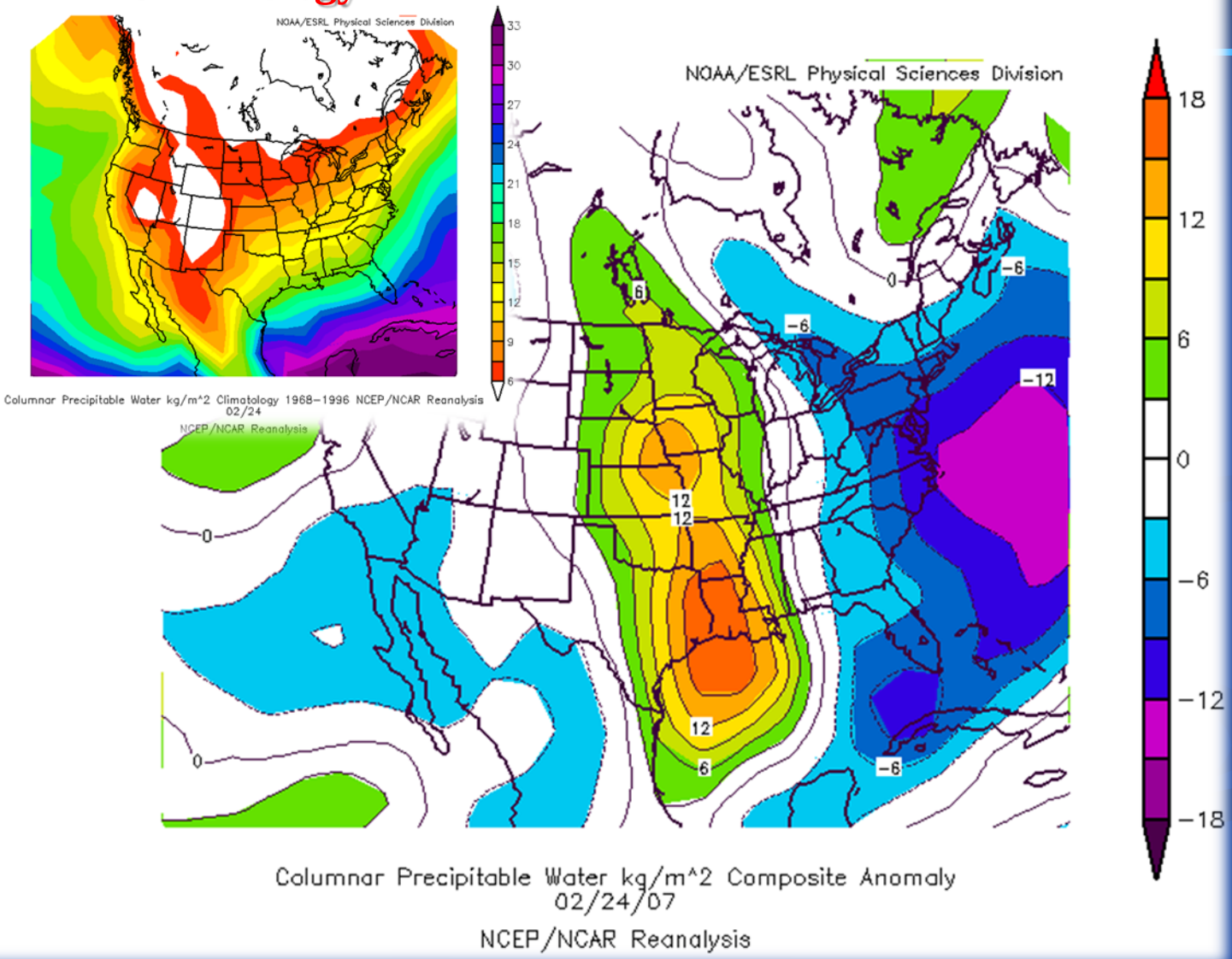
- **Climatology**





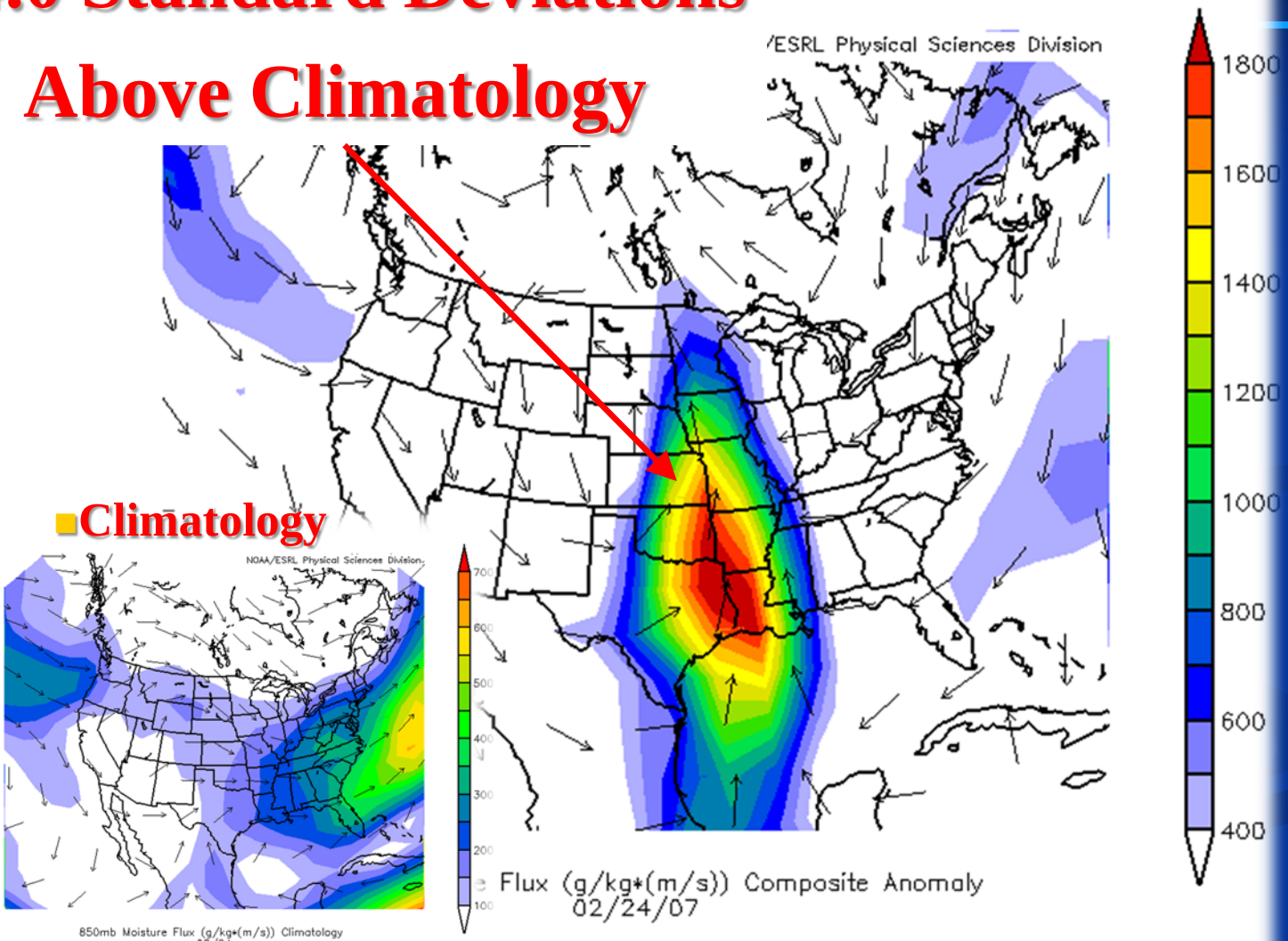
24 Feb 07 NCEP Reanalysis – PWAT Anomaly

- **Climatology**



24 Feb 07 NCEP Reanalysis – Moisture Flux Anomaly

>4.0 Standard Deviations Above Climatology



Regional Table: “Surveillance”

www.wrh.noaa.gov/slc/projects/anomaly/frames_sector_newvars.php?dom=nc&name=NC&heading=North Central

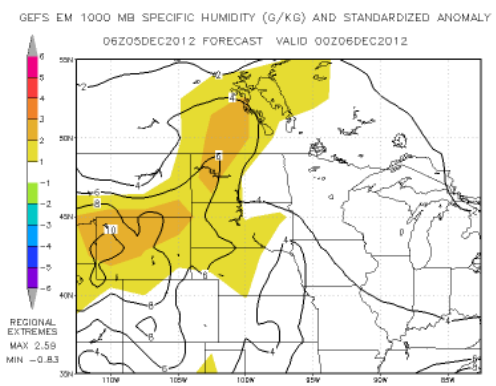
very cold

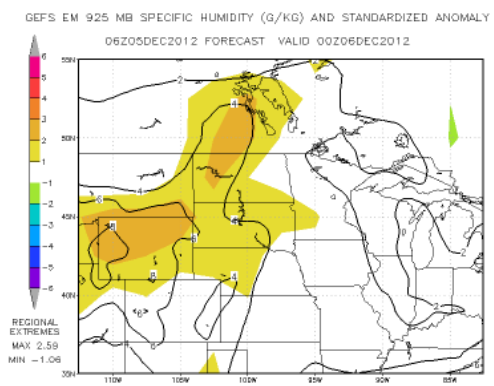
ARX Intranet | Meso Model Matrix | webcams | SPC MesoA | ARX Wx Story | Leave Form | ShiftLog | BOIVerify | CMS Login | DOC Learn | SSD Wiki | LSR App | CTel Mail | NWSChat Live

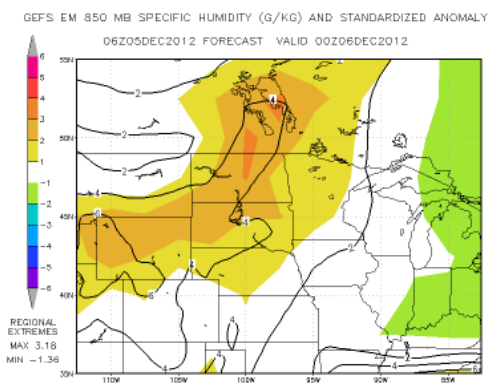
North Central US Table | December 5th 2012 | **06z run**

	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126	132	138	144	150	156	162	168	174	180
	Wed 05th			Thu 06th				Fri 07th				Sat 08th				Sun 09th				Mon 10th				Tue 11th				Wed 12th			
	06z	12z	18z	00z	06z	12z	18z	00z	06z	12z	18z	00z	06z	12z	18z	00z	06z	12z	18z	00z	06z	12z	18z	00z	06z	12z	18z	00z	06z	12z	18z
Height	1.9	1.8	1.7	-1.9	-2.1	-2.4	-2.4	-2.0	-1.7	-1.3	-1.3	-1.4	-1.4	-1.4	-1.5	-1.4	-1.5	-1.4	-1.5	-1.6	-1.8	-2.0	-2.0	-2.0	-1.8	-1.6	-1.6	-1.7	-1.8	-1.9	-1.8
MSLP	1.7	1.6	-1.6	-1.8	-2.0	-2.3	-2.4	-1.9	-1.7	-1.3	-1.2	-1.1	-1.1	-0.9	-1.0	1.2	1.4	1.5	1.3	-1.4	-1.6	-1.8	-1.7	-1.5	-1.3	-1.4	-1.4	-1.2	-1.2	-1.1	-1.1
Temp	2.8	2.3	3.0	2.8	2.8	2.1	2.0	1.8	2.3	1.8	1.7	1.5	1.7	1.6	-1.6	-1.6	-1.7	-1.9	-1.9	-1.9	-1.8	-1.8	-1.7	-1.6	-1.5	-1.4	1.4	-1.2	-1.2	-1.0	1.7
U-Wind	-3.4	-2.8	3.5	3.7	3.7	2.7	3.0	2.4	2.3	2.1	1.8	1.8	-1.8	1.7	1.9	1.9	1.7	1.6	1.3	-1.7	1.5	1.9	2.1	2.3	1.9	2.0	1.7	1.5	1.6	1.9	1.5
V-Wind	3.9	3.5	3.8	3.6	3.9	3.7	2.8	2.0	1.6	-1.5	-1.4	1.5	-1.3	-1.4	-1.7	-1.6	-2.2	-2.4	-2.4	-2.3	-1.9	-2.1	-2.0	-1.8	-2.0	-1.9	-1.7	-2.1	-1.3	1.5	-1.2
Mag Wind	3.7	3.5	4.4	4.1	4.0	4.2	3.9	2.4	2.2	2.1	-2.0	-2.0	-2.1	-2.0	-2.0	-2.0	-2.1	2.0	-1.9	-1.8	-1.9	2.3	2.0	2.1	2.6	2.5	2.1	-1.9	-2.0	-2.2	-2.0
SHum	3.2	3.9	3.6	3.9	3.8	3.9	3.5	3.7	2.8	2.7	2.0	1.9	2.0	1.9	-1.4	-1.5	-1.4	-1.3	-1.7	-1.8	-1.3	1.5	-1.6	-1.5	-1.0	1.0	-1.2	-1.4	-1.1	-1.1	-1.7
MFlux	0.0	0.0	0.0	0.0	0.0	0.0	500 mb		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PWAT	3.3	3.6	3.0	3.1	2.9	3.5	2.9	2.4	1.9	1.8	1.7	1.8	1.5	1.4	-1.0	-1.1	-1.2	-1.2	-1.1	-1.2	-1.2	1.3	-1.2	-1.0	-1.1	-1.5	-1.5	-1.4	-1.2	-1.2	-1.1

Table Explanation | Anomaly Page | Northwest | Southwest | Alaska | Northeast | South Central | Southeast | W Conus Table | CONUS | Alternate Color







Real-time Model Anomalies

- HPC: http://www.hpc.ncep.noaa.gov/training/SDs/
- Penn State: http://eyewall.met.psu.edu/ensembles/java/ModelDisplay.html
- Regional Table: http://www.wrh.noaa.gov/slc/projects/anomaly/frames_sector_newvars.php?dom=nc&name=NC&heading=North%20Central

Ensembles For High Impact Weather

- We try to assess impact by using ensemble probabilities.
- Target impact graphics

Ensembles For High Impact Weather

- SPC SREF Products
  - http://www.spc.noaa.gov/exper/sref/
- Plumes
  - http://eyewall.met.psu.edu/plumes/
- SREF Matrix – new!

SPC SREF Products

- Useful “impact” products:
  - Probability of FZRA lasting 3 or more hours
  - Probability of FZRA > 0.05” in 3 hours
  - Probability of FZRA changing to RA
  - Probability of new snow/ice on roads in last 6 hours
  - Probability of Snowfall Rate of 1”, 2”,3” per hour
  - Probability of Dendritic Growth Zone Depth > 50 mb, > 100 mb

Please Note: Several graphics that are dependent on vertical velocity have been removed, owing to incorrect vertical velocity fields in the NMM and NMMB members. **Click here for more info.**

SPC Guidance | Overview | Moisture | Instability | Kinematic | Lift | Precip | Severe | Winter | Fire | Aviation | Links

Start | Stop | FRAME 1 of 30 | SPEED << >> 2 img/sec | DIR REV FWD | Rock | DWELL | > | On/Off

Norman, OK

[MNSD]:850MB_Temp
[SP]:850MB_Temp_0C_Isotherm
[PR]:850MB_Temp_<=-2C
[PR]:850MB_Temp_<=0C
[PR]:850MB_Temp_<=+2C
[MNSD]:700MB_Temp
[PR]:1000-500MB_Thickness_<=5280m
[PR]:1000-500MB_Thickness_<=5340m
[PR]:1000-500MB_Thickness_<=5400m
[MAX]:3hr_Snowfall(inches)
[MN]:3hr_Snowfall(inches)
[PM]:3hr_Snowfall(inches)
[MN]:6hr_Snowfall(inches)
[MN]:12hr_Snowfall(inches)
[MN]:Snowfall_Ratio(Snow:Liquid_Eqv)
[PR]:Snowfall_Rate_>=1in(perhr)
[PR]:Snowfall_Rate_>=2in(perhr)
[PR]:Snowfall_Rate_>=3in(perhr)
[PR]:Freezing_Rain_Rate_>=0.05_in(per3hr)
[PR]:Freezing_Rain_lasting_>=3hrs
[PR]:Rain_Change_to_Freezing_Rain
[PR]:Freezing_Rain_Change_to_Rain
[MDXN]:Dendritic_Growth_Zone_Depth(mb)
[PR]:Dendritic_Growth_Zone_Depth_>=50mb
[PR]:Dendritic_Growth_Zone_Depth_>=100mb
[MN]:Precipitation_Type_(NCEP_Algorithm)
[PR]:Probability_Rain(All_members)
[CPR]:Cond_Prob_Rain(Given_member_precips)
[PR]:Probability_Snow(All_members)
[CPR]:Cond_Prob_Snow(Given_member_precips)
[PR]:Probability_Ice_Pellets(All_members)
[CPR]:Cond_Prob_IP(Given_member_precips)
[PR]:Probability_Freezing_Rain(All_members)
[CPR]:Cond_Prob_ZR(Given_member_precips)
[PR]:Front_>=0.1_and_MPV_<=0.25_850mb
[PR]:Front_>=0.1_and_MPV_<=0.25_700mb
[PR]:Front_>=0.1_and_MPV_<=0.25_900-650mb

Storm Prediction Center
Norman, Oklahoma

Short Range Ensemble Forecast (SREF) Products

Active Field: SREF_SNOWRATE_1INCH__

Active Model Run: latest

* **New** Plumes Page

Most Recent Model Run

2012120509z in through **f087**

Previous Model Runs

2012120503z
2012120421z
2012120415z
2012120409z
2012120403z
2012120321z
2012120315z

****Official SPC Forecasts****

Day 1 Conv. Outlook
Day 2 Conv. Outlook
Day 3 Conv. Outlook
Day 1 Fire Outlook
Day 2 Fire Outlook

Map Overlays

CWAs

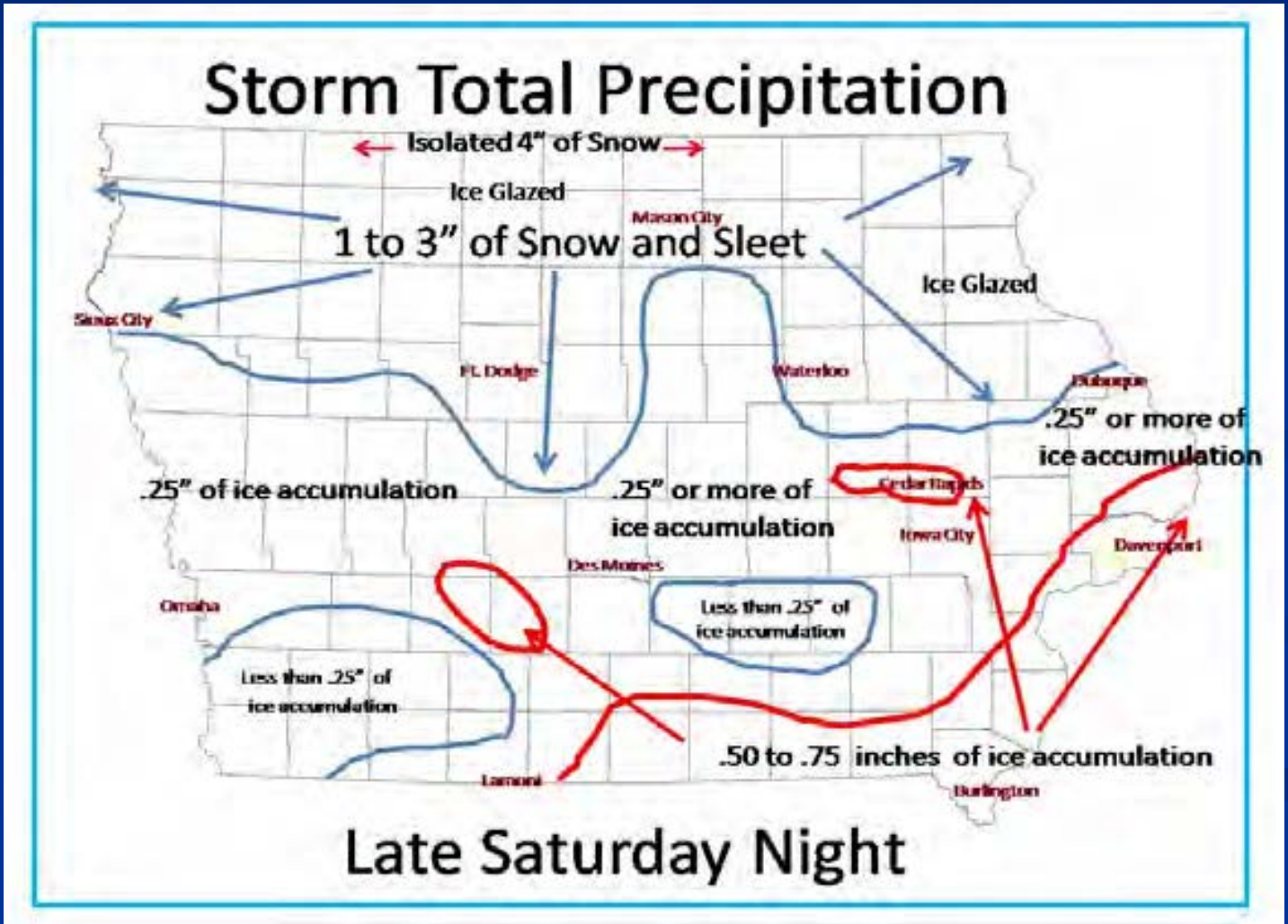
This guidance product is not available at this forecast hour.

NOAA

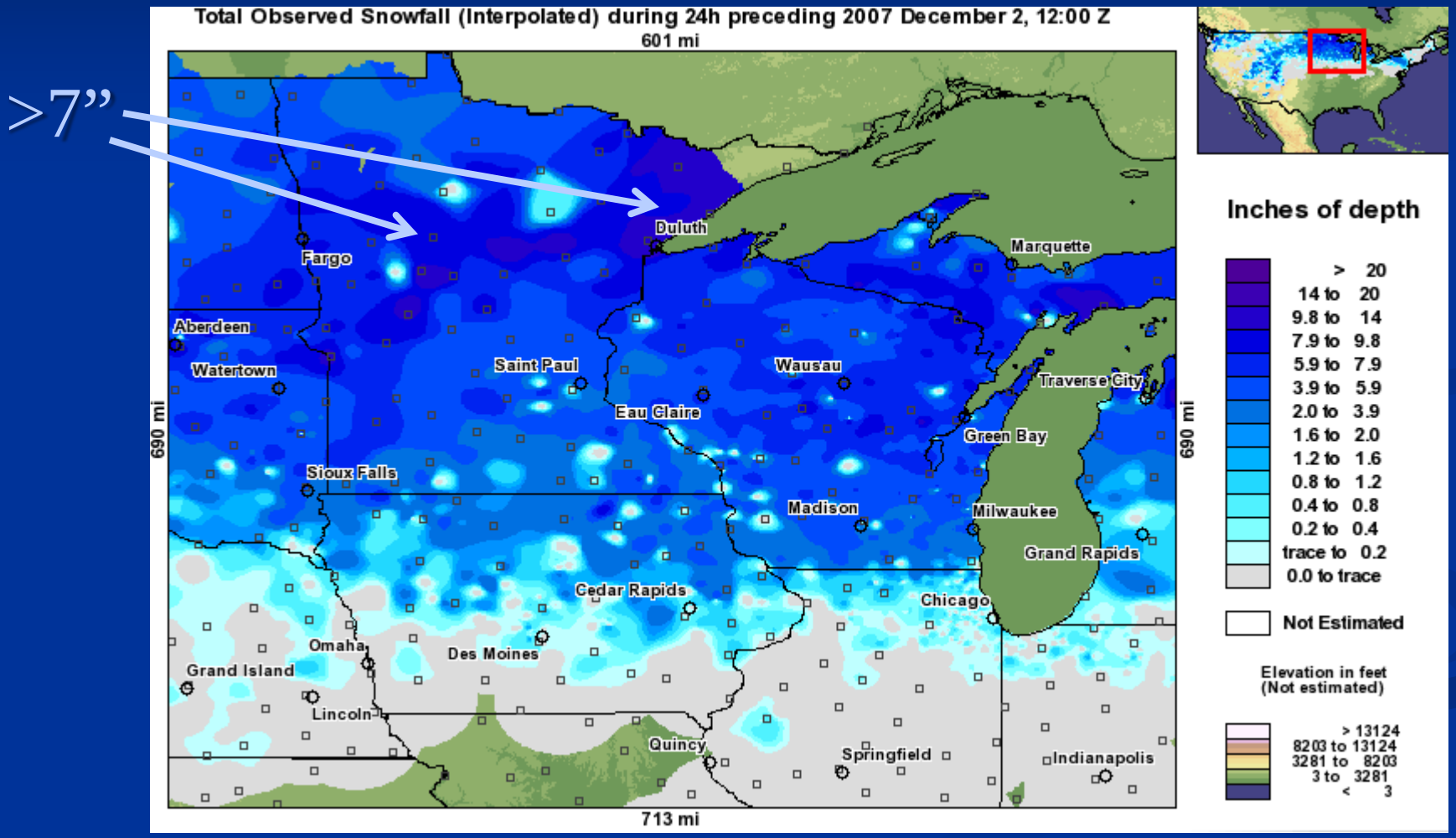
December 1 2007

- 5-7 hours of freezing rain in IA and IL.
  - In Des Moines: United Express with 44 people on board slid off taxiway. Airport closed 7 hours.
- 3-5 hours of sleet in southern/central WI and southern MN.
- Heavy snow northern MN, northern WI.

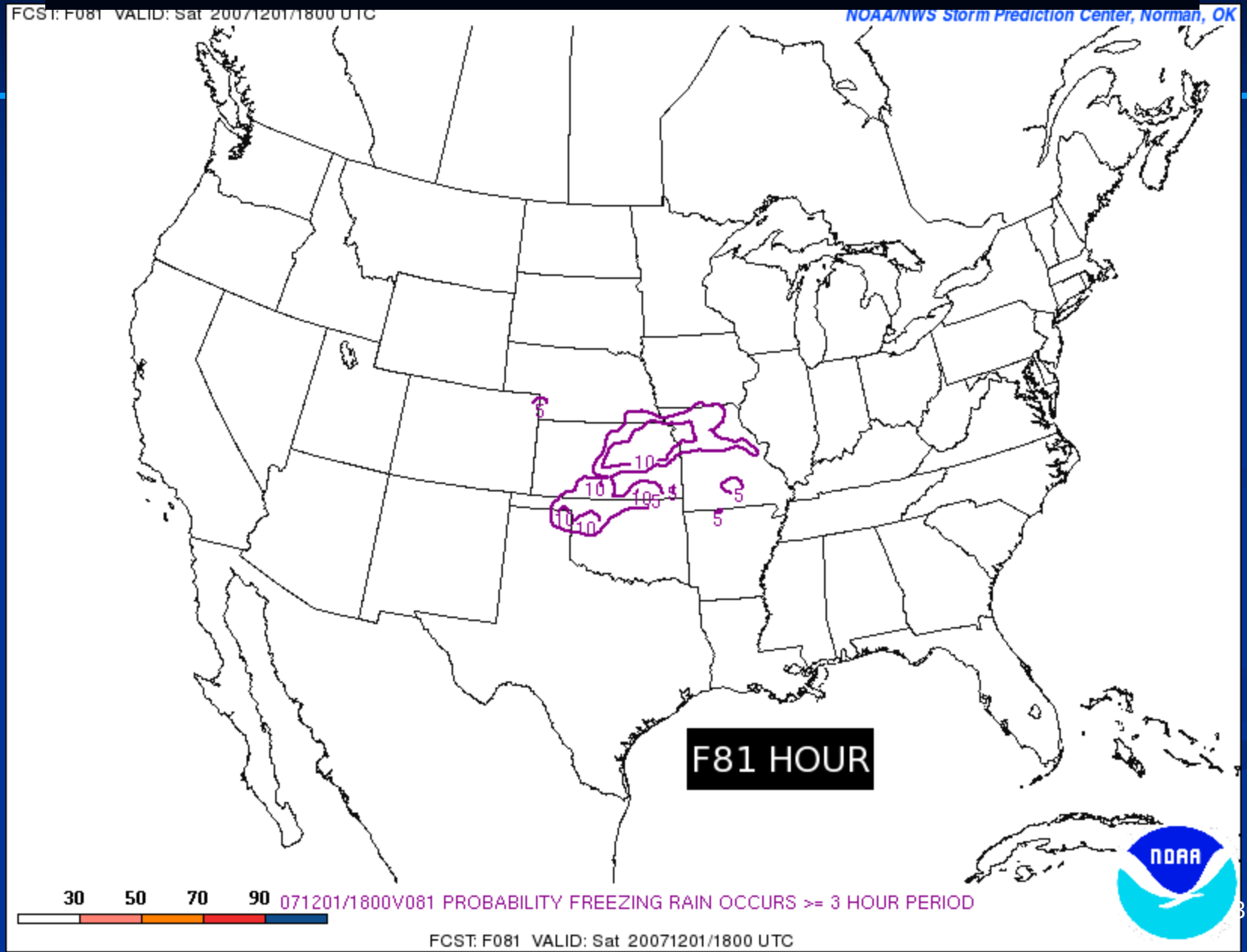
December 1 2007



December 1 2007

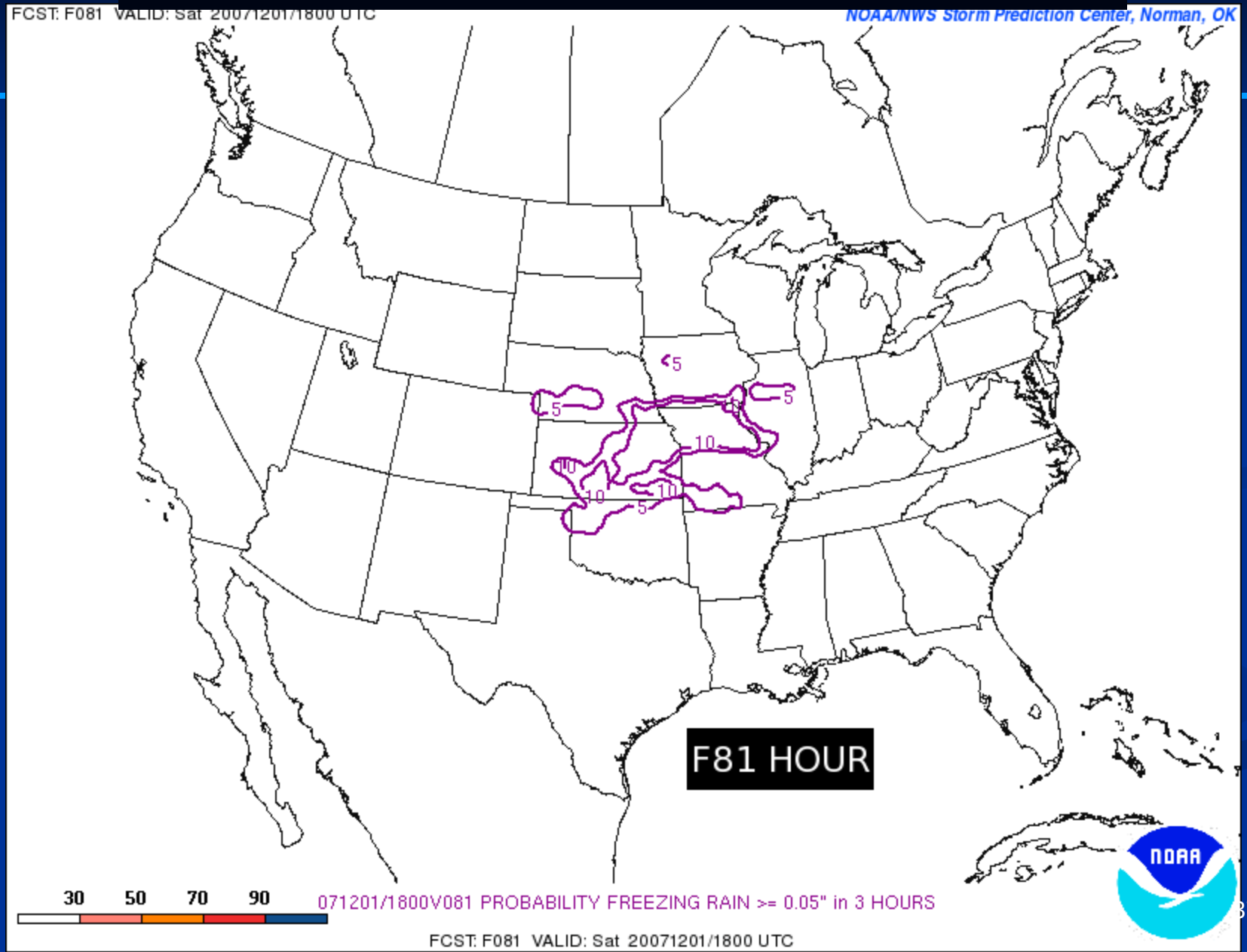


SREF Probability of Measurable FZRA Lasting 3+ Hours SAT 18Z



SREF Probability FZRA > 0.05” in Last 3 Hours

SAT 18Z



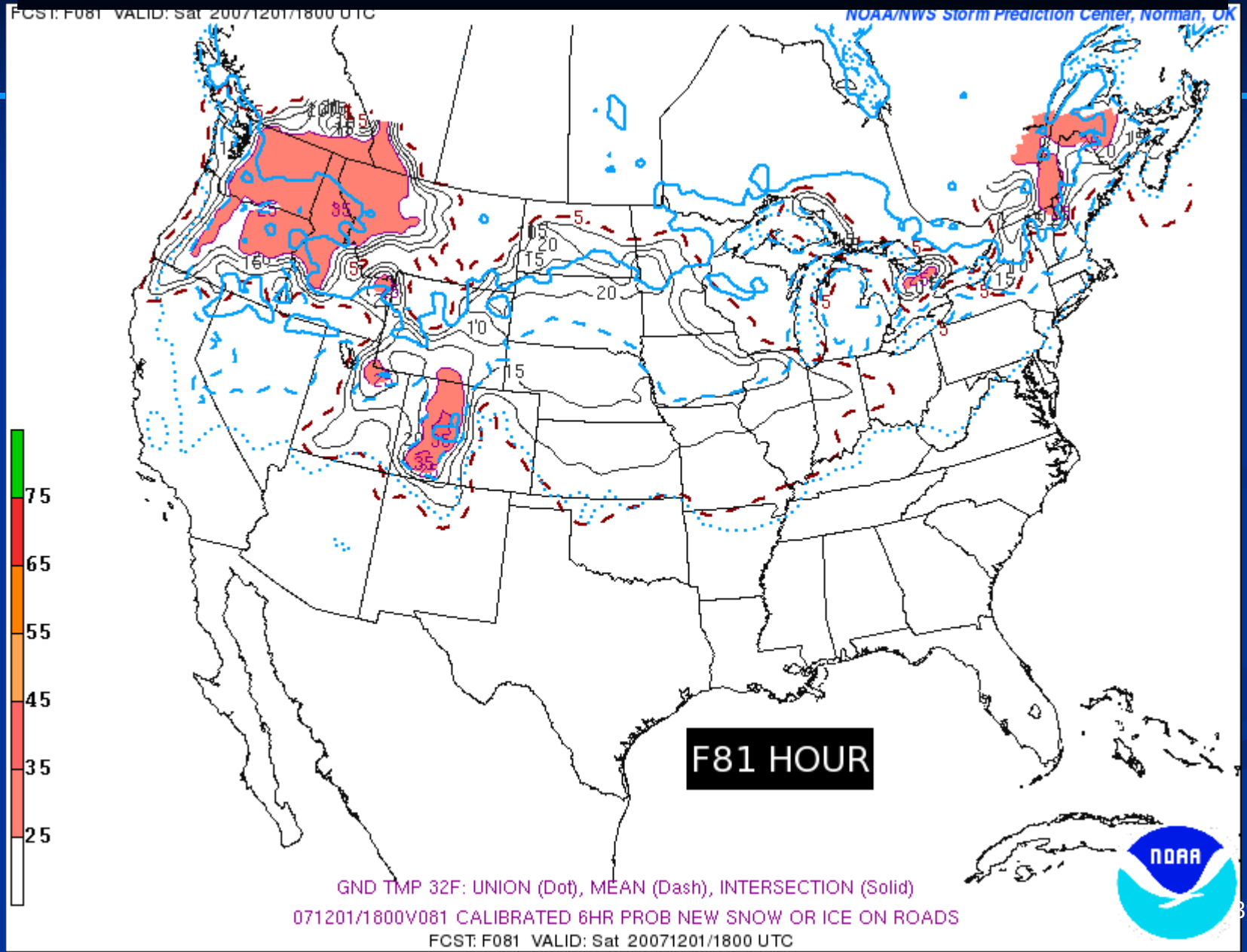
SREF Probability New Snow or Ice on Roads – Last 6 hours SAT 18Z

Road Snow/Ice Probabilities Use:

1. SREF Precipitation-type algorithms (FZRA, PL, SN)
2. SREF Radiation Parameters
   - Snowmelt parameterization (RSAE)– Evaluates fluxes to determine if 3” of snow melts over a 3h period.
   - Boundary-layer Temperature
   - Ground Temperature
   - Surface Net Radiation Flux
3. Calibration via MADIS road data (e.g., MNDOT)

** Showed skill in Winter 2004-2005, forecast values usually < 50%. (David Bright, SPC)

SREF Probability New Snow or Ice on Roads – Last 6 hours SAT 18Z



KDSM Surface Obs

Sat 09Z – Sun 00Z

13Z
FZRA

21Z
RA

KDSM 010854Z 11009KT 10SM OVC075 M04/M14 A3029 RMK AO2 SLP271 T10441139 58025

KDSM 010954Z 11007KT 10SM OVC070 M04/M13 A3027 RMK AO2 SLP264 T10441133

KDSM 011054Z 11012KT 10SM OVC065 M04/M13 A3023 RMK AO2 SLP249 T10391133

KDSM 011230Z 10013G20KT 9SM -FZRA BKN020 OVC050 M04/M09 A3018

KDSM 011254Z 11012G20KT 9SM -FZRA BKN020 OVC044 M04/M09 A3016 RMK AO2 SLP226 PLB08E278SNE23FZRAB23 P0002 T10441089

KDSM 011427Z 11013G23KT 2 1/2SM -FZRAPL BR OVC018 M04/M06 A3010

KDSM 011547Z 12013G21KT 1 1/4SM -PL BR FEW007 OVC012 M03/M05 A3002

KDSM 011638Z 12014G23KT 1 3/4SM R31/6000VP6000FT PL BR BKN007 OVC014 M02/M03 A2995

KDSM 011710Z 13017G27KT 4SM -FZRA BR OVC007 M01/M02 A2990

KDSM 011836Z 14013G22KT 2 1/2SM -FZRA BR BKN009 OVC014 00/M01 A2981

KDSM 011951Z 14018G26KT 2 1/2SM R31/5000VP6000FT FZRA BR BKN009 OVC016 01/M01 A2972 RMK AO2 PK WND 14026/1949 RAB1856E50FZRAE1856B50 CIG 007V013 PRESFR P0010

KDSM 012038Z 15015G20KT **7SM -RA** BKN007 OVC010 01/M01 A2968 KDSM 012129Z 15017G22KT 6SM -RA BR OVC010 01/00 A2964 RMK AO2 PK WND 16030/2110 CIG 006V013 P0001

KDSM 012154Z 15017G24KT 7SM OVC010 02/00 A2962 RMK AO2 PK WND 16030/2110 RAE48 CIG 007V014 SLP040 P0002 T00170000

KDSM 012326Z 15016KT 6SM -RA BR BKN009 OVC014 02/01 A2960

KLSE Surface Obs

Sat 16Z – Sun 04Z

16Z +SN

3.2” Snow

19Z PL

1-2” Ice Pellets

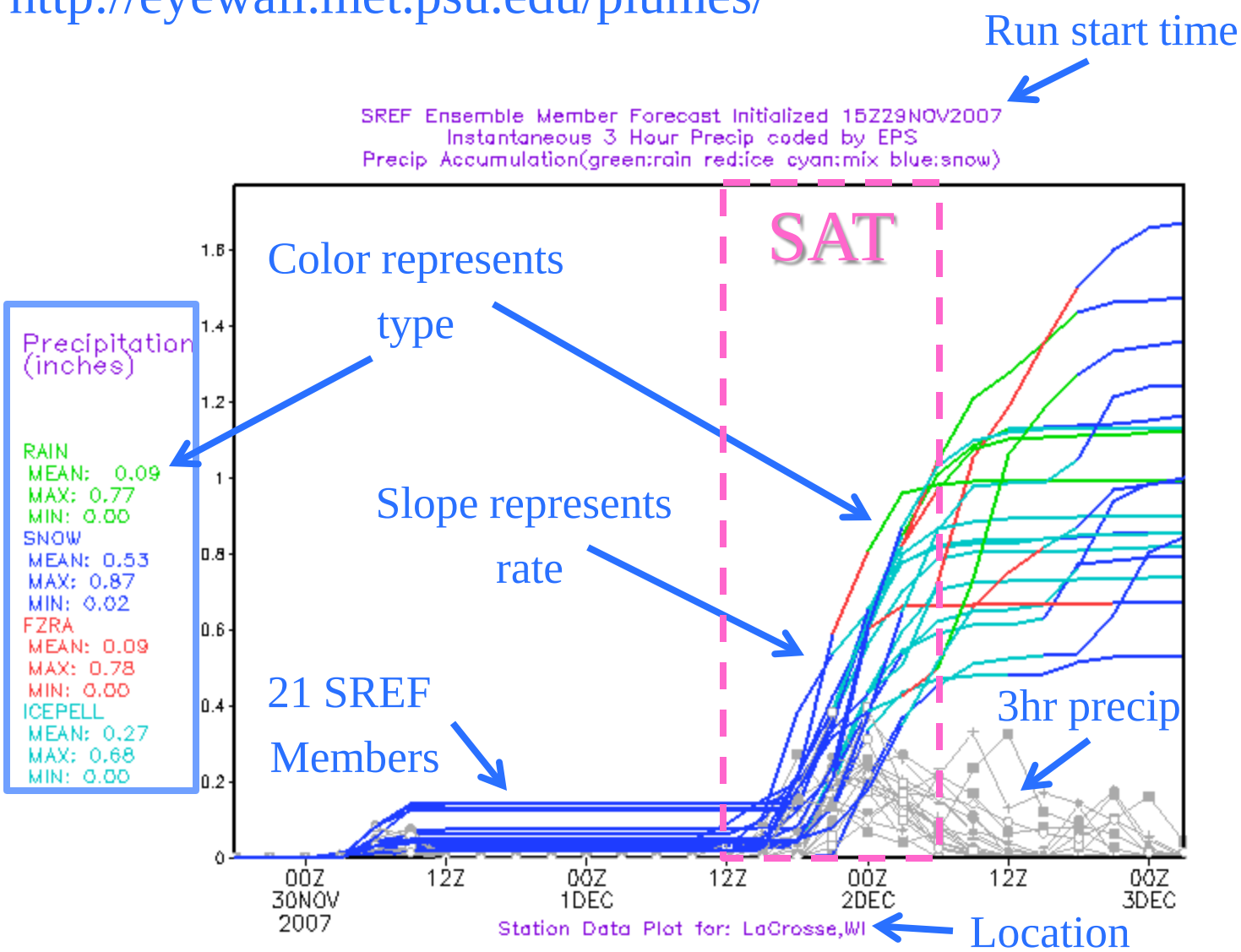
00Z -FZRA

0.10” Ice Accumulation

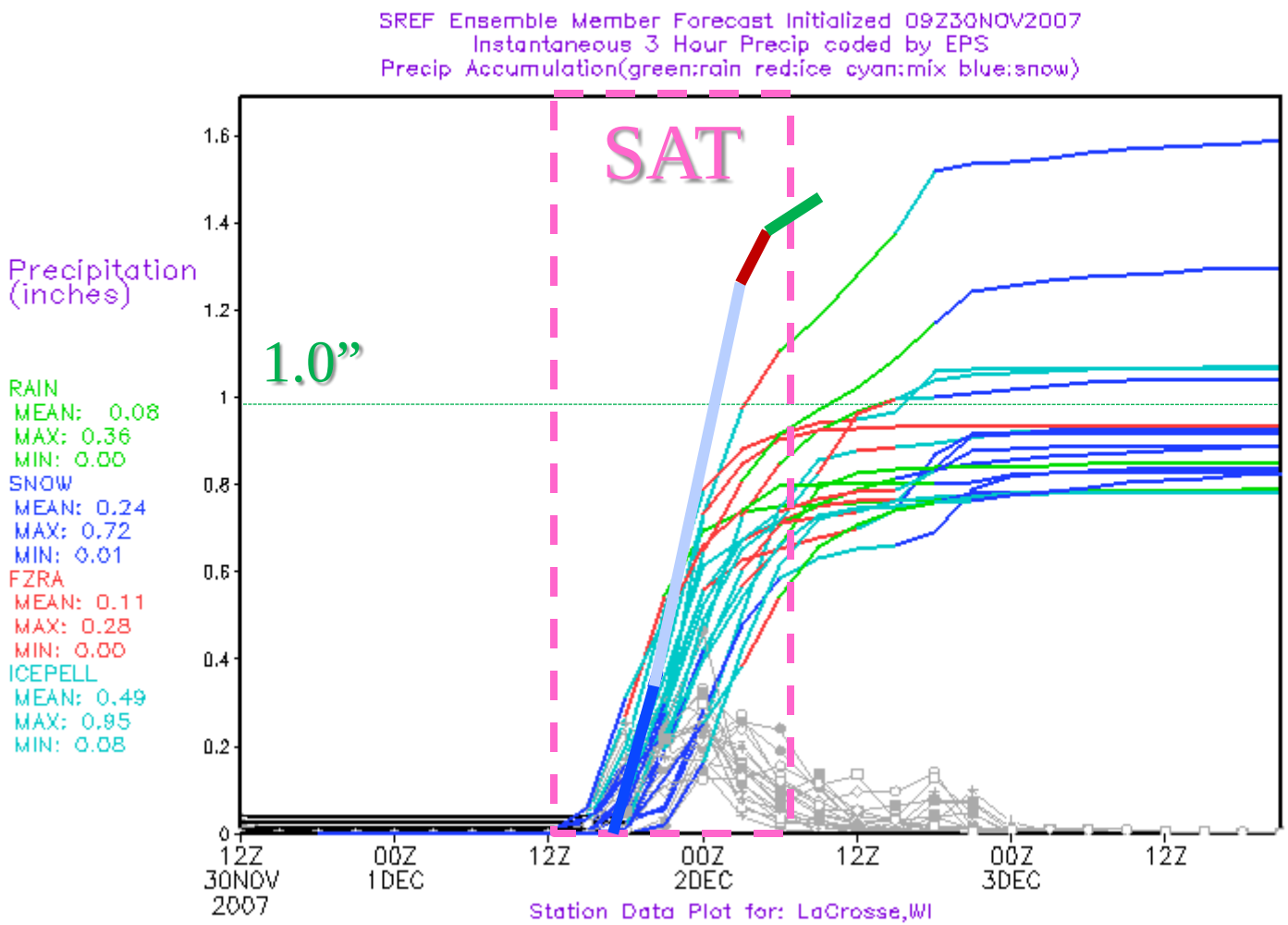
04Z -RA

SREF Plume Forecasts
KLSE: 15Z THU SREF

http://eyewall.met.psu.edu/plumes/



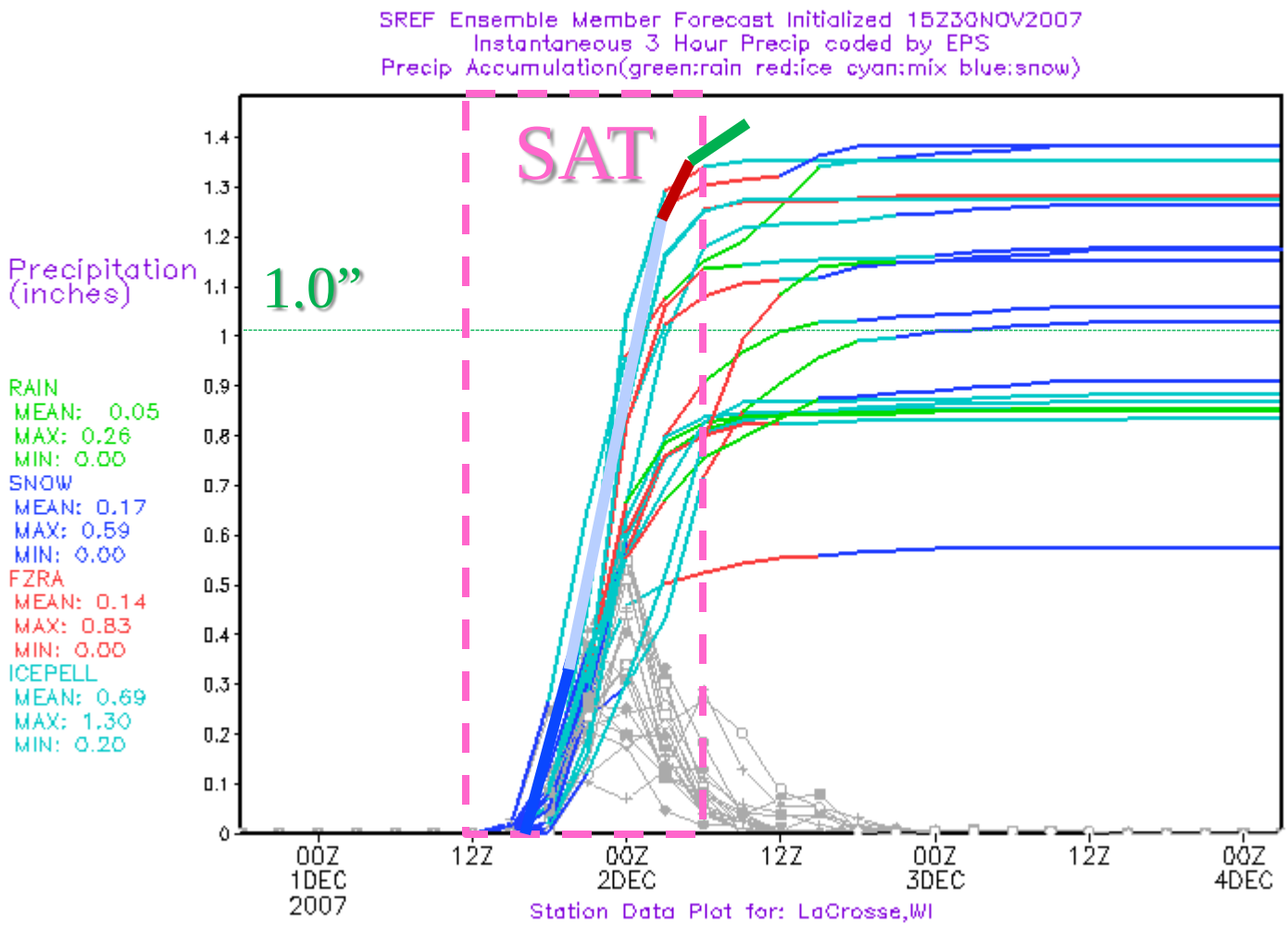
SREF Plume Forecasts
KLSE: 09Z FRI SREF
Data in Forecasters Hand: 11 am



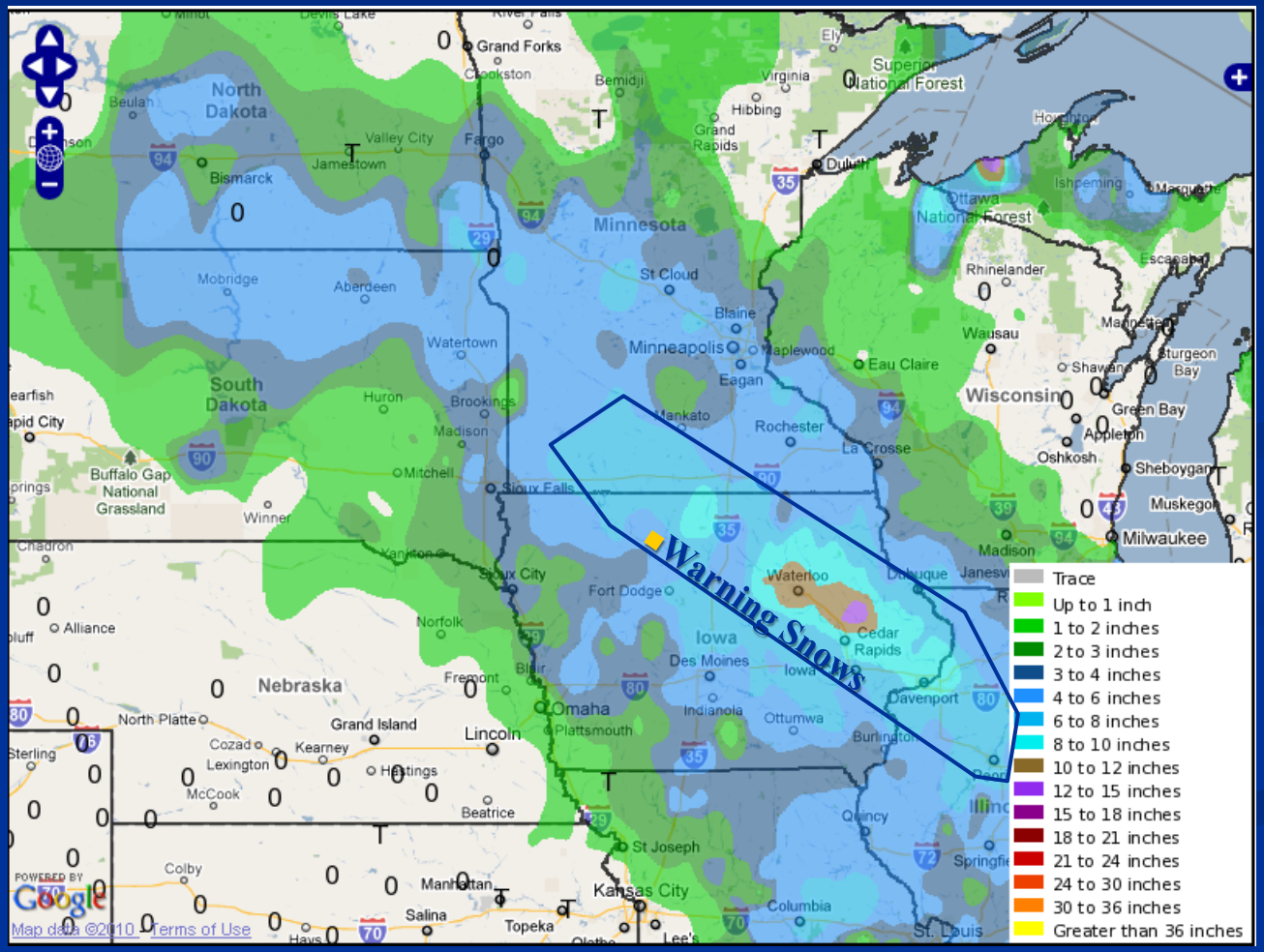
SREF Plume Forecasts

KLSE: 15Z FRI SREF

Data in Forecasters Hand: 4-5 pm

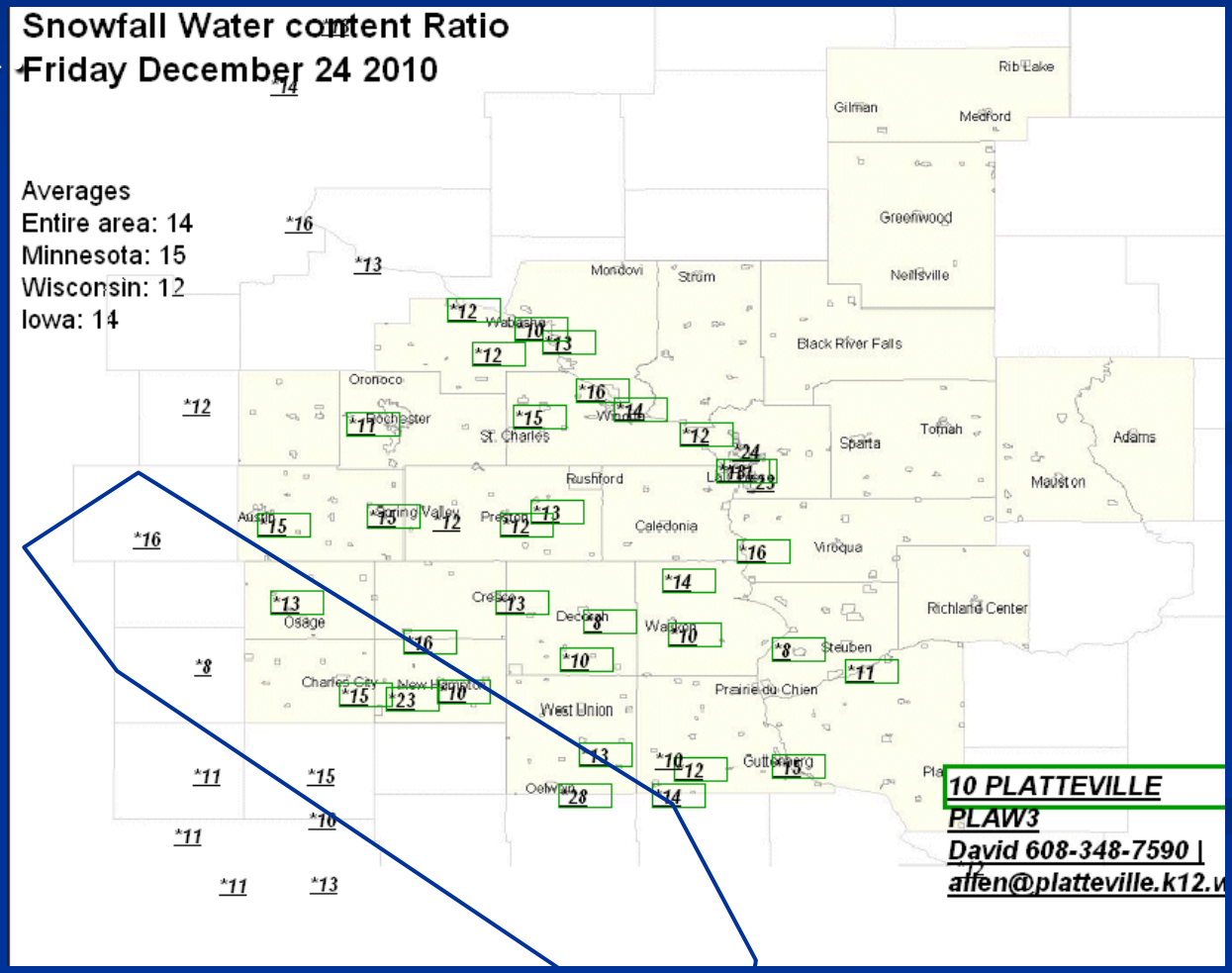


Dec 23-24 2010 Snow Total



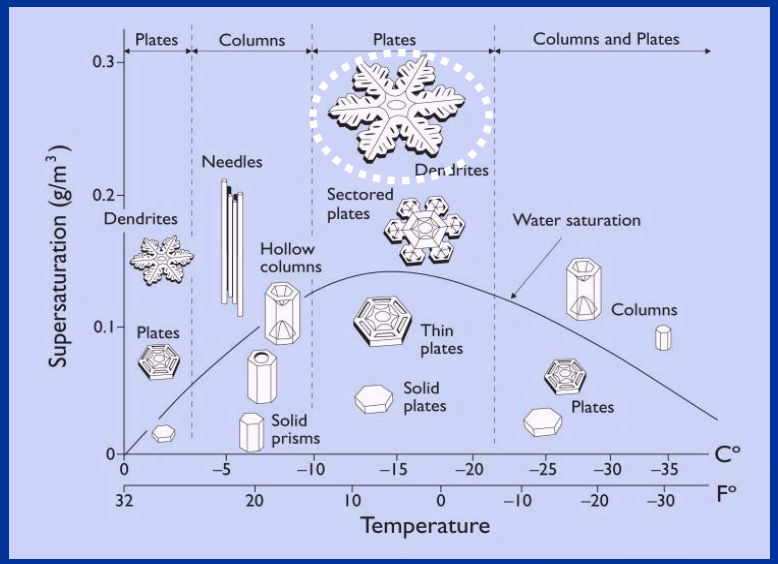
Dec 23-24 2010 Snow Ratios

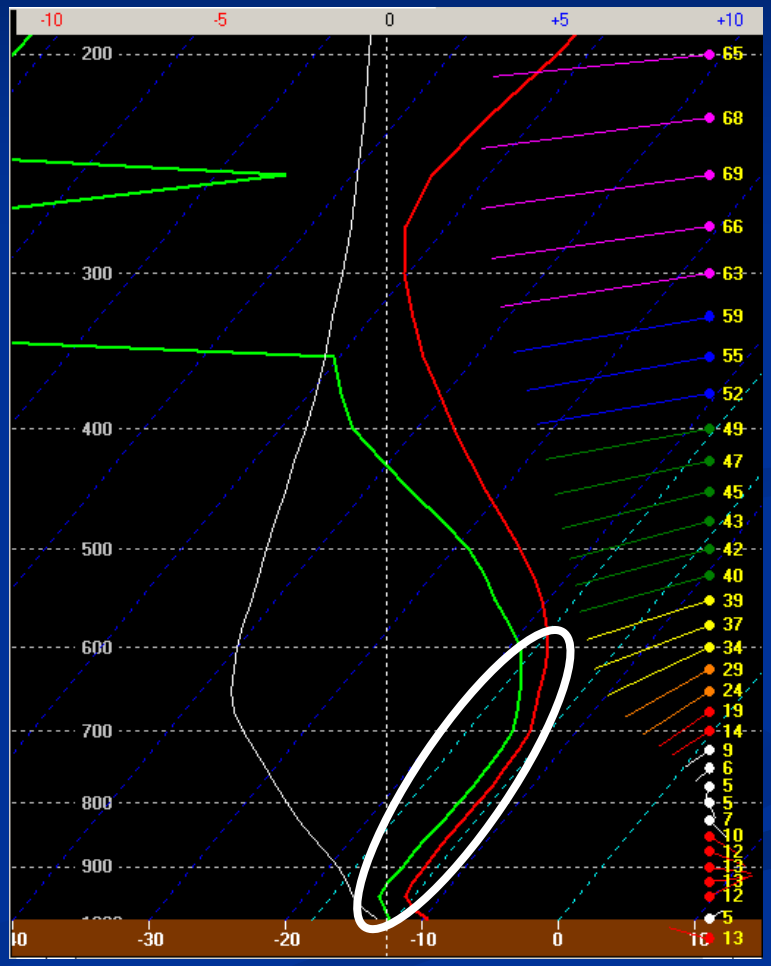
- Mostly 13-16:1 ratios, with some values over 20:1



Composite Sounding: Max Snowfall Time

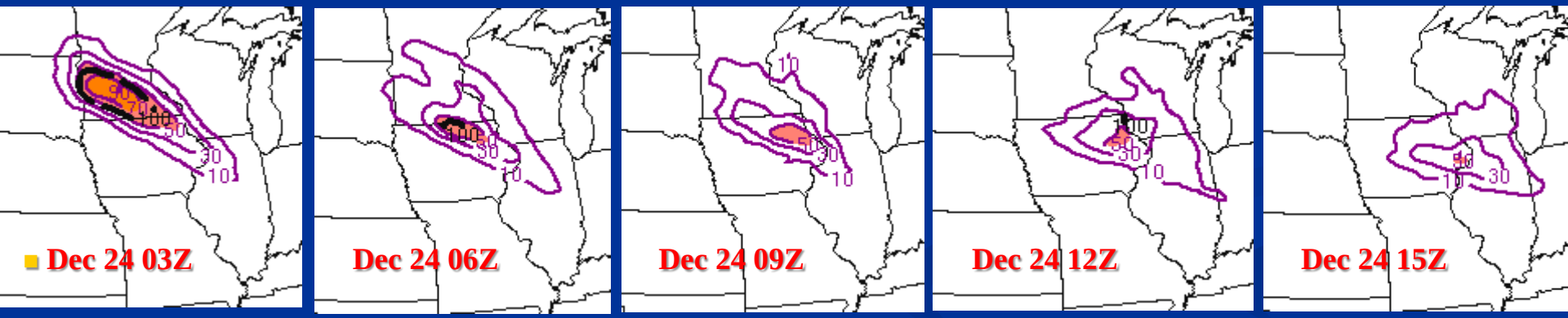
- Layer between 925-600mb nearly saturated and completely within stellar dendrite zone!





23.03Z SREF: Prob Dendrite Layer > 100 MB

- Signals were present that a layer of deeper dendritic crystal growth would be present over the SWRN forecast area from about Dec 24th 06Z to 12Z.



SREF Matrix

StnID: kauw Model: sref Run: 20121205/1500 Using Car Snow Amount Tool (Cobb) v5.7

Date/Hour SREF Members: Probability of Cobb Precipitating Type Total Members: 22 (of 22) Ver:1.0

Date/Hour	Dry	SNOW	SNPL	PL	FZMIX	FZRA	FZDZ	RA/DZ	OTHER	SRat
121205/1600Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121205/1700Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121205/1800Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121205/1900Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121205/2000Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121205/2100Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121205/2200Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121205/2300Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121206/0000Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121206/0100Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121206/0200Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121206/0300Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121206/0400Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121206/0500Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121206/0600Z	100%	0%	0%	0%	0%	0%	0%	0%	0%	0:1
121206/0700Z	95%	0%	5%	0%	0%	0%	0%	0%	0%	0:1
121206/0800Z	86%	0%	5%	0%	0%	0%	0%	5%	5%	0:1
121206/0900Z	55%	0%	0%	0%	0%	36%	0%	9%	0%	0:1
121206/1000Z	86%	0%	0%	0%	0%	5%	0%	9%	0%	0:1
121206/1100Z	59%	0%	0%	0%	0%	9%	0%	32%	0%	0:1
121206/1200Z	50%	0%	0%	0%	0%	5%	0%	36%	9%	0:1
121206/1300Z	36%	9%	0%	0%	0%	0%	0%	36%	18%	10:1
121206/1400Z	23%	9%	0%	0%	0%	0%	0%	36%	32%	12:1
121206/1500Z	18%	0%	0%	0%	0%	0%	0%	50%	32%	0:1
121206/1600Z	27%	0%	0%	0%	0%	0%	0%	50%	23%	0:1
121206/1700Z	36%	0%	0%	0%	0%	0%	0%	50%	14%	0:1
121206/1800Z	45%	0%	0%	0%	0%	0%	0%	55%	0%	0:1
121206/1900Z	77%	0%	0%	0%	0%	0%	0%	23%	0%	0:1
121206/2000Z	82%	0%	0%	0%	0%	0%	0%	18%	0%	0:1
121206/2100Z	91%	0%	0%	0%	0%	0%	0%	9%	0%	0:1
121206/2200Z	91%	0%	0%	0%	0%	0%	0%	9%	0%	0:1
121206/2300Z	95%	0%	0%	0%	0%	0%	0%	5%	0%	0:1
121207/0000Z	91%	0%	0%	0%	0%	0%	0%	5%	5%	0:1
121207/0100Z	95%	0%	0%	0%	0%	0%	0%	5%	0%	0:1
121207/0200Z	95%	0%	0%	0%	0%	0%	0%	5%	0%	0:1

Items of Interest>

Science and Research>

Bufkit Cobb Output

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La Crosse, WI

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- Education Resources

Bufkit Cobb Precipitation Type

Caribou Snow Amount Tool (via BUFKIT Hourly Output, v5.7, Cobb)

State	City	NAM	GFS	RAP	SREF Mean	SREF Matrix
Wisconsin	La Crosse	klse	klse	klse	klse	klse
	Eau Claire	keau	keau	keau	keau	keau
	Wausau	kauw	kauw	kauw	kauw	kauw
	Necedah	knec		knec	knec	knec
	Blue River	kblr	kblr	kblr	kblr	kblr
	Oshkosh	kosh	kosh	kosh	kosh	kosh
	Sheyboygan	ksbm			ksbm	ksbm
	Rhinelander	krhi	krhi	krhi	krhi	krhi
	Menomonie	kmnm	kmnm	kmnm	kmnm	kmnm
	Green Bay	kgrb	kgrb	kgrb	kgrb	kgrb
	Milwaukee	kmke	kmke	kmke	kmke	kmke
	Madison	kmsn	kmsn	kmsn	kmsn	kmsn
Minnesota	Rochester	krst	krst	krst	krst	krst
	Minneapolis	kmsp	kmsp	kmsp	kmsp	kmsp
	Waseca	kwsc	kwsc	kwsc	kwsc	kwsc
Iowa	Mason City	kmcw	kmcw	kmcw	kmcw	kmcw
	Waterloo	kalo	kalo	kalo	kalo	kalo
	Dubuque	kdbq	kdbq	kdbq	kdbq	kdbq
Illinois	Chicago/OHare	kord	kord	kord	kord	kord
	Chicago/Midway	kmdw	kmdw	kmdw	kmdw	kmdw
	Rockford	krfd	krfd	krfd	krfd	krfd

Using Anomaly and Ensemble Data To Forecast Higher Impact Weather

Dan Baumgardt
NOAA/NWS La Crosse WI

December 2012 Media Seminar