Precipitation in Eastern North Dakota During June and July of 2008, 2010, and 2012

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NORTHERN PLAINS CONVECTIVE STORM SYMPOSIUM

UNIVERSITY OF NORTH DAKOTA

MAY 3, 2016

Objective

Show that the rainfall received during June and July of 2008, 2010, and 2012 (POLCAST field projects) are not outliers for Eastern North Dakota.

Fargo NDAWN station

Courtesy of Dave Delene.

The Big Picture

- Why is precipitation important?
- What are the effects of drought (below average precipitation)?
- Why is important to know if June and July of 2008, 2010, and 2012 are outliers?

Courtesy of Dave Delene.

Motivation

- Agriculture is the number one industry in North Dakota.

Crops	% of U.S. Production
Flax	96%
Canola	90%
Durum	68%
Pinto Beans	65%
Dry edible peas	64%
Navy beans	46%
Spring Wheat	45%
All sunflowers	44%
Confectionary sunflowers	42%

Motivation

- High crop yields rely on sufficient precipitation.
- The lack of precipitation leads to a limited harvest.
- A limited harvest will affect the livelihood of farmers in North Dakota.

Low Rainfall Amount (Drought)

↓

Crop Damage
- The state lost $223 million in 2002*
- The state lost $425 million in 2006*

↓

Smaller Harvests

* (National Conference of State Legislatures)

What is POLCAST

Polarimetric **C**loud **A**nalysis and **S**eeding **T**est

- Field Projects in Eastern North Dakota (Summers of 2006, 2008, 2010, and 2012)
- University of North Dakota C-Band Polarimetric Radar
- Randomly seeded convective clouds (2008, 2010, 2012) = 37 cases

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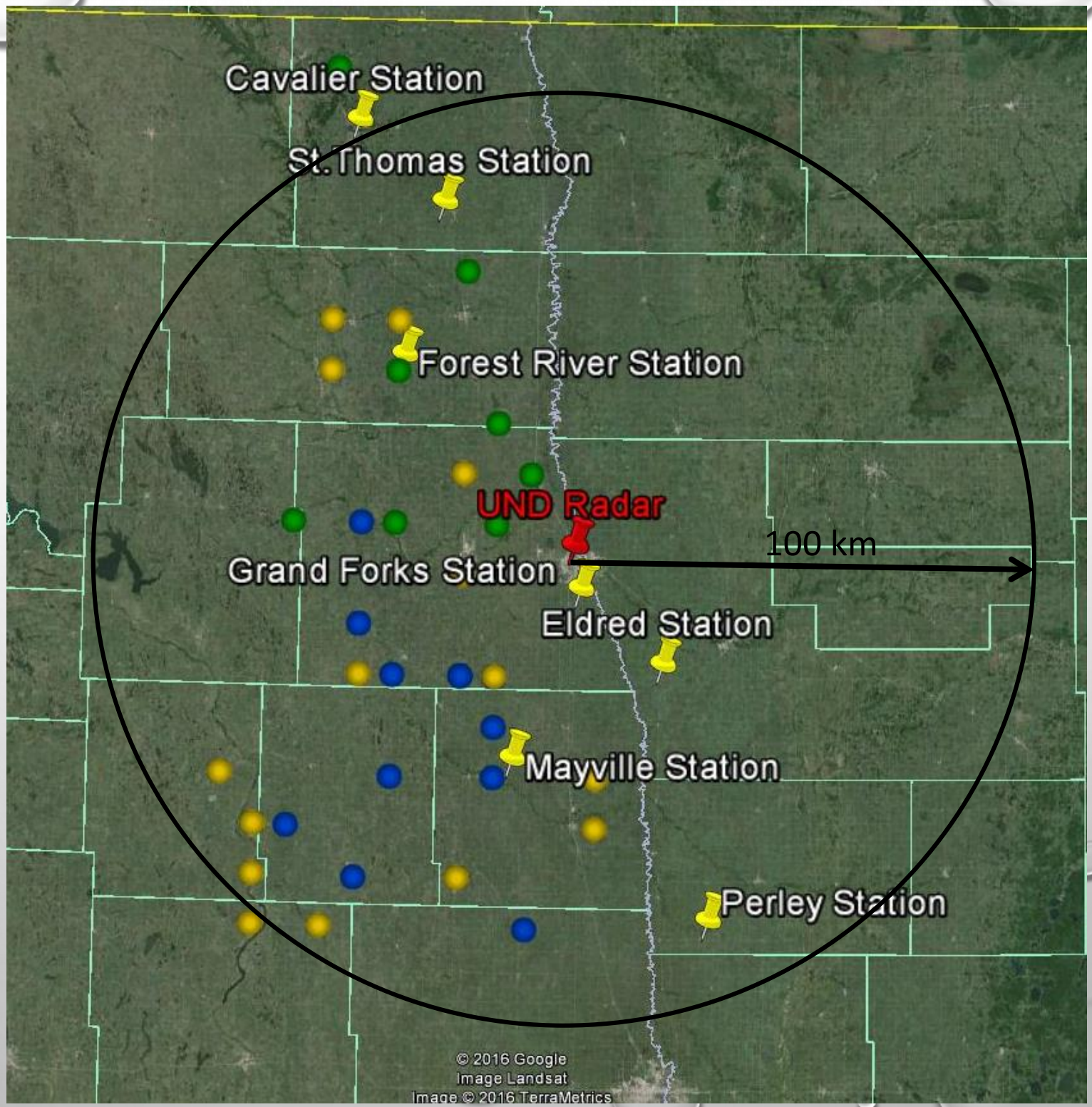
- 2008
- 2010
- 2012



Precipitation Parameters

- Cloud Base Cloud Condensation Nuclei Concentration
- Cloud Base Temperature
- Cloud Base Altitude

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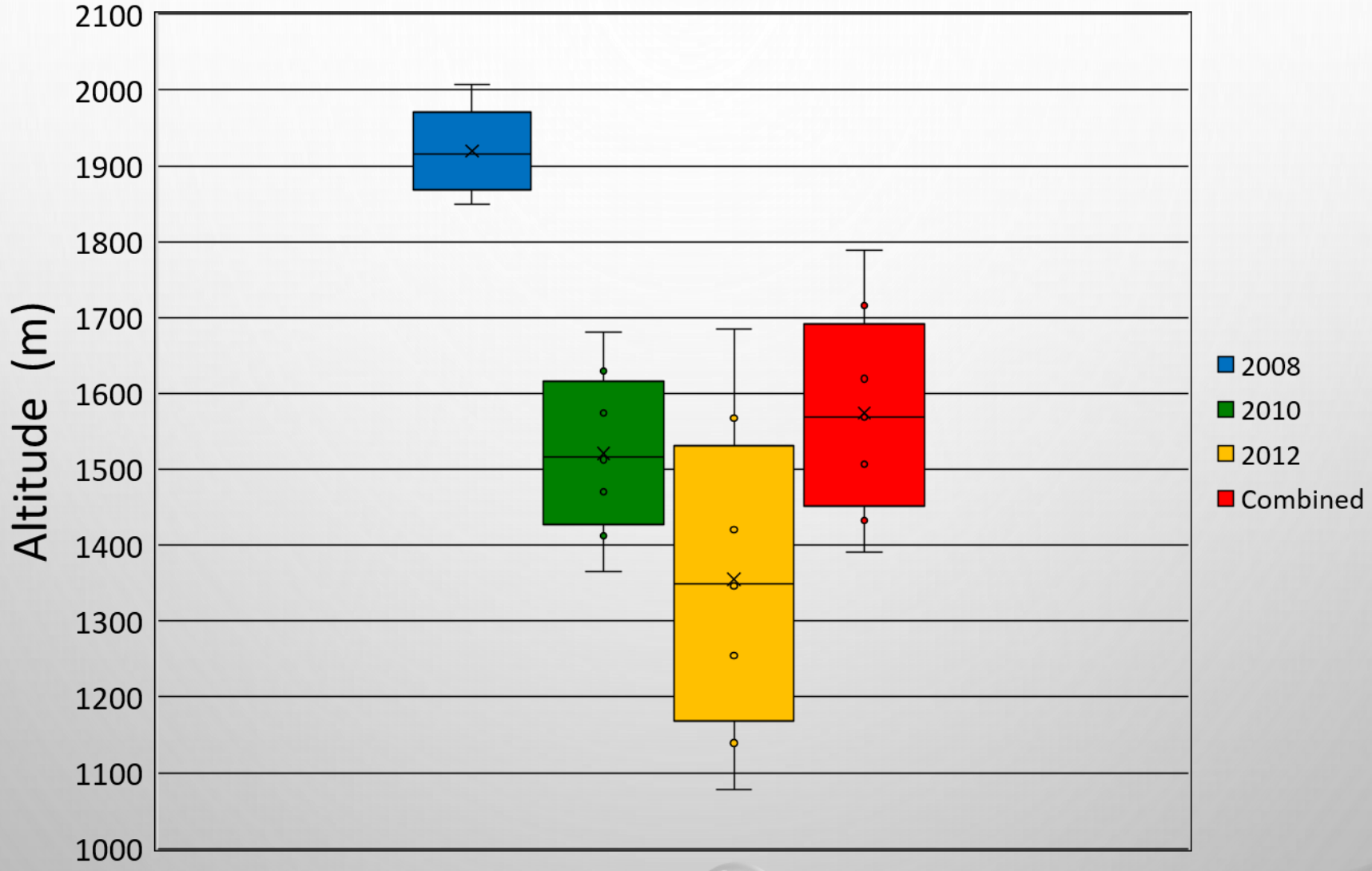
Why are these precipitation parameters important?

How can each be used to determine if precipitation is usual during 2008, 2010, and 2012?

Cloud Base Precipitation Parameters



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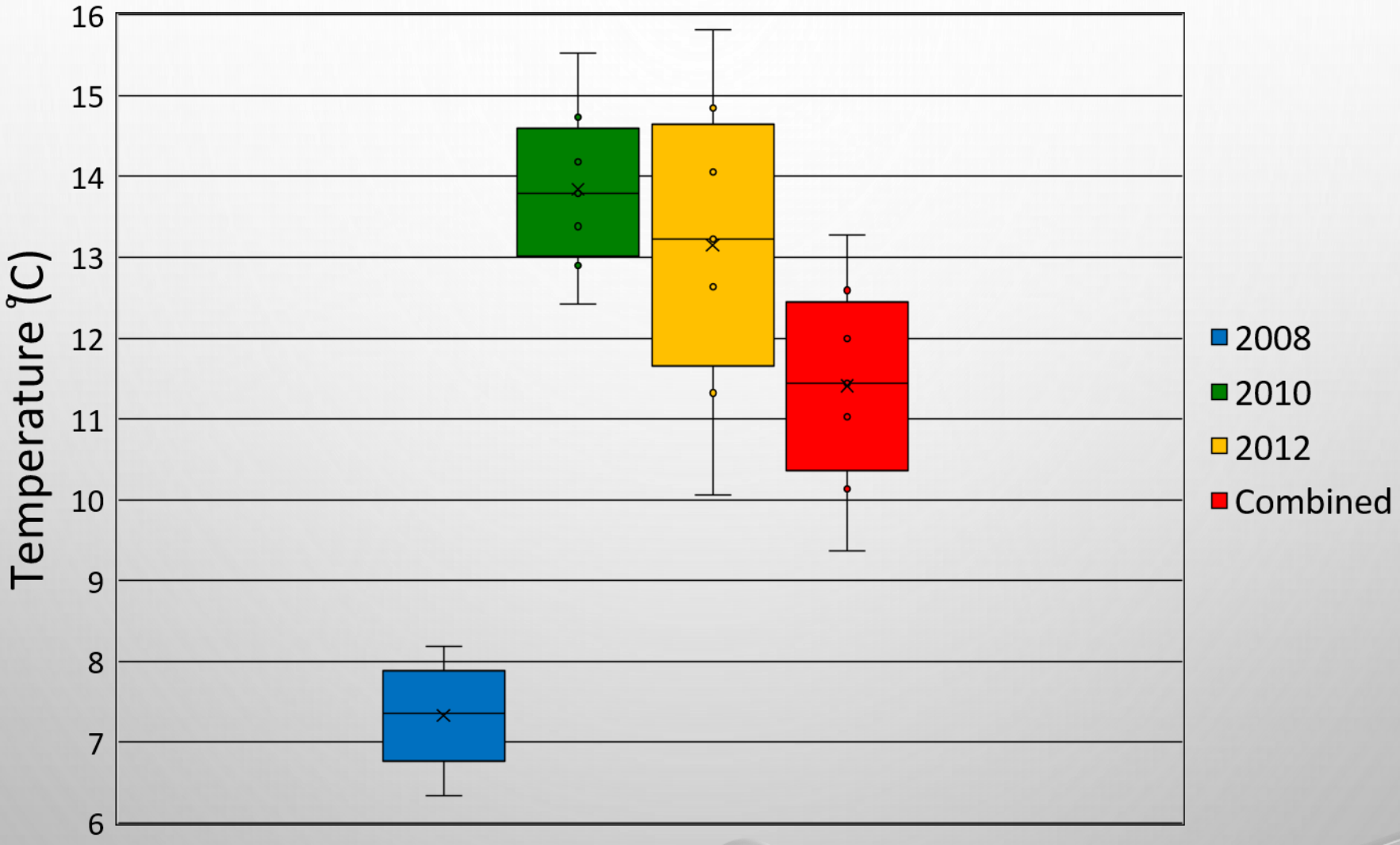

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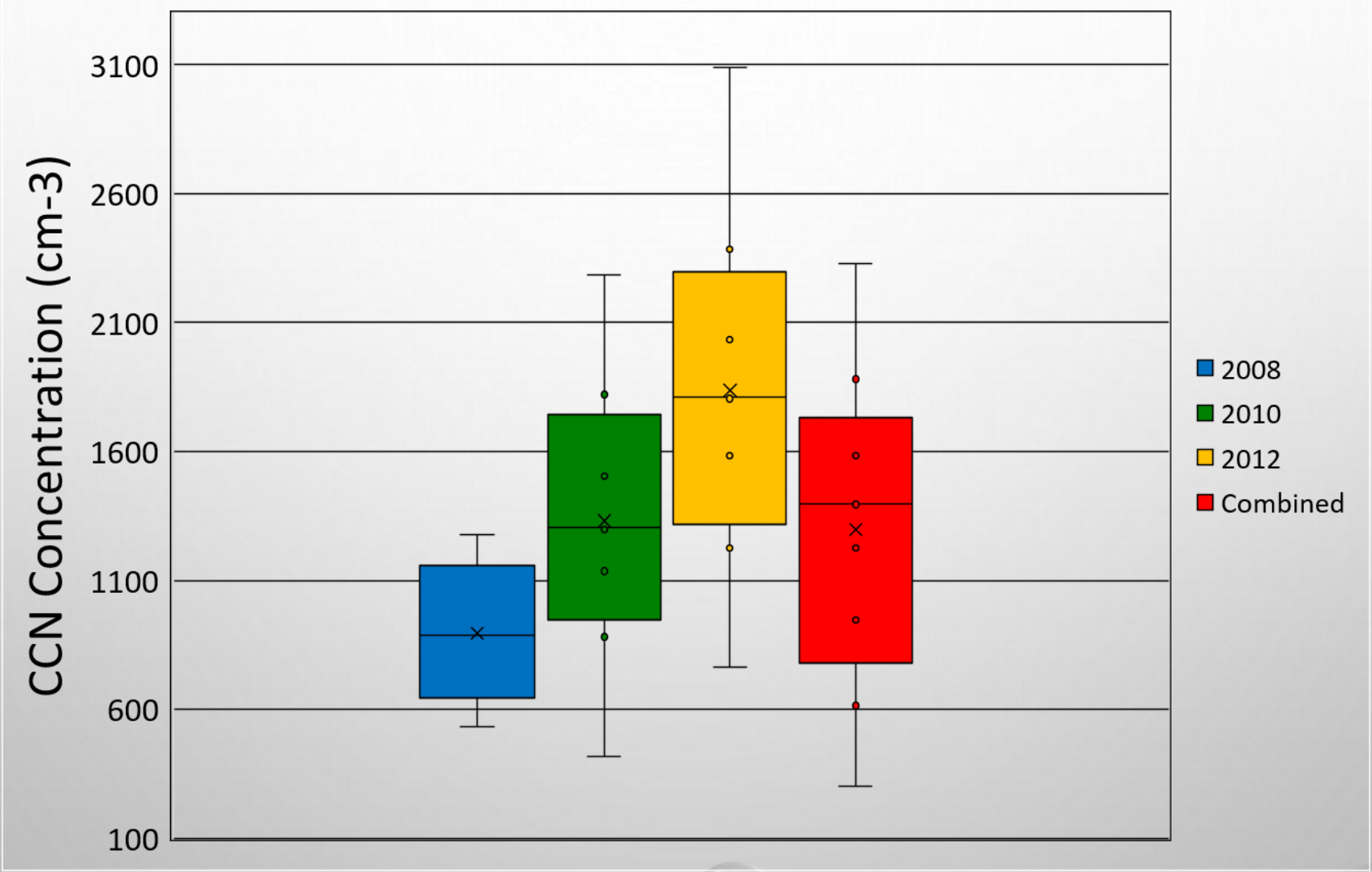

Mann-Whitney U Statistical Test

$$U = n_1 n_2 + \frac{n_1(n_2+1)}{2} - \sum_{i=n_1+1}^{n_2} R_i$$

U=Mann-Whitney U test

n_1 = Sample size one

n_2= Sample size two

R_i = Rank of the sample size

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n_1 = Seeded Cases

n_2= Non-Seeded Cases

R_i = Rank of the sample size

Null hypothesis = distributions of both the seed and non-seed cases are identical/similar.

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U=Mann-Whitney U test

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Property	Test Statistic (U)
Mean Cloud Base CCN Concentration	154.5
Mean Cloud Base Temperature	153.5
Mean Cloud Base Altitude	158.5

Mann-Whitney U Statistical Test

Alpha = 0.05 (two-tailed)

n1\n2	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2							0	0	0	0	1	1	1	1	1	2	2	2	2
3				0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8
4			0	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	14
5		0	1	2	3	5	6	7	8	9	11	12	13	14	15	17	18	19	20
6		1	2	3	5	6	7	10	11	13	14	16	17	19	21	22	24	25	27
7		1	3	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
8	0	2	4	6	7	10	13	15	17	19	22	24	26	29	31	34	36	38	41
9	0	2	4	7	10	12	15	17	20	23	26	28	31	34	37	39	42	45	48
10	0	3	5	8	11	14	17	20	23	26	29	33	36	39	42	45	48	52	55
11	0	3	6	9	13	16	19	23	26	30	33	37	40	44	47	51	55	58	62
12	1	4	7	11	14	18	22	26	29	33	37	41	45	49	53	57	61	65	69
13	1	4	8	12	16	20	24	28	33	37	41	45	50	54	59	63	67	72	76
14	1	5	9	13	17	22	26	31	36	40	45	50	55	59	64	67	74	78	83
15	1	5	10	14	19	24	29	34	39	44	49	54	59	64	70	75	80	85	90
16	1	6	11	15	21	26	31	37	42	47	53	59	64	70	75	81	86	92	98
17	2	6	11	17	22	28	34	39	45	51	57	63	67	75	81	87	93	99	105
18	2	7	12	18	24	30	36	42	48	55	61	67	74	80	86	93	99	106	112
19	2	7	13	19	25	32	38	45	52	58	65	72	78	85	92	99	106	113	119
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63	67	72	76
67	74	78	83
75	80	85	90
81	86	92	98
87	93	99	105
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If U > 106 accept the null hypothesis that the properties are randomly distributed.

NDAWN Stations

MINNESOTA:

ELDRED

PERLEY

NORTH DAKOTA:

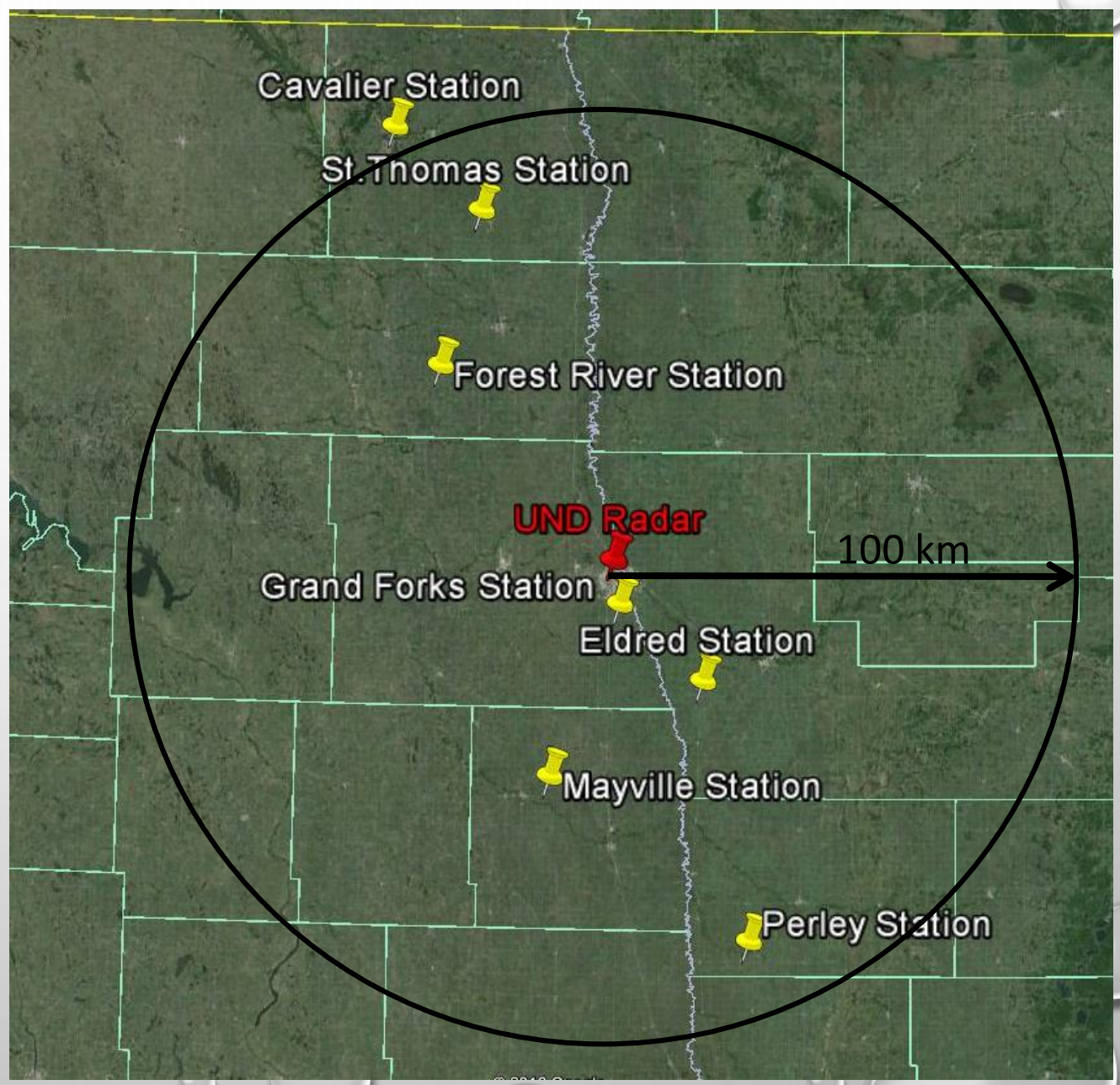
CAVALIER

FOREST RIVER

GRAND FORKS

MAYVILLE

ST. THOMAS

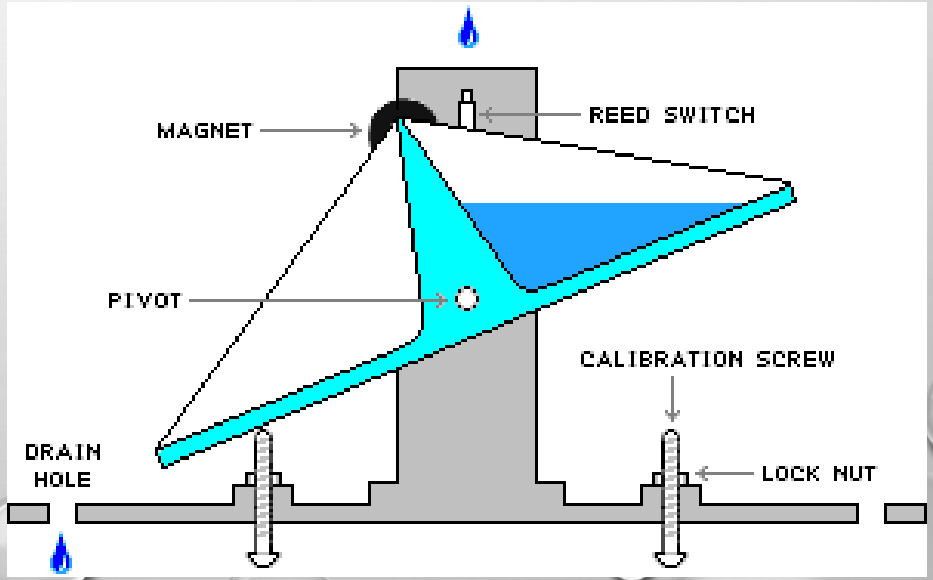


Rain Gauge Measurements

- Each station has a 6 inch diameter tipping bucket rain gauge.

- The rain gauge measures in 0.01 in resolution.

- Increments provided at each station include:
  - Hourly
  - Daily
  - Weekly
  - Monthly



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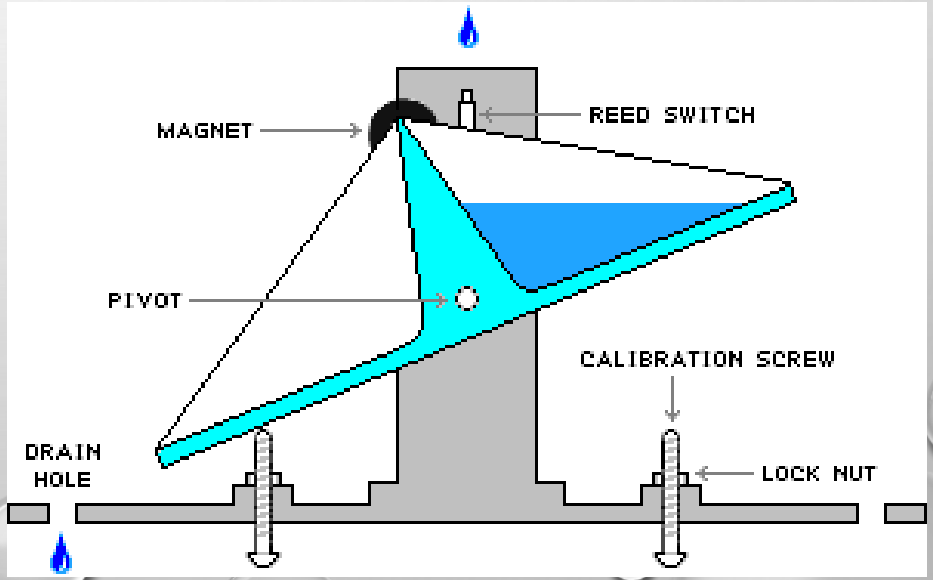
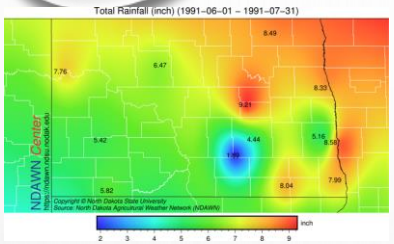
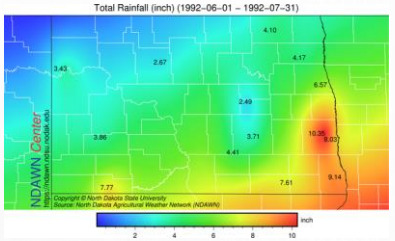
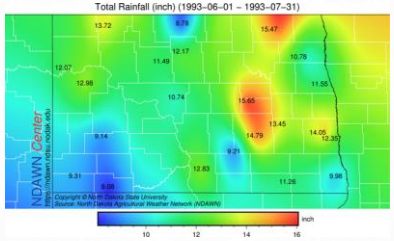
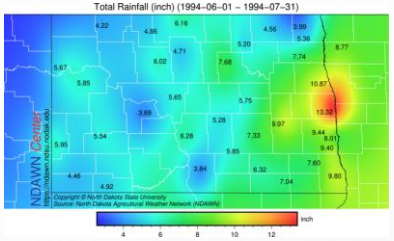


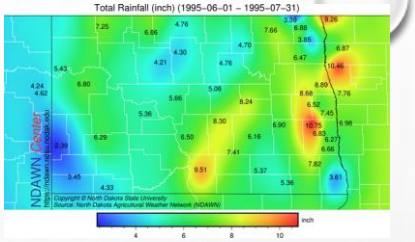
Total Rainfall: 1991 - 2015

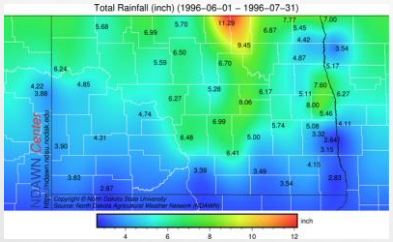


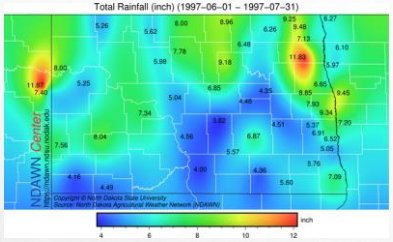


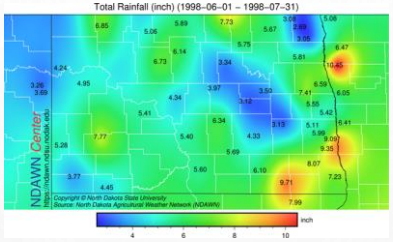


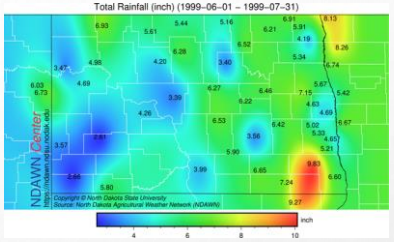


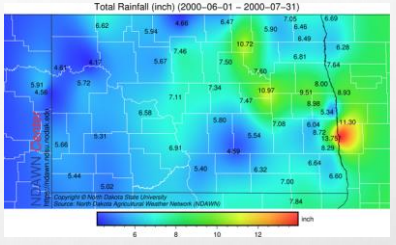


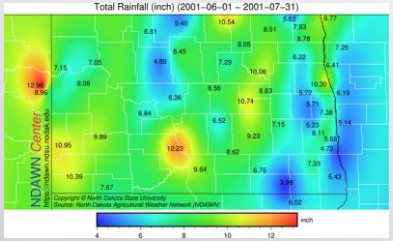


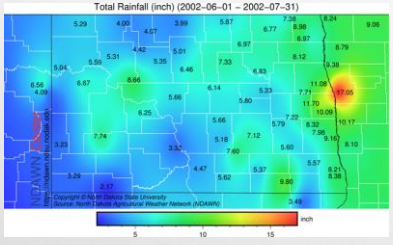


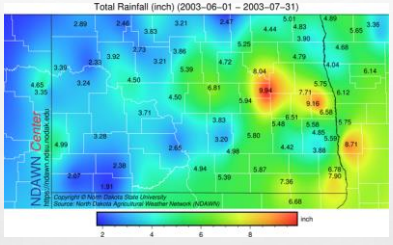


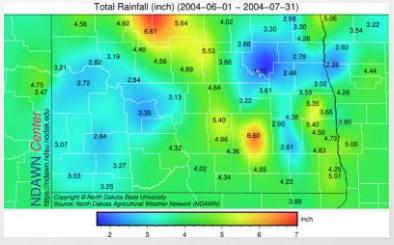


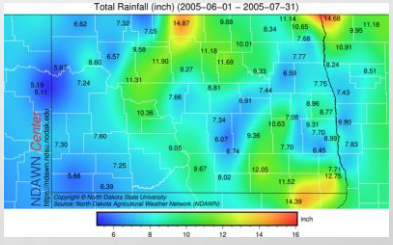


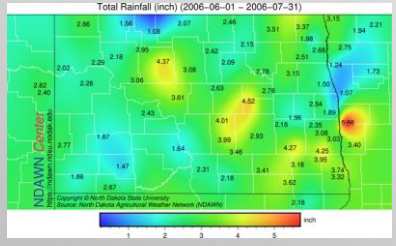


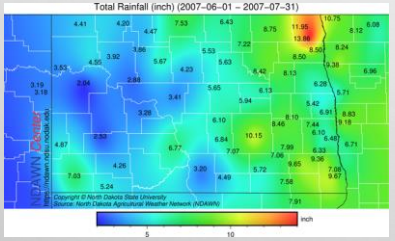


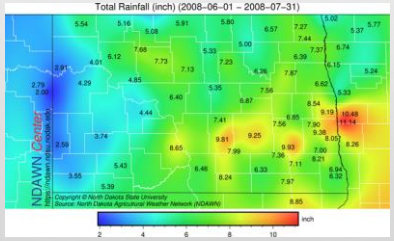


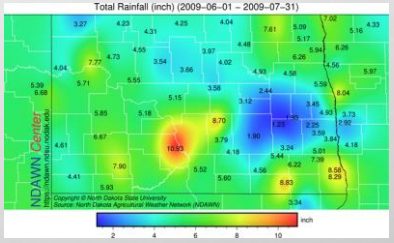


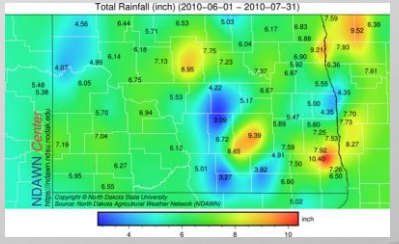


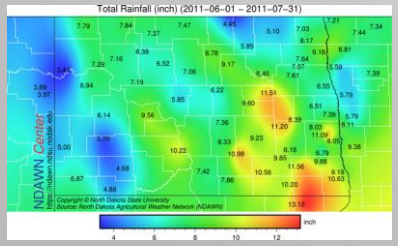


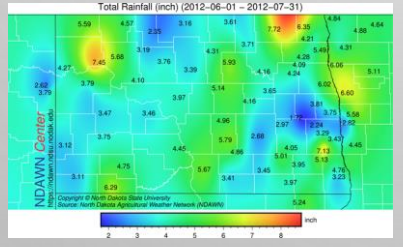


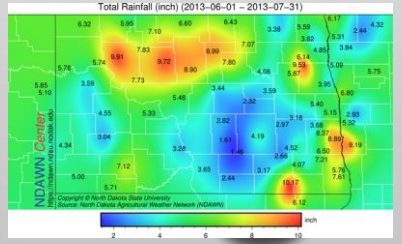


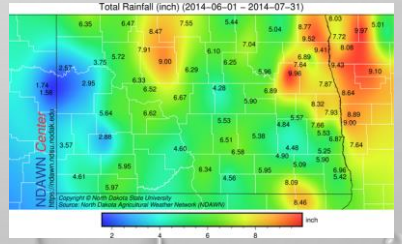


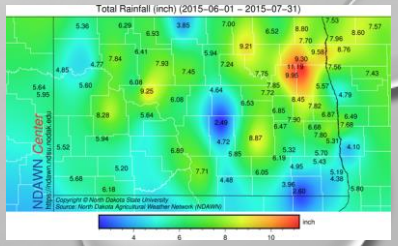




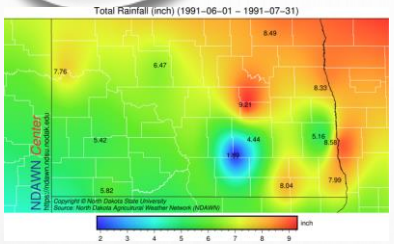


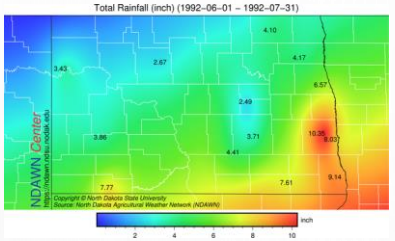


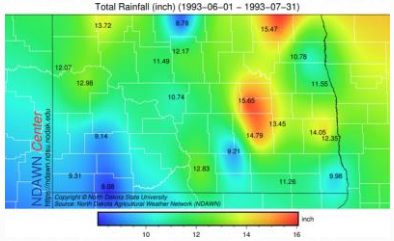


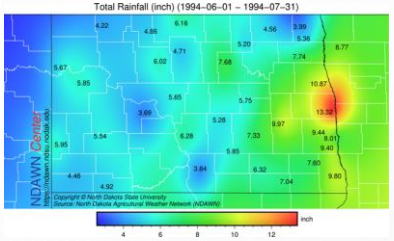


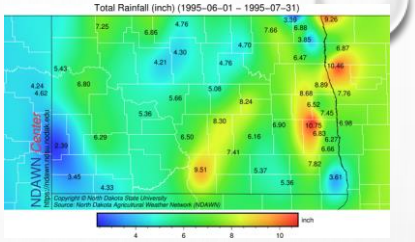
Total Rainfall: 1991 - 2015

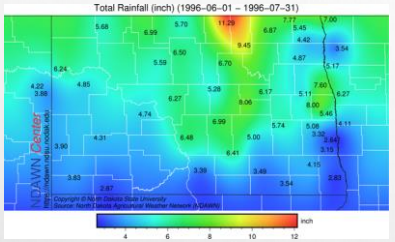


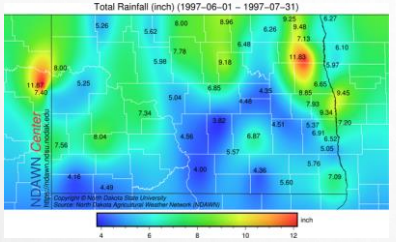


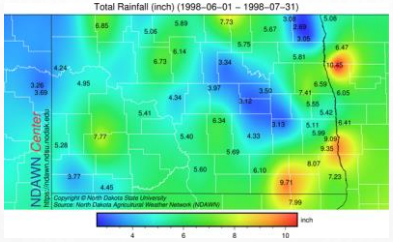


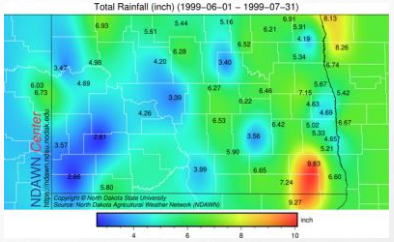


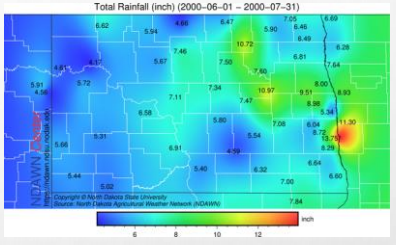


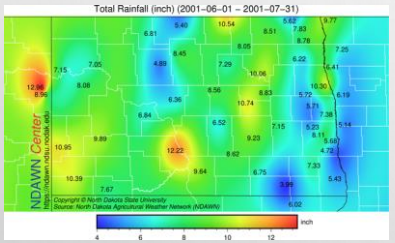


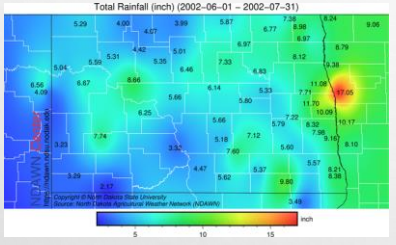


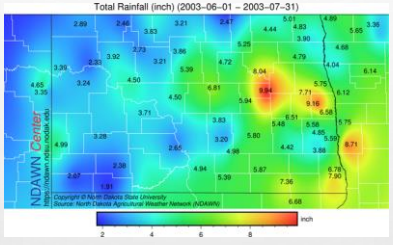


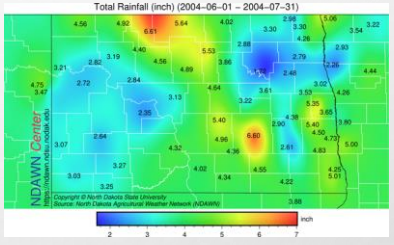


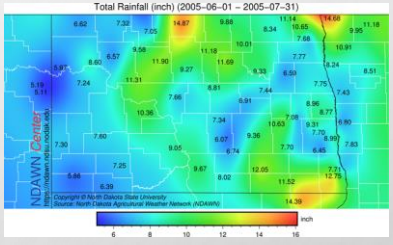


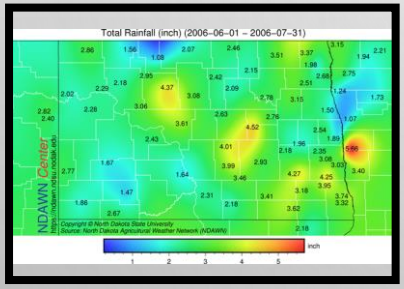


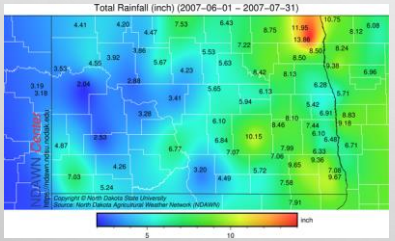


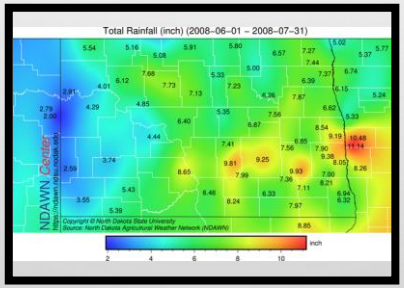


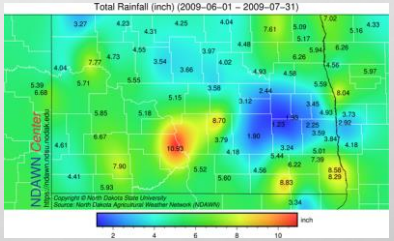


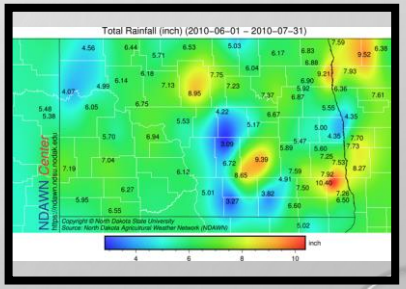


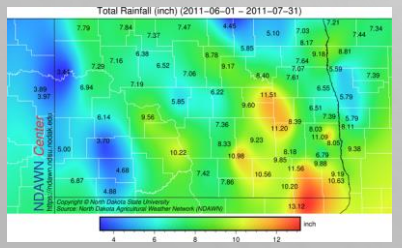


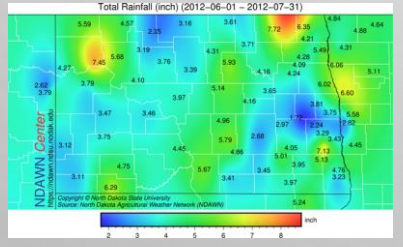


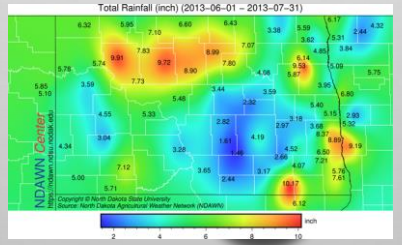


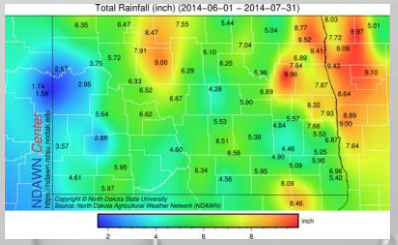


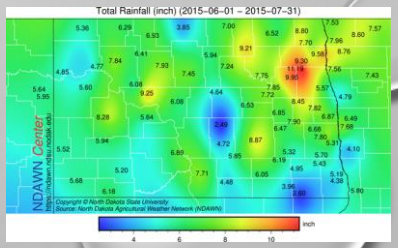












Which Values Were Used??

Downloaded NDAWN data for each station.

↓

Data between 1200-1800 local during April – October.

↓

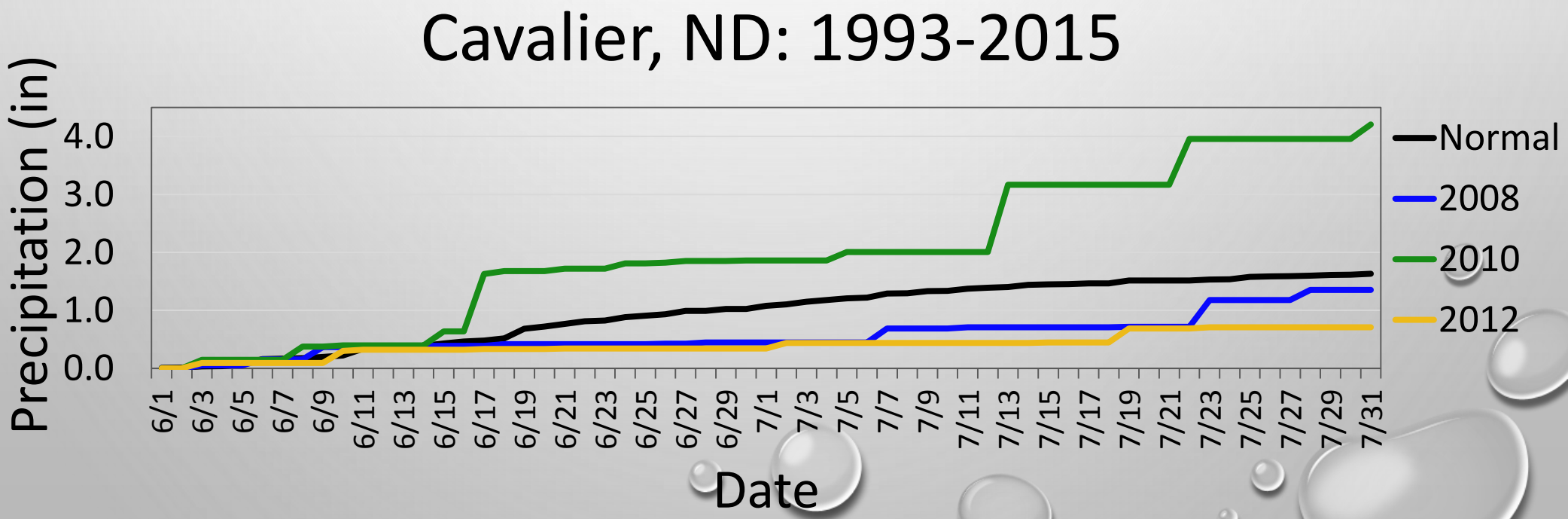
Calculate the cumulative amount over the timespan of rainfall data taken at each station.

Why Cumulative?

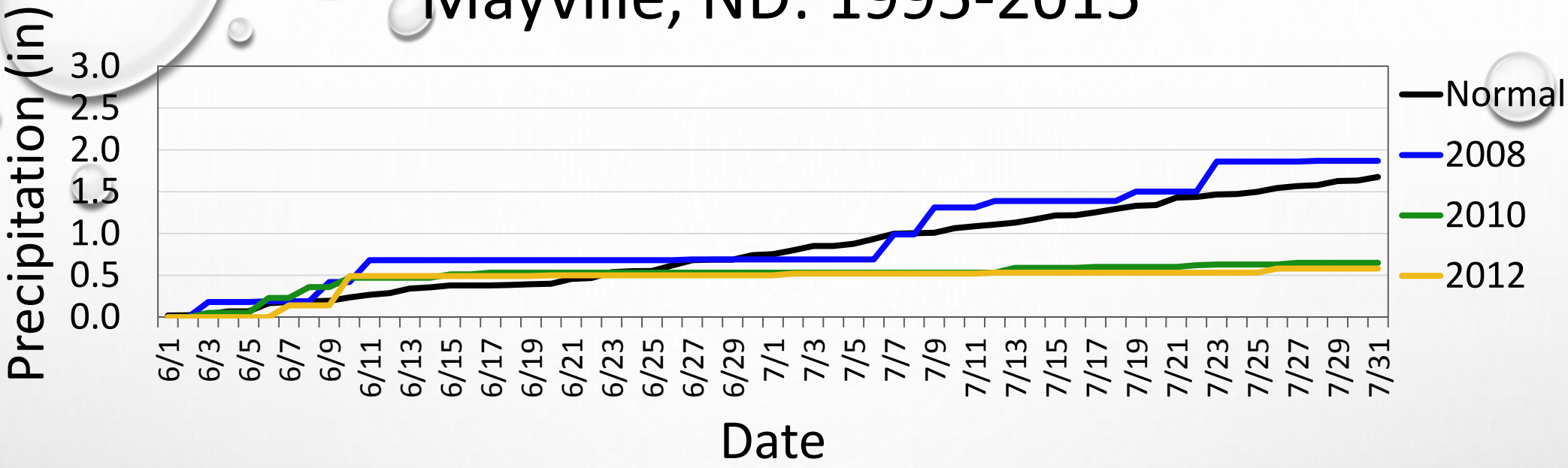
- Using the cumulative plot allows us to compare to the 2008, 2010, and 2012 to the climatology rainfall data.
- If any of the years were outliers, it could be easily seen.

Analysis

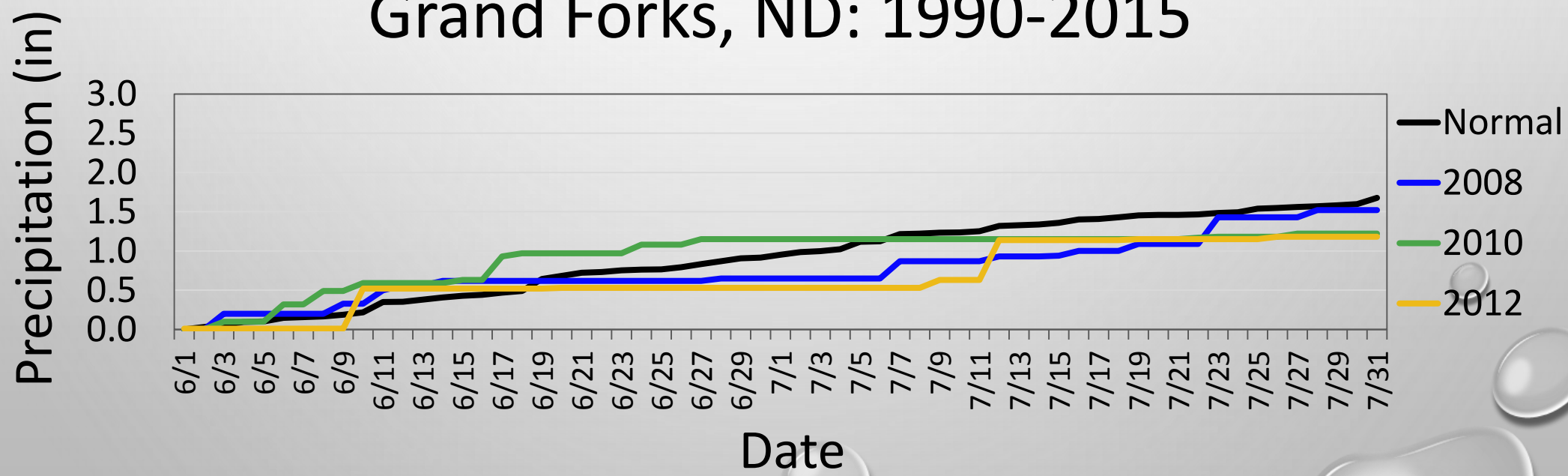
- Cumulative rainfall amount measured at NDAWN stations between 1200-1800 local time.
- 7 stations



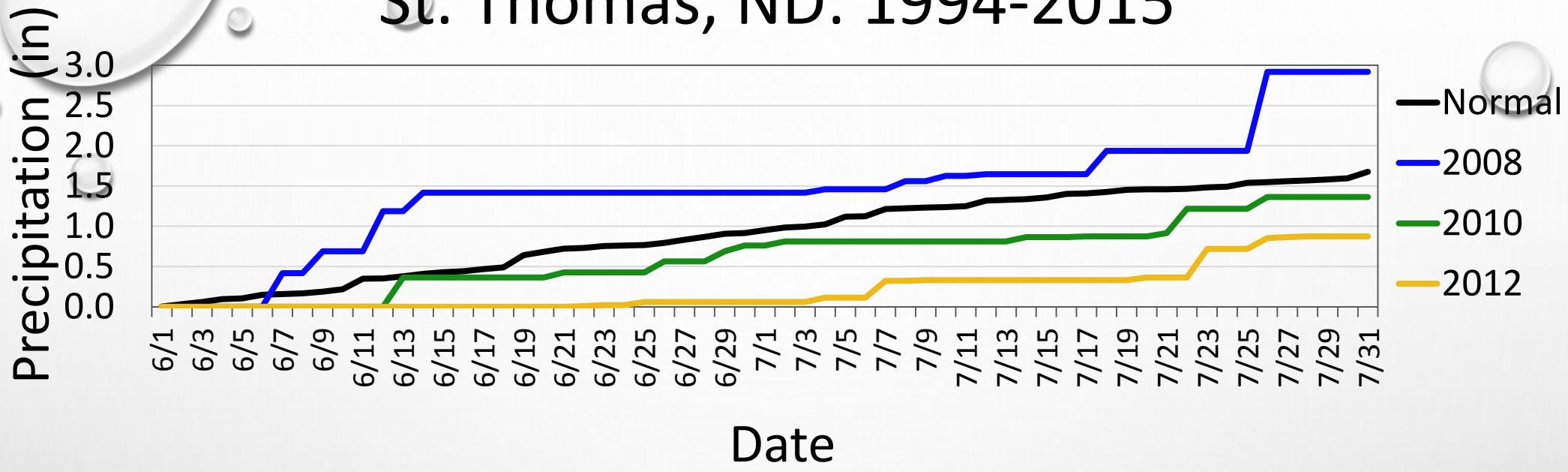
Mayville, ND: 1995-2015



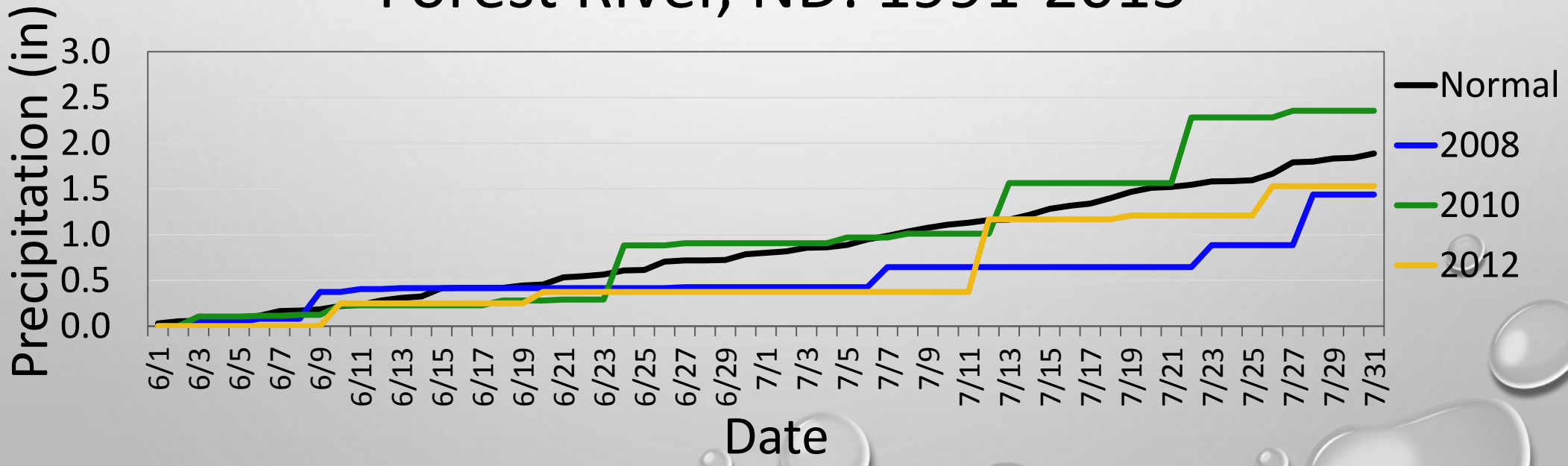
Grand Forks, ND: 1990-2015



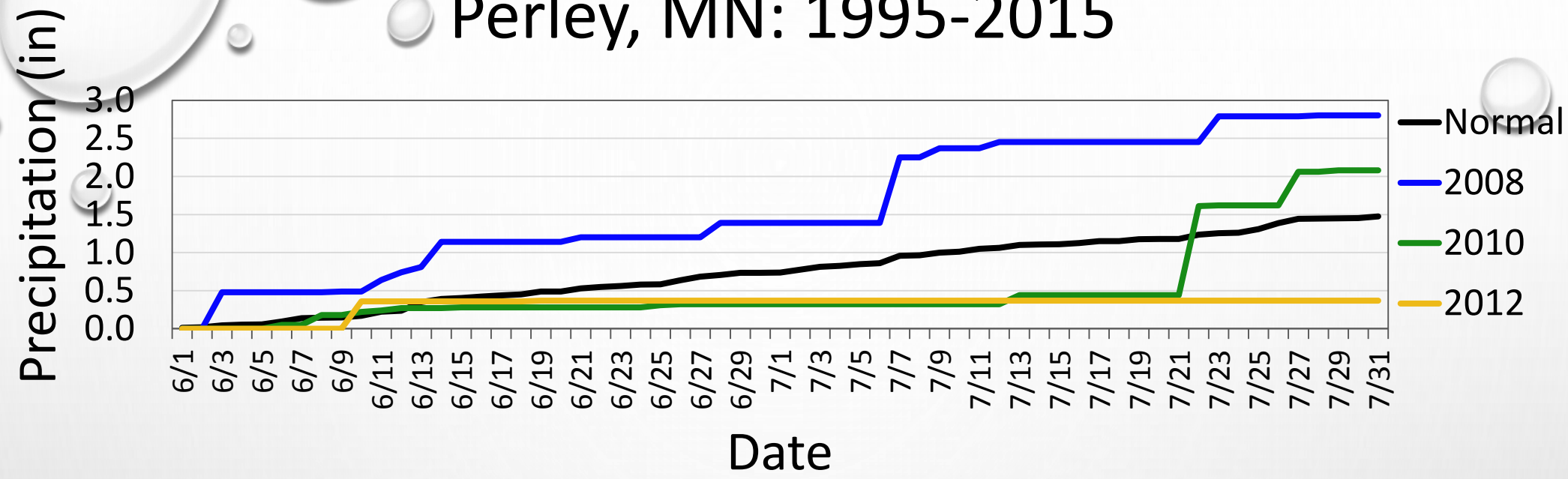
St. Thomas, ND: 1994-2015



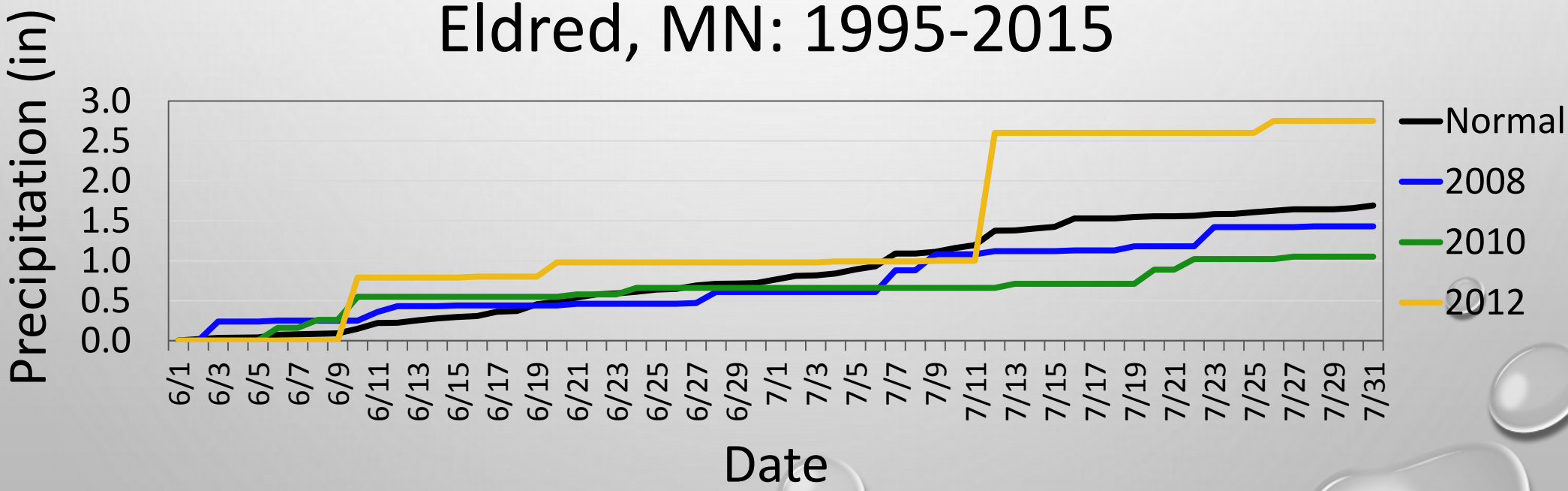
Forest River, ND: 1991-2015



Perley, MN: 1995-2015



Eldred, MN: 1995-2015



Average Percentage of Rainfall

Station and years of data	June	July	June and July
Cavalier, ND (1993-2015)	20 %	19 %	39 %
Mayville, ND (1995-2015)	18 %	18 %	36 %
Grand Forks, ND (1990-2015)	21 %	18 %	39 %
St. Thomas, ND (1994-2015)	20 %	19 %	39 %
Forest River, ND (1991-2015)	20 %	19 %	39 %
Perley, MN (1995-2015)	20 %	18 %	38 %
Eldred, MN (1995-2015)	20 %	18 %	38 %

Conclusions

- Grand Forks, North Dakota receives 20 percent in June and 18 percent in July of the total rainfall between April and October (calculated from NDAWN station data).
- The cumulative rainfall for June and July between 1200-1800 local not unusual for Eastern North Dakota.
- Cloud base parameters (CCN, temperature, altitude) are inferred as usual for Eastern North Dakota due to precipitation being usual.

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Questions??
Image Courtesy of Prairie Public Broadcasting