HB 1166

Thank you for this opportunity to speak to you today.

My name is Jon Wert. I farm with my family near New England in Southwest North Dakota. We raise wheat, corn and canola. My daughter is in the 9th grade and my son is a senior and plans on attending BSC this fall and majoring in agronomy. His plan is to return to the farm and carry on the tradition.

In January of 2017 I had the opportunity to testify at a committee hearing on the water commission budget at the state capital. Much of what I have here today is from my testimony.

I would like to start by saying weather modification is an extremely important issue facing producers in our part of the state. It is a hot button issue because rainfall or lack thereof determines our success, our ability to continue the occupation we love that has been handed down to us from our hard working parents and grandparents. Whether or not we can continue to provide a living for our families and keep the farms and ranches going is largely determined by rainfall.

If one looks at the weather modification page of the water commission website, a case is laid out in support of cloud seeding. However, it reads like an infomercial full of propaganda and hyperbole. If I was on the water commission I would be extremely concerned with the person laying out the case in favor of the project. An honest portrayal instead should be presented.

If you just read the summary, as I'm sure most people do, one could easily be in favor of the system. I however have read the entirety of the studies listed on the webpage that is offered up as proof. Only because I and a majority of the producers in our area believe the claims don't stand to reason, they contradict common sense. What you will hear from most producers is that a storm will be heading our direction from Montana and that when the planes start seeding the clouds the storm dissipates and we receive little or no precipitation. This has been going on for years, even decades.

The website suggests the (Smith et al. 2004) and (Wise,2005) studies show there was an increase in rainfall of 4.2% to 9.2% more than the upwind control areas. But when one actually reads the studies they say something quite different to those paying attention to the detail. The Smith study concludes by saying "This analysis of the climatic rain gage data from the NDCMP target area and upwind control areas in eastern Montana has yielded no significant evidence of an effect of the NDCMP seeding on the summer-season rainfall in the target area. " The study when on to say " an analysis of wheat yield data suggested an increase of about 6% in the NDCMP target areas that could be attributed to the seeding activity" . The idea that the wheat yielding 6% higher in my area versus eastern Montana is because of cloud seeding is preposterous, and shows the lack of agronomic knowledge of the author. Soil quality alone would suggest a much larger difference.

damaging hail results. The rain shaft of the storm is broadened by early rainout. Measurable precipitation falls in some areas that otherwise would have remained rain-free. Other areas that would have received locally intense rain and hail receive less intense rain and significantly less hail damage." This is exactly what happens. We will receive the little rain described, usually .05" or .10" instead of the 1.00" we would have received. As any farmer will tell you the .05 or .10 rainfall does not benefit the crop at all. Our daily crop use rates in July are around .20" .So .05" or .10" of rainfall will not even get to the roots. 1.00" however, will feed the crop for 5 days. For every 1.00" additional rainfall equals 5 bushels of wheat.

The Texas Weather Modification Association website is at least honest when they admit: "Thus far, available evidence suggests that seeding for hail suppression, if anything, decreases, rather than increases, rainfall from seeded storms.

Since I testified last January at the capital showing the problems with using these studies to support weather modification the website has been updated with another study. This one is from 1975. It was based on 4 years worth of data (1969-1972). It states in results: "the result of Type 1 days show less rain on seed days than on no-seed days but the results fail to achieve statistical significance. The results for Type 2 days are also in-conclusive." The final type of days Type 3 he states "The pseudo rank-sum result for Type 3 das does not achieve a 10% significance level, although the pseudo chi-square test for number of rainfall event does so. The results can therefore be interpreted as supporting the Rapid Project findings for shower days but not conclusively." Lastly in his conclusions he states; "It is possible that rainfall from some hail- bearing cells is suppressed, but the NDPP results provide no evidence to this effect." Well I have evidence to this effect. The effect that he states is not only possible it is likely.

Knowing that our rainfall has decreased due to cloud seeding I set out to prove it. But I wanted more concrete data to bolster this argument. As the weather is highly variable I decided I needed long term data from many years if not decades to take out the variability. In fact the water commission website under "How do we determine the effects of seeding" states: "These evaluations require long-term relationships to be established between seeded and unseeded areas, and a long period of operations for comparison purposes." Unfortunately the evaluations offered as proof on the website are all short term studies with as little as 4 years worth of data.

I first gathered data from the 30 years prior to cloud seeding (1930-1960). This data was obtained from John Enz former state climatologist. I also gathered data from a book entitled "Climate Of North Dakota" written by North Dakota State Climatologist Ray E. Jensen which also uses data from the same time frame.

The book shows a map of my area (New England) receiving greater than 16 inches of precipitation, while the National Weather Service data from state climatalogist John Enz shows the west. This contradicts the rainfall average prior to cloud seeding and the normal increase as one moves from west to east.

Lastly the website offers a study by NDSU showing the increase in revenue to producers from weather modification. However, all the study does is put an economic value on rainfall increases of 5% and 10%, values given to them by the Atmospheric Resource Board based on studies I showed clearly don't support that result. Just like the CBO they only score what you give them. Under the 10% scenario they came up with a 16 million dollar gain per year from cloud seeding. However based on the data I compiled from the state climatologist we have **lost** over 10% of our rainfall. This suggests a greater than 16 million dollar loss per year! It is no wonder auction sales in our area are much more prevalent than young people coming back to the farm.

The website also states in the economic analysis the following: "The analysis of hail suppression activities shows the average crop value saved through cloud seeding (Table 6 in the report) is $3.7 million per year, which equates to $1.57 per planted acre." Every farmer I know will give up $1.57 per acre in hail loss to gain $60 an acre in increased production.

I can buy hail insurance to protect my farm from a loss from hail. But a year after year loss in rainfall cannot be insured unless the yield drops below my crop insurance guarantee of 65-70%. 2016 was a good example. We were short moisture and our yields were 30% below our average. We received no insurance check and paid a big premium showing our bankers a big loss. Many producers are not getting funding to farm another year. This could all be prevented.

I was told by a member of the committee I testified at last January on the water commission budget that it came out of committee with a unanimous vote to not fund the weather modification. However in the end when it went to the whole body the money was block granted allowing the water commission the discretion on how the money could be spent.

It's time for government to look out for the people.

PROGRAMS, EVALUATIONS, ECONOMIC BENEFITS & COSTS

HOW CAN WE DETERMINE THE EFFECTS OF SEEDING?

Seeding effects and benefits can be demonstrated in a number of ways. The most direct method is to conduct a project over several years in which half of the storms are randomly seeded and the resulting precipitation from the seeded and unseeded storms is compared. From 2005-14, The Wyoming Weather Modification Pilot Program (WWMPP, 2014) accomplished this goal by setting up a randomized cloud seeding program to research and evaluate the enhancement of snowfall. The results point to an increase in snowfall of 5-15% during ideal seeding conditions. For other cloud seeding programs in the U.S., the problem is that project sponsors usually want all of the seedable clouds treated, not just half, to attain the maximum potential benefit from the program. In that scenario, evaluations using crop-hail insurance data, crop yield data, or rainfall and hail data are useful if done properly. These evaluations require long-term relationships to be established between seeded and unseeded areas, and a long period of operations for comparison purposes, but do not require that only half of the suitable clouds be treated.

ARE THERE NORTH DAKOTA PROJECTS THAT HAVE DETERMINED THE EFFECTS OF SEEDING?

Yes. The first such effort, which built the foundation of cloud seeding in North Dakota was called the North Dakota Pilot Project (NDPP) (Miller et al., 1975). Conducted in McKenzie County from 1969-72 (Mountrail and Ward Counties also participated in 1972), the NDPP was a randomized experiment, which provided for the best possible statistical analysis of the results.

Experimental protocol set up eight-day blocks in advance of each project season where six days were randomly designated "seed" days and two were "no-seed" days. Following the four-year project, data from 67 rain gauges in McKenzie County were subjected to a variety of statistical tests to determine the seeding effects. *Analysis of the data revealed strong evidence that silver iodide seeding of towering summertime clouds led to an increase in the frequency of rainfall events, an increase in the average rainfall per rainfall event, and an increase in the total rainfall in the seeded area.* Further, the total potential rainfall increase for the area was estimated at one inch per growing season. *Hail data from the NDPP showed less hail on seed days than on no-seed days and lower crop-hail insured losses on seed days versus no-seed days.*

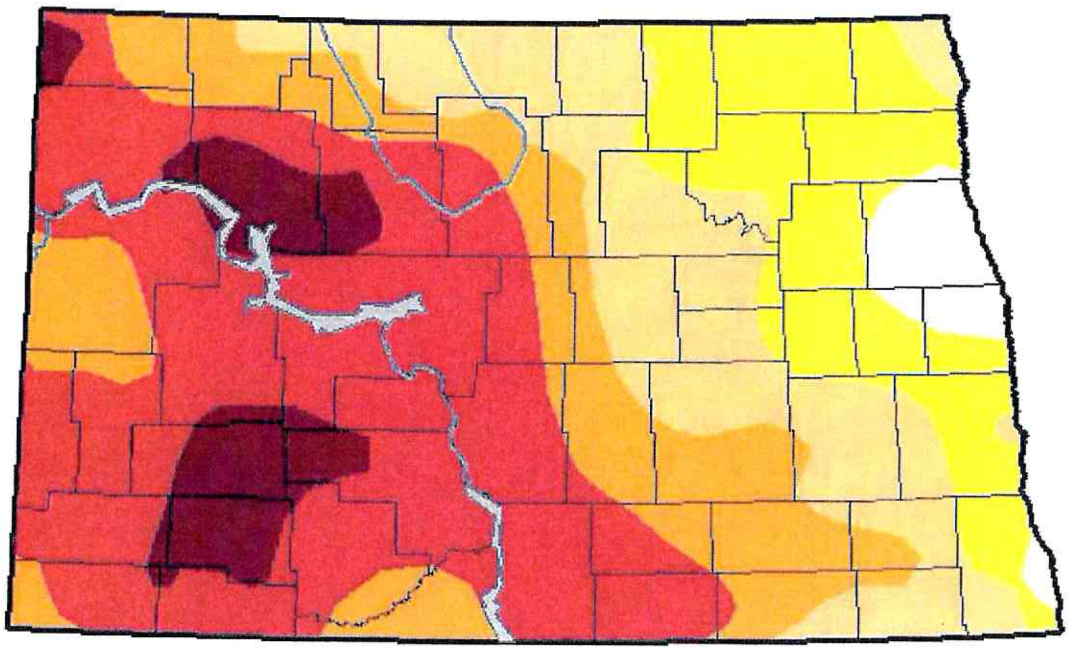
U.S. Drought Monitor

North Dakota

August 1, 2017

(Released Thursday, Aug. 3, 2017)

Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	3.09	96.91	81.74	62.45	44.09	7.62
Last Week 07-25-2017	6.61	93.39	79.21	61.16	45.56	7.62
3 Months Ago 05-02-2017	91.22	8.78	0.00	0.00	0.00	0.00
Start of Calendar Year 01-03-2017	93.87	6.13	0.00	0.00	0.00	0.00
Start of Water Year 09-27-2016	96.70	3.30	0.41	0.00	0.00	0.00
One Year Ago 08-02-2016	90.05	9.95	2.98	1.20	0.00	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Deborah Bathke
National Drought Mitigation Center

http://droughtmonitor.unl.edu/

TOWN	1971-2000 30 yr avg.	1981-2010 30 yr avg.	Change	Losers	Gainers
Abercrombie	21.17	23.86	2.69		2.69
Adams	18.73	19.68	0.95		0.95
Alexander	14.35	14.25	-0.10	-0.10	
Almont	16.64	16.87	0.23		0.23
Ambrose	14.59	14.15	-0.44	-0.44	
Amidon	14.85	14.43	-0.42	-0.42	
Ashley	18.3	19.57	1.27		1.27
Beach	15.26	15.23	-0.03	-0.03	
Belcourt	17.95	18.92	0.97		0.97
Berthold	17.77	17.38	-0.39	-0.39	
Beulah	16.59	17.02	0.43		0.43
Bismarck AP	16.84	17.85	1.01		1.01
Bismarck 7NE	17.88	18.51	0.63		0.63
Bottineau	18.45	17.97	-0.48	-0.48	
Bowbells	16.77	17.06	0.29		0.29
Bowman	15.5	15.59	0.09		0.09
Butte	16.65	17.65	1.00		1.00
Cando	15.43	19.3	3.87		3.87
Carrington	18.73	20.15	1.42		1.42
Carrington 4N	19.89	20.3	0.41		0.41
Carson	16.7	16.92	0.22		0.22
Casselton	21.53	23.37	1.84		1.84
Cavalier	18.25	19.17	0.92		0.92
Center	17.48	18.51	1.03		1.03
Chaffee	20.55	21.72	1.17		1.17
Colgate	18.37	19.76	1.39		1.39
Cooperstown	20.5	21.58	1.08		1.08
Courtena	18.78	19.32	0.54		0.54
Crosby	14.94	14.92	-0.02	-0.02	
Devils Lake	18.93	20.42	1.49		1.49
Dickinson Exp Stn	16.61	16.71	0.10		0.10
Dickinson Ranch	15.5	16.84	1.34		1.34
Drake	16.36	17.34	0.98		0.98
Dunn Center	16.36	15.59	-0.77	-0.77	
Edgeley	19.32	20.38	1.06		1.06
Edmore	18.16	19.47	1.31		1.31
Elgin	17.19	18.17	0.98		0.98
Ellendale	21.43	22.64	1.21		1.21
Enderlin	19.6	22.24	2.64		2.64
Fairfield	14.79	14.97	0.18		0.18
Fargo AP	21.19	22.58	1.39		1.39
Fessenden	17.07	16.92	-0.15	-0.15	
Forbes	19.51	20.65	1.14		1.14
Forman	20.58	22.12	1.54		1.54
Fort Yates	14.14	14.83	0.69		0.69

TOWN	1971-2000 30 yr avg.	1981-2010 30 yr avg.	Change	Losers	Gainers
Oakes	19.55	22.35	2.80		2.80
Park River	19.89	20.84	0.95		0.95
Pembina	18.58	20.65	2.07		2.07
Petersburg	20.06	20.22	0.16		0.16
Pettibone	17.45	18.51	1.06		1.06
Powers Lake	16.1	15.32	-0.78	-0.78	
Pretty Rock	16.92	16.24	-0.68	-0.68	
Reeder	16.88	16.45	-0.43	-0.43	
Reeder 13 N	16.01	15.52	-0.49	-0.49	
Richardton	17.78	16.55	-1.23	-1.23	
Rolla	18.58	18.65	0.07		0.07
Rugby	18.27	19.64	1.37		1.37
Sharon	21.23	21.19	-0.04	-0.04	
Sherwood	13.13	14.07	0.94		0.94
Sheilds	16.92	16.9	-0.02	-0.02	
Stanley	19.73	18.69	-1.04	-1.04	
Steele	18.77	19.38	0.61		0.61
Streeter	17.09	18.4	1.31		1.31
Sykeston	18.9	19.8	0.90		0.90
Tagus	17.01	16.34	-0.67	-0.67	
Tioga	14.7	14.93	0.23		0.23
Towner	16.68	17.19	0.51		0.51
Trotters	14.71	14.81	0.10		0.10
Turtle Lake	17.62	17.55	-0.07	-0.07	
Tuttle	16.83	17.35	0.52		0.52
Underwood	17.77	16.74	-1.03	-1.03	
Upham	17.72	17.91	0.19		0.19
Valley City	18.89	20.62	1.73		1.73
Velva	18.1	18.81	0.71		0.71
Verona	19.17	20.4	1.23		1.23
Wahpeton	21.87	22.31	0.44		0.44
Walhalla	19.74	20.92	1.18		1.18
Washburn	17.8	17.18	-0.62	-0.62	
Watford City	14.41	14.67	0.26		0.26
Watford City 14 S	15.49	15.75	0.26		0.26
Westhope	17.02	17.43	0.41		0.41
Wildrose	14.65	15.17	0.52		0.52
Williston AP	14.16	14.37	0.21		0.21
Williston Exp St	14.99	14.31	-0.68	-0.68	
Willow City	17.17	17.83	0.66		0.66
Wilton	18.28	19.1	0.82		0.82
Wishek	18.45	20.89	2.44		2.44
Woodworth	17.93	18.99	1.06		1.06
Avg across state			0.68	-0.48	1.00
Number of locations			136	31	105

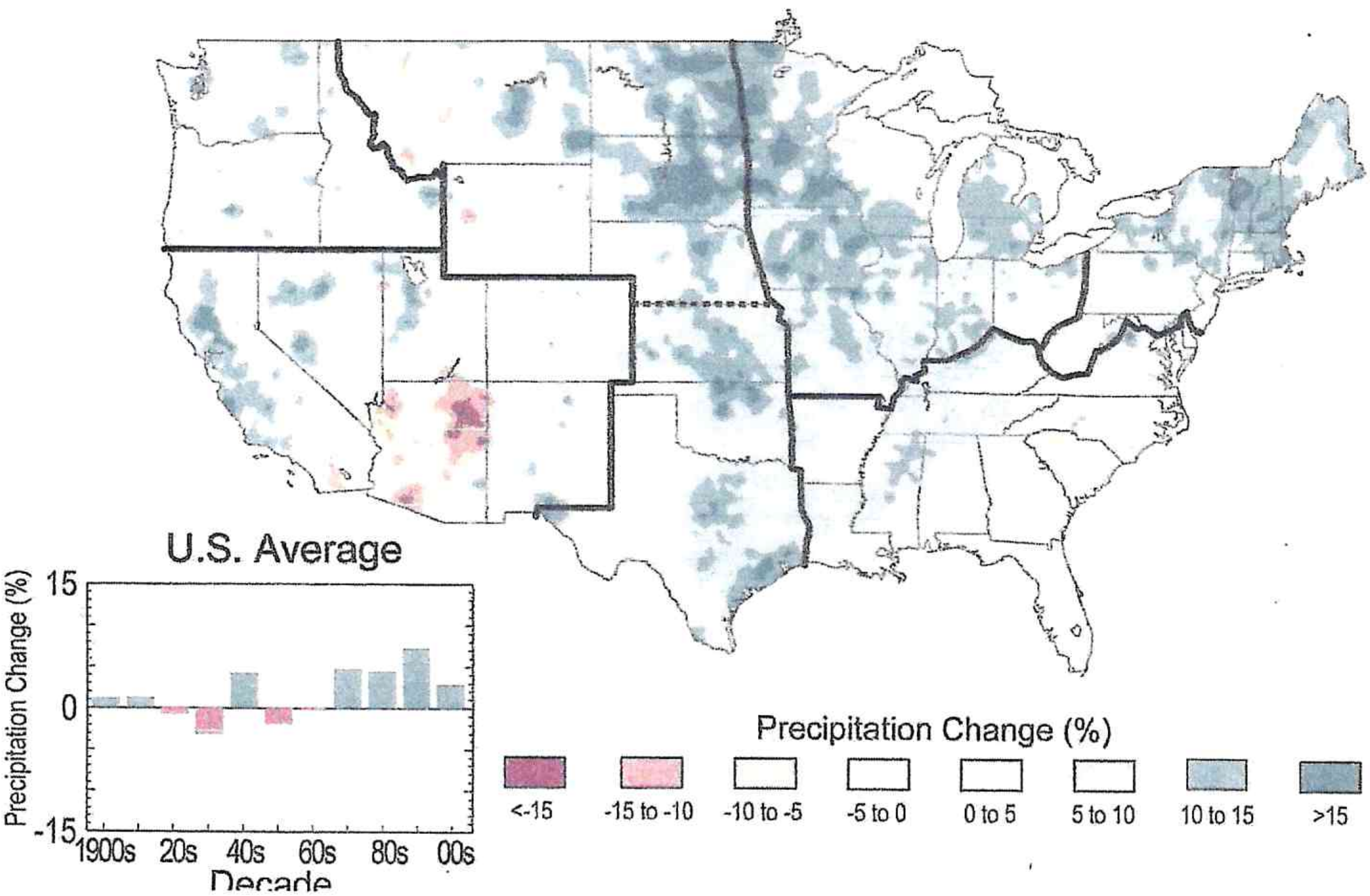
1979	11.29	
1980	11.15	
1981	17.78	
1982	23.72	
1983	13.83	
1984	11.67	
1985	17.18	
1986	17.61	
1987	15.6	**16.08**
1988	8.53	
1989	15.34	
1990	11.87	
1991	15.59	
1992	12.3	
1993	15.54	
1994	17.25	
1995	19.52	
1996	12.7	
1997	15.17	**14.38**
1998	18.26	
1999	16.69	
2000	15.97	
2001	14.63	
2002	12.13	
2003	14.61	
2004	13.32	
2005	17.55	
2006	13.84	
2007	15.31	**15.23**
2008	12.4	
2009	18.43	
2010	14.57	
2011	19.3	
2012	11.94	
2013	15.51	
2014	18.55	
2015	13.99	
2016	12.72	**15.27**

1979	0.38	
1980	3.78	
1981 M		
1982 M		
1983 M		
1984 M		
1985	7.61	
1986	14.06	
1987	13.33	**M**
1988	6.82	
1989	11.85	
1990	9.61	
1991	16.32	
1992	12.13	
1993	22.29	
1994	15.95	
1995	14.33	
1996	17.17	
1997	17.98	**14.45**
1998	20.46	
1999	20.19	
2000	12.92	
2001	13.01	
2002	10.54	
2003	14.91	
2004	18.32	
2005	21.64	
2006	13.69	
2007	14.83	**16.05**
2008	13.29	
2009	14.95	
2010	16.55	
2011	14.34	
2012	9.6	
2013	25.1	
2014	15.62	**15.96**
2015 M		
2016 M		

1979	5.62	
1980	9.98	
1981 M		
1982	16.36	
1983	9.56	
1984	10.25	
1985	11.59	
1986	15.2	**8 yr avg.**
1987 M		**10.36**
1988	8.67	
1989	17.62	
1990	8.83	
1991	22.79	
1992	11.87	
1993	24.23	
1994	13.45	
1995	14.49	
1996	19.76	
1997	17.53	**15.92**
1998	20.4	
1999	17.12	
2000	17.93	
2001	15.45	
2002	13.16	
2003	16.34	
2004	12.37	
2005	21.74	
2006	13.82	
2007	14.15	**16.25**

No.	Station Name	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	
		PRECIPITATION NORMALS (Total in Inches)													
070	HEBRON	.26	.31	.56	1.66	2.53	3.23	2.70	1.64	1.69	1.28	.58	.29	16.73	17.29
071	HETTINGER	.30	.32	.60	1.59	2.54	2.95	2.16	1.46	1.40	1.35	.53	.31	15.51	15.65
072	HILLSBORO 3 N	.50	.55	.93	1.56	2.35	3.46	3.23	2.78	2.05	1.92	.89	.48	20.70	21.62
073	HURDSFIELD 8 SW	.49	.45	.64	1.26	2.22	3.35	2.57	1.96	1.45	1.35	.69	.39	16.82	
074	JAMESTOWN MUNICIPAL AP	.62	.52	.89	1.36	2.21	3.05	3.22	2.33	1.74	1.40	.71	.44	18.49	18.77
075	JAMESTOWN ST HOSPITAL	.50	.35	.73	1.27	2.27	3.24	3.28	2.43	2.01	1.49	.63	.33	18.53	19.60
076	KEENE 3 S	.39	.37	.59	1.26	2.32	3.19	2.47	1.51	1.68	1.16	.66	.40	16.00	16.71
077	KENMARE 1 WSW	.83	.63	.90	1.26	2.07	2.66	2.67	1.80	1.92	1.19	.69	.53	17.15	18.30
078	KILLDEER 8 NW	.44	.50	.87	1.57	2.30	3.36	2.09	1.57	1.65	1.44	.66	.47	16.92	16.29
079	LAKE METIGOSHE ST PK	.68	.68	.80	1.09	2.70	3.15	3.26	2.64	2.24	1.34	.95	.55	20.08	20.11
080	LA MOURE	.78	.64	1.36	1.85	2.67	3.69	3.42	2.30	1.90	1.78	.91	.45	21.75	22.77
081	LANGDON EXP FARM	.42	.39	.61	1.00	2.36	3.33	3.18	2.73	1.66	1.38	.66	.39	18.11	19.42
082	LARIMORE	.53	.53	.97	1.25	2.24	3.57	3.45	2.91	2.05	1.55	.91	.45	20.41	
083	LEEDS	.55	.51	.83	1.28	2.08	2.98	3.17	2.07	1.61	1.53	.84	.48	17.93	19.43
084	LINTON	.34	.37	.77	1.36	2.32	2.95	2.57	1.80	1.30	1.44	.51	.39	16.12	16.90
085	LISBON	.63	.48	1.09	1.47	2.59	3.45	2.87	2.27	2.20	1.82	.86	.45	20.18	21.13
086	LITCHVILLE 2 NW	.65	.50	1.10	1.66	2.65	3.68	3.18	2.17	2.00	1.97	.90	.44	20.90	21.73
087	MADDOCK	.49	.45	.77	1.05	2.03	3.27	3.25	1.92	1.80	1.41	.71	.43	17.58	18.45
088	MANDAN EXPERIMENT STN	.38	.37	.58	1.52	2.41	2.91	2.90	2.02	1.56	1.41	.62	.36	17.04	17.95
089	MARMARTH	.37	.40	.68	1.38	2.23	2.90	2.00	1.32	1.24	1.13	.57	.36	14.58	15.48
090	MAX	.55	.43	.74	1.48	2.16	3.21	2.69	1.84	1.72	1.41	.63	.44	17.30	18.08
091	MAYVILLE	.72	.62	1.08	1.38	2.29	3.50	2.73	2.85	1.98	1.77	.86	.60	20.38	23.92
092	MC CLUSKY	.58	.49	.71	1.49	2.13	3.41	2.61	2.06	1.61	1.39	.71	.49	17.68	17.56
093	MC HENRY 3 W	.60	.48	.87	1.32	2.28	3.63	3.09	2.76	1.99	1.47	1.03	.57	20.09	21.19
094	MC LEOD 3 E	.65	.51	1.01	1.30	2.63	3.39	3.54	2.32	2.05	1.78	.94	.42	20.54	22.45
095	MC VILLE	.58	.36	.88	1.09	2.26	3.39	3.23	2.54	2.16	1.38	.83	.46	19.16	21.74
096	MEDINA	.46	.47	.87	1.32	2.26	3.32	3.02	2.00	1.87	1.29	.61	.36	17.85	18.52
097	MEDORA	.35	.36	.64	1.35	2.26	2.89	2.16	1.38	1.45	1.12	.58	.37	14.91	16.04
098	MINOT AP	.65	.53	1.05	1.55	2.31	3.15	2.70	1.95	1.74	1.32	.86	.63	18.44	17.19
099	MINOT EXPERIMENT STN	.77	.60	1.03	1.56	2.28	3.01	2.52	2.01	1.78	1.40	1.05	.64	18.65	18.59
100	MOFFIT 3 SE	.29	.33	.66	1.31	2.16	3.00	2.64	2.08	1.73	1.36	.50	.27	16.53	16.90
101	MOHALL	.52	.42	.73	1.24	2.17	2.98	2.86	2.17	1.89	1.46	.63	.39	17.46	17.17
102	MONTPELIER	.59	.54	1.07	1.73	2.59	3.50	3.05	2.40	2.18	1.67	.91	.41	20.64	20.48
103	MOTT	.41	.50	.80	1.83	2.59	3.17	2.13	1.69	1.26	1.24	.55	.38	16.55	16.56
104	NAPOLEON	.58	.51	.98	1.64	2.48	3.20	2.88	2.19	1.77	1.55	.80	.44	19.02	19.74
105	NEW ENGLAND	.38	.39	.69	1.62	2.46	3.38	1.93	1.73	1.44	1.37	.47	.38	16.24	15.78
106	NEW SALEM 5 NW	.47	.49	.81	1.88	2.42	3.17	2.76	2.11	1.53	1.38	.76	.50	18.28	17.41
107	OAKES 2 S	.60	.44	1.04	1.71	2.45	3.25	2.76	2.04	2.26	1.77	.82	.41	19.55	22.35
108	PARK RIVER	.66	.56	.92	1.25	2.41	3.42	3.19	2.61	1.80	1.64	.88	.55	19.89	20.84
109	PEMBINA	.44	.40	.72	.99	2.09	3.41	2.95	2.68	2.12	1.48	.85	.45	18.58	20.65
110	PETERSBURG 2 N	.66	.43	.94	1.17	2.27	3.62	3.25	2.71	2.06	1.54	.90	.51	20.06	20.22
111	PETTIBONE	.53	.38	.69	1.34	2.14	3.32	2.81	1.86	1.80	1.44	.71	.43	17.45	18.51
112	POWERS LAKE 1 N	.38	.37	.72	1.27	2.12	2.74	2.90	1.94	1.71	1.07	.55	.33	16.10	15.32
113	PRETTY ROCK	.33	.41	.86	1.89	2.64	3.02	2.34	1.76	1.40	1.34	.62	.31	16.92	16.24
114	REEDER	.36	.36	.68	1.61	2.88	3.29	2.23	1.59	1.49	1.52	.54	.33	16.88	16.45
115	REEDER 13 N	.39	.41	.82	1.61	2.51	2.94	1.97	1.58	1.51	1.41	.54	.32	16.01	15.53
116	RICHARDTON ABBEY	.45	.48	.86	1.75	2.49	3.39	2.27	1.88	1.60	1.41	.75	.45	17.78	16.55
117	RIVERDALE	.37	.29	.39	1.16	2.04	3.18	2.37	1.78	1.70	1.17	.38	.26	15.09	
118	ROLLA 3 NW	.51	.52	.76	1.13	2.30	3.41	2.87	2.55	1.95	1.25	.80	.53	18.58	18.65
119	RUGBY	.51	.45	.80	1.28	2.25	3.05	3.21	2.28	1.92	1.32	.70	.50	18.27	19.64
120	SAN HAVEN	.43	.58	.61	.93	1.90	2.69	2.68	2.59	1.80	1.26	.43	.40	16.30	
121	SHARON	.68	.54	1.12	1.33	2.65	3.55	3.45	2.67	2.05	1.67	.97	.55	21.23	21.19
122	SHERWOOD 3 N	.16	.19	.31	.80	1.77	2.65	2.57	1.82	1.44	.91	.28	.23	13.13	14.07
123	SHIELDS	.42	.42	.87	1.75	2.61	2.88	2.55	1.69	1.31	1.41	.63	.38	16.92	16.90
124	STANLEY 3 NNW	.57	.49	.87	1.59	2.58	3.88	2.94	2.13	2.15	1.23	.76	.54	19.73	18.69
125	STEELE 3 N	.48	.44	.98	1.51	2.53	3.24	2.95	2.01	1.90	1.55	.74	.44	18.77	19.33
126	STREETER 7 NW	.31	.34	.68	1.26	1.96	3.04	3.09	2.38	1.97	1.10	.69	.27	17.09	18.40
127	SYKESTON	.57	.51	.88	1.49	2.23	3.39	2.99	2.03	1.78	1.73	.83	.47	18.90	19.80
128	TAGUS	.66	.54	.96	1.33	1.97	3.14	2.35	1.68	1.85	1.22	.72	.59	17.01	16.34
129	TIOGA 1 E	.48	.36	.58	1.17	2.00	2.60	2.20	1.80	1.58	.94	.59	.40	14.70	14.93
130	TOWNER 2 NE	.55	.55	.72	1.21	1.93	2.67	2.69	2.06	1.83	1.30	.64	.53	16.68	17.19
131	TROTTERS 3 SSE	.35	.39	.58	1.23	2.09	2.90	1.89	1.50	1.61	1.16	.61	.40	14.71	14.81
132	TURTLE LAKE	.63	.49	.85	1.44	2.19	3.32	2.67	1.96	1.50	1.32	.73	.52	17.62	17.55
133	TUTTLE	.44	.39	.62	1.38	2.29	3.14	2.81	1.77	1.76	1.28	.59	.36	16.83	17.35
134	UNDERWOOD	.54	.46	.78	1.64	2.25	3.52	2.48	1.77	1.59	1.44	.77	.53	17.77	16.74
135	UPHAM 3 N	.57	.47	.76	1.33	2.07	3.32	2.71	2.00	1.80	1.28	.85	.56	17.72	17.91
136	VALLEY CITY 3 NNW	.54	.46	.80	1.22	2.60	3.27	2.75	2.43	2.10	1.53	.80	.39	18.89	20.62
137	VELVA 3 NE	.68	.50	.78	1.34	2.30	3.22	2.80	1.83	1.62	1.61	.92	.50	18.10	18.81
138	VERONA	.39	.35	.97	1.75	2.50	3.37	3.11	2.01	2.04	1.70	.72	.26	19.17	20.40

Observed U.S. Precipitation Change



The colors on the map show annual total precipitation changes for 1991-2012 compared to the 1901-1960 average, and show wetter conditions in most areas. The bars on the graph show average precipitation differences by decade for 1901-2012 (relative to the 1901-1960 average). The far right bar is for 2001-2012. (Figure source: NOAA NCDC / CICS-NC).

22 yrs

The latest study "Precipitation evaluation of the North Dakota Cloud Modification Project using rain gauge observations" authored by Tuftedal, Delene,and Detwiler and was released in Dec, 2021.

The authors state: "NDCMP secondary goal after hail suppression is precipitation enhancement In the target area, not in downwind areas: therefore, the analysis focuses on precipitation changes in the target area only and does not consider downwind regimes."

"Precipitation generally increases from west to east, which corresponds with increasing distance from the Rocky Mountains that is consistent with the climatological precipitation pattern. The Bowman target area is highly correlated with the Carter and Fallon control areas" "In general, target/control correlations are highest with control areas to the southwest of the target area."

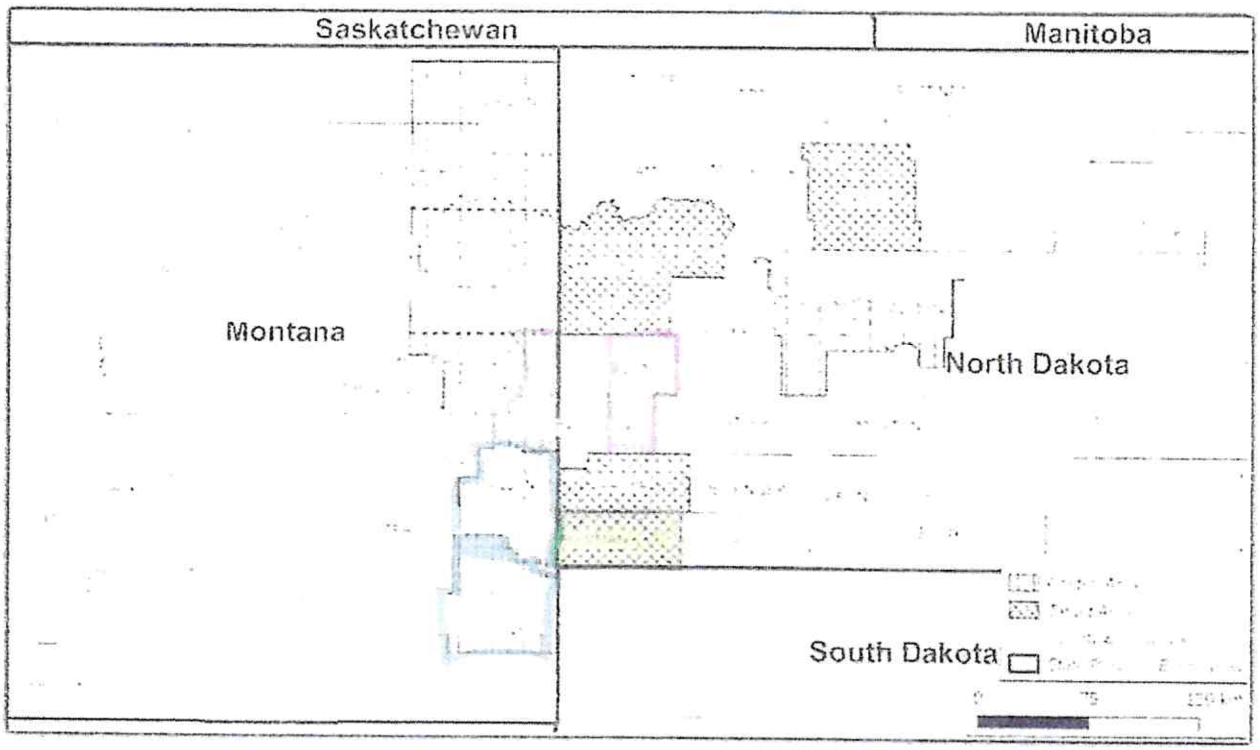


Fig. 2. A political map showing North Dakota and surrounding states that have counties near the North Dakota Cloud Modification Project (NDCMP) operational area. Crossed lines highlight the target area and vertical lines highlight the control area.

Table 1

Monthly and seasonal (June, July, and August) area-wide precipitation using measurements from National Weather Service (NWS) Cooperative Observer Program (COOP) for 1950–1975, and North Dakota Atmospheric Resource Board Cooperative Observer Network (ARBCON) and NWS COOP for 1977–2018.

County	June (cm)		July (cm)		August (cm)		Seasonal (cm)		
	1950–1975	1977–2018	1950–1975	1977–2018	1950–1975	1977–2018	1950–1975	1977–2018	
McKenzie	8.71	7.52	5.22	6.07	4.31	4.04	18.25	17.63	
Bowman	9.26	7.60	5.28	5.27	3.94	4.00	18.48	16.88	−9%
Ward	8.82	8.66	5.76	6.50	5.09	4.73	19.61	19.90	
Billings	10.29	7.52	5.47	5.80	4.66	4.50	20.42	17.92	
Mercer	8.87	8.87	5.95	6.96	4.86	5.08	19.68	20.62	
Wibaux	9.87	7.17	5.30	5.57	4.47	4.29	19.64	17.03	
Richland	7.70	6.38	4.90	5.40	4.12	3.43	16.72	15.22	
Roosevelt	7.17	[illegible]	4.79	5.69	4.22	3.37	16.19	15.72	
Carter	9.78	8.32	5.52	5.45	3.88	4.54	19.18	18.31	−5%
Fallon	7.67	6.34	4.37	4.10	3.14	3.25	15.18	13.69	−10%