

## Precipitation Evaluation of the North Dakota Cloud Modification Project (NDCMP) using Rain Gauge and Radar Observations

North Dakota started a weather modification project in the 1950s and a managed cost sharing program in 1976 (Smith et al. 1992). NDCMP currently seeds clouds for hail suppression and rain enhancement over Western North Dakota in two areas. The northern section includes Williams, Burke, Ward, Mountrail, and McKenzie counties, while the southern section includes Bowman and part of Slope counties. Previous studies have shown an increase of rainfall between 6 and 9 percent using 1977 to 2004 rain gauge data (Wise 2005). Since 2004, additional rain gauge locations have been added in Western North Dakota that enhance the network. New radar observations and analysis software allow for rainfall amounts to be determined for larger areas, instead of at specific rain gauge sites. The objective of this study is to analyze daily rainfall data from surface observations for 1977-2018 to determine the effects of the NDCMP on rainfall amounts. Radar derived rainfall amounts will be compared with observation across Western North Dakota from 2009 to 2018.

Daily rainfall data from 1977-2018 will be used from the North Dakota Atmospheric Research Board Cooperative Observer Network (NDARBCON) rain gauge network to analyzed the effect of cloud seeding using target/control analysis and the results compared to previous analysis for the 1977 to 2004 period (Wise 2005). To determine the control and seeded region's precipitation, circles with a radius of influence of 40 km will be used to weigh rain gauges observations to a single location. To determine the weight of each rain gauge, the distance from the center point to the rain gauge will be calculated and subtracted from the radius of the circle. The weighted calculated rainfall for the entire county will be used for comparison to the control county (Wise 2005). The seeded circle must be in counties that have participated in the NDCMP since 1977, and the control circle must not participate in the project and have rain gauge measurements available. To detect the effects of the cloud seeding, a single and double ratio statistical tests will be conducted using the control and seeded circles (Breed et al. 2013).

Additional analysis will compare radar derived rainfall amounts to rain gauge observations for seeded and control areas during the period of 2009 to 2018. The Thunderstorm Identification, Tracking, Analysis and Nowcasting (TITAN) radar software will determine area rainfall amounts from the C-band radar data provided by NDCMP using standard algorithms (Z-R relationship) built within TITAN for radar derived rainfall amounts. The S-band Weather Surveillance Radar 1988-Doppler (WSR-88D) used by the National Weather Service (NWS) will also be used to analyze rainfall amounts using standard methodologies used by NWS. Radar derived rainfall amounts will be compared to observations through NDARBCON rain gauges, National Weather Service rain gauges, and North Dakota Agricultural Weather Network weather stations.

Results of this study can help determine the overall effectiveness of the NDCMP on increasing rainfall due to seeding in Western North Dakota. Along with providing information that will be useful in determining the economic cost benefits of running the program. The NDCMP has been the focus of several studies in the past but has not been reevaluated since a paper in 2005. Therefore, a reevaluation may be necessary to validate previous studies and determine recent years effectiveness.

References:

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