

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

North Dakota started a weather modification project in the 1950s and a managed cost sharing program in 1976 (Smith et al. 1992). North Dakota Cloud Modification Project (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. NDCMP has been the subject of many studies to evaluate the projects effectiveness. Johnson (1985) found weak evidence of increased rainfall when seeding for hail suppression and no evidence of the effectiveness when seeding for rainfall. Smith et al. (1992) analyzed wheat yields for seeded and non-seeded counties and found an increase in wheat yields in seeded regions. More recently, Wise (2005) used rain gauge data from 1977-2004 to identify an increase of rainfall due to cloud seeding of 6-9 percent.

Since these earlier studies, an unprecedented amount of rainfall data exist to provide an estimate the impacts of cloud seeding. 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. Daily rainfall data from 1977-2018 will be used from the North Dakota Atmospheric Research Board Cooperative Observer Network (NDARBCON). Similar to prior methodologies, a target/control method will be used. To determine the control and seeded region's precipitation, circles with a radius of influence of 40 km will be used to weigh rain gauge observations to a single location. The circles' center point rain amount will be determined using a Cressman distance-weighting scheme that is applied to each rain gauge within the circle. Circular regions within seed countries and non-seed counties will be used for the target/control analysis. The seeded circle are in counties that have participated in the NDCMP since the project start in 1977, and the control circle are in counties that have not participated in the cloud seeding project and have rain gauge measurements available. Counties selected to be used for target regions are McKenzie, Ward, Bowman and Slope County and for the control counties, Billings, Golden Valley, western section of Stark, Mercer and McLean County. These counties will be paired between control and seeded regions by geographical area to minimize impacts due to spatial variability in precipitation. To detect the effects of the cloud seeding, a single ratio statistical tests will be conducted using the control and seeded circles (Breed et al. 2013), along with a bootstrap statistical analysis to examine the statistical significance of the data.

Results of this study help determine the overall effectiveness of the NDCMP on increasing rainfall totals due to cloud seeding in Western North Dakota. The study attempts to reproduce results of the previous North Dakota assessment, which was last conducted in 2005 and compare the results to from the previous analysis for the 1977-2004 period to this project. Assessment of the effectiveness are necessary to provide information in determining the economic cost/benefit ratio of running the program. Assessment studies are important so sponsors and the public are well informed about program and weather modification in general. Depending on the results from this analysis, the methods used could be applied to other weather modification projects in an attempt to validate the project effectiveness.

References:

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