Methodology and 2017 Results of using Radar Observations to Evaluate Hail Mitigation by the Alberta Hail Suppression Project ¹David Delene (delene@aero.und.edu), ²Bruce Boe, and ¹Andrew Detwiler ¹University of North Dakota; ²Weather Modification International

Motivation

The Alberta Hail Suppression Project is an operational cloud seeding program designed to reduce hailstone-induced property damage in the metropolitan cities of Calgary and Red Deer. Evaluation of the program uses observations from a C-band radar located at the Olds-Didsbury Airport, approximately half-way between Calgary and Red Deer, and an Environment Canada radar at Strathmore, about 40 km east of Calgary.



Methodology

Effectiveness in hail reduction uses indicators of Maximum [통 Vertically Integrated Liquid (MaxVIL) and storm area greater than $\mathbf{T}^{\mathbf{T}}$ or equal to 60 dBZ (Ar60) to relate observations before and during the project's cloud seeding operations. The MaxVIL indicator is more sensitive to the size of large hail, while the Ar60 indicator is more sensitive to the area of hail. Several different seeding effectiveness metrics are evaluated using 21 hail cases from 2017.

- Natural Hail Trajectory
- Beneficial Competitio
- Early Rain-out
- Lowering
- Promotion of Coalescence

Active Storm Period (ASP)

- Length of time that a case is studied.
- Case needs to stays inside 100 km radar ring.
- Case has the potential to produce damaging hail.



An Idealized Reflectivity of a Hailstorm



Hail Likelihood Period (HLP)

- Time duration in the ASP that has damaging hail.
- Damaging Hail Indicators:
- Max. Vertically Integrated Liquid (MaxVIL) \geq 30 kg/m²
- Storm Area greater than 60



2017 Seeding Effectiveness (SE) using **Increasing Hail Ratio (IHR) Metric**

- i MaxVIL Increasing Duration for BSP j Total Duration of BSP
- k MaxVIL Increasing Duration for ESP
- l Total Duration of ESP

 $IHR_{BSP}^{MaxVIL} - IHR_{ESP}^{MaxVIL}$ BSP – Before Seeding Period IHR_{BSP}^{MaxVII} ESP – Effective Seeding Period

• The Increasing Hail Ratio (IHR) Metric measures increasing indicator (MaxVIL or Ar60) duration during a period relative to

• Seeding Effective (SE) is the difference of the Hail Metric between the BSP and ESP periods normalized by the BSP



Conclusions and Future Work

• Presented herein is an overview of Sankha Maitra Master Thesis, completed in December 2021 at the University of North Dakota. • The 2017 averaged Increasing Hail Ratio (IHR) metric is 0.12 (1.0 is highest possible value) for both MaxVIL and Ar60 indicators, which indicates a reduction in damaging hail. • The number of cases can be increased using additional seasons since 2014 to increase the statistical significance.

• Automated scripts enables relatively straightforward analyze of additional storms using the developed methodology.