Evaluation of the Alberta Hail Suppression Project Using 2017 Radar Observations

Sankha Subhra Maitra (sankhasubhra.maitra@ndus.edu) and David Delene

University of North Dakota, Grand Forks, North Dakota

Motivation

Severe hailstorms are a common occurrence around the Calgary region in Alberta, Canada. Hailstorm induced property damages worth approximately 500 (CAD) million were reported in the last two decades alone. Insurance companies have funded weather modification programs since 1997 to reduce property damages from hailstorms. But the need to determine the feasibility of such programs has led to the commencement of a research aiming to evaluate the effectiveness of the Calgary weather modification programs. Statistical analysis of storms from data collected over several years is used to obtain an overall project effectiveness which would then be used in a cost-benefit analysis of the program. A favorable cost-benefit result would lead to a reduction in the damage cost paid by the insurance companies, leading to a reduction in the insurance premium amount making insurance affordable to a greater number of people.

Hail Swath From July 8, 2013

Data

- 2017 season data from the C-band Doppler radar located at Olds-Didsbury Airport.
- The radar is operated with less than 4 minutes volume scans.
- 2017 season data from an Environment Canada operated C-band Doppler radar placed in Strathmore is also used.
- The Strathmore radar is operated with less than 5 minutes volume scans.
- Data is analyzed using the LIDAR Radar Open Software Environment (LROSE) software package to quantify the amount of damaging hail present within observed storms.

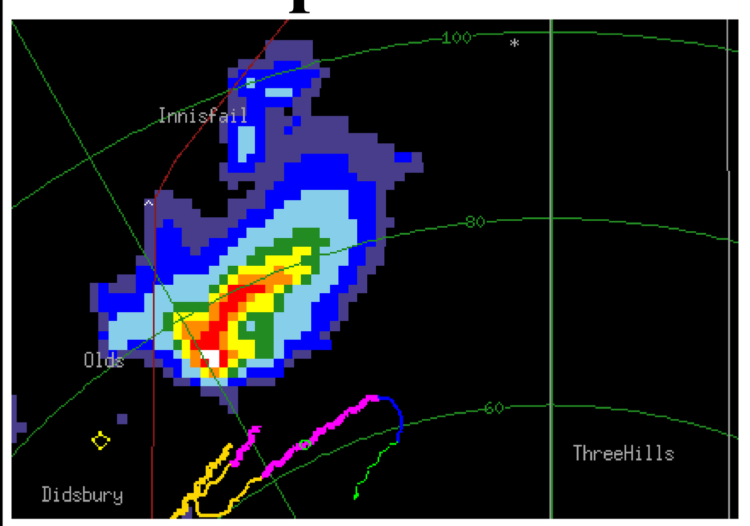
Methodology

- Storms are identified into three possible target categories, seeded, non-seeded or non-analyzed.
- Lifetime of the seeded cases are divided into the Before Seeding Period (BSP), the Effective Seeding Period (ESP) and the Post Seeding Period (PSP).
- First derivatives of Vertically Integrated Liquid Water Content (VIL) and Area of Storm having reflectivity greater than 60 dBZ (Ar60) with respect to time are plotted for the seeded cases.
- Mean of the first derivative values are computed during the BSP and ESP to calculate the average overall change in VIL and Ar60.
- Ratio of number of points greater than or equal to zero to total number of points are taken during the BSP and ESP to calculate the increasing trend in VIL and Ar60.

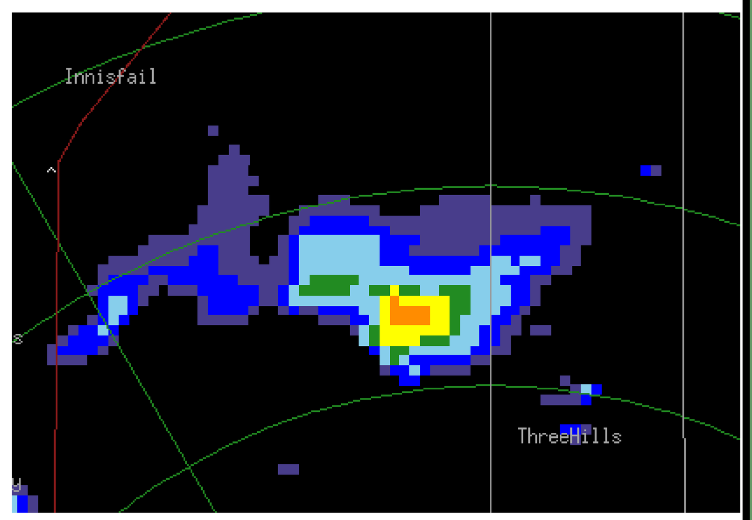
Classification of Target Cases

- Storms that threaten the protected zone inside the radar coverage area and are treated with at least 2 kg of seeding material are categorized as treated (seeded) cases.
- Storms inside the radar coverage area but not threatening the protected area are not treated with seeding materials. These constitute the non-treated (non-seeded) cases.
- Parts of storms that re-strengthen at least 30 minutes after the termination of seeding are also classified as non-treated (non-seeded) target cases.
- Storms falling into none of the above mentioned categories are classified as non-analyzed cases and are not studied.

Comparison of Storm Area > 60 dBZ



During BSP

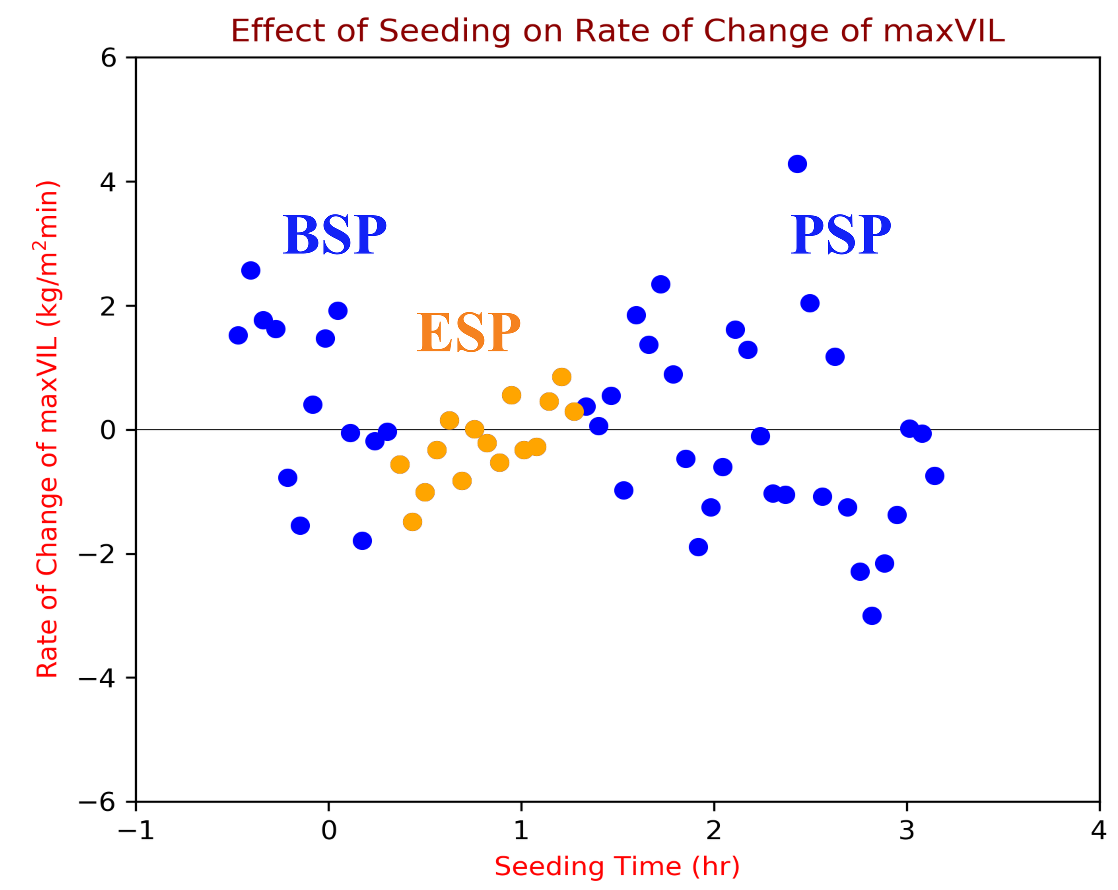


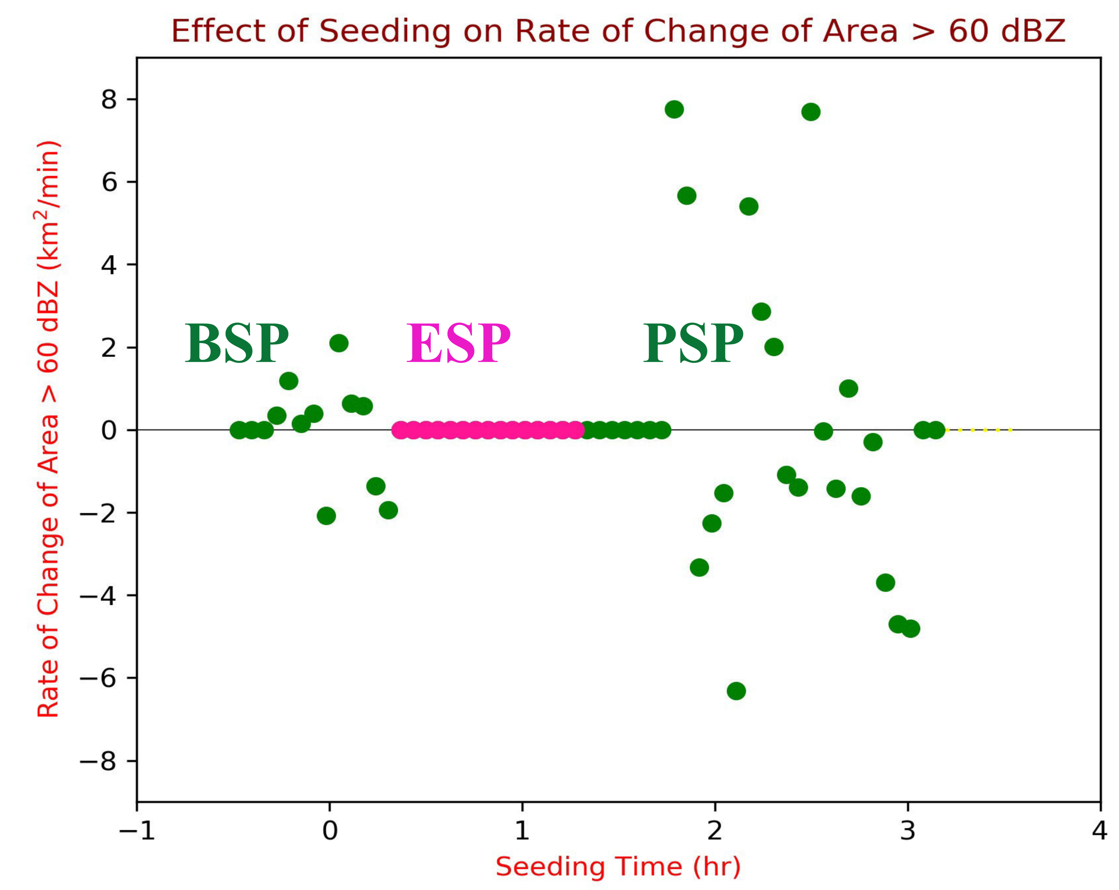
During ESP

Storm area > 60 dBZ is shown in shades of orange and red

Example Plots of a Seeded Case That Occurred on July 28, 2017

Storm Details : CAPE = 1180 J/kg , Shear = 12 m/s





Average maxVIL change during BSP = + 0.53 kg/m²

Average maxVIL change during ESP = - 0.22 kg/m²

Average maxVIL increasing trend during BSP = +0.54

Average maxVIL increasing trend during ESP = +0.40

Average Ar60 increase during BSP = + 0.10 km²

Average Ar60 increase during ESP = 0.00 km²

Average Ar60 increasing trend during BSP = +0.54

Average Ar60 increasing trend during ESP = 0.00

Results and Conclusions

- Initial observations from 24 seed cases show an average maxVIL increase of 0.52 kg/m^2min during the BSP while a decrease of 0.39 kg/m^2min during the ESP. On an average the maxVIL shows an increasing trend for about 59 % of the time during the BSP and only 39 % of the time during ESP.
- The storm area greater than 60 dBZ increases by 0.22 km^2/min during the BSP and by only 0.08 km^2/min during the ESP.
- However, the storm area greater than 60 dBZ shows an increasing trend for about 34% of the time during the BSP and 36 % of the time during the ESP which is contrary to the expected pattern.

References

Dixon,M., Wiener, G., 1993.TITAN:Thunderstorm Identification Tracking Analysis and Nowcasting- A Radar Based Methodology.J.Atmos.Oceanic Technol. 10, 785-797. https://doi.org/10.1175/1520-0426(1993)010<0785:TTITTAA>2.0.CO,2

Gilbert, D.B., Boe,B.A.,Krauss, T.W., 2016. Twenty Seasons of Airborne Hail Suppression In Alberta, Canada. The Journal of Weather Modification 48, 68-92.

Future Work

Analysis to be carried out using data from multiple years to obtain a statistically significant result.