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Estimation of the Results of the Cumulonimbus Cloud Modification Aiming at Hailstorm Mitigation in Alberta (Canada) on the Radar and Numerical Modeling Data

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Abstract—In this paper, physical effects caused by a crystallizing reagent in the deep stable cloud, which was developing on July 7, 2006 in Alberta, Canada, are analysed. The ultimate goal of that experiment was reducing economical losses caused by hail. The radar data analysis and numerical modeling showed that use of the reagent allowed significant reducing the hail particles size.

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1. INTRODUCTION

Droughts, hailstorms, and floods continue their devastating activity in many regions in the world. Human and property losses increase with growth of population concentration. In many countries, cloud modification is carried out, aiming improving weather and mitigating economic losses due to hazardous atmospheric phenomena [1, 4–7, 10–12, 20, 25–27].

The WMI (Weather Modification Inc., USA) carries out the cloud modification in the province of Alberta (Canada) since 1996, in order to reduce economic losses caused by hail. This is the first project in the world, in which the works are financed by private insurance companies and not by the government.

During the period of 1987–1995, the insurance companies in Alberta have paid out more than $1 billion to their clients because of damage from hail, which makes $113.2 million a year. During the 7-year period of 1996–2002, $452.6 million was paid out, or $64.7 million yearly. The 43% decrease of payments represents an indirect evidence of the cloud modification work efficiency.

The big cities in the province, Calgary and Red Deer, are permanently damaged by hailstorms. In Calgary, three to four hailstorms a year occur [16]. In this connection, the area between Red Deer in the north and Calgary in the south has been chosen as a polygon for hail modification aiming at mitigation of property losses. As an example, a case of hailstorm on September 7, 1991, in Calgary can be mentioned, which caused $416 million of damage [18].

In the paper, one of the experiments is considered of a cumulonimbus cloud modification, in which the effect was rather pronounced (July 7, 2006). The purpose of the paper is estimating the modification effect on the basis of complex analysis of radar data and numerical simulation results.

2. INSTRUMENTATION

For modification, the instrumented aircrafts are used. As an agent for modification, pyrotechnical mixtures on the basis of silver iodide are used as produced by Ice Crystal Engineering (USA). The onboard generators are applied which contain 150 g of the reagent. Their burning time is 4.6 min. The upper part of the cloud is subject to direct seeding when crossed by the aircraft. Temperature at the flight level is below the threshold temperature for reagent action (usually, below –5°C). Below the cloud, seeding also took place, when the reagent is injected into the updraft flow. Also, 20-g shooting cartridges are used. They are injected in the upper part of the cloud, the time of burning being 37 s, which corresponds to the dropping path within the cloud of about 1.2 km. Chemical composition of both modification agents is similar. Ice-generation efficiency is about 3.0×10^{13} g^{-1} ice nuclei under temperature of –10°C [14]. The girders with shooting