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Investigation of Cb Motion in the Province of Alberta (Canada)

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Abstract—Cb motion is analyzed in the paper. Storm observations were carried out in the province of Alberta (Canada) in 2005 with the help of radar. A new approach, based on determination of the vector of cloud track between radar scans, was used to study motion characteristics. Results of observations have shown that storms moved straight with some offset to the right in most cases. The merging of cells can significantly change storm track in some cases. The data obtained do not permit us to make a conclusion about the impact of seeding on cloud motion.

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INTRODUCTION

Investigation of Cu congestus and Cb motion is of undoubted interest to cloud physics and also is of interest for planning and conducting cloud seeding. This problem is important for aviation forecasts and for a number of applied problems. In previous publications, results of investigations of Cu motion were presented [1–4, 7, 10, 12, 13]. It was shown that in the Northern Hemisphere a strong updraft, which is the main dynamic factor of thunder-hail storm, is located as a rule in the right part of the cloud relative to the main updraft in the atmosphere. In this case, the deviation in the motion of a well-organized multicell Cb reaches 10–90° to the right from the dominant flow, while Cu cells can deviate 0–80° to the left from the dominant flow. For weakly organized cloud systems, different convective cells deviate in different directions in relation to the motion of the whole cloud field. In some cases, convective cells can deviate from the initial direction by 60–90°.

Some ideas are proposed in the literature to develop a seeding method of Cu clouds with the aim to change their motion [6], which is undoubtedly of great practical interest.

Let us briefly consider what physical factors lead to Cb deviation from a straight motion. This problem is poorly investigated theoretically due to its high complexity. Clouds are not a passive entity but have a complicated dynamical structure, that is, an essentially complicated interaction with their motion in the wind field. Really, on the one hand, the high vertical depth of Cu, and hence complexity in determination of the cloud motion direction due to wind shears, and on the other hand, the vertical transfer of momentum, side inflow, formation and dissipation of cells, all this significantly complicates the calculation of cloud motions.

It is known that objects moving in the Earth’s atmosphere are influenced by the relative acceleration (Coriolis acceleration) due to the Earth’s rotation. Without discussing a theory of this problem, we remark that this force is directed to the right from the direction of motion in the Northern Hemisphere, naturally, influencing Cb motion.

S.M. Shmeter [7] points out that one of the causes of the lack of coincidence of Cu direction of motion with wind direction is the Magnus effect, that is, the appearance of the cross force which arises due to Cb rotation along the vertical axis. A local pressure decrease takes place in the area where linear rotation velocity of the cloud is added to the relative velocity of its motion but in the opposite direction: its increase takes place. As a result, when rotation is cyclonic, which usually occurs in the Northern Hemisphere, clouds deviate to the right, and when rotation is anticyclonic, they deviate to the left relative to the wind.

Motion of a single cell under conditions of the atmosphere with wind shear is considered in [5]. It is shown that forces due to air inflow and outflow from a rotated updraft cause a cross component V_{cr} of cell velocity, which can be calculated by the formula