# Investigation of Large Vertical Depth Cb in India

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## I. INTRODUCTION

Investigation of severe storms is of great interest to cloud physics as there are a lot of dangerous atmospheric phenomena which are caused by them. There are a lot of publications which present their characteristics and analyze atmospheric conditions when such storms were observed, see, for example, Dovgaljuk et all., 1997, Krauss and Santos,2004, Sinkevich A.A.,2001, Stepanenko V.D., 1983. Here, we analyze the case study when super large Cb was developing. Radar data, satellite data and numerical simulation were used to study main characteristics of the cloud.

## .II. PRESENTATION OF RESEARCH

Development of large Cb was observed in Andhra Pradesh province in India on September 28 2004. Cloud top exceeded 18 km. The atmosphere was extremely unstable and convective available potential energy (CAPE) was equal to 6100 J/kg. Observations of the cloud were carried out during 6 hours and 17 min. The storm development was stimulated by several mergings with feeder clouds. The Cb produced intensive lightning though no hail was registered. Meteosat observations showed that a large anvil had formed at the beginning of observations and existed during all the life cycle of the Cb.

Radar measurements indicate that the duration of the developing stage of the storm was equal to 70 min Fig.1), the mature stage 100 min, and the dissipating stage 150 min. Maximum cloud area (projection to surface level) was equal to 1400 km$^2$. Maximum velocity of top growth was 16.6 m/s and top descent was -11.1 m/s. Radar reflectivity was relatively small for such a huge storm and did not exceed 44 dBz.

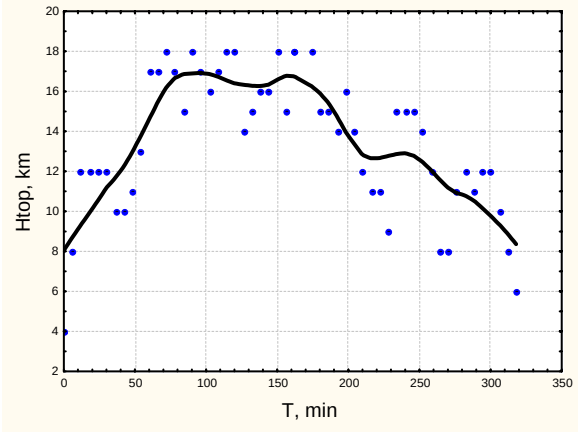


FIG. 1: Cloud top versus time.

Aircraft seeding with AgI glaciogenic reagent to increase precipitation was carried out during 104 minutes. It resulted in significant development of new feeder cells that merged with the main cell and affected the direction of its propagation.

Numerical simulation of storm development was carried out. A 1.5 time dependent numerical model was used. The results had demonstrated that vertical development of the cloud depended on its radius and significant development was observed only for clouds with radius greater than 10 km. Maximum updraft was very big and reached 50 m/s. Maximum LWC was also significant at 7.7 g/m$^3$.

## III. RESULTS AND CONCLUSIONS

Development of a huge tropical storm was observed when the CAPE value was extremely high.

Field experiment and results of numerical modeling indicate that the process of development of this huge tropical storm was determined in great extent by processes of main cell merging with feeder cells. Radar measurements indicate that its reflectivity was relatively small and that is significantly less than one can expect from such a large cloud. The reason could be the result of the absence of hail (no hail was registered from this storm). One can propose that the main mechanism of precipitation formation involved liquid drops coalescence. The formation of ice crystals could be the result of splinters emission during drop freezing. High velocities of updrafts provided possibility for liquid drops to reach high heights where they froze and formed a high concentration of splinters. The high concentration of such ice splinters could possibly be the reason for the absence of hail formation.

Aircraft seeding of the Cb resulted in the formation of new radar echo associated with new precipitation region (feeder cell), and further merging of this new feeder cell with the main cell. All this led to further cloud development.

## IV. AKNOWLEDGMENTS

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## V. REFERENCES

Krauss, T.W., J.R. Santos.,2004: Exploratory Analysis of the Effect of Hail Suppression Operations on Precipitation in Alberta. *Atmos. Res.*, 71, 35-50.

Dovgaljuk Yu.A., et all., 1997: Results of Investigations of Cu cong Characteristics After Seeding. *Meteorology and Hydrology*, 11, .20-29.

Sinkevich A.A.,2001:Cu of North-West of Russia. *Hydrometeoizdat*, 106 p.

Stepanenko V.D., 1983: Radars in Meteorology. *Hydrometeoizdat*, 203 p.