T-RE PLOTS GENERATED FROM MSG DATA IN SEVERE STORM FORECASTING – TESTING IN CENTRAL EUROPE

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I. INTRODUCTION

The use of T-re profiles (*T* represents cloud top temperature and *re* means effective particles radius) in the severe storms and their dangerous accompanying attendant phenomena (such as hails or tornadoes) was introduced by Daniel Rosenfeld (Institute of Earth Sciences, The Hebrew University, Jerusalem, Israel) and Itamar Lensky (The Department of Geography and Environmental Studies, The Hebrew University, Jerusalem, Israel) already in 1998 (Rosenfeld and Lensky, 1998). According to their assumptions the MSG data can be efficiently used to track cloud particles effective radius evolution depending on convective cloud top temperature, these theories were used in various projects. T-re plots were tested and verified in several countries, namely Texas, California, Brazil, Israel and southern Africa, where concretely MSG data was used to observe the evolution of T-re relationship (Lindsey et al., 2006). Therefore their methods can afford another nowcasting tool aimed at dangerous weather event forecasting in Central Europe and can improve forecasting fruitfulness of these weather phenomena.

II. PRESENTATION OF RESEARCH

We use MSG data focused on Central Europe for cloud top temperature and cloud particles effective radius observing using the T-re plots. These plots show some typical features useful in severe weather nowcasting. The evolution of cloud top effective radius (*re*) with cloud top temperature (*T*, or height) at specific time for cloud group is similar to T-re evolution of given cloud in this location. The *re* near cloud top is similar to that inside clouds at the same height before precipitation falls through these clouds. Constructed T-re plot of a convective cloud area is stable in time and depends mainly on the thermodynamic and aerosol properties of the air mass (Lensky and Rosenfeld, 2005). These assumptions mean that we can use T-re plot for the whole chosen area instead of tracking T-re evolution for each individual cloud. Cumulonimbus clouds have nearly the same T-re relation such as clouds which did not reach the Cb stage.

Mostly the 15th percentile is analyzed, because it represents younger vigorously growing clouds in the given height (temperature). Temperature of -38 °C expressing homogenous freezing threshold and particle radius size of 14 μm showing precipitation threshold are taken in account, analysis is done according to the shape and steepness of the T-re plot, position of described temperature and size to 15th percentile line is also very important indicator in the analysis and forecasting. Some other values such as TL (temperature of the liquid phase top), Tg (temperature of glaciation phase bottom) and their relations are analysed and can help to find cloud areas prone to grow into severe storms. For more details, see e.g. (Rosenfeld et al., 2008).

III. RESULTS AND CONCLUSIONS

Testing of the T-re plots was done for example in North America, South America, South Africa or Israel. Different satellite images (MSG included) were used depending on location, evaluation was done with help of radar, radiosonde measurement and special cloud scanner aboard jet aircraft (Martins et al., 2007; Rosenfeld et al., 2006].

Described assumptions tested in several countries are evaluated for the Czech Republic and its vicinity on archive data for days when intensive accompanying phenomena of storms were reported. Received profiles are very similar to those from the USA so it can be an applicable tool for severe storm nowcasting in the Czech Republic as well. One chosen analysis (due to extent of this paper) for Central Europe region follows, dangerous phenomena and T-re features are described.

Central Europe was influenced by low pressure trough and accompanied cold front on the 12th June 2010 that was moving to south-east, temperature maxima were about 26 °C, after 15 UTC near Olomouc and Tábor mighty Cbs were observed, after 16 UTC in the vicinity of Šumperk thunderstorms developed. Near Tábor a supercell probably formed, rotation of the cloud system was observed and funnel cloud was reported, after 17 UTC 3 cm hail and heavy rain occurred. Strong wind gusts about 18.30 UTC followed by heavy precipitation in southern Moravia was reported, cellars were flooded. After 20 UTC strong wind gusts damaged some roofs in southern Moravia. In Austria strong wind was observed about 18.30 UTC, it raised sand and dust and was followed by heavy rain, roof and chimney damage was reported, after 15 minutes wind speed on squall line was 25 m/s.

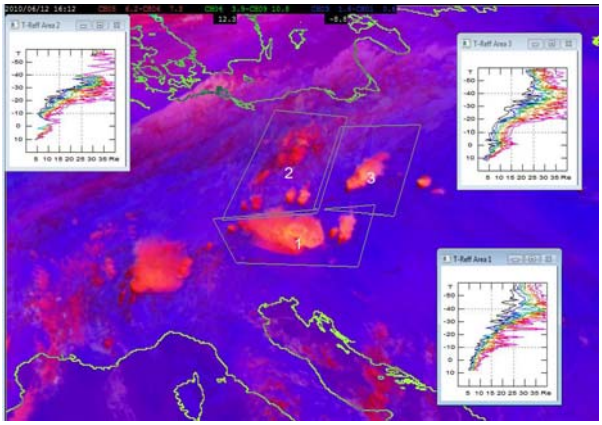

FIG. 1: Analysis of the 12th June 2010, 16.12 UTC

Analysis on Figure 1 shows that T-re plots of clouds include very small particles (less than 15 μm in radius) up to

temperature (height) about -20 °C, from this reason it seems there must be strong updraft in the lower part of clouds, namely in the plot signed Area 1, we can recognize long and nearly linear part of plot indicating severe weather occurrence was possible. Plots in Figure 1 are very similar to that profiles gained by Rosenfeld during his test in USA etc. when hail and other severe weather events occurred. This may be confirmed by hail report from the south of Bohemia and other dangerous phenomena nearby.

The basic principle of described theory is satellite observation of clouds in the different spectral channels, what enables to generate T-re plots of microphysical constitution of clouds. These profiles were already successfully tested in different countries. If we confirm their validity in the Central Europe, we would get useful nowcasting tool for severe convective storms and their dangerous accompanying phenomena, improving our skills of forecasting that may help to protect estate as well as people's lives. Our analysis was done on archived satellite data chosen according to dangerous weather reports. But applicability of this theory has to be confirmed by analyzing of nonsevere situations to separate weather events that endanger people and their property from the nonsignificant weather phenomena. From this reason, the next step is operative testing of this theory on real-time MSG data during convective season. Objective criterion based on these analyses should be established and in case of interest of national weather service automatization of this tool will be constructed.

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