The evolution of severe convective systems causing local flash floods represents a rapid process, which is still hardly possible to predict and thus it is difficult to provide a reasonable forecast or even warning to the public. For that reason the case studies, collecting complex information from various data sources as well as the application of fine mesh NWP models, serve as a useful tool to increase understanding of processes of cloud systems evolution, resulting into a flash rainfall.

In this contribution we document a rapid evolution of storms on the 15th July 2002 by a series of Meteosat imagery, together with the relevant radar data. The major storm occurred at central Moravia (the Blanensko region) and caused a large local damage in the area to the north of the town Brno between the Svratka river and the Svitava river. The paper shows the results of experimental integration of NWP model (horizontal resolution 2.8km) and compares the model-retrieved cloud structure with satellite and radar information.

1. INTRODUCTION

The prediction of convective systems is still hardly possible and the deeper understanding of processes taking place in the evolution of such complex systems is necessary. The multi-sensor analyses of convective systems using satellite, radar and NWP outputs can help us in this process of understanding. The direct comparison of model outputs with other information sources is difficult and the calculation of synthetic satellite and/or radar measurements could serve as a valuable tool when studying the quality of model results.

This paper presents the first experiments with calculation of satellite synthetic images using LM COSMO model (the 3.7 version introducing the ability of synthetic images calculation was released in April 2004)

2. SYNOPTIC SITUATION

The large-scale situation was characterized by the pressure low over Northern Italy and eastern to southeastern warm and humid flow to the area of CR. During 13th July 2002 the convective activity was observed over the whole Czech territory and it intensified again on 15th July. The overall synoptic situation is documented by Figure 1. At 14 UTC the convective storm appeared 20-30 km northwest from the town Blansko and cold outflow from this storm met with the eastern warm and humid flow through the troposphere. The convective storm then evolved and remained in nearly steady position from 15 to 17 UTC.

The maximum precipitation amount of 171 mm was measured by Olesnice station and caused the flash flood in the Svratka river catchment and Svitava river branches (for details see Soukalova, 2002 or http://www.chmi.cz/poboc/BR).
Figure 1. Synoptic situation in the central Europe on 15th July 2002 analyzed by Berliner Wetterkarte.

3. MODEL CONFIGURATION

The model results were produced by LM COSMO (Doms, Schaettler, 1999) version 3.9. The calculation of synthetic satellite images was originally developed as LMSYNSAT (Keil, Tafferner, 2003) and starting from LM version 3.7 it became the integral part of LM COSMO. The LM provides only the interface and the RTTOV7 library licensed by EUMETSAT is used to calculate synthetic satellite image from model outputs (Eyre, 1991, Saunders et al., 1999).

The LM was used in two steps – the driving model covers the majority of Europe and the driven model contains the area of CR and surrounding.

Driving model (LLM) was run with horizontal resolution 11 km, 35 vertical levels and 229 x 173 grid points. Initial and lateral boundary conditions were taken from ECMWF objective analysis in 6-hour time-step. The cumulus parameterization by Tiedtke was used (Tiedtke, 1989). The LLM run started at 15th July 00 UTC and kept going to 16th July 12 UTC.

Driven model (SLM) was used with horizontal resolution 2.8 km, 50 vertical levels and 251 x 191 grid points. The SLM used the initial and lateral boundary conditions from LLM in hourly time-step. The explicit modeling of cloud convection took place in this model configuration. The SLM was run with the LLM results starting 15th July 06 UTC and the period of forecast was 18 hours. The model domains of LLM as well as SLM are shown on Figure 2.

The radar data from radar Skalky (Gematronik METEOR 360AC, C band with the wavelength 5.3 cm, operated by the Czech Hydrometeorological Institute) were used in this study. CHMI Praha-Libus provided the METEOSAT PDUS images.
4. RESULTS

The first experimental tests of LM model allowing the production of synthetic satellite fields is presented in this paper. We concentrated only on the comparison of IR METEOSAT images although the RTTOV library can produce images in other spectral channels and/or of other satellites. Figure 3 shows the METEOSAT and synthetic satellite images for the area of LLM. The basic structure of the cloudiness in the central part of the model domain seems to be well interpreted by the model. There is a clear tendency of the model to produce higher values of brightness temperatures. The model images also seem to be behind the real situation. The convective processes are less pronounced by model synthetic images. The origin of the cloud band in the northwest area of model domain is not clear. The cloud band proves no activity in precipitation fields as follows from Figure 4 and the cloud structure indicates the high cloudiness. This should be confirmed by the analysis of model cloud water and cloud ice fields.
Figure 4. Model accumulated precipitation for 06 – 18 UTC.

Figure 5 shows the comparison of satellite and synthetic model images for the SLM run. The convective structures are better expressed in this case, however the location of cloud fields is not perfect. The waves are visible in the eastern part of model domain. The underestimation of cloud top temperatures is also apparent. The comparison of accumulated model precipitation with the accumulated radar rainfall is on Figure 6.

Figure 5. METEOSAT and synthetic model images produced by SLM for 12 UTC, 15 UTC and 18 UTC
5. CONCLUSIONS

It is obvious that the results of comparison of synthetic and satellite images depend on the quality of model forecast. The very first results indicate the underestimation of cloud top brightness temperature. We plan additional tests with various model parameters. Apart from precipitation amounts the analysis of cloud variables model fields is necessary.

Various modifications of model runs will be tested with verification of precipitation forecast by radar (the work will be presented in ERAD 04).

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7. REFERENCES


