RELATIONSHIPS BETWEEN DATA MEASURED BY WEATHER RADARS AND METEOSAT SECOND GENERATION FOR CONVECTIVE STORMS

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I. INTRODUCTION

The techniques of remote sensing have been particularly developed for monitoring of convective systems that produce heavy rainfalls and consequently local flash floods. Some works dealing with these techniques are focused either on detecting of convective storms by weather radars (e.g. Johnson et al., 1998) or meteorological satellites (e.g. Setvák et al., 2003). Some of the studies have also worked with both types of data to find a suitable rain-rate retrieval algorithm and thus to obtain more accurate information (e.g. Amorati et al., 2000).

The aim of this study is to determine quantitative and qualitative relationships between data measured by weather radars and the meteorological satellite. The Convective Rainfall Rate (CRR) algorithm developed within the Satellite Application Facility on support to Nowcasting and Very Short-Range Forecasting (SAF NWC) context (SAFNWC a, 2009) has been used for this purpose as well as in order to test the algorithm on the area of the Czech Republic (CR).

II. PRESENTATION OF RESEARCH

Data used in this study were measured in the warm parts (April to September) of the years 2007-2008. For validation purposes data for convective event in June 2006 were used as well. The study deals with two types of data.

The first type represents cloud top temperatures scanned by geostationary meteorological satellite Meteosat Second Generation (MSG-2) which measures temperature every 15 minutes (at 00, 15, 30 and 45 min in each hour) in 12 different SEVIRI (Spinning Enhanced Visible and Infrared Imager) channels. Subsequently, time integration has been used in order to obtain hourly precipitation data.

The second type of data was derived from radar reflectivities which were performed every 10 minutes (at 00, 10, 20, 30, 40 and 50 min in each hour) in a horizontal resolution of 1 km by Czech weather radar network CZRAD (Brdy, Skalky). Reflectivities were converted into rainfall intensities through standard Z-R relationship (Novák and Kráčmar, 2002) and hourly precipitation sums were obtained by time integration and merging with daily rain gauge measurements using two methods. The first method is based on the interpolation of the modified ratio method (MRM) described in (Sokol, 2003) and it is used as a main adjusted method in this paper. The second adjusted method MERGE was described by (Šálek et al., 2004) and it is used here for validation purposes.

III. RESULTS AND CONCLUSIONS

Data have been processed according to the Algorithm Theoretical Basis Document (ATBD) for the MSG product PGE05 (CRR) of the SAF NWC/MSG software package (SAFNWC a, 2009). Although all SAF NWC/MSG software package is coded for "C" in Linux, in this contribution data were prepared and computed in "Matlab" using Windows operational system. Therefore it is probable to expect slightly different results during verification.

In this study, two types of verification method have been processed. After obtaining hourly precipitation sums derived from SAF the first verification method was performed by comparing with radar derived precipitation sums, taken as "truth data", in 3 x 3 pixels boxes. If the term did not exist for both types of data, this one was excluded from the verification process. The results of processing data from the period 2007-2008 including the categorical statistics derived from contingency table convention for both types of adjusted methods are shown in the tab. I. The table contains also the results of validation report (SAFNWC b, 2009) and results of verification with data provided by Czech Hydrometeorology Institute (CHMI) for convective event occurred on 25 June 2006 (described later). The threshold for distinction of occurred event was set up according to the validation report as an event higher than 0 mm/h. It is important to notice that data processed in this validation report include only 28 convection days from summer 2008 over the area of Spain.

	SAF_V2009 x RADAR	SAF_CR x MRM	SAF_CR x MERGE	SAF_CR x SAF_CHMI
CSI	38,80%	8,93%	9,79%	55,39%
PC	64,50%	79,05%	78,56%	82,94%
POD	49,70%	75,47%	76,22%	64,22%
FAR	36,00%	90,80%	89,90%	19,88%
MAE	0,84 mm/h	0,11 mm/h	0,12 mm/h	0,73 mm
RMSE	2,15 mm/h	0,30 mm/h	0,35 mm/h	2,23 mm

TABLE I: The accuracy and categorical statistics of MSG data with regard to radar rainfall estimates for validation report (SAFNWC b, 2009) including data from summer 2008 (2nd column), adjusted method MRM (3rd column) and MERGE (4th column) for data from 2007-2008 as well as data processed in CHMI for convective event occurred on 25 June 2006 (5th column). Abbreviations in the 1st column: CSI – critical success index, PC - proportion of correct, POD - probability of detection, FAR - false alarm ratio, MAE - mean average error, RMSE - root mean square error.

Both types of adjusted methods gave very similar results but they are far from the results of validation report. Some of the categorical statistics (CSI, FAR) gave worse results than the validation report but on the contrary PC and especially POD are higher. This fact is caused by including non-precipitation days during data processing. Quantitative differences between data derived from radars and satellite were not as marked as probably in the validation report (for instance mean precipitation amount for data derived from satellite was 0,17 mm/h and for data derived from radar 0,03 mm/h). This can explain lower values MAE and RMSE. Generally, different results in our work can be affected by using of matrices defined in (SAFNWC a, 2009) and also by using data from longer period.

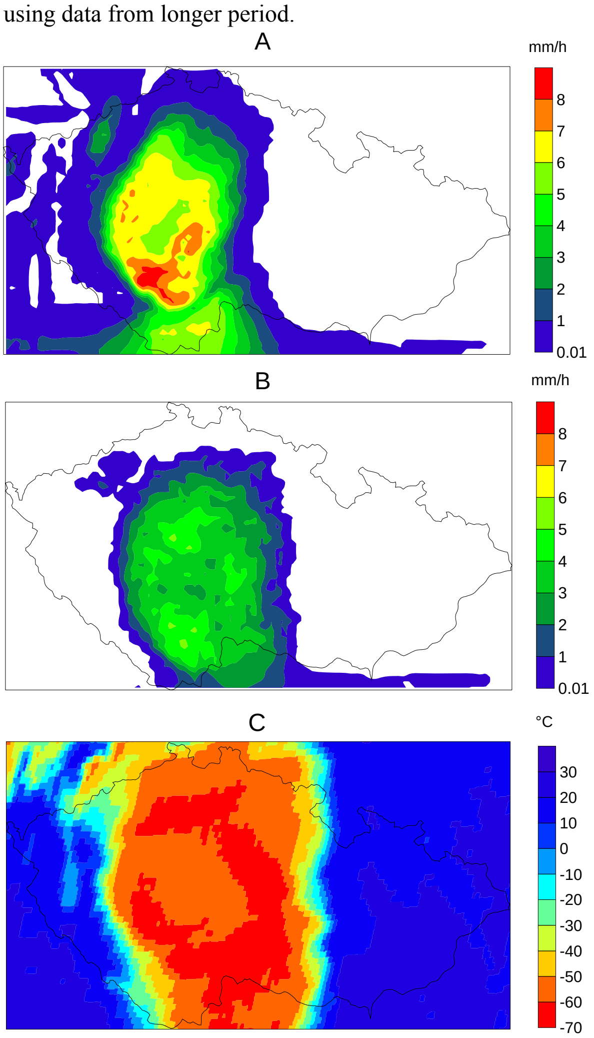

FIG. 1: The convective event occurred on 25 June 2006, 15-16 UTC over the area of the CR processed with SAF NWC by our algorithm using "Matlab" (subfigure A) and with SAF NWC processed in CHMI using "C" (subfigure B). Subfigure C shows temperature field as seen by MSG-2 in IR 10.8 band.

The second verification method was based on comparing of data generated by our algorithm with data processed in CHMI using Linux operational system and "C" for convective event which occurred on 25 June 2006 and which caused extensive damages and local flash floods (Setvák et al., 2007). Data were provided from 11 UTC to 17 UTC in a horizontal and time resolution corresponding to resolution of MSG scan over the area of the CR (3-4 km for horizontal and 15 min for time resolution). The first hour (11-12 UTC) was excluded from the processing because of a lack of data (no convection). Subsequently, time integration has been performed in order to obtain hourly precipitation estimates. Data were compared pixel by pixel for each hour and the evaluation was processed in the same way as in the first verification method. The results are shown in the last column of the table I and the example of this convective event from 15 to 16 UTC in fig. 1. The structure of the storm (so called "*cold-U/V* or *enhanced*") (Setvák et al., 2007) is very similar as well as the position within the area of the CR. However, the quantitative values of precipitation amounts slightly differ and both data types are far from to be accurate in comparison with adjusted radar precipitation amounts.

Therefore, some steps needs to be done. The possible improvement can be reached by creating of the own calibrating matrices for the area of the CR. The next step will be aimed at including of advection flow into the CRR algorithm and comparing with data without advection. Future work will also deal with the relationships between MSG data and operational radar products, such as CAPPI 2km (constant altitude radar reflectivity field at altitude of 2 km), ECHOTOP (echo top heights) which is defined as the maximum height (in km) where at least 4 dBZ are measured, and VIL (vertically integrated liquid water content).

IV. AKNOWLEDGMENTS

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