15B.3 RADAR-BASED RAINFALL NOWCASTING AT EUROPEAN SCALE: LONG-TERM EVALUATION AND PERFORMANCE ASSESSMENT

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1. INTRODUCTION

Precipitation is the triggering agent of natural hazards that have very serious impacts on people's life and goods (i.e. floods, debris flows, landslides…), which require very high-resolution rainfall forecasts to improve the capability of issuing alerts with enough anticipation.

Germann et al. (2006) and Berenguer et al. (2012) showed that the use of Continental radar mosaics allows clear improvement in the performance of nowcasting techniques based on the extrapolation of radar observations, providing reasonable forecasts for lead times up to 6 hours using NEXRAD observations over the central-eastern Continental US. Also, Berenguer et al. (2012) found that, on average, radar-based nowcasting outperformed radar data assimilating models for 2–4 h after initialization, and models not assimilating radar data for up to 5 h after initialization.

Recently, the EUMETNET programme OPERA (Matthews et al*.,* 2011) has succeeded in operationally generating a European precipitation map in real time from the National radar networks in Europe, with the resolution of radar measurements (2x2 km^2 and every 15 minutes). This product fulfills the requirements of many applications involved in anticipating precipitation-induced hazards (for instance, in decision-making in Civil Protection agencies). This study analyzes the skill of very short-term rainfall forecasts generated from the Continental OPERA precipitation maps, to what constitutes the first application of these maps for rainfall nowcasting at European scale.

2. DATASET AND NOWCASTING ALGORITHM

Input data of this study are the Continental radar mosaics generated from the National radar networks in Europe within the EUMETNET programme OPERA. These benefit from the quality control performed at the European Radar Data Centre (Odyssey). The data used here were collected between 01 June 2012 and 31 May 2013 and 8-hour rainfall forecast were generated operationally every 15 minutes.

Figure 1 shows the map of the frequency of observed reflectivity values exceeding 10 dBZ for the month of June 2013. This map illustrates the high detail of the precipitation field at European scale. For example, it shows the lack of precipitation over the Southern part of the Iberian Peninsula, or that in the Eastern Alps, some areas had precipitation for more than 15% of the time (extreme flooding occurred in south and east Germany, Czech Republic and Austria at the beginning of June). The Figure also shows the coverage of the network, which decreases with distance in the edges of the network (as shown by the lower frequency values). On the other hand, the Figure also evidences areas with reduced radar coverage due to the orography over the main mountain ranges (e.g. over the Alps or in the area between Sweden and Norway), and shows some artifacts (such as systematic ground and sea clutter or interferences) that will need to be further taken care in future versions of the quality control process.

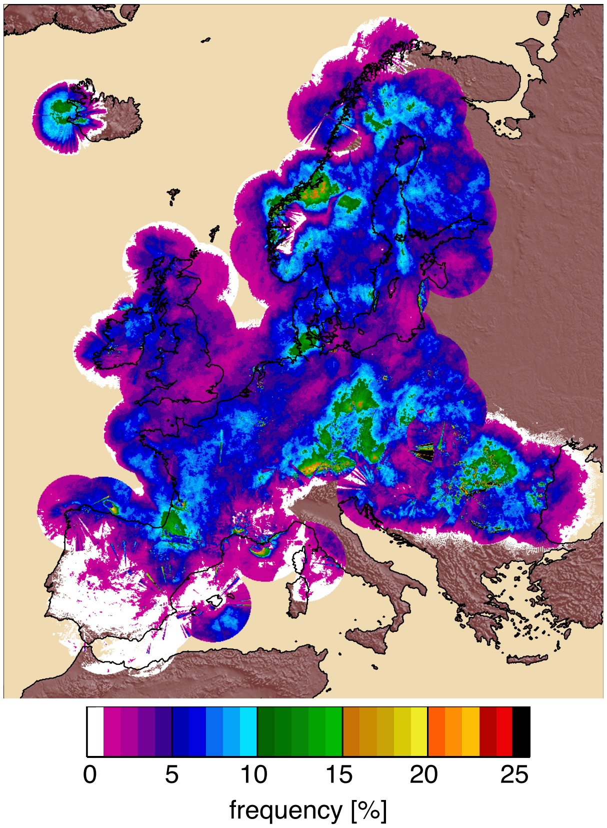

Fig. 1. Frequency of radar echoes exceeding 10 dBZ during the month of June 2013.

The nowcasting technique used in this work is the same as used by Berenguer et al. (2011), and it has been adapted to run on OPERA mosaics. The motion of

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Corresponding author address: Marc Berenguer, CRAHI-UPC, Barcelona (Spain). Phone: (+34) 934054195; email: marc.berenguer@crahi.upc.edu the precipitation field (one example is shown in Fig. 2.) is estimated from recent observations at a resolution of 50 km and interpolated to the grid resolution. Finally, precipitation nowcasts are obtained by advecting the most recent mosaic with a semi-Lagrangian backward scheme.

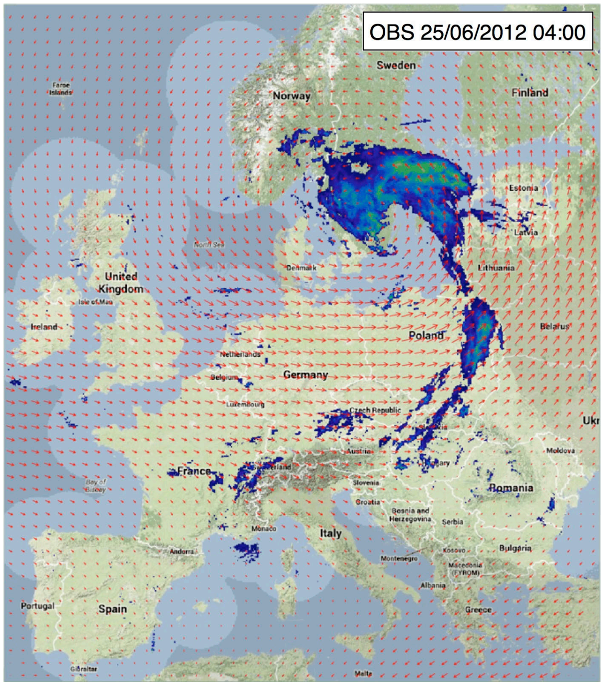

Fig. 2. Motion field of precipitation estimated on 25 June 2012 at 04:00 UTC.

3. RESULTS

Figure 3 shows the mean correlation between rainfall nowcasts and observations [calculated without subtracting the mean, as proposed by Germann et al. (2006)] as a function of the lead time for the entire analysis period. The decorrelation time (or life time) was used by Germann et al. (2006) to assess the performance of the algorithm in different precipitation events. The average lifetime for the analyzed period (01 June 2012 to 31 May 2013) has been found to be around 5.2 hours over the entire domain for the analyzed period.

This value is very similar to those reported by Germann et al. (2006) and Berenguer et al. (2012) for long-term evaluation of radar-based nowcasts over North America.

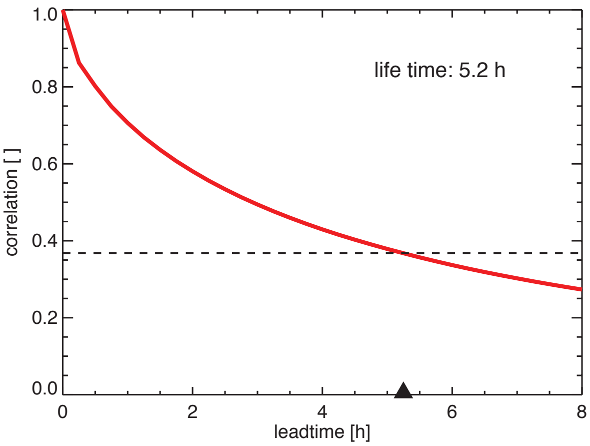

Fig. 3. Average correlation between observations and forecasts as a function of leadtime for the period 01 June 2012 to 31 May 2013.

4. VARIABILITY IN SPACE AND TIME

However, there is a major variability of the performance of extrapolation-based nowcasting. In this sense, the evolution of lifetime during the analyzed period (Fig. 4) shows significant variability with values ranging from 2 to 15 hours (the latter mostly coinciding with large-scale long-lasting precipitation systems).

Also, the performance of nowcasting is variable over the OPERA domain. This can be seen in Fig. 5, which shows the poor performance near the Western edges of the OPERA network, where the Atlantic systems cannot be forecasted due to the lack of observations.

The highest lifetime values are obtained over France and Great Britain (with values exceeding 10 hours) and over the Northeastern Baltic and Finland. These regions benefit from good coverage of the OPERA network and from the better predictability of the precipitation systems affecting them.

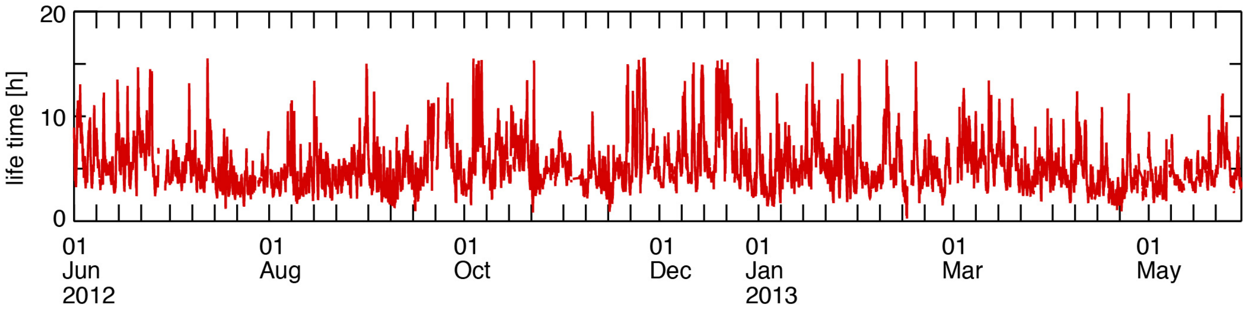

Fig. 4. Time series of lifetime computed from precipitation nowcasts during the period from 01 June 2012 to 31 May 2013.

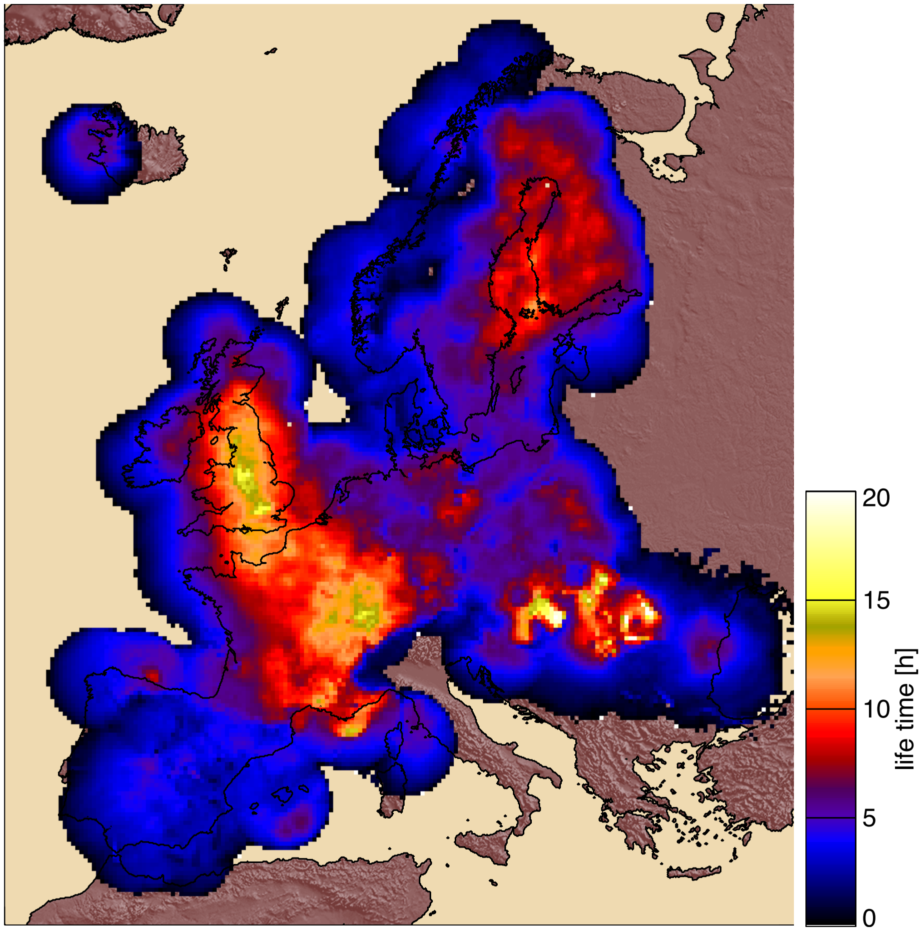

Fig. 5. Average lifetime for the period from 01 June 2012 to 31 May 2013.

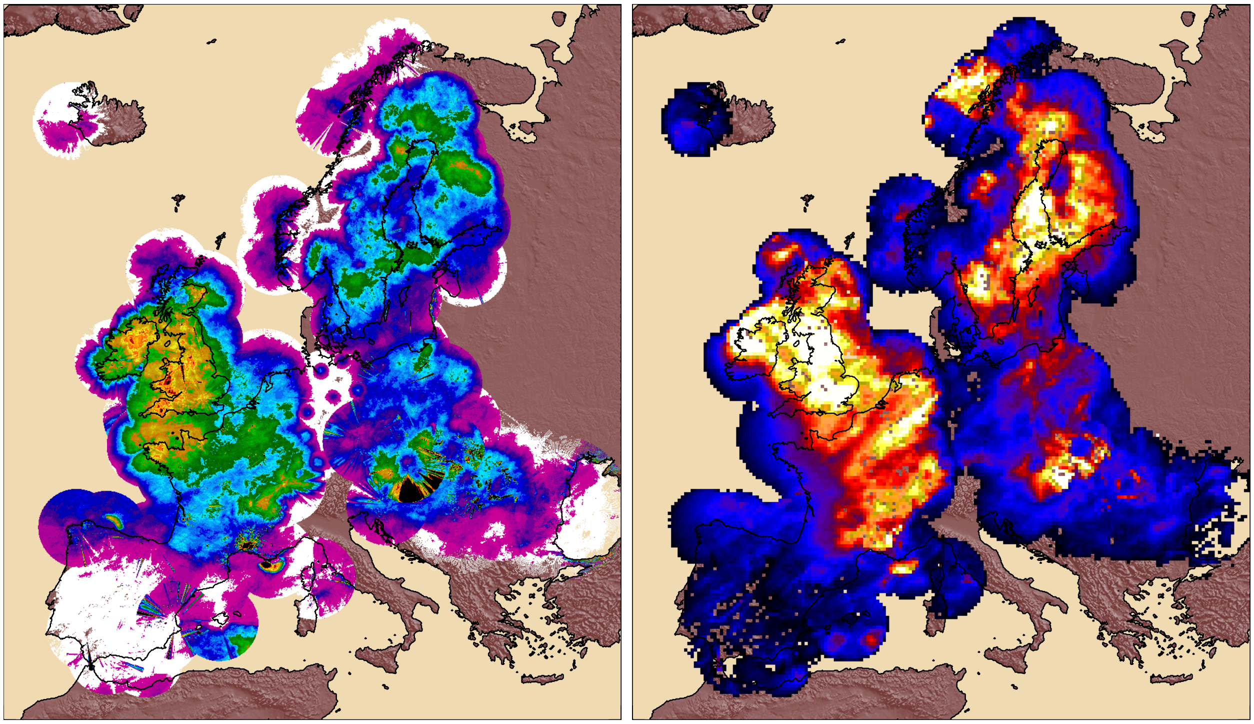

Fig. 6. Frequency of radar echoes exceeding 10 dBZ (left) and average lifetime (right) for the month of June 2012.

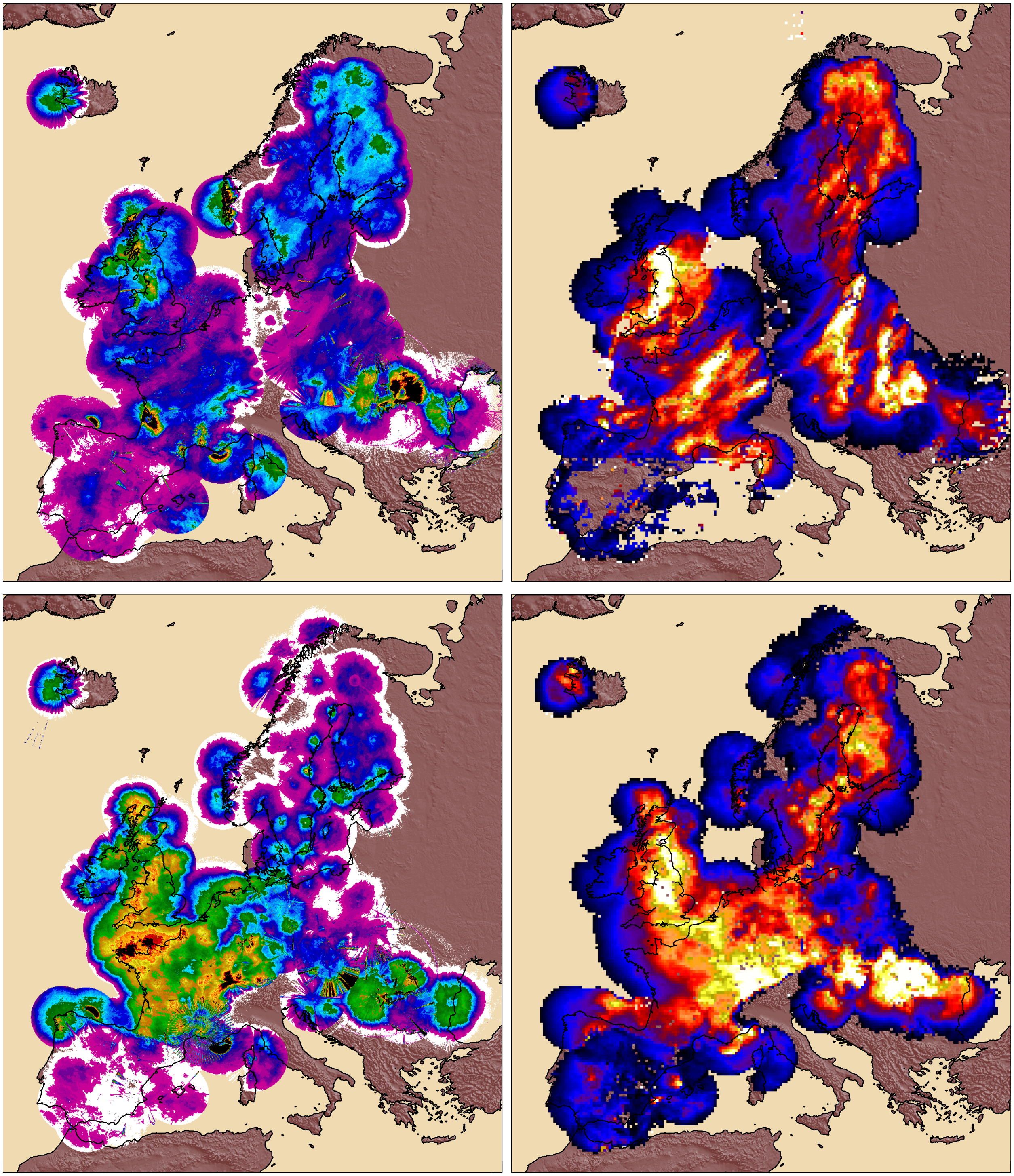

Fig. 7. Same as Fig. 6 but for September 2012 (top) and December 2012 (bottom).

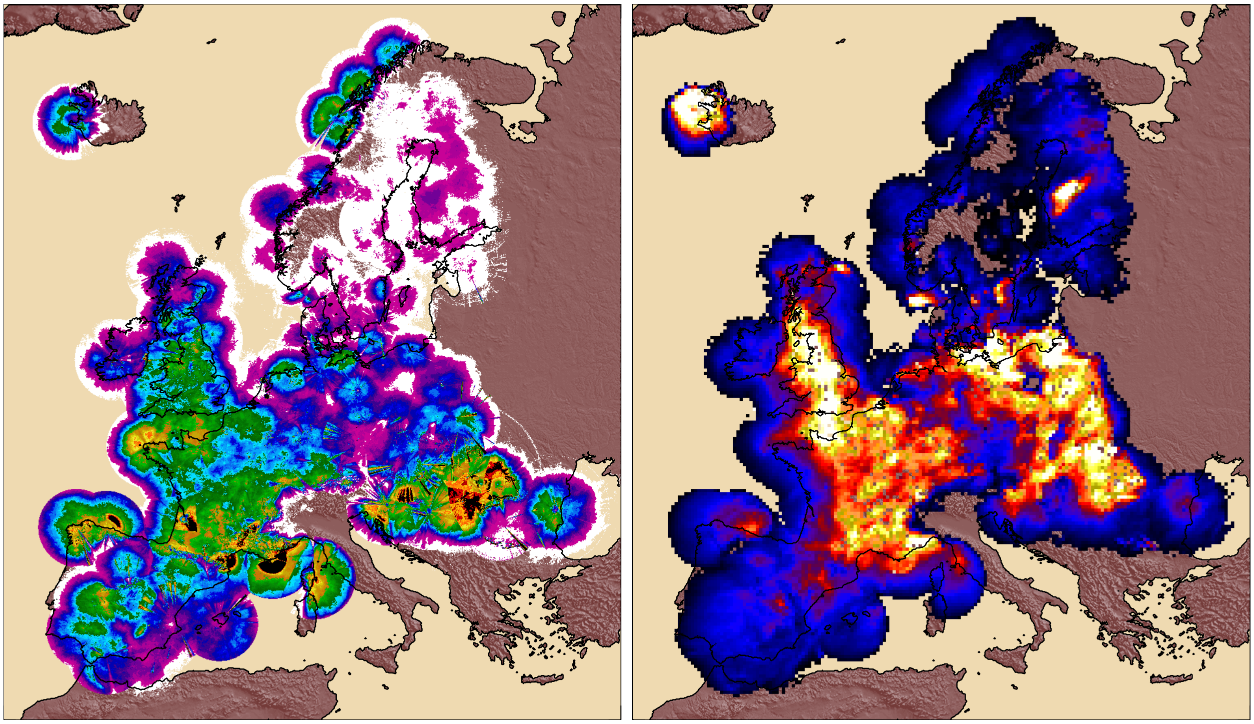

Fig. 8. Same as Fig. 6 but for March 2013.

Also, there seems to be some degree of correspondence between the frequency of precipitation and the quality of the nowcasts (expressed in terms of the lifetime): better skill is obtained in the areas where precipitation occurred more frequently. This can be observed in Figs. 6-8 for the months of June, September, December 2012, and March 2013.

5. NOWCASTING-NWP COMPARISON

A first comparison of the performance of nowcasting with that of the rainfall forecasts obtained with the Numerical Weather Prediction model HIRLAM (as run operationally at the Finnish Meteorological Institute) is presented for the event of 01-02 June 2013 (the radar-based rainfall accumulation for the entire event is shown in Fig. 9). Fig. 10 shows the correlation between rainfall forecasts and OPERA rainfall accumulations. In the Figure it can be seen that the model needs about 2 hours to start generating rainfall. Beyond the third hour, the correlation takes a relatively constant value of around 0.45 for up to around 36 hours. On the other hand, nowcasts show a very high correlation with rainfall observations, decreasing with leadtime. For this particular case, the different nowcasting runs performed better than NWP for around 4-5 hours.

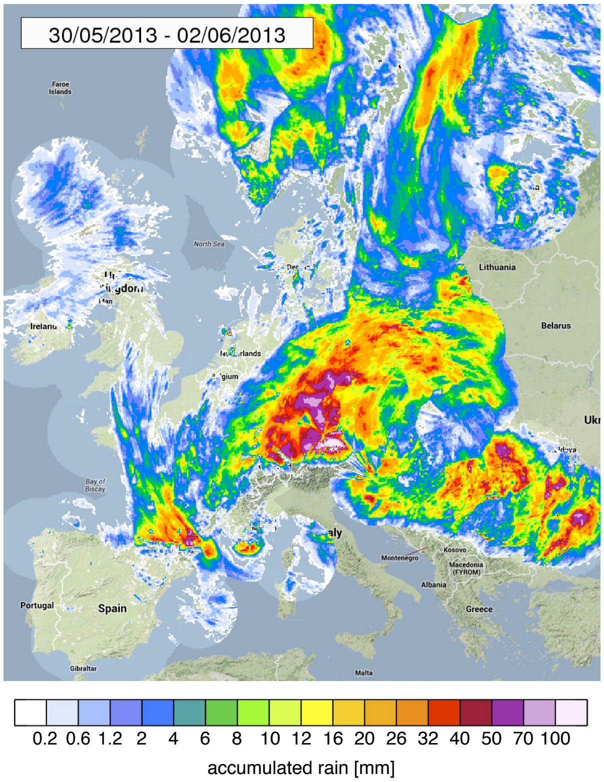

Fig. 9. Rainfall accumulation estimated from OPERA mosaics corresponding to the period 30 May to 02 June 2013.

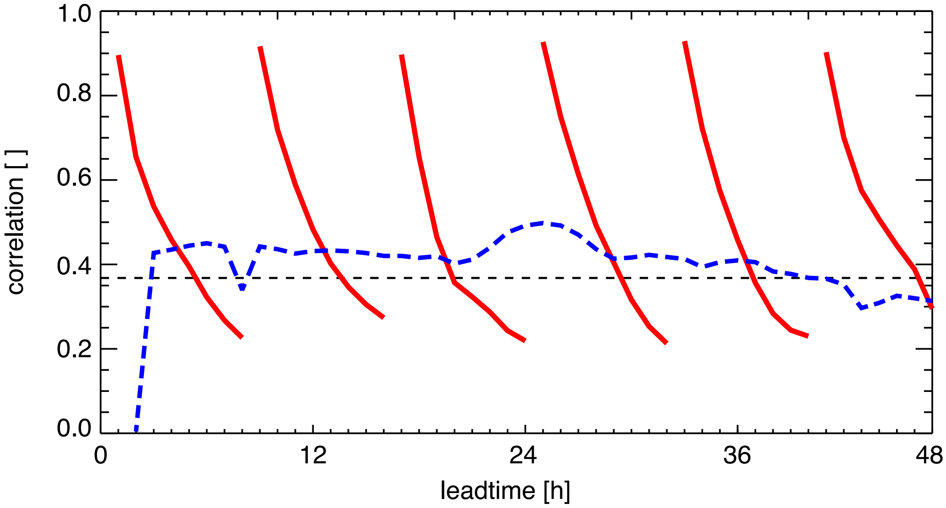

Fig. 10. Correlation between OPERA observations and rainfall forecasts obtained with the HIRLAM run corresponding to 01 June 2013 at 00:00 UTC (dashed blue line), and with the analyzed nowcasting system run on 01 June 2013 at 00:00, 08:00, 16:00 UTC and on 02 June 2013 at 00:00, 08:00 UTC (red lines).

6. CONCLUSION

This paper examines the performance of an algorithm for rainfall nowcasting at European scale using the radar mosaics generated within the EUMETNET programme OPERA during the period from June 2012 to May 2013.The study shows a mean decorrelation time of around 5.2 hours [similar to those reported by Germann et al. (2006) and Berenguer et al. (2012) over North America]; however, significant time and space variability of the performance of the algorithm has also been found, with the best performances achieved in the areas most affected by precipitation, especially in the Great Britain and northern part of France, and in the Baltic region.

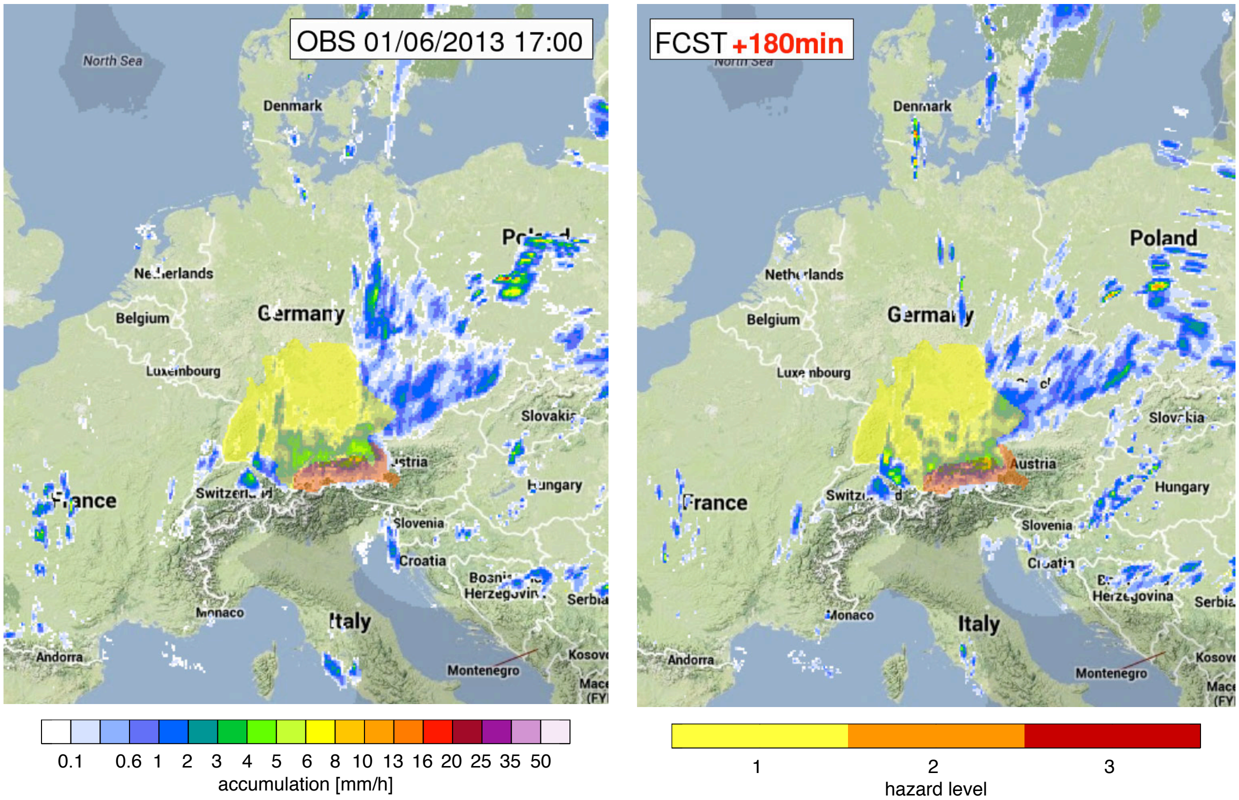

Fig. 11. Hazard level overplotted on hourly rainfall accumulations for 01 June 2013 at 17:00 obtained from radar observations (left), and from 3-hour rainfall forecasts (right).

The system has been used to demonstrate its usefulness for hazard assessment within the Prevention Project HAREN funded by the EC Humanitarian Aid and Civil Protection Office. With this aim, the nowcasting system has been coupled with the intense rainfall thresholds used by the national Meteorological Services participating in the EUMETNET project METEOALARM. Different thresholds are used in different regions within Europe to assess the hazard level (yellow, orange and red levels, as shown in the example of Fig. 11) depending on the expected danger of the observed/forecasted precipitation.

ACKNOWLEDGEMENTS

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