Predictability assessment of nowcasts in high-impact heavy precipitation events

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1. Introduction

Heavy rainfall events and subsequent flash flood forecasting are among the most significant challenges faced by hydrometeorological agencies. Therefore, successful hydrological management includes prioritizing Flood Early Warning Systems based in very short term precipitation forecasts, or nowcasting systems, as recently reviewed by Pierce et al. (2012).

In such a context, the simulation of the basin response is affected by a number of errors of different nature, which limit the performance of the forecasting system. The development of a probabilistic approach able to provide additional information on the reliability of flow simulations would certainly be valuable for the operators in charge of issuing warnings and decision-making as illustrated in Berenguer et al (2005, 2011) and German et al. (2009).

In this study we examine several heavy precipitation events and assess the predictability of short term (up to 3 h) forecasts. The analysis is illustrated here with the 2 November 2008 event that affected Catalonia (NE Spain) with heavy rainfall (24 h precipitation exceeding 100 mm) an F2 tornado and a microburst (Figure 1) – see Bech et al. (2011) for more details.

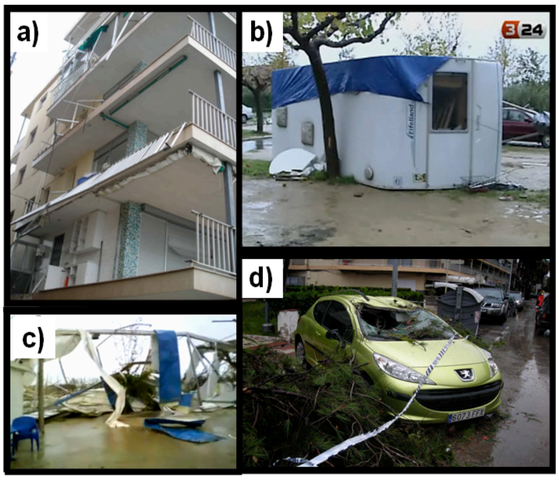

Figure 1. *Heavy rainfall with subsequent flash floods and strong wind caused severe damage on the 2nd November 2008 on southern Catalonia (NE Iberian Peninsula). The four panels show damage in Salou (a,c, and d) and a nearby camping area (b) – source: Bech et al. (2011).*

2. Methodology

The precipitation nowcasts used in this study are derived as follows. From a series of quality controlled radar reflectivity fields, a motion field of precipitation is first derived. Most recent field is extrapolated accordingly considering a Lagrangian Persistence (LP) approach. When observations become available forecast verification for each lead time is performed (Figure 2). This process is iterated at every time step. An ensemble approach based on the hypotheses of the String of Beads model (Pegram and Clothier 2001, Berenguer et al 2011) is used to describe the uncertainty in nowcasts by Lagrangian Persistence.

Additionally, comparison with raingauges allows obtaining a specific assessment of the nowcasts quality, which usually is obtained only from radar quantitative precipitation estimates as reported in previous studies.

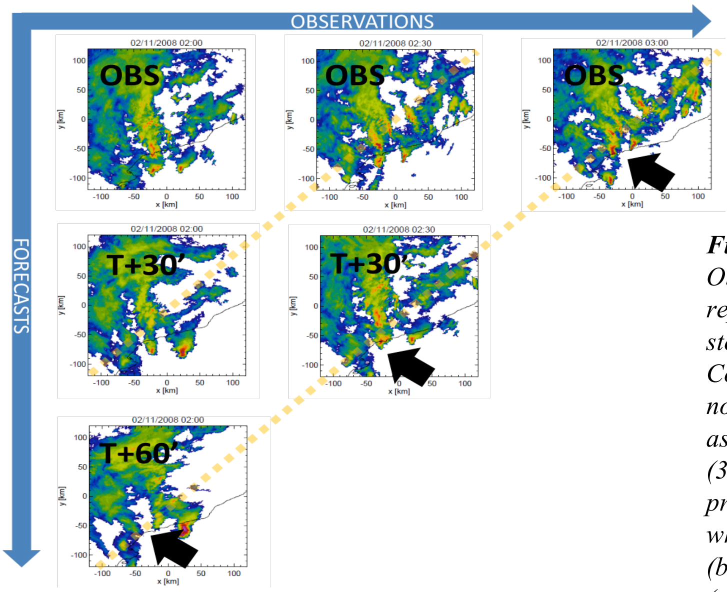

Figure 2. *Illustration of the analysis process in Observations - Forecasts space. The upper row represents the observations sequence. At every time step a column (series of forecasts) is generated. Comparisons along diagonals allow describing the nowcasts quality dependence on lead time, used here as a proxy for predictability. The last observation (3:00 UTC) corresponds to the local maximum of precipitation in the Salou area (see black arrows) which caused the damage shown above. 60' forecasts (bottom) indicated moderate intensities but from 30' (center) the nowcast accuracy improved rapidly.*

3. Case study: 2 November 2008

Figure 3 shows the total precipitation field estimated by the quality controlled radar data and scatter plot comparing radar and raingauge observations. Moreover, the temporal evolution of the nowcasts correlation and critical success index are also shown – computed for the entire domain.

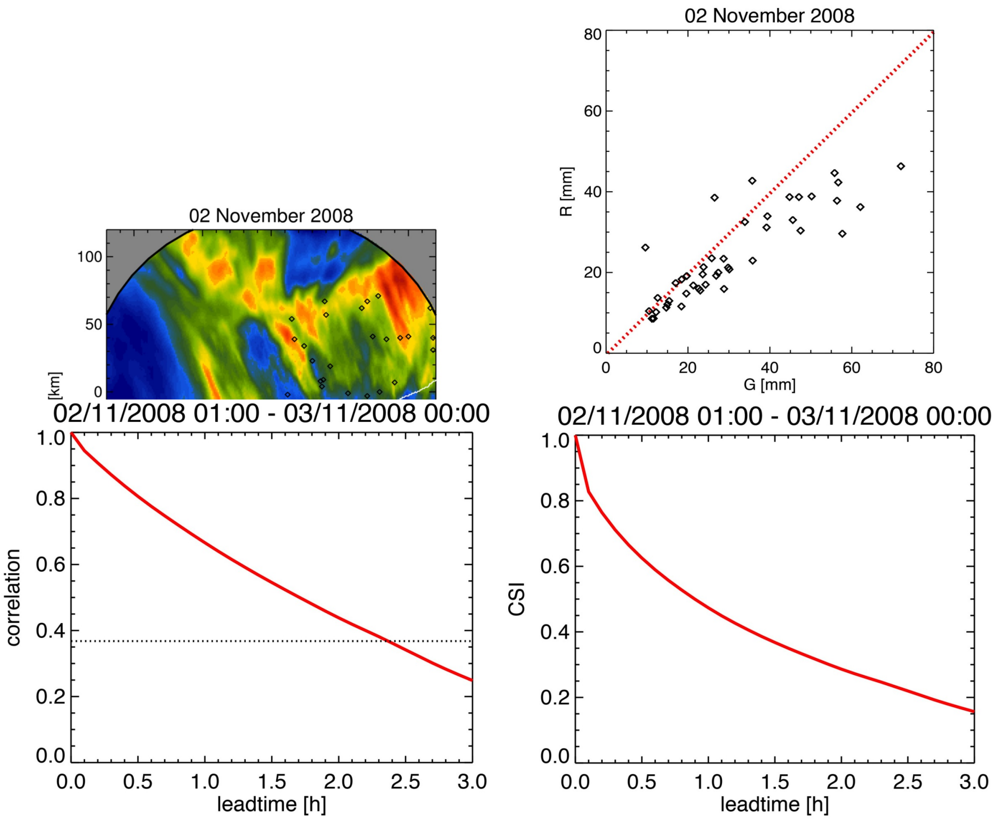

Figure 3. *1 Total (24h) radar derived precipitation and scatter plot showing the comparison between radar estimates and raingauge observations (top row). Correlation vs lead time and CSI of the radar reflectivity nowcasts during the event studied.*

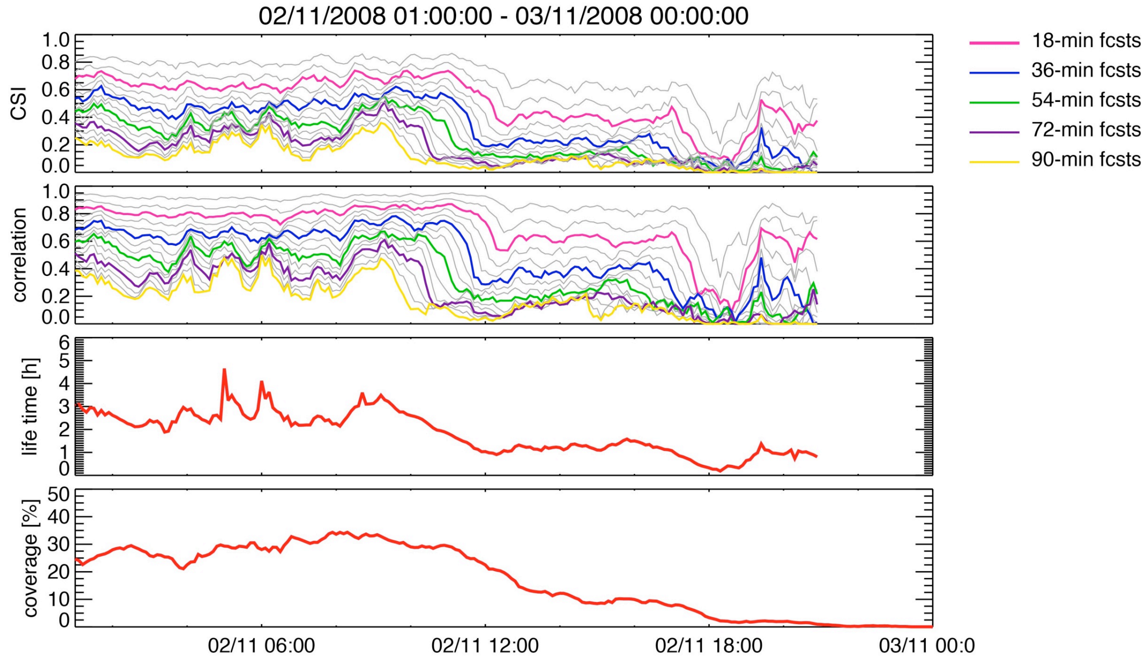

Figure 4. *Temporal evolution of selected parameters during the event (from top to bottom): CSI of radar reflectivity short term forecasts (each line represents a nowcast series, generated every 6'); temporal correlation of nowcasts for a given time step; life time (a predictability measure); area (%) of the radar reflectivity field exceeding 15 dBZ.*

The analysis of the forecasts includes the computation of a number of scores at different lead times. Figure 4 shows the temporal evolution of four different parameters (CSI, correlation, life time and % area) during the event, in this case obtained from comparing nowcasts with radar estimates. Figure 5, instead, shows the correlation (integrated over the entire event) but restricted only to gauge data (red line) or collocated radar estimates (blue line).

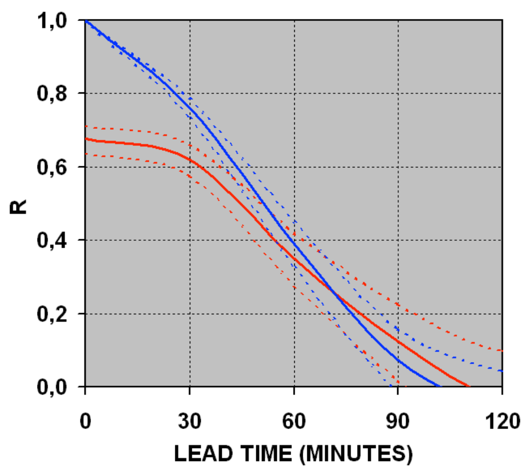

Figure 5. *Correlation of short term forecasts with radar QPE (blue line) and raingauge observations (red line) as a function of lead time. Dashed lines indicate 95% confidence levels.*

4. Final remarks

Preliminary results allow getting some insight of the predictability of Lagrangian persistence-based nowcasts applied to the 2 November 2008 heavy precipitation event. Future plans include studying additional events to asses the case-to-case variability and examining in more detail the quality of the nowcasts, not only from the comparison with radar precipitation estimates, but also with raingauge data in more detail considering categorical forecasts for different intensity thresholds, in particular those used currently to issue warnings. Results obtained will ultimately contribute to provide elements to improve the current deterministic and probabilistic nowcasts of early warning flood forecasting systems.

Acknowledgments

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