Thunderstorm warnings: design and development of a real-time automatic warning system for the authorities and the population

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INTRODUCTION

Thunderstorm warnings are a high priority task for national weather services. Severe thunderstorms represent a serious danger and warnings are very important in order to inform the population and the authorities with sufficient warning time. Unfortunately, the predictability of such events is often very limited. The biggest challenge from the perspective of a thunderstorm warning system is to achieve both precision (high time and spatial resolutions, useful estimate of intensity) and accuracy (high probability of detection and low false alarm ratio), in order to satisfy users' needs in their decision processes. Moreover the opportunities offered by increasingly connected users (i.e. through mobile telecommunication devices) have recently opened new possibilities for experimentations in the field of automatic warning systems.

OBJECTIVES OF THE PROJECT OWARNA - AUTOMATIC THUNDERSTORM ALERTS

In the contest of a project of the Swiss Federal Administration called OWARNA (Optimisation of Early Warning and Alerting of Natural Hazards) MeteoSwiss, the Swiss federal office of meteorology and climatology, has developed a new automatic thunderstorm warning system based on radar data. The aim of the new system is not only to alert a user directly on his phone, but also to support the overall warning system of MeteoSwiss for the thunderstorms. Until now, the thunderstorm warnings are sent out manually by the forecaster for one of the 159 warning regions of Switzerland. In very intense convective situations, with a lot of thunderstorm cells, the limits of this manual approach are soon achieved. We are convinced that one of the most benefits of the automatic system will be the reduction in the „emission time": automatic warning systems can be faster in comparison to the manual emissions.

METHODOLOGY

Research activities within MeteoSwiss have recently focused on real-time nowcasting of thunderstorms based on the early identification of thunderstorm cells and the retrieval of critical parameters such as cell extension, velocity, direction and vertical development thanks to weather radar observations. These efforts have successfully led to the development of an operational algorithm called „TRT" (Thunderstorms Radar Tracking) able to detect and track automatically the thunderstorm cells over Switzerland. As explained in figure 1, the weather radar detects the convective cells and TRT derives their motion and intensities. After extrapolating the location of each cell a notification informing about the location, the intensity and the lead-time of the convective cell can automatically be sent to the users. The tool allows a user to receive thunderstorm information for a given location directly and automatically on his phone and/or e-mail box whenever the system detects an incoming thunderstorm cell.

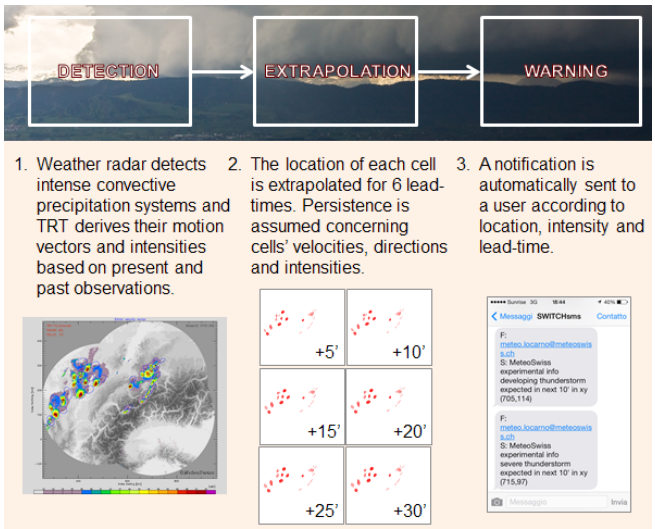

Figure 1. Basic scheme of how the automatic warning system works

RESULTS

During the summer seasons 2014 and 2015, MeteoSwiss has launched two test campaigns with more than 500 beta testers. The results of the both test campaign have been very promising. With a POD (Probability Of Detection) of 77% in 2014 and 88% in 2015, and a FAR (False Alarm Ratio) of 23% in 2014 and 33% in 2015, the beta testers' feedbacks reported a quite encouraging scenario from the users' point of view. Finally, users showed general satisfaction for the new automatic system and they appreciated the opportunities offered by such systems (e.g. customization). Especially the possibility to get thunderstorm warnings for given location, defined by geographical coordinates, has been appreciated.

In addition to the test campaign with the beta testers, during the both summers a systematic comparison between the automatic and the manual thunderstorm warning system was carried out, in order to evaluate their performance. This comparison was performed at the level of the 159 warning regions. Figure 2 shows some results of the statistical validation of the test campaigns 2014 and 2015: it emerges that the overall performance of the automatic system was better than the performance of the (manual emitted) Flash Orage. Especially interesting is the comparison of the lead time for the warnings: the automatic system was able to send out warnings 14-18 minutes before the manual warning system. This is a very significant improvement for nowcasting thunderstorm warnings.

CONCLUSIONS

The overall results show that the automatic thunderstorm warning system outperforms the manual Flash Orage warnings issued by forecasters.
This conclusion is supported by performance scores computed for both systems in the most comparable possible way. Therefore MeteoSwiss plans to integrate it in its operational warning system, starting with the summer season 2016.

REFERENCES

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***Thunderstorm-Info*'s analysis is used as reference during the validation period June to August for 2014 (left) and June to mid august 2015 (right)**

Skill scores 2014:

rank ≥	warn syst	POD	FAR	CSI
3	*automatic*	0.34	0.55	0.24
3	*manual (current)*	0.35	0.77	0.16

Skill scores 2015:

rank ≥	warn syst	POD	FAR	CSI
3	*automatic*	0.28	0.59	0.20
3	*manual (current)*	0.21	0.58	0.16

Lead-time 2014: 29.1 min

Lead-time 2015 : 24.7 min

Lead-time min displayed by the manual system in 2014 and 2015: 11 min

Figure 2. Basic scheme of how the automatic warning system works

KEYWORDS

Thunderstorms; nowcasting; intense precipitations; automatic warnings

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