EMS Annual Meeting Abstracts
Vol. 13, EMS2016-136, 2016
16th EMS / 11th ECAC

Real-time Thunderstorm Warnings for the Population and the Authorities

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Thunderstorm warnings are a high priority task for national weather services. Indeed, the impact of thunderstorms can be very severe. Thunderstorms represent a serious danger due to the likelihood of heavy precipitations, strong wind gusts, hail and lightning, in addition to serious damages caused by flash floods. For these reasons, 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 because of their chaotic nature and the strong gradients on spatiotemporal scales that characterize convective cells. 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.

Research activities within MeteoSwiss, the Swiss federal office of meteorology and climatology, have therefore 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) that helps MeteoSwiss forecasters to identify severe thunderstorms that might lead to the manual emission of warnings to the population. These warnings are known as Flash Orages and represent the current "back bone" of the storm warning system at MeteoSwiss, which is still manual.
However, a growing need for higher performance warning systems together with 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.

In the contest of a project of the Swiss Federal Administration called OWARNA (at English: Optimisation of Early Warning and Alerting of Natural Hazards) MeteoSwiss has developed a new automatic thunderstorm warning system based on TRT forecasts. 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.

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 ap-preciated.

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. From the 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.

At the EMS conference we will present the overall results of the two test campaigns and we will illustrate how MeteoSwiss will use the new potentialities of the real-time automatic warning system in order to improve

the quality of the thunderstorm warnings for the authorities and for the population. We will also discuss how important is to involve the users during the development phase of a new warning system, in order to take care of users' needs in their decision processes.