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Reducing false alarms by focusing the operational warning process for thunderstorms

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4 years ago, the German Weather Service DWD started to issue weather warnings on a county scale, i.e. for areas of sizes between 100 km^2 (cities) and 10000 km^2 (rural areas). Thunderstorm warnings are given in three categories depending on the severity of the phenomena accompanying the lightning, e.g. often gusts, sometimes precipitation and rarely hail.

The warning process is more complicated than the prediction of "normal" weather due to at least three factors: (1) small spatial and temporal scales of thunderstorms make it difficult to observe and model thunderstorms; (2) there are two additional degrees of freedom to decide on for the operational forecaster: when to issue the warning (forecast range) and how long the warning should last (warning duration). For "normal" forecasts these parameters are pre-determined and require no additional decision; (3) "Normal" forecasts have the relatively simple constraint to not severely under or over predict the frequency of occurrence of the event. Warnings have a completely different constraint, in that they should not miss too many severe events, but, at the same time, they should lead to an acceptable rate of false alarms. Given the uncertainty about the future, the delicate balance between missing events and issuing false alarms has to be found so as to minimize the total expenses of users of warnings. The later is very difficult to quantify.

The impact of the last two factors on the quality of thunderstorm warnings at DWD will be analysed in this presentation. Thunderstorm warnings for counties issued by the DWD are compared to lightning observations from a lightning detection system. Warnings/non-warnings are verified for each hour separately, which is a very hard way of verification and yet it reflects roughly the operating time scales of the fire brigades,

which are one of the prime users of the warnings. Additionally, it allows analysing and optimising the warning process in detail.

The relative frequency of the occurrence of a thunderstorm in a county varied between one in ten to one in 1000 hours. It is largely a function of the size of the counties. Thus an optimal warning strategy should account for this effect. But this would lead to a quite erratic spatial pattern, which is not desired at the moment. The probability to detect an occurring thunderstorm (POD= number of hits/number of events) mostly exceeded 90%.

It is a very desirable property that hardly any thunderstorms are missed by the warnings. However, the false alarm ratio (FAR= number of false alarms / number of forecasts of the event) is of a similar magnitude to the POD, i.e. between 70% and 95%, with the highest false alarm ratios occurring in small counties. The high number of false alarms is due to two sources: a high uncertainty about the forecast and the pressure to hardly miss an event. The combination of the two factors leads to a substantial over prediction of thunderstorms, especially in small counties and consequently to the aforementioned high number of false alarms.

It was observed, that the duration of thunderstorm warnings was very often more than 6 hours during the initial two years of the warning activities. This was deemed to be too excessive for reasons of predictability and not helpful to most users as well. Thus it was agreed on much shorter warning durations of between 3 and 6 hours. This, combined with more spatially focused warning activities, led to a substantial reduction in the over prediction of thunderstorms.

The reduction in over prediction again led to a substantial reduction (-8% on average) of the false alarm ratio, in some areas even a decrease of more than 15%. Finally, the overall skill, as measured with the Heidke skill score HSS, exhibits a substantial improvement as well, although on a low level.

Thus it has been shown, that thunderstorm warnings on a small spatial and temporal scale can be skilful. They have potentially great benefits to the users, since they reflect their operational requirements. The greatest improvements in the quality of the warnings have and will come from reductions in the number of false alarms.