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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "A reconstruction of the August 1st 1674 thunderstorms over Holland" *by* Gerard van der Schrier and Rob Groenland

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Dear Dr. Brohan,

Many thanks for the review of this manuscript. While you note that the study is impressive as it combines the distinct fields of documentary data and storm meteorology, you note that it suffers from some shortcomings. Perhaps the most severe concern is the presentation and in particular the absence of any motivation why this report is relevant for today's severe weather meteorology and the expectation of the nature of extreme weather events in the Netherlands.

It is true that the relevance of discussing an extreme weather event of nearly 350 years ago has not been discussed explicitly in the manuscript. The idea in the back of our heads was that the description of the 1674 event and its interpretation in terms of a

strongly-developed squall line with downdrafts causing the damages would naturally emphasize the importance of such events for the Netherlands. Nevertheless, the reviewer has a point that the study will be more interesting for a wider community when the implications for today's severe weather warnings would be formulated explicitly and more clearly.

In the study we aim to describe the scale and severity of damages related to downdrafts in a strongly developed squall line. This paints a picture of what such an event is capable of. However, the reviewer points us in another direction by asking us if we should reduce our expectation of tornado damage, and increase our expectation of straight-line wind damage. A well-founded conclusion would require a more exhaustive study than the one we have done on this single event.

Perhaps the way forward is to point to one of the observations in the hallmark study of Fujita and Wakimoto (1981), which makes clear that damages related to strong downdrafts, with their detailed spatial structure of burst swaths, are often mistaken for tornado-related damages (e.g. the caption of their figure 4). Prompted by the concern of the reviewer, we briefly analysed one of the most extreme summer-storm events in the Netherlands of the past century (the 'Borculo event', 1925). Similar to the 1674 event, this event was initially related to a single tornado, the damage caused by this event can be traced from the south eastern part of the Netherlands to the eastern parts of the Netherlands over a path of up to several 10s of km. Although the characteristic tube associated with a tornado has been spotted in several locations, analyses of this event (Wessels, 1967) indicate that most of the damage was actually related to downdrafts.

To address the issue of the reviewer, we could present this event and briefly discus the existing literature on this event. This would make clear that two events leading to widespread damage are related to downdrafts. However, we cannot claim that this motivates to advise the Dutch extreme weather forecaster to reduce their expectation of tornado damage, and increase their expectation of straight-line wind damage. For

such an advise, a more complete and exhaustive would be necessary.

Another concern of the reviewer is that much of the evidence is taken at face value. One example is the maximum observed hail size. Here the reviewer has a point (again). Many observations (like prams taken up in the air or complete horse and carriages) are observed at several places and documented by independent sources. However, the observation of the largest hail stone (with the description of its size 'like a baby's head') is mentioned by one source only and seems to be a single observation. Although we do not claim to be historians, we do feel that would be highly unlikely to expect to find an independent verification of an observation of hail size in Strassbourg made in 1674. However, reports of extreme hail (both size and quantities) are mentioned by several sources for many places. This makes us confident that the 1674 event saw some extreme hail as well – making the possibility to observe extremely large hail stones less unlikely. However, in a revised manuscript, the observation will still be mentioned but the fact that this is not independently verified will be explicitly mentioned. This will downplay the significance of this part of the analysis.

The reason for not using return times based on the wind gusts rather than hail size – which are indeed more relevant for the damage – is that a climatology of downdraft-related wind gusts is not available in the Netherlands (or in neighbouring countries). The network of anemometers is simply too scarce to pick-up such events (this contrasts to winter storms which have a much larger spatial scale and are spatially more homogeneous, making the probability of having wind gusts measurements much more likely).

Nevertheless, the reviewer is right in noting that extrapolating the distribution of hail sizes to estimate the return times of hail way outside the distribution will have enormous uncertainties. We are aware of this and in the revised manuscript, this will be made more explicit. However, we refrain from leaving out this analysis completely, since we think that this is the only possible way to produce some estimate of the frequency of such events. Another concern of the reviewer relates to the embedded vortices. Here

the study of Fujita and Wakimoto (1981) leads the way. In this study, the damage of downbursts on a forest is analysed, including the direction in which the trees have fallen. The patterns of damage reflects the burst swaths associated with these downbursts. It can be observed that most trees fell in the direction of the movement of the front, with at the sides of the burst swaths some individual trees which fell sideways or (nearly) against the direction of the movement of the front. In the revised manuscript, a more thorough discussion of the Fujita and Wakimoto (1981) paper will be included. The arguments why downdrafts rather than a whirlwind like a tornado is more likely for the 1674 will be highlighted a little better than what is now the case.

The comment on the formulation in section 6 (on the orientation of the church) is easily explained. All churches in the Netherlands (and I guess in Europe) have their choirs facing east. With the storm moving over the Low Countries from south to north, the churches will have the straight-line winds perpendicular to the long side of their structures. Any difference in damage between churches cannot be related to differences in the 'line of attack' of this storm.

Finally, the abstract can be made more explicit following the advice of the reviewer.

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