

Interactive comment on “Re-Analysis of one of the deadliest Tornadoes in European History and its implications” by Alois M. Holzer et al.

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This is not a full review but a list of comments which, I hope, are helpful for the authors in completing their study. (1) A comment on additional information not yet included: Contemporary newspaper reports uniformly state that 39 fatalities of the tornado were buried at the cemetery of Wiener Neustadt two days after the tragedy. This number is remarkably consistent in all newspapers, though many of them had sent their own correspondents to the site of the tragedy. It can therefore be assumed that this number also had an official origin (possibly "Korrespondenz Wilhelm", then the official organ of the empire, though this was not mentioned anywhere). There is no obvious explanation for the discrepancy between this piece of information and the "official" police list with

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32 fatalities referred to in this paper, but at least the possibility should be taken into account that the police list could have been incomplete. Most notably, the list on the memorial stone depicted in Fig. 10 - if I understand it correctly that it is identical with the police list - contains mostly German and a few Slavic names, reflecting the blend of population near the capital of the Habsburg empire, a melting pot between "indigenous" people and migrants attracted from its Slavic crown lands. However, contemporary sources state that a large number of workers in the locomotive fabric, and presumably other places nearby, were Russian prisoners of war. Given that a considerable number of Russian citizens must have been exposed to the tornado when it reached its peak intensity, it would be highly surprising if none of them had fallen victim to its furor. The IMO most plausible explanation is that the Russian victims of the tornado were also among the 39 people buried during the solemn funeral, but stayed anonymous in this process and, in particular, were not filed by the police. There is likely no way to prove this assumption right or wrong anymore, but I think some considerations like these should be addressed. In addition, contemporary newspaper reports also include at least half a dozen other detailed eye-witness reports, which were not quoted in this study but contain valuable information about the tornado's track, width, damage marks, and other characteristics. Answer 31: Thank you for these additional (but probably mostly secondary) sources that we will try to review before we are going to revise our manuscript. In the sources we found it was explicitly mentioned that news of higher numbers of victims that were spread in Vienna are lacking any basis. In case the material has already been collected by you (e.g. in the form of PDF files), we would be glad if you could offer these files to us in order to save time.

In particular, there are two reports with detailed information from Dreistetten, the village where the tornado track started. They also include an additional victim, a 12-year old boy lifted up and killed by the tornado in Dreistetten, which is not mentioned in this manuscript yet. These yet lacking information sources may seem minor in comparison to the huge amount of de-archiving the authors have already done (which I explicitly appreciate!). However, this study is still incomplete as long as they are not included.

Playing the devil's advocate, one could state that the authors already fail when addressing the first of their research questions (p. 3, line 10): "What kind of original sources can be found?" All of these newspaper reports are readily accessible at the Austrian National Library. The additional amount of work required to browse them and to process their information is limited. Answer 32: We are quite sure that secondary sources can hardly ever be completely collected for such a case, as even newspaper reports in other languages and countries are possible. Following the rules of media research, the content of additional information typically is very limited, if not misleading, because of increasingly anecdotal nature of such retold pieces of information. Assessment of the trustworthiness of such sources is difficult in most cases. Also "correspondents" of newspapers cannot per se be seen as reliable sources. Regarding the Dreistetten case we invested several days to find out what really happened there: The death of a boy is anecdotal, the very probable truth (see manuscript text: "local personal communication (Karl, 2017; Schramböck, 2017" – the head of the local administration knew the injured soldier in person) is that a young soldier was lifted up and severely injured, but he survived.

(2) A comment on the meteorological reconstruction: While I can follow the authors' main conclusions in section 3, it is a bit disappointing to see them interpret the surface wind and pressure field of a 125 km spaced reanalysis (without me wishing to dispute the big value of ERA-20C). This does not live up to their claim of a "forensic" approach which they state several times in the manuscript. It is obvious that not every detail can be reconstructed, not every hypothesis proven 101 years later; this is nothing to be ashamed of. However, weather reports from eye-witnesses, newspapers, and historic weather maps would allow a much closer reconstruction and a much stronger emphasis of potentially important aspects and processes. I am most intrigued by the sharpness of the thermal boundary, shown in Fig. 4. Information on the station height, not given in the manuscript (e.g., one of the 33 measurements was taken at 850m), reveals that the thermal gradient amounted to $>10\text{K}$ across 100 km in terms of potential temperature. It is extremely rare for a preconvective situation in European

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mid-summer to feature such a strong thermal contrast. It is unlikely that a synoptic frontal zone alone could have created and sustained it against the influence of strong diurnal heating, which tends to level such differences. Instead, a true forensic analysis should place more emphasis on the "footprints" of previous deep convection prior to the tornadic storm. Weather and newspaper reports mention that strong thunderstorms with heavy rain and very high lightning activity, possibly an MCS, moved across the area 50-100 km north of Wiener Neustadt in the evening prior to the tornado, 9 July 1916, affecting e.g. Vienna (48 mm of rain and flash floods were reported) and Znojmo in Czechoslovakia. It appears likely that residual cloudiness and/or a particularly low Bowen ratio (i.e., a high latent heat and a low sensible heat flux) towards the north intensified the thermal boundary, and the attendant convergence zone, in the morning of 10 July. The first thunderstorm(s) in the earlier afternoon, prior to the tornadic supercell, could then have completed the work to concentrate the boundary in an ever sharper form close to Wiener Neustadt. Hailstones in the size of dove eggs or chicken eggs were multiply reported from the vicinity of the tornado. Dörr (1917) mentioned "only" walnut sized hail. It is unclear if he was unaware of these reports, or if he just focused too much on the tornado to pay much attention to the hailfall. There are other reports of hailstones in the size of fists or duck eggs from a handful of places about 20 km upstream of the first tornado evidence, but allegedly at 6.20 pm, i.e. after the tornadic storm. Either the reported time is wrong, or indeed another (supercell) storm followed tracked along the still existing boundary in the wake of the tornadic storm. Either way, there is much more evidence from contemporary reports than the authors describe how conducive this situation was for organized storms and how favourably the ingredients merged for the most extreme development. In general, I miss a "scale cascade" in the manuscript. Why should we not follow the "forecast funnel" from large to small scales, advocated by Dave Schultz, also in the reconstruction of a historic event? Answer 33: Please refer to general comment C above.

(3) The paragraphs of the introduction appear like they were shaken by a random generator. As a result, the reader is left rather clueless about the contemporary state of

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knowledge of the 1916 tornado and about the authors' motivation to reopen this case. The listed "aims" (p. 3, lines 9-13) are no aims but rather research questions. Luckily the rest of the manuscript addresses many more aspects than just these questions, otherwise it would be very meagre. Nonetheless I recommend a reformulation of the entire introduction, and of the aims / research questions in particular. Answer 34: Thank you for this comment. We will review the order of paragraphs in section 1. We will also consider renaming the aims into research questions. We will also add more clearly the state of knowledge of 1916, documented in the Dörr 1917 paper, which was primarily a collection of impacts and weather reports, and that there was no magnitude assessment possible at that time.

(4) I don't think Fig. 1 is necessary. It basically shows that many historic tornadoes are known where the population density is high, and few where the population density is low, but this information is not essential. I think it would suffice to mention that tornadoes (also strong ones) did occur in this area, and that information on them is stored in ESWD. Answer 35: We will reconsider this.

(5) The text contains a lot of place names, which sometimes make it difficult to follow for someone not familiar with this area. I would suggest to remove names not ultimately necessary for an understanding, and to insert a map which provides an overview of all referred locations at one glance at the beginning of Section 3. Ideally, it would also contain a height shading in order to emphasize the geographic and topographic characteristics of the target area, which would make some of the conclusions more comprehensible. Answer 36: We discussed a lot about this. Finally we decided to go for the place names, because it would be difficult for readers to look them up in the original sources. We will consider making them better visible in the map of Figure 6.

(6) The map in Fig 3. is very informative but much too specific for such an early placement in this manuscript. Again following a "scale cascade", it should rather find its place somewhere behind Fig. 6. What is the difference between buildings shaded in white ("damage"), dark grey ("minor damage") and black ("major damage") in Fig.

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3? The legend does not make this clear. Please remove the TORRO scale references in the legend, as you do not address and explain the TORRO scale anywhere in the text body. Answer 37: Thank you for this suggestion.

(7) I would not introduce two "predecessor tornadoes", which might mislead a superficial reader to assume that three separate tornadoes occurred on that afternoon. I don't see enough evidence that the two "predecessor tornadoes" could have dissipated, or done anything more mystic and less prosaic, before the main tornado emerged. I would rather call the entire west-east moving vortex the "main tornado", regardless whether its track might have been interrupted somewhere in-between, and the north-south moving subvortex a "satellite tornado" that was finally ingested by the main tornado. Answer 38: We want to stay with evidence and keep such speculations out of the paper. We definitely cannot be sure which of the two "predecessor tornadoes" had a continuous track, if one at all, or if even both.

(8) I see the DI-DoD approach as a very useful approach and an important achievement on the path towards an International Fujita scale. This could be emphasized more strongly! The single sentence at the end of the manuscript might easily get lost to the reader's mind, even more as it does not appear connected to the rest of the text. I think this study is very interesting, and I hope the authors attend to my remarks. I am looking forward to seeing the final version achieved! Georg Pistotnik (ZAMG) Answer 39: Thank you, we agree.

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