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Natural Hazards
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Discussions

Interactive comment on "Lightning risk assessment at a high spatial resolution using the resident sub-district scale: A case study in Beijing metropolitan areas" *by* Hai Bo Hu and Jing Xiao Li

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The paper presents interesting arguments concerning risks from lightning strokes in areas of varying terrain features. After some revisions it can be published. The parts that relate to technical risks and the corresponding quantitative considerations are sound and will not be criticized. However, the handling of lightning needs substantial changes as is explained below.

1. The paper deals with CG strokes. It is not explained why IC strokes are not present, or how they are eliminated. That can disturb the CG density estimate. The strange procedure to declare that CG+ are in fact IC+ is not sufficient or satisfactory. Response: Drüe et al. (2007) concluded that IC-detection efficiency of ADTD LPATS sensor is

very low, estimated to be around 1%. The ADTD can only determine the latitude and longitude of CG lightning and cannot efficiently locate the IC lightning, differing from SAFIR which should deal with IC strokes. Thus the LLS data of ADTD are only related to CG lightning so we do no work on IC strokes.

2. The authors mention multiple contacts of strokes that occur within one flash. However, there are also multiple strokes that contact ground at the same point. When one deals with strokes densities (Ng), this point becomes crucial. Response: Although multiple strokes can contact ground at the same point, they produce multiple strokes on the ground and should be recounted multiply on account of being considered as causing disaster factor. Meanwhile, using the LLS data, it is impossible of determining the actual ground strike-point density. So, following the standards of IEC 62858, we supplementarily derived the ground strike-point density from the LLS data and used it in lightning risk estimates. Please see Fig 4d, Fig 6c, p.4 line 5-6, p. 8 line 26-27, and p.10 line 7-9.

3. A location accuracy of 1 km is claimed. This is much too optimistic when 1/3 of the locatings are performed with only 2 or 3 sensors. DF is known to produce errors of many km. Response: Admittedly, our description in p.3 line 7 is imprecise and we reedited it to be "The manufacturers claimed that the DE of ADTD sensors could be 90% in a distance between 300 and 600 km, with a median location accuracy within 1 km". Please see p.3 line 7.

4. On p.5 line 8 the authors claim that 90% of the flash DE can be validated. This statement is not understandable and needs a clear explanation. Response: We reedited the statement to be "However, only the flash DE can be 90%, but with a lower stroke detection efficiency (SDE)". Please see p.3 line 8.

5. On p.5 line 7 it is claimed that the sensor range is 300 or 600 km. This is not correct, because the detection depends on the current of the stroke. A weak current of 4 kA will not be detected at all, while a 100 kA stroke can be seen as far as 1000 km. Response:

We reedited it. Please see p.3 line 7.

6. It is absolutely necessary to show a current distribution of the used strokes. Response: We accordingly appended the histograms of probability density of +CG, –CG and total lightning peak currents, respectively. Please see the newly-added Fig. 1 and p. 3 line 5-6.

7. It is not understandable how the authors “calculate” or estimate the true DE of the system (result in Fig. 1). The true occurrence of strokes is not known; in particular, the true current distribution is unknown. Thus, there is no way to determine the absolute DE. The peak of the current distribution is the only parameter that allows estimate of relative DE with respect to other networks. It may be suspected that the CMA network exhibits the peak above 10 kA; then, the DE would be quite low because strokes with current around 5 kA are very prominent, as can be seen from highly sensitive networks elsewhere. All together, the DE scaling is not convincing and could be replaced by a mere guess. Response: We added some description of our DE estimate method for a clear introduction of its fundamentals. Please see p.8 line 6-9 and line 20.

8. On p. 7 line 13 the authors speculate that the stroke signals can be absorbed by terrain effects such that the stroke density decreases. This is not in accordance with solid observations that propagation is very well approximated by 1/D (distance D). Response: We give the statement referring to the literatures of Cummins et al. (2006) et al. and Schütte (1988), which declared a damping factor in different underlying surface conductivities. However, Tyahla and Lo′pez (1994) concluded that the conductivity of the underlying surface does not significantly affect the magnitude of the peak magnetic field, and hence, the peak current, in the first return stroke of a cloud-to-ground lightning flash. At this point, it is controversial of explaining the relative low CG stroke density in maintains. Accepting the referee’s advice, we delete the statement. Please see p.7 line 16.

9. It is understandable that technical structures (different buildings) give rise to different

stroke risks. Insofar, a small grid size is meaningful, although 5 m is much too small. For lightning risks, however, a grid size of 5x5 m is totally unacceptable. The authors should consult the international norm for determining flash densities (IEC 62858). Both the rare occurrence (in 5x5 m2 the stroke chance is 1 stroke every 10,000 years), and the large location error of the network prohibit such a procedure. Response: The resolution of lightning risk assessment downscaled from 1km grid size of CG flash density to that of 5m just demonstrated that, in the framework, it is possible of fulfilling the extremely high resolution risk assessment, which is presented as a case study in our manuscript. The model results in this high resolution not only give the lightning risk of NDLE in each grid cell, representing risk at specific sites, but also the distribution of NDLE in a region of resident sub-district. It presents relative high and low lightning risk zonings in that region, contrasting with the terrain characteristics of underlying surface and distribution of man-made structures, and even visualizing lightning risk characteristics in real world. Then risk recognition at this high resolution facilitates the formulation of practical risk management strategies for disaster prevention and provides information in a form that is straightforwardly understandable to local decision and policy makers. Technically, based on an interpolation method, the CG stroke densities of 1*1 km grids were downscaled to these of 5*5 m, essentially having a very little chance of being stricken by lightning on account of its small exposed area. However, this procedure kept the original uncertainty of derived CG stroke densities in 1*1 km grids, which in some degree (not fully) are in accordance with the grid size requirement of IEC62858 for obtaining an uncertainty of less than 20% and 90% confidence level. Furthermore, to meet the requirement of IEC62858, we appended 2012-2014 ADTD data, meaning recently 8 years of LLS data (2007-2014), by now, were used to derive the CG flash density, stroke density and strike-point density. So we replaced figure 4 and 6b, and edited the corresponding paragraphs. Please see Fig. 4, Fig. 6, p. 2 line 24, and p.8 line 23.

Reference

Tyahla, L. J., and R. E. Lo′pez, 1994: Effect of surface conductivity on the peak magnetic field radiated by first return strokes in cloud-to-ground lightning. J. Geophys. Res., 99 (D5), 10 517–10 525. IEC62858. Lightning density based on lightning location systems (LLS)-General principles. IEC, Geneva, Switzerland, 2015.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2016-231/nhess-2016-231-AC2-supplement.pdf

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