Centre National de Recherches Météorologiques
42 avenue G. Coriolis
31057 TOULOUSE CEDEX 1, FRANCE

Report on the doctoral dissertation of Mgr. Jana Minářová

Dear Sir or Madam,

Dear Colleagues,

As requested, please find hereafter my report on *'Extreme precipitation in low mountain ranges in Central Europe: a comparative study between the Vosges and the Ore mountains'*, a doctoral dissertation submitted by Mgr. Jana Minářová. The thesis elaborates on ~50-yr climatologies of daily rain gauge data in comparable low-mountain ranges located in Central Europe, with an emphasis on extreme precipitation. Because of its societal impacts, extreme precipitation is an important research topic. The characteristics of extreme precipitation are of particular interest to understand the process that lead to exceptional rainfall and mitigate its detrimental effects on society. The thesis provides in-depth analyses on this topic for two low mountains – the Vosges and the Ore Mountains –, both known to experience catastrophic floods, among others.

The dissertation is broken down into eleven sections. However, some sections are rather condensed so that the overall number of pages of the dissertation is kept relatively short (139 p.).

After the first section which briefly (1 p.) introduces the thesis and its *raison d'être*, the second section presents the state of the art in terms of extreme precipitation and its characterization, the effects of mountains on precipitation, and the climatology of precipitation in the targeted areas. Although the word 'extreme' may seem at first glance self-explanatory, its definition in the field of precipitation analysis is manifold. The review of the multiple definitions of extreme precipitation is thus much appreciated, all the more since it is presented in a clear, well-structured way. The rest of the section is of equal quality and provides useful information about the scientific context of the thesis. Still, the insertion of maps of the Vosges and Ore Mountains regions in subsections 2.4 and 2.5, respectively, would help the reader.

This state-of-the-art section is followed by a short (1 p.) section which unfolds the objectives of the thesis and outlines the methodology that has been used to reach the objectives. The next section gives a detailed view of the study area, data, and methods that have been employed in the thesis.

A fifth, short (1 p.) section introduces the five articles that are inserted in the dissertation as sections 6–10. The first article constitutes an introductory study to the climatology of precipitation in the Vosges area. Daily rain gauge precipitation data from 14 meteorological stations are analysed. Different aspects (annual average rainfall, monthly average rainfall, inter-annual evolution of precipitation, degree of continentality,...) are studied. The second article provides a more thorough view of precipitation in the Vosges area. The rain gauge data set is extended to 168 stations, additional statistics are computed: peaks over threshold, block maxima, and return periods. As in the first article, Hrudička's (1933) 'ombric continentality' index is computed. However, whilst some difficulties are reported in the former article, the latter article claims that this index 'surprisingly well expresses the seasonality of precipitation and its clear correlation with the mean annual totals in the studied region’. This looks somewhat contradictory at first glance and would deserve some comments. In the third article, the Weather Extremity Index (WEI, Müller and Kaspar 2014) is introduced and used to combine rarity, spatial extent, and duration. An attempt is also made to characterize each extreme precipitation event in terms of synoptic conditions through the use of weather type classifications over Central Europe. The fourth article presents a similar study over the Ore Mountains area. The same tools (WEI and weather type classification) are applied to a data set of 167 daily rain gauge stations. The fifth article compares the climatologies of extreme precipitation in the Vosges and Ore Mountains areas.

A short (2 p.) section closes the manuscript with some conclusions and perspectives. The perspectives (2 sentences) are somewhat frustrating since, in my opinion, the work presented in the thesis opens quite a wide field of investigation. I think it is important that the PhD candidate shows that she is able to plan further research, so I expect that this part will be strengthened during the PhD defence.

The manuscript is well-written and easy to read. The methodology is clear and appears scientifically sound. It is notable that, among the five presented articles, which have all been written by Mgr. Jana Minářová as lead author, three of them have already been published in international peer-reviewed journals. This corroborates the high quality of the work presented in this dissertation. In view of all of this, I believe that Mgr. Jana Minářová’s PhD dissertation meets all the standards required for a doctoral degree and so I recommend that she is allowed to defend her thesis.

Toulouse, 9 August 2017

Olivier Caumont, PhD
Senior scientist

Questions for the *viva*:

- The WEI is one of the main tools that are used in the thesis work. Its advantages over other methods are clearly demonstrated throughout the manuscript. Some shortcomings are also mentioned. For example, WEI is shown to depend on the domain size. In the fifth article, where the WEI is used to compare extreme precipitation events over two distinct domains, this is circumvented by converting the WEI through computation of its maximum theoretical value in the different regions.

From the description of the method, I understand that the area of extreme precipitation does not need to be contiguous. It means that there can be only one event over the whole domain at a given time. If this is correct, that would mean that events of different characteristics, but occurring at the same time could not be differentiated, and this is more likely to happen as the domain size increases. Could the WEI method be improved (and if yes, how?) to enable the separation of concurrent extreme precipitation events?

- Related to the previous point, the time resolution of 1 day may be insufficient to discriminate two consecutive events or short-lasting events, as correctly pointed out in the thesis. The natural way of solving this issue would be to use sub-daily accumulations, as suggested in the thesis. Would it allow the WEI method to detect short-lasting convective events, which can cause flooding through surface runoff, especially in urban areas? Which conditions should be met so that it is actually possible to detect such short-lasting extreme events?

- Several attempts are made to associate extreme precipitation events with specific weather conditions – a very good idea, in my opinion. For this, essentially two distinct methods are used. One relies on synoptic weather classifications over (Central) Europe, whilst the other one consists of considering atmospheric parameters over the region of interest. For both methods, either a synoptic weather pattern (*Großwetterlage*) or a meteorological parameter value is associated with each extreme precipitation event. This is interesting to know which synoptic weather pattern or meteorological parameter can potentially lead to an extreme precipitation event. However, the distribution of synoptic weather patterns or meteorological parameter values in non-extreme precipitation events is not much discussed. That could help estimate the probability of a particular weather pattern or meteorological parameter value to lead to an extreme event.

For example, in Figure 10 of Minářová et al. (2017), the wind and humidity flux are plotted both for extreme and non-extreme precipitation events. In Section 3.5 of the same article, the following sentence is written: ‘The strongest EPEs occurred when strongest values of variables were measured, which is especially true for the airflow at 500 hPa level.’ By looking at Fig. 10, it seems that the converse of this statement is not true, i.e., the strongest values of variables do not necessarily lead to extreme precipitation events. Have such non-extreme events been studied? Is there any explanation why they did not result in extreme precipitation events? I do not expect a thorough analysis of all these non-extreme events, but either an illustrative example or general considerations that could explain such behaviours.

References:

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