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Hydrology and Earth System Sciences
Discussions
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Interactive comment on "Little evidence for super Clausius–Clapeyron scaling of intense rainstorm properties with air temperature" *by* P. Molnar et al.

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The paper presents an investigation of the relationship between precipitation events and surface temperature for 50 stations in Switzerland. Hourly precipitation data are aggregated into events, and the change in mean and peak intensity as a function of temperature are presented for average and extreme events. An effort is made to separate convective and stratiform precipitation by making use of lightning data, which is related to strong convective storms. The results show an increase in mean event intensities by about the Clausius-Clapeyron rate of change, and a slightly lower rate of change for peak intensities. Convective events are found to be more sensitive to temperature than stratiform events. An analysis of trends in the number of convective events with time shows a significant increase over the period 1982-2011. A smaller section deals with using other variables than surface temperature.

The paper is well written, and the topic and method of analysis is relevant and interesting for the readers of the journal. I appreciate the use of precipitation events rather than fix interval measurements, however, I have some concerns about some definitions in the paper and possible artifacts of using hourly data. I recommend major revisions as outlined below.

Major comments:

1. Event based analysis

The authors need to revise the text to make it perfectly clear how the analysis was carried out, especially for the event based analysis. As hourly data was used, there will be lots of intermittancy (non precipitating times) hidden in the data. This has potentially large effects on the results. Convective events were shown in Haerter et al. (2010) and Berg et al. (2013) to have an average duration of 30-60 minutes, thus even events of 1h duration will likely contain large intermittancy (no precipitating times). The longer the duration, the less of an issue this should be, but that is here only relevant for large scale stratiform storms.

It is not clear how an event was defined, e.g. starting when the intensity reaches above a certain threshold and ends when going below this. It is also not clear whether 1h event duration were used in the analysis. The use of hourly resolution means that likely clusters of storms are used for the analysis rather than individual storms. I therefore have problems to relate the peak intensity to storm dynamics.

Furthermore, the authors show that the durations decrease with higher temperature. For short storms, this will affect the intensities more strongly since this might inflate the intermittancy times within the hourly time step. Also the comparison of I and I_p might be affected by this, since I will approach Ip when the duration approaches 1h, i.e. the

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resolution of I_p.

Berg et al. (2013) made a sub-selection of durations and showed the temperature relationship for these separately, I suggest the same is done here as potentially interesting information might be lost when grouping all data.

In section 3.4, it is revealed that 10 min precipitation measurements are indeed available. I don't understand why this was not used for the event based analysis! Please redo all analysis with this data base instead.

2. Presentation of data

It is difficult to assess the quality of the slope estimations, since no actual data are shown. I suggest to include a figure showing some suitable examples (good and poor examples from different stations) to show some data and fitted slopes. E.g. a multi-panel figure with different stations in each panel showing I_m for (i) all events (ii) Beta=0 and (iii) Beta>0.8

3. Investigation of other atmospheric variables

Section 3.3 dealing with the relation to different atmospheric variables is lacking detail, and is not possible to evaluate in its current form. The text does not reveal exactly what was done. E.g. it is not presented for which time precipitation is predicted (lagging observations, all day,...) and what is actually meant with predicted. I suggest removing this analysis completely and present an extended analysis in a later publication. It is indeed interesting work, and I hope the authors will keep working on it.

Minor and technical comments: [Add 8900 to the page numbers given below]

P24 L9: Please define "90th percentiles". Of what? See also below.

P24 L18: That this is a consequence of, or even related to, a warming climate is not supported by the analysis, and should be removed.

P25 L10-13. This sentence is not complete, and is difficult to understand. Please

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rephrase.

P25 L16: "...was proposed to be due to a positive.." not explained.

P25 L5: Why use hourly data for this, when it seems 10 minute data are available?

P27 L2: Please include a map over the area, where all stations mentioned by name in the paper are indicated.

P27 L10-11: "we are of the opinion" Could you please explain, and support, why you are of that opinion? Perhaps " we assume that wind-driven...appreciably, because..."

P27 L28: How is the use of the inter-arrival time implemented? Which events are used, and which are thrown away? Sensitivity experiments?

P27 L29: Please define what constitutes an event. Rising above/below a certain threshold? Also, which is the shortest event used? 1h?

P29 L16: "during which Ip exeeded I* over the period..." Writing it like this would be clearer as the defintions are already there.

P29 L22: "(resolution)" I don't understand what is mean here.

P29 L22-23: To my knowledge also by Berg et al. (2013), Moseley et al. (2013) and in a recent paper by Panthou et al. (2014)

P30 L12-13: Define the 90th percentile. Is this for R, I_m or some other quantity? I would suggest using I_m.

P30 L13: Here, it would be good with the figure with examples of data and slopes are I suggest in the major comments.

P30 L20: 5.1

P31 L26: That Im increases at a stronger rate than Ip could be at least partly a consequence of the hourly time step used. It was already noted that the event duration decreases with temperature. This means that Im is likely to approach Ip and can thus have a stronger rate of change only for that reason. Furthermore, Ip is also more likely to underestimate the peak intensity as the duration decreases, e.g. below 1h (in the fully resolved timescale).

P31 L27: "practically independent" I find it to be around 2

P32 L9-11: The names do not comply with the fig 4 legend

P32 L13: "is indeed not the case." I think you can only say "does not support this hypothesis/reasoning"

P32 L13-14: The PCA analysis needs to be explained in more detail.

P32 L15: Is surface temperature for 1200UTC here, or the same as used previously?

P32 L16: "explanatory power" of what exactly?

P32 L16: CAPE and CIN are highly heteorogeneous fields and it is quite circumstantial for any given time. How long were the records used for this analysis? How was CAPE and CIN calculated?

P32 L17: "weak relation to precipitation" and L21 "predictor of precipitation intensity" What is actually being predicted and how?

P33 L13: "in a warming climate" needs to be supported by temperature measurements, which are available. 30 years of data is probably not enough to make statements of climate change phenomena. Please mention this.

P35 L19-20: "smoothing the effect of air warming" Please rephrase this as its meaning is not clear.

P36 L4: Again "warming climate" needs to be supported by measurements.

Fig. 1: bottom right panel does not seem to fit with the text and other figures and Tables. Please check. Please also change the horizontal axis to

Fig. 2: Missing degree sign on vertical descriptor. Please mark the 7

Fig. 4b: Please increase the size of the red points.

Fig. 5: The figure would be much improved by removing the dry day information, and instead of using some density function for the plots (e.g. hexbin or smoothScatter if you use R). As it stands it is impossible to see how the bulk of the data behaves. It would also be interesting to see the same thing for the 90th percentile of the events, e.g. with contours on top of the others.

Fig. 6: Please indicate the magnitude of the trend, e.g. as percentage change.

References: Berg, P., Moseley, C., Haerter, J. O. (2013). Strong increase in convective precipitation in response to higher temperatures. Nature Geoscience, 6(3), 181-185.

Haerter, J. O., Berg, P., Hagemann, S. (2010). Heavy rain intensity distributions on varying time scales and at different temperatures. Journal of Geophysical Research: Atmospheres (1984–2012), 115(D17).

Moseley, C., Berg, P., Haerter, J. O. (2013). Probing the precipitation life cycle by iterative rain cell tracking. Journal of Geophysical Research: Atmospheres, 118(24), 13-361.

Panthou, G., Mailhot, A., Laurence, E., Talbot, G. (2014). Relationship between surface temperature and extreme rainfalls: a multi-timescale and event-based analysis. Journal of Hydrometeorology, (2014)

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