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Hydrology and Earth System Sciences Discussions

Interactive comment on "Interaction of valleys and circulation patterns (CPs) on small-scale spatial precipitation distribution in the complex terrain of southern Germany" *by* M. Liu et al.

Anonymous Referee #1

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Summary

This manuscript presents a statistical analysis of a long data set (about 40-50 years) to highlight what the authors call the "narrow-valley effect". This effect takes place at intermediate scales from 1 to 10 km typically (and at the daily time scale in this study), and correspond to the interactions between the dominant weather type (and mainly wind/precipitation advection direction) and the local topography. When the valley is aligned with the dominant wind direction, a station in the valley (named valley station) receive similar rain amount to stations located in the surrounding higher-elevation re-

gions (named mountain stations). When the dominant wind is not aligned, the valley stations receive a larger amount than the mountain stations. Overall, the valley and mountain stations exhibit different distribution from open-land stations. This narrow-valley effect is evidenced using standard statistical tests (Kolmogorov-Smirnov and one-way analysis of variance). A way to take this effect into account using kriging with external drift is suggested by defining a "surrogate elevation" for valley stations.

Recommendation

The topic is relevant for HESS, and the manuscript presents an original contribution about the interactions between precipitation and topography at such intermediate scales. The context in which this work has been developed is well presented, the data set is long so robust statistics can be derived. However, I have the feeling that the manuscript was "rushed" in the sense that the last part of the text is less clear and more speculative. I think the authors should improve their demonstration of this narrow-valley effect and its physical explanations. A list of general and specific comments is provided below to help the authors in this task. Given the amount of work required to improve the manuscript, I recommend to send the manuscript back to the authors for major revisions.

General comments

1. The statistical tests employed in this study are used check if 2 stations have the same distribution of rain rate at the daily time scale. When the null hypothesis is clearly rejected (low p-values), then it can be safely concluded that the 2 stations do not have the same distribution. But when the null hypothesis is not rejected (high p-values) this does not necessarily imply that the null hypothesis is true.

From the text (p.14177, l.16), it seems that the authors make this confusion. For both regions (BW and Bayern) there are relatively low p-values (ex: T1-CP14, T3-CP18, T5-CP10), and the null hypothesis may not hold true for these cases.

2. Out of the large number of stations in the data set, only 6 triplets could be used to investigate this narrow valley effect. I think it could be relevant to try to use more information, by for instance mapping a similarity criterion (e.g., Kolmogorov-Smirnov distance) between a given station and all neighboring stations. This would likely highlight interesting patterns associated with the weather types (CP). This would strengthen the identification of the narrow valley effect, as the approach proposed in the manuscript depends a lot on the selection of the mountain/open-land stations.

3. The explanations proposed to explain this narrow valley effect are (very) speculative. For instance on P.14177-l.25-26, what does “prevent the moisture from sinking and thus receive more rainfall" mean? There could be evaporation that on the contrary would decrease the amount of precipitation... My overall feeling about the explanations provide about the narrow-valley effect (also on P.14178-l.7-10 and l.13-15) are very speculative, and should be strengthened. The larger-scale topography and atmospheric dynamics could also play a role and are not considered (e.g., if there is a large mountain range upstream the study area or the origin of the air masses).

4. The uncertainty in precipitation measurements are neither considered nor mentioned. The wind, especially in mountainous regions can have a significant influence of the measured amount. In addition, there is no mention of the seasonality: the mountain stations can receive a significant proportion of precipitation as snowfall in winter, and the uncertainty and wind effect are much larger for snowfall. The authors should at least mention these limitations in their analysis.

5. In Section 4, a way to take into account the narrow-valley effect by using a sur-

rogate elevation for the valley station is not convincing: I do not see by eye in Figure 14 that the error is “more normally distributed" when the surrogate elevation is considered, and is an improvement of 0.18 mm day^{-1} (about 10%) in bias really significant given all the uncertainties?

Specific comments

1. P.14169, l.25: 500 mm of annual amount does not really correspond to “abundant" precipitation...

2. Section 2.2: information about the type of rain gauge, if they are heated or not, etc... should be provided as this is relevant to characterize the uncertainties associated with the measurements.

3. P.14170, l.24-25: a reference explaining how the circulation patterns are defined/obtained should be given.

4. P.14176, l.22: the distribution of rain rate is highly skewed, so are we still in the case of “modest violation of the assumption" of normality when applying the ANOVA test?

5. P.14177, l.1: what is this “standard error"?

6. P.14177, l.6-7: what is large and medium in terms of sample size?

7. P.14178, l.1: it is not clear how far you go upstream and downstream to define the surrogate elevation.

8. P.14182, l.5: a more quantitative proof should be given for the more normally distributed error (ex: Shapiro-Wilk test).

9. P.14189-14190, Tables 4 and 5: the sample size should be provided, as well as for which triplet/CP the different significance levels (0.05 and 0.15) are used. For T1, there should be parenthesis for the general line. For T3, I think Urbach should be listed first (valley station) to be similar to T1 and T2. Same for Wildflecken, Garmisch and Ruhpolding.

10. Figures in general: the captions should define all symbols and plots.

11. P.14192, Figure 2: it would be nice to include a second y-axis indicating the number of gauges.

12. P.14201, Figure 11: the scale should be provided so that the reader can have an idea of the distance between the stations.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 14163, 2012.