We would like to acknowledge the valuable work made by Witold Strupczewsky and a second anonymous reviewer with their constructive comments. Following the reviewers' suggestions we revised the manuscript as described in the following answers.

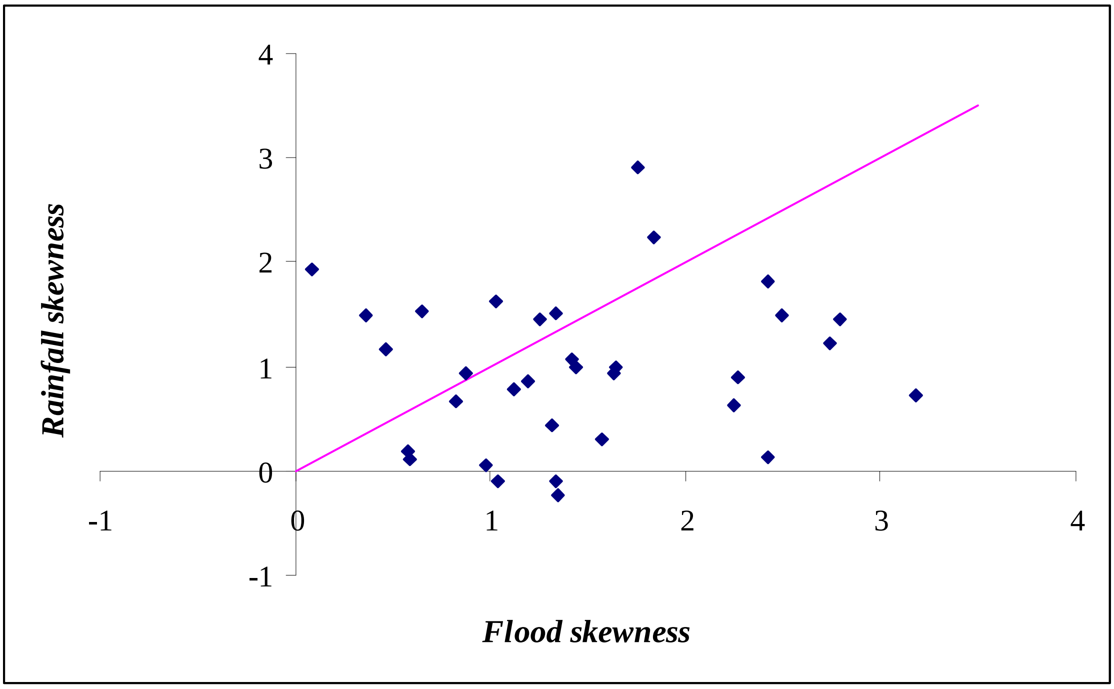
Response to Reviewer 1, Witold Strupczewsky

Specific comments

RC1: Prior to a reading the paper, I considered the skewness of annual maximum rainfall distribution as the dominated factor for the AM peak flow skewness value. Then I have learned from the TCIF analysis that the runoff mechanism can increase the rainfall intensity skewness even more than three times (see Table 9 as example). The fact of an increase does not surprised me as being in agreement with various concepts of causes of inverse-power distribution in nature (e.g. Strupczewski et al., 2010) but its high rate is amazing. Is it realistic, or is it the feature of TCIF distribution only? It is the novelty being in the contrary to McCuen and Smith (2008) findings (recalled in Introduction p.5562, line 28 till p.5563, line 3).

AC.1: I am sure we don't say anything new if we recall the Matalas so called "condition of separation" (i.e. high dispersion of coefficients of skewness in annual maximum floods, Matalas, 1975). The same condition is not frequently observed in rainfall. While such observation has triggered a lot of hydrological research and mainly the studies on the regional analysis of floods, we have found that, apart from simple sample variability, still there is space in the hydrological literature for trying a physical motivation for it and this is what the TCIF model tries to provide exploiting the specificity of different mechanisms of runoff generation.

On the other hand the results of the application of the TCIF model to real cases (Iacobellis at al., 2011) shows that the ratio between skewness coefficient of floods and rainfall can be characterized by high values as we can observe looking at the following figure in which the C_s of floods versus the C_s of rainfalls of the for 33 river basins located in Southern Italy is reported:



On the other hand, such kind of situation could be related to particular values of the soil properties that could even be not easy to observe in nature but were included in the sensitivity analysis in order to provide a complete picture of possible Cs values.

Regarding the McCuen and Smith (2008), as explained in the introduction, they found that the flood skew estimation mainly depends from rainfall skew and watershed storage and that the flood skew decreases from the rainfall skew as storage increases; as shown in the tables 5-9, we found that the flood skewness increases for low values of storage capacity and decreases for high values of storage capacity: this last behavior is in accordance with the findings of McCuen and Smith (2008); we presented a sensitivity analysis performed assuming rainfall as exponential distributed; the difference respect to the findings of McCuen and Smith (2008) consists in the fact that in our case the resulting flood skew is always higher than that of rainfall and it reaches its maximum values when the probability of observing two different runoff components is high. Nevertheless such issue is still to be considered an open field of investigation.

By the light of such considerations we reinforce the paper introduction and conclusions.

RC.2: A great number of variables and parameters scattered all over the paper discourages from studying it. The list of all variables, parameters and acronyms would be very helpful.

AC.2: We accepted this suggestion, in the new version of the paper we introduce a list of model parameters.

RC.3: Describing the properties of a pdf by means of moments and moment ratios one usually starts from the mean then variance and coefficient of variation and so on. What about to start from lower order moments of TCIF? In fact, the IF (but not TCIF) models' relationship between the coefficient of variation (Cv) of the annual flood series was subject to Iacobellis et al. (2002) paper.

AC. 3: In the proposed paper, we start from the analysis of the skewness rather than the average for two main different reasons:

1) we believe that the behavior of the mean and the coefficient of variation of the TCIF distribution is strongly influenced by the ordinary component, thus, both aspects have been addressed in previous articles (with reference to the IF model Iacobellis et al., 2002 and Gioia et al., 2005) but may be investigated in future works with specific reference to the TCIF model;

2) in the hierarchical approach for regionalization (Fiorentino et al., 1987) , the procedure for parameters estimation, starts from the evaluation of the higher order moments, so it make sense to investigate first the spatial variability of these parameters that in the actual procedures are often keep constant because of their high sample variability.

By the light of such considerations we reinforce the paper introduction.

RC.4: p.5564, lines 3-4. Please explain why in Gamma distribution the β is named the scale parameter but not "the shape parameter" and the a_L and a_H the position parameters instead of "the scale parameter". Compare p.5569 l. 13.".
AC.4: In several research papers (e.g. Rossi and Villani 1992), mainly based on the flood index method, it is possible to find reference to parameters depending on the mean as "location parameters", on the coefficient of variation as "scale parameters" and on the coefficient of skewness as "shape parameters". Nevertheless, in order to avoid any confusion in the reader, in the new version of the paper we eliminate from the revised paper any of such references and refer to "*a parameter β strictly correlated to the coefficient of variation and parameters dependent from the mean value once that CV is fixed, as from the parameter equations*".

RC.5: The sign of multiplication but not the addition should be between the two CDFs of L and H-type floods' driving mechanisms. Eq. (4) can be found in the quoted paper Iacobellis et al. (2011) as Eq.(A17) and has been copied in erroneous form. Here the sensitivity analysis of the pdf (5) is made modeling rainfall intensity by Exponential distribution which is the limiting case among other distributions of Weibull distribution. Replacing wherever necessary Weibull by Exponential distribution greatly simplifies the notation making the algebra more digestive. Also the classification into two categories of flood's driving mechanisms (frequent and rare response) can mislead a reader, who could identify frequent as low and rare as high peak flood flow.

AC.5: Equation 4 was written erroneously, we correct this equation in the revised paper. Moreover we accepted the suggestion to replace wherever necessary Weibull by Exponential distribution to simplify the notation; in the revised paper we move the equations 4 and 5 after the equation 8, simplifying them and introducing k=1.

RC.6: p.5565, line 14 and p. 5568 line 10. There is "Assuming the rainfall intensity Gumbel distributed k = . . . ". The rainfall intensity is considered Weibull distributed (p. 5564, line 2) with the shape parameter k. So k = gives the Exponential distribution but not Gumbel. In fact, one can get Gumbel distribution for annual maximum rainfall intensity based on the (Poisson/Exp) POT model.

AC.6: We correct the sentence (p. 5564, line 2) by writing: " *In compound Poisson processes, the common observation of annual maximum series Gumbel distributed, corresponds to exponential distribution of the base process. In this hypothesis we may assume k=1*"; moreover at page 5568 – line 10, the word "*Gumbel*" has been replaced by the word "*exponential* ".

RC.7: p. 5571, lines 1–6 There is "The growth curve depends on scale factor". The growth curve Kx (Eq.16) is for the dimensionless rescaled data. Therefore its parameters are dimensionless as well, e.g. the moment ratios C_V ;C_S,. . . . . There is "The coefficient of variation of such distributions, controlling the scale factor,. . . ". The coefficient of variation is dimensionless therefore it can not control the scale factor.

AC. 7: Again, like in AC4, in the flood index method, the growth factor has mean = 1. Hence the coefficient of variation only depends on the variance and thus controls the scale factor. Anyway, even in this case, in the revised paper, we avoid any confusion by eliminating such kind of reference to the scale factor.

RC. 8: p.5571. In accordance with the title of the paper, one expects a demonstration of dependence of the skewness coefficient of TCIF distribution on the soil parameters. It is done by Tables 5-9 while a large majority of results is reported in the form of growth curve probability plots (Figs 1–13) and each of them is characterized by the same mean annual number of flood events Λ_q. Authors claim that the coefficient of variation of TCIF distribution mainly depends on the mean annual number of flood events Λ_q. If so the probability plot for a fixed value of Λ_q would allow the (indirect, i.e. visual) identification of skewness of TCIF distribution. The Λ_q value is not given in Figures but it can be computed from Eq. (4) putting the mean annual number of rainfall events Λ_p =21. It is not convenient for a reader, if accepted it calls for explanation. Anyhow the plots (Figs 1–13) allows to assess the TCIF's sensitivity of upper quantile values to the soil parameters which is the main interest of FFA.

1. What is a reason to use the plots instead of tables which seems to be more compact and gives the values of the skewness coefficient C_S….

2. It is worth to show that the statement “the coefficient of variation of POT and in particular TCEV distributions depends mainly on the mean annual number of flood events Λ_q “ (p.5571, lines 3–8) is acceptable for TCIF and in general for TCEV. It easy to show that it is holds for TCEV if the magnitude distributions of the both variables are identical in terms of a function and parameter values and the threshold is a small value, e.g. for (POT/EXP) model:

$$C_V = \frac{\pi}{\sqrt{6}\,[(\ln\lambda_q + C) + (\varepsilon/\beta)]}$$

where β is the Exp distribution parameter and ε is the threshold value while C is the Euler constant.

AC.8: Following the reviewer’s suggestion we have reduced the number of figures and provided the following explanation for the display of those that remain.

1. The plots are introduced in the paper to better show the effect of the soil parameters on the skewness coefficient and, in general, on the FFA behavior; in particular the figs 1-5 are useful for showing the influence of the soil parameters concurrently on Cs and Cv of the annual maximum flood peaks; in order to account separately for Cs and Cv, the same cdfs shown in Figs. 1–5 are reported in Figs. 6–10 assigning for each subplot the value of ϕ/I_A strongly correlated to Cv; observing the Figs. 6–10 one could notice that the minimum skewness is provided by a higher value of r_L and the largest scatter is provided with a low value of r_L and a high r_H . The Fig. 11 groups all the TCIF cdfs having the same values of r_L and r_H in order to provide a complete overview of the effects due to the parameters I_1,A, W_A/I_A and ϕ/I_A; in fact in the subplots 11*a* and *b*, characterized by the highest scatter in the shape factor, the cdfs with different scale factor show a marked overlap and in the subplots 11c and d, with lowest scatter in shape factor, the difference in the scale factor dominates the cdfs behaviour.

In order to provide the reader with a clear evidence of such behavior and at the same time reducing the number of figures, we eliminated figures: 2, 3, 4, 11b and 13. (Figure numbering as in the original manuscript version)

2. before the reviewer’s comment we were confident that strong relationship holds between Λ_q and the Coefficient of Variation based on the same considerations he makes. After his comment we have numerically investigated the relationship between Λ_q and the Coefficient of Variation and we found that the coefficient of variation of the TCIF distribution depends mainly on the mean annual number of flood events Λ_q. Such results were mentioned but not included in the revised paper.

RC.9: p. 5574–5576. Conclusions. It would be convenient for a reader if every conclusion is referred to respective Tables or Figures.

AC.9: Done.

Technical corrections

RC.1: 5570, line 6. “varies ”instead of “aries’ .

AC.1: Done.

RC.2: Tables 5-10. Incomplete titles “standard of skewness” does not make any sense. By the way, although the origin of the SD values of skewness displayed in Tables 5 to 10 is explained (page 5572 lines 4 to 7), still reading such small values in separation from the text can make illusion (Figs 1–13) that thanks to TCIF the skewness of AM distribution is totally under control.

AC.2: Done.

Response to Reviewer 2

Specific Comments:

RC.1: The title of the paper should be changed to indicate the main parameters investigated and that the analysis is based on the TCIF model, holding all the assumptions and hypotheses. I suggest that the title of the paper should be changed to: “Influence of soil infiltration and soil storage capacity on the skewness coefficient of the annual maximum flood peaks using the TCIF model”.

AC.1: Following the reviewer’s comment the revised paper is entitled: “Influence of soil properties on the skewness of the annual maximum flood peaks using a theoretically derived distribution”

RC.2: The authors should spell out the acronym TCIF model at least once in the beginning of the paper. This will help the reader of the paper.

AC.2: Done

RC.3: The derived CDF (Eq. 4) should be the product of the two CDFs of L- and H-type events and not the addition of those. Please correct.

AC.3: As indicated in the response to Reviewer 1 - AC.5, we have corrected the equation 4.

RC.4: The authors, correctly, present the TCIF model. However, there are too many symbols and it is difficult for the reader to follow them. I suggest to the authors to put a list of all symbols (with their explanation) used in the paper. For some of them there is no explanation at all in the paper, eg. Λp.

AC.4: As reported in the response to Reviewer 1 - AC.2, in the new version of the paper we have introduced a list of all model parameters and symbols;

RC.5: On page 5 line 14 and elsewhere later in the paper is written "Assuming the rainfall intensity is Gumbel distributed….." But on page 4 line 24 is written "The rainfall intensity is considered Weibull distributed….." Please correct.

AC.5: we have already revised the text as discussed in the response to Reviewer 1 - AC.6;

RC.6: The authors use a very large number of tables and figures to present their results. However, some of them are repetition of others. For example, the information conveyed by Tables 5 to 9 is also graphically shown in Figures 1 to 10 and the results presented on Table 10 are reproduced on Figure 12. I prefer the analytical information conveyed by the tables. The authors may keep some of the figures in the paper for specific cases (not all the cases presented on the tables) for illustration purposes. However, Figures 11 and 12 and Table 11 are redundant and convey no additional information.

AC.6: we have already discussed such point in the response to Reviewer 1 - AC.8;

RC.7: The authors use interchangeably the terms soil infiltration and permeability. They should use the term soil infiltration.

AC.7: the terminology will be reviewed thoroughly in the text.

Minor Technical Comments

RC: 1. In many pages of the paper the specific figures and tables should be denoted as Figures and Tables. (e.g. page 6 line 28, it should be Table 1 instead of table 1). 2. Page 7 line 2. It should be written eqs. 6 and 7 instead of eq.s. 6 and 7 3. On Table 1, the two cases $i>\phi$ and $i> \phi + W_A$ should be put on the headers of table columns. 4. On Tables 5-9, the caption of the tables should be written as "Mean and standard deviation of skewness coefficient…." 5. Page 11 line 32. "…this figures…" should be corrected to ": : :these figures.." 6. Page 12 line 1. "…this figures…" should be corrected to "…these figures.." 7. The reference Loukas, 2002 is cited two times on the reference list.

AC: All these changes have been made.

References

Fiorentino, M., Gabriele, S., Rossi, F., and P. Versace, Hierarchical approach for regional flood frequency analysis, in V. P. Singh (eds), Regional flood frequency analysis, 35-49, D. Reidel, Norwell, Mass, 1987.

Gioia A., Fiorentino M., Iacobellis V., Margiotta M. R.. "Theoretical derivation of the Index flood", Advances in Geosciences, ISSN 1680-7340, 2, 249-253, 2005, www.adv-geosci.net/2/249/2005/, doi:10.5194/adgeo-2-249-2005.

Iacobellis, V., P. Claps and M. Fiorentino. Climatic control on the variability of flood distribution, Hydrology & Earth System Sciences, EGS, ISSN: 1027-5606, 6(2), pp. 229-237, 2002.

Iacobellis, V., Gioia, A., Manfreda, S., and Fiorentino, M.: Flood quantiles estimation based 25 on theoretically derived distributions: regional analysis in Southern Italy, Nat. Hazards Earth Syst. Sci., 11, 673–695, doi:10.5194/nhess-11-673-2011, 2011.

Matalas, N. C., Slack, J. R., and Wallis, J. R.: Regional skew in search of a parent, Water Resour. Res., 11(6), 815–826, 1975.

Rossi, F. and Villani, P.: Regional methods for flood estimation, In: Coping with Floods, edited by: Rossi, G., NATO-ASI Series, Kluwer, 1992.