

Interactive comment on “A model for the spatial distribution of snow water equivalent parameterised from the spatial variability of precipitation” by T. Skaugen and I. H. Weltzien

Anonymous Referee #2

Received and published: 19 April 2016

In this study a gamma distribution (SD_G) for snow distribution was implemented in a parameter parsimonious rainfall runoff model. Snow water equivalent (SWE), snow covered area (SCA) and runoff were simulated with SD_G and compared with the usage of a log-normal distribution for 71 Norwegian catchments. Both distributions simulate runoff almost similar, although the log-normal distribution artificially creates “snow towers”, which leads to a positive trend in SWE. Simulations for the SCA were validated with MODIS satellite data and show that the gamma distribution performs better than the log-normal distribution.

The novelty of this study is the implementation of the already existing gamma distribution to the rainfall runoff model and testing of the model performance for catchments of

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different size.

The main criticism of the paper is the fact that it is not clearly presented, which leads to unknown answers to the reader. I classify the paper with major revision.

1. At the first time it sounds contradictory, that an improved SWE simulation does not improve the model performance in runoff. As this is one major results it needs to be clearer evaluated.

2. The main novelty of this study is the implementation of SD_G to the rainfall runoff model and testing for large catchments. I would suggest including an analysis to answer some of the following research questions: In which catchments is the model performance best? Large or small catchments? High or low elevated catchments? Catchments in the south or in the north?

3. What would happen if the simulations using SD_LN were restarted each year in autumn with no snow? This would solve the problem of the “snow towers”. For me it is not clear why this is not considered? At least, it should be discussed in more detail.

The quality of the figures needs to be improved. References in the text should be ordered first chronologically and then alphabetically. Also the reference list at the end of the manuscript needs to be revised because the format is not consistent (e.g. page 31 line 7-8 vs. page 31 line 10-11 vs. page 32 line 37-38).

Introduction: The introduction is very technical e.g. page 6 line 4-18 belongs more to the methods. The introduction does not have a clear story. It is not clear how you get the information of the spatial variability of the precipitation in order to estimate the parameters for SD_G.

Methods: The methods part is very detailed with a lot of formulas. For the reader it is very difficult to follow and it is not clear for which parts in the results all these formulas are necessary. You should include the period of simulation in the methods and also your runoff measurements. Where are the data from? The description of the MODIS

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satellite (page 20 line 20 – page 21 line 3) belongs also to the methods and not to the results part.

Results: This part is very short compared to the methods. The authors need to evaluate runoff, SCA and SCA with respect to different characteristics (size, elevation,...) of the 71 catchments.

Details: Commas are sometimes missing after an equation (e.g. equation 7), also a colon before the equation (e.g. page 13 line 11).

The correct spelling is “i.e.” instead of “i.e”

Page 2 line 11: ..in the already existing parameter ?

Page 6 line 6: You should define the SD_LN here and not later on page 7 line 1.

Page 8 line 3-5: Include log-normal distribution, gamma distribution. . . .

Page 8 line 9: should be “changed its shape”

Page 8 line 13: Skaugen and Randen (2013)

Page 8 line 21: include the parameter for shape and scale in the text.

Page 9 line 3: “reminder”

Page 9 line 6: Γ is not defined.

Page 9 line 11: space is missing in equation 3.

Page 10 line 16: spatial mean

Page 10 line 18: There is no straight line in Fig 1b)

Page 12 line 15: Do “units” have the same meaning as pixels or area in this context?

Page 13 line 7: delete the comma

Page 14 line 6: bracket is not closed

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Page 14 line 15: I would suggest to use f_m instead of f_s for the abbreviation of snowmelt in order to be consistent with f_a (accumulation).

Page 14 line 16: delete “the same”

Page 15 line 3: “with respect to”

Page 15 line 10: why is “spatial” written in italic?

Page 15 line 13: why “left”?

Page 16 line 21: How is the correction be applied? Can you provide more details?

Page 17 line 4: I would suggest to name the cited literature. (“is found in Skaugen. . .”)

Page 17 line 6: From Table 1 only 5 instead of 11 model parameter are bold. The explanation of the reduction of the calibrated parameter is written in the discussion of the manuscript.

Page 17 line 9: “2.6” instead of 2.5

Page 17 line 11: delete “from”

Page 17 line 18: The following procedure was conducted:

Page 18 line 20: delete “for”

Page 19 line 11: delete “).”

Page 20 line 2: What do you mean with “most catchments”? How many catchments have these “snow towers”? Is this phenomenon only observed for high elevated catchments?

Page 20 line 18: You wrote that you found 150 estimates for SCA for each catchment. In page 21 line 4 you wrote that 69 catchments have values for SCA and 2 have no SCA observations. Also why did you write in line 7 70 catchments? Please correct these inconsistencies or explain better!

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Page 21 line 5: delete “for”

Table 1: On page 16 line 18 you wrote that you use temperature and precipitation lapse rates, but why are they 0 in Table 1? Additionally, I would suggest shortening the table to the most relevant parameters, because you do not use the most of the parameters in the following. Include a space between Table and 1 (page 34 line 1) Also correct “Mean elevation of catchment”

Table 2: Where does this 1.02 value come from? You wrote in the table caption, that 1 is the ideal value.

Figure 1: “Spatial mean and standard deviation of observed precip.” I would additionally suggest including the parameter values of the fitted line and rename “m” on the x-axis to “mean”.

Figure 2: This figure is very hard to understand. Where comes the 0.1 on the x-axis label come from?

Figure 5: Why do you include a running average over the catchments? Are they sorted by size, mean elevation,..?

Figure 6: Is your time unit days? It would be better to choose years! What does the “16.75” in the figure caption mean?

Figure 7: I would suggest changing the y limits in the figures a and b to clearer see the differences between the log-normal and gamma distribution. Is the unit of slope of regression “mm” and “C”? I think it should be mm/time and °C/time (°C/year; mm/year)

Figure 8: include the unit of the RMSE. Does this mean that the model is around 15% wrong in estimating the SCA? Do the models underestimate or overestimate the SCA? Where are the largest errors observed?

Figure 9: It is very difficult to see anything from this figure.

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Interactive comment on The Cryosphere Discuss., doi:10.5194/tc-2016-43, 2016.

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