Answer to Reviewer 2 HESS-2019-152

We thank Reviewer 2 for his detailed comments. We provide here our responses to his comments, including the plan to revise the manuscript in response to reviewer comments. The original review comments are in normal black font while our answers appear in blue font.

General Comments

Dear authors,

Your study is a case study (a nice one, I admit). I am personally not very interested in such studies, where actually only the data owner and model operators learn something about their specific data chain in a single event in their region. With some adjustments it might fit in NHESS. For HESS I see too limited added information for the community.

Where is the true novelty? You use well citable tools and data for a specific event. Their present combination might be novel, but surely not original (different resolution, different initial conditions, different density of stations).

We thank Reviewer 2 for this comment. Substantial changes will be made to the initial paper to show how this case study of an extreme flood in mountainous terrain can bring a scientific contribution to the international community.

First of all, some of the results that were presented in the initial manuscript will be removed since they correspond to expected results with a lack of real novelty as detailed Reviewers 2 and 3. We will remove from the manuscript:

- the precipitation analysis at 10 km using the default stations (*CaPA 10 km Def*). This precipitation analysis used the same stations as the operational analysis at the time of the event but its quality is mediocre due the low density of stations in mountainous terrain. In the revised manuscript, we will only keep the precipitation analysis generated with all the precipitation data for each horizontal resolution (10, 2.5, 1 km). Theses different precipitation data will be presented as our best estimation of the precipitation at each horizontal resolution.
- the results corresponding to the different Manning options that were described in the section *Results*. We will describe the selection of the correction factor applied to the default values of the Manning coefficients in the section *Methods*. See below our answer to the specific comment on this question.

Removing these two components of the initial manuscript will allow us to focus the revised manuscript on the factors governing the predictions skill of extreme late-spring flood in mountainous terrain. The three **scientific questions** of the **revised manuscript** will be as follows:

1. How does the resolution of the atmospheric forcing influence the predictability of the hydrological response during extreme late-spring flood in mountainous terrain?
2. At kilometric scale, can the rain/snow partitioning from an advanced cloud microphysical scheme improve the predictability of the hydrological response during this kind of event?
3. How does the sensitivity of the hydrological response to the resolution of the atmospheric forcing and to the phase partitioning method compare to (i) the sensitivity to the initial snow conditions and (ii) the uncertainty in soil datasets?

An ensemble of hydrological simulations will be used to answer these questions:

- three atmospheric forcings will be used at 10, 2.5 and 1 km as in the initial manuscript. At each resolution, the precipitation forcing will consist of the CaPA analysis including all the stations available in the region to obtain our best estimate of precipitation at a given resolution.

- for each atmospheric forcing, the same two initial snow and soil conditions will be used as in the initial manuscript.
- finally for each atmospheric forcing and initial snow/soil conditions, two different soil database will be considered: the Global Soil Dataset for Earth System Model (GSDE, (Shangguan et al., 2014) and the Soilgrid dataset (Hengl et al., 2017). These 2 database can be considered as reference soil databases for Earth system models (Dai et al, 2019).
- for the atmospheric forcing at 1 km, for each soil dataset and initial snow conditions, three hydrological simulations will be carried out with GEM-Hydro using different phase partitioning methods (PPM): (i) a constant threshold depending on air temperature (0°C, the default value in GEM-Hydro), (ii) a more advanced PPM combining temperature and relative humidity (Harder and Pomeroy, 2013) and (iii) the direct precipitation phase from the P3 cloud microphysical model running in GEM at 1 km.

These hydrological simulations will be evaluated at a new set of 12 unregulated stations located in the headwaters of the Red Deer, Bow and Oldman River basins (see below our answer to the next general comment regarding the statistic). This new set of the stations will made our analysis less localised and will allow us to derive more general conclusions useful for the international community.

For example, we will add and discuss in the revised manuscript results on the influence of the resolution of the atmospheric forcing on the simulation of the snow melt dynamic during the rain-on-snow event at each sub-basin where snow was initially present. Figure 1 shows that the contributions of the turbulent fluxes to the total energy input to the snowpack is larger with the atmospheric forcing at 2.5 and 1 km than at 10 km. This result is consistent across all the sub-basins and results from larger wind speed at 2.5 and 1 km than at 10 km. It illustrates that the importance of the wind field downscaling on simulated turbulent fluxes and resulting snowmelt. To our knowledge, a quantification of these effects on the hydrological response during extreme floods has never been proposed in previous studies and constitutes an original contribution of our study.

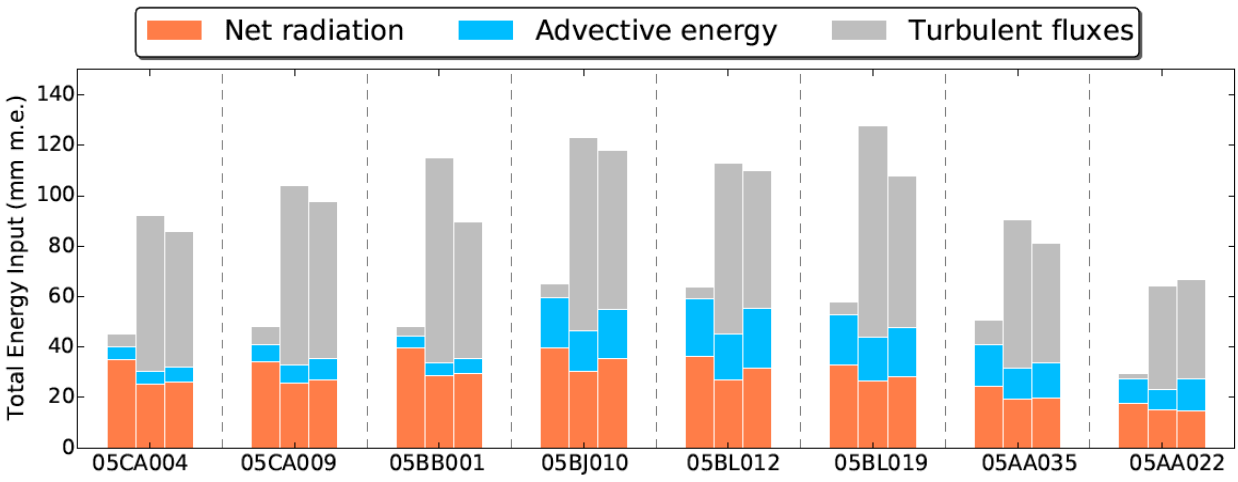


Figure 1: Contribution of energy balance terms to the total averaged energy input to the snowpack (expressed in millimetre melt equivalent) during the flooding event simulated using atmospheric forcing at different resolutions (Left: 10 km; Middle: 2.5 km; Right: 1 km) for different sub-basins. The location of the sub-basins is shown on Fig. 2 below.

Following these substantial changes, we will propose a new title for the paper: *Assessing the factors governing prediction skill of extreme late-spring flood in mountainous terrain*. The section *Discussion* of the revised manuscript will be rewritten to better highlight the scientific contribution of this study.

Where is the solid statistic?

An improved experimental design will be used in the revised manuscript. 12 unregulated stations located in the headwaters of the Red Deer (2 stations), Bow (6 stations) and Oldman (4 stations) River basins will be selected for the evaluation of hydrological simulations. Among these 12 stations, 4 stations were used in the initial manuscript. The location of these stations is given on the map below. In total, the river basins of these 12 stations cover 12700 km^2 and were characterised by different total precipitation amount, initial snowpack conditions and soil characteristics. For each of this stations, hydrological simulations will be evaluated in terms of flood volume, peak magnitude and timing. This will provide a more solid evaluation framework to assess the factors governing prediction skill of extreme late-spring flood in mountainous terrain.

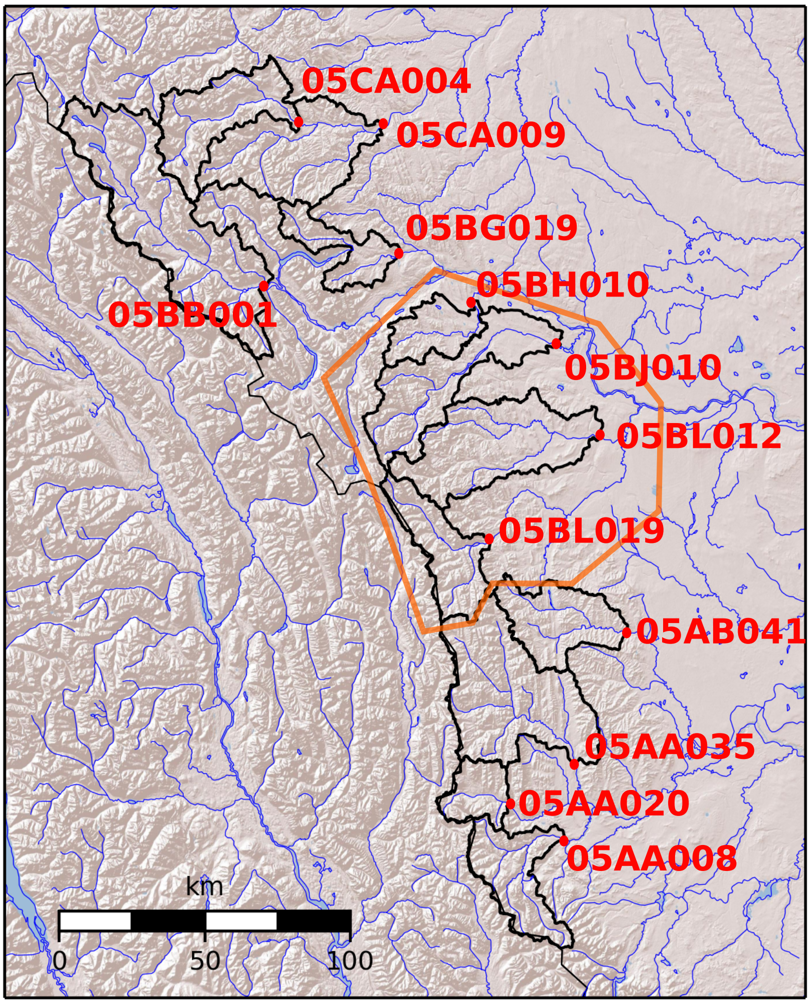


Figure 2. Location of the 12 hydrometric stations proposed for the evaluation of hydrological simulations in the revised manuscript. The black lines represent the limits of the catchments associated with each station. The orange polygon delineates the location of the catchments that were used for model evaluation in the initial manuscript.

Comments from the pdf

Main points:

- Your study is a case study. Fits in my opinion better in NHESS than in HESS. I am personally not very interested in such studies, where actually only the data owner and model operators learn something about their specific data chain in a single event.

See above our answer to this comment.

- Where is the true novelty? You use well citable tools and data for a specific event. Their present combination might be novel, but surely not original (different resolution, different initial conditions, different density of stations).
See above our answer to this comment.

-Figures 10-12 suggest a range based on only two member. This is not adequate.
We thank Reviewer 2 for this comment. The filled area will be systematically removed from the figures showing hydrographs in the revised manuscript to avoid any mis-interpretation of the results.

Introduction
The whole introduction reviews previous analysis of the here analyzed event and introduces the specific models and data used by the authors.
Please correct me, but I don't see any link to current challenges in hydrological modelling of rain-on-snow events, current methods in simulation of floods and previous similar approaches in other areas.
What is the knowledge gap here?
The fact that "Despite its severe hydrological consequences, this extreme weather event has received little attention from a hydrological modelling point of view."?
Is the question "cam my model cope with this event" still a relevant one in the times where model assessment relies on multi-model and multi ensemble input for periods of several years?

The Introduction in the revised manuscript will be fully rewritten to put our study in a general context and better highlight the current challenges in modelling of extreme floods in complex terrain and downstream regions.

We will first include a general paragraph on extreme flooding events in mountainous terrain mentioning previous severe events such as the flood in the mountainous catchments of central Europe in June 2013 (Grams et al., 2014), the Colorado Flood in September 2013 (Gochis et al., 2015) or previous flooding events in the mountains of Western Canada (Buttle et al., 2016). These events were characterised by large amount of rainfall strongly influenced by the local topography (e.g. Friedrich et al., 2016). In late spring, these heavy rainfall can occur with high-freezing level leading to a rain-on-snow (ROS) event in areas that are still covered by snow (Mc Cabe et al., 2007; Corripio and Lopez-Moreno, 2017). The June 2013 Flood in Alberta corresponds to this type of event (Pomeroy et al., 2016). We will then briefly detail the main hydro-meteorological features of this extreme event.

We will then write paragraphs on the modelling strategies that are used to predict these extreme events (e.g. Hapuarachchi et al., 2011; Pagano et al. , 2014). In particular, we will discuss the main source of uncertainties for operational flood forecasting in complex terrain (Mascaro et al., 2010, Zappa et al., 2011). We will highlight the importance of the spatial and temporal accuracy of the rainfall forcing (e.g. Jasper et al., 2002; Vincendon et al., 2011, Lobligeois et al., 2014). The influence of initial soil moisture and snow conditions will be discussed as well (e.g. Anquetin et al., 2010; Silvestro and Rebora, 2010; Edouard et al. 2018). In particular, we will mention the benefit for runoff prediction of using snow information from a dedicated external snow monitoring system (Jörg-Hess et al., 2015; Griessinger et al., 2016). Finally, the uncertainties associated with the soil dataset will be mentioned (Lovat et al., 2019).

A specific paragraph presenting the challenges of ROS modelling will then be written. We will mention past studies focusing on hydrological prediction of specific rain-on-snow events (Rössler et al., 2014, Corripio and Lopez-Moreno, 2017) and the main conclusions from these studies. In particular, we will insist on the importance of an accurate estimation (i) the areal extent and snow water equivalent at the beginning of the ROS (McCabe et al., 2007) (ii) the contribution of the turbulent fluxes to total snow melt during ROS events (e.g. Marks et al., 1998; Garvelmann et al., 2014; Würzer et al., 2016) and (iii) the evolution of the rain/snow partitioning during the event (Jasper et al., 2002) and the potential benefit of the phase partitioning from cloud microphysical schemes implemented in atmospheric models (Harpold et al., 2017). We will also mention the influence of the initial snowpack properties at the beginning of the ROS (e.g. Würzer et al., 2016).

We will finally describe the scientific objectives of this paper and give an overview of the modelling strategy.

The list of the references mentioned here is given at the end of this document.

P 2 L 27: Pagano, T. C., Wood, A. W., Ramos, M. H., Cloke, H. L., Pappenberger, F., Clark, M. P., ... & Verkade, J. S. (2014). Challenges of operational river forecasting. Journal of Hydrometeorology, 15(4), 1692-1707.
As described in our previous answer, this reference will be added to the introduction when describing the general context of your study.

Text
P4. L4L Are these data available only for the event or also for some training periods before?
Measurements of precipitations and snow water equivalent are available both for this event and for other time periods before and after the flooding event. Daily discharge data are available through the Canadian Water Office website and cover the periods of operation of the different hydrometric stations. Finally, hourly discharge data for the flooding event were obtained through a specific request to the Canadian Water Office. Only hourly discharge data were used in our study since we focused on the short-term hydrological response during the flooding event. We will improve the description of the data availability in the revised manuscript.

P5 L1-2 Large literature on this: E.g.
Jonas, T., Marty, C., & Magnusson, J. (2009). Estimating the snow water equivalent from snow depth measurements in the Swiss Alps. Journal of Hydrology, 378, 161-167. https://doi.org/10.1016/j.jhydrol.2009.09.021
We fully agree with Reviewer 2 that methods such the one proposed by Jonas et al. (2009) could be used to obtain an estimation of SWE from the ECCC snow depth analysis, even if this method was initially developed in the Swiss Alps and may present limitations in the Canadian Rockies. The low resolution of the ECCC snow analysis (10 km) is the main reason why we did not use this product in our study. We will make this point more clear in the revised manuscript.

P6 L15-16 These are operational runs or ad-hoc hindcasts?
All the GEM simulations used to drive the hydrological simulations are ad-hoc hindcasts that were specifically generated for this study using the operational versions of the GEM atmospheric model available in June 2018. We will clarify this point in the revised manuscript.

P 7 L 7-9 Large set on international literature on this.
E.g.: Germann, U., Galli, G., Boscacci, M., & Bolliger, M. (2006). Radar precipitation measurement in a mountainous region. Quarterly Journal of the Royal Meteorological Society: A journal of the atmospheric sciences, applied meteorology and physical oceanography, 132(618), 1669-1692.
The reference provided in the initial manuscript was published in an international journal and was specific to the June 2013 flooding event. We will consider adding additional references from the international literature in the revised manuscript.

P 8 L1 I accept your argumentations. This is for me a reason to ask nevertheless for simulation of other (smaller) events in order to evaluate the non-randomness of your analyses.
We do not plan to add the simulations of additional events in the revised manuscript. Indeed, this work has required the generation of new GEM hindcasts of the June 2013 Flood at different resolutions. This cannot be easily extended to other events. Instead, a new set of 12 stations will be used for model evaluation in the revised manuscript (see our answer above to the second general comment).. This new set of stations will consist of the main unregulated stations located in the headwaters of the Oldman, Bow and Red Deer Rivers basins. We believe that this new selection of stations will allow us to derive less localised conclusion and improve the quality of our analysis.

P 8 L 23: Sevruk, B. (1983). Correction of measured precipitation in the Alps using the water equivalent of new snow. Hydrology Research, 14(2), 49-58.
Nešpor, V., & Sevruk, B. (1999). Estimation of wind-induced error of rainfall gauge measurements using a numerical simulation. Journal of Atmospheric and Oceanic Technology, 16(4), 450-464.
Savina, M., Schäppi, B., Molnar, P., Burlando, P., & Sevruk, B. (2012). Comparison of a tipping-bucket and electronic weighing precipitation gage for snowfall. Atmospheric Research, 103, 45-51.
We will add these references in the revised manuscript.

P 8 L 28-29
This study also uses alternatively row model conditions and SWE estimations at model initialization in the context of runoff and SWE forecasting in mountainous terrain. SWE estimation based on observations improve the forecast of discharge volume
Jörg-Hess, S., Griessinger, N., & Zappa, M. (2015). Probabilistic forecasts of snow water equivalent and runoff in mountainous areas. Journal of Hydrometeorology, 16(5), 2169-2186. https://doi.org/10.1175/JHM-D-14-0193.1
P9 L3: Figure 10 in Jörg-Hess, S., Griessinger, N., & Zappa, M. (2015). Probabilistic forecasts of snow water equivalent and runoff in mountainous areas. Journal of Hydrometeorology, 16(5), 2169-2186. https://doi.org/10.1175/JHM-D-14-0193.1
We thank Reviewer 2 for this very interesting reference. It will be added in the introduction as well as in the discussion of the revised manuscript. The impact of the insertion of SNODAS SWE on the simulation of the flood volume will be discussed in regards to the results obtained by Jörg-Hess et al. (2015) on the forecast of runoff volume in the Swiss mountains.

P 10 L3-5 : Is such behavior to be expected also for less severe events?
An overall improvement of quantitive precipitation estimation with atmospheric models running at convective-resolving resolution compared to lower resolution models has been obtained in many studies in complex terrain (Rasmussen et al., 2011; Gutmann et al., 2012; Lundquist et al., 2019). Therefore, we estimate that similar conclusions are expected for less severe events as well. ß

- Gutmann, E., Rasmussen, R., Liu, C., Ikeda, K., Gochis, D., Clark,M., et al. (2012). A comparison of statistical and dynamical downscaling of winter precipitation over complex terrain. J. Clim. 25, 262–281. doi: 10.1175/2011JCLI4109.1

- Lundquist, J., Hughes, M., Gutmann, E., & Kapnick, S. (2019). Our skill in modeling mountain rain and snow is bypassing the skill of our observational networks. Bulletin of the American Meteorological Society, (2019).

- Rasmussen, R., Liu, C., Ikeda, K., Gochis, D., Yates, D., Chen, F., et al. (2011). High-resolution coupled climate runoff simulations of seasonal snowfall over Colorado: a process study of current and warmer climate. J. Clim. 24, 3015– 3048. doi: 10.1175/2010JCLI3985.1

P 10 L 6 Red Deer seem to be also fine at 10 km standard application. Why?
CaPA 10 km Def shows improved performances for the Red Deer River basin compared to the Bow and Oldman Rivers basins as shown on Fig. 7a of the initial manuscript. This can be explained by the fact that most of the precipitation over the Red Deer basin fell between 20 June 06 UTC and 21 June 00 UTC, mostly after the transition from convective to stratiform precipitation that occurred between 06 and 08 UTC on 20 June (Kochtubajda et al., 2016; Li et al., 2017). GEM at 10 km provides a more accurate precipitation background during the stratiform period than during the convective period. However, a more detailed look at Fig. 5 of the initial manuscript shows that *CaPA 10 km Def* presents an underestimation of precipitation on the eastern side of the headwaters of the Red Deer River and an overestimation in the western side of the headwaters. This results from an error in the location of the precipitation in the 10-km background that was not corrected by the analysis since no station was used in the headwaters of the Red Deer River by *CaPA 10 km Def* (see Fig. 1 of the initial manuscript). The additional stations used in *CaPA 10 km New* corrected this error in the location of the precipitations (Fig. 6d of the initial manuscript), leading to improved performances of the analysis for the Red Deer Basin (Fig. 7b of the initial manuscript).

A table containing the performances metrics (Bias, RMSE, R2) for each CaPA experiment and each main basin will be added to the revised manuscript as suggested by Reviewer 3. In addition, the performances metrics will be computed for the whole event and computed separately for the convective and stratiform periods as defined in Kochtubajda et al. (2016) and Li et al. (2017). This will allow a better explanation of the performances of the CaPA experiments for the different basins.

P 10 L 17-18: Citation?
We will add the following references to the revised manuscript:
- Bracken, L. J., Cox, N. J. and Shannon, J. (2008), The relationship between rainfall inputs and flood generation in south–east Spain. *Hydrol. Process.*, 22: 683-696. doi:10.1002/hyp.6641
- Huang, Y., Bárdossy, A., and Zhang, K.: Sensitivity of hydrological models to temporal and spatial resolutions of rainfall data, Hydrol. Earth Syst. Sci., 23, 2647–2663, https://doi.org/10.5194/hess-23-2647-2019, 2019.

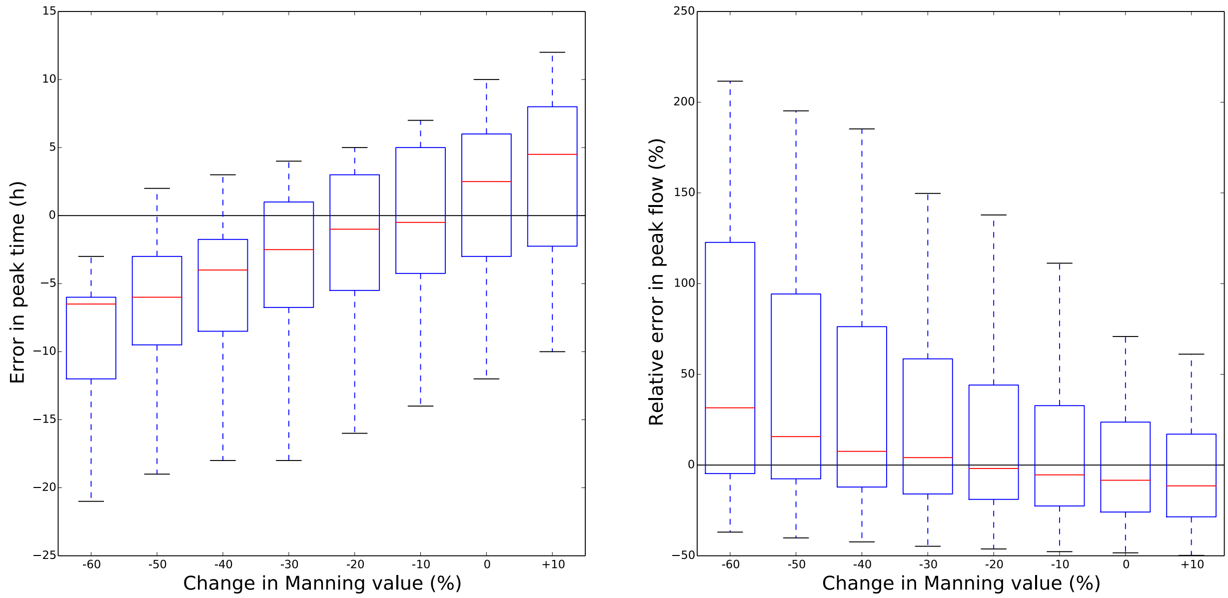
P 11 L 7 : Nice Figure, but difficult to see the black lines from the barcharts to the gauges.
Thanks for this comment. The bar charts will be modified in the revised manuscript to improve the readability of the figure. Note that the figure will be modified as well since new hydrometric stations will be used for model evaluation (see our answer to the first general comments).

P 11 L 9: So, 10km_Def always profits from SND instead of OPT. The other forcings partly.
The atmospheric forcing *10km_Def* suffers from a systematic underestimation of precipitation which is systematically and partially compensated by the increase in initial SWE when using *SND* as the initial snow condition. The other precipitation forcing benefits from additional stations which greatly improves their quality in the headwaters, removing the underestimation of precipitation and removing the main source of uncertainty of the hydrological simulations. Therefore, hydrological simulations using these improved atmospheric forcing are more sensitive to error in the initial snow conditions; in particular in the headwaters where SND tends to overestimate the initial SWE conditions and lead to overestimated flood volume (see station 05BL019 for example).
The different source of uncertainties and there relative importance will be better described in the revised version of the paper, as mentioned above in our answer to the first general comment.

P 11 L 23: Same for at least two other creeks
These two creeks correspond to the hydrometric stations 05BL027 and 05BL023. No snow was present in the drainage basins of these 2 stations on 18 June 2013. Note that these two stations will be removed from the analysis in the revised manuscript.

P12 L 1-2: I don't see the point in filling the areas between OPT and SND in panels c) and f) of both Figures. You suggest here a range like for probabilistic forecasts with only two members.
Same in Figure 12.
See above our answer to the 3rd general comment.

P 12 L 26-27 : We see the results, but we don't see the numbers for all Manning options. Table would be useful
We thank Reviewer 2 for this comment. In the revised manuscript, the results corresponding to the different Manning options will be removed from the section *Results*. We will describe the selection of the correction factor applied to the default values of the Manning coefficients in the section *Methods*. Indeed, as mentioned by Reviewers 2 and 3, the adjustment of the Manning coefficient does not bring novelty to our study. Therefore, we decided to present it as a calibration step in the revised manuscript. The correction factor selected at this calibration step will then be used in the rest of the analysis.
The figures below shows the impact of the correction factor on the distribution of model errors in terms of peak magnitude and timing. Results are given for all the hydrometric stations and for 4 hydrological simulations: *2.5km_OPL*, *2.5km_SND*, *1.0km_OPL* and *1.0km_SND*. These figures will be added to the supplementary material of the revised manuscript



Distribution of model errors in terms of peak timing (Left) and magnitude (Right) for different correction factors applied to the default Manning coefficients.

This new presentation of the Manning options will leave more room in the section *Results* for additional results that will strengthen the paper as described above. The challenges associated with the choice of the routing parameter for such extreme event will be kept in the discussion.

P 14 L 32: Is this really the first citation to a international study?

The paper by Bernhardt and Schulz (2010) describes the SnowSlide scheme which can be considered in the snow hydrology community as one of the reference schemes that simulate gravitational snow redistribution in a hydrological model. However, it is clear that it is not the first time that the importance of gravitational snow redistribution for mountain snow hydrology is mentioned in a paper. In the revised manuscript, we will add the reference to the one of the earlier studies on this topic (Blösch and Kirnabauer, 1992).

Blösch, G. and Kirnbauer, R. (1992), An analysis of snow cover patterns in a small alpine catchment. Hydrol. Process., 6: 99-109. doi:10.1002/hyp.3360060109

<u>List of references that will included in the introduction (not exhaustive):</u>

Anquetin, S., Braud, I., Vannier, O., Viallet, P., Boudevillain, B., Creutin, J. D., & Manus, C. (2010). Sensitivity of the hydrological response to the variability of rainfall fields and soils for the Gard 2002 flash-flood event. *Journal of hydrology*, *394*(1-2), 134-147.

Buttle, J. M., Allen, D. M., Caissie, D., Davison, B., Hayashi, M., Peters, D. L., ... & Whitfield, P. H. (2016). Flood processes in Canada: Regional and special aspects. *Canadian Water Resources Journal/Revue canadienne des ressources hydriques*, *41*(1-2), 7-30.

Corripio, J., & López-Moreno, J. (2017). Analysis and Predictability of the Hydrological Response of Mountain Catchments to Heavy Rain on Snow Events: A Case Study in the Spanish Pyrenees. *Hydrology*, *4*(2), 20.

Edouard, S., Vincendon, B., & Ducrocq, V. (2018). Ensemble-based flash-flood modelling: Taking into account hydrodynamic parameters and initial soil moisture uncertainties. *Journal of Hydrology*, *560*, 480-494.

Friedrich, K., Kalina, E. A., Aikins, J., Gochis, D., & Rasmussen, R. (2016). Precipitation and cloud structures of intense rain during the 2013 Great Colorado Flood. *Journal of Hydrometeorology*, *17*(1), 27-52.

Garvelmann, J., Pohl, S., & Weiler, M. (2014). Variability of observed energy fluxes during rain-on-snow and clear sky snowmelt in a midlatitude mountain environment. *Journal of Hydrometeorology*, *15*(3), 1220-1237.

Gochis, D., Schumacher, R., Friedrich, K., Doesken, N., Kelsch, M., Sun, J., ... & Matrosov, S. (2015). The great Colorado flood of September 2013. *Bulletin of the American Meteorological Society*, *96*(9), 1461-1487

Grams, C. M., Binder, H., Pfahl, S., Piaget, N., & Wernli, H. (2014). Atmospheric processes triggering the central European floods in June 2013. *Natural Hazards and Earth System Sciences*, *14*(7), 1691-1702.

Griessinger, N., Seibert, J., Magnusson, J., & Jonas, T. (2016). Assessing the benefit of snow data assimilation for runoff modeling in Alpine catchments. *Hydrology and Earth System Sciences*, *20*(9), 3895-3905.

Hapuarachchi, H. A. P., Wang, Q. J., & Pagano, T. C. (2011). A review of advances in flash flood forecasting. *Hydrological processes*, *25*(18), 2771-2784.

Harpold, A. A., Kaplan, M. L., Klos, P. Z., Link, T., McNamara, J. P., Rajagopal, S., Schumer, R., and Steele, C. M.: Rain or snow: hydrologic processes, observations, prediction, and research needs, Hydrol. Earth Syst. Sci., 21, 1–22, https://doi.org/10.5194/hess-21-1-2017, 2017.

Jasper, K., Gurtz, J., & Lang, H. (2002). Advanced flood forecasting in Alpine watersheds by coupling meteorological observations and forecasts with a distributed hydrological model. *Journal of hydrology*, *267*(1-2), 40-52.

Jörg-Hess, S., Griessinger, N., & Zappa, M. (2015). Probabilistic forecasts of snow water equivalent and runoff in mountainous areas. *Journal of Hydrometeorology*, *16*(5), 2169-2186.

Lobligeois, F., Andréassian, V., Perrin, C., Tabary, P., and Loumagne, C.: When does higher spatial resolution rainfall information improve streamflow simulation? An evaluation using 3620 flood events, Hydrol. Earth Syst. Sci., 18, 575–594, https://doi.org/10.5194/hess-18-575-2014, 2014.

Lovat, A., & Vincendon, B. (2019). Assessing the impact of resolution and soil datasets on flash-flood modelling. *Hydrology and Earth System Sciences*, *23*(3), 1801-1818.

Marks, D., Kimball, J., Tingey, D., & Link, T. (1998). The sensitivity of snowmelt processes to climate conditions and forest cover during rain−on−snow: A case study of the 1996 Pacific Northwest flood. *Hydrological Processes*, *12*(10−11), 1569-1587.

Mascaro, G., Vivoni, E. R., & Deidda, R. (2010). Implications of ensemble quantitative precipitation forecast errors on distributed streamflow forecasting. *Journal of Hydrometeorology*, *11*(1), 69-86.

McCabe, G. J., Clark, M. P., & Hay, L. E. (2007). Rain-on-snow events in the western United States. *Bulletin of the American Meteorological Society*, *88*(3), 319-328.

Pagano, T. C., Wood, A. W., Ramos, M. H., Cloke, H. L., Pappenberger, F., Clark, M. P., ... & Verkade, J. S. (2014). Challenges of operational river forecasting. *Journal of Hydrometeorology*, *15*(4), 1692-1707.

Rössler, O., Bosshard, T., & Weingartner, R. (2016, April). Using rain-on-snow events to evaluate the quality of bias correction to represent complex inter-variable dependencies. In *EGU General Assembly Conference Abstracts* (Vol. 18).

Silvestro, F., & Rebora, N. (2014). Impact of precipitation forecast uncertainties and initial soil moisture conditions on a probabilistic flood forecasting chain. *Journal of hydrology*, *519*, 1052-1067.

Vincendon, B., Ducrocq, V., Nuissier, O., & Vié, B. (2011). Perturbation of convection-permitting NWP forecasts for flash-flood ensemble forecasting. *Natural Hazards and Earth System Sciences*, *11*(5), 1529-1544.

Würzer, S., Jonas, T., Wever, N., & Lehning, M. (2016). Influence of initial snowpack properties on runoff formation during rain-on-snow events. *Journal of hydrometeorology*, *17*(6), 1801-1815.

Zappa, M., Jaun, S., Germann, U., Walser, A., & Fundel, F. (2011). Superposition of three sources of uncertainties in operational flood forecasting chains. *Atmospheric Research*, *100*(2-3), 246-262.