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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "A meteo-hydrological modelling system for the reconstruction of river runoff: the case of the Ofanto river catchment" *by* Giorgia Verri et al.

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General comments The paper deal with a hydro-meteorological modelling system in order to simulate the river runoff in the Ofanto basin in the Puglia region, Southern Italy during two episodes: one between January and March 2011 and the second between November and December 2013. I found the paper interesting to be published in the NHESS journal. The use of WRF-Hydro is wide spreading in the scientific community and I appreciate also the effort to describe in the appendix A and B mathematical formulas of algorithm and processes. However, a major review has to be done; in

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particular, the authors have to better clarify some parts that are not clear and are missing in the text (see below).

Specific comments The paper is readable and understandable, but I suggest to take care about punctuation marks and changing of the paragraph, since some sentences are not linked between each other, see for instance P2 L25-28, P5, L1-3, P7 L 18-21. Authors: Thanks for the remarks.

Furthermore, some parts in the text are not clear, for instance: P4, L25: Have you ever carried out a calibration and validation with this hydro-meteorological chain in previous years? Or, as it seems, you calibrate and validate only and during these two events? Authors: Preliminary sensitivity tests including CalVal activities (not shown) have been performed over several time ranges, from weekly to seasonal, for setting up the final configuration of the WRF model (Table 1). The coupled WRF-Hydro system instead, has been calibrated and validated only over the Experiment 1 and 2 periods as shown in this paper. The CalVal with observational data has been performed on the whole two periods and not only during the extreme events.

P8, L23-24: Why did you not maintain equal the lead-time of forecast? As also reported in table 2, where it is written that for the event 1 the simulation starts 2 days before the main peak and for the event 2 on the same day? How do you conclude that "the WRF needs to be re-initialized approximately 1.5 days earlier"? Is there anything that, for the sake of brevity, it is not reported in the text? Authors: We appreciated the reviewer's comment and we realized that more details are required in order to make our concatenation strategy clear. Giorgia per favore guarda il mio commento prima, a mio parere devi dire se hai sostituito nella serie temporale il re-run per gli eventi 1 e 2. We performed two simulation experiments, each of them done for 2 different seasons (winter 2011 and autumn 2013). They were done simply concatenating 72 hours hindcasts, re-initialized every 3 days. The first experiment contained the heavy rainfall Event 1 that was found to occur 48h later than the start time of the hindcast. The second experiment contained the heavy rainfall Event 2 that was found to occur at the

the start time of one of the re-initialization hindcasts.. We performed extra WRF 72h runs to test the sensitivity of Event 1 and 2 to the initialization time and we found out that the optimal spin-up for capturing the peak events is 1.5 days. These results are shown in Figure 8. For this reason we mentioned as one of our future plans the development of a robust WRF ensemble, which consists of overlapping chains of 72h simulations with a delayed start-time (See Conclusion section). To avoid any misunderstanding we re-wrote two sentences of section 4.2.1 and they read as follows: -Sentence at page 8 line 21 has been modified as follows: "In addition to Experiment 1 and Experiment 2 we performed extra WRF 72h runs focusing on specific events to test the sensitivity of the simulated precipitation in relation to the initialization time: the panels of Figure 8 highlight the differences between the 24h cumulated precipitation on February 18th 2011 started 14 hours and 38 hours before the rain peak of Event 1 ." -Sentence at page 8 line 26 has been modified as follows: "We conclude that our WRF model would need to be re-initialized approximately 1.5 days earlier than the start of the heavy rain events to increase skill in the predicition of precipitation. . For this reason as a future step we plan to develop a robust WRF ensemble, which consists of overlapping chains of 72h simulations with a delayed start-time" By the way we believe the underestimation of the river runoff peak triggered by Event 2 (Figure 10) is partially due to the Event 2 onset overlapping the start time of WRF 72h simulation, we added this comment in section 4.3.2: "It should be also noted that the Event 2 onset overlaps the start time of WRF 72h simulation (Table 2) and this probably affects the underestimation of the runoff peak starting on December 2nd 2013".

P9, L17-24: Here, you compare the results of your experiments with values of other researches carried out in different areas, basins, etc. I did not understand this comparison: have you tried the 3D-Var assimilation on the Ofanto river basin? Authors: We performed a "post-processing correction method" based on the Objective Analysis plus the Least Squares Method while Yucel (2014) considers a 3D-Var assimilated field. The comparison is conceived to stress the level of accuracy of our corrected precipitation with respect to previous studies even based on more advanced correction tools as

the 3D-Var.

P10, L24: In which period did you carry out the calibration? I would clarify better these parts in the text. Take care that there are lots of parameters and variable you introduced in your analysis: maybe it is better to focus on a few of them? Authors: The calibration procedure has been performed for the whole period of Experiment 1, January-March 2011, and Experiment 2, November-December 2013.. The strategy for calibrating such a high number of parameters consists of the two steps briefly described now in section 4.3.1. We have now explained in more detail the preliminary step of the calibration procedure (based on PEST software, see section 4.3.1) which enabled us to reduce the original set of 25 to 7 tunable parameters. The coefficients showing a high correlation (i.e. |corr|>0.9) or the ones that preserved almost the original values after the PEST run, have been excluded from the second step, i.e. the manual calibration of the reduced set of parameters. Few details on the preliminary calibration have been added in section 4.3.1 and we modified the text as follows: "As a first step we adopted an automated calibration procedure, based on the PEST software (Doherty, 2002). This procedure minimizes an objective function, given by the sum of the mean squared differences between the modelled and observed river streamflow, using the Gauss-Marquardt-Levenberg non-linear least squares method. Several tests were carried out and we identified the most relevant parameters to be calibrated for our case study. The coefficients with a high correlation (i.e. |corr|>0.9) or the ones that preserved almost the original values after the PEST tests have been excluded. Thus we reduced the original set of 25 tunable parameters to 7 that are, found to play a key role in the Ofanto basin. They are: the surface roughness scaling factor which controls the hydrograph shape and the timing of the peaks; the infiltration coefficient, the saturated hydraulic conductivity and the aquifer coefficients which control the total water volume". Finally we would like to underline that the WRF-Hydro system involves several tunable coefficients but ensures a good compromise between the number of parameterizations involved and the number of described physical processes, differently from simplified rainfall-runoff models as HEC-HSM and TOPKAPI among the others.

Finally, a general check to the figures and tables is strictly recommended. Authors: Figures 2, 5 and 11 have been modified following the reviewer's comments in the Technical Corrections.

Technical Corrections Authors: We thank the reviewer for the technical corrections. We modified the manuscript accordingly. Some clarifications are between the lines

P1, L11: Add a comma after "however" and please the same in rest of the text P1, L20: remove "in" P2, L1: Please, choose to write Apulia or Puglia in the whole text P2, L4: replace "with" with "between" P2, L7: I suggest: " ::: validation procedures, but they need ::: " P2, L9: In addition, ::: P2, 10: ::: catchments, but :: P2, L13: The term embed is it appropriate? I suggest "take into account" P2, L16: I suggest to replace "end result" with "final result" P2, L19: ::: and, thus, :: P2, L22: Finally, :: P3, L9: Remove "thus" P3, L14: I suggest: :: river runoff, and the evaluation ::: P3, L15: I suggest: predictions P3, L16-19: I would not begin a new paragraph P3, L22: I suggest: The Ofanto river basin P3, L22: What do you want to mean with "relocatable" Authors: We mean that the final configuration of our meteo-hydrological modeling chain may be easily applied to investigate rainfall and runoff events in other study areas with similar physiographic characteristics: "This is intended to be a relocatable case study as the final configuration of our meteo-hydrological modeling chain may be easily applied to investigate rainfall and runoff events in other study areas with similar physiographic characteristics".

P3, L25: dry season, but may ::: P3, L27: Please, add a space between numbers and units. Check it in the rest part of the paper. P3, L28: I would write 720 mm without year, since you wrote it is an annual mean rainfall P3, L32: I suggest: " ::: a small village, located at 715 m above the sea level." P4, L6: I suggest "four" in letters and not in number and in rest of the paper as well. P4, L8: In particular, the Calitri gauge ::: P4, L8: Replace "and" with "which" P5, L2: I would not begin a new paragraph P5, L12: after "thus", "overall", "in addition", "however", please add a comma in the text P5, L31: replace "in" with "on" P6, L18: I suggest: " ::: precipitation is crucial for the

reconstruction ::: " P8, L10: I suggest "these" instead of "both" P8, L16: initialization time in small letters P9, L9: please add here a reference after Yucel and Senatore P9, L17: The acronym for the WRF-ASS, it is not introduced P10, L17. I suggest: " ::: 0 and 1.0, where values equal to 1.0 mean that ::: " P12; 32: I suggest: The study also highlighted:: P13, L15: Please change with "hydro-meteorological variables" P15, L6: I suggest: " ::: coefficients: the first ::: P16, L22: Please, add a space after "section". P16, L28: area not ar,ea P16, L29: remove "is" P24, Figure: the font of letters is too small. Please, increase it. The legend of the top panel goes from 0 to 4000 m a.s.l., but it seems that the highest altitude is much less: please review it. Then, is t worth to show the right panel? I cannot appreciate colours in the figure. Authors: We modified the upper value of the colorbar for the top panel of Figure 2, thanks for your suggestion. The new picture is attached below for convenience.

Figure 2. The Ofanto River Catchment. Top panel: Topography height (units of m) and location of 27 rain-gauge stations

We maintained the bottom right panel of Fig.2, because it gives an idea of the GIS procedure we adopted for drawing the river network and the hierarchy of tributaries with the colorbar showing the number of draining cells and thus the flow directions.

P25, Figure 3: The hydro meteorological modelling chain. Authors: The coauthor David Gochis recommends the expression "meteo-hydrological modeling chain" instead.

P26, Figure 5: The coloured spots are the all available rain gauges previously shown in figure 2? Can you add the basin contour line? Authors: Figure 5 as well as Figure 11 have been modified following your suggestion. The new pictures are attached below for convenience.

Figure 5. Maps of 24h cumulated precipitations (in mm/day, colours) during the peak events on March, 1st 2011 (Top panels) and December,1st 2013 (Bottom panels): shaded maps of modelled (left panel), and assimilated (right panel) precipitation with overlapped observed spots over the Ofanto basin

Figure 11. Maps of 24h cumulated precipitations (in mm/day, colours) on November, 4th 2011 (Top panels) and November, 10th 2013 (Bottom panels): shaded maps of modelled (left panel), and assimilated (right panel) precipitation with overlapping observed spots on the Ofanto basin

P27, Figure 6: I would use “dam” as unit of the geopotential height instead of “m/10” and C instead of Cdeg. The same for Fig. 7. P28, Figure 8: replace “or” with “and” P29, Figure 9: Validation of the Ofanto discharge ::: P30, Figure 10: I would repeat in this figure as well the problem of missing data. The legend font is too small, also in figure 12 and 13

Please also note the supplement to this comment:
https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2017-102/nhess-2017-102-AC3-supplement.pdf

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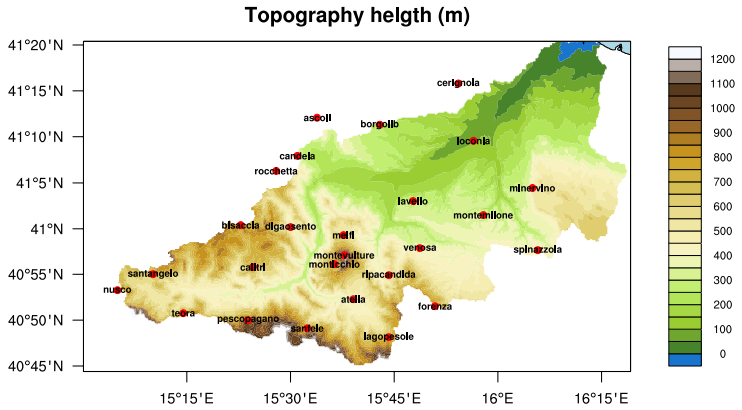

Fig. 1. Figure2 Caption in the text

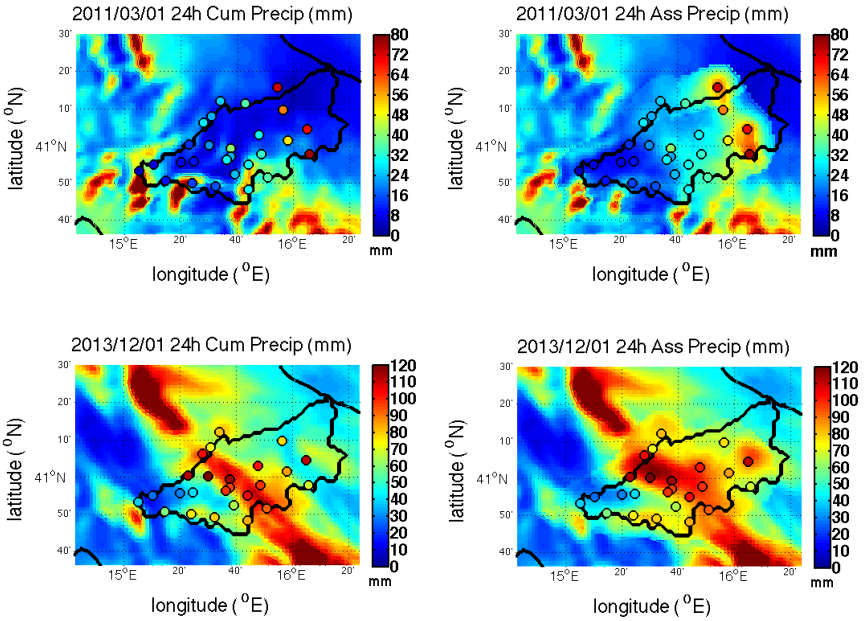

Fig. 2. Figure5 Caption in the text

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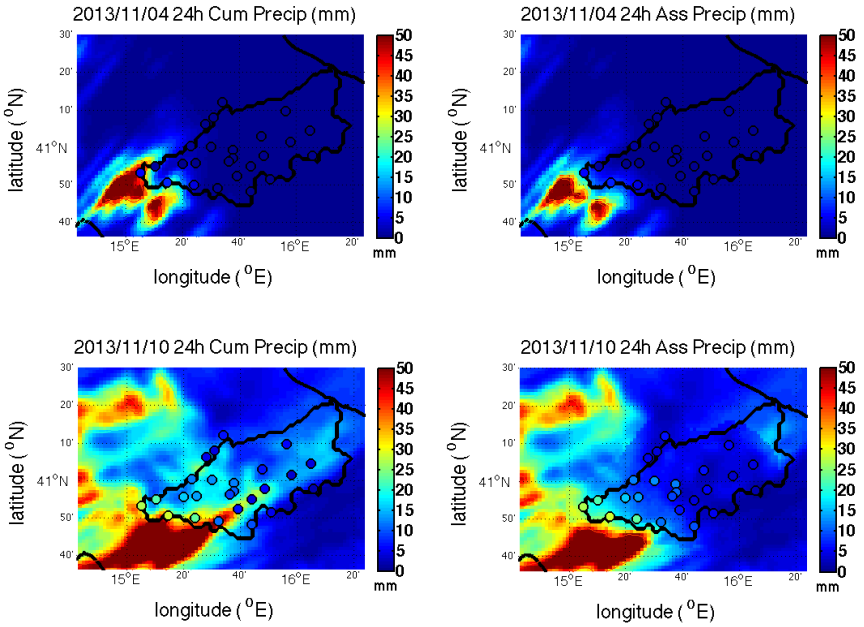

Fig. 3. Figure11 Caption in the text

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