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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Brief communication: Preliminary hydro-meteorological analysis of the flash flood of 20 August 2018 on "Raganello Gorge", Southern Italy" *by* Elenio Avolio et al.

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We warmly thank the referees for their comments and their careful reading of our paper. Please find below our answers to all items raised (bold text).

(Major) comments Page 4, line 11 to line 26: It seems that no spinup has been applied to generate the initial condition of land surface variables, including soil moisture. This may be problematic for a WRF-Hydro application, as a too wet soil condition in the forcing data may cause a discharge peak artifact at the beginning of the simulation. In the case of Senatore et al. (2015) a two-month spinup time was used. Please discuss this issue in the revised version.

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Discussion paper

The referee is right. In our study, initial and boundary conditions were provided directly by ECMWF-IFS in its deterministic forecast version at 9 km resolution. We acknowledge the importance of proper spin-up and we plan to study this issue with more detail (P8L11 in the manuscript: "future work will be devoted to the improvement of soil moisture initial conditions, through a dedicated hydrological analysis assuring a proper spin up time"). According to referee's suggestion, we will discuss with more detail (even though briefly, in compliance to the request of conciseness for Brief Communications) the issue in the revised version of the manuscript, summarizing the discussion provided in the following.

We believe that, in the framework of a Brief Communication, the choice made about initial conditions is consistent with the objective of providing preliminary and early indications for operational hydro-meteorological forecasting purposes in the study area. Proper spin-up for soil moisture can be done operationally (actually, it is currently done in some systems) through off-line seamless run of the hydrological model fed by observations provided in real time, but this procedure is feasible only for the innermost domain and requires that the forecasting system is expressly set-up with several non-trivial procedures (e.g., real-time seamless data transmission and validation from the monitoring network, real-time spatial interpolation of punctual observations and production of input fields, possible data assimilation procedures, replacement of the land surface initial conditions in the model, etc.). Senatore et al. (2015) used a two-month spin-up strategy, for a 3-year simulation period. In that case, no operational (short-term) forecast purposes were pursued and ERA-Interim reanalysis was used.

Since the topic of soil moisture initialization is addressed by both referees (please refer also to our response to referee 1 third major comment), we were motivated to perform a preliminary test running a simulation with ERA5 reanalysis boundary conditions (of course, this product is not usable operationally) for

the two weeks preceding the event. The soil moisture fields achieved were then used as initial conditions for our simulation. Preliminary results shown in Fig. 1 in this reply (please find it at the end of this document) seem to suggest that improved soil moisture initialization, alone, is not able to improve convective cell positioning. The accumulated rainfall fields over the catchment are quite similar, such as the resulting hydrographs. Anyway, it should be highlighted that the slight difference between discharge forecasts should be attributed to both the differences in the rainfall fields and in initial soil moisture conditions, therefore the effect of the latter cannot be isolated. Furthermore, even though isolated, their added value over the hydrological simulation could not be appreciated in this specific case, due to the lack of discharge observations.

Page 5 line 23 to page 6 line 7: the comparison between the different model configuration results would be much more powerful in the framework of a model ensemble. The authors could generate a small ensemble based for example on randomly perturbed initial soil moisture condition, and assess how robust the differences between the model configurations are.

The issue of ensemble/probabilistic forecasting is certainly of paramount importance. We thank the referee for highlighting this point, that will be introduced and discussed in the revised version of the manuscript. However, it is worth it to recall that many ensemble approaches can be adopted, concerning both the atmospheric and hydrological modelling compartments. In this work, our main goal is to evaluate the modelling forecasting skills for early warning purposes, trying to minimize the lead-time with which forecasts are provided (this issue is particularly important for small, highly responsive catchments), in order to set-up a possible operational forecasting system devoted to hydrological risk assessment. Clearly, an operational procedure including a number of ensemble simulations would significantly penalize the calculation/processing speed of the forecast results, with consequent increase of lead-time, if not adequately sup-

ported by heavy computational resources.

Concerning the ensemble experiment proposed by the referee in order to "assess how robust the differences between the model configurations are", our opinion is that it, though interesting, would provide only a partial picture of the probability forecasting, especially in the framework of a Brief Communication. Therefore, we would prefer to avoid treating this topic in the manuscript. Nevertheless, intrigued by the suggestion of the referee, we have already performed some preliminary tests. Specifically, we have perturbed initial soil moisture conditions of simulations RUN_SA (the first identified optimal configuration) and RUN_SST_FC (the best performing configuration), considering in both cases uniform changes of $\pm$5%.

Preliminary results show interesting points. E.g., for RUN_SA, 5% increased initial soil moisture provides enough water to the system, so that the rainfall peak value increases up to a value comparable to RUN_SST_FC. On the other hand, with RUN_SST_FC rainfall increase/decrease is not so straightforwardly correlated to soil moisture increase/decrease. These results, within the framework of a comprehensive ensemble forecast, will be considered for further improvements of the forecasting system.

Minor comment

page 4, line 8: I suggest to replace "the diurnal cycle of Sea Surface Temperature" by "Sea Surface temperature dynamics", unless the author confirm that their input data provides subdaily variation of SST.

Thanks for this suggestion. We will change the text accordingly in the revised manuscript.

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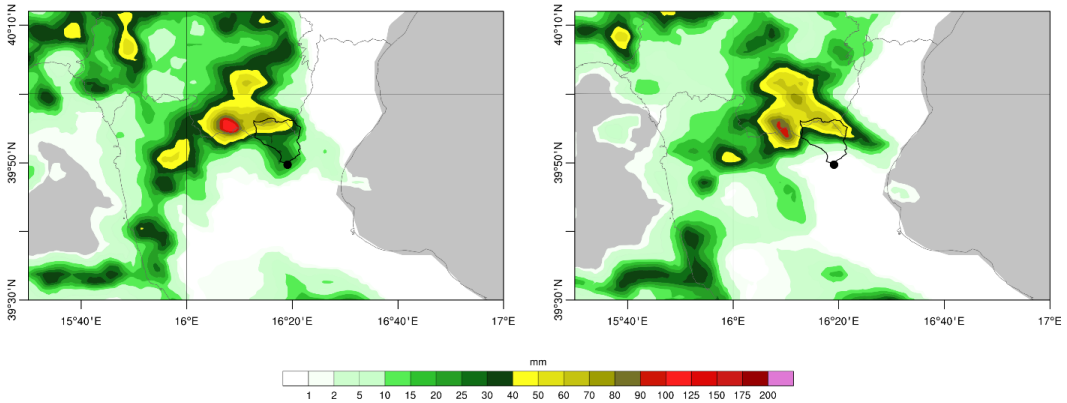

Fig. 1. On the left, Fig. 1c of the manuscript (24h accumulated precipitation according to the run RUN_SST_FC); on the right, the same but with improved soil moisture initialization.

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