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Interactive comment on "Assimilation of probabilistic flood maps from SAR data into ahydrologic-hydraulic forecasting model: a proof of concept" *by* Concetta Di Mauro et al.

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We would like to thank the Referee #1 for the careful reading of the manuscript and the valuable comments provided. We agree with the suggestion to change the manuscript title in order to add the word "coupled". Referee #1 argues that the concept of assimilating remotely sensed flood maps into flood models is not new. Regarding this statement, we would like to highlight that only few recent studies (a handful at maximum) have proposed methods to assimilate flood extents into flood inundation models, Lai et al. (2014) being the first one to our knowledge. We believe this shows that the technique is recent and there are still plenty of related research questions to answer before this can be routinely applied. In particular, the method proposed by Hostache et al. (2018) is new and needs further investigation to better understand its current limitations and strengths and therefore assess its global applicability. Moreover, in addition to the validation of the approach in a controlled environment, our study demonstrates the importance of an enhanced tempering method to avoid the degeneracy and for a bias removal in the SAR observations prior to the assimilation. Referee #1 also raises the concern that SAR observations effect can be fed back to streamflow and stage height only if a tight coupling of the models is used and consequently that the proposed approach is not globally applicable considering that most of the current flood inundation forecasting frameworks rely on loosely coupled models. We would like first to clarify that our implementation of a particle filter relies on a sequential importance sampling (SIS) that does not include a variable update step. Indeed, only the particle weights are updated based on the observation and then used to compute the expectation (weighted mean) of the augmented state vector (including hydraulic state variables of water depth, plus flood extents and boundary conditions). In our forecasting system, the hydrological model (SUPERFLEX) and the hydraulic model (LISFLOOD-FD) are loosely coupled similarly to the other studies reported in the review. Indeed, the streamflow simulated with SUPERFLEX feeds LISFLOOD-FP as upstream boundary conditions to simulate flood inundation extents. This also implies that the domains of the two models are not overlapping, but they are only connected at the upstream boundary condition of the hydraulic model. Moreover, we acknowledge that the flood wave entering the hydraulic model via the upstream boundary conditions needs some time to propagate across the hydraulic model domain. Conse-quently, the observed flood extent is closely linked to past time steps of the boundary conditions rather than the current (i.e. at the assimilation time) boundary conditions value. Therefore, when computing the weights (analysis step) based on the observed flood extent, the best performing particles are the ones having past forcing (upstream boundary conditions of the hydraulic model) values closer to the truth. It could be argued that the particles that were better in the past should be equally better at the assimilation time and for subsequent time steps. This is confirmed by figure 10 and 11 were the expectations (i.e. analysis weighted mean) of the stream water depth (at Saxon's Lode, within the hydraulic model domain) and the upstream discharge (at Bewdley, upstream boundary condition of the hydraulic model) are closer to the truth than the open loop at every assimilation step. Of course, we recognize that spurious correlations may occur between SAR observations and the model variables due to limited ensemble size. Enlarging ensemble size could be necessary if this occurs. Indeed, the objective of a future study will be to address this issue.

We will add this detailed explanation on the validity of the approach based on a loose coupling in the results and discussion part of the revised version of the article, if accepted. As a conclusion, based on the above elements, we believe that our approach based on usual state augmentation is valid, regardless of the type of model coupling, and applicable to many different forecasting systems.

Please also note the supplement to this comment:
https://hess.copernicus.org/preprints/hess-2020-403/hess-2020-403-AC2-supplement.pdf

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