Hydrol. Earth Syst. Sci. Discuss., 8, C977–C980, 2011
www.hydrol-earth-syst-sci-discuss.net/8/C977/2011/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Assimilating SAR-derived water level data into a hydraulic model: a case study" *by* L. Giustarini et al.

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Received and published: 19 April 2011

General comments

This manuscript describes a new framework for utilizing SAR-base inundated area for flood forecast using a hydrological-hydraulic model. The methodology of data assimilation based on a particle filter is well organized, and the result of the hydraulic simulation is carefully examined and discussed. Especially, the simulation with real-event case study is the point to be mentioned in this manuscript because the real-event case study brings more knowledge and know-how for future study on data assimilation using SAR observations than the previous studies using synthetic observations. I recommend this manuscript to be accepted for HESS though some minor corrections are required.

Specific comments

(1) P.2105 L.14 "with a reliable observation uncertainty of 50 cm":

The uncertainty of the SWOT observation is better to be mentioned with a spatial resolution. The uncertainty of 50 cm is the value for one pixel with its size of 50 m by 50 m, and the uncertainty of water surface elevation decreases when it is averaged for larger area [Lee et al., 2010].

(2) The performance of the hydraulic model should be checked before the data assimilation experiments. It seems from Figure 5 that the observed discharge at the upstream boundary is available. Then using the observed discharge, it is better to show whether HEC-RES is able to reproduce reasonable spatio-temporal variations of water surface elevation when the realistic upstream boundary discharge is given as input.

(3) P.2118:

The procedure of calibration is not clearly explained.

- Which upstream boundary discharge was used as the input to HEC-RES?

- Was the roughness parameter perturbed independently for each cross section within a single model run for calibration (i.e. in this case the model run should be repeated 31x31x31x31 times if the roughness coefficient is perturbed with the interval of 0.001 for the 4 cross sections)? Or, was the best parameter for each cross section derived from an independent model run (i.e. in this case the model run should be repeated 31 times)? The second approach is not strict because the stage-discharge relationship can be affected not only from the local water stage but also from the hydrodynamics within the surrounding reach (i.e. backwater effect should be considered). Given that the river bed slope of the study area is not so steep (approximately 70cm / 1km from Figure 3) for neglecting the backwater effect and the full-form of momentam equation with the backwater effect is used in HEC-RES, I think the first approach should be

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taken.

(4) P.2121 L.7 "The poor quality of the model results at this cross section could thus be explained with a badly calibrated model":

The authors explain that the poor quality at Walferdange is caused by the model's uncertainty due to the insufficient parameter calibration, but another explanation can be made. I suppose it take a few hours for a floodwave to be transferred within the 19 km reach of the Alzette River. Given that the SAR observations are made near the inflow peaks (as shown in Figure 5), the error in the timing of peak upstream boundary discharge can also cause the situation that "the model results are good for some cross-section but at the same time bad for other corss-sections". This possibility due to the error in inflow peak timing should also be discussed.

(5) P.2111 L.1 "Model parameters, forcings and initial conditions of the hydrologic model were perturbed in such a way that the ensemble mean differs from the observation by a value that is equal to the time average of the ensemble spread (De Lannoy et al., 2006)."

I do not think this assumption for ensemble spread is sufficient because, as discussed in the comment above, the timing of peak inflow also determines the spatial distribution of water surface elevation when SAR observations are made. It seems from Figure 5 that the timing of peak inflow is same for most of the ensemble members. The spread of discharge within a single time step is of course important, but I think the timing of peak inflow (i.e. response time between rainfall and runoff) should also has some spread due to the hydrological model's uncertainties. Some descriptions on this point are better to be included at least in a discussion part.

Technical corrections

(1) P.2108 L.27: "aswell as" -> "as well as"

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(2) P.2113 L.1: Where is "Section 2.1.2"?

(3) P.2116 Eq.6: "The bar for indicating average" is missing from Q_k^1 in the denominator.

(4) P.2116 L.3: $\overline{Q_i^1}$ in "$\overline{Q_i^1}$ is the average, considering the analysis step k" should be $\overline{Q_k^1}$?

(5) P.2117 L.8: "Period" is doubled.

Reference

H. Lee, M. Durand, H. Jung, D. Alsdorf, C.K. Shum and Y. Sheng, Characterization of surface water storage changes in Arctic lakes using simulated SWOT measurements, *International Journal of Remote Sensing*, Vol.31 no.14, 2010, 3931-3953

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