Hydrol. Earth Syst. Sci. Discuss., 8, C1065–C1068, 2011
www.hydrol-earth-syst-sci-discuss.net/8/C1065/2011/

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.

J. Neal (Referee)

j.neal@bristol.ac.uk

Received and published: 20 April 2011

This paper applies a data assimilation method known as the particle filter to a one-dimensional hydraulic model to assimilate remotely sensed water levels. The methods and results are both interesting and novel in my opinion, so the paper should be published after some revisions. I would be interested to see some more discussion of chosen error distributions for the measurement uncertainty and specifically the impact of any assumptions on the results, as mentioned in the specific point below.

Regarding the wider context of the paper, this appears to be a method that is more suited to a significantly longer reach than used in this test case, especially if the ultimate objective is to use the updated levels for forecasting applications. In my opinion, the

authors could add value by directly discussing these scaling issues at the end of the paper.

Specific points:

P2104, L15: "significant reduction in the model forecast uncertainty", do you mean forecast here or that the uncertainty is significantly reduced at the analysis time?

L21-22: Might be worth saying why SAR is regarded as the most promising technology.

P2105 L7: You could be more specific here and refer to shorelines instead of inundated areas because this is the critical location for water level extraction.

P17: add "as" after "However,"

P24-27: Does this conclusion apply to the newer high resolution SAR's as well as ASAR or should this be instrument/resolution/polarization specific?

P28-29: " In a data fusion..." I don't understand this sentence so it might need rewording?

P2107: It might be worth saying why Neal et al. (2009) chose not to assimilate all the data because the reason relates to a data quality issues with remotely sensed derived water levels, rather than not wanting to use all the information available. Essentially they suggest a quality control step prior to assimilation is needed because some locations will obviously produce biased data (e.g. shorelines next to steep slopes and tall vegetation).

P2108 L16: do you need to say "actual"?

P2110 L5: What happens in the case where an upper bound is under estimated at an upstream point... are all subsequent level distributions biased low until the upper level drops below the incorrect level or is there some procedure for spotting outliers. Further the uncertainty in the observations may also be underestimated which leads to too many particles being given zero/low weights. I'm worried that rather than removing

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poor quality data this approach has the potential to do the opposite and it would be better to use the data assimilation to filter the less certain observations rather than use a rule based system, especially as you results seem to indicate there is not enough uncertainty in the observations when assimilated globally?

P2111: I think you mention it later but as your discussing the uncertainty and ensemble generation it would be good to state your assumptions about hydraulic model structural/parameter errors and the likely magnitude of these relative to other errors.

P2112 L8: A minor point but the EnKF doesn't necessarily give a Gaussian output... its an ensemble method. Rather the covariance matrix is assumed Gaussian.

P2113 L2-4: Here I think it would be good to demonstrate that the uniform distribution is a better fit to the empirical data than say a normal or log normal distribution. I'd imagine there is some simple statistical test you could use for this. You argue quite correctly that the normal distribution makes assumptions that the data validates but presumably this doesn't mean its the worst distribution you could use or that the uniform distribution is better?

L17-18: proposed SWOT data are very different to gauge data, so you might want to clarify that you don't expect the errors in these data to be the same as gauge data.

P2115 L24: Could you state the expected impact of this rapid spread on forecast lead times. Given the reach length and a wave speed of something like 0.5-1 ms-1 it will only take 15-30 mins for inflows at the top of the reach to arrive at the downstream boundary. This means the majority of any forecast and the uncertainty in the forecast will depend on the boundary update. I don't think this detracts from the main novelty of the paper (e.g. the application of the particle filter assimilation scheme with real data) but it does mean the example here is a far better estimator of river state at the time of the overpass than forecaster of future state. Explaining this and maybe even suggesting potential improvements may be a way of describing some of the future development that could improve the scheme implemented here.

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P2117 L13: Is there a risk that narrowing the uncertainty in the water level distribution has caused too many particles to be rejected?

P2120 L29: If I understand correctly, the use of a uniform distribution with equation 3 means that if a particle is outside the uniform distribution at any location it is assigned a weight of zero, and that this may explain why more particles are retained when assimilating the more accurate ground data. Would it be possible to add this behavior and its implications to the discussion of the global results on the next two pages. In particular is is desirable to have such an strict accept reject criteria for a global analysis given the limitation in the model and data you outline, where poor prediction at a single point can lead to a zero weight? It might also be worth integrating this point with conclusion 3 should you agree with it.

P2127 L1: Am I correct in thinking the time series data from the gauge was not assimilated at that this could be done in theory?

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 2103, 2011.