Hydrol. Earth Syst. Sci. Discuss., 8, C1273–C1278, 2011
www.hydrol-earth-syst-sci-discuss.net/8/C1273/2011/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Estimating flooded area and mean water level using active and passive microwaves: the example of Paraná River Delta floodplain" *by* M. Salvia et al.

Anonymous Referee #2

Received and published: 2 May 2011

Review Salvia et al.

General assessment:

The manuscript submitted by Salvia et al. describes a method combining active and passive microwave remote sensing imagery for the monitoring of mean water levels in vegetated river floodplains. ENVISAT ASAR images are used to estimate the fraction of the flooded area and together with brightness temperature observations from AMSR-E and model simulations the approach provides estimates of water level in vegetated floodplains.

I have to admit that I am not very familiar with passive microwave remote sensing technology and for this reason my review mainly focuses on the active remote sensing aspects of this study and, more particularly, on the added-value of combining active and passive microwave remote sensing observations. The main appeal of the technique introduced here is that with AMSR-E coarse resolution remote sensing imagery very high temporal resolutions can be potentially achieved. However, the model used by the authors of this study makes use of the "fraction of flooded areas" derived from moderate resolution active remote sensing imagery (with associated lower temporal resolution). Unless very strong assumptions are made concerning the changes in flooded area between acquisitions, the method critically depends on the availability of ENVISAT ASAR images in Wide Swath Mode. This means that it is important to discuss the advantages and shortcomings of this method over water level estimation methods that make use only of active remote sensing imagery (see, e.g., Alsdorf et al., 2009, Matgen et al., 2007). In my opinion the main advantage of the method introduced here could be that it is rather straightforward (when compared to the direct measuring techniques based on interferometry) and that it does not require any topographic data as input data (when compared to the indirect measuring techniques based on the fusion of flood edges with DEMs). However, I have some doubts remaining concerning the accuracy and reliability of the method. In this respect it does not help that the paper uses rather poorly the available ground measurements for evaluating its findings and better supporting its conclusions.

In fact, the objective of the paper is "to estimate both the fraction of inundated area and the mean water level inside the wetland" (p.2899 l.4). With the data at hand it is impossible to assess if these objectives were reached. All we see is that the remote sensing-derived "mean water level" increases steadily over the investigation period. The fact that water levels recorded at a single river gauge increase in a similar way does not provide strong evidence for the validity of the approach. Moreover, the paper does not include an evaluation of the SAR-derived "fraction of inundated area". Finally, I found some assumptions not defendable or at least debatable (e.g. "the fractional area of permanent water bodies is constant" or "the temperature difference of flooded land is constant"). However, no particular effort is undertaken to verify these hypotheses. In general, the results section is very short and there is hardly any discussion of the results.

There are certainly elements of this study that are of interest for the community. The method introduced here is potentially useful for monitoring water levels over large areas in densely vegetated wetlands. However, the paper in its current form suffers from a quasi-inexistent critical evaluation of the results. Since the manuscript does not include a comparison with state-of-the-art solutions, it is difficult to understand the merits of the proposed method.

Specific comments:

p.2896 l.11 forecasting instead of forecast p.2896 l.14 please delete "strong" p.2896 l.15 I don't necessarily agree with this statement, for some applications, e.g. flooding in built-up environments, spatial resolution matters more than temporal resolution. Hence, it is debatable whether it is better to have more images with lower resolution or fewer images with higher resolution. SAR high-resolution constellations (e.g. Cosmo SkyMed) might be seen as a promising way forward to have both. p.2896 l.23-25 "adopt the absolute difference. . ." adopt for what? Detection of flooded areas? not very clear, please clarify. p. 2896 l. 24define acronym PI p. 2896 l.25 delete "at all" p.2897 l.5 It is not clear what is meant by "moderate" and "high" water levels as even with "moderate" water levels the height of the emerged vegetation is reduced. Is the moisture of a flooded soil having an influence on the brightness temperature? p.2897 l.7 replace "Indexes" by "indices". p.2897 l.15 you could add the double bounce from buildings (or geometric structures in general, including vegetation) p.2897 l.20 "at C-band, the overall effect produced by a moderate flooding is an increase of the backscattering coefficient due to an increase of the double bounce contribution". It needs to be emphasized that this applies only to flooding under canopy. On bare soils and on most lightly vegetated soils the effect of flooding would be to decrease the backscattering co-

efficient due to specular reflection (i.e., efficient redirection of the wave incident upon a smooth surface away from the source). Please clarify. p.2897 l.24 on most surfaces (e.g. bare soils) there is no relation at all between the backscattering coefficient and the water level. In the presence of a flooded soil only the roughness of the water surface impacts the backscattering. Please clarify. p.2898 l.1 replace "ideal" by "good"

Introduction: The introduction mostly focuses on microwave remote sensing of floods under a canopy. However, in many cases where flooding occurs on bare soils, grasslands or built-up environments, the most relevant flooding-related backscattering mechanisms are quite different. Hence it is necessary to highlight these differences. Also it is worth mentioning that other techniques exist to estimate water level from space. For example, the fusion of remote sensing-derived flood boundaries with topographic data provides distributed water elevation data from space. You may add references to Matgen et al., 2007; Schumann et al., 2007 and Zwenzner and Voigt, 2009. You may also mention direct measuring techniques (e.g. Alsdorf et al., 2007) to provide a more complete picture of available techniques.

p.2901 l.17 define acronym IFOV p.2902 l.9 proportional to the sum

Fig.3 Why not show all the ASAR WSM images here? Can you show the boxplots or histograms of backscattering coefficients as this would show the increase of the spread in backscattering values? In my opinion the increase of backscatter due to "moderate flooding" also comes from wetter soils in the non-flooded parts of the AOI and not only from the double bounce effect of the flooding. This is important, as there is a risk of overestimating the fraction of inundated areas if the backscattering increases because of soil moisture rather than because of a double bounce effect under a canopy. p.2904 l.13 Not sure if hypothesis 3 and 4 are defendable as high floods will submerge vegetation (e.g. agricultural land) and cause DTf to become DTw and fw to increase. Please discuss this. p.2904 All explanations referring to the radiative transfer model are rather vague (e.g. section 2.5.4). It is not clear to what extent this model is sensitive to its parameters and input data. p.2905 l.9 Is there any background on the assumption that the LAI is reduced linearly with increasing water levels? Please clarify the rationale behind this assumption. p.2905 l.25 consisting p.2906 l.14 on six different dates p.2906 l.22 depend Section 2.5.1 The choice of threshold values is critical. I would expect that an increase of the backscattering coefficient by 1.5 db could also be due to an increase in surface soil moisture (mostly on bare soils, if there are any within the AOI). With this (simplistic) algorithm there is certainly a high risk to overestimate the fraction of flooded area. Section 2.5.1 Do you have any idea on the accuracy of the ENVISAT ASAR-derived ff estimate within wetlands. The observed increase in backscattering is arguably due to flooding under the canopy AND soil moisture. This should be clarified and discussed. What would be the effect of overestimating ff? p. 2908 l.18 are in good agreement with p.2908 l.12 you assume that DTnf and DTw are constant in time (values in Table 3). In this case I suggest indicating the observed values of DTnf and DTw at each acquisition, as this would better support this assumption. p.2908 l.19 please provide some plot indicating the "good agreement" between model simulations and AMSR-E measured values for DTnf. p.2909 l.11 should be Table 3 Fig. 5 It would be interesting to provide more physical background on how brightness temperature varies with water level. Moreover, is there any way to indicate how reliable the look-up table DTff – water level depicted in Fig. 5 is? Would it be possible to add on the same plot values of actual water level and DTff measurements? p.2909 l.24 "Slope" not appropriate term to characterize curves in Fig.5 p.2910 l.-17 edit sentence p.2911 l.9 edit sentence p.2912 l.18 using

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 2895, 2011.