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Hydrology and Earth System Sciences Discussions

Interactive comment on "Consistency between hydrological model, large aperture scintillometer and remote sensing based evapotranspiration estimates for a heterogeneous catchment" *by* B. Samain et al.

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In the reply to the issues raised by the reviewer, the remarks by the reviewer are repeated, and then the replies are introduced by 'REPLY'. In the citation of the remarks, the original page, paragraph, table, figure, and line numbers have been used.

* Section 3.2: The computation of the available energy requires G to be estimated at the surface, whereas measurements performed with soil heat flux sensors are made at a

certain depth within the soil. Were corrections done for correcting these measurements for the heat storage above the plates?

REPLY: The soil heat flux sensors were installed just below the surface. As the heat storage in the thin soil layer above the heat flux sensors can be considered to be very small, no correction is made for soil heat storage to the measurements of the soil heat flux. This is also assumed by e.g. Houser et al., 2001 and Lagouarde et al., 2002. P. R. Houser, P.R., Gupta, H.V., Shuttleworth, W.J., Famiglietti, J.S. (2001). Multiobjective calibration and sensitivity of a distributed land surface water and energy balance model. J. Geophys. Res., 106 (D24), 33421-33433. Lagouarde, J., Bonnefond, J., Kerr, Y., McAneney, K., and Irvine, M. (2002). Integrated sensible heat flux measurements of a two-surface composite landscape using scintillometry. Boundary-Layer Meteorology, 105 (1), 5-35.

* Section 4: More details should be given about the ETlook model. It is said its temporal resolution is 1 day. Does this mean that eq. (1) and (2) are computed only once a day and that daily averages of Rn and G fluxes, and of resistances are introduced in eq. (1) and (2)? If so how are they determined?

REPLY:The model is run with time steps of one day, meaning that all inputs and outputs are daily values and equations 1 and 2 are solved once for every day. Since Rn and G are defined with respect to surface (W/m2) rather than time (eg. J/s), Rn and G are introduced into the equations as daily totals. Daily Rn is computed by correcting solar radiation at the top of the atmosphere for atmospheric influences and surface albedo, and adding the occurring upward and downward longwave radiation. As explained in the paper, the LAI is then used to partition net radiation between canopy and soil. This will be added in the text.

* Section 4: How is the roughness length parameterized from the NDVI? a few indications or a reference (to SEBAL?) would help the reader.

REPLY:Surface roughness is computed based on the terrain slope and the obstacle

height that is assumed to be associated with a certain type of land cover. Since the latter variable is not constant over time due to a varying canopy height, LAI is used to correct for this. For an extensive discussion on computing surface roughness length based on vegetation cover and the relation between roughness length and aerodynamic resistances, the reader is referred to Bastiaanssen et al. (1998).This will be added in the text.

* Section 4: The same question rises for the soil resistance determined with the help of satellite microwave measurements.

REPLY: The soil resistance is a function of the soil moisture content in the top soil, which can be measured with microwave sensors on board of satellites. With less moisture in the top soil the resistance to evaporation will increase. More information can be found in Pelgrum et al. (2010). This will be added in the text.

* Section 4: The computation of the soil moisture using the precipitation of the preceeding 14 days needs more details and discussion.

REPLY: As stated in the text, an empirical relation between the actual top soil moisture and the weighted precipitation surplus of the preceeding fourteen days has been used. This relation has been derived from recent measurements in Belgium and The Netherlands where the empirical relation has been found plausible and thus applicable for the use of ETLook in this study. An extended explanation of the derivation of the empirical relation is however not relevant and therefore not extensively discussed in this paper.

* Section 5.1: The question of how to estimate the daily averages of flux measurements is not clear neither for EC nor LAS (see below). Why the threshold of 12 values out of 24? Why to keep such incomplete data? How are nighttime data taken onto account?

REPLY: The initial reason to keep a threshold of 12 values out of 24 was to keep as much data in the analysis as possible without disturbing the daily average too much (more than half of the data of a day have to be present in order to calculate a daily

average seemed us to be reasonable for a daily average). However, we understand the concerns of the reviewer about the incompleteness of the data. Therefore, we recalculated the daily averages for those days where 24 out of 24 hourly EC-fluxes are available. This resulted in new scatterplots for Fig 3 a-c where 159 instead of 165 data points are present for the H and LE-fluxes, but without changing much to the statistics and the concluding discussion in the text. The text will be changed in this respect, together with Figure 3. Night-time data from the EC-station are calculated using the TK2-software package which is able to calculate the night-time fluxes from EC-data.

* p. 10878, l.19-21: what are the surroundings of the EC station in the footprint?

REPLY: As mentioned in Section 2.2, the EC station is installed on a grassland. However, there is an agricultural field next to this grassland which can be part of the source area (footprint) of the EC-measured fluxes depending on the wind speed and direction (cfr. Samain et al., 2011a). However, as the comparison between EC-determined and ETLook-determined fluxes is on a daily basis, it seemed to us unreasonable to make a footprint analysis on a daily basis as wind speed and wind direction change throughout the day and there exist no real “day-averaged footprint”. Because of this and because the main footprint for the EC-station is situated on grassland, only the ETLook-calculated fluxes from the EC-pixel are considered for the analysis.

* Section 5.2: lines 10 to 20: similarly to EC case, why only half the data (12/24) are considered to be enough to average the LAS measurements over 24 h periods? Moreover, please detail the case of negative H values (that the LAS cannot measure by itself negative fluxes unless an assumption is made about atmospheric stability). Why setting H=0 for stable conditions? What has exactly been done for integrating the LAS values over the day (24 hours) should be summarized here and made clearer.

REPLY: Because of the procedure for sensible heat flux calculation from LAS-data, there are a considerable amount of hours where no H (and resulting LE) could be determined, and hence less daily averages could be calculated as there are a con-

siderable number of days where no 24hourly data were available. Therefore, we had chosen to define a valid daily mean for days where more than half of the 24hourly data were available. As stated in the text, this calculation procedure are part of the differences between LAS and ETLook-flux estimates. As we understand the concerns of the reviewer, we are willing to omit this analysis and leaving only the analysis based on the full 24h-averages (with only 99 resulting points in the LE and H-scatterplots of Fig 5 (e) and (f) and omitting Fig (a), (b) and (c). It is also worth mentioning that this has an impact on Figure 4 where (again) less data of the LAS can be shown. The text will be changed in this respect. And also Figures 4 and 5 will be changed. The procedure for calculating H from LAS data for 24h periods has been extensively tested and described in Samain et al. (2011b) where different algorithms have been tested to determine continuous time series of H from LAS-data by estimation of the stability conditions. Also the importance of fluxes under stable (night-time) conditions are discussed and it has been concluded that it is better to calculate H in stable conditions from LAS-data than to assume H to be 0 W/m2 during stable conditions (night time) which can result in different daily averages of H.

TECHNICAL COMMENTS

* Section 2.2: At p. 10870 there is a repetition of exactly the same sentence about the equipment of net radiation and soil heat flux measurements at Liederkerke and Ternat. Simplify the second one.

REPLY: This will be adjusted.

* Is the depth of the soil heat sensor also 5 cm below the surface at Ternat?

REPLY: It is even not that deep under the surface. That is why it is mentioned as 'just below the surface'.

* Section 2.3.2: How the 'no reliable hourly CN2' values and the failures of the algorithm for computing the LAS derived H flux' can be explained (7.6% of data loss)?

REPLY: As the algorithm for computing continuous series of H from LAS-data is based on the diurnal cycle of CN2-data (from the LAS) and Rn-measurement from a ground station, sometimes the algorithm fails: - As hourly CN2-values are hourly averages from 1-minute data (that are averages from 500Hz)-data, sometimes unreliable hourly CN2-values result from 60 (or less) minute data which are omitted in the analysis - When no clear CN2-minimum can be found in the hourly CN2-series or when more than one CN2-minimum is found around the transition from unstable to stable conditions (or vice versa), the algorithm not always gives a clear solution for these transition hours, resulting in some more data loss As this is explained in Samain et al. (2011 b), the authors think this should not be added in the text. However, if the reviewer insists, it can be added.

* Section 3: p. 10872, l. 26 typing error : please correct measurements

REPLY: This will be adjusted.

* Section 3.1: p. 10873, last paragraph: the information 9.5 km and 102.3 km2 have already been given (p. 10872, l. 14-15).

REPLY: This will be adjusted.

* A few words to clearly state that the footprint of the scintillometer measurements has been taken into account in the comparison process and with what method would be useful (with possibly a reference).

REPLY: This has been stated in the introduction (p 10868 lines5-10).

* Section 4: p. 10877, l. 14-22: the estimation of the roughness length has already been evocated p. 10876, l. 18-21.

REPLY: This will be adjusted.

* Please avoid repetitions and detail how the NDVI is used (see previous comment).

REPLY: This will be adjusted.

* Figures 4 and 5: the scales are much larger than the range of effective values, which partly masks the scattering of points. Is it possible to correct for this?

REPLY: The idea was to put all fluxes on the same scale so one can see the magnitude of each flux in respect to the available energy. If the reviewer insists, we can rescale the figures.

* Finally, last detail, I noted too many repetitions in the text of 'as'. Is it possible to suppress some of them?

REPLY: The text will be screened and evaluated on 'as'.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 10863, 2011.