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Hydrology and Earth System Sciences
Discussions

Interactive comment on "How to predict hydrological effects of local land use change: how the vegetation parameterisation for short rotation coppices influences model results" *by* F. Richter et al.

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General thanks:

We very much appreciate the general attention given to our manuscript and the constructive remarks of all reviewers and try to answer them here. Special Thanks to Referee #3, who gave very detailed comments and essentially contributed to improve the text.

Reply to Anonymous Referee #3

1. R#3: “General comments The paper parameterises the hydrological model system WaSim (Schulla and Jasper 2013) using of Leaf Area Index (LAI), stomatal resistance (Rsc) and leaf unfolding (LU) date. Data were collected in a short rotation coppice (SRC) plantation of a poplar clone (Max 1, Populus nigra x P. maximowiczii) in the 2nd (2012) and 3rd (2013) years of the mono-stem cycle. With the aim to assess the effect of parameterisation uncertainties of poplar SRC land use on modelling results, the hypothesis tested is that the variables measured (LAI, Rsc and LU) fit better than values extracted from literature. The paper is too long and its different sections are not easy to understand. Some paragraphs which are not closely related to the topic could be eliminated (see also Technical corrections). In particular, data on long term phenological estimate of Populus tremula could be left out. In fact, due to different microclimate patterns the phenology of adult plants in the forest is not the same as the one of the younger plants of SRC cultivation.

A: We disagree and would like to retain the paragraph. The comparison to the long term phenological estimate of Populus tremula is of particular importance. We explained in the paper that phenological data and parameters for Max1 are hard to find. Therefore for the modelling they are either measured directly on site or taken from literature In the latter case due to the mentioned scarcity of data for clones like Max1, the parameters sets from similar plants are adopted, e.g. from Populous tremula which is well observed, even over long periods and at different sites. Such adoptions are the cause of uncertainty, which we demonstrated by comparing the modelling results with two different parameter sets of these certainly different species (Max1 and Populous tremula). As the differences in estimating leaf unfolding (LU) have to be analysed on longer time scales to show the effects under extreme climate conditions (e.g. early or late spring) we employed the long-term time series from Tharandt, which is the nearest, comparable IPG site. It is also true that microclimate influences phenology, but for commonly used estimations of LU from temperature sums the meteorological data

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are seldom taken from direct onsite measurements. More often (usually) the data from nearest meteorological stations are used which has definitely different microclimate than the vegetation stand. So, micrometeorological effects are mostly neglected when LU is estimated from temperature sums.

2. R#3: “The main result emerging in this work concerns the exact knowledge on the precise growing period the beginning of which is affected by the species/clone utilized, local environmental parameters and plantation density. SRC cultivation during the first 1-2 years have not yet developed a full canopy closure. This can have a strong effect on local microclimate and on energy fluxes between canopy and atmosphere and soil and atmosphere.

A: It is not quite clear from these statements what should be improved in the manuscript. It is true – generally the best way would be to use locally measured or derived parameters for modelling. As we already stated in the manuscript, this is not always possible, and this is exactly the motivation of present study: to show the uncertainty of results caused by the use of transferred or even insufficient parameter sets. The poplar SRC we investigated was 3 years old when LAI and Rsc were measured. We explained in the paper that this SRC can be seen as hydrologically fully developed. In WaSim land use types are parameterized with rooting depth, LAI, Rsc, albedo and canopy closur. All parameters of the poplar SRC Reiffenhausen are comparable to estimates of other poplar SRC′s – if not necessarily the same clone or age. LAImax is 6-8 m2 m-2, depending on the measurement technique. Difficulties of Rsc are discussed, canopy closure is almost maximal (plant height is already 6 m and due to the planting design in double rows plant density is high). So, all parameters influencing the hydrology in the model are in the order of a fully developed SRC, although it is in mono-stem cycle.

3. R#3: “Plant available soil water is not coherent with stomatal resistance values (Rsc) implemented in WaSim (Figures 5 and 6), because these values are not compatible with the SRC canopy behavior on a daily and monthly basis. The absolute minimum

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Rsc value measured of 80 s m-1 cannot be maintained during the entire growing season and since it is reduced to its half, it becomes even more irrealistic, because of the isohydric behaviour of poplar clones (see Tardieu and Simonneau 1998, Journ. Exp. Bot. 49:419-432).

A: The Rsc value used in WaSim, represented the minimal resistance for a state when plants are fully supplied with water. So the model needs the minimal resistance. The real transpiration is further influenced by meteorological boundary conditions and the available soil water. Therefore one could not see a clear coherence of PAW and Rsc in figures 5 and 6, as also not in figure 4. In the reality the minimum of Rsc does not occur every day, but this is not the value that has to parametrized in WaSim. And of course the reduction of the measured minimum Rsc to 40s m-1 is not realistic (at least we could not measure this value) but this was a specific model-adaptation to improve the model fit to measured soil water contents. Additionally, more drought-tolerant, anisohydric water use strategies are also reported from greenhouse experiments for poplar clones (Ceulemans et al., 1988; Larchevêque et al., 2011). Schmidt-Walter et al. (2014) reported also a poor stomatal control of water loss estimated from field measurements of a poplar SRC.

4. R#3: "Local land use change with poplar SRC indicates high levels of ETR and GWR (Table 5). It is suitable to compare these estimated values with alternative crops and other poplar plantations of the same region (see Petzold et al. 2011, Eur. J. Forest Res 130:695-706).

A: The comparison to other crops is not the focus of this study; the land use change aspect serve as motivation for investigating the parameterisation of poplar SRC, to be used for land use change analysis in a next step. The mentioned study of Petzold et al. (2011) reported ∼470 mm of transpiration, our model results showed 425-527 mm total evapotranspiration (ETR, Tab. 5). So, transpiration of SRC is not high compared to Petzold et al. As precipitation (especially the inter-annual distribution) and soil types are not comparable between the different locations, we would like to avoid such com-

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parisons. Additionally we would compare measured and modelled values of different locations. Petzold et al. also reported max. daily transpirations rates of 6.7 mm/d (2.2 mm/d in average), these values are comparable to our model results(max. 6.9 mm/d, mean ∼1.7 mm/d; April-September for the period 1969-2013), but as already stated we would like to avoid thus comparisons of different location, years and sources of data.

5. R#3: "Specific comments Figure 1 is repeated in panel (a) of Figure 4 and therefore has to be deleted from the latter.

A: Figure 1 is in the sections where measurements are presented, here additional information is provided. Of course figure 4 is partly repeating information of figure 1, but it presents the model parameterisation for the simulation. To facilitate for a reader the interpretation of figures 5 and 6 we decided to include the LAI information also in figure 4 to enlarge overview and comparability.

6. R#3: "Figure 2 lower panel. In my opinion the Vapour Pressure Deficit (VPD) of the air, calculated from meteorological data recorded in situ, rather than the maximum daily temperature, could better explain the seasonal variation of stomatal resistance.

A: It is correct. However, the purpose of the presented max. daily temperature was not the explanation of seasonal variations of Rsc, but the demonstration of daily effects due to high air temperatures Compare local measurements of June 14 and 18. At these particular dates soil water availability is quite comparable, the dominant difference are from meteorology, especially maximum air temperature, effecting Rsc values and/or measurements.

7. R#3: "Figure 3 panels a-c. Please specify Temperature in the upper titles. Long term estimates of panels (e) and (f) do not add information on SRC phenology characterised by repeated rotations within very few years.

A: a) What temperatures do you mean? The degree-days? b) "Long-term estimations. . ." - This is true, but the rotation aspect of SRC is not the focus here.

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8. R#3: “Technical corrections Please insert a glossary of Abbreviations

A: We explained all abbreviations when they are used for the first time. Difficult abbreviations like for the different model simulations are explained in table 3. If a glossary is desired by the editor, it could be included.

9. R#3: “Page 406 - line 17 delete “the description of”

A: OK

10. R#3: “Page 407 - line 21 “perennial” rather than “all year”

A: OK

11. R#3: “Page 407 - line 22 “combined “ rather than “in combination“

A: OK

12. R#3: “Page 407 – line 23 “compared” rather than “comparing”

A: OK

13. R#3: “Page 407 - line 24 “canopy interception evaporation” rather than “interception evaporation”

A: OK

14. R#3: “Page 408 - lines 22 and 26 “growing season” rather than “growing period”

A: OK

15. R#3: “Page 408 - line 27 “values reported in literature” rather than “literate values”

A: OK

16. R#3: “Page 409 - line 3 delete “most extensive investigations were carried out at the” and continue with “study site is”

A: OK

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17. R#3: “Page 409 - line 15 after “. . .Max1 (Populus. . .)” insert “, hereinafter Max1”

A: OK

18. R#3: “Page 409 - line 22 “low: only” rather than “low – only”

A: OK

19. R#3: “Page 409 - line 23 “(. . .for the long term mean value of the same period of the year)” rather than “(. . .for the long term mean)”

A: OK

20. R#3: “Page 409 - line 24 “... for the mono-stem cycle of the poplar SRC” rather than “. . .for the poplar SRC”

A: OK, but in our opinion the poplar SRC is fully developed in hydrological terms, as already explained, therefore results should also be valid in the non-mono-stem cycle.

21. R#3: “Page 410 – lines 4-11 delete from “Comparing to . . .” up to “. . .et al., 2014”

A: OK

22. R#3: “Page 410 – line 13 “Meteorological and local soil measurements” rather than “Micrometeorological and local soil measurements”

A: OK

23. R#3: “Pages 411-412 delete from line 10 of page 411 “The Tharandter ..” up to line 5 of page 412 “. . .climatological measurements.” Specify briefly the source of long term meteorological records of Wildacker and Grillenburg.

A: As long term phenological observations from Tharandt are important we suggest reformulating the paragraph as follows: “Additionally to the data of Reiffenhausen, meteorological and phenological data are used from region of Tharandter Wald (Tharandt Forest) being located in the federal state Saxony (Germany), 15km southwest of city of Dresden. As, climate characteristic of this region is comparable with Reiffenhausen,

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a proper set of comparison data are provided. Detailed information about measurement programs of Tharandter Wald can be found, i.a., in Bernhofer (2002) and Spank et al. (2013). In frame of this study, phenological observation data from the International phenological garden Tharandt-Hartha (IPG) and meteorological measurement data (air temperature, air humidity and precipitation) from climate stations Grillenburg and Wildacker have special importance. Grillenburg and Wildacker are the nearest meteorological long-term measurements sites from IPG and are situated approx. 3 km away. Both stations provide meteorological and climatological information since 1958. The station Grillenburg represents a standard climate station fulfilling all guidelines and standards of World Meteorological Organisation (WMO) for large-scale representativeness of climatological observations. However, measurements on this site sometimes does not represent micro-scale climatic characteristic of the region, particularly related to daily minimum and maximum of air temperature. In contrary, climate station Wildacker, being not fulfill WMO standards of fetch and horizon heightening, better represent local climatic situation."

24. R#3: "Page 412 – lines 11 and the following: correct LI191SA with LI-191 SA and LAI2000 with LAI-2000 all in the text

A: This is actually the page 413. Correct. Initially we used the abbreviations in the manuscript draft, because they correspond to the simulation acronyms. However, the correct instrument names (LI-191SA and LAI-2000) should be used. We will change it in text and explain the simulation acronyms.

25. R#3: "Page 412 – line 22 "...of short-wave (400-700 nm)" rather than "...of short-wave"

A: The remark is not quite correct. Different instruments use different spectral ranges. E.g. Li-Cor plant canopy analyser uses the short wave radiation below 490 nm. Therefore, we would like to use the general term: "short-wave radiation".

26. R#3: "Page 412 – line 25 "...below the canopy" rather than "...for the vegetation

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layer" and R#3: "Page 412 – line 26 "...above the canopy" rather than "...to the vegetation layer" and "... below the canopy" rather than "at the lower bound of vegetation layer"

A: These corrections are not necessary – here we are using the general definition: the LAI could be estimated for any vegetation layer including the whole canopy.

27. R#3: "Page 413 – lines from 23 to 28: any specification on view cap used for LAI-2000, rings analyzed and sampling method used with LI-191 SA

A: The LAI-2000 was used in two-instrument mode with 25% view restriction caps to eliminate the influence of observer. The measurements with line quantum sensors LI-191SA were also carried out in two-instrument mode the measurement design is absolutely identical to LAI-2000. We will include this explanation in manuscript.

28. R#3: "Page 414 line 8 "its" rather than "it's"

A: OK

29. R#3: "Page 414 line16 "every week or two weeks" rather than "every week"

A: OK, We will replace it with "were carried out weekly or fortnightly"

30. R#3: "Page 414 line 18 "plots" rather than "...locations in the poplar SRC"

A: OK

31. R#3: "Page 414 lines 19-20 delete "so called", "to be measured at different times" rather than "to measure the same leaf at different times". Please specify the number of sun leaves marked.

A: a) OK, we will delete it b) 3 sun leaves were marked at every plot. We will include the information in text

32. R#3: "Page 416 lines 19-23 delete from "This IGP ..." to "Seidler (1995)" and thus citation from References section, too.

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A: OK

33. R#3: “Page 417 line 4 “a poplar SRC in the 3rd growing season of its mono-stem cycle” rather than “an approx. 3 year-old poplar SRC”. The mono-stem cycle specification indicates that the roots have the same age of the stems!

A: OK

34. R#3: “Page 417 line 25 “from 1969 to ...” rather than “of 1969 to ..”

A: OK

35. R#3: “Page 418-419 lines 23-24 and 1 of page 419. Delete from “Maximal..” to “(not shown)”

A: OK

36. R#3: “Page 419 line 9 delete “at the poplar SRC Reiffenhausen”

A: OK

37. R#3: “Page 419 line 10 “SD” rather than “SDs”

A: OK, but this was done by HESS, I would also like to introduce the abbreviation SD at the first time it is used.

38. R#3: “Page 419 line 25 “We used in situ phenological” rather than “We used phenological”. Delete “in Reiffenhausen”

A: first OK; second “in Reiffenhausen” was inserted to clearly distinguish between the different sources of phenological data.

39. R#3: “Page 420 line 7 “from” rather than “to”

A: OK

40. R#3: “Page 420 line 8 insert “(Table 2) after “respectively”

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A: OK

41. R#3: “Page 421 line 7 “2012-2014” rather than “2012-1014”

A: OK

42. R#3: “Page 421 line 14 “Goettingen and Wildacker, respectively” rather than “Goettingen and Wildacker”

A: OK

43. R#3: “Page 422 line 2 “(LAI-2000 and LI-191 SA using Rsc80 in both cases)” rather than “LAI200 Rsc80 and LI191SA Rsc80”

A: These are not the names of instruments but the names of corresponding experiments that’s why we would prefer the use of the introduced abbreviations.

44. R#3: “Page 422 line 9 and line 16 “measured” rather than “observed”

A: OK

45. R#3: “Page 422 line 17 “plant available water (PAW)” rather than PAW

A: PAW is introduced already at page 422 line14

46. R#3: “Page 422 line 18 “Nash-Sutcliffe criterion (NSC)” rather than “Nash-Sutcliffe criterion”

A: OK

47. R#3: “Page 424 line 23 “PBIAS” rather than “PBAIS”

A: OK

48. R#3: “Page 425 line 2 “longest meteorological period without missing data” rather than “longest period meteorological forcing data are available without missing data”

A: OK

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49. R#3: “Page 426 line 23 “affected” rather than “effected”

A: OK

50. R#3: “Page 426 line 26 “Populus species” rather than “populus clones” and “(Populus grandidentata, P. tremula and P. tremuloides)” rather than “(Populus grandidenata, Populus tremula and Populus tremuloides)”

A: OK

51. R#3: “Page 427 line 28 “. . . shows a wide variability in the date of leaf unfolding” rather than “. . .shows a wide spread in the date leaf unfolding started”

A: OK

52. R#3: “Page 428 line 5 “evident” rather than “visible”

A: OK

53. R#3: “Page 428 line 15 “ground water recharge (GWR)” rather than “GWR”

A: GWR is already introduced in the introduction; of course we can repeat it here once again.

54. R#3: “Page 428 line 27 “. . . occurring thermal inversion” rather than “. . .occurring inversion conditions”

A: OK

55. R#3: “Page 431 line 18 “. . . local soil water budget” rather than “local water budget”

A: We are also showing ETR for the long term simulations, that’s why we talk about water budget in general.

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