

Interactive comment on “Exploring water cycle dynamics through sampling multitude stable water isotope pools in a small developed landscape of Germany” by N. Orlowski et al.

Anonymous Referee #2

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This paper presents an extensive data set from an agricultural catchment in central Germany, where various parts of the water cycle, streams, groundwater, precipitation and soil water are sampled for about 2 years. This data set is used to investigate runoff generation and connectivity between the water cycle components and builds up on a hydrometric paper published in 2014. The paper states that the groundwater system controls streamflow, and no strong influence of precipitation on groundwater and streamflow was observable. The paper is very well written, very informative in background, and the field effort and the data set are great.

Nevertheless, there are also several shortcomings in the paper that need attention. I

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think the analysis needs some more rigor and attempts to a better quantification should be made. At first, the paper often claims statistical differences etc., without presenting p-values etc. These p-values need to be reported, this would be absolutely necessary for the reader to be convinced. I understand that lacks of variability in stable isotopes restrict the use of the classical tools, but I do not fully agree about the lack of variability in this work. In my opinion, there is a variability of $\delta^2\text{H}$ in Figure 4. Just plotting a moving average in the stream flow stable isotopes should present some variability. In the lowest panel you clearly see the heaviest stable isotopes values around 7/1 or 8/1, while the values in later winter early Spring are lightest (not sure how important snow in the area would be). Reporting this, e.g. temperature would be good, I don't think this area (with this elevation) has a long term snow cover over the winter. But that said, the variation seem to be 5-6‰ (the figures are not that easily visible). This variation is a factor ten above measurement precision, and comparable (or even higher) than the differences in McGuire et al. (2005, WRR) (their figure 4). They used 1‰ (and clearly less for ^{18}O) for mean transit time estimations in the HJA.

Further, the previous paper (Orlowski et al., 2014, Water) presents one events that showed reaction of stable isotopes on incoming precipitation. I am not aware of the number of sampled events, but I think the authors should clearly put more effort on presenting individual events, perform Isotope hydrograph separation on them, and present when and when we do not have some precipitation influence on the response and why. This would be a very good link with the hypothesis 1 (where you should clarify the meaning of “strong temporal” (page 1814), because every reader will have a different perception of such a subjective term), and the importance of the switch between different sources in a catchment and the link to catchment stage are important. Here I would suggest the TRANSIT approach (Weiler et al., 2003, WRR), since it could yield comparable results to the presented response times in Orlowski et al (2014). Further you can present what the difference between the two streams is, if they are individually sampled. Beyond, the limitations of the methods/or result presentation I think the merger of results and discussion was not that efficient for the paper. This takes out

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some clarity, and leaves the reader with some wondering what's new. And I don't think this actually accounts for the information wealth the paper delivers. Thus I would like to see a separation of results and discussion in the revised version, and a discussion that also outlines what we learnt new compared to the current understanding in runoff generation in developed/agricultural catchments. The discussion and the cited references need some stronger focus on the research question of the paper, e.g. I do not think that a general discussion of how the precipitation compares to other precipitation stable isotope studies is necessary. Same holds for discussing stable isotopes in soil water. All valid and interesting points, but please present in the results only data in detail that is necessary for the research question, and shorten the presentation of precipitation data. This will help the paper to get more focussed and will eventually help a clear discussion of the generated understanding. In the introduction you outline general effects of fractionation, precipitation behavior of stable isotopes in detail, while this is not the focus of the work. Please present towards the end of the introduction (Page 1811 and 1812 are really nice) why this work was performed, and how these hypotheses are based on the current research need. I had the feeling this was not convincingly presented, this will also help to present the novelty in the discussion.

In summary, add event based result section, where you can present response (also hydrometric) for several events, e.g. using TRANSEP (if sequential precipitation stable isotope data is available for events), and explain differences between the events. Second, separate results and discussion, and focus in the discussion points that are clearly related to the research questions, and how that compares to other work.

General comments: The manuscript seems to have some problems with "ff".

P1810L2: I think the abstract would need an introduction sentence that sets the research field and reasoning.

P1811L13 "Garvelmann et al., 2012", I do think this is a wrong citation, there is not transit time work involved there. Please re-check, otherwise this would be confusing.

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Same line: “transit”, sometimes you are using “transit” sometimes “residence” time in the manuscript, please unify where it makes sense.

P1811L17: You have quite some substantial elevation difference in the catchment, more than 100m, and call the catchment low-mountainous, I don’t think this is comparable to real low angle catchments. Further, you need to better support this claim of poorly understood, I am not sure about that. What exactly? Further, I think here and in the following lines you need to better describe what was done and understood in developed catchments (also make the difference developed in sense of urbanisation or agriculture or both) and what is still a question of research. Please cite the necessary references to lay out the claim.

P1811L22-24: You need to support this claim better with (more) references, and clearly state why it is limited. The why helps to focus the paper, the “that” is not so important.

P1812L1 “few hydrological and especially stable water isotope”. Are you really sure about this? In the following you cite some work from agricultural catchments (e.g. Cey et al., 1998) about tracer work. You can also find some citations of agricultural catchments and stable isotope work in Klaus and McDonnell (2013, JoH, their table 2). There are also quite some more studies in agricultural catchments. I do see limitations here.

P1812L7ff: This is very detailed information about stable isotopes in precipitation, while this seems not to be the focus of the paper. I think this can be substantially shortened, and a stronger focus on runoff generation should be introduced (if this is the main focus). From these lines on, please try to focuss on research gaps to better support the hypotheses.

P1812L24: “residence time” unify terminology.

P1812L28: “Kendall and McDonnell, 1998” The book consists of individual chapters from various authors, please cite the author of the relevant chapter, and have the Editor

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of the book in the reference list. Please improve throughout the manuscript.

P1813L25: “water lines” in general a catchment should have one LMWL, since it describes the precipitation, it reads confusing here. Since water sources other than precipitation cannot have a LMWL.

P1814L24 “strong temporal” Please avoid subjective descriptions. You also could relate this hypothesis to new/old water paradox work from Kirchner and other authors.

P1815L3ff: Please make this more clear.

P1815L10ff: You should make clearer when you write about the one stream and about the other. Present the individual catchment boundaries in fig1. In the text it needs be more clear what information is linked to what (sub-) catchment.

P1816L6ff.: Do you have long term data for the area, would be better than presenting precip sum for only one year. Catchment outlet referes to the Schwingbach Catchment?

P1816L19 “Significant” should only be used in relation to statistical tests. Please avoid otherwise.

P1816L9ff. “>114 L s⁻¹”. Why “>” and not the exact value? I think the unit might be better in depth (mm)/area to have comparability if this is a lot or not.

P1818L9-12: I think such information should be in the introduction, not in the method section.

P1820, Chapter 3.1. Here a decision regarding the focus is necessary; the whole section of precipitation is very detailed, while not really linked to the hypotheses/research question. In general this could be shortened. Further I think the introduction of the LMWL (3.5) should be together with chapter 3.1.

P1824L19ff: As outlined earlier, there are variations, with heavier values in summer/fall and lighter values in spring. It is not even close to a straight line.

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P1825L8: Here again, standard deviation is already 3 times higher than analytical precision.

P1825L21: Did you try some mixing calculations?

P1826L4/5 “Statistically similar”, please provide p-value (t-test?)

P1826L14: Please also report p-value here and throughout the manuscript.

P1826L23-27: These lines are not needed. This should be clear from intro and method, here you should just report the results.

P1827L12-13: “. . .(Fig. 8).”, this is difficult to see, please test statistically incl. p-value. Same for lines 16 and 20.

P1827L22-24: What did you expect to see? So how should rainfall influence the groundwater signal? Maybe the volume of preferential flow is low compared to the volume of GW and no (strong) effect can be seen.

P1827-1828L28-2: It would be important to work out the site differences and related the differences in measurement to this.

P1830L10ff. Lots of details, but it needs to be clearer what the message is. I think with separating results/discussion this will automatically become clear, if the discussion is related to the hypotheses and general progress in the field.

P1831L5: If the focus is on the LMWL please add this to the precipitation isotope section. If you want to compare the water lines of individual water cycle components make that clear, and the analysis statistically more sound.

P1831L21: How do you exclude moisture recycling?

P1832L5-6: From the elevation range they seem not to be comparable.

P1832L17: Here event based hydrograph separation would be nice, they should present how much % groundwater contributions are during events.

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P1832L20: “a larger contribution. . .” You did not present calculations.

Figure 1: Please present sub-catchments. Fonts are too small to decipher.

Figure 2: What is the relation to hypotheses/research questions? I think this figure could be removed.

Figure 4: Too small. For trying, plot a moving average, I guess you start seen some seasonal patterns.

Figure 5: Larger fonts needed.

Figure 8: font size

Figure 10: please report equations of water lines, here.

Thanks for the reading, I am looking forward to the revisions.

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