Comments on “Variations in groundwater contribution to a stream” by Duvert et al.

This is an interesting study that would be of considerable value to readers of HESS. Understanding transit times in catchments is important for a range of endeavours and this study makes use of tritium, which in the southern hemisphere has become an invaluable tracer (due to the much lower bomb peak) for this purpose. The study has a really nice design whereby it is possible to use both short-term tracers (stable isotopes and Cl) and tritium – most studies have the data to use one of these approaches and few have used both.

While the quality of the data and interpretations are good, the paper is difficult to follow in places and the conclusions are not always well justified. Section 5 is long and could benefit from some statements explaining the aims of the various sections. Some of the material in Section 5 is also background material and data presentation; as this is a long section it would be good to remove that material and focus on what the important aspects are. Making that section clearer would improve the impact of the study.

I don’t particularly like lots of non-standard abbreviations in papers (while the authors will know these well, the reader often gets confused and too many makes the paper difficult to read). It would make the paper more intelligible to remove the TT’s, TTD’s, RTD’s etc. I would also call it the “Mean Transit Time” as “Transit Time” gives the impression of a specific time rather than a range of times.

Terminology – ^{18}O (^{2}H) are the tracers $\delta^{18}O$ ($\delta^{2}H$) are the units of measurement.

Specific Comments

Introduction

This section provides a good overview of the background to the study; however in places it is not clearly written. In the final version of the paper, try to make this section as clear as possible so that the reader gets a good idea of exactly what you are doing. I also have a few specific comments:

- Catchment transit time (rather than the streamflow transit time) is probably clearer
- The paragraph starting on line 23 of page 8037 seems out of place. It discusses details of the models while the next paragraph goes back to discussing more general aspects.
- Other issues with using Cl or stable isotopes as transit time indicators are that detailed catchment-specific input functions are needed (ideally weekly for several years) and such data are rare globally. Also use of these tracers typically gives a single transit time estimate whereas tritium can be used to estimate transit times at a range of streamflows.
- Page 8040 middle paragraph. It might be good to make it clear that the reason that most studies have used the time series approach to estimate a single transit time is due to the bomb pulse problem. You mention the lower bomb pulse in the southern hemisphere in the previous paragraph and it would be good to reiterate it here.
- Last sentence on Page 8040 is not clear (not clear what “but also in the limitations of using single 3H samples to calculate streamwater TTs” means)

Section 2. This section presents most of the relevant background information for the study. It would be helped by a few more specific details, for example “Climate in the region is humid subtropical with extremely variable rainfall, most of which falls from November to April. While Teviot Brook is a

perennial stream, the distribution of discharge is uneven throughout the year" would more informative with some value for rainfall and discharge. Some other comments

- The end of Section 2.1 is a bit confused – the discussion alternates between details of the geology and information on the bore construction, it needs to be reorganised so that the information is grouped better.
- In Section 2.2 you discuss the recent rainfall but given that the transit times are likely to be longer than a few years, the longer-term average rainfall is also important and should be specified.

Section 3

Specific Comments

- Section 3.1 not clear what "Streamwater and groundwater samples were collected... ...following the same sampling scheme as the rainfall samples (Fig. 1)" means (Fig. 1 is a map not a description of the sampling methodology.
- The statement (page 8044) "A sample collected in August 2013 was excluded from the dataset since it was analysed twice and yielded inconsistent results" is a concern – how many of your samples were repeated (and what was the agreement).
- Section 3.1. Make sure that you list the uncertainties for all the analytical techniques, you have it for some not for others.
- There is a potential problem with the use of digital filters and chemical mass balance (end of Section 3.2.1). Digital filters separate baseflow and quickflow BUT importantly the baseflow is all delayed sources of water (eg bank return flow, interflow, groundwater inputs etc); the Nathan & McMahon paper discusses this. Chemical mass balance probably partitions interflow and bank return flow into the event water component (see discussion in McCallum et al. 2009, Water Resour. Res., 46, W07541, doi:10.1029/2009WR008539 and Cartwright et al. 2014, Hydrol. Earth Syst. Sci., 18, 15–30, 2014, doi:10.5194/hess-18-15-2014). While it is good to integrate these techniques into the study, you need to consider exactly what they tell you. I'd suggest only incorporating one of these (perhaps the CMB as it is a chemical technique that is easier to compare with your geochemical data).
- Section 3.2.2. With the explanation of the LPM equations, it would be clearer if they were written out in full (ie with the decay term) and then you explain that that term is not needed for the stable isotopes. This way it is clearer where in the equation the decay term fits.

Section 4.

- Is there any reason that you need to present data even in a summary table that you don't use? If you are going to present these data, you need to say more about it than "there are some extra data in a table" which tells us little about the data is and why it is important.
- Section 4.1. d2H values should be quotes as whole numbers and d18O values to 1 decimal place in accordance with their precision.
- Some of the material that appears in Section 5 (eg the variation of stable isotopes and Cl in rainfall) are descriptive and would be better in this section.

Section 5

This section goes through the data in a logical manner, but in several places you need clearer / fuller explanations to be convincing. There is a lot in this section and it is not always easy to follow, for example you use different LPM models for the young and old water fractions (Sections 5.1 & 5.3) and reading through Section 5.5 it is not clear whether you need another water store (water from the sedimentary aquifer) as well as the quickflow component and water from the alluvial sediments. I think that I agree with most of what is in this section but it is difficult to follow and I'd suggest re-ordering this material as follows:

1. Firstly set up the conceptual model. Currently you introduce information such as the changes in Fe concentrations late in this section to support the conceptualisation, but they really are what allow you to conceptualise the system in the first place.
2. Follow the conceptualisation with the discussion of the young and old water modelling; in this way it makes more sense as the reader has a clear picture of what the system looks like.
3. Try to avoid general comments in this section (it is long enough as it is). For example the comments on stable isotopes at the end of Section 5.1 belong in the introduction and are distracting here.
4. Do more to lead the reader through each section. For example you talk about correlations in several of the sections and while you describe whether correlations exist, you never really make it clear what the purpose of assessing the correlations is

A lot of thought has gone into interpreting the data but a reader not familiar with tritium and LPM's would find it hard to follow, which lessens the impact of the study. Some other specific comments

- Page 8050. Why are the stable isotope ratios in the rivers lower than in rainfall (does this hint at a problem with representative sampling of rainfall either in time or space)?
- Page 8050. The assertion that evaporation increases Cl concentrations and changes the stables may be true, but looking at your data the change in stable isotopes implies evaporation of only a few% which would not change the Cl concentrations significantly (is that the case?). As with a number of the ideas in this section, you can be more rigorous in your discussion.
- Pages 8050-8051. Somewhere you need to justify your choice of LPM models. The exponential model is probably OK but many studies (eg the several by Morgenstern) use an exponential-piston flow model with the piston flow component used to simulate the recharge through the unsaturated zone. Discuss this a bit more fully.
- There appears to be no attempt at error propagation. You could try sensitivity analyses based on
    - Propagation of analytical uncertainties for 3H
    - Assessing the uncertainties around the chemical mass balance
    - Comparing alternative lumped parameter models
- Page 8059, line 8. I Is this the case; the Morgenstern et al. (2010) paper does discuss young water inputs (see pg. 2029) and applied a binary model.
- Section 5.6. The section on evaporation impacts on tritium is superfluous (or could be dealt with in a sentence). Again in this section try to focus on the most important things, you don't have to discuss everything in detail.

Section 6. In this section try not to repeat the specific conclusions but to draw out the more general aspects of the study. Some of the discussion in Section 5.6. might be better in the conclusions. As with the other sections try to focus on what is most important.

Figures.

Figures 3 & 4 would be better with larger symbols and/or colour