

Interactive comment on “Calibration of a transient transport model to tritium measurements in rivers and streams in the Western Lake Taupo catchment, New Zealand” by M. A. Gusyev et al.

Anonymous Referee #1

Received and published: 7 September 2012

General comments This paper is fairly well written; however it is not clear what is new in the manuscript (the word “new” is used in the manuscript referring to the calibration procedure). It seems that if the title and point of the paper is to present an approach for calibrating a groundwater model then the manuscript should demonstrate the amount of information that is provided by the tritium data. However, the calibration approach relies on a simple trial and error approach and it is not clear that the model performance was improved by the use of tritium. Also, there is no information provided to allow the reader to assess how well the model is calibrated (contour maps showing measured verses simulated head or 1:1 plots, fits statistics, etc.). Additionally, calibrating a steady

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state model is typically one step toward calibrating a transient model. The other issue is that the transport model is run as transient; however, the flow model is steady state. Justification and limitation of this approach need to be stated. Additionally, important information is left out, and this leaves the reader wondering if many of the approaches and assumptions are justifiable. For example, the model is constructed assuming that all the flow in the river originates as groundwater. However, this assumption is not stated or justified. Also, the median flow is used as a calibration target; however, this does not seem like a reasonable approach for estimating the steady state groundwater discharge to the stream, even if all streamflow originates as groundwater. Considering there are already several great examples of the use of tritium for constraining and calibrating groundwater models, I don't find this paper to be a very useful contribution to the literature (e.g., Plummer et al., 2000; Ground Water Journal; Szabo et al., 1996, WRR). Finally, the paper lacks discussion of the approach, results, and assumptions. Below I am including specific points illustrating my overall statements stated above, as well as, indicating additional significant issues with the manuscript.

Specific comments P9744 L20-22: The comment regarding limited understanding of the dynamics of the groundwater component that transmits much of the water from rainfall to streams is somewhat misleading. For one, the groundwater component in streams is highly variable from region to region and depends on one's definition of groundwater. For example, one might consider shallow subsurface stormflow as groundwater; however this water is very young. Dispersion and mixing with GW discharge to shallow soils can make new water look old. For this problem, tritium does not help because it suffers from the same issues related to mixing. Thus, the debate is not satiated by the use of tritium, which has been applied to these problems for decades (e.g., Szabo et al., 1996, WRR; Plummer et al., 2000, Ground Water). P9745 Lines 8-10: This sentence is misleading. As shown by Szabo et al., 1996, WRR, tritium was an effective tracer for GW model calibration when the effects of the bomb pulse were still apparent. P9745 Line 13: A sample of water typically contains a distribution of ages, especially stream water. It is not accurate to refer to the “age” of

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a water sample without some kind of qualifier (e.g., mean age). P9747 Lines 17-20: Is there no overland runoff or shallow subsurface storm flow? If not then this should be stated. Recharge=Precip-ET typically works when averaged over a basin but not usually for each model cell due to runoff in the uplands where K_v is typically small. Also, there is the issue of subsurface storm flow that really is not recharge. Also, is there phreatophyte ET in these basins? If so, then one cannot subtract ET from precipitation to calculate recharge. P9747 Lines 25-29: If one uses the median flow in the river then this likely includes water that does not flow through aquifers, unless there is no surface water or shallow subsurface stormflow reaching the streams. However, in your simulations you are assuming the all of this flow travels through the aquifers. Why use the median streamflow as a calibration target? The long term average discharge to streams (steady state) reflects the long term sum of streamflow divided by the measurement period (mean). The median may or may not reflect the long term average GW discharge to a stream, even if precipitation minus ET equals groundwater recharge. Also, are there phreatophytes in the basin? If so, then recharge will be greater than precipitation minus ET because ET occurs after recharge has occurred. If there is a component of streamflow that does not come from groundwater then this cannot be simulated with the MODFLOW model described in this manuscript. P9748 Lines 16-17: What is meant by deduced in this context? It would help if the authors explained what a tritium measurement in surface water represents? P9748 Lines 22-23: Here again, the authors are making assumptions about what a tritium sample from surface water represents without explaining these assumptions. It seems that due to mixing of a wide range of water (runoff, subsurface stormflow, groundwater flow, hyporheic flow, banks storage, etc.) that matching tritium in surface water would be very non-unique and not provide a very good constraint on the distribution of residence times. A discussion is warranted on these issues in order to propose this approach for model calibration. It is not clear how much information is provided by the tritium data. P9749 Lines 22-23: Please explain why you chose these values, especially the longitudinal dispersivity. P9751 Line 3: what aspects of the transport model were fine-tuned?

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P9751 Lines 9-11: Why doesn't the model match the bomb-peak? Please provide explanation. P9753 Lines 1-2: One cannot model concentrations of nitrate in a stream using a large scale groundwater model. Hyporheic and floodplain zone processes are important processes affecting nitrate concentrations and these processes cannot be simulated with a coarse MODFLOW models as suggested in the manuscript. P9753 Lines 11-12: I assume these are simulated groundwater age distributions, please clarify. P9755 Lines 5-6: It is not clear what is "new" about this calibration. Folks have been using tracers with MODFLOW and particle tracking for decades. This seems like a very simple trial and error type calibration procedure. P9755 Lines 17-18: Measured how? This seems strange because measurements of aquifer properties are typically local values and model values represent effective values for large grid blocks.

Technical corrections Figure 4: These are simulated ages, correct? P9751 Line 2: "mode" should be "model" P9752 Line 16: "pattern" should be "patterns"

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 9743, 2012.

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