We would like to thank anonymous referee #2 for his or her comments on our paper. We consider the comments very helpful. Our response to the comments is given below.

Title: We have decided to change the title to “Runoff generating processes in adjacent tussock grassland and pine plantation catchments as indicated by mean transit time estimation using tritium”. We also will include more discussion comparing the catchments.

Rigour of modelling analysis:

The reviewer has concerns about the rigour of the modelling analysis, particularly because of the small number of measurements at each site. We agree that more explanation is required to better substantiate the transit time estimates. We have included here the results obtained using a wider range of models (viz. the dispersion (DM) and exponential piston-flow (EPM) models, as well as the double dispersion model (DDM); see Table 1). Results in the table show that the best DM and DDM fits are similar in quality to each other as shown by the standard deviation (sd), while the best EPM fits are much poorer in all cases. The variation of the goodness-of-fit parameter (sd) with the mean transit time (MTT) for the DM is shown in Fig. 1, that for the DDM with the mean transit time of the old water component (MTT2) is given in Fig. 2 (this is Fig. 5c in the paper).

The best-fit transit time distributions with the DM and DDM for GH1 are plotted in Fig. 3 (this is modified from Fig. 4c in the paper). The DM has a high peak near zero age (not shown on the plot because of the scale) and a long tail that extends to almost 50 years. With only two parameters the DM has a constrained shape, but it is apparent that by optimising the fit the model is trying to accommodate a lot of young water and some very old water. The DDM was used in the paper to try to delineate these two age components more clearly (i.e. the first DM accommodates the young water component, and the second DM the old water component). The transit time distribution of the DDM with its two peaks has approximately the same shape as the transit time distribution of the DM. In contrast, the EPM transit time distribution cannot be changed enough to accommodate the measurements well (see Table 1), because f (the ratio of the exponential to the total volume) cannot be greater than 100%. The double EPM (DEPM) likewise is not very satisfactory.

As described in the paper, there is evidence that many catchments discharge both young and old water (e.g. Kirchner et al., 2000; Stewart et al., 2010). Hence it is logical to apply a two-component transit time model such as the DDM. This is reinforced at Glendhu, because there are indications of the presence of bomb tritium in the wetland and streams (i.e. by stream tritium concentrations being greater than recharge tritium levels) showing the presence of old water, while all models show that the remainder of the water is young.

Although only three tritium measurements have been made at each site, they are 3-4 years apart in time. Hence they are applicable to estimating longer transit times. More measurements at short time intervals would be needed to investigate the young water component of the DDM, and more measurements in the future will help refine the overall transit time distribution. It is true that many different models and parameterisations could give good fits to the data, but we believe that these would produce the nearest representation consistent with the constraints of the various models to the underlying transit time distribution describing average baseflow in the catchment.

We reject the 4 years MTT2 parameter because the standard deviations of the modelled fits for 4 years and 25 years (MTT2) for GH1 are in fact considerably different (±0.08 TU and ±0.04 TU respectively), i.e. the 25 years MTT2 gives a much better fit to the data. Apart from the poorer fit, the 4 years MTT2 does not predict bomb tritium influence, so it produces worse fits for all of the other sites as well. We did not attempt to model the CFC ages because of equilibration of CFC concentrations with the atmosphere (particularly at the outlet streams, GH1 and GH2), and the possibility that CFCs could have been chemically degraded in the wetland. In fact, an earlier paper (Stewart et al., 2005) showed that the CFC concentrations at GH5 were approximately consistent with that expected from the tritium results, assuming that chemical degradation in the wetland had not affected the CFCs. There are currently no plans to drill boreholes in the catchment. We plan to take account of the tritium measurement errors to estimate the uncertainty of the parameters derived.

Table 1. Best-fit parameters for simulation models (double dispersion model (DDM), dispersion model (DM), and exponential piston flow model (EPM). (The parameters of the young component of the DDM are MTT1 = 0.1 year, DP1 = 0.1.)

| Site | Double dispersion model | | | | Dispersion model | | | EPM | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | b | MTT2 | DP2 | sd | MTT | DP | sd | MTT | f | sd |
| GH1 | 0.84 | 25 | 0.04 | 0.04 | 1.0 | 2.3 | 0.05 | 0.5 | 100 | 0.11 |
| GH2 | 0.74 | 26 | 0.03 | 0.01 | 2.7 | 1.5 | 0.03 | 0.85 | 100 | 0.19 |
| | | | | | | | | | | |
| Midbog | 0.77 | 34 | 0.01 | 0.00 | 3.9 | 3.1 | 0.00 | 41.5 | 19 | 0.06 |
| N-tube | 0.00 | 40 | 0.01 | 0.10 | 40 | 0.01 | 0.10 | 42 | 20 | 0.22 |
| GH5 | 0.69 | 39 | 0.01 | 0.11 | 0.6 | 10 | 0.12 | 0.1 | 100 | 0.23 |
| 70 m d/s GH5 | 0.92 | 34 | 0.01 | 0.03 | 0.3 | 10 | 0.04 | 0.1 | 100 | 0.10 |

b is fraction of young component, MTT2 and DP2 are parameters of the old component in the DDM, sd is the goodness-of-fit expressed as the standard deviation of the simulation about the measurements, MTT and DP parameters of the DM, and MTT and f parameters of the EPM.

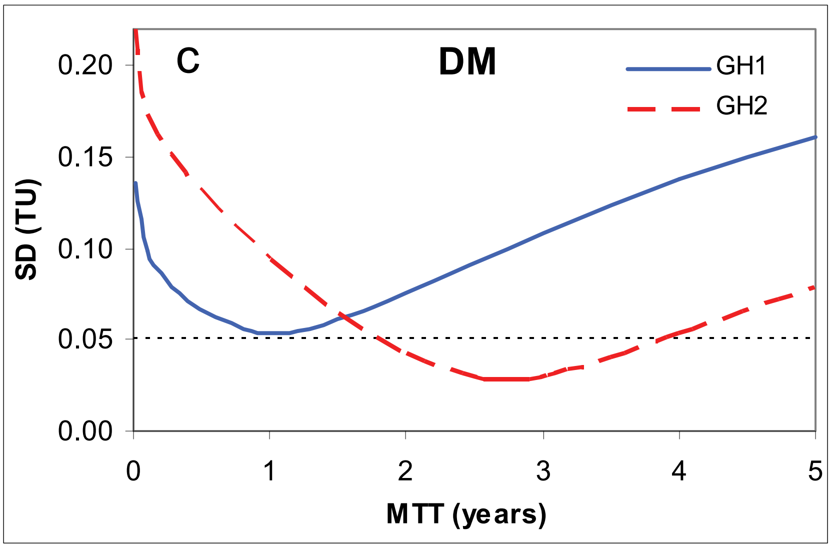


Fig.1 Quality of fit of simulations to measurements for GH1 and GH2 with variation of the mean transit time (MTT) using the dispersion model (DM).

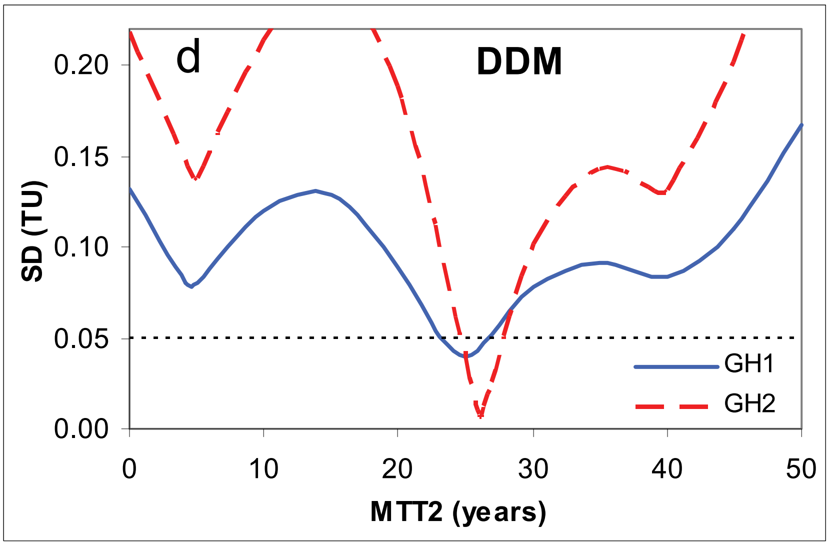


Fig. 2 Quality of fit of simulations to measurements for GH1 and GH2 with variation of the mean transit time of the old component (MTT2) using the double dispersion model (DDM).

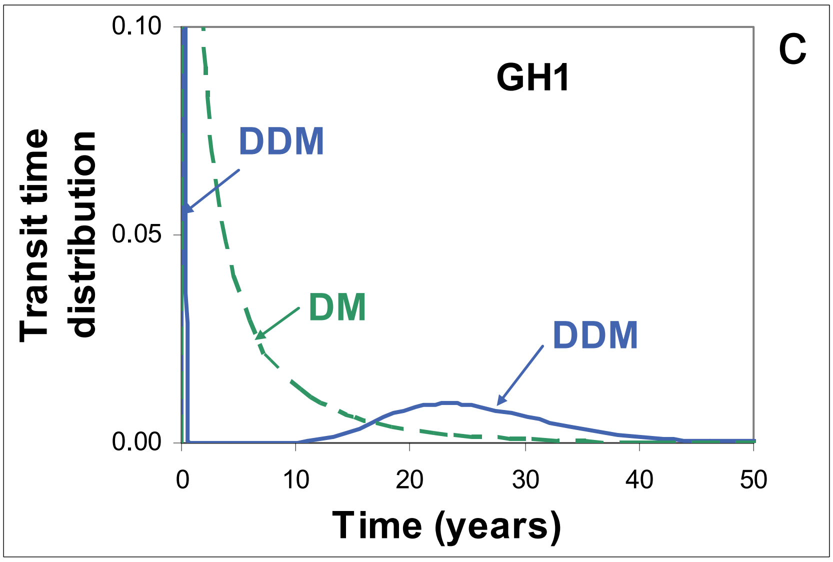


Fig. 3 Best-fit DM and DDM transit time distributions for GH1. Both show high proportions of a young water component (peaks not shown) and small proportions of an old water component.

Specific comments:

Title: See above.

P1075 L7-8: OK

P1075 L9: This statement is not important to the paper, but can be justified by many isotope studies (e.g. Bonell et al., 1990 at Glendhu).

Abstract: We agree that a concluding statement should be included here.

P1080 L14: See above. We will remove this inference.

P1080 L22: Noted.

Fig. 3: We will describe the black dotted lines in the caption.

P1085 L1-8, Fig. 4: Discussed above.

Fig. 5: Different model parameterisations have been discussed above. Fig 5c will be explained more clearly in the caption and text.

General: Agreed. The term mean transit time (or MTT) will be used consistently instead of either mean residence time or MRT.

References:

Bonell, M., Pearce, A. J., and Stewart, M. K.: The identification of runoff-production mechanisms using environmental isotopes in a tussock grassland catchment, Eastern Otago, New Zealand. Hydrol. Process. 4, 15 – 34, 1990.

Kirchner, J.W., Feng, X., and Neal, C.: Fractal stream chemistry and its implications for contaminant transport in catchments. Nature, 403, 524-527, 2000.

Stewart, M. K., Fahey, B. D., and Davie, T. J. A.: New light on streamwater sources in the Glendhu Experimental Catchments, East Otago, New Zealand. N.Z.H.S., I.A.H., N.Z.S.S.S. Conf. 'Where Waters Meet', Auckland, N. Z., Nov., 2005.

Stewart, M. K., Morgenstern, U., and McDonnell, J. J.: Truncation of stream residence time: How the use of stable isotopes has skewed our concept of streamwater age and origin, Hydrol. Process., 24, DOI: 10.1002/hyp.7576, 2010.