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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Irrigation return flow causing a nitrate hot spot and denitrification imprints in groundwater at Tinwald, New Zealand" *by* Michael Kilgour Stewart and Philippa Lauren Aitchison-Earl

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Reply to Anonymous Referee #1 (R1)

R1: The paper considers the contribution by irrigation return flow to high nitrate concentrations in groundwater and points out how this contribution of nitrate needs to be incorporated into assessment of nitrate load limits. The authors also note the occurrence of denitrification processes in a group of wells as indicated by N and O isotopes even though the levels of DO in those wells are not particularly low (up to 4 mg N/ L).

This indicates that averaged DO concentrations may not exclude denitrification. The authors suggest denitrification may occur in localised areas with fine pores or reduced microsites even while average DO levels are higher than would be expected for denitrification to occur.

Authors: We thank Reviewer #1 for constructive evaluation of our work.

R1: Principal Criteria Scientific Significance: Good (2) The scientific significance is good – see summary above. There is a discrepancy presented regarding the likely source or location of the denitrification. In the abstract, discussion and conclusions it is suggested that the denitrification may occur in localised areas with fine pores or reduced micro-sites, whereas in the results section (line 272 – 274) it states that the denitrification occurred "most probably within the soil the nitrate was leached from."

Authors: An important point. Our initial conception was that such denitrification would have been within the soil before leaching to the groundwater, but further consideration and perusal of the literature suggested that denitrification can occur in fine pores or reduced micro-sites in the vadose zone – groundwater continuum. We will amend the text to be more consistent with the latter explanation.

R1: Scientific Quality: Good(2) Scientific method and approach are valid and are carried out well. The approach and conclusions could have been improved with the addition of excess N2 data as this would have confirmed denitrification along the flow and added to the conclusions.

Authors: We did not have excess N2 data, but agree this could have strengthened the evidence for denitrification.

R1: Presentation Quality: Excellent (1) The paper is written in a clear and readable fashion and is easy to follow. The number and quality of the figures and tables is good and adds to the presentation of information in the paper. Referee questions – all covered and good. Specifics The final paragraph in the discussion section (lines 451 –

454) makes an observation about a dual porosity system in the groundwater at Tinwald which is consistent with the proposed site(s) for denitrification. Dual porosity has been studied in these alluvial gravel aquifers by, for example, Dann et al. 2009 and similar papers, and this paper(s) could usefully be incorporated to provide more context and insight to the discussion.

Authors: We agree and will add this reference. We think more evidence is needed here.

R1: Probable typo – In line 163-164 it gives the precision for the isotope analyses "except for samples below 100 mg/L NO3-N." All samples are below this level so I suspect the units or number is incorrect.

Authors: Yes, the number should have been 0.1 mg/L (100 μg/L)

R1: Typos: line 505. Denitrification spelt wrong. Line 539. Canterbury spelt wrong Line 545 review spelt wrong.

Authors: These will be corrected.

Reference: Dann, R.L.; Close, M.E.; Flintoft, M.J.; Hector, R.; Barlow, H.; Thomas, S; Francis, G. (2009). Characterization and estimation of hydraulic properties in an alluvial gravel vadose zone. Vadose Zone Journal 8(3): 651-663.

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