

Interactive comment on “Submarine groundwater discharge to a small estuary estimated from radon and salinity measurements and a box model” by J. Crusius et al.

Anonymous Referee #1

Received and published: 22 February 2005

This manuscript reports the results of a steady state mass-balance box model used to quantify SGD into Salt Pond. The authors use a set of Rn and salinity measurements taken in a channel which is the only outlet/inlet of water to the pond other than the groundwater. The measurements are taken over a 4 day study in the summer. Results from this model are compared with seepage meter data and hydrological models. The paper is well written and provides useful data emphasizing the role of SGD to coastal nutrient balance. Although this is not the first paper published using Rn and salinity to estimate SGD or the first paper to report SGD rates for this area it is original in using these specific tracers in Salt Pond thus is worthy of publication in BG. There are however a few issues that should be clarified before publication and are listed below.

(1) In the introduction the authors indicate that hydrological models are problematic as

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they extrapolate over a large spatial scale while the seepage meters provide measures on short time scale and local spatial scale. Thus the advantage of using Rn is that it integrates over more appropriate space and time scales. After arguing this the authors compare the Rn-salinity model results to the seepage meters and hydrological models and use the general agreement to support their conclusions. I find this a bit circular. (2) More information about the hydrology should be given (recharge rate, seasonality in recharge and discharge, head etc.). (3) The box model and related assumptions should be included in the methods as this is an important and central part of the paper. The authors do a good job identifying the assumptions but should also discuss the errors that may arise from these assumptions. (4) I highly recommend reporting the Rn activity in units of dpm/L this is what is used in practically all other SGD papers and it would be nice to be consistent. I know this is a trivial conversion but it is useful. (5) If the conclusion is that only freshwater is being discharged why is there a need to define SGD in this paper as including re-circulated seawater? (6) Explain why salinity min and Rn max are lagging by almost 1 hour the low tide. (7) Discuss Ra results mentioned but not discussed was Ra measured in the pond (particularly short lived)? If so do flux calculations agree? Is the Ra in the GW consistent with only a fresh water component? (8) How representative is the Rn-nitrogen relation in GW? I would expect the Rn/N in GW to be quite variable? (9) Is it possible to explain why the results for the model using salinity and Rn do not fully agree and if not this should be discussed in the text. (10) What do the authors mean by Rn lost from saline GW by advection? This is not clear, how is would the Rn get lost and why? (11) Why are the results from August not reported here (these are mentioned)? It may strengthen the paper to include these data rather than write yet another paper representing 2 more days in the summer at the same site. (12) Was the salinity of the GW end member ever higher than a few units? Were Ra levels high in the GW sampled with the pizometers compared to the pond? (13) What is the assumption that GW is only discharging at low tide based on? Just the model fit? Can this be justified from the hydrology? Can a different combination of fluxes and Rn/salinity or a variable set of such parameters yield a fit to the model that

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can accommodate discharge at all times? This is particularly important to justify since the seepage meters recorded flux at all times. (14) Is the R_n in the incoming water from the marsh really constant? (15) Are fluctuations of 50% in GW R_n common? Could this variability be explained? (16) How good are the water exchange estimates through the channel based only on water level? This assumes the same flow rates in and out of the channel at high and low tide respectively. To get a good representation of the net R_n loss through the channel (which may be equated to the SGD R_n input) ADCPs or ADVs or some other current meters should be deployed in the channel along with the CTD.

A few other more specific issues are listed here:

Page 3 line 9 - “Ë.study the processes that transform elements in theË” The use of the word transform is not clearËIn what way are the elements “transformed” what are they transformed to? May be it is better to use “study of processes that affect element distribution and concentrations in GW”

Page 4 line 11 - Additional methods to identify the locations, and estimate the rates of discharge (not measure the locations and rates).

Page 10 line 21 - we can thus infer the GW flux to the pond from the measured net outflow of R_n from the channel (e.g. outflow minus inflow).

Interactive comment on Biogeosciences Discussions, 2, 1, 2005.

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