

## ***Interactive comment on “Analyses of uncertainties and scaling of groundwater level fluctuations” by X. Liang and Y.-K. Zhang***

### **Anonymous Referee #1**

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This paper deals with uncertainties in groundwater level in unconfined aquifers due to temporal variations of hydrological processes. It derives the head covariance function for 1-D transient flow in a bounded unconfined aquifer with random recharge as well as random initial and boundary conditions. Associated time-dependent spectral densities are also derived, allowing to investigate the existence of temporal scaling of groundwater level fluctuations. The topic of the note lies within the aims and scope of Hydrology and Earth System Sciences and is a valuable addition to the existing literature. The paper is well-written and concise, and deals with a topic of considerable interest. The mathematical derivations are accurate. Specific suggestions to improve the quality of the paper are listed below.

1. The authors should mention specific applications of their results to real cases, to

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help the paper convey a take-home message. 2. I suggest to add a schematic of the system investigated for the sake of clarity. This will help clarifying the meaning of the quantity  $M$ , defined at line 152 as the average saturated thickness of the aquifer. Since  $h$  is random,  $M$  should incorporate an element of randomness. 3. A key assumption in the analysis is that  $W(t)$ ,  $Q(t)$ , and  $H(t)$  are uncorrelated (see line 137). Given the geometrical setup, this assumption is not warranted. The paper could benefit from discussing this issue, and, specifically, realistic conditions for the validity of the assumption. 4. (a) Temporal scaling of groundwater level fluctuations is shown to exist at intermediate and late times, and to be dominated by the effect of random recharge as opposed to that of random boundary conditions. Why? Is this valid only for the specific parameters examined? (b) When spectra associated with one random effect at a time are examined, different scalings ( $1/f$ ,  $1/f^2$ ) are found. Why does this happen?

Minor points: 1. Check keywords. 2. Check line 75. 3. Check equation (12). 4. Check Line 173, 'is' is missing. 5. Line 175, in 'decay' a 's' is missing. 6. Line 204, check if 'the' is missing. 7. Line 223, check if 'on' is missing. 8. Check the sentence at lines 346-347.

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