

Interactive comment on ‘Observed groundwater temperature response to recent climate change’ by K. Menberg et al.

Review by Y. Fan

**Reply to comments:**

**Comment:** I find it interesting that the water table is deeper at Dansweiler and Sinthern (~17m), at a lower elevation of ~61m, than the Hardtwald wells (water table ~6m), although at a much higher elevation of ~121m. The two sites are not too far apart, and unless the underlying geology and hydrogeology (sources/sinks) make them entirely separate flow systems, one would expect that the water table is shallower in the lower part of the landscape. Perhaps the authors could discuss the hydrogeological system in more details and provide insights on this.

**Reply:** The two study sites close to Karlsruhe and Cologne are approx. 240 km apart from each other and belong to different aquifer systems, which cannot be seen from Figure 1. The description of the hydrogeological settings will be extended accordingly to clarify this issue.

**Comment:** Equation-1. The bulk thermal diffusivity is missing.

**Reply:** Correct. In the submitted version of the manuscript the bulk thermal diffusivity was indeed missing. This error was corrected during type-setting and in the online HESSD version of the manuscript Equation 1 is displayed correctly including the thermal diffusivity.

**Comment:** Equation-2. Perhaps the authors should mention that the Darcy velocity  $q$  in the convective term is related to water table recharge rate.

**Reply:** We agree. A statement that the  $q$  term (Darcy velocity) is taken as the recharge rate will be included in the manuscript below Equation 2.

**Comment:** Page-11, line 33. Remove one of the “in”.

**Reply:** The second ‘in’ will be removed.

**Comment:** Page-12, line 21-24. I tend to think that GWT change should be more as a trend than as steps, because of its delay and dampening of atmospheric signals, which smooth out the sharp rises (and falls) of the surface forcing. So a more fundamental explanation is

perhaps not the short regime, but the nature of groundwater response. This bears out in the p values anyway, as the last sentence of the paragraph suggested.

**Reply:** We agree that the general diffusive nature of the subsurface thermal signal in comparison to the air or surface thermal signals should be discussed more prominently in this section. We will rephrase the paragraph accordingly, not only noting possible methodological reasons for this significant trend here, but also mentioning the generally more gradual behavior of the GWT regimes.

**Comment:** Page-14, line 18 and onward. Maybe replace the word “annual” to “inter-annual” to avoid confusion with “annual cycle” which refers to seasonal cycle within a year, not between years as is the case here? There are more of this word later, e.g., page-16, line-11.

**Reply:** We agree. The word ‘annual’ may indeed be misleading in this context, as we refer to the variations in the annual values. Consequently, the respective words will be changed into ‘inter-annual’.