

Referee Comments 3 (Anonymous Referee):

The paper by Gabriel C. Rau et al. with title: “Technical Note: Disentangling the groundwater response to Earth and atmospheric tides to improve subsurface characterization” presents an interesting study regarding the method to deal with the groundwater response to Earth and atmospheric tides. It seems to me that the approach for estimating barometric efficiency (BE) proposed in the manuscript is of particularly novelty. The study is well done and publication is recommended after the following concerns are addressed (moderate revision).

Many thanks for this positive review.

Major comments:

1. Page 4. Paragraph 4: Equation about the complex response to atmospheric tides alone shows some difference with that of Acworth et al., 2016. Phase shift between the Earth tide and barometric pressure was considered in Acworth et al., 2016. Why authors simplified this term? Please say something about this.

We did not simplify this term in Acworth et al. (2016). At that time, we were not aware that there are more complicating factors to be considered when disentangling tidal influences. This awareness first came when analysing datasets with a strong Earth tide component and obtaining erroneous BE results when using our original method. We will add some clarifications to the revised manuscript.

2. Page 7. Paragraph 1: “In such cases, the concept of BE is no longer valid.” The initial concept proposed by Jacob (1940) was that a change in groundwater head measured in a piezometer was directly proportional to the change in barometric pressure. BE value ranges from 0 to 1. BE=0 for an unconfined aquifer and BE=1 for an extreme ideal confined aquifer. Semi-confined conditions maybe belong to between such two extreme situations (e.g., a confined aquifer with a weakly permeable upper confining bed overlain by an unconfined aquifer). Why did authors consider it should be no longer valid in semi-confined conditions? Authors may wish to put some constraints or limitations.

May we point out that the relationship between BE and confinement is a misconception that often appears in the literature. The concept of BE quantifies the relative sharing of stress between liquid in the pores and the solid matrix which, by definition, only exists for semi- to confined conditions. It is important to note that the value of BE is not indicative of confinement. For example, a clay system can have BE~0 (because clay is highly compressible) and still be fully confined. This is further explained in Turnadge et al. (2019) which is cited in the manuscript. To make this crystal clear, we will add some more clarifications to the manuscript during the revisions.

3. Figure 3b and Figure 4: These two figures show some similarities. You may consider merging Figure 3b into Figure 4 and show more components in Figure 4.

We considered this in the original submission but decided against it for two reasons: (a) Figure 4 visualises the core of disentanglement (a very important but non-intuitive methodology) based solely on the components M2 and S2, (b) any other components are not involved, adding them will distract from the clear message and overcrowd this figure (i.e., make it much harder to understand the disentanglement). In the interest of showing all components we decided to add Figure 3b. In the interest of clearly and simply explaining the core method we decided to single out the relevant components in Figure 4. We wish to retain this communication strategy.

Minor comments:

1. Page 4. Paragraph 3: “The groundwater response to Earth tides only, for example at frequency M2, is assumed to be the same because the frequency is very close.” Did you mean that M2 is assumed to be the same with S2? Please make it clearly.

We meant that the water level response to pore pressure at M2 and S2 should be the same because both frequencies are so close together. We will clarify this in our revisions.

2. Page 5 around Paragraph 2: “ $K=5 \cdot 10^{-5}$ m/s” K should be changed as K’.

Thanks, we will make this change.

3. Page 5 Figure 1 highlights: “Figure ??” should be changed as Figure 1.

We will correct this mistake.

4. Equation (7) and Equation (10): A_c indicates the amplitude of pressure relationship between subsurface and well water level in Equation (7), however, in Equation (10) A_c indicates the amplitude of the well water level to an ET component. So, they are different in the physical aspect. It is easy to cause confusion if using the same symbol. Please replace one of them.

This is a mistake that we will rectify during the revisions.

5. Page 7. last paragraph: Please add the value of the sampling frequency in this paragraph.

We will add this information during the revisions.

6. Page 8. last sentence in the last paragraph: Where is the Earth tide component M1? Please check it.

Thanks for spotting this mistake! We will carefully revise the figure to show all components.

7. Figure 3: Please make the label clearly in your Figure and avoid overlap of the label.

We will fix overlapping labels in the revised figure.

8. Figure 3: The abbreviation of APES should be explained in the text or in the caption of the figure.

In the meantime, we have renamed this method to harmonic least-squares (HALS) and will revise and explain this abbreviation appropriately.