

## ***Interactive comment on “A framework for deriving drought indicators from GRACE” by Helena Gerdener et al.***

### **Anonymous Referee #1**

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The authors developed a framework for deriving synthetic terrestrial water storage change (TWSC) from the GRACE observations for computing drought indicators. The synthetic TWSC enables comparisons of existing drought indicator methods and analyses of the influence of GRACE trend and noise on the drought detection. I think that the topic is important for further understanding of hydrological drought and the findings are valuable, shedding lights to characteristics of different drought identification methods. The manuscript is fairly well written; however, I have some concerns and need some clarifications. Thus, I recommend major revision and the specific comments are listed below.

1. The authors chose three existing indicators of Zhao et al (2017), Houborg et al (2012), and Thomas et al (2014) methods because they are based on the monthly

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GRACE data. The comparison of the methods is interesting, but I don't think this framework is a fair ground for evaluating their skills, especially for the Houborg-method. As I understand it, the CDF (which is the basis for the percentile computation) is based on the historical simulation of 1948-2010. This analysis focuses on the GRACE period of 2002-2016 and it mentions about disregarding the bias correction. Also for Zhao-method, a bias correction is not applied. I understand that direct comparison of these indicators are not possible as Houborg is regional, but the indicators in their final product form (as opposed to the method concepts) may be able to detect the drought that were missed in this study. 2. Is the GRACE-specific noise dependent on the instrument or the solution? As it is an important term and needs to be characterized well, I am wondering if it would be different when using different GRACE-TWSC solutions such as mascon solutions from JPL or CSR. Is the same approach (equation 21) applicable to other GRACE data? What is the grid size of the TU GRAZ data (0.5 degree)? 3. [Page4;Ln9-18] The equations 1-3 are not referred later in the text. I agree that TWSC corresponds to precipitation anomaly accumulation in many cases, but it does not seem to tie in with the rest of the discussions. 4. [Page9; Ln5-7] Identifying regional clusters seems very important and I wonder where else clusters are located. 5. [Page9; Ln16-17] It would be helpful to present the list of droughts included in step 3, in a table or supplement. 6. [Page10,Ln20] It was not clear to me if the study addressed the last point of this framework's benefit "...identify the most suitable indicator for a specific application". 7. [Figure 5] I understand that the purpose of this figure is to show the importance of spatial GRACE noise, especially in SA. However, the TWSC time series for EB and WI have low TWSC amplitudes that are equally as low as that of during the simulated drought period in later 2016 (EB) and 2003/2004 (WI). Can you add an explanation to what distinguishes 2005 from these low TWSC? 8. [Section 4.4] I am a bit confused how Figure 11 using real GRACE data is very different from the corresponding figure 10 center, right using the synthetic TWSC. Related to point 5 above, the synthetic data can detect only 2005 drought by design? 9. [Page21; Ln20] It is not clear what "simplified noise models" mean. Please elaborate. 10. [Page22; Ln10-11] I

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do not follow “when we did not simulate a trend”. When did you? 11. [Page23; Ln10] It will be helpful to name the four new indicators (or refer to equations).

Minor edits: [Equation 19] dot typo? [Table 3] What are the two values for Annual and Semi-annual? [Page14;Ln16] DSID appears twice. [Page15;Ln1] This sentence is incomplete. [Figure 6] DSI appears as black line in the plots while legend for DSI is blue. [Page21;Ln7] GRACE and the DSIA6 -> GRACE DSIA6?

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