

## ***Interactive comment on “Identifying water deficit and vegetation response during the 2009/10 drought over North China: Implications for the South-to-North Water Diversion project” by B. Zhu et al.***

### **Anonymous Referee #1**

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General Comments: This manuscript aims to identifying the water deficit under an extreme drought in North China by using the GRACE data, and comparing with the response of vegetation, towards the implications for the well-known South-to-North Water Diversion (SNWD) project. It is not new to investigating the GRACE-derived water storage changes under droughts. As the author mentioned that several previous studies have done this with varying focuses, but it remains very interesting in the North China, where the water shortage is aimed to be mitigated by the SNWD. Besides, due to the differences on the drought characteristics such as duration and severity, the detection and variation of GRACE-derived water storage changes may vary from place

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to place. Thus, this manuscript addressed a good scientific question and may attract interests from the community of hydrology, geodesy, and even the public people. To achieve above purposes, the study derived the total water storage anomalies (TWSA) and groundwater storage anomalies (GWSA) from GRACE time-variable gravity data, and compared it with model simulations and LAI. The method used in this study is generally appropriate and the result is reliable. However, some efforts may still be needed to improve the quality of this manuscript and make it easier to be understood.

Major Comments: [1]Section 2.3.2, Evaluation of GRACE TWSC: This manuscript compares the so called net recharge (this name is confusing, actually it is commonly written as  $dS/dt$  or TWSC in many papers) derived from GRACE and land surface models. It should be noticed that in Equation (2), the runoff should be the net runoff (i.e. outflow minus inflow). Since the North China is a self-defined region with a shape of rectangle, it is definitely not a closed basin. How is the net runoff calculated? Please give more explanations. Instead of the net recharge, there is another way for evaluation, i.e. using the observations of groundwater storage (GWSA) and surface water storage (SWSA), and model simulations of the soil moisture storage (SMSA), with the equation:  $TWSA = GWSA + SWSA + SMSA$ . [2]Section 4.2, Vegetation response: More deep analysis is needed to figure out the vegetation response under the drought. For example, can the monthly LAI help to interpret the response while compared with the monthly TWSA?

Minor Comments: [1]Line 22: should be : is one of the most damaging. . . [2]Line 27: ‘quality data sets’ is confusing [3]Line 111: please point out the GRACE data used is Level-2 or Level-3 [4]Line 120: ‘total water’ should be ‘total water storage’ [5]Line 121: ‘groundwater water change’ should be ‘groundwater storage change’ [6]Line 159: ‘groundwater table’ is better to be replaced with ‘groundwater level’ [7]Line 199: ‘to detect groundwater’ should be ‘to detect groundwater storage’ [8]Line 204: ‘groundwater level measured in situ’ should be ‘in situ measured groundwater level’ [9]Line 209: the symbol of  $G S M C W$  is not typically used in the GRACE hydrology community, I

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suggest to using  $GWSA = TWSA - SMSA - SWSA - CWSA$  [10]Line 222: what is precipitation deficit? I can not understand how is the 14 mm and 47 mm derived. [11]Line 253: 'fluctuations' better to be replaced with 'amplitude' [12]Line 261: 'departure' is not easy to understand, usually we use 'anomaly' or 'difference' [13]Line 262: it is hard to say the drought events mainly occur in the south of North China, as the groundwater exploitation is complicated in space. [14]Line 264: 'normal' or 'average'? [15]Line 275: 'public supply' should be 'domestic use' [16]Line 283: 'downward' should be 'decreasing' [17]Line 287: delete 'approximately', same in many other places throughout the manuscript [18]Line 311: 'groundwater decline' should be 'groundwater level decline' [19]Line 352-354: references are not commonly found in the conclusion section [20]Figure 1: the year for annual precipitation, long-term mean or some specific year? [21]Figure 1: 'Groundwater Gauge Stations' should be 'Groundwater Level Monitoring Wells' [22]Figure 2(b): do not use abbreviation for the name of y-axis [23]Figure 2(a): what is the time for annual average, 53-year mean? [24]Figure 3(b): No name for the x-axis in the small figure inside. The green histogram and red dots seems represent the same thing. If not, please give more explanation. [25]Figure 5: What is the meaning of '/' in 'May/June 2009' and the others? Is it the average TWSA of May and June 2009? Please make it clearer. [26]Figure 7: The name of the right y-axis should be 'Equivalent Water Height (mm)'

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