Dear editors & reviewers,

Thanks for your efforts and advices. We have substantially revised our manuscript after reading the comments provided by the two reviewers.

All the revisions are firstly traced based on page and line in original submission NHESS Discussion Documentary (referred as NHESSD in following context). Places with revision are marked on both revised manuscript and NHESSD.

Answers to reviewers:

Reviewer #1:

1) **NHESSD, Pg. 3252. Line 26. Precipitation is not a component of TWS.**

Answer:

This is our mistake. Precipitation is not a component of TWS. It is one part in the water balance which determines final TWS changes.

NHESSD, Pg. 3252. Line 26. ‘these technologies primarily provide only variation information for single components in TWS, such as …’

In new manuscript Pg. 2. Line 3-4.

Corrected as ‘these technologies primarily provide only variation information for single factor related to TWS, such as …’

2) **NHESSD, Pg. 3253. Line 1. Should be groundwater level.**

Answer:

Here we misused ‘water level’ and we originally mean ‘river/lake level’, as we mentioned altimetry at the beginning of the sentence.

NHESSD, Pg. 3253. Line 1. ‘… snow cover, and water level.’

In new manuscript Pg. 2. Line 5.

Corrected as ‘… snow cover, and river/lake level.’

3) **NHESSD, Pg. 3256. Line 6. Gobi cannot be a land cover type.**

Answer:

Thanks for pointing out the mistake. Gobi is Mongolian word for ‘desert’. Desert is the land cover type.

NHESSD, Pg. 3256. Line 6. ’ Desert and Gobi are dominant land covers in northwestern China,’

In new manuscript Pg. 5. Line 1-2.

Corrected as ‘Desert is the dominant land cover in northwestern China,’

4) **NHESSD, Pg. 3257. Line 10. In Equations (1) what is i and j? This needs to be clearly stated in the text**

Answer:

We clarified the meanings of i and j in Equation (1) in manuscript.

NHESSD, Pg. 3257. Line 4. ‘which is set to 300 for measurement error and 100 for leakage error’
In new manuscript Pg. 5. Line 27-29.
Corrected as ‘which is set to 300 for measurement error and 100 for leakage error, number i and j mean the value in the i*th* column and j*th* row of the grid data.’

5) NHESSD, Pg. 3257. Line 11. It is not clear what is the difference between Errorregion and Errortotal ? Clear explanation is required in the text.

Answer:

We made adjustment in the manuscript and added explanation to $\mathrm{Error}_{\mathrm{region}}$ and $\mathrm{Error}_{\mathrm{total}}$.

NHESSD, Pg. 3256. Line 27 to Pg. 3257. Line 4:
‘Because of spatial correlation among neighboring grids, covariance was considered in the calculation (Landerer et al., 2012).The dist in Eq. (1) is the geometric distance between any two grids in the basin (unit: km), n is the number of valid grids in a specific basin, β is the de-correlation length, which is set to 300 for measurement error and 100 for leakage error.’
In new manuscript, Pg. 5. Line 23-30.
The above text was revised as:
‘Because of spatial correlation among neighboring grids, covariance was considered in the calculation of regional scale error $\mathrm{Error}_{\mathrm{region}}$ (Landerer et al., 2012; Eq. (1)). The dist in Eq. (1) is the geometric distance between any two grids in the basin (unit: km), n is the number of valid grids in a specific basin, β is the de-correlation length, which is set to 300 for measurement error and 100 for leakage error, number i and j mean the value in the i*th* column and j*th* row of the grid data. And the regional scale total error $\mathrm{Error}_{\mathrm{total}}$ included both regional scale measurement error $\mathrm{Error}_{\mathrm{measure}}$ and regional scale leakage error $\mathrm{Error}_{\mathrm{leakage}}$(Eq. (2)).’

6) NHESSD, Pg. 3260. The entire paragraph starting from line no. 9 till 19 has to be rewritten. The text here is very confusing and it is not clear what the authors are trying to convey.

Answer:

We rewrote the paragraph as required.

NHESSD, Pg. 3260. The entire paragraph starting from line 9 till 19:
‘In Fig. 2, spatial difference in the RMS of TWS from scaled GRACE data have been expanded from approximately 6 cm to approximately 12 cm, and the highly left-skewed empirical PDF curve is quite similar to those from the model simulations with for the RMS of the TWS from the unscaled GRACE data, the empirical PDF curve has a different relative peak position around with RMS value of 3 cm. The right boundary of RMS represents a strong TWS amplitude in space, and they are distinct among TWS model estimates’ and GRACE observations because differences in the model mechanisms are amplified in TWS active regions. The TWS from the scaled GRACE data, the MOSAIC, VIC, CLM and GLDAS ensemble mean all have a left boundary of RMS close to 0 cm. Spatially, this corresponds to northwest China, which is an arid climate zone with vast deserts (Figs. 1, 3b and c).’
In new manuscript Pg. 8 Line 16-27. It was rewritten as:
‘The RMS value of TWS time series in a specific grid is an indicator for the amplitude of local

TWS. And the empirical probability density distribution (empirical PDF) curve for RMS values in research region described the statistical distribution of TWS amplitude within the area. In Fig.2, empirical PDF curves based on TWS data from modeled TWS data (MOSAIC, VIC, CLM, NOAH and GLDAS ensemble mean) and observation TWS data (scaled and unscaled GRACE data) were compared. Empirical PDF curves based on scaled GRACE data and modeled data (except CLM) all showed larger RMS value range in x-axis than that based on unscaled GRACE data. This means the range of TWS amplitude within research area has been stretched after scaling. In addition, empirical PDF curves based on scaled GRACE data and most modeled data showed RMS values concentrated in the relative low numerical zone, with lowest values close to 0 cm. Spatially, areas with low RMS values corresponds to northwest China, which is an arid climate zone with vast deserts (Figs. 1, 3b and c).'

7) **NHESSD, The statement made on Pg. 3262 line no. 24, (i.e. "Disagreement between. . .. . .. in this basin) is not supported by the results and the conclusion seems to be far fetched.**

Answer:

The original statement 'Disagreement between GRACE TWS, the TWS estimates and water resources records also revealed that there was an impact of human activities on the TWS variations in this basin.' is too brief.

According to Figs. 4, 5, 6, in Yellow River Basin, there are different changing processes between the GRACE TWS, gross water resource and precipitation. In research period, GRACE TWS was generally decreasing. Meanwhile, gross water resource and precipitation showed v-shaped processes (decreased at first and then kept increasing). However, Fig. 7 showed that areas with large decreasing trends mainly located in midstream of yellow river basin, Shanxi and Shaanxi provinces, places famous for coal mining. But we still don't have enough data to identify the causes for the decreasing of TWS.

NHESSD, The statement made on Pg. 3262. Line 24-26,

'… after 2007.Disagreement between GRACE TWS, the TWS estimates and water resources records also revealed that there was an impact of human activities on the TWS variations in this basin'

In new manuscript Pg. 10. Line 22-27.

It was revised as:

… after 2007. The basin averaged TWS, gross water resource and precipitation also showed different processes in the latter half of research period. But Fig.7 revealed that areas with large long term decreasing trends mainly located in midstream of Yellow River basin(Shanxi and Shaanxi Provinces), where is famous for coal mining. To identify the exact causes for decreasing TWS, more local statistical data and groundwater level records should be collected.'

8) **NHESSD, Pg. 3263. Line 25. - Pg. 3264. Line 4. The first paragraph of Section 3.3 is mostly one single sentence. Such long sentences are confusing and should be avoided.**

Answer:

Thanks for this suggestion. We rewrote this paragraph.

NHESSD, Pg. 3263. Line 25. - Pg. 3264. Line 4.

‘At a large scale, spatial patterns of linear trends calculated from scaled and unscaled GRACE TWS are consistent (Fig. 7a and c), but there are also some discrepancies at the small spatial scale and the former one seems to better correspond to natural features of the TWS intensity distribution, such as the absolute values of trends are usually larger around river networks. From 2003 to 2013, four main regions were identified with intensive and significant long-term trends in TWS, and their performances were different in different seasons (Fig. 8).’

In the manuscript, Pg. 11. Line 22-28.

Revised as:

‘When focusing on differences between large regions, spatial patterns of linear trends calculated from scaled and unscaled GRACE TWS are consistent (Figs. 7a and c). But at local scale, results from scaled GRACE TWS are better corresponding to natural features of the TWS intensity distribution. Areas around river networks usually have large quantity of TWS, thus present big absolute values of trends. From 2003 to 2013, four main regions were identified with intensive and significant long-term trends in TWS. Results also revealed that seasons in a year made different contributions to these trends (Fig. 8).’

9) NHESSD, Pg. 3264. Line 14. The sentence “. . ... where is intensively equipped with irrigation. . ..” Does not make any sense. Please rewrite.

Answer:

We rewrote the sentence as required.

NHESSD, Pg. 3264. Line 14.:

‘The groundwater is a major source to water consumptions in Huang-Huai-Hai plain, where is intensively equipped with irrigation facility to withdraw freshwater from deep wells (Foster et al.,2004; Kendy et al., 2004).’

In the new manuscript, Pg. 12. Line 6-8

Revised as:

‘The groundwater is a major source to water consumptions in Huang-Huai-Hai plain, agricultural irrigation consumed large amounts of freshwater pumped from deep wells every year (Foster et al., 2004, Kendy et al., 2004).’

10) NHESSD, Pg. 3266. Line 9-11: A very confusing closing statement. Unfortunately there are many like this and has to be meticulously corrected.

Answer:

We check the NHESSD for similar problems and revised them in new manuscript.

(1) NHESSD, Pg. 3261. Line 5-7:

‘Generally, basins with large areas are less affected by leakage errors and have slopes close to 1, but geographical location and hydrological cycle characteristics will contribute to this effect, as well.’

In the manuscript, Pg. 9. Line 11-13.

was revised as ‘Generally, basins with large areas are less affected by leakage errors and have slopes close to 1.'

(2)NHESSD, Pg. 3261. Line 18-20:
'This process may be controlled by changes in some large-scale climate processes, which need to be further analyzed in the future.'
In the manuscript, Pg. 9, Line 23-25. This sentence was deleted.

(3)NHESSD, Pg. 3262. Line 1-2:
'Reservoir regulations may be one of the factors that alter the TWS signal.'
In the manuscript, Pg. 10. Line 2. This sentence was deleted.

(4)NHESSD, Pg. 3264. Line 4-6:
'According to the analysis in previous section, we inferred that human activities rather than climate parameters are responsible for the significant TWS depletion in North China,'
In the manuscript, Pg. 11. Line 29-30.
revised as:
'According to the analysis in previous section, we inferred that human activities rather than climate parameters could be responsible for the significant TWS depletion in North China,'

(5)NHESSD, Pg. 3266. Line 9-11:
'Thus, more data needs to be added to further quantify and verify the extent of identified TWS change at small scale in the future research'
In the new manuscript, Pg. 13. Line 25-26. This sentence was deleted.

11) NHESSD, Pg. 3267. Line 1-4. In the Summary and Conclusion section the statement of attributing the TWS trends in certain basins to the overexploitation of deep aquifers is an assumption that is not supported by the results presented here.
Answer:
We noticed this problem. We decided to just focus on what we really found in analyses.

NHESSD, Pg. 3267. Line 1-4.
'The TWS variations generally followed the variations in annual precipitation, but depletion in deep aquifers caused by overexploitation played a significant role in these trends until 2012 in the Hai River basin and Yellow River basin.'
In the new manuscript, Pg. 14. Line 11-13.
Revised as:
'The TWS variations generally followed the variations in annual precipitation at basin scale, but they showed inverse changes in 2007-2013 in both Hai River basin and Yellow River basin.'

Reviewer #2:
1) Reevaluate precision and number of significant figures throughout. Are these really realistic, and being applied in the same manner throughout?
Answer:
We checked original GRACE Tellus TWS Dataset, the unit for TWS is cm and grid values offer

three significant figures after the decimal point. Thus, we chose to keep all the calculated numbers with two significant figures after the decimal point.

Detailed changes are list as follows:

(1)NHESSD, Pg. 3252. Line 6-9:

'TWS generally followed variations in annual precipitation, it decreased linearly in Huai River basin (−0.564 cm yr^{-1}) and increased with fluctuations in Changjiang River basin (0.348 cm yr^{-1}), Zhujiang basin (0.552 cm yr^{-1}) and Southeast Rivers basin (0.696 cm yr^{-1}).'

In the new manuscript, Pg. 1. Line 14-17.

Revised as:

TWS generally followed variations in annual precipitation, it decreased linearly in Huai River basin (−0.56 cm yr^{-1}) and increased with fluctuations in Changjiang River basin (0.35 cm yr^{-1}), Zhujiang basin (0.55 cm yr^{-1}) and Southeast Rivers basin (0.70 cm yr^{-1}).

(2) NHESSD, Pg. 3262. Line 11-13:

'Moreover, detection depth of GRACE is much deeper than the layers considered in models (1.9 m in VIC, 2.0 m in NOAH, 3.5 m in Mosaic and 3.43 m in CLM) …'

In the new manuscript, Pg. 10. Line 11-13.

Revised as:

''Moreover, detection depth of GRACE is much deeper than the layers considered in models (1.90 m in VIC, 2.00 m in NOAH, 3.50 m in Mosaic and 3.43 m in CLM) …'

(3) NHESSD, Pg. 3262. Line 23:

'… and it changed more slowly (−0.132 cm yr^{-1}) after 2007.'

In the new manuscript, Pg. 10. Line 22.

Revised as:

'… and it changed more slowly (−0.13 cm yr^{-1}) after 2007.'

(4) NHESSD, Pg. 3262. Line 27:

'… showed a long-term descending trend (−0.564 cm yr^{-1}),'

In the new manuscript, Pg. 10. Line 28.

Revised as:

'… showed a long-term descending trend (−0.56 cm yr^{-1}),'

(5) NHESSD, Pg. 3263. Line 4-5:

'… all followed an increasing trend from 2003 to 2013, at 0.348, 0.552 and 0.696 cm yr^{-1}, respectively.'

In the new manuscript, Pg. 11 Line 2.

Revised as:

'… all followed an increasing trend from 2003 to 2013, at 0.35, 0.55 and 0.70 cm yr^{-1}, respectively.'

(6) NHESSD, Pg. 3263. Line 11-12:

'The percentage of TWSC variance explained by SMC could be as high as 61.7 % at the national scale'

In the new manuscript, Pg. 11. Line 9.

Revised as:

'The percentage of TWSC variance explained by SMC could be as high as 62 % at the national scale'

(7) NHESSD, Pg. 3263. Line 13-14:

'… with high percentages in Changjiang basin and Zhujiang basin (63.9 and 67.1 %).'

In the new manuscript, Pg. 11. Line 10-11.

Revised as:

'… with high percentages in Changjiang basin and Zhujiang basin (64 and 67 %).'

(8) NHESSD, Pg. 3263. Line 17-18:

'… precipitation, evapotranspiration and runoff each contributed 45.7, 40.8 and 32.1%, respectively,'

In the new manuscript, Pg. 11. Line 14-15.

Revised as:

'… precipitation, evapotranspiration and runoff each contributed 46, 41 and 32%, respectively,

(9) NHESSD, Pg. 3263. Line 22-23:

'… with the highest explained variance in Zhujiang basin (59.9 %), followed by 43.6 % in Changjiang basin.'

In the new manuscript, Pg. 11. Line 19-20.

Revised as:

'… with the highest explained variance in Zhujiang basin (60 %), followed by 44 % in Changjiang basin.'

(10) NHESSD, Pg. 3264. Line 8:

'…with decreasing trends less than -0.8 cm yr^{-1}'

In the new manuscript, Pg. 12. Line 1-2.

Revised as:

'…with decreasing trends less than -0.80 cm yr^{-1}'

(11) NHESSD, Pg. 3265. Line 8:

'… precipitation is the main recharge source to runoff, with a ratio of 63.15 %.'

In the new manuscript, Pg. 13. Line 3.

Revised as:

'… precipitation is the main recharge source to runoff, with a ratio of 63 %.'

(12) NHESSD, Pg. 3266. Line 20-22:

'These increase percentages reached up to over 50 % in Huai River basin (57.2 %) and Zhujiang basin (53.6 %), but were tiny for basins with larger sizes, such as Liao River basin (9.5 %) and Yellow River basin (8 %).'

In the new manuscript, Pg. 14. Line 3-6.

Revised as:

‘These increase percentages reached up to over 50 % in Huai River basin (57 %) and Zhujiang basin (54 %), but were tiny for basins with larger sizes, such as Liao River basin (10 %) and Yellow River basin (8 %).’

(13) NHESSD, Pg. 3267 Line 5-7:

‘(3)Changes in soil moisture storage contributed 61.7% of the TWSC variance at the national scale, and the percentages were generally beyond 50% in all basins with exceptions in Heilongjiang River basin (38%) and Yellow River basin (46.3%). Under the control of the monsoon climate, precipitation and runoff explained more variance in TWSC than evapotranspiration did, and precipitation’s ability to explain TWSC variations was stronger in the south basins than in the north, reaching up to 59.9% in Zhujiang basin.’

In the new manuscript, Pg. 14. Line 14-19.

Revised as:

‘‘(3)Changes in soil moisture storage contributed 62% of the TWSC variance at the national scale, and the percentages were generally beyond 50% in all basins with exceptions in Heilongjiang River basin (38%) and Yellow River basin (46%). Under the control of the monsoon climate, precipitation and runoff explained more variance in TWSC than evapotranspiration did, and precipitation’s ability to explain TWSC variations was stronger in the south basins than in the north, reaching up to 60% in Zhujiang basin.’

’

(14) NHESSD, Pg. 3276:

Table 3 Error statistics of regionally averaged TWS (unit: cm)

Regions	Areas(km^2)	Measurement Error	Leakage Error	Total Error	Bias for GLDAS
China	9,510,610	0.380	0.312	0.537	0.629
Changjiang	1,815,855	0.900	0.793	1.273	1.470
Heilongjiang	956,832	0.980	0.719	1.386	1.095
Yellow River	860,883	0.776	0.733	1.097	0.720
Zhujiang	463,050	1.861	1.621	2.632	3.347
Hai River	327,096	1.301	1.364	1.840	1.591
Liao river	310,881	1.132	0.984	1.601	1.605
Huai River	288,152	1.742	1.535	2.463	3.514
Southeast Rivers	242,524	1.440	1.287	2.037	3.692

In new manuscript Pg.25

Revised as:

Table 4 Error statistics of regionally averaged TWS (unit: cm)

Regions	Areas(km^2)	Measurement Error	Leakage Error	Total Error	Bias for GLDAS
China	9,510,610	0.38	0.31	0.54	0.63
Changjiang	1,815,855	0.90	0.79	1.27	1.47
Heilongjiang	956,832	0.98	0.72	1.39	1.10
Yellow River	860,883	0.78	0.73	1.10	0.72
Zhujiang	463,050	1.86	1.62	2.63	3.35
Hai River	327,096	1.30	1.36	1.84	1.59
Liao river	310,881	1.13	0.98	1.60	1.61
Huai River	288,152	1.74	1.54	2.46	3.51
Southeast Rivers	242,524	1.44	1.29	2.04	3.69

(15) NHESSD, Pg. 3277 Table 4:

Table 4 Slopes of the fitting for the basin-averaged TWS from the scaled and the unscaled GRACE data

Region	HLJ	LR	HaiR	HuaiR	YR	CJ	ZJ	SERs	CHN
factor	1.256	1.095	1.315	1.572	1.080	1.338	1.536	1.107	1.188
R^2	0.996	0.989	0.988	0.994	0.982	0.992	0.996	0.991	0.982

In new manuscript Pg.26

Revised as:

Table 5 Slopes of the fitting for the basin-averaged TWS from the scaled and the unscaled GRACE data

Region	HLJ	LR	HaiR	HuaiR	YR	CJ	ZJ	SERs	CHN
factor	1.26	1.10	1.32	1.57	1.08	1.34	1.54	1.11	1.19
R^2	0.996	0.989	0.988	0.994	0.982	0.992	0.996	0.991	0.982

(16) NHESSD, Pg. 3278 Table 5:

Table 5 Coefficient of determination R^2 between precipitation (P), evapotranspiration (E), runoff (Q), soil moisture change (SMC) from GLDAS ensemble mean and TWSC from the scaled GRACE data in 2003-2013

	HLJ	LR	HaiR	HuaiR	YR	CJ	ZJ	SERs	CHN
P	0.039	0.195	0.180	0.347	0.408	0.436	0.599	0.225	0.457
E	0.001	0.082	0.102	0.089	0.281	0.245	0.301	0.000	0.321
Q	0.082	0.263	0.291	0.310	0.384	0.466	0.504	0.181	0.408
SMC	0.380	0.522	0.527	0.571	0.463	0.639	0.671	0.508	0.671

In new manuscript Pg.27

Revised as:

Table 6 Coefficient of determination R^2 between precipitation (P), evapotranspiration (E), runoff (Q), soil moisture change (SMC) from GLDAS ensemble mean and TWSC from the scaled GRACE data in 2003-2013

	HLJ	LR	HaiR	HuaiR	YR	CJ	ZJ	SERs	CHN
P	0.04	0.20	0.18	0.35	0.41	0.44	0.60	0.23	0.46
E	0.00	0.08	0.10	0.09	0.28	0.25	0.30	0.00	0.32
Q	0.08	0.26	0.291	0.31	0.38	0.47	0.50	0.18	0.41
SMC	0.38	0.52	0.527	0.57	0.46	0.64	0.67	0.51	0.67

2) Please provide some measure of uncertainty (and explain what that uncertainty is) to the values given.

Answer:

Uncertainty of GRACE TWS (total error) mainly comes from measurement error and leakage error, the latter one was caused by data noise filting process. These two error fields had already been offered along with the GRACE TELLUS TWS dataset. We further calculated the total error for basin averaged GRACE TWS.

For the estimated TWS from GLDAS model assemble mean, since uncertainty for specific model is unknown, we simply take the standard deviation relative to multi-model assemble mean as the estimate of models' uncertainty (referred as bias for GLDAS in this paper).

Detailed values have been listed in NHESSD, Pg. 3276. Table 3. (Table 4 in the new manuscript, Pg 25.)

Regions	Areas(km^2)	Measurement Error	Leakage Error	Total Error	Bias for GLDAS
China	9,510,610	0.38	0.31	0.54	0.63
Changjiang	1,815,855	0.90	0.79	1.27	1.47
Heilongjiang	956,832	0.98	0.72	1.39	1.10
Yellow River	860,883	0.78	0.73	1.10	0.72
Zhujiang	463,050	1.86	1.62	2.63	3.35
Hai River	327,096	1.30	1.36	1.84	1.59
Liao river	310,881	1.13	0.98	1.60	1.61
Huai River	288,152	1.74	1.54	2.46	3.51
Southeast Rivers	242,524	1.44	1.29	2.04	3.69

3) Bring in more of a context of why this pertains to natural hazards, in the introduction, and then various places throughout the manuscript.

Answer:

We emphasized TWS's role in disaster monitoring and assessment in introduction. The main influence of nature disaster is reflect in the annual variations of basin scale TWS. Detailed analysis on TWS anomaly (drought or flood) is mainly included in another manuscript under preparation, thus we can't put too much content in this paper.

NHESSD, Pg. 3253. Line 7-10:

'At global, regional or basin scale, GRACE data have been applied to analyze seasonal cycle characteristics of TWS (Schmidt et al., 2006; Syed et al., 2008; Strassberg et al., 2007), to identify TWS anomalies caused by extreme climate (Andersen et al., 2005; Chen et al., 2009; Long et al., 2013), etc.'

In the new manuscript. Pg. 2. Line 11-20.

Revised as:

'At global, regional and basin scale, GRACE data have been applied to analyze seasonal cycle 13 characteristics of TWS (Schmidt et al., 2006;Syed et al., 2008;Strassberg et al. 2007). 14 Because of its sensitivity to water amount over large area, GRACE data can also be a useful 15 tool for identifying impact caused by extreme climate events like drought and flood, or 16 tracking climate change's influence on local water resource(Andersen et al., 2005; Long et al., 17 2013; Phillips et al.,2012). Scientist found that inclusion of GRACE-based total water storage information allows assessing the predisposition of a river basin to flooding as much as 5–11 19 months in advance (Reager et al., 2011). Chen et al.(2009,2010) quantified 2005 extreme 20 drought and 2009 except flood in Amazon river, and found that local interannual TWS 21 changes are closely connected to ENSO events in the tropical Pacific.'

With the above revision, there are two more references been added to the new manuscript.

'Chen, J. L., Wilson, C. R. and Tapley, B. D.: The 2009 exceptional Amazon flood and interannual terrestrial water storage change observed by GRACE, Water Resour. Res, 46(12), W12526, 2010.'

'Phillips, T., Nerem, R. S., Fox-Kemper, B., Famiglietti, J. S. and Rajagopalan B.: The influence of ENSO on global terrestrial water storage using GRACE, Geophys. Res. Lett., 39, L16705, 2012.'

4) There are MANY acronyms and variables. Please provide either one or two tables with these listed, what they mean, call them Table 1 (or Tables 1 and 2), introducing them early on, and renumbering all the other Tables.

Answer:

In the new manuscript, we provided one table for important acronyms and variables, and renumbered all other tables in original submission. NHESSD.

In the new manuscript, Pg. 22. We added new Table 1

Table 1 List for Acronyms and Variables showed in paper

Acronym/Variable	Full name
GRACE	Gravity Recovery and Climate Experiment
NASA	National Aeronautics and Space Administration
DLR	Deutsches Zentrum für Luft- und Raumfahrt
CSR	University of Texas, Center for Space Research
JPL	Jet Propulsion Laboratory
GFZ	Deutsches GeoForschungsZentrum
CMAP	Climate Prediction Center Merged Analysis of Precipitation
CPC	Climate Prediction Center
CMA	China Meteorological Administration
GLDAS	Global Land Data Assimilation System
CLM	Community Land Model
VIC	Variable Infiltration Capacity model
RMS	Root-mean-square
PDF	Probability Density Distribution
TWS	Terrestrial Water Storage
TWSC	Terrestrial Water Storage Change
SWE	Snow Water Equivalent
CWS	Canopy Water Storage
SM	Soil Moisture
P	Precipitation
E	Evapotranspiration
Q	Runoff

Accordingly, there are some other relative changes:

(1)NHESSD. Pg. 3274. Table 1 is Table 2 in new manuscript, Pg. 23;

(2)NHESSD. Pg. 3275. Table 2 is Table 3 in new manuscript, Pg. 24;

(3)NHESSD. Pg. 3276. Table 3 is Table 4 in new manuscript, Pg. 25;

(4)NHESSD. Pg. 3277. Table 4 is Table 5 in new manuscript, Pg. 26;

(5)NHESSD. Pg. 3278. Table 5 is Table 6 in new manuscript, Pg. 27;

(6)NHESSD. Pg. 3255. Line 17.
'Monthly flux/state variables (Table 1) from GLDAS'
In the new manuscript. Pg. 4. Line 17
Revised as:
'Monthly flux/state variables (Table 2) from GLDAS'

(7)NHESSD. Pg. 3256. Line 27.
'… the GRACE products (Eqs. (1), (2) and Table 4).'
In the new manuscript. Pg. 5. Line 22
Revised as:
'… the GRACE products (Eqs. (1), (2) and Table 5).'

(8)NHESSD. Pg. 3258. Line 2-3:
'… are listed in Table 2.'
In the new manuscript. Pg. 6. Line 18
Revised as:
'… are listed in Table 3.'

(9)NHESSD. Pg. 3258. Line 15:
'…estimates from the GLDAS simulations (Table 3).'
In the new manuscript. Pg. 6. Line 29
Revised as:
'…estimates from the GLDAS simulations (Table 4).'

(10)NHESSD. Pg. 3261. Line 2:
'…amplified to different degrees (Table 4), …'
In the new manuscript. Pg. 9. Line 8
Revised as:
'…amplified to different degrees (Table 5), …'

(11)NHESSD. Pg. 3261. Line 4:
'The slopes in Table 4 can be regarded as …'
In the new manuscript. Pg. 9. Line 10
Revised as:
'The slopes in Table 5 can be regarded as …'

(12)NHESSD. Pg. 3263. Line 10-11:
'… changes in soil moisture contributed significantly to TWSC (Table 5).'
In the new manuscript. Pg. 11. Line 8
Revised as:
'… changes in soil moisture contributed significantly to TWSC (Table 6).'

(13)NHESSD. Pg. 3263. Line 18:
'…, respectively, of the TWSC variance in China (Table 5).'

In the new manuscript. Pg.11. Line 15
Revised as:
'… , respectively, of the TWSC variance in China (Table 6).'

5) Ensure that what you are doing statistical is clear to the reader. So for example, "Correlation coefficients" in Table 2, it is not stated what kind of correlation coefficients these are in the table caption or in the text, nor if it is r or r^2, nor how one might determine the statistical significance of these. Please go through the entire paper, and ensure that any statistical analyses done are clear 'what' the error/correlation/uncertainty is, how it was determined, so that another reader can reproduce it. In some place statistics are clear–but dense–it is hard to read, as it is almost short hand. In other places, it is not always clear what was done, number of values used, etc., to arrive at the values given.
Answer:
(1) For correlation coefficients, in this paper we used Pearson correlation. Since the calculation is based on monthly values in 11 year, there are enough samples, thus significance is not the problem. Besides, we more focused on those high R values which stand for good performance of specific model in specific basin. So we didn't test the significance.

NHESSD, Pg. 3258. Line 2-3:
'Correlation coefficients between TWS from scaled GRACE and model simulations are listed in Table 2'
In the new manuscript. Pg. 6. Line 17-18
Revised as:
'Pearson correlation coefficients R between TWS time series from scaled GRACE and model simulations are listed in Table 3'

NHESSD, Pg. 3275. Table 2, Caption of Table 2,
'Table 2. Correlation coefficients between regionally averaged TWS from the scaled GRACE data and model simulations in China and eight of its basins. Bold numbers highlight the best model result in each region.'
In the new manuscript. Pg. 24. Caption of Table 3
Revised as:
'Table 3. Pearson Correlation coefficients R between regionally averaged TWS from the scaled GRACE data and model simulations in China and eight of its basins. Bold numbers highlight the best model result in each region.'

(2) Significance of trends
We supplemented in the new manuscript.

NHESSD, Pg. 3259. Figure 12-15:
'To identify major areas with significant TWS increase or depletion in the recent decade, linear trend for each grid was calculated from the scaled GRACE TWS, and the long-term trends of seasonal average TWS were also analyzed.'
In the new manuscript. Pg. 7. Line 23-27

Revised as:

'To identify major areas with significant TWS increase or depletion in the recent decade, linear trend of scaled GRACE TWS for each grid was calculated based on linear regression, and the long-term trends of seasonal average TWS were also analyzed. Grids with trends passed the F-test (significant of 95% confidence level) are marked with black dots in Figs. 7 and 8.'

NHESSD, Pg. 3285. Figure 7, Caption of Figure 7:

'Figure 7. Spatial distribution of linear trends for TWS in 2003–2013 (unit: cm yr^{-1}); (a) and (b) are linear trends from the scaled GRACE data and its detailed diagram for west part of China, (c) is linear trend from the unscaled GRACE data.'

In the new manuscript. Pg. 34.

Revised as:

'Figure 7. Spatial distribution of linear trends for TWS in 2003–2013 (unit: cm yr^{-1}); (a) and (b) are linear trends from the scaled GRACE data and its detailed diagram for west part of China, (c) is linear trend from the unscaled GRACE data. Grids with trends significant at 95% confidence level are marked with black dots.'

NHESSD, Pg. 3286. Figure 8, Caption of Figure 8

'Figure 8. Spatial distribution of linear trends for the seasonal averaged TWS in 2003–2013 from the scaled GRACE data (unit: cm yr^{-1}); (a) spring; (b) summer; (c) autumn.'

In the new manuscript. Pg. 35.

Revised as:

'Figure 8. Spatial distribution of linear trends for the seasonal averaged TWS in 2003–2013 from the scaled GRACE data (unit: cm yr^{-1}); (a) spring(March-May); (b) summer(June-August); (c) autumn(September-November). Grids with trends significant at 95% confidence level are marked by black dots.'

(3) Uncertainty or Error

In fact, quantifying uncertainty is always a tough job in GRACE TWS research. Uncertainty is not only related to the input data, but also depends on those methods dealing with the data, such as noise filtering and scaling technology. It is also difficult to collect the true uncertainty information of all the variables used.

Uncertainty of GRACE TWS (total error) mainly comes from measurement error and leakage error (caused by data noise filtering process). These two error fields had already been offered along with the GRACE TELLUS TWS dataset. We further calculated the total error for basin averaged GRACE TWS.

For the estimated TWS from GLDAS model assemble mean (uncertainty for specific model is unknown), we simply take the standard deviation relative to multi-model assemble mean as the estimate of models' uncertainty (referred as bias for GLDAS in paper).

The sources of uncertainty and error of GRACE and GLDAS data are introduced in section 2.2.1 and Table 3 in NHESSD

Regions	Areas(km^2)	Measurement Error	Leakage Error	Total Error	Bias for GLDAS

China	9,510,610	0.38	0.31	0.54	0.63
Changjiang	1,815,855	0.90	0.79	1.27	1.47
Heilongjiang	956,832	0.98	0.72	1.39	1.10
Yellow River	860,883	0.78	0.73	1.10	0.72
Zhujiang	463,050	1.86	1.62	2.63	3.35
Hai River	327,096	1.30	1.36	1.84	1.59
Liao river	310,881	1.13	0.98	1.60	1.61
Huai River	288,152	1.74	1.54	2.46	3.51
Southeast Rivers	242,524	1.44	1.29	2.04	3.69

More details on the GRACE Tellus TWS Dataset were introduced in Landerer et al.(2012), which was cited in NHESSD. We also found that one recent work 'Long, D., L. Longuevergne, and B. R. Scanlon (2015), Global analysis of approaches for deriving total water storage changes from GRACE satellites, Water Resour. Res., 51, 2574–2594, doi:10.1002/2014WR016853.' has done a more comprehensive analysis on the uncertainty of GRACE derived TWS data.

NHESSD, Pg. 3255. Line 16:
'… were calculated following Landerer's method based on NCAR's CLM4 model (Oleson et al., 2008).'
In the new manuscript. Pg. 4. Line 14-17
Revised as
'… were calculated following Landerer's method based on NCAR's CLM4 model (Oleson et al., 2008). Recently, Long et al. (2015) conducted comprehensive comparisons to assess skills and uncertainties of different approaches for processing GRACE data to restore signal losses caused by spatial filtering.'

The new reference was added in the new manuscript.Pg. 19. Line 4-5.
'Long, D., Longuevergne L., and Scanlon B. R.: Global analysis of approaches for deriving total water storage changes from GRACE satellites, Water Resour. Res., 51, 2574–2594, 2015.'

6) Please ensure that you do not state 'more' in terms of conclusions than what the data are telling you.
Answer:
We check the NHESSD for similar problems and revised them in new manuscript.

(1) NHESSD, Pg. 3261. Line 5-7:
'Generally, basins with large areas are less affected by leakage errors and have slopes close to 1, but geographical location and hydrological cycle characteristics will contribute to this effect, as well.'
In the manuscript, Pg. 9. Line 11-13.
was revised as 'Generally, basins with large areas are less affected by leakage errors and have slopes close to 1.'

(2)NHESSD, Pg. 3261. Line 18-20:

‘This process may be controlled by changes in some large-scale climate processes, which need to be further analyzed in the future.’
In the manuscript, Pg. 9, Line 23-25. This sentence was deleted.

(3)NHESSD, Pg. 3262. Line 1-2:
‘Reservoir regulations may be one of the factors that alter the TWS signal.’
In the manuscript, Pg. 10. Line 2. This sentence was deleted.

(4)NHESSD, Pg. 3264. Line 4-6:
’According to the analysis in previous section, we inferred that human activities rather than climate parameters are responsible for the significant TWS depletion in North China,’
In the manuscript, Pg. 11. Line 29-30.
revised as:
‘According to the analysis in previous section, we inferred that human activities rather than climate parameters could be responsible for the significant TWS depletion in North China,’

(5)NHESSD, Pg. 3266. Line 9-11:
‘Thus, more data needs to be added to further quantify and verify the extent of identified TWS change at small scale in the future research’
In the new manuscript, Pg. 13. Line 25-26. This sentence was deleted.

7) Please ensure that for all figures, the TEXT is big enough to read. Some of it is very small.
Answer:
We have reproduced Figure 1 - Figure7 as required.

8) Figure 3. If using colour, please indicate the legend.
Answer:
This is a mistake. We have fixed Figure 3 and added the color bar in the new manuscript.

9) Where appropriate, add y-axis labels where there are none now (along with units).
Answer:
We have added y-axis labels in Figure 4 - Figure 6.

10) Figure 7 and 8. Add units to the legend (text above or to right or below). For the divisions, it is better to do "-1.0 to -0.8" rather than "-1 - -0.8" [note precision, and getting rid of - for ’to’]
Answer:
We have changed divisions label in Figure 7 and 8 as required.

11) Spring and other seasons. You never state what months these cover.
Answer:
We have clarified the months for these seasons in the caption of Figure 8.
NHESSD, Pg. 3286. Caption for Figure 8.
‘Figure 8. Spatial distribution of linear trends for the seasonal averaged TWS in 2003–2013 from the scaled GRACE data (unit: cm yr^{-1}); (a) spring; (b) summer; (c) autumn.’

In the new manuscript. Pg. 35.

Revised as:

'Figure 8. Spatial distribution of linear trends for the seasonal averaged TWS in 2003–2013 from the scaled GRACE data (unit: cm yr^{-1}); (a) spring(March-May); (b) summer(June-August); (c) autumn(September-November). Grids with trends significant at 95% confidence level are marked by black dots.'

In addition to the revisions based on reviewers' comments, we made some other minor revisions in the new manuscript:

1) NHESSD, Pg. 3252. Line 9-12.

'In Hai River basin and Yellow River basin, groundwater exploitation may have altered TWS's response to climate, it began to restore since 2012. Changes in soil moisture storage contributed over 50% in of variance in TWS in most basins.'

In the manuscript, Pg. 1. Line 17-20.

Revised as:

'In Hai River basin and Yellow River basin, groundwater exploitation may have altered TWS's response to climate, and TWS kept decreasing until 2012. Changes in soil moisture storage contributed over 50% of variance in TWS in most basins.'

2) NHESSD, Pg. 3253. Line 2.

'The GRACE twin satellites were launched …'

In the manuscript, Pg. 2. Line 6.

Revised as:

'The Gravity Recovery and Climate Experiment(GRACE) twin satellites were launched …'

3) NHESSD, Pg. 3254. Line 9.

'China is one of the countries that is confronted with problems of water scarcity. '

In the manuscript, Pg. 3. Line 15-16.

Revised as:

China is one of the countries that is confronted with problems of water scarcity and suffered several regional extreme climate events in recent decade.

4) NHESSD, Pg. 3256. Line 8-9.

'Vector data for desert, glacier and lake are acquired from the Data Sharing Infrastructure of Earth System Science (http://www.geodata.cn).'

In the manuscript, Pg. 3. Line 15-16.

Revised as:

Vector data for desert is acquired from the Data Sharing Infrastructure of Earth System Science (http://www.geodata.cn). The Second Glacier Inventory Dataset of China (Version 1.0) is acquired from Science Data Center for Cold and Arid Regions (http://westdc.westgis.ac.cn).

5) NHESSD, Pg. 3256. Line 25.

'… missing values from absent months were interpolated from …'

In the manuscript, Pg. 5. Line 20.

Revised as:
'… missing values for absent months were interpolated from …'

6) NHESSD, Pg. 3261. Line 10.

'but different processes also exist in certain basins or over certain periods because of the influence of other factors'

In the manuscript, Pg. 9. Line 16.

Revised as:

'but distinct processes also exist in certain basins or over certain periods because of the influence of other factors'

7) NHESSD, Pg. 3261. Line 12.

'TWS in China was in a relatively positive condition before 2006, …'

In the manuscript, Pg. 9. Line 18.

Revised as:

'TWS in China was in a relatively high condition before 2006, …'

8) NHESSD, Pg. 3261. Line 14.

'During this period, extreme climate disasters occurred frequently …'

In the manuscript, Pg. 9. Line 19.

Revised as:

'During this period, severe droughts occurred frequently …'