We are greatly thankful for the insightful and constructive comments from the anonymous reviewer. We have carefully studied them and revised the manuscript accordingly. This document contains our specific responses to the comments.

Anonymous Referee #2

1. *The major concern is that the inter-annual water storage change is assumed to be negligible even though hydrologic year is used. The estimated value of w could be affected by this assumption of storage change. Since the purpose of this study is to evaluate the contribution of vegetation and seasonal climate variability to inter-annual variability of water balance, this assumption is important and needs to be further invsetigated and discussed.*

Response: Thanks for reviewer's good suggestion. And the other anonymous referees also figured out this problem and suggested us build the relationship between ω and M as well as S on the long-term scale. However, after checking the relationship of M and S on the 5-year, 10-year and 30-year scales, we found that they are cross correlated. Particularly, the correlation coefficients increase with the lengths of time scale, and the determining coefficient (R^2) is 0.8 for the 30-year scale. If M and S is not independent of each other, they cannot be used together to express different functions. After substantial tests, we found that the relationship between M and S is not significant in a period of hydrologic year. Thus, they can be used to express the controlling parameter. Furthermore, there are several researches have figured out that although the parameter in the Budyko relationship has been used to represent the catchment characteristics, this parameter is also affected by climate seasonality (Milly, 1994;Donohue et al., 2011;Williams et al., 2012;Berghuijs and Woods, 2016;Zhou et al., 2016). In our study, we also found that parameter ω has a negative correction with climate seasonality. Thus, the climate seasonality should be incorporating into the parameter.

Your concern about the changes in water storage is really very important in water balance equation. To exclude the potential impacts, we checked the interannual variation of catchment-scale water storage in some studies, and presented some discussion about this part. Specifically, we found that the water storage change in the Loess Plateau is relative small compared with the other regions of China. In such cases, assessing catchment-scale water balance by ignoring water storage change should be reasonable on a time scale of hydrologic year.

Despite that catchment-scale water storage changes are usually assumed to be zero on long-term scale, the interannual variability of storage change can be an important component in annual water budget during dry or wet years (Wang and Alimohammadi, 2012), and cannot be ignored. However, the Loess Plateau has a subhumid to semiarid climate, the water storage and its annual variation are relatively small compared with humid regions (see Figure 5 from Mo et al., 2016). For example, using GRACE (Gravity Recovery and Climate Experiment), the water storage variations in the Yangtze, Yellow and Zhujiang from 2003 to 2008 were analyzed by Zhao et al. (2011), and the values for the Yangtze and Zhujiang basins were 37.8 mm and 65.2 mm, while no clear annual variations are observed in the Yellow River basin (3.0 mm). Furthermore, Mo et al. (2016) found that the water storage in Yellow River kept decreasing from 2004 to 2011, whereas it was changing slowly with a rate of 1.3 mm yr^{-1}. Therefore, considering the small water storage change in study area, ignoring water storage change in a period of hydrologic year is reasonable.

2. *To develop the semi-empirical formula of parameter w, the limiting conditions of M and S were considered in this paper, which is significant for understanding the variability of water balance under the extremely hydrometeorological conditions. However, I think the limiting condition of S is not exactly right: when $\emptyset \rightarrow \infty$ and $\delta_{ET_0} \neq 0$ in the equation (3), i.e. P→ 0, and monthly ET0 is not uniform distributed within a year, w can also close to unity.*

Response: Yes, the limiting condition of S is indeed not right and we have corrected it according to your suggestion in the revised manuscript, thanks for your carefulness.

If $S \rightarrow \infty$, i.e. $\emptyset \rightarrow \infty$ and $\delta_{ET_0} \neq 0$ in the equation (3), which means monthly ET_0 is not uniform distributed within a year and $P \rightarrow 0$, thus $ET \rightarrow 0$, and $\omega \rightarrow 1$.

3. *It has been reported that the first-order approximation (ignoring the higher orders of the Taylor expansion) in the Equations (4-6) will bring errors (Yang et al. 2014, WRR); furthermore, the function of P and ET0, and their interaction may play some roles in the attribution analysis. Thus, it is better to consider these errors in the paper.*

Response: Thanks for reviewer's good suggestion and we agreed with your opinion. Thus, we applied the new method proposed by Zhou et al. (2016) to conduct attribution analysis. The algebraic identities in their work can ensure that the change in runoff/*ET* can be decomposed into two components precisely without any residuals and reduced the errors of ignoring the higher orders of the Taylor expansion in the traditional attribution method. Furthermore, the errors and uncertainties induced by the attribution analysis have been added and presented in the discussion section.

Errors still exhibited in the attribution analysis of ET changes. As the changes in evapotranspiration has been decomposed without residual by the complementary method (Equation 6-7), the errors were induced from the developed empirical formula for *w* (Equation 11). It suggested that ω cannot be completely explained by M and S, and it might include some other factors. Therefore, discussing more factors influencing ω remains future work.

4. *In previous attribution analyses of variation in runoff or ET based on the climate elasticity method, the study period was first divided into two periods, and then the contribution of a variable on the change in runoff or ET from the first period to second period was defined as the product of the elasticity coefficient and the variation of this variable. While in this study, the climate elasticity method was used to explain the change trend of ET for the whole study period. Even the comparisons of these two methods was conducted in the discussion section, there still need more data to support this estimation.*

Response: Thanks for reviewer's good suggestion. We have to admit that the attribution method we used will produce some uncertainties. And other two anonymous referees also figured out this problem. Therefore, considering the suggestions of three referees, "the complementary method" proposed by Zhou et al. (2016) was adopted in our revised manuscript. And the corresponding revision was shown in the section 2.3 and 4.3.

2.3. Evaluating the contributions of climate change and surface condition alterations to *ET* changes

Based on the climate elasticity method, which was introduced by (Schaake and Waggoner, 1990) and improved by (Sankarasubramanian et al., 2001), the contribution of change for each climate factor to runoff was defined as the product of the sensitivity coefficient and the variation of the climate factor (Roderick and Farquhar, 2011):

$$dR = \frac{\partial R}{\partial P} dP + \frac{\partial R}{\partial ET_0} + \frac{\partial R}{\partial \omega} d\omega \tag{5}$$

However, due to ignoring the higher orders of the Taylor expansion in equation (5), this method will result in high errors (Yang et al., 2014). Recently, Zhou et al. (2016) proposed a new method to partition climate and catchment effect on the mean annual runoff based on the Budyko complementary relationship, called "the complementary method". The algebraic identities in their work can ensure that the change in runoff can be decomposed into two components precisely without any residuals. Here, we extend "the complementary method" to conduct attribution analysis of *ET* changes for each basin by further incorporating the effects of vegetation coverage and climate seasonality:

$$\Delta ET = \alpha \left[\left(\frac{\partial ET}{\partial P}\right)_1 \Delta P + \left(\frac{\partial ET}{\partial ET_0}\right)_1 \Delta ET_0 + P_2 \Delta \left(\frac{\partial ET}{\partial P}\right) + ET_{0,2} \Delta \left(\frac{\partial ET}{\partial ET_0}\right) \right]$$
$$+ (1-\alpha) \left[\left(\frac{\partial ET}{\partial P}\right)_2 \Delta P + \left(\frac{\partial ET}{\partial ET_0}\right)_2 \Delta ET_0 + P_1 \Delta \left(\frac{\partial ET}{\partial P}\right) + ET_{0,1} \Delta \left(\frac{\partial ET}{\partial ET_0}\right) \right] \tag{6}$$

where α is a weighting factor that varies from 0 to 1, which can determine the upper and lower bounds of the climate and the controlling parameter effect. In this study, we defined α=0.5 according to the recommendation of Zhou et al. (2016).The difference operator (Δ) refers to the difference of a variable from period 1 (1981 to the changing point detected by Pettitt's test (Pettitt, 1979)) to period 2 (period-1 end to 2012) ,e.g., $\Delta ET_0 = ET_{0,2} - ET_{0,1}$. Then the contributions of *P*, ET_0, and ω changes to the *ET* changes can be expressed as follows:

$$C\_(P) = \alpha\left[\left(\frac{\partial ET}{\partial P}\right)_1 \Delta P\right] + (1-\alpha)\left[\left(\frac{\partial ET}{\partial P}\right)_2 \Delta P\right] \quad (7a)$$

$$C\_(ET_0) = \alpha\left[\left(\frac{\partial ET}{\partial ET_0}\right)_1 \Delta ET_0\right] + (1-\alpha)\left[\left(\frac{\partial ET}{\partial ET_0}\right)_2 \Delta ET_0\right] \quad (7b)$$

$$C\_(\omega) = \alpha\left[P_2\Delta\left(\frac{\partial ET}{\partial P}\right) + ET_{0,2}\Delta\left(\frac{\partial ET}{\partial ET_0}\right)\right] + (1-\alpha)\left[P_1\Delta\left(\frac{\partial ET}{\partial P}\right) + ET_{0,1}\Delta\left(\frac{\partial ET}{\partial ET_0}\right)\right] \quad (7c)$$

After obtaining the contribution of parameter ω to the *ET* change, the contributions of vegetation coverage (*M*) and climate seasonality (*S*) to *ET* change can be further decomposed as follows.

First, the contributions of *M* and *S* to parameter ω are calculated by using the sensitivity method similar to Eq. (5) based the relationship between ω and *M* as well as *S* we built:

$$\Delta\omega = \frac{\partial\omega}{\partial M}\Delta M + \frac{\partial\omega}{\partial S}\Delta S \quad (8)$$

Furthermore, the individual relative contributions (RC) of *M* and *S* to ω can be calculated. Then, the contributions of *M* (C_(*M*)) and *S* (C_(*S*)) to *ET* changes can be obtained as follows:

$$C\_(M) = C\_(\omega) \times RC\_(M) \quad (9a)$$

$$C\_(S) = C\_(\omega) \times RC\_(S) \quad (9b)$$

4.3. Quantitative attribution of the variation in *ET*

The impacts of vegetation changes on *ET* have been widely studied with the Budyko framework by assuming surface conditions can be represented by the controlling parameter. However, according to the developed relationships in our study, the controlling parameter is not only related to surface condition change, but also to climate seasonality. The contributions of changes in climate (*P*, ET_0, and *S*) and vegetation (*M*) to the *ET* change were thus estimated by using the semi-empirical formula for parameter ω in the context of Fu's framework.

Trend in hydrometeorological variables and vegetation coverage were first analyzed for each basin (Table 4). ET_0 and *S* in all basins exhibited an upward trend, though with different significances. Similarly, *M* in most basins increased during past several decades. Based on the sensitivity coefficients of *ET* (Table S1) and the changes in mean annual *P*, ET_0, ω, *M* and *S* from period I to period II (Table 5), the changes in *ET* due to those in *P*, ET_0, *M* and *S* were estimated using the method described in Section 2.3. The contributions of four variables to *ET* change for each basin were presented in Table 5. In basin #1, 3-4 and #6, the *ET* changes were controlled by vegetation improvement; however, in the other basins, the dominant factor was precipitation. Except for basin #6, #9 and #12, elevated vegetation in most basins positively contributed to *ET* changes, which is consistent with Feng et al. (2016). *ET* in several basins showed a downward trend even though *M* positively contributed to *ET* changes; which is due to the offsetting effect of the other factors.

Table 4. Trend analysis for the hydrometeorological variables and vegetation coverage[b].

ID	Basin	*ET*,mm yr^{-2}	ET_0,mm yr^{-2}	*P*,mm yr^{-2}	*M*	*S*
1	Huangfu	1.89	1.16	0.61	0.002*	0.001
2	Gushan	0.76	3.85**	-0.01	0.004**	0.012
3	Kuye	2.34*	2.04*	0.53	0.004**	0.006
4	Tuwei	1.87	2.33**	0.53	0.005**	0.006
5	Wuding	0.88	1.17	0.31	0.006**	0.004
6	Qingjian	-0.45	1.78*	-0.94	0.007**	0.006
7	Yan	-1.62	2.03*	-1.99	0.005**	0.006
8	Beiluo	-5.4*	4.6*	-6.2*	0.0001	0.017
9	Jing	-0.97	1.47*	-1.79	0.002**	0.001
10	Fen	-0.72	1.93*	-1.16	0.002*	0.003
11	Xinshui	0.33	1.80	-0.12	0.003**	0.005
12	Sanchuan	1.49	1.84	0.09	-0.0004	0.004
13	Qiushui	-0.50	1.79	-0.83	0.002	0.008

[b] * and ** indicate the trend is significant at the level of p = 0.05 and p = 0.01 by the Mann–Kendall test, respectively.

It should be noted that the climate seasonality (represented by *S*) played an important role in the catchment *ET* variation. The contributions of *S* to *ET* changes ranged from 0.1% to 65.5% (absolute values). Besides basin #6, #9 and #12, the climate seasonality had a negative effect on *ET* variation in most of the basins, which means that larger seasonality differences between seasonal water and heat will lead to smaller amounts of evapotranspiration. Accordingly, if ω is supposed to only represent the landscape condition, the effects of landscape condition change on *ET* variation will be underestimated in basin #1, #3, #6-7, #9 and #11. Except for basin #9, the area of these basins is relative smaller; while its effects will be overestimated in the other basins, and the error would be equal to the contributions of *S* to *ET* changes.

5. *Line 64. Also cite Donohue et al. 2012 JOH.*

Response: This reference has been cited.

Table 5. Attribution analysis for *ET* changes for each basin [c]

ID	Basin	Break point of ET	Change from Period 1 to Period 2					ET_0/ P/M/S induced ET change (mm)					Contribution to ET change (%)			
			ΔET	ΔET_0	ΔP	ΔM	ΔS	C_ (ET_0)	C_ (P)	C_ (ω)	C_ (M)	C_ (S)	φ_ (ET_0)	φ_ (P)	φ_ (M)	φ_ (S)
1	Huangfu	2001(ns)	41.7	7.0	22.2	0.03	0.01	0.28	18.67	22.70	22.73	-0.04	0.7	44.8	54.6	-0.1
2	Gushan	2000(ns)	33.6	64.9	20.6	0.07	-0.10	2.81	17.01	13.77	8.87	4.90	8.4	50.6	26.4	14.6
3	Kuye	2000(**)	51.4	32.0	17.3	0.06	0.05	1.54	13.34	36.48	55.95	-19.47	3.0	26.0	108.9	-37.9
4	Tuwei	2000(**)	43.2	39.6	24.0	0.07	-0.03	2.57	15.28	25.35	21.85	3.49	5.9	35.4	50.6	8.1
5	Wuding	2000(*)	35.2	17.6	26.9	0.09	-0.12	0.77	21.82	12.64	8.24	4.40	2.2	61.9	23.4	12.5
6	Qingjian	1988(**)	-50.1	32.0	-48.0	0.08	0.19	2.06	-37.80	-14.31	-47.09	32.78	-4.1	75.5	94.08	-65.5
7	Yan	1985(**)	-82.3	44.6	-86.9	0.05	0.30	3.19	-69.52	-15.96	22.19	-38.14	-3.9	84.5	-27.0	46.4
8	Beiluo	1985(**)	-65.1	49.4	-79.8	0.01	0.19	4.33	-62.9	-6.75	3.69	-10.43	-6.6	96.3	-5.7	16.0
9	Jing	1990(**)	-33.7	43.0	-47.8	0.03	0.11	4.1	-37.2	-0.61	-8.23	7.61	-12.2	110.3	24.4	-22.6
10	Fen	2005(ns)	23.1	8.5	21.2	0.07	-0.20	0.33	19.00	3.81	2.13	1.68	1.4	82.1	9.2	7.3
11	Xinshui	1990(**)	-19.1	39.7	-24.7	0.02	0.09	2.06	-21.08	-0.14	0.41	-0.55	-10.8	110.1	-2.1	2.9
12	Sanchuan	1996(ns)	-27.0	45.4	-43.4	-0.01	0.22	3.01	-32.52	2.56	0.20	2.36	-11.2	120.6	-0.7	-8.8
13	Qiushui	1996(ns)	-80.3	77.5	-103.5	-0.01	0.68	3.76	-83.68	-0.40	-0.02	-0.37	-4.7	104.2	0.1	0.5

[c] The relative contribution of a certain variable to the *ET* change ($\varphi(x)$) was calculated as follows: $\varphi(x) = (\mathrm{C\_}(x)/\Delta ET) \times 100\%$, where C_($x$) represents the contribution of each variable.

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