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Widespread decline in terrestrial water storage and its link to teleconnections across Asia and eastern Europe

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Introduction

The Supporting Information mainly provides comparison of GRACE-derived and GLDAS-derived TWS, example of time series decomposition of TWS, trend in TWS across the whole study area and five hotspot, and the correlation between TWS and TCs for five hotspots.

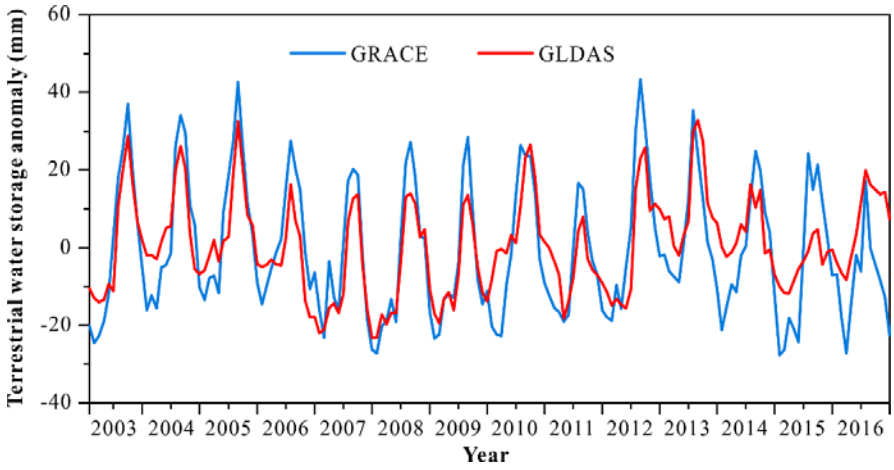

Figure S1. Comparison between GRACE observed terrestrial water storage and GLDAS simulated terrestrial water storage by summing canopy water, four layers soil moisture and snow equivalent water over the Asia and Eastern Europe region during 2003~2016.

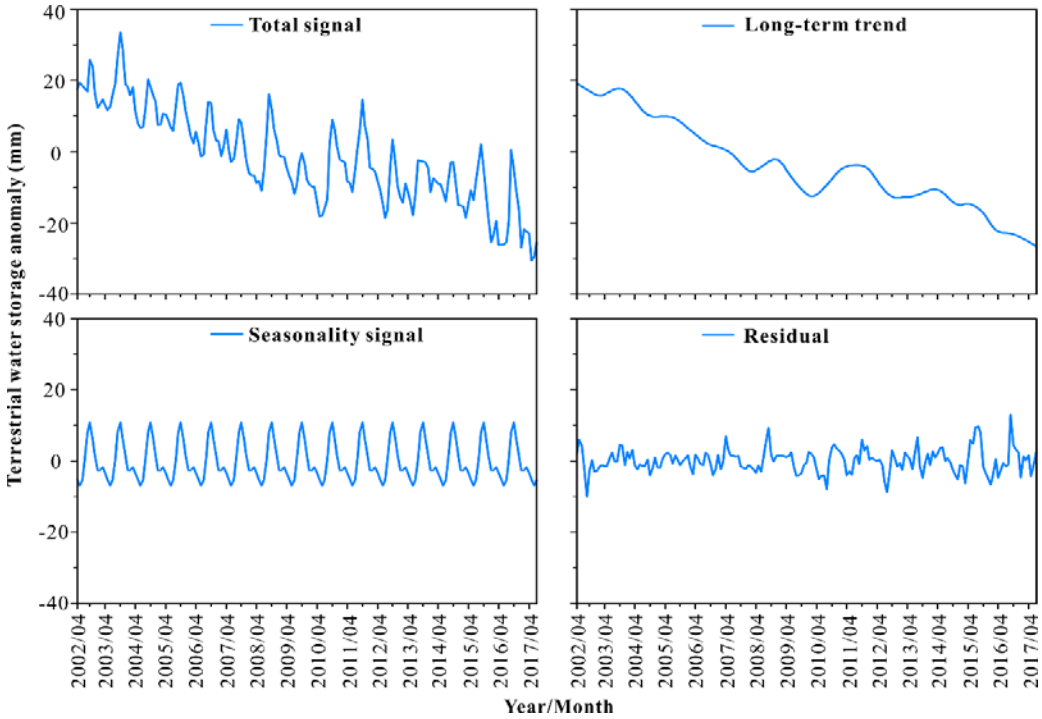

Figure S2. Time series decomposition of TWS into long-term trends, seasonality signal, and the residual components using an implementation of Seasonal Decomposition of Time Series by Loess (STL) approach over northwest India (region 3) during 2002~2017.

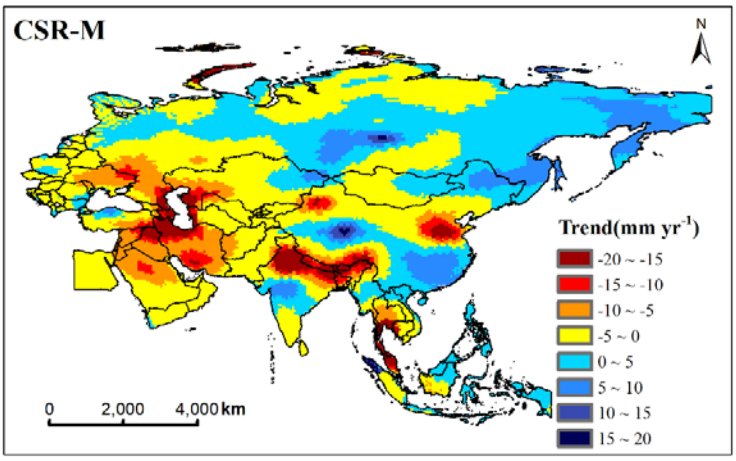

Figure S3. Spatiotemporal changes in TWS as obtained from CSR mascon solution over the Asia and Eastern European regions during 2002-2017.

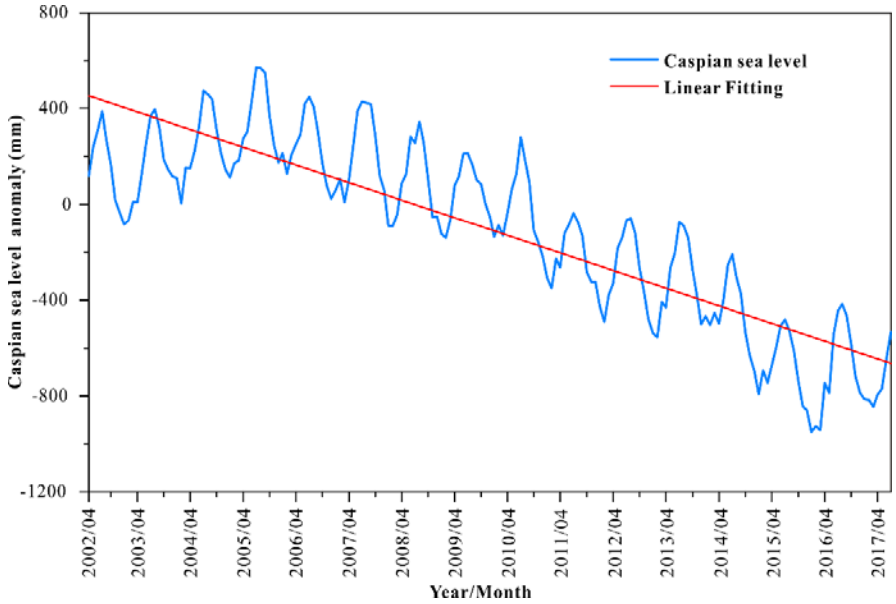

Figure S4. Changes in Caspian Sea Level during 2002-2017.

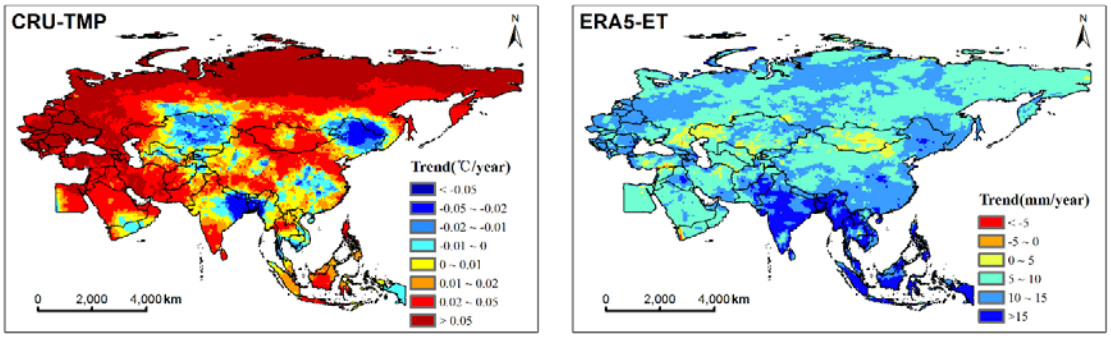

Figure S5. Spatiotemporal changes in temperature as obtained from CRU (left) and evapotranspiration as obtained from ERA5 (right) across the Asian and Eastern European regions during 2002–2017.

Table S1. Trends in TWS estimated by JPL-M and CSR-M in five hotspots during 2002-2017.

Hotspots	JPL-M (mm yr^{-1})	CSR-M (mm yr^{-1})
Region1	-8.94	-7.13
Region2	-15.92	-10.46
Region3	-21.79	-16.07
Region4	-11.74	-10.53
Region5	-10.93	-9.31

Table S2. Maximum correlation coefficients between TWS and water storage components and teleconnection indices in five hotspots. r1, r2, r3, r4 and r5 indicate region 1 to region 5. (significance threshold: |r| > ~0.15 given a significant level = 0.05 and a time series number = 183)

Components	NAO	AO	WP	SCAND	EAWR	PNA	ENSO	IOD	EA	AMO	polarEA	PDO
r1-jpl	-0.17							0.15				
r1-surface	0.19	0.19	-0.17	0.20	0.15	0.17	-0.17	0.19	-0.20	-0.20		
r1-sm	0.19				0.15		0.19	-0.25				
r1-ground	0.19	0.15	0.18	-0.17								
r2-jpl	-0.23	-0.20							0.15		-0.16	
r2-surface	-0.16	-0.33	0.17	0.23		-0.16	0.33		-0.16	-0.33		
r2-sm	0.18	-0.29			-0.30	0.22	0.50	0.27	0.26	0.35	-0.23	0.23
r2-ground	-0.19			-0.16							0.18	
r3-jpl		0.23									0.16	0.24
r3-surface	0.15				0.16	-0.20	0.25	-0.26				0.21
r3-sm		-0.24			0.21		-0.18			0.24		
r3-ground	-0.19	0.19	-0.18	-0.19	-0.20	0.17	0.28	-0.15	0.16			0.27
r4-jpl	0.16		-0.17									
r4-surface	-0.31		-0.16	-0.22	-0.18	0.15		0.16	0.16	0.25	-0.22	
r4-sm	-0.20		-0.23		-0.20	0.17				0.16	-0.16	
r4-ground		0.15		-0.15								
r5-jpl	-0.20	-0.21	0.16	-0.16								
r5-surface		-0.24	0.16	0.21	0.25			-0.17	-0.26			
r5-sm	0.21		-0.18	-0.18		-0.15	0.19		0.16	0.22	-0.17	
r5-ground			0.23			0.15						

Table S3. Dominant indices for water storage components in each hotspot. The numbers in the brackets in cell show correlation coefficient and corresponding time lag. (significance threshold: |r| > ~0.15 given a significant level = 0.05 and a time series number = 183)

Components	Region1	Region2	Region3	Region4	Region5
Total water storage	NAO (0.23, 3)	NAO (-0.23, 0)	PDO (0.24, 6)	WP (-0.17, 2)	AO (-0.21, 1)
Surface water	AMO (-0.20, 0)	AO (-0.33, 1)	ENSO (0.30, 3)	NAO (-0.31, 3)	EA (-0.26, 1)
Soil moisture	IOD (-0.25, 0)	ENSO (0.52, 6)	AO (-0.24, 3)	WP (-0.23, 2)	AMO (0.22, 0)
Groundwater	NAO (0.19, 1)	NAO (-0.19, 0)	ENSO (0.29, 6)	SCAND (-0.15, 4)	WP (0.23, 1)