# 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.

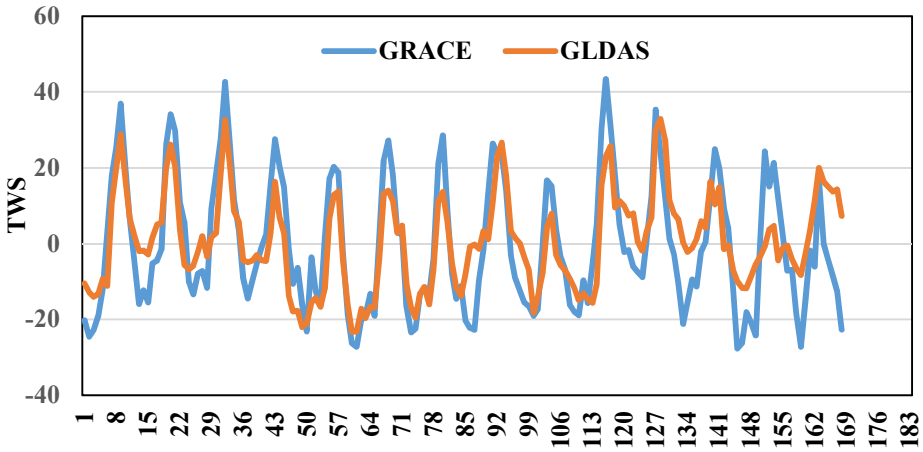


**Figure S1.** Comparison between GRACE observed terrestrial water storage and GLDAS simulated terrestrial water storage by summing canopy water, four layers soil moisture and snow equivalent water over the Asia and Eastern Europe region during 2002~2017.

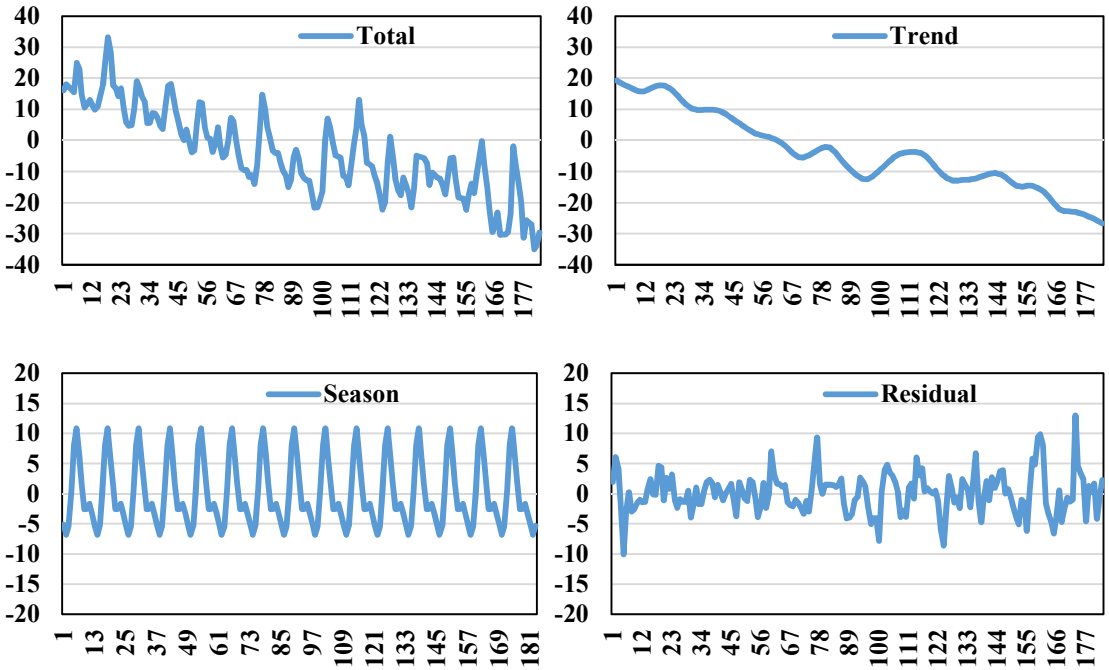


**Figure S2.** Time series decomposition of TWS into long-term trends, seasonality signal, and the residual components using an implementation of Seasonal Decomposition of Time Series by Loess (STL) approach over northwest India (region 3) during 2002~2017.

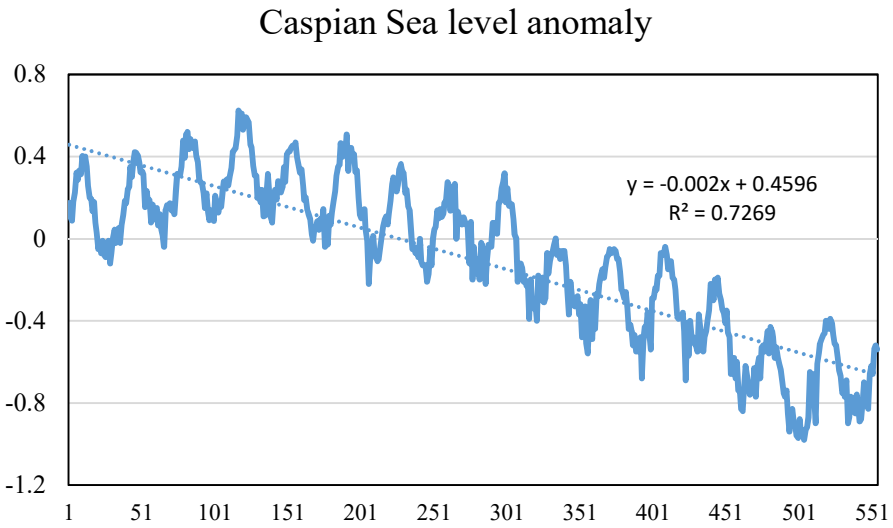


**Figure S3.** Time series of Caspian Sea Level during 2002-2017.

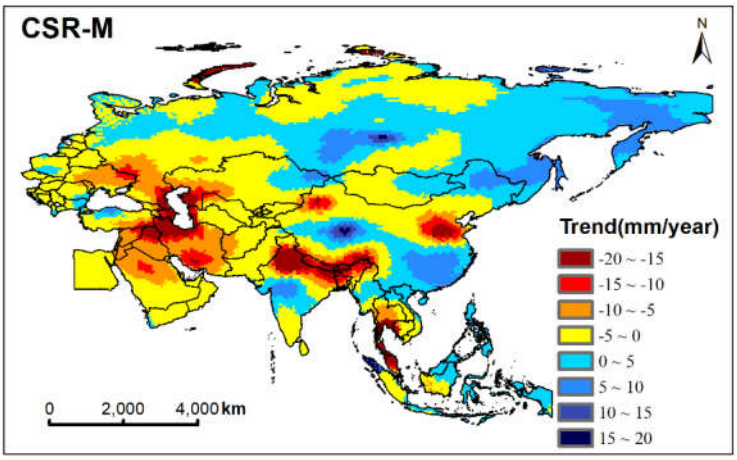


**Figure S4.** Spatial distribution of trends in terrestrial water storage obtained from CSR mascon over the Asia and Eastern Europe region during 2002~2017.

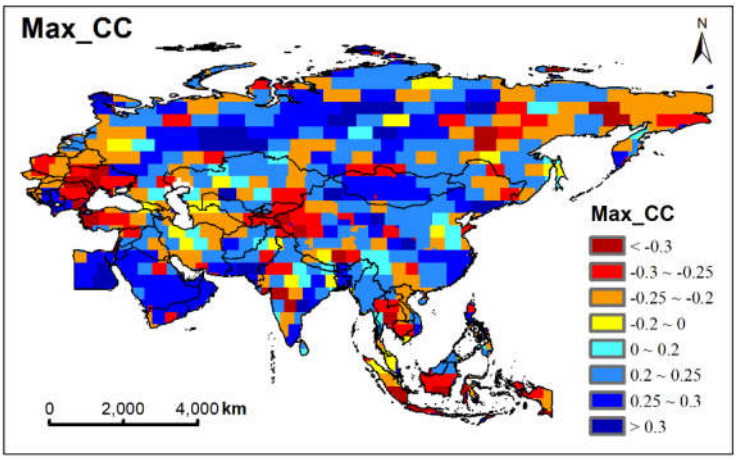


**Figure 5.** Spatial pattern of maximum correlation coefficients between TWS and teleconnection indices. Maximum phase shift in the correlation analysis was limited to 0~24 months (significance threshold: $|r| > \sim 0.15$ given $\alpha = 0.05$ and $n = 183$).

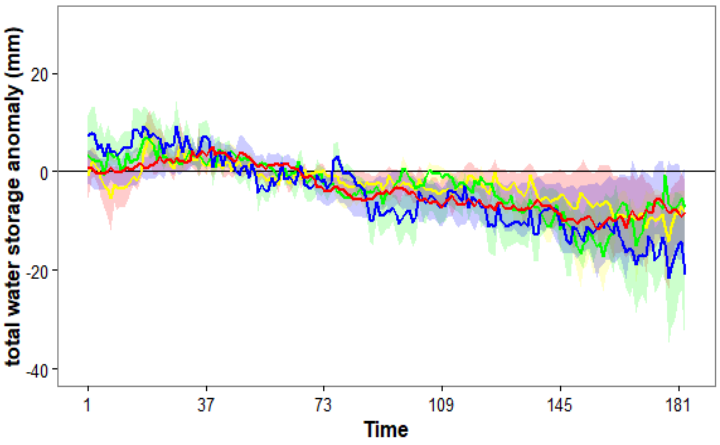


**Figure S6.** Changes in terrestrial water storage across five hotspots. Uncertainties represent 95% confidence interval.

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

| Hotspots | JPL-M (mm/yr) | CSR-M (mm/yr) |
|---|---|---|
| Region1 | -8.94 | -7.13 |
| Region2 | -15.92 | -10.46 |
| Region3 | -26.33 | -22.48 |
| Region4 | -19.52 | -12.86 |
| 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: $|r| > \sim 0.15$ given $\alpha = 0.05$ and $n = 183$)

| 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: $|r| > \sim 0.15$ given $\alpha = 0.05$ and $n = 183$)

| 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) |