The water storage change anomaly and its causes in the middle-lower reaches of Yangtze River basin

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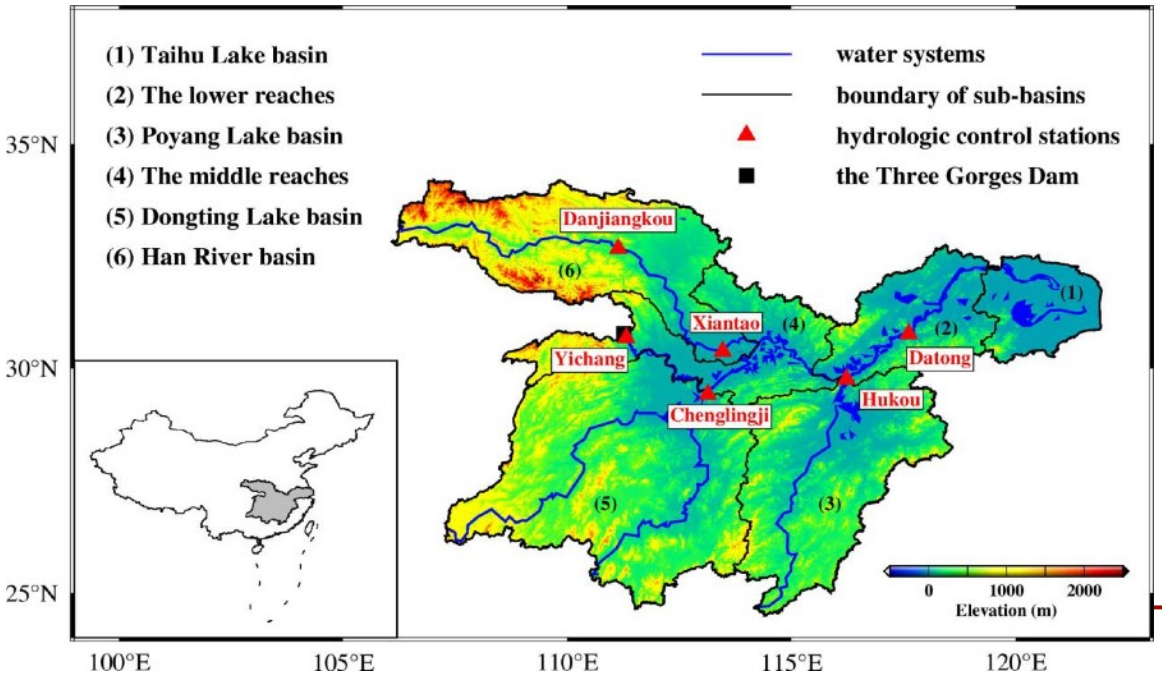
Motivations

» The middle-lower Yangtze River Basin (MLYRB)

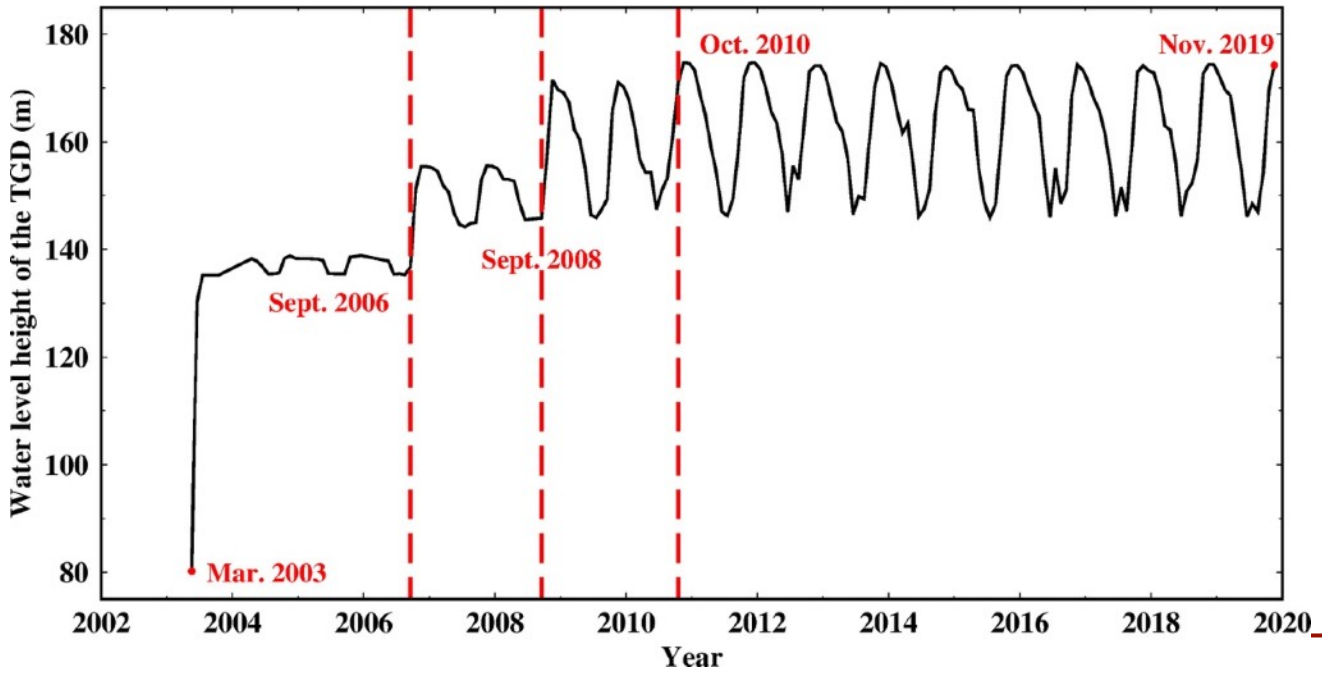
- mainly controlled by a subtropical and temperate monsoon
- can be divided into 6 sub-basins based on the mainstream and its hydrological systems
- the investigation enables us to explore the influence of different factors



Motivations

» The impoundment of Three Gorges Dam (TGD)

- April 2003 to September 2006
- September 2006 to September 2008
- September 2008 to October 2010
- Since October 2010 (Full operation)



Motivations

» The extreme weather events in MLYRB

2011 Poyang Lake

2016 Wuhan

Motivations

- The effects of TGD and ENSO on the hydrological change in the MLYRB
- The correlation between TWS anomaly and ENSO before and after the full operation of TGD
- If the correlation could be enhanced enough to give a potential early warning to the extreme hydrological events

Data and Methods

» Data used

Data type	Data sources	Version	Resolution	
			Spatial	Temporal
GRACE	CSR	RL06	1°×1°	monthly
Precipitation	TRMM 3B43	7A	0.25°×0.25°	monthly
Runoff	Hydrological stations	-	-	hourly
ENSO index	NOAA MEI	2.0	-	monthly
Dryness index	CRU PDSI	3.26	0.25°×0.25°	monthly

Data and Methods

» TWS anomaly from GRACE

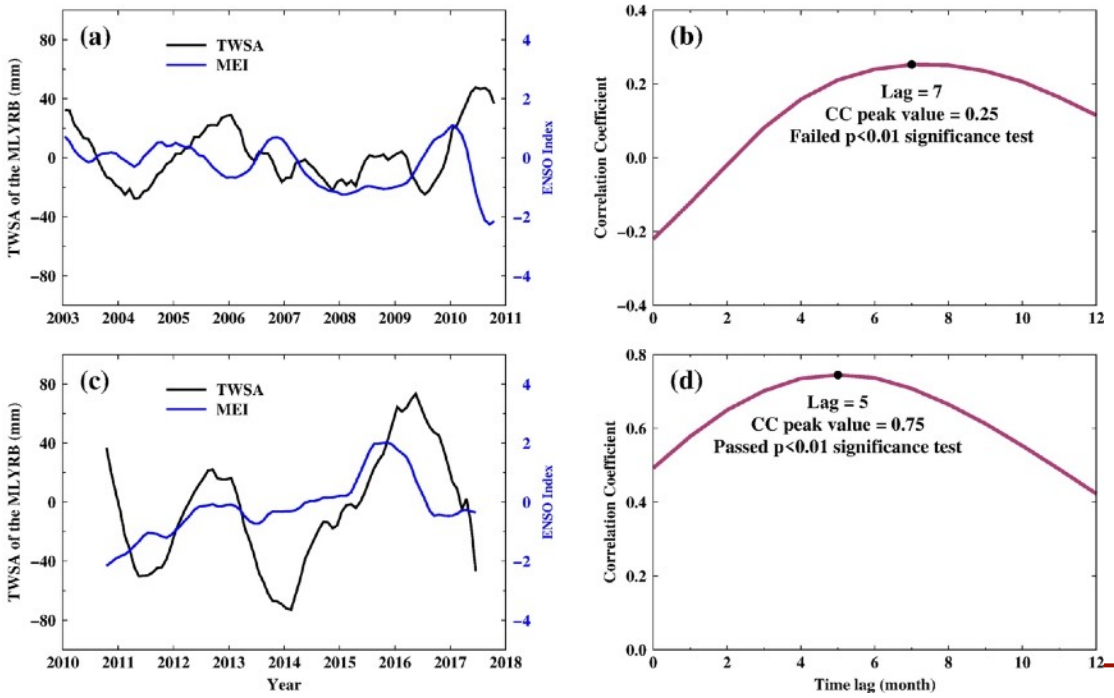
- CSR RL06 monthly spherical harmonic coefficients
- degree 1 and C20 replaced
- Gaussian filter with 300 km
- decorrelation filter from Swenson
- scale factors by Landerer

- trend, annual and semi-annual signals are removed
- a 13-month moving-average filter is applied to TWS anomaly, MEI, precipitation and runoff

Results and discussions

» The effect of ENSO on TWS anomaly in the MLYRB

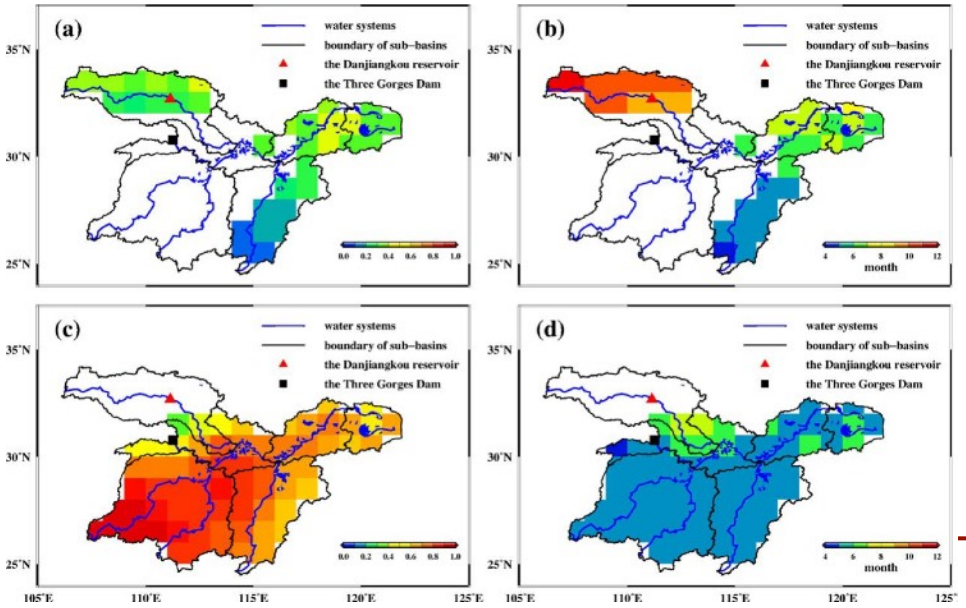
- from January 2003 to October 2010, the cross-correlation analysis failed to pass the significance test with $p<0.01$
- from October 2010 to June 2017, the correlation coefficient (CC) is 0.49, and the peak CC is 0.75 with a time lag of 5 months



Results and discussions

» The effect of ENSO on TWS anomaly in the MLYRB

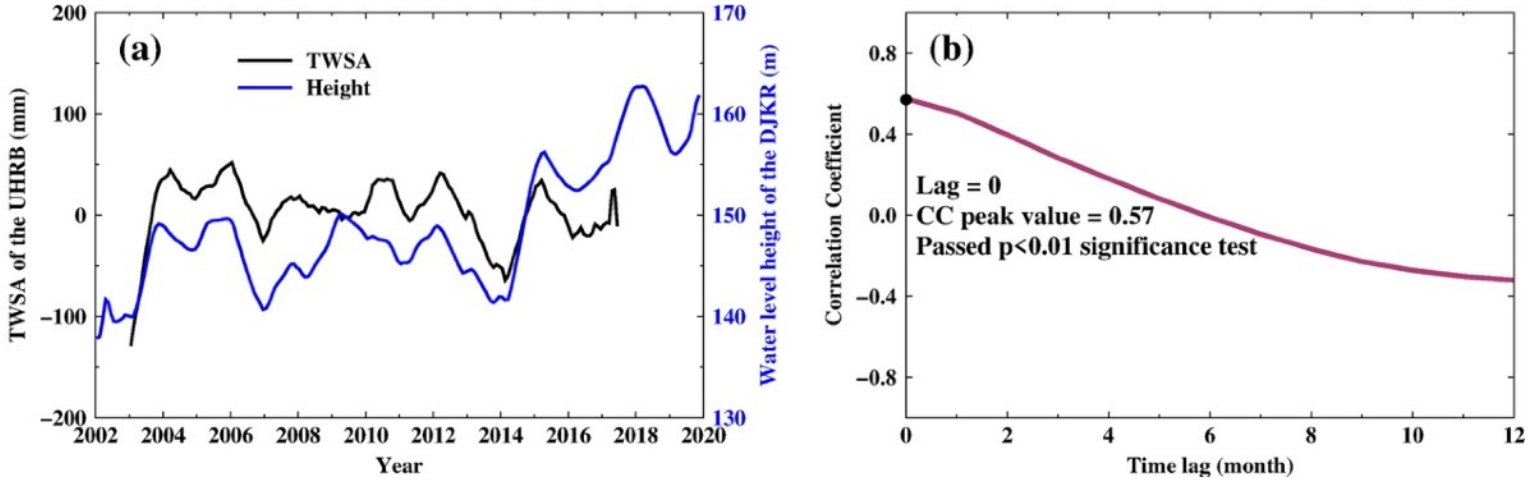
- from January 2003 to October 2010, over 55% of grid cells have failed the significance test, the remaining 45% with a peak CC < 0.43 at a lag time from 4 to 12 months
- from October 2010 to June 2017, over 85% of the grid cells have passed the significance test with a peak CC > 0.60 at a typical time lag of 5 months, and a maximum peak CC of ~ 0.90



Results and discussions

» The causes of TWS anomaly in the Han River Basin

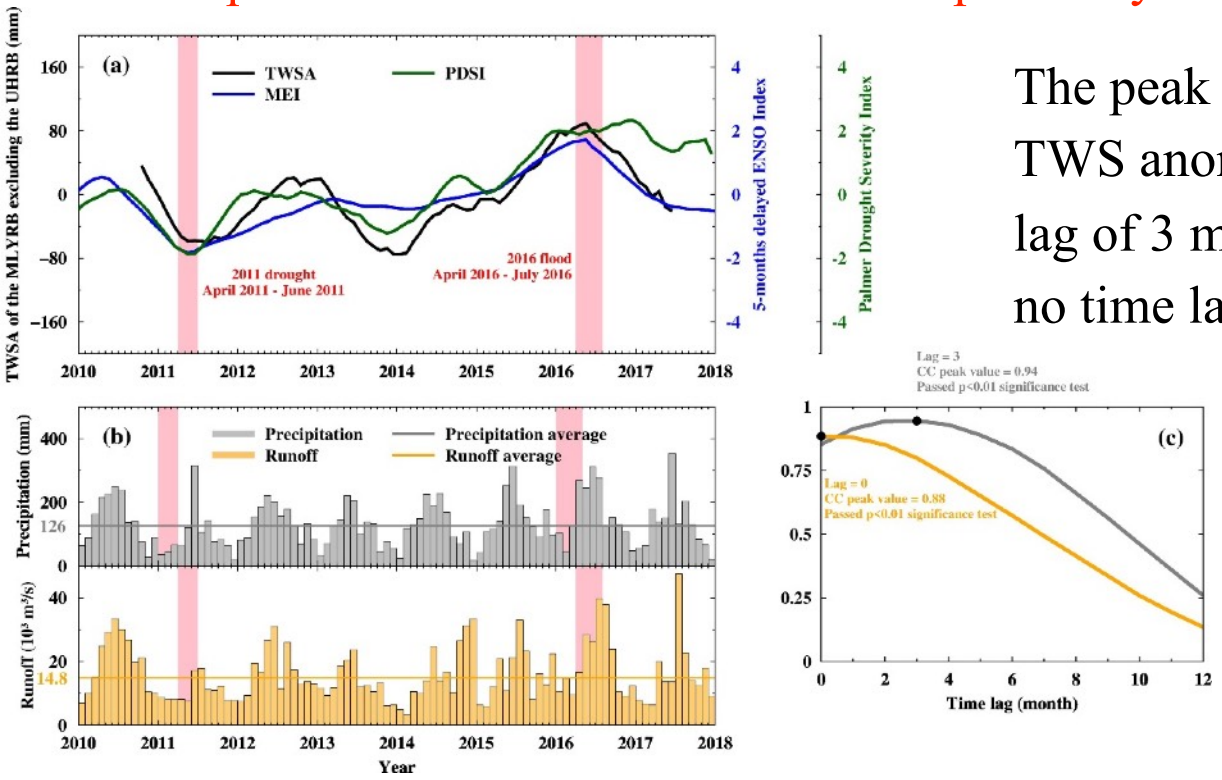
- to serve the Central Route of South-to-North Water Transfer Project in China, the Danjiangkou dam has heightened from originally 97 m to 111.6 m during 2005-2009
- from January 2003 to June 2017, the impoundment and water diversion of the Danjiangkou reservoir has a significant impact on the TWS anomaly of the upper Han River basin with a peak CC of 0.57



Results and discussions

» The possible connections between ENSO and the TWS anomalies

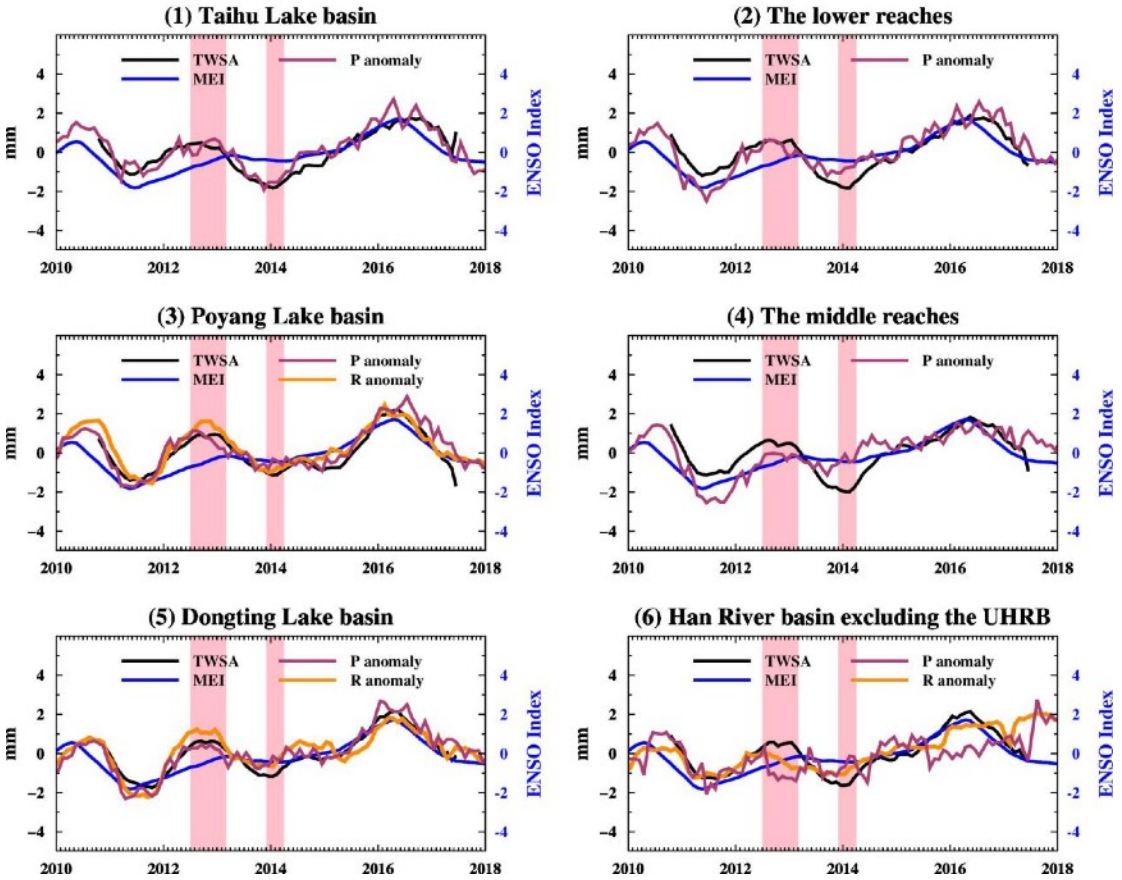
- the 2011 drought and the 2016 flood are captured by TWS anomaly, PDSI and MEI simultaneously
- two peaks in 2012 and 2014 are not captured by ENSO



The peak CCs between P, R and TWS anomaly are 0.94 at a time lag of 3 months and 0.88 with no time lag

Results and discussions

» The possible connections between ENSO and the TWS anomalies



The normalized time series in 6 sub-basins

- The peaks in 2012 and 2014 are also captured by TWS anomaly in 6 sub basins
- The peaks are mainly caused by runoff in the Han River basin, and by precipitation in the other basins

Conclusions

» Before the full operation of TGD, the TWS anomalies in the MLYRB have a very weak correlation with ENSO

» After the full operation of TGD, the effect of ENSO on the TWS anomalies became more significant with a peak CC of 0.75 at a time lag of 5 months in the whole MLYRB, and even up to 0.90 for the southwestern Dongting Lake basin

» The TWS anomaly induced by extreme hydrological disasters could be early warned by the ENSO index with a nearly 5-month time lag and by the precipitation with a nearly 3-month time lag in the MLYRB

Thank you!