GRACE Science Team meeting

Hydrological Mass Variations Caused by Extreme Weather Conditions in Yangtze River Basin Measured by GRACE and Connections with ENSO

Zizhan Zhang[1,3] B. F. Chao[2] Jianli Chen[3] C.R. Wilson[3,4]

GSTM, 2013, Austin

[1]Institute of Geodesy and Geophysics, Chinese Academy of Sciences, Wuhan, China
[2]Institute of Earth Sciences, Academia Sinica, Taiwan, China
[3]Center for Space Research, University of Texas at Austin, Austin, USA
[4]Jackson School of Geosciences, University of Texas at Austin, Austin, USA

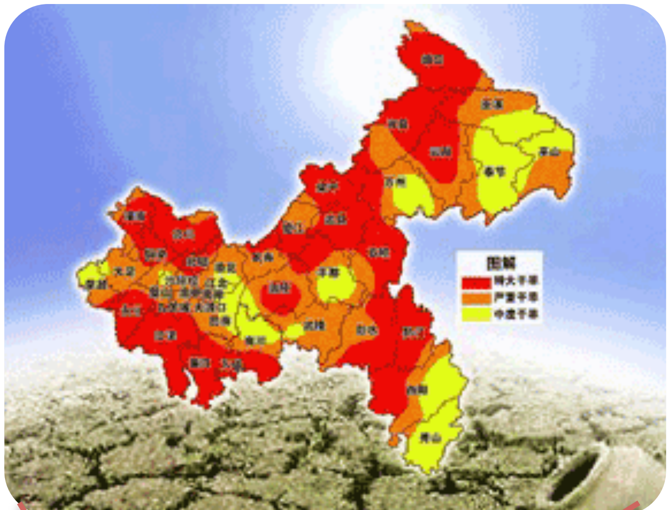
OUTLINE

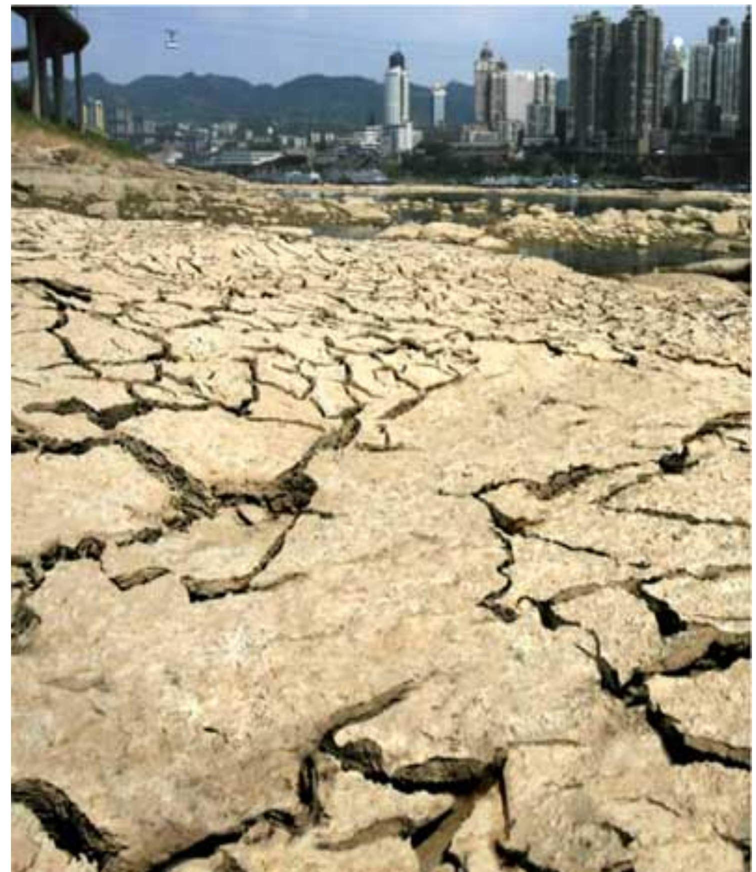
1. Introduction
2. Method and data processing
3. Water storage anomaly observed by GRACE
4. Evident from climate models and river gauges
5. Connections with ENSO index
6. Summary

1. Extreme drought events in Yangtze River basin

2006/8-9,

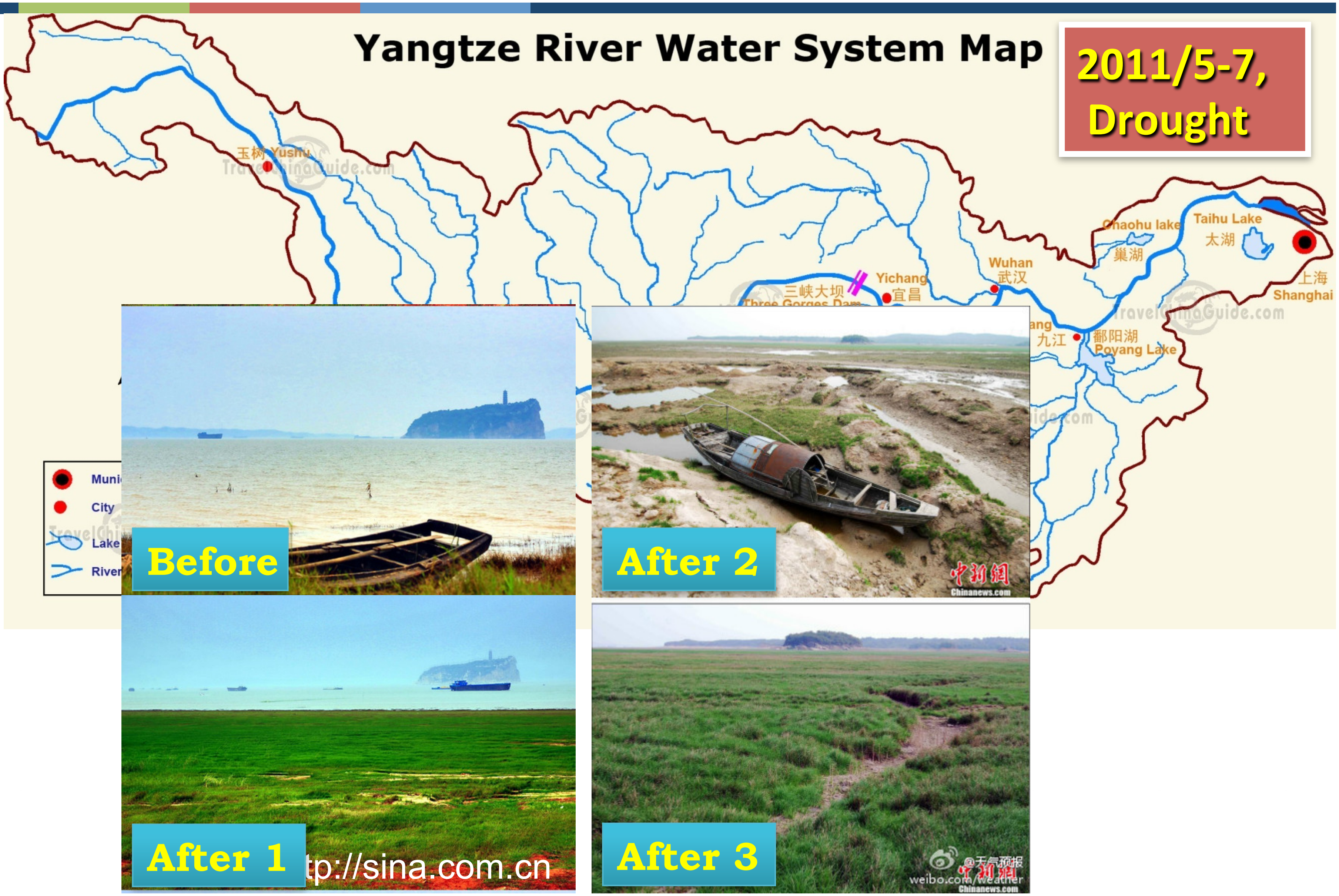
Drought





The severe drought of Chongqing occurred in 2006 with long duration, high temperature, was the most serious drought rarely seen in the last 100 years.

1. Extreme drought events in Yangtze River basin



2.1 Land hydrology

Land water mass storage ("soil moisture") budget:

ΔStorage (as seen by GRACE)

= **Precipitation – Evapotranspiration – Runoff**

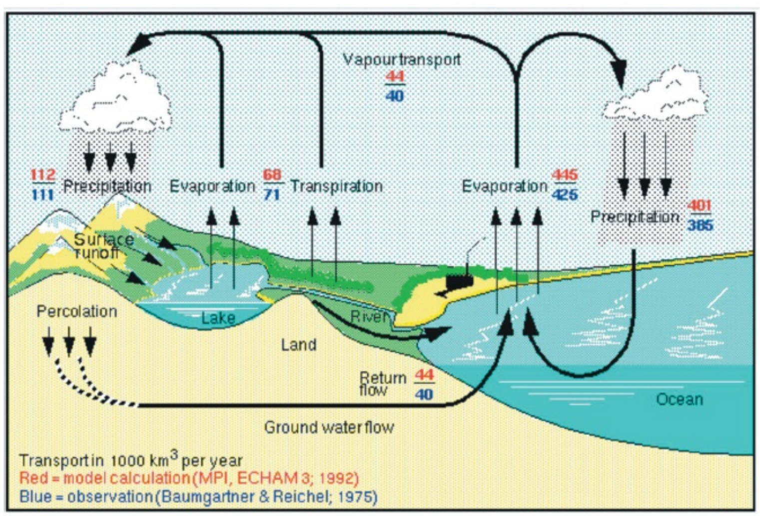
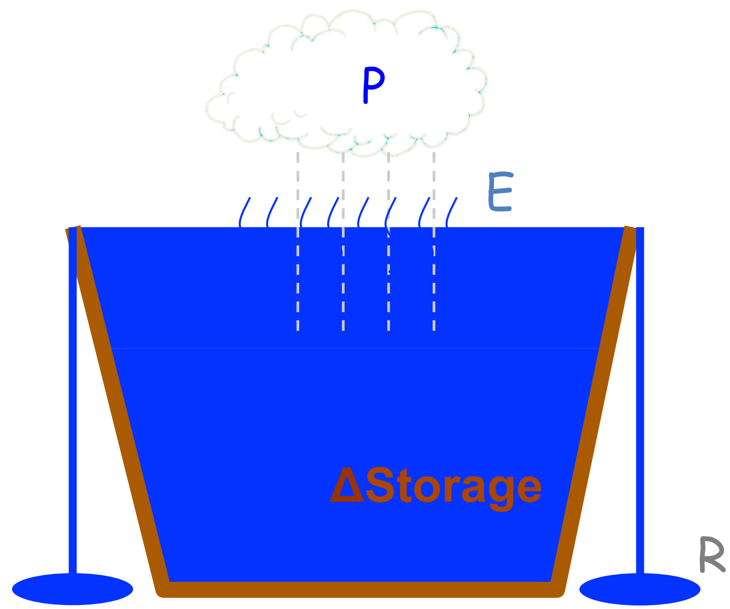


Figure 3.4.1: *The global hydrological cycle (Max-Planck-Institute for Meteorology, Hamburg)*



Bucket model

2.2 GRACE time-variable gravity data

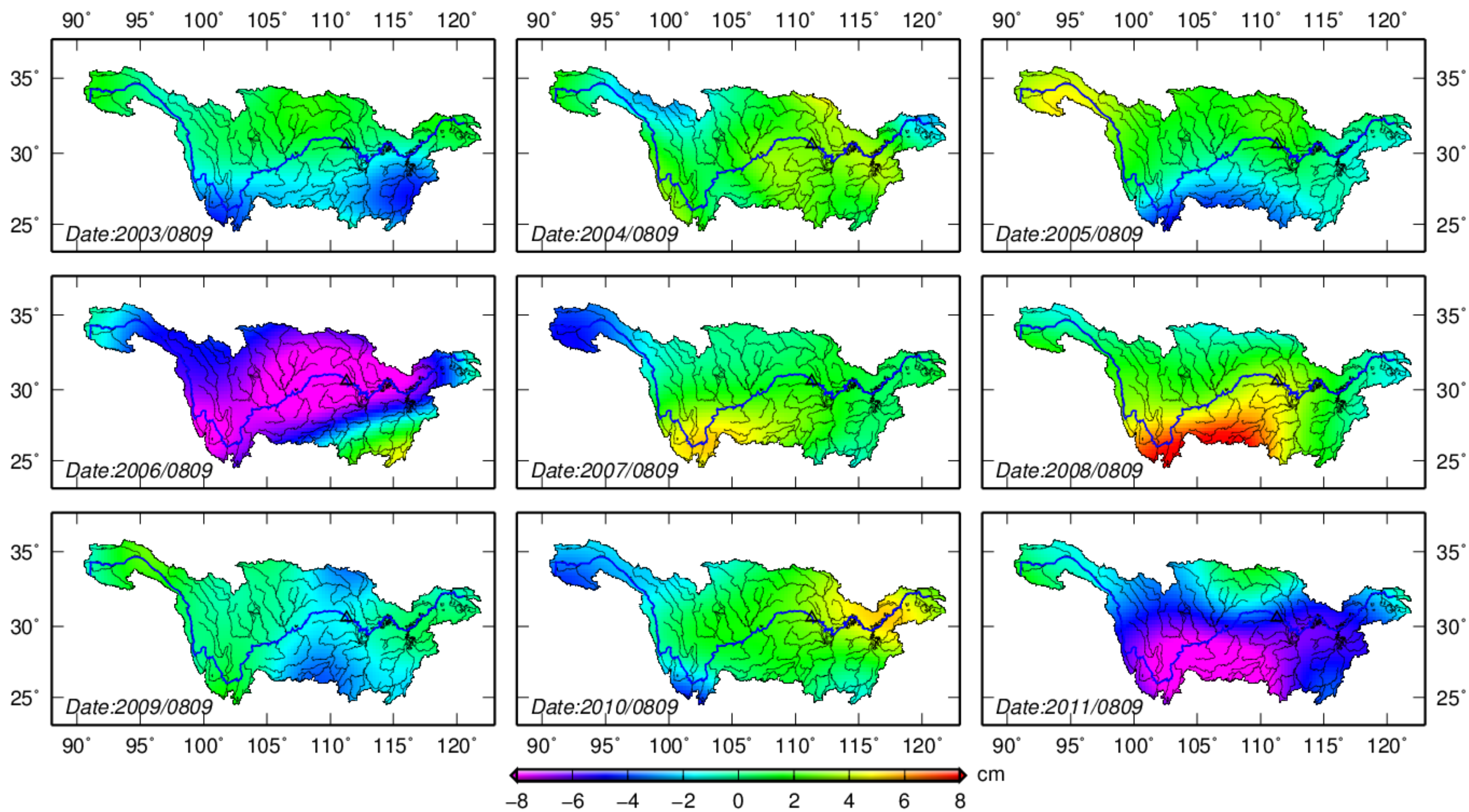
- CSR RL05 GSM solutions up to degree 60
- 113 monthly solutions: Jan. 2003 – Sep. 2012
- C_{20} from SLR (*Cheng and Ries, 2011*)
- 250 km Fan filter smoothing (*Zhang et al., 2009*)
- de-correlation filter (*Swenson & Wahr, 2006*)

2.2 Hydrological Data

- Global Land Data Assimilation System (GLDAS-Noah)
- WaterGAP Global Hydrology Model (WGHM)
- Tropical Rainfall Measuring Mission (TRMM)-Precipitation
- YangTze river gauge data

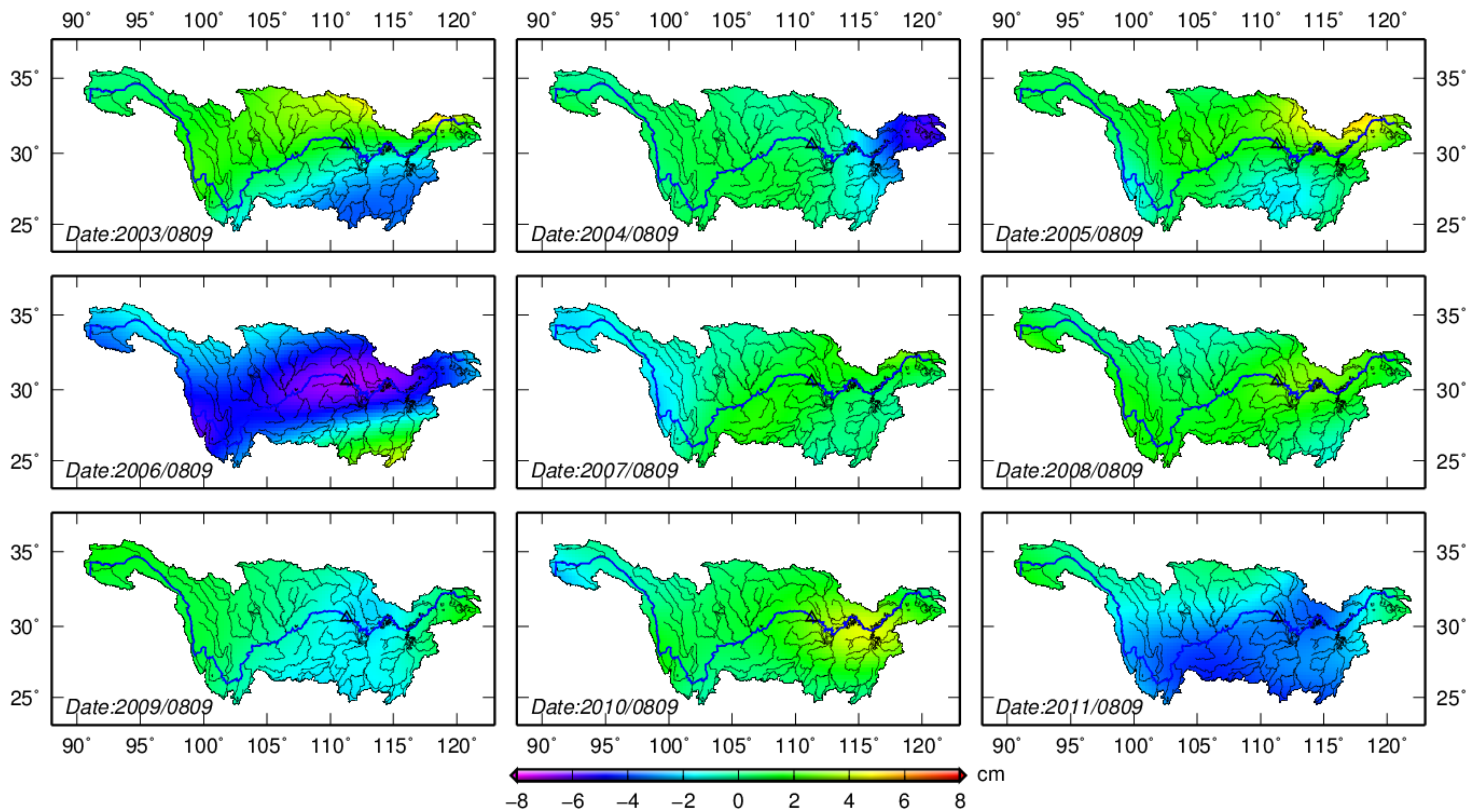
3.1 GRACE-averaged August and September water storage changes in Yangtze River basin (de-trend, de-season)

(a P5M11 de-correlation and 250 km Fan filter scheme is applied,in centimeters of water)



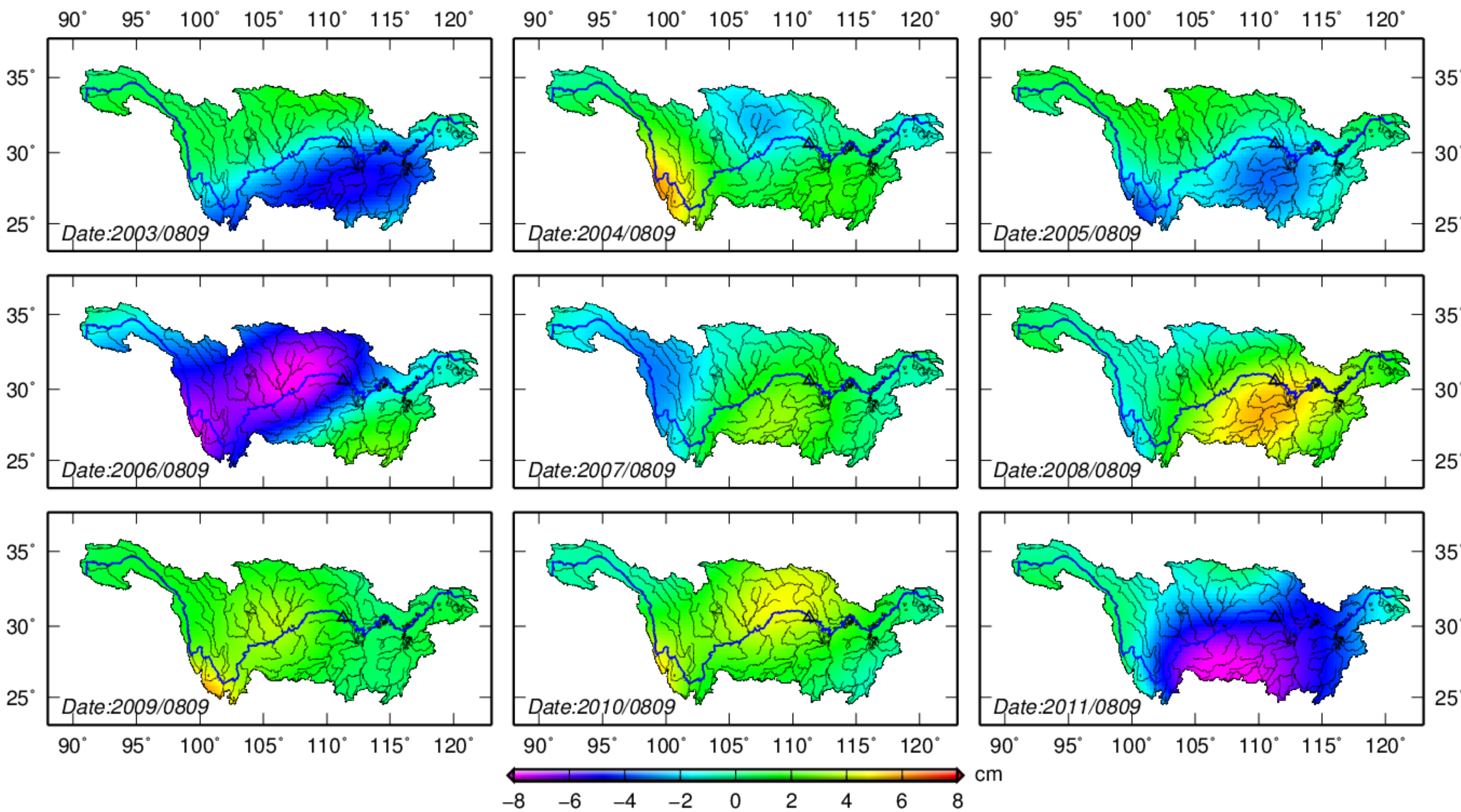
3.2 WGHM-averaged August and September water storage changes in Yangtze River basin (de-trend, de-season)

(250 km Fan filter scheme is applied,in centimeters of water)

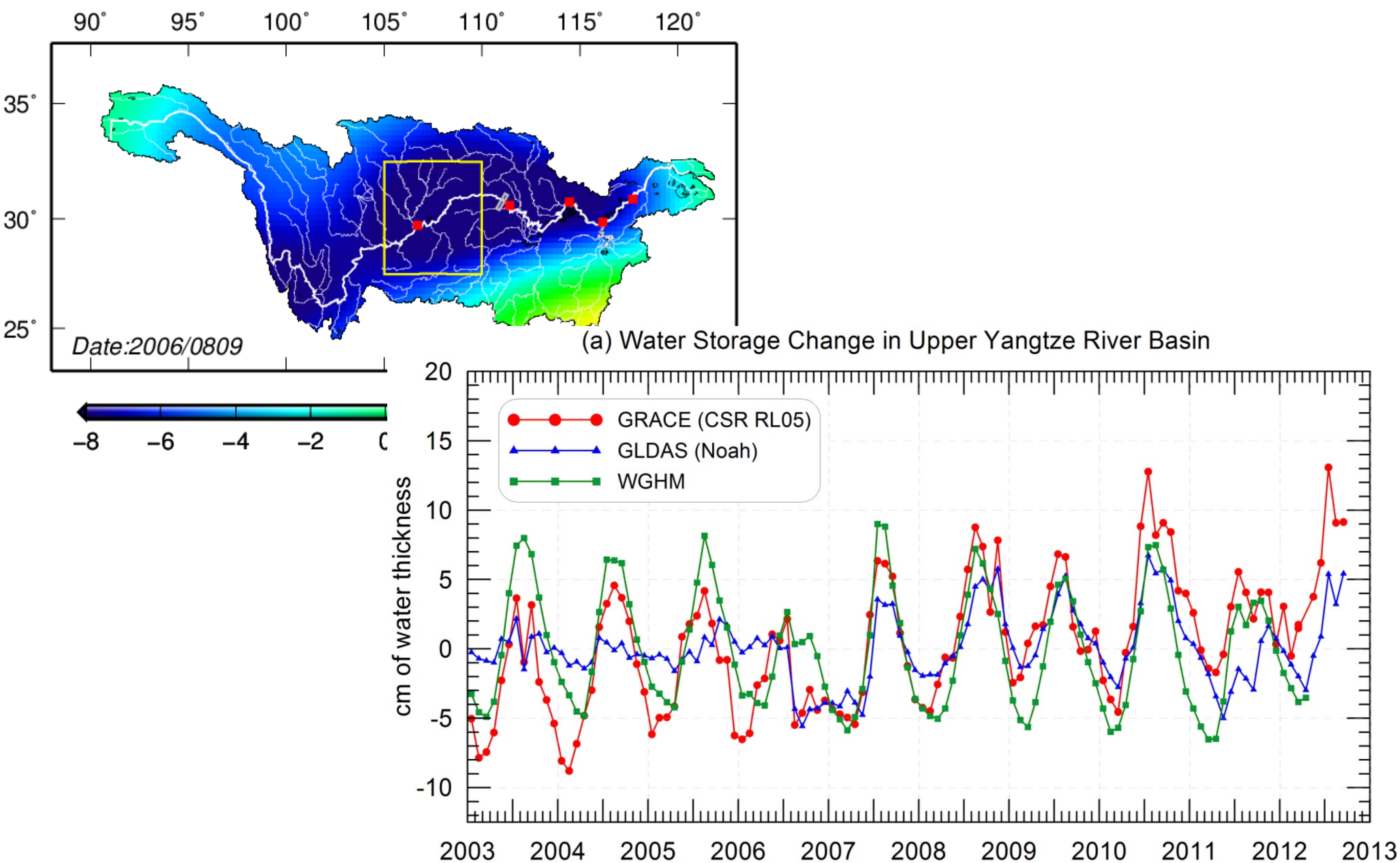


3.3 GLDAS (Noah)-averaged August and September water storage changes in Yangtze River basin (de-trend, de-season)

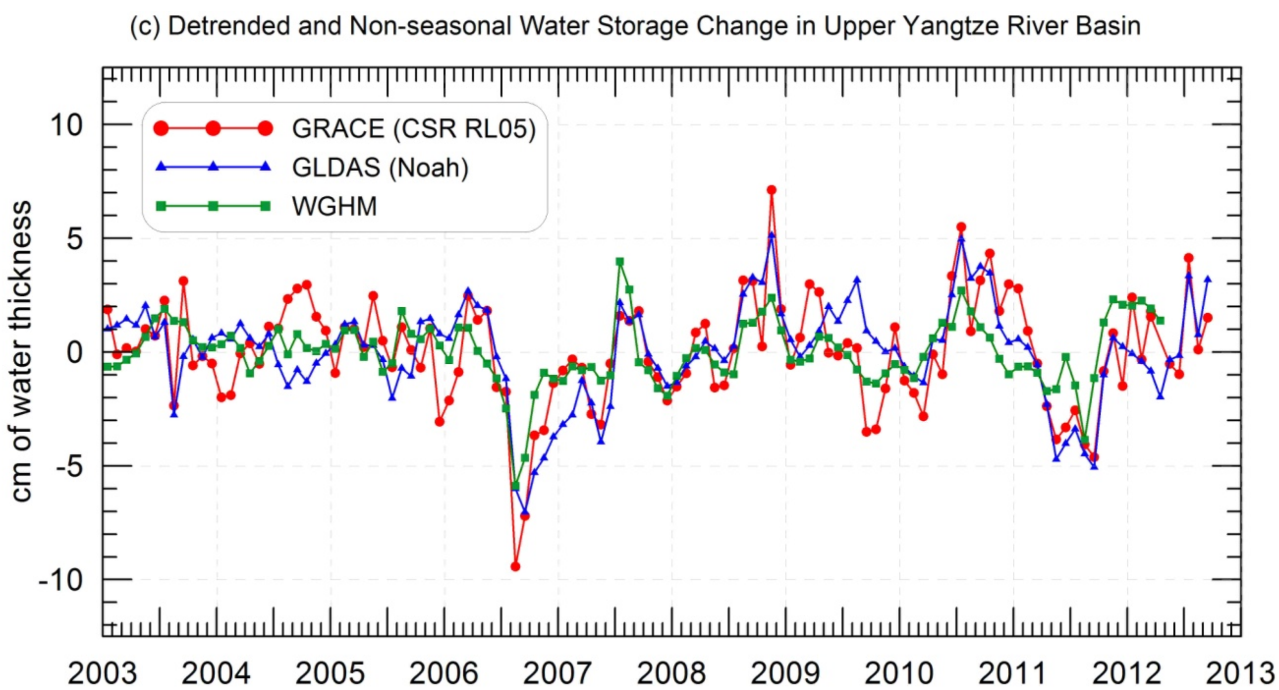
(250 km Fan filter scheme is applied,in centimeters of water)



3.4 Water Storage Change in Upper Yangtze River Basin

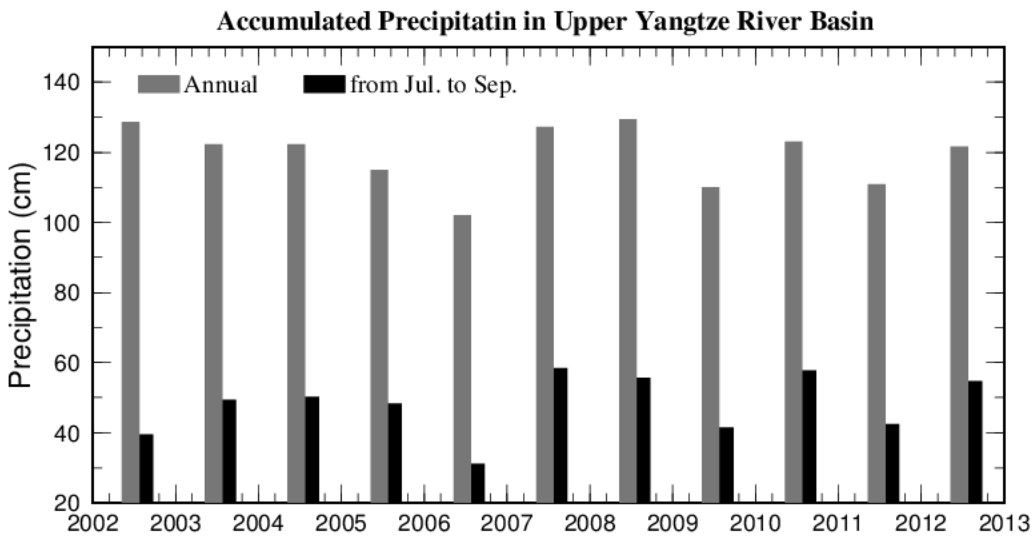


3.4 Water Storage Change in Upper Yangtze River Basin



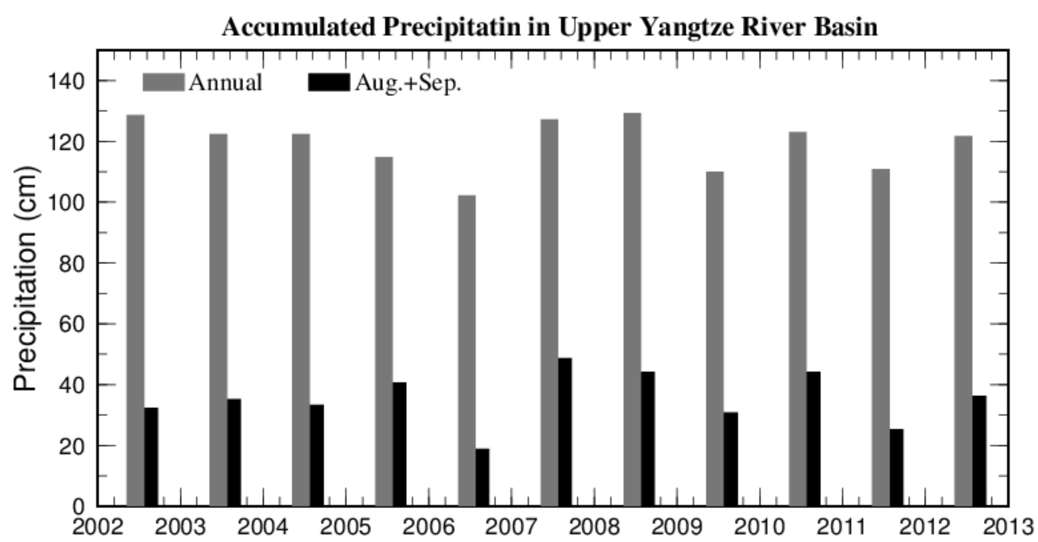
Non-seasonal TWS changes in this area, annual, semiannual and slope have been removed through unweighted least squares fit.

4.1 Precipitation from TRMM in Upper Yangtze River Basin

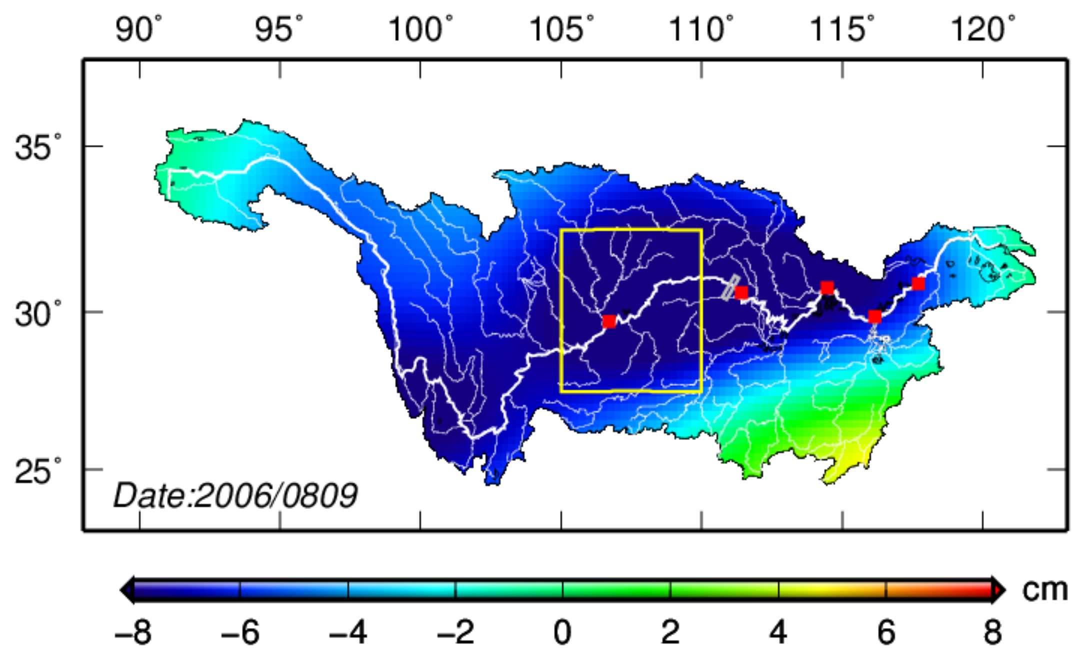


Annual precipitation and accumulated precipitation during July to September

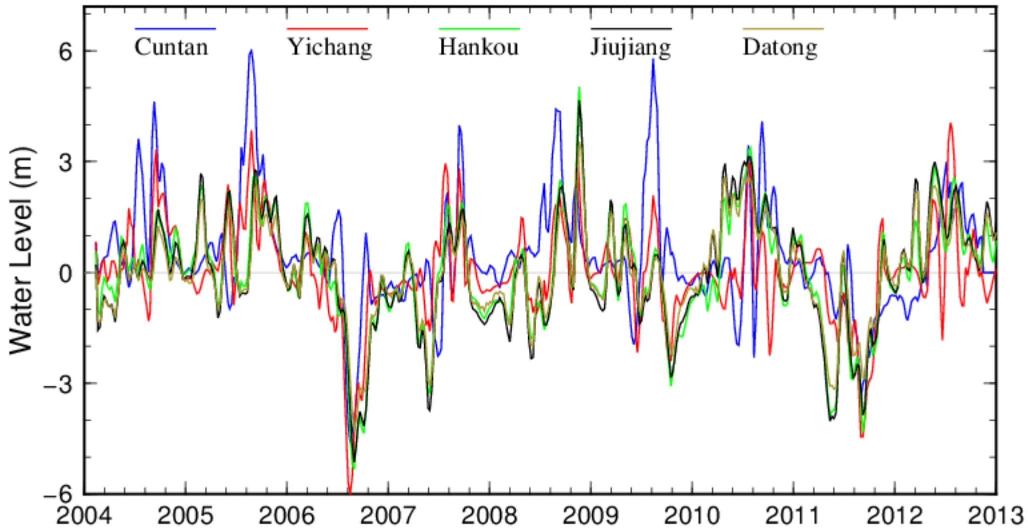
Annual precipitation and Accumulated precipitation during August to September



Location map of 5 river gauge stations in the Yangtze basin

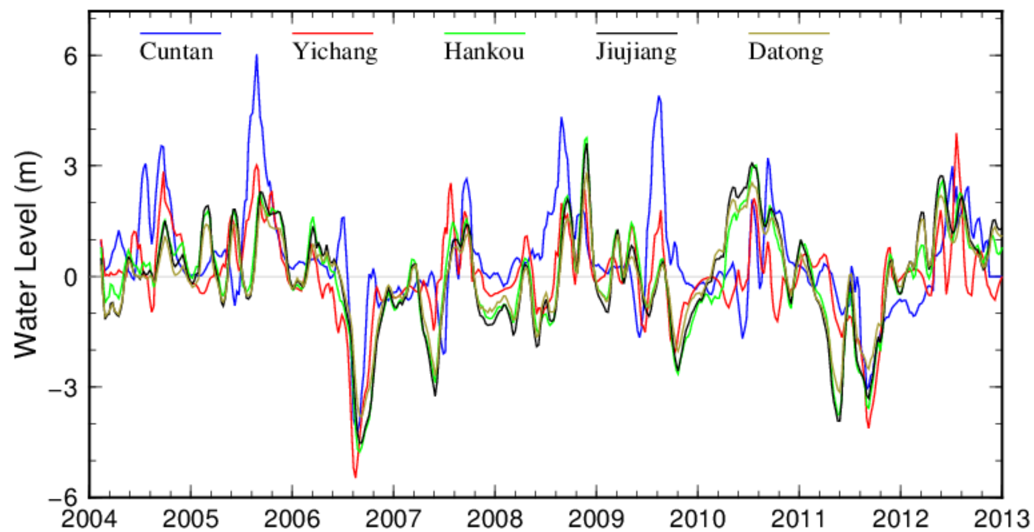


4.2 Water level changes at 5 selected gauge stations

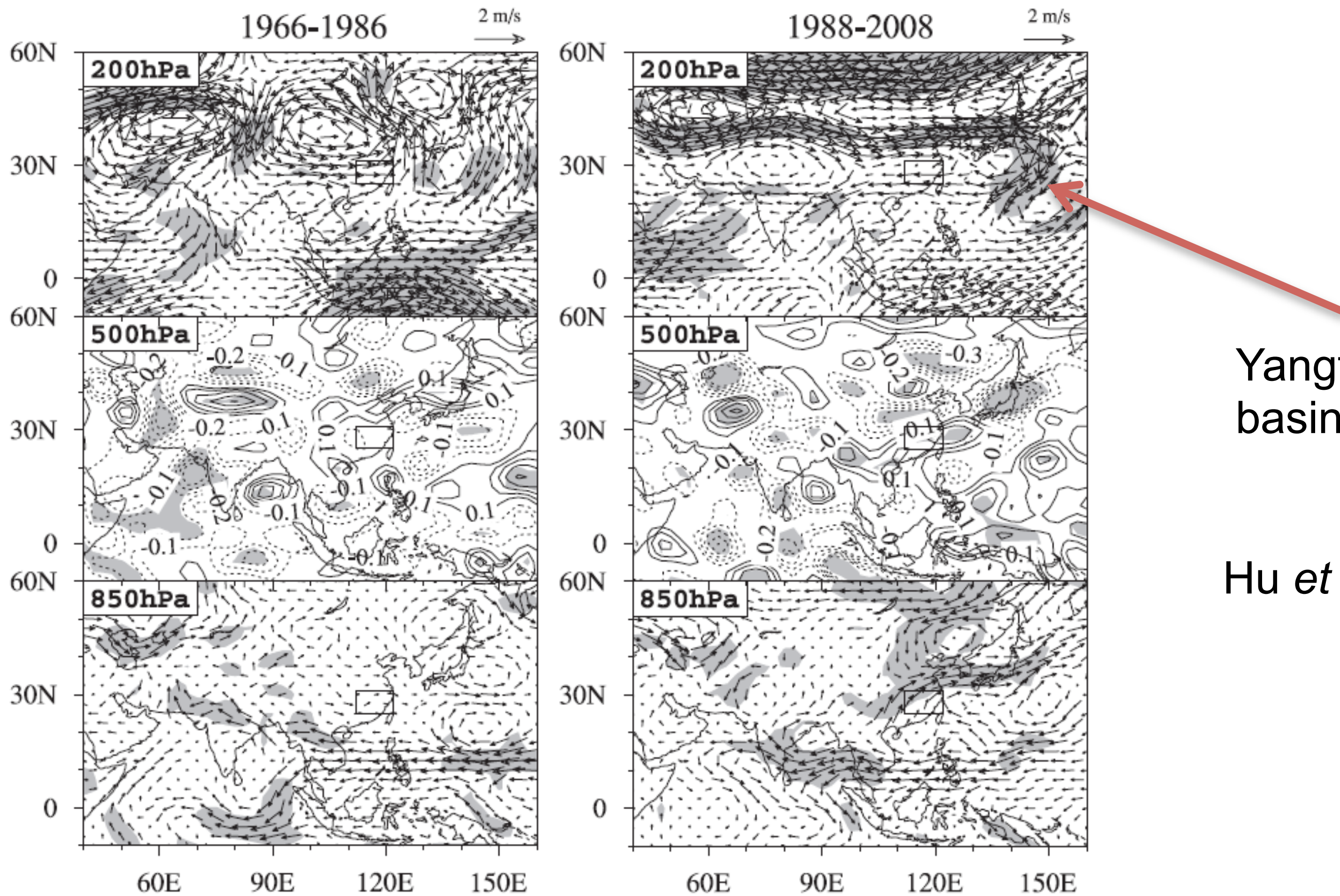


Weekly
Seasonal signal removed

monthly
Seasonal signal removed



ENSO and Yangtze river

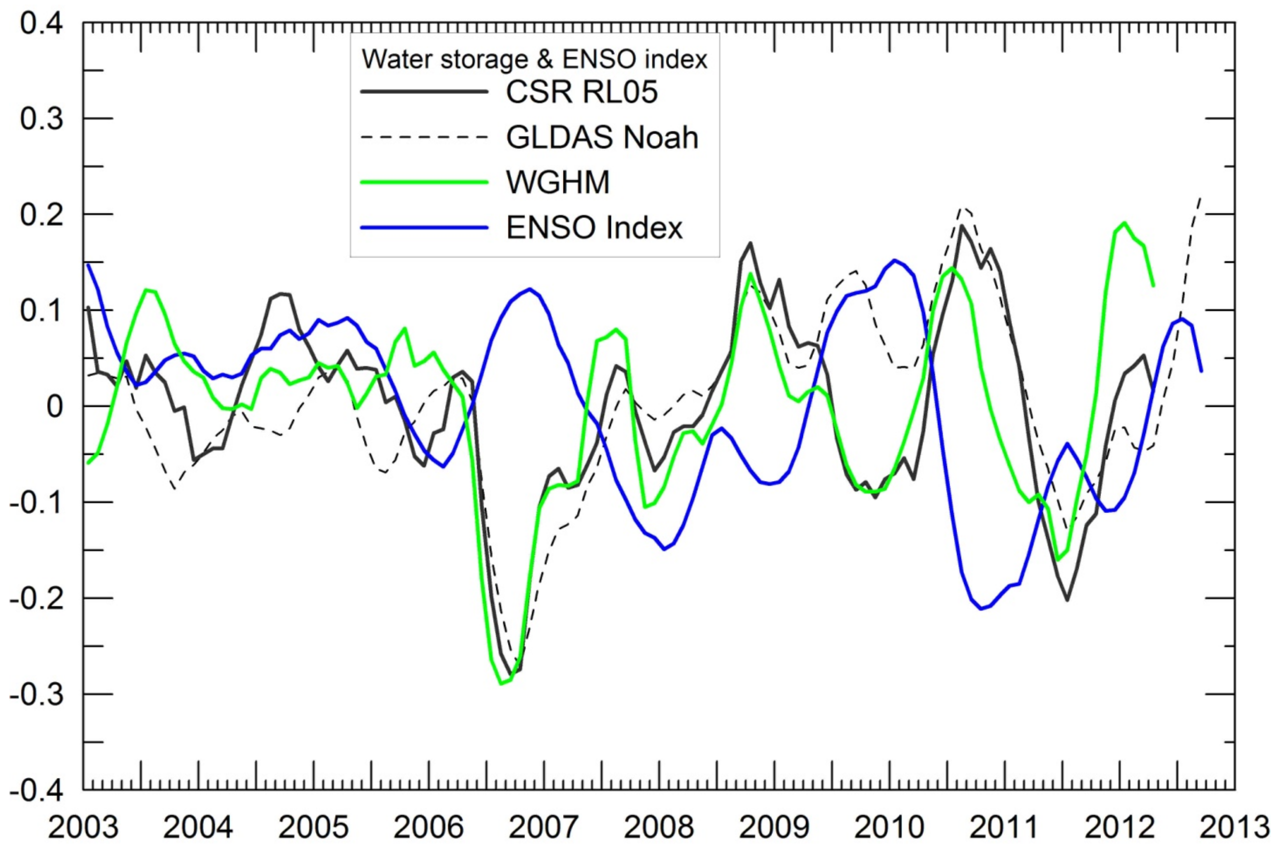


Yangtze River basin

Hu *et al.*, 2012

Strong relationship between ENSO and extreme height temperature events over Yangtze River Basin has been identified.

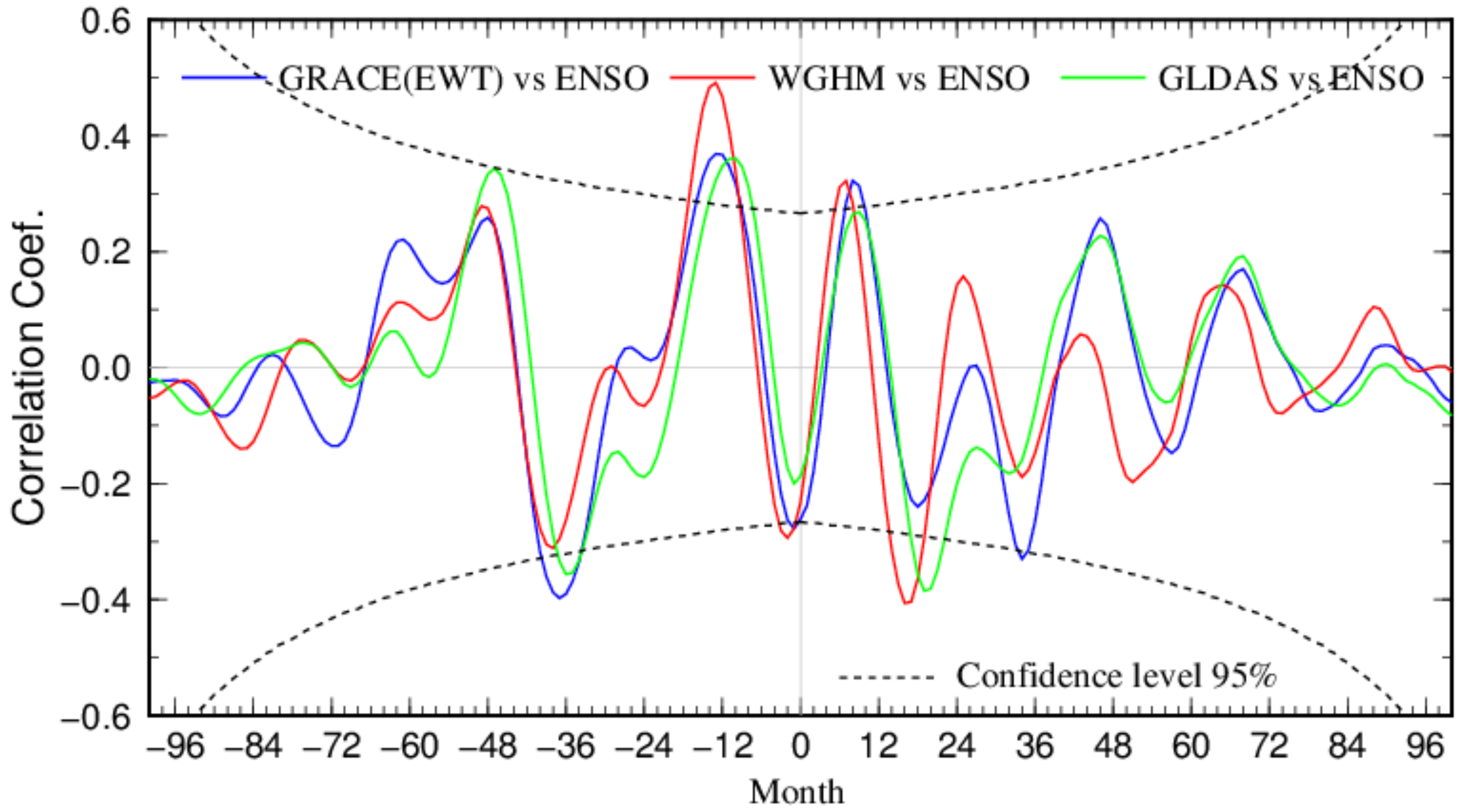
5.1 Water storage changes Vs. ENSO



GRACE: removed annual, semi-annual signal and de-trend

ENSO : sea surface temperature (SST3.4) anomaly

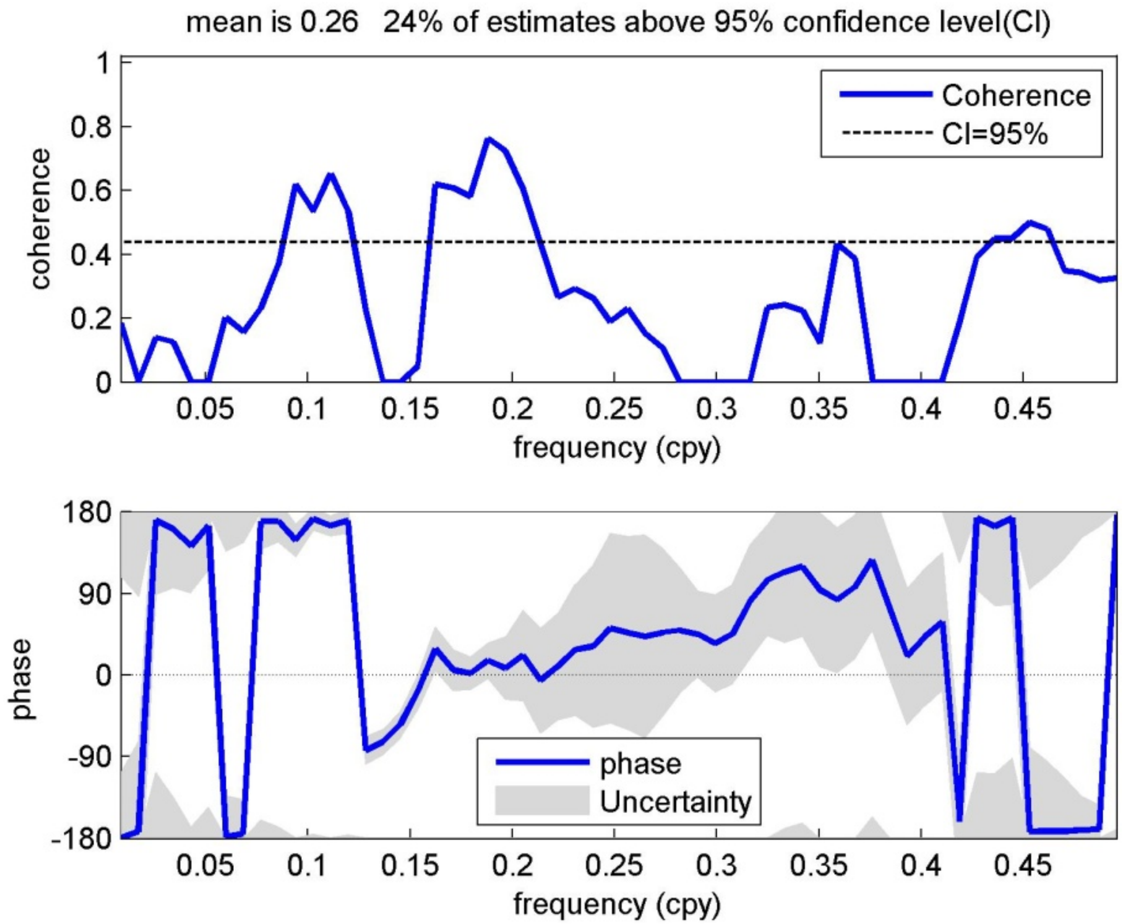
5.2 Correlation analysis



Correlation between water storage change from GRACE (RL05), WGHM, GLDAS and ENSO SST3.4 over time.

Dished line(---): Confidence level 95%, determined by Monte Carlo method

5.3 Coherence analysis (EWT_GRACE vs. ENSO)



Coherence analysis by using the multi-taper method(MTM), and the uncertainty of phase was estimate by Monte Carlo method.

6. Summary

◆ Conventional data resources are insufficient in understanding and quantification of drought occurrence, extent, and intensity.

◆Numerical climate models are valuable in analyzing and diagnosing climate variability, but quantifying and simulating abnormal/extreme meteorological events remain a major challenge.

◆The correlation and coherence between TWS changes in the Yangtze River basin and ENSO index are significant at non-seasonal scales.