Combined Measurements of Lake Levels and Surface Extent Change

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Outline

- Introduction
- Data Sets
- Methodology
- Results
- Conclusion
- Outlook

Introduction

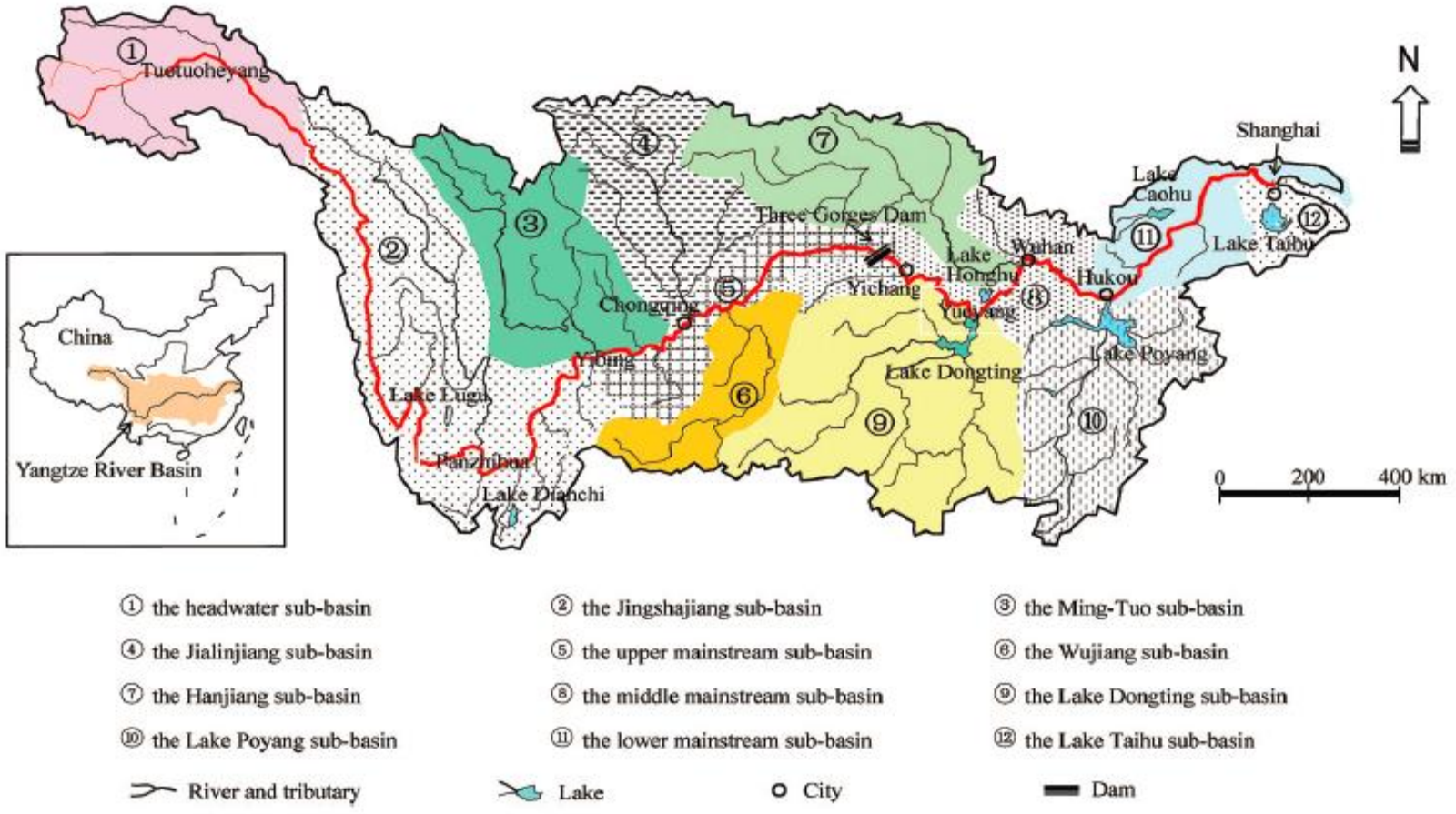
- **Satellite Missions for hydrological purpose**

  (T/P, Jason1/2, **Envisat**, Cryosat2, ICESat……)

- **Water resource problem in China** (caused by local climate, the other land features and human activities)

- **Target Area**: middle and lower reaches of Yangtze river basin (Dongting Lake, Taihu Lake and Hongze Lake)

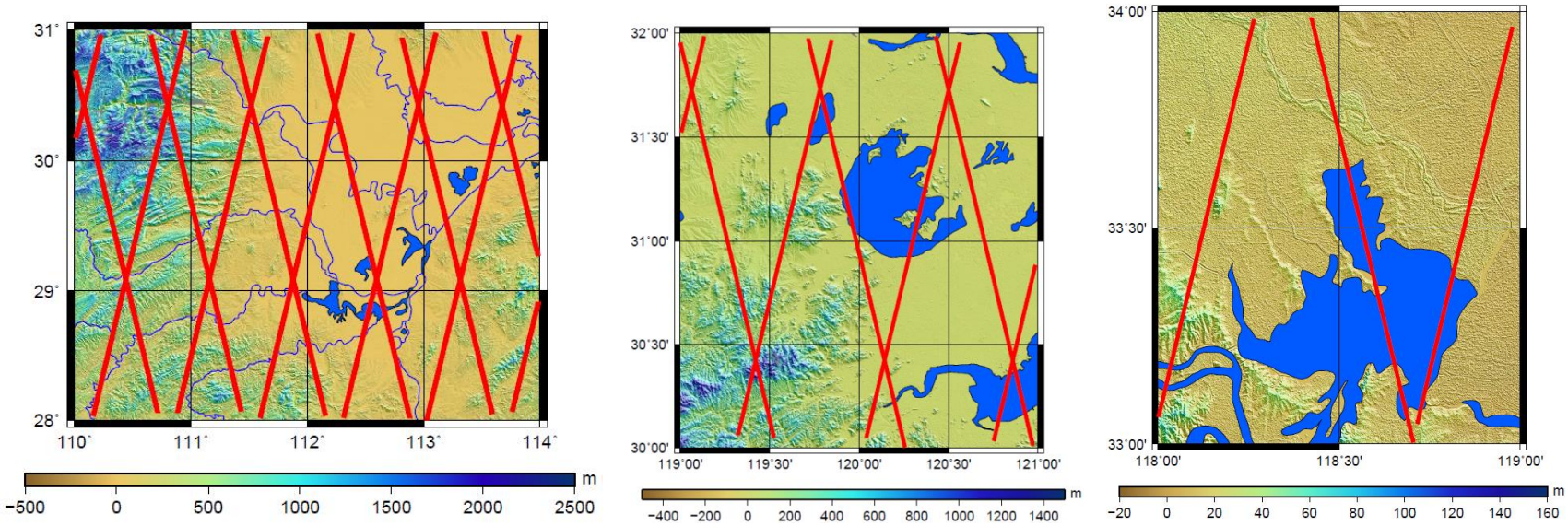
Introduction



Distribution of Yangtze river basin

Data Set

- **Altimetry Part**:
  - Envisat Data Records (GDRs), from may 2002 to March 2012, sampling 18Hz;
  - China_topo_riverlake database of GMT with the available tracks of target lakes



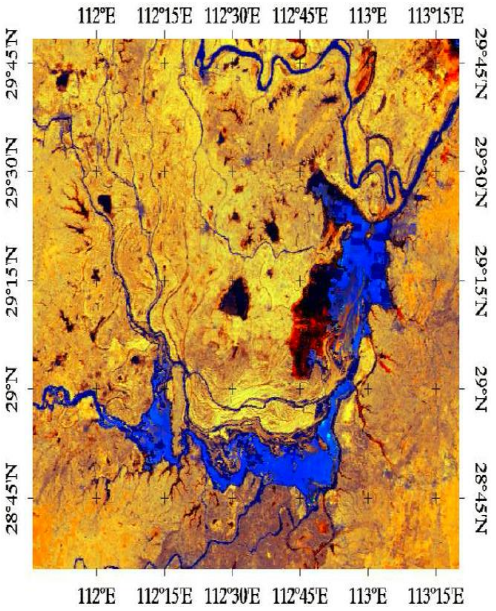
(a) Dongting (b) Taihu (c) Hongze

Avaible ground tracks of Envisat

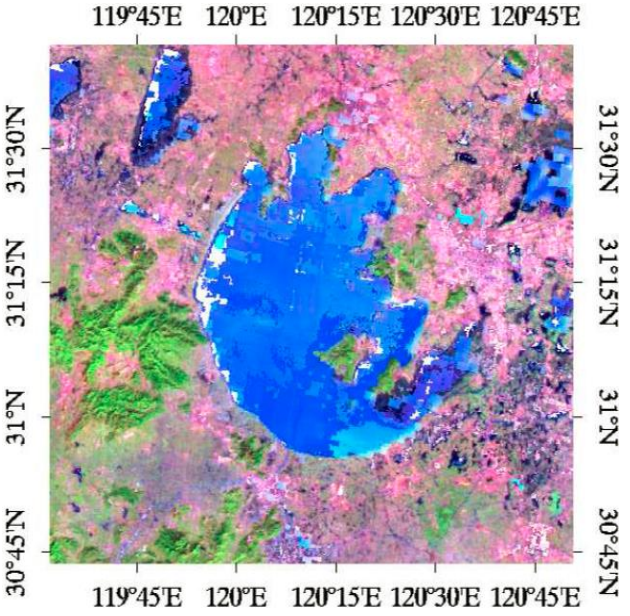
Data Set

- **Surface Extent Part:**

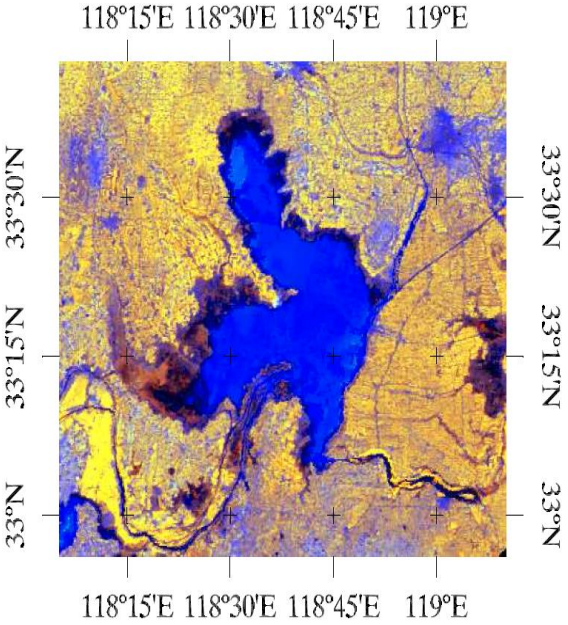
  MODIS data level 3 16 Day vegetation indices (MOD13Q1) data sets with 250m spatial resolution



(a) Dongting



(b) Taihu



(c) Hongze

MODIS images over lakes

Methodology

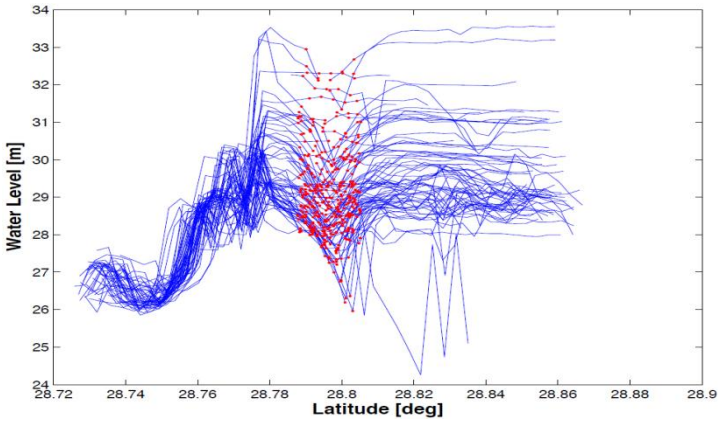
- Water level monitoring from satellite passes

$$L = R_{alt} - R - \Delta R$$

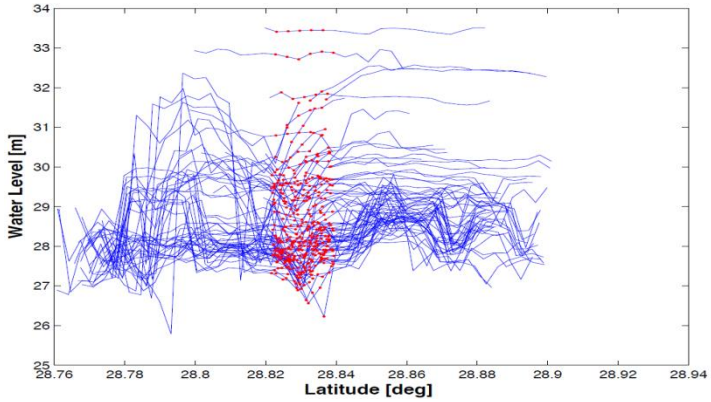
- Outlier elimination LLSPA (Linear Least-Squares Parametric Adjustment)

$$h(t_i) = a + bt_i + ct_i^2 + d\sin\left(\frac{2\pi}{T}t_i\right) + e\cos\left(\frac{2\pi}{T}t_i\right)$$

- Dongting Lake

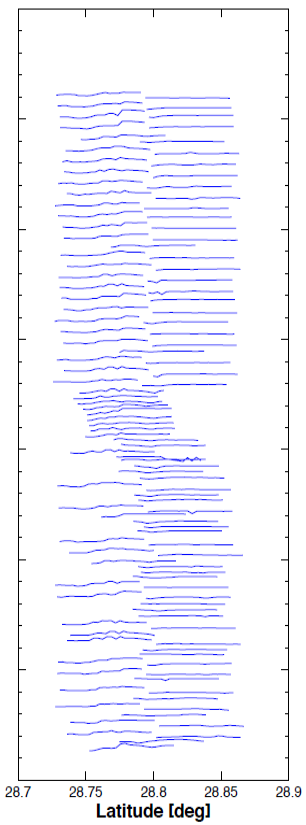


(a) Track 347

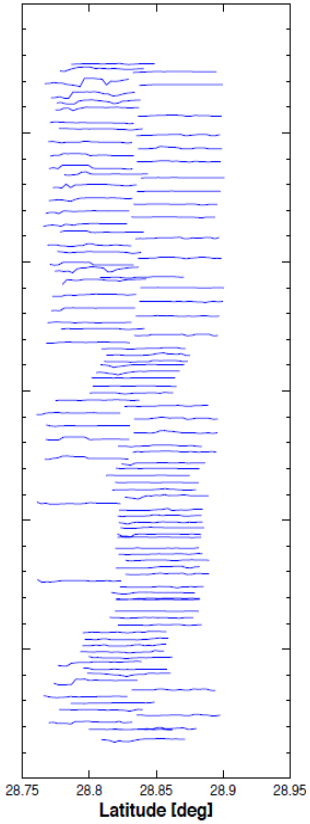


(b) Track 440

Water level from all satellite passes



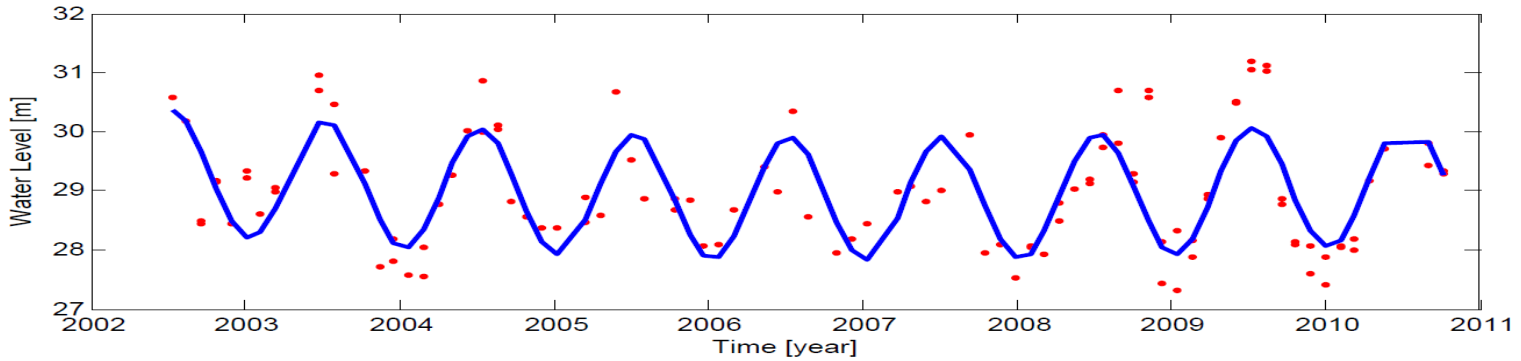
(a) Track 347



(b) Track 440

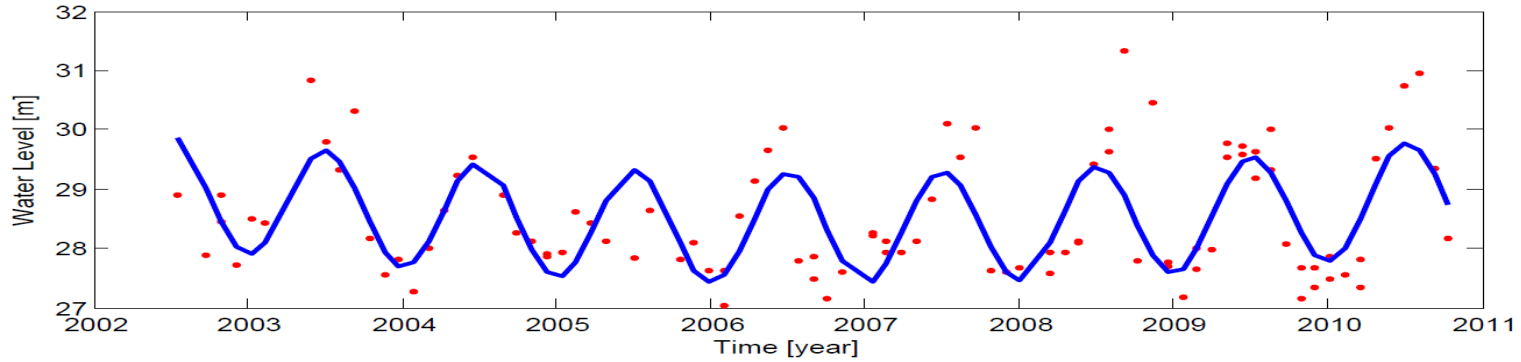
Water level from separate satellite passes

- Dongting Lake



(a) Track 347

Residuals before: 78cm; residuals after: 51cm

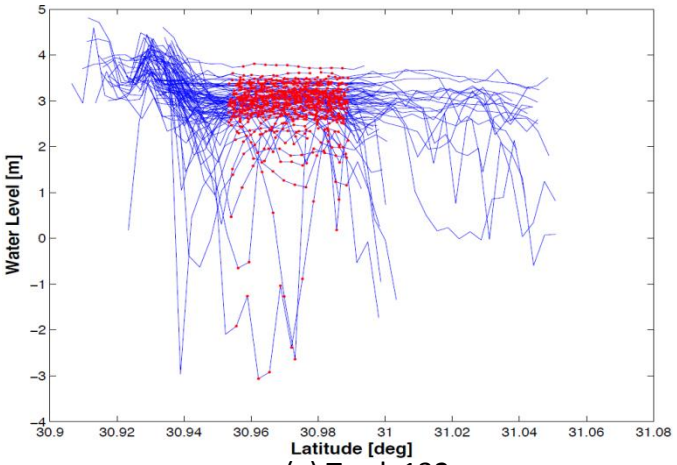


(b) Track 440

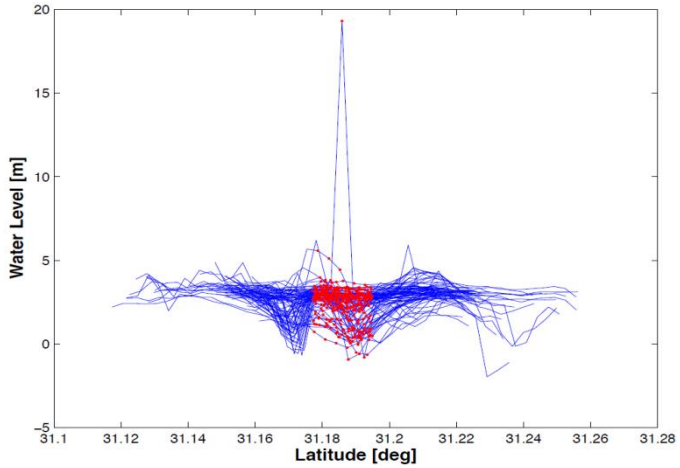
Residuals before: 90cm; residuals after: 32cm

Water level time series fitting the trend to mean values based on ice-1

- Taihu Lake

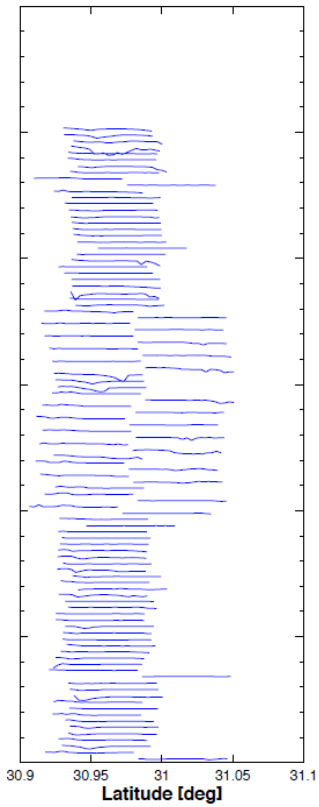


(a) Track 132

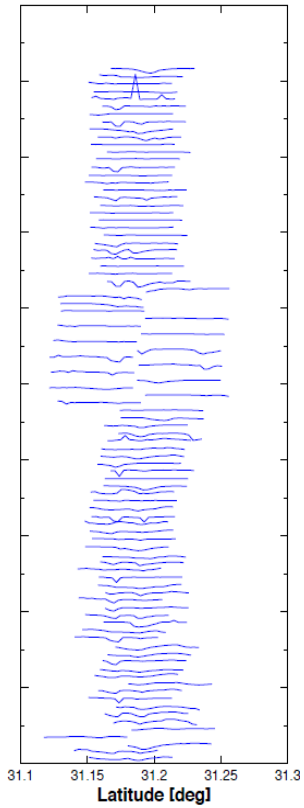


(b) Track 454

Water level from all satellite passes



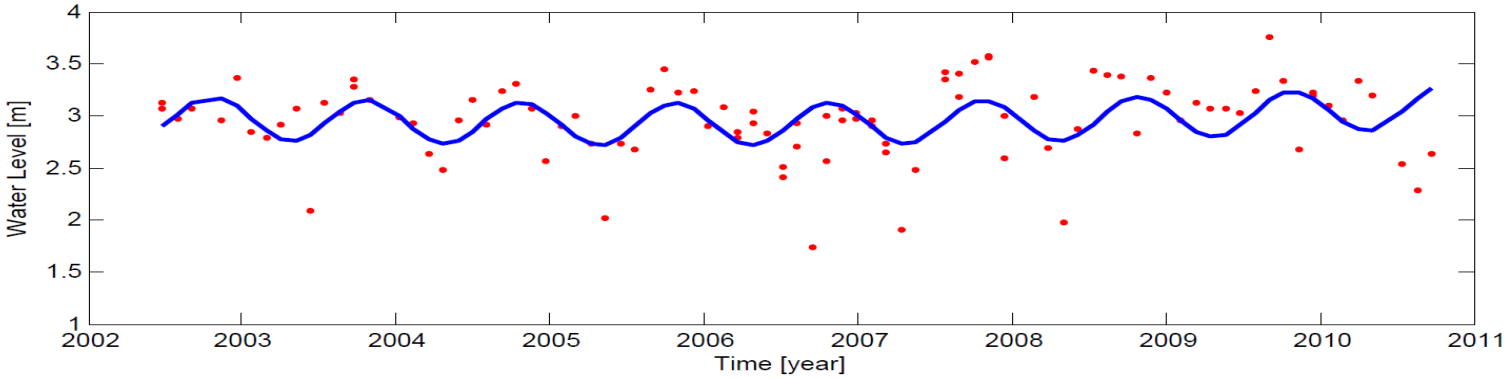
(a) Track 132



(b) Track 454

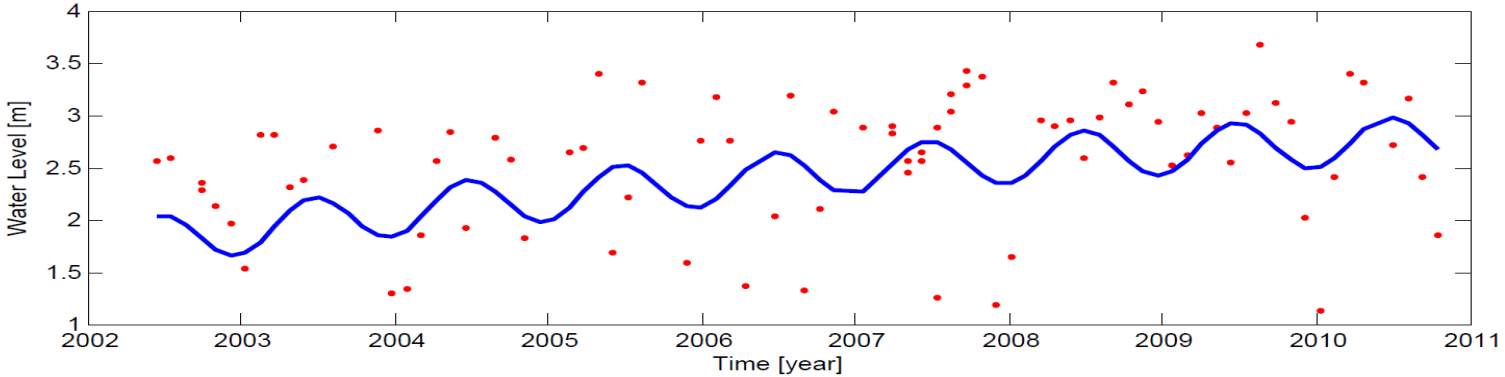
Water level from separate satellite passes

- Taihu Lake



(a) Track 132

Residuals before: 50cm; residuals after: 21cm

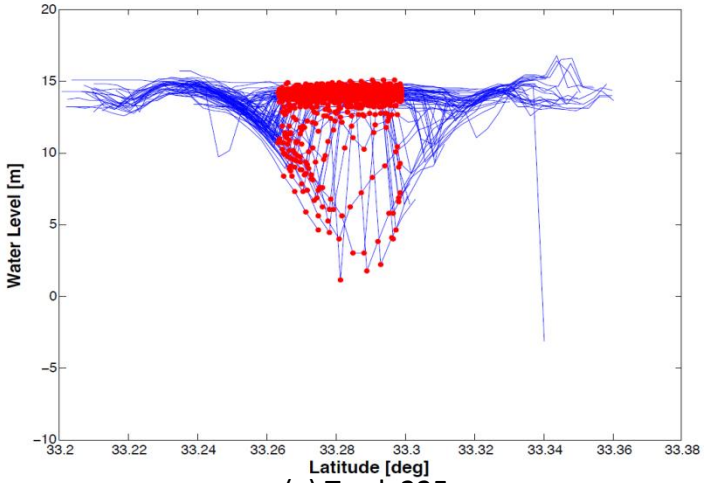


(b) Track 454

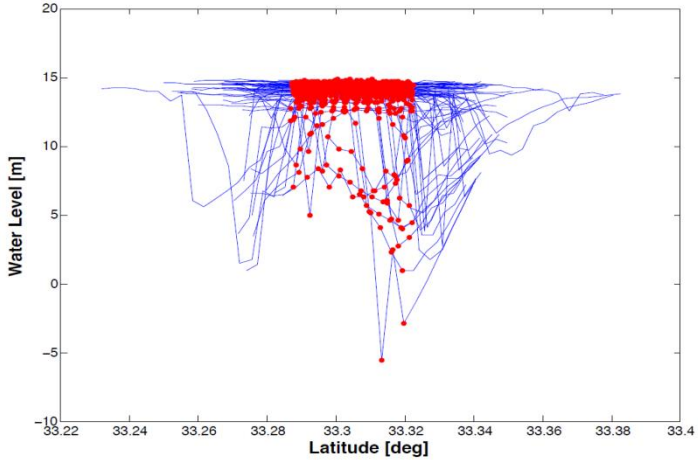
Residuals before: 83cm; residuals after: 31cm

Water level time series fitting the trend to mean values based on ice-1

- Hongze Lake

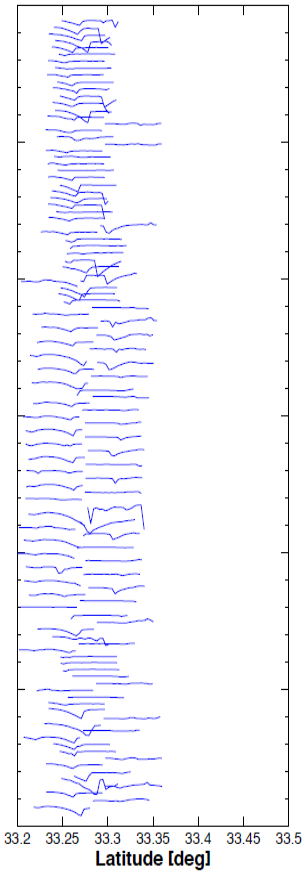


(a) Track 225

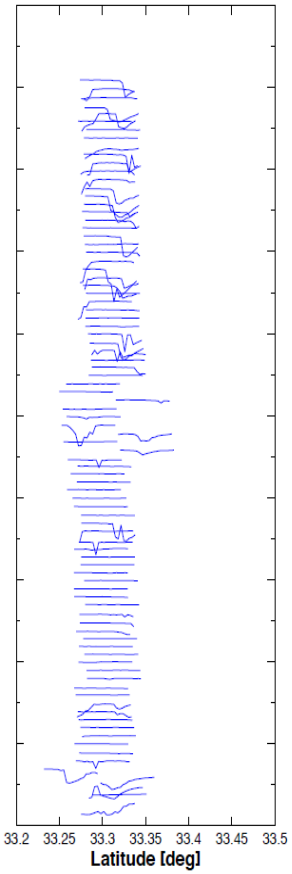


(b) Track 447

Water level from all satellite passes



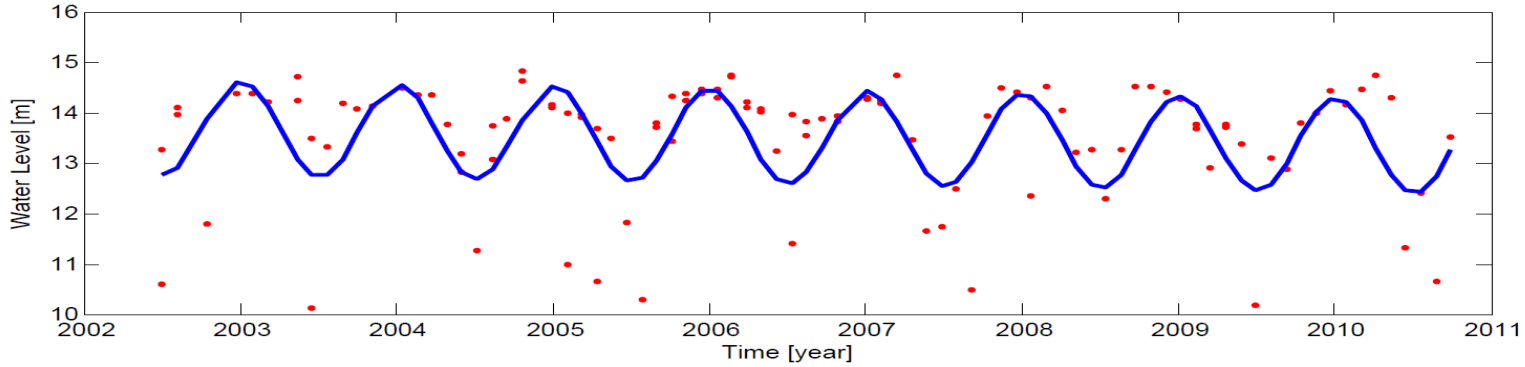
(a) Track 225



(b) Track 447

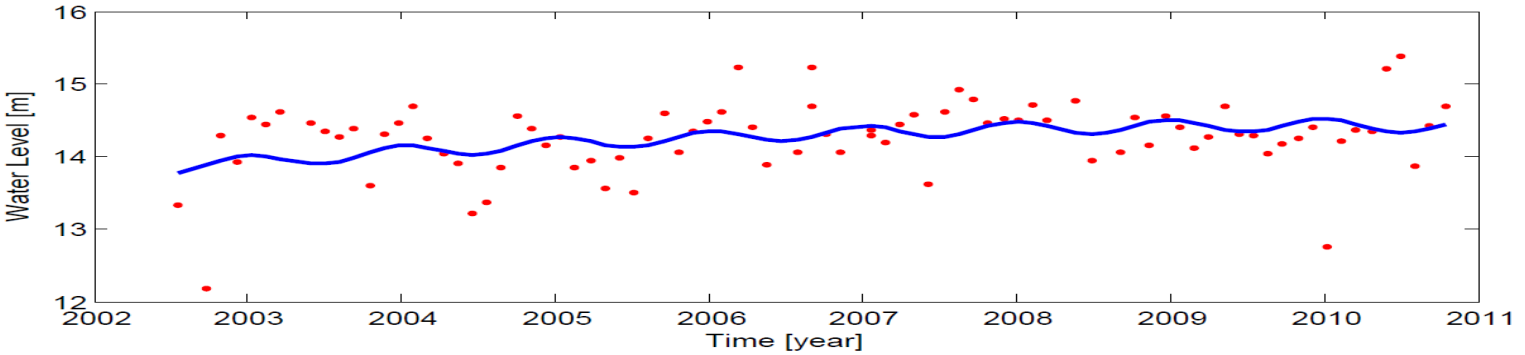
Water level from separate satellite passes

- Hongze Lake



(a) Track 225

Residuals before: 137cm; residuals after: 35cm



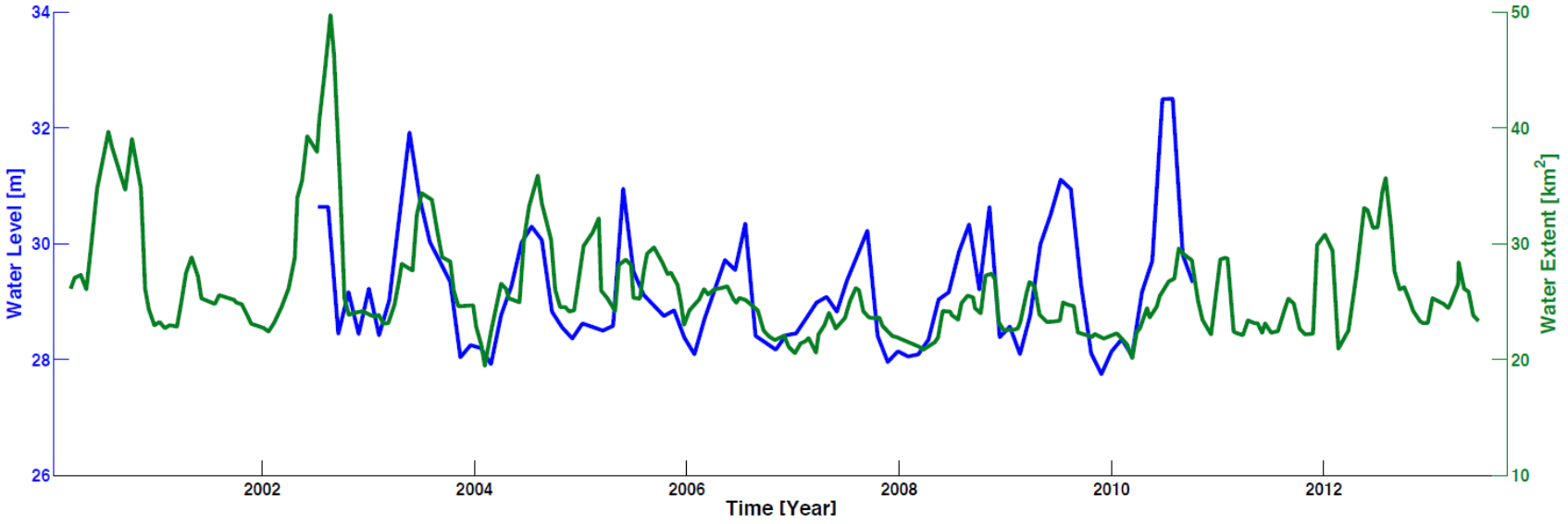
(b) Track 447

Residuals before: 130cm; residuals after: 39cm

Water level time series fitting the trend to mean values based on ice-1

Results

- Dongting Lake



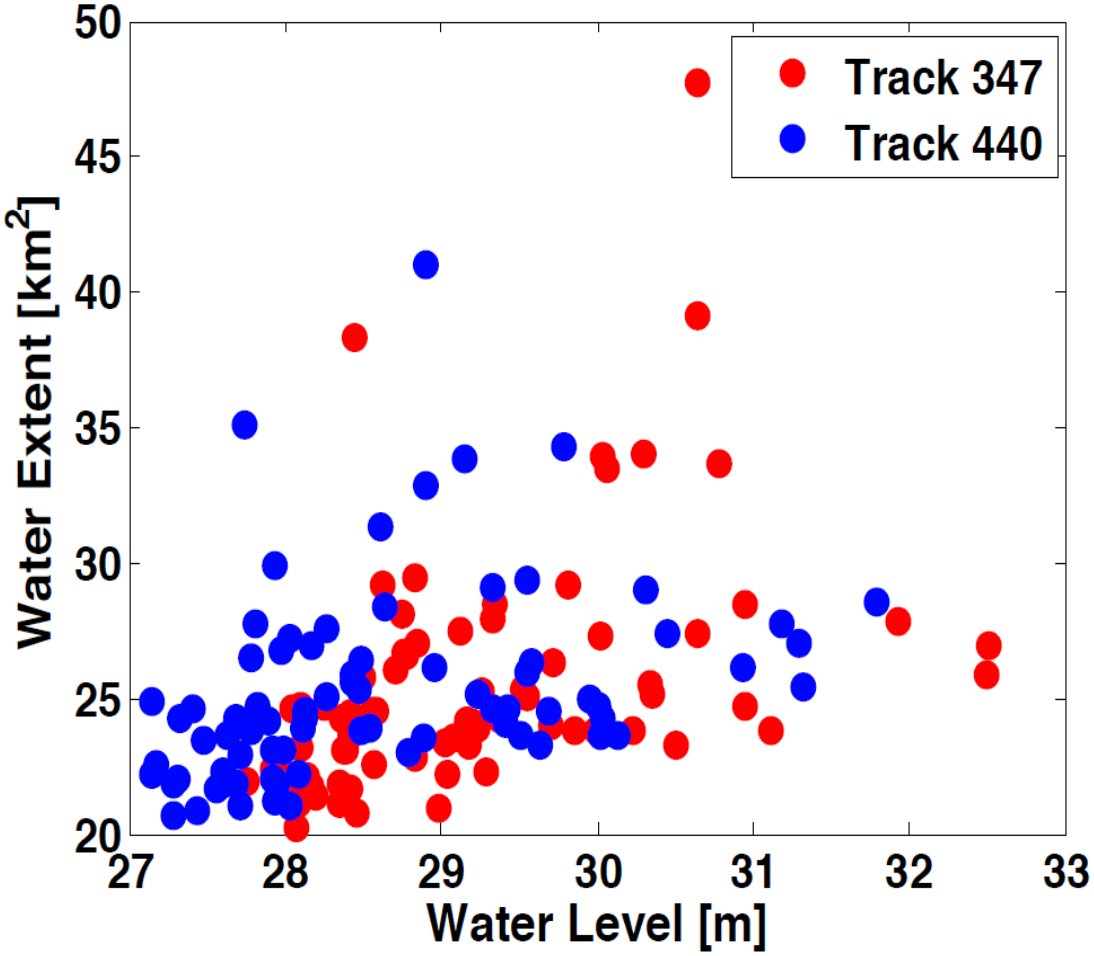
Combined time series of water level and water surface extent

Results

- Dongting Lake

$\rho_s(347) = 0.59$

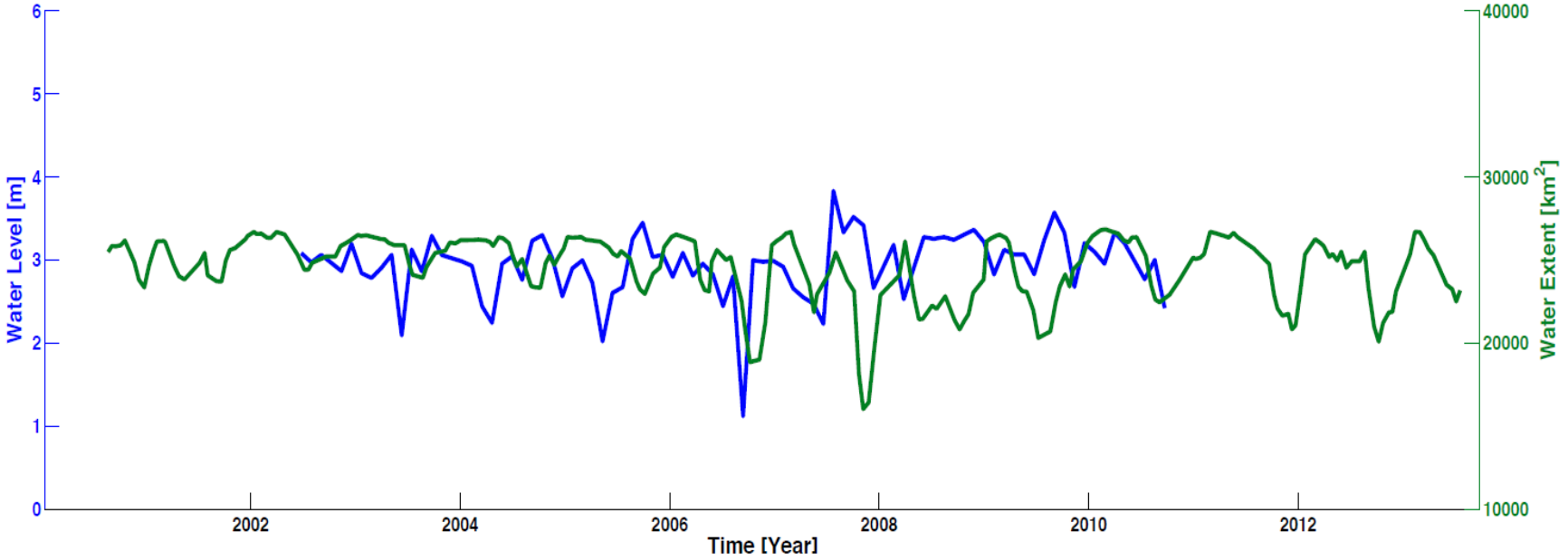
$\rho_s(440) = 0.53$



Scatter plots of water level and surface extent

Results

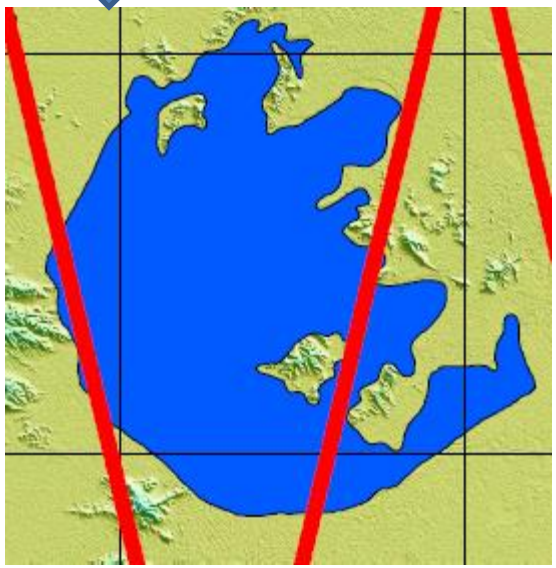
- Taihu Lake

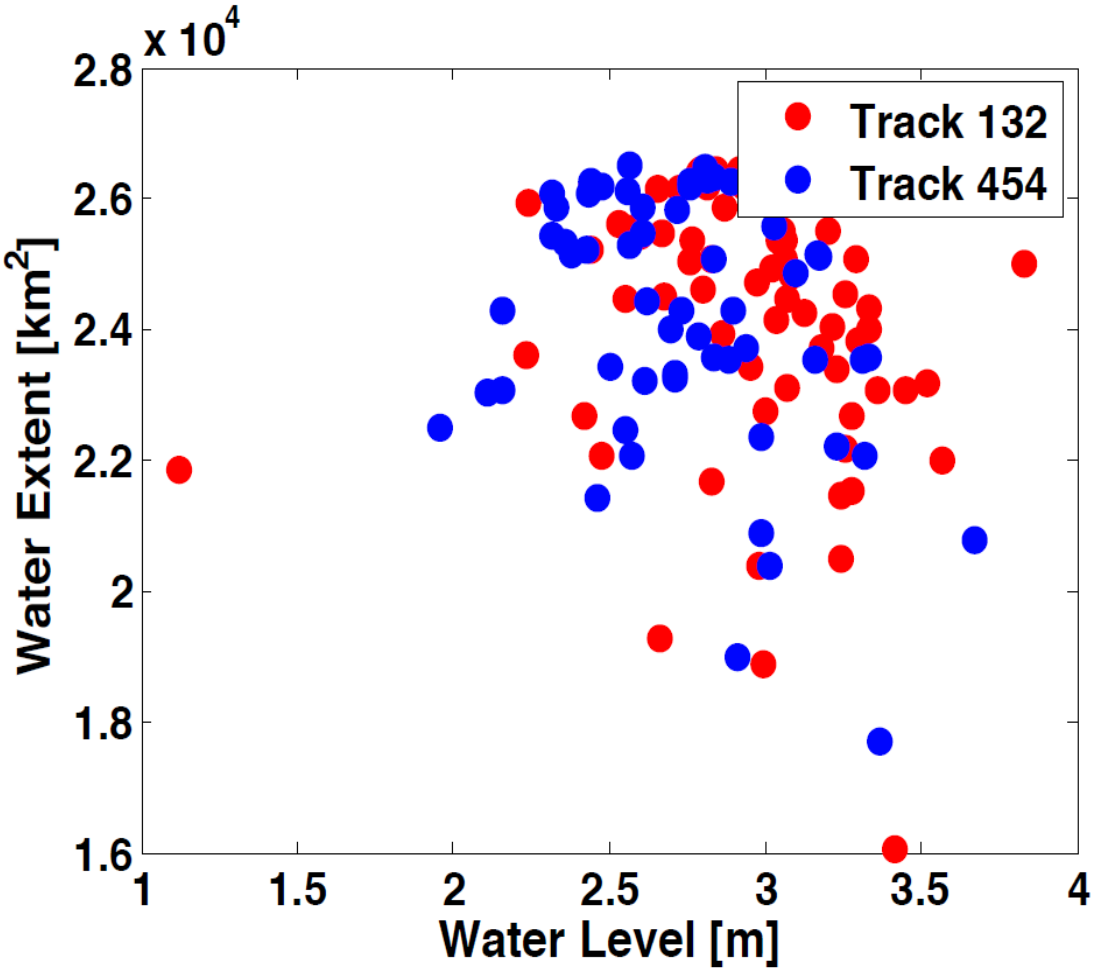


Combined time series of water level and surface extent

Results

- Taihu Lake
- ρ_s Minus

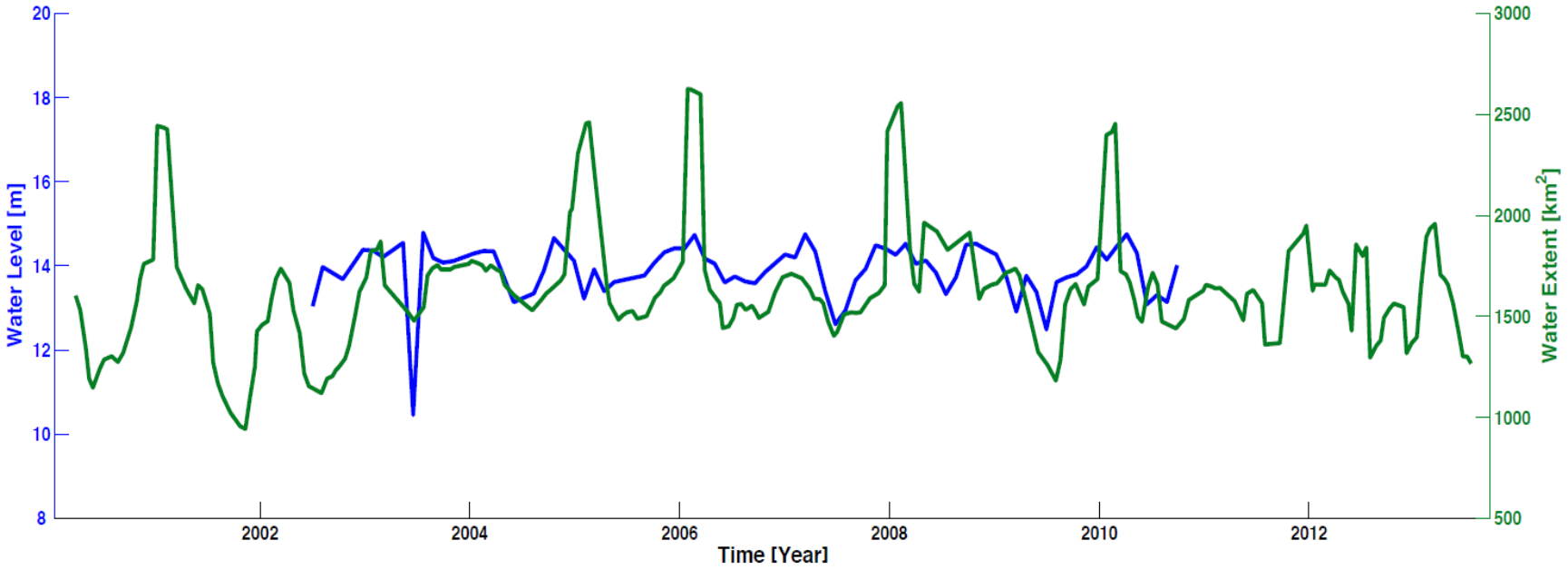




Scatter plots of water level and surface extent

Results

- Hongze Lake



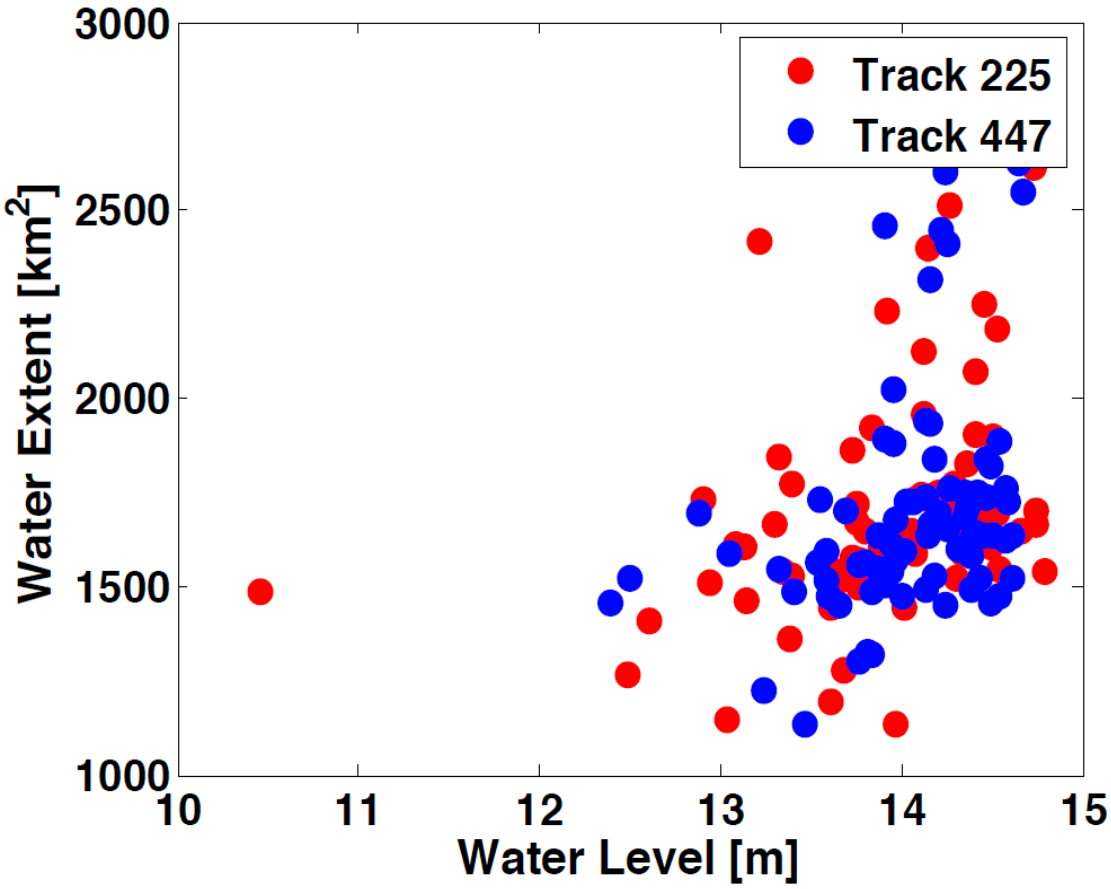
Combined time series of water level and surface extent

Results

- Hongze Lake

$\rho_s(225) = 0.46$

$\rho_s(447) = 0.40$



Scatter plots of water level and surface extent

Conclusion

- Median value and mean value of each satellite pass both presents good estimation when based on ice-1 re-tracker;
- Water surface change allows parts of similar tendency with comparison to the water level change;
- The target lakes have obvious ups and downs representing relative wet and dry seasons respectively in one year but not appear regular

Outlook

- For altimetry part, retracking should be needed further;
- Despite Envisat, other satellite missions applied to hydrology could be used as multiple data sources;
- More connection between water levels of Dongting Lake, Yangtze river and Three Gorges Dam effect over water system could be examined in future

Thank you for your attention!