Combined Measurements of Lake Levels and Surface Extent Change

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Outline

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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

Available ground tracks of Envisat
Data Set

- **Surface Extent Part:**
  MODIS data level 3 16 Day vegetation indices (MOD13Q1) data sets with 250m spatial resolution

MODIS images over lakes

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

Combined Measurement of Lake Levels and Surface Extent Change
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*

*Water level from separate satellite passes*
• Dongting Lake

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

Water level from all satellite passes

Water level from separate satellite passes
• Taihu Lake

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

Residuals before: 50cm; residuals after: 21cm

Residuals before: 83cm; residuals after: 31cm
• Hongze Lake

(a) Track 225
(b) Track 447

Water level from all satellite passes

Water level from separate satellite passes
• **Hongze Lake**

![Water level time series fitting the trend to mean values based on ice-1](image)

- **(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
- $\rho_s$ 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!