

Tidal estimation in China Seas based on satellite altimetric data

Yongcun Cheng (1, 2), Qing Xu (3,4), Yuan Zhang (5) and Hans-Peter Plag (3)

1 Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA, USA

2 Mitigation and Adaptation Research Institute, Old Dominion University, Norfolk, VA, USA

3 College of Harbor, Coastal and Offshore Engineering, Hohai University, Nanjing, China;

4 Key Laboratory of Coastal Disasters and Defense of Ministry of Education, Hohai University, Nanjing, China;

5 School of Marine Sciences, Nanjing University of Information Science & Technology, Nanjing, China

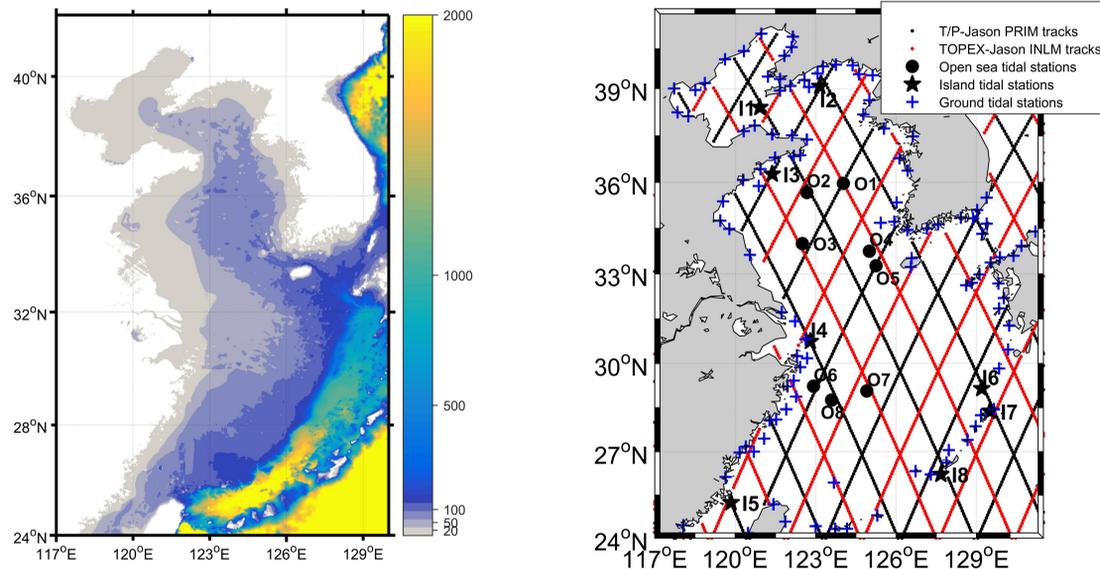
Introduction

The tidal solutions are far less accurate in the coastal regions due to the accuracy and coverage of altimetry data. Moreover, the complexity of tides over the coastal regions (water depth less than 20 m) scales down the accuracy of tide estimations attributing to the generation of nonlinear tidal constituents from interaction between the astronomical constituents.

In this study, response analysis of TOPEX/Poseidon-Jason-1-Jason-2 (T/P-Jason) primary mission and TOPEX-Jason-1 (TOPEX-Jason) interleaved mission along-track data is performed to derive 4 principal tidal constituents (M_2 , S_2 , K_1 and O_1) in the Bohai, Yellow and East China Seas (BYE).

Tide Gauge Data

The tide gauge data sets used for evaluating the altimetry tidal solutions are from published literatures. The first and the second data sets are harmonic constituents at 8 islands (I1-I8 in Figure 2) and 8 open sea (offshore) stations (O1-O8 in Figure 2), respectively. More details about the stations can be found in Fang et al. (2004). The third data set is harmonic constituents derived at 116 tide gauge stations (ground tidal stations) most of which are along the coast of the BYE and marked as pluses in the Figure below.

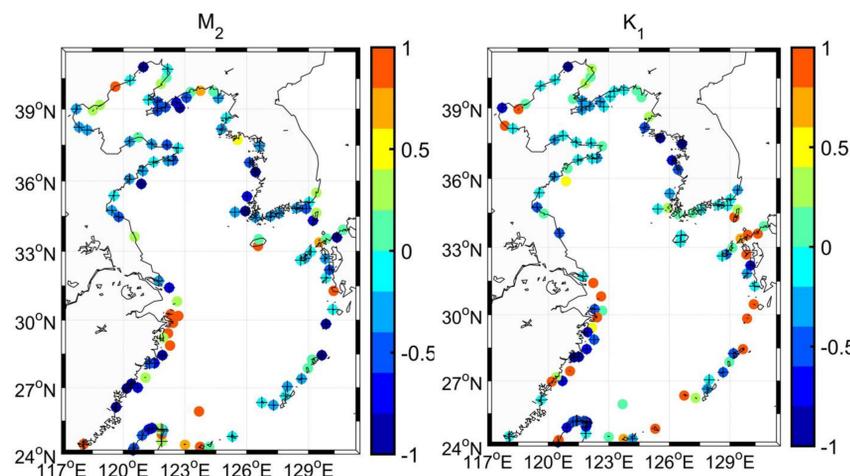


Bathymetry (m) in the Bohai, Yellow, and East China Seas. The black and red dots denote the PRIM and INLM ground-tracks of the joint T/P-Jason PRIM and TOPEX-Jason INLM in the BYE, respectively.

Locations of ground tidal stations (pluses), island tidal stations (stars, I1-I8) and open sea (dots O1-O8) tidal stations, respectively. The distribution of ground-tracks of the joint T/P-Jason PRIM (small black dots) and TOPEX-Jason INLM (small red dots) are overlaid to demonstrate their distance with the selected sites.

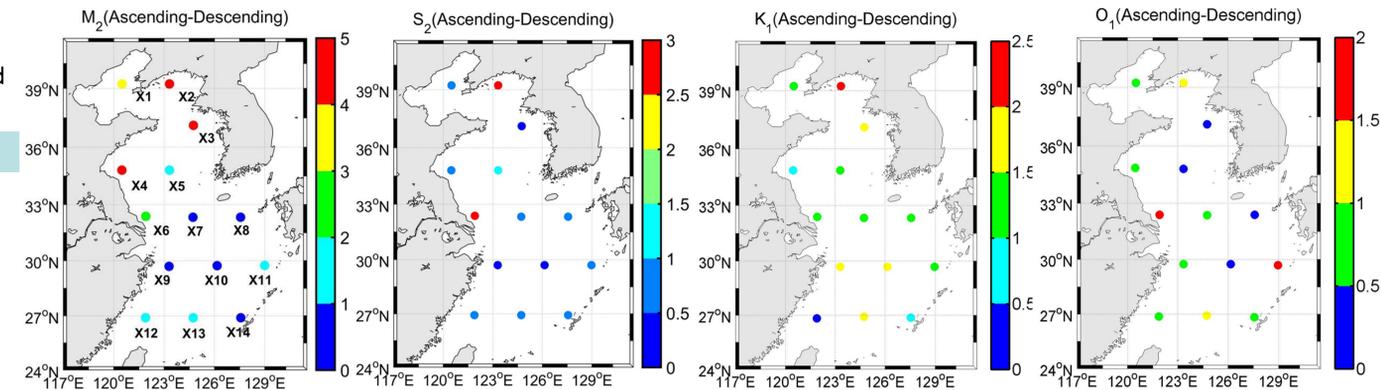
Results

Ratio of improvements (dots with pluses) in amplitude discrepancy of M_2 (a) and K_1 (b) tidal constituents while supplementing T/P-Jason PRIM data instead of 10 years of T/P data with TOPEX-Jason INLM data. The negative values stand for the improvements in estimated amplitude of tidal constituents. The distribution of ground-tracks of the joint T/P-Jason PRIM and TOPEX-Jason INLM in the BYE are overlaid as small black and red dots, respectively.

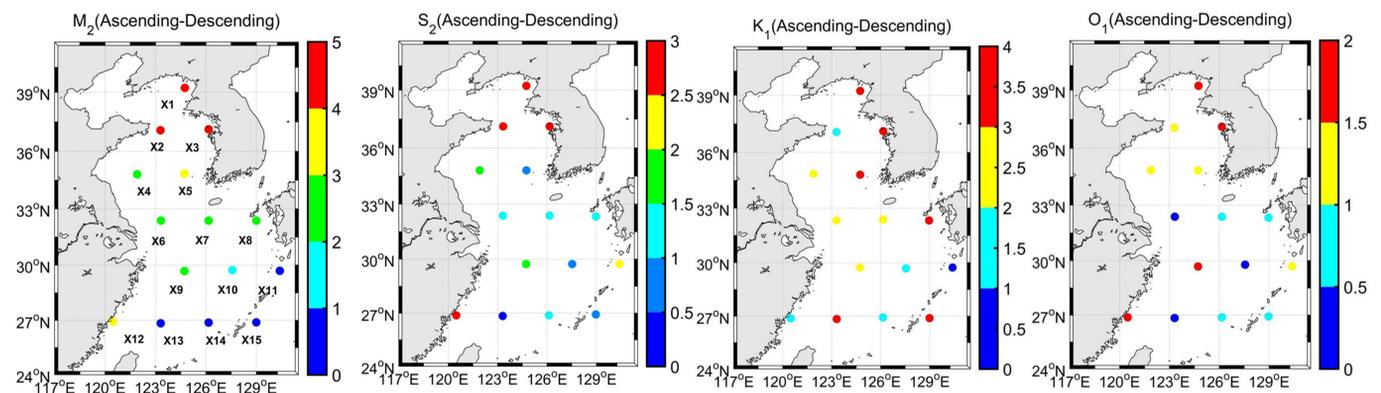


Results (continued)

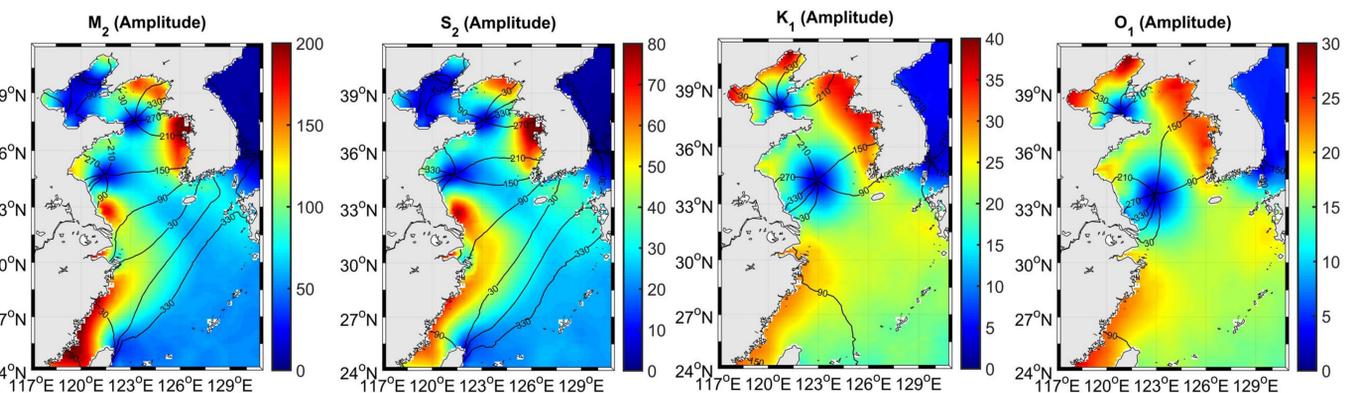
To evaluate the tidal estimations from T/P-Jason PRIM and TOPEX-Jason INLM data, the tidal solutions derived from both ascending and descending records at crossover points are compared with each other in the BYE.



The vectorial difference (cm) between tidal solutions derived from T/P-Jason PRIM ascending and descending passes at crossover points (X1-X14) for M_2 (a), S_2 (b), K_1 (c) and O_1 (d).



The vectorial difference (cm) between tidal solutions derived from TOPEX-Jason INLM ascending and descending passes at crossover points (X1-X15) for M_2 (a), S_2 (b), K_1 (c) and O_1 (d).



The co-tidal charts of M_2 , S_2 , K_1 and O_1 tides estimated from combined T/P-Jason PRIM and TOPEX-Jason INLM data in the BYE. The colors denote the amplitude (cm) and the curves denote the Greenwich phase lags.

Summary

The inter-comparison at crossover points and comparison with the ground truth show that the combination of T/P-Jason primary with TOPEX-Jason interleaved mission data are suitable for estimating the 4 principal tidal constituents in the regions. Three datasets of harmonic constants determined from tide gauge records are used to investigate the impacts of TOPEX-Jason interleaved mission data on tidal constituent estimation over the BYE regions. The accuracy of estimated tidal constituents using T/P-Jason data is slightly better than that using 10 years of T/P data in comparison with tide gauge data over the coastal regions. However, comparisons with 116 tide gauge data show that the root mean square differences in amplitude are reduced by 31.26%, 38.31%, 6.62% and 7.19% (M_2 , S_2 , K_1 and O_1) when using primary mission and interleaved mission data to replace the T/P-Jason primary mission data for tide estimation in the study area.