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Observations of the singlets of higher modes based on the OSE

Shiyu Zeng (1) and Wen-Bin Shen (1,2)

(1) Wuhan University, School of Geodesy and Geomatics, Institute of Geophysical Geodesy, Wuhan, China (syzeng@whu.edu.cn), (2) Wuhan University, State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing, Wuhan, China (wbshen@sgg.whu.edu.cn)

In this study, we select 18 SG (superconducting gravimeter) records from 15 GGP stations (http://www.eas.slu.edu/GGP/ggphome.html) and 99 radial, 69 transverse components of IRIS broadband seismograms (http://ds.iris.edu/ds/nodes/dmc/) during 2004 Sumatra Earthquake to detect the splitting of higher Earth's free oscillations modes (0S4, 0S7∼0S10, 2S4, 1S5, 2S5, 1S6) and 13 inner-core sensitive modes (25S2, 27S2, 6S3, 9S3, 13S3, 15S3, 11S4, 18S4, 8S5, 11S5, 23S5, 16S6, 21S6) by using OSE (optimal sequence estimation) method. Results indicate that OSE can completely isolate singlets of high-degree modes in time-domain, and significantly reduce the possibility of mode mixing and end effect, so that OSE could improve some signals' SNR (signal-to-noise ratio). We also compare the results of SG records with seismic data sets, and it shows that the number of SG records is limited to observe all of the singlets of higher modes. Hence we mainly select seismograms of IRIS to observe the mutiplets of higher modes. This study demonstrates that OSE is effective in isolating singlets of Earth's free oscillations modes. We estimate frequencies of the singlets using AR method (Chao & Gilbert, 1980) and following Häfner & Widmer-Schnidrig (2013) we obtain the error bars through the bootstrap method (Efron & Tibshirani, 1986). Finally we compared the observations with the predictions of PREM model (Dziewonski & Anderson, 1981) and 1066A model (Dahlen & Sailor, 1979). Our experimental results may provide constraints to the construction of 3D Earth model. This study is supported by National 973 Project China (grant No. 2013CB733305), NSFC (grant Nos. 41174011, 41429401, 41210006, 41128003, 41021061).