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www.elsevier.com/locate/csr

PII: S0278-4343(17)30643-X
DOI: https://doi.org/10.1016/j.csr.2018.06.005
Reference: CSR3775

To appear in: *Continental Shelf Research*

Received date: 13 December 2017
Revised date: 25 May 2018
Accepted date: 6 June 2018

Cite this article as: Zheng Guo, Haidong Pan, Anzhou Cao and Xianqing Lv, A harmonic analysis method adapted to capturing slow variations of tidal amplitudes and phases, *Continental Shelf Research,* https://doi.org/10.1016/j.csr.2018.06.005

A harmonic analysis method adapted to capturing slow variations of tidal amplitudes and phases

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Abstract

Harmonic analysis (HA) is a widely used tool in the study of tides. To capture the slow variation of tidal amplitudes and phases revealed in recent research, namely, variations on a timescale of multiple months or longer, an empirical HA approach is presented and validated in this study. This empirical HA relies only on a knowledge of tidal frequencies and allows post facto analysis of dynamics. In essence, it is incorporation of piecewise linear functions into the conventional HA through the least squares matrix, permitting slow variations in amplitudes and phases. The advantage of linear functions over other functions such as cubic splines lies in their simple calculation and avoidance of artificial oscillation. In the approach, independent points (IPs) are selected to define the sub-domains for the piecewise functions. Tests with synthetic hourly water levels and application in practical contexts show that the new approach with sufficient IPs is able to reproduce the evolution of tidal amplitudes and phases. Its performance can be further improved by selecting suitable number of IPs