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METHOD OF SELECTION OF CONSTITUENTS IN HARMONIC ANALYSIS

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ABSTRACT

A practical method based on the principle of diagonal dominance is introduced to select proper constituents in the tidal analysis. The method is discussed from the mathematical points of view and provides a convenient way for the choice of maximum limit of the constituents other than the principle astronomical constituents O_1, P_1, K_1, N_2, M_2, S_2, K_2, M_4 and MS_4 if the length of tidal observation is known.

INTRODUCTION

Harmonic analysis is a common method to analyze and predict tides at a specific place. The method assumes that the tides are composed of finite partial tides or constituents of known angular speed. The amplitude and phase lag of the constituents are determined from the observed tidal data. Theoretically, there exist infinite constituents (Schureman, 1924). The available data of tidal observation only permit finite number of the constituents to be selected for the purpose of tidal analysis. The classical harmonic method (Schureman, 1924) is limited to a few important constituents such as O_1, P_1, K_1, N_2, M_2 and S_2 due to the cumbersome procedure of calculations. After applying the computer to the harmonic analysis, more constituents can be included. The accuracy of the analysis is, therefore, improved.

The number of constituents to be used will depend upon the accuracy required and the length of the observed tidal data available. Some of the constituents have extremely small differences in angular speed. Therefore, criteria to be able to decide, at least approximately, which constituents may reasonably be computed are needed. A rule of thumb is that the length of the series of observation to separate two constituents from each other is an exact multiple of the synodic period of the two constituents (Dronker, 1964, Schureman, 1924). The synodic period of two constituents is defined as the interval between two consecutive conjunctions of the phase. Thus, if the angular speed of each constituents is σ_1 and σ_2 degrees per hour, the synodic period is $360^\circ/(\sigma_1-\sigma_2)$ hours. The longer the series of tidal observations, the greater the number of synodic periods of any two constituents can be included.

A method more accurate than the synodic period method was found by the author in doing harmonic analysis. The method which will be discussed later is based on the principle of diagonal dominance in solving simultaneous equations required by the analysis and enables one to properly select the constituents by knowing the number of the observed tidal data.

HARMONIC ANALYSIS

The classical harmonic analysis implies that the vertical tide at any place can be expressed in terms of a sum of finite constituents which are harmonic function.

$$y(t)=h_0+\sum_{i=1}^{M} f_i h_i \cos[\sigma_i t+(V_0+u)_i-k_i] \qquad (1)$$

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