SYNTHETICALLY GENERATED ERRORS IN TIDAL CONSTITUENTS

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Abstract

The paper comprises the calculations of amplitudes and phases of tidal harmonic constituents, performed on hourly sea level data recorded at Split tide gauge in the period 1957-2001. Interannual changes have been detected, stronger in phases than in amplitudes. The differences are presumably generated by clock error, uncertainties in time positioning of the charts and the errors within the digitalisation process. Therefore, two groups of artificial sea level series have been generated, in order to simulate time drift and shift in the series and to verify their impact on the constituents.

Keywords: tide gauge, chart record, harmonic analysis.

Introduction

The computations of tidal amplitudes and phases can incorporate artificial errors if extracted from analogous chart records [1], which were commonly operated in the Adriatic Sea in the last half a century. The first calculation of Adriatic harmonic constituents was based on Bakar data measured in 1950, extracting 7 significant constituents with amplitude higher than 1 cm. Polli [2] performed a comprehensive tidal analysis (29 stations) and plotted amplitudes and phases for the whole Adriatic, but using rather old data collected at the beginning of 20th century.

Data and methods

The analysis of sea level data collected in 1957-2001 period at Split chart-recording tide gauge will be performed in this work, in order to check quality of the data and practicability of previously estimated harmonic constants in tidal forecasting. The digitalisation of the charts has been performed using two different software packages: (1) the charts from 1978 to 2001 were digitalised on an older VAX system, thus the data is more prone to digitalisation errors (T3 period), and (2) the charts older than 1978 were digitalised recently using PC based package, and therefore it is expected to result in more accurate data than the older one (T1 period – low quality charts, T2 period – high quality charts). Harmonic analysis was performed using TASK package (Tidal Analysis Software Kit) developed at Proudman Oceanographic Laboratory. Furthermore, simulations of time drifts and shifts in the series was carried out in order to evaluate the influence of errors that may occur during digitalisation process, both on the amplitudes and phases of major tidal constituents.

Results

Fig. 1 shows interannual variability of diurnal tides calculated at Split for period 1957-2001. The difference between the constants seems to be rather significant. For example, amplitudes are the lowest in the T1 period (except of N_2 tide), oppositely to phases which are commonly the largest in the T1 period (except of K_2). Additionally, T1 period is characterized by the highest standard deviations. The amplitudes in T3 period are even a bit higher, whereas the phases are lower compared to T2 period.

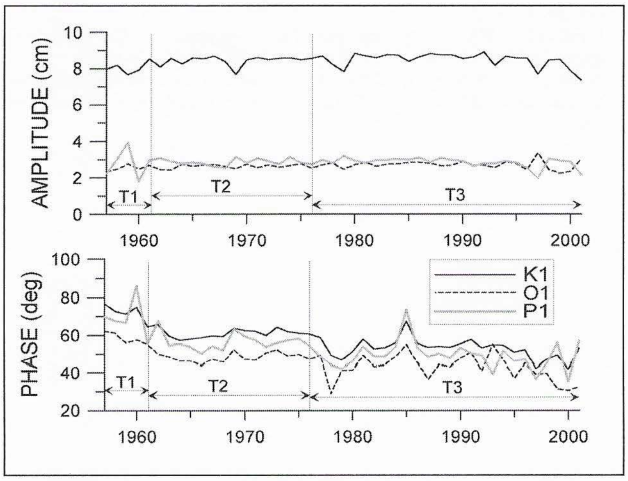

Fig. 1. Annual amplitudes and phases of diurnal constituents at Split.

Simulated changes in constituent amplitudes and phases due to the simulated artificial drift in time series are shown in Fig. 2. One can see that the changes in amplitude are not as pronounced as the changes in phase, both for semidiurnal and diurnal constituents. Nevertheless, if the drift is large enough, semidiurnal amplitudes decrease rather rapidly, while the phases change linearly as a function of the drift rate. The exception is P_1 tide, which increases in amplitude when the drift rate is negative. Such behaviour is a result of artificial energy transfer from K_1 to P_1 tide, as K_1 tide has a period rather close to the P_1 (23.93 h of K_1 *versus* 24.07 h of P_1).

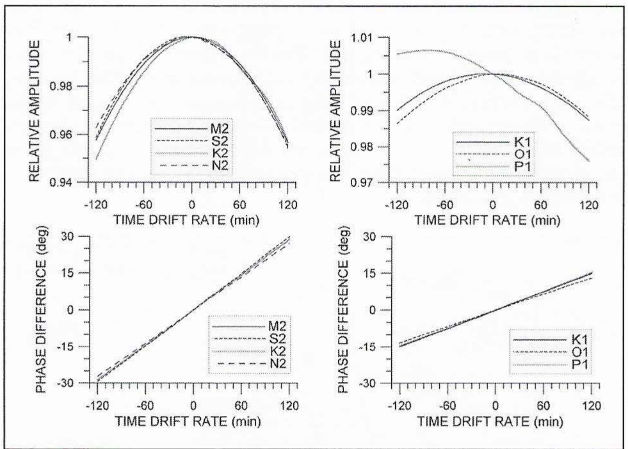

Fig. 2. Simulated changes in relative amplitudes and phase differences versus time drift rate. The respective amplitude and phase are supposed to be 1 and 0 when no time drift was simulated.

Generally, time variations of the tidal constituents have been presumed to come from systematic errors that occurred during sea level measurements, and during the digitalisation process of the charts. The changes seem to be dependent on the digitalisation technique, clock errors as well as on the uncertainties in the time positioning of the charts. The phases of the harmonic constituents are more vulnerable to all of the errors, while the amplitude suffers only when large time drift and shift are presented in the series. In particular, semidiurnal tides with low amplitudes such as K_2 and N_2 can be significantly changed, whereas diurnal tides are relatively stable in amplitude.

Acknowledgement. A part of sea level charts has been digitised within ESEAS-RI project (EU funded project EVR1-CT-2002-40025). Permanent Service for Mean Sea Level kindly provided TASK software package.

References

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2 - Polli S., 1960. Le propagazione delle maree nell' Adriatico (in Italian), Atti del IX Convegno dell' Associazione Geofisica Italiana, Roma, 1-11.