

Fundamental modes of Mano Bay detected by simultaneous observations at the head and the mouths

著者(英語)	Kuniaki Abe
journal or publication title	Bulletin of the Nippon Dental University. General education
volume	36
page range	9-14
year	2007-03-20
URL	http://doi.org/10.14983/00000623



Fundamental modes of Mano bay detected by simultaneous observations at the head and the mouths.

Kuniaki ABE

Niigata Junior College, Nippon Dental University

Abstract

Sea level oscillations were simultaneously observed at a head and mouths of Mano Bay using pressure gauges. The records obtained at 1 minute interval for six hours are decomposed into the spectra. The most dominant period of 52 minutes were commonly observed at the head and the mouths without phase lag. The amplitude profile suggests that the node is located at a bay mouth. From these evidences we concluded that it is fundamental mode of the bay oscillation.

Key Words : Fundamental mode, Mano bay, Simultaneous observation

Introduction

Sea level in a bay oscillates without evident external force and it is called seiche. Honda et al. (1908) carried out observations of seiche at many bays in Japan. Recently Abe (2005) surveyed Sanriku coast, Japan and obtained the dominant periods at 36 bays. Aida et al. (1968) observed sea level oscillation at head of Onagawa bay and compared it with those observed at Enoshima tide gauge station located at the mouth. Generally speaking identification of the node is one of difficult problems in a bay oscillation. It is related to stability of dominant period of the bay. It is a reason to expect a simultaneous observation of seiche at head and mouth in a bay.

Method

We prepared two handy typed pressure gauges made at the same company. They are brought to a bay. One of them is settled at bay head and another at coast near the mouth. The sensor is hanged with a rope in the sea of 1-2m under the surface. The observation is simultaneously carried out. Sea level is detected every 1 minute for six hours and decomposed into the spectra with the same method as Abe (2005).

Result

Observations were conducted at Mano bay in Sado Island, Japan on Mary 23-24, 2006. First six hours were given to the simultaneous observation at Futami (bay mouth) and Sawada (bay head). The record at Sawada is abbreviated as Sawada1. Second ones were given to that

at Ootatsu (bay mouth) and Sawada (bay head) (Sawada2). Third ones to that at Toyota (bay mouth) and Sawada (bay head) (Sawada3). The locations are shown in Fig.1 and the elements are shown in Table 1. Observation point of Sawada is fixed in the same point through the three observations. It is also the same point as the previous observation by Abe (2003).

Observed sea levels and the spectra are shown in Figures 2-4. As the most dominant frequencies we obtained 0.32 mHz (52 minutes in period) for Sawada1, 2, Futami and Ootatsu. For Sawada3 and Toyota they are 0.38 mHz (44 minutes in period) and 0.34 mHz (49 minutes in period), respectively. Thus, it is notable that the same dominant period of 52 minutes were observed at Futami and Sawada1, Ootatsu and Sawada2.

Moreover, phase lags in the spectral components were calculated for the three pair observations as shown in Figure 5. The lag is defined as a phase lag of Sawada to that of Futami (Ootatsu, Toyota). As the result the phase lag in the most dominant period is 6.3 degrees for the first pair of Futami. It is -4.8 degrees for the second pair of Ootatsu. Both of them are very small and nearly equal to zero. In the precise description a small phase lag within 10 degrees is kept for the first pair in the range of 0.24-0.34 mHz (69-49 minutes in period) and for the second one in the range of 0.22-0.40 mHz (76-42 minutes in period). These facts show that oscillations of the dominant period are in phase between Sawada and Futami, Sawada and Ootatsu, respectively. It is characteristic of a fundamental mode. Thus, it is concluded that the dominant period of 52 minutes is attributed to

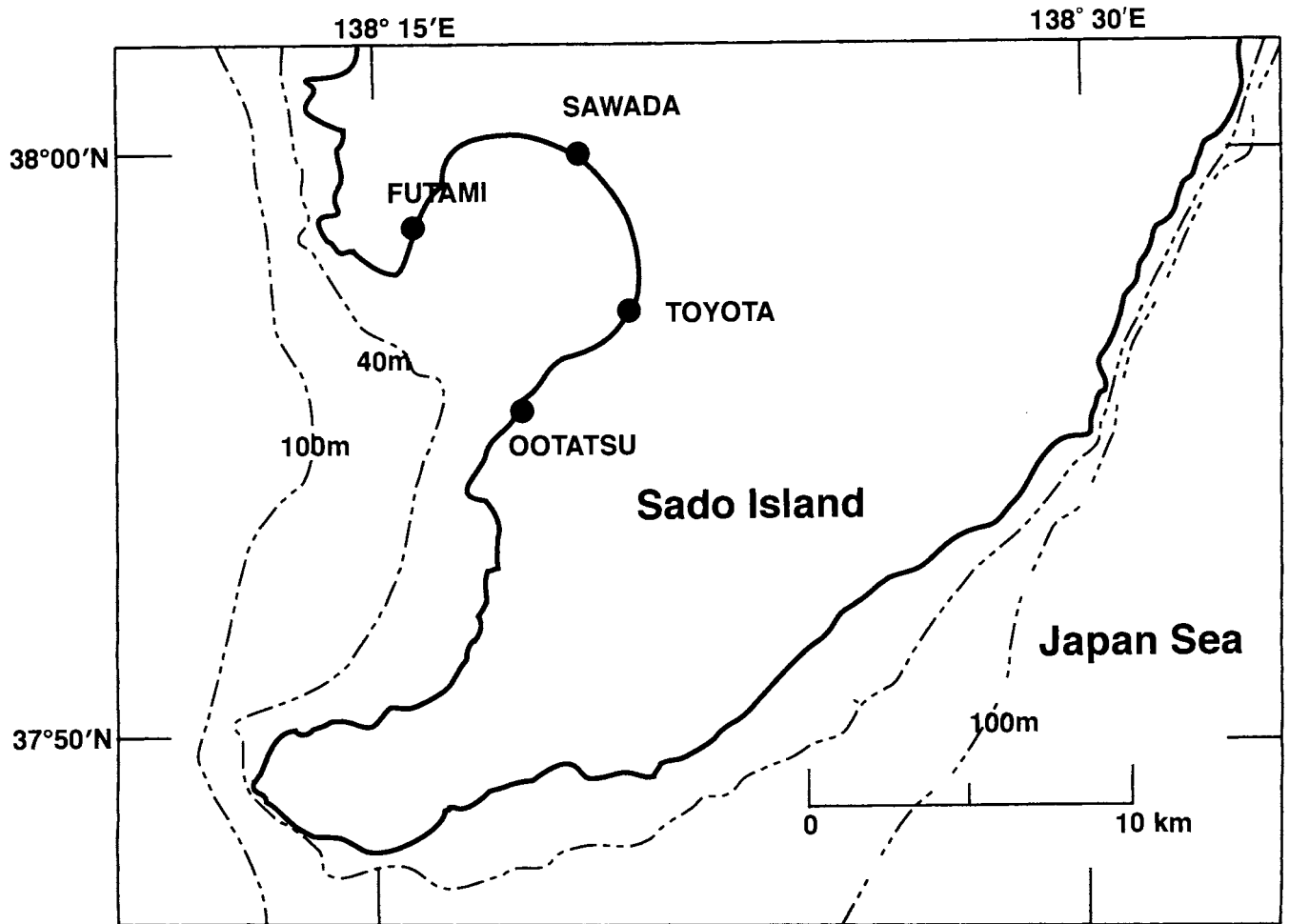


Figure 1 Location of observation points (solid circles) in Mano Bay.

Table 1. Elements of observations.

No	date	time	observation stations	
			Bay Head	Bay Mouth
1	May 23, 2006	10:52-16:52	Sawada	Futami
2	May 23, 2006	17:37-23:37	Sawada	Ootatsu
3	May 23-24, 2006	23:59-5:59	Sawada	Toyota

excitation of fundamental mode in the bay oscillation.

The spectral amplitude at the dominant period of 52 minutes is plotted as the relative ones to those of Sawada as shown in Figure 6. Ones of Toyota (49 minute) and Sawada3 (44 minute) are also included in the same figure. The profile is typical of fundamental mode oscillation showing the node at the mouth and the loop at the head including no node between the mouth and the head. Moreover, it is shown from the profile that the

node is close to east cape running out into the sea. It is estimated without any information about sea depth.

Discussion

In the previous one-point observation Abe (2003) obtained dominant period of 47 minutes in the same bay. At that time the dominant period was also supported from calculation on the finite element model. We can point out that there is a difference of 5 minutes in

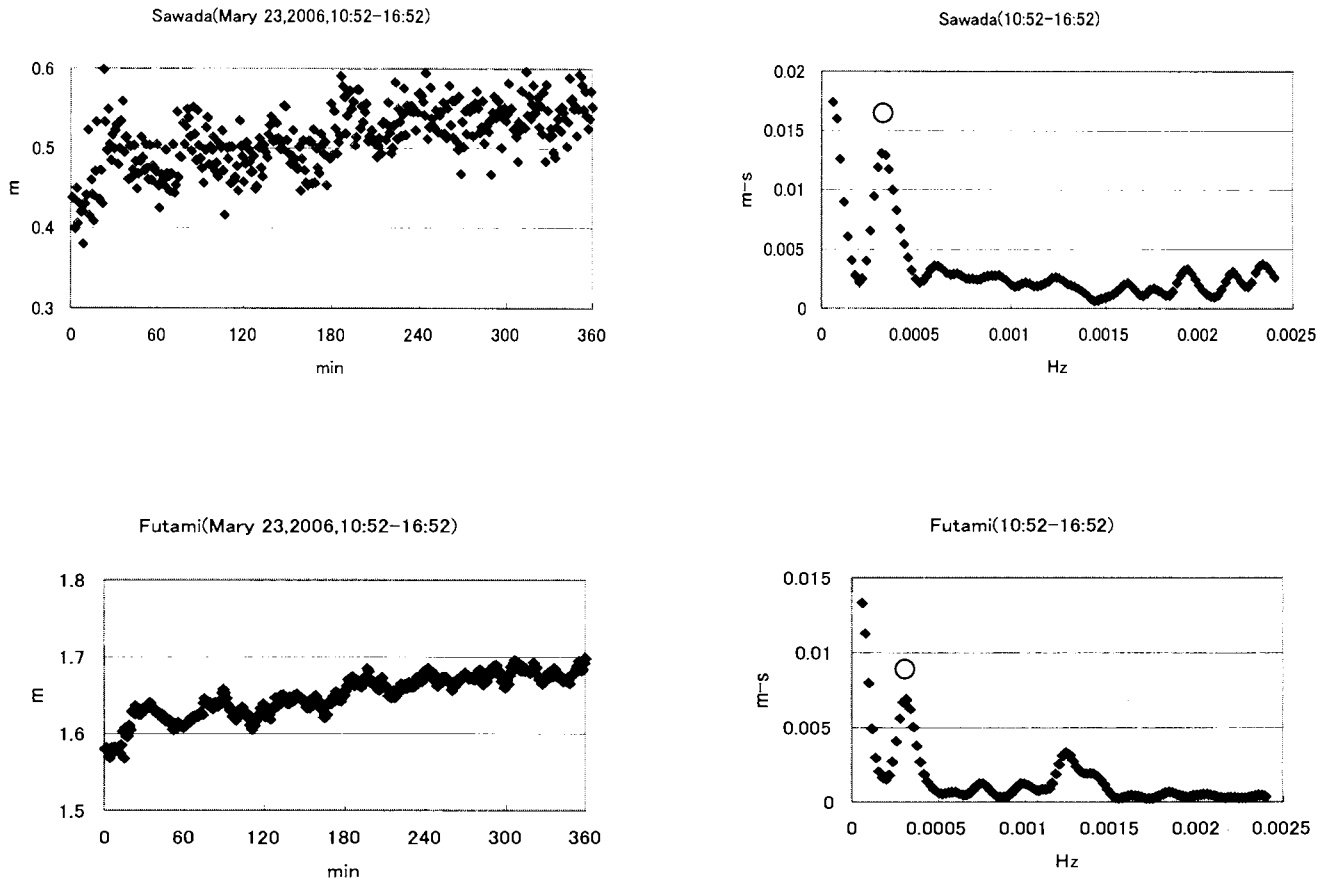


Figure 2 Sea level oscillations (left side) and the spectra (right side) simultaneously observed at Sawada (top side) and Futami (bottom side). Circles in the right figures show the fundamental modes.

comparison with 52 minutes of this case. At that time the calculation was conducted on the model having the mouth at the west cape. The east cape is 10.2 km distant and west one is 6.7 km distant from the head. It is estimated that the difference of dominant period is caused by the difference of the nodal position. Amplitude profile of the dominant period of 47 minutes and excitation mechanism of the fundamental mode should be clarified.

Sawada3 showed the dominant period of 44 minutes. This value is shorter than that of the former dominant period, 47 minutes. Meteorological data of Aikawa nearest to Sawada showed that the observation time corresponded to that of intense wind (about 10 m/s) having the direction of NNW to NW (JMA,2006). The intense wind probably displaced the dominant period of fundamental mode from long period to short one.

Summary

Simultaneous observations of sea level oscillations were carried out at Mano bay in Sado island. The 6 hour records were decomposed into the spectra. From the amplitude and the phase lag a dominant period of 52 minutes was observed having characteristic property of the fundamental mode. The node was estimated at the east cape from the amplitude distribution.

Acknowledgement

This study is supported by a Research Promotion Grant (NDUF-00-00) from The Nippon Dental University.

References

Abe, K., Long wave measurements at bay-shaped coasts using a pressure gauge (II) (Mano and Ryotsu bay), Bull. Nippon Dental Univ., General Education, **32**, 15-26, 2003.

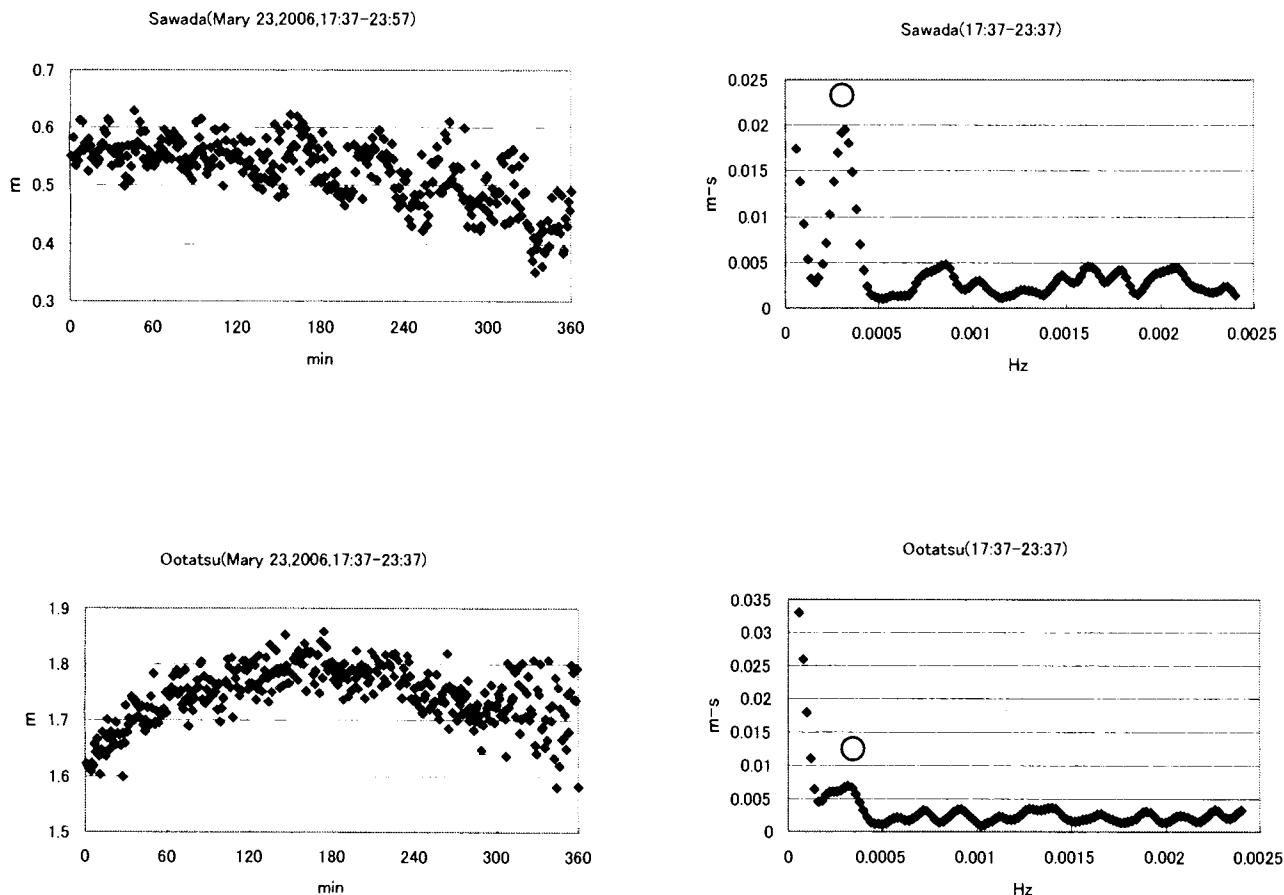


Figure 3 Sea level oscillations (left side) and the spectra (right side) simultaneously observed at Sawada (top side) and Ootatsu (bottom side).

Abe, K., Tsunami resonance curve on dominant periods observed at bays, in "Tsunamis: Case studies and recent developments", ed. by K. Satake, Springer Publishing, 97-113, 2005.

Aida, I., M. Koyama, D. Date and S. Sakashita, Long-period waves in the vicinity of Onagawa Bay (III)-Time change of the seiche characteristics in the bay, Jour. Oceanogr.

Soc. Jpn, **31**,9-18, 1975.

Honda, K., T. Terada, Y. Yoshida and D. Isitani, The secondary undulations of oceanic tides, Jour. Coll. Sci., Imper. Univ. Tokyo, **24**, 1-110, 1908.

Japan Meteorological Agency (JMA), <http://www.jma.go.jp/jma/>, 2006

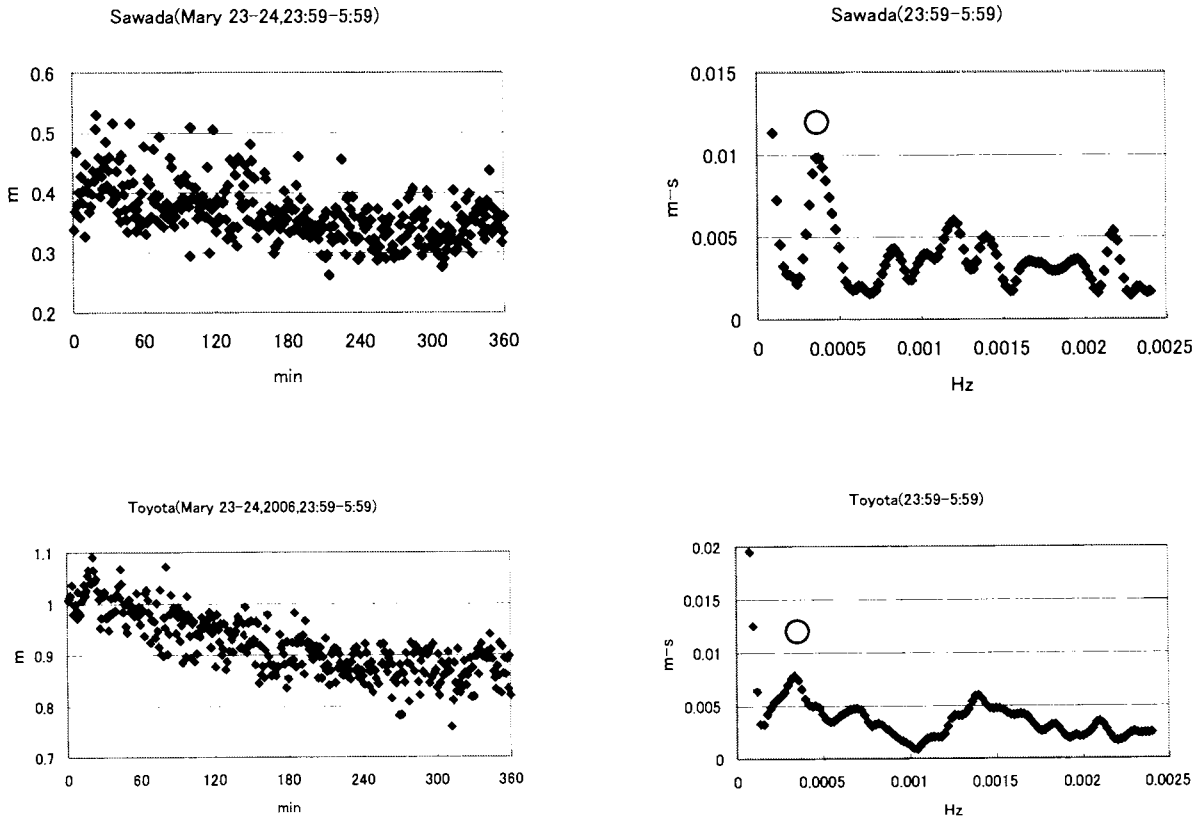
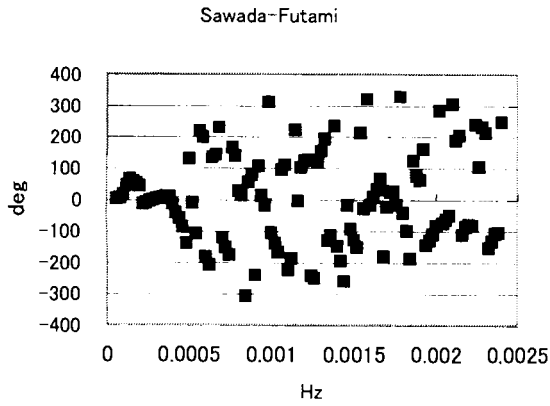
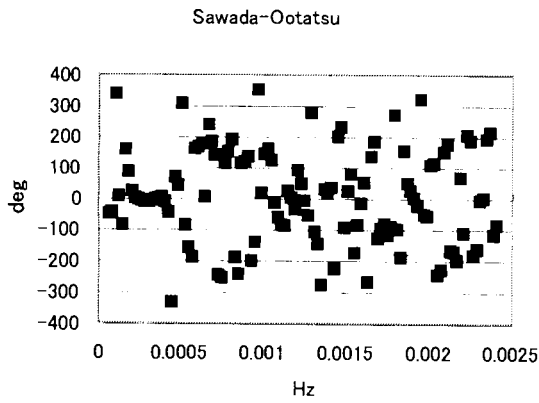


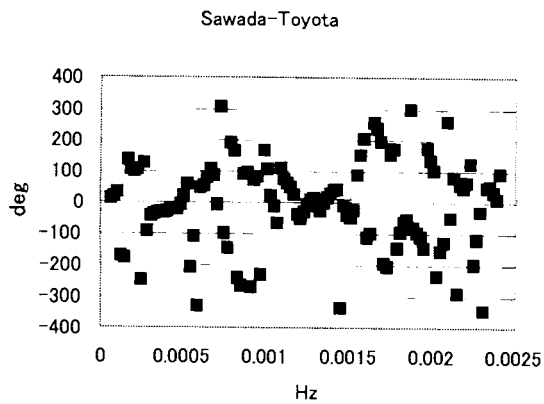
Figure 4 Sea level oscillations (left side) and the spectra (right side) simultaneously observed at Sawada (top side) and Toyota (bottom side).



(a)



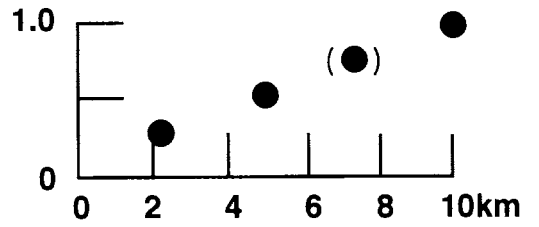
(b)



(c)

Figure 5 Phase differences for the spectral components between Sawada and Futami (a), Sawada and Ootatsu (b) and Sawada and Toyota (c).

relative amplitude of spectra



sea depth

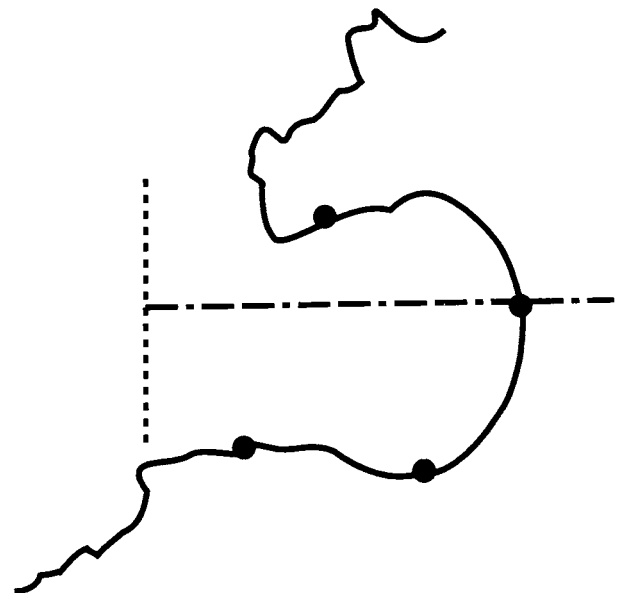


Figure 6 Relative amplitude of the spectra normalized by amplitude of Sawada at bau head (top), sea depth (middle) shown for a profile of the bay and the observation points (solid circles) (bottom). Parenthesis is for a modified period components. The profile is taken along the center line (dash-dotted line).