MEASUREMENTS OF AMBIENT NOISE GENERATED BY LARGE-AMPLITUDE INTERNAL WAVES IN LUZON STRAIT: THE FIRST EXPERIENCE

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ABSTRACT The experiment on study of ambient nose generated by large-amplitude internal waves in Luzon Strait is analyzed. Simultaneous observations of internal waves and characteristics of ambient noise generated by them were carried out. Fast 50-m solitary internal wave propagated to the northwest direction with speed more than 3 m/s was observed. It was revealed an enhancing of ambient noise level (at frequency range 1-2 kHz) at a time of passing the face side of the solitary wave.

KEY WORDS: Solitary Internal Waves, Ambient Noise, Luzon Strait

1. INTRODUCTION

Propagation of internal waves usually accompanies by their manifestation on the sea surface in the form of intermitteren bands of slicks and ripples (by the way, this property make possible a vision of internal waves by remote sensing from space). Intense internal waves have strong orbital currents which lead to enhancing of ripples or transforming them to rips and even lead to generation of choppy waves. As it was recently demonstrated (Serebryany et al, 2005) on the basis of measurements carried out near Mascarene Ridge in the Indian Ocean intense internal wave can generate significant ambient noise. It was revealed rising (up to 18 dB) of underwater noise at range of 5-15 kHz during passing solitary 50-meter internal wave. We have repeated measurements of underwater ambient noise in a presence of large-amplitude internal waves in the South China Sea. The South China Sea is well known region of the World Ocean with internal waves of biggest amplitudes (Liu et al, 1998). These internal waves have prominent surface manifestations which usually clear seen on SAR satellite images.

2. METHOD AND INSTRUMENTAIONS

We have conducted an experiment on study of ambient nose generated by large-amplitude internal waves in Luzon Strait in May, 2006. The measurements were made from drifting vessel Ocean Researcher 1 in time of passing internal waves. We carried out simultaneous observations of internal wave parameters and characteristics of ambient noise generated by them. Measurements of noise were made by a system consists of one omnidirectional hydrophone (0.1-20 kHz) immersed at a depth 60-70 m and supported by a buoy (to be in upper layer of thermocline) and at a distance of 230 m from the vessel. Unfortunately due to a schedule of the expedition we have no possibility to work in regime of salience which was very desirable for ambient noise measurements. To exclude errors in recording signals of ambient noises connected with surface waves oscillations we used the hydrophone inside of a fairing of neutral buoyancy accompanied by temperature and depth sensors. It was possible to estimate the internal wave parameters from data obtained by means of echosounder EK 500 and ADCP 150 kHz worked during the experiment. Photos of radar images of the sea surface were used for internal wave parameter estimations as well.

3. OBSERVATIONS

Two separate internal wave events were observed. On May, 23 we observed solitary internal wave of 50-m height and on May, 24 we observed train of intense short-period internal waves with amplitudes up to 25-30 m. All observed internal waves were accompanied by bands of rips or choppy waves on the sea surface due to strong own orbital currents of internal waves (See Figure 1). These "surface waves" is non-traditional source of the noise which is significant in the case of internal waves of large amplitude.

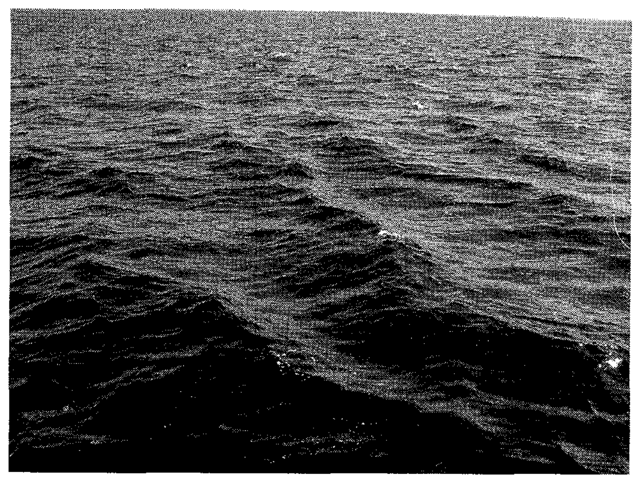

Figure 1. The sea surface with white caps during passing of intense internal waves on May, 24.

The observed internal waves in the both cases propagated to the northwest direction. (See Figure 2 and 3). In the first case it was registered alone wide band of choppy waves (1300-m width). The band propagated fast to northwest with speed of 3.3 m/s. ADCP's and echosounder records registered the first mode internal wave features. The temperature vertical profile together with hydrophone position is shown on Figure 4. In the case of solitary wave the fairing of neutral buoyancy was in a stable state while in the case of a train it oscillated vertically from horizon 70 m up to 50 m.

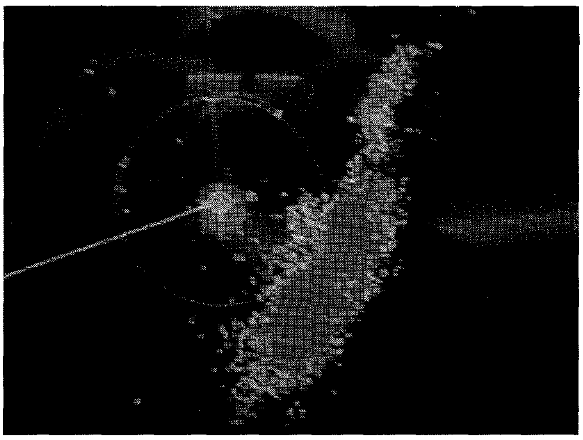

Figure 2. Radar image of solitary internal wave observed on May, 23.

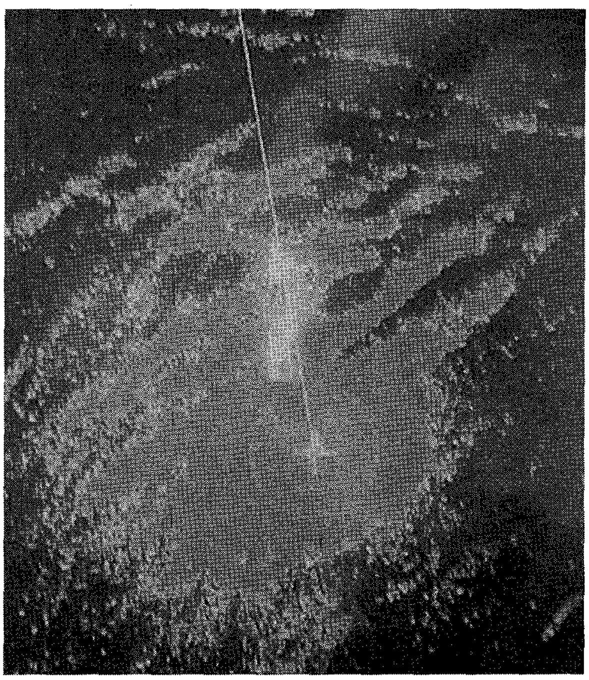

Figure 3. Radar image of internal wave train observed on May, 24.

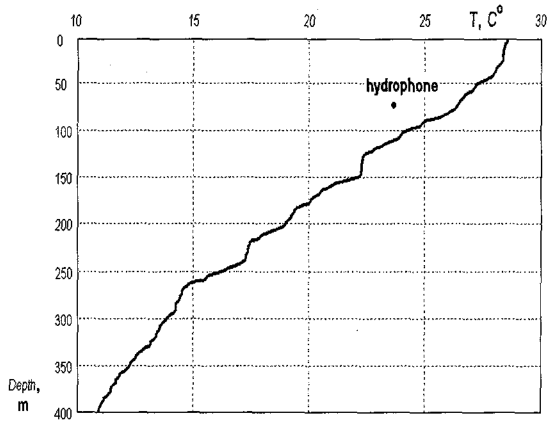

Figure 4. Vertical temperature profile and position of hydrophone.

We have made a preliminary processing of data recorded by hydrophone. It was revealed an enhancing of ambient noise level up to 5-8 dB (at frequency range 1-2 kHz) at a time of passing the face side of the solitary wave (see Figure 5). Detailed comparison these data with data of observations near the Mascarene Ridge (Serebryany et al, 2005) had revealed similarity between both observations in the main features.

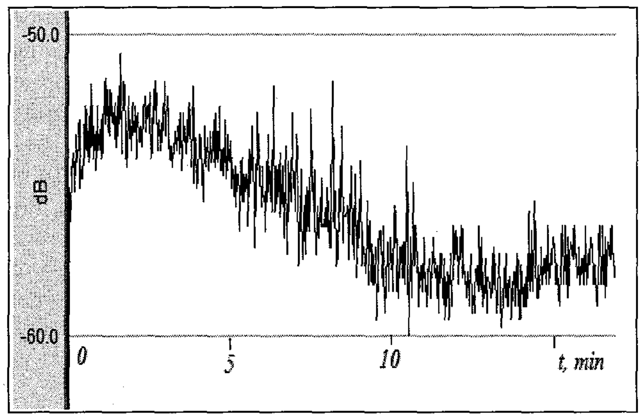

Figure 5. Variations of ambient noise level at frequency of 1 kHz for the time of passing of 50-m solitary internal wave on May, 23 (1/3 octave filtering was applied).

4. CONCLUSIONS

The mechanism of the underwater sound generation as we assume is connected with generation of bubbles by breakings surface waves (breaking surface are generated due to strong orbital currents of internal waves in the subsurface layer of the sea) and consistently involving of them by the orbital currents and transport down from the surface layer. Observations presented here is the first experience of registration noise from internal waves in the South China Sea. Father investigations of this phenomenon are required due to internal waves with rip bands are widespread in the ocean including shelf zone. Thus this source of underwater noise must be widespread as well. Moreover, due to choppy waves generated by internal waves are clear seen by remote sensing, it is possible to monitor this underwater noise from the space.

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