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Temporal Variation of Cross-Shore Bottom Profile along an Observational Pier at Joetsu-Ogata Coast

TEMPORAL VARIATION OF CROSS-SHORE BOTTOM PROFILE ALONG AN OBSERVATIONAL PIER AT JOETSU-OGATA COAST

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ABSTRACT

Joetsu-Ogata coast is located along Japan Sea coast and has been suffered from severe beach erosion since 1960s. Ogata Wave Observatory (OWO) is one of observational facilities belonging to Disaster Prevention Research Institute (DPRI), Kyoto University, and the cross-shore bottom profiles along the T-shaped Observation Pier (TOP) of OWO have been measured once a month. This paper shows the temporal variations of cross-shore bottom profiles along the observational pier of OWO, and recent variation characteristics of cross-shore bottom profiles are discussed. It is found from observed results that there are some shift on the trend of profile variation and that shoreline advance is observed in recent years.

Keywords: Field observation, cross-shore bottom profile, temporal variation

1. INTRODUCTION

Ogata Wave Observatory (OWO) belonging to the Disaster Prevention Research Institute (DPRI), Kyoto University is located in the middle of Joetsu-Ogata coast in Niigata prefecture, and faces to Japan Sea (Figure 1). Joetsu-Ogata coast has been suffered from severe beach erosion since 1960s. In winter season, strong monsoon wind continuously blows from northwest in the Japan Sea, and it causes high wave condition along Japan Sea coast. These storm conditions could be one of the causes of severe beach erosion along the coast facing the Japan Sea.

Field observations on wave, wind, current and bottom profile have conducted by employing the Observation Pier (Yamashita et al., 1998, Kato et al., 2001, Uchiyama 2005). A wide-area field observation along the Joetsu-Ogata coast was carried out from December 1998 to March 1999 in cooperation with the Niigata Prefecture Government and DPRI. The observation results of wind, waves, and currents at the Joetsu-Ogata Coast illustrates that the coastal currents inside and outside the surf zone are generated by both waves and wind. It was

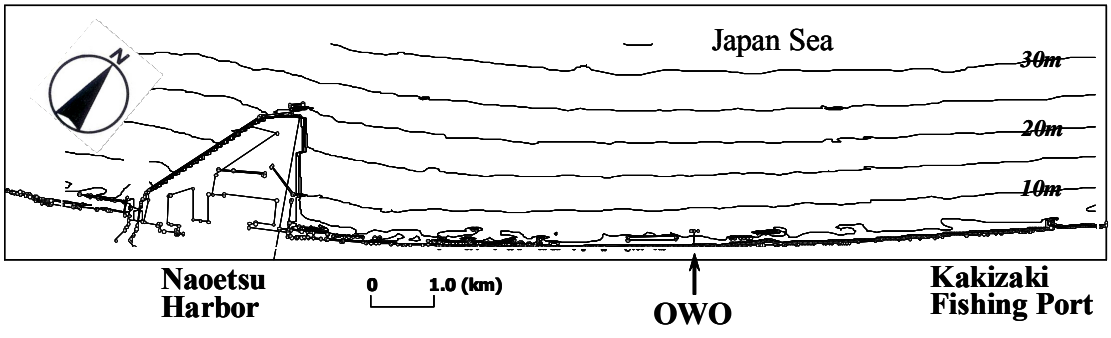

Figure 1 Joetsu-Ogata coast and Ogata wave observatory (OWO)

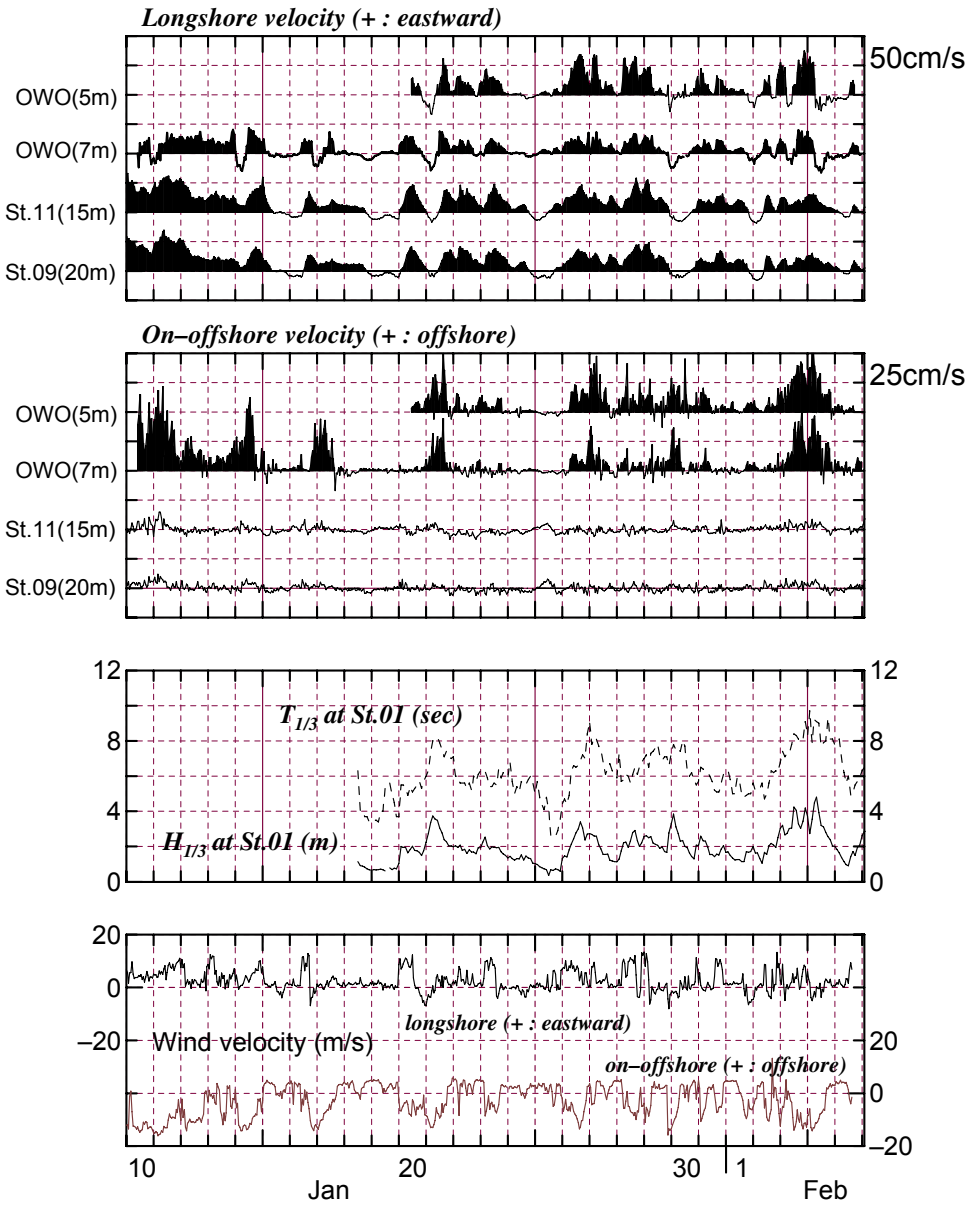

Figure 2 Temporal variations of depth-averaged velocity, $H_{1/3}$, $T_{1/3}$ and wind velocity measured during field observations at the Joetsu-Ogata Coast, Japan in 1999

also found that the wind-driven currents have strong magnitude to generate considerable sediment transport (Baba, 2001).

Figure 2 shows an example of temporal variations in the depth-averaged velocity measured by an ADCP (Acoustic Doppler Current Profiler) during the joint field observations mentioned above. It is clear that strong longshore currents are generated not only in shallow water but also in the offshore region during the storm events. It is also found that strong offshore-going currents occur in the surf zone under high wave conditions and that offshore-going currents are never observed at stations deeper than 15 m. These lonshore and cross-shore currents have high velocities under strom conditions and a considerable sediment transport, which causes bottom profile change, may occur under storm events in both shallow water and offshore region.

In the present paper the temporal variations of cross-shore bottom profile along the observational pier are shown and recent variation characteristics of cross-shore bottom profiles are discussed.

2. TEMPORAL VATIATIONS OF CROSS-SHORE BOTTOM PROFILES

Figure 3 displays the interannual variations of the cross-shore bottom profiles in March from 1998 to 2006. In March, winter storm period draws to an end, and cross-shore bottom profiles in Figure 3 are close to the terminal beach profiles past winter storm season. The cross-shore profiles after 2001 are similar to each other, although the cross-shore profiles before 2000 have some different characteristics from the profiles after 2001. The retreat of shoreline makes progress until 2004.

Figure 4 shows the overlaid cross-shore profiles in every other year from 1998 to 2006. The temporal variations of cross-shore profiles display the following characteristics.

1. the position of shoreline is almost fixed at 25m in cross-shore direction except in 2006
2. obvious profile changes are observed in 1998 and 2000.
3. cross-shore profiles in 2002 and 2004 are similar to each other.
4. shoreline advance and sediment accretion are measured in 2005 and 2006

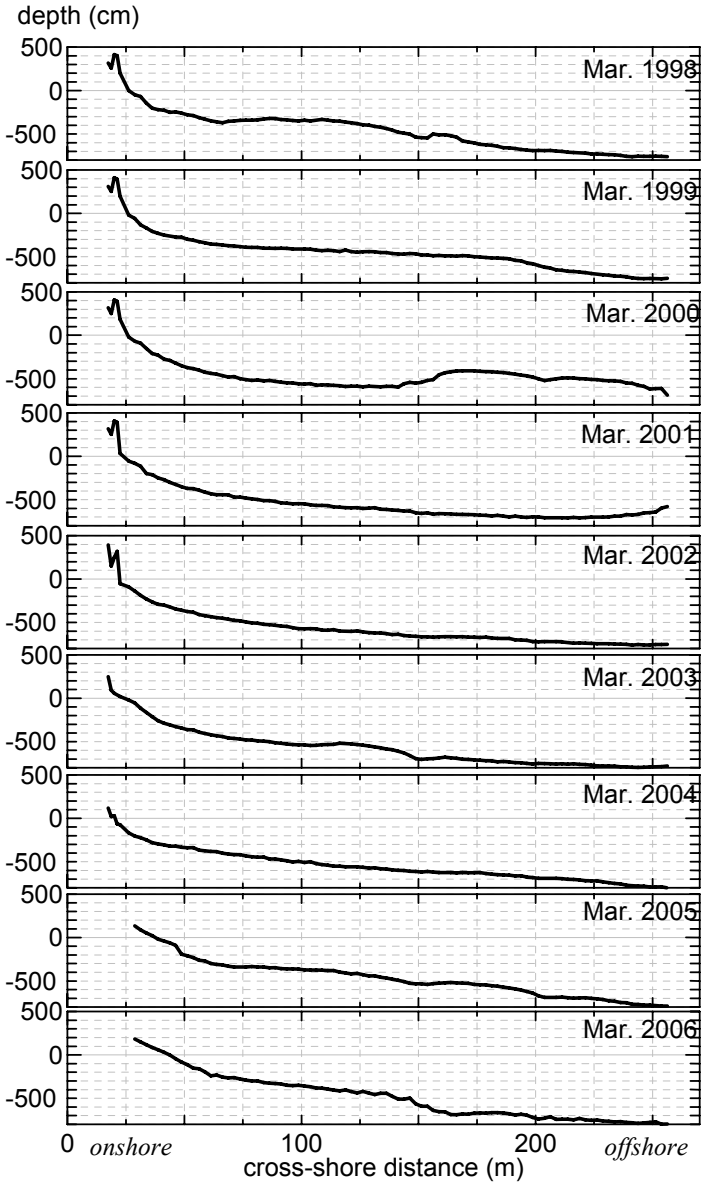

Figure 3 cross-shore bottom profiles along the observational pier of OWO

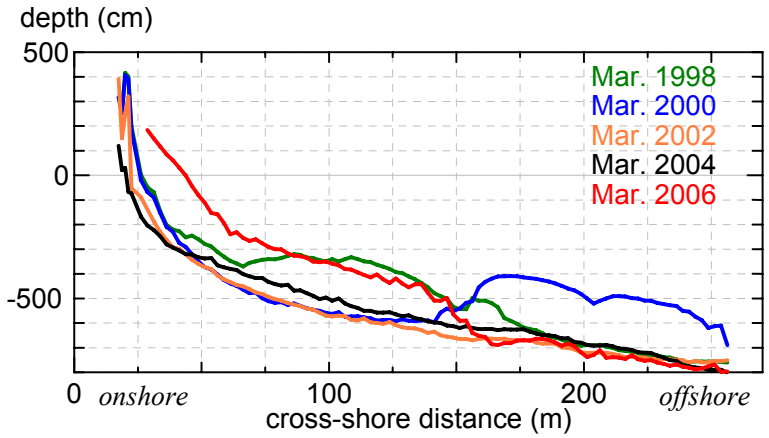

Figure 4 overlaid cross-shore bottom profiles from 1998 to 2006

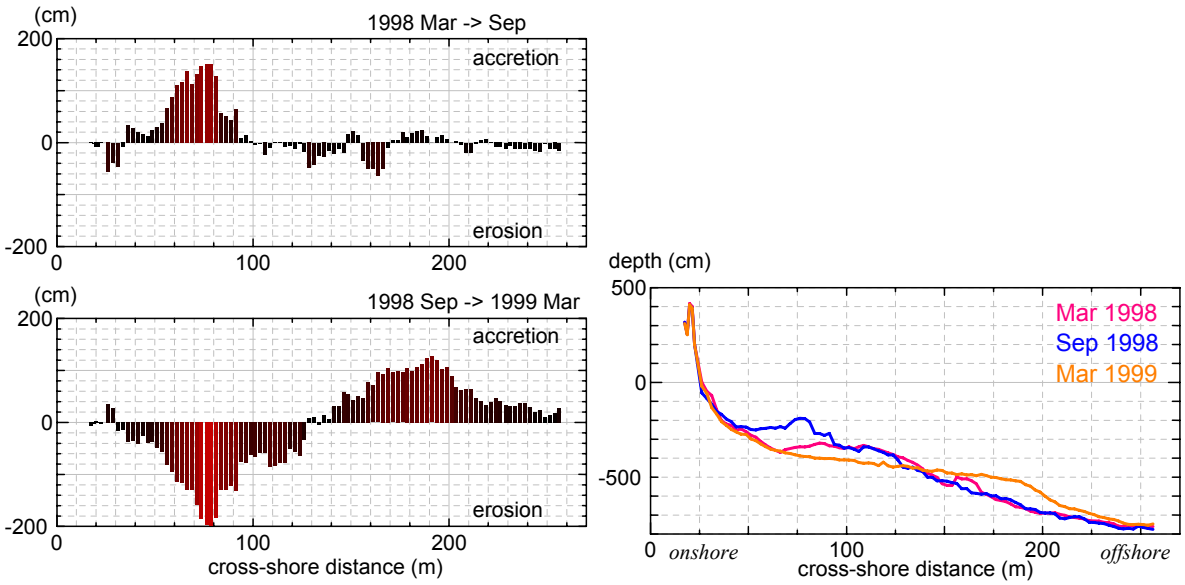

Figure 5 interannual cross-shore bottom profiles (right) and semiannual sediment budget (left) from Mar 1998 to Mar 1999

3. INTERANNUAL VARIATIONS OF CROSS-SHORE BOTTOM PROFILES AND SEDIMENT BUDGET

As mentioned above, Joetsu-Ogata coast has been suffered from severe beach erosion since 1960s, and it is obvious that the retreat of shoreline makes progress until 2004. However, the shoreline advance is measured in 2005 and 2006. In this section, interannual variations of cross-shore bottom profiles are shown with semiannual sediment budget.

Figure 5 shows interannual variations of cross-shore profiles and sediment budget from Mar 1998 to Mar 1999. The wave conditions around Joetsu-Ogata coast differ with the season, severe in winter and clam in summer. Typical seasonal variation of cross-shore profile is displayed in Figure 5. Onshore sediment transport is observed (around 100m in cross-shore distance) by the comparison between the cross-shore profiles in Mar 1998 and Sep 1998. Meanwhile, it is found that some amount of sediment is washed away toward offshore due to storm events in winter seasons (Sep 1998 to Mar 1999). These characteristics of profile change are also described by the semiannual sediment budget.

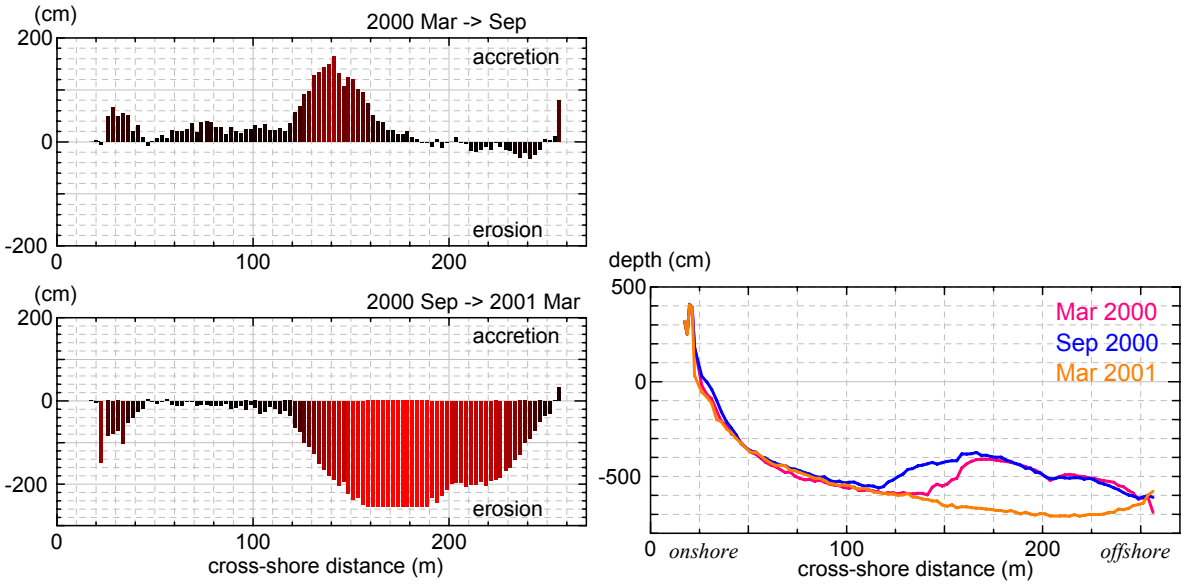

Figure 6 interannual cross-shore bottom profiles (right) and semiannual sediment budget (left) from Mar 2000 to Mar 2001

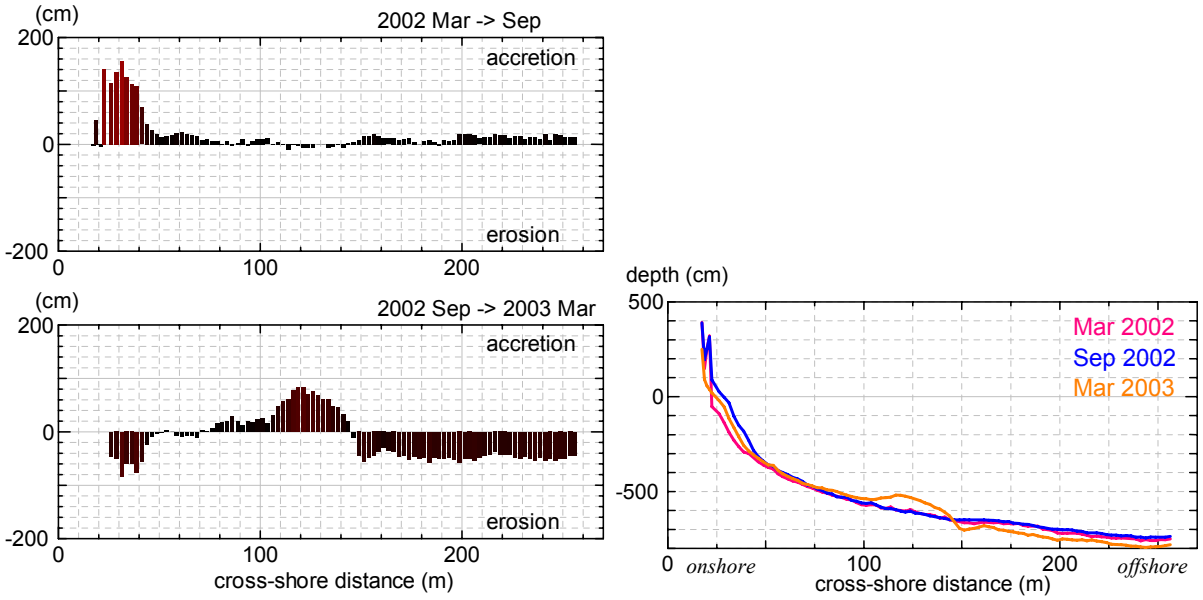

Figure 7 interannual cross-shore bottom profiles (right) and semiannual sediment budget (left) from Mar 2002 to Mar 2003

Figure 6 and 7 show interannual variations of cross-shore profiles and sediment budget from Mar 2000 to Mar 2001 and from Mar 2002 to Mar 2003, respectively. It is particularly noticeable in Figure 6 that heavy erosion occurred and bottom profile close to shoreline attains to a quasi-stable state. In Figure 7, the magnitude of profile variation becomes very small and cross-shore bottom profiles keep similar to each other. It seems that these bottom profiles describe a certain kind of terminal stage of bottom profile.

The recent observed results of interannual variations of cross-shore profiles and sediment budget (from Mar 2004 to Mar 2005) are shown in Figure 8. The trend of semiannual sediment budget in this period is completely different from previous results shown in Figure 5, 6 and 7. Some amount of accretion is observed in the whole measured area,

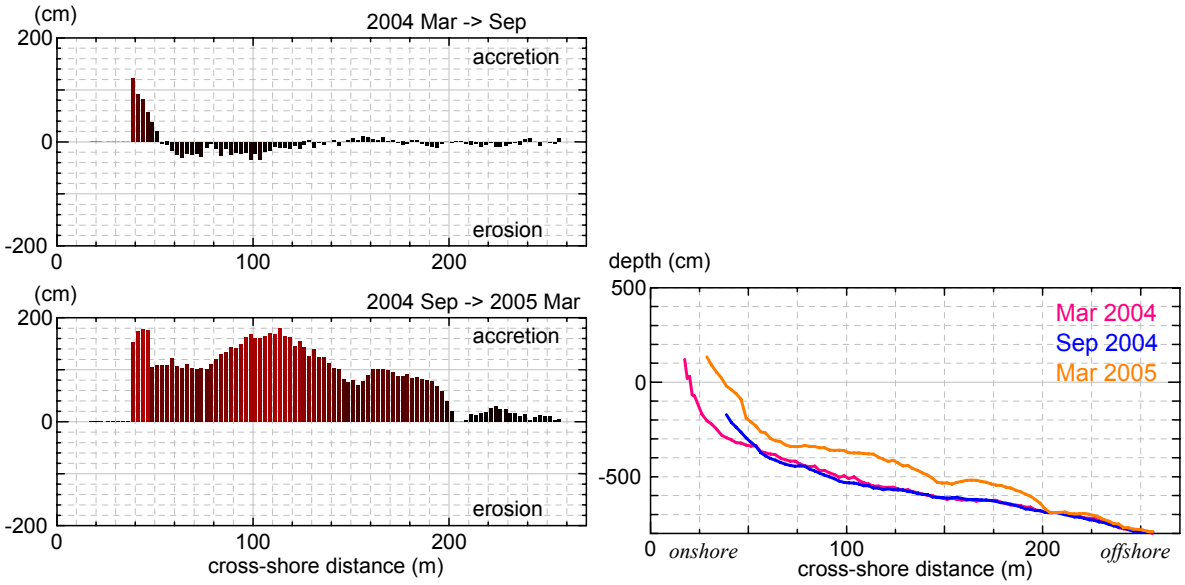

Figure 8 interannual cross-shore bottom profiles (right) and semiannual sediment budget (left) from Mar 2004 to Mar 2005

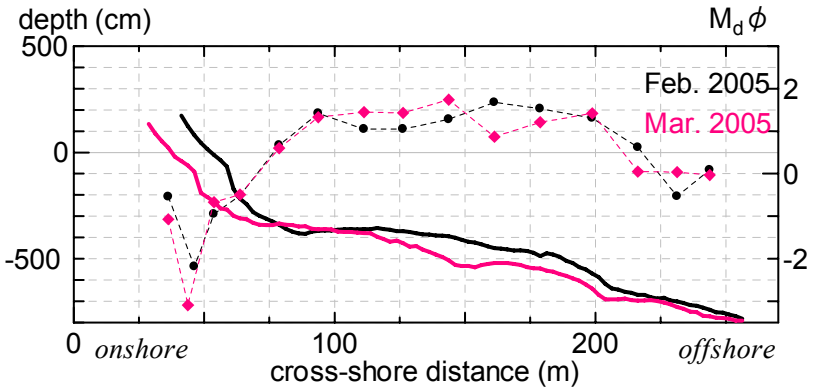

Figure 9 Comparisons of cross-shore bottom profile and grain size distribution between Feb and Mar in 2005

especially more than 1m accretion in the area of less than 200m in cross-shore distance, and shoreline advance up to 20m occurs in half a year including stormy winter season. These profile change (accretion trend) is supported by the bathymetry measured by Naoetsu Port and Harbor Office, Niigata Prefecture.

4. SHORT-TERM VARIATIONS OF CROSS-SHORE BOTTOM PROFILE AND GRAIN SIZE DISTRIBUTION

Figure 9 shows the comparisons of cross-shore bottom profile and mean grain size (in phi scale) distribution between Feb and Mar in 2005. During this period, it is right in the midst of winter storm season, and coastal area has been exposed to high wave condition under storm conditions. During this period (from Feb to Mar in 2005), storm conditions attacked Joetsu-Ogata coast several times. As the results, it is found that shoreline retreat up to 10m long occurs and that erosion of bottom profile is observed. The difference between grain size distributions is not too much in comparison to the clear erosion of bottom profile.

5. CONCLUDING REMARKS

The present paper shows the temporal variations of cross-shore bottom profile along the observational pier at OWO and discusses the variation characteristics of cross-shore bottom profiles by the observed data.

Joetsu-Ogata coast has been suffered from severe beach erosion for a long time, and continuous storm conditions in winter season could be one of dominant factors which cause sever beach erosion. Under storm conditions, current velocity has enough magnitude to generate considerable sediment transport in longshore and cross-shore directions, and offshore-going currents wash away some amount of sediment to offshore region. As the result, the erosion of bottom profile is caused to reach obvious shoreline retreat. These profile change is typical around this coastal region and the retreat of shoreline makes progress until 2004. However, the trend of sediment budget in recent years (2005 and 2006) is different from previous years. The shoreline advance is observed in 2005. The reason for the shoreline advance is not clear because the balance of sediment transport in longshore and cross-shore directions determines the evolution of beach profile. Continuous observational tasks are required to investigate the evolution process of beach profiles in long-term perspective.

The shift of the trend of sediment budget is observed from the interannual viewpoint, and the shoreline advance is reported (this results is also supported by the bathymetry results by local office). However, the erosion of bottom profile is also observed from the short-term (monthly) viewpoint according to the current field under storm conditions, even though the difference of grain size distribution is not too much.

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