An integrated observation system from the ocean bottom to the atmosphere to study air-sea interaction in the Kuroshio region south of Shionomisaki

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The Kuroshio, the western boundary current in the North Pacific, transports huge amounts of water volume and heat from the subtropical region to the downstream south of Japan, where active interaction occurs perpetually between the atmosphere and the ocean. Massive water vapor is supplied from the ocean to the atmosphere, which drives energetic disturbances to cause disasters such as typhoons and explosive cyclones. On the other hand, the atmospheric disturbances promote development of wind waves and storm surges at the sea surface and intensify vertical mixing due to enhanced turbulence inside the ocean. In the Kuroshio region, conventional ship-based measurements can hardly approach the actual condition of the air-sea interaction mainly because of ordinarily strong currents and frequent attacks of severe storms. However, recent studies present probability of detecting the oceanic and atmospheric events by using bottom pressure gauges distributed at the sea floor originally for monitoring the hydraulic pressure fluctuations due to submarine earthquakes. This study aims to construct an integrated observation system from the ocean bottom to the atmosphere in order to elucidate processes of the air-sea interaction in the Kuroshio region, which generate frequently several disturbances in the atmosphere and ocean. This observation system is expected to contribute to realization of more accurate monitoring or forecasting of severe natural disasters.

Our new observation system focuses on the region south of Shionomisaki, the southern tip of Kii Peninsula, where several atmospheric and oceanic events frequently occur under influences of the Kuroshio and the Dense Ocean floor Network system for Earthquakes and Tsunamis (DONET) has been arranged widely by JAMSTEC at the sea floor since 2006 for monitoring precisely the hypocentral region of Tonankai earthquake that are very likely to occur around Nankai trough. DONET/DONET2 (the second phase of DONET) consists of a 300/450 km length of a backbone cable system with 20/29 observatories, each of which is equipped with a high-precision quartz pressure gauge and seismometer. The pressure gauge can measure fine fluctuations of water pressure at the bottom with an accuracy of 0.01 db, hence in some cases it has a potential to detect signals attributed to disturbances generated in the ocean interior, at the sea surface, and even in the atmosphere, in addition to its intended purposes. Our new observation system is mainly composed of three platforms: (1) a network of water pressure gauges at the ocean bottom by DONET and DONET2, (2) an atmospheric observatory located at Shionomisaki wind effect laboratory of DPRI, Kyoto Univ., and (3) a cooperated ship-observatory among the R/V Shinsei-maru, JAMSTEC, the T/S Seisui-maru, Mie Univ. and the D/V Chikyu, JAMSTEC.

The first trial of our new system was conducted in autumn 2018 mainly to validate the accuracy of detecting sub-mesoscale oceanic frontal disturbances linked with fluctuation of the Kuroshio current-path by the bottom pressure gauges of DONET/DONET2, as part of the observational campaigns. In the cruise period, the Kuroshio has taken a large meander path; therefore, the Kuroshio flowed far away from Kii Peninsula and all the DONET/DONET2 points were covered with the slope waters. Timeseries of the bottom pressure at 0.1 s intervals presented temporal variation identical within the range of 0.16 db to

the barotropic fluctuation of the external tide estimated from an astronomical tide model. Cross-spectral analysis of the bottom pressure fluctuations suggested that oceanic disturbances with the period of one hour propagated northeastward from the front of the Kuroshio located southwest of Kii P. to the slope water region southeast of Kii P. The first trial of this new system presented a capability of the sea floor observatory to detect oceanic disturbances originated from the Kuroshio front even under the calm conditions in autumn 2018.

Keywords: integrated observation system, DONET, ocean bottom to atmosphere, Kuroshio

