Improvement for Practical Use of High Resolution Ocean Radar – Evaluation of Measurement Precision and Development of Data Assimilation Model –

Background

CRIEPI has been developing a high-resolution ocean surface radar (hereafter DBF radar＊1) system to observe surface currents widely and continuously for the practical use of the ocean environmental assessment and the efficient monitoring of coastal currents around power plants. The DBF radar can detect surface current pattern every 15 minutes, one fourth as short as the conventional ocean radars. The applicability of the DBF radar as an observational instrument was evaluated through the field observation in Ise Bay, however more field researches are needed to verify the precision of the DBF radar in other seas dominated by different current features. Besides, the continuous surface current data of the DBF radar are suitable for a data assimilation model to infer the vertical current motion in subsurface layers providing useful information to investigate the mechanism of water quality formation or to predict marine litter accumulation.

Objective

The aim of the study is to evaluate the velocity measurement precision of the DBF radar and to develop a data assimilation model analyzing three-dimensional coastal currents based upon short time interval data of DBF radars.

Principal Results

1. Measurement Precision of DBF Radar

The field observation by the DBF radar and ADCP (Acoustic Doppler Current Profiler) was conducted for about two months in winter, 2003 to evaluate the precision of DBF radar measurements in the Akashi Strait where the coastal currents are too large and vary rapidly.

(1) As the result of comparison of velocity components in the line of sight by the DBF radar with that by the ADCP, both values coincided well with the correlation coefficient 0.97 in the total number of the data 97 (Fig.1), which indicates the DBF radar is a useful observation tool even in strong current region such as straits.

(2) The spatial error magnitudes occurring in synthesis of horizontal current vectors was evaluated theoretically which provides useful index of the measurement precision by the DBF radar (Fig.2).

(3) The wide and long-term data of the DBF radar can be useful to investigate the spatial current characteristics such as tidal currents and residual currents through statistical analysis (Fig.3).

2. Development of Data Assimilation Model for Three-dimensional Current Analysis

(1) A data assimilation model with a nudging method to infer three-dimensional coastal currents was developed to take surface current data by the DBF radar into numerical model as surface shear stress.

(2) As the result of calculation in the head of Ise Bay, the prediction results of the assimilation model improved the vertical current profile in the layers from surface to subsurface against the no-assimilation model results (Fig.4). However there is room for improvement in the model concerned with reproduction of the currents affected by river run-off.

Future Developments

We aim to improve the data assimilation model for three-dimensional coastal current analysis and to propose the marine environmental protection program by realizing the real-time monitoring system based upon DBF radar observations.

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Reference

S. Sakai, et.al., 2003, "Short-time observation of coastal currents with DBF radar", Proc. IEEE International Geoscience and Remote Sensing Symposium, Toulouse, France, Vol. 7, pp. 4283-4285.

＊1：The DBF radar with VHF (very high frequency) band developed by CRIEPI provides high distance and velocity resolutions and features a short measuring time interval using digital beam forming technique.

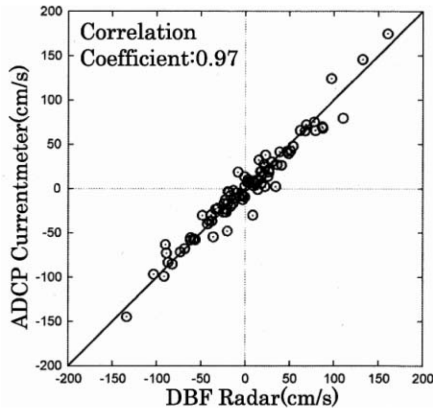

Fig.1 Comparison of the measured velocity by the DBF radar (horizontal axis) with that by the Acoustic Doppler Current Profiler (vertical axis)

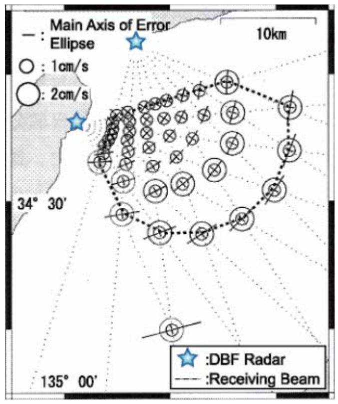

Fig.2 Spatial distribution of error magnitudes of synthesized current vectors. As an example, the magnitudes of 1cm/s and 2cm/s are indicated as circles

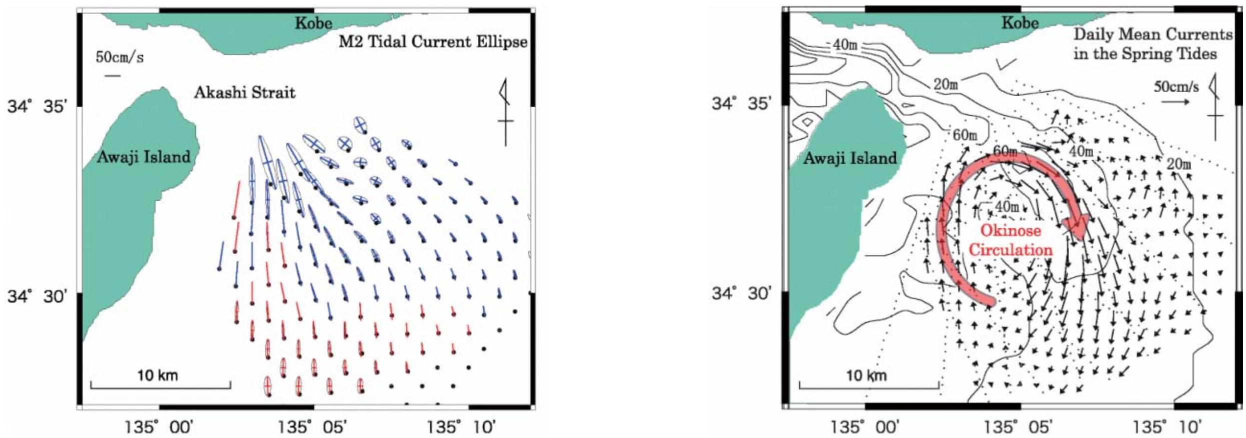

Fig.3 Spatial distributions of principal M2 tidal currents (left) and daily mean residual currents in the spring tides (right) detected by the DBF radar measurements. The blue and red ellipse indicate the cyclonic and anticyclonic motion respectively and the solid circle indicates the phase of M2 tidal current. There is Okinose anticyclonic circulation in the center of the observational domain with the radius of 15km in the right figure

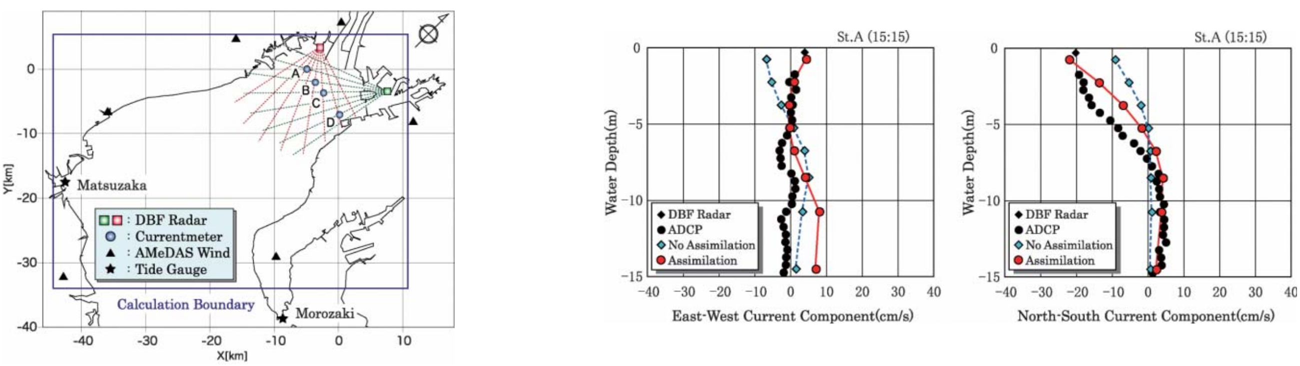

Fig.4 Calculation Domain (left), predicted results of vertical current profile of east-west component (center) and north-south component (right). Assimilation results (red solid circle) improve current profile rather than no assimilation results (blue solid diamond) compared with the observational data (black solid diamond and circle) by the DBF radar and ADCP in the center and right figures