HF Radar Measurement of Surface Current around Taiwan – Some Preliminary Results and Validations

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ABSTRACT

To investigate the surface current around Taiwan, a HF Radar system consisted of 15 CODAR-sites was set up within past four years, from 2008 to 2011. Due to radar function being sensitive to the environment condition, a practical example is used to illustrate whole procedures for the construction of a radar site. Up to now there are three radar sites on operation from end of 2009 and validation of the measured velocity is still on-going. In this study, some preliminary results and validation are presented.

KEY WORDS: HF Radar; radar site construction; data validation.

INTRODUCTION

Ocean current data is vital as it’s the solid and fundamental element to underpin oceanography and marine engineering, and to studies of fluctuations, massive ocean circulations, etc. in physical oceanography, of interdisciplinary ocean science, such as bio-physics, geophysics, chemo-physics, meteorology, hydrology, shipping and transportation management, environmental engineering, etc. Before radar technology was applied to enhance the measurement technology of surface current, it’s clearly not easy to obtain current data. Current meter mooring is an expensive and inconvenient way to measure current velocity field, because it needs to be re-deployed periodically due to the limit on electricity and memory storage; furthermore, it may cause temporal vacancies on database if the mooring is failed to be retrieved. The advantage of using the current measuring radar is the ability of long term and wide range measurement, and the measured data can be promptly returned to the control center through the network connection. Radar sites are constructed on land, having constant power supply and are easier to be maintained, and consequently, the cost of long term measurement on ocean current could be greatly reduced.

Taiwan island is located in East Asia and Taiwan Strait is situated in the west side with the water depth less than 100 meters in most area. This shallow water always would conduce to complex current velocity field, and also in this area the semi-diurnal tidal current is strongly dominated that tends to change direction rather quickly up to four times per day. The strong western boundary current of the Pacific called the Kuroshio flows northward near the east coast of Taiwan. The north coast area is the southern East China Sea and the current field is influenced by the interaction of the Kuroshio and the northward current from Taiwan Strait. Under mixing of both currents, this area forms an important natural fishery field. The southern of Taiwan is the Luzon Strait and there is a branch of the Kuroshio passes by this area in winter. As a whole, ocean current velocity field around Taiwan is composed of various kind of current, and there are a lot of fishery and maritime transportation activities in this area. However, limited to the ocean measuring technology, long term coastal current monitoring system had not been established formerly to develop current forecasting ability and enhance search-and-rescue performance for the marine activities.

At the same time as Taiwan Ocean Research Institute (TORI) was established in July of 2008, a 4-year project was implemented to mapping surface current around Taiwan by using HF radar. Excluding support of science study, TORI is assigned to provide the real time current information for the assistance of disaster mitigation (including victims succor, oil spill response, humanitarian, decision making, etc.) occurring on the sea. Hence, successful establishment and subsequent operation of HF radar is important and under highly anticipation.

THEORY OF CURRENT MEASURING BY HF RADAR

Formally frequency range of High Frequency (HF) radar waves is defined as from 3 MHz to 30 MHz with the wavelength varying from 100 meters to 10 meters, which is similar to ocean surface gravity waves. Vertical polarized HF radio signals could transmit along ocean surface and spread beyond-the-horizon, on the basis of its characteristic, and HF radio waves is appropriate to measure the ocean waves and currents. While radar waves confront ocean surface protrusions such as waves, it would scatter in all directions. If the wavelength of sea wave is integer multiples of a half wavelength of the transmitted radar wave, due to additive effect, larger reflected energy would be produced and transmitted along the incident path in the opposite direction. This phenomenon is called Bragg scattering, and the condition can be expressed with following equations: