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ON UPWELLING ALONG THE EASTERN COAST OF TAIWAN: A REVIEW OF HYDROGRAPHIC AND CHEMICAL DATA

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ABSTRACT

A study of eight years of hydrographic and chemical data from the sea east of Taiwan confirms previous reports (Tominaga, 1972; Hung, 1975) that some upwelling occurs along the east coast of the island. Upward flow of water from depth along the coast frequently leads to relatively cool patches of subsurface water, especially around latitude 23°N. It occurs at depths down to several hundred meters and is indicated by shoreward rises in isotherms and isohalines along with corresponding increases in nutrient and decreases in dissolved oxygen concentrations in the water close to the shore. Southerly and westerly winds tend to generate upwelling in the uppermost several tens to three hundred meters at most, especially in the spring and summer seasons, while upward flows occurring at greater depths would be caused by the current (Kuroshio) and its interaction with the coastal shelf and submarine topography. Persistent deep upflow in the area around latitude 22°45′N to 23°N is topographically induced by the current crossing a submarine ridge just northeast of Taitung, and there may in addition be some yet undetermined shoreward and upward flow along the coast due to friction between the current and shelf bottom. However, the hydrographic regime which characterizes coastal upwelling tends also to be associated with a strong northward moving western boundary current, and it is present in the region to the south of Taiwan as well as along its east coast.

INTRODUCTION

Upwelling is generally caused by divergences produced in the surface layers of the sea, compensated by upward flow from depths below. Upwelling can occur anywhere in the oceans; it is typically a wind-driven process which occurs on a large scale in eastern boundary current regions, such as along the west coasts of the American and African continents. Persistent longshore equatorward winds there together with the earth's rotation drive surface water away from the coast, which, due to the presence of the continental boundaries, is subsequently replaced by upward flow of water from depths below. The total mass transport (M) for a given wind stress (τ) acting on the ocean surface is

$$M=\tau/f$$

where f is the coriolis parameter, and it moves in a direction to the right of the wind (in the northern hemisphere). Wind-driven surface flow is more or less confined to the uppermost few tens of meters of the sea. Compensating upflow from depth usually occurs within ten or twenty kilometers from the shore, and significant upwelling may usually be observed in the eastern boundary current regions following a day or so of persistent longshore prevailing winds. Source depths of upwelled water do not usually exceed 200 to 300 meters. Any upward flow of water towards the ocean surface brings about enrichment in nutrients and consequent increase in fertility and primary productivity of the region, and regions of upwelling are therefore, as well-known, of considerable economic as well as scientific interest.

Upwelling along the eastern coast of Taiwan was first observed in a Satellite Gemini X