WATER MASS PROPERTIES, VARIABILITIES AND ORIGINS IN NORTHERN BORNEO

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CONTENTS

DEDICATION

To My Wife Sharifah Hidayah and My Children Alya Dafinah, Aryan Darwish and Adam Dhani

ABSTRACT

Abstract of thesis presented to the Senate of University Malaysia Terengganu in fulfillment of the requirement for the degree of Master of Science

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Institute : Institute of Oceanography and Environment

We present a definition of water mass properties, variabilities and origins along the coast of northern Borneo based on 55 CTD casts taken during cruises in July 2009. We also studied data from four Argo profiling floats in the surrounding seas. The temperature salinity (TS) relation in the South China Sea, Sulu Sea and Celebes Sea show the existence of eight water masses. Earlier studies defined the surface mixed layer water masses as Open Sea Water (OSW), Continental Shelf Water (CSW) and Seasonal Thermocline Water (STW). Below the layer of this active mixing are subsurface zones of rapid transition called the Tropical Surface Water (TSW) and Maximum Salinity Water (MaxSW). Permanent Thermocline Water (PTW), Minimum Salinity Water (MinSW) and Deep Water (DW) are at the intermediate layer to about 1000 m.

BLUElink ReANalysis (BRAN) global ocean models demonstrated how current circulations influence the exchange of water masses between the three seas. The Sulu Sea sits in the middle, and has very limited connections between the other two seas. Connection with the Celebes Sea occurs at a depth of 200m.

Water exchange happens in two ways; (i) surface inflow and (ii) subsurface outflow. In the South China Sea, water inlet is limited to a depth of 50m and surface flow dominates.

The current circulation of the South China Sea demonstrates that some water mass originated from as far as the north South China Sea and the Pacific Ocean. We further classified water mass differences between the seas to distinguish dissimilarities, and define the different origins. This study shows that the North Pacific Tropical Water (NPTW) salinity maximum and the North Pacific Intermediate Water (NPIW) salinity minimum originating in the Pacific Ocean can be traced to near the coast of Sabah with a wide density range of 23.5 to 25.5 σ_t and 26.4 to 26.8 σ_t, respectively. This implies that the NPTW and NPIW in the SCS are modified largely compared to those in the North Pacific, while in the Celebes Sea they are conserved with similar characteristic of North Pacific water mass. The Pacific core signatures of NPTW and NPIW cannot be found in the Sulu Sea

Given the unique geographical background and current circulation of the area, the properties of the interaction between water mass distribution and current circulation provides new valuable information about the study area. These new findings provided by CTD casts, Argo floats data and BRAN improves our understanding of the water mass definition and circulation of the region and spurs new research on ocean modeling for the future.

ABSTRAK

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu sebagai memenuhi keperluan untuk ijazah Master Sains.

CIRI-CIRI, VARIASI DAN ASAL-USUL JISIM AIR DI BORNEO UTARA

SHUKRI BIN ARSAD

Disember 2013

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Kami telah membentangkan definisi ciri-ciri, variasi dan asal-usul jisim air di sepanjang perairan pantai di utara Borneo berdasarkan persampelan 55 data CTD yang diambil semasa pelayaran pada Julai 2009. Kami juga mengkaji data dari empat unit Argo profil terapung yang berada di laut sekitarnya. Hubungan suhu saliniti di Laut China Selatan, Laut Sulu dan Laut Sulawesi menunjukkan kewujudan lapan jenis jisim air. Kajian awal menunjukkan jisim air di lapisan permukaan yang bercampur dikenali sebagai *Open Sea Water* (OSW), *Continental Shelf Water* (CSW) dan *Seasonal Thermocline Water* (STW). Di bawah lapisan percampuran aktif ini ialah zon subpermukaan peralihan pesat yang dikenali sebagai *Tropical Surface Water* (TSW) dan *Maximum Salinity Water* (MaxSW). *Permanent Thermocline Water* (PTW), *Minimum Salinity Water* (MinSW) dan *Deep Water* (DW) berada di lapisan perantaraan sehingga kira-kira 1000 m.

BLUElink ReANalysis (BRAN) iaitu model lautan global telah menunjukkan bagaimana peredaran arus mempengaruhi pertukaran jisim air di antara tiga laut ini. Laut Sulu yang berada di tengah-tengah dan mempunyai sambungan yang sangat terhad di antara Laut China Selatan dan Laut Sulawesi. Sambungan diantara Laut Sulu dan Laut Sulawesi berlaku pada kedalaman sehingga 200 m. Pertukaran air yang berlaku adalah melalui dua cara; (i) aliran masuk permukaan dan (ii) aliran keluar subpermukaan. Manakala di antara Laut China Selatan dan Laut Sulu, aliran air adalah terhad kepada kedalaman maksimum 50 m sahaja dan didominasi oleh aliran permukaan.

Peredaran arus di Laut China Selatan menunjukkan bahawa terdapat jisim air yang berasal jauh iaitu dari utara Laut China Selatan dan Laut Pasifik. Seterusnya kami mengkelaskan jisim air diantara Laut China Selatan, Laut Sulu dan Laut Sulawesi untuk melihat perbezaan dan penentuan asal-usulnya. Kajian ini menunjukkan bahawa *North Pacific Tropical Water* (NPTW) saliniti maksimum dan *North Pacific Intermediate Water* (NPIW) saliniti minimum yang berasal dari lautan Pasifik dapat dikesan berhampiran perairan Sabah dengan kadar densiti 23.5 sehingga 25.5 σ_t dan 26.4 sehingga 26.8 σ_t, masing-masing. Hal ini menunjukkan bahawa NPTW dan NPIW di Laut China Selatan sebahagian besarnya termodifikasi berbanding dengan yang asal dari Laut Pasifik utara, manakala di Laut Sulawesi kadar densitinya terpelihara dengan ciri yang sama dengan jisim air Laut Pasifik utara. Tiada tanda teras kehadiran jisim air Laut Pasifik NPTW dan NPIW yang dijumpai di Laut Sulu.

Memandangkan perairan Sabah mempunyai latar belakang geografi yang unik dan adanya peredaran arus, ciri-ciri interaksi diantara taburan jisim air dan peredaran arus telah memberi maklumat baru yang bernilai di kawasan kajian tersebut. Penemuan baru ini yang diperolehi dari CTD, Argo profil terapung dan BRAN telah meningkatkan pemahaman tentang definasi jisim air dan peredaran arus di rantau ini dan mendorong kajian baru berkaitan model lautan di masa hadapan