

**DYNAMIC INTERACTION BETWEEN
SOUTHERN SOUTH CHINA SEA AND GULF
OF THAILAND CIRCULATION PATTERN**

NURUL RABITAH BINTI DAUD

**DOCTOR OF PHILOSOPHY
UNIVERSITI MALAYSIA TERENGGANU**

2019

NURUL RABITAH BINTI DAUD

DOCTOR OF PHILOSOPHY

2019

**DYNAMIC INTERACTION BETWEEN SOUTHERN SOUTH
CHINA SEA AND GULF OF THAILAND CIRCULATION
PATTERN**

NURUL RABITAH BINTI DAUD

**Thesis Submitted in Fulfilment of the Requirement for the Degree of
Doctor of Philosophy in the Institute of Oceanography and Environment
Universiti Malaysia Terengganu**

MAY 2019

DEDICATION

To science,

my parents; Daud Adam & Siti Mariam A.Rahman,

*my siblings; Anisah Daud, Amir Farhan Daud, Hafiz Daud & Rabiatul
Adawiyah Daud,*

*also to my late grandmother, Ngah bte Saleh and my late grandfather, Adam
Yusof who told me that anything is possible with hard work and discipline,
parents' blessing and Allah's will,*

and

whoever might find this work interesting.

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu
in fulfillment of the requirement for the degree of Doctor of Philosophy

**DYNAMICS INTERACTION BETWEEN SOUTHERN SOUTH
CHINA SEA AND GULF OF THAILAND CIRCULATION PATTERN**

NURUL RABITAH DAUD

MAY 2019

Main supervisor : Assoc. Prof. Dr. Mohd Fadzil Bin Mohd Akhir, PhD

**Co-Supervisor : Assoc. Prof. Dr. Aidy@Mohamed Shawal Bin M Muslim,
PhD**

Co-Supervisor : Assoc. Prof. Dr. Lee Wei Koon, PhD

School/Institute : Institute of Oceanography and Environment

The southern South China Sea and the Gulf of Thailand region is largely influenced by the monsoon season. The oceanographic events (e.g., coastal upwelling and thermal front) in east coast Peninsular Malaysia and the Gulf of Thailand, located in the southern South China Sea region, are generally affected by the monsoon seasons. Since the discovery of seasonal upwelling and thermal front in east coast of Peninsular Malaysia and the Gulf of Thailand is at an initial phase, this study focuses on the dynamic interaction between the Gulf of Thailand and the southern South China Sea in order to provide novel information on physical oceanography associated with oceanographic events in this region. This study utilizes satellite imagery and numerical modelling i) to observe seasonal variability and the influence of El-Niño Southern Oscillation on coastal upwelling associated thermal front, ii) to examine seasonal circulation patterns and eddy kinetic energy in the southern South China Sea and the Gulf of Thailand and iii) to determine the various transports (volume, heat, salt and freshwater) between the Gulf of Thailand and the southern South China Sea. The results show that the east coast of Peninsular Malaysia coastal upwelling associated thermal front along the east coast of Peninsular Malaysia, the presence of a thermal front at the opening of the Gulf of Thailand and the subsurface eddy in southern South China Sea basin occur in the

southwest monsoon. The coastal upwelling associated thermal front was affected by the strong El-Niño event. The convergence-divergence surface currents between Peninsular Malaysia and the Gulf of Thailand are observed during the southwest monsoon and northeast monsoon, respectively. Additionally, a subsurface eddy was spotted during the southwest monsoon in the northern part of Peninsular Malaysia. The volume, heat, salt and freshwater transport across the Gulf of Thailand was high during the southwest monsoon while the transport in the southern South China Sea was higher during the northeast monsoon. The heat, salt and freshwater transport in both regions essentially followed the volume transport trend. Conclusive evidences indicate that the oceanographic dynamics in the southern South China Sea has a major influence on the oceanographic dynamics in the Gulf of Thailand, specifically in controlling the seasonal inflow and outflow from the Gulf.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu sebagai memenuhi keperluan untuk Ijazah Kedoktoran

**DINAMIK PEREDARAN ARUS ANTARA LAUT CHINA SELATAN
DAN TELUK THAILAND**

NURUL RABITAH DAUD

MEI 2019

**Penyelia Utama : Prof. Madya Dr. Mohd Fadzil Bin Mohd Akhir,
PhD**

**Penyelia Bersama : Prof Madya Dr. Aidy@Mohamed Shawal Bin M
Muslim, PhD**

Penyelia Bersama : Prof Madya Dr. Lee Wei Koon, PhD

Pusat Pengajian/Institut : Institut Oseanografi dan Sekitaran

Laut China Selatan dan Teluk Thailand sebahagian besarnya dipengaruhi oleh musim monsun. Proses oseanografi fizikal (contohnya, pengaliratan dan zon ke hadapan haba) di Semenanjung Malaysia dan Teluk Thailand terjadi disebabkan oleh pengaruh angin monsun. Oleh kerana penemuan pengaliratan dan zon ke hadapan haba di Semenanjung Malaysia dan Teluk Thailand masih baru ditemui, kajian ini telah dijalankan bagi memberi tumpuan kepada interaksi dinamik antara Teluk Thailand dan bahagian selatan Laut China Selatan. Sebagai maklumat tambahan baru mengenai oseanografi fizikal di rantau ini yang membantu untuk memahami proses oseanografi fizikal tersebut. Kajian ini telah menggunakan imej satelit dan pemodelan berangka lautan, i) untuk melihat variabiliti bermusim dan pengaruh ENSO terhadap pengaliratan dan zon ke hadapan haba, ii) untuk mengkaji peredaran arus bermusim dan tenaga kinetik di bahagian selatan Laut China Selatan dan Teluk Thailand, iii) untuk menentukan pelbagai pengangkutan (isipadu, haba, kemasinan dan air tawar) di antara Teluk Thailand dan bahagian selatan Laut China Selatan. Hasil daripada kajian ini menunjukkan pengaliratan di Semenanjung Malaysia, zon ke hadapan haba pada pembukaan Teluk Thailand dan pusaran di bahagian sub-kedalaman air di bahagian selatan Laut China Selatan yang berlaku pada musim monsun barat daya. Selain itu, zon ke hadapan haba terjejas oleh

kejadian El-Niño yang kuat. Tambahan lagi, arus yang terpisah pada permukaan air di antara pantai timur Semenanjung Malaysia dan Teluk Thailand dapat diperhatikan semasa musim monsun timur laut dan monsun barat daya. Satu pusaran bawah permukaan air telah ditemui semasa monsun barat daya di bahagian utara Semenanjung Malaysia. Jumlah isipadu, haba, kemasinan dan air tawar yang merentas Teluk Thailand lebih tinggi semasa monsun barat daya manakala di Laut China Selatan pengangkutan lebih tinggi pada monsun timur laut dan pada kedua-dua kawasan pengangkutan kebanyakannya mengikuti trend pengangkutan isipadu. Secara ringkasnya, dinamik di bahagian selatan Laut China Selatan menjadi pengaruh utama ke atas dinamik di Teluk Thailand khususnya mengawal aliran arus keluar dan masuk ke dalam Teluk Thailand.