Floating Circle of Objects Simulation with the Princeton Ocean Model for the Gulf of Thailand

Chairote YAIPRASERT[1] Krisanadej JAROENSUTASINEE[1] and Tawat VERUTTIPONG[2]

School of Science[1], Walailak University, Thasala, Nakhon Si Thammarat 80160, Thailand.
Communication Ground Systems Section[2], Jet Propulsion Laboratory, California Institute of Technology, California, USA.

ABSTRACT

The Princeton Ocean Model (POM) was modified to simulate motion of a group of particles floating on the sea surface in the Gulf of Thailand. The particles in this group were set up so that they formed a circle. The radius reflected uncertainties of longitude and latitude directions while the centre was set at the point of interest. POM was incorporated with tidal forcing on the boundary, which included used current forcing on the inflow by wind velocities, high resolution and realistic ocean bottom topography, temperature and salinity. The model domain for the Gulf of Thailand extended from latitude 3°N-14°N and longitude 99°E-109°E. A horizontal grid resolution of 0.1 degree (approximately 11.1 km) was used in the model. Therefore, the grids consisted of 101×111 cells. Twenty one levels in sigma coordinate were used in vertical resolution. The model results were verified using TOPEX/Poseidon and JASON satellite data. The results of the simulation were used to gain a better understanding of the sea current and object movement patterns in the Gulf of Thailand.

Key words: Floating circle of objects - Hydrodynamic model - Princeton ocean model - Satellite - Sea surface elevation

INTRODUCTION

People have utilised the oceans for centuries, but seafaring has always brought an element of danger. Search and rescue marine operations have become very important for saving lives and reducing the loss of property in the maritime environment. The rescue operation is needed for people who live in coastal areas. At present, there is no such rescue system for coastal regions in Thailand. The aim of this research is to examine how sea surface circulation affects object movement in the Gulf of Thailand.

There have been many maritime accidents in the territorial waters of Thailand. For example, a passenger ferry King Cruiser (1,2,3,4,5) hit the coral reef on a routine run to

Phi-Phi Islands on the 4th May 1997. It was a bright day with partly cloudy sky, no wind and a calm sea. The sinking process lasted one hour and all of the 600 passengers were safely rescued by local diving and fishing boats. A number of oil spill accidents have occurred in the coastal waters of Thailand. A tanker carrying about 1.06 million gallons of diesel (6) and liquefied petroleum gas spilled about 105,670 gallons of diesel fuel into the sea some 6.4 km of the eastern Sriracha coast after its collision with an unidentified cargo ship on the 6th March 1994. Concentration of dissolved/dispersed petroleum hydrocarbons was detected (7) and measured at 78 sites in 1994 and 1995 in coastal waters of the Gulf. In another incident, some 243 tonnes of bunker oil (6,8,9) leaked from a Panamanian-registered ship off the country's eastern coast when it crashed against a rock on the 17th January 2002. A huge oil slick reached the beaches in Sattahip in the eastern Chonburi province. A 5,342 ton Panamanian-registered oil tanker (6,8,10) spilled diesel fuel into the Gulf of Thailand on the 17th December 2002 after a collision with a 16,731 ton Singaporean-registered cargo freighter. The accident occurred a few nautical miles off the Thai port of Laem Chabang. The leaked diesel fuel from tanks serving the ship's engines spilled into the sea and spread about 200 square meters around the collision site.

Maritime accidents are likely to occur in the territorial waters of Thailand in the future. Therefore, the movement of the leaked diesel fuel or sink cruiers is a critical factor in search and rescue planning. The result from this study is useful in developing a rescue system in the future.

The numerical simulation and prediction of oil spill processes is an important tool for planning and protection, and spill response operations. For the purposes of long-term spill protection planning, the most evident application of oil spill simulation systems is a risk analysis of environmental pollution from existing and planned potential oil spill sources for sensitive areas (e.g. power stations, water supply plants, recreation areas, marine farms etc.). For organising the spill recovery after accidental marine oil spills and for short term environment protection planning, the prediction of the spill trajectory and oil fate is most important.

Sea levels and currents play an important role in coastal exploitation, navigation and management of oil spills. In general, two factors affect sea level variation (11). The first factor is astronomical tides that are produced by the gravitational attraction of the moon and sun acting on the rotating earth. The second is nontidal sea level variation that is primarily generated by the surface wind. Surface winds and currents are the most important factors in determining the direction and rate at which the oil slick moves (12). The physical, chemical, and biological reactions modify oil as it drifts and spreads over various time scales ranging from a few hours to months and even years. Therefore, to adequately calculate oil spill processes and the transport of oil pollution in the sea, it is necessary to know the environmental condition (i.e. winds, currents, waves, turbulence, salinity, and temperature).

Oil spill modelling is an area of pollution modelling that has attracted a great deal of attention because of the immediate and catastrophic results of recent major accidents. Spills can originate from subsea pipelines or drilling operations with or without the presence of gas, long-term leaks or virtually instantaneous releases of oil at the sea surface from tankers or platform operations or above sea discharges of oil and gas from a platform blowout. The purpose of this study is to show spatial motion patterns of group object movement in the Gulf of Thailand environments in relation to the hydrodynamic circulation mode. The Princeton Ocean Model (POM) will be incorporated with tidal forcing on the boundary, which includes used current forcing on the inflow by wind velocities, high resolution and realistic ocean bottom topography, temperature and salinity.

Physical Setting of the Gulf of Thailand

The Gulf of Thailand **(Figure 1)** is a semi-enclosed basin located between Latitude 6°N to 14°N and Longitude 99°E to 105°E Thailand (13,14,15). The Gulf is bounded on the east by the coastline of Cambodia, Vietnam and the South China Sea, and the west by the coastlines of southern Thailand and Malaysia. The northern boundary of the Gulf is bordered by the coastline of Thailand. The area measures approximately 400 km × 800 km, with a coastline of approximately 1,840 km on the Gulf of Thailand. The mean depth is 45 m, and the maximum depth is approximately 80 m.

The water exchange is strong, water inflow from the rivers like the Chao Phraya, Tha Chin, Mae Klong, and Bang Pakong rivers. The low salinity level of the water in the Gulf is the result of dilution by rain and freshwater runoffs. The major monsoons over the Gulf area are the Northeast Monsoon that prevails in November to February and the Southwest Monsoon that prevails in May to September. Moreover, there are two transitional periods between the opposing monsoons. The circulation in the Gulf of Thailand is complex because it is dominated by the combination of wind (wind-driven current), tide, density gradient, and bottom topography of the Gulf.

Tides in the Gulf of Thailand are the result of tidal waves propagating from the South China Sea, which are known as co-oscillation tides. The analysis of the tidal data from tide gauges reveals that the amplitudes of diurnal components are larger than the semidiurnal components. The upper part of the Gulf of Thailand is dominated by a mixed tide, while the mixed tide prevails in the area further from the inner Gulf. The diurnal tide is prevalent along the eastern and western sides of the Gulf. At the upper and southern part of the Malay Peninsular, mixed diurnal-dominated tides and mixed semidiurnal-dominated tides prevail respectively (16).

MATERIALS AND METHODS

POM is a time-dependent, primitive equation circulation model on a three-dimensional grid that includes realistic ocean bottom topography and a free surface, finite difference ocean model designed to accommodate mesoscale phenomena, including the often nonlinear processes such as upwelling and eddy dynamics, commonly found in estuarine and coastal oceanography (17). The principal attribute of the model is that it contains an imbedded turbulence closure sub-model to provide vertical mixing coefficients. It is a sigma coordinate model in that the vertical coordinate was scaled on the water column depth. The horizontal grid uses curvilinear orthogonal coordinates and an "Arakawa C" differencing scheme. The horizontal time differencing is explicit whereas the vertical differencing is implicit. The latter eliminates time constraints for the vertical coordinate and permits the use of fine vertical resolution in the surface and bottom boundary layers. The model has a free surface and a split time step. The external mode portion of the model is two-dimensional and uses a short time steps based on the Courant Friedrichs Levy condition and the external wave speed. The internal mode is three-dimensional and uses a long time step based on the Courant Friedrichs Levy condition and the internal wave speed. Complete thermodynamics have been implemented.

The model domain for the Gulf of Thailand extended from latitude 3ºN - 14ºN and longitude 99ºE - 109ºE. A horizontal fine grid resolution of 0.1 degree (about 11.1 km) was used in the model. Therefore, the grids consisted of 101×111 cells. Twenty one levels in sigma coordinate were used in vertical resolution. The model showing variations of tidal currents, associated to realistic bottom topography on a 5' grid was extracted from NOAA National Geophysical Data Center.

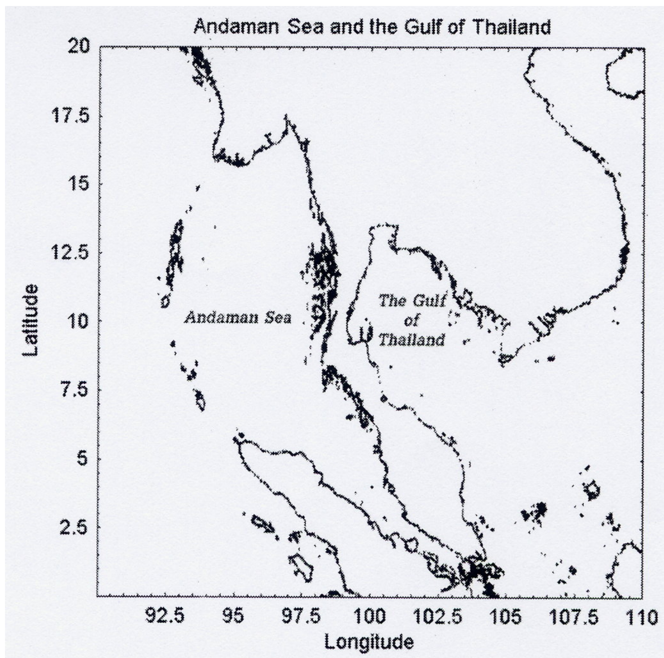


Figure 1. The Andaman Sea and the Gulf of Thailand Coastline.

Experiment I: Model Response to Co-oscillation Tides

To investigate the effect of tide on sea surface elevation, the model was driven by only co-oscillation tide at the open boundaries. These include the simulation of sea surface height in January 2004 to April 2004 which were then compared with the sea surface height (SSH) of TOPEX/Poseidon (T/P) and JASON satellite. Tidal elevation and current were derived from Oregon State University Tidal Inversion Software (OSUTIS) regional scale (1/6º) model of Indonesian Seas (18) in the form of harmonic constants. T/P satellite data were assimilated along with tide gauges to the OSUTIS in the Asian semi-enclosed Seas, particularly in the South China Sea and in the Indonesian Seas. The software had a domain with longitude and latitude limits 95°E - 165°E, 21°S - 15.6667°N. It analysed the sea surface elevation from an altimeter, which was the sensor on the T/P satellite.

The calculated tidal elevation was analysed to retrieve amplitude and phase of those constituents by using harmonic analysis. Eight principal tidal constituents, composed of four diurnal tides and semi-diurnal tides were used to compute tidal elevation by the following equation:

$$h(t) = \sum A_i \cos[(V_o + u)_i + \sigma_i t - \kappa_i] \tag{1}$$

Where: κ_i is the phase lag behind equilibrium for each constituent

$(V_0 + u)_i$ is the nodal factor

σ_i is the phase increment per mean solar hour of each constituent

A_i is the amplitude of each constituent

The forcing input was specified in the form of amplitude (m) and phase (GMT) for each constituent at each point along the open boundary. The relatively fine 0.1° resolution (3°N - 14°N, 99°E - 109°E) was used for estimating details of the tides in this boundary area.

Experiment II: Model Response to a Combination of Meteorological Data and Co-oscillation Tides

The winds transferred momentum to both ocean surface waves and ocean currents. Calculations were made for two weather conditions: calm sea for the period of June 2003 and tropical depression storms for the period of October 2003 (tropical storm on the 21st-28th October 2003). The determination of the sea level resident was of major interest in the modelling conducted here. So that non-linear effects between all contributing factors were taken into account. Tidal forcing was included in the open boundaries together with meteorological effects at the sea surface. Two aspects of the sea level were considered: the co-oscillation tide at the open boundaries and the meteorological effects (i.e. wind, and atmospheric pressure). Wind and pressure data were obtained from the Navy Operational Global Atmospheric Prediction System (NOGAPS); data incorporates atmospheric and oceanographic parameters (19) based on the 12-hour forecasts on a 1×1 degree grid, for the entire global by the primitive equation model. The hourly time series of calculation of SSH were compared with the satellite altimeter data.

Floating Circle of Objects Simulation

POM was appropriate for tracking several particles together on the sea surface in the Gulf of Thailand. It was modified to simulate a floating circle of objects (FCO) in the Gulf of Thailand environments. The circular shape of the particles reflects uncertainties in both longitude and latitude directions when the target centre was acquired from any incident. The computational grid was set to have a resolution of 0.1×0.1 degrees and had 21 sigma levels in the vertical direction. Tides were included in the boundary conditions of the model while wind velocities were incorporated as forcing conditions on the surface. The model was also set up with realistic ocean bottom topography (20), and proper temperature and salinity in the form of Levitus (21). It was simulated for FCO that had the centre at Longitude 101ºE and Latitude 12.2ºN. One hundred particles were set up around the centre with a radius of 2 minutes. Simulations were run for 20 days in two weather conditions: calm sea for the period of June 2003 and tropical depression storm for the period of October 2003. In addition, it did not take into consideration the inflow/outflow of current from the South China Sea which in fact had an influence on the pattern of currents in the Gulf (16).

RESULTS AND DISCUSSION

Experiment I: Model Response to Co-oscillation Tides

The model was run for a simulated time of 152 days (December 2003 to April 2004), with the first month of predictions assumed mark with starting transients and not used. The remaining 121 days of predicted data was saved at hourly intervals and tidally analysed. A discussion of the tidal currents and elevations will also be included. The SSH satellite observations within the Gulf are made in the time zone +7 hours GMT and were compared with those calculated from the model results as illustrated in **Figure 2**. The elevation simulated were not in good agreement with SSH satellite.

The elevation differences were averaged over the 121 days period to obtain the monthly mean. This was the SSH of the satellite minus the calculated elevation from the model at the same time and space. The mean difference is shown in **Figure 3**. These showed a range of elevations from -10.4269 to 4.60512 m. The tidal elevation results from the model were higher than the values obtained from the satellite by a mean of about 1.84716 m.

Open boundary formulation was an important factor in the modelling of storm surges. Generally, there would be more than one condition that can solve the problems associated with the inclusion of an open sea boundary, which appeared to solve the problems associated with the inclusion of an open sea boundary. In the models, various inputs including tides and sea levels were applied to open boundaries. Meteorological effects were applied to the interior, making the choice of boundary condition difficult. In choosing the condition used, the following must also be considered:

1. The major source of errors in modelling was in the approximation of meteorological effects.
2. None of the open boundaries were completely satisfactory in a general sense.

Considering the factors included in the discussion above, it appeared that the tidal height and the relevant meteorological effects (if available) for each particular scenario were considered adequate for the models considered in this study. For each model, the merits and drawbacks of such an open boundary are given individual attention in the relevant sections. The mathematical and computational bases for tide and/or storm surge models have been described. The choice of model used depended upon the region being investigated.

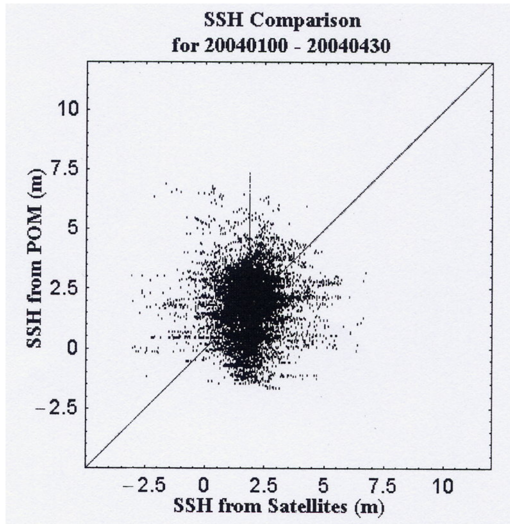


Figure 2. Scatter diagram of the elevation (m) compared between the elevations from the satellite data values and the hydrodynamic model.

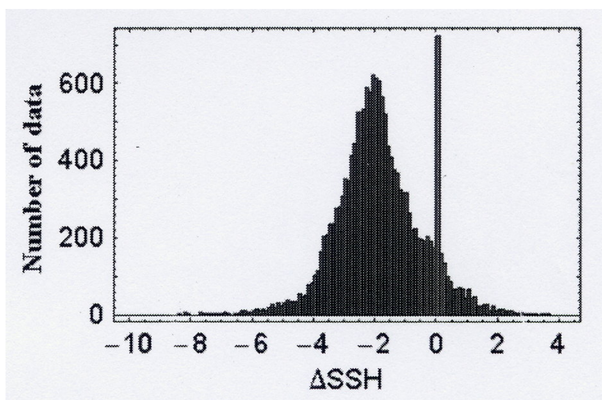


Figure 3. The histogram of elevations difference incorporating continuous statistical distributions with a range from -10.4269 to 4.60512 m. $\bar{x} \pm$S.D.=-1.84716 $\pm$ 1.42002 m.

Experiment II: Model Response to a Combination of Meteorological Data and Co-oscillation Tides

Two aspects of the sea level were considered the co-oscillation tide at the open boundaries and the meteorological effects. Tides were computed as described in Experiment I. The period of June 2003 and October 2003, hourly wind and atmospheric pressure data were provided by NOGAPS. The validation of the NOGAPS data was supported the use of T/P and ERS satellites as illustrated in **Figure 4** and **Figure 5**. The validation was compared for the period of January 2003 to June 2003. There was a narrow range of statistical distributions for wind difference. NOGAPS winds were in good agreement with satellite winds. Therefore, NOGAPS wind data were used in this study as a wind velocity on the sea surface level.

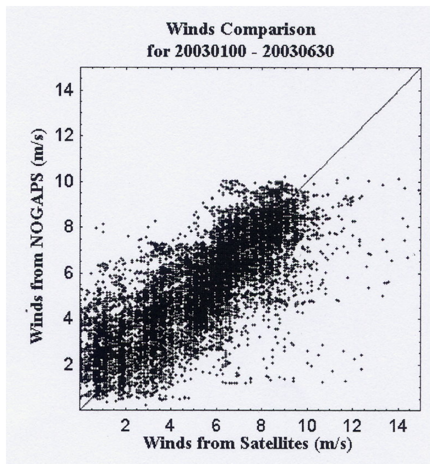


Figure 4. Scatter diagram of the wind velocity (m/s) compared between the wind velocity from the satellite data values and the NOGAPS data.

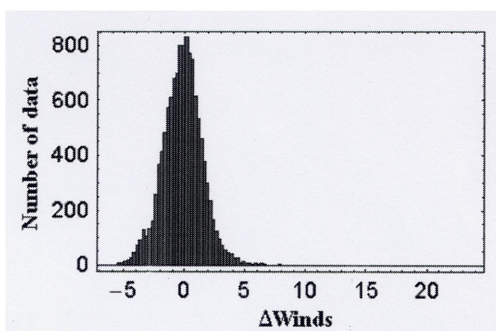
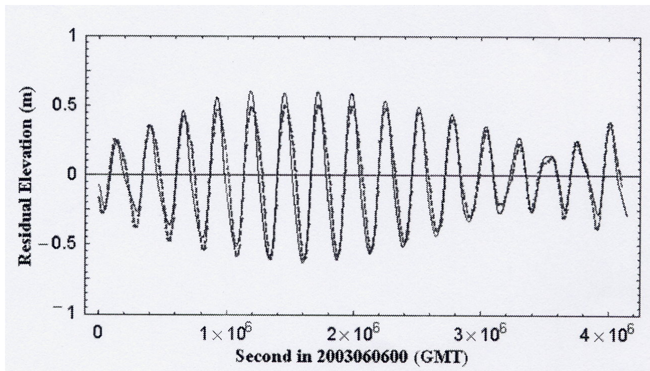
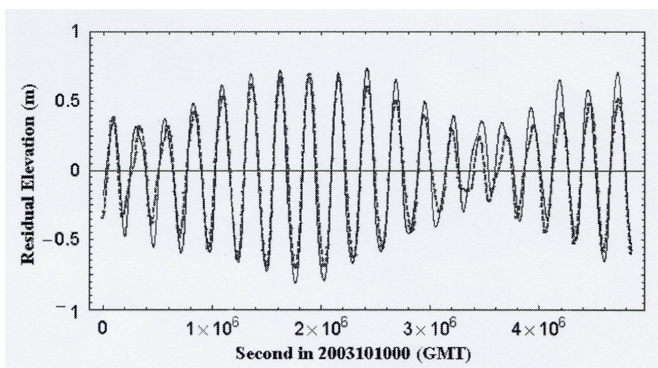


Figure 5. The histogram of wind difference displayed as a continuous statistical distribution, with a range from -7.24905 to 24.7246 m/s. $\bar{x}\pm$S.D.=-0.127108 ± 1.73435 m.

The effect of wind and pressure fields over the Gulf of Thailand combined with tide entering the system caused the observed point within the Gulf. Tide strongly affected the sea surface elevation. However, during strong wind conditions (tropical storm), the sea surface elevation was dominated by wind surges as depicted in **Figure 6a-b**. Results of sea surface elevation from the model including meteorological effects (solid line) and not including meteorological effects (dash line). Sea surface elevation fluctuated in a similar manner. Non-linear effects between all contributing factors were taken into account, tidal forcing was included on the open boundaries together with meteorological effects at the sea surface.



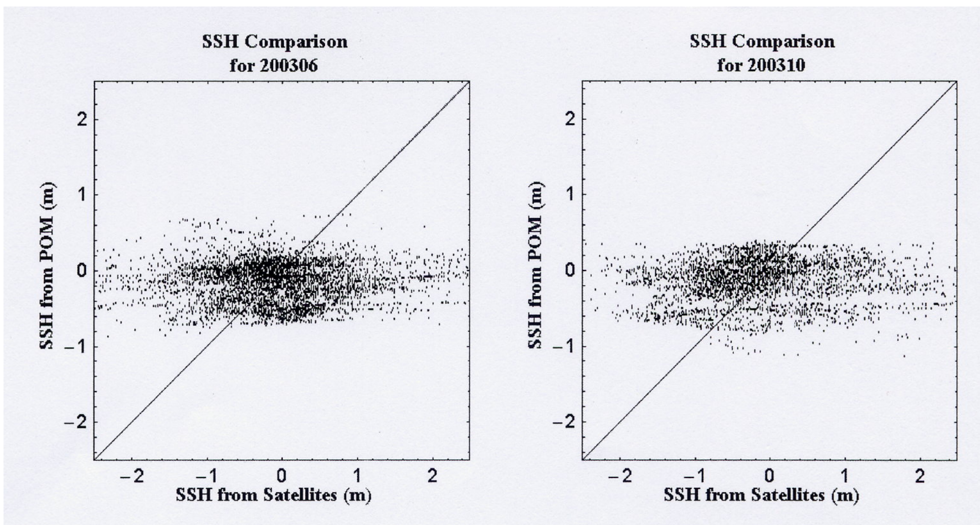
(a)



(b)

Figure 6. The sea level residents simulated at longitude 101°E and latitude 12.2°N, in which the dash line was the elevation from the model, not including meteorological effects, and the solid line was the elevation from the model including meteorological effects. (a) calm sea condition for the period of June 2003; (b) storm sea condition for the period of October 2003.

The hourly time series of calculation of SSH in the Gulf of Thailand were compared with the satellite altimeter data and are shown in **Figure 7a-b** and **Figure 8a-b**. These plots show that the sea surface elevation difference from the model results did not correlate with the satellite altimeter data. The sea surface elevation difference gave a wider range distribution. One reason is the wind field for this study, which was derived, from a global numerical weather prediction model with coarse resolution (1 degree), resulting in uniform wind field over the Inner Gulf. Moreover, the model only responds to prescribed tide, wind and initial horizontal density gradient and stratification in the water column, other governing processes are not considered by this model. In summary, the results showed that the accuracy in the simulated currents and sea surface elevations depends on various factors; the shape and depth of model domain, and the accuracy of the prescribed tide at the defined open boundaries.

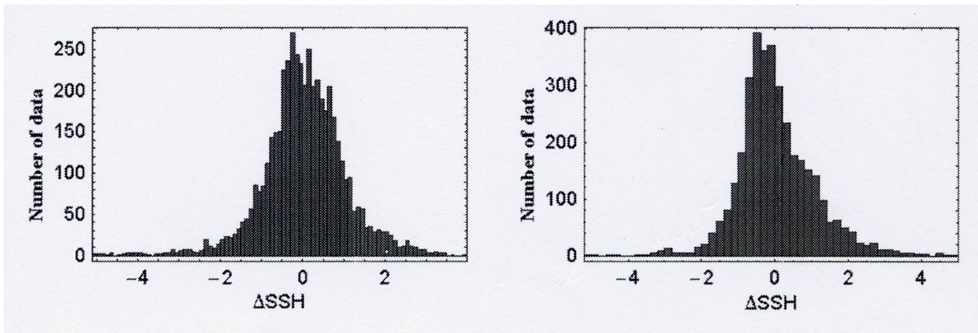


(a) **(b)**

Figure 7. Scatter diagram of the SSH (m) compared between the SSH from the satellite data, in which the model included tide and meteorological effects. (a) calm sea condition for the period of June 2003; (b) storm sea condition for the period of October 2003.

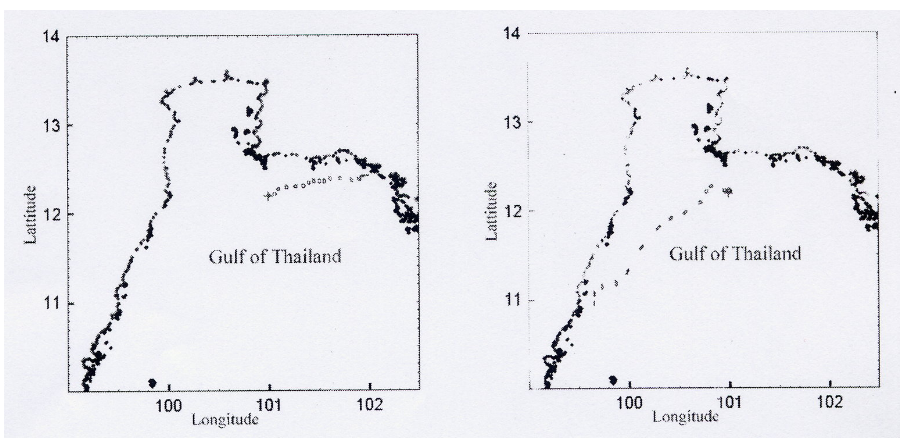
Floating Circle of Objects Simulation

The object movement used a particle tracking routine which models advection by a Lagrangian. In the first case (calm sea condition), **Figure 9a** shows the distribution of the FCO on the sea surface in the Gulf of Thailand. The shape of the FCO changed from circular with the passage of time due to the resulting currents. The centre of the FCO moved eastward by the sea surface circulations to the coastline to the northeast of its original position. In the second case (tropical depression storm condition), **Figure 9b** showed the distribution of the FCO for the period of October 2003. As time passed, the shape of the FCO changed faster than in the first case as the currents distorted it strongly. The currents towards the coast of southern Thailand moved the centre of the FCO south-westward. The wind condition also moved the FCO centre south-westward and southward at a later stage.



(a) **(b)**

Figure 8. The histogram of SSH difference displayed as continuous statistical distributions. (a) calm sea conditions ranging from -5.08013 to 3.99025 m $\bar{x} \pm \text{S.D.} = 0.0415058 \pm 1.02276$ m ; (b) the storm sea conditions ranging from -5.04052 to 4.80602 m. $\bar{x} \pm \text{S.D.} = 0.0246012 \pm 1.05706$ m.

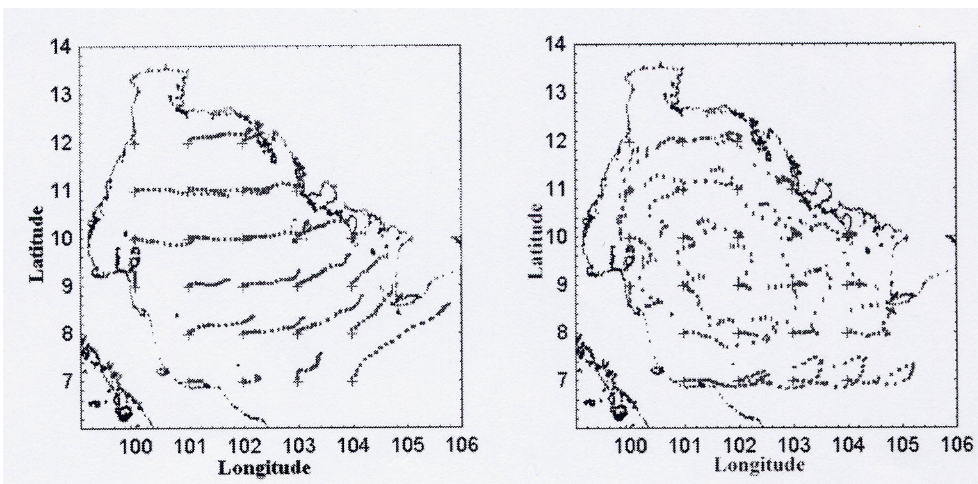


(a) **(b)**

Figure 9. FCO simulations in the Gulf of Thailand at longitude 101°E and latitude 12.2°N (plus sign, +) and motion changes over a period of time due to the force of currents (circle, o). (a) calm sea case during the period of June 2003; (b) tropical depression storm case during the period of October 2003.

The POM was modified for the FCO simulation and was run for both calm sea and tropical depression storm conditions. The FCO motions in both cases were found to be consistent with sea current patterns. The prevailing surface current in the Gulf of Thailand moving southward and south-eastward along the coastline exerted a controlling influence on the initial migration of the FCO. The configuration of these objects changed over a period of time due to the force of the currents. The actual shape at a specific time can be used to determine a possible search area for an object moving on the sea as illustrated in **Figure 10**.

The present computational grids may be too coarse for practical application but finer resolutions can be achieved with better topography and weather data. However, despite the limitations as outlined above, the results of the simulation are useful in helping us to gain a better understanding of the sea current and object movement patterns in the Gulf of Thailand, such as the movement and spread of pelagic larvae, fine sediments, oil slicks and marine accidents due to ocean currents is of interest and concern to marine scientists, fishermen and conservationists.



(a) **(b)**

Figure 10. FCO simulations in the Gulf of Thailand. (a) calm sea case during the period of June 2003; (b) tropical depression storm case during the period of October 2003.

FUTURE WORK

The model has a number of parameters to be optimised. One of the most important controls over the model is through the input inner grid size. In order to use the analysed tidal height data from OSUTIS forcing input is specified in the form of amplitude and phase for each constituent at all grid points that is not forcing on open boundary only. The calculation tidal elevation is analysed to retrieve amplitude and phase of those constituents by using harmonic analysis. Besides, a generic module in which tides, surges and waves are incorporated will be developed. Two existing numerical models, a wave model and a hydrodynamic model are being performed to investigate the sensitivity of waves and surges to coupling.

ACKNOWLEDGEMENTS

Invaluable assistance in the comments on the drafts of this study was provided by Thana na Nagara Mullica Jaroensutasinee and David Harding. We thank Dr. Pual May, Naval Research Laboratory for his advice about the numerical model. This work was supported in part by the Co-operative Research Network (CRN), Commission on Higher Education, The Thailand Research Fund, and Complex System Key University Research Unit of Excellence (CX-KURUE), the Institute of Research and Development, Walailak University.

REFERENCES

1) Diving hotel Thailand. Phuket King Cruiser Wreck [On-line]. Available from: http://www.diving.Hotelthailand.com/phuket/kingcruiser.html. 20 June 2003.
2) Diving Phuket. King Cruiser Wreck [On-line]. Available from: http://www.diving.phuket.com/divingsites/kingcruiser.htm. 20 June 2003.
3) Phuket dive sites. King Cruiser Wreck [On-line]. Available from: http://www.phuketguide.net/phuket_diving/king_cruiser.htm. 20 June 2003.
4) Scandinavian Divers. King Cruiser Wreck [On-line]. Available from: http://www.scandinavian-divers.com/en/daytrips3.html. 20 June 2003.
5) Thailand Wreck Diving. Wreck Listings [On-line]. Available from: http://www.thaiwreckdiver.com/Thailand_shipwrecks_listing.htm. 20 June 2003.
6) The Mariner Group. History [On-line]. Available from: http://www.marinergroup.com/oilspillhistory.htm. 20 June 2003.
7) Wattayakorn G King B Wolanski E Galloway D Suthanaruk P. Petroleum Contamination of Coastal Waters of the Gulf of Thailand [On-line]. Available: http://www.aims.gov.au/ ibm/reports /thai.html. 15 July 1996.
8) Associated Press. Ship leaks fuel after collision near Thai port. Environmental News Network [On-line]. Available from: http://www.enn.com/news/wirestories/2002/12/12182002/ap_49204.asp. 18 December 2002.
9) Reuters News Service. Thailand mops up oil spill, THAILAND [On-line]. Available from: http://www.planetark.org/dailynewsstory.cfm/newsid/14121 /story.htm. 21 January 2002.
10) Reuters News Service. Fuel spill in Thai Gulf after ships collide [On-line]. Available from: http://www.planetark.org/dailynewsstory.cfm/newsid/19117 /story.htm. 18 December 2002.

11) Zhang A Parker BB Wei E. Assimilation of water level data into a coastal hydrodynamic model by an adjoint optimal technique. *Continental Shelf Res 2002; 22: 1909-34.*
12) Korotenko KA Mamedov RM Mooers CNK. Prediction of the dispersal of oil transport in the Caspian Sea resulting from a continuous release. *Spill Sci & Tech Bull 2000; 5(6): 323-39*.
13) International Cooperative Study of the Gulf of Thailand. About the Gulf of Thailand [On-line]. Available from: http://www.start.or.th/got/gotwww/index.htm. 20 June 2003.
14) Lowe S. Thailand [On-line]. Available from: http://www.apecsec.org.sg/member/apecthai.html. 15 December 2001.
15) Wikipedia. The Free Encyclopedia. Gulf of Thailand [On-line]. Available from: http://www.wikipedia.org/wiki/Gulf_of_Thailand. 20 June 2003.
16) Douglas MJ Johnston MD. Water circulation and ocean dynamics. *SAEPOL Integrated Studies of the Gulf of Thailand 1998; 1: 1-69.*
17) Mellor GL. User guide for a three-dimensional primitive equation numerical ocean model. New Jersey: Program in Atmospheric and Oceanic Sciences, Princeton University [On-line]. Available from: http://www.aos.princeton.edu/WWWPUBLIC/htdocs.pom/. 21 July 2002.
18) Egbert GD Erofeeva SY. Efficient inverse modelling of barotropic ocean tides. *J Atmos Ocean Tech 2002; 19(2): 183-204.*
19) Official U.S. Navy. Navy Operational Global Atmospheric Prediction System [On-line]. Available from: https://www.fnmoc.navy.mil/PUBLIC/MODEL_REPORTS/MODEL_SPEC/nogaps4.0.html. 20 December 2004.
20) NOAA. Data Announcement 88-MGG-02. Digital relief of the Surface of the Earth. National Geophysical Data Center, Boulder, Colorado, 1988.
21) Levitus S Boyer T. Temperature. World Ocean Atlas 1994. *NOAA ATLAS NESDIS 1994; 4(4): 1-117*.

บทคัดย่อ

ชัยโรจน์ ใหญ่ประเสริฐ[1], กฤษณะเดช เจริญสุธาสินี[1], ธวัช วิรัตติพงศ์[2]

การจำลองวัตถุลอยน้ำรูปวงกลมด้วยแบบจำลอง Princeton Ocean Model สำหรับอ่าวไทย

แบบจำลอง Princeton Ocean Model (POM) ถูกปรับปรุงจำลองการเคลื่อนที่ของกลุ่มอนุภาคที่ลอยบนผิวน้ำทะเลในอ่าวไทย กลุ่มของอนุภาคได้กำหนดรูปแบบเป็นวงกลม รัศมีวงกลมสะท้อนให้เห็นถึงความไม่แน่นอนในแนวละติจูดและลองจิจูดที่มีศูนย์กลางเป็นจุดที่สนใจศึกษา แบบจำลอง POM นี้จะเป็นการถูกรวมเข้ามาของแรงของน้ำขึ้นน้ำลง กระแสลม พื้นผิวภูมิประเทศความละเอียดสูง อุณหภูมิและความเค็ม เข้าไปในแบบจำลอง การจำลองสำหรับอ่าวไทยมีขอบเขตที่ละติจูด 3 - 14 องศาเหนือ และลองจิจูด 99 - 109 องศาตะวันออก ความละเอียดของตาราง (grid) ในแนวนอนที่ 0.1 องศา (ประมาณ 11.1 กิโลเมตร) ได้ถูกใช้ในแบบจำลอง ซึ่งจะมีตารางจำนวน 101×111 ช่อง สำหรับความละเอียดในแนวดิ่งใช้พิกัดแบบซิกมา (sigma coordinate) จำนวน 21 ระดับความลึก โดยผลของแบบจำลองนี้ได้มีประโยชน์ในการช่วยให้ได้เข้าใจกระแสน้ำของทะเลและรูปแบบการเคลื่อนที่ของวัตถุในอ่าวไทย

[1] สำนักวิชาวิทยาศาสตร์ มหาวิทยาลัยวลัยลักษณ์ อำเภอท่าศาลา จังหวัดนครศรีธรรมราช 80160

[2] Communication Ground Systems Section, Jet Propulsion Laboratory, California Institute of Technology, California, USA.