APPLICATION OF SIMULATING WAVES NEARSHORE (SWAN) MODEL IN ANDAMAN SEA 2014

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1. INTRODUCTION

Andaman Sea is a beautiful sea with many tourists from around the world. The fishery, tourist destination and ship transportation are three main purpose in Andaman Sea which is an important economic in Thailand. However, Thailand energy consumption has increased in the last 5 years due to economic expansion with main energy is petroleum and second main is electricity. Thus, renewable energy such as wave energy can be produced as an electricity and Andaman Sea can be used as producing wave energy for Thailand. There are researchers who using numerical model to simulate ocean wave height. Ekphisutsuntorn et al. [1] used SWAN model to simulate wave height in the Gulf of Thailand. Kemdem et al. [2] studied wave energy potential in the Gulf of Thailand using SWAN model during 1997 typhoon Linda. Therefore, the aim of this study is to simulate significant wave height for Andaman Sea and compare the results with satellite data, which provided by Jason-2, during the end of monsoon period at October 2014. After this study, a distribution seasonal wave energy for Andaman Sea will be study in the future.

2. METHODOLOGY

2.1 STUDY AREA

The study are is Andaman Sea, covered by south of Myanmar, west of Thailand, north-west of Malay Peninsula, north of Sumatra and east of the Andaman Islands, India. Andaman Sea usually used for fishery and transportation between coastal countries and tourism due to many of beautiful islands, popular tourist destinations. The mean depth of Andaman Sea is around 1,000 meters or 3,300 feets which is deeper than the depth of GoT. At the northern and eastern parts are shallower than 180 meters or 590 feets because the Irrawaddy River deposits the silt to the Andaman Sea. The western and central seabed areas are around 900 to 3,000 meters deep or 3,000 to 10,000 feets. The sea depth, deeper than 3,000 meters are less than 5% of the sea. East of the Andaman-Nicobar Ridge is exceed 4,000 meters or 13,000 feets. The seabed is covered with pebbles, gravel, and sand. Figure 1 shows an Andaman Sea. The study area cover from latitude 6° to 15° and longitude 90° to 99°.

2.2 SWAN MODEL

The numerical model used in this study is SWAN model, which based on the action balance equation as shown in Eq.1. It provides realistic estimates of wave parameters in open seas, coastal areas from wind, bottom, and current conditions.

$$\frac{\partial N}{\partial t}+\frac{\partial c_x N}{\partial x}+\frac{\partial c_y N}{\partial y}+\frac{\partial c_\sigma N}{\partial \sigma}+\frac{\partial c_\theta N}{\partial \theta}=\frac{S_{tot}}{\sigma} \quad (1)$$

The first term on the left-hand side represents the rate of change of action in time, the second and third term represent the propagation of action in x and y axis. The fourth and fifth term are the frequency shift and refraction induced by depth and currents. Where N is the action density spectrum, σ is the frequency, θ is the direction, c_x and c_y is the propagation velocities in x and y direction. The right-hand side of this equation represents the effects of generation, dissipation, and nonlinear wave-wave interactions. Therefore S_{tot} is the source term of energy density that include atmospheric input (S_{in}), dissipation due to depth-induced wave breaking, bottom friction, and white-capping (S_{dis}), triad and quadruplet nonlinear wave-wave interactions (S_{nl}).

2.3 WIND DATA

The wind data in this study adapted from Navy Global Environmental Model (NAVGEM) in October 2014. The wind data is collected every 6 h with resolution of 0.5 degree or around 57 km which includes wind data at 10 m above water surface. Wind data type is provided in GRIB format.

2.4 BATHYMETRY DATA

The bottom data in this study is adapted from Earth Topography (ETOPO1), which is the data provided by National Geophysical Data Center (NOAA). The data type is provided in ArcGIS ASCII Grid. The resolution for ETOPO1 is 1 degree resolution (1.85 km).

3. PROCEDURE AND DATA COLLECTION

The procedure for using the wind data and bathymetry data in this study are used the as method as Kompor et al. [4]. The observed data used to validate the model data in this study is from Jason-2 data which provided by Physical Oceanography Distributed Active Archive Center (PO.DAAC). The 6 cycles observed data was collected in October 2014 and used to compare with model data in this study.

Fig.1 Andaman Sea (adapted from ArcGis)

4. RESULTS AND DISCUSSION

The results from using SWAN model in the Andaman Sea from this study are compared with 6 cycles (90 points) observed data, which is Jason-2 data, during October 2014. Fig.2 shows a spatial distribution of significant wave height in 16th October 2014. The line shows the satellite (Jason-2) moving from point A to point B. The graph shows the significant wave height comparison between model and Jason-2. The wind speed comparison between NAVGEM model and Jason-2.

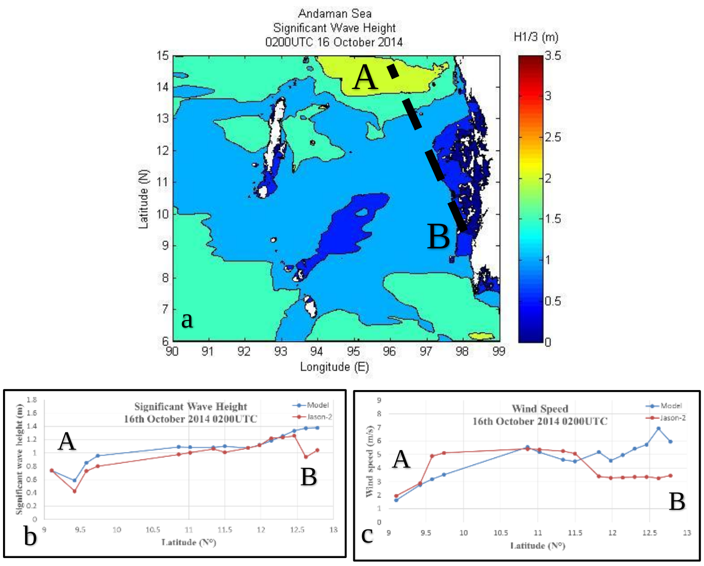

Fig.2 Significant Wave Height (H1/3) at 16th October 2014
(a) H1/3 in Andaman Sea (b) H1/3 comparison
(c) Wind speed comparison

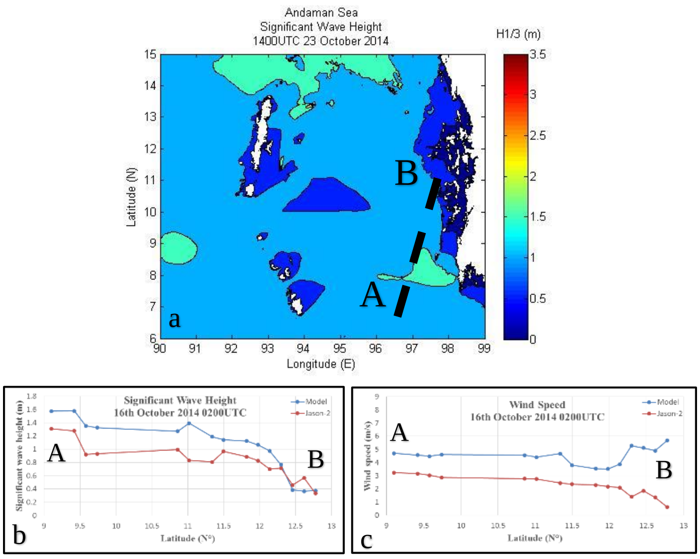

Fig.3 Significant Wave Height (H1/3) at 23th October 2014
(a) H1/3 in Andaman Sea (b) H1/3 comparison
(c) Wind speed comparison

From the significant wave height shows a good agreement on 16th October 2014 due to the different between wind speed from NAVGEM model and Jason-2. However, at latitude between 11.5 to 13, the wind data shows a different between NAVGEM model and Jason-2 data. So, the significant wave height shows a different between model and Jason-2 data at the end of the line, which is around 12.5 to 13, in 16th October 2014. Fig.3 also shows a spatial distribution, significant wave height comparison and wind speed comparison in 23th October 2014. The satellite (Jason-2) moved in this cycle moved from point A to point B as shown in the figure. The results on this cycle shows a different significant wave height results from model and Jason-2 data due to different wind speed data in this cycle. The wind speed in NABGEM model on this day is higher than the wind speed from Jason-2. Thus, the significant wave height in 23th October 2014 from model is higher than the observed data from Jason-2 data. Fig.4 shows the total significant wave height data in October 2014 from 6 cycles (90 points) of Jason-2. The root mean square (RMSE) of significant wave height in October 2014 is 0.219 m. Some points of model and Jason-2 result show different. The reason is probably because the quality of obsereved data (satellite). Becauase on this month is the end of monsoon period, so there might be effected the quality of the observed data. And another reason is the quality of NAVGEM data, which shown in Fig.2 and Fig.3, gives a different results.

CONCLUSION

From this study the results from using SWAN model compared with Jason-2 data shows a good agreement. However, some time period shows a different in significant wave height due to different wind speed from wind model, quality of satellite data, and various time of collected between model and satellite which moving fast per one cycle. From this study, create the seasonal wave energy distribution map for Andaman Sea for the future study.

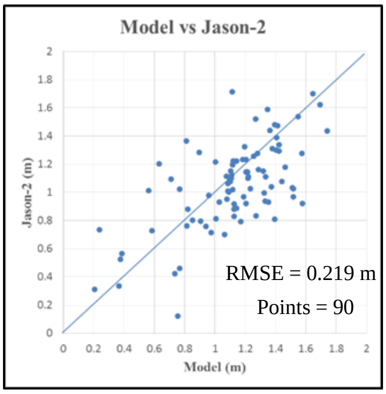

Fig.4 The relationship of significant wave height between SWAN model and Jason-2 data

REFFERENCE

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[2] Kemden N., Ekkawatpanit C., Wannawong W., Kositgittiwong D. “Wave energy potential for power generation in the Gulf of Thailand”, 5th International Conference on Sustainable Energy and Environment (SEE 2014): Science, Technology and Innovation for ASEAN Green Growth 19-21 November 2014, Bangkok, Thailand

[3] Kompor W., Tanaka H, Ekkawatpanit C., Kositgittiwong D., “Application of Simulating waves Nearshore (SWAN) model in Gulf of Thailand”, Tohoku Journal Natural Disaster Science, Vol.52, 2016 (in press)