The 2nd Regional Scientific and Technical Committee Meeting for the SEAFDEC/UN Environment/GEF Project on Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand

21st – 23rd May 2019
Thansur Sokha Hotel, Kampot Province (Fisheries Refugia Site), Cambodia

GIS MAPPING AND EXISTING OCEAN MODELLING:

PROGRESS IN OCEAN FORECASTING SYSTEM IN THAILAND

Thailand-China Joint Laboratory for Climate and Marine Ecosystem

Phuket Marine Biological Center•

1. Beginning of OFS on the platform of IOC/WESTPAC and officially launched in Thailand

Ocean Forecasting Demonstration System (OFDS) was officially launched for the first time during the 8th IOC-WESTPAC Meeting in Bali, Indonesia in May 2010. The system was developed by the First Institute of Oceanography (FIO) based on wave-tide-circulation model. In Phase I of the project in 2010-2012, the first version of OFS covers only the southern South China Sea and was operated by Dr.Wendy Watson-Wright, Executive Secretary of IOC, Assistant Director General of UNESCO. Then, the system has provided ocean forecast through the website: http://221.0.186.5/IOC_WESTPAC/OFS beginning since the 9th Intergovernmental Session of the IOC/WESTPAC on 9-12 May 2012, in Busan, Republic of Korea.

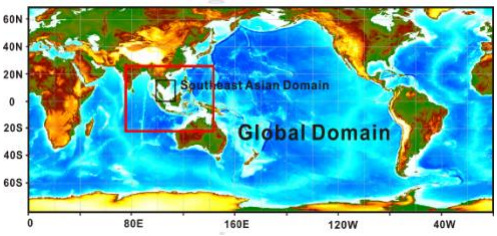
During Phase II in 2013-2015, the domain was exended to cover entire Southeast Asian area including northwest Pacific, South China Sea, and the northeastern Indian Ocean. The breakthrough of the OFS happened on 9 October 2013when Chinese Premiere Keqiang Li proposed to initiate the China-ASEAN Cooperation Fund and announced to subsidize the first 17 projects which included the OFS in the 16th China-ASEAN Summit. Later in 2014, Department of Marine and Coastal Resources (DMCR) has got the budget for in setting up the OFS system in Thailand, and Dr.Wijarn Simachaya, the Permanent Secretary of Ministry of Natural Resources and Environment, Thailand, and Mr.Chen Lianzeng, Deputy Administrator of State Oceanic Administration (SOA), presided over the opening ceremony of project under joint research projects to name the project “Ocean Forecasting and Marine Disasters Mitigation System for Southeast Asia Seas” during the 4th Thailand-China Joint Committee Meeting on Marine Cooperation on 17 July 2015.

Since 2015, the DMCR in collaboration with the FIO installed the OFS system at Phuket Marine Biological Center (PMBC), Phuket, Thailand and also organize workshops instructing the DMCR to operate the system routinely. This was considered an official launch of the OFS Thailand. Meanwhile, PMBC linked the OFS website, http://ofs.dmcr.go.th/thai_land/result.jsp, to the Central Database System and Data Standard for Marine and Coastal Resources webpage, https://marinegiscenter.dmcr.go.th, to distribute the forecast product to the public. So far, more than five training courses have been organized in Qingdao, China, yearly in order to trains the DMCR colleagues and other scientists to analyze and interpret the data.

Moreover, both parties have constantly conducted joint cruise observations both in the Gulf of Thailand, the Andaman Sea, as well as the Bay of Bengal to obtain observed data for validating the model and further updating it into high resolution. Presently, four buoys have been deployed in Andaman Sea constantly giving measurements such as temperature, current, and wave height.

2. Ocean Forecasting System Framework

OFS is based on wave-circulation coupled model, MASNUM: Laboratory of MArine Sciences and NUmerical Modeling, State Oceanic Administration, China. The circulation part is based on POM (Princeton Ocean Model) and the wave component is based on MASNUM-WAM model. The model is forced by forcing obtained from NCEP products. An advancement of this model is a way to couple wave and circulation model through the so-called wave-induced viscosity *Bv* by introducing it into the Mellor-Yamada scheme (Mellor and Yamada, 1982) in POM. A nested scheme from the quasi-global to Southeast Asian area is used to obtain the open boundary conditions (figure 1).



OFS Thailand Products	
Domain	80° E – 150° E, 20° S – 25° N
Resolution	1/6° x 1/6°
Grids	Horizon: 421x271 Vertical: 21 layers
Results	July, 2015 – present

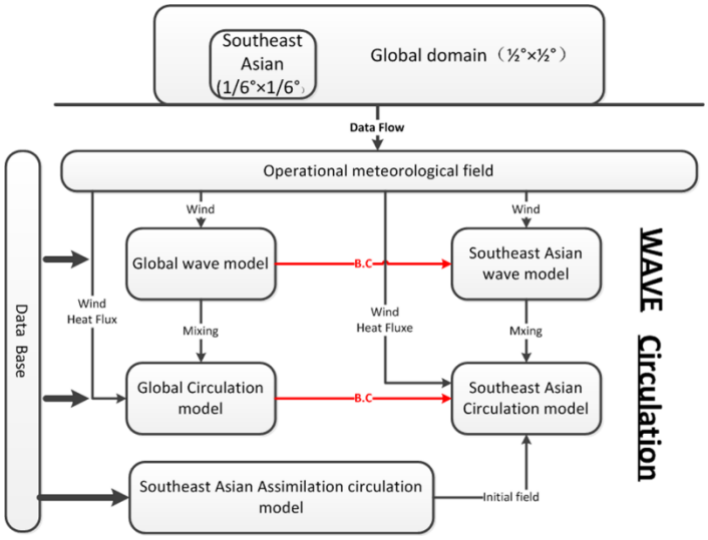


Figure 1 OFS simulation domain (Left) and framework (right)

The half-century challenge of ocean circulation model is that simulated sea surface temperature is overestimated while the sub-surface temperature is underestimated especially in summer time. Qiao *et al*. (2004, 2010, and 2016) proposed that the non-breaking surface wave could generate turbulence through wave-turbulence interaction and developed the wave-induced mixing theory, which agreed to both laboratory experiments and in situ observations. Validated by ocean circulation models from different research group; i.e., GFDL (Fan and Griffies, 2014), Uppsala University of Sweden (Wu et al., 2015), LEGOS of France (Malek and Babanin, 2014), Budapest University of Technology and Economics of Hungary (Péter and Krámer, 2016), Ocean University of China (Lin et al, 2006); the non-breaking wave-induced vertical mixing*, Bv*, is proven to dramatically improve the simulating capacity of the different ocean circulation models.

3. OFS and best practices in Thailand

OFS Thailand has run since July 2015 providing output in five parameters; i.e., wind, wave height, sea level, current and temperature, the last two of which are in 21 layers. The forecast results can be shown

the vertical profiling which are beneficial for capturing the mixed-layer depth. The data archives are available for downloading at http://ofs.dmcr.go.th/ thailand/archives.jsp. (details in figure 2)

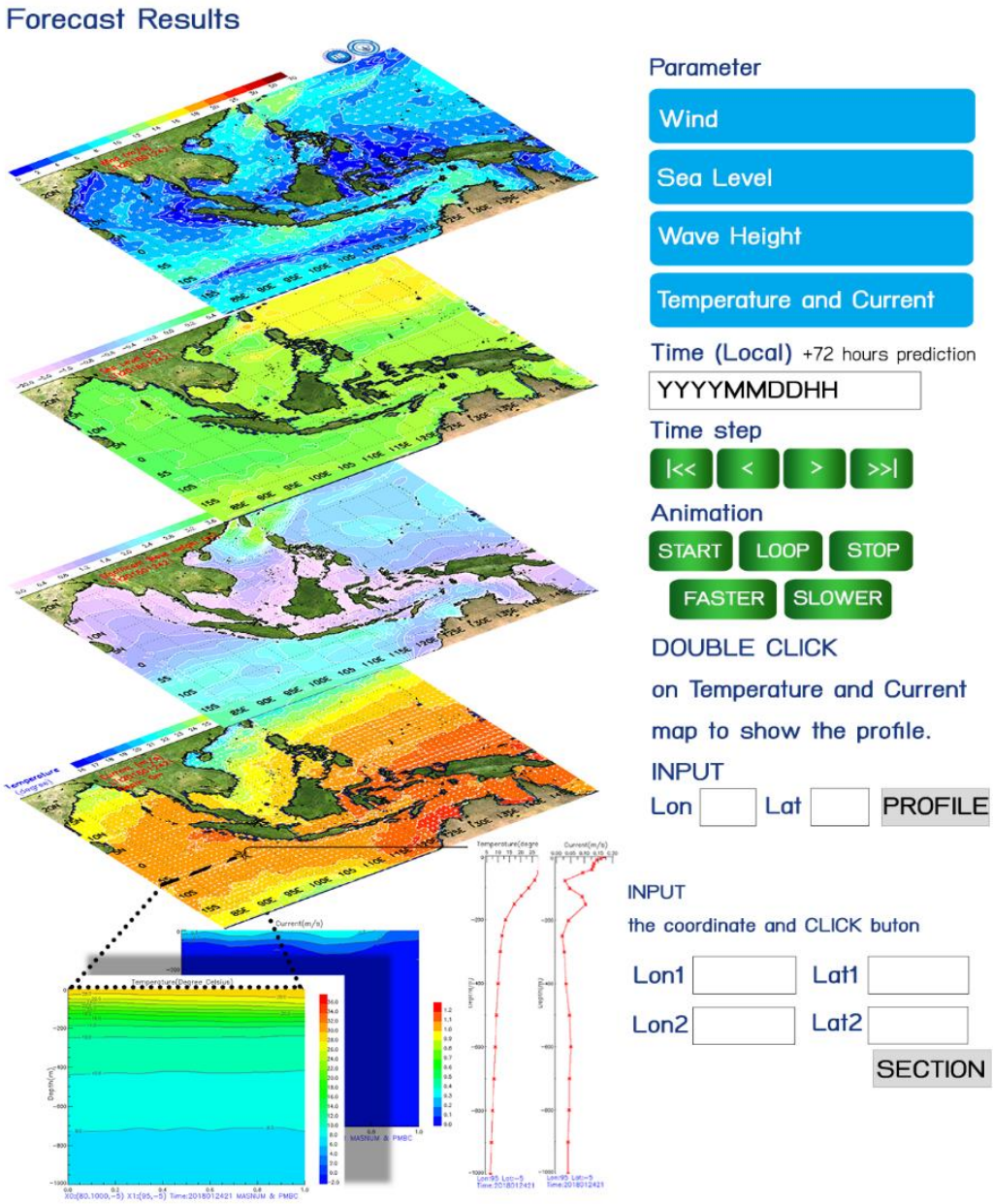


Figure 2 OFS visualization and tools for extracting specific results

During past three years, there were many contributions from the OFS. For example, it was used as boundary condition along the coast for sediment transport and coral dispersion model. Moreover, it was also used as one of products acquired to monitor and forecast the next level of events like coral bleaching in 2016, sunken boat in Phuket due to heavy storm and strong surface wave in 2018 causing 47 missing, and Pabuk typhoon moving across the Gulf of Thailand to the Andaman Sea in 2019 inundating many coastal areas for a couple of weeks.

Considering sunken ship case, both parties, Mr.Wannakiat Thubthimsang, Dr.Somkiat Khokiattiwong, and Prof. Fangli Qiao, had serious discussion and energetically to give support by providing

the forecasting products to those in charge. An emergency technical support team from FIO and PMBC was immediately established. Within 24h after the accident, the OFS team successfully provided the first forecasting report of surface currents, wave heights and suggested search area of missing people. Totally 7 forecast reports were provided to the Thailand rescue team and forecasting results are confirmed by the following rescue, which is a new success for practical applications.

4. Establishing high resolution and its application

With OFS breakthroughs during the 2nd phase, the first surface wave-tide-circulation coupled model of FIO-COM was established in 2013, and then adopted as the core to produce reanalysis dataset for the period Jan., 2014 to April, 2016. It became in the operational OFS since May, 2016. Highly efficient parallel scheme is designed to use full-scale of Taihu-Light with 10,649,600 CPU cores (Qiao et al., 2016), which was on the finalist of the international ACM Gordon Bell Prize. The forecasting products can be easily accessed both through website http://221.215.61.118:2018/#/ and cell phone APP of "Global Ocean on Desk" (GOOD). To cite this dataset this dataset, please quote the version number and cite Qiao *et al*, (2019) (figure 3)

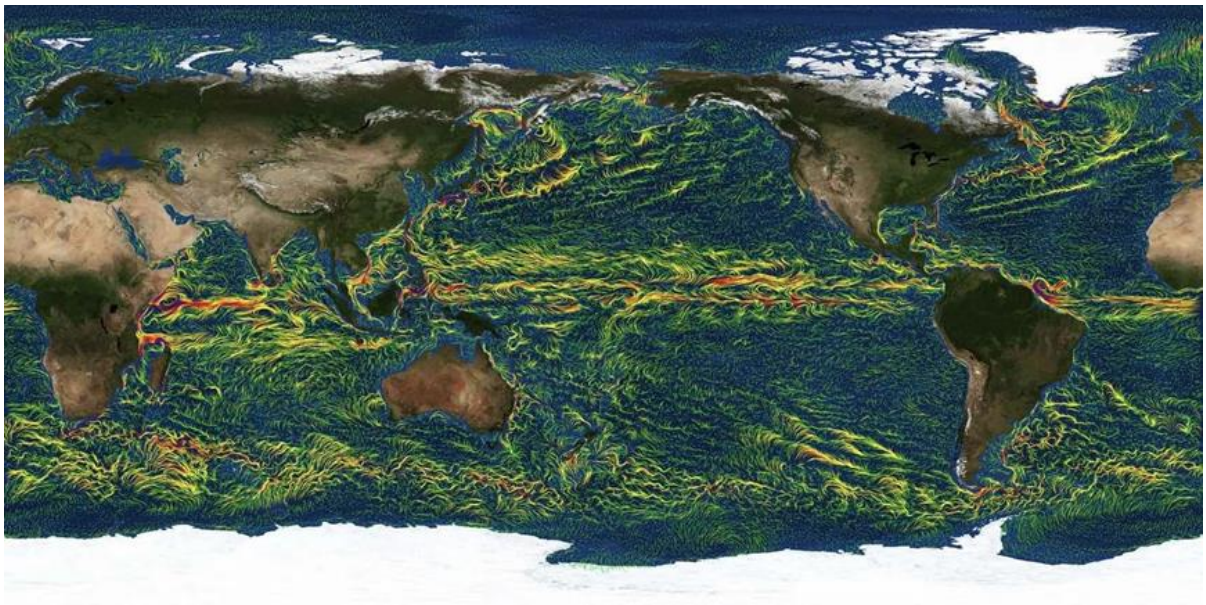


Figure 3 The snapshot of the OFS for 21st Century Maritime Silk Road published on 10 December, 2018 through http://221.215.61.118:2018/#/

Thailand now prepares for an extended basement to upgrade the new system which the smallest grid will be re-fined down to less than 200 meters near the coasts. Including the simulation results, it is going to include tide and salinity which related to processes in mixed-layer depth and to the primary productivity and fisheries products. Visualization will also be upgraded to be more user-friendly, and tracer module will be included into new webpage for prediction of floating in the sea.

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