Item 5.1.2.1 of the Provisional Agenda

PROGRESS REPORT ON
OCEAN FORECASTING SYSTEM (OFS)
(May 2015–April 2017)

In accordance with Terms of Reference of IOC Sub-Commission for the Western Pacific, the report is provided to facilitate the consideration by the Sub-Commission on the progress made on the WESTPAC-SEAGOOS pilot project – Ocean Forecasting System (OFS).

The report presents a summary of the activities and results of OFS over the last intersessional period. The Sub-Commission is invited to consider its work plan for the next intersessional period.
I. Project

1. SEAGOOS Ocean Forecasting System project will develop an operational ocean forecasting system for the entire Southeast Asia region and its adjacent seas, and demonstrate the value of this system through its application to scientific research and ocean management, resources exploitation, reduction and prevention of the impacts of natural hazards, mitigation of the impact and adaptation to climate change and variability. The Ocean Forecasting System (OFS) includes ocean model, data assimilation, ocean monitoring and observation, products generation and visualization, products distribution and service.

II. Project objectives and expected outputs/outcomes

2. Objectives:
   - Establishing a regional ocean forecasting system with higher resolution ((1/30)°×(1/30)°) model for the geographic coverage (20°S-20°N, 80°E-145°E);
   - Establishing several pilot ocean-forecasting systems for selected sub domains;
   - Improving the application of OFS to scientific research and ocean governance;
   - Enhancing regional and national capacity for ocean modelling development, data assimilation, and model validation.

3. Expected outputs/outcomes:
   - A regional ocean forecasting system with higher resolution model for the South-east Asian seas
   - Several pilot ocean-forecasting systems for selected sub domains such as Gulf of Thailand (GOT) and the Malaysian East Peninsula Shelf
   - Enhanced understanding of key processes and scientific issues of regional ocean in the region; and
   - Enhanced regional capacity in numerical ocean modeling

III. Principal Investigator (Chairperson) and Project Steering Group

4. Principal Investigator:
   Professor Fangli Qiao
   Deputy Director General of the First Institute of Oceanography (FIO), State Oceanic Administration, China

5. Project Steering Group:
   Prof Dr Fangli Qiao
   First Institute of Oceanography, China
   Prof Dr Fredolin Tangang
   National University of Malaysia, Malaysia
   Prof Dr Somkiat Khokiattiwong
   Phuket Marine Biological Center (PMBC), Thailand
   Dr Budi Sulistiyo
   Research and Development Agency for Marine and Fisheries
   Ministry of Marine Affairs and Fisheries, Indonesia

IV. Terms of Reference of the Project Steering Group

- To discuss and determine the main research activities of OFS
- To coordinate joint cruises
- To organize and chair workshops
- To seek financial support for OFS
- To Guide the development of OFS

V. Activities carried out and/or to be carried out during the last intersessional period (May 2015 – April 2017)

6. The Activities carried out and/or to be carried out can be divided into three parts: OFS installation and training, Model development and Joint Cruise. The OFS was successfully installed in the servers in PMBC in Thailand and was officially launched in 2015. A global eddy-resolving wave-tide-circulation coupled ocean model, the High resolution regional model in Gulf of Thailand (GOT) and the particle trace model were developed and validated. Joint cruises between China and Thailand in the Andaman Sea were carried out between 18~24 April 2016 and 12~15 July 2016 separately.


7. On 17th July 2015, after the 4th steering committee meeting on the China-Thailand marine science and technology, as a key outcome of the meeting, Mr. Lianzeng Chen, Deputy Director General of SOA and Mr. Wijarn Simachaya, Director General of Pollution Control Department and acting Deputy Permanent Secretary Ministry of Natural Resources and Environment (MONRE) of Thailand, officially launched the Thailand Ocean Forecast System. This marks that Thailand becomes a nation with national marine environmental forecasting capacity.

![Fig. 1 Mr. Lianzeng Chen, Deputy Director General of SOA, China and Mr Wijarn Simachaya, Director General of Pollution Control Department and acting Deputy Permanent Secretary Ministry of Natural Resources and Environment (MONRE) of Thailand, officially launched the Thailand Ocean Forecast System on 17th July 2015](image-url)
2 Installing OFS in Thailand in August of 2015

During July 28~ Aug 9, 2015, 4 researchers of FIO installed OFS v1.0 in PMBC of Thailand. The OFS code was installed during July 29 ~ August 5. The OFS started operational run since August 6. The OFS will automatically download GFS wind at 2:00 and start operation running at 8:00 each day. Forecast production can be download online internet since August 9; web site is http://61.90.186.190/thailand/results.jsp.
Fig. 3 The internet website of the Ocean Forecast System for the Kingdom of Thailand and its forecast production: Wave height, Temperature and current, Sea level and Wind

3. **Training OFS in Thailand in 2015**

9. The first training was carried out from Aug 6-7, 2015 with 8 trainees after the OFS was installed by the 4 scientists from FIO. The second training was carried out from during 15-22 Oct 2015. Invited by Dr. Somkiat, Dr. Changshui Xia of FIO gave 5 lectures on the fundamentals of numerical ocean model and instructed the trainees to set up the tidal model for the upper Gulf of Thailand during the training course on OFS hosted by PMBC.

<table>
<thead>
<tr>
<th>Time</th>
<th>Lecturer</th>
<th>Title</th>
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<tbody>
<tr>
<td>Thursday morning</td>
<td>Guansuo Wang</td>
<td>Introductions of the Coupled Forecast System</td>
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<tr>
<td>6 Aug., 2015</td>
<td>Changshui Xia</td>
<td>General Introductions Ocean Models</td>
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<tr>
<td>Thursday Afternoon</td>
<td>Changshui Xia</td>
<td>Detailed Introductions to POM</td>
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<tr>
<td>6 Aug., 2015</td>
<td>Guansuo Wang</td>
<td>MASNUM wave modeling and parameterization of wave induced mixing</td>
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<tr>
<td></td>
<td>Changshui Xia</td>
<td>General Introductions to wave-circulation Coupled model</td>
</tr>
<tr>
<td>Friday Morning</td>
<td>Lin Zhou</td>
<td>Introduction to OFS website and visualization system</td>
</tr>
<tr>
<td>7 Aug., 2015</td>
<td>Lin Zhou</td>
<td>Introduction to the progress of marine information and visualization system in FIO</td>
</tr>
<tr>
<td></td>
<td>Zhen Jia</td>
<td>OFS website and visualization system administrator Training</td>
</tr>
<tr>
<td>Friday Afternoon</td>
<td>Guansuo Wang</td>
<td>Introductions to parallelization and its applications</td>
</tr>
<tr>
<td>7 Aug., 2015</td>
<td>Changshui Xia</td>
<td>Introductions to the analysis and graphic tools—Netcdf, Ferret and Surfer etc.</td>
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<td>All of team</td>
<td>Operational test</td>
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</tbody>
</table>

Fig 4. Schedule of the first Ocean Forecast System Training Aug 6-7, 2015
Fig. 5 Working and group photos of the first training course on the Ocean Forecast System for the Kingdom of Thailand Aug 6-7 2015
Fig. 6 Group photos of the second training course on Ocean Forecast System for the Kingdom of Thailand 15-22 Oct 2015.

Fig. 7 The tidal model for the upper Gulf of Thailand set up by the trainees during the second OFS training course
left: model domain, right: model result

4. **The SEAGOOS OFS Strategy Development workshop was held in Guangzhou**

10. Given the ever-increasing demands of WESTPAC Member States for such an ocean forecasting system in the region, and the pressing need to provide a clear roadmap guiding its future development, therefore this Strategy Development workshop was designed aiming to develop a long-term strategy for the OFS development in the region, which is expected to be published as a IOC Technical Manual. The WESTPAC Technical Workshop on SEAGOOS Ocean Forecasting
System Strategy Development (WESTPAC/SEAGOOS-OFS-VI) was held 14-16 December 2015 in Guangzhou, China hosted by FIO and SOA. 12 officials and scientists from the IOC/ WESTPAC office in Bangkok, China, Thailand, Malaysia, Indonesia and Vietnam attended the workshop.

11. Detailed objectives of this workshop are to:

   - review the recent development status of SEAGOOS Ocean Forecasting System at regional and national level;
   - develop detail the action plan of OFS development for the period of 2016-2017;
   - share perspectives on the future development of OFS, and ultimately jointly develop a long-term strategy of OFS in the region.

12. The progress and outcome of the OFS I-VI was reviewed in the workshop and scientists reported the progress and plan. The draft version of the SEAGOOS Ocean Forecasting System Strategy Development documents was discussed in the workshop.

5. **The High resolution regional model in the Gulf of Thailand (GOT) and adjacent waters**

14. The High resolution regional model in GOT and adjacent waters has established based on Finite Volume Community Ocean Model (FVCOM) non-orthogonal irregular triangular mesh. The maximum resolution is about 500m near the coastline and islands and the minimum resolution is set to 0.1° at the open boundary of model. The topography is structured combining measured scatter data that is corrected to mean sea level near shore and the General Bathymetric Chart of the Oceans (GEBCO) data with 30 arc-seconds off shore.

15. A one-year simulation is carried out after verify the reliability of model. The simulated co-tidal charts of the $M_2$, $S_2$, $K_1$, $O_1$ main constituents are shown in Fig 10. The model results agree with observation and previous studies well.
Fig. 10 The simulated co-tidal charts of the M2, S2, K1, O1 main constituents.
Blue line: Amplitude  Red Line: Phase

6. Establishment and validation of a global eddy-resolving wave-tide-circulation coupled ocean model

16. A global eddy-resolving wave-tide-circulation coupled ocean model with horizontal resolution of 1/10° was established. Its unique feature is that the global circulation system, mesoscale eddy field, improved upper layer ocean condition, internal tide and global barotropic tide are concurrently resolved in this single model. The model can provide open boundary conditions for the OFS project.
7. Development of Particle Trace Model

17. A Lagrangian Tracer Model was developed based on the wind and current forecast from the OFS forecast system. Particle trace experiments were carried out in using the OFS forecast result in January 2016.
8. Joint Cruise

Joint cruises between China and Thailand in the Andaman Sea were carried out between 18~24 April, 2016 and 12~15 July, 2016 separately. The number of survey stations during the first cruise is 15, survey contents are physical oceanography, Marine meteorology, biological and chemical oceanography. 2 subsurface buoys were deployed. 10 sets of Ground Wave Radar were deployed along the Gulf of Thailand by Thailand Scientists, continuous water temperature, current and wave data were obtained by the Ground Wave Radar.

Fig. 13 Survey stations and group photo of the Joint cruises between China and Thailand in the Andaman Sea between 18~24 April 2016
9. **Activities to be carried out from now to May 2017**

- To develop OFS validation system;
- To consider tide current in OFS;
- To implement real-time river runoff in OFS;
- To develop and validate Lagrangian tracer model

VI. **Problems encountered and actions to be considered by the 11th Intergovernmental Session, tentatively scheduled for April 21-23, 2017, Qingdao, China**
### VII. Workplan and Budget for May 2017 – May 2019

<table>
<thead>
<tr>
<th>Project</th>
<th>Activities</th>
<th>Objectives</th>
<th>Expected outputs/outcomes</th>
<th>Date and place</th>
<th>Funding Required</th>
<th>Other sources (i.e. from national or international)</th>
<th>Remark</th>
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<tbody>
<tr>
<td><strong>Ocean Forecasting System (OFS)</strong></td>
<td>1. To improving visualization system; improving visualization system of the forecast production such as wave height, temperature, current and wind</td>
<td>To improving visualization system</td>
<td>A user-friendly interface visualization system</td>
<td>May 2017-May 2018</td>
<td>IOC</td>
<td>FIO China</td>
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<td>2. To share and transfer forecast products to end users; sharing and transferring forecast production such as wave height, temperature, current and wind to end users;</td>
<td>To share and transfer forecast products</td>
<td>An automatic data share transfer system</td>
<td>May 2017-May 2018</td>
<td>IOC</td>
<td>FIO China</td>
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<td>3. To develop sub-domain high-resolution models with scientists from the OFS project member counties.</td>
<td>To develop sub-domain high-resolution models such as the Gulf of Thailand and Malaysian Peninsula East Shelf with scientists Thailand and Malaysia.</td>
<td>sub-domain high-resolution models in the Gulf of Thailand and Malaysian Peninsula East Shelf</td>
<td>May 2017-May 2019</td>
<td>IOC</td>
<td>FIO China</td>
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