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# MEMFiS Annual Report 2020

Marine Ecosystem Modeling and Forecasting System in the China Seas and Northwestern Pacific (MEMFiS)

Authors: Jingyuan Xi, Feng Zhou, Yuntao Wang

## 1. Selected highlights

### 1.a. Selected scientific highlights since last report

*Last report was submitted to Brest SSC meeting, June 2019. Each highlight needs to be VERY short, bullet points, with a link to publication if applicable.*

- ✓ *The high-resolution marine ecosystem forecasting system of the China Seas and Northwestern Pacific has been built in the National Marine Environmental Forecast Center, and the trial operation of the forecast system will be prepared in the next few months.*
- ✓ *Using multipal observational techniques, the dynamical processes, e.g., frontal activities, and their impacts on regional circulation and chlorophyll distribution in the South China Sea are comprehensively investigated. Series of restuls were published, such as "Wang Y, Yu Y, Zhang H, et al. Distribution and variability of sea surface temperature fronts in the South China Sea [J]. Estuarine, Coastal and Shelf Science, 2020", "Yu Y, Wang Y, Cao L, et al. The ocean-atmosphere interaction over a summer upwelling system in the South China Sea [J], Journal of Marine Systems, 2020", "Chen H, Tang R, Zhang H, et al. Investigating the Relationship between Sea Surface Chlorophyll and Major Features of the South China Sea with Satellite Information. Journal of Visual Experiment, 2020, e61172", "Yu Y, Xing X, Liu H, et al. The variability of chlorophyll-a and its relationship with dynamic factors in the basin of the South China Sea, Journal of Marine Systems, 2019, 200: 103230" , "Yu Y, Zhang H, Jin J, et al. Trends of sea*

*surface temperature and sea surface temperature fronts in the South China Sea during 2003–2017. Acta Oceanologica Sinica, 2019, 38(4): 106–115".*

- ✓ *Using a three-dimensional Pacific physical-biological model, namely ROMS-CoSiNE, the interannual variation of phosphate transport via Kuroshio intrusion (KIPT) in the eastern boundary of the East China Sea (ECS) was investigated, and its influence on the ECS biological process was also explored. The relevant results are published in "Lin Z, Wang X, Xiu P, et al. Boundary Phosphate Transport of the East China Sea and Its Influence on Biological Process[J]. Journal of Geoscience and Environment Protection, 2019, 7(9): 79-104. DOI: 10.4236/gep.2019.79007".*
- ✓ *Based on long-term observation data, the summertime oxygen depletion and acidification in the bottom water of Bohai Sea was explored, and how the changes of phytoplankton community structure effect on dissolved oxygen was also analyzed. The relevant results are mainly published in "Song G, Zhao L, Chai F, et al. Summertime Oxygen Depletion and Acidification in Bohai Sea, China[J]. Front. Mar. Sci.,2020, 7:252. doi: 10.3389/fmars.2020.00252".*
- ✓ *The parametric method of the sub-mesoscale temperature vertical convection term is used to improve the low-resolution model. Taking the East China Sea as a case study, a high-resolution hydrodynamic model of the East China Sea was established, and the role of sub- mesoscale processes in heat transfer across the transcline layer was studied in depth. The relevant results are published in "Xuan J, Su J, Wang H, et al. Improving low-resolution models via parameterisation of the effect of submesoscale vertical advection on temperature: A case study in the East China Sea[J]. Ocean Modelling, 2019: 51-65. DOI: 10.1016/j.ocemod.2019.03.002".*
- ✓ *Linking extensive in-situ datasets with a coupled physical-biological model, namely ROMS-CoSiNE, the physical and biogeochemical processes that create high-biomass phytoplankton production and hypoxia off the Changjiang (Yangtze River) Estuary in the East China Sea was investigated. The relevant results are published in "Zhou F, Chai F, Huang D, et al. Coupling and Decoupling of High Biomass Phytoplankton Production and Hypoxia in a Highly Dynamic Coastal System: The Changjiang (Yangtze River) Estuary[J]. Frontiers in Marine Science, 2020. DOI:10.3389/fmars.2020.00259".*
- ✓ *Using observational data and modeling results, the driving mechanisms for the strong interannual variability of chlorophyll in the northern South China Sea between different phases of ENSO was examined. Both cyclonic eddies and wind-induced mixing affect phytoplankton variability, but the former is the dominant factor regulating the interannual variability of chlorophyll during La Niña years, while the latter becomes the dominant one during El Niño years. The relevant results are published in "Xiu P, Dai M, Chai F, et al. On contributions by wind-induced mixing and eddy pumping to interannual chlorophyll variability during different ENSO phases in the northern South China Sea[J]. Limnology and Oceanography, 2019, 64(2): 503-514. DOI: 10.1002/lno.11055".*
- ✓ *Observations from two Bio-Argo floats deployed in the northern and central South China Sea show distinct seasonal patterns of vertical chlorophyll distribution. Using the coupled physical-biological model, the roles of wind-and buoyancy flux-induced mixing on phytoplankton dynamics in the northern and central South China Sea was evaluate. The relevant results are published in " Geng B, Xiu P, Shu C, et al. Evaluating the Roles of Wind-and Buoyancy Flux-Induced Mixing on Phytoplankton Dynamics in the Northern and Central South China Sea[J]. Journal of Geophysical Research, 2019, 124(1): 680-702. DOI: 10.1029/2018JC014170".*

- ✓ *By combining multiple satellite products to resolve both mesoscale and submesoscale dynamic regimes, the contributions of submesoscale processes associated with mesoscale eddies were evaluated. In worldwide subtropical gyres, the contribution of submesoscale structures around mesoscale eddies to high chlorophyll is comparable to that of mesoscale eddies (34.1% versus 30.8%). The relevant results are published in "Guo M, Xiu P, Chai F, et al. Mesoscale and submesoscale contributions to high sea surface chlorophyll in subtropical gyres[J]. Geophysical Research Letters, 2019, 46(22): 13217-13226. DOI: 10.1029/2019GL085278".*
- ✓ *The significance of the Kuroshio to the East China Sea has long been recognized during the last decades. However, the quantitative contribution in terms of nutrients from the Kuroshio to the East China Sea shelf is unclear due to the lack of data, particularly in an inter-annual time scale. Based on velocity calculated with geostrophy and satellite altimetry, and nutrient data from in situ measurements, we studied the temporal and spatial variations for 22-year (1993-2014) cross-shelf nutrient exchange at the 200-m isobath section in the East China Sea. Nitrate transport shows a significant three-dimensional spatial structure with annual and inter-annual variations. Spatial structure of nitrate transport is determined by velocity in the horizontal and nitrate concentration in the vertical. Temporal variation in nitrate transport is mainly determined by velocity and particularly by its geostrophic component. The relevant results are published in "Ding R, Huang D, Xuan J, et al. Temporal and Spatial Variations of Cross-Shelf Nutrient Exchange in the East China Sea, as Estimated by Satellite Altimetry and In Situ Measurements[J]. Journal of Geophysical Research, 2019, 124(2): 1331-1356. DOI:10.1029/2018JC014496".*

## 1.b. Publications since last report

*Please add all publications since last report to the table below (see notes for details on "Class" and "Activity" fields).*

| ***Publication*** *with DOI* | ***Class 1, 2, 3*** | ***Activity**** |
|---|---|---|
| *Geng B, Xiu P, Shu C, et al. Evaluating the Roles of Wind- and Buoyancy Flux-Induced Mixing on Phytoplankton Dynamics in the Northern and Central South China Sea[J]. Journal of Geophysical Research, 2019, 124(1): 680-702. DOI: 10.1029/2018JC014170* | *3* | |
| *Guo M, Xiu P, Chai F, et al. Mesoscale and submesoscale contributions to high sea surface chlorophyll in subtropical gyres[J]. Geophysical Research Letters, 2019, 46(22): 13217-13226. DOI: 10.1029/2019GL085278* | *3* | |
| *Xiu P, Dai M, Chai F, et al. On contributions by wind-induced mixing and eddy pumping to interannual chlorophyll variability during different ENSO phases in the northern South China Sea[J]. Limnology and Oceanography, 2019, 64(2): 503-514. DOI: 10.1002/lno.11055* | *3* | |
| *Xuan J, Su J, Wang H, et al. Improving low-resolution models via parameterisation of the effect of submesoscale vertical advection on temperature: A case study in the East China Sea[J]. Ocean Modelling, 2019: 51-65. DOI: 10.1016/j.ocemod.2019.03.002* | *3* | |

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|---|---|---|
| *Tian D, Su J, Zhou F, et al. Heat budget responses of the eastern China seas to global warming in a coupled atmosphere-ocean model[J]. Climate Research, 2019, 79(2): 109-126. DOI: 10.3354/cr01579* | *3* | |
| *Lin Z, Wang X, Xiu P, et al. Boundary Phosphate Transport of the East China Sea and Its Influence on Biological Process[J]. Journal of Geoscience and Environment Protection, 2019, 7(9): 79-104. DOI: 10.4236/gep.2019.79007* | *3* | |
| *Li Z , Zhang R , Liu K , et al. Late onsets of tropical cyclones in the decaying years of super El Niño events[J]. Acta Oceanologica Sinica, 2019, 38(7):67-73. DOI: 10.1007/s13131-019-1458-0* | *3* | |
| *Yu Y, Xing X, Liu H, et al. The variability of chlorophyll-a and its relationship with dynamic factors in the basin of the South China Sea[J]. Journal of Marine Systems, 2019, 200: 103230. DOI: 10.1016/j.jmarsys.2019.103230* | *3* | |
| *Yu Y, Zhang H, Jin J, et al. Trends of sea surface temperature and sea surface temperature fronts in the South China Sea during 2003–2017[J]. Acta Oceanologica Sinica, 2019, 38(4): 106-115. DOI: 10.1007/s13131-019-1416-4* | *3* | |
| *Zhi H, Lin P, Zhang R, et al. Salinity effects on the 2014 warm "Blob" in the Northeast Pacific[J]. Acta Oceanologica Sinica, 2019, 38(9): 24-34. DOI: 10.1007/s13131-019-1450-2* | *3* | |
| *Shao W, Zhu S, Sun J, et al. Evaluation of Wind Retrieval from Co-Polarization Gaofen-3 SAR Imagery Around China Seas[J]. Journal of Ocean University of China, 2019, 18(1): 80-92. DOI: 10.1007/s11802-019-3779-8* | *3* | |
| *Ding R, Huang D, Xuan J, et al. Temporal and Spatial Variations of Cross-Shelf Nutrient Exchange in the East China Sea, as Estimated by Satellite Altimetry and In Situ Measurements[J]. Journal of Geophysical Research, 2019, 124(2): 1331-1356. DOI:10.1029/2018JC014496.* | *3* | |
| *Yang W, Wei H, Zhao L, et al. Parametric subharmonic instability of the semidiurnal internal tides at the East China Sea shelf slope[J]. Journal of Physical Oceanography, 2020. DOI: 10.1175/JPO-D-19-0163.1* | *3* | |
| *Song G, Zhao L, Chai F, et al. Summertime Oxygen Depletion and Acidification in Bohai Sea, China[J]. Front. Mar. Sci.,2020, 7:252. DOI: 10.3389/fmars.2020.00252* | *3* | |
| *Zhou F, Chai F, Huang D, et al. Coupling and Decoupling of High Biomass Phytoplankton Production and Hypoxia in a Highly Dynamic Coastal System: The Changjiang (Yangtze River) Estuary[J]. in Marine Science.,2020. DOI:10.3389/fmars.2020.00259* | *3* | |
| *Wang Y, Yu Y, Zhang H, et al. Distribution and variability of sea surface temperature fronts in the South China Sea [J]. Estuarine, Coastal and Shelf Science, 2020. DOI: 10.1016/j.ecss.2020.106793* | *3* | |
| *Yu Y, Wang Y, Cao L, et al. The ocean-atmosphere interaction over a summer upwelling system in the South China Sea [J],* | *3* | |

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|---|---|---|
| *Journal of Marine Systems, 2020. DOI: 10.1016/j.jmarsys.2020.103360* | | |
| *Chen H, Tang R, Zhang H, et al. Investigating the Relationship between Sea Surface Chlorophyll and Major Features of the South China Sea with Satellite Information. Journal of Visual Experiment, 2020, e61172.* | *3* | |

**If appropriate, please list the IMBeR activity through / by / from / during which the publication arose*

****<u>***Notes on publications***</u>****

Publications are logged in the IMBeR Zotero library which is publicly accessible online - https://www.zotero.org/groups/2448334/imber_library_2/library

[Due to space limitations, publications from 1999-2017 are in a separate Zotero library - https://www.zotero.org/groups/38770/imber_library_1/library]

Publications are categorised by "Class" and linked to "Activities":

<u>***Class 1 publications***</u> are specifically generated through/by/from/during <u>***IMBeR activities***</u> - for example, arising from IMBIZOs and IMBeR conferences such as the IMBeR open science meeting and the IMBeR CJK symposia and from the activities of the working groups, regional programmes and the SPIS scoping teams.

<u>***Class 2 publications***</u> are on topics relevant to the IMBeR Science Plan that benefitted from some interaction with IMBeR or <u>***IMBeR activities***</u>, for example by IMBeR symposium attendees, past and present SSC members, working group, regional programme and endorsed project members, or national contacts.

<u>***Class 3 publications***</u> are on topics relevant to the IMBeR Science Plan but for which there is no direct link to or benefit from an IMBeR activity. These might include publications by SSC members, working group, regional programme or endorsed project members or members of the IMBeR international community that were written as part of the normal scientific activity of the authors and would have occurred irrespective of IMBeR's existence. You can report Class 3 publications, but they will no longer be logged in the IMBeR database.

[See https://drive.google.com/open?id=1OQWn41KJvQ-LyWJlkiYnc5qZ2IuNQOrg or https://pan.ecnu.edu.cn/p/DTrpUb4QiFAYoQ4 for further information on "What is an IMBeR publication?".]

<u>***Why list 'Class' and 'Activity'?***</u> This helps us to declare authentically which publications IMBeR has helped to generate, and it makes it easier for us to demonstrate the value of the Regional Programmes, the Working Groups, the Endorsed Projects, and IMBeR in general, and it helps us to justify support for IMBeR activities when we can list tangible outputs.

### 1.c. Events, Meetings, and Workshops

*List all international and national events, meetings and workshops. Describe the level of participation: e.g. chairing session/workshop, organising meeting. Include Endorsed Project meetings and workshops.*

*Format: Title of event. Date. Location. Description of participation. Any other pertinent details.*

- ✓ *The 4th Global Ocean Acidification Observing Network (GOA-ON) International Workshop in Hangzhou, China on 14-17 April 2019. 270 participants from 108 institutions of 62 countries attended this workshop. We held this workshop aim to a) discuss emerging aspects from the coupled effects of ocean acidification with multi-stressors, b) review global ocean acidification status and forecast capabilities, and c) explore opportunities for capacity development.*
- ✓ *Annual Project meeting in Hangzhou, China on 20-22 November 2019. 65 members of our project and 9 experts attended this meeting. We held this project meeting aim to a) summarize the project work in the past whole year, b) invite experts to make suggestions on the project work carried out in the past, c) arrange work tasks for the next year.*

## 2. International collaboration and links

*The 4th Global Ocean Acidification Observing Network (GOA-ON) International Workshop took place in Hangzhou, China on 14-17 April 2019. The workshop was attended by 270 participants from 108 institutions of 62 countries to a) discuss emerging aspects from the coupled effects of ocean acidification with multi-stressors, b) review global ocean acidification status and forecast capabilities, and c) explore opportunities for capacity development. It was the fourth in a series, but the first time in China (even Asia), that aimed to build a sustained observing system for ocean acidification and the related biological responses that extends from local to global scales. This workshop has effectively promoted China's participation in this global network. It also helped boost up the construction and development of ocean acidification observing systems in China. Through mini-training-workshop and sharing of data, this workshop contributed to promote and enhance these countries' capacities in addressing global climate change impacts. It provided an arena for China to share her vision and solutions to global marine environmental governance and climate change. See http://www.goa-on.org/workshops/hangzhou2019/workshop.php for further information.*

## 3. Input to management, policy and governance

*Add anything that in line with the IMBeR Grand Challenge III: Improving and achieving sustainable ocean governance*

*Per requested by the Nature Review – Earth Environment, a review paper regarding building a sustainable global observational system for marine biogeochemical features was recently accepted for publication. The cutting-edge techniques are discussed in the paper, e.g., their advantages for observing biogeochemical parameters and be transferred into marine ecosystem forecasting system. A sustainable and autonomous observational system will be fundamentally important for fostering marine ecosystem health in future. The paper can be found in Chai et al., 2020, Monitoring ocean biogeochemistry with autonomous platforms, Nature Review – Earth Environment, 10.1038/s43017-020-0053-y.*

*A recent accepted paper co-authored by scientists from China and USA suggested that "Traditionally, the monitoring and research of red tides in Chinese coastal waters has been administratively restricted to toxic algae blooms. However, high-biomass production that lead to hypoxia also are recognized as an important aspect of HABs having substantial ecological impacts to pelagic and benthic systems. Hypoxia off the Yangtze Estuary has become a seasonal phenomenon, and one where the intensity and spatial scale of hypoxia has been expanding." The definition of HABs and in-situ investigation should take into account the hypoxia generated by these massive diatom blooms in the Chinese Changjiang (Yangtze River) Estuary and probably other coastal regions. See also in Zhou et al., 2020, Frontiers in Marine Science, doi: 10.3389/fmars.2020.00259).*

## 4. Education and outreach

- ✓ *With the support of our project, 7 Master students and 1 PhD student were successfully graduated in 2019. The training of graduate students can export more high-quality talents for the marine study team.*
- ✓ *The high-resolution coupled physical-biological model for the Yellow Sea and East China has been shared to the Zhejiang Ocean University, Xiamen University, and the Centre for Coastal Research at the Helmholtz-Zentrum Geesthacht (HZG).*

## 5. Planned activities for next year

### Activities and Outreach (Convening sessions, meetings, etc)

- ✓ Further study on the a) new primary productivity and carbon flux in the Western Pacific, b) seasonal forecasting of pH and dissolved oxygen in the central Yellow Sea, c) seasonal prediction of hypoxia and algal blooms in the East China Sea, d) effects of special events, such as typhoon, on nutrient and phytoplankton community structure in the South China Sea.
- ✓ Achieve the formal operation of the high-resolution marine ecosystem forecasting system platform in the China Seas and Northwestern Pacific.
- ✓ *An IMBeR-releveant meeting "Coastal Ecosystem Change under Multi-Stressors: Eutrophication, HABs, hypoxia, acidification and bio-diversity loss" is in preparation for the first announcement and will be held in China (Hangzhou, Zhejiang or Beihai, Guangxi) in October 2021, which is inherited from the International symposium on coastal ecosystem change in Asia: hypoxia, eutrophication, and nutrient conditions, held in Matsuyama, Japan on Nov 14-15 2019.*