CLIVAR REPORT

Climate and Ocean: Variability, Predictability, and Change

CLIVAR-FIO Summer School
Ocean Macroturbulence and Its Role in Earth's Climate

Report

15-20 August, 2022
Qingdao, China and Online

CLIVAR Report No.: 04/2022

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1. Introduction

1.1 Background

With strong emphasis of WCRP (World Climate Research Programme) and CLIVAR (Climate and Ocean – Variability, Predictability and Change) on the capacity building in particular for Early Career Scientists, and thanks to the great support from the First Institute of Oceanography (FIO), Ministry of Natural Resources of China, the host agency of the International CLIVAR Project Office (ICPO), a five-year agreement was signed between WCRP and FIO in January 2018 for organizing CLIVAR-FIO Summer Schools every two years. CLIVAR-FIO Summer Courses covers a wide range of topics which are the current focus of the CLIVAR groups. Also, the CLIVAR Summer School aims to establish a platform to foster international joint research among lectures and trainees, and to provide opportunities of exchanging visiting scholars and doctoral education.

The 1st CLIVAR-FIO Summer School was successfully organized in Qingdao on 25-30 June, 2018 under the theme "Past, Present and Future of Sea Level Change". The summer school was held back-to-back with the UNESCO/IOC-RTRC-ODC Training Course on "Ocean Forecasting Systems" training (2-7 July 2018). The summer school was fruitful and widely recognized by the participants (report). Kemgang Ghomsi Franck Eitel from Cameroon was nominated directly by the lecturer to be a member of the CLIVAR Atlantic Regional Panel for his outstanding performance during the summer school, and the nomination was approved by the CLIVAR Scientific Steering Group. Some of the excellent articles submitted by the trainees were published in 76th special issue of CLIVAR *Exchanges* (doi: 10.36071/clivar.76.2019).

The 2nd CLIVAR-FIO Summer School was proposed and coordinated by the CLIVAR Atlantic Region Panel (ARP). However, affected by the global COVID-19 outbreak at the beginning of 2020, the 2nd CLIVAR-FIO Summer School, which was originally planned for June 2020, was postponed. After discussion, it was rescheduled in a hybrid format on 15-20 August, 2022. The physical venue was in Qingdao, China, with livestream and online interaction options provided to connect both onsite and online participants.

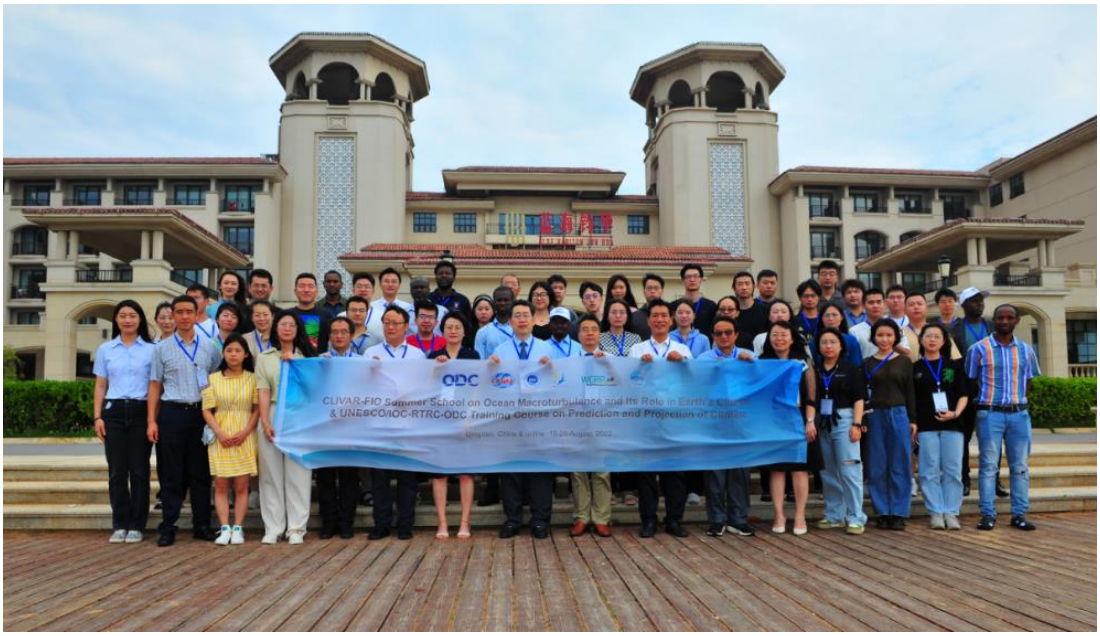
1.2 Course Description

The theme of the 2nd CLIVAR-FIO summer school was "Ocean Macroturbulence and Its Role in Earth's Climate". The course covered the observation and data analysis of ocean macroturbulence, its dynamic mechanism and its interaction with large-scale ocean circulation, numerical simulation, and the impact of macroturbulence on climate change simulations and predictions, etc. 14 leading experts from China, France, Germany, New Zealand, UK and USA were invited to give lectures addressing the observations, dynamics, modelling of the ocean meso- and sub-mesoscale motions,

as well as their role in the earth's climate, with the support from 3 teaching assistants and staff at the International CLIVAR Project Office (ICPO), the First Institute of Oceanography (FIO), Ministry of Natural Resources of China and the UNESCO/IOC Regional Training and Research Center on Ocean Dynamics and Climate (ODC). The full list of the lecturers and staff of the summer course can be found in Appendix A.

Fig.1 Lecturers and teaching assistants

This summer school received a total amount of 216 applications from students and researchers from 33 countries all over the world through an open call for applications. During the selection process, the Organizing Committee assessed the relevance of the applicants' potential contributions to the summer school. Throughout the process, the Committee considered potential for future knowledge transfer as an important factor, and also evaluated the education background as well as the scientific expertise. The Committee also aimed to achieve the widest possible geographical distribution of the trainees, and a gender balanced distribution, as well as to contribute to the capability building of developing countries. As the Summer School was planned to be hybrid, the Committee also decided to give this training opportunity to more applicants by including people as online participants. With these considerations, 146 candidates from 26 countries (93 males and 53 females) were selected for the CLIVAR-FIO summer school in 2022, 20 of which attended the courses onsite and 126 online. The full list of participants can be found in Appendix B. The Summer School was co-hosted by First Institute of Oceanography, Ministry of Natural Resources and the Administrative Committee of Qingdao Western Coast New Area, China, and supported by the World Climate Research Programme (WCRP).



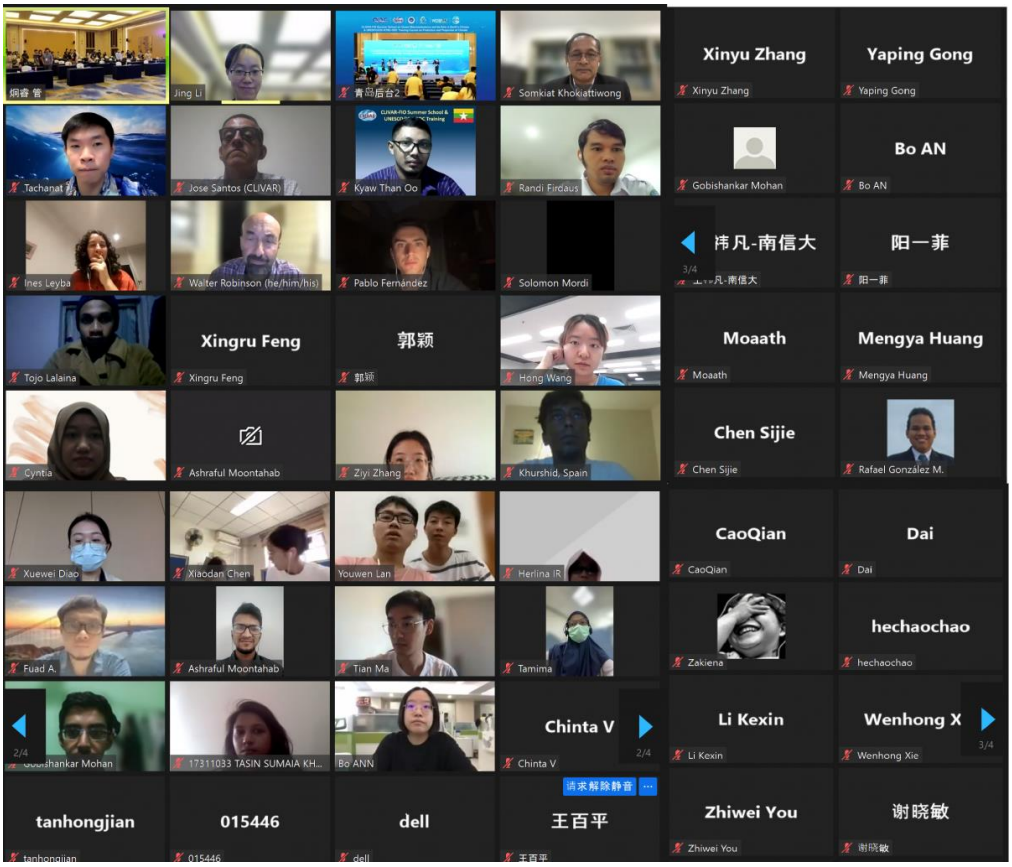


Fig. 2 Group photos for in-person and online participants

Fig. 3 Distribution of the trainees

The 6-day Summer School comprised of lectures, Q&A, discussions of recent journal articles, exercises with observational and model data sets provided by instructors for groups of participants to analyze. As the Summer Course was aimed to help establish research networks, and identify possible areas of cooperation among trainees and their institutions, trainees were required to submit a 5-minute presentation video before the courses, which covered his/her main research focus, his/her institution's areas of work, and preliminary idea for cooperation with other countries in the region. In addition, in order to encourage teamwork, both onsite and online trainees were divided into groups during the summer school, and they were provided with guidelines for proposal development and were required to formulate a group proposal during this week, which was presented at the end of the summer school on August 20, receiving feedback from several of the instructors. A site visit to FIO was also arranged during the week. The full agenda for the summer school can be found in Appendix C.

Online participation for the summer school was enabled via **Zoom and livestream**. **Slack channel** was established to facilitate the group communications, offline Q&A and announcements. In order to enable the trainees located in different time zones to attend the courses as much as possible in live, **pre-recorded lectures** have been prepared by teachers and uploaded on the CLIVAR webpage before the course. The **slides, archived recordings, reading materials as well as datasets for exercises** were uploaded to cloud drive, and the links were available on the programme page (https://www.clivar.org/2022-clivar-fio-summer-school-programme).

2. Opening Session

The ceremony, chaired by Dr. Li Li from International Cooperation Department of FIO, was attended by Mr. Shengzhi Sun, Inspector of International Cooperation Division, Ministry of Natural Resources; Dr. Mike Sparrow, Head of World Climate Research Division, WMO & Head of WCRP Secretariat, Dr. Somkiat Khokiattiwong, former Chairperson, IOC Sub-Commission for the Western Pacific & former vice-chair, IOC; Dr. Fangli Qiao, Deputy Director General of First Institute of Oceanography, Ministry of Natural Resources, and Mr. Yingming Zhao, Director of Qingdao West Coast New Area Marine Development Bureau. In their welcome speeches, they fully affirmed the achievement of the CLIVAR-FIO summer schools and ODC training courses and warmly congratulated.

Dr. Jose Santos, Executive Director of ICPO, briefly introduced 2022 CLIVAR-FIO summer school, including the basic information, training objectives, overall theme and daily arrangements, the faculty and organizing committee of the summer courses. Ms. Jing Li, Staff Scientist from ICPO, announced the logistic notes, including the onsite and online arrangements, resources and different platforms to be used for the summer school.

3. Course Content

In what follows, we present short summaries of the contents of the presentations made by lecturers on ocean macroturbulence and its role in Earth's climate. The **slides, archived recordings, reading materials as well as datasets for exercises** were available on the programme page (https://www.clivar.org/2022-clivar-fio-summer-school-programme).

3.1 Day 1: Dynamics

Overview of science issues (Walter Robinson, N. Carolina State Univ.)

- What is ocean macroturbulence?
- Ocean (mesoscale & sub-mesoscale) vs Atmosphere (synoptic & mesoscale)
- The world with & without macroturbulence: the conveyor belt
- Why a school? Themes focused on new observations, dynamical understanding of sub-mesoscale motions and their interaction with larger-scale circulation, high-resolution models, climate scales, etc.
- Outcomes of the summer school
- Science issues
  - ✓ How does meso- and sub-mesoscale motions arise and behave
  - ✓ How do these motions interact with the earth’s climate system
  - ✓ Climate variability & prediction
    - Eddy impacts on atmosphere
    - Signal/noise for decadal prediction

- ✓ Modeling ocean macroturbulence
- ✓ Climate change: trends (1993-2020) in ocean eddy kinetic energy (EKE)
- ✓ Ocean macroturbulence & biogeochemistry

Statistical and Dynamical Analysis of Oceanic Mesoscale Eddies (Changming Dong, NUIST)

- Basic concepts of mesoscale eddies (definitions, types, 3-D structure, generative mechanism)
- Automatic eddy detection algorithm (5 algorithms, constraints, boundary)
- The influence of mesoscale eddies
  - ✓ Response of atmospheric boundary layer to eddy
  - ✓ Eddy-induced atmosphere variable change
  - ✓ Eddy-induced heat and freshwater transport
  - ✓ Eddy-induced chlorophyll distribution
  - ✓ Eddy-induced vertical heat transport
  - ✓ Mesoscale eddy associated with near-inertial energy inputs
  - ✓ Mesoscale eddy-induced mixing
  - ✓ The near-Global Ocean Mesoscale Eddy Atmospheric-Oceanic-Biological Interaction Observational Dataset (GOMEAD): https://www.scidb.cn/en/s/Zfeu6b
- Sub-mesoscale processes associated with oceanic mesoscale eddies

Mesoscale air-sea interaction: Impact of mesoscale SSTs on atmospheric weather patterns (Xiaohui Ma, OUC)

- Introduction
- Review 2022: Largescale extratropical SST
- Review 2019: Mesoscale extratropical SST
- Midlatitude Ocean -Atmosphere Systems
- Midlatitude Mesoscale Ocean -Atmosphere Interaction
- Largescale and Mesoscale SST-THF Relationship
- Local Atmospheric Response to Mesoscale SSTs: wind, cloud and rain
- Experiment Design
- Local Atmospheric Response to Mesoscale SSTs: storm tracks
- Remote Atmospheric Response to Mesoscale SSTs: storm tracks and mean flow
- Remote Atmospheric Response to Mesoscale SSTs: Atmospheric Rivers (ARs)
- Response of Extratropical Cyclone (EC) vs AR

The Surface Wave Related Turbulence and its Key Roles in the Earth's Climate (Fangli Qiao, FIO)

- The Surface Wave Related Turbulence and its Key Roles in the Earth's Climate
- Wave-induced turbulence in the ocean
- Wave turbulence effects in air-sea fluxes
- Summary

Exercise: Examine the local atmospheric response to mesoscale SSTs in the Kuroshio extension region (Weiwei Ma, OUC)

3.2 Day 2: Air-sea Interactions

Upward influence of ocean macroturbulence (Walter Robinson, N. Carolina State Univ.)

- Scales: Ocean vs Atmosphere
- Why shouldn't it care? Scales & structures
- Geopotential height response from 500 km patch of shallow heating (1- 3 km)
- North Atlantic Oscillation
- 800-pound gorilla
- Ocean macroturbulence => atmospheric climate scale: extratropical cyclones
- Extratropical cyclones: scale still a problem?
- Cyclones have mesoscale structures that contribute to growth through latent heat release
- Impacts extend to climate scale
- Role for ocean macroturbulence?
- Deep convection
- Front-front interactions
- Boundary layer impacts
- Example from observations: Gulf Stream impacts on atmospheric large scale
- Upward influence of ocean macroturbulence

Mesoscale air-sea interaction: Upscaling mechanism from oceanic eddies to atmospheric storms (Xiaohui Ma, OUC)

- Mesoscale Ocean-Atmosphere Interaction: Scale Match
- Response of water vapor Q to mesoscale SSTs: storms and Ars
- Upscaling: Nonlinearity between warm and cold eddies?
- Upscaling (Nonlinearity): AR case study
- Upscaling: other possibilities

Eddy-Resolving Global Ocean Prediction (Atmospheric Responses to Oceanic Eddies), (Changming Dong, NUIST)

- Background of Eddy-Resolving Global Ocean Prediction
- Methodology
- Results
- Summary

EUREC4A/ATOMIC overview and early result (1) - EUREC4A-OA (Sabrina Speich, IPSL)

- Introduction of EUREC^{4}A-OA/ATOMIC-OA

- North Tropical Atlantic largescale circulation
- EUREC^{4}A-OA/ATOMIC-OA: the field experiment
- EUREC^{4}A-OA Field experiment strategy
- NBC rings -key in understanding physical and biogeochemical processes
- A unique turbulent tropical oceanregion
- The ocean small-scale & CO_2 Air-Sea exchanges: Assessments from EUREC4A-OA/ATOMIC
- The ocean small-scale & Turbulent Air-Sea fluxes
- The ocean small-scale & Turbulent Air-Sea fluxes: A statistical approach from satellite, in situ data and numerical simulations

EUREC^{4}A/ATOMIC overview and early result (2) – ATOMIC: Results from ATOMIC: Air-sea interaction and fluxes in the trade winds (Suneil Iyer, U. Washington)

- Why study the trade winds?
- Observations from ATOMIC
- SWIFT drifters and Wave Gliders
- SWIFT and Wave Glider deployments
- How do currents influence momentum flux?
- Wind, wave, and current directions from SWIFT drifters during ATOMIC
- Case study: four SWIFTs drift southwestward with the trade winds
- Comparisons with COARE bulk momentum flux
- Summary: Currents and momentum flux
- Chapter 3: Heat fluxes from the ATOMIC campaign
- Case study: Wave Gliders drive across a SST front
- Heat flux gradients across a sharp SST front
- SST gradients from SWIFT drifters during the ATOMIC campaign
- Fluxes across SST gradients
- Spatial flux variability in the trade winds
- Summary and conclusions

Exercise: The influence of oceanic eddies on the overlying atmospheric wind speed and rain rate (Changming Dong, NUIST)

3.3 Day 3: Observations

Observing mesoscale eddies to understand the fate of eddy kinetic energy in the global ocean (Gwyn Evans, NOC)

- Why do we care about mesoscale eddies?
- What remains to be understood about the role of mesoscale eddies in the global ocean?
- What happens to mesoscale eddy energy?
- What do we know about eddies at western boundaries?
- MeRMEED- Mechanisms Responsible for Mesoscale Eddy Energy Dissipation

In-situ Network Observations of Mesoscale Eddy and Submesoscale Processes in the South China Sea, Dongxiao Wang

- Background
- New Features of Mesoscale Eddy
- Dynamics of Submesoscale Processes
- Mesoscale Eddy induced Cross-slope Transport
- Summary

SeaSTAR – the ESA Earth Explorer 11 satellite mission to measure small-scale ocean surface dynamics (Adrien Martin, NOC)

- Science drivers of the SeaSTAR mission
- Observing small scale ocean features
- The need for 1km resolution in the ocean
- Impacts at large scales
- Small-scale ocean dynamics in coastal & shelf seas
- SeaSTAR primary science objectives
- SeaSTAR secondary science objectives
- SeaSTAR primary products requirements
- SeaSTAR coverage and revisit
- SeaSTAR requirement principle
- ATI measuring principle
- Airborne proof-of-concept and expected performance
- ESA OSCAR airborne demonstrator
- Timing, complementarity with other missions

Exercise: Work with Glider/Satellite data (Gwyn Evans, NOC)

3.4 Day 4: Modeling

Representation of ocean macro-turbulence in GCMs (Fangli Qiao, FIO)

- The scientific challenges for OGCM and GCM
- Turbulence closure models
- Wave-induced and tidal mixing in OGCM
- Summary

A global eddy resolving ocean forecast system in China--LICOM Forecast System (LFS), (Hailong Liu, IAP-CAS)

- Basic Concepts of Ocean Forecast
- LICOM Forecast System (LFS)

Role of ocean macroturbulence in climate simulation and prediction, projection-

--- Ideas from FIO-ESM (Zhenya Song, FIO)

- Motivation of FIO-ESM
- FIO-ESM v1.0 development
- FIO-ESM v2.0 development
- Perspectives on the ESM
- FIO-ESM v2.0 products

Exercise: A diagnostic toolkit for the impact of ocean model resolution (Yiwen Li, IAP-CAS)

3.5 Day 5: Biogeochemistry and societal relevance

Meso- and submeso-scale eddy dynamics and biogeochemical processes and the impact on heat and carbon transport (Annalisa Bracco, Georgia Tech)

- Oceanic space and time scales
- The flow of energy in the Ocean
- Dynamics at the ocean submesoscales
- Underlying Research Theme
- Why Submesoscale dynamics are prominent near the ocean vertical boundaries?
- 1. PATTERN FORMATION AND SUBMESOSCALES: horizontal mixing and oil dispersion
- 2. PATTERN FORMATION AND SUBMESOSCALES: horizontal convergence and implication for carbon cycling
- 3. GENERATION OF SUBMESOSCALE EDDIES ALONG CONTINENTAL SLOPES
- Connectivity of Callogorgia delta

Contribution of meso-/submeso-scale eddies to marine extreme events, (Ivy Frenger, GEOMAR)

- Marine extreme events: Why of interest?
- Quantifying the role of eddies in marine extreme events
- How do eddies cause extreme conditions?

Physical/biological interactions at meso/submeso scales and its implication for decision makers (Alice della Penna, U. of Auckland)

- A quick introduction
- Impact of (sub)mesoscale features on plankton
- Impact of (sub)mesoscale features on swimming animals (nekton)
- What does it mean for conservation and management?

Breakout discussion: Identifying knowledge gaps in understanding of the phy/biological process with societal relevance (Alice and Ivy)

Exercise: Marine predators in a turbulent ocean (Alice and Ivy)

3.6 Site visit to FIO

On Aug.17, a site visit to FIO was arranged. The students visited the China Ocean Sample Repository, Bailong Buoy, High-performance Computing Center, and Laboratory of Marine Science and Numerical Modeling in FIO.

3.7 Group Work on Proposal Development

A capacity building activity on proposal development was conducted throughout the week. The trainees are divided into 11 groups (4 in-person groups, 7 online groups) and were asked to prepare a research proposal together related to the summer school themes with their own interests during the week. On Aug. 16, Prof. Changming Dong and Prof. Fangli Qiao gave a one-hour lecture on how to develop a project proposal. Dr. Qiao firstly introduced the key points for a proposal:

- What we should focus on? (e.g., Accurate Africa Climate Prediction)
- Social and scientific needs
- Progress (reference review on climate prediction, and if any prediction system exists)
- Analyze the challenge
- Research content (main research area and topic for the research)
- Background to support the research
- Your team
- What kind of support you need to do the project

The trainees were encouraged to brainstorm for the ideas of proposals, and each group, either in-person or online, presented their ideas on Aug. 16 and refined it and developed the draft proposal after the courses through Aug.17 to 19. On Aug. 20, four in-person groups and four online groups presented their proposals and received feedbacks from the board of experts. Two online groups cannot present due to time zone issues, and one group dropped. Another week was provided to develop the full proposals by incorporating the comments from the board of experts. There were 11 proposals received from 4 in-person groups and 6 online groups by Aug.27. The list of the proposals can be referred to Appendix D.

3.8 Trainee Certificates

For evaluating the performance of trainees during the training course, a score was given to each trainee. The score was determined by attendance, activity performance, discussion during the training course and the quality of trainee report and group report. A certificate of accomplishment was issued to the trainees who complete at least 85% of the course. Four trainees were selected as the best trainees (two in-person and two online) according to their training scores.

Name	Institute	Country	Participation format
Tolulope Emmanuel Oginni	Zhejiang University	Nigeria	In-person
Xiaowei Wang	Institute of Atmospheric Physics Chinese Academy of Sciences	China	In-person
Pablo Fernández École	Laboratoire de Météorologie Dynamique	France	Online
Fuad Azminuddin	University of Science and Technology Korea Institute of Ocean Science and Technology	Republic of Korea	Online

Fig. 4 Certificate for best trainees

4. Trainees Feedback

After the completion of the course, a feedback questionnaire was send to all participants in order to receive their comments/impressions on both the logistical and academic aspects of the course. 25 responses were received.

Good interaction among trainees and between lecturers and trainees were observed

both during the class and the breaks. According to the feedback from trainees, the content, quality and arrangement of the lectures were well designed and delivered. There were interrelations among lectures, and the key concepts and messages on theme have been reviewed and re-emphasized by several lecturers during their talks.

However, we also observed from the survey that more than half of the students experienced some issues when downloading the data for exercises from the cloud drive, when the files are too big (e.g., over 1G). Some students felt the content of homework (D1 & D2) were difficult for them. Also, some online students cannot get the response from their groupmates, which made it difficult for that group to conduct group discussion and prepare the group proposal.

There were also some critical comments that are useful for future design and implementation of the Summer School, which are summarized as below:

- In-person participation for future are strongly anticipated.
- More attention and support to be provide to the online students, especially when arranging discussions and practical sessions.
- The course is a bit compact. To arrange more time for discussion and exercise in the future.
- Considering the different background of the students, and some may not have programming skills. It might be a burden for them to install different software and packages. More trainings that will expose the students to software and programing languages may be organized to aid the students in carrying out research. The style for hands-on session by Dr. Yiwen Li should be followed, i.e., the trainees were guided through from installation to using the tool, diagnosing and etc. The detailed installation guide/steps/links with detailed comments in the script/code, like what Prof. Alice della Penna did.

Topics for future capacity building activities were also suggested by the respondents.

The full analysis of the trainees' feedback can be referred to Appendix E.

Appendix A: Lecturers and Supporting Staff

Invited Speakers

Dr. Mike Sparrow
Head, World Climate Research Division, WMO & Head of the WCRP Secretariat

Dr. Somkiat Khokiattiwong
Former Vice-Chair, IOC/UNESCO & Former Chair of IOC-WESTPAC

Mr. Shengzhi Sun
Inspector of the Department of International Cooperation, Ministry of Natural Resources (MNR), China

Lecturers (By order of teaching)

Prof. Walter Robinson

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Prof. Changming Dong

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Dr. Alice della Penna
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Local Organizers

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Volunteers

Ms. Jing Ren
PhD candidate
First Institute of Oceanography Ministry of Natural Resources

Mr. Bo Liu
Master student
First Institute of Oceanography, Ministry of Natural Resources

Ms. Youting Wu
Master student
First Institute of Oceanography, Ministry of Natural Resources

Appendix B: List of Participants

No	Name	Country	Institute	Participation format
1	Bo Liu	China	First Institute of Oceanography, Ministry of Natural Resources	In-person
2	Jing Ren	China	First Institute of Oceanography, Ministry of Natural Resources	In-person
3	Youting Wu	China	First Institute of Oceanography, Ministry of Natural Resources	In-person
4	Guixian Li	China	Institute of Atmospheric Physics Chinese Academy of Sciences	In-person
5	Jingwei Xie	China	Institute of Atmospheric Physics Chinese Academy of Sciences	In-person
6	Xi Wang	China	Institute of Atmospheric Physics Chinese Academy of Sciences	In-person
7	Xiaowei Wang	China	Institute of Atmospheric Physics Chinese Academy of Sciences	In-person
8	PingXiang Chu	China	N/A	In-person
9	Linhai Wang	China	Sun-Yat-sen University	In-person
10	Lixuan Huang	China	Sun-Yat-sen University	In-person
11	Ying Hung	China	Sun-Yat-sen University	In-person
12	Changlong Liu	China	Zhejiang University	In-person
13	Xinyu Li	China	Zhejiang University	In-person
14	Aston Matwayi Nyongesa	Kenya	Climate Change Research Center Institute of Atmospheric Physics UCAS	In-person
15	Onyango Augustine Omondi	Kenya	International Center for Climate and Environment Sciences （ICCES） Institute of Atmospheric	In-person
16	Eghosa Igun	Nigeria	Institute of Atmospheric Physics Chinese Academy of Sciences	In-person
17	Emmanuel Eresanya	Nigeria	Key state tropical laboratory of Oceanography	In-person
18	Tolulope Emmanuel Oginni	Nigeria	Zhejiang University	In-person
19	Dickson Mbigi	Tanzania	Institute of Atmospheric Physics Chinese Academy of Sciences	In-person
20	Zacharia Florence Mtewele	Tanzania	Institute of Atmospheric Physics Chinese Academy of Sciences	In-person
21	Matías Dinápoli	Argentina	CNRS – IRD – CONICET – UBA. Instituto Franco-Argentino para el Estudio del Clima y sus Impactos （IRL 3351 IFAECI）. Buenos Aires Argentina.	Online
22	Inés Leyba	Argentina	Departamento de Ciencias de la Atmósfera y los Océanos – Facultad de Ciencias Exactas y Naturales – Universidad de Buenos Aires	Online
23	Fernando Becker	Argentina	Universidad de Buenos Aires	Online
24	Ashraful Moontahab	Bangladesh	Bangabandhu Sheikh Mujibur Rahman Maritime University	Online

No	Name	Country	Institute	Participation format
25	Tasin Sumaia Khan	Bangladesh	Bangabandhu Sheikh Mujibur Rahman Maritime University	Online
26	Siraj Uddin Md. Babar Chowdhury	Bangladesh	Celestial tech Ltd. Dhaka Bangladesh.	Online
27	Sakia Shabnam Kader	Bangladesh	Daffodil International University	Online
28	Raiyan Ahamed	Bangladesh	Department of Oceanography University of Chittagong	Online
29	Md. Shahin Hossain Shuva	Bangladesh	Eutech Systems Limited	Online
30	K M AZAM CHOWDHURY	Bangladesh	University of Dhaka	Online
31	Adeola Michael Dahunsi	Benin	UNESCO International Chair in Mathematical Physics and Applications University of Abomey Calavi	Online
32	Hongbing Miao	China	College of Marine Geosciences Ocean University of China	Online
33	HONG WANG	China	Faculty of science and technology University of Macau	Online
34	Jiacai Xiong	China	Hainan Province Ocean Monitoring Forecasting Center	Online
35	Qingyan Wang	China	Hainan Province Ocean Monitoring Forecasting Center	Online
36	Tao Zhou	China	Hainan Province Ocean Monitoring Forecasting Center	Online
37	Bo AN	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
38	Chenyang Jin	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
39	Haolan Ren	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
40	Kexin Li	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
41	Panpan Li	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
42	Peng Fan	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
43	Run Guo	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
44	Tianyan Li	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
45	Tingwei Cao	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
46	Wei Hu	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
47	Xiaodan Chen	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
48	Xiaojuan Zhang	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online

No	Name	Country	Institute	Participation format
49	Yiran Xu	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
50	Ziying Xuan	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
51	Ziying Xuan	China	Institute of Atmospheric Physics Chinese Academy of Sciences	Online
52	Peng Lian	China	Institute of Oceanology of the Chinese Academy of Sciences	Online
53	MengQi Wang	China	Marine Disaster Reduction Center Ministry of Natural Resources	Online
54	Wenhong Xie	China	Nanjing University of Information Science and Technology	Online
55	Zhiwei You	China	Nanjing University of Information Science and Technology	Online
56	Chaochao He	China	Nanjing University of Information Science and Technology	Online
57	Xiangyu Shen	China	Nanjing University of Information Science and Technology	Online
58	Jingyuan Xue	China	Nanjing University of Information Science and Technology	Online
59	Yifei Yang	China	Nanjing University of Information Science and Technology	Online
60	Ziyun Wang	China	Nanjing University of Information Science and Technology	Online
61	Yifan Wang	China	Nanjing University of Information Science and Technology	Online
62	Yang Jin	China	Nanjing University of Information Science and Technology	Online
63	Qian Cao	China	Nanjing University of Information Science and Technology	Online
64	Lianjie Lin	China	Nanjing University of Information Science and Technology	Online
65	Minghan Fu	China	Nanjing University of Information Science and Technology	Online
66	Hui Gao	China	Nanjing University of Information Science and Technology	Online
67	Jinyan Liu	China	Nanjing University of Information Science and Technology	Online
68	Sijie Chen	China	Nanjing University of Information Science and Technology	Online
69	Fangyuan Teng	China	Nanjing University of Information Science and Technology	Online
70	Weiyuan Dong	China	Nanjing University of Information Science and Technology	Online
71	Ziyi Zhang	China	Nanjing University of Information Science and Technology	Online
72	Yuxin Liu	China	National Satellite Ocean Application Service	Online
73	Hailin Wang	China	Ocean University of China	Online
74	Shidong Liu	China	Ocean University of China	Online

No	Name	Country	Institute	Participation format
75	Xiaojie Ding	China	Ocean University of China	Online
76	Xingru Feng	China	Ocean University of China	Online
77	Yaping Gong	China	Ocean University of China	Online
78	Youwen Lan	China	Ocean University of China	Online
79	Zhuoran Li	China	Ocean University of China	Online
80	Haixia Dai	China	Polar Research Institute of China	Online
81	Long Lin	China	Polar Research Institute of China	Online
82	Rongwang Zhang	China	South China Sea Institute of Oceanology Chinese Academy of Sciences	Online
83	Yuxin LIN	China	Southern University of Science and Technology	Online
84	Tian Ma	China	Sun-Yat-sen University	Online
85	Hongjian TAN	China	Third Institute of Oceanography Ministry of Natural Resources	Online
86	Zhiyong long	China	University of Macau	Online
87	FOUAD ISSOUFA ALI	Comorin	National Agency of Civil Aviation and Meteorology Ministry of Marine and Land Transport	Online
88	Felipe Condo	Ecuador	Escuela Superior Politecnica del Litoral （ESPOL）	Online
89	Rafael González Muñoz	Ecuador	Independent Researcher	Online
90	Nativi M. Sophia	Ecuador	Instituto Oceanográfico y Antártico de la Armada （INOCAR）	Online
91	Getachew Mehabie Mulualem	Ethiopia	Bahir Dar university	Online
92	Pablo Fernández	France	École Normale Supérieure/ Laboratoire de Météorologie Dynamique	Online
93	Gaston Manta	France	ENS Paris	Online
94	Mohamed Naziq.S Sabeeulla	India	/	Online
95	Bijit Kumar Kalita	India	Center for Atmospheric and Oceanic Sciences Indian Institute of Science Bangalore India	Online
96	DHANENDRA SINGH	India	Dept. of Geography HNB Garhwal University India	Online
97	Lakshmanna Ballari	India	INDIAN INSTITUTE OF CHEMICAL TECHNOLOGY- COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH	Online
98	PUNYA P	India	Indian Institute of Space science and Technology	Online
99	Venkadesh Samykannu	India	Nammazhvar College of Agriculture and Technology	Online
100	PAVAN KUMAR	India	Rani Lakshmi Bai Central Agricultural University	Online

No	Name	Country	Institute	Participation format
101	VEERANJANEYULU CHINTA	India	State key laboratory of oceanography South China Sea Institute of Oceanology （SCSIO） Chinese Academy of Sciences University of Chinese Academy of Sciences	Online
102	Mary Carolin Kurisingal Cleetus	India	University of Basque Country Spain	Online
103	Ferdy Gustian Utama	Indonesia	BMKG	Online
104	Setiya Wati Kadek	Indonesia	BMKG	Online
105	CYNTIA Cyntia	Indonesia	Indonesia Agency for Meteorology Climatology and Geophysics （BMKG）	Online
106	Tamima Amin	Indonesia	Indonesia Agency for Meteorology Climatology and Geophysics （BMKG）	Online
107	Randi Firdaus	Indonesia	Indonesian Agency for Meteorology Climatology and Geophysics （BMKG）	Online
108	Deni Okta Lestari	Indonesia	Institut Teknologi Sumatera	Online
109	Herlina Ika Ratnawati	Indonesia	Ministry of Marine Affairs and Fisheries	Online
110	Elaheh Owlad	Iran	IRIMO	Online
111	Fadia al-azawi	Iraq	Al-Karkh university of science	Online
112	Gandy Rosales Quintana	Japan	Tokyo University of Marine Science and Technology	Online
113	Tojo Lalaina NOMENJANAHARY	Madagascar	NMHS Madagascar	Online
114	Nurrul Fazlina Osman	Malaysia	APPGM-SDG	Online
115	Franky Herman	Malaysia	Faculty of Science and Natural Resource	Online
116	Ivaldo Fumo	Mozambique	Eduardo Mondlane University	Online
117	KYAW THAN Oo	Myanmar	Nanjing University of Information Science and Technology	Online
118	Oyebola Elemide	Nigeria	Federal University of Oye Ekiti Ekiti State Nigeria	Online
119	Samuel Akande	Nigeria	Federal University of Technology Akure	Online
120	LYNDA-UTA OKON	Nigeria	Institute of Oceanography University of Calabar Nigeria; CSIR-National Institute of Oceanography Goa India	Online
121	Kayode Oyekan	Nigeria	National Weather Forecasting and Climate Research Centre Nigerian Meteorological Agency （NiMet）	Online
122	Adetayo Folorunso	Nigeria	The Federal University of Technology Akure	Online
123	Peter Ekpang	Nigeria	University of Calabar Nigeria	Online

No	Name	Country	Institute	Participation format
124	NOORUDDIN KHASKHELI	Pakistan	Education Department	Online
125	FARMAN ALI	Pakistan	FOREST AND WILDLIFE DEPARTMENT GILGIT BALTISTAN PAKISTAN Aerospace Information Research Institute （AIR） Chinese Academy of Sciences （CAS）	Online
126	JAN MUHAMMAD	Pakistan	Pakistan Meteorlogical Department	Online
127	Adnan Arshad	Pakistan	PODA-Pakistan	Online
128	Muhammad Imran	Pakistan	Sir Syed University of Engineering and Technology	Online
129	Hazrat Bilal	Qatar	Hamad Bin Khalifa University	Online
130	Fuad Azminuddin	Republic of Korea	University of Science and Technology Korea Institute of Ocean Science and Technology	Online
131	Mykyta Turko	Russia	Moscow Institute of Physics and Technology	Online
132	Vasilisa Koshkina	Russia	Moscow Institute of Physics and Technology （MIPT）	Online
133	Moaath Ghanem	Saudi Arabia	Hodaidah University	Online
134	Tasha Smith	South Africa	SOCCO CSIR	Online
135	KEMGANG GHOMSI Franck Eitel	South Africa	University of Cape Town Department of Oceanography	Online
136	ZAKIENA HOOSSEN	South Africa	UNIVERSITY OF WITWATERSRAND AND CSIR-SOCCO	Online
137	Md. Khurshid Alam Bhuiyan	Spain	University of Cadiz	Online
138	Gobishankar Sathiyamohnan	Sri Lanka	University of Peradeniya	Online
139	Kamal Aldien Alawad	Sudan	Sudan Meteorological Authority	Online
140	Estel Font	Sweden	Department of marine science University of Gothenburg Sweden	Online
141	Theo Spira	Sweden	University of Gothenburg	Online
142	Venugopal Reddy Thallam	Sweden	Uppsala University	Online
143	Bojara Asvakittimakul	Thailand	Kasetsart University	Online
144	Tachanat Bhatrasataponkul	Thailand	School of Marine Technology Burapha University	Online
145	Ophelie Meuriot	UK	Imperial College London	Online
146	Yao Meng	UK	University of Exeter	Online

Appendix C: Agenda

2nd CLIVAR-FIO Summer School on Ocean Macroturbulence and Its Role in Earth's Climate (Time Zone: GMT+8)

Time	Activities	Speaker/Chair
Monday 15 August 2022		
08:00-09:00	**Registration and testing of online platform**	
09:00-10:00	**Opening Ceremony**	**Chaired by Li Li**
09:00-09:05	Introducing the leaders and participants	**Li Li**
09:05-09:10	Opening remark from Ministry of Natural Resources	**Shengzhi Sun**
09:10-09:15	Opening remark from the World Climate Research Programme	**Mike Sparrow**
09:15-09:20	Opening remark from IOC-WESTPAC	**Somkiat Khokiattiwong**
09:20-09:30	Introduction to the CLIVAR-FIO Summer School series and ODC Center	**Fangli Qiao**
09:30-09:35	Introduction to the 2022 CLIVAR-FIO Summer School	**Jose Santos**
09:35-09:40	Logistic information	**Jing Li**
09:40-09:45	Courses opening	
09:45-10:00	Group photo	
10:00-10:30	**Training Lecture** Overview of science issues	**Walter Robinson**
10:30-10:45	**Discussion**	**Walter Robinson**
10:45-11:15	**Coffee break & Group photo**	
11:15-11:45	**Training Lecture** Statistical and Dynamical Analysis of Oceanic Mesoscale Eddies	**Changming Dong**
11:45-12:15	**Training Lecture** Mesoscale air-sea interaction: Impact of mesoscale SSTs on atmospheric weather patterns	**Xiaohui Ma**
12:15-12:30	**Discussion**	**Changming/ Xiaohui**
12:30-14:00	**Lunch**	
14:00-14:45	**Training Lecture** The Surface Wave Related Turbulence and its Key Roles in the Earth's Climate	**Fangli Qiao**
14:45-15:00	**Discussion**	**Fangli Qiao**
15:00-16:00	**Exercise:** Examine the local atmospheric response to mesoscale SSTs in the Kuroshio extension region	**Xiaohui Ma & Weiwei Ma**
16:00-16:30	**Coffee break**	
16:30-17:30	Participants lightning talks	**All students & teachers**

Tuesday 16 August 2022		
09:00-09:30	**Training Lecture** Evidence for dynamical upwelling of ocean eddy influence on the atmosphere	**Walter Robinson**
09:30-10:00	**Training Lecture** Mesoscale air-sea interaction: Upscaling mechanism from oceanic eddies to atmospheric storms	**Xiaohui Ma**
10:00-10:30	**Discussion**	**Walter/Xiaohui**
10:30-11:00	**Coffee break**	
11:00-12:00	**Training Lecture** Eddy-Resolving Global Ocean Prediction	**Changming Dong**
12:00-12:30	**Discussion**	**Changming Dong**
12:30-14:00	**Lunch**	
14:00-14:30	**Journal article discussion**	**Agostino Meroni**
14:30-15:00	**Training Lecture** EUREC^{4}A/ATOMIC overview and early result - EUREC^{4}A-OA	**Sabrina Speich**
15:00-15:30	**Training Lecture** EUREC^{4}A/ATOMIC overview and early result- ATOMIC	**Suneil Iyer**
15:30-15:45	**Discussion**	**Agostino Meroni**
15:45-16:45	**Exercise:** The influence of oceanic eddies on the overlying atmospheric wind speed and rain rate	**Changming Dong**
16:45-17:00	**Coffee break**	
17:00-18:00	**Research ideas 'speed dating'**	**All students & teachers**
18:00-18:30	**Voting for top 10 research ideas**	**All students & teachers**
Wednesday 17 August 2022		
07:30-09:00	**Depart from hotel**	**All students & volunteers**
09:00-12:00	**Site visit to FIO**	**All students & volunteers**
12:00-14:30	**Return to hotel & lunch**	**All students & volunteers**
14:30-15:00	**Training Lecture** *In situ* observations of eddies & eddy-atmosphere interaction	**Gwyn Evans**
15:00-15:30	**Training Lecture** The deformation and sub-mesoscale ageostrophic motion within mesoscale eddy in South China Sea	**Dongxiao Wang**

15:30-16:00	**Training Lecture** Satellite observation of eddies & eddy-atmosphere interaction-SeaSTAR	**Adrien Martin**
16:00-16:15	**Discussion**	**Gwyn Evans**
16:15-16:30	**Coffee break**	
16:30-17:30	**Exercise:** Work with Glider/Satellite data	**Gwyn/Dongxiao/Adrien**
17:30-18:30	**Work on Proposals**	**Groups**
21:00-22:00	**Evening online Q&A**	**Gwyn**
Thursday 18 August 2022		
09:00-10:00	**Training Lecture** Representation of ocean macroturbulence in GCMs	**Fangli Qiao**
10:00-10:30	**Discussion**	**Fangli Qiao**
10:30-11:00	**Coffee break**	
11:00-12:00	**Training Lecture** A global eddy-resolving ocean forecast system in China – LICOM Forecast System (LFS)	**Hailong Liu**
12:00-12:30	**Discussion**	**Hailong Liu**
12:30-14:00	**Lunch**	
14:00-14:30	**Journal article discussion**	
14:30-15:15	**Training Lecture** Role of ocean macroturbulence in climate simulation and prediction, projection----Ideas from FIO-ESM	**Zhenya Song**
15:15-15:30	**Discussion**	**Zhenya Song**
15:30-16:00	**Coffee break**	
16:00-17:30	**Exercise** A diagnostic toolkit for the impact of ocean model resolution	**Yiwen Li**
17:30-18:30	**Work on Proposals**	**Groups**
Friday 19 August 2022		
09:00-09:45	**Training Lecture** Meso- and submeso-scale eddy dynamics and biogeochemical processes and the impact on heat and carbon transport	**Annalisa Bracco**
09:45-10:30	**Training Lecture** Contribution of meso-/submeso- scale eddies to marine extreme events	**Ivy Frenger**
10:30-11:00	**Coffee break**	
11:00-11:30	**Discussion for Ivy's talk**	**Ivy Frenger**
11:30-12:15	**Training Lecture** Physical/biological interactions at	**Alice della Penna**

	meso/submeso scales and its implication for decision makers	
12:15-12:30	**Discussion for Alice's talk**	**Alice della Penna**
12:30-14:00	**Lunch**	
14:00-14:30	**Journal article discussion**	**Alice della Penna**
14:30-15:00	**Breakout discussion:** Identifying knowledge gaps in understanding of the phy/biological process with societal relevance	**Alice/Ivy**
15:00-15:30	**Coffee break**	
15:30-17:00	**Exercise** Marine predators in a turbulent ocean	**Alice/Ivy**
17:00-18:00	**Work on Proposals**	**Groups**
21:00-22:00	**Evening online Q&A**	
Saturday 20 August 2022		
09:00-11:00	**Proposal presentations (10 mins each group + 5 mins discussions)**	**Groups**
11:00-11:30	**Coffee break**	
11:30-12:00	**Closing ceremony**	

Appendix D: Group research proposals

In person Group 1: Warm Eddies induced Marine Heatwave and its impacts on Genesis of Super Typhoon Hato (T. E. Oginni, P. Chu, Z.F. Mtewele, L. Wang)

In person Group 2: Asymmetric Impacts of El Niño and La Niña on Mesoscale Eddies in the North Indian Ocean (D. Mbigi, X. Li, X. Wang, G. Li).

In person Group 3: The sensitivity of the path of the Kuroshio Extension for different resolutions of numerical model (Y. Wu, J. Ren, A. Eghosa, X. Wang, Y. Huang, B. Liu)

In person Group 4: The Evolution of Indo-Pacific Warm Pool and Its Impacts on Asia-Africa Climate in Past Decades (E. Eresanya, J. Xie, L. Huang, C. Liu, A. Omondi)

Online Group 1: (1) Seasonal variation of Mesoscale Eddies in the BoB and its relationship with South East Asian Monsoon (R. Firdaus, T.O. Kyaw, G. Rosales, K. Li, Z. Xuan, Z. Zhang)

(2) Interactions of Myanmar Winter Rainfall with The Oceans Temperature and Mix Layer Depth (T.O. Kyaw)

Online Group 2: Regional Characteristics of Surface Mesoscale Eddies around The Northwest Pacific (F. Azminuddin, H. Wang, F. Herman, P. Lian, T. Li, A. Arshad, T. Bhatrasataponkul, V. Chinta, T. Ma)

Online Group 3: Correlation between Eddy Track and Large Scale Circulation (Y. Lan, X. Chen, Y. Gong, Z. Li, H. Miao, P. Punya, G. Sathiyamohnan, H. I. Ratnawati)

Online Group 4: Impact of mesoscale eddies on ENSO (T. L. Nomenjnahary, P. Fernández)

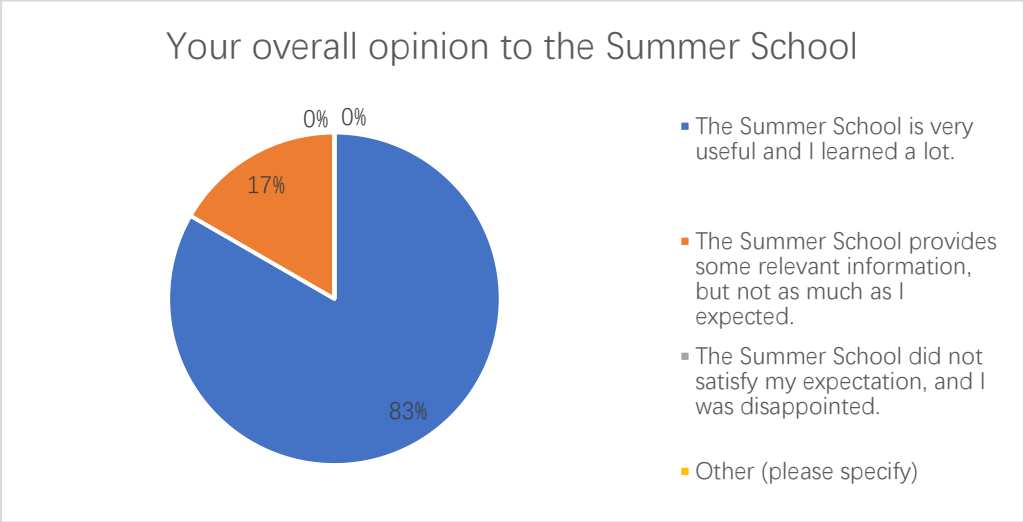
Online Group 6: Climatological to daily influence of mesoscale eddy field on air-sea heat fluxes in the Arabian sea and their ventilation potential (E. Font, T. Spira)

Online Group additional: Development of Nested Lagrangian Particle Model (W. Dong, H. Gao, F. Teng, Z. You, Q. Cao, S. Chen, W. Xie, J. Xue, Y. Yang, Z. Wang, Y. Wang, Y. Jin, L. Lin, M. Fu, C. He, X. Shen)

Appendix E: Feedback on CLIVAR-FIO Summer School

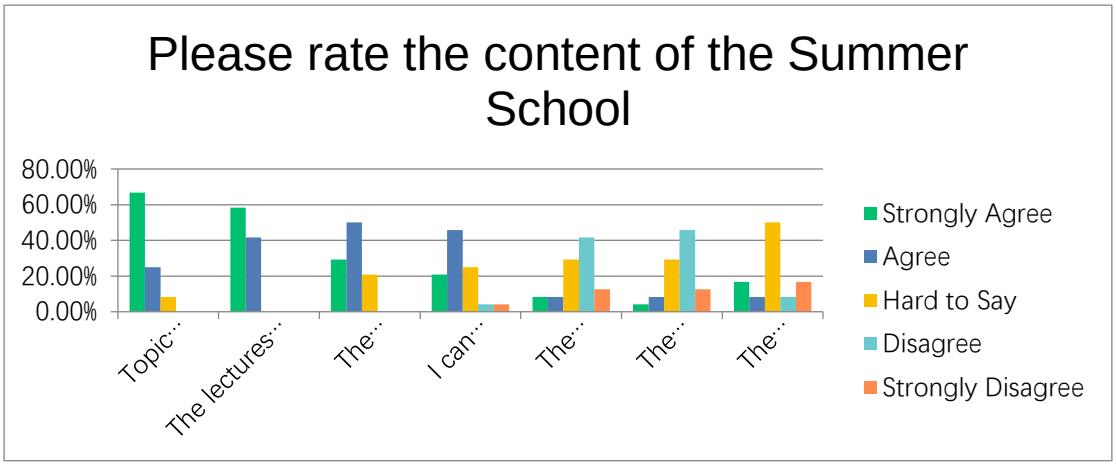
1. Your overall opinion to the Summer School:

Answer Choices	Responses
The Summer School is very useful and I learned a lot.	83.33%
The Summer School provides some relevant information, but not as much as I expected.	16.67%
The Summer School did not satisfy my expectation, and I was disappointed.	0.00%
Other (please specify)	0.00%



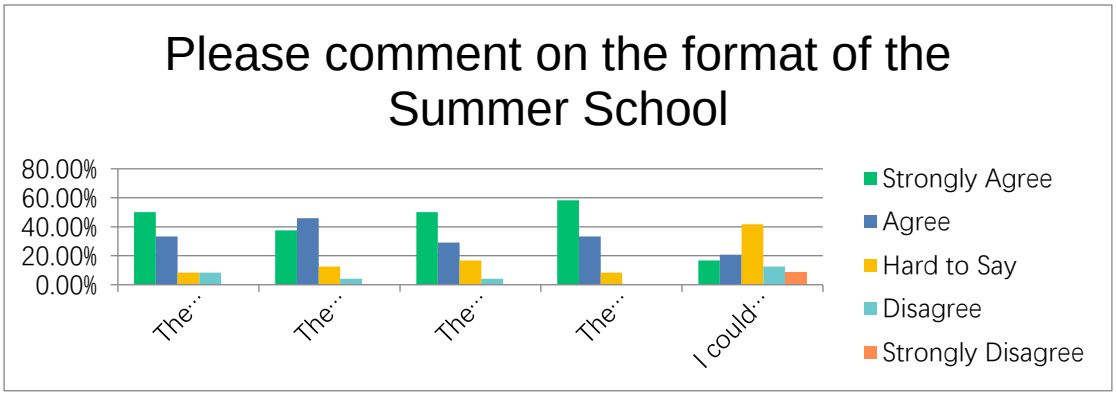
2. Please rate the content of the Summer School

	Strongly Agree	Agree	Hard to Say	Disagree	Strongly Disagree
Topic coverage and relevance were satisfactory.	66.67%	25.00%	8.33%	0.00%	0.00%
The lectures were well prepared.	58.33%	41.67%	0.00%	0.00%	0.00%
The exercises were well prepared and clearly instructed.	29.17%	50.00%	20.83%	0.00%	0.00%
I can complete the exercises with the instructions provided by lecturers.	20.83%	45.83%	25.00%	4.17%	4.17%
The contents of the lectures were too difficult for me.	8.33%	8.33%	29.17%	41.67%	12.50%
The contents of the exercises (D1, D4 & D5) were too difficult for me.	4.17%	8.33%	29.17%	45.83%	12.50%
The homework (D1 & D2) was too difficult for me.	16.67%	8.33%	50.00%	8.33%	16.67%



3. Please comment on the format of the Summer School

	Strongly Agree	Agree	Hard to Say	Disagree	Strongly Disagree
The pre-recorded lectures are useful and I watched them before the courses.	50.00%	33.33%	8.33%	8.33%	0.00%
The livestream was useful and smooth.	37.50%	45.83%	12.50%	4.17%	0.00%
The archived recordings are useful and timely uploaded, and I watched them after the class.	50.00%	29.17%	16.67%	4.17%	0.00%
The programme page was timely updated, and I could always find the information I need in the page easily.	58.33%	33.33%	8.33%	0.00%	0.00%
I could easily download the files from the cloud drive used by the summer course.	16.67%	20.83%	41.67%	12.50%	8.33%



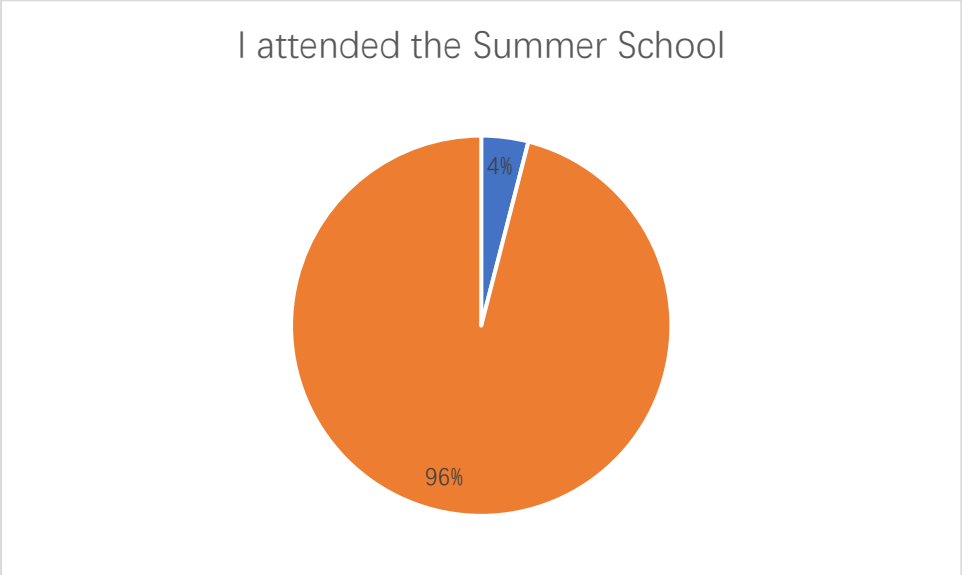
4. What do you think about the distribution of lectures, discussion, exercise and Q&A sessions?

I think it is reasonable.
There were too many lectures that limited the time allocated for completion of exercises, which led to working till late nights or even during some lecture sessions

lowering fully participation.
There are too many exercises，plot by data needs long time. As to group work, I can’t contact with them. There is little response.
There are too many things to learn and too much software to install. Consider using online software such as Google Colab to release the burden of installing software.
I think the distribution of instructors, exercises, and Q&A is very good and structured. Thank you
very good
Adequate
It was well distributed, enough time for the discussion and question
The Timing is not conducive for me to attend. I tried attending the first two classes which resulted to serious sickness for me which I was unable to continue with the classes. Subsequent program should try to balance things up regarding the online students. My expectations Is that I'll be put through latest development and introduced to new software and script. I want to use this opportunity to thank the organisers but the online students should be part of their consideration in the next programme.
While the lectures were well planned out, the exercises were a bit difficult considering that most of the participants are from different backgrounds in Ocean science and some do not have programming skills, e.g. Python.
all good
All are best and distribution way of materials are very easy to download through provided link.
Don't have enough time to play with exercises. As I am doing my job and concentrations on this at the same time. Summer school should give more support for online participants as well. For me I couldn't done my exercises because of the larger files and inadequate time schedule, but I attended all the courses.
All is good, they're provided and distributed very well but sometimes there are some materials were difficult to downloaded cz it’s too large
The arrangement of the program are ok, but some lecture have limited time.
It's very well structured~
Fair
GREAT
Maybe the morning lectures can start some time ahead to leave enough time for lunch and nap time
Good
It was good enough for me. I’m satisfied!
The distribution of lectures, discussions, and Q & A was good enough. But the exercise methods could be done in python.
The homework and exercise should be given sample one and then make questions similar.
The course is a bit compact. May arrange more discussion time in the future.

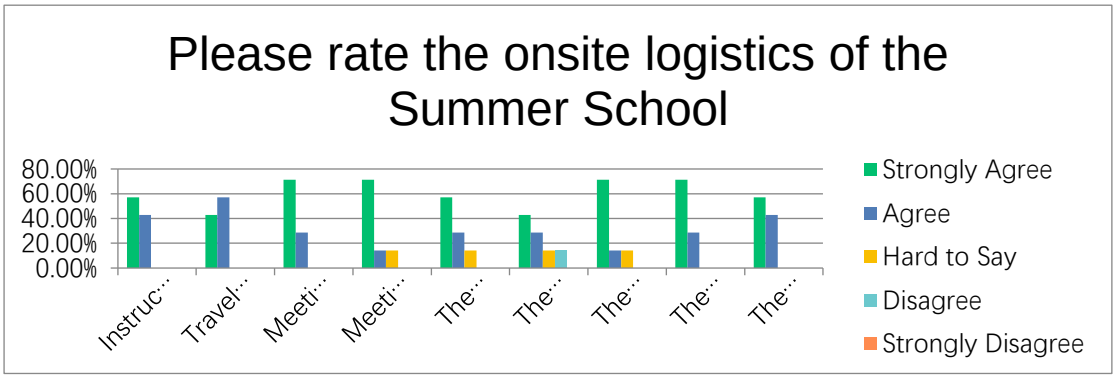
5. I attended the Summer School

	Responses
In-person	29.17%
Online	70.83%



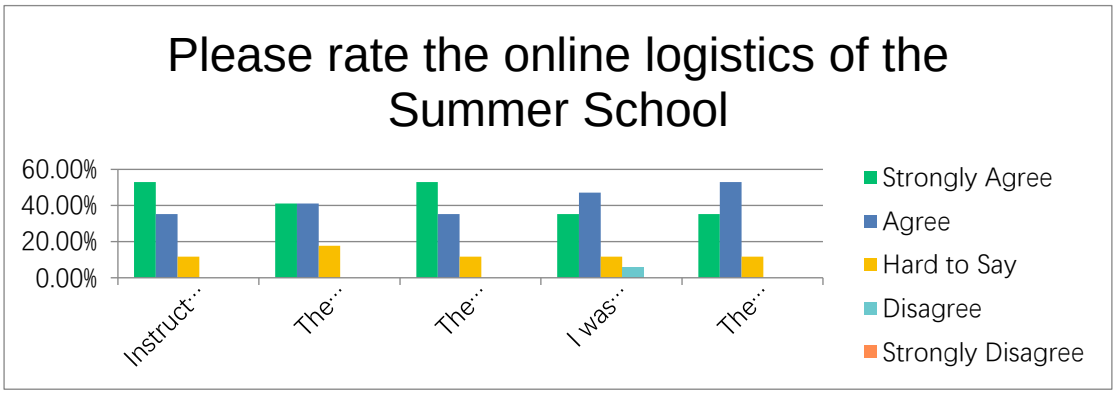
6. Please rate the onsite logistics of the Summer School

	Strongly Agree	Agree	Hard to Say	Disagree	Strongly Disagree
Instructions provided before/during the Summer School were clear and timely.	57.14%	42.86%	0.00%	0.00%	0.00%
Travel and accommodation were well arranged.	42.86%	57.14%	0.00%	0.00%	0.00%
Meeting room facilities were satisfactory for smooth interaction with participants.	71.43%	28.57%	0.00%	0.00%	0.00%
Meeting room facilities allow smooth interaction with online participants.	71.43%	14.29%	14.29%	0.00%	0.00%
The site visit was well organized.	57.14%	28.57%	14.29%	0.00%	0.00%
The food was delicious and timely provided.	42.86%	28.57%	14.29%	14.29%	0.00%
The WeChat group was useful, I could find required information in a timely manner.	71.43%	14.29%	14.29%	0.00%	0.00%
The staff and volunteers were friendly and able to address my requests.	71.43%	28.57%	0.00%	0.00%	0.00%
The onsite technical support was efficient.	57.14%	42.86%	0.00%	0.00%	0.00%



7. Please rate the online logistics of the Summer School

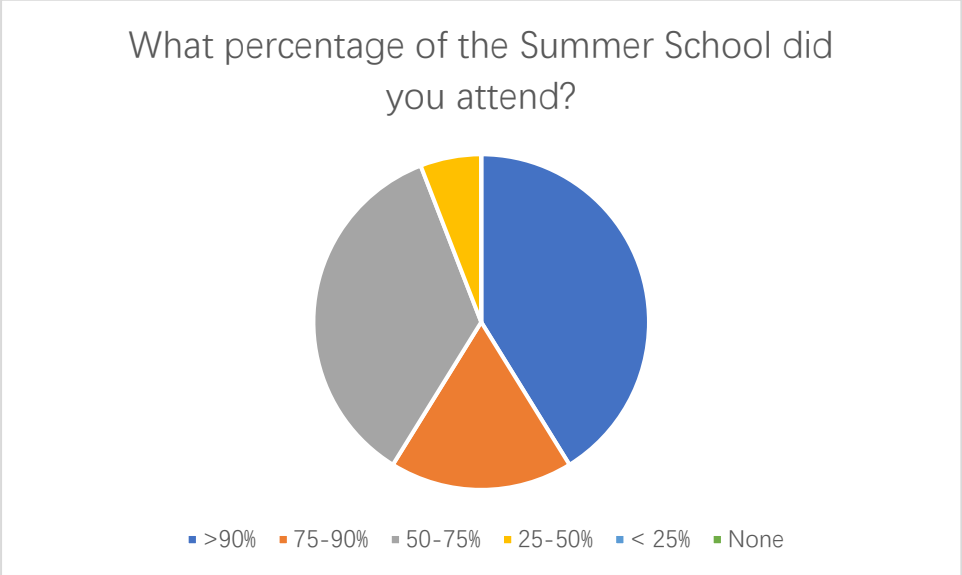
	Strongly Agree	Agree	Hard to Say	Disagree	Strongly Disagree
Instructions provided before/during the Summer School were clear and timely.	52.94%	35.29%	11.76%	0.00%	0.00%
The technical support and troubleshooting were timely and efficient.	41.18%	41.18%	17.65%	0.00%	0.00%
The meeting platforms (Zoom and SLACK) were easy to connect and use.	52.94%	35.29%	11.76%	0.00%	0.00%
I was able to raise my questions, share my viewpoints and interact with onsite participants via chat box in Zoom and SLACK.	35.29%	47.06%	11.76%	5.88%	0.00%
The SLACK channels are well-arranged and I can find the information needed.	35.29%	52.94%	11.76%	0.00%	0.00%



8. What percentage of the Summer School did you attend?

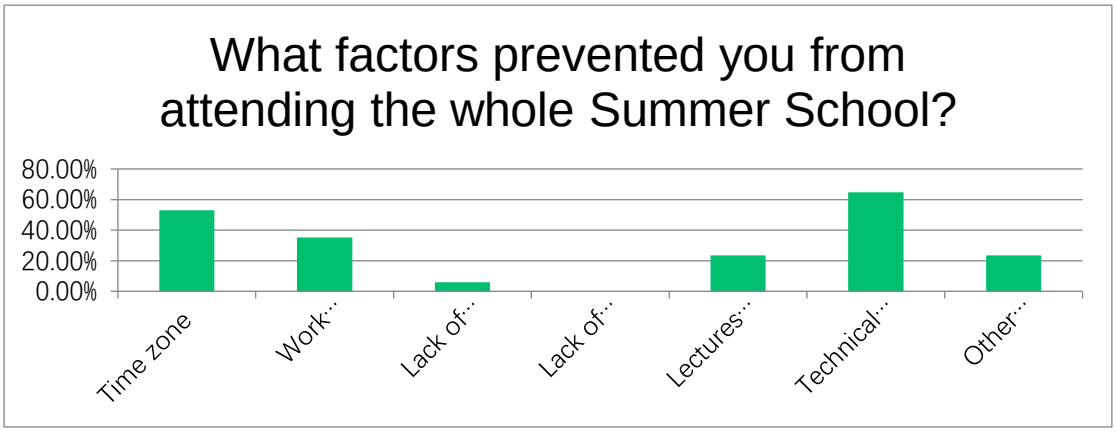
	Responses
>90%	41.18%
75-90%	17.65%
50-75%	35.29%
25-50%	5.88%

< 25%	0.00%
None	0.00%



9. What factors prevented you from attending the whole Summer School?

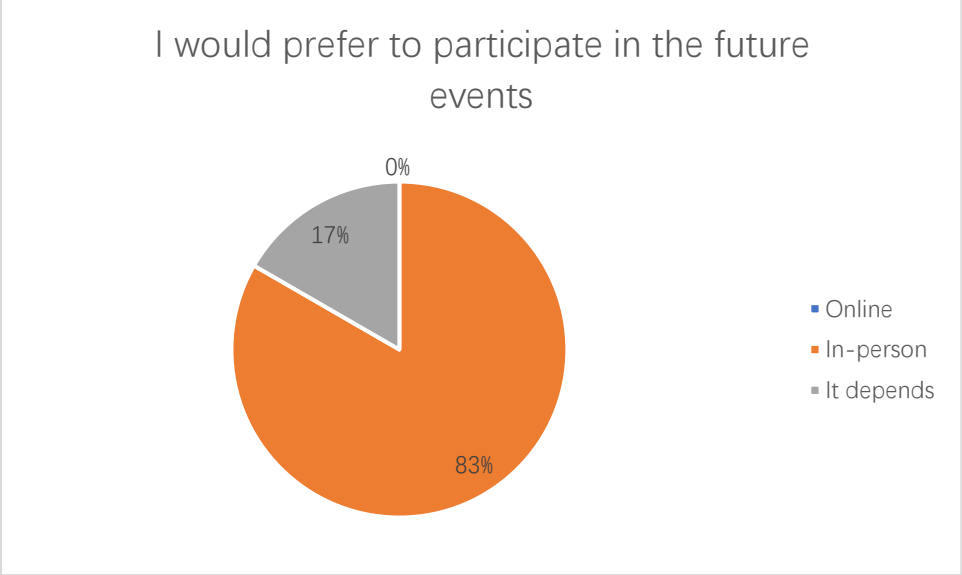
	Responses
Time zone	52.94%
Work commitments	35.29%
Lack of relevance	5.88%
Lack of interest	0.00%
Lectures were too difficult to understand	23.53%
Technical issues (e.g., poor internet connection)	64.71%
Other (please specify)	23.53%
	No group mates response
	Downloading the larger files. Should have sent this week before to be ready.
	DATA SO HEAVY
	N/A



10. I would prefer to participate in the future events

	Responses

Online	0.00%
In-person	83.33%
It depends	16.67%



11. What is the most interesting/useful thing you've learnt during the Summer School?

The Matlab and python analysis
The role of surface waves and (sub) mesoscale eddies in ocean macro-turbulence, as well as scripting with multiple programming languages
I can use the raw GOMAT data and code some scripts. I learned some of multi scales interaction.
the trajectory of eddies
Eddies are important and play important role in many aspects
Everything was very interesting for me
Usage of Python for Ocean observation and prediction
A good recap of basics that I forgot/did not know since I transferred into this field.
The interesting part is the exposure to new areas of research. Areas that I can venture into and dig more into those research area shown. But I prefer the summer school should organise more training that will expose students to softwares and programming languages that will aid the students in carrying out Research.
Most importantly, the significance of eddies in air-sea interaction, particularly in ocean circulation.
many scientific thoughts
All presentations are very fruitful to provide lot of knowledge. Thanks to provide such nice training for us.
physical oceanography lectures
I like how Prof. Hong taught; he was so spiritfull
Eddies and its vertical variation, MLD dynamics
Mesoscale eddies and its influence on climate through atmosphere ocean interaction.
The key role of the MLD, eddies.
Lectures from academic leaders.
improve my English ability
GOMEAD is an amazing dataset, probably I will use it in further work.
Being able to interact with various experts and participants

Things about the eddy tracking.
New ocean analysis techniques.
The lectures on Day 5 with the linkage to biogeochemical community and social relevance.

12. What topic(s) would you propose for future capacity building activities?

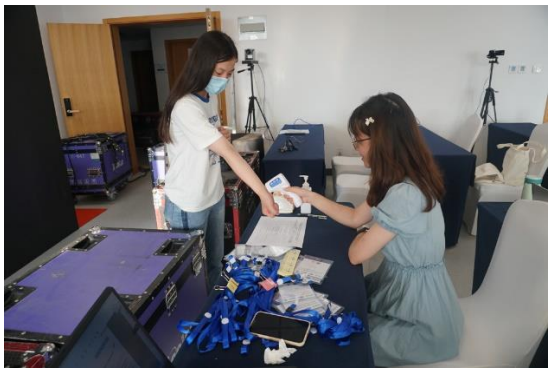
the typhoons-related study
"1. Acquiring and analysis of CMIP(6) model datasets to examine projected climate conditions. 2. Downscaling of general circulation models to regional circlation models."
About group work. It has too many difficulties.
the reception part is not pleasant, consider providing full information about how we check in before we arrive
Sea Level Variability
Ocean Macroturbulence and Its Role in Earth’s Climate
Usage of Python for Ocean observation and prediction
How the atmosphere affects the ocean (this course had a lot of how the ocean affect the atmosphere)
"Coastal erosion and flooding, causes and solutions. Because that's the major problem we are facing in my country"
Simplified Modules to teach from scratch ocean modeling, and sediment transport.
much harder
Majority of topics will be used for the future capacity building activities
Atmospheric sciences
Coastal flood and its roles
More interdisciplinary topic
The topic should focus on extreme events like floods/cyclones/hurricanes/typhoons.
Modelling eddies
Qiao's topic, for example, The Surface Wave Related Turbulence and its Key Roles in the Earth's Climate.
I have no idea now
N/A
Particle tracking method in Oceanic and Atmospheric Sciences
I propose the topic of the interaction of cyclones with oceanic eddies for future capacity-building activities.
The Interaction of Atmospheric and Ocean for future Climate Prediction
More cross-cutting topics with the consideration of different background of trainees, and more relevant to practitioners.

13. Do you have any further comments on the Summer School that you would like to share?

I prefer to apply the Summer School in-person if I have the chance in the future.
Increasing the number of onsite trainees to enhance fully participation on the summer school and trainees networking.
Best regards.
no
just to say congratulation for the team
In person participation allow full concentration and focus on the workshop and enhance full interaction. Capacity development and participation
It was great to attend the school, very interesting topics (maybe not as relevant to my work) and gives me a view of other research.

Must be conduct this types trainings in-site instead of online.
Please give more time to online participation. I have attended more than 90 percentage of lectures. If the certificate/ award is not provided, it is not worth my time. Over all the summer is satisfactory when considering the contents.
It was well organise and gave opportunity to make new friends in my field. I appreciate all the organisers and lecturer.
"The summer school (SS) should be all (Global) inclusive. Evidently, lecturers representation was 'biased'. Africa and some Global parts were not represented. The hands on section should follow the style for Dr. Yiwen Li where trainees are guided through from installation to using the tool, diagnosing and such. The trainees should also be informed to install tools like Python, Matlab, R , Ferret, IDL. This will make it easy to practice the exercises and move together as a group. If possible, detailed installation guide/steps/links with detailed COMMENTS in the script/code like Prof. Alice della Penna. I hope future SS will be insightful. Gratitude to all who took part to make the SS a success. Thanks."
I hope there will be a chance for me to continue the next year courses.
N/A
I enjoyed the summer school, but it will be better if the schedule is not too tight. It can be a two-week summer school program.
Nil

Appendix F: Photo Gallery




Registration

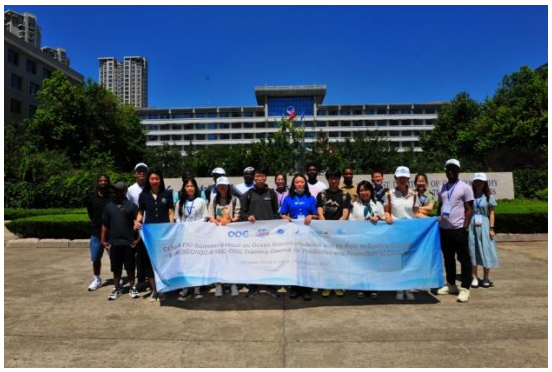

Opening Ceremony of the Summer School

Interaction between trainees and lecturers

Online and onsite interaction



Group discussion and exercise





Site visit to FIO