SOUTHERN OCEAN OBSERVING SYSTEM

Report Series

Report on the Southern Ocean Modelling Workshop: Status and Observational Data Requirements

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Report on the Southern Ocean Modelling Workshop: Status and Observational Data Requirements

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SOUTHERN OCEAN OBSERVING SYSTEM

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Introduction and Workshop Aims:

The Southern Ocean has profound influences on global ocean circulation, planetary-scale biogeochemical cycles and ecosystems, and the Earth's climate. Limited observations suggest that the Southern Ocean is experiencing detectable changes. However, because of the harsh conditions, the vastness and remoteness, in situ observations of the Southern Ocean are extremely expensive and difficult to attain. Therefore, an efficient Southern Ocean observing system is critical to delivering the observations required for understanding and predicting the Southern Ocean variability.

With the revolution in observational technology over the past several decades, the maturing of ocean modelling, and the power of our knowledge of dynamical systems theory, it is now important to combine efforts from different nations to advance understanding the role of the Southern Ocean in the climate system. To best utilise the new developments and resources, a Southern Ocean Observing System (SOOS) modelling workshop was held at the Second Institute of Oceanography (SIO), State Oceanic Administration (SOA), Hangzhou, China on 7-8 May 2018. The 36 participants included Earth System, polar and Southern Ocean modelers from China, international observers and the SOOS Scientific Steering Committee.

The aims of the workshop were to bring together the SOOS modelling and scientific community and enhance collaboration with Chinese researchers. Specific objectives include:

- Provide an overview of current status of modelling efforts in China and in specific Southern Ocean disciplinary areas.
- Identify an initial list of observational gaps for modelers, across disciplines, to better communicate model□data requirements to SOOS community.
- To identify next steps required for moving forward with regional observing system design.
- Determine synergies with other groups, including assessment of what can be leveraged from Chinese Arctic research activities.
- Stimulate collaboration between modelling and observational groups to best utilise resources.

The workshop consisted of three sessions:

- Review of the status of physical modelling capabilities for the Southern Ocean. (Convenor: Fei Chai)
- Biogeochemistry and ecosystem modelling (Convenor: Matthew Mazloff)
- Data-modelling synergy (Convenor: Andrew Constable)

A primary outcome was enhancement of Southern Ocean research collaboration between China and other nations. In particular, a vision emerged of how Chinese observational and modelling efforts can assist SOOS working groups and task teams in achieving their goals.

Summary of Key Points:

The Southern Ocean modelling community in China is relatively small at present; however China plans to expand the Southern Ocean and Arctic Ocean observing systems, and enhance modelling capabilities over the next decade. This workshop provided an opportunity for enhanced research collaboration between Chinese and the international Southern Ocean research community, and also an opportunity for polar synergies, in leveraging from Chinese Arctic research activities.

Through presentations and discussions from the three sessions, workshop participants showed support for the development of inter-disciplinary modelling that includes physical, biogeochemical, and ecological components. Workshop participants also supported expanding platforms, including biogeochemical-Argo (BGC-Argo) float and glider observation, and discussed the need to enhance synergy of these platforms with other components of the Southern Ocean observing system, including satellite observations. The coupled observing approach will benefit the extent of our knowledge about Southern Ocean changes. Key points of outcomes from the workshop focused on three parts:

- The community must address the following pressing problems using both models and observations:
  - Buoyancy and momentum fluxes are uncertain, and are necessary at high-frequency.
  - Ocean mixing is poorly represented in models, and is necessary for accurately reflecting physics and ecosystems.
  - The Southern Ocean lower overturning cell and Antarctic Bottom Water formation is not well understood, and poorly represented in models.
- Regarding design of the SOOS:
  - Models should be used to prioritise how and where to measure, and to focus design.
  - How to best use the SOOS data for modelling and assimilation, and also how to best engage the modelling community in order to receive feedback on further improving the observing system?
  - How to incorporate use of models for addressing broader community needs?
- SOOS must continue to foster collaboration among different groups present at workshop:
  - Collaborations on well-designed model inter-comparisons facilitate model development and technology transfer.
  - Communication between researchers utilising a variety of models are mutually beneficial. The model diversity spans global, circumpolar, and regional with a variety of components (e.g., ice shelves, biogeochemical cycles, ecology) and complexity.
  - It is vital to utilise both data and models. Data assimilation products should be made available with easy access. Model validation should be made available. Shared software packages for comparing data and models will facilitate advancement.

Priority recommendations to achieve future vision:

Recommendations from the workshop mainly focused on three issues:

(a) Identifying the needs for better interdisciplinary ocean modelling

The needs for better understanding of physical and ecosystem processes have been identified for SOOS. In the future,

- It is recommended that biogeochemistry and ecosystem modelers fully engage with the Earth-system modelling process. Their needs must be communicated to physical modelers.
- It is recommended that modelers document what observations best constrain the model solutions and inform how to reduce model biases and errors, and consider all categories of observations and products (e.g., may recommend surface wave measurements, mixing measurements, assimilated products).
- It is recommended that the science community communicates priorities to guide modelling development and improvement needs. For example, what are priority needs for representations of habitat and species.

(b) Developing data quality control procedures and data-model fit software

In order to use ocean observation data efficiently and apply them for model inter-comparison, it is recommended:

- To develop model-based semi-automated data quality controls procedures. This is a pathway towards efficient and uniform data quality.
- To develop a data-model fit software resource. This facilitates adoption of best practices in data use, including usage of data in less process formats (e.g. radiative transfer functions). This also facilitates robust validation in Model Intercomparison Projects (MIPs). It is recommended that the data-model fit software resource have different tiers: (1) raw data (2) derived parameters (3) gridded products.

(c) Designing and Performing Observing System Simulation Experiments

Observing System Simulation Experiments (OSSEs) utilise the methods of data assimilation to investigate the impacts of current and future observing systems. They are a powerful tool to optimise mooring locations, identify gaps in the existing observational programs, and assess the value of planned observing systems for predictions. To develop an OSSEs for SOOS:

- It is recommended that the community identify or produce so-called “nature runs”, which are model solutions that reproduce the majority of the spectrum of ocean processes. This allows valuable and robust OSSEs. The OSSE value depends on processes captured by “nature run”. It is recommended that SOOS advise on observations (e.g., moorings, BGC-Argo, and gliders) and procedures for validating statistics of the “nature run”.

Sponsorship for the workshop was provided by SOOS, the Australian Research Council’s Antarctic Gateway Partnership, State Key Laboratory of Satellite Ocean Environment Dynamics (SOED), the Second Institute of Oceanography (SIO), Institute of Oceanography, Shanghai Jiao Tong University, and College of Oceanography, Hohai University.

Appendix 1: Workshop Program

MONDAY 7th MAY 2018		6th FLOOR MEETING ROOM ADMINISTRATIVE BUILDING, SIO
Time	**Topic**	**Presenter**
09:00 - 09:10	Opening and welcome	Fei Chai
SESSION 1 - REVIEW THE STATUS OF PHYSICAL MODELLING CAPABILITIES FOR THE SOUTHERN OCEAN CONVENOR: FEI CHAI		
09:10 - 09:40	Southern Ocean Modelling: past and future intercomparisons, advances and persistent problems	Riccardo Farneti
09:40 - 10:00	Mesoscale eddies in the Southern OCean: upgradient transport, anisotropic diffusivity, and its relation with topography	Jianhua Lu
10:00 - 10:20	Impact of synoptic atmospheric forcing on the mean ocean circulation	Yang Wu
10:20 - 10:50	*Group Photo followed by Morning Tea*	
10:50 - 10:10	Decadal change of the Antarctic Intermediate Water	Xiaoyi Yang
11:10 - 11:30	Mean, variability and trend of Southern Ocean wind stress: role of wind fluctuations	Xia Lin
11:30 - 12:30	Discussion	
12:30 - 14:00	*Lunch*	
SESSION 2 - BIOGEOCHEMISTRY AND ECOSYSTEM MODELLING CONVENOR: MATTHEW MAZLOFF		
14:00 - 14:20	Pathways and retention times to a biologicall productive canyon on the West Antarctic Peninsula	Oscar Schofield
14:20 - 14:40	Scaling biological models for projecting ecosystem change in the Southern Ocean: an ensemble approach to facilitate collaboration	Andrew Constable
14:40 - 15:00	BGC-Argo and physical-biogeochemical modelling	Fei Chai
15:00 - 15:20	NAPA development and its application to bio-physical coupled Arctic carbon cycling model	Hao Wei
15:20 - 15:40	*Afternoon Tea*	
15:40 - 16:00	Impact of icebergs on net primary productivity in the Southern Ocean	Shugui Hou
16:00 - 16:20	Atmospheric-Marine biogeochemical processes of carbon, nitrogen, sulfur, and iron as well as their air-sea fluxes modelling in the Soutehnr Ocean	Liqi Chen
16:20 - 16:40	“Biological Pump” and its response to changes in sea ice in the Prydz Bay, East Antarctica	Zhenging Han
16:40 - 17:30	Discussion	
18:00 - 20:00	*Workshop Dinner*	

TUESDAY 8th MAY 2018		6th FLOOR MEETING ROOM ADMINISTRATIVE BUILDING, SIO
Time	**Topic**	**Presenter**
SESSION 3 - DATA-MODELLING SYNERGY		CONVENOR: ANDREW CONSTABLE
09:00 - 09:20	Chinese progress of coupled ice-ocean numerical modelling and related observations in the Southern Ocean	Jiuxin Shi
09:20 - 09:40	Data assimilation and the Southern Ocean Observing System	Matthew Mazloff
09:40 - 10:00	The development of LICOM from CMIP5 to CMIP6 and the preliminary evaluation in Southern Ocean	Pengfei Lin
10:00 - 10:20	Year of Polar Prediction - Southern Hemisphere (YOPP-SH): A brief introduction	Qinghua Yang
10:20 - 10:50	*Morning Tea*	
10:50 - 11:10	The role of surface waves in ocean modelling	Qi Shu
11:10 - 11:30	Sea ice parameter retrieval with active and passive satellite remote sensing	Shiming Xu
11:30 - 12:30	Discussion	
12:30 - 13:30	*Lunch*	

Appendix 1: List of Participants

Name	Affilation
Beja, Joana	British Oceanographic Centre
Bricher, Phillippa	SOOS International Project Office
Buesseler, Ken	Woods Hole Ocenaographic Institution
Chai, Fei	Second Institute of Oceanography, SOA
Chen, Dake	Second Institute of Oceanography, SOA
Chen, Jianfang	Second Institute of Oceanography, SOA
Chen, Liqi	Third Institute of Oceanography, SOA
Coleman, Richard	University of Tasmania
Constable, Andrew	Australian Antarctic Division
Diggs, Steve	Scripps Institution of Oceanography
Farneti, Riccardo	CLIVAR/CLiC/SCAR Southern Ocean Region Panel; International Centre for Theoretical Physics
Han, Zhengbing	Second Institute of Oceanography, SOA
Henley, Sian	University of Edinburgh
Hou, Saisai	Ocean University China
Hou, Shugui	Nanjing University
Lee, Sang Hoon	Korean Polar Research Institute

Lin, Pengfei	Institute of Atmospheric Physics, Chinese Academy of Sciences
Lin, Xia	Nanjing University of Information Science and Technology
Liu, Hailong	Institute of Atmospheric Physics, Chinese Academy of Sciences
Lu, Jian Hua	Sun Yat-sen University
Mazloff, Matthew	Scripps Institution of Oceanography
Newan, Louise	SOOS International Project Office
Pei, Yuhua	SOOS International Project Office; Second Institute of Oceanography, SOA
Schloss, Irene	Instituto Antárctico Argentino
Schofield, Oscar	Rutgers University
Shi, Jiuxin	CLIVAR/CLiC/SCAR Southern Ocean Region Panel; Ocean University of China
Shu, Qi	First Institute of Oceanogaphy, SOA
Swart, Sebastiaan	University of Gothenburg
Waite, Anya	Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research
Wei, Hao	Tianjin University
Williams, Michael	National Institute of Water and Atmospheric Research Ltd
Wu, Yang	Hohai University
Xu, Shiming	Tsinghua University
Yang, Qinghua	Sun Yat-sen University
Yang, Xiaoyi	Xiamen University
Zhao, Liang	Tianjin University of Science & Technology

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