



Respiration in the Mesopelagic Ocean (ReMO): Reconciling ecological, biogeochemical and model estimates

SCOR Working Group 161 2022-2023

1. Brief summary with the main highlights (200-300 words)

We have held 10 online WG meetings at approximately monthly intervals between June 2022 and June 2023, in addition to focused subgroup meetings to progress particular deliverables. The monthly meetings include a seminar which is recorded and made available via our website and YouTube channel <https://www.remo-scor-wg161.com/about-3> Our mentoring scheme continues to thrive <https://www.remo-scor-wg161.com/copy-of-home> and discussions within the WG have contributed to 2 review papers published in Annual Review of Marine Science ([Herndl et al., 2023](#) and [Iversen, 2023](#)). Our major activity this year has been a 6 day training course in Las Palmas, Gran Canaria for 10 international early career researchers in person and another 29 students online. This involved hands-on practical experience of methods used to measure mesopelagic respiration, seminars on using BGC Argo data, calculating AOU budgets and using models and 8 lectures. The course instructors included 12 members of the WG and 4 members of the research teams of the WG members. Lecture recordings, the Argo data seminar and the AOU budget seminar are available online <https://www.remo-scor-wg161.com/about-8>.

2. Activities since previous report to SCOR (e.g., virtual or in-person meetings, email discussions, special sessions). Limit 1000 words

We continue to hold online meetings at approximately monthly intervals. The membership spans 21 time zones and so we hold duplicate meetings at 08:00 UTC on the last Thursday of every month and at 19:00 UTC on the following Monday. These meetings are recorded for anyone who cannot attend, they last for up to 2h and they each focus on a particular task or tasks and include progress updates from the co-leaders of each task. We have held 10 such meetings between June 2022 and June 2023.

Alongside these meetings, we host a monthly seminar series. The seminars are given by WG members or members of the research teams of the WG members, they are recorded and available to the wider research community through our website and our YouTube channel <https://www.remo-scor-wg161.com/about-3>

We have also held additional online meetings for subgroups within the WG to progress particular deliverables including the training course, intercomparison exercise, position paper, modelling paper and the mentoring scheme. We continue to use a Google site for all working group documents.

We held a 3-day hybrid annual meeting in Las Palmas de Gran Canaria, Spain in May 2023 where we spent up to 2 hours discussing the progress of each of the deliverables, in particular structuring a review paper, best methods manual, paper for young people, global dataset and data paper.

Alongside this annual meeting, we held a 6 day training course for 10 international early career researchers (from France, Denmark, Spain, India, and the USA) and 29 online students (from Xiamen, Shandong, Shanghai Ocean, Tongji, Shanghai Jiao Tong and East China Normal Universities and the Ocean University of China in UTC+8 time zone). The teaching activities included lectures, hands-on practical sessions with analytical methods, and data exercises with models, budgets and BGC Argo data. The students then undertook a team project comparing two different approaches to determine mesopelagic respiration that they had learnt during the week, and gave a presentation on their results. The students were mentored before and during the training course and one of their tasks is to give a presentation or practical training session to their colleagues at their host institution in order to pass on the knowledge they have gained.

At the beginning of 2022 we launched a ReMO mentoring scheme to encourage exchange of expertise and establish international collaborations between WG members and early career researchers. Four mentees (Josué Villegas Mendoza, México; Saumya Silori, India; Jordan Toullec, France and Yi Xu, China) are now paired with WG mentors and progressing their collaborative objectives. These include progressing data interpretation, learning and setting up the facilities for a new analytical method and progressing a fellowship proposal. We had a second call for applications in December 2022, and two further mentees (Yang Xiang, USA and Yixue Zhang, China) are now paired with WG mentors and we are discussing the potential to continue to mentor at least some of the attendees at the training course.

Members of the WG have given a range of presentations at national and international conferences and workshops which have mentioned the work of the WG. These include the UK Challenger Society for Marine Science conference 2022 and the ASLO Aquatic Sciences Meeting in 2023.

3. Documents published since previous report to SCOR (e.g., peer-reviewed journal articles, reports, Web pages) and should be limited to publications that resulted directly from WG activities and which acknowledge SCOR support

ReMO activities were acknowledged in two manuscripts published in 2023 in the Annual Review of Marine Science : ([Herndl et al., 2023](#) *Prokaryotic life in the deep ocean's water column* and [Iversen, 2023](#) *Carbon export on the ocean: A biologist's perspective*) and one in Global Biogeochemical Cycles ([Sulpis et al., 2023](#) *Respiration Patterns in the Dark Ocean*).

We continue to update our Google Site to use within the WG – this includes all notes, actions and recordings from the meetings, editable WORD and EXCEL documents that we use to progress the deliverables, and information on membership, the mentoring scheme, the training course and WG outputs.

We continue to update our external facing webpage <https://www.remo-scor-wg161.com/> with information on the training course, mentoring scheme and seminar series. This also links with our twitter account @ReMO_SCOR161.

We have a YouTube channel <https://www.youtube.com/@remowg161> where the recordings of the seminar series and training material from the training course can be found.

4. Progress toward achieving group's terms of reference. List each term of reference separately and describe progress on each one. Limit 1000 words

Terms of reference (1-5) are detailed below, along with the relevant deliverables (D1-D11), the year-end by which they were planned to be completed (2021-2024) and a [statement on progress](#).

1. Identify, quantify and prioritise gaps in our knowledge, and prepare an action plan to reduce these gaps by reviewing available information on mesopelagic respiration

D1. An action plan to identify gaps in knowledge and propose ways to address those gaps (2021)

This deliverable is now complete and hosted on the WG Google site. We envisage the plan to be a 'living document', evolving as new information becomes available and that it provides the foundations for the ReMo papers.

D2. A position paper, based on the plan, highlighting the importance of reliable estimates of mesopelagic respiration, and suggesting priority research questions (2021)

A draft of a review paper led by Jack Middelburg and Gerhard Herndl has been shared online, with sections delegated to WG members to write. Submission is expected to be in late 2023.

D3. A model intercomparison / data sensitivity paper (2022)

This paper also derives from the action plan and data compilation. A draft led by Iris Kriest, Giorgio Dall'Olmo, Jack Middelburg and Katja Fennel is expected to be ready for submission in 2024.

2. Develop a global dataset of mesopelagic respiration estimates, derived from the range of ecological and biogeochemical techniques available, in order to create a resource for validation of biogeochemical models including Earth System Models used for climate projection

D4. A global dataset, linked to international marine data hubs, for use by modellers, launched at a Town Hall meeting at an international conference such as Ocean Sciences (2023)

We were successful in gaining additional funding from the UK Natural Environment Research Council (NERC) to compile and interpret this database. A data template has been created and made available to the community. We are working with the British Oceanographic Data Centre (BODC) to produce new and updated controlled vocabularies to describe the methods used to determine mesopelagic respiration. Fifty-five contributors from 14 countries have agreed to contribute their data during 2023/24.

D5. A data paper in Earth System Science Data <https://www.earth-system-science-data.net/> (2023)

This paper is being prepared for Earth System Science Data, a draft is in progress and the aim is to submit in 2024.

3. Produce a new synthesis of open ocean mesopelagic respiration

D6. A synthesis paper on a model/observational case study, and presentations at appropriate international conferences (2024)

This is being led by Anton Salgado based on data collected in the North Atlantic Ocean in 2017 and scheduled for submission in 2024.

4. Produce a best practice manual of techniques and approaches to determine mesopelagic respiration, and make recommendations as to which is the most appropriate method or combination of methods for a particular application, including best practice on how to reconcile approaches across time and space scales

D7. A best practice manual for ecological and biogeochemical methods used to derive mesopelagic respiration (2023)

We have a draft structure of this manual, with co-leads identified for the different sections. We have had a number of discussion sessions on the structure and the document is editable on the Google site. Section writing will progress during 2023 aligned with the review and data paper and the new controlled vocabularies created by BODC.

D8. A method inter-comparison paper and dataset (2024)

We planned a method intercomparison exercise in May 2023 in Las Palmas, Canary Islands. However, due to equipment failure and bad weather, this had to be cancelled at short notice. During the annual meeting we decided to progress this deliverable through a number of intercomparison papers that WG members are involved with based on recent and forthcoming research cruises e.g. REMAIN and APERO. WG members are also involved in a recently funded NERC proposal (PARTITRICS) which will involve method intercomparison during a cruise in May/June 2024.

5. Build capacity, share knowledge and transfer technical skills, particularly to scientists in developing nations

D9. A training course on model and observational approaches to derive mesopelagic respiration for early career and experienced researchers, particularly aimed at scientists from developing nations (2023)

This deliverable was completed in May 2023. Ten students attended the training course in person and another 29 joined online. The 6-day course involved lectures, seminars and hands-on practical sessions related to methodologies used to determine mesopelagic respiration. We are very grateful to SCOR for the funding awarded to three participants and one lecturer on the training course. Several WG members were also able to raise funding to cover their participation in the course.

D10. Online training materials such as lectures and practical demonstrations of analytical techniques, budgeting exercises and modelling approaches (2024)

This deliverable was completed in May 2023. The training materials are available via the ReMO website <https://www.remo-scor-wg161.com/about-8> and YouTube channel.

*D11. A manuscript for children on mesopelagic microbial respiration in *Frontiers for Young Minds* <https://kids.frontiersin.org/> (2024)*

This is in progress, with potentially two abstracts being prepared for volume 4 of The Ocean in FYM, including with one of the early career ReMO mentees as a co-author.

Capacity development : Mentoring scheme

Six early career mentees (within 10y of receiving their PhD) have been paired with WG members to progress collaborative tasks such as data interpretation, learning new methods and writing proposals. We also mentored the 10 attendees at the training course and are discussing whether some of these mentor/mentee links will continue.

5. WG activities planned for the coming year. Limit 500 words

The review paper (D2), model paper (D3), and data paper (D5) are planned to be submitted in the coming year. We will also progress the data compilation (D4), best practices method manual (D7), model/data case study (D6), intercomparison papers (D8) and manuscripts for young people (D11), and continue our capacity development activities : a monthly seminar series and mentoring programme.

We would like to hold a face-to-face meeting in 2024, possibly alongside the SOLAS Open Science Conference in Goa, India in November.

6. Is the group having difficulties expected in achieving terms of reference or meeting original time schedule? If so, why, and what is being done to address the difficulties Limit 200 words

The meeting in May 2023 (i.e. year 3 of the 4 year WG) was the first opportunity we have had to meet face to face, and it was very obvious how much more productive a 3-day face to face meeting can be compared to online sessions. However, there were still almost 50% of the WG members who could not attend, or could only attend for a few hours online due to unsociable time zones, meaning that the ideal of us all working together hasn't yet been fulfilled.

The extra workload, illness and emotional toll created by the COVID-19 pandemic has reduced the time we all have had to dedicate to the WG and so slowed our progress in terms of publication submissions. The cancellation of all fieldwork during the pandemic means that there is a backlog of research cruises to catch up on, hence 2022-24 includes an unusually high proportion of fieldwork for ReMO members.

We therefore request the opportunity to continue progressing and completing the deliverables we set ourselves in the ReMO proposal through a 2 year no-cost extension to the WG, to enable at least two more face to face meetings, completion of all the deliverables and the opportunity to launch and advertise the outputs of the WG at Ocean Sciences in 2026.

7. Any special comments or requests to SCOR. Limit 100 words.

As above – we would like to request a 2 year no cost extension to ReMO. We have only held one face to face meeting, and so potentially still have funds for at least 2 more.

Additional information can be submitted and may be posted at the SCOR Annual Meeting webpage at the discretion of the SCOR Executive Committee Reporter for the WG and the SCOR Secretariat.