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

SCOR Working Group 161 2023-2024

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

We have held 6 online WG meetings between August 2023 and July 2024. The meetings in October 2023, November 2023 and February 2024 included seminars which were 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 publications with early career first authors (Sulpis et al., 2023, and Guo et al., 2023).

During the Ocean Sciences 2024 meeting in New Orleans, we organized a Town Hall meeting (TH33K) called ReMo: Respiration in the Mesopelagic. The meeting aimed to bring together a larger group of scientists to broaden the discussion of mesopelagic respiration measurements and share data and experiences across temporal and spatial scales. The Town Hall meeting was well visited and started exciting discussions that have so far resulted in direct collaborations between the SCOR WG ReMo and the SCOR WG PRIMO. Morten Iversen (ReMo) and Kai Ziervogel (PRIMO) have been granted funding to support Kai´s visit to Morten´s group in Germany to develop new protocols for microbial hydrolytic enzymic activities in combination with respiration measurements on sinking particles. Hence, combining the aims of the two SCOR Working Groups.

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 2 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 6 such meetings between August 2023 and July 2024.

Alongside these meetings, we host a monthly seminar series. The seminars are given by WG members, members of the research teams of the WG members, or colleagues 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 modelling paper and the mentoring scheme. We continue to use a Google site for all working group documents.

The ReMO mentoring scheme continues to progress well. There are three mentees that began in 2022 and two that began in 2023, and the collaboration with their mentors has continued, during 2023 and 2024. One example is the collaboration between Natalia Osma and Josué Villegas, who were successful in gaining funding for Josué to visit Natalia in Chile in November 2023 to learn the ETS technique, draft a manuscript and arrange a collaborative agreement between their two institutions. In October 2023, we opened a third call of the mentoring program, but it was targeted only to the students that attended the training course organized by ReMO in Las Palmas in May 2023. The aim of this call was to further facilitate participants to initiate and maintain collaborations with the lecturers on the course and other WG members, and to strengthen their network in the field of mesopelagic respiration globally. We had two successful applications and the collaboration of these mentor-mentee pairs will progress during 2024.

This has been a busy year in terms of research cruises – at least two 1-2 month research cruises have each included collaborations between the research groups of 3-4 WG members.

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 Town Hall at Ocean Sciences where Morten Iversen gave an overview of ReMO and its aims, achievements, and the emerging scientific questions that have been identified as a result of the interactions between the members of ReMO. We plan further presentations at the forthcoming UK Challenger Society for Marine Science Conference 2024.

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

Two peer reviewed publications published in 2023/24 benefitted from discussions within the ReMO WG – (Sulpis et al., 2023, and Guo et al., 2023).

ReMO members have successfully submitted abstracts to *Fronters for Young Minds* for future submissions of manuscripts 'Living under pressure' led by Gerhard Herndl and 'The mystery of respiration in the dark ocean' led by Haimanti Biswas.

We continue to update our external facing webpage https://www.remo-scor-wg161.com/ with information on the mentoring scheme and seminar series. This also links with our X (formerly twitter) account @ReMO_SCOR161.

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

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.

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 2024.

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 funding (2022-2025) from the UK Natural Environment Research Council (NERC) to compile and interpret this database. Data is currently being compiled and interpreted for a conference presentation in September 2024 and publication in 2025.

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 early 2025.

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 2024/5.

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 2024 aligned with the review and data papers and the new data descriptors created by the British Oceanographic Data Centre.

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. We will progress this deliverable through a number of intercomparison papers that WG members are involved with based on recent collaborative research cruises e.g. REMAIN, BioCARBON and APERO.

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.

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 https://www.youtube.com/@remowg161.

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

This is in progress, with two abstracts accepted, and manuscripts developing for submission in 2024/25.

Capacity development : Mentoring scheme

Seven 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.

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 aim to hold an in-person meeting in October 2024, hosted by the University of Vienna.

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

A busier than usual fieldwork season (in part from the backlog in shiptime allocations due to Covid) reduced the regularity of our online meetings and the progress of the publications. We expect our forthcoming in-person meeting to speed up progress again. Many thanks to SCOR for a 2 year no cost extension to enable us to work towards a session at Ocean Sciences in 2026 in Glasgow.

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

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.