SCOR Working Group 166: Developing resources for the study of Methylated Sulfur compound (MSC) cycling PROcesses in the ocean (DMS-PRO)

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

During the last year, the DMS-PRO working group has undergone an internal reorganization. Former co-chair Daniela del Valle (INIDEP, Argentina) stepped down because of difficulties in her country, which is suffering major budget cuts and layoffs. Full members Steve Archer (Bigelow, USA) and Frances Hopkins (PML, UK) have taken over as new co-chairs. We incorporated Katherina Petrou (UTS, Australia) as new associate member, balancing the group's composition. Still regarding internal organization, this year we reduced the frequency of meetings to avoid overloading our members, and placed more emphasis on collaborative work using online documents.

Regarding our first two important deliverables, the Standard Operating Procedures (SOP) and the database of MSC cycling rates, we have made significant progress towards their completion. However, after a first round of discussions and collaborative work, and a thorough literature review, we identified the need for improving the classification of MSC cycling processes and related measurement techniques. The systematization of these measurements is a major undertaking because of the many cycling processes and techniques involved (see the diagram, which is being updated, in our new website). In summary, the reformulation of these deliverables has not produced visible results yet, but is critical to maximize the impact of the new tools and their utility for the MSC research community.

This year we have also placed emphasis on community building activities, including communication and exchange with the wider community. We created a logo, published a new website, and organized an online webinar. An online workshop is planned for early fall 2024. Below we provide more details of our activities and overall progress, as well as a detailed timeline for the following year.

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

Internal organization and meetings:

- Emails and online questionnaires were the main form of communication. During August-October 2023 we collected information of our WG members' ongoing projects and research prospects through and internal questionnaire. We also asked members about their participation in events like the UN Ocean Decade Conference in Barcelona, Spain (April 2024) and the upcoming SOLAS OSC (Goa, India, November 2024), but there was not enough quorum to justify SCOR funding of travels for in-person attendance (e.g. in side-events).
- A plenary meeting was held on 9 April. Several meetings were held by the Communication (3), SOP (3) and database (2) teams. Meeting recordings and minutes were shared afterwards. Note the Funding team did not convene since last July: this team will reactivate as we approach the DMSP Symposium and the last two years of the DMS-PRO project.

Progress towards the completion of key DMS-PRO deliverables:

- Internal discussions and intense work on several collaborative documents took place

between September and February 2024 within the SOP and the database teams.

- Through these discussions, we identified the need for (i) further reflecting on how to classify and categorize MSC rate measurements, which is a central issue to both SOP and database structure design; (ii) the need for collecting feedback from colleagues outside DMS-PRO before proceeding with SOP writing and database implementation.
- Results of this reflection process are (i) the organization of an open workshop (early fall 2024, see below); (ii) the ongoing work on an updated MSC cycling diagram and a related "taxonomy" of MSC cycling processes that bridges the molecular, biogeochemical and numerical modeling disciplines; (iii) the literature compilation through the "bibliothon" and subsequent bibliometric analysis (see below).
- As a consequence, key tasks were put on hold and the release of the corresponding deliverables has been delayed.

Communication:

- In September 2023 the new logo design was approved.
- An internet domain was purchased and, in February 2024, the DMS-PRO website (https://dms-pro.org/) was made public after some iterations with the webmaster. The webmaster from Plymouth Marine Laboratory (co-chair F. Hopkins' institution) graciously offered her time to create and update the website at no cost.
- A mailing list of oceanic methylated sulfur researchers was assembled (see next section).

Public events and wider community engagement:

- In February 2024 we organized an open online webinar that was repeated at two different times to facilitate global attendance. The webinar served both as a formal presentation of our WG and as a means to engage researchers in specific DMS-PRO activities (e.g. invitation to SOP writing or to contribute to the database). Over 140 colleagues worldwide were invited by email, of which 30 attended. Colleagues were asked if they wished to sign out, and offered a link where to download the recording of the webinar in case they could not join live.
- In April 2024 the co-chair M. Galí was invited to an OASIS-SOLAS round table (satellite event of the UN Ocean Decade Conference in Barcelona) in representation of DMS-PRO, on the topic of "Unifying Strategies to Develop Integrated Global Air-Sea Community Networks".

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

A new web page was published in February 2024, and will be updated regularly depending on the group's activities and communication needs: https://dms-pro.org/.

Presentations at meetings:
Galí, M., D.A. del Valle, S.D. Archer, H.W. Bange, E. Bucciarelli, E.S.M. Deschaseaux, J.M. González, H. Hayashida, F.E. Hopkins, S. Kameyama, B. McNabb, E. McParland, K-T Park, D. Shenoy*, J. Stefels, J.D. Todd, L. Winkel, G-P Yang, M. Zárate, M. Zhang. *Establishing an International, Multidisciplinary*

Community of Practice for the Study of Methylated Sulfur Compounds in the Ocean: SCOR Working Group DMS-PRO. Poster presentation (abstract submitted) at the SOLAS Open Science Conference. Goa, India, November 2024.
*presenting author

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

T1. *To develop community consensus on the measurement of MSC cycling rates, evaluate the suitability of available methods, and recommend standard operating practices (SOP).*

The SOP Team, led by Steve Archer, Frances Hopkins and Daniela del Valle, coordinated the creation of an inventory of MSC cycling rate measurements and the corresponding techniques. Thanks to the contribution of WG members through collaborative documents and spreadsheets, over 50 different MSC cycling processes were identified, each of which can be measured with one or more methods. This comprehensive inventory is the basis for the SOP, database and related resources. To facilitate the use of these resources, we identified the need for an updated diagram of MSC pools and cycling processes. This diagram is still being reviewed internally, but we anticipate it will represent an important update to the pre-existing conceptual diagrams of MSC cycling processes. The thorough revision that led to the updated inventory, and the discussion on how to organize the method descriptions, has delayed the writing of the SOP, which we plan to start in fall 2024.

T2. *To compile a comprehensive database of MSC cycling rates in the ocean and to freely disseminate the database and related documentation according to the FAIR principles.*

The Database Team, led by Martí Galí and José González, made progress in the design and implementation of the MSC cycling rates database. The main achievements during this period are:

1) A functional installation of ERDDAP (NOAA's data server that will be used to distribute DMS-PRO data) was completed on ICM-CSIC servers and is available at the URL https://dms-pro.icm.csic.es/erddap/index.html. The database currently contains test data only. An open call for contributions is planned for the first half of 2025, coinciding with the 7th DMSP Symposium.

2) An improved template for data submission has been designed, identifying compulsory and optional fields for each type of rate measurement. However, the compilation of rate measurements was kept on hold because the inventory of available methods by the SOP team was still evolving (as explained above, T1). This delay may in the end be beneficial, because it will increase the coherence between the SOP, the database, and the underlying conceptual diagram of MSC cycling processes and their "taxonomy". The diagram itself will assist data contributors to clearly categorize their measurements, eventually reducing the data curation workload.

3) In April 2024 we organized a collaborative 2-week event restricted to DMS-PRO members, called the "DMS-PRO bibliothon", with the goal of compiling scientific literature on MSC cycling. This event was quite successful, since >160 published datasets and some additional unpublished ones were listed, allowing us to identify virtually all the existing datasets that could potentially be contributed to the database by their authors.

T3. *To develop a transparent framework for the quality assessment and control, standardization, and curation of MSC cycling datasets.*

This term of reference is tightly connected to T1 and T2. The discussion process that informed the inventory of MSC cycling measurements for the SOP and the database, and the ongoing quest for community feedback (T7), will be extremely valuable to define a quality control and assessment framework. T3 will become increasingly important as soon as datasets contributed by the community start to populate the database.

T4. *To analyze and summarize the patterns of MSC cycling rates in the global ocean in relation to their abiotic and biotic environment.*

This activity is currently scheduled for Year 4, once a first consolidated release of the database becomes available.

T5. *To provide expert guidance on the use of the MSC cycling database for model development and evaluation.*

The ongoing development of an updated MSC cycling diagram, along with the detailed descriptions provided in the SOP, is a key resource that will help bridge the gaps between experimentalists and modelers. This diagram has been designed in a way that facilitates translation of experimental data into model equations and jargon, fostering a more informed use of rate data for model development and evaluation purposes. Our full member Hakase Hayashida (Database team) committed to lead an event targeted to modelers during the 7th DMSP Symposium (April 2025).

T6. *To improve the coordination between measurements of MSC cycling rates and stocks, and foster interdisciplinary research by relating these to other biogeochemical variables and molecular and 'omics data (Overarching term of reference).*

The inclusion of colleagues with expertise in molecular microbiology and bioinformatics in DMS-PRO paves the way for an improved coordination across disciplines. For example, the outline of the SOP now includes techniques like gene transcription (e.g. by qPCR) and enzymatic activity assays that were not contemplated initially. Although strictly speaking these techniques cannot quantify in situ rates, they can help bridge the gap between genetic potential and realized biogeochemical rates, which is a key knowledge gap that hinders the prediction of the oceans' response to global change. As another example, collaborations between research groups are emerging under the umbrella of DMS-PRO, such as the enhanced coordination of field measurements between the CARES and COCO-VOC projects (led by Plymouth Marine Laboratory, UK) and the GOOSE project (led by ICM-CSIC).

T7. *To establish an international community of practice focused on research, capacity development, and oceanographic multidisciplinary collaboration in the topic of oceanic S cycle (Overarching term of reference).*

During the last year we made significant progress towards achieving this term of reference. In addition to the publication of our website, we organized an open webinar to explain the objectives and approach of DMS-PRO to the wider community, which was attended by over 30 people worldwide. Three open workshops are planned for early fall 2024 (described in the next section). These open events were (or are being) advertised through the website, social networks and via email. Our full member Erin McParland (Communication Team), who is also co-organizer of the upcoming 7th DMSP Symposium, led the compilation of an updated mailing list that as of

today includes over 150 researchers interested in MSCs. This mailing list has been extremely useful to advertise DMS-PRO activities and enhance our working group's visibility.

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

The coming year will be critical to the success of DMS-PRO activities, including the writing of the SOP and the public release of a functional database. The year will be marked by two events open to the wider community:

September-October 2024: As a follow-up of the webinar held in February 2024, we are organizing an open workshop composed of three sessions. Each session will be 1.5 hours long and cover a different topic. A brief introduction given by two invited speakers will be followed by an open discussion. This event will be instrumental to refine the outline of the SOP, engage writers from outside DMS-PRO, and refine the design of the database and related data submission workflow. The planned sessions are:

- 26/09. Rafel Simó and Daniela del Valle. Biological consumption of MSCs: Tracer vs. bulk (inhibitor) measurements.
- 03/10. Jacqueline Stefels and Jon Todd. DMSP synthesis: pathways, players, and measurement methods.
- 10/10. Katherina Petrou and Steve Archer. Particulate turnover processes: from the microscale to zooplankton grazing rates.

April 2025: DMS-PRO supports the organization of the "7th International Symposium on biological and environmental chemistry of DMS(P) and related compounds" planned for April 2025 in Mobile, USA. This Symposium offers a great opportunity for building our community of practice, and will be the first opportunity for all DMS-PRO members to meet in person simultaneously. The DMSP Symposium is a key milestone in our working plan because, during it, we will start collecting community feedback on the first draft of the SOP and on the design and functionality of the database. This feedback will allow us to improve the deliverables that will be released over the following months.

Plenary meetings will be held at the beginning of critical periods for improved coordination of the various tasks. Thematic team meetings will be organized on demand. The Gantt chart below depicts the tasks and events planned for next year. Besides each activity, we show in parentheses the Terms of Reference it addresses and the teams that are in charge of it.

Activities (ToR; responsible teams)	Year 2024					Year 2025						
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Bibliometric analysis of "bibliothon" (T1-T6; SOP + database)												
Website update, avertise workshop (T1, T2, T3, T6, T7; communication)												
Workshop organization and reporting (T1, T2, T3, T6, T7; SOP + database)												
Co-organization of the 7th DMSP Symposium (T1-T7; to be determined)												
7th DMSP Symposium (T1-T7; whole group)												
SOP: consolidated outline and writing assigned (T1; SOP)												
SOP writing: first draft and internal revision (T1; SOP + whole group)												
SOP writing: community feeback and final revision (T1; SOP)												
Database: initial workflow design and internal testing (T2, T3; database)												
Database: workflow consolidation (T2, T3; database)												
Database: call for community contributions (T2, T3; whole group)												
Plenary meetings (T1-T7; whole group)												

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

Because of the challenges faced by the scientific community in Argentina, which suffered major personnel layoffs and budget cuts, Daniela del Valle had to step down as DMS-PRO co-chair so she can better align her efforts with the objectives of her research group. The full members Steve Archer and Frances Hopkins, who have been highly active in the working group as coordinators of the SOP team along with Daniela, agreed to share the co-chair responsibilities moving forward. Although Daniela will continue contributing to the group in the capacity of a full member, co-chair rotation has posed a challenge for the WG and especially for the advancement of the SOP (T1).

In the previous report we had described difficulties arising from the low engagement of a few members. We tackled this issue by emphasizing collaborative work on shared documents, and organizing internal events like the “bibliothon” that prompted researchers to ensure the visibility of their own work. We also took a more vertical approach to occasionally request specific tasks. Our efforts were partially successful. We also tackled this issue by organizing open events (webinar, upcoming workshops) to engage colleagues from outside DMS-PRO, which allowed us to collect valuable feedback and enrich the debate.

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.