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**Ozone Research Managers of the parties to the
Vienna Convention for the Protection of the
Ozone Layer
Eleventh meeting, part I***
Online meeting, 7 and 8 October 2020

Report of the Ozone Research Managers on the work of their eleventh meeting

Introduction

1. Owing to the ongoing coronavirus disease (COVID-19) pandemic, the eleventh meeting of the Ozone Research Managers of the Parties to the Vienna Convention for the Protection of the Ozone Layer could not be held in person either in Geneva from 1 to 3 April 2020, as had originally been planned, or in Montreal, Canada, from 8 to 10 July 2020, as subsequently rescheduled. With the face-to-face meeting planned to take place in Geneva from 14 to 16 April 2021, the co-chairs of the tenth meeting of the Ozone Research Managers, in consultation with the co-chairs of the Scientific Assessment Panel of the Montreal Protocol on Substances that Deplete the Ozone Layer and the Ozone Secretariat, decided to convene an interim online meeting to allow for the presentation and initial discussion of the issues under session 4 of the agenda, entitled “International monitoring programmes: looking ahead”. The online meeting was designated part I of the eleventh meeting, with the face-to-face meeting to be held in Geneva in April 2021 representing part II.
2. The online meeting took the form of two substantially identical technical sessions, held on 7 and 8 October 2020, to facilitate the participation of those in the different world time zones.

I. Opening remarks by the co-chairs of the tenth meeting of the Ozone Research Managers

3. Mr. Kenneth Jucks opened the first technical session of the eleventh meeting of the Ozone Research Managers (part I) at 5 p.m. (Nairobi time (UTC + 3)) on 7 October 2020 and Mr. Gerrie Coetzee opened the second substantially identical technical session at 6 a.m. (Nairobi time (UTC + 3)) on 8 October 2020.
4. Providing an overview of the rationale for and goals of the online sessions, Mr. Jucks began by recalling that, in its decision XXXI/3, the Thirty-First Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer had requested the Scientific Assessment Panel to work with the Ozone Research Managers at their meeting in 2020 to identify gaps in the global coverage of atmospheric monitoring of controlled substances and to provide options on ways to enhance such monitoring, as well as exploring options for informing the parties of preliminary information indicating unexpected emissions of controlled substances, for the consideration of the Thirty-Second

* Part I of the eleventh meeting of the Ozone Research Managers addressed only the issues set out in the current provisional agenda. All other issues will be considered at part II of the meeting, which is scheduled to be held in Geneva from 14 to 16 April 2021.

Meeting of the Parties to the Montreal Protocol and the Conference of Parties to the Vienna Convention at its twelfth meeting, in 2020.

5. The Ozone Research Managers, a Vienna Convention body, and the Scientific Assessment Panel, a Montreal Protocol body, had different but complementary purposes: Panel assessments served as the communication device between the research community and decision makers, enabling the parties to evaluate the control measures under the Montreal Protocol, but did not provide policy recommendations or research planning, although they provided input for both. The Ozone Research Managers' reports addressed research and monitoring needs in the light of the scientific understanding provided by Scientific Assessment Panel assessments and made specific recommendations regarding international actions for improved research coordination and networking. It was therefore appropriate that the two bodies work together to address the parties' request in decision XXXI/3.

6. During the online technical sessions, the Ozone Research Managers would consider the issue of emissions monitoring, including a white paper entitled "Closing the gaps in top-down regional emissions quantification: needs and action plan". The white paper, prepared by the Scientific Assessment Panel in cooperation with experts in the atmospheric monitoring of substances controlled under the Montreal Protocol, was set out in the annex to document UNEP/OzL/Conv.ResMgr/11/4/Rev.1. The outcome of the discussion would be used to update the white paper as needed and to prepare a response to the parties' request that would be further discussed by the Ozone Research Managers at part II of its eleventh meeting and subsequently presented to the parties to the Vienna Convention and the Montreal Protocol at their meetings in 2021.

II. Introductory remarks by the Ozone Secretariat

7. Ms. Megumi Seki, Acting Executive Secretary of the Ozone Secretariat, welcomed the participants and thanked them for their willingness to contribute to the online sessions.

8. At the first technical session, Ms. Seki introduced Ms. Tina Birmpili, the former Executive Secretary of the Ozone Secretariat, who would provide input to the meeting as a special resource person, owing in particular to her close involvement in the preparation of the Scientific Assessment Panel's white paper to be presented and discussed under item 3 of the agenda for the online meeting. At the first session, Ms. Birmpili presented her views on the issue of gaps in atmospheric monitoring and how it could be addressed and her vision of the future role of the Ozone Research Managers, and at the second session, Ms. Seki summarized Ms. Birmpili's presentation. The presentation was also available to the participants on the meeting website.¹

9. Noting that the science-policy interface was one of the strengths of the Montreal Protocol, Ms. Birmpili said that the parties to the Montreal Protocol wanted to have access to accurate, timely and relevant scientific information to inform their decision-making. Raw data was of limited use, however, and the role of the scientific community had always been to gather the data, assure their quality and disseminate the information to the parties.

10. The recent experience of unexpected emissions of trichlorofluoromethane (CFC-11) had highlighted the importance of early warning of problems and early identification of trends. The parties had indicated their desire to be ready to identify similar issues in the future, including with respect to hydrofluorocarbons (HFCs), where the goal of phase-down rather than phase-out could complicate the work of ensuring that commitments were being adhered to. Ms. Birmpili underscored the challenge faced by institutions, such as the Ozone Secretariat, the United Nations and the ozone treaties, in attempting to reduce the time lag between the provision of scientific information and policy action. The engagement of research managers from all over the world was crucial for the ozone treaties, as was an attempt to strike a balance between scientific credibility and policymaking.

11. Turning to the question of emissions monitoring, Ms. Birmpili stressed that monitoring should cover all the controlled substances. The blind spots for emissions were known and areas of potential emissions could probably be determined. It would also be important to be able to declare areas free of unexpected emissions. Funding, particularly in the context of the COVID-19 pandemic, could be expected to be limited, meaning that both prioritization and ideas for ways to increase funding were needed. There would be an ongoing need for global monitoring from the ground, monitoring by aircraft and satellites and remote monitoring. International cooperation and the combined efforts of research institutions and monitoring networks from as many countries as possible was crucial. Networks that monitored other gases could also play a role. The benefits a country could derive from funding a monitoring scheme should also be made clear to the parties.

¹ <https://ozone.unep.org/meetings/11th-meeting-ozone-research-managers/presentations>.

12. Ms. Birmpili suggested several ways in which the Ozone Research Managers could play an important role in the accountability phase of the Montreal Protocol, including by providing more specific recommendations to the parties to the Vienna Convention; monitoring emissions as well as undertaking research and monitoring of the ozone layer to safeguard what had been achieved; providing ideas for funding and feeding into the work of the Advisory Committee of the General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention for the Protection of the Ozone Layer on developing short- and medium-term projects to be funded by the parties; and clearly articulating needs while suggesting ways to bring governments and other possible stakeholders together to strengthen monitoring and research.

III. Organizational matters

A. Adoption of the agenda

13. The Ozone Research Managers adopted the agenda for part I of their eleventh meeting on the basis of the provisional agenda (UNEP/OzL/Conv.ResMgr/11(I)/1/Rev.1).

B. Attendance

14. The list of participants is available from: <https://ozone.unep.org/meetings/11th-meeting-ozone-research-managers/post-session-documents>.

IV. Gaps in the global coverage of atmospheric monitoring of controlled substances and options on ways to enhance such monitoring

A. Remarks about the “white paper” prepared by the Scientific Assessment Panel, entitled “Closing the Gaps in Top-Down Regional Emissions Quantification: Needs and Action Plan” (document UNEP/OzL/Conv.ResMgr/11/4/Rev.1)

15. Introducing the item, Mr. Paul Newman, co-chair of the Scientific Assessment Panel, underscored the importance of finding faster ways to provide new and appropriate information on controlled substances and other compounds. Providing timely information on increases in emissions was challenging for scientists owing to the rigorous scientific process that had to be followed to evaluate the raw observation data and generate information that would be useful to policymakers and the public. The white paper had been prepared in response to that concern.

B. Presentation of the “white paper”

16. Mr. Ray Weiss presented the white paper entitled “Closing the gaps in top-down regional emissions quantification: needs and action plan” (UNEP/OzL/Conv.ResMgr/11/4/Rev.1, annex) on behalf of the Scientific Assessment Panel. Mr. Ronald Prinn then made a presentation on the use of observing system simulation experiments (OSSEs) to assess potential sites for new high-frequency measurement stations.

17. Mr. Weiss began his presentation by observing that the recent discoveries of anomalous CFC-11 emissions had shown that the “bottom-up” reporting under the Montreal Protocol was vulnerable in terms of unknown or unreported emissions, which was a risk for all the substances regulated under the Montreal Protocol. Current measurement networks allowed for global monitoring of abundances and trends of such substances, and could detect global and hemispheric emissions anomalies, but were less well-suited to identifying the locations of such anomalous emissions on finer regional scales.

18. Regional sources could be identified and quantified by combining high-frequency measurements with inverse atmospheric transport modelling. The problem was that current measurement capacity provided only limited geographic coverage. As an indication, a map showing the “footprint” of the Advanced Global Atmospheric Gases Experiment (AGAGE) consortium and National Oceanographic and Atmospheric Administration (NOAA) ground-based observational networks, which are the largest global networks monitoring Montreal Protocol gases, showed that most of North America, Western Europe and Eastern Asia was essentially covered, but that South and

Central America, most of Africa, South Asia, Central Asia, Southeast Asia, most of Australia, Eastern Europe, and the Middle East remained without coverage. The goal was therefore to close those gaps.

19. In order to begin closing the gaps and to address the request of the parties in decision XXXI/3, the white paper proposed a pilot project to expand measurements and modelling. Mr. Weiss summarized the costs associated with a measurement programme consisting of both flask sampling, especially for exploratory measurements, and the establishment of new high-frequency measurement stations. He also highlighted the importance of robust, well-maintained calibrations as a necessary component of any such expansion in observations. International collaboration, including exchanges of technical knowledge, expertise and calibration standards, open data access and model-sharing, was also critical, and OSSEs should be used to guide the selection of new observing sites.

20. The Scientific Assessment Panel was seeking the Ozone Research Managers' endorsement of the white paper so that it could be considered by the Open-Ended Working Group of the Parties at its meeting in 2021. Sources of pilot project support also needed to be identified; the scale of what could be accomplished would depend on the availability of financial and infrastructure resources that could assure the 5- to 10-year continuity needed to fully realize the benefits of the initiative.

21. Following Mr. Weiss's presentation, Mr. Prinn described how OSSEs were used to assess potential observing sites. He first described the inverse mathematical operation involved in estimating changes in emissions based on observations and station sensitivity, and then demonstrated how OSSEs could be used to generate a sensitivity map, or footprint, for a proposed station location, and hence to assess the extent to which a proposed site could help fill the gaps in monitoring coverage.

V. Discussion

A. Proposed amendments to the white paper

22. A few minor edits to the white paper were suggested for clarification and information purposes and additional details regarding the sensitivity units of the modelling "footprints" were requested for the caption to figure 1. The authors indicated that they would make appropriate adjustments, keeping in mind the need for the descriptions to be meaningful to readers who were not numerical modellers. Responding to a request for clarification on the \$150,000 estimate for the costs of modelling proposed sites with OSSEs and maintaining a modelling capability, Mr. Weiss and Mr. Prinn said that that it was based on the costs seen for the sites that had been modelled to date. Costs could vary widely, however, depending on whether the research scientists involved had access to research funding. Broadly speaking, the costs consisted of the research scientists' time and computational time, and potentially the indirect cost of employee benefits. Mr. Prinn added that once the maps were produced, they were shared and could be used for any long-lived molecule that was effectively inert in the troposphere. The results still needed to be stored, however, which also involved costs.

23. Asked why the white paper did not provide more information on the potential contribution of aircraft and satellite measurement programmes under the section on current capabilities and limitations, Mr. Weiss explained that while they agreed that such programmes could be of assistance in the longer term, the authors had felt that the near-term focus should be on enhancing existing capabilities that had led to proven inverse modelling results. Mr. Jucks noted that there were ongoing investigations of a very slim chance that one particular type of satellite observation could reveal something, particularly for the strongest greenhouse-gas-type ozone-depleting substances like CFC-11, provided that the data was appropriately analysed for infrared sounders.

B. Site selection

24. One participant asked whether the OSSE results had been matched with locations of large production facilities to estimate the risk of emissions from production areas, and suggested that input be sought from the Technology and Economic Assessment Panel on potential emission sites that should be covered by monitoring. The suggestion was generally welcomed, including by a representative of the Technology and Economic Assessment Panel attending the session, who said that the Panel already reported on production sites and could intensify its work in that area. Mr. Newman proposed that the Scientific Assessment Panel and the Technology and Economic Assessment Panel hold joint discussions to identify optimal locations for a range of priority compounds. It was pointed out that site selection should take into account emissions not only from the locations of the production of substances but also from locations of their subsequent uses.

25. One participant proposed that capacity-building be considered a key metric for measurement site selection. Responding to the comment, Mr. Weiss observed that while flask sampling did not require a research scientist, real-time stations were generally set up on the initiative of someone associated with a local university or research laboratory who then became part of the international collaborative effort. Mr. Prinn proposed a different understanding of capacity-building; while he acknowledged that any opportunity to expand real-time measurements should be taken, including in developed countries, with a good scientific base when presented, capacity-building should be viewed primarily as supporting developing countries in building good science programmes. It was important to build local capacity to run stations in developing countries rather than importing expertise. Full cooperation of the host country was required, however. As an example of such capacity-building, he pointed to an AGAGE site recently set up in Rwanda, driven in part by the interest of the President of Rwanda. The Rwandan chief scientist for the station, a former Massachusetts Institute of Technology student, was employed by the Ministry of Education, and the Government of Rwanda covered all the day-to-day operating costs of the station. The instruments for the station had been financed by donations from Massachusetts Institute of Technology alumni.

26. Addressing the issue of capacity-building, Mr. A. R. Ravishankara, chair of the Advisory Committee, noted that if the General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention for the Protection of the Ozone Layer were to be involved in that effort, then the issue of capacity-building would be central to those deliberations.

C. Costs and funding

27. Given its relatively lower cost, a substantial portion of the discussion focused on flask sampling and its role in expanding monitoring coverage. It was generally agreed that optimal use should be made of flask sampling in expanding the network to fill the gaps in coverage. According to Mr. Prinn, flask sampling was an important tool for early site assessment prior to investing, and there was also a need for flask sampling in regions that were not expected to have large sources of emissions but that could provide the boundary conditions for doing regional studies.

28. One participant commented that, in addition to indicating the value of a given site, flask sampling could reveal a lot about the many gases being emitted. Both Mr. Prinn and Mr. Weiss cautioned that, while that was true, there was a limit to the scaling up of flask measurement programmes; even if many gases could be measured, the measurement data would need to be calibrated and looked at critically. A solid monitoring system therefore required adequate human resources to perform the needed measurements and interpretation.

29. A question was raised regarding the capacity of the NOAA laboratory, which currently processed flask samples, to handle the expansion of flask sampling proposed in the white paper under the pilot project, and the possible need for another laboratory to be set up as part of the project. Mr. Stephen Montzka responded that there was additional capacity in the NOAA laboratory, which, in particular, could assist in a survey to determine which regions merited further characterization. The question of whether such activities could be sustained or expanded in the future would require additional discussion, however. Also responding to the comment, Mr. Weiss said that it was also important to look beyond the pilot project. It was unlikely that individual research laboratories or the kind of collaboration currently occurring would be sufficient in the long run. As the gaps were filled, international collaboration would become key, with many laboratories working together in an expanded network.

30. One participant, noting that bags were used for sample collection in the methane community, proposed that bags be considered as a less costly alternative to flasks. Mr. Weiss responded that bags were an unproven technology for substances with abundances 10,000 to 100,000 times lower than that of methane, for which surface effects became much more important. Permeability was an issue with any plastic, and the Tedlar bags used in methane research were permeable, although less so than most other plastics. Flasks were reusable, able to be posted by mail and could be pressurized more than bags, which was a consideration given that both volume and weight were factors in posting costs. Furthermore, flasks might prove to be recyclable and reusable on the same scale as bags. Consequently, while bags should not be excluded as a potential sampling tool, they would be more of a subject for research than an existing technology to be applied to the problem raised by the parties. Mr. Montzka echoed Mr. Weiss's arguments and added that, in his experience, bags were not currently used to measure halocarbons.

D. International collaboration

31. The importance of international collaboration and the role of national governments was another focus of discussion. In response to a question on that topic, Mr. Jucks observed that the expanded monitoring and enhanced understanding of emissions sought by the parties would require observations in locations that were by nature multilateral, requiring the involvement of all nations in one way or another. When it was determined that a station was needed at a given site, the cooperation of the national Government involved would be essential. He also stressed that for the activities involved to be effective, the data would need to be extremely transparent and available for everyone to use and understand going forward.

32. Mr. Montzka indicated that in the past, measurement capabilities had generally been expanded in two ways: from the bottom up, by finding someone who was interested in pursuing such measurements and becoming involved in the larger cooperative effort; and from the top down, as in the case of Rwanda, where a country sought to become involved. Both avenues could be developed to enhance international collaboration.

33. One participant asked whether a centralized coordination body would be needed to oversee the multiple networks expected to collaborate in the work. Mr. Weiss responded that scientists tended to self-associate, but also offered the Comprehensive Nuclear-Test-Ban Treaty Organization as a model. Much like what was needed for Montreal Protocol emissions monitoring, that organization had 60 stations measuring radioactive isotopes in the atmosphere and used inverse back trajectory modelling to determine the origin of detected nuclear activities. It also had a centralized data facility in Vienna, and shared all its data. He added that the director of that organization had indicated a willingness to host the monitoring activities being contemplated at some of their stations, which could help to reduce the costs associated with expanding the Montreal Protocol network.

34. It was suggested that the World Data Centre for Greenhouse Gases, which currently archived ozone-depleting substance measurements, could play a coordinating role; however, that would require a larger commitment on the part of the centre. Mr. Jucks noted that data storage and distribution was expensive and substantial resources would be required for a large coordinated network. The Network for the Detection of Atmospheric Composition Change (NDACC) also provided a potentially applicable model for data portals and sharing of data; Mr. Prinn observed that NDACC was already playing a role, providing a platform for discussion surrounding surface measurement of column amounts of gases and measured column Fourier Transform Infrared spectrometry (FTIR) measurements, which, although still far from operational, could eventually prove useful.

35. Also on the topic of global coordination, one participant noted that the white paper mentioned that China was in the process of establishing a regional monitoring network and asked whether that network was expected to be integrated into a broader effort. Mr. Weiss expressed the hope that it would, but observed that while participants in such efforts generally knew that better results were obtained when scientists worked together and were given the opportunity to share, they would not necessarily be obliged to do so.

E. Timeliness of information

36. There was some discussion on options for improving the timeliness of information in order to address the parties' request in decision XXXI/3. Mr. Prinn commented that significant additional resources would be required to provide daily information for CFC-11 and other substances around the world, although he allowed that such information could be of value in raising public awareness. Mr. Montzka said that NOAA and AGAGE posted results on their websites fairly quickly, so that information on how atmospheric gases changed over time was fairly readily available on specific sites. The Montreal Protocol community wanted information on emissions, however, and the process of producing such information took time. The timeline could probably be shortened somewhat but any such enhancements would require personnel, prioritization and resources. He suggested that avenues for communicating the science to the parties also be explored.

F. Additional technical points

37. Mr. Montzka also responded to a question on the possibility of switching from low-frequency to high-frequency measurements when forecasts indicated a benefit in doing so. He confirmed that automated flask samplers could be set up in such a way as to make that possible.

38. Mr. Prinn addressed a question regarding other types of observations that might be required for successful inverse modelling, and the role of vertical profiles. He indicated that vertical profiles could be very useful, in particular for determining the real lifetime of each chlorofluorocarbon (CFC), which

required an understanding of the loss rate in the stratosphere as a function of altitude. They would need to get into the stratosphere, cover a wide range of gases, and ideally be performed probably at least four times to capture any seasonal differences.

VI. Summary of the discussion

39. The chair of the Advisory Committee, proposed, and the participants agreed, that the following points constituted the outcome of the discussion:

(a) No objections had been raised about the white paper, apart from a few suggested modifications and clarifications, which the authors would take into account in a revised version to be prepared prior to part II of the eleventh meeting of the Ozone Research Managers, to be held in April 2021. The white paper, including the proposed pilot project, would hopefully be endorsed by the Ozone Research Managers and forwarded for consideration by the Conference of the Parties at its meeting in 2021.

(b) Resources were required to take the steps envisioned in the white paper to scientifically assess the potential of a given site to host measurement facilities. Consequently, a sponsor should be sought for each potential site or else the parties to the Montreal Protocol might consider providing seed funding for the activities proposed.

(c) Additional sites should be found for both flask sampling and high-frequency measurement stations; it was not a question of one or the other.

(d) The involvement of the Technology and Economic Assessment Panel in that work would be important as its experts could provide input on potential sites, based on their knowledge of likely current and future sites for production, use (such as in feedstock) and breakdown.

(e) Existing extra capacity in current measurement networks such as the NOAA and AGAGE networks could potentially be used, at least in the initial phases of the project.

(f) The first step in assessing sites that would be proposed for the project would be to perform OSSEs, which thus represented a key need for funding when considering requests from parties to assess a given site. Offers from countries to support the assessment of their proposed sites using OSSEs would be warmly welcomed.

(g) A number of measurement options had been mentioned, including bags and the use of satellite measurements. While those could be useful research topics, participants were in agreement on the immediate way forward set out in the white paper.

(h) Capacity-building potential should be considered a key criterion in the decision to establish a new station.

VII. Closure of the meeting

40. Following the customary exchange of courtesies, the two online technical sessions of the eleventh meeting of the Ozone Research Managers (part I) were declared closed at 7 p.m. (Nairobi time (UTC + 3)) on 7 October 2020 and 7.35 a.m. (Nairobi time (UTC + 3)) on 8 October 2020, respectively.