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Presentations by the assessment panels on their synthesis of the 2018 quadrennial assessments

Synthesis of the 2018 assessment reports of the Scientific Assessment Panel, the Environmental Effects Assessment Panel and the Technology and Economic Assessment Panel

Note by the Secretariat

1. The annex to the present note contains a synthesis report that highlights the main findings of the following three 2018 quadrennial assessment reports prepared pursuant to Article 6 of the Montreal Protocol on Substances that Deplete the Ozone Layer:

- *Scientific Assessment of Ozone Depletion: 2018* and *Scientific Assessment of Ozone Depletion: 2018 – Executive Summary*, prepared by the Scientific Assessment Panel[1]
- *Environmental Effects and Interactions of Stratospheric Ozone Depletion, UV Radiation, and Climate Change: 2018 Assessment Report*, prepared by the Environmental Effects Assessment Panel[2]
- *Technology and Economic Assessment Panel: 2018 Assessment Report*, prepared by the Technology and Economic Assessment Panel[3]

2. The synthesis report has been prepared by the co-chairs of the assessment panels. The individual assessment reports have been posted on the web pages of the respective panels, on the website of the Ozone Secretariat[4] and on the web portal of the Thirty-First Meeting of the Parties to the Montreal Protocol for consideration by the parties.[5] The Secretariat would like to express its sincere gratitude to the three assessment panels for their work.

* UNEP/OzL.Pro.31/1.

[1] Available at https://ozone.unep.org/science/assessment/sap.

[2] Available at https://ozone.unep.org/science/assessment/eeap.

[3] Available at https://ozone.unep.org/science/assessment/teap.

[4] https://ozone.unep.org/.

[5] http://conf.montreal-protocol.org/meeting/mop/mop-31/presession/SitePages/Home.aspx.

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Annex

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Synthesis of the 2018 assessment reports of the Scientific Assessment Panel, the Environmental Effects Assessment Panel and the Technology and Economic Assessment Panel

Introduction

1. The Scientific Assessment Panel, the Environmental Effects Assessment Panel and the Technology and Economic Assessment Panel are charged with providing periodic assessments within their areas of expertise to the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer. The present report provides a high-level synthesis of the 2018 assessment reports of the three panels.

2. Previous synthesis reports have highlighted the success of the Montreal Protocol in stopping the growth in the atmospheric abundances of ozone-depleting substances, thereby reducing stratospheric ozone depletion and protecting the environment. The present report provides updated information highlighting the continued success of the Montreal Protocol in regulating ozone-depleting substances and further reducing their abundances in the atmosphere. The indications that those actions are leading to ozone recovery are now clearer, especially in the upper stratosphere and over the Antarctic region.

3. Since the publication of the 2014 assessment reports, the Kigali Amendment to the Montreal Protocol was adopted in 2016. The Amendment sets out schedules for limiting the production and consumption of specific hydrofluorocarbons (HFCs). The technological issues associated with the Amendment, along with its climate and environmental benefits, are highlighted herein and discussed in detail in the individual assessment reports of the Scientific Assessment Panel,[6] the Environmental Effects Assessment Panel[7] and the Technology and Economic Assessment Panel.[8]

4. The significant impact that stratospheric ozone depletion and ultraviolet (UV) radiation have on human health and the environment, the anticipated stratospheric ozone recovery and climate change continue to be evaluated pursuant to the Montreal Protocol. Since full recovery of the ozone layer in the mid and high latitudes of the southern hemisphere will take several decades, long-term monitoring of total ozone and UV radiation is essential for tracking the associated effects, including those that may arise from unexpected changes in the ozone layer.

Key findings

I. Actions taken under the Montreal Protocol have led to decreases in the atmospheric abundance of controlled ozone-depleting substances and the start of the recovery of stratospheric ozone

5. The atmospheric concentrations of both total tropospheric chlorine and bromine from long-lived ozone-depleting substances controlled under the Montreal Protocol have continued to decline since the 2014 assessments. Progress continues to be made in every consumer, commercial, industrial, agricultural, medical and military sector, with ozone-depleting substances having been phased out of many applications worldwide. For example, CFC-containing metered-dose inhalers have been successfully replaced by a wide range of CFC-free inhalers without harm to patients. The phase-out of HCFC-22 is essentially complete in non-Article 5 parties and progressing in Article 5 parties. The year 2015 marked the final production and consumption phase-out date for controlled uses of methyl bromide in Article 5 parties; presently, about 99 per cent of global reported controlled uses have been phased out.

6. The controls on ozone-depleting substances established by the Montreal Protocol have substantially protected global stratospheric ozone from more severe depletion. The evidence for changes in the atmospheric abundances of ozone-depleting substances comes from continuous, long-term measurements from a global network of monitoring stations. Information derived from those measurements, combined with information on the lifetimes of ozone-depleting substances, is used to calculate and monitor annual emissions of those substances. Those values are compared with emission

[6] Available at https://ozone.unep.org/science/assessment/sap.

[7] Available at https://ozone.unep.org/science/assessment/eeap.

[8] Available at https://ozone.unep.org/science/assessment/teap.

values derived from data reported to the United Nations Environment Programme (UNEP), thereby enabling an assessment of compliance with Montreal Protocol phase-out schedules.

7. Detecting stratospheric ozone recovery and attributing it to any given factor is challenging because of large natural variability in ozone amounts, as well as confounding factors such as climate change and changes in tropospheric ozone. Although the Antarctic ozone hole continues to occur every year, the ozone layer is recovering generally. Outside the polar regions, upper stratospheric ozone has increased by 1–3 per cent per decade since 2000. No significant trend in total column ozone was detected outside polar regions over the period 1997–2016, with average values in the years since the 2014 assessments remaining roughly 2 per cent below the average for the period 1964–1980.

II. The Montreal Protocol contributes to environmental sustainability and human health and well-being, in line with many Sustainable Development Goals

8. The Montreal Protocol has stimulated intense research into the health risks of skin cancer and other diseases from high levels of solar UV radiation, leading to increased knowledge and improved diagnosis and treatment. Likewise, there has been greater focus on the environmental effects of increased UV-B radiation and on the interaction with the effects of rapid climate change.

9. Changes in UV radiation, stratospheric ozone and climate are linked through a number of complex processes. Understanding those processes is made difficult by rapidly changing environmental conditions and the nature of the biological systems that they impact.

10. Human health and well-being have been protected from excessive increases in damaging UV-B radiation (280–315 nanometres) by the Montreal Protocol. While moderate levels of exposure to UV-B radiation are needed for human health (e.g., for the natural production of vitamin D in the skin) and crops (e.g., for the production of compounds that enhance nutritional quality and resistance against pests and pathogens), high levels of UV radiation are harmful, in particular to the human skin and eyes, the food supply and the integrity of our infrastructure. The effects of rising temperatures, drought and extreme weather events interact with those of UV radiation to threaten ecosystems and agriculture, and they compromise the structural integrity and service lifetimes of materials used in construction, such as plastics and wood.

11. Exposure to UV radiation accounts for over half the risk of developing malignant melanoma in light-skinned populations, a risk that would have increased many times over if the depletion of the stratospheric ozone layer had been more severe. Skin cancer in many non-Article 5 countries is the most expensive cancer, with treatment costs for cutaneous malignant melanoma in the United States of America estimated at $457 million in 2011 and projected to increase to $1.6 billion by 2030.

12. Given that UV-B radiation is also a major risk factor for cataracts and other eye diseases, a major increase in levels of blindness has also been avoided. In 2015, cataracts were responsible for blindness in over 12 million people, with visual impairment in a further 52 million, and macular degeneration affected 8.4 million people worldwide, although mainly as a result of longer wavelengths of UV radiation.

13. Human behaviour is an important additional regulator of exposure to UV radiation and is influenced by changing climate conditions. The Montreal Protocol has prompted the establishment of many sun protection programmes by raising awareness of the harm caused by exposure to high levels of UV radiation due to stratospheric ozone depletion.

14. The Montreal Protocol has also stimulated a much better understanding of the role of solar UV radiation as a factor in other pressing environmental challenges. For example, UV radiation degrades and breaks down many plastics, contributing to the formation of microplastics, which we now know have accumulated in many organisms, including fish marketed for human consumption. Similarly, UV radiation can, in some instances, modify the toxicity of certain contaminants in aquatic ecosystems, including pesticides and compounds from the incomplete burning of fuels, garbage, flesh and plants. Future changes in stratospheric ozone and UV radiation may also interact with climate-related changes in the seasonal timing of animal, plant and agricultural crop development. The extent of the consequences of the interaction among future changes in solar UV radiation and other environmental changes as well as their various effects are not known at present.

15. While further investigation remains necessary to provide a detailed understanding of the implications of that interaction, there is no doubt that the societal benefits of a restored UV radiation environment under the Montreal Protocol contribute to the achievement of many Sustainable

Development Goals, including Goals 2 (zero hunger), 3 (good health and well-being), 11 (sustainable cities and communities), 13 (climate action), 14 (life below water) and 15 (life on land).

III. Full implementation of the Kigali Amendment will significantly decrease projected HFC emissions. Those emissions would have contributed substantially to climate change by 2100

16. HFCs are increasingly used as alternatives to ozone-depleting substances in refrigeration and air conditioning, as aerosol propellants and in foam blowing. While they do not contain ozone-depleting chlorine or bromine, they are nevertheless greenhouse gases. The Kigali Amendment, which was adopted in 2016 and came into force in 2019, sets schedules for the phase-down of global production and consumption of specific HFCs. Although the radiative forcing from atmospheric HFCs is currently small, the Kigali Amendment is designed to avoid unchecked growth in emissions and associated warming arising from projected increases in demand in coming decades.

17. The atmospheric abundances of most currently measured HFCs are increasing, as projected in the baseline scenario of the 2014 assessment. Emissions of HFCs in carbon dioxide (CO_2)-equivalence, which originate from both Article 5 and non-Article 5 parties, increased by 23 per cent between 2012 and 2016.

18. Radiative forcing by HFCs currently amounts to 1 per cent (0.03 Watts per square metre ($W\ m^{-2}$)) of the 3 $W\ m^{-2}$ supplied by all long-lived greenhouse gases, including CO_2, methane (CH_4), nitrous oxide (N_2O) and halocarbons. While radiative forcing by HFCs is currently small, it has been estimated that, without the Kigali Amendment, radiative forcing would have reached 0.25 $W\ m^{-2}$ by 2050. Owing to the Kigali Amendment, it is projected that global average warming due to HFCs will be reduced from a baseline of 0.3°C–0.5°C to less than 0.1°C by 2100. A more rapid phase-down of HFCs than that required by the Amendment would further limit climate change from HFCs.

19. The planned HFC phase-down under the Kigali Amendment, as well as regional regulations, are driving industry towards low-global-warming-potential HFC alternatives and innovative applications, especially with respect to refrigeration, air conditioning and foam. However, the fact that the options for new products with lower global warming potential are limited creates challenges in finding the best solution for each application, taking into consideration factors such as flammability, toxicity, availability and operating conditions (e.g., under high ambient temperatures).

IV. Improvements in energy efficiency during the HFC phase-down have the potential to accelerate and further increase the climate benefits from the Kigali Amendment

20. There is a steady increase in the demand for air conditioning, which will increase with climate change. Improved energy efficiency of air conditioners will reduce energy use and limit the need for new power plants. Improving the energy efficiency of air conditioning in residential settings in the near term is particularly important for developing nations, which are in the early stages of projected substantial growth in air-conditioning use.

21. Around 90 per cent of the potential improvements in energy efficiency in refrigeration and air conditioning would come from the technological innovation of equipment, rather than refrigerant changes. However, change in refrigerants during the HFC phase-down under the Kigali Amendment will provide an opportunity to simultaneously improve the energy efficiency of refrigeration and air-conditioning equipment, which will reduce the increasing global energy demand. These twin phenomena constitute societal benefits of the HFC phase-down.

22. In selecting a refrigerant, several factors must be considered, including its suitability for the targeted use, the availability and cost of the refrigerant, the availability and cost of the associated refrigeration and air-conditioning equipment, the cost and effectiveness of servicing, energy efficiency, safety and flammability, ease of use, and its impact on climate and the environment. Since 2014, 35 new refrigerants have received a standard designation and safety classification, of which 5 are single-compound refrigerants and 30 are blends. Research conducted under high-ambient-temperature conditions has identified viable low-global-warming-potential refrigerant alternatives. There is more awareness of the challenges faced under high-ambient-temperature conditions in the design, installation, operation and servicing of equipment that is capable of delivering a high level of energy efficiency using low-global-warming-potential refrigerants.

V. Global total CFC-11 emissions have increased unexpectedly, inconsistent with the expected release from banks, suggesting new global production not reported under the Montreal Protocol

23. In response to Montreal Protocol controls, the abundance of CFC-11 in the atmosphere has been declining steadily for more than two decades. Given its substantial atmospheric abundance and the slow rate of decline due to its 52-year atmospheric lifetime, CFC-11 will remain a major source of stratospheric ozone-destroying chlorine in coming decades. There is major concern that the CFC-11 decline has recently slowed more than expected, which suggests that new production has taken place.

24. Before its phase-out, CFC-11 was used primarily as a foam-blowing agent, as a refrigerant and in a range of other smaller or less common uses, including medical inhalers and in tobacco expansion. Non-ozone-depleting-substance replacements for all those applications have been available since the mid1980s. Production of CFC-11 was phased out in non-Article 5 parties in 1996, and in Article 5 parties in 2010, except for essential uses in Article 5 parties, which ceased to be the case in 2014. No feedstock uses of CFC-11 have been reported.

25. An increase in global CFC-11 emissions after 2012 has been inferred from CFC-11 measurements made by two independent global observation networks. Average emissions for the period 2014–2016 were approximately 10 gigagrams (Gg yr^{-1}) higher than those for the period 2002–2012, which were already greater than projected emissions from the release of CFC-11 from the estimated banks (i.e., CFC-11 contained in existing equipment and products). Those new emissions are likely arising from new production, which has not been reported to UNEP and is hence in contravention of the Montreal Protocol. At least part of the increase in emissions originates from Eastern Asia, although the relative contribution of that region to the overall rise in global emissions has not been quantified. Understanding the potential continued uses of CFC-11 and the release rates from CFC-11 banks is essential in projecting future patterns of CFC-11 emissions.

26. Further investigation is required to provide a detailed understanding of the causes and implications of those unreported emissions. The Scientific Assessment Panel and the Technology and Economic Assessment Panel are working together to provide timely updates on this issue to the Parties. In response to decision XXX/3 of the Thirtieth Meeting of the Parties, the two panels are engaged in coordinated efforts to provide additional information regarding atmospheric monitoring and modelling related to the unexpected CFC-11 emissions, with a particular focus on potential sources of emissions of CFC-11 and related controlled substances.

VI. Sources of carbon tetrachloride are now better understood, considerably closing the gap between known sources of emissions and estimates from atmospheric observations

27. Significant carbon tetrachloride (CCl_4, CTC) emissions have been identified and newly quantified to be in excess of 25 Gg yr^{-1}. Those emissions originate mainly from the industrial production of chloromethanes, perchloroethylene and chlorine, and fugitive emissions from the chlor-alkali process. The global budget of CTC is now much better understood than before, and the previously unexplained large gap between industry-based emission estimates and higher estimates based on observations has been substantially narrowed. Improved manufacturing practices to reduce fugitive emissions and a more comprehensive review of production facilities for chloromethanes and perchloroethylene could lead to a reduction in CTC emissions.

VII. The atmospheric abundances of a number of minor ozone-depleting substances have been increasing; cumulatively, those compounds may eventually have an impact on stratospheric ozone

28. Dichloromethane (DCM, CH_2Cl_2) (180-day lifetime) contributes a small percentage to current total stratospheric chlorine loading. Total chlorine from very-short-lived-substance source gases increased by about 20 parts per trillion (ppt) between 2012 and 2016 to reach 110 ppt. Dichloromethane is the main component of very-short-lived-substance chlorine and accounts for the bulk of the rise in total chlorine from very-short-lived substances between 2012 and 2016. Given market trends in chemical production and DCM usage, global DCM production and atmospheric concentrations are currently not expected to increase significantly in the next few decades.

29. Dichloroethane (EDC, CH_2ClCH_2Cl) (82-day lifetime) is also a very-short-lived substance. Based on projected EDC consumption, the background atmospheric concentration of EDC could double by 2030, but its impact on stratospheric chlorine is expected to be small because of the short lifetime of EDC.

30. Observation-based analyses show an unexpectedly stable or even increasing abundances of some low-level CFCs between 2012 and 2016, including CFC-13 (3 ppt, 640-year lifetime); CFC-113a (0.7 ppt, 55-year lifetime); CFC-114 (15 ppt, 189-year lifetime; and CFC-115 (8.5 ppt, 540-year lifetime).

31. Vigilance regarding the atmospheric abundance of those minor compounds is warranted to preclude surprises with respect to future stratospheric ozone depletion.

VIII. While halon abundances are declining slowly, the demand for halon-1301 remains, which may not be met in the future without new production

32. Total bromine in the atmosphere from halons has decreased from a peak of 8.5 ppt in 2005 to 7.7 ppt in 2016. The abundances of halon-1211, halon-2402 and halon-1202 continued to decline between 2012 and 2016. In contrast, the abundance of halon-1301 initially increased, but then appeared to stabilize by 2016. That suggests higher-than-projected emissions of halon-1301 into the atmosphere. Since there has been no known production of halons for two decades, the stock of halon-1301 could be significantly less than that required to fill ongoing needs.

33. Demand for halons for fire-fighting uses persists, and will ultimately exceed the supply from stockpiles without the implementation of alternatives. There are continuing long term uses of halons (e.g., in oil and gas facilities, nuclear facilities and military installations) and growing demand from civil aviation for halon-1301 owing to the lack of replacements for engine and cargo compartment fire-fighting applications in new aircraft. The increased emissions suggest that stockpiles of halon-1301 could run out sooner than the previous estimates of between 2032 and 2054. In addition, there are regional imbalances, which could mean that those parties that lack dedicated, long-term stockpiles could run out even earlier. Therefore, there is a strong likelihood that essential use nominations for the production of new halon-1301 will be submitted to supply those important fire-fighting uses, especially for civil aviation and oil and gas operations.

IX. Quantifying ozone-depleting-substance banks and the time course of their continued emissions is key to determining the pace of ozone layer recovery

34. Estimates of the amounts of ozone-depleting substances contained within existing equipment and products, referred to as banks, are combined with atmospheric ozone-depleting-substance observations to develop scenarios for future emissions of ozone depleting substances. Knowledge of the sources, absolute amounts and rates of release are critical to understanding future emissions from banks. For example, quantifying the bank associated with the recently identified, unreported emissions of CFC-11 will depend on how the CFC-11 was used. This is particularly important in estimating the total amount of CFC-11 that was produced and its potential impact on stratospheric ozone recovery (see sect. V above).

35. In the past, it would have been valuable to recover and destroy ozone-depleting substances in banks. Now, as the proportion of ozone-depleting substance in banks declines and they become less accessible, doing so will become more difficult and less economically viable, with declining environmental benefit. Nevertheless, if it were feasible, eliminating the current known banks of CFCs, halons and HCFCs would result in a slightly larger contribution to the reduction of future ozone depletion than the complete elimination of HCFCs, methyl bromide and CTC production over the next four decades.

X. Stratospheric ozone depletion and climate change are linked because ozone-depleting substances are powerful greenhouse gases and climate change modifies stratospheric ozone

36. Cooling in the lower stratosphere due to ozone depletion has very likely been the dominant cause of changes in the summer climate of the southern hemisphere in the late twentieth century. The changes include the observed poleward shift in southern hemisphere tropospheric circulation, with an associated impact on surface temperature and precipitation. There is growing evidence that ecosystems and agriculture in the southern hemisphere are being affected by these changes in climate, with examples of positive and negative effects on the biodiversity and productivity of aquatic and terrestrial organisms. The ecological effects are expected to reverse as the Antarctic region recovers from severe stratospheric ozone loss. No robust link has been established between stratospheric ozone depletion and long-term surface climate changes in the northern hemisphere.

37. Changes in the levels of ozone-depleting substances have a direct impact on climate since, in addition to depleting ozone, they are also powerful greenhouse gases. Total radiative forcing from controlled ozone-depleting substances and their replacements continues to be strongly limited by the Montreal Protocol, including the Kigali Amendment. Without the Montreal Protocol, radiative forcing from ozone-depleting substances would have increased to about 40 per cent of CO_2 forcing by 2020. Owing to the Protocol, radiative forcing from CFCs is presently about 14 per cent of CO_2 forcing. The sum of CFC and HCFC radiative forcing has been stable for about two decades and is just starting to decline, along with their atmospheric abundances.

38. Future geoengineering efforts to mitigate climate change by generating stratospheric aerosols to reflect sunlight have the potential to alter stratospheric ozone in ways that we do not yet fully understand.

XI. The timing and extent of the recovery of stratospheric ozone depends on future concentrations of ozone-depleting substances and greenhouse gases

39. The processes controlling future changes in stratospheric ozone are complex. As levels of ozone-depleting substances decrease, total column ozone in the mid latitudes of the northern hemisphere is expected to return to 1980 values in the 2030s, and total column ozone in the mid latitudes of the southern hemisphere is expected to do the same around the middle of the twenty-first century. The Antarctic ozone hole is expected to gradually close, with springtime total column ozone returning to 1980 values in the 2060s.

40. In the second half of the twenty-first century, by which time the influence of ozone-depleting substances is expected to have greatly diminished, emissions of the principal greenhouse gases, namely CO_2, CH_4 and N_2O, are predicted to become the main drivers of stratospheric ozone changes through their effects on climate and atmospheric chemistry. Without the substantial mitigation of projected future levels of greenhouse gases, by 2100 the stratospheric column of ozone is expected to decrease in the tropics by about 3 per cent from 1980 values. In the mid-latitudes and the Arctic, stratospheric ozone is expected to recover and eventually exceed average values for the period 1960–1980.

41. In addition to continuing to constrain future atmospheric concentrations of ozone-depleting substances, the Montreal Protocol, in particular with the adoption of the Kigali Amendment, has made and will continue to make a substantial contribution to preventing climate change through controlling HFCs.

XII. The decline in atmospheric concentrations of methyl bromide has halted

42. The controlled use of methyl bromide has declined by over 99 per cent from its peak in 1991 of 64,000 tonnes. However, atmospheric concentrations of methyl bromide have stopped declining, indicating possible continued use in an amount greater than that currently reported for quarantine and pre-shipment (exempted) applications. An estimated 40 per cent of reported quarantine and pre-shipment uses have immediately available alternatives, but these have not been adopted because quarantine and pre-shipment uses are exempted under the Protocol. Furthermore, around 70 per cent of current methyl bromide emissions from reported quarantine and pre-shipment uses could be avoided through re-capture or destruction in the case of quarantine and pre-shipment uses for commodities and

through the installation of barrier films in the case of remaining pre-plant soil fumigation uses that have been classified as quarantine and pre-shipment uses. The resulting reductions in atmospheric concentrations of methyl bromide would provide near-term benefits for the ozone layer.

XIII. Foam production continues to increase with the on-going transition from ozone-depleting substances to zero-ozone-depleting-potential and low-global-warming-potential blowing agents

43. There have been significant improvements in the development and availability of additives, co-blowing agents, equipment and formulations that have enabled the successful commercialization of foams and foam systems containing low-global-warming-potential blowing agents.

44. In Article 5 parties, growth in the construction sector and in the handling, processing and transportation of perishable goods (e.g., through a cold chain), coupled with the adoption of enhanced energy efficiency criteria for buildings, have led to a steady growth in demand for thermal insulation materials.

45. Total global production of polymeric foam is projected to grow to 29 million tonnes by 2023. The production of foams used for insulation will grow in line with global construction and the continued development of refrigerated food processing, transportation and storage. Estimated demand for blowing agents for polyurethane and expanded polystyrene is greater than 400,000 tonnes, with demand of an additional 10,000 tonnes for use in the production of other foam types.

46. The conversion from the use of HCFC-141b to the use of hydrocarbons in insulation foam applications has been largely successful within most large and some small and medium-sized enterprises, where the critical mass of the operation is sufficient to justify investment in hydrocarbon technologies. However, managing the transition to the use of flammable blowing agents in the production of foam remains a challenge for many small and medium-sized enterprises in both Article 5 parties and non-Article 5 parties.

XIV. The continued success of the Montreal Protocol in protecting stratospheric ozone depends on continued compliance with Protocol provisions

47. Non-compliance with the Montreal Protocol (e.g., in respect of CFC-11 emissions: see sect. V above) and unexpected increases in unregulated ozone-depleting substances (e.g., dichloromethane; and methyl bromide in quarantine and pre-shipment uses) increase ozone depletion and have the potential to substantially delay the recovery of the ozone layer. The larger the emissions and the longer they persist, the greater the impact on the ozone layer. Thus, continued compliance with Montreal Protocol provisions is essential to guaranteeing the recovery of the ozone layer and maximizing the speed of that recovery. The discovery of unreported CFC-11 emissions highlights the value of long-term, comprehensive networks in measuring atmospheric levels of ozone-depleting substances and the global budgets derived from those measurements.

48. Considering ozone-depleting substances other than CFC-11, the availability of additional options to hasten the recovery of the ozone layer is limited, mainly because the decisions that could help significantly have already been taken. Remaining options would individually lead to small-to-modest ozone benefits. Those options could include the complete elimination of both controlled and uncontrolled emissions of ozone-depleting substances; bank recapture and destruction of unwanted or surplus CFCs, halons and HCFCs; and the reduction of HCFC and methyl bromide production and consumption (e.g., in quarantine and pre-shipment uses).