

The 2014 WMO/UNEP Scientific Assessment of Ozone Depletion Overview

14 January 2014

I. Scope

The state of scientific understanding regarding the ozone-depletion issue has advanced in recent years as a result of the concerted efforts of hundreds of scientists worldwide. Acknowledging this progress, the assessments are now focused on answering the question, “What’s *new* regarding this issue that is of utmost relevance to the Parties to the Montreal Protocol?”

The most recent assessment (2010; the “green book”; 5 chapters; URL: <http://www.esrl.noaa.gov/csd/assessments/ozone/2010/>) built upon the knowledge of the 2006 assessment (“tan book”; 8 chapters) and focused on a few topics that were: (i) ones in which substantial advances had occurred (e.g., climate-ozone connections) and (ii) updated/new information requested by the Parties to the Montreal Protocol.

The 2014 assessment will continue in this tradition of updating the previous assessment in describing “what’s new” and providing the Parties with information that they specifically requested for the 2014 report (see the Attachment A on page 6, Terms of Reference from Decision XXIII/13 of the Parties to the Montreal Protocol, Bali, Indonesia, November 2011). With regard to the second point, the 2014 assessment will have an increased emphasis on providing information in policy-relevant formats that are most conducive to use by decision-makers, such as the Parties to the Montreal Protocol. This is based on the feedback we have received from the Parties, the UNEP Ozone Secretariat, and others in the decision-making community. To accomplish this goal, we have made some changes to the approach used in past assessments.

II. Approach

Overview

Recognizing that the assessment is fundamentally driven by the needs of decision-makers and is produced in accordance with the terms of the Montreal Protocol, a new approach to publishing the assessment will be used for 2014 (see schematic, next page). In this approach, the assessment will have a component that is aimed specifically at meeting the needs of decision-makers. This component will be a short document, on the order of 30-40 pages including figures (plus appendices), focused on policy-relevant information and highlights, and written in a very understandable language to facilitate its use by the Parties and other decision-makers. This document will subsume—and add to—the material previously referred to as the “Executive Summary” of the assessment. It will be published both in printed form and on the Web. Detailed scientific chapters will still provide the scientific basis for the above document for decision-makers. As in the past, the chapters will be published on the Web; but unlike in the past, they will not be published in a printed book (following the path that most scientific journals now employ).

The above approach will have several advantages.

- *For decision-makers:* The new approach will emphasize policy-relevant information in a way that communicates more effectively with decision-makers. By putting all the information they need into one, shorter document—instead of distributing it within an Executive Summary and accompanying ~500-page document that is largely too scientifically detailed for their needs—the decision-relevant information will be presented in a much more accessible fashion.
- *For the authors:* The new approach will provide a more focused, and thereby improved, mechanism for the authors and contributors to convey the policy-relevant science information.

- *For the scientific community:* The detailed scientific update will still be achieved via the assessment’s chapters, and the information generated will be provided in a format (digital, web-based) that is now the norm for scientific publications.
- *For all:* All materials will be readily accessible on the Web.
- *For the sponsoring organizations:* Expenses (staff time, printing costs) will be significantly reduced.
- *For the environment:* The amount of printed material will be greatly reduced, thereby reducing shipping costs and materials usage (paper, ink, etc.).

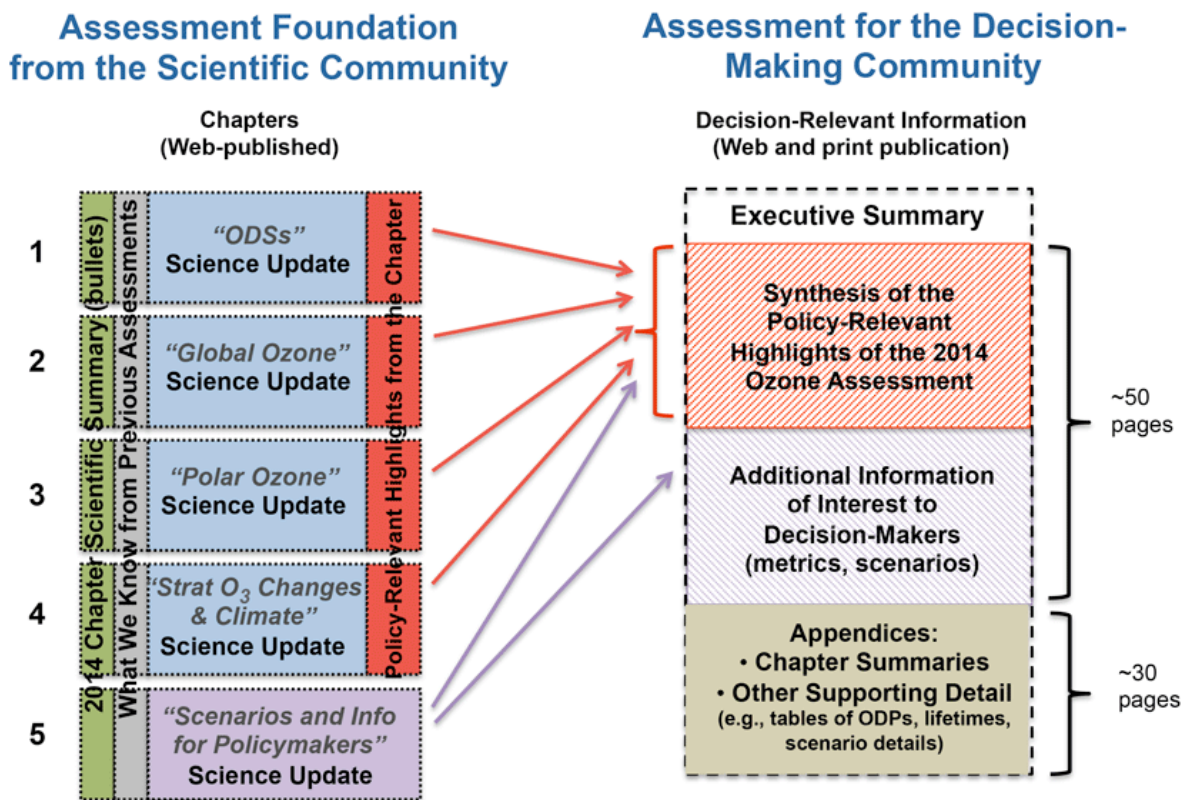
The 2014 assessment will use much of the same basic chapter structure that was used in the 2010 assessment (the “green book”). This will greatly simplify the early discussions of organizing chapter material, decisions on topic placement within the chapter structure, and cross-chapter coordination. This also allows us to focus on only what is new, without repeating what is in the green book. This simplification enables some of the changes in approach and schedule that are discussed below.

Assessment Structure

As described in the above overview, the assessment process will result in two components:

- (1) Scientific Chapters
- (2) Information for the Decision-Making Community

The structure of each of these is shown in the schematic below.



The Scientific Chapters (left side of schematic)

- As in the past, the chapters will begin with a scientific summary (~2-4 pages) that gives a bulleted list of the science highlights of the chapter.
- A short section (~1-2 pages) at the start of each chapter summarizes highlights of the 2010 assessment, thus giving the reader a useful recap of the “starting point.”

- The bulk of the chapters will have explicit references to what is new since the 2010 assessment, so that the message that “this is an update” is executed successfully. Focused chapters will be encouraged by emphasizing that the assessment should “start from the green book and build forward.”
- New for 2014: The chapters will conclude with a section (~3-5 pages maximum) that distills policy-relevant information highlights. Figures in this section will be specifically designed to convey the information in a less detailed, more digestible format than the figures typically found in the scientific literature.

Information for the Decision-Making Community (right side of schematic)

This document will provide information that is specifically of interest to decision-makers, such as the Parties to the Montreal Protocol. Three major components are envisioned:

- Part 1 (red hatched) – a synthesis of the policy-relevant highlights of the chapters (derived from the red sections of Chapters 1-4 and perhaps some components of Chapter 5)
- Part 2 (purple hatched) – information newly developed for this assessment that is specifically relevant for decision makers, including the scenarios material developed in Chapter 5
- Appendices (brown) – As done in the 2010 assessment, the more-detailed bullets from the Chapter Summaries will be compactly provided as an appendix. In addition, other appendices will include detailed information that is most closely linked to the above policy-relevant information, such as details of the scenarios, ODPs, GWPs, ODS lifetimes, etc. A detailed list of all participants in the assessment and their roles will be provided here as well (following Appendix A of the 2010 ozone assessment).

This document for the decision-making community will be drafted and reviewed by the Cochairs, Steering Committee, Lead Authors, Chapter Editors, and Les Diablerets panel reviewers. Because the Chapters form the scientific foundation for this document, the Chapters will be finalized earlier in the process than in past assessments (before Les Diablerets; see Timeline in Attachment C, page 7). The Panel Review meeting in Les Diablerets will be focused on producing the assessment for decision-making (right side of the schematic).

Chapter Team Structure

The 2014 ozone assessment chapters will return to the author structuring used in 2006 and earlier assessments, namely: two Lead Authors, Coauthors, and Contributors. The Coordinating Lead Author tier used in 2010 will not be used in 2014 (this is in response to feedback we received in 2010). New for 2014: Each chapter will have two Chapter Editors, who will ensure that review comments are adequately and appropriately dealt with, and will also help the Lead Authors coordinate with other chapters. Chapter Editors could also assist the Lead Authors in identifying policy-relevant information from the chapter.

Information from Other Assessments, Reports, and Publications

The 2014 ozone assessment will both draw from and build upon the findings of:

- the 2010 ozone assessment;
- the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (to be published in early 2014, but released in late 2013 at <http://www.ipcc.ch/report/ar5/wg1/>);
- the SPARC assessment/reevaluation of the lifetimes of halogen source gases, *Lifetimes of Stratospheric Ozone-Depleting Substances, Their Replacements, and Related Species* (published on 19 December 2013; see <http://www.sparc-climate.org/publications/sparc-reports/sparc-report-no6/>);
- new studies published in the peer-reviewed literature since the 2010 ozone assessment.

Leadership and Timetable

The Cochairs and Steering Committee of the Scientific Assessment Panel are listed on page 6. The estimated timetable for the 2014 assessment is shown on page 7.

III. Chapters and Their Topics

The 2014 assessment's chapter structure contains five chapters, paralleling much of the chapter structure of the 2010 assessment (with a recasting of Chapters 2 and 3, and with slight rewordings of the chapter titles in some cases):

1. Update on Ozone-Depleting Substances (ODSs) and Other Gases of Interest to the Montreal Protocol
2. Update on Global Ozone: Past, Present, and Future
3. Update on Polar Ozone: Past, Present, and Future
4. Stratospheric Ozone Changes and Climate
5. Scenarios, Information, and Options for Policymakers

Because the chapter material will be an update of the 2010 report, the cumulative sum of their pages will aim to be about half the sum total of the five chapters of the green book. Guidelines on number of pages and figures will be established for each of the chapters and strictly adhered to.

A brief synopsis of each chapter's topics is given below.

Chapter 1. Update on Ozone-Depleting Substances (ODSs) and Other Gases of Interest to the Montreal Protocol

Focus: Long-lived and short-lived substances that deplete the ozone layer (e.g., CFCs, HCFCs, methyl bromide) and other molecules of special interest to the Parties (e.g., HFCs, N₂O, other recent substitutes, very short-lived substances). Major sections will address updated information on lifetimes, trends, and budgets, based on observations and models. The information will take into account, and draw from, the data and analyses in the 2010 ozone assessment and the AR5 report by the IPCC (to be published in early 2014; pre-release version available at <http://www.ipcc.ch/report/ar5/wg1>), as well as the SPARC assessment on lifetimes of halogen source gases (due out November 2013; pre-release version available at: <http://www.sparc-climate.org/publications/sparc-reports/sparc-report-no6/>). Updated information on the carbon tetrachloride budget is specifically requested by the Parties and will be included, as will information also requested by the Parties on the potential new ODS, R-316c. The chapter (via interactions with the Technology and Economics Assessment Panel) will provide emissions information used in Chapters 2, 3, and 4 (below) of this 2014 ozone assessment. Any special, hitherto unassessed issues related to degradation of ODSs will be discussed. A discussion of tropospheric OH will be included, considering its importance in determining the atmospheric lifetimes of ODSs and related gases. For short-lived substances, there will be two major emphases of the chapter: (i) the short-lived gases in the Protocol that are still significant contributors to ODS loading (e.g., methyl bromide); and (ii) any updates to the thinking developed in previous assessments regarding the "very" short-lived substances (atmospheric lifetimes of less than about 0.5 yr), for which the traditional concept of a single, emission geography-independent and time-independent Ozone Depletion Potential does not apply (see Attachment A, Terms of Reference from the Parties to the Montreal Protocol, page 6). The spatial and temporal dependences of ODPs, discussed in Chapter 5 of this 2014 ozone assessment, will be referenced. This chapter will no longer cover material related to carbon dioxide and only a limited update regarding methane, since the IPCC AR5 will provide a very recent and comprehensive update for that information.

Chapter 2. Update on Global Ozone: Past, Present, and Future

Focus: Updated status of the observations and understanding of global ozone and rationalization of the variance (all scales) of the observations, including the potential roles of climate change and other non-halogen effects; update on expected trends of future ozone based on model calculations. This chapter assesses the insights that are possible by analyzing a combination of different satellite and ground-based data sets and sondes, as well as the role of large-scale, longer-term dynamics in the ozone changes of the lower stratosphere. Observations of aerosols, and the possible influences of changes in aerosols as well as the solar cycle, are core information for this chapter. The chapter applies rigorous statistical methods in defining ozone changes. Discussion of causes of past ozone changes is also included in the chapter by the analysis of a range of model simulations (two-dimensional or 2-D and three-dimensional or 3-D).

This chapter also addresses the trends of future ozone based on recent model calculations. This is a key “closure” issue for the Montreal Protocol. This chapter addresses the question of how climate change will affect the evolution of the ozone layer and ozone-layer recovery, with emphasis on the mechanisms and key processes involved. Coupled chemistry-climate models (CCMs) will be used to elucidate and examine the mechanisms and processes. Two primary issues regarding the future ozone layer are (i) the detection and attribution of ozone recovery, and (ii) the projections of future ozone through the 21st century. CCMs would be used to explore several possible future developments relevant to the ozone layer, such as circulation acceleration in the tropical lower stratosphere. Potential influences such as volcanoes, geoengineering, and tropospheric composition changes (including emission scenarios) will be briefly included. Model predictions will include a discussion of uncertainties and potential for future surprises.

Chapter 3. Update on Polar Ozone: Past, Present, and Future

Focus: Polar ozone/temperature changes and processes; update on expected trends of future Arctic and Antarctic ozone and scientific understanding. The chapter includes a thorough update on the understanding of ozone trends and variability in the Arctic and Antarctic, building upon recent extensive observations, field studies, and theory. The Antarctic section additionally assesses recent changes and near-term expectations. Past assessments have underscored the fact that small year-to-year variability is expected (e.g., changes in vortex patterns and early formation and/or breakup) and, here, the overall picture for the persistence of the ozone hole for decades is explored. The 2011 Arctic ozone losses are briefly discussed in the context of long-term trends and expectations. The climatology of polar stratospheric clouds (PSCs) is discussed mainly in the context of the Arctic region. Our understanding of the observed ozone changes due to halogen loading, temperature changes, and dynamical processes is highlighted.

As with the Global Chapter 2, this chapter also updates the trends of future Arctic and Antarctic ozone based on most recent investigations using model calculations and scientific understanding. Because polar ozone losses are the most prominent effects of ODSs on our atmosphere, this is a key “closure” issue for the Montreal Protocol. This chapter addresses the question of how climate change will/will not affect the evolution of polar ozone and recovery, with emphasis on the mechanisms and key processes involved. CCMs are used to elucidate and examine the mechanisms and processes. Two primary issues regarding the polar ozone are (i) the detection of both Antarctic (ozone hole) and Arctic recovery, and (ii) assessment of future polar ozone levels through the 21st century. Potential influences such as volcanoes and geoengineering are briefly included. Model predictions include a discussion of uncertainties and potential for future surprises.

Chapter 4. Stratospheric Ozone Changes and Climate

Focus: The influence of stratospheric ozone changes on tropospheric and surface climate. The chapter discusses changes in stratospheric composition, as well as changes in stratospheric temperature and circulation. The effects of stratospheric ozone change on the tropospheric circulation are assessed, and the effects on surface climate, the ocean, sea ice, radiative forcing, and tropospheric chemistry are discussed. This chapter will also include the discussion of water vapor (including observations of its changes), stratospheric aerosols, and source gas changes in the context of stratospheric temperature trends. The chapter assesses the effects of future changes in stratospheric ozone on the troposphere.

Chapter 5. Scenarios, Information, and Options for Policymakers

Focus: Projected future behavior/scenarios of effective equivalent stratospheric chlorine (EESC). Future scenarios will be developed (via interaction with the Technology and Economic Assessment Panel) for emissions of controlled substances expected under the Protocol and other assumptions. The major characteristics of the future abundances will be explored (including the impact of revised lifetimes), and the differences among the scenarios could be quantified with respect to the estimated anthropogenic impact of ODSs on stratospheric ozone depletion. Updated (where needed) ODPs and GWPs will be included in the chapter. The chapter also will examine the implications of different policy approaches for the radiative forcing by HFCs and their potential replacements.

A. Request from the Parties to the Montreal Protocol

The following are the Terms of Reference for the Scientific Assessment Panel, from Decision XXIII/13 of the Parties to the Montreal Protocol:

“...that the 2014 report of the Scientific Assessment Panel should include:

- (a) Assessment of the state of the ozone layer and its future evolution, including in respect of atmospheric changes from, for example, sudden stratospheric warming or accelerated Brewer-Dobson circulation;*
- (b) Evaluation of the Antarctic ozone hole and Arctic winter/spring ozone depletion and the predicted changes in these phenomena, with a particular focus on temperatures in the polar stratosphere;*
- (c) Evaluation of trends in the concentration in the atmosphere of ozone-depleting substances and their consistency with reported production and consumption of those substances and the likely implications for the state of the ozone layer and the atmosphere;*
- (d) Assessment of the interaction between the ozone layer and the atmosphere; including:*
 - (i) The effect of polar ozone depletion on tropospheric climate;*
 - (ii) The effects of atmosphere-ocean coupling;*
- (e) Description and interpretation of observed ozone changes and ultraviolet radiation, along with future projections and scenarios for those variables, taking into account among other things the expected impacts to the atmosphere;*
- (f) Assessment of the effects of ozone-depleting substances and other ozone-relevant substances, if any, with stratospheric influences, and their degradation products, the identification of such substances, their ozone-depletion potential and other properties;*
- (g) Identification of any other threats to the ozone layer...”*

B. Cochairs and Steering Committee of the Scientific Assessment Panel of the Montreal Protocol

Cochairs:

Ayité-Lô Ajavon (Togo)
Paul A. Newman (United States of America)
John A. Pyle (United Kingdom)
A.R. Ravishankara (United States of America)

Steering Committee:

David Karoly (Australia)
Malcolm Ko (United States of America)
Ted Shepherd (United Kingdom)
Susan Solomon (United States of America)

C. Estimated Timetable

Discussion Paper circulated for comments by scientific community	February 2013
Lead Authors and Chapter Editors established	early April
Chapter author teams assembled, early preparation steps begin	early May
Draft of Chapter outlines due	late May
First meeting of Lead Authors, Cochairs, Steering Committee, Chapter Editors (to discuss/plan first drafts)	10-11 June; Cambridge, UK
Individual Chapter team meetings (convened by Lead Authors)	July-August-September
First drafts of Chapters completed	30 October
Mail Review of Chapter first drafts	1 November to 10 December
Second draft of Chapters completed	early March 2014
Second meeting of Lead Authors, Cochairs, Steering Committee, Chapter Editors, and other reviewers (to review Chapter second drafts, discuss mail review comments and responses, and finalize Chapter bullets)	8-10 April; Boulder, USA
Drafting of Assessment for Decision-Makers begins	early April
Final drafts of Chapters completed	mid-May
Draft of Assessment for Decision-Makers distributed to Les Diablerets Panel Reviewers	early June
Panel Review Meeting (to discuss and finalize the Assessment for Decision-Makers)	23-27 June; Les Diablerets
Assessment for Decision-Makers available on Web	10 September
Assessment for Decision-Makers printed, and Chapters available on Web	December 2014