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Ongoing and Planned Activities Relevant to the World Plan of Action on the Ozone Layer

Contribution

by

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CO-ORDINATING COMMITTEE ON THE OZONE LAYER

FIFTH SESSION

COPENHAGEN, 12-16 OCTOBER 1981

Recent research results and ongoing and planned research programmes and activities relevant to the World Plan of Action on the Ozone Layer

(Submitted by the representative of WMO)

Summary

This document reviews action taken by WMO in executing tasks allocated to the Organization in the World Plan of Action on the Ozone Layer since the Co-ordinating Committees' fourth session, through the implementation of the WMO Global Ozone Research and Monitoring Project. It also briefly outlines studies to be undertaken in the future.

INTRODUCTION

1. It will be recalled that WMO was designated lead agency in several fields of the World Plan of Action on the Ozone Layer and its activities are being carried out within the WMO Global Ozone Research and Monitoring Project established by the WMO Executive Committee in Resolution 8 (EC-XXXIII) in 1976.

PURPOSE OF DOCUMENT

2. This document informs the UNEP Co-ordinating Committee on the Ozone Layer of progress made by WMO of direct concern to the implementation of the World Plan since the fourth session of the Committee (Bilthoven, November 1980) and makes proposals for future activities and support.

DISCUSSION

3. The WMO Executive Committee at its thirty-second session, in considering future activities for the WMO Ozone Project, felt that efforts in future years should be directed towards promoting:

- Studies aimed at clarifying physical processes and phenomena which are relevant to ozone photochemistry and stratospheric dynamics;

- Studies of the radiative effect of ozone and other minor species relevant to ozone photochemistry and stratospheric dynamics;

- The use of multiwave-length "short Umkehr" evaluations to achieve a significant increase of vertical ozone profiles, and

- Studies of the affect of aerosol contamination of the stratosphere on Umkehr evaluation.

Total ozone

4. Efforts have continued to upgrade and standardize the global total ozone observing network upon which most other activities in the World Plan depend to some degree. These efforts, detailed below, have been actively supported by UNEP for which WMO is thankful.

5. In the past year, WMO has arranged for upgrading, reactivating, checking and/or re-locating Dobson spectrophotometers 7,17,35,43,47,64,69 and 100. Instrument No. 7 (located at Singapore) was recalibrated after developing a fault; No. 17 was modernised and calibrated by the Canadian AES and returned to Invercargill (New Zealand); an expert visited No. 35 located at St. Helena for calibration and maintenance; No. 43 was returned to Quetta (Pakistan)

following upgrading by the Canadian AES; No. 47 from Italy was re-calibrated after developing problems; No. 64 was calibrated and upgraded by NOAA and will be returned to Egypt and No. 100 was upgraded and then calibrated relative to No. 43 at Quetta. The UK secondary standard No. 41 was carefuly inter-compared with the world primary standard No. 83 at Boulder, Colorado.

6. The WMO Executive Committee at its thirty-third session (June 1981) designated the NOAA laboratories in Boulder, USA as the World Dobson Spectrophotometer Central Laboratory with the function of maintaining Dobson No. 83 as the world primary standard spectrophotometer and of assisting in the upgrading and comparisons of other Dobson ozonespectrophotometers as necessary.

7. Until recently, comparisons between Dobson instruments brought together at a particular location have been the primary means in trying to ensure standardization of ozone observations and data. However, for various reasons (mainly, lack of financial resources) the system is not working as well as desired. Therefore, WMO, taking advantage of the development of the readily portable Brewer spectrophotometer, has arranged for travelling comparisons. An expert with a well calibrated Brewer instrument visited Europe for purposes of comparing Dobson instruments at Belsk, Arosa, Uccle and Bracknell. It is still too soon to report on the success or not of this exercise but first indications are encouraging.

8. A further method for calibrating the global Dobson network has been implemented. In this instance, the world's active Dobson instruments have been divided into seven regional groupings to which calibrated standard lamps sets, payed for by WMO and kindly supplied by NOAA, have been sent. These lamps are intended to be shipped to each station in turn over the course of a year and then returned to NOAA in Boulder where the N values would be checked and the lamps sent back to the stations for the exercise to be repeated. Theoretically, by providing indications of the current conditions of various instruments and identifying needs for revision and comparison, this mechanism is a more efficient and much less expensive way to maintain high standards in the global network.

Vertical ozone distribution

9. Arrangements were made for the Indian balloon-borne ozonesonde to be compared with the FRG used sondes at Hohenpeissenberg in December 1980. This development means that all the world's operational ozonesondes have now been compared relative to each other, thus completing the programme started in 1978. The differences existing between various types of ozonesondes must be considered in any analysis of vertical ozone distribution.

10. WMO has recently arranged for an Egyptian expert to visit the Hohenpeissenberg observatory for purposes of instruction on the operation of balloon-borne ozonesonde observations which are due to start on a trial base in Cairo.

11. WMO has informed Members of the development of the short Umkehr method for determining vertical ozone profiles using Dobson spectrophotometers. This method reduces the time required from about 5 hours to 1-3 hours. Extensive use of the method would provide researchers with a great deal of valuable vertical distribution information, particularly in the 30-50km layer.

12. As has been reported to previous CCOL sessions, WMO supported by FAA NOAA and NASA is engaged in a large study of assessing performance characteristics of various rocket-borne ozone observing systems. A meeting of selected scientists, that is those that took part in the actual intercomparison (Wallops island, Autumn 1979) was held in Saskatoon, Canada from 23-27 March 1981. The Study is progressing well and is expected to provide an assessment of historical rocket data. Also of relevance to this activity was the sponsoring of a Meeting of Experts on Ozone Photochemistry held in Boulder, USA also in March 1981.

Stratospheric assessment

13. Continuous activities carried out, in parallel, or directly under the World Plan and the WMO Ozone Project have generated a great deal of knowledge on the stratosphere and ozone. In view of this, WMO, with support from NASA, NOAA and UNEP organized a meeting of experts on the State of the Stratosphere-1981, whose purpose was to summarize all information available into a single document. The meeting was held at Hampton, Virginia, USA in May 1981. ~~The main~~ Some of the conclusions of the meeting can be summarized as follows (paragraph 14-21).

14. In recent years, although the basic theory of stratospheric chemistry has not changed a great deal, advances in laboratory techniques have provided many new values of chemical reaction rate coefficients and their temperature and pressure dependencies. These determinations are subject to less uncertainty because in many instances the reaction products have now been directly observed, unlike the situation in the past. As a result, the chemical reaction rate coefficients for the reactions involving HO_x species have had to be revised (notably for $OH + HNO_3$, $OH + HO_2NO_2$ and $OH + HO_2$). The pressure dependence of the rate coefficient for $OH + HO_2$ is still a matter of debate. The major effect of these rate coefficient changes has been to change the vertical profile of ozone destruction and production. In the upper stratosphere (~40 km) they have had little impact on predicted ozone depletions due to increased Cl_x or NO_x - there the depletions are still large. However, in the lower stratosphere the impact has been great - most models now predict an increase in ozone in this layer due to CFC's emission with the net result of a greatly reduced overall percentage reduction of the total ozone column. As well the depletion/production of ozone due to increases in NO_x are critically dependent on altitude.

15. Model calculations using the revised chemical reaction rate coefficients indicate a reduction in the stratospheric ozone ranging from about 5 to 10 per cent at steady state ~~(50 to 100 years)~~ for continued release of CFM's at the 1977 rate. Calculations using the same models indicate that large fleets of aircraft, whether supersonic or subsonic operating in or above lower stratospheric altitudes (15 km in the middle and polar latitudes in the current models) would significantly deplete the ozone layer; that fleets operating exclusively below such altitudes would cause some ozone increases. Thus the ozone change attributable solely to existing or planned fleets would depend upon their sizes and operating altitudes.

16. The comparison of model calculations with atmospheric observations of ClO shows that the previous discrepancy in the lower stratospheric altitudes has all but disappeared. However, the observations are about a factor of 2 larger than the model calculations near 40 km.

17. The continuing uncertainty in the ~~$OH + HO_2$~~ reaction rate coefficient makes a direct measurement of OH in the 15-25 km range vitally important.

18. The roles of tropospheric-stratospheric transport and CH_4 oxidation in the stratospheric water vapour budget are still unresolved.

19. The range of available measurements, resulting from different techniques and lines and locations of observations, for other stratospheric trace species (e.g. NO, HNO_3, HCl) is such that these measurements do not provide sufficiently well defined distributions to validate the theoretical models. Clearly, there is a need to carry out further experimental programmes emphasizing in-situ simultaneous measurements of the key trace species.

20. The SBUV data for 1978-79 are reported to give ozone concentrations at 40 km about 5% less than ~~similar~~ SBUV measurements in 1970-71. However detailed analysis has apparently revealed no statistically significant way to interpret this as a trend in upper stratospheric ozone over the decade. In general, individual scenarios for ozone change (e.g. CFMs) cannot at this time be tested for trends against the observations. In addition to natural atmospheric variability and observational deficiencies, the trend may be masked by a variety of possible alternative effects - tropospheric ozone increases due to combustion products (including aircraft emissions), stratospheric increases due to CO_2 cooling, solar variations in 11 year and 22 year range, etc. Hence, one finds that although there are only few positive model validations in terms of measured values and profiles of constituents ~~such as the CFMs, ClO, etc.~~, there is still no way using the available ozone data to statistically confirm or deny the existence of a small ozone trend component.

21. This leads to the conclusion that there is no scientific basis to reject the hypothesis that theoretical model predictions of ozone trends are consistent with the observational evidence and to the recognition that there is a threat of a considerable depletion of the ozone layer in the future. The prudent course of action would be to continue to step up efforts to reduce the scientific uncertainties.

22. The report from the meeting (≈400 pages) is now being edited and will be issued in the WMO Ozone Project publications for wide distribution toward the end of 1981.

Other items

23. Final editing is in progress on a review entitled "Impact of Ozone and Other Atmospheric Minor Gases on Global Climate Changes" prepared by a group of Soviet scientists for the WMO Ozone Project.

24. Although the direct effect of a reduction in stratospheric ozone on global surface temperatures may be small (~0.1°C), other aspects render the ozone layer of importance in the climate problem. Among these are a surface warming component up to 1°C due to tropospheric ozone and the CFMs, dynamical changes in the stratosphere, aerosol effects and links to solar-terrestrial processes, all of which needs further detailed studies.

25. A review is nearing completion on "The use of satellites in ozone measurements, including data availability". The review is being performed by Dr. D. Heath (NASA).

26. Work is continuing on an extensive review on "Stratospheric circulation and ozone analysis". The work is being undertaken by Mr. F. Finger (USA) and Drs. R. Murgatroyd (UK) and R.D. Bojkov (WMO).

27. Publication is expected shortly of a report on ozone 2D modelling capability prepared by Dr. J. Chang (USA).

ACTION PROPOSED

28. The Co-ordinating Committee on the Ozone Layer is invited to note:

- The efforts made and the continuing need to support, maintain and upgrade the Global Ozone Observing System (GOOS), having regard to: Spectrophotometer networks (total ozone and Umkehr profiles); Satellite measurements (upper stratospheric values, particularly important for early trend detection); Ozonesondes (increased importance due to tropospheric and lower stratospheric projected increases);

- Improved information on reaction rate coefficients and continuing need to narrow uncertainty ranges;

- The need for more co-ordinated measurements of trace constituents with particular emphasis on ClO, OH, etc., and of solar radiation parameters;

- The requirement for improved two and three-D modelling with further emphasis on the troposphere and lower stratosphere;

- The latest figures for CFM ozone depletion - about 5 to 10 per cent reduction in total ozone at steady state.