

**Vienna Convention for the
Protection of the Ozone Layer****Ozone Research Managers of the
Parties to the Vienna Convention for the
Protection of the Ozone Layer****Twelfth meeting**

Geneva, 24–26 April 2024

**General Trust Fund for Financing Activities on Research and
Systematic Observations relevant to the Vienna Convention****Note by the Secretariat****I. Introduction**

1. The present note provides an overview of issues related to the General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention for the Protection of the Ozone Layer (hereinafter the “Trust Fund”), including a summary of the operation of the Trust Fund and an update of its current status and the activities under its purview.
2. The objectives and activities of the Trust Fund are important to the work of the Ozone Research Managers of the Parties to the Vienna Convention at the international level, but also at the national level in respect of their own research and monitoring capabilities. The mandate of the Ozone Research Managers, set out in decision VC I/6 of the Conference of the Parties to the Vienna Convention, on subsidiary bodies, is to review ongoing national and international research and monitoring programmes to ensure proper coordination of those programmes and identify gaps that need to be addressed.
3. At their twelfth meeting, the Ozone Research Managers are expected to consider the issues set out in the provisional agenda of the meeting and make recommendations, as appropriate. The recommendations arising from the meeting will be communicated to and considered by the Conference of the Parties to the Vienna Convention at its thirteenth meeting to be held jointly with the Thirty-Sixth Meeting of the Parties to the Montreal Protocol in Bangkok from 28 October to 1 November 2024.

II. The operation of the Trust Fund and its Advisory Committee

4. The General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention was established by decision VC VI/2 of the Conference of the Parties to the Vienna Convention, on ozone-related monitoring and research activities for the Vienna Convention, at its sixth meeting in 2002. It is an extrabudgetary fund for receiving voluntary contributions from the parties and international organizations for the purpose of financing certain research and systematic observation activities related to the Convention in developing countries and countries with economies in transition.
5. The primary aim of the Trust Fund, according to the decision, is to provide complementary support for the continued maintenance and calibration of the existing World Meteorological Organization (WMO) Global Atmosphere Watch ground-based stations for monitoring column ozone, ozone profiles and ultraviolet radiation in the developing countries and in the countries with

economies in transition, to address balanced global coverage. In the decision, the Conference of the Parties also recognized that consideration should be given to supporting other activities identified by the Ozone Research Managers and, in consultation with the co-chairs of the Montreal Protocol Scientific Assessment Panel and Environmental Effects Assessment Panel, for the improvement of the observation network and relevant research.

6. Since 2015, the activities under the Trust Fund have been overseen by an advisory committee, established pursuant to decision VC X/3 of the Conference of the Parties, on the Trust Fund, in 2014 with the following mandate:

(a) To develop a long-term strategy and implementation objectives and priorities in the light of the four overarching goals identified by the Ozone Research Managers at their ninth meeting;¹

(b) To develop a short-term action plan that would take into account the most urgent needs of the Global Ozone Observing System and which would make the best possible use of the resources available in the Trust Fund;

(c) To ensure quality control of the individual project proposals developed under the Trust Fund, striving for regional balance in the projects supported by the Fund and identifying possibilities for complementary funding to maximize its resources.

7. The long-term strategy and short-term plan of action for the Trust Fund, prepared by the Advisory Committee after receiving feedback from the Ozone Research Managers at their tenth meeting, in March 2017, were presented to the Conference of the Parties at its eleventh meeting, in November 2017.² Thereafter, the Conference of the Parties adopted decision VC XI/2, on the Trust Fund, in which the Advisory Committee was requested, with the assistance of the WMO and the Secretariat, to implement its long-term strategy and short-term plan of action for the Trust Fund.

8. An update of the report on the Committee's work was presented to the Conference of the Parties at the second part of its eleventh meeting, in October 2021.³ In decision XII(II)/2, on the Trust Fund, adopted at that meeting, the Advisory Committee was requested to continue to implement its long-term strategy and short-term plan of action for the Trust Fund, paying particular attention to identifying gaps and needs in research and monitoring of ozone and related climate variables and parameters; facilitating the relocation of unused Dobson and Brewer instruments and the use of ozonesondes to new observation programmes; fostering stronger relationships with scientific institutions and related global networks; and exploring opportunities to leverage and catalyse its resources to safeguard necessary research and observation activities. While the Committee will provide a comprehensive report on its response to that decision to the Conference of the Parties at its thirteenth meeting in October 2024, it will present an update of its work during the current meeting.

9. In terms of individual project proposals developed under the Trust Fund, from the start of its work in 2015 until February 2024 the Advisory Committee considered 27 activities, including 8 project proposals submitted in 2016 and 2017 in response to the Secretariat's invitation to developing countries and countries with economies in transition for submission of relevant proposals in March 2016, and 11 project proposals submitted in response to a similar request by the Secretariat in December 2020. The Committee approved 17 of those 27 activities.

10. Key information on the status of the Trust Fund and its activities is provided in the following sections. More information on the history of the Trust Fund and the operation of its Advisory Committee is set out in annex I to the present note.

III. Status of the Trust Fund

11. As at 29 February 2024, a total of \$869,372 had been provided voluntarily by parties to support the activities of the Trust Fund since its inception in 2003. That amount includes direct financial contributions to the Trust Fund from 15 parties, the interest income earned, the exchange gains and losses incurred by the Trust Fund (totalling \$833,827), and a contribution by one party to WMO on the condition that the funds be used for activities under the Trust Fund (\$35,545). Of the total amount, \$635,426 has been disbursed or allocated for completed, ongoing or planned activities. The funds currently available for future activities, including administrative costs, amount to \$233,946.

¹ UNEP/OzL.Conv.10/6.

² UNEP/OzL.Conv.11/6, section E and annex. The long-term strategy for the Trust Fund is also available as a background document on the portal of the current meeting: <https://ozone.unep.org/meetings/12th-meeting-ozone-research-managers/pre-session-documents>.

³ UNEP/OzL.Conv.12(II)/8 (section VII).

12. The status of the Trust Fund from its inception in 2003 until 29 February 2024 is shown in table 1. Information on any additional contributions that may be received thereafter will be provided at the thirteenth meeting of the Conference of the Parties, in October 2024.

IV. Activities and associated costs

13. Since its inception in 2003, the Trust Fund has disbursed or allocated funds in support of 22 activities, 17 of which were approved after evaluation by the Advisory Committee of the Trust Fund from 2015 onwards. All supported activities as at 29 February 2024 and associated costs are listed in table 2, comprising:

- (a) Calibrations of Brewer instruments (three activities);
- (b) Intercomparisons of Dobson instruments (seven activities);
- (c) Workshop on data quality (one activity);
- (d) Training courses for Dobson and Brewer operators, respectively (two activities);
- (e) Relocations of Dobson instruments (three activities);
- (f) Launch of and training on ozonesondes (two activities);
- (g) Capacity-building on data management and instrument calibration (one activity);
- (h) Supply of a second-hand Brewer instrument (one activity);
- (i) Purchase of instrumentation (one activity);
- (j) Monitoring of solar ultraviolet B (UV-B) radiation (one activity).

In total, more than 50 developing countries and countries with economies in transition have participated as beneficiaries in the activities supported by the Trust Fund.

14. The geographical distribution of all approved activities can be found on the respective pages of the Ozone Secretariat website, along with brief summaries of all the activities completed by the time of preparation of the present note.⁴ For ease of reference, brief summaries of all activities completed by 29 February 2024 are set out in annex II to the present note.

15. In November 2023, the Secretariat invited developing countries and countries with economies in transition to submit new project proposals by 15 March 2024 for possible support under the Trust Fund. By the time of preparation of this note, the Secretariat had received fourteen project proposals from eleven parties, those being Burundi, Chile, Comoros, Ecuador, Indonesia, Morocco, Mozambique, Rwanda, Somalia, Uganda and the Bolivarian Republic of Venezuela, as listed in table 3.

16. All submitted proposals have been forwarded to the Advisory Committee for its consideration. An update of the status of these proposals and any other that the Secretariat may receive will be provided prior to the combined thirteenth meeting of the Conference of the Parties to the Vienna Convention and the Thirty-Sixth Meeting of the Parties to the Montreal Protocol in October 2024.

⁴ <https://ozone.unep.org/activities>.

Table 1

Status of the General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention, as at 29 February 2024

(in United States dollars)

| <i>Party</i> | <i>Feb 2003– Feb 2019^e</i> | <i>2020</i> | <i>2021</i> | <i>2022</i> | <i>2023</i> | <i>Feb 2024</i> | <i>Total</i> |
|---|---|---------------|---------------|----------------|---------------|---------------------|----------------|
| Andorra | 5 573 | – | – | – | – | – | 5 573 |
| Australia | 28 011 | – | – | – | – | – | 28 011 |
| Austria | 17 773 | – | – | 20 576 | – | – | 38 349 |
| Czechia | 18 000 | – | – | – | – | – | 18 000 |
| Estonia | 2 000 | – | – | – | – | – | 2 000 |
| Finland | 66 230 | 3 509 | 8 265 | 8 231 | 5 336 | – | 91 571 |
| France ^a | 53 620 | 10 689 | 10 626 | 10 040 | 10 549 | – | 95 524 |
| Kazakhstan | 11 361 | – | – | – | – | – | 11 361 |
| Netherlands (Kingdom of the) ^b | – | – | – | 32 609 | 31 881 | – | 64 490 |
| Norway | 88 877 | 33 948 | – | – | 20 059 | – | 142 884 |
| South Africa | 60 000 | – | – | – | – | – | 60 000 |
| Spain | 12 341 | – | – | – | – | – | 12 341 |
| Sweden | 44 121 | – | – | 16 605 | 19 867 | – | 80 593 |
| Switzerland | 51 488 | – | 16 322 | 15 790 | – | 17 618 | 101 218 |
| United Kingdom of Great Britain and Northern Ireland | 40 987 | – | – | – | – | – | 40 987 |
| Total contributions | 500 382 | 48 146 | 35 213 | 103 851 | 87 692 | 17 618 | 792 902 |
| Exchange gain/(loss) | 574 | 719 | (1 800) | 127 | – | – | (380) |
| Interest income | 37 416 | 2 315 | 1 365 | 209 | – | – | 41 305 |
| Total income | 538 372 | 51 180 | 34 777 | 104 187 | 87 692 | 17 618 | 833 827 |
| Expenditures/Disbursements ^c | (379 151) | (33 900) | (50 850) | – | – | – | (463 901) |
| To be disbursed ^c | – | – | – | – | – | – | (154 504) |
| Balance available (Trust Fund) | – | – | – | – | – | – | 215 422 |
| German contribution to WMC | 35 545 | – | – | – | – | – | 35 545 |
| Expenditures ^c | (17 021) | – | – | – | – | – | (17 021) |
| Balance available (WMO)^d | – | – | – | – | – | – | 18 524 |
| Total balance available | – | – | – | – | – | – | 233 946 |

^a A pledge of EUR10,000 was received on 13 February 2024. Funds from the donor are awaited.^b A pledge of EUR30,000 was received on 16 February 2024. Funds from the donor are awaited.^c Amount includes administrative costs of UNEP and WMO.^d Using United Nations exchange rate of 1 December 2017 (\$1 = €0.844).^e Annual contributions for the period February 2003 – 31 December 2019 are set out in documents UNEP/OzL/Conv.ResMgr/10/2 and UNEP/OzL/Conv.ResMgr/11(II)/2.

Table 2

Supported activities under the General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention as at 29 February 2024

(in United States dollars, including administrative costs)

| No.* | Completed activities | Funds disbursed |
|--|--|---------------------|
| 1 | Dobson intercomparison – <i>Dahab, Egypt, 23 February–12 March 2004</i> | 16 950 |
| 2 | Calibration of Brewer instrument no. 116 – <i>Bandung, Indonesia, 5–9 September 2006</i> | 18 193 |
| 3 | Calibration of Brewer instrument no. 176 – <i>Kathmandu, 20–26 September 2006</i> | |
| 4 | Dobson intercomparison – <i>Irene, South Africa, 12–30 October and 15–26 November 2009</i> | 25 083 |
| 5 | Workshop on data quality in the total ozone network – <i>Hradec Králové, Czechia, 14–18 February 2011</i> | 38 227 |
| 6 | Relocation of Dobson no. 14 (formerly deployed in Tromsø, Norway) to Tomsk, Russian Federation, <i>September 2015</i> ; and Dobson training course – <i>Hradec Králové, Czechia, 7–14 April 2015^a</i> | 13 593 |
| 7 | Dobson training course – <i>Amberd, Armenia, 28 September–4 October 2015</i> | |
| 8 | Dobson intercomparison campaign for Asia – <i>Tsukuba, Japan, 7–25 March 2016^a</i> | 27 445 |
| 9 | Dobson intercomparison campaign for Australia and Oceania <i>Melbourne, Australia, 13–24 February 2017^a</i> | 20 204 |
| 10 | Dobson intercomparison campaign for northern Africa – <i>El Arenosillo, Spain, 4–15 September 2017^b</i> | 32 654 |
| 11 | Training workshop for Brewer operators – <i>Sydney, Australia, 4–9 September 2017^a</i> | 20 000 ^c |
| 12 | Joint project proposal by WMO Global Atmosphere Watch and Southern Hemisphere Additional Ozonesondes: <i>Jülich Ozone Sonde Intercomparison Experiment 2017 Jülich, Germany, 9–20 October and 23 October–3 November 2017</i> | 20 000 |
| 13 | Kenya (part 1): Capacity-building on data management and instrument calibration: <i>Hradec Králové, Czechia; and Payerne, Zürich and Dübendorf, Switzerland, 18 June–6 July 2018</i> | 42 036 |
| | Kenya (part 2): Capacity-building on data management and instrument calibration: <i>Kenya, 18–27 March 2019</i> | |
| 14 | Dobson intercomparison campaign for Latin America and the Caribbean <i>Buenos Aires, 4–22 March 2019^a</i> | 40 000 ^d |
| 15 | Ecuador: The Ecuadorian Highlands Ozonesondes project <i>Cumbayá, Ecuador, 1 March 2019–30 April 2020</i> | 56 274 |
| 16 | Dobson intercomparison campaign for southern Africa – <i>Irene, South Africa, 7–18 October 2019^b</i> | 25 513 |
| 17 | Kyrgyzstan: Technical support, information exchange for atmospheric monitoring at the shore of the high mountain lake, Issyk-Kul, <i>22 January 2020 – 30 June 2020^e</i> | 33 900 |
| No. | Ongoing activities | Funds disbursed |
| 18 | Comoros: Project on the establishment of an ozone observatory in Comoros <i>Comoros, 11 May 2021 – 30 April 2022^f</i> | 50 850 ^g |
| 19 | Brazil: South American Brewer Spectrometer Network <i>Santa Maria, Brazil, 23 February–8 March 2024</i> | 52 804 ^h |
| No. | Planned activities | Funds allocated |
| 20 | Burkina Faso: Acquisition of a ground-based ozone column measurement instrument (<i>On hold</i>) ⁱ | 22 600 |
| 21 | Mexico: Monitoring of solar ultraviolet radiation band “B” in Central America and the Caribbean (<i>to be determined</i>) | 56 500 |
| 22 | Relocation of Dobson no. 8 (formerly deployed in Spitzbergen, Norway) to Belarus ^{a,j} (<i>On hold</i>) | 22 600 |
| Total funds disbursed and allocated | | 635 426 |

*Activities are numbered in the order they were approved.

^a Activity listed for priority funding by the Ozone Research Managers at their ninth meeting in May 2014.^b Activities 10 and 16 were listed for priority funding at the ninth meeting of the Ozone Research Managers as one activity but were subsequently divided into two activities, covering northern and southern Africa, respectively.^c Activity also supported by the Canadian Brewer Trust Fund with an additional amount of \$20,000.^d Activity also supported by WMO trust fund with an additional amount of \$10,000^e Activity completed on 12 July 2023 owing to project delays caused by the coronavirus pandemic.^f Activity not completed by 29 February 2024 due to implementation delays caused by technical and administrative issues.^g Activity also supported by WMO with an additional amount of \$10,544.^h Activity also supported by the Canadian Brewer Trust Fund with an additional amount of \$35,480.ⁱ Activity currently on hold due to political instability in the country.^j Relocation previously destined for Sri Lanka and then Singapore. In the absence of interest from those parties, the Advisory Committee decided to lend the instrument to Belarus to assist the party to implement its proposal entitled “Preparing for and undertaking intercomparison sessions of three instruments to monitor total ozone and ultraviolet radiation in Belarus”. The project is presently on hold due to the political instability in the region.

Table 3

Project proposals currently under consideration by the Advisory Committee

(in United States dollars)

| | <i>Party</i> | <i>Project proposal</i> | <i>Funds requested</i> |
|------------------------------|------------------------------------|--|------------------------|
| 1 | Burundi | Systematic observations of atmospheric composition over Bujumbura using the Pandora spectrophotometer | 50 000 |
| 2 | Chile | Renovation and maintenance of stations of the ultraviolet radiation network in Chile | 50 282 |
| 3 | Comoros | Monitoring and measurement of the total ozone column in the Union of the Comoros | 78 348* |
| 4 | Ecuador | Advanced environmental monitoring: developing a real-time UV radiation mapping system for equatorial Andean regions | 47 400 |
| 5 | Indonesia | Monitoring of the dynamics of ozone, ozone-depleting substances, UV radiation and air pollutants | 49 425 |
| | | Observation of vertical distribution of ozone-depleting substances and UV radiation in Indonesia by using an aerial drone as a carrier for miniaturized samplers and portable sensors | 49 646 |
| 6 | Morocco | Ground-based total column observation in Africa using PANDORA spectrometer | 81 700 |
| 7 | Mozambique | Restoration of the solar radiation and ozone measurement network in Mozambique | 4 000 000 |
| 8 | Rwanda | Enhancing data quality in the total ozone network: A workshop initiative in Rwanda | 50 000 |
| 9 | Somalia | Strengthening ozone monitoring and capacity-building in Somalia | 50 000 |
| 10 | Uganda | Activities on research and systematic observations relevant to the Vienna Convention | 50 000 |
| 11 | Venezuela (Bolivarian Republic of) | Ozone column monitoring project and ozone profiles in the Bolivarian Republic of Venezuela | 48 340 |
| | | Training plan for the internal control of refrigerant gases, aimed at officials of the Ministry of People's Power for Eco-socialism | 32 808 |
| | | Awareness plan on the safe handling of fluorinated refrigerant gases, known as substances with high potential for depletion of the ozone layer and global warming, in the commercial sector (supermarkets) | 29 321 |
| Total funds requested | | | 4 667 270 |

* Using United Nations exchange rate of 15 March 2024 (\$1 = €0.914).

UV: Ultraviolet

17. Despite the limited resources of the Trust Fund, the activities undertaken have been effective and important, yielding positive results for the continuation and enhancement of global systematic observations. The importance of the Trust Fund has been recognized by the parties on several occasions.⁵ Evidently, however, the balance available in the Trust Fund is not sufficient to cover the costs associated with any proposals that may be submitted in the future. The Ozone Research Managers may wish to consider the situation and make appropriate recommendations.

V. Availability of funds for future activities

18. The information provided above may be summarized as follows:

(a) The total income of the Trust Fund from February 2003 to February 2024 (21 years), taking into account the interest accrued, fluctuations in exchange rates, and the contribution by one party to WMO for activities under the Trust Fund, was \$869,372;

⁵ See, for example, decisions X/3, XI/2 and XII(II)/2 of the Conference of the Parties to the Vienna Convention.

(b) From February 2003 to February 2024, funds were disbursed or allocated to a total of 22 activities, 17 of which were approved after evaluation by the Advisory Committee from 2015 onwards. The total cost of the 22 approved activities was \$635,426;

(c) In the light of the above, the current available balance, including administrative costs, is: \$233,946;

(d) To date, 14 proposals, submitted by 11 developing countries in response to the Secretariat's call in November 2023, amount to a total of \$4,667,270 and are currently under consideration by the Advisory Committee.

19. The Ozone Research Managers are expected to consider the status of the Trust Fund and the activities under its purview, along with the work of the Advisory Committee, and make any appropriate recommendations.

Annex I

History of the General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention

A. History of the Trust Fund

1. In decision VI/2 of the Conference of the Parties to the Vienna Convention, the United Nations Environment Programme (UNEP) was requested, in consultation with the World Meteorological Organization (WMO), to establish an extrabudgetary fund for receiving voluntary contributions from the parties and international organizations, for the purpose of financing activities on research and systematic observation relevant to the Convention in developing countries and countries with economies in transition.
2. The primary aim of the Trust Fund is to provide complementary support for the continued maintenance and calibration of the existing WMO Global Atmosphere Watch ground-based stations for monitoring column ozone, ozone profiles, and ultraviolet radiation in the developing countries and in the countries with economies in transition, to work on balanced global coverage. Support to other activities, identified by the Ozone Research Managers and in consultation with the co-chairs of the Montreal Protocol Scientific Assessment Panel and Environmental Effects Assessment Panel, should also be considered for the improvement of the observation network and relevant research.
3. In September 2005, UNEP, represented by the Ozone Secretariat, and WMO signed a memorandum of understanding on the institutional arrangements for making decisions on the allocation of funds in the Trust Fund, and presented it to the Conference of the Parties to the Vienna Convention at its seventh meeting in 2005. In its decision VII/2, the Conference of the Parties requested UNEP and WMO to continue their cooperation with regard to the Trust Fund pursuant to the terms set out in that memorandum and on the understanding that the agreement could be changed as necessary to meet evolving needs and conditions.
4. The Trust Fund was established in February 2003 with a five-year term ending on 31 December 2007. Thereafter, the term of the Trust Fund was extended three times. The current term will expire on 31 December 2026. At its sixth session, held from 26 February to 1 March 2024, the United Nations Environment Assembly approved a fourth extension of the Trust Fund until 31 December 2030, along with other trust funds in support of multilateral environmental agreements and action plans, “unless otherwise requested by the appropriate authorities”.¹ The Conference of the Parties will consider this extension at its thirteenth meeting in October 2024 and take an appropriate decision.

B. Operation of the Advisory Committee of the Trust Fund

5. Pursuant to decision VC X/3, the Advisory Committee of the Trust Fund consists of 10 members, including the two co-chairs of the Scientific Assessment Panel, the two co-chairs of the Ozone Research Managers, one representative of the Ozone Secretariat and up to five scientists and experts in ozone observations, as well as one representative of WMO as an observer, striving for equitable geographical and gender representation.² The terms of reference of the Committee, developed and adopted at its second meeting, in October 2016, are available on the Secretariat website.³
6. The Committee, which convenes electronically or in the margins of relevant meetings, has met fourteen times since its establishment in 2015.⁴ The fifteenth meeting of the Advisory Committee will take place in person on 23 April 2024, immediately prior to the twelfth meeting of the Ozone Research Managers.

¹ Document UNEP/EA.6/L.2, Section B, paragraph 6 (c). The same decision noted that the extension of trust funds is an administrative matter that falls under the delegation of the Executive Director and hence will, as of the seventh session of the Environment Assembly, no longer require a decision by Member States,

² The current composition of the Advisory Committee may be found on the Ozone Secretariat website at: <https://ozone.unep.org/vienna-advisory>.

³ <https://ozone.unep.org/sites/default/files/Terms-of-reference-for-the-Advisory-Committee-of-the-Trust-Fund.pdf>.

⁴ On 31 October 2015 (Dubai, United Arab Emirates); 9 October 2016 (Kigali); 27 March 2017 (Geneva); 11 October 2017; 19 March 2018; 20 February 2019; 20 February 2020; 26 March 2021; 12 July 2021; 21 July 2022; 16 November 2022; 16 March 2023; 6 September 2023; and 15 March 2024.

Annex II

Summaries of completed activities under the Trust Fund¹

1. Dobson intercomparison, Dahab, Egypt, 23 February–12 March 2004

Nine Dobson spectrophotometers from Algeria, Botswana, Egypt, Kenya, Nigeria, Seychelles and South Africa were sent to Dahab, Egypt, for intercomparison under the leadership of the Egyptian Meteorological Agency. External experts from the United States of America National Oceanic and Atmospheric Administration, the German Weather Service and the Czech Hydrometeorological Institute participated. Eight of the nine instruments were calibrated and made capable of measuring total ozone with better than 1 per cent accuracy, while one instrument was sent to Germany for repair and calibration before being returned to service.

2. Calibration of Brewer instrument no. 116 in Bandung, Indonesia, 5–9 September 2006

The calibration was completed at the Indonesian National Institute of Aeronautics and Space facilities in Bandung by an expert from International Ozone Services Inc. with support from the General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention through WMO. The instrument was installed in early 1995 and last visited in 2001 but had been out of service for the previous four to five years. The instrument required a new power supply, microboard and ultraviolet filter in front of the photomultiplier tube to return it to service. The Indonesian National Institute of Aeronautics and Space supported the work.

3. Calibration of Brewer instrument no. 176 in Kathmandu, 20–26 September 2006

The calibration was completed at the Kirtipur campus of Tribhuvan University near Kathmandu by an expert from International Ozone Services Inc. with support from the Trust Fund through WMO. The instrument was installed in early 2001 and operated for two years but had then been out of service until the expert visit in September 2006. The instrument required a new main power supply and reprogramming of its new electronics.

4. Dobson intercomparison, Irene, South Africa, 12–30 October and 15–26 November 2009

An intercomparison exercise for the African Dobson instruments took place in Irene, South Africa, in October and November 2009. Eight important instruments were involved in that exercise, including those from Cape Town, Springbok and Irene in South Africa, Maun in Botswana, and Seychelles. Another four instruments, from Botswana, Kenya, Nigeria and Seychelles, took part in the extension of the exercise from 15 to 26 November 2009. All the participating instruments are now well calibrated and in good operational condition, except for that from Seychelles, which has a marginal calibration error and may need better expert attention before the next intercomparison event, which was scheduled to take place in 2014 or 2015. In addition, as another extension of the calibration campaign, an instrument from Cairo was calibrated in Germany in May 2010.

5. Workshop on data quality in the total ozone network, Hradec Králové, Czechia, 14–18 February 2011

A workshop was held from 14 to 18 February 2011 in Hradec Králové, Czechia, bringing together Dobson total ozone data managers and experts from the central facilities of the WMO Global Atmosphere Watch programme to discuss how to re-evaluate and reprocess some important past data sets. The workshop was organized by the Czech Hydrometeorological Institute and the Scientific Advisory Group on Ozone of the Global Atmosphere Watch programme provided expert guidance. The main goals of the workshop were to bring together managers of the archive data sets from the Dobson stations and provide guidance on how to re-evaluate and reprocess important past data; to collect the primary (0-level) Dobson data sets and calibration metadata from the stations to be archived in the World Ozone and Ultraviolet Radiation Data Centre; and to present themes and actual results in terms of the operation of the Dobson instruments and data quality assurance at the stations. The workshop was attended by 34 participants, including 21 station data managers from 51 Dobson stations representing some 70 per cent of the currently active Dobson stations. A unified template of the information held by the individual stations was developed for circulation to all stations in the

¹ Based on the reports submitted upon the completion of the activities.

network. The participants learned about problems with the earlier data, and methods of reprocessing data using the freeware developed by the regional Dobson calibration centres.

6. Relocation of Dobson no. 14 (formerly deployed in Tromsø, Norway) to Tomsk, Russian Federation, September 2015 and Dobson training course, in Hradec Králové, Czechia 7–14 April 2015

The relocation of Dobson no. 14 from Tromsø, Norway, to Tomsk in the Russian Federation was successfully carried out in July 2015 and the instrument was released from Customs in September 2015 and put into operation. A training course on the operation of the instrument was arranged for two Russian operators in Hradec Králové, Czechia, from 7 to 14 April 2015. The instrument, which had been deployed in Tromsø for many years, was repaired and calibrated at the Hohenpeissenberg Observatory of the German Weather Service prior to its shipment to Hradec Králové. After the training course the Dobson instrument was shipped to Tomsk, Russian Federation. Two participants from the ozone observatory in Nairobi also took part in the training course.

7. Dobson training course in Amberd, Armenia, 28 September–4 October 2015

An experienced Dobson expert from the Czech Hydrometeorological Institute visited Amberd, Armenia, from 28 September to 4 October 2015 and provided training to the local staff on Dobson observations. New Dobson software was installed and some technical problems were resolved so that the instrument delivers data of good quality.

8. Dobson intercomparison campaign for Asia, hosted by the Japanese Meteorological Agency, 7–25 March 2016

The WMO Global Atmosphere Watch regional Dobson intercomparison for Regional Association II (Asia) was held at the Aerological Observatory in Tsukuba, Japan, from 7 to 25 March 2016, hosted jointly by WMO and the Japan Meteorological Agency, which serves as the regional Dobson calibration centre for Asia for total ozone. The purpose of the activity was to ensure traceability to the regional standard Dobson spectrophotometer (D 116) through the intercomparison with those Dobson spectrophotometers (D 75, Xianghe/China; D 90, Bangkok/Thailand; and D 100, Quetta/Pakistan) operated in Regional Association II member countries. Four experts from China, Pakistan and Thailand participated in the intercomparison, which was conducted under the direction of a skilful expert from the National Oceanic and Atmospheric Administration of the United States and a former ozone coordinator in the Japanese Meteorological Agency. The experts also instructed participants in the proper operation of the instruments and data processing in their home countries. Although the weather was changeable during the period, the intercomparison was successfully performed during clear days.

9. Dobson intercomparison campaign for Australia and Oceania, Melbourne, 13–24 February 2017

The WMO Global Atmosphere Watch regional Dobson intercomparison campaign was held at the Bureau of Meteorology field annex outside Melbourne, Australia, from 13 to 24 February 2017, hosted by the Australian Bureau of Meteorology. The primary goal of the campaign was the intercomparison of the Regional Association V (South-West Pacific) Regional Standard Dobson (D 105) against the World Standard (D 083). Two additional Dobson instruments from the region's member countries also participated: D 072 from Lauder, New Zealand, operated by the National Institute of Water and Atmospheric Research and D 052 from Manila, operated by the Philippines Atmospheric, Geophysical and Astronomical Services Administration. Furthermore, the Regional Association II (Asia) Standard (D 116), operated by the Japanese Meteorological Agency, also took part in the intercomparison in order to provide traceability of Asian instruments to the World Standard. All participating instruments were successfully calibrated against the World Standard during a short spell of sunny weather in the second week of the campaign. The Trust Fund supported the travel costs of the two participants from the Philippines as well as the shipping of Dobson 052 from Manila to Melbourne, Australia. This support also enabled the extensive training provided by Dobson experts from Australia, Japan and the United States regarding Dobson operation and testing procedures, as well as the refurbishment and repair of the instruments. Together, these actions should ensure a high quality of ozone observations in the tropical western Pacific.

10. Dobson intercomparison campaign for northern Africa, El Arenosillo, Spain, 4–15 September 2017

The WMO Global Atmosphere Watch regional Dobson intercomparison campaign ElAreno2017 took place at the “El Arenosillo” Atmospheric Sounding Station at Huelva, Spain, from 4 to 15 September 2017, hosted by the National Institute for Aerospace Technology. The Regional Dobson Calibration Centre for Europe of the Meteorological Observatory at Hohenpeissenberg, Germany, with its regional standard D 064 was in charge of the technical and scientific organization. The Dobson instruments that participated in the campaign came from Europe (D 118 – Greece, D 013 – Portugal, D 120 – Spain) and Africa (D 011 – Algeria, D 096 – Egypt, D 089 – South African standard instrument from the Regional Dobson Calibration Centre for Africa, D 056 – Uganda). The instruments from Portugal and Spain were refurbished at the Meteorological Observatory at Hohenpeissenberg (D 013 repaired, new electronics were installed in both instruments) in the run-up to this campaign. D 011 from Algeria did not arrive in time because of customs problems in Madrid and it was therefore taken to the Meteorological Observatory at Hohenpeissenberg for the calibration service and returned to Algeria from Germany.

The main goals of the campaign were the check, initial calibration, repair and improvement of operation (as necessary) and final calibration (detailed reports will be published soon). Despite the late arrival of the African instruments due to customs issues, all the goals were achieved successfully. In addition, participating technicians and scientists that had only limited experience in Dobson operation were trained in the optimal operation of Dobson instruments. The representative of the Egyptian Meteorological Authority was trained in how to perform an intercomparison himself, as the other two Egyptian instruments will be calibrated during an internal campaign in Egypt against the D 096 with remote support from the Regional Dobson Calibration Centre for Europe. The travel costs of the participants from Algeria, Egypt, South Africa and Uganda, as well as the transportation of their instruments, were supported by the Trust Fund.

11. Training workshop for Brewer operators, Sydney, Australia, 4–9 September 2017

The sixteenth WMO Global Atmosphere Watch Brewer Operator Course (Asia and the Pacific) took place in Sydney, Australia, from 4 to 9 September 2017, hosted by the Bureau of Meteorology Sydney office. The workshop was attended by operators from China, India, Indonesia, Japan, Malaysia, Republic of Korea, Thailand and Viet Nam, as well as Australia, in addition to four international Brewer experts who provided state-of-the-art training. Detailed hands-on instruction was provided to participants on topics such as the set-up and operation of Brewers, basic maintenance, lamp-tests, software installation, establishing measurement schedules and data processing and submission. The travel costs of the participants from developing countries and the four invited trainers were supported by the General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention in partnership with the Canadian Brewer Trust Fund. The workshop is expected to greatly improve the skills and knowledge of Brewer operators in south and east Asia, ensuring that instruments are being operated according to best modern practice and thereby leading to much improved submission of high-quality total ozone data.

12. Joint project proposal by WMO Global Atmosphere Watch and the Southern Hemisphere Additional Ozonesondes: Jülich Ozone Sonde Intercomparison Experiment 2017, Jülich, Germany, 9–20 October and 23 October–3 November 2017

In October and November 2017, the joint WMO Global Atmosphere Watch and Southern Hemisphere Additional Ozonesondes campaign (JOSIE 2017) was conducted at the World Calibration Centre for Ozone Sondes,² established at the Institute for Energy and Climate Research in Jülich, Germany. The main objective of the campaign was to resolve ongoing discontinuities in the existing ozonesonde data records in general, and in particular in Southern Hemisphere Additional Ozonesondes due to ground equipment, standard operating procedures, and changes in sonde manufacture and performance.³ A unique feature of the campaign was that the ozonesondes were prepared by 12 operators from organizations representing Southern Hemisphere Additional Ozone Sonde sites in nine countries, namely Brazil, Costa Rica, France, Germany, Kenya, Malaysia, South Africa, Viet Nam and the United States of America. Capacity-building activities during both sessions included lectures on sonde quality assurance, the importance of metadata reporting, troubleshooting, and training with coaches from sponsoring organizations: National Aeronautics and Space Administration (NASA) Goddard Space Flight Centre, National Oceanic and Atmospheric Administration Global Monitoring Division,

² https://www.fz-juelich.de/iek/iek-8/EN/Expertise/Infrastructure/WCCOS/WCCOS_node.html.

³ <https://www.youtube.com/watch?v=5KwHw4gNLzg>; https://www.youtube.com/watch?v=zOgL_0_pu00.

the Royal Netherlands Meteorological Institute, the Royal Meteorological Institute of Belgium, Federal Office for Meteorology and Climatology (MeteoSwiss), Environment and Climate Change Canada, and the Finnish Meteorological Institute.

Six coaches from Finland, the Kingdom of the Netherlands and the United States guided and advised operators on best practices and standardized approaches to ensure the high quality of measurements and data. Ten experts from Belgium, Canada, Germany, Japan, Switzerland and the United States took part in the campaign as referees and observers. Financial support for the operators from tropical regions was provided by the Trust Fund, administered by UNEP.

Operators are essential contributors to ozonesonde quality assurance by providing detailed metadata information on each sonde launch and maintaining uniformity in their preparation and launch procedures. Bringing together Southern Hemisphere Additional Ozonesondes operators for training and knowledge-sharing helps to ensure that best practices are applied to operations in a consistent manner across the network. The results from the campaign have been presented at several scientific workshops and conferences, including of the European Geosciences Union, American Geophysical Union, Atmospheric Processes and their Role in Climate, Commission for Instruments and Methods of Observation Technical Conference on Meteorological Instruments and Methods of Observation, and published in scientific literature.⁴

The new insights gained from this intercomparison experiment have enabled the community to take important steps to improve the performance of the ozonesondes, from both a scientific and an operational perspective. Those results also led to the initiation of a new WMO, Network for the Detection of Atmospheric Composition Change and Intergovernmental Oceanographic Commission activity, entitled “Assessment of Standard Operating Procedures of Ozone Sondes” (ASOPOS 2.0) to evaluate and revise existing standard operating procedures to improve the uncertainty level of ozonesondes to less than 5–10 per cent in the global sonde network of WMO Global Atmosphere Watch, Network for the Detection of Atmospheric Composition Change and Southern Hemisphere Additional Ozonesondes. While the first results and recommendations have already been published in scientific literature, further and more comprehensive analysis continues. A new ASOPOS 2.0 report was published as a WMO Global Atmosphere Watch report in November 2020.⁵

13. Capacity-building on data management and instrument calibration: Part 1, Hradec Králové, Czechia, and Payerne, Dübendorf and Zurich, Switzerland, 18 June–6 July 2018; and part 2, Kenya, 17–29 March 2019

The capacity-building initiative was designed for WMO region I and implemented in 2018 and 2019 to strengthen or develop the technical and scientific expertise required to maintain high quality measurements, data processing and analysis, and relevant knowledge on the preparation and submission of observation data to relevant world data centres. The activity was supported by MeteoSwiss, the Swiss Federal Laboratories for Materials Testing and Research, and the Observatory, Hradec Králové, Czechia, through the Trust Fund. It was implemented in two phases, involving staff of the Kenya Meteorological Department.

The first part of the training course was focused on data management and instrument calibration and took place in Czechia (Hradec Králové) and in Switzerland (Payerne, Dübendorf and Zurich) from 18 June to 5 July 2018. Four Kenya Meteorological Department staff participated in full-day training sessions, which included lectures, practical exercises and hands-on work. The staff gained theoretical and practical knowledge on the Dobson and Brewer spectrophotometer measurement techniques, service, maintenance and calibration of the instruments as well as on data archiving and analysis. The group also received intensive training and information on ozonesondes including standard operating procedures for pre-flight preparation, launching, data acquisition, processing, analysis, transmission of data to twinning partners at MeteoSwiss, Payerne, and data archiving. The WMO Observing Systems Capability Analysis and Review Tool was introduced, along with practical work on the metadata and specific information related to observations in Kenya. A separate session was dedicated to learning the R statistical programme to help systematically analyse both vertical profiles and surface data. Part of the phase 1 training covered building competence in calibration of the TEI49i O₃ analyser and Picarro instrument for carbon dioxide (CO₂), methane (CH₄) and water (H₂O) measurements. The knowledge and skills gained during the training course were shared with colleagues and students at the WMO Regional Training Centre, Institute of Meteorological Training and Research, Nairobi, and have led to improved work performance at the Kenya Meteorological Department.

⁴ <https://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-17-0311.1>.

⁵ https://www.gruan.org/gruan/editor/documents/meetings/icm-12/pres/pres_204_Smit_ASOPPOS-20.pdf.

Subsequently, the competencies of eight operators and engineers from Nairobi and Mount Kenya Global Atmosphere Watch stations in Kenya were further advanced through a workshop on data management held from 17 to 29 March 2019. The objective of the second phase of the training was to enhance already acquired knowledge and skills in the operation of ozone-measuring instruments and data handling by reviewing best practices in conducting measurements, instrument calibrations, data management and documentation, as well as data submission to the World Ozone and Ultraviolet Radiation Data Centre. Specific sessions addressed working with the Observing Systems Capability Analysis and Review Tool and WMO Integrated Global Observing System metadata related to the observations made from Kenyan Global Atmosphere Watch stations; operating, maintenance, and troubleshooting of ozonesondes and Brewer spectrophotometers; and retrieving vertical profiles from ozonesonde flights and analysing data. At the end of the workshop, means to maintain and transfer the skills beyond the initially trained staff whenever appropriate were proposed. Knowledge gained during the training in 2019 improved the performance of the staff for the benefit of the quality of the observations made by the Kenya Meteorological Department and has assisted in sustaining the quality of the regional and global monitoring activities.

14. Dobson intercomparison campaign for Latin America and the Caribbean, Buenos Aires, 4–22 March 2019

The international comparison of Dobson spectrophotometers of WMO Global Atmosphere Watch region III took place at the Villa Ortúzar Observatory, Buenos Aires, from 4 to 22 March 2019. The intercomparison was organized by the WMO secretariat, the National Meteorological Service of Argentina, the United States National Oceanic and Atmospheric Administration Global Monitoring Division, and the University of Colorado Cooperative Institute for Research in Environmental Sciences. Participants included operators from: Argentina, Brazil (Dobson D 093 from Natal and Dobson D 114 from Cachoeira Paulista – São Paulo, both supported by the Brazilian Space Agency), Cuba, Mexico, Peru, Uruguay and the National Oceanic and Atmospheric Administration’s travelling standard instrument. The primary purpose of the event was to check and harmonize calibrations and perform maintenance of Dobson spectrophotometers operated within WMO region III, as well as two instruments from region IV which also took part in the intercomparison. Overall, 12 Dobson instruments participated in the intercomparison campaign: D 065 (the World Secondary Standard instrument), D 067, D 070, D 087, D 093, D 097, D 098, D 099, D 114, D 131, D 133, and D 134.

All 11 Dobson spectrophotometers from 6 different monitoring and research institutions in Latin America and the Caribbean were inspected, serviced and calibrated, as necessary, so that data obtained at the measurement sites could be standardized and comparable locally and globally. The Regional Dobson Standard for South America was calibrated against the World Secondary Standard stationed in Boulder, Colorado, United States. Instructions on the operation and routine maintenance of the instruments were provided to participants along with the final intercomparison to ensure that calibrations and repairs are correct and sufficient to bring instruments within an error of 1 per cent. The relative uncertainty of each Dobson was also estimated. In addition to the instruments participating in the Dobson intercomparison, the regional Brewer Ozone spectrophotometer and Pandora spectrometers, owned by NASA, conducted measurements at Villa Ortúzar during that period. Special Umkehr observations on the zenith sky were made by all participating instruments on the morning of 21 March 2019 to create a reliable data set for verification of different technologies used for processing these observations.

15. The Ecuadorian Highlands Ozonesondes project, Cumbayá, Ecuador, 1 March 2019–30 April 2020

The purpose of the activity was to expand monitoring capabilities to regions where observations of atmospheric constituents are scarce and provide the ozone science community with a unique set of data from a geographically relevant region of the world. Owing to the coronavirus pandemic, completion of the activity was extended from 30 April 2020 to 30 June 2021. The first launch of the project was carried out on 6 March 2020 in the presence of Government officials and university authorities. While launches were discontinued between 16 March 2020 and the end of May 2020 owing to the pandemic lockdown, a total of 28 ozonesonde launches took place from March 2020 to July 2021. According to the final project report four additional ozonesondes were planned to be launched after the project completion from August to September of 2021. Furthermore, it was reported that collaboration with NASA SHADOZ (Southern Hemisphere Additional Ozonesondes) had been established which would ensure the continuity of the ECHOZ sounding in Quito for four more years from September 2021 to 2024. Through that collaboration, Ecuador would also begin launching

ozonesondes starting from the Galapagos campus. Two papers were prepared, Cazorla et.al. (2020)⁶ and Maria Cazorla (2021)⁷, and more analyses were reported to be on the way.

16. Dobson intercomparison campaign for southern Africa, Irene, South Africa, 7–18 October 2019

The Dobson intercomparison campaign for southern Africa was held in South Africa from 7 to 18 October 2019. The campaign was hosted by the South African Weather Service at the weather station in Irene. Eight Dobson instruments from six countries – Botswana, India, Germany, Kenya, South Africa and the United States – participated in the campaign. The participation of a Dobson instrument from Nigeria was not possible owing to the operator’s visa being delayed, resulting in eight out of the nine originally planned Dobson instruments participating in the campaign. The number of participating instruments is equivalent to almost 10 per cent of the world’s operating Dobson spectrophotometers. The World Secondary Standard Dobson (United States) and the European Dobson Standard (Germany) were intercompared after more than three years. The experts used the World Secondary Standard Dobson (D 065) and the European Standard to inter-compare the performance of the instruments.

All Dobson spectrophotometers from different monitoring and research institutions in Southern Africa and India were inspected, serviced as necessary and calibrated. The Dobson instrument from India needed extensive work and its mirrors were renewed. The three South African and Kenyan Dobson spectrophotometers were serviced, intercompared, calibrated and are now in very good condition. The instrument from Botswana was cleaned and serviced and is now in good condition. All participants were given as much training as possible and, with renewed and regular email contact with the South African Weather Service and between the members, the observations are expected to be of good quality. With strong commitment to maintaining regular contact, the operators from Botswana can be guided to resume the measurements at Maun. Through this activity, the data obtained at the measurement sites will be standardized and will be comparable locally and globally. Reports of individual instruments from the activity were prepared and shared with the community. The event was part of the WMO Global Atmosphere Watch quality control requirements for monitoring atmospheric total ozone.

17. Technical support, information exchange for atmospheric monitoring at the shore of the high mountain lake, Issyk-Kul, 22 January 2020–12 July 2023

The activity aimed at improving the quality, timeliness and continuity of monitoring of the ozone layer in the atmosphere of the mountainous region of Central Asia on the base of the modernized Issyk-Kul Ozone Monitoring Development station, Kyrgyzstan. The objective of the activity was the acquisition and commissioning of monitoring equipment (Brewer Mk Spectrophotometer) to provide reliable, timely and continuous measurement of the total ozone in the atmosphere. The Brewer Mk IV (#083) was donated to WMO by the Government of Canada and its transfer to and installation at the Issyk-Kul station, with necessary operator training, was carried out through support by the Trust Fund.

The Brewer instrument was successfully transferred to the station in April 2021. Station personnel were then trained in the installation, configuration and commissioning of the instrument through online technical training, conducted by an external expert from International Ozone Services from 12 to 23 November 2021. Following the successful installation of the Brewer instrument at the station, systematic and continuous field measurement began in November 2021. Data on ozone and ultraviolet radiation are now being submitted to the World Ozone and Ultraviolet Radiation Data Centre.⁸ The implementation of the project was delayed owing to the coronavirus pandemic and administrative issues.

⁶ <https://www.sciencedirect.com/science/article/pii/S1309104220302567?via%3Dihub>.

⁷ <https://www.witpress.com/elibrary/wit-transactions-on-ecology-and-the-environment/252/38151>.

⁸ <https://www.woudc.org/home.php>.