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Ozone Research Managers of the  
Parties to the Vienna Convention for the  
Protection of the Ozone Layer  
Eleventh meeting, Part II  
Online, 19–23 July 2021

## 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”). It outlines issues related to the Trust Fund’s operation and provides an update on its current status and the activities under its purview.
2. The mandate of the Ozone Research Managers, set out in decision I/6 of the Conference of the Parties to the Vienna Convention, 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. 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.
3. Issues pertaining to the Trust Fund and related activities were originally planned for consideration by the Ozone Research Managers at their eleventh meeting scheduled to take place in Geneva in April 2020. Owing to the coronavirus disease (COVID-19) pandemic that meeting could not be held and was subsequently postponed twice. Given the parties’ interest in issues related to gaps in the global coverage of atmospheric monitoring of controlled substances, set out under session 4 of the provisional agenda of the meeting entitled “International monitoring programmes: looking ahead”,<sup>1</sup> the co-chairs of the tenth meeting of the Ozone Research Managers, in consultation with the co-chairs of the Scientific Assessment Panel of the Montreal Protocol on Substances that Deplete the Ozone Layer and the Ozone Secretariat, decided to convene an online meeting to allow for the presentation and initial discussion of those issues. That online meeting, held in October 2020, was designated part I of the eleventh meeting<sup>2</sup> with the current meeting representing part II.<sup>3</sup>
4. At part II of their eleventh meeting, the Ozone Research Managers are expected to consider all issues set out in the provisional agenda of the meeting and make recommendations, as appropriate. The outcomes of the meeting, along with any recommendations, will be presented for consideration to the Bureau of the twelfth meeting of the Conference of the Parties to the Vienna Convention, which will convene in the margins of the combined twelfth meeting of the Conference of the Parties to the Vienna Convention (part II) and the Thirty-Third Meeting of the Parties to the Montreal Protocol in

<sup>1</sup> UNEP/OzL/Conv.ResMgr/11(II)/1.

<sup>2</sup> <https://ozone.unep.org/meetings/11th-meeting-ozone-research-managers-part-i>.

<sup>3</sup> <https://ozone.unep.org/meetings/11th-meeting-ozone-research-managers-part-ii>.

October 2021, and will subsequently be presented to the combined meeting, as appropriate. The parties will consider the recommendations of the Ozone Research Managers and may take any relevant decisions.

## II. Aim of the Trust Fund and its Advisory Committee

5. The General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention, established by decision VI/2 of the Conference of the Parties to the Vienna Convention in 2002, 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.

6. 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's Scientific Assessment Panel and Environmental Effects Assessment Panel, for the improvement of the observation network and relevant research.

7. Since 2015, the activities under the Trust Fund have been overseen by an advisory committee, established pursuant to decision X/3, adopted by the Conference of the Parties to the Vienna Convention in 2014. The mandate of the Advisory Committee is:

(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;<sup>4</sup>

(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.

8. 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.<sup>5</sup> Thereafter, the Conference of the Parties adopted decision XI/2, 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.<sup>6,7</sup>

9. In accordance with its mandate, and taking into account paragraph 3 of decision X/2,<sup>8</sup> the Advisory Committee has considered 17 activities from the start of its work in 2015 to date. The outcome of the Committee's evaluations is presented in section IV below. The Committee will provide an update of its work in response to decision XI/2 during the current meeting.

10. 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.

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<sup>4</sup> UNEP/OzL.Conv.10/6.

<sup>5</sup> UNEP/OzL.Conv.11/6, section E and annex.

<sup>6</sup> Long-term strategy for the Vienna Convention Trust Fund.

<sup>7</sup> The relevant provisions of decision XI/2 are highlighted in document UNEP/OzL/Conv.ResMgr/11(II)/3, section II B.

<sup>8</sup> Decision X/2, para. 3: "To accord priority to capacity-building activities, in particular the specific projects identified for priority funding under the General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention, related to the inter-calibration of instruments, the training of instrument operators and increasing the number of ozone observations, especially through the relocation of available Dobson instruments."

### III. Status of the Trust Fund

11. As at 31 May 2021, a total of \$626,249 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 14 parties, the interest income earned, the exchange gains/losses incurred by the Trust Fund (\$590,704), 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, \$503,522 has been disbursed or allocated for completed, ongoing or planned activities. The funds currently available for future activities, including administrative costs, total \$122,727.

12. The status of the Trust Fund from its inception in 2003 until 31 May 2021 is shown in table 1. Information on any additional contributions that may be received thereafter will be provided at the twelfth meeting of the Conference of the Parties, part II, in October 2021.

### IV. Activities and associated costs

13. Since its inception in 2003, the Trust Fund has disbursed or allocated funds in support of 19 activities comprising:

(a) Five activities completed by 2014, prior to the establishment of the Advisory Committee; and

(b) Fourteen activities evaluated and approved by the Advisory Committee, including: seven activities listed for priority funding at the ninth meeting of the Ozone Research Managers in 2014,<sup>9</sup> one of which was subsequently divided into two;<sup>10</sup> one additional activity;<sup>11</sup> and five out of eight project proposals submitted in 2016 and 2017 in response to the Secretariat's call in 2016 to developing countries and countries with economies in transition.

14. Altogether, more than 40 countries have participated in the above-mentioned activities and the total funds disbursed or allocated to those activities amount to \$503,522.

15. All supported activities as at 31 May 2021 and associated costs are listed in table 2, comprising:

(a) Two calibrations of Brewer instruments;

(b) Seven intercomparisons of Dobson instruments from a total of 30 countries;

(c) One workshop on data quality;

(d) Two training courses for Dobson and Brewer operators, respectively;

(e) Two relocations of Dobson instruments (one of which is yet to be implemented);

(f) Five projects comprising: two projects related to ozonesondes; one project on capacity-building on data management and instrument calibration; one project on supply of a second-hand Brewer instrument and one on purchase of instrumentation.

16. The status of the three remaining project proposals (out of the eight proposals submitted to the Secretariat in 2016 and 2017) is presented in table 3. Brief summaries of all the activities completed by 31 May 2021 are set out in annex II to the present note. Information about the activities under the Trust Fund is also available in the website of the Ozone Secretariat.<sup>12</sup>

17. In December 2020 the Secretariat invited developing countries and countries with economies in transition to submit project proposals by 30 June 2021 for support under the Trust Fund. By the time of preparation of the present report, four parties submitted proposals: China, Ecuador, India and Pakistan. The Secretariat forwarded the proposals to the Advisory Committee for its consideration. The proposal by Pakistan has already been considered by the Committee and was not approved.<sup>13</sup> The proposals received from the three other parties are currently under consideration and are listed in table 4. An update of the status of these proposals and any other that the Secretariat may receive will be provided prior to the combined twelfth meeting of the Conference of the Parties to the Vienna Convention (part II) and the Thirty-Third Meeting of the Parties to the Montreal Protocol in October 2021.

<sup>9</sup> Priority for funding was accorded to eight activities, one of which was subsequently cancelled.

<sup>10</sup> See table 2, activities 10 and 16.

<sup>11</sup> See table 2, activity no. 7.

<sup>12</sup> <https://ozone.unep.org/activities>.

<sup>13</sup> The proposal, entitled "Upgradation of emissions and ambient monitoring facility at CEPS (Center for Environmental Protection Studies), PCSIR (Pakistan Council of Scientific and Industrial Research)", requesting an equivalent amount of \$194,000 (approximate figure), was found to be outside the scope of the proposals sought in the Secretariat's 2020 call.

Table 1

**Status of the General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention, as at 31 May 2021**

(in United States dollars)

<i>Party</i>	<i>February 2003– February 2017<sup>d</sup></i>	<i>March– December 2017</i>	<i>2018</i>	<i>2019</i>	<i>2020</i>	<i>May 2021</i>	<i>Total</i>
Australia	28 011	–	–	–	–	–	28 011
Austria	–	17 773	–	–	–	–	17 773
Andorra <sup>a</sup>	5 573	–	–	–	–	–	5 573
Czechia	18 000	–	–	–	–	–	18 000
Estonia	2 000	–	–	–	–	–	2 000
Finland <sup>a</sup>	55 859	3 555	3 497	3 318	3 525	–	69 754
France <sup>a</sup>	53 620	–	–	–	10 664	–	64 284
Kazakhstan	11 361	–	–	–	–	–	11 361
Norway	–	27 943	28 438	32 537	36 132	–	125 050
South Africa	60 000	–	–	–	–	–	60 000
Spain	12 341	–	–	–	–	–	12 341
Sweden	–	–	44 121	–	–	–	44 121
Switzerland	20 677	15 856	14 955	–	–	–	51 488
United Kingdom of Great Britain and Northern Ireland	40 987	–	–	–	–	–	40 987
<b>Total pledges</b>	<b>308 429</b>	<b>65 127</b>	<b>91 011</b>	<b>35 855</b>	50 321	–	<b>550 743</b>
Exchange gain/(loss)	1 074	(917)	(1 355)	2 074	719	–	1 595
Interest income	28 583	1 535	2 690	3 243	2315	–	38 366
<b>Total income</b>	<b>338 086</b>	<b>65 745</b>	<b>92 346</b>	<b>41 172</b>	53 355	–	<b>590 704</b>
Expenditures/advances to WMO <sup>b</sup>	(176 788)	(52 653)	(27 923)	(130 287)	(33 899)	(42 351)	(463 901)
Approved activities							(22 600)
<b>Balance available (Trust Fund)</b>							<b>104 203</b>
German contribution to WMO	–	35 545	–	–	–	–	35 545
Expenditures <sup>b</sup>	–	–	–	(17 021)	–	–	(17 021)
<b>Balance available (WMO)<sup>c</sup></b>							<b>18 524</b>
<b>Total balance available</b>							<b>122 727</b>

<sup>a</sup> Income as at 28 February 2017 corrected to align with records in the UNEP accounting system.<sup>b</sup> Amount includes administrative costs charged by UNEP and WMO.<sup>c</sup> Using United Nations exchange rate of 1 December 2017 (\$1 = €0.844).<sup>d</sup> Annual contributions for the period February 2003–28 February 2017 are set out in document UNEP/OzL/Conv.ResMgr/10/2.

Table 2

**Supported activities under the General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention as at 31 May 2021**

(in United States dollars, including administrative costs)

<i>Activity No.*</i>	<i>Completed activities</i>	<i>Funds disbursed</i>
1	Dobson intercomparison Dahab, Egypt, 23 February–12 March 2004	16 950
2	Calibration of Brewer instrument no. 116 Bandung, Indonesia, 5–9 September 2006	18 193
3	Calibration of Brewer instrument no. 176 Kathmandu, 20–26 September 2006	
4	Dobson intercomparison Irene, South Africa, 12–30 October and 15–26 November 2009	25 083
5	Workshop on data quality in the total ozone network Hradec Králové, Czechia, 14–18 February 2011	38 227
6	Relocation of Dobson no. 14 (formerly deployed in Tromsø, Norway) to Tomsk, Russian Federation, <sup>a</sup> April 2015; Dobson training course in Hradec Králové, Czechia, 7–14 April 2015	13 593
7	Dobson training course in Amberd, Armenia, 28 September–4 October 2015	
8	Dobson intercomparison campaign for Asia <sup>a</sup> Tsukuba, Japan, 7–25 March 2016	27 445
9	Dobson intercomparison campaign for Australia and Oceania <sup>a</sup> Melbourne, Australia, 13–24 February 2017	20 204
10	Dobson intercomparison campaign for northern Africa <sup>b</sup> El Arenosillo, Spain, 4–15 September 2017	32 654
11	Training workshop for Brewer operators <sup>a</sup> Sydney, Australia, 4–9 September 2017	20 000 <sup>d</sup>
12	Joint project proposal by WMO/Global Atmosphere Watch and Southern Hemisphere Additional Ozonesondes: Jülich Ozone Sonde Intercomparison Experiment 2017 <sup>c</sup> Jülich, Germany, 9–20 October and 23 October–3 November 2017	20 000
13a	Kenya: Capacity-building on data management and instrument calibration: part 1 <sup>c</sup> Hradec Králové, Czechia; and Payerne, Zürich and Dübendorf, Switzerland, 18 June–6 July 2018	25 015
13b	Kenya: Capacity-building on data management and instrument calibration: part 2 <sup>c</sup> Kenya, 18–27 March 2019	17 021
14	Dobson intercomparison campaign for Latin America and the Caribbean <sup>a</sup> Buenos Aires, 4–22 March 2019	40 000 <sup>e</sup>
16	Dobson intercomparison campaign for southern Africa <sup>b</sup> Irene, South Africa, 7–18 October 2019	25 513
<i>Activity No.</i>	<i>Ongoing activities</i>	<i>Funds disbursed</i>
15	Ecuador: The Ecuadorian Highlands Ozonesondes project <sup>c</sup> Cumbayá, Ecuador, 1 March 2019–30 April 2020 <sup>f</sup>	56 274
18	Kyrgyzstan: Technical support, information exchange for atmospheric monitoring at the shore of the high mountain lake, Issyk-Kul <sup>c</sup> 22 January 2020 – 30 June 2020 <sup>f</sup>	33 900
19	Comoros: Project on the establishment of an ozone observatory in Comoros <sup>c</sup> 11 May 2021 – 30 April 2022	50 850
<i>Activity No.</i>	<i>Planned activities</i>	<i>Funds allocated</i>
17	Relocation of Dobson no. 8 (formerly deployed in Spitzbergen, Norway) to an interested party <sup>a,g</sup> (to be determined)	22 600
<b>Total funds disbursed and allocated</b>		<b>503 522</b>

\*Activities are numbered in the order they were approved.

<sup>a</sup> Activity listed for priority funding by the Ozone Research Managers at their ninth meeting in May 2014.<sup>b</sup> 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.<sup>c</sup> Project proposal submitted in response to the Secretariat's invitation in 2016.<sup>d</sup> The activity was also supported by the Canadian Brewer Trust Fund with an additional \$20,000.<sup>e</sup> The Trust Fund disbursed only \$40,000 out of the \$50,000 originally allocated to the activity, as WMO kindly covered the remaining \$10,000 from another trust fund.<sup>f</sup> The activity is expected to be completed by 30 June 2021 owing to pandemic-related delays.<sup>g</sup> Originally destined to be relocated to Sri Lanka.

Table 3

**Project proposals not approved or under consideration as at 31 May 2021**

(in United States dollars)

	<i>Project proposal</i>	<i>Funds requested</i>	<i>Status</i>
1	Belarus: Preparing for and undertaking intercomparison sessions of three instruments to monitor total ozone and ultraviolet radiation in Belarus	50 000	Under consideration <sup>a</sup>
2	Oman: Measurement of the diurnal and seasonal variation of ozone towards improving knowledge on ozone trend estimates: case study of Oman	50 000	Not approved
3	Togo: Construction and equipping of a laboratory for continuous measurement of the stratospheric ozone layer and atmospheric ozone	786 073	Not approved
<b>Total funds requested</b>		<b>886 073</b>	

<sup>a</sup> The Advisory Committee has proposed instead support of \$20,000 and requested Belarus to respond to the offer.

Table 4

**Project proposals received in 2021 under consideration by the Advisory Committee**

(in United States dollars)

<i>Party</i>	<i>Project proposal</i>	<i>Funds requested</i>
China	International Integration and Capacity Building for Observations of Controlled Substances in Asian Developing Countries	50 000
	International and Domestic Communication on ODS and HFCS Monitoring Technology, Data Analysis and Quality Control Methods	50 000
Ecuador	Expanding ozone sounding operations in Ecuador from the Andes to the Galapagos Islands: the ECHOZ-SHADOZ synergy	36 945
	Exposure to ultraviolet radiation and dermatological effects on people linked to productive sectors of the provinces of Pichincha, Guayas, Manabi, Pastaza and Galápagos, in Ecuador	50 000
	Implementation of the Research Centre on Solar Energy and Ozone "Mitad Del Mundo"	50 000
India	Capacity Building and Awareness Workshop on Stratospheric and Tropospheric Ozone Measurements and Calibration of Ozone Measuring Equipment	49 920
	Impact of trace gases emissions changes on the stratospheric ozone layer and the present day and future climate over South Asia	50 000
<b>Total funds requested</b>		<b>336 865</b>

ODS: Ozone-depleting substances; HFCs: hydrofluorocarbons

ECHOZ: The Ecuadorian Highlands Ozonesondes project

SHADOZ: Southern Hemisphere Additional Ozonesondes

18. 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.<sup>14</sup> 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

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

(a) The total income of the Trust Fund from February 2003 to May 2021 (18 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 \$626,249;

<sup>14</sup> See, for example, decisions X/3 and XI/2 of the Conference of the Parties to the Vienna Convention.

(b) From February 2003 to May 2021, funds were disbursed or allocated to a total of 19 approved activities, including all 7 activities listed for priority funding at the ninth meeting of the Ozone Research Managers in 2014, and 5 out of the 8 project proposals received by the Secretariat in 2016 and 2017;

(c) Since 2015, a total of 17 activities/proposals have been evaluated by the Advisory Committee of the Trust Fund, 14 of which have so far been approved by the Committee, while 2 have not been approved and 1 is still under consideration awaiting the party's response to the offer suggested by the Advisory Committee;

(d) The total cost of the 19 approved activities was \$503,522;

(e) In the light of subparagraphs (a) and (d) above, the current available balance, including administrative costs, is: \$122,727.

20. 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 Trust Fund and operation of its Advisory Committee

#### (a) History of the Trust Fund

1. By 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, according to the decision, 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 address balanced global coverage. The decision further states 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.
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. The request for its third extension, set out in decision XI/2 in 2017, was approved by the United Nations Environment Assembly at its third session, in December 2017, in its decision 3/3.<sup>1</sup>

#### (b) Operation of the Advisory Committee of the Trust Fund

5. Pursuant to decision X/3 decision, 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.<sup>2</sup> The terms of reference of the Committee, developed and adopted at its second meeting, in October 2016, are available on the Secretariat's website.<sup>3</sup>
6. The Committee, which convenes electronically or in the margins of relevant meetings, has met eight times since its establishment in 2015.<sup>4</sup> The ninth meeting of the Advisory Committee will take place online prior to part II of the eleventh meeting of the Ozone Research Managers.

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<sup>1</sup> United Nations Environment Assembly decision 3/3, on the management of trust funds and earmarked contributions, section II, paragraph 7 F (c).

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

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

<sup>4</sup> 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; and 26 March 2021.

## Annex II

### Summaries of completed activities under the Trust Fund<sup>1</sup>

**1. Activity 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. Activity 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–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. Activity 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 General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention 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. Activity 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 is 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. Activity 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

<sup>1</sup> Based on the reports submitted upon the completion of the activities.

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 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. Activity 6: Relocation of Dobson no. 14 (formerly deployed in Tromsø, Norway) to Tomsk, Russian Federation and Dobson training course, 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. Activity 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. Activity 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. Activity 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 General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention 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. Activity 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, although some of the participating technicians and scientists had only minor experience in Dobson operation, they 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 General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention.

**11. Activity 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 8 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, ensure instruments are being operated according to the best modern practice and thereby lead to much improved submission of high-quality total ozone data.

**12. Activity 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,<sup>2</sup> established at the Research Centre in Jülich, Germany. The main objective of the campaign was to resolve ongoing discontinuities in the existing ozonesonde data records in general and particularly in Southern Hemisphere Additional Ozonesondes due to ground equipment, standard operating procedures, and changes in sonde manufacture and performance.<sup>3</sup> A unique feature of the campaign was that the ozonesondes were prepared by 12 operators from organizations representing Southern Hemisphere Additional Ozone sites in nine countries, namely Brazil, Costa Rica, France, Germany, Kenya, Malaysia, South Africa, Viet Nam and the United States of America.<sup>4</sup> Capacity-building activities during both sessions included lectures on sonde quality assurance, the

<sup>2</sup> [https://www.fz-juelich.de/iek/iek-8/EN/Expertise/Infrastructure/WCCOS/WCCOS\\_node.html](https://www.fz-juelich.de/iek/iek-8/EN/Expertise/Infrastructure/WCCOS/WCCOS_node.html).

<sup>3</sup> <https://www.youtube.com/watch?v=5KwHw4gNLzg>; [https://www.youtube.com/watch?v=zOgL\\_0\\_pu00](https://www.youtube.com/watch?v=zOgL_0_pu00).

<sup>4</sup> <https://vimeo.com/240986625>.

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, the Royal Netherlands Meteorological Institute, the Royal Meteorological Institute of Belgium, MeteoSwiss, Environment and Climate Change Canada, and the Finnish Meteorological Institute. Six coaches from Finland, 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 General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention, 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, Stratospheric 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.<sup>5</sup> The new insights gained from this intercomparison experiment have brought the community forward in making important steps to improve the performance of the ozonesondes, both in scientific and operational perspective. Those results also led to the initiation of a new WMO-Network for the Detection of Atmospheric Composition Change-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 is in preparation, expected to be published as a WMO Global Atmosphere Watch report in the course of 2020.

**13. Activity 13: Capacity-building on data management and instrument calibration: Part 1, Hradec Králové, Czechia, and Payerne, Dubendorf and Zurich, Switzerland, 18 June–6 July 2018; and part 2, Kenya, 18–27 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 the Federal Office of Meteorology and Climatology (MeteoSwiss), the Swiss Federal Laboratory for Materials Testing and Research, and the Observatory, Hradec Králové, Czechia, through the General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention. 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, Dubendorf and Zurich) from 17 June to 6 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 knowledge 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 Observing System Capability Analysis and Review Tool of WMO 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 program to help systematically analyse both vertical profiles and surface data. Part of the phase 1 training covered building competence in calibration of the TEI49i O<sub>3</sub> analyser and Picarro instrument for carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and water (H<sub>2</sub>O) measurements. The knowledge and skills gained during the training course were shared with colleagues and students at the WMO Regional Training Centre, Institute of

<sup>5</sup> <https://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-17-0311.1>.

Meteorological Training and Research, Nairobi, and have led to improved work performance at the Kenya Meteorological Department.

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; 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. Activity 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, Argentina's National Meteorological Service, the United States National Oceanic and Atmospheric Administration's Global Monitoring Division, and the University of Colorado Cooperative Institute for Environmental Research. 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, 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. This event is part of the WMO Global Atmosphere Watch quality control requirements for monitoring atmospheric total ozone and ensures the quality of total ozone data sets. 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 in the morning of 21 March 2019 to create a reliable data set for verification of different technologies used for processing these observations.

**15. Activity 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 Africa 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 due 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 amounts 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 intercompare 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 the participants were given as much training as possible, and with renewed and regular email contact with the South Africa 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. The reports of individual instruments from this activity were prepared and shared with the community. The final combined report is under preparation. This event is part of WMO Global Atmosphere Watch quality control requirements for monitoring atmospheric total ozone.

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