

Report on Activities of the Regional Dobson Calibration Center (RDCC) for WMO RA VI: The Meteorological Observatory Hohenpeissenberg (Germany) and The Solar and Ozone Observatory Hradec Králové (Czech Republic)

2004

Introduction:

The European RDCC at the Meteorological Observatory Hohenpeissenberg (MOHp)/Solar and Ozone Observatory Hradec Králové (SOO-HK) continued its regular work (service and calibration of operational Dobsons in the European network) in 2004 with three international Dobson intercomparisons held at Hohenpeissenberg in May/June (**MOHp2004-1**), June/July (**MOHp2004-2**) and July (**MOHp2004-3**). Additionally two participants from MOHp and one from SOO-HK assisted in the organization and realization of an WMO intercomparison for RA I Africa in Dahab (Egypt) in February/March (**DICE2004**). This campaign was also used for the due calibration of the Regional Standard D064 towards the World Standard D065 from NOAA /Boulder, USA). In total 9 European Dobsons got a maintenance service and were calibrated towards the MOHp reference instrument Dobson No. 064. Two of these instruments - the so-called Antarctic Dobsons No. 073 and 123 from the British Antarctic Survey BAS - were undergone a complete refurbishment (replacement of the old fashioned electronics by the new US type, optical and mechanical work), which started already in fall 2003. This work enabled the BAS to continue its very important monitoring of the Antarctic ozone layer with instruments of a high quality calibration level.

Again some of the proposed candidates for calibration were not able to come from different reasons (lack of money and/or time). Additional problems occurred with timing of the campaigns. Although the number of instruments would have been appropriate for only two campaigns, three had to be performed to meet everybody's requirements. This experience and those of previous five years of operation RDCC-E have led to the decision to modify the campaign scheme, which is described in detail under **Offered Services and Plans for 2005**.

The problem of the calibration level of the traveling Microtops No. 3785, which occurred during the calibration check of the Icelandic Dobson No. 050 in 2003 (see corresponding report), could be solved by a re-determination of the factory constants. In addition three Microtops instruments of the German DLR got a kind of remote calibration.

Spare parts supply of the Dobson community, mentioned in former RDCC/E reports as one of the urgent problems, has been stabilized in 2004. A company was identified, which produces special microamperemeters exactly after our requirements at a reasonable price. Thus we will be able to replace many of the very old instruments, which obviously reached the end of their lifetime.

The excellent "Dobson – Brewer co-operation" was continued during 2004. Members of expert groups met several times during international meetings (e.g. at the Quadrennial Ozone Symposium at Kos in Greece,

the WMO/GAW SAG for Ozone at Boulder, USA and during the NDSC meeting at Andoya in Norway). Future Dobson activities were discussed especially at the Dobson IC at Dahab, Egypt during a meeting of the DAHC. Comparisons of the long term Dobson and Brewer records from Hohenpeißenberg and Hradec Kralove with the latest satellite data sets TOMS-V8 and GOME-WFDOAS revealed some very interesting features. The results confirm the importance of measuring the thickness of the ozone layer with different and totally independent instruments simultaneously at well-maintained GAW stations. Scientists and technicians of the SOO-HK contributed substantially to establishment and activities of the RBCC-E, Izaña, Spain.

SOO-HK continued training courses organized in cooperation with WMO for operators of Dobson spectrophotometers from GAW ozone stations located outside RA-VI. This long-term educational programme represents the contribution of RDCC-E to the capacity building on monitoring of the ozone layer in developing countries. In 2004 the programme was extended by a technical assistance provided to selected stations in Africa and was supported by a special 3-year development project of the Czech Government.

Thus MOHp and SOO-HK have again confirmed, that they are able to meet the demands on maintenance the high quality calibration level in the expanded Dobson network in Europe. The Quality Assessment/Quality Control (QA/QC-programme of WMO) developed for the global total ozone monitoring network of Dobson spectrometers will be guaranteed by both institutions from Germany and Czech Republic in the RA-VI Region on a long term basis.

The following sections give a description of the offered services, the work done in 2004 including results achieved and the activities planned for 2005. An outlook will outline further intentions in the near future.

Offered Services:

In the following the tasks and offered services of the RDCC-E MOHp/SOO-HK are listed with a short description and responsibilities that are given in brackets:

- Maintenance/provision of absolutely calibrated regional reference instruments (D064 at MOHp, D074 at SOO-HK), being regularly compared with standard instruments of the WDCC (NOAA/CMDL, Boulder, Colorado). These comparisons (as done in June 2002 and February/March 2004) and/or Langley measurements for absolute calibrations should be performed at least every two or three years.
- Technical and scientific organization, performance and evaluation of regular Dobson calibration campaigns at MOHp, until 2003 2 – 3 campaigns per year (each 2 – 3 instruments). From 2004 on only one campaign per year will be held at Hohenpeißenberg (up to 5 instruments which need intensive work). Well maintained Dobsons with minor problems will be gathered once per 4-5 years in larger campaigns (10 instruments in the maximum) organized either at El Arenosillo (Spain) or Arosa (Switzerland) and assisted by RDCCs specialists from MOHp and SOO-HK. The reason is that the Hohenpeißenberg facility does not allow to handle more than 5 instruments during one IC.
- Refurbishment of Dobsons being out of operation and/or spectrophotometers that are equipped with old components (e.g. installation of new electronics - the US style modified by MOHp etc.), supply of spare parts (mainly MOHp with support of SOO-HK). New sources for some special parts (e.g. sun director produced by a Czech workshop, providers of new type of a small and stable SL-power supply and of a modern shutter-motor) have been found or are under investigation (e.g. for the microammeters).
- Service for the European Dobson stations, technical/scientific support additional to the regular inter-comparisons (MOHp, SOO-HK) including the provision of a traveling instrument (e.g. Microtops) for in-situ calibration checks (MOHp).

- Development of new techniques, tools, software and other methods to improve instruments' maintenance, tests, operation and data processing/analyses in cooperation with the WDCC in Boulder, WMO and the Dobson Ad-Hoc Committee (MOHp, SOO-HK).
- Thorough and continuous analyses/control of data quality, support/advice in data re-evaluations, comparisons with other instruments (other Dobsons, other types: e.g. satellite validation), detection/explanation/quantifying of principal differences (e.g. to the Brewer) (MOHp, SOO-HK) in close co-operation with the **Dobson Ad-Hoc Committee (DAHC)** and the **Regional Brewer Scientific Group (RBSG)**. The comparison of the MOHp D104 and BR010 and SOO-HK D074 and B098 with the latest TOMS Version 8 reveals some doubts.
- Preparation and maintenance of Standard Operating Procedures in co-operation with WDCC Boulder, WMO and Dobson Ad-Hoc Committee (MOHp, SOO-HK). Continuous upgrading of the new special Dobson Manual for experts written by Archie Asbridge (MOHp mainly responsible, SOO-HK with advisory function) under the auspices of WMO.
- Education and training of Dobson operators for the regular operation, standard tests and maintenance work both for RA VI and stations located in developing countries selected after consultation with WMO (SOO-HK).
- Education and training of the own staff of RDCC/E (MOHp, SOO-HK).
- The following equipment (hardware and software) is already available for the above mentioned tasks:
 - Semi-automated two-lamp unit for wedge calibrations (MOHp).
 - Set of spectral lamps for calibration of wavelength setting with Q-levers → Q-tables (MOHp, SOO-HK).
 - Microtops Filter Ozonometer as traveling instrument for in-situ calibration checks (MOHp).
 - Traverse Microscope incl. video system for measurement and adjustment of slit width (MOHp).
 - Special tools like traverse lamp device, 1/3-2/3-device, miniature UV-spectrometer etc. for special tests and alignment procedures (MOHp, SOO-HK).
 - Completely equipped optical laboratory.
 - Special Dobson software package for data processing, archiving and transfer, free release and available for users (SOO-HK).
 - Semi-automated PC-controlled facility for reading and processing the Dobson total ozone observations (SOO-HK).
 - Web pages of the Dobson network <http://www.chmi.cz/meteo/ozon/dobsonweb/welcome.htm> (SOO-HK).
 - Stock with selected pieces of spare parts (New US-type electronics, SL- and HG-power supplies, phototubes, optical components etc.).

Some other stations in Europe also have various tools (spectral lamps e.g. in U.K. and Switzerland), which can be used on demand.

Activities in 2004:

The RDCC/E MOHp/SOO-HK performed the following activities at various locations in 2004 - responsibilities are given in brackets:

- Maintenance and provision of the two regional reference Dobson instruments No. 064 (MOHp) and No. 074 (SOO-HK).

- The Microtops filter ozonometer for in-situ calibration checks of Dobsons at their stations was not used for this purpose in 2004, but after the experience in 2003 with the Dobson No. 050 at Reykjavik (Iceland) the determination of new calibration constants was performed in July during MOHp2004-3. In addition three Microtops instrument from the DLR at Oberpfaffenhofen were recalibrated by a remote kind of calibration -their measurements on August 9 were compared with simultaneous total ozone observations at Hohenpeissenberg, which is about 35 km apart (MOHp).
- Technical and scientific organization, performance and evaluation of two Dobson intercomparisons held at the RDCC Hohenpeissenberg: MOHp2004-1 with the D032, D035 and D041 (all from UK, Met. Office) and D092 (Denmark) from May 9 to 29, MOHp2004-2 with D0073 and D123 (both from UK, BAS) from June 20 to July 3 and MOHp2004-3 with D013 (Portugal), D044 (Armenia) and D071 (Germany, Lindenberg) from July 11 to 24. Additionally a campaign (DICE2004) was held at Dahab in Egypt for 9 instruments: D011 (Algeria), D015 (Botswana), D018 (Kenya), D057 (Seychelles), D059 (Egypt), D069 (Egypt), D089 (South Africa), D096 (Egypt) and Shimadzu 5703 (Nigeria). This WMO intercomparison was held under the scientific and technical organization of the WDCC/Boulder (B. Evans, M. O'Neill), participating with the secondary world standard D065, assisted by M. Stanek (SOO-HK, Czech Republic) and U. Köhler / B. Dömling (MOHp, Germany) with regional standard D064 to be compared against the world standard within the regular schedule of 2 years (last calibration at Boulder in 2002. Results of the European campaigns are given in **Attachment 1**: Both panels show the difference between the N-values ("raw data") of standard instrument D064 and the Dobsons to be calibrated. Left panel before adjustment during the initial calibration, right panel after adjustment during the final calibration (MOHp, SOO-HK). The right panels always show a significant improvement of the instrumental performance after the final calibration compared with the status of the Dobsons, when they arrived for the intercomparison (left panel) (MOHp, SOO-HK).
- A complete refurbishment of two Dobsons D073 and D123 ("Ozone hole instrument") from the **British Antarctic Survey BAS** (replacement of electronics, optical alignment) was finished in early 2004 and these instruments then participated in the MOHp2004-2-IC (MOHp).
- The problematic D041, which could not be calibrated in 2003, was finally calibrated after its successful repair. Similar problems with the Danish D092 have been already solved in 2004 by replacement of the complete electronics. The final calibration of this instrument, however, had to be postponed from MOHp2004-1 to MOHp2004-3 (MOHp).
- The examination and adjustment of two Italian Dobsons D046 and D113 had unfortunately to be shifted again to 2005 due to a full schedule at MOHp in 2004.
- Participation as co-partners in applications for two EU projects (TRAM, which is unfortunately rejected and EURONET, which is currently under evaluation) (MOHp, SOO-HK).
- Participation and presentation of contributions on activities of RDCC-E at international meetings:
 - The meeting of the WMO/GAW Scientific Advisory Group for Ozone (SAG-Ozone), Boulder, USA, 06.-08.10.2004 (SOO-HK).
 - The WMO Dobson Ad-Hoc Committee meeting, Kos, Greece, June 2004 - discussion of the current state of the Dobson network, future developments e.g. re-location of unused Dobsons to other or new GAW stations, problems at various stations with instrumentation, operation, evaluation of data records and co-operation between Dobson and Brewer groups in the RA-VI, updating of the Dobson Standard Operation Procedures SOP's. (MOHp, SOO-HK).
 - The Quadrennial Ozone Symposium, Kos, Greece, 01-08.06.2004 - the joint presentation with MOHp, SOO-HK and NOAA/CMDL: "The Dobson Instrument - Still a Backbone of Ozone Monitoring?" (MOHp, SOO-HK).

- The EUMETSAT's Ozone Satellite Application Facility - Algorithm Forum III meeting, 30. 09. 2004, Helsinki - invited presentation: "Quality of Ground-based Total Ozone Measurements in the WMO/GAW Network" (SOO-HK).
 - The NDSC Steering Committee Meeting, Andoy, Norway, September 2004 (MOHp).
 - The XVI. Conference of the Parties to the Montreal Protocol, Prague, 22-26 November 2004 (SOO-HK).
- Supervision of the new Dobson station in Armenia, monitoring of the produced data and test results, this year "in-situ" assistance in technical problems (broken SL-lamp, doubtful symmetry test) during MOHp2004-3 (MOHp).
 - Installation and in-situ technical check of the Dobson instrument including installation of the Dobson software package at the newly established GAW station in Maun, Botswana (SOO-HK).
 - Maintenance and updating of Dobson Web Pages - an Internet site of the Dobson part of the GAW ozone monitoring network, located at the server of CHMI (SOO-HK) with the following URL: <http://www.chmi.cz/meteo/ozon/dobsonweb/welcome.htm>. (SOO-HK).
 - Training of Dobson observers from Algeria (1) and Botswana (3) at SOO-HK (30.08.-10.09.2004) in operation and maintenance of the instrument, processing of measurements at their home stations and re-processing of their historical records. A detailed report has been prepared and submitted to WMO/ENV by K. Vanicek and can be found on the above mentioned Dobson Web Page (SOO-HK).
 - Further development and improvement of the software for controlling the new semi-automated wedge calibration unit (MOHp).
 - Further development, production and purchase of necessary RDCC/E tools, equipment and Dobson spare parts (modification of the new US-type electronics, mirror coating, SL-power supplies, shutter motors, sundirectors) (MOHp, SOO-HK).
 - Send out of a questionnaire to update the status quo and the future in the European Dobson network.
 - Beginning of the arrangement of next Dobson-campaigns to be held at MOHp in 2005 (MOHp, SOO-HK).
 - Upgrade of the semi-automated facility for recording and processing of Dobson total ozone observations that has been installed at several stations of the GAW network under the Czech GAW assistance project (SOO-HK).
 - Investigation of relation between Dobson, Brewer and recent satellite data sets from collocated measurements performed at MOHp and SOO-HK and their presentation (e.g. the EC funded CANDIDOZ project).
 - Expert consultations provided to the newly established Regional Brewer Calibration Centre of RA-VI at Izana, Spain.

The following staff was responsible for the realization of the above RDCC/E tasks and participated in particular activities:

Dipl. Met. Ulf Köhler, scientific head of the Dobson Calibration Centre (MOHp)
 Dr. Karel Vanicek, head of the SOO-HK

Dr. Wolfgang Steinbrecht, scientist (MOHp)
Ing. Martin Stanek, engineer (SOO-HK)
Ing. Fritz Schönenborn, electronic engineer (MOHp)
Jiří Pokorný, technician (SOO-HK)
Bert Dömling, technician (MOHp)
Ferdinand Strommer, technician (MOHp)
Alois Stögbauer, workshop (MOHp)
Hans Eding, electrical workshop (MOHp)

Plans for 2005:

The following list gives an overview about the intended activities to be performed in 2005:

- Technical and scientific preparation, organization, performance and evaluation of one Dobson inter-comparison at MOHp:
 - **MOHp2005-1**, tentatively from June 5 to June 18 (extension to June 25 possible if necessary). Expected participants are 3 instruments: from Czech Republic (secondary European Regional Reference D074, Martin Stanek), Poland (D084, Bonaventura Rajewska-Wiech, N.N.) and Russia (D107 as the regional standard for the network of Russian filter instruments, one M124 filter instrument and an UVOS Ultraviolet Ozone Spectrometer, Arkady Shalamiansky and N.N.) (MOHp, SOO-HK). This campaign will be combined with:
 - **Training** in Dobson adjustment, repair and calibration for a technician of the South African Weather Service, who will be responsible for calibration activities in the WMO RA I Africa at the RDCC to be established in the future. At least one of two Italian instruments, being at Hohenpeißenberg since 2003 will be checked, aligned, repaired and calibrated too (MOHp, SOO-HK).
- Maintenance of the D064 and D074 spectrophotometers as secondary regional references and the inter-comparison of D074 with D064 at MOHp (MOHp, SOO-HK).
- Complete refurbishment (installation of new US-type electronics and replacement of mechanical parts of the wedge device) of the Swiss Dobson No. 062 at Hohenpeißenberg (MOHp).
- Complete refurbishment of the D018 instrument and its re-installation at the new station in Nairobi, Kenya including installation of the software package and training of operators (MOHp, SOO-HK in cooperation with MeteoSwiss).
- Discussion and possible decisions about the further deployment of unused Dobsons (new candidates for a transfer to new stations are instruments from Hungary D120, Italy, Belgium, Norway and UK) in the frame of WMO/DAHC (MOHp, SOO-HK).
- Evaluation of the 2004-questionnaire. This will be helpful for the classification of the instruments' service demands (appropriate to the "simple" medium size calibrations or candidates for more intensive service at MOHp during small campaigns) (MOHp).
- Participation in the proposed project EURONET (if approved) (MOHp, SOO-HK).
- Installation of semi-automated facilities at selected GAW stations in South America, Egypt and Kenya including training of observers in operation of the related software tools (SOO-HK).
- Presentation of particular RDCC-E activities at:
 - The WMO/GAW Quadrennial Workshop, Geneva, March, 2005, (MOHp, SOO-HK)
 - WMO Regional Workshop on Global Climate Observing System (GCOS) for Eastern and Central Europe, Leipzig, April 2005 (SOO-HK)
 - WMO/UNEP Ozone Managers Meeting, Vienna, September 2005 (MOHp, SOO-HK)
 - The Conference of the Regional Association VI, Tutzing, October 2005 (SOO-HK)
- Further updating of the Dobson Web Pages with the aim to get comments of visitors and to announce actual events related to the GAW Dobson network; designing and creating a RDCC/E-Web Page at the MOHp-server as a supplement to the Czech web site (SOO-HK, MOHp).
- Training of Dobson operators at the GAW station in Nairobi (SOO-HK).
- Further improvement of the technical equipment and software (wedge calibrator, Dobson software package) (MOHp, SOO-HK).
- Further supervision of the Dobson station in Armenia and monitoring of the produced data, to ensure the demanded data quality within the global Dobson network (MOHp).
- Presentation of "An Overview of the GAW RCC Dobson System" at the GAW 2005 Workshop, Geneva, March 2004 (SOO-HK).
- Further investigations Dobson-Brewer-TOMS and presentation of the results (among others) is intended at the Brewer Workshop at Delft in June (MOHp, SOO-HK).
- Presentation of the current state of the Dobson (and Brewer)- network at the NDSC Steering Committee Workshop at Tenerife in November (MOHp).

Further Outlook:

As in the recent years financial problems in most of the countries engaged in the ozone monitoring and research still persist in the short and medium time range of works needed in this important environmental area. Thus following two particular problems, already mentioned in previous Annual Reports, are still on the agenda.

- 1) The continuation of long-term records of total ozone measured with Dobsons is questioned.
- 2) The realization of the fundamental requirement of the global Dobson calibration system - the regular absolute calibrations of the standard instruments (at least each two/three years) - is currently very difficult.

The solution of the item of the 2003 report: "Modification of the new calibration concept" is currently in progress. Therefore only one small campaign will take place at Hohenpeißenberg in 2005. A first medium size campaign for "easy" instruments is scheduled within the next two years.

Number of unused Dobsons available for a possible relocation is increasing. Their future operation has to be discussed in the WMO/DAHC and decisions made in a close coordination with the lending countries/institutions and the candidates for new Dobson stations. The financial aspects of these transfers could possibly be solved or at least attenuated by means of the recently submitted EU-project EURONET or by another application for the TRAM project.

The refurbishment and standardization of the instruments is another goal for the coming years. The replacement of the large variety of old electronics by the new US-type with MOHp-modification etc. should continue. Each Dobson designated for relocation should be undergone such a renewal. The costs for this activity can partly be covered by the official RDCC-budget of the German Weather Service DWD depending on the financial situation of the operating institution/country.

The Staehelin's et al.-paper on "Comparison of total ozone measurements of Dobson and Brewer spectrophotometers and recommended transfer functions" (WMO/GAW Report No. 149, WMO TD No.1147, Geneva, March 2003), initiated also by DAHC, is still a good guidance how to handle the parallel Dobson and Brewer data series created at a considerable number of stations. The latest results of the comparison Dobson/Brewer data with the new TOMS Version 8 and GOME-WFDOAS confirm the need of a certain number of selected high quality stations, where parallel operation of both types of spectrophotometers are continued. These stations are the fundament for reliable validation of satellite data, which will be one of the key activities of the two branches of the GAW total ozone monitoring network with synergetic effects. Further investigations of the principal differences between Dobson and Brewer data series are still very important in this context. The implementation of new findings related to the different temperature dependences of the Dobson and Brewer absorption coefficients in a potential data correction gave encouraging results.

The hopefully positive effect of the modified calibration will be assessed after the second calibration cycle in about three or four years. The new concept with a combination of annual small MOHp-campaigns for labour intensive instruments and a quadrennial medium size intercomparison for Dobsons with less demand on repair service should significantly reduce the amount of necessary work without a negative effect on the quality.

Hohenpeißenberg, April 2005

Hradec Králové, April 2005

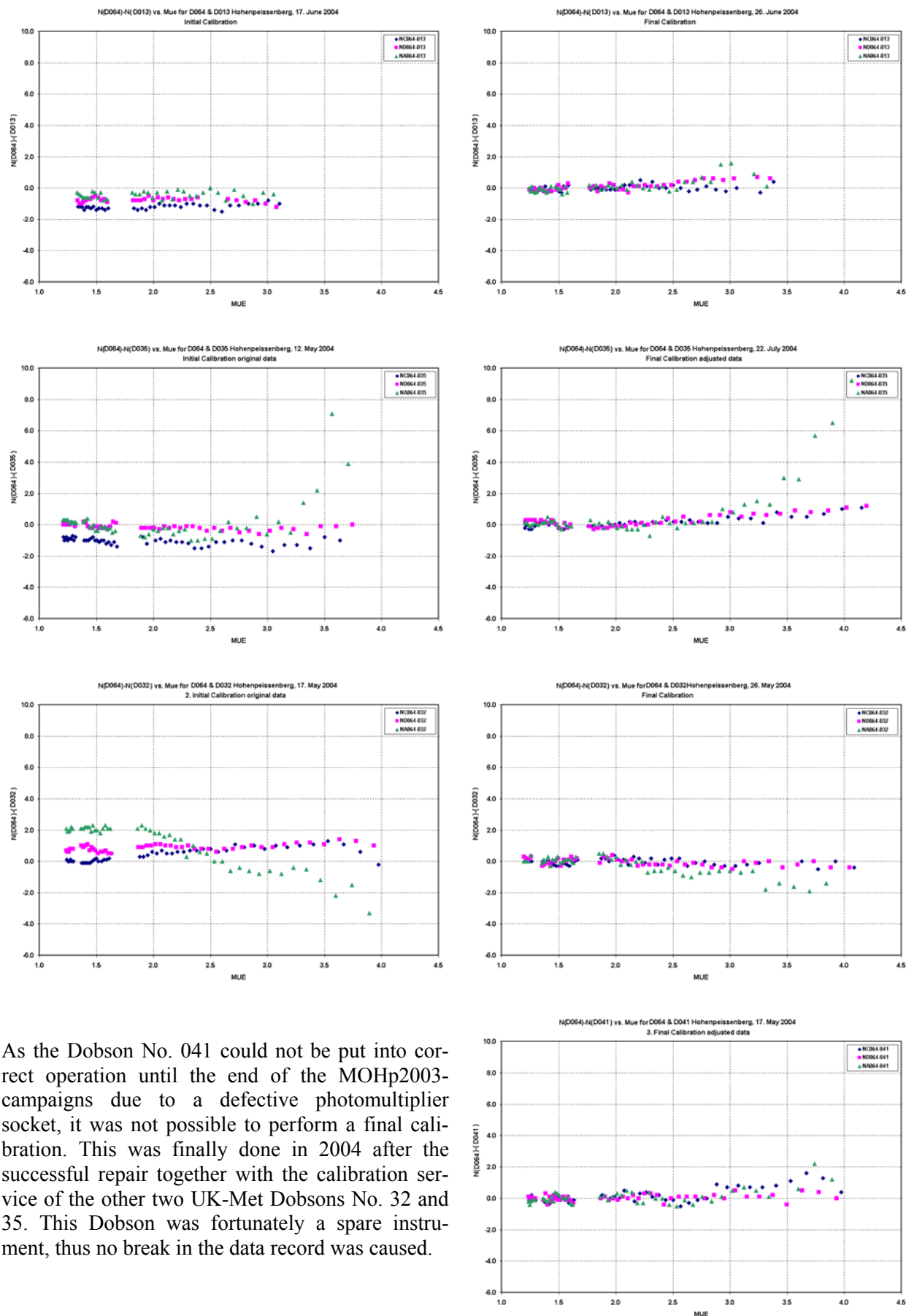
(Ulf Köhler)

(Dr. Karel Vaniček)

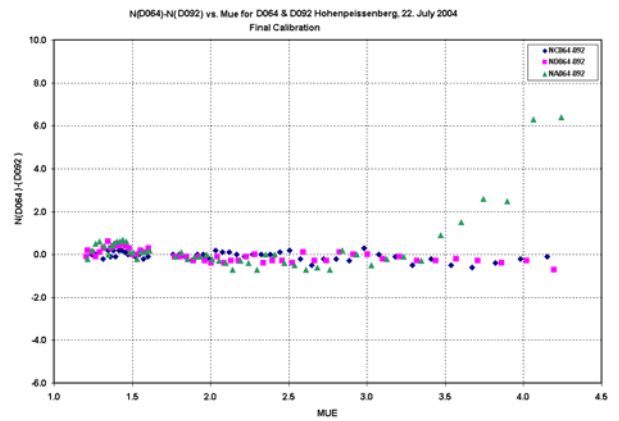
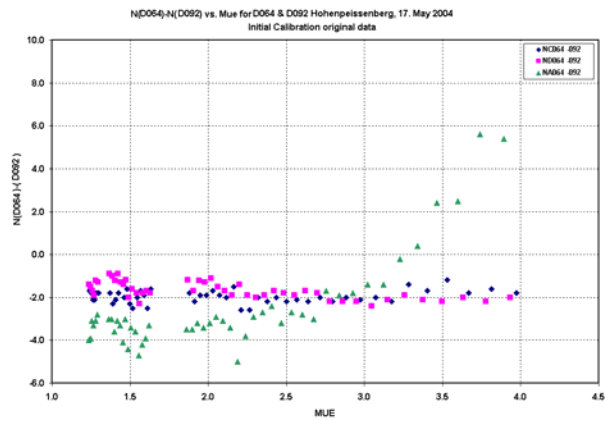
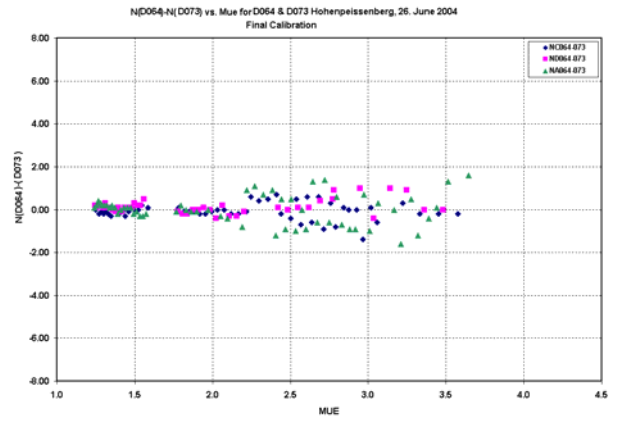
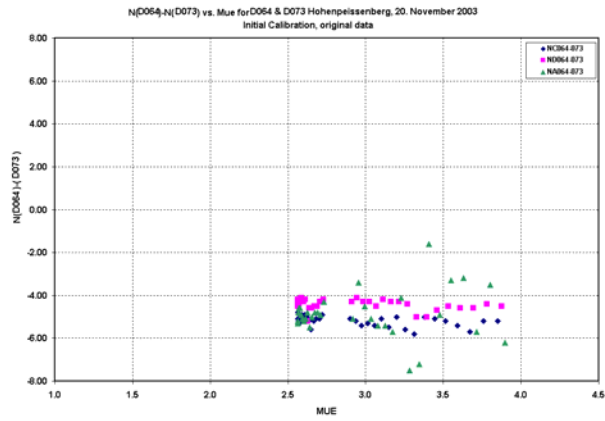
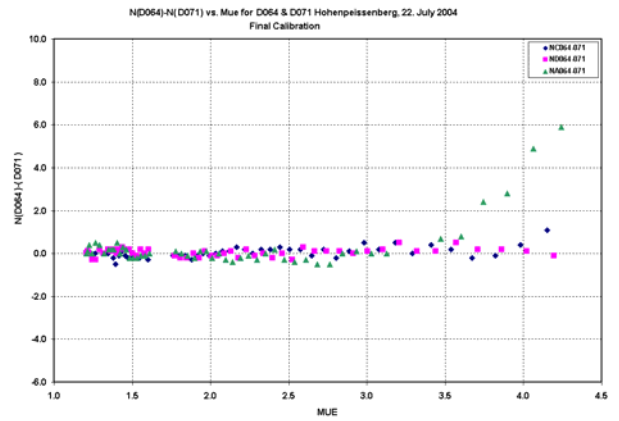
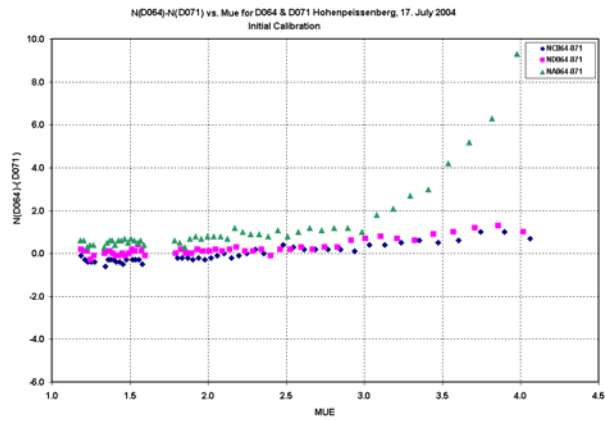
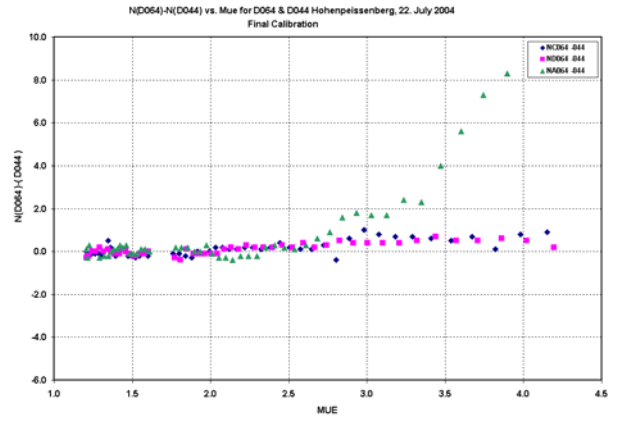
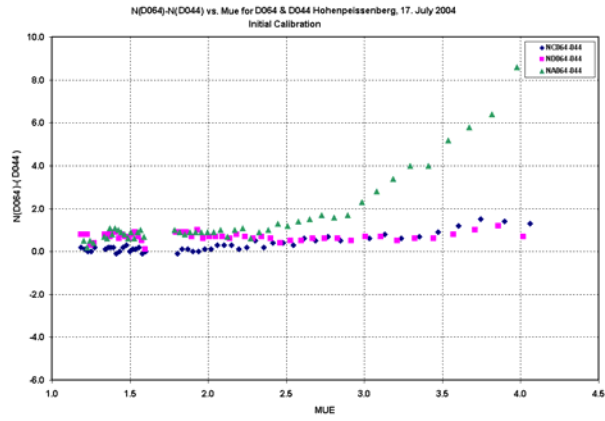
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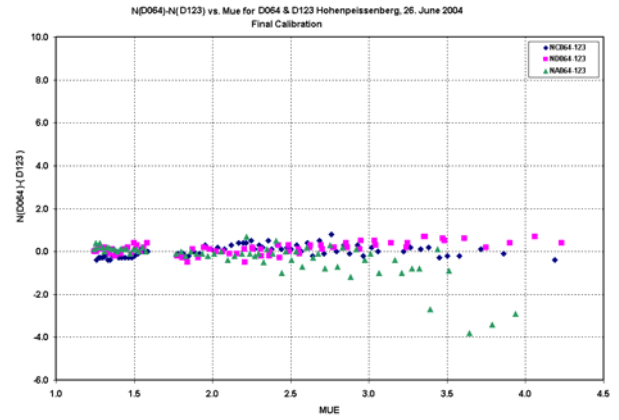
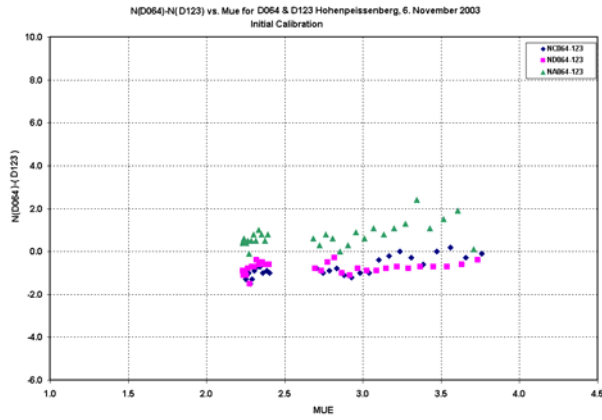
1. Summary graphs of the Dobson calibrations MOHp2004-1, MOHp2004-2 and MOHp2004-3: Initial calibrations of the various instruments on the left hand, final calibrations on the right hand; shown are the differences of the raw data between standard Dobson and instruments under calibration in the three used wavelength pairs (3 pages). In addition the good agreement between standard Dobson No. 064 and the "traveling Microtops" No. 3785 is shown in the final diagramm.
2. Actual table of all operational European Dobson stations incl. calibration state and schedule (1 page) for 2005.

Attachment 1: Graphs of the Calibration Results

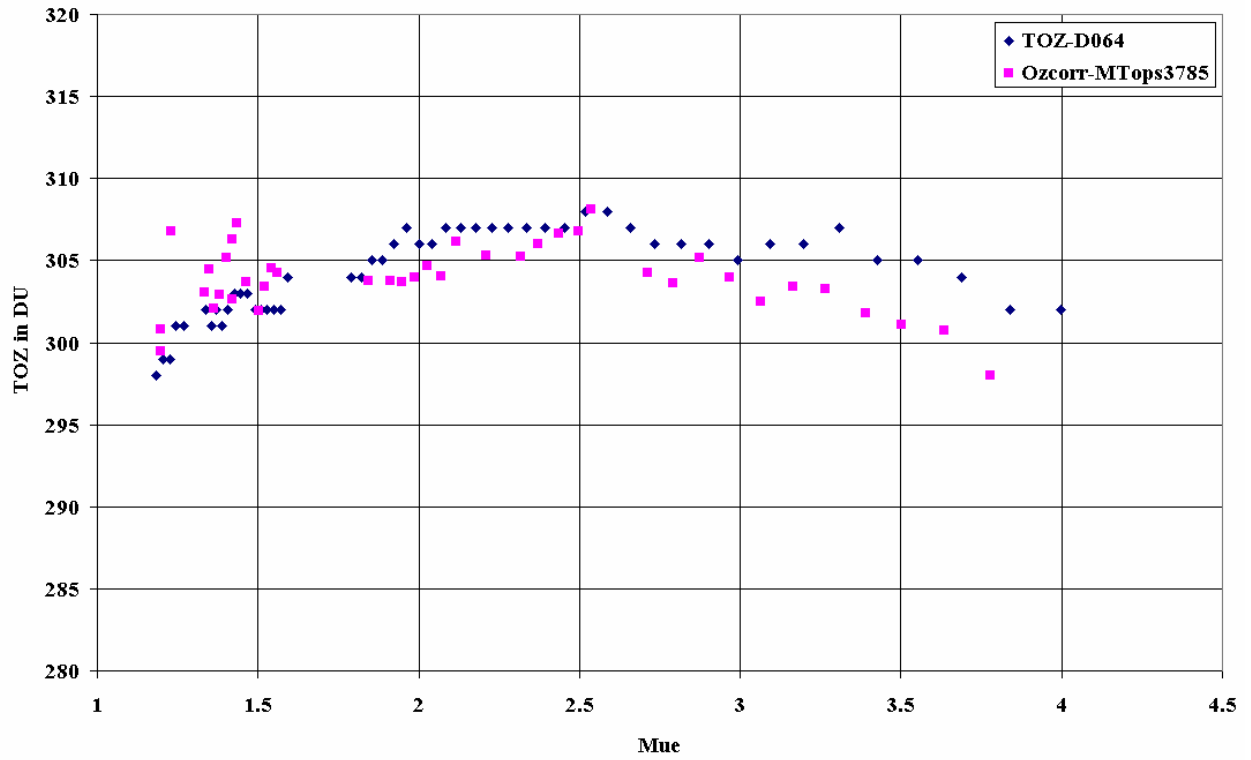


As the Dobson No. 041 could not be put into correct operation until the end of the MOHp2003-campaigns due to a defective photomultiplier socket, it was not possible to perform a final calibration. This was finally done in 2004 after the successful repair together with the calibration service of the other two UK-Met Dobsons No. 32 and 35. This Dobson was fortunately a spare instrument, thus no break in the data record was caused.





Comp. D064 - MTops 3785 July 17, 2004, MOHp



Attachement 2: Table of State and Schedule for the European Dobsons 2004

Summary of European Dobson Stations							
No.	Dobson No.	Country	Location	Last Cal.	L. Cal. Location	Next Cal.	N.Cal. Location
5	D018	Kenia	Nairobi	04/2005	MOHp	2005	MOHp
13	D046	Italy	Brindisi	?	?	2005	MOHp
21	D062	Switzerland	Arosa	7/99	Arosa	2005	MOHp
27	D074	Czech	Hradec Kralove	7/2002	MOHp	2005	MOHp
28	D084	Poland	Belsk	6/2001	MOHp	2005	MOHp
34	D104	Germany	Hohenpeissenberg	7/2001	MOHp	2005	MOHp
36	D108	Russia	Voeikovo	7/2001	MOHp	2005	MOHp
38	D113	Italy	Cagliari/Elmas	?	?	2005	MOHp
6	D030	Sweden	Vindeln	6/2001	MOHp	2006	El Arenos.
14	D047	Italy	Vigna di Valle	7/2002	MOHp	2006	El Arenos.
16	D049	France	Campistrous,	7/2002	MOHp	2006	El Arenos.
17	D050	Iceland	Reykjavik	7-8/1995	Arosa	2006	El Arenos.
22	D064	Germany	Hohenpeissenberg	2-3/2004	Dahab	2006	El Arenos.
29	D085	France	Haute Provence	7/03	Arosa	2006	El Arenos.
32	D101	Switzerland	Arosa	7/03	Arosa	2006	MOHp
39	D118	Greece	Athens	7-8/97	Kalavryta	2006	MOHp
40	D120	Spain	El Arenosillo	6-7/03	MOHp	2006	El Arenos.
41	D121	Romania	Bucharest	7/2001	MOHp	2006	El Arenos.
15	D048	Italy	Sestola	7/03	Arosa	2007	MOHp
18	D051	Switzerland	Arosa	?	?	2007	MOHp
35	D107	Russia	Moscow	5-6/03	MOHp	2007	MOHp
2	D013	Portugal	Lisbon	2004	MOHp	2008	MOHp
4	D015	Botswana	Maun	3-4/2000	Pretoria	2008	Dahab
8	D032	UK	Lerwick	5/04	MOHp	2008	MOHp
9	D035	UK	Camborne	5/04	MOHp	2008	MOHp
11	D041	UK	Camborne	6-7/03 5/04	MOHp	2008	MOHp
12	D044	Armenia	Nor Amberd	07/2004	MOHp	2008	MOHp
20	D059	Egypt	Harghada	2-3/2004	Dahab	2008	Dahab
24	D069	Egypt	Aswan	2-3/2004	Dahab	2008	Dahab
25	D071	Germany	Lindenberg	7/04	MOHp	2008	MOHp
30	D092	Denmark/Gre	Thule	05/04	MOHp	2008	MOHp
31	D096	Egypt	Cairo	2-3/2004	Dahab	2008	Dahab
26	D073	UK	Cambridge	6-7/04	MOHp	2010	MOHp
42	D123	UK	Cambridge	6-7/04	MOHp	2010	MOHp
1	D008	Norway	Ny Alesund			?	?
3	D014	Norway	Tromsø	5/1998	Oslo	?	relocation?
10	D040	Belgium	Uccle	5-6/00	MOHp	?	relocation?
19	D056	Norway	Harestua	7/99	Arosa	?	relocation?
23	D066	Italy	S. Pietro Capofume	?	?	?	?
37	D110	Hungary	Budapest-Lorinc			?	relocation?
7	D031	UK (Ukraine)	Vernadsky	?	?		
33	D103	UK	Halley	?	?		
Description:							
Next Calibration				Calibration in 2 years			
Calibration next year				Calibration recently			
Status unknown/not operational							