

# CONTENTS

1. INTRODUCTION . . . . .	7
2. MONITORING OF TOTAL OZONE IN HRADEC KRÁLOVÉ . . . . .	8
a) The Solar and Ozone Observatory in Hradec Králové – characteristics . . . . .	8
b) Programme of total ozone observations at SOO-HK . . . . .	8
c) Calibration histories of ozone spectrophotometers operated at SOO-HK . . . . .	8
<b>2.1. Observations made with the Dobson spectrophotometer D074 . . . . .</b>	<b>9</b>
a) Types and schedules of measurements . . . . .	9
b) Processing of observational data – theory . . . . .	11
c) Maintenance of the Dobson data records . . . . .	12
<b>2.2. Observations made with the Brewer spectrophotometer B098 . . . . .</b>	<b>13</b>
a) Operation schedules for total ozone and SO <sub>2</sub> measurements . . . . .	13
b) Processing of the observational data – theory . . . . .	15
c) Maintenance of the Brewer data files . . . . .	16
<b>2.3. Application of the total ozone data from SOO-HK – a need of re-evaluation . . . . .</b>	<b>16</b>
a) Scientific and operational applications of data . . . . .	16
b) Reasons for re-evaluation . . . . .	17
3. RE-EVALUATION OF THE DOBSON TOTAL OZONE OBSERVATIONS, 1961–2002 . . . . .	17
<b>3.1. Calibration history of the Dobson spectrophotometer D074 . . . . .</b>	<b>17</b>
a) Dobson reference spectrophotometers, international comparisons . . . . .	17
b) Intercomparisons of D074 – relation towards the reference instruments . . . . .	18
c) Re-definition of calibration constants of D074 for the period 1961–2002 . . . . .	18
<b>3.2. Re-calculation of D074 total ozone observations . . . . .</b>	<b>20</b>
a) Ozone absorption and Rayleigh scattering coefficients . . . . .	20
b) Calculation of the relative optical air mass of the ozone layer – $\mu$ . . . . .	21
c) Input raw-data sets . . . . .	22
d) Re-processing of direct sun (DS) observations . . . . .	22
e) Re-processing of zenith observations (ZB.ZC) – updating of the zenith polynomials . . . . .	22
<b>3.3. Evaluation of outputs . . . . .</b>	<b>24</b>
a) Quality assessment of re-calculated observations . . . . .	24

b)	Differences between the original and re-calculated total ozone data series . . . . .	28
c)	Sampling the data for type of observations . . . . .	29
d)	Impact of number of days with observations on the accuracy of calculation of monthly mean total ozone . . . . .	31
e)	Creation of new D074-V2003 data files for WOUDC. . . . .	32
<b>4.</b>	<b>RE-EVALUATION OF THE BREWER TOTAL OZONE OBSERVATIONS, 1994–2002.</b> . . . . .	<b>33</b>
<b>4.1.</b>	<b>Calibration history of the Brewer spectrophotometer B096</b> . . . . .	<b>33</b>
a)	Brewer reference spectrophotometers, international comparisons . . . . .	33
b)	Intercomparisons of B098 – relation towards reference instruments . . . . .	33
c)	Validity of calibration constants of B098 in the period 1994–2002 . . . . .	34
<b>4.2.</b>	<b>Re-calculation of B098 total ozone and SO<sub>2</sub> observations</b> . . . . .	<b>35</b>
a)	Re-processing of direct sun (DS) total ozone observations . . . . .	35
b)	Re-processing of direct sun (DS) total SO <sub>2</sub> observations . . . . .	35
c)	Re-processing of zenith sky observations – updating of the zenith polynomials . . . . .	36
<b>4.3.</b>	<b>Evaluation of outputs</b> . . . . .	<b>37</b>
a)	Quality assessment of re-calculated observations . . . . .	37
b)	Differences between the original and re-calculated total ozone data series . . . . .	38
c)	Sampling the data for daily and monthly averages . . . . .	41
d)	Creation of new B098-V2003 data files for WOUDC. . . . .	42
<b>5.</b>	<b>COMPARISON OF DOBSON AND BREWER DATA SERIES</b> . . . . .	<b>42</b>
<b>5.1.</b>	<b>Comparison of monthly and daily averages (WOUDC files)</b> . . . . .	<b>42</b>
a)	Monthly averages – all observations . . . . .	42
b)	Monthly averages – DS observations . . . . .	43
c)	Daily averages – DS observations. . . . .	45
<b>5.2.</b>	<b>Comparison of individual simultaneous DS observations</b> . . . . .	<b>45</b>
a)	Data sets . . . . .	45
b)	Corrections for ozone effective temperature and ozone absorption coefficients . . . . .	46
c)	Corrections for total SO <sub>2</sub> . . . . .	47
d)	Corrections for $\mu$ – dependence . . . . .	47
e)	Other possible factors . . . . .	49
f)	Shift of the calibration levels of D074 and B098 instruments. . . . .	50

<b>5.3. Comparison of D074-V2003 and B098-V2003 data with satellite observations of total ozone . . . . .</b>	<b>51</b>
a) Comparison with TOMS data sets . . . . .	51
b) Comparison with GOME data sets . . . . .	52
<b>6. CONCLUSIONS AND RECOMMENDATIONS . . . . .</b>	<b>53</b>
<b>REFERENCES . . . . .</b>	<b>57</b>
<b>ACRONYMS . . . . .</b>	<b>61</b>

The re-evaluation of ozone in the stratosphere provides the most important information that characterizes conditions of the upper atmosphere. Ozone in the stratosphere, throughout the total ozone measured and measured from ground-based satellites. Both spectra were separately and general data sets of specific quality, size and ge-

<b>APPENDIX A Uncertainty in the monthly means of total ozone estimated from incomplete sets of daily values. . . . .</b>	<b>63</b>
<b>APPENDIX B Monthly averages of total ozone calculated from the re-evaluated D074-V2003 and B098-V2003 data sets or ALL and DS only observations . . . . .</b>	<b>67</b>

The total ozone column was determined using ground-based and satellite observations. Monthly total ozone can be measured by several methods: in the ground, the observations made with Dobson and Brewer ozone spectrophotometers located at about 100 stations (about 20 in Europe, 2000-2003) produce the absolute majority of total ozone data used for climate and applications. Both spectrophotometers have been in operation and were regularly operated and maintained under separate calibration systems. However, different calibration scales and due to certain differences in technology of spectrophotometers, D074 ozone data originally used Dobson and Brewer (DB) spectrophotometers, and therefore as independent data for scientific analyses. This was important aspect of differences in data sets are taken from individual or duplicated DB stations, mainly for estimation of long-term trends or for validation of satellite observations.

The Total and Ozone Observatory (SOO-HK) of the Czech Hydrometeorological Institute (CHMI) in Hradec Králové, Czech Republic is one of active DB calibration stations of the GAW network where both were maintained and regularly calibrated systems spectrophotometers have been operating for a long time. Routine measurements of total ozone observations carried out at SOO-HK allow investigation of relation between DB data series. The analyses of simultaneous measurements taken under various atmospheric and operational conditions can contribute to assessment or expansion of differences between Dobson and Brewer total ozone observations that have been identified at other calibrated stations (Machida et al., 2002; Marquardt, the re-process of DB data sets from SOO-HK for other conditions to validation of total ozone data from space systems (DAMS, GOME)).

The early identification of necessity of re-evaluation requires analysis of reliable observations, originated with different instruments. The quality of such observations must be well evaluated, especially at stations with long-term continuous records. This was the main reason why a complete re-evaluation of total ozone observations from Hradec Králové has been included as a specific task inside the WGI of the CANDICE project. The re-evaluation continues and extends outputs from a previous work done at SOO-HK in the earlier phases (1997-1999).

