

O3Dobson

Martin Stanek
Solar and Ozone Observatory
500 08, Hradec Kralove, Czech Republic, stanek@chmi.cz

1. Introduction

O3Dobson is the software for reduction of total ozone observations with the Dobson spectrophotometer. This system is the upgrade of the software named "Dobson", which was created at the Solar and Ozone Observatory of the Czech Hydrometeorological Institute at the end of the last century -

<http://www.chmi.cz/meteo/ozon/dobsonweb/software.htm>.

O3Dobson is a modification of O3EDobson - the software for the semiautomatic Dobson spectrophotometer data recorder, which use the same data and files of constants structure.

The program is designed to keep correct calibration level of the Dobson spectrophotometer. In case of the changes of ETC constants or wavelengths settings (for example due to the change of measuring place with the different altitude), the software can reset proper values based on standard and mercury lamp tests results.

As part of O3Dobson package there is a software for calculation of coefficients of zenith polynomials "O3Dpoly" and software for recalculation of data files "O3Drec".

2. Hardware requirements

- IBM PC compatible, screen resolution 1024x768 (recommended)
- MS Windows 95/NT/98 ...XP
- laser printer - optional

3. O3Dobson directory and file structure

If the installation launcher is not running, double-click on setup.exe in the root directory of your O3Dobson CD to start the installation.

All files of constant must be set manually using editor (Notepad) before total ozone calculations. After installation the constants are set as example from Dobson #074.

After installation there must be these files in one directory:

O3Dobson.exe - main program

O3Dobson.ini, O3DPoly.nnn, O3DECOR.nnn, O3DRNT.nnn, O3DQTab.nnn... - files of constants ([initialization file](#), [files of constants](#))

Ddata ... Data directory

Djjjyyyy.nnn ... ozone data file (jjj – julian day, yyyy – year, nnn – instrument number) - [header](#), [data format](#)

Lampxxx.slf ... standard lamp files

4. Using O3Dobson

Observation

- Input of raw observation data, editing and printing records.
- Calculation of total ozone for all selected wavelength pairs.
- Display daily results of total ozone
- Save data to daily files - Djyyyyyy.nnn

O3Dobson

Observation Data Tests Setup ?

Input

Date: 17.05.2002

Time GMT [h,m,s]: 9 8 0

Type of Observation:

Direct Sun
 Zenith Blue
 Zenith Cloud
 Focused Moon

Direct Sun

RC: 09:08:00 0.0
RD: 09:09:00 0.0
RA: 09:10:00 0.0

Summary

		AVG	STD	N	S
DS	AD	338.0	3.9	35	-3.87
	CD	327.4	4.1	37	-0.16
	A	346.9	5.0	35	-5.20
	C	351.0	6.1	37	-2.85
ZB	AD	335.1	5.9	9	
	CD	333.1	3.6	9	
ZC	AD	0.0	0.0	0	
	CD	0.0	0.0	0	

Save

Type	Time	ZA	MU	XAD	XCD	X(seq.)				
DS	07:25:30	51.1	1.589	341.8	331.4	353.7	381.1	349.9		
ZB	07:31:30	50.2	1.558	343.8	341.0					
DS	07:36:30	49.5	1.535	343.0	328.2	355.2	388.2	352.3		
DS	07:43:30	48.4	1.503	343.4	332.1	356.2	385.8	352.1		
DS	07:51:30	47.2	1.470	342.4	330.2	356.2	388.1	351.9		
DS	08:01:30	45.8	1.431	342.7	329.4	357.8	392.7	353.1		

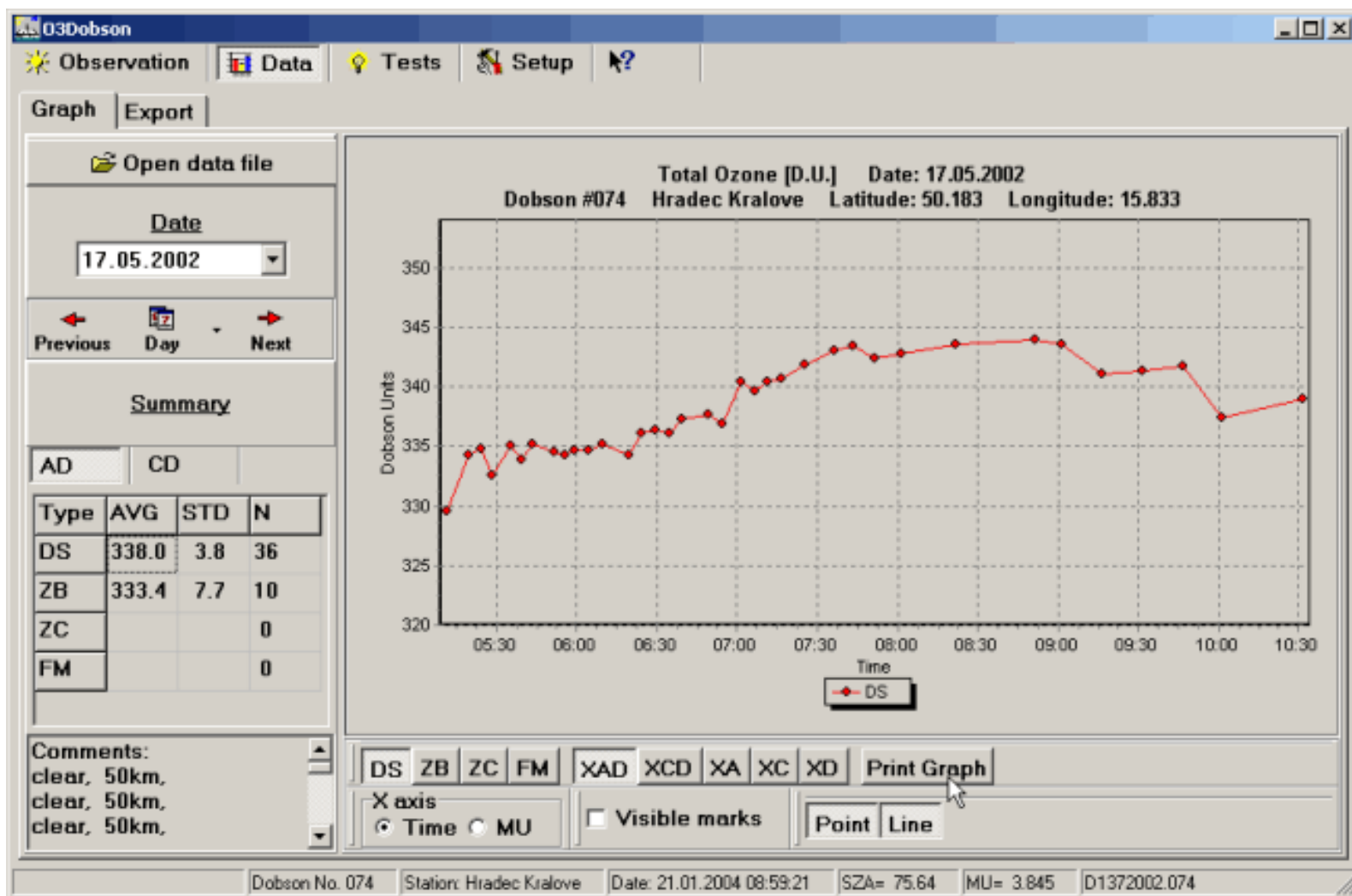
Edit Delete Flag Print

Dobson No. 074 Station: Hradec Kralove Date: 19.02.2004 09:10:20 SZA= 66.96 MU= 2.511 D1372002.074

In the grid there are final results of each observation of the day - type of observation, time of XAD, Solar zenith angle, air mass, total ozone XAD, XCD, and XC, XD, XA - for CDA sequence. Daily summary is calculated and AVG, STD, N, and ETC correction (when N > 4 and MU range > 1) are displayed.

Data

Here you can display, print or save to file any individual values or daily averages of the total ozone measurements for one day, month, year or selected period of time.



Buttons below "Date" - "Previous", "Day", "Next" - allow fast navigation in data files and plot daily records or daily averages.

In the Export section there is a "WODC code wizard" for easy coding to the new WODC extended comma separated values (extCSV) data format.

Data outputs are in ASCII code and it is possible to choose export to *.prn or *.csv file.

The screenshot shows the O3Dobson software interface with the 'WODC Code' wizard active. The window title is 'O3Dobson' and the menu bar includes 'Observation', 'Data', 'Tests', 'Setup', and '?'. The 'Export' section is selected, and the 'WODC Code' wizard is open. The wizard has two tabs: 'Individual measurements' and 'Daily averages', with 'Individual measurements' selected. The 'Date from' field is set to '21.01.2003' and the 'to' field is set to '21.01.2004'. The 'Type of measurement' section has four checkboxes: 'DS' (checked), 'ZC' (unchecked), 'ZB' (checked), and 'FM' (unchecked). The 'Individual measurements' section has four main checkboxes: 'Date' (checked), 'Type of measurement' (checked), 'Wavelengths used, kind of observation' (unchecked), and 'Sequence of observation' (unchecked). Below these are three columns of checkboxes for 'RA - time', 'RC - time', and 'RD - time', each with sub-options for 'AVG', 'STD', and 'NA/NC/ND'. To the right are two boxes for 'XAD' and 'XCD', each with checkboxes for 'Time', 'MU', 'ZA', and 'XAD/XCD'. The status bar at the bottom displays: 'Dobson No. 074 Station: Hradec Kralove Date: 21.01.2004 08:59:44 SZA= 75.60 MU= 3.838 D1372002.074'.

Observation Data Tests Setup ?

Graph Export

Save Print WODC Code

Date from 21.01.2003 to 21.01.2004

Type of measurement DS ZC ZB FM

Individual measurements Daily averages

Date
 Type of measurement
 Wavelengths used, kind of observation
 Sequence of observation

RA - time RC - time RD - time
 RA - AVG RC - AVG RD - AVG
 RA - STD RC - STD RD - STD
 NA NC ND
 XA XC XD

XAD
 Time
 MU
 ZA
 XAD

XCD
 Time
 MU
 ZA
 XCD

Dobson No. 074 Station: Hradec Kralove Date: 21.01.2004 08:59:44 SZA= 75.60 MU= 3.838 D1372002.074

SL Test

Processing of results from the standard lamp test.

In the same directory must be at least one standard lamp file (lampxxx.slf, xxx .. name of SL) because lamp names are added to dialog window - see [files of constants](#) for *.slf structure.

New corrections of N tables are saved in O3Dobson.ini file for the future calculations.

1. press 'Start' button to choose the lamp name and instrument temperature
2. fill in the form
3. use 'Calculate' button finally
4. 'Save' and 'Print' results

The screenshot shows the O3Dobson software interface. The title bar reads "O3Dobson". The menu bar includes "Observation", "Data", "Tests", "Setup", and "?". The "Tests" menu is active, showing "Standard Lamp Test" and "Mercury Lamp Test". Below the menu bar are buttons for "Start", "Calculate", "Save", "Reset", and "Print".

The main area displays the following information:

Standard Lamp Name: QJ1
Instrument Temperature: 11.2

	1	2	3	Mean	N-value	N-ref.	Delta N
Test A	27.9	27.8	27.8	27.8	12.52	12.50	-0.02
Test C	32.5	32.5	32.5	32.5	16.02	16.11	0.09
Test D	36.6	36.6	36.6	36.6	18.01	18.18	0.17

At the bottom, there are two boxes for Q-level settings:

Setting of Q2: A= 48.60 C= 75.51 D=106.68

Setting of Q1: A= 48.27 C= 75.02 D=106.20

The status bar at the bottom contains the following information: Dobson No. 074 Station: Hradec Kralove Date: 21.01.2004 09:02:24 SZA= 75.39 MU= 3.787 D1372002.074

The correct setting of Q-levers is calculated based on the instrument temperature.

HG Test

Processing of results from the mercury lamp test (symmetry test).

O3Dobson creates new table of settings of Q based on the test results.

If difference between test mean and table value is more than 0.3, the O3Dobson offers you creation of new Q-table.

O3Dobson

Observation Data Tests Setup ?

Standard Lamp Test Mercury Lamp Test

Save Reset Create new Q-Table Print

S2Q1 S2Q2 S3Q1 S3Q2

Instrument Temperature - Start

Q1 up	<input type="text" value="79.0"/>	<input type="text" value="79.0"/>	<input type="text" value="79.0"/>	<input type="text"/>	<input type="text"/>
Q1 down	<input type="text" value="86.0"/>	<input type="text" value="86.0"/>	<input type="text" value="86.0"/>	<input type="text"/>	<input type="text"/>
	<input type="text" value="82.50"/>	<input type="text" value="82.50"/>	<input type="text" value="82.50"/>	<input type="text"/>	<input type="text"/>

Instrument Temperature - End

Test Mean

Table Value at Mean Temperature

Difference

Setting of Q2
HG = 83.11

Setting of Q1
HG = 82.53

Dobson No. 074 Station: Hradec Kralove Date: 21.01.2004 09:03:56 SZA= 75.26 MU= 3.759 D1372002.074

New Q-table is saved in a file and must be printed separately. The button "Create new Q-Table" change constants in Q-Table file automatically.

Setup

Input of the reference parameters which are necessary for running the program.

notes:

It is possible to edit sequences of observation using "A", "C" or "D" (up to six) capital letters only and develop any kind of sequences for the automated mode of observation.

Instrument | Data Path | N Table Corrections | Data Submission | Application

Instrument No.

Location

Name of station

Country

G030S

Latitude

Longitude

Altitude [m]

Mean pressure [hPa]

Height of O3 Layer [m]

Ozone absorption and atmospheric scattering coef.

	Alpha (atm-cm) ⁻¹	Beta (atm) ⁻¹
A	<input type="text" value="1.806"/>	<input type="text" value="0.114"/>
C	<input type="text" value="0.833"/>	<input type="text" value="0.109"/>
D	<input type="text" value="0.374"/>	<input type="text" value="0.104"/>

Sequence of observation

DS	<input type="text" value="CDA"/>
ZB	<input type="text" value="CDA"/>
ZC	<input type="text" value="CDA"/>
FM	<input type="text" value="CDA"/>

Time difference of readings

30 seconds 1 minute

Save Changes to INI File

Dobson No. 074 Station: Hradec Kralove Date: 21.01.2004 09:05:01 SZA= 75.18 MU= 3.740 D1372002.074

Appendix

Main differences between O3Dobson and old Dobson software

- 32 bit application for W95...XP
- data are in ASCII code in daily files and there is a header with all important constants at the beginning
- possibility of using random sequence of observation (up to 6 wavelengths)
- calculation and print new of Q table based on HG results
- calculation of R-N table corrections
- time of observation must be in GMT

Equations for Calculation of Total Ozone

Example, AD wavelength, B-P Scale

Direct Sun, Focused Moon

- $XAD = (NA / MU[A] - ND / MU[D]) / 1.432 - (0.0086 * (M[A] + M[D]) * P / (MU[A] + MU[D])) / P0$
- $XAD = XAD * 1000 + EcDSAD[1] + EcDSAD[2] * MU[AD] + EcDSAD[3] * MU[AD]^2$

where

MU[A] is MU in time of RA reading ...

EcDSAD[1..3] ... empirical correction function

P0 ... 1013.25

P ... mean pressure at the station

Zenith Blue

$X = dN = NA - ND$

$Y = MU[AD]$

- $XAD = ZBAD[0] + ZBAD[1] * Y + ZBAD[2] * X + ZBAD[3] * Y * Y + ZBAD[4] * X * X + ZBAD[5] * Y * X + ZBAD[6] * Y * Y * X + ZBAD[7] * Y * X * X + ZBAD[8] * Y * Y * Y + ZBAD[9] * X * X * X$
- $XAD = XAD * EcZBAD$

where

ZBAD[0..9] ... coefficients of the zenith polynomial

EcZBAD ... empirical correction

Zenith Cloud

$X = dN = NA - ND$

$Y = MU[AD]$

- $XAD = ZBAD[0] + ZBAD[1] * Y + ZBAD[2] * X + ZBAD[3] * Y * Y + ZBAD[4] * X * X + ZBAD[5] * Y * X + ZBAD[6] * Y * Y * X + ZBAD[7] * Y * X * X + ZBAD[8] * Y * Y * Y + ZBAD[9] * X * X * X$
- $XAD = XAD - \text{Cloud correction function}$

Cloud correction function (1) = $ZCAD1[0] + ZCAD1[1] * XAD + ZCAD1[2] * MU[AD] + ZCAD1[3] * XAD * MU[AD]$

ZCAD1[0...3] – uniform stratified layer of small opacity

ZCAD2[0...3] – uniform or moderately variable layer of medium opacity

ZCAD3[0...3] – uniform or moderately variable layer of large opacity

ZCAD4[0...3] – highly variable opacity, with or without precipitation

ZCAD5[0...3] – fog

Working with charts

Chart zoom and scroll

Scrolling and zooming a chart is simply setting its axis scales to the desired values. After zooming or scrolling a chart, all series will repaint their points in their new positions. Charts can be zoomed by user interaction with mouse dragging. Users can zoom drawing a rectangle around the chart area they want to see in detail. You should press the left mouse button to draw the zoomed area. Dragging should be done from top/left to bottom down. Dragging in the opposite direction resets axis scales [no zoom]. As soon as users release the mouse button, chart repaints to show the zoomed area. Scrolling is very similar to zoom. Axis scales are incremented or decrement and the whole chart component is repainted to show series points at their new positions. You should press the right mouse button and drag.

O3Dobson Data Files Structure - Header

Dobson2	Version of data file
7	Day
2	Month
2001	Year
Hradec Kralove	Location name
74	Instrument number
50.183	Latitude
15.833	Longitude
285	Altitude
980	Mean pressure [hPa]
21000	Height of O3 layer [m]
1.806	Ozone absorption coefficient - A wavelength
0.833	Ozone absorption coefficient - C wavelength
0.374	Ozone absorption coefficient - D wavelength
0.114	Atmospheric scattering coefficient - A wavelength
0.109	Atmospheric scattering coefficient - C wavelength
0.104	Atmospheric scattering coefficient - D wavelength
dN	
0.1	dNA - correction of RNA table
-0.1	dNC - correction of RNC table
-0.2	dND - correction of RND table
NTable	
-10.2, -1.8, 6.6, 14.8, 22.8, ...	RNA table, R=0,10,20,...,300
-10.2, -1.8, 6.6, 14.9, 23.0, ...	RNC table, R=0,10,20,...,300
-12.2, -3.8, 4.7, 13.0, 21.2, ...	RND table, R=0,10,20,...,300
Zpoly	
254.65762, -431.83249, 10.48619, ...	Coefficients of zenith polynomial - AD wavelength pair
319.82532, -420.20405, 24.51519, ...	Coefficients of zenith polynomial - CD wavelength pair
12.13830, -0.04950, -14.66870, 0.05870	Cloud correction function AD - uniform stratified layer of small opacity

12.13830, -0.04950, -14.66870, 0.05870	Cloud correction function AD - uniform or moderately variable layer of medium opacity
12.13830, -0.04950, -14.66870, 0.05870	Cloud correction function AD - uniform or moderately variable layer of large opacity
12.13830, -0.04950, -14.66870, 0.05870	Cloud correction function AD - highly variable opacity, with or without precipitation
12.13830, -0.04950, -14.66870, 0.05870	Cloud correction function AD - fog
12.13830, -0.04950, -14.66870, 0.05870	Cloud correction function CD - uniform stratified layer of small opacity
12.13830, -0.04950, -14.66870, 0.05870	Cloud correction function CD - uniform or moderately variable layer of medium opacity
12.13830, -0.04950, -14.66870, 0.05870	Cloud correction function CD - uniform or moderately variable layer of large opacity
12.13830, -0.04950, -14.66870, 0.05870	Cloud correction function CD - highly variable opacity, with or without precipitation
12.13830, -0.04950, -14.66870, 0.05870	Cloud correction function CD - fog
EmpCor	
0, 0, 0	Empirical correction DS - AD
0, 0, 0	Empirical correction DS - CD
1, 1	Empirical correction ZB - AD, ZB - CD
1, 1, 1, 1, 1	Empirical correction ZC - AD
1, 1, 1, 1, 1	Empirical correction ZC - CD

O3Dobson Data Files Structure

DS	Type of observation
000	Flag, L,S - Wavelengths used, kind of observation
CDA	Sequence of observation
XA	<i>XA block (sequence dependent)</i>
10:09:30	Averaged time of RA reading
212.4	AVG - RA
0.1	STD - RA
163.4	NA
301.6	Total ozone - A wavelength, XA
XC	<i>XC block (sequence dependent)</i>
10:08:30	Averaged time of RC reading
127	AVG - RC
0.0	STD - RC
90.1	NC
305.4	Total ozone - C wavelength, XC
XD	<i>XD block (sequence dependent)</i>
10:08:59	Averaged time of RD reading
84.5	AVG - RD
0.1	STD - RD
55.6	ND
324.1	Total ozone - D wavelength, XD
XAD	<i>XAD block</i>
10:09:14	Time - XAD
2.491	Mu - XAD
66.8	Solar zenith angle - XAD
295.7	Total ozone - AD wavelength, XAD
XCD	<i>XCD block</i>
10:08:44	Time - XCD
2.493	Mu - XCD
66.8	Solar zenith angle - XCD
290.1	Total ozone - CD wavelength, XCD

comment	<i>Comment block</i>
text	Text of comment

Flags used

0, 9

L - Wavelengths used

0 - AD

2 - CD

S - Kind of observation

0 - Direct Sun

1 - Focussed Moon

2 - Zenith Blue

3 - Zenith Cloud - uniform stratified layer of small opacity

4 - Zenith Cloud - uniform or moderately variable layer of medium opacity

5 - Zenith Cloud - uniform or moderately variable layer of large opacity

6 - Zenith Cloud - highly variable opacity, with or without precipitation

7 - Zenith Cloud - fog

O3Dobson files of constants

RN Tables - O3DRNT.nnn

1. column - NA values for R = 0 .. 300, step 10
2. column - NC values for R = 0 .. 300, step 10
3. column - ND values for R = 0 .. 300, step 10

R	NA	NC	ND
0	-10.2	-10.2	-12.2
10	-1.8	-1.8	-3.8
20	6.6	6.6	4.7
30	14.8	14.9	13
40	22.8	23	21.2
50	30.6	30.9	29.1
60	38.4	38.7	36.9
70	46	46.3	44.5
80	53.5	53.8	52.1
90	61.1	61.5	59.7
100	68.9	69.2	67.4
110	76.6	76.8	75
120	84.3	84.5	82.7
130	92.4	92.4	90.5
140	100.7	100.5	98.5
150	109.1	108.6	106.5
160	117.6	117	114.7
170	126.3	125.6	123.2
180	135.1	134.2	104.8
190	143.9	142.8	140.3
200	152.6	151.3	148.7
210	161.2	159.9	157.1
220	170.2	168.6	165.7
230	179.3	177.5	174.6

240	188.1	186.3	183.2
250	197.1	194.9	191.5
260	206.1	203.6	200
270	214.8	212.2	208.6
280	223.3	220.5	216.8
290	231.9	228.9	225
300	240.5	237.3	233.2

Zenith Polynomials - O3DPoly.nnn

- 1. row - coefficients of zenith polynomial - AD wavelength pair
- 2. row - coefficients of zenith polynomial - CD wavelength pair
- 3. - 7. row - coefficients of the cloud correction function (1 .. 5) - AD wavelength pair
- 8. - 12. row - coefficients of the cloud correction function (1 .. 5) - CD wavelength pair

cloud correction function (1) = uniform stratified layer of small opacity

cloud correction function (2) = uniform or moderately variable layer of medium opacity

cloud correction function (3) = uniform or moderately variable layer of large opacity

cloud correction function (4) = highly variable opacity, with or without precipitation

cloud correction function (5) = fog

2.55E+02	-4.32E+02	1.05E+01	1.95E+02	-1.73E-02	-3.92E+00	7.07E-01	-3.39E-03	-2.94E+01	1.01E-04
3.20E+02	-4.20E+02	2.45E+01	2.04E+02	1.47E-01	-1.38E+01	2.18E+00	-1.20E-02	-3.07E+01	-7.42E-04
12.1383	-0.0495	-14.6687	0.0587						
12.1383	-0.0495	-14.6687	0.0587						
12.1383	-0.0495	-14.6687	0.0587						
12.1383	-0.0495	-14.6687	0.0587						
12.1383	-0.0495	-14.6687	0.0587						
12.1383	-0.0495	-14.6687	0.0587						
12.1383	-0.0495	-14.6687	0.0587						
12.1383	-0.0495	-14.6687	0.0587						
12.1383	-0.0495	-14.6687	0.0587						

Empirical Corrections - O3DECOR.nnn

0	0	0			Correction function DS - AD
0	0	0			Correction function DS - CD
1	1				Empirical correction ZB - AD, ZB - CD
1	1	1	1	1	Empirical correction ZC - AD (1..5)
1	1	1	1	1	Empirical correction ZC - CD (1..5)

File of setting of Q for 15 deg C. - O3DQTab.nnn

0.129	Temperature coefficient of Q1
83.11	Standard wavelength setting of Q lever at 15 deg.C for HG-3129
48.60	Standard wavelength setting of Q lever at 15 deg.C for A
75.51	Standard wavelength setting of Q lever at 15 deg.C for C
106.68	Standard wavelength setting of Q lever at 15 deg.C for D

Standard Lamp File - LampName.slf

QJ1	Name of standard lamp
13.2	Reference reading of NA value
17.1	Reference reading of NC value
18.6	Reference reading of ND value