O3Dobson

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1. Introduction

O3Dobson is the software for reduction of total ozone observations with the Dobson spectrophotometer. It was developed in Delphi IDE and it is compatible with MS Windows operating systems. This software has modification named O3EDobson - the software for the semiautomatic Dobson spectrophotometer data recorder, which share the same data and files of constants structure. The last program version (8.0) apply ozone absorption cross-sections from Serdyuchenko et al.,2014. The effective temperature climatology for all latitude bands (McPeters, Labow), or data from file calculated for particular place can be used for estimation of the ozone temperature.

The program can process results from mercury and standard lamp tests and it is designed to keep correct calibration level of the Dobson spectrophotometer. In case of ETC constants changes or wavelengths settings (for example due to the change of measuring place with the different altitude), the software can update proper values based on standard and mercury lamp tests result.
As part of O3Dobson software collection there is a tool for calculation of coefficients of zenith polynomials "O3Dpoly", software for recalculation of data files "O3Drec" and also software for recalculation of existing data files with new IUP ozone absorption coefficients and effective ozone temperature – “DobsonIUP”.

This software is possible to download from website www.o3soft.eu. The updates are not regular, mostly created based on users requests. Users are not informed about updated versions automatically. The software does not send any information via the internet.

2. O3Dobson installation

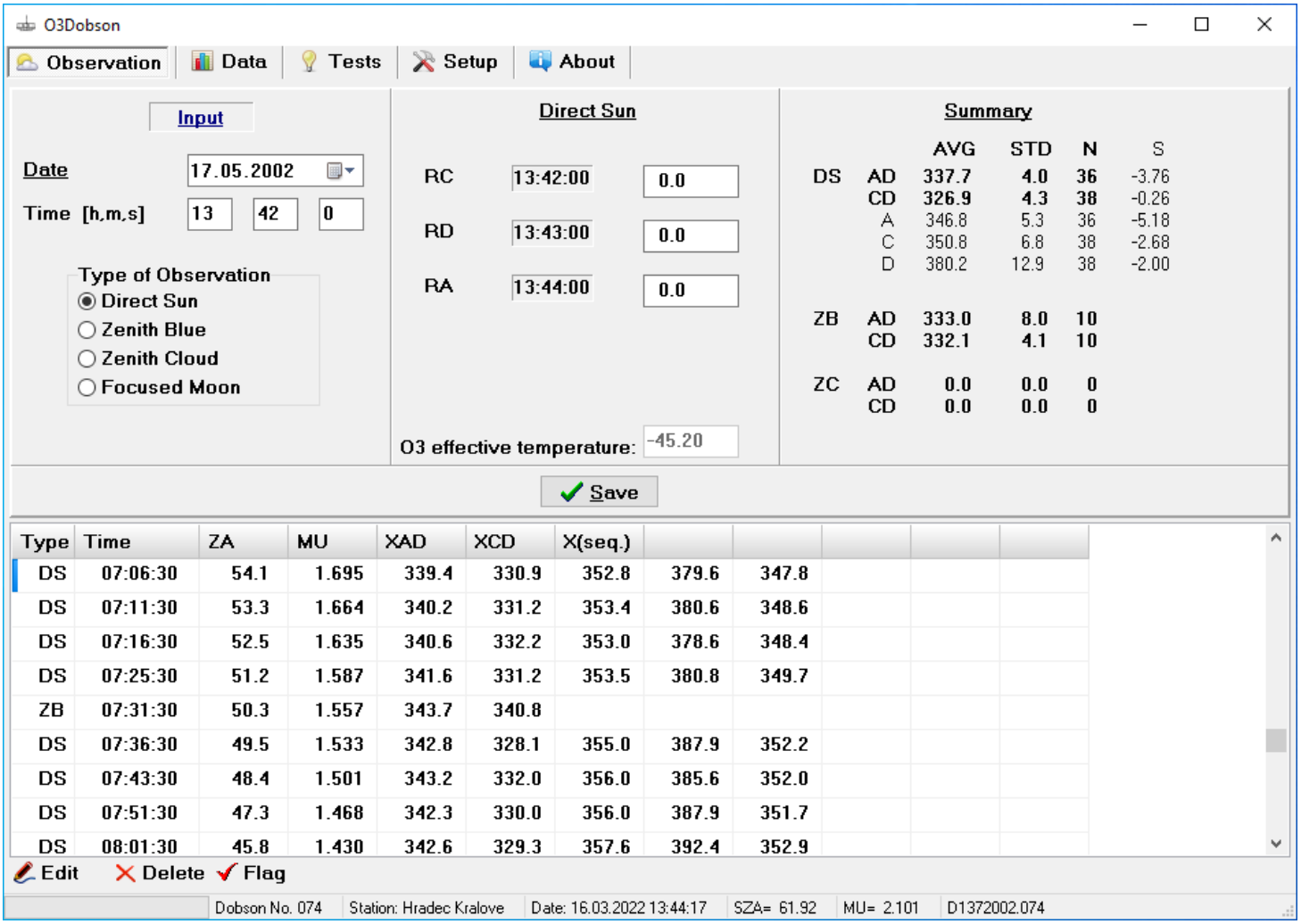
There are no special hardware requirements for installation. Software is designed for Microsoft Windows system. The main program and files of constants must be in the same folder on local computer drive. The O3Dobson creates files to save data in ASCII code. Data folder can be set in local or remote drive and there is no encryption to protect information.

O3Dobson.exe - main program
O3Dobson.ini - setup file for the main program
O3Dobson.pos - support constants, software position on the screen
O3DPoly.nnn, O3DECor.nnn, O3DRNT.nnn, O3DQTab.nnn... - files of instrument constants
Ddata - Data directory
Djjjyyyy.nnn - ozone daily data file (jjj – day of year, yyyy – year, nnn – instrument number
Lampxxx.slf - standard lamp files
SLtest.fr3, HGtest.fr3, HGSymmetry.fr3, QTable.fr3 … lamp test forms, Q-Table

3. Using O3Dobson

Observation

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

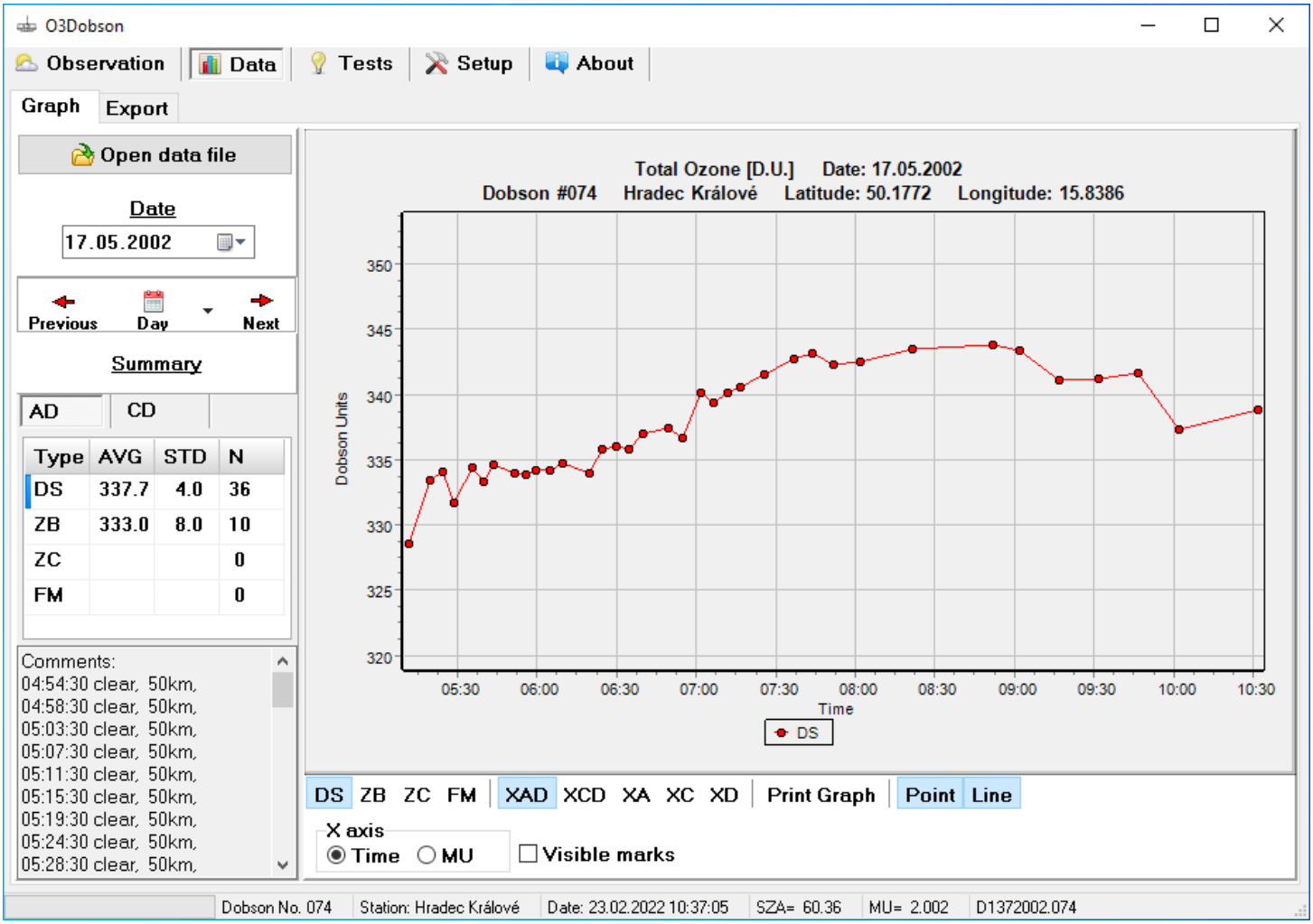


In the grid there are results of each observation of the day - type of observation, time of XAD, Solar zenith angle, air mass, total ozone XAD, XCD, and XC, XD, XA - for CDA sequence. Daily summary is calculated - AVG, STD, N and ETC correction (when N > 4 and MU range > 1) are displayed.

The Edit button on the bottom is used for corrections of existing records. Press the Edit button and then the record line you want to change. The program compare actual constants with constants saved in a data file and inform you in case of differences.

Data

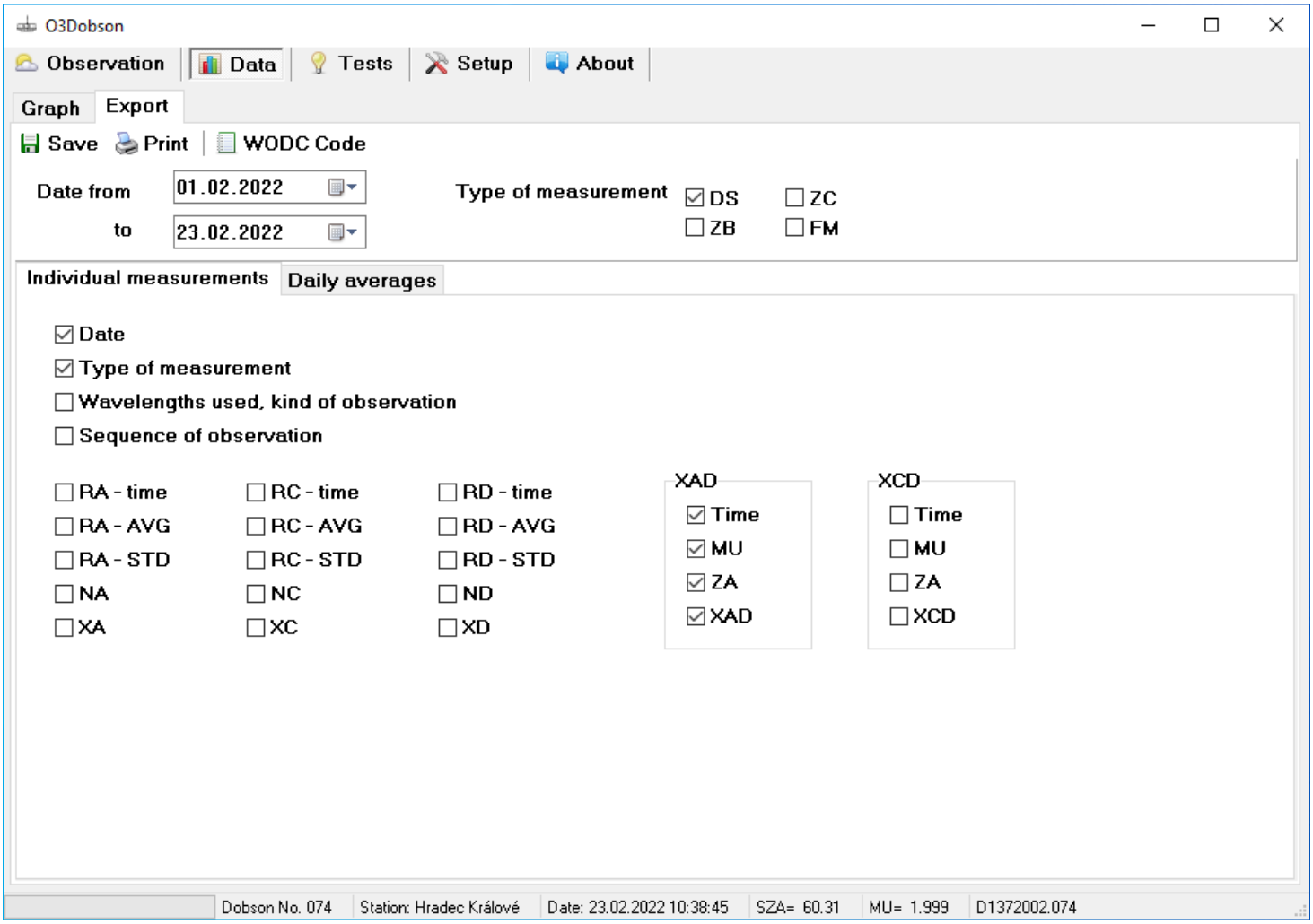
Here you can display, print or save to file any individual values or daily averages of the total ozone measurements for one day, month, year or selected period of time.

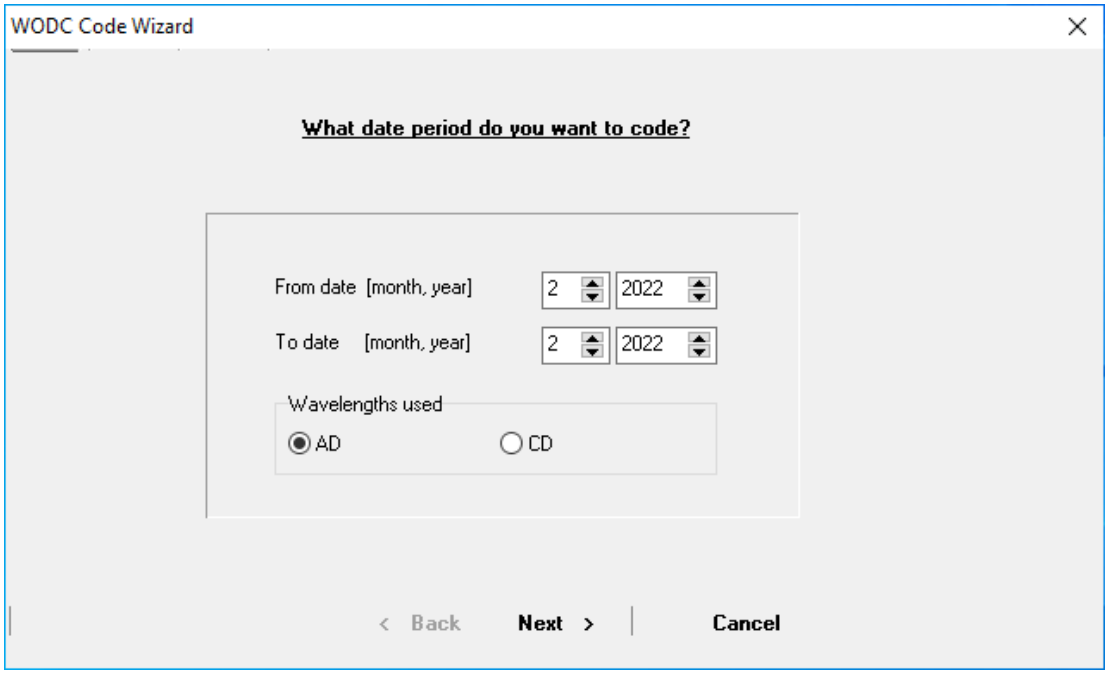


Buttons below "Date" - "Previous", "Day", "Next" - allow fast navigation in data files and plot daily records or dailyaverages.
There is a possibility to put some comments at the end of each observation. The option “Show Comment Dialog” in Setup/Application must be checked.

Export

In the Export section there is a "WODC code wizard" (assistant) for easy coding to the WOUDC extended comma separated values (extCSV) data format.
Data outputs are in ASCII code and it is possible to choose export to *.txt or *.csv file.

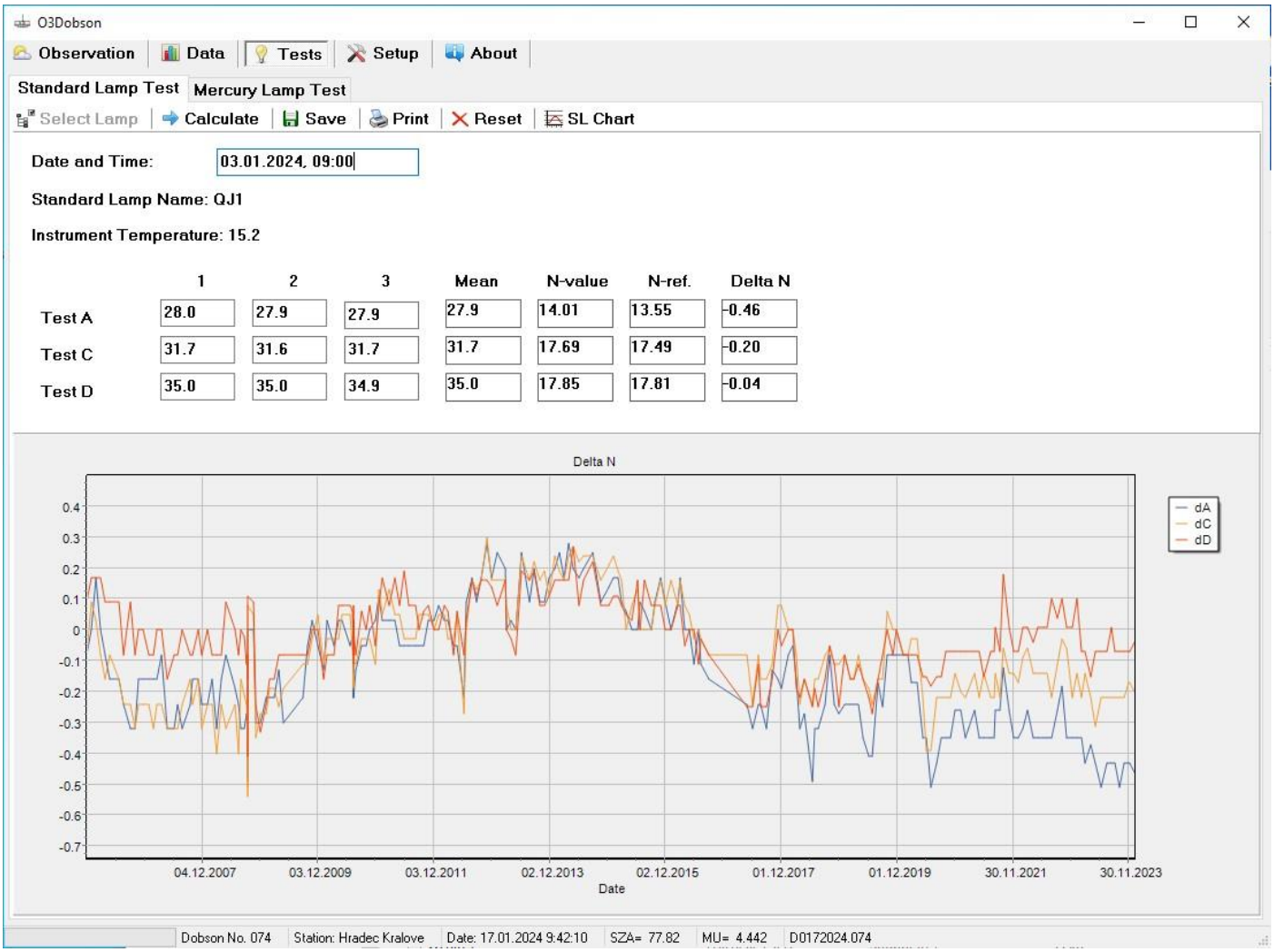




Standard Lamp Test

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) and file SLtest.fr3 to print or save results in PDF format.
The output of the SL test are new corrections of N tables. These values are saved in O3Dobson.ini file for the next ozone calculations.

1. press 'Select Lamp' 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 form could be saved in PDF format. There is a PDF icon in the “Print Preview”.

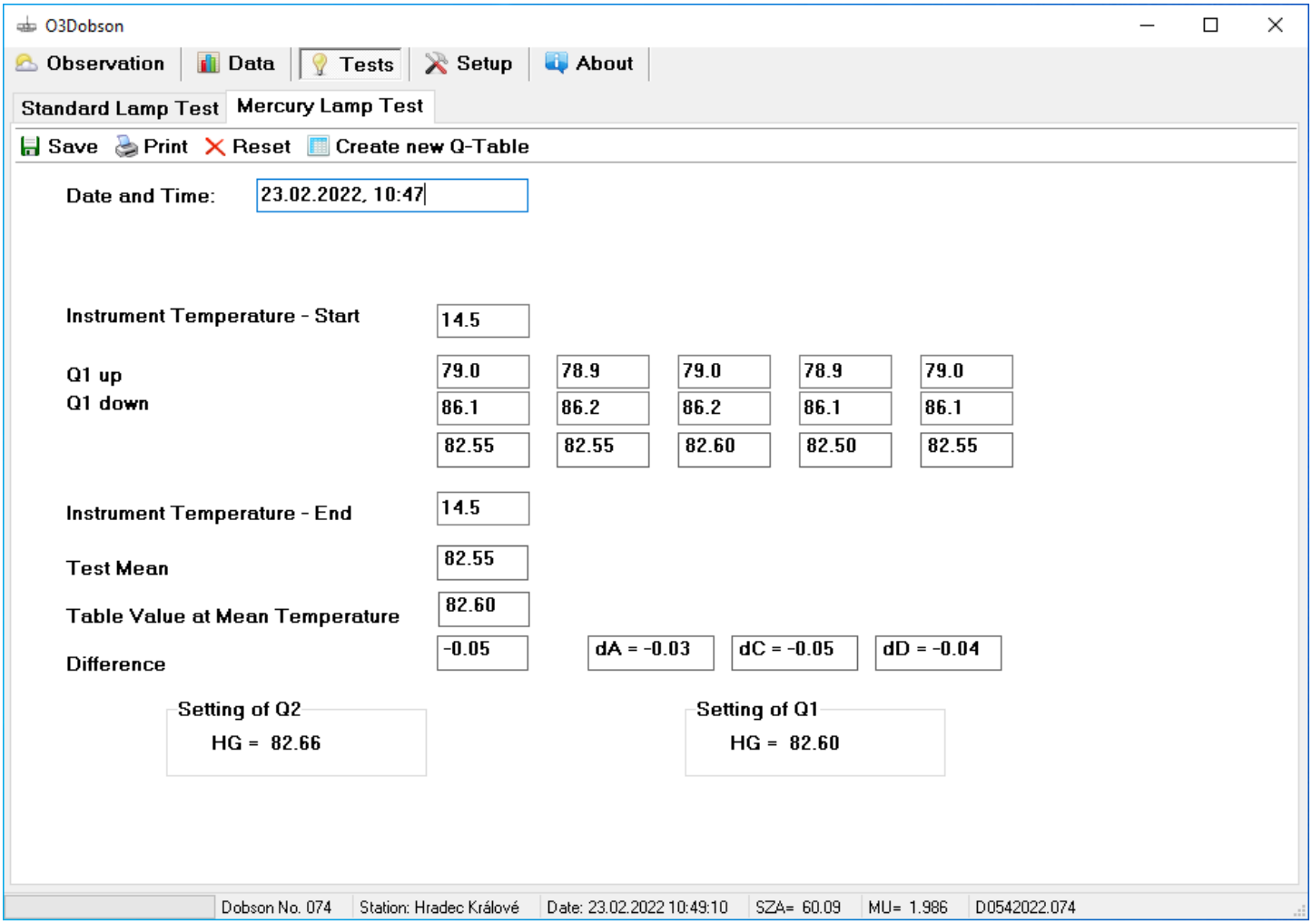


The correct setting of Q-levers is calculated based on the instrument temperature.

Mercury Lamp Test

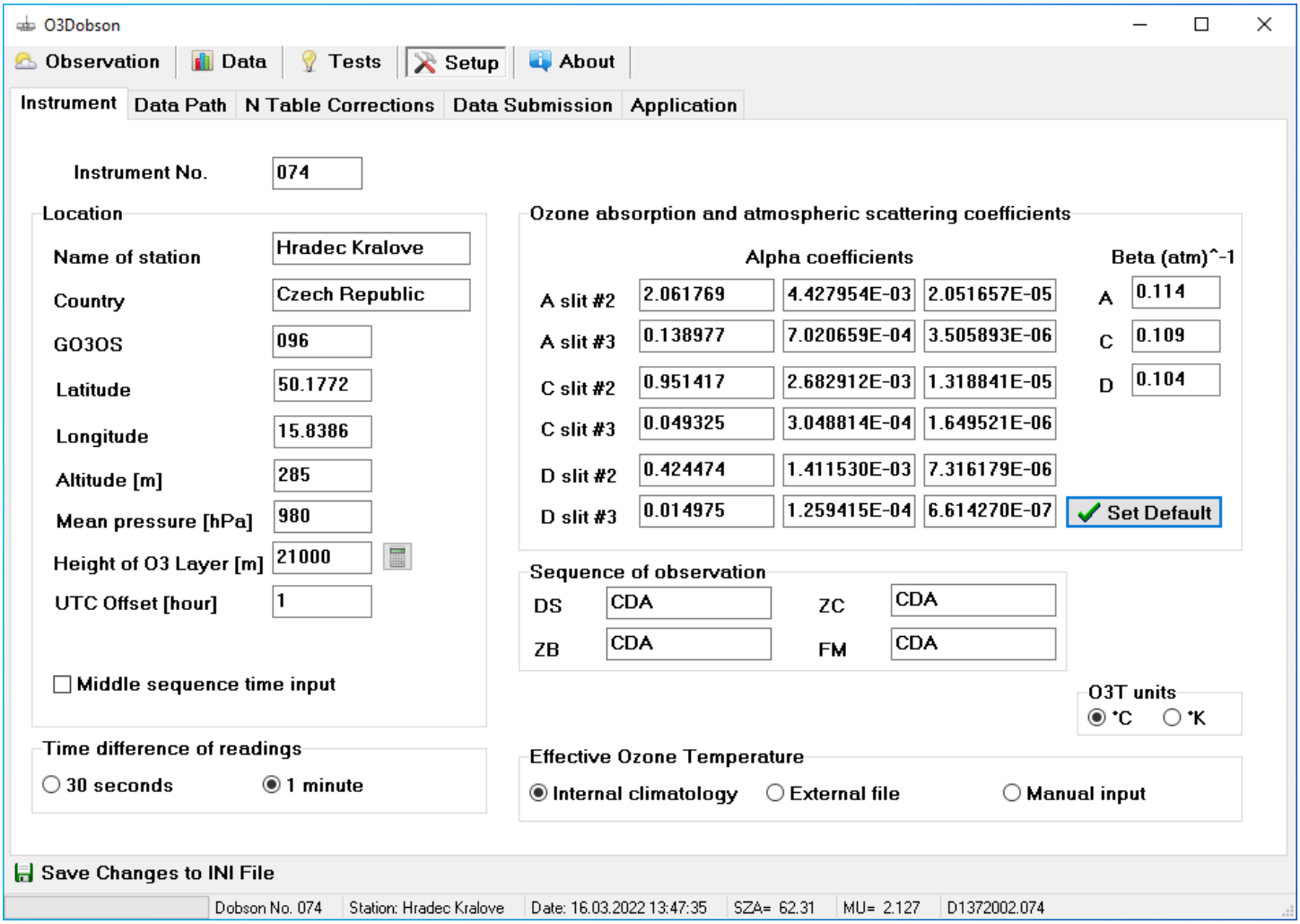
Here is input of results from the mercury lamp test or symmetry test. The program can create new Q-table based on test results if the difference between test mean and table value is more than 0.3 degrees.

There is an option to process also “Symmetry test” in menu “Setup/Application”. Another option at the same place “Check HG test results with Q-Table” can remind the user to update Q-Table when the test difference is out of specification (>0.3).



Setup

Input of the reference parameters which are necessary for running of the program and total ozone calculation.
It is possible to edit sequences of observation using "A", "C" or "D" (up to six) capital letters only and create sequences for the automated mode of observation.



Appendix

Equations for Calculation of Total Ozone

Example, AD wavelength

Direct Sun, Focused Moon

XAD = (NA / MU[A] - ND / MU[D]) / (AlphaA - AlphaD) –
(BetaA - BetaD) / (AlphaA - AlphaD) * (M[A] + M[D]) * P / (MU[A] + MU[D]) / P0
2. XAD = XAD * 1000 + EcDSAD[1] + EcDSAD[2] * MU[AD] + EcDSAD[3] * MU[AD] ^2

MU[A] is MU in time of RA reading
EcDSAD[1..3] … empirical correction function
P0 ... 1013.25
P ... mean pressure at the station

The ozone absorption coefficients are given as a function of effective ozone temperature, T in °C
$Alpha=A0+A1*T+A2*T^2$

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

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 - 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

O3Dobson Data Files Structure - Header

Dobson3	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]
-46.3	Ozone effective temperature [°C]
1.787	Ozone absorption coefficient - A wavelength
0.817	Ozone absorption coefficient - C wavelength
0.364	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
O3Abs	
2.061769E00	A0, Slit 305.5 nm
4.427954E-03	A1, Slit 305.5 nm
2.051657E-05	A2, Slit 305.5 nm
1.38977E-01	A0, Slit 325.0 nm
7.020659E-04	A1, Slit 325.0 nm
3.505893E-06	A2, Slit 325.0 nm
9.51417E-01	A0, Slit 311.5 nm
2.682912E-03	A1, Slit 311.5 nm
1.318841E-05	A2, Slit 311.5 nm
4.9325E-02	A0, Slit 332.4 nm
3.048814E-04	A1, Slit 332.4 nm
1.649521E-06	A2, Slit 332.4 nm
4.24474E-01	A0, Slit 317.5 nm
1.41153E-03	A1, Slit 317.5 nm

7.316179E-06	A2, Slit 317.5 nm
1.4975E-02	A0, Slit 339.9 nm
1.259415E-04	A1, Slit 339.9 nm
6.61427E-07	A2, Slit 339.9 nm
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
12.1383, -0.0495, -14.6687, 0.0587	Cloud corr. function AD - uniform stratified layer of small opacity
12.1383, -0.0495, -14.6687, 0.0587	Cloud corr. function AD -uniform or moderately variable layer of medium opacity
12.1383, -0.0495, -14.6687, 0.0587	Cloud corr. function AD - uniform or moderately variable layer of large opacity
12.1383, -0.0495, -14.6687, 0.0587	Cloud corr. function AD - highly variable opacity, with or without precipitation
12.1383, -0.0495, -14.6687, 0.0587	Cloud correction function AD - fog
12.1383, -0.0495, -14.6687, 0.0587	Cloud correction function CD - uniform stratified layer of small opacity
12.1383, -0.0495, -14.6687, 0.0587	Cloud corr. function CD -uniform or moderately variable layer of medium opacity
12.1383, -0.0495, -14.6687, 0.0587	Cloud corr. function CD - uniform or moderately variable layer of large opacity
12.1383, -0.0495, -14.6687, 0.0587	Cloud corr. function CD - highly variable opacity, with or without precipitation
12.1383, -0.0495, -14.6687, 0.0587	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	*XA block (sequence dependent)*
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	*XC block (sequence dependent)*
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	*XD block (sequence dependent)*
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	*XAD block*
10:09:14	Time - XAD
2.491	Mu - XAD
66.8	Solar zenith angle - XAD
295.7	Total ozone - AD wavelength, XAD
XCD	*XCD block*
10:08:44	Time - XCD
2.493	Mu - XCD
66.8	Solar zenith angle - XCD
290.1	Total ozone - CD wavelength, XCD
comment	*Comment block*
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-2	-3.92E+0	7.07E-1	-3.39E-3	-2.94E+01	1.01E-4
3.20E+02	-4.20E+02	2.45E+01	2.04E+02	1.47E-1	-1.38E+1	2.18E+0	-1.20E-2	-3.07E+01	-7.42E-4
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						
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 °C for HG-3129
48.60	Standard wavelength setting of Q lever at 15 °C for A
75.51	Standard wavelength setting of Q lever at 15 °C for C
106.68	Standard wavelength setting of Q lever at 15 °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

Effective ozone averaged temperature - Climatology

GMI_Merra and O3sondes Climatology Teff: Degree C

LAT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
-85.0	-33.3	-38.5	-47.5	-58.8	-68.5	-74.7	-77.6	-74.2	-59.9	-45.6	-34.8	-31.5
-75.0	-33.8	-38.4	-46.2	-55.9	-64.9	-70.9	-73.5	-69.8	-57.5	-44.7	-35.3	-32.4
-65.0	-35.2	-38.8	-45.1	-52.5	-59.9	-65.3	-67.2	-62.9	-54.7	-45.1	-37.9	-34.9
-55.0	-37.5	-39.9	-44.3	-49.5	-54.8	-58.7	-59.1	-55.3	-50.3	-44.8	-40.8	-38.3
-45.0	-40.2	-41.4	-44.1	-47.5	-51.2	-53.4	-52.7	-49.8	-47.2	-45.1	-43.3	-41.2
-35.0	-41.5	-41.8	-43.4	-45.6	-47.9	-48.9	-48.2	-47.0	-46.0	-45.2	-44.1	-42.8
-25.0	-43.0	-42.9	-42.8	-43.3	-44.3	-44.5	-44.5	-44.0	-43.3	-42.9	-42.7	-42.8
-15.0	-44.8	-44.6	-43.4	-42.6	-42.5	-42.8	-43.3	-43.2	-42.6	-42.1	-42.6	-43.8
-05.0	-44.2	-43.9	-42.5	-41.8	-41.8	-42.0	-42.5	-42.4	-41.5	-41.0	-41.7	-43.2
05.0	-43.1	-42.9	-41.7	-40.9	-41.4	-42.2	-43.2	-43.3	-42.8	-42.1	-41.9	-42.3
15.0	-43.7	-43.2	-42.0	-41.0	-41.3	-42.7	-43.8	-43.9	-43.2	-42.6	-42.2	-43.3
25.0	-46.0	-45.5	-43.6	-42.2	-41.7	-42.5	-43.1	-43.3	-43.0	-43.1	-44.5	-45.3
35.0	-49.0	-48.4	-47.2	-45.3	-43.1	-41.5	-40.8	-41.3	-42.8	-45.3	-47.8	-49.0
45.0	-50.6	-49.6	-48.8	-46.8	-44.0	-41.7	-40.7	-41.6	-44.1	-47.7	-50.9	-51.6
55.0	-53.0	-51.0	-49.4	-47.1	-43.5	-40.6	-39.6	-41.0	-44.7	-49.4	-53.3	-54.2
65.0	-56.8	-53.6	-50.2	-46.6	-42.4	-39.0	-38.0	-40.1	-45.2	-51.3	-56.1	-57.8
75.0	-60.7	-56.8	-51.8	-46.2	-41.2	-37.5	-36.7	-39.6	-46.0	-53.5	-58.9	-61.4
85.0	-63.1	-58.9	-53.0	-46.0	-40.6	-36.6	-35.9	-39.1	-46.5	-55.0	-60.9	-63.6

Effective ozone averaged temperature – External file

(first column: day of year; second: temperature)

1,-56.61
2,-56.40
…
365,-55.98