

Aethalometer Optical Noise-Reduction Averaging (ONA) Program

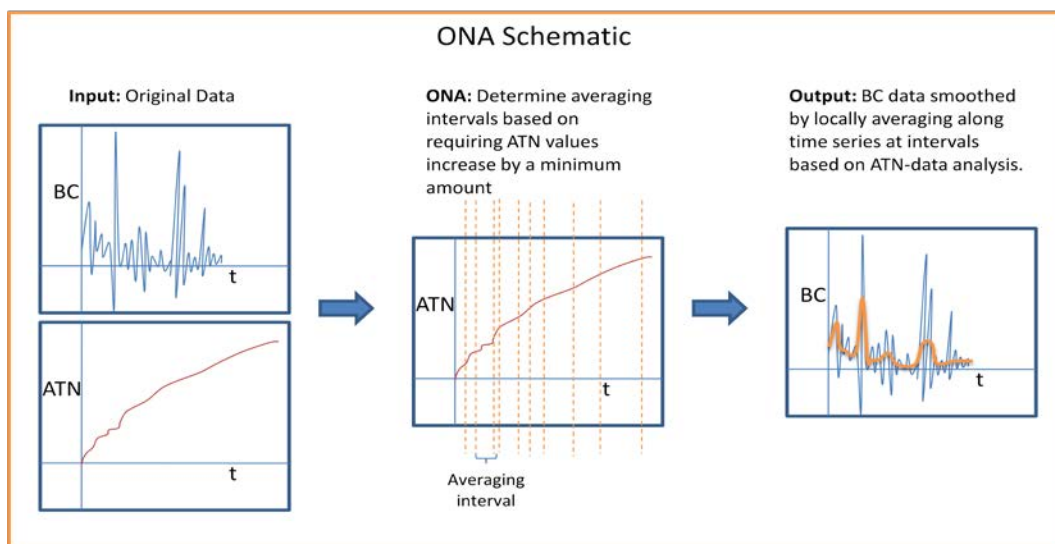
Instructions

General description:

The purpose of this program is to conduct **variable time-averaging** of black carbon data produced from the Magee Aethalometer in order to reduce noise in the data. The program requires that the Aethalometer data provided has recorded the time, black carbon values, and the light attenuation (ATN) values.

The program operates by two rules:

- Rule #1: The time window is set such that the difference in light attenuation (ATN) values from time 1 to time 2 is equal or higher than a minimum value (ΔATN_{\min}).
- Rule #2: That the final ATN value for a given time window (e.g., $\text{ATN}_{\text{time2}}$) is the last occurrence of that value in the rest of the time series. The program will average BC over up-down fluctuations in the ATN time series.



A journal article describing the algorithm is available (<http://aaqr.org>):

Hagler, G.S.W., Yelverton, T.L.B., Vedantham, R., Hansen, A.D.A., Turner, J.R. Post-processing method to reduce noise while preserving high time resolution in Aethalometer real-time black carbon data. Aerosol and Air Quality Research, in press.

Installation:

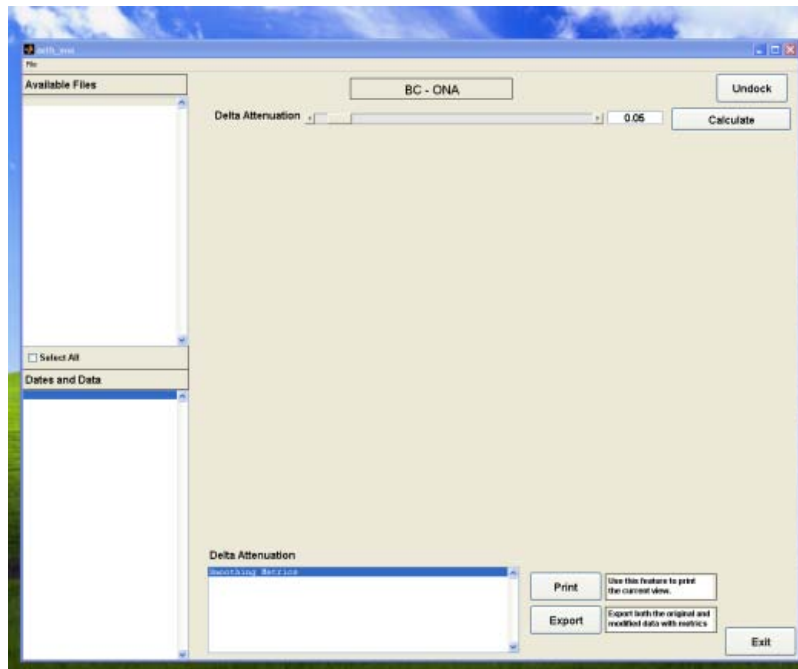
1. You need to have administrative privileges to install the program.
2. Click on the BC_ONA Installation.exe – this will initiate the installation. It **will take a few minutes** for the program to install and start-up for the first time, as the program is installing a MATLAB library of functions. **Do not close the black command window** during installation. After installation, you should see a little green robot icon on your desktop labeled "ONA".

Run the Program:

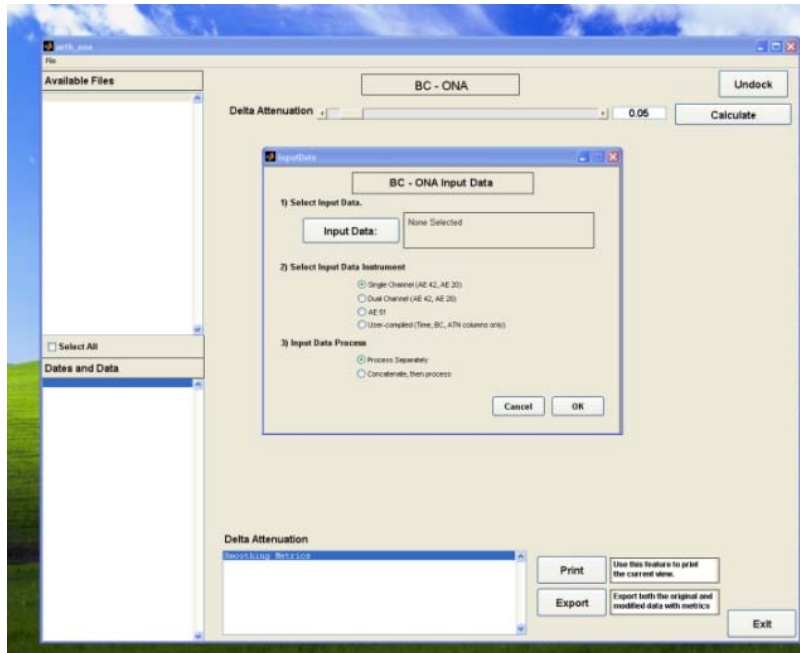
1. Doubleclick on the green robot icon to start the program. A black command window may be visible for minute, and then a disclaimer text box will pop up. Click “OK” in the text box.



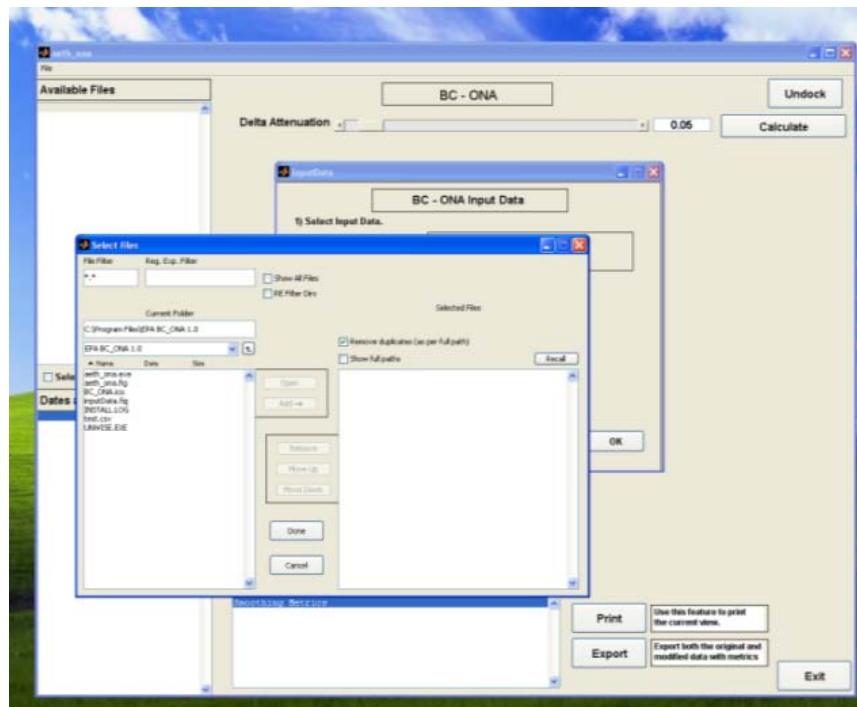
2. You will see the program main screen come up as shown below.



- Click "File" (upper left) then "Input Files" – a new screen should pop up.



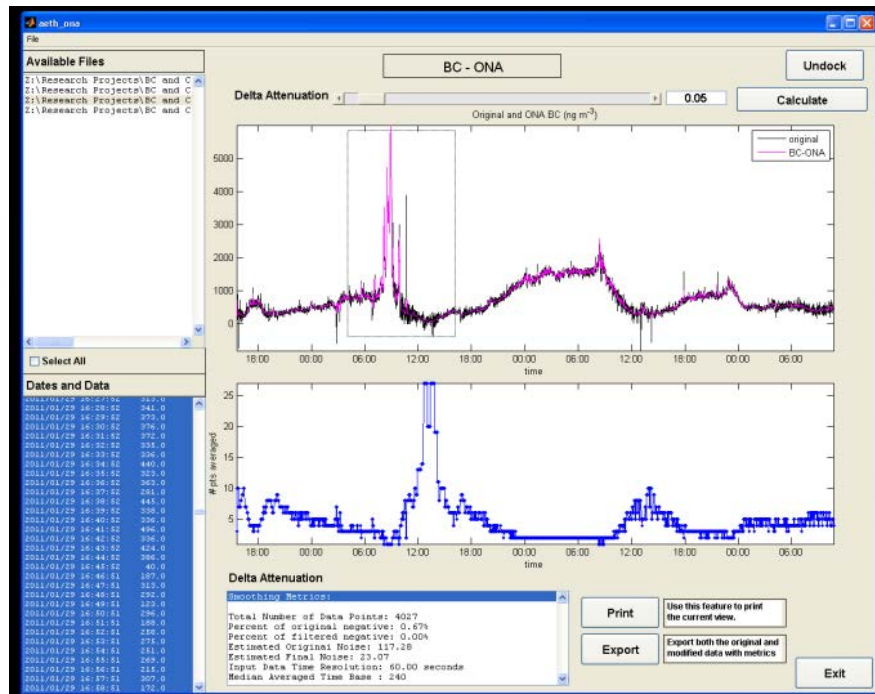
- Click on the "Input Data" data button to navigate to your files. Navigate using the boxes on the left under "Current Folder", then select one or multiple (CTRL+mouseclick) files and click the "Add" button. Then click "Done".



5. You will return to the “inputData” screen, where you then will choose parameters under 2) and 3) – the data type and whether, for multiple files (e.g., A, B, C), if you want the final smoothed data to be kept as separate files (A-smoothed, B-smoothed, C-smoothed) or concatenated into one long time series (A+B+C-smoothed). Click “OK” once you have made your selections. The program will now automatically run using a default delta-attenuation value of 0.05.
6. Navigate the screen: Two figures are shown – the top figure shows the data before/after smoothing, the bottom figure shows the number of points averaged for a given stretch of data. The bottom of the screen shows the smoothing metrics. The top left shows the input files and the bottom left shows the original time series data (timestamp and BC).
 - a. *Zooming*: You can zoom in by mouse-click and drawing a box over the region you want to zoom in. You can zoom back out by clicking the mouse in the figure (or hitting the “Calculate” button again). When you pick a certain region, the time series on the bottom left will highlight the data shown on the screen in blue.
 - b. *Undock figures*: You can “undock” the figures by clicking the top right button. This will open the two figures up as separate windows where you can zoom/print/etc.
 - c. *Change delta-ATN*: You can change the delta-ATN smoothing parameter either by dragging the sliding bar or by manual entering a value in the box above the figures, then click “Calculate”.

Note: Based on the analysis shown in Hagler et al. (2011) a default value of 0.05 is provided.

 - d. *Change the file*: If you had selected “Process files separately” during the input files process and you had multiple files imported, you will see the list of files on the top left. If you click on a different file, the smoothing program will run automatically.
 - e. *Export data*: If you click “Export” a screen will pop up asking for a file name for an exported .csv file, which will contain the original and smoothed data as well as the smoothing metrics and selected delta-ATN value.



Verification that Program is Working:

It is never comfortable to run your data through what may feel like a “black box”. A suggested way to assure the program is working as intended is to do a manual check of the ONA data output in Microsoft Excel as follows:

1. At the start of your timeseries, calculate your first target ATN value by adding the set minimum delta ATN value to the first ATN data point (e.g., $ATN_{target} = 0.01 + 0.05 = 0.06$).
2. Look through the ATN time series to determine the *last* occurrence of the ATNtarget value. This row of data will be the “end” of your first averaging interval.
3. Average the BC values between the start and end of the interval and count the number of rows – the average BC value should be identical to the value in “BC_ONA_Mod” column for the same time period and the count should be the same value as what is shown in the “# pts in average” column.

An example verification of the test data set (AE51_testdata.dat) for the first three averaging periods is shown below.

Date Time	BC_orig	BC_ONA_Mod	ATN_orig	# of points avg.	Manual application of algorithm (checks completed for first 4 min)						
					ATN target	Average	N	Verdict			
7/21/2010 9:00	38489	37283.1	-19.17	10	-19.12	START	37283.1	10	OK		
7/21/2010 9:00	39814	37283.1	-19.16	10							
7/21/2010 9:00	33716	37283.1	-19.16	10							
7/21/2010 9:00	47777	37283.1	-19.15	10							
7/21/2010 9:00	25754	37283.1	-19.14	10							
7/21/2010 9:00	40123	37283.1	-19.14	10							
7/21/2010 9:00	42762	37283.1	-19.13	10							
7/21/2010 9:00	34215	37283.1	-19.13	10							
7/21/2010 9:00	44067	37283.1	-19.12	10							
7/21/2010 9:00	26114	37283.1	-19.12	10		END					
7/21/2010 9:00	35991	37617.6364	-19.11	11	-19.06	START	37617.64	11	OK		
7/21/2010 9:00	36687	37617.6364	-19.11	11							
7/21/2010 9:00	27713	37617.6364	-19.1	11							
7/21/2010 9:00	57746	37617.6364	-19.09	11							
7/21/2010 9:00	30919	37617.6364	-19.09	11							
7/21/2010 9:00	44595	37617.6364	-19.08	11							
7/21/2010 9:00	21038	37617.6364	-19.08	11							
7/21/2010 9:00	41277	37617.6364	-19.07	11							
7/21/2010 9:00	39643	37617.6364	-19.07	11							
7/21/2010 9:00	42966	37617.6364	-19.06	11							
7/21/2010 9:00	35219	37617.6364	-19.06	11		END					
7/21/2010 9:00	13658	34028.1667	-19.05	12	-19.00	START	34028.17	12	OK		
7/21/2010 9:00	46520	34028.1667	-19.05	12							
7/21/2010 9:00	30703	34028.1667	-19.04	12							
7/21/2010 9:00	37310	34028.1667	-19.04	12							
7/21/2010 9:00	47427	34028.1667	-19.03	12							
7/21/2010 9:00	31562	34028.1667	-19.03	12							
7/21/2010 9:00	20233	34028.1667	-19.02	12							
7/21/2010 9:00	47655	34028.1667	-19.02	12							
7/21/2010 9:00	9109	34028.1667	-19.02	12							
7/21/2010 9:00	59494	34028.1667	-19.01	12							
7/21/2010 9:00	16782	34028.1667	-19	12							
7/21/2010 9:00	47885	34028.1667	-19	12		END					

Questions, comments, suggested improvements? Please contact Gayle Hagler at hagler.gayle@epa.gov