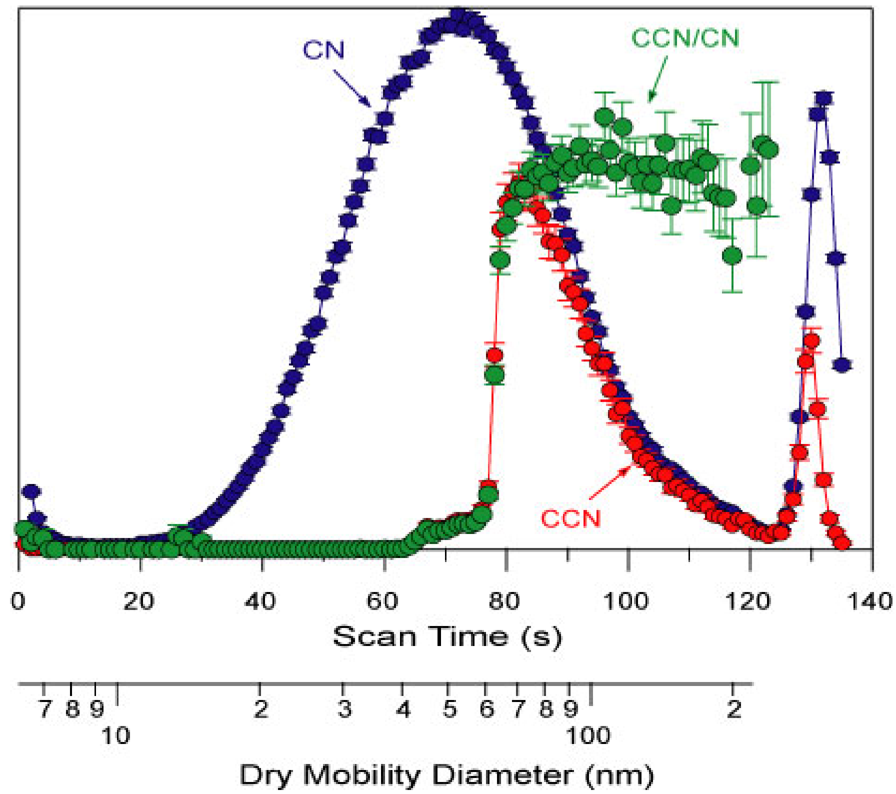
Scanning Mobility CCN Analysis



Instruction Manual

Version 8/1/2010 Draft

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TERMS OF USAGE:

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(i) Link to SMCA webpage: http://nenes.eas.gatech.edu/SMCA/ where users can download the latest software and manuals

(ii) Reference to the SMCA technique paper: Moore, R.H., A. Nenes, and J. Medina, Scanning Mobility CCN Analysis – A Method for Fast Measurements of Size-Resolved CCN Distributions and Activation Kinetics, *Aerosol Science and Technology*, 2010

ACKNOWLEDGEMENTS:

We acknowledge the support of a National Science Foundation CAREER award and the National Oceanic and Atmospheric Administration under grant NA04OAR4310088. RHM acknowledges support from a DOE Graduate Research Environmental Fellowship and a Georgia Tech Presidential Fellowship. JM acknowledges support from a NASA Earth System Science Fellowship. We thank A. Asa-Awuku, K. Bougiatioti, G. Engelhart, P. Kumar, T. Lathem, L. Padró and T. Raymond for their feedback on the SMCA inversion software.

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1. INSTRUMENTATION AND SETUP

This manual refers to Scanning Mobility CCN Analysis (SMCA) performed using a Droplet Measurement Technologies' Cloud Condensation Nuclei Counter (CCNC, www.dropletmeasurement.com) and a TSI, Inc., Scanning Mobility Particle Sizer (SMPS, www.tsi.com). SMCA can be done with other commercial or non-commercial instrumentation, but that is not discussed in this manual.

The SMPS and CCNC are arranged as shown in Figure 1. The polydisperse aerosol inlet of the SMPS can be connected to an aerosol generation system (for calibration) or an inlet for ambient sampling.

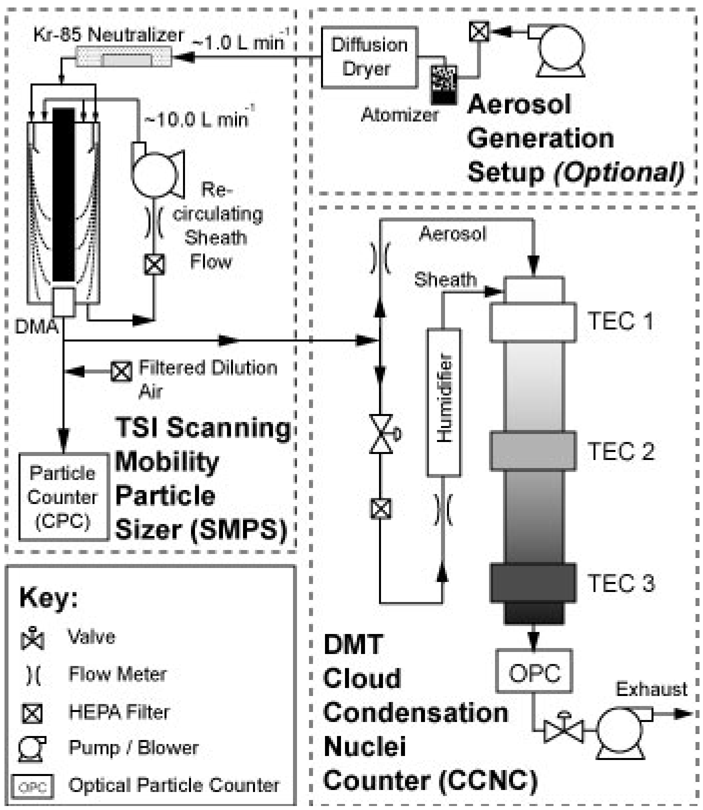


Figure 1: Typical Instrument Setup

The TSI Aerosol Instrument Manager (AIM) software is used to control the SMPS system. For operational settings, please refer to the TSI SMPS and AIM manuals. Typically, a 120-second voltage upscan and a 15-second voltage downscan are sufficient for most cases. Longer scan times may be necessary in environments with low particle concentrations, while shorter scan times would be beneficial in rapidly-changing environments (e.g., aircraft operation). In the scheduling tab, ensure that only 1 scan comprises each sample and that many samples are scheduled if continuous sampling is desired.

The DMT CCNC control software is used to control operation of the CCNC. For operational settings, please refer to the DMT CCNC manual. For multiple supersaturations and typical SMPS settings (120-second upscan / 15-second downscan), 12 minutes per supersaturation is suggested to ensure at least 3 replicates, as CCNC temperature transients during supersaturation changes may produce unreliable spectra if they occur during a voltage upscan.

Before starting the CCNC and AIM software, ensure that the system times on each computer are synchronized to within 1-2 seconds! The timestamp from each computer will be used to align the data during post-processing.

The data files obtained from the CCNC software are in CSV format and do not need to be modified prior to post-processing. The SMPS output files are S80 format and need to be exported to tab-delimited TXT files for post-processing. To export the SMPS data, do the following within the TSI AIM software:

- Select all Scanned Samples
- Select File -> Export to File
- Make sure the following are selected:
    - Data types: Number and dW/dlogDp
    - Delimiter: Tab
    - Orientation: Column
- Select the Raw Data checkbox
- Click OK

2. CCNC AND SMPS FILE POST-PROCESSORS

The post-processing executables comprise the following programs:

`mklst.bat`	Makes a text file with the CCNC and SMPS filenames
`scanfile.exe`	Makes "scanfiles" with the date/times of the CCNC and SMPS data; for the CCNC, it also specifies the times for each supersaturation
`smca3.exe`	SMCA inversion program (ver. 3). This program combines all SMPS and CCNC files into a delimited array containing CCN, CN concentrations, average OPC droplet sizes, supersaturations, and temperatures.

The data post-processing procedure is as follows:

Step 1:
First make a directory and put the relevant CSV and TXT data files in it (note: the current SMCA inversion program does not support experiments comprising more than one day, so each day would need to be in its own directory).

Step 2:
Copy the `mklst.bat`, `scanfil.exe`, and `smca3.exe` files into the directory.

Step 3:
Execute `mklst.bat`. This batch file creates a text file called "`files.lst`" that should only have the names of the CCNC and SMPS files found in the current directory (one file name per line). Open "`files.lst`" in Windows Notepad to ensure that this is the case; if there are more files listed than should be, delete them.

Step 4:
Execute `scanfile.exe`. It asks for the file with the CCN and SMPS data file names, which is the `files.lst` file created in Step 3. Enter "files.lst" without the quotes at the prompt. If everything works well, the program should scan all of the data files and exit by saying "Scanning finished". The program has created two new files:

`SCN_SMPS.DAT`	Contains all the dates, scan start & stop times, and scan info found in the SMPS files
`SCN_CCNC.DAT`	Contains all the dates and supersaturation start & stop times found in the CCNC files

Step 5:
Execute `smca3.exe`. The program asks for the SMPS scanfile (enter `SCN_SMPS.DAT`) and the CCN scanfile (enter `SCN_CCNC.DAT`). The program asks for how many additional seconds of data should be included to properly align the SMPS and CCN scans. Typically, 30-60 seconds is sufficient if the computer times were synchronized and if the tubing connecting the DMA to the CPC and to the CCNC were both short (< 1 meter) and approximately the same length.

If everything goes well, the program generates a series of files called "`SCN_SMCAxx.DAT`", where `xx` is `00`, `01`, `02`, etc. Each file contains the CCN and SMPS scans. The number of files generated is equal to the number of SMPS files found in the current directory (this enables one to open the files within MS Excel despite its 256 column limit). The `SCN_SMCAxx.DAT` files should be opened in MS Excel as space-delimited files. The results are straightforward. Each column refers to one SMPS scan and contains:

- Scan timestamp (date and start/end time of scan)

- Nominal supersaturation, ΔT_{set}, and the maximum deviation (%) of the measured ΔT (T3-T2) from the setpoint. The temperature deviation is used as a diagnostic to see if temperature transients affect the instrument supersaturation during the scan

- The size distribution (dN/dlogDp) and standard deviation of the distribution

- The raw CPC counts vs. scantime and the corresponding Dp obtained from the TSI AIM software inversion

- The CCN concentrations vs. scantime. To facilitate alignment of the CCN and CPC distributions, the program writes additional seconds (as specified during the program execution) of CCN data compared to SMPS data (i.e., if the SMPS scan cycle lasts 135 seconds and 30 additional seconds are specified in `smca3.exe`, then 165 seconds of CCN data are written).

- The average droplet size at the CCNC OPC vs. scantime. Additional seconds of scan data are added here, as described in the previous bullet point.

- The % deviation of T3-T2 (which is most sensitive to transients) from the the setpoint T3-T2 vs. scantime. This can be used to see the very detailed temperature fluctuations. When $\%\Delta T$ is approximately constant, the scans look good. When $\%\Delta T$ varies by more than 5%, the scan should be discarded (see discussion in next section).

3. SMCA ANALYSIS SPREADSHEET

The SMCA analysis spreadsheet (`SMCAProcessor.xls`) is used to process and analyze the `SCN_SMCAxx.DAT` files obtained from Part 2.

The analysis procedure is as follows:

Step 1:
Open `SMCAProcessor.xls`, making sure to Enable Macros if prompted. Then, open the `SCN_SMCAxx.DAT` file with Excel. Highlight Column A, and select Data -> Text to Columns…. Choose the “Delimited” data type and click “Next”. Choose “Space” delimiters and ensure that the “Treat consecutive delimiters as one” box is checked (see Figure 2). Then, click “Finish”. The data should now be sorted into columns (one column per SMCA scan), except for Column A, which is blank (the data in Column B doesn’t appear until around Row 110).

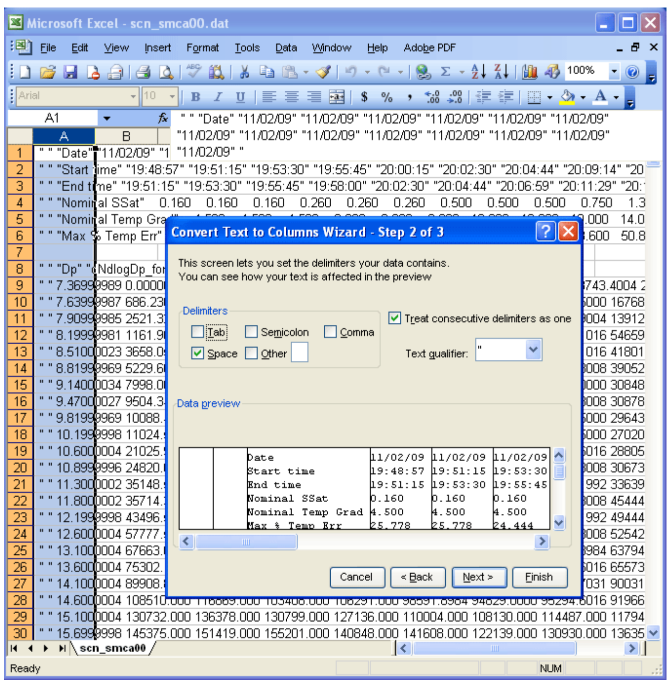
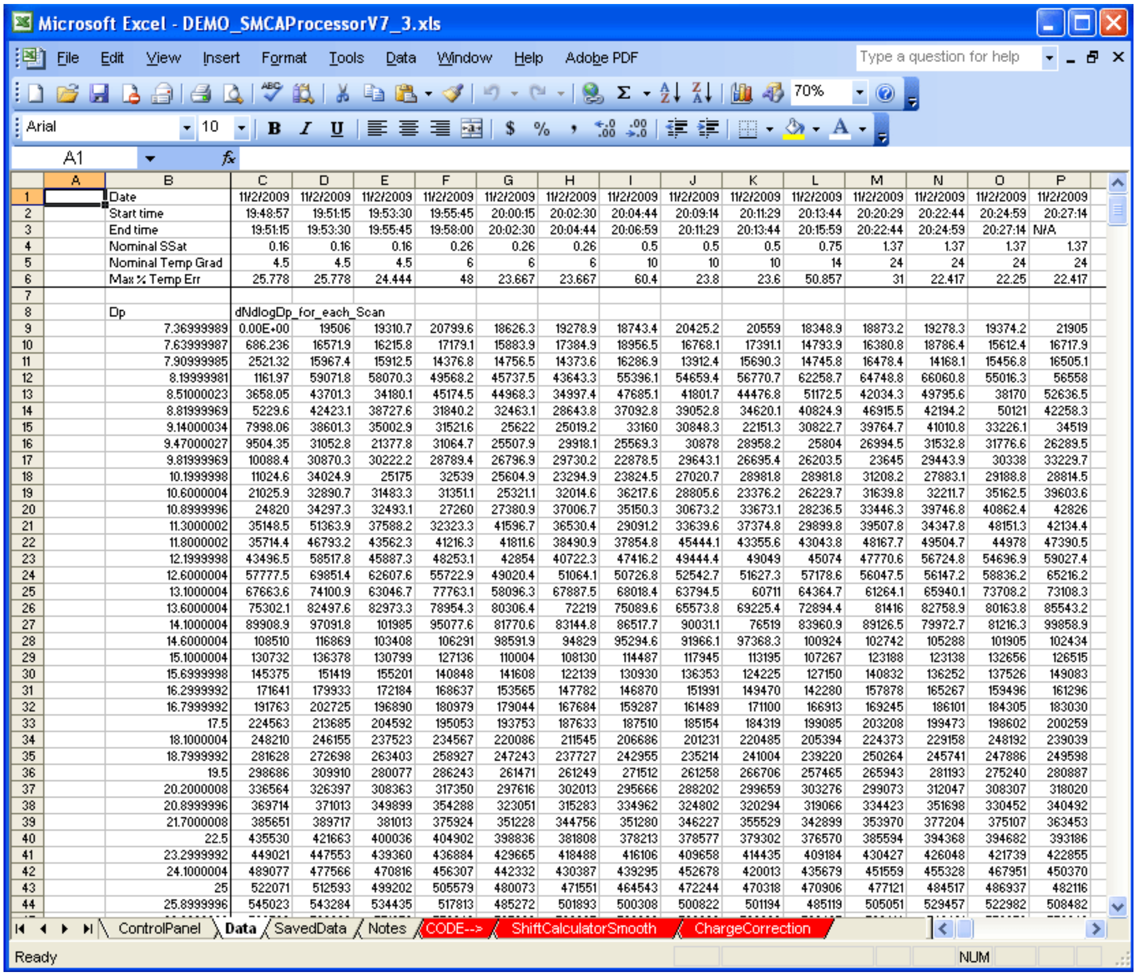


Figure 2: Importing SCN_SMCAxx.DAT into Excel as Text-to-Columns

Copy Columns B through the end into a new tab (by default named “Data”) in `SMCAProcessor.xls`, beginning at Column A (see Figure 3).



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1		Date	11/2/2009	11/2/2009	11/2/2009	11/2/2009	11/2/2009	11/2/2009	11/2/2009	11/2/2009	11/2/2009	11/2/2009	11/2/2009	11/2/2009	11/2/2009	11/2/2009
2		Start time	19:48:57	19:51:15	19:53:30	19:55:45	20:00:15	20:02:30	20:04:44	20:09:14	20:11:29	20:13:44	20:20:29	20:22:44	20:24:59	20:27:14
3		End time	19:51:15	19:53:30	19:55:45	19:58:00	20:02:30	20:04:44	20:06:59	20:11:29	20:13:44	20:15:59	20:22:44	20:24:59	20:27:14	N/A
4		Nominal SSat	0.16	0.16	0.16	0.26	0.26	0.26	0.5	0.5	0.5	0.75	1.37	1.37	1.37	1.37
5		Nominal Temp Grad	4.5	4.5	4.5	6	6	6	10	10	10	14	24	24	24	24
6		Max % Temp Err	25.778	25.778	24.444	48	23.667	23.667	60.4	23.8	23.6	50.857	31	22.417	22.25	22.417
7																
8		Dp	dNdlogDp_for_each_Scan													
9		7.36999989	0.00E+00	19506	19310.7	20799.6	18626.3	19278.9	18743.4	20425.2	20559	18348.9	18873.2	19278.3	19374.2	21905
10		7.63999987	686.236	16571.9	16215.8	17179.1	15883.9	17384.9	18956.5	16768.1	17391.1	14793.9	16380.8	18786.4	15612.4	16717.9
11		7.90999985	2521.32	15967.4	15912.5	14376.8	14756.5	14373.6	16286.9	13912.4	15690.3	14745.8	16478.4	14168.1	15456.8	16505.1
12		8.19999981	1161.97	59071.8	58070.3	49568.2	45737.5	43643.3	55396.1	54659.4	56770.7	62258.7	64748.8	66060.8	55016.3	56558
13		8.51000023	3658.05	43701.3	34180.1	45174.5	44968.3	34997.4	47685.1	41801.7	44476.8	51172.5	42034.3	49795.6	38170	52636.5
14		8.81999969	5229.6	42423.1	38727.6	31840.2	32463.1	28643.8	37092.8	39052.8	34620.1	40824.9	46915.5	42194.2	50121	42258.3
15		9.14000034	7998.06	38601.3	35002.9	31521.6	25622	25019.2	33160	30848.3	22151.3	30822.7	39764.7	41010.8	33226.1	34519
16		9.47000027	9504.35	31052.8	21377.8	31064.7	25507.9	29918.1	25569.3	30878	28958.2	25804	26994.5	31532.8	31776.6	26289.5
17		9.81999969	10088.4	30870.3	30222.2	28789.4	26796.9	29730.2	22878.5	29643.1	26695.4	26203.5	23645	29443.9	30338	33229.7
18		10.1999998	11024.6	34024.9	25175	32539	25604.9	23294.9	23824.5	27020.7	28981.8	28981.8	31208.2	27883.1	29188.8	28814.5
19		10.6000004	21025.9	32890.7	31483.3	31351.1	25321.1	32014.6	36217.6	28805.6	23376.2	26229.7	31639.8	32211.7	35162.5	39603.6
20		10.8999996	24820	34297.3	32493.1	27260	27380.9	37006.7	35150.3	30673.2	33673.1	28236.5	33446.3	39746.8	40862.4	42826
21		11.3000002	35148.5	51363.9	37588.2	32323.3	41596.7	36530.4	29091.2	33639.6	37374.8	29899.8	39507.8	34347.8	48151.3	42134.4
22		11.8000002	35714.4	46793.2	43562.3	41216.3	41811.6	38490.9	37854.8	45444.1	43355.6	43043.8	48167.7	49504.7	44978	47390.5
23		12.1999998	43496.5	58517.8	45887.3	48253.1	42854	40722.3	47416.2	49444.4	49049	45074	47770.6	56724.8	54696.9	59027.4
24		12.6000004	57777.5	69851.4	62607.6	55722.9	49020.4	51064.1	50726.8	52542.7	51627.3	57178.6	56047.5	56147.2	58836.2	65216.2
25		13.1000004	67663.6	74100.9	63046.7	77763.1	58096.3	67887.5	68018.4	63794.5	60711	64364.7	61264.1	65940.1	73708.2	73108.3
26		13.6000004	75302.1	82497.6	82973.3	78954.3	80306.4	72219	75089.6	65573.8	69225.4	72894.4	81416	82758.9	80163.8	85543.2
27		14.1000004	89908.9	97091.8	101985	95077.6	81770.6	83144.8	86517.7	90031.1	76519	83960.9	89126.5	79972.7	81216.3	99858.9
28		14.6000004	108510	116869	103408	106291	98591.9	94829	95294.6	91966.1	97368.3	100924	102742	105288	101905	102434
29		15.1000004	130732	136378	130799	127136	110004	108130	114487	117945	113195	107267	123188	123138	132656	126515
30		15.6999998	145375	151419	155201	140848	141608	122139	130930	136353	124225	127150	140832	136252	137526	149083
31		16.2999992	171641	179933	172184	168637	153565	147782	146870	151991	149470	142280	157878	165267	159496	161296
32		16.7999992	191763	202725	196890	180979	179044	167684	159287	161489	171100	166913	169245	186101	184305	183030
33		17.5	224563	213685	204592	195053	193753	187633	187510	185154	184319	199085	203208	199473	198602	200259
34		18.1000004	248210	246155	237523	234567	220086	211545	206686	201231	220485	205394	224373	229158	248192	239039
35		18.7999992	281628	272698	263403	258927	247243	237727	242955	235214	241004	239220	250264	245741	247886	249598
36		19.5	298686	309910	280077	286243	261471	261249	271512	261258	266706	257465	265943	281193	275240	280887
37		20.2000008	336564	326397	308363	317350	297616	302013	295666	288202	299659	303276	299073	312047	308307	318020
38		20.8999996	369714	371013	349899	354288	323051	315283	334962	324802	320294	319066	334423	351698	330452	340492
39		21.7000008	385651	389717	381013	375924	351228	344756	351280	346227	355529	342899	353970	377204	375107	363453
40		22.5	435530	421663	400036	404902	398836	381808	378213	378577	379302	376570	385594	394368	394682	393186
41		23.2999992	449021	447553	439360	436884	429665	418488	416106	409658	414435	409184	430427	426048	421739	422855
42		24.1000004	489077	477566	470816	456307	442332	430387	439295	452678	420013	435679	451559	455328	467951	450370
43		25	522071	512593	499202	505579	480073	471551	464543	472244	470318	470906	477121	484517	486937	482116
44		25.8999996	545023	543284	534435	517813	485272	501893	500308	500822	501194	485119	505051	529457	522982	508482

Figure 3: SMCA data loaded into SMCA_Processor.xls

Step 2:
Switch to the "Control Panel" worksheet and update the following information:

- DataSource (Cell F4) should be the name of the Data sheet containing the `SCN_SMCAxx.DAT` data. The default is "Data".

- The formula in Counts2ConcConv_for_CPC (Cell F5) should be modified to account for the proper CPC flow rate. This conversion factor converts the reported raw CPC particle counts per second to a volumetric concentration (particles per cc). The cell should equal $[(\text{CPC Flowrate in LPM})*(60 \text{ seconds / minute})*(1 \text{ liter / } 1000 \text{ cc})]^{-1}$. This factor depends solely on the CPC used and is as follows:
  TSI 3022, 3025 (with 0.3 LPM internal flow), Factor = $[0.3*60/1000]^{-1} = 0.2$
  TSI 3010 (with a 1 LPM internal flow), Factor = $[1*60/1000]^{-1} = 0.06$

The calculations above assume that no dilution air is added to the CPC inlet stream or that the dilution air is added before the monodisperse aerosol stream is split between the CPC and the CCNC. If dilution air was added to the CPC sample stream only, that should also be accounted for in this conversion factor.

- SMPS_timeseries_duration (Cell F9) should be set to the sum of the SMPS upscan and and the SMPS downscan times (in seconds).

- Additional_time_in_CCN_timeseries (Cell F10) should be set to the number of additional seconds specified in the SMCA3.exe program.

- The three numbers given as Timeseries_in_DataSource_sheet (Cells F11:H11) refer to row number corresponding to the data in the Datasource worksheet as follows:

    Cell F11 has a row number; column C of that row in the DataSource worksheet should contain “Counts_for_each_SMPS_Scan”

    Cell G11 has a row number; column C of that row in the DataSource worksheet should contain “CCNCounts_for_each_CCNC_Scan”

    Cell H11 has a row number; column C of that row in the DataSource worksheet should contain “AvgSiz_for_each_CCNC_Scan”

Step 4:
Pick the SMCA scan you want to invert. “ScanColumn” (Cell F7) contains the DataSource column with the SMCA scan of interest. Usually, you start at Column C and invert one scan at a time. Browse through the columns by clicking the “+1 Column” and “-1 Column” buttons (See Figure 4).

Change the “CCN Data Shift” time (seconds) in Cell F6 to align the “SMPS” and “CCN 3 pt avg” timeseries shown in Worksheet Figure A. “Aligned” means that both timeseries reaches a minimum at the same time (around ~120 seconds). You can use the “+1s shift” and the “-1s shift” buttons for conveniently aligning the timeseries. An example of aligned timeseries is shown in Figure 5.

Step 5:
After alignment, check the quality of the activation curve using Worksheet Figures B and D. Figure B shows the CCN activation curve, i.e., CCN/CN versus dry particle diameter (nm). The light blue points show the raw CCN/CN, while the dark blue points show the CCN/CN size distribution after multiple-charge correction (this step hasn’t been performed yet, so the dark blue points reflect the

previously-analyzed SMCA scan). To see the raw curve clearly, set both curves to the raw data by clicking the "Initialize Charge Correction" button.

As in Figure 5, note the sigmoidal shape of the activation curve (in this case for ammonium sulfate) moving from CCN/CN ~ 0 at low diameters (< 50 nm) to CCN/CN ~ 1 at higher diameters (> 90 nm). Also, observe the small hump at 50 nm < Dp < 75 nm. This results from the misclassification of doubly-charged particles and will be removed in later steps. There is relatively little scatter in the data, consistent with the good counting statistics from high particle concentrations measured in each size bin (see Worksheet Figure A within Figure 5). When making low concentration measurements, the activation curves can become very noisy (particularly at the largest size bins). Consequently, it may be necessary to adopt a dynamic binning scheme to increase counting statistics, which is not currently included in the standard SMCA processor – contact the authors for more information about incorporating dynamic binning into SMCA.

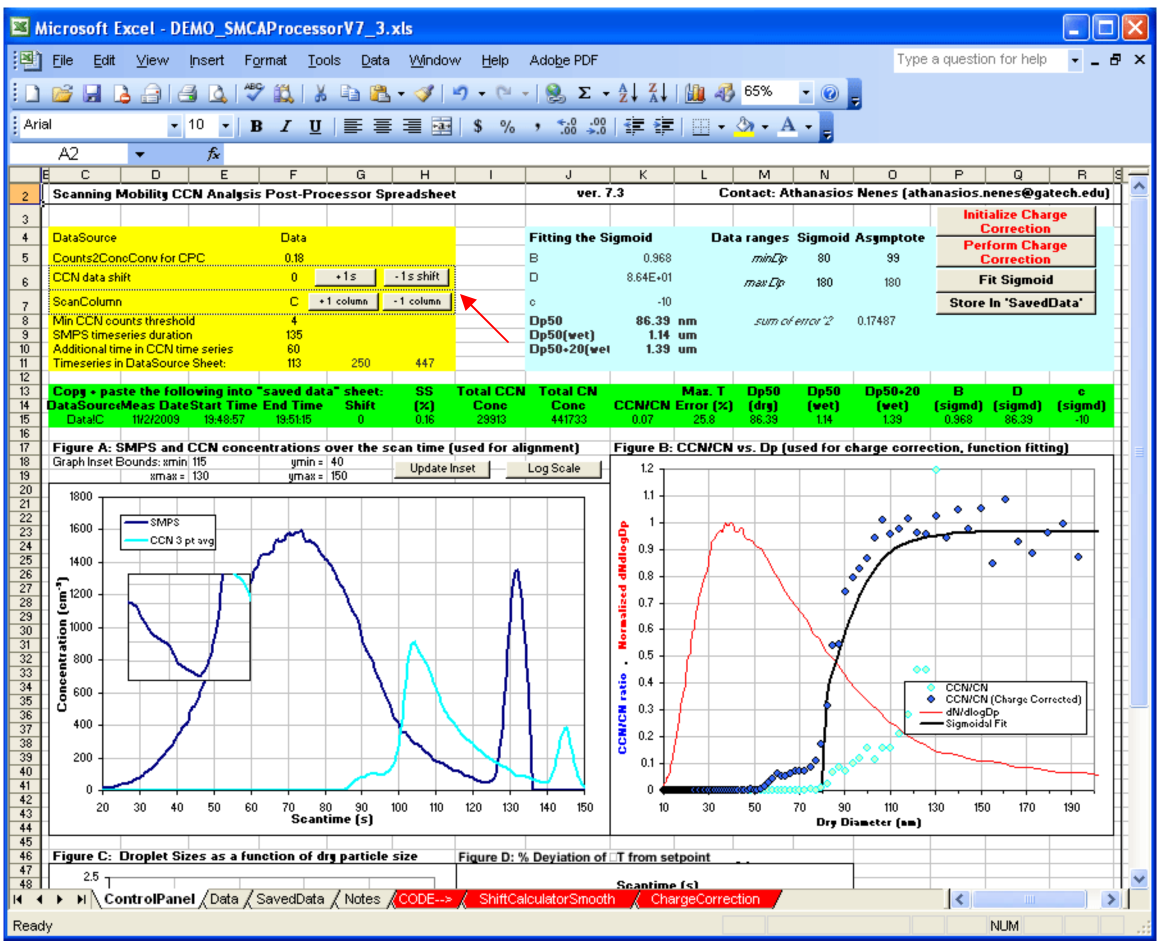


Figure 4: Top part of the Control Panel worksheet, showing sample SMCA timeseries that have not yet been aligned. The red arrow denotes the Column Shift and CCN Data Shift buttons.

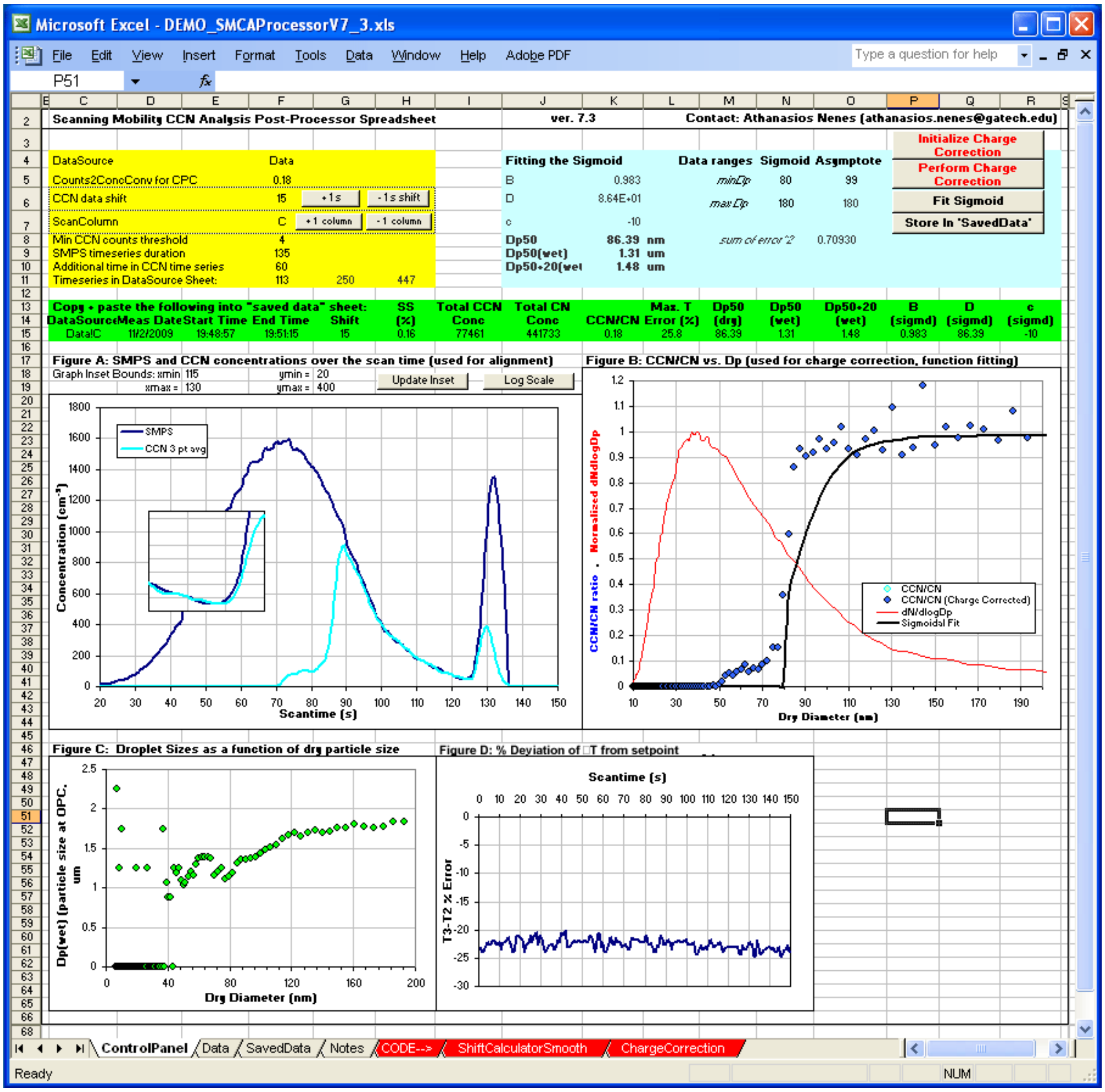


Figure 5: The Control Panel worksheet, showing aligned SMCA timeseries.

Also, note the nearly constant temperature error in Worksheet Figure D (see Figure 5 here). This error reflects the % maximum error between (T3-T2) and ½ ΔT or between (T2-T1) and ½ ΔT and is used to detect temperature transients during an SMCA scan. Note that due to the operating settings of the DMT CCNC software (T3-T2) never equals ½ ΔT, so this error never equals 0% (and usually deviates by more than 10%). However, it should be nearly constant (to within ~5%, except during temperature changes).

A deviation of more than ~5% in the temperature error (as indicated by Worksheet Figure D) during the upscan portion of the SMCA scan indicates that the CCNC temperature field, and hence supersaturation, was not constant during the entire scan and that that particular scan should be discarded. Figure 6 shows exemplary scans with and without a temperature transient.

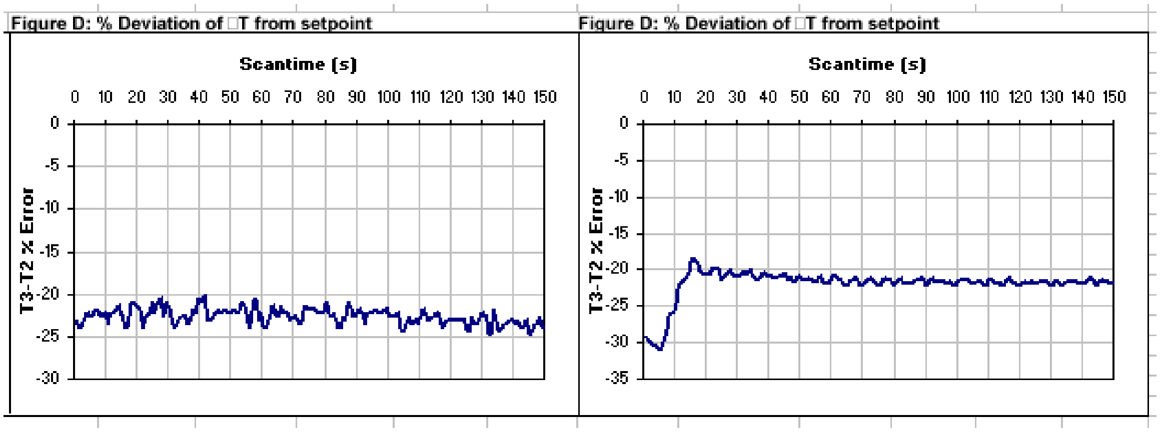


Figure 6: Temperature error timeseries for two exemplary SMCA scans. The timeseries at right shows a temperature transient during the first 15 seconds of the scan, and should be discarded.

If the activation curves and temperature errors are consistent with a good scan, proceed to Step 6. Else, select a new scan and repeat Steps 4 and 5.

Step 6:
Perform the multiple charge correction to re-bin misclassified doubly-charged and triply-charged particles into their actual size bins. If you haven't already, start by clicking the "Initialize Charge Correction" button to set all points to the raw CCN/CN as a first guess. Then, click the "Perform Charge Correction" button 3-4 times until there is no noticeable change in the dark blue (Charge Corrected) CCN/CN points in Worksheet Figure B. The multiple clicks are necessary because the multiple-charge correction algorithm uses a recursive method as detailed in Moore, Nenes, and Medina, *Aerosol Sci. Technol.*, 2010.

Step 7:
Next, we'll fit the activation curve using a sigmoidal function of the form:

$$\frac{CCN}{CN} = \frac{B}{\left(1 + \frac{Dp}{Dp50}\right)^{c}}$$

where CCN, CN are the CCN and CN concentrations, respectively, Dp is the dry mobility diameter, and B, c, and Dp50 are fitting coefficients that describe the asymptote, the slope, and the inflection point of the sigmoid, respectively. First, we need to define the size range over which we'll concentrate. This is easily done by hovering the mouse over the charge-corrected points in Worksheet Figure B to identify the diameters corresponding to specific parts of the curve.

First, specify the CCN/CN "asymptote" (i.e., the nearly-constant CCN/CN plateau at large diameters, typically greater than 100 nm). It is automatically calculated by entering the minimum and maximum diameters of the asymptote into Cells O5 and O6, respectively. For example, if the data between 100 nm and 150 nm expresses the asymptotic CCN/CN, then you should put 100 in Cell O5 and 150 in Cell O6 (Figure 7).

Next specify the minimum and maximum diameters that should be considered for the fitting the sigmoidal function to the data. The minimum diameter should correspond to a diameter where CCN/CN is around zero and should be entered into Cell N5. The maximum diameter should be the same as that entered for the asymptote in Cell O6 and should be entered into Cell N6. So, for example, if the sigmoid ranges from 50 nm to 150 nm, enter 50 and 150 into Cells N5 and N6, respectively. (Figure 7). Next, click the "Fit Sigmoid" button to automatically fit the curve.

If a Visual Basic error occurs, the Solver add-in may not be installed or it may not be referenced in the Visual Basic environment (see Troubleshooting section to fix this). You can run the solver manually. After installing the Solver add-in (via Tools -> Add-ins…), go to Tools -> Solver and click "Solve" to fit the sigmoid.

If the curve is fit correctly, the message "Solution found, optimality and constraints satisfied" or some other positive-sounding message will appear under the button. The solution algorithm is constrained and initial guesses are specified so that a solution is almost always achieved; however, an error may result if the bounds specified in Step 7 are reversed or if the Sigmoid *maxDp* and Asymptote *maxDp* are not the same.

Step 8:
Congratulations, you've inverted the CCN curve and obtained parameters describing its main characteristics. (1-B) is the insoluble (non-CCN-active) aerosol fraction; Dp50 describes the critical activation diameter above which most particles are CCN; c describes the chemical heterogeneity of the soluble (CCN-active) aerosol fraction. You will likely want to save this information, which can be done by clicking the "Store In 'SavedData'" button. This copies the green-highlighted data (Row 15) from the "ControlPanel" worksheet to Row 3 of the "SavedData" tab. Each time the button is pressed, the existing data in "SavedData" is shifted down one row and the new data is written to Row 3.

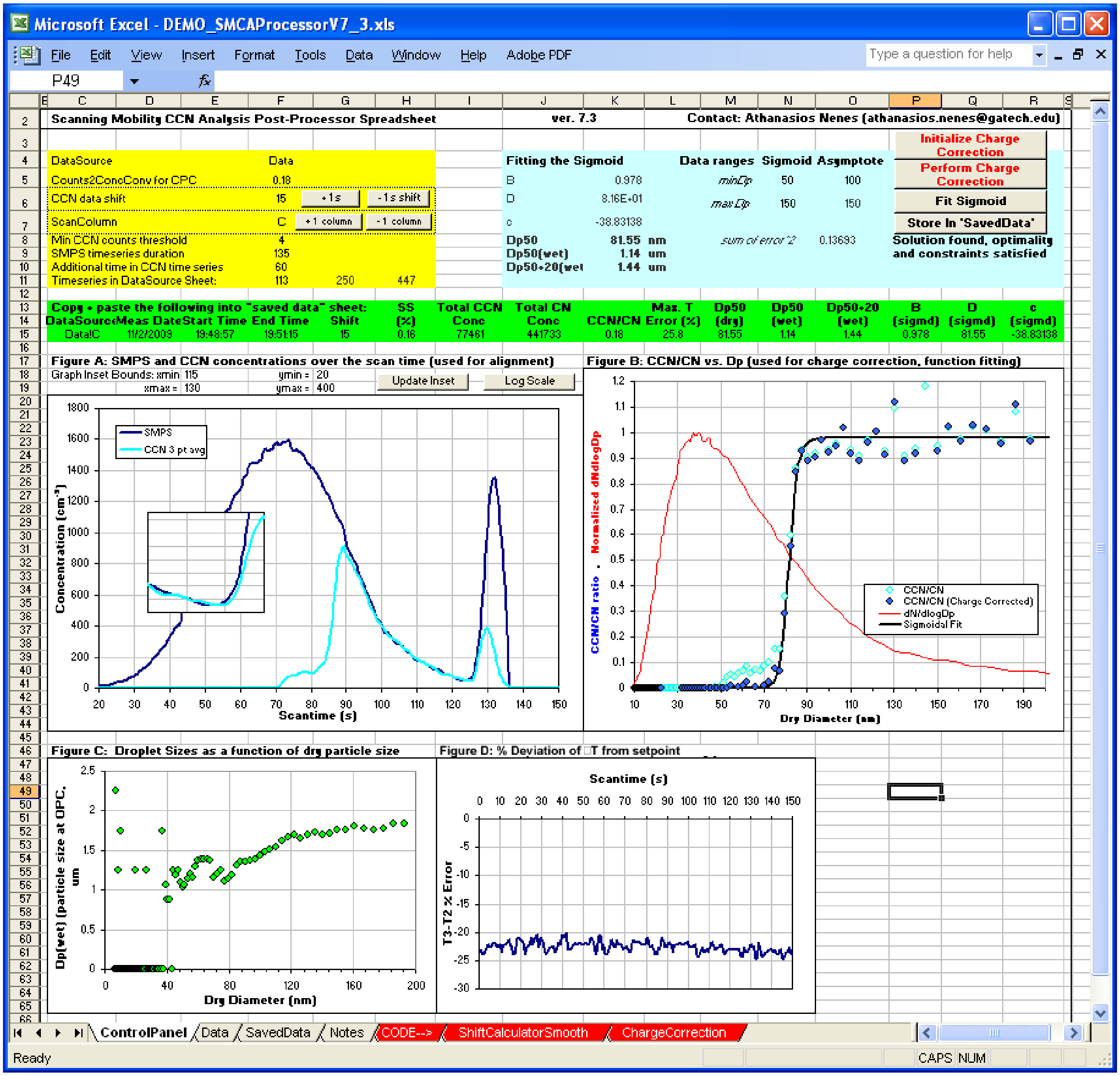


Figure 7: Control Panel worksheet showing aligned SMCA timeseries and fitted sigmoidal curve.

4. CALIBRATION USING KÖHLER THEORY

The `SMCAProcessor.xls` spreadsheet includes built-in Köhler theory calculations that can be used to determine the supersaturation - ΔT relationship necessary for calibrating the DMT CCNC. The required inputs are the critical diameter (Dp50 parameter) obtained from SMCA and the instrument ΔT_{set} (°C).

Calibration aerosol properties are given on the "Aerosol_Props" worksheet. In order to switch between ammonium sulfate and sodium chloride aerosol properties, simply copy and paste the Solute data into the "Summary" worksheet.

The spreadsheet uses a polynomial fit to Pitzer model output data in order to account for non-stoichiometric van't Hoff factors. Also, a dynamic shape factor of 1.08 is applied for sodium chloride. The details of the Köhler theory calculations are given by Moore, Nenes, and Medina, *Aerosol Sci. Technol.*, 2010.

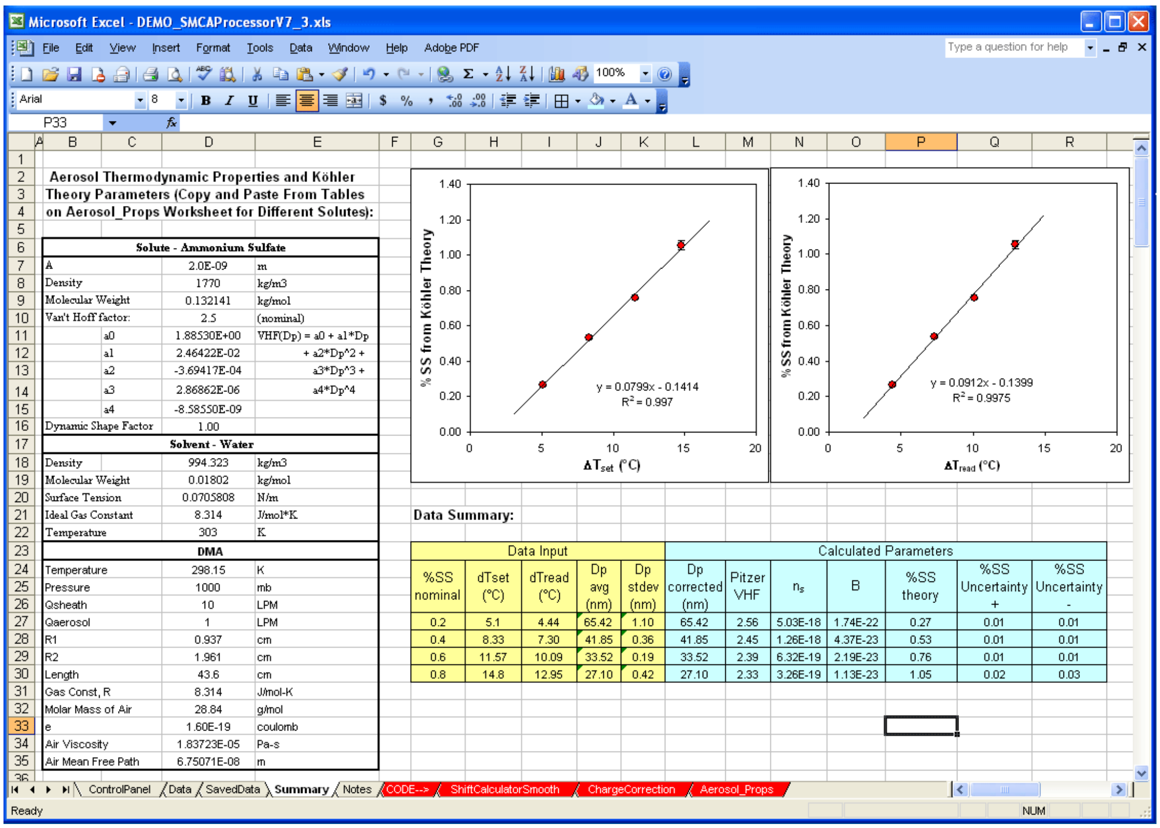


Figure 8: Summary worksheet with built-in Köhler theory calculations.

5. TROUBLESHOOTING

Below are solutions to some problems encountered using the executable files and the SMCA Processor in Microsoft Excel 2003. The solutions described here may change slightly based on the version of Excel used. Please send any additions or corrections to nenes@eas.gatech.edu.

Problem	Possible Cause	Solution
The `SCN_SMCAxx.DAT` file does not contain any data under the "Counts_for_each_SMPS_Scan" section heading. This causes there to be no data visable in SMCA Processor Worksheet Figure A.	The "Raw Data" box was not checked or the wrong delimiter was used when the SMPS data was exported to a TXT file.	Open the S80 file for the experiment using TSI Aerosol Instrument Manager and re-export the data following the procedure described in Section 1.
The `SCN_SMCAxx.DAT` file does not contain any scan data. That is, the first two columns contain the header information and the diameter timeseries, but no scans are listed in Columns C and so on.	The SMPS S80 file may have been exported to a TXT file using TSI Aerosol Instrument Manager on a computer set to a different time zone than what was set during data collection.	TSI AIM appears to use the system time zone to correct the date and time stored in the SMPS file. Consequently, the SMPS scans stored in the text file contain date/time stamps shifted by a few hours relative to the CCN data. Either re-export the data from AIM after resetting the time zone or manually correct the hour timestamps in the SMPS TXT file to match those of the CCN data. (note: the minute & second parts of the SMPS timestamp should be unaffected).
Alternatively, there is some scan data present, but many scans are missing.	The Windows time on the computers running the CCNC and AIM software were not synchronized to within a few seconds prior to starting the software	The timestamps in either the CCNC CSV or the SMPS TXT files will need to be adjusted manually so that they are consistent between the files.

Problem	Possible Cause	Solution
The `SCN_SMCAxx.DAT` file contains garbage scans or no scan data during and for some time after a date change.	The smca3.exe data post-processor does not currently support data spanning multiple dates	The data for each day should be placed into separate folders to be analyzed using SMCA separately. For the SMPS files, export samples from each day into separate TXT files by highlighting only those samples before selecting File -> Export to File. For the SMPS scans and CCNC file containing the date change, the date/timestamps in each file will need to be manually adjusted so that they can be treated as the same day. For example, 04/25/10 00:00:00 would become 04/24/10 24:00:00 and 04/25/10 00:00:01 would become 04/24/10 24:00:01 and so on to the end of the set of relevant samples. If this becomes overly problematic, contact the authors regarding an updated script.
CCN Concentration timeseries is subtantially greater than (or, for calibrations, less than) the SMPS Concentration timeseries in Worksheet Figure A	"Counts2ConcConv for CPC" (Cell F5) is not set correctly.	Ensure that the correct CPC flow rate is used in the formula ([(Q in LPM)*(60sec/1000cc)]^-1). For example, Q ~ 0.3 for TSI 3022 CPC and Q ~ 1 for TSI 3010 CPC. This number may be adjusted slightly so that the CCN~CN at the alignment point to account for uncertainty in the CPC flow rate. If dilution air was added to the CPC inlet stream, also ensure that this is accounted for.
(T3-T2) % Error shows a drop to zero for multiple consecutive scans	Scantime and worksheet points not set correctly	Verify the scantime information provided in Cells F9 and F10 is correct. Also verify that the Row numbers in Cells F11, G11, and H11 correspond to the <u>Section Titles</u> in the Data worksheet.
Pressing the "Fit Sigmoid" button produces a Visual Basic Run-time Error '1004': "The macro ' SolverReset' cannot be found.	The Solver add-in is not installed in MS Excel and/or the Solver add-in is not referenced in Visual Basic.	Go to Tools -> Add-ins…, and check the box beside the "Solver Add-in". Click OK. Then go to Tools -> Macro -> Visual Basic Editor. Within the Microsoft Visual Basic window, go to Tools -> References… Ensure that the box beside "SOLVER" is checked. If no "SOLVER" reference is listed, you will need to browse to the directory containing the solver DLL file (typically in the library directory within the MS Office program files directory). Click OK. You should be able to use the "Fit Sigmoid" button now, error-free. If not, see the next box.
	The Solver add-in is installed and properly referenced in Visual Basic, but hasn't ever been run before. Consequently, Excel may need an example run by hand to work correctly (thanks, Microsoft!)	Go to Tools -> Solver… All of the settings should be pre-loaded from the worksheet. Click the "Solve" button. The "Fit Sigmoid" button should work directly in the future.

6. SMCA References

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