

GW – WINKS SDA

Windows KwikStat
Statistical Data Analysis
for Time Series Programs

Getting Started Guide

An Overview of GW-WINKS Time Series Programs

GW- WINKS is an add-on component of the WINKS SDA Statistical Data Analysis software. It utilizes the foundation of the WINKS program to handle data entry and manipulation and provides you with access to a number of time series procedures mentioned in the book *Applied Time Series Analysis (ATSA)* by Woodward, Gray and Elliott.

These tutorials describe some of the fundamental procedures you should know to use this program. Details about the specific use of the time series procedures are discussed within the book.

Installation

The GW- WINKS software can be downloaded from the following webpage:

<http://www.texasoft.com/ATSA>

Follow the installation instructions on the screen to download and install the program. When you begin GW- WINKS for the first time, a dialog box will appear, asking for a key code. Enter the code: T858-TENE-KRCR-QJFJ. After the installation you will be prompted to choose program options. Select options you want to change, or leave the default options in place (recommended) and choose Ok. You can change these options at any time by choosing Change Setup Options from the Help menu.

For general information on using WINKS, refer to the WINKS SDA Getting Started Guide which you can access by clicking on the How to get Started button on the main WINKS Data Editor window or by selecting Start/ All Programs/Texasoft/WINKS7/Getting Started Guide. These tutorials will help you understand how to use WINKS for general statistical analysis such as descriptive statistics. Not all WINKS procedures are available in the GW-WINKS version, but those pertinent to a time series analysis are available. Also, the Help (click on the Question Mark or select Help/Help Topics) provides additional information on WINKS procedures. To display the full WINKS Users Guide, in the WINKS main Data Editor page, click on: Help/ Help on the Web, and from the displayed web page, click on [WINKS SDA Version 7 Manual](#). This tutorial can easily be accessed while running GW-WINKS by selecting Time Series Tutorial at the bottom of the Time Series Analysis menu.

Tutorials

GW-WINKS provides a platform for performing a variety of time series analyses. In the tutorials that follow we illustrate just some of the features and capabilities of GW-WINKS. While programs are available (for example, stand alone R code, SAS, etc) for performing most of the analyses illustrated here, the key feature of GW-WINKS is that it is designed to assist the student or experienced analyst in fitting ARMA-type models to data, examining the quality of these fits and features of the model fitted, finding and plotting forecasts, spectral estimates, etc. with ease.

The following tutorials are designed to illustrate some of the features and capabilities of GW-WINKS for analyzing time series data. The tutorials are:

Tutorial 1 – Using GW-WINKS to Analyze a Realization

Tutorial 2 – Generating Realizations using GW-WINKS

Tutorial 3 – Using GW-WINKS Graphics (also using the Attributes Tab)

Tutorial 4 – Factor Tables

Tutorial 5 – Preparing Data for GW-WINKS

The native file format for GW- WINKS is an .SDA file. Tutorials 1,3 and 4 are based on time series data sets in .SDA format. Tutorial 2 involves generating data within GW-WINKS and Tutorial 5 illustrates techniques for reading data into GW-WINKS from other types of data files such as Excel (.XLS), .DBF, and text files (.CVS, .TXT, .DAT etc.).

Note: All of the data sets used in these tutorials reside in the WINKS SDA subdirectory. By default, this is the subdirectory that is shown when entering data using the File menu. in GW-WINKS.

Tutorial 1 – Using GW-WINKS to Analyze a Realization

The GW- WINKS program provides a time series analysis environment in which you can easily perform several time series analysis tasks. In this tutorial we illustrate some of these features.

Step 1: Open the SUN.SDA data set (annual sunspot data 1749-1924) by following these steps:

- a) On the File menu at the top left of the screen, select Open Data Set.
(By default the WINKS SDA subdirectory will be shown.)
- b) Enter SUN.SDA in the Filename entry box and click Open. (You may also select SUN.SDA from the list of SDA files in the subdirectory.) You will see a spreadsheet-style screen that contains the sunspot data in the first column and is blank otherwise. This screen is referred to as the Data Editor.

Step 2. Calculate sample autocorrelations.

- a) In the Time Series Analysis menu and select Sample Autocorrelations
- b) Select COUNT as the variable for which to calculate the sample autocorrelations and click Ok. You will see a new column AUTOCORR_COUNT that contains the sample autocorrelations of the sunspot data in COUNT.

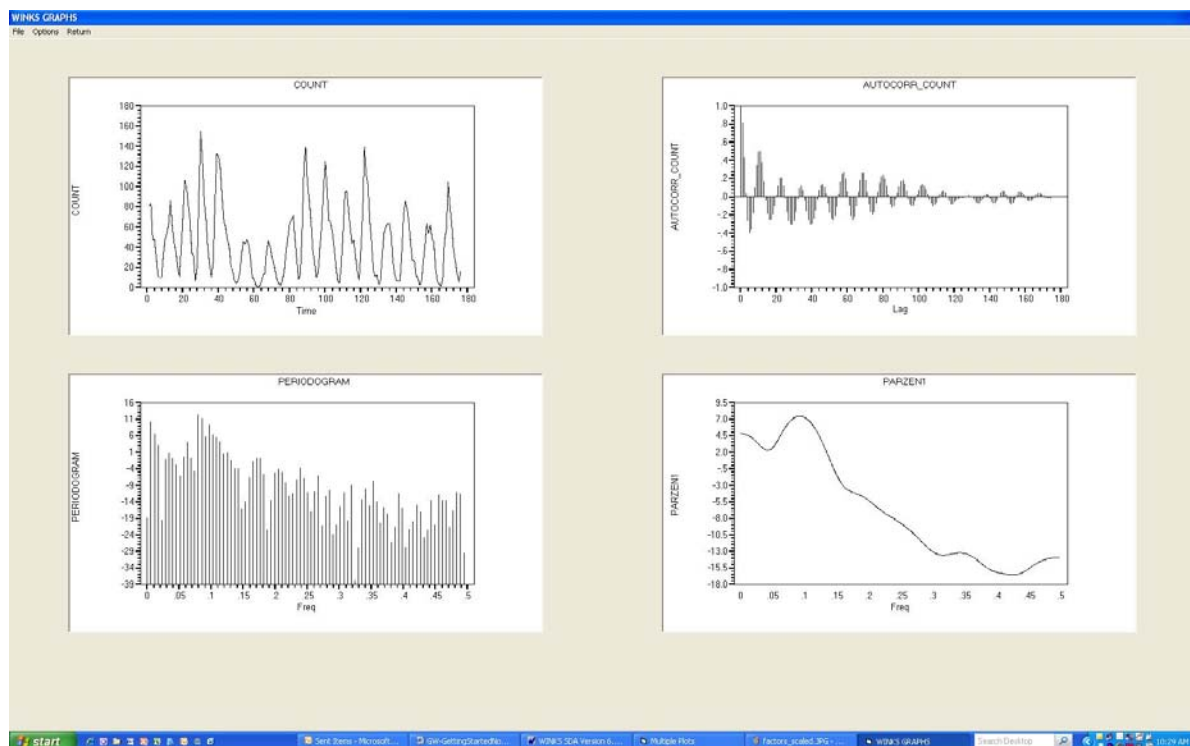
Step 3: Calculate nonparametric spectral estimates. (In this step we will compute the periodogram and Parzen window estimates. In Step 6 we will calculate the ARMA-spectral estimate based on the fitted model.)

- a) On the Time Series Analysis menu select Spectrum
- b) Select COUNT as the variable and click Ok.
- c) You will see a Spectral Density Estimates selection box. You can select to plot the Periodogram and up to 3 window-based estimates. The default selection is to compute the periodogram, along with the Bartlett, Tukey, and Parzen window estimates using the default truncation point $M = 2\sqrt{n}$, which in this case is $M = 26$. All spectral estimates are by default in log scale (recommended). In this tutorial:
 - i) Select Periodogram (This is the default – there is no action required. To de-select Periodogram you would click on the selection box to remove the check.)
 - ii) In the first menu (that shows Bartlett), scroll down and choose Parzen and leave the truncation point at 26.
 - iii) In the second menu (that shows Tukey) select Parzen again and change the truncation point to 70.

- iv) In the third menu again select Parzen and change the truncation point to 10.
- v) Select Ok and you will see information in the Output Viewer related to your spectral estimates
- vi) Select Data View (toward the upper left of the screen) to return to the Data Editor and you will see 4 new variables: PERIODOGRAM, PARZEN1, PARZEN2, and PARZEN3.

Step 4: Plot the results

- a) Select the Graphs/Charts menu
- b) On this menu select Line/Time Series Plots
- c) On the resulting menu select Line plots one or multiple
- d) Select the variables COUNT, AUTOCORR_COUNT, PERIODOGRAM and PARZEN1, click Add, and then click Ok.
- e) You will see the 4 selected plots. Note that the names of the variables were used by the plot routine to identify the type of variable to be plotted. Tutorial 3 will show you how to modify graphs to fit your needs.



- f) To return to the Data Editor: On the File menu at the upper left of the plot screen, select Return.

Step 5: Identify model orders for an ARMA fit to the data

- a) Select AIC on the Time Series Analysis menu to use AIC to pick the model order.
- b) Select COUNT as the variable to be analyzed and click on Ok.
- c) Select 0 as the minimum AR order and 10 as the maximum AR order. Also select 0

and 3 as the minimum and maximum MA orders. Select AIC and select MLE as the estimation type, and click Ok. The following output contains the first few lines of the information given by GW-WINKS which tells us that AIC selects an AR(8) model for the data.

Gray-Woodward AIC 7.0.3 PROFESSIONAL Edition October 18, 2011

 AIC Estimates (MLE) C:\Program Files (x86)\TexaSoft\WINKS7\SUN.SDA

Ranges searched AR: 0 to 10 and MA: 0 to 3

P	Q	WNV	AIC	
8	0	212.60278	5.4617	Smallest AIC
8	1	211.09674	5.46595	
6	1	216.19531	5.46709	
9	0	211.70127	5.46881	
6	2	214.18143	5.4691	

d) Click Data View at the top of the Output Viewer to return to the Data Editor

Notes about the Output Viewer:

1. The Output Viewer is in ASCII format that contains output from procedures run in GW-WINKS. This file can be saved to a file as a record of the analyses performed.
2. At any point in the analysis you can select Output Viewer to the right of the question mark on the gray menu bar toward the top of the Data Editor. Select Data View at the top left of the Output Viewer screen to return to the Data Editor. You can delete the current contents of the Output Viewer by selecting Clear Contents at the top left of the Output Viewer Screen.
3. By default GW-WINKS keeps a cumulative record of the analyses that have been performed. At this stage of the current tutorial, at the top of the Output Viewer you will also see information about the spectral estimates that were obtained in Step 3.
4. If you want to change the default setting to only keep the contents of the most recent analysis in the Output Viewer, from the Data Editor screen go to the Help pull down menu, select Change Setup Options, and remove the check in the selection box for Append output in viewer.
5. While in the Output Viewer is open, you can save the contents to a file by going to the File menu at the top left of the Output Viewer and choosing Save as. The file can be saved as a .txt, .doc, or .rtf file.

Step 6. Find ML estimates of the parameters of the AR(8) model

- a) On the Time Series Analysis menu select Estimate Parameters
- b) Select COUNT as the variable to be analyzed and click Ok
- c) Enter 8 in the P= text box, select MLE and click Calculate.

You will again be shown the Output Viewer. At the bottom of this cumulative record of analyses you will find the following output concerning the ML estimates. Note on the factor

table at the bottom of the output that the root closest to the unit circle is associated with frequency .0968, i.e. period = $1/.0968 = 10.3$ years.

Maximum Likelihood Estimates				

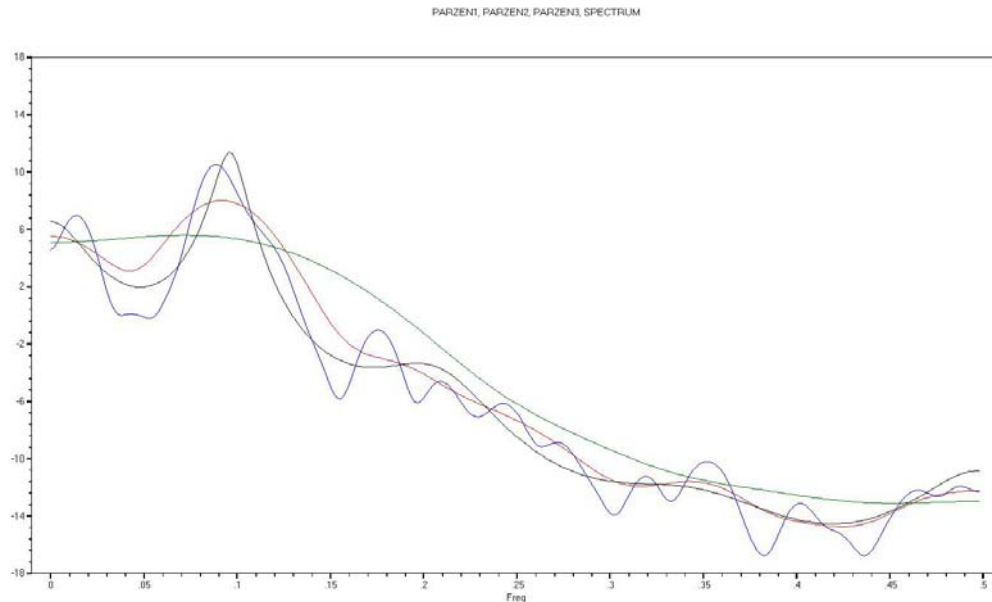
Estimated MLE AR Parameters:				
1)	1.247772	2)	-0.496268	
3)	-0.138457	4)	0.177162	
5)	-0.153936	6)	0.074181	
7)	-0.124517	8)	0.206736	
White Noise Variance	=	212.6028		
AIC	=	5.461698		
Iterations	=	35		
AR Factors for MLE Estimates				
OPERATOR	COEFS	ROOT	ABS RECIPI	FREQUENCY
1 -	1.557B + 0.900B^2	.8653 ± .6021i	0.9486	0.0968
1 -	0.883B	1.1331	0.8825	0.0000
1 -	0.417B + 0.660B^2	.3163 ± 1.1900i	0.8121	0.2086
1 +	0.798B	-1.2538	0.7976	0.5000
1 +	0.812B + 0.495B^2	-.8201 ± 1.1611i	0.7035	0.3479

- d) Click the Data View menu option to return to the Data Editor and observe that 3 columns have been added to the sheet: ARMA_SPECTRUM, ARMA_AUTOCORR and RESIDUALS. ARMA_SPECTRUM is the autoregressive spectral density estimate associated with the AR(8) model fit to the data, ARMA_AUTOCORR are the theoretical autocorrelations associated with the fitted model, and RESIDUALS contains the residuals from the fitted model.

Step 7. Overlay plots of the AR(8) and Parzen spectral estimates from Step 3 and save the plot to a file.

- Select the Graphs/Charts menu
- On this menu select Line/Time Series Plots
- On the resulting menu select Line plots one or multiple
- Select the variables PARZEN1, PARZEN2, PARZEN3, and ARMA_SPECTRUM, click Add, and then click Ok.
- You will see plots of the 4 spectral estimates.
- To overlay these plots: On the Options menu at the top left of the screen select Overlay, specify 4 plots to overlay, and click Ok. The 4 spectral estimates are now shown on the same plot, making comparison easy. Note that for truncation point 70 (blue curve) the Parzen window (PARZEN2) has several spurious peaks (under-smoothed), and for $M = 10$ the estimate (green curve) is over-smoothed and loses important detail. The AR(8) spectral density (black) and the Parzen spectral estimator with $M = 26$ (red) are similar with the primary features being a distinct peak at about $f = .1$ and another peak at $f = 0$.

- g) To save this plot as a BMP (graphics) file for later use: On the File menu at the top left of the screen select Capture plot as BMP file, select the plot you want to capture (in this case there is only one plot), and then choose Capture. You will then need to choose a Windows subdirectory and filename for the saved plot. The overlay plot saved by this method is shown here.

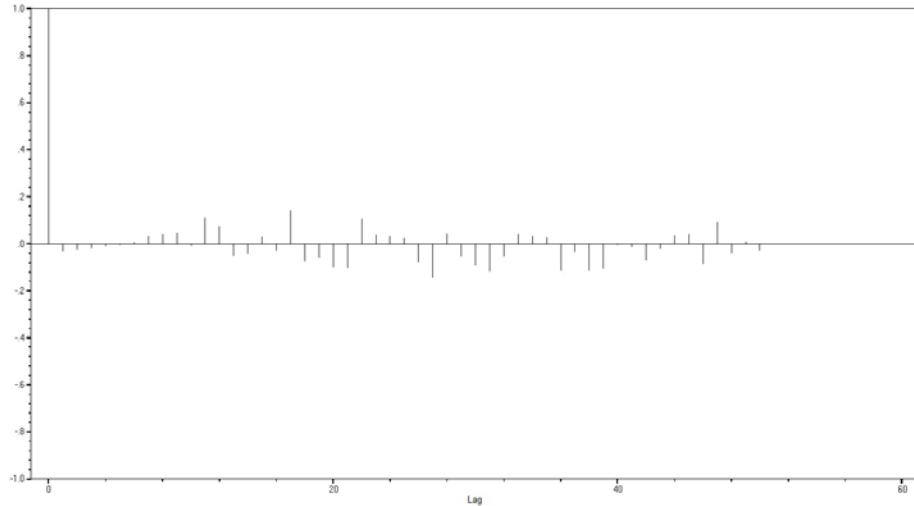


- h) Return to the Data Editor by selecting Return at the top of the plot screen.

Step 8. Analyze the residuals of the fit

- a) Perform the Ljung-Box test: On the Time Series Analysis menu, select Ljung/Box test and specify RESIDUALS as the variable, set $p=8$ and $q=0$ since this is the order of the model from which these are residuals, and clicking Ok.
 - b) The Output Viewer will be shown to you (you may need to scroll down to see the most recent computations). You will see the Ljung-Box test which show that the tests at $K = 24$ and 48 have p-values $.3305$ and $.5106$ respectively indicating that there is not sufficient evidence to reject white noise.
 - c) Click Data View to return to the Data Editor.
- d) Check the sample autocorrelations of the residuals
 - i) Compute the sample autocorrelations for the RESIDUALS variable by clicking on Time Series Analysis menu and selecting Sample Autocorrelations. Then select RESIDUALS as the variable for which sample autocorrelations will be calculated. The sample autocorrelations will be stored in a data editor column with a variable name AUTOCORR_RESIDUA.
Note: Row 1 of the data editor contains the autocorrelation at lag 0 (i.e.1), row 2 contains the autocorrelation at lag 1, etc.
 - ii) To plot these data, select the Graphs/Charts menu
 - iii) On this menu select Line/Time Series Plots

- iv) On the resulting menu select Line plots one or multiple
- v) Select the variable AUTOCORR_RESIDUA, click Add, and then Ok.
- vi) You will see the following plot showing sample autocorrelations. Tutorial 4 discusses techniques for editing graphics. In particular, in that tutorial you will be shown how to add 95% limit lines to a sample autocorrelation plot.



- vii) Return to the Data Editor by selecting Return toward the upper left of the graphics screen.
- viii) To save the expanded data file (containing the calculated variables), click the File menu at the top left of the Data Editor screen and select Save as... and enter a file name. For example, entering the name SUN1 will create a file named SUN1.SDA in the current subdirectory.

Tutorial 2 – Generating Realizations using GW-WINKS

GW-WINKS provides a powerful platform from which to generate time series realizations from ARMA(p,q) models and from signal-plus-noise models. This makes an excellent pedagogical tool for examining the features of models.

Step 1: On the Time Series Analysis menu select Generate Realization. If a data set is currently open in the Data Editor, the program will ask you “Erase all data current in the data editor?”

- a) If the contents of the Data Editor have not been saved and you want to keep them for later use, select Cancel, return to the Data Editor, and save the data before proceeding to Step 2. (See Step 8, (d) viii in Tutorial 1.)
- b) If the contents of the Data Editor have either been saved or will not be needed for future use, proceed to Step 2

Step 2: Select Ok. You will see a dialog box such as the following:

This dialog box allows you to specify either a signal-plus-noise model or an ARMA(p,q) model. In this tutorial we will discuss the generation of realizations from ARMA(p,q) models. Notice that there are two methods for entering coefficients: “Entering operators by factors” and “Entering operators by coefficients.” Chapter 3 of the *ATSA* text discusses factoring ARMA models. For convenience, the program “remembers” the most recent model from which realizations were generated. In the dialog box above the most recently used model was the AR(2) model $X_t - \mu - 1.6(X_{t-1} - \mu) + .9(X_{t-2} - \mu) = a_t$ where $\mu = 50$, $\sigma_a^2 = 1$, and the realization is length $n = 200$. Note that here we use the ARMA(p,q) model notation

$$X_t - \mu - \phi_1(X_{t-1} - \mu) - L - \phi_p(X_{t-p} - \mu) = a_t - \theta_1 a_{t-1} - L - \theta_q a_{t-q},$$

used in the *ATSA* text. (Be careful with signs of coefficients!)

In this tutorial we will generate realizations from the ARMA(4,3) model

$$X_t - .3X_{t-1} - .9X_{t-2} - .1X_{t-3} + .8X_{t-4} = a_t + .9a_{t-1} + .8a_{t-2} + .72a_{t-3},$$

where $\sigma_a^2 = 1$ and from the form of the model we see that $\mu = 0$. This is the ARMA(4,3) model discussed in Example 3.15 in the *ATSA* text. In Step 3A we show how to enter a model using operator coefficients and in Step 3B we show how to enter factor coefficients.

Step 3A: Generating realizations using the operator coefficients.

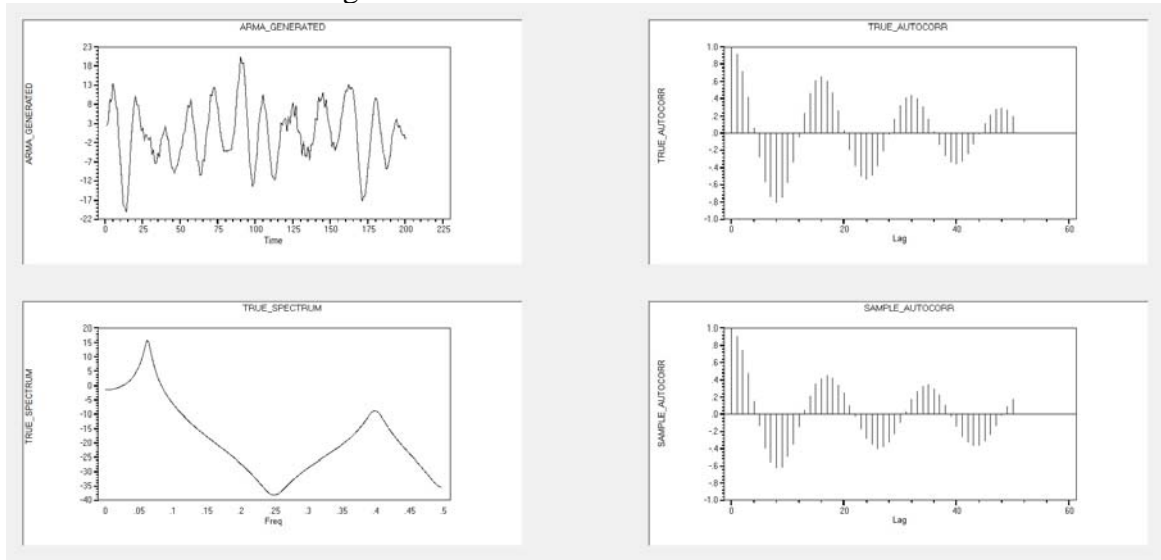
- Select ARMA under Generate a Realization section at the top of the entry box (ARMA is the default).
- Select Enter operator by coefficients in the Time Series Generating Routine section.
- Enter 4 for P, 3 for Q, and 0 for Mean.
- In the upper right-hand corner there will be 4 entry lines under P and 3 entry lines under Q. By default these values are all 1.0. In the P column enter the values .3, .9, .1, and -.8 (again – be careful with signs) and in the Q column enter -.9, -.8, and -.72.
- Enter 1 for White Noise Variance, a positive integer (3465 is ok) for Seed, and 200 for Series length.

Note: If you enter a positive number for Seed, a unique realization is generated each time the program is run. That is, if you use 3465 for the seed and then decide to generate another realization from the ARMA(4,3) model and also use the seed 3465, a different realization will be generated the second time. However, if a negative integer is used for the seed and later you generate a realization using the same (negative) seed, then the second realization is the same as the first.

- The default name for the variable name appears in the Enter variable name to create entry box. Change this to ARMA43. The dialog box should look like

The screenshot shows the 'Series Generation' dialog box. The 'Select' section has 'ARMA' selected. The 'Time Series Generating Routine' section has 'Enter operators by coefficients' selected. The 'Enter P=' field is 4, 'Enter Q=' is 3, and 'Mean=' is 0. The 'P' coefficients are .3, .9, .1, and -.8. The 'Q' coefficients are -.9, -.8, and -.72. The 'White Noise Variance=' is 1 and 'Seed=' is 3465. The 'Series length=' is 200. The 'Enter variable name to create:' field is ARMA43. The 'Cancel' and 'Create' buttons are at the bottom.

- g) Select Create to generate the realization. The Output Viewer is shown to you, and at the bottom of the Output Viewer you can see information about the model and the realization.
- h) On the Graph menu at the top of the screen select Display Graph. You will see a plot such as the following:



The upper left graph is a plot of the generated realization, the upper right and the lower left are plots of the true autocorrelations and spectral density for this ARMA(4,3) model. The plot on the lower right shows the sample autocorrelations based on the generated realization.

- i) Selecting Return at the top left of the screen will return you to the Output Viewer.
- j) Select Data View to return to the Data Editor. There you will see the 4 columns of information that were plotted. Specifically: ARMA43 contains the realization of length 200, TRUE_AUTOCORR contains true autocorrelations for lags 0 through 249, TRUE_SPECTRUM contains the true ARMA(4,3) spectral density calculated at 251 values from $f=0$ to $f=.5$. Finally, SAMPLE_AUTOCORR contains sample autocorrelations.
- k) Using the File menu this data set can be saved by selecting Save as ... and giving the data sheet a name (default is a .SDA file – the primary file mode for GW-WINKS). You can also save the data in an Excel file (.XLS) or a .CSV file. This will be discussed further in Tutorial 5.

Step 3B: Generating realizations using the factor coefficients. In this step we will generate realizations from the same ARMA(4,3) model used in Step 3A but this time we will enter the coefficients of the factors. We assume that Steps 1 and 2 have been run and that a dialog box such as the one shown in Step 2 is visible.

- a) Select ARMA under Generate a Realization section at the top of the entry box (ARMA is the default).
- b) Select Enter operators by factors in the Time Series Generating Routine section.

- c) Enter 4 for P, 3 for Q, and 0 for Mean
- d) Underneath the Enter P= and Enter Q= boxes are entry boxes for entering the number of factors. In this step we will use the factored form of the model, which from Example 3.15 is

$$(1 - 1.8B + .95B^2)(1 + 1.5B + .85B^2)X_t = (1 + .9B)(1 + .8B^2)a_t.$$

In the No. Factors box below Enter P=, type 2. Similarly, type 2 in the No. Factors box underneath Enter Q= since both the 4th order AR component and the 3rd order MA component of the model are factored into 2 factors.

- e) There are two rows of entry boxes under the heading Enter parameters for AR factors (separate with commas). In the first box enter 1.8,-.95 (don't forget the comma) and in the second box enter -1.5,-.85. Also in the two rows of entry boxes under the heading Enter parameters for MA factors(,), enter -.9 and in the first box and in the second box enter 0,-.8 (the coefficient on B is zero).

All other data entry is the same as in Step 3A (beginning with e). That is, procedures for entering the mean and white noise variance, selecting a sample size, seed, etc. are the same as in Step 3A.

Step 4: After a realization has been generated (by either Step 3A or 3B for entering the model), the model parameters are remembered by GW-WINKS. The following steps could be used for viewing several realizations from a given model (this can be useful to students and researchers to understand the behavior that changes from realization to realization vs. the behavior that stays the same).

- a) Select Data View at the top of the Output Viewer
- b) Select Time Series Analysis and then Generate Realization
- b) GW-WINKS will ask "Erase all data current in the data editor?" Select Ok and you will see the Generate a Realization dialog box containing the model information you entered in Step 3A or 3B. (Note: If you want to retain the data from the previous realization you should save it to a file by using Save as ... under the File menu before generating another realization.)
- c) On the Generate a Realization dialog box select Create. Note: As long as the SEED is a positive integer, it need not be changed from realization to realization.
- d) On the menu at the top of the Output Viewer select Graph and then Display Graph. You will see a plot similar to the one shown for the first realization. The true autocorrelations and spectral density (upper right and lower left plots) are based on model parameters and will be the same for any realization from this particular model. The realization (upper left plot) and sample autocorrelations (lower right plot) will be different from realization to realization.
- e) Select Return to go back to the Output Viewer and then select Data View to return to the Data Editor.

Step 4 a) through e) can be repeated as many times as desired.

Tutorial 3 – Using GW-WINKS Graphics (also using the Attributes Tab)

It is important to understand that GW-WINKS recognizes certain variable names and sets the data characteristics accordingly. The following is a list of variable naming conventions:

<u>Variable Name Contains</u>	<u>Variable Type Assumed</u>
AUTOCORR	Autocorrelations
SPECTRUM	Spectral plot
BARTLETT	Spectral plot
TUKEY	Spectral plot
PARZEN	Spectral plot
PERIODOGRAM	Spectral plot (using vertical bars)
All other names	Time series realization

The windowed spectral estimators (Bartlett, Tukey, and Parzen) as well as true and estimated ARMA(p,q) spectral densities are evaluated at 251 values between $f = 0$ and $f = .5$. Thus, when plotting a variable whose name indicates that it is one of these types of variables, GW-WINKS assumes that the horizontal axis is frequency and is scaled between 0 and .5. GW-WINKS evaluates the periodogram at $f_j = j/n$, $j = 1, \dots, n/2$ if n is even and at $f_j = j/n$, $j = 1, \dots, m$ where $n = 2m + 1$ if n is odd.

In this tutorial we illustrate some of the more advanced capabilities of GW-WINKS graphics.

Step 1: Open the TUTORIAL3.SDA data set

- a) Select Open Data Set from the File menu at the top left of the screen.
- b) By default the WINKS SDA 6 subdirectory will be shown.
- c) Enter TUTORIAL3.SDA in the Filename entry box and click Open. (You may also select TUTORIAL3.SDA from the list of .SDA files in the subdirectory.)

Step 2: This data set has data on 4 variables named VAR1, VAR2, VAR3, and VAR4. These variables contain the following information:

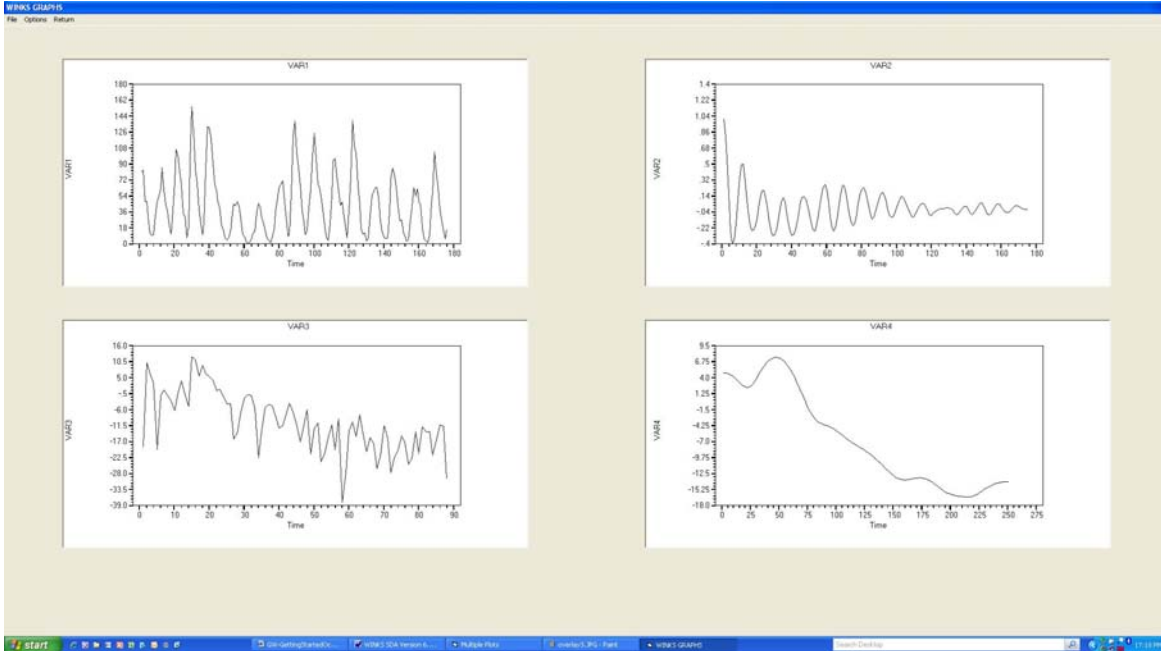
- VAR1: sunspot data used in Tutorial 1
- VAR2: sample autocorrelations for VAR1
- VAR3: Periodogram of VAR1
- VAR4: Parzen spectral density estimator for VAR1 (M=26)

Step 3: Plot the data

- a) Select the Graphs/Charts menu
- b) On this menu select Line/Time Series Plots
- c) On the resulting menu select Line plots one or multiple
- d) Select all 4 of the variables, click Add, and then Ok.
- e) You will see the 4 selected plots.

Note: The names VAR1-VAR4 provided GW-WINKS with no information concerning variable types. Consequently, all variables were plotted simply as time series realizations. Note that the horizontal axis is Time in each of these plots and the axis limits are from 1 to the number of data values in the Data Editor for that variable. In order to plot these variables correctly, we will use the Attributes tab.

Step 4: Select Return at the top left of the graphics screen to return to the Data Editor. At the bottom of the data window, note that there are two tabs: Data and Attributes. You can toggle



back and forth between these two settings by clicking on the tabs. In this tutorial we will show how to use the Attributes mode to change variable names and characteristics.

Step 5: Select the Attributes tab. The following will be shown on the screen.

WINKS SDA Version 7.0.3 C:\Program Files (x86)\TexaSoft\WINKS7\TUTORIAL3.SDA

File Edit Time Series Analysis Analyze Graphs/Charts Tools Window Help

Output Viewer How to Get Started (web/pdf) N= 251

	Name	Type	Width	Decimals	Missing	Label	Formats
1	VAR1	N (Number)	7	2			
2	VAR2	N (Number)	10	5	-9999		
3	VAR3	N (Number)	10	5	-9999		
4	VAR4	N (Number)	10	5	-9999		
5							
6							
7							
8							
9							
10							
11							
12							

Step 6: The Attributes view of the data shows variable names, variable types, and other information. In this tutorial we will edit the variable names.

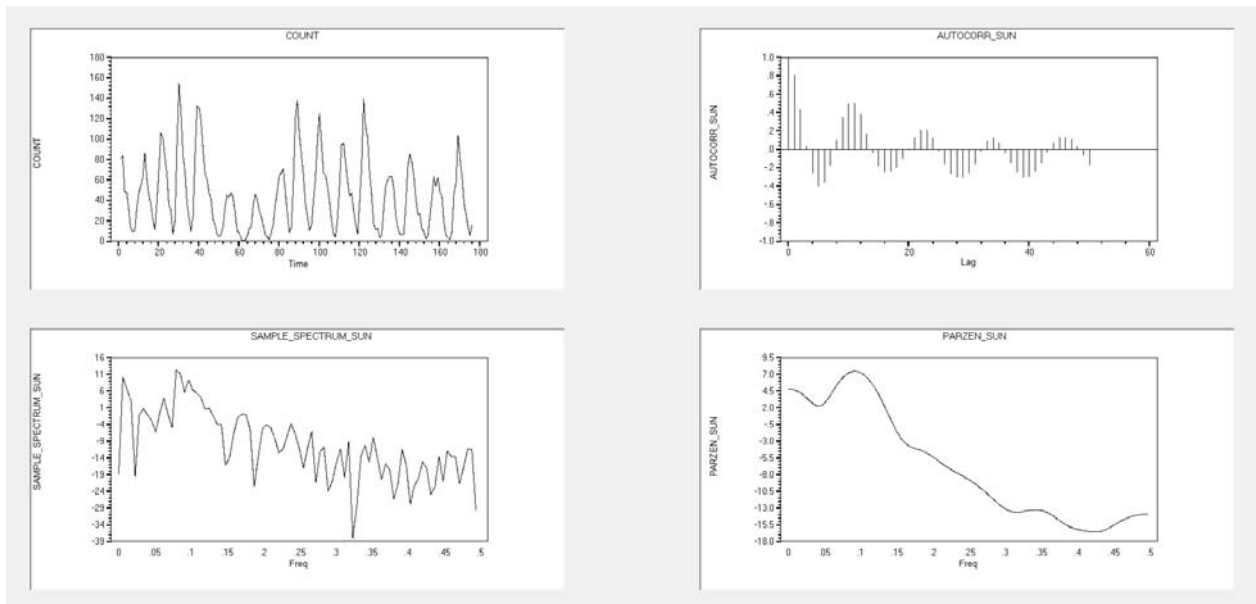
- a) Change VAR1 to COUNT by double clicking on the cell containing VAR1, using the backspace key to clear the cell, and then typing COUNT.
- b) Using the technique in a)
 - i) Change VAR2 to AUTOCORR_SUN
 - ii) Change VAR3 to SAMPLE_SPECTRUM_SUN
 - iii) Change VAR4 to PARZEN_SUN
- c) Return to the Data Editor by clicking on the Data tab at the bottom left.

Note: You can change characteristics of the variables such as width and number of decimals. These variables are all numeric. Variables can also be identified as Character and Date variables. Note that GW-WINKS automatically sets -9999 as the missing value for any calculated variable.

Step 7: Plot the data as in Tutorial 3, Step 3

- a) Select the Graphs/Charts menu
- b) On this menu select Line/Time Series Plots
- c) On the resulting menu select Line plots one or multiple
- d) Select all 4 of the variables, select Add, and then Ok.

The 4 plots should look like the following.

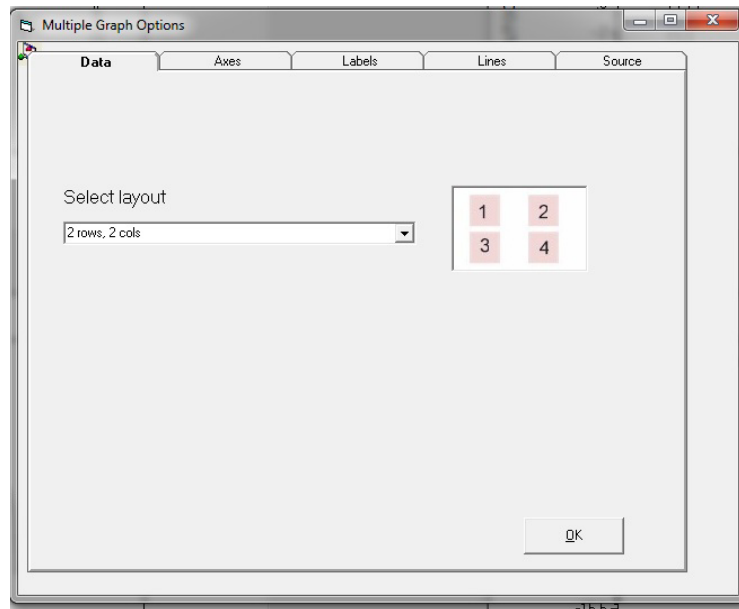


Note that this time the variables are automatically plotted appropriately, i.e. GW-WINKS recognizes AUTOCORR_SUN as autocorrelations and SAMPLE_SPECTRUM_SUN and PARZEN_SUN as spectral plots.

In the following, we will illustrate some of the graphics editing features.

Step 8: Editing plots using the Multiple Graph Options dialog box

a) Right click anywhere on the plot obtained in step 7 to display the Multiple Graph Options dialog box shown here.



Notice the tabs at the top of this dialog box (Data, Axes, Labels, Lines, and Source). By default the Multiple Graph Options box comes up under the Data/Ok tab. Selecting a tab displays plot options for that topic.

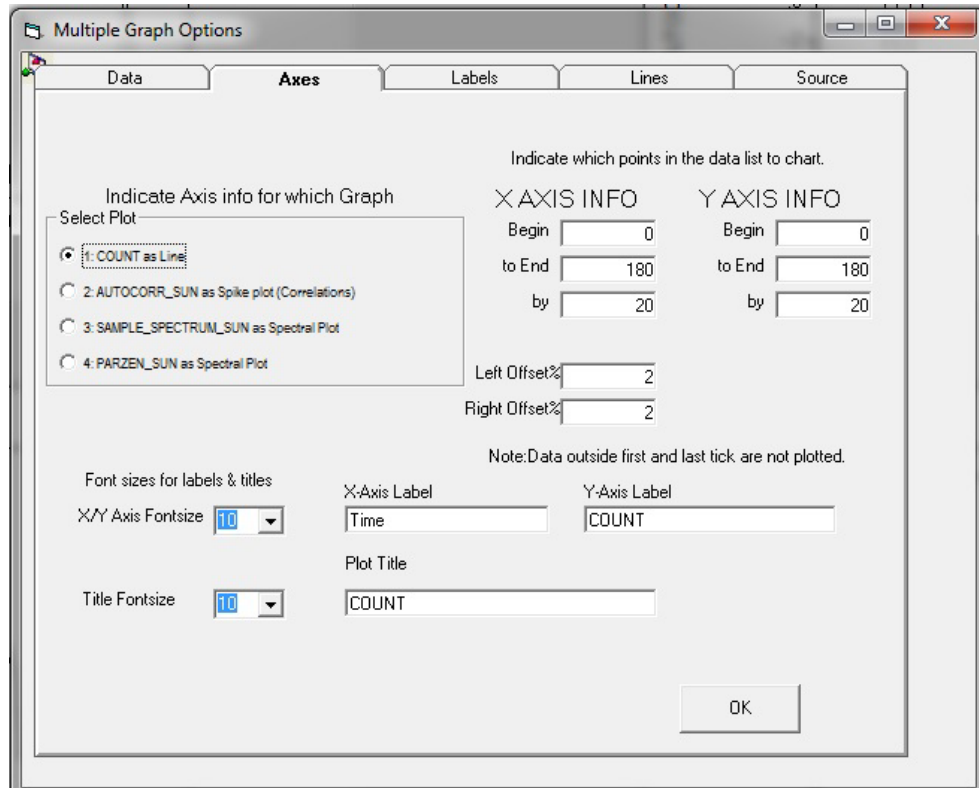
Step 9: Using the Data Tab

This tab controls the selection of plots shown. Note that there are up to 4 Data Source options. The plots are displayed in the order you selected them from the Multiple Plots dialog box.

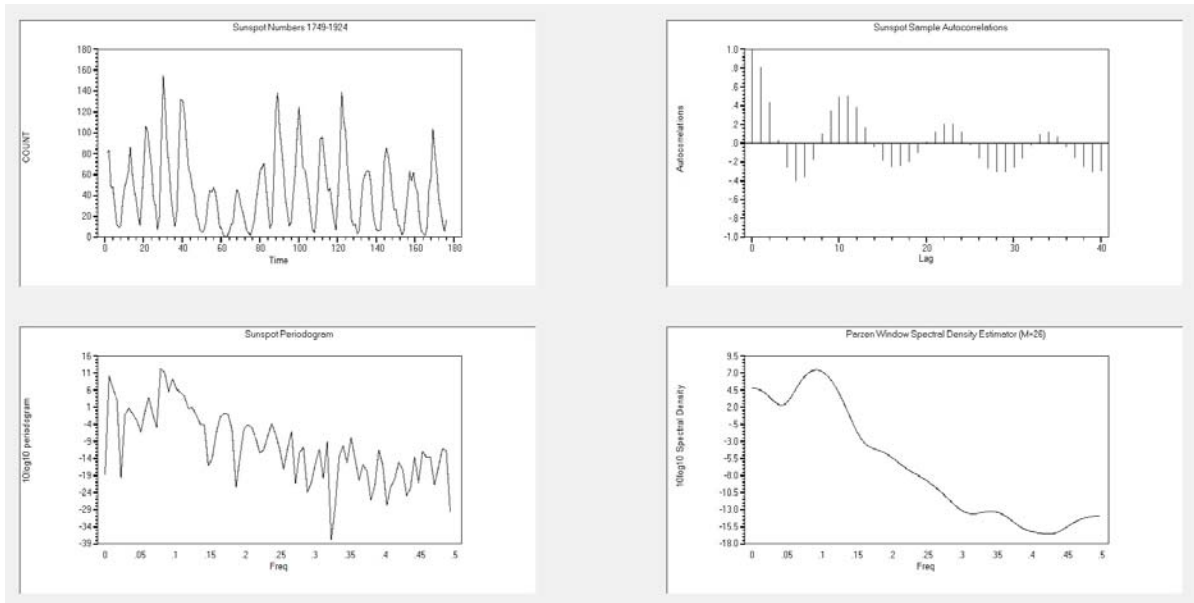
- To plot only the COUNT and AUTOCORR columns, choose 2 rows and 1 column on the Select layout dialog box.
- Select Ok and the plots will be displayed (not shown here).
- For the remainder of this tutorial we will use the 2 rows, 2 cols layout, so select the 2 rows, 2 cols option to continue.

Step 10: Using the Axes Tab. The Axes tab allows you to specify ranges for the x and y axes for each plot.

- Right click on the plots to return to the Multiple Plots dialog box
- Select the Axes tab and the following dialog box is shown.

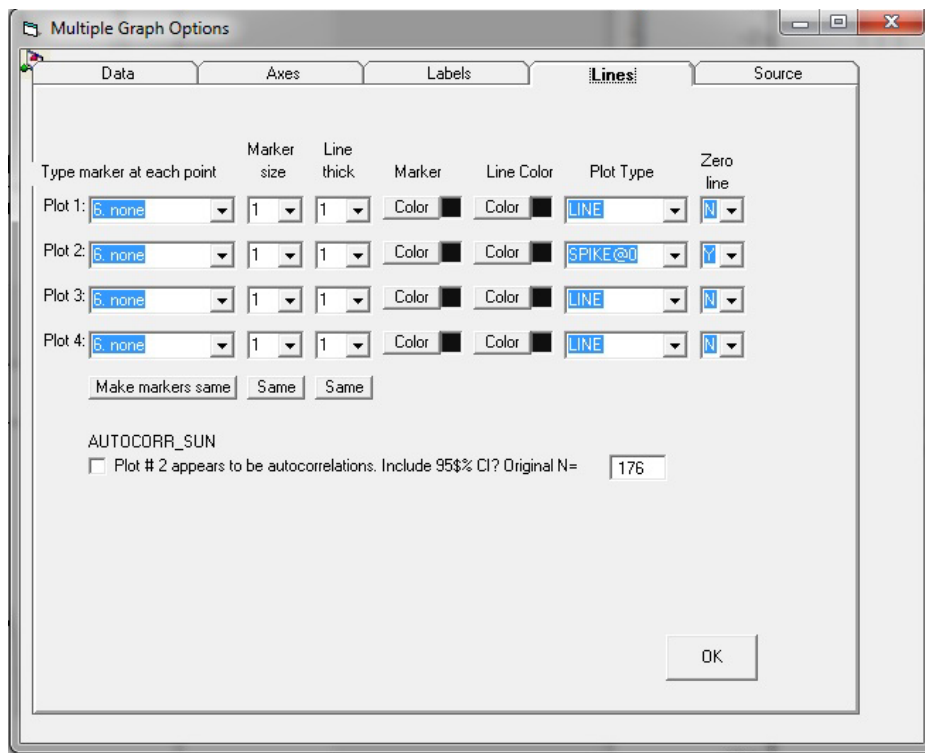


- c) COUNT: These are counts of sunspot numbers. The plot title is COUNT. A better title would be Sunspot Numbers (1749-1924). Make this change in the Plot Title box.
- d) AUTOCORR_SUN: These are autocorrelations that go from lag 0 to lag 175.
 - i) Click on the open circle to the left of AUTOCORR_SUN
 - ii) Change the X AXIS INFO to End at 40
 - iii) Change the by from 20 to 10 for labeling purposes.
 - iv) Change the Y AXIS INFO to begin at -1 and end at 1
 - v) Change the Y Axis Label to Autocorrelations
 - vi) Change the Plot Title to Sunspot Sample Autocorrelations
- e) SAMPLE_SPECTRUM_SUN: This variable contains the periodogram. Since the phrase “SPECTRUM” is in the name, the plot is a spectral plot (i.e. the X-axis is frequency.
 - i) Click on the open circle to the left of SAMPLE_SPECTRUM_SUN
 - ii) Change the Y-Axis Label to $10\log_{10}$ Periodogram
 - iii) Change the Plot Title to Sunspot Periodogram
- f) PARZEN_SUN:
 - i) Click on the open circle to the left of PARZEN_SUN
 - ii) Change the Y-Axis Label to $10\log_{10}$ Spectral Density
 - iii) Change the Plot Title to Parzen Window Spectral Density Estimator (M=26)
- g) Click Ok at the bottom right and the following plot will be displayed.

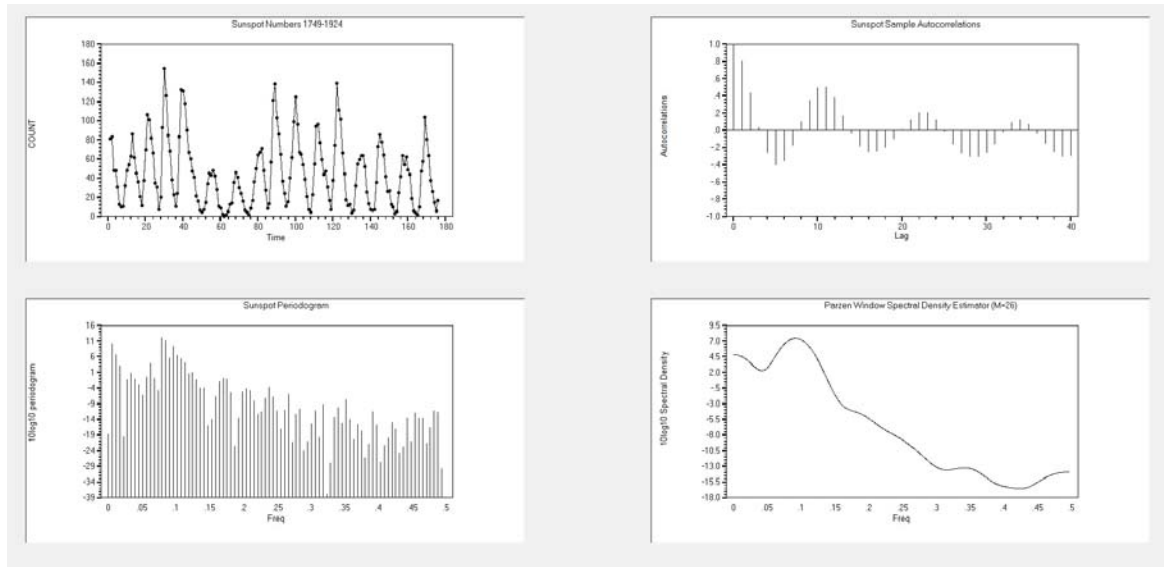


Step 11: Using the Lines tab

- a) Right click anywhere on the graph
- b) Select the Lines tab on the Multiple Graph Options dialog box and you will see the following



- c) Plot 1: In order to display the actual 176 plotted values, select “1. Closed circle” under the heading Type marker at each point leaving all other selections at defaults.
- d) Plot 3: To plot the periodogram using the common format of spikes, select Spike@Min in the Plot Type box.
- e) Select Ok at the bottom of the box and the following will be displayed.



Note: The periodogram plot as it appears below could also have been obtained by naming the variable PERIODOGRAM_SUN or any other name that includes “PERIODOGRAM” as part of the name. The use of the name SAMPLE_SPECTRUM_SUN was used here to illustrate the procedure for changing the plot type.

- f) Return to the Data Editor by selecting Return at the upper left of the graphics screen.

Step 12: In this step we will show how to place the 95% limit lines on sample autocorrelations. We will fit the same AR(8) model based on ML estimates of the sunspot data that we obtained in Tutorial 1. (The variable COUNT in the current file (TUTORIAL3.SDA) is the same as the variable COUNT in SUN.SDA used in Tutorial 1.)

- a) On the Time Series Analysis menu select Estimate Parameters
- b) Select COUNT as the variable to be analyzed and click Ok
- c) Enter 8 in the P= text box, select MLE and click Calculate.
- d) Click on the Data View menu option to return to the Data Editor to observe that 3 columns have been added to the sheet: ARMA_SPECTRUM, ARMA_AUTOCORR, and RESIDUALS.

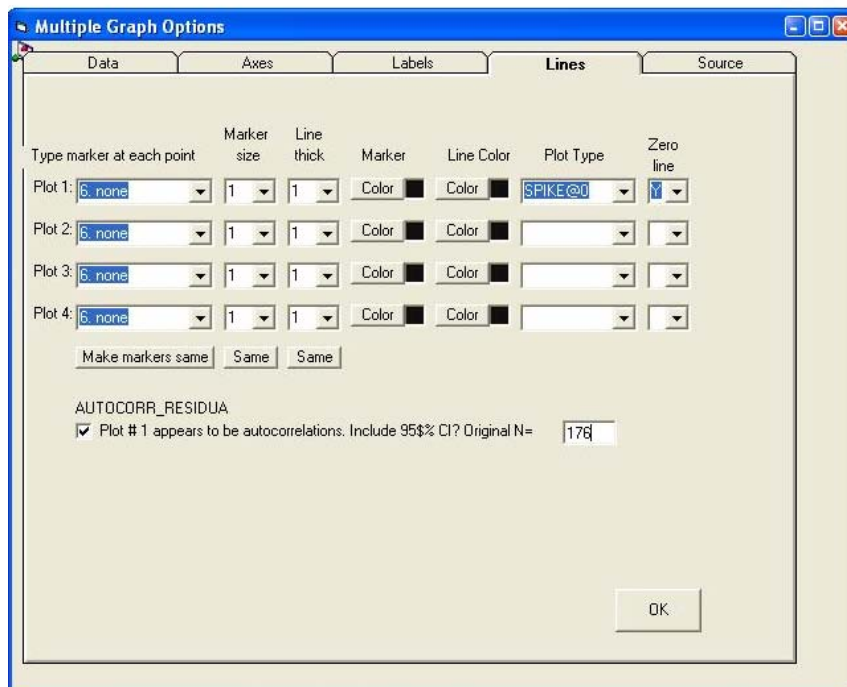
The variable RESIDUALS contains the residuals from the fitted model.

- e) Compute the sample autocorrelations for the RESIDUALS variable by clicking on Time Series Analysis menu and selecting Sample Autocorrelations. Then select RESIDUALS as the variable for which sample autocorrelations will be calculated. The sample autocorrelations will be stored in a data editor column with a variable name AUTOCORR_RESIDUA.

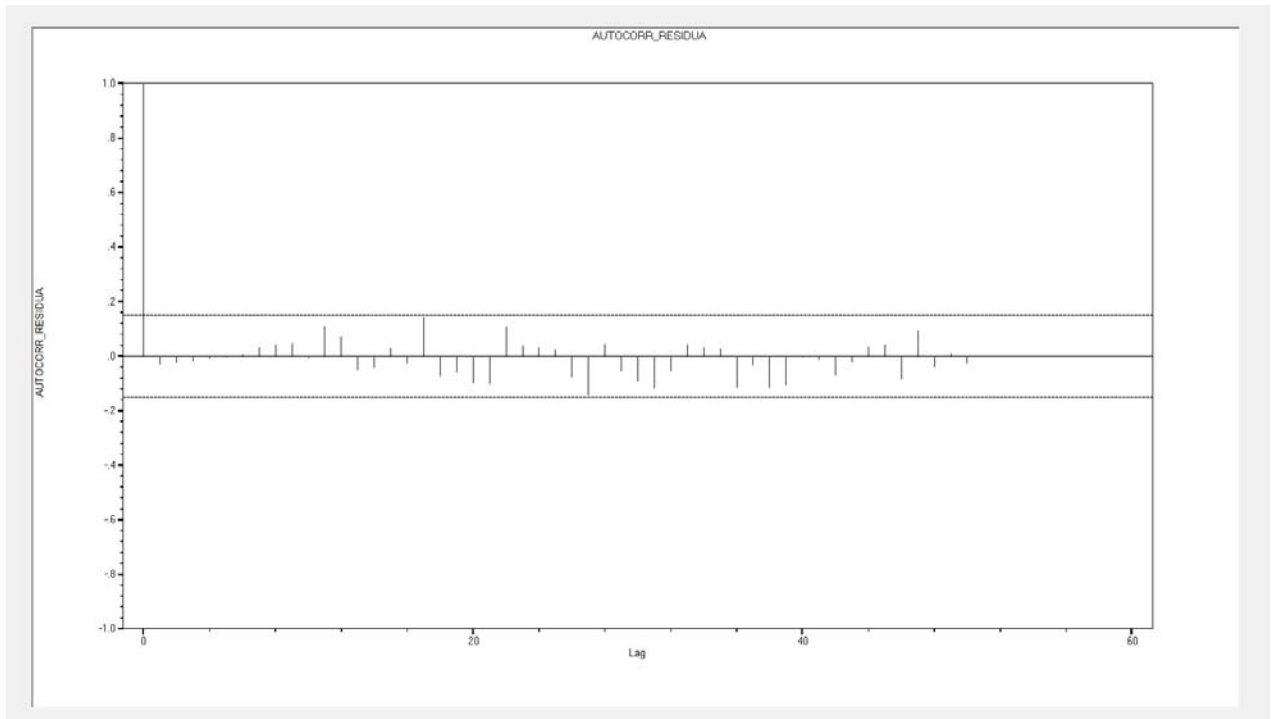
- f) To plot the sample autocorrelations of the residuals, select the Graphs/Charts menu
- g) On this menu select Line/Time Series Plots
- h) On the resulting menu select Line plots one or multiple
- i) Select the variable AUTOCORR_RESIDUA, click Add, and then Ok. You will see the sample autocorrelations that were plotted at the end of tutorial 1.
- j) Right click anywhere on the plot to display the Multiple Graph Options dialog box. Select the Lines Tab. At the bottom of the dialog box is the following:

AUTOCORR_RESIDUA Plot#1 appears to be autocorrelations. Plot 95% CI? Original N= 176

- k) Click on the left entry box and enter 176 for N. The multiple graph dialog box should look like the following after your entries:



- l) Click Ok and the following plot should appear



Note: When you right click on a plot and select the Lines Tab on the Multiple Graph Options dialog box, then you will see a comment such

Plot#1 appears to be autocorrelations. Plot 95% CI? Original N=

for any plotted variable that contains AUTOCORR somewhere in the name. However, the plotting program does not distinguish between sample autocorrelations and true autocorrelations. When true autocorrelations are plotted, these limit lines are meaningless and should not be plotted. For example, in Tutorial 2, Step 3A, part (h) we show a plot that has true autocorrelations in the upper right and sample autocorrelations in the lower right plots. Right clicking on the plot and selecting the Lines Tab in the Multiple Graph Options dialog box will result in the selection options

- TRUE_AUTOCORR Plot#2 appears to be autocorrelations. Plot 95% CI? Original N= 200
- SAMPLE_AUTOCORR Plot#4 appears to be autocorrelations. Plot 95% CI? Original N= 200

Since Plot #2 (upper right) shows true autocorrelations, the (sample based) limit lines make no sense and should not be plotted. The “Original N=200” for Plot #2 indicates that 200 true autocorrelations were calculated, i.e. there are 200 values in the TRUE_AUTOCORR column. Of course, the sample autocorrelations in Plot#4 will exceed the 95% limit lines for most lags indicating (the obvious fact) that the data are not white noise.

Tutorial 4 – Factor Tables

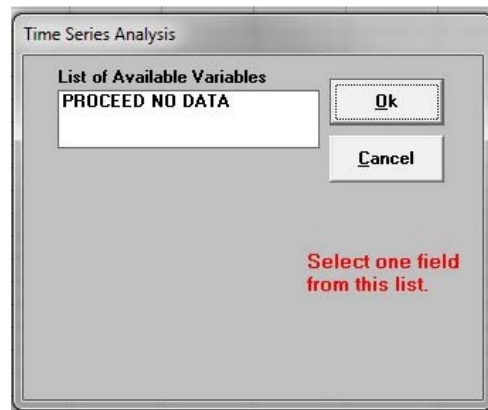
One of the key tools discussed in *ATSA* for studying ARMA models is the factor table. This tutorial goes through the steps for using GW-WINKS to calculate factor tables. GW-WINKS allows you to (a) enter the coefficients of a model manually in order to find the factors and (b) find the factors of an estimated AR model fit to the data.

Step 1: Entering coefficients manually

- a) On the Time Series Analysis menu select Factoring Routines

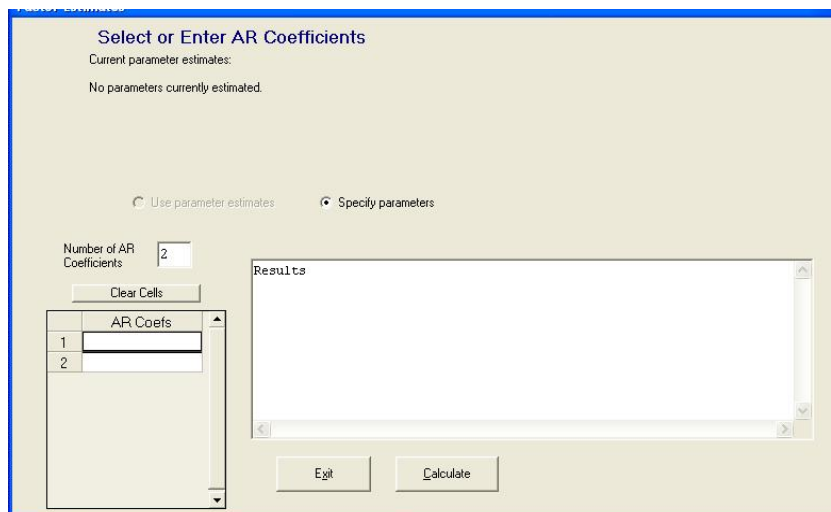
Note: This routine allows a “No Data” mode so it does not matter whether any data are currently in the Data Editor.

- b) If the Data Editor contains no data, then you will see a dialog box such as

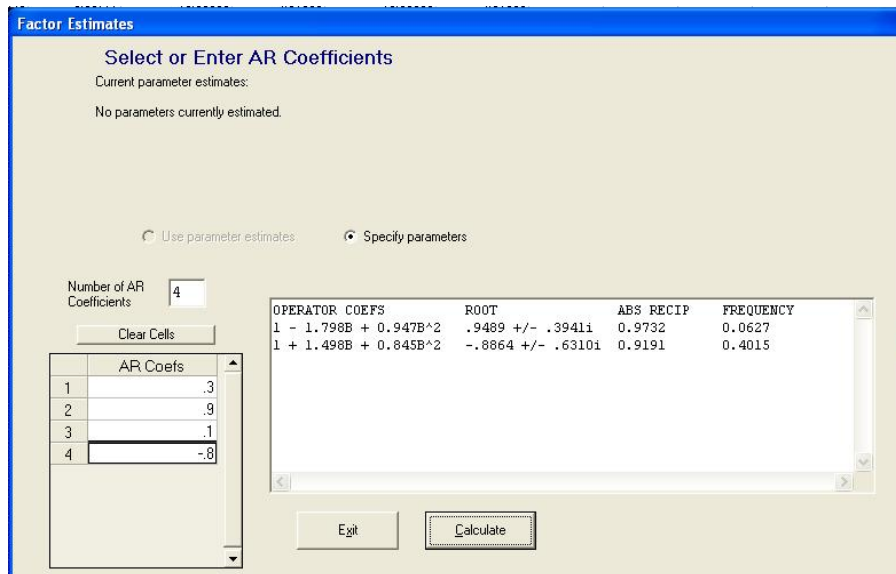


If the Data Editor contains data, the variable names will appear in the dialog box above PROCEED NO DATA.

- c) In either case (if the Data Editor contains data or not) select PROCEED NO DATA and Ok. You will see the following data entry screen.



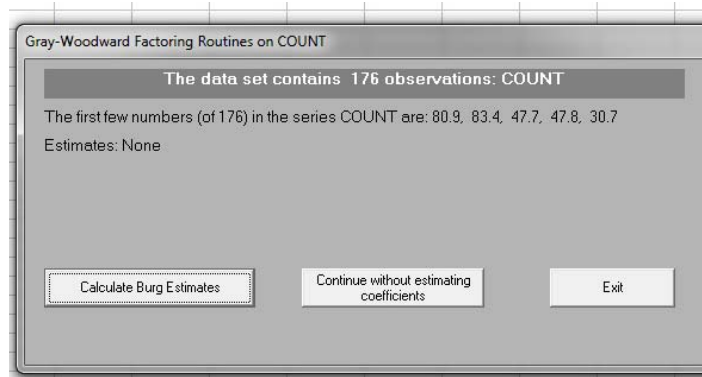
- d) Enter 4 as the Number of AR Coefficients, and then enter: .3, .9, .1, and -.8 in the 4 entry boxes.
- e) Select Calculate and you will see the following screen which shows the factor table that was previously given in Table 3.6 of the *ATSA* text. It can also be seen that the factors $1 - 1.8B + .95B^2$ and $1 + 1.5B + .85B^2$ (after rounding) are the ones used in Tutorial 2.



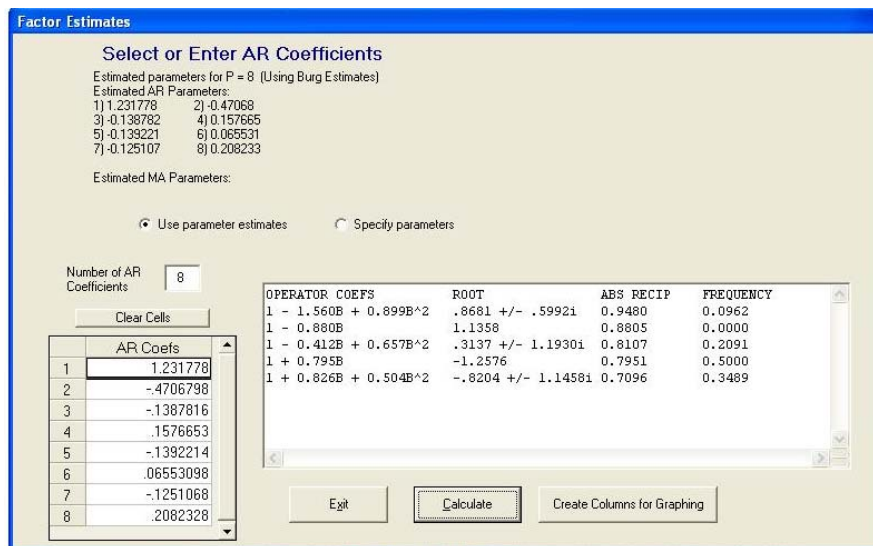
- f) Selecting Exit takes you to the Output Viewer and selecting Data View returns you to the Data Editor.

Step 2: Finding Factor Tables for an estimated model (assuming that TUTORIAL3.SDA is in the Data Editor)

- a) Open the SUN.SDA data set
 - i) Select Open Data Set from the File menu at the top left of the screen.
 - ii) By default the WINKS SDA 6 subdirectory will be shown.
 - iii) Enter SUN.SDA in the Filename entry box and click Open.
- b) On the Time Series Analysis menu select Factoring Routines
- c) You will see the dialog box similar to the one shown in part (b) of Step 1 of this tutorial except that COUNT now shows in the list of available variables. This time select COUNT and Ok. You will see the following:



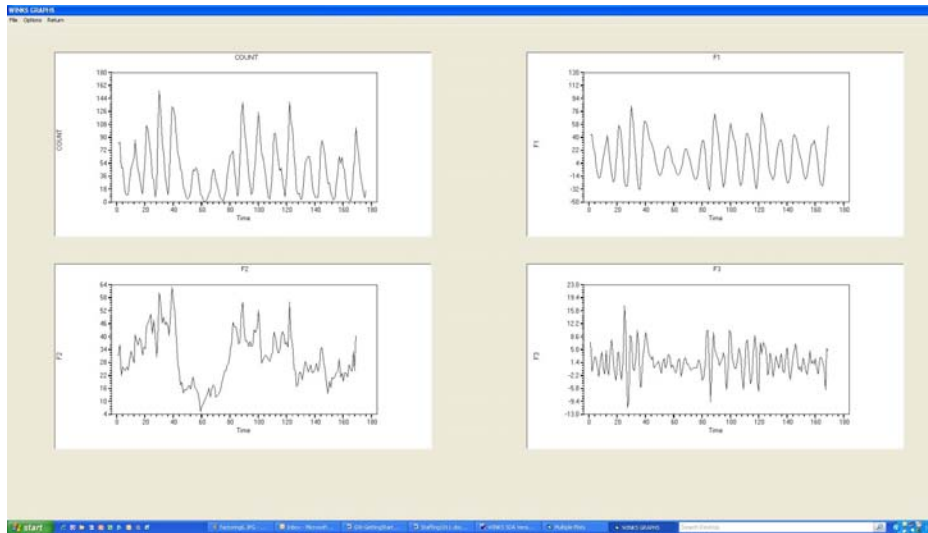
- c) Select Calculate Burg Estimates, enter 8 when you are asked for the model order, and click Ok.
- d) You will see a screen with the 8 AR coefficients. These are the Burg estimates for an AR(8) fit to the sunspot data. Select Calculate to obtain the corresponding factor table displayed here.



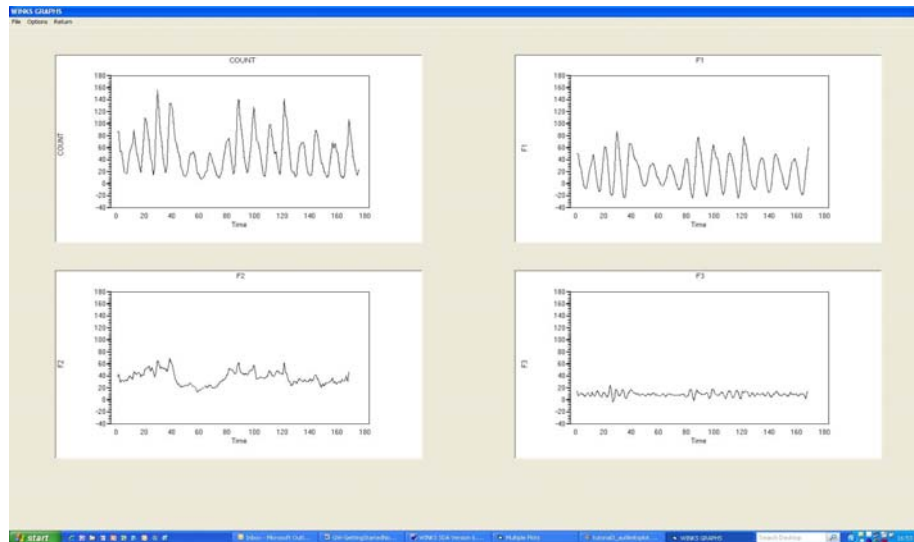
Note that as expected the factor with roots closest to the unit circle is associated with a frequency of about $f = .1$.

- e) Select Create Additive Components at the bottom right o calculate the additive components associated with the fitted model. (See Section 3.4 of *ATSA*)
- f) Select Data View and in the Data Editor and you will see that 5 new variables (F1 – F5) have been created. Variable Fk is the additive component associated with the kth row of the factor table.
- g) To plot VAR1 (the sunspot data) along with the first 3 additive components (F1 – F3)
 - i) Select the Graphs/Charts menu
 - ii) On this menu select Line/Time Series Plots
 - iii) On the resulting menu select Line plots one or multiple
 - iv) Select VAR1, F1, F2, and F3 and click Ok.

You will see the following plots.



- h) In order to plot all components on the same vertical scale
- i) Right click anywhere on the plot
 - ii) Select the Axes tab on the Multiple Graphs Options dialog box
 - iii) For each of the variables, click the Select Plot button, and set the Y-Axis limits to begin at -50 and to end at 180 and to increment by 20.
 - v) Select Ok and you will see the plots



In these plots it can be seen that the first component (F1) describes the cyclic behavior and that the second component (F2) seems to model the variability in peak heights. The third component (F3) seems to model a weak high frequency behavior.

- i) Select Return at the top left of the Graph sheet to return to the Data Editor.

Tutorial 5: Preparing Data for GW-WINKS

The native file format for GW- WINKS is an .SDA file. GW- WINKS can also read .DBF, Excel (.XLS) and text files (.CVS, .TXT, .DAT etc.).

Time series data are recorded as a series of data values. In GW- WINKS (as in most statistical software) the data are recorded as one observation per record. This tutorial discusses several ways to enter data into GW-WINKS .

Importing Data from a Text File (.txt, .csv, .dat)

Consider the text file AIRLOG.TXT file which is shown here as it would look in Microsoft Notepad.

```

airlog.txt - Notepad
File Edit Format View Help
LOGPASS
4.7185
4.7707
4.8828
4.8598
4.7958
4.9053
4.9972
4.9972
4.9127
4.7791
4.6444
4.7707
4.7449
4.8363
4.9488
4.9053
4.8283
5.0039
5.1358
5.1358
5.0626
4.8903

```

Observe that the first row of the data set contains the name LOGPASS followed by the values of the series. This data set contains the natural logarithms of the classical airline passenger data (monthly data for 12 years). To open this data set in GW-WINKS

- a) Select Open Data Set from the File menu at the top left of the GW-WINKS screen.
- b) By default the WINKS SDA subdirectory will be shown.
- c) Enter AIRLOG.TXT in the Filename entry box and click Open
(Alternatively, in the Files of type entry box you can choose .csv, .dat, .txt Text files (Comma separated), then select AIRLOG.TXT from the list of, and click Open.)
- d) You will be asked if the first row in the file AIRLOG.TXT contains the variable name. Since the first row contains the name LOGPASS select Yes and click Ok

The data are now opened in GW- WINKS. Note that the name LOGPASS is the variable name used by GW-WINKS. Inserting the variable name as the first value in a .txt file is optional. If the data in AIRLOG.TXT simply began with the first data value (i.e. 4.7185) in line 1 (instead of LOGPASS), then by default GW-WINKS would assign the variable name VAR1.

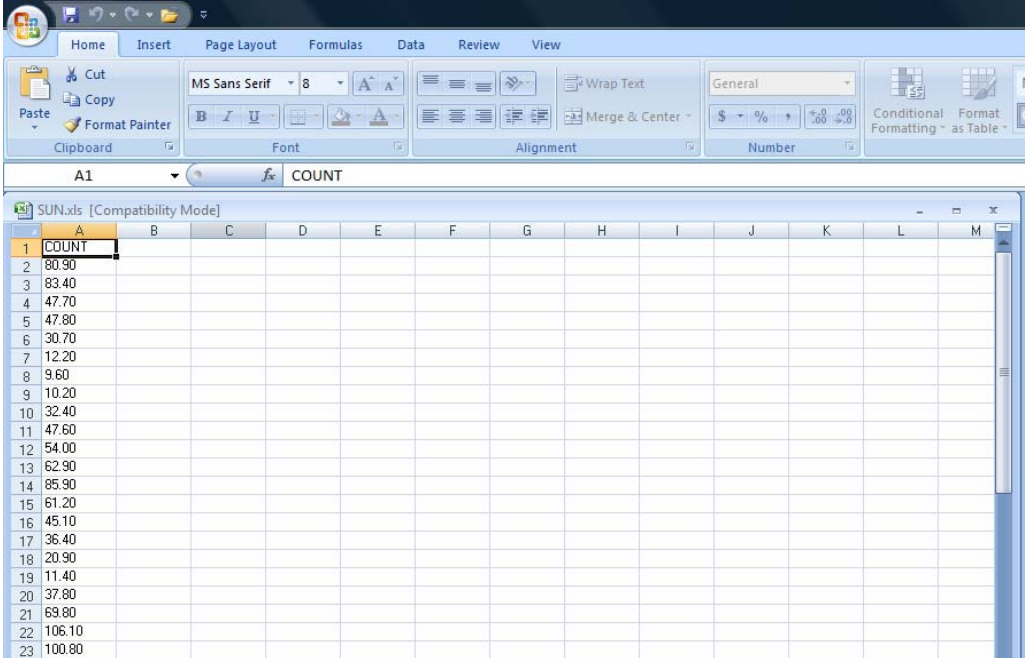
We recommend that you do the following to save the data file in the native .SDA format:

- a) Select Save as... from the File menu.
- b) Enter the name AIRLOG.SDA in the Filename entry box
- c) Click Save

To change attributes of variables such as variable type (number, character), number of decimal places, and missing values, click on the Attributes tab at the bottom of the GW- WINKS Data Editor window. The use of this feature is more fully described in Tutorial 3 and WINKS Help.

Importing Data from an Excel File

GW- WINKS can also import data from Microsoft Excel files. The data to be imported must be in an acceptable format. For example, the file SUN.XLS contains annual sunspot numbers from 1749 to 1924 (the same data as in SUN.SDA that was used earlier). The first part of that Excel file is shown here.



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	COUNT												
2	80.90												
3	83.40												
4	47.70												
5	47.80												
6	30.70												
7	12.20												
8	9.60												
9	10.20												
10	32.40												
11	47.60												
12	54.00												
13	62.90												
14	85.90												
15	61.20												
16	45.10												
17	36.40												
18	20.90												
19	11.40												
20	37.80												
21	69.00												
22	106.10												
23	100.80												

Observe that the variable name (COUNT) is in the first row of the Excel data file (again - optional) followed by the values of the series.

To open this data set in GW-WINKS,

- a) Select Open Data Set from the File menu at the top left of the GW-WINKS screen.
- b) By default the WINKS SDA subdirectory will be shown.

- c) Enter SUN.XLS in the Filename entry box and click Open
(Alternatively, in the Files of type entry box you can choose .xls Excel 97 or newer, then select SUN.XLS from the list of .xls files and click Open.)
- d) At this point GW-WINKS shows a dialog box asking which sheet in the Excel file to open since Excel files can contain more than one worksheet). In this case the only worksheet is shown as 1) Data . Click Import.
- e) You will be asked if the first row contains the variable name. Since the first row in SUN.XLS contains the name COUNT select Yes. You will see the GW-WINKS Data Editor screen that looks like

The screenshot shows the GW-WINKS Data Editor window. The title bar reads 'WINKS SDA Version 6.0.92 C:\Program Files\TetraSoft\WINKS SDA 6\SUN.xls'. The menu bar includes File, Edit, Time Series Analysis, Analyze, Graphs/Charts, Tools, Window, and Help. The toolbar contains icons for file operations and analysis. The spreadsheet has a single column labeled 'COUNT' with values ranging from 80.90 to 102.10. The first row is highlighted, and the value 80.90 is selected.

	COUNT	%var	%var	%var	%var	%var	%var	%var	%var	%var
1	80.90									
2	83.40									
3	47.70									
4	47.80									
5	30.70									
6	12.20									
7	9.60									
8	10.20									
9	32.40									
10	47.60									
11	54.00									
12	62.90									
13	85.90									
14	61.20									
15	45.10									
16	36.40									
17	20.90									
18	11.40									
19	37.80									
20	69.80									
21	102.10									

Note: GW- WINKS can read Excel files from version 97 to 2003. If you are using Excel 2007 or 2010, go to Excel and save the data (Save As) in the older .XLS version (rather than .XLSX) before opening the data file in GW- WINKS. (You could also simply copy the data in your Excel file and paste them into the GW- WINKS Data Editor, then save the file in the GW- WINKS.SDA format.)

More information

GW-WINKS has other features such as forecasting that are not described in these tutorials. In the *ATSA* text, short discussions in paragraphs headed by **Using GW-WINKS** are given throughout the book that discuss how to use GW-WINKS to perform analyses.

To display the WINKS Users Guide, in the GW-WINKS main Data Editor page, click on Help/ Help on the Web/Internet, and from the displayed web page, click on

[WINKS SDA 7 Manual](#)

To see a Getting Started Guide for the full WINKS (non-time series) software, go to

<http://www.texasoft.com>

and click on Getting Started Guide, Version 7.