

APPLICATION NOTE

EdiRe Software for Micrometeorological Applications



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WHEN MEASUREMENTS MATTER

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EdiRe Software for Micrometeorological Applications

EdiRe is flexible software that can quickly provide various types of data analysis. This application note introduces some of the more commonly used processing and analysis features of EdiRe software. These features include creating processing and format lists, computing covariance and flux, filtering data, and performing other statistics. The application note is not intended to be a comprehensive manual for EdiRe. It provides a basic understanding of this powerful software, which can be used as a springboard for performing the more complicated processing and analysis required to meet your specific research and analysis needs.



Online and offline help is available to help users take full advantage of EdiRe. Please refer to the Getting Help for EdiRe section for more information.

Introduction

EdiRe is a software tool for micrometeorological applications written by the University of Edinburgh. It is a user-friendly tool for analyzing data from the eddy covariance and other micrometeorological measurements. For data processing and analysis, customers can input directly into the EdiRe a raw, binary file containing data collected from a Campbell Scientific datalogger.

Acquiring EdiRe

EdiRe was written for the Windows environment. Customers can download, at no charge, a copy of EdiRe at:

<http://www.geos.ed.ac.uk/abs/research/micromet/EdiRe/>

Click on the Downloads link either from the “Section Contents” column on the left or from the main window on the right. This will take you to the EdiRe software's downloads page. To process data collected from Campbell Scientific dataloggers, you will only need to download the *EdiRe installation file*. The EdiRe executable and EdiRe help files are for upgrading EdiRe software that was previously installed. The EdiView and RawPeak utilities are for non-Campbell Scientific datalogger users. After downloading the EdiRe installation file, unzip the EdiRe installation zip file, and execute the setup.exe to install EdiRe to your PC.

Preparing Campbell Scientific Data for EdiRE

Campbell Scientific's table-based dataloggers, such as CR800, CR1000, CR3000, and CR5000 store data in TOB3 format (table-oriented-binary 3). However, EdiRe processes data in the TOB1 file format only. Therefore, the time series data collected from these dataloggers must be converted from TOB3 to TOB1 before EdiRe can process it.



Additional information on data retrieval using LoggerNet and PC/CF card, as well as file management using Baler can be found from Section 4 of the OPEC manual.

Analyzing Your Data

The following example computes covariances between vertical wind (U_z) and sonic temperature (T_s) from the CSAT3 sonic anemometer, as well as carbon dioxide (CO_2) and water vapor (H_2O) measurements from the LI-7500 irga.

Creating a Processing List and Format List

Follow the steps below to create a processing list and format list.

1. Open EdiRe, and go to Processing → Interpreter (see Figure 1).

2. This will bring up a dialog box (see Figure 2).

3. Check both the “Create raw file format list” and “Create basic processing list” boxes (see Figure 2).

4. Click on the pull-down menu for “Raw data file type”, and select Campbell Scientific (see Figure 2).

5. Click on the browse button for “Sample file”, and select the TOB1 file you wish to analyze (see Figure 2).

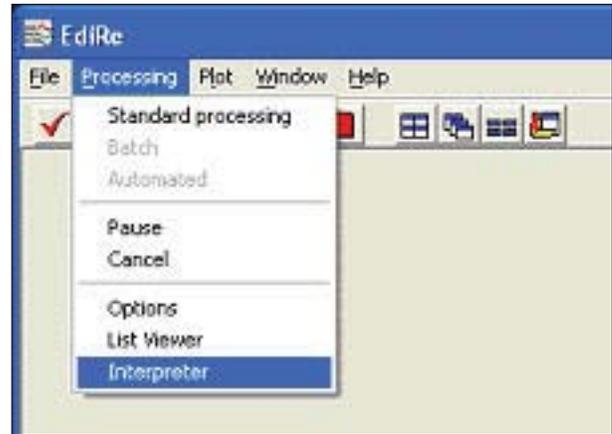


Figure 1: Select Interpreter from the Processing menu.

6. Click on the browse button for “Format list file name”, and select the name and path for the format list you are about to create (see Figure 2).

7. Click on the browse button for “Processing list file name”, and select the name and path for the processing list you are about to create (see Figure 2).

8. Check box next to “Load new lists?” (see Figure 2).

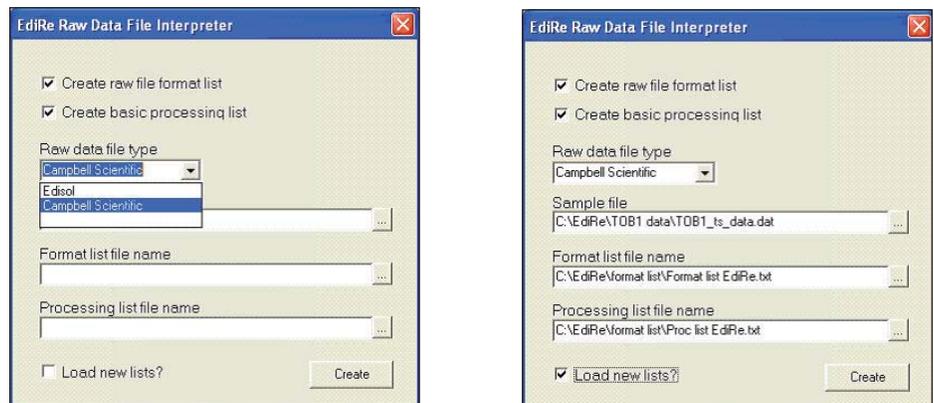


Figure 2: At left, Campbell Scientific is chosen for the Raw data file type. At right, the Interpreter dialog box has been filled out and the create button should be clicked.

- Click on the "Create" button, and EdiRe will open the "Sampling frequency verification" window with the estimated sampling frequency filled in for the raw time series file you have selected from the "EdiRe Raw Data File Interpreter" window (see Figure 3).

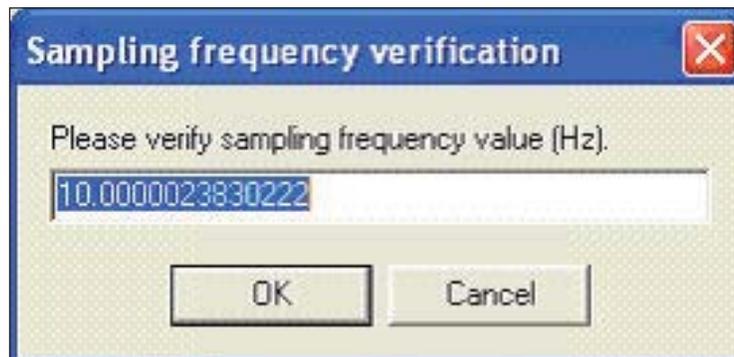


Figure 3: The Sampling frequency verification window displays an estimated value for the sampling frequency.

- Enter the exact sampling frequency (Hz) for your raw data file (see Figure 4).

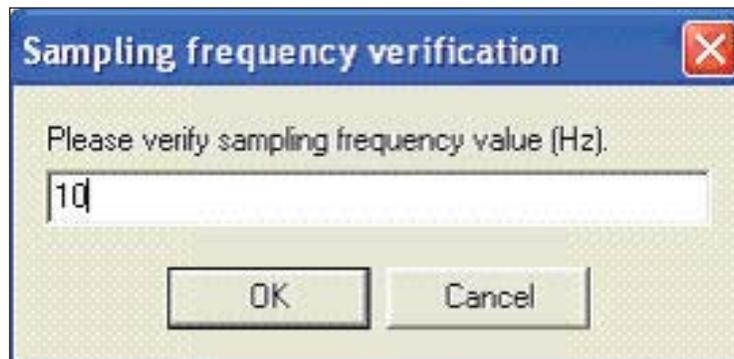


Figure 4: Enter the actual sampling frequency of the collected data, which are being processed.

- Click OK, and you will see the message shown in Figure 5.

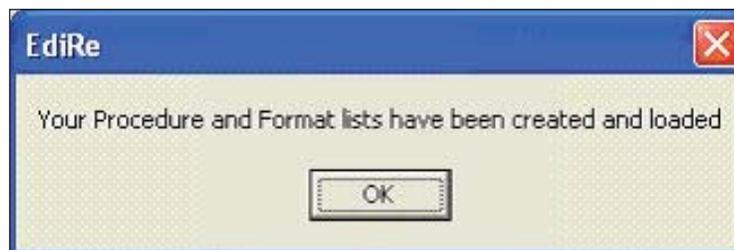


Figure 5: This message is displayed when your processing and format list have been successfully created.

- All the windows will close except for the EdiRe main window. Click on the ✓ button from the toolbar to bring up the EdiRe Options window. You can also go to Processing → Options.

13. You may navigate through each tab to see what has been filled out already. You will see that “Processing Steps” tab and “Raw File Format” tab have been filled out with the basic lists.

14. Click on the “Processing Steps” tab. We can start adding the “Processing Items” in preparation for computing the covariances (see Figure 6). Click on the pull-down menu for “Processing Items” from the upper right corner. Scroll down to find “2 chn statistics”. You can also start typing the processing item name on the “Processing Items” line, if you know it beforehand. As you type the name EdiRe will automatically find the closest match from its list.

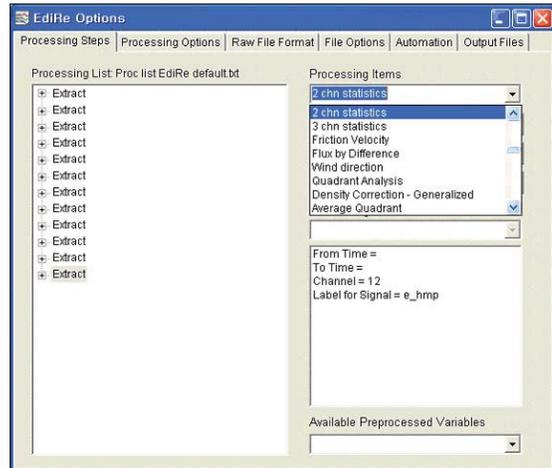


Figure 6: The processing item “2 chn statistics” is being selected from the list on the upper right.

15. When you find the item, click on “Add” button to add it to the “Processing List” on the left.

16. After adding it to the list, click on the “+” box next to “2 chn statistics” to expand the options as shown Figure 7.

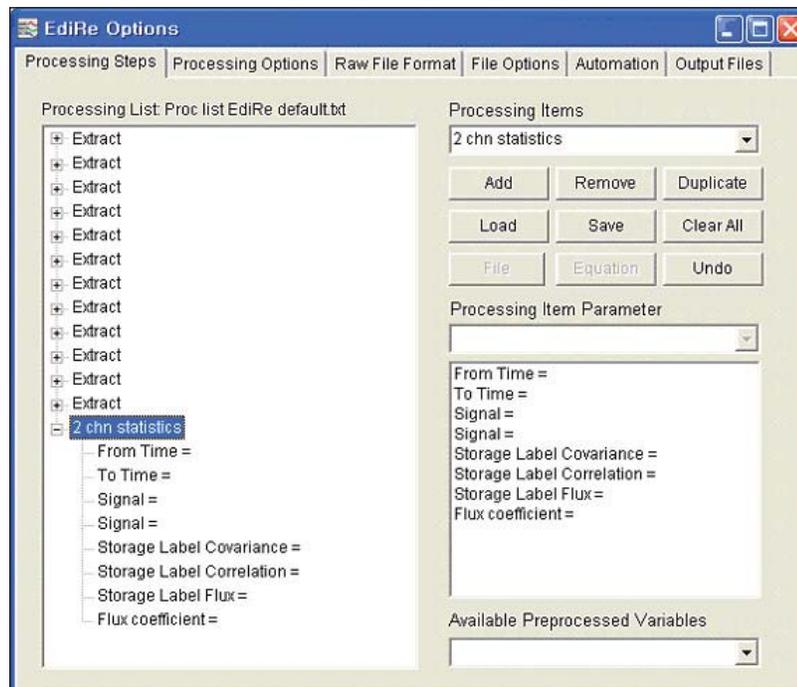


Figure 7: The “+” has been clicked to expand the processing options.

17. You can now start filling out the options for the selected “2 chn statistics”.

18. Using the "Processing Item Parameter" pull-down list, select the appropriate values for the "Signal" parameters (see Figure 8). The values selected for Signal's are the raw values that will be used for computation. The available values from the "Processing Item Parameter" list will have the same variable names that you used on the datalogger program to store the raw data.

19. Once the raw values are selected for "Signal" parameters, you can type in the label for the computed covariance value. This can be done by highlighting the appropriate parameter either from "Processing List" on the left, or from box below "Processing Item Parameter" pull-down menu.

20. After selecting the parameter, you can type in the label on the "Processing Items Parameter" line.

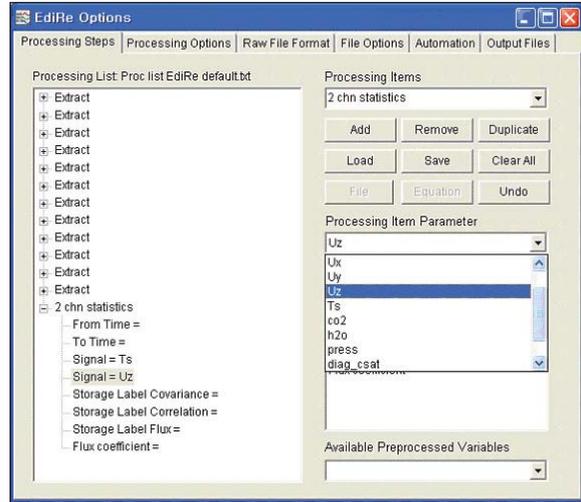


Figure 8: The "+" has been clicked to expand the processing options.



EdiRe does not accept parenthesis or commas as labels; use `cov_Ts_Uz`, instead of `cov(Ts,Uz)`.

21. If you wish to compute fluxes, you can also type in the label for the computed flux and the appropriate flux coefficient. In this example, we are computing the sensible heat flux, using the sonic temperature, T_s , and vertical wind speed, U_z . The flux coefficient of sensible heat flux is computed from the temperature and vapor pressure data. These data are measured and computed online by the datalogger and stored in the time series data file, `ts_data.dat` (see Figure 9).

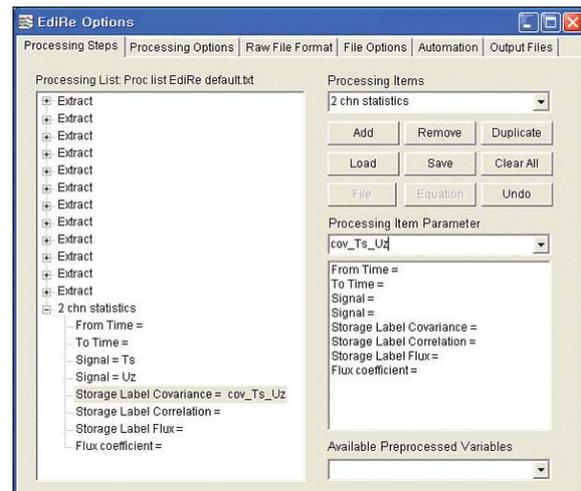


Figure 9: Data are measured and computed online by the datalogger and stored in the time series data file, `ts_data.dat`.



If the temperature and vapor pressure values are not known, we can use $1296.0243 \text{ J m}^{-3} \text{ K}$ as the estimated sensible heat flux coefficient, while using 1.29 kg m^{-3} for the estimated mean air density, and $1004.67 \text{ J kg}^{-1} \text{ K}$ for the estimated heat capacity of air.

22. In order to compute the sensible heat flux coefficient, we first compute mean values for vapor pressure, air temperature, and air pressure. The raw values are stored in the `ts_data.dat` time series data file by the dataloggers. Figures 10 through 12 show how it is done.

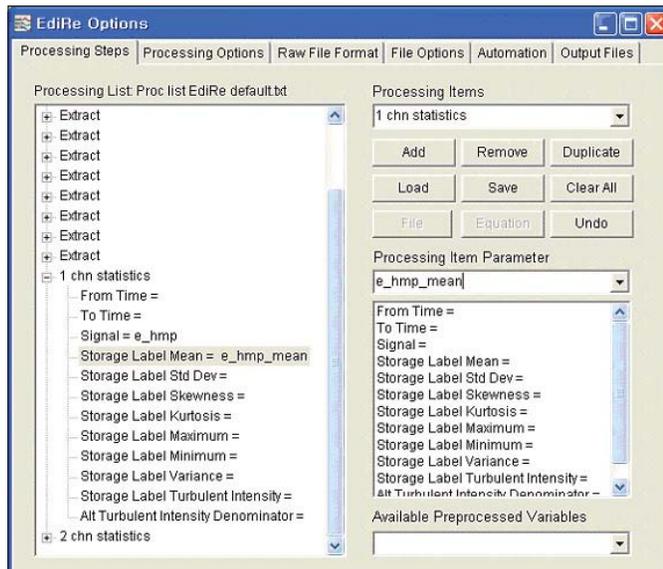


Figure 10: Add 1 chn statistics and fill in Storage Label Mean = `e_hmp_mean` to compute mean vapor pressure.

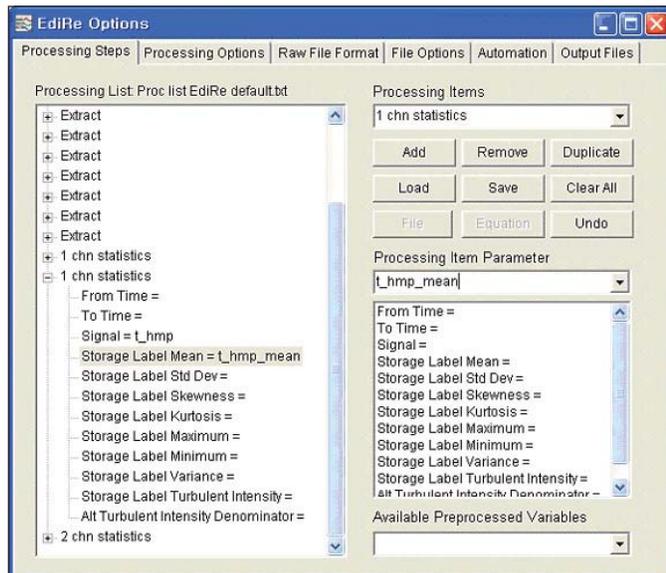


Figure 11: Add second 1 chn statistics and fill in Storage Label Mean = `t_hmp_mean` to compute mean air temperature.

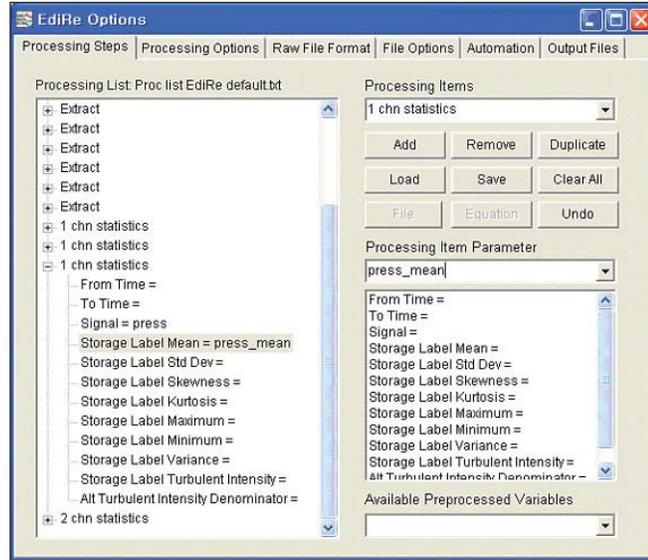


Figure 12: Add third 1 chn statistics and fill in Storage Label Mean = press_mean to compute mean air pressure.



We can also compute mean values for other signals, such as U_z , CO_2 , and H_2O .

23. Once the mean values for e_{hmp} , t_{hmp} and $press$ are computed, we can use “User defined” instruction from “Processing Items” to compute the mean air density ρ_{mean} . Figures 13 through 16 show how to compute the mean air density value using “User defined” instruction, and finally compute the sensible heat flux coefficient $\rho \cdot C_p$.

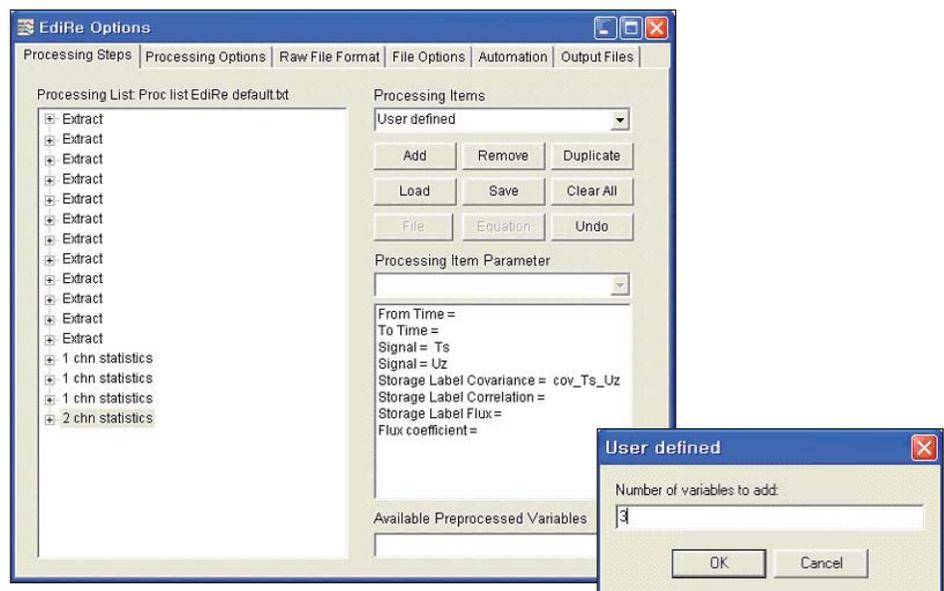


Figure 13: In the User defined instruction, enter 3 for a number of variables to be used in the equation.

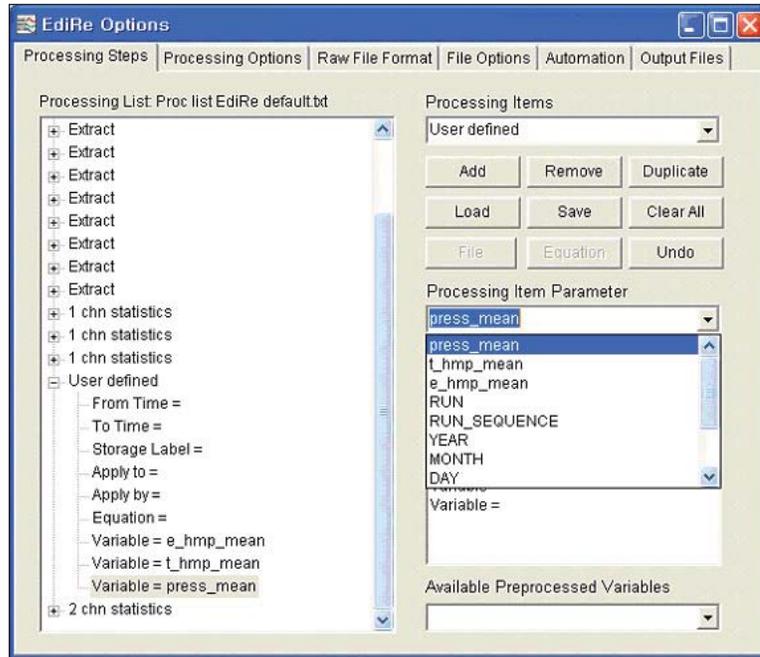


Figure 14: In the figure above, the `press_mean` variable is chosen as one of the three variables to be used to compute rho-mean.

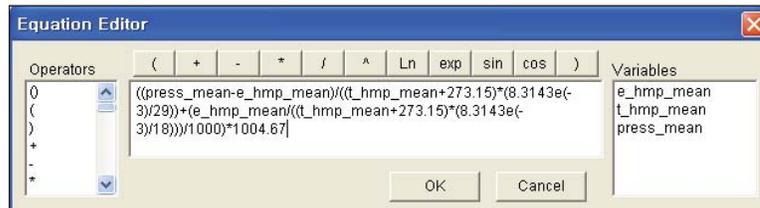


Figure 15: After the equation button is chosen, the equation is entered using the Equation Editor.

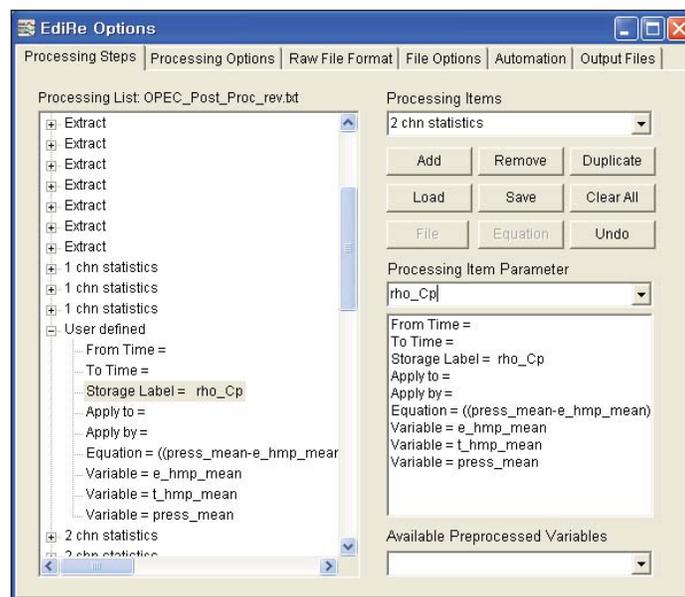


Figure 16: Enter `rho_Cp` for the Storage Label.



You need to make sure that “User defined” instruction comes after “1 chn statistics” instruction, but before “2 chn statistics” instruction. This way the mean values are computed before the computation of the sensible heat flux coefficient, and the computed sensible heat flux coefficient is available for the flux computation later.

24. You can now plug in the computed sensible heat flux coefficient to the “2 chn statistics” instruction to complete the flux computation, as shown in Figure 17.

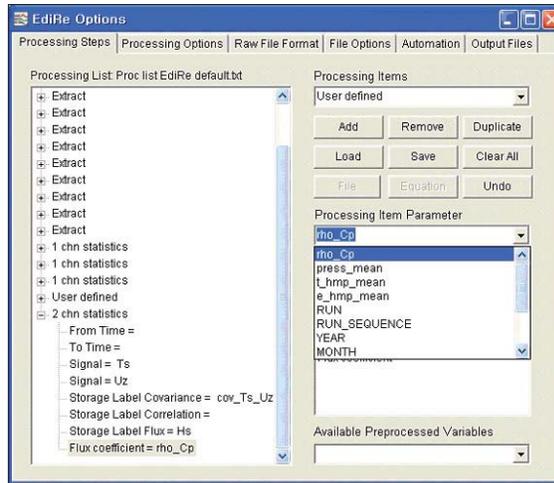


Figure 17: The computed sensible flux coefficient is plugged into the 2 chn statistics instruction.

25. You can add more “Processing Items” to compute additional covariances and fluxes. The example also computes $\text{cov}(\text{CO}_2, U_z)$, labeled cov_CO2_Uz , and carbon flux F_c , as well as the $\text{cov}(\text{H}_2\text{O}, U_z)$, labeled $\text{cov_H}_2\text{O_Uz}$, and latent heat flux LE. The estimated latent heat of evaporation 2440 J g^{-1} was used in computation of LE (Figure 18).

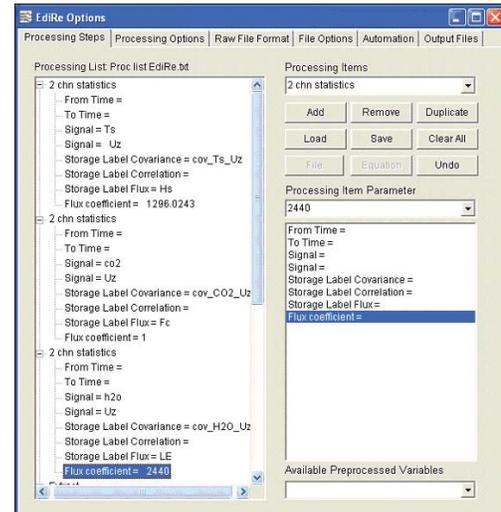


Figure 18: A flux coefficient of 2440 is entered.



If the order of the instructions are incorrect, you can drag and drop the items to change the order they are processed on the “Processing List”, after you added them.

Setting Output Interval

Click on the “File Options” tab to set the output interval for the desired processing (see Figure 19). You can do this by changing the interval from the “Run Length (min)” section. You can either type in your desired length, or use the arrow button.

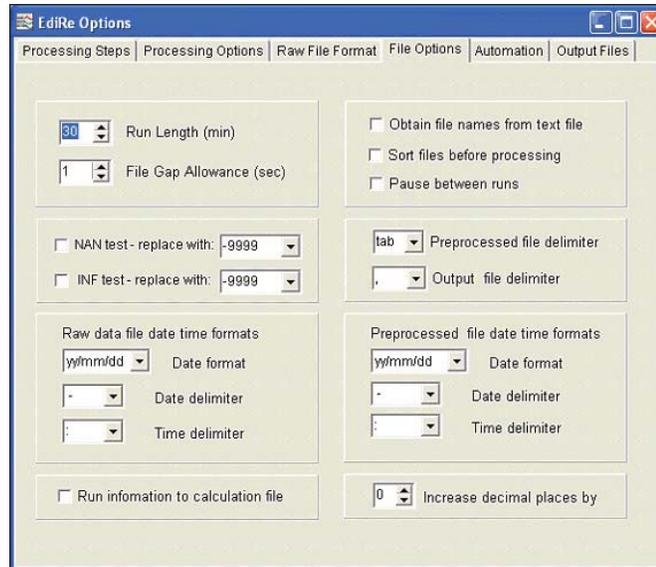


Figure 19: The file option tab is used to enter the minimum run length.

Setting Number of Decimal Places

You can set the number of decimal places for your processed data using the “Increase decimal places by” option on the lower right corner of the “File Options” tab, as shown in Figure 20.

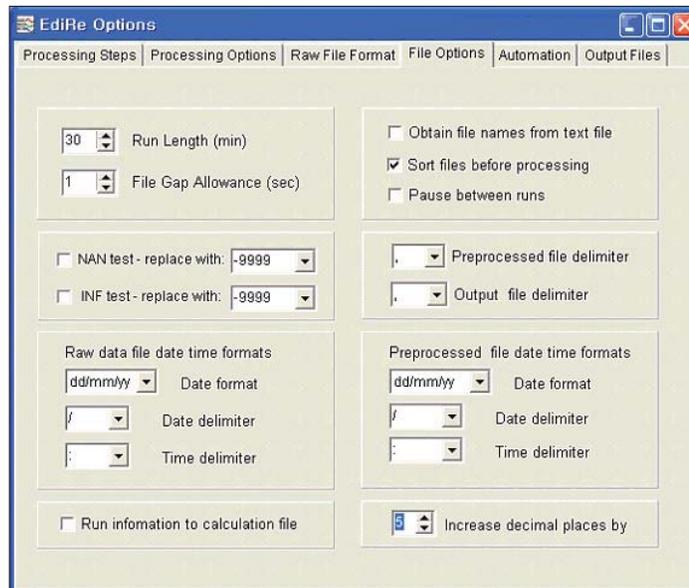


Figure 20: The decimal places have been increased to five.

Data Filtering using CSAT3 Diagnostics Data

You can filter out CSAT3 and IRGA data based on the CSAT3's diagnostics value. Figures 21 through 23 show how to program EdiRe to filter the data, when any of the CSAT3's diagnostics flags are set. This is done by using "Raw Subset" instruction.

Adding Raw Subset instruction

Find the "Raw Subset" instruction from the "Processing Items" pull-down menu (Figure 21). When you click "Add" button, it will open a dialog box asking how many subsets you wish to create. The example below shows how to filter out U_x , U_y , U_z , T_s , CO_2 and H_2O data when the CSAT3's diagnostics value is greater than 4096 (at least one flag set high), and create subsets for these raw data sets.



Add the "Raw Subset" instruction before any processing takes place. This way no bad data is used for processing, and the data quality control takes place properly.

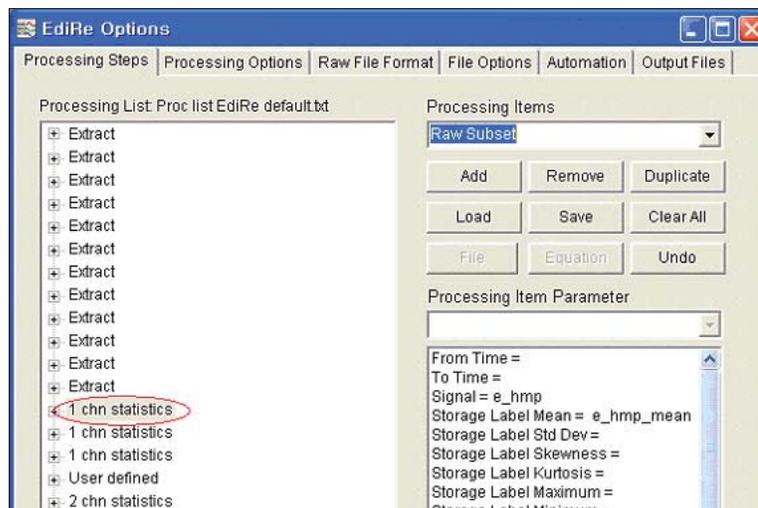


Figure 21: The "1 chn statistics" instruction is highlighted on the left to ensure the "Raw Subset" instruction is added before any processing takes place.



Figure 22: Enter 6 in the dialog box to filter six raw data values.

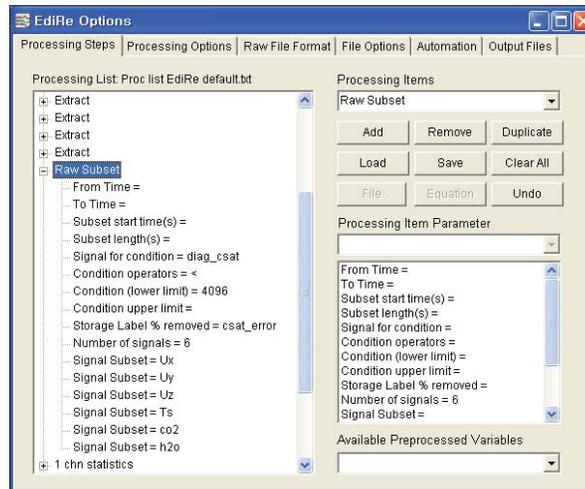


Figure 23: The U_x , U_y , U_z , T_s , CO_2 and H_2O data are filtered out.



The `csat_error` value represents the percent of data removed from this filtering process.

Data Filtering using IRGA data and NAN and INF Values

You can add the second “Raw Subset” instruction to filter raw data based on the quality of the IRGA data. You can do this by filtering out data when IRGA data is NAN or INF.

Replacing NAN and INF with -9999

To do this, you program EdiRe to replace all NAN’s and INF’s with -9999 by using the following procedure.

1. Go to the “File Options” tab.
2. Select -9999 for replacement values for NAN and INF as shown in the Figure 24, and check the boxes next to NAN test and INF test to activate this feature.

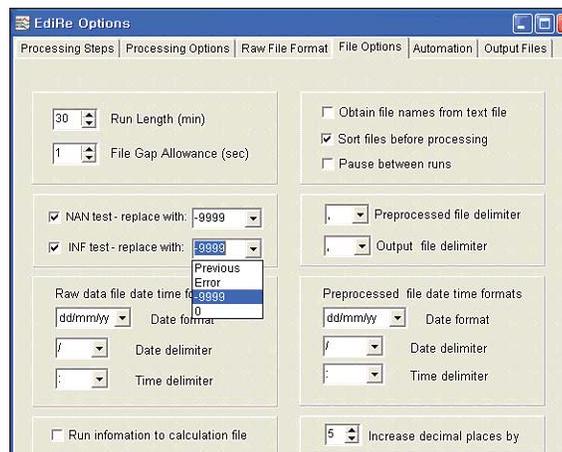


Figure 24: A replacement value of -9999 has been selected for NAN and INF.

Filtering data if values are -9999

Add the second “Raw Subset” instruction to filter out data when CO₂ data from IRGA is -9999 as shown in Figure 25.

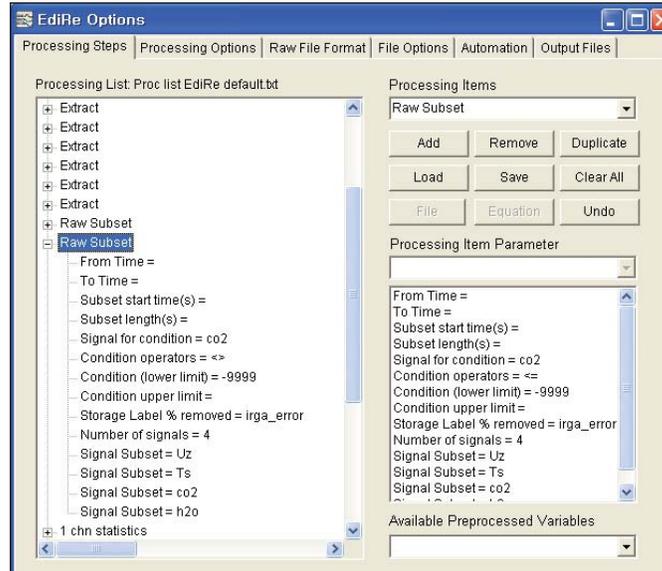


Figure 25: Add second “Raw Subset” to filter data based on CO₂ data from IRGA.



The U_x and U_y data will not be filtered out based on IRGA data. This is because the U_x and U_y data will be used to compute compass wind speed and direction later on. Unnecessary filtering is not desirable based on the quality of the IRGA data.

Setting the Location of the Output File

To do this, specify the path and file name from the “Output Files” tab, or select a “Location Output Files” instruction from the “Processing List” (see Figure 26). The created data file contains comma separated values. Campbell Scientific recommends selecting a “Location Output Files” instruction from the “Processing List”, rather than using the “Output Files” tab. This prevents accidental merger of results from multiple stations.

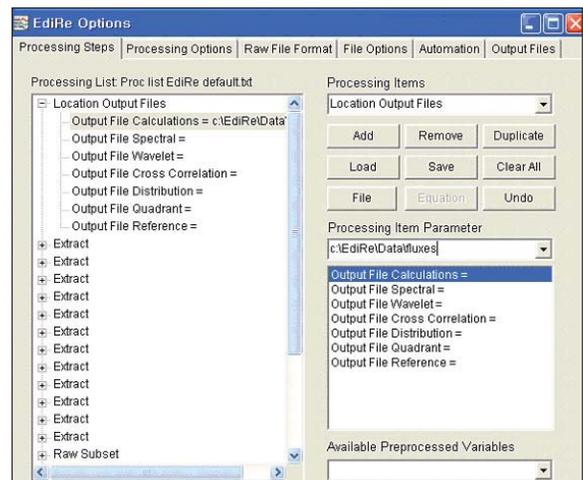


Figure 26: A “Location Output Files” instruction has been selected from a list, and the path and file name of the output file is entered in on the right under “Processing Item Parameter”.

Additional Processing

Computing Compass Wind Speed and Direction

You can compute compass wind speed and direction using the “User defined” and “Wind direction” instructions in the “Processing List”. In order to compute wind speed using “User Defined”, you first need to compute U_x_mean and U_y_mean , using “1 chn statistics” (see Figure 27).

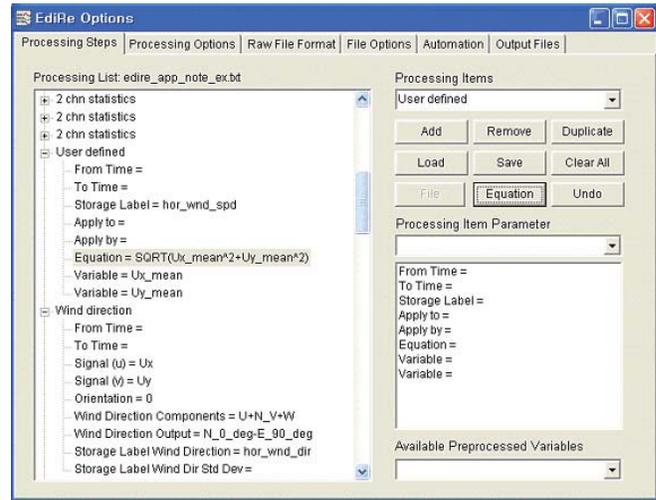


Figure 27: Compass wind speed and direction are computed using the user-defined and wind direction instructions.

Remove Lag instruction

Removing a Signal Lag When the Lag is Known

If you know the lag from a signal, you can remove it using the “Remove Lag” instruction. This instruction moves the signal forward by the specified amount of time. It is done by converting the specified lag time to number of scans based on the sampling frequency value. In Figure 28, the lag time of 0.3 seconds is applied to the CO_2 and H_2O signals with a lower limit of -1 and an upper limit of 1 seconds. Note that a lag time of 0.3 seconds corresponds to 3 scans at 10 Hz sampling frequency.

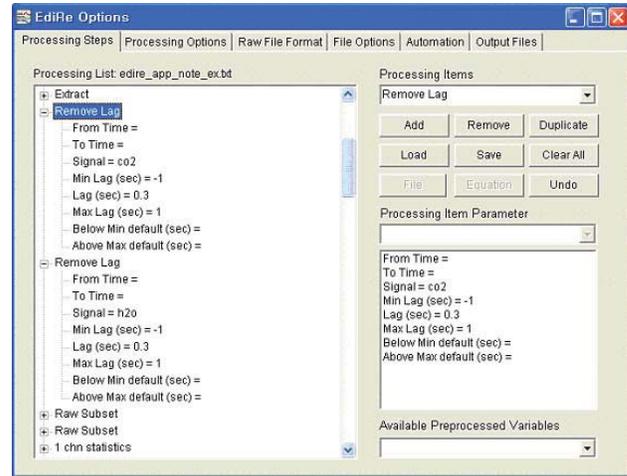


Figure 28: The lag time of 0.3 seconds is applied to the CO_2 and H_2O signals.



Lag removal needs to be done before other processing takes place. The lag removal shown above was an example only. The fixed logs in the CSAT3 and the LI-7500 have been removed by the Campbell Scientific datalogger programs.

Removing a Signal Lag When the Lag is Not Known

If you do not know the lag from a signal, you first need to find the lag. This can be done, using the “Cross Correlate” instruction. Figure 29 shows how to compute the signal lag for CO₂ against the U_z signal, and, then, remove the computed lag from the CO₂ signal, using the “Remove Lag” instruction.

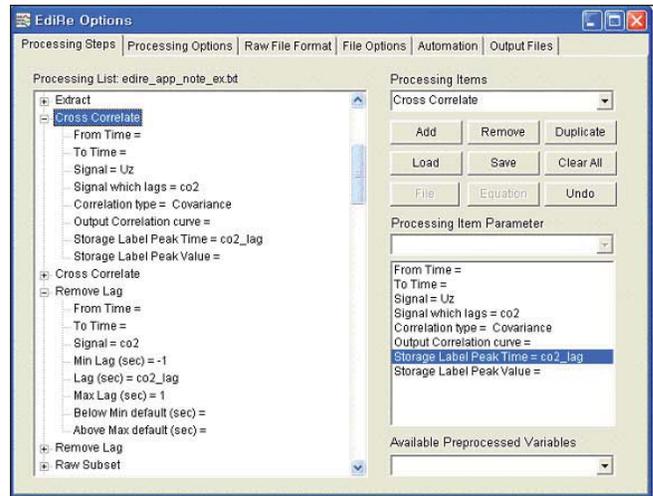


Figure 29: The lag is removed by selecting cross correlate (left) and Storage Label Peak Time = co2_lag.



NOTE

Lag removal needs to be done before other processing takes place.

WPL Correction

The EdiRe software allows you to perform the WPL corrections. Figure 30 shows a portion of the “Webb correction” instruction that can be used for the WPL correction.

The details about how to perform the WPL correction using EdiRe are covered during the EC training course conducted at Campbell Scientific. Please contact Campbell Scientific for more information about our EC training course.

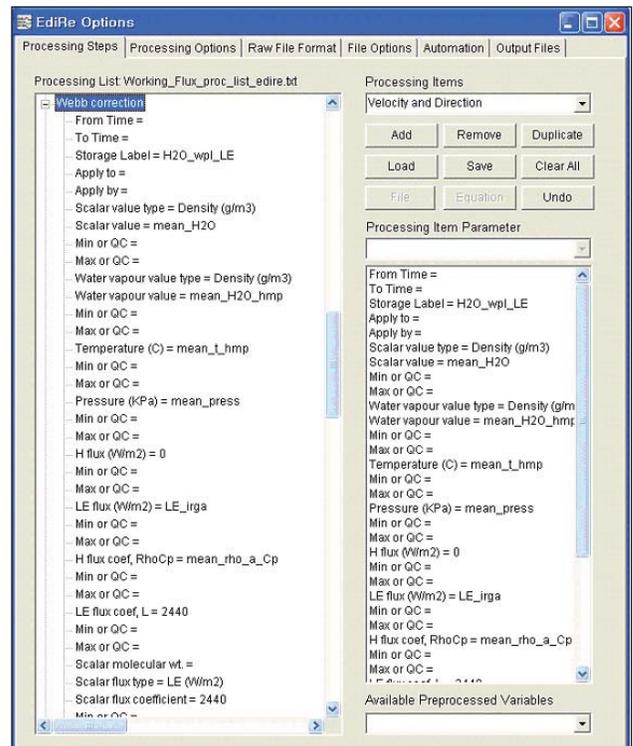


Figure 30: A portion of the WPL correction is shown.

Plotting computed values

You can plot the computed values using the “Plot Value” instruction. Figure 31 shows the “Plot Value” instruction to plot F_c and LE fluxes.

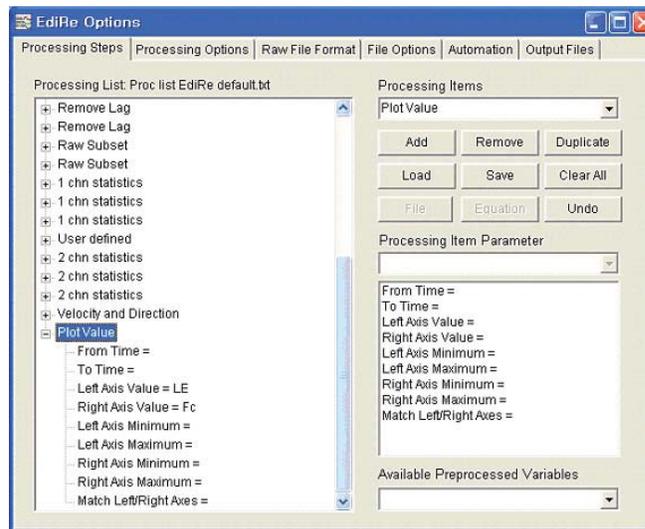


Figure 31: The computed values are plotted using the “Plot Value” instruction.

You are now ready to perform the processing. You can close the “EdiRe Options” window. EdiRe will automatically save all the changes you have made each time you close the “EdiRe Options” window.

Executing EdiRe for Data Processing

Follow the steps below to execute EdiRe for data processing.

1. From the main window's toolbar, click on the button with “P” and a blue arrow pointing to the right. You can also go to Processing → Standard Processing.
2. EdiRe will open a dialog box to let you select the raw data file. Browse to find a raw data file in TOB1 format that you wish to process.
3. When you close this window, EdiRe will open another window for “Start Time Verification” (see Figure 32). This window lets you change the timestamp of the first data to be processed from the selected data file. The EdiRe will find a raw data with the exact time stamp provided in this window to start the processing. If you do not make the change on the start time, EdiRe will process your raw data starting the first record in the file.

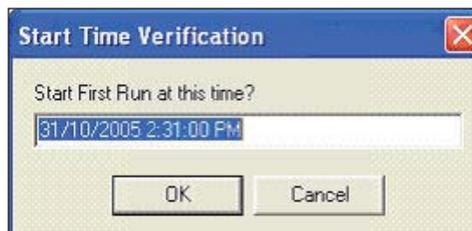


Figure 32: The Start Time Verification Window is opened.



If your raw data file starts in the middle of the desired output processing period (i.e., starting at 12:03 instead of 12:00), the timestamp for the processed data will appear skewed accordingly. You may wish to change the start time to either 12:00 or 12:30 to avoid this from happening. If you change the start time to 12:00, but your actual raw data started at 12:03, EdiRe will use the data from 12:03 to 12:30 for half-hourly processing.

- Upon pressing the OK button, EdiRe will begin retrieving the raw data and processing them. You will see the graph plotting as it performs the processing, if you added "Plot Value" instructions. Figure 33 is a snapshot of EdiRe plotting the computed values, as the processing goes on.

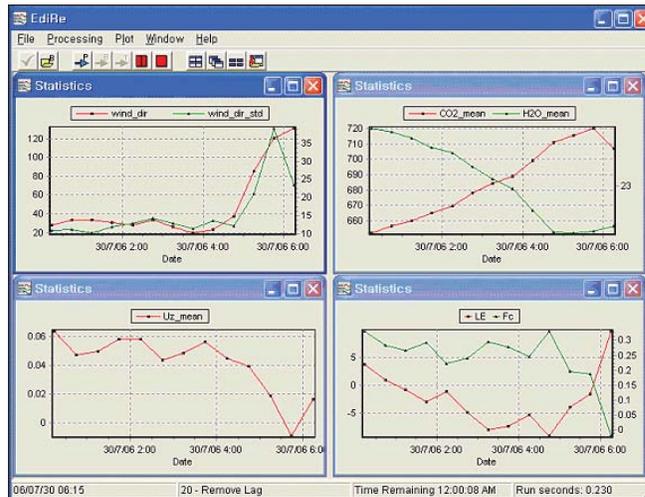


Figure 33: A snapshot of EdiRe plotting the computed values, as the processing goes on.

- While EdiRe is processing the raw data, the processing status will be displayed on the bottom of the EdiRe screen (see Figure 33). Once the processing is complete, this status message will disappear automatically, and the completed plots will remain on the screen (see Figure 34).

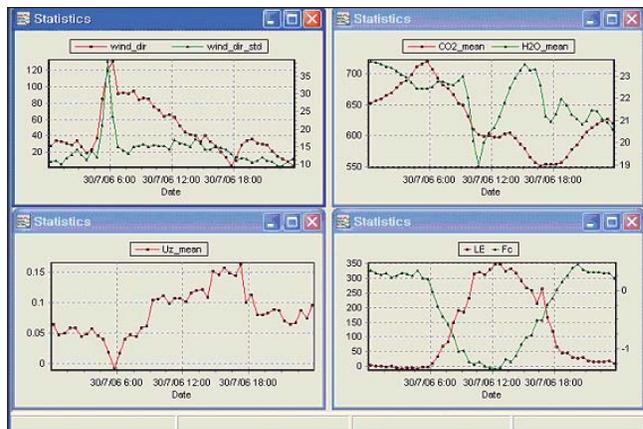


Figure 34: Status information such as Time Remaining and Run Seconds has disappeared from the bottom of the screen indicating that processing is complete.

Viewing the Processed Data

The output data file, if output in CSV file type, can be opened using Microsoft Excel. Figure 36 provides a snap shot of the processed data file opened in Microsoft Excel.

	A	B	C	D	E	F	G
1	Date/Time	cov_Ts_Uz	Hs	cov_CO2_Uz	Fc	cov_H2O_Uz	LE
2	31/10/2005 3:15:00 PM	0.00672411	8.71461441	0.03005636	0.03005636	0.00002493	0.06081928
3	31/10/2005 3:45:00 PM	0.00418622	5.42544923	-0.02278078	0.02091872	0.00006456	0.15753407
4	31/10/2005 4:15:00 PM	0.00439236	5.69260890	-0.02740779	-0.02740779	-0.00003714	-0.09061204
5	31/10/2005 4:45:00 PM	0.00418805	5.42781309	-0.02668037	-0.02668037	0.00004313	0.10523576
6	31/10/2005 5:15:00 PM	0.00452051	5.85869097	0.04898084	0.04898084	0.00003846	0.09384618
7	31/10/2005 5:45:00 PM	0.00145099	1.88052273	0.04396483	0.04396483	0.00006949	0.16956071
8	31/10/2005 6:15:00 PM	0.00070102	0.90853405	0.03341631	0.03341631	0.00003372	0.08227065
9	31/10/2005 6:45:00 PM	0.00040908	0.53017165	0.03907308	0.03907308	0.00005787	0.14119395
10	31/10/2005 7:15:00 PM	-0.00013407	-0.17375498	-0.02413619	-0.02413619	-0.00001963	-0.04789204

Figure 36: The output data file is displayed in Microsoft Excel.

EdiRe Time Stamp

EdiRe reports the time stamp for the processed data in a way that is different than how our dataloggers report the time stamp (see the Figure 37).

	A	B
1	EdiRe TimeStamp	CSI Datalogger TimeStamp
2	31/10/2005 3:15:00 PM	10/31/2005 15:30
3	31/10/2005 3:45:00 PM	10/31/2005 16:00
4	31/10/2005 4:15:00 PM	10/31/2005 16:30
5	31/10/2005 4:45:00 PM	10/31/2005 17:00
6	31/10/2005 5:15:00 PM	10/31/2005 17:30
7	31/10/2005 5:45:00 PM	10/31/2005 18:00
8	31/10/2005 6:15:00 PM	10/31/2005 18:30

Figure 37: Time stamps reported by EdiRe are shown next to our datalogger time stamps. Besides using a different method of determining the time stamp, the formats for reporting them are also different.

As you can see from Figure 37, EdiRe reports the middle of the output processing period as the time stamp for that period, whereas our dataloggers report the end of the period as the time stamp.

Getting Help for EdiRE

The following resources are available to help users with the EdiRe software.

- EdiRe Help file
- Tutorials
- EdiRe Forums
- Campbell Scientific, Inc.



The help file is included with the EdiRe software, and the Tutorials and the EdiRe Forums can be accessed from the following site: <http://www.geos.ed.ac.uk/abs/research/micromet/EdiRe/>