

acsIX Libero

Quick Start Guide

Version 3.0

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The AEGIS Technologies Group, Inc.

410 Jan Davis Drive
Huntsville, AL 35806
U.S.A.
Phone: (256) 922-0802
info@acsix.com
www.acslix.com

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Introduction to acsIX Libero

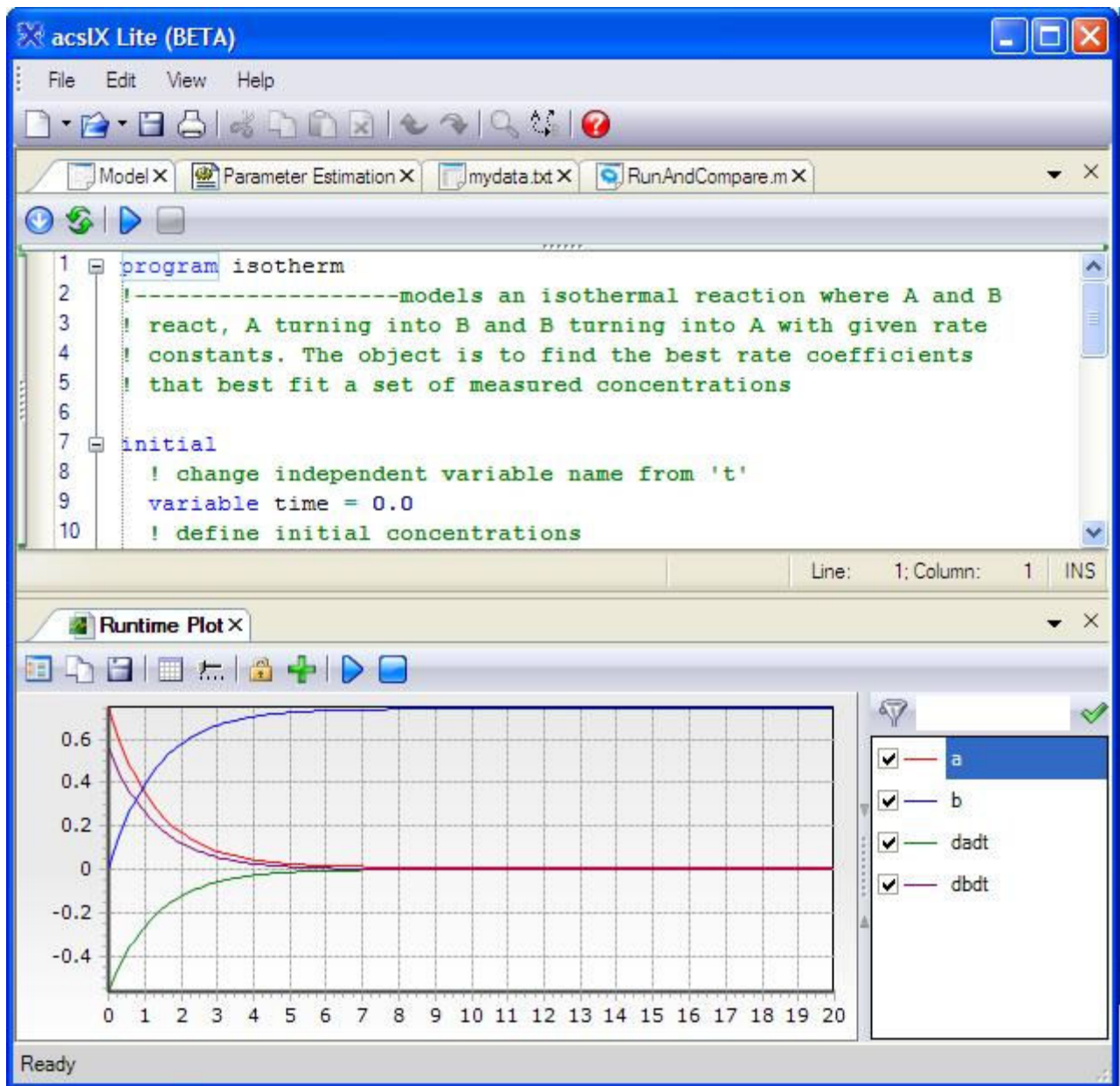
acsIX Libero is a tool for developing and analyzing mathematical models of systems and processes which can be described by ordinary differential equations or differential algebraic equations. Mathematical models are specified using a simple, equation-based language called "CSL" (Continuous Simulation Language). Model outputs (predictions) may then be displayed or analyzed in a variety of ways, including:

- A variety of 2-D and 3-D plot types
- Tabular (spreadsheet) display of both model predictions and measured data
- Minimization/maximization of a user-specified objective function
- Sensitivity analysis (both local and global)
- Estimation of model parameters from measured data
- Monte-Carlo analysis

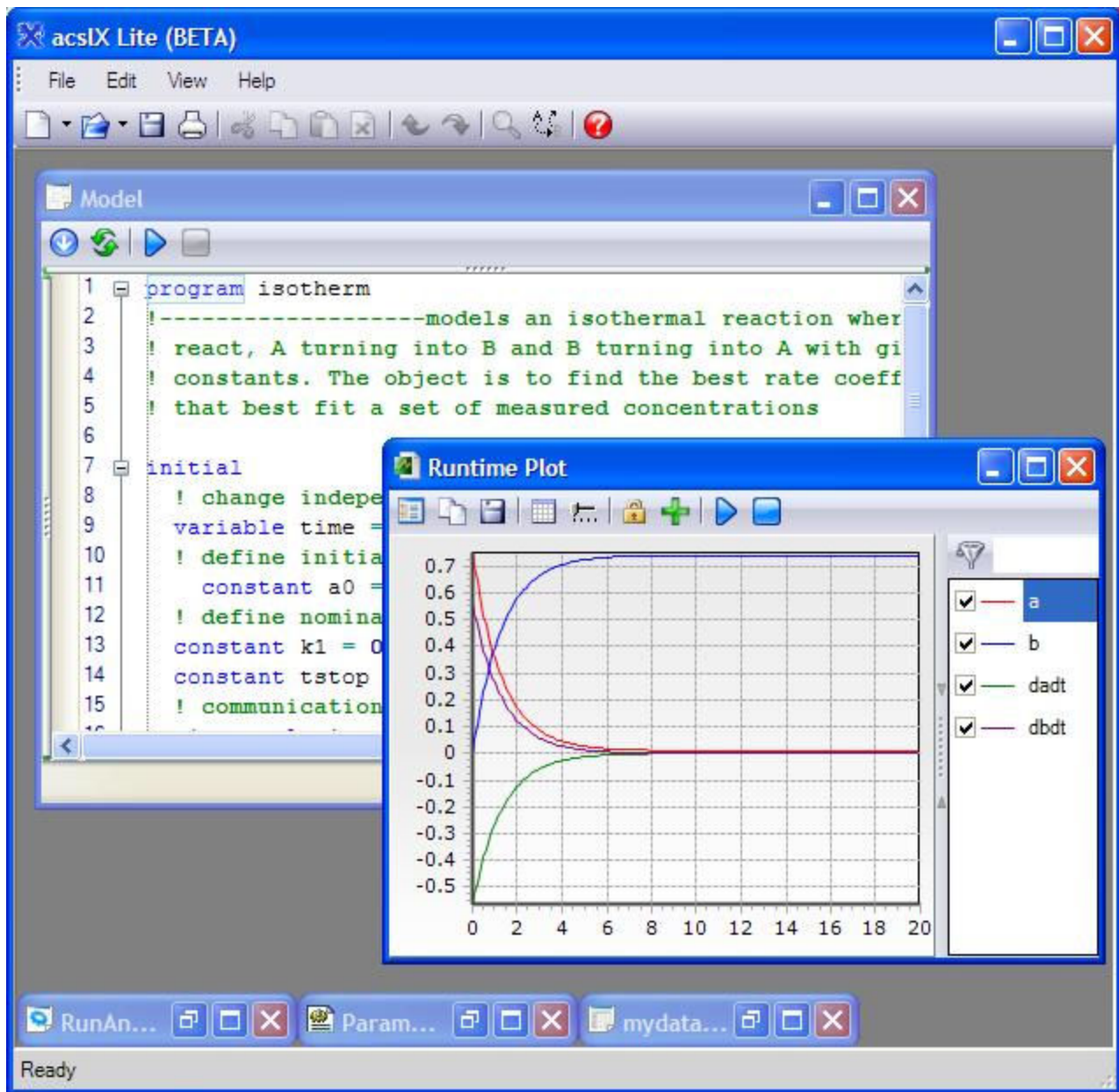
Most of these analyses can be performed using a simple dialog-based user interface. For more sophisticated analyses, however, a scripting language based on the popular "M" language is available. This language allows arbitrarily complex scripts to be developed for importing, exporting, manipulating and visualizing data in a variety of ways; performing hundreds of mathematical operations on parameters, data, or simulation outputs; and exercising detailed control over how the simulation runs, how parameters are set, how the various analyses are performed, and how results are reported.

Overview of the User Interface

acsIX Libero uses a variety of windows for editing model or script code, displaying plots or tables of data, specifying settings related to various analyses, etc. By default, these windows are arranged as tabs in the main application window. To make one of these windows active, simply click the corresponding tab. To display two or more windows simultaneously, drag the tab of one of the windows and drop it over the middle of the window.



Alternatively, windows may be arranged as individual MDI (multi-document interface) windows by selecting the "Toggle MDI/Tabbed Layout" option on the View group under the main menu.



acsIX Libero utilizes a variety of windows corresponding to various activities:

- Model Window: the window in which the equations for the mathematical model are specified using the CSL language
- Plot Windows: windows in which 2-D or 3-D plots of model predictions or measured data are plotted
- Data Windows: windows which contains spreadsheet views used to display and edit measured data, or present simulation results in a tabular view
- Min/Max Settings Windows: windows which present a series of dialogs in which settings related to a min/max analysis are specified

- Sensitivity Analysis Settings Windows: windows which present a series of dialogs in which settings related to a sensitivity analysis are specified
- Parameter Estimation Settings Windows: windows which present a series of dialogs in which settings related to a parameter estimation are specified
- Monte Carlo Settings Windows: windows which present a series of dialogs in which settings related to a Monte-Carlo analysis are specified
- Web Browser Window: windows which contain a web browser control, which is used to browse the online help, or to connect to online sources of models, data, etc.
- Report Window: windows which present reports detailing the results of one of the analyses supported in acsIX

A number of additional windows are displayed as floating "tool" windows, which are not contained in the tab or MDI area of the main application window:

- Parameters Window: contains a set of fields and "sliders" which can be used to easily manipulate the values of one or more model parameters, and interactively run the simulation to see the results of the parameter changes
- Directory Browser Window: displayed the list of files in the current folder, buttons for navigating the folders on local hard drives, and options for quickly opening and editing the various file types recognized by acsIX

Overview of the Modeling and Analysis Workflow

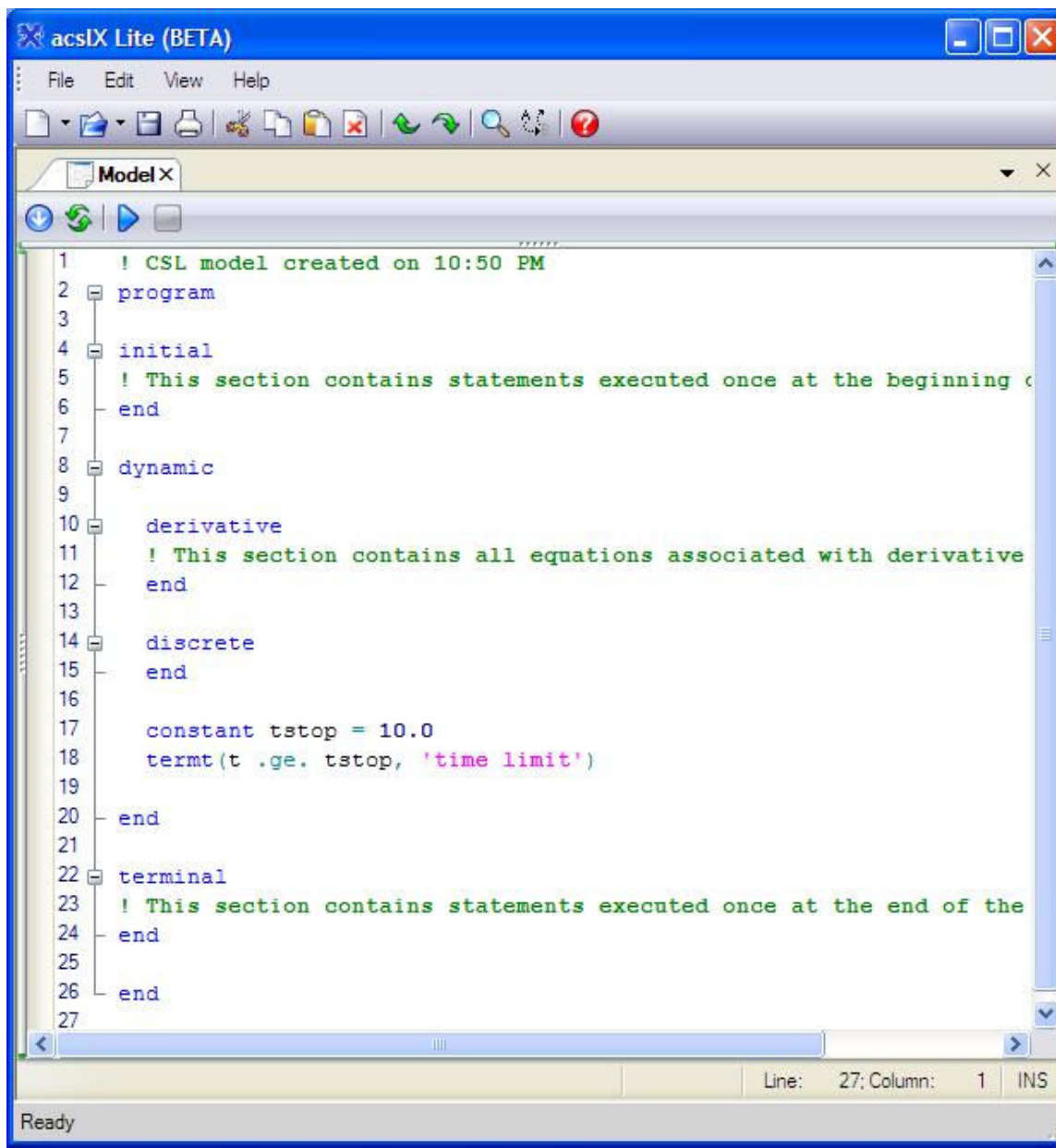
While the file types used in acsIX Libero are identical to those used in acsIX, the workflow has been significantly streamlined. To start acsIX Libero and start working with a particular model, simply double-click on the model file in Windows Explorer. The model is automatically built after it loads, and is then ready to run. To run the model, click the "run" button at the top of the model code window. At the conclusion of the run, a default plot is automatically constructed. The specific outputs to be plotted may be changed by selecting the checkboxes next to their names in the plot legend. Model parameters may be assigned to "slider" controls in order to quickly adjust parameters, re-run the simulation, and update the plots. Data files may be imported and displayed in tabular format by opening the data file directly using the main menu File -> Open options.

In brief, acsIX Libero avoids the use of the Project and Workspace organizational metaphors employed in the full acsIX in favor of directly opening and editing files in folders on your hard drive. Detailed descriptions of the use of the various windows and dialogs are contained in subsequent sections.

For detailed syntax descriptions of the languages used in acsIX for specifying mathematical models and scripting analyses, please refer to the acsIX Language Reference and acsIX Command Reference Manuals.

Creating a New Model

When acsIX Libero is started, the model editor is displayed with a template model. To create a new model after acsIX Libero has been started, select the "New Model" menu or toolbar option.



The code shown in the editor window is a skeletal CSL program, containing the basic "sections" which constitute a mathematical model in acsIX. Each section is a container for one or more CSL statements, where each statement generally corresponds to an equation in the mathematical model. The sections denote when and how those statements or equations are executed or evaluated.

To run the model, simply press the "play" button at the top of the code editor. This will cause the model to be translated and compiled, if necessary. At the conclusion of the model run, a runtime plot window will be displayed showing the model predictions for the first few quantities defined in the model.

To translate and compile the model without running it, press the "build" toolbar button (down arrow). If any syntactical errors are discovered during the build process, they will be displayed in a message box.

The "reload" button (circular arrows) is used to reset the model quantities back to their default values as defined in the CSL code. The values typically change at runtime, or are changed as parameters are adjusted to various values. Reloading the model is a convenient way to reset these values back to the defaults.

The rectangular "stop" button can be used to halt a long simulation run in progress.

Loading an Existing Model

To load an existing CSL model file, simply double-click the file icon inside of Windows Explorer. This will cause Libero to start, load the file, and compile it. If errors are encountered during compilation, a list of errors is displayed. Otherwise, the compiled model is loaded into memory and is ready to run using the "run" button.

To load an existing model file from inside Libero while it is running, select File -> Open -> Open Model from the Main Menu or Toolbar.

The CSL Modeling Language

The CSL language is primarily designed to encode mathematical equations. In addition to the arithmetic operators in most programming languages, CSL includes operators

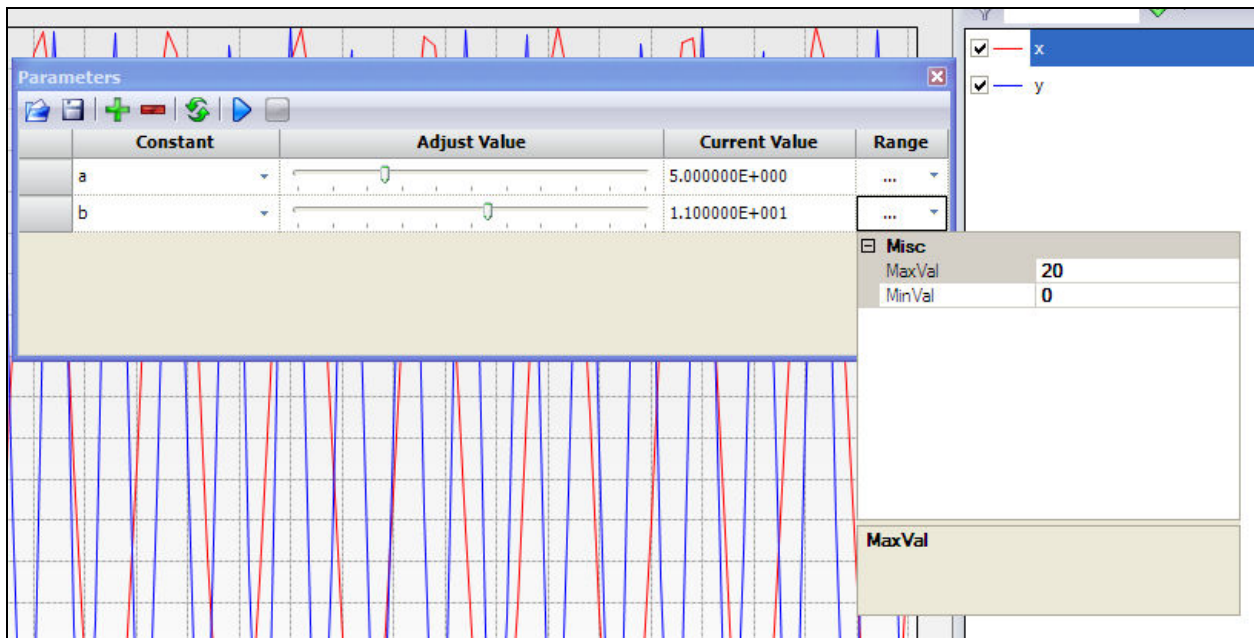
specifically useful for encoding ODEs, DAEs and delay DEs. CSL also includes numerous operators for trig, arithmetic, logical and assorted nonlinear operations. With some exceptions, the order in which equations are specified is arbitrary (statements are sorted). Equations (statements) in CSL are grouped into "sections", which designate when and how an equations should be evaluated.

For a detailed description of the CSL modeling language, please refer to the "acsIX Language Reference."

Running a Simulation

Once a simulation has been built and loaded into memory, the simulation can be started by either pressing the "start" button on the model window, or by typing the "start" command in the command window.

Starting the simulation by using the "start" button will cause the simulation to run to completion, after which a runtime plot will be displayed presenting plots of the first few variables in the models. The model can be run again by using the start button, or by adjusting the values of model parameters using the "parameters" window, described below.



The parameters window contains a grid, where each row in the grid can be assigned to a model parameter (constant), and cells in the grid can be used to change the values of model parameters.

To add a row to the parameters window, press the “plus” button on the toolbar, then select the model parameter to be assigned to this row from the dropdown list in the first column. To remove a row, simply highlight the row by clicking the row header, and then select the “minus” button. To adjust the value of a parameter, either drag the slider in the middle column, or assign a value directly using the cell in the third column. To adjust the range of the slider, click the cell in the fourth column and enter the desired range information in the drop down properties grid.

The simulation will automatically re-run when the slider is release after dragging, or when a new value is typed into a cell in column three. To force the simulation to run manually, press the “start” button at the top of the parameters window.

To save or reload the configuration of the parameters window (i.e., the list of parameters, their values, and the slider settings), use the file open and save buttons at the top of the parameters window.

Plotting Simulation Results

Simulation results are automatically plotted in a “runtime plot” window at the conclusion of a simulation run. By default, the first few variables defined in the model are plotted, but the variable list at the right side of the runtime plot window can be used to turn on or off individual variables. Simply click the check box next to any variable to be displayed in the plot, and uncheck the box next to any variable which should not be displayed.

To search the list of variables for a particular variable or group of variable, enter the name of the variable or a patter including the wildcard character (“*”) into the search box at the top of the list, then press the “filter” button. To view or hide the selected variables, click the “check” drop down button and then select either the “check selected” or “uncheck selected” menu item.

At the top of the runtime plot window is a toolbar with a number of buttons for configuring or exporting the plot and running the simulation:

The “properties” button opens a dialog from which many aspects of the plot itself can be configured.

The “copy” button copies the plot images data to the Windows clipboard, from which it can be pasted into an image editing program or other document.

The “save” button is used to export the chart data to a variety of formats.

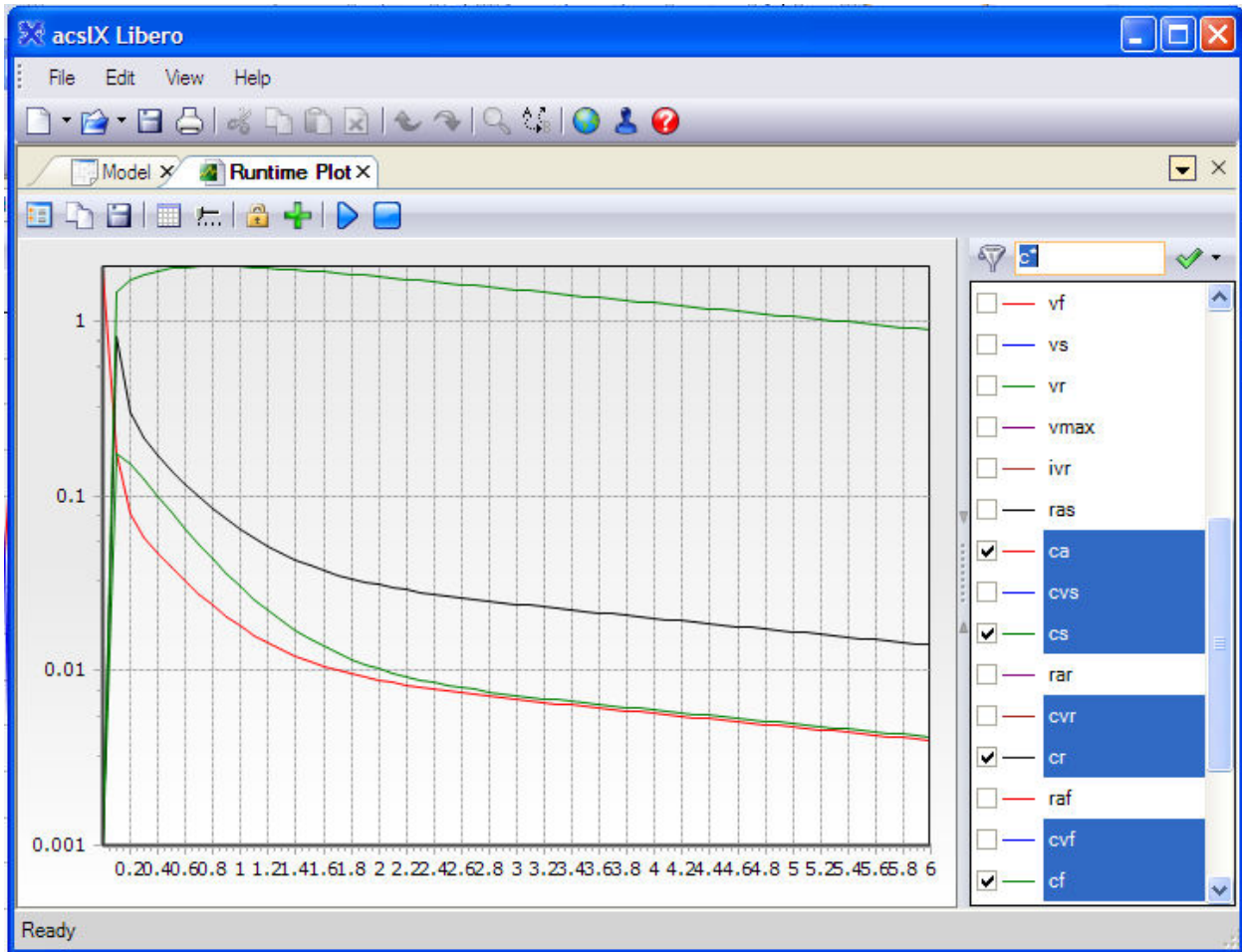
The “spreadsheet” button opens the plot data into a spreadsheet view in a new window.

The “slider” button opens the parameters window, as described above.

The “lock” window causes a new runtime plot window to be created when the simulation is run the next time, leaving the current runtime plot window “locked” and displaying the data from the previous run.

The “plus” button causes each simulation run to append to the existing data on the plot; i.e., multiple runs are shown simultaneously on the plot window.

The “run” and “stop” buttons work the same as the corresponding buttons on the model window.



To zoom the plot, left mouse click and drag down/right to select the area to zoom. To zoom out, click and drag up/left. To pan the plot, right mouse click anywhere on the plot and drag.

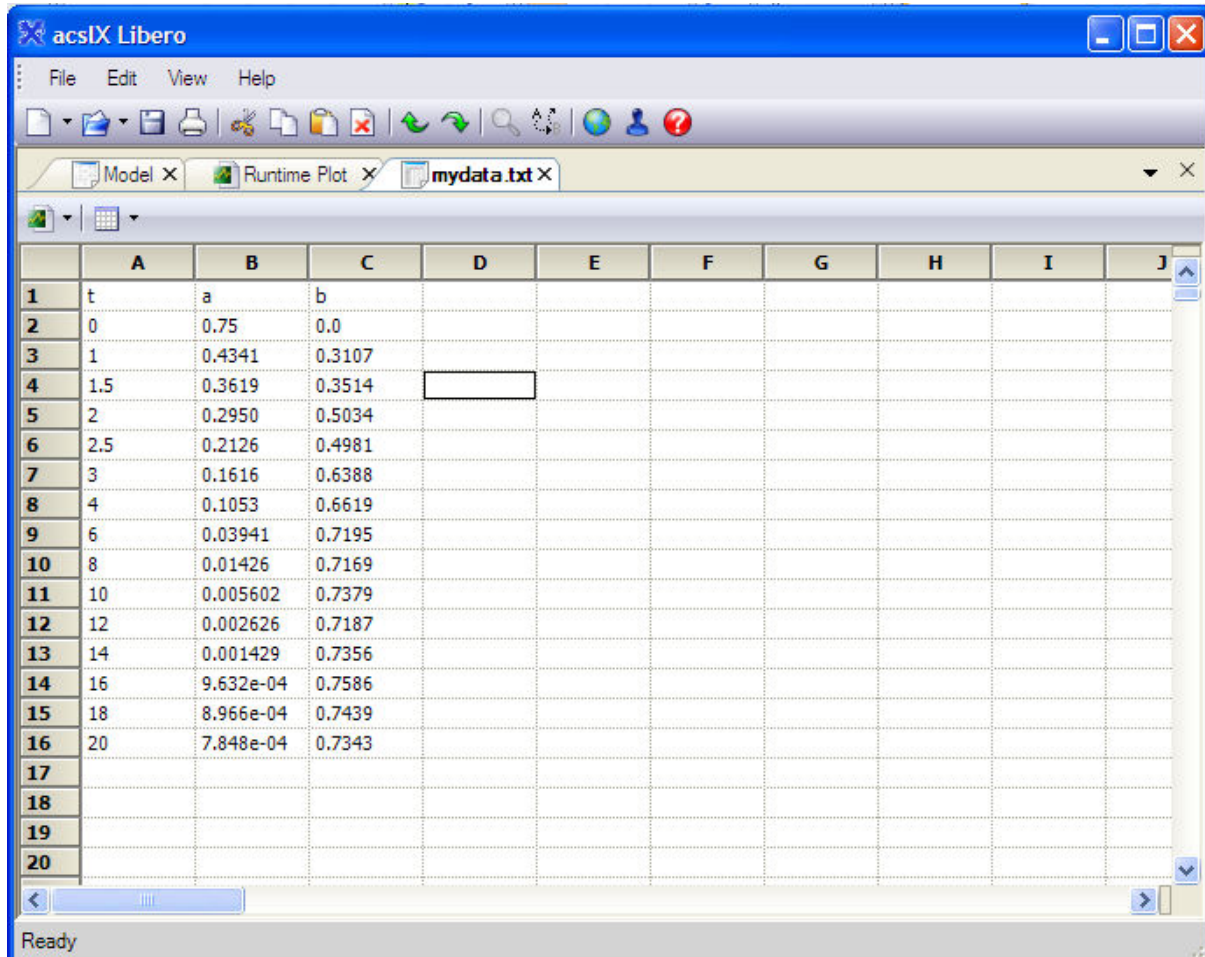
Creating, Loading, Editing and Plotting Data Sets

acsIX Libero is capable of importing data from a variety of file formats, including CSV, TXT, DAT and MAT.

To create a new data set, click File -> New -> New Data Set on the Main Menu or toolbar. A new spreadsheet window will be displayed into which data can be entered directly, or pasted from another document. To add/remove rows or columns from the

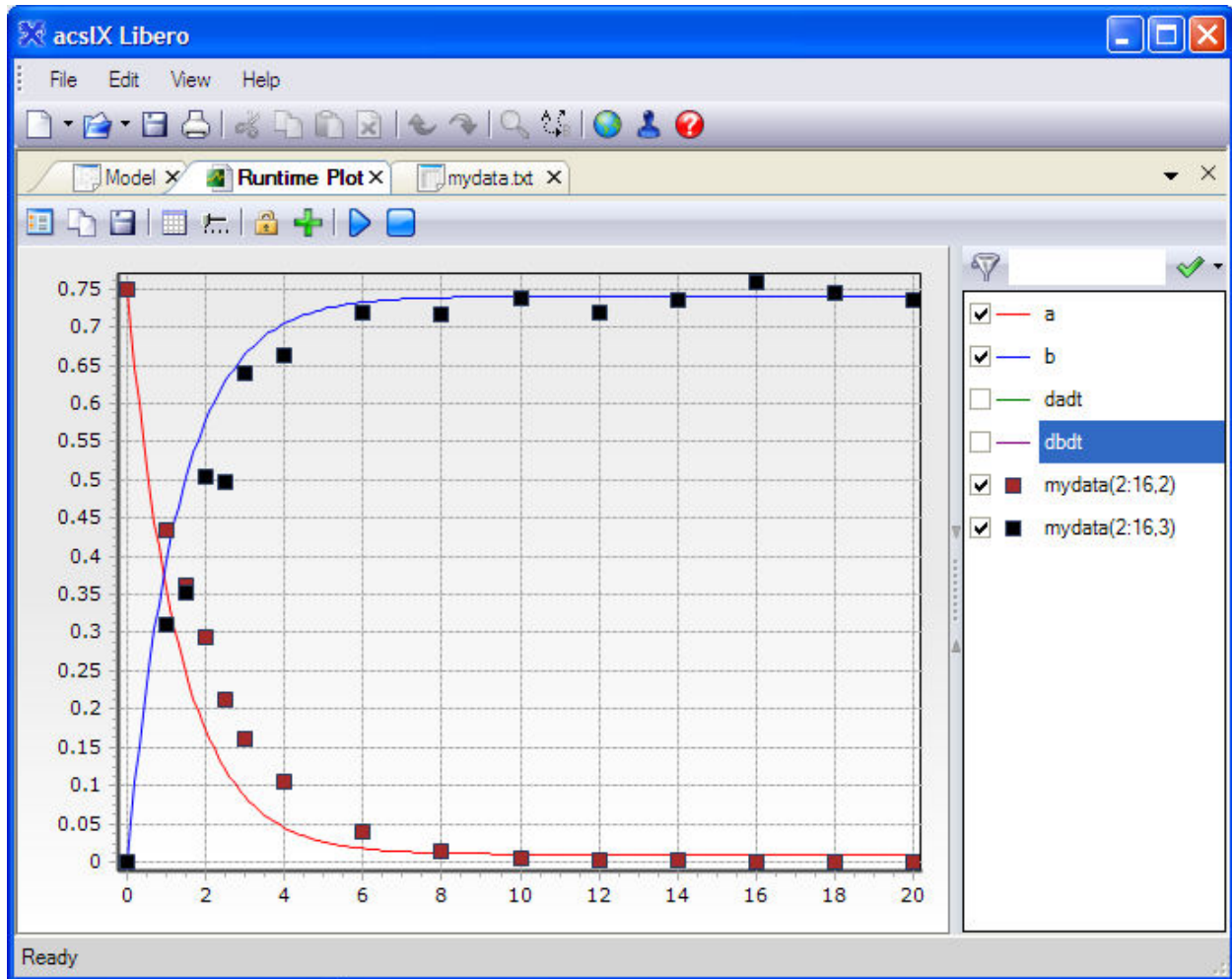
spreadsheet, use the “sheet” drop down button on the spreadsheet toolbar, and select the appropriate menu item.

To load an existing data set, click File -> Open -> Open Data Set.



To save this dataset, use the File -> Save menu item or toolbar button.

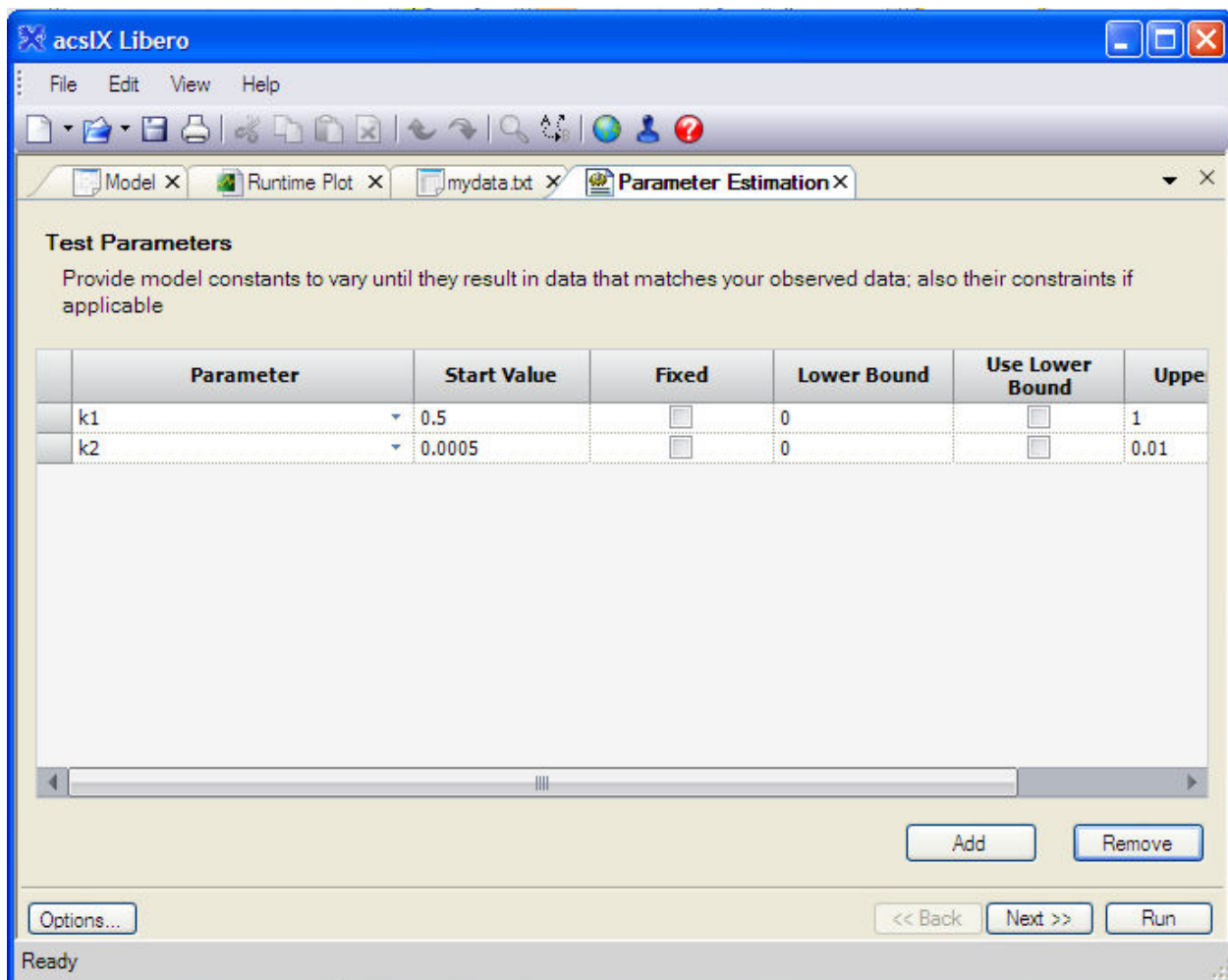
To plot the data in this data set, select the range of cells to be plotted, click the plot button on the spreadsheet toolbar, then click the “Plot Selected Range” menu item. To use a column other than the default for the x-axis values, select the desired column index in the dropdown list in this menu (“Column to use for x axis data”). This will cause the data to be plotted as a point series in the current runtime plot, overlaying any simulation results.



Parameter Estimation, Sensitivity Analysis, etc...

Parameter estimation, sensitivity analysis and Monte Carlo analysis can be performed as in the full acslX environment using Wizard dialogs. To create one of these analyses, select the appropriate option from the “New” menu: e.g., File -> New -> New Parameter Estimation. The same Wizard dialog used in acslX is displayed. The pages on these dialogs work similarly to the way they do in acslX, with a couple of important exceptions. First, since these files are loaded and saved via the File -> Open and File -> Save menu items, in contrast with the project tree metaphor used in acslX. Second the analyses are started using the “Run” button at the bottom of the wizard page, which takes the place of the “Finish” button in acslX. Otherwise, these analyses are

configured and executed in the same manner as in acslX; Libero and acslX use the same file formats for all of these analyses, in fact.



At the conclusion of the analyses, the same reports are displayed as in acslX.