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# ASW Reach-back Cell Oceanography Analysis System (ARCOAS) Version 3 User's Guide

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<b>14. ABSTRACT</b>  ARCOAS consists of customizations of ESRI's ArcMAP that make ArcMAP easier to use by the operational forecaster and oceanographer in the military support setting. This user manual gives setup instructions and describes functionality of each of the tools distributed with ARCOAS. The set of tools included in ARCOAS as well as the ArcGIS platform (ArcMAP) on which it runs assists the oceanographer forecasters at NAVOCEANO in analyzing geophysical data as it pertains to supporting the anti-submarine warfare mission. This system could be extended in support of other missions as well.						
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# 1. Introduction

ARCOAS is a user interface designed as a set of customizations of ArcMAP, a powerful software package using geographic information system (GIS) technology developed by Environmental System Research Institute (ESRI), Inc. A highly flexible programming language used in Microsoft Office applications, Visual Basic for Applications (VBA), is also built into ArcMAP and provides a rapid development path for invoking the powerful GIS functionality of ArcMAP coupled with helpful graphics classes of Microsoft Office Components. Thus, ARCOAS is designed and built with an object-oriented approach that incorporates listeners, dialog boxes, interactive displays, clickable buttons all put together to offer the user tools tailored to the work at hand. ARCOAS is made of classes and modules to make in interface that offers a certain environment and language in which the oceanographer is familiar and comfortable, while providing environmental information in a common geographic reference frame.

Implemented using a GIS display and associated GUIs, users can display geophysical data derived from observations collected in a variety of ways, their locations on the map and information about that data in tables and graphs. Geophysical parameters made available in four dimensions can be displayed on the map in 2-dimensional layers which can be enhanced for visualisation. Typically, this form of data which we will call a “dataset” but usually known as “models” comes from numerical model output intended to provide prediction information and typically comes in the form of netCDF files in the COARDS convention. Geophysical data for the purposes of supporting Naval operations both observations and model predictions of oceanographic and meteorological parameters include but are certainly not limited to temperature, salinity, currents, wind, humidity, pressure, and, water elevations.

The next section will provide guidance in setting up and installing ARCOAS to get the user started. Then a substantial section describes each of the user tools in detail. Included is an Appendix with tips on creating an animation and section with frequently asked questions.

## 2. Setting up

### 2.1 System Requirements

- Microsoft Windows XP Operation System (32-bit) Professional Edition with SP3
- ArcMAP with Spatial Analyst License
- ArcMAP Toolboxes
  - Conversion Tools
  - Data Management Tools
  - Multi-dimension Tools
  - Spatial Analyst Tools
- Microsoft Office 2003 or Microsoft Office XP (or if Microsoft Office 2007 is installed, Office Web Components version 12)
- Hardware
  - 1.6 GHz recommended or higher
  - Intel Core Duo, Pentium or Xeon Processors
  - 1 GB minimum RAM

- 24-bit colour depth display
- Screen resolution 1024x768
- Swap space 500 MB minimum
- Disk space 3.2 GB

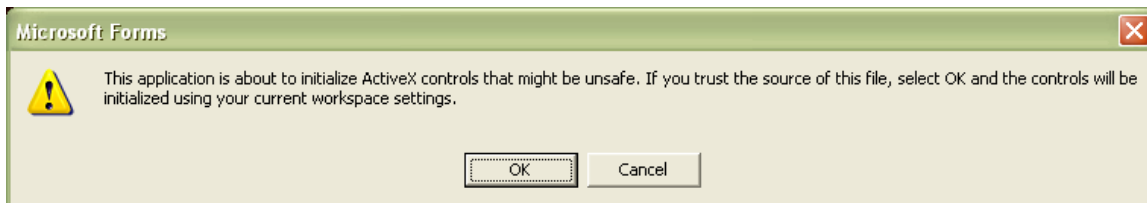
## 2.2 Installation

The installation process is user-oriented, i.e. it is controlled by the user and alters only user's environment and files. No administrative help is required.

1. Run the *ARCOAS\_Installation.vbs* script to install ARCOAS.
2. If the installation fails, verify that ArcMAP is installed on the computer by starting ArcMAP. Close ArcMAP then attempt to install ARCOAS again using the installation script.

## 2.3 Creating a Workspace

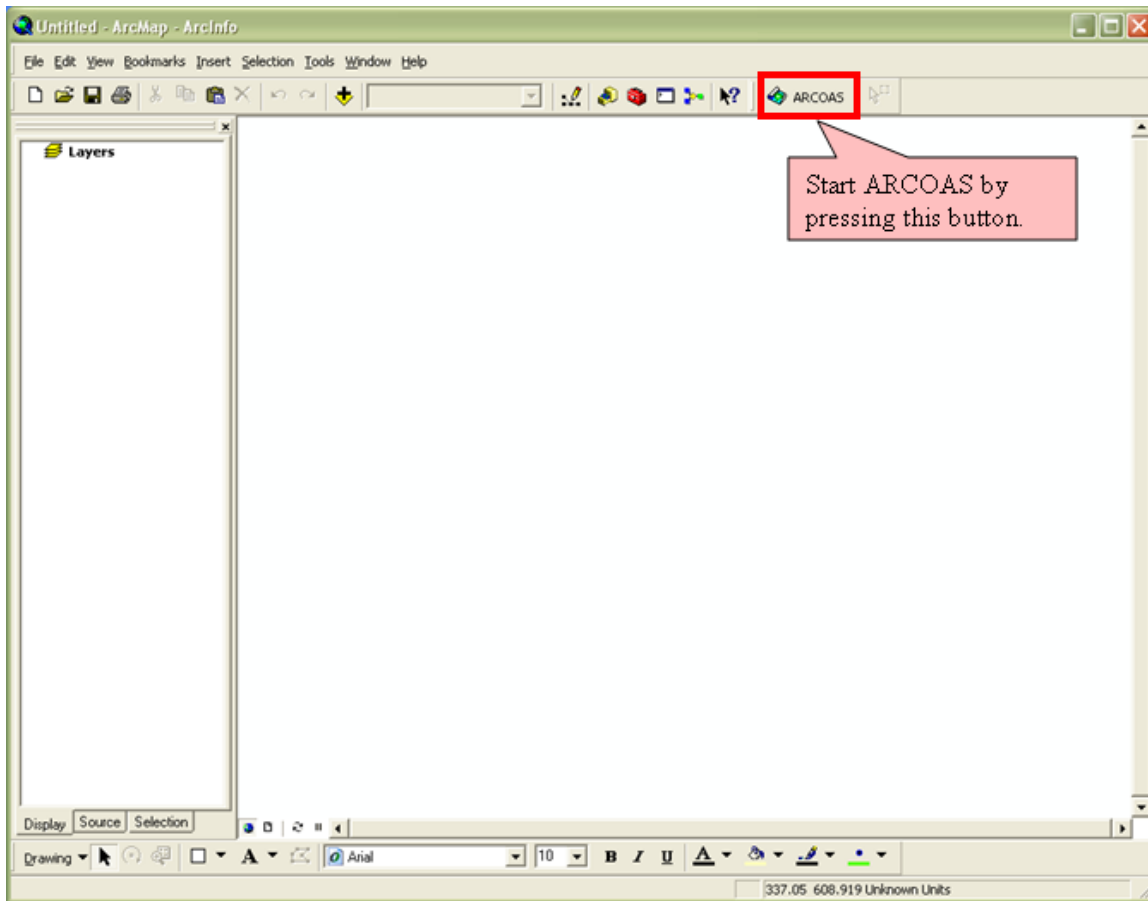
1. Start ArcMAP by using the ARCOAS icon on the desktop.
2. Click OK in response to the message box indicating that ActiveX controls are being used by the application (Figure 2.1).



**Figure 2.1: Warning dialog box indicating ActiveX controls could be unsafe.**

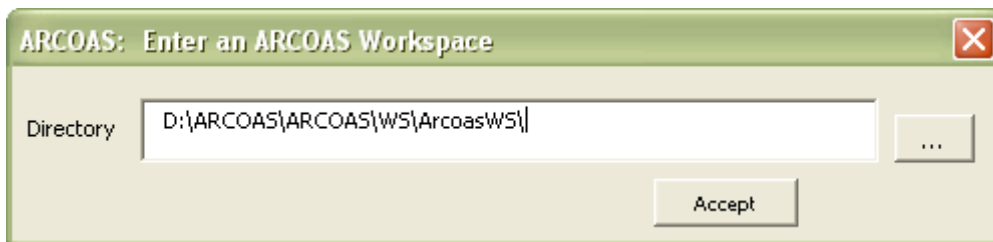
3. Open an existing map or create a new empty map.
4. Start ARCOAS by clicking the *ARCOAS* button in the ARCOAS toolbar (Figure 2.2).





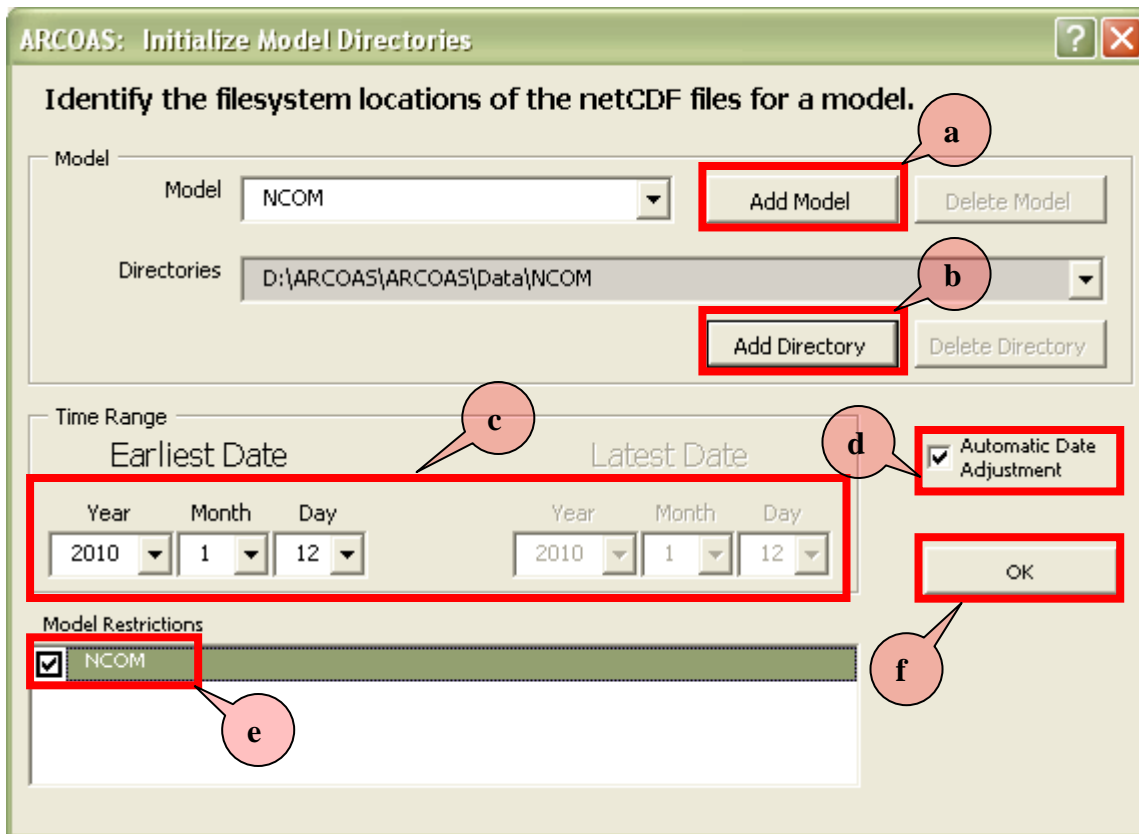
**Figure 2.2: Opening window of ArcMAP with the ARCOAS button indicated.**

5. Identify the file system location for storing the layer information created while using ARCOAS and click *Accept* (Figure 2.3).



**Figure 2.3: Initial workspace dialog box.**

6. When a workspace is initially created, the directory locations for the netCDF files being accessed are entered along with a date range to limit the ARCOAS functionality (Figure 2.4).
  - a. Click the *Add Model* button so that the group of netCDF files can be easily identified while using the ARCOAS functionality.
  - b. Click the *Add Directory* button to identify the file directory that the netCDF files are located.
  - c. Adjust the time range to include only the dates necessary.
  - d. Check the *Automatic Date Adjustment* box so that the time range is automatically adjusted to access the most recent files.
  - e. Check the models which will be used by ARCOAS.
  - f. Click the *OK* button when complete.

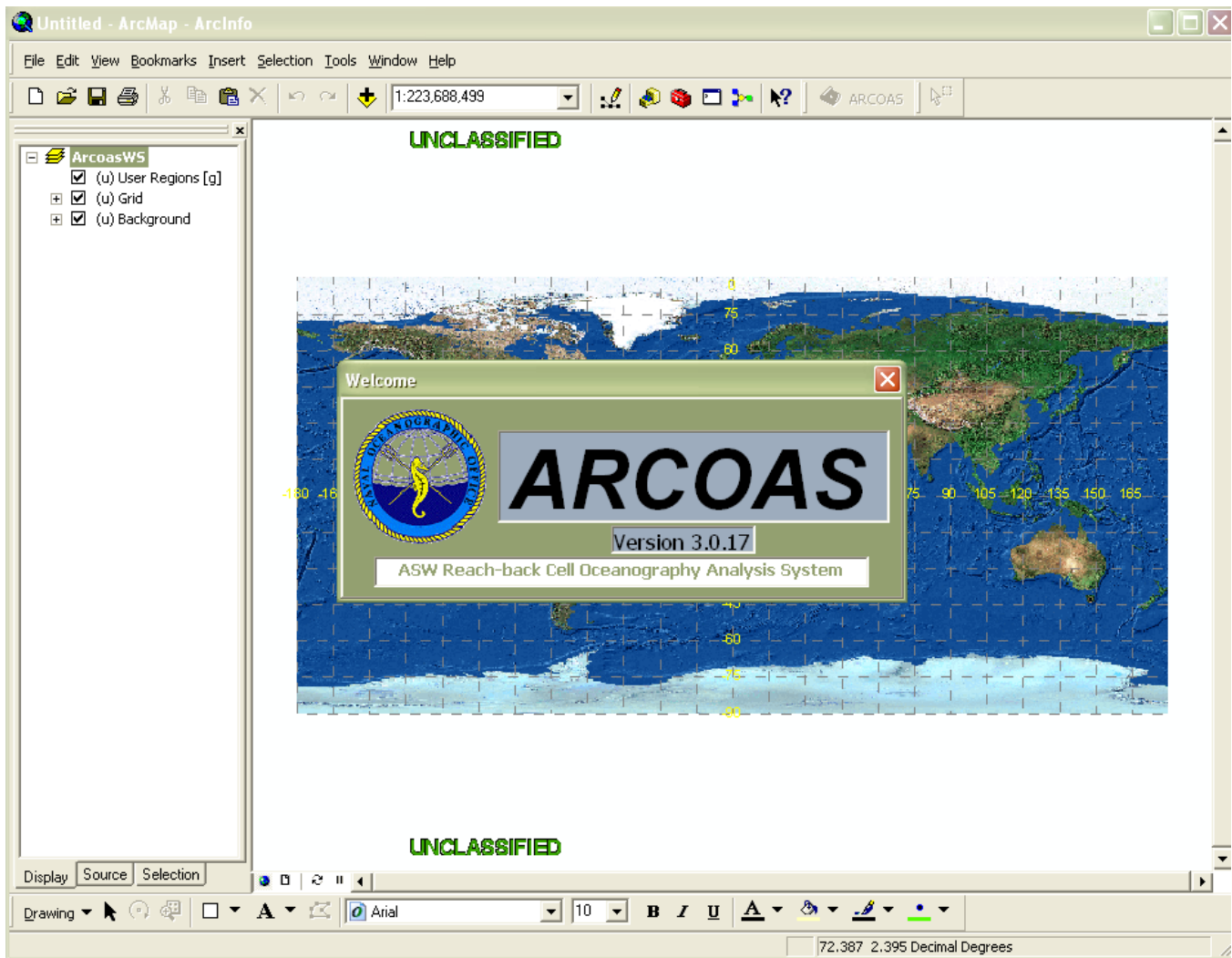


**Figure 2.4: Initialization of model data directories.**

NOTE: By setting the *Earliest Date* to nothing, all files in the *Model* directories prior to and including the *Latest Date* will be processed and accessible through ARCOAS.

NOTE: If model information is already accessible through ARCOAS, a dialog box will ask if the model information needs to be loaded. Loading the model information can take a significant amount of time if the netCDF files have been migrated; however, it is necessary for many of ARCOAS's tools to function properly.

7. The ARCOAS *Welcome* screen is displayed as the World Image is added and other startup options are being performed (Figure 2.5).



**Figure 2.5: Welcome screen and the world image is display whilst startup options are performed.**

8. If the *ARCOAS Tools* button is not visible, right click on the ArcMAP menu bar and select *ARCOAS Tools* from the list (Figure 2.6).

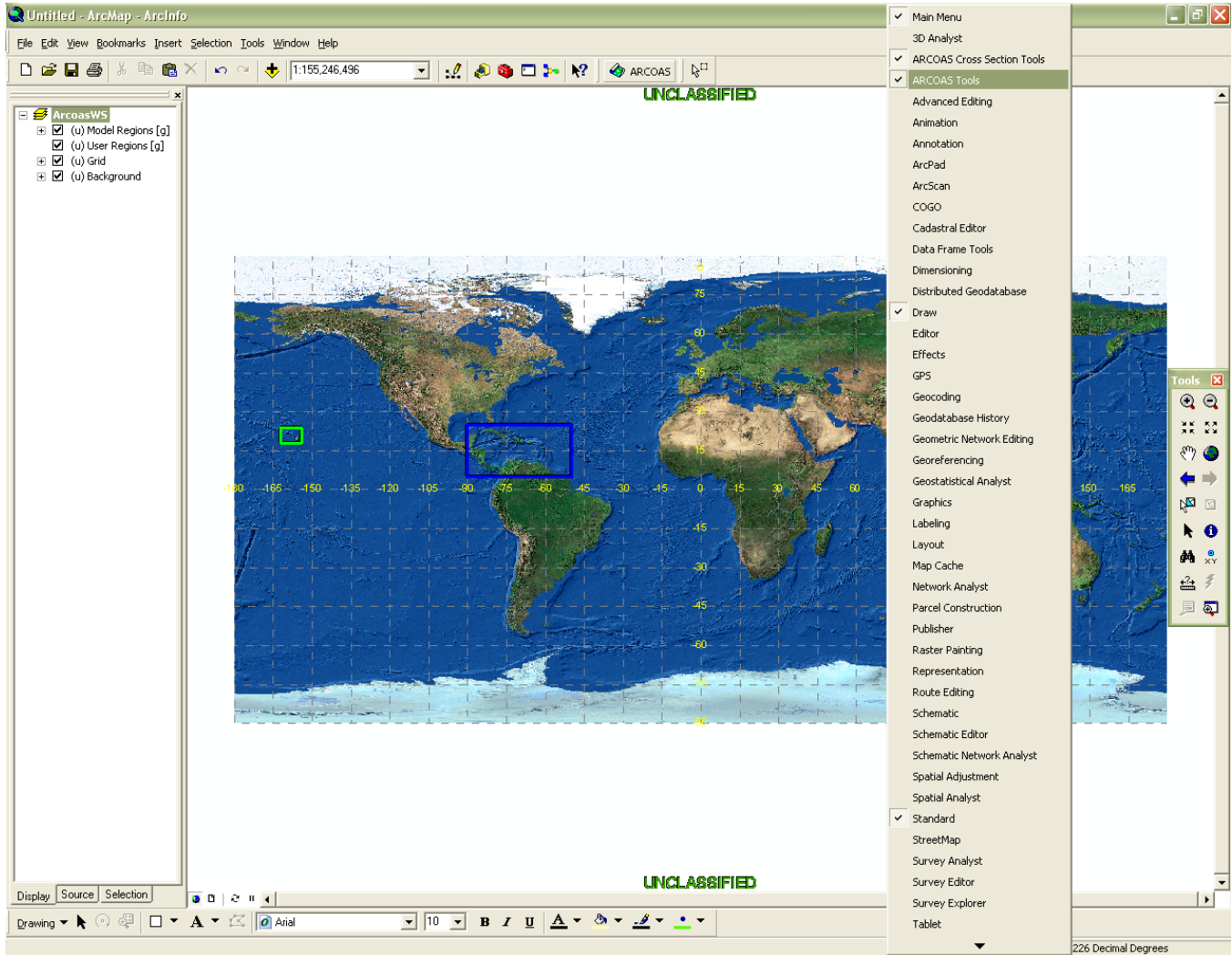


Figure 2.6: ARCOAS Tools Selection

### 3. Ongoing Features

ARCOAS has a few features not constrained to any particular tool. They are constantly maintained while operating ArcMAP. These features are:

1. Security classifications of layers are maintained and the highest security classification of all the layers is displayed.
2. The density and sizes of wind and water symbols are automatically adjusted based on the zoom level of the view (can be disabled).
3. A longitude-latitude grid is overlaid over the map. The grid is automatically adjusted based on the zoom level of the map.
4. The regions identified by the netCDF files included in the model directories are displayed in ArcMAP. The regions are color-coded based on the model name assigned during the setup process. When using the ARCOAS Tools, the region being accessed is highlighted.

## 4. ARCOAS Tools

The ARCOAS tools can be organized into four main categories: Layer adding, adjustments, analysis and maintenance (Figure 4.1). The layer adding tools are used to add raster and feature layers to ArcMAP while the adjustment tools manipulate these layers. The analysis tools are used to compare data added by the other tools. The maintenance tools provide access to ARCOAS settings and features that make the ARCOAS tools easier to use.

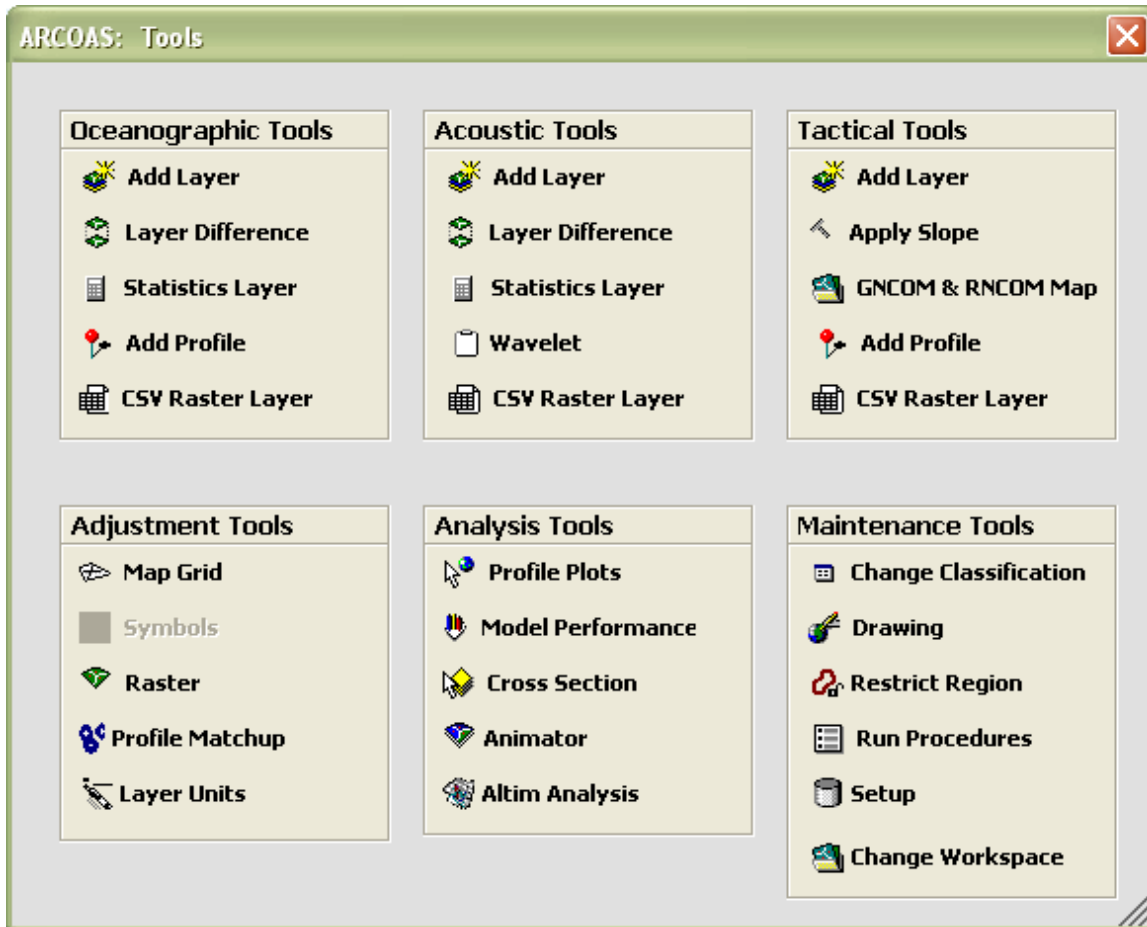


Figure 4.1: Main *Tools* menu.

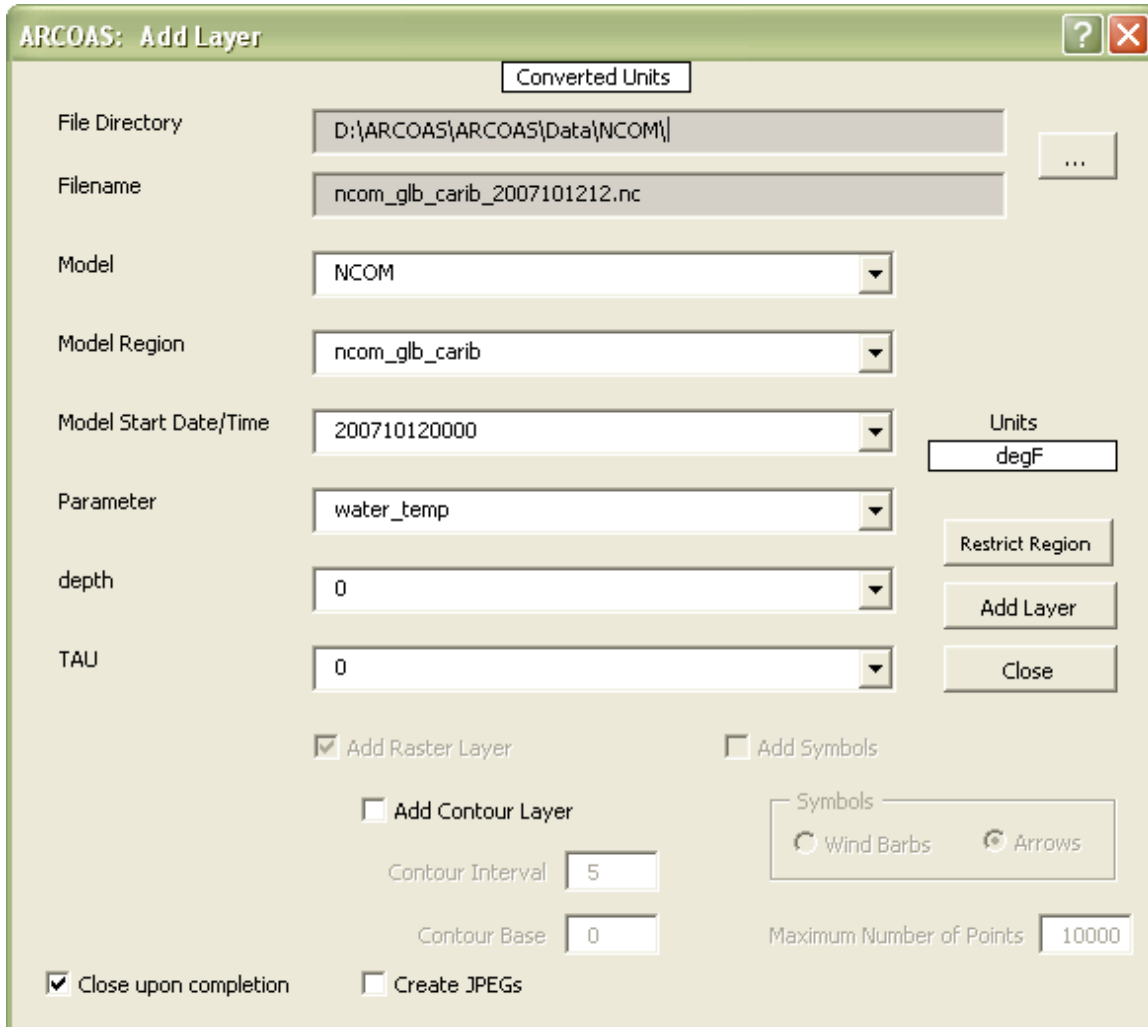
### 4.1 Layer Adding

#### 4.1.1 Adding a raster layer

The *Add Layer* tool is used to create new raster layers in ArcMAP by accessing netCDF files (Figure 4.2). The tool has four main functions:

1. Create a raster layer based on a selected parameter, depth, and forecast hour (TAU). Contours for a raster layer can also be created.
2. Add wind barbs or arrows for parameters associated with magnitude and direction parameters in a netCDF file.

3. Add wind barb or arrows by calculating the magnitude and direction based on u/v components from a netCDF file.
4. Add a sound speed raster layer by calculating the sound speed using water temperature and salinity parameters.



**Figure 4.2:** *Add Layer* dialog box.

The parameter name is used to identify which function is being performed by the tool. If the parameter ends with “\_mag/dir”, symbols will be created based on magnitude and direction parameters from the netCDF file. If the parameter ends with “\_u/v”, symbols will be created based on calculations for magnitude and direction from u/v components in the netCDF file. If the parameter ends with “\_soundspeed”, a raster layer will be created based on calculations for sound speed from water temperature and salinity components in the netCDF file. The magnitude, direction, u-, and v-components being searched for within the netCDF file are adjustable within the *ARCOAS Settings* (Section 4.4.5.1.2). All other parameters signify that a raster layer will be created based on the parameter.

#### 4.1.1.1 *Selecting the NetCDF file*

To select the netCDF file to base the layer being created, two approaches are available. Primarily, the file is chosen by selecting the *Model* that is associated with the netCDF file, followed by selecting the *Model Region* encompassed by the netCDF file and finally the *Model Start Date/Time*. Once the *Model* is selected, the *Model Region* can be selected by clicking on the map near the desired region. These three options generally narrow the available netCDF files to a single file for the parameter to be selected. The second approach uses the file browser to locate the netCDF file required.

#### 4.1.1.2 *Selecting the parameter*

Once the netCDF file being accessed is determined, the parameter being displayed is selected followed by the depth/height and TAU of the parameter. If the parameter cannot be used to add symbols to ArcMAP, the only options available are whether or not to include a contour of the raster and the contour's interval. If the parameter can be used to add symbols to ArcMAP, options are available to identify the type of symbol being added, wind barbs or arrows, and to limit the maximum number of symbols to include in the layer.

#### 4.1.1.3 *Unit conversions*

The final option is to determine the units of the resulting layer. The units for the layer being created are displayed in the Units label. This conversion affects only the resulting layer(s) in ArcMAP, not the data in the netCDF file. The units may be able to be adjusted by clicking on the label at the top of the tool; this option switches between the native netCDF units and converted units.

#### 4.1.1.4 *Layer creation*

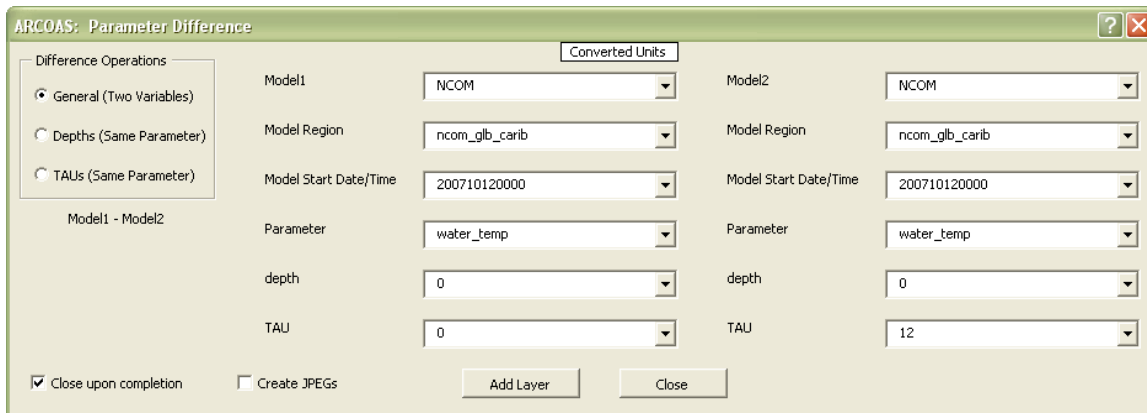
Once the parameter is chosen and the options have been selected, the layer in ArcMAP is created using the *Add Layer* button. The coloring scheme for a raster is specified by the *Parameter Color Schemes* (Section 4.4.5.2) and the *ARCOAS Settings* (Section 4.4.5.1.3). For the rasters displayed with a stretch renderer, the high and low values are based on the values in the netCDF file for the parameter or as defined by the *Parameter Color Scheme*. Symbol density and size are adjusted based on the current zoom level. Manual adjustments to the symbols are possible using the *Adjust Symbols* tool (Section 4.2.2).

A raster with a size smaller than the netCDF region can be created by pushing the *Restrict Region* toggle button down then using the mouse to create a box depicting the desired raster's size and location. The resulting layers which are restricted in size will still depend on the options from the combo boxes and option boxes.

A copy of the layer can be saved as a JPEG file by selecting the *Create JPEGs* option.

### 4.1.2 Differences between two layers

The *Layer Differences* tool creates a raster layer in ArcMAP that displays the differences between two parameters (Figure 4.3). The difference can be based on comparing the same parameter for different depths/heights or different TAUs, or the difference can be based on any two parameters from any two models as long as the models' regions overlap. The *Depth* and *TAU* difference operations are provided to simplify the selections when the same parameter is being compared based on different depths/heights or TAUs, respectively.



**Figure 4.3: ARCOAS - Layer Difference dialog box.**

#### 4.1.2.1 Selecting the NetCDF file and parameter

To select the netCDF files being used to create the difference layer, the *Models* that are associated with the netCDF files are selected, followed by selecting the *Model Regions* encompassed by the netCDF file and finally the *Models Start Date/Time*. Once the *Model* is selected, the *Model Region* can be selected by clicking on the map near the desired region (Left-click for *Model1*, Right-click for *Model2*). The parameters being compared are then selected followed by the depth/height and TAU of each parameter.

#### 4.1.2.2 Layer creation

The difference layer is created using the *Add Layer* button. The coloring scheme for the difference raster is specified by the *Parameter Color Schemes* (Section 4.4.5.2) or the *ARCOAS Settings* (Section 4.4.5.1.3). For the rasters displayed with a stretch renderer, the high and low values are based on the differenced values in the raster or as defined by the *Parameter Color Scheme*.

A copy of the layer can be saved as a JPEG file by selecting the *Create JPEGs* option.

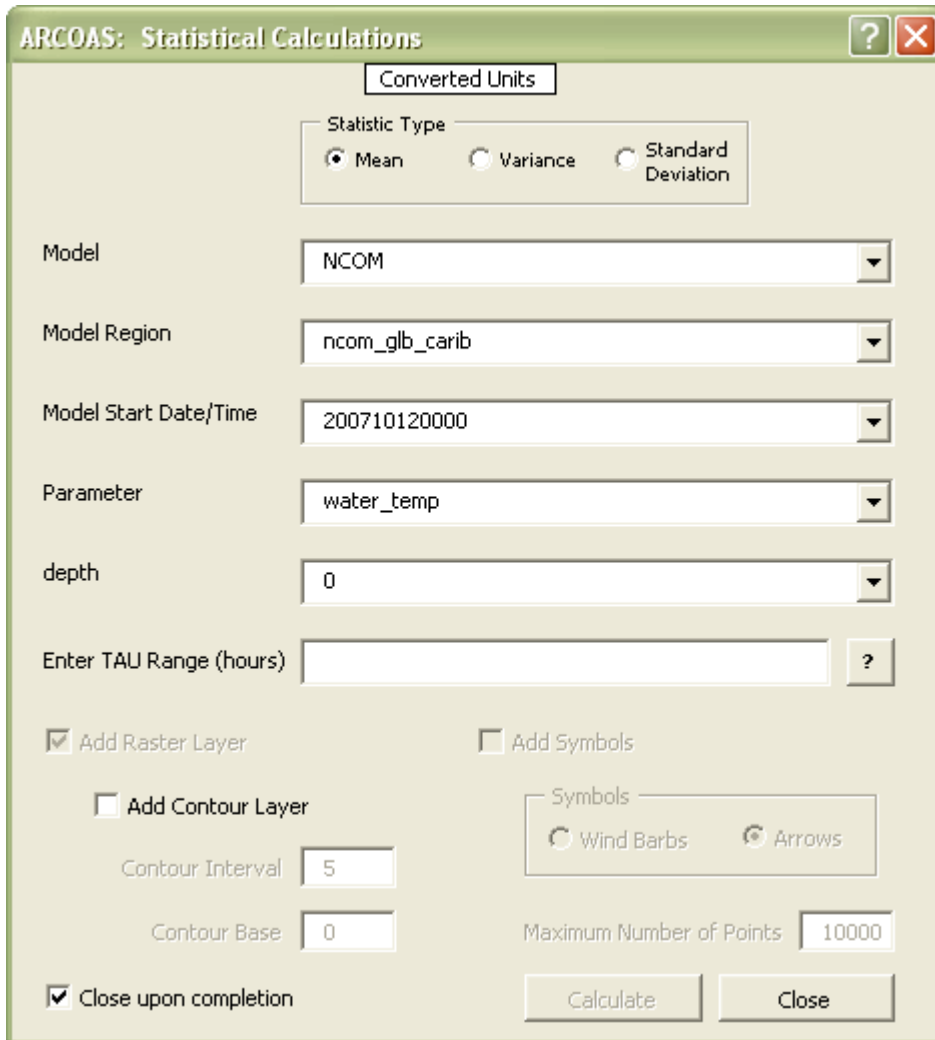
#### 4.1.2.3 Unit conversions

The option is provided to convert all of the values displayed by the ARCOAS tools between the netCDF files native units and converted units. By clicking on the label at the top of the tool, this option switches between the native units and converted units. The resulting layer will also be in the units chosen.

### 4.1.3 Statistics for a series of layers

The *Statistical Calculations Layer* tool is used to create a new layer in ArcMAP by calculating the mean, variance, or standard deviation of a parameter's value over a series of TAUs (Figure 4.4). The type of calculation is determined by the *Statistic Type* selected when the *Calculate* button is pressed.





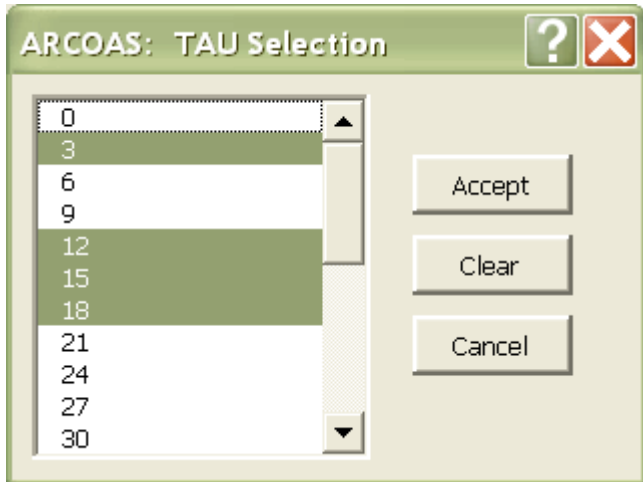
**Figure 4.4:** *Statistical Calculation Dialogue box.*

#### 4.1.3.1 *Selecting the NetCDF file*

To select the netCDF files being used to create the statistical layer, the *Model* that is associated with the netCDF file is selected, followed by selecting the *Model Region* encompassed by the netCDF file and finally the *Model Start Date/Time*. Once the *Model* is selected, the *Model Region* can be selected by clicking on the map near the desired region.

#### 4.1.3.2 *Selecting the parameter*

Once the netCDF file being accessed is determined, the parameter that the statistic is based upon is selected followed by the depth/height of the parameter. The TAUs being used for the statistic's calculation are determined by the TAU range string entered. A *TAU Selection* tool is provided to help create a valid TAU range.



**Figure 4.5:** *TAU Selection* dialogue box.

#### 4.1.3.3 *Layer creation*

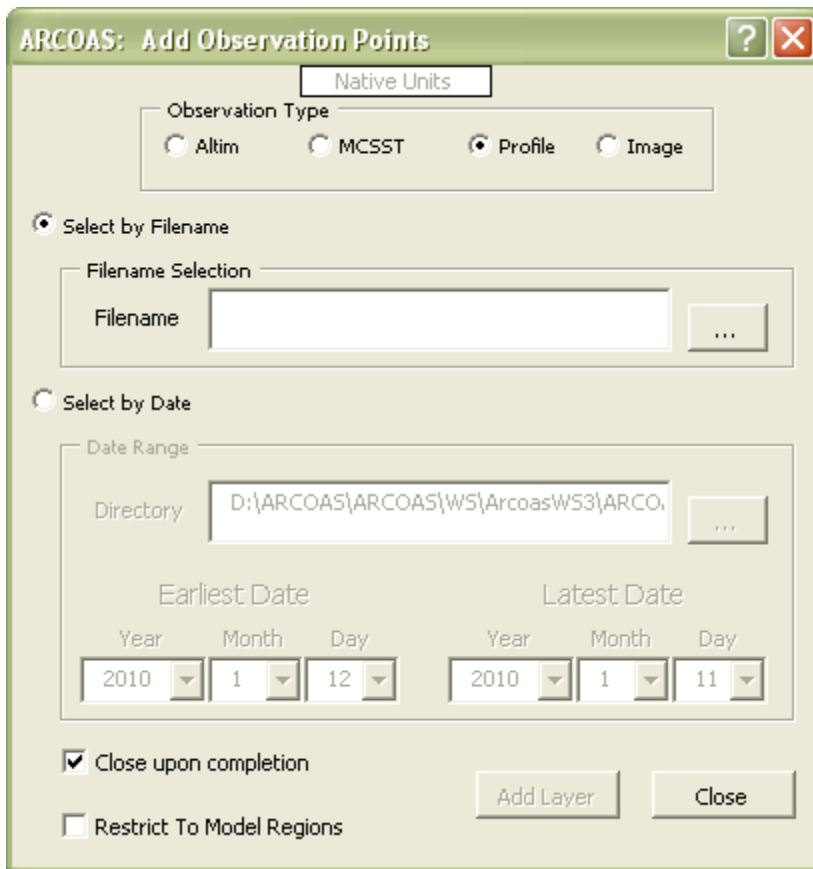
Once the parameter has been chosen and the TAU range has been entered, the layer in ArcMAP is created using the *Calculate* button. The coloring scheme for a raster is specified by the *Parameter Color Schemes* (Section 4.4.5.2) and the *ARCOAS Settings* (Section 4.4.5.1.3). For the rasters displayed with a stretch renderer, the high and low values are based on the values in the raster or as defined by the *Parameter Color Scheme*. Symbol density and size are adjusted based on the current zoom level. Manual adjustments to the symbols are possible using the *Adjust Symbols* tool (Section 4.2.2).

#### 4.1.3.4 *Unit conversions*

The option is provided to convert all of the values displayed by the ARCOAS tools between the netCDF files native units and converted units. By clicking on the label at the top of the tool, this option switches between the native units and converted units. The resulting layer will also be in the units chosen.

#### 4.1.4 *Adding observation data*

The *Add Observation Points* tool is designed to read varying observation files and display the results in ArcMAP (Figure 4.6). The file formats supported are binary files containing profile data; binary and ASCII files containing altimeter data; binary, ASCII, and netCDF files containing MCSST (multi-channel sea surface temperature) data; and image files.



**Figure 4.6:** *Add Observation Points* dialog box.

#### 4.1.4.1 *Selecting the observation files*

In order to use the *Add Observation Points* tool, the first option is to choose the observation type being read. Then, the option is provided to process a single file or multiple files at once. The *Select by Filename* option is selected to process a single observation file. The observation file's path is either typed in the textbox or entered by using the file browser provided. To process multiple observation files at once, the *Select by Date* option is used. Enter the directory that the observation files are located and set the time range for observation file inclusion.

#### 4.1.4.2 *Layer creation*

Clicking the *Add Layer* button reads the observation file(s) and organizes the layers in ArcMAP. The layers created have points indicating the locations that the observations occurred. The profile points are colored so that the newer observations are darker than the older observations. The altimeter points are colored based on the sea surface height anomaly value, and the MCSST points are colored based on the sea surface temperature value. For MCSST data, raster layers are created and displayed in order to speed up the map refreshes. All of the data from the files are contained in the created feature layers' table.

The *Restrict to Model Regions* option is enabled for the profile observations. This option allows only the profile observations within the range of the model regions to be added to the feature layer.

#### 4.1.5 Importing CSV data to make a raster layer

The *CSV Raster to Layer* tool is designed to read a CSV (comma-separated values) file and display the results as a raster in ArcMAP (Figure 4.7). The tool allows for the display field and cell size to be adjusted prior to layer creation.

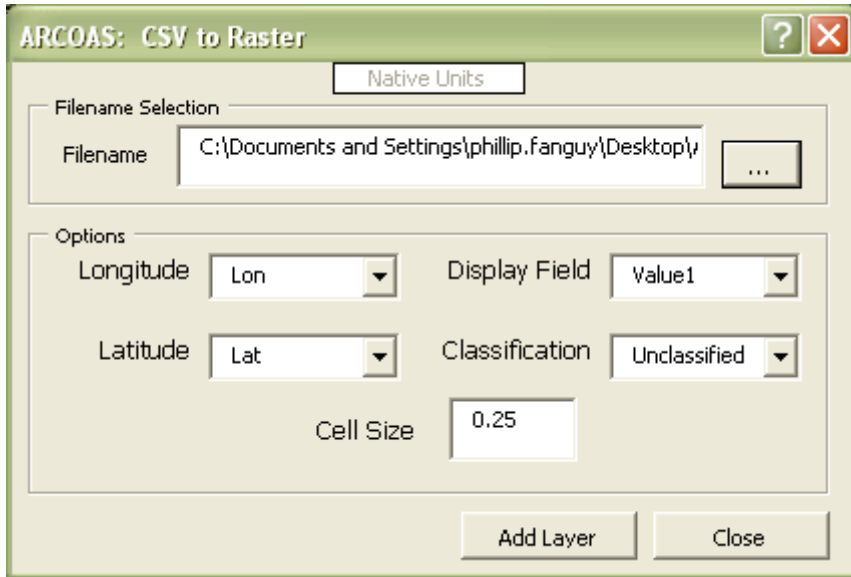


Figure 4.7: *CSV to Raster* dialog box.

##### 4.1.5.1 Selecting the CSV file

In order to use the *CSV to Raster Layer* tool, the CSV file's path is either typed in the textbox or entered by using the file browser provided. Once the CSV file is selected, the options are filled with the potential values to create the raster layer. Multiple CSV files can be processed simultaneously by selecting multiple files from the file browser. The options for longitude and latitude are taken from the first CSV file in the list.

##### 4.1.5.2 Creating the raster layer

Clicking the *Add Layer* button reads the CSV file and adds the layer to ArcMAP. The values used to create the raster are determined by the *Display Field* selected.

#### 4.1.6 Wavelet files: converting to netCDF and displaying

The *Wavelet Conversion* tool is designed to read a wavelet file, convert to netCDF, and display the results as a raster in ArcMAP (Figure 4.8). The resulting layer is still connected to the netCDF file and can be used to create cross-sections. The netCDF files created during the wavelet conversion process are placed in the *Wavelet* directory of the workspace and can be accessed using the existing ARCOAS tools.

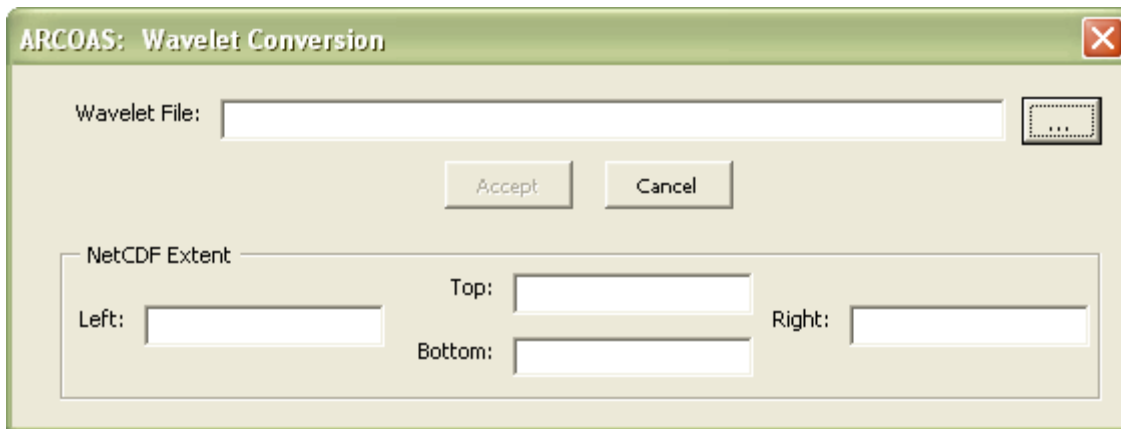


Figure 4.8: Wavelet Conversion dialog box.

#### 4.1.6.1 Selecting the wavelet file

In order to use the *Wavelet Conversion* tool, the wavelet file's path is either typed in the textbox or entered by using the file browser provided. Once the wavelet file is selected, the area of the wavelet file is displayed in the map as a white rectangle. Prior to adding the wavelet information as a layer, the resulting netCDF data can be restricted to a subset of the wavelet file by drawing a box with the mouse which is displayed in orange or set manually using the *NetCDF Extent* boxes. Multiple wavelet files can be processed simultaneously by selecting multiple files from the file browser.

#### 4.1.6.2 Layer creation

Clicking the *Accept* button converts the wavelet file to a netCDF file and adds the layer to ArcMAP. The netCDF file is located in the Wavelet directory of the workspace. The raster layer is connected to the netCDF file and can be used to create a cross-section.

#### 4.1.7 Slope of a raster layer

The *Raster Slope* tool is designed to calculate the slope of an existing raster layer and display the results as a raster in ArcMAP (Figure 4.9). In order to use the *Raster Slope* tool, the existing layer is selected using the combo box which lists all of the existing raster layers in the map. The type of units for the output layer is selected as either degrees or percentage as well as the Z factor which adjusts the output as well. The slope layer is created using the *OK* button.

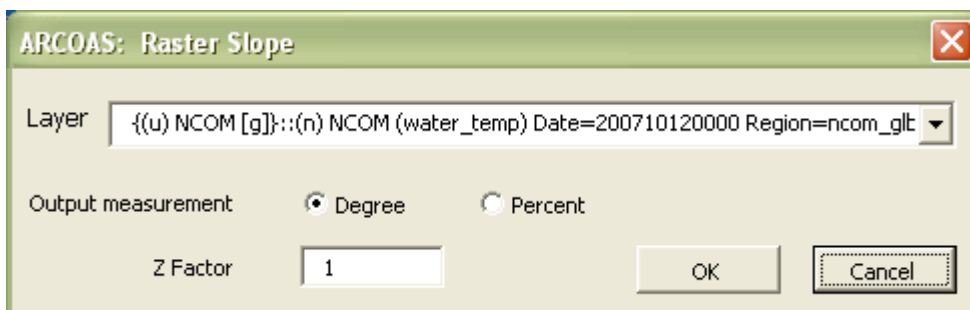


Figure 4.9: Raster Slope dialog box.

## 4.2 Layer Adjustments

### 4.2.1 Color enhancement of raster layers

The *Raster Layer Configuration* tool allows the color scheme for existing raster layers in ArcMAP to be changed easily (Figure 4.10). It allows for multiple raster layers to be set with the same options simultaneously. First, the rasters which are being adjusted are selected from the list of rasters in the *Raster Selection* frame. Next, the new color scheme of the selected rasters is chosen either using existing color schemes created by the *Parameter Color Scheme* tool (Section 4.4.5.2.1) or by manually setting the color scheme. The *New/Edit* button allows access to the *Parameter Color Scheme* tool to permanently edit an existing color scheme or to create a new color scheme.

#### 4.2.1.1 Manual stretch renderer

For a stretch renderer type, the adjustable settings for the rasters include the number of color ramps used by the stretch render, the *Maximum* and *Minimum* values for the raster and the colors associated with the maximum and minimum values for each color ramp. Setting both the *Maximum* and *Minimum* values to 0 allows the selected rasters to adjust the high and low values based on the values within the rasters. The *Null Value* is used to identify the value that will be ignored by the renderer and displayed with a transparent color. The *Symbol* color is changed by double-clicking the symbol box associated with each color ramp color. An *Invert* checkbox exists in order to easily reverse the order of the color ramps.

#### 4.2.1.2 Manual classified renderer

For a classified renderer type, the adjustable settings for the raster include the number of classification levels being rendered as well as the *Maximum* and *Minimum* values for each classification level being rendered. The *Symbol* color is changed by double-clicking the symbol box associated with each classification level.

#### 4.2.1.3 Automate scheme

A classified renderer can be automated by using the following process:

1. Select the *Color Scheme* type.
2. Select the number of levels for the classified renderer.
3. Input a minimum value for the top level.
4. Assign a color for the top level.
5. Input a maximum value for the bottom level.
6. Assign a color for the bottom level.
7. Click the *Automate Scheme* button.

The classified renderer will be created by entering evenly divided values for each level and colors between the two colors selected.

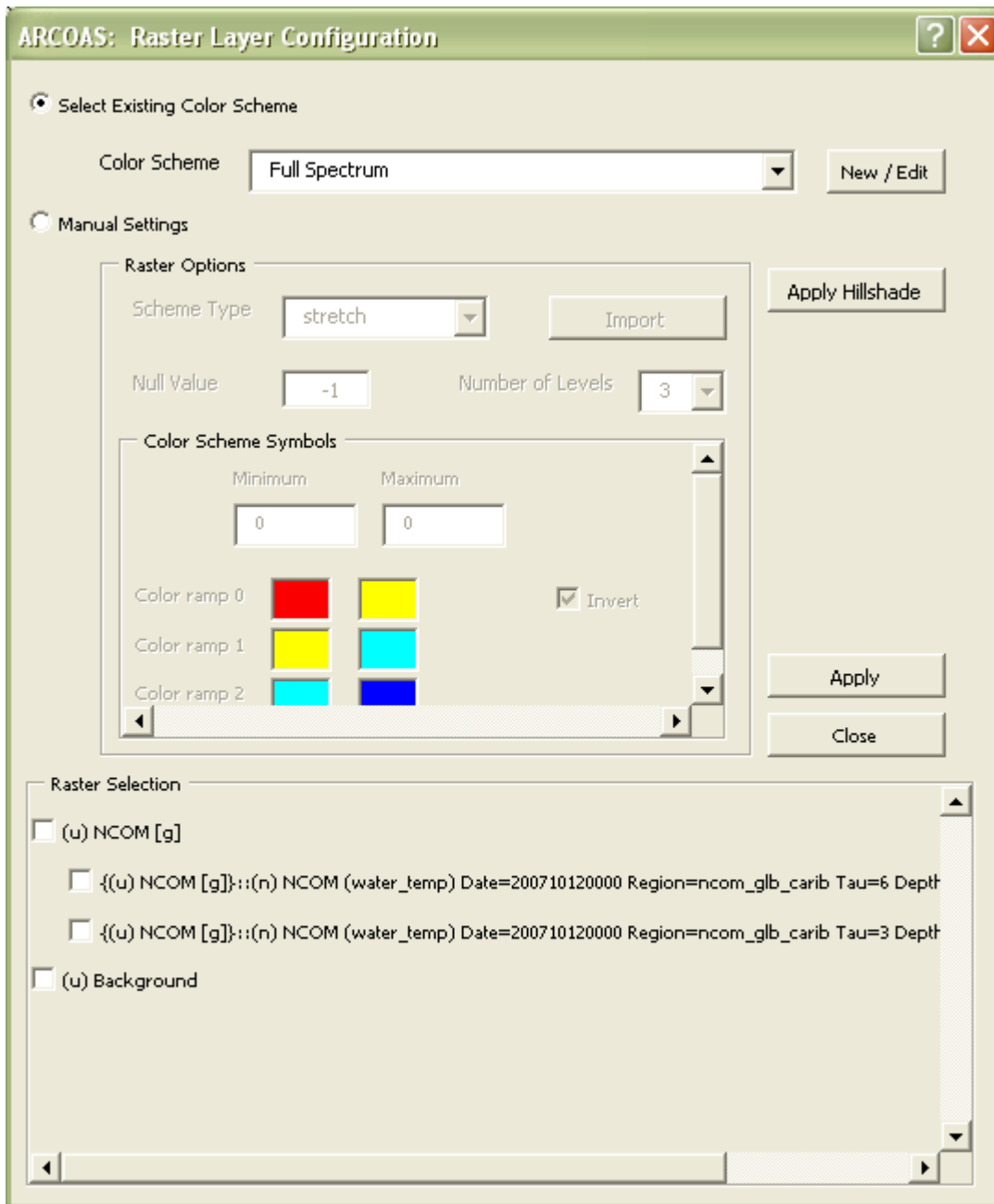


Figure 4.10: *Raster Layer Configuration* dialog box.

#### 4.2.1.4 *Import layer renderer*

An *Import* button is provided to load the renderer information from a raster layer into the *Manual Settings* frame. The renderer information that is imported includes:

- The scheme type (*Stretch* or *Classified*)
- The null value (*Stretch* renderer only)
- The number of levels
- The *Minimum* and *Maximum* values for the color ramps/classification levels

- The colors for the color ramps/classification levels
- Whether the color ramps are inverted or not (*Stretch* renderer only)

#### 4.2.1.5 Apply color scheme

The *Apply* button pushes the changes to the selected layers in ArcMAP.

#### 4.2.1.6 Raster hillshade

A hill shade can be applied to any raster layer in the map by selecting the *Raster Hillshade* button. The raster layer having the hill shade applied is selected using the *Layer* combo box. The tool allows the *Azimuth*, *Altitude*, *Z Factor* and *Model shadows* to be adjusted. The *Azimuth* is the angle of the light source and it is a value in degrees between 0 and 360 measured clockwise from north. The *Altitude* is the angle of the light source above the horizon and it is a value in degrees between 0 and 90 with 0 degrees being at the horizon and 90 degrees being directly overhead. The *Z Factor* is the number of ground x-y units in one surface Z unit. The Z values are multiplied by the *Z Factor* when calculating the raster layer. The *Model shadows* option allows both local illumination angles and shadows to be considered for the output. Once the hill shade layer is created, it is placed under the original raster layer and grouped with the original raster layer. The original raster layer is made partially transparent so that the hill shade can be seen.

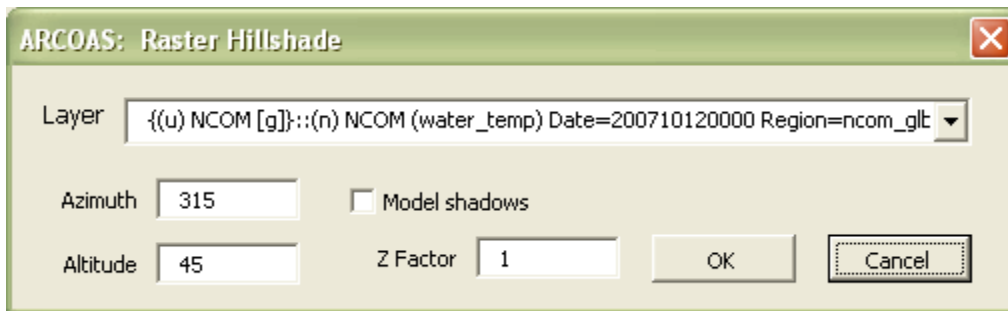


Figure 4.11: *Raster Hillshade* dialog box.

#### 4.2.2 Arrows and wind barb symbol adjustment

The *Adjust Symbol Density* tool is utilized to change the density and size of the wind barb and arrow symbols (Figure 4.12). The utility can only be used if a layer containing wind barbs or arrows is visible in ArcMAP. The tool is used by first selecting from the *Feature Layer* combo box the layer that will have its symbols adjusted. The number of symbols being displayed by the layer is adjusted by using the *Thin Arrows* slider bar. The bar is moved to the left to display no symbols and to the right to display all of the symbols. The size of the symbols is adjusted using the *Arrow Size* combo box which indicates the font size of the symbol. The *Speed Minimum Threshold* is used to further thin the symbols so that the focus can be placed on the symbols greater than some value. The *Symbol Color* option adjusts the color of the arrows while the *Flip Symbols* button flips the symbols in the selected layer 180°.



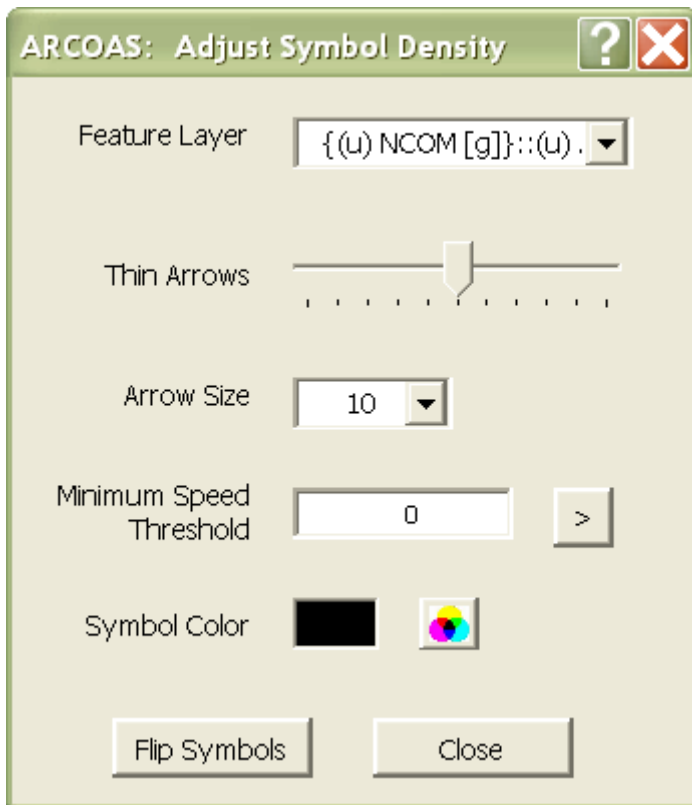


Figure 4.12: *Adjust Symbol Density* dialogue box.

#### 4.2.3 Map grid adjustment

The *Adjust Grid* tool is utilized to change the density of the grid overlaid on the map (Figure 4.13). The utility can only be used if the grid layer is visible in ArcMAP. The bar is slid to the left to enlarge the gap between the grid lines and to the right to shrink the gap between the grid lines.

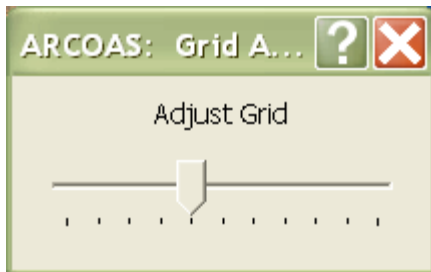
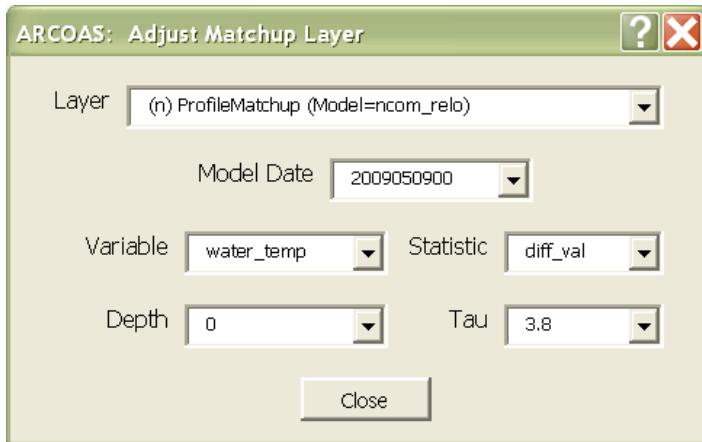


Figure 4.13: *Adjust Grid* dialogue box.

#### 4.2.4 Matchup layer adjustment

The *Adjust Matchup Layer* tool is designed adjust the *Layer* in ArcMAP to display a *Statistic* of a *Variable* for a particular *TAU* and *Depth* (Figure 4.14).



**Figure 4.14:** *Adjust Matchup Layer* dialogue box.

#### 4.2.4.1 *Selecting the matchup layer*

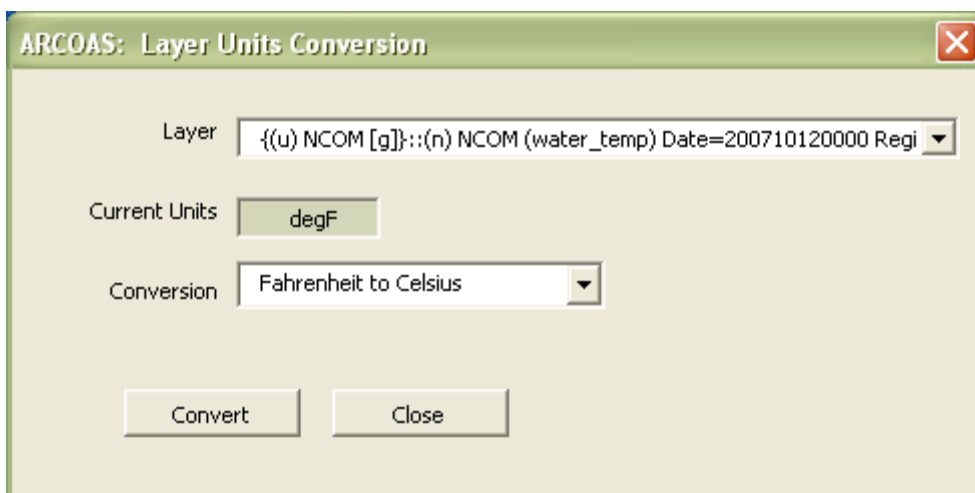
In order to use the *Adjust Matchup Layer* tool, the matchup *Layer* is selected from the *Layer* combo box.

#### 4.2.4.2 *Layer adjustments*

To display particular results for a layer, the *Depth*, *Tau*, and *Model Date* combo boxes are used to filter the information in the layer. The display is refreshed as soon as a selection is made for one of these combo boxes. The statistic being displayed can also be changed by using the *Variable* and *Statistic* combo boxes. Depending on the variable and statistic being displayed, the ranges of values vary for the color scheme.

#### 4.2.5 *Layer units conversion*

The *Layer Units Conversion* tool is designed to convert the units of the data referenced by the *Layer* (Figure 4.15). First, the *Layer* being converted is selected. The units of the data are displayed in the *Current Units* box. Based on the *Layer's* units, the possible conversions for the *Layer* are displayed by the *Conversion* box. The *Convert* button is used to perform the unit conversion for the *Layer*.



**Figure 4.15:** *Layer Units Conversion* dialogue box.

## 4.3 Analysis

### 4.3.1 Profile plotting – observed and modelled data

The *Profile Plotting* tool allows for observational data and model data to be compared through the use of a plot (Figure 4.16). To produce a comparison plot, a profile layer must have been added to ArcMAP using the *Add Profile* tool prior to opening the *Profile Plotting* tool and access must be available to the model's netCDF files by using the *Model* selection Interface. After the tool is opened, plots are produced whenever the mouse is left-clicked in ArcMAP within range of either a observation point (when *Click Observation Point* is selected) or within range of the Model's netCDF file (right-clicking changes the *Model Region*).

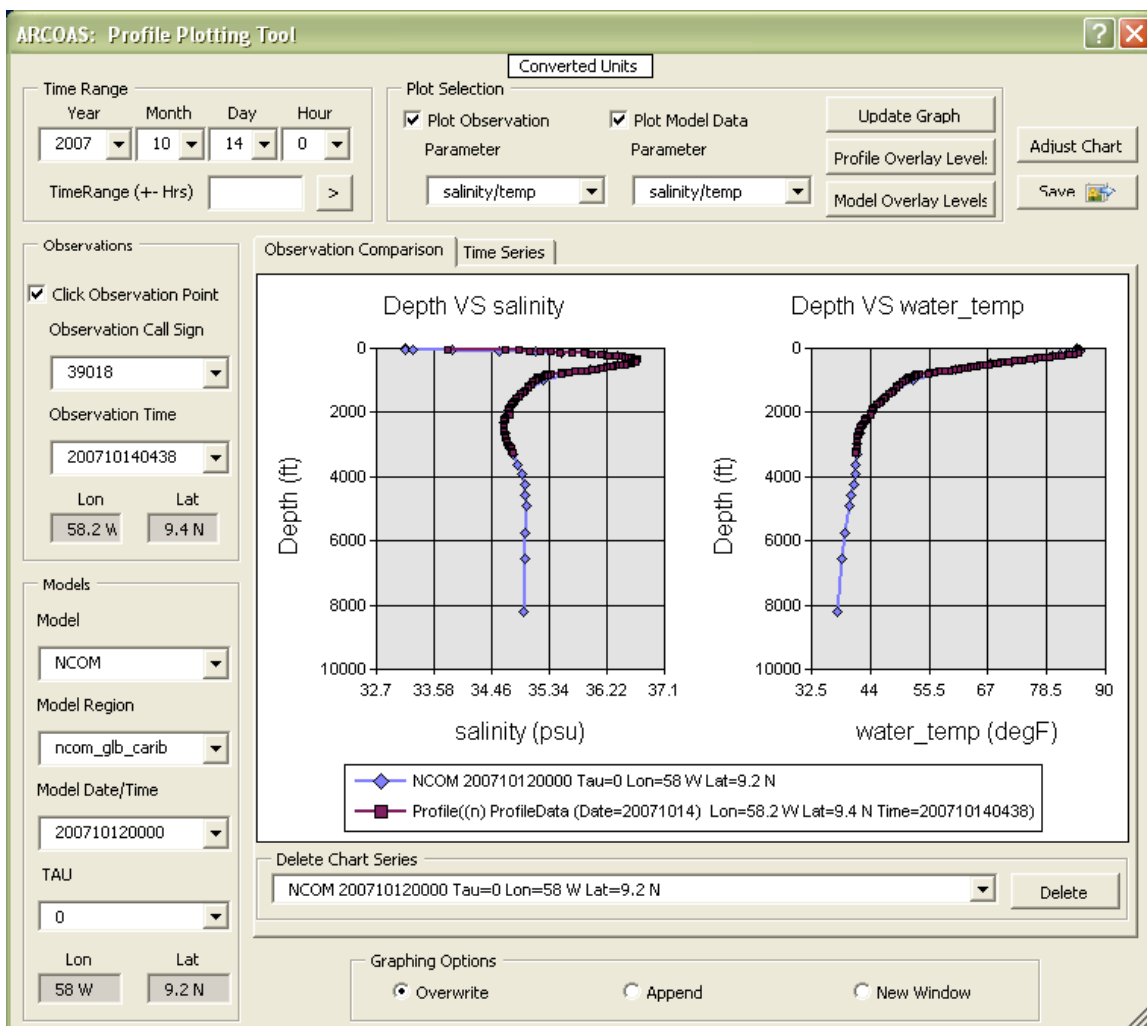
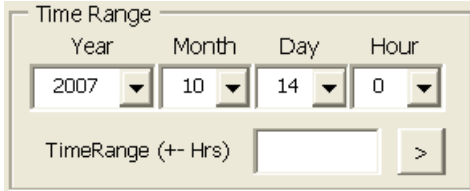


Figure 4.16: Profile Plotting dialogue box.

#### 4.3.1.1 Observation and model data restrictions

To restrict the profile and model data available for plotting, the Time Range is adjusted (Figure 4.17). Only the observations and model TAUs which occur within the specified number of hours of the date will be selectable. By leaving the time range blank, all observations and model TAUs are selectable.

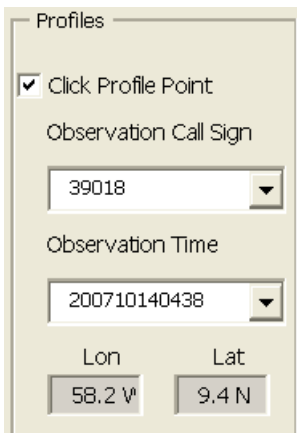


The screenshot shows a 'Time Range' dialog box with four dropdown menus for Year (2007), Month (10), Day (14), and Hour (0). Below these is a text input field for 'TimeRange (+- Hrs)' which is currently empty, followed by a right-pointing arrow button.

**Figure 4.17: Profile Plotting - Time Range section.**

#### 4.3.1.2 Observation location selection

The profile point being compared can be chosen by either manually selecting the *Observation Call Sign* and the *Observation Time*, or the observation can be chosen by selecting the *Click Profile Point* option and clicking near the profile point in the ArcMAP display (Figure 4.18). Once the desired profile point is selected, remove the *Click Profile Point* selection so that the observation point is not changed by future clicks on the map.

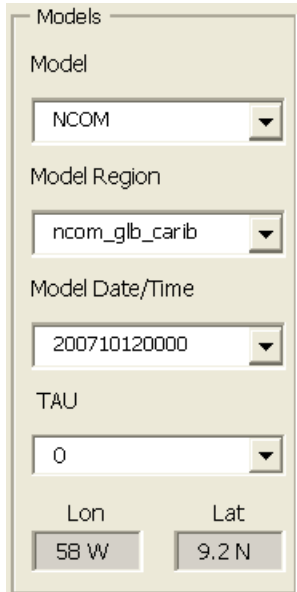


The screenshot shows a 'Profiles' dialog box. It has a checked checkbox for 'Click Profile Point'. Below it are two dropdown menus: 'Observation Call Sign' with the value '39018' and 'Observation Time' with the value '200710140438'. At the bottom, there are two text input fields for 'Lon' (58.2 W) and 'Lat' (9.4 N).

**Figure 4.18: Profile Plotting - Profiles section.**

#### 4.3.1.3 Model selection

The netCDF file being accessed is chosen by selecting the *Model* that is associated with the netCDF file, followed by selecting the *Model Region* encompassed by the netCDF file and finally the *Model Date/Time* (Figure 4.19). The *Model Region* can be selected by right-clicking near the region in ArcMAP display. The *TAU* of the *Model* is also selected at this time.



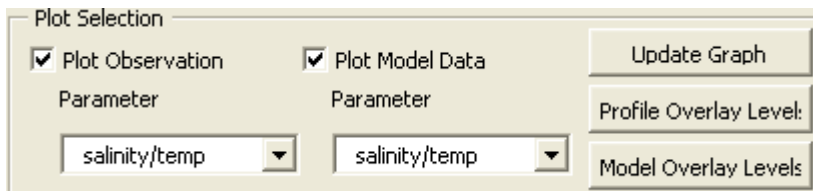
The 'Models' section of the software interface includes the following elements:

- Model:** A dropdown menu with 'NCOM' selected.
- Model Region:** A dropdown menu with 'ncom\_glb\_carib' selected.
- Model Date/Time:** A dropdown menu with '200710120000' selected.
- TAU:** A dropdown menu with '0' selected.
- Lon:** An input field containing '58 W'.
- Lat:** An input field containing '9.2 N'.

**Figure 4.19: Profile Plotting – Models section.**

#### 4.3.1.4 Parameter selection

The parameter selection for what will be plotted is made in the *Plot Selection* frame (Figure 4.20). The profile and model data is plotted by selecting the *Plot Observation* and *Plot Model Data* options, respectively. The profile and model *Parameter* being plotted is selected independently with both being plotted only if the parameters are the same, i.e. salinity/temp or sound speed. Otherwise, only the profile *Parameter* will be plotted. The *Plot Profile* option must not be selected to plot other parameters from the model or just the model data.



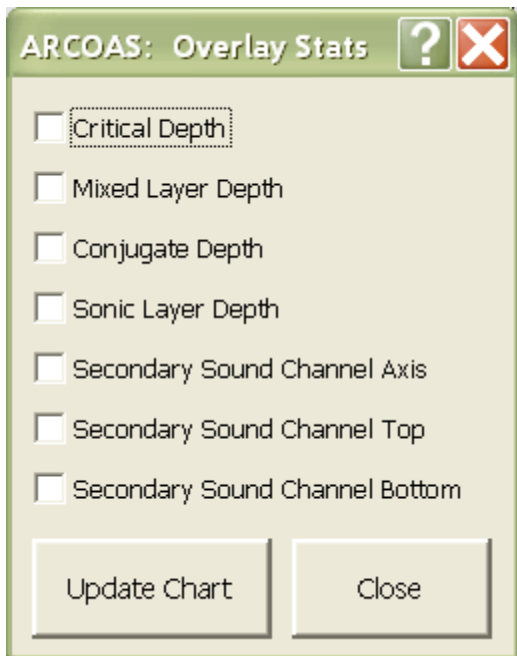
The 'Plot Selection' section of the software interface includes the following elements:

- Plot Observation:** A checked checkbox.
- Plot Model Data:** A checked checkbox.
- Parameter (Observation):** A dropdown menu with 'salinity/temp' selected.
- Parameter (Model):** A dropdown menu with 'salinity/temp' selected.
- Update Graph:** A button.
- Profile Overlay Level:** A button.
- Model Overlay Levels:** A button.

**Figure 4.20: Profile Plotting - Plot Selection section.**

The *Update Graph* button is used to update the graph with the selected information at the same longitude and latitude location previously clicked. Then the plot can be refreshed with changed observation, model, or parameter information for the same longitude and latitude location as the previous plot.

The *Overlay Levels* buttons allow statistics taken from the selected profile point or model to be added to the plot (Figure 4.21). The observation's or model's selected statistics are overlaid on the plot until the selection is removed.



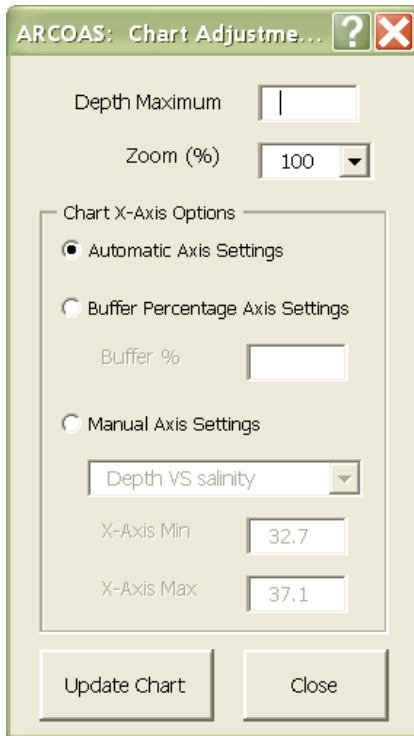
**Figure 4.21: Profile Plotting - Overlay Stats dialog box.**

#### 4.3.1.5 Model point selection

The model data's longitude and latitude position is determined by clicking the map. The closest model data point is plotted along with the profile data, if applicable. If *Click Profile Point* is selected, the closest profile point to the clicked location is chosen and the model data's point is determined using the profile point's position rather than the clicked location. The *Update Graph Button* is provided so that a different parameter from the observation or model can be plotted for the same observation or model point since clicking on the map would change the point.

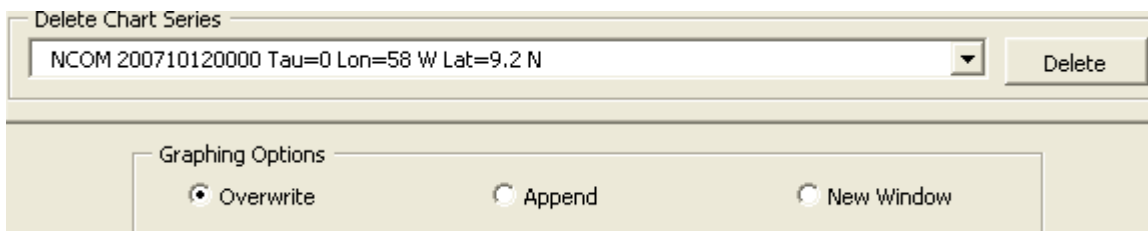
#### 4.3.1.6 Chart adjustments

The bounds of the chart's axis are adjustable using the *Adjust Chart* button. The graph's maximum depth (Y-Axis) is adjustable as well as the bounds on the X-Axis (Figure 4.22). By leaving the *Depth Maximum* blank, the Y-Axis will be adjusted automatically based on the data plotted. Similarly, by selecting *Automatic Axis Settings*, the X-Axis will be adjusted based upon the data plotted. The amount of space prior to the minimum value and after the maximum value is adjustable by using the *Buffer Percentage Axis Settings*. A buffer percentage of 10% is used if the percentage is blank. The X-Axis for each plot can also be adjusted individually by using the *Manual Axis Settings*. To manually set the X-axis values, first, the plot is selected using the combo box. Then, the minimum and maximum values for the axis are set.



**Figure 4.22: Profile Plotting - Chart Adjustments dialog box.**

The graph can be zoomed to the desired percentage by using the zoom combo box. When the graph is zoomed, scroll bars appear to focus on a particular part of the graph. The entire graph can be enlarged or shrunk by adjusting the size of the *Profile Plotting* tool. The size of the *Profile Plotting* tool is adjusted by clicking the symbol at the bottom right portion of the form and dragging the mouse to the desired size.



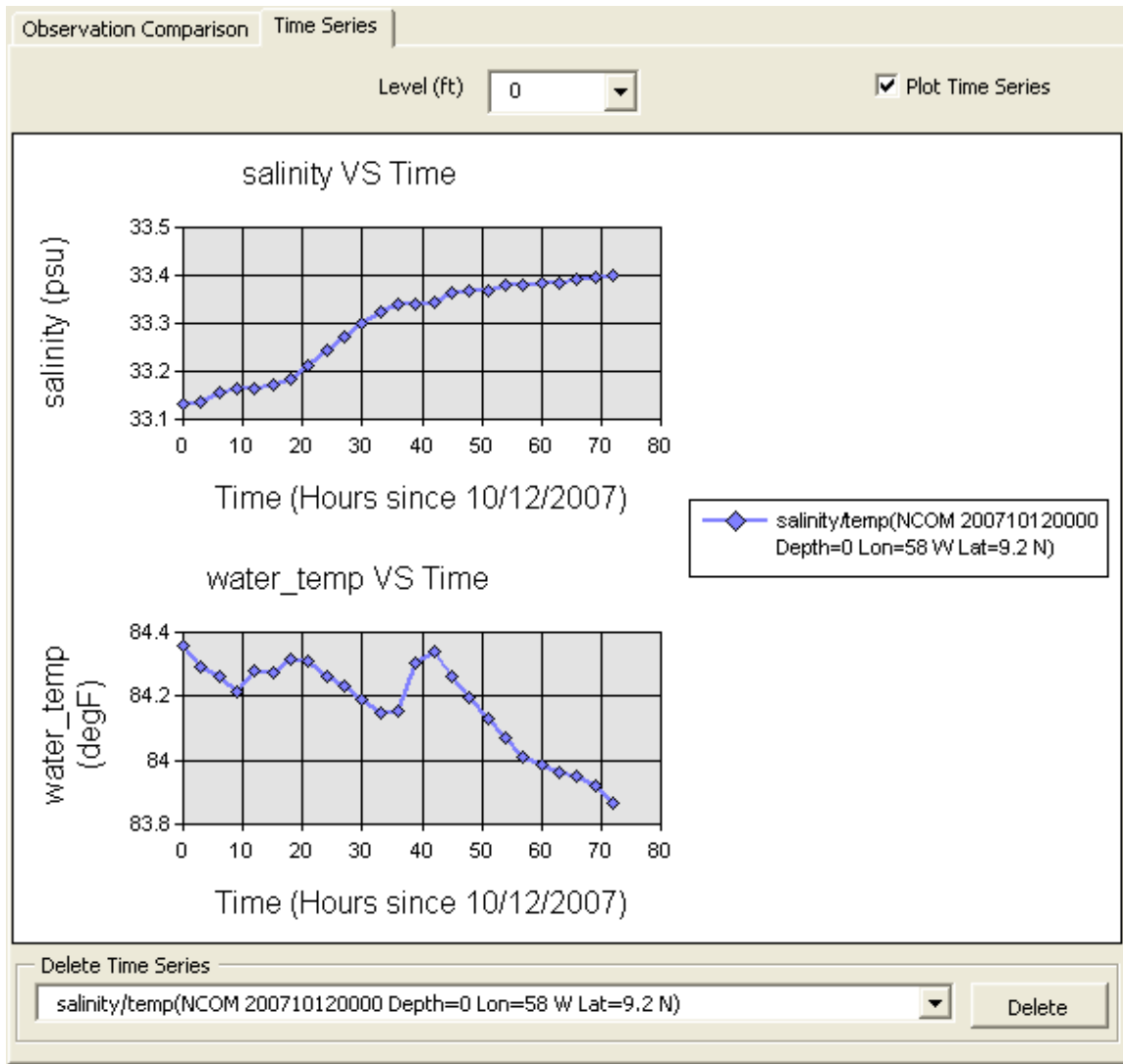
**Figure 4.23: Profile Plotting - Delete Series section.**

A series can be deleted from the plot by selecting the series from the *Delete Chart Series* box and clicking the *Delete* button (Figure 4.23). A series can be added to an existing plot by selecting the *Append* option in the *Graphing Options* frame then clicking on the map. Appending can only occur when the parameter being plotted is unchanged. The *New Window* option is provided so that an existing plot can be maintained for future usage while further plotting can still occur in a separate window. The separate window is created when the *New Window* option is selected and either the *Update Graph Button* is pressed or a new point on the map is clicked. The *Overwrite* option plots the selected data after removing all the previous data from the plot.

A copy of the plot can be saved as an image file in the following formats: GIF, JPG, PNG, CSV.

#### 4.3.1.7 Time series plot

The *Time Series* plot displays the values at a particular depth for the selected parameter(s) for all of the TAUs associated with the *Model Start Date/Time* (Figure 4.24). The *Time Series* shows a plot only when the *Plot Time Series* check box is selected. The depth is changed using the *Level* combo box. The parameter is changed using the *Model Data* combo box and the *Time Series* plot is refreshed using the *Update Graph* button.



**Figure 4.24: Profile Plotting – Time Series tab.**

#### 4.3.1.8 Unit conversions

The option is provided to convert all of the values displayed by the ARCOAS tools between the netCDF files native units and converted units. By clicking on the label at the top of the tool, this option switches between the native units and converted units. The values in the plots are adjusted automatically based on the selected units.



### 4.3.2 Model Performance

The *Model Performance* tool is used to display model-observation matchup data as well as statistics calculated using this matchup information (Figure 4.25). The displayed results can then be used to compare observational data to model data.

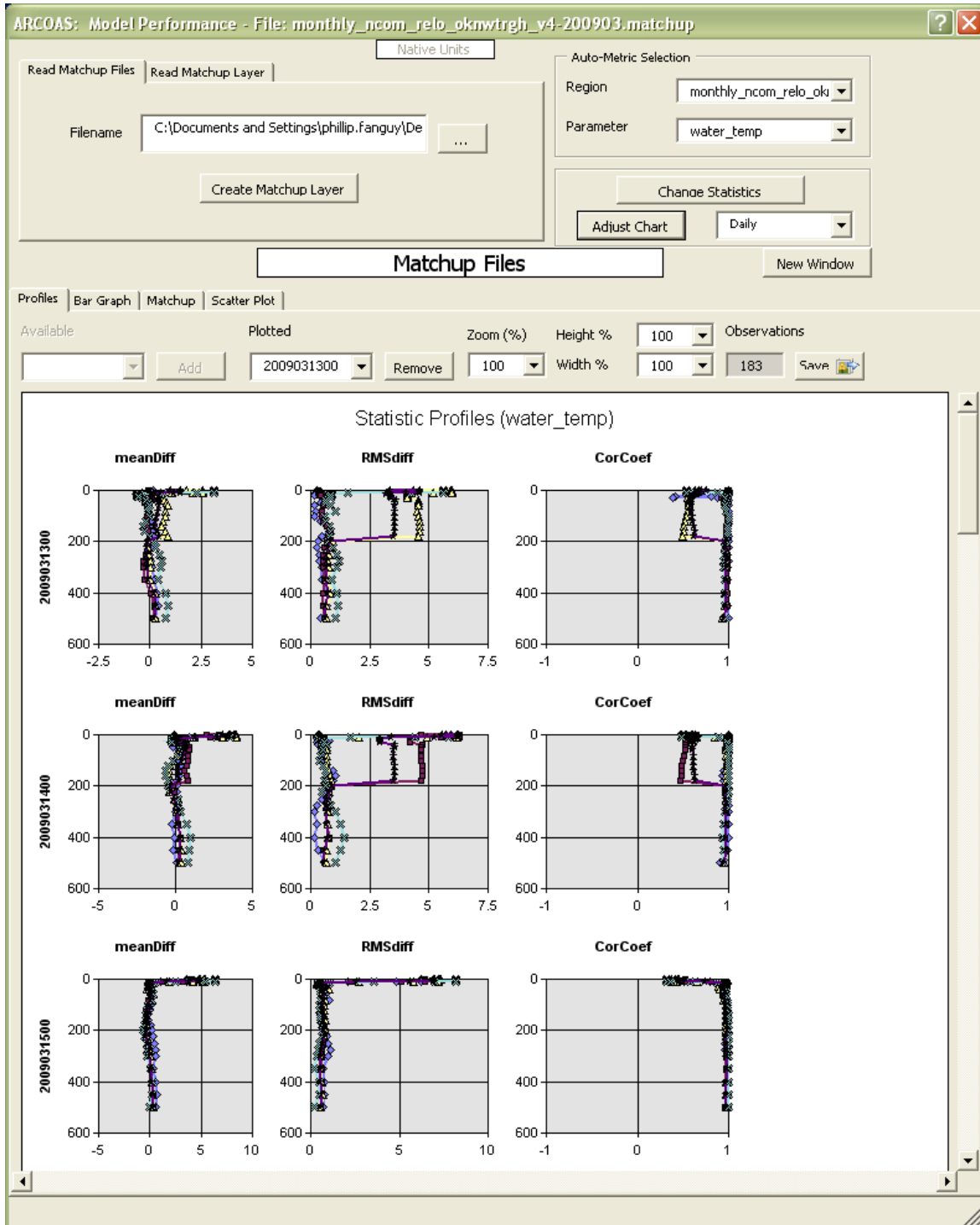


Figure 4.25: Model Performance – Profiles tab.

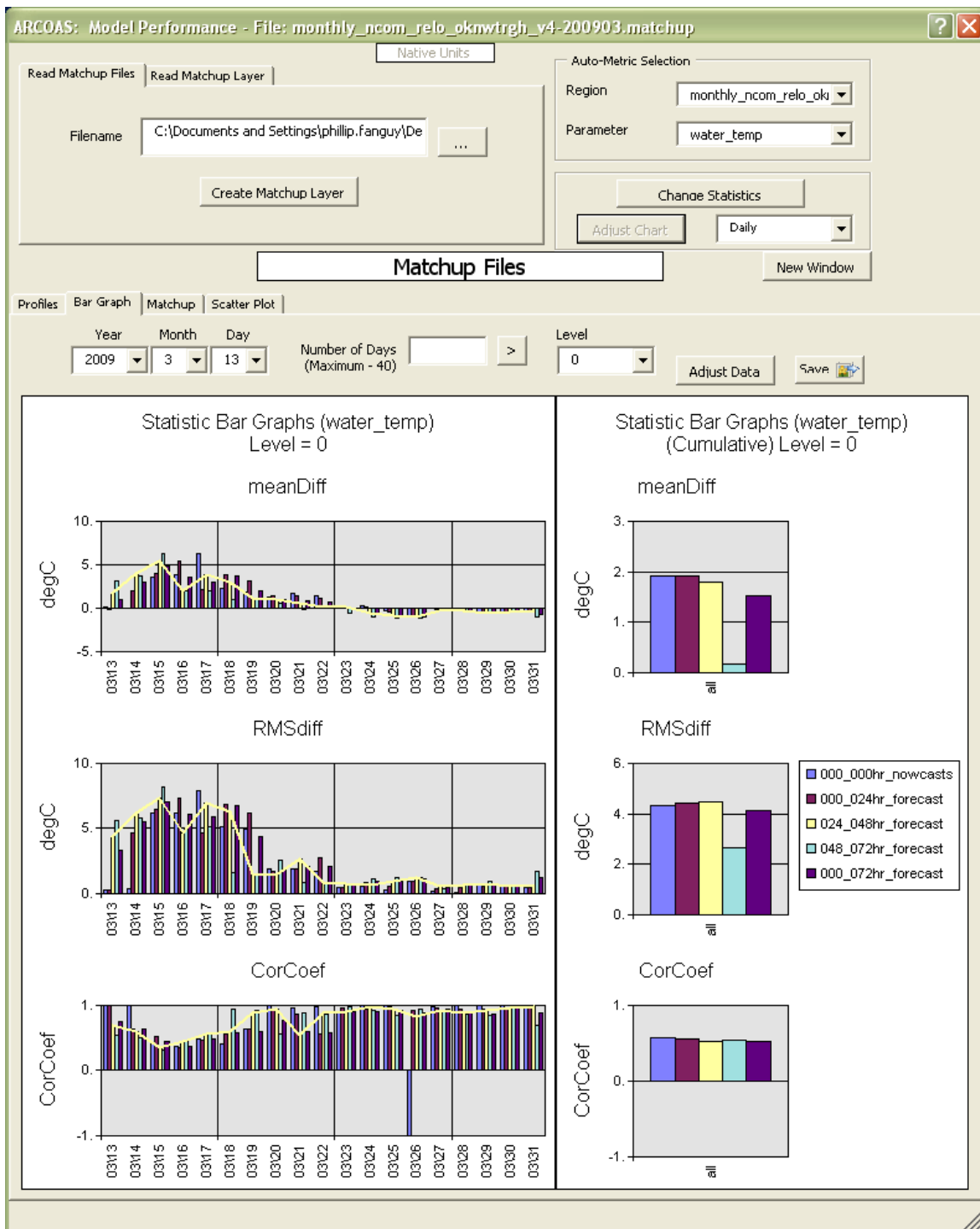


Figure 4.26: Model Performance - Bar Graph tab.

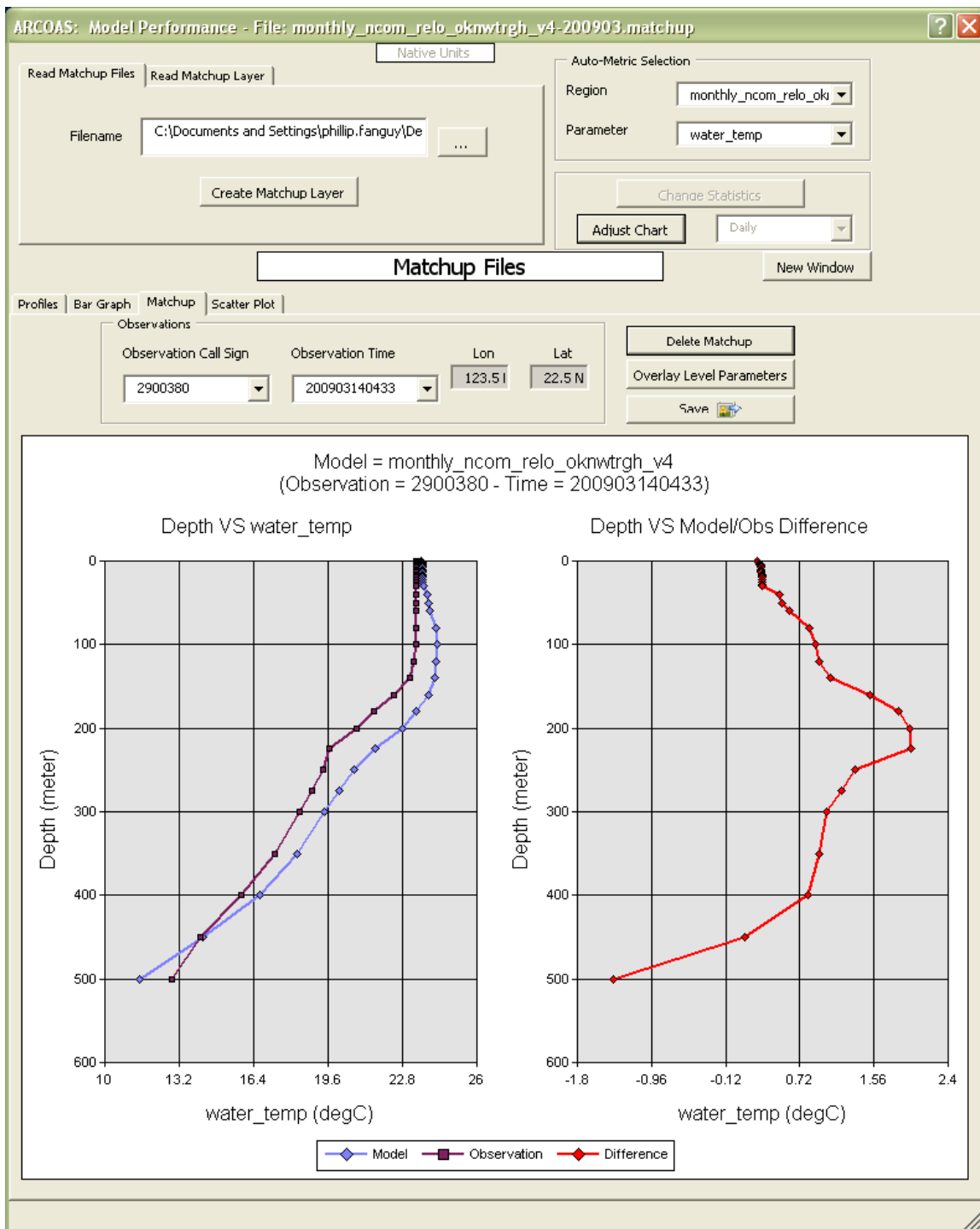


Figure 4.27: Model Performance - Matchup tab.

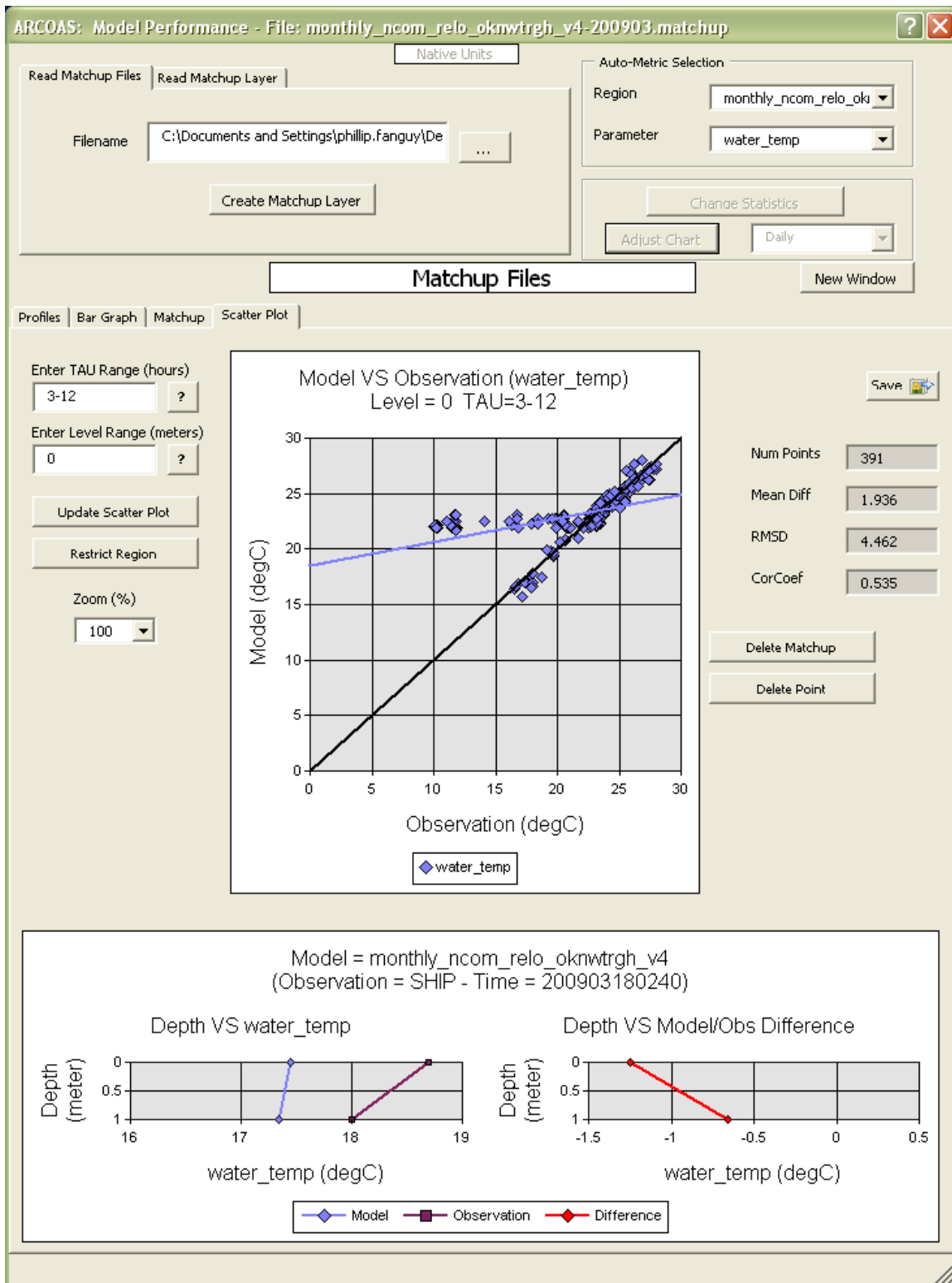


Figure 4.28: Model Performance - Scatter Plot tab.

#### 4.3.2.1 Reading matchup files

To load the matchup data for graphing, either the matchup files or a layer containing the matchup data is read. Matchup files are selected using the file browser interface; while a matchup layer is accessed by selecting the matchup layer from the Layer combo box. After reading the matchup data, several statistics (mean error, RMS error, and correlation coefficient) are calculated for the forecasts. Once the statistical calculations are completed, the *Region* and *Parameter* selection boxes are populated, and the graphs for the selection are plotted. As the *Region* and *Parameter* are adjusted, so are the graphs.

The display of the statistics can be based on grouping the data by day, week, month, quarter, or year.

#### 4.3.2.2 Layer creation

If the matchup data is loaded using matchup files, it is possible to create a matchup layer by clicking the *Create Matchup Layer* button below the *Filename* textbox. The layer created has points indicating the locations that the observations matchups occurred. The points are colored so that the values near 0 are white, negative values are shades of red, and positive values are shades of green. Points with invalid matchup values are marked with a circled X. All of the matchup data from the file(s) is contained in the created feature layer's table.

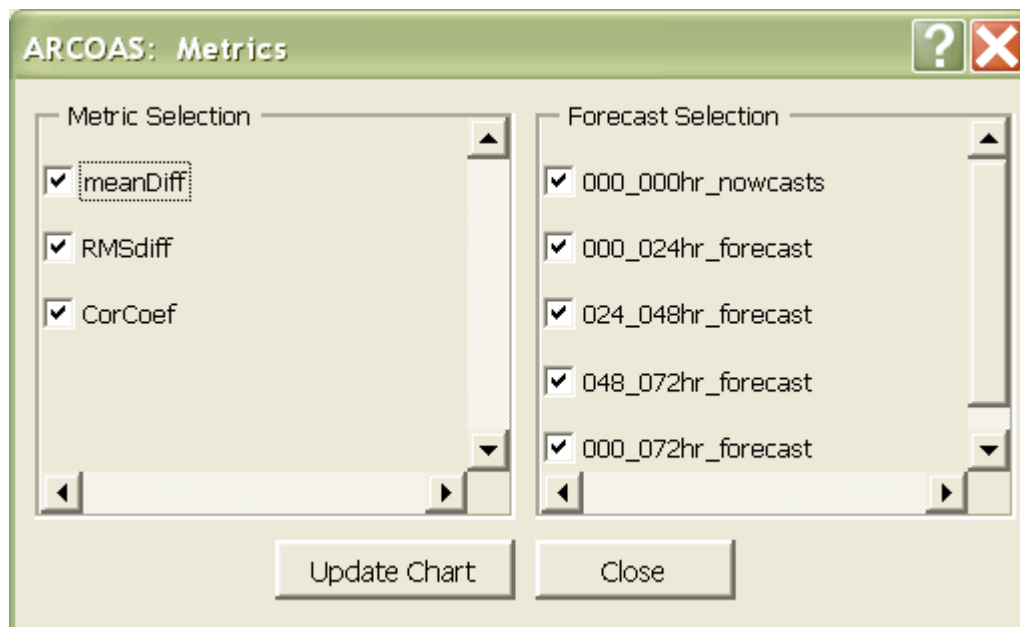


Figure 4.29: Model Performance – Metrics tab.

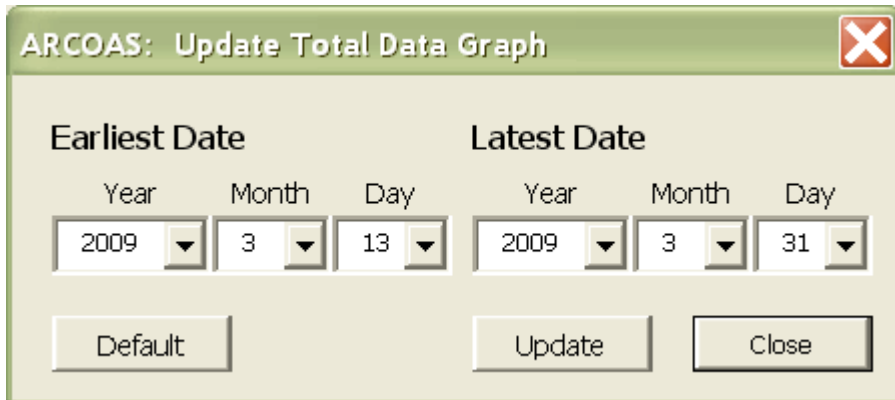
#### 4.3.2.3 Profile graphof statistics

The *Profiles* tab displays the line graphs for the dates showing the statistics selected from the *Metric Selection* screen (Figure 4.25, Figure 4.29). The dates displayed can be adjusted by adding dates in the Available list and Removing dates from the Plotted list. The profiles can be zoomed using the Zoom combo box.

#### 4.3.2.4 Bar graph of statistics

The *Bar Graph* tab displays bar graphs over all the dates for the *Mean Error*, *RMS Error*, and *Correlation Coefficient* for a selected depth level (Figure 4.26). The dates being displayed can be

adjusted by changing the initial date followed by entering the number of days that follows. Leaving the number of days blank displays all of the days, with a maximum of 40 days being displayed.



**Figure 4.30: Model Performance - Bar Graph tab – Update Total Date Graph dialog box.**

The *Cumulative* bar graph displays the statistic based on the data from all of the dates. The date range being displayed can be adjusted by using the *Adjust Data* button (Figure 4.30).

#### 4.3.2.5 Matchup plot

The plot in the *Matchup* tab displays the actual values from the model and the observations as well as the differences between these values for every depth (Figure 4.27). The data is organized based on the observation call sign and observation time. Additional information can be overlaid in the graph, for example, *Sonic Layer Depth* and *Surface Elevation*. If the matchup data has been read from a matchup layer, the selected observation is highlighted in ArcMAP.

The option is available to delete an entire matchup by using the *Delete Matchup* button. This removes the matchup from the *Scatter Plot* calculations, but not the *Profiles* graphs. If a matchup layer is created after the matchup deletion, the deleted matchup will not be contained in the matchup layer.

#### 4.3.2.6 Scatter plot

The *Scatter Plot* displays a comparison between the *Model* value and the *Observation* value for every matchup point (Figure 4.28). A line with a slope of one and a trend line for the data is provided for reference. The *Mean difference*, *RMS difference*, and *Correlation Coefficient* statistics are calculated based on the points included in the *Scatter Plot*. The points included in the *Scatter Plot* can be adjusted by changing the *TAU Range* and/or the *Level Range* then clicking the *Update Scatter Plot* button.

A short version of the matchup graph is provided below the *Scatter Plot* in order to display the matchup values for a particular point in the *Scatter Plot*. A point is selected in the *Scatter Plot* by hovering over the mouse over the desired point. The matchup graph below the *Scatter Plot* then switches to the selected observation with the graph focused only on the point's depth. Switching to the *Matchup* tab allows the entire matchup to be viewed.

A copy of the any of the graphs can be saved as an image file in the following formats: GIF, JPG, PNG, CSV.

### 4.3.3 Cross sections

The *Cross Section* tool is used to create a cross section of an existing netCDF raster layer (Figure 4.31). The resulting cross section displays the raster's values along a user-drawn line for all of the netCDF file's depths. Multiple cross section results can exist simultaneously.

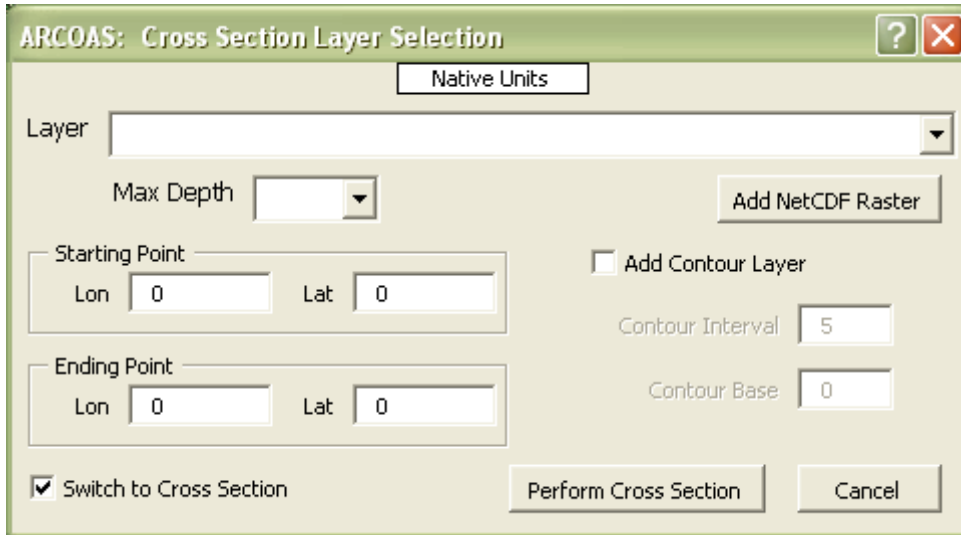


Figure 4.31: *Cross Section* dialog box.

#### 4.3.3.1 Adding a NetCDF raster layer

A raster layer which remains connected to the netCDF file can be created by using the *Add NetCDF Raster* button on the *Cross Section* tool. Once the button is pressed, a form similar to the *Add Layer* tool is displayed for the layer to be selected (Figure 4.32). The form is simplified to only allow raster layers to be added along with all of the depths. The NetCDF file is selected by using the *Model*, *Model Region*, and *Model Start Date/Time*. The *Parameter* being displayed and the *TAU* are then selected prior to the layer being added. The resulting layer must be in the native units for the raster layer to remain connected to the NetCDF file; therefore, the option to switch between native and converted units is not provided.

The screenshot shows a dialog box titled "ARCOAS: Add Layer". It contains the following fields and controls:

- File Directory:** A text box containing the path "anguy\My Documents\ARCOAS\_Drive\ARCOAS\ARCOAS\Data\NCOM\" and a browse button "...".
- Filename:** A text box containing "ncom\_glb\_carib\_2007101212.nc".
- Model:** A dropdown menu with "NCOM" selected.
- Model Region:** A dropdown menu with "ncom\_glb\_carib" selected.
- Model Start Date/Time:** A dropdown menu with "200710120000" selected.
- Units:** A text box containing "degC".
- Parameter:** A dropdown menu with "water\_temp" selected.
- TAU:** A dropdown menu with "0" selected.
- Buttons:** "Add Layer" and "Close" buttons are located at the bottom right.

**Figure 4.32:** *Cross Section* – *Add Layer* dialog box.

#### 4.3.3.2 Creating the cross section

To create a cross section, the raster layer having a cross section taken must be connected to a netCDF file. This fact can be verified by accessing the properties for the layer and identifying the existence of a NetCDF tab. The *depth* dimension must also exist in the netCDF file and be used as the *Band Dimension* for the layer (Figure 4.33).

The netCDF raster layer being cross sectioned is selected using the *Layer* combo box from the *Cross Section* tool. A maximum depth for the cross section is assigned and a line delineating the location of the cross section is made using the mouse. The option is provided to add contours to the cross section. The line is created by holding down the left mouse button as the mouse is moved. The selected line is then displayed in the map and the starting and ending points displayed in the cross section tool. The cross section is made by pressing the Perform Cross Section button (Figure 4.34).



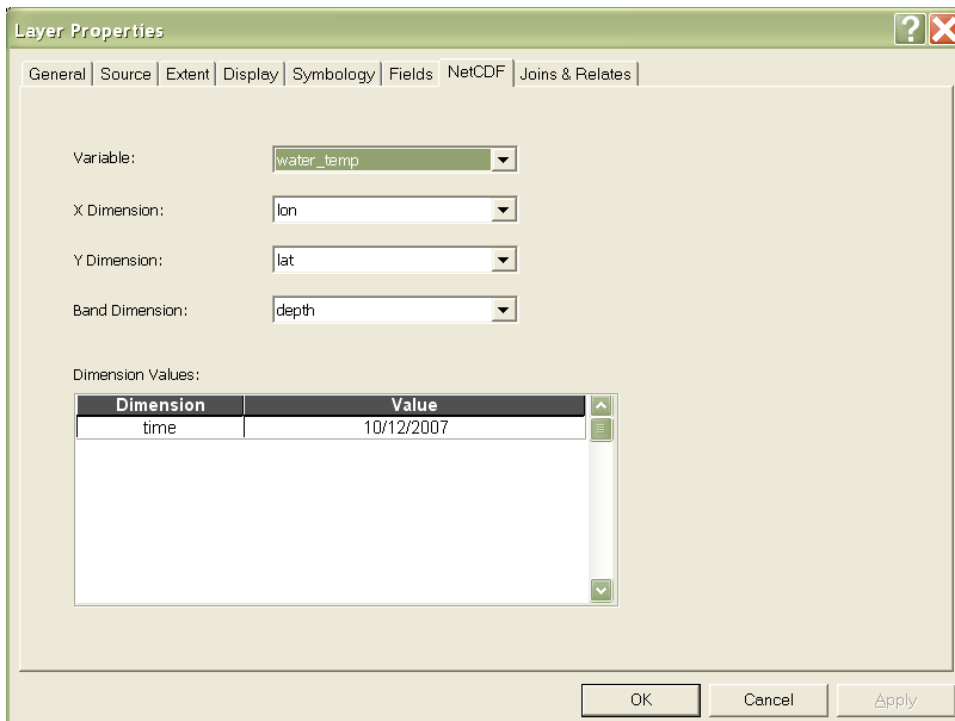


Figure 4.33: Cross Section - Raster Layer Properties dialog box.

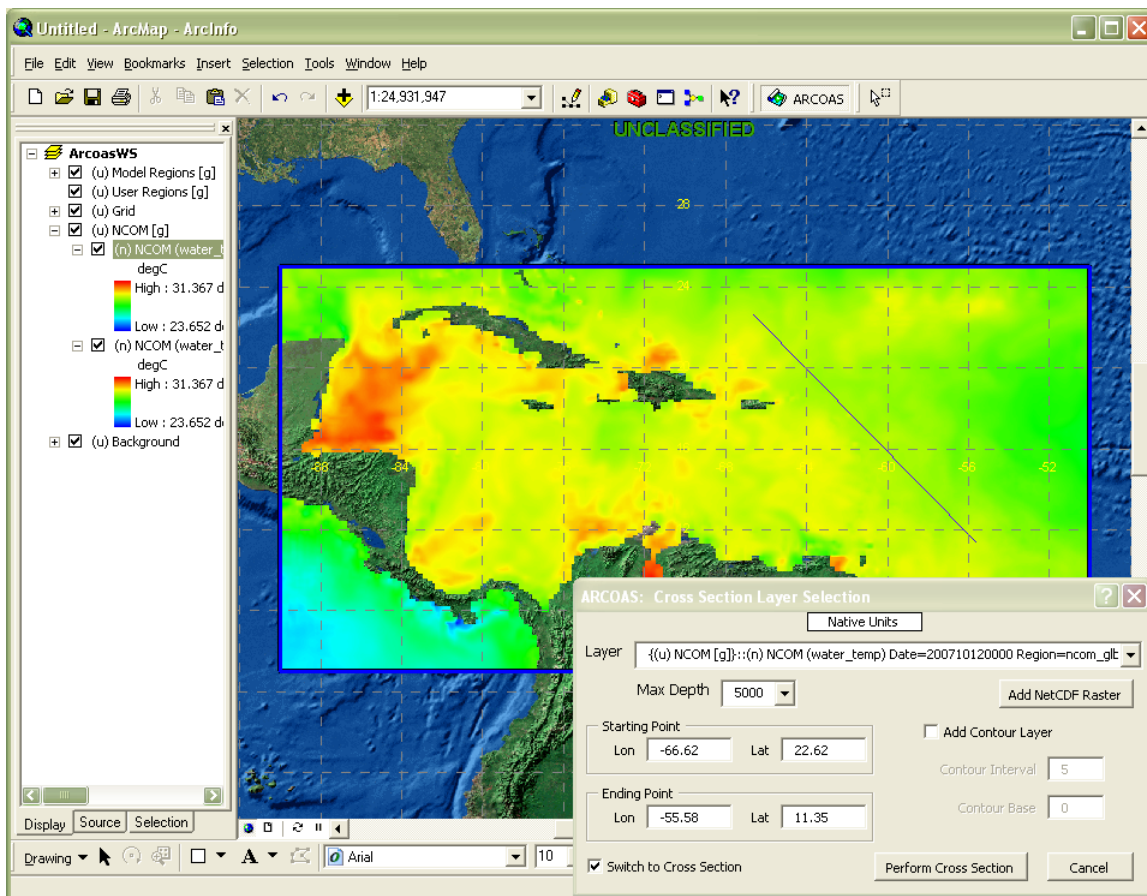


Figure 4.34: Cross Section creation demonstrated with ArcMAP display and tools dialog box.

By un-checking the *Switch to Cross Section* option, it is possible to create multiple cross sections prior to viewing any of the created cross sections.

#### 4.3.3.3 Unit conversions

The option is provided to convert all of the values displayed by the ARCOAS tools between the netCDF files native units and converted units. By clicking on the label at the top of the tool, this option switches between the native units and converted units. The resulting layer will also be in the units chosen.

#### 4.3.3.4 Cross section results

The resulting cross section is displayed in a separate data frame from the existing layers (Figure 4.35). None of the ARCOAS tools, with the exception of the *Adjust Raster* tool, are operable in this separate data frame. To return to the original data frame, one of the following operations needs to be performed:

1. Right-click the *Layers* data frame in the ArcMAP *Table of Contents* and select *Activate*.
2. Right-click the *Cross Sections* data frame in the ArcMAP *Table of Contents* and select *Remove*.
3. Click the *Cross Section* button from the *ARCOAS Tools* toolbar.

Switching between multiple cross sections is done by selecting *Activate* from the right-click menu of the desired data frame.

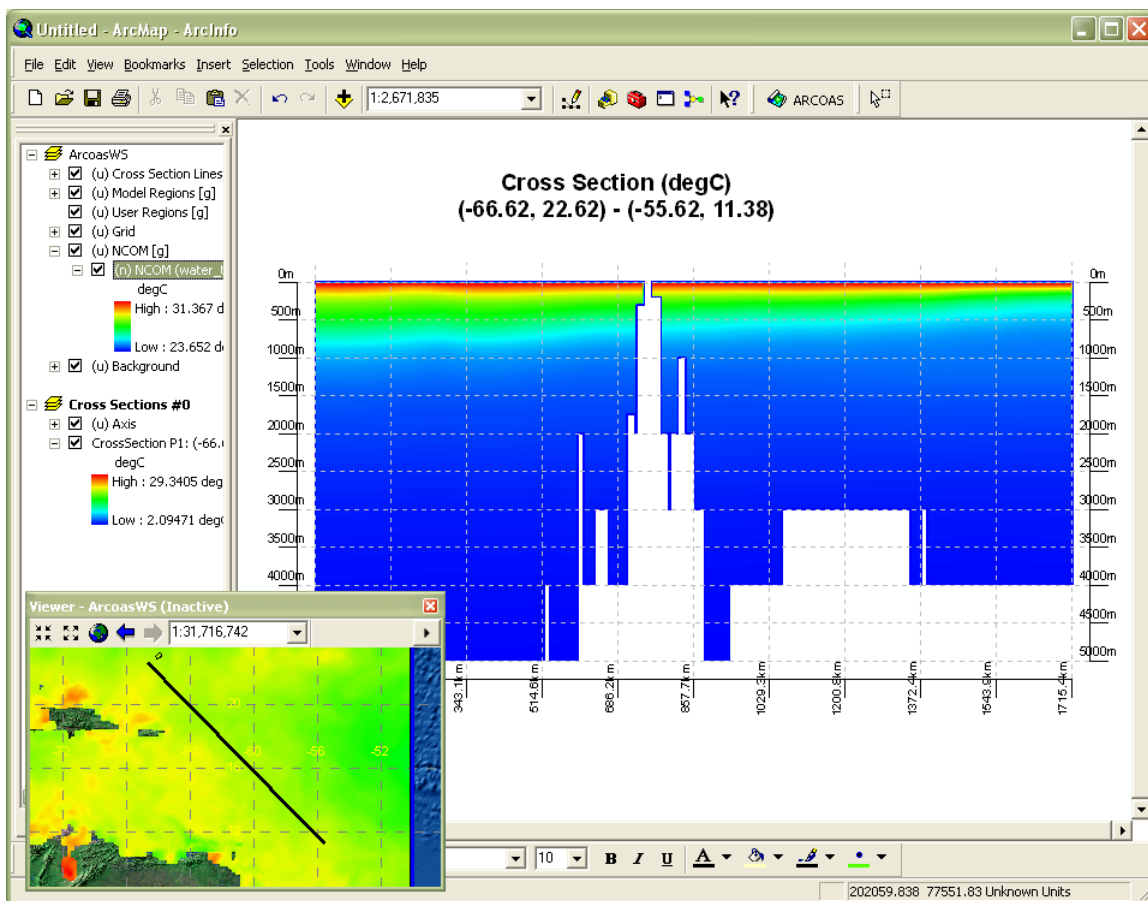


Figure 4.35: Cross Section results displayed in a new data frame in ArcMAP.

Included in the display of the cross section is a window which displays the location of the cross section line on the original map. The cross section line is displayed with a number to indicate which cross section to which it pertains. Deleting the cross section frame deletes the line from the original map.

#### 4.3.4 NetCDF Animation

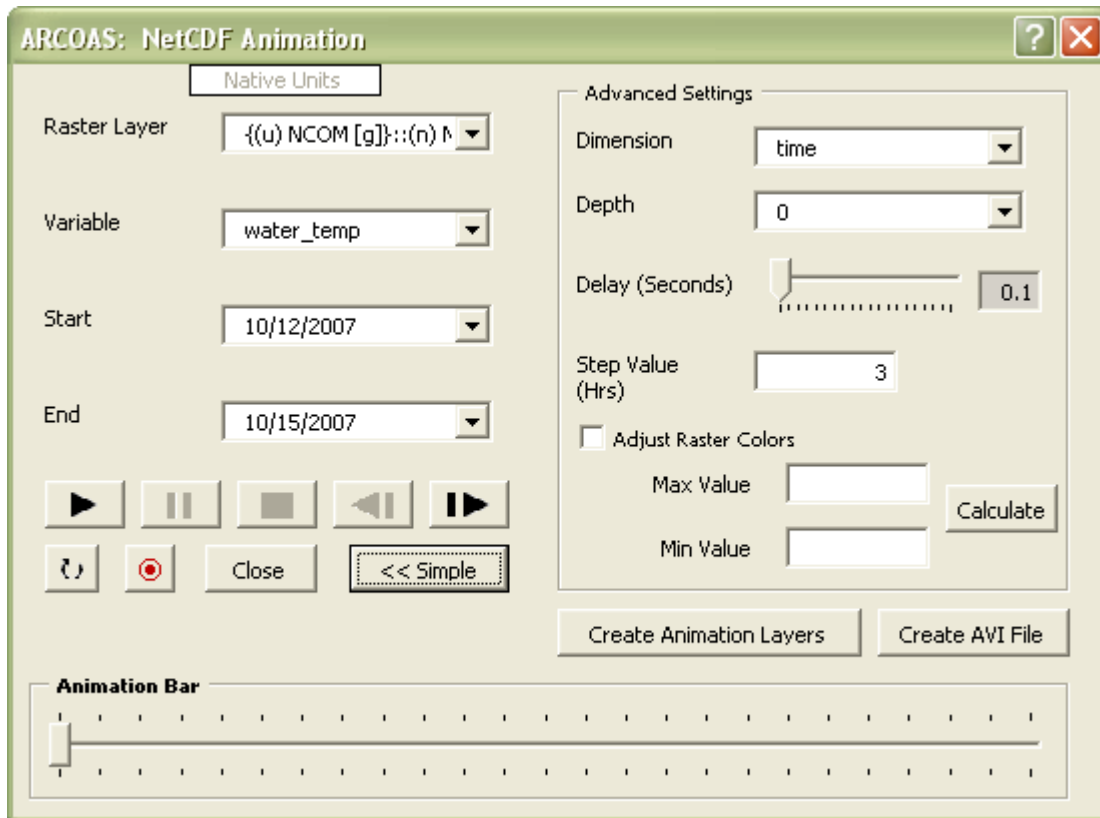


Figure 4.36: *NetCDF Animation* dialogue box.

The *netCDFAnimation* tool allows for the time and depth animation of raster layers that have been created from netCDF files and the animation of raster and feature layers grouped by a group layer (Figure 4.36). The raster and feature layers organized in a group for animation can be created using the *Create Animation Layers* button (refer to Appendix A).

##### 4.3.4.1 Simplified settings

In order to animate a layer, the layer must be visible. The layer being animated is selected using the *Raster Layer* combo box. The *Start* and *End* times for the animation are then chosen. If the animation is being performed on a raster connected to a netCDF file, the *Variable* on which the animation is based is adjustable through the *Variable* combo box. The animation controls include options to play (▶), pause (⏸), stop (■), single-step reverse, single-step forward and repeat (↻). The record (Ⓜ) button can be used to save the animation to an AVI file.

##### 4.3.4.2 Advanced settings

Advanced settings are provided when the *Advanced Button* is clicked. The majority of these options are adjustable only if the animation is being performed on a raster connected to a netCDF file. Included in

these settings is the ability to change the animation from a time animation to a depth animation using the *Dimension* combo box. Also, the non-animated dimension value can be adjusted to a specific value. Speed and step value adjustments are also possible using the advanced settings. At the bottom of the *Advanced Settings* is an *Animation Bar* so that the animation can be controlled manually.

#### 4.3.4.2.1 Raster colors adjustments

The *Adjust Raster Colors* option is provided so that a consistent maximum and minimum range can be set for all the rasters in the animation. Otherwise, the rasters will likely adjust the maximum and minimum values for each step of the animation. The option also provides a method of ensuring that the maximum and minimum range is acceptable for the parameter being animated, since the parameter can be changed using the *Variable* combo box. If the range of values is unknown, the *Calculate Button* is provided to determine the maximum and minimum values from all of the rasters in the animation; these values then can be adjusted manually, as necessary.

#### 4.3.4.2.2 AVI file creation

An AVI file can be created by through ARCOAS by using the Create AVI File button in the Advanced Settings. The AVI file requires a sequence of bitmap images which can be selected using a file browser. Once the individual images are selected, the Accept button is clicked so that the AVI file can be created.

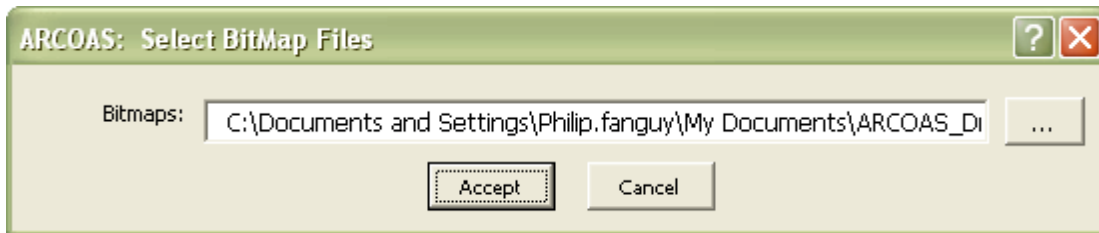


Figure 4.37: *NetCDF Animations – Select Bitmap Files* dialog box.

#### 4.3.4.3 Animation recordings

To record an animation, the record (Ⓢ) button is used. The size of the resulting file is dependent upon the size of the ArcMAP map being animated. If the resulting AVI file is too large or the recorded animation is jumpy, shrink the ArcMAP window to improve the recording.

#### 4.3.5 Altimetry plot

The *Altimetry Plot* tool allows the altimeter data to be analyzed further by creating a graph to display the sea surface height anomaly values between two selected points along an orbital track. (Figure 4.38). The altimetry data is added using the *Add Observation* tool (Section 4.1.4). The *Altim Analysis* button is then selected and, using the mouse, two altimetry points are clicked. The graph displaying the altimetry data between the two points is shown. The graph is accessible through ArcMAP using the *Tools -> Graphs*. The colors of the points within the graph are based on the colors of the points in ArcMAP.

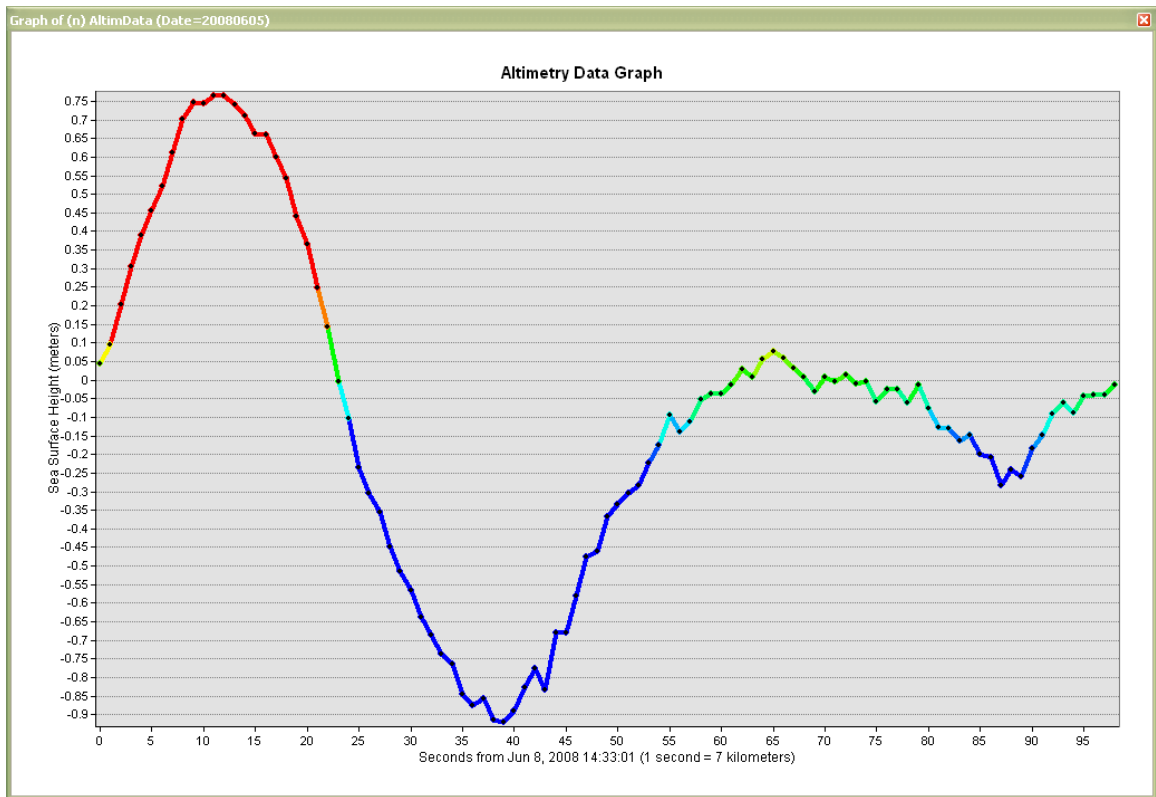


Figure 4.38: Altimetry Data Plot along an orbital track.

## 4.4 Maintenance

### 4.4.1 Changing security classification of layers

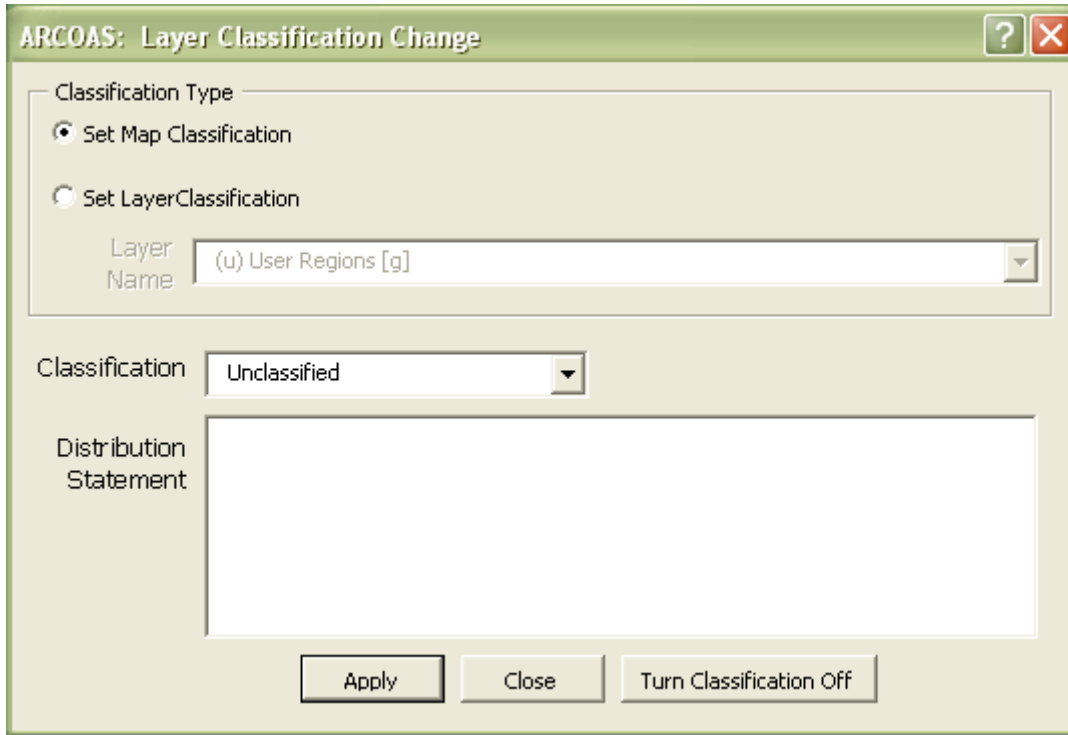


Figure 4.39: *Security Classification Change* dialog box.

The *Security Classification Change* tool is used to change the map's and/or layer's current security classification to a new user selected classification (Figure 4.39). First, whether a particular layer's classification is being changed or whether the entire map's classification is being changed is selected within the *Classification Type* frame. If a layer's classification is being changed, the layer is selected as well. Next, the new classification for the map or layer is selected using the *Classification* combo box. An additional distribution statement can be displayed on the map along with the security classification by entering text in the *Distribution Statement* area. Once completed, the *Apply* button pushes the changes to the display. All ArcMAP layers are included in the list of layers for the tool, and the security classifications are *Unclassified*, *Confidential*, *Secret* and *Top Secret*. The *Turn Classification Off* button hides the classification labels overlaying the map in ArcMAP.

### 4.4.2 Drawing shapes

The *User-Defined Shapes (Drawing)* tool allow for the creation of varying shapes to be added to ArcMAP in order to help the user focus on the area of interest (Figure 4.40). The shapes include rectangles, polygons, circles, ellipses, lines, curves, and points. The shapes are stored as feature layers and are located in the *User Regions* group layer.

#### 4.4.2.1 Creating a shape

The drawing tool allows existing user-defined shapes to be loaded as well as new user-defined shapes to be created. To load an existing user-defined shape, the *Load* button is used and the associated shapefile is selected. The shape is then associated with its proper *Shape Type*.

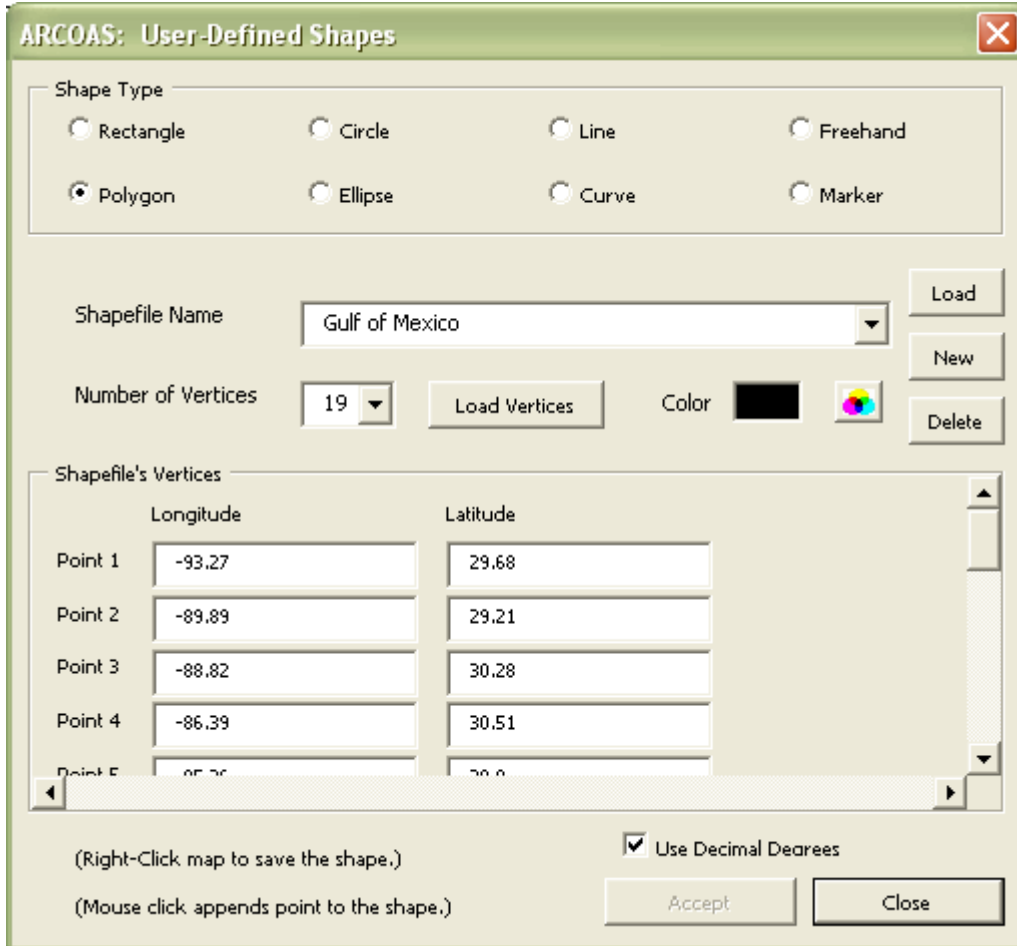


Figure 4.40: *User-defined Shapes (Drawing)* dialogue box.

To create a new user-defined shape, the *Shape Type* is selected. The *New* button is used to create a new user-defined shape. Once a name for the shape is entered, the shape can be created using the mouse. The color of the shape can be changed by setting the *Color* box to the desired color. The *Use Decimal Degrees* option is provided to switch the longitude and latitude values between decimal degrees and degrees/minutes/seconds.

##### 4.4.2.1.1 Rectangle

A *Rectangle* is created by pressing with the mouse and dragging until the desired rectangle is created. Releasing the mouse button creates the layer for the rectangle. Edits to the rectangle can be performed by editing the values displayed for the rectangle or by redrawing the rectangle in ArcMAP using the mouse.

#### 4.4.2.1.2 Polygon

A *Polygon* is created by using the mouse to click at the location of polygon's vertices on the map. The polygon is saved to a layer by either right-clicking on the map or clicking the *Accept* button.

The polygon's existing vertices can be edited manually by changing the longitude and latitude locations in the text boxes. Additional *Vertices* can be added in the same manner as when the polygon was originally created. The latest *Vertices* added can be deleted by adjusting the *Number of Vertices* combo box to a number less than the current number of vertices. Once all of the edits are complete, the *Accept* button is clicked to push the changes to the polygon. The additional option to load vertices from an ASCII file is provided given columns of longitude and latitude information is contained in the file.

NOTE: Perform the editing of the points either by editing the text boxes of the vertices or by clicking on the map, but not by a combination of the two. Accept the changes between the edits if both techniques are required.

#### 4.4.2.1.3 Circle

A *Circle* is created by pressing with the mouse and dragging until the desired circle is created. The initial click point is the center of the circle. Releasing the mouse button creates the layer for the circle. Edits to the circle can be performed by editing the values displayed for the circle or by redrawing the circle in ArcMAP using the mouse.

#### 4.4.2.1.4 Ellipse

An *Ellipse* is created by pressing with the mouse and dragging until the desired ellipse is created. Releasing the mouse button creates the layer for the ellipse. Edits to the ellipse can be performed only on the rotation of the ellipse by editing the value displayed or by redrawing the ellipse in ArcMAP using the mouse.

#### 4.4.2.1.5 Line

A *Line* is created by using the mouse to click at the location of the line's points on the map. The line is saved to a layer by either right-clicking on the map or clicking the *Accept* button. Edits to the line can be performed by editing the values displayed for the line's points. Additional points can be added to the line by clicking the locations in the map.

#### 4.4.2.1.6 Curve

A *Curve* is created by using the mouse to click at the location of the curve's points on the map. The curve is saved to a layer by right-clicking on the map for the last point of the curve. A curve cannot be edited but can be redrawn by clicking on the map to start a new curve.

#### 4.4.2.1.7 Freehand

A *Freehand* line is created by pressing and holding the mouse button while dragging the mouse. Releasing the mouse button creates the layer for the freehand line. A freehand line cannot be edited but can be redrawn by clicking on the map to start a new line.

#### 4.4.2.1.8 Marker

A *Marker* is created by using the mouse to click at the location of the marker points on the map. Multiple markers can be placed in the same layer by clicking multiple times on the map. Each marker is



number so that it can be identified from the main dialogue box. The markers are saved to a layer by either right-clicking on the map or clicking the *Accept* button. Edits to the markers can be performed by editing the values displayed for the marker points. Additional points can be added to the layer by clicking the locations in the map. The additional option to load vertices from an ASCII file is provided given columns of longitude and latitude information is contained in the file.

#### 4.4.3 Region restriction

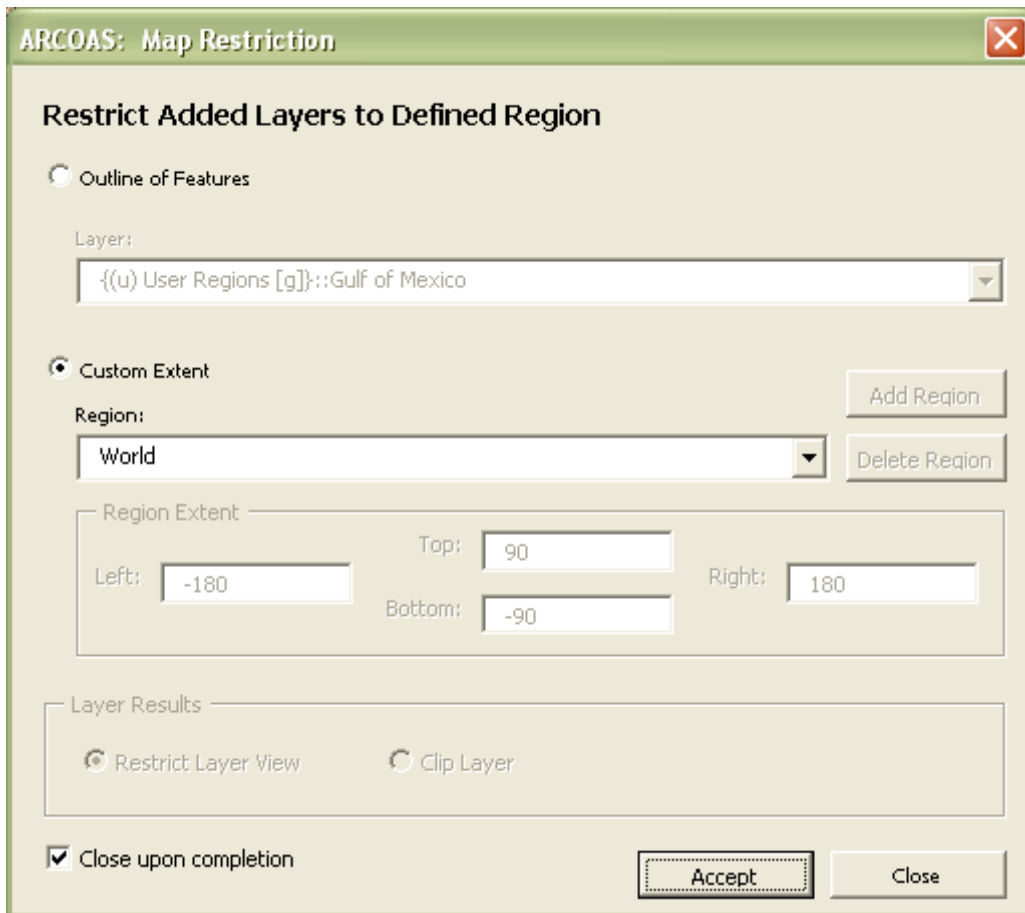


Figure 4.41: *Map Restriction* dialogue box.

The *Map Restriction* tool allows the user to restrict the map view to only the area being worked (Figure 4.41). The map can be restricted to either a predefined feature layer created using the *User-defined Shapes* tool (Section **Error! Reference source not found.**) or to a custom extent defined by the user. he *Accept* button is used to restrict the map to the defined area.

Custom extents are saved for future usage in the ARCOAS settings. To create a custom extent, the *Region* box is changed to “User Defined...” The mouse is then used to draw the rectangle being used to limit the map extent. The extent can be edited manually by setting the *Top*, *Bottom*, *Left*, and *Right* locations of the rectangle. Clicking the *Accept* button will allow the user to enter a name for the extent so that it can be identified in the future, and the map view is restricted to the area.

Existing restrictions can be deleted by selecting the region then clicking the *Delete Region* button.

#### 4.4.4 Running a set of procedures

The *Procedures List* tool allows for operations which are performed often to be organized in a manner so that the operations can be performed at the push of a single button (Figure 4.42). The operations that can currently be performed by a procedure are: adding a raster layer, adding a symbol layer, adding a difference layer, adding an observation layer, and zooming to a location on the map.

##### 4.4.4.1 The Procedure List

A form that is displayed as a result of clicking either the *New* or *Edit* button from the *Procedure List*, the *Procedure's Operation List* form identifies the operations that compose a procedure (Figure 4.43). The *Procedures* frame contains the name which is used to identify the procedure in the procedure list. An option also exists to schedule the procedure to be performed on ARCOAS startup starting at a particular date and on a set schedule. If either the procedure name or the startup options is changed, the *Update* button is provided to save the changes.

The *Operations* frame lists the existing operations for the procedure and provides functionality to create a new operation as well as *Edit*, *Delete*, or view the *Details* of existing operations.

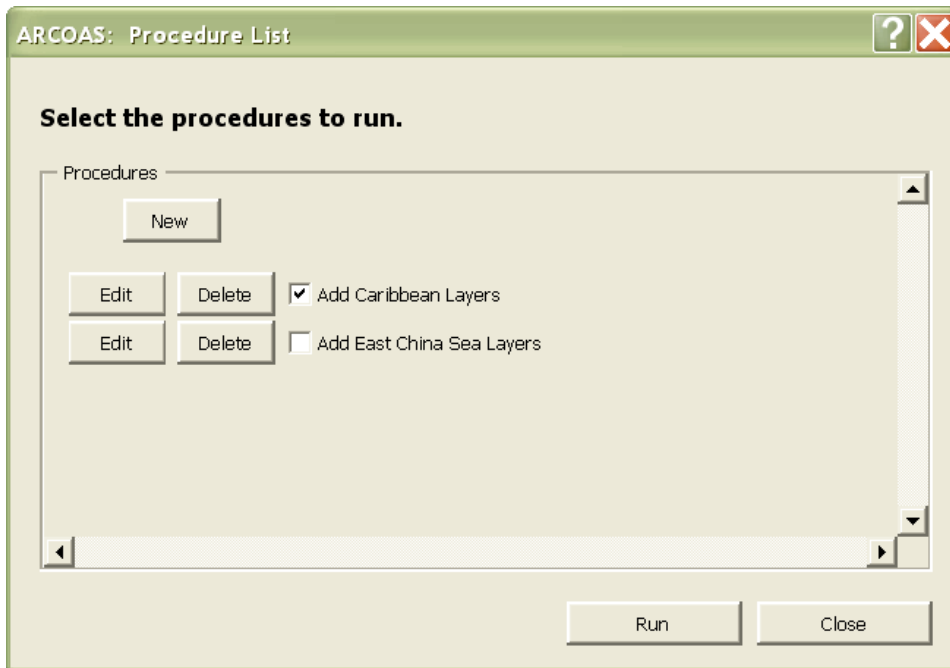


Figure 4.42: *Procedure List* dialog box.

When the *Run Procedures* tool is opened, a list of existing procedures is given along with the option to create a new procedure. Procedures are run by selecting the procedures' name then clicking the *Run* button. The *Edit* button allows an existing procedure to be edited, and the *Delete* button allows the procedure to be deleted from the procedure list.

#### 4.4.4.2 The procedure's operation list

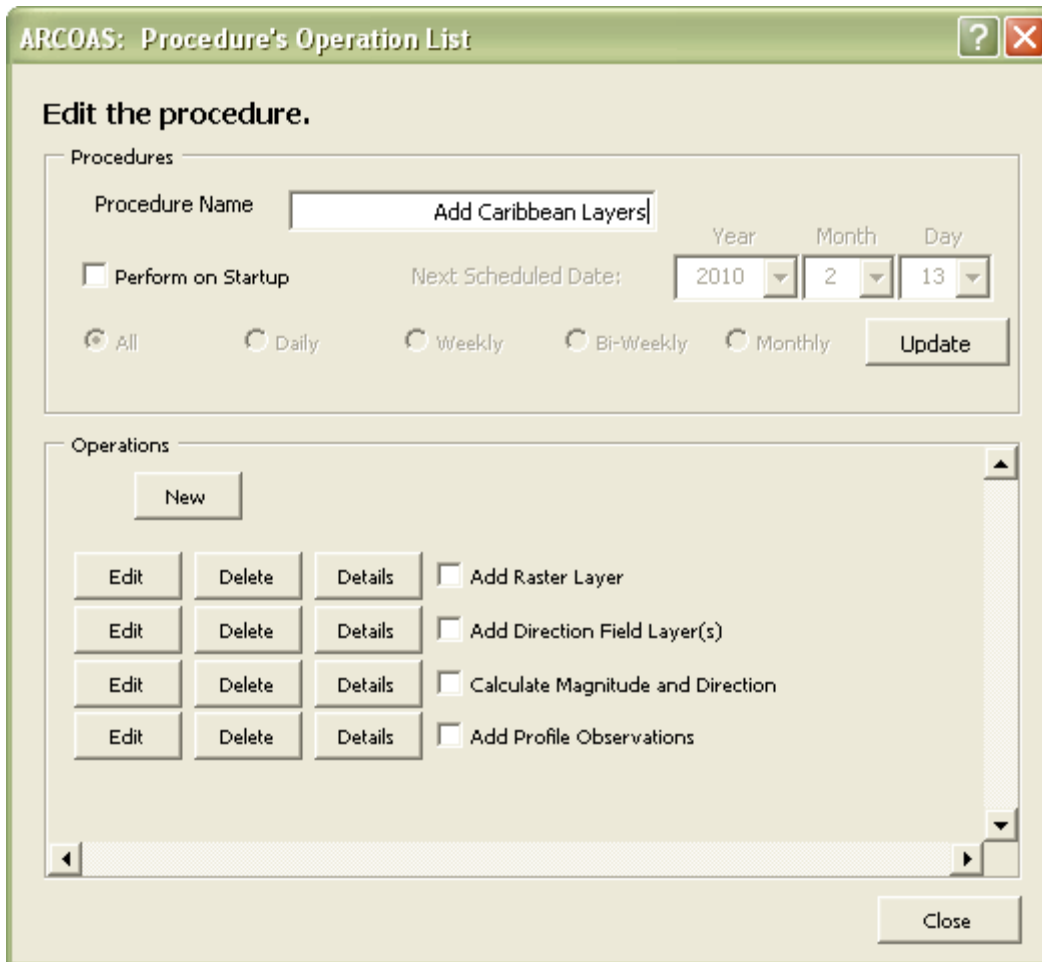


Figure 4.43: Run Procedures - Procedures Operation List dialog box.

#### 4.4.4.3 Creating a new operation

The *Operation Wizard* is started when a new operation is being created (Figure 4.44). The form provides the option on the type of operation to be added to the procedure and identifies the interface that will be opened when the *Next* button is clicked.

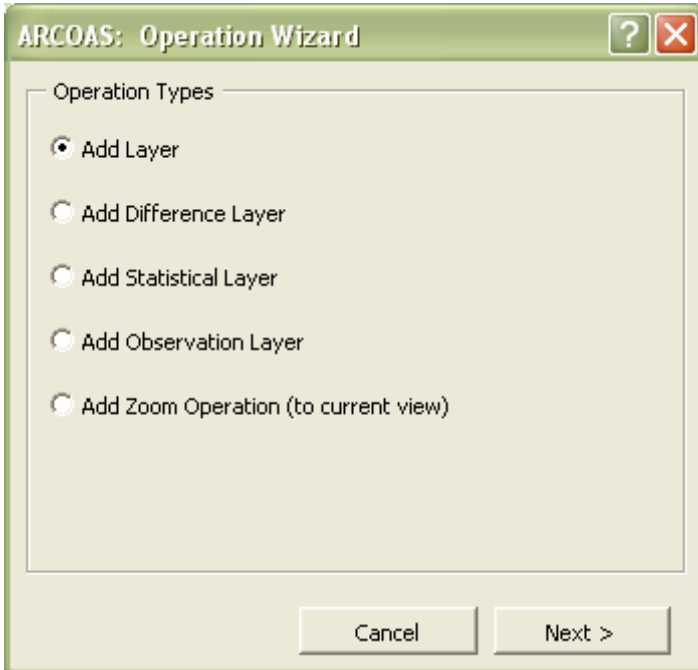
- *Add Layer* (Section 4.1.1)
- *Layer Difference* (Section 4.1.2)
- *Statistical Layer* (Section 4.1.1)
- *Add Observation Layer* (Section 4.1.4)
- *Add Zoom Operation* – Sets zoom to the current view

After the layer information is entered into the respective tool and the *Add Layer* button clicked, the *Operation Wizard* requests further information regarding the date and security classification of the layer(s) produced (Figure 4.45). The date range options are:

- *Single Date* – A single layer is produced using the information from the file with the specified date.

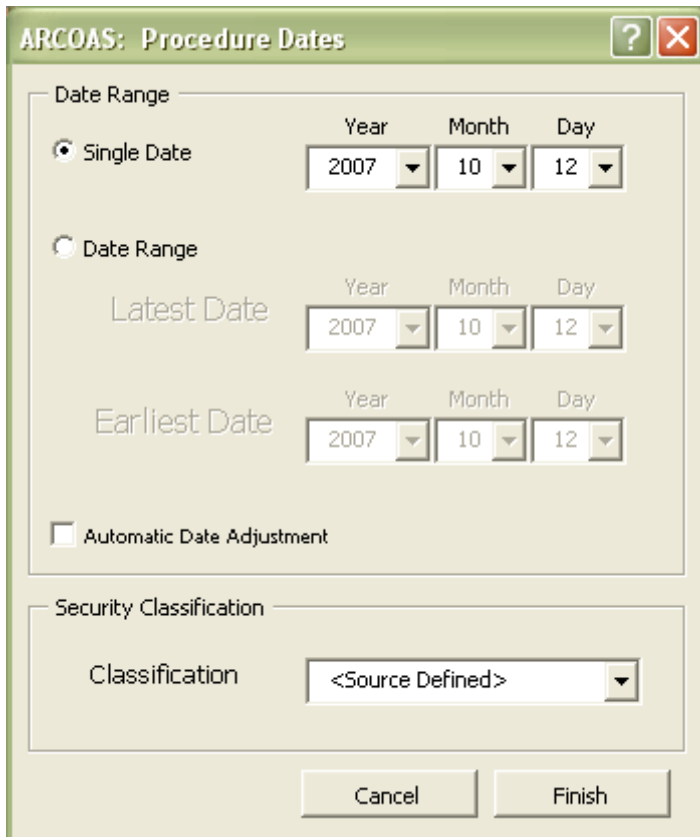
- *Date Range* – The number of layers produced varies according to the date range specified. The dates of the file(s) being accessed are the same for every running of the operation.

The automatic date adjustment option allows the date range to be adjusted each day so that the current data is always being accessed.



**Figure 4.44:** *Run Procedures - Operation Wizard* dialogue box.

The *Security Classification* options allow the security classification of the layers produced to be set without referring to the security classification from the netCDF file. Setting the security classification to “<Source Defined>” allows the security classification of the layer to be assigned as normal.



**Figure 4.45: Run Procedures - Procedure Dates dialog box.**

#### 4.4.4.4 Editing an operation

When the *Edit* button is clicked for an operation in the operation list, the *Edit Operation Wizard* is shown (Figure 4.46). The wizard allows the different aspects of the operation to be edited:

- Date Information – Opens the Operation Dates form so that the date information can be edited (Figure 4.45).
- Layer Details – Opens the appropriate Layer Adding form for the operation so that the details can be edited (Section 4.4.4.3). The zoom operation causes the zoom envelope to be changed to the current view.
- Envelope Restrictions – Opens the Layer Extent form to edit the visible extent of the new layer being created (Figure 4.47). Allows the extent to be defined as either the current extent entered or the default extent of the layer.
- Image Creation – Opens the Image Creation form so that the type of image file being created, the color scheme for the output raster, and the TAUs being displayed can be set (Figure 4.48).

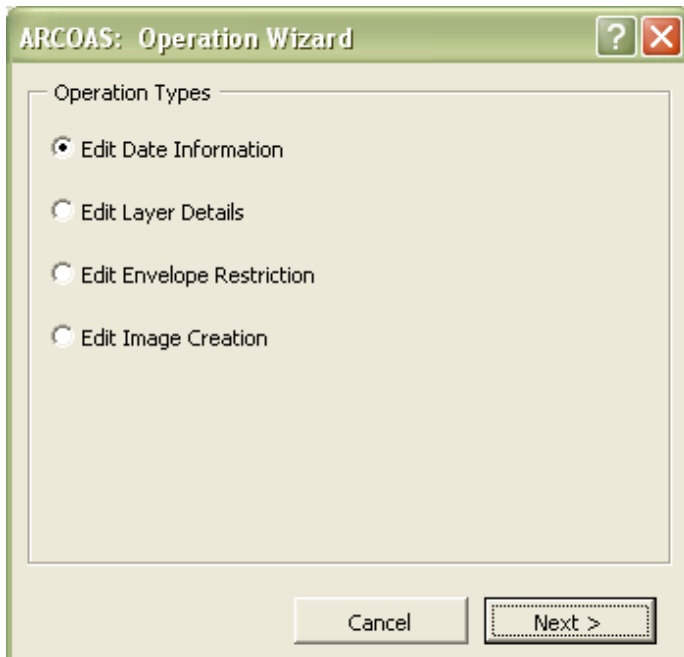


Figure 4.46: Run Procedures - Edit Operation Wizard dialogue box.

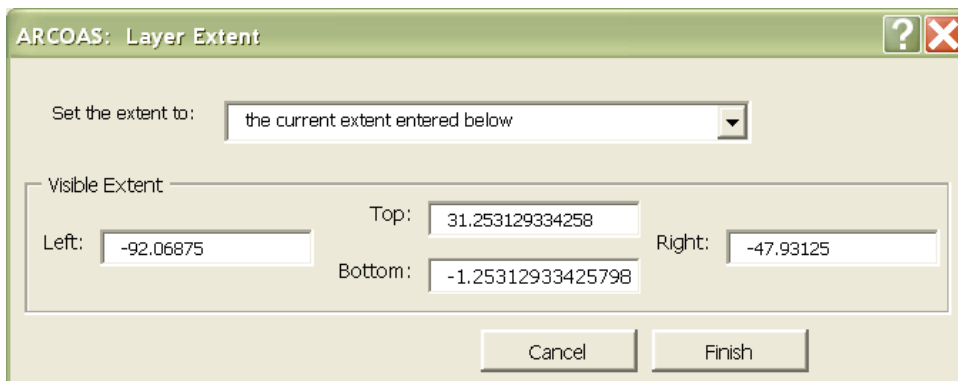


Figure 4.47: Run Procedures - Layer Extent dialogue box.

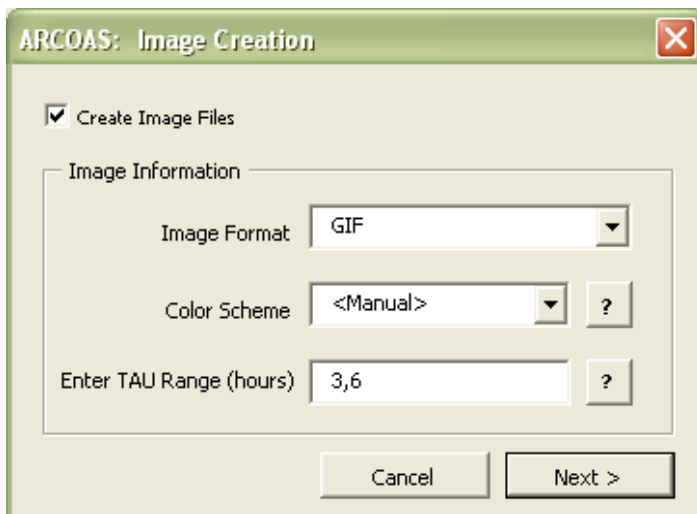


Figure 4.48: Run Procedures - Image Creation dialogue box.

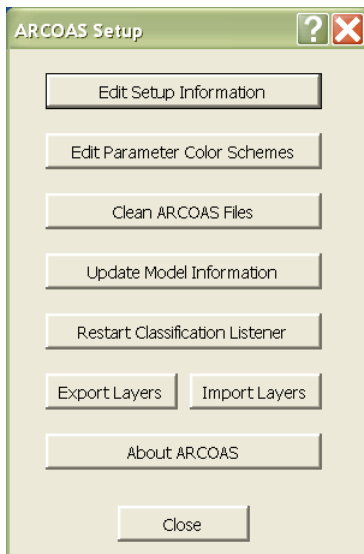
#### 4.4.4.5 Operation details

The *Operation's* details are displayed by clicking the *Details* button associated with an operation. The details include all of the information used to define the operation:

- Operation being performed
- Security classification of the layer(s) produced
- Area of Interest – to restrict the layers size or for zooming
- File path
- Model
- Region
- Parameter
- Unit Conversion
- Depth
- TAU
- Start Date and End Date
- Contour values for the base and interval
- Type of symbol and number of symbols

#### 4.4.5 Setup

The *Setup* tools include the tools that provide maintenance features to ARCOAS. These tools include *Editing Setup Information*, *Editing Parameter Color Schemes*, *Cleaning ARCOAS Files*, *Updating the Model Information*, *Restarting the Classification Listener*, *Exporting and Importing ArcMAP Layers*, and providing details on the version of ARCOAS (Figure 4.49).



**Figure 4.49:** *Setup* dialogue box.

##### 4.4.5.1 Editing setup information

The *Edit Setup Information* tool is used to change the ARCOAS settings utilized by the other ARCOAS tools. There are four categories of settings that can be changed with this tool: *Model*, *NetCDF File*,

*ArcMAP Layer and Filesystem*. The *OK* button is used to accept any changes made to any of the setup pages and closes the *Settings* form. The *Apply* button accepts the changes to any of the setup pages and allows further changes by not closing the *Settings* form. The *Cancel* button ignores any changes since the last time the settings were saved and closes the *Settings* form. A message is displayed if changes have not been saved prior to closing the form.

#### 4.4.5.1.1 Model settings

The *Model* settings are the settings used by the other ARCOAS tools to associate the directories containing netCDF files to the *Model* names (Figure 4.50). The *Model Name* is an identifier for the group of directories being searched for netCDF files. There is also the option to restrict which netCDF files will be processed by ARCOAS by setting the time range as a start and end date. Included with the time range settings is the option to automatically update the latest date to the current date so that the newest model information will always be accessible (*Automatic Date Adjustment*) and the option to update the ARCOAS model information whenever a change is detected in a netCDF directory (*Automatic Update*). When the *Automatic Date Adjustment* option is set, the *Latest Date* is disabled and when the date changes, the *Earliest Date* is adjusted to maintain the same number of days as set by the *Time Range*. To force all of the netCDF files contained in the specified directories to be read, set the *Automatic Date Adjustment* option and set the *Earliest Date* to blanks. The *Model Restrictions* further restricts which netCDF files are accessed since ARCOAS only accesses the netCDF files within the time range of the checked *Models*. Changes to the *Model* frame are accepted once the action is performed while changes to the *Time Range* and *Model Restrictions* frames are only accepted if the *Apply* or *OK* buttons are used. The *GNCOM & RNCOM Map* button is available to display the global and regional areas on the global map.



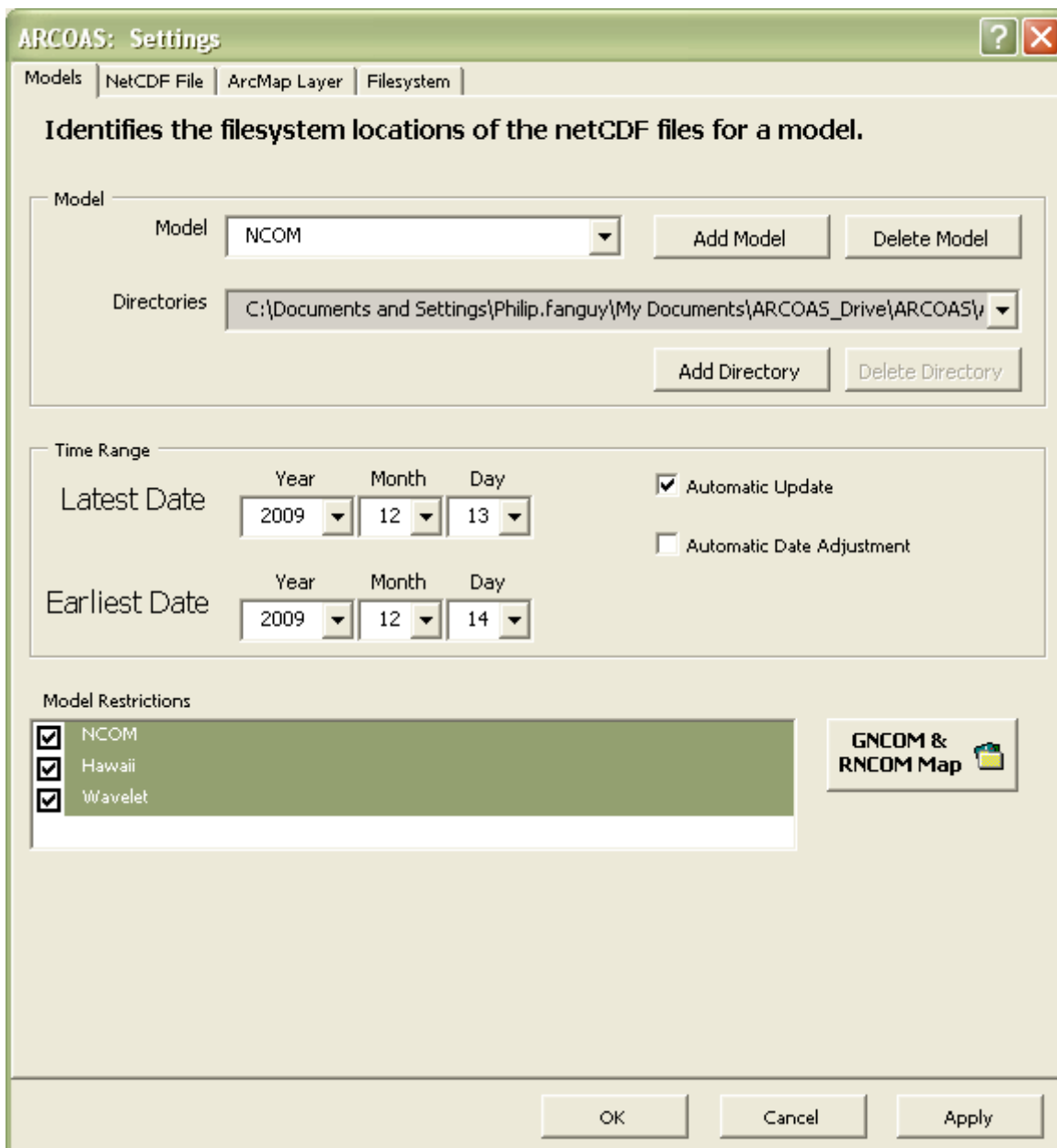
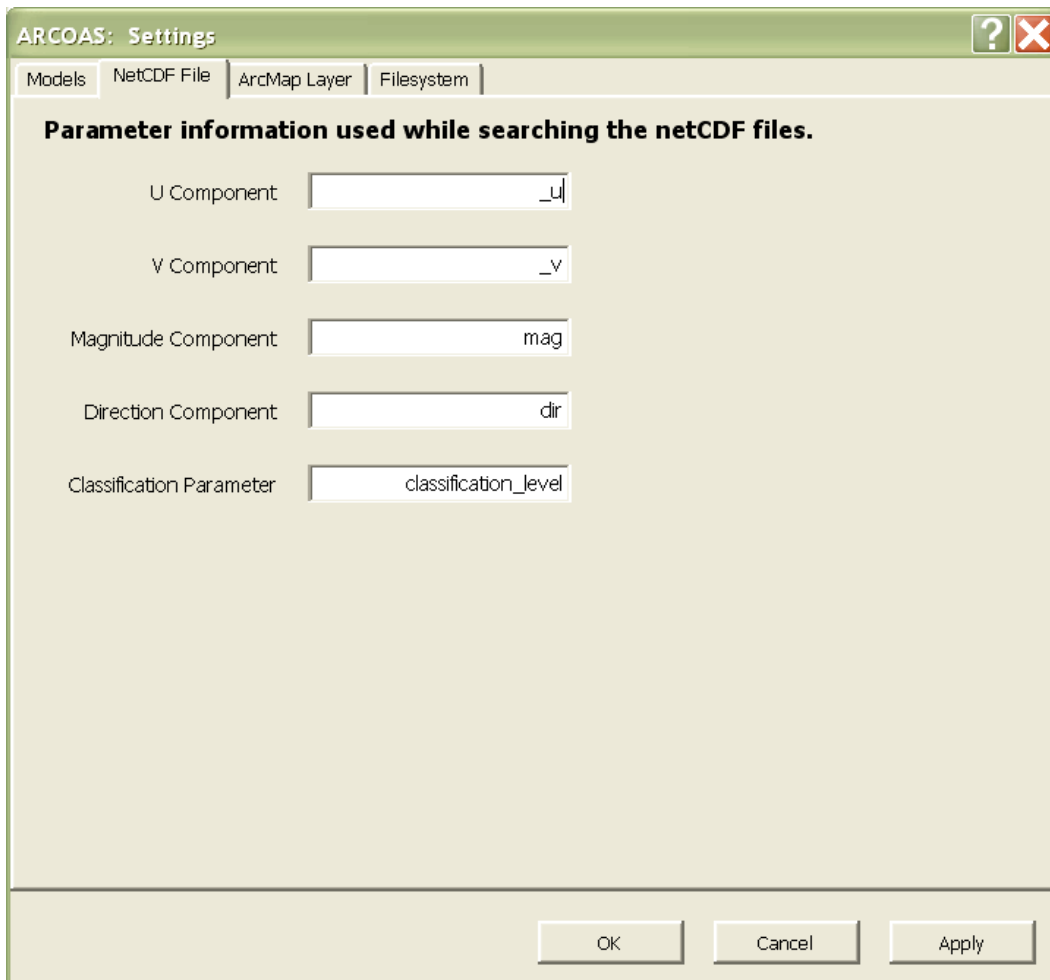


Figure 4.50: Settings – Models tab.

#### 4.4.5.1.2 NetCDF file settings

The *NetCDF File* settings include those options associated with the variables and attributes in the netCDF files (Figure 4.51). The settings are used to search the netCDF files for specific information. The *U Component* and *V Component* settings are used to search the netCDF file for two variables which are identical with the exception of the u- and v-components. If these two variables are located, the *Add Layer* tool will use them to calculate magnitude and direction so that a vector layer can be added to ArcMAP. Similarly, the *Magnitude Component* and *Direction Component* are used to find two variables which are identical with the exception of the magnitude and direction components so that a vector layer can be added to ArcMAP; however, this layer will be directly connected to the netCDF file. The

*Classification Parameter* is used to locate the attribute for the security classification of the netCDF file. This security classification is used as the security classification for the layers created from the netCDF file.



**Figure 4.51: Settings - NetCDF File tab.**

#### 4.4.5.1.3 ArcMAP Layer Settings

The ArcMAP Layer settings are the settings that ARCOAS uses when creating the layers in ArcMAP (Figure 4.52). Changes to these settings will affect future layers created by tools, with the *Update ArcMAP Layers* button provided to push the changes to the existing layers in ArcMAP.

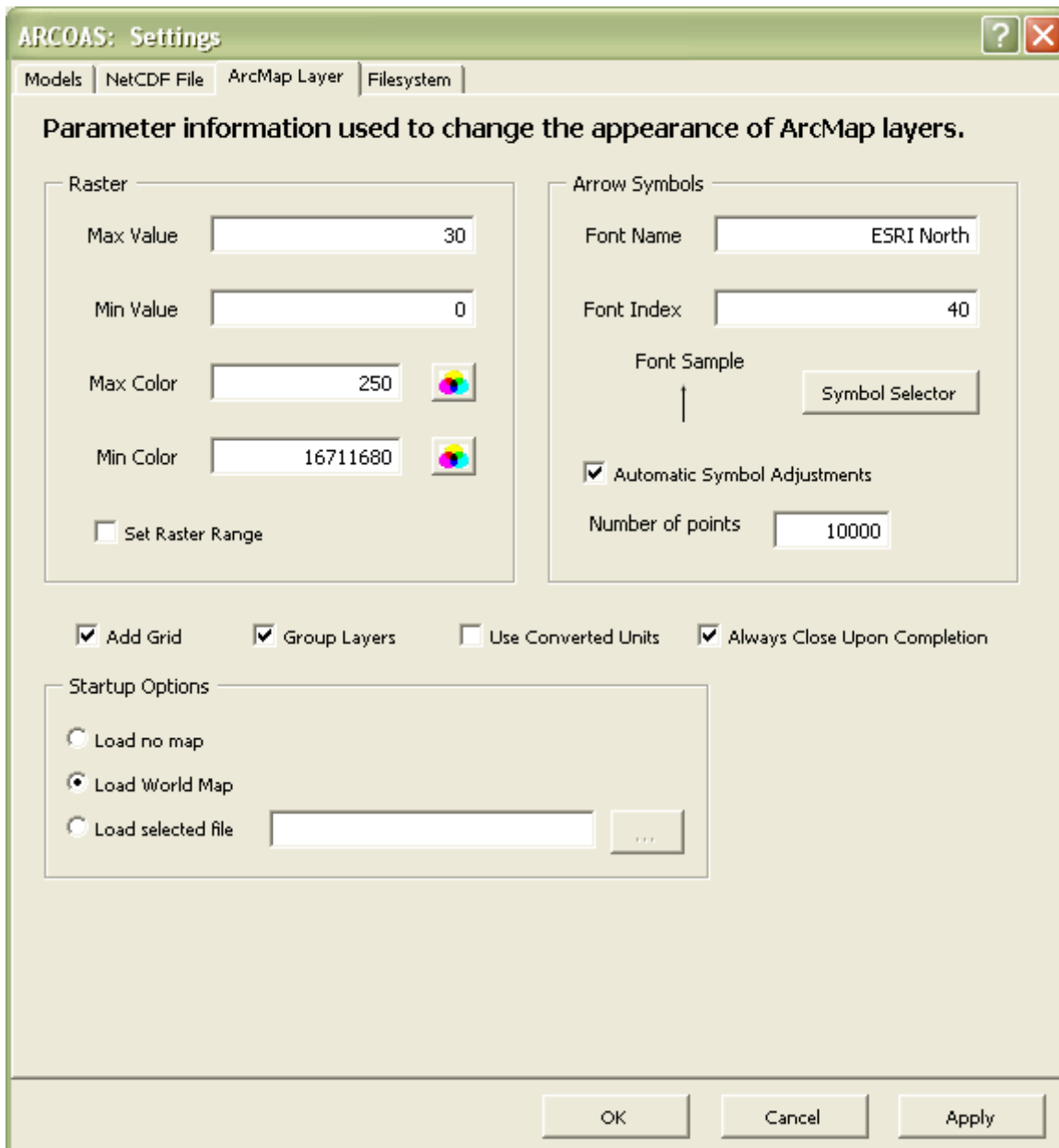


Figure 4.52: Settings - ArcMAP Layer tab.

#### 4.4.5.1.3.1 Raster settings

The settings for a newly created raster include the *Max Val* and *Min Val* values for the raster as well as the colors associated with the maximum and minimum values, *Max Col* and *Min Col*. Buttons to color selectors are provided to help with entering the RGB values for the colors. The *Set Raster Range* option is provided to turn on and off using the *Max Val* and *Min Val* values to define the raster's range. This option should only be enabled if all future rasters being created need a consistent value range. These raster settings are used if the raster's color scheme is not already defined by the *Parameter Color Scheme* tool (Section 4.4.5.2).

#### 4.4.5.1.3.2 Arrow symbol settings

The *Arrow Symbols* settings are included so that the arrow font can be changed to the desired font. Changes to the *Font Name* and *Font Index* are reflected in the *Font Sample*. The *Automatic Symbol Adjustments* option is provided to allow the feature that adjusts the size and density of the symbols based on the zoom level of ArcMAP to be turned on and off. The *Number of Points* textbox is provided so that the default maximum number of symbols created by the *Add Layer* tool can be adjusted.

#### 4.4.5.1.3.3 Startup options

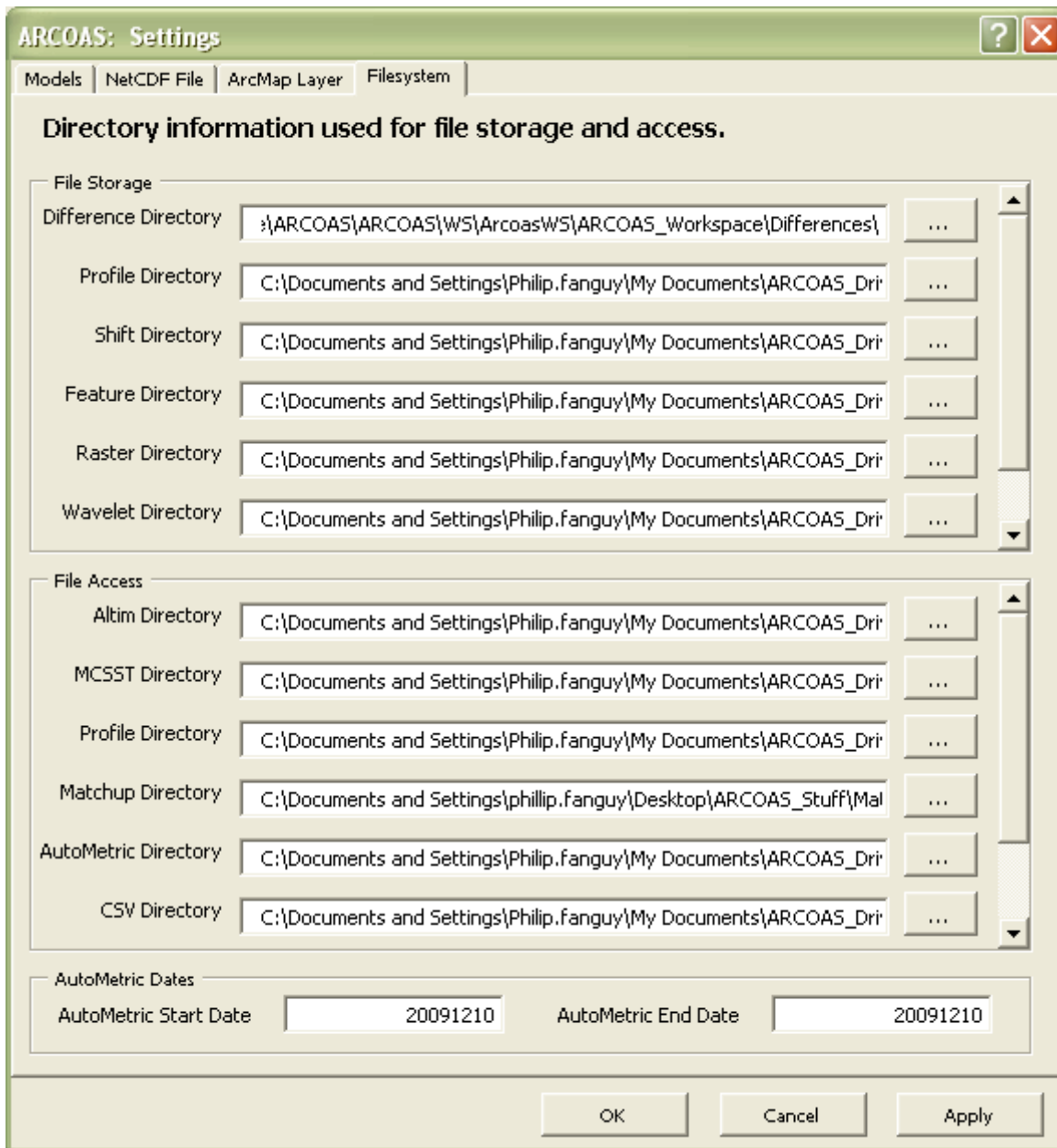
The *Startup Options* are included to control what image is loaded on ARCOAS startup. The options are to load no image, to load the ESRI World image, or to load a user defined image from a file. These images are loaded by ARCOAS on startup only if no layers are included in the *Table of Contents*.

#### 4.4.5.1.3.4 Other Settings

The *Always Close Upon Completion* option is used as the default value for the *Close Upon Completion* options for the ARCOAS forms. The *Add Grid* option determines if the *Map Grid* will be overlaid on the map. The *Group Layers* option determines whether the layers produced by the *Add Layer* utility will be organized by group layers. The *Use Converted Units* option provides the default setting for the units used by the ARCOAS tools.

#### 4.4.5.1.4 File system settings

The *Filesystem* settings include directory information for files created by the ARCOAS project and for locating observation and AutoMetrics files (Figure 4.53). The directories in the *File Storage* section are used by ARCOAS to organize files created by the ARCOAS project. These directories should only be changed if it is necessary to have the ARCOAS-created files located elsewhere. The directory location should not be changed. The *File Access* directories are used to set the default locations for the observation and AutoMetrics files. Directory browser buttons are provided for each of the directory text boxes. The *AutoMetrics Dates* are used as the default dates for the *Metric Plots* tool for limiting the AutoMetrics files read.



**Figure 4.53: Settings - Filesystem tab.**

#### 4.4.5.2 Selecting and editing parameter color schemes

The *Edit Parameter Color Schemes* tool is used to assign *Raster Color Schemes* to parameter names from netCDF files (Figure 4.54). New parameters are added to the list using the *New* button and existing parameters are removed from the list using the *Delete* button. The assigned color scheme is selected using the *Color Scheme* combo box. *New Color Schemes* can be created and existing *Color Schemes* can be edited using the *New/Edit* button (Section 4.4.5.2.1). The *Accept* button is used to accept the *Color Scheme* assignment to the parameter. The accepted assignments are stored in an ArcMAP table when the tool is closed.

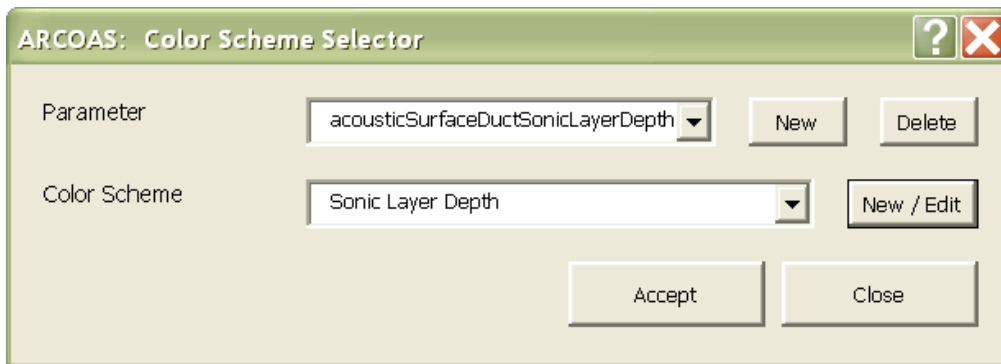


Figure 4.54: Setup - Color Schemes Selector dialogue box.

#### 4.4.5.2.1 Creating or editing a color scheme

The *Edit Color Scheme* tool is used to edit existing color schemes and to create new color schemes for rasters (Figure 4.55). Existing color schemes are selected using the *Color Scheme* combo box while the *New* button is used to create a new color scheme. The *Scheme Type* signifies the type of raster renderer the color scheme uses: *Classified* or *Stretch*. The *Null Value* is used by the stretch renderer to identify the value that is assigned a transparent color. The *Number of Levels* is the number of color ramps used by the stretch renderer or the number of classification levels being rendered by the classified renderer.

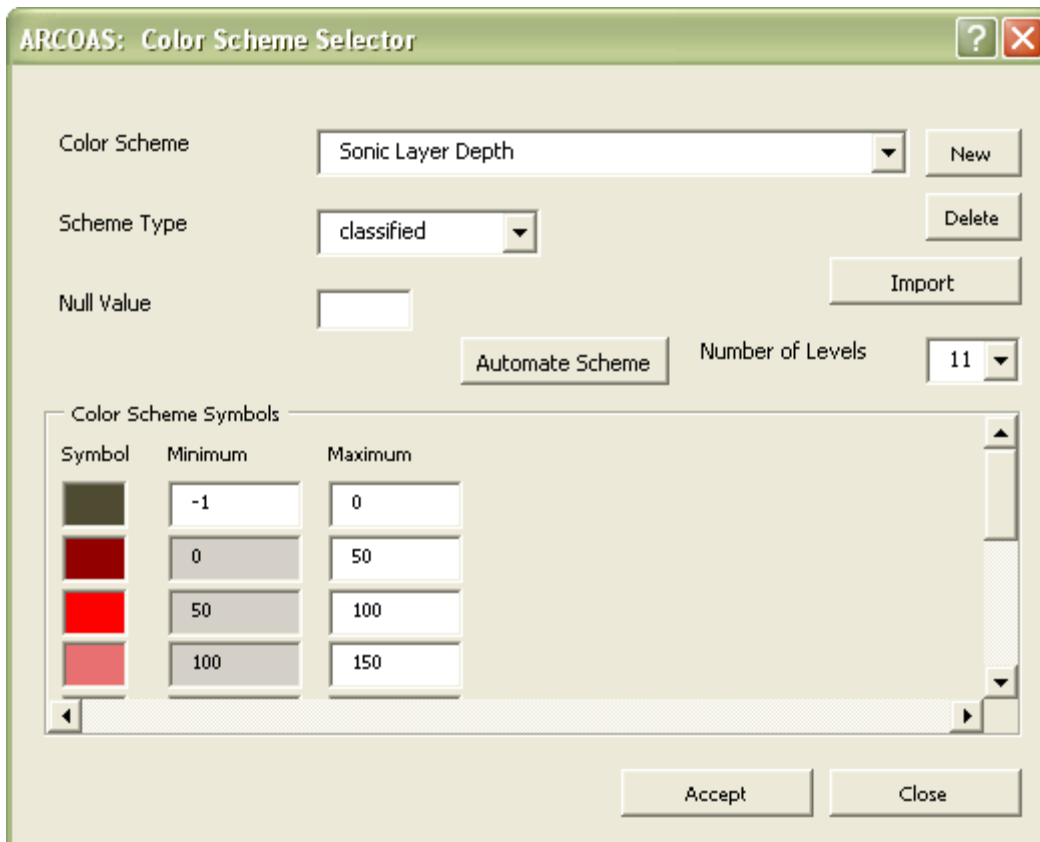


Figure 4.55: Setup - Color Scheme Selector dialogue box.

#### 4.4.5.2.1.1 Stretch renderer

For a *stretch* renderer type, the adjustable settings for the rasters include the *Maximum* and *Minimum* values for the raster and the colors associated with the maximum and minimum values for each color ramp. Setting both the *Maximum* and *Minimum* values to 0 allows the selected rasters to adjust the high and low values based on the values within the rasters. The *Symbol* color is changed by double-clicking (oh no not double clicking...) the symbol box associated with each color ramp color. An option to *Invert* the color ramps exists in order to easily reverse the order of the color ramps.

#### 4.4.5.2.1.2 Classified renderer

For a *classified* renderer type, the adjustable settings for the raster include the Maximum and Minimum values and the symbol color for each classification level being rendered. The Symbol color is changed by double-clicking the symbol box associated with each classification level.

#### 4.4.5.2.1.3 Saving changes

The changes to a *Color Scheme* are accepted using the *Accept* button and the accepted changes are saved to the ArcMAP table when the tool is closed. Changes are lost if the changes are not accepted prior to changing the color scheme or closing the tool.

#### 4.4.5.3 Cleaning up ARCOAS files

The File Cleanup tool allows that unused files created while running ARCOAS be deleted. The form allows which files are deleted using the options to limit the file groups as well as the dates of the files being deleted. The *Clean Files* button is used to delete the unnecessary files from the file system.

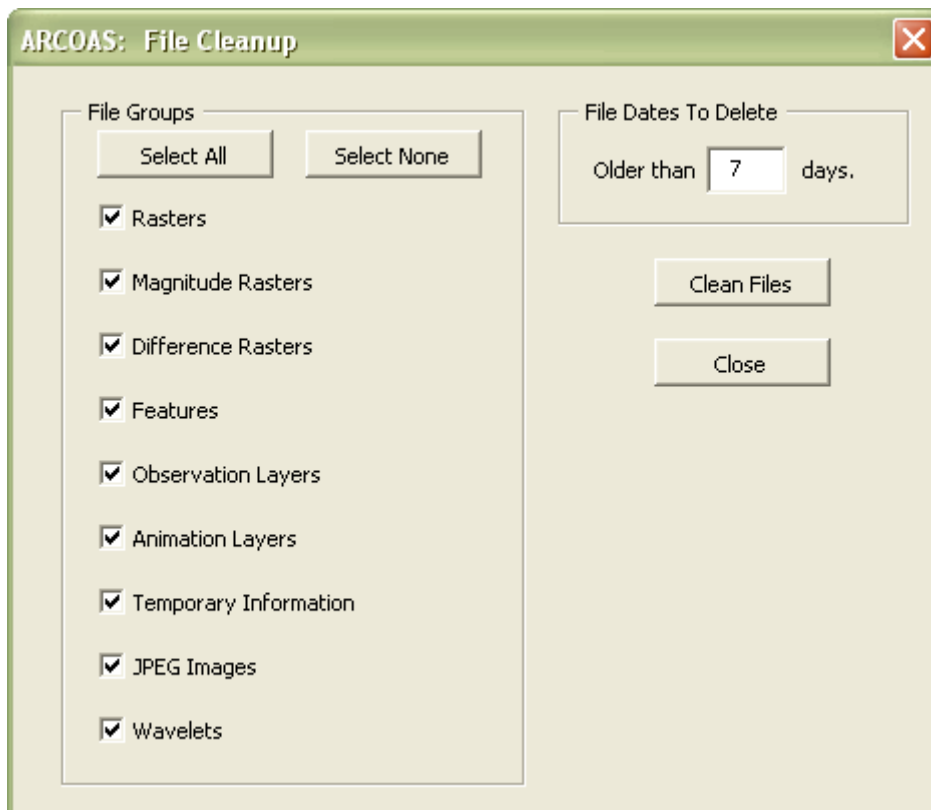


Figure 4.56: Setup – File Cleanup dialog box.

#### 4.4.5.4 Updating model information

The *Update Model Information* button is used to update the netCDF file information contained in ARCOAS whenever changes occur to the netCDF files in the directories associated with a model name.

#### 4.4.5.5 Restarting classification listener

The *Restart Listener* button is provided for when there are issues with the security labels in ArcMAP not being updated properly. Issues include the label not updating when the highest security classification of the visible layers changes and the labels not moving when panning and zooming occurs.

#### 4.4.5.6 Exporting and importing layers

The *Export Layers* and *Import Layers* buttons are used to save the current layer state in ArcMAP so that the current layer state can be returned at a later time. This is expected to be used primarily when the ARCOAS project is being updated to a new version. In order to retain the current layers when upgrading ARCOAS to a new version, the following steps should be done.

1. The *Export Layers* button creates a copy of the current layers and stores them in the *Export* directory.

NOTE: Do not delete the layers from ArcMAP after exporting the layers.

2. The current ARCOAS project is closed.
3. The new ARCOAS project file is placed in the same directory as the current ARCOAS project.
4. When the new ARCOAS project starts, the exported layers are automatically loaded. If multiple export layer folders exist, the most current export folder is loaded.

If the layer information is not automatically loaded, the *Import Layers* button can be used to load the exported layers.

#### 4.4.6 Changing the workspace

The *Change Workspace* tool allows the workspace being used by ARCOAS to be changed (Figure 4.57). The workspace contains all of the user's settings as well as which netCDF files should be accessed. Switching the workspace will cause the map to be zoomed to the world's extent and update the ARCOAS model information.

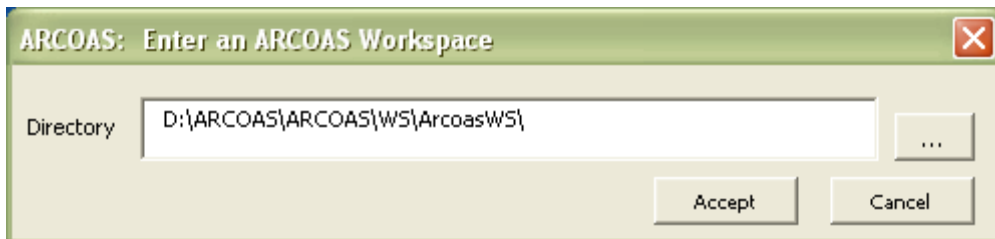


Figure 4.57: Setup – Change ARCOAS Workspace dialog box.



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# Appendix

## A Creating Animation Layers

The *Animation Layer Creator* is similar to the *Add Layer* tool with the exception that the *Animation Layer Creator* is able to create multiple layers at once (Figure 4.58). The *Animation Layer Creator* is used when it is necessary to animate a sequence of events which cannot be contained in a raster layer connected to a netCDF file, for example, magnitude rasters, symbol layers, and layers connected to netCDF files with a single TAU. Based on the dimension selected, multiple layers are created for the parameter based on either varying time or depth. The number of layers created is determined by the *Start* and *End* combo boxes as well as the *Step Value* textbox (which identifies if any *Dimension* values are skipped when making the layers).

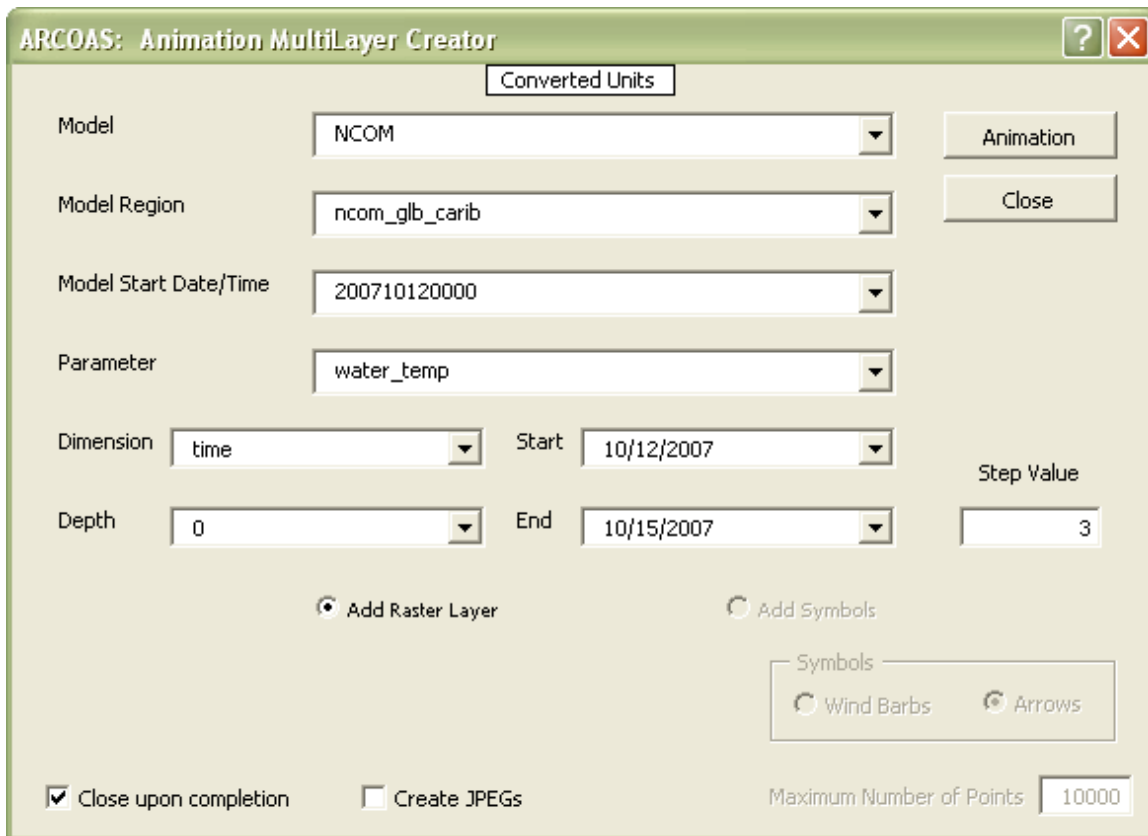


Figure 4.58: *Animation MultiLayer Creator* dialogue box.

### A.1 Types of layers

The *Animation Layer Creator* can create either raster layers or symbol layers. The *Add Raster Layer* option is available for the majority of the parameters with the exception being when the parameter ends with “\_mag/dir”, in which case only adding symbol layers is possible. The only other parameters that allow symbol layers to be produced are parameters which end with “\_u/v”.

## A.2 Selecting the NetCDF file

The netCDF file being accessed is chosen by selecting the *Model* that is associated with the netCDF file, followed by selecting the *Model Region* encompassed by the netCDF file and finally the *Model Start Date/Time*. These three options generally narrow the available netCDF files to a single file for the parameter to be selected.

## A.3 Selecting the parameter and dimension

Once the netCDF file being accessed is determined, the *Parameter* being animated is selected followed by the *Dimension* being animated and the other dimension's value, if necessary. The *Start* and *End* values are entered to identify the start and end points for the animation along with the *Step Value* for the animation. If the *Parameter* can be used to add symbols to ArcMAP, options are available to identify the type of symbol being added, wind barbs or arrows, and to limit the maximum number of symbols to include in the layer.

## A.4 Unit conversions

The final option is to determine the units of the resulting layer. The option is provided to convert all of the values displayed by the ARCOAS tools between the netCDF files native units and converted units. By clicking on the label at the top of the tool, this option switches between the native units and converted units. This conversion affects only the resulting layer(s) in ArcMAP, not the data in the netCDF file.

## A.5 Animation layer creation

Once the *Parameter* is chosen and the options have been selected, the layers in ArcMAP are created using the *Animation Layer Creation* button. The coloring scheme for the rasters is specified by the *Parameter Color Schemes* (Section 4.4.5.2) and the *ARCOAS Settings* (Section 4.4.5.1.3). For the rasters displayed with a stretch renderer, the high and low values are based on the values in the netCDF file for the parameter or as defined by the *Parameter Color Scheme*. Symbol density and size are adjusted based on the current zoom level. This can be adjusted using the *Adjust Symbols* tool (Section 4.2.2).

# **B Frequently Asked Questions**

## B.1 NetCDF File Selection

### *B.1.2 Why is the Model Selection Interface empty?*

If the Model combo box does not contain any information, the reason is that the model information needs to be updated. Close the tool and update the model information from the Setup Menu before reopening the tool (Section 4.4.5.4). If the Model Selection Interface is still empty, model information needs to be entered in the ARCOAS settings (Section 4.4.5.1.1).

### *B.1.3 Why does the Model Selection Interface have information only in the Model combo box?*

First, verify that the directories associated with the model contain netCDF files. Second, verify that the time range set in the ARCOAS Settings allows the desired files to be processed.

#### *B.1.4 Why is the model region that I need not listed in the Model Region combo box?*

Only the model regions that can be viewed within the map's view are included in the Model Region combo box. Zoom out to the World view then change either the Model or Model Start Date/Time options to update the Model Region combo box. If the region is still not available, ensure that a netCDF file for the region exists in a directory associated with the model name for the specified date.

## B.2 Arrows and Wind Barbs

#### *B.2.1 How can I add arrows and/or wind barbs using ARCOAS?*

To add arrows and/or wind barbs using ARCOAS, the following conditions need to be met:

1. One of the following sets of variable need to be contained in a single netCDF file.
  - i. U and V component variables
  - ii. Magnitude and Direction variables
  - iii. Direction variable only
2. The variable names must be named similarly with a single part of the term differentiating between the two components, e.g. water\_u and water\_v, wind\_speed and wind\_dir, etc.
3. The ARCOAS NetCDF settings must be set to identify the differentiating part of the variable correctly, i.e. U Component = \_u, V Component = \_v, etc.
4. The Parameter combo box in the Model Selection Interface must be set to the variable ending with \_u/v, \_speed/dir, or the direction component.
5. The Add Symbol check box must be enabled and selected and the Maximum Number of Points must be greater than 0.

#### *B.2.2 Why are no arrows displayed after I just created an arrow layer?*

When an arrow layer is created, the arrow layer is adjusted based on the zoom level to improve the display of the arrows. This adjustment tool has determined that the zoom level is too far to adequately view the layer. To view the arrows:

1. Zoom in until the arrows are displayed.
2. Use the Adjust Symbols tool to adjust the density of the arrows (Section 4.2.2).

#### *B.2.3 Why does the display of my arrow layer change after I adjusted it using the Adjust Symbols tool?*

All arrow layers are adjusted when the map view changes based on the zoom level to improve the display of the arrows. To disable this feature, disable the Automatic Symbol Adjustments option in the ARCOAS Settings -> ArcMAP Layer tab (Section 4.4.5.1.3.2).

#### *B.2.4 Why is the Adjust Symbols tool disabled even though I have a arrow layer in ArcMAP?*

The Adjust Symbols tool is only enabled if the arrow layer is visible, i.e. checked, in the ArcMAP Table of Contents.

## B.3 Animation

#### *B.3.1 Why are none of my raster layers able to be animated?*

The Animator tool limits the animations to only the layers which are visible, i.e. checked, in the ArcMAP Table of Contents. Also, only raster layers which are connected to netCDF files or group layers are able to be animated. To verify that a raster layer is connected to a netCDF file, check the properties menu of the layer for a NetCDF tab.

*B.3.2 How do I create a raster layer connected to a netCDF file?*

Use the Add Layer tool to add a raster layer without performing unit conversions (Section 4.1.1).

*B.3.3 Why will my netCDF connected raster not perform a time-series animation?*

Some netCDF files only contain a single TAU value preventing the Animator from performing a time-series animation. If this type of animation is required, the Animation Layer Creator can be utilized to create a group layer that will allow the desired animation to be performed (A).

*B.3.4 Why is the animation speed so slow?*

The animation speed is affected by a number of factors.

1. **Factor:** The number of visible layers set in the Table of Contents.  
**Solution:** Make all layers which are not essential to the animation invisible by unselecting them in the Table of Contents.
2. **Factor:** The Delay scroll bar in the Animators Advanced Settings.  
**Solution:** The speed of the animation is increased as the delay between animation steps is decreased by sliding the bar to the left.
3. **Factor:** The Band Dimension of a netCDF connected raster.  
**Solution:** Verify that the Band Dimension in the layer's NetCDF Properties is blank.

*B.3.5 Why does the high/low values for the animated raster change in each animation step?*

The raster's high/low values are based on the values contained in the raster. Since the raster is changed for each step of the animation, the high/low values are changed as well. To force the values to remain constant throughout the animation,

- Select the Adjust Raster Colors option in the Animator's Advanced Settings and enter the necessary high/low values in the boxes. The Calculate button can be used to calculate the maximum and minimum values over all of the animated layers (Section 4.3.4.2.1).
- Set the Edit High/Low Values option in the layer's Symbology Properties. The option is available when the Stretch Type is set to Minimum-Maximum.

*B.3.6 I've changed the variable being animated and now the color range is no longer accurate. How do I adjust the high/low values for the animated rasters?*

Select the Adjust Raster Colors option in the Animator's Advanced Settings and enter the necessary high/low values in the boxes. The Calculate button can be used to calculate the maximum and minimum values over all of the animated layers (Section 4.3.4.2.1).

*B.3.7 The AVI file created by the Animator appears to skip steps. How can I improve the saved AVI file?*

The quality of the saved AVI file is dependent upon the size of the map in ArcMAP. If the map is too large, the AVI file will be large and have issues being displayed in media players. Try shrinking the size of the ArcMAP window to improve the saved AVI file.

## B.4 Profile Plotting

### *B.4.1 Why does the plot not change even though I am clicking at different locations on the map?*

Verify that the Click Profile Point option is not selected. If this option is selected, the closest profile point to the clicked location is plotted along with the model point closest to this profile point. By unselecting the option, the map clicks will be used to locate the closest point contained in the netCDF file selected by the Model Selection Interface.

### *B.4.2 Why will the Profile information and the Model information not plot when I click on the map?*

The profile and model information will only plot if:

1. Both the Plot Profile and Plot Model Data options are selected in the Plot Selection frame.
2. The parameters selected for both the Profile Plot and Model Data Plot are identical.
3. The map click is near the model data identified by the Model Selection Interface and either the profile point is already selected or the click is near a profile point

To plot one or the other, unselect the other's option in the Plot Selection frame prior to clicking on the map.

## B.5 Cross Section

### *B.5.1 Why are no layers available from which to create a cross section even though raster layers exist in ArcMAP?*

Only visible raster layers connected to netCDF files are listed in the Layer combo box (See Section B.3.2 for details on creating a netCDF raster layer).

### *B.5.2 Why is the cross section a solid colored box or a line?*

The cross section tool relies on a multi-banded raster to compute and display the cross section for the raster. If this error occurs, the tool was unable to properly adjust the Band Dimension in the layer to the depth dimension (Section 4.3.3.1). Adjust the Band Dimension to depth and apply the changes (even if the Band Dimension already is depth). Then repeat the steps to create the cross section.

### *B.5.3 How do I return to the regular map from the cross section screen?*

To return to the original data frame, one of the following operations needs to be performed:

- Right-click the Layers data frame in the ArcMAP Table of Contents and select Activate.
- Right-click the Cross Sections data frame in the ArcMAP Table of Contents and select Remove.
- Click the Cross Section button from the ARCOAS Tools toolbar.