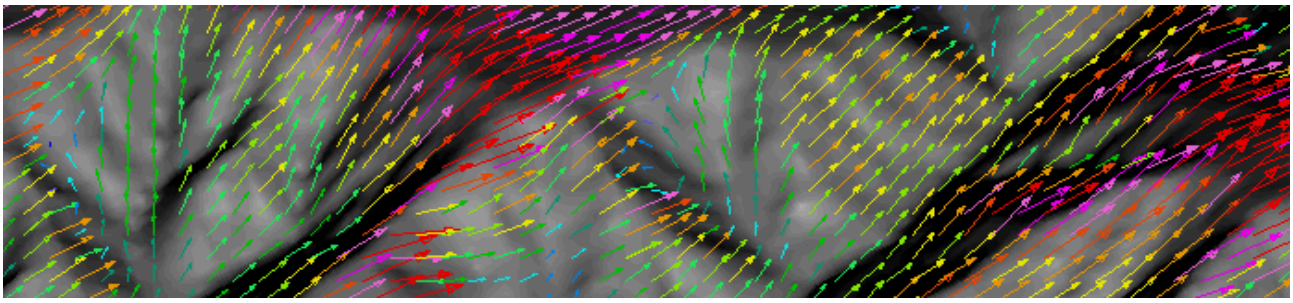
# WindWizard User's Guide



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**What is WindWizard?**

WindWizard is an interface to a computational fluid dynamics model (CFD) (FLUENT®) to simulate the mechanical influence terrain has on air flow (Butler and others 2004). CFD technology was initially developed by the aerospace and automotive industries to simulate fluid flow around or through aircraft, automobiles, pipes, etc. WindWizard output is wind velocity and direction (20-foot) in raster and vector format (commonly 30-300 m resolution). Multiple runs of wind speed and direction can be simulated to create a "wind library" for use in prescribed fire planning, wildland fire use, wildfires, and reviews.

Surface winds for an instant in time are calculated using terrain information obtained from a digital elevation model (DEM) (USGS 1990) and a user-defined upper-level wind speed and direction. This input speed differs from the 20-ft wind speed; usually, *two to three times* that of the observed 20-ft ridgetop wind to produce the desired results. Simulations assume a neutrally stable atmosphere and do not include buoyancy effects (diurnal and fire induced winds). WindWizard output is not a forecast, but a snapshot in time of what the local surface winds *may be* given the synoptic wind scenario (Butler and others 2006a).

The DEM must be in meters, should be 20-30% larger than the area of interest, and the subject area located in the center of the DEM. The buffer is needed to accurately simulate the influence the surrounding terrain may have on wind flow in the subject area. If DEMs are inaccessible for your area of interest, the United States Geological Survey (USGS) Rapid Data Delivery System (RDDS) (http://firedata.cr.usgs.gov/) provides a quick and efficient way to obtain a DEM and other ancillary layers.

Gridded wind has two principle functions: visualization and model input. Shapefiles can be plotted in a GIS to help managers visualize the channeling and checking effect topography has on wind flow for operational, planning, and educational purposes (Stratton 2006). Output can be imported into FARSITE or FlamMap and frequently improves fire growth and behavior simulations, particularly at a local scale (Butler and others 2006b).

**How Does It Work?**

(1) A DEM is imported into WindWizard. Modeling domains should be less than 1,000 km²; the smaller the modeling domain, the finer the simulation or calculated resolution. For example, a one 7.5´ quadrangle area in central Utah (~ 49 mi²/127 km²) will yield a mesh resolution of ~ 50 m (the ASCII Raster file is 3-4 MB), when the *fine* resolution is selected. However, with the same settings, a 4-quad area (2 by 2) will typically yield a mesh resolution of 100 m and a 9-quad area (3 by 3 or ~ 1,100 km²) will yield a 150 m resolution.

(2) Using the DEM, WindWizard builds a 3-dimensional mesh of the DEM and atmosphere above the terrain. This mesh consists of thousands of 3-dimensional tetrahedral and wedge shaped cells.

(3) A user-defined wind speed and direction is used to force flow through the mesh and then mass, momentum, and turbulence equations are solved simultaneously for each cell to compute the wind flow.

(4) Output files are written in shapefile and ASCII Raster format.

**Recommended System Requirements**

The WindWizard program is computationally demanding. For this reason, use of WindWizard is not recommended unless the following system requirements are met.

- PC with 233-300 megahertz or higher processor clock speed (single or dual processor system) (e.g., Intel Pentium/Celeron or AMD K6/Athlon/Duron)
- 1-2 gigabytes of RAM
- 5 gigabytes of available hard disk space
- Windows 2000 or XP

**WindWizard Installation**

1. Obtain a copy of the WindWizard program by emailing Jason Forthofer (jforthofer@fs.fed.us) or Bret Butler (bwbutler@fs.fed.us). You will be directed to an FTP site containing a zip file containing the WindWizard program, this user's guide, the f2f program, and supporting documentation.

2. Carefully follow the installation instructions provided in the text file (Installation_instructions.pdf).

**Running the WindWizard Program**

1. Open the WindWizard by double-clicking on the FloWizard icon on your desktop and click **Next** (Figure 1.)

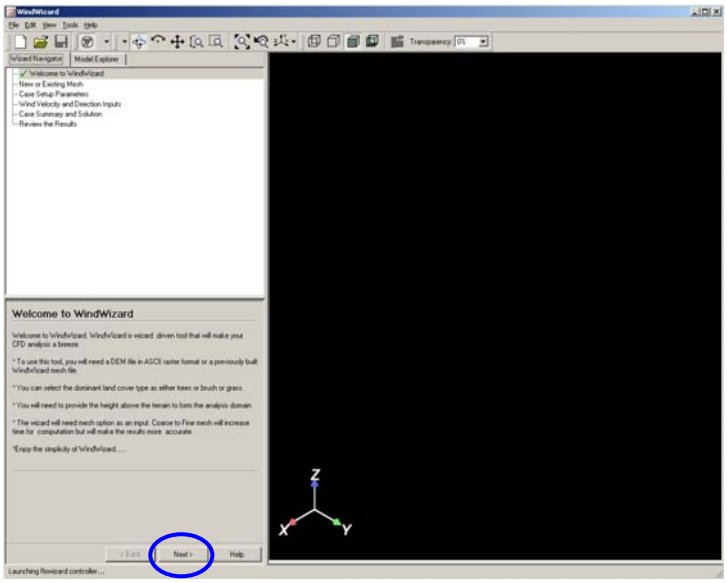


Figure 1. WindWizard opening screen.

2. Select **Create New Geometry and Mesh** or if you are using an existing mesh (i.e., if you previously ran WindWizard) select **Open Existing Case**, click **Next** (Figure 2), click **Browse** to select the existing mesh, and then **Read Case**. Additional information can be obtained by selecting the **Guide Me...** button.

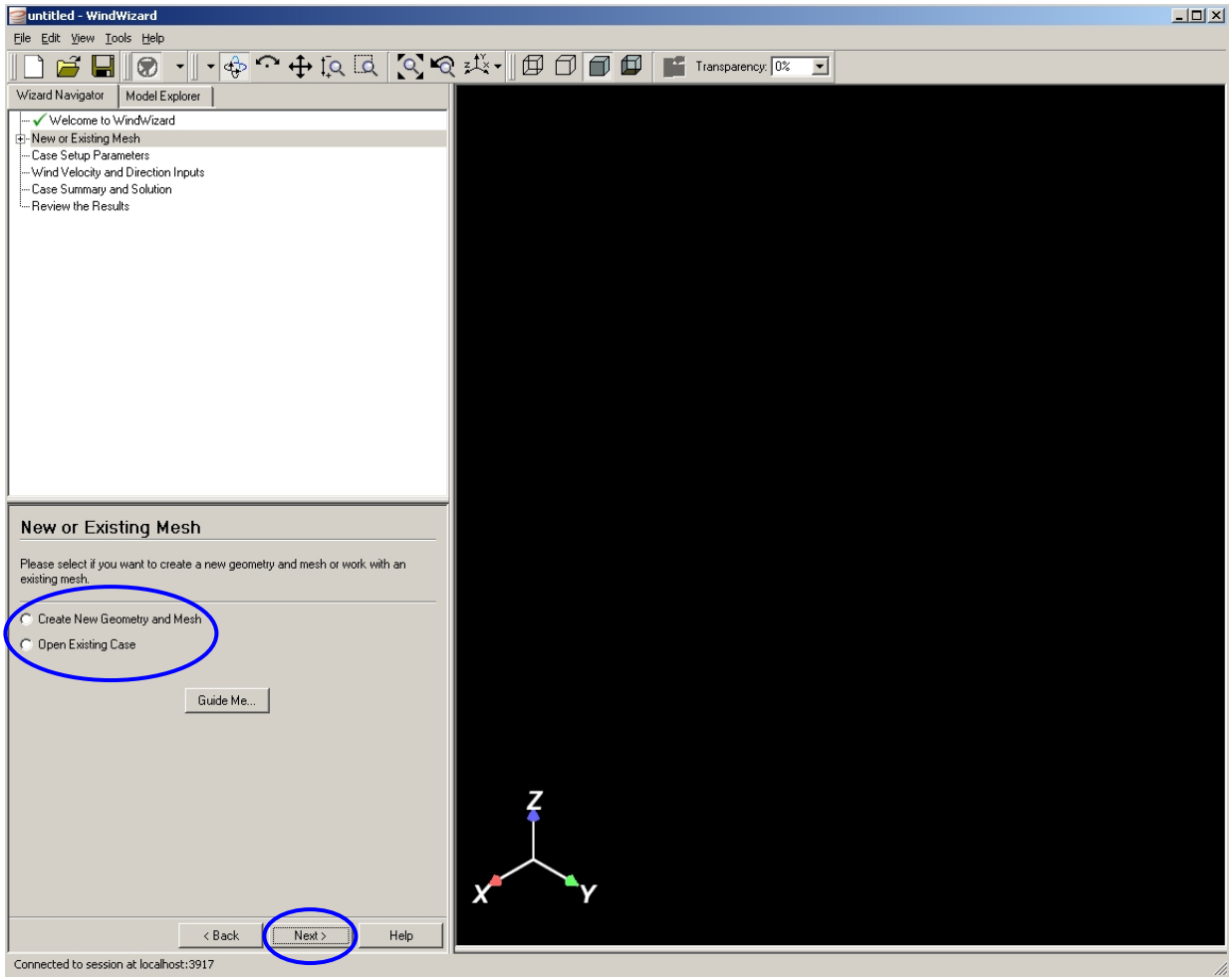


Figure 2. WindWizard mesh selection window.

3. Click **Browse** to select the DEM. Make sure the DEM contains no values of "NODATA" (typically attributed as -9999). A quick way to check is to open the DEM (ASCII Raster file) in WordPad© and search for -9999 values. If NODATA values exist, use a GIS to modify the modeling domain.

4. Select the **desired mesh resolution** from the **dropdown arrow** (coarse, medium, or fine). The mesh—an interconnected lattice of 3-dimensional cells—determines the calculated resolution of the simulation. This calculated resolution is different than the spatial resolution of the output files. By choosing a coarser mesh resolution, the simulation will take less time, but the calculated resolution will be coarser. *In most cases*, the additional computational time required for the fine resolution is well worth the more "accurate" product.

5. Check that the **flow domain height** is set to 5,000 m (the default). The flow domain height defines the top of the mesh domain. Under most circumstances the default domain height will be adequate. However, if a user experiences the following error: "Mesh Creation Failed. Please change the meshing options and try again," increase the domain height incrementally (e.g., 2,000 m at a time).

6. Click **Create** to start the meshing process (Figure 3). NOTE: The progress bar is inaccurate and should be disregarded. Depending on your CPU and mesh resolution, the meshing process will take 5 to 30 minutes.

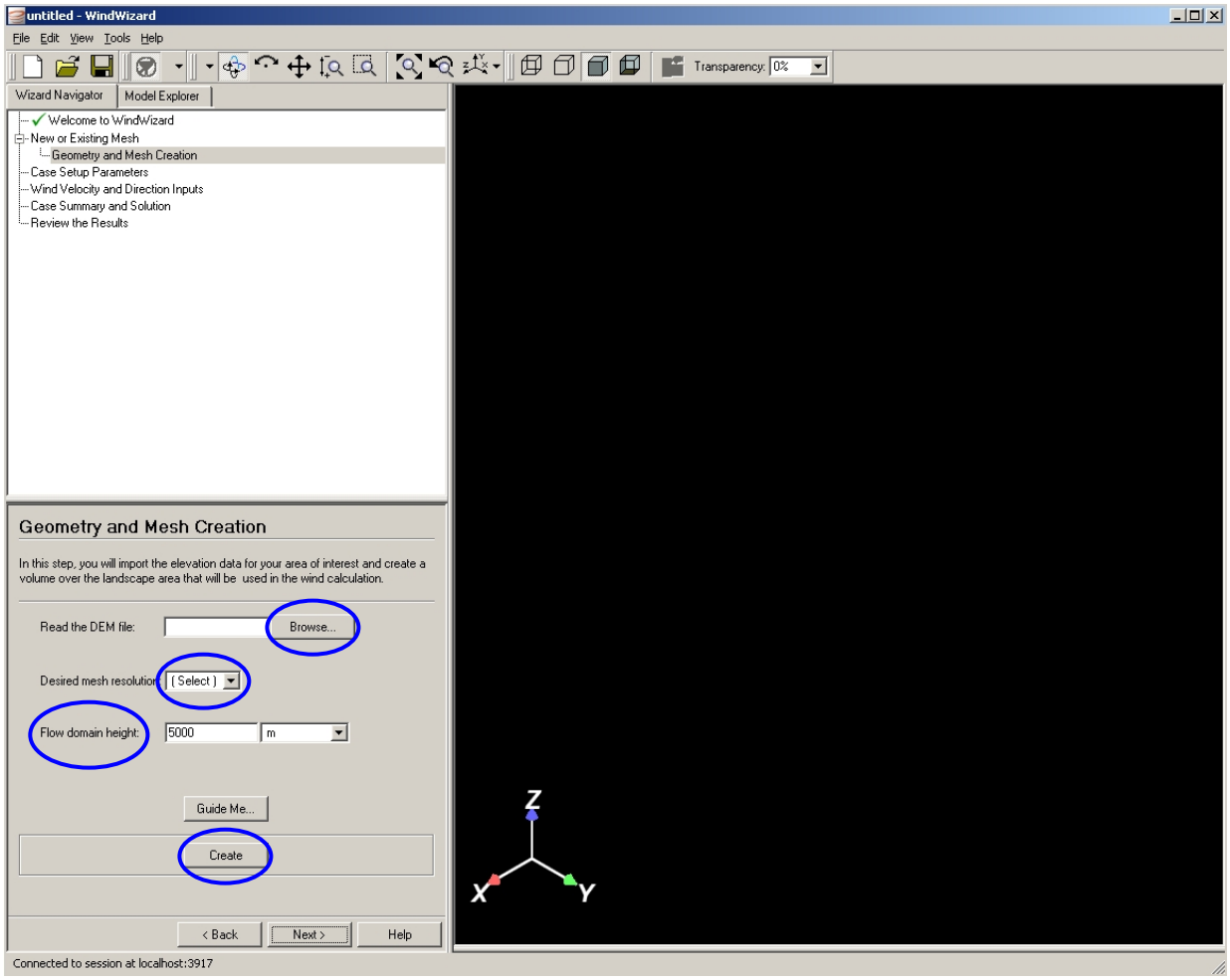


Figure 3. WindWizard geometry and mesh creation window.

7. Click **OK** when the meshing operation is complete to reveal the mesh.

8. Click **Next**.

9. Select the **Surface Property** (Forest, Shrubs, or Grass) from the dropdown arrow. This selection defines the drag effect of the ground surface. It is applied uniformly over the domain. Choose the *most dominate* cover-type in those areas where there is mixed vegetation.

10. Select the **Output File Resolution** and units. This selection determines the resolution of the output files. The output resolution is different than the mesh resolution (coarse, medium, or fine). The mesh resolution is the resolution used to compute the wind flow. The output file resolution is the spatial resolution of the ASCII Raster and shape files. Wind speed and direction values from the mesh—the calculated resolution—are *interpolated* to the output files.

11. Check that the **Number of Iterations** is set to 200 (the default). The mathematical solver used in WindWizard steps iteratively toward the "true" wind flow. The higher the number of iterations, the closer the simulated wind field gets to the mathematically "true" solution. The default value is adequate for most simulations.

12. Click **Next** (Figure 4).

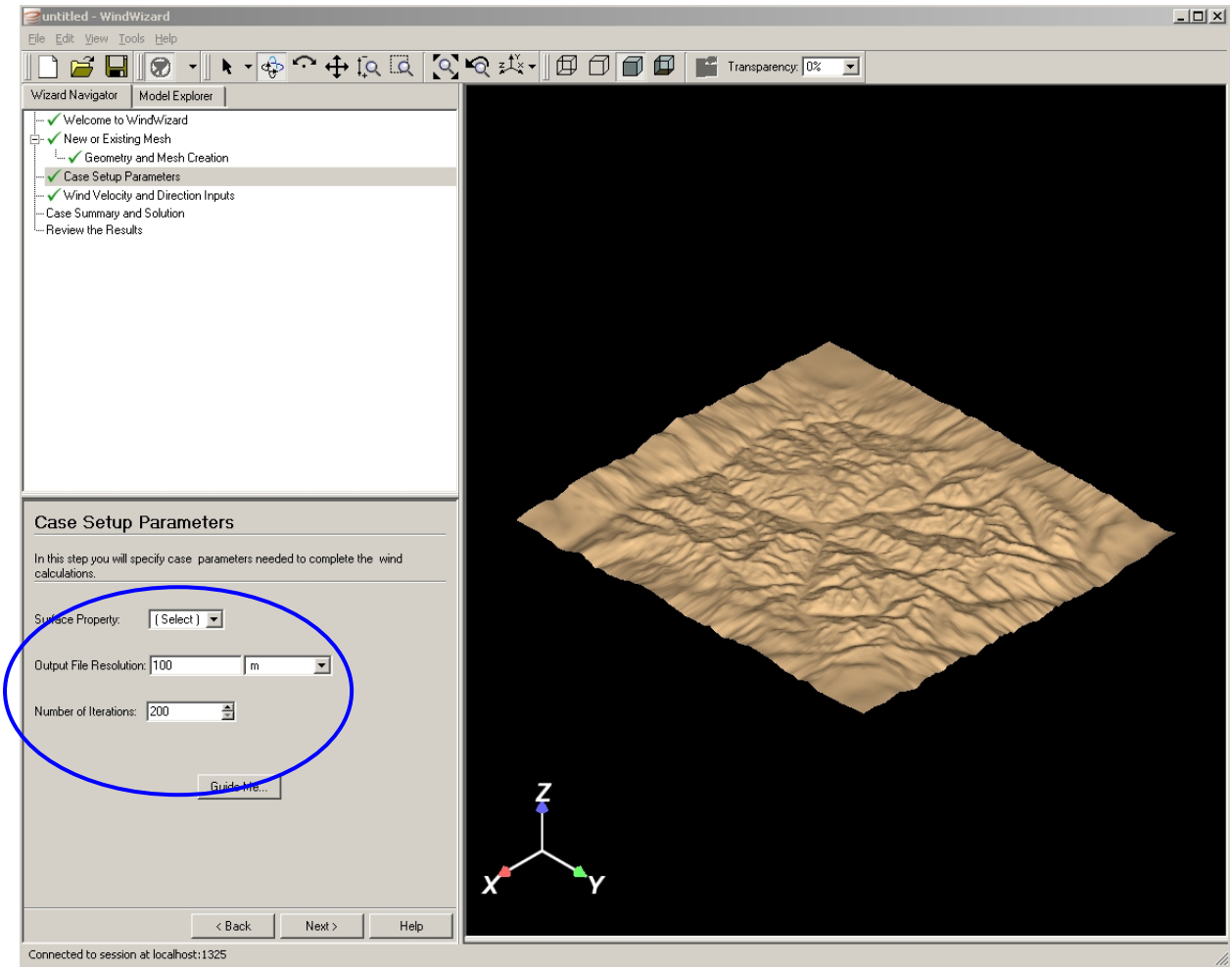


Figure 4. WindWizard case parameters window.

13. Select the **Number of Runs** (maximum of 10).

14. Input the **wind speed** (mph) and **wind direction** (0-360°) for each run. The input speed and direction describes upper level flow. The input wind speed differs from the actual wind speed observed on the ground and is influenced by the terrain. To determine the input wind speed, decide on a 20-foot ridgetop wind speed for the area of interest and then *double* that value. This general rule works under most conditions except when the DEM contains a prominent mountain range (e.g., Wasatch Range, UT; Colorado Front Range) running through the entire domain, sloping downward to a large valley floor. If this is the case, a lower input wind speed is usually required (Table 1). This is due to the amount of air at the inlet (the valley bottom) and the proximity of the top of the mountain range to the top of the mesh domain (see step 5).

| Input (mph) | Prominent Range & Valley (mph) | Most Other Landscapes (mph) |
|---|---|---|
| 15 | 10-15 | |
| 25 | | 10-15 |
| 30 | 20-25 | |
| 40 | | 20-25 |
| 45 | 30-35 | |
| 60 | 40-45 | 30-35 |
| 80+ | | 40-45 |

Table 1. WindWizard input wind speed as it relates to the desired 20-ft ridgetop winds.

15. Click **Next** (Figure 5).

16. Click **Save As** to save the mesh and settings.

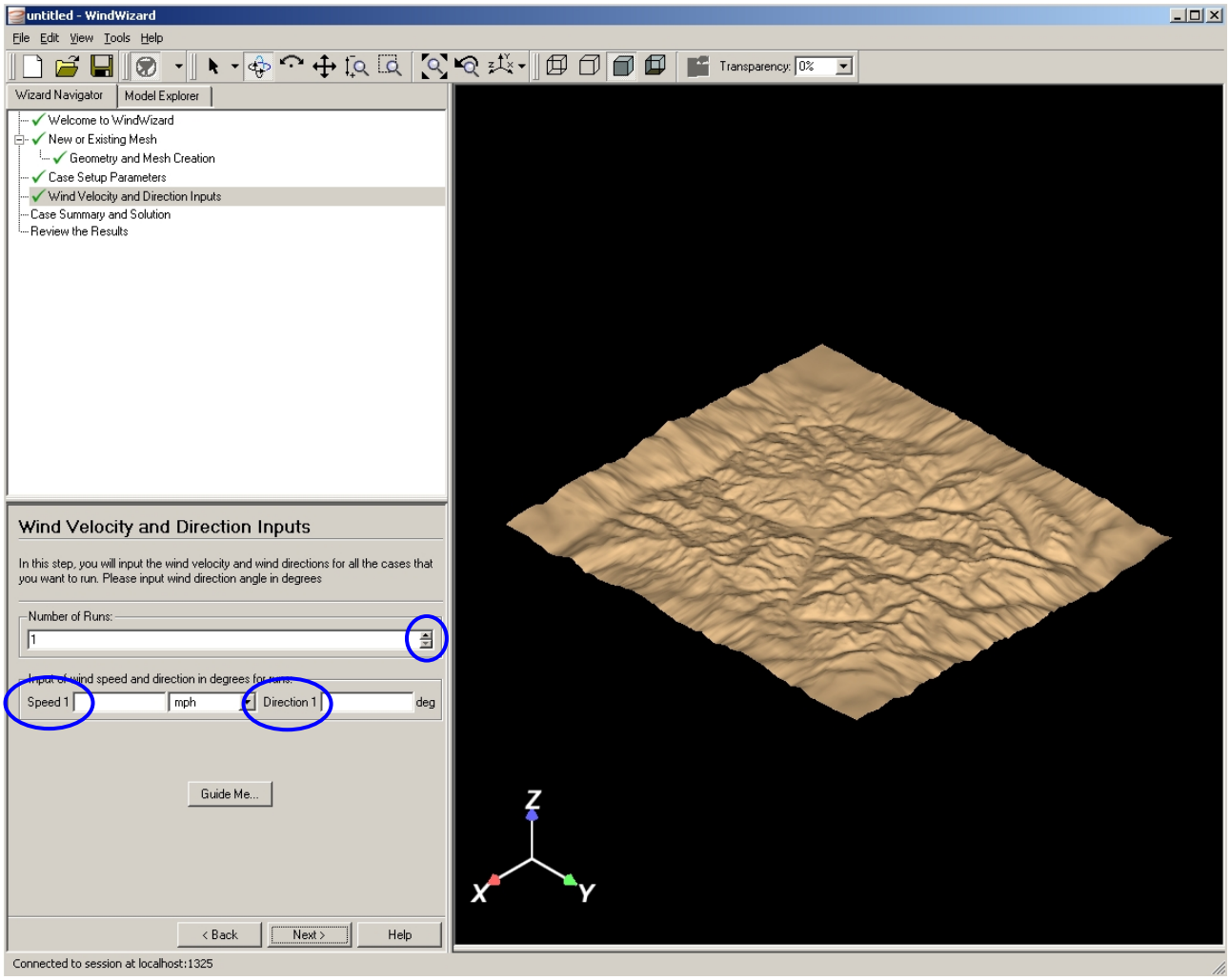


Figure 5. WindWizard wind velocity and direction input window.

17. Click on **Review Summary** to verify input and output variables. It is a good idea to save the WindWizard Session Summary with a screen capture (e.g., use the "Print Screen" key on your keyboard). This information is needed if you use the f2fvis.exe program to resample gridded wind output at a different spatial resolution then was specified in the output file resolution (See Appendix A).

18. Click **Solve** to compute the wind flow. As mentioned earlier, the progress bar is not accurate. A better way to check the completion status is to look in the text box in the lower right and view what iteration number the simulation is on in relation to the number of iterations that were specified in step 11 (Figure 6). Depending on your CPU, the solving process will take 45 to 90 minutes *per wind speed and direction*.

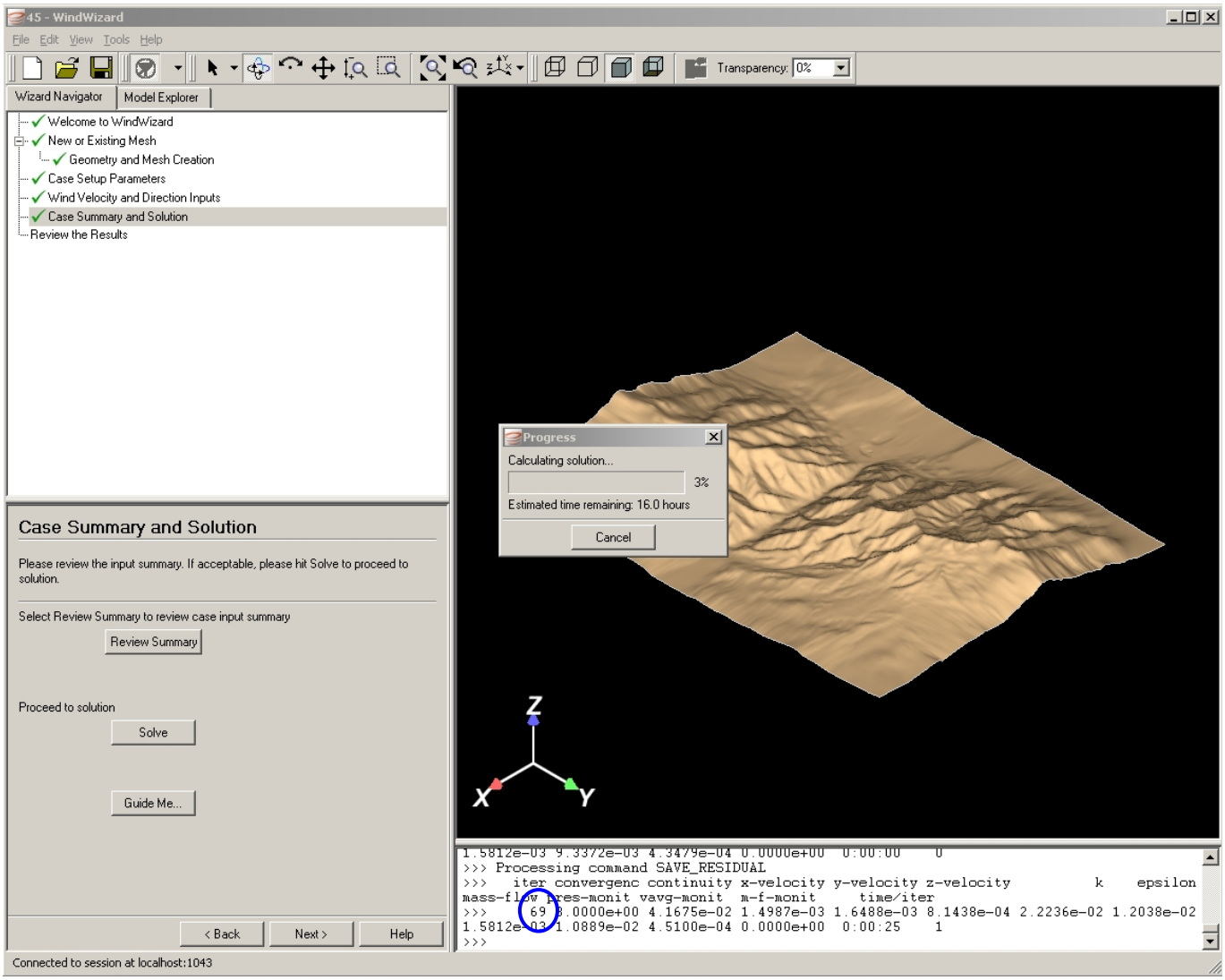


Figure 6. WindWizard progress pop-up and simulation information window (lower right). Because the progress bar is imprecise, a quick way to check on the status of a simulation is to view what iteration number the simulation is on in relation to the number of iterations that were specified in step 11 (in this case the iteration number is 69).

19. When the simulation finishes, click **OK**, then save the run(s) by clicking on the **Save** icon or **File > Save**.

- At this point WindWizard can be closed. Clicking on **Next** to review the results is not recommended because the displayed velocities are not accurate. Viewing of the products is better done in ArcMap, ArcView, FlamMap, or Google Earth.

**Viewing WindWizard Output**

WindWizard output can be viewed in ArcMap, ArcView, FlamMap, or Google Earth. WindWizard produces shape (ArcMap/ArcView) and ASCII Raster (FlamMap/FARSITE) files. Google Earth files are derived using a stand-alone program.

ArcView & ArcMap

Appendix B (ArcView) and Appendix C (ArcMap) contain instructional briefs on how to view WindWizard output in ArcView and ArcMap. Viewing gridded wind in a GIS offers the most flexibility in displaying the WindWizard output and is shown in Figure 7.

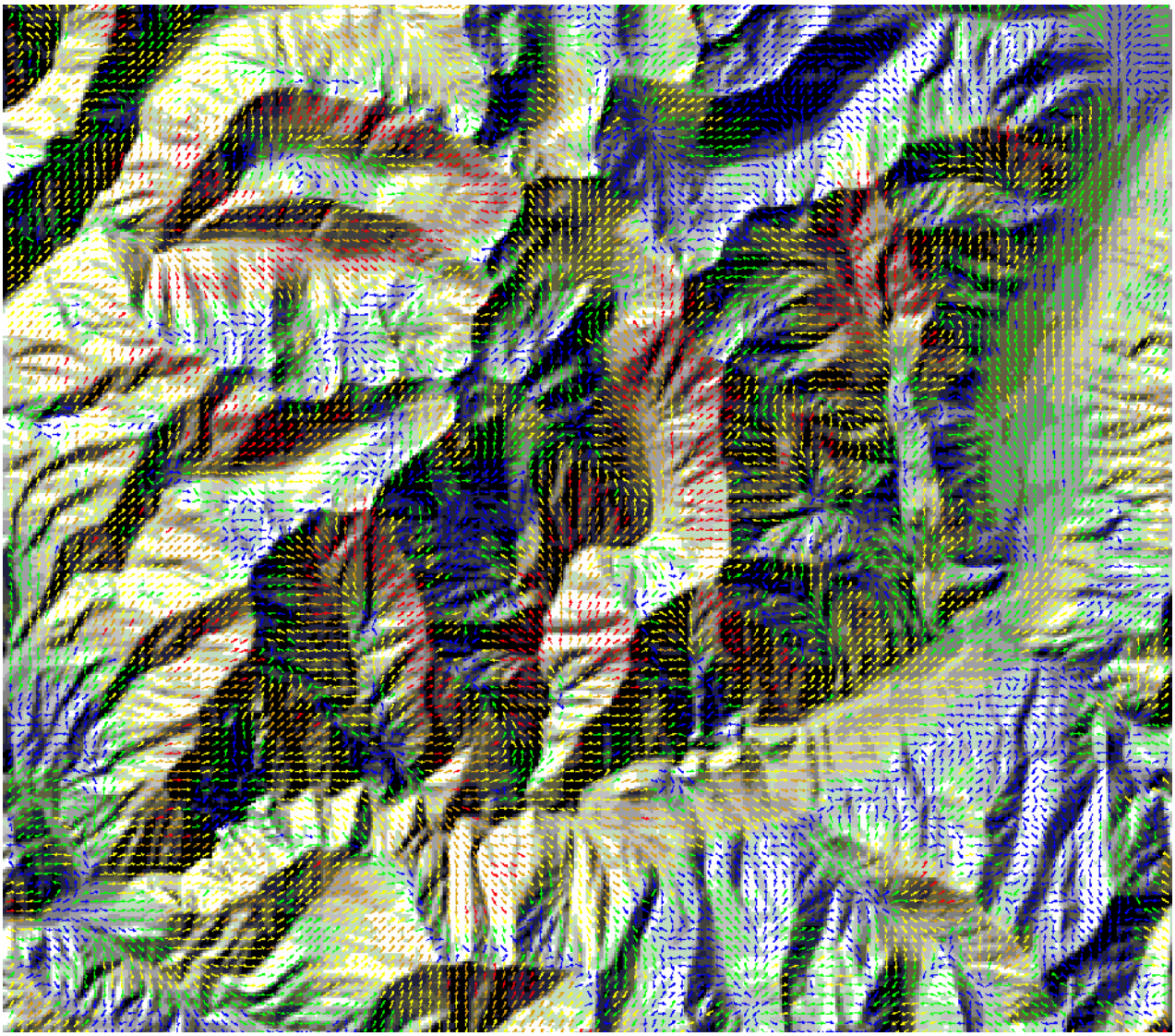

Figure 7. Gridded wind derived from WindWizard based on 25-30 mph ridgetop winds from the southwest in the Goat Mountain area of the Boise National Forest. Wind vectors point in the direction of flow and are colored by speed with 0-4 mph in blue, 5-7 (green), 8-11 (yellow), 12-15 (orange), and 16+ (red).

FlamMap

WindWizard output can be imported into FlamMap 3.0. This option requires no GIS skills and products can be displayed quickly in a 3-dimensional format. *Gridded wind products must be in the same projection and datum as the LCP to display the vectors.* To view WindWizard output, load an LCP, create a new run, under "Winds" select "Wind Vectors." Input the angle ASCII Raster file (*ang.asc) for direction and the velocity ASCII Raster file (*vel.asc) for speed. Select "Create and Display" to view the wind vectors (Figure 8 and 9).

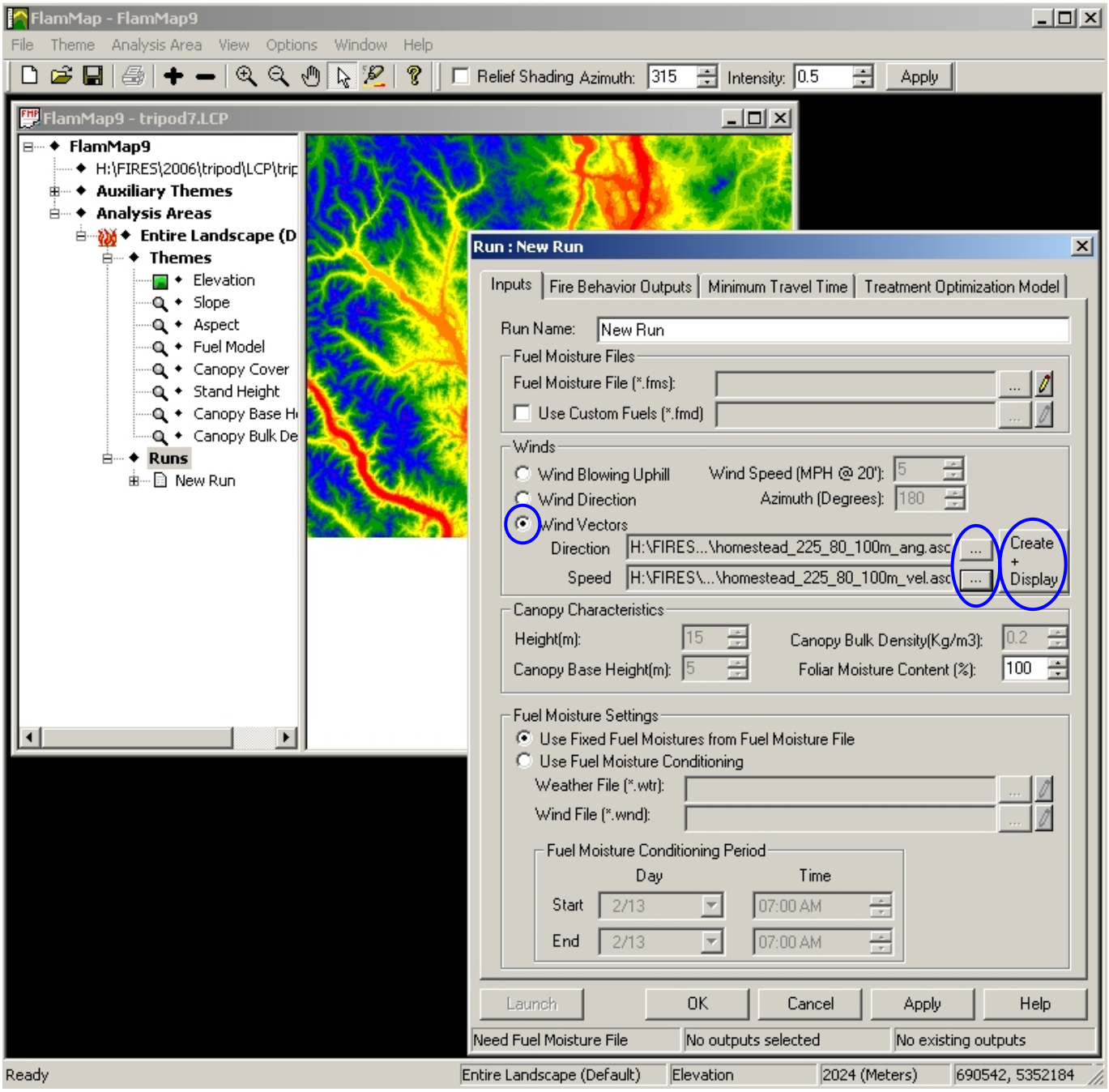


Figure 8. Use WindWizard ASCII Raster files in FlamMap by selecting the "Wind Vectors" radio button and importing the ASCII Raster direction and speed files.

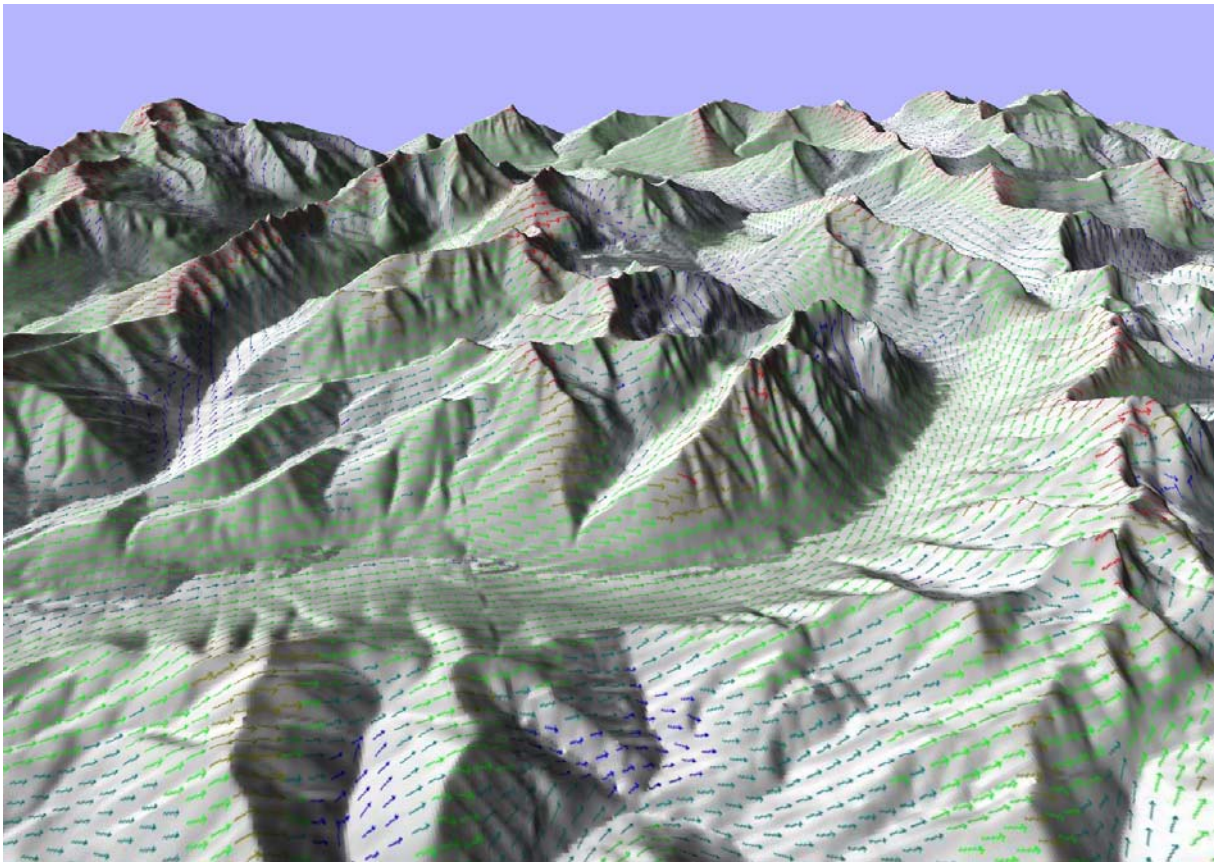

Figure 9. Gridded wind derived from WW and displayed in FlamMap for the Rampage Fire area in Glacier National Park, MT (2003).

Google Earth

WindWizard output can be viewed in Google Earth. WindWizard does not generate files for viewing in Google Earth (KMZ files) automatically. However, these can be created using the f2fvis.exe utility (hereafter referred to as the f2f program; Appendix D). The f2f program comes with WindWizard and is located in the "bin" folder (C://Program Files/FloWizard/FloWizard2.*/user/WindWizard2/bin/f2fvis.exe). Google Earth projects on the fly making overlaying of GIS data convenient, however, the arrow size, type, and color ramp are predefined (Figure 10). Currently, the f2f program only works on WindWizard output that is in a UTM projection.

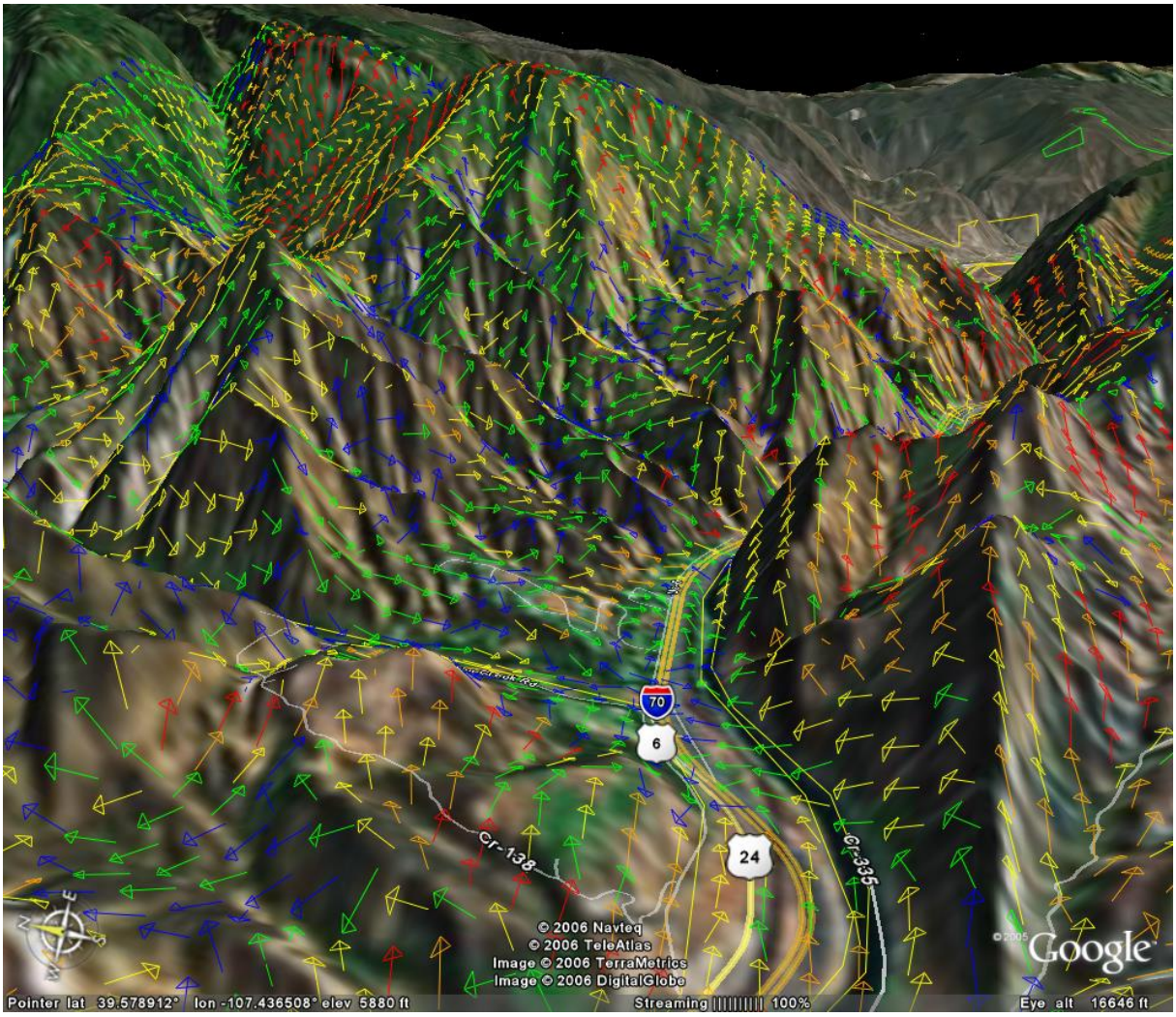


Figure 10. Gridded wind derived from WindWizard and displayed in Google Earth for the South Canyon area, CO.

**Using WindWizard Output to Model Fire Behavior**

Gridded wind can be imported into FARSITE or FlamMap. In FlamMap, import the angle and velocity ASCII Raster files as previously discussed and displayed (Figure 8). For FARSITE, select Input > Project Inputs > Select Wind Files (.ATM). The atmosphere file (ATM)—a text file specifying month, day, hour, wind speed file, direction file, and cloud cover file—must be precisely formatted to function in FARSITE and in the same folder as the ASCII Raster velocity, angle, and cloud cover files (refer to FARSITE Help) (Figure 11). For modeling convenience, WindWizard creates a cloud cover file (*cld.asc), but does not simulate cloud cover; rather it outputs a 0% cloud cover at every pixel on the landscape.

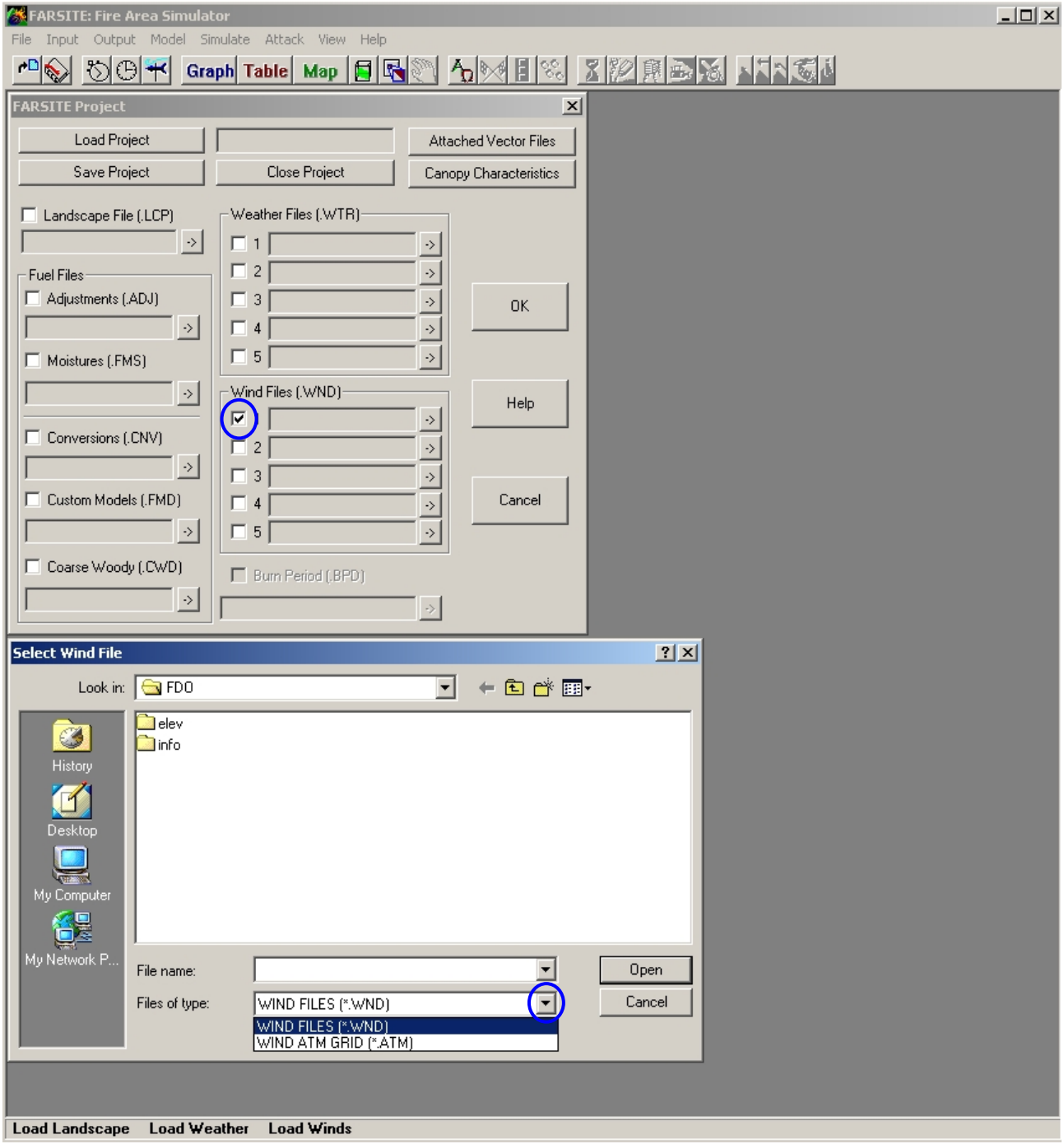


Figure 11. Use WindWizard ASCII Raster files in FARSITE by creating an ATM file and importing it by checking the Wind Files (.WND) box and selecting “Wind ATM GRID (*.ATM)” from the drop down list.

**Resampling WindWizard Output**

The default WindWizard output spatial resolution is 100 m. As discussed earlier, although this cell size is 100m, the computational mesh resolution is governed by the size of the DEM and selection of the mesh resolution (coarse, medium, or fine). However, sometimes a different spatial resolution is desired. For example, when displaying the results in a GIS the arrows are too close together or obscuring the view of the base layer (e.g., shaded relief), or additional arrows are needed in a smaller project area. Use the f2f program to resample WindWIzard output, following the instructions provided in Appendix A. The resampling process requires the height of the near cell wall, the .XYZ file, the surface property, and the DEM. This information can be obtain from (1) the review summary screen by opening the .flowizard file in WindWizard (File > Open), (2) viewing the review summary

screen capture—if one exists (see step 17), or (3) opening the *.dbs file in WordPad © and search for “vertical cellsize near the ground” (near cell wall) (Figure 12) and opening the *_journal.script file and searching for “surfRough” (surface property) (Figure 13).

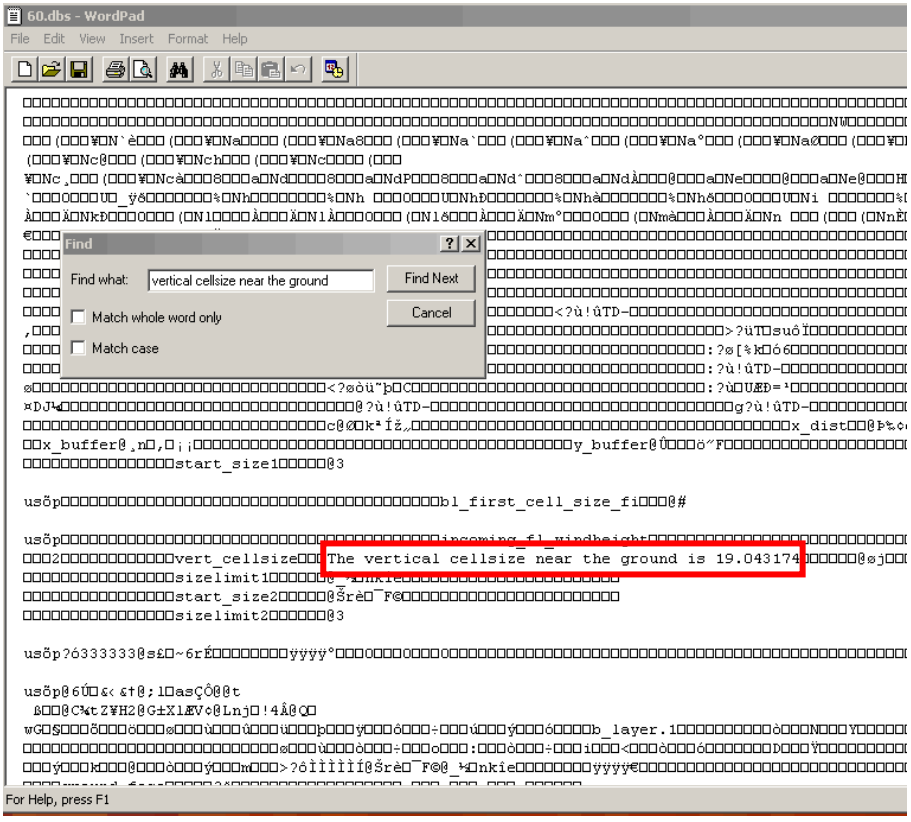


Figure 12. Viewing the *.dbs file in WordPad © to find the near cell wall height (19.043174).

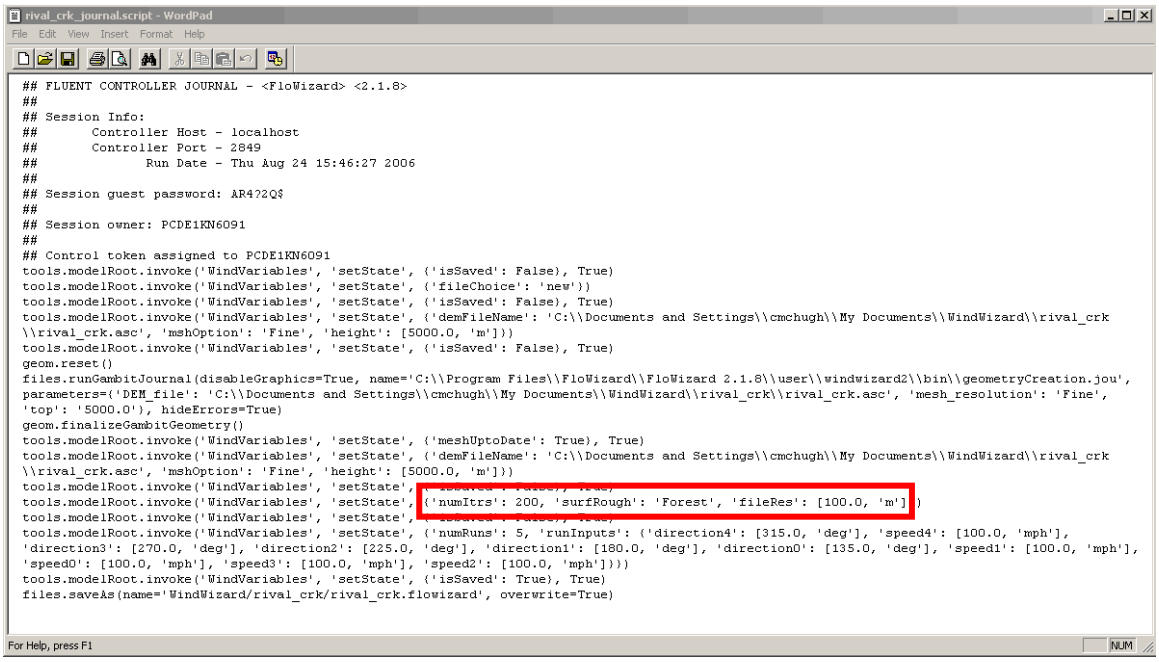


Figure 13. Viewing the *_journal.script file in WordPad© to find the surface property (forest).

**References**

Butler, B.W.; Forthofer, J.M.; Finney, M.A.; Bradshaw, L.S.; Stratton, R.D. 2004. High resolution wind direction and speed information for support of fire operations. In: Aguirre-Bravo, Celedonio, et al. Eds. Monitoring Science and Technology Symposium: Unifying Knowledge for Sustainability in the Western Hemisphere; 2004 September 20-24; Denver, CO. Proceedings RMRS-P-42CD. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Butler, B.; Finney, M.; Bradshaw, L.; Forthofer, J.; McHugh, C.; Stratton, R.; Jimenez, D. 2006a. WindWizard: A new tool for fire management decision support. In: Andrews, Patricia L.; Butler, Bret W., comps. 2006. Fuels Management—How to Measure Success: Conference Proceedings. 28-30 March 2006; Portland, OR. Proceedings RMRS-P-41. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 809 p.

Butler, B., Forthofer, J., Finney, M., McHugh, C., Stratton, R., and Bradshaw, L., 2006b. The impact of high resolution wind field simulations on the accuracy of fire growth predictions. ed. D.X. Viegas proc. 5th Intl. Conf. on For. Fire Res. 27-30 Nov., 2006 Figueira daFoz, Portugal, University of Coimbra. Elsevier, Forest Ecology and Management 234 Supplement 1 (2006).

Stratton, Richard D. 2006. Guidance on spatial wildland fire analysis: models, tools, and techniques. Gen. Tech. Rep. RMRS-GTR-183. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 15 p.

U.S. Department of Interior, Geological Survey. 1990. Digital elevation models. U.S. Department of Interior, Geologic Survey Data User's Guide. Reston, VA, Vol. 5. 51 p.

**Appendices**

## Appendix A: Using the f2f Program

## Resampling of WindWizard Outputs Using the f2f Program

Kyle Shannon, RMRS, Fire Sciences Lab, Missoula, MT, 406-329-4963, kshannon@fs.fed.us.
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The typical spatial resolution of gridded wind outputs using the WindWizard program is 100m. While this level of detail is necessary for spatial fire modeling in *FARSITE* and FlamMap, it can be too fine a resolution for maps displays of WindWizard output. Display maps using this level of detail are often "too busy" making their interpretation difficult due to the density of vectors on the background coverage. The f2f program allows for resampling of gridded wind outputs to a coarser or finer spatial resolution without the user rerunning WindWizard. This assumes that the user has not deleted the necessary input files (DEM ASCII Raster and .xyz) and has documented information on the surface roughness and near cell wall height. The f2f program generates a new shapefile, a set of resampled ASCII Raster output files, and an optional kmz file (Google Earth). Google Earth files require UTM and datum information of the DEM. For display purposes a spatial resolution of 300m is typical and has been found to provide an adequate level of detail.

### Prior to Running the f2f Program

To run f2f first create a shortcut on the desktop to the executable f2fvis.exe. The default location for this file is in the C:\Program Files\FloWizard\FloWizard 2.1.8\user\WindWizard2\bin folder. Figure 1 shows the location of the required executables within the bin folder. Do not move f2f.exe, as the program only looks in a specific folder for this file.

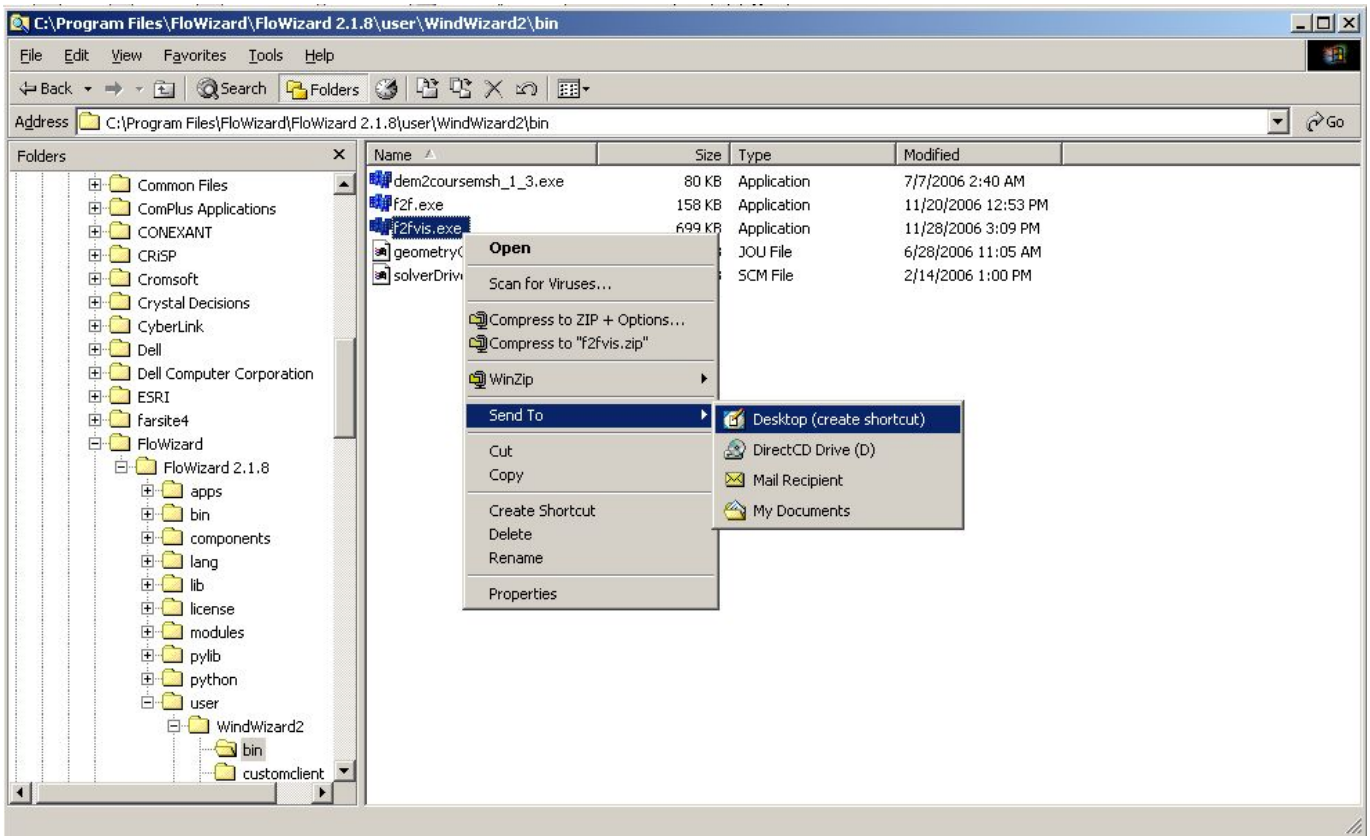



Figure 1. Location of the bin folder where the f2f.exe and f2ffvis.exe programs are located and creating a shortcut of the f2fvis.exe.

**Running the f2f program**

After the user has completed the previous steps the f2f program can be run. The user will need to supply additional inputs as prompted by the f2f program, these are:

1. The xyz file from the initial WindWizard run. This file is stored within the individual WindWizard run output folder and has a .xyz extension. The name of this file is included in the new resampled output file.
2. The DEM file associated with the xyz file.
3. The desired resampled spatial resolution in *meters*. This value must be in meters as this is the native resolution of this data. The windspeed value in the new resampled value will be in the same units as the initial WindWizard run.
4. The *surface property* of the initial run (grass, shrub, forest). The same surface property used in the initial run must be used during the resampling process. This value should be documented during the run process by the user or can be accessed from the WindWizard session summary (see Figure 11).
5. The *near cell wall height* of the initial run. This value should be documented during the run process by the user or can be obtained from the WindWizard session summary.
6. The desired wind height for the output files—20ft is recommended. For a custom height (other than 20ft or 10m) select "Custom" from the dropdown menu and enter the desired number in the field and choose the appropriate units.
7. If Google Earth kml/kmz files are needed, check the "Create Google Earth Files" box and the group of options below will become active.
    a. The UTM zone *must be known*. Look for the projection file (*.prj) for this information. The f2f executable will not check the accuracy of the UTM zone, only their presence. Inaccurate data will result in the vectors being plotted in the wrong place. If the projection file does not exist, open the UTM zone map included with the installation file. From this the UTM zone should be clearly apparent or do not run f2f. In such a case, rerun WindWizard with a new DEM and known UTM zone.
    b. The datum which the original DEM is in must also be known. Currently there are three choices, WGS-84, NAD-83, and NAD-27. If the datum is not known, rerun WindWizard with a new DEM and known datum.
    c. The default vector display is recommended. Vectors are scaled by color and size depending on the value. If uniform colors are needed, there are five choices. Constant length is available as well. Check the appropriate radio buttons in the two boxes for different vector displays.

Start the f2f program by double-clicking on the desktop shortcut; the f2f program will open.

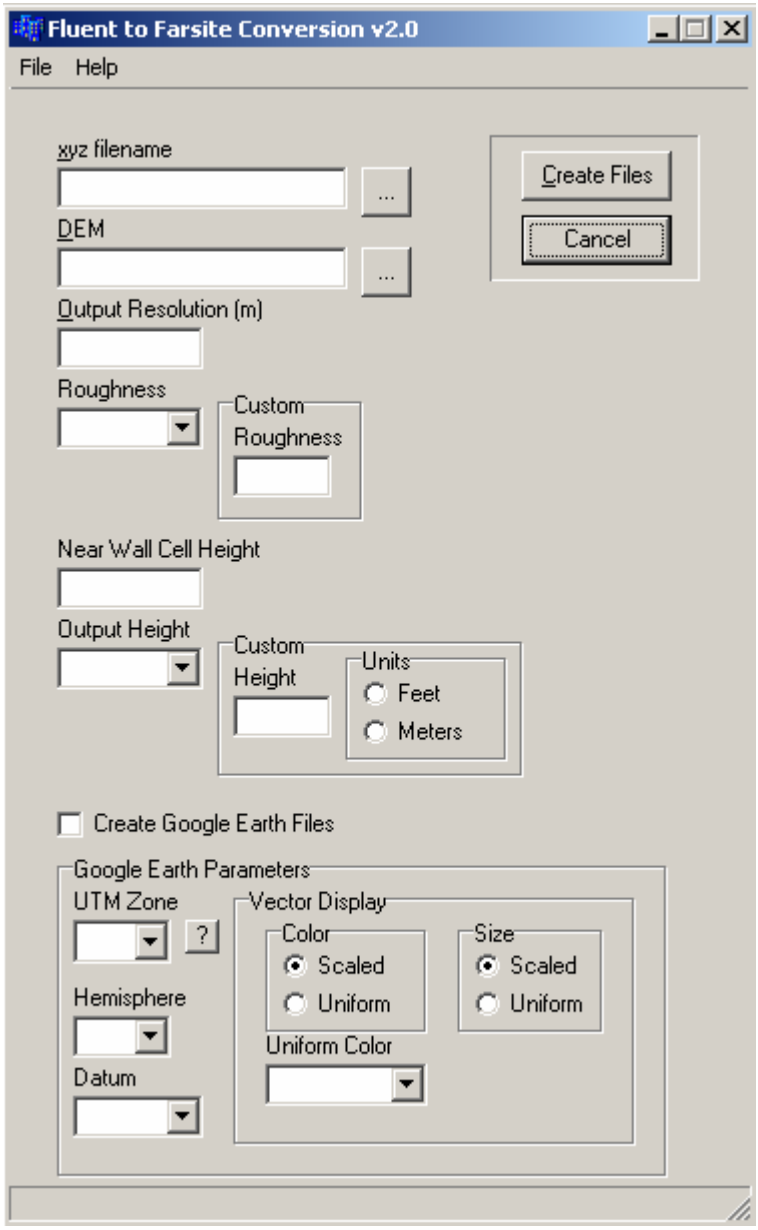



Figure 2. f2fvis.exe window.

Click on the xyz filename field to open a dialog box to choose the incoming xyz file. After the xyz file is chosen, click the DEM field to open the associated DEM file. If the files are not associated, or the one of the files do not exist, f2f will return an error.

Enter the desired output resolution (in meters) and choose a roughness from the dropdown list. Then enter the Near Wall Cell Height. Instructions for obtaining this value are below if it has not been recorded previously.

## f2f Results

After running the f2f program six or seven additional files will be located in the results folder depending on the Google Earth option. Three new ASCII Raster files and the three files associated with the shapefile (.shx, .shp, .dbf) and possibly a .kml file. After running the f2f program, a run folder should be similar to Figure 6. In this example the data were resampled to a new spatial resolution of 300 meters; the program automatically includes this in the new file name during execution of the program.

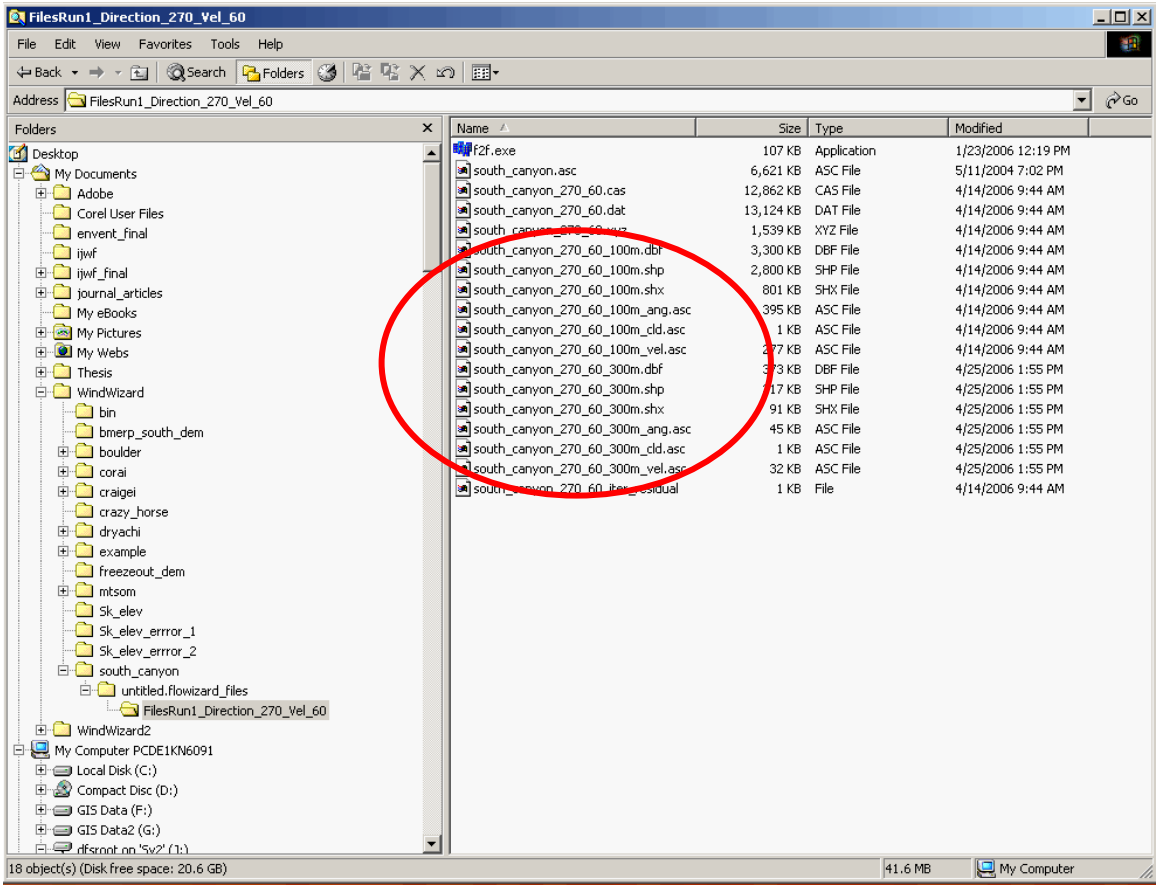



Figure 3. Results folder after running the f2f program. In this case the data were resampled to a spatial resolution of 300 meters. The folder has both the resampled shapefile as well as the ASCII Raster data. The new file retains the name of the input DEM ASCII file (south_canyon), the initial wind direction (270), and windspeed (60), and adds the new spatial resolution value (300m) into the file name. The shapefile (.dbf, .shp., and .shx) are all included as well as the ASCII files (.asc) for use in *FARSITE* or FlamMap. A Google Earth file (.kmz) may also be present.

## Accessing the WindWizard Session Summary

The easiest way for the user to retain the information required to run the f2f program is to document the data in a notebook or print out the run summary prior to executing the original WindWizard run. However, if the user did not do this but has saved the original run the user can recall the **WindWizard Session Summary** and obtain this information. This section outlines the process to access this information.

The first step is to start a WindWizard session and select **"Next"** which will open the window displayed in Figure 7. At this point the user selects the radio button next to **"Open Existing Case"** followed by the "**Next**" button. This action will take the user to the next window (Figure 8).

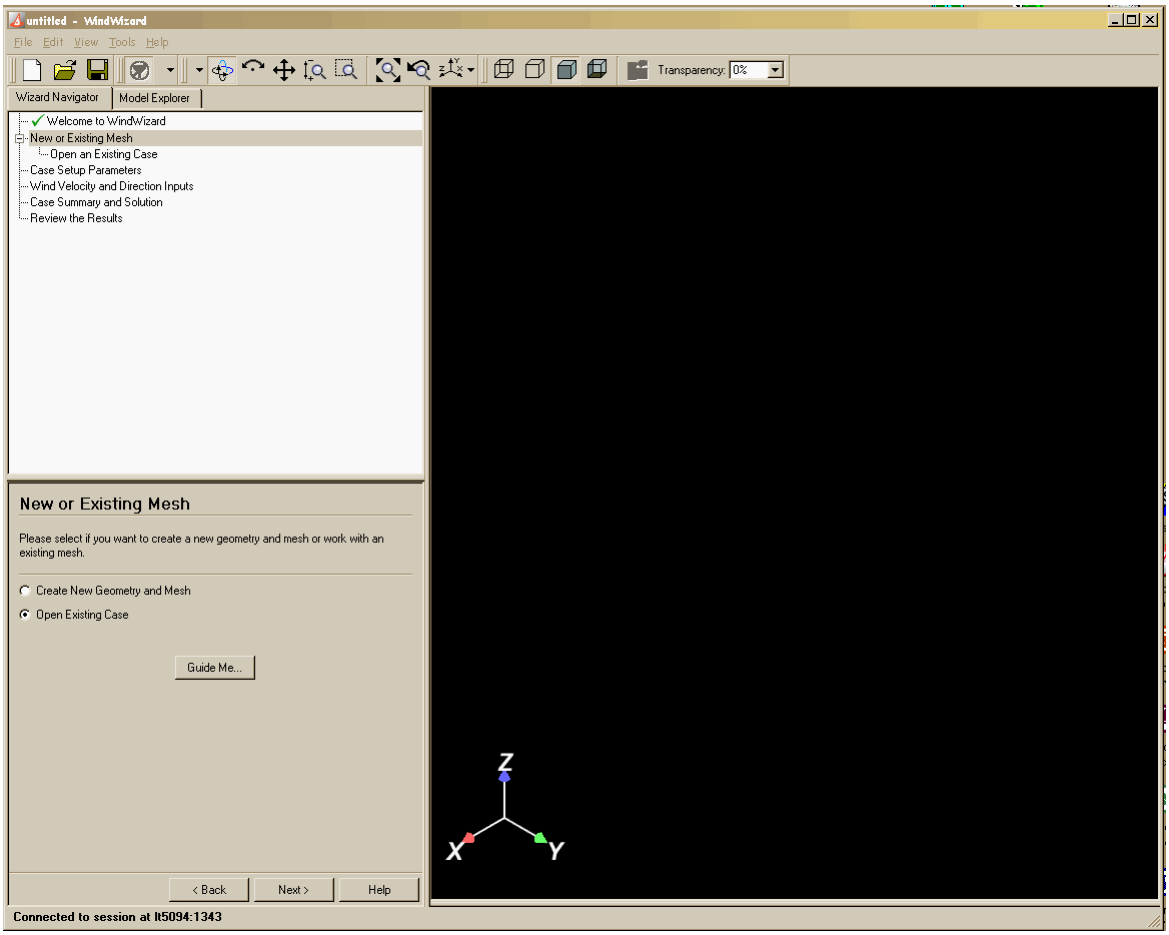



Figure 7. Initial WindWizard window. Select the radio button for "Open Existing Case."

The next step is to select the "**Browse"** button which will open a dialog box (Figure 8). Once the dialog box is open, navigate to the location of the WindWizard run the user wants to resample. In this example the WindWizard file is corai_nw_ver_1.flowizard (Figure 8). After selecting the desired file the user then selects the **"Read Case"** button.

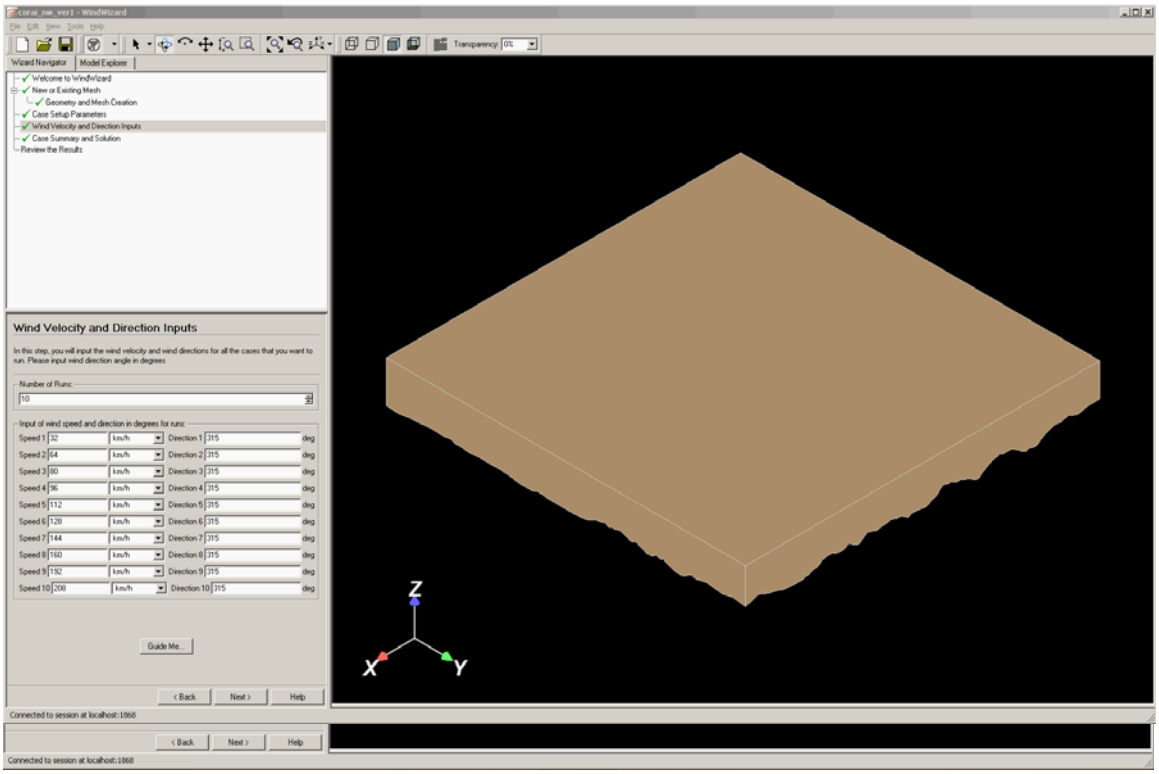



Figure 8. WindWizard window with dialog box allowing the user to navigate to a previous WindWizard run.

After selecting a previous WindWizard file and selecting the **"Read Case"** button the window should look like Figure 9. This view will differ based on the number of runs the user defined in the original simulation. In this example a total of 10 different wind directions and velocities were defined. In this example, the information contained in the **WindWizard Session Summary** and needed as inputs for the f2f program are the same for each of the individual runs. **REMEMBER** f2f must be run separately for each of the WindWizard simulation results the user wishes to resample.

At this point the user can then select the **"Case Summary and Solution"** in the top left-hand directory tree (Figure 9). Doing this will change the WindWizard view allowing the user to select the **"Review Summary"** (Figure 10). Selecting the "**Review Summary"** button will open up the **WindWizard Session Summary** for the current active session (Figure 11). At this point the user can transcribe the information, print the session summary or use a screen capture program for documentation purposes.

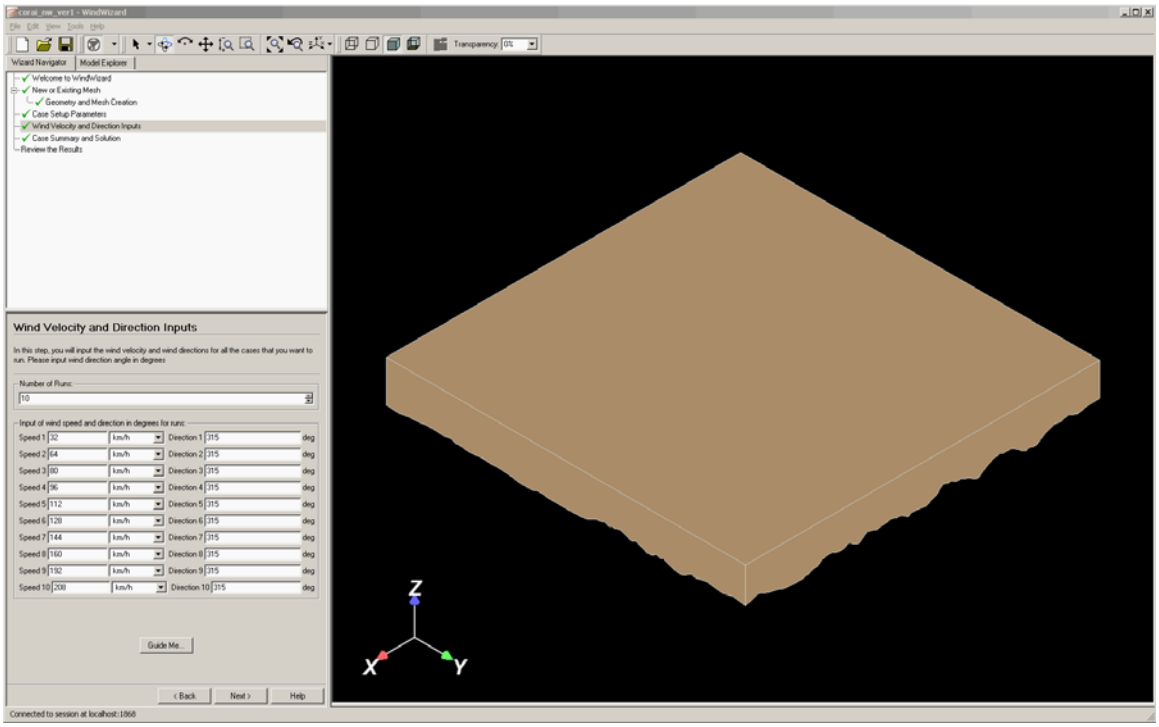



Figure 9. Window after opening a previous WindWizard session file.

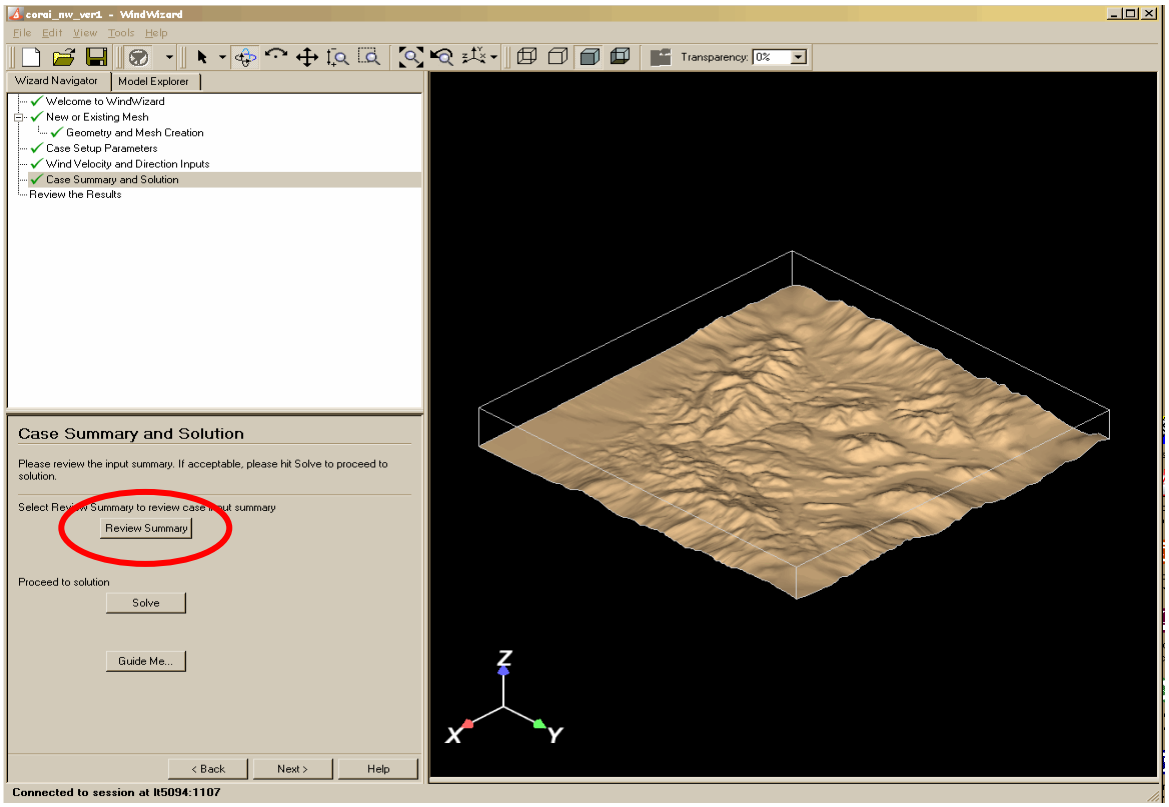



Figure 10. WindWizard window showing the Review Summary button allowing the user to view the session settings used for this particular simulation.

The **WindWizard Session Summary** contains the information needed to run the f2f program. **The Set up Parameters** area contains the **Surface Property** used in the initial run. While the **Mesh Information** contains the **Height of Near Cell Wall**.

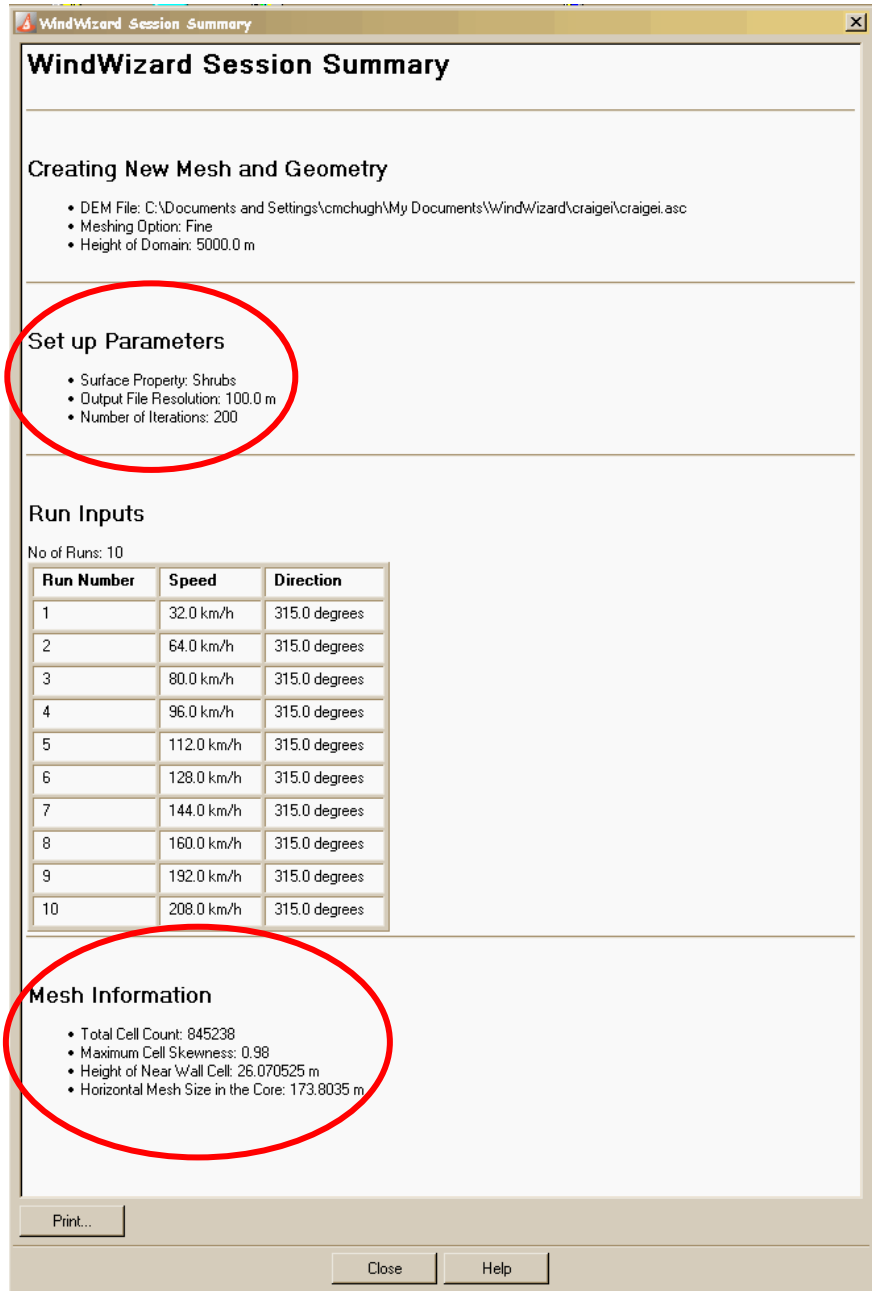



Figure 11. WindWizard Session Summary information.

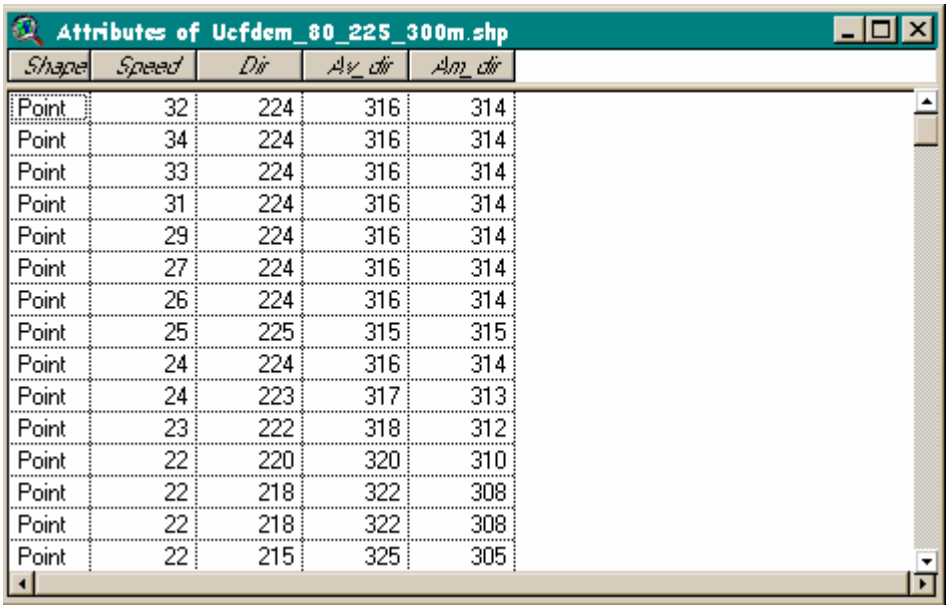
## Appendix B: Displaying Wind Vectors in ArcView

**Displaying and Rotating Wind Wizard Derived Vectors**
**In ArcView 3.2x**

Chuck McHugh, RMRS, Fire Sciences Lab, Missoula, MT, 406-829-6953, **cmchugh@fs.fed.us**.

## A. Displaying Wind Wizard generated gridded Wind Direction – Speed vectors in ArcView.

1. Data requirements are an ArcView shapefile format. The shapefile generated during the Wind Wizard process will contain five data fields in the associated .DBF file (Figure 1).




| Shape | Speed | Dir | Av_dir | Am_dir |
|---|---|---|---|---|
| Point | 32 | 224 | 316 | 314 |
| Point | 34 | 224 | 316 | 314 |
| Point | 33 | 224 | 316 | 314 |
| Point | 31 | 224 | 316 | 314 |
| Point | 29 | 224 | 316 | 314 |
| Point | 27 | 224 | 316 | 314 |
| Point | 26 | 224 | 316 | 314 |
| Point | 25 | 225 | 315 | 315 |
| Point | 24 | 224 | 316 | 314 |
| Point | 24 | 223 | 317 | 313 |
| Point | 23 | 222 | 318 | 312 |
| Point | 22 | 220 | 320 | 310 |
| Point | 22 | 218 | 322 | 308 |
| Point | 22 | 218 | 322 | 308 |
| Point | 22 | 215 | 325 | 305 |

Figure 1. Attribute table for Wind Wizard generated shapefile as displayed in ArcView.

   a. *Shape*: Point indicates that the feature type for the shapefile is a point.
   b. *Speed*: Is the Wind Wizard generated windspeed at the 20-foot level in miles per hour (mph).
   c. *Dir*: Is the Wind Wizard generated azimuth direction the wind is coming from in degrees.
   d. *Av_dir*: Is the Wind Wizard manipulated value required for use in ArcView for display purposes.
   e. *Am_dir*: Is the Wind Wizard manipulated value required for use in ArcMap for display purposes.

2. After loading the file into the ArcView project open up the **Legend Editor** (Figure 2) by double clicking on the shapefile in the view. The first step is to select the **Legend Type** by selecting the drop down arrow and selecting **Graduated Symbol**.

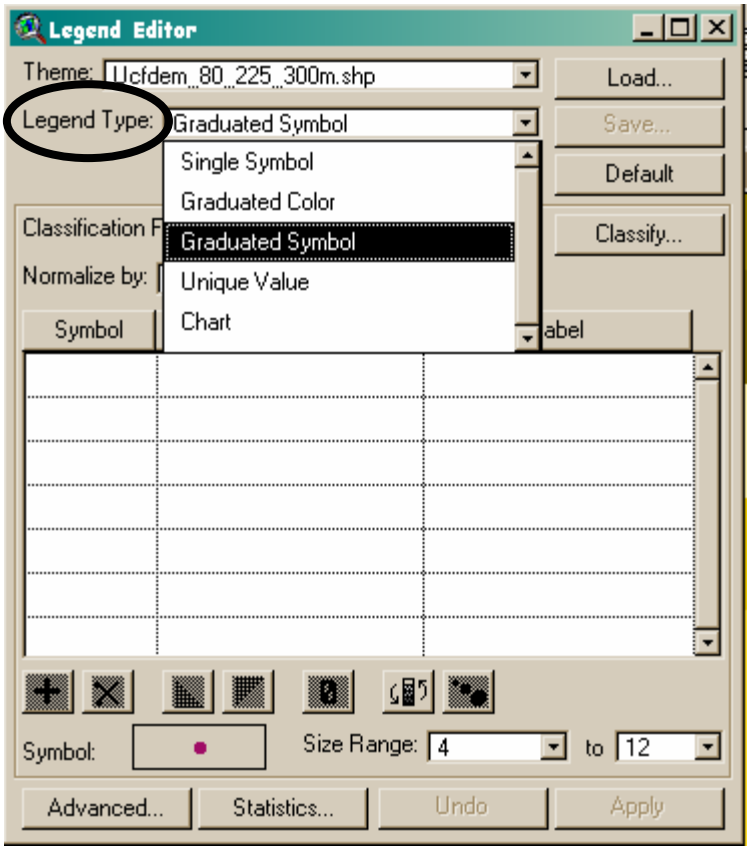



Figure 2. Legend Editor dialog box showing Legend Type selection for display in ArcView.

3. In the **Classification Field** select Speed. This will scale all the arrows for the shapefile by the respective windspeed value in mph (Figure 3).

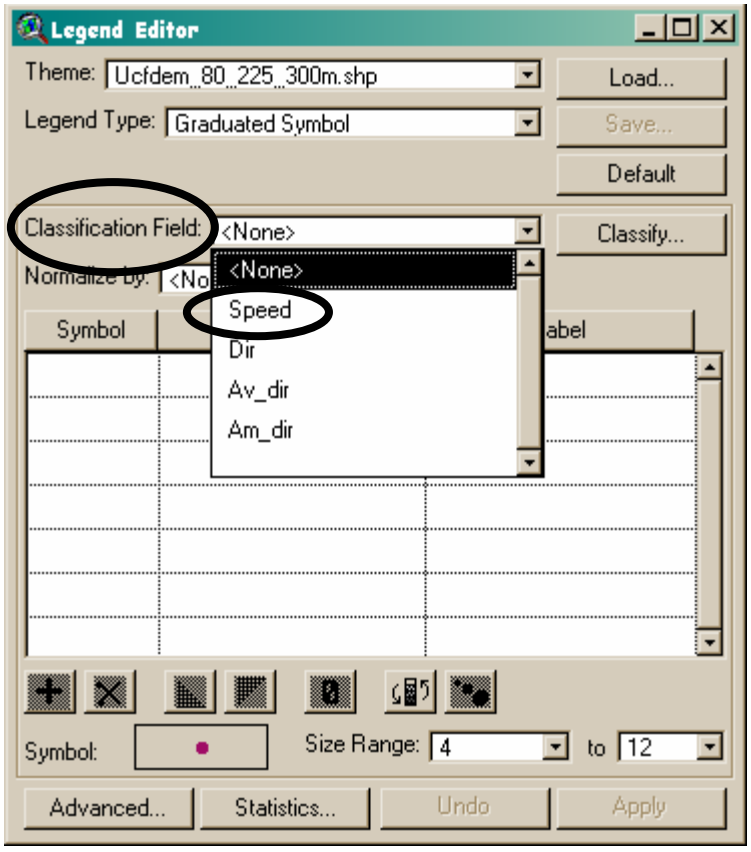



Figure 3. Legend Editor dialog box showing Classification Field selection for display in ArcView.

**4.** Select **Advanced Tab** and in **Rotation Field** select Av_dir from the available options and **OK** (Figure4).

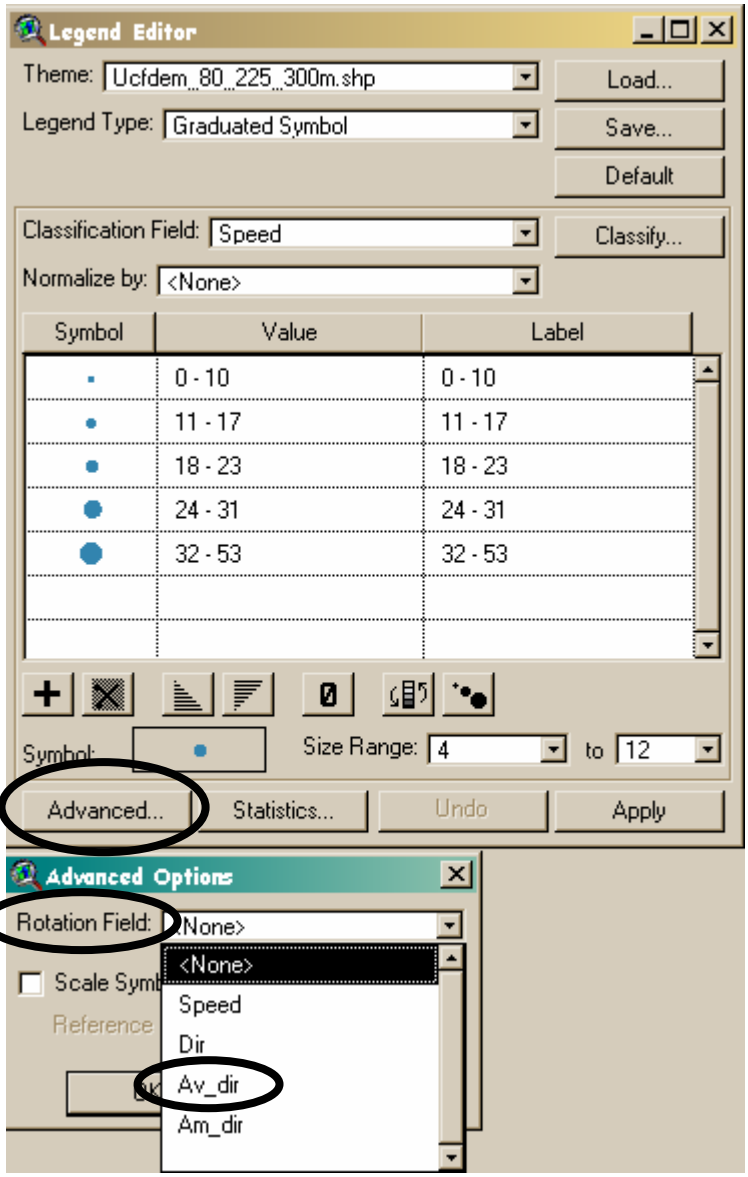



Figure 4. Legend Editor dialog box showing Classification Field selection for display in ArcView.

5. To get an arrow you may need to load the ESRI arrow palate. Double-click on the shapefile in the view to open the **Legend Editor** (Figure 5), then double-click on the **Symbol** type button which will open the Palette Maker (Figure 5). Select the palette button (blue circle) then the **Load** button. This will open up the **Load Palette** dialog box in Figure 6.

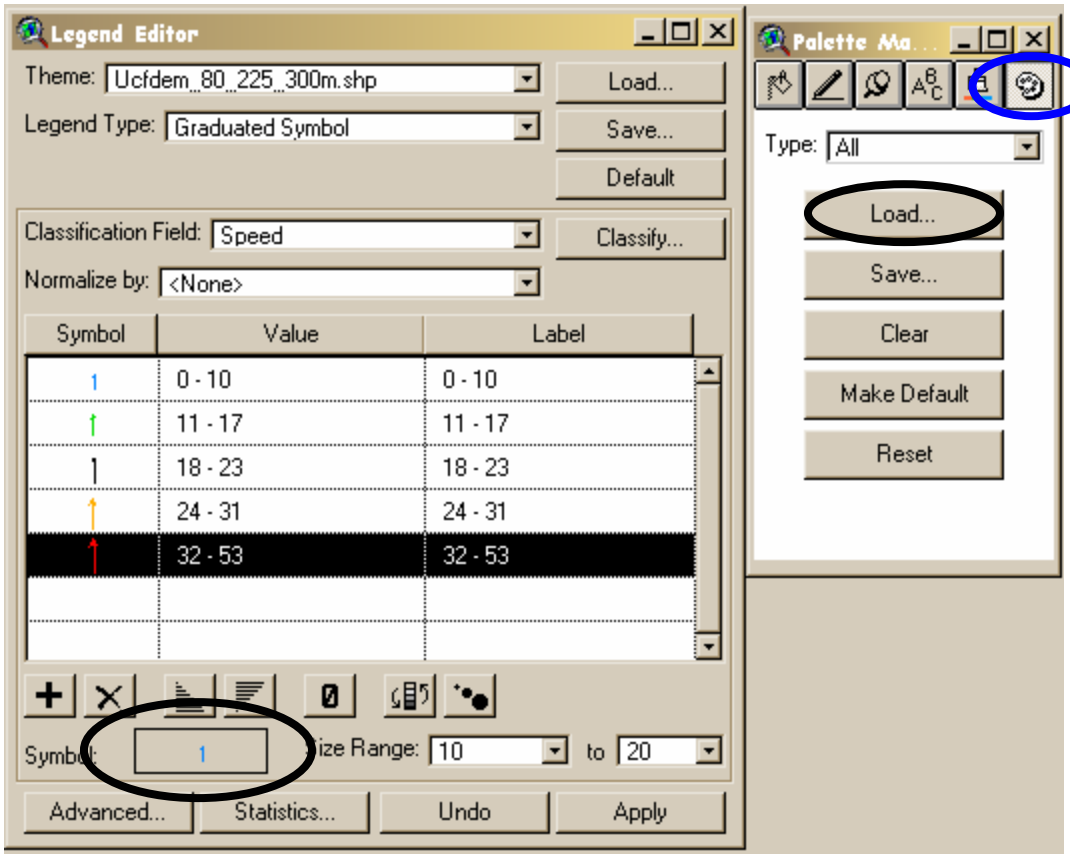



Figure 5.

In Figure 6 you need to navigate to the location that the ESRI arrow palette is stored. On Forest Service imaged machines the path will likely be:

C:\fsapps\esri\av_gis30\arcview\symbols

Double-click on the arrows.avp filename which will make these symbols available in your symbol set.

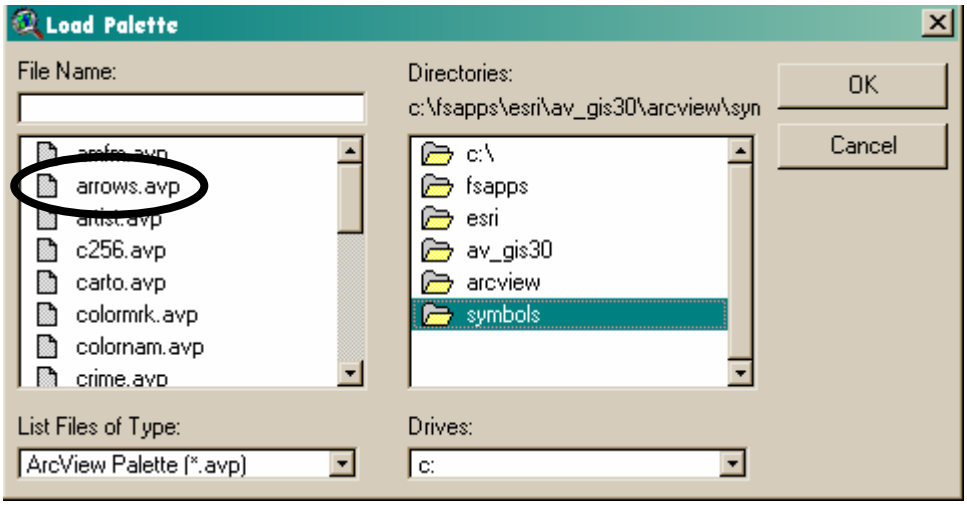



Figure 6.

After loading the arrow palette then click on the Pushpin icon which will make the symbols available for use visible (Figure 7). Using the scroll bar, scroll down to the bottom where the various arrow styles can be selected.

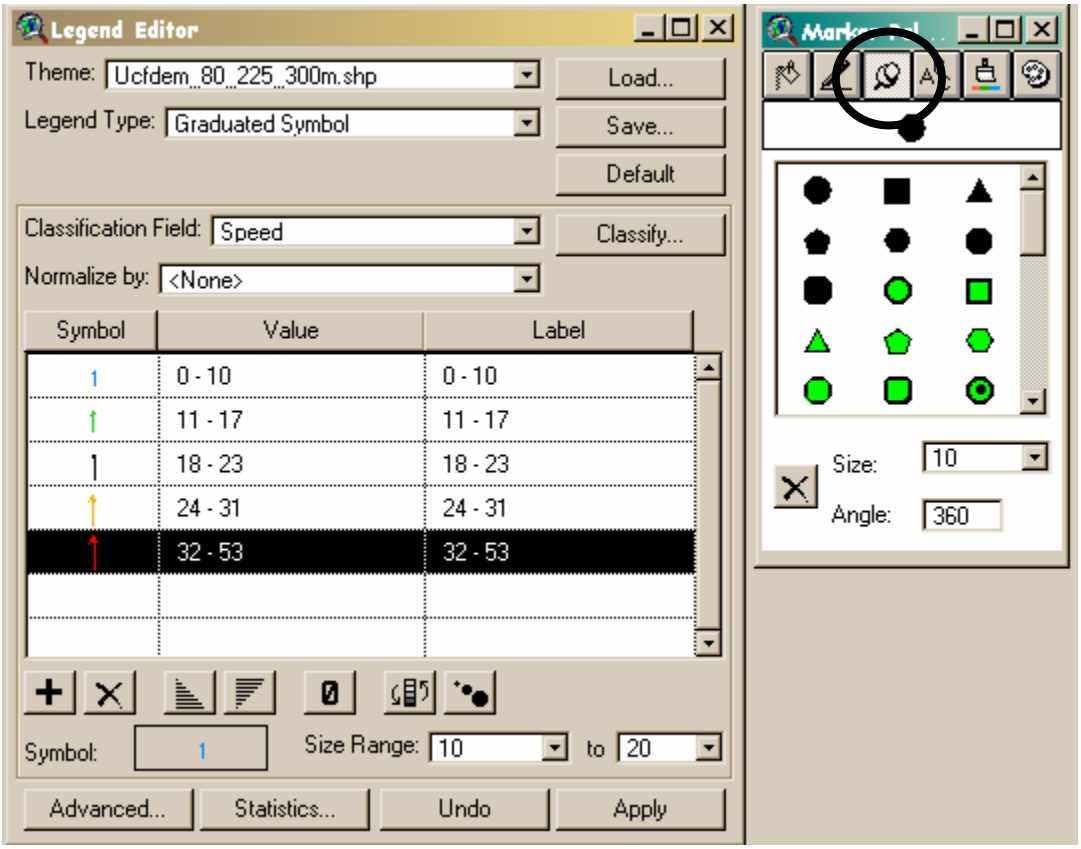



Figure 7.

Also at this stage you can scale the symbol by changing the **Size Range** (Figure 7). It is recommended changing the **size range** to start from 10 and ending at 20 and that you do this prior to changing the colors of individual arrows or they will revert back to a single color scheme. At this point you should also change the colors of your arrow. Don't forget to select the **Apply** button to ensure that all changes have taken effect.

### B. Query the Gridded Wind Output in ArcView

To correctly rotate the arrows in ArcView as described above requires manipulation of the data generated by the Wind Wizard software for display purposes. In Figure 8 the query information for the circled arrow shows the wind speed as 32 mph, Dir is 222 degrees with an Av_dir of 318. The Av_dir value for wind direction in the shapefile **IS NOT** the same value as generated by the Wind Wizard software. Values for Speed (32 mph) and Dir (222 deg.) are the Wind Wizard derived values that should be used in any analysis using this shapefile.


Figure 8. Query results of gridded wind shapefile in Arcview showing the difference in the wind direction in the shapefile and the rotation angle of the arrow.

Figure 9 focuses on the same point on the landscape. However, in this case the ArcView shapefile is overlayed on the GRID of wind direction generated by the Wind Wizard software. A query of the individual raster cell shows a Value of 222 degrees that corresponds to the rotation of the wind direction arrow. This is the same value displayed for Dir in Figure 8.


Figure 9. Query of the gridded wind generated ArcView shapefile overlayed on the GRID ASCII Raster output from the from the wind wizard process.

## Appendix C: Displaying Wind Vectors in ArcMap

**Displaying and Rotating Wind Wizard Derived**
**Wind Direction and Windspeed Vectors in ArcMap 8.3**

Chuck McHugh, RMRS, Fire Sciences Lab, Missoula, MT, 406-829-6953, **cmchugh@fs.fed.us**.

## A. Displaying Wind Wizard generated Gridded Wind Direction – Speed vectors.

Data requirements are an ArcMap shapefile format. The shapefile generated during the Wind Wizard process will contain five data fields in the associated .DBF file (Figure 1).

Attributes of ucfdem_80_225_300m

| FID | Shape | speed | dir | AV_dir | AM_dir |
|---|---|---|---|---|---|
| 0 | Point | 32 | 224 | 316 | 314 |
| 1 | Point | 34 | 224 | 316 | 314 |
| 2 | Point | 33 | 224 | 316 | 314 |
| 3 | Point | 31 | 224 | 316 | 314 |
| 4 | Point | 29 | 224 | 316 | 314 |
| 5 | Point | 27 | 224 | 316 | 314 |
| 6 | Point | 26 | 224 | 316 | 314 |
| 7 | Point | 25 | 225 | 315 | 315 |
| 8 | Point | 24 | 224 | 316 | 314 |
| 9 | Point | 24 | 223 | 317 | 313 |
| 10 | Point | 23 | 222 | 318 | 312 |
| 11 | Point | 22 | 220 | 320 | 310 |
| 12 | Point | 22 | 218 | 322 | 308 |
| 13 | Point | 22 | 218 | 322 | 308 |
| 14 | Point | 22 | 215 | 325 | 305 |
| 15 | Point | 23 | 215 | 325 | 305 |
| 16 | Point | 23 | 214 | 326 | 304 |
| 17 | Point | 23 | 217 | 323 | 307 |
| 18 | Point | 23 | 217 | 323 | 307 |
| 19 | Point | 20 | 211 | 329 | 301 |

Record: 1 Show: All Selected Records (0 out of 17544 Selected.) Options

Figure 3. Attribute table for Wind Wizard generated shapefile as displayed in ArcMap.

a. FID: Feature ID, a unique number assigned to that point by ArcMap.
b. Shape: Point indicates that the feature type for the shapefile is a point.
c. speed: Is the Wind Wizard generated windspeed at the 20-foot level in miles per hour (mph).
d. dir: Is the Wind Wizard generated azimuth direction the wind is coming from in degrees.
e. AV_dir: Is the Wind Wizard manipulated value required for use in ArcView for display purposes.
f. AM_dir: Is the Wind Wizard manipulated value required for use in ArcMap for display purposes.

1. Open ArcMap and load other data coverages and fire perimeter files of interest.

6. Load the ArcMap Wind Wizard shapefile for the fire of interest. The wind vector grid will appear on the coverage as individual points (Figure 2).

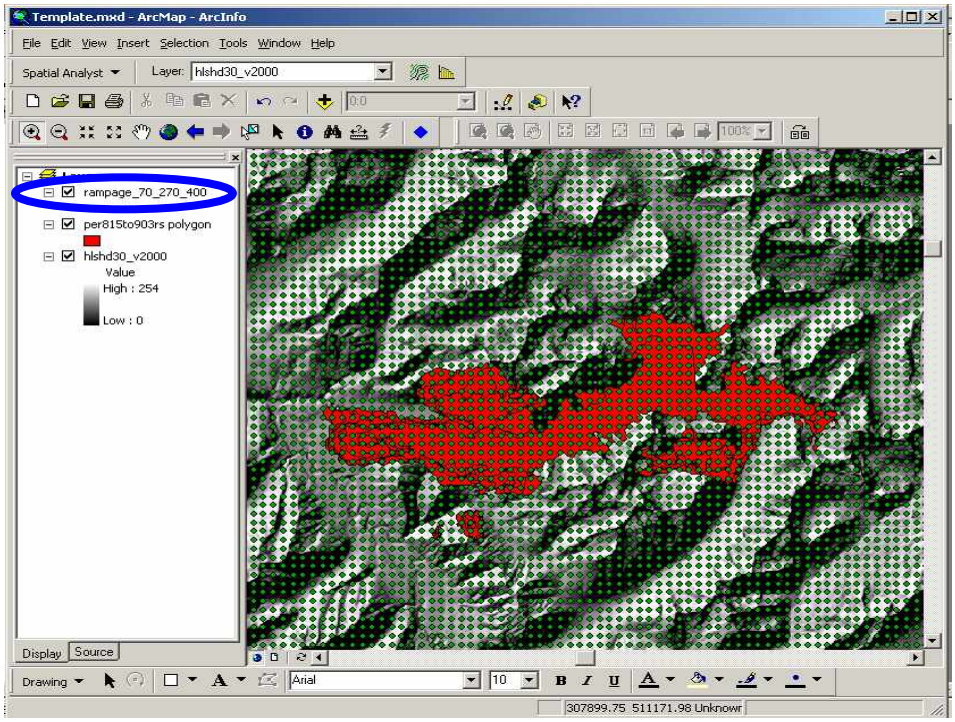



Figure 2. Example ArcMap project with Wind Wizard generated shapefile as displayed in ArcMap prior to scaling and rotation of the Wind Wizard generated vectors.

7. After loading the file into the ArcMap project, double click on the layer name in the **Table of Contents** to open the **Layer Properties**. This will open the dialog box in Figure 3.

8. Click on the **Symbology** tab. (Figure 3).

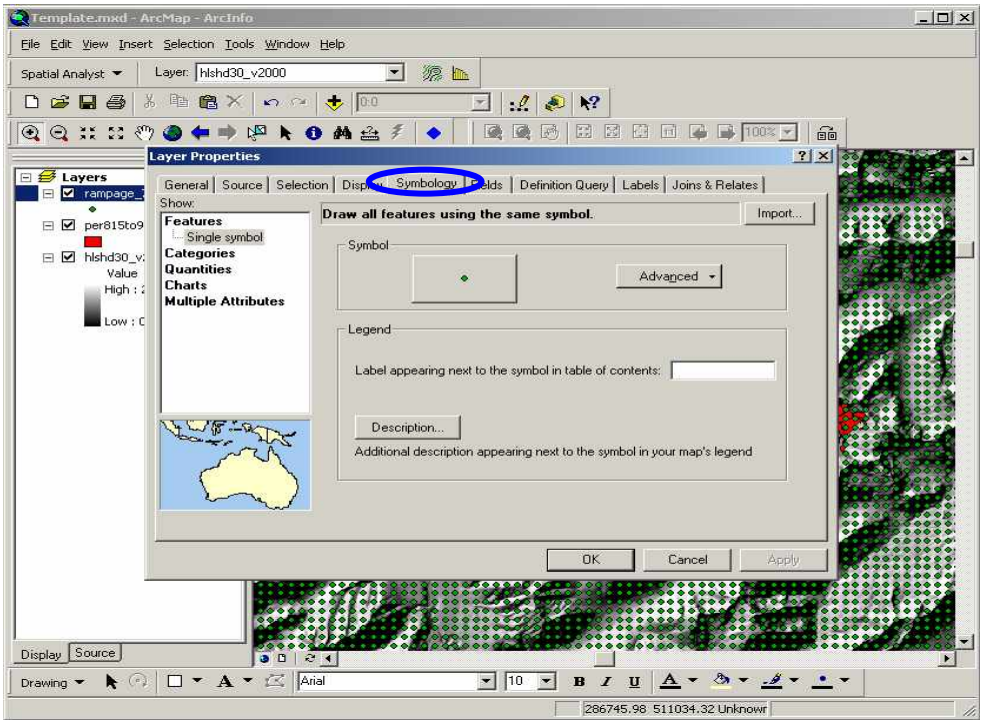



Figure 3. Layer Properties dialog box as displayed in ArcMap.

9. In the **Show** pane on the left side, select **Quantities** then **Graduated symbols** (Figure 4).

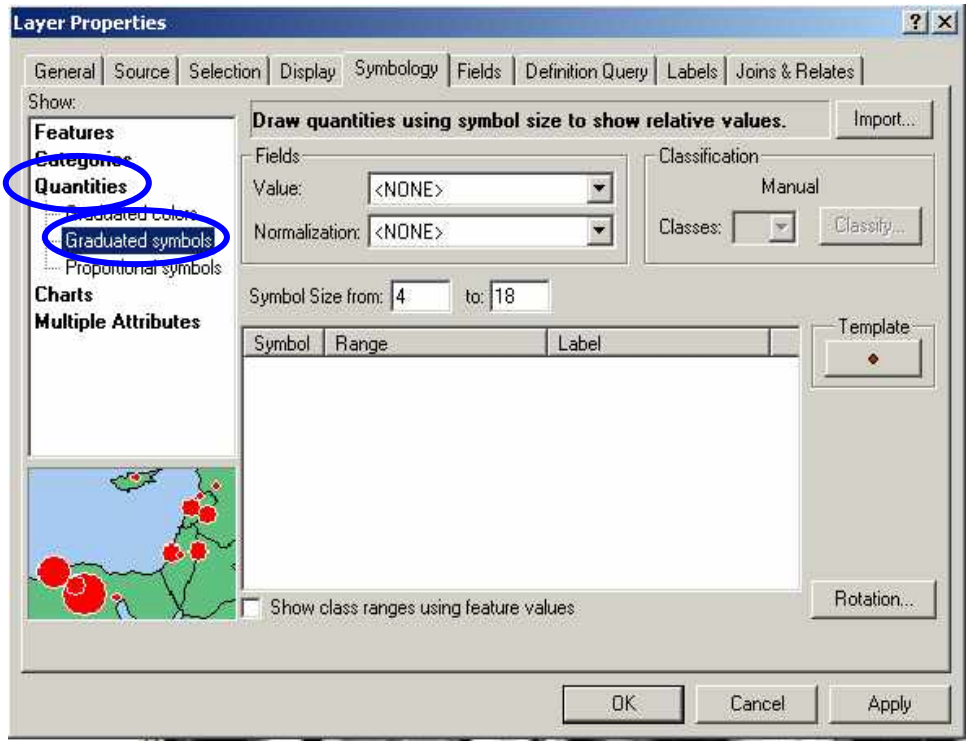



Figure 4. Selecting the Quantities and Graduated symbol.

10. In the **Value** window click on the dropdown arrow and select **speed** from the available options**.** The following **Warning Message** (Figure 5) will appear depending on the number of records in the associated shapefile. Click

on the **OK** button and the **Warning Message** will disappear. To change the number of records in ArcMap refer to Appendix D.

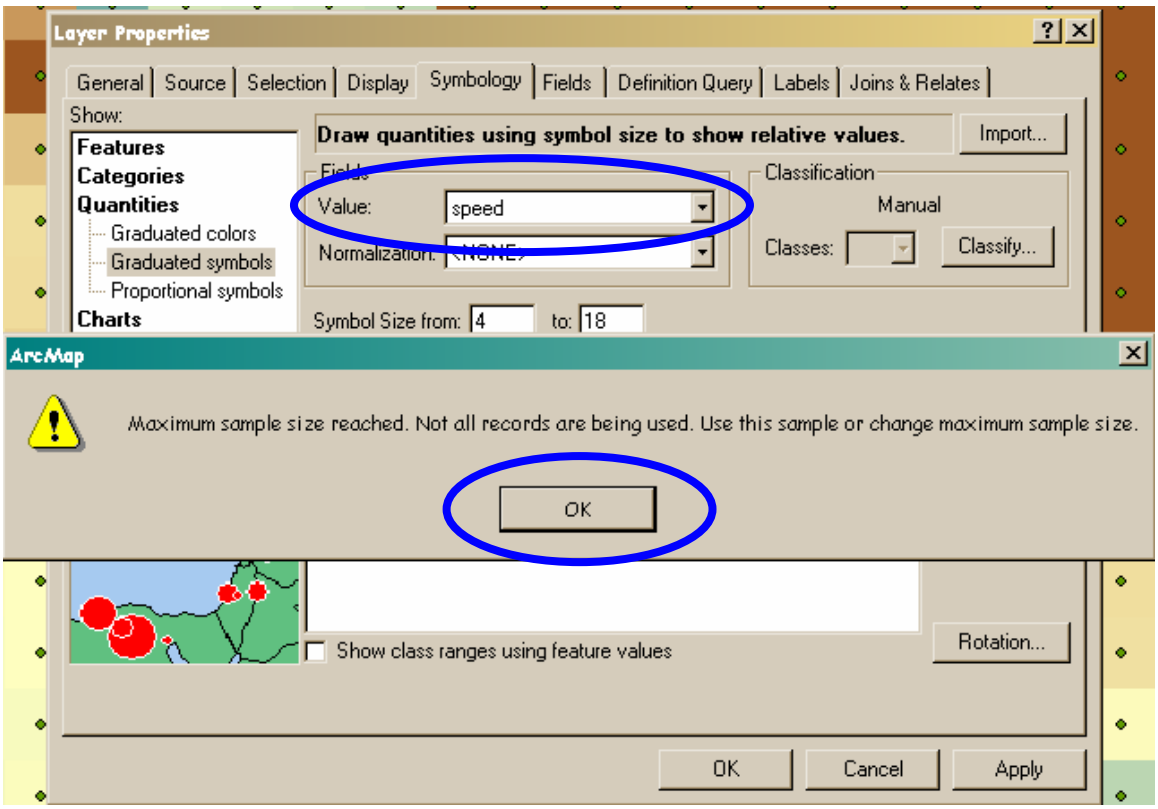



**Figure** 5. Selecting speed as the value to graduate the symbol and removing the Warning Message box.

11. Selecting the display symbol and changing the **Symbol Size** (Figure 6). Enter a **Symbol Size** range (20 -30). Arrows are not in the default symbol sets, so to select an arrow to display you need to choose one of the symbol sets that have arrows in it. This is done by clicking on the **Template** button (Figure 6).

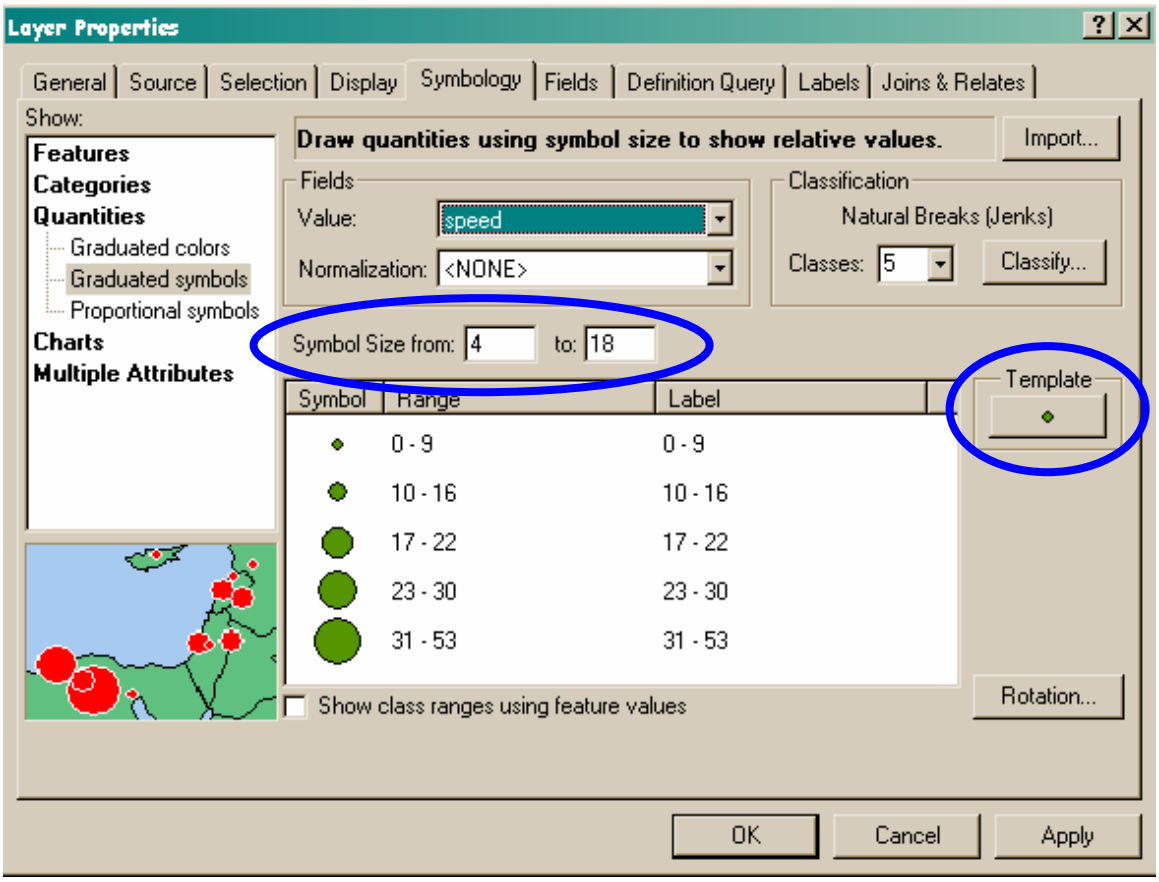



Figure 6. Changing the Symbol Size Range and choosing a new symbol set with arrows.

12. Select a symbol to represent the wind vectors. Under **More Symbols** choose either the **IGL** or **Forestry** symbol sets. The arrows toward the bottom work well in the **IGL** symbol set (Figure 7).

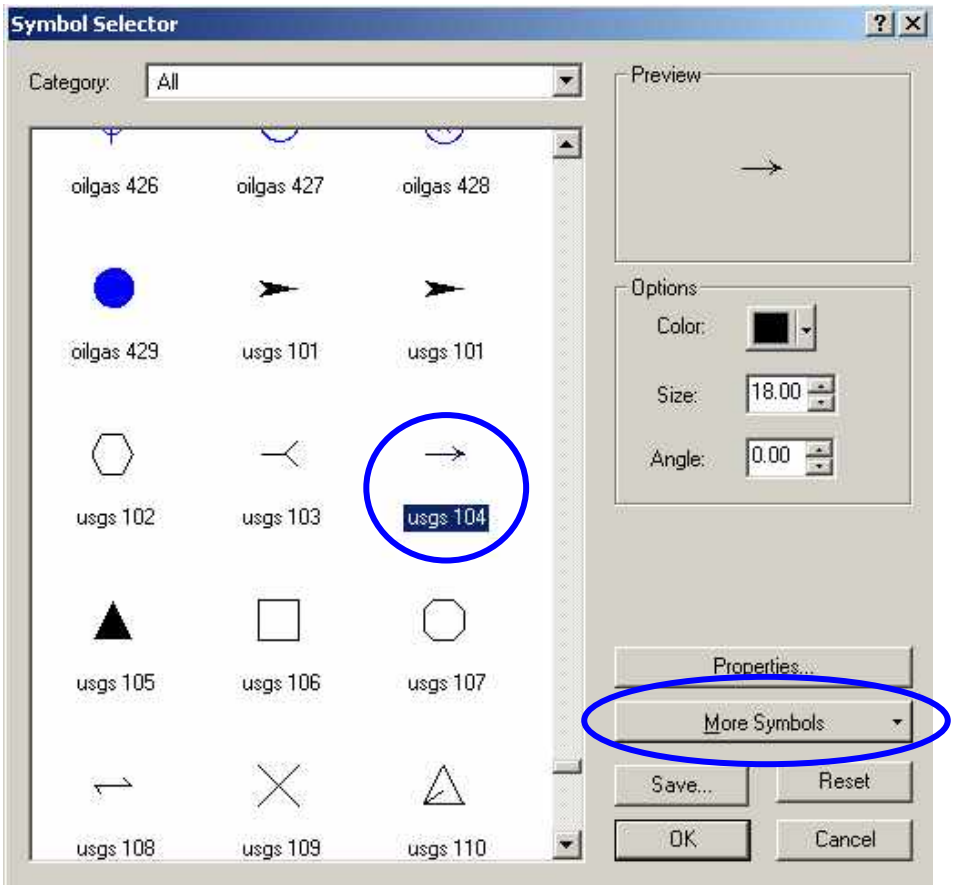



Figure 7. Selecting an appropriate arrow for display from the IGL symbol set.

13. Click **OK** to return the **Layer Properties**.

14. Click on the **Rotation** button which will open the **Rotation** dialog box (Figure 8). Click on the dropdown arrow and select **AM_dir** to rotate the points from the available options and select **Geographic** in the radio button for **Rotation Style.**

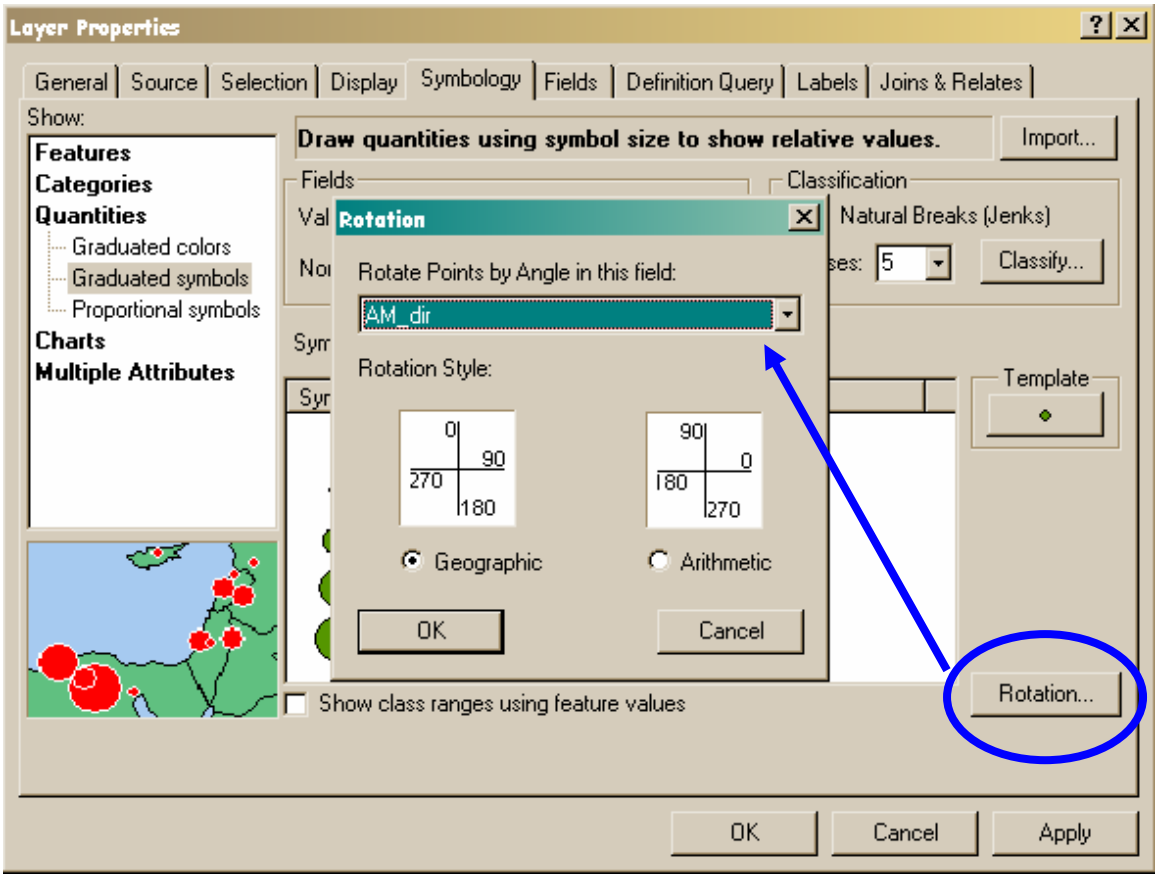



Figure 8. Selecting the data field and Rotation Style for arrow rotation.

15. Click **OK** to close the **Rotation** window and **OK** again to close the **Layer Properties** window.

16. The wind vectors will appear over the existing layers (Figure 9).

17. Symbol colors can be changed by clicking on the individual symbols in the **Table of Contents** for the respective shapefile (Figure 9).

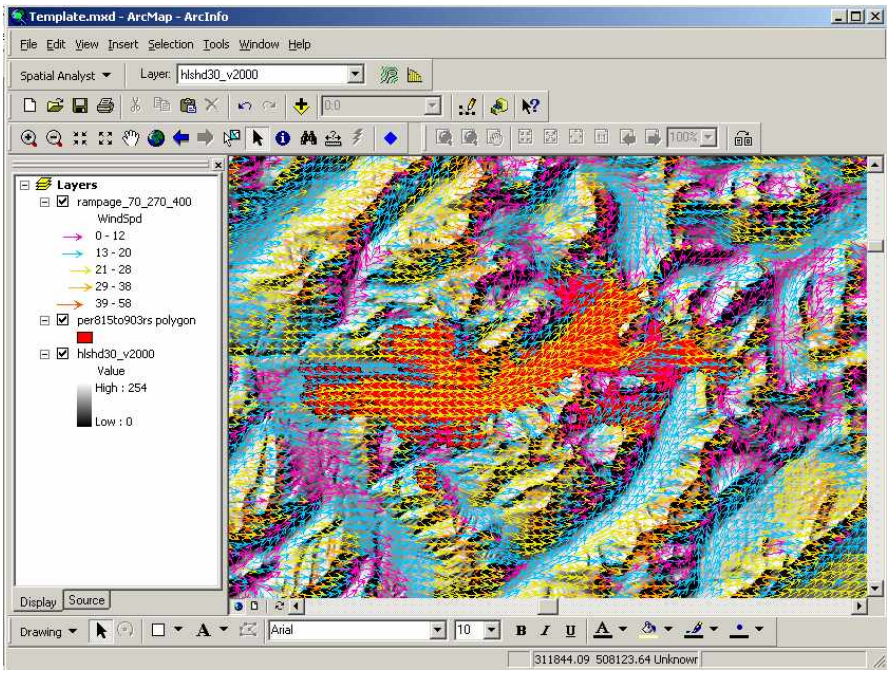



Figure 9. ArcMap display of rotated and graduated wind direction and speed.

## B. Query the Gridded Wind Output in ArcMap

To correctly rotate the arrows in ArcMap as described above requires manipulation of the data generated by the Wind Wizard software for display purposes. In Figure 10 the query information for the circled arrow shows the wind speed as 32 mph with an AM_dir of 312. The AM_dir value for wind direction in the shapefile **IS NOT** the same value as generated by the Wind Wizard software; it is for rotation and display purposes only. For this point the windspeed is 32 mph (speed) and wind is coming from 222 degress (Dir). The values for speed and dir are the Wind Wizard derived values that should be used in any analysis using this shapefile.

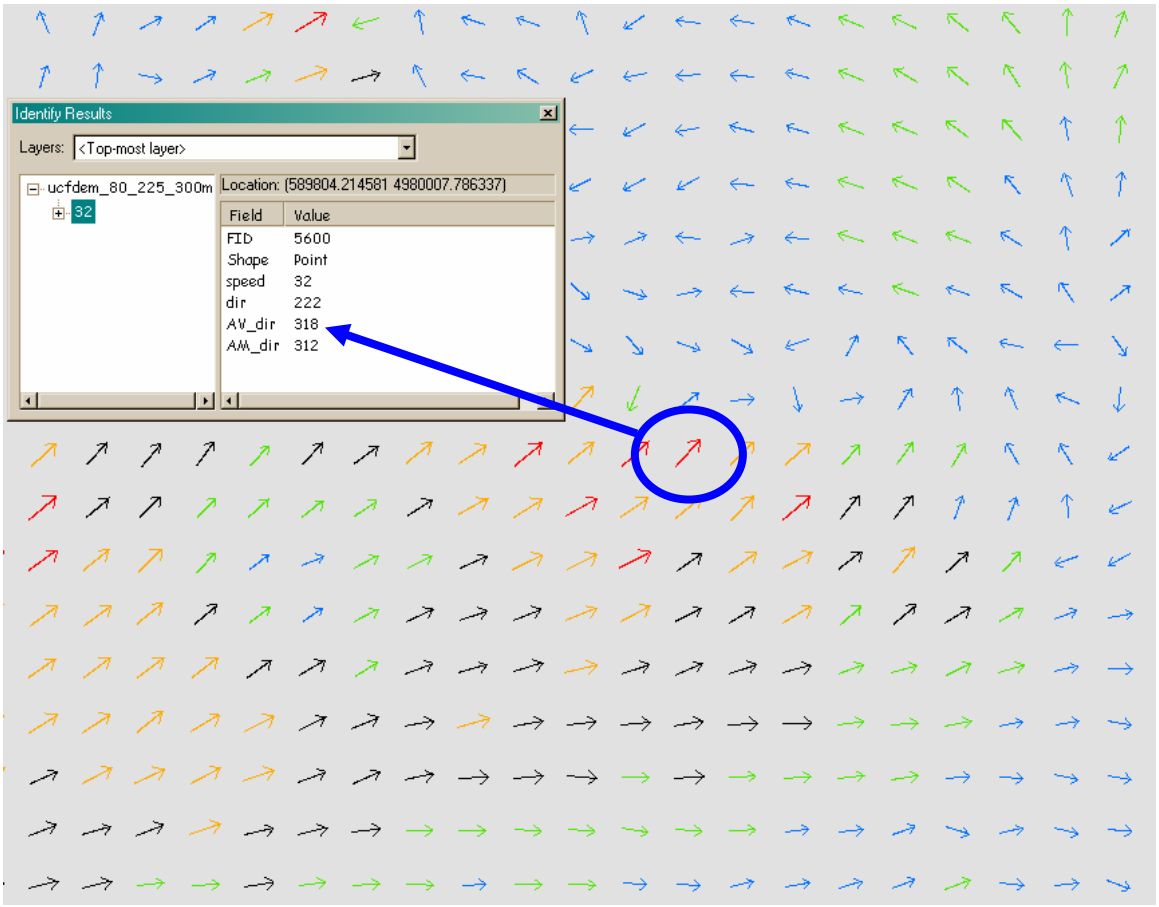



Figure 10. Query results of gridded wind shapefile in ArcMap showing the difference in the wind direction in the shapefile and the rotation angle of the arrow.

Figure 11 focuses on the same point on the landscape. However, in this case the ArcMap shapefile is overlayed on the GRID of wind direction generated by the Wind Wizard software. A query of the individual raster cell shows a Pixel value of 222 which corresponds to the direction the wind is coming from.

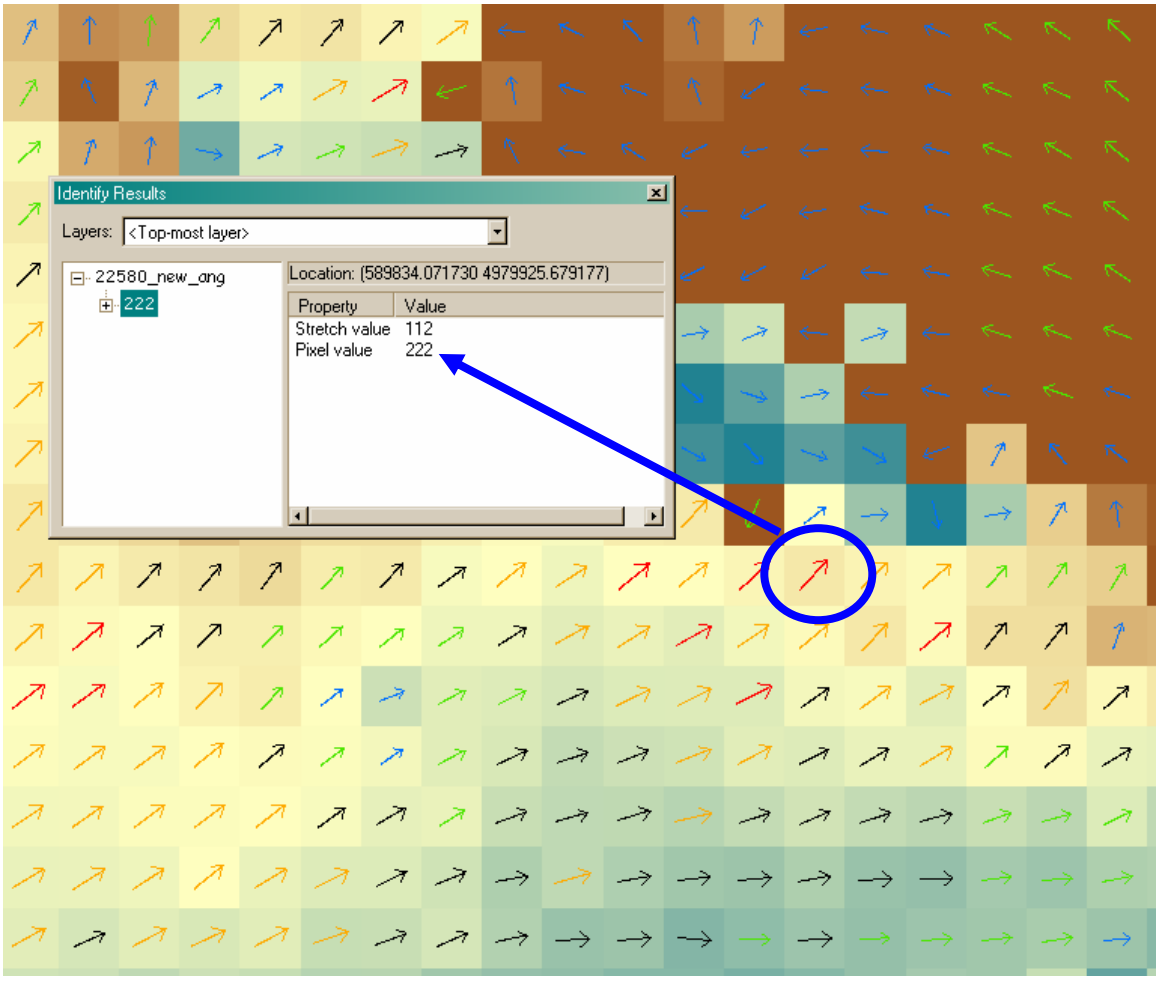



Figure 10. Query of the gridded wind generated ArcMap shapefile overlayed on the GRID ASCII Raster output from the wind wizard process.

## Appendix D: How to Change the Number of Records Used In ArcMap when Displaying Wizard Shapefile Output

## Appendix D: How to Change the Number of Records Used In ArcMap when Displaying Wizard Shapefile Output

Chuck McHugh, RMRS, Fire Sciences Lab, Missoula, MT, 406-829-6953, **cmchugh@fs.fed.us**.

When displaying the Wind Wizard derived wind direction-speed shapefile information in ArcMap, the warning displayed in Figure 1 will often occur. This is because the default number of records to be displayed in ArcMap is the **First 10,000 Records** regardless of the distribution and spatial location of the data. Depending on the output file resolution selected in the Wind Wizard software and the landscape extent this number can easily be exceeded. As a consequence, not all records in the shapefile will be used during display of the windspeed values. Additionally, within ArcMap your choice of Classification Method and the number of Classes will also affect the displayed ranges of information.

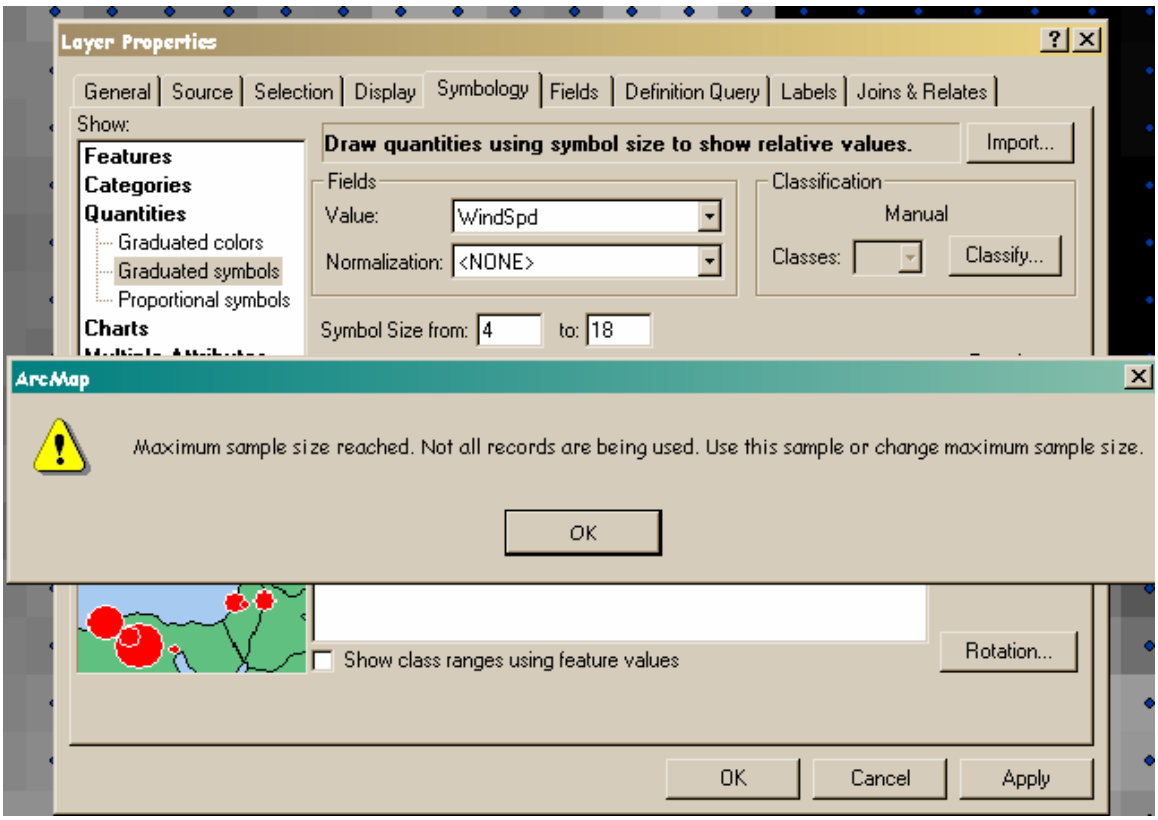
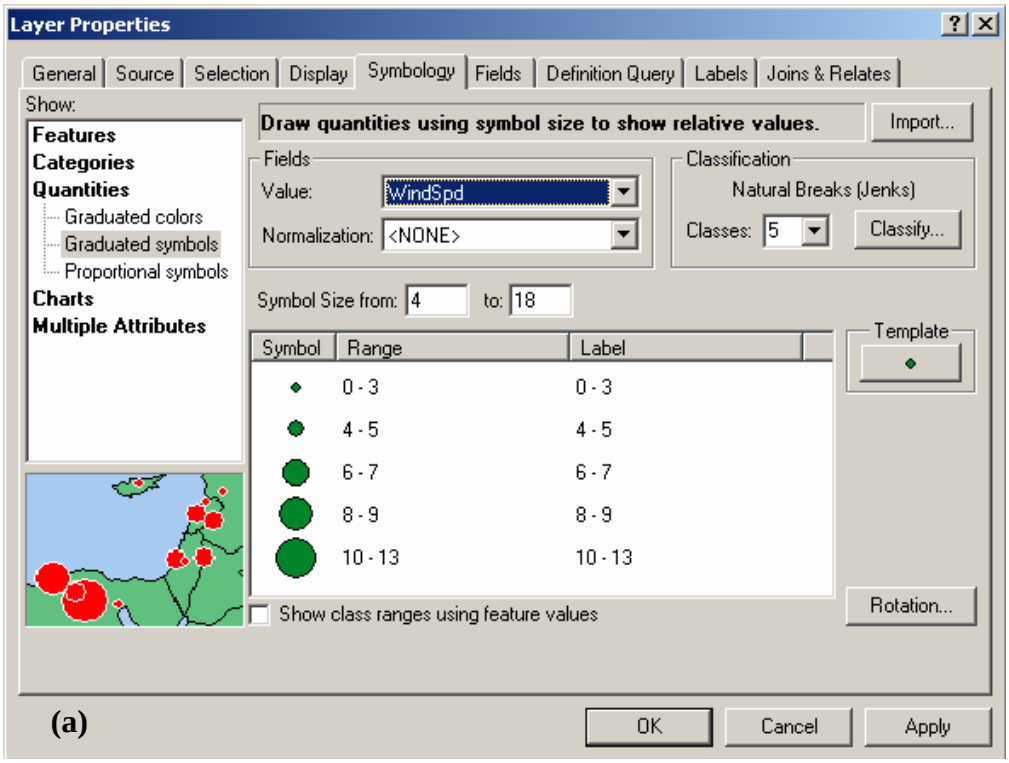



Figure 4. Error message when the number of records in the Wind Wizard ArcMap shapefile exceeds the default settings.

Because only the first 10,000 records are used not all the information will be used in defining the ranges of windspeed during the rotation process. This can lead to a misunderstanding of what the maximum and minimum windspeed values really are. For example, in Figure 2a the maximum windspeed value displayed is 13 mph while in Figure 2b the maximum windspeed value displayed is 20 mph.



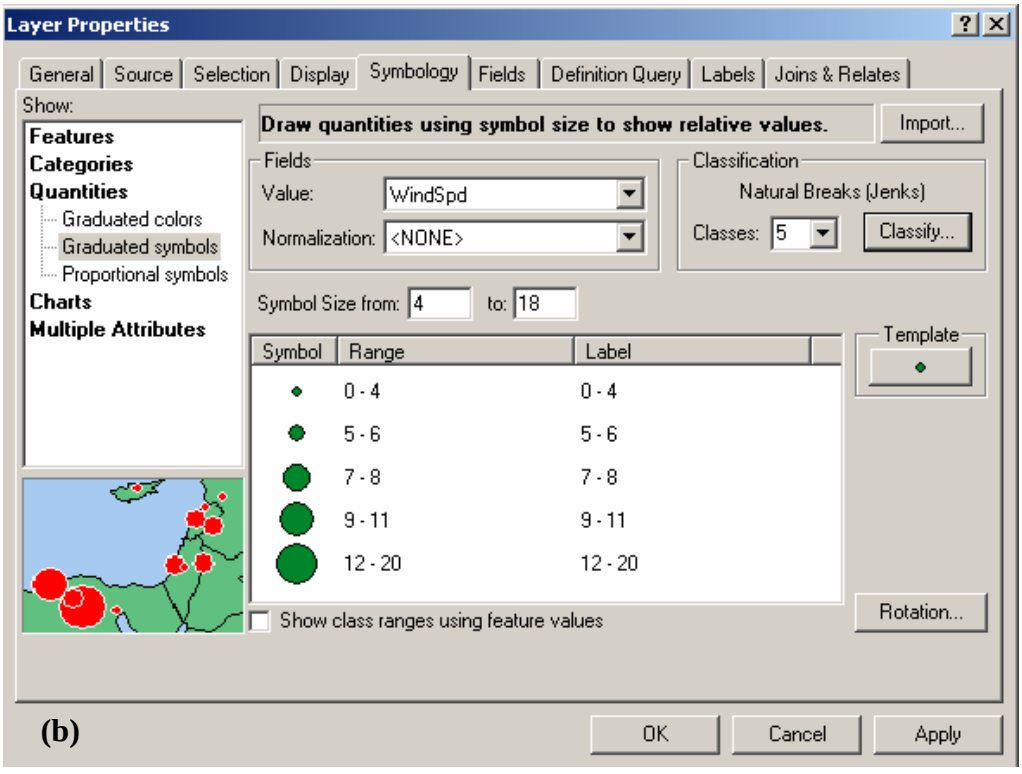




Figure 5. Displayed ranges of wind speed values based on Maximum Sample Size. (a) using default setting of 10,000 records and (b) setting Maximum Sample size so all records are used.

To change the number of records used for the shapefile is an easy change. This is not a universal change to the settings but only applies to the shapefile while active in the view. To change the settings first click on the **OK** button in the warning message; this will remove the warning message box. Next, select **Classify** (Figure 3).

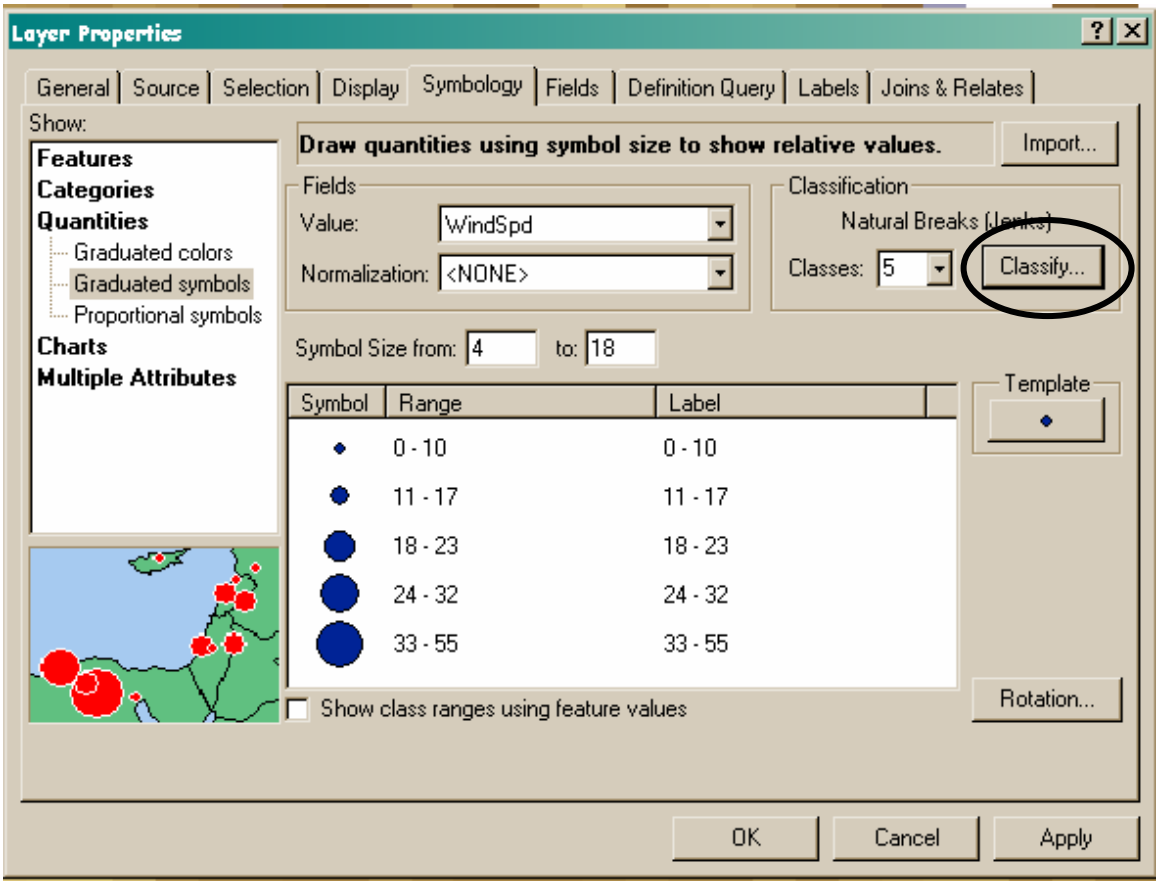



Figure 3. Classify button to start the process of changing the default settings for number of records displayed in ArcMap.

Selecting the **Classify** button will open the window displayed in Figure 4.

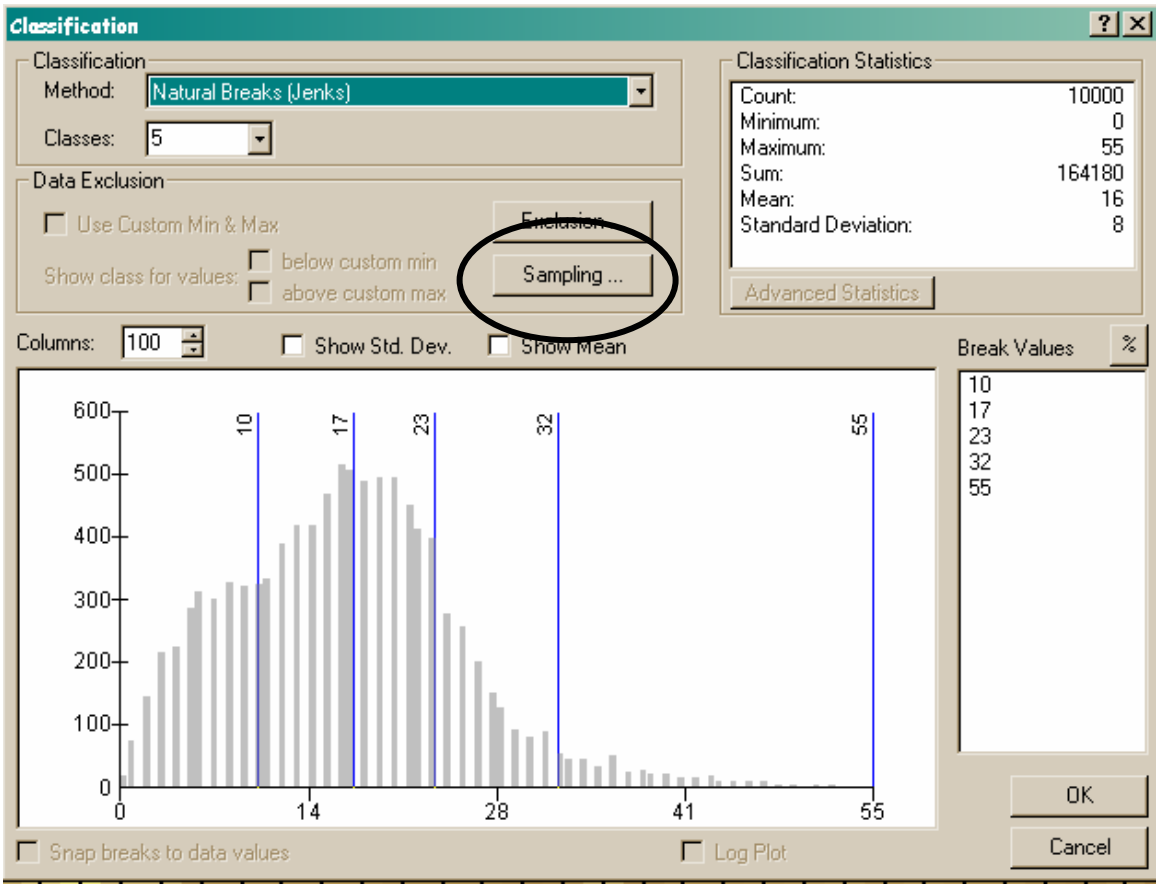



Figure 4. Classification window showing the number of records used in the Classification Statistics displayed in ArcMap.

In the **Classification Statistics** pane in the upper right you can see the number of records used (Count), minimum and maximum, mean, and standard deviation. All these values will change based on the **Data Sampling** method selected; in this case the number of values is the default value of **First 10,000 Records**.

The number of records or sampling method chosen here does not affect summary or statistical operations performed on the data fields within the shapefile attribute table. Operations performed on the shapefile attribute table will use all the records available for the selected data field unless a subset of the records has been selected.

To change the **Maximum Sampling Size,** select the **Sampling** button (Figure 4). This will open the **Data Sampling** dialog box displayed in Figure 5.

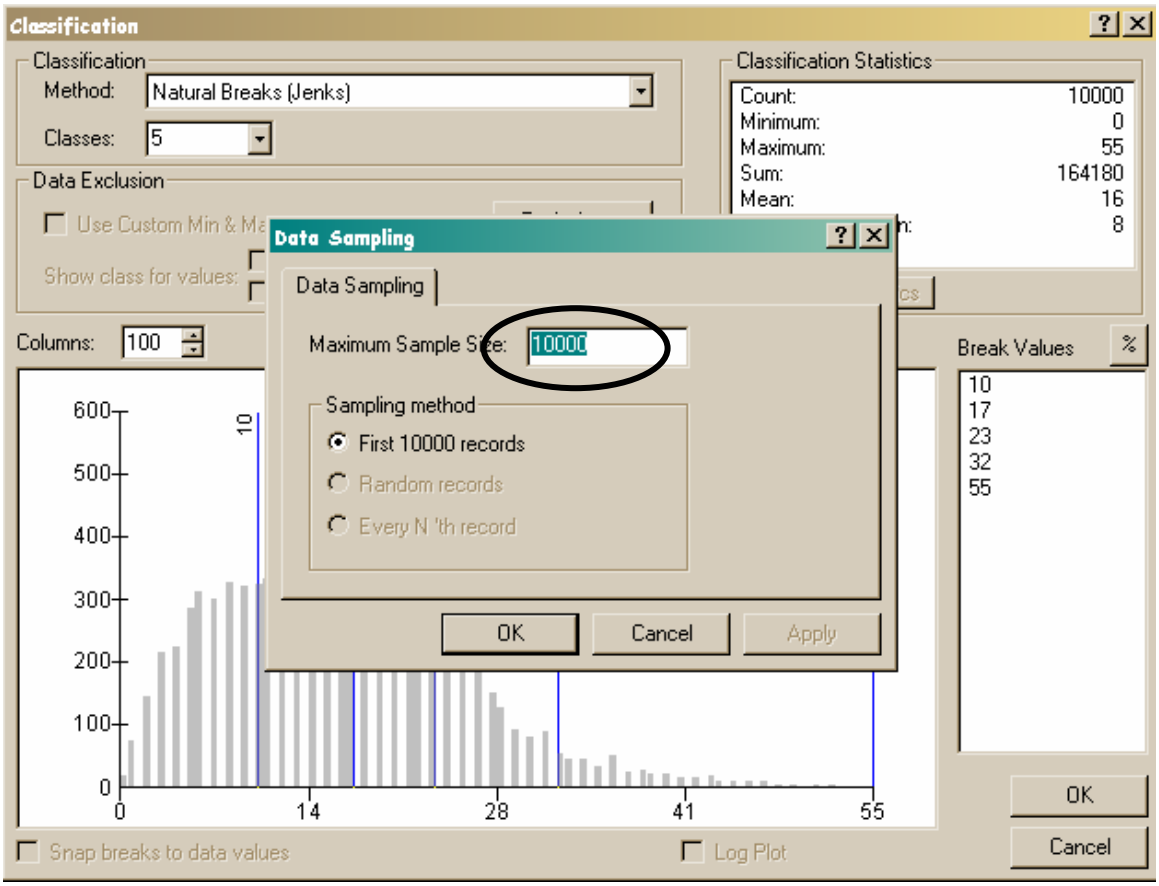
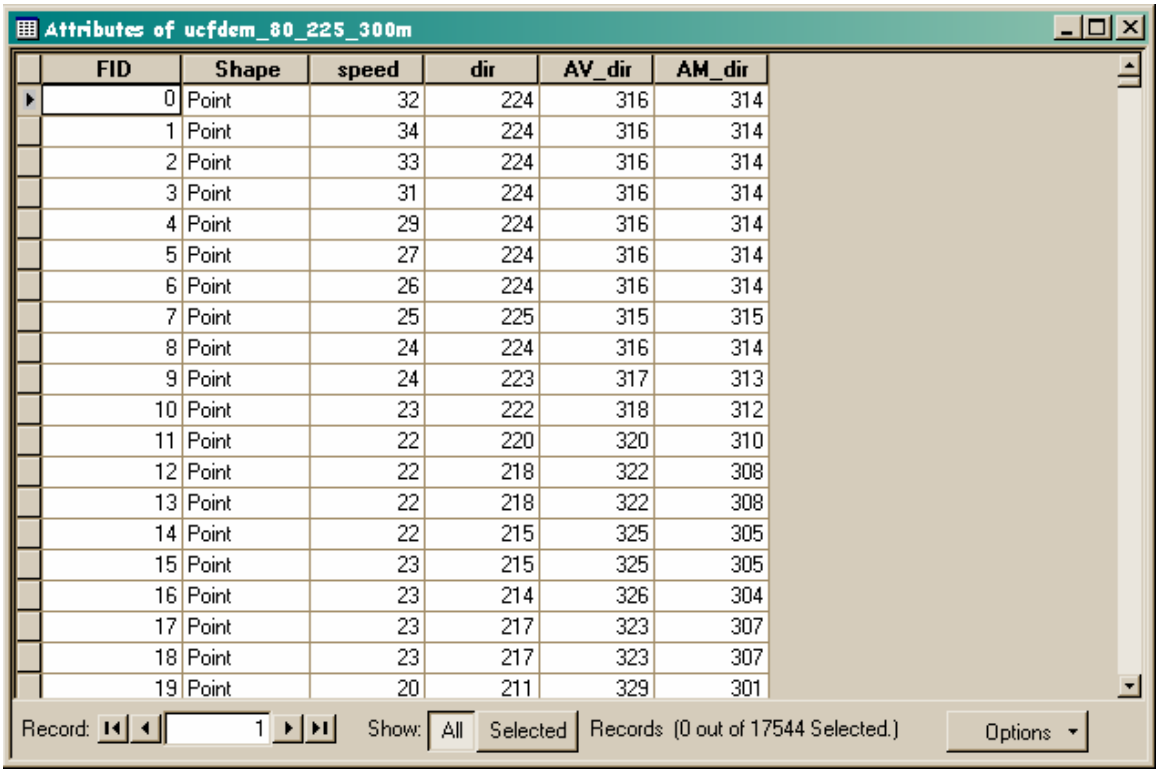



Figure 5. Dialog box to change the data sampling and sampling methods for the shapefile in ArcMap.

In the **Data Sampling** dialog box you will need to change the **Maximum Sample Size** used from 10,000 to a larger value (Figure 5). After changing the **Maximum Sample Size** value click on **OK** until all dialog boxes have closed. For most shapefiles changing this value to 100,000 should ensure that all records are being used. However, the number of records included in any one shapefile is determined by the size of the landscape as well as the output resolution selected in the Wind Wizard software. Because of this you may need to set this value higher in some cases. To see how many records are in the shapefile, you can do the following.

1. In the **Table of Contents** pane right-click on the shapefile of interest.
2. Select **Open Attribute Table**.
3. On the bottom right-hand side will be the statement “Records (0 out of ## Selected). The ## will be the total number of records in the shapefile (Figure 6). If a subset of the total number of records has been selected this too can be determined. The number of selected records would show up where the 0 is for this example.




| FID | Shape | speed | dir | AV_dir | AM_dir |
|---|---|---|---|---|---|
| 0 | Point | 32 | 224 | 316 | 314 |
| 1 | Point | 34 | 224 | 316 | 314 |
| 2 | Point | 33 | 224 | 316 | 314 |
| 3 | Point | 31 | 224 | 316 | 314 |
| 4 | Point | 29 | 224 | 316 | 314 |
| 5 | Point | 27 | 224 | 316 | 314 |
| 6 | Point | 26 | 224 | 316 | 314 |
| 7 | Point | 25 | 225 | 315 | 315 |
| 8 | Point | 24 | 224 | 316 | 314 |
| 9 | Point | 24 | 223 | 317 | 313 |
| 10 | Point | 23 | 222 | 318 | 312 |
| 11 | Point | 22 | 220 | 320 | 310 |
| 12 | Point | 22 | 218 | 322 | 308 |
| 13 | Point | 22 | 218 | 322 | 308 |
| 14 | Point | 22 | 215 | 325 | 305 |
| 15 | Point | 23 | 215 | 325 | 305 |
| 16 | Point | 23 | 214 | 326 | 304 |
| 17 | Point | 23 | 217 | 323 | 307 |
| 18 | Point | 23 | 217 | 323 | 307 |
| 19 | Point | 20 | 211 | 329 | 301 |

Figure 6. Attribute table for Wind Wizard generated shapefile in ArcMap.