Preparation of Graphics for Publications with MATLAB

Many authors use MATLAB (http://www.mathworks.com/) to prepare graphics for publication and presentations. However, the default MATLAB settings often lead to inappropriately small font sizes and narrow line widths. It is also important to save the figure with an appropriate graphics format. The following brief discussion will help authors address these issues.

For print publication, AIP recommends that the font size on figure labels be 8 pt or larger (http://www.aip.org/pubservs/style/4thed/toc.html, 1997 Addendum). The font size in MATLAB usually defaults to 10 pt. However, when the figure is reduced to fit the publication's column width, the reproduced font size is often much smaller than the original value. Authors should endeavor to assess how much their figure will be reduced and scale the fonts accordingly. A font size of 14 pt or even larger is often appropriate.

The following simple example illustrates how to change the font size when working from the MATLAB command line (with prompt indicated by >>). First, we plot a curve for the dependence of sounds speed on temperature in dry air:

```
>> T=linspace(0, 20);
>> c=331.6*sqrt(1+T/273.15);
>> plot(T, c)
```

A figure window will now display the curve. To change the numbers on the coordinate axes to 18-pt font size, we would type

```
>> set(gca, 'fontsize', 18)
```

in which `gca` refers to the axes of the current graph. The axes can be labeled by entering:

```
>> xlabel('Temperature (\circC)', 'fontsize', 18)
>> ylabel('Sound speed (m s^{-1})', 'fontsize', 18)
```

Here, the "`^{-1}`" and "`\circ`" are TEX-style commands for special characters supported by MATLAB. For best results in a publication, graphics should generally be saved to an encapsulated postscript file. Such files store lines in a vector format, which remains sharp when the figure is rescaled for printing. The print function can be used for this purpose. To create the file MyFigure.eps,

```
>> print -deps2 MyFigure
```

The option `-deps2` saves the figure to a black-and-white file, even if the lines appear in color in the figure window. This is normally desirable for publication. The option `-depsc2` saves the graphic in color. Multiple lines on a figure can be distinguished using different line styles in MATLAB.

A TIFF format, rather than postscript, would be appropriate for images, such as those created with the MATLAB image, surf, and mesh functions. The default MATLAB settings for the `-dtiff` option save the TIFF file at a high resolution appropriate for publication. Other formats, such as GIF, JPEG, and Windows Bitmap (bmp), should generally be avoided for publications (and indeed are not accepted by many journals, including the *Journal of the Acoustical Society of America*), as they often lead to a substantial loss in image quality.

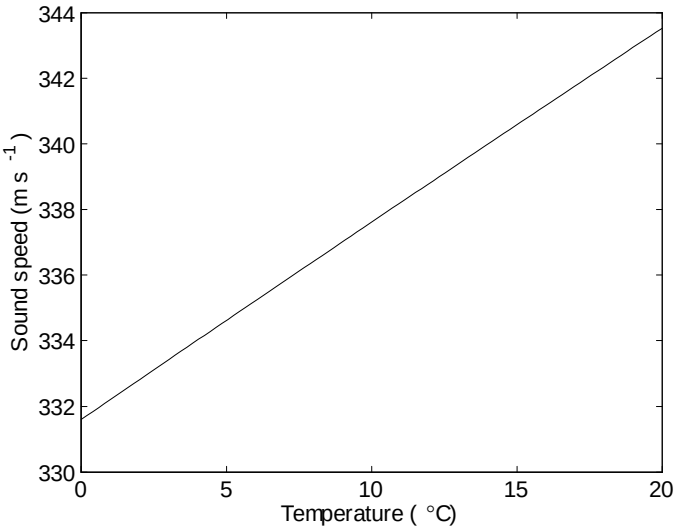

Figure 1: Plot of the sound speed vs. temperature, as saved to an encapsulated postcript file. Font size was increased to 18 pt.

These formats may be desirable for incorporation into presentations, however. In particular, JPEG often produces images with satisfactory compression and quality.

Figures 1 and 2 compare an encapsulated postscript file with 18-pt fontsize to a bitmap file with the default MATLAB font size. Particularly when these figures are printed, the curve in Figure 1 will appear smoother.

As with figures prepared for publication, those prepared for presentations should generally have larger font sizes than the MATLAB defaults. It also is important to increase the width of the lines in figures for presentations. The MATLAB default line width, 0.5 pt, is too thin to project well. A width of 2 pt or larger is recommended. Also, for a presentation, we may wish to adjust the colors to best effect, rather than saving them to a black-and-white or gray-scale format (as with `print -deps2`). We thus might choose to generate a JPEG file, to be incorporated into a PowerPoint presentation, as follows:

```
>> plot(T, c, 'r', 'linewidth', 2)
>> set(gca, 'fontsize', 18, 'linewidth', 2)
>> xlabel('Temperature (\circC)', 'fontsize', 18)
>> ylabel('Sound speed (m s^{-1})', 'fontsize', 18)
>> print -djpeg MyFigure
```

Note that the linewidth has been increased for both the plotted curve and the coordinate axes. The result is shown in Figure 3.

These instructions have described how to change the font size and line widths using command-line instructions. These and other graphics properties can also be changed interactively. Choose the "Edit Plot" (pointer) tool near the top of the figure window, select the objects to be changed, and then right-click on the desired object to change its properties.

The font sizes and line widths can also be adjusted using a figure copy template. After

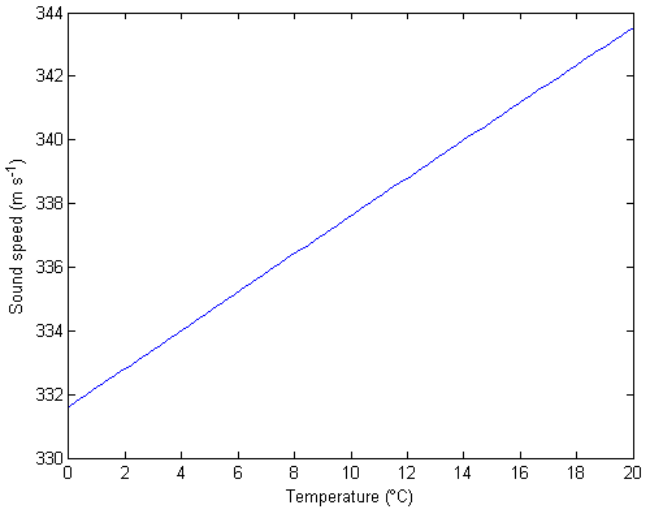

Figure 2: Plot of the sound speed vs. temperature, as saved to an Windows bitmap file. Font size is the default for Matlab.

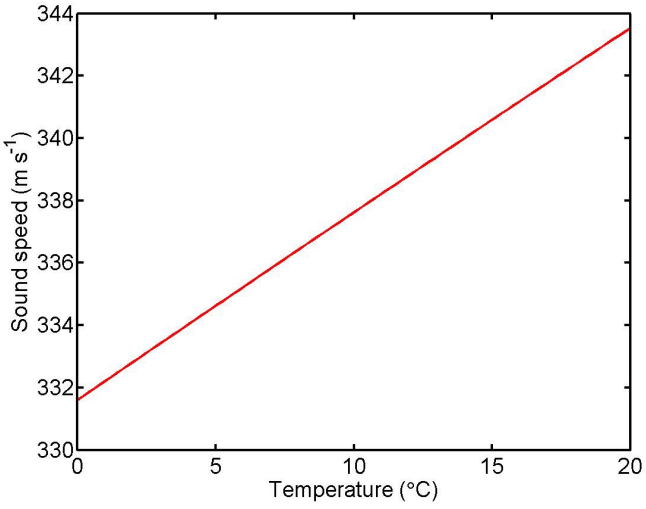

Figure 3: Plot of the sound speed vs. temperature, as saved to an encapsulated postcript file. Font size was increased to 18 pt and the linewidth to 2 pt.

creating the figure (but leaving the font sizes and line widths to their defaults), go to the File menu on the top of the figure window, and then select "Preferences." Next, select "Figure Copy Template." Click on "PowerPoint", and then "Apply to Figure". This will automatically change the font weight to bold, increase the font size by 120%, and change the width of all lines to 2 pt. The file can then be saved to an appropriate format.

Note that the "Save As..." option (selected from the File menu) and the corresponding command-line `print` function and do *not* always produce graphics of the same quality. For example, `print -dtiff` produces a TIFF file with less compression than "Save As...". Use `print -dtiffnocompression` to avoid compression altogether. (This will often be a very large file!)

Finally, we mention a capability of MATLAB that can be a valuable time saver if figures must be slightly modified at a later time, for example if a reviewer suggests that the label on an axis should be changed, as frequently happens. After creating the figure, go to the File menu, and then select Save. Save the graphic as a MATLAB figure (.fig) file. Later, the file can be reopened by going to the File menu, and then selecting Open. Modifications can be made readily, and the results can then be saved to a graphics file.

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