Paper AD-48

SAS/GRAPH® and ANNOTATE Facility–More Than Just a Bunch of Labels and Lines

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ABSTRACT

SAS/GRAPH procedures enhanced with the ANNOTATE facility are a cornerstone capability that provide flexible power to customize graphical displays that go well beyond the "standard" outputs of SAS/GRAPH PROCs. This paper does not attempt to describe unique or seldom used abilities in SAS/GRAPH, but instead it exposes the audience to several ways of exploiting the ANNOTATE facility to enhance output far beyond an occasional label or line drawing. The products reviewed provide situational awareness to military planners and decisions makers daily.

INTRODUCTION

The 14th Weather Squadron in Asheville, NC, is the Department of Defense's climatology organization supplying planning weather and climatological statistics to military, intelligence, and research communities. The squadron has exploited SAS® capabilities for over 25 years, but recently implemented dynamically built SAS/GRAPH graphics-based capabilities ranging from simple "cartoon" visualizations for deploying military members to complex statistical extreme-values gradient maps for national laboratory researchers. This paper will highlight SAS/GRAPH capabilities including GFONT, GMAP, G3GRID, GINSIDE, GSLIDE, and more.

THE ANNOTATE DATA SET

The annotate data set containing a minimum of a handful of tasks defining "what to do" (FUNCTION), "where to place the object" (X, Y), "a reference system" (XSYS, YSYS) and "some attributes" (COLOR, ANGLE, and more) along with a reference to the annotate data set in the graphical procedure can drastically alter the usability of a chart, map or other graphical output. This paper will not go into detail about every aspect of ANNOTATE, but instead will cover a short review of the basics and follow up with examples. For an excellent explanation of the ANNOTATE facility, review Sarah Mikol's SESUG 2012 paper.[1]

EXAMPLE 1: THE BASICS WITH GSLIDE

The following example, although using a somewhat complicated data set, is a simple way to understand the foundation of ANNOTATE and how things may go awry. A SAS GSLIDE procedure is used to "freehand" a map using data from a SAS map data set of Afghanistan. This example uses only the minimum ANNOTATE data set parameters of X, Y, XSYS, YSYS, and FUNCTION along with COLOR for emphasis to draw a line in a graphic area. NOTE: As a convenience for the reader to test the code, this example uses a map data set for the locations to draw and may or may not be a good substitute for other SAS mapping features. GSLIDE does not have a data coordinate system; therefore, in this example, all plotting is based on a percentage of the slide area (XSYS and YSYS='3').

```
/****************************************************
* Build a map based on percentage of the graphic area
****************************************************/

/****************************************************
* Find boundaries of my map first (used to determine
* percentage of map for plots later).
****************************************************/
proc sql noprint ;
    select max(lat), min(lat), max(long), min(long)
            into :max_lat, :min_lat, :max_lon, :min_lon
    from mapsgfk.afghanistan ;
quit ;

/****************************************************
* Let's start drawing--nothing but the basic variables
* to draw and color a line with an ANNOTATE data set
```

```
    * named etch_a_sketch.
    ****************************************************/
DATA etch_a_sketch ;
    /* assign a reference system of percent of graphic area */
    RETAIN xsys ysys '3' ;
    KEEP x y xsys ysys function color ;
    SET mapsgfk.afghanistan ;
    /* use the unprojected lat/long coordinates to transform them into a
       percentage of the graphical area (GSLIDE does not have data values)*/
    x=(long-&min_lon)/(&max_lon-&min_lon)*100 ;
    y=(lat-&min_lat)/(&max_lat-&min_lat)*100 ;
    function='draw' ;
    if _n_=1 then color='red' ; /* highlight the first line for a reference */
RUN ;

GOPTIONS DEVICE=png ;

PROC GSLIDE ANNOTATE=etch_a_sketch ;
RUN ;
QUIT ;
```
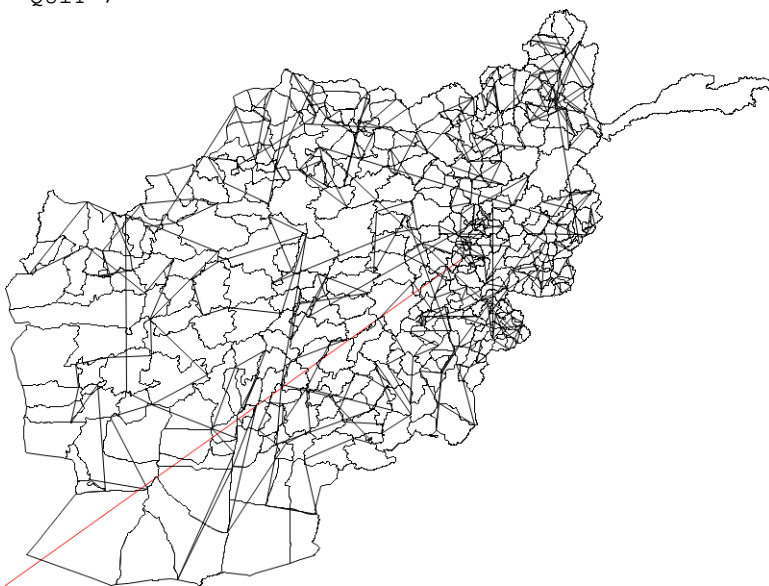

Figure 1. The Etch-A-Sketch® Effect Drawing

Figure 1 highlights the ANNOTATE drawing function working in a mode similar to the Etch-A-Sketch toy. Drawing started at the default start location (0,0) and the first line was drawn to the first point in the data set (highlighted in red for emphasis). Notice how the "pen" never lifted off the paper when a new province was encountered (straight lines). The following code adds a simple fix to move (FUNCTION='move') to the start of each province without drawing along the way. Once there, the drawing continues until the last segment of each province is reached (Figure 2).

```
    /********************************************************
    * Some clean up in order. This time move the "pen" to
    * a new location for the beginning of each province
    * drawn. Also, let the system default the color to black.
    ********************************************************/
DATA province_map ;
    /* assign a reference system of percent of graphic area */
    RETAIN xsys ysys '3' ;
    KEEP x y xsys ysys function ;
    SET mapsgfk.afghanistan ;
    BY id segment ;
    /* use the unprojected lat/long coordinates to transform them into a
```

2

```
        percentage of the graphical area (GSLIDE does not have data values)*/
x=(long-&min_lon)/(&max_lon-&min_lon)*100 ;
y=(lat-&min_lat)/(&max_lat-&min_lat)*100 ;
if first.segment then function='move' ;
else function='draw' ;
RUN ;

PROC GSLIDE ANNOTATE=province_map ;
RUN ;
QUIT ;
```


Figure 2. A Complex Drawing Using Simple ANNOTATE statements

This example highlighted the simple premise of ANNOTATE; move to a location (X, Y), do something, and repeat as needed. The more complex your situation, the more you may want to rely on other capabilities like ANNOTATE macros and other functions like BAR and PIE. Those functions augmented with enhancement attributes like COLOR, ANGLE, LINE, etc., add a level of effectiveness unavailable with basic SAS/GRAPH output. The rest of this paper will demonstrate the power of ANNOTATE using nothing more than a handful of keystone ANNOTATE capabilities.

EXAMPLE 2: FUNCTION='LABEL' WITH GMAP

Example 1 highlighted the drawing function and Figures 3 and 4 both leverage FUNCTION='draw', but this time on a map produced with GMAP and annotated using FUNCTION='label' too. FUNCTION='label' is probably the simplest function to use since it is the one of the functions that does not require a "move" statement first. Note, unlike the GSLIDE example above, GMAP has data references (latitudes and longitudes) so ANNOTATE on this product relied on data area references (XSYS and YSYS='2'). Figure 3 displays tropical storm tracks. The stars are the letter 'V' MARKER font with color based on speed. The lines could have easily been colored too based on a timespan. This map conveys a big message produced with a few simple ANNOTATE statements.
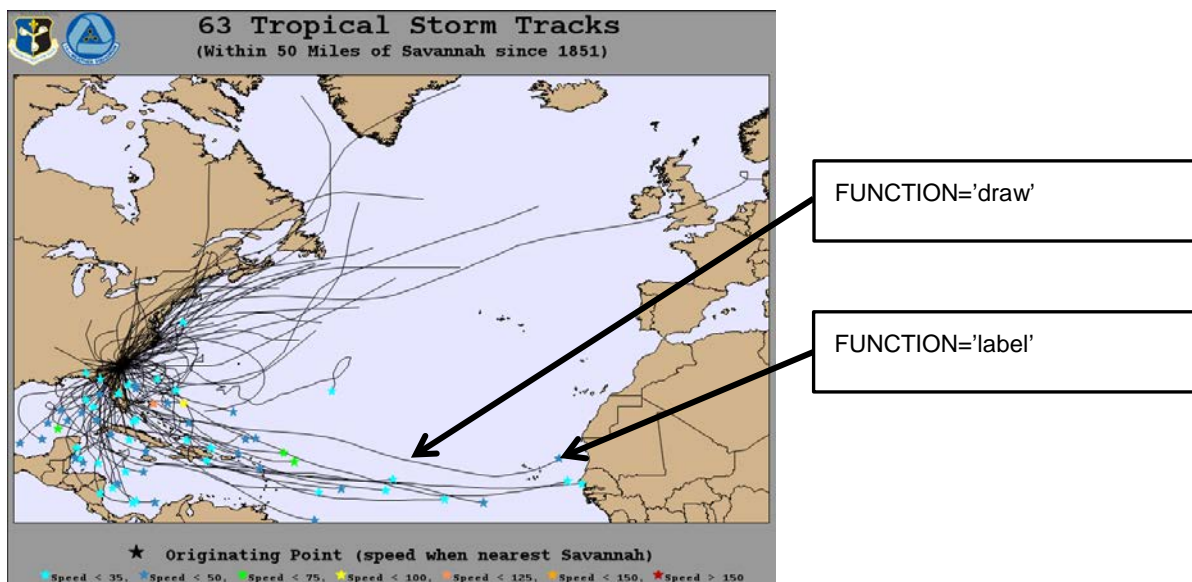
FUNCTION='draw'

FUNCTION='label'

Figure 3. Tropical Tracks

Flight level winds are a cornerstone product in aviation weather. Figure 4 was built using GMAP and annotated with FUNCTION='label' to plot wind barbs (a graphical depiction of wind speeds and direction used in meteorology) along with text values of temperatures in blue. The great circle flight route was calculated and shown in red using FUNCTION='draw'. Winds are represented as a combination of small 5 knot barbs, large 10 knot barbs, and if winds are strong enough, 50 knot triangle barbs. The functionality is essentially the same as the previous figure; however, this time instead of a MARKER font for symbols, the winds are a single "letter" from a custom built GFONT character. For example, 55 knots in this font is a "letter" built using filled and stroked SAS/GFONT capabilities (triangles and line barbs) and is represented as a ⊿⎯ (50+5). Additionally, FUNCTION='angle' allows the wind barb to be rotated to highlight the wind flow direction. Once again, by using a few ANNOTATE statements, a picture can be worth a thousand words.

FUNCTION='label'

FUNCTION='draw'
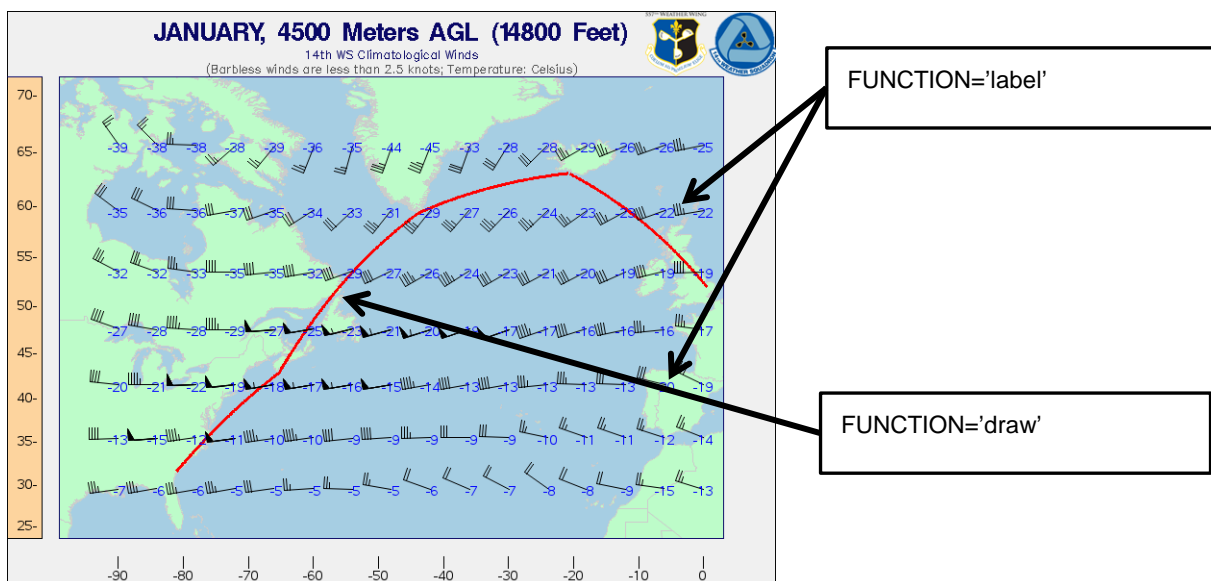
Figure 4. Flight Level Wind Chart

EXAMPLE 4: FREEHANDING SLIDES USING GSLIDE

Figures 5, 6, and 7 are a bit more complicated and leverage these five other functions: ARROW, BAR, IMAGE, PIE, and POLY, while continuing to rely on the cornerstone functions DRAW and LABEL to freehand a complete pictograph of climate expectations. Figure 5 shows one of the early iterations of this product that saved hundreds of hours over the previously hand-built presentations.
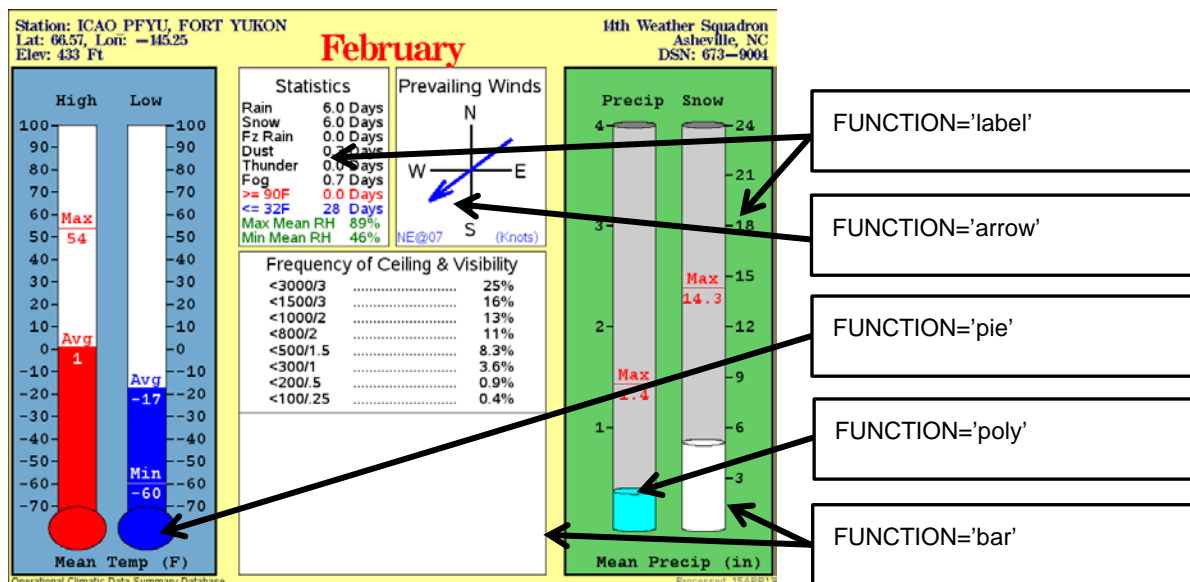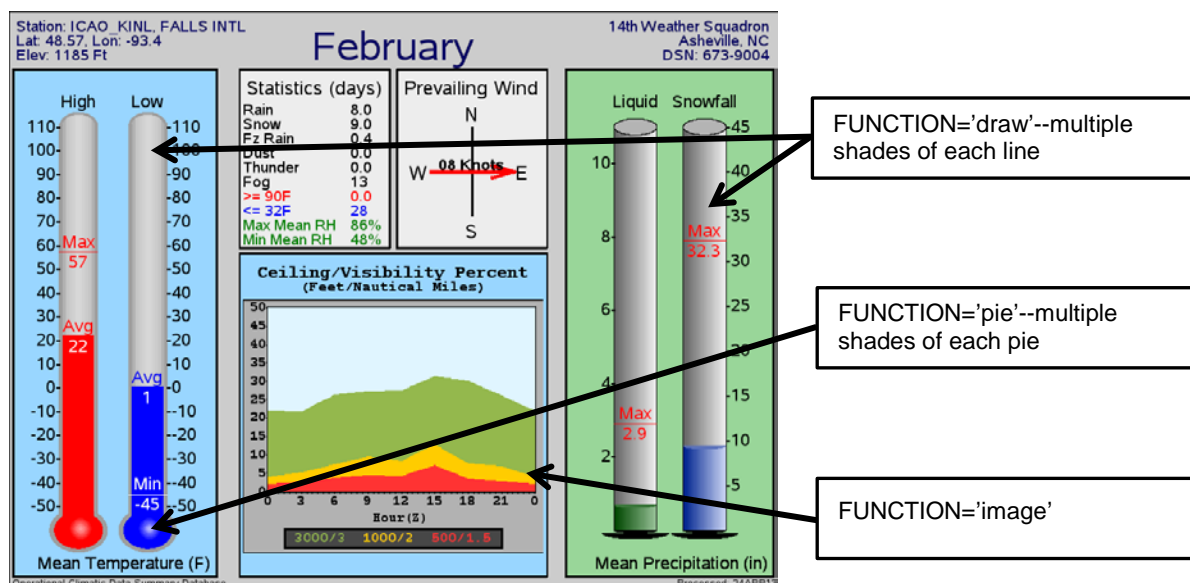

Figure 5. Pictograph

Figure 6. Pictograph Enhanced with Shaded Lines and an Inserted Graphic

Figure 6 shows enhancements made by shading the gauges. This was accomplished by drawing numerous small vertical lines or pies and changing the color shade for each one. It is a small enhancement with big visual rewards! Additionally, this version also has a Ceiling/Visibility graphic added (FUNCTION='image'). Figure 7 was built by leveraging the pie function and highlights the capability to build a go-no-go decision matrix dashboard. It enables the production of thousands of products in minutes whereas the hand-build slides took hours to build individually. As an added bonus, the automation eliminates hand-jamming errors!
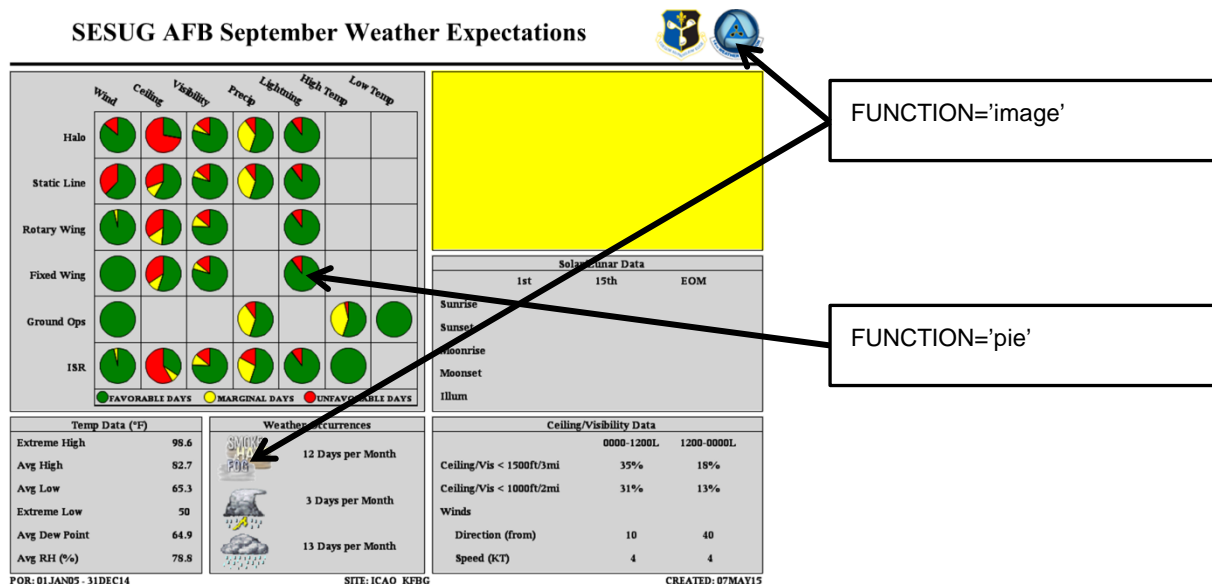
Figure 7. Go-No-Go Stoplight Dashboard from GSLIDE

EXAMPLE 5: ANNOTATING GRADIENT MAPS

Figure 8 depicts the result of processing a course grid of ½ degree precipitation data with PROC G3GRID to produce .05 degree resolution gradient data set that was further refined with PROC GINSIDE to eliminate data outside the country boundaries. The result is a crisp quality display. The entire map including the gradient (thousands of .05 degree bar plots) and the province boundaries were drawn onto a rectangular GMAP "map" area consisting of only four corner points (XSYS and YSYS='2'). Those points were derived from Afghanistan's maximum and minimum latitude/longitude coordinates. The legend and logo were placed using the graphical area percentage system (XSYS, YSYS='3').
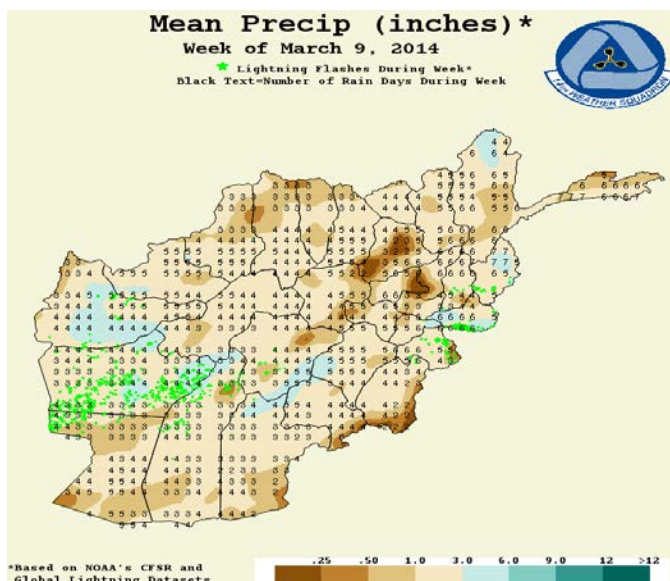
Figure 8. Gradient Map Incorporating GINSIDE

MORE EXAMPLES:

The following examples highlight other products relying almost entirely on the ANNOTATE facility.
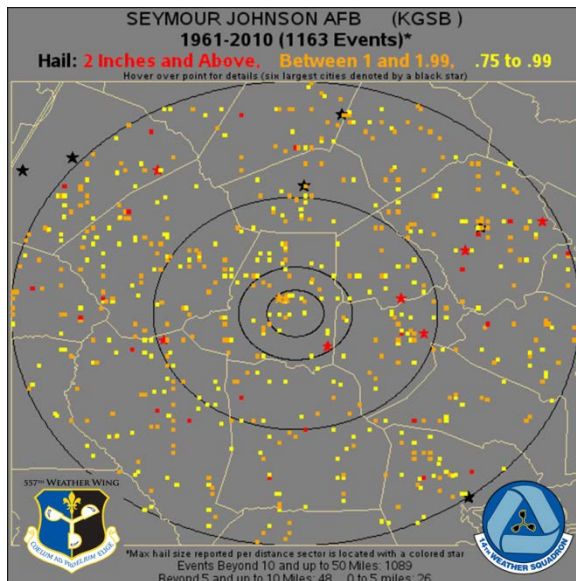
Figure 9. Labels with Hyperlinks for Each Hail Event
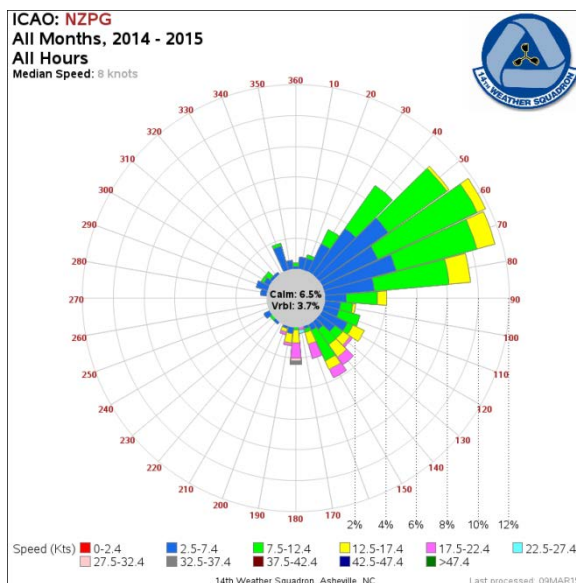
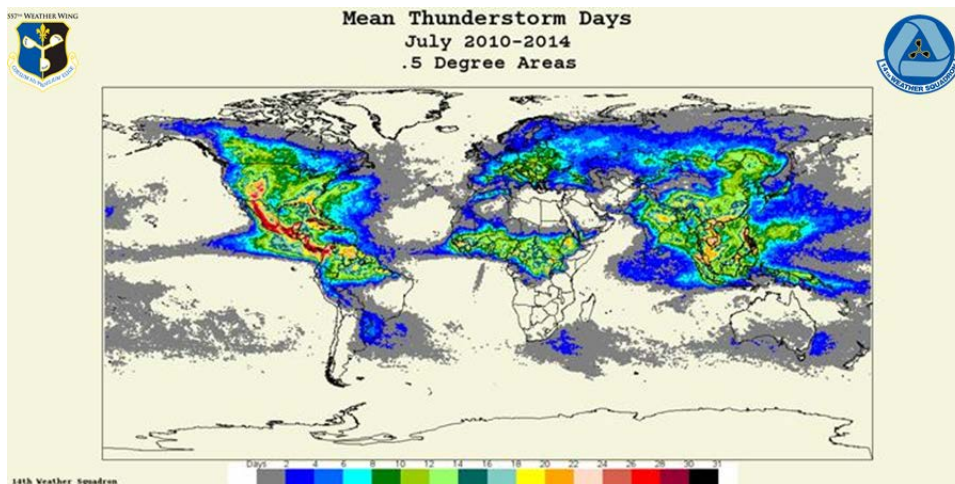**Figure 10. Wind Rose (36 Compass Points) Highlighting FUNCTION='pie'**

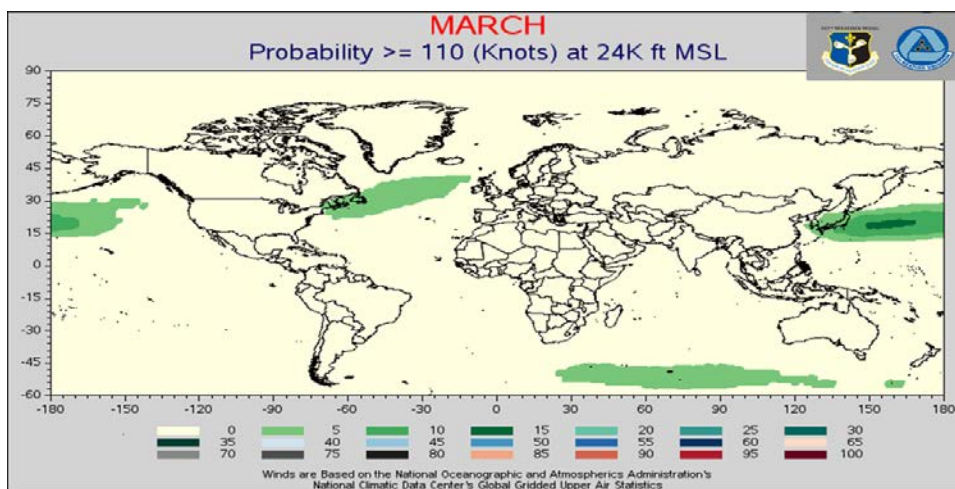**Figure 11. Thunderstorm Climatology Built with FUNCTION='bar'**

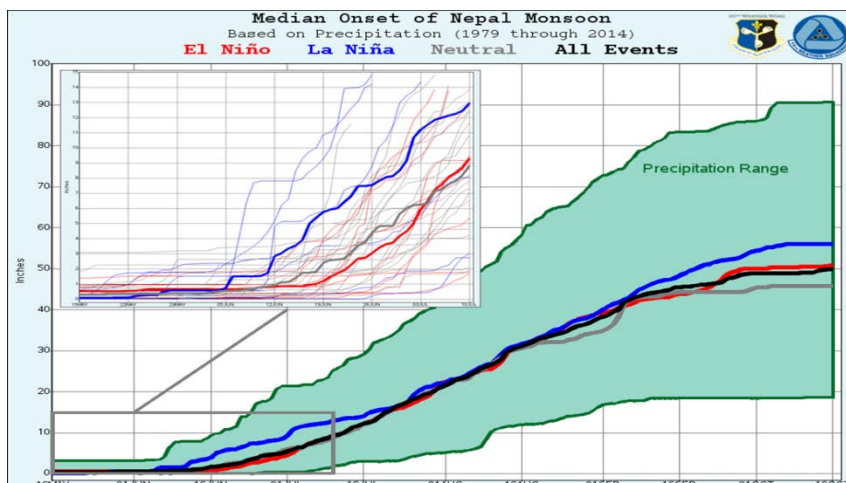**Figure 12. Probability Expectations Built with FUNCTION='bar'**

Figure 13. Emphasize an Inset with FUNCTION='image'

CONCLUSION

The ANNOTATE facility adds pizazz to potentially ho-hum standard SAS/GRAPH output. Using only the basic DRAW and LABEL functions provides flexible enhancements impossible using SAS/GRAPH alone. Combined with a bit more complex, yet simple to use functions like BAR and PIE, graphical output can be further enhanced or created entirely from scratch.

REFERENCES

1. Mikol, Sarah. *Don't Avoid It, Exploit It: Using Annotate to Enhance Graphical Output*. Proceedings of the Southeast SAS Users Group 2012 Conference. Durham, North Carolina. Available at analytics.ncsu.edu/sesug/2012/RI-06.pdf

ACKNOWLEDGMENTS

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