P2.12 Examples of GFESuite and D2D Use in Operations During 2004

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1. INTRODUCTION

In the past few years, the Graphical Forecast Editor (called the GFESuite or GFE) has become the primary tool that operational forecasters at National Weather Service (NWS) forecast offices use to create and edit their gridded forecast fields (LeFebvre et al., 2003). As the GFESuite continues to evolve, new tools and capabilities are offered for this purpose. Also evolving is the primary AWIPS two-dimensional data display (D2D) that is used by NWS forecasters and offers additional datasets and higher-resolution data. In this study we are evaluating how forecasters are using these tools to forecast the weather and to generate and maintain their gridded forecast fields.

An initial evaluation of GFESuite use in 2003 (Roberts, 2004) provided the first baseline for tracking changes in GFESuite use. Several studies have also been conducted over the years evaluating D2D operational use (Kucera, et al., 1997, Roberts et al., 1993, for example). These studies will be used for comparison purposes with these results.

In this study, GFE computer logs collected in 2004 are examined to determine which tools and capabilities are being used by the NWS forecasters. The GFE logs record status information, which tools and capabilities are used, and a time stamp indicating exactly when tools are used or when specific actions are performed. Week-long log "snapshots" are being collected from different forecast offices and during varied weather conditions. With these snapshots, we can examine the range and frequency of product usage by a number of forecasters who have a variety of forecast responsibilities. Additionally, a sample of D2D logs was collected at one of the sites in order to determine how and when forecasters use each of these capabilities. As with the GFE logs, the D2D logs record nearly every D2D action taken on the graphics workstation by the forecasters along with a time stamp and workstation identification. The D2D logs were continuously available from this site, so a 4-month sample was collected and analyzed.

A summary of these log analyses results, including any common usage patterns that arose are presented here. Comparisons with previous studies are also presented along with a combined GFESuite/D2D analysis to determine when each function is used during the forecast process.

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2. GFE COMPONENT USE

The GFE user interface is divided into functional groups similar to many interactive computer applications. The menu bar contains a large variety of operations from pull-down menus. The tool bar contains animation controls, drawing, editing, and configuration tools. There is also a specialized interface for managing and creating forecast grids, as well as smart tool capabilities and context-sensitive mouse button options. The interface has not changed significantly over the past year. Each of these functional areas are discussed below.

2.1 Grid Manager

The Grid Manager interface provides both inventory information, display controls, and whole-grid editing capabilities (Wier, et al., 1998). It allows users to select specific forecast grids or groups of grids, as well as generate new grids.

The grid manager had about 800 - 2500 log entries on average per day. This was a significant increases (30% to 60%) from the previous

evaluation. The large number of grid manager entries and increase in use is consistent with the large number of grids (on the order of 1000) maintained in the forecast database at any one time, along with the increase in the number of forecast days and elements. As with the 2003 data, this indicates that each forecast grid is likely to be accessed at least once daily.

2.2 Main-Menu Actions

Main Menu Actions also increased at both of the previously evaluated sites. Populate/Copy, Edit and Interpolate are frequently used options from main menu options. These commands account for over half of the main menu actions at two of the sites. As the name implies, Populate/Copy is used to populate forecast weather element grids with data derived from numerical models, or to copy grids from one time period to another. Interpolate fills in time periods between previously generated grid times. The Edit function will undo previous edit changes. At the third site the weather element browser was frequently used. This allows a user to load and unload Weather Elements into the grid manager. The Delete Grids function was also frequently used by one of the sites.

Grids were published to the official database twice or more each day at each site. The GFE was also started and stopped several times per day. Some of the functions used in the IFP process are not part of the GFE, so the GFE is typically turned off when it is not in use, and other programs (including D2D) are used on those machines.

Several procedures are also accessed through the main menu. Procedures allow users to run a list of commands, including Smart Tools, with one button click. Procedures typically generate new forecast elements and grids from previously generated forecast elements. Table 1 lists some of the commonly-used Procedures. The names indicate how the Procedures are used.

Many of the procedure names are identical or nearly identical to the names listed from the 2003 results. However, the actual functions called within the procedures are updated as new techniques are adapted for use. Procedure calls are used in a variety of ways. Some Procedures derive new fields from existing fields (e.g., DirunalTfromMinMaxT), some are specific to forecast duty areas (e.g., FinalPrep_FireSeason_Procedure), and some are seasonal (e.g.,Make_RH_WindChill). ForecastWrapUp is an example of a procedure designed to run at the end of the forecast grid preparation process in order to generate a variety of additional grids and to preform consistency checks.

TABLE 1.
Names of frequently used Procedures.

DirunalTfromMinMaxT
Calc_all_24hr_Changes
RHs_from_Dewpoints
Discrepancy_Value_Grid
ISC_Discrepancies
Make_RH_WindChill
FinalPrep_FireSeason_Procedure
PoP_Machine
Obs_Loader
FireOutLook_Machine
Grid_Completeness
Make_RH_WindChill
Copy_Windspeed_to_Gust
ForecastWrapUp
Copy_All_ISC

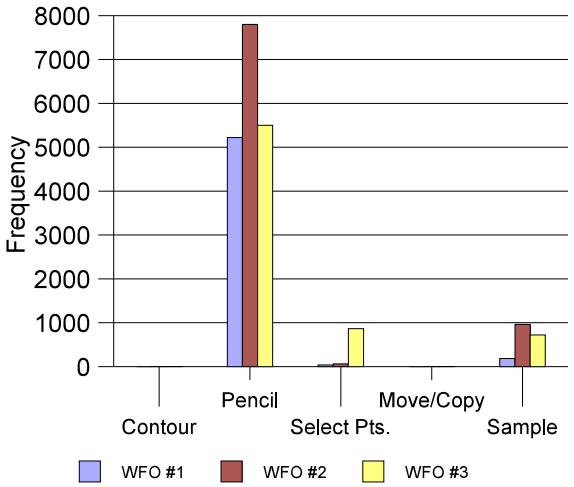
2.3 Tool Bar Actions

The GFE Tool Bar has operators that control the GFE screen layout, animation controls, edit tools, and edit area controls. As with the 2003 evaluation, we will be focusing the edit tools and the edit area controls.

There are five different edit tools available on the GFE tool bar. The Contour Tool allows users to draw, modify, add, and delete contours with the spatial editor. The Pencil Tool allows users to modify grid values by drawing virtual contours. The Move/Copy Tool allows users to move defined areas within a grid from one location to another. The Sample Tool allows for alphanumeric displays of data on the gridded fields.

Figure 1 shows the accumulated weekly frequency of use of all five tools from each of the WFOs. The Pencil Tool continues to be the most

Figure 1. Edit Tool Use



frequently used edit tool. The pencil tool actions have increased significantly at both of the sites evaluated in 2003 with a nearly twofold increase at one site and nearly threefold at the other. It is used in a variety of ways depending on the context of the editor. For example, it is used to define areas which get an assigned value, or the defined areas can be smoothed using a smart tool in order to blend data better with surrounding values. This latter technique is used around WFO boundaries in Intersite Coordination (ISC) mode when discrepancies exists. The Pencil tool use increase is likely due to several factors including additional weather element grids and time periods, ISC considerations, and resolving small-scale features with higher resolution grids in complex terrain.

The Sample Tools and Select Points are the second and third most frequently used Edit Tools, respectively. Their use has also increased. Contour and Move/Copy tools were used infrequently.

Other tool bar actions have also increased significantly. Toggle ISC Mode is frequently used by all of the sites. ISC mode allowed users to view ISC grids from surrounding offices and their own grids at the same time. Intersite coordination is a key component for generating the National Digital Forecast Database (NDFD) and this feature helps assure that discontinuities between sites are easily identified and addressed before grids are published. Clear Reference Set and Save Forecast were also frequently used.

2.4 Smart Tool Use

The Smart Tool framework allows users to write object-oriented programming code that preforms numerical functions on grids (LeFebvre, et al., 2002). Once Smart Tools are written, they can be selected from the GFE menu to preform actions on selected grids or selected parts of grids. A large variety of Smart Tools have been written by developers and forecasters, and shared among offices. Smart Tool repositories have also been set up to collect and manage the ever-increasing number of Smart Tools.

Use of the four basic smart tools: “Smooth”, “Adjust Value Up”, “Adjust Value Down”, and “Assign Value” showed a decrease from the 2003 evaluation. A larger variety of other more sophisticated Smart Tools are used routinely at the sites. Most of these other Smart Tools are are applied to entire grids, or are used to generate new grids. Thus, these other Smart Tools may only need to be utilized once per forecast cycle to accomplish a significant amount of work. Table 2 lists some of the other more frequently used Smart Tools. Like Procedures, the Smart Tool names give a good indication of how they are used.

TABLE 2.
Names of other frequently used Smart Tools.

Show_ISC_Info
Shrink_Stretch
AdjustUpWithTaper
ISC_Copy
MatchMOS
WindGust_fm_Wind
LimitQPF_to_PoP15
Wind10kftFmModel
Model_Blend
CalcLAL_from_WX
serp
WxCov_match_PoP
WsProb_match_Pop
Assign_Value
LimitTd_below_T
MixHtg2004
Show_ISC_Highlights

2.5 Mouse Button 3 Popup Menus

Mouse Button 3 use increased significantly since 2003. Mouse Button 3 allows forecasters to use context-sensitive popup menu selections without having to select options from the main menu or the tool bar. Button 3 options continue to be used most frequently with the Grid Manager to copy, paste, split, and delete grids, as well as other functions. The most significant increases in Button 3 Popups was with simple editing tools such as the pencil, sample, and select points. Increased use of Smart Tools from these Button 3/Edit Tool Popups was also noted.

3. HOURLY USE OF GFE CAPABILITIES

As in 2003, we also assessed when GFE components were used during operational shifts in 2004 and whether significant changes have occurred in hourly use. Hourly statistics of GFE use were generated for each of the three sites for the week-long collection periods. The log entries were divided into categories as previously discussed. Figures 2.a - 2.c show the hourly statistics from each site for these 2004 snap shots.

The hourly distributions indicate a similar pattern of use when compared to the results from the analysis of logs from 2003. Two distinct peak-use periods come on the day shift (~14UTC - 22UTC) and mid shift (~6UTC - 14UTC), before the issuance of the text zone forecasts packages. Offices use the text formatters to help generate these text products.

Figure 2.a Hourly GFE Use at WFO#1

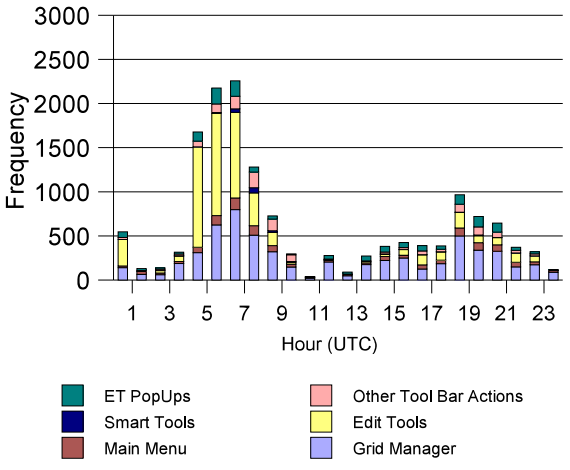


Figure 2.b Hourly GFE Use at WFO#2

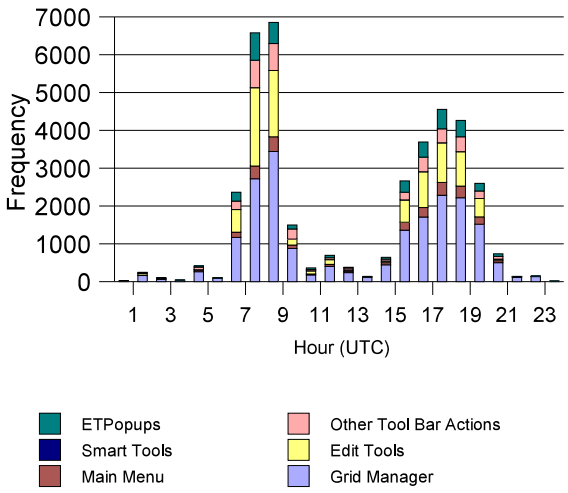
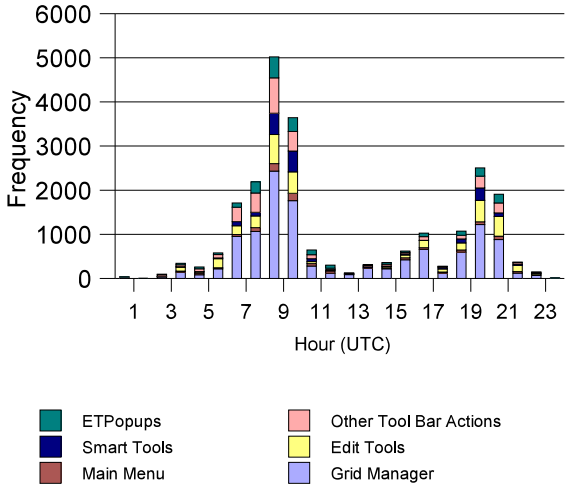


Figure 2.c Hourly GFE Use at WFO#3



4. D2D USAGE LOG COLLECTION

The AWIPS two-dimensional data display (D2D) is the primary display program for meteorological data on AWIPS. D2D usage logs from one NWS Forecast Office, Boulder (BOU), are continuously collected at FSL. Results of the analysis of the four-month 2004 warm season (May through August) are presented here and compared to a similar study conducted in 1997 (Kucera, et.al.,1997).

A total of 263,228 product loads were recorded during the 4-month period. The number of loads is nearly 87% higher than the number of loads recorded in 1997. This indicates an average increase of over 10% per year in product loads over the period. Previous studies indicated an

annual growth rate of about 3% in the mid-1990's (Kucera, et.al.,1997).

A new D2D operational software build (OB3) was loaded on the BOU system during this collection period. OB3 introduced some significant changes to operations including the addition of 8-bit radar products and the Global Forecast System (GFS) model which replaced the Aviation (AVN) and medium-range forecasts (MRF) models. These changes are reflected in the logs and will be noted in the following discussion.

4.1 Most Commonly Used Products

Table 3 lists the top 26 most frequently used products for the period. These products account for 25% of all product loads for the period.

TABLE 3.
Most requested D2D products for the 2004 BOU warm season

Product	Freq.
METAR	6990
kftg 0.5 Reflectivity	5314
IR Satellite	3608
kftg 1.5 Reflectivity	3120
AVN/GFS80 500MB Height	2734
30 min Local Data Plot	2504
ETA80 500MB Height	2503
AVN/GFS80 MSL Pressure	2436
15 Minute Lightning Plot	2423
Visible Satellite	2393
kftg 2.4 Reflectivity	2364
kftg 0.5 Velocity	2190
AVN/GFS80 700MB Height	2174
kftg 0.5 Storm Rel Vel 8bit	2078
MesoETA40&20 MSLP	2041
AVN/GFS 500MB Vorticity	2035
ETA80 700MB Height	1943
ETA80 500MB Vorticity	1891
AVN/GFS80 1000MB-500MB Thickness	1841
MesoETA40 700MB Height	1827
AVN/GFS80 700MB Omega	1805
AVN/GFS80 Precipitation	1781
kftg 3.4 Reflectivity	1752
MesoETA(40&20) Surface Wind	1632
kftg 1.5 Storm Rel Vel 8bit	1621
MesoETA(40&20) 500MB Height	1619

Note that nearly all of these products were also listed in the top 1997 products. However, the number of times these products were loaded has risen significantly.

4.2 Products by Category Type

As in previous studies, product categories are used to group similar types of workstation products: Surface, Satellite, Radar, Vertical, Upper Air, Models, and Extensions.

Table 4 list the product categories and the daily average product loads for each category and the percentage. We also included the percentage from the 1997 study for comparison purposes. Remarkably, the relative percentages have remained about the same as the 1997 study. The radar category show the highest relative increase in use. Satellite, and surface products showed relative decreases, but the average number of loads per day actually rose. A discussion of the distribution of product requests within each category follows.

Table 4.
Distribution of products by product category.

Product type	Mean	sd	%	(% '97)
Model	1338	346	62	(63)
Radar	514	482	24	(16)
Surface	179	69	8	(10)
Satellite	72	28	3	(6)
Extensions	30	14	1.4	(1.5)
Vertical	24	13	1.2	(3.5)
Upper-Air	6	6	0.3	(0.5)
Total	**2163**			

Model Model data were the most-used product category, accounting for nearly 62% of the total product loads at the BOU WFO during the study period. The daily average of model products used was significantly higher this year with a mean of 1339 compared to a mean of 743 in the Denver 1997 warm-season study. The standard deviation was also higher this year with a value of approximately 350. The standard deviation in 1997 was about 305.

The AVN/GFS 500mb Height product was the most frequently used product in the Model

category with a frequency of use of 2734 times during the period of study. Not far behind the AVN 500mb Height product was the ETA 500mb Height product with a frequency of use of 2503 times. The third most frequently used product was the AVN/GFS MSL Pressure with a frequency of use of 2436 times. Well over 2800 other model fields were also accessed during this period which underscores the wide range of model products used by operational forecasters.

Table 5 lists the various models, the number of loads (frequency) and the percentage based on all model loads. The ETA and MesoEta account for half of all model loads. The GFS and its predecessors AVN and MRF account for another 30%. All of the different resolutions of the models available on AWIPS were used.

Table 5.
Distribution of model products by model type.

Model	Freq.	%
ETA	61658	37.4
MesoETA	24295	14.7
GFS	24146	14.6
AVN	18372	11.1
RUC	9967	6.0
MRF	7915	4.8
MM5Hot	6608	4.0
NGM	4121	2.5
MSAS	2891	1.8
LAPS	2048	1.2
ECMWF	753	0.5

Radar The Radar category showed heavy use during this warm-season at BOU WFO, representing nearly 24% of all the products loaded on the workstation. This year's Radar product usage shows significant increase compared to the Denver 1997 warm-season, which had a Radar product usage of 17%. The daily average of products used per day was substantially higher this year with a mean of 515 compared to a mean of 197 in 1997. The standard deviation was also higher this year with a value of approximately 483 compared to 202 in 1997. The high standard deviation, also seen in earlier studies, is driven by the decrease in radar use on days without significant convective weather.

The kftg 0.5 Reflectivity product was the most frequently used Radar category product with a frequency of use of 5314 times during the period of study. The second most frequently used product was the kftg 1.5 Reflectivity product. The kftg 1.5 Reflectivity product had a frequency of use of 3120 times, approximately 2000 times less than the kftg 0.5 Reflectivity product. The third most frequently used product was the kftg 2.4 Reflectivity product with a frequency of use of 2364 times. Other radar products were used less frequently, but the overall increase in use of all radar products indicates that their use is critical during warm-season convective weather forecasting.

During the study, the BOU WFO upgraded their workstations to AWIPS version OB3. With the upgrade many new products were available including the higher resolution 8 bit products. The most frequently used 8 bit product was the kftg 0.5 Storm Rel Vel 8 bit product with a frequency of use of 2078 times.

There were a total of eight different radars that were used by the forecasters during the study. They are as follows: KFTG, KPUX, KGLD, KCYS, KGJX, KRWI, KDDC, and KLNX. The KFTG radar accounted for nearly 88% of the total radar product usage. There were approximately 315 different KFTG radar products that were used during this period. KPUX, KGLD, and KCYS accounted for about 7% of the total radar product usage and there were more than 40 different products used from each of these radar. The other 2% of the products used were from the KGJX, KRWI, KDDC, and KLNX radars.

Surface The products in the Surface category accounted for about 8% of all the product loads at the BOU WFO. The daily average of products used per day was higher this year with a mean of 180 compared to a mean of 114 in the Denver 1997 warm-season study. The standard deviation remained constant at 69.

The METAR surface observations on all scales remained the most frequently used Surface category product with a frequency of use of 6990 times during the period of study. The Lightning data in increments of 30, 15, and 5 minutes was second with a frequency of use between 2504 and 1612 times. The 15-minute Local Data Plot was third with a frequency of use of 1589 times.

Satellite Products in the Satellite category accounted for approximately 3% of all the product loads at the BOU WFO. The daily average of products used per day was slightly higher this year with a mean of 73 compared to a mean of 70 in the

Denver 1997 warm-season study. The standard deviation remains constant at 28.

The IR Satellite was the most frequently used Satellite category product with a frequency of use of 3608 times during the period of study. Second to the IR Satellite, was the Visible Satellite with a frequency of use of 2393 times. The Water Vapor Satellite had a frequency of use of 1558 times. All other Satellite products were used less than approximately 840 times.

Vertical Skew-T plots and time-height plots of profiler data make up this category. The products in the Vertical category accounted for approximately 1% of the total product loads at the BOU WFO. The daily average of products used per day was higher in 1997 with a mean of 42 than this year with a mean of 24. The standard deviation in 1997 was also higher with a value of 25 compared to this year with a standard deviation of nearly 14.

The most frequently used product in the Vertical category was the KDNR Skew-T with a frequency of use of 1599 times during the period of study. The KDNR Skew-T greatly exceeds the frequency of use of the other products in the category by approximately 500 times. The second most frequently used product was the Platteville CO profiler with a frequency of use of 447 times. The third most frequently used product was the KGJT Skew-T with a frequency of use of 218 times. The other products in the category had frequencies of use less than 100 times.

Earlier studies have shown that the profiler sites located closest to Denver were accessed most often over other profiler sites. This is still the case. The Denver 1997 warm-season study shows that Platteville CO profiler was accessed 674 times whereas this year it was accessed 447 times. The Granada profiler was accessed 224 times in 1997 and 53 times this year and Medicine Bow was accessed 135 times in 1997 and 71 times this year.

Upper Air The products in the Upper Air category accounted for 0.3% of the total product loads at the BOU WFO. The Denver 1997 warm-season study showed that 0.5% of the product loads were from the Upper Air category. The daily average of products used per day was slightly higher in 1997 with a mean of 7 compared to this year's mean of 6. The standard deviation was higher this year with a value of 6.

The most frequently used product in the Upper Air category was the 500mb UA Plot with a frequency of use of 250 times for the period of study. The second most frequently used product was the 300mb UA Plot with a frequency of use of 243 times. The third most frequently used product was the 700mb UA Plot with a frequency of use of 236 times. These three products greatly exceeded the use of the other products in the category by approximately 200 times. The other products used had a frequency of use less than 30 times.

Extensions The Extensions category accounted for approximately 1.5% of the total loads at the BOU WFO. The Denver1997 warm-season study showed that the same percentage. The daily average was higher this year with a mean of approximately 31 compared to a mean of 18 in 1997. The standard deviation was slightly higher this year with a value of approximately 15 whereas in 1997 the standard deviation was 10.

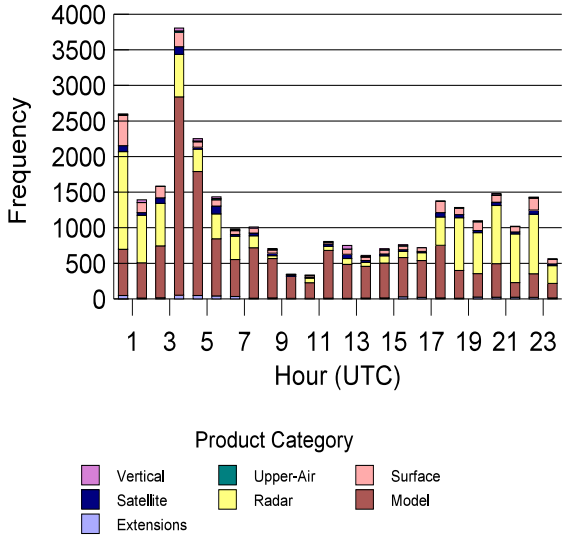
The most frequently used product in the Extensions category was the Interactive Points with a frequency of use of 1314 times. Interactive Points are used to generate model soundings and time-height cross sections. Interactive Points was used approximately 300 times over any other extension. The next most frequently used Extension was WarnGen with a frequency of use of 906 times. The third most frequently used extension was Distance Speed with a frequency of use of 505 times.

4.2 Hourly D2D Use

Figure 3 shows the cumulative hourly distribution of product use by category during a 12 day period from July 17th through July 29th, 2004 for BOU. This figure indicates how D2D product use changes during the course of a day.

The pattern of use follows similar warm-season studies (e.g. Steiner, et al., 1992). The rise in radar product use corresponds to the onset of convention which is typical in the early afternoon and continues through the evening hours (about 1800 UTC to 0200 UTC). Model use is highest preceding issuance of the text zone forecast packages (at 10 UTC, and 22 UTC).

Figure 3. BOU D2D Hourly Distribution July 17-29, 2004



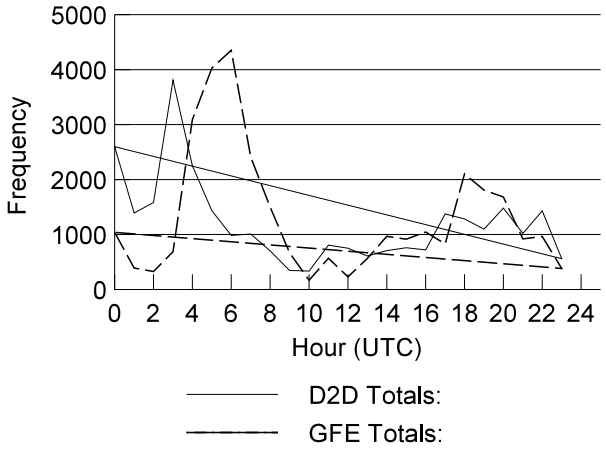
5. COMPARISON OF HOURLY USE OF GFE AND D2D CAPABILITIES

This 2004 usage log evaluation has given us the first opportunity to compare operational use of both the GFE and D2D concurrently at the same site. This comparison is important since both applications run on AWIPS and are used to generate nearly all of the routine products produced by the forecast offices. Prior to the operational use of the GFE, forecasters typically typed all of their products using the AWIPS alpha-numeric display. Now, forecasters generate weather element grids using the GFE and most of the text products are generated from these weather element grids (Hansen, et al., 2003).

Forecasters have indicated that they typically use D2D to review the meteorological data, then use the GFE to generate and modify their forecast grids, then generate their text products from the girds (Roberts, 2004). The forecasters then review the text products and make any necessary changes before publishing them.

In order to see whether this pattern is reflected in the logs, we have compared the cumulative hourly frequency distributions of both the GFE and D2D for a 12-day period for BOU in July. In Figure 4, the sequential peaks of D2D use followed by GFE use is clearly shown between 0200 UTC and 0800 UTC. Another sequential peak pattern occurs between 1700 UTC and 2100 UTC. However, D2D use does not drop off as significantly due to its use during the active convective period of the day, as discussed earlier. This comparison agrees with comments made by forecasters about how they use the applications to generate their forecasts. This pattern also follows earlier, pre-GFE, studies (Lusk, 1993) of use of the graphics screens prior to text workstation use for typing text forecast products

Figure 4. BOU D2D and GFE Hourly Distribution July 17-29



6. CONCLUSION

This 2004 analysis of the GFE has shown that GFE use has increased at NWS Forecast Offices. Basic editing tool use has increased as well as use of sophisticated Smart Tools. This is due, in part, to the increase in the number of forecast girds generated by the offices, the increased forecast grid resolution, and forecasters continued development of better smart tools to generate and adjust weather elements.

D2D use has also increased significantly. The relative percentage of use within each product category remained about the same, but the volume and range of accessed products has increased within all categories. Forecasters are clearly taking advantage of the higher resolution models, radar products, and other fields which are now provided. Future studies will continue to track the evolution of D2D and GFE use in operations and feed this information into the AWIPS development process.

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