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INTERNET METEOROLOGY: INCREASING EFFICIENCY WITH COST-EFFECTIVE APPROACHES

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I. INTRODUCTION – HISTORY AND NEED

The internet has become one of the most widely used means for gathering and exchanging information in the modern era. This is readily apparent in the field of meteorology, where government agencies, universities, and private weather companies all employ the web to distribute large quantities of weather data. Due to the vast amount of information, forecasters - both professional and hobbyists - can spend more time getting to the data rather than analyzing it. This holds especially true when dealing with a slow connection, which can make assessing large images a grueling and often frustrating process.

As a forecaster, I was first exposed to the internet working as a meteorologist for the Maryland Department of the Environment's Air and Radiation Management Administration (MDE-ARMA) in 1993. MDE meteorologists in conjunction with meteorologists from the University of Maryland, College Park were called upon to issue forecasts of ground level ozone - a primary component of smog. A successful air quality forecast was largely contingent on the meteorologists' ability to recognize synoptic- and meso-scale weather patterns conducive to high concentrations of ozone. This in turn required a thorough analysis and forecast of critical weather variables. Due to budget constraints, meteorologists at MDE were mostly on their own to acquire and display weather information. However, MDE did have internet access, albeit through a dial-up internet service provider (ISP). Consequently, considerable time was spent waiting for data to download over a phone line.

The slow internet connections frustrated MDE forecasters and inhibited their ability to provide the best possible forecast. Sharing thoughts on a given satellite or forecast image entailed either emailing the image of interest to other parties, pointing others to the appropriate web site, or simply gathering around a common terminal. This proved inefficient and

cumbersome. Consequently, forecasters identified two primary needs:

1. Allow multiple users to view "shared" weather imagery without interfering with each other.
2. Streamline the acquisition of web-based forecast data

After several weeks of research and testing, two software packages were discovered that would address these requirements and ultimately change the way forecasters at MDE and the University of Maryland conducted the daily air quality forecast.

The first primary need - allowing multiple users to view common weather images - was solved by SuperJPG, a multi-tasking image display software. SuperJPG allowed multiple users on different terminals to view weather image files, either with animations or point and click image manipulation. Images were manually downloaded to a network drive, with each staff member responsible for a different suite of data. Once the files were downloaded, forecasters were free to devote their time to analyzing the data with no fear of images being overwritten or connections timing out (the proverbial modem "click.") However, the problem of manually downloading weather data would be compounded by the departure of staff at MDE, leaving only one meteorologist to download, save, and analyze weather imagery.

Through trial and error, a versatile yet easy-to-use download utility was discovered. Wingflyer, software developed by James Borrer, provided the flexibility and control necessary to automate the entire download process. While many software packages allow users to download web images or entire web pages, only Wingflyer granted full control. In particular, Wingflyer provided three key features: (1) the ability to specify exactly which images to download, (2) where the files should be stored locally, and (3) what the new filenames should be (if necessary). This capability enabled files to be renamed and stored in a structured format that ultimately allowed an image viewer such as SuperJPG to act as a weather analysis tool, mimicking on a simple scale some of the capabilities of more advanced weather utilities such as AWIPS and NAWIPS. In addition, Wingflyer allows the use of batch command

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files, which further simplified the downloading process, and opened the door to automating downloads with the Windows scheduling utility.

While this software tandem was initially employed out of necessity, increasing connectivity speeds and expanding online sources of weather data took the process to a whole new level. The original idea was to allow the user to start a download over a phone line, proceed with other tasks, then come back after several hours and analyze data that had been saved to a network drive. But with the increasing download bandwidths came the opportunity to grab more information; what had begun as an effort to merely grab the “early Eta” and “MRF” graphics over a dial-up connection soon expanded to downloading virtually all available model forecast data, model output statistics, DIFAX charts, surface and upper air data, as well as a wide suite of satellite and radar imagery over a T1 line. Since first being introduced at the MDE over 10 years ago, Wingflyer and SuperJPG are now vital components of daily operations at the Joint Agricultural Weather Facility (JAWF) in Washington, D.C. At last count, Wingflyer was being used to download over 10,000 images and text files daily in support of JAWF operations.

II. USING WINGFLYER.

Wingflyer is a simple-to-use download utility. The software can be accessed online at www.wingflyer.com, and is available for free on a trial basis (a nominal fee grants unlimited usage and free upgrades.) A screen shot of Wingflyer is shown in Figure 1. There are two methods for downloading a web page or image with Wingflyer:

- 1) Manually enter the URL and download location.
- 2) Create a batch file and acquire the images specified in the batch file by using the “Auto Request” button.

Option 1 is best suited for downloading the entire contents of a webpage. This option is rarely used at the JAWF because it can place a large burden on the website from which data is being downloaded; additionally, this option does not give the user control over renaming downloaded files. However, cases arise where an online directory contains a sequence of images the user wishes to download and save. In this



Figure 1. A screen capture of the Wingflyer menu form. Users can either enter a website in the “Website Name:” dialogue box or select a batch file download using “Auto Request.”

scenario, the entire URL name is entered in the “Website Name” text box, while the saving location is specified in the “D/L Name” text box. If downloading an entire web site and its associated files, the user must select the “Multi-level download” option and enter “1” into the “# Levels” prompt that appears after this radio button is enabled. Wingflyer will then download the entire contents of the website when the “Send Request” command is selected. Once again, caution should be used when exercising this option.

The most common method for weather data acquisition at the JAWF is to use batch files to download and rename images. Each batch text file contains the following format (one line per image, all on one line):

**-options http://www.website.com/Sourcelmage.gif
c:\DownloadDirectoryNewImageName.gif**

```

-os http://weather.noaa.gov/pub/fax/QHUA04.TIF e:\weather\difax\12z\all\850mb.tif
-os http://weather.noaa.gov/pub/fax/QHTA07.TIF e:\weather\difax\12z\all\700mb.tif
-os http://weather.noaa.gov/pub/fax/QHTA11.TIF e:\weather\difax\12z\all\500mb.tif
-os http://weather.noaa.gov/pub/fax/QMUA15.TIF e:\weather\difax\12z\all\300mb.tif

```

Figure 2. An example of a Wingflyer batch job which downloads and renames DIFAX charts from the National Weather Service. The source image is specified on the left, while the final name and location of the file is defined on the right. Wingflyer batch files must end with the “txt” suffix (i.e. DIFAX-12z.txt).

Figure 2 shows part of a Wingflyer batch job used to download DIFAX charts from the National Weather Service. This batch file is stored in a Wingflyer sub-directory (i.e. “WingFlyer\Batch\Charts\DIFAX-12z.txt”), and is run using the Auto Request option. A pop-up dialogue box enables the user to select the appropriate file. In this example, the options (following the “-”) are:

- o – Overwrite the existing file on the local drive if it already exists.
- s – Strip the file of any potential tags; this option is probably unnecessary, but is employed as additional virus protection.

In addition, files are renamed and sorted. The existing filename (i.e. QHUA04.TIF) is of little use in trying to quickly access a particular chart. Therefore, a new file name can be specified within the Wingflyer batch job to something more user-friendly, although the file type (TIF) must remain the same. (Converting files from one type to the other will be discussed in Section III.)

The ability to specify a new directory structure and filename within Wingflyer is perhaps the most important aspect of the entire download-and-analyze process. For example, JAWF operations center around a network which allows multiple users to view and share files. As Eta forecast images are downloaded with Wingflyer, they are sorted by type and model-run time specified within the batch job. The time when Wingflyer is run denotes which batch job (and subsequent saving location) is used. The Eta forecast images listed in Figure 3 were downloaded by the “Eta-12z” batch job run at 12:30 p.m., Eastern Standard Time (1730z). This batch file saves images into the “Eta\12z\” directory; while perhaps a bit cumbersome at first, having separate batch files for different model-run times allows previous model runs to be saved on the network for comparison.

III. IMAGE ANALYSIS AND MODIFICATION

Structured directories and sequential filenames allow for efficient image analysis. While there are many image viewers available, the discussion of two software packages here does not represent an endorsement of one software over the other. However, several key features available within each of the following utilities led to their widespread use at the JAWF.

SuperJPG is a powerful, easy-to-use image viewer with multi-tasking capabilities. This software allows multiple users to view imagery in a variety of methods, including thumbnails, pan and zoom, and slideshow. However, it should be noted that shortly after this paper was begun, the developers of SuperJPG (MidnightBlue) retired. The software, which had been available for a free trial basis at www.midnightblue.com, is no longer available on this website. It is the author's sincere hope that SuperJPG is made available again to the public either as Freeware or for a nominal fee. Shareware versions of the software are still available at various software download sites, but the software will only work during the 30-day

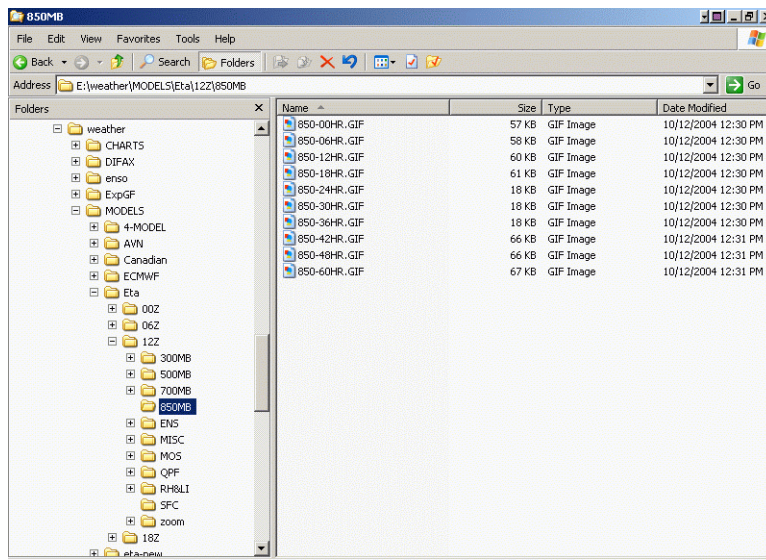


Figure 3. This screen capture of Windows Explorer shows the file structure created by a Wingflyer download. In this case, Eta forecast images are sorted by parameter and forecast time.

trial period (not much help). Consequently, this paper will briefly discuss SuperJPG, and focus on general concepts as well as alternate software.

The initial choice of SuperJPG was based on two capabilities. The first and foremost was the ability to view images seamlessly using a "Screen Show" option. Other software packages tested also incorporated screen shows, but transitioning from one image to the next was frequently accompanied by a "flash" or some other undesirable effect. SuperJPG did this process transparently, and therefore allowed for smooth viewing of model and satellite image sequences. It is recommended that when searching and testing image viewers for meteorological applications, users seek a utility that allows for seamless screen shows.

The second feature which made SuperJPG a strong tool for meteorological applications was the ability to have multiple images open simultaneously. This allowed the user to go easily from one model level to the other, or to compare, in detail, a sequence of similarly mapped images. Other useful features within SuperJPG included easy zooming, color enhancements, image modification, screen capture, and file conversion; however, these tasks are also easily completed with other software packages.

It is not the author's intent to elaborate about software which is no longer available. Therefore, the uses and features of SuperJPG will not be discussed further. However, adequate replacements surely exist; one in particular which has been used with increasing frequency at the JAWF is IrfanView. It should be noted that IrfanView has been used to supplement SuperJPG, not replace it (since existing SuperJPG licenses do not expire). However, it has many similar capabilities and in some aspects excels where SuperJPG fell short.

IrfanView is a powerful image analysis and manipulation software utility. Developed by Irfan Skiljan (Vienna University of Technology), the software can be accessed at numerous software download sites (a search on "IrfanView" will bring up many download options). A screen capture of IrfanView can be seen in Figure 4.

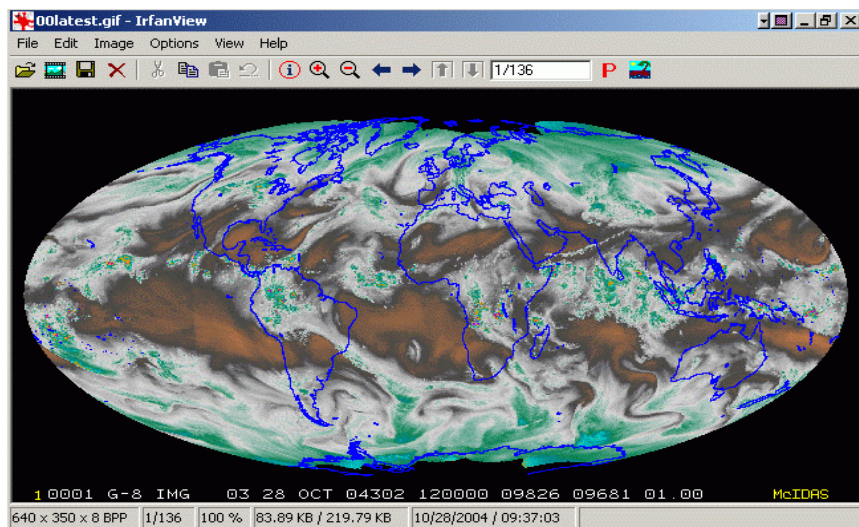


Figure 4. A screen capture of the IrfanView image viewer.

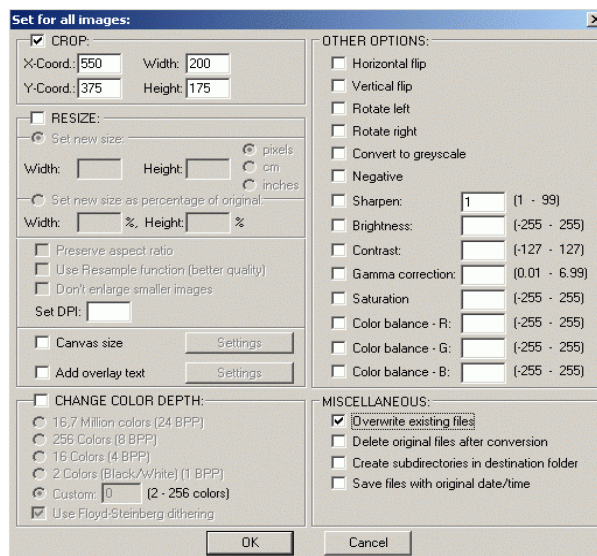


Figure 5. Batch conversion menu in Irfanview. Numerous options are available for editing a large number of image files simultaneously.

One of the biggest advantages of IrfanView is the ability to run batch file conversions either through an interactive menu (Figure 5) or through a batch command file. In addition, IrfanView incorporates many standard image-viewer features, such as pan-and-zoom, thumbnail previews, image enhancement (sharpen, contrast, etc.), and slideshow. Despite these options, static imagery still can present a considerable challenge due to the inability to alter the images parameters efficiently. For example, the National

Center's for Environmental Prediction (NCEP) creates forecast images of the Eta, GFS, and NGM for North America which can accessed at:

<http://www.nco.ncep.noaa.gov/pmb/hwprod/analysis/>

Displaying and analyzing this imagery in a screen show can be difficult due to the large image size and coverage area (Figure 6). IrfanView solves this problem by allowing the user to define and create sub-sectors for more detailed analysis.

Cropping imagery with IrfanView is accomplished by an interactive menu (Figure 5) or with batch commands. The latter option offers a degree of speed and flexibility that lends itself to operational applications. IrfanView offers an extended list of batch commands which can be accessed through the software's help menu; the "crop" command is frequently used to modify and create imagery at the JAWF. Figure 7 shows a sample batch conversion file utilizing the "crop" command.

IrfanView batch conversion files are similar in several ways to Wingflyer batch files, with a few notable exceptions. The primary differences include:

1. IrfanView batch files are essentially DOS executable statements, and therefore must end with the ".bat" suffix. Wingflyer batch jobs are text files called within the program and consequently must end in ".txt"
2. Irfanview batch jobs must reside in the IrfanView program folder (at least that is the author's experience). Wingflyer batch jobs can be called from any location.
3. Since IrfanView batch jobs are executable, shortcut icons can be used to access and run IrfanView. This allows the user to create a separate folder containing these shortcuts, bypassing the need to wade through the IrfanView program folder.

The syntax used in the IrfanView batch file is relatively straightforward. The first line given in Figure 7 is explained as follows:

1. `i_view32.exe` – IrfanView executable; Calls the program which will execute the statements listed after the command.

```
i_view32.exe e:\eta\12z\sfc\*.gif /crop=(550,375,200,175) /convert=e:\eta\12z\mid-at1\sfc\*.gif /silent
i_view32.exe e:\eta\12z\850mb\*.gif /crop=(550,375,200,175) /convert=e:\eta\12z\mid-at1\850mb\*.gif /silent
```

Figure 7. An IrfanView batch job that crops Eta forecast images which have been downloaded from the NCEP web site. The result is a forecast image zoomed-in on the Mid-Atlantic region.

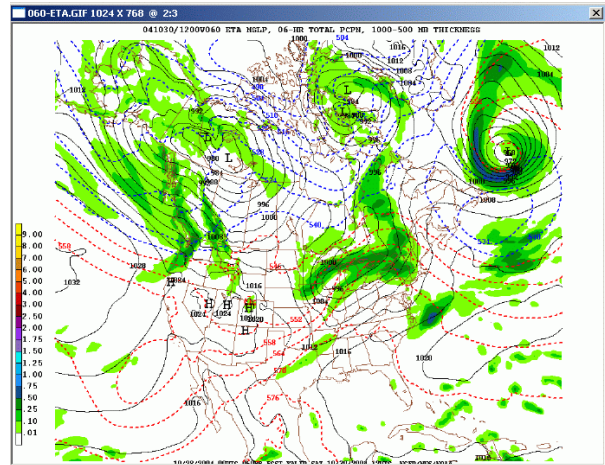


Figure 6. A sample Eta forecast image of Mean Sea Level Pressure, 1000-500mb thickness, and 6-hour precipitation available from the NCEP web site. This image is "medium" resolution, and covers most of North America.

2. `e:\eta\12z\sfc*.gif` – Input file(s); in this case, the "*" acts as a wildcard, which causes all ".gif" files in the directory to be read and modified.
3. `/crop=(550,375,200,175)` – Image cropping definitions. In this scenario, (X,Y, W, H), all are variables defined in pixels:
 - a. X = "Crop" starting point from the Left.
 - b. Y = "Crop" starting point from the Top
 - c. W = Image Width (to the right) from X
 - d. H = Image Height (down) from Y
4. `/convert=e:\... *.gif` – This function creates the new "zoomed" files and saves them in the specified directory with the original filenames. Images could also be changed to another format in this step, such as TIF or JPG.
5. `/silent` – Turns off error messages (error messages will halt the batch job.)

Multiple commands may be inserted within the same line. For example, a satellite image may not only be cropped, but also sharpened and resized. Another useful feature is the "rotate" option, which allows JAWF

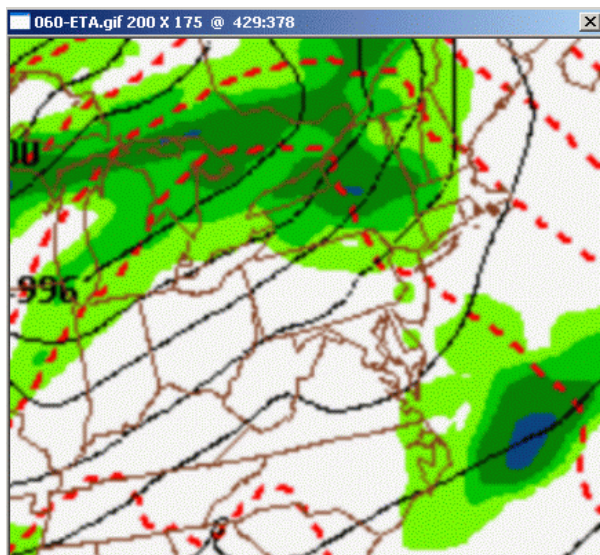


Figure 8. Same as Figure 6, but cropped by the IrfanView batch job shown in Figure 7. When shown in full-screen mode, the image can be easily viewed and analyzed.

staff to readily incorporate DIFAX charts into the daily weather briefing (DIFAX files display “upside down” in their original form.)

The final result of the IrfanView batch job discussed in this section is a sequence of forecast images for the east-central United States (Figure 8.) The batch file is run by double-clicking the corresponding shortcut icon, reducing the time to create the zoomed images to a matter of seconds. This method is widely used at the JAWF on a variety of U.S. and international imagery, and has greatly reduced the time required to analyze weather data and assemble briefings.

Acquiring the image cropping parameters may seem a tedious task at first, but is easily accomplished within IrfanView. While “trial and error” will eventually lead to desirable results, opening the base image in IrfanView allows the user to easily extract this information. In Figure 9, the original surface forecast image is displayed in IrfanView. The user outlines the desired sub-region, and the corresponding parameters appear in the blue program bar. In this example, the variables shown at the top of the image are defined as:

- 550 = “X” Starting point
- 375 = “Y” Starting point
- 200 = “W”, or width (in pixels)
- 175 = “H”, or image height (in pixels)

- 1.143 = Width-to-Height ratio; Not needed in the batch file

These variables are then input into a batch file (Figure 7), eliminating the need to manually crop the image.

IV. AUTOMATION

To increase efficiency and lessen the burden on network traffic and computer resources, downloading and cropping imagery can be automated with the Windows scheduler. Since both IrfanView and Wingflyer allow for command-line execution, this task is accomplished with a batch file containing the program executable.

Scheduling Wingflyer to run automatically has several advantages. Internet speeds increase substantially during the overnight hours. In addition, off-hour downloads lessen the burden placed on servers from which data are acquired. Consequently, the largest downloads at the JAWF are scheduled to run between 2 and 6 a.m., EST. This is accomplished through “nested batching”; a batch file is run by Windows, which then runs a Wingflyer batch download. The primary batch file is entered into the Windows scheduler to run at the desired time(s), and the process then occurs automatically. An example of this process is given in

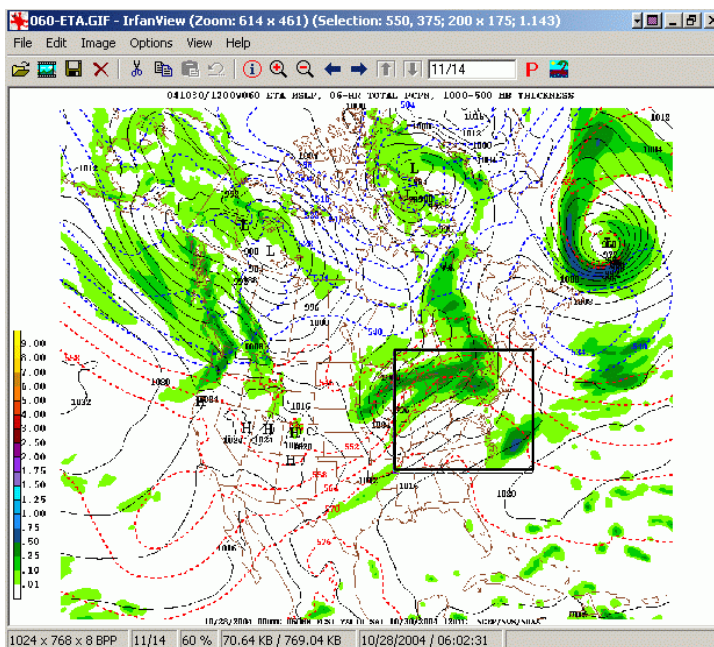


Figure 9. Same as Figure 6, but with a box drawn to outline the sub-region of interest. The corresponding sub-region parameters are given above the image (in the blue program bar) following the "Selection:" statement.

```

00z-Model-AllViaNcep.bat - Notepad
File Edit Format View Help
e:
cd \
cd wingflyr
wingflyr /F e:\wingflyr\batch\models\00z\All-NCEP.txt

```

Figure 10. An example of a "parent" batch file which is called by the Windows scheduler. This batch file (00z-Model-AllViaNcep.bat) runs Wingflyer, which downloads imagery specified in the "All-Ncep.txt" file.

Figure 10. The parent batch file (00z-Model-AllViaNcep.bat) is called by the Windows scheduler to run at 3 a.m., EST. The commands within this batch file will then be executed until completed. They are summarized below:

- e: - switches the computer to the "e:" drive.
- cd \
- cd wingflyer - these two commands switch to the "Wingflyer" directory on the user drive, where the Wingflyer executable is located.
- Wingflyer /F – this is the command-line option to run Wingflyer. It is followed by the location of the batch file, which in this case is stored in "e:\wingflyr\batch\models\00z\All-NCEP.txt"

"All-NCEP.txt" is a Wingflyer batch file, much like the example shown in Figure 2. Consequently, all of the model forecast images specified in this file will already be downloaded when staff arrive in the morning, and there will be no need to tax the NCEP server during the busier late-morning and early-afternoon hours.

Automating IrfanView processes can be accomplished by two methods. The first is to create a "parent" batch file which then calls the IrfanView batch file, while the second method involves calling the IrfanView batch file directly. The first option allows the user to organize all parent batch jobs in one location, while the latter reduces potential confusion. However, since IrfanView batch jobs already contain executable statements, creating a parent batch file is not necessary. At the JAWF, scheduled tasks include cropping model imagery and printing DIFAX charts.

V. FUTURE PLANS

While operations at the JAWF have become more efficient with these software packages, there are newer methodologies and techniques being explored. These include:

- Developing additional IrfanView batch jobs to enhance productivity at the JAWF; in particular, create more sub-regions of

analyses and model forecasts that correspond to agriculturally sensitive areas.

- Expanding automation; Examples include creating additional Wingflyer downloads and automating more IrfanView processes.
- Testing new software; with SuperJPG no longer available, a capable replacement will eventually need to be found. In particular, there is a need for software that allows for seamless screen shows of a directory's contents with a single mouse click.
- Implementing new methods for acquiring online weather data.

Several alternative means for acquiring online weather data are currently being explored. "GhccSat", software developed Michael Bryson at www.hurricanalley.net, downloads satellite imagery from the NASA-GHCC web site (<http://www.ghcc.msfc.nasa.gov/GOES/goes.html>) for later viewing. In addition, this software automatically searches for the most current satellite images, and allows for concurrent image sector downloads. NEXRAD3, also developed by Michael Bryson, downloads NEXRAD data; in many ways, this software mimics the radar capabilities of AWIPS, without the painstaking "Localization" procedures. NEXRAD3 is available for a 30-day trial, after which it must be purchased for a nominal fee. Lastly, programming done with Visual Basic or other computer languages can further streamline Wingflyer downloads, especially when dealing with date-coded filenames (either in the URL or in the file-save location). Currently, simple macros are used to update Wingflyer batch jobs that contain date-specific filenames. However, Bob Stefanski (USDA meteorologist) has written Visual Basic programs that download imagery much like Wingflyer, but will also work with date-coded filenames.

VI. CONCLUSIONS

While standard web browsers offer an acceptable method for accessing online data, software packages are available which streamline this process. Wingflyer has greatly increased efficiency at the JAWF through automated downloads of large quantities of weather data. Meanwhile, image viewers such as SuperJPG and IrfanView have enhanced the ability of JAWF meteorologists to analyze, display, and enhance this data. However, new tools and methods are constantly being introduced which may further revolutionize the way the web is used, and the author looks forward to these improvements with great anticipation.

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