P7.2 AWIPS AS A GLOBAL METEORLOGICAL ANALYSIS AND DISPLAY SYSTEM

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1.0 INTRODUCTION

The National Weather Service Spaceflight Meteorology Group (SMG) is located at the Johnson Space Center (JSC) in Houston, Texas. The SMG provides weather support to NASA for all human spaceflight operations. This mission requires the use of a meteorological analysis and display system capable of displaying global weather data on scales ranging from the synoptic down to the mesoscale level for any given location around the world.

In June 2000, the NWS delivered a WFO AWIPS to SMG. This system was assigned the AWIPS identifier "SFMG" so that the Network Control Facility, (NCF), could differentiate SMG from a NWS field office. As delivered, the SFMG AWIPS was localized to Southeast Texas, and was only useful for providing local weather support to the JSC community. Since its delivery, SMG's Techniques Development Unit (TDU) has devoted much of its time and resources towards expanding the capabilities of AWIPS, and evaluating the best strategy for integrating AWIPS with SMG's existing McIDAS based weather display system. The McIDAS system, otherwise known as the Meteorological Interactive Data Display System (MIDDS), required much customization before it could be used for Shuttle weather support.

As delivered, the SFMG AWIPS ingested data from the NWSTG and GOES-East channels on the Satellite Broadcast Network, (SBN). The system was delivered with all of the necessary hardware for receiving the GOES-West and NOAAPort channels; however the communication processors, (CPSBNs), were not configured to recognize these circuits. The SFMG AWIPS also ingested data from twenty-two WSR-88D radars, located across the US and on Pacific Islands; however, it did not have the capability to display much of the radar data in a usable fashion. For example, the Honolulu and Guam radars could only be displayed offset 90° clockwise on the Northern Hemisphere scale.

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Just over a year since delivery, the SFMG AWIPS is ingesting data from all four SBN channels and additional local data sets that include Meteosat-7satellite imagery, Spanish radar data, and forecast grids from the Workstation Eta model that is being run over Spain and Northern Africa. While the SFMG AWIPS is not yet a global forecast system, it is capable of providing weather data to SMG for assessing weather conditions at the primary shuttle landing facilities in the CONUS, Europe, and Northern Africa.

This paper describes the process of expanding the SFMG AWIPS from a system designed to support a local NWS WFO, to a system that will eventually be capable of providing global coverage. This paper also discusses some of the advantages and limitations that SMG has found with the existing AWIPS platform.

2.0 RE-LOCALIZATION

2.1 Database

The first step in the re-localization project was to adjust the SFMG AWIPS database so that it was centered over Melbourne, Florida instead of Houston, Texas. The Florida localization would improve SMG's ability to display data over the Shuttle Landing Facility (SLF) at the Kennedy Space Center, located 30 miles north of MLB. A result of this project was that the MesoEta, LAPS, MAPS, RUC40, and other model grids were re-centered over Florida, and the GOES-East high-resolution satellite sectors were enlarged so that they extended from West Texas to the Bahamas. The larger satellite areas required two compromises. The first was to reduce the number of high-resolution satellite images stored in /data/fxa so that there was room in the database for the larger images. The second compromise was accepting a slower loading time of high-resolution images on the display workstations. The gain was that the SFMG AWIPS now could display high-resolution GOES-8 data over all of the Southeast US, including the KSC and JSC areas.

2.2 East CONUS D2D Localizations

The next step was to develop D2D display localizations for KSC and JSC. The Houston, TX and Melbourne, FL WFO localizations were used as starting points. However the Techniques Development Unit recognized that the SFMG AWIPS localizations would increasingly differ from their baseline WFO localizations, so they were given unique identifiers. This proved to be a beneficial move when SMG upgraded to AWIPS versions 5.0 and 5.1.1. The TDU also recognized that D2D needed to offer the same look and feel to a forecaster regardless of what localization was selected. The only obvious differences would be in the "scales" drop-down menu. The default regional and state scales were enlarged to improve the available coverage of high-resolution data. The satellite, radar and grid display menus were configured so that only displayable data would be available as choices. An example is that if a map of Florida were chosen, only radars that could display over Florida would be available in the radar drop-down menu. Likewise, model grids would be unavailable in the volume browser menu unless they could be displayed on the chosen scale. Once the D2D localizations were completed for KSC and JSC, the SMG forecasters began to increasingly use AWIPS for their daily operations.

2.3 West CONUS D2D Localizations

The next focus was on the Western US with the TDU developing new D2D localizations for Edwards Air Force Base, California, (EDW), and the White Sands Space Harbor, New Mexico, (NOR). This work went much faster because it was based on knowledge gained from earlier localization efforts. As the Western CONUS localizations took shape, inadequate satellite coverage immediately jumped to the head of the list of problems to be addressed. The GOES-East channel contains low-resolution CONUS satellite images that are updated every 30 minutes, however the lower frequency and quality of this data rendered it useless for mesoscale display over the Western sites. After much scouring of available documentation and several telephone calls, an NCF systems analyst identified that two additional serial ports on the back of the CPSBNs needed to be activated before AWIPS could ingest the additional SBN channels, (a standard AWIPS site has two serial data inputs on each CPSBN, while the SFMG and National Center CPSBNs have four serial ports).

Once the two additional channels were activated, SMG had GOES-West and NOAAPort data flowing in to the CPSBNs, but then the data "fell on the floor". The only new data that was automatically decoded by AWIPS was the satellite mosaic of the Northern Hemisphere that was broadcast on the NOAAPort channel. There was no information in the AWIPS documentation on how to simultaneously ingest data from both GOES satellites. Through experimentation, the TDU discovered that the satDataInfo.txt and satDepictInfo.txt files could be modified to assign navigation to both the GOES-East and GOES-West regional sectors. With GOES-West data available in D2D, the SMG forecasters gained full satellite, radar and numerical model coverage over all CONUS shuttle-landing sites.

2.4 TAL Localization

Once the CONUS localizations were established, the emphasis shifted to develop D2D localizations for the Transoceanic Abort Landing, (TAL), sites in Spain and Africa. Sample "National Center" and "OCONUS" D2D localizations contained in the AWIPS Build 5.0 Release provided examples for developing global scales and realizations for non-CONUS locations. The NWS Western Region Headquarters sent SMG a copy of their procedures for importing RAMSDIS (McIDAS) AREA files into AWIPS and distributing the data to Western Region AWIPS sites. These procedures provided much of the information that SMG needed to ingest high-resolution Meteosat-7 satellite and Spanish radar data into AWIPS. McIDAS AREA files are converted to AWIPS compatible netCDF with a Java application written by Tom Whittaker of the Space Science and Engineering Center at the University of Wisconsin. The TDU has also experimented with converting McIDAS AREA files to the AWIPS GINI format, and feeding the GINI files to AWIPS as if they originated from the SBN, however, this project has been unsuccessful so far.

The initial TAL D2D localization allowed SMG to only display the MRF, UKMET, and ECMWF models over the TAL sites. The default North American AVN model projection cut off over the Mid-Atlantic Ocean, and the Northern Hemisphere AVN grids were "too thin" to be used for much more than analyzing long-wave patterns. During a visit from the NOAA Forecast Systems Laboratory, (FSL), in February 2001, the SMG TDU learned about the Global AVN WAFS grids being broadcast over the SBN. These grids

contained the data resolution that was available in the North American projection, however they also offered global coverage. With this information, the TDU replaced both the North American and Northern Hemispheric AVN grids with the global AVN WAFS grids. Output from the Workstation Eta model, run over Spain and Northern Africa, has since been added to AWIPS.

Surface observation coverage has been expanded to include Southern Europe, Northern Africa, and Australia, (Australia is the anticipated drop site for the X-38 International Space Station Crew Return Vehicle prototype in 2002). Perl scripts were used to automate the process of adding new stations to AWIPS. The scripts take surface reporting station listings from McIDAS and convert them into the necessary format to be appended to the afosMasterPIL.txt, surfaceCitiesInfo.txt, and surfaceStationList.txt files. After AWIPS Build 5.1.1 is installed, these observations will be added to the text database, however the initial goal was to just get the additional observations to decode and display in D2D.

3.0 LOCAL DEVELOPMENT

Both AWIPS and the McIDAS make extensive use of the Tcl/Tk scripting language for GUI development. This similarity has facilitated the re-hosting of several applications between systems. Prior SMG experience with Tcl/Tk and the HP-UX programming environments has also made it easier to develop newer applications for AWIPS. The TDU has already re-hosted the existing daily practice and mission support forecast editors to AWIPS. A new upper-wind forecast editor is under development that will allow the forecasters to interactively edit forecasts from a GUI. Other applications that have been locally developed include a meteorological calculator for generating runway crosswind and density altitude information, a utility for examining the climatology for a given landing site for any month of the year, and a menu system that allows the forecasters to select text bulletins for display by product title or description vs. WMO or AWIPS identifiers.

The SMG TDU is continuing its efforts to incorporate custom background maps that define flight rule boundaries, exclusion zones, and runway layouts for the shuttle landing sites. These maps improve SMG's ability to analyze potential flight-rule violations in D2D. This project involves the conversion of existing map backgrounds from the McIDAS system into ASCII files that can be filtered through Arc View to create "shape files" that are displayable on AWIPS.

4.0 EXTERNAL DEVELOPMENT

In February 2001, several representatives from NOAA FSL visited SMG to discuss some of the data ingest and display needs that are unique to the shuttle program. As a result of this meeting, SMG and FSL have developed a list of development tasks that are waiting for NASA funding. These tasks will add tools to the SFMG AWIPS that are required to more efficiently analyze data sets received from the shuttle landing facilities. Proposed work includes improving graphical and text displays of surface observations and mesonet data with user configurable thresholding, basic meteorological contouring of surface and upper air point data, and the re-hosting of applications currently being developed for the USAF Range Standardization and Automation, (RSA), weather system; the RSA Weather System is being built on an AWIPS-like platform. While prioritizing tasks, SMG attempted to choose projects that would benefit most NWS field offices in order to get the most value from any work performed by FSL. SMG also recognized that the widespread acceptance of custom D2D applications would improve the likelihood of them eventually being accepted into the AWIPS baseline.

5.0 LDAD UTILIZATION

In September 2001, the SMG TDU and the local contractors responsible for the McIDAS system connected the two weather systems, using LDAD as a shared file server. Both systems can now read and write data from LDAD through firewalls, however neither system has direct access to the other. This connection will greatly improve SMG's ability to import locally developed data sets to AWIPS. For nearly a year, SMG has relied on a remote ftp file server for exchanging data between the two systems. This process had direct limitations in that SMG has no control over the external file server, there was no event notification, and the size of data sets had to be minimized to reduce traffic over the AWIPS WAN. The new direct connection between weather systems will allow for larger and more frequent data exchanges between systems, providing the necessary bandwidth to eventually provide global satellite coverage on AWIPS.

6.0 STRENGTHS AND LIMITATIONS

The advantages of AWIPS vs. McIDAS are found largely in the flexible and user friendly displays provided by D2D. A forecaster can simultaneously monitor up to 10 graphical displays on AWIPS vs. a single display with McIDAS. AWIPS also provides more user-friendly tools and editors for writing macros, procedures, and color enhancement tables, and has proven to provide a shorter learning curve for forecasters to demonstrate system proficiency. AWIPS has demonstrated itself to be a capable system for ingesting and displaying locally ingested data types: at this time, this includes satellite, radar, and numerical gridded data.

The disadvantages of AWIPS vs. McIDAS are mostly found in AWIPS' limited data manipulation capabilities. McIDAS is much more powerful when it comes to manipulating and combining data sets, whether they be satellite, numerical model, or decoded alphanumeric data files. The SMG has determined that it will not be able to entirely replace McIDAS with AWIPS in the near future because of McIDAS' broader data manipulation capabilities. Plans call for McIDAS to become more of a background data processor that will ingest, manipulate, and feed data to AWIPS.

There are only a few significant shortfalls on the display end of AWIPS. The primary limitation is that high-resolution satellite imagery appears "fuzzier" in D2D compared to McIDAS. SMG has also observed a three to five minute delay between satellite imagery ingested locally to imagery received over the SBN. These shortfalls would be barely noticeable for most users. However SMG frequently requests GOES-East rapid-scan during mission operations, and tracks small cloud features, 1-2 km in diameter, that could produce a slant range visibility or ceiling problem when they pass over the SLF. The next obvious weakness is AWIPS' poor graphic printing capability. (What you see is NOT what you get.) Finally, AWIPS stores its macros, procedures, and enhancement tables as netCDF files which make it more difficult to exchange procedure or enhancement information with other AWIPS sites. Text retrieval is sufficient in AWIPS; however, it would be nice to have more powerful tools for querying the text database. One example would be to have the ability to query the database using a partial WMO header and a string of characters to match in the returned product.

7.0 CONCLUSION

Overall, AWIPS has proven to be a very capable meteorological analysis and display system. SMG has been very successful with their initial goal of making AWIPS capable of displaying satellite, radar, surface and model data over all of the space shuttle landing facilities. However, the long-range goal of making the SFMG AWIPS a global forecast system has yet to be realized. Most of the remaining work to be done involves the incorporation of additional non-GOES satellite imagery, and international surface and upper air observations into the AWIPS database. SMG also needs to re-host many local datasets and applications from the MIDDS system to the SFMG AWIPS before it can replace the display portion of the MIDDS system for shuttle support. SMG is confident that by 2003, both of these goals will have been met.

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