LOCAL DATA ANALYSIS ON AWIPS AT NWS MELBOURNE, FL

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1. INTRODUCTION

A version of the Advanced Regional Prediction System (ARPS, Xue et al. 2000) Data Analysis System (ADAS) has been implemented at the National Weather Service (NWS) Office in Melbourne, Florida (Case et al. 2002). ADAS was configured with the assistance of the National Aeronautical and Space Administration's (NASA) Applied Meteorology Unit (AMU, Ernst and Merceret 1995). Nearly simultaneously, a similar configuration was installed at the NWS Spaceflight Meteorology Group (SMG) at Johnson Space Center in Houston TX (Oram et al. 2001). These efforts were undertaken to integrate the various data sets in proximity to the Kennedy Space Center (KSC) and throughout much of the Florida peninsula to generate diagnostics every 15 min for enhancement of short-range (<6 h) forecasts (Manobianco and Case 1998). These detailed three dimensional analyses were recently ported to the Advanced Weather Interactive Processing System (AWIPS) at NWS Melbourne. The detailed analyses provided by the ADAS in conjunction with the powerful data manipulation capabilities of AWIPS can assist forecasters in diagnosing the state of the atmosphere ranging from the mesoscale to quasi-stormscale in near real-time. This paper will describe the ADAS setup and configuration and the process of porting the analyses to AWIPS. Operational forecast applications will also be discussed. Examples of various AWIPS Display 2 Dimensions (D2D) depictions will be shown at the conference and are available within an electronic version of this paper at: http://www.srh.noaa.gov/media/mlb/pdfs/LocalDataAnalysisonAWIPSatNWSMelbourne.pdf.

2. REAL-TIME DATA INGEST

Certain data sets available to Melbourne forecasters are unique compared to other NWS offices, due to the relatively dense network of instrumentation supporting the United States Space Program. Data from the KSC meso-network include: 44 wind towers, five 915-MHz boundary layer Doppler radar wind profilers and a 50-MHz Doppler radar wind profiler. Other data available for ingest into ADAS include Geostationary Operational Environmental Satellite (GOES-8) 1-km resolution visible and 4-km infrared imagery, METAR surface reports, Florida Automated Weather Network (FAWN) surface observations, Automated Position Reporting System (APRS) WXNET observations, Aircraft Communications Addressing and Reporting System (ACARS) reports, and Melbourne (KMLB) Weather Surveillance Radar - 1988 Doppler (WSR-88D) base radial velocity and reflectivity fields.

3. ADAS CONFIGURATION

ADAS is available from the Center for Analysis and Prediction of Storms in Norman, OK. The NWS Melbourne configuration of ADAS produces analyses on two nested grids with 10-km and 2-km horizontal grid spacing (**Fig. 1**). The outer 10-km domain covers much of Florida, with the exception of the panhandle and extreme south Florida. The 2-km grid covers much of the Melbourne NWS forecast area. The ADAS analysis cycle is run every 15 min, with the start of the cycle occurring 14 min after the valid time to allow retrieval of the various data sets from a remote server, and to account for inherent latencies of data such as satellite imagery. On average, output is available 16 min after the valid time. A schematic of how the various data sets, background fields and analyses are routed in and out of the ADAS is depicted in **Fig. 2**. This schematic also addresses future plans including routing the WSR-88D base (Level II) data to SMG for their ADAS configuration, as well as to the National Climatic Data Center (NCDC) for archival purposes. Implementation of the ARPS numerical weather prediction model is planned and will be discussed in a later section.

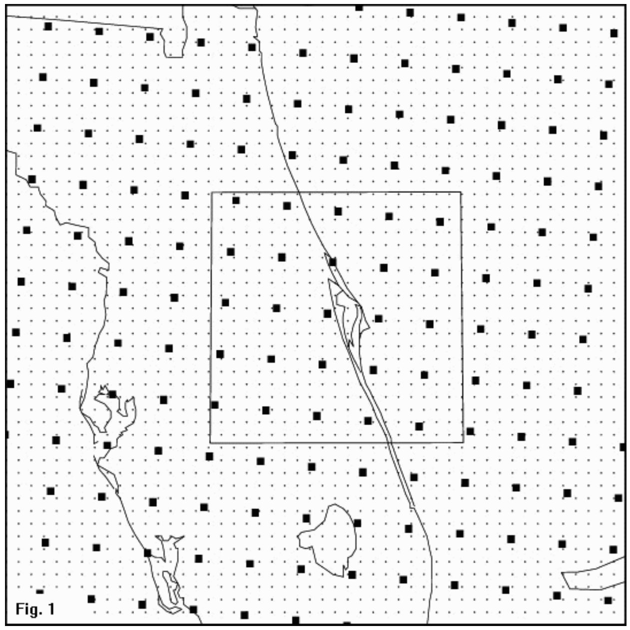

Fig. 1. NWS Melbourne ADAS on two nested grids with 10-km and 2-km horizontal grid spacing.

ADAS was configured to use 40-km Rapid Update Cycle (RUC, Benjamin et al. 1998) model hybrid coordinate system forecasts for background fields to the analyses. The native hybrid scheme offers advantages over the isobaric coordinate system, such as providing background fields for the surface rather than requiring ADAS to extrapolate from 1000 mb quantities. The ability to retrieve surface fields becomes especially useful during the Winter when typical surface pressures are significantly higher than 1000 mb and 4-5 additional RUC levels may be available between 1000 mb and the surface. The RUC 3-6 hour forecasts are linearly interpolated in time every 15 min to provide background fields for the 10-km analyses. Subsequently, the 10-km analyses are spatially interpolated to provide background fields to the 2-km analyses.

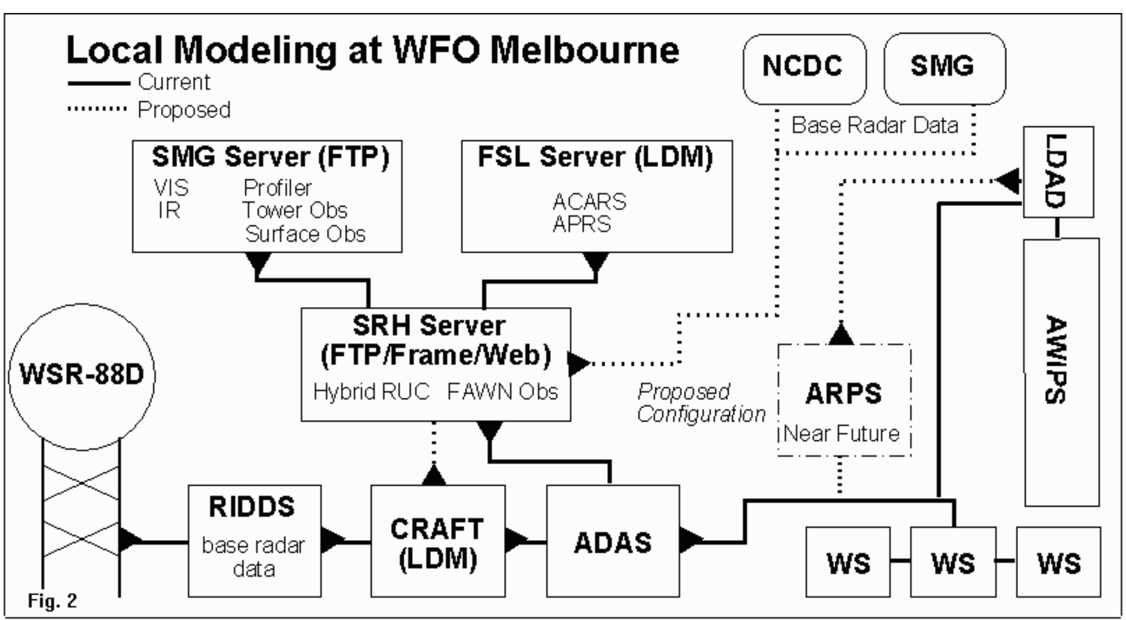

Fig. 2. Local modeling data flow for ADAS at NWS Melbourne.

Surface observations, meso-network tower winds, profiler data as well as visible and infrared satellite imagery are collected for assimilation into the ADAS every 15 min. These data are obtained from the SMG Meteorological Interactive Data Display System (MIDDS, Rotzoll et al. 1990). At present, the data are routed to NWS Melbourne via a server at the NWS Southern Region Headquarters in Ft. Worth, Texas using multiple-scheduled File Transfer Protocol (FTP) sessions. While this non-direct communication process (mandated by NASA security concerns) adds some delay to the receipt of data, computational savings are achieved locally by having the data pre-processed at SMG.

FAWN observations, a mesonet of sensors in support of agricultural concerns across the state of Florida (Woods 1999), are available via an anonymous FTP server provided by the University of Florida. APRS observations are taken by a network of amateur weather spotters. The APRS data are compiled and a degree of quality checking is performed by the Forecast Systems Laboratory (FSL) before they are uploaded to an anonymous FTP server. Both the FAWN and APRS observations greatly supplement the standard METAR reports. These data sets are often updated at 15 min increments and provide surface information for analyses when METAR reports are often unavailable. A composite map of all surface data sites within the 10-km grid domain is shown is **Fig. 3**.

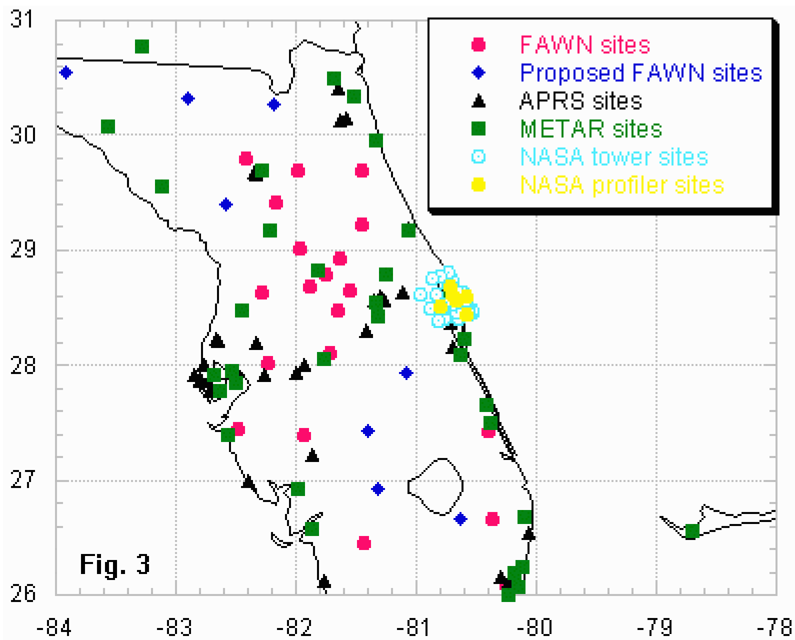

Fig 3. Surface data sites within the 10-km ADAS grid.

ACARS provides additional three dimensional wind and temperature data, and at great heights, to areas outside the immediate KSC tower network. A significant amount of commercial aviation flights en route to and from numerous large Florida airports supplement analyses over the domain. FSL provides this data via the University Corporation for Atmospheric Research Unidata Local Data Manager (LDM), after performing accuracy checks. The ACARS data are available every 10 min, with the ADAS configuration utilizing data up to 45 min prior to the time of the analyses.

KMLB high-resolution WSR-88D Level II data are incorporated into the ADAS analyses via two independent workstations. One workstation collects the base data from the Radar Data Acquisition unit and re-distributes it through a local Radar Interface and Data Distribution System (RIDDS, Jain and Rhue 1995), designed by the National Severe Storms Laboratory. A second workstation retrieves data from RIDDS through another workstation running an LDM server and using software developed under the Collaborative Radar Acquisition Field Test (CRAFT). CRAFT allows for the real-time compression and transmission of WSR-88D base data via TCP/IP (Droegemeier et al. 2001). The file system containing the Level II data ingested by the LDM is mounted so that the workstation running ADAS can access and re-map the radar data to each analysis grid.

4. ADAS ANALYSES ON GARP, AWIPS AND THE WORLD WIDE WEB

Once the ADAS cycle is completed, each analysis is converted to GEneral Meteorological PAcKage (GEMPAK) formatted files that can be accessed by workstations networked throughout the office. Forecasters can then utilize the GEMPAK Analysis and Rendering Program (GARP) graphical user interface to view pre-defined horizontal gridded analysis fields, cross sections, multiple gridded macros, and associated time animations.

An intermediate processing step converts the ADAS analyses into a GRIB format output. The GRIB files are then converted to NetCDF by a utility called GRIB2NET. The NetCDF file format is native to AWIPS, allowing display on the D2D software. The conversion to NetCDF outside of the AWIPS system reduces the computational load for the local AWIPS data server. In addition, running ADAS outside of the local AWIPS network allows for changes to analysis configurations and hardware improvements independent of the AWIPS platform. The ADAS output in NetCDF format is deposited on the external side of the AWIPS Local Data Acquisition and Dissemination (LDAD) using an implementation of the LDM. Perl scripts obtained from the NWS Western Region Headquarters (Jason Burks, personal communication) pull the NetCDF files across the LDAD firewall for storage on the data server. Local customization procedures upon AWIPS D2D workstations allow the ADAS analyses to be viewed by operational forecasters.

When used in conjunction with the data manipulation capabilities of the D2D software, ADAS analyses can greatly enhance the forecasters ability to diagnose the synoptic and mesoscale structures of the atmosphere. The importation of ADAS analyses onto the primary NWS data display platform provides 3- dimensional information at spatial and temporal resolutions previously unavailable. Thermodynamic and wind fields updated at fine temporal intervals significantly improve the ability to determine the near-storm environment and resultant threats in convective situations. Additionally, the ADAS analyses include data sets that are currently unavailable for direct inclusion into the Local Analysis and Prediction System (LAPS, McGinley 1995), the standard AWIPS platform local analysis package.

A limited set of analysis fields are generated in GIF format for posting on the NWS Melbourne Web site in near real-time. The GEMPAK GIF utility creates wind, pressure, humidity, temperature, stability and cloud analyses for access on the world wide web at the end of each analysis cycle. By posting a limited set of products on the web, other Florida NWS forecast offices, the United States Air Force 45th Weather Squadron at Cape Canaveral, Florida, and local emergency management officials have the opportunity to view the detailed analyses in support of local decision making responsibilities. Media partners and the general public can also benefit from the posting of such analyses by viewing highly detailed and frequently updated sensible weather parameters in near real-time, compared to the traditional text products which are available only once per hour. These graphical products can be viewed at: http://www.srh.noaa.gov/mlb/?n=adas_static.

5. FORECAST APPLICATIONS

The high temporal and spatial resolution surface wind analyses, particularly within the 2-km ADAS analysis grid, will better assist forecasters with the placement and movement of mesoscale boundaries. Knowledge of these features is especially important during the Florida wet-season when sea/lake breeze and outflow boundaries are primarily responsible for the forcing of diurnal convection (**Fig. 4**). Additionally, thermodynamic diagnostics (e.g. convective available potential energy, lifted index) and local severe weather applications (e.g. microburst day potential index; Wheeler and Roeder 1996) combined with the wind analyses will likely aid nowcasts of convective initiation and severe weather potential (Blottman et al. 2001).

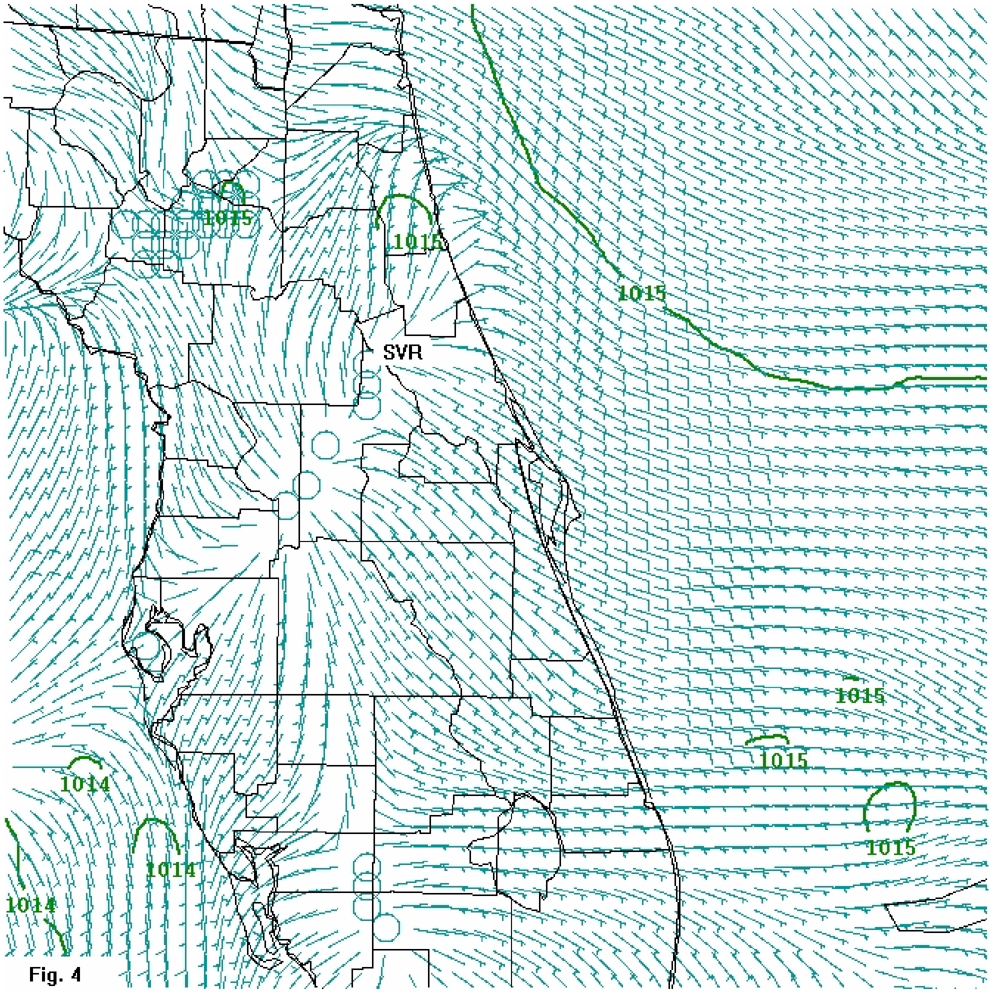

Fig. 4. Sea breeze boundary interactions depicted by ADAS across Central Florida.

Sharp and Hodanish (1996) stated that mesoscale low-level boundaries must be considered by east-central Florida forecasters both during pre-storm analysis and radar assessment to improve the early detection of supercell thunderstorms. In certain situations, severe weather warning decisions may be made more confidently and/or timely by coupling the knowledge of the near-storm environment gained by ADAS analyses in combination with standard diagnostic methods. The precise location and past movement of mesoscale boundaries, along with depiction of the local trends of key thermodynamic parameters gained from ADAS, may help improve the Probability of Detection and False Alarm Rate numbers.

The identification and placement of low-level boundaries and moisture trends is also important to NWS forecasters when providing spot fire weather forecasts to land management agencies and fire fighters. The specific location and timing of mesoscale features and the wind speed and direction associated with these features can have significant impact on fire resource management, threats to property, and the safety of personnel working a fire.

Routine examinations of the analyses can also benefit the short-term marine forecast program. A more detailed current depiction and evolution of wind along the Atlantic coastal plain allows forecasters to refine marine nowcasts. A more accurate adjustment of the nearshore and offshore forecasts can be realized from the improved visualization of the wind fields.

Aviation forecasts will be supplemented by the complex cloud scheme of ADAS (Zhang et al. 1998), which is derived from the LAPS package. Forecast improvements can be achieved by monitoring the evolution of detailed cloud cover and ceiling products available from the cloud scheme.

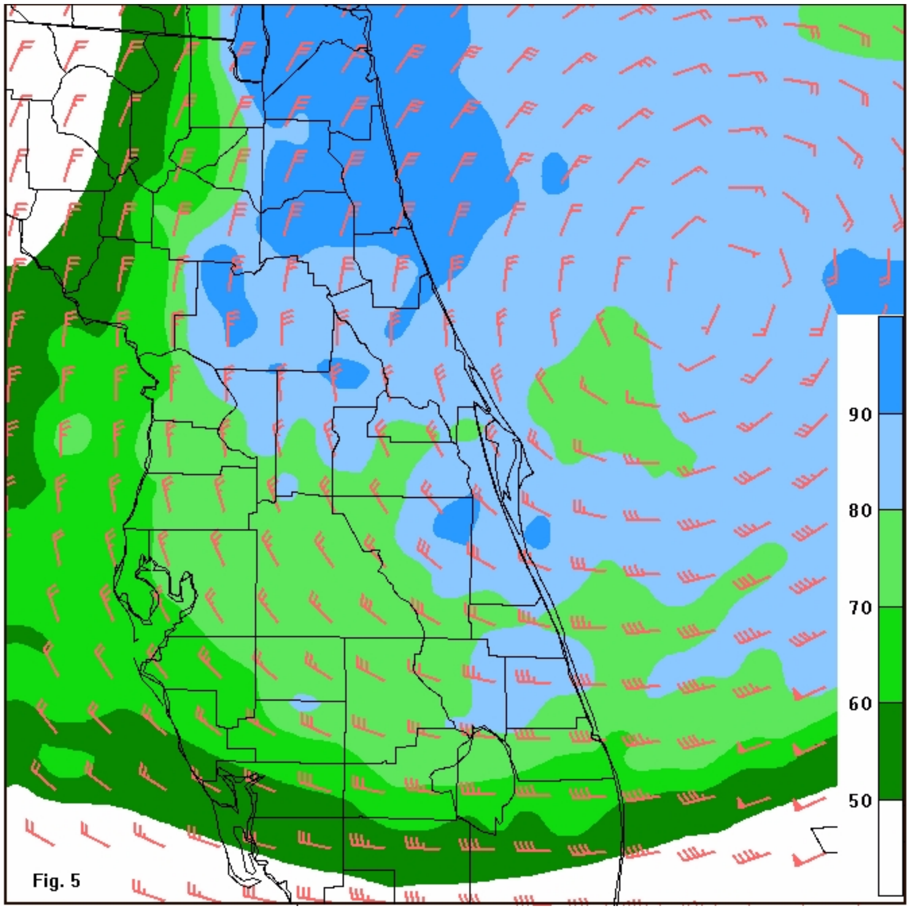

Fig. 5. ADAS depiction of Tropical Storm Gabrielle.

The analyses can also prove useful for defining synoptic scale features affecting central Florida and for monitoring their evolution. The inclusion of ACARS data and WSR-88D velocity information within ADAS helps to nudge the analysis wind fields closer to reality. Examination of mean low-mid level wind products can be used to determine the steering flow for areas of convection and to precisely locate the center of important features such as Tropical Storm (TS) Gabrielle, shown in **Fig. 5**. During this event, ADAS was utilized to carefully track the center of the TS across the central Florida peninsula and into the Atlantic, as well as to observe trends associated with strong onshore gradient winds. Additionally, the additive ACARS and radar reflectivity data helped to improve the background RUC moisture fields. Areas of deep moisture and precipitation were depicted well (coincident with the strong northeast gradient flow indicated in Fig. 5), as well as the deep-layered drying wrapping around the periphery of the TS.

ADAS can more precisely locate synoptic scale frontal zones. Incorporating the dense network of surface observations, along with ACARS and radar supplemented mid-level moisture fields leads to high quality stability analyses. The trends of such stability products can be used to closely follow the movement of frontal zones and to forecast areas most susceptible to precipitation. **Fig. 6** shows an analysis of a sharp stability gradient across central Florida, indicative of the precise location of the frontal boundary, and helpful for ascertaining regions still prime for rainfall.

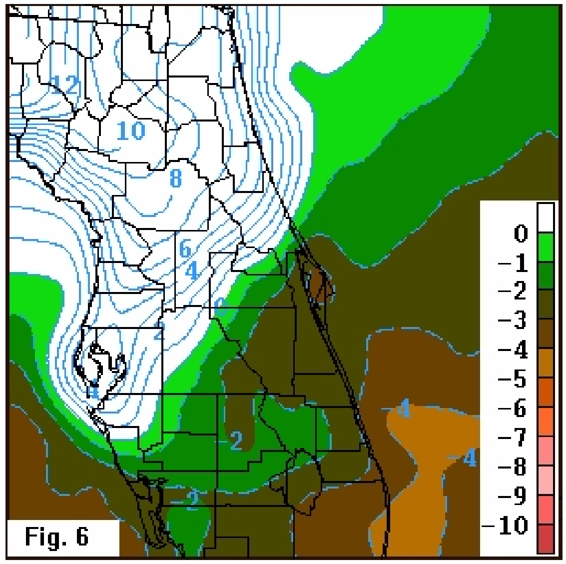

Fig. 6. ADAS depiction of sharp stability gradient across central Florida.

6. FUTURE INITIATIVES

The current post-configuration period will continue to focus on familiarizing the entire operational staff to the integrated data analysis package in support of various forecast programs. This effort will further prepare the staff for assimilating current conditions in a processed format versus viewing disparate data sets and integrating them manually to form a mental picture of the atmosphere (McPherson 1999).

Additional data sets will be evaluated for potential inclusion into the ADAS analyses. WSR-88D Level III data from surrounding sites would be helpful in providing additional low-level velocity and reflectivity data to the 10-km and 2-km ADAS grids. Even more useful would be the ability to acquire base data from adjacent sites, such as Tampa Bay, as well as from the Orlando Terminal Doppler Weather Radar site.

Currently, METAR reports from local Automated Surface Observing Systems (ASOS) are produced every 5 min, but are only transmitted (and ingested into ADAS) once per hour and when certain aviation thresholds are reached. Plans are currently underway to exploit local dial-in modem capabilities for retrieving ASOS data every 15 min for ingest into ADAS.

Finally, the ultimate goal is to implement the ARPS numerical weather prediction model into forecast operations, in combination with the ADAS analyses. The existing ADAS analyses could be cycled with the ARPS prediction model to run a local four-dimensional data assimilation system over the Florida peninsula. It is anticipated that the forecast output from the prognostic component of ARPS will provide detailed and accurate information to assist in the generation of forecasts within the first 24 hours. Additionally, these fine resolution gridded fields could be used as input into the AWIPS Interactive Forecast Preparation System (IFPS) at NWS Melbourne to help initialize local forecast matrices.

Incorporating ADAS and ARPS output onto the AWIPS platform will allow forecasters to fully realize the utility of critical local data assimilation and powerful workstation resources to provide a new and improved mesoscale forecast tool. Such a configuration, together with innovative visualization techniques will provide an interface to the next generation of weather modeling (i.e. implementation of the Weather Research and Forecasting model, Michalakes 1999).

7. REFERENCES

Benjamin, S. G., J. M. Brown, K. J. Brundage, D. Devenyi, D. E. Schwartz, T. G. Smirnova, T. L. Smith, L. L. Morone, and G. J. DiMego, 1998: The operational RUC-2. Preprints, *16th Conf. on Weather Analysis and Forecasting*, Phoenix, AZ, Amer. Meteor. Soc., 249-252.

Blottman, P.F., S.M. Spratt, D.W. Sharp, A.J. Cristaldi, J.L. Case, and J. Manobianco, 2001: An operational local data integration system (LDIS) at NWS Melbourne. Preprints, *18th Conf. On Weather Analysis and Forecasting*, Ft. Lauderdale, FL, Amer. Meteor. Soc. J135-138.

Case, J. L., J. Manobianco, T.D. Oram, T. Garner, P.F. Blottman, and S.M. Spratt, 2002: Local data integration over east-central Florida using the ARPS data analysis system. *Wea. Forecasting*, in print.

Droegemeier, K. K., J. J. Levit, K. Kelleher, T. D. Crum, S. A. Delgreco, L. Miller, D. W. Fulker, and H. Edmon, 2001: Project CRAFT: A test bed for demonstrating the real time acquisition and archival of WSR-88D base (Level II) data. Submitted to *Bull. Amer. Meteor. Soc.*

Ernst, J. A. and F. J. Merceret, 1995: The Applied Meteorology Unit: A tri-agency applications development facility supporting the space shuttle. Preprints, *Sixth Conf. On Aviation Weather Systems,* Dallas, TX, Amer. Meteor. Soc., 266-269.

Jain, M. and D. Rhue, 1995: WSR-88Ds live data stream now accessible in real-time. *NSSL Briefings*, Summer 1995, 11.

Manobianco, J. and J. Case, 1998: Final report on prototype local data integration system and central Florida data deficiency. *NASA Contractor Report CR-1998-208540*, Kennedy Space Center, FL, 57 pp.

McGinley, J. A., 1995: Opportunities for high-resolution data analysis, prediction, and product dissemination within the local weather office. Preprints, *14th Conf. on Weather Analysis and Forecasting*, Dallas, TX, Amer. Meteor. Soc., 478-485.

McPherson, R., 1999: The future of the North American radiosonde network. Preprints, *3rd Symp. on Integrated Observing Systems*, Dallas, TX. Amer. Meteor. Soc., 14-17.

Michalakes, J., J. Dudhia, D. Gill, J. Klemp, and W. Skamarock, 1999: Design of a next-generation regional weather research and forecast model. *Towards Teracomputing*, World Scientific, River Edge, New Jersey, 117-124.

Oram, T.D., T. Garner, and J.L. Case, 2001: Short-term forecasts at Kennedy Space Center using the ARPS data analysis system. Preprints, *18th Conf. On Weather Analysis and Forecasting*, Ft. Lauderdale, FL, Amer. Meteor. Soc. 88-91.

Rotzoll, D.A., S.J. Cunningham, and E.K. Hogan, 1990: Evolution of MIDDS II in JSC Space Shuttle Operations. Preprints, *7th International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology.* New Orleans, LA, Amer. Meteor. Soc., 48-53.

Sharp, D. W., and S. J. Hodanish, 1996: A survey of supercells over east central Florida. Preprints, *18th Conference on Severe Local Storms,* San Francisco, CA, Amer. Meteor. Soc., 335-339.

Woods, C., cited 1999: FAWN adds new monitoring stations at Alachua and Hastings. [Available on-line from http://fawn.ifas.ufl.edu/preview/about/press/news4.html.]

Wheeler, M.W., and W.P. Roeder, 1996: Forecasting wet microbursts on the central Florida Atlantic coast in support of the United States Space Program. Preprints, *18th Conference on Severe Local Storms*, San Francisco, CA, Amer. Meteor. Soc., 654-658.

Xue, M., K. K. Droegemeier, and V. Wong, 2000: The Advanced Regional Prediction System (ARPS) - A multi-scale nonhydrostatic atmospheric simulation and prediction model. Part I: Model dynamics and verification. *Meteor. Atmos. Phys.*, **75**, 161-193.

Zhang, J., F. H. Carr, and K. Brewster, 1998: ADAS cloud analysis. Preprints, *12th Conf. On Numerical Weather Prediction,* Phoenix, AZ, Amer. Meteor. Soc., 185-188.