2.4 HIGH RESOLUTION DIAGNOSTICS AND SHORT TERM PROGNOSTICS IN SUPPORT OF FIRE WEATHER OPERATIONS AT NWS MELBOURNE, FL

Peter F. Blottman*, John C. Pendergrast, Scott M. Spratt, David W. Sharp
NOAA/National Weather Service, Melbourne, FL

1. INTRODUCTION

Versions of the Advanced Regional Prediction System (ARPS, Xue et al. 2000) and the ARPS Data Analysis Systems (ADAS) have been implemented at the National Weather Service office in Melbourne, Florida (MLB, Case et al. 2002). This local version of ADAS/ARPS was configured with the assistance of the National Aeronautics and Space Administration's (NASA) Applied Meteorology Unit (AMU, Ernst and Merceret 1995). ADAS was configured in order 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 the enhancement of short-range (<6 h) forecasts (Manobianco and Case 1998). The ARPS mesoscale model, when utilizing ADAS analyses for its initialization, provides prognostics that generate an evolution of mesoscale features depicted in ADAS and at the same fine spatial resolution. This paper will describe the ADAS/ARPS system in place at MLB, and present the advantages of using high-resolution diagnostics and prognostics in support of fire weather operations.

2. REAL-TIME DATA SETS

A dense network of instrumentation supporting the United States space program provides unique data sets to MLB for inclusion in ADAS analyses. Data from the KSC meso-network include: 44 wind towers, five 915-MHz Doppler radar wind profilers and a 50-MHz Doppler radar wind profiler. Other data sets available for the ADAS analyses include: Geostationary Operational Environmental Satellite (GOES-12) 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.

*Corresponding author address: Peter F. Blottman
NOAA/NWS Forecast Office, 421 Croton Road
Melbourne, FL 32935 email: peter.blottman@noaa.gov

3. ADAS CONFIGURATION

ADAS/ARPS is available from the Center for Analysis and Prediction of Storms in Norman, OK. The MLB configuration of ADAS produces analyses on a 177 by 177 grid with a horizontal spacing of 4-km. This domain provides high-resolution coverage for most of the state of Florida with the exception of portions of the panhandle and the Keys (Fig. 1). ADAS analyses are generated every 15 min, with the start of the cycle occurring 14 min after the valid time to allow for the retrieval of the disparate data sets. On average, analyses are available to the forecaster 16 min after the valid time. Figure 2 depicts a schematic of how the various data sets, background fields, analyses, and forecasts are routed in and out of ADAS/ARPS. 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 RUC 1-3 hour forecasts are linearly interpolated in time every 15 min to provide background fields for the 4-km analyses.

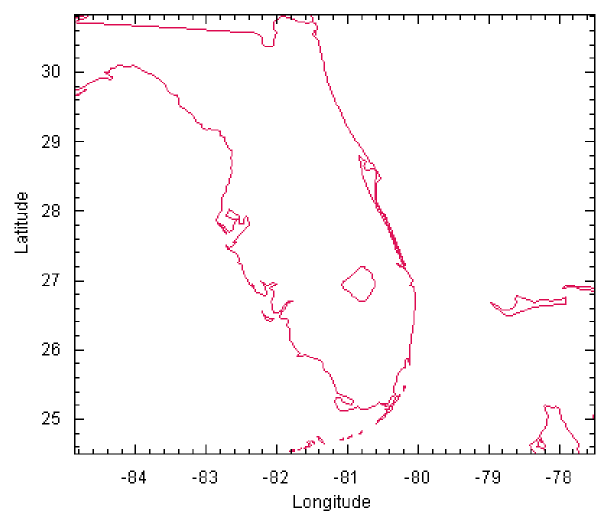

Fig. 1 ADAS/ARPS domain configured at MLB.

Surface observations, meso-network tower winds, profiler data, and visible and infrared satellite imagery are collected for assimilation into the ADAS every 15 min. These data are obtained from the Spaceflight Meteorology Group (SMG) Meteorological Interactive Data Display System

(MIDDS, Rotzoll et al. 1990). At present, the data are routed to MLB 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 surface and profiler data pre processed at SMG.

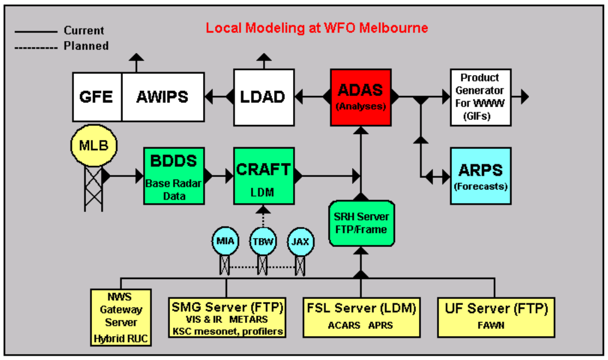

Fig. 2 Schematic of the various data sets and the hardware/software components which make up the ADAS/ARPS configuration at MLB.

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 unavailable. A composite map of all surface data sites within the 4-km grid domain is shown in Fig. 3.

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.

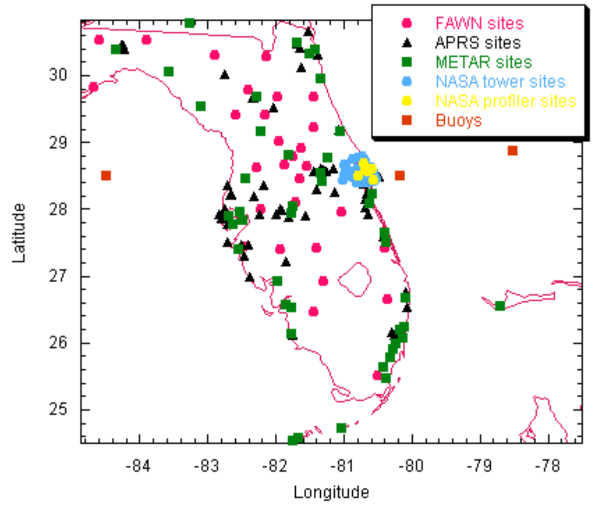

Fig. 3 Composite of all surface data sites within the ADAS/ARPS domain.

KMLB high-resolution WSR-88D Level II data are incorporated into the ADAS analyses via the Base Data Distribution System (BDDS; Crum et al., 2003). A second workstation running the LDM software retrieves data from the BDDS 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. ARPS CONFIGURATION

The ARPS mesoscale model at MLB runs on a 10-node, 20-processor Linux cluster. The current hardware provides for the generation of a 0 to 9 hour forecast within 3.5 h. The ARPS output is on the same 177 by 177 domain and 4-km horizontal resolution as ADAS. The model contains 45 vertical levels and current post-processing strategies produce a temporal resolution of 30 min. Model output is post processed as forecast increments are finished, providing guidance to the forecaster as timely as possible. The 9-hour forecast length was chosen to maximize the frequency of forecast updates with fresh ADAS observational analyses under the current hardware constraints. Four ARPS runs are initialized each day at 3, 9, 15 and 21 UTC.

The MLB ARPS uses the 3-12 hour, 40-km RUC forecast as its background field and lateral boundary conditions. At the start of each model run, an Intermittent Data Assimilation (IDA) cycle is completed. The IDA cycle incorporates observational data into the ARPS model by alternating between ADAS analyses that initialize very short range ARPS forecasts over a specified time interval (Case 2003). The IDA is typically run over a one hour pre-forecast period, but can be adjusted to any length of time. An IDA strategy has been instituted to start the ARPS forecast model with as much mesoscale detail as possible. At the start of the IDA, the RUC 2-h forecast is used as the first guess field for the initial ADAS. This first ADAS analysis is then used to initialize a short 15 min ARPS forecast interval. Following this 15 min forecast interval, a second ADAS analysis is generated with a complete set of new observational data and uses the ARPS 15 min forecast as its first guess field. This process of generating new ADAS analyses and then 15 min ARPS forecasts continues through the entire IDA cycle. The last ADAS analysis is used to initialize ARPS as it begins the 9-hour forecast.

5. FIRE WEATHER FORECAST SUPPORT

Twice a day MLB forecasters issue routine Fire Weather Forecasts (FWF) that provide detailed meteorological information, as well as specific fire weather parameters for 36 or 48 hours into future (NWS, 2003). These forecasts also include more general information out 3 to 5 days. The FWF includes content specifically requested by land management agencies to assist in conducting routine operations, including planning, resource allocation, and prescribed burns. These same forecasts are also used for planning purposes during wildfires.

Additionally, NWS meteorologists are charged with providing short-fused ‘spot’ fire weather forecasts. These forecasts are requested by agencies that require site specific forecast information to support wildfire or prescribed burn operations. Forecast requirements under these conditions are critical since lives, resources, and properties may all be at risk. Spot forecasts provide highly detailed wind, moisture, temperature, and precipitation information at point locations with temporal resolutions of 2 hours or less. Before the implementation of ADAS/ARPS, three-dimensional/graphical guidance to support the preparation of forecasts at these space and time scales was unavailable to MLB meteorologists.

Both the ADAS analyses and ARPS forecasts have been ported to the MLB Advanced Weather Interactive Processing System (AWIPS), which is the primary NWS meteorological data display system. Redistribution within AWIPS allows adjacent NWS offices within the domain to also access output. When ADAS is used in conjunction with the data manipulation capabilities of AWIPS, ADAS analyses can greatly enhance the forecaster’s ability to diagnose the synoptic and mesoscale structures of the atmosphere (Blottman et al. 2002). ADAS analyses provide three-dimensional information at spatial and temporal resolutions previously unavailable. Thermodynamic and kinematic fields updated at fine temporal intervals significantly improve the ability to monitor moisture and low level wind trends so critical to land management agencies. 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).

The prognostics provided by ARPS can predict sea breeze onset and progression, as well as assist the forecaster in producing detailed forecasts on the development and evolution of convective storms (Fig. 4). The specific location and timing of mesoscale features and the wind speed and direction associated with these features can have

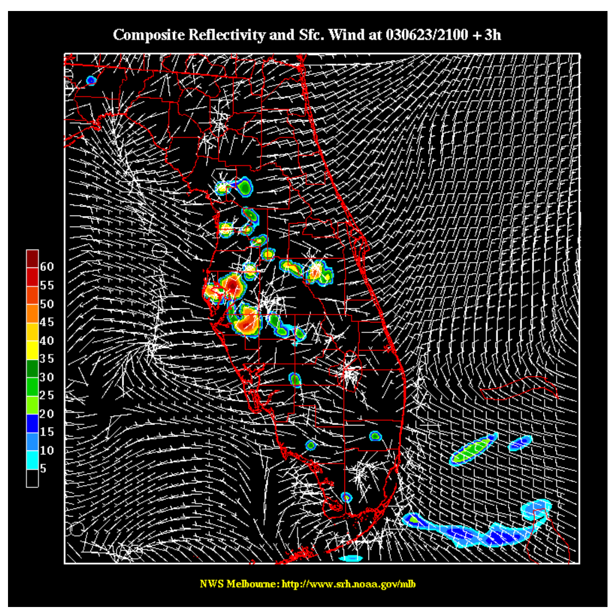

Fig. 4 ARPS 3-h forecast depicting thunderstorm Composite Reflectivity and surface wind field.

significant impacts on fire resource management. Furthermore, threats to the safety of personnel working wildfires and nearby property may be reduced.

Low level moisture (relative humidity) and wind direction and speed are perhaps the two most important parameters to land management decision makers. These two variables are incorporated into most Red Flag Warning and Fire Weather Watch programs across the country. ADAS analyses allow meteorologists to not only monitor these forecast variables for possible updates, but to also provide forecast verification and feedback following an event. ARPS forecasts provide guidance in the preparation of both routine and 'spot' forecasts, as well as determine the likelihood of watch/warning criteria being met. Traditionally, radiosonde observations of temperature and dew point are used to estimate the degree of surface drying expected during the diurnal cycle. An experimental product generated by both ADAS and ARPS presents relative humidity and wind 1-km above the surface (Fig. 5). During the diurnal cycle as surface heating intensifies, dry regions aloft will mix downward to the surface, given sufficient heating. This product has proven to highlight those areas that will experience the most rapid drop in surface relative humidity. The inclusion of thermodynamic and kinematic information from ACARS, radar, and profiler observations provides a more complete depiction of the state of the atmosphere than any single point source sounding would allow.

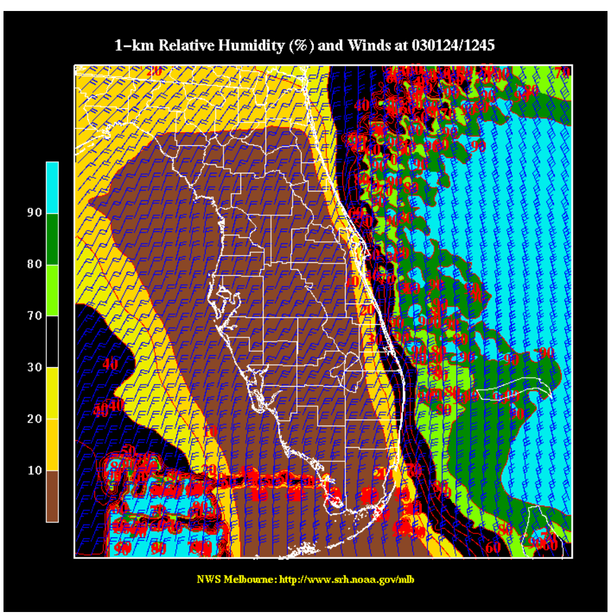

Fig. 5 1-km Relative humidity and winds.

In many parts of the country, aircraft are used to support ground-based operations in suppressing wildfires. These aircraft may be deleteriously influenced by excessive shear in the low levels of the atmosphere. Fig. 6 shows an experimental product depicting the vector difference between the surface winds and winds 300m (1000 feet) above the surface. The shear vector is also depicted. NWS meteorologists can monitor low-level shear trends with ADAS and alert aircraft personnel to impending hazardous flight conditions. ARPS, on the other hand, can forecast areas most likely to experience excessive low-level wind shear up to 9 hours in advance.

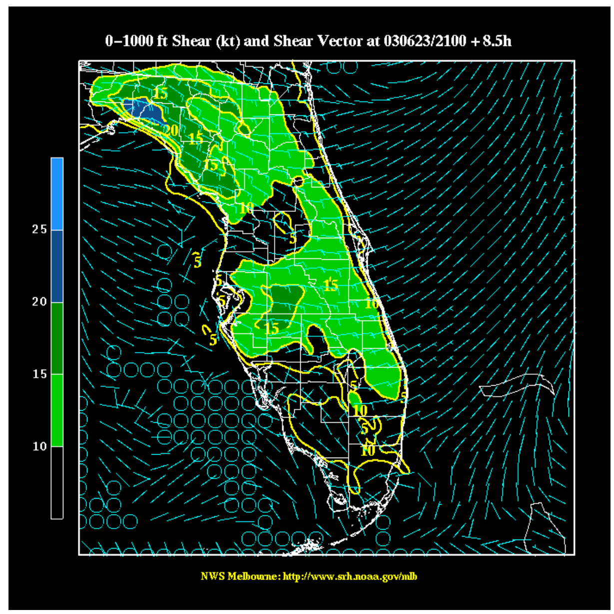

Fig. 6 ARPS 8.5-h forecast of 0-300 m shear and shear vector.

6. ADAS DIAGNOSTICS ON THE WEB

A limited set of ADAS analysis fields is 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, local land management agencies, 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 on the World Wide Web at the following URL: http://www.srh.noaa.gov/mlb/ldis/ldis_realtime_top.htm

7. SUMMARY

The advanced data analysis and mesoscale forecast system, ADAS/ARPS, has been configured at the NWS office in MLB. The system ingests many unique observational data sets available across the state of Florida. A local four-dimensional data assimilation system for the state of Florida has been achieved by cycling the ADAS analyses with the ARPS mesoscale forecast model. A primary motive has been to seek an appropriate means to facilitate the provision of gridded forecast information for tactical use by the local NWS office. For fire weather forecasting, the emphasis is on generating spot forecasts through gridded information during wildfire and controlled burn situations. ADAS diagnostics, combined with the prognostic capabilities of ARPS, have provided essential forecast guidance to support the MLB fire weather program, as well as to allow monitoring capabilities for land management officials in the field.

Additional improvements to ARPS will likely be achieved through extensive testing and evaluation. Re-running the ARPS model in a post event simulation mode will allow for the local tuning of adaptable parameters. ADAS analyses will continue to improve by incorporating additional data sets within the analysis domain, such as adjacent WSR-88D radars, the Terminal Doppler Weather Radar at the Orlando International Airport, the Florida Road Weather Information System (RWIS) network (Anne Brewer, personnel communication), and in-situ surface observations obtained by personnel on location at wildfires.

8. 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.

Blottman, P.F., S.M. Spratt, D.W. Sharp, K.R. Waters, B.N. Meisner, 2002: Local Data Analyses on AWIPS at NWS Melbourne FL. Preprints, AWIPS Symposium, 82nd AMS Annual Meeting, Orlando, FL, Amer. Meteor. Soc., 1-6.

Case, J. L., 2003: Reference Guide for the Real-Time ARPS/ADAS at the National Weather Service in Melbourne, FL. NASA Contractor Report NAS10-01052, Kennedy Space Center, FL, 17 pp.

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*, **17**, 3-26.

Crum, T. D., D. Evancho, C. Horvat, M. Istok, and W. Blanchard, 2003: An Update On NEXRAD Program Plans for Collecting and Distributing WSR-88D Base Data in Near Real-Time. Preprints, *19th Int. Conf. on Interactive Information Processing Systems (IIPS) for Meteorology*, Oceanography, and Hydrology, Long Beach, California, Amer. Meteor. Soc., 14.2.

Droegemeier, K. K., K. Kelleher, T. Crum, J.J. Levit, S. A. Delgreco, L. Miller, C. Sinclair, M. Benner, D. W. Fulker, and H. Edmon, 2002: Project CRAFT: A Test Bed for Demonstrating the Real-Time Acquisition and Archival of WSR-88D Level II Data. Preprints, *18th Int. Conf. on Interactive Information Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology.,* Orlando, FL, Amer. Meteor. Soc., 136-139.

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.

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.

National Weather Service, 2003: Fire Weather Services, NWSPD 10-4 NWS Office of Climate, Water, and Weather Services, July 2, 2003.

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.

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 Non-hydrostatic 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.