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LOCAL DATA INTEGRATION IN EAST CENTRAL FLORIDA USING THE ARPS DATA ANALYSIS SYSTEM

Jonathan Case* and John Manobianco
NASA Kennedy Space Center / Applied Meteorology Unit / ENSCO, Inc.
1980 N. Atlantic Ave. Suite 230
Cocoa Beach, FL 32931

1. INTRODUCTION

This paper describes the Applied Meteorology Unit's (AMU) efforts to configure, implement, and test a version of the Advanced Regional Prediction System (ARPS) Data Analysis System (ADAS; Brewster 1996) that assimilates all available data within 250 km of the Kennedy Space Center (KSC) and the Eastern Range at Cape Canaveral Air Station (CCAS). The objective for running a Local Data Integration System (LDIS) such as ADAS is to generate products which may enhance weather nowcasts and short-range (< 6 h) forecasts issued in support of ground and aerospace operations at KSC/CCAS. A LDIS such as ADAS has the potential to provide added value because it combines observational data to produce gridded analyses of temperature, wind, and moisture (including clouds) and diagnostic quantities such as vorticity, divergence, etc. at specified temporal and spatial resolutions. In this regard, a LDIS along with suitable visualization tools may provide users with a more complete and comprehensive understanding of evolving weather than could be developed by individually examining the disparate data sets over the same area and time.

The AMU implemented a working prototype of the ADAS which does not run in real-time. Instead, the AMU is evaluating ADAS through post-analyses of weather events for a warm and cool season case. The case studies were chosen to investigate the capabilities and limitations of a LDIS such as ADAS including the impact of non-incorporation of specific data sources on the utility of the subsequent analyses.

2. ANALYSIS CONFIGURATION

The configuration of ADAS follows the layout used for the terminal wind analysis in the Integrated Terminal Weather System (ITWS; Cole and Wilson 1995). ADAS is run every 15 minutes over an outer and inner grid with horizontal resolutions of 10 km and 2 km, respectively. The 10-km (2-km) analysis domain covers an area of 500 × 500 km (200 × 200 km), and consists of 30 vertical levels that extend from the surface to about 16.5 km above ground level (AGL). The vertical levels are stretched, with the finest resolution near the surface (20 m spacing) and the coarsest resolution at upper levels (~1.8 km spacing).

Data density and coverage in east central Florida varies considerably depending on the level in the atmosphere and distance from KSC/CCAS. The data currently incorporated by ADAS include KSC/CCAS tower, surface, 915 MHz and 50 MHz profiler, satellite (GOES-8), radar (WSR-88D), rawinsonde, and commercial aircraft observations. Manobianco and Nutter (1998) give specific details on the data distribution, coverage, and resolution used for this specific configuration of ADAS.

The analyses in ADAS are produced following Bratseth (1986) who developed an iterative successive correction method that converges to statistical or optimum interpolation (OI). Therefore, the Bratseth scheme is more computationally efficient than conventional OI but has the advantages of OI schemes which account for variations in data density and errors in the background fields and observations.

The background fields used on the 10-km analysis domain are the Rapid Update Cycle (RUC; Benjamin et al. 1998) grids of temperature, wind, relative humidity, and height at 25-mb intervals from 1000 to 100 mb. The RUC analyses are available at a horizontal resolution of 60-km (40-km) every 3-h (1-h) for the warm (cool) season case. The RUC grids are linearly interpolated in time every 15 minutes for each 10-km ADAS cycle. The resulting 10-km grids are then used as background fields for analyses on the 2-km domain. This nested-grid configuration and cascade-of-scales analysis follows that used for terminal winds in ITWS. With such an approach, it is possible to analyze for different temporal and spatial scales of weather phenomenon.

The observational data are incorporated into ADAS using multiple passes of the Bratseth scheme based on the varying spatial resolution of the data sources. Data with similar resolutions are grouped together in the same computational pass such that the ADAS incorporates each data source without excessively smoothing the resolvable meteorological features. This methodology ensures that each data source is utilized in the LDIS to its maximum potential, based on the meteorological features that the data can resolve.

3. DIAGNOSIS OF AN OUTFLOW BOUNDARY

A warm season case has been selected from 26-27 July 1997 to investigate the capabilities and utility provided by ADAS. A typical, undisturbed warm season environment characterized the case. Early in the afternoon, scattered thunderstorms developed across the peninsula (Fig. 1a) and a sea-breeze was evident along the east coast. Later in the afternoon, strong thunderstorms developed to the southwest of KSC/CCAS and were evident on both radar (not shown) and GOES-8 satellite imagery (Fig. 1b). An outflow boundary from these storms propagated to the northeast and caused an increase in wind speeds that was noted on the KSC/CCAS mesonet towers around 2245 UTC. This outflow boundary forced Atlas launch operation A1393 to be scrubbed for the day.

Both 10-km and 2-km grid analyses were generated for the warm season case at 15-minutes intervals from 1800 UTC

*Corresponding author address: Jonathan Case, ENSCO, Inc., 1980 N. Atlantic Ave., Suite 230, Cocoa Beach, FL 32931. E-mail: jonc@fl.ensco.com.

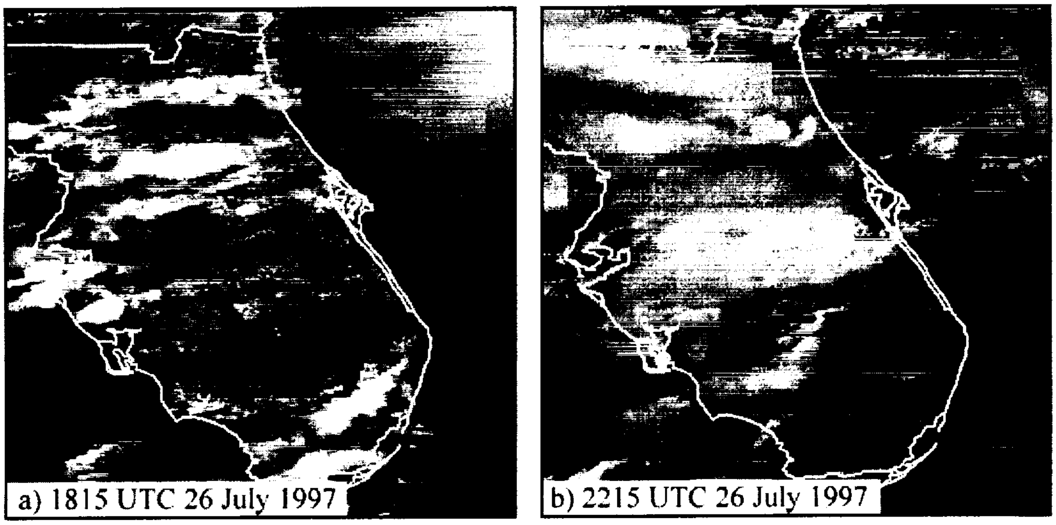

Figure 1. GOES-8 visible satellite imagery valid on 26 July 1997 at times (a) 1815 UTC and (b) 2215 UTC.

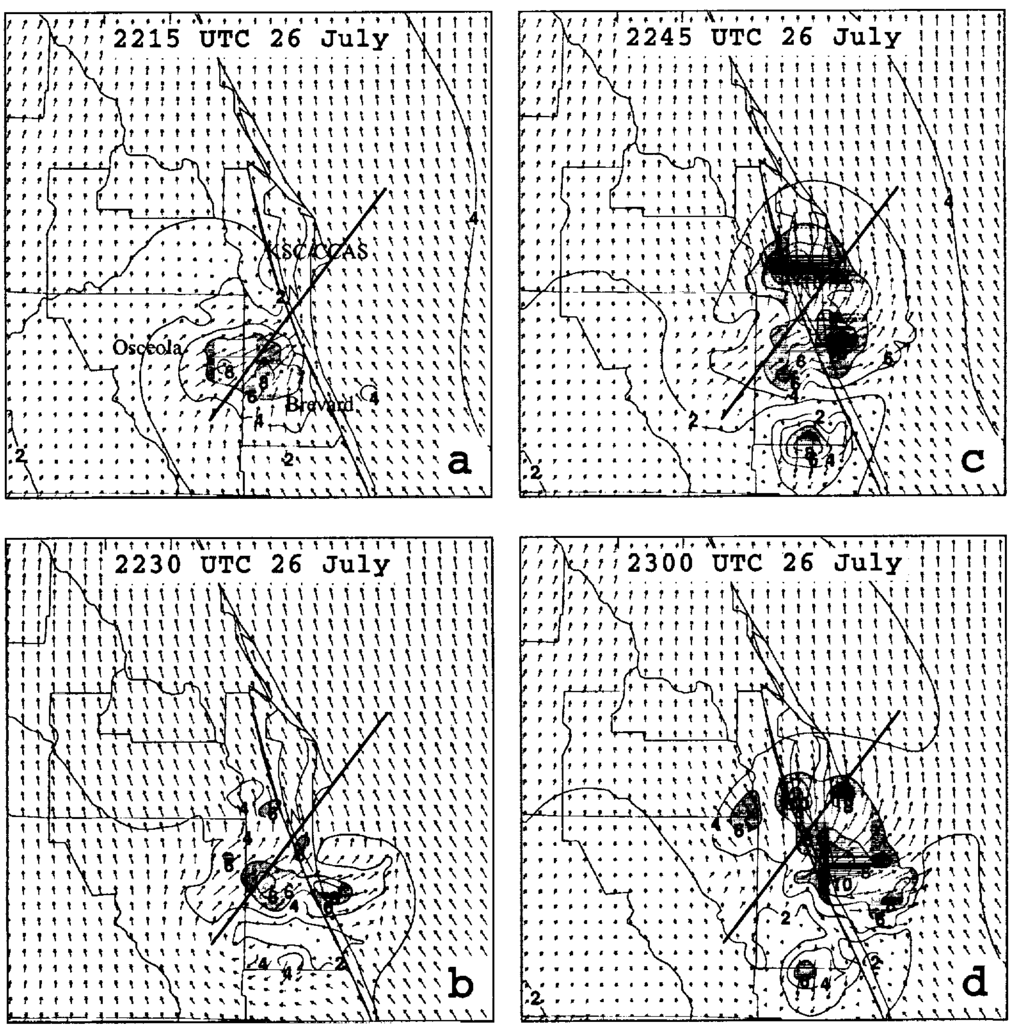

Figure 2. Wind speed (contoured, shaded above 6 m s^{-1}) and wind vectors (arrows) at 480 m MSL, valid on 26 July 1997 for the following times: (a) 2215 UTC, (b) 2230 UTC, (c) 2245 UTC, and (d) 2300 UTC.

26 July to 0200 UTC 27 July, using all available data. The resulting analyses discussed below show the fine-scale evolution of the outflow boundary on the 2-km grid.

The evolution of the wind speeds and wind vectors at 480 m above mean sea level (MSL; Figs. 2a-d) illustrates the formation and intensification of this outflow boundary. Wind speeds greater than 8 m s^{-1} develop over the Brevard/Osceola county border at 2215 UTC 26 July (Fig. 2a) and spread radially over the next 45 minutes. The maximum winds (> 12 m s^{-1}) move northeastward into the KSC/CCAS area and offshore regions of central Brevard county by 2245 UTC (Fig. 2c), the approximate time that the Atlas launch was postponed.

Above the lowest 200 m MSL, surface data do not influence the analyses. Therefore, changes in the horizontal wind field above the surface develop primarily in response to WSR-88D radial velocities in areas where radar reflectivity targets are available. Examination of level II radar reflectivity and radial velocity data (not shown) indicates that features present in the high resolution wind analyses (Fig. 2) are consistent with the scale and motion of patterns associated with the observed thunderstorm. It should be noted that the detailed structure of horizontal winds associated with this boundary would likely be more difficult to visualize in real-time using only radial velocity displays.

Cross sections taken along lines oriented southwest-northeast (see Fig. 2) help to illustrate the vertical structure and evolution of wind speeds analyzed on the 2-km domain. A core of relatively strong winds (8–10 m s^{-1}) associated with the convection to the southwest of KSC/CCAS extends from near the surface to 5000 m MSL at 2215 UTC (Fig. 3a). At 2230 UTC, a separate low-level wind maximum with speeds greater than 6 m s^{-1} develops between 200 m and 500 m MSL ahead of this core (Fig. 3b). Fifteen minutes later, this low-level wind maximum advances northeastward (left-to-right along the cross section) and increases in intensity to greater than 10 m s^{-1} (Fig. 3c). By 2300 UTC, the winds between 1000 m and 5000 m MSL weaken, but the low-level wind maximum maintains its intensity. Also at this time, a third wind maximum becomes evident in the 0–200-m MSL layer on the right side of Figure 3d.

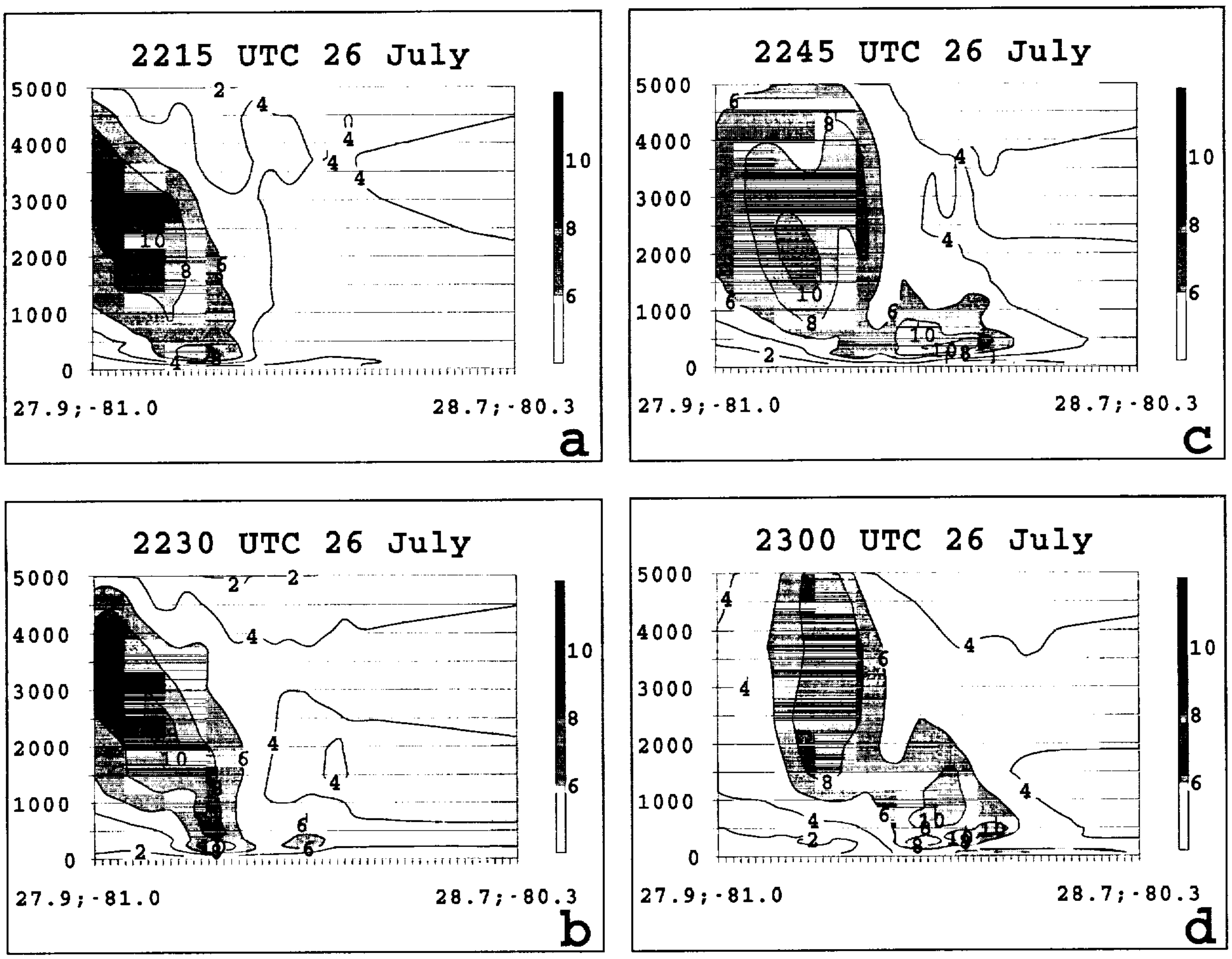

Figure 3. A southwest-to-northeast cross section of wind speeds on the 2-km grid, with winds > 6 m s^{-1} shaded according to the scale provided. The orientation of the cross section is denoted in Figure 2. Valid times on 26 July 1997 are (a) 2215 UTC, (b) 2230 UTC, (c) 2245 UTC, and (d) 2300 UTC.

The structure of the wind field shown in Figure 3d is a consequence of different data types that are used by the Bratseth scheme in ADAS. The wind maximum between 200–500 m MSL at 2300 UTC (Fig. 3d) shows a gradual upward tilt from southwest to northeast (left to right). This feature results from the incorporation of radar data which slopes upward away from the radar site. Furthermore, note that the winds are less than 6 m s^{-1} between the tilted wind maximum and the wind maximum in the lowest 200 m. These weaker winds are located at levels below the influence of radar data, but above the influence of near-surface KSC/CCAS tower data. Therefore, the background winds from the 10-km analysis are retained, and the two features are distinct. However, if data were available to fill in this gap, the outflow boundary would likely be analyzed as a single continuous feature from the surface to 1000 m MSL, in advance of the mid-level wind maximum (1000-5000 m MSL) associated with the dissipating thunderstorm.

4. SUMMARY AND FUTURE WORK

Results from the 26-27 July case demonstrate that subsequent 15-min analyses of horizontal winds on the 2-km domain can depict the formation and propagation of a thunderstorm outflow boundary. A LDIS has the potential to provide added value because it can incorporate data which are currently available only at KSC/CCAS and run at finer spatial and temporal resolutions over smaller domains than current national-scale, operational models such as the RUC and Eta.

The presentation at the conference in January 1999 will focus on additional results from the warm and cool season cases and future AMU efforts to assess whether changes to the prototype configuration are required to run a LDIS such as ADAS in real-time.

5. REFERENCES

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