AD-A175 934 METEOROLOGICAL SUPPORT TO THE EASTERN TEST RANGE(U) 1/1
EASTERN SPACE AND MISSILE CENTER PATRICK AFB FL
B F BOYD ET AL. JAN 87 ESMC-TR-87-01

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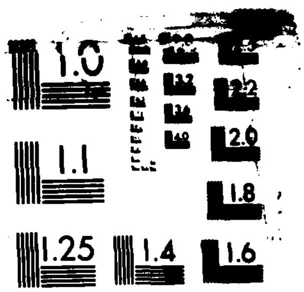

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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SECURITY CLASSIFICATION OF THIS [PAGE]

AD-A175 934

REPORT DOCUMENTATION PAGE

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18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*: Meteorology, Range Support, Instrumentation, Forecasting, Observations

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

Background is presented on the organizational structure and mission of weather support to the Eastern Test Range. The meteorological observational systems are presented and the data analysis and display system described. Computer programs, model support, and some current and projected forecasting improvement efforts are listed.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS ☐

21. ABSTRACT SECURITY CLASSIFICATION: Unclassified

22a. NAME OF RESPONSIBLE INDIVIDUAL: B. F. Boyd

22b. TELEPHONE NUMBER *(Include Area Code)*: 305-494-5915

22c. OFFICE SYMBOL: ESMC/WER

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INSTRUCTIONS FOR PREPARATION OF REPORT DOCUMENTATION PAGE

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ESMC-TR-87-01

METEOROLOGICAL SUPPORT TO THE EASTERN TEST RANGE

Billie F. Boyd
T. M. Myers
F. P. Lockwood
ESMC/WE Staff Meteorologist
Patrick Air Force Base, Florida 32925

January 1987

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(Final)

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EASTERN TEST RANGE
RANGE SUPPORT OFFICE
PATRICK AIR FORCE BASE, FLORIDA 32925

Report No. ESMC-TR-87-01

METEOROLOGICAL SUPPORT TO THE EASTERN TEST RANGE

B. F. Boyd, T. M. Myers, and F. P. Lockwood

Office of the Staff Meteorologist
Eastern Space and Missile Center
Patrick Air Force Base, Florida 32925

1. BACKGROUND

The Eastern Space and Missile Center (ESMC) is comprised of two major operational and a typical number of host organizations. The two major operational organizations of ESMC are the Eastern Test Range (ETR) and the 6555th Aerospace Test Group (ASTG). There are also numerous tenant organizations, including Detachment 11, 2nd Weather Squadron of the Air Weather Service, United States Air Force (USAF).

As a national range, the ETR supports the National Aeronautics and Space Administration (NASA), Army, Navy, Air Force, and foreign government space and missile programs. This support begins at Cape Canaveral and continues through the Caribbean and into the South Atlantic Ocean.

The most familiar mission of the ETR is its support to the Space Shuttle. Although Shuttle launches increased in frequency between 1981 and 1985 (see Table 1), those launches represented only a small part of the total launches at the ETR (see Table 2).

YEAR	NUMBER OF LAUNCHES
1980	0
1981	2
1982	3
1983	4
1984	5
1985	9
TOTAL	23

Table 1. Number of Shuttles launched at the ETR 1980-1985.

ORGANIZATION	NUMBER OF LAUNCHES
Air Force	11
NASA	61
Navy	123
Army	46
Total	241

Table 2. Summary of major launches at the ETR 1980-1985.

2. METEOROLOGICAL ORGANIZATION AND FUNCTION

The Commander, Detachment 11, 2nd Weather Squadron, is the Staff Meteorologist (ESMC/WE) to the ESMC. Detachment 11 provides meteorological, environmental, and aerospace support to the ESMC, ETR, NASA, Air Force Technical Applications Center (AFTAC), and DOD Manager for Space Transportation System Contingency Support Office (DDMS). Detachment personnel provide forecasts, observations, climatological studies, and consultant services to a wide variety of range users listed above. Most observational data are taken by the Range Contractor's Meteorological Systems Department, responsible for surface, upper air, and high altitude rocket measurements at Kennedy Space Center (KSC), Cape Canaveral Air Force Station (CCAFS), and the downrange island stations. The Range Contractor also does meteorological equipment maintenance and meteorological software program development and maintenance.

3. METEOROLOGICAL OBSERVATIONAL SYSTEMS

Meteorological systems used to input data to meet the forecast requirements at the ETR represent some of the best operational systems available. Those include the following.

3.1 Upper Air Instrumentation

3.1.1 Meteorological Sounding System (MSS)

Designed to provide highly precise, 0.1 second interval data with the more accurate, faster commutating sondes to meet stringent ESMC test needs, the MSS is also compatible with current standard sondes. The MSS is used to make rawinsonde observations to altitudes of approximately 30 kilometers, rocketsonde observations to approximately 65 kilometers, and windsonde observations to at least 20 kilometers. The system receives in the 1660 to 1700MHz frequency range from balloon-borne radiosondes or rocketsondes. The system transmits in the 400-406 MHz frequency range as the up-link carrier for a

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3.1.2 MSS Data Inputs Below 20 Kilometers

Several instruments are used to gather specialized data in the lower 20 kilometers, in addition to the standard daily rawinsonde releases. These include: tetroons for constant density level, windsondes for wind only soundings, and Jimspheres for high resolution winds. The Jimsphere is a rigid radar reflective balloon made of mylar. It is aerodynamically stable, retains a constant volume, and is skin tracked by radar to give high resolution wind speed, direction, and shear from the surface up to 18 kilometers.

3.1.3 Rocketsondes

Atmospheric measurements are taken from an altitude of 20 kilometers (65,000 feet) up to 90 kilometers (295,000 feet), using the Super Loki meteorological rocket system. The system provides information on winds, temperature, pressure, density, speed of sound, and wind shear after data analysis and reduction by the Meteorological Data Resolution Section (MDRS). The Super Loki meteorological rocket uses a four inch diameter, solid propellant rocket motor to carry a payload to an altitude of 60 kilometers (200,00 feet) or up to 115 kilometers (377,000 feet). Separation of the rocket motor and payload occurs at about 5,000 feet after which the dart coasts to its apogee. Four configurations are used:

a. PWN-10D meteorological probe contains a telemetry payload (sonde) consisting of a temperature sensing device and a transponder. At apogee (65 kilometers/215,000 feet), this instrument is deployed and decends on a parachute type decelerator. The transmitter telemeters temperature data from the sensor to the ground receiver. Wind data can be derived using the positions obtained from either the ground receiver or range radars.

b. PWN-10D, MOD I meteorological probe is similar to the 10D, but the rocket motor follows a stable ballistic flight to impact.

c. PWN-11D meteorological probe carries a temperature sensing device and transmitter to approximately 75 kilometers (240,000 feet).

d. PWN-12A meteorological probe carries an inflatable mylar sphere (Robin) to an apogee altitude of approximately 115 kilometers (377,000 feet). The sphere is ejected, inflates, and is radar skin tracked during its descent to provide atmospheric wind data from 90 kilometers (295,00 feet). Atmospheric density data are calculated from the vertical deceleration of the sphere and winds are calculated from the horizontal displacements of the sphere as it falls. Pressure and temperature data are calculated to fit the measured density profile using the equation of state.

3.2 Local Surface Observing System

In addition to the normal surface observations, the following systems are in use at the KSC/CCAFS complex.

3.2.1 Weather Information Network Display System (WINDS)

The WINDS consists of 25 instrumented towers plus instruments along the Shuttle runwa[illegible] launch pads that feed information int[illegible] Cape Canaveral Forecast Facility (CC[illegible]) [illegible]ensors are mounted at heights of 30 to 54 [illegible] plus one tower with sensors to 500 feet a[illegible] other towers instrumented to 200 feet. T[illegible] sensors provide wind direction and speed, temperature, dew point, and atmospheric pressure. Data are recorded every six seconds and averaged to a five minute value. The network has been temporarily expanded to include another 20 sites.

3.2.2 WSR-74C Weather Radar

The WSR-74C radar console is located in the CCFF while the transmitter/receiver antenna is located atop Building 423 at Patrick AFB. This weather radar provides displays of the horizontal and vertical cross sections and intensity measurements of precipitation areas within a 250 nautical mile radius of Patrick AFB. A digital video integrator and processor permits automatic contouring of precipitation intensity levels. Antenna controls provide for continuous scan, manual positioning, and elevation sector scan selection. The radar presentation can be displayed over the closed circuit television (CCTV) system. The CCFF also has dial-up access to the National Weather Service (NWS) radar at Daytona Beach and other NWS radar locations.

3.2.3 Launch Pad Lightning Warning System (LPLWS)

The LPLWS was designed to assist forecasters at the CCFF to monitor impending and current atmospheric electrical activity. It gives the forecasters information on trends in electric field potential and on locations of highly charged clouds and charge centers associated with lightning. The LPLWS consists of 34 electric field mills, computer software for reduction, and a CRT display in the CCFF. Its static field program contours the field mill data during periods without lightning. During lightning activity, the LPLWS program outputs the charge centers or source of the lightning activity.

3.1.2 MSS Data Inputs Below 20 Kilometers

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System (WINDS)

The WINDS consists of 25 instrumented towers plus instruments along the Shuttle runway and launch pads that feed information into the Cape Canaveral Forecast Facility (CCFF). Sensors are mounted at heights of 30 to 54 feet plus one tower with sensors to 500 feet and two other towers instrumented to 200 feet. The sensors provide wind direction and speed, temperature, dew point, and atmospheric pressure. Data are recorded every six seconds and averaged to a five minute value. The network has been temporarily expanded to include another 20 sites.

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3.2.4 Lightning Location and Protection (LLP) System

This lightning detection system locates cloud-to-ground lightning in the Patrick AFB, CCAFS and KSC areas. This system complements the LPLWS which can locate charge centers, but not actual ground strike locations. The LLP system consists of two independent systems--a low gain and a medium gain system. The low gain system has two direction finder (DF) antennas, one located at Space Coast Executive Airport and the other on North KSC. The low gain DFs can detect lightning from within 100 kilometers. The medium gain system has three DFs located at Melbourne Airport, Orlando Airport, and North KSC. These DFs detect lightning within 200 kilometers. The low and medium gain systems have their own central position analyzer (PA). The DFs communicate to their respective PA via half-duplex lines. The medium gain system is designed to detect only negatively charged strokes; however, the low gain system detects both negative and positive strokes.

4. DATA ANALYSIS AND DISPLAY SYSTEM

To assist the forecaster with the problems of integrating data from various sources and producing mission support products which use available data in an internally consistent manner, the Meteorological Interactive Data Display System (MIDDS) was developed under contract with the Space and Science Engineering Center (SSEC). That contract was funded jointly by KSC and the ETR. The MIDDS (Young, 1985) consists of an IBM computer with appropriate peripherals and workstations in supporting a variation of the Man Computer Interactive Data Access System (McIDAS) software (Suomi, 1983). The system provides integration of the data sources available to the CCFF into a single data base where the various types of data can be melded and displayed together for forecaster use. It also provides growth for new data sources and allows for a significant increase in the applications which the forecasters and system users are expected to make after they become more familiar with the power of the system.

The MIDDS, still under development, will input worldwide meteorological observations, satellite data, and all local sources. The MIDDS has been described elsewhere in detail (Young et al 1985 and Boyd and Myers, 1986) and specific utilization detailed by Myers and Boyd (1985) and Kolczynski et al (1986).

4.1 Data Inputs to MIDDS

The MIDDS global data input consists of real time Geostationary Operational Environmental Satellite (GOES) data and hourly conventional data received via the FAA604 circuit. Gridded data via the NWS Numerical Meteorological Center's products circuit are planned. Local data bases are input from the WINDS, LLP, LPLWS, and upper air sensors. Radar improvements have been subcontracted out by SSEC to include a volumetric scan radar with associated products which will be incorporated into the MIDDS.

4.2 MIDDS Software

The MIDDS software can be divided into four categories of interest to the meteorologist. They are support software, interactive workstation software, meteorological software, and image processing software.

Support software includes: the ingestors which monitor the incoming data for unique events and trigger other programs, the system scheduler which starts activities based on time, builds displays of various products and maintains them automatically without forecaster intervention, and the user interface building sub-system which allows the user to create or modify plain language menu templates which invoke commands and processes with single stroke action by the user.

The interactive workstation software controls the workstation, and provides instant access to the image and graphic displays stored in the workstation. Other workstation commands provide looping of graphics, images, or both; annotation of graphics; superposition of graphics on images; interactive gray scale modification; and compositing of two images.

The meteorological software provides extensive capabilities for the forecaster to create numerous products of interest.

The image processing software provides image display, image enhancement in gray scale and frequency domains, multi-image combination products, and dynamic 3-D loops of the satellite images.

5. COMPUTER PROGRAMS AND MODEL SUPPORT

5.1 Meteorological Data Reduction Section (MDRS)

Meteorological computer programs run at the CCC are maintained by the Range Contractor's MDRS. Meteorological programs are basically of two types; programs that process data in a batch mode, and those that process continuously. There are approximately 50 weather programs on the Cyber 740 and NOVA 3 computers and another 27 for various applications on the Meteorological Sounding System. During major launches, the weather programs must be integrated into the ETR's intensive CCC schedule.

5.2 Blast Damage Assessment Prediction Model

A Blast Damage Assessment Model is run at the CCC to help ESMC Safety assess potential property damage and consequent casualties in the event of an inadvertent detonation of a rocket or missile system during launch. The potential hazards depend upon several factors including explosive yield, the meteorological conditions, and the distance to population centers. Meteorological inputs to the model are pressure, wind, temperature and dewpoint from the instrumented wind towers and rawinsondes. Monte Carlo simulation techniques are used to evaluate uncertainties in meteorological data and resulting propagation conditions. As a by-product of the Monte Carlo simulation techniques, the model produces not only the expected value of airblast property damage and casualties, but also designed to detect only negatively charged strokes; however, the low gain system detects both negative and positive strokes.

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5.3 Rocket Exhaust Effluent Diffusion Model (REEDM)

REEDM is used to forecast the diffusion of the rocket exhaust ground cloud. The REEDM computer code includes basic mathematical expressions for atmospheric dispersion models, cloud-rise models, and models for calculating the gravitational deposition of acid droplets from the exhaust cloud. In addition to tabular output, four input parameters (temperature, potential temperature, wind speed, and wind direction) are graphically output for easy identification of atmospheric changes.

5.4 Meteorological And Range Safety Support (MARSS)

The MARSS system was developed by ENSCO, Inc., under contract to the U.S. Air Force, for the real-time assessment of toxic material spills. The initial version of MARSS has been used operationally since early May 1984 at the CCAFS and KSC. An enhanced version of MARSS with full color graphics, a high resolution map background, crash grid, and a combined toxic corridor-trajectory forecast model became operational during the summer 1985. The system supplies the user with displays of local winds (both as wind barbs and as a wind field) and a forecast of the ground level footprint of a toxic cloud resulting from a hazardous materials release. The MARSS program also provides graphic displays of weather tower data, rocket exhaust diffusions, and tabular numeric outputs (Bobowicz, 1985).

6. FORECASTING SYSTEMS

In addition to the systems discussed, additional efforts to improve forecasts include the following.

6.1 Model Improvements

Air Force contracts are presently in force to improve all models listed above. A KSC contract is currently funded to explore the possibility of incorporating a version of the Pilke 3D Model or Pilke 2D Model for use at the CCFF for seabreeze induced formation of thunderstorms.

6.2 Weather Expert Forecasting System

Arthur D. Little, Incorporated completed an evaluation and feasibility study and is currently under a KSC contract for a Thunderstorm Weather Forecasting Expert System (TWFES) Prototype Development Project. The objective is to demonstrate the feasibility of the A. D. Little developed architecture by capturing and encoding in scenario-form weather forecasting expertise related to forecasting thunderstorms which form within five miles of the Shuttle operational areas.

7. SUMMARY

A general overview of the organizational structure, mission, and special meteorological systems at the ETR has been presented. For more details on any particular area, one is referred to the papers referenced.

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