1. INTRODUCTION

Since 2001, the Forecast Systems Laboratory (FSL) has been supporting the Air Force Range Standardization and Automation (RSA) program. Based on the National Weather Service's Advanced Weather Interactive Processing System (AWIPS), a system has been tailored by FSL to support space launch operations at the Western (Vandenberg) and Eastern (Cape Canaveral) Ranges. A major goal of this work is to replace legacy systems with an integrated weather display, thus improving the Launch Weather Officers' effectiveness and efficiency.

The space launch community requires access to standard weather datasets, which are supplied to the Ranges by the National Oceanic and Atmospheric Administration's NOAAPORT (NWS 2004) data service. A connection to the local WSR-88D radar provides local radar data, with products from nearby radars also available via NOAAPORT. Launch and recovery operations, however, are subject to stringent weather-related constraints such as wind shear, temperature, and atmospheric electrical activity. A significant part of FSL's RSA development work (Davis et al. 2002) has involved the collection, processing, and display of these local datasets, including instrumented towers, profilers, SODARs (sonic detection and ranging systems), and atmospheric electricity sensors.

2. DATA INGEST AND PROCESSING

The two Ranges are in markedly different climate regimes. At Vandenberg, lightning is infrequent, whereas Cape Canaveral is one of the most electrically active places in the world. Accordingly, different sets of sensors are installed at the Ranges. At the Western Range, cloud-to-ground strikes are monitored by a Lightning Location and Protection System (LLPS) network. At the Eastern Range, a similar Cloud-to-Ground Lightning Surveillance System (CGLSS) network is operated. In addition, a network of field mills to detect the electrostatic field strength above the instrument is deployed around the Cape Canaveral area, and a Lightning Detection and Ranging (LDAR) system monitors electrical activity in the atmosphere above the launch complexes.

At both Ranges, however, the locally-collected data are preprocessed external to FSL's weather subsystem.
for the intermediate data storage. While it worked well, a standard disk file also performed well, and is easier to manage.

The first data delivery method considered uses a NFS (Network File System) mount point to pick up the data on the workstation via the network (as is standard for all other datasets). An LDAR Inventory process runs on each workstation to maintain a rolling inventory of available data slices. The LDM distribution method uses LDM to pass the raw data to each workstation, where the storage method is replicated for local access. The third data distribution method uses a multicast model to pass the data to the workstations for local storage and retrieval. Since the NFS method matches what is used elsewhere in the system, and testing showed it to meet the requirement of no more than five-second latency, the LDM and multicast methods were never developed.

3. DISPLAY

The Eastern Range atmospheric electricity data are displayed in three basic ways: as text, in a tabular format; in two dimensions, as plan views of strike locations or electric field intensity, as well as contour or image renderings of the latter; and in three dimensions for the volumetric LDAR data.

3.1 Tabular text

Of the electricity data, only the field mill electric field measurements are displayed in text form on the RSA weather system. Range safety rules require monitoring of the electric field strength within a mission-specific range of the launch pad. A snapshot of the legacy display of field mills is shown in Figure 2, with the critical field mills highlighted in yellow. If a measurement exceeding the safety threshold is observed, the station is highlighted in red, and a 15-minute timer is initiated. The RSA weather version is still under development; a completed display will be shown at the conference.

3.2 2-d display

Two-dimensional (plan-view) displays of the atmospheric electricity datasets include one- and five-minute summaries of both CGLSS and field mill-detected strikes; five-minute sequences from each of these systems, color coded by age (see Figure 3); and plots of the field mill charge values, along with contour and image depictions of an on-the-fly analysis of these data (Figure 4).
3.3 3-D display

As noted, the LDAR system monitors electrical activity in the space above the launch facilities, reporting three-dimensional locations of in-cloud and cloud-to-ground discharges using seven antennae. The legacy display shows south, west, and top views of the volume, and a histogram of the number of strikes by minute. The new display replicates these items, and adds an interactive 3-D window to examine the volume. Figure 5 is a snapshot of the data part of this display. The user can zoom in on the Top and 3D panels using the mouse or the controls shown in Figure 6. The West and South views are ganged to the Top view, so they respond to its magnification. The 3D view can also be rotated to any perspective using the mouse.

Figure 5. Data section of 3-D LDAR display. Events are color coded by age, as indicated in the data histogram in Figure 6.
4. CONCLUDING REMARKS

As the legacy systems at the two space launch weather centers are replaced, we do not expect that the Launch Weather Officers’ jobs will get any easier, but believe that the new tools should help them do their job more effectively and efficiently. The atmospheric electricity displays outlined in this paper are more integrated with other datasets than the subsystems they replace, and such integration leads to better and quicker comprehension of the weather situation by the user.

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6. REFERENCES


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