ARM-UAV Mission Gateway System

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Introduction

The Atmospheric Radiation Measurement-unmanned aerospace vehicle (ARM-UAV) Mission Gateway System (MGS) is a new field support system for the recently reconfigured ARM-UAV payload. The MGS is responsible for the following critical tasks:

- Provides an interface for command and control of the ARM-UAV payload during a flight.
- Receives and displays mid-flight state of health information, to help ensure the integrity and safety of the payload.
- Receives and displays data snapshots, averaged data, or sub-sampled data.
- Provides a user configurable, moving map display to enable the Mission Controller and the science team to monitor the progress of the sortie.
- Logs all significant events, and displays them in a color-coded message viewer. Events may be screened by instrument group, and sorted by various criteria.
- Receives and displays data snapshots, averaged data, or sub-sampled data.
- Retrieves data post-flight and processes raw data into products useful to the scientific community.
- Provides visualization tools to help identify data system or instrument problems before the next scheduled flight.
- Provides a full suite of network services to the field team: Web based reports, file transfer (FTP), remote secure login, windows file sharing (SMB), and network number address management via DHCP.

Hardware and Network

The computer used for the system includes dual Intel Xeon processors (2 GHz each), 1GB of Rambus PC800 memory, 120 GB of primary disk storage, and 120 GB of secondary backup disk storage. It has several communication interfaces, including a dial-up satellite (Iridium) interface; 100 Mbps ethernet to

the payload during pre-flight operations, 100 kbps Free Wave 900 MHz radio modem to the payload for use within 30 miles or so; and 100 Mbps ethernet to an Internet router. Figure 1 shows the network configuration used for the fall 2002 ARM-UAV deployment.

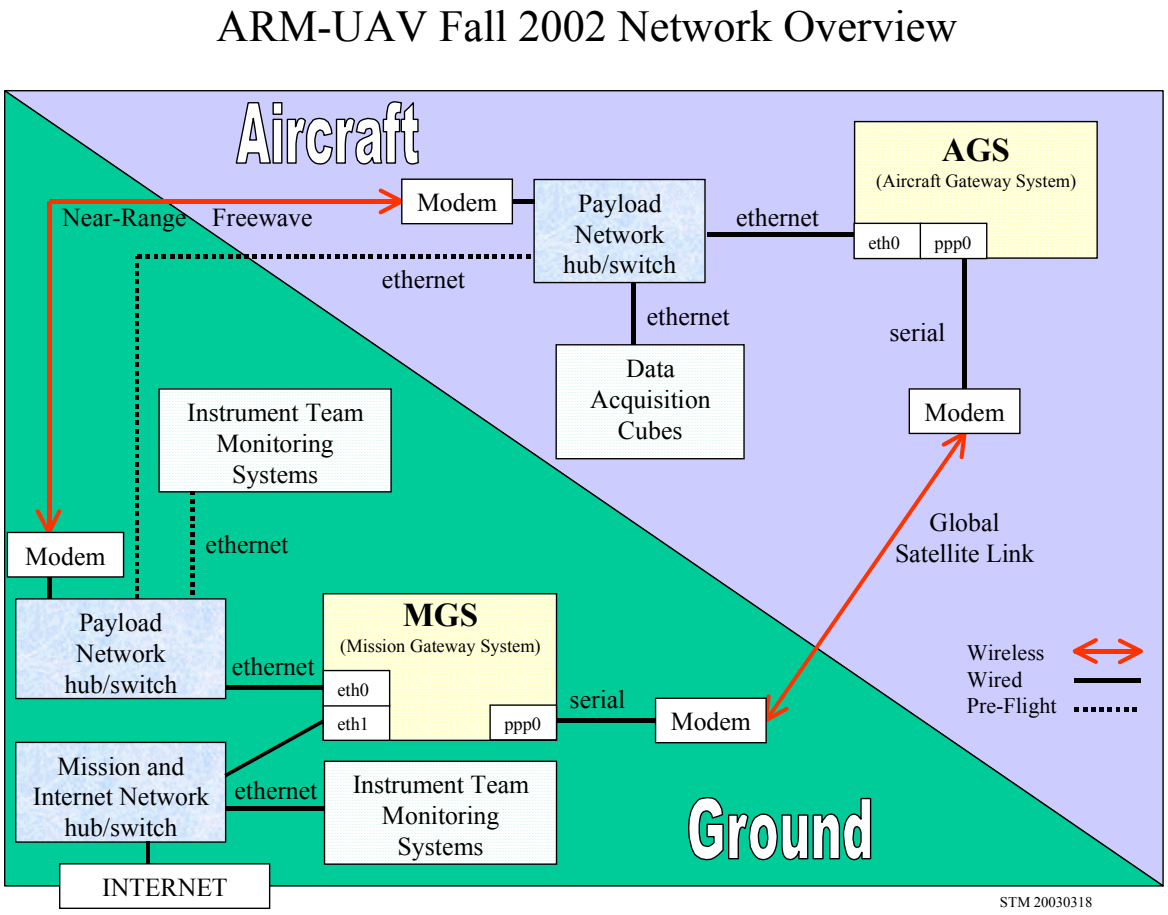

Figure 1. Network diagram.

MGS Software Features and Usage

The system was built with the following features:

- Modular design with functions categorized by instrument group. This allows for easy addition or removal of instruments without significant changes to the system code.
- Utilizes PERL for controlling processes, formatting output, and generating on-the-fly web pages. Mid-flight data file access and conversion functions written in C for efficiency.
- Most commonly used functions accessible via the web resulting in great flexibility regarding operator location, while minimizing hardware needed by the client.

- Displays automatically updated to ensure change in payload status is conveyed to team members in a timely fashion.

- Built upon Linux to ensure reliability, remote management, system security and efficient processing of multiple simultaneous users.

- Utilizes IDL as a high-level language for data analysis and visualization tasks.

Homepage

Figure 2 shows the homepage for the Mission Gateway System. From here, a user can monitor all aspects of a flight in progress. In addition, the mission controller can issue uplink commands to the onboard payload anytime before, during, or after a mission. The system automatically handles the transition from ground network tether to high-speed free wave radio, or low speed Iridium satellite.

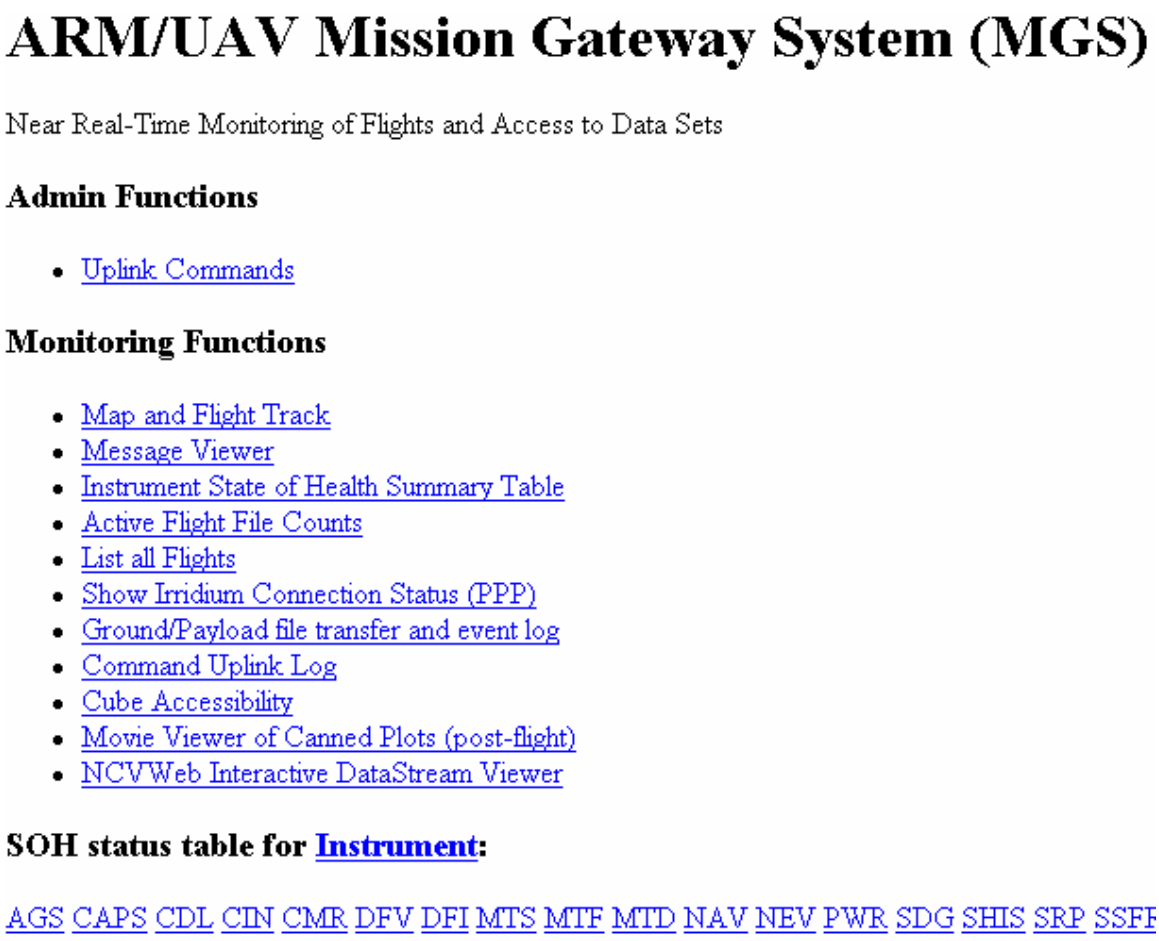

Figure 2. MGS homepage on the Web.

Uplink Control of the Payload

The uplink interface is designed to be easy to use under high-pressure situations. Very quickly, one can drill down to the commands appropriate for a particular instrument and send that command on to its intended destination.

Figure 3 is an example of the uplink control window for the Cloud Detection Lidar (CDL) instrument. The mission controller fills in any optional parameters, and then clicks on the command to be sent. A confirmation dialog box is displayed. If accepted, the command is quickly dispatched to the aircraft payload by the best possible means at that time.

Uplink Commands for CDL

LIDAR Disable CDL 0	Standby Off STANDBY off	Standby On STANDBY on	Detector Gate Delay [0] GATELAG {0-255}	Debug Command [21] DEBUG {10...21}
LIDAR Enable CDL 1	Mode Standby MODE 0	Set Time TIME	Counter Bin Delay [0] CNTRLAG {0-255}	WFOV Command [off] WFOV {off...down}
Laser Disable LASER off	Background MODE 1	Set Data File Interval (min) [5] DATA_TICS {1-60}	Bin Width [2] BINW {1-1024}	
Laser Enable LASER on	Single Shot MODE 2	Set SOH File Interval (min) [5] SOH_TICS {1-60}	Measurement Duration [1] DURATION {1-1000}	
Heater [off] HEATER {off...on}	Free Run MODE 3	Neutral Density Filter [0] NDF {0-7}	Laser Shot Rate [0: 5000 Hz] SHOTRATE {0-7}	

Return to Instrument List MGS User Page

Figure 3. Uplink command interface for the CDL.

Geographical Map

Figure 4 depicts the continuously updating mission map. Using the map, the Mission Controller and others can coordinate other aircraft in the area, ensure that flight plans are being followed correctly, plan for an unexpected return to base, or scope out remote landing possibilities. The map also assists scientists in determining which time periods correspond to data collection periods of interest based on geographic position.

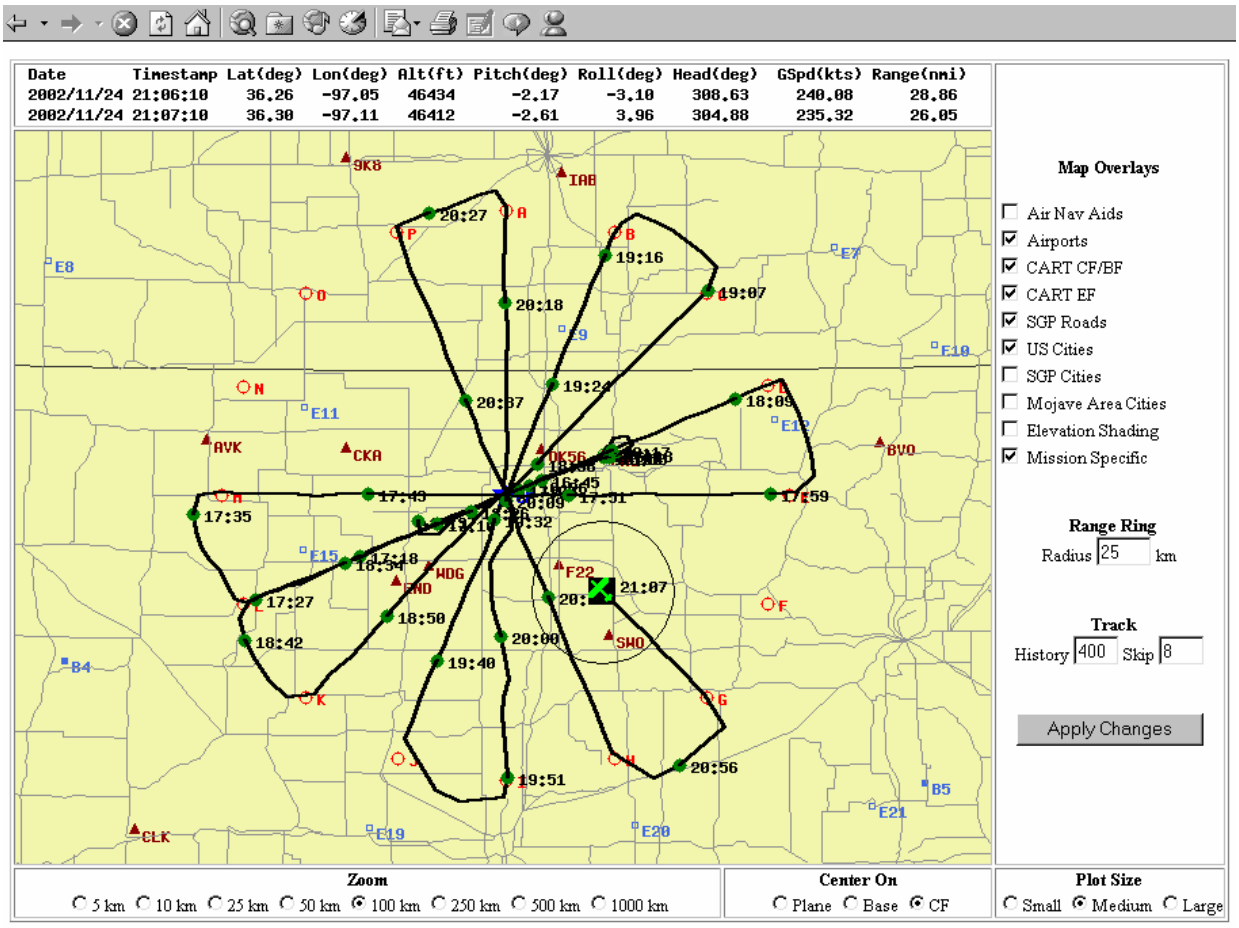

Figure 4. Near real-time Mission map.

The map is fully vector based, which allows for arbitrary zoom and pan control. The user also has a wide choice of various thematic layers to apply - including airports, ARM sites, roads, and cities. The map can be set to follow the aircraft (center of map equals plane location) or the center can be set to the operational base, or some other landmark such as the Cloud and Radiation Testbed (CART) Central Facility.

Instantaneous position, altitude, pitch, roll, heading, ground speed, and range are available in textual form as well as in graphical representation on the map. A range ring of any size can be extended from the aircraft center to assist with determining map scale and planning flight contingencies. The history of aircraft positions is displayed as a track with timestamp markers, spaced according to user desire.

Message Viewer

Any messages that the instruments generate are displayed on our message viewer application (Figure 5), which sorts the messages either by time, instrument, or severity and will notify the Mission Controller of any problems as they happen.

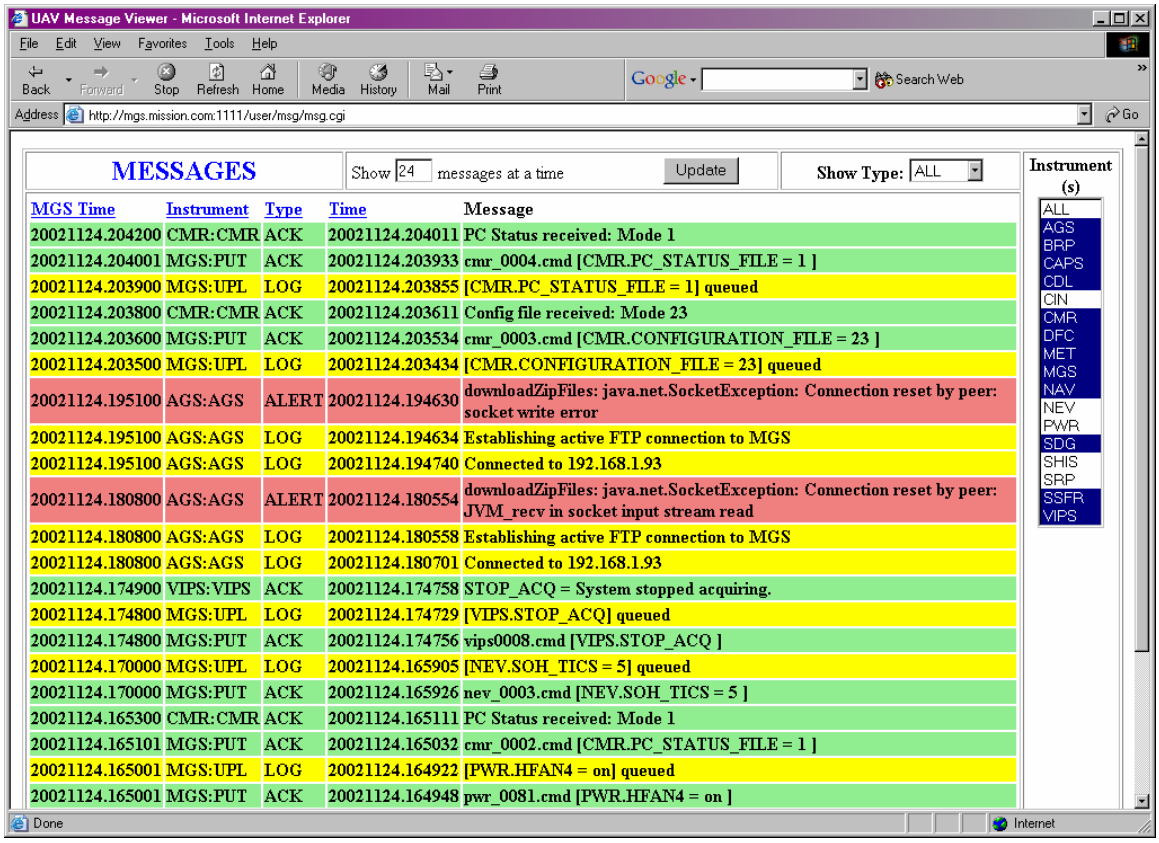

Figure 5. Message viewer.

Mid-Flight Data Quicklook

Using our Quick Look system, users have many ways to monitor and keep track of the flight in progress. An example of monitoring the Diffuse Field Camera (DFC) is given in Figure 6.

Each instrument has its own display, showing either current data values, or summary statistics of what the instrument has been detecting over the past minute or so.

Datastream Visualization

NCVweb is available to display flight data once it has been ingested to the NetCDF format. Figure 7 is an example of an image plot made from CDL data during the November 23, 2002 sortie. NCVweb is available at several ARM data repositories. Visit http://arm.mrcsb.com/ for details.

Comprehensive Diagnostic Plots and Movie Viewer

Once all the data for a sortie has been ingested, the MGS system will generate comprehensive plots of all variables for all the data streams. Rather than have an analyst laboriously generate plots one by one, he or she can quickly cycle through these auto generated plots using our movie viewer. The display interval is user selectable, and the user can easily revisit data streams of interest. When a particular

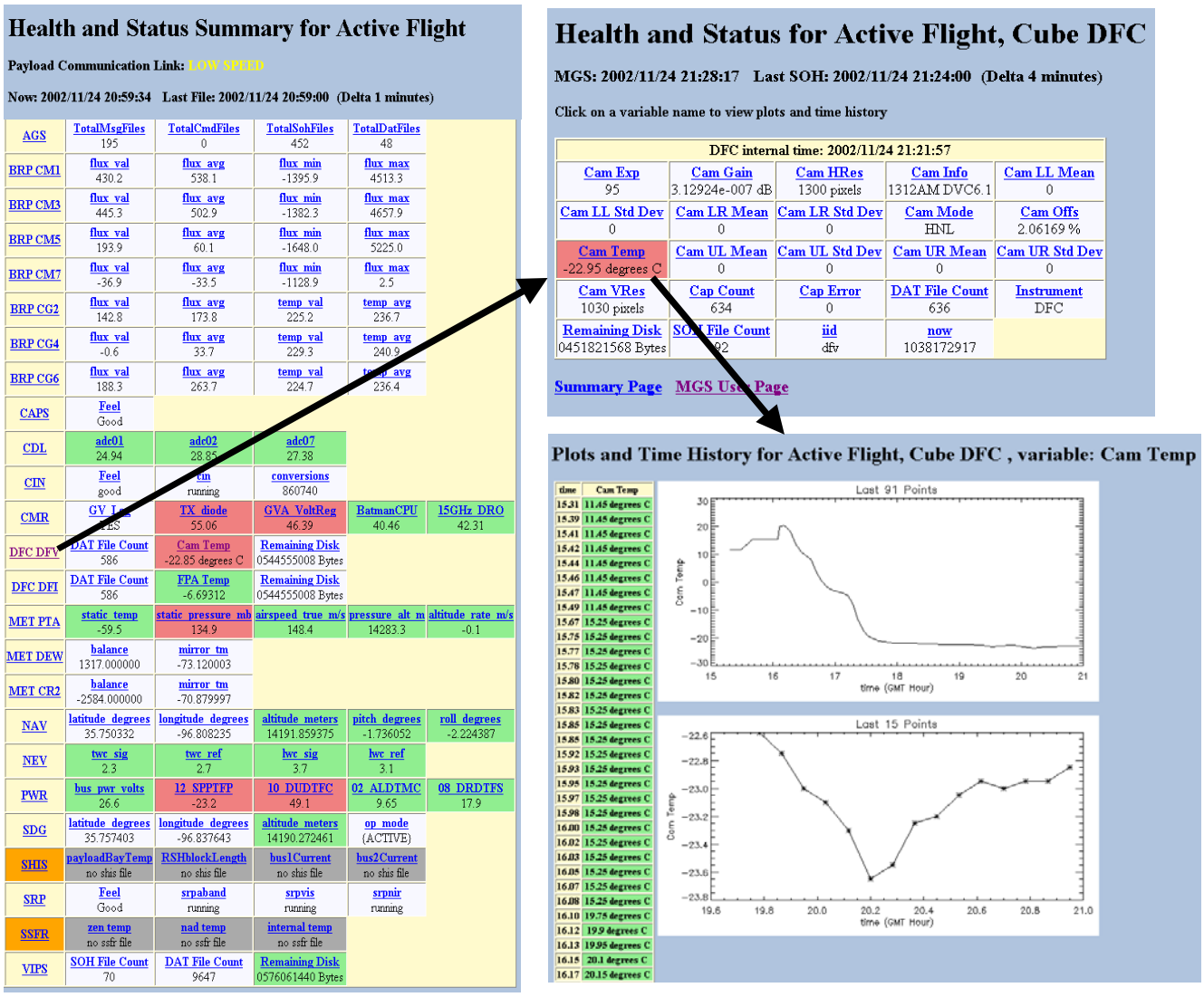

Figure 6. Health and Status Web displays.

variable needs further evaluation; the user can click a link that immediately places the data within NCVweb for detailed exploration. The movie viewer can also be used to display arbitrary png, gif, or jpeg files.

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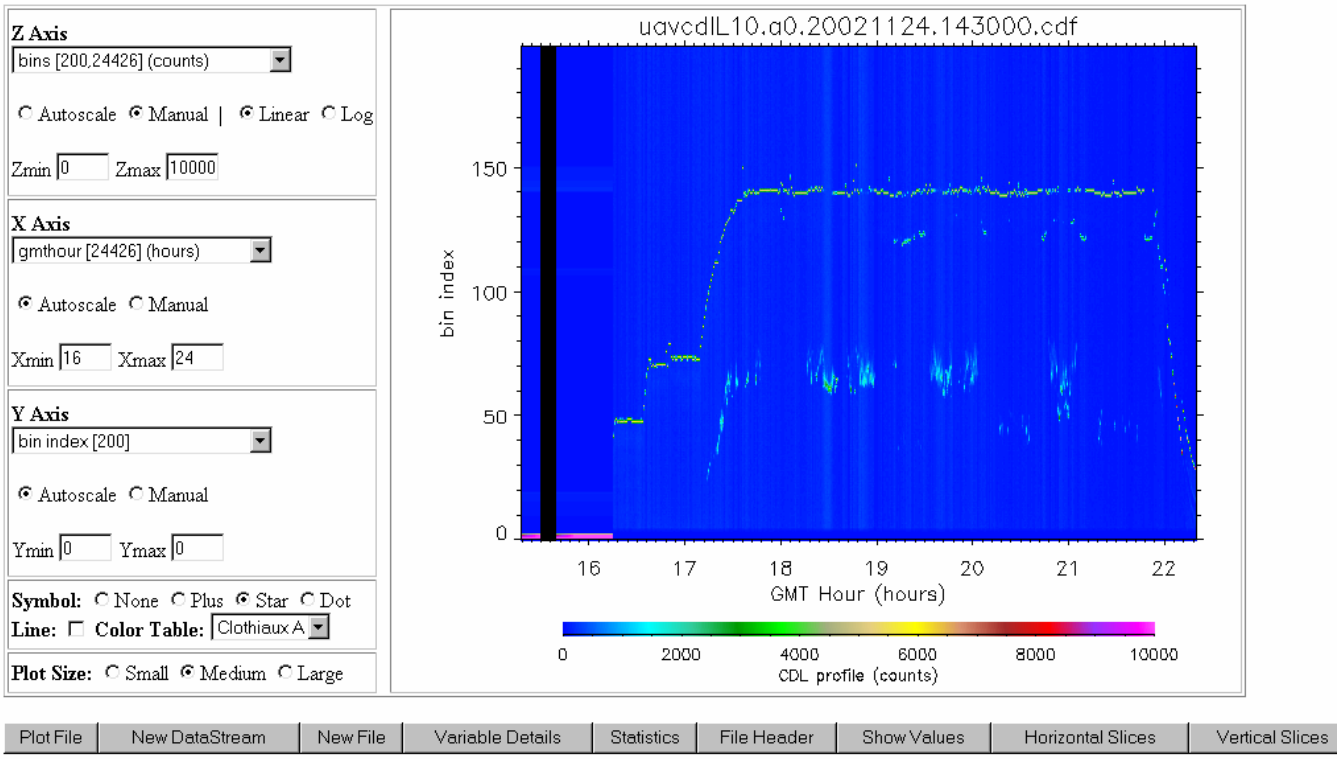

Figure 7. NCVweb displaying CDL data.