Meteorological Support for Unmanned Aerial Systems at U.S. Army Dugway Proving Ground

Susan Krippner, Erik Vernon and John Pace
Meteorology Division, West Desert Test Center
U.S. Army Dugway Proving Ground, Dugway, UT

Introduction: In September 2009, the U.S. Army Program Manager for Unmanned Aerial Systems (PM-UAS) officially stood up the Rapid Integration and Acceptance Center (RIAC) at Dugway Proving Ground (DPG). To assist this Army initiative, the DPG Meteorology Division developed new weather modeling capabilities and products by leveraging the ATEC Four-Dimensional Weather (4DWX) numerical weather modeling system. These new products can also be generated at other Army Test Ranges with UAS operations and 4DWX capability. An Area Test Execution forecast product called a FLIMSY, was also developed to provide a consistent format for weather support information for UAS flights. The DPG FLIMSY also contains significantly more information relevant to UAS operations than is available on the current DD 175-1.

Dugway Terrain: DPG is located in the Great Basin area of western Utah, south of the Great Salt Lake, with nearly 800,000 acres of desert conditions. The terrain combines large areas of relatively flat ground, with a few isolated mountain ranges extending about 1000m above the range floor. The ground surface includes patchy low vegetation, dry sandy soil, and salty playas.

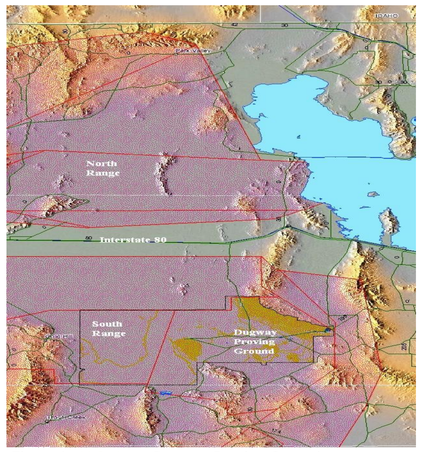

Figure 1. U.S. Army Dugway Proving Ground and Utah Test and Training Ranges

Dugway Weather:

- DPG and the surrounding vicinity is a region of scattered mountains and broad intervening valleys and basins.
- The climate is characterized by a hot dry summer, a cool spring and fall, a moderately cold winter and a general year-round lack of precipitation.
- Mountain barriers, oriented in a north-south direction, tend to restrict the movement of weather systems into this area.
- DPG is subjected occasionally to well-developed cyclones and fronts.
- Precipitation can vary widely due to terrain and seasonal variations.
- Long term meteorologists working at DPG have an in-depth knowledge of the mesoscale weather patterns that affect the area.

UAS: Various types and sizes of UAS will be tested at DPG. Some are not much larger than a pencil, and others can carry payload and weapons. Figures 2 through 7 show the variety of the supported UASs and Table 1 shows aircraft characteristics.

Figure 2. The Wasp UAS

Figure 3. The Raven UAS

Figure 4. The Puma UAS

Figure 5. The Shadow UAS

Figure 6. The Hunter UAS

Figure 7. The Warrior UAS

Table 1. UAS Systems and Statistics

UAS System	Weight	Wing Span	Max Endurance	Max Altitude
Wasp	.95 lbs	25 inches	45 minutes	50-1000 feet
Raven	4.2 lbs	4.5 feet	80 minutes	100-500 feet
Puma	9.9 lbs	5.9 feet	3 hours	500 feet
Shadow	328 lbs*	12.3 feet	7 hours	15,000 feet
Hunter	275 lbs*	29 feet	12 hours	15,000 feet
Warrior	3200 lbs*	56 feet	30+ hours	29,000 feet

*With payload.

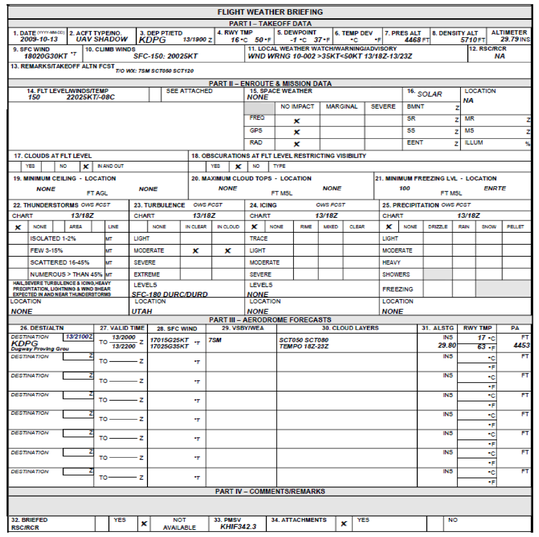

Figure 8. DD175-1 Forecast Valid 18Z 13 October 2009

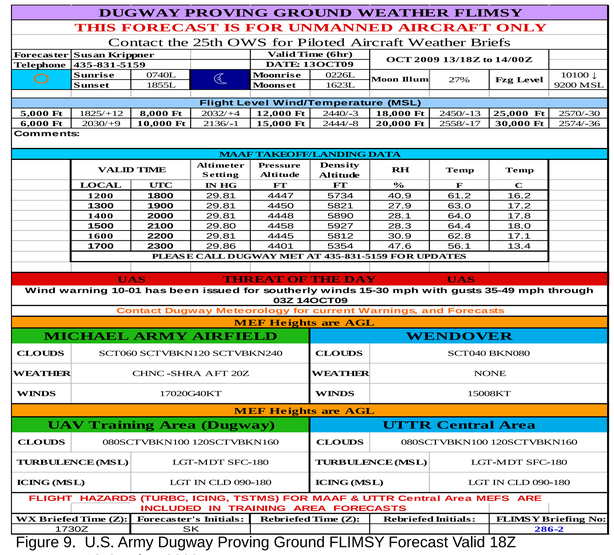

Figure 9. U.S. Army Dugway Proving Ground FLIMSY Forecast Valid 18Z 13 October 2009

FLIMSY vs. DD 175-1:

- Traditionally DD 175-1 briefs (Figure 8) were provided to the pilots.
- DD175-1's are adequate for a destination flight for larger aircraft, but for smaller UAS aircraft loitering over a small test area, a much more detailed area weather product is needed.
- A Test Execution FLIMSY forecast form was designed by DPG meteorologists for use at DPG to provide the required detail (Figure 9).
- DPG meteorologists have the luxury of using a large suite of locally deployed instruments, such as a large network of surface weather stations, two Doppler weather surveillance radars, sodars, lidars, ceilometers, rawinsondes, a vertically pointed Frequency Modulated Continuous Wave (FM-CW) radar, and profilers, for the development of the daily FLIMSY forecast.

Four Dimensional Weather System (4DWX):

- DPG has a state of the art weather modeling capability called the 4DWX, developed with the National Center for Atmospheric Research (NCAR).
- An operational weather and research forecasting (WRF) real-time data assimilation system using nudging.
- Two operational configurations.
- Single-run model forecasts winds, temperature, and relative humidity (RH) on a 1.1 km grid every 500 ft from surface to 30,000 ft mean sea level (MSL) every three hours (Figure 10).
- A 30-member mesoscale ensemble (3.3 km) runs every six hours.
- The ensemble provides estimates of uncertainty in 4DWX output (Figure 11).
- https://dpg-ingest.dpg.army.mil.
- A new modeling product in development is the WRF climate-four dimensional data assimilation (C-FDDA) Climatography, a 20-year reanalysis at a 3.3 km grid increment over DPG.
- A four dimensional climatography can be developed for any point within the grid model.

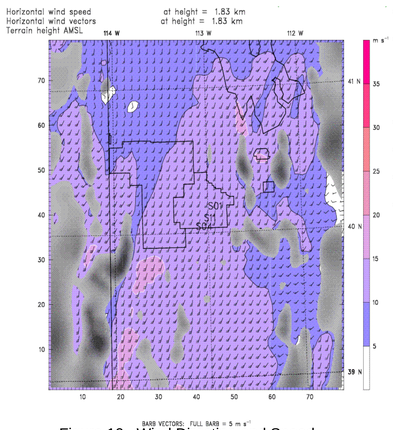

Figure 10. Wind Direction and Speed Indicated by Wind Barbs and Speed Contours at FL060. Gray Areas are Land Features that Extend Above the Flight Level.

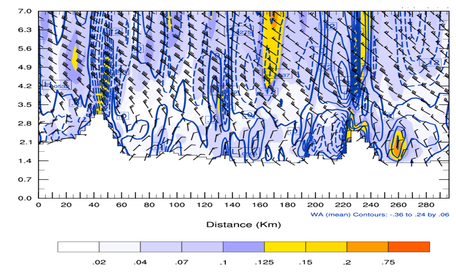

Figure 11. Ensemble Cross Section of Wind Speeds.

Summary: Rapidly integrating new technologies and getting UAS aircraft fielded to support the Soldier is an Army priority and the DPG Meteorology Division has assisted this effort. By providing new observational tools and models to better determine when conditions exceed the UAS's weather restrictions, such as adverse and colder weather when turbulence and icing are forecast, planned UAS operations are completed more successfully with lower mission aborts. The DPG Meteorology Division will continue to provide in-depth local weather expertise with advanced forecasting tools at all Army Test Ranges for more efficient and successful UAS operations.