Glenda Project – Dayton, WA

"Lone Tree" Launch Site – Profiling in Motion

"Lone Tree" Launch Site – Dayton, WA

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"Lone Tree" Launch Site – Background

The Blue Mountain Rocketeers (BMR) initiated launches at the "Lone Tree" site in 2000, and immediately noticed a bizarre behavior that when rockets were flown above 1,500 feet, that during recovery, they were blown by apparent high winds towards the direction of the gravel perimeter road located at the northern edge of the launch site even though ground wind speed was at a minimum.

Prior to BMR's use of the site, "Lone Tree" was also used as a runway by local crop dusters who also noticed this effect as well and were able to fly with heavier loads of agricultural sprays due to the increased winds at altitude.

The Glenda Project saw this effect as an opportunity to test out various sensors and provide wind velocity mapping data to BMR in support of the National Association of Rocketry (NAR) safety code requirement of assurance of recovery of all high powered rockets within the fields boundaries.

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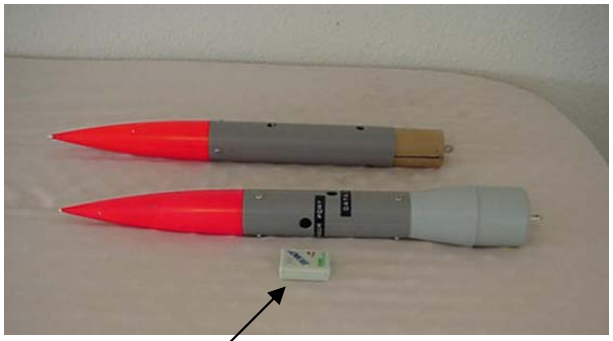
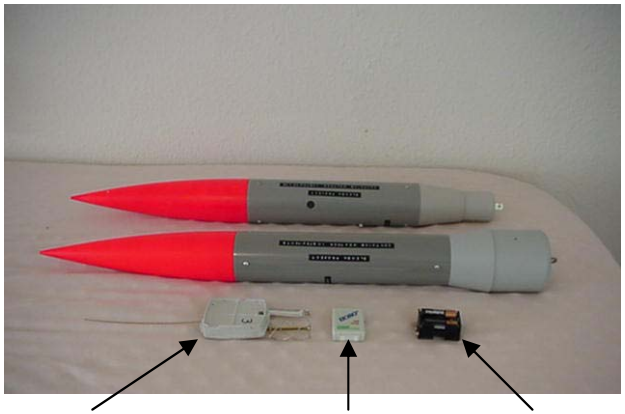
"Lone Tree" Launch Site – Glenda Capsules

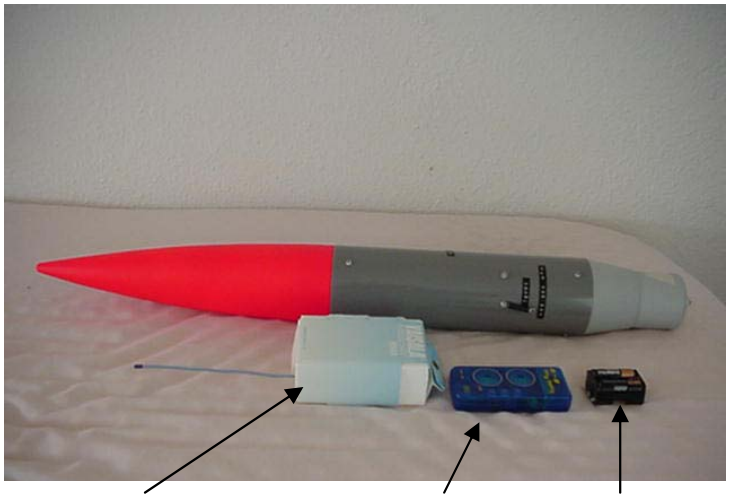
The Glenda project has used several different payloads in order to gain information about the "lone Tree" launch site



Datalogger



RS92 Digital Radiosonde Datalogger Battery Pack



RS80 Analog Radiosonde Locator Beacon Battery Pack

54mm (2.125") Capsules

- Datalogger Payloads
- Measures Temperature & RH values at 1 second intervals.
- Used by 54mm & 75mm boosters.

75mm (3") Capsules

- Datalogger Payloads
- Measures Temperature & RH values at 1 second intervals.
- RS92 Digital Radiosondes transmitting temperature, RH, barometric pressure, and GPS coordinates.
- Used by 54mm & 98mm boosters.

98mm (4") Capsule

- RS80 Analog Radiosonde transmitting temperature, RH, and barometric pressure.
- Audio location beacon
- Used by 75mm boosters.

Glenda Project – Thermal Mapping Mission

September 25, 2004 Columbia County / Dayton, Washington

During September 2004, Glenda performed a thermal mapping mission using the chart recording ground station, and both active and passive payloads.

The purpose of these two flights was to confirm, or refute the existence of a region of thermal activity over the “Lone Tree” launch site.

The first rocket sounding employed the Glenda 98mm capsule lofting an active transmitting payload broadcasting temperature, relative humidity and barometric pressure data to the ground station.

The second sounding flight was made using the Glenda 54mm capsule carrying a passive payload recording temperature and relative humidity.

Glenda Project – Thermal Mapping Mission

September 25, 2004 Columbia County / Dayton, Washington

At the time of the Glenda flights, the ground temperature was around 80 degrees, with a Relative Humidity around 37-38%. Under the standard atmospheric model, temperature goes down, as does humidity as you increase in altitude.

At “Lone Tree”, this was not the case.

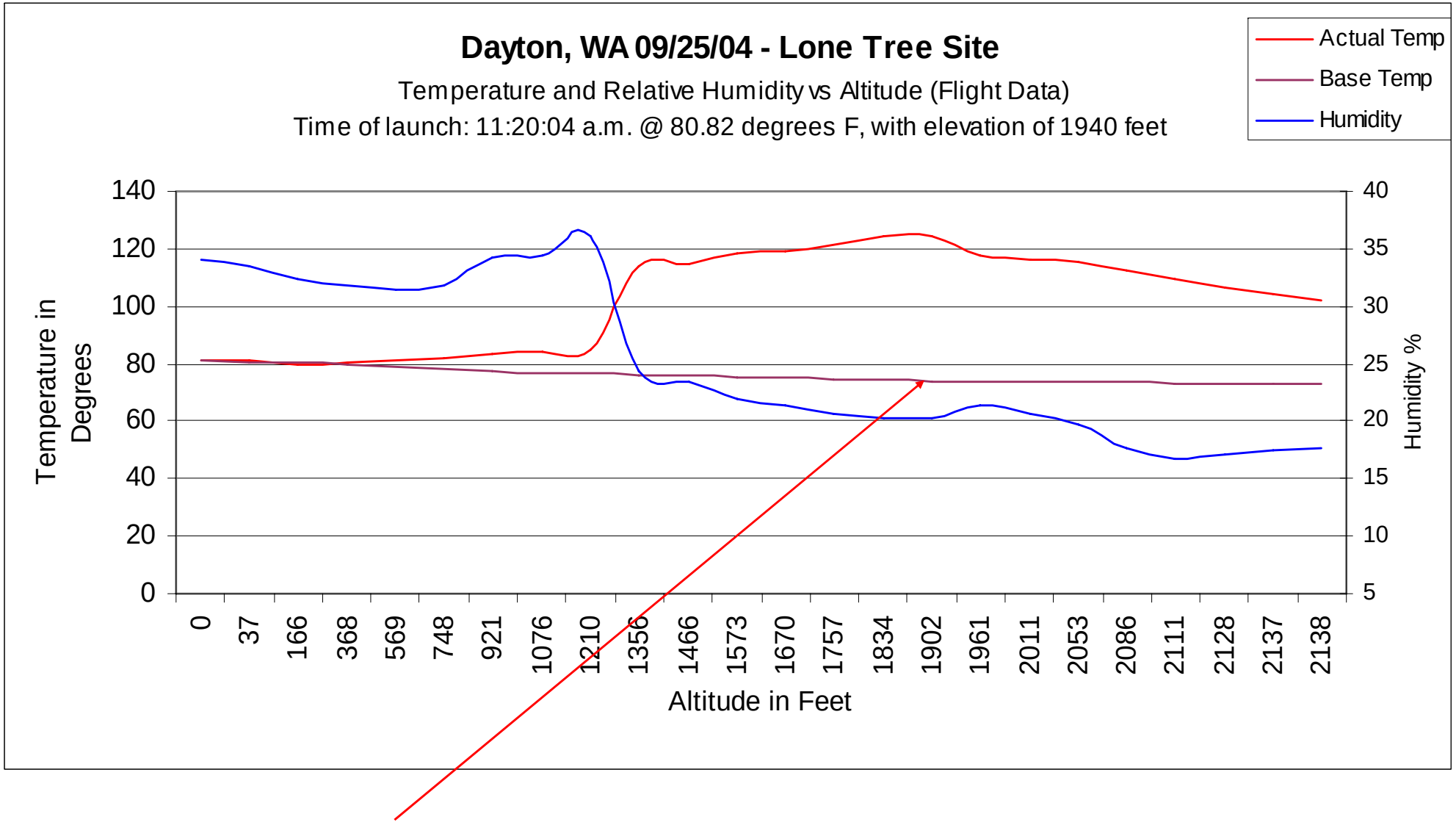
Temperature and humidity stayed relatively constant until 1,300 – 1,400 feet. Then things got interesting. The temperature rose rapidly, and the humidity level dropped. The sensors detected a 500 foot layer of hot, dry air which topped over 124 degrees at 11:00 in the morning. That's a 40+ degree difference from ground conditions. As the sensors penetrated the layer, more "normal" readings were detected.

The data between the two flights supported one another and have provided a body of evidence proving the existence of a thermal layer above the launch site.

The mapping mission was a success and the results are shown on the following slide.

Glenda Project – Thermal Mapping Mission

September 25, 2004 Columbia County / Dayton, Washington



Projected Temperature based on Standard Atmospheric Model – Something definitely out of the ordinary is happening!

Glenda Project – Thermal Mapping Mission

September 14, 2008 Columbia County / Dayton, Washington

Four years later in September 2008, the Glenda Project took this investigation to the next level by flying a hybrid payload containing a GPS transmitter to measure wind velocity, and a datalogger to measure temperature and RH.

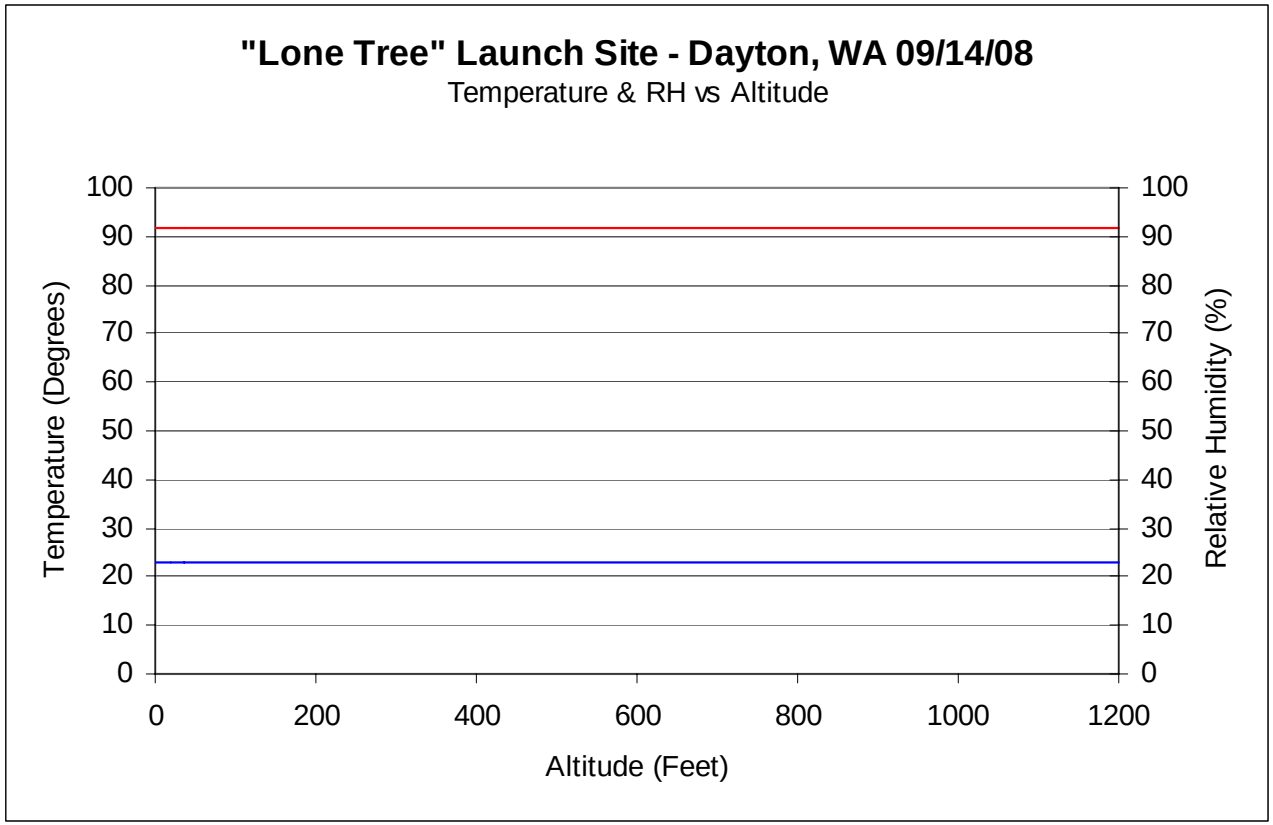
The most significant difference between the 2004 and 2008 flights was in the condition of the launch site. In 2004, the site was sown in Alfalfa and was uncut. In 2008, the site was still in Alfalfa. However, it had been freshly cut and bailed. It was unknown how this would effect the atmospheric conditions above the launch site.

The differences between the temperature vs. altitudes between 2004 and 2008 were striking. In 2008, with the cut field, the air temperatures remained constant through the capsules decent envelope.

The 2008 temperature and RH data vs. altitude chart is shown in the next slide.

Glenda Project – Thermal Mapping Mission

September 14, 2008 Columbia County / Dayton, Washington



A distinct difference between a cut and an uncut field on air temperature and humidity!

Glenda Project – Wind Velocity Profiling

September 14, 2008 Columbia County / Dayton, Washington

This “cut” condition effected the wind velocity vs. altitude as well.

An area of calm air existed between 1,200 feet when wind velocity measurement commenced, and 800 feet when changes to wind speed and direction occurred.

The advantage of GPS capsule positioning is that the Glenda capsule can rapidly detect changes aloft, transmit them to the ground station, then map these changes in multiple dimensions.

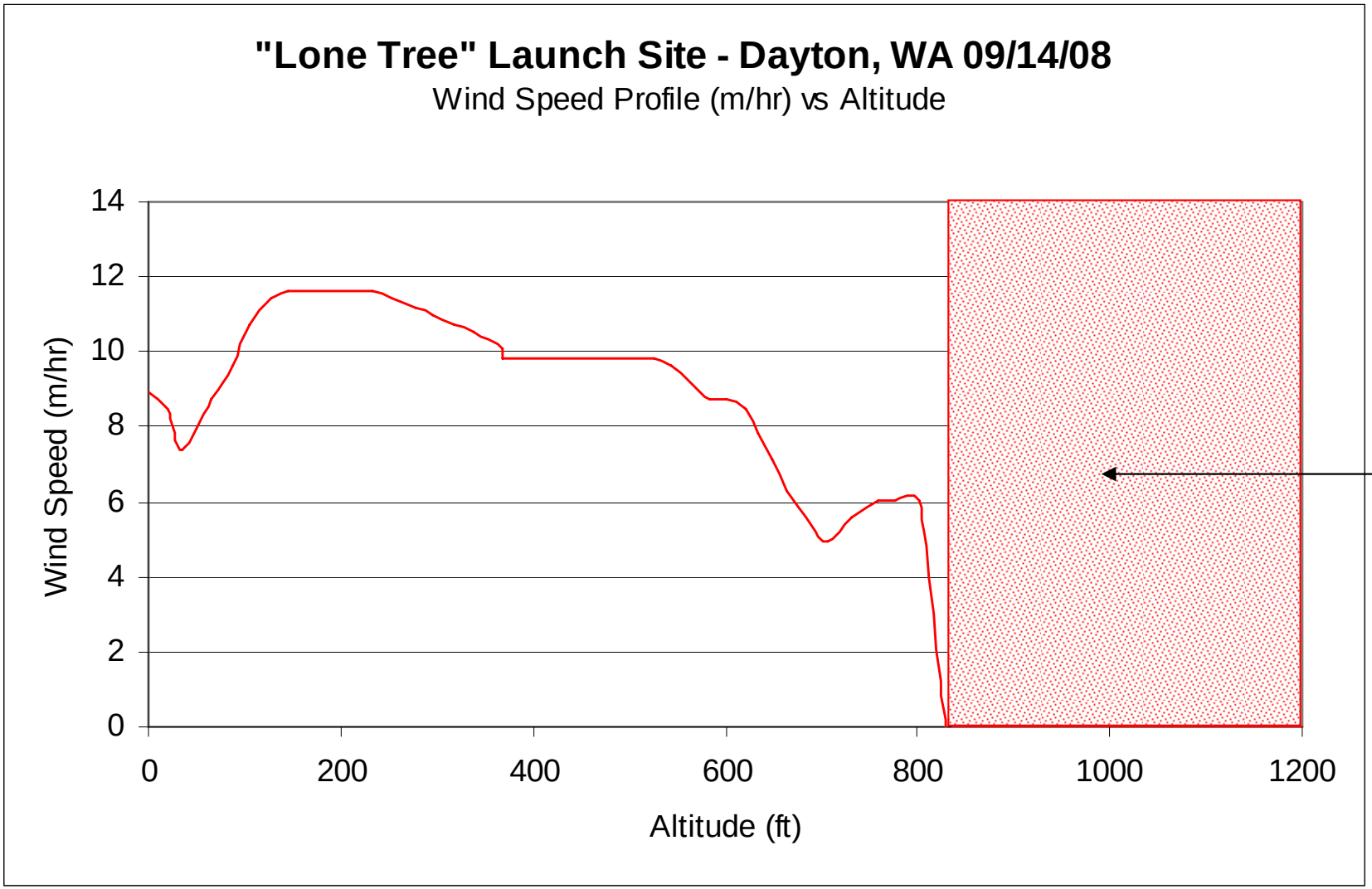
Wind velocity and capsule positioning are shown in the following two charts.

Glenda 75mm Capsule

Glenda 54mm Booster

Glenda Project – Wind Velocity Profiling

September 14, 2008 Columbia County / Dayton, Washington

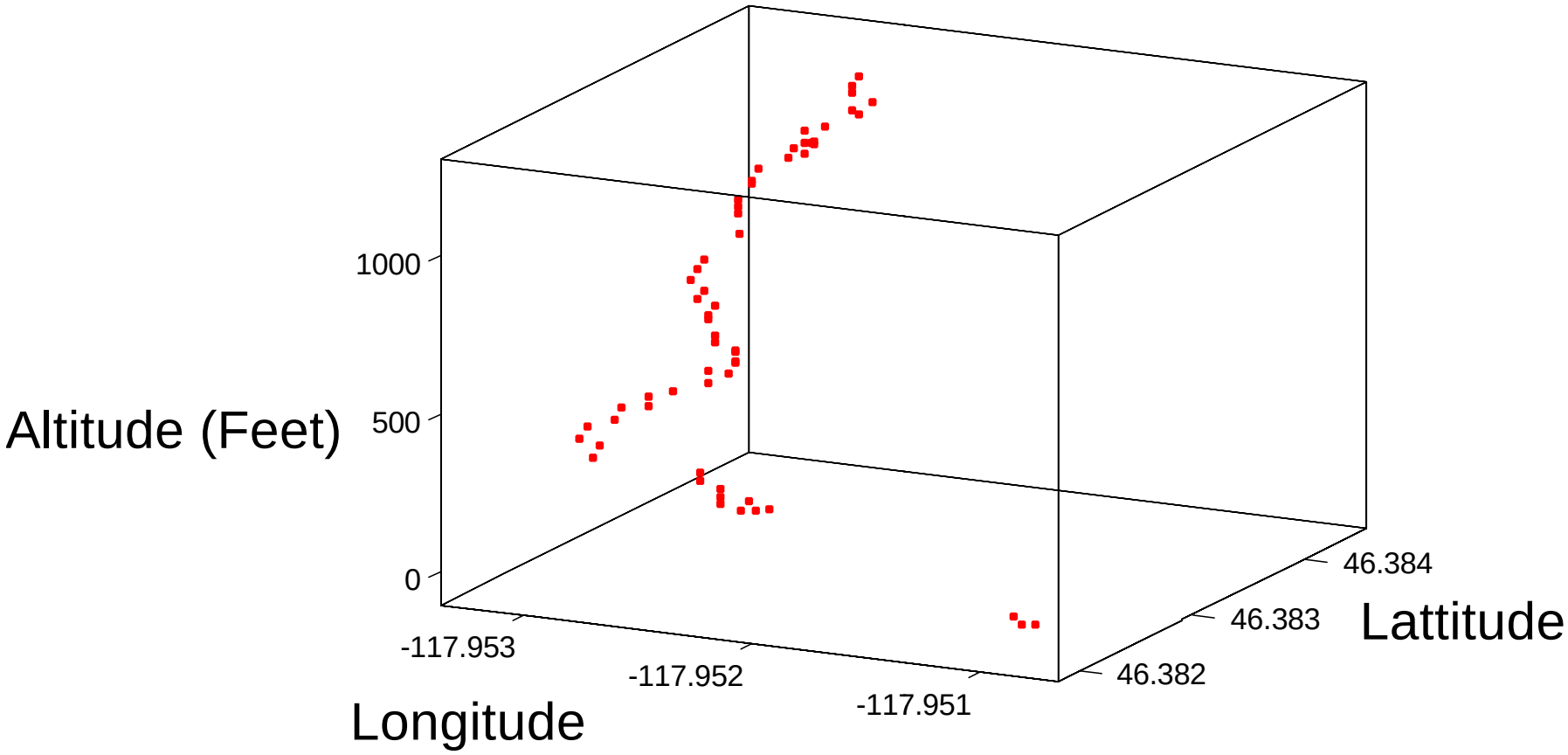


Insignificant wind speed from 800 to 1,200 feet

Glenda Project – Wind Velocity Profiling

September 14, 2008 Columbia County / Dayton, Washington

Active GPS Payload tracks motion of the capsule over the launch site in three dimensions



GPS functionality allows capsule tracking plus wind velocity determination capabilities

Glenda Project – Dayton, WA

"Lone Tree" Launch Site – Preliminary Findings

- A cut Alfalfa field has a significant positive impact on reducing air temperatures and wind speeds above the launch site.

- As air temperatures are reduced above the launch site, updrafts and turbulence are reduced as well, reducing the possibility of vehicle recovery outside of the field perimeter creating a safer launch environment.

- It is recommended that BMR have the alfalfa cut prior to launch operations in order to mitigate the evaporative effects of the alfalfa creating the increased temperature inversions and the associated wind speeds.

- Additional hybrid payload flights containing both dataloggers and GPS be made in order to study the effects various temperature ranges and field conditions have on the thicknesses, wind velocities and temperatures of the inversion layers above the launch site.

Glenda Project – Dayton, WA

"Lone Tree" Launch Site – Field Condition Parameters

Winds aloft Flying Conditions based on varying field conditions

	Alfalfa Height Low (freshly cut)	Alfalfa Height Medium (less than two feet tall)	Alfalfa Height High (greater than two feet tall)
Ground Temperature Over 60 Degrees	Winds aloft will match closely with observed ground wind speed conditions.	This area is the most turbulent and unpredictable based on the rate of evaporation from the alfalfa. As temperature rises, evaporation rises as well increasing the winds aloft. Wind speed above 1,000 feet could easily exceed 50%, of the ground observed wind speed.	Worst of all situations. Expect winds aloft to be at least twice that of the observed ground speed due to the evaporation updrafts. History has shown a significant thermal layer from 1,500 to 2,000 feet elevation.
Ground Temperature Under 60 Degrees	Best of all conditions. Low temperatures and low alfalfa. Because of the low evaporation, expect ground wind speed to also exist at altitude	Lower temperatures reduce evaporation which reduce winds aloft regardless of alfalfa height. Expect winds aloft just slightly higher than observed ground speed conditions	Conditions will be very similar to the Medium Height alfalfa. However, once temperatures cross the 60 degree threshold, wind conditions will start to degrade.

When the alfalfa, or predicted temperatures are high, the best flying conditions will be near dawn or dusk due to reduced levels of evaporation. Once the temperatures start to rise, wind speed will rise as well.