Glenda Project – September 18, 2010 - Dayton, WA

"Lone Tree" Launch Site – Microclimate Profiling in Motion

"Lone Tree" Launch Site – Dayton, WA

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"Lone Tree" Launch Site – Background

The Blue Mountain Rocketeers (BMR), club, 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 updrafts 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.

Glenda Project – September 2010

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For September 2010, our goals were to build on the flights from 2008 and 2009. Three flights were planned with altitudes of 2,500 feet to 4,000 feet. All would have multi-channel telemetry including the important 4D GPS (latitude, longitude, altitude, & motion) which was tested in 2008 / 2009.

The purpose of these flights will be to determine the boundaries and strength of the updraft layer above the “Lone Tree” launch site.

Flights will be made at different times of the day from early morning to mid afternoon in order to capture different flight profiles over different ground temperature conditions.

The boosters for these flights are shown on the following slide.

Glenda Project – September 2010 Flight Vehicles

9875 Booster

- 4” diameter booster, 3” diameter capsule
- RS92 Digital Radiosonde Payload with GPS
- Temp / RH Datalogger
- I211 Aerotech Motor – 2,800 foot altitude

5475 - HV Booster

- 2.125” diameter booster, 3” diameter capsule
- RS92 Digital Radiosonde Payload with GPS
- I218 CTI 54mm motor with 4,000 foot altitude

5475 Booster

- 2.125” diameter booster, 3” diameter capsule
- RS92 Digital Radiosonde Payload with GPS
- Temp / RH Datalogger
- I170 motor - 3,000 foot altitude

Glenda Project – September 2010 - Actual

While we had a really good plan, nature threw us, literally, a curve. A series of fast moving storm systems moved through the Columbia county area with rains on Friday and Saturday nights. The cloud base kept moving up and down through out the day on Saturday, and a decision was made to scrub the 5475HV flight as its altitude would exceed the cloud base.

The 9875 booster flew first on its I211 motor. The GPS board starting going erratic on the launch pad. However, not sufficiently enough to scrub the launch. During boost, the GPS board totally failed and at separation, only temperature and RH data was recorded by the onboard datalogger. While this data was solid, without altitude data to compare it against, it was basically useless.

After this in flight failure, a decision was made to swap out the new 4D capsule from the 5475-HV booster and fly it on the 5475 “Standard” booster powered by a CTI I170. The new capsule was designed to handle the higher accelleration loads and would survive the boost of the “I” motor.

The flight of the 5475 was picture perfect. However, nature then threw us a curve. Right at separation, the capsule hit a major updraft and wind shear and was accidentally “ingested” by a passing storm cloud. The capsule was spun around horizontally, breaking GPS lock. However, all other sensors continued to function. After several seconds, the capsule was ejected from the cloud and re-achieved GPS lock at 2,000 feet. Both capsule and booster landed over ½ mile down range and were successfully recovered. It was not our intent to penetrate the cloud base. However, nature had other plans.

The following series of slides displays the data collected during the flight, plus from the groundstation.

Glenda Project – Updraft Profiling

September 18, 2010 Columbia County / Dayton, Washington

The optimal sink rate of a Glenda capsule is 26 feet per second. Mathematically, this translates to -26 fps, as negative values indicate that the capsule is moving down, while positive values mean that the capsule is moving up.

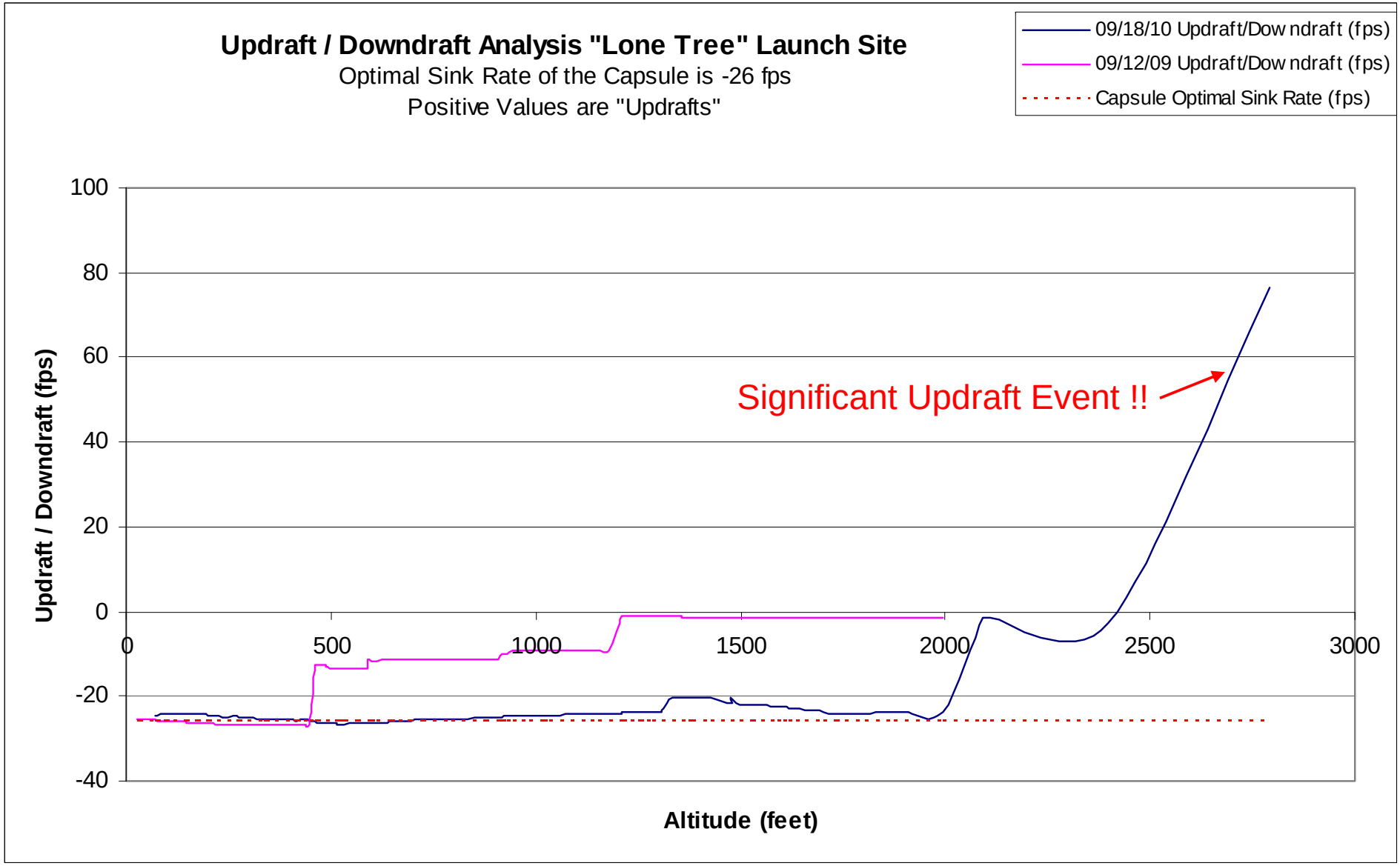
At separation at 2,700 feet, the capsule was caught up in a nearly 80 feet per second updraft. This translates to over 100 miles per hour, a significant updraft event!

This updraft, tumbled the capsule, resulting in only partial signal reception with the groundstation. The capsule eventually re-stabilized at 2,000 feet where GPS lock was re-acquired and was nominal to recovery.

The updrafts finally reached “normal” levels at around 1,200 feet where the flight proceeded under nominal conditions.

Glenda Project – Updraft Profiling

September 18, 2010 Columbia County / Dayton, Washington



Note: The September 2009 Updraft data is included as topical reference

Glenda Project – Wind Velocity Profiling

September 18, 2010 Columbia County / Dayton, Washington

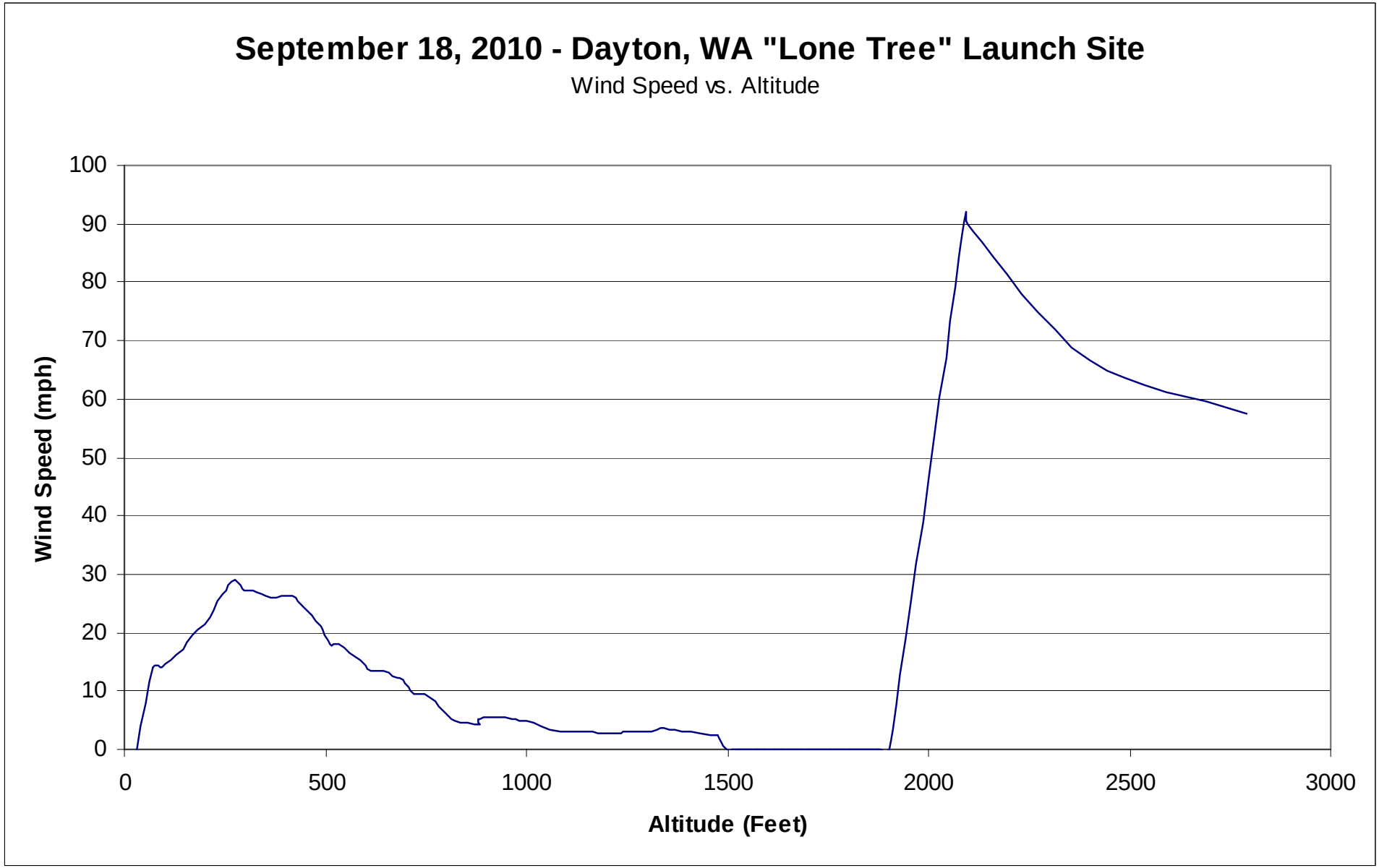
One of the major advantages of the Glenda system is its ability to measure wind speed at various altitudes. This launch gave the system a real work out when the capsule hit the combination updraft and wind shear in the altitudes from 2,700 to 2,000 feet.

Wind speeds of just over 90 miles per hour were detected at the 2,000 foot altitude, while another layer of close to 30 miles per hour was detected at the 250 foot level.

Note: These higher velocity winds were at the altitudes where we do the bulk of our flying and was playing havoc with tracking and landing trajectories. I know of one individual flying an Aerotech Cheetah who made four flights and went on four long recoveries from four different directions all based off of differing altitudes driven by motor selection. A very tough recovery day for a lot of folks.

Glenda Project – Wind Velocity Profiling

September 18, 2010 Columbia County / Dayton, Washington



While the winds at ground level reflected nominal conditions, the winds aloft were brutal!

Glenda Project – 4D GPS Positioning

September 18, 2010 Columbia County / Dayton, Washington

One of the improvements made prior to this series of launches was to modify the groundstation antenna system in order to receive signals in two planes. In the past, we used a dual antenna system, with both antennas oriented in the vertical direction. The intent was to increase signal coverage. However, it did not address the basic issue that the capsule did not stay in the vertical orientation for the entire flight. At apogee, the capsule went horizontal, and we lost signal. By aligning one of the antennas along the horizontal plane, it was hoped that signal quality would be improved.

Data quality significantly improved with this flight. However, nature exposed a weakness to this approach. While our “dual” plane antenna system addressed, vertical to horizontal, it did not address changes within the horizontal plane! When the capsule was “ingested” in the updraft / wind shear, the capsule was spun horizontally loosing signal!

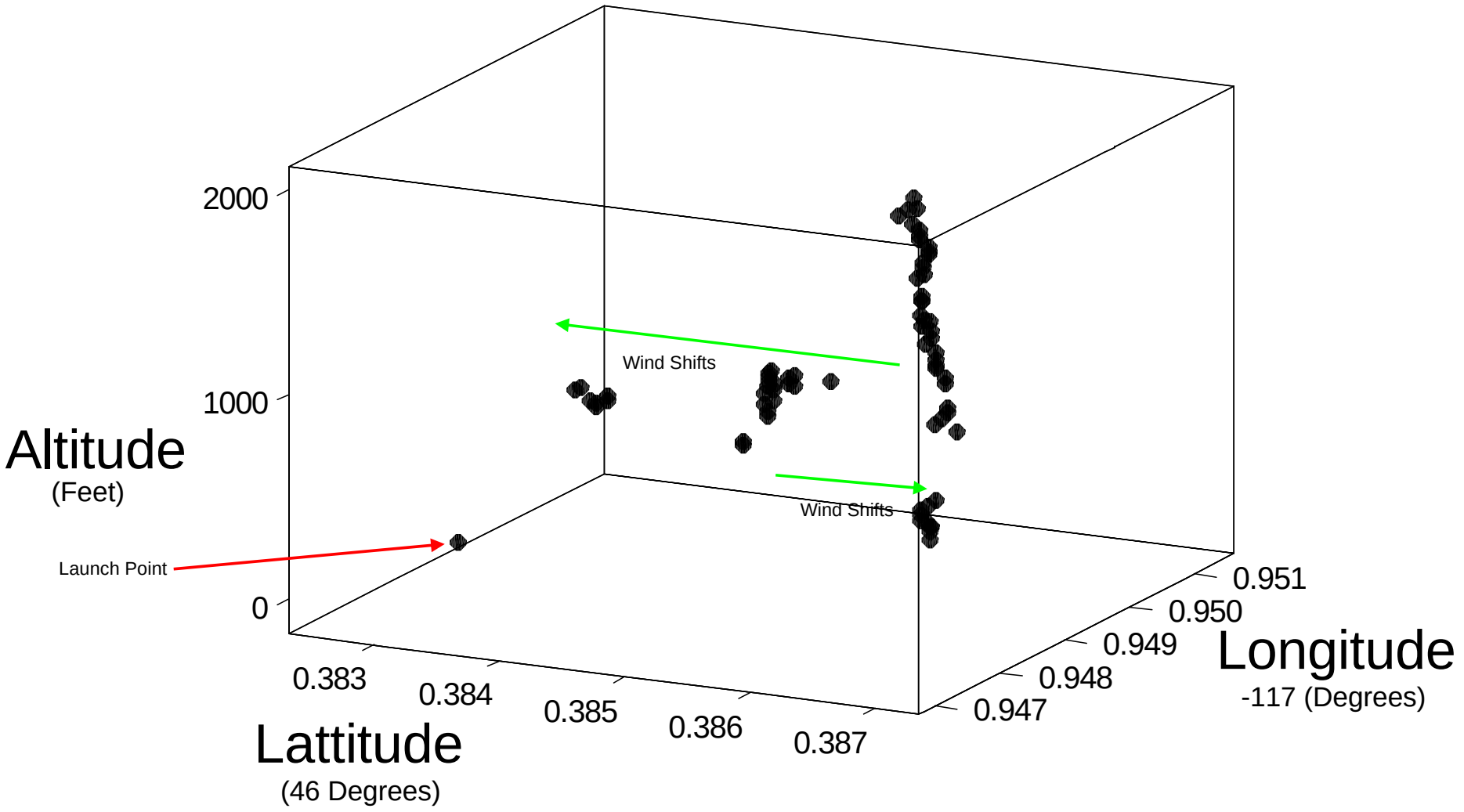
The 4D GPS system (Latitude, Longitude, Altitude, plus motion) transmitted excellent data, when not being spun around and in our antenna systems “blind spots”.

For next season, we’ll be deploying a “Quad Plane” antenna system which will solve this signal reception problem.

Nature sometimes presents us with situations which drives improvements which will make our data collection and signal reception even better.

Glenda Project – 4D GPS Positioning

September 18, 2010 Columbia County / Dayton, Washington



Note: The changing wind shifts as the capsule descends.

Glenda Project – Temperature Profiling

September 18, 2010 Columbia County / Dayton, Washington

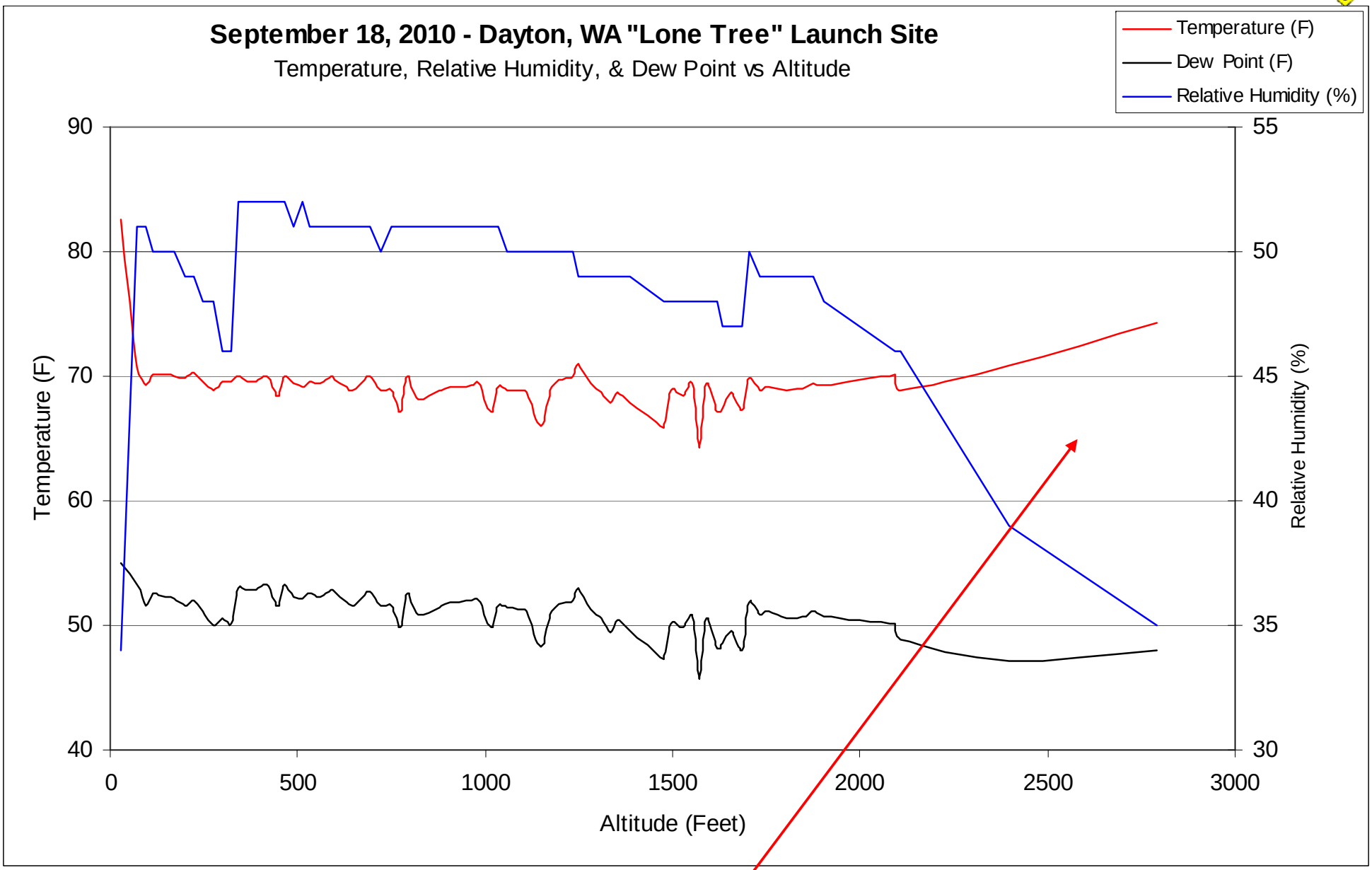
On previous Glenda flights, we've used onboard dataloggers to collect temperature and relative humidity data. This system resulted in additional pre-flight preparation to initiate the datalogger, plus the post flight downloading time and post processing. This datalogger data, combined with the transmitted positioning data, allowed us to "profile" temperature and relative humidity data versus altitude. One of our goals with Glenda is to present data in real time, in order to make real time decisions.

At the September launch, the set of flights used a datalogger system on the 9875 flight and a fully transmitted data suite of temperature and relative humidity sensors for the 5475 flight. The purpose of this was to ensure data collection in the event the transmitted data suite failed during flight. The exact opposite happened. The 9875 flight, with its proven reliable electronics, had an on-board failure of its data transmission system, while the 5475 flight with its untested system performed flawlessly. The major advantage of this new system is that pre flight preparation is greatly simplified. All that is needed is the basic "power on" and the on-board electronics does the rest. We will be transitioning to this new data transmission suite on future flights.

The "Lone Tree" site is a unique microclimate where temperature rises, rather than falls with altitude, and the inverse with relative humidity. The onboard sensors detected the updraft / wind shear was at a higher temperature and lower humidity than at lower altitudes. The exact opposite as to what should be expected.

Glenda Project – Temperature Profiling

September 18, 2010 Columbia County / Dayton, Washington



Note the environmental shift while the capsule is in the updraft / wind shear

Glenda Project – Groundstation Data

September 18, 2010 Columbia County / Dayton, Washington

For this launch, we deployed our “traditional” groundstation suite of instruments, as we wanted a digital record of the data, rather than “snap shots” provided by our TMQ-34, or our other “stand alone” sensors. An improvement in our USB-Serial hub allowed us to collect data from all of the necessary ground sensors without disrupting the signal reception and processing of the data being received from the capsule.

The time of the 5475 flight was in the 3:00 pm local time frame. So we were able to synchronize the transmitted data from the capsule with the recorded data from the groundstation.

Based on the recorded groundstation data, we were definitely between storm systems, and per the Launch Director, Saturday night was the first time floatation devices were issued at a BMR launch. The incoming rain and winds severely curtailed Sunday’s activities.

Glenda Project – Groundstation Data

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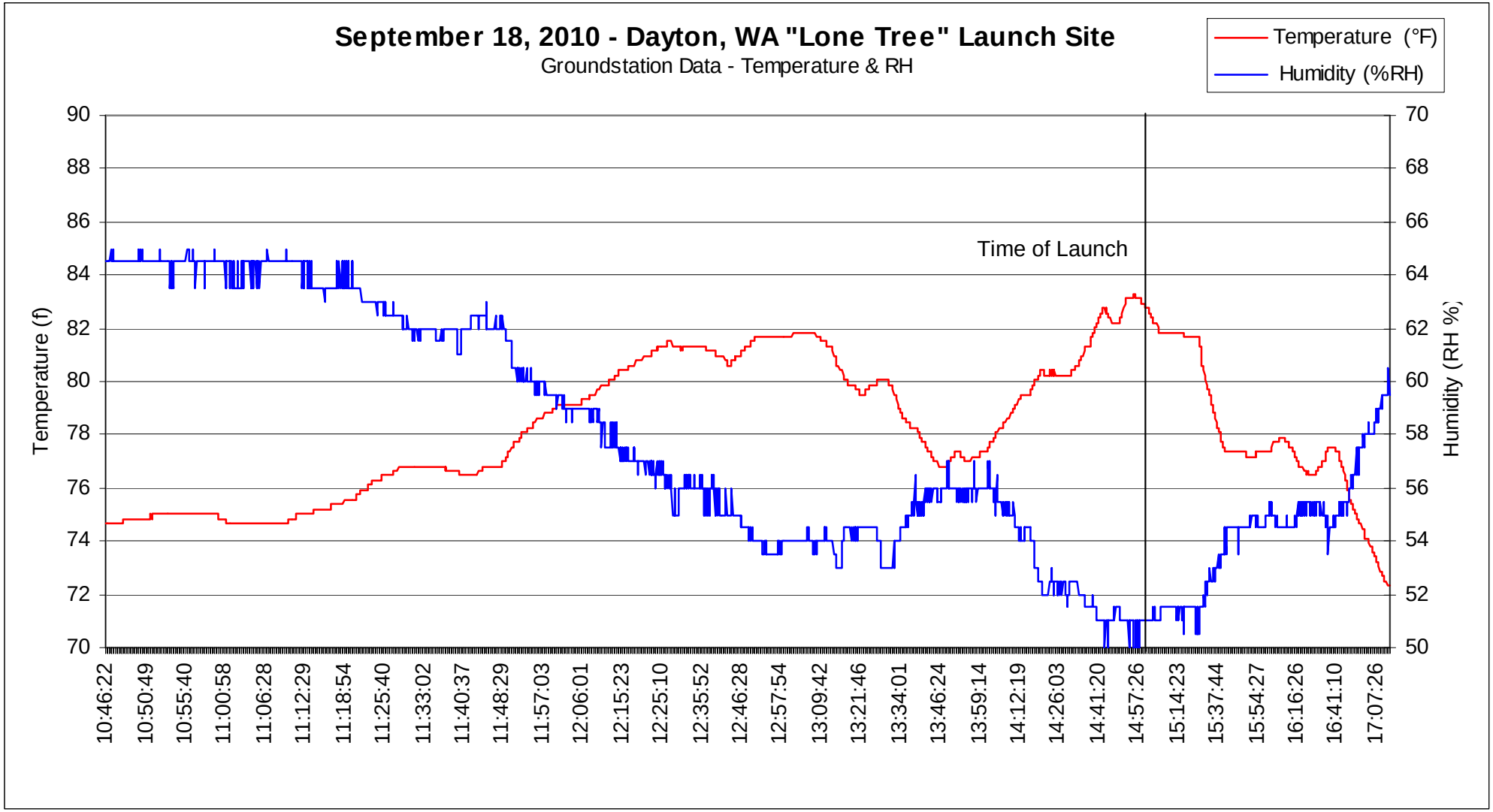

Temperature and Relative Humidity fluctuated during the data as the storm system approached

Glenda Project – Groundstation Data

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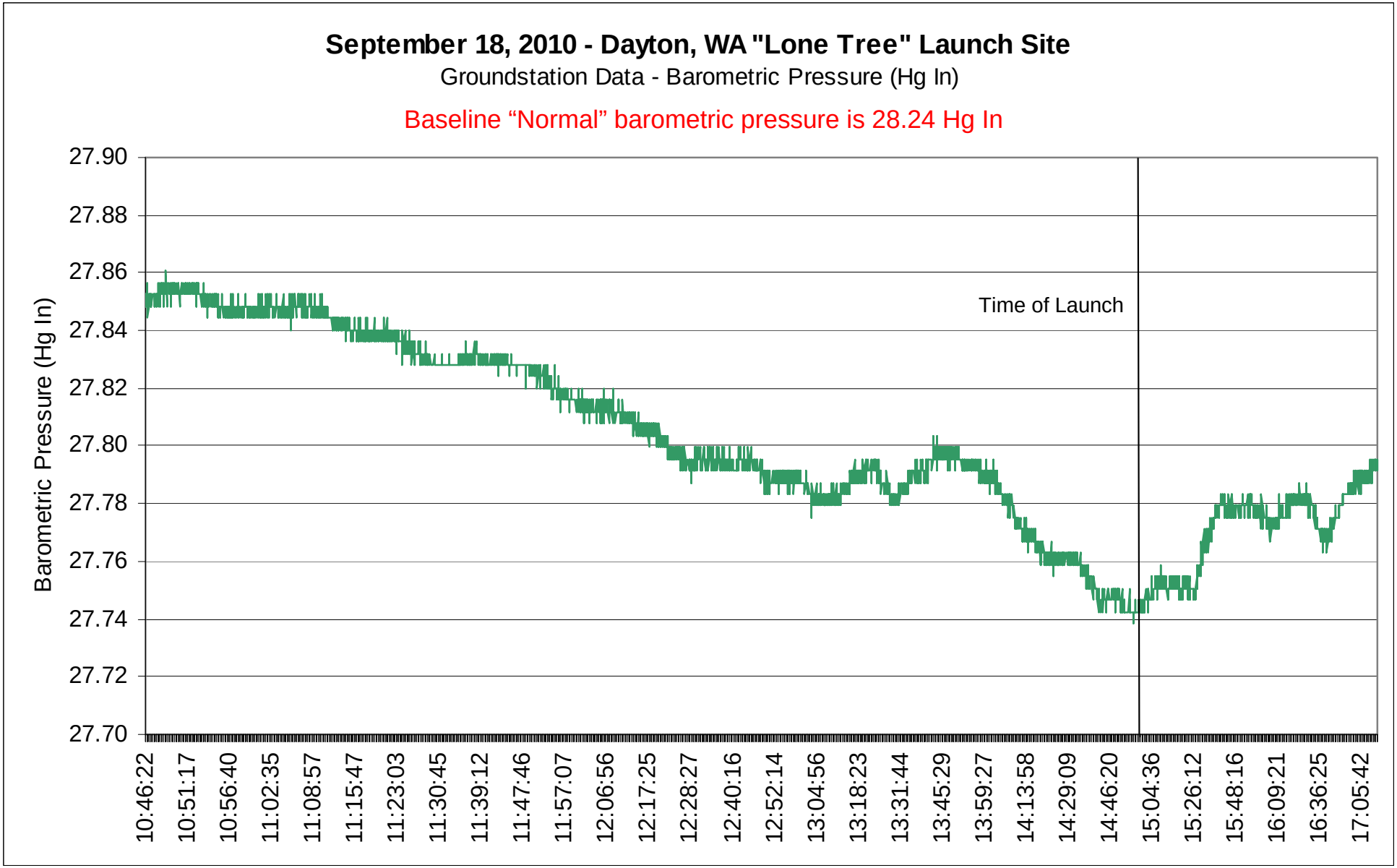

Barometric pressure was falling prior to launch

Glenda Project – Groundstation Data

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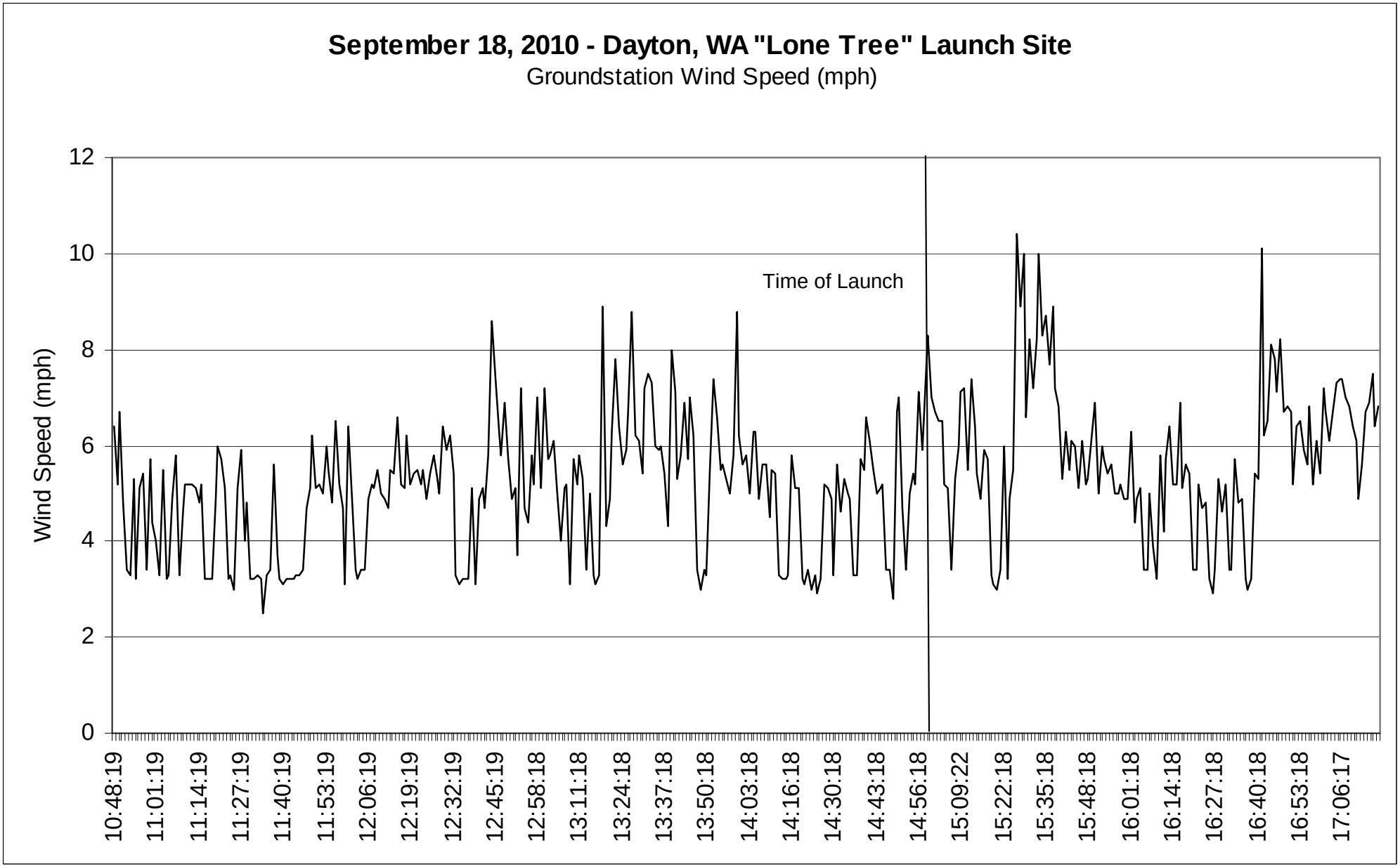

Glenda Project – September 2010 – In Conclusion

The Glenda Project continues to grow, and develop. The September 2010 launch featured the first flights of “I” level motors, a full sensor suite, and an integrated groundstation.

Problems continue to be resolved as we extend the flight envelope. Data quality continues to improve and become more reliable.

For 2011, we’ll deploy the new “Quad Plane” antenna, a new 98mm booster with 54mm motor capability, and upgraded capsules.

Flights will continue in 2011 with the focus being to the map the thermal layer above the “Lone Tree” launch site with the intent to develop a prediction model for updraft conditions.

The Glenda Project would also like to thank the members of BMR for their continued support in our efforts. You all help in so many ways making this all possible.

The 5475 taking flight
Photo courtesy of
Steve Thatcher

The existing dual antenna

The center section of the new “Quad Plane” antenna