Glenda Project – “Climate Day 2013”

“Climate Day 2013” – Definitions

- **Weather-** “the state of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness”.

- **Climate – “**the average course or condition of the weather at a place usually over a period of years as exhibited by temperature, wind velocity, and precipitation”

“Climate Day 2013” – Definitions

- **Temperature -** Air higher in pressure is usually cooler air and air lower in pressure is usually warmer air.

- **Humidity -** How much water is in the air over how much water could fit in the air (right before the water begins to condense out of the air).

- **Dew point -** Temperature at which the moisture saturates the air is the dew point and is at the point where clouds form.

- **Barometric Pressure -** The pressure exerted by the earth's atmosphere at any given point upon the earths surface and is effected by elevation. The value of a standard or normal atmospheric pressure, equivalent to the pressure exerted by a column of mercury 29.92 in. high, or 1013 millibars at sea level (zero elevation)

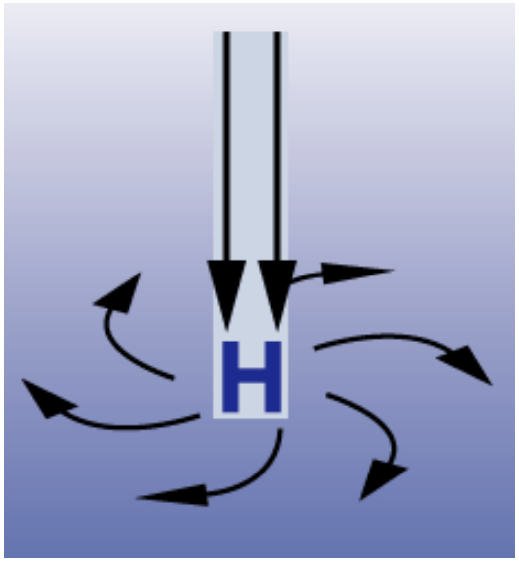
“Climate Day 2013” – Definitions

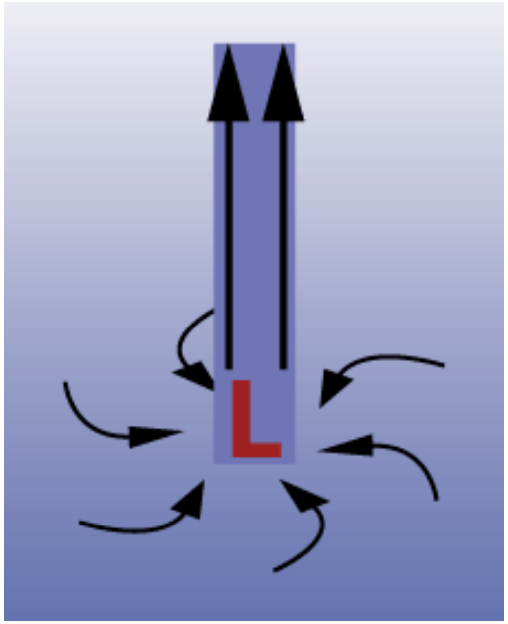
- <u>High Pressure</u> - Higher pressure than what is normal for that altitude.

  Brings clear skies and fair weather. The sinking cold air warms as it does so and becomes stable.

- <u>Low Pressure</u> - A low pressure region (depression or cyclone) is caused by rising air.

  Clouds, rain, and very strong winds occur due to the rising warm, moist air becoming unstable.





“Climate Day 2013” – Definitions

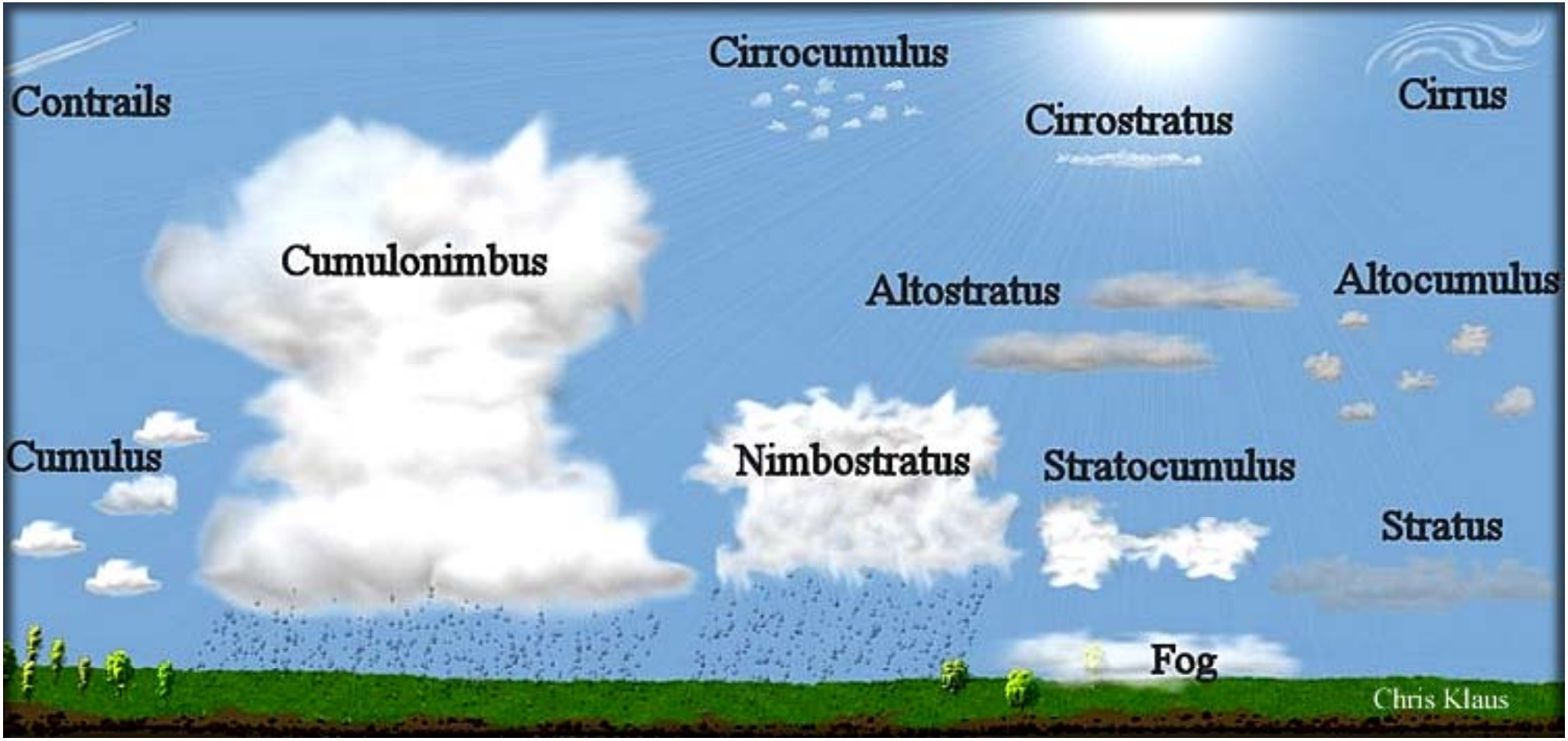
Cloud Formation

Clouds form when water vapor (water that has evaporated from the surface of the Earth) rises into the atmosphere, then condenses (turns into liquid water or solid ice) onto microscopic dust particles (or other tiny particles) floating in the air.

This condensation (cloud formation) happens when warm and cold air meet, when warm air rises up the side of a mountain and cools as it rises, and when warm air flows over a colder area, like a cool body of water. This occurs because cool air can hold less water vapor than warm air, and excess water condenses into either liquid or ice.

“Climate Day 2013” – Definitions

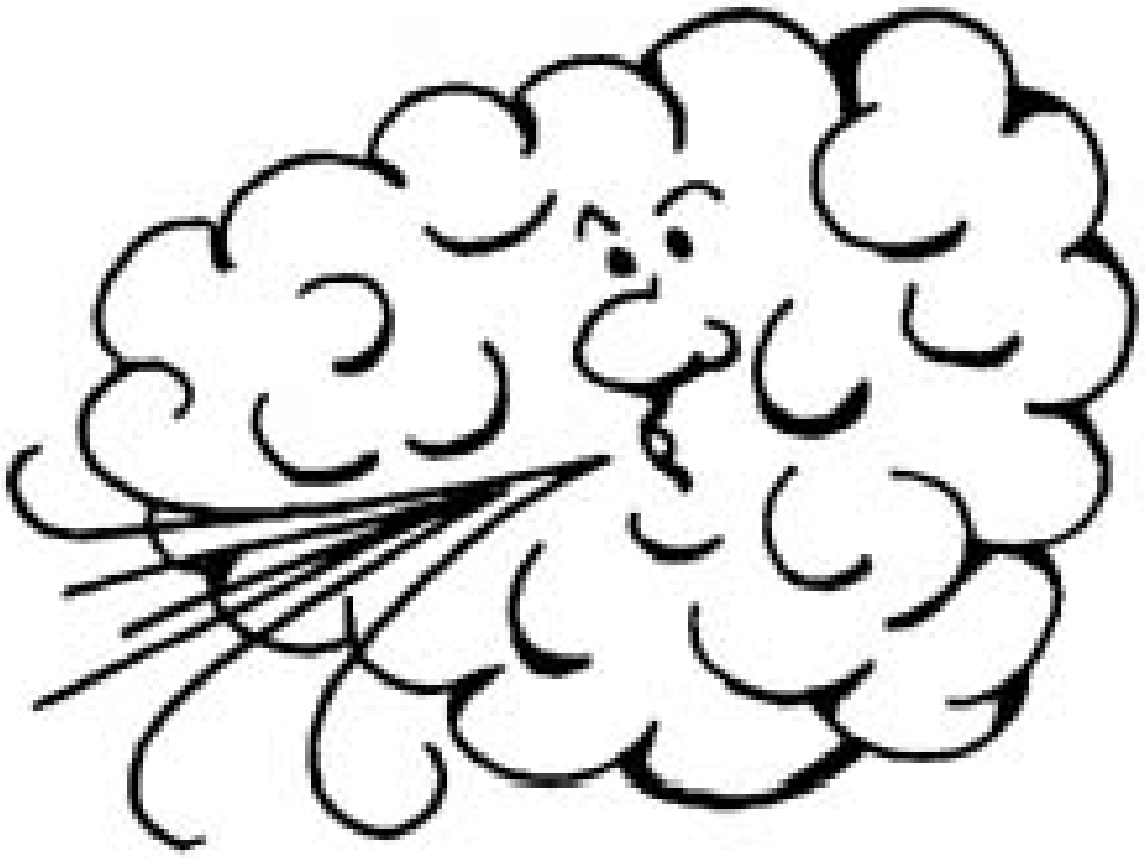
Cloud Types



“Climate Day 2013” – Definitions

Wind

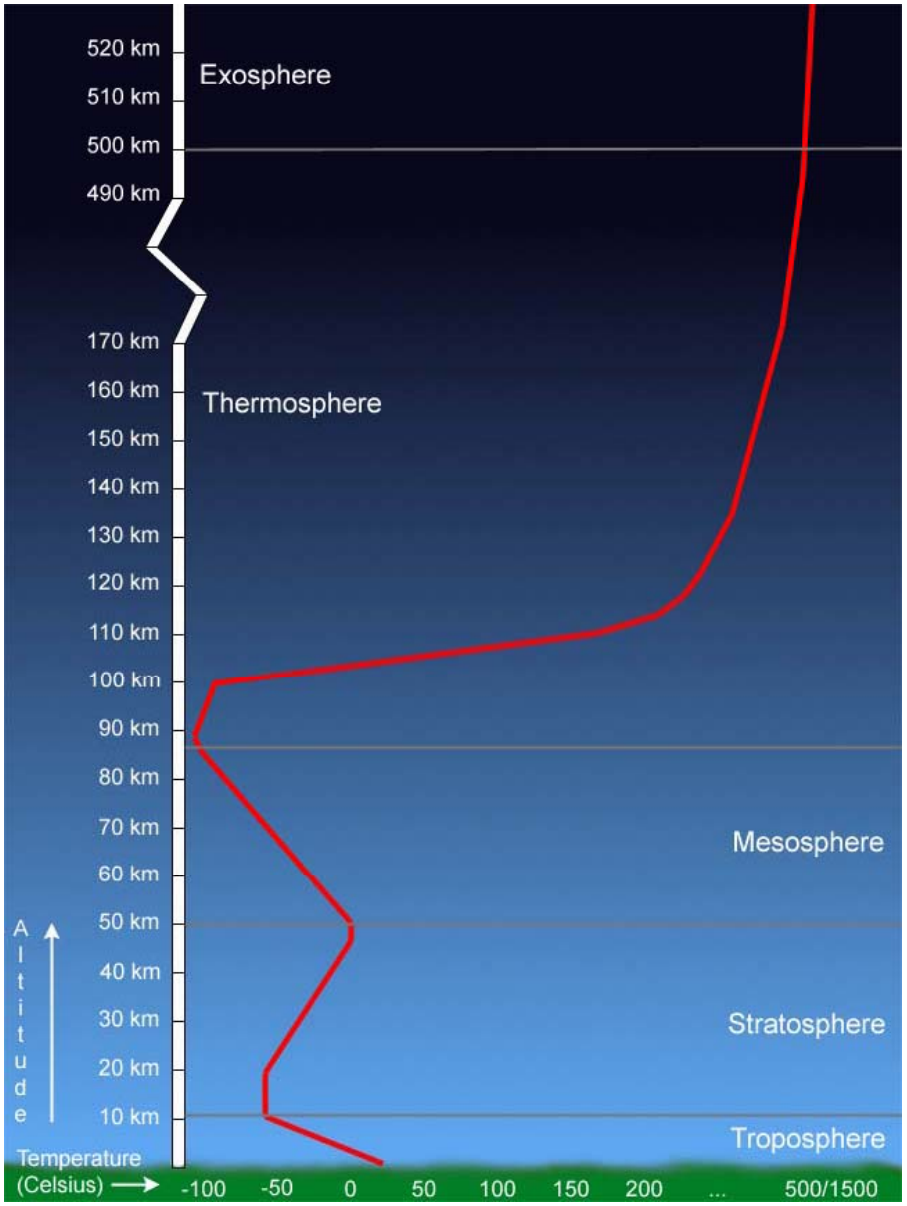
Wind is caused by the earth’s surface being heated unevenly by the sun, and by changes in the environment between areas of high and low pressure.



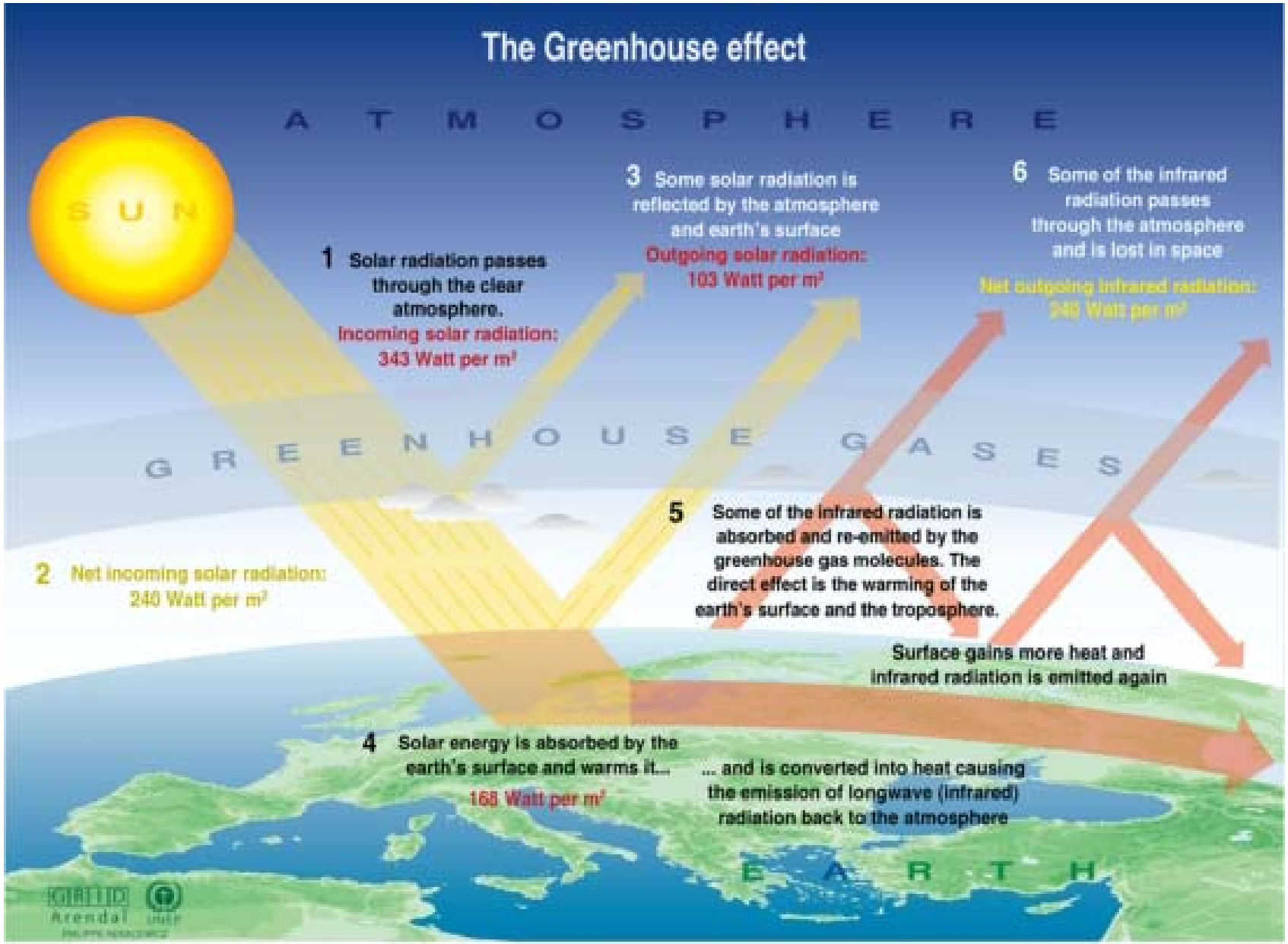
“Climate Day 2013” – Definitions

Atmosphere

- **Troposphere** - Most of the weather occurs.
- **Stratosphere** - 19% of the atmosphere’s gases are here; ozone layer is here
- **Mesosphere** - Most meteorites burn up here.
- **Thermosphere** - High energy rays from the sun are absorbed; hottest layer.
- **Exosphere** - Molecules from atmosphere escape into space; satellites orbit here.



“Climate Day 2013” – Definitions



Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

Glenda Project – Executive Summary - 2013

Glenda Project – Purpose

The primary mission of the Glenda Project is to provide the capability to rapidly gather previously inaccessible localized microclimate data from altitudes ranging from ground level to 20,000 feet and to return this data for immediate use.

The Glenda Project is mix of adaptable ground stations combined with a reusable sounding rocket delivery system designed to place instrument packages into areas previously considered to be to hazardous or inaccessible using traditional platforms such as balloons, aircraft, helicopters, kites, etc.

Glenda Project – Data Capabilities

The Glenda Project has the capability to collect temperature, humidity, barometric pressure, wind speed and other types of environmental data from ground level to 20,000 feet.

Glenda payloads are designed to be launched into thunderstorms, tornados, and other volatile weather environments and to return intact with its collected data.

Glenda Project – Engineering / Computing / Remote Sensing

David Davis – Edmonds, WA – Engineering - Brings decades of experience from engineering work in private industry and United States government in rocket research, and aerospace. Extensive background in electronics, mechanics, communications, computing, and storm spotting. Member of the National Association of Rocketry since 1983, and been involved with hobby related rocketry since the 1960's.

Robert Pullman – Ponchatoula, LA - Remote Sensing - Has three decades of experience in communication and the computer industry and his expertise is world renown. His work has enabled governments to formulate policies and legislation in international, national and local forums. He has developed products that are used by universities for seminars, by corporations for internal operations to meet government regulations, by scientists for research work in field and laboratory conditions, by government departments for device operations and maintenance, and by the military for use in battlefield activities.

Glenda Project – Media Communications / Public Relations

Tim Quigg in Dayton, WA brings a unique mix of personal background and professional experience to the Glenda Project. Quigg has over two decades of experience in customer service and media relations. He is the former Assistant Editor of Extreme Rocketry Magazine (2000 to 2007), as well as a freelance writer of numerous articles for Sport Rocketry Magazine. He is a current member of the National Association of Rocketry, and is the 2001 recipient of the National Association of Rocketry's President's Award, in recognition of his work with youth in model rocketry on a national level. He has also written a book on the topic of high power rocketry; "A Guide to Level One Certification" currently published by ARA Press. Quigg is a highly decorated 30-year veteran of law enforcement, and is currently the supervisor at a Southeastern Washington State E911 Communications Center.

CERTIFIED SKYWARN SPOTTER

Glenda Project – Columbia County, WA - Intercept Teams

John Quigg in Dayton, WA, brings to the project a mix of skills ranging from high tech computing, to storm spotting field abilities. As the head of our field operations Intercept Team, John plans the missions, deploys the field assets, and collects the data. A SKYWARN trained storm spotter, and a master behind the camera, John continues to bring back amazing photos, and video from the field on our continuing storm intercept operations.

CERTIFIED
SKYWARN
SPOTTER

Glenda Project – Data Collection Methods

Glenda has several methods of collecting data:

- Rocket Launched - Active Flight Data Collection Systems - Transmitters
- Rocket Launched - Passive Flight Data Collection Systems – Dataloggers
- Balloon Launched – Active Data Collection Systems - Radiosondes
- Ground Stations

Glenda Project – Typical Flight Vehicles

9875 Booster

- 4” diameter booster, 3” diameter capsule
- RS92 Digital Radiosonde Active Payload with GPS
- GPS, and Temperature dual data logger payload
- 2,000 to 20,000 ft altitude envelope

FAR 101 Booster

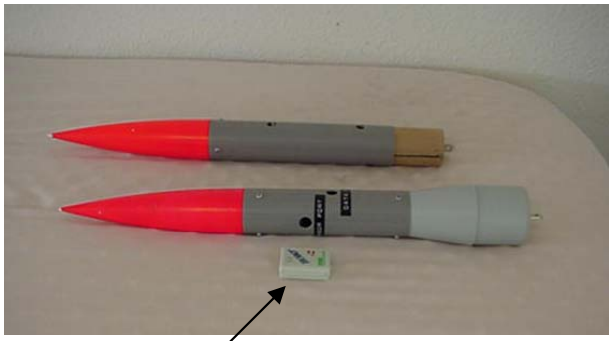
- 3” diameter booster, 2.125” diameter capsule
- GPS, and Temperature dual data logger Payload
- 2,500 foot altitude envelope
- Exempt from FAA Waiver Constraints

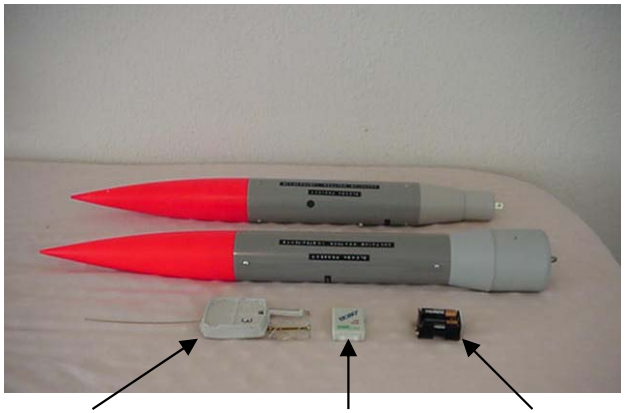
5475 Booster

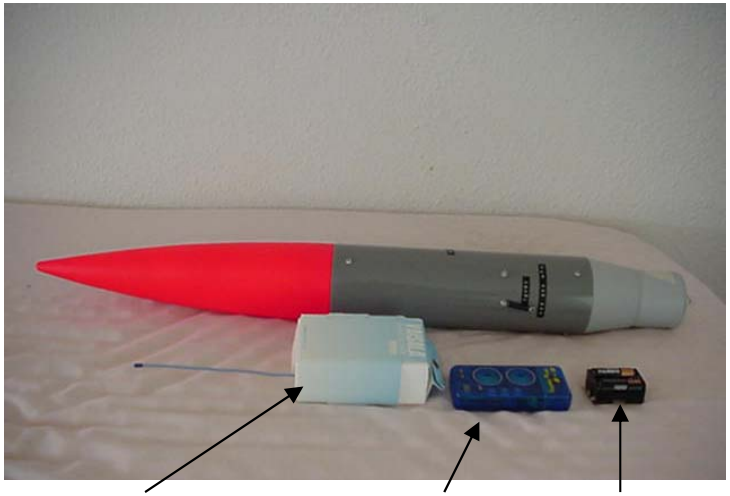
- 2.125” diameter booster, 3” diameter capsule
- RS92 Digital Radiosonde Active Payload with GPS
- GPS, and Temperature dual data logger payload
- 2,000 to 15,000 ft altitude envelope

Glenda Project – Typical Flight Payloads

The Glenda project uses several different payload capsule configurations carrying a variety of instrumentation in order to gain weather related information, and other micro-climate data







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.

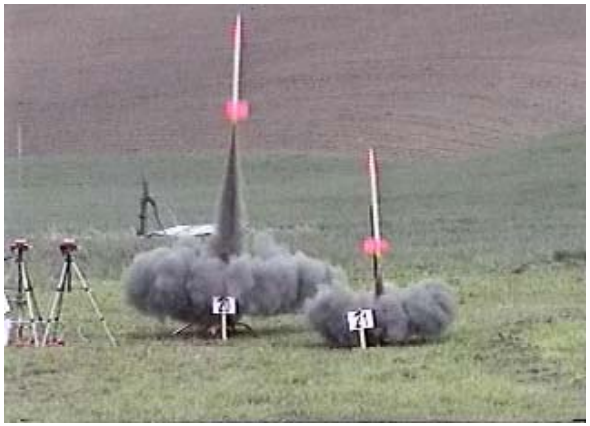
Glenda Project – Typical Flight Profile

2 – Intercept Phase

3 – Data Collection Phase

4 – Recovery Phase

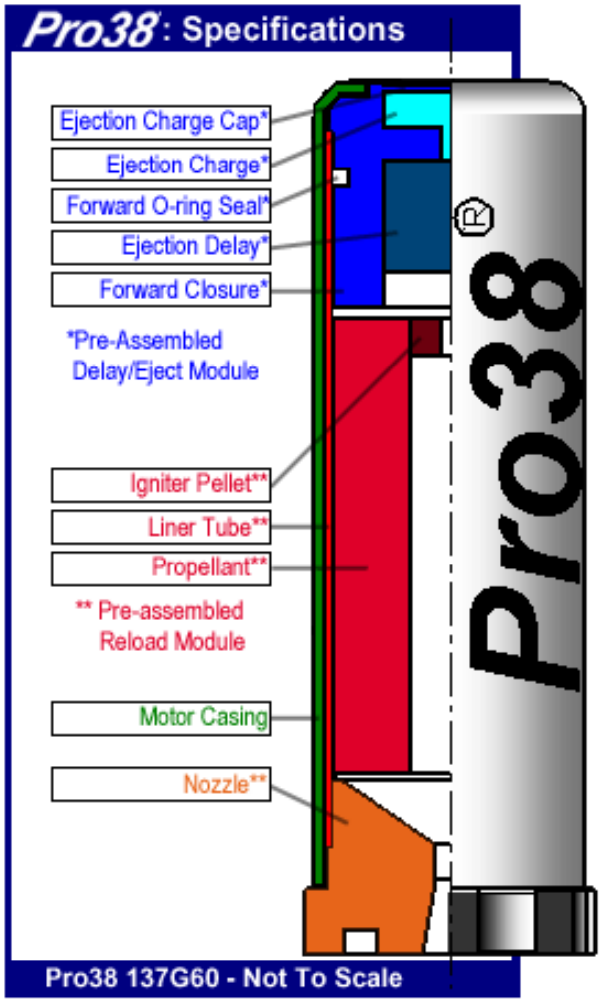
1 – Launch Phase

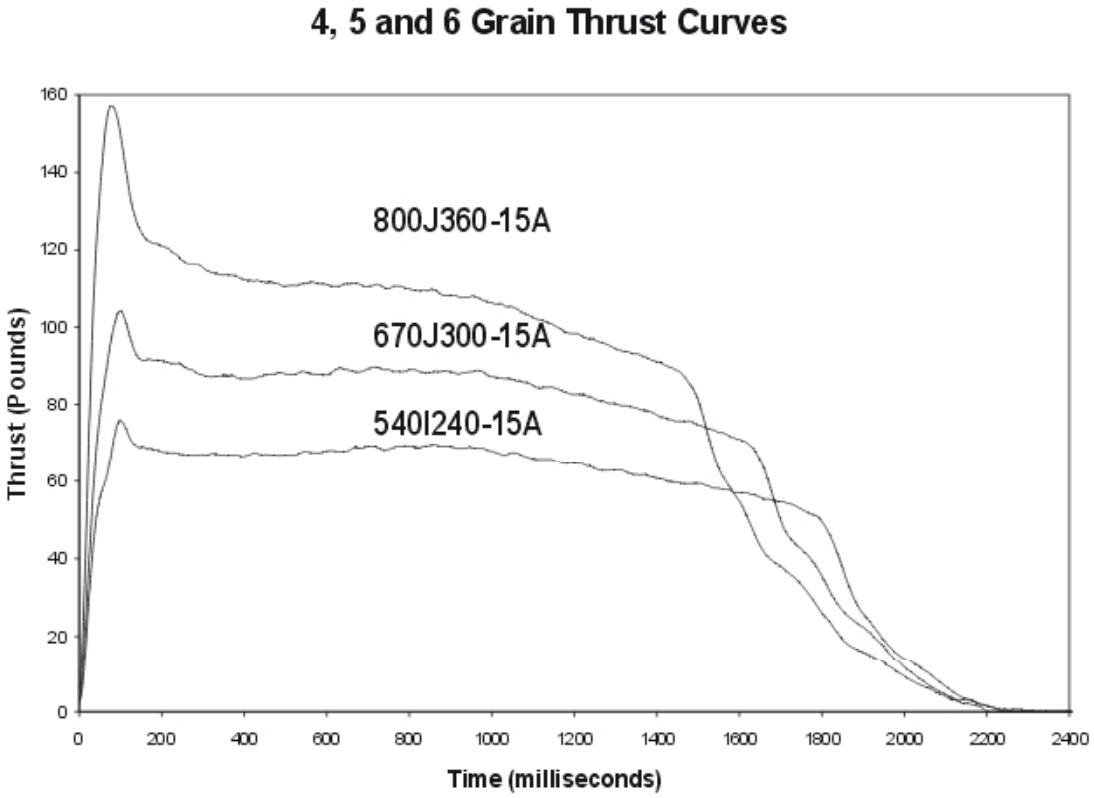


Note: Propulsion is provided by reloadable /reusable rocket motors giving the capability of rapid turnaround between flights.

Glenda Project – Propulsion

The Pro38 / Pro54 rocket motor propulsion system is the first commercial thermoplastic propellant-based solid rocket motor and is produced by Cesaroni Technology Inc. of Toronto Canada. The Pro38 / Pro 54 is a modular, reloadable Solid propellant rocket motor system designed primarily for use in launching small experimental payloads by universities, colleges, research institutes and sport rocketry enthusiasts.



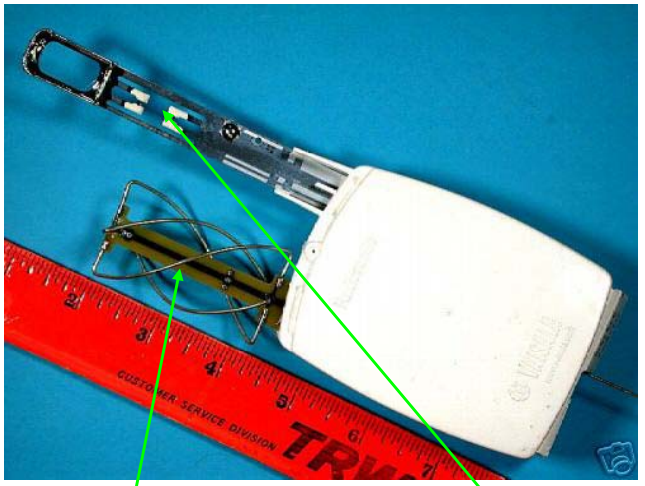


Glenda Project – Active Payloads - Transmitters

Converted Radiosonde Payloads

The Glenda Project uses converted radiosondes that are designed primarily for use with weather balloons. The circuitry and sensors function properly under thrust loads of the Glenda boosters and are compatible with NOAA radiosonde receiver systems.

The radiosonde contains instruments capable of making direct measurements of air temperature, humidity and pressure. These observed data are transmitted immediately to the ground station by a radio transmitter located within the instrument package.



Vaisala RS92 Radiosonde

Radiosonde Specifications:

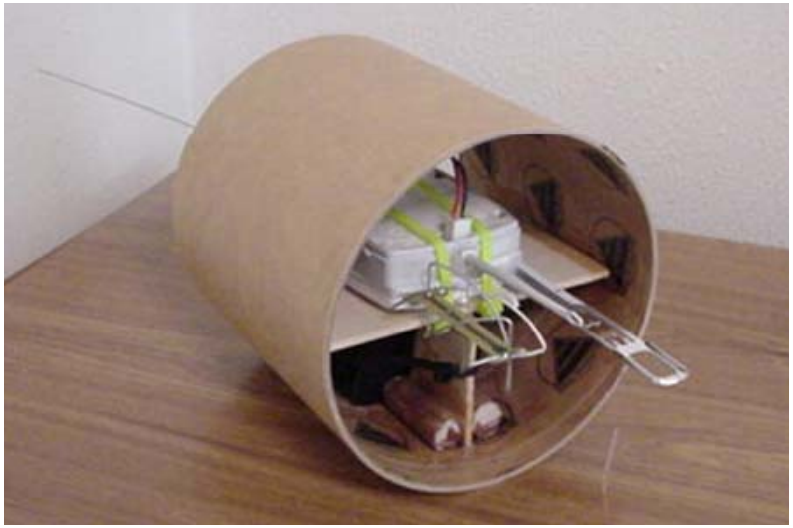
- Pressure range 3mb to 1060mb +/- .1mb
- Operating temperature range of -90°C to +60°C
- Relative Humidity from 0 to 100%
- Sampling Rate of once per second for the sensor suite
- Provides positioning data via GPS for payload location and wind velocity

Glenda Project – Active Payloads - Transmitters

Data Acquisition Flow Diagram

Sensor Data Transmitted from Capsule

- Barometric Pressure Sensor Data
- Temperature Sensor Data
- Relative Humidity Sensor Data
- GPS - Payload Position Data



Active Payload cushioned within the flight capsule

Ground Receiver and Antenna System

Data recorded into Laptop and graphically displayed

GPS – Ground Station / Chase Vehicle Position Data

Glenda Project – Active Payloads - Application

Mobile Ground Station / Intercept Vehicle

Isolated Laptop Power Supply

Telemetry Receiver

Cellular Modem w/ internet connection

Laptop

Not Shown:

a) External Telemetry Receiver Antenna
b) External GPS Antenna
c) External Cellular Modem Antenna

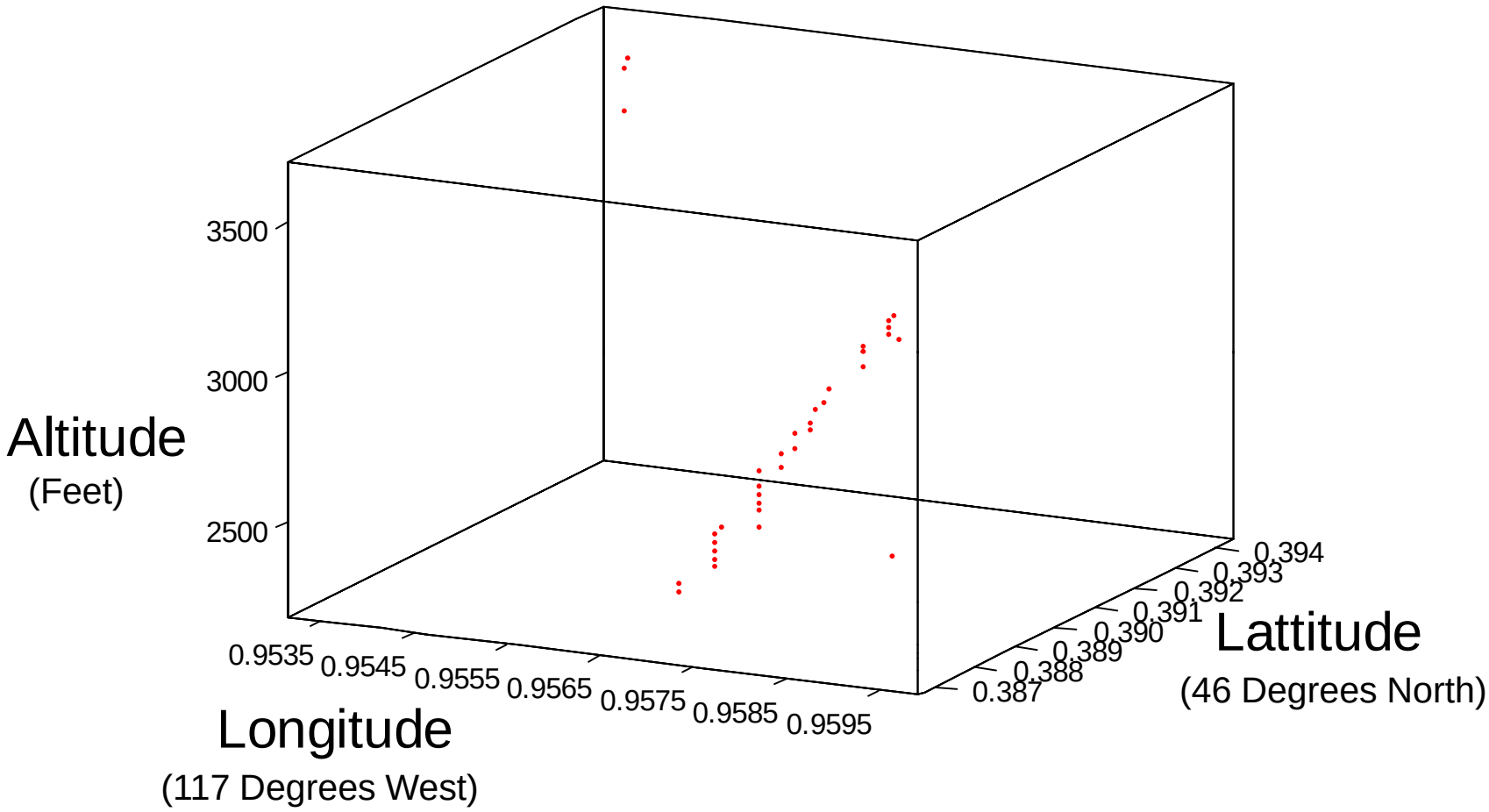
Flight Vehicle

Payload Capsule

Length: 65”
Diameter: 3”
Dry Weight: 3.5 Pounds
Attainable Altitudes: 2,000 feet to 20,000 feet

Glenda Project – Active Payloads - Application

"Lone Tree" Launch Site – June 11th, 2011
Lattitude / Longitude / Altitude / Motion

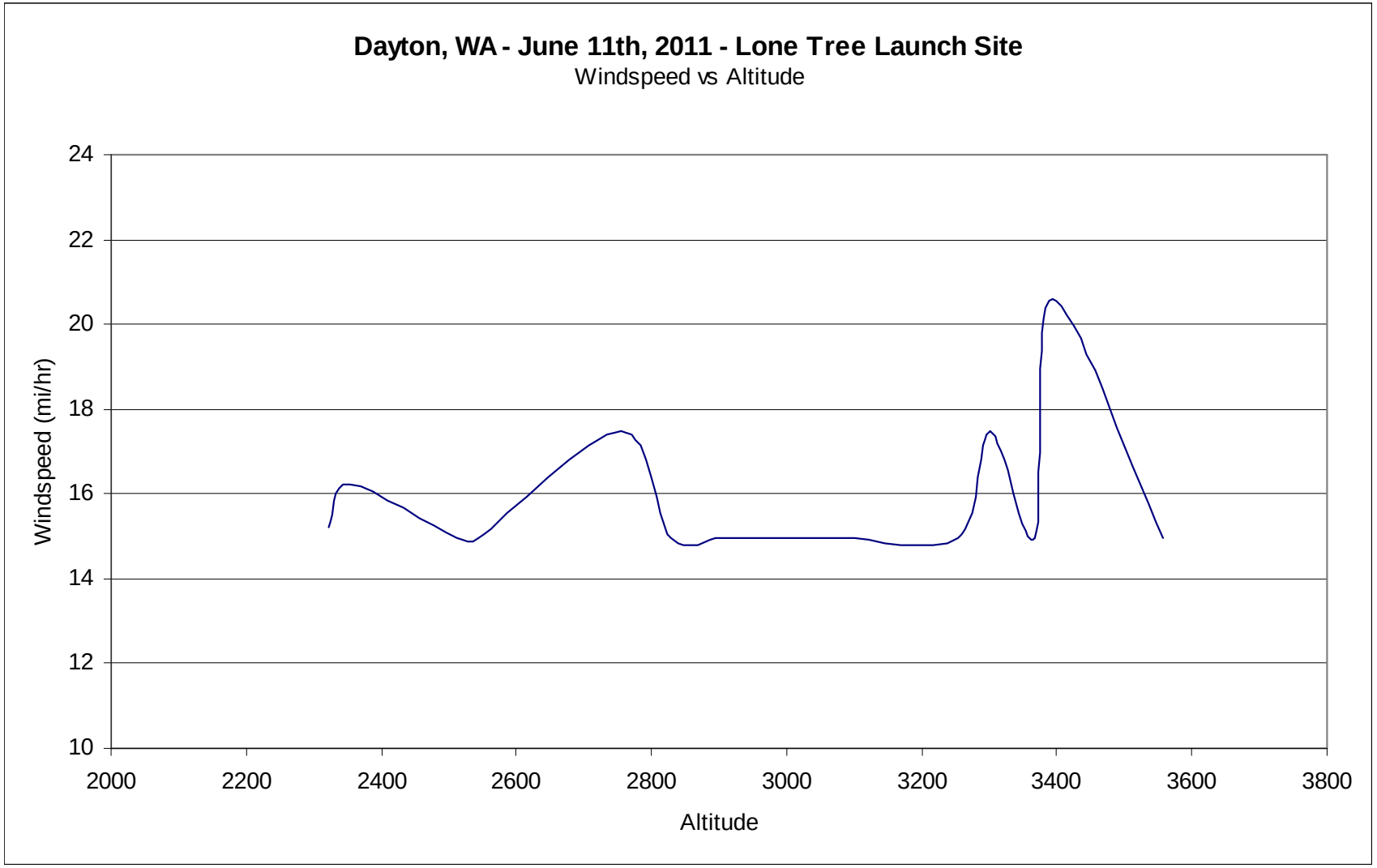


Note: After an initial shift at altitude, due to the winds aloft, recovery was nominal

Glenda Project – Active Payloads - Application

Wind Speed vs. Altitude

"Lone Tree" Launch Site – June 11th, 2011

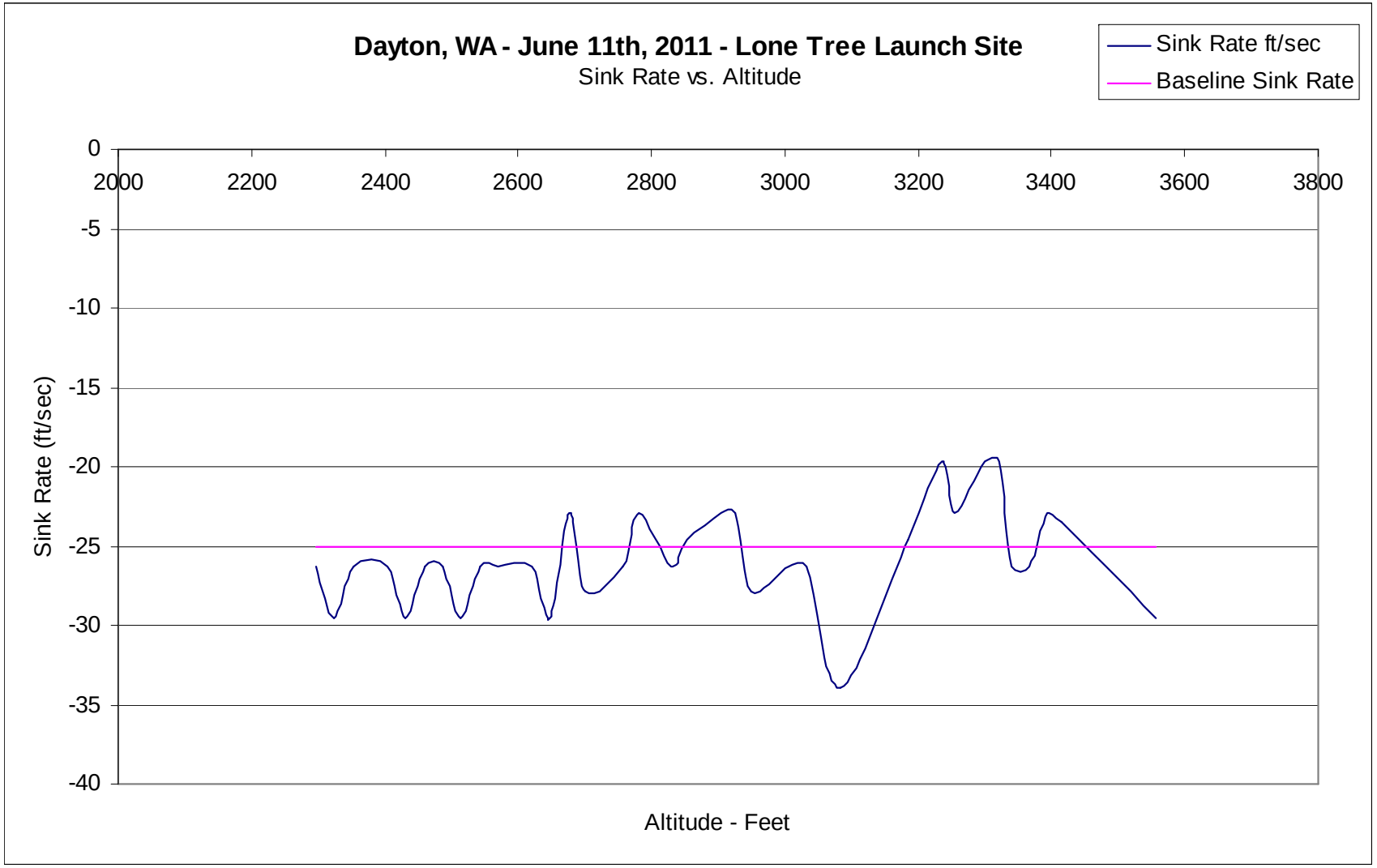


Note: Windspeed values remained relatively consistent during the flight

Glenda Project – Active Payloads - Application

Sink Rate vs Altitude

"Lone Tree" Launch Site – June 11th, 2011



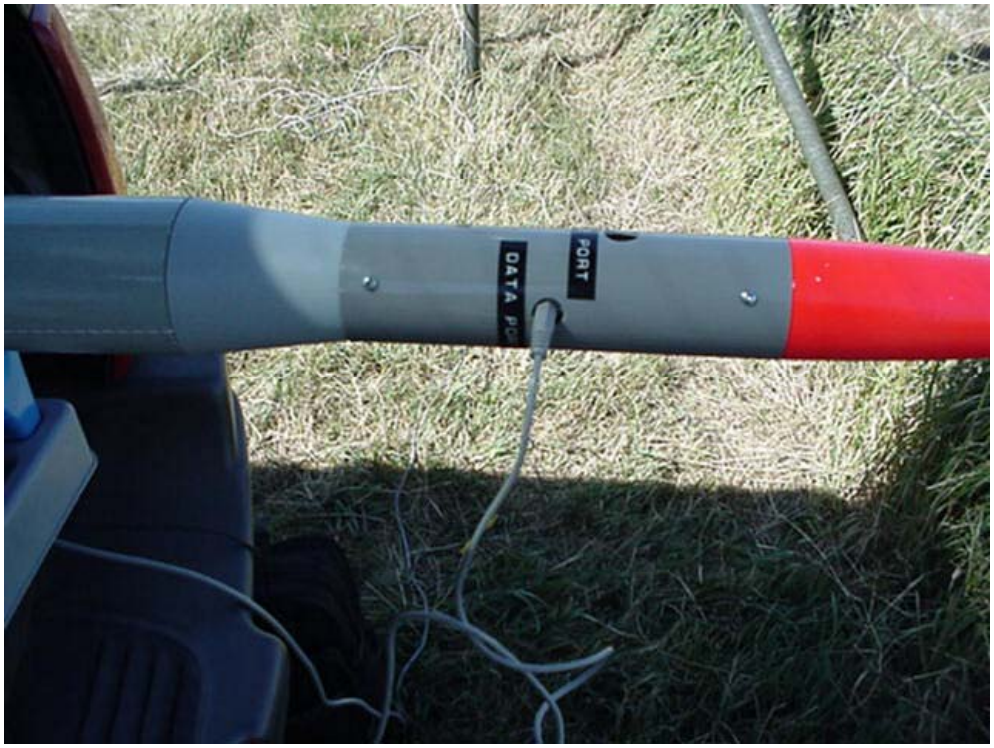
Note: The baseline capsule sink rate was 25 feet per second (-25 fps) and was able to continue to detect updrafts and downdrafts. No consistent pattern was detected.

Glenda Project - Passive Payloads – Data Loggers

A data logger is an electronic instrument that records measurements over time. Typically, data loggers are small, battery-powered devices that are equipped with a microprocessor, data storage and sensors. Most data loggers utilize software on a personal computer to initiate the logger and view the collected data.

Prior to a Glenda launch, the data logger is connected to a laptop computer. Then, systems software is used to select logging parameters (sampling intervals, start time, etc.) and initiate the logger. The logger is then disconnected from the laptop and installed inside the Glenda payload capsule. Upon launch, the logger records each measurement and stores it in memory along with the time and date.

Post recovery, the logger is then reconnected to the laptop computer and the software is used again to readout the data and see the measurements as a graph, showing the profile over time. The tabular data can be viewed as well, or exported to a spreadsheet for further manipulation.



Holux M-241 GPS Data Logger

The M-241 is a high performance GPS data logger. Capable memory size to record up to 130,000 positions, including latitude, longitude, time, velocity, and altitude.

Data logger Specifications:

- 32 parallel satellite searching channels
- Receiver: L1m 1575.42 MHz
- Adjustable sampling rates from 1 second +
- Satellite signal reception sensitivity: -159dbm
- Position: +/- 2.2 meters Horizontal
- Powered by a standard AA battery with 12 hour life cycle
- Size/Weight: 1.26 x 1.18 x 2.93" (32.1 x 30 x 74.5 mm)/approx. 2.5 oz.(71 grams)
- Time to reposition: < 0.1 second average
- Time to boot: 36 seconds (cold), 1 sec (hot)
- Maximum Acceleration: 4G
- Maximum Altitude: 60,000 feet (18,000 m)

MicroLite Temperature Datalogger

The MicroLite USB Datalogger is a small electronic device for monitoring and recording temperature. Manufactured to stringent IP68 standards, the MicroLite logger is dustproof and is only 4.3” long and 1” thick. The data logger features a three digit LCD display, direct USB connection, wide temperature range, high accuracy and large sample memory. Data can be displayed on the small numeric screen or downloaded to the MicroLab Lite software via the USB 2.0 connector.

Datalogger Specifications:

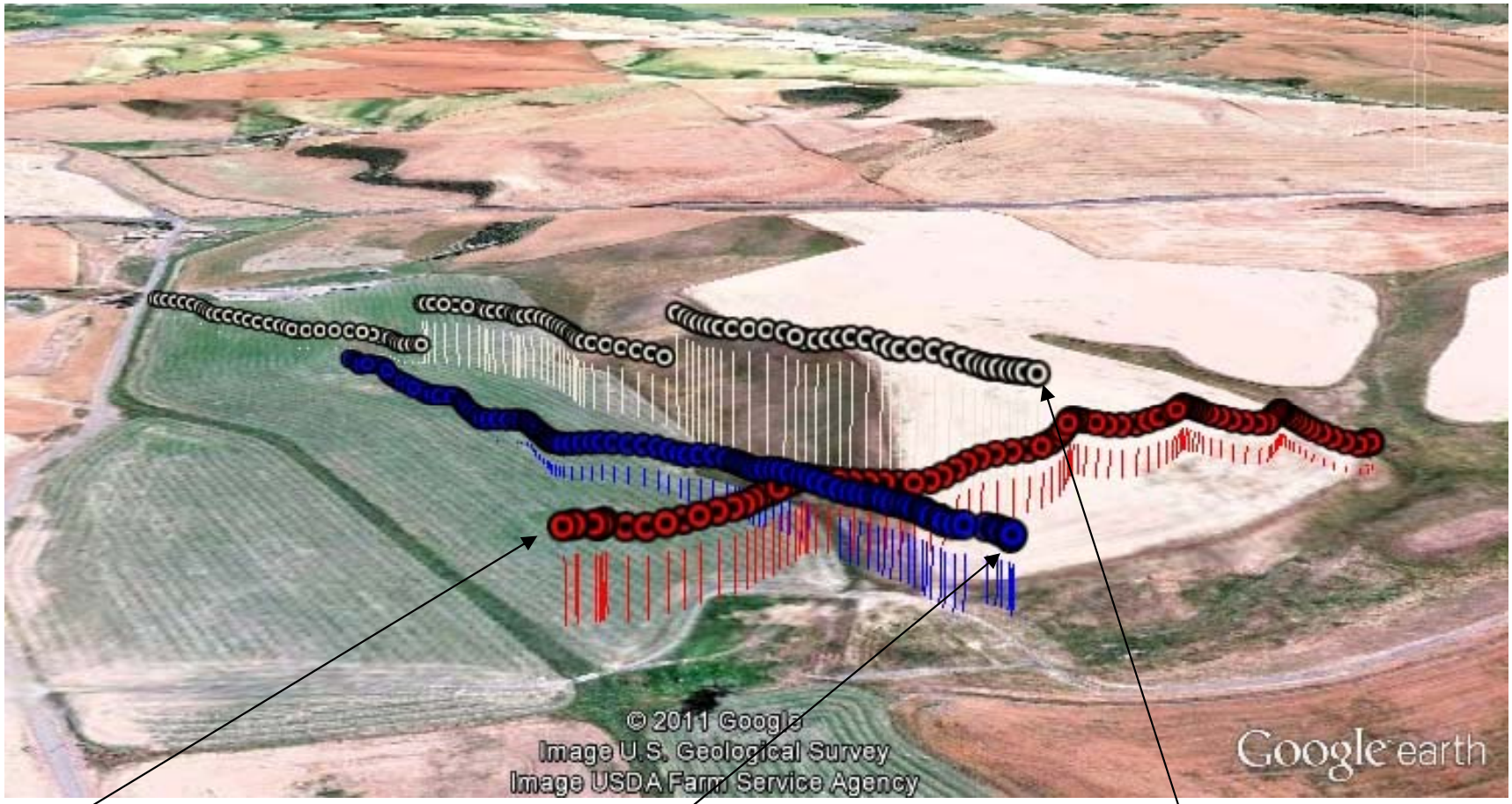
- Internal Temp Sensor: -40°C to 80°C Thermal Conductor enabling a fast sensor response time
- Sampling Resolution A/D Resolution: 16Bit 0.1°C
- Data Storage Capacity: 16,000 Samples
- Sampling Rate: 1 per second to 1 per 2 Hours
- Battery: Replaceable 3V Lithium Battery - CR2032
- Battery Life: 2 Years at 1 second Sampling Rate
- Dimensions: 11cm x 3.9cm x 2.6cm (4.3" x 1.5" x 1.0")
- Weight: 45.5 grams (1.6oz)
- Software: MicroLab Lite for Windows
- Standard Compliance: IP68, NEMA6 (30 Minutes for 0.5 meter Depth) CE, FCC

Glenda Project - Passive Payloads – Application

GPS Data Logging

4D wind current mapping over local terrain.

(4D is latitude, longitude, elevation and velocity)



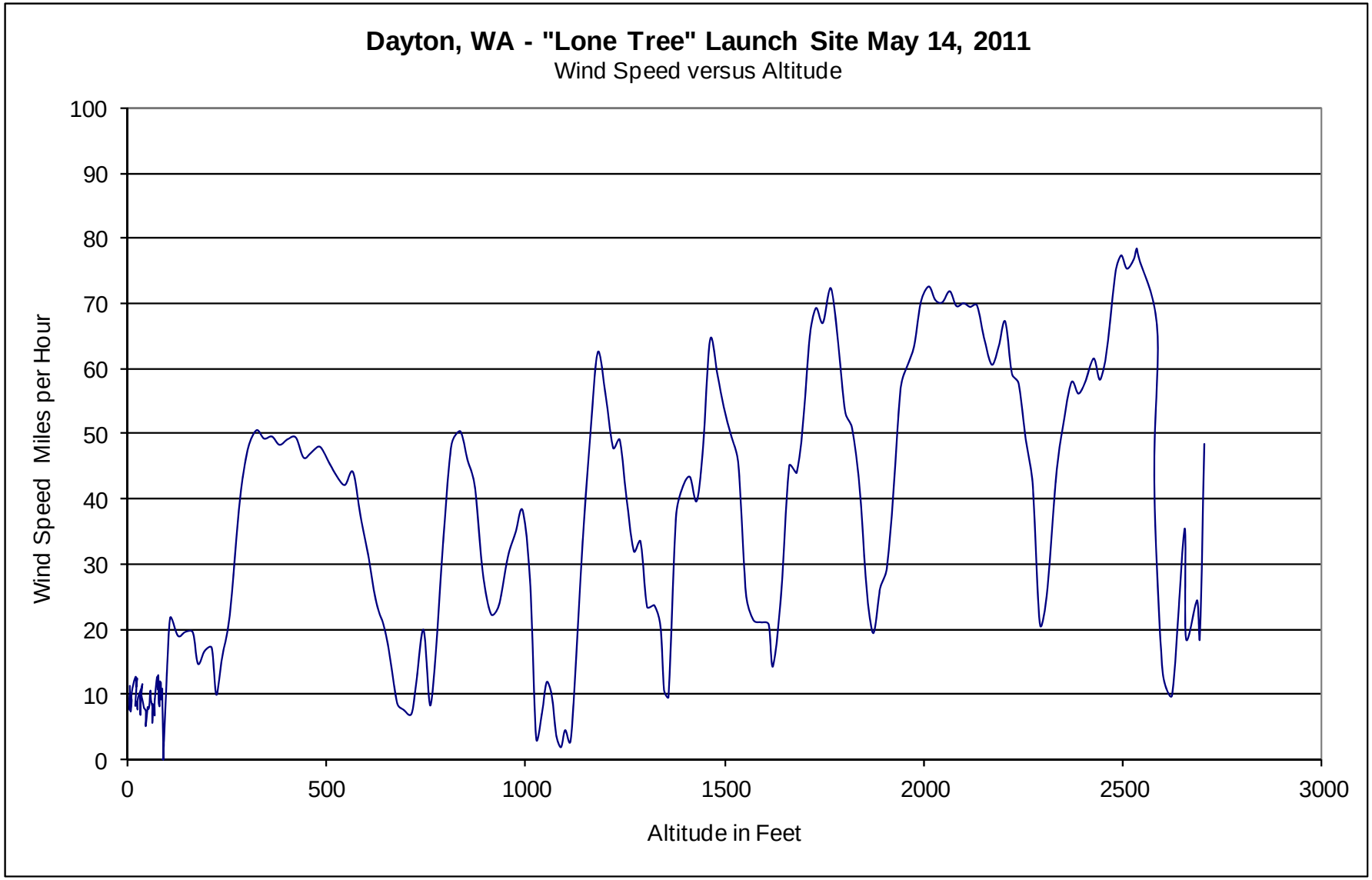
May 14th
7554 Booster – Aerotech I211
"Thunderstorm Intercept"
Apogee: 2,706 Feet
Ground Level Wind Speed: 4.5 mph

June 11th
9875 Booster – CTI I170
Apogee: 2,211 Feet
Ground Level Wind Speed: 10 mph

October 1st
7554 Booster – Aerotech I211
Apogee: 2,354
Ground Level Wind Speed: 14.5 mph

Glenda Project - Passive Payloads – Application

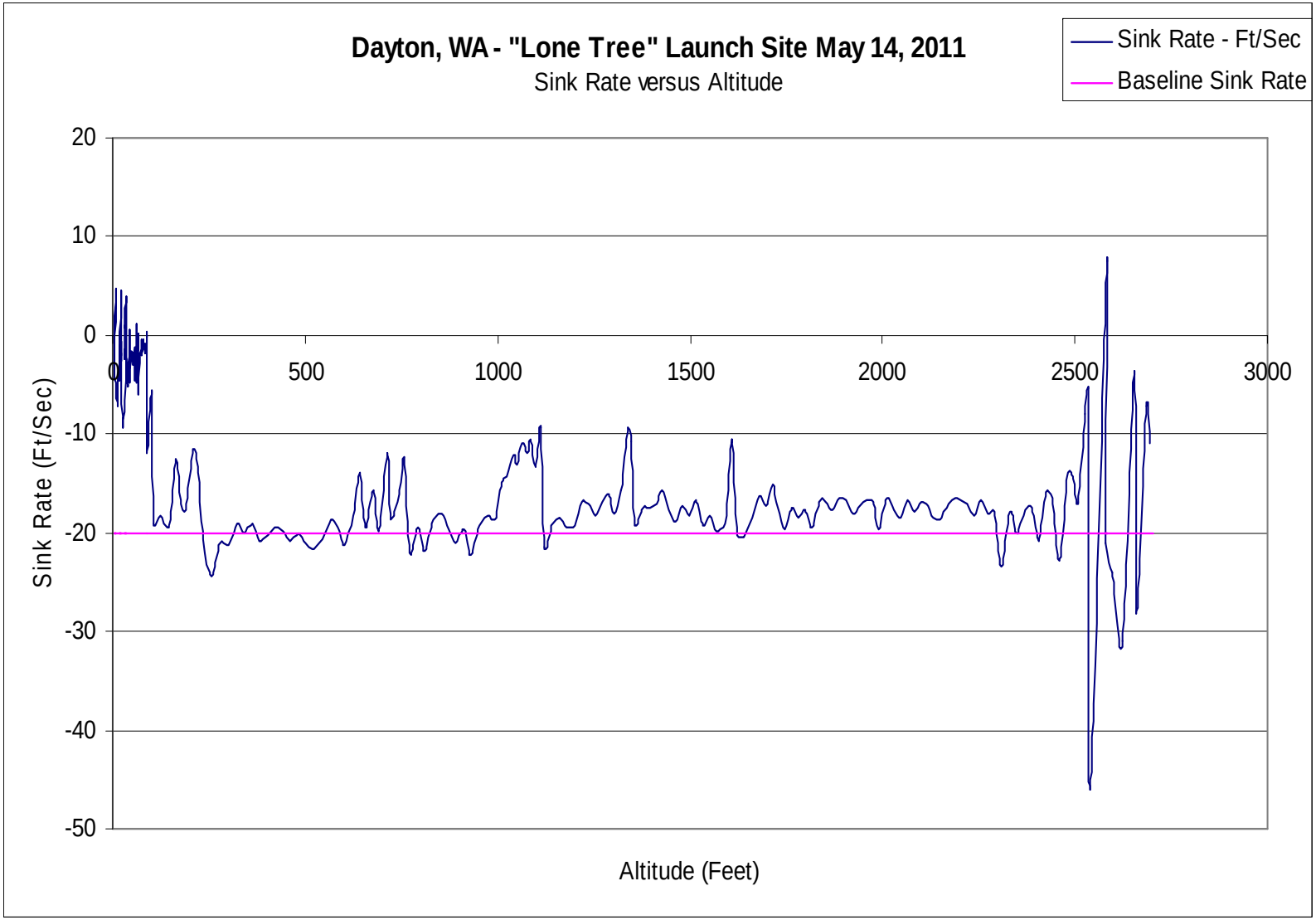
GPS Data Logger – Wind Speed vs Altitude
"Lone Tree" Launch Site – May 14th, 2011



Note: Wind Speed is increasing with Altitude

Glenda Project - Passive Payloads – Application

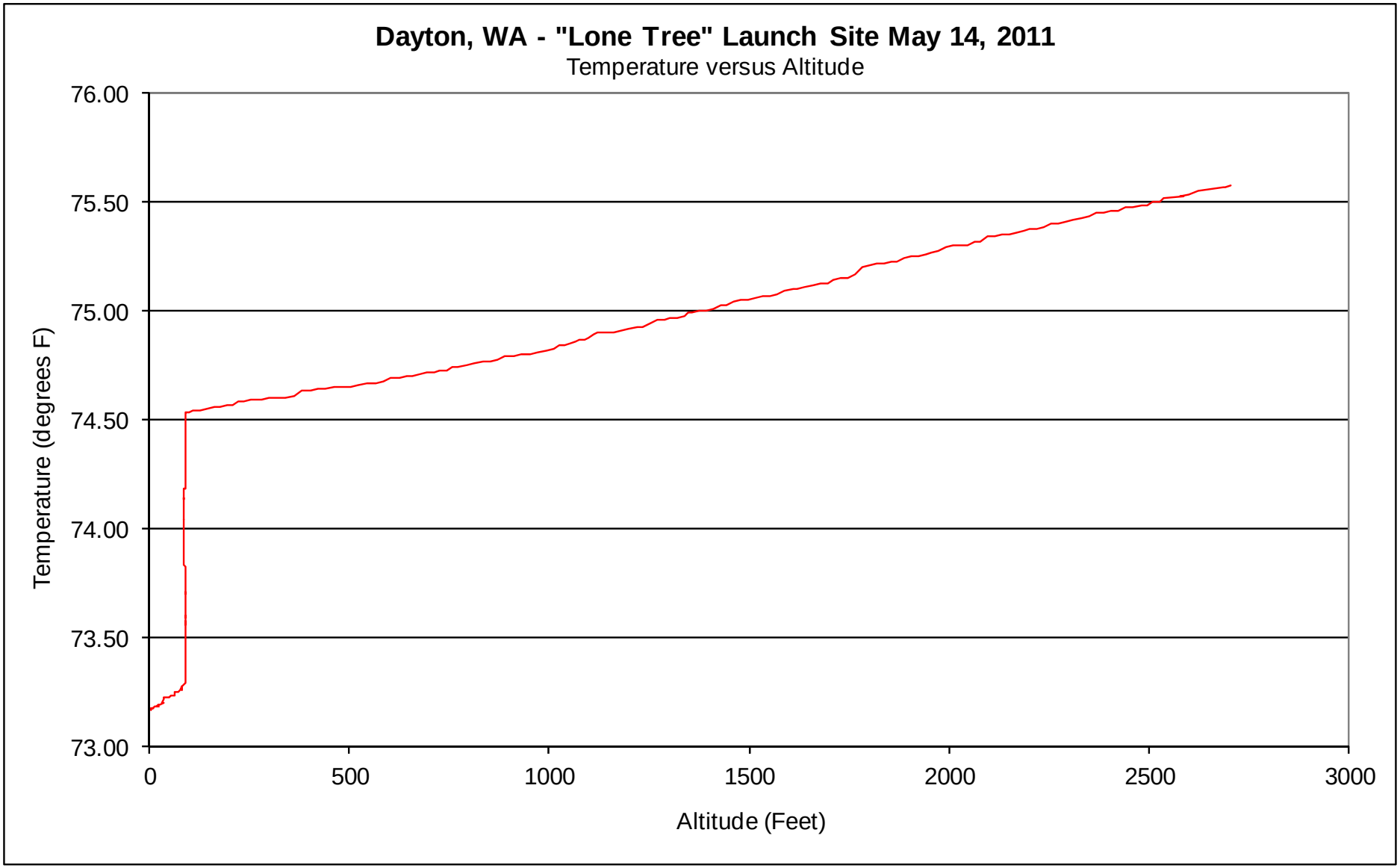
GPS Data Logger – Sink Rate vs Altitude
"Lone Tree" Launch Site – May 14th, 2011



Note: The "Baseline" Sink Rate of the capsule is 20 feet per second (-20)
There are significant Updrafts and Downdrafts due to the approaching thunderstorm

Glenda Project - Passive Payloads – Application

Temperature / GPS Data Logger – Temperature vs Altitude
"Lone Tree" Launch Site – May 14th, 2011



Glenda Project – Ground Stations

The Glenda Project has found that, over time, without knowing ground level weather conditions, there is no effective baseline to measure from as we launch instrument packages into severe weather systems.

This acknowledgement has driven the development of several different types of mobile ground station where their usage can be adapted based on our mission and data requirements.

Some typical examples:

a) Digital Chart Recorders

b) Recording Anemometers

c) TMQ-34 Mobile Military system

d) Coastal Environmental WeatherPak 400 Wireless ground station

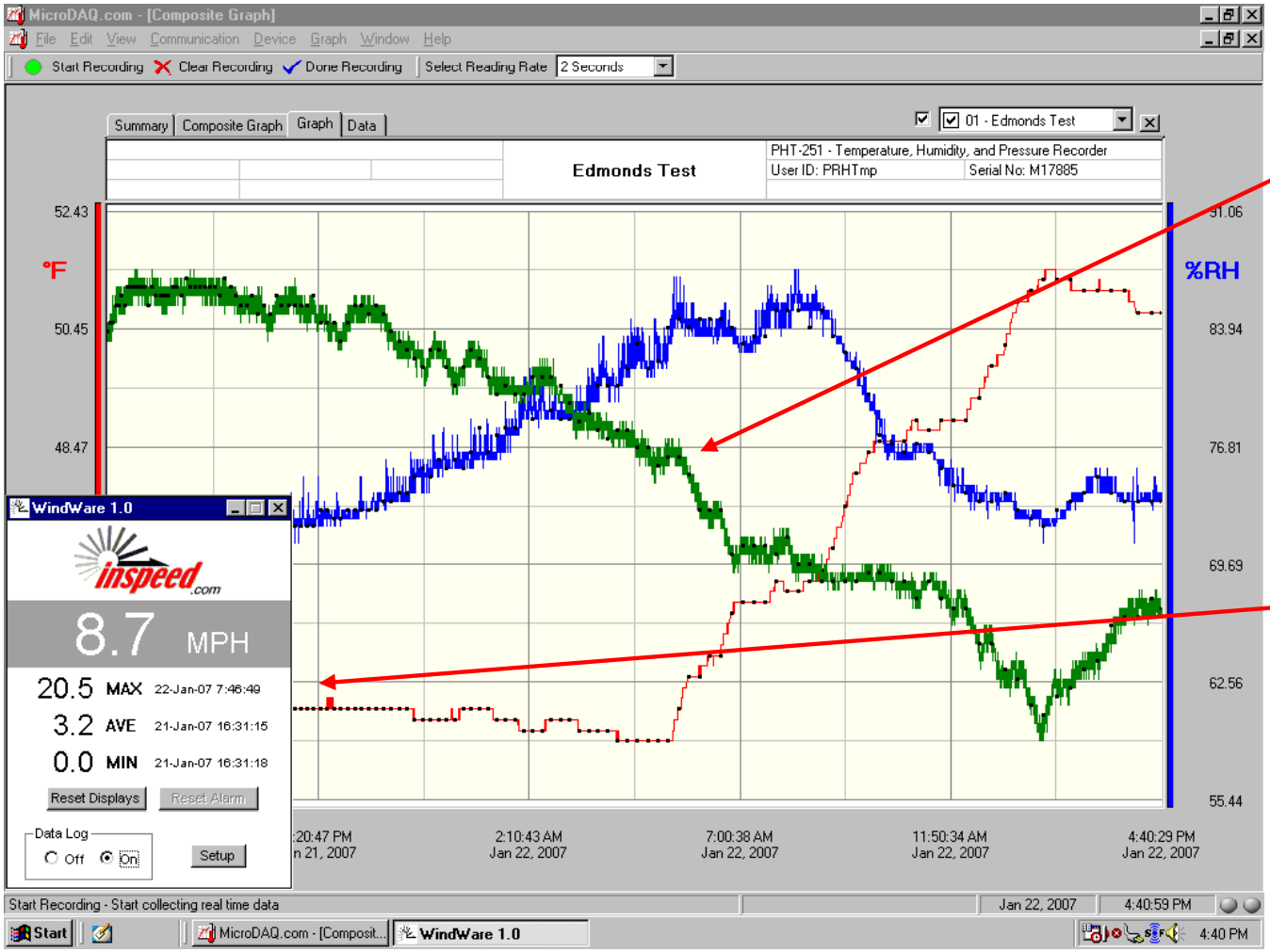
e) Mobile Mesonet ground stations

Glenda Project – Ground Stations

Digital Chart Recorders

Glenda Project utilizes sensors combined with ground based laptops to provide a digital based chart record of ground baseline conditions mapped over time.

The basic example below is a digital chart record of temperature, humidity, barometric pressure and wind speed at a test site.



Pressure, Temperature, & Barometric Pressure data stream using Micro-DAQ software and COM 1 port

Wind Speed data using InSpeed Anemometer and supporting software Using COM 3 port via USB port application adapter

Glenda Project – AN/TMQ-34 Ground Station

Glenda also has an operational portable military weather station. This acquisition further enhances the projects ground condition data collection capabilities.

The TMQ–34 is a military self contained portable weather measuring system that is powered by a rechargeable Ni CAD battery.

The TMQ–34 alphanumerically displays wind speed and direction, peak wind, temperature, dew point, barometric pressure, 3-hour pressure change, and the minimum and maximum temperature.

The entire TMQ–34, including the system case, weighs about 20 pounds. The set contains a computer module with a pressure sensor, and the main sensor module with a red sensor for temperature, a white sensor for humidity, a wind direction compass, and an anemometer to measure wind speed.

The TMQ–34 can operate in temperatures ranging from a low of –59.5°F to 132°F. The TMQ–34 is intended for use in a tactical environment with an operating range of 100 feet below sea level to 10,000 feet above sea level.

Glenda Project – WeatherPak 400 Ground Station

Coastal Environmental Wireless HazMat Weather Station

The Glenda Project has been able to obtain a Coastal Environmental WeatherPak 400 TRx2 mobile wireless weather station.

Some of its numerous features are:

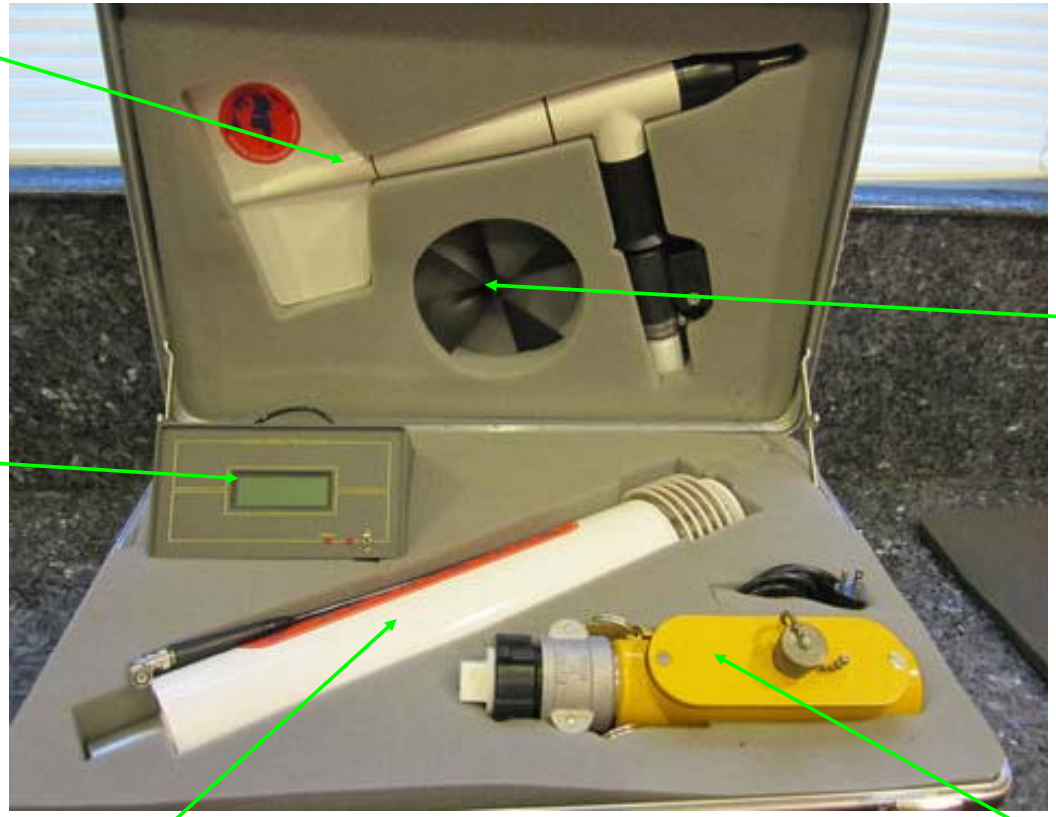
- Wireless radio data Telemetry with a 5 mile range
- Self aligning Fluxgate Compass
- Complete sensor suite to record Temperature, Relative Humidity, Barometric Pressure, Wind Speed, and Wind Direction.
- Weighs less than 10 pounds and is deployable in less than 60 seconds
- Highly portable with its own transit case
- Serial data interface to support data logging and display
- Alternate Power Sources from 120VAC to 12 VDC
- “Stand Alone” capability without requiring a computing interface
- Tested and designed for HazMat and severe environments
- Capability to measure “Sigma Theta” to determine atmospheric instability

Glenda Project – WeatherPak 400 Ground Station

Coastal Environmental Wireless HazMat Weather Station

System Components

Anemometer / Wind Direction Sensor



Anemometer Propeller

Telemetry Receiver Display

Sensor Suite Unit containing Temperature, Relative Humidity, Barometric Pressure and Telemetry Radio transmitter

Power Distribution Junction Box

Glenda Project – WeatherPak 400 Ground Station

Sigma Theta Overview

One of the datasets collected by the Weatherpak 400 is called “Sigma Theta” and is a measurement of Atmospheric Stability.

Atmospheric Stability can be defined as the resistance of the atmosphere to vertical motion. Vertical motion is directly correlated to different types of weather systems and their severity. Atmospheric vertical motion can be either ascending, or descending and are commonly called updrafts, or downdrafts.

Often under calm conditions, and especially over flat terrain, heated air parcels do not rise immediately. They have inertia and remain on the surface until some disturbance permits cooler surrounding air to flow in beneath and provide the needed buoyancy. This disturbance is the trigger for atmospheric in-stability.

Thunderstorms with strong updrafts and downdrafts develop when the atmosphere is unstable and contains sufficient heat, and moisture.

As air rises, it cools and serves as an indicator of atmospheric stability. The term for the rate of this cooling is called the “Adiabatic Lapse Rate”, and is the traditional method for determining atmospheric stability.

In mountainous terrain, temperature and humidity measurements taken at mountaintop and valley-bottom ground stations provide reasonable estimates of the lapse rate and moisture conditions in the air layer between the two levels.

Adiabatic Lapse Rates (under “baseline” conditions):
Dry: 5.5 degrees F decrease per 1,000 feet elevation increase.
Moist: 3 degrees F decrease per 1,000 feet elevation increase.

A large decrease in temperature with height indicates an unstable condition which promotes up and down wind currents. A small decrease with height indicates a stable condition which inhibits vertical motion. Where the temperature increases with height, through an inversion, the atmosphere is extremely stable. (ie capping)

Lapse rate data is typically collected using balloon carried radiosondes, or rocket launched capsules, as the data is not attainable using conventional ground stations.

Glenda Project – WeatherPak 400 Ground Station

Sigma Theta Overview

"Sigma Theta" (ST) is a compound term with its origins coming from both the Statistical / Mathematic community and the Physical Sciences.

The term "Sigma" comes from the Statistical community and is a mathematical term used to define the concept / process called "standard deviation". Standard Deviation is a process used to explain the amount of variability within a data set with the higher the deviation, the higher the level of variability within the data set.

"Theta" comes from the Physical Sciences / Weather community as the term defining the angle of wind direction.

"Sigma Theta" translated means the amount of variability of the changes in wind direction within a dataset.

Robert Yamartino developed the "standard" ST model back in the 1980's and it has been adopted by the HazMat / EPA community as their preferred model for measuring atmospheric stability using ground based sensors and is based off of the following equations:

Step 1: Compute the average sine of wind direction, the average cosine, and epsilon

$$S = \frac{1}{N} \sum_{i=1}^{N} \sin \theta_i \qquad C = \frac{1}{N} \sum_{i=1}^{N} \cos \theta_i \qquad \varepsilon = \sqrt{1-(S^2 + C^2)}$$

Step 2: Compute sigma theta as the arcsine of epsilon, and apply a correction factor

$$\sigma_\theta = \text{arcsine}(\varepsilon) \left[1 + \left(\frac{2}{\sqrt{3}} - 1 \right) \varepsilon^3 \right]$$

Glenda Project – WeatherPak 400 Ground Station

Sigma Theta Overview

Frank Pasquill took the next step, and determined levels of Sigma Theta for differing degrees of atmospheric stability. He created a seven tiered system from "A" to "G", where Class "G" reflects the most stable atmospheric condition, to Class "A" which reflects the highest level of atmospheric in-stability.

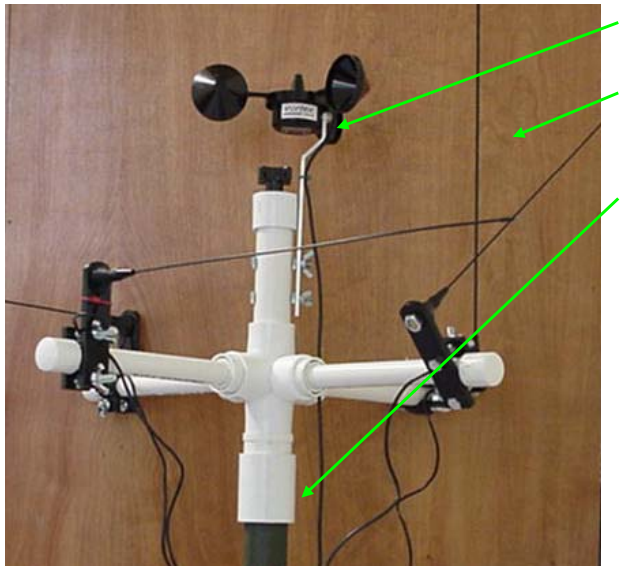
His results are shown in the table below:

Stability Class		Description	Definition
1	A	Extremely Unstable	$22.5 \leq \sigma_\theta$
2	B	Moderately Unstable	$17.5 \leq \sigma_\theta < 22.5$
3	C	Slightly Unstable	$12.5 \leq \sigma_\theta < 17.5$
4	D	Neutral	$7.5 \leq \sigma_\theta < 12.5$
5	E	Slightly Stable	$3.8 \leq \sigma_\theta < 7.5$
6	F	Moderately Stable	$2.1 \leq \sigma_\theta < 3.8$
7	G	Extremely Stable	$\sigma_\theta < 2.1$

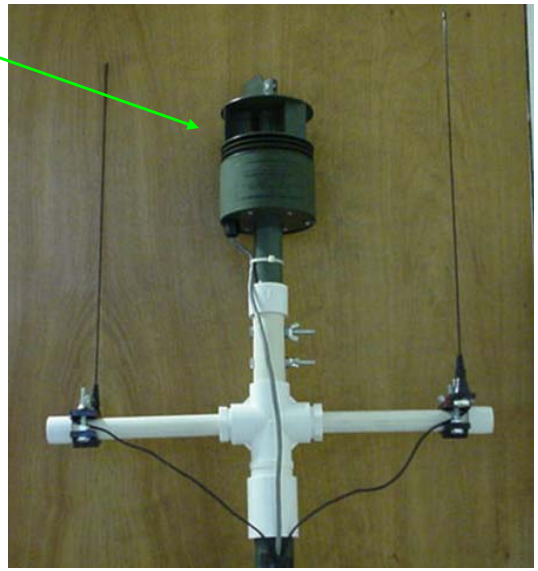
Based on this Stability Class table, we can now make determinations of atmospheric stability based on ground station data and not have to rely on balloon launched radiosondes, or rocket launched payloads.

Glenda Mobile Ground Station Mast System

Removable / Adaptable Mast Sensor Head

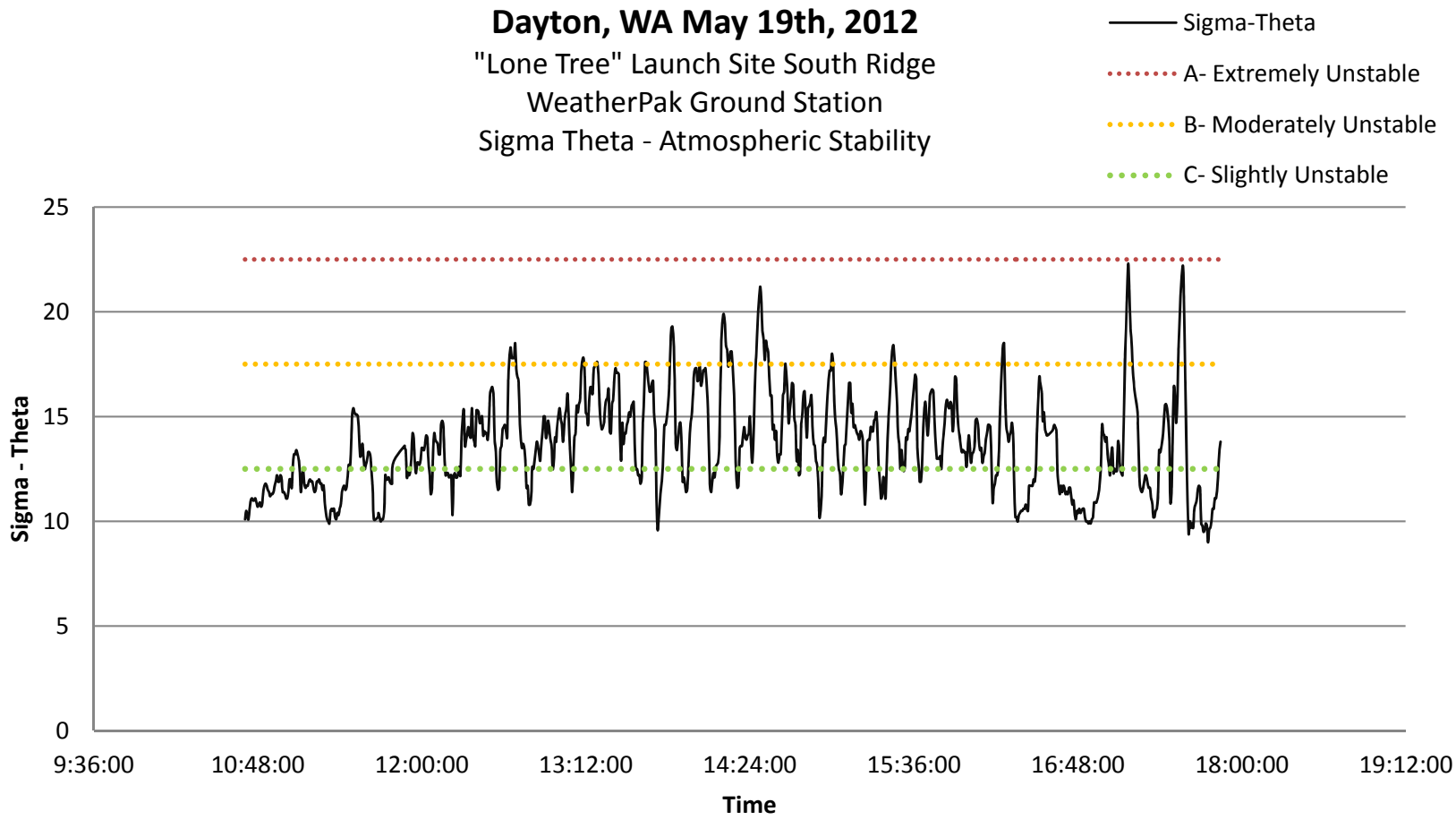


- In-Speed Anemometer / TMQ-34 Sensor
- Two / Four Wide Band Receiver Antennas for Radiosonde telemetry signals.
- Mast System Interface Adapter
- Light weight PVC / Fiberglass construction to reduce potential for lightning strike
- Antennas with 1.2 GHz capability allows multiple frequencies and multiple radiosonde reception
- Mast head integrates with man portable mast system



Glenda Project – Ground Station - Application

WeatherPak 400- Sigma Theta



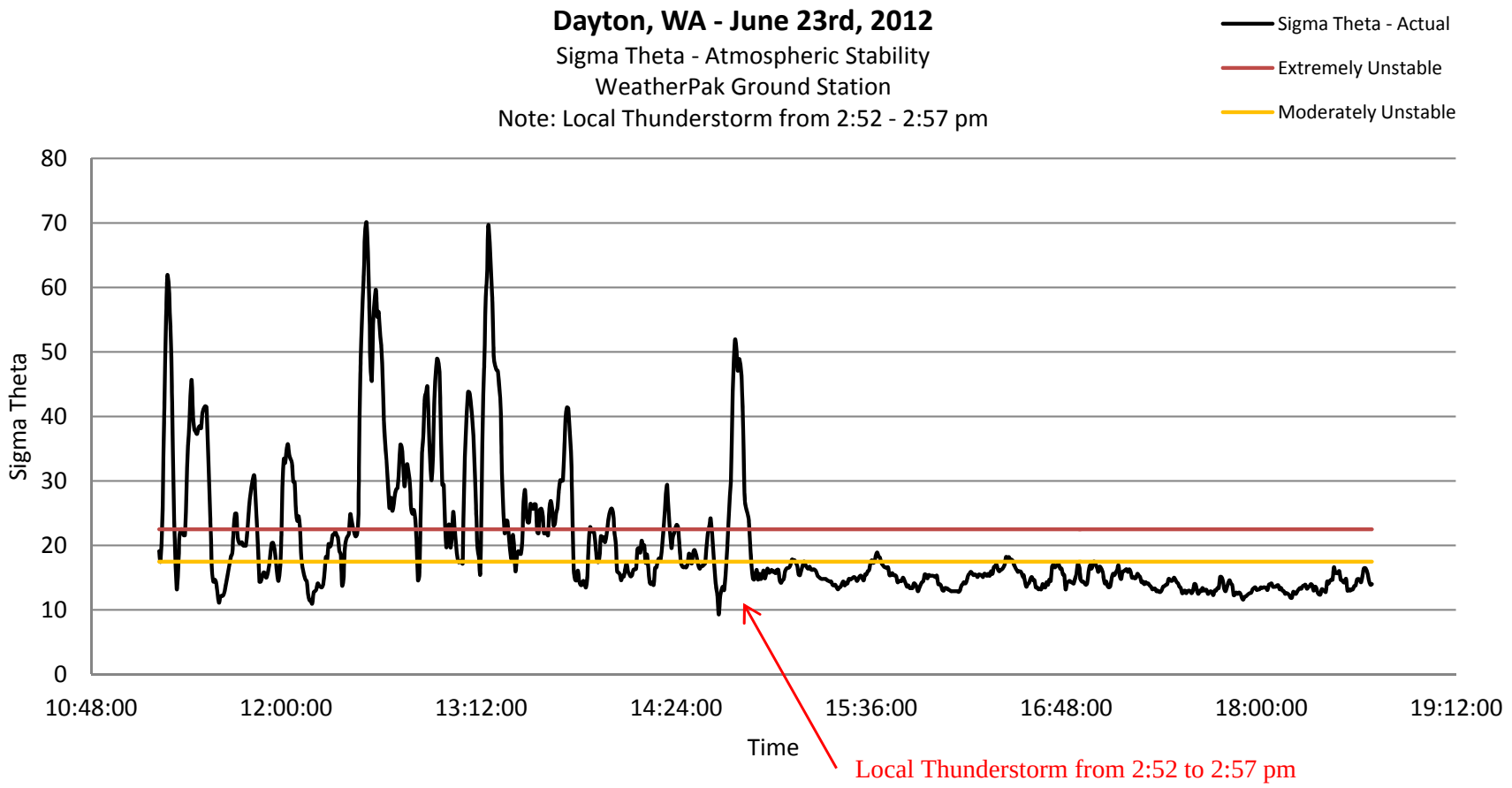
Note that the bulk of the ST data falls in the “Slightly Unstable” range with several points falling into the “Moderately Unstable” band. This implies that atmosphere instability is occurring. However, not severe.

Note also, that atmospheric instability is independent from wind speed as you can have strong winds in a stable atmosphere and calm winds in an unstable atmosphere.

Sigma Theta provides us a tool to measure atmospheric stability using ground based sensors in a mobile environment without the need for lapse rate data and its supporting infrastructure requirements.

Glenda Project – Ground Station - Application

WeatherPak 400- Sigma Theta



On June 23rd, the WeatherPak 400 was deployed on the south ridgeline above the BMR "Lone Tree" launch site.

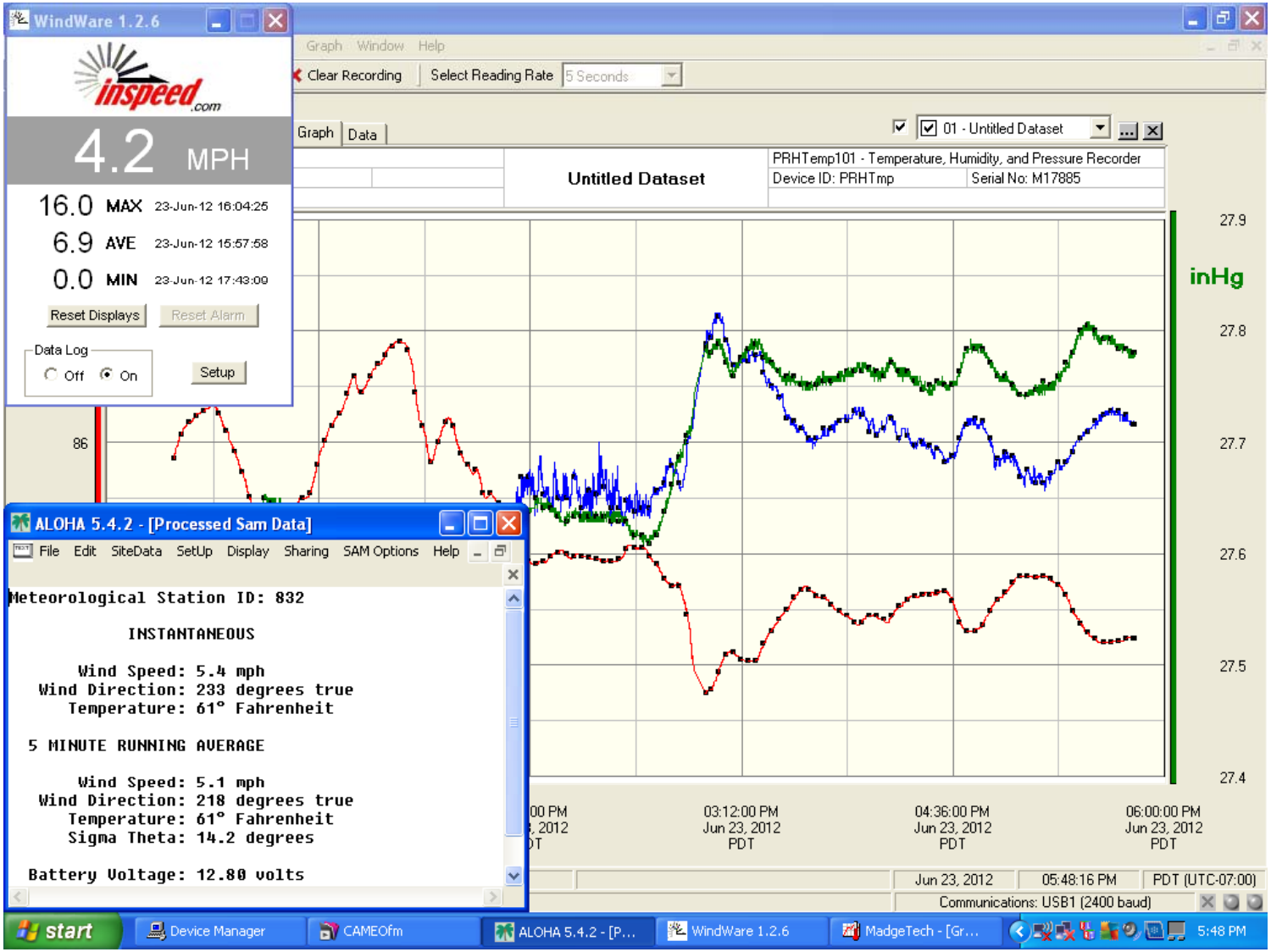
Sigma Theta values reflected "Extremely Unstable" conditions until the passage of a local thunderstorm from 2:52 to 2:57 pm where the Sigma Theta values returned to normal limits.

A case can now be made that Sigma Theta values can be used as a severe weather pre-cursor, and continued deployment opportunities are expected.

Glenda Project – Ground Station - Application

Dual Ground Station Deployment

Dayton, WA – June 23rd, 2012

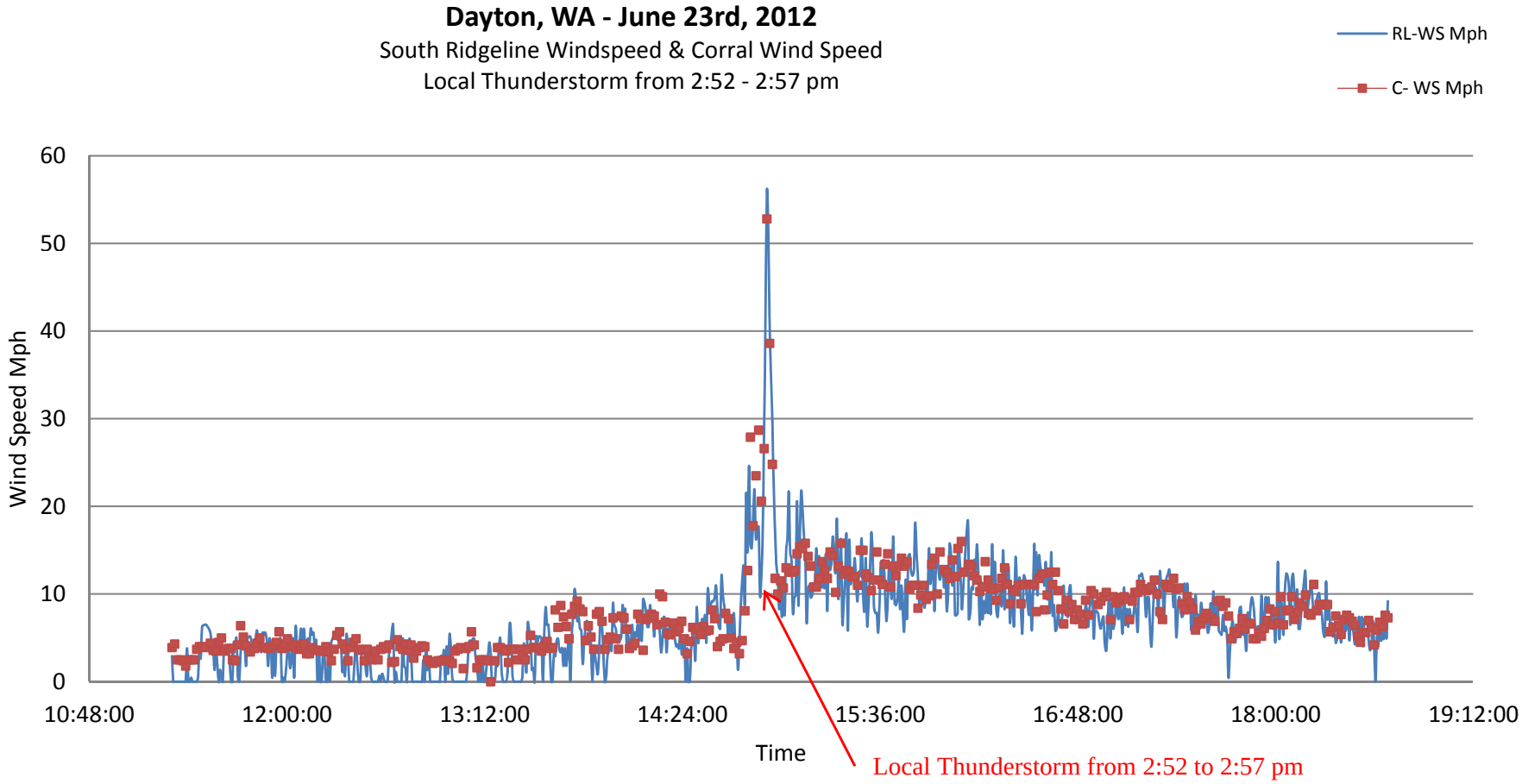


Data from both the wireless and mobile ground stations were displayed side by side on a common interface for seamless integration.

Glenda Project – Ground Station - Application

Dual Ground Station Deployment

Dayton, WA – June 23rd, 2012

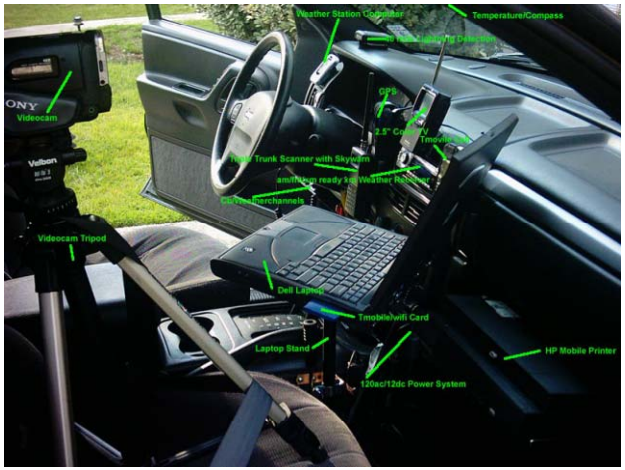


On June 23rd, our first dual deployment accoured as a thunder storm passed over two ground stations simultaneously with one station the wireless WeatherPak and the second, our hard wired mobile station.

Glenda Project – Intercept Teams

In order to obtain data from dynamic weather phenomena it is necessary to seek out and intercept storms and to launch sensors into the heart of the disturbance, capture the data, and return the data for immediate processing and analysis. Hence the name, Intercept Team.

The Intercept Teams utilize Jeep Grand Cherokee 4 wheel drive units, and other heavy duty trucks, equipped with specialized tires and suspension to handle road debris situations and evasive maneuvers while on the go. When storm data is required, the teams immediately equip the vehicles with instrument packages and laptop computers inside the vehicle and attach to the roof, weather instrumentation, satellite dishes, sensors and communication gear. Portable rocket launching stands and weather rockets are loaded into the back of the jeep. Transforming from a ordinary vehicle to a fully operational weather pursuit vehicle takes as little as five minutes.



Glenda Project – Intercept Teams

Mobile Mesonet Ground Station Vehicles

Intercept Team vehicles can feed information directly over the web to Acurite and Weather Underground fully automatically. Vehicles are equipped with full weather station sensors and forecasting ability, weather warning radios, a short wave wefax system, wifi connectivity both local and cellular, and 20 meter and 2 meter transmission systems which allows communications between team vehicles and Emergency Management and First responders . Vehicles have the capability of independent operation with either an onboard generator and / or back-up 12 VDC battery systems.

Glenda Project – Intercept Teams

Columbia County – Dayton, WA

In 2012, the Columbia County / Dayton, WA Intercept Team became the “eyes” for Emergency Management and First Responders in severe weather situations.

SKYWARN

Approaching Storms for Intercepts

Glenda Project – Intercept Teams

Columbia County – Dayton, WA

The Dayton storm team made significant advances in 2012 in the areas of micro-climate research and coordination with regional emergency management resources.

The year started out with significant upgrades to data collection and analysis hardware. Extech RHT50 data loggers were deployed this year. These compact data loggers record barometric pressure, temperature and humidity at rates of up to one minute intervals, recording over 10,000 data points for later download and analysis. Two such data loggers are now in operation; one that records at the team's base of operations in Dayton, while the other travels with the team recording the team's movements in relation to the micro-climate they are in. Team member safety has been enhanced through the use of StrikeAlert II lightning detectors, which monitor electromagnetic field densities and can detect approaching lightning strikes up to 40 miles away. In addition to a hand-held Kestral wind meter, a vehicle-mounted Vortex anemometer has also been deployed this year.

Real-time Doppler radar has been incorporated into the storm team's expanded list of tools this year as well. Using the Doppler radar coupled with the on-board Holux GPS navigation system, the team can pinpoint their exact location in relation to storm systems, providing them the best possible opportunity to position themselves in relation to storm system movements to obtain the best possible data. Unlike other storm "chase" teams, this capability allows the Dayton Intercept Team to concentrate less on chasing storms, and more on positioning themselves to intercept storms.

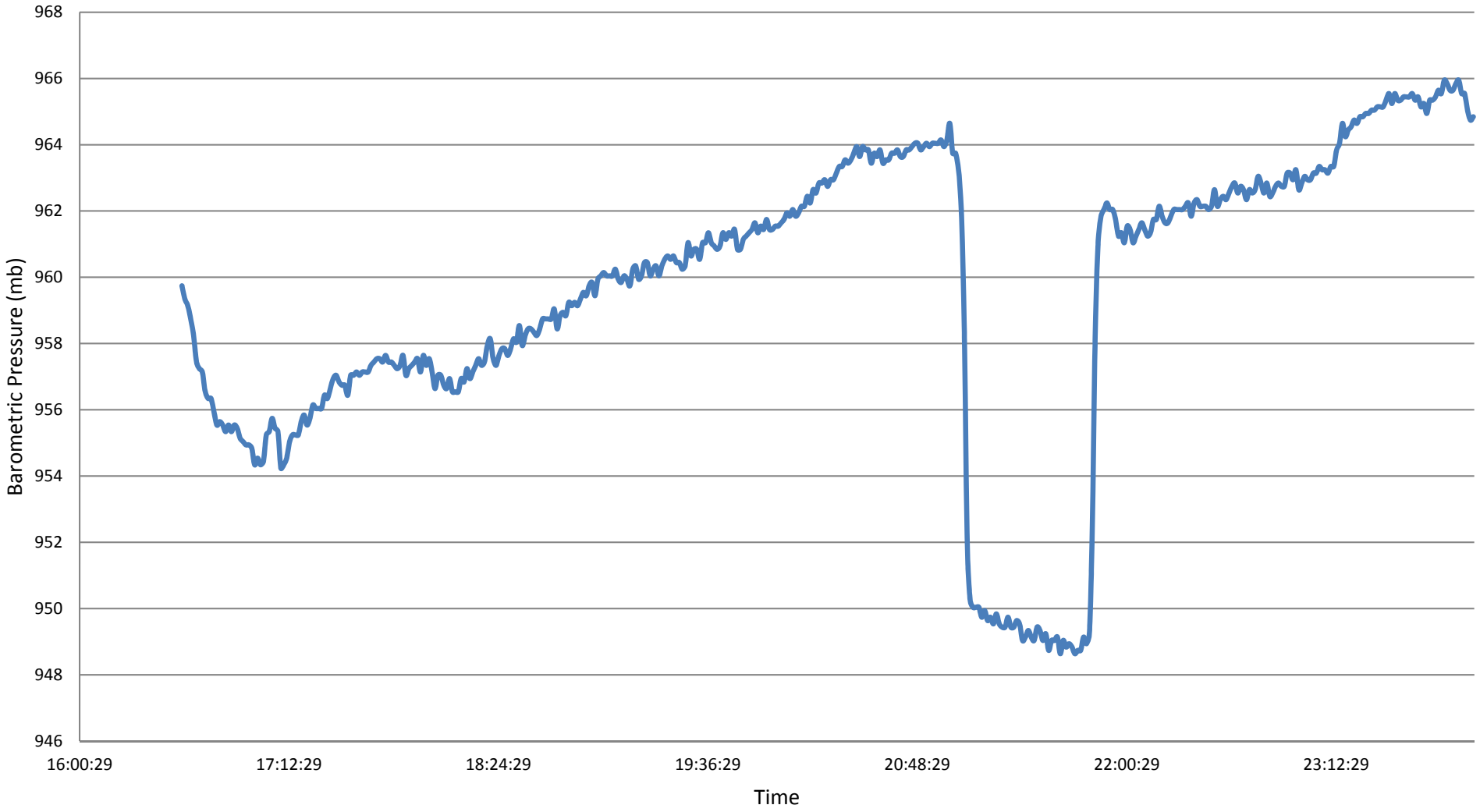
Glenda Project – Intercept Teams - Applications

Between the months of April and August of 2012, the Dayton storm team intercepted five major storm fronts that traveled through southeastern Washington State. One storm on July 8th, 2012 created a micro-burst over the north residential area of the town of Dayton, which was recorded on the team's on-board data loggers. Responding to the affected area, the team was able to assist with and coordinate emergency services response. They coordinated storm debris removal to assist with the response of fire, ambulance and law enforcement units, the evacuation of an elderly person trapped in their residence by storm debris, and assisted with crowd control until power was restored by the power company hours later. All information and storm observations were relayed by the Dayton storm team in real time to the Pendleton National Weather Service and to the local Emergency Management office which resulted in local and regional severe weather alerts being issued.

Glenda Project – Intercept Teams - Applications

Dayton, WA - July 8th, 2012

Barometric Pressure (mb) - 15 mb Pressure Drop during Micro Burst



The Columbia County / Dayton, WA Intercept Team achieved a successful intercept of a microburst thunderstorm and recorded a 16 mb pressure drop during the event.

Glenda Project – Intercept Teams - Applications

As a result of the team's response to the July 8th, storm emergency, subsequent meetings were held with local emergency services. The Dayton storm team has been requested to assist regional emergency services in future storm events. The team has now been equipped with a BK digital radio system that operates over narrow band microwave in the 155 mhz range. This system allows them direct radio communications to regional law, fire, ambulance and emergency management field units as well as the regional 9-1-1 public safety communications center. The team's integrated real time Doppler and GPS capabilities have allowed them the opportunity to coordinate with local and regional fire departments during lightning storms to aid in the staging of fire assets to suppress lightning strike fires.

Additionally, the team has also been asked to provide storm preparedness presentations to the public through local 9-1-1 Public Education Programs and through venues such as National Night Out. The team was also the recipient of an equipment grant from the United States National Forest Service in the form of a complete Olympus OM-2S 35mm camera set complete with multiple lenses to be used for the purpose of documenting storm structures and lightning.

Glenda Project – Intercept Teams – Payload Tracking

GPS – Payload Tracking System Operational

When capsules are launched into severe weather systems, one of the primary challenges, is their return.

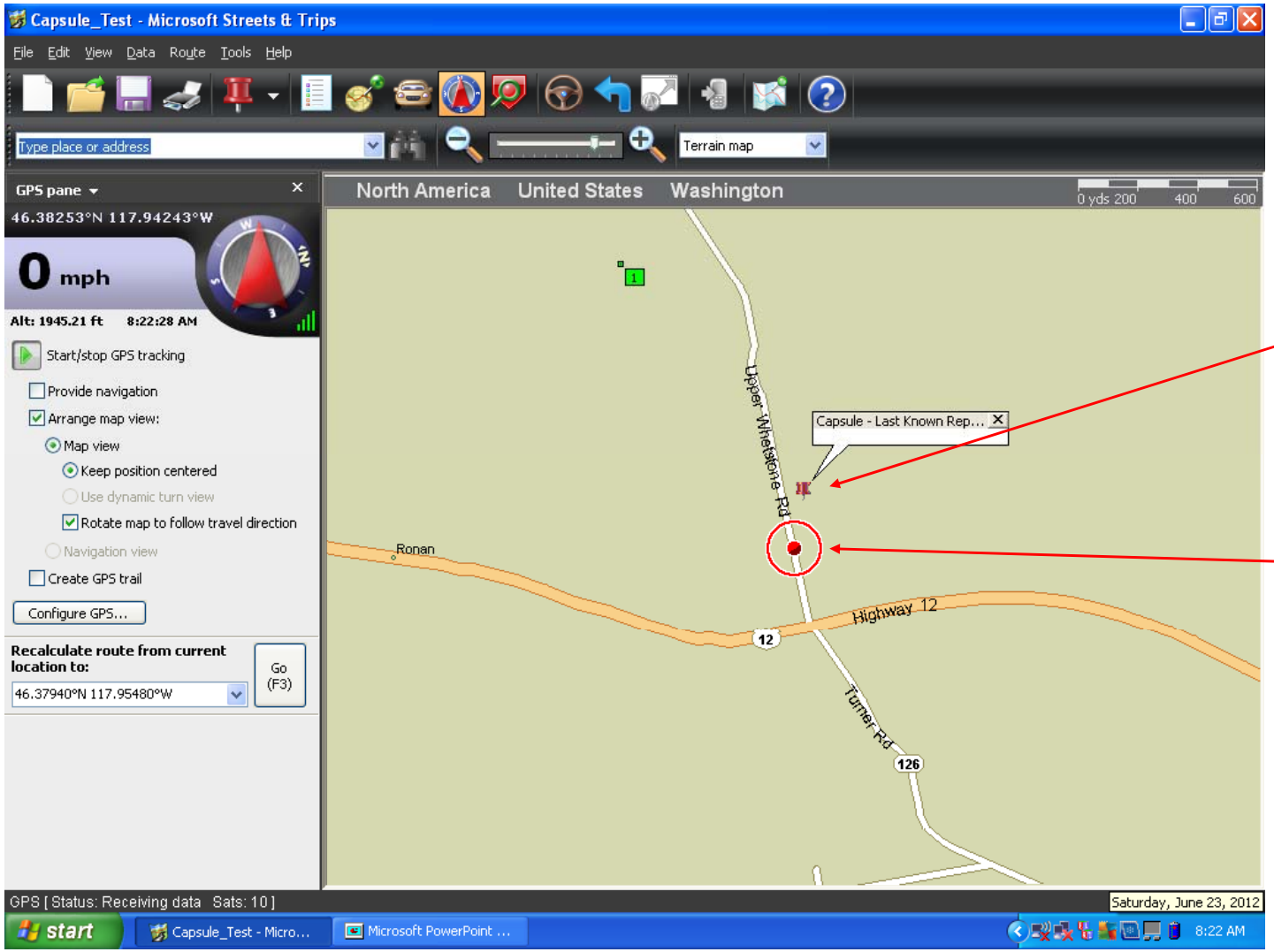
Glenda now has the capability to track capsule positions using GPS in real time combined with real time display of the “intercept” vehicles position using “non-internet / non-cellular” driven GPS positioning.

The capsule transmits its GPS position to the intercept vehicle, while that vehicle integrates its own position in relation to the moving capsule in real time.

This capability allows real time deployment capture and rapid return to flight for multiple intercepts with the same storm system.

Glenda Project – Intercept Teams - Applications

GPS – Payload Tracking System Operational
Dayton, WA – June 23rd, 2012



Capsule Position

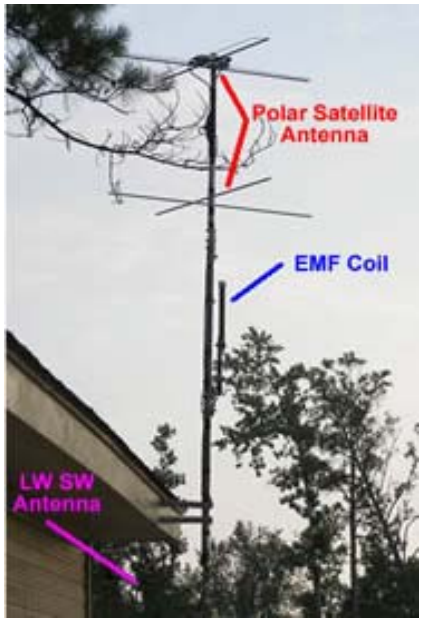
Intercept Vehicle Position

GPS positioning data from both the payload capsule and the intercept vehicle can now be displayed on a common screen in real time allowing for rapid intercepts and near real time return to flight.

Glenda Project – Remote Sensing
Bayou Canada Research Facility

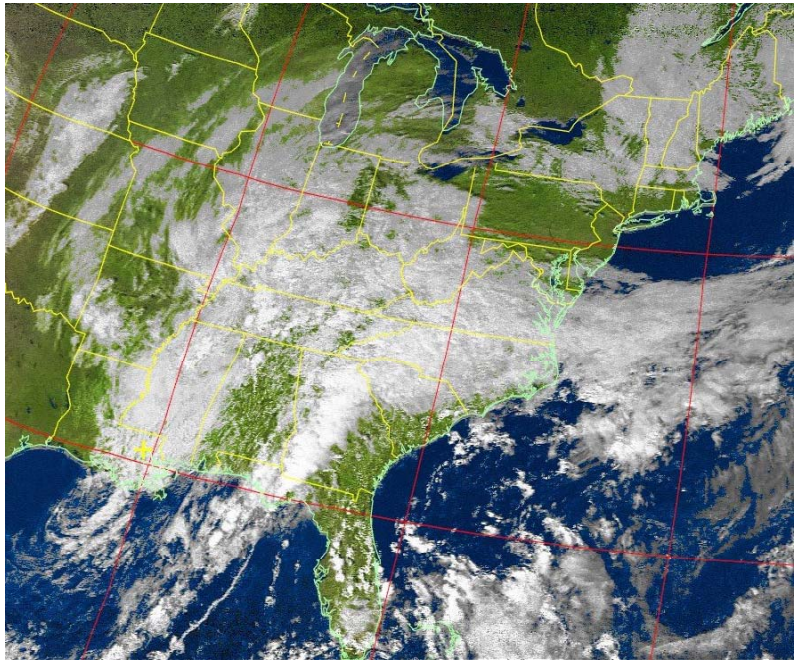
The Bayou Canada Weather Research Facility is located in Ponchatoula, Louisiana, roughly 60 miles north of the Gulf of Mexico.

Bayou Canada feeds out weather data in regular intervals as quickly as every two seconds depending on the need for data and weather conditions. We post real time data including radiation and EMF on our website, as well using both web and over the air radio transmissions. We feed directly to: NOAA and the National Weather Service, APRS via ham radio station KE5JJC both over the web and over 2 meter ham frequencies, Citizens Weather Observation Program, Hamweather, PRSWeather, WeatherBUG, and Weather Underground / The Weather Channel.



Glenda Project – Remote Sensing
Bayou Canada Research Facility

Weather information is fed automatically into various computer processing centers as well as the National Weather Services. Because our information is sent at much shorter intervals than most typical airport weather stations, the analysis of our data is quicker and affects the decisions and warning announcements issued by the National Weather Service. Because we can provide both mobile and base visuals, additional information can be sent to the National Weather Service via cell phone or ham radio transmissions. The NWS monitors particular ham radio frequencies for reports in major weather situations. The National Weather Service will issue watches and warnings both over the air (weather stations and public networks) and over the web based on the information that we and additional stations send them. The NWS is of course the official source for Emergency Management Centers.



Glenda Project – Successful Move to Louisiana

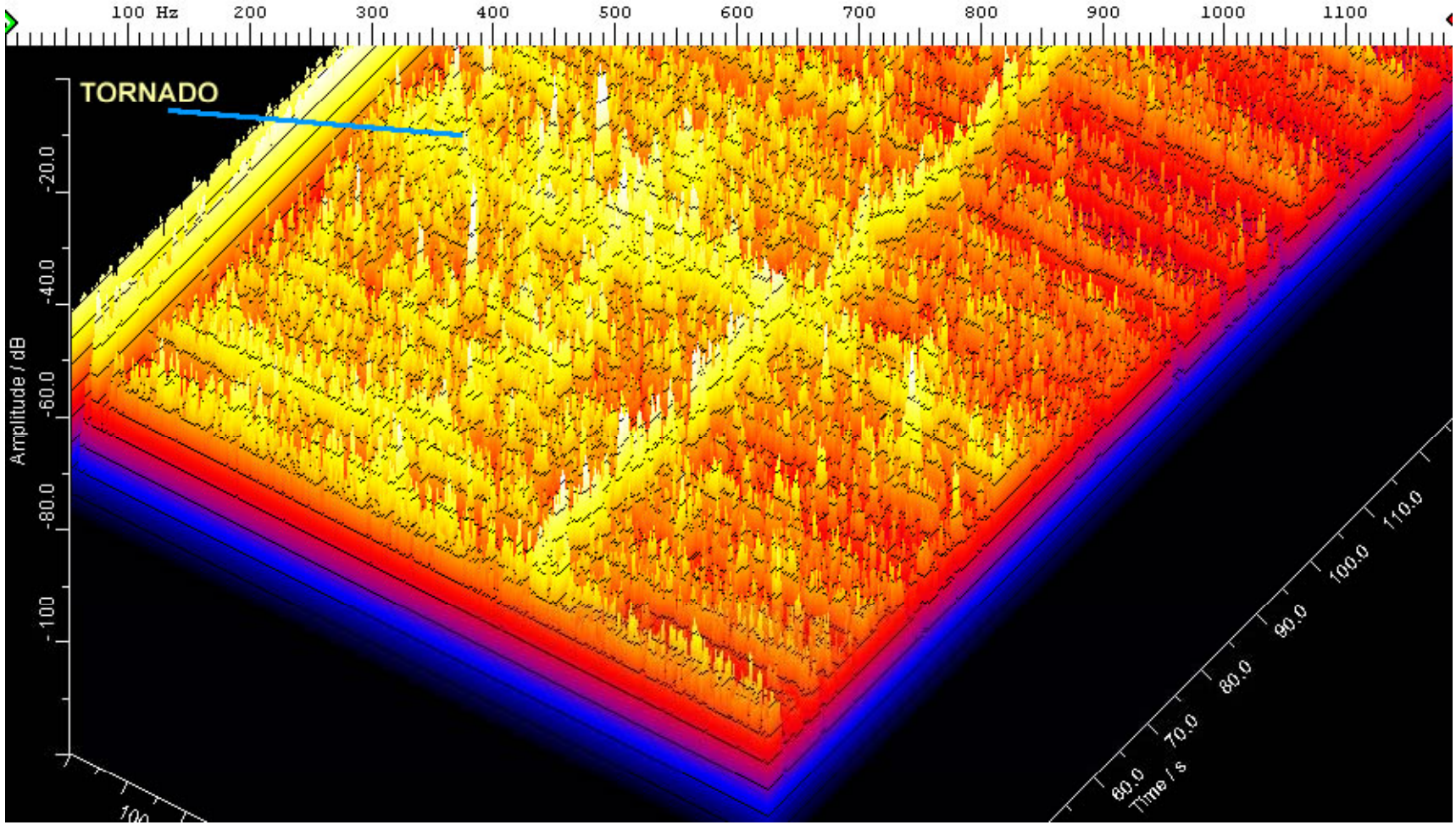
In 2012, the Glenda Project successfully moved from its base in Petal, Mississippi to Pontchatoula, Louisiana.

Service and functionality continue to improve at our new facility while still pursuing field applications and work with both Louisiana and Mississippi first responders and emergency management.

Glenda Project – Remote Sensing – Application

EM Field Mapping

Combining Glenda computing and sensors allows the capability for advanced analysis and detection. Shown below is a 3D Electromagnetic Field (EMF) analysis of a tornado based off of a three second data capture. The circular effects of the funnel are easily visible and provide a snap shot of the electrical activity around a tornado.

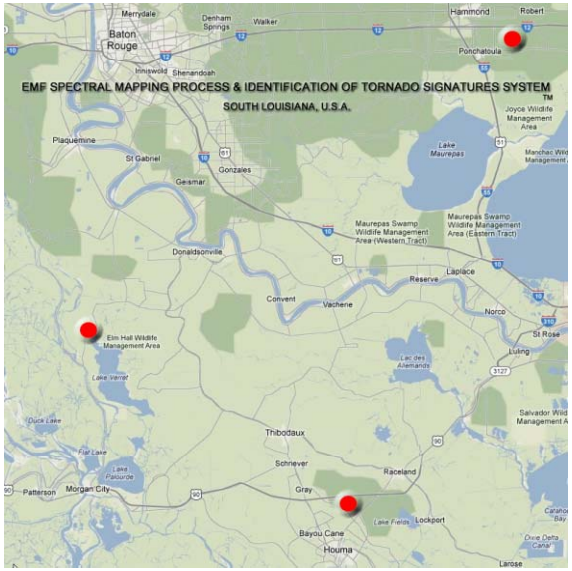


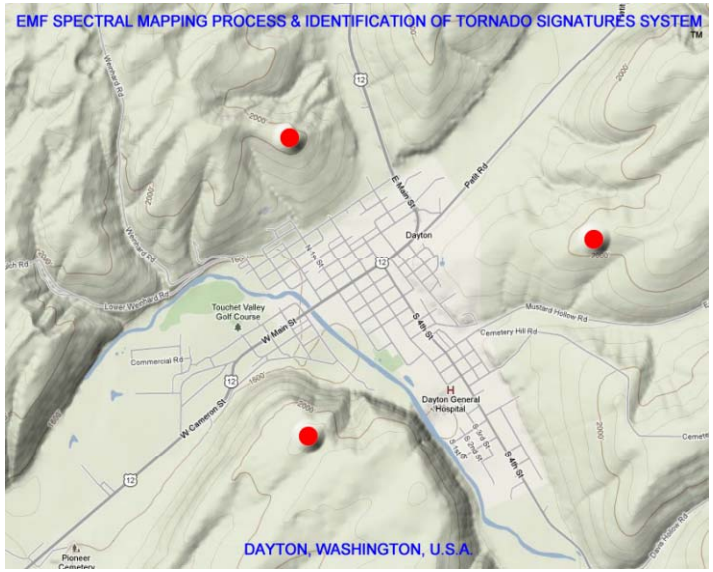
Glenda Project – Remote Sensing – Application

Electro Magnetic Field Mapping and Identification of Tornadic Signatures

Pullman Geosciences Research Foundation has developed an Electro Magnetic Field Spectral Mapping Process and Identification of Tornado Signatures System. The system uses an integrated network of automatic direction finder (ADF) instrumentation that automatically and continuously displays the bearings of energy disturbances in the atmosphere. Using a standard triangulation methodology and an advanced interlinked computer network for data analysis 3D models of the atmosphere can be built reproducing the real time conditions. The system has the ability to identify and track single item energy disturbances and forecast the path across the terrain. This allows the ability to track for example the signature of a tornado as it crosses land similar to weather radar.

The first complete integrated computer network with sensors is under construction with Beta testing of the system starting in Spring 2013.

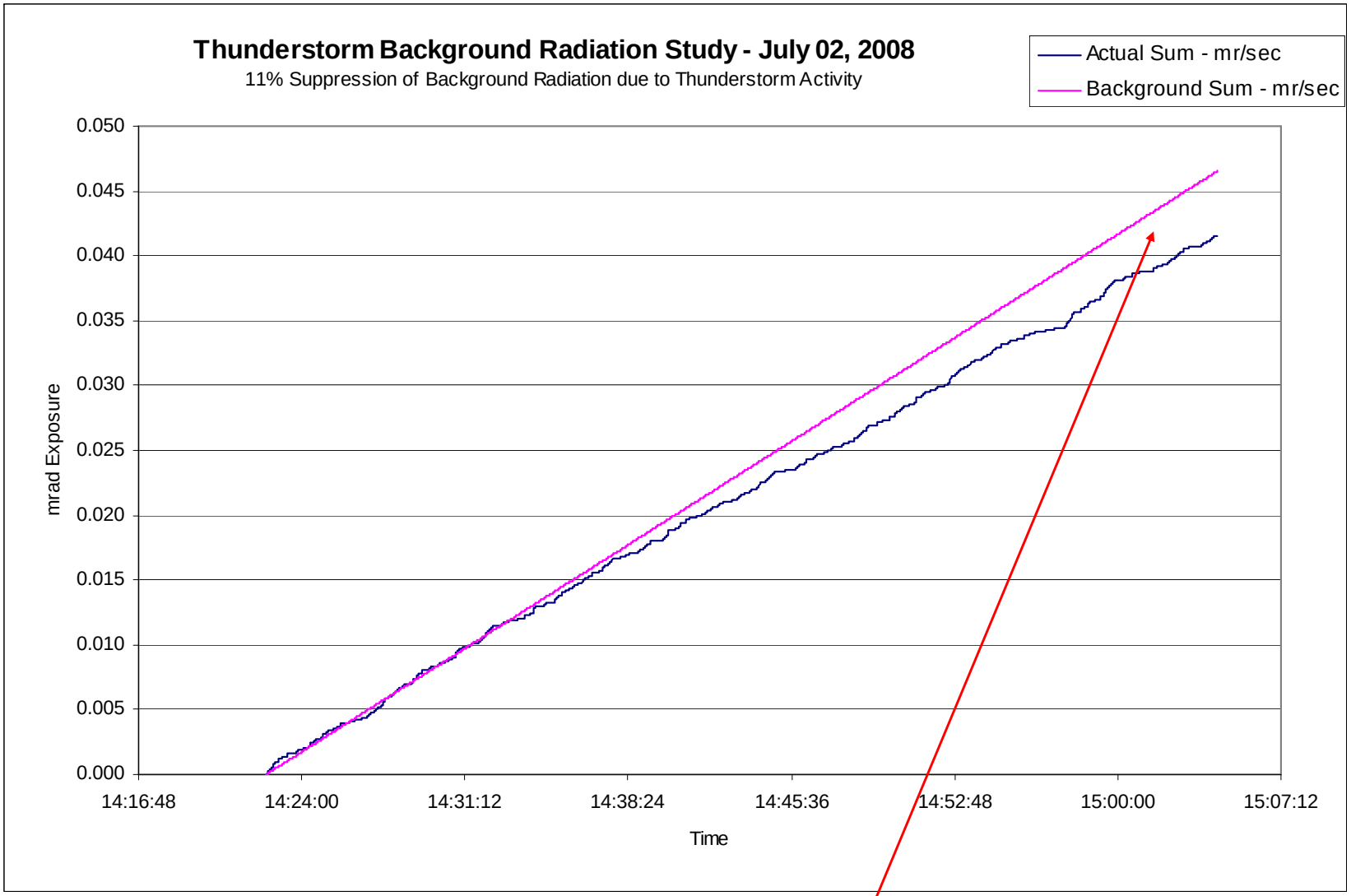




Glenda Project – Remote Sensing – Application

Gamma Radiation Studies

Data collection capability of Gamma Ray Radiation during Thunderstorms



During this extensive Thunderstorm, lightning suppressed the “background” gamma radiation count by 11 percent

In Conclusion

The Glenda Project is a highly mobile data collection system designed to place instrument packages into areas previously considered to be to hazardous or inaccessible using traditional platforms such as balloons, aircraft, helicopters, kites, etc.

The operational Glenda Project shows the differences between Hollywood “fiction”, “Reality Television” publicity stunts, and engineering “fact”, from mapping local environments to a full tornadic funnel with a suite of sensors.

In 2012, we achieved multiple storm intercepts, deployed a wireless long range ground station with Sigma Theta capability and built on sustaining relationships with emergency managers and first responders.

For 2013, we’re developing a balloon deployment capability for applications where booster launches are not feasible and continue to develop the flight envelop of our sensors and ground stations. The Glenda Project is up to the task.

Severe Weather – General Observations

Tornado Season is Here!

Severe Weather – General Observations

There's a difference between a "Tornado Watch" and a "Tornado Warning"

A "Tornado Watch" is issued by the National Weather Service (NWS) when there is a good possibility that a tornado will touch down. A tornado watch usually encompasses many counties and last several hours.

A "Tornado Warning" is issued when severe weather is actually happening. When a tornado warning is issued, it's time to go to a safe place and put your emergency response plan into action.

The present average response time between the issue of a tornado warning and severe weather coming into your area is less than 15 minutes.

Severe Weather – General Observations

What to do during a "Tornado Watch"

Stay tuned to local radio and TV stations or a National Oceanographic and Atmospheric Administration (NOAA) Weather Radio for further weather information.

What to do during a "Tornado Warning"

If you are outside when you hear a warning notification, seek inside shelter, preferably in a steel framed or concrete building.

If you are inside when you hear a warning notification, go to the interior hallway or other enclosed area that is away from windows and on a lower floor of the building. Avoid going into auditoriums, gymnasiums, mobile homes or other areas where roof collapse is likely. Take position for greatest safety by crouching on knees, head down with hands locked at the back of the neck.

Stay tuned to local radio and TV stations or a National Oceanographic and Atmospheric Administration (NOAA) Weather Radio for further weather information.

Rooms with large glass areas should not be used for shelters.

Severe Weather – General Observations

After any severe storm – Beware of any standing water.

If you can't see the "bottom", you may not find it until you hit it.
Driving through any standing water is always a risk.

Severe Weather – General Observations

There's more to severe weather than wind, and rain

Hail Stones

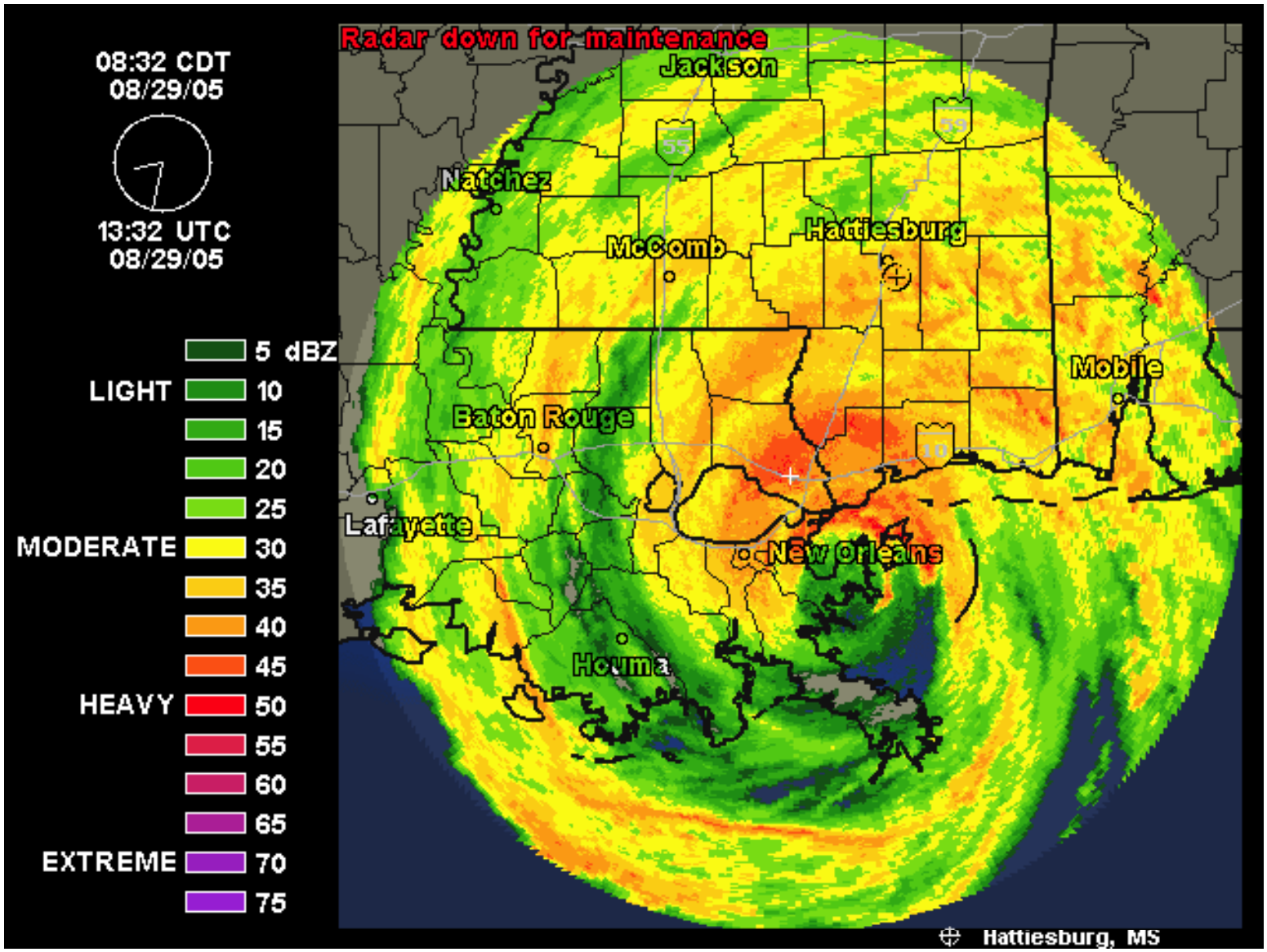
Hail can severely damage antennas, cables, and any externally mounted hardware

Lightning Strikes

Lightning strikes are deadly to ungrounded antenna systems and unprotected computer networks

Severe Weather – General Observations

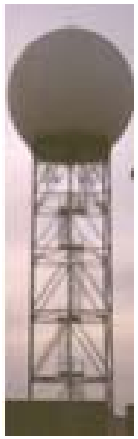
The Weather Scientist's Favorite Tool - RADAR



While Radar may be a useful tool, it's not perfect.

Severe Weather – General Observations

Weather Radar's Weakness



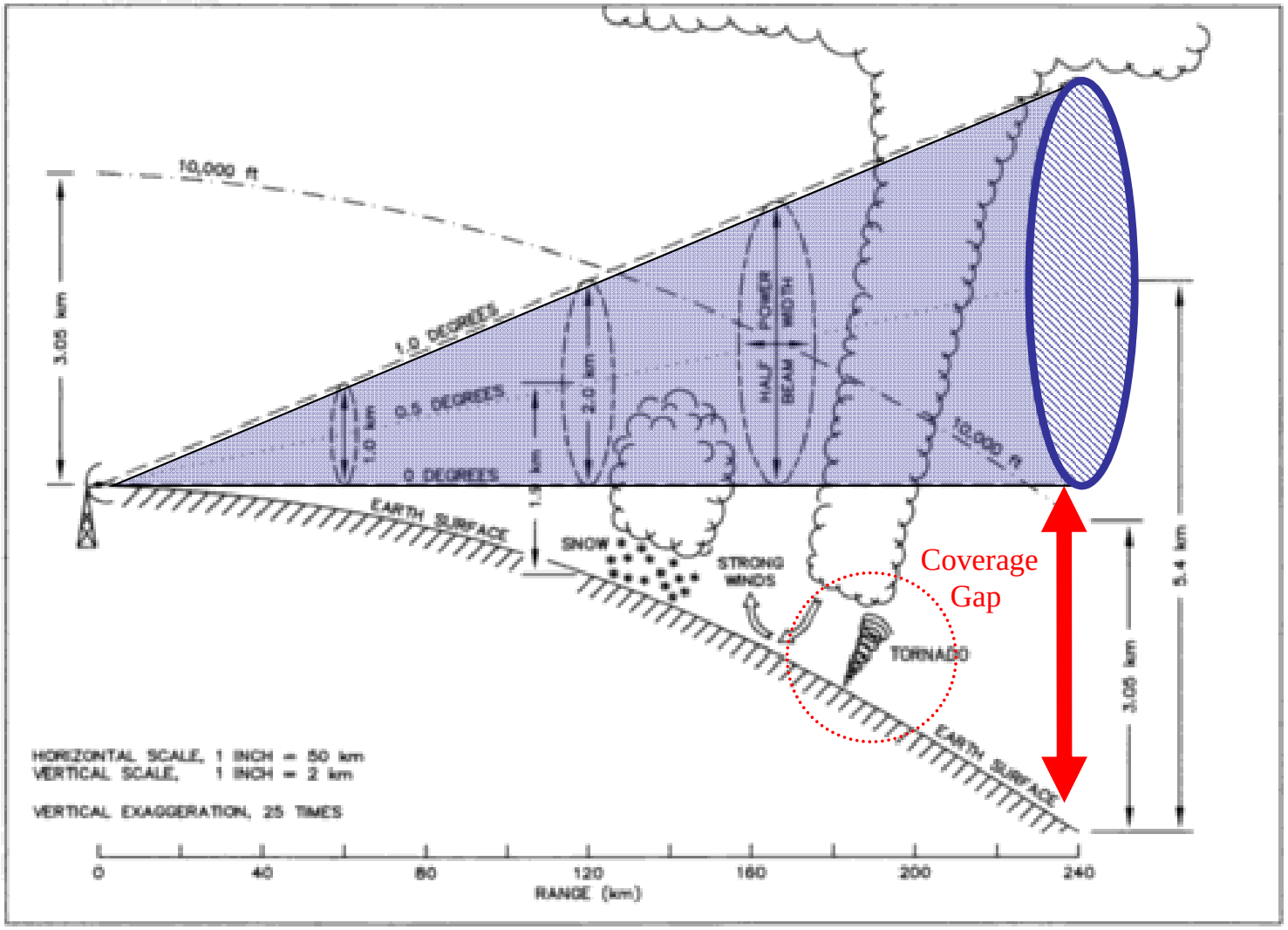


Figure A-3 Diagram illustrating the effect of range and earth curvature (with standard atmospheric refraction) on NEXRAD cross-beam resolution and coverage of low-level weather phenomena. Courtesy of SRI International.

Earth curvature effects prevent 72% of the troposphere below 1 km from being observed

Severe Weather – General Observations

While Radar is a great tool, it is not a substitute for local ground observations.

<u>Here is where the individual can contribute most:</u>

- SKYWARN
- APRS WxNet

Severe Weather – General Observations

What is SKYWARN ??

SKYWARN™ is a concept developed in the early 1970s that was intended to promote a cooperative effort between the National Weather Service and communities. The emphasis of the effort is often focused on the storm spotter, an individual who takes a position near their community and reports wind gusts, hail size, rainfall, and cloud formations that could signal a developing tornado. Another part of SKYWARN™ is the receipt and effective distribution of National Weather Service information.

Check out the web site: www.Skywarn.org for additional information and local resources

SKYWARN is actively support by ARRL, and ARES

Severe Weather – General Observations

What is APRS WxNet?

The Citizen Weather Observer Program (CWOP) is a group of ham radio operators and other private citizens around the country that have volunteered the use of their weather data for education, research and use by interested parties. The APRS-IS collects weather data transmitted from individual stations and communicates these data to the amateur radio findU server where the data are organized and made available to the MADIS Program at 15-minute intervals. The CWOP data also go to the MADIS Quality Control and Monitoring System (QCMS) which checks data quality using a variety of techniques.

The Automatic Position Reporting System (APRS tm) is a part of ham radio that provides an ideal way for weather station operators to distribute their weather data much further than the regions within their transmitter range. APRS was originally intended for position information data but actually provides a means for automatic transmission of all sorts of digital data. This is especially true now that the original APRS packet radio concept has been enhanced to include the capabilities of the Internet. The reporting of citizen weather data is a particularly useful application of the APRS Internet Service (APRS-IS).