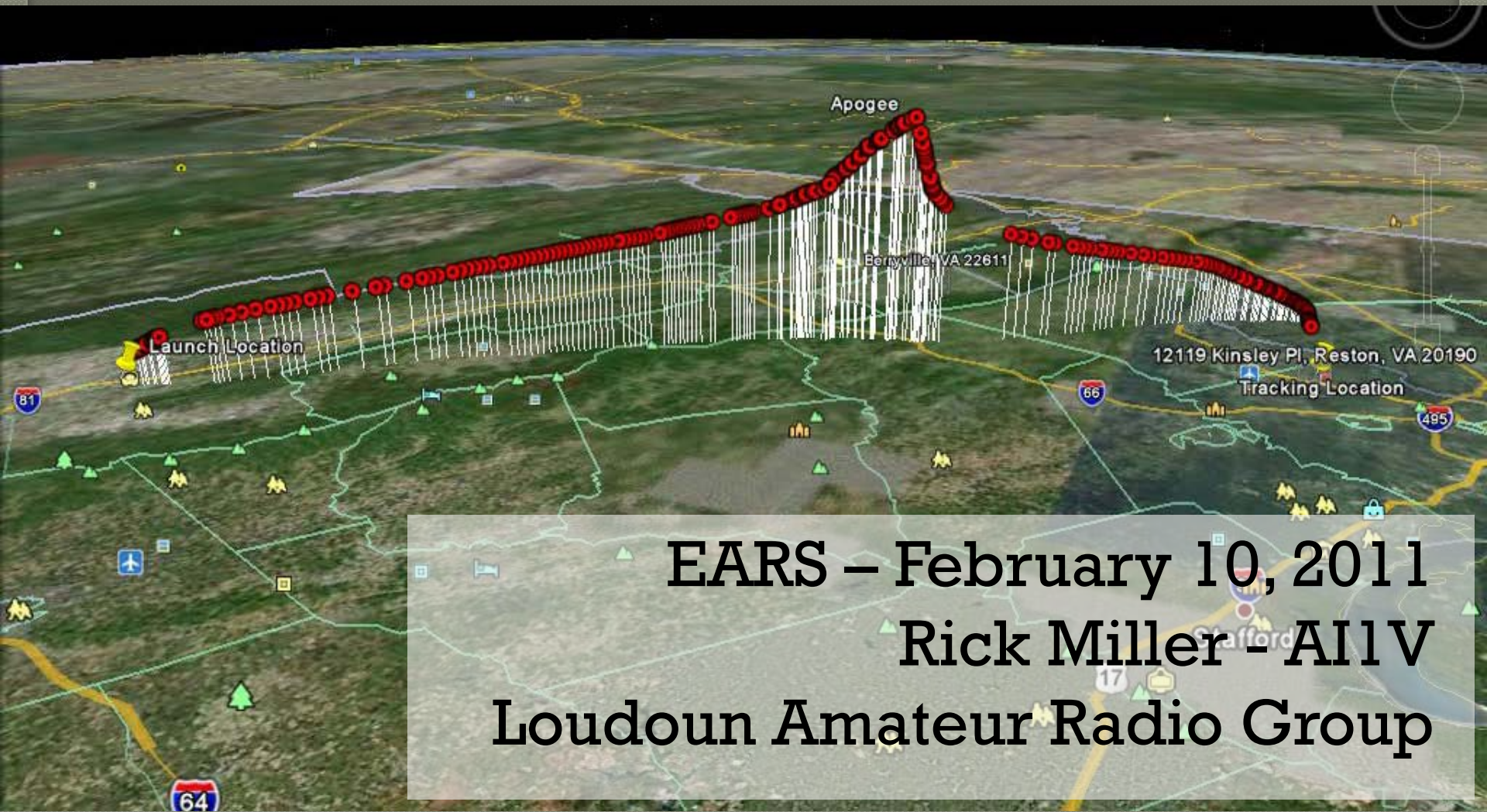
# Amateur Balloon Operations




EARS – February 10, 2011

Rick Miller - AI1V

Loudoun Amateur Radio Group

# Taking You Higher…

- Introduction – about LARG
- Why do balloon operations?
- Elements of a successful mission
- Flight Package Components
- Launch Planning and Operations
- Tracking and Recovery
- Communications

# Loudoun Amateur Radio Group

- LARG is a family oriented club
  - Currently 59 members
- Have activities in almost every facet of ham radio
  - Contesting, DX, Public Service/Emergency Operations, Experimenting, Training
- 5 Weekly Nets (2m, SSB, CW, Digital, YL)
- Very active on Field Day
  - Run a 5A setup
  - Have been in top 10 for 5A class for 10 years
  - Last year we were #2
- We don't own any repeaters!

# We also fly balloons!!

- We've had 9 balloon operations since 2000.
- We have a standing "balloon committee" with its own budget.
- Usually around 20 people participate in each mission.

# Why in the world would you want to do this?

- Operational Planning Practice
  - Operations are surprisingly involved
- Education
  - Lots of opportunities to learn about engineering and physics
- Involve non-hams and kids
  - Lots of roles for licensed and non-licensed folks
- Improve radiolocation and DF capabilities
  - Great tracking target
- Electronics design and construction
  - Build your own payload
- Have fun – *lots* of fun!!

# So what does it take?

- Planning
- Hardware
  - Balloons, gas, payloads, tracking equipment
- Planning
- People
  - Designers, flight analysts, trackers, launch, recovery, telemetry analysts, diplomats (to talk to property owners for recovery)
- Planning
- Transportation
  - Be ready to drive far and fast
- Planning
- Communications
  - Very helpful to have net that covers entire op area (wide area repeater, networked repeaters, NVIS HF)
- And one last thing – planning!

# Flight Package Components

# The Balloon

- "Sounding Balloons" as used by the NWS for radiosondes
- We get ours from Kaymont Corporation – http://www.kaymont.com/
- Sold by weight
  - 600g
  - 1500g
- Latex sphere
- $80 - $90

# Fill 'er up

- We use helium for lift
  - Getting pretty expensive-about $75 per mission
  - Considering hydrogen in the future
- Fill sufficiently to burst at max altitude


Before

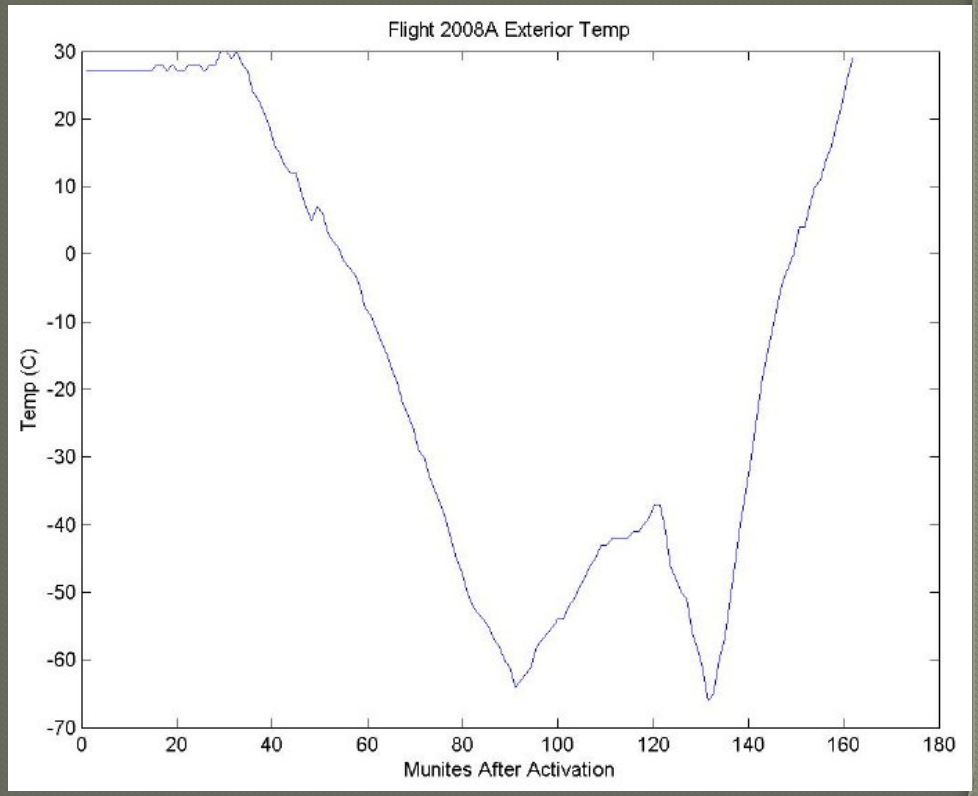

After

# Payloads

- The "passengers" of the mission
- Common features
  - Sensors
    - Temperature, pressure, battery voltage, still or video camera
  - Data link
    - Radio (hey, we're hams!)
    - CW, Packet, analog video
- Suspended by light rope from the balloon and parachute

# Payload Construction

- Don't forget the environment!
  - It gets cold up there- expect -70C
  - Good insulation a must
  - Low pressure too
- There's no ground
  - Antenna ground plane
- Comply with weight and surface area restrictions
- Put an informative label on it



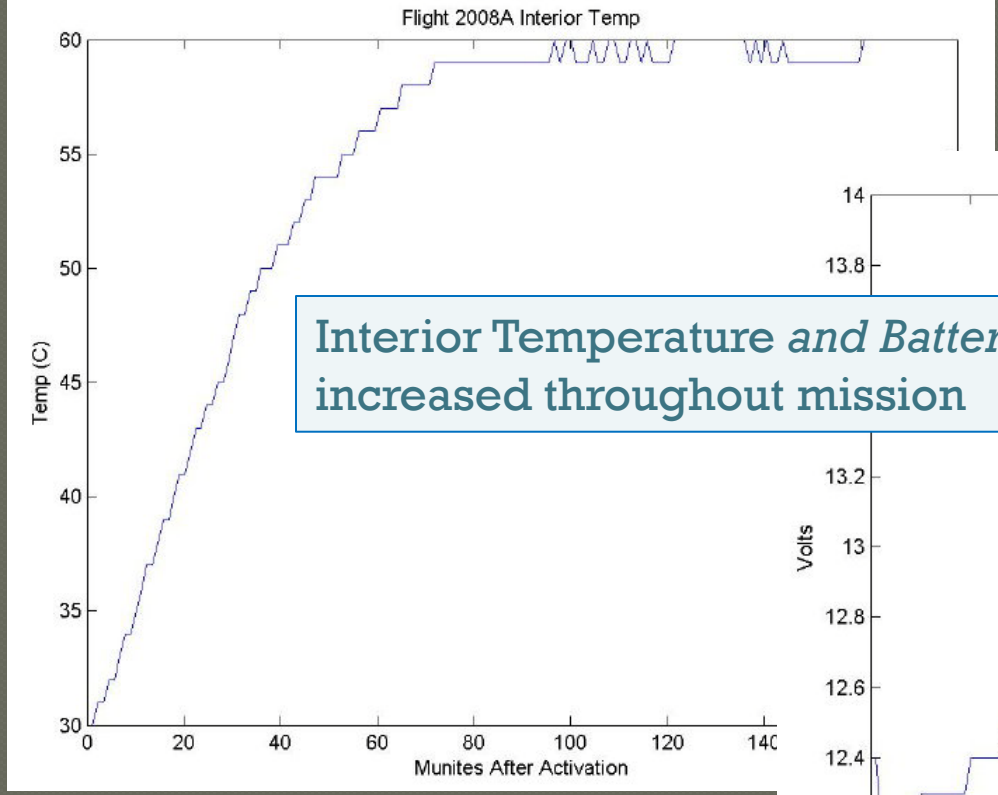
# Some Payloads

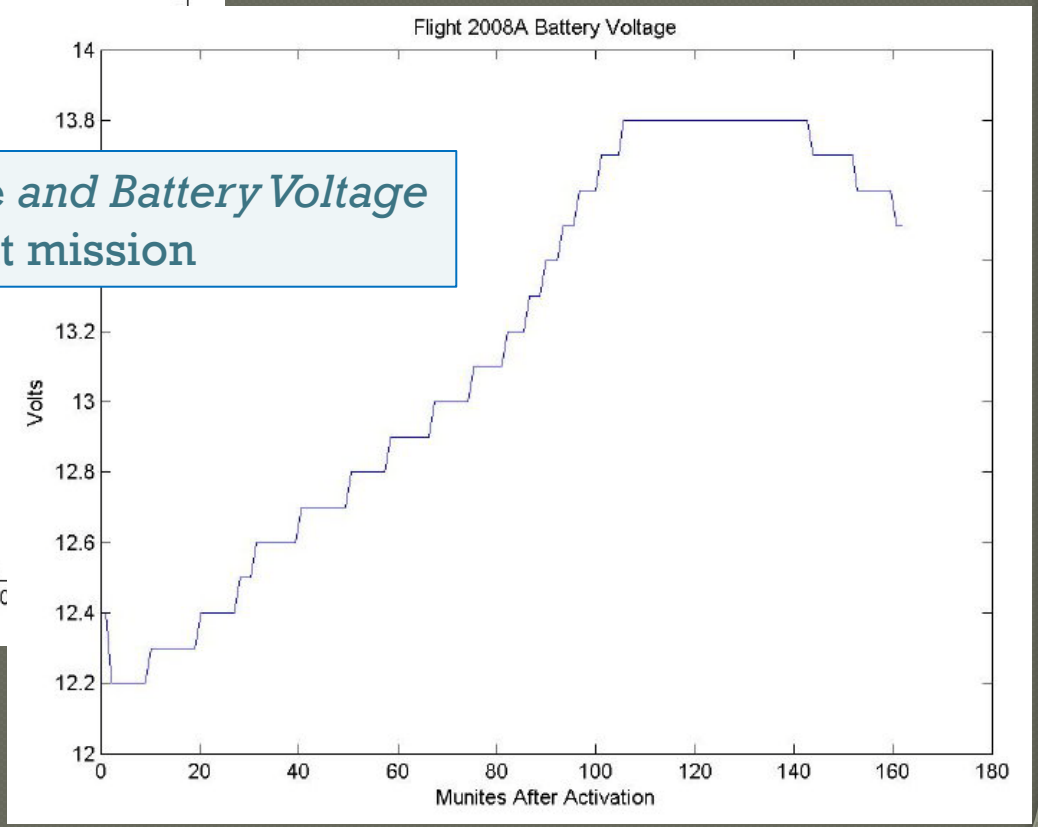


# Be creative and careful with your payloads.

- Regular alkaline batteries don't work great when cold – we use LiPO
- Temperature and humidity extremes can cause condensation
  - We use 2 liter soda bottles, cut then taped back together
  - Encase in styrofoam and cover in space blanket

# Temperature control can be surprising!

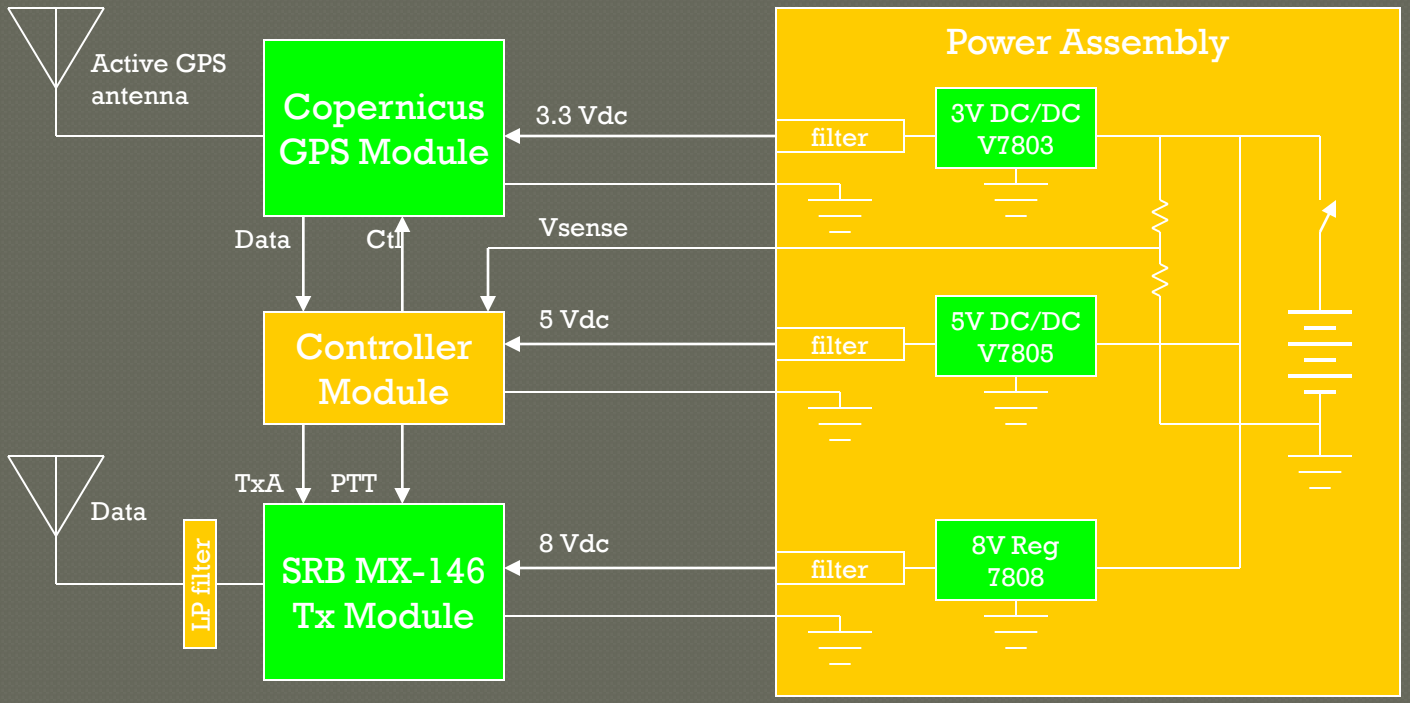



Interior Temperature *and Battery Voltage* increased throughout mission

Looking at Tx duty cycle and linear regulator cycling for temperature control.

# Payload being developed




- Controller Inputs
  - Temp: analog x 5
  - Vsense: analog x 1
  - GPS data: digital x 1

- Controller Outputs
  - Modem data out: digital x 1
  - Modem mode: digital x 2
  - Radio PTT: digital x 1
  - GPS data: digital x 1

# Other payload considerations

- GPS – make sure it can be set to operate at high altitude
- Don't assume a stable platform – payloads tend to spin at the end of the rope
  - Video can be dizzying and photos can be blurred
- Multiple payloads can fly
- Don't send anything up that you can't afford to lose!!

# Stuff sure is cool when it works!

- View of the Blue Ridge from *Sky Eye 1*, July 21, 2001


# Launch Planning and Operations

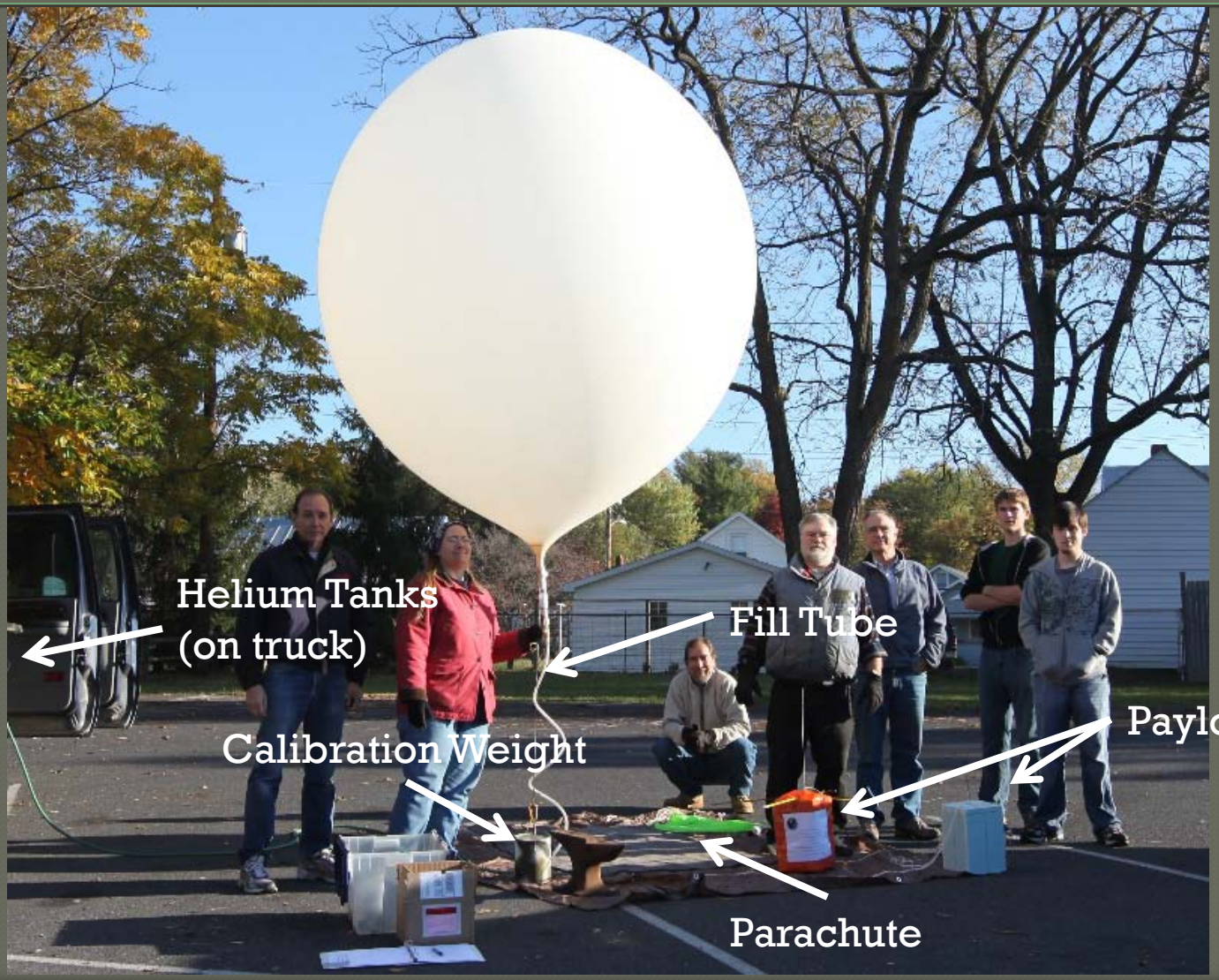
# Planning Phases

- Long range
  - Budgeting, payloads, wind tendencies, personnel
- Payload Construction and Test
- Launch date and location selection
  - Choose a couple of options based on expected wind uncertainties
- Tracking station planning
  - Sites, equipment personnel

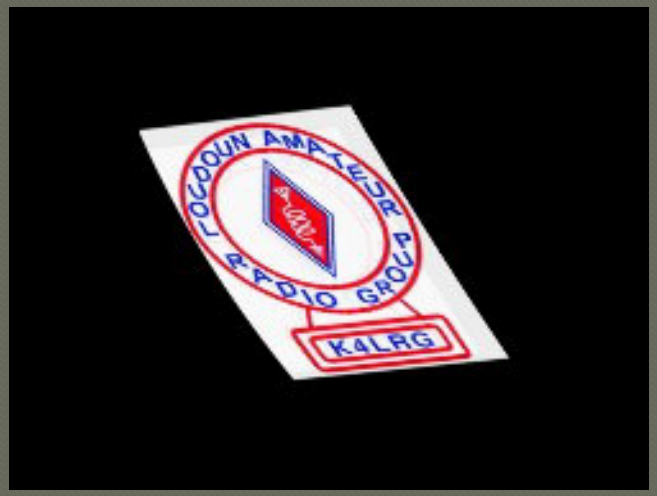
# What does it take to launch?

- First, pick a desired landing zone
  - Not near airports, dense populations, or large bodies of water
- Compute estimated trajectory and work backwards to launch site candidates
  - Free tools available for planning, e.g. http://www.eoss.org/wbaltrak/
  - Winds aloft forecasts also available on-line
  - The more current the data, the better the prediction

# Launch preparation



# Launch Video





Click Here To Download & Play Launch Video
70 MB File - Start Download Then Come Back When It Starts


# Other launch considerations

- Survey your sites for accessibility and room, power-lines, proximity to airports, etc.
- *What about the FAA – don't they care?*
  - In general, no. Covered under FAA 101 regs. Just be sure that:
    - Multiple payloads don't add up to more than 12 lbs
    - Single payload weighs 6 lbs or less
    - Any payload that weighs more than 4 lbs has a weight/surface area ratio < 3 oz / sq in (measured on the smallest surface)
  - Don't launch anything that could hurt somebody!


# Tracking and Recovery

# Tracking

- The goal is to not lose the payload (simple, huh?)
- GPS is pretty easy to integrate and fly, but not a good idea to make it your only tracking mode.
- DF is reliable and usually good enough, but requires work.
  - Think of it as a long range "flying fox hunt".
- We usually have a fox hunt in preparation for a flight to make sure people and equipment are ready.

# Mission Control/DF Tracking Station

# DF is simple and effective (if done right!)

# Don’t forget the step attenuator and the compass!

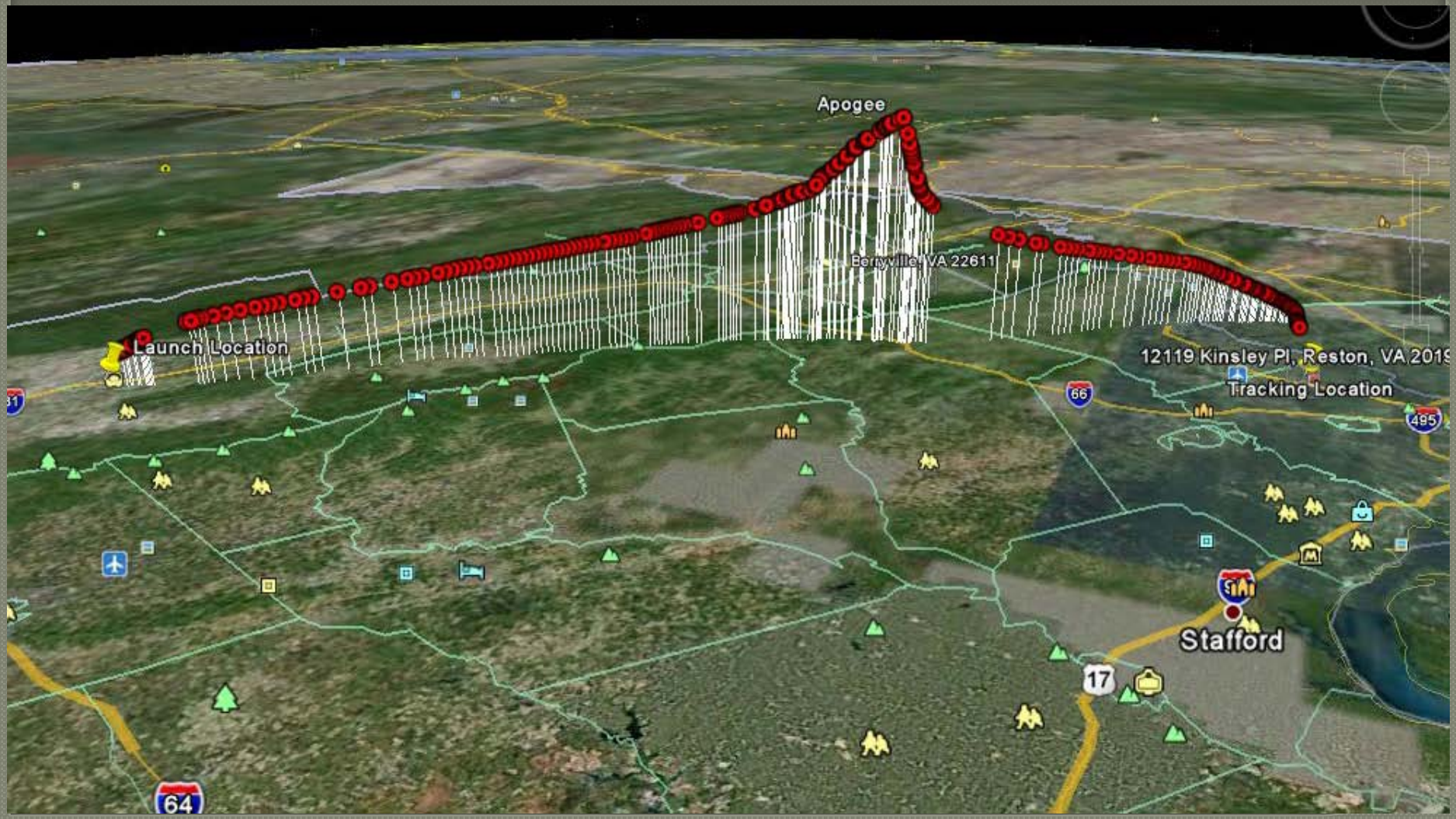
# TDOA setup can give better bearings.

Also called Doppler or pseudo-Doppler DF, this setup has only two elements but works well.

# GPS Tracking

- Make sure your GPS works at altitude
- APRS is good link standard
  - Lots of off-the-shelf equipment available
  - We avoid 144.39 since we don't use DCD and we want to be sure that we get most packets. We use experimental VHF frequencies.
  - We're looking at setting up an I-Gate to get the position reports on the Internet. Other groups do this.
  - Gives good 3D position and packets can also have some other telemetry.

# GPS Track of 2009 Mission in Google Earth



# Recovery Operations

- Vehicles (fueled!), maps, communications, and local knowledge are all necessary.
- Also good to bring an accomplished diplomat to sweet talk property owners!
- Time is crucial since battery life is limited.
- Note: balloons achieve ground speeds of 100+ mph. Be prepared to do some driving!
- Sometimes the public helps and calls the number on the placard.
- Fox Hunt is also great practice for the "end game" in the recovery process.

# Successful Recoveries



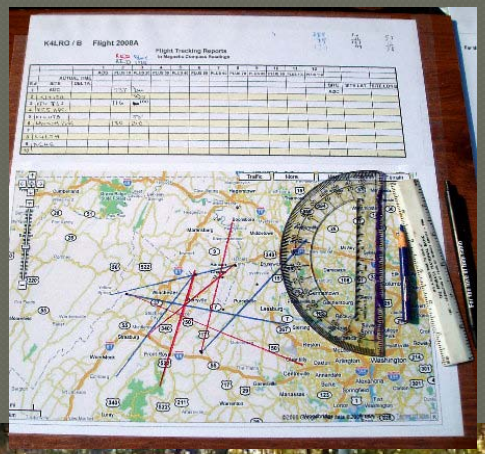
# Communications

# You need to talk to be successful

- Coordination communications are important and challenging
  - Essential for DF reports and recovery operations
  - Operational areas can span over 100 miles with widely varying terrain
- Options
  - Wide area repeaters
  - HF Mobile (NVIS)
  - Cell phones where available
- Use good directed net procedures!
- Downlink frequency coordination
  - Never underestimate the capability of a 90,000' antenna!

# Now go do it!

# Have fun, make friends, learn!





# Resources

- Most all our flights are documented
  - http://www.k4lrg.org
  - Use "Flights" drop down menu near top of page
- Balloons: http://www.kaymont.com/
- Planning software: http://www.eoss.org/wbaltrak/
- Ascent rate calculator: http://www.nearspaceventures.com/cgi-bin/ascent.pl
- Amateur Radio High Altitude Balloon site: http://www.arhab.org

# Thanks, 73, and have fun!

Be sure to visit us at:
http://www.k4lrg.org

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