

# Maryland Space Grant Consortium Balloon Payload Program



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# What We Do!

- We build small payloads, inspired by the cubesat model, and launch them on a helium-filled weather balloon
- Payloads are exposed to space-like conditions of temperature, pressure, radiation (“nearspace”)
- Balloon bursts at high altitude, payloads return to earth via parachute and are recovered using on-board tracking systems
- Payloads can have science objectives, demonstrate engineering technologies, or just take pictures
- Full payload string weight should be less than 12 lbs so that flight can be exempt from federal regulation



# A little History ...

- **Started at UMCP in 2003 with the help of Morgan State and Hagerstown CC**
- **First 3 flights were lost because tracking systems did not work**
- **Most recent flight was our 58<sup>th</sup>!**
- **Number of students involved over the years: approximately 400 at UMCP; more at affiliate institutions**
- **Spinoff Projects: CanSat, HASP, NFB**
- **Funding level varying between \$10K and \$40K per year**
- **Current launch frequency: 2 flights each semester; 2 or 3 over the summer**



Photo courtesy of Bach's Box

# Goals of the Balloon Payload Program

- **Hands-on experience on the space side**
  - A microcosm of a real launch experience
  - Deadlines, Payload Readiness Reviews, Thermal Test
  - Launch delays due to weather or groundtrack
- **To get and keep students interested in aerospace engineering in the early years**
- **To challenge upperclassmen to design and build meaningful flight experiments**
- **To provide a balloon flight platform for graduate research on atmospheric characteristics**
- **Training for experimental engineering research and real-world problem solving**
- **To create a welcoming engineering club for all students who are enthusiastic and energetic**

# Balloon Payload Team



- **Program run almost entirely by undergraduates:**
  - freshmen through seniors
  - mostly engineers, aerospace, mechanical, computer engineering,...
  - also majors in science like atmospheric and oceanographic sciences
  - diverse, colorful, creative, hard-working, responsible, skilled
  - older students serve as mentors for younger students
- **Numbers keep increasing because it is a social club!**

# Typical Launch Weekend

## ➤ Friday afternoon

- Pick up vans
- Final ground track & weather predictions
- Launch decision: Sat or Sun
- Flight readiness review of all payloads

## ➤ Saturday morning

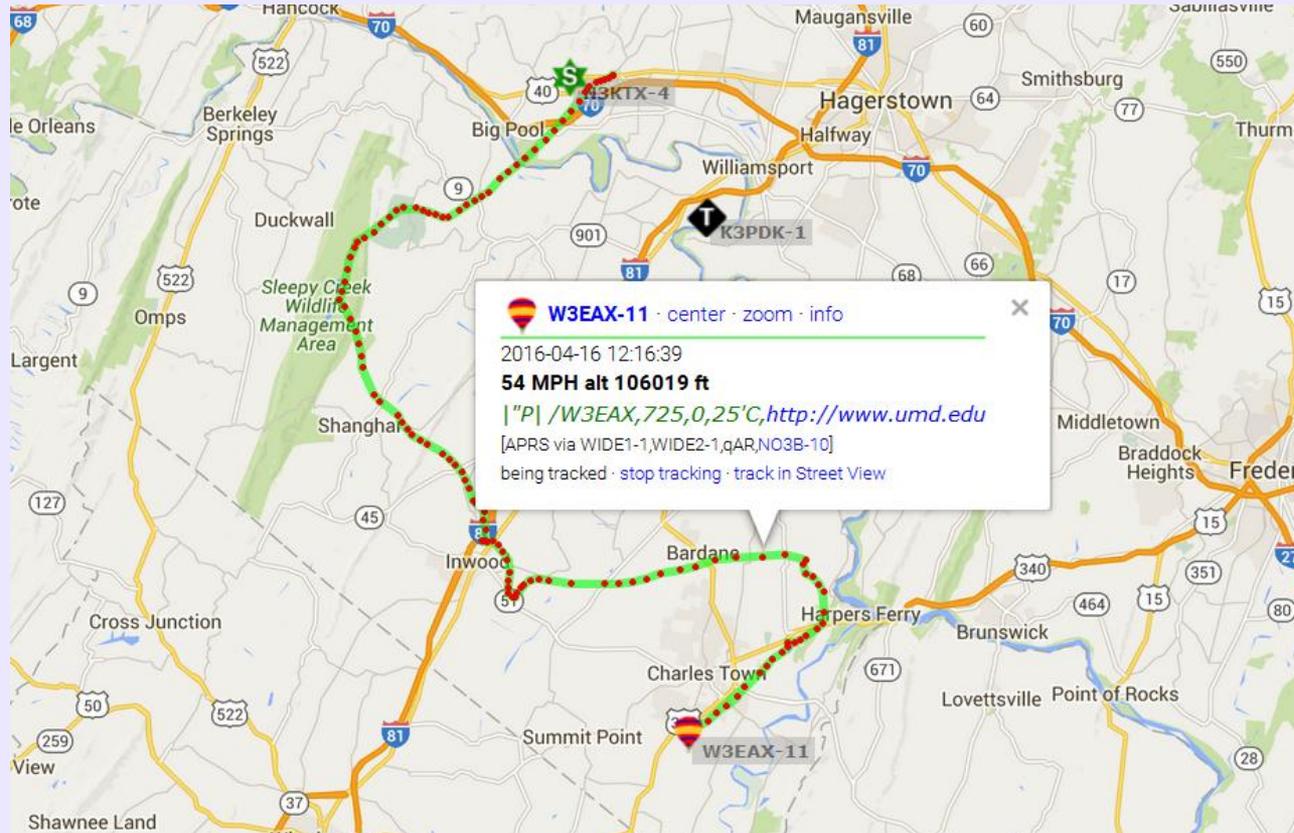
- 430am - meet at SSL and load vans for 5am departure
- 7am - gather in Clear Spring, MD, for payload string assembly
- 8am - balloon inflation & final payload closeout
- 830am - balloon release then all tracking vehicles load up and chase
- 10am - payloads land somewhere (MD, PA, WV, VA)
- 11am - payloads tracked and found, usually in the top of tallest tree
- 1pm – eat lunch at Pizza place and debrief

## ➤ Sunday morning

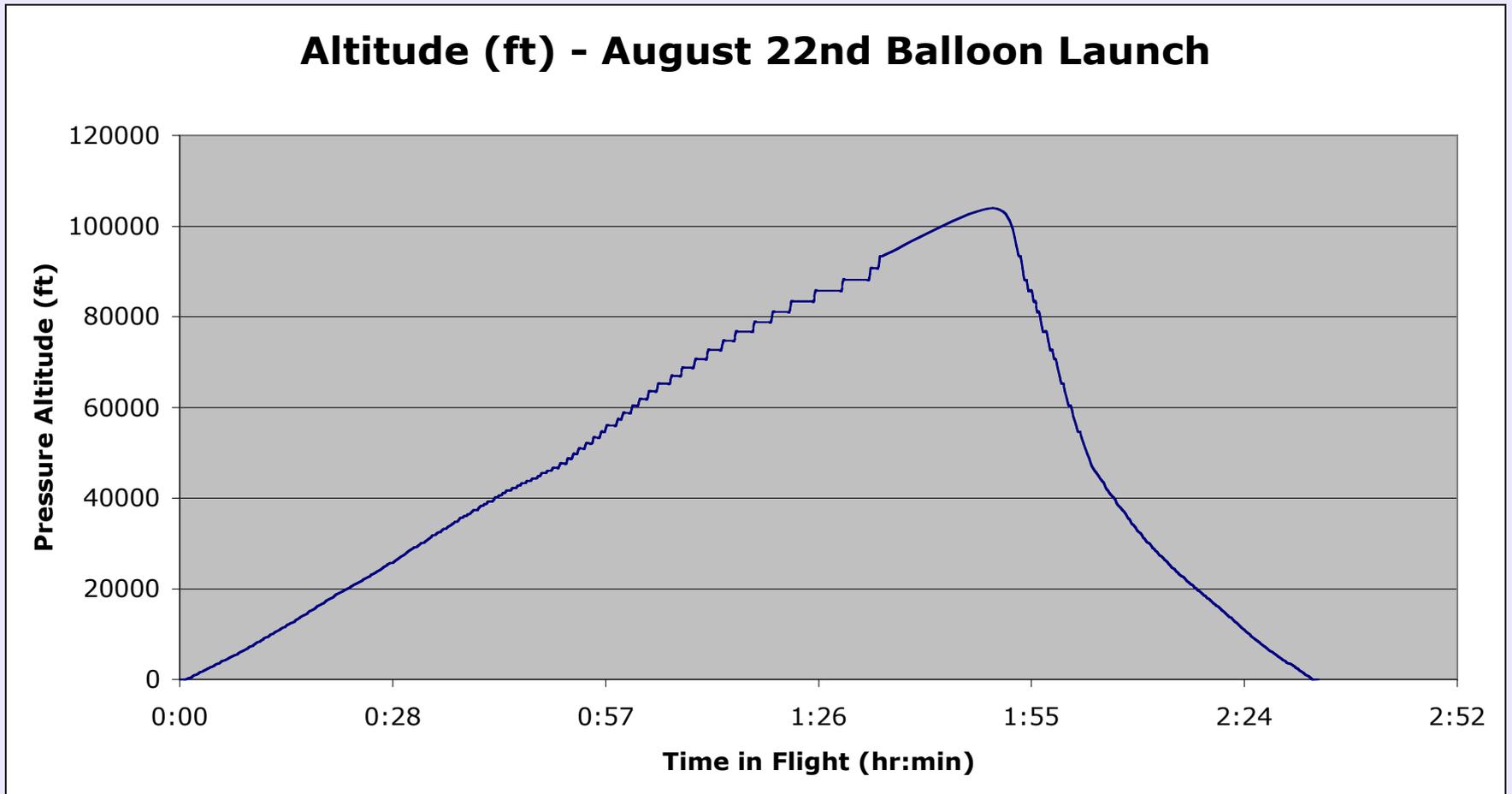
- Call Tree Climber to get payloads down if necessary!

# Ground-track Prediction

- We launch in one of the most populated regions of the US with numerous airspace restrictions
- Accurate ground-track predictions and real-time tracking of balloon and payload train are essential



# Flight Profile



# Payloads Attached to the Balloon



# Cold Weather Launch





# Maryland From 90,000 Feet



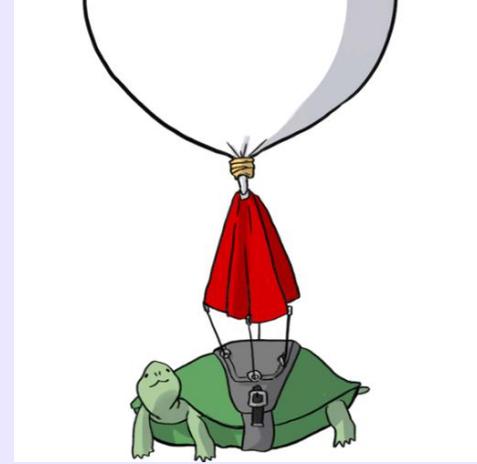
## Payload Recovery Operation

- The most common place for the payloads / parachute to land is in a tree!
- This one was easy because the fire department was nearby and wanted to practice with their ladder truck!
- Many recoveries involve hiking through the woods and pulling stuff out of the trees
- There is some risk of losing payloads (Chesapeake Bay, Aberdeen Proving Grounds, ...)



# Freshman Payloads

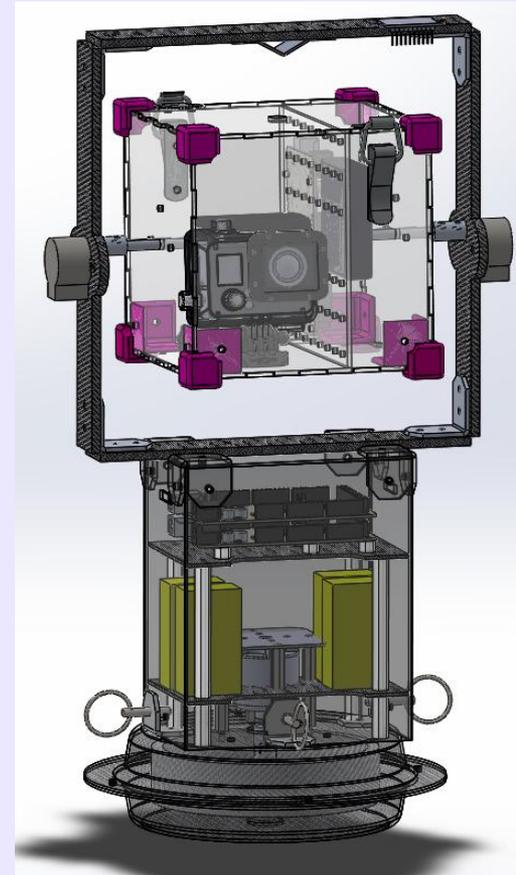
- Each Fall, we recruit around 25 new freshmen to build payloads
- Each team works on a unique payload but with some common elements
- All students learn basics of box design, a bit of electronics, software for microprocessors, soldering skills, camera programming
- Each payload has an additional experiment:
  - $\alpha/\varepsilon$  demo, battery performance, solar cell performance
  - magnetic field measurement, upper atmosphere contaminants
  - ground imaging, in-flight video, accelerometer data
  - yeast growth, acoustic experiments, temp, pressure
  - Velocity measurement, controlled descent



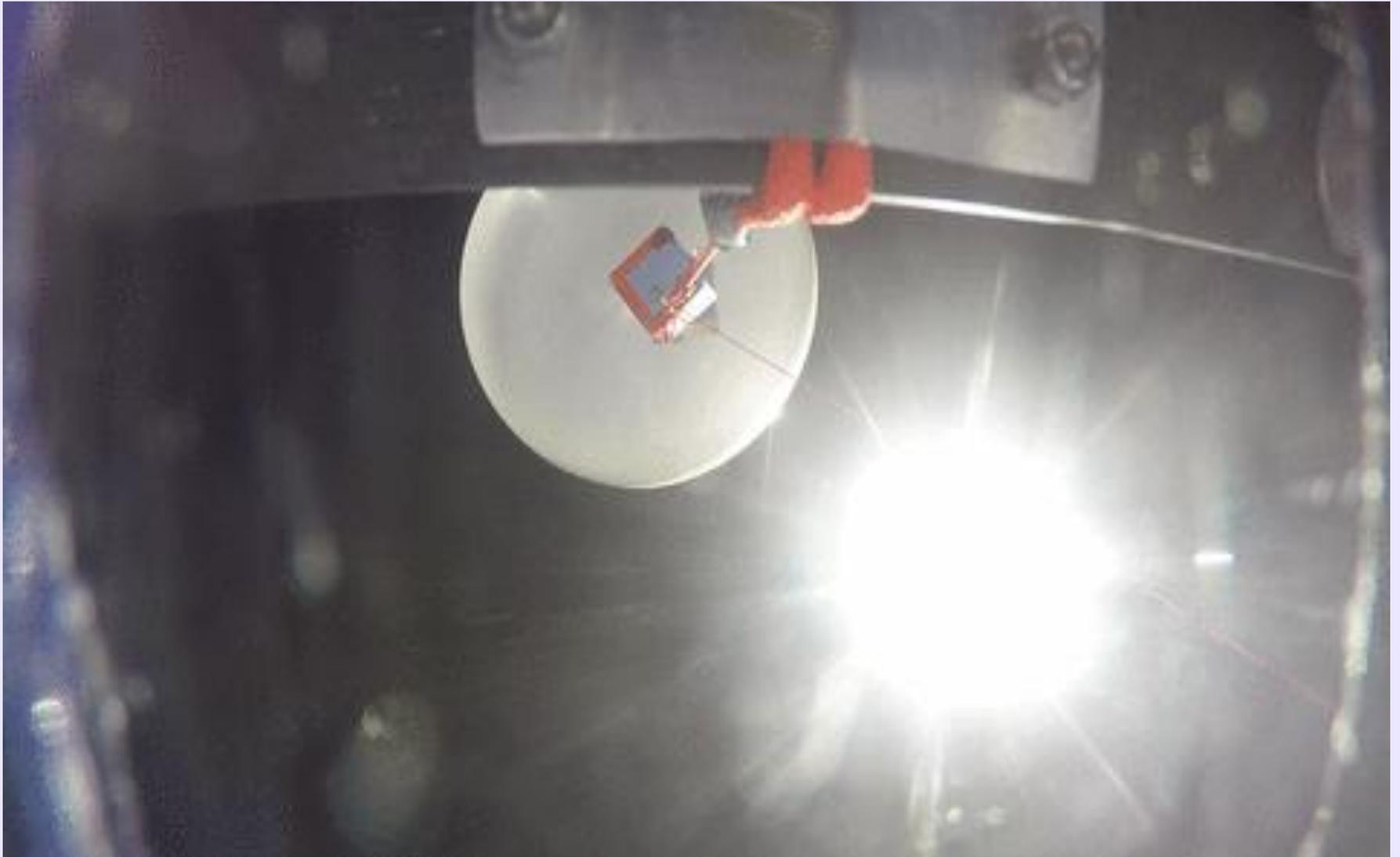
# Upperclass Payloads

- **Payload Stabilization System**
- **Supersonic Payload**
- **Cut-Down Mechanisms**
- **Solar Pointing Sensor System**
- **Parachute Deployment Mechanism**
- **Dynamics of Payload String**
- **Weather Payload from AOSC**
- **Command Module with GPS for tracking**

**Generally, each payload team develops its own onboard electronics with embedded micro-processor (Arduino) and radio transmission of data**



# Balloon Burst NS-53



# Conclusions

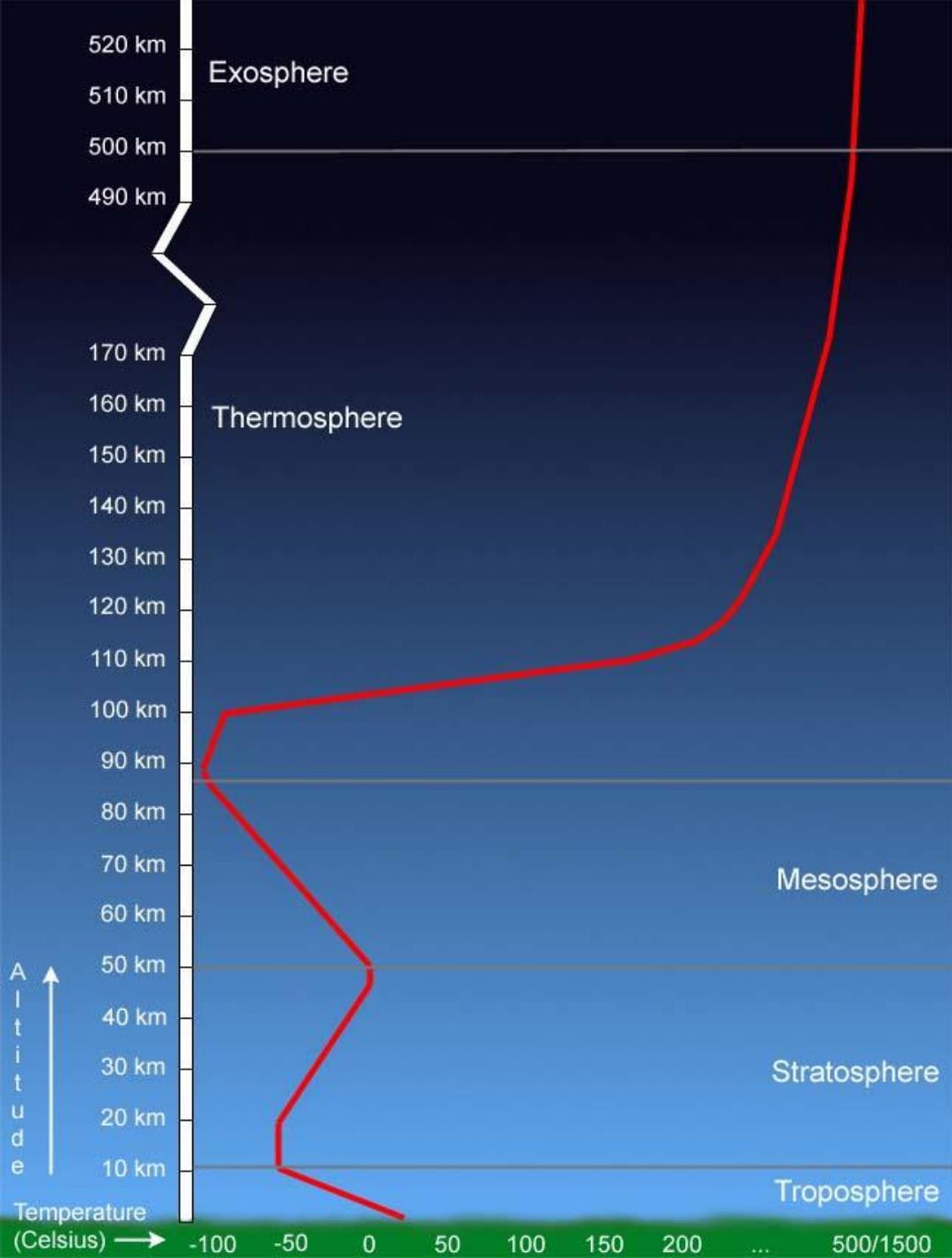
- **This program has contributed significantly to the enrichment of the Aerospace Engineering undergraduate curriculum at UMCP**
- **This program can lead to other more advanced programs such as rocket payloads, orbital cubesats, and other flight hardware**
- **Anecdotal evidence of the value of this kind of experience:**
  - **Valuable on grad school applications and job interviews**
  - **Increased enthusiasm for and understanding of engineering**
  - **Past Balloon Program leaders now working at JPL, SpaceX, Intelsat, Boeing, APL, ...**

# Questions?



**Next Launch:  
Saturday 29 October 2016  
8:00 am Clear Spring, MD**





# Temperature at Different Altitudes in the Earth's Atmosphere

(Notice how temp drops and then starts rising again around 20-30 km, roughly 70,000 ft)

# Flight Data from April '05 Launch

