

MAE 2: Introduction to Aerospace Engineering

Class Design Project – Balloon-Sat

Purpose / Goals:

First-year aerospace engineering students work in teams to design, build, and fly multi-disciplinary payload experiments on balloon satellites to near-space. Students gain real-world engineering experience developing and assembling sub-systems on space flight critical systems.

Instructors: John B. Kosmatka & Keiko Nomura

Fall, 2008

The Mission Plan



4 On-Board Payloads:

- (1) **Atmospheric Sensors:** measure pressure, temperature, humidity, wind velocity, time, radiation, magnetic field, UVa, and UVb with altitude.
- (2) **Solar-Cell Efficiency with Altitude.**
- (3) **UCSD Astronauts:** Environmental chambers containing cockroaches, water-bears, and planeria.
- (4) **Horizontal and Vertical Cameras:** continuous shots every 30 seconds

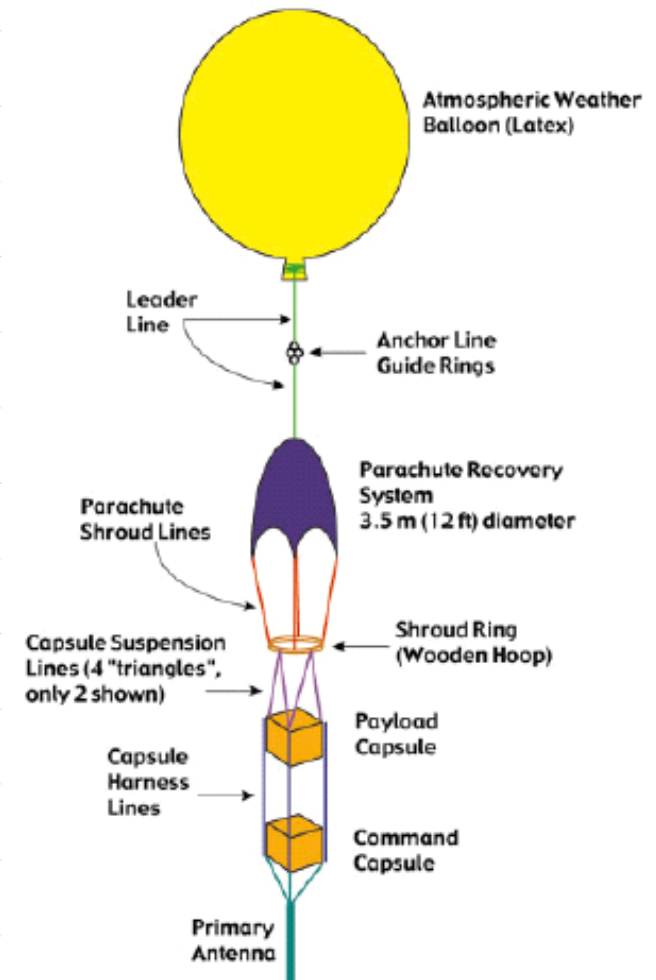


Figure 1. Typical BalloonSat configuration.

Twenty-Two Students in Six Sub-Teams



Project Advisor: John Kosmatka
TA's: Andrew Cavender and Zach Lovering
Launch Integrators: Strato-Star
Flight-Day Field Assistant: Joel Kosmatka
Sponsor: California Space Grant (Tehseen Lazzouni)

Team	Student
Atmospheric Sensors	Farah Ahmed
	David Hernandez-Ibarra
	Peter Reed
	Drew Tobias

Solar Cell Evaluation	David Gross
	Pranay Sangani
	Josiah White

UCSD Astronauts	Ty Lee
	Ryotaro Shimizu
	Kimberly Tomasino

Onboard Camera	Joseph Dillon
	Sarah Lohman
	Ronald Jeter

Structure and Test	Benjamin Bancroft
	Casey Barrett
	Denise Choi
	Randall Hughes
	Hyung Jin O

Mission Control	Owen Eigenbrot
	Mitchell Nihonyanagi
	Christopher Schmidt
	Kwok Yuen

Project Construction





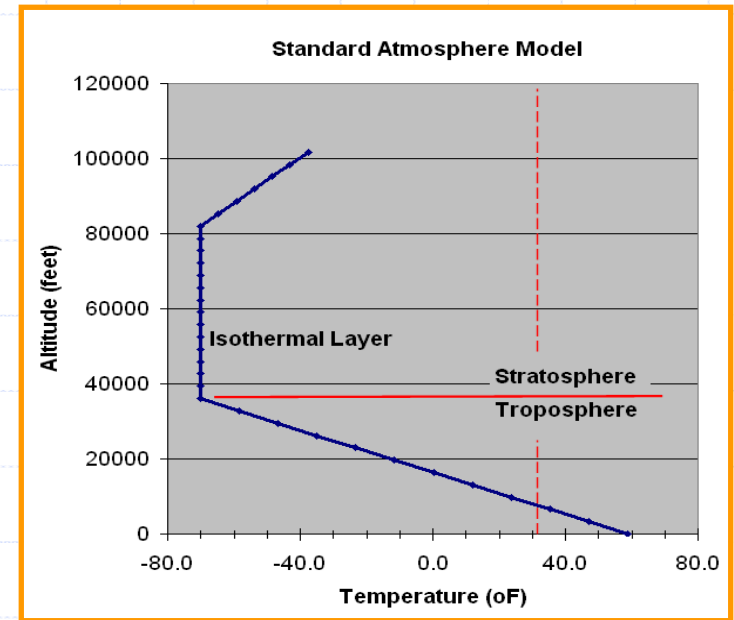
Project Construction

Payload Bay Heaters

Standard atmosphere models show linear cooling to (-70 oF) at stratosphere edge, then constant temperature (-70 oF) isothermal layer, followed by linear heating above 82,000 feet.

Payload heaters are required to warm sensors, cameras, and some astronaut capsules. Options:

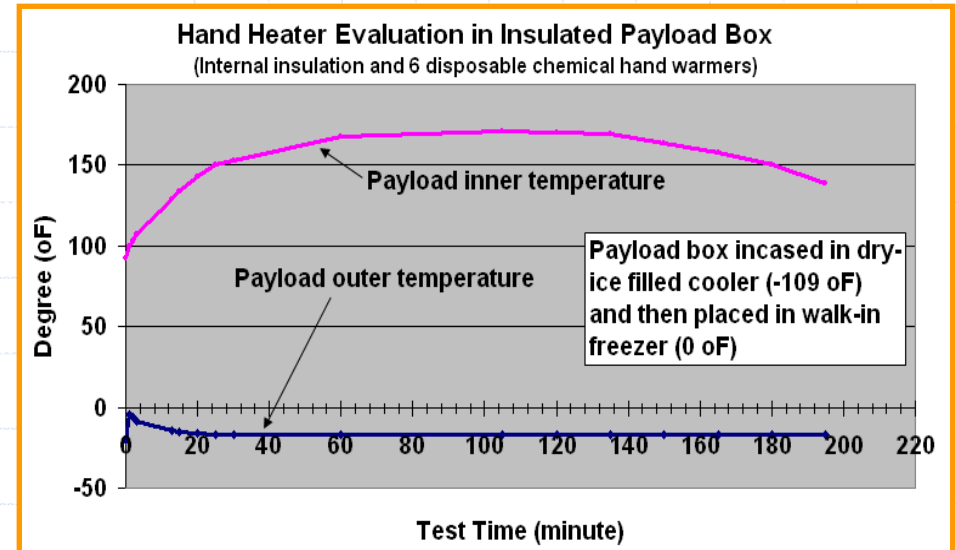
- Chemical (disposable vs reusable)
- Electronic (long-lead development)




Air-activated seven hours of heating at 135 - 156 oF. (REI). Unknown Performance in space (no air, vaccuum).



Reusable 130-degree heating in 15 seconds. One hour. Reuse by boiling in water for six minutes (REI). UCSD tests show no leakage in space vaccuum.

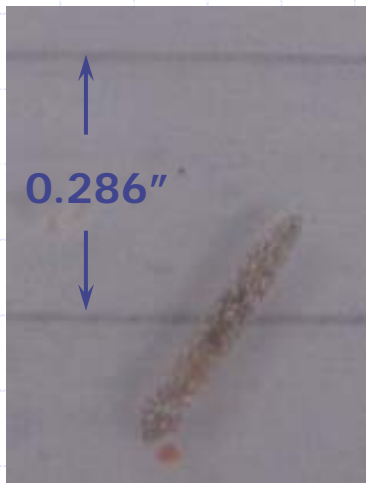




- Temperature
- Pressure and Humidity
- Wind Velocity
- Time
- Radiation (Geiger Counter)
- Solar Cell Evaluation



Cockroaches & Planaria & Water-Bears



<i>environment</i>	<i>earth</i>	<i>near-space</i>
Altitude (feet)	0	85,000
Temperature (oF)	90	-40
Pressure (psi)	14.7	0.334
Radiation	low	high



On-Board Cameras



Top and Side Cameras

- Continuous Photo Shoot at 30-second intervals
- Installed reusable chemical hand-warmers to heat camera bodies



Launch Day (12/06/2008)



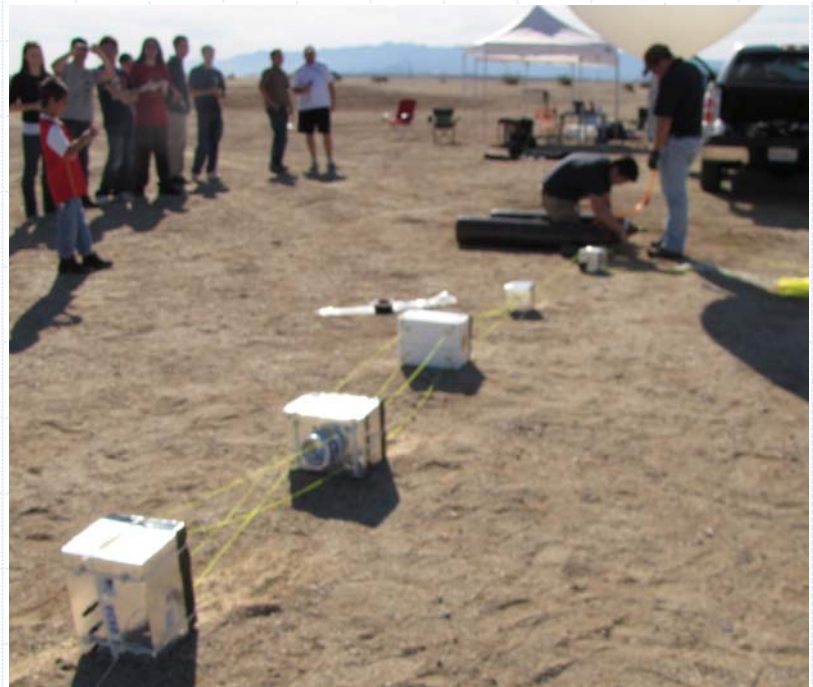
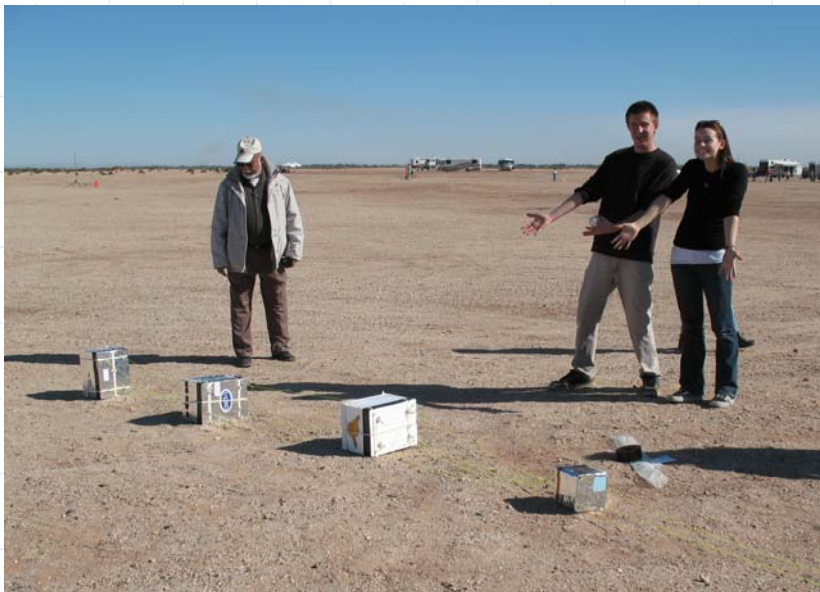
Plaster City, California

Pre-Launch (Set-Up)



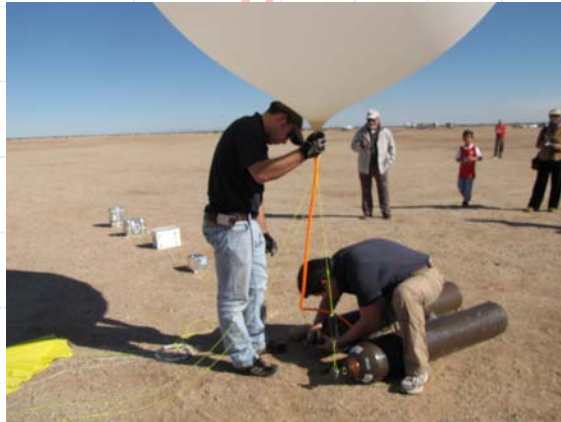


Pre-Launch (Final Assembly)





Pre-Launch (Balloon Fill)



Plaster City, California



Pre-Launch (Tracking Station Set-Up)



Plaster City, California

Launch (11:50 AM)



Side View



Bottom View

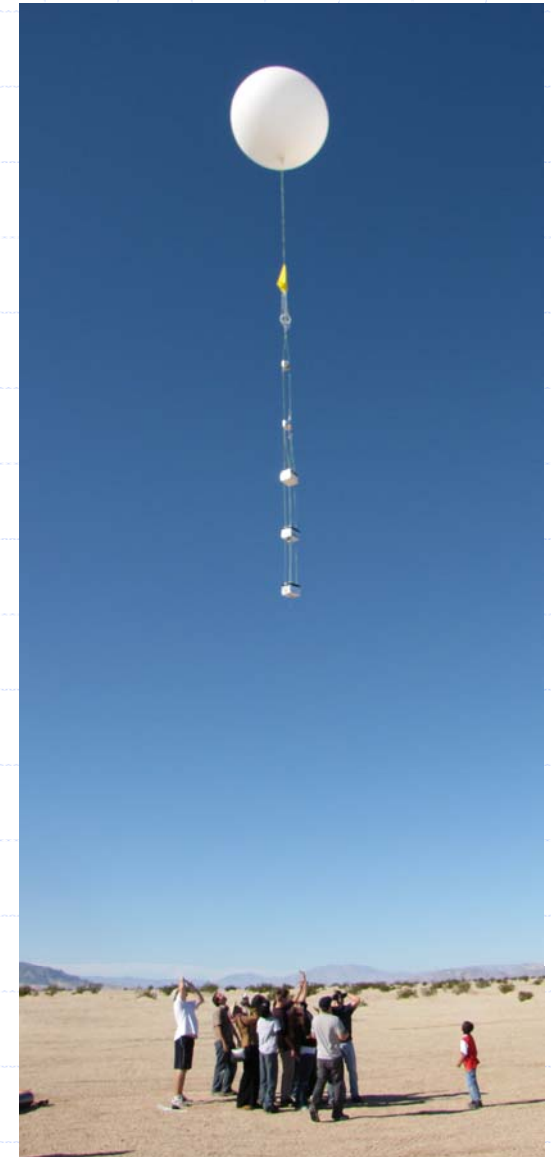


Plaster City, California

Flight (11:50:30 AM)



Side View



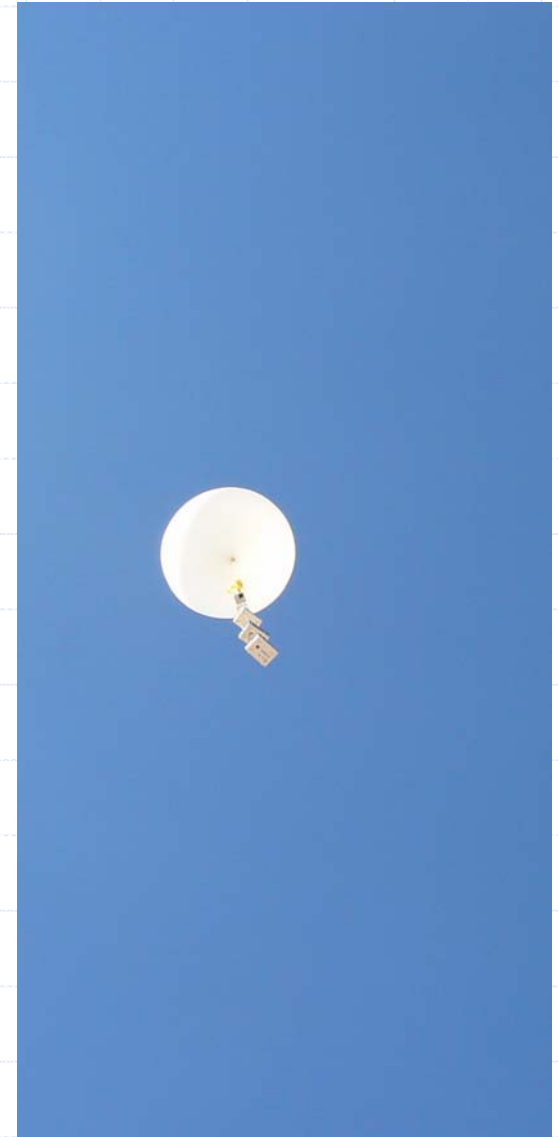
Bottom View

Plaster City, California

Flight (11:51:00 AM)



Side View



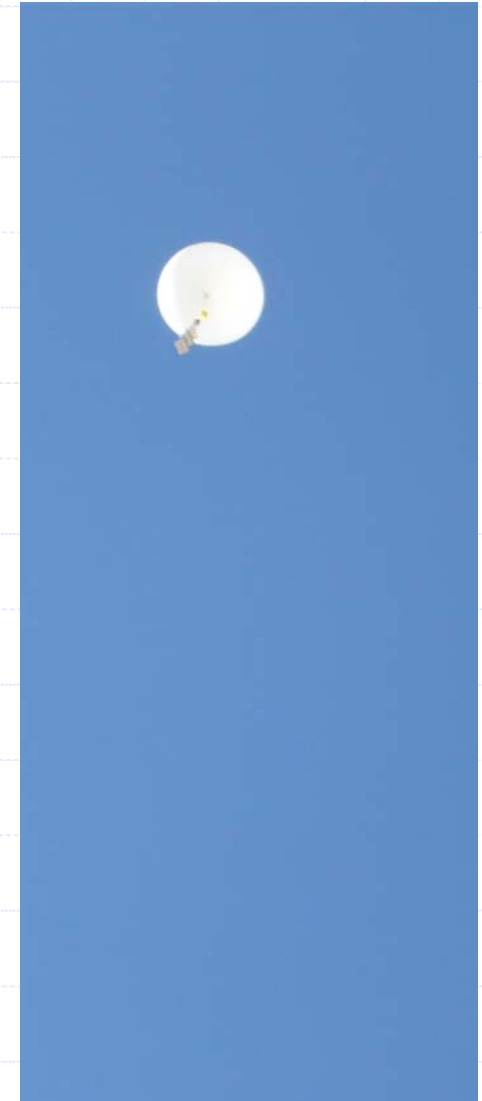
Bottom View

Plaster City, California

Flight (11:51:30 AM)



Side View



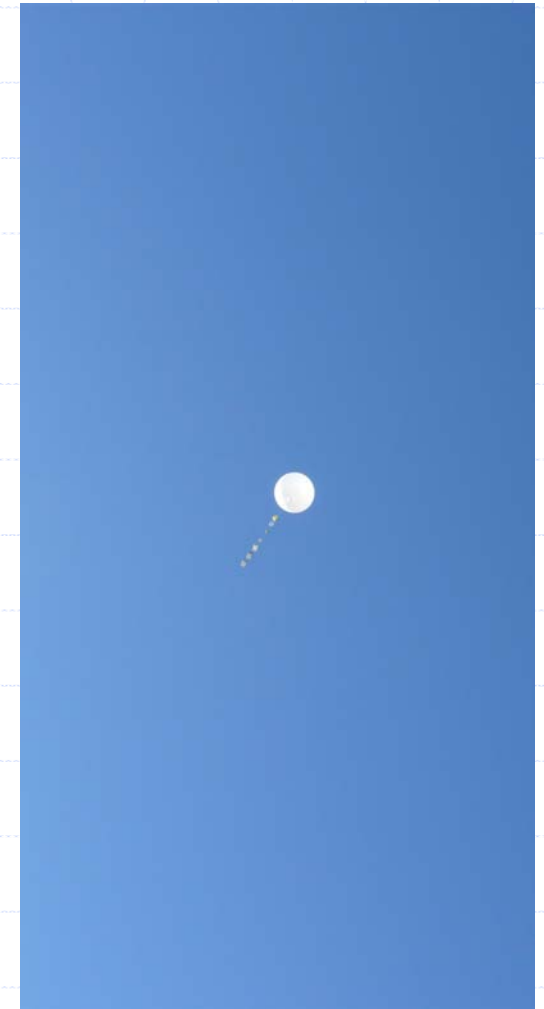
Bottom View

Plaster City, California

Flight (11:52:00 AM)



Side View



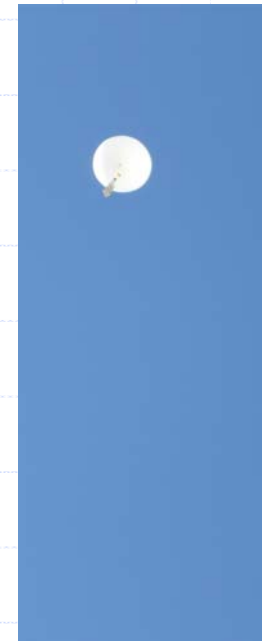
Bottom View

Plaster City, California

Flight (11:52:30 AM)



Side View



Bottom View

Plaster City, California



Flight (12:00:00 Noon)



Side View



Bottom View



Flight (12:15:00 PM)



Side View



Bottom View





Flight (12:30:00 PM)



Side View



Bottom View



Flight (12:35:00 PM)

<http://aerospace.ucsd.edu/> Mechanical and Aerospace Engineering Department, University of California, San Diego



Side View



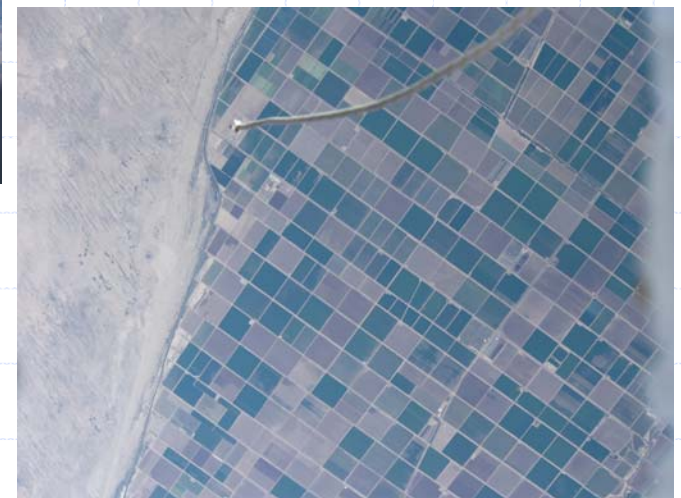
Bottom View



Flight (12:45:00 PM)



Side View



Bottom View



Flight (1:00:00 PM)



Side View



Bottom View



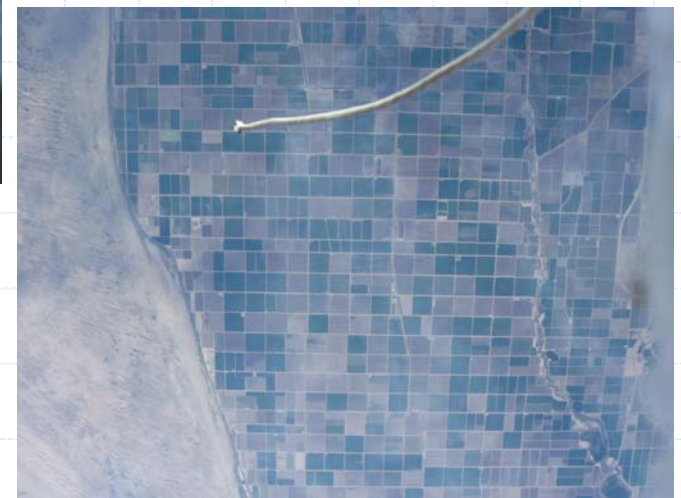
Flight (1:08:00 PM)



Side View



84,000 feet

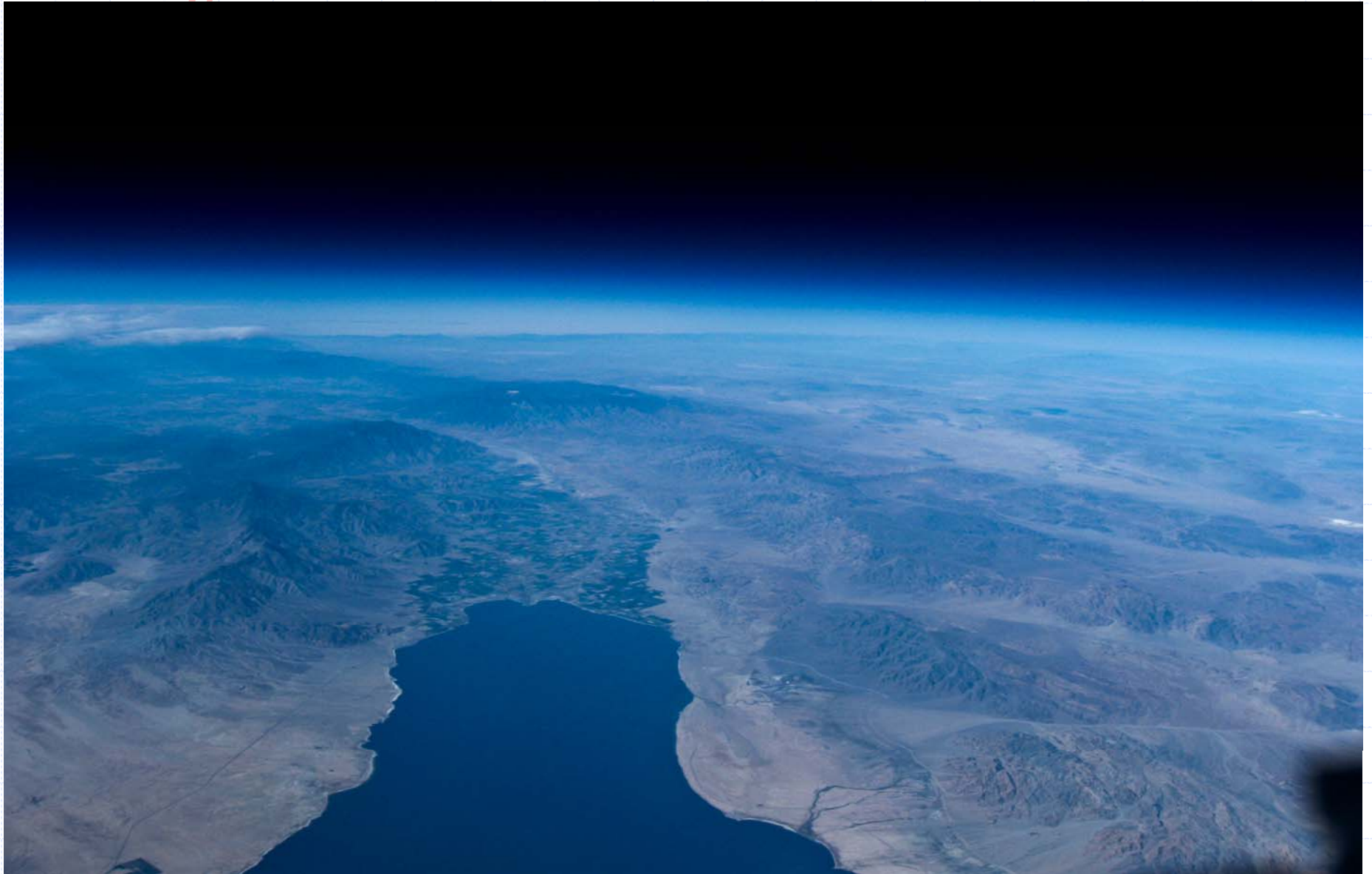


Bottom View



Looking North Over Salton Sea at 84,000 feet

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Flight (1:09:00 PM)

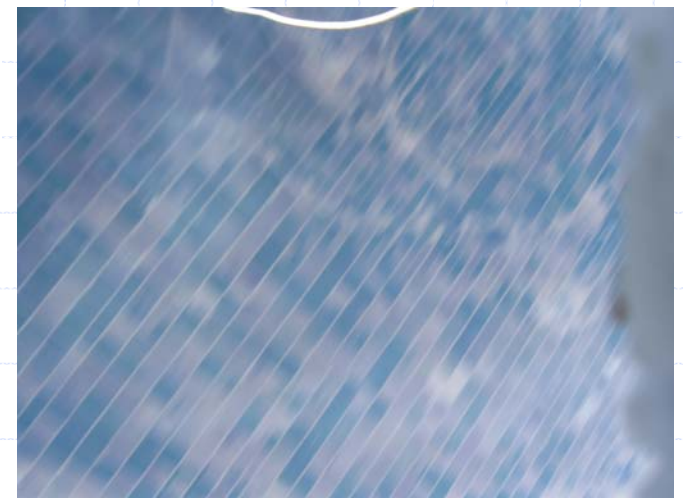


Side View



Balloon Burst –
Free-Fall Tumbling
Begins

Bottom View





Flight (1:38:00 PM)



Side View

30-minute
Parachute Drop



Bottom View



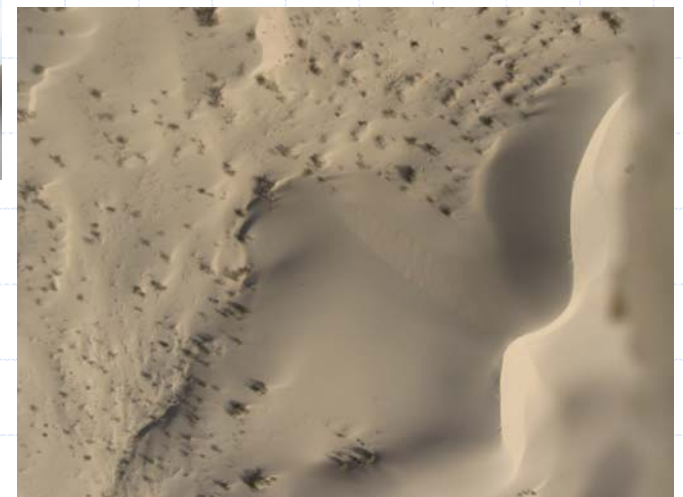
Flight (1:39:00 PM)



Side View



Landing



Bottom View

Flight Summary (12/06/2008)



Time: 1 Hour 51 Minutes

Distance: 65 miles

Altitude: 84,000 feet

Fall, 2008

Plaster City, California

Glamis, California



Payload Recovery (1:46 PM)



Osborne Lookout (65 miles away)



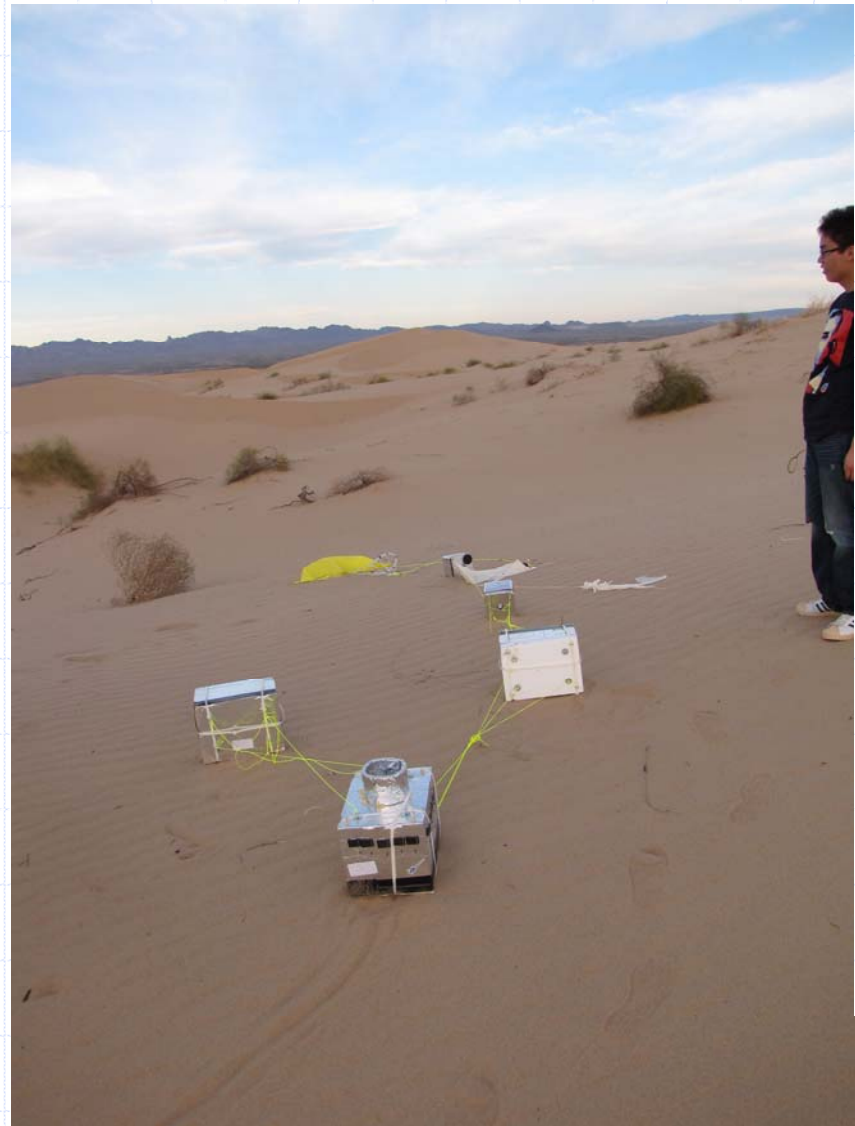
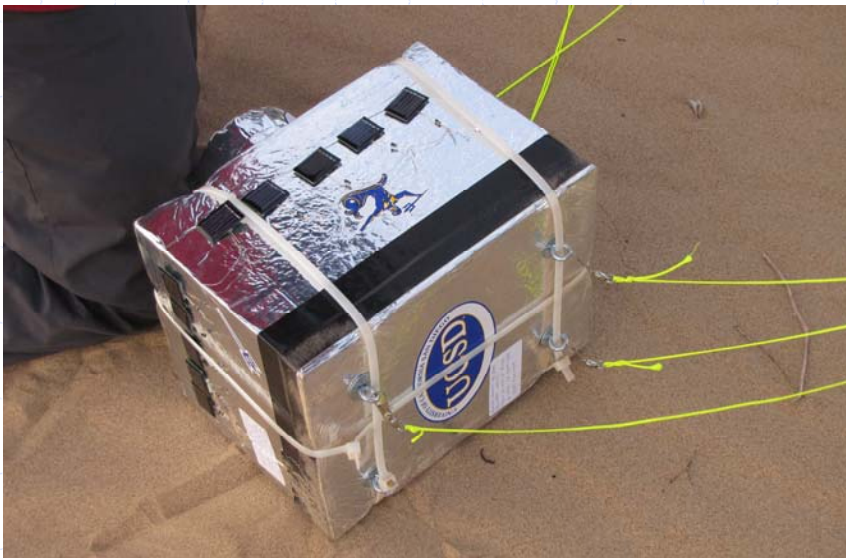
Hike with GPS Tracking (3:11 PM)



2.2 mile hike into desert nature preserve



Payload Found (4:00 PM)



Payload Recovered





March Out of the Desert





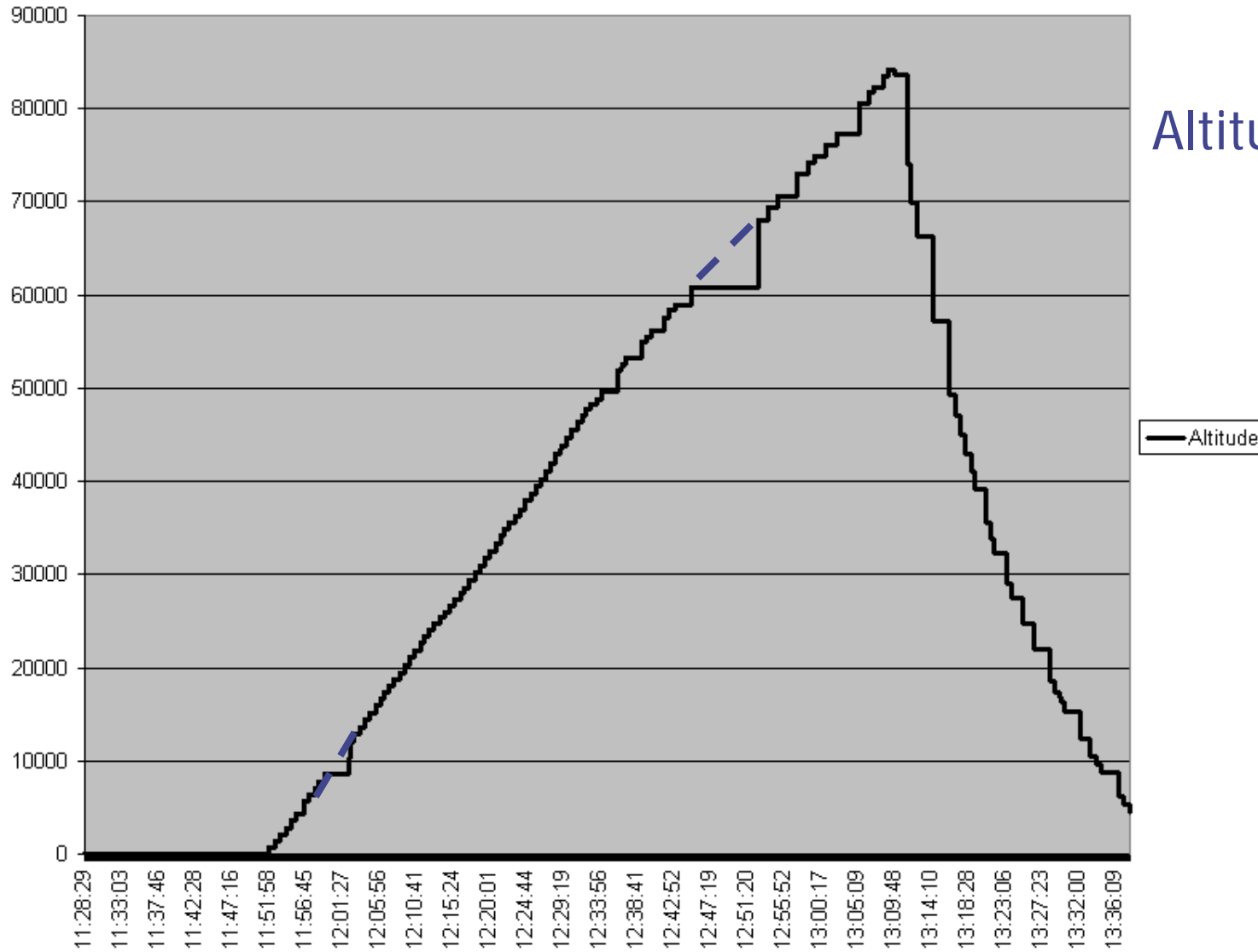
On-Board Cameras Were Still Recording



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Post-Flight Studies

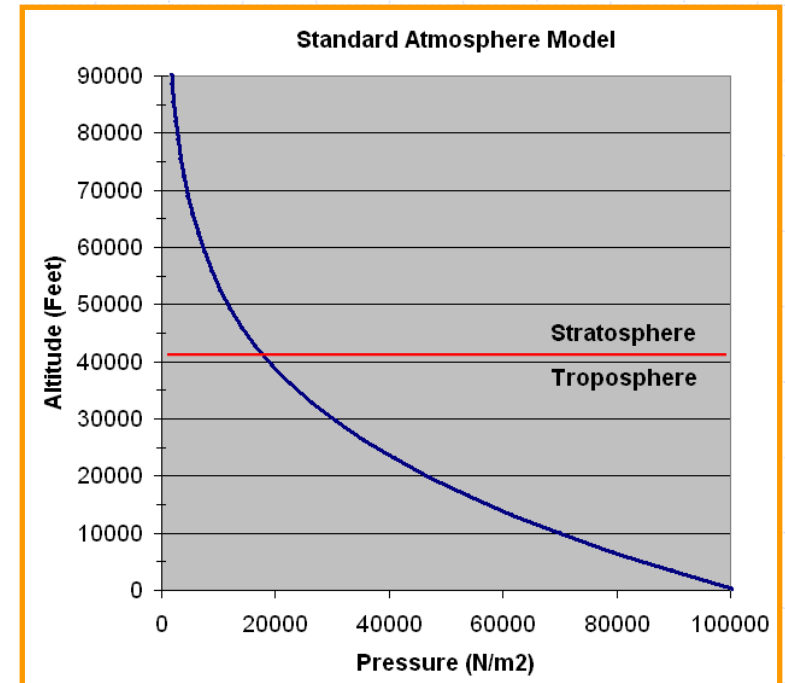
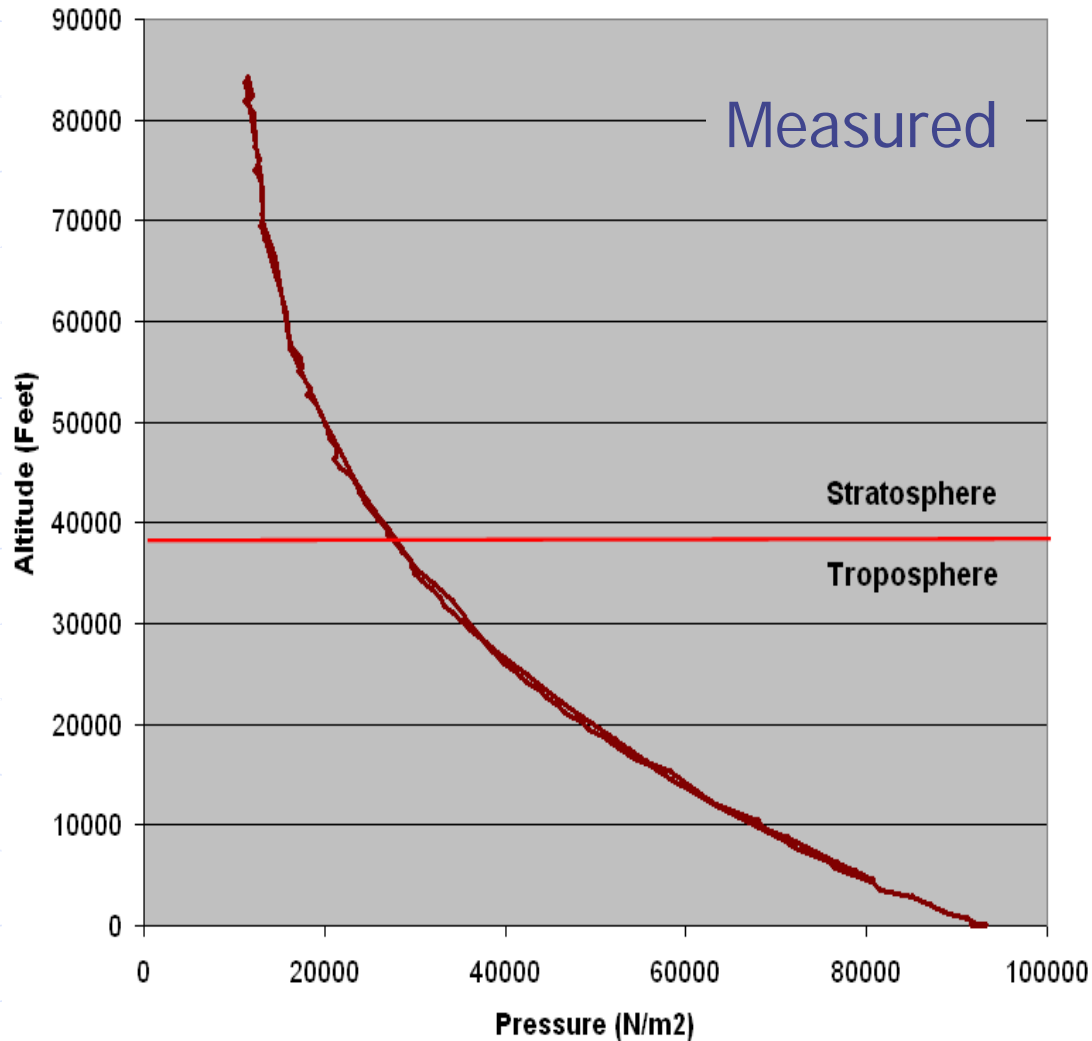


Altitude vs Time

Post-Flight Studies



Pressure vs Altitude

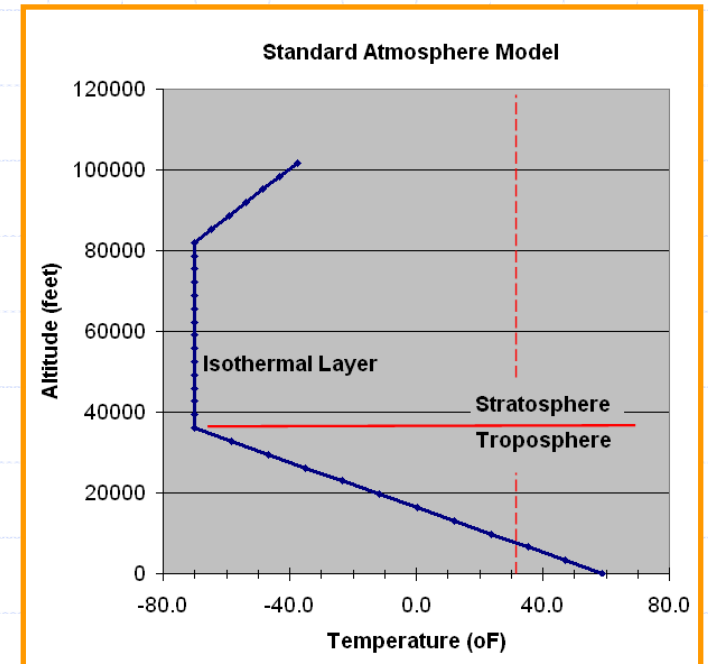
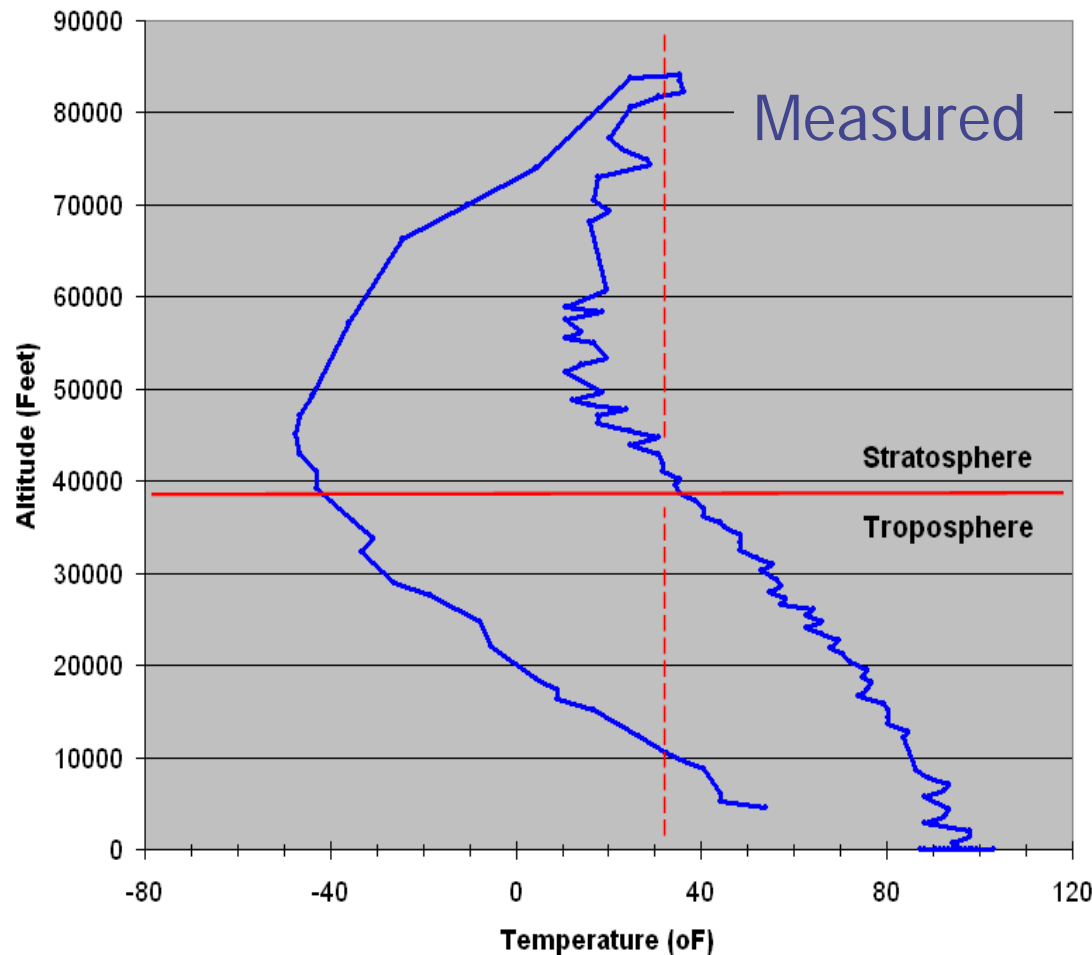


Standard atmosphere models show exponential reduction in pressure with increasing altitude

Post-Flight Studies



Temperature (oF) vs Altitude



Standard atmosphere models show linear cooling to stratosphere edge, then constant temperature isothermal layer, followed by linear heating above 82,000 feet

Post-Flight Studies



Cockroaches survived

- -40 oF,
- space (0.333 psi) pressure,
- space radiation

Planaria Worms survived

- space radiation

