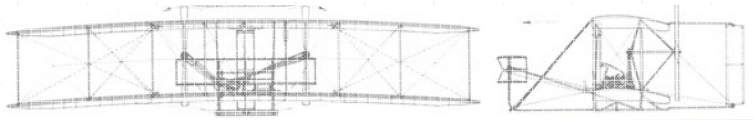


MAE 2: Introduction to Aerospace Engineering

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

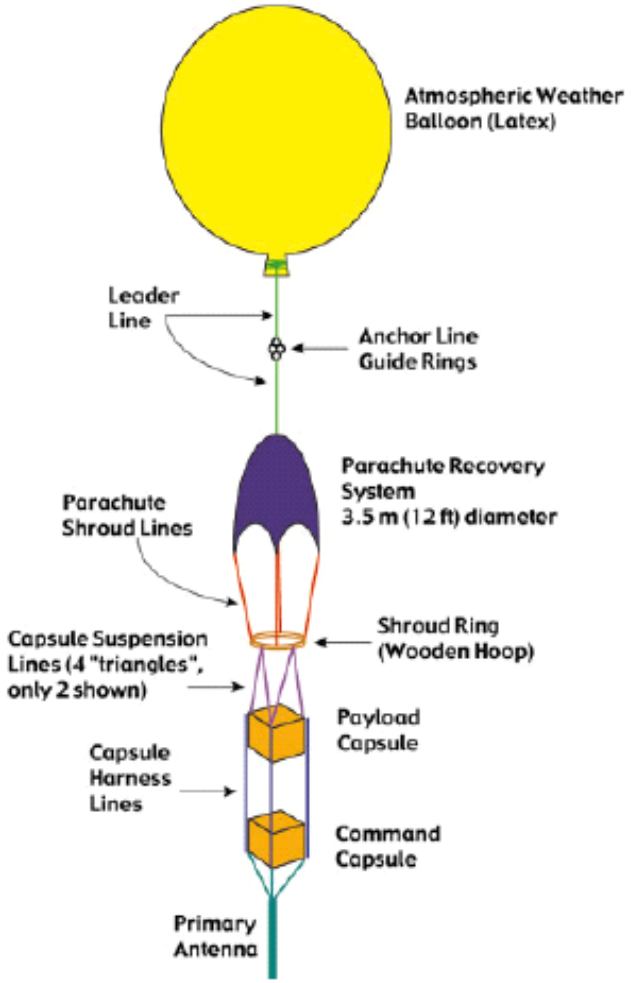


Figure 1. Typical BalloonSat configuration.

Twenty-Two Students in Six Sub-Teams

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 Advisor: John Kosmatka

TA's: Andrew Cavender and Zach Lovering

Launch Integrators: Strato-Star

Flight-Day Field Assistant: Joel Kosmatka

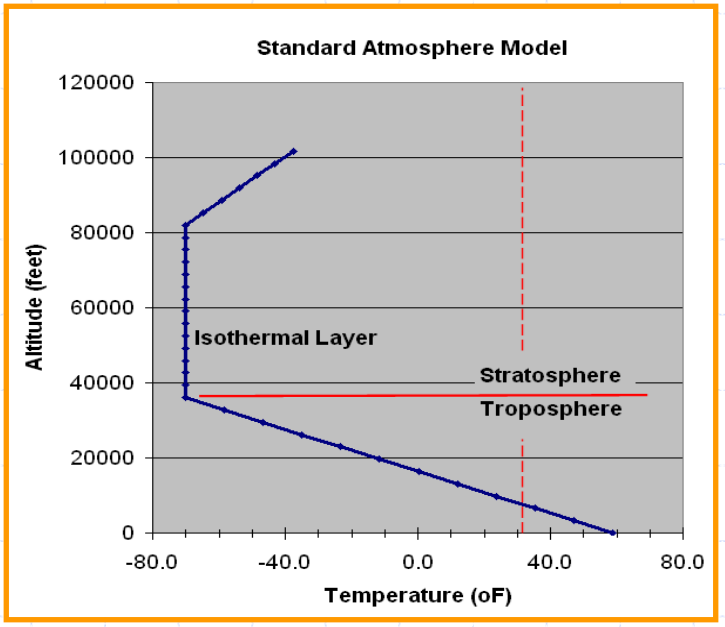
Sponsor: California Space Grant (Tehseen Lazzouni)

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.

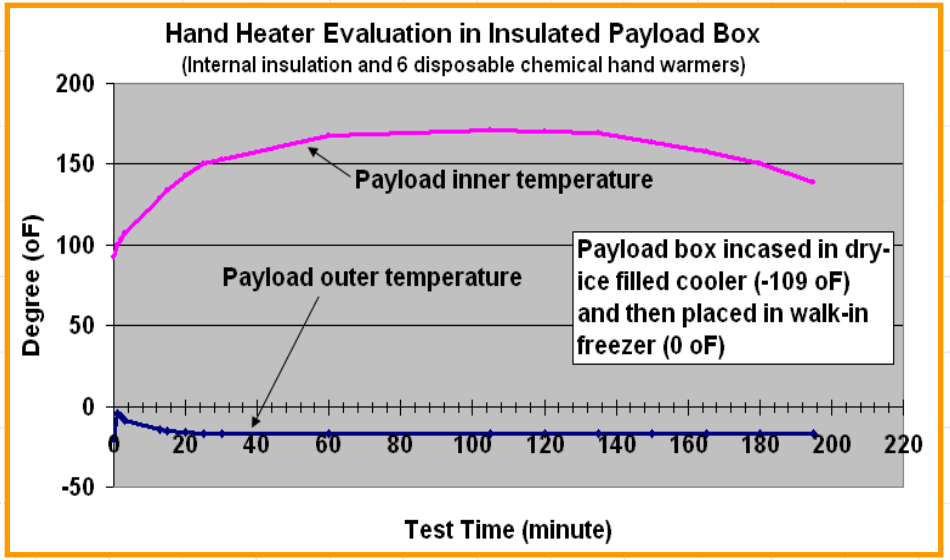


Payload heaters are required to warm sensors, cameras, and some astronaut capsules. Options:

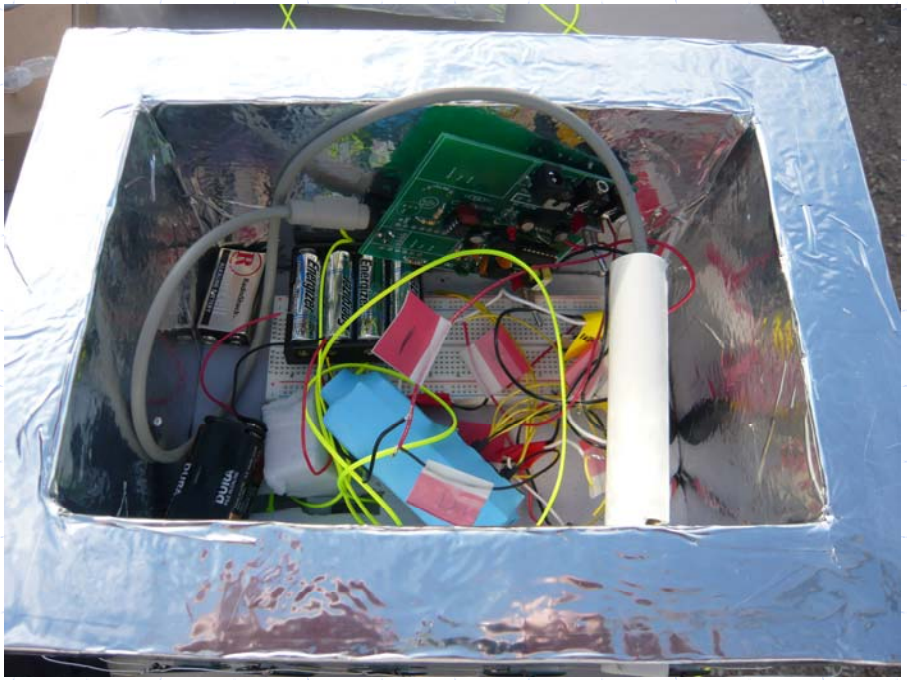
- **Chemical (disposable vs reusable)**
- **Electronic (long-lead development)**

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.**



Atmospheric Sensors and Solar Cell Efficiency



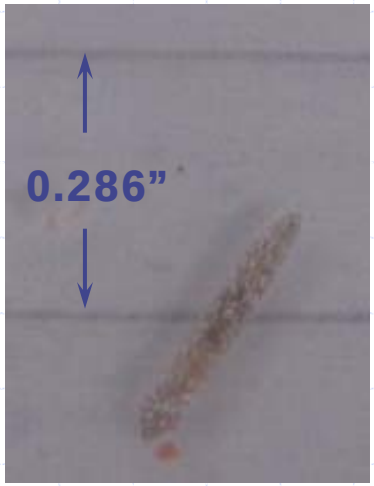
- Temperature
- Pressure and Humidity
- Wind Velocity
- Time

- Radiation (Geiger Counter)
- Solar Cell Evaluation

Installed chemical reusable hand-warmers to protect electronics

UCSD Astronauts

Cockroaches & Planaria & Water-Bears



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

Installed chemical reusable hand-warmers in some bug capsules

On-Board Cameras

Top and Side Cameras

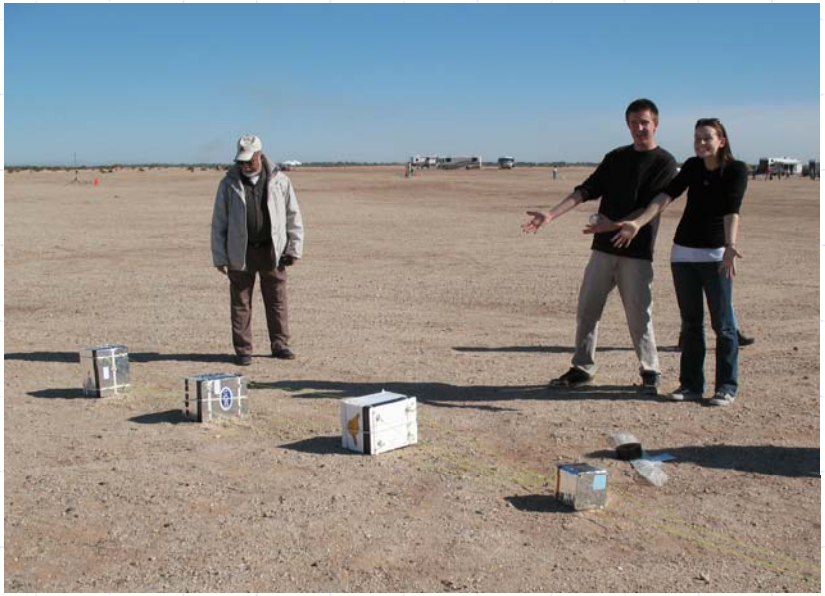
- Continuous Photo Shoot at 30-second intervals
- Installed reusable chemical hand-warmers to heat camera bodies

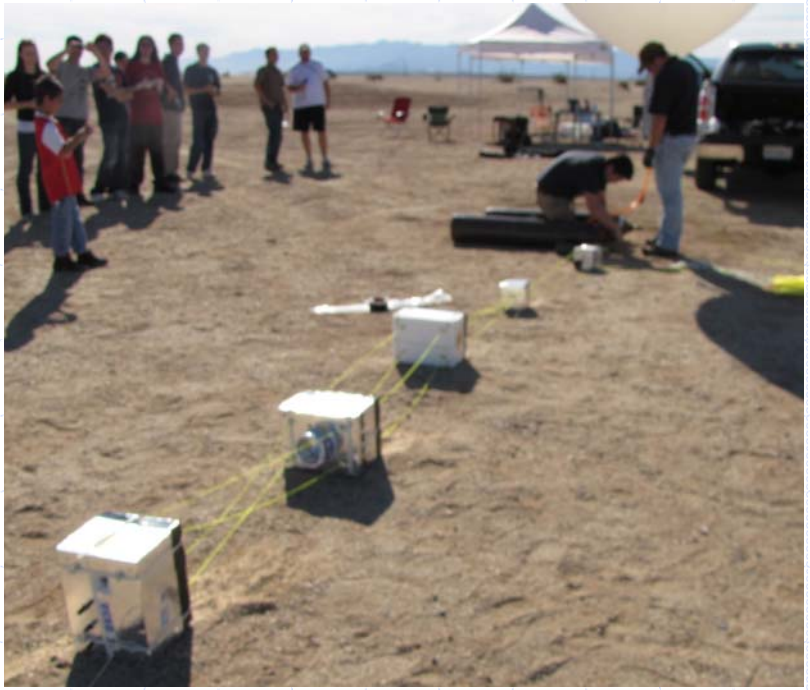
Launch Day (12/06/2008)

Pre-Launch (Set-Up)

Plaster City, California

Pre-Launch (Final Assembly)





Plaster City, California

Pre-Launch (Balloon Fill)

Plaster City, California

Pre-Launch (Tracking Station Set-Up)

Plaster City, California

Launch (11:50 AM)

Side View

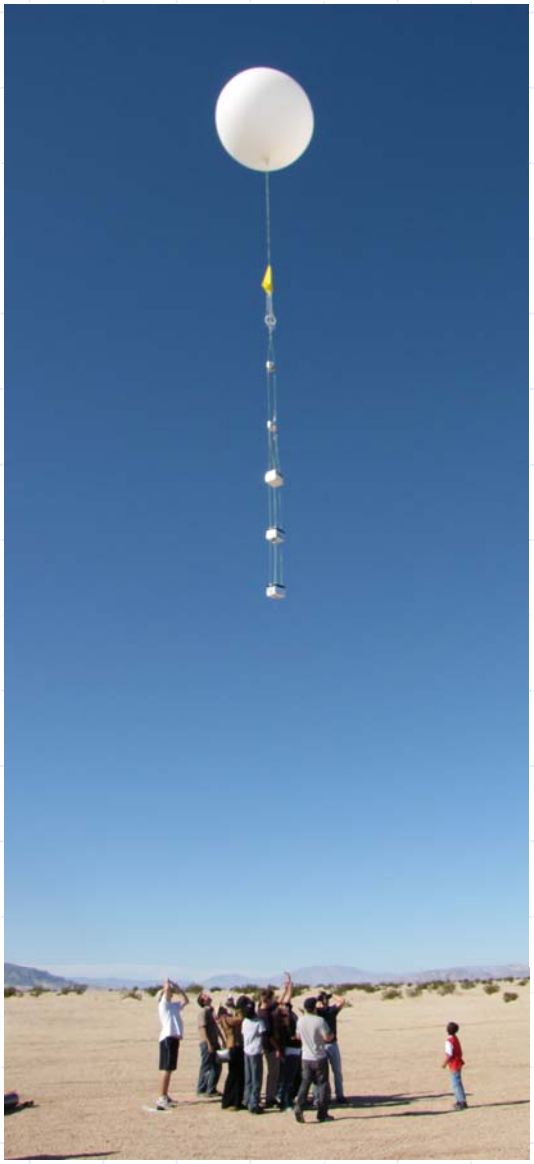
Bottom View

Plaster City, California

Flight (11:50:30 AM)

Side View

Bottom View

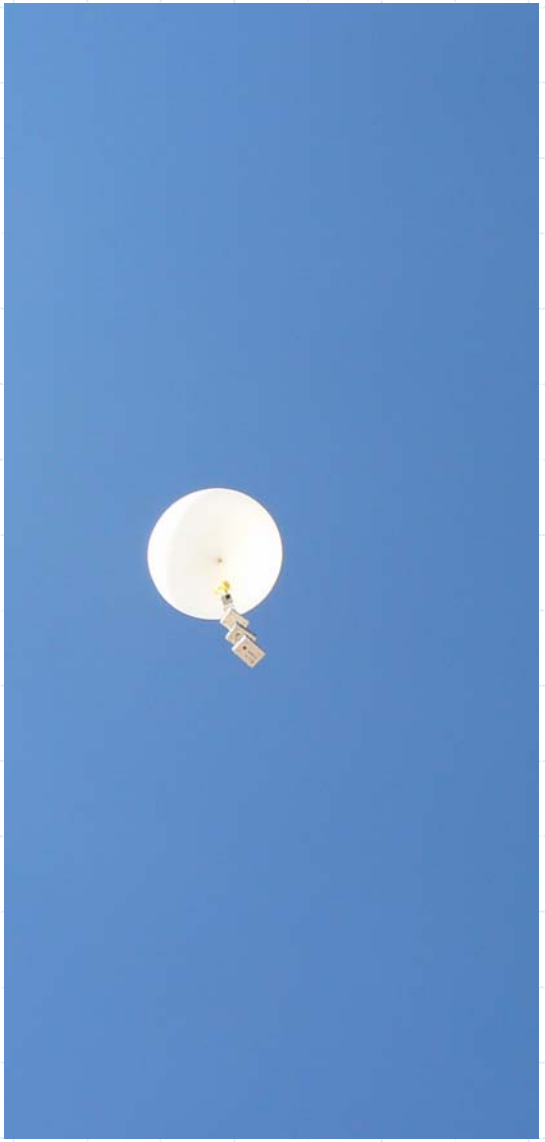


Plaster City, California

Flight (11:51:00 AM)

Side View

Bottom View



Plaster City, California

Flight (11:51:30 AM)

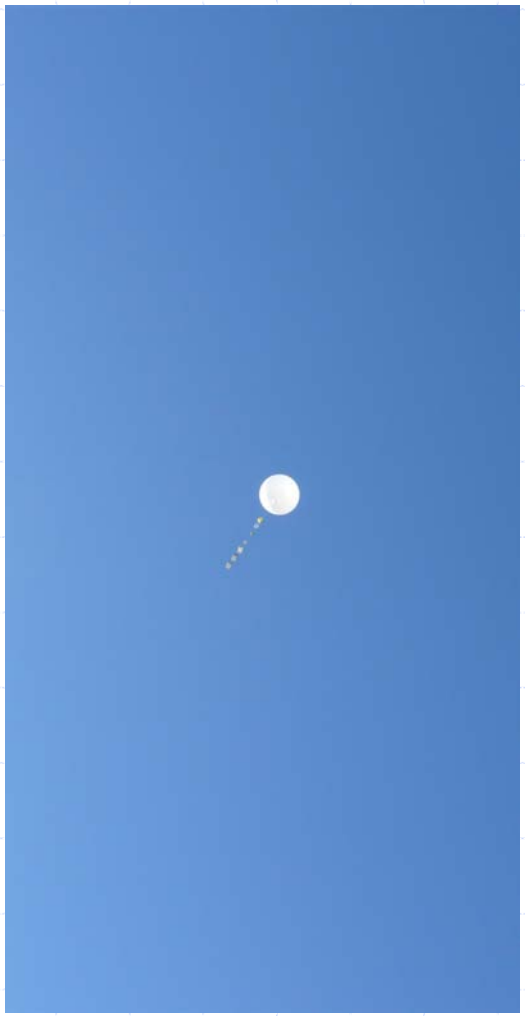
Side View

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

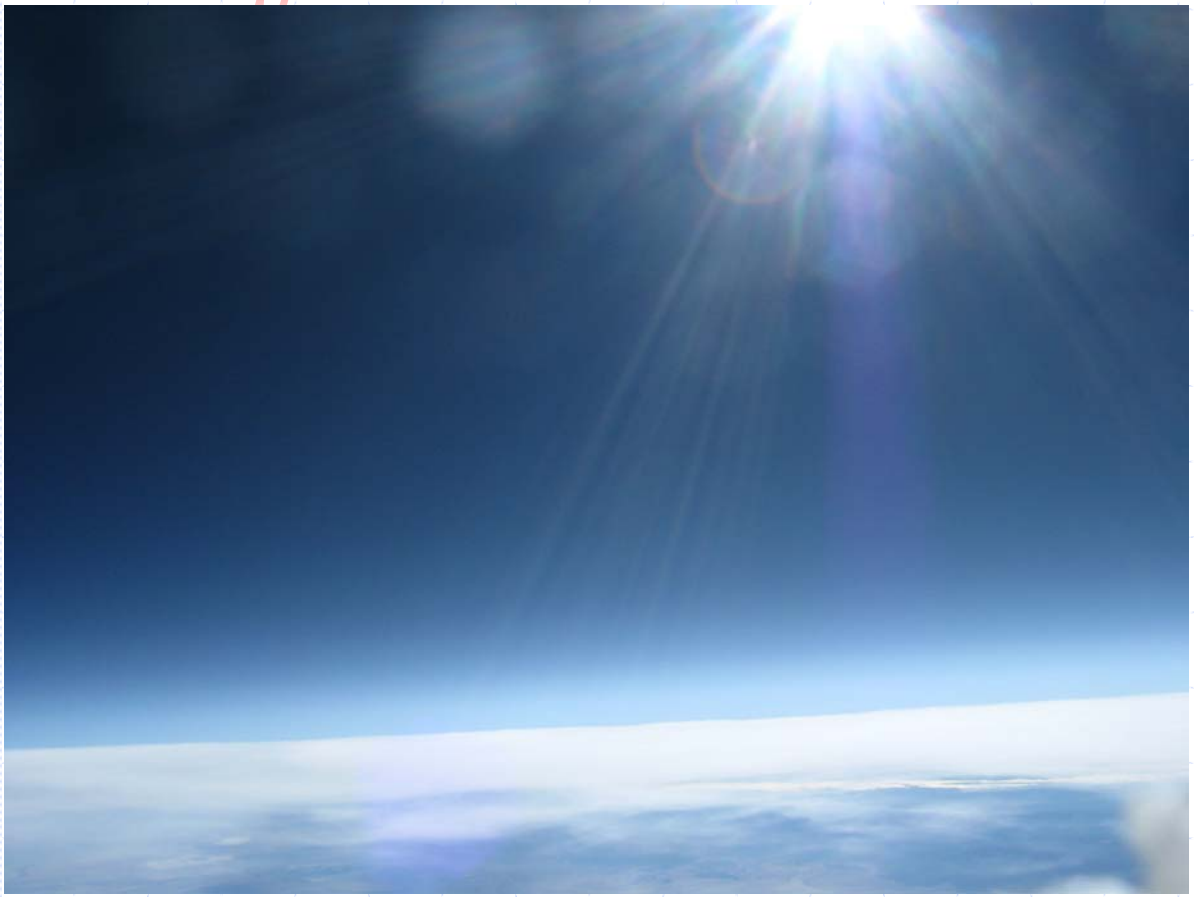
Bottom View

Flight (12:30:00 PM)

Side View

Bottom View

Flight (12:35:00 PM)

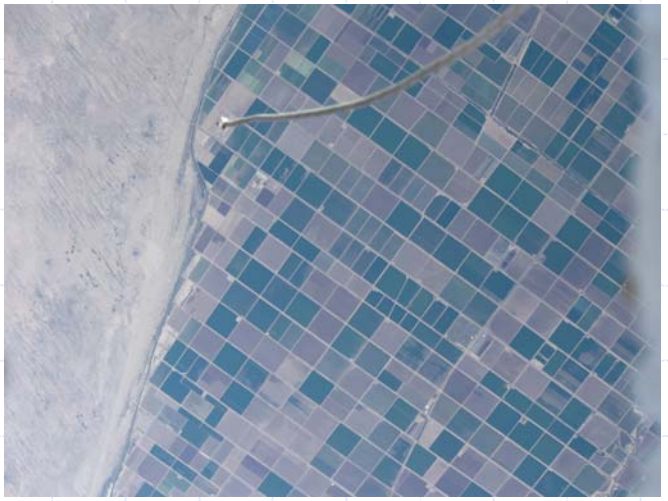


Side View

Bottom View

Flight (12:45:00 PM)

Side View



Bottom View

Flight (1:00:00 PM)

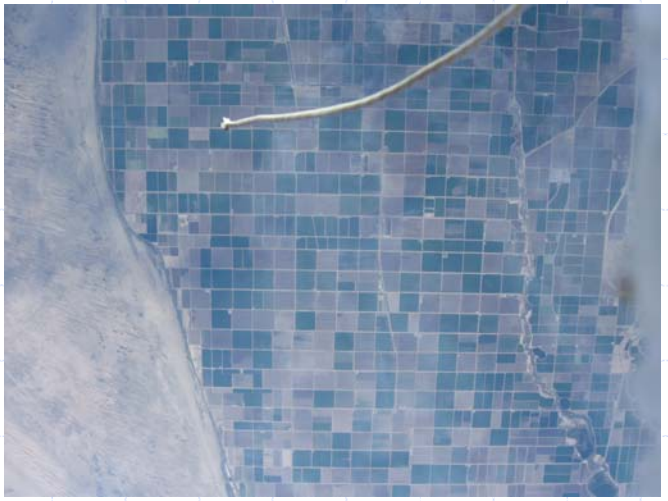
Side View

Bottom View

Flight (1:08:00 PM)

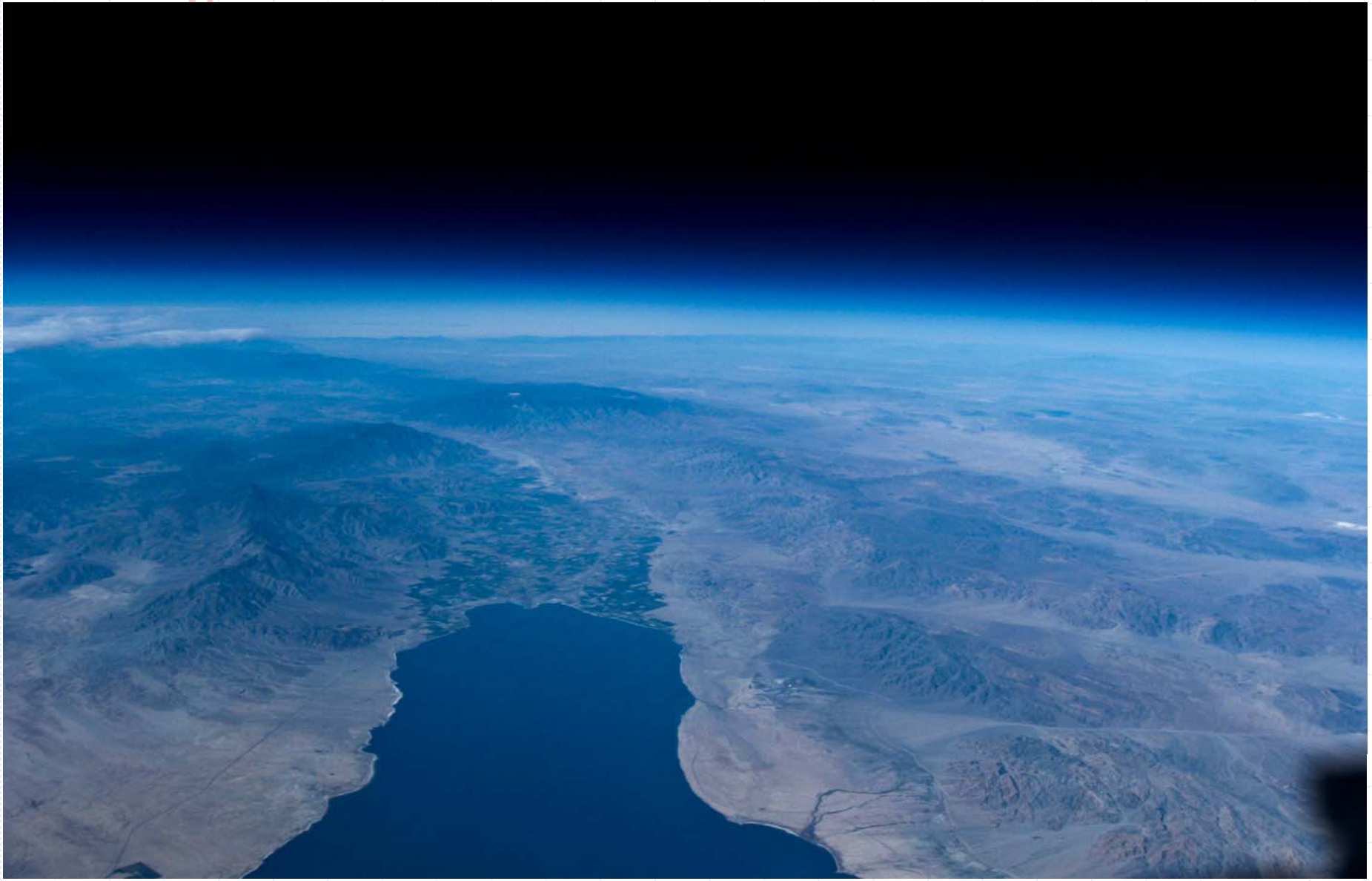
Side View

84,000 feet

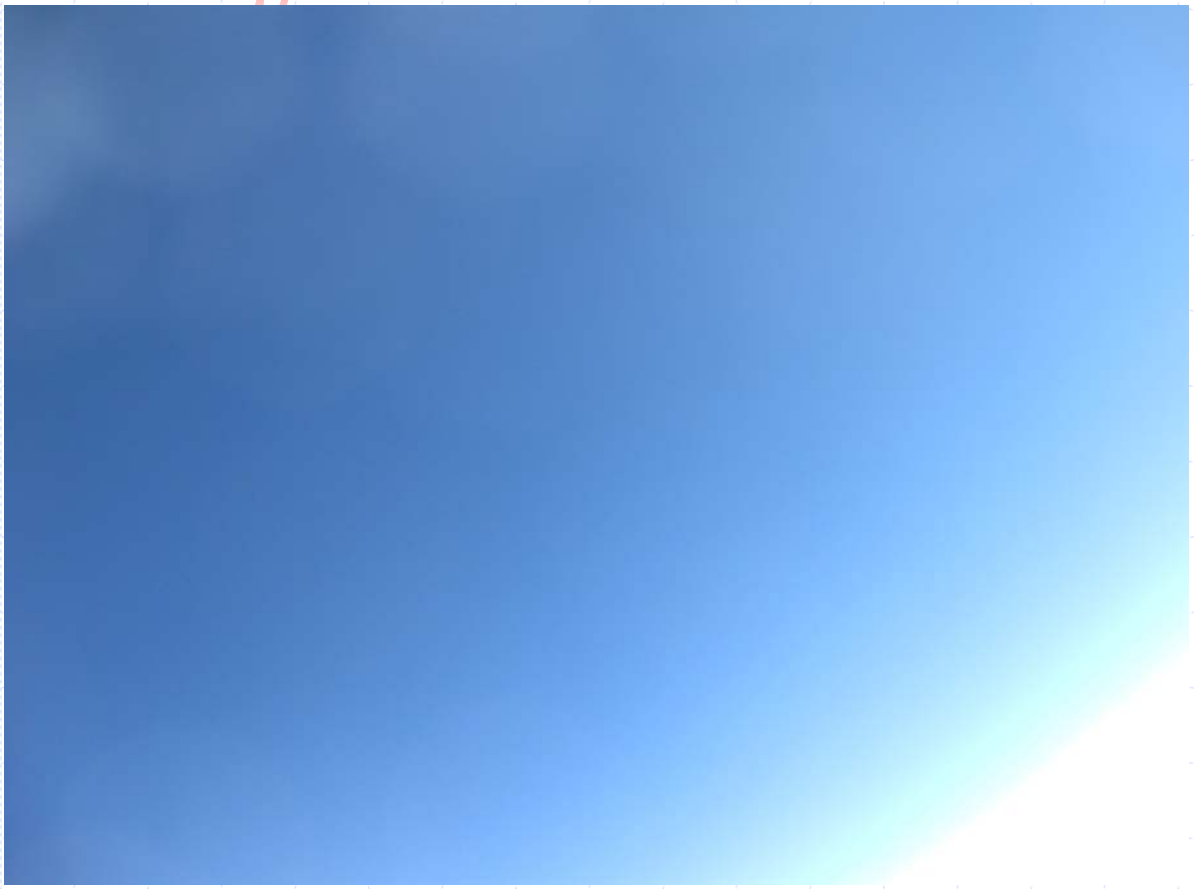


Bottom View

Looking North Over Salton Sea at 84,000 feet



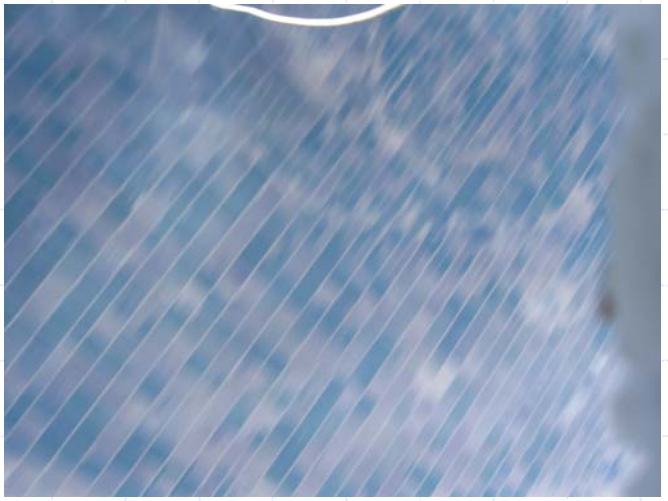
Flight (1:09:00 PM)



Side View

Balloon Burst –

Free-Fall Tumbling Begins

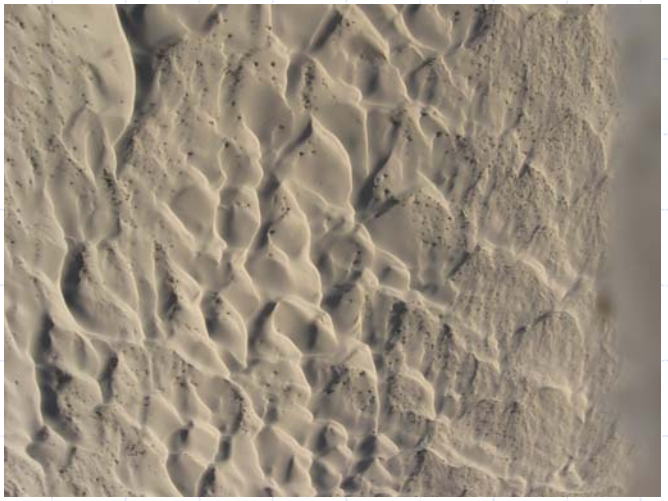


Bottom View

Flight (1:38:00 PM)

Side View

30-minute
Parachute Drop

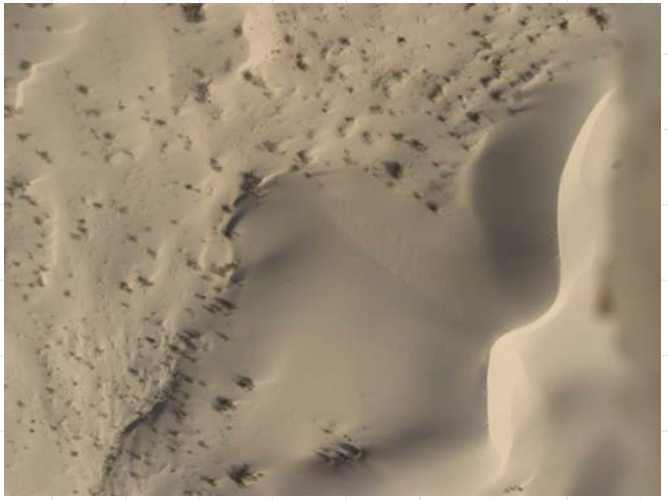


Bottom View

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

Plaster City, California

Glamis, California

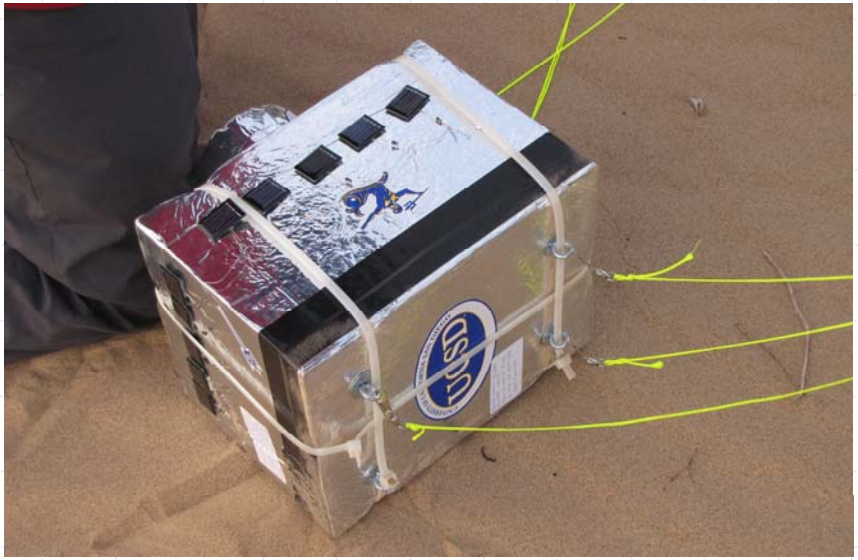
Payload Recovery (1:46 PM)

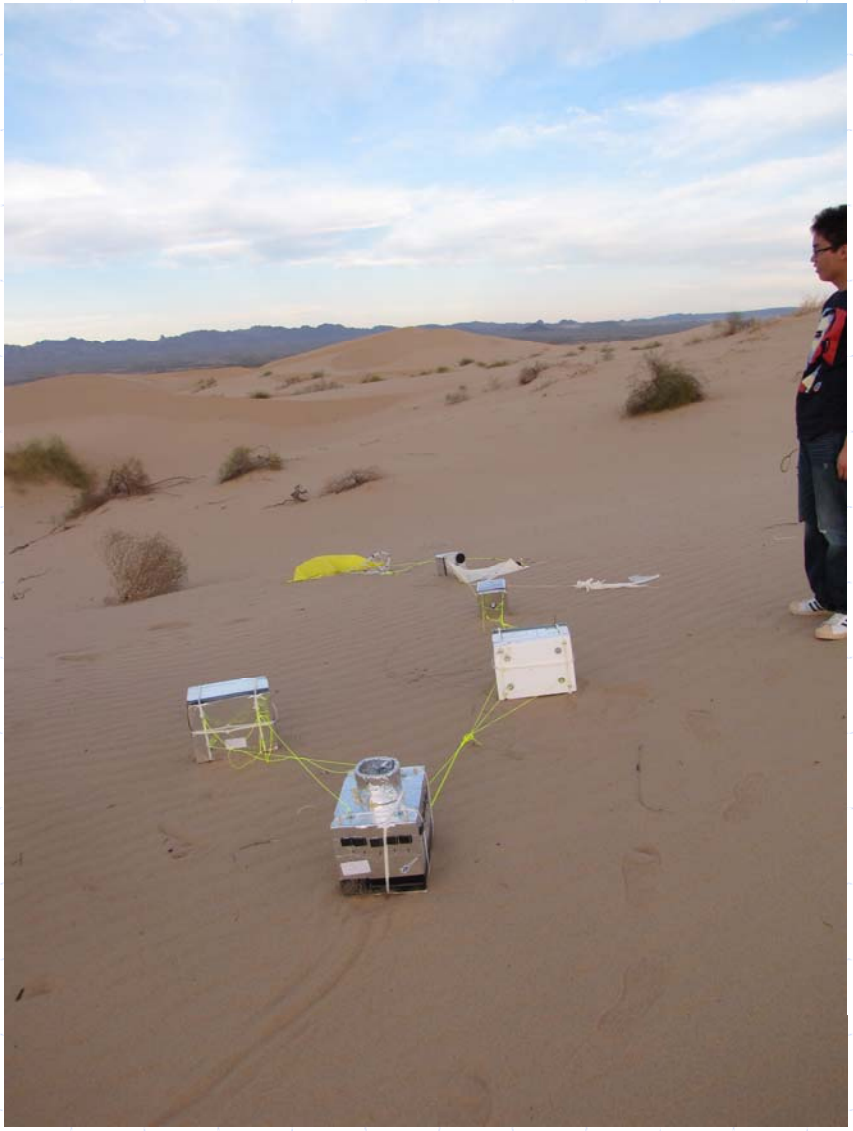
Osborne Lookout (65 miles away)

Hike with GPS Tracking (3:11 PM)

2.2 mile hike into desert nature preserve

Payload Found (4:00 PM)



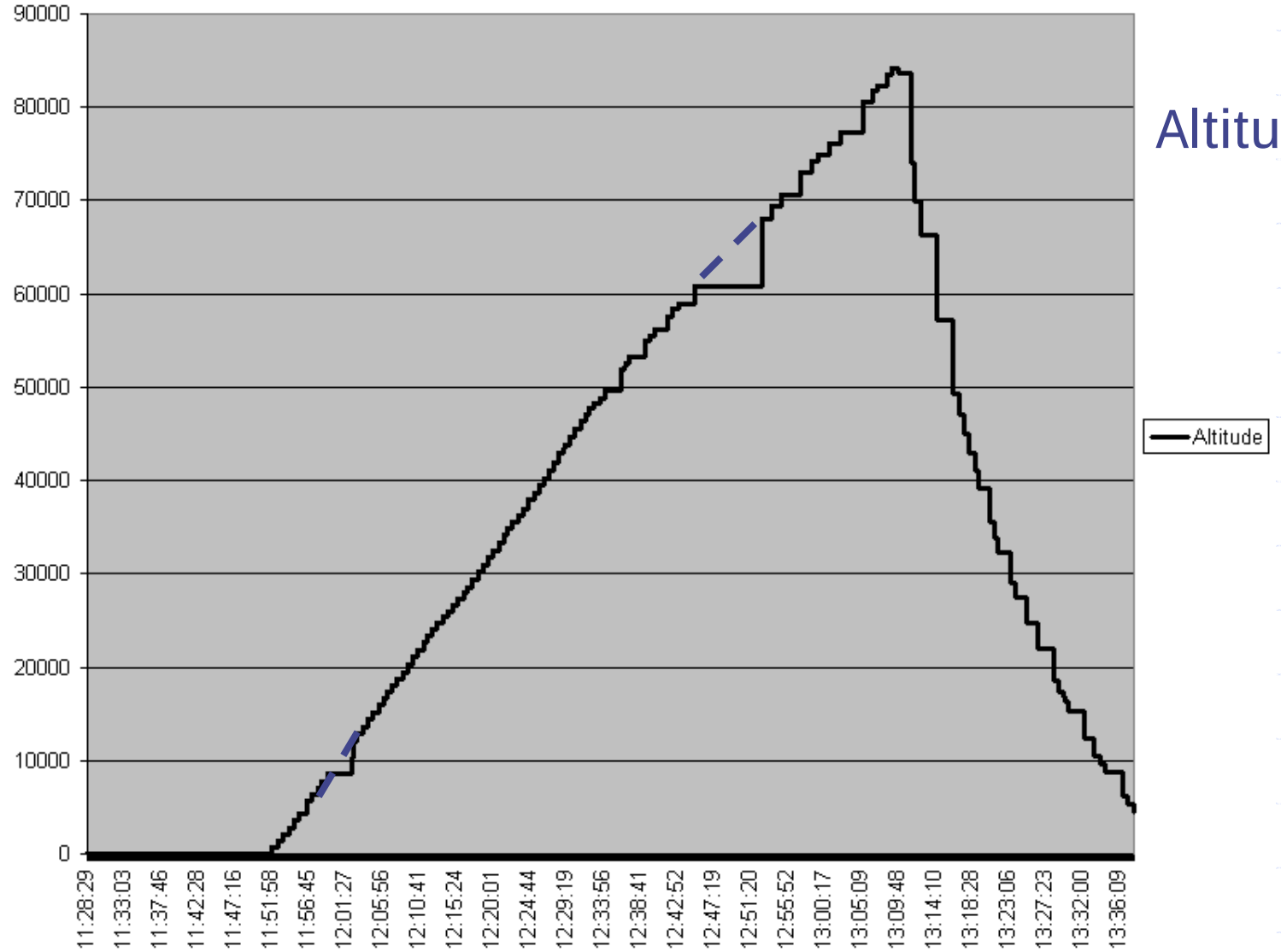


Payload Recovered

March Out of the Desert

On-Board Cameras Were Still Recording

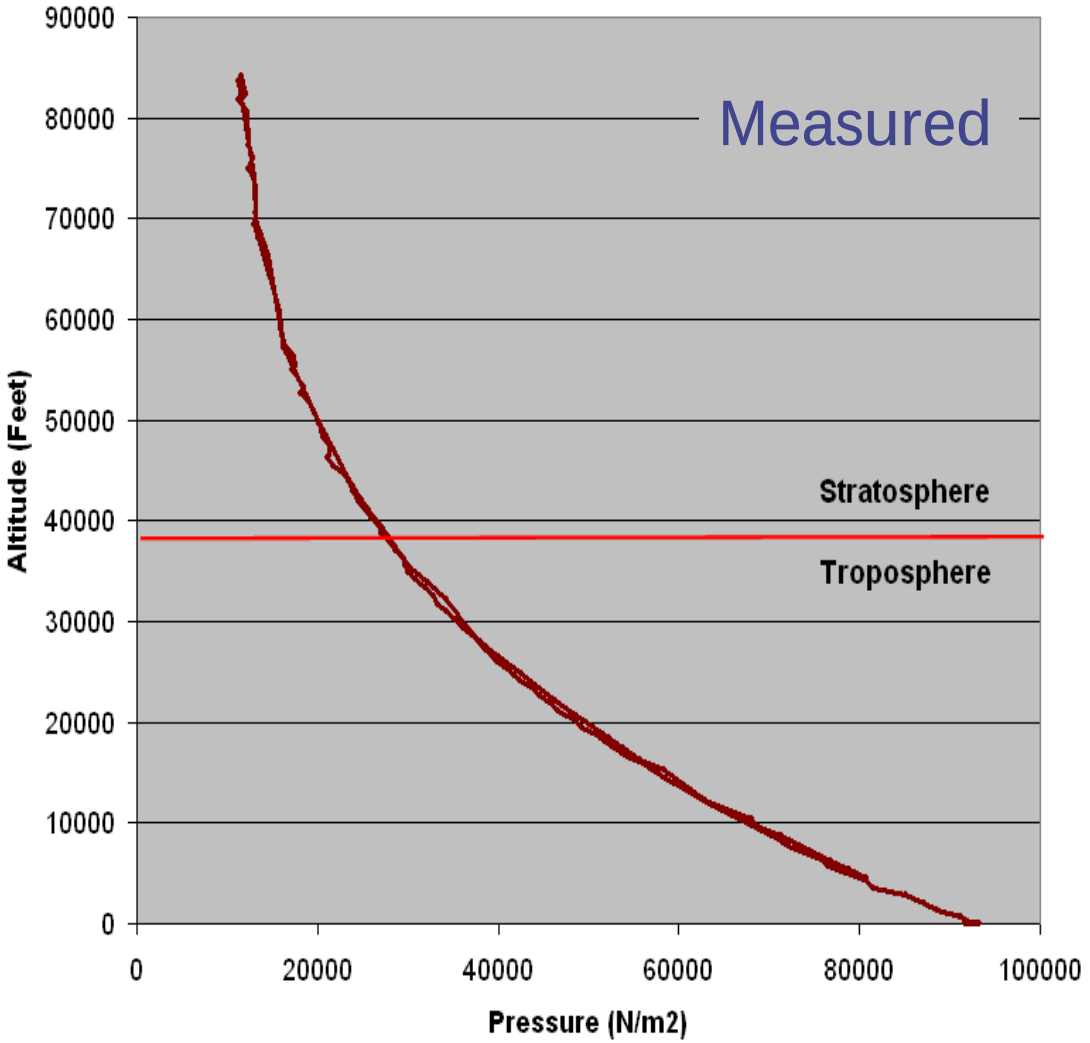
Post-Flight Studies

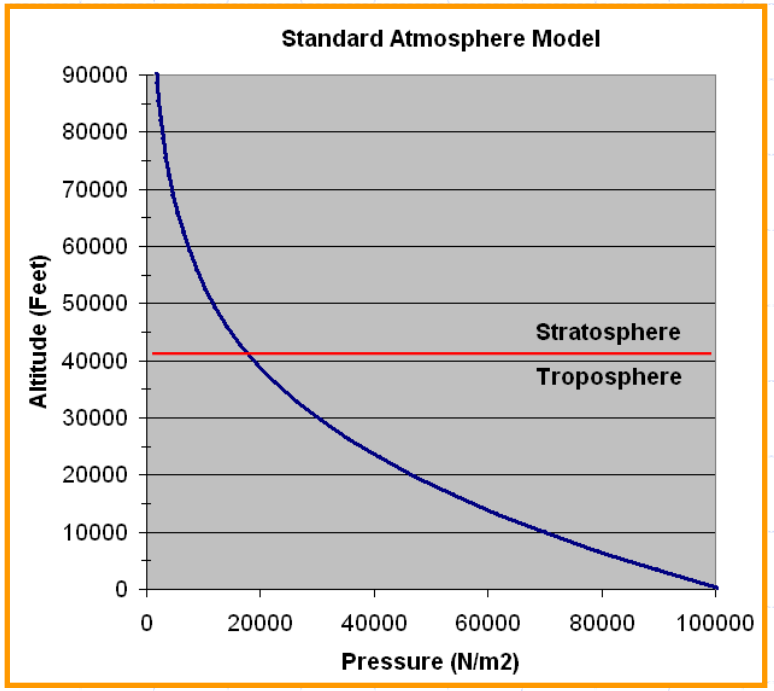


Altitude vs Time

Post-Flight Studies

Pressure vs Altitude

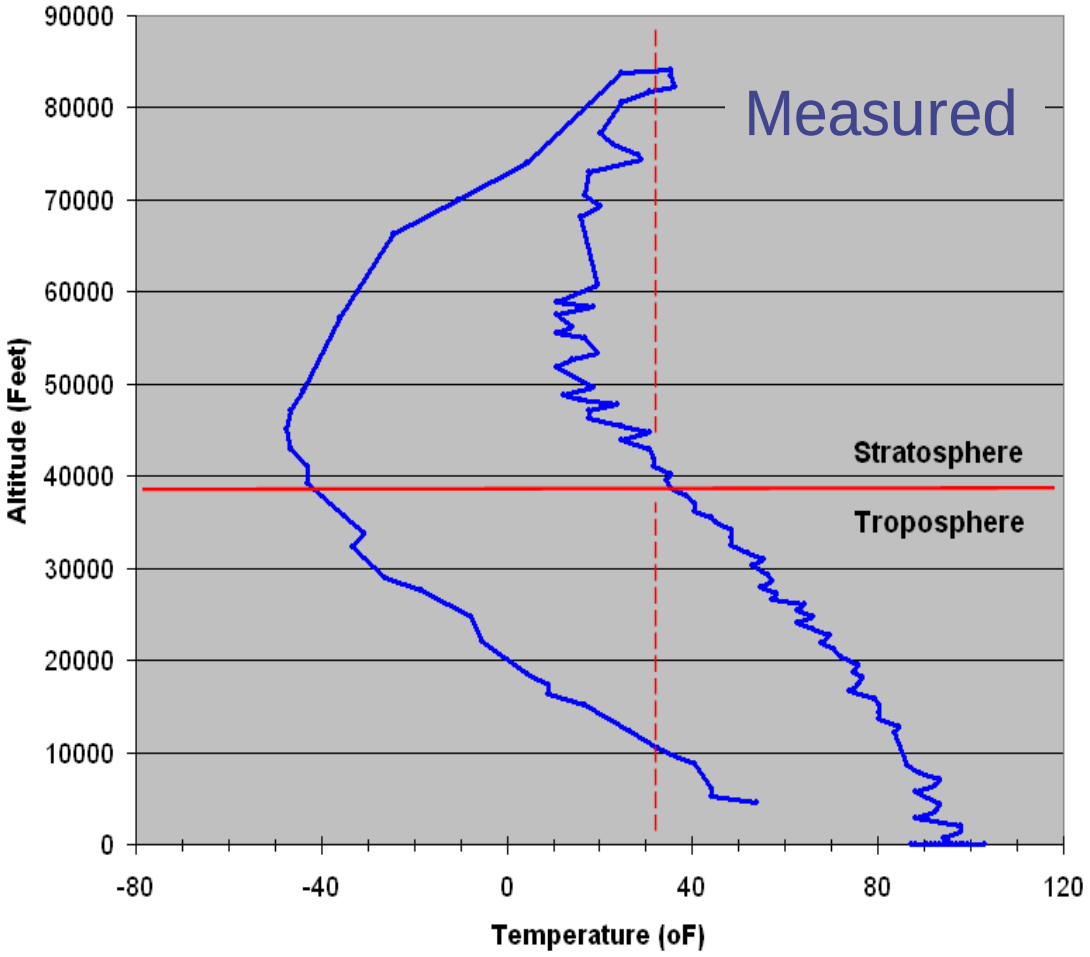


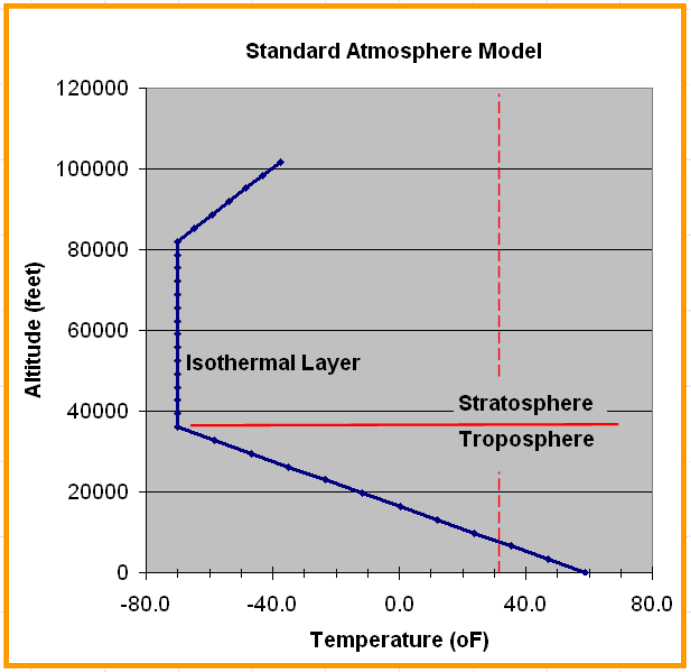


Standard atmosphere models show exponential reduction in pressure with increasing altitude

Post-Flight Studies

Temperature (oF) vs Altitude



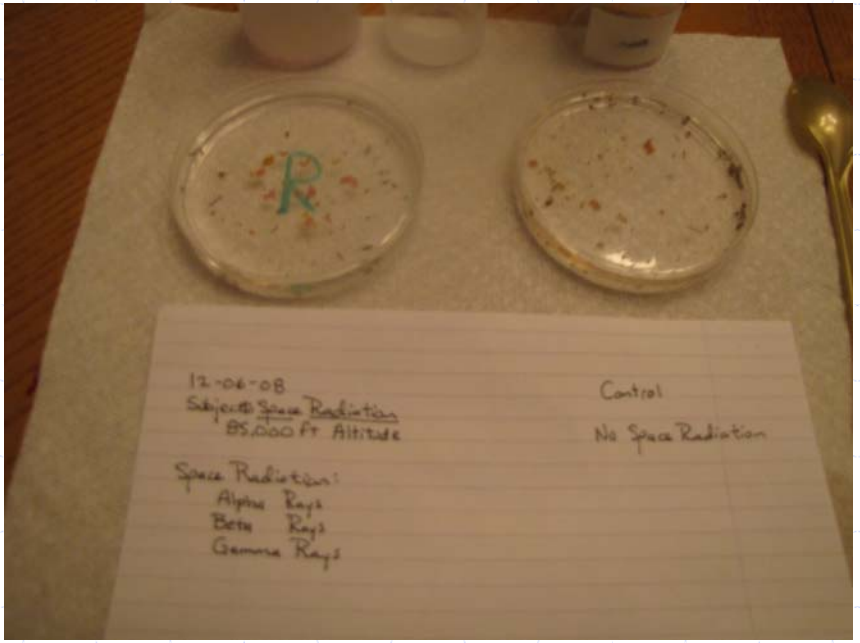


Standard atmosphere models show linear cooling to stratosphere edge, then constant temperature isothermal layer, followed by linear heating above 82,000 feet

Post-Flight Studies

Cockroaches survived

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



Planaria Worms survived

•space radiation