Access to Space! (ESS 205)

Instructors:

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Launch Prep at Moses Lake, Washington

Class Website: http://earthweb.ess.washington.edu/Space/ESS205

Class Video: http://www.youtube.com/watch?v=ogij1zLyb14&hd=1

ISS Video: https://www.youtube.com/watch?v=FG0fTKAqZ5g

Images from prior ESS205 balloon flights.

‘edge’ of space!
(2008 class)

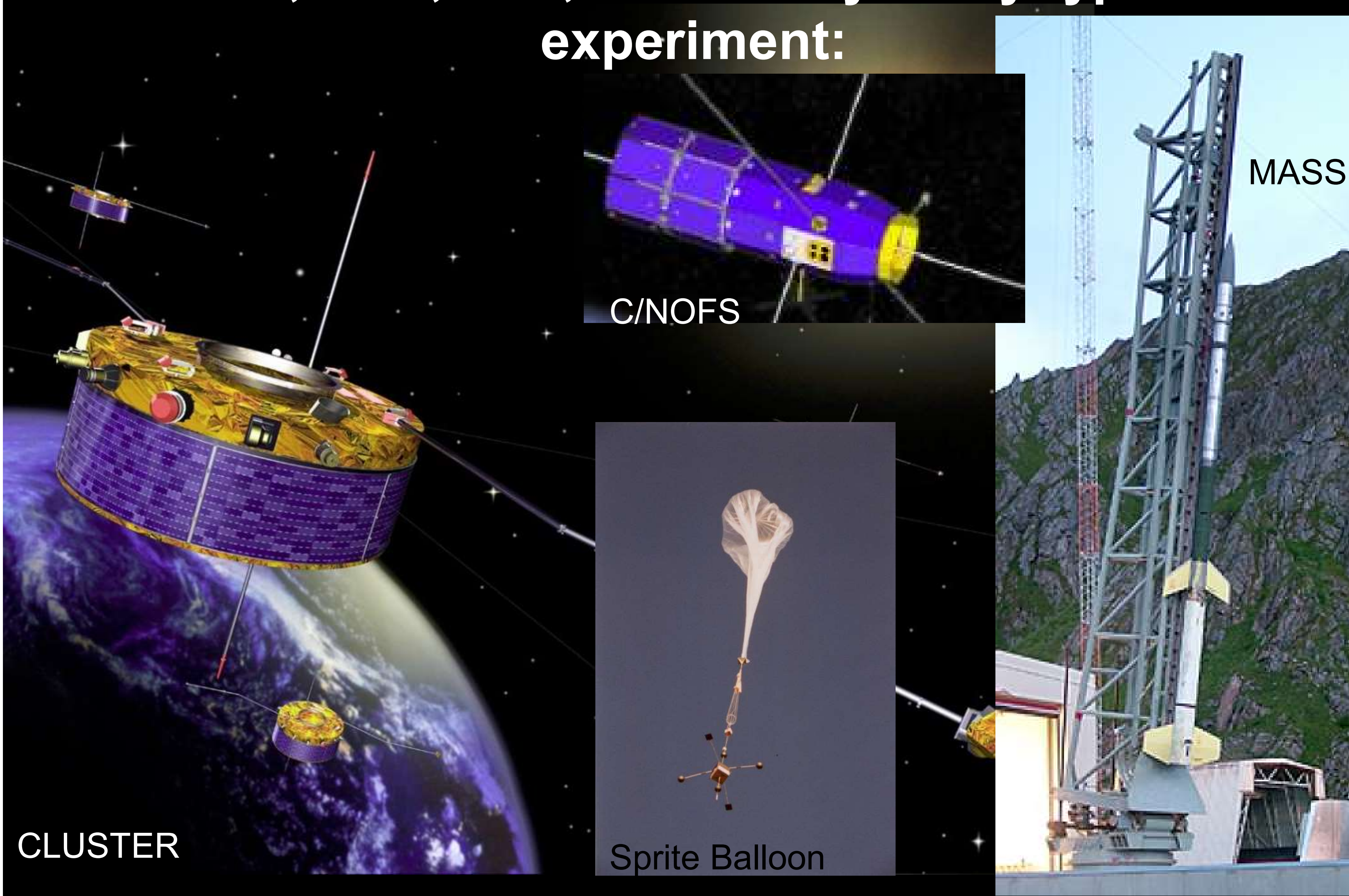
ESS 205 Course Description:

GOAL: To provide a hands on research experience with the **science, techniques, challenges, and rewards** of space exploration.

APPROACH: Provide the opportunity to build, test, and fly your own experiment to study a region of the Earth's atmosphere.

- Targeted Learning: We will learn about our space environment and what makes it valuable for study.
- Technology Literacy: We will explore the techniques and technology of scientific exploration
- Mission Planning: We will introduce the "NASA" way of preparing and managing a scientific mission.
- Mission Implementation: We will take our experiments to the field and run them under real world conditions.

NASA, ESA, NSF, and UW fly many types of experiment:



The same basic mission model applies to them all!

Course Implementation:

ESS205 is a 5 Credit Course: All content is geared to a student with college entry level science and math background (no college level prerequisites)

There are 3 Primary Elements to ESS205

1) **Lectures (M-W-F 10:30 – 11:20p)**

2) **Laboratory (AA - TTh 12:30-2:20p JHN 127)**

(AB - TTh 2:30-4:20p JHN 127)

3) **Experiment (Lab and Outside Work: Launch Event)**

Lectures:

(Three types, all given in the regular ESS205 lecture hall)

1) **Topical Introductory Lectures on our Science Target:**
(the Earth's Atmosphere from 0-30 km and near space – ionosphere and magnetosphere Space Weather)

2) **Technology Presentations:** (Electrical Components, Circuits, Tracking, Antennas, Communications, Platforms, Data Analysis)

3) **Invited Presentations:** (Specialists, Mission Principal Investigators, New Technologies, Aerospace Companies)

Grading related to Lectures:

Lecture questions. Midterm Exam May 5^{th}, tentative date

Laboratory:

Four Hours Each Week (Room 127 JHN):

1) **Mission Planning Activities:** (Concept development, Project presentation, Building and Testing)
2) **Hands on Technology Introduction:** (Building and testing circuits, Antennas, Construction, Data Analysis, Building our own CricketSat)

- **Grading related to Labs:** Laboratory Writeups, midterm questions

Experiment:

This is what we're here for!

1) **Break up into teams** that work with graduate student mentors. (The team selections will be made prior to the first hardware lab)
2) **Develop an independent experiment** (you pick the topic) that can operate from a weather balloon.
3) **Participation in** a 'dry run' launch of a **CricketSat** from campus.
4) **Fly experiment** on a balloon from our 'launch facility' in Moses Lake. This requires a combination of time in lab, work outside lab doing planning, construction, and testing, and ***mandatory*** attendance at our launch on Saturday May 20 (if you can't do this, come see us *now*).

- **Grading:** All must submit a mission design/management plan, analysis of testing and flight integration, an analysis of the CricketSat, and a post mission report (i.e. Final Report)

Where you'll be on May 20, 2017

Audio included

Better technique

DRAFT Class Schedule (2017)

Monday date	Monday Lecture	Lab Day 1	Wednesday Lecture	Lab Day 2	Friday Lecture	Weekly highlig
March 27	**Introduction** Scope of course intro-lec2017.pdf	Group selection lab1.2017.pdf	Basic electrons: Voltage and current lec-voltsandcurrent17.pdf	Volts and Meters, Ohm's Law lab2.17.pdf multimeterguide.pdf	The Layered Atmosphere layered_17.pdf	
April 3	Scientific Ballooning ballooning.17.pdf	Circuits which respond to the environment lab3.17.pdf	Capacitors and Inductors cap_ind_diode_17.pdf	RC circuits and motors (project discussions last 45 minutes) lab4.17.pdf	Upper Atmosphere and ionosphere upper_A_and_ionos17.pdf	
April 10	Aurora and Magnetosphere aurora_magnetosphere17.pdf	AC signals and frequency response lab5.17.pdf	Operational Amplifiers opamps_17.pdf	Operational Amplifiers lab6.17.pdf	Radiation Belts radiation_belts.17.pdf	Project Concep Approv
April 17	Sun-Earth Connections solar_weather17.pdf	Lab 7 555 timer lab7.17.pdf	Project Description writeup then break into teams ProjectProposalPresentations	CricketSat and Intro to soldering CricketSat_Assembly.pdf	Solar physics solar17.pdf Earth Day Friday April 22 Seattle Events UW Earth Day 2016	
April 24	Cosmic rays CosmicRays17.pdf	CricketSat fab	Navigation and GPS lec_gps.17.pdf	ProjectProposalPresentations	Charged Atmosphere ChargedAtmos17.pdf	Present of Proj Concep
May 1	Feedback, with global warming discussion feedback17.pdf	CricketSat Launch	Midterm Review: dont miss it if you'd like to lab_review.pdf	CricketSat data analysis and Working on Payloads Cricketsat writeup Cricket_Sat_Data_Analysis SP 2017.pdf	Midterm Exam	Cricket Launch
May 8	Heliophysics heliophysics2017.pdf	Project cost estimates and construction	Direction Finding Exercise	Project construction	Radio Frequency Links radiolinks2017.pdf	
May 15	Field Trip signups VanSignups17.pdf Final Report Guide	Project Construction	Final Field Trip Planning finalprep17.pdf	Final Payload Prep/integration	Undergrad Research Symposium/Mary Gate Hall	**LAUN Saturd May 2(**
May 22	Data Analysis Lecture data_analysis17.pdf	Flight data analysis	Ben Franklin ben_franklin.pdf	Flight Data analysis	Panel discussion about Geosciences degrees	
May 29	(Holiday)	Report Writing Final Report Guide	Odds'n' ends oddsNends2017.pdf	Report Writing	Final Report submission; Closing Ceremonies	
June 5	Finals Week	Final Reports Due Tuesday				

The First Assignment!

- The experiment platform is a high altitude ‘sounding’ balloon.

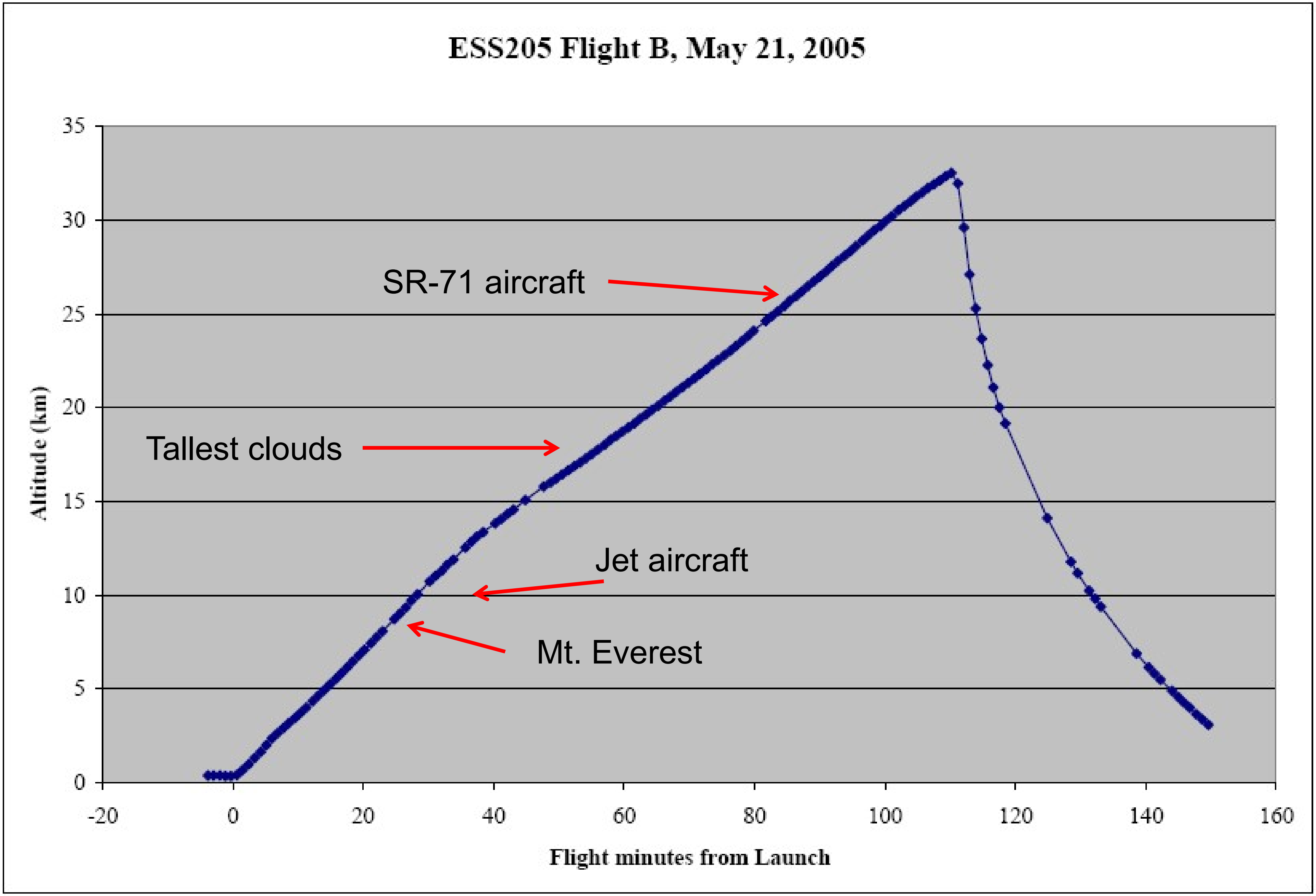
- Each group must develop a concept that measures something (anything!) that *changes*.

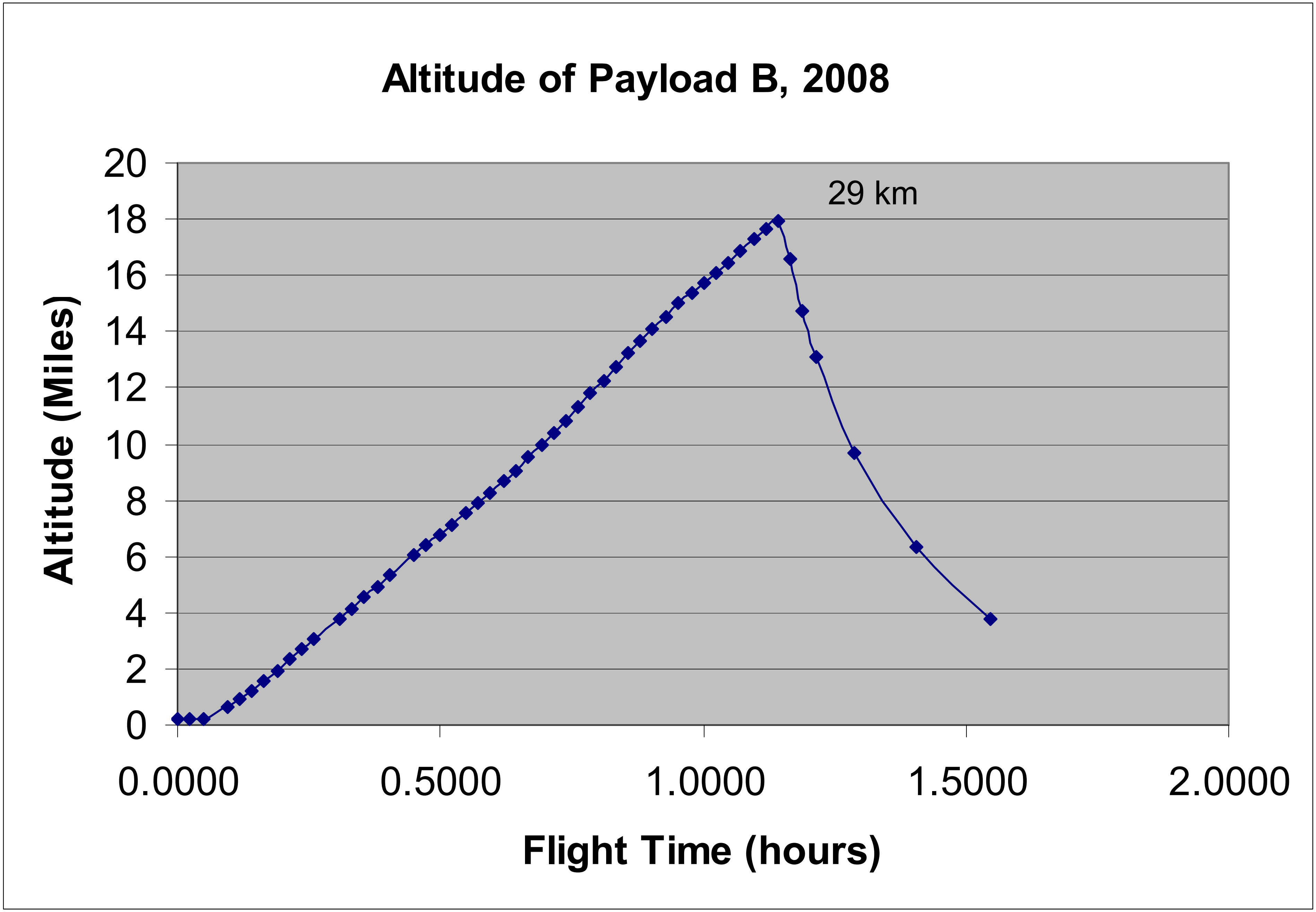
- Each experiment must fit with constraints of budget (<$50), weight (<1 lb), and size (~ shoebox). (This is the same basic restriction that those of us who fly experiments must operate under)

- The sooner an idea is developed the more time there is to order parts (if needed) and to work out problems in development.

- The first lab will be dedicated to breaking up into groups and discussing the plan for experiment development.

Bring ideas for discussion!


ESS205 Flight B, May 21, 2005
Altitude (km)
35
30
25
20
15
10
5
0
-20
0
20
40
60
80
100
120
140
160
Flight minutes from Launch
SR-71 aircraft
Tallest clouds
Jet aircraft
Mt. Everest



Soundings: http://weather.uwyo.edu/upperair/sounding.html

What changed in the environment of the payload as it rises?

30 km

List:
(think about the atmosphere: what's in it? What are it's properties? What's passing through it? Physical matter, radiation and light, radio waves ..)

0 km

What Kind of Experiment?

You have only one *scientific* requirement:
What Kind of Experiment?
You must measure something that changes!

Some things that have been tried:

Anything you CAN'T try???

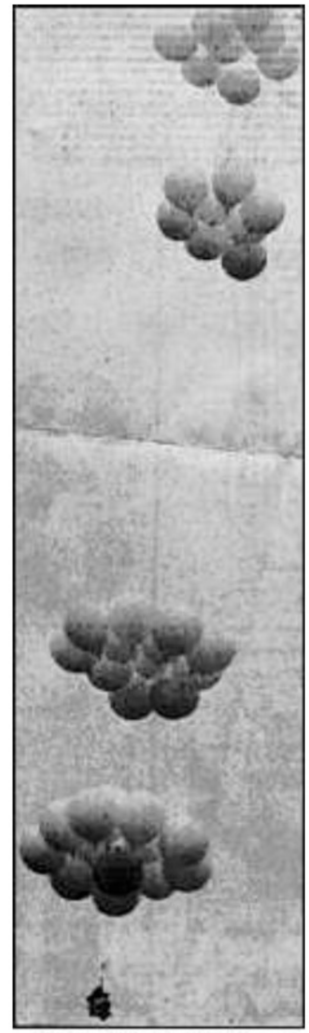
- 1) Air Pressure.
- 2) Air Resistance.
- 3) Temperature.
- 4) Light (visible, infrared, UV).
- 5) Magnetic and Electric Fields.
- 6) Habitability (Biosphere).
- 7) Humidity
- 8) cosmic rays

Armchair Larry:

‘Patron Saint of ESS205’ and winner of Honorable Mention from the Darwin Awards

Lawn Chair Larry (Patron Saint of ESS205):

Larry's Heart was in the right place (but perhaps not his brain)……



Associated Press

Larry had always wanted to learn to fly.

But his eyesight (not to mention intellect) were not up to the task.

In April, 1982 he attached 24 helium weather balloons to his lawn chair ("Inspiration 1") and strapped himself in with a pellet gun, sandwiches and beer.

With the plan of hovering about 30' over his house until he shot out some of the balloons to come down, he released the line holding the chair to his jeep……

Lawn Chair Larry (Patron Saint of ESS205):

Larry's chair didn't stop at 30'….or 100'….or 1000'…..or *10000'* !!! It went up to 16000'!!!!!

Lesson 1) Shooting balloons to get down sounds like a ***much*** dumber idea at 16000' than at 30'.

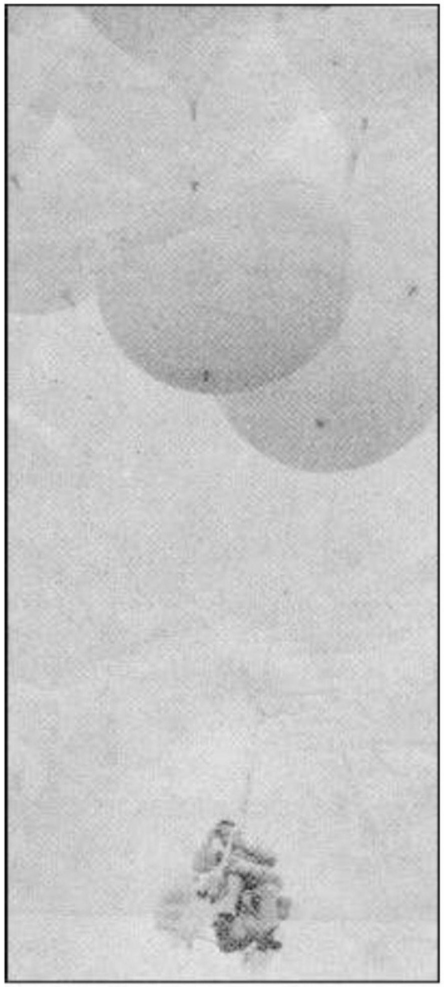
Lesson 2) As you will see in this class, it is a ***lot*** colder at 16000'.

Lesson 3) You generally can't ***steer*** a balloon from a lawn chair, even if you really want to because you've drifted into the approach at LAX!

Lesson 4) If you get cold enough and drink enough beer, you are able to unlearn lesson 1.

Lesson 5) When you return to the ground, power lines are a good thing to avoid…..

Lesson 6) FAA Fines are ***expensive***…



Associated Press 1982

Larry's Biggest Mistake?

Associated Press 1983
and http://www.flightdata.com

Lesson 7:

Before attaching your lawn chair to weather balloons and going for a ride……

Be SURE to take ESS 205!!!

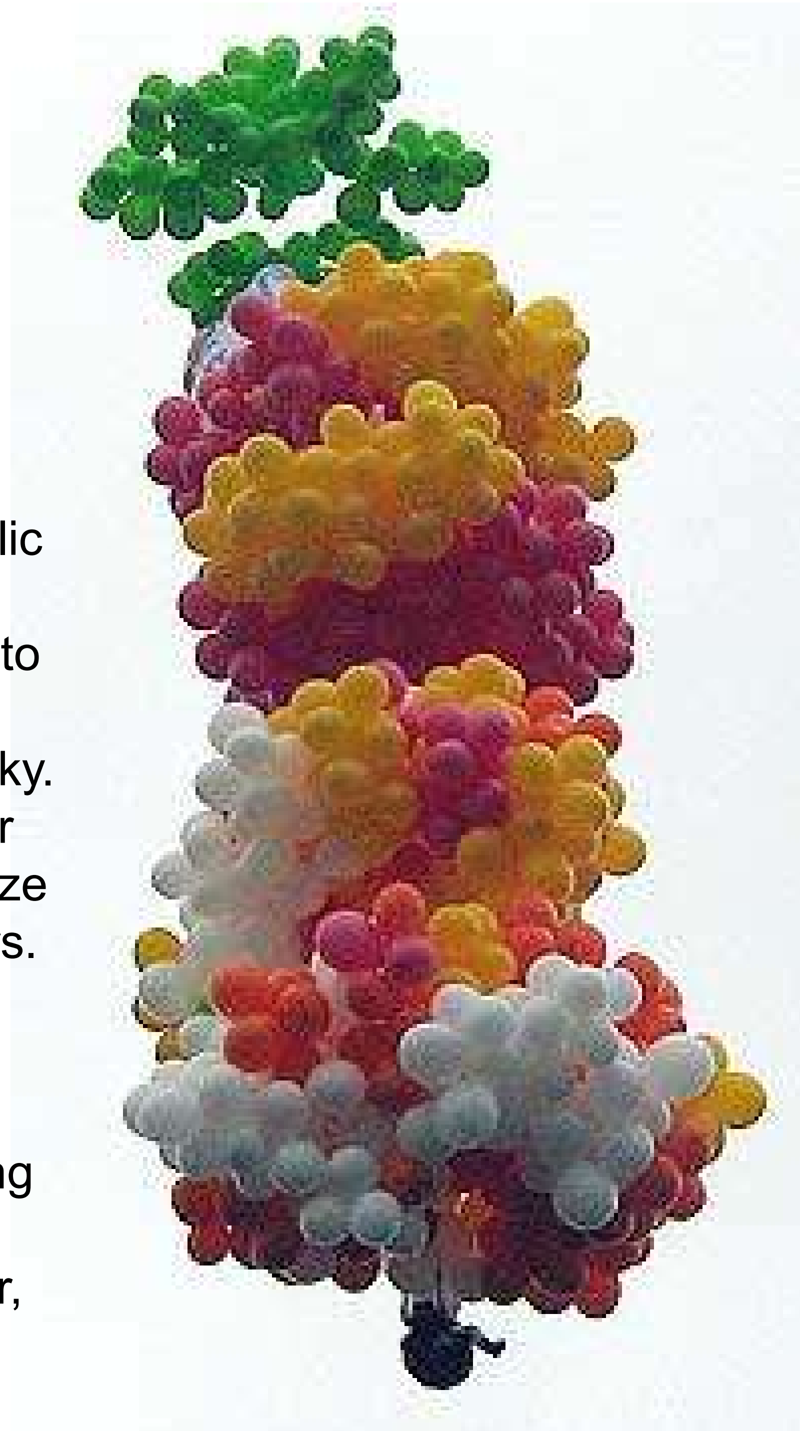
Definitive reference:

http://www.snopes.com/travel/airline/walters.asp

The Balloon Priest (Padre Baloneiro)

2008 Darwin Award Nominee
Confirmed True by Darwin

(20 April 2008, Atlantic Ocean, Brazil) A Catholic priest recently ascended to the heavens on a host of helium *party balloons,* paying homage to **Lawn Chair Larry's aerial adventure.** Larry survived but Adelir Antonio, 51, was not so lucky. His audacious attempt to set a world record for clustered balloon flight was intended to publicize his plan to build a spiritual rest stop for truckers. But, as truckers know, sitting for 19 hours in a lawn chair is not a trivial matter even in the comfort of your own backyard. The priest took numerous safety precautions, including wearing a survival suit, selecting a buoyant chair, and packing a satellite phone and a GPS. However, the late Adelir Antonio made a fatal mistake.
He did not know how to use the GPS.



The winds changed, as winds do, and he was blown inexorably toward open sea. He could have parachuted to safety while over land, but chose not to. When the voyager was perilously lost at sea, he prudently phoned for help--but rescuers were unable to determine his location, since he could not use his GPS. He struggled with the unit as the charge on the satellite phone dwindled.
Bits of balloons began appearing on mountains and beaches. Ultimately the priest's body surfaced, confirming that he, like Elvis, had left this earth.

Aside: The kicker? **It's a Double Darwin.** Catholic priests take vows of celibacy. Since they voluntarily remove themselves from the gene pool, Adelir Antonio wins twice over!


On to our science topics!

Our Research Topic:

Characteristics of the Upper Atmosphere and Space Environment near the Earth.

- What are the characteristics of the atmosphere with changing altitude?
- How does the atmosphere and space environment interact with the Sun?
- How do these characteristics change with time and in response to human activity?

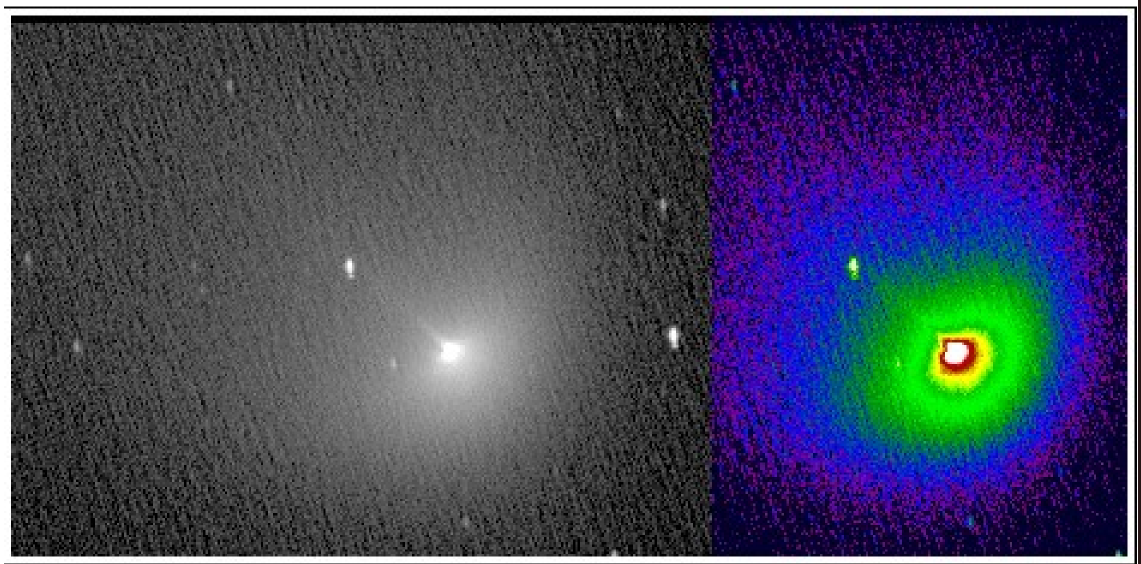
Atmospheres and the Near Space Environment:

- At a basic level the atmosphere and near space environment are the regions that transition from a planet interior/surface to the outside environment (*sphere of influence*).

- The atmosphere is the distribution of neutral gasses and charged particles that extend out into the space surrounding a planetary body.

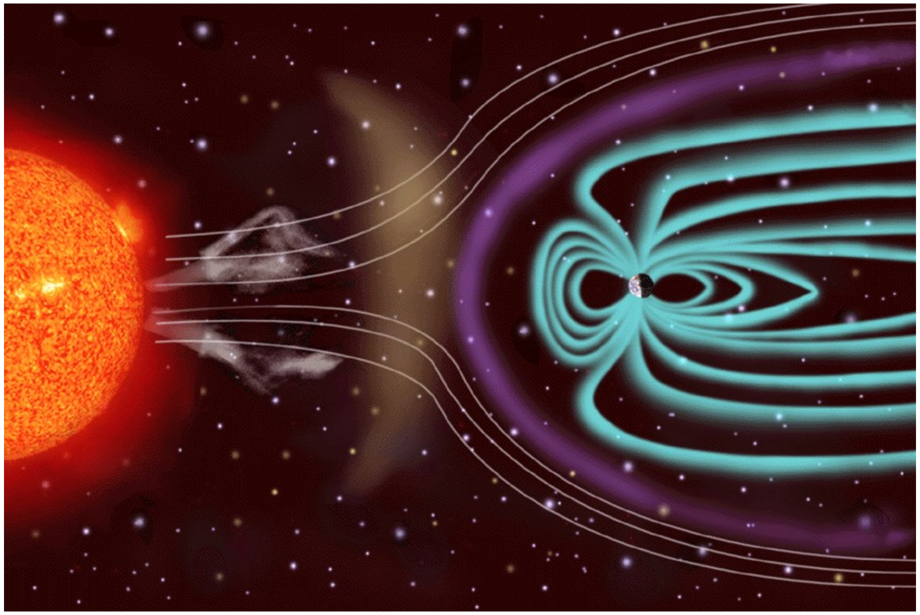
Atmospheres and the Near Space Environment:

- Atmospheres vary significantly within our solar system.
- From unbound expanding gas flows from comets.
- To the hot, thick atmosphere of Venus.
- To Atmosphere-Planets like Jupiter.



Atmospheres and the Near Space Environment:

- The Near Space Environment of a planet is the region where the thin atmosphere and the planetary magnetic field (if present) interact directly with the flow of material and high energy radiation from the Sun and interstellar space.

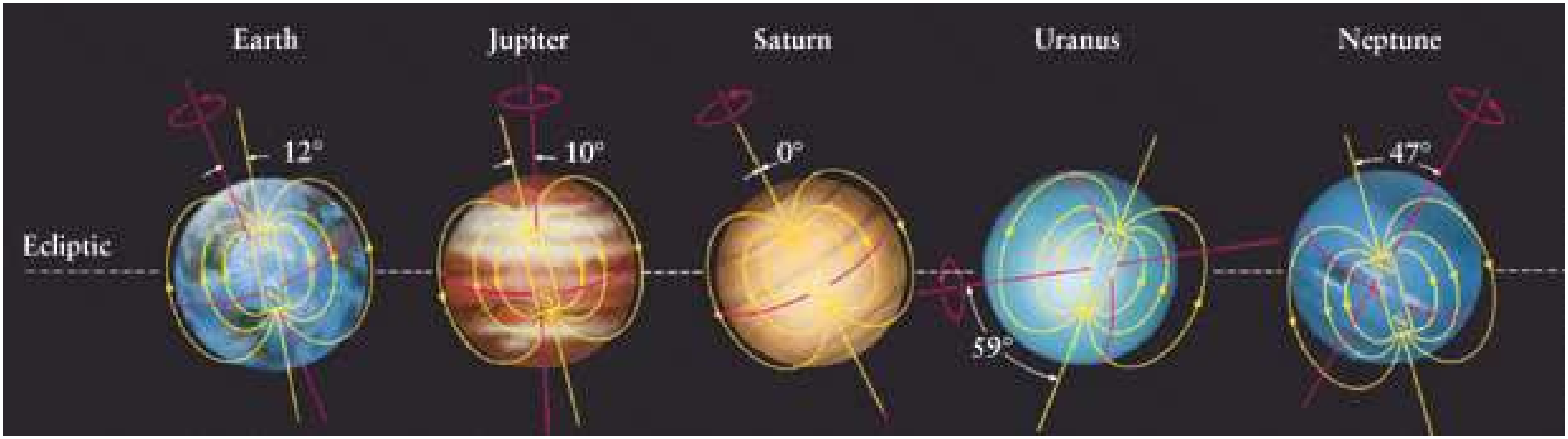


Magnetic Fields:

- Magnetic fields vary significantly within our solar system.

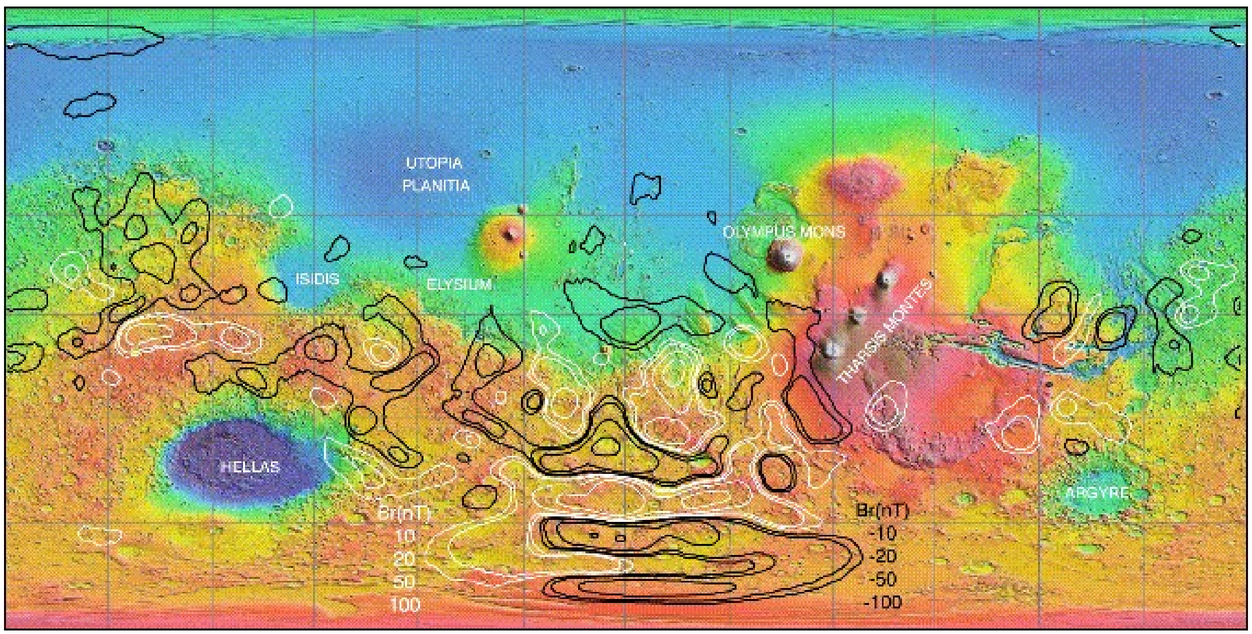
- The Gas Giant planets (and the Earth) have strong internally generated fields extending well out into space.

- Jupiter's intact *magnetosphere* (the region controlled by the magnetic field) is much larger than the Sun!

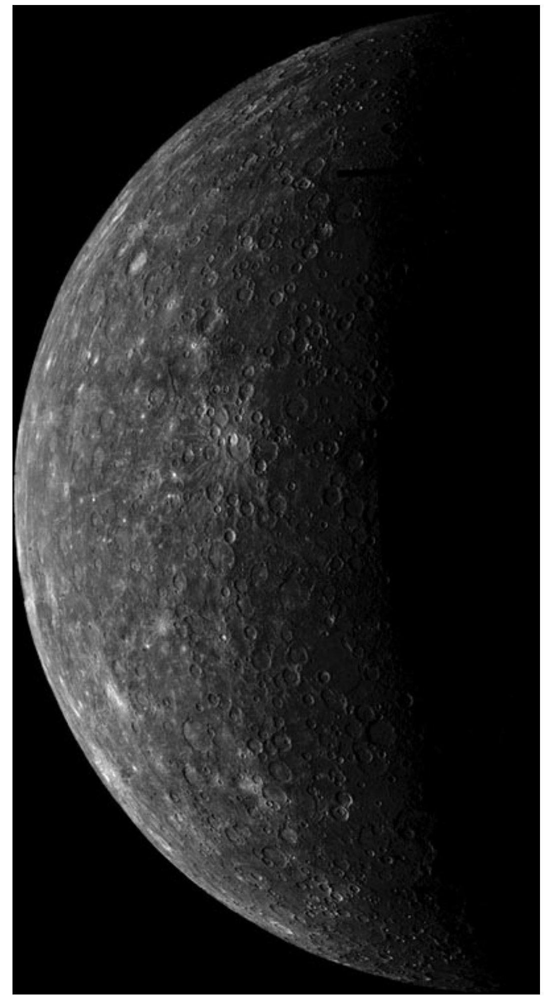


Magnetic Fields:

- Other planets have weak or remnant (similar to a bar magnet) fields that affect only the region close to the planet.

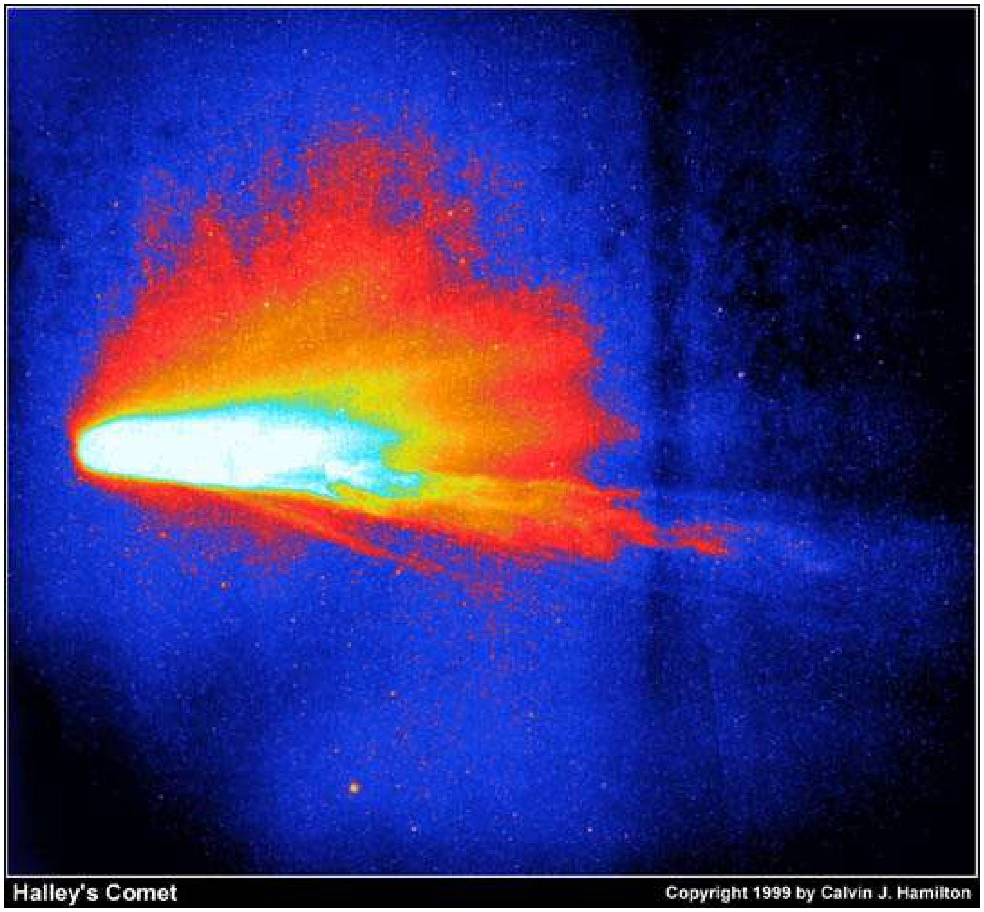


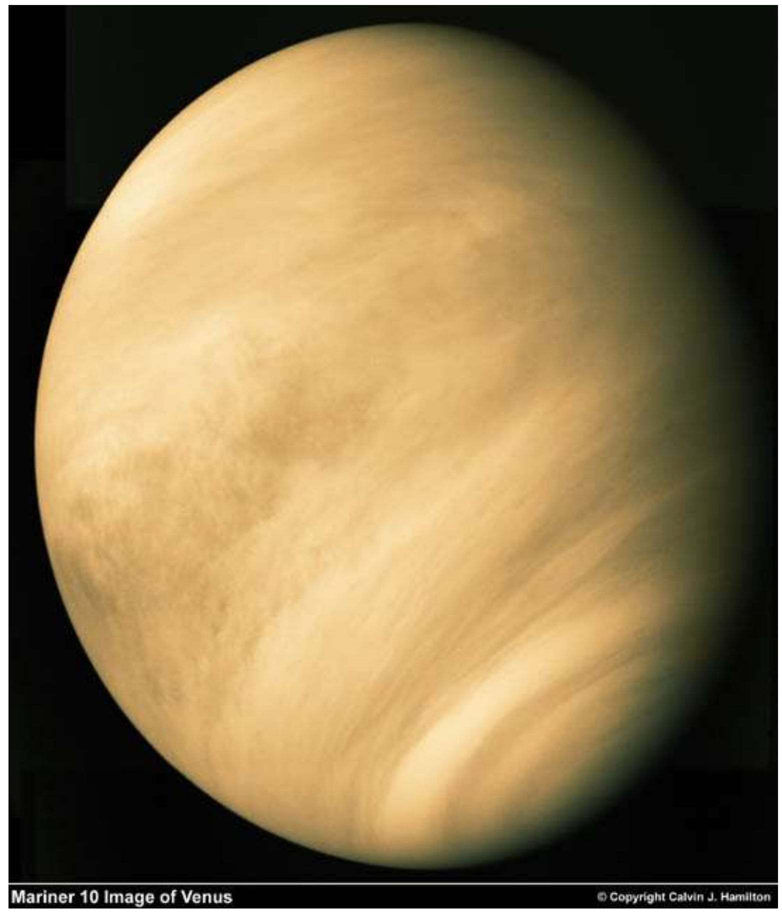
Mars remnant magnetic structure



Magnetic Fields:

- Many more have no field at all (Venus or Comets). In these bodies the magnetosphere is *induced* by the interaction of the atmosphere and the Solar Wind.



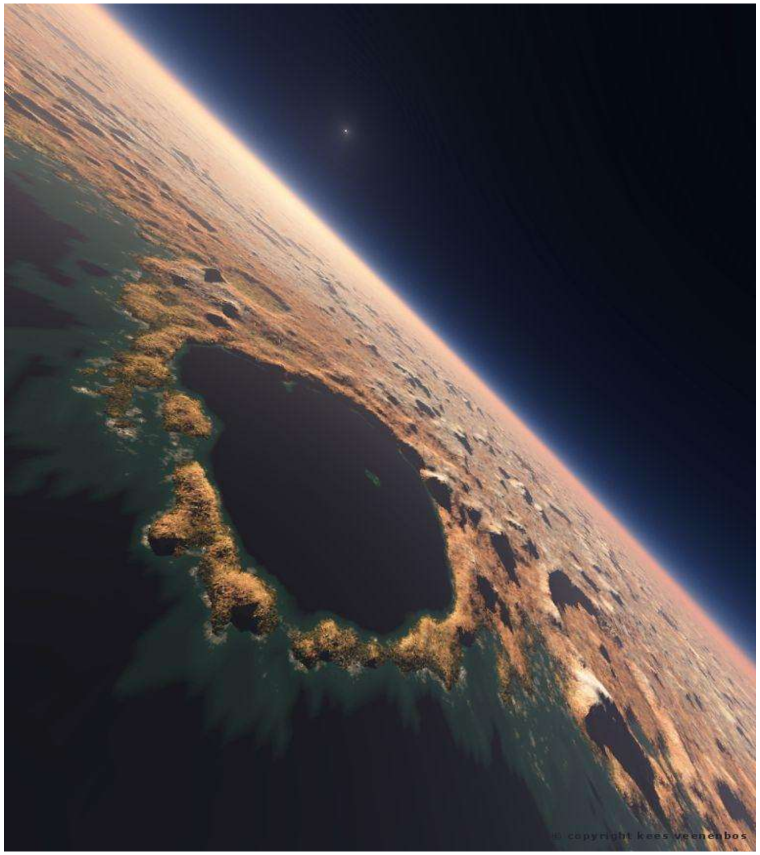


Structure and Evolution of Planetary Environments:

- A century ago we had little understanding of the structure of our own atmosphere beyond the first few km of altitude.

- Fifty years of direct study has shown the basic elements of the Earth environment, but has provided only partial insight into the nuances of the forces that control our fragile environment.

- Observations of other planets has shown both how circumstances control the state of an atmosphere, but also that conditions can change dramatically with time.



- The study of how the atmospheres and near space environments of the planets are different is called *<u>comparative planetology</u>*.

- However, Earth is the basic model!

Atmospheres 101: Basic Elements

Rudimentary atmospheric physics can be broken down into 4 parameters.

1. Composition and density: What gasses are present and how much of them are there?

2. Energy Input: How much energy delivered to an atmosphere and *where and in what form*?

3. Gravity: How well does a planet hold onto its atmosphere and how extended is it in altitude?

4. Magnetic Fields: Does a planet have one and how does it affect the interaction with the outside environment?

Atmospheric Layers

As we move from the surface of a planetary body outward into space the characteristics of the atmosphere change.

- The temperature and temperature gradient (change with altitude) changes.

- The composition and charge state changes.

- The type, rate, and location of energy input changes.

Altitude regions where these parameters uniformly characterize the atmosphere are referred to as atmospheric layers.