Sample
Student Payload Ideas

LaACES Program Payload Requirements

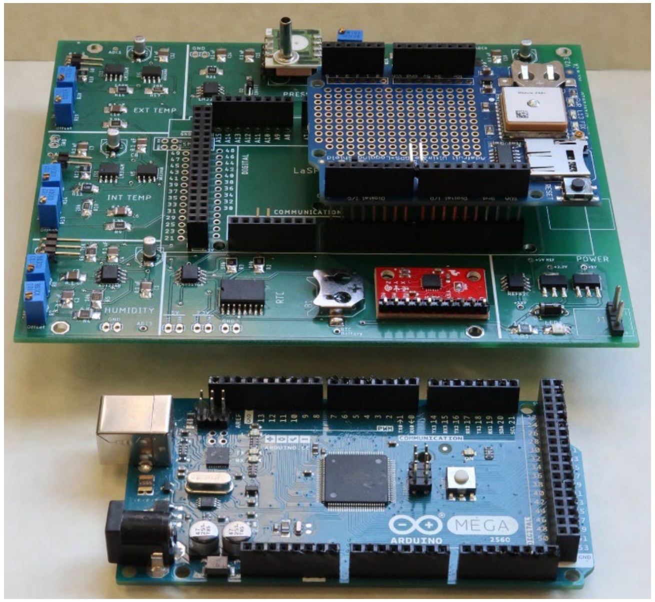
YOUR PAYLOAD SHALL:

- Weigh less than 500 Grams
- Have a weight/area ratio of > 13 g/cm^2 (This means a max weight payload sides must be larger than 39 cm^2)
- Be housed in a soft semi-rigid foam container (such as R3 insulation foam)
- Have two unobstructed vertical penetrations, 17 cm apart, large enough to pass kite string through
- Penetrations shall be sufficiently reinforced to prevent rip-out with 50lbs of force perpendicular to the axis of the penetration
- Have sufficient power for 4 hours of operation
- Have sufficient data storage for 4 hours of operation
- Operate at pressures down to 10 mBar
- Operate with outside temperatures of -50C
- Operate with outside temperatures of 50C

Payload mechanical interface

LaACES MegaSat Core

- The core of your payload will be the LaACES MegaSat that includes
  - Two temperature sensors, one humidity sensor, one pressure sensor, 3-axis accelerometer, 3-axis gyroscope, and a real-time clock with backup battery
- Payload controller will be the Arduino Mega.
- Will have the Adafruit Ultimate GPS Logger shield for GPS data throughout the flight and recording your data on a SD card.



LaACES MegaSat payload stack

- You can use the prototype area on the Adafruit GPS shield or a separate board to interface with other sensors.
- You will begin construction of your MegaSat shield in a few weeks
- Need to include in your planning
  - The components that will be part of your payload
  - Time needed to construct the MegaSat shield
  - How you will interface your sensors to the Mega

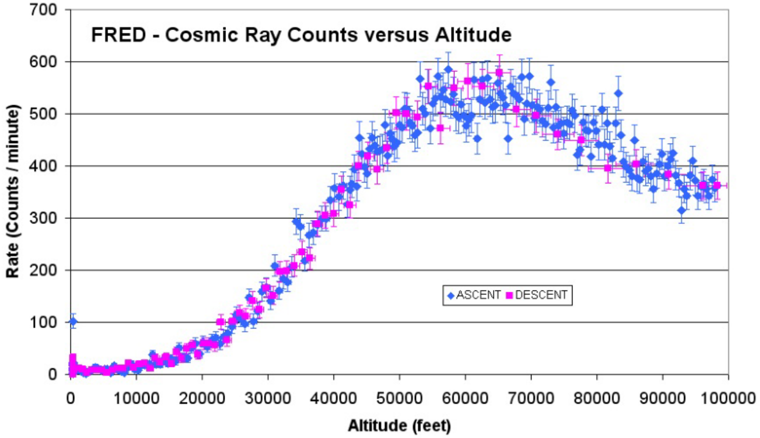
Need to begin thinking now!

- Given the constraints, you need to think about and address issues throughout the academic year
- Here we discuss some example payloads
  - Either previously developed and flown or
  - Should be feasible to develop and fly within the limitations of this program
- Your team will have two weeks to develop your Pre-PDR
  - Research and write the scientific background for your payload
  - Determine your mission goal, objectives, and requirements
  - Establish a general schedule for payload development
- You will write a complete a defense (i.e. the FRR) of your payload by the end of this semester.

Some possibilities

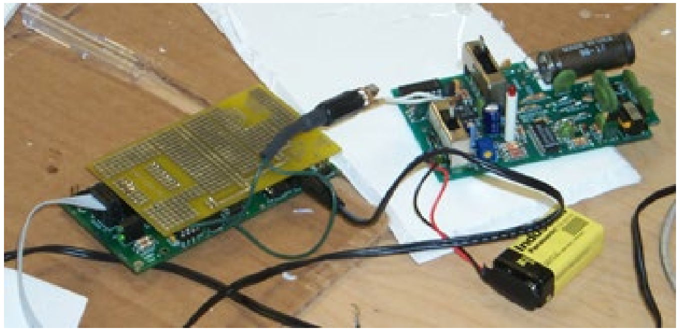
- Radiation Intensity as a function of altitude
- Measure intensity of UV bands as function of altitude to deduce properties of ozone layer
- Directly measure concentration of O3, NOx, COx gases as a function of altitude using solid state sensors
- Develop a system to measure air flow (e.g. hot wire anemometer) at high altitudes (i.e. very low pressure).
- Investigate methods to optimize atmospheric temperature measurements
- Investigate thermal flow and conductivity of boundary layer around payload
- Develop an inertial sensing system which will provide sub-minute of arc orientation knowledge

Radiation Intensity vs Altitude



- This payload would determine the radiation flux as a function of altitude on ascent and descent
- Two sensors to implement and compare 1) Geiger-Muller tube, 2) Scintillator and solid state PM

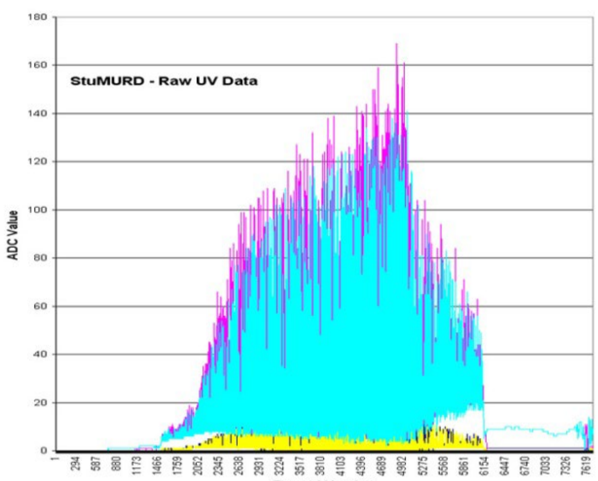
- Cosmic rays are high energy nuclei that originate outside our solar system.
- CR interact in Earth's atmosphere producing a shower of particles
- The intensity of this radiation varies with altitude

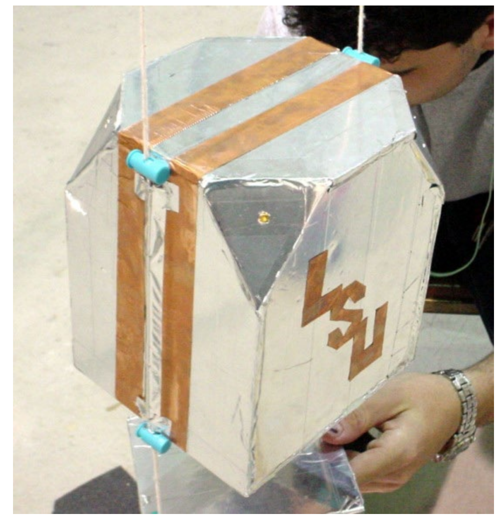


- Determine a rough energy spectrum by comparing count rates with different thresholds.

Intensity of UV versus Altitude

- UV is absorbed by ozone in the upper atmosphere
  - Surprisingly there are few (none?) published measurements of UV intensity in the stratosphere.
  - This effort has the potential of generating a journal publication with the team as authors!
- Payload would measure the UV intensity as a function of altitude and infer the vertical distribution of ozone
- One or more sensors (or the appropriate wavelength sensitivity) would monitor UV from the Sun.

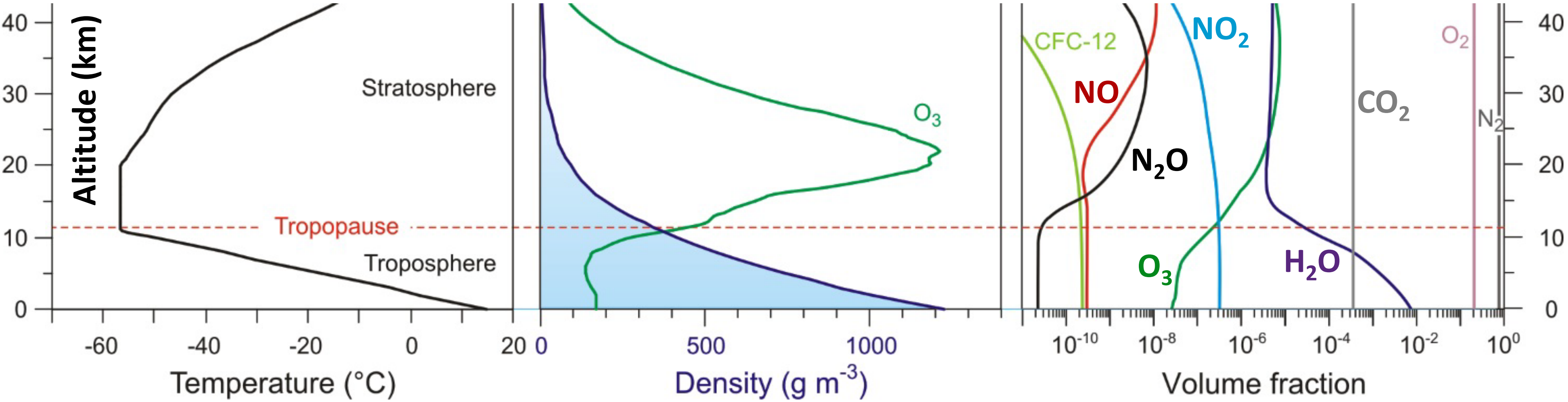




- The signal from the sensor would need to be conditioned and converted to a digital number by an ADC
- You will need to take into account rotation of the balloon craft
- Calibrations of sensor and ADC will be needed to determine flux

Measure Atmospheric Components

- The gas composition of the atmosphere changes as a function of altitude
- The increase in temperature above the Tropopause is related to the ozone layer
- Correlate stratospheric temperature with ozone concentration
- The aerosol particle density also changes as a function of altitude
- Determine how to measure aerosol characteristics (density, size distribution) as a function of altitude

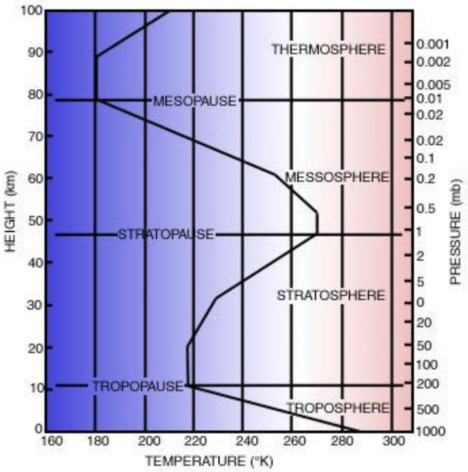


Generalic, Eni. "Troposphere." *Croatian-English Chemistry Dictionary & Glossary*. 20 Oct. 2018. KTF-Split. 9 Jan. 2020. <https://glossary.periodni.com>.

Air Flow Sensing

- Payload would measure the air flow or ‘wind speed’ as a function of altitude using a hot-wire anemometer
- Investigate various techniques used to build hot-wire anemometers
- Investigate methods to calibrate a hot-wire anemometer sensitive enough to measure small ‘wind speeds’
- Determine the wind speed and the air pressure and use them to calculate the air mass flow rate
- Payload can use the upward movement of the payload to generate the wind across the anemometer

Accurate Atmosphere Temperature



- The temperature and pressure of the atmosphere vary as a function of altitude.
- Temperature initially decreases with increasing altitude, then increases as UV is absorbed in the atmosphere.
- Pressure decreases in an exponential manner

- Many factors influence the accuracy of atmospheric temperature, including the sensor color, airflow around the sensor, and where the sensor is placed
- This payload would need to investigate and quantify the different influences, develop a method for accurately measuring the atmospheric temperature, and quantify the measurement uncertainty
- Measurements should be compared with NOAA soundings

Thermal Investigations

- Investigate thermal flow & conductivity of boundary layer around payload
- Temperature sensors on box interior, interior surface, exterior surface, 5 cm boom and 10 cm boom
- Determine heat flow and the payload effect on measuring the temperature of the atmosphere.
- Optimizing thermal shields for temperature sensors
- Temperature sensors on 10 cm booms with white, black, checkered and silver shields
- Measure and model the "atmospheric temperature" measured by the four sensors

Minute of Arc Inertial System

- Develop an inertial attitude sensing system that would be accurate to less than one minute of arc
- Use to investigate the rotation and turbulence of the payload during flight
- Use some combination of magnetometer compass, tilt sensors, fiber-optic gyroscopes, accelerometers and a sun sensor

- Develop system that would determine payload attitude to about one arc-minute
- Correlate observed turbulence with atmosphere layers