Stratospheric Observation of Light And Renewables

Jadon Lee, Ian Thyer, Gabrielle Yannotta, Max Avdyunin, Chinmay Somayajula,

Colorado Space Grant Consortium, University of Colorado Boulder

Overview

Goal: Analyze how atmospheric conditions impact solar panel efficiency in monocrystalline vs. Polycrystalline panels

Key Factors Studied:

- Temperature
- UV radiation
- Humidity
- Luminosity
- Atmospheric density
- Panel angle

Method:

- Collect environmental data at different altitudes
- Measure voltage output from both panel types
- Compare performance under varying conditions

Outcome:

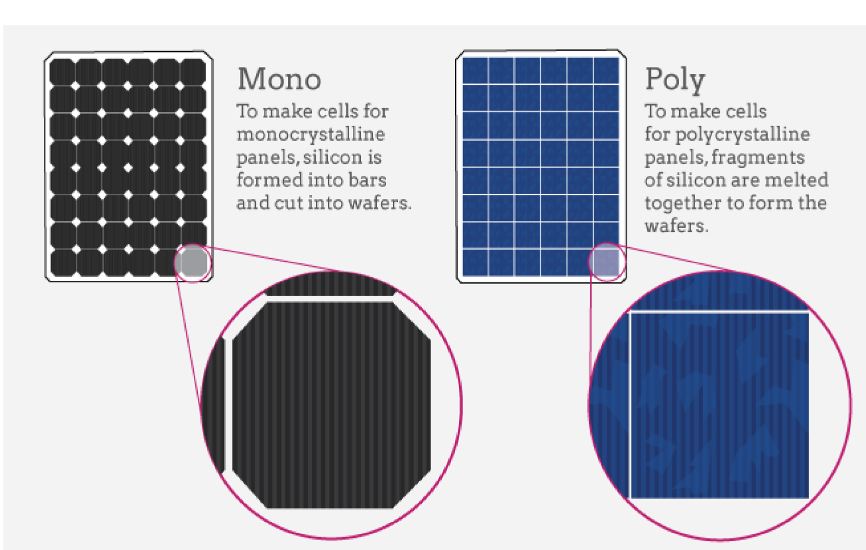
- Identify optimal conditions for each solar panel type
- Improve solar design for satellites, aircraft, and probes
- Increase power efficiency and reliability (higher factor of safety)

Objectives

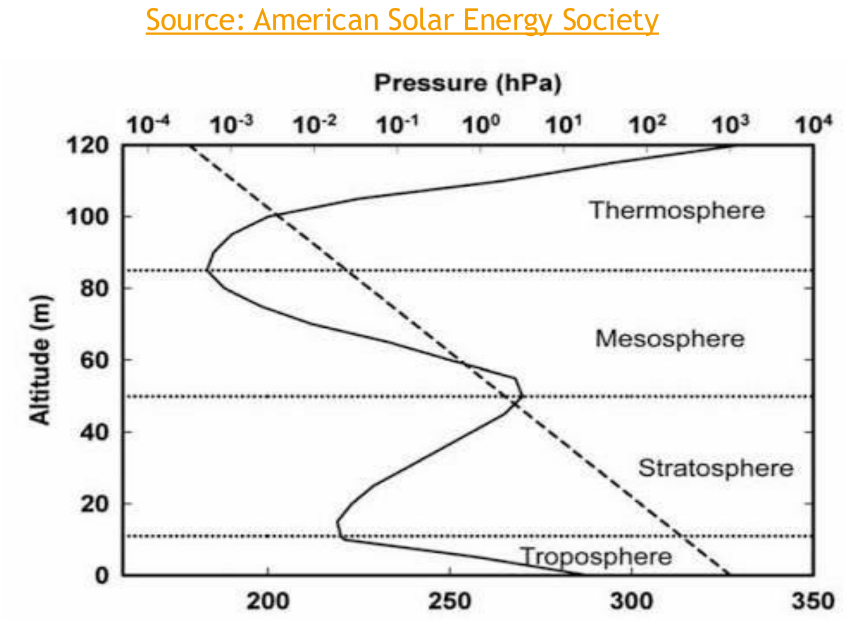
Test monocrystalline and polycrystalline solar panels, at varying atmospheric conditions to discover a cause for a potential variance in solar efficiency.

In doing so, this will help us determine the optimal solar panel layout & configuration for any mission environment in order to provide the required power levels for missions occurring in our altitude range.

Background Info



Source: American Solar Energy Society



Martins, Douglas. (2009). Development of methods for measurement of biosphere-atmosphere exchange of carbon and nitrogen. ETD Collection for PurdueUniversity.

Materials & Methods

Component	Weight (g)
Outer shell + Insulation + Flight Tube	208
Solar Panels (5 mono + 1 poly)	54
Solar Sensor Stack + Arduino	132
Main Sensor Stack + Arduino	143
Batteries	100g
	637g

Material	Quantity	Source	Cost ($)
INA219 (current sensor)	3	Adafruit	$35
		Total=	$35

Sensor (Arduino 2)	Load	Total
INA219 (V,C,&P)	12 B (3x)	518.4 KB
BH1750 (Light Sensor)	3 B	43.2 KB
ADXL335 (Altimeter)	6 B	86.4 KB
	Total	648 KB
Sensor (Arduino 1)	**Load**	**Total**
Si7021 (Temp/humidity)	7 B	100.8 KB
015PAAA5 (Pressure)	4 B	57.6 KB
ADXL335 (Altimeter)	6 B	86.4 KB
	Total	244.8 KB

Structure

Hexagon shape, solar panels in columns on the outside. Flight tube integrated vertically.

External Sensors: Temperature, humidity, UV, luminosity

Internal Sensors: Accelerometer, temperature, humidity, pressure, current

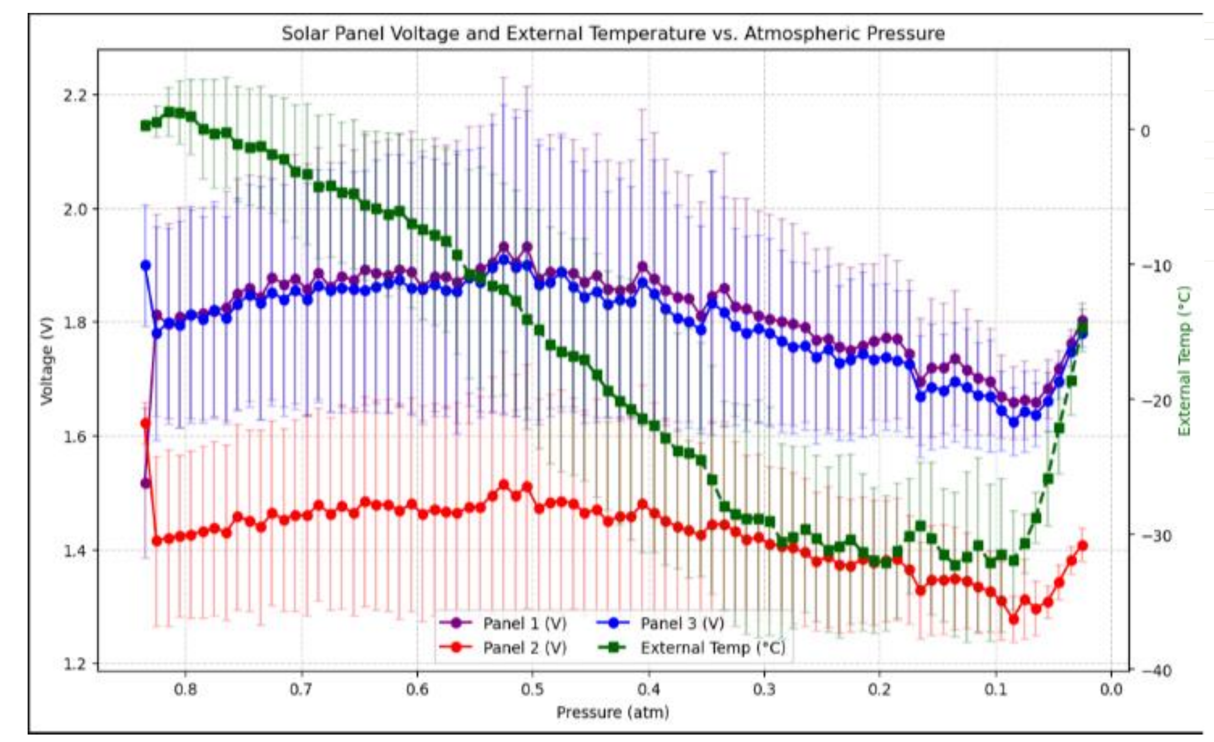
Predictions

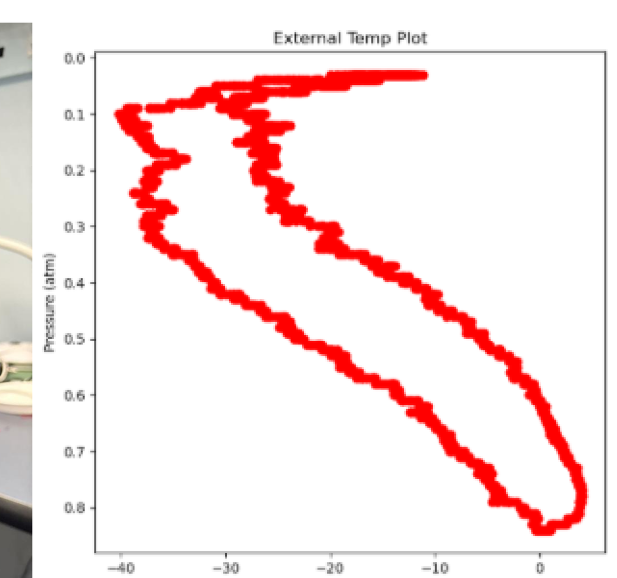
While monocrystalline panels are regarded as the more efficient type of solar panel, polycrystalline panels are known to increase in efficiency with lower temperatures. As altitude increases, the air pressure lowers, so the solar panels will get more direct sunlight and produce more voltage. Polycrystalline panels might handle tilting or spinning better due to their increased efficiencies in less ideal sunlight because of their fragmented silicon structure. Overall, there are many factors that play into the efficiencies of each solar panel, and the combination of changes made by increasing altitude will reveal which type of panel will be successful.

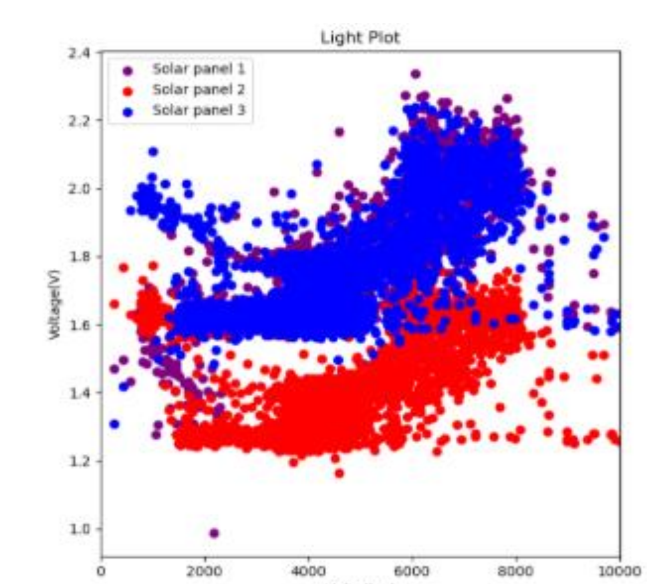
Results

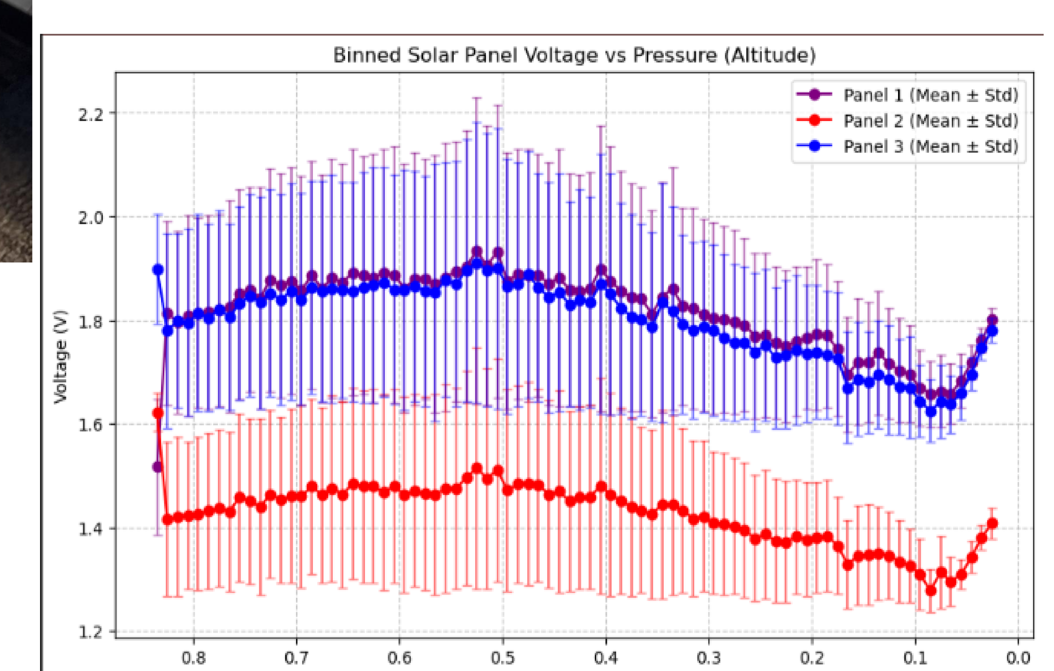
Luminosity: Both tended to follow the same trend. However, poly worked more efficiently at higher luminosities and mono worked better at lower luminosities.

Temperature & Altitude: While both generally followed the same trend, the poly solar panel was generally more efficient at a lower temperature but higher altitude. Since it was previously proven that poly solar panels work worse at lower temperatures, we can extrapolate that the poly solar worked better at lower pressure when compared to the mono solar panel.

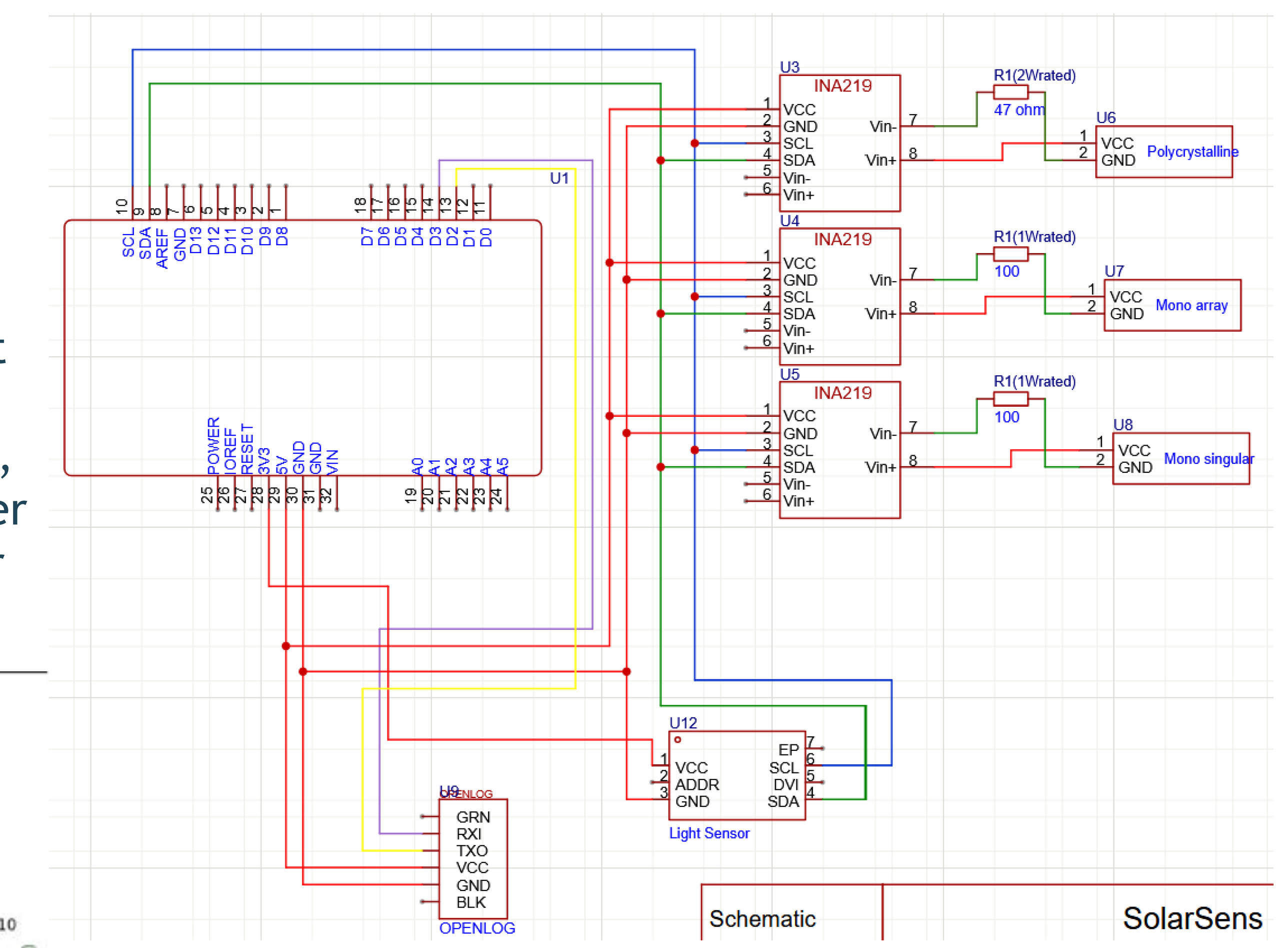




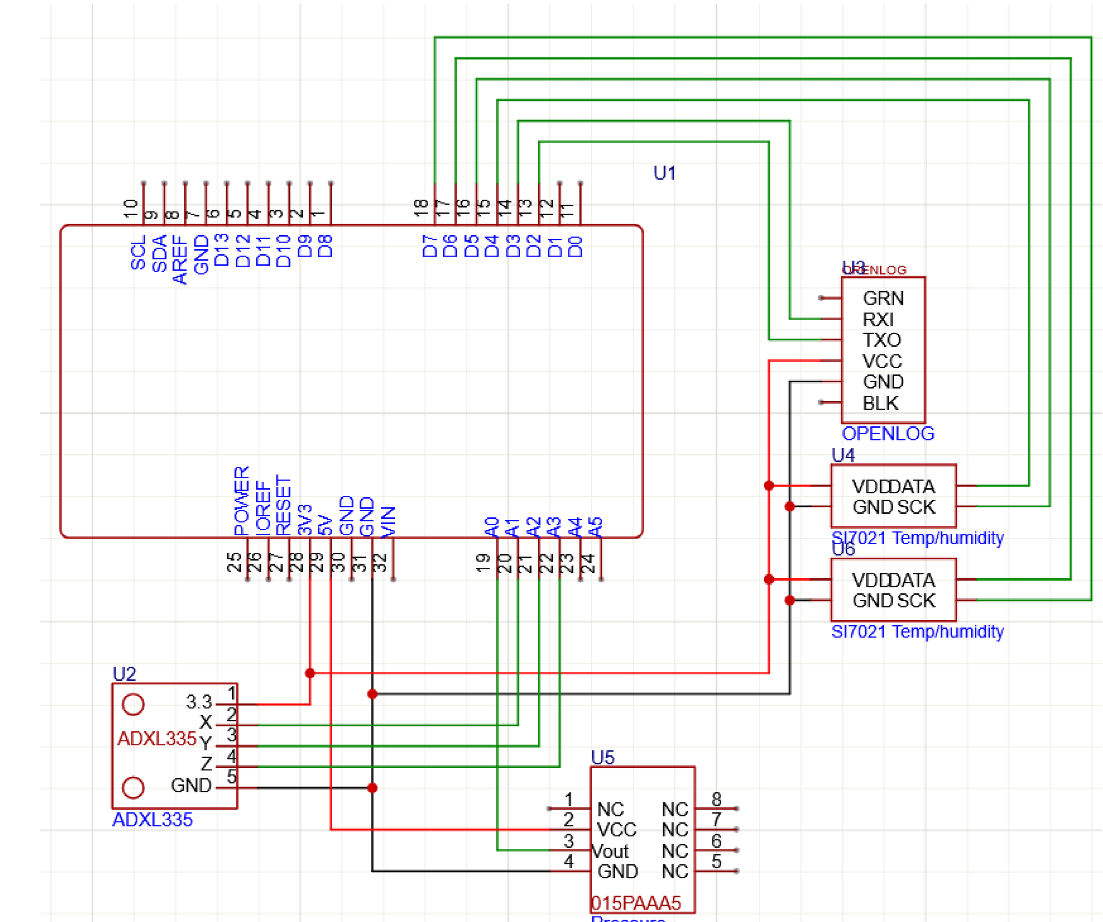




Solar Panel Circuit Diagram



Main Sensor Circuit



Flight Path