J240328

POWER REQUIREMENTS FOR BATTERY MAINTENANCE AND TEMPERATURE PROFILE ON HIGH ALTITUDE PLATFORM

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ABSTRACT

Experiments on high-altitude platform (HAP) at the near-space must be faced with extremely low temperatures, reaching as low as -50 degrees Celsius, which exceeds the operational range of electronic systems. Especially, the battery that requires a heating system and thermal insulation. This paper will report temperature profile on the HAP flight and the results of experiments with the installation of the heating system to determine its adequacy, and measuring the electrical power needed for heating.

KEYWORDS

High altitude platform

Battery maintenance

Stratospheric satellite

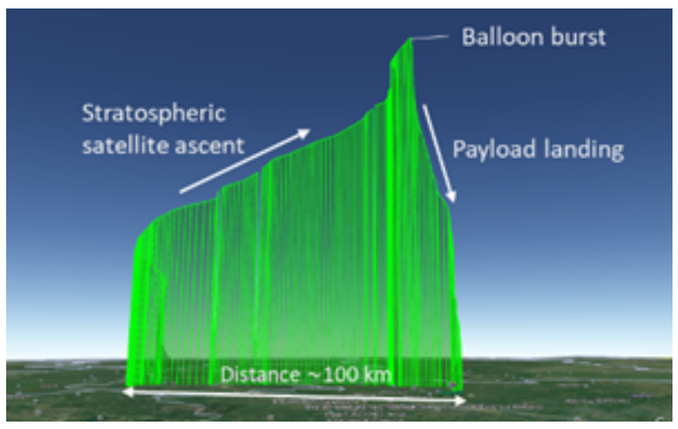
Near space fight

Heater

NEAR SPACE JOURNEY WITH HAP

Conducting experiments in near space with a high-altitude platform (HAP) is launching experiments to the upper atmosphere layer at stratospheric levels (near-space) with maximum heights of 49 kilometers above sea level. The conditions closely resemble aspects of outer space, such as extremely low air pressure, higher solar radiation compared to the Earth's surface, the extreme temperature conditions from -50°C to 50°C. The near space conditions are beneficial for conducting experiments and practicing in building space technology.

The travel characteristics of HAP flight by buoyancy platforms such as balloons. For this research is using a high-altitude balloon filled with helium. The journey of the experiment start from the balloon ascends until it reaches maximum height. The balloon may burst upon reaching a certain altitude or cut off the rope by telecommand. The payload then descends with a parachute to the ground,



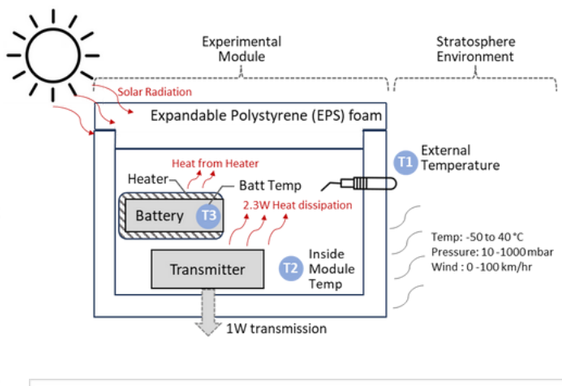
approximately 100 kilometers away from the launch site. Data obtained from this experiment represents the profile of a sounding balloon.

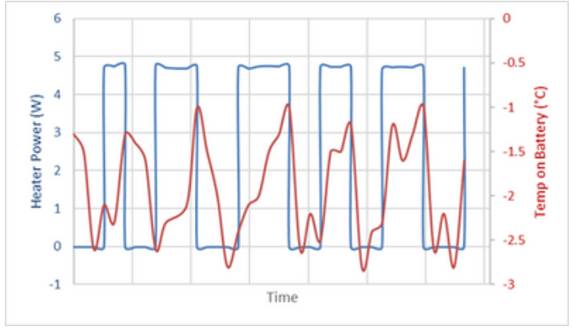
LIMITATION OF EQUIPMENT ON FLIGHT

- the equipment most significantly affected is the lithium-ion battery.
- Its capacity gradually decreases with temperature, reducing from 3300 mAh to less than 2200 mAh or remaining only 66% at temperatures not lower than -20°C.
- If charging is required, it must be done at temperatures not lower than 0°C; otherwise, it may cause permanent damage to the battery.

MAINTAIN BATT TEMPERATURE

the goal of this research is to maintain the battery temperature above 0°C along the mission. This research uses a heater plate as the temperature control of the battery. It has a resistor characteristic with a resistance of 14.4 ohms, supplied with a voltage of 8V to produce a power of 4.44 Watts. The electronic equipment and sensors are enclosed in a 1-inch-thick expandable polyethylene (EPS) foam box.



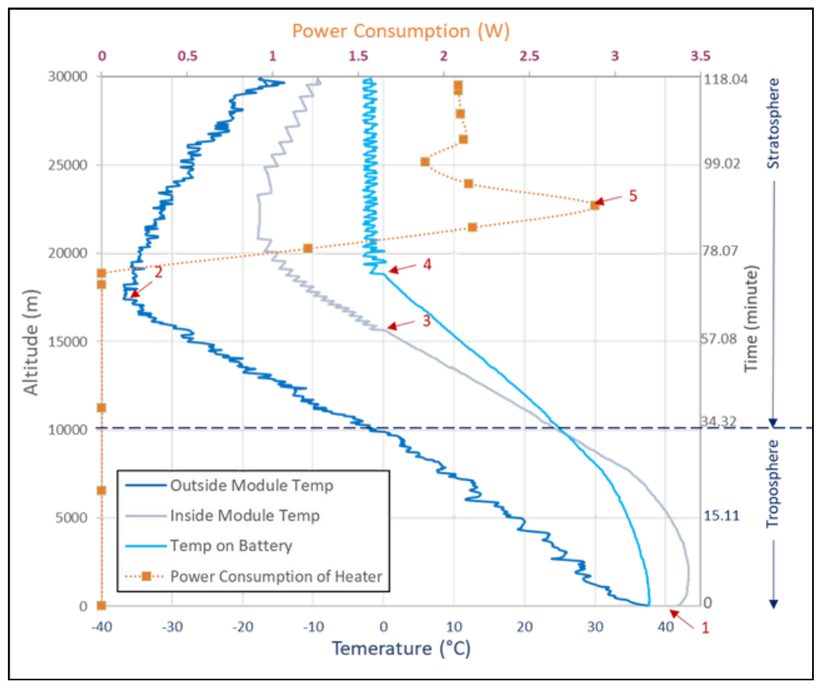


There are 3 sources of heat energy: Heater, circuit board dissipation and solar radiation. In this research, three temperature sensors are installed:

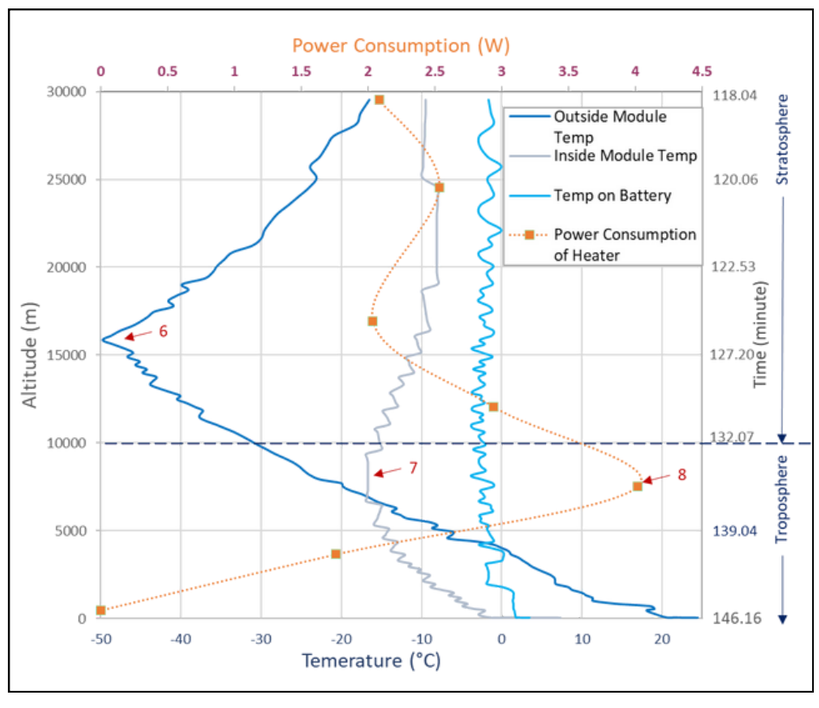
- T1 External Temperature: Measures the near-space environment directly.
- T2 Inside the module temperature: Measures the overall temperature inside the box.
- T3 On the battery surface: Measures the temperature of the battery itself to control the on/off operation of the heater.

RESULT & CONCLUSION

ASCENDING PHASE



DECENDING PHASE



State 1: preparation
the module is exposed to sunlight, the temperature rise to 42°C. (point 1)

State 2: Launch
The external temperature decreases, reaching a minimum of -36.9°C (point 2) at an altitude between 15-18 km ASL. The temperature inside the module decreases more slowly due to insulating material. After 1 hour, the temperature inside the payload box drops below the freezing point (point 3)

State 3: Control system operation
The temperature control system starts operating (point 4).

State 4: Landing
The external temperature reached a minimum of -49.8 °C (point 6). The temperature control system continues to keep the battery in the range of -3 to 0 °C. It can be observed that the temperature inside changes slowly than the external. It reaches a minimum of -17.9 °C (point 7).

State 5: Payloads reach the ground
The temperature inside the module increases more slowly. The heating system stops working from an altitude of 3.85 km ASL.

Conclusion
It is advisable to choose equipment materials that are resilient to such temperature variations of range of temperatures from -50 to 50°C. And Protecting the battery with a 4W heater wrapped around it is a guideline that can keep the battery operating at no less than -3°C. It requires an average power of 0.054 Wh throughout the 3-hour flight.