# CALIFORNIA STATE SCIENCE FAIR
## 2017 PROJECT SUMMARY

**Name(s)**

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**Project Number**

**S0326**

**Project Title**

# An Altitude Control System for Long Duration, High Altitude Balloon Flights

**Abstract**

**Objectives/Goals**

The primary objective of this project is to design, build, and test an altitude control system for high altitude, long duration weather balloon flights. Ordinarily, weather balloons are filled with enough helium so that they rise rapidly to maximum altitude and burst in less than two hours. This ensures that the balloon does not drift very far from the launch site and makes recovery easier. However, this technique does not allow data to be gathered over long time periods or at specific altitudes. An altitude control system would enable flights of many days over thousands of miles. The secondary objective is to develop an electrical system with solar panels and rechargeable batteries capable of providing power for multi-day operations. Last, the balloon should send telemetry and be trackable anywhere on the planet, over both land and sea.

**Methods/Materials**

The vertical speed of a balloon can be controlled by venting helium or by releasing sand ballast. My altitude control module consists of three Arduino Mini Pros (Primary, Secondary, and Reset), a GPS, and an SD card for data storage. The GPS unit sends time, coordinates, and altitude data to the Primary which then calculates the average vertical speed. The Primary sends the altitude and vertical speed to the Secondary and this data is used to operate the helium and sand valves, as needed. Linear functions of the form, $t = a+bv$, where v is the vertical speed and t is the valve opening time, were used to control the valve operation. Computer simulations were used to determine workable values for a and b.

**Results**

To date, one flight has been made to test the altitude control system. The plan was to ascend to 8,000 m and then maintain this altitude for four hours. Although helium was released during the flight, the ascent rate was not brought under control before the balloon burst at 25,885 m. The electrical system and GPS trackers worked as expected.

**Conclusions/Discussion**

Further simulations and ground testing will be conducted and the results used to improve my software and equipment. Once improvements are made, another test flight will be conducted. My long term goal is to fly a weather balloon around the world while recording cosmic ray counts, track the balloon during the entire flight, and then recover the equipment at the end of the flight.

**Summary Statement**

My goal is to develop a weather balloon altitude control system that will make it possible to make long duration studies of cosmic rays on an around the world flight.

**Help Received**

My sand ballast bottle was made by Mr. David Bezinque using the 3D printer at the Fresno State Physics Department. Paul McWhorter#s tutorial on the Arduino GPS tracker was helpful. My father taught me how to program an Arduino and helped to get my program working.