



ASCEND SOLAR ECLIPSE PAYLOAD

Compiled and Edited by Jack Crabtree
Arizona Space Grant ASCEND Eclipse Project Manager
Adjunct Professor, Embry-Riddle Aeronautical University

Our Mission

The primary mission of the ASCEND Solar Eclipse Payload is to provide NASA a live video streaming source of the moon's shadow crossing the earth from a high altitude balloon during the total eclipse of the sun on August 21, 2017. The secondary mission is to provide students with the opportunity to develop and fly balloon-based scientific instruments to observe effects of the eclipse.

Implementation

Arizona students from Arizona State University and Embry-Riddle Aeronautical University, faculty, and support team members will conduct the flight of two helium filled high altitude balloons with student-built payloads to capture and transmit live video from approximately 80,000 feet during the totality of the eclipse. Additional scientific payloads will enhance our understanding of the eclipse's effects on the earth. The balloons' flight paths will cross over the ground station at Glendo State Park, Glendo, Wyoming. Arizona/NASA Space Grant Consortium is partnering with the non-profit organization, Arizona Near Space Research, and the Prescott Astronomy Club to make this project possible.

Primary Payloads

The Primary Mission Payloads were initially constructed during a NASA sponsored Eclipse Balloon Project Workshop held at Montana State University in August of 2016. Students from Arizona State University (ASU) and Embry-Riddle Aeronautical University (ERAU) participated in the workshop with groups of students from 42 other schools to construct a common baseline set of payload modules and ground station. Since the workshop, ERAU

students have been updating and improving the baseline designs to enhance the performance of the equipment. Extensive hardware and software changes to the video and image modules have been made and tested. The primary payloads consist of:

- Video Payload- To fulfil the primary mission of the project, a live streaming video system is being flown. This consists of a Raspberry PI microcomputer and PI Camera aimed at the horizon that generates live video. A 5.8 GHz Wi-Fi transceiver running about 0.5 Watts transmits the video to the ground station using a medium gain antenna. To dampen the spin of the Video Module, a system of four wooden rods about 3 feet in length with Styrofoam balls at their ends are used. This payload weighs about 1.8 kg (4 pounds).
- Image Payload- In addition to the live video, this payload takes periodic still pictures of the earth and transmits them to the ground station. Similar to the video payload, the pictures are generated by a PI Camera and a Raspberry PI. The camera alternates aiming at the ground and at the horizon. A 2.4 GHz Wi-Fi transceiver running about 0.5 Watts transmits the pictures to the ground station using a medium gain antenna. This payload weighs about 1.8 kg (4 lbs).
- Iridium Tracking Payload – To facilitate tracking by the ground station and the FAA, a GPS receiver generates balloon position data. This is transmitted to the ground by the Iridium satellite communications system. This data along with data from all the participating teams is collected on a common server and made available to the FAA and the AZ ASCEND ground station via the internet. The Iridium system also provides a channel to the balloon that passes a possible payload cut-down command to the Cut-down module. This payload weighs about 820 g (1.8 lbs).
- Cut-down Payload – FAA regulations require a means to terminate the flight in case of an emergency. If necessary a command will be sent via the Iridium communication system to the Iridium Tracking module and then relayed via a low power 2.4 GHz transceiver to the Cut-down module. Here, a rotating circular blade will be activated to sever the cord between the parachute and the balloon. It is not anticipated this function will be used. This payload weighs about 270 g (0.6 lbs).

ASU Experimental Payload

The goal of the ASU Experimental Payload goal is to measure how the solar eclipse will induce changes in the atmosphere in terms of light levels, air temperature, humidity, atmospheric pressure, and wind currents. In addition to measuring heat changes in the atmosphere, a long wave infrared and visible camera will be used to visually observe how the path of totality changes the temperature on the ground. To provide better context for sensor data, a ground weather station will be used as a reference to compare to the payload sensor array, as well as an orientation sensor will be used for determining payload orientation with respect to the eclipse. This payload weighs about 1.8 kg (4 lbs). Following are the sensors implemented for this payload:

- 3 axis accelerometer measuring payload acceleration

- 3 axis gyroscope measuring spin in degrees per second
- 3 axis compass measuring the magnetic field in micro Teslas
- Accelerometer, gyro, and compass are combined to calculate 3D orientation, roll, pitch, and heading.
- Humidity sensor measuring temperature, humidity, used to calculate how hot the humidity makes it "feel" to a human touch.
- Wide range thermocouple temperature sensor capable of extreme cold temperature measurement for the outside.
- Internal temperature sensor for measuring payload insulation failure or electronics getting too cold or hot.
- FLIR Duo infrared and visible camera for imaging and measuring temperature dynamic temperature changes as the moons shadow passes over the Glendo region.

ERAU 360 Degree Camera Payload

A Kodak PIXPRO 360-degree camera will fly on one of the AZ ASCEND! Balloons. This will provide a recorded view of the earth horizon to horizon throughout the flight. To minimize spin, stabilization rods with Styrofoam balls will be incorporated on this payload. To further enhance the recorded video University of Arizona students will “de-spin” the video utilizing MATLAB video utility software. Processing of the video will be done post-flight. Students from ERAU are responsible for this payload.

Outreach Payload

The Arizona ASCEND! Team will also fly an outreach payload from the Department of Physics and Astronomy of the University of Central Arkansas. This payload will measure pressure, temperature, and light intensity as well as GPS position including latitude, longitude and altitude in addition to taking photos. The payload will be contained in an 8in X 8in X 8in foam carton and have a mass of 700 grams (1.54 pounds).

APRS Tracking beacons

To provide redundant tracking information for the ground stations, four tracking beacons, two on each balloon, will accompany the flight. Redundancy is desired to counter anticipated internet congestion during the eclipse. These consist of GPS receivers, modems, and transmitters operating in the VHF amateur radio band. The signals will be used to provide pointing data for the ground station as well as position data for our chase teams to recover the payloads after the flight.

Mode-C Transponder

In addition to using the Iridium tracking system on one balloon, the second balloon will carry a Mode-C transponder to provide FAA with position data for safety.

Ground Station

The Arizona ASCEND! team will use a portable ground station to track and receive the mission data from the high altitude balloons. The ground station will include:

- Space Grant Tracker – This component of the ground station will have a 5.8 GHz microwave high gain dish antenna and a transceiver to receive the video signal. It will automatically track the air-borne video payload using the Iridium and APRS GPS beacons. This part of the ground station was student built at the Montana State U. workshop and is common to all the eclipse teams.
- ANSR tracker – Due to the weight of the required 2.4 GHz high gain dish antenna, a second tracking system will be implemented. This system will use the APRS signals to maintain pointing on the balloon payloads. This tracker system was assembled by ANSR members.
- Hughes Satellite Internet Terminal – To guarantee adequate internet service in a very congested period during the eclipse, a stand-alone portable satellite internet terminal will be utilized. This terminal uses the new Hughes Internet Satellite system and will provide the bandwidth for streaming live video to the NASA and public viewers.