

# 2016 Elijah High Altitude Balloon Launch Team Summer Proceedings Report

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## Abstract

The 2016 Wisconsin Space Grant Consortium Elijah High Altitude Balloon Launch Team was comprised of students from the Milwaukee School of Engineering, UW– Fox Valley, and Carthage College. This year, a majority of the students involved were discovering the balloon launch experience for the first time. The 2016 Elijah Balloon Launch Team held a meeting for the new members to learn how all of the equipment worked through a practice run using the tools in a trial. The flight location was based on launch predictions ran in the week leading up to the launch. The balloon was launched from Clinton, Wisconsin, and landed near Darien, WI. This launch did not follow the launch prediction as accurately as expected, but the payload was recovered in safely and in good condition and launch reached a peak altitude of 31,021m, which was above our goal of 30,480m. Therefore, the launch was deemed successful.

## Introduction

The purpose of the 2016 Wisconsin Space Grant Consortium (WSGC) Elijah Balloon Launch program was to provide four students from WSGC affiliate universities with the opportunity to organize and launch high altitude weather balloons in order to fly science experiments in near-space environments. The team was responsible for coordinating with the WSGC Elijah Balloon Payload design team in order to create and execute a flight plan in order to carry the payload constructed by the design team to an altitude of approximately 31,000m in elevation.

The balloon launch program provided the team members with experience in planning and organizing experiments and scientific events. The team needed to coordinate with multiple third parties which provided the opportunity to improve on their communication and problem solving techniques.

## Launch Planning

**Team meetings.** The team held meetings throughout the summer to discuss and plan the launch of the scientific payload built by the Elijah High Altitude Payload Team. On 13 July 2016, the Launch Team met for training on the launch predictions procedures. The team met again on 21 July 2016 to practice launch procedures. The Launch Team then communicated with the payload team to schedule a launch date. Leading up to the launch the team began running predictions and checking weather reports at their various locations. The results of these predictions were communicated over email.

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**Flight predictions.** A key part of choosing a launch location was the predicted flight path. In preparation for a launch, the team conducted daily flight predictions using an online software created by Cambridge University Spaceflight to find an appropriate launch location (Greig, March 2010). The team began running these predictions seven days before the scheduled launch date. The final predictions were run on the morning of the launch. Both the launch and landing locations were required to be over five miles away from any airports, clear of any flight restrictions, and free of trees, power lines, and wind turbines. The landing location also needed to be at least five miles away from any large bodies of water, marshlands, heavily wooded areas, and developed communities. Over the years, a list of launch locations had been compiled by the Launch Teams (Farrow, et. al., 8 July 2014). In previous years, the locations were chosen from this list, as long as it met all of the requirements laid out for a launch location; however, this proved difficult this year as some locations were now inside of restricted airspaces. This drove the team to look into alternative launch locations. After browsing numerous alternative launch locations and their predicted flight paths, Clinton, WI was chosen as the launch location for the Payload Team's flight. Launching from Clinton, WI kept the flight clear from any restricted airspace, was surrounded by wide-open fields, and was only an hour from MSOE.

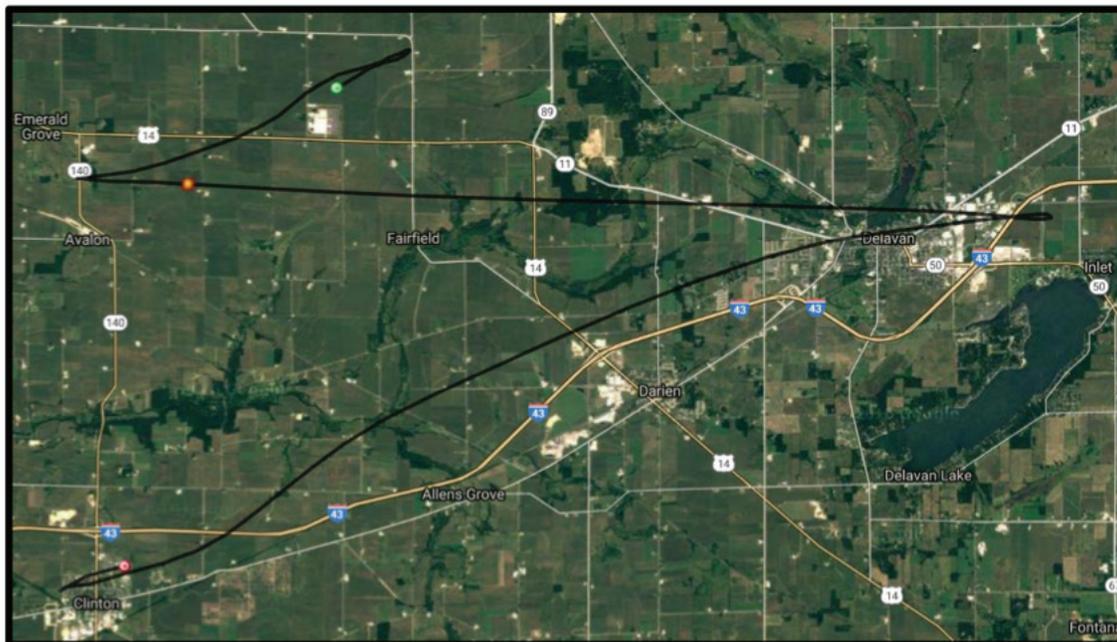


Fig. 1: The flight path prediction ran moments after the launch on 30 July 2016 in Clinton, WI (Greig).

**Weather forecasting.** The weather forecast and jet stream were also analyzed beginning five days before launch. The team looked at wind speeds and ground weather using weather reports and analyzed the jet stream using an online program created by affiliates of San Francisco State University (Dempsey, 19 June 2012). (Fig. 2) shows the jet stream map for the 30 July 2016 launch. The speed of the jet stream on launch day was less than 60 mph, which meant the team was able to launch the balloon without fear of the jet stream winds interfering with the flight.

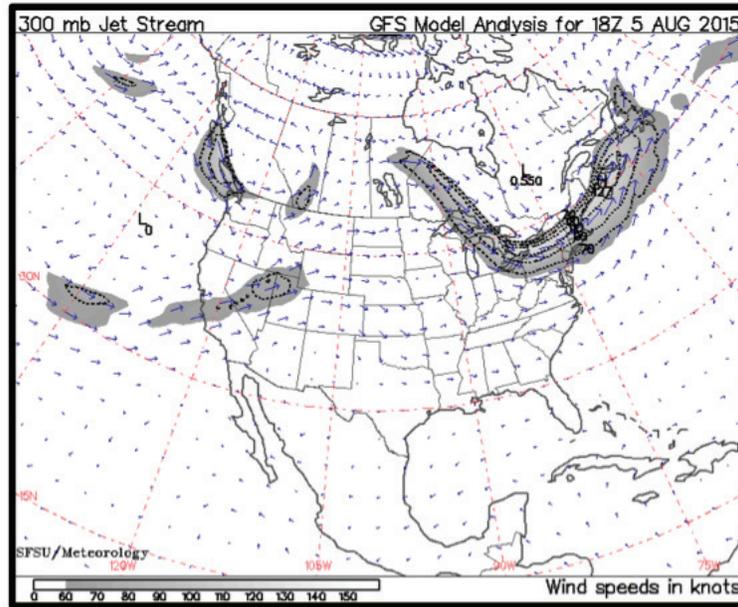


Fig. 2: Jet stream for 30 July 2016 - Launch Successful (Dempsey)

**Balloon and payload set-up.** The balloon was set up with the goal to successfully recover the payload in an undamaged condition. To increase the chances of this, the balloon had two tracking payloads attached to it. The primary tracking payload used GPS to transmit its location to Microsoft Mappoint, a tracking software downloaded on the laptops in the chase vehicles. The secondary payload sent out a radio signal that could be tracked by inputting the frequency of the tracker to a website, enabling the team to collect the data. The purpose of having two tracking payloads was to have a fail-safe in case one of them stopped working. Both tracking payloads were battery powered and were insulated to avoid damage from the low temperatures of the upper atmosphere. The balloon also had a parachute attached that opened when the balloon burst at its apogee. The purpose of the parachute was to slow the descent of the payloads in order to prevent damage to them upon landing. The scientific payload launched was designed by the Elijah High Altitude Payload Team. The payload contained experiments researching vegetation health, air quality, payload stability, and 360° video. The balloon's setup is shown in (Fig. 3).

### Launch.

This year the Launch Team released and retrieved the Elijah High-Altitude Weather Balloon Payload Team's project on 30 July 2016. The release of the balloon and its payloads occurred without a problem with all systems in the payload team's project working properly, as well as, the tracking payloads. Immediately after the balloon was released, both the primary and secondary

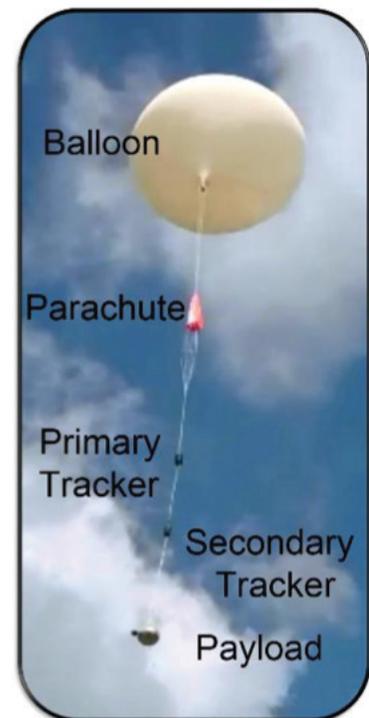


Fig. 3: Layout of the balloon's attachments

tracking payloads transmitted their locations regularly, allowing the Launch Team flight path points to compare with the predicted flight path shortly after release. (Fig. 4) shows the path of the balloon's flight.



Fig 4: Balloon Flight Path on 30 July 2016 from Clinton to Delevan, WI.

The balloon began its flight in Clinton, WI at a latitude of  $42.56^\circ$  and longitude of  $-88.86^\circ$ . Elevation of the launch site was 959 feet above sea level with ground wind speeds of 3-9 miles per hour with gust between 10 and 15 miles per hour and jet stream speeds under 69 miles per hour.

In general, the launch was a success. Although this was the first time the Launch Team actually set up and released a balloon, everything went smoothly from the time the team left MSOE's campus to the time the balloon and payloads were recovered. From practice dry runs, the team easily prepped and then inflated the balloon. Also, having practiced using the tracking payloads in Milwaukee, the balloon's deviation from the predicted flight path did not become a problem as the team quickly adjusted.

## Conclusion

Overall the team had great communication throughout the summer and was well prepared for the launch on 30 July 2016. The team was able to develop teamwork, problem solving, and organizational skills while learning how to plan and conduct high altitude balloon launches. The team hopes to complete another launch for a WSGC affiliate in fall or spring and looks forward to training the 2017-2018 team in spring.

## References

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