AN ANALYSIS OF WIND SHEAR FORCES IN MICHIGAN

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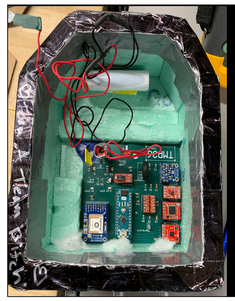
INTRODUCTION

Wind shear is the difference in wind speeds in the atmosphere over small distances. This phenomenon has wide ranging impacts from how long a thunderstorm might last to the safety of an aircraft and its occupants.

One way to measure such forces is through the use of weather balloons. To investigate, our team designed a payload that could be attached to a weather balloon to record wind shear forces and analyze them at different altitudes during the flight. The TMP36 payload was equipped with various sensors to measure pressure, GPS, acceleration and altitude from which wind shear forces could be determined. This poster presents an analysis of wind shear forces present in Michigan at varying altitudes of the atmosphere.

PAYLOAD



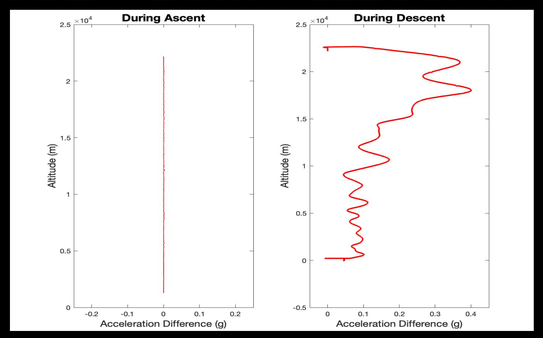
Our payload was designed to resemble a TMP36 sensor. It was built with insulated foam to protect it's delicate components. Our package was attached to the payload train using a velcro loop and carabiner.

CONCLUSION

The jetstream above Michigan lies at about 7-12 km above sea level. Our collected data revealed that wind shear forces in Michigan reach a maximum magnitude of 1.077 g's at an altitude of 13,852 meters - this lies near the theoretical maximum height of the jetstream. Therefore, we chose to conclude that wind shear forces are reach a maximum at the highest point of the jetstream.

Additionally, the maximum y-axis acceleration reached throughout flight was 5.2 g's. However, the balloon and other payloads generated an indistinguishable noise on our acceleration data throughout flight. For future experiments, we would put forth effort to launch in a more controlled balloon, specifically with no other packages that would potentially skew our data.

IRREGULAR ACCELERATION



This graph shows the difference between our current and total flight average acceleration. Looking at the graph, significant shearing forces were not recorded during the balloons ascent. We were expecting significant data here, but there isn't - likely due to other payloads on the balloon train affecting the accelerations experienced by our package.

FINDINGS

During our ascension through the atmosphere, we experienced accelerations as expected consistent with gravity. Wind shearing forces, or irregular accelerations, were not significantly detected before the balloon carrying our payload popped. Detecting was proved difficult, due to the significant noise in our acceleration data. However, our data showed that the maximum acceleration in the x,y and z direction is as follows: 1.99 g's, 5.2 g's and 4.66 g's. These values were obtained at altitudes that lie just above the jetstream, around where we would've expected.

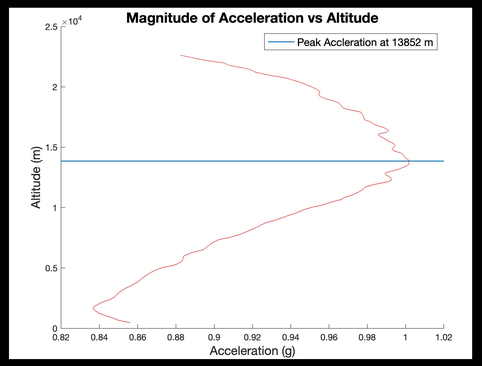
During descent, we consistently recorded irregular acceleration. Intuitively, this shows the chaotic forces our package should experience as it free falls through the atmosphere. As for our scientific data regarding shearing forces, we were able to record accelerations during our ascent. We reached a maximum magnitude of acceleration at 13,852 meters. This follows the theoretical prediction of shearing forces being highest around the jetstream - which occurs near 7 to 12 km above sea level.

Furthermore, our GPS collected latitude, longitude, and altitude data throughout the duration of the flight.

FLIGHT PATH

The payload was in the air for a span of 3 hours, and traveled about 90 miles - mostly eastward. It was launched near Union City, Michigan and landed north of Monroe. The package safely landed in an empty field about 2 miles from the coast of Lake Erie, where recovery would've been impossible.

MAXIMUM ACCELERATION

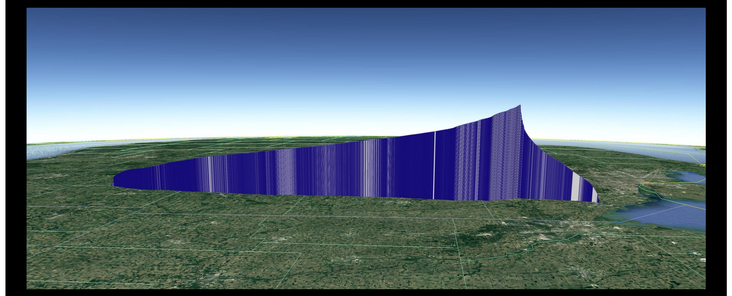


During our ascent, we recorded a maximum normalized acceleration just above the jet stream. It was difficult to derive a conclusion from this data due to the noise generated from acceleration due to gravity.

SUMMARY

- Data was recorded for 173 minutes. Flight was eastbound, across southern Michigan.
- Our payload reached a maximum altitude of 26,039 meters.
- It recorded its highest magnitude of acceleration at 13,852 meters.
- We were not able to isolate significant shearing forces during ascent, due to acceleration noise from gravity and other payloads.
- During descent, irregular accelerations were continuously recorded. This reinforces the idea that our balloon experienced a chaotic freefall.

ALTITUDE



This plot shows the altitude of the payload during its flight. The balloon climbed steadily for the majority of the flight, peaking at an altitude of 26,039 meters before the weather balloon popped. The payload then entered freefall, until the parachute was fully deployed - which allowed for a safe, controlled descent back to Earth.

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