Post-Launch Assessment Review (PLAR)

Carbon Dioxide Analysis in Troposphere with Autonomous Air Brakes

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AIAA OC Section
4/23/17

Table of Contents

1. Summary of PLAR Report

1.1 Team Summary

The name of the team is AIAA OC Section.

1.1.1 Team Name and Mailing Address

1.1.2.1 Robert Koepke (Electrical Engineer, Programmer, Level 2 NAR)

Robert has been co-leading TARC teams for eight years and a part of the STEM outreach for AIAA for seven years. He has a BS degree in Electrical Engineering from USC and has worked as an electronics designer, programmer, and now the manager of the software department for Honeywell. Robert worked on the F-20 Tigershark while at Northrop. Robert launched his first rockets shortly after Sputnik in 1957 and has continued in rocketry with his own children and grandchildren and Indian Princesses and Indian Guides.

1.1.2.2 Jann Koepke (Artist, Mom, Level 1 NAR)

Jann has been co-leading TARC teams for eight years. She has a bachelor's degree in Fine Arts from Cal State University Los Angeles in 1979. She has worked in electronic business as an assembler and in the accounting office. Now she is retired. She has been doing Rocketry for 25 years with her husband children and grandchildren. Jann is the AIAA OC Section Council member in charge of education. She has also led 4H projects in livestock, including lambs, goats, and beef.

1.2 Brief Payload Description

Our payload, the K30 CO_2 sensor, has the sole purpose of collecting carbon dioxide samples from different altitudes.

1.2.1 Payload Title

K30 CO_2 sensor

1.2.2 Summarize Experiment

Our scientific experiment is to test the effect of altitude on carbon dioxide levels, hoping to find a strong correlation and regression (exponential, linear, or parabolic) within the explanatory and response variables.

1.3 Launch Vehicle Summary

1.3.1 Vehicle Dimensions

- Length - 101.5 in
- Diameter - 4 in
- Semi Span of Fins - 4.5 in
- Total Mass, -10891.8868 g or 24.0125 lbs

1.3.2 Motor Used

We have chosen the Cesaroni K555 motor to help us with our flight.

1.3.3 Recovery System

The recovery electronics will be in the avionics bay, a 12.2.5" tube coupler with a 3" collar made of 4" G10 fiberglass body tube to separate the upper and middle body tubes. It is a redundant dual deploy system with an 84" main parachute and 18" drogue parachute.

2 Launch Day Review

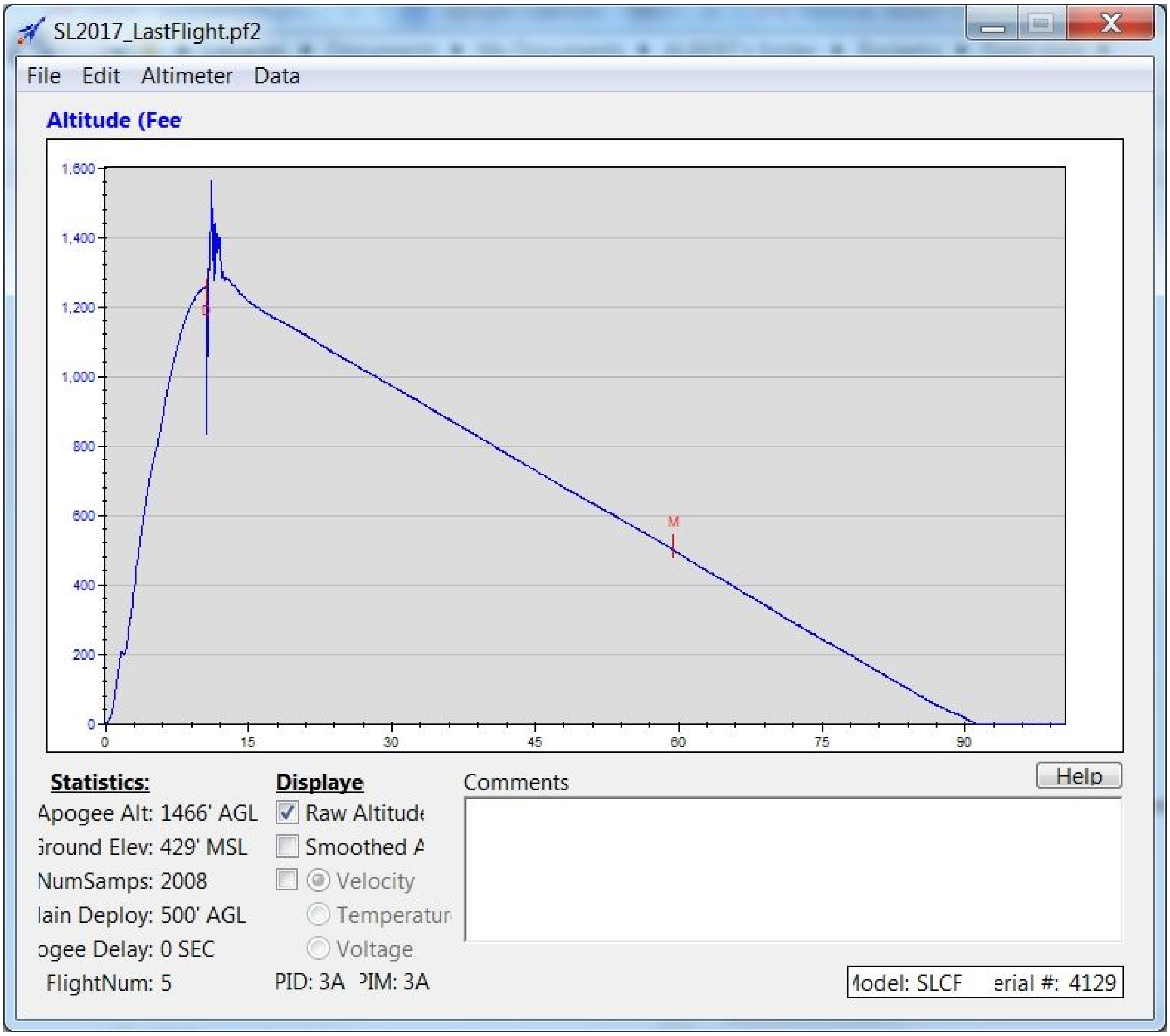
2.1 Altitude Reached

1499 feet

2.2 Vehicle Summary

Our rocket was obtained, electronics and all, after the flight. There was only some minor tearing in the drogue chute due to the thorns. The rocket was unharmed, albeit muddied.

2.3 Data Analysis



Judging by the altitude spikes of the extremely low apogee, the avionics facing the drogue chute may not have been properly insulated. That is not the case for the avionics facing the main chute, as there is no observable spike in altitude.

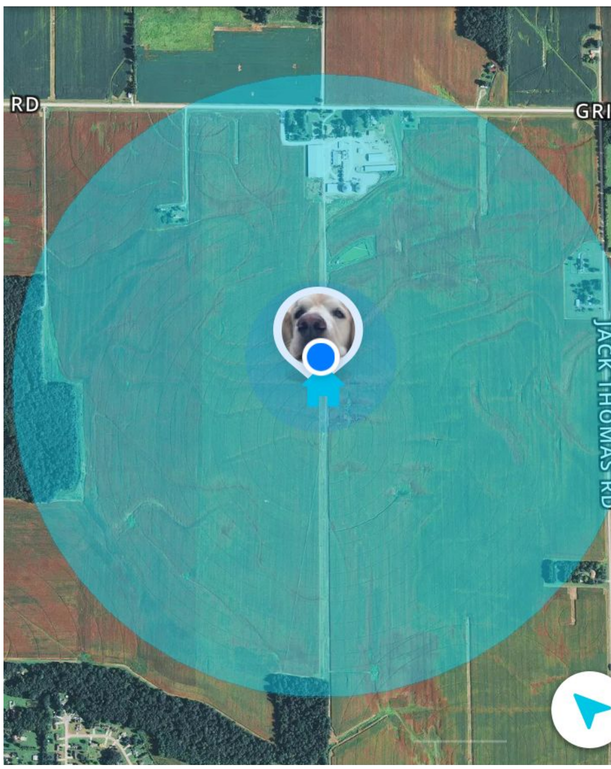
The spike may also have been caused by the rocket's continued velocity due to the flight.

The max altitude of roughly 1500 ft. was the result of the loss of pressure while the rocket was on the launch pad. This was due to a defective nozzle, which prevented the rocket from building the pressure it needed to leave the launchpad.

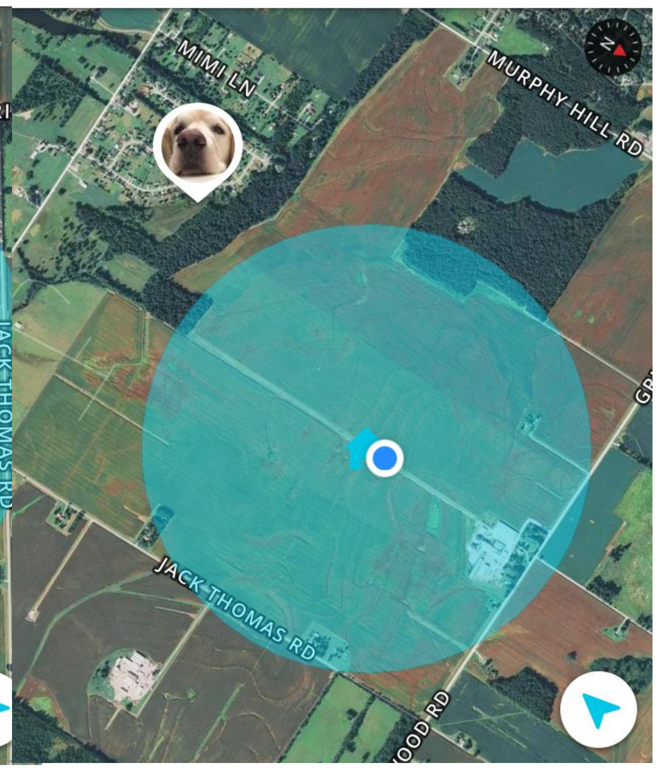
2.3.1 Results of Vehicle

The engine of our rocket malfunctioned on the launch pad. The rocket was unable to build up enough pressure and therefore had no thrust. The end result was an extended period of time resting on the launch pad before the rocket launched, spiralling towards the forest about 1.25 miles out from the launch pads, toward the south. In short, the flight literally went south. The rocket landed out past the forest in the swamp area where four team members retrieved it with help from the neighbors.

While the launch did not go as planned, the rocket landed unbroken and safely away from the crowd. Additionally, it luckily didn't enter the property of the neighbors on the opposite side of the fence and cause property damage.



Before



After

3 Payload

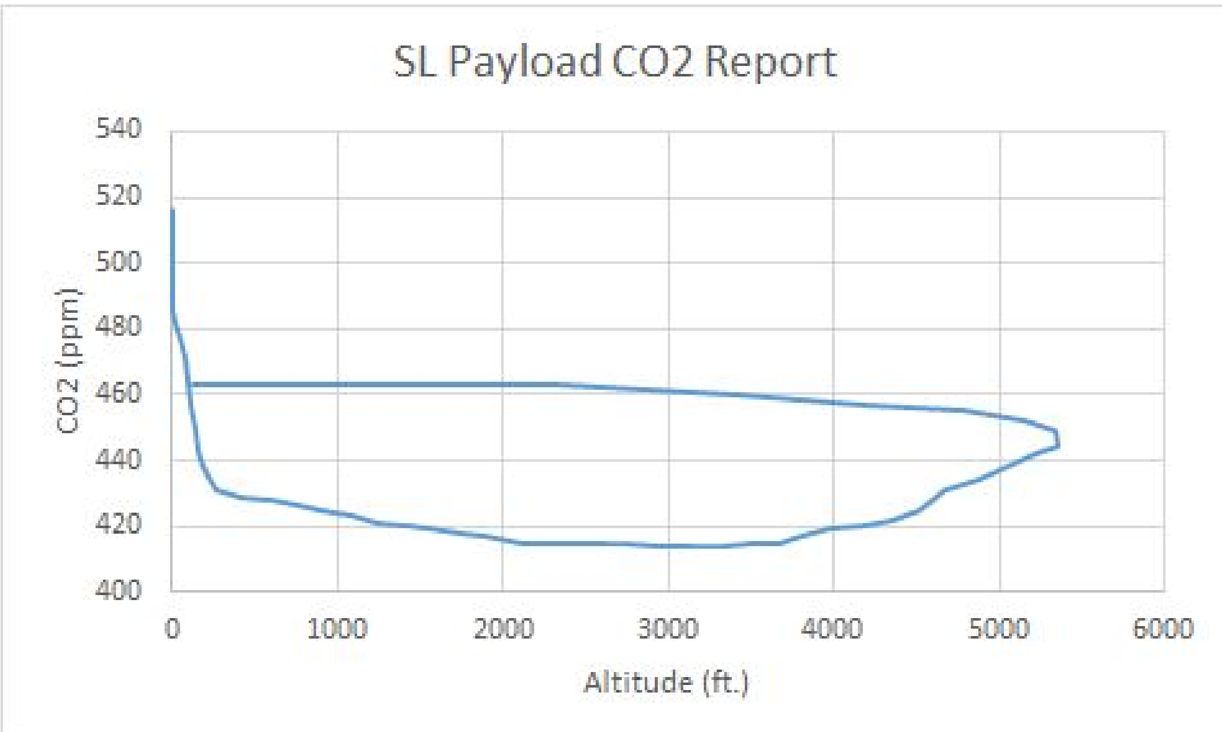
3.1 Payload Summary

Our experiment for the payload is to test the effect of altitude on carbon dioxide levels. Our goal is to establish some sort of trend between the two variables, so it therefore follows that a successful experiment constitutes of a well defined correlation between altitude and carbon dioxide levels.

3.2 Data Analysis

3.2.1 Results of Payload

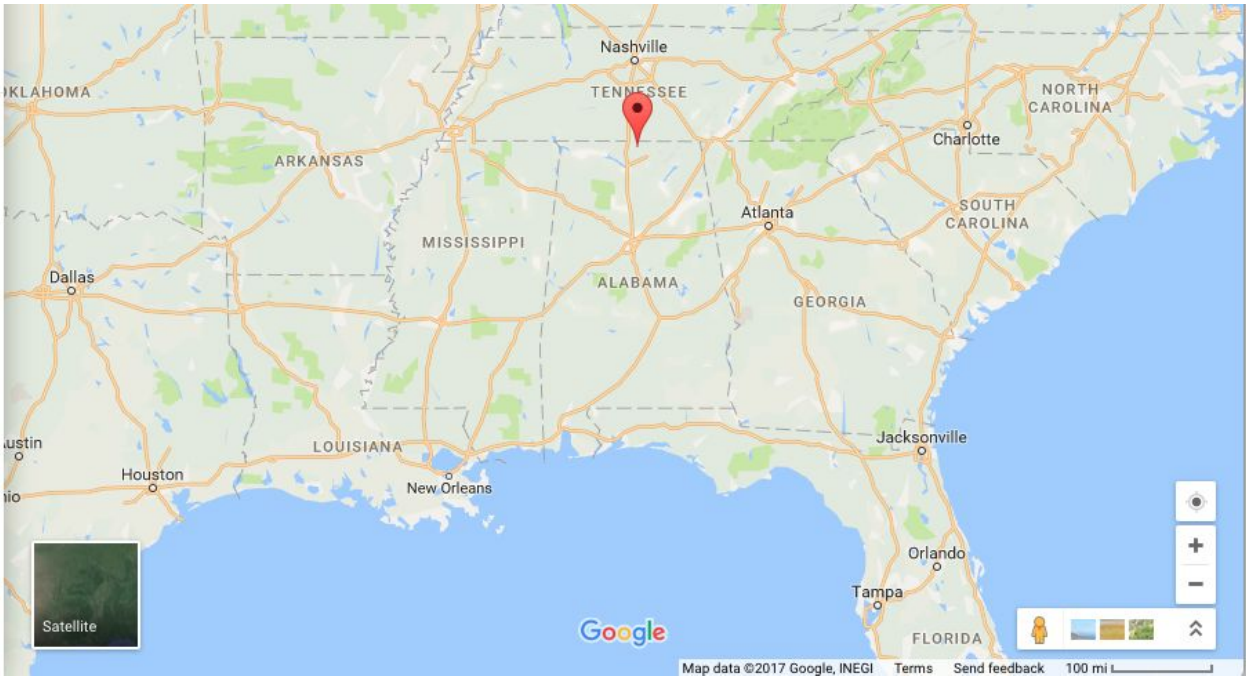
Our payload did not produce any data from our launch at Huntsville because not only did our SD card fail to read data from the CO_2 sensor, but our rocket also suffered some problems and did not reach a high enough altitude to give an accurate representation of the change in carbon dioxide levels at increasing altitudes. However, if the rocket had launched successfully, we would expect the SD card readings to be similar to the data presented in the graph below, showing data from our last test flight.



As shown by the graph, the CO_2 levels stay constant at about 460 ppm during ascension until after apogee, where it drops down to almost 410 ppm and spikes back up when the rocket landed.

3.2.2 Scientific Value of Data

This is the approximate location of where the location of our launch took place on April 8


Nashville
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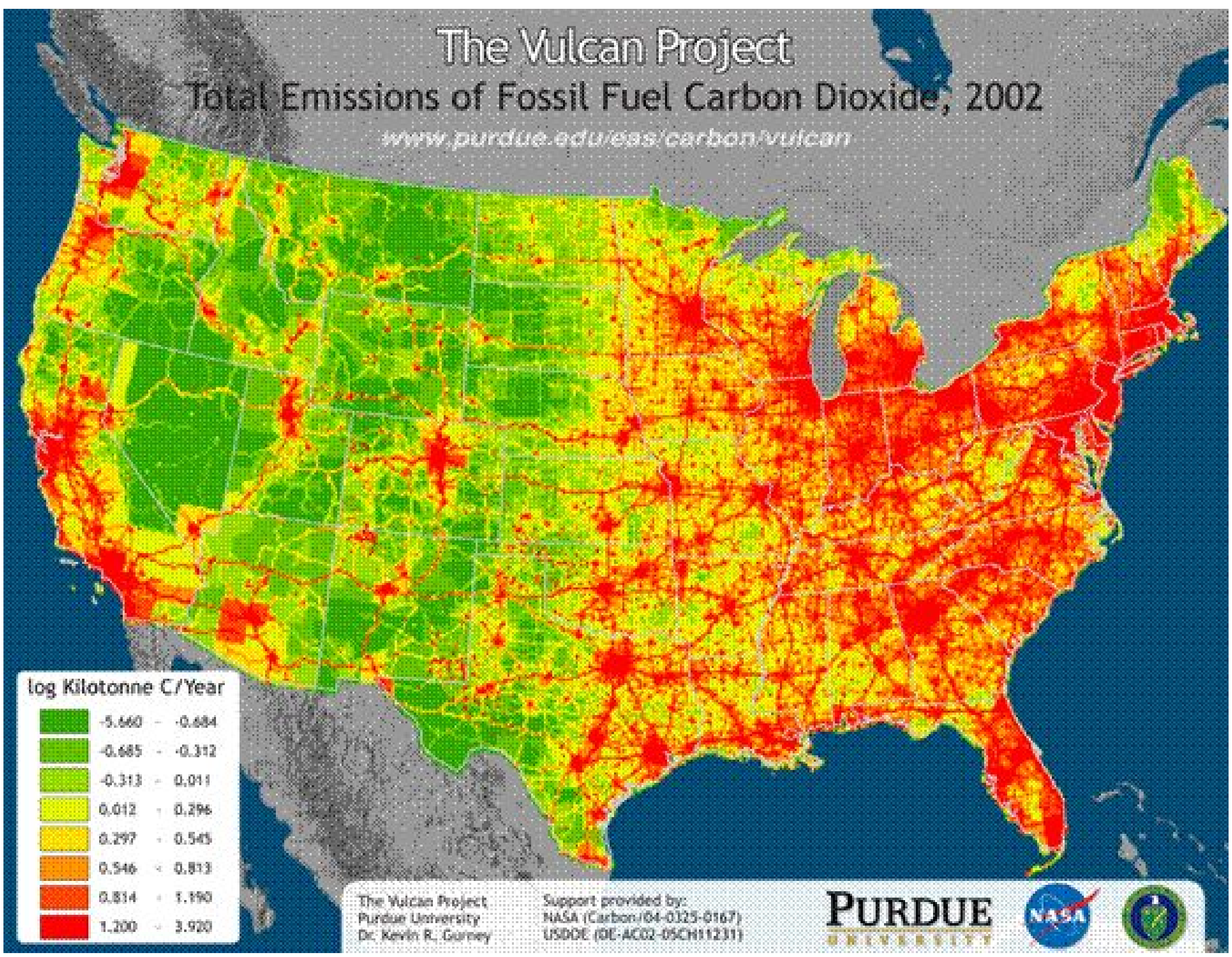
The Vulcan Project
Total Emissions of Fossil Fuel Carbon Dioxide, 2002
www.purdue.edu/eas/carbon/vulcan
log Kilotonne C/Year
-5.660 - -0.684
-0.685 - -0.312
-0.313 - 0.011
0.012 - 0.296
0.297 - 0.545
0.546 - 0.813
0.814 - 1.190
1.200 - 3.920
The Vulcan Project
Purdue University
Dr. Kevin R. Gurney
Support provided by:
NASA (Carbon/04-0325-0167)
USDOE (DE-AC02-05CH11231)
PURDUE UNIVERSITY

Knowing this data, we can observe some old data from NASA in 2002. The units are log base 10 of kilotons of carbon. Toney would be highlighted with red, indicating it released anywhere from $10^{1.200}$ to $10^{3.900}$ kilotons of carbon during that year.

If our payload had been functional and ascended to one mile, we would have data to compare to the CO_2 levels of before.

4 Reflection

4.1 Visual Data Observed

The flight path taken by the rocket was extremely different from usual as we had a faulty motor that provided insufficient thrust. After remaining on the pad for the first 10-12 seconds, most of the thrust was used up until the rocket finally lifted off the launch rail in which it almost immediately tilted over away from the crowd. Though it was approximately flying through the air at a 45 degree angle, it still successfully deployed the main chute and had a “safe” descent. At first, the problem we thought we saw was that the launch rail had been too dirty and had caught the rocket during its take off which led to its delayed launch but once the rocket was retrieved from past the tree line the true error was clear. The motor had an odd material that made up the nozzle and the nozzle was strangely large and then the pieces came together. The odd material that composed the nozzle was burned which was already highly unusual but the large diameter of the nozzle prevented the motor from attaining its necessary pressure for lift off and wasted most of the initial thrust leading to a failed launch.

4.2 Lessons Learned

This year we made a lot of mistakes and learned a lot of lessons that we will apply next year, should we continue to do Student Launch. One of our primary mistakes this year was procrastination, especially procrastinating with our documentation.

4.3 Summary of Overall Experience

Our first year participating in NASA SL went well; we were grateful for this opportunity and believe that we made the most of it. Although it was difficult to grasp the magnitude of this project early in the process, we were able to understand what we needed to accomplish and get the ball rolling. We learned many skills useful for our futures, including budgeting, team management, communication, collaboration, and time management. Preparing proposals and documents throughout the year gave us real-world applications we hope to use later on.

4.4 Educational Engagement Summary

The team went on multiple hands-on rocketry educational activities to introduce young children to rocketry. We helped Girl Scouts in launching their model rockets and also introduced rocketry to kids at a fair in Irvine High School and taught them how to construct and fly their own paper rockets.

In San Diego, we helped Boy Scouts fly their model rocket kits.

At Irvine High School, we helped students construct their very own cut-out rockets, constructed with sheets of paper, tape, and pennies.

4.5 Budget Summary

The total project expense was $10,499. The totals of each subsection were: $943 in total scale vehicle cost, $1,620 in total vehicle cost, $825 in total recovery cost, $445 in total payload cost, $170 in total educational outreach cost, and $6,496 in total travel costs. Our sponsors were Apex Desks, Pegasus Management, Yogurtland, IvyMax, and Velur Enterprises, Inc.