1 Why Air Brakes?

The IREC scores a team based on how close to your target altitude you achieve and penalizes you the further you under or overachieve that target.

This makes air brakes very advantageous as you can engineer the rocket to intentionally overshoot your target by a small margin and allow your air brakes to cut down that extra altitude the exact right amount.

2 The Problem

Why go through all the trouble to do this simulation and math when there are tools out there that will do it for you?

Well, OpenRocket simply does not have the tools needed to simulate reactive air brakes. Plus, it’s fun to try and solve the problem yourself such that it suits your needs.

3 Understanding the System

Going to follow this lecture from MIT  
<https://web.mit.edu/16.unified/www/FALL/systems/Lab_Notes/traj.pdf>

from Newton’s 2nd Law, and from mass conservation

You can go read the full lecture via the link in the description. I’m going to skip to the end where we get to an iterable system.

However, we can make this system simpler by letting much smarter people do the work for us. OpenRocket does an outstanding job calculating the behavior of a rocket, so let’s use that simulation to crunch out numbers and give us some initial conditions to piggyback off of.

Since we conveniently don’t want our air brakes to deploy during the boost phase of the rocket, we can take the OpenRocket result from the boost phase and use that as a starting point. Additionally, after the boost phase is complete, we can safely exclude both thrust and change in mass over time in our system of equations. This gives us the following

However, we can’t call it finished here. We can use OpenRocket to get the altitude, velocity, mass, gravity, air density, and even time but can no longer use it to calculate a coefficient of drag.

4 Drag

The Coefficient of Drag is not simple to determine. It depends on too many unknowns in the system to calculate it. We are trying to use it to calculate the force on the rocket and there is no way to analytically calculate it without knowing the resultant force.

In an ideal world, a scale model of the rocket would be constructed and placed in a wind tunnel, in which you could use Dimensional Analysis to calculate an accurate for the air brakes. However, we didn’t have the resources or time for that. Thus, **RAAAAAA ADD SHIT HERE!!!**