Characterization of Pressure and GPS Altitude Measurement Techniques to 60,000 ft.

Trey McFerrin
UAH Mechanical and Aerospace Engineering Department

Overview
Altitude measurements were taken during a high altitude balloon flight using two independent sensing techniques:
- Pressure - Measurement Specialties MS5637
- Global Positioning System (GPS) – Antenova M10382, Ublox 6 based

The International Standard Atmosphere (ISA) model was used to convert pressure to altitude, with a boundary condition correction for local conditions. The GPS unit output altitude directly. The two techniques were compared.

Impact
Our work provides an accuracy characterization of two low cost altitude sensing techniques currently in use by the UAH Space Hardware Club. The results are available to support future rocketry and ballooning projects of the Club which utilize these technologies.

This instrument served as a course project for MAE 311 “Principles of Measurement and Instrumentation,” UAH Department of Mechanical and Aerospace Engineering.

Key Findings
- The two altitude measurements were within 4% of each other during flight.
- Above 11 km (36,000 ft.), the difference between the two altitude measurements was within the rated error (accuracy) band of the sensors.
- Between 1 and 11 km, the difference between the two altitude measurements was outside the rated error (accuracy) band of the sensors. This is suspected to be due to a departure of actual atmospheric pressure distribution from the ISA model.

Explanation
Altitude sensing is an important instrumentation need of most flight vehicles. Here we demonstrate and compare two solid approaches. These techniques are useful in determining the altitude of aircraft, rockets, and balloons in a variety of applications.

International Standard Atmosphere (ISA) model

\[ p(z) = p_0 e^{-\frac{g}{R} \int_0^z \frac{1}{T_0(T(z))} dz} \]

Key assumptions:
- Air is static and satisfies hydrostatic equation \( \frac{dp}{dz} = -\rho g \)
- Ideal gas: \( p = \rho RT \)
- Given standard temperature distribution with altitude \( T(z) \)

Boundary condition: \( (p_0, z_0) \)
- Defined as standard sea level conditions in the ISA model
- However, we correct the ISA model for a ground level boundary condition matching local weather.

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