SCARLET HAWK I – HASP 2013

October Status Update
10/25/13

INTRODUCTION

Summary of progress

This month, AIAA-IIT has continued to analyze our data and prepare a rough draft for the science / flight report that is due in December. Additionally, AIAA-IIT will be taking advantage of the beginning of the school year to recruit new members to the high altitude ballooning team and begin conceptual design for a 2014 HASP payload. Preliminary analysis of GPS tropospheric data was done using a mixture of data collected during the flight as well as standard atmospheric models.

Upcoming deadlines

- November 1: Completion of Science Report Rough Draft
- December 13: Science Report Due
- December 20: HASP 2014 Application Due

Updated Team Structure

Project Manager: Peter Kozak

Faculty Adviser: Keith Bowman

GPS & Comm.

Aniruddha Katre (Subgroup Leader), Raisa Vitto, Lou Grimaud, Collin Rutenbar

Electronics and Sensing

Shalmik Borate (Subgroup Leader), Peter Kozak, Raisa Vitto

Image Processing

David Finol (Subgroup Leader), Rodolfo Manotas, Corey Page, Collin Rutenbar, Abdulrhman Arnaout

Structure

Miguel Javier (Subgroup Leader), Manpreet Singh

GPS Preliminary Analysis

The Tropospheric error for a radio signal traveling along the path of a 90 degree Elevation angle, an angle measured from the horizon, can be estimated by the following equation:

$$T = 10^{-6} \int [N_D(h) + N_W(h)] dh$$

Where T is the total Tropospheric error (meters), N_D is the dry component of the index of refraction, N_{0w} is the wet component of the index of refraction and h is the height from the receiver (meters).

The challenge is to accurately calculate the dry and wet components of the indices of refraction in order to be able to achieve an accurate result for the tropospheric error. These components can be calculated using equations derived by Rueger (2002):

$$N = 77.6890 \frac{P_0}{T_0} - 6.3938 \frac{P_W}{T_0} + 3.75463 \times 10^5 \frac{P_W}{T_0^2}$$

Where N is the total index of refraction, P_0 is the total pressure (millibars), P_w is the partial pressure of water (millibars) and T_0 is the absolute temperature (K).

The partial pressure of water vapor can be calculated by using the equations derived by Buck (1981):

$$e_{sat} = (1.007 + 3.46 \times 10^{-6} P_0) * 6.1121 * exp\left(\frac{17.502 T_0}{T_0 + 240.97}\right)$$

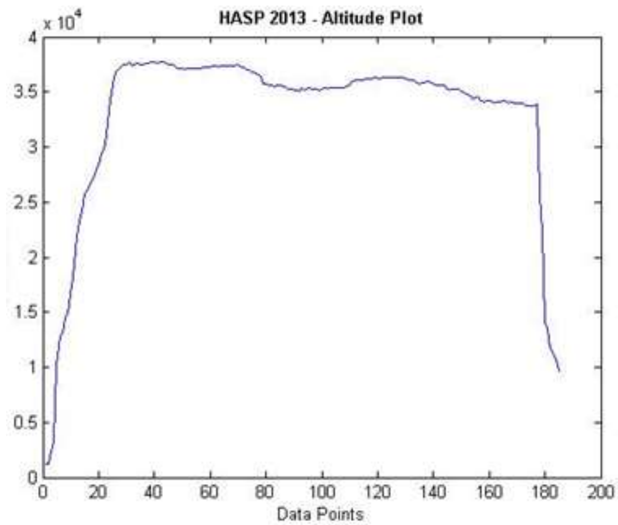
$$P_{w0} = e_{sat} * RH_0 * \left[1 - (1 - RH_0) \frac{e_{sat}}{P_0}\right]^{-1}$$

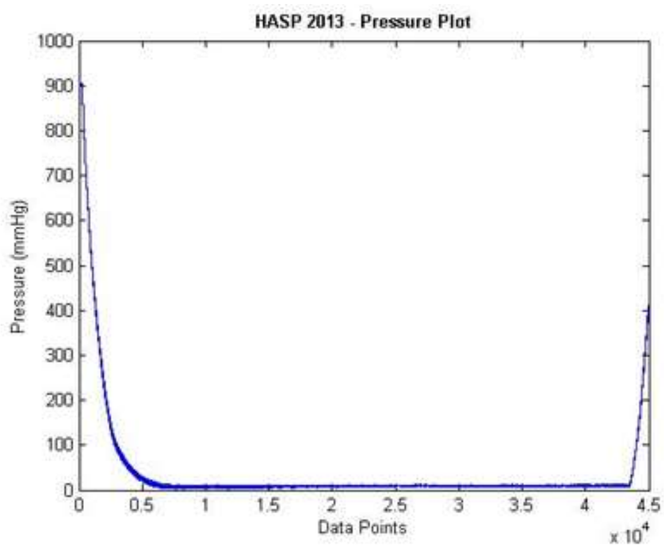
Where e_{sat} is the saturation vapor pressure (millibars), RH_0 is the relative humidity and P_{w0} is the partial pressure of water vapor (millibars).

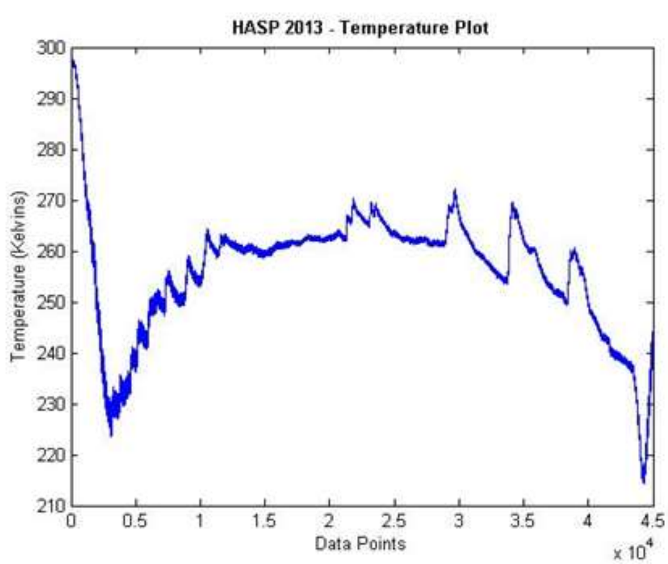
The following tasks must be completed for the GPS section of the final science report.

1) Implement the Relative Humidity Standard Model to allow further analysis.
2) Determine a solution to the low volume of altitude data.
3) Calculate the tropospheric error and compare it to existing models
4) Conduct Error Analysis to determine the statistical parameters associated with this experiment.

Plots of pressure, temperature and altitude after aligning time stamps and removing anomalous data are attached below:


HASP 2013 - Altitude Plot
x 10^4
4
3.5
3
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
120
140
160
180
200
Data Points


HASP 2013 - Pressure Plot
Pressure (mmHg)
1000
900
800
700
600
500
400
300
200
100
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Data Points
x 10^4


HASP 2013 - Temperature Plot
Temperature (Kelvins)
300
290
280
270
260
250
240
230
220
210
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Data Points
x 10^4