Calculating Smoke Plume Height from Video Feed
Andrew Gabel* and Fok-Yan Leung
Laboratory of Atmospheric Research, Washington State University REU

Introduction

• Biomass burning smoke plumes contain atmospheric chemicals that have been linked to health effects, ranging from asthma to allergies.
• Some fires, depending on the size, can have ash that travels over 200 miles.
• The fire of interest was during the RX-Cadre campaign, February 2011, staged at Fort Walton.

Objective

• Calculate smoke plume height from the data collected using hand held cameras to be used for evaluation of plume heights from satellite data derived plume heights, specifically, plume heights calculated from data from the NASA MISR instrument, which is housed on the TERRA satellite.
• In order to correct for compass heading, smoke plume origin needs to be corrected for.

Methods

• Take video feed from the February 2011 burn and create static images from them. Figure 1.1 is an example of a static image from the video.

Results

• By adding the following formula to the program:
  \[ \text{PixelAngle} = \arctan \left( \frac{\# \text{Pixel}}{70} \right) \times \left( \frac{180}{\pi} \right) \]
  Calculations to correct for compass heading can be obtained. This is a zeroth order approximation, assuming a linear relationship between correction angle and displacement of the plume origin from the midpoint.

Acknowledgements

This work was supported by the National Science Foundation's REU program under grant number 0754990.
Background from:
http://creativity103.com/collections/Smoke/rainbow_smoke.jpg

* Corresponding Author can be reached at gabel.andrew@gmail.com

Trial 1 Cameras Analysis

<table>
<thead>
<tr>
<th>Angle</th>
<th>Incorrect</th>
<th>Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plume Height</td>
<td>82 m</td>
<td>82 m</td>
</tr>
<tr>
<td>Lat/Long</td>
<td>30.38143 / 86.16926</td>
<td>30.39550 / 86.17105</td>
</tr>
</tbody>
</table>

Trial 1 Angle Correction Comparison

<table>
<thead>
<tr>
<th>Camera A Pixel Origin</th>
<th>17.0</th>
<th>27.0</th>
<th>37.0</th>
<th>47.0</th>
<th>57.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera B Pixel Origin</td>
<td>13.6504°</td>
<td>21.0923°</td>
<td>27.8596°</td>
<td>29.7448°</td>
<td>35.5376°</td>
</tr>
</tbody>
</table>

Trial 2 Cameras Analysis

<table>
<thead>
<tr>
<th>Angle</th>
<th>Incorrect</th>
<th>Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plume Height</td>
<td>83 m</td>
<td>83 m</td>
</tr>
<tr>
<td>Lat/Long</td>
<td>30.37180 / 86.16703</td>
<td>30.39009 / 86.17597</td>
</tr>
</tbody>
</table>

Trial 2 Angle Correction Comparison

<table>
<thead>
<tr>
<th>Camera A Pixel Origin</th>
<th>50.0</th>
<th>60.0</th>
<th>70.0</th>
<th>80.0</th>
<th>90.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera B Pixel Origin</td>
<td>35.5376°</td>
<td>40.6012°</td>
<td>45.0000°</td>
<td>50.0000°</td>
<td>55.0000°</td>
</tr>
</tbody>
</table>

Conclusion and Future Work

Conclusions:
• With the correction of the angle, there is no apparent major changes to plume height, but noticeable change within lat/long distances.

Future Work:
• Correction for the tilt angle and vertical displacement of plume origin from center line of the camera.
• Plume heights calculated from hand held cameras will be compared to satellite data derived plume heights.