Calculating Smoke Plume Height from Video Feed

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Introduction

- Biomass burning smoke plumes contains 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 calculate 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 footage taken from the video.

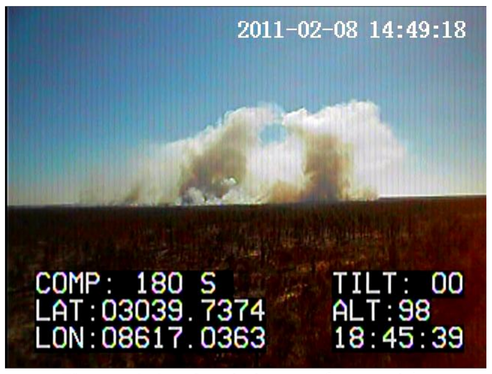


Figure 1.1 – Static image from video

- After obtaining the static image, crosshairs were applied to each image . With having the crosshairs, it will make it easier to find the middles. Refer to figure 1.2 for crosshair demonstration.
- The use of an industry standard program was used to create a pixel grid for the static images.

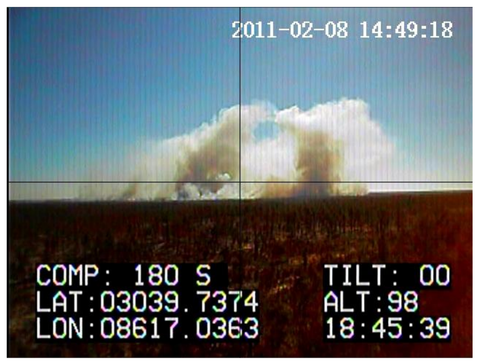


Figure 1.2 - Crosshairs being applied to image

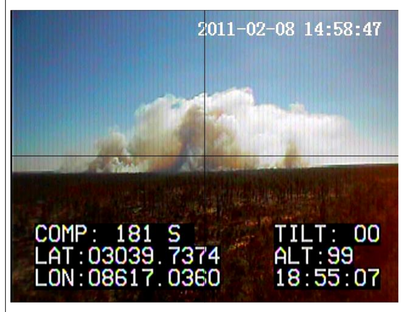
- Data from 2 cameras placed at different locations and recorded simultaneously or at least, very closely, are necessary in order to calculate plume height and location.
- Camera data included date, time, latitude, longitude, elevation, azimuth, and tilt angle. Magnetic declination was obtained by outside source for camera location.

Results

- By adding the following formula to the program:

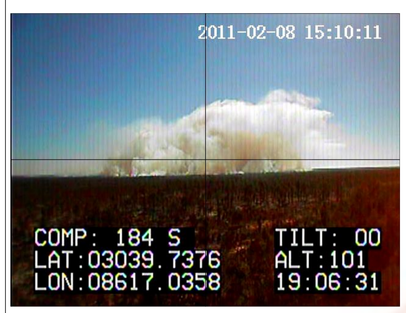
PixelAngle = arctan (# Pixel / 70) * (180 / !Pi)

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.



Camera A Trial 1

Camera B Trial 1



Camera A Trial 2

Camera B Trial 2

Trial 1 Cameras Analysis

Angle	Calculated Plume Height	Calculated Lat/Long
Incorrect	82 m	30.38143 / 86.16926
Correct	82 m	30.39550 / 86.17105

Trial 1 Angle Correction Comparison

Camera A		Camera B	
Pixel Origin	Correction Angle	Pixel Origin	Correction Angle
17.0	13.6504°	30.0	23.1985°
27.0	21.0923 °	40.0	29.7448 °
37.0	27.8596°	50.0	35.5376°

Trial 2 Cameras Analysis

Angle	Calculated Plume Height	Calculated Lat/Long
Incorrect	83 m	30.37180 / 86.16703
Correct	83 m	30.39009 / 86.17597

Trial 2 Angle Correction Comparison

Camera A		Camera B	
Pixel Origin	Correction Angle	Pixel Origin	Correction Angle
50.0	35.5376°	15.0	12.0947°
60.0	40.6012 °	25.0	19.6538 °
70.0	45.0000°	35.0	26.5650°

- This will then gradually start allowing the conversion between Cartesian to rotational coordinates.

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.

Acknowledgements

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Background from:

http:// creativity103.com/collections/Smoke/rainbow_smoke.jpg

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