Automation of Cloud Detection From Webcam Images

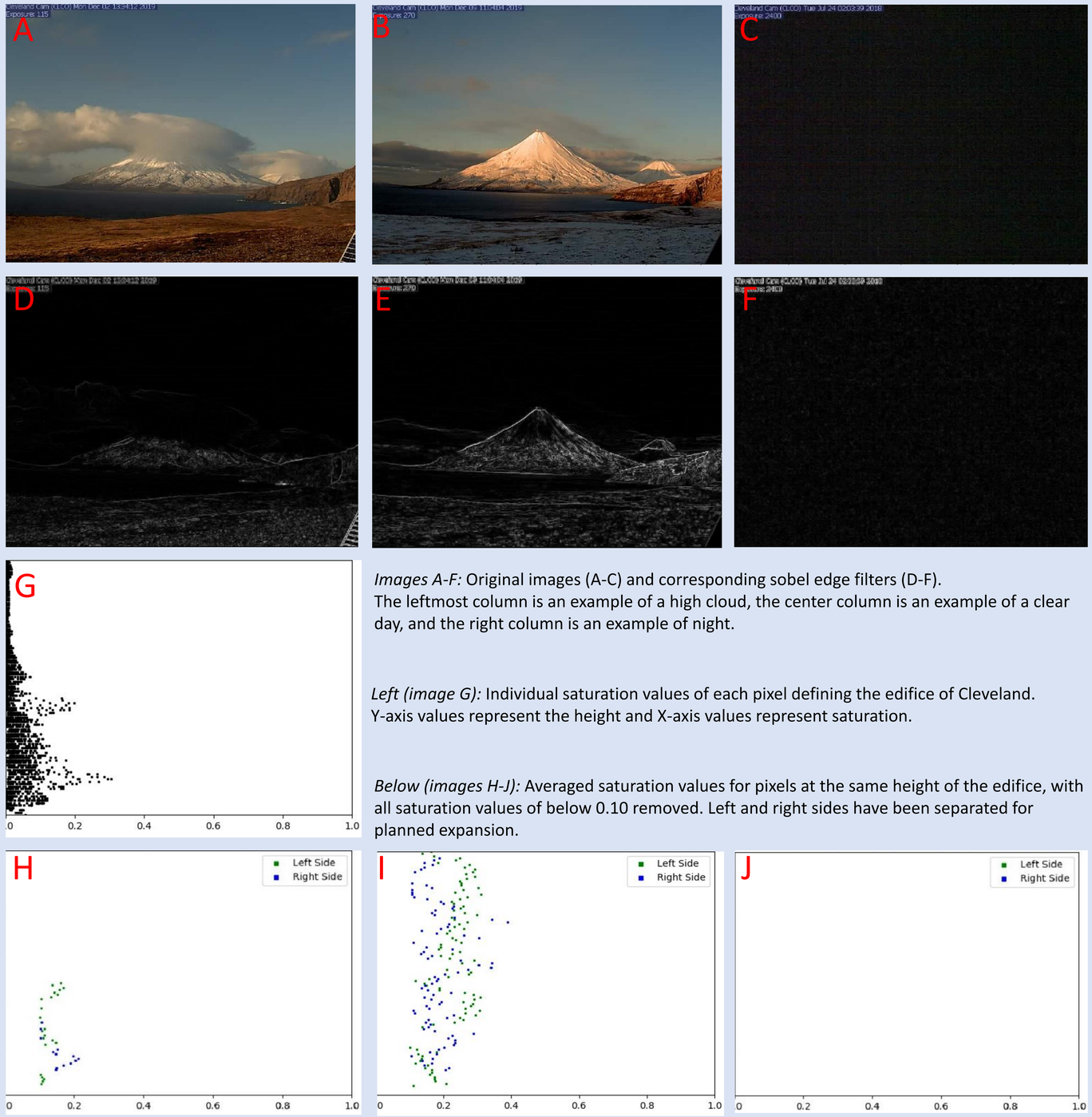
Motivation:

Multi-axis DOAS scans may be used to construct a flux estimate of volcanic plumes. Currently, automated scans are made every 10 minutes. Weather conditions, particularly clouds, strongly affect error estimates[1,2], so automatically detecting which DOAS scans are unobstructed by clouds without needing to manually consult an image would save time.

Methods and Process:

- Weather conditions analyzed using Alaska Volcano Observatory image archives from the CLCO webcam for 2020 (n = 7526).
- Images split into night/fog, low clouds, high clouds, and clear.
- For the reference image:
  - Clear image was processed through edge detection.
  - Non-edifice blacked out manually.
  - All non-black pixels assigned to white.
  - All white pixels used to define array of edifice X, Y values.
- For cloud detection:
  - Image name parsed for date/time.
  - Image processed through sobel edge detection.
  - Divided image by reference array values (values: 0 – 1).
  - Arbitrary cutoff of 0.1 applied to remove noise.
  - All values averaged for equal Y coordinates on left and right sides.
  - Output the date, time, and True/False statements for each category.

Input and Processed Visualization



Images A-F: Original images (A-C) and corresponding sobel edge filters (D-F).
The leftmost column is an example of a high cloud, the center column is an example of a clear day, and the right column is an example of night.

Left (image G): Individual saturation values of each pixel defining the edifice of Cleveland.
Y-axis values represent the height and X-axis values represent saturation.

Below (images H-J): Averaged saturation values for pixels at the same height of the edifice, with all saturation values of below 0.10 removed. Left and right sides have been separated for planned expansion.

Output Format:

'-mm-dd	time(UTC)	Night/Fog	Low_Clouds	High_Clouds	Clear(Tru
1/1/2020	0:33:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	1:02:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	1:03:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	1:32:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	1:33:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	2:00:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	2:02:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	2:03:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	2:30:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	2:32:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	2:33:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	3:00:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	3:02:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	3:32:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	3:33:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	4:00:00	TRUE	FALSE	FALSE	FALSE
1/1/2020	4:02:00	TRUE	FALSE	FALSE	FALSE

- Current infrastructure will analyze all images and discriminate between night/fog conditions and no night/fog conditions.
- Each image is given a corresponding timestamp and True/False statement for each weather condition.

Future work directions:

- Metrics need to be applied for classification of high and low clouds.
- False positivity/negativity rate assessments.
- DOAS scans need to be paired to each webcam image (will require station installation).

Expected Scalability:

- Implementation for other volcanoes possible with reference image code.
- May serve as baseline for evaluating efficacy of alternative methods, e.g. machine learning.

References:

[1]Galle et al. (2010) J. Geo. Res.; V. 115, 19 pp
[2]Kern et al. (2012) J. Geo. Res.; V. 117, 23 pp