Cloud Image #1 Report

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MCEN 4151: Flow Visualization
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I. Introduction

This image was captured for the first cloud assignment for the course Flow Visualization, the art and physics of fluid flow. The objective of this project was to capture the natural beauty of cloud formations as well as analyzing the structure of the cloud and the weather conditions to predict information about the cloud type and its formation. I chose to take multiple pictures of the sky and stitch them into a panorama to show a more complete view of the clouds at that moment.

II. Location and Time

The images in this panorama were taken at 5:35pm MST on Tuesday, February 18, 2014 at the National Center for Atmospheric Research at the base of the flatirons in Boulder, Colorado. The camera was pointed towards the northeast to capture the series of photos. The left edge of the image it closer towards the north and the right edge is more towards the east. The camera was angled at about 20° above horizontal to capture the cloud formation.

III. Cloud Types and Atmospheric Conditions

The main cloud type in this image is Altocumulus Standing Lenticularis, seen especially well on the right side of the frame. These clouds are orographic, meaning they were formed from passing over an obstacle. In this case the obstacle was the Rocky Mountains. As wind forces air up the slope of a mountain, the air expands, causing it to cool and slow down. As the air slows, suspended water particles tend to collide and merge, forming droplets which remain suspended in the air, resulting in an observable cloud.[1] Given the geography of Boulder, these clouds are relatively common here. The wind begins to oscillate on the other side of the obstacle, and parallel wind streams will form clouds at the same spot in different elevations.[1] This creates the "stack of pancakes" effect seen in the photo. Figure 1 below shows this phenomenon graphically.[2]

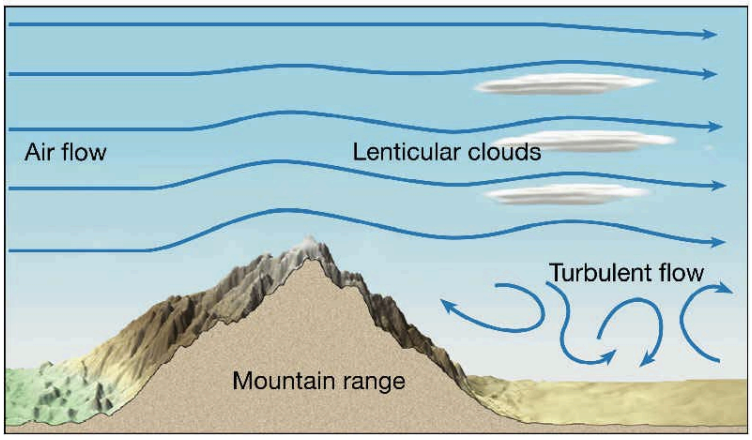

Figure 1: Illustration of lenticular loud formation

Figure 2 below is a Skew-T diagram showing the upper atmospheric soundings from a weather balloon launched from the Denver International Airport.[3] This particular diagram was for the 6pm sounding on February 18, 2014 (6am on Feb 19, in Zulu time) and was accessed through a database from the University of Wyoming's department of atmospheric science. Altocumulus lentincularis clouds tend to form in a stable atmosphere, and the CAPE value of zero on the Skew-T diagram confirms that the atmosphere was indeed stable at the time the photo was taken. Altocumulus clouds are mid-level clouds, typically forming at 2000-6000 m above the earth's surface. The Skew-T diagram gives clues about the altitude of the clouds. Right around the 5650 m line, abrupt changes in temperature and humidity occur, which are the conditions that we would expect for clouds to form. It is also noticed that wind speeds were relatively high at this elevation and moving from the west to the east, or from the mountains towards the plains.

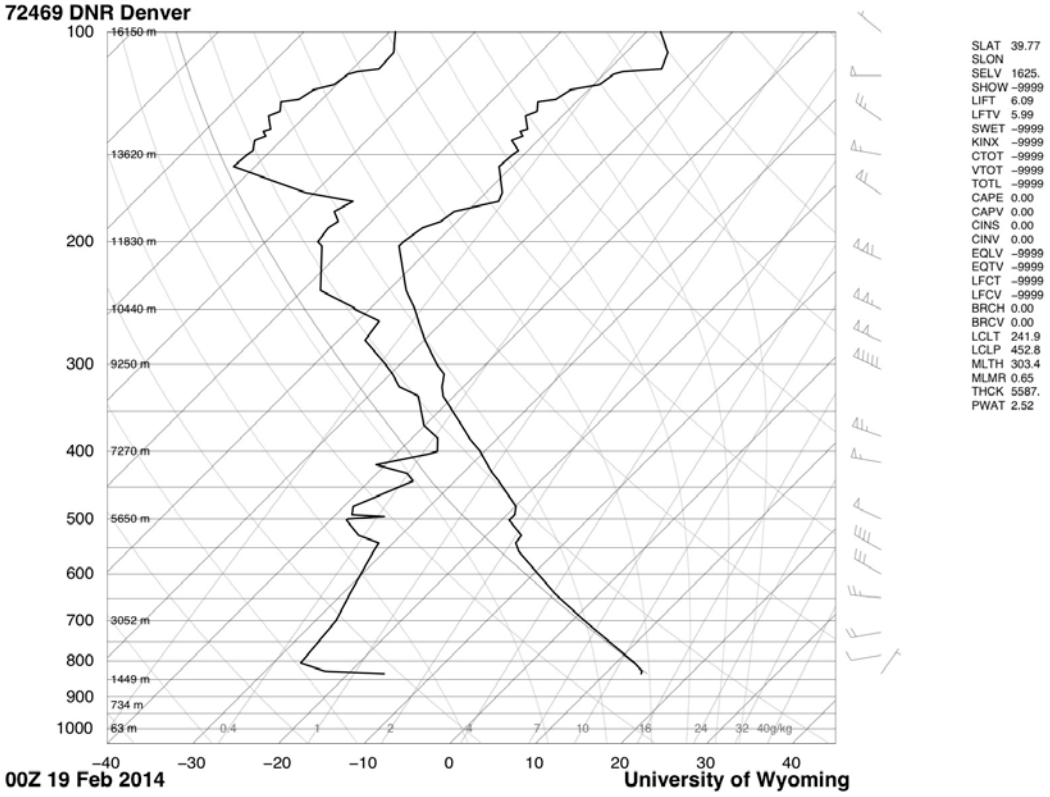

Figure 2: Skew-T Diagram

IV. Camera and Settings

A Canon EOS 60D DSLR camera equipped with an 18-135mm lens was used to capture the images that comprise this panorama. The images were shot at the minimum focal length of 18mm to maximize the field of view. An F-stop of f/9, a shutter of 1/320 sec, and an ISO of 250 were used. The image was shot in the evening at about 5:30pm using natural lighting. The panorama, which consists of 5 different photos, had a final size of 9188x3926 pixels. It is estimated that the panorama encompasses about 120°, or one-third of the horizon.

Image processing and post-production was done using Adobe Photoshop software. The five base images were stitched together using Photoshop's "photomerge" tool. Since photomerge attempts to autocorrect distortion, the outputted panorama had curved edges, so the image was cropped to be rectangular. The color was also altered, although very minimally. I heightened the contrast and increased the saturation for lighter colors to get a bluer sky and whiter clouds. The before and after photos can be seen in Figures 2 and 3 below.

Figure 3: Unedited Photo

Figure 4: Photo After Editing

V. Conclusions

This photo does indeed fulfill its intent of capturing an interesting cloud formation and revealing the physics behind how the cloud formed. I feel that the use of a panorama gives a more complete illustration of the clouds at that moment, and the slight Photoshop editing creates pleasant contrast and colors. The image clearly displays Altocumulus Standing Lenticular clouds, and they Skew-T diagram reveals details on how this cloud structure formed. For future work related to this project, I might try to increase the scope of the panorama by either extending it through the east and into the south or capturing more of the clouds overhead as well as clouds near the horizon.

VI. References

1. Pretor-Pinney, Gavin. *The Cloudspotter's Guide.* New York: Penguin Group, 2006. Print.

2. <http://www.geo.hunter.cuny.edu/~tbw/wc.notes/5.cond.precip/clouds/lenticular.jpg>

3. "Atmospheric Soundings." *University of Wyoming College of Engineering Department of Atmospheric Research*. Web. 19 Feb 2014. <http://weather.uwyo.edu/upperair/sounding.html>.