Flow Visualization: The Physics and Art of Fluid Flow

Cloud Image Report #2

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The fourth assignment in the Flow Visualization course (MCEN 4151) is to capture clouds for a second time. My personal intent for this assignment was to capture an interesting effect in the clouds, and make an overall appealing image that enables the viewer to observe part of this beautiful natural phenomenon that occurs just about every day. Most people take little notice of the clouds above them, unless there is some sort of precipitation occurring. This assignment was not only used for personal benefit, but also to share the majestic views of what resides above us. Having a residence in or near Boulder, Colorado is quite the advantage to this assignment, as being so close to the mountains enables an amazing scene with extraordinary weather patterns. Since this was the second cloud assignment of the course, an additional personal goal was to attempt a different technique, and capture a single interesting part of a cloud, instead of a landscape full of clouds that was captured in my first assignment.

As I exited the grocery store in the late afternoon on Sunday, March 11^{th}, 2012, I noticed astonishing clouds over the mountains. I quickly grabbed the only camera available; a fancy point-and-shoot style camera described in more detail below, and started taking pictures of this beautiful sight. I focused on one part of the large cloud mass that I thought had the greatest detail and interesting action. The cloud mass began on the south side of the Flatirons, and the formation extended all the way across the mountains to the north side of the Flatirons, above Red Rocks in Boulder, Colorado. The image was captured at approximately 7:08 pm MST. The camera faced west, and was held in my hand at eye level, about 5.5 ft from the ground, angled at about 20^0 upward from the horizontal sidewalk surface that I stood on. The image captures the northernmost part of the cloud. The surface temperature was about 57^0 F, and the winds were gusting at about 18.3 mph from the west [1].

According to the Skew-T plot shown below in Figure 1, there were no clouds in the sky. There are a few reasons for this discrepancy. One is the time difference. The picture was taken at 02:00 Z on March 2012, however the closest available Skew-T plot was taken at 00:00 Z on that date. The plot was also taken at a weather station in Denver, Colorado. The center of Denver resides about 30 miles southeast from the center of Boulder, where the photo was taken. The geography of these two areas is far different as well, which is apparent due to Boulder's proximity to the mountains on Colorado's Front Range. Weather can change drastically in a few minutes of time, especially this close to mountains. For a more accurate representation of the weather at the time of the photograph, weather sounding data closer to the actual cloud was located, originating from the CU Boulder campus weather station [3].

Unfortunately, this weather station can only report information on the surface. The maximum surface relative humidity that day was 37%, which would also indicate the lack of clouds in the sky. The formation of these clouds must have occurred due to the mountain geography, making them orographic clouds. This would also correspond to the winds coming from the west. When air is forced to rise quickly, as in over a mountain, it is cooled rapidly. If the air cools to the dew point, condensation forms on particulate matter in the air parcel, and clouds form. This is likely what caused the cloud in the final image. Although the high winds shear the top of the cloud, the bottom and middle sections remain relatively undisturbed, and form in a thin layer, indicative of a stable atmosphere. This does not correspond to the Skew-T plot, for reasons noted above.

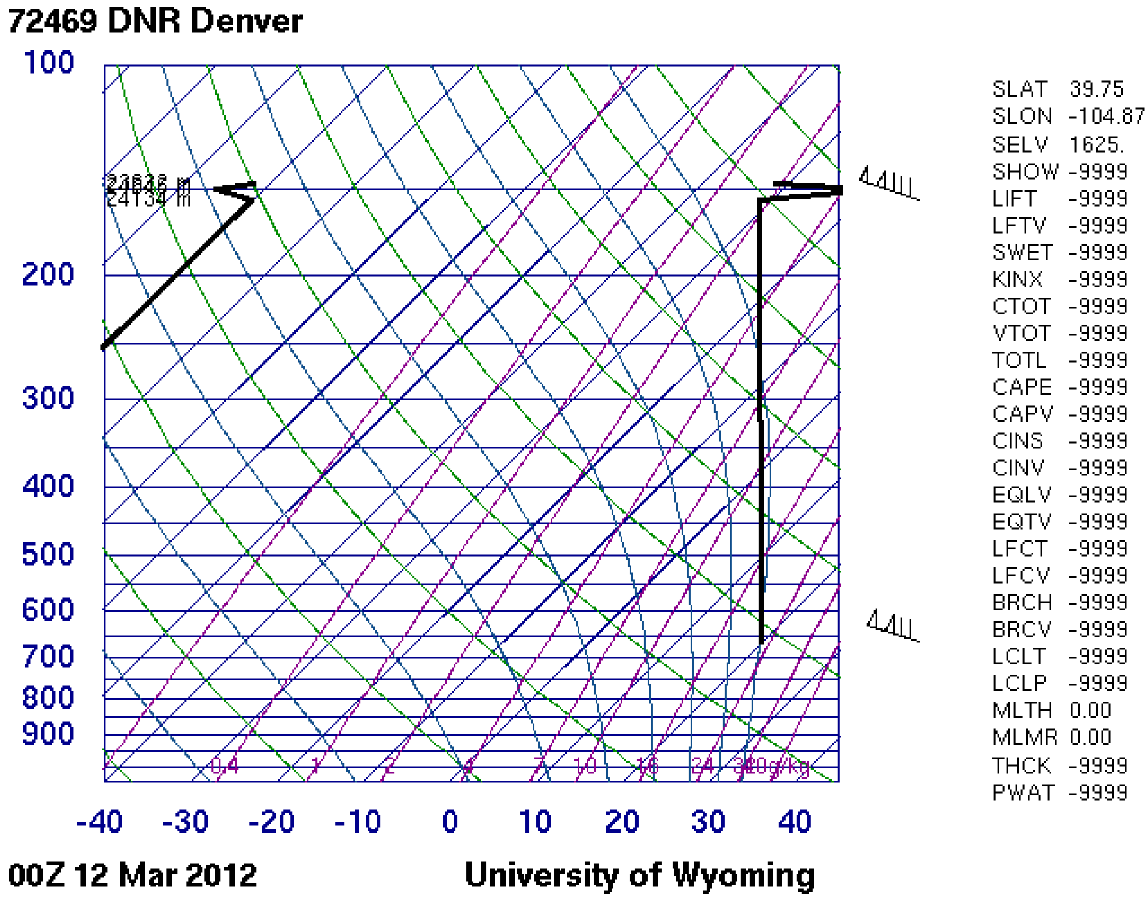

Figure 1: Skew-T Plot. Provided by the University of Wyoming Engineering Department. [2]

The clouds are likely a stratocumulus, because the cloud is in a stable layer, but the layer is wide and fluffy in appearance. The clouds are an estimated 6,500 ft above sea level, which is only slightly higher than 1,000 ft above the elevation of Boulder at 5,430 ft. The entire cloud was about 2,000 ft wide; the camera only captured a small portion of the entire cloud.

The camera used to capture this image was a Nikon Coolpix P7000, which is a point-and-shoot camera with the control of an SLR. The lens focal length was 20.1 mm. I was able to manipulate the settings without having manual control of the focus. The field of view is an estimated 100 ft wide. The ISO was set at 100 in order to produce the crispest image possible, along with an aperture at f/5.0 to allow enough light into the camera, as it was during sunset, so lighting was dim. The shutter speed was 1/180th of a second, this was a quick shutter speed, and allowed every part of the image to be captured without movement or motion blur. The only post processing used a rotation of the image, as the final image is flipped 180 degrees from the original orientation. Original and final image dimensions are both 3648x2736 pixels, which is the largest available format while shooting in JPEG mode, because the picture appeared more colorful in JPEG compared to RAW.

The image reveals some interesting fluid flow. I was able to capture an appealing picture that shows a single cloud in great detail. I chose to flip the image upside down because it added more interesting characteristics, with the brighter half on top, while the darkness remains on the bottom. After much debate, I chose to leave the tiny tree in the upper middle of the photograph in without removing it with Photoshop. I like how the tree gives a false scale to the cloud, because the tree is much closer to the camera than the cloud is, making the cloud seem abnormally massive. The cloud has great detail and contrast to the background with the red color. In order to develop this idea further, it would take enough patience to wait for this specific cloud to appear again around Boulder, which happens quite often around sunset.

Works Cited

1. Weatherspark Beta. Web. 01 May 2012. <http://weatherspark.com/#!graphs;a=USA/CO/Boulder>.
2. "Atmospheric Soundings." *Wyoming Weather Web*. Web. 01 May 2012. <http://weather.uwyo.edu/upperair/sounding.html>.
3. "Atmospheric and Oceanic Sciences." *Atmospheric and Oceanic Sciences*. Web. 01 May 2012. <http://paos.colorado.edu/index.php?option=com_wrapper>.

Appendix A – Original Image