Jason Ortmann
Flow Visualizations
MCEN 4228-010

Assignment 5: CLOUDS 2

Though most of the fluid phenomena that are captured on film are done in a very controlled environment, we must still rely on nature to supply some of the most extraordinary images in a very uncontrolled way. The most common form of this can be seen each day in clouds, and despite their presence nearly every day, we tend not to appreciate them. The behavior of the clouds along with the extremely uncontrolled environments combine to provide some of the most intriguing flow visualizations. The goal of this photograph was to capture one of these moments to not only show characteristics of the fluid flow, but also to create a very eye catching image.

The original image (seen in Figure X) was taken facing west from the top of the Engineering center parking garage at the University of Colorado at Boulder. This location was high enough up so that no trees were blocking the view of the clouds. Knowing the approximate distance from the photograph and the height of the clouds themselves (shown in Figure 1 below), the angle of elevation was approximated to be __° using the following trigonometric equation:

$$\theta = \tan^{-1}\left(\frac{height}{length}\right)$$

Equation – 1

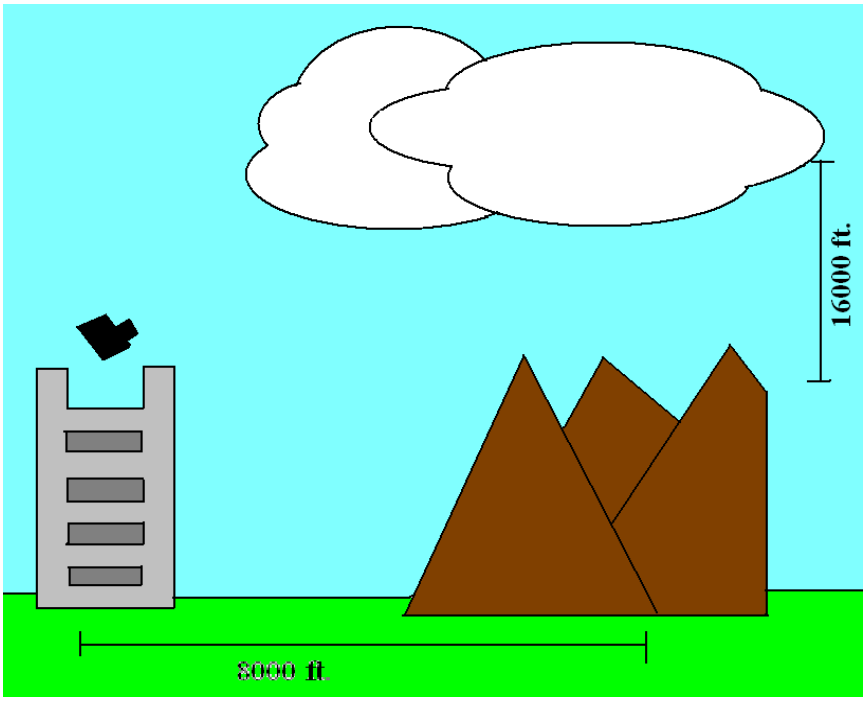

Figure 1 – Photograph Setup

This image was captured several hours after sunrise on April 2nd, 2009 at 9:35 in the morning. This time of day allowed for all light to come from the east behind the camera.

As shown in Figure X, the clouds in this image are at a moderate height and sweep across the sky. Due to the relative height and shape of the clouds, the clouds in this image are appear to be Altocumulus Lenticularis (3). The lenticular cloud is very common to the rocky mountain region because they only form over mountain peaks (5). There were also several others of this type of cloud in other portions of the sky at the time of the photograph. Below is a Skew-T Plot from Denver (approximately 20 miles from location) a few hours before the photograph was taken.

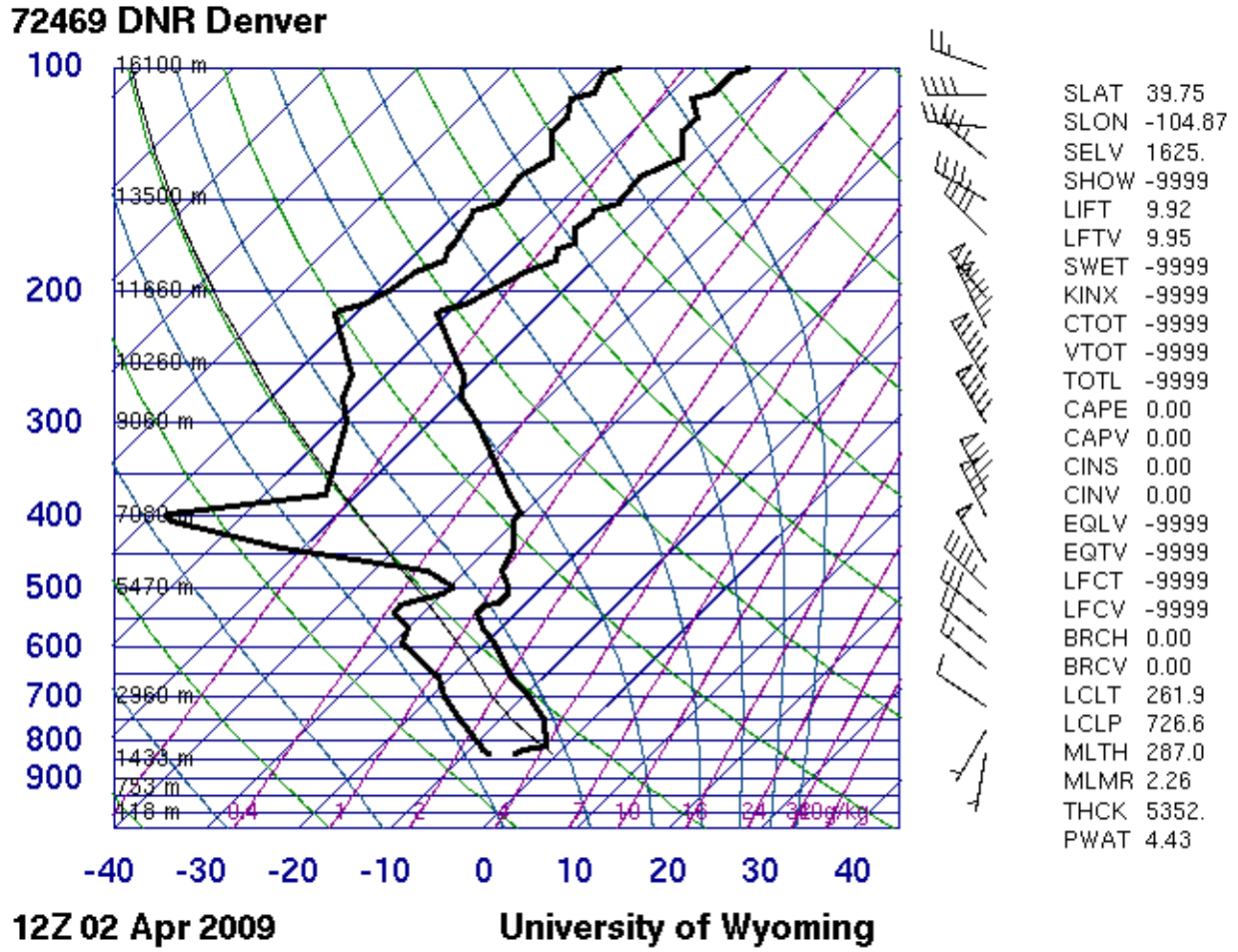

Figure X- Skew-T plot for Denver on April 2 at 6:00 AM (1)(2)

From the plot, we can estimate that the elevations of the clouds in our image are around 5000 m (or 16,000 ft). At that altitude, the dew point is closest to the temperature of the air and has the most chance of producing clouds. When comparing the change in temperature as the altitude increases of the reference line and the adiabatic line, it is apparent that the slope is greater for the reference line. This indicates that as the air rises, it will be warmer than the air surrounding it, causing it to continue to increase and become unstable. This instability is what causes the type of clouds that we see in the photograph. Because these are likely Cumulus clouds (below 20,000 feet [3]), the temperature is moderately low which has an effect on the clouds and their flow due to the instability. Finally, there were moderate gusts at the time of the photograph, which also plays a role in the motion of the clouds and how they sweep across the sky in Figure X.

The image was taken a great distance from the object due to the fact that clouds were the focus of the image. The distance from the object to lens can be approximated once again using the height and length from the object. The equation used is the Pythagorean equation below.

$$a^2 + b^2 = c^2$$ Equation – 2

Knowing the approximate height and length of the photograph (shown in Figure 1) allows for the distance from the object to lens of 17,888 to be calculated. The field of view of the image can also be determined from the following equation:

$$\frac{o}{d} = \frac{i}{f}$$ Equation – 3

Where "o" is the field of view, "d" is the distance from object to lens, "i" is the field stop, and "f" is the film distance (4). Though this would give an exact field of view, the distance from the object to lens was approximated and therefore would not yield a good representative field of view. Instead, the field of view can be approximated visually to be about 5 miles wide. The lens focal length for this image was 6.7mm and was taken with an Olympus 720SW digital camera. The size of the image taken was 3072 x 2304 pixels, with an f-stop of f/6.3 and an ISO rating of 64. The shutter time was approximately ¼ of a second. Also, because the image was taken outdoors during the day, no additional light was necessary. Finally, some Photoshop enhancements were done to enhance features of the clouds. The image was first cropped to emphasize the clouds with a final image size of 3075 x 1759 pixels. The curves feature in Photoshop was then utilized to alter the darkness of the image and change the color levels to match the range of the intensities present in photo. This brought out the colors and provided a contrast to boost the features of the clouds and mountains.

After reviewing the final image, I believe the intent of the image was fulfilled completely. The image is able to show unique flow characteristics of the clouds while portraying it in a very dramatic way. I like that though very little of the image was changed due to Photoshop effects, the feature of the clouds become more visible and the mountains almost begin to look fake. Although I would not prefer to use Photoshop to alter the image, it was necessary in this case to enhance the image, and no drastic changes were done to the image other than cropping. These enhancements bring out the physics of the clouds that are present in the image. One thing I would like to improve on is the detail present in the image. This would require an optical zoom that is no available with the camera I used. A more advance lens would be needed to show the desired detail. Overall, I was very satisfied with the image.

Works Cited

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(2)
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(4)
Jacobson, Ralph (et al.) (1988). *The Manual of Photography* (8th ed. ed.). Focal Press.
ISBN 0-240-51268-5. p.48

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"Altocumulus Lenticularis."
http://mmem.spschools.org/grade5science/weather/altocumulusII.html

Appendix A

Figure X – Final Photograph

Figure X – Original Photograph