# Project 2: “Clouds 1”

MCEN 5151 – Flow Visualization
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## 1.0 Introduction

This report focuses on the first cloud assignment for MCEN 5151 – Flow Visualization (Flow Vis), Spring 2013. The clouds assignments are designed to photograph atmospheric phenomena, and then comparing the pictures to correlating atmospheric readings. The first clouds project provided a look into another focus area of photography; shooting large depths-of-field. This project was measurably different from the first assignment, "Get Wet", which focused on photography objects on a much smaller, more close-up scale.

The final photograph was part of a series of orographic clouds that formed off the Flatirons in Boulder, CO. Photo-editing for white-balance was completed in the freely distributed software program GIMP (*www.gimp.org*).

## 2.0 Photograph Timeframe

The final photograph, shown on the front cover of this document and in Figure 3, was taken on Flagstaff road's first Boulder Valley overlook, facing SE. The time of the photograph was Feb 17th, 2013, 3 PM MST, or Feb 17th, 2013, 9 PM GMT. At that specific time, the temperature was 61 $^{O}$F, and a western wind was recorded at 23 mph.[1] The clouds were taken approximately 60$^{O}$ from the horizontal plane, and was greater than 6,500 feet above sea level.

## 3.0 Atmospheric Determination

The clouds in the final photograph are primarily altocumulus clouds. The sun was directly on the cloud at the time of the photograph, yet the undersides of the clouds are not particularly dark, which are a good indicator of the clouds instead being stratocumulus.[2] The main cloud in the final photograph is comprised of a number of cloudlets, giving the clouds the appearance of altocumulus stratiformis.[2] Similar clouds could be seen throughout the very blue sky, but were particularly prevalent to the southeast, as they moved farther away from the mountains.

Looking at atmospheric conditions, weather was very cooperative in the days surrounding the photograph. There was a steady increase in daily temperatures prior to the photograph, peaking at similar conditions on Saturday, February 16th, 2013. While temperatures did cool off in the days following, no measureable precipitation was observed until Thursday, February 20th, 2013. The winds were characteristic for the time of year, with a spike in wind-speed in the early afternoon hours.[1]

A Skew-T diagram also does an excellent job of exhibiting atmospheric conditions. As Skew-T diagrams are recorded in GMT, the closest diagram for Sunday, February 17th, 2013, at

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[1] Taken from WeatherSpark beta, February 17th, 2013; *www.weatherspark.com*

[2] Pretor-Pinney, G. *The cloudspotter's guide: the science, history, and culture of clouds*. New York, NY: Perigee, 2006. Print.

15:00 MST (21:00 GMT), would be the Skew-T for Monday, February 18th, 2013, at 00:00 GMT:[3]

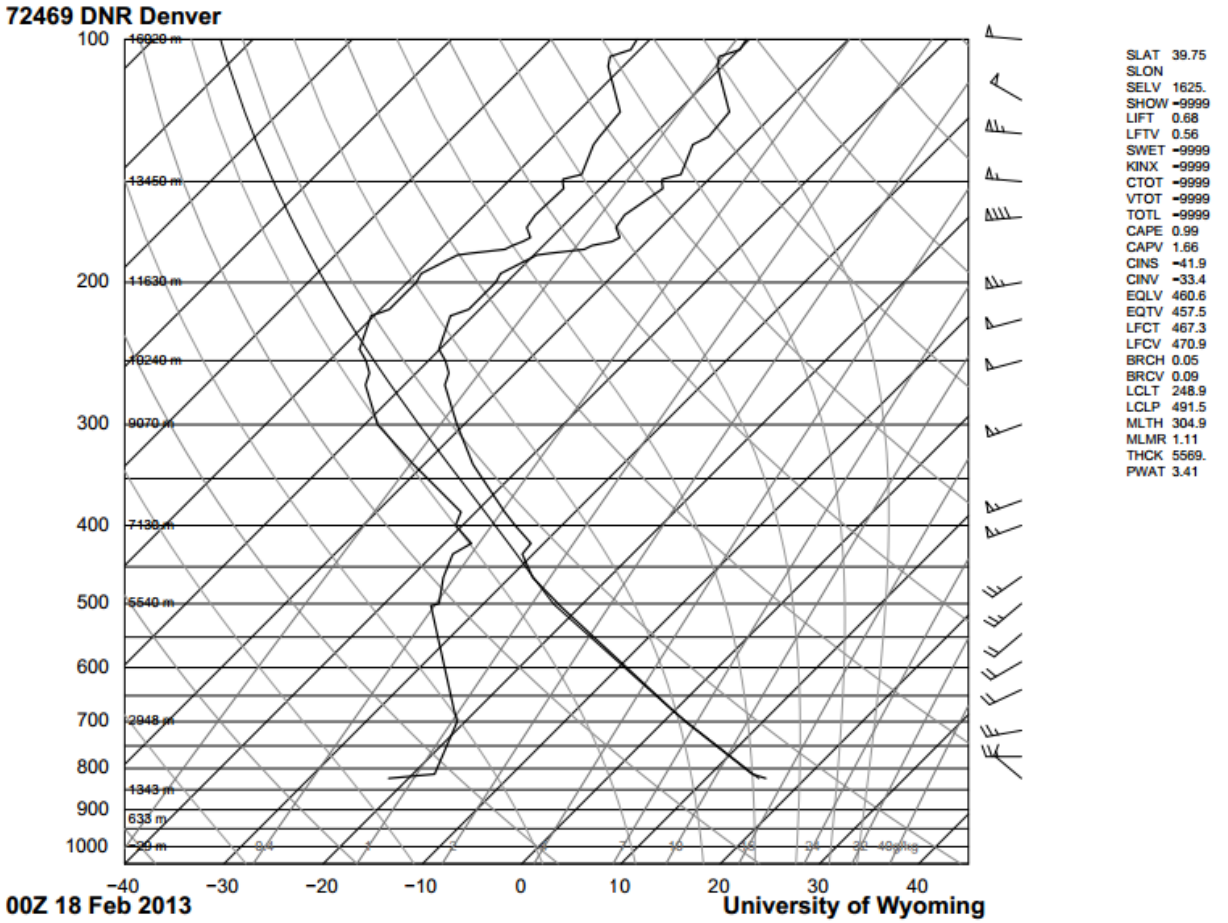


**Figure 1: Skew-T Diagram for 15:00 MST, February 17th. 2013 Timeframe**

Looking at the Skew-T's CAPE value, the atmosphere during the photograph was beginning to destabilize; altocumulus clouds occur on the border of instability. The stability is also shown by raising a parcel of air to cloud height. Looking at the adiabat (light black, smooth curve) line, it would experience cooler temperatures and desire to return to its original location. The temperature and dew point lines pinch together around 22000 feet for cloud-forming.

## 4.0 Photograph Specifics

Being so close to the foot of the Flatirons, it was the perfect place to watch the clouds form as the rolled over the mountain range. The wind would push the clouds over the Flatirons peaks, which would then re-form into new clouds shapes as they drifted farther to the east. Watching the clouds re-form was the inspiration behind the photographs taken, as they could be observed in succession to tell the life-story of the cloud.

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[3] Taken from the University of Wyoming, College of Engineering, Department of Atmospheric Science site *http://weather.uwyo.edu/upperair/sounding.html*

The final photograph was taken with the Olympus Stylus XZ-2 digital camera. The field of view was at a large angle from horizontal, in an effort to remove any traces of Boulder at the bottom of the photograph. A 1.0x zoom was used, and the focal length was 6.4 mm (30.0 mm – 35mm equivalent). The shutter speed was 1/800 sec, the aperture size was F6.4, and the ISO was set at 100. The original image was 3968x2232 (16:9 ratio) pixels and taken in .JPEG format. The original photograph is shown in Figure 2. After some post-processing, the final image was 3968x2232 and .TIF format.

**Figure 2: Original Image**

The white balance for the photograph was recorded at 5300K. However, the blue color of the sky suggested that the correct white balance was closer to 6,500K. To compensate, the white balance levels were adjusted in post-processing to attempt to correct the slight loss in color. Using GIMP, the white balance was adjusted using the levels tool for each the R, G, and B values. Because of the limited range of the colors in the photograph, both the input and output were modified to provide a more full range. The final white balance values are listed in Table 1.

**Table 1: R,G,B Levels Adjustments**

| | | | | |
|---|---|---|---|---|
| **Red** | Input<br>Output | 25<br>20 | .50 | 162<br>255 |
| **Green** | Input<br>Output | 50<br>18 | .65 | 182<br>255 |
| **Blue** | Input<br>Output | 87<br>66 | 1 | 191<br>213 |

While adjusting levels did reset the white balance closer to true, the background still retained a purple hue. The final image is again shown in Figure 3.

**Figure 3: Final Image**

## 5.0 Conclusions

Although it is only one image from the series photographed, the image still shows some interesting fluid flow. The beginning cloud formation following its appearance over the Flatirons is visible. The cloud also has a couple of wispy areas that appear to be controlled by gravity, which add texture to the cloud. According to the Skew-T diagram, the clouds formed around 22,000 ft. This was higher than expected, but clouds ranges are hardly strictly defined.

Future work includes fixing the overly fluorescent-shaded white clouds in center of photographs, to have a more natural white, and further adjust the blues to not approach black near the top of the photograph. Additional future work includes applying the same editing techniques to the whole picture series, and stringing them together in a time-lapse sequence. In doing so, one could better visualize the full cloud forming together after rolling over the Flatirons.

## 6.0 References (Re-listed)

1) WeatherSpark beta – Data taken for February 18th, 2013, 00:00 GMT

2) Pretor-Pinney, G. *The cloudspotter's guide: the science, history, and culture of clouds*. New York, NY: Perigee, 2006. Print.

3) University of Wyoming, College of Engineering, Department of Atmospheric Science site *http://weather.uwyo.edu/upperair/sounding.html*