Formation of Cirrocumulus Clouds Over Folsom Field

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Clouds Second Assignment
Flow Visualization Fall 2018
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Introduction

Since the Clouds First assignment, I have been keeping an eye out for unique cloud formations whenever I am outside. With the weather starting to be much colder, many different cloud formations have been visible that weren't around for the Clouds First assignment. There were several days where clouds formations looked very cool, but were not much different than my Clouds First assignment. I wanted to capture something different for Clouds Second and I was able to do this at the CU Football game versus Washington State. I, unfortunately, had a feeling that the Buffs weren't going to win this but I was able to capture my image while the Buffs were ahead. SKO!

Experimental Setup

There was no controlled experimental setup for this image. This image was captured at 2:31pm on November 10, 2018.

Cloud Physics

As shown in the image, the clouds captured are classified as Cirrocumulus. Cirrocumulus clouds are formed in stable atmospheres. Cirrocumulus clouds are high level clouds that typically form between 6,500 to 13,000 meters above ground level. These types of clouds are typically slightly larger than cirrus but smaller than cirrostratus. Often times, Cirrocumulus clouds can form due to the breaking down of thunderstorm clouds. I believe that this may have been the case for these clouds because, on the next day (11/11), a severe snow storm came through Boulder dumping almost a foot of snow. The Skew-T shown in Figure 1 will allow us to analyze exactly where these clouds were located.

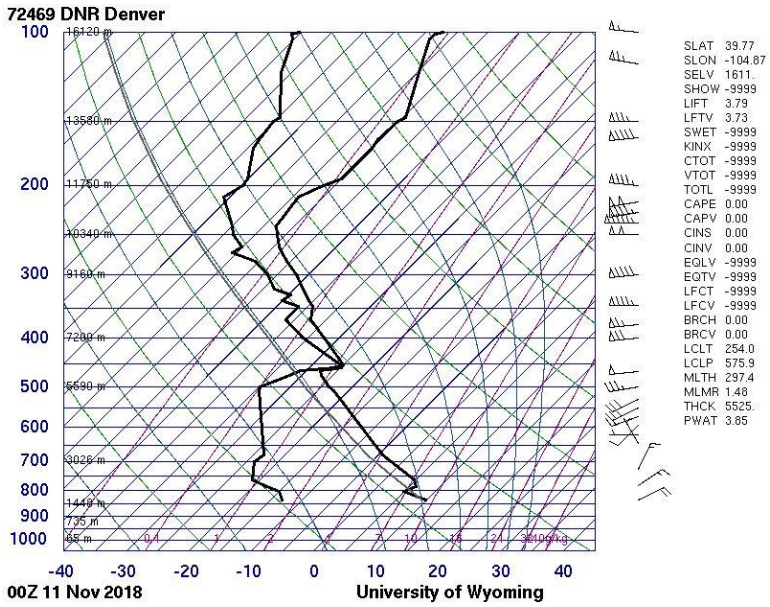

Figure 1: *Skew-T data from Denver International Airport at 6pm MST on November 10, 2018*[1]

The Skew-T plot shows a variety of atmospheric information; for the purpose of this report we will focus on the following items. The dark black line on the right half of the plot shows the atmospheric temperature, while the dark black line on the left half shows the dew point. It is important to note that when the temperature and dew point become close to one another, the likelihood of a cloud forming at this location is high. This is because that at this altitude, the atmospheric temperature is close to the required temperature to generate moisture (dew point). From Figure 1, the two dark black lines become extremely close around 6,500 meters. Note that below this altitude, the two lines are extremely far apart suggesting that no clouds will be formed at these altitudes. Above 6,500 meters, the two lines stay close to one another, this means that there is a decent chance that clouds will form. At roughly 10,000 meters the lines begin to stray away from one another. Based on this information, it can be determined that the clouds captured in this image exist between 6,500 and 10,000 meters, supporting the claim that they are Cirrocumulus.

As shown by the wind indicators on the Skew-T in Figure 1, the wind at all altitudes is blowing almost directly east. This wind direction is a very common occurrence in Boulder due to the nature of the valley that we live in. The clouds at 6,500 meters are moving east at

[1] "University of Wyoming Atmospheric Sounding Data." Atmospheric Soundings. (00Z) November 11, 2018. http://weather.uwyo.edu/upperair/sounding.html.

approximately 50 knots. This is a high speed and supports the knowledge that a storm front is being blown into the area. This made for a very windy and chilly game!

Finally, the CAPE value (shown to the right of Figure 1) is 0, cementing that the atmosphere was stable for these clouds. In addition to the Skew-T data, a Ceilometer reading was obtained for this day. Ceilometers typically work by emitting a strong beam of infrared or ultraviolet light (or this can be a laser depending on the application) at the cloud ceiling overhead. The reflected light by the base of the clouds is then received by a photocell that can estimate the height and thickness of the clouds.[2] This data can be seen in Figure 2 below.

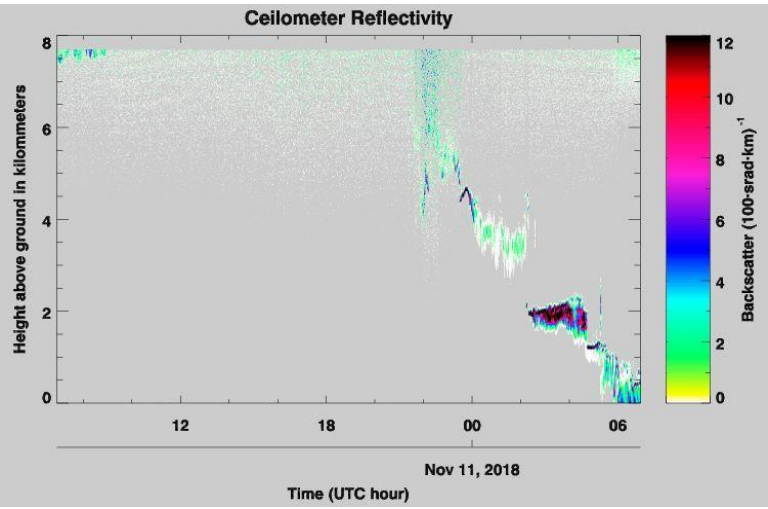

Figure 2: *Ceilometer Reflectivity Data[3]. Note that the time the image was captured was at 2100 (UTC hour) on November 10, 2018.*

Both sets of data support the assumption that the clouds within the foreground of the image are Cirrocumulus. Additionally, it is fun to note that as the night progresses, the clouds become much closer to the ground. This is because on November 11th, there was a severe snow storm that came through Boulder. The low clouds represent those snow clouds.

Photographic Technique & Post Processing

This assignment required little precision and was really a "push-here-dummy" type shoot, I just let the clouds do all of the work. The camera that was used to take this photograph was an iPhone X. This experiment did not require extremely quick shutter speed; however, the iPhone

[2] Morris, VR. "Ceilometer Instrument Handbook." *US Department of Energy*, 2016. doi:10.2172/1036530.
[3] "Ceilometer Reflectivity." Skywatch Observatory. November 10, 2018. http://skywatch.colorado.edu/.

decided to modify its exposure time to 1/3003sec. The shot was captured in the stands of Folsom Field under direct sunlight. No additional lighting was required. The camera settings used were as follows:

Photo Dimensions	3024 x 4032 Pixels
ISO Speed	ISO - 25
F-Stop	f / 1.8
Exposure Time	1 / 3003 sec
Flash Mode	No Flash
Focal Length	4 mm

Table 1: *Camera Settings*

Colorado is well known for its blue skies and bright white clouds, and this was no exception, in post-processing I essentially just tweaked the color curve to make the background blue pop and bring out some color within the brick of Folsom Field. I preformed my post-capture editing through Gimp. Figure 2 shows the color curve utilized to generate the editing progression seen in Figure 3. The raw image captured slightly more than I desired so I did some slight cropping to bring the focus back to the clouds. Additionally, I cropped out any advertisements (don't want to be sued).

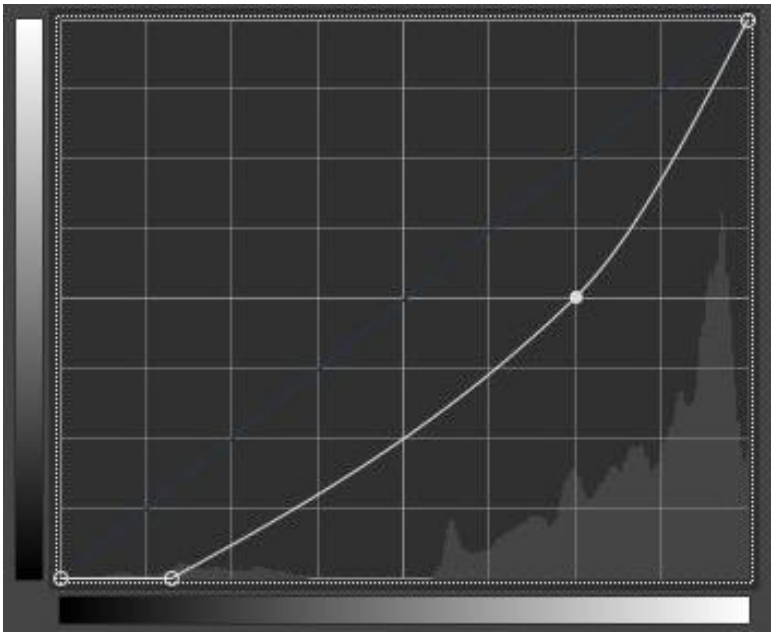

Figure 2: *Color correction curve utilized to generate the final image.*

Figure 3: *Image progression after editing. Raw file is shown on the left, final edited photo on the right.*

Visualization Technique

This image required no visualization techniques, nature is beautiful this way!

Results

I am extremely please with this image! My Clouds First image did not have a great foreground and I really wanted to capture something that would have a nice foreground as well as the subject of the image. This image allowed me to capture some CU Buffs football as well as clouds all in one image. I will continue to photograph natures beauty in the future!