Clouds & Atmospheric Phenomenon

Cirrostratus, December 1, 2021, 9:50AM MDT, Boulder, CO

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Cloud 2 Assignment Report

1 Introduction

For the second cloud photo, I wanted to capture something visually pleasing and atmospherically interesting. I trained myself to always be looking at the sky conditions so I could capture clouds. With so many photos I was able to sift through them and find the ones containing interesting atmospheric phenomenon. I had previously explored the concept of Kelvin-Helmholtz (KH) instability through the use of smoke. During my research of the phenomenon I realized that this was something that could be observed in clouds. With that knowledge, I began to notice KH instability much more often. This is what led me to use this photo for my final submission. I was walking onto campus, as I do every morning, and facing west. With the Flatirons as a backdrop, I captured what I thought was a striking example of a cirrostratus cloud hovering over the mountains and stretching for miles. Upon further inspection, I noticed the cirrus clouds above and could see an almost textbook example of KH roll-ups. This is a picture I capture a lot because it is one of the most pleasing views on campus and it just so happened that I was also able to catch one of the most visually pleasing atmospheric phenomena in this setting.

2 Discussion of Circumstances

My submission image for the second cloud assignment was captured in Boulder, CO which is about 25 miles northwest of Denver, CO. The image was taken as I was walking onto campus adjacent to the Business Fields. The field of view was oriented west-southwest so as to capture the Flatirons next to the Koelbel Building. I didn't point the camera much above horizontal because the field of view is more than wide enough to capture a large swath of sky and capturing this particular view of the campus is aesthetically pleasing. I captured this image at approximately 9:50am on December 1, 2021.The way the morning light is cast on the leeward side of the mountains and the east face of the campus buildings makes this a compelling image on almost any day.

3 Discussion of Clouds & Atmospheric Conditions

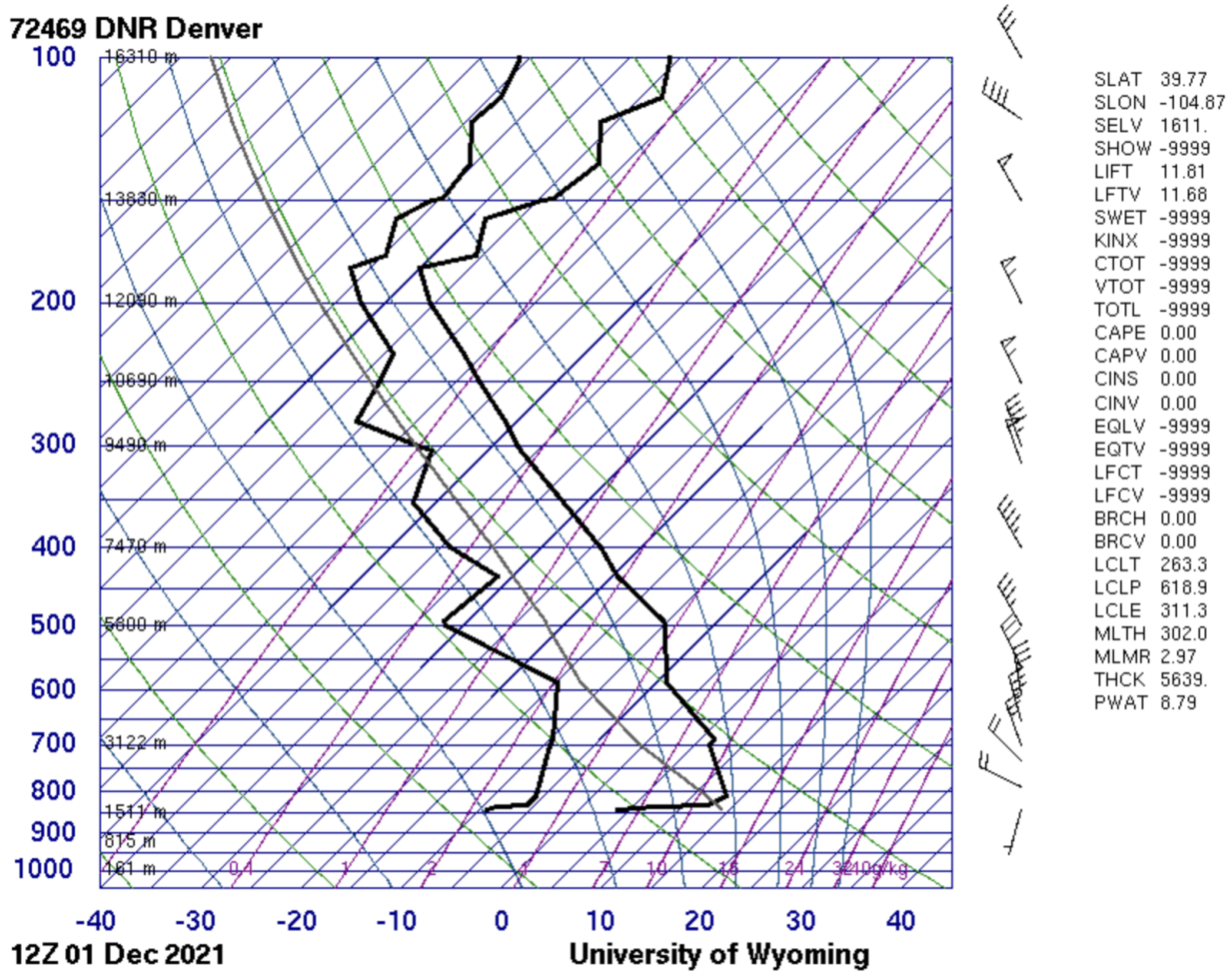

Figure 1: Skew-T plot from Denver station on December 1, 2021

The Skew-T plot on December 1, 2021 reveals that the clouds are most likely to form at approximately 12,500 meters or 40,000 feet. This agrees with the photo itself which clearly shows that the clouds are at very high altitude. We can also see that the CAPE value is 0.00, which would suggest a stable atmosphere. This conflicts with the observation of KH instability and could be explained by local instability further away from the observation station. The presence of cirrostratus clouds at at a slightly lower altitude does indicate that the atmosphere was generally stable. The winds aloft at this altitude are in excess of 50 knots which is fairly typical for air at this altitude.

The KH roll-ups that can be seen are a result of shear forces between two different layers of air. In clouds, this can mean that there is a local volume of air where the wind in the upper layer is moving much faster than the wind in the lower layer. Typically the upper layer contains dryer air which causes evaporation and explains why the they cloud formations tend to disappear so quickly. KH instability can also be caused by temperature inversions where warmer air that is more dense ends up on top of cooler, less dense air resulting in a wave-like pattern in the clouds.

4 Visualization Technique & Equipment

(a) Before post-processing (b) After post-processing

Figure 2: Before and after post-processing

Once again, I captured this photo with my iPhone 13 Pro. I used this in conjunction with an application called Halide which gives manual control over exposure settings. I like to take advantage of the telephoto lens for many of my cloud photos because it allows me to avoid capturing distractions like street lights, power lines, and random buildings. These sorts of man made objects usually detract from the aesthetic value of the photo and are unavoidable since I don't usually get to choose when and where I see interesting clouds. However, I chose to use the main wide angle lens this time because I wanted to capture the surroundings.

This lens has a 5.7mm focal length and simulates a 26mm focal length on a DSLR. It has an $f/1.6$ aperture by default. For this photo I used an $f/1.5$ aperture setting, an ISO of 50, and a $\frac{1}{6211}s$ shutter speed. The original image had a size of 4032x3024 pixels and was cropped to a size of 2231x1577 pixels. This allowed to photo to be uploaded more easily and brought cut out some of the less important aspects of the image. I also made several adjustments to the image in Apple's Photos application which are detailed in the table below:

Brilliance	0.34
Exposure	-0.03
Highlights	-0.06
Shadows	0.06
Brightness	0.06
Contrast	0.07
Black Point	0.06
Saturation	0.13
Vibrance	0.08

5 Conclusions

My image reveals the beauty of KH instability in the atmosphere is a testament to the incredible weather phenomenon that can be observed along the Front Range of northern Colorado. I was pleased with the way these high altitude clouds complimented the views of campus and the Flatirons in the mid-morning light. I liked having to opportunity to use such an interesting image that included more subjects than just the cloud. Previously I had focused on only the cloud because of the less aesthetic surroundings. I am also happy to have seen KH instability in a cloud because it will definitely make me more aware of this phenomenon in the future. I could certainly develop this idea further by continuing to capture images of interesting atmospheric phenomena with a gorgeous natural or man made backdrop. I will most likely continue to use my iPhone for this and develop my skills with manual exposure settings through the use of prosumer grade applications like Halide.

References

"Atmospheric Soundings", http://weather.uwyo.edu/upperair/sounding.html

Oblack, Rachelle. "What Is a Kelvin-Helmholtz Cloud?" ThoughtCo, ThoughtCo, 11 Mar. 2019, https://www.thoughtco.com/kelvin-helmholtz-clouds-3443792.

"Types of Clouds and What They Mean", https://www.jpl.nasa.gov/edu/learn/project/the-types-of-clouds-and-what-they-mean/