Clouds First Report

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Flow Visualization Fall 2022

Cumulus Virga cloud, 9/29/22, 5:58 PM, Kittredge Fields Boulder, CO

Context and Purpose

This image was produced for the first cloud assignment of the semester. I chose this as my final image to edit mainly because of the rainbow, but also because of the way the rainbow appears to emerge from the low hanging cloud. Additionally, the green field added more color to the image that was not present in many of the other cloud images I had taken.

Circumstances

This image was taken facing southeast at the edge of Kittredge fields on CU Boulder's main campus. Captured at 5:58 PM on September 29, 2022, the camera was facing roughly 5 degrees above horizontal, in order to capture the ground as well as the clouds.

Cloud Information

While it is difficult to classify clouds, there are some clues in this image that help identify it. The rest of the sky in the image appears partly cloudy with good visibility, and no precipitation was expected for the rest of the day. At the time, winds were 12 mph heading WNW. There were no tall column clouds visible, suggesting a stable atmosphere.

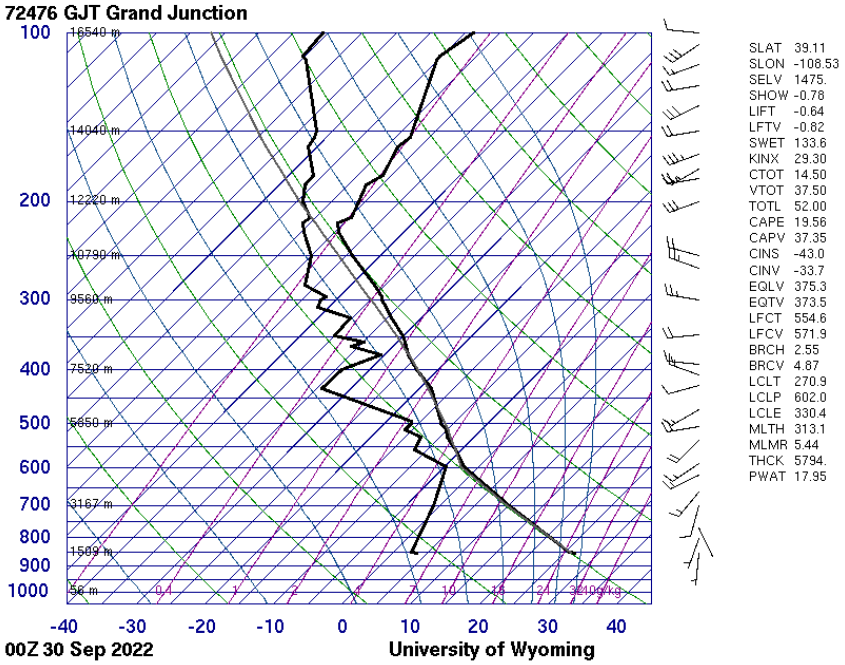
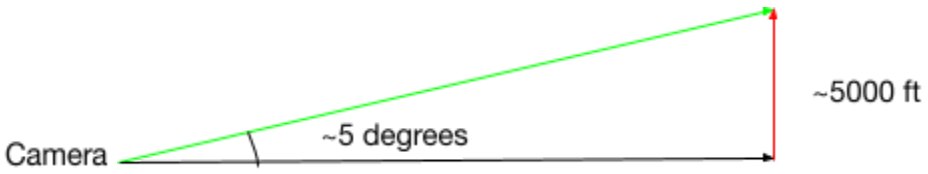


Figure 1. Skew-T diagram for September 29, 2022 ~6 PM

The skew-T diagram reveals that there were cloud formations at roughly 4,000 m and 8,000 - 11,000 m. The general shape of the cloud being "puffy" or a stack of smaller clouds, this suggests that it is some form of cumulus cloud. The cloud also seems to be relatively low, meaning that it is not likely an altocumulus or cirrocumulus, but rather a simple cumulus cloud. This observation notably does not agree with what the skew-T diagram implies, which would

put the cloud well above the typical range for the formation of cumulus clouds. According to weather archives for Boulder, CO on the day of this photo, there was almost no rain, except for brief showers at 9 AM. The bottom left area of the cloud has streaks that look like falling rain, contrasting with the weather archive. What this leads me to believe is that the cloud is a Cumulus Virga cloud. The characteristic feature of Cumulus Virga clouds are evaporating strips of precipitation. The rain-like streaks occur when precipitation falling from the cumulus cloud evaporates before reaching the ground. According to whatsthiscloud.com, the 'virga' cloud feature is common where the air is dryer, which is generally true for Boulder. This could also possibly explain the existence of the rainbow without the precipitation. I could not find information about whether a cold front or warm front were present at the time of the photograph. With the fact that the weather conditions were stable, there was no chance of precipitation, and the direction of the wind blowing from west to north west, it is likely that the cloud was formed due to the orographic effect. Assuming a stable atmosphere, the orographic effect would cause the cloud's elevation to be lowered as it was pushed over the Flatirons.

Photographic Techniques



I will be assuming that the cumulus cloud is at its upper elevation range of 5000 ft, and that the angle of the camera was 5 degrees.

$$d_{object} = \frac{5000\,ft}{sin(5^{\circ})} \approx 57,000\,ft$$

This puts the cloud at a distance of 57,000 ft from the camera. I used my iPhone 11 camera to capture this photo, which has a focal length of 4.25 mm, and a sensor size of 1/2.55 in.

$$FOV = d_{object} * tan^{-1}(sensor\ size/2 * focal\ length)$$

Using the above equation, the calculated FOV is 4,757 ft. Information about aperture, shutter speed, and ISO were not available from my iPhone camera on Darktable software, and thus are not included in this report.

Figure 2. Original unedited photo.

There were two edits I made to the original photo to get my final image. Those were to crop out most of the foreground, and to adjust the RGB curve to increase contrast in the cloud. The saturation was also slightly increased.

Conclusion

I am very pleased with the image I captured, and also am confident in my assessment of cloud type. I would like to know a way to better judge the elevation of the cloud in order to get a better understanding of possible cloud types. I also wish the weather data and skew-T diagram were more accurate to the specific position where the image was taken. If I were to continue developing this report, I could also look into the physics of rainbows interacting with clouds and see if that could provide further answers.

Appendix

University of Wyoming College of Engineering (2022) http://weather.uwyo.edu/upperair/sounding.html

Smith Falls Flying Club https://smithsfallsflyingclub.com/pilot-resources/cloud-tops-skew-t/

Weather Underground (2022) https://www.wunderground.com/history/daily/us/co/loveland/KFNL/date/2022-9-29

What's This Cloud https://whatsthiscloud.com/cloud-features/virga/

Edmund Optics (2010) *https://www.edmundoptics.com/knowledge-center/application-notes/*