Clouds First Report

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Cumulus congestus clouds
Taken 6:18 p.m. on 09/16/2022
Valmont Butte – Boulder, CO

MCEN 4151 – Flow Visualization

10/23/2022

This is my submission for the first Cloud Image assignment for MCEN 4151, Flow Visualization. I've been watching the sky all semester to capture some of the interesting clouds we see in Boulder. This image was taken on an evening in mid-September with a large storm creeping over the 13,000 ft Indian Peaks of the Front Range and spilling down onto the foothills. I wanted to capture the dramatic billows and curls of the storm clouds and seize the chance to photograph what was likely one of the last of this type of storm with Colorado's monsoon season approaching its September expiration date.

Seeing the cloud activity over the mountains, I packed my camera gear and drove east to Valmont Butte to find a good vantage point. The butte is the only high point in the area and has a great view of the mountains to the west. This photo was taken from the top of the butte facing approximately 250° W and +1° from the horizontal on September 16th at 6:18 p.m. The sun set at 7:08 p.m. that evening and was low in the sky at the time this picture was taken, lighting the clouds from behind. Afternoon thunderstorms are common throughout the summer. This time of year is referred to as the monsoon season in Colorado. Monsoon season typically ends in the late summer when daytime temps no longer get high enough to create thunderstorms[2].

The clouds in the foreground of this image are likely cumulus congestus, which are typical for this kind of late season afternoon thunderstorm in Colorado[1]. In the background, some clouds at a higher elevation are visible too. They are likely altostratus clouds based on their apparent height and uniformity. Figure 1 is a Skew-T plot from Grand Junction, Colorado on the west side of the continental divide. The plot is generated from weather balloon data collected at 6:00 pm on September 16th, just before I took my photo.

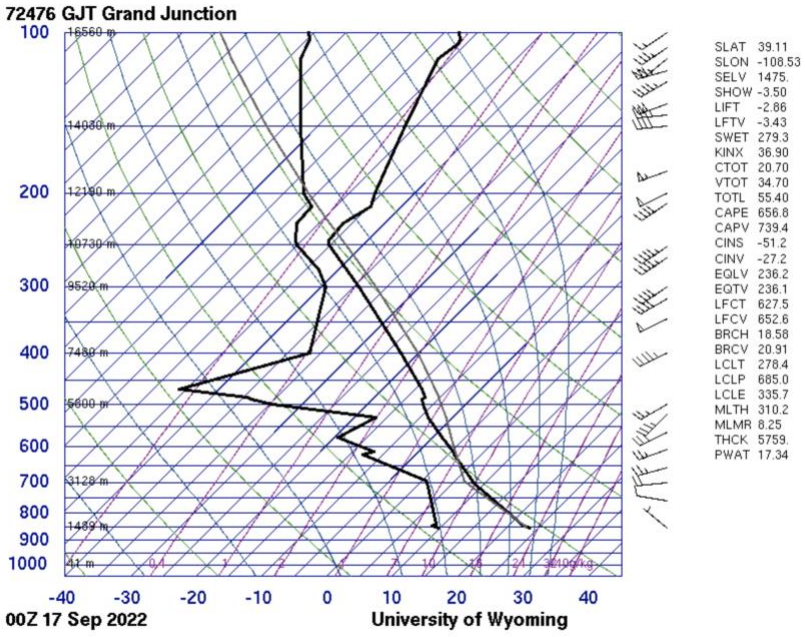

Figure 1: The Skew-T chart, derived from data collected by a weather balloon in Grand Junction, CO at 6:00 p.m. on September 16th, shows a CAPE index of 656.8, a level of atmospheric instability indicative of thunderstorms.

Clouds are likely to exist where the temperature line on the right jogs close to the dewpoint line on the left[3]. This Skew-T in Figure 1 indicates clouds at elevations of about 1,800-5,600 m and 9,500-11,000 m, which agrees with my observation of the two distinct layers. Of course, Grand Junction is far from Boulder, and with a massive mountain range between the locations, it's likely the weather was somewhat different. The CAPE index is a clue that the weather in Grand Junction might have been similar on this day. A CAPE of 656.8 indicates a high atmospheric instability[3], with thunderstorms becoming possible above a value of 500.

This photograph was taken with a Sony Alpha a6300 mirrorless digital camera with a 55-210 mm lens. The field of view is approximately three quarters of a mile based on the appearance of the mountains beneath the clouds, and I was standing about 5 miles away on Valmont Butte in East Boulder when I took the image. I zoomed the lens to a focal length of 180 mm to fill the frame with the cloud features shown. The aperture was set to f/8, the exposure time to 1/640 s, and the ISO to 400. The original image, unedited, is shown below in Figure 2.

Figure 2: Raw, unedited original capture. 6,000 x 4,000 px

Of course, minor image manipulations were required to arrive at the final, edited image. The most notable alteration was the RGB curve, which I dragged down in the center to push the darks to be blacker and increase contrast in the mid tones. I also increased the digital sharpness a small amount. Finally, I cropped the image slightly to direct the viewer's focus to the most interesting parts of the clouds.

My favorite part of this picture is the curling, wisping cumulus "finger" that is reaching out of the bank of clouds. It does a great job illustrating the instability in this storm system. I don't love how dark and austere the picture turned out, but I choose to view it as awe-inspiring. The fluid physics are shown well, but I wish I could have captured more from this storm. I am happy with the result but would like to try some different camera and positioning techniques. Too bad I must wait for next monsoon season to photograph more thunderstorms in Boulder!

REFERENCES/BIBLIOGRAPHY

[1] – Hertzberg, Jean. MCEN 4151 – Flow Visualization, University of Colorado at Boulder. *Clouds 1: Names.* Fall 2022.

[2] – Hertzberg, Jean. MCEN 4151 – Flow Visualization, University of Colorado at Boulder. *Clouds 2: Why Are There Clouds? Lift Mechanism 1: Instability.* Fall 2022.

[3] – Hertzberg, Jean. MCEN 4151 – Flow Visualization, University of Colorado at Boulder. *Clouds 3: Skew - T and Instability.* Fall 2022.