Clouds First Report
MCEN 4151-001: Flow Visualization

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Introduction

On May 11, 2023 at 4:44 PM, this photograph was captured from the summit of Chautauqua Peak in Boulder, Colorado. The photograph captures orographic clouds, which is a type of cloud that forms due to air flowing over a mountain or elevated peak. The elevation this image was taken at was 7381 ft,allowing for the image to capture various peaks and mountains. The intent of this image was to highlight a different cloud formation, and visualize the beauty behind it.

Figure 1: Final Selected photograph

Circumstances of Image

The photograph, depicted in Figure 1, was taken from the summit of Chautauqua Peak in Boulder, Colorado. The elevation at this location was approximately 7381 ft above sea level. I stood upon a fence post and rested my camera on it to ensure I got a steady shot. The camera lens was facing 260 degrees West, facing Apache Peak, Mt.Audubon, Mt Jasper, and Mt Epworth. The camera angle from the ground was roughly negative two degrees below horizontal. An image of the setup is provided below:

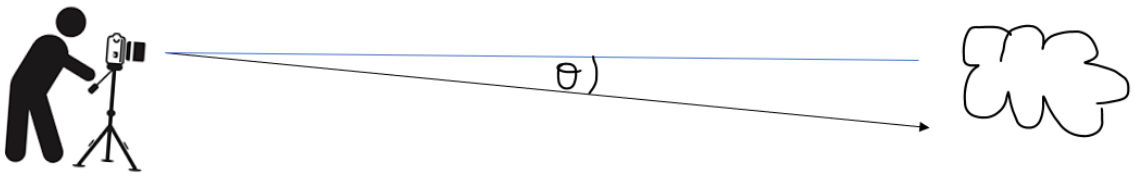

Figure 2: Camera Setup used throughout photoshoot

Physics of Flow

The clouds in the image are Orographic Clouds. Orographic clouds form as a result of air flowing over a mountain or elevated terrain. They form because the moist air is forced to rise over the top of a mountain range, and as the air ascends it cools and reaches its dew point, leading to the condensation of water vapor into visible cloud droplets. The picture of the cloud was captured on a very cold day, the air temp was 46 degrees Fahrenheit, and the average wind speed was 12 miles per hour. It also rained before and during this photograph. With these given factors the atmosphere was most likely unstable during this period of time. The Skew-T diagram for this day is provided below:

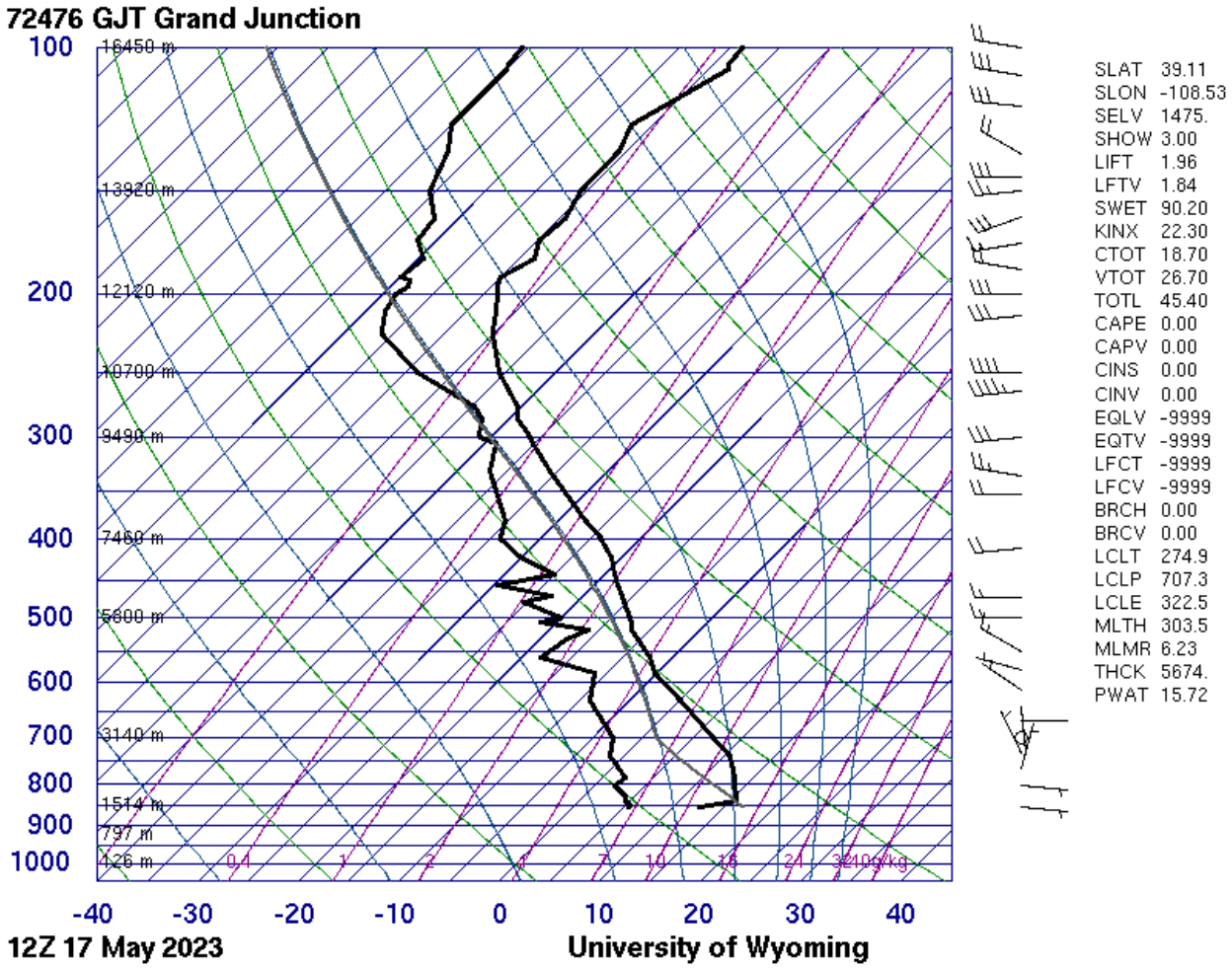

Figure 3: Skew-T diagram for the closest day to the date of the photograph

We can determine the atmosphere was unstable due to the fact that temperature was experiencing variations. During that week the average temperature was 56 degrees Fahrenheit, so with a chance of 10 degrees Fahrenheit. Rising air was triggered and caused the condensation level to rise. Which in turn caused the cloud to fall back over the mountain [1]. The Skew-T suggests that the clouds would form at 12000 meters or as low as 9410 meters. This is because the temperature line depicted on the right and the line on the left which is depicted as the dew point are getting closer together. When these two lines get closer together a cloud is likely to exist within that given range. So I believe the clouds I took a photograph of were at an elevation of 9410 meters above sea level [1]. This is due to the fact that I was very far away from the clouds, and they fall across a mountain range.

Visualization and Photographic Techniques

The visualization technique used in the photograph is an example of a marked boundary [1]. The image shows the distinction between the mountain face and the cloud flowing up and over it. The size of the field of view is approximately 5 miles, this is due to my camera being positioned so far away from the clouds. The distance from the object to the lens is 3 miles.
The camera was an iPhone 12, with the following specifications:

Lens Focal Length	26mm
ISO	32
Shutter Speed	1/1162s
Aperture	f/6
Image Size	4032 x 3024 pixels

With this specific image I only changed the color aspect to black and white, I did this inorder to create more contrast between the cloud structure and the mountain faces behind it, as you can see in Figure 4 and Figure 5.

Figure 4: Final edited photo

Figure 5: original photo

Conclusion

This image reveals the different kinds of cloud structures in an unstable atmosphere. I liked the black and white aspect before I made that edit. The image was kind of hard to focus on due to the trees, and the mountains. But, with the removal of color it really brings the clouds to the forefront of the image. I think this photo captured my goal of highlighting different cloud structures and their beauties. The only thing I dislike about my image is how far away the clouds are. I wish I could have driven closer to the clouds to get a better focus on the cloud structure. To continue developing this idea, I would like to take a time lapse of the clouds, this would really highlight the movement of the clouds over the mountains. Which would in turn showcase the fluid flow of the clouds better and allow the audience to envision the entire cycle of motion. I hope on the next rainy and cold day to take my camera up to the same spot and take more observations.

References

[1] Hertzberg, Jean. “Flow Vis Guidebook.” Flow Visualization, 13 July 2023, www.flowvis.org/Flow%20Vis%20Guide/overview-3-lighting/

[2] “Denver Colorado Weather & Temperature Info.” *Visit Denver*, www.denver.org/about-denver/resources/weather/. Accessed 17 Dec. 2023.