UNIVERSITY OF COLORADO - BOULDER

MCEN 5151 - FLOW VISUALIZATION

CLOUDS 1 REPORT

Boulder Before Rain

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October 11, 2021

I. Introduction

The purpose of this assignment was to capture a photo and analyze the characteristics of an interesting cloud formation. I did not have any clear goal in mind or specific cloud formation I was trying to capture for this assignment, rather, I simply took pictures every time I saw an interesting formation. The final image was selected based on what I thought was most visually interesting. The following report gives some context for the image, discusses the cloud characteristics (including the associated Skew-T diagram), and outlines the photographic techniques (including post-processing) used to obtain the final image.

II. Context and Circumstances

This image was taken in Boulder, CO, across the street from the Jennie Smoly Caruthers Biotechnology Building at 35th and Colorado. The camera was facing northeast at roughly 20 degrees from the horizon. This was taken roughly a couple hours before a rainstorm on October 8th at 202pm MST.

III. Cloud Characteristics

Although a bit challenging to identify accurately, some helpful features can be used to identify the variety of cloud formations seen in the final image. Based on the continuous, blanketing features seen from the clouds at the bottom left of the image (and their relatively low elevation compared to the rest of the clouds), these were determined to be stratocumulus clouds. Moving rightward at roughly the same elevation, this blanket disperses into what appear to be regular cumulus clouds. Lastly, covering the entire sky at a much higher altitude lies a blanket of altostratus clouds. Provided below in Figure 1 is a Skew-T diagram from the nearest time and location corresponding to when and where this image was taken, at 00Z (UTC) on October 9th in Denver, CO, respectively. This atmospheric sound data was taken from the University of Wyoming Department of Atmospheric Science's website, [1].

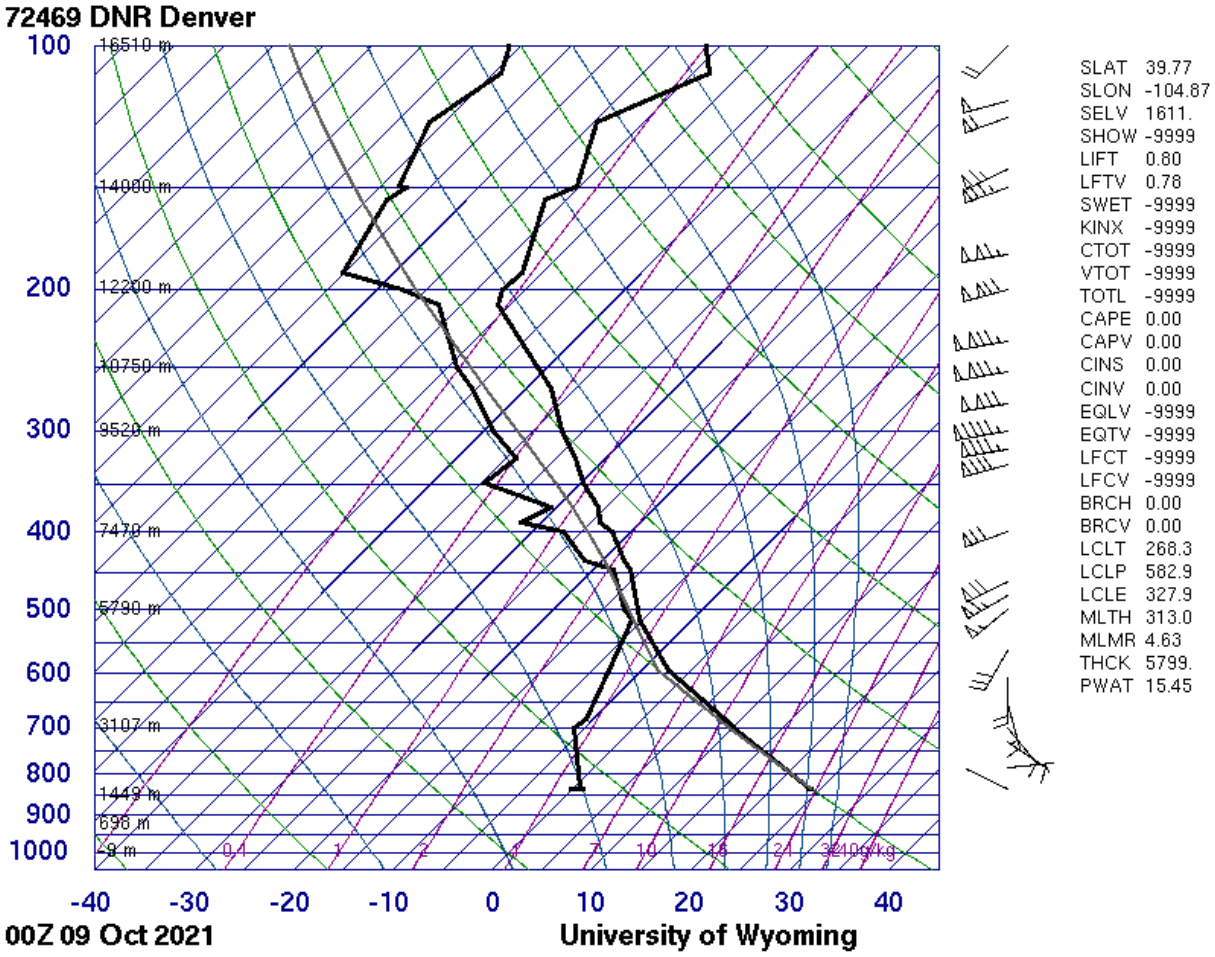

Fig. 1 Skew-T Diagram

Despite the difference in location and time, the diagram does show some interesting information. Firstly, the extremely high wind speeds aloft (at altitudes ranging from 5000 to 15000m) suggest the jet stream was present overhead that day. Another interesting note is how closely the dew point line lies relative to the actual temperature line from 5000m all the way to 12000m. This would definitely explain all of the different layers of clouds seen in the image, with the stratocumulus and cumulus clouds most likely forming at the 5000 to 6000m range. Although the CAPE value of zero suggests a stable atmosphere, the increase in the dewpoint temperature in the planetary boundary layer (1600m to 5500m) may suggest some latent instability.

IV. Photography Technique

This image was taken with a simple smartphone camera (a OnePlus 3 camera), although manual adjustments were taken within the "pro mode" in order to change ISO, aperture, and get a sharper focus. Because of the natural brightness of clouds, the ISO was lowered dramatically and the shutter speed was quite fast in order to not overexpose what was being captured. The difference in these settings on the same camera sensor can be seen when comparing to some of my previous photos from the image 1 and image 2 reports, [2, 3]. This resulted in the sharpest image possible considering the sensor that was used. The specific camera settings are listed below:

- Camera: 16 MP Sony IMX 298 sensor (in a OnePlus 3 smartphone)
- Aperture: f/2
- Focal Length: 4.26mm
- ISO: 125
- Shutter Speed: 1/2000s
- Original Size: 4640 x 2610p

Similar to previous reports, Darktable was the program used for post-processing of the image (the appendix includes the original image for reference). The bottom of the image was cropped to eliminate the distracting construction area. Although, I did purposefully leave some of the surroundings (namely, tops of the mountains) in order to keep some context for the viewer. Lastly, the sharpness and contrast of the image was increased in order to better visualize the higher level cloud layers.

V. Conclusion

Personally, I would have liked better depth contrast in the image, because as it stands, it is very hard to distinguish all the different cloud formations present. That being said, I'm definitely happy with how the final image turned out, especially compared to the original, which doesn't show any detail in the higher level atmopshere.

References

[1] Oolman, L., "Atmospheric Soundings," *University of Wyoming: College of Engineering*, 2021. URL http://weather.uwyo.edu/upperair/sounding.html.

[2] Stone, S., "Leaf Droplet Surface Tension," *University of Colorado Boulder*, 2021. URL https://www.flowvis.org/wp-content/uploads/2021/09/ShawnStoneImage1Report.pdf.

[3] Stone, S., "Marangoni Effect Patterns," *University of Colorado Boulder*, 2021. URL https://www.flowvis.org/wp-content/uploads/2021/10/Shawn_Stone_Image_2_Report.pdf.

VI. Appendix

Fig. 2 Original Unedited Image