UNIVERSITY OF COLORADO - BOULDER

MCEN 5151 - FLOW VISUALIZATION

CLOUDS 2 REPORT

Cloud Shelf in Boulder

Author:

Shawn STONE

Professor:

Scott WIELAND

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I. Introduction

The purpose of this assignment was to capture a photo and analyze the characteristics of an interesting cloud formation. Similar to the approach taken for the first clouds report [1], I did not have any clear goal in mind or specific cloud formation I was trying to capture for this assignment, instead I just took pictures every time I saw an interesting formation. For this cloud formation in particular, it came as a complete surprise as I was biking home from the Aerospace Building, when I looked up and saw this huge wall facing the mountains. 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, on the west side of the Jennie Smoly Caruthers Biotechnology Building off of Colorado Avenue. The camera was facing roughly west-northwest at roughly 10 degrees from the horizon. The photo was taken the on October 21st at 11:14am MST (17:14 UTC).

III. Cloud Characteristics

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 12Z (UTC) on October 21st in Denver, CO. This atmospheric sound data was taken from the University of Wyoming Department of Atmospheric Science's website, [2]. Looking more closely, a key takeaway can be seen in the wind barbs of the Skew-T diagram, which shows very low wind speeds with westerly winds turning to the north as the elevation increases. These slow speeds combined with drastic directional changes could be one of the reasons this wall was formed. However, a more likely cause is a pressure gradient caused by the presence of the mountains near Boulder.

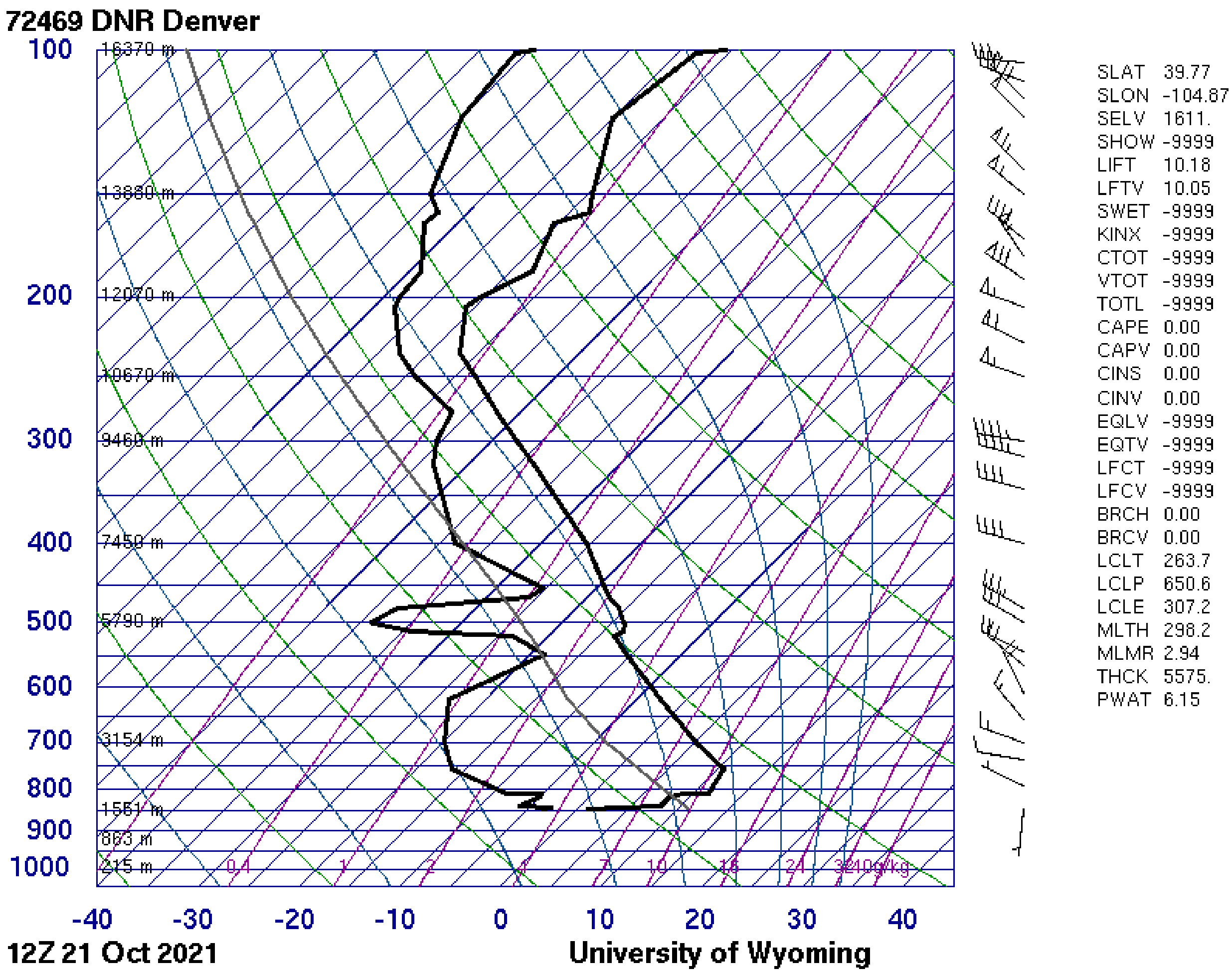

Fig. 1 Skew-T Diagram

Another interesting note about this Skew-T are the two spikes, at 550 mbar and again at 450 mbar, where the dewpoint line approaches the parcel lapse rate. This could indicate where this cloud wall is located in terms of elevation. Overall, nothing seems to indicate atmospheric instability, as many of the measured parameters are zero (most notably the CAPE and CAPV values) or below roughly 650.

IV. Photography Technique

This image was taken with a simple smartphone camera (a OnePlus 3 camera), although manual adjustments were taken to change ISO, aperture, and get a sharper focus. Because of the natural brightness of clouds, the ISO was lowered as far as possible and the shutter speed was also increased in order to not overexpose what was being captured, which is the same approach taken for the first clouds report [1]. 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, [3, 4]. 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: 100
- Shutter Speed: 1/640s
- Original Size: 4640 x 2610p

As with all of my other 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 zone near 30th and Colorado Ave. Although, I did purposefully leave some of the surroundings (namely, tops of the mountains and the trees) in order to keep some context for the viewer. Secondly, I slightly tweaked the color profile of the image to make ir slightly more vibrant. Lastly, the sharpness and contrast of the image was increased slightly in order to better distinguish cloud borders.

V. Conclusion

If I were to retake this picture, I really wish I was in a better position, as taking a picture from below doesn't really capture the true feeling of what was seen. Ideally, I would have liked to take it from up near the flatirons looking east, but I didn't have the time to do so. In addition to adding a better sense of scale, this would have also given information about the height of the cloud layer.

References

[1] Stone, S., "Boulder Before Rain," *University of Colorado Boulder*, 2021. URL `https://www.flowvis.org/wp-content/uploads/2021/10/Shawn_Stone_Clouds_1_Report.pdf`.

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

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

[4] 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