Flow Visualization: Cloud 2/Image 4

MCEN 4151 - Flow Visualization

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Figure 1: Stratus and cirrus cloud formation
Boulder, CO - October 22nd, 2021 at 4:26 PM

Context

This image was taken for the second cloud image assignment for MCEN 4151 and flowvis.org. I captured this image when I was walking home from campus in the afternoon and noticed a unique stratus and cirrus cloud formation over the foothills. I took a couple of photos from different angles and then settled on figure 1 shown above.

Circumstances

This photo was taken in Boulder, Colorado on Broadway St right outside of Kittredge at CU Boulder. The time was 4:26 PM during which I had just gotten out of class and was beginning to walk home. I was facing northwest and took the photo at approximately 30 degrees in relation to the horizon.

Cloud Formation

Figure 1 below is my final image. In the image, stratus clouds, more specifically lee wave clouds are seen to the northwest [3]. The stratus/lee wave clouds are the darker, lower hanging clouds that have a distinct break seen at the top of the left light post in the image. The cirrus clouds are higher up and take up the rest of the image.

Figure 1

The temperature was in the low 60's Fahrenheit, not very windy, and mostly cloudy in every direction. The clearest part of the sky was the northwest as pictured. The day was consistently overcast and continued to be cloudy until dark. There was not any inclement weather preceding

or following the photo. The general formation and type of the clouds remained constant, with varying density and speed as the winds shifted. A skew-T plot is shown below from the closest sounding station at Denver International Airport.

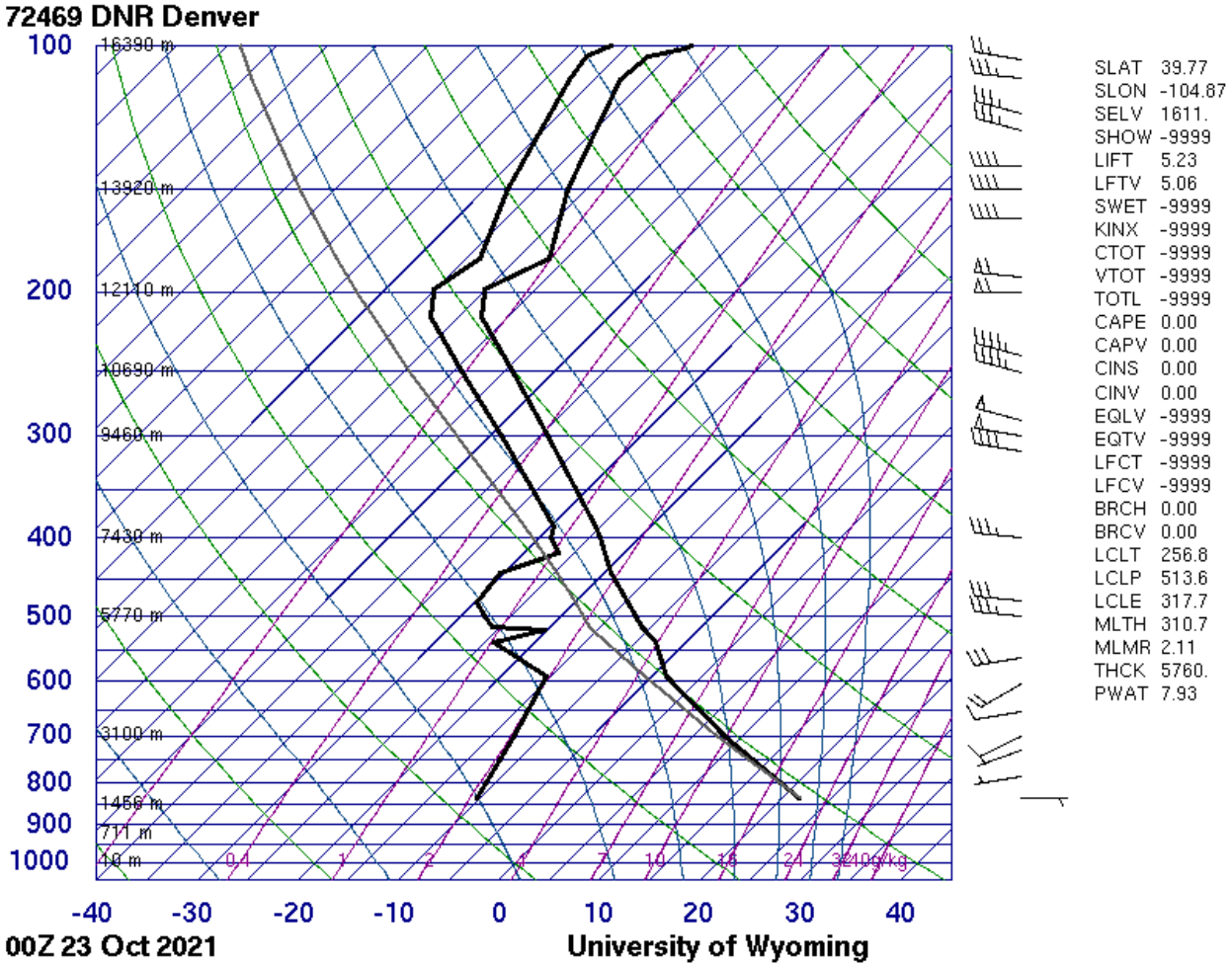

Figure 2: Skew-T plot from the University of Wyoming [1]

This weather sounding was taken at 6:00 PM October 22nd. This sounding was the closest to when I captured my image at 4:26 PM. The weather station for this sounding was at Denver International Airport which is about 43 miles away from where I took the photo. The weather in Boulder will vary from the weather at the airport because of the foothills in Boulder. The geography out by the airport is flat and gradually gets more hilly closer to Boulder, where you then meet the base of the Rocky Mountains. Mountains have a significant effect on weather. As air reaches mountains, it is forced to flow up and over the peaks. As the air rises, it cools and its

volume decreases, causing an increase in humidity levels and cloud formations, including the stratus/lee wave cloud seen in my image. Lee wave clouds form on the leeward side of mountains [3]. Air on the leeward side of a mountain range is warmer and drier [2]. It would then make sense that Boulder would see more clouds and precipitation than out at the airport, and thus the skew-T plot would likely indicate more stable atmospheric conditions than reality in Boulder. Regardless, the skew-T indicates a CAPE value of zero which usually correlates to a stable atmosphere. This mostly agrees with my observations in my photo, a calm and mostly overcast sky with little wind. The skew-T plot possibly indicates cloud formations beginning at 7000 meters and going up to 16390 meters, which is where maximum height that the skew-T records. The indications for cloud height are the points on Figure 2 where the temperature and dew point lines get closer together. The lee wave cloud has a darker underside, indicating it is either low hanging or alto. It seems to be more alto just by looking at it compared to the mountains. The cirrus clouds are really high up because they are bright in color and seem wispy. From these observations, I would say the skew-T is mostly an accurate indication of the cloud height, although the lee wave cloud is likely lower.

Photographic Technique

To capture this photo I used a base model iPhone 12 at 1X zoom. The camera has a 26 mm focal length which correlates to roughly a 70 degree field of view. I used the automatic settings on the iPhone camera to capture the photo, as I find this is usually the best method for phone shots. The distance from my camera to the clouds varies due to the height of the clouds, and because the clouds are overhead and extend far out in direction the camera is pointed. I would say it's many kilometers to the clouds. The automatic mode shoots f/1.6 aperture. The sizes of both the images are 4032 x 3024 pixels. I did some post processing on the image in order to add some definition to the layers of the clouds and to darken the landscape in order to attract the viewer's eye towards the clouds. Specifically, I altered the shadows and highlights levels in the GIMP application. Below on the next page are the original and edited images.

Figure 4: Edited vs original images (left to right)

Conclusion

The final image reveals a fascinating mixture of a stratus/lee wave and cirrus cloud formation in Boulder, Colorado on October 22nd. My favorite part of the image is how the darker stratus/lee wave cloud has a distinct break near the foothills, which extends far to the north. This image did fulfill my intent of capturing a fairly unique cloud formation. There isn't much I would change about this shot, considering my location. But if I had the time to find an open field, I think that would make for a less distracting and appealing landscape. The field of view provides a good perspective I think. The road, light posts and buildings give a good idea of the size of the clouds. I also appreciate how the clouds in my image are a clear demonstration of cloud physics near mountain ranges.

Work Cited

[1] Skew-T plot
http://weather.uwyo.edu/cgi-bin/sounding?region=naconf&TYPE=GIF%3ASKEWT&YEAR=2021&MONTH=10&FROM=0300&TO=0300&STNM=72493

[2] "How Do Mountains Affect Precipitation?" *DTN*, 28 Mar. 2019, https://www.dtn.com/how-do-mountains-affect-precipitation

[3] Turnbaugh, Kay. "Cloud-Struck in Boulder." *GetBoulder.com*, 22 Oct. 2021, https://getboulder.com/cloud-struck-boulder