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Cloud Image

Introduction

This project's goal was to capture cloud formations that were both visually interesting and demonstrated interesting flow phenomena. This was the first cloud image and as such the intent was kept simple in order to ensure success despite a lack of familiarity with clouds as well as their mercurial nature.

Set Up

This image was taken at 2:48 PM MDT 10/11/21 outside the CU Boulder Engineering Center in Boulder, Colorado. As such it was taken at an elevation of approximately 5300 ft. The approximate weather conditions leading to the cloud formation can be seen below in the Skew-T diagram.

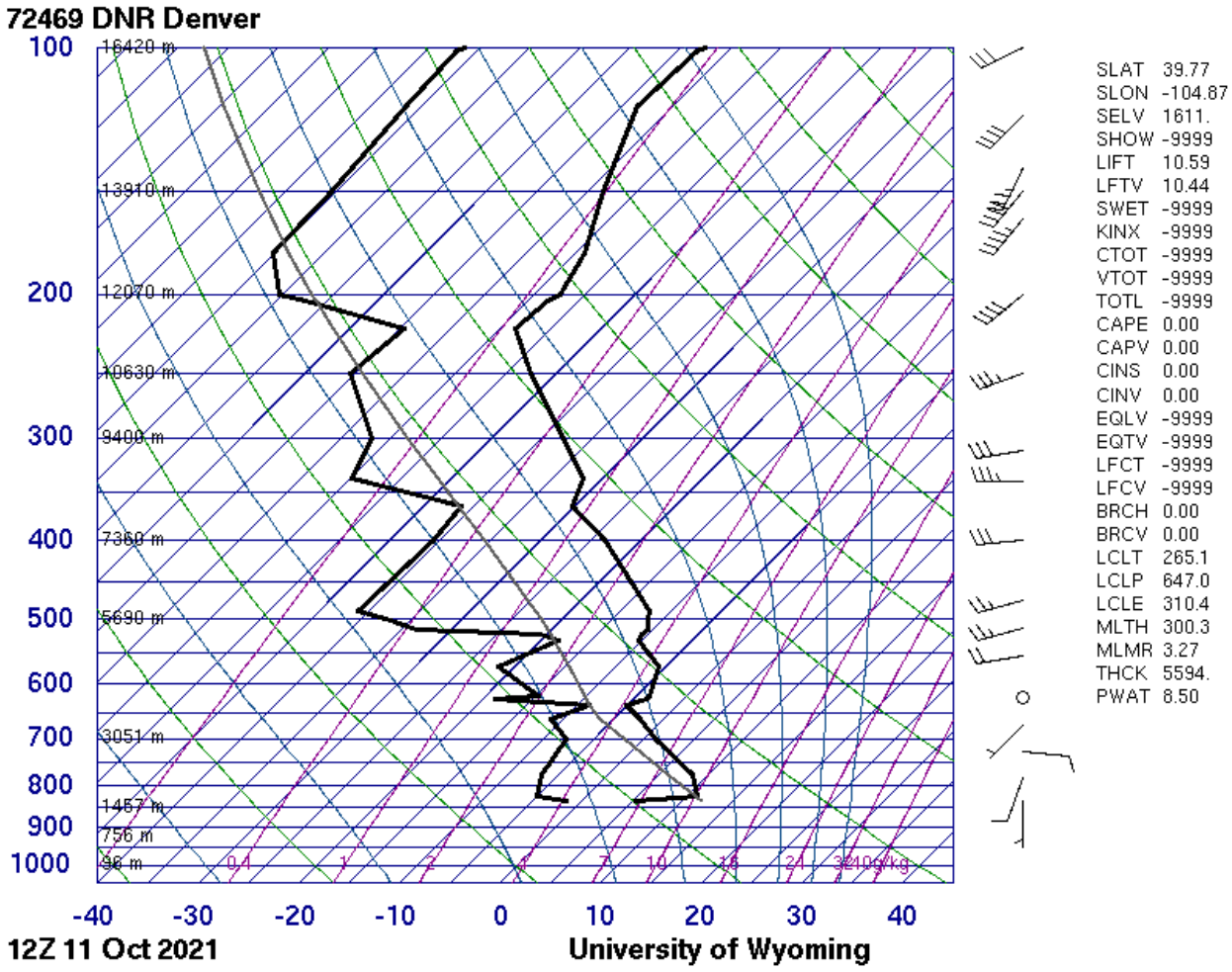

Figure 1: Denver Skew-T diagram

Fluid Dynamics

Looking at the Skew-T plot in Denver, on the day this photo was taken, there are a few likely areas for cloud formation. At approximately 3500 m, 8000 m, and 11,000 m the temperature line is closest to the dew point line, thus precipitation is likely to form. The form of the cloud suggests that they are Altoclumulus clouds, thus it can be concluded that these clouds likely formed around 8,000 m or 3,500 m in the air. At these altitudes the wind lines on the right hand side of the graph can be seen to blow slowly and very parallel to the ground. This flow of wind over the clouds is likely what causes the wave-like pattern seen in the bottom right cloud. The shear of the wind over the surface of the cloud could have propagated a Kelvin-Helmholtz instability which would cause the more dense cloud layer to curl up and over into the air layer.

Visualization

The only visualization technique that highlights the cloud is the natural seeded boundary between the water particles in the cloud and the surrounding air. Most of the visual clarity was added via post processing enhancement. No additional light was added to the image, only the natural sunlight shining on the cloud.

Photographic Technique

Figure 3: Raw image before post processing.

This Image was taken on a Pixel 3 with an aperture of F 1.8, a shutter speed of 1/3356 sec, a focal length of 4.44mm, and an ISO of 66. These settings were automatically determined by the phone camera and thus could not be changed to enhance the image. In order to obtain more detail, contrast, and visual interest to the image, it was processed in photoshop. First, the image was cropped to from 4032 X 3024 to 4032 X 2304 in order to remove excess blank space and better frame the cloud. After this, the brightness and contrast of the image was modified to emphasize the details within the cloud. Finally, the color curves were adjusted to bring out a wider variety of blue in the background and emphasise the gradient from dark to light in order to add visual interest.

Conclusion

The thorough detail highlighted in the cloud from post processing as well as the rich gradient of blue in the surrounding sky does successfully make this image visually interesting to the viewer. The clear Altocumulus form and the Kelvin-Helmholtz waves visible in the clouds give the image significant depth in terms of fluid dynamics at play and the Kelvin-Helmholtz waves in particular are easily recognized by the viewer. As such, the intent of this image was thoroughly achieved. If this image were to be redone, it would be desirable to capture this image with more appropriate camera settings on a non phone camera. Furthermore, in enhancing background colors some detail was lost in the cloud and it would be beneficial to the image detail to experiment with masking or white balancing to prevent this. In the future, I would be interested in exploring further cloud images that demonstrate other common fluids instabilities in similar ways to how this image demonstrates the Kelvin-Helmholtz instability.

Bibliography

Atmospheric Soundings, University of Wyoming, http://weather.uwyo.edu/upperair/sounding.html.