Clouds 1 Report
Flow Visualization
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I. Introduction

I took this photo when I was exploring an abandoned sugar mill near Longmont, CO. It was a warm, sunny day and I was able to take this image as the sun set below the cloud layer. This created a really interesting backlit effect showing the outline of the clouds. This image was taken on September 5th, 2022 at around 7:15pm as the sun was setting facing west towards the mountains.

II. Cloud Description

These clouds are likely a combination of mostly stratocumulus and a few altocumulus clouds. Stratocumulus clouds are typically long, stretched out piles of cloud stuff. These are the most common clouds that we see in the sky. In the image, we can see the clouds on the bottom of the photo especially show these characteristics. They are puffy and fairly low, while also being stretched out fairly flat. Many of the clouds in the top of the image share this characterization, but there are some smaller piles of cloud stuff that, while still puffy, are far smaller and less flat than their stratocumulus neighbors. These clouds are likely altocumulus, as they are smaller and higher in the sky. This is supported by the rule of fingers discussed in the flowvis guidebook, as the smaller cloud elements are between one and three fingers wide. Below is a Skew-t diagram taken in Grand Junction, CO about 1.5 hours before the image was taken.

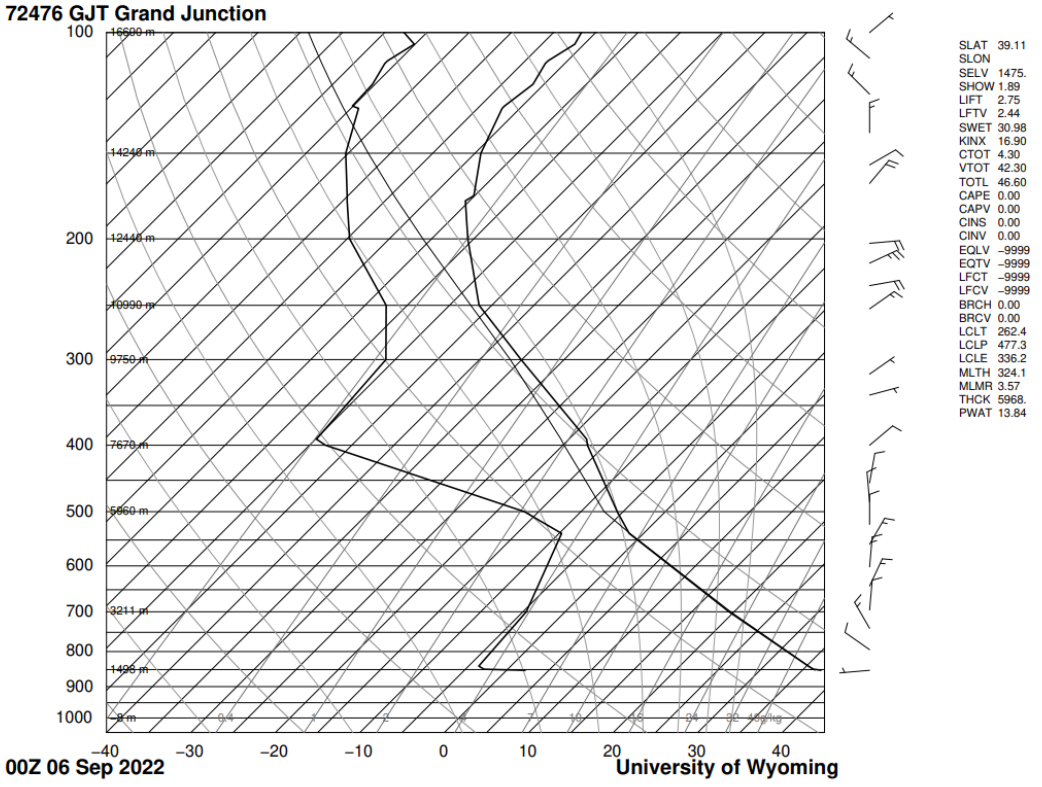

Figure 1: Skew-t diagram taken on September 5th at 6pm MDT

We can tell a few additional pieces of information from this diagram. First, we can tell that these are stable clouds as the CAPE value listed on the diagram is 0.00. This means that at this time, the air below these clouds was generally cooler than the air above them. This is unusual during summer months because the ground is typically heated faster than the air, causing the air to be warmed closer to the ground. We can also see from the diagram what altitude most clouds were forming at on that day by examining where the dew point line is nearest to the temperature line. This situation will result in more water condensing at that altitude, which will in turn lead to cloud formation. Looking at the skew-t in figure 1, we can see that clouds are mostly forming at an altitude of around 5,200m. This is within the range that altocumulus clouds typically form (2,000m-7,000m), which would indicate that most of the upper clouds are stratocumulus. This data was taken roughly 200 miles away from where the image was taken, which could explain the discrepancy between the skew-t's prediction of what clouds are forming and what clouds are actually forming. Another interesting piece of information that the skew-t displays is the wind direction around the altitude that the clouds are forming. According to figure 1, the winds are blowing mostly north at a speed of approximately 15 knots. From this information, we can calculate the Reynolds number for these clouds.

$$Re = \frac{\rho V D}{\mu}$$

In this equation, the density $\rho = 0.7364 \frac{kg}{m^3}$[1], velocity $V = 7.717\ m/s$, dynamic viscosity at 5℃[2] $\mu = 17.4 * 10^{-6} Pa - s$[3], and length scale of a droplet $D = 20 * 10^{-6} m$[4]. This yields a Reynolds number of 6.532, which is soundly laminar flow.

III. Photographic Technique and Post-Processing

This image was taken by a Samsung Galaxy S9+, which automatically sets most of the camera specifications without an easy way to read them. The following image shows the unedited image before it was brought into darktable.

[1] Engineering Toolbox 2
[2] FAA
[3] Engineering Toolbox 1
[4] UCAR

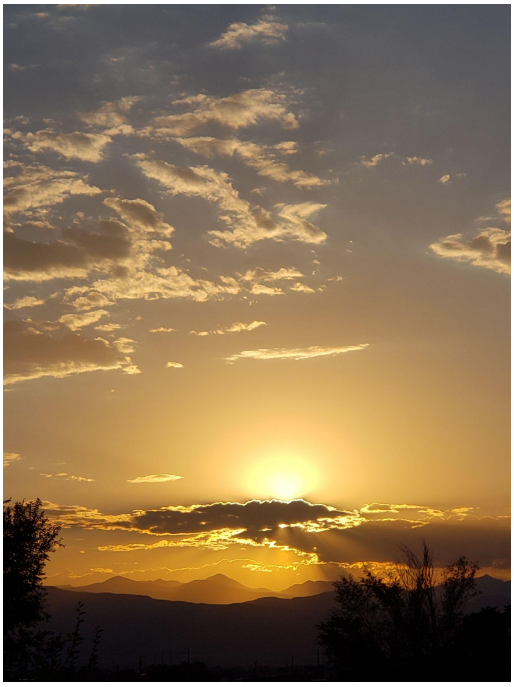

Figure 3: Raw image

Once the image was brought into Darktable, the contrast was boosted slightly to help accentuate the contrast between the shadows of the clouds and their bright outlines, but other than that the image was mostly unedited.

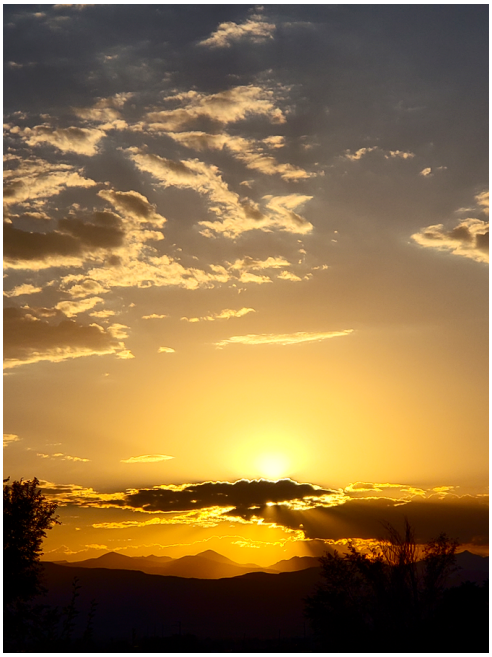

Figure 3: Final image

IV. Conclusion

I was very happy with this image, I think that the way the camera catches the individual rays of light makes for a dynamic image. The outlines of the flatirons also look mystical in the way they are shadowed. If I would change anything, it would be that I had to zoom in fairly far to get a well framed image which resulted in a slightly grainy photo if you look closely. So, I would ideally use a camera more well designed for long distance shots such as these, potentially with more pixels to work with.

V. References

Engineering Toolbox (1). "Air - Dynamic and Kinematic Viscosity." *The Engineering ToolBox*, https://www.engineeringtoolbox.com/air-absolute-kinematic-viscosity-d_601.html. Accessed 24 October 2022.

Engineering Toolbox (2). "U.S. Standard Atmosphere vs. Altitude." *The Engineering ToolBox*, https://www.engineeringtoolbox.com/standard-atmosphere-d_604.html. Accessed 24 October 2022.

FAA. "Section 3. Cold Temperature Barometric Altimeter Errors, Setting Procedures and Cold Temperature Airports (CTA)." *FAA*, https://www.faa.gov/air_traffic/publications/atpubs/aim_html/chap7_section_3.html. Accessed 24 October 2022.

UCAR. "Sizes of Aerosols, Raindrop and Cloud Droplets | Center for Science Education." *UCAR Center for Science Education*, https://scied.ucar.edu/image/aerosols-raindrop-cloud-droplets-sizes. Accessed 24 October 2022.