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**MCEN 4151**

**Cloud First Assignment**

**Figure 1:** Final cloud submission

Initially, I did not anticipate the amount of work required to capture a cloud photograph. I was completely unaware of the variety of shapes and sizes of clouds. Having spent days trying to capture a photo of a cloud, I was finally able to do so on March 8th, 2018 at 1:30pm. The purpose of this assignment was to capture a picture of clouds and explain the type of cloud, the motion of the cloud, and the stability of the atmosphere. I captured this image on the top floor of the Engineering Garage facing southwest towards Bear's Peak. I captured this image using my iPhone 6 which was tilted around 30 degrees above the horizon. Having attempted numerous photos before, I was unable to achieve the resolution I desired. The iPhone struggles to capture clouds with too much sunlight or higher elevated clouds. I also wanted to avoid any powerlines or trees which proved difficult in Boulder. I spotted these Mountain Wave clouds drifting over the peaks and was able to capture this image with the perfect background and no distractions. In critiques, the Cirrus Fibratus clouds located in the background were pointed out to me. They are very faint but add a pleasing effect to the image. The Mountain Wave clouds dissipated shortly after this image was taken.

Wave clouds are formed near mountain ranges with a stable atmosphere. As air travels over the range, the moisture in the air is condensed from the immediate shift in elevation and forms a cloud. These clouds appear for a short period before they evaporate from interaction with warmer air. After analyzing the Skew-T diagram, the difference between the dew point curve and the temperature confirmed these clouds were most likely Mountain Wave and explained the quick evaporation of the clouds. Bear's Peak has an elevation of 2,578 meters, so I would estimate these clouds were between 2,500 m to 3,000 m. The cape was zero, which also confirms the atmosphere was stable. The diagram also showed a pinch point around 6000 meters, where Cirrus Fibratus clouds typically form. The temperature was 58 degrees Fahrenheit which was recorded from National Weather Service at the time of this photo. The Skew-T shows the wind was traveling west, but I observed the wind to be traveling east at the time of this photo. The wind was recorded around $3.5\ m/s$ on average at this time. To calculate the Reynold's Number of this cloud, I assumed the cloud was $150\ m$ in length, a density of $1.0\ Kg/m^3$, and a viscosity of $1.7 * 10^{-5}\ Ns/m^2$. These figures were taken from Engineering Toolbox. Using the Reynold's Number Equation:

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

$$Re = 3.09 * 10^7$$

This would suggest the cloud itself was turbulent. An iPhone 6 image is 3,600 pixels wide. If I assume the leftmost cloud takes up a third of the image, then the cloud is roughly 1,200 pixels wide. I would estimate the image is resolved to roughly 50 pixels, or 2 meter spatial resolution.

In post processing, I used Raw Pics IO, an online photo editor. I have become familiar with this software and find it produces better images in less time compared to Photoshop. I increased the contrast by 200 and decreased the brightness by 150. I also changed the curve to the shape pictured below in figure 2.

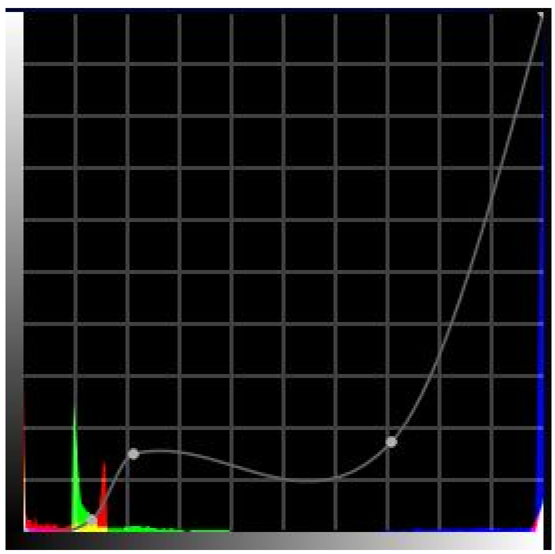

**Figure 2:** Curve diagram for post processing

I found this created a nice silhouette of the mountain range. It also made the sky appear much darker and highlighted the clouds. The sun streaks at the top of the image were also reduced and did not take away from the clouds. My intent was for the viewer's eyes to be drawn to the bright clouds immediately. Upon further inspection, the horizon to the left of the mountains has an orange hue. Overall, I was please with how this image turned out. I like the clouds that I was able to capture and believe I was able to determine the correct cloud types. In my next cloud image, I plan to work with my teammates to use a higher quality camera. I would also like to play with the curve feature more and try to highlight certain colors, like the orange horizon in this image. It would also be interesting to try to measure the length and speed of the cloud more accurately to calculate a more accurate Reynold's Number.

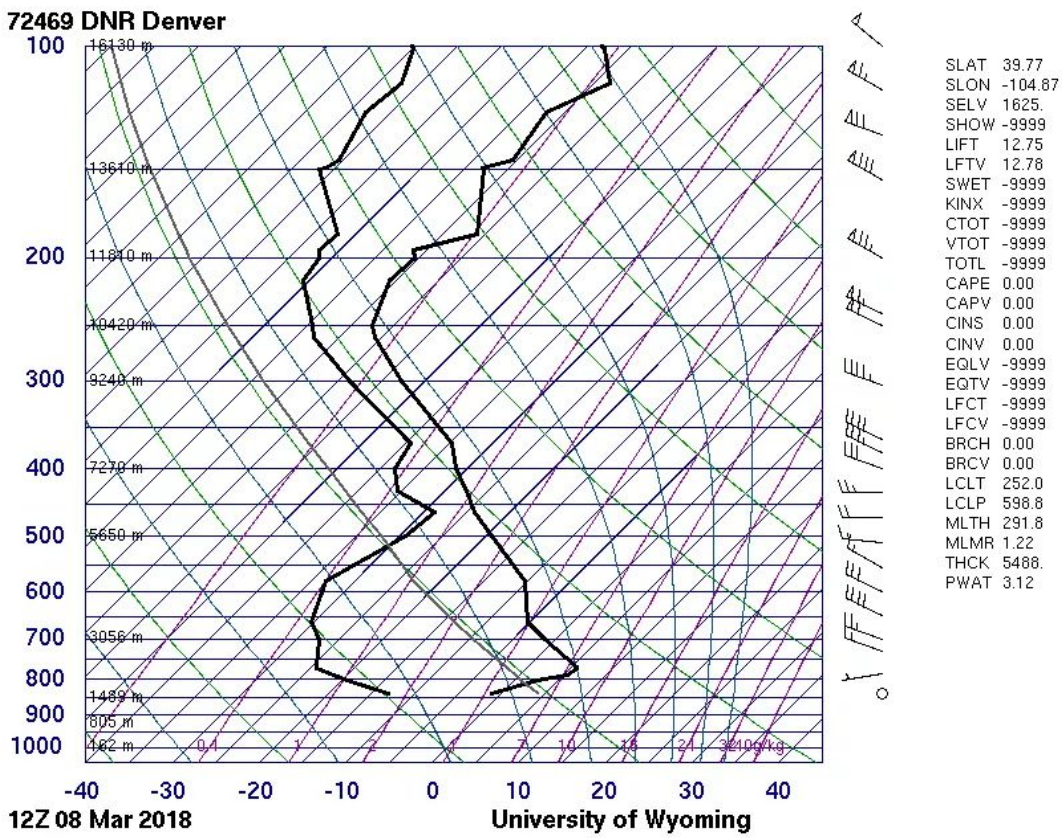


**Figure 3:** Skew-T diagram

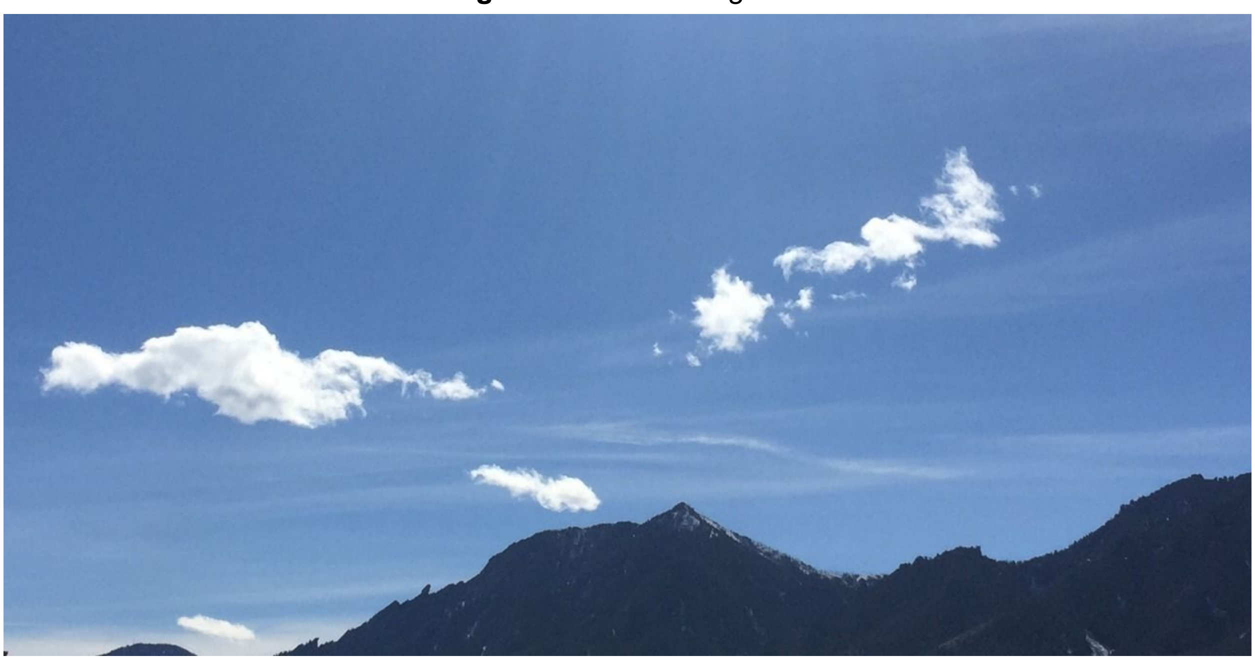

**Figure 4: My original image**

**References**

https://www.engineeringtoolbox.com/standard-atmosphere-d_604.html