“Superior Sunrise”
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MCEN 5151

Introduction

The picture captured above was taken for class MCEN 5151, Flow Visualization, offered at the University of Colorado - Boulder. This is the second project of the semester, “Cloud Image 1”, which consists of taking a picture of a clear, identifiable cloud formation that is also preferably aesthetically pleasing to the observer. With this particular assignment, I wanted to be sure I had my camera near me at all times during the day, because at any moment a different or unique cloud formation could pop up. I took hundreds of pictures over the last few weeks of numerous clouds types at various times during the day to try and get a plethora of images to choose from. For my final image, I decided to capture the early sunrise over eastern Colorado and really concentrated on how the light hit a set of altostratus clouds that were formed over Superior, CO. I thought the sunrise offered a unique way of looking at this particular cloud formation along with contributing a very distinctive light that gave the clouds a very eerie, and unique, look to them.

Circumstances

This particular cloud image was taken in Superior, CO at approximately 6:22 AM on Monday, September 28th, 2015. The sunrise that morning was estimated to be around 6:54 AM, so this was roughly 30 minutes before official sunrise, hence the reason for the darker complexion in both the foreground and

shadows within the clouds themselves. The camera was pointed towards the east at a slight angle, approximately 5 degrees off the horizon, as seen in the picture. The picture was taken on the top of the hill which is why the horizon is so far off in the distance, and the image has such a large amount of the sky within it.

Cloud Description

The final image depicts a series of altostratus clouds that are shown just before sunrise. The weather was fairly calm all day, particularly the morning the image was taken. Since I get to work at consistently the same time every morning, I did notice a similar weather pattern in the mornings both the day before and after this image was taken. The silky, almost blurry altostratus clouds, is a fairly common feature for this particular cloud type and they're commonly seen in the morning hours when the atmosphere is stable. In order to verify that the atmosphere was truly stable and that these clouds were most certainly altostratus clouds the Skew-T diagram was used from the Denver International Airport at 6 AM that day, Septermber 28th. The Skew-T diagram shown in Figure 1 was pulled from the University of Wyoming, the college of engineering website for September 28th, 2015 at 12Z, which is equivalent to 6 AM Denver time[2].

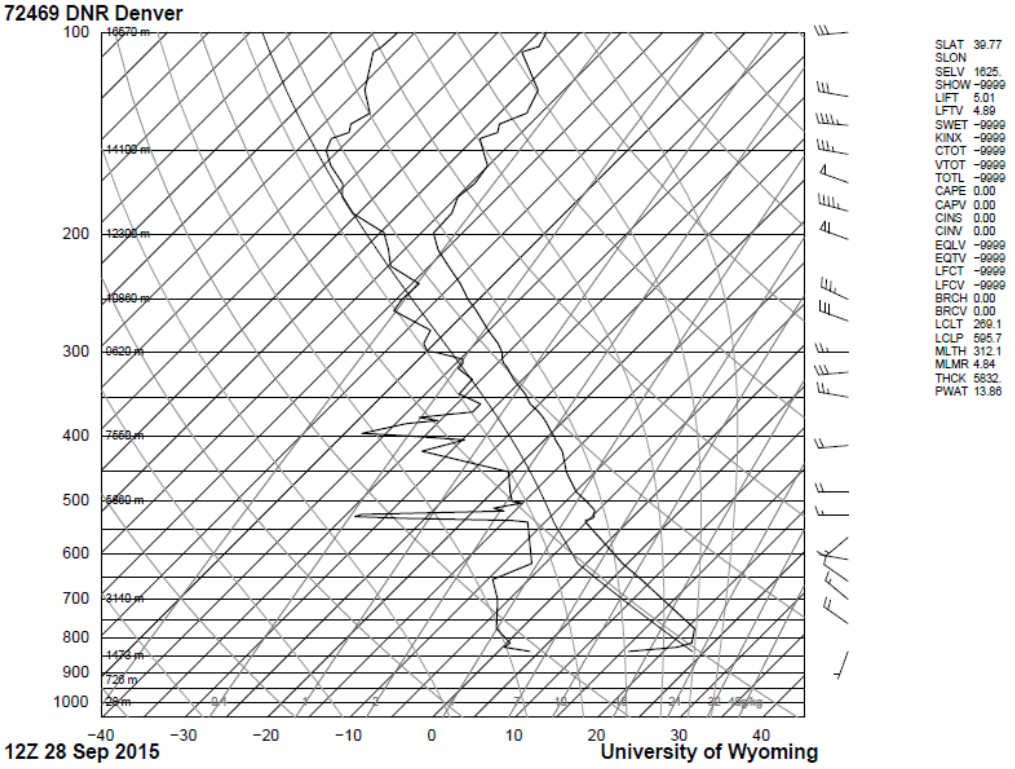

Figure 1: Skew-T Diagram for September 28th, 2015 12Z from Denver International Airport

A few simple details can be pulled from the Skew-T diagram including the location of the clouds in the atmosphere, the stability of the atmosphere, the wind and temperature at various elevations, and a number of other weather conditions. I was fortunate to take the photo at roughly 6:20 AM because the

conditions taken with the Skew-T plot are nearly in line with the image. As described in the Cloudspotter's Guide book, the altostratus clouds should sit between 6,500-23,000 feet[1], and based on the Skew-T diagram, a rather large disturbance (dew point and temperature lines have an abrupt change in slope and start converging on each other) was at 5000 m, or 16500 feet, so right in the middle where the altostratus clouds would typically be found. At this point the temperature and dew point lines are fairly close together, and it's assumed that this is where the cloud formation has started. As expected, the temperature consistently decreases with elevation as the air particles expand resulting in a cooling temperature, but at 5000 m in altitude a sudden increase in temperature takes place. The same can be said about the dew point measurement, where the line is fairly stable until a sudden increase takes place right around 5000 m. It's also noted that there are some extreme pockets of drier air in the atmosphere, where the dew point and temperature line diverge from each other (just under 5000m and 7500m elevation), indicating a dry region within that elevation. The CAPE value, found on the right hand ledger, reads 0.00, indicating that the atmosphere was extremely stable that morning. The wind barbs on the left side of the diagram indicate the wind is coming from the west at a fairly steady speed, ranging from 5-50 knots[3] depending on the elevation. At lower elevations the winds are fairly calm, but in the upper atmosphere (10000-15000 meters) the wind speeds are a lot higher, in the 50 knot region. As discussed in class, at about the 12200 meters the temperature line starts to increase in temperature and this is right about the elevation of tropopause, going into the stratosphere region. These increases in temperature as shown in the Skew-T diagram, and are due to the absorption of the UV rays in the ozone layer. In this range the atmosphere is extremely stable and the area is free of any weather conditions such as clouds[4]. This is a common spot (12,000 meters) for commercial airliners to fly at in order to avoid any turbulence and provide a smooth flight for its passengers.

Photographic/Visualization Technique

Although it wasn't recommended in Professor Hertzberg's tip for taking cloud photos, I really thought the aspect of taking a cloud photograph with the sunrise as a backdrop was really interesting and gave a very eerie and dark characteristic to the image. I also thought the sunrise showed the details of the altostratus cloud type well, really emphasizing silkiness and smoothness of the clouds. It also brought in some unique colors, some dark oranges and blues, that I felt really made the image pop. The actual cloud length that is captured in the image is a little hard to determine since the clouds spread across the entire span of the picture, but in one of the photos taken earlier, and shown in Figure 2, a small airplane is seen within the cloud structure. This gives a good perspective, at least within that portion of the cloud, how large the image spans across the sky.

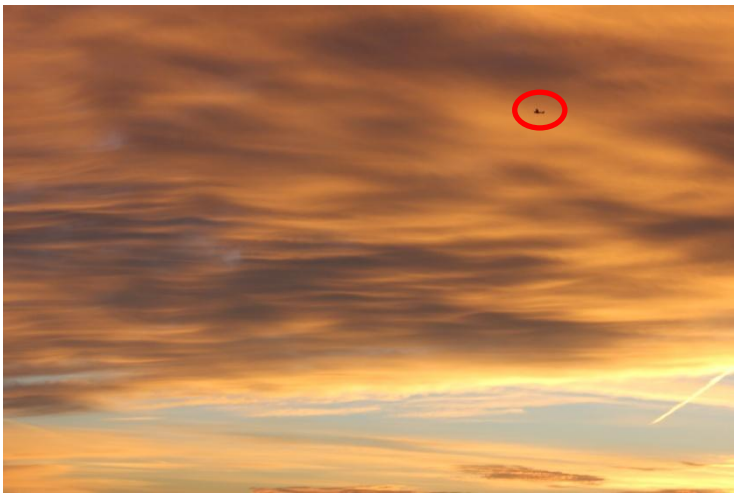

Figure 2: Small Plane within Cloud Structure

The settings of the camera became an important aspect when taking the picture. The aperture mode was selected on my DSLR Canon T2i camera in order to adjust both the aperture values while automatically using the shutter and ISO properties the camera deemed appropriate. I also used the manual focus setting on the lens to get the cloud in focus. Numerous angles, physical distances, zoom distances and aperture settings were experimented with in order to come up with the best image. Table 1 below breaks down of the final settings that were used for the final image. The combination of an aperture setting of F9.0 and an ISO setting of 100 (chosen automatically) allowed for a clear, well focused image in the space I was working with. A shutter speed of 1/50 was used, although that wasn't a vital property to get a great cloud image in this particular instance. I also choose to underexpose the photo, using a setting of -1, in order to darken the image a slight amount since I felt it brought in more of the characteristics of the altostratus cloud type. I didn't zoom in (18mm was used) on any particular object when taking the picture and really used the entire landscape to get a quality photo that brought in the entire morning ski. The image has a pixel size of 5184 x 3456 and really centers the sky and foreground together. The image was in a .png format initially but was brought into GIMP and darkened slightly in order to bring out more of the colored sky, so it's not as washed out. The final image was exported as a .tif image. Both the original and final images are shown in Figure 3 below.

Table 1: Camera Settings

Setting Description	Setting Value
Aperture	F9.0
Shutter Speed	1/50
ISO	100
Zoom/Focal Length	18mm
Original Pixel Size	5184 x 3456

Figure 3: Original and Final Image

Conclusion

I definitely didn't have a specific intention or particular cloud type in mind when going into this project. I kind of just kept my eye on the sky and if I saw a particular cloud formation that looked cool, I took a picture of it. After taking numerous pictures of all different types of clouds at all different times in the day, I really enjoyed what my final image looked like for the Cloud 1 project. I remember looking up at the cloud formation when I initially started taking a picture of it and felt it was a really interesting and unique set of clouds, looking very silky and smooth. It reminded me a little bit like a set of waves in the sky, but no specific detail or characteristic stood out from the rest. After reading about altostratus clouds, the muted details of the cloud are a pretty standard feature of this cloud type. I also thought the sunrise gave a really eerie and dark story to the image that stood out from the rest I took. The colors that were captured within the image were really nice too, containing various amounts of oranges and blues that really contrasted nicely with each other. The only other thing I would've loved to do was stick around until sunrise and see how the colors and features with the cloud formation changed with the upcoming sunrise. I've noticed when taking all these clouds pictures that a cloud can look completely different from one minute to the next. Maybe, taking a picture over a longer time lapse (longer exposure) or even a video would be a really cool way of showing how a particular cloud formation really changes over time.

References:

[1] Pretor-Pinney, Gavin, *The Cloudspotter's Guide: The Science, History, and Culture of Clouds,* New York: The Penguin Group. (2006)

[2] University of Wyoming, College of Engineering, Department of Atmospheric Science. (2015). Atmospheric Soundings.http://weather.uwyo.edu/upperair/sounding.html

[3] ATMO – University of Arizona, ATMO 336: Weather Climate and Society, Fall 2012, (2012) retrieved from http://www.atmo.arizona.edu/students/courselinks/fall12/atmo336/lectures/sec1/skewt.html

[4] Weather & Climate, http://www.weather-climate.org.uk/index.php, retrieved from http://www.weather-climate.org.uk/02.php