Whipped and Ripped

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Mechanical Engineering

MCEN 4151: Flow Visualization

April 16th, 2013

Introduction

I walked out of the Engineering Center one spring afternoon, and I was excited to see a snowstorm moving in which was bringing with it a wide variety of cloud types. I proceeded to spend the better part of the next hour taking photos of the many different magnificent clouds in the sky. In my flow visualization course I produced the cover image of this document for my second cloud assignment. I wanted to capture the widest variety of clouds that I could in hopes that I could get a really unique and beautiful picture. In this particular picture my goal was to capture the vividly white cumulus fractus clouds in front of the ominous and dark storm on the horizon. The phenomenon that I was capturing was the lower cumulus clouds forming in front of and under the building storm clouds.

Circumstances

I captured this image standing on top of the University of Colorado Engineering Center parking garage in Boulder, Colorado. I was facing to the northeast, where I could see large cumulonimbus clouds forming. I had the camera at about a twenty-degree angle above the horizon as to be able to capture the city for scale, the clouds in the background, and of course the cumulus fractus clouds in the center of the image. I took the picture at 1554 local time on March 11 with the sun still above the mountains behind me when I was taking the picture.

The Clouds

This image provides a spectacular display of many different types of cumulus clouds. I will start by explaining the clouds in the background of the image from lower to higher elevation and then I will explain the cloud in the front and center of the image. If you look in the bottom fourth of the image just above the horizon you will see a dark band of stratocumulus clouds. Stratocumulus clouds are low laying clouds that form anywhere from 2000-6500’ above the ground level covering large amounts of the sky.[1] Stratocumulus clouds can form due to a temperature inversion that occurs near to the ground, but not at ground level.[1] The cumulus clouds near the ground rise until they reach the point where the temperature inversion occurs.[1] This happens because the rising thermal currents are not strong enough to pass through the temperature inversion; subsequently, the currents spread horizontally to the ground causing the cumulus clouds they brought with them to spread into a layer of stratocumulus clouds.[1] As you can see in the Skew T diagram in Figure 1 there is a temperature inversion that occurs near the ground (somewhere between 1500-3500’ above the ground) which probably caused this stratocumulus layer of clouds to form.[2]

Above and closer to the camera than these stratocumulus clouds but still behind the front and center cloud you can see a multitude of light grey altocumulus clouds. Altocumulus clouds can form anywhere from 6500-18,000’ above the ground.[1] After looking at the WeatherSpark[3] data for Boulder I found that there were cloud layers at 11,000, 9000, and 8000' above the ground. I assumed that these clouds were indeed close enough to be considered over Boulder.[3] Just to be sure I also checked the cloud heights at Longmont, which revealed one layer of clouds at 11,000' above the ground.[3] From this information I determined these clouds were indeed the altocumulus clouds that I was seeing in the image.

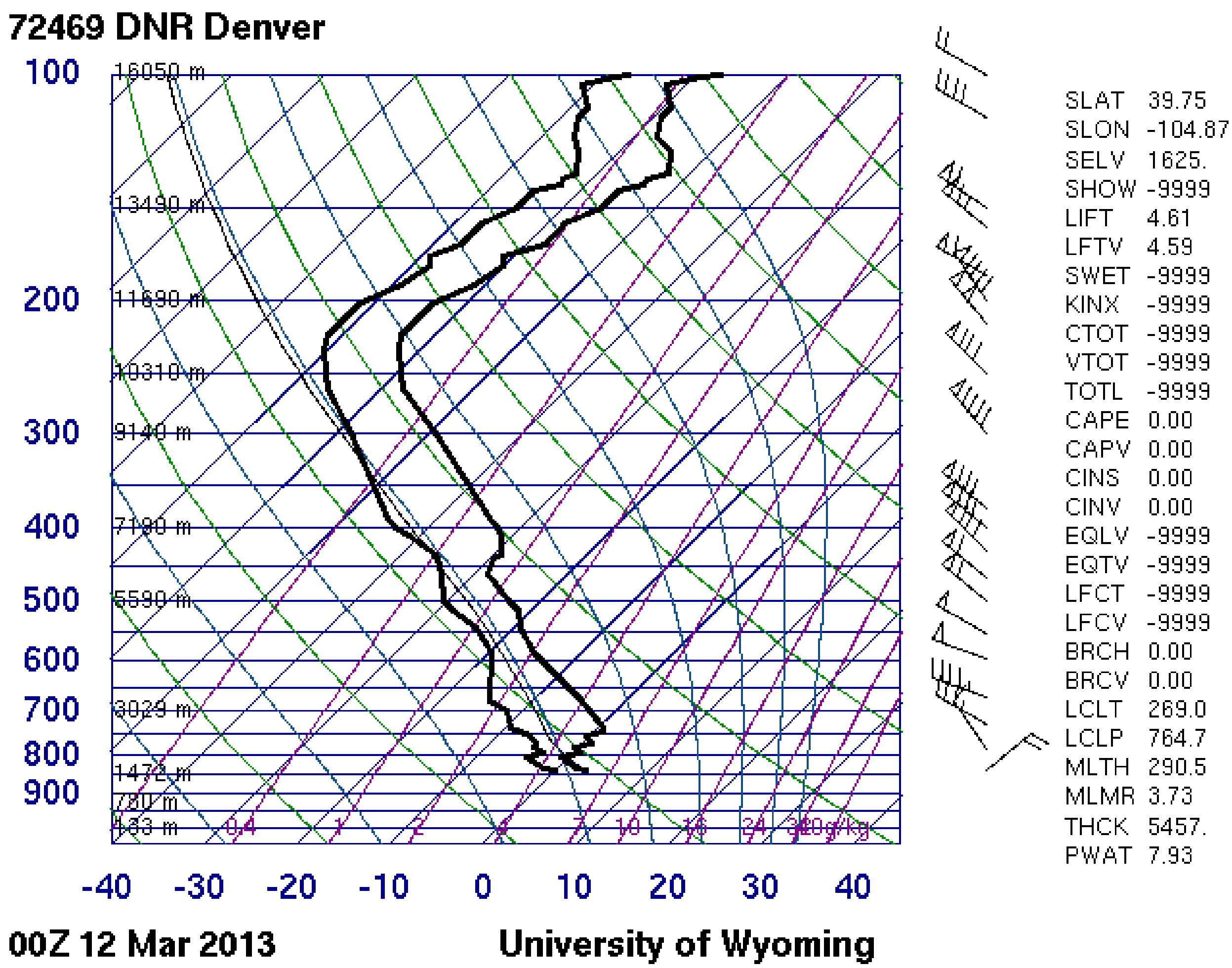

Figure 1: Skew T Diagram[2]

The large, dark, and ominous clouds towering above and beyond the top of the image were cumulonimbus clouds. Cumulonimbus clouds can form anywhere from 2000-45,000' above the ground.[1] The WeatherSpark data reported that there was a cloud ceiling of 22,000' above ground level over Denver which probably marked the top of these cumulonimbus clouds; cumulonimbus clouds can grow much higher than this especially with stronger thermal updraft currents. There are three conditions that make it ideal for cumulonimbus clouds to form.[1] One, the cloud must have enough warm and moist air to allow it to form.[1] In this case, the temperature was 50 degrees Fahrenheit which is relatively warm for that time of year, and from experience the air was moist.[3] Two, the wind needs to get stronger as the elevation increases, and this must happen in the same direction as the cloud is traveling.[3] This increase in wind from the northwest can be seen in the Skew T diagram in Figure 1. Three, there must be an unstable atmosphere.[3] Even though the Cape reads 0 on the Skew T diagram, if you look at the slope of the temperature line you can see that it is a steeper slope than the dew point line until approximately 16,000' above ground level. For this reason I hypothesize that the atmosphere was unstable below approximately 16,000' and then it became stable above that. The atmosphere is unstable when the surrounding air becomes colder faster, and therefore the rising air continues to be warmer than its surrounding air allowing it to continue to rise.[1]

The cloud in the front and center of the image is a cumulus fractus cloud. A fractus cloud is described as having "ragged edges and broken up. Can form in moist air below rain clouds."[1] This is a perfect description of the clouds in the center of this image. They were changing so quickly that you could visually see them swirling at real time, and if you looked away for more than five seconds they would be a completely different shape. From experience, the air was also moist and there where clouds that would later precipitate in the area. The fractus cloud's closeness combined with its wildly active nature made it magnificent to watch.

The weather turned from sunny and 54 degrees Fahrenheit when I took the picture to snowing and in the upper twenties that night and the next day.[3] A cold front bringing 0.1 inches of precipitation in the form of snow moved through the area that night and the next day.[3] This cold front pushed ahead of it the beautiful array of clouds that I was able to photograph as the sky changed by the second. The snowstorm, which brought a very small amount of snow, explains the relatively low cloud tops for cumulonimbus clouds. The winds were out of the northwest, and they were relatively strong aloft at 18,000' above the ground where they were blowing at 80 knots.[2] These strong winds are characteristic of fronts as there is a pressure difference between the front and the surrounding area.

Photography

The field of view in the image is very large as I was facing to the east where the terrain is very flat. The fractus clouds in the front and center of the image were very close and no more than 1500 feet in width and 500 feet in height. The fractus clouds were approximately 3000 feet from the camera. I determined this by using the ground as a reference, and from recalling how close these clouds were when I shot the image. The focal length of the lens was 16.2mm. I used a digital Canon PowerShot SX260 HS. The original image was 4000x3000 pixels and the final image is 3436x2520 pixels. I set the aperture to f/4.5. Because it was still very bright, and I used a low F-stop. I had to set the shutter speed to 1/2000 seconds in order to let a low amount of light onto the sensor. I used the lowest possible ISO of 100 in order to make the image as clear and crisp as possible. I post processed the image in Adobe Photoshop. I cropped the photo in order to center the white fractus clouds in the image. I also manipulated the curves in order to turn the overall grey image into the deep blues and vivid whites that I saw when I was taking the picture. The colors are more vivid in the final image than when I was taking the picture, but it enhances the beauty of the image as well as bringing out more information than can be seen in the original image shown in Figure 2. The manipulation that I did with the curves function also enhances the depth of field by making the white clouds stand out in front of the darker storm clouds.

Figure 2: Original Image

Conclusion

The image reveals several different types of cumulus clouds. I like how the broken and wispy fractus clouds provide beauty as they are contrasted against the dark storm clouds in the background. I would have liked to capture all of the beauty of the sky that day, but it was changing so quickly that it made it impossible to photograph in one picture. I was absolutely able to fulfill my intent of capturing many different types of clouds while getting a visually stunning image that is both beautiful and impressive. I would like to improve the amount of information that you can see in the background clouds; I was able to do this somewhat by post processing with Photoshop, but I would have liked to capture more information in the original image. Overall, I was very pleased with my image as it presents the beautiful contrast of a dark storm approaching behind wispy fractus clouds that are still in a sunny and bright area.

Appendix

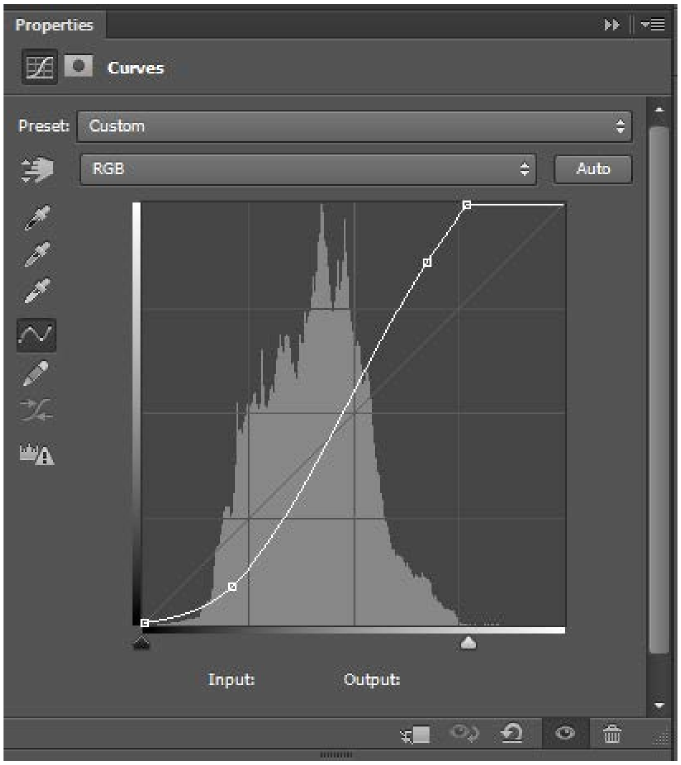

Figure A1: Adobe Photoshop Curves Function

Reference

[1] Pretor-Pinney, Gavin. *The Cloudspotter's Guide*. London: Sceptre, 2006. Print.

[2] "Atmospheric Soundings." *Atmospheric Soundings*. University of Wyoming Department of Atmospheric Sciences, n.d. Web. 17 Apr. 2013. <http://weather.uwyo.edu/upperair/sounding.html>.

[3] "WeatherSpark Beta." *Beautiful Weather Graphs and Maps*. N.p., n.d. Web. 17 Apr. 2013. <http://weatherspark.com/>.