Clouds I Report: Cirrus Fibratus

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Introduction

The picture on the cover of this report is the final edited image submitted to complete the Clouds I assignment. The intent of this assignment was to capture an interesting and beautiful image that reveals the physics and flow phenomenon associated with clouds. Investigating the physics behind the numerous cloud types creates an appreciation for one of the natural beauties of our planet that is often overlooked. I took many pictures in the Denver and Boulder areas of Colorado and ultimately chose this image to submit because I find the filament structure of the Cirrus fibratus among the most interesting of all cloud formations and it lacked obstructions that would have drawn the attention from the main focus. This image was taken, facing directly north at an 80° angle above the horizon, from my backyard in Denver, CO on February 16, 2011 at 12:30 p.m.

Atmospheric Physics and Conditions

From observation of the image it was easy to tell from the fibrous and silky appearance that this was a Cirrus type of cloud [1]. It was hard to determine the cloud variety, but after discussing with my professor, Jean Hertzberg, we ultimately decided that it was of the fibratus variety based on the straight/curved filaments that are mostly distinct from each other and do not terminate in hooks or clumps [1]. At the time the picture was taken the clouds were covering almost the entire western half of the sky and were heading east. To determine if there was a front moving in at the time the picture was taken I conducted an nine day weather study for the four days prior to and four days after February 16th, which is shown in Table 1. Through the nine day weather period it had only rained on the last two days. Based on the very noticeable temperature drop that occurred after February 16th and the shift of wind direction from the southward to the northward direction, I determined that a cold front was moving in on the day the picture was taken.

Table 1: Weather Conditions Four Days After and Before Image was Taken [2]

Date	Mean Temperature	Average Wind Speed	Conditions
2/12/2011	42 °F	11 mph (West)	Day – mostly cloudy / Night – clear skies
2/13/2011	48 °F	12 mph (WSW)	Day – mostly cloudy / Night – clear skies
2/14/2011	46 °F	10 mph (WSW)	Day – mostly cloudy / Night – clear skies
2/15/2011	54 °F	18 mph (WSW)	Day – mostly cloudy / Night – clear skies
2/16/2011	54 °F	6 mph (South)	AM – partly cloudy / PM - mostly cloudy
2/17/2011	34 °F	10 mph (SW)	AM – clear skies / PM – mostly cloudy
2/18/2011	40 °F	2 mph (WNW)	Day – mostly cloudy / Night – clear skies
2/19/2011	42 °F	6 mph (West)	Day – partly cloudy / Night – clear skies
2/20/2011	34 °F	14 (WNW)	Day – partly cloudy / Night - overcast

Cirrus clouds formed in the upper troposphere at altitudes typically ranging from 16,500 - 45,000ft. They are composed of falling ice crystals that evaporate in the warmer air below the cloud and thus, produce no precipitation that hits the ground. The movement of the falling ice crystals in the wind is what gives them their flossy, streak-like formations. The wind is often on the order of 100-150 mph, which means they don't stay in one spot for long. The fibratus variety in my image indicates the presence of very high wind speeds in the upper troposphere. Cirrus clouds are often a sign that the weather is about to change. This holds true in this case and can be seen from observation of Table 1 by looking at the temperature drop and the change in wind direction that occurred directly after February 16th. A skew-T plot, shown in Figure 1, is used to determine if the atmosphere was stable and the height at which clouds are most likely to form. This skew-T plot is for 6 p.m. on February 16, which is the closest one available to 12:30 p.m.

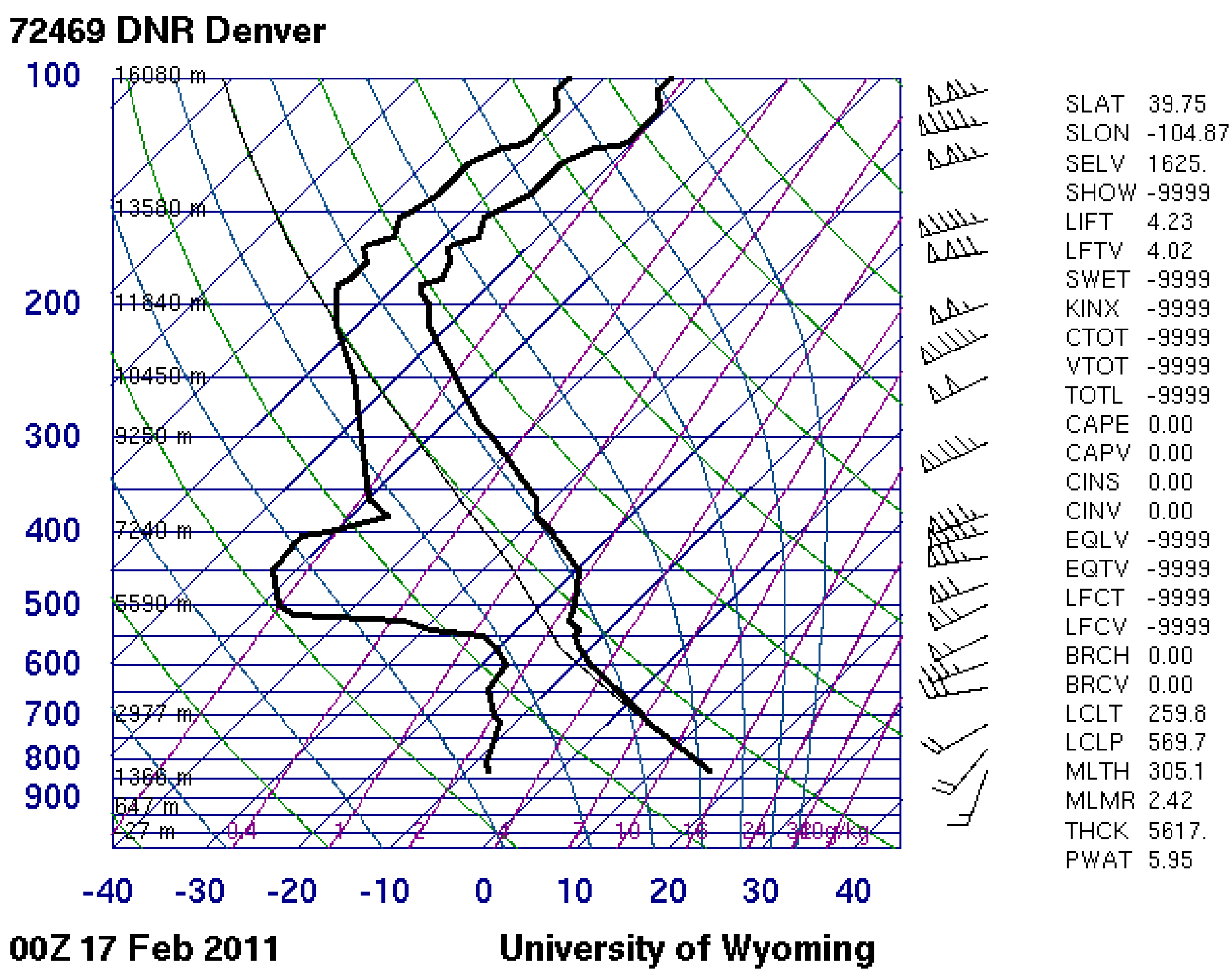

Figure 1: Skew-T plot for February 16, 2011 at 6:00 p.m.

Since a skew-T plot for the exact time I took the picture could not be provided, I looked at the before (2/16 12:00Z) and after (2/17 0:00Z) to determine if the atmosphere was stable. In both diagrams the CAPE value was zero meaning that entire atmosphere was stable. The two heavy black lines are used to determine where clouds are most likely to exist. The actual air temperature is depicted by right black line and the left black line represents the dew point temperature. Where these two lines come closest together is where the clouds are most likely to form. The diagram shows the lines closest at altitudes ranging from 12,000-15,000m (39,370-49,212ft), which lies within the highest range of cirrus clouds and agrees with my observation.

Photographic Technique

In the search for a perfect cloud to photograph, my main criteria was to get a picture that was interesting, beautiful, and had no distracting elements that take away from the physics of the flow. This proved much harder than one might think, with the main issues being contrails, power lines, and trees. To help with the later two issues, I used and 80° angle from the horizon. By looking through the camera and comparing points in the sky which correspond with the edge of the picture I was able to estimate the field of view to be 130°, to get an exact calculation is impossible unless the cloud dimensions are known. Taking into account the 80° from horizon and that the clouds were approximately 45,000ft in altitude that allows us to calculate using simple geometry the distance from the cloud to the camera lens to be about 47,888ft.

This image was shot using a point-and shoot Sony DSC-H10 8.1MP digital camera and gave a final image of 2448x3264 pixels and was never cropped for the final edited image. The camera was at a focal length of 0.25in (6.3mm), aperture stop of 3.5, shutter speed of 1/125s, and an ISO setting of 125. The original image is shown in Figure 2.

Figure 2: Original (unedited) Image

From looking at the original image it is a little difficult to tell were some of the edges of the cloud are because of its thin and featherlike structure. To fix this I used the curves setting to adjust the contrast using a nonlinear curve to help darken the blue sky. The only other thing that I edited was using the stamp tool to remove an almost unnoticeable contrail from the top left portion of the image.

Conclusion

The main scientific phenomenon this image reveals is the significant effect of the wind flow through the cloud creating the filament structure. I really like the balance of this image, how it is almost split in half, diagonally. I also really like the lighting on the clouds and how it highlights the internal features. What I dislike is how it cuts off a small portion of the cloud tips on the right side of the picture. This image displays the physics really well, the ice crystals being blown from the cloud and disappearing from evaporation is easily shown, but might need to be explained to unfamiliar minds. This aspect alone fulfilled my intent for this assignment. To improve this image, I would like to retake it without leaving out the cloud tips and adjusting my camera settings some more to try to increase the depth of field and improve the sharpness. The only question that remains in my mind is how a skew-t plot could change over the twelve hours where there is no data, but it must be decently reliable to at predict the weather, at least sometimes.

References

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

[2] *Weather underrground*. (n.d.). Retrieved from http://www.wunderground.com/