UNIVERSITY OF COLORADO

Colored Sunset Mountain Wave Clouds

Cloud Image Assignment 2

Aaron Lieberman

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Human interest in clouds has existed for a long time because clouds can make some of the most magnificent formations as viewed from below and above. Depending on the light, atmospheric stability, weather, and time of day clouds display an incredible amount of variability. From an artistic and viewer's perspective, this makes clouds some of the best foundations for creating an imaginative, yet scientific piece. Examining the physics behind clouds can reveal much of what goes on in the atmosphere at a certain elevation. A particularly interesting phenomenon occurs at sunset when the Sun's light reflects off of clouds in a particular way that produces spectacular color. This colorful sight as well as Flow Visualization's second cloud image assignment was the motivation behind my final image.

My final image was taken near downtown Boulder, Colorado. Specifically, it was taken just west of the intersection of 9th Street and Arapahoe Avenue off of the third story deck of my apartment on March 14, 2013, during sunset at 7:00 P.M. The time of day is clearly revealed in the image through the yellow under lit clouds displayed. The clouds photographed were hovering directly over the flatirons of Boulder. To capture the clouds photographed, I pointed my camera southwest at an angle of about 30 degrees from the horizontal.

The exact cloud type photographed was a Stratocumulus Mountain Wave cloud. This can be proven by the low elevation of the cloud formation and the puffy congregation of the cloud [3]. At this time of day on March 14, 2013, the temperature was 62 degrees Fahrenheit and very calm with a wind speed of 3.4 miles per hour [4]. Overall, the day was a very nice day. It produced magnificent clouds, but was sunny at the same time. At 7:00 P.M. light was fading rapidly so it was very interesting to see the change in color the clouds displayed. At first, they were a very bright yellow, and they quickly faded to a dark orange before darkness blocked all light. There were many other clouds in the sky, including clouds to the north, south, east, and west. The day before the image was taken, there was no precipitation, and it was another beautiful spring day with a maximum temperature of 65 degrees Fahrenheit. March 15, 2013, was even nicer with a maximum temperature of 76 degrees Fahrenheit, and no precipitation was seen in Boulder, Colorado on any of the days [4]. On March 14, 2013, the day the photograph was taken, the atmosphere exhibited parcel stability due to the CAPE number being 0 as displayed below in the skew-T plot in Figure 1 [1]. Translating this into the physics of the cloud, there was little to no acceleration in the updraft in the atmosphere. The skew-T diagram represents the atmosphere in Denver, Colorado, but can be assumed to closely model Boulder, Colorado's atmosphere also. Latent stability is also prevalent because there was no storm on the day the photograph was taken or the days surrounding March 14, 2013 [2].

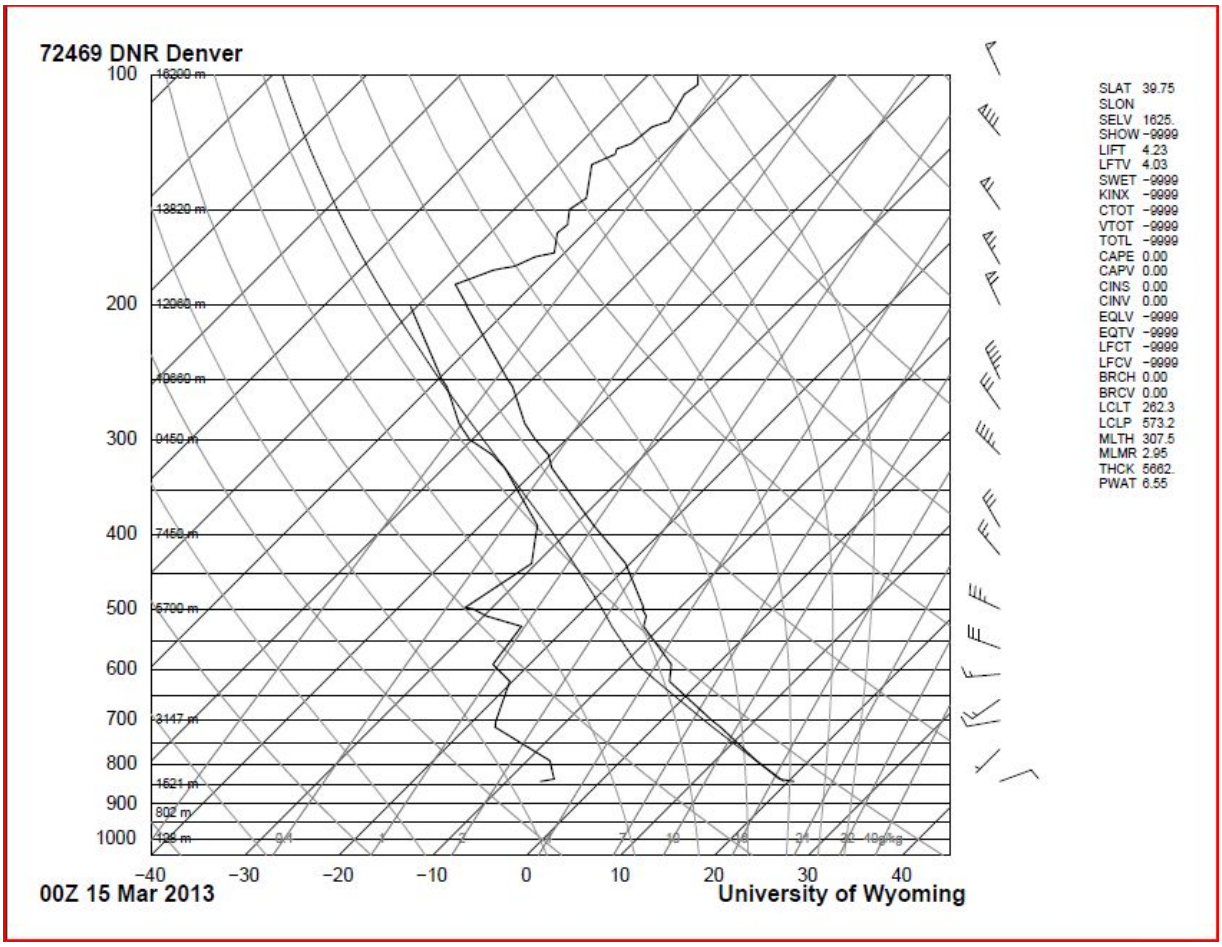

Figure 1: Skew-T Diagram for Denver on March 14, 2013, at 7:00 P.M.

It can be seen from the skew-T diagram that the temperature at any particular elevation did not reach dew point. This explains why there was no precipitation on this day. Since the skew-T diagram shows elevation from sea level, and Boulder, Colorado can be approximated to reside at about 5,500 feet above sea level (about 1,680 meters) the elevation of clouds must be examined adding the initial elevation of Boulder. The typical elevation that stratocumulus clouds form at is between 1,500 to 3,000 meters [3]. From this information, the elevation of interest on the skew-T diagram is between about 3,100 to 4,680 meters. As the dew point temperature moves towards the actual temperature line, clouds can be expected at the elevations around 3,200 meters, 5,000 meters, and 6,700 meters. The elevation of clouds at about 3,200 meters is congruent with the clouds seen in the image photographed since stratocumulus clouds will usually form around 1,500 meters above ground. These 3,200 meters accounts for the 1,680 meters of Boulder above sea level plus the 1,500 meters the clouds formed above the ground. It can also be seen that the wind was blowing southwest in the region around 3,200 meters, which was backed up by observations of the clouds moving to the south and west.

When taking the picture from my deck, I was about 600 feet away from the top of the flatirons. From this information, the field of view seen in the unedited image seen below in Figure 2 can be estimated to be about 90 feet in width by 70 feet in height. The settings used to take the picture included a lens focal

length of 9 millimeters, an aperture of 4.64, an F-stop number of f/5, exposure time of 1/80 seconds, and an ISO speed of 80. In the dimming light of the sunset, these settings were used to highlight the color of the fading clouds and to take in enough light to make the clouds visible. The width and height of the original image was 4,224 pixels by 2,816 pixels respectively.

Figure 2: Unedited Image

The edited image, seen below in Figure 3, features a width and height of 4,204 pixels by 2,360 pixels respectively. To take the picture, I used a Samsung ST65 digital point-and-shoot camera. Cropping the original image to delete some of the distracting features served as the only editing completed to produce the final image.

Figure 3: Edited Image

The colorful clouds seen in the photograph reveal the magnificent sunset seen on this evening of March 14, 2013. It shows how spectacular clouds can look when the Sun's light reflects off of them to produce amazing colors. The cloud elevation aligns perfectly with the skew-T diagram confirming that Denver's atmospheric data represents Boulder's atmospheric data fairly accurately on this particular day. I am very pleased with how the image looks, and I thoroughly enjoyed watching the sunset on this day. To improve the image, the tree on the right could have been edited out to focus the attention of the view on the clouds. Furthermore, to improve the dramatic nature of this sunset, a panorama photograph could have been taken as there were many clouds to the north and south with similar qualities. Also, a time lapse would have been able to capture the colors of the clouds as they changed quickly and fell into darkness. Another suggestion for enhancing the final image could be darkening the flatirons to create a complete silhouette. This would increase the contrast and dramatic aura to the photo.

References

[1] "Atmospheric Soundings." *University of Wyoming*. University of Wyoming College of Engineering, n.d. Web. 15 Apr. 2013.

[2] "SKEW-T BASICS." *The Weather Prediction*. N.p., n.d. Web. 15 Apr. 2013.

[3] "The Cloud Collector's Reference." *The Cloud Collector's Reference*. N.p., n.d. Web. 15 Apr. 2013.

[4] "WeatherSpark Beta." *WeatherSpark*. N.p., n.d. Web. 15 Apr. 2013.