

Fire in the Sky

Clouds 2 Assignment, MCEN 4151 Flow Visualization

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This image is for the second cloud assignment in MCEN 4151, Flow Visualization. The objective of this assignment was to capture an image of clouds to visualize the airflow in the atmosphere. My goal for this image was to capture a vivid sunset over the mountains.

On the evening of February 23, 2014, the sunset produced beautiful colors on the clouds over the mountains west of Boulder, Colorado. This image was taken at 5:59 pm MDT just after the sun had passed below the horizon from the fourth floor study room in Kittredge Central Hall on the CU campus. The mountains and the foreground are in shadow, but the higher clouds are bathed in the colors of the sunset. The image looks west over Boulder Canyon towards Sugarloaf Mountain. To understand the distance seen in the image, the tree on the left side is located in the Kittredge area of the CU campus. The closest and darkest range of mountains contains the Flatirons and Flagstaff Mountain, and the dark clouds in the sky are above this ridge. Behind this ridge, there are two additional ridges, which are over 2 miles away from the camera. The colorful clouds are above and behind these ridges. For this image, the camera was about 10 degrees above horizontal.

There are two sets of clouds in this image. The clouds that are colored by the sunset are altocumulus lenticularis clouds, mountain wave clouds. These clouds are formed as air moving from west to east is forced over the mountain tops. As the air rises, it cools and condenses into clouds if there is sufficient moisture at that elevation of the atmosphere. As the air descends on the eastern face of the mountains, the air warms and the clouds dissolve. In this image, the mountains responsible for these clouds are likely the Indian Peaks, which are further to the west and are not visible. The highest point in the Indian Peaks is 13,502 feet.¹ Therefore, these colorful clouds are probably around 16,000 above sea level. However, the rest of the skies were clear, so ceilometers and other cloud height sensors did not give an accurate height for these clouds. Near the top of the image, another set of altocumulus lenticularis clouds are in shadow. The clouds are the remnants much longer mountain wave cloud that extended across the mountain range containing the Flatirons and Flagstaff Mountain earlier in the day. By the time this image was taken, the wave cloud was disintegrating. Since it is in shadow, it is much lower in elevation than the colorful clouds, and it is significantly closer to the camera as well. It is probably located at about 8,000 feet above sea level. From the Skew-T diagram below in Figure 1, the atmosphere was stable with a CAPE value of zero. Mountain wave clouds are commonly found in stable atmospheres. From the cloud and pressure data, it appears that these clouds formed in a several hour gap between two storm systems.² There was precipitation the night before and the night after the image was taken, but the atmosphere was stable for a few hours in between the two systems when these clouds formed.

¹ Roach, Gerry. "Summits of Colorado's Indian Peaks Wilderness Area." *Summits of Colorado's Indian Peaks Wilderness Area – Sorted by Elevation*. Web. 12 Apr. 2014.

² "WeatherSpark Beta." *Beautiful Weather Graphs and Maps*. Cedar Lake Ventures, Inc. Web. 13 Apr. 2014.

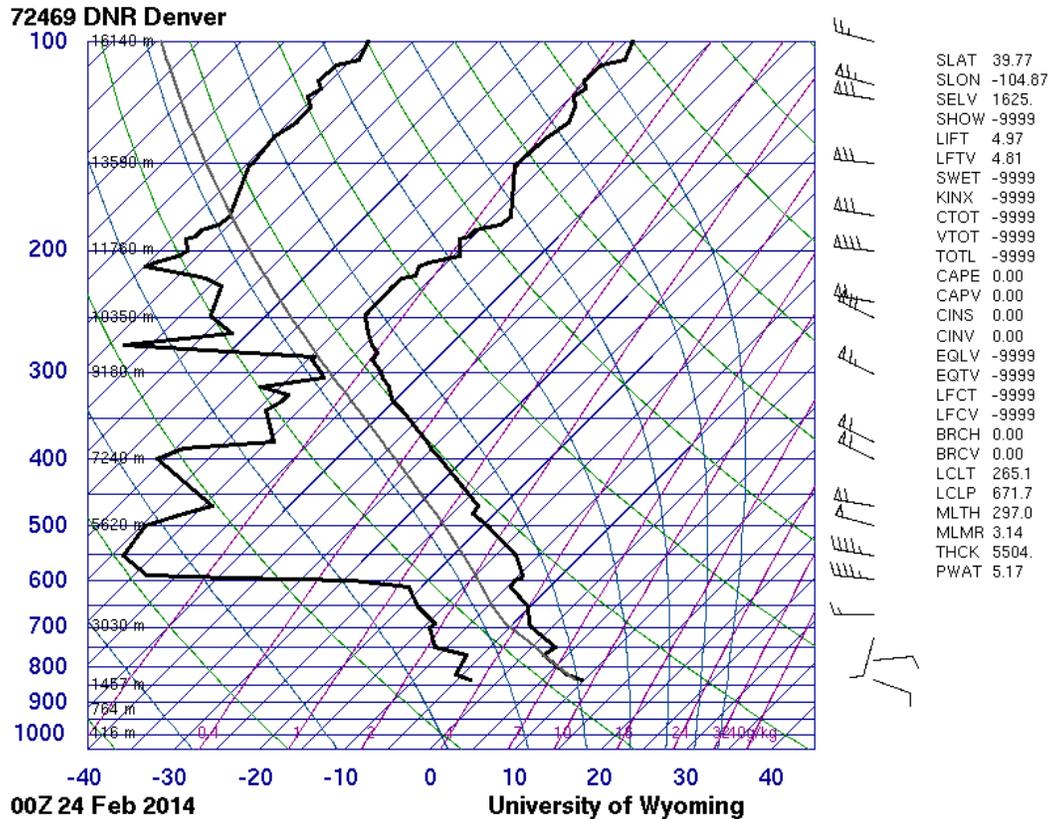


Figure 1: Skew-T Diagram with a Stable Atmosphere

This image was taken with a Canon PowerShot SX280 HS digital camera that has 12.1 megapixels. The telephoto lens has a 4.5 to 90.0 mm focal length and a 20 times image-stabilized optical zoom. The aperture ranges between 1:3.5 and 1:6.8, and the camera has an ISO from 80 to 6400. I was interested in capturing the depth of the mountains, so the aperture was set to f/6.3, and the focal length was 23 mm. However, it was sunset, and there was a low amount of light available to enter the lens. To compensate for this, the ISO was set to 1600. The shutter speed was set at 1/125 second. At longer speeds than this, the image would have become shaky from the movement of my hands. The camera was handheld because I did not have a tripod at that time. The field of view varies depending of the distance of the object to the camera. The mountains, which are closer than the colorful clouds, are about 1 mile across. The colorful clouds are much farther away, and they are easily 5 miles across or more. The clouds that are in shadow are about 1 mile from the camera, and the colorful clouds are about 12 miles away over the Indian Peaks.

Despite the efforts to capture a well exposed image, the original image that came from the camera was still dark and noisy from the high ISO. In post processing with GIMP 2.8, the Selective Gaussian Blur tool was used to reduce the noise. The contrast was then increased to lighten the image while maintaining the colors in the clouds. Increasing the contrast also exaggerated the transitions between some colors, which gave areas of the image unnatural textures and patterns. To correct this, the Selective Gaussian Blur tool was used again to smooth the transitions and provide a uniform gradient between regions of different colors. The original

image was 4,000 pixels by 3,000 pixels with a bit depth of 24, and these parameters were not changed in post processing. The original image is shown below in Figure 2.



Figure 2: Original Image

I like how this image captures the beauty of a sunset in Colorado. These beautiful sunsets do not happen every day, because the clouds need to be in the correct location at sunset. I am glad that I was looking out the window and saw this sunset in time. The image highlights how specific clouds are generated by the terrain below them. There are two different mountain wave clouds shown, and each one is generated by a different mountain range. I do not like how noisy and dark the original image was. Post processing can help, but it would be easier if the original image were lighter and less noisy. In the future, I would like to use a tripod when taking images like this one. A tripod would allow me to use a much longer shutter speed allowing more light into the lens. With a longer shutter speed, I could use a lower ISO, which would reduce the noise in the image. I could also consider using a wider aperture to allow even more light into the lens. I called this image *Fire in the Sky*, because the reds in the clouds reminded me of the phrase from John Denver's song, *Rocky Mountain High*.³

³ Denver, John. *Rocky Mountain High*. RCA Victor. Milton Okun, 1972. Vinyl recording.

But the Colorado rocky mountain high
I've seen it rainin' fire in the sky
The shadow from the starlight is softer than a lullaby
Rocky mountain high

References

- ¹ Roach, Gerry. "Summits of Colorado's Indian Peaks Wilderness Area." *Summits of Colorado's Indian Peaks Wilderness Area – Sorted by Elevation*. Web. 12 Apr. 2014.
- ² "WeatherSpark Beta." *Beautiful Weather Graphs and Maps*. Cedar Lake Ventures, Inc. Web. 13 Apr. 2014.
- ³ Denver, John. *Rocky Mountain High*. RCA Victor. Milton Okun, 1972. Vinyl recording.