Cloud Image #1 Report

MCEN 4151

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This report discusses the first cloud assignment for the MCEN 4151 Flow Visualization class. The scope of the assignment is simply to watch the sky and capture an image of interesting clouds. The intent of the photo that was taken was to clearly see the details within the cloud while still displaying the surrounding landscape. The phenomenon that was attempted to be shown in the image is the various layers from top to bottom throughout the lenticular cloud.

The photo that was taken was shot in the early morning on the way to the engineering center at 7:13 AM. The location that the image was captured from was the eighth floor in the stairwell. The picture was shot through the westward facing window looking directly west towards the flatirons. The elevation angle of the camera was very close to horizontal and may have been a couple degrees above horizontal to capture the top of the clouds.

The clouds that are seen in the image are altocumulus lenticularis. This can be determined by the various lens-like layers that are seen in the clouds from bottom to top. The rest of the sky in the surrounding area was clear with the exception of similar clouds above mountains north and south of Boulder. The weather the previous day was similar to the weather in the morning but did not display the same clouds. However, there was a front that moved through during the day after the photo was taken. There was snowfall in the evening after the image was captured. In Boulder the winds were calm to nonexistent. This being said, the lenticular clouds suggest that there were easterly winds in the mountains that allowed the formation of the clouds. According to the Skew-T diagram that can be seen in Figure 1, the atmosphere on the morning of February 5 was stable. This can be determined in two different manners. First, the CAPE value on the right of the plot is 0. This is a metric for the stability of the atmosphere, as the value gets higher, the atmosphere becomes more unstable. The other method to determine atmospheric stability is to view the lines on the diagram. The two lines that are required to determine stability is the rightmost bold line, temperature, and the black dry adiabat line that rises to the left from the temperature line. The two lines rise roughly parallel in the case seen in Figure 1. Instability occurs when these lines depart from parallel and the slope of the temperature line, if projected further, would cross the dry adiabat line.

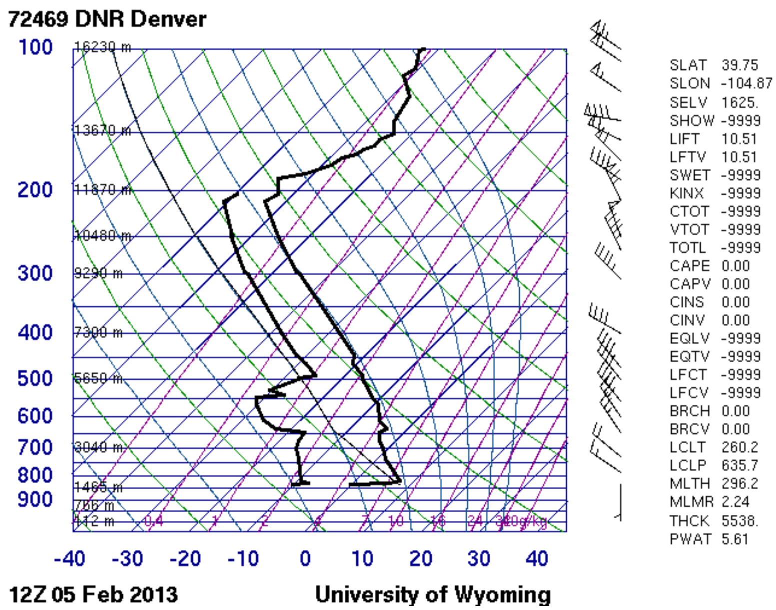

Figure 1. Skew-T diagram for Denver - Morning of Feb. 5th

Also from the Skew-T plot, an estimate of expected cloud height can be made. Determining this involves using the dew point line which is the bold line located to the left of the temperature line. Clouds can be expected where the dew point line departs from running close to parallel with the temperature line. In the Skew-T seen in Figure 1, it can be estimated that clouds would be forming around 5650 meters (18,536 feet) above sea level or about 3,000 meters (9842 feet) above the ground. This does not agree with the image that was taken. Using the mountains as known distances, the length of the cloud from south to north is about 5 kilometers. This allows for the estimation of the altitude of the cloud to be about a kilometer above the ground. From the stability of the atmosphere and the general weather in the area, altocumulus clouds could be expected. The clouds seen in the image are a subset of the altocumulus, lenticularis. The physics behind the altocumulus lenticularis clouds involve wind flowing over mountains and creating large standing waves on the downwind side of the mountain. As the air flows up the standing wave, the temperature drops lower than the dew point and condenses forming the cloud.

The photographic technique that was used was simply to capture the full cloud as clearly as possible since the photo was being taken through a window. The cloud could be assumed to be at an infinite distance when concerning the depth of field. As discussed previously, the field of view from left to right is approximately 5 kilometers, and from top to bottom is about 2.5 kilometers. Since the clouds form above mountains, it is assumed that the linear distance to the mountain below the cloud is approximately the distance to the front edge of the cloud. Using GoogleMaps, a distance from the engineering center to the mountain in the image is about 4 kilometers. The focal length that was used was 18 millimeters which allows the maximum field of view with the lens that was on the camera. The image was taken with a Nikon D60 DSLR in the RAW formatting mode. The original and final images, which can be seen in Figure 2, have a pixel height and width of 3,900x2613 and 3200x2613 respectively.

Figure 2. Original image (left) and final image (right)

To capture the original image, a shutter speed of 1/200 of a second, an aperture of 6.3, and an ISO of 400 was used. These settings were chosen to allow for the maximum amount of light and depth of field while still quickly capturing the image. Finally, Photoshop was used to brighten up the image while increasing the contrast to display more detail. The image was cropped to remove the majority of the campus buildings and the Photoshop content aware feature was used to remove the buildings that remained in the photo. Lastly, the HDR facet of Photoshop was used to brighten up the face of the mountains in the photo.

The final image reveals the various layers of the altocumulus lenticularis clouds. I like the clarity of the image and how well the details within the clouds turned out. Also, I was happy with how well the mountains in the image brightened up. Something I wish I could have improved is being able to see the whole cloud, potentially using more photos in a panorama. To develop the idea further I could find multiple mountain tops that display the lenticular clouds over each peak. Overall, I am very satisfied with the outcome of the image.