Clouds Assignment #1

George Seese

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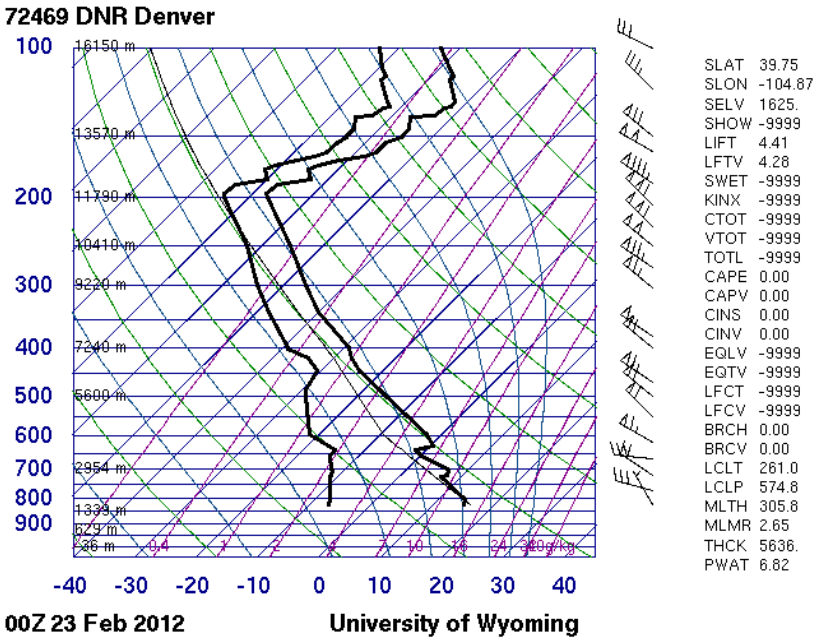
The image was taken to fulfill the requirements of the first cloud assignment in the Flow Visualization class. The image is not the image that was originally going to be used for the assignment. A number of images had been captured several days before. However, the cloud formations were not as interesting as the one that was captured in the image that was used. Additionally, the clouds that were captured in the first image were small and isolated and were captured from nearly a 90 degree angle, which meant that it was difficult to establish their traits such as elevation and size. The primary intent in switching was to use an image that captured a much rarer cloud formation than the previous images had, as well to capture a much more aesthetically pleasing image. Due to the fact that the primary image had already been taken when this cloud was spotted, the image was not captured with a dedicated camera, but was taken with a phone camera.

The image was captured from on the CU Boulder campus. It was taken while standing in front of the Norlin library. The location presented a challenge in capturing the image, as it proved difficult to find a position that minimized the number of buildings, light poles, and trees that were visible in the bottom of the image frame, though the few that were present in the image were cropped or edited out. The picture was taken facing nearly straight to the west, however there was a rotation several degrees to the south from due west. The flatirons are visible in the lower right corner of the unedited version of the image, which can gives an indication of the direction the camera was facing. The image was taken by hand without use of a tripod, so establishing an exact elevation angle is difficult. Based on the ground references visible in the image, and estimation of the angle while capturing the image the incline was approximately 30 to 40 degrees from horizontal. The image was captured on Wednesday, February 22, 2012 at 3:58 PM. The form of the cloud and the lighting remained consistent for a period of about 15 minutes.



There are two different clouds visible in the image. The cloud that is farther west is a mountain wave cloud. It can also be classified as a lenticular cloud. The cloud that is visible at the top of the image is more difficult to classify, however it may also be a lenticular cloud. It may also be classified as an altocumulus cloud[1]. The sky was very overcast at the time that the image was taken, and the the only portion of the sky that was visible was the thin ribbon of blue sky that was present in the center of the image. The weather had been mostly clear but slightly windy in the days leading up to the time that the image was captured. It was very windy when the image was taken, and winds were around 30 mph on the ground at the time the image was taken. Based on the skew-T diagram, clouds would be expected to form around 10000m or slightly higher. The data from the graph must only be considered an estimate however, as the high winds present mean that conditions could vary significantly between where the image was captured and DIA, where the balloons are launched from. However, there is a contrail visible in the cloud in the upper part of the image, and it can be seen that the contrail is at nearly the same height as the cloud base because it fades in and out of the cloud. Based on the average cruising altitude of a commercial airliner, the results tend to agree. Further, on close inspection, an airplane is visible in the center of the image, however it appears to be a small craft well below the clouds, further supporting the notion that the clouds are actually fairly high in the atmosphere. The

atmosphere is relatively stable at the time of the image capture. The lenticular cloud is most likely formed by most air being forced upwards by the mountains and then cooling. The cloud in the upper part of the image is likely caused by the wind carrying the raised moisture out over the plains.

The field of view of the image is difficult to determine exactly, but may be estimated at around three miles across. The distance to the cloud from the lens an be estimated using the height of the cloud and the approximate angle of elevation of the camera. Assuming a cloud height of 25,000 due to the fact that the lenticular cloud in the bottom of the image was slightly lower than the cloud in the upper part of the frame, and using an estimated angle of 35 degrees, an equation can be created of the form x=25000/tan(35). The result of the equation is 35700 feet, or approximately 6.75 miles. This estimate seems reasonable as the CU campus approximately three miles from the base of the front range, and accounting for the extra distance to the peaks and travel due to wind this would be approximately where one would expect a lenticular cloud to form. The image was captured with a phone camera. The phone model is a Motorola Droid Bionic with an 8 megapixel camera. The original image size was 3264x2448 pixels, and the edited image was 3264x2164 pixels. The phone does not provide extensive control over camera settings and does not provide much data on the settings it uses in capturing the image. The available data does show a focal length of 5mm and an aperture setting of 3. The f stop is listed as f/2.8. The recorded shutter speed is 1/3712 seconds. There is no ISO information provided to determine if this is an accurate shutter speed or not. The image was edited in several ways. The image was cropped to cut out items visible from the ground, and then the clone stamp was used to remove any artifacts that remained in the bottom of the image, as well as the contrail and the plane in the upper part of the image. Contrast was slightly increased using the levels tool. Finally, though not originally intended to be used as a final product, a black-white inversion was performed.

The edited image loses some of the context, and is difficult to tell it is a cloud. However, the inversion makes the lines within in the cloud more visible and clearly shows the flow of the vapor within in the cloud. The image turned out to be more aesthetically pleasing than expected, and the

quality provided by the phone camera exceeded expectations. The intent of the image was to provide a unique look at a cloud while also attempting to capture the flow of moisture within the cloud, and both goals were achieved. The idea could be improved and taken further in several ways including use of a panoramic image or a time lapse. However a time lapse may not have provided as dramatic a result because the lighting conditions that enabled the capture of the image only lasted for a relatively short period of time.

References

1. Pretor-Pinney, Gavin. *The Cloudspotter's Guide.* (Perigee Books, New York. 2001)