Altocumulus Lenticularis Cloud
Near Boulder, CO

Flow Visualization
Terese Decker
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Introduction

Flow visualization is traditionally perceived as an art-science in which the artist and/or scientist realizes an intended flow by devising it in the laboratory. The beautiful thing about clouds is that they are a form of flow visualization that Mother Nature realizes and devises. It is only up to the artist-scientist to capture the essence of her magnificence. In the case of clouds, even scientists often disregard all the factors that contribute to the brilliance of the sky – the time of year, the location, the impinging weather patterns and other extraneous factors such as pollution and wind. These are the factors which uniquely contribute to making the scientist realize the image in the beauty of the sky. This image is the first time the artist-scientist has intentionally photographed clouds as art. Her only intention was to capture the magnificence of the Colorado sky in a single image, regardless of the actual sky conditions at the time.

Methods

This photo was taken on January 18, 2010 at 5:00pm at the scenic overlook point of interest off Highway 36, just southeast of Boulder, CO toward the southwest about 30º from the horizon. In this image, the sky looks pleasing, yet dark, as the sun sets. The weather was mild and there were no fronts approaching and no precipitation that day. The corresponding Skew-T plot for this date and location is shown below in Figure 1.

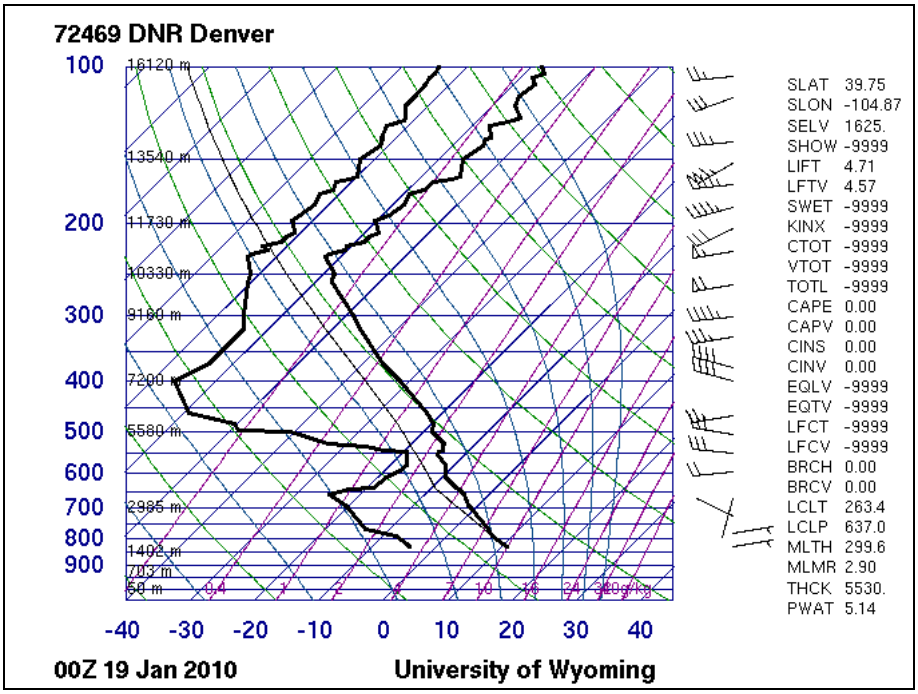

Figure 1. Skew-T plot for January 18, 2010 at 6pm in Boulder, CO.

The Skew-T plot for 6pm on January 18th (indicated by 00Z 19 Jan 2010) shows that the clouds are at about 5500 m, where the dew point is closest to the temperature. The convective available potential energy (CAPE) is zero, indicating that the atmosphere was stable on this day. This means that the atmosphere did not support the movement of air molecules upward at this location on this day. The cloud in this image is an altocumulus

lenticularis, also known as a mountain wave cloud. There is a cirrostratus layer in the back of the photo, which is shown on the skew-T plot about 11,000 m.

The photographer for this image was situated many miles away from the clouds, making the distance from the object to the lens quite large. The camera used to take this photo was a digital 10 Megapixel Nikon Coolpix S220. The focal length of the camera was 9.3 mm. The shutter speed was 10/1364 seconds. The exposure program was classified as normal. The f-stop was f/3.9. The ISO speed rating was 113. The flash fired with no strobe return detection and no red-eye reduction. The original photo was 3648 pixels wide by 2736 pixels high, and it was cropped to 3648 pixels wide by 1098 pixels high. No other alterations were made to the photo except increasing the contrast and saturation of some of the warmer colors already present in the image.

Analysis

The unique aspect of a lenticularis cloud is that it only exists in mountainous regions, such as the foothills of the Rocky Mountains in Colorado seen in this photograph. They are periodic changes of atmospheric pressure, temperature and orthometric height in a current of air caused by vertical displacement. This picture shows the orographic lift when the wind blows over a mountain range. In this situation, a mountain wave cloud forms from the rising branches of mountain waves and occupies the crests of the waves. The distinctive characteristics of mountain wave clouds are the appearance of vertical propagating waves. These propagating waves are atmospheric internal gravity waves formed by the oscillation of the air over mountain ridges, as shown in Figure 2.

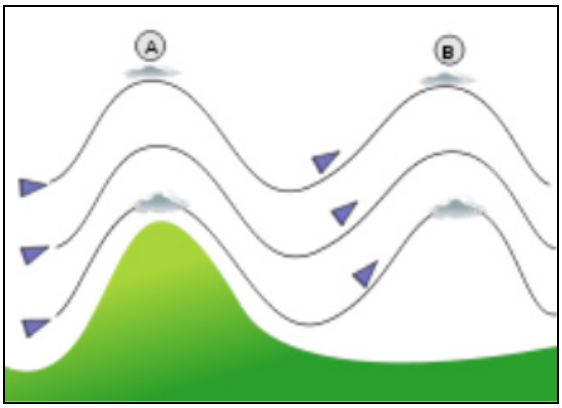

Figure 2. Streamlines of wind over a mountain and the resulting clouds

In Figure 2, the streamlines of the wind are shown as they flow toward and over a mountain. The first oscillation over the mountain produces the first cloud, as indicated by the letter A in Figure 2. The first oscillation is followed by more waves, which produce similar looking clouds on top of the flow, as shown by the letter B in Figure 2. The following waves will have a smaller amplitude because of the natural damping of the flow, creating the vertical propagation of the mountain wave and the resulting clouds.

Conclusion

This image adequately reveals the beauty of the mountain wave cloud over the mountain range. The physics of the mountain wave clouds are shown moderately well. Overall, the

artist is pleased with this image because of the beautiful range of colors and the clear depiction of the mountain wave cloud directly above the mountains, and therefore the intent of the image was fulfilled. This image, like most cloud images, was hard to depict because of the brilliance of the Colorado sky which is so hard to photograph for amateurs. Only with practice will photos of this nature become more advanced in order to adequately portray the real beauty of the flow related to clouds.

References

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[2] Lee wave - Wikipedia, the free encyclopedia. 26 February 2010. Accessed at http://en.wikipedia.org/wiki/Lee_wave

[3] Pretor Pinney, Gavin. The Cloudspotter's Guide, Perigee Press, 2006.