Altocumulus Lenticularis Clouds in San Luis Valley, Colorado

Andrew Scholbrock
University of Colorado at Boulder

April 19th, 2011

Figure 1: Final image of altocumulus lenticularis clouds taken in the San Luis valley just west of the Sangre de Cristo range looking north.

The purpose of this project was to observe different clouds and determine how different atmospheric, meteorological, and topological conditions have an effect on cloud shapes and formations. Much of my free time over the duration of this project was spent hiking in the Rocky Mountains in Colorado. During these hikes I observed many different cloud types ranging from puffy cumulus clouds to wispy cirrus clouds. The final image that was chosen contains a few altocumulus lenticularis clouds located over the Sangre de Cristo range. The image additionally contains some cumulus clouds at lower elevations and a few cirrus clouds at higher elevations.

As mentioned before, the image was taken in the San Luis Valley. Specifically the picture was taken at the Zapata Falls trail head located just east of highway 150 northwest of Alamosa, CO. The image was taken looking north towards Great Sand Dunes National Park and Preserve. The peaks in the lower left corner of the photo are Crestone Peak and Needle. The elevation of the trail head is at 9,040 ft. The angle of the camera was slightly deviated from horizontal, but not more than a degree or two. The time that the image was taken was in the afternoon at 2:24 PM on April 2nd, 2011.

The main cloud type of interest in this photograph was that of an altocumulus lenticularis could. Judging from the distance between the clouds and the mountains (whose elevations are around 14,000 ft) I would estimate that the elevation of the altocumulus clouds were around 20,000 ft. Typical altitudes for cumulus clouds are in the range of 6,500 to 23,000 ft. [1]. Hence my estimates are in agreement with the typical altitudes that these clouds are observed at. The distinct lens shapes to the clouds made it obvious that the specific clouds being photographed were altocumulus lenticularis. The cumulus clouds in the image were identified due to their puffy nature at lower altitudes [1]. Furthermore the cirrus clouds were also identified from their wispy shapes and great height in altitude [1]. In addition to analyzing the shapes and altitudes of the clouds, the atmospheric stability conditions were also studied. Figure 2 shows the atmospheric sounding data from the University of Wyoming that was collected at 6 PM on the same day that the image was taken [2]. However since Denver is quite far from where the clouds were observed, data from Grand junction was also analyzed as seen in figure 3 [2]. From both of these plots we can see that the dry air temperature profile shows that the atmosphere is stable [3]. This is consistent with the 0 value for the CAPE analysis given on the right of figures 2 and 3 [3]. Although the dew point never touches the dry temperature, it is closest at an elevation of about 5,700 meters, or about 18,700 ft. for both Grand Junction and Denver.

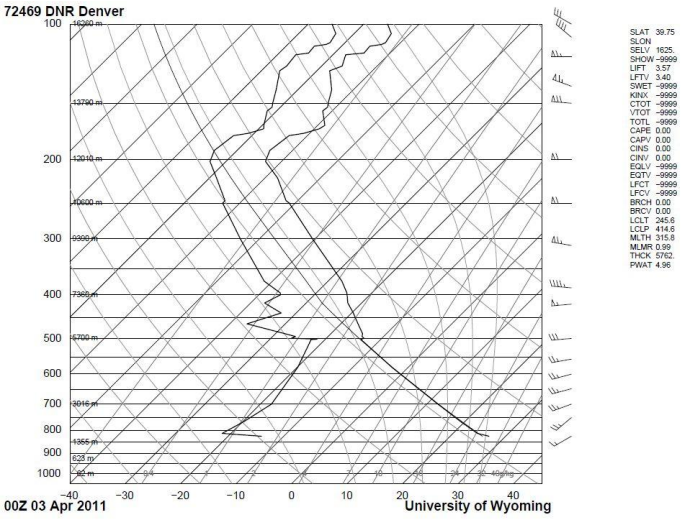

Figure 2: Atmospheric Sounding Data from the University of Wyoming for the Denver area at 6 PM of the day that the clouds were photographed [2].

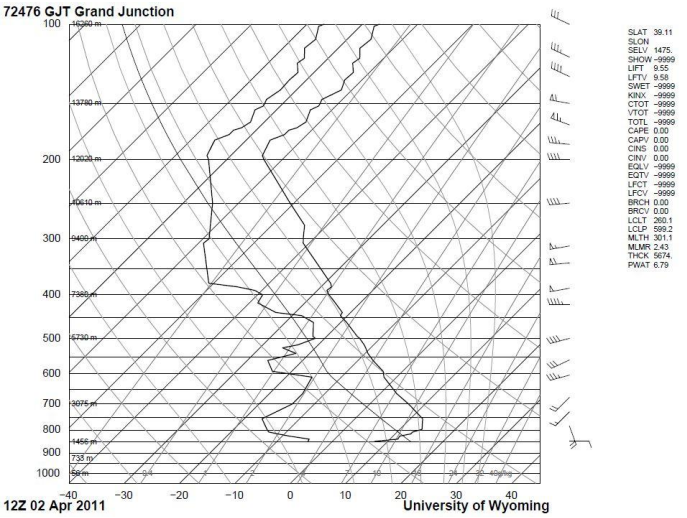

Figure 3: Atmospheric Sounding Data from the University of Wyoming for the Grand Junction area at 6 PM of the day that the clouds were photographed [2].

This value is a little lower than what I estimated the cloud elevation to be. However the estimation of 20,000 ft. was for the altocumulus clouds and there were cumulus clouds located. Additional discrepancies between the atmospheric sounding data and what was observed can be attributed to the fact that the distance and time between the two measurements were somewhat significant. A closer temporal and spatial SKEW-T data could provide more insight into the cloud physics. The weather on April 2nd produced no precipitation. However on April 3rd there was some light precipitation in the form of snow. The temperatures recorded in Moffat, CO on April 2nd were a high of 73°F and a low of 18°F [4]. This wide range of temperatures is above and below the mean high and low temperature data from previous years [4]. In observing the

weather throughout the day it was initially calm with very little wind. At this time the sky was clear without any clouds. As the day went on the winds increased and clouds began to form. This was probably due to the ground being heated by the sun causing the air to rise. With the topology of the mountains the water in air that rose condensed and formed clouds in lenticular shapes [5]. These lenticular shapes are due to the air pushed up and over the mountains and causing the water content to remain in place. The dissipation of these clouds has been attributed to radiative cooling and large scale subsidence [6].

To photograph the image I used a digital Panasonic DMC-ZS7. I chose this camera because it is small, portable and lightweight making it ideal to carry along with me at all times, especially while hiking in the mountains. The camera is also equipped with a GPS that records the position that the photo was taken in the image's metadata. Like the first cloud project the field of view for this image is quite large as portions of the Sangre de Cristo range are located in the image. If I were to estimate the field of view I would have to say that it is on the order of about forty to fifty miles as I can see several different mountains in the range. The distance from the object (the lenticular clouds) to the lens is about twenty miles. The focal length of the lens was 12 mm. The original image size in pixels was 4000 pixels wide by 3000 pixels high. This was then cropped down to the final size of 4000 pixels wide by 2678 pixels high. In exposing the image an aperture of f/4.1 was used along with a 1/1300 second exposure time and an ISO of 80. The aperture, exposure time and ISO were all manually set. To set the focus for the image the camera was focused on the mountains and then recomposed towards the sky. Post processing was then done on a computer using the open sourced program GIMP version 2.6. In GIMP the image was first cropped to remove part of the ground that distracted from the clouds in the image. The next step was to increase the contrast using GIMP's "curves" feature. With this done the saturation of the image was then decreased as the colors seemed too oversaturated.

The image for this project reveals that cloud formations are affected by factors such as temperature variations, atmospheric stability conditions, and topology. It shows that because of these factors certain lens shaped clouds can form to create altocumulus lenticularis clouds. It would be interesting to study the clouds more quantifiably and determine certain phenomenon such as the ice and water concentration levels which has been done by Carey *et al*. before [7]. It would also be nice to spend more time exploring the sky in order to capture an image where just lenticular clouds are present.

References:

[1] G. Pretor-Pinney, "Altostratus," in *The Cloudspotter's Guide: The Science, History, and Culture of Clouds*, New York, Perigee/Penguin Publishers, 2006, ch 6, pp. 136 – 149.

[2] SKEW-T Weather, University of Wyoming, College of Engineering, Department of Atmoshperic Science, <http://weather.uwyo.edu/upperair/sounding.html>, Last accessed April 19th, 2011.

[3] Haby, Jeff, "SKEW-T Basics", <http://www.theweatherprediction.com/thermo/skewt/>, Last Accessed: April 19th, 2011.

[4] Weather Spark Archived Weather History. <http://weatherspark.com/#!graphs;q=Moffat,+CO,+USA>, Last Accessed: April 20th, 2011.

[5] A. Heymsfield, *et al.* An Observational and Theoretical Study of Highly Supercooled Altocumulus. *American Meteorological Society* 1991, pp. 923 – 945.

[6] V. Larson, *et al.* The death of an altocumulus cloud. *Geophysical Research Letters*. vol. 28 no. 13 pp. 2609-2612, 2001.

[7] L. Carey, *et al*. The Vertical Profile of Liquid and Ice Water Content in Midlatitude Mixed-Phase Altocumulus Clouds. *American Meteorological Society* 2008 pp. 2487-2495.