Wide Mountain Wave

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Clouds Second
ATLS 4151 - Flow Visualization
Altostratus Lenticularis
Picture taken: 10/17/2019 6:10pm
Boulder, 16th and Euclid
Report written: 12/05/2019

Unlike the Clouds First assignment, this time the Clouds Second assignment wasn't due until after we were given several lectures on clouds and cloud types. This really helped me find a lot more unique clouds in the sky to photograph this time. I actually had so many cool cloud pictures that I couldn't choose which ones I wanted to use.

Image Circumstances

This picture was taken right outside my house on 16th street near the intersection with Euclid in Boulder, CO. I was facing north-east at an angle of 45° from the horizon. It was almost sunset, and I was looking out the window in front of my desk, and saw this amazing cloud. I quickly grabbed my phone and ran outside, and took 50 pictures over the course of 20 minutes. This picture was taken at 6:10pm.

Cloud Type

This cloud is an Altostratus Lenticularis, also known as a lenticular cloud for its lense like shape, caused by a mountain wave. These types of mountain waves and mountain wave clouds are caused by wind and air compressing as it travels up and over a mountain, and then accelerating on the way down after the mountain both from the subsequent expansion and from gravity. As this accelerated wind travels down the backside of the mountain, it hits the ground and bounces back upward creating an oscillating wave pattern in the wind in the upper atmosphere as it bounces up and down. At the peaks of the wave, warmer and less dry air is brought up to a higher altitude where it condenses and forms a lenticular cloud. Figure 1 shows an illustration of this phenomenon.

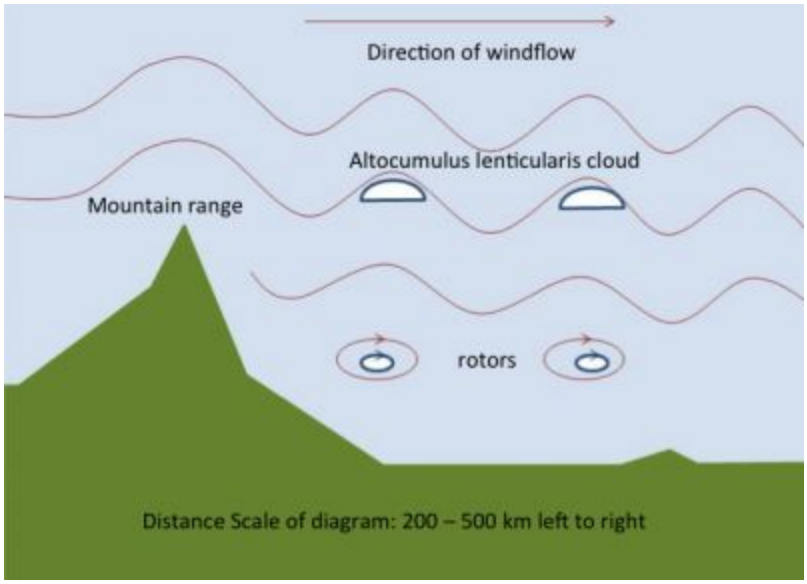

Figure 1: An illustration of the mountain wave and cloud type that is happening in this picture. Illustration courtesy of SKYbrary (https://www.skybrary.aero/index.php/Mountain_Waves).

The wind is moving very fast in this wave shape, meaning that moist air is constantly pulled into the peak where it condenses into a cloud, but also that the condensed water is then pulled out of the peak where it evaporates again into the air. This means that the cloud is almost stationary despite the wind moving very fast; also that even though the cloud appears to not be moving, it is actually in very rapid flux. A good indicator of mountain waves occurring by the mountains like this is strong winds in the upper atmosphere that are all aligned vertically meaning there is minimal wind shear. These conditions can be seen in the wind flags on the right side of the skew-T diagram that I included taken just 10 minutes before the picture (figure 2).

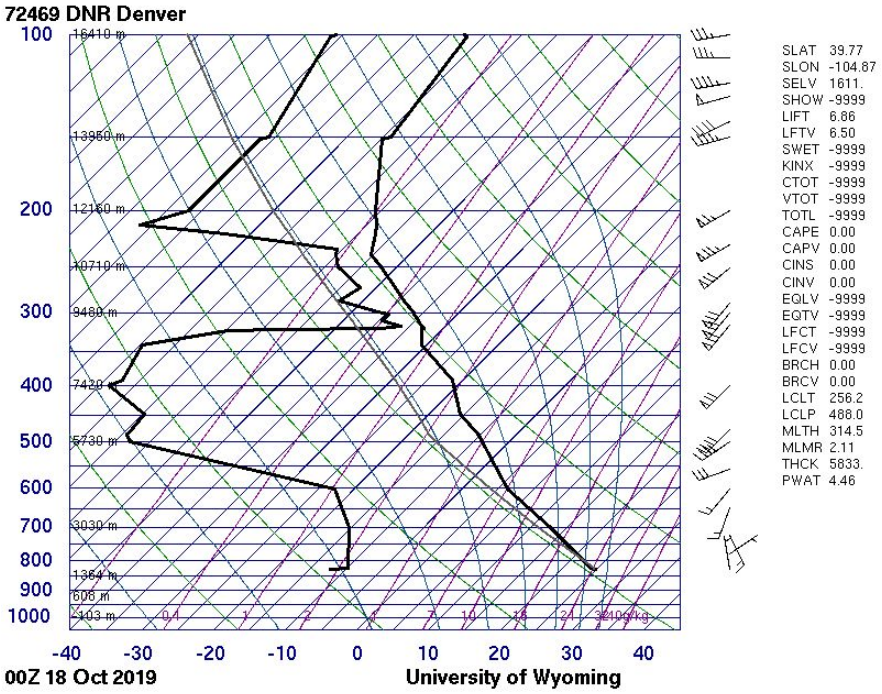

Figure 2: The skew-T diagram of the atmospheric conditions taken ten minutes before my picture at Denver provided by the University of Wyoming (http://weather.uwyo.edu/upperair/sounding.html).

Photographic Technique

To estimate the field of view I have a quarter of a “photosphere” (figure 4), and I can find the portion of the sky contained in the submitted photo. It’s very subjective, but to me it looks like about a 40° to 50° horizontal field of view and a 30° to 40° vertical field of view. The picture was taken with my phone at the time, a Google Pixel 2 XL. The resulting camera settings were: aperture f/1.8, shutter speed 1/616 seconds, focal length 4.459mm, and ISO61. The original image shown in figure 3 was 4032x3024 pixels. I didn’t want to really do any editing to the photo this time around because I didn’t want to make the sky look unrealistic at all, and I didn’t want to lose any scientific information. But there still was a distracting power line and tree in the shot. I could crop them out of the shot, but then I would lose field of view, so instead I decided to use

photoshop’s “healing tool” to effectively remove them from the shot without any cropping. After a good amount of tweaking, the effect turned out really nice, and you can’t even tell that there was originally a power line or tree in the photo.

Figure 3: The original photo before any edits

Figure 4: A 180° horizontal by 100° vertical field of view of the whole cloud for some context.

Conclusions

I had a really hard time picking which photo of this cloud to submit for the assignment because I had so many cool pictures of it. My original intention was to submit the very wide view shown in figure 4 or a heavily edited version of it. But I was having a hard time making the photo look as nice as I had intended, so I went with a more close-up shot that looked artistically way better. This new shot ended up telling a way different story about the cloud however. I originally wanted to show just how wide this cloud was, it stretched all the way from the north to the south of the sky. But instead my new picture showed the interesting shape that the cloud formed in the east-west direction. I'm pleased that the photo I submitted has a lot of artistic merit, and I'm glad it shows scientific significance of the cloud, but I still wish I could have shown the vast north-south size of the cloud somehow.

References

University of Wyoming. *Upper Air Sounding.* Web, 2019.
http://weather.uwyo.edu/upperair/sounding.html

SKYbrary Aviation Safety. *Mountain Waves.* Web, 2019.
https://www.skybrary.aero/index.php/Mountain_Waves