Kenneth Olavarria
Clouds First Report
MCEN 4151

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Figure 1: Final, cropped, and edited image.

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Motivation

The purpose of this assignment is to photograph clouds that we come across in our everyday lives. I would say that we take clouds for granted – they come and go, and don't really appear quite unique at first glance. However, clouds demonstrate interesting physical phenomena about how our world works.

Circumstances of the Image

This image was taken near Hartsel, CO. I was facing northwest and pointing my camera about 30 degrees above the horizon. The image was taken on October 14, 2023 (annular eclipse day) at around 16:00PM MST (22:00 UTC).

Circumstances of the Image

The clouds presented in the image are of the lenticular kind – mountain waves! Lenticular clouds are easily recognizable due to their lens-like shape. But what exactly are lenticular clouds? How do they form?

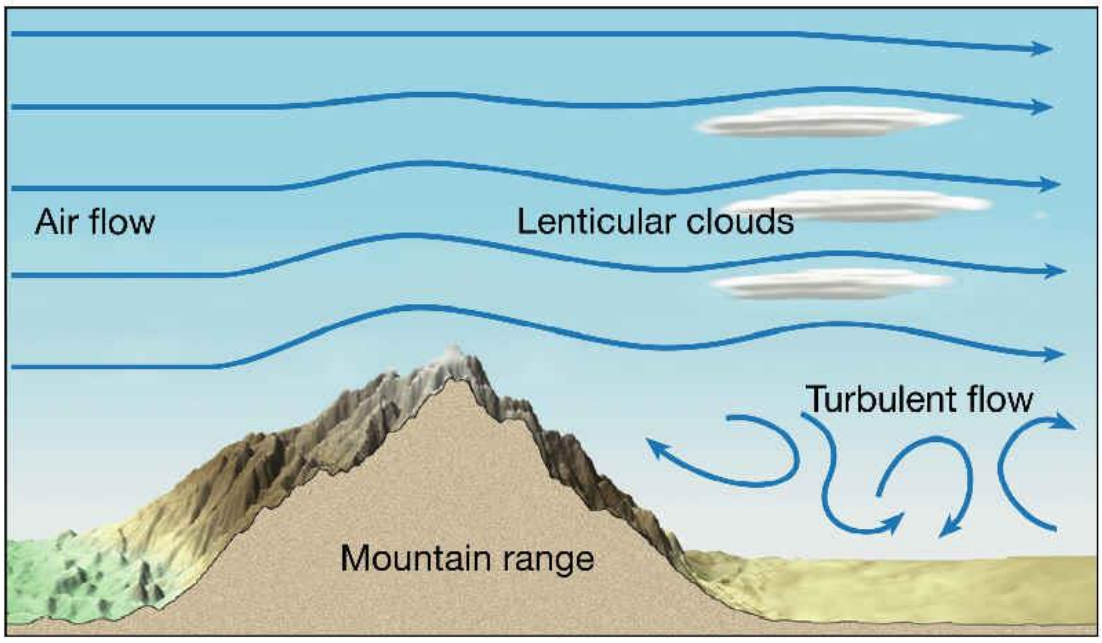

Figure 2: Diagram illustrating the formation of lenticular clouds.

According to NOAA, Altocumulus Standing Lenticular (ACSL) clouds are formed when relatively stable air is forced up and over a topographic barrier (such as a mountain) that is oriented

somewhat perpendicular to the directions of the upper-level winds. The moist, stable air then condenses if the temperature at the top of the wave is below the local dew point.

This was not surprising at Hartsel, CO, where the mean altitude is roughly 9000ft ASL – nearby mountains usually top 11,000 ft and have lower temperatures at their summits, leading to higher likelihood of condensation. The sky that day was very clear. No clouds were present in the morning, and lenticular clouds began to appear as the day progressed.

The Skew-T for the location and date matches the conditions needed for these lenticular clouds to form. The CAPE index was 0, which indicated a stable atmosphere. Synoptic weather data for the day also supported evidence for a stable atmosphere. The Skew-T diagram for the time and place, as well as the synoptic weather map for that day are displayed below.

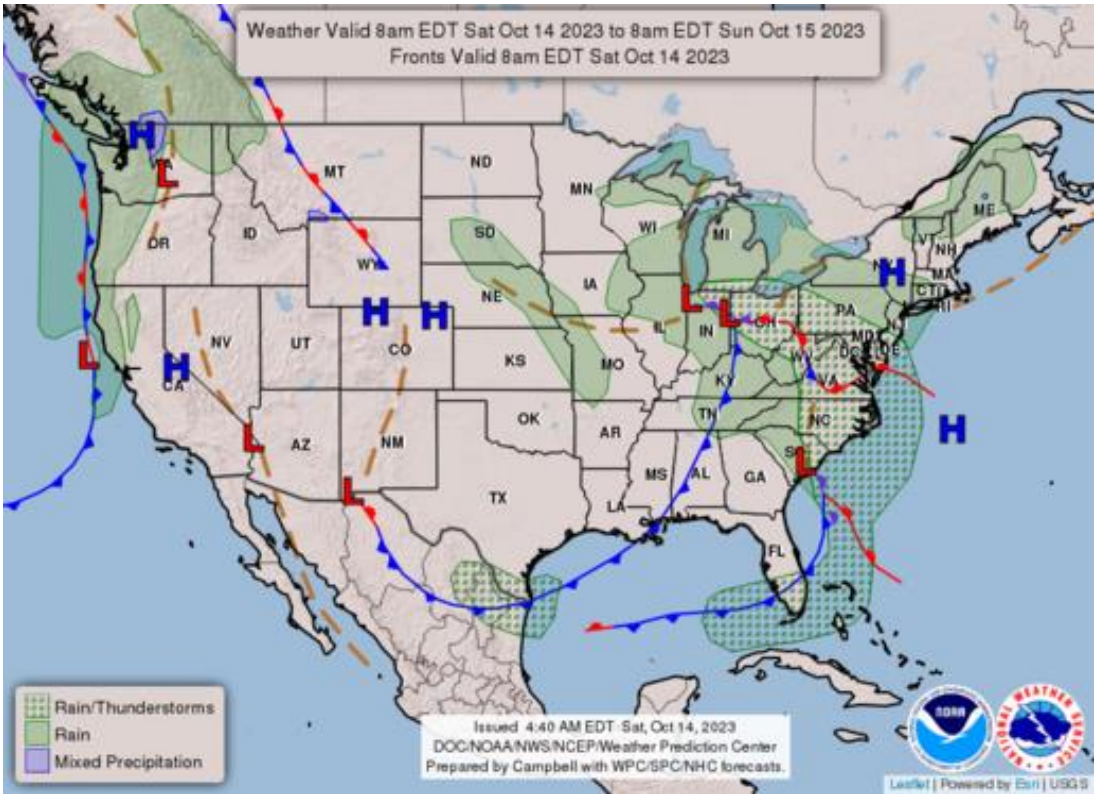

Figure 3: Synoptic Weather Chart for October 14, 2023.

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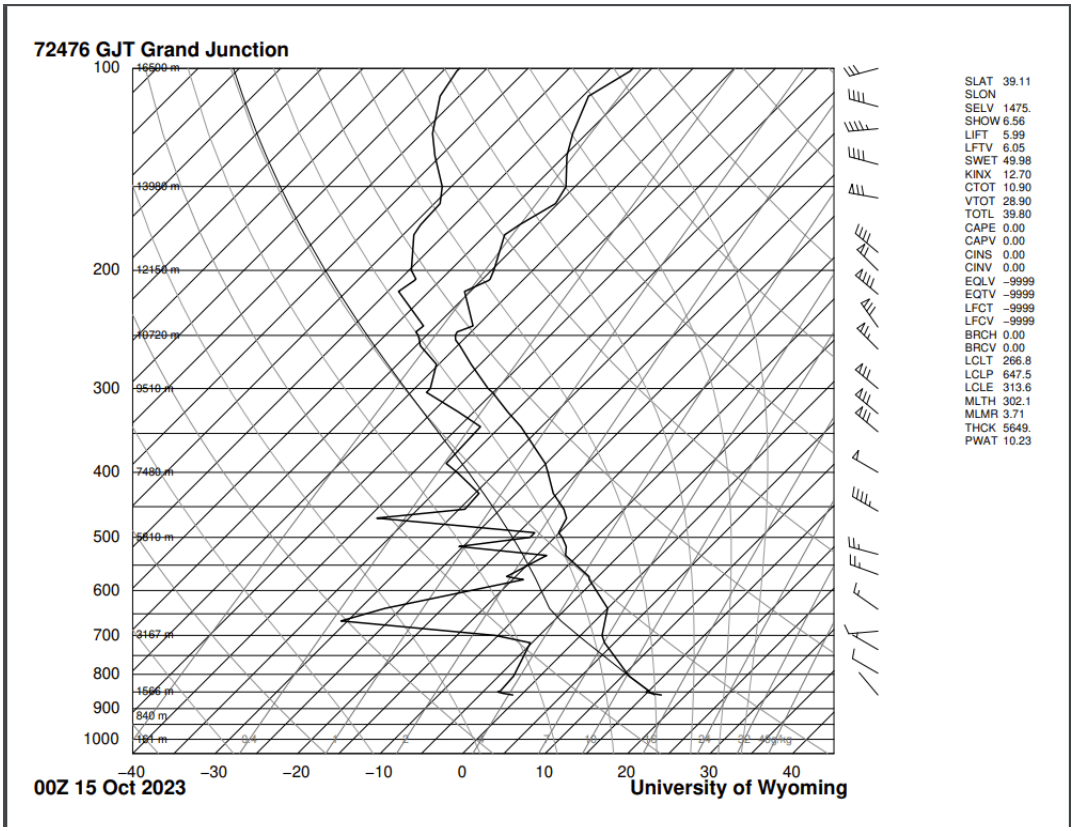

Figure 4: Skew-T Diagram for October 14, 2023, GJT.

The Skew-T diagram was taken from the University of Wyoming's atmospheric sounding lab and displays the data for the Grand Junction Station (72476 GJT) at 00Z (6:00PM Mountain Time). One can see that the Skew-T line (right black line) and the dew-point line (left, jagged line) come quite close at ~5400m of altitude, which corresponds to roughly 17,700 ft ASL. This is consistent with my observations of the lenticular clouds that day – they were well above some of the mountains surrounding my location. As such, I estimate these lenticular clouds to be at that altitude level.

Photography

For this photograph, I used my iPhone 14 Pro, which contains 3 separate camera lenses. The information for this image stated the following camera settings for the lens used for this specific photo. My iPhone used the 24mm focal length camera for this photo.

Setting	Value
ISO	64

Focal Length	24mm
f number	f/1.78
Shutter Speed	1/8197
Image Size	4032x3024

I was not entirely sure how far away these clouds were, but by using a little bit of trigonometry and the Skew-T data, we can get a rough estimate of how far away they were.

$$dist = \frac{altitude}{\sin(30)} = \frac{17{,}700}{\sin(30)} = 35{,}400ft = 6.7\ miles$$

To calculate the field of view, we can use the focal length of the camera and the size of the camera sensor. The stated sensor size for this lens of the iPhone 14 pro is 9.8x7.3mm. Using a bit of trig, we can calculate the FoV.

$$FoV = 2 * \arctan\left(\frac{Sensor}{2 * focal\ length}\right) = 23.1\ deg$$

Considering I was using 2x zoom on my iPhone, this value for FoV checks out.

I decided to crop and edit the image using Darktable. I adjusted the RGB curve to darken the surrounding sky, and increase the contrast between the sky and the clouds. The final image was cropped down to a size of 3567x2105 px.

The original image and the final, cropped image are shown below.

Figure 5: Original, unedited photo.

Figure 6: Final, edited photo.

Conclusion

I am quite satisfied with how the final image turned out. I was not expecting to see lenticular clouds that day, and I am quite happy that I got to capture them and know what they are. I