MCEN 5151 Clouds Second Report

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Figure 1: Final Edited Image

Introduction

During the course of this class, I have primarily chosen to focus on the scientific side of flow visualization, emphasizing the underlying physics and highlighting interesting phenomena. For my final visual for the semester, I decided to focus my attention on the artistic side of flow visualization. For my 'Clouds Second' assignment, I chose to submit one of the photos that I took during a solar winds event, causing the northern lights to become visible in northern Colorado. The image was taken at 11:16 PM, north of Longmont, CO, just off of US-287. Pointing north, the image captures the Aurora Borealis back-lighting a altocumulus lenticularis cloud.

Methodology

Astral and aurora photography often present a particular challenge. The lack of environmental light, and the infeasibility of adding light to the environment, means that capturing an image requires a carefully managed exposure. Finesse, and subsequently patience, is required to capture an image in these specific conditions. A long, multi-second, shutter speed is one of the first keys. Leaving the camera's sensor exposed for multiple seconds allows for the sensor to 'collect' the ambient light of the surroundings. This can allow cameras to capture phenomena that are imperceptible to the naked eye.

The Aurora Borealis, or the northern lights, is a phenomena that occurs due to space weather. When the sun ejects mass, known as a solar flare, it launches particles out into space, known as a *coronary mass ejection* (CMI) [1]. While these particles may not reach the earth immediately, they do often make it out as far as earth's orbit. These charged particles, when they do reach Earth, interact with the magnetosphere and are pulled in towards the magnetic poles in the north and south. When these particles hit the atmosphere, they then begin to release energy in the form of photons, creating dazzling displays. Most often, the Aurora is only seen close to the poles, however when large flares occur, the extent of the light show can extend closer to the equator.

Cloud spotting at night is a difficult task. During the day, the light provided by the sun shows the high and low density regions, the shapes, and makes it much easier to estimate heights and sizes. At night, those shapes, sizes, and heights are much more difficult to discern. In low-lighting, determining the height of a cloud often comes from an atmospheric sounding, which provides information about the thermodynamic quantities in the atmosphere. From this, the lifting condensation level (LCL) gives the pressure level above which clouds may be present. The Skew-T diagram in Figure 2 provides the sounding data closest to the time the photo was taken. The Nov. 12th, 0Z sounding from Grand Junction shows a stable atmosphere, and an LCLP of 602.2 mbar. This places the lower cloud height at approximately 4400 meters. This height, (14400 ft) supports the case that the clouds captured are of the 'alto' class. The fingers that can be seen extending from the cloud indicate some level of shear, indicating that the visualized clouds are altocumulus lenticularis clouds. The presence of shear makes sense from a topographical perspective, with wind often coming off of the mountains to the west [2]. The 'fingers' extending to the right of the image, or the east, support that theory.

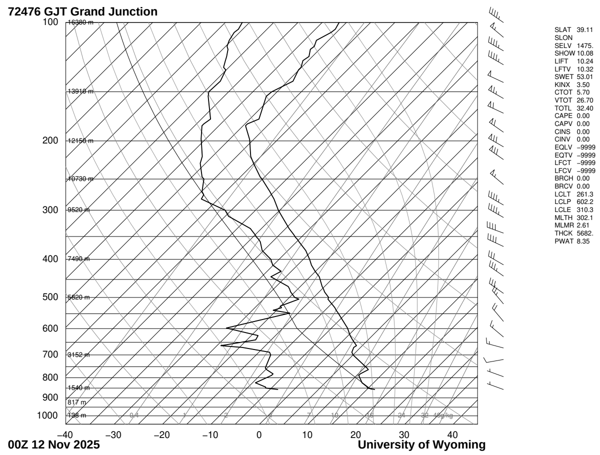

Figure 2: Atmospheric Sounding from Grand Junction, CO

Camera Settings

To capture this image, I used my Sony A7ii with a 28-70mm lens. The aperture was set higher, as to keep both the cloud and the lights from the sky in focus, a reasonable depth of field was required. Given a higher aperture, a longer shutter speed was needed. Through experimentation, I found that a fifteen second shutter speed worked the best to capture the color and brightness of the sky without the lights of passing traffic blowing out the image. Information about the camera and settings can be found in Table 1.

Camera Information	**Value**
Focal Length	70 mm
Aperture	f/8.0
Shutter Speed	15”
ISO	1600
Focus Distance	1.04 m
Original Image Width	6048 pixels
Original Image Height	4024 pixels
Edited Image Width	4559 pixels
Edited Image Height	2992 pixels
Camera Sensor Size	Full Frame 35mm
Camera Make & Model	Sony A7ii

Table 1: Camera Information

Very limited editing was required for the image. Changes such as a crop, slight exposure adjustment, a small mask, and denoising were the only required changes. The original photo can be found in Figure 3.

Figure 3: Unedited Photo

Conclusion

I am incredibly proud of the final photo that I captured for this course. I believe as though I captured the artistic essence of the clouds as I had hoped, while also capturing an image with scientific relevance. The Aurora Borealis is a striking inclusion to the cloud photo, almost making a statement about the power of nature. It feels like a truly fitting conclusion to a course focused on the physics of fluid flow.

References

[1] Liza Bondurant and Sten Odenwald. “The Aurora Borealis”. In: *The Science Teacher* 88.2 (2020), pp. 54–62.

[2] Timothy Kittel. “LENTICULAR CLOUDS”. In: *Bulletin of the American Meteorological Society* 61 (Jan. 1980), pp. 212–213.