Clouds 1 – Fog on Rollins Pass

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Figure 1: Clouds 1 image captured by Cole Smith

Context and Purpose

The intent of this image was to capture the unique fog cloud phenomena that I had been seeing in various forms all day while backpacking through the Indian Peaks wilderness. Once we set up camp, I decided to take a medium-long exposure image at night with my iPhone 13 Pro because the moonlight of the full moon was illuminating the clouds in a beautiful way that provided amazing contrast and depth. In the foreground my tent is captured and is illuminated by a headlamp inside on the red-light setting. In the background, down valley, clouds are captured that are undulating and hanging in the valley all the way down into Nederland and then into Boulder beyond that. A timelapse video of the fog pictured is linked here as well: https://vimeo.com/758967114. This timelapse illustrates the undulating gravity and buoyancy forces at play causing the valley to look like a sea made of fog. This video was captured over a period about approximately 25 minutes which allows for visualization of not only the shifting and developing cloud formations, but also of the effect that changing light conditions have on how the clouds appear.

Circumstances

This image was taken near Rollins Pass on September 10, 2022 at 8:30 PM at about 11300ft of elevation. While I didn't measure the exact angle of elevation from horizontal, I would estimate based on the position of the horizon line within the frame of the image that the angle of elevation lies in the range of 0-5 degrees above horizontal. The direction faced in this image is west looking down the valley that leads into the town of Eldora, just north of Rollins Pass.

Cloud Identification

These clouds can be characterized as fog that is orographically influenced by the mountains and valleys below it. The primary reason why it's fog is because it's suspended at the earth's surface, which I was able to extensively confirm beyond what is shown in the image after having hiked up the valley through the fog all morning. After cross-referencing between the image and a topographical map of the area, I would estimate that the fog is hovering around 10800-10200 ft of elevation at its highest in this photo. The rest of the sky above the fog is clear which indicated that fog is the only cloud formation visible. It was very windy all day which continued into the night, however, as is seen in the video, this didn't blow the fog away but rather just caused it to undulate and "crash" like waves up and down the valley. The wind was blowing powerfully from east to west, which was especially notable in its strength and effect on the fog below as we passed over the mountain ridge approximately ~400 feet of elevation above and behind from where the image was captured. I'm unsure of the weather conditions in this location the day before this image was taken. However, in Boulder the prior day the fog was present and it was raining, yet while trekking through the fog on the morning that the image was taken there was no actively falling precipitation, only dew found on the trees and grass. The Skew-T graph for 6pm on the night of September 10th, 2022 in Grand Junction, CO is shown below.[1] This is the most proximal skew-T for both time and location to the image. It shows that the atmosphere at this time in Grand Junction is stable as indicated by the CAPE index being equal to 0. This atmospheric stability is reflected in this photo as nearly no mixing nor significant vertical movement is occurring between the fog and the rest of the atmosphere above it. The presence of fog can be explained as being potentially both Valley Fog and Advection Fog. These are types of heat transfer-based fogs wherein the land surface or top of the fog cools

by emitting radiation to space at night and also either loses heat or gains moisture to passing winds during the day, or some combination of the two. This causes the ground and the fog itself to cool, which leads the dense, cold air to pool in the valley, allowing for water condensation and further fog formation.[2] Based on the Skew-T graph there are no extremely obvious indications that we would be certain to see clouds. However, we could expect to see the most likely formation of clouds around 10400ft (3170m) as this is the most proximal point between the measured temperature line and the dew point line. As previously stated, the elevation of the fog is approximately 10800-10200 ft, which is reflected by this Skew-T indication for cloud elevation. The next most likely elevation where clouds might occur based on the diagram would be at around 23500 ft (7150m) which means that since the atmosphere is stable we could expect cirrostratus or altostratus clouds. However, due to several intertwining factors, perhaps wind direction, wind intensity, and humidity, these clouds did not exist where and when this image was captured. This shows that the Skew-T graph is potentially partially representative of what is going on in the image despite the fact that it's measuring Western Slope weather as opposed to Front Range weather.

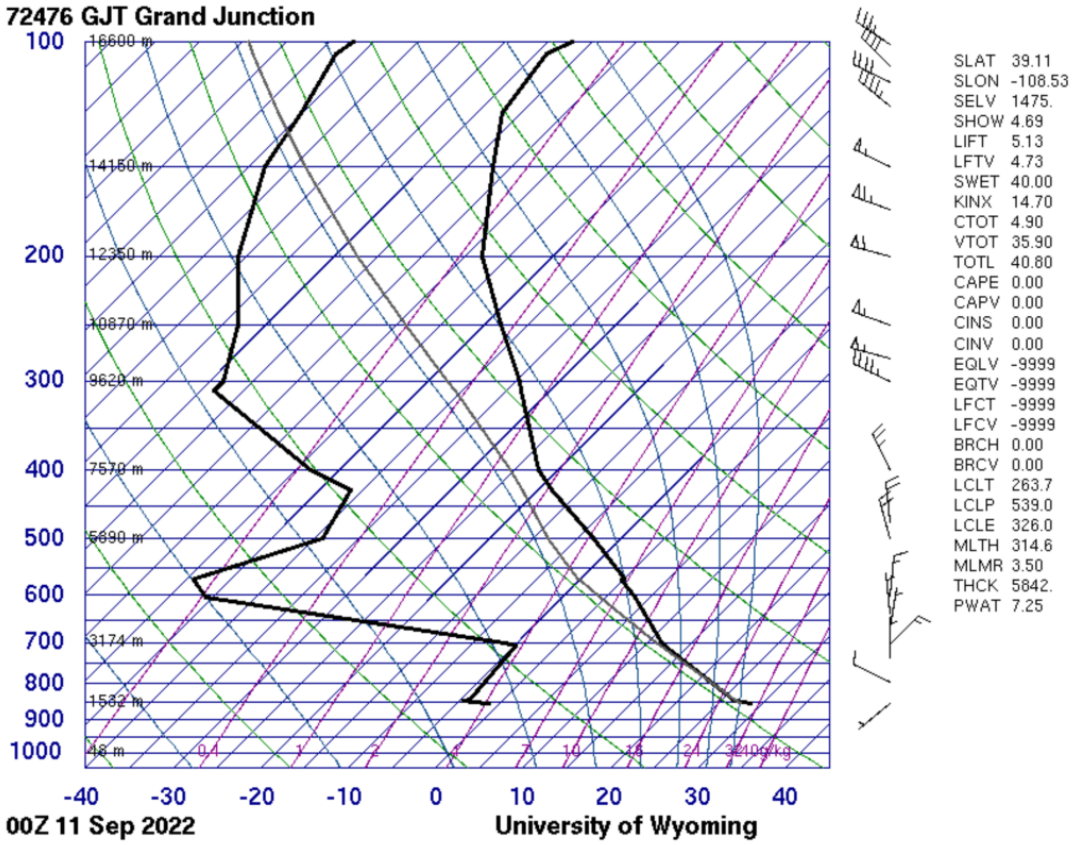

Figure 2: Skew-T diagram from Sept 10, 6:00 PM MST in Grand Junction, CO [1]

Photographic Technique

The abstract photographic technique used here is non-zoomed long-exposure low-light-mode on my iPhone 13 Pro. The size of the FOV is very difficult to quantify due to the scale and varying depths within this image, however I would estimate that in the foreground the width is

~15 ft, in midground along where the mountains drop below the clouds the width is 2-3 miles, and the height of the image is unquantifiable as it goes off into the clear sky. The distance from the object to the lens was primarily 1.5-5 miles but most likely extends beyond this based on the extensive depth of the clouds within the image. The lens focal length was 26mm. The camera used was the iPhone 13 Pro Wide Camera, and it was capturing images in HEIF format. My original photo is 3024 x 4032 pixels and 727 KB, and the exported high-quality post-processed photo has the same pixels but is a PNG file and is 69.9 MB large. The aperture was f/1.5, shutter speed was 1/2 second, and ISO was 3200. In terms of post-processing on my image I used the tone curve to balance the tones on the image, specifically the coloration of the tent and the red light coming from within it, the sea of clouds in the center of the image, and the night sky. I used the sharpen tool to make the lines of the trees and clouds sharper and reduce motion blur effects, and the exposure tool to slightly brighten the image for visibility of detail. Additionally, I used both the astrophoto denoise and profiled denoise modules to remove unnecessary or distracting noise that could have been introduced by nature of it being a longer exposure, low-light, night photo. The ISO, focal length, FOV, image size, file type, and aperture were all those automatically chosen by my iPhone 13 Pro's low-light photography mode given the imaging conditions and camera lens used. In regard to the timelapse video it was shot in 1080p at a frame rate of 30fps over a period of about 25 minutes, and is 45.1 MB large as a HEVC file, all of which are the automatic timelapse mode settings.

Image Insights

This image reveals a unique perspective of cloud formations from an elevated perspective that we're normally only able to see from airplane windows. Additionally, it reveals the fascinating behaviors of orographically influenced fog formations in alpine conditions, namely elevation, wind, temperature, and geography. I love this image because it captures both an extremely fascinating and unusual cloud formation from a unusual perspective, but it also has other interesting focal points and subject matter to keep the viewer engaged. The tent in the foreground lit by my red-light headlamp provides contrast against the clouds behind it, gives depth perspective, and adds a human element to the image. Additionally, the clear night sky shows the waxing gibbous, nearly full moon along with some stars and planets, giving a sense of awe and immensity to the image. The only thing that I dislike about the image is how there is a slight overexposure of the moon, and how, while they're central in the image, the cloud formations don't take up a larger portion of the photographic real estate. I believe this image fulfilled the intent that I had of capturing these clouds in this moment, and in their undulations and texture they are a clear and understandable demonstration of orographically affected fog formations. In future night, astrophotography, and cloud images that I take I will improve the scale of my subject in relation to the surroundings, I will utilize a tripod to reduce any motion blur in the long exposure image, and I will fine tune aperture or ISO to reduce overexposure of brighter objects like the moon.

References

[1] *Atmospheric Sounding Data*. University of Wyoming Department of Atmospheric Science, 2022, http://weather.uwyo.edu/upperair/sounding.html.

[2] "The Physics of Fog." *Metservice Blog*, 2022, https://blog.metservice.com/Physics-of-Fog.