MCEN 5151-001 Clouds First Report

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Figure 1: Submitted Photo

Introduction

Clouds have the distinction of being one of the most well known flow phenomena. Most of the world will see a variety of clouds every day, ranging in size, shape, and type. The presence or lack of clouds in an area can provide information about the atmospheric conditions and can allow for the visualization of driving factors. For example, the presence of Kelvin-Helmholtz instabilities in a cloud formation can indicate strong shear layers in that part of the atmosphere.

Methodology

The photo that I captured shows what appears to be a cumulous cloud with a streak of virga below it. Virga is precipitation that dissipates, frequently by evaporation, before reaching the ground [1]. The photo was taken outside of the Aerospace Engineering Sciences building at the University of Colorado at 5:34 PM on October 1, 2025, facing east-northeast. There had been intermittent storms throughout the day with light rain and primarily low energy cells, as opposed to the high intensity, short, convective cells that are more common in Boulder. There was no real intention behind my cloud photograph, other than capturing a photo that I found to be impressive.

Environment & Behavior

The storm cell seen in the photo can be correlated to weather radar data. The National Severe Storm Lab compiles all weather data taken into the Multi-Radar/Multi-Sensor System (NSSL MRMS) which is archived and can be used to view weather data from a given time and place. Figure 2 shows the composite reflectivity information, taken using the MRMS Operational Viewer, at the time that the photo was captured.

Composite reflectivity is a radar product that provides information about the strength or intensity of a storm. It does so by using a vertical scan taken by a weather radar, and identifying the highest valued return, or echo, that the radar receives in each latitude-longitude pair, given a domain size provided by the spacial resolution of the radar itself. By identifying the strongest echo, the composite reflectivity gives meteorologists a measure of the relative strength of a storm. The MRMS product for this cloud shows a relatively low intensity storm, on the order of 5-10 dBZ. This is consistent with what was seen physically, as the storm did not appear to be producing significant precipitation.

Meteorologists also use the information from atmospheric soundings to understand the environmental conditions in a vertical column. These soundings consist of instrumentation attached beneath weather balloons released at specific times. The instruments vary, but frequently measure the ambient temperature, pressure, humidity,

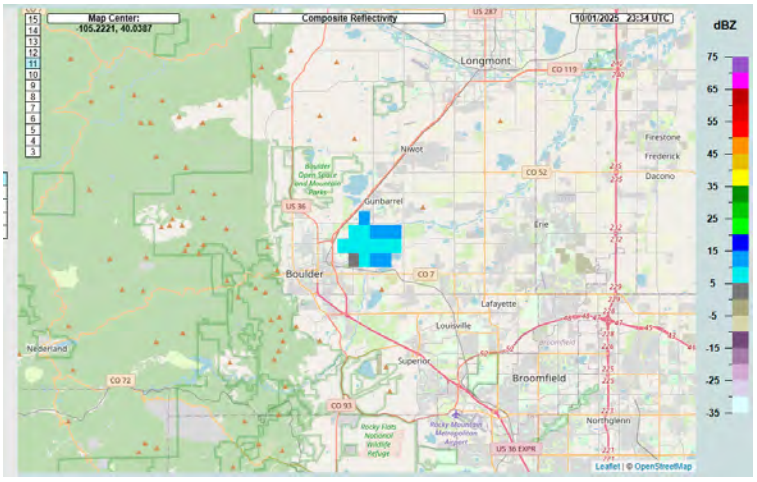

Figure 2: Reflectivity Plot at Time of Capture

wind speed, and wind direction. From those measurements, quantities like the Lifting Condensation Level (LCL) and Convective Available Potential Energy (CAPE) can be backed out, giving further information about the atmosphere. The LCL is a measure that provides information about the pressure-height at which clouds begin to form, which can be described as the lower cloud level. The CAPE provides information about the energy available in the atmosphere, which gives a measure of how likely convective initiation (CI) is in a given area. When a convective updraft is strong enough and is able to punch through the temperature inversion present at the top of the troposphere, that causes the formation of cumulonimbus clouds, and frequently leads to a super-cell thunderstorm, distinguished by the existence of a rotating mesocyclone [2].

Data produced by soundings are frequently visualized using a Skew-T diagram. These diagrams show temperature and pressure trends moving upwards in the vertical column. The pressure and temperature lines given by a Skew-T diagram provide information about the stability of the atmosphere. Figure 3 is the Skew-T diagram from the 0Z sounding (30 minutes after the photo was taken) from the nearest site in Grand Junction, CO.

This Skew-T diagram indicates a stable atmosphere. Taking a parcel of air from the surface, elevating it along the dry adiabat until the condensation pressure line (LCLP) then raising it along the moist adiabat line maintains a parcel temperature below the ambient. This indicates a stable atmosphere because the parcel, if then released, would fall back down to its original position. This idea of a stable atmosphere is further backed up by a calculated CAPE value of 0 J/kg.

The presence of a stable atmosphere usually indicates that the conditions are well posed for the generation of storms. However, because of the behavior physically seen, I don't believe that the sounding performed at Grand Junction is representative of the atmospheric conditions in Boulder at the time of the photo. A CAPE value of

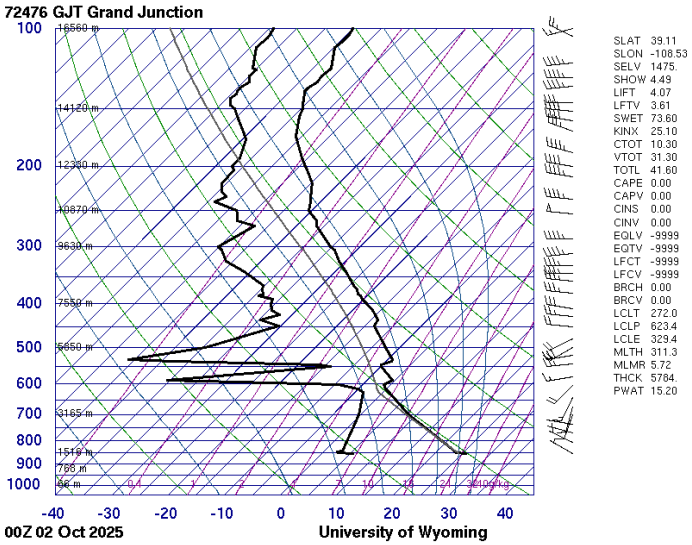

Figure 3: 0Z Grand Junction Sounding

0.0 J/kg would usually indicate no energy for storm production, which would usually also indicate no precipitation. The virga present in the photo lends itself to the idea that the atmosphere was not entirely stable when the photo was taken.

Photography & Editing

The photo was taken on an iPhone 16 Pro, taken on the 12 MP telephoto camera. The metadata reported by the phone indicates the camera settings reported in Table 1.

Camera Information	Value
Focal Length	120 mm
Aperture	f/2.8
Shutter Speed	1/2358
ISO	50
Original Image Width	4032 pixels
Original Image Height	3024 pixels

Table 1: Camera Information

The editing of the photo for this submission was relatively minimal. There were minor adjustments in the contrasts and highlights. The primary goal of this was to highlight the lighting differential between the clouds and the sky. Further, I intended to draw the eye to the 'cut line' in the lighting of the virga, in which the sunlight was being cut by the flatirons, creating a cool effect. Figure 4 shows the unedited version of the photo.

Figure 4: Unedited Original Photo

Conclusion

Cloud photography frequently feels like a game of luck, being in the right place in the right time to capture the behavior of an interesting cloud. I felt very fortunate about capturing this photo on my way home, because had I left a couple minutes later of a couple minutes earlier, I would have missed such an impressive display.

References

[1] E. Evans et al. "On Precipitation and Virga over Three Locations during the 1999–2004 Canadian Prairie Drought". In: *Atmosphere-Ocean* 49.4 (2011), pp. 366–379. DOI: 10.1080/07055900.2011.608343.

[2] Russ S. Schumacher and Kristen L. Rasmussen. *The formation, character and changing nature of mesoscale convective systems*. June 2020. URL: https://www.nature.com/articles/s43017-020-0057-7#Abs1.