Clouds Second: Alto-Stratus Clouds Paint the Morning Sky
Photo Taken at 7:21am on November 1st, 2023, in Boulder, Colorado
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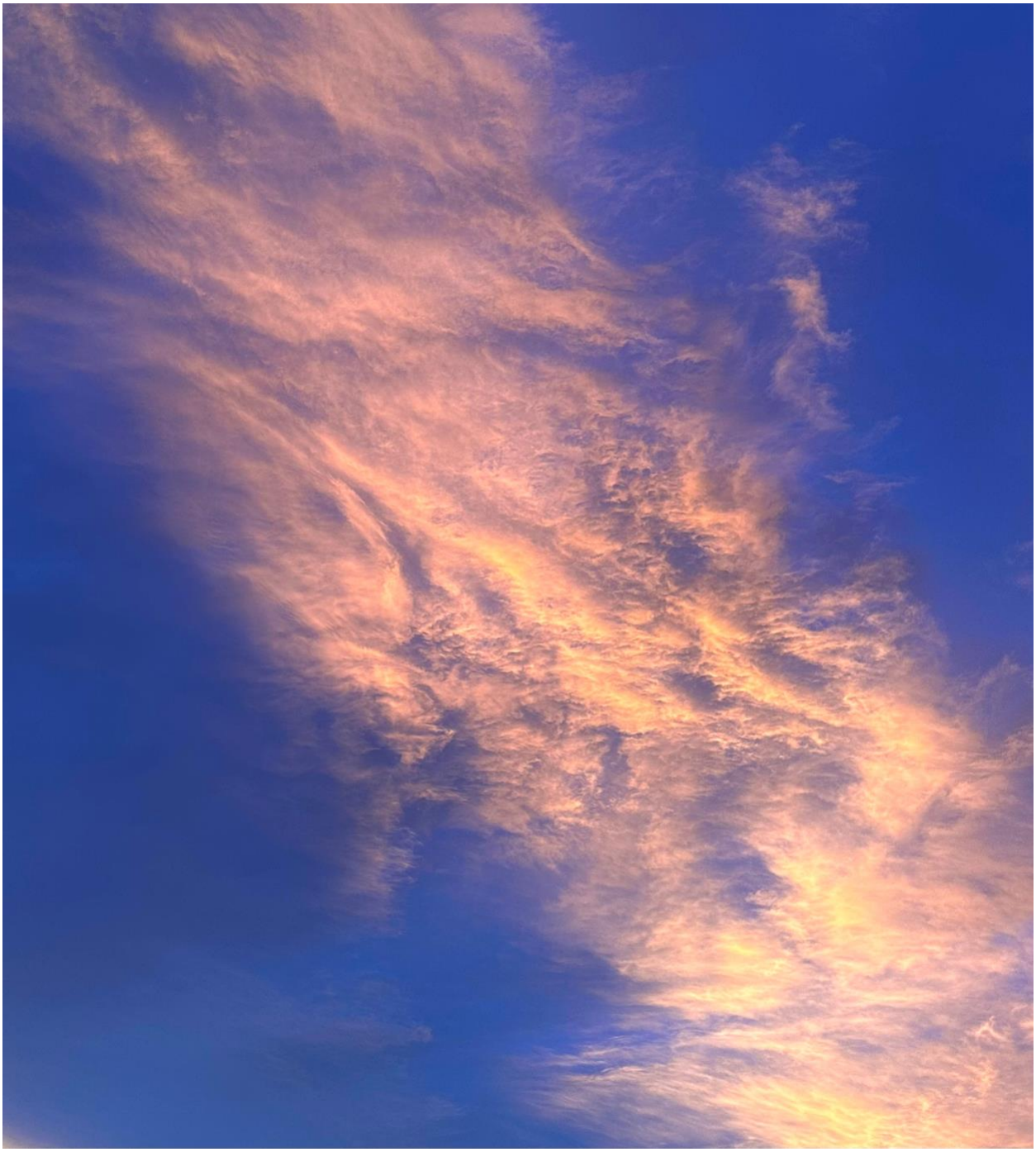
MCEN 4151: Flow Visualization
12/13/2023



1 BACKGROUND

This image was taken November 1, 2023, just east of CU Boulder's campus, facing southeast. This captures alto stratus clouds as the sun rises at 7:21am. This is the second cloud assignment of the MCEN 4151: Flow Visualization Fall 2023 course. These clouds span across the frame in a beautiful orange reach. As the sun comes up, the orange and yellow hues shine on the white clouds against the starkly bright blue sky behind. The intent of this image was to highlight the splendor of nature. Over the entire month of November, many photos of clouds were taken, but this one was the most interesting and represented flow well.

2 CIRCUMSTANCES OF IMAGE

This photograph of stunning clouds was taken near the University of Colorado Boulder's campus. At the intersection of Aurora Avenue and 28th Frontage Road, this image was captured in Boulder, Colorado. The elevation of the photographer was at 5,341 feet above sea level. The photographer stood with the camera facing southeast and almost directly upwards toward the sky. The camera angle from horizontal (the ground) of the image was about 140 degrees, as shown in Figure 1 below. Finally, the image was taken at 7:21am on November 1, 2023.

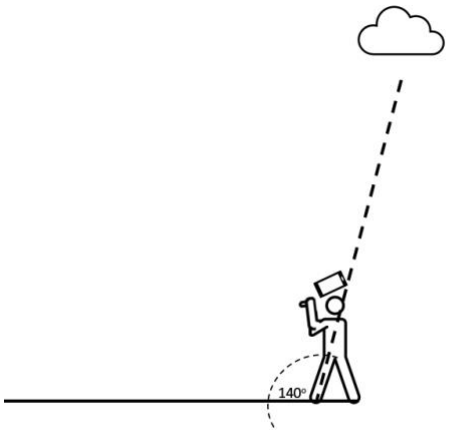


Figure 1: Angle of photographer toward the clouds when photo was taken.

3 PHYSICS OF THE FLOW

The clouds in this image are alto-stratus clouds [3]. Alto-stratus clouds form when a warm front comes in and a large mass of air rises in a uniform manner. As the air is rising, the air cools and the water reaches its dew point. The water vapor cools off and condenses and these clouds are formed [4]. The altostratus clouds are a mid-layer cloud that are found around 6,000 to 20,000 feet of elevation (around 2,000 to 6,000 meters) [6]. An image capturing more of the sky can be seen in Figure 2.

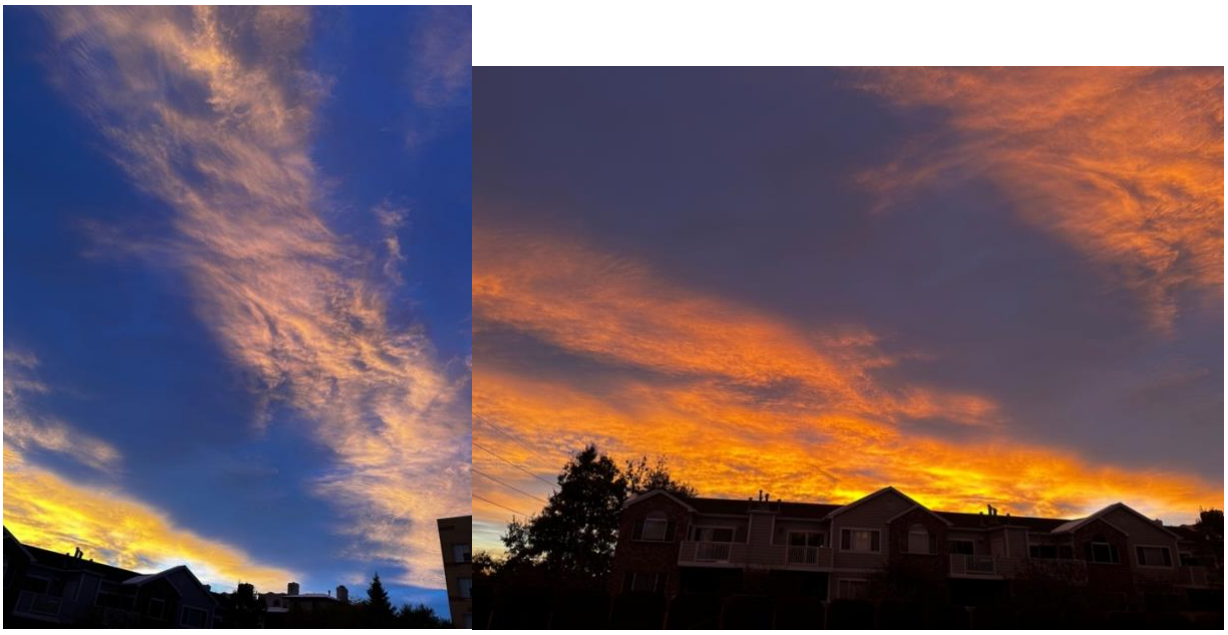


Figure 2: Extended images of the sky on November 1, 2023. In the right image, the upper right corner is the cloud captured in the featured photo.

These clouds were captured on a day with calm weather. There was very little wind this morning with a light gust blowing west to east at about 5 miles per hour. The temperature outside was around 38°F. With the combination of these conditions, the atmosphere was most likely stable during this photograph. The circumstances on this day that generated such a beautiful cloud formation can be further explained with the skew-T diagram. Figure 3 displays this weather analysis tool. [2]

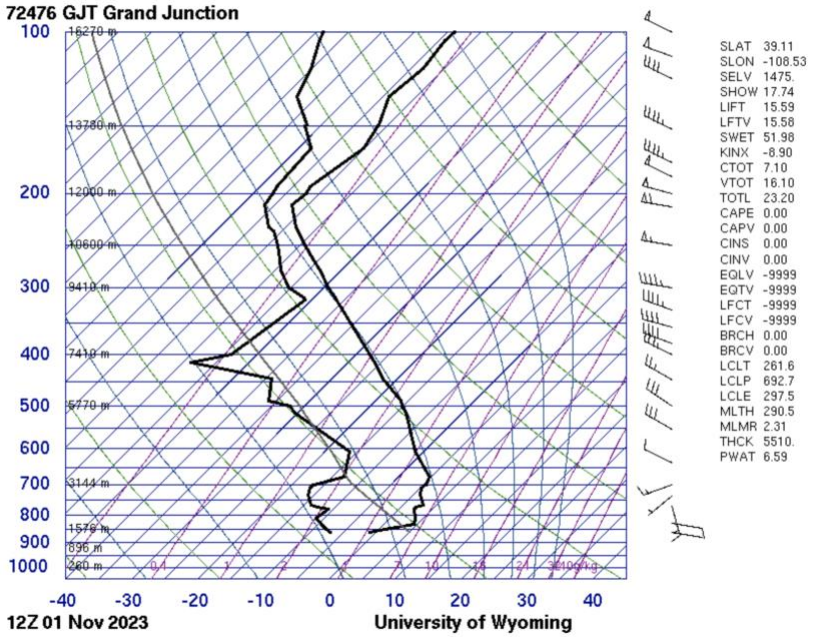


Figure 3: Nearest Skew-T diagram at the time my cloud photo was taken. [2]

A skew-T diagram captures the dewpoint and temperature. The dewpoint line is the left line, and the temperature is the line on the right. There are three main ways in which a skew-T diagram can tell us that a cloud is forming. The closer the lines are together, the higher the relative humidity. The other two options of cloud formation based on this diagram are when the gray line crosses paths with the temperature line or the temperature line moves to the right. In this instance, the altitude of these clouds can be identified as around 2,000 to 3,150 meters or at 9,000 meters. I believe this image is capturing clouds at around 3,000 meters, making them alto-stratus clouds.

4 VISUALIZATION AND PHOTOGRAPHY TECHNIQUES

The photographic technique is marked boundary [1]. The image clearly shows the distinction between the clouds and the sky as a marked boundary. I was drawn to taking this image because of the interesting clouds and the different layers of background produced with the wispy orange cloud layer between the sky and the clouds. The goal was to use the entire frame to capture the clouds. I wanted them to diagonally span across the frame and only have the sky with no trees or buildings. The field of view was entirely the cloud.

This photo was taken with a iPhone 14 Pro with the 24mm lens with an ISO of 100, shutter speed of 1/121s, and f-stop of 1.78. This iPhone camera is a digital camera. The original photo was 4,032 x 3,024 pixels. The edited photo was 2,277 x 2,050 pixels. The aspect ratio of the edited picture is much larger. See Figure 4 below for the edited and unedited photos.

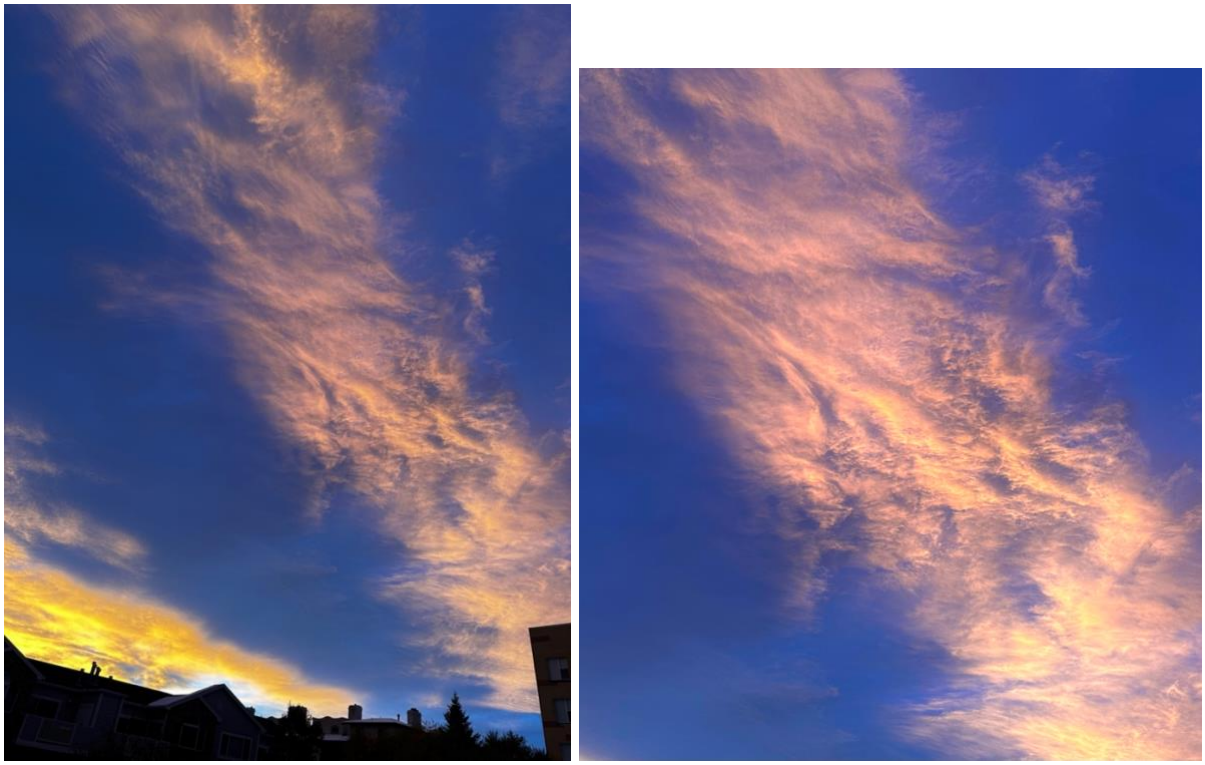


Figure 4: The unedited, raw image can be seen on the left in comparison with the edited photo on the right.

Based on the height of the cloud and the elevation of the photographer, the distance from the object to the lens was around 1,500 meters.

The key editing done to this photo was as follows: the exposure was increased, the brilliance was decreased, the highlights were decreased, the shadows were slightly decreased, and the contrast and brightness were increased. Additionally, saturation and warmth were added.

5 CONCLUSION

In my opinion, this image is truly stunning, it captures such a beautiful flow described by physics while also being visually interesting. I like how the orange contrasts with the vibrant blue sky behind it. I admire the framing of this image; the clouds spanning across the diagonal uses the space well. I think the photo reveals the physics of the cloud type very well. I think this image fulfilled my intent of capturing a natural beauty well. The remaining question I have is if this cloud could be a mix of different types of cloud? I am still on the fence if this is an alto stratus or alto cumulus cloud. In the future, I would like to improve the definition of the clouds. I think the cloud could be sharper. To continue developing this idea, I would like to keep examining clouds. All in all, I enjoy the way that this cloud photo turned out. I am very proud of this photo and believe I achieved the desired intent of capturing a pretty and physically interesting cloud. I will constantly be examining the sky for other clouds like this one as it is a glowing display of nature.

6 REFERENCES

[1] Hertzberg, Jean. “Flow Vis Guidebook.” *Flow Visualization*, 13 July 2023, www.flowvis.org/Flow%20Vis%20Guide/overview-3-lighting/.

[2] *Atmospheric Soundings*, weather.uwyo.edu/upperair/sounding.html.

[3] World Meteorological Organization. “Cloud Descriptions.” *International Cloud Atlas*, cloudatlas.wmo.int/en/home.html.

[4] Puiu, Tibi. “Altostratus Clouds: Overview and Weather Prediction.” *ZME Science*, 1 Aug. 2023, www.zmescience.com/feature-post/natural-sciences/climate-and-weather/weather-and-atmosphere/altostratus-clouds/.

[5] Platt, C. M. R., 1977: Lidar Observation of a Mixed-Phase Altostratus Cloud. *J. Appl. Meteor. Climatol.*, **16**, 339–345, https://doi.org/10.1175/1520-0450(1977)016<0339:LOOAMP>2.0.CO;2.

[6] Potter, Thomas D., and Bradley Roy Colman. “Chapter 21: The Classification of Clouds.” *Handbook of Weather, Climate and Water*, Wiley, New York, 2003.