Fractus Formation and Dissipation

Sam Lippincott

December 2, 2023

Flow Visualization: The Physics and Art of Fluid Flow

Project 6: Clouds Second

Introduction

One of the most important features of clouds is how they evolve in time. I chose to capture the clouds over a period of time to show this evolution for the Clouds Second assignment. The day I chose to shoot I noticed the clouds were clearly moving very quickly even just to the naked eye, so I figured if I created a timelapse I would also get some interesting effects.

Location

The video was recorded December 2nd, 2023 at approximately 3:40pm MST (22:30 UTC) from Aurora Avenue and Frontage Road in Boulder, Colorado. Boulder is1655m (5430 ft) above sea level. I was facing South South West about 60 degrees above the horizon.

Cloud Discussion

The clouds in the video appear to be fractocumulus clouds. The sky was reasonably clear besides all the fractus clouds. There was a noticeable amount of wind blowing and shaping the clouds.

Fractus clouds are small cloud fragments with ragged edges that constantly form and deform. They are caused by strong winds shearing them and causing small vortices. While often accompanied by a larger cloud carrying precipitation, these clouds seemed isolated. But, the days leading up to the day I shot the clouds were very overcast, so perhaps these were fragments off those cloud sheets.

In the video you can see small vortices that form now and again. Vortices are classic signs of turbulent flow and can also arise from the differences in velocity between two layers of flow. It is a little unclear what mechanic specifically caused the vortices in the video, but it’s safe to say the flow was very turbulent with strong winds coming off the mountains and slowing down to a point of turbulence.

The clouds are also likely orographic clouds, meaning that they are driven by gravity waves. This means that the clouds are formed from moist air coming over the mountains and bouncing in waves as the mountains fall away, condensing as the moist air rises and cools.

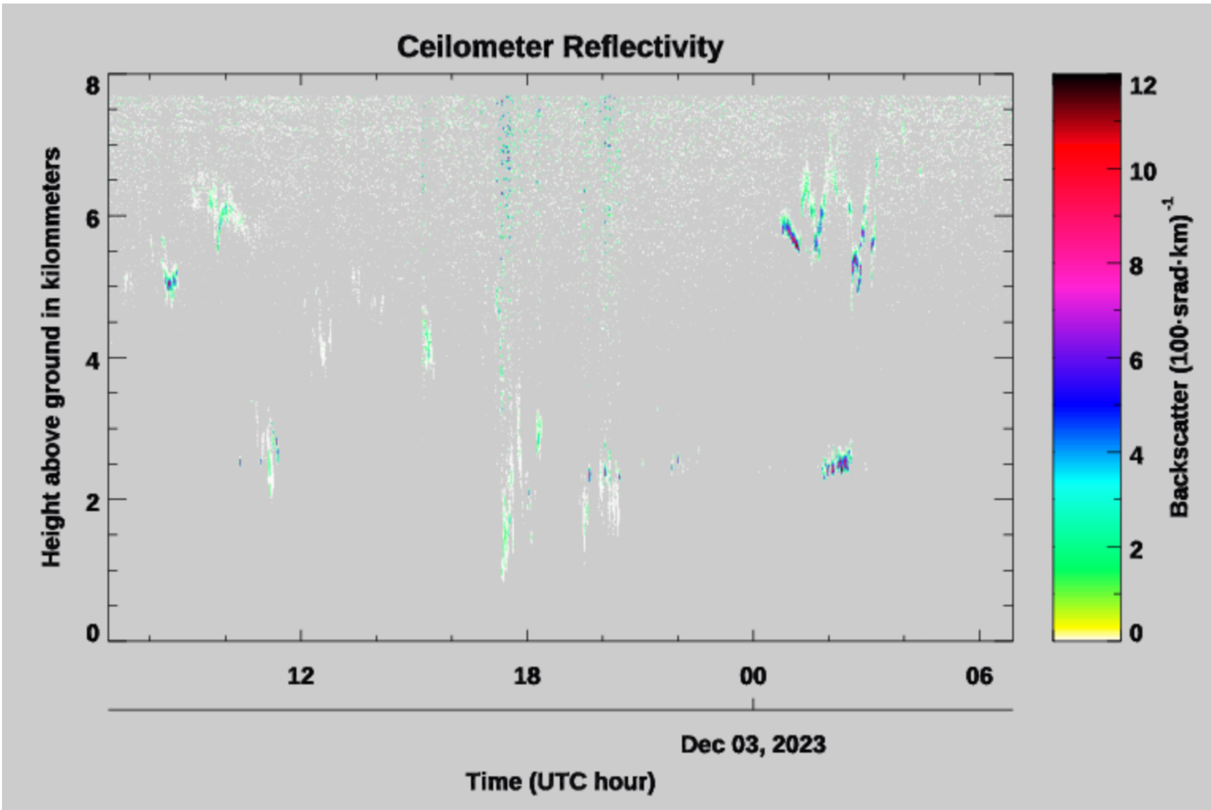

Fig 1. Ceilometer Reflectivity[1]

The photo was taken at 22:30 UTC, and, as you can see in the ceilometer (Figure 2) there are small blips at around 2.5 km mark above the ground in Boulder, Colorado. Comparing the ceilometer reflectivity diagram to the skew T diagram (Figure 3), the dew-point line (the left black line) and the temperature profile (the right black line) begin to come back together at around 3 km which would reasonably match the ceilometer reflectivity.

The CAPE value of 0.00 in Figure 3 informs us that the overall atmosphere was stable.

As mentioned, the days leading up to December 2nd, when the video was recorded, were very overcast with the days following also being overcast. These clouds seemed to be in the brief gap between weather fronts.

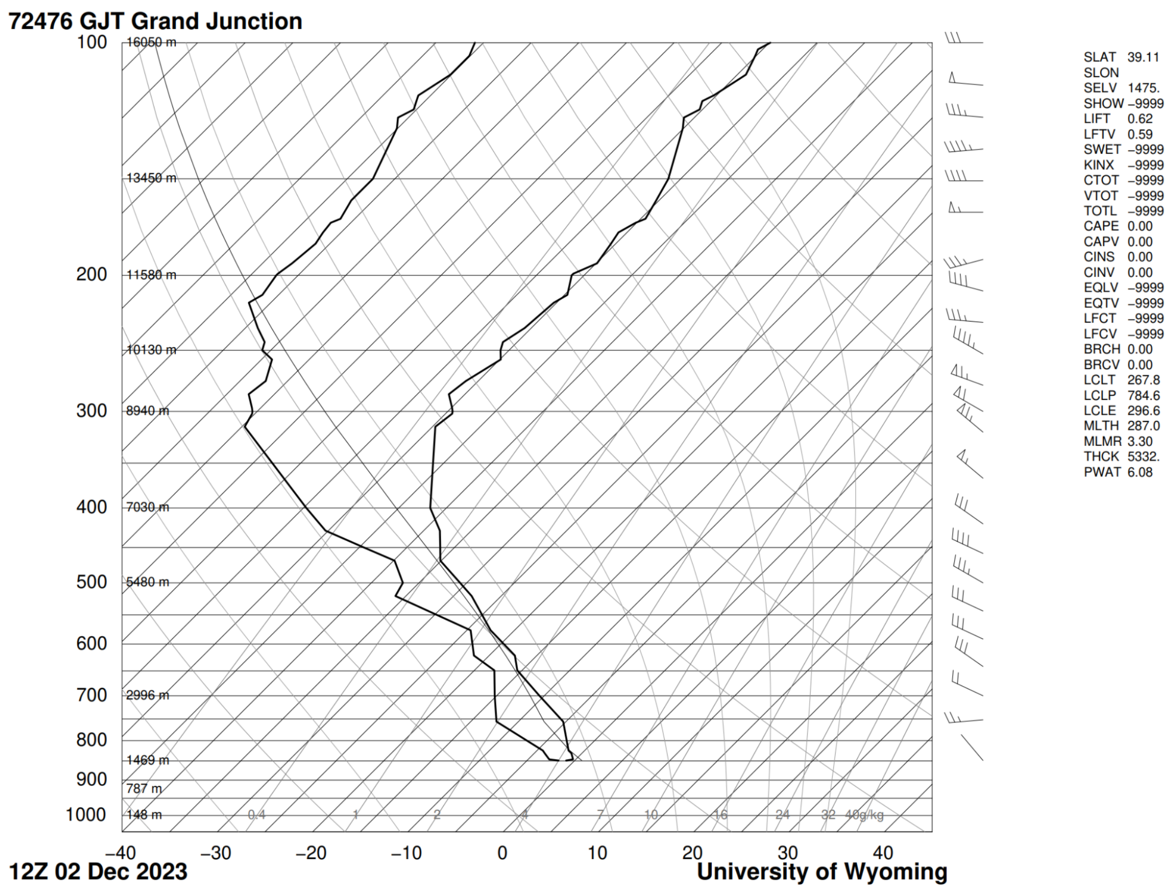
72476 GJT Grand Junction
100
200
300
400
500
600
700
800
900
1000
16050 m
13450 m
11580 m
10130 m
8940 m
7030 m
5480 m
2996 m
1469 m
787 m
148 m
0.4
1
2
4
7
10
16
24
32
40g/kg
−40
−30
−20
−10
0
10
20
30
40
12Z 02 Dec 2023
University of Wyoming
SLAT 39.11
SLON
SELV 1475.
SHOW −9999
LIFT 0.62
LFTV 0.59
SWET −9999
KINX −9999
CTOT −9999
VTOT −9999
TOTL −9999
CAPE 0.00
CAPV 0.00
CINS 0.00
CINV 0.00
EQLV −9999
EQTV −9999
LFCT −9999
LFCV −9999
BRCH 0.00
BRCV 0.00
LCLT 267.8
LCLP 784.6
LCLE 296.6
MLTH 287.0
MLMR 3.30
THCK 5332.
PWAT 6.08

Fig 2. Skew T[2]

Photography

The scale of the clouds in question I would roughly estimate to approximately 3200 meters or so. This estimate comes from calculating the distance in the simple trigonometry equation below, where h is the height in meters, and d is the distance from the camera in meters.

$$d = \frac{h}{sin(70°)} = \frac{3000}{0.940} = 3200\, m$$

The video's dimensions are unchanged from 1920x1080. The raw footage was 17:50 in duration with a frame rate of 23.98 (~24) fps. In order to make the final cut the required 1 minute long, I sped the original footage up by 1750%, reducing the final cut to 59 seconds.

The camera specifications and settings I used are as so:

Camera Make and Model	Canon EOS Rebel T6
F-Stop	F/8
Exposure Time	1/4000s
ISO	400
Focal Length	75mm
Maximum Aperture	4.125

To edit the footage, I mostly wanted to make sure the features were clear, so I sharpened the footage and then adjusted the contrast settings. I also boosted the brightness as the original cut was a bit underexposed in order to try to preserve detail in the highlights.

Here are the adjustments I made. All edits were performed in Adobe Premiere Pro 2024

Adjusted Setting	**Value**
(RGB) Black Input Level	20
Lighting Effects > Light 1 > Light Type	Directional

Sharpen	90

Here we can see a snapshot of the video before edits were implemented as well as afterwards.

	
Figure 3. Unedited Snapshot	Figure 4. Edited Snapshot

Conclusion

I’m very pleased with the outcome of my photo. I think the time lapse video format nicely displays fractus clouds in their ever-changing nature. In the video you’re able to see small vortices form and dissipate showing the speed and turbulence of the flow. The only questions I have are on the physics side of the piece, namely the potential flow cause of the vortices. I would imagine it’s only due to laminar flow slowing down enough to become turbulent but I’m not certain. This project was my first time recording video footage on a DSLR so I think in future projects, there’s potential to become more familiar with and improve my nature cinematography skills.

Works Cited

1. Department of Atmospheric and Oceanic Sciences (ATOC). *Skywatch Observatory*, University of Colorado, Boulder, https://skywatch.colorado.edu/. Accessed11 December 2023.
2. Oolman, Larry, and University of Wyoming, Department of Atmospheric Science. “Atmospheric Soundings.” *Wyoming Weather Web*, https://weather.uwyo.edu/upperair/sounding.html. Accessed 11 December 2023.