

# Cumulus and Stratus Clouds Over Denver

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Taken at 15:00 on 9/30/22 in Golden, CO

MCEN 5151: Flow Visualization  
Clouds 1

University of Colorado Boulder  
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Figure 1: Cumulus and Nimbostratus Clouds over Denver

For this first clouds assignment, students were tasked with taking photos of different types of clouds. One additional requirement was that the photo taken must be within the time frame of August-October 2022, meaning it must have been taken in the time since the class began. The intent behind this particular image was to capture the contrast between the Cumulus clouds and the blue sky elsewhere in the atmosphere. The timing was difficult as I was in a moving vehicle and only had a couple seconds to capture the image.

This photo was taken while driving on Highway 93 through Golden, with the hope of capturing the city of Denver along with a break in the storm clouds featured overhead. The camera is facing directly East from the highway (which runs North-South), and is parallel with the horizon. It was taken at 15:00 on September 30th– right at peak thunderstorm time for the summer weather pattern.

This image prominently features Cumulus, Stratus, and Stratocumulus clouds, as the atmosphere was unstable at the time. Figure 2 depicts the Skew-T diagram most closely associated with the location:

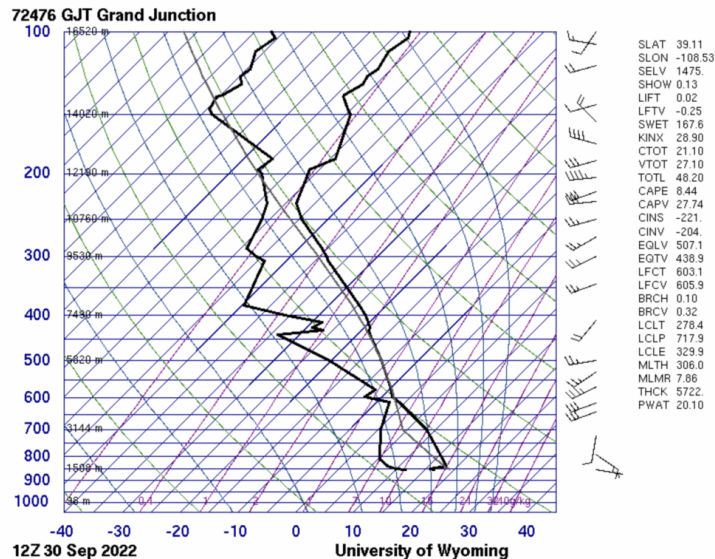


Figure 2: Skew-T Diagram of Grand Junction on 30 Sept 2022

As seen in Figure 2, the dew point temperature and actual temperature lines are quite close together around 4000 meters, indicating that cloud formation is likely to be occurring. A secondary point of evidence is shown by the CAPE number. If this value is greater than 0, the atmosphere is known to be unstable. During this particular time frame, the CAPE number was 8.44, indicating instability/ cloud formation. This is also supported by the weather information for the location at the time; there was a rainstorm moving in from the West from over the Front Range— the sky was quite dark in that direction, and precipitation followed in the next few minutes. As such, the photo captures the last bit of blue sky visible on the horizon! This is indicative of the "summer weather pattern" (which often lasts through September) in Colorado, where rain clouds appear in the afternoon after typically clear skies in the morning. There was also not a large amount of wind, just a few short gusts here and there.

For the clouds depicted, the typical altitude at which these types form begins at approximately 4-5000 ft above ground level. [1] This makes sense, as in the skew T diagram, we can see the clouds should begin forming around 10000 feet, and since Denver is already 5000 feet above sea level, that would put these clouds about 5000 feet above the ground. Additionally, one can see that the atmosphere was unstable, as the sky is quite dark and completely coated with layers of clouds.

Cumulus clouds form due to convection, and the heat from summer afternoons makes them quite common. Additionally, the mountains near Golden, CO aid in the formation of such clouds. Figure 3 from Orville in 1965 is a good visualization of a water stream function over four instances in time as a cloud moves over mountainous terrain. [2]

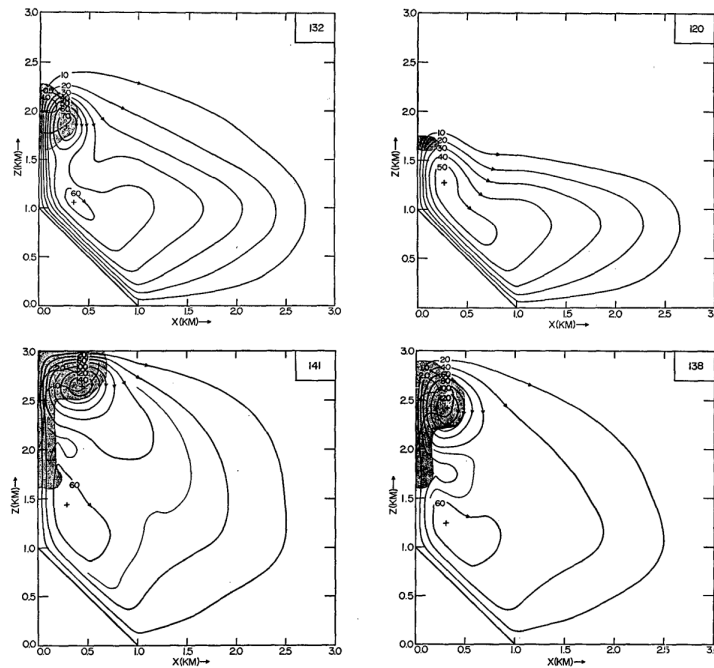


Figure 3: Orville (1965): Evolution of Stream Function Field and Liquid Water Content for Cumulus Initiation on Rainy Summer Day

Figure 3 is useful to visualize the manner in which the cumulus clouds form! The bottom left corner shows the equivalent of the front range mountains— one can see the way that the streamline experiences turbulence along the mountain face that causes an updraft, eventually causing the densest water concentration higher up.

This image was taken with a Nikon D3400 DSLR camera, using a fixed 35mm lens. The photo was taken with a focal length of 35mm at aperture f/1.8. The shutter speed was 1/4000s, at ISO 100. The goal of the framing of the image was to capture the city of Denver on the horizon with the storm clouds looming above. The FOV of the image spans a region of approximately 20x10 miles (at 6000x4000 pixels originally, cropped to 6000x2500), and the subject (Denver) was approximately 16 miles away from the lens.

After taking the initial photo, I decided to apply a few digital alterations to highlight the region of interest, along with the city skyline. I started by altering the RGB curve to darken the shadows and emphasize the whites from the clouds. Next, I cropped the image to 2500 pixels tall, and then applied a slight hue shift to emphasize the blues. I also used the clone tool to remove a post that was present on the left side of the original. Lastly, I lowered the exposure of the overall image. Figure 4 depicts the original vs. edited photo.



Figure 4: Original vs. Edited Photo

In conclusion, this image depicts neat unstable cloud patterns over Denver, including Cumulus, and Stratus clouds. I am quite happy with the way that it turned out, and I really like how dramatic the clouds look as well as the subtle framing of the city in the middle. I will say that the exposure was a challenge overall with this image, and I am still unsure of whether or not the lower portion of the image should be exposed somewhat more. I was successful in fulfilling my intent with this image, and if I were to do it again I would prefer to set up a tripod instead of taking it from a moving vehicle in order to minimize motion blur.

## References

- [1] "Cloud Classification." Cloud Classification  
(Centre for Atmospheric Science - The University of Manchester),  
<http://www.cas.manchester.ac.uk/resactivities/cloudphysics/background/classification/>.
  
- [2] Orville, Harold D. "A Numerical Study of the Initiation of Cumulus  
Clouds over Mountainous Terrain." AMETSOC, American Meteorological Society, 1 Nov. 1965,  
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