Cloud 1 Report
Flow Visualization | CINE 4200

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Cumulus Clouds at 11:22am MT Sept 28th at 40°01'47.6"N 105°12'58.3"W looking west towards the mountains.

Introduction:

This is the first image of clouds for this semester. In this image, some cumulus clouds can be seen forming, while some cirrus clouds are slightly formed overhead. The intent of the image was to capture this dramatic array of clouds and to describe their formation behavior from the associated Skew-T diagram obtained from the University of Wyoming. Over the course of a few weeks, many pictures of clouds at different times of day were taken, none as encapsulating as the finalized image above. It was found that the lighting for the clouds around noon or midday seemed best for framing the clouds in a manner that highlighted form and not color, and that's why this image was produced around noon on September 28th.

Setup:

This image was taken at 11:22am on September 28th at the intersection of Valmont and Butte Mill Road, looking west towards the mountains. The image was taken at roughly at 15 deg angle from horizontal looking up at the clouds. This was done to ensure that the bottom field of the image did not contain the surrounding trees/road. This way, the image solely focuses on the clouds and nothing else distracts in the field of view. The elevation of the image is around 5330' as it was taken in east Boulder. Below are the relevant skew-t diagrams from the Denver station at 6am on the 28th and 6pm on the 28th. These capture the evolution of these cumulus clouds fairly well.

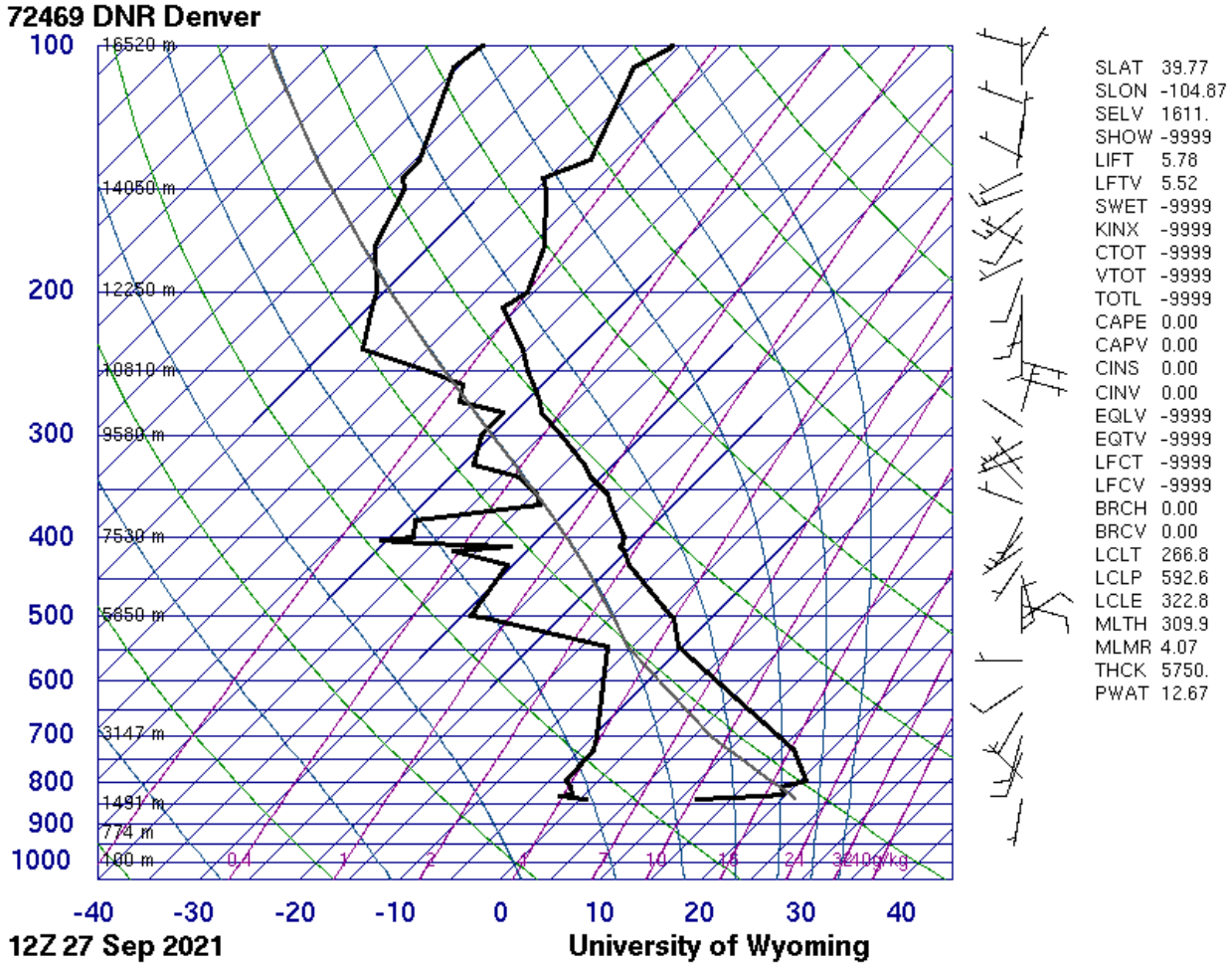

Figure 1. Skew-T from the Denver station on the morning of September 28th at 6am.[1]

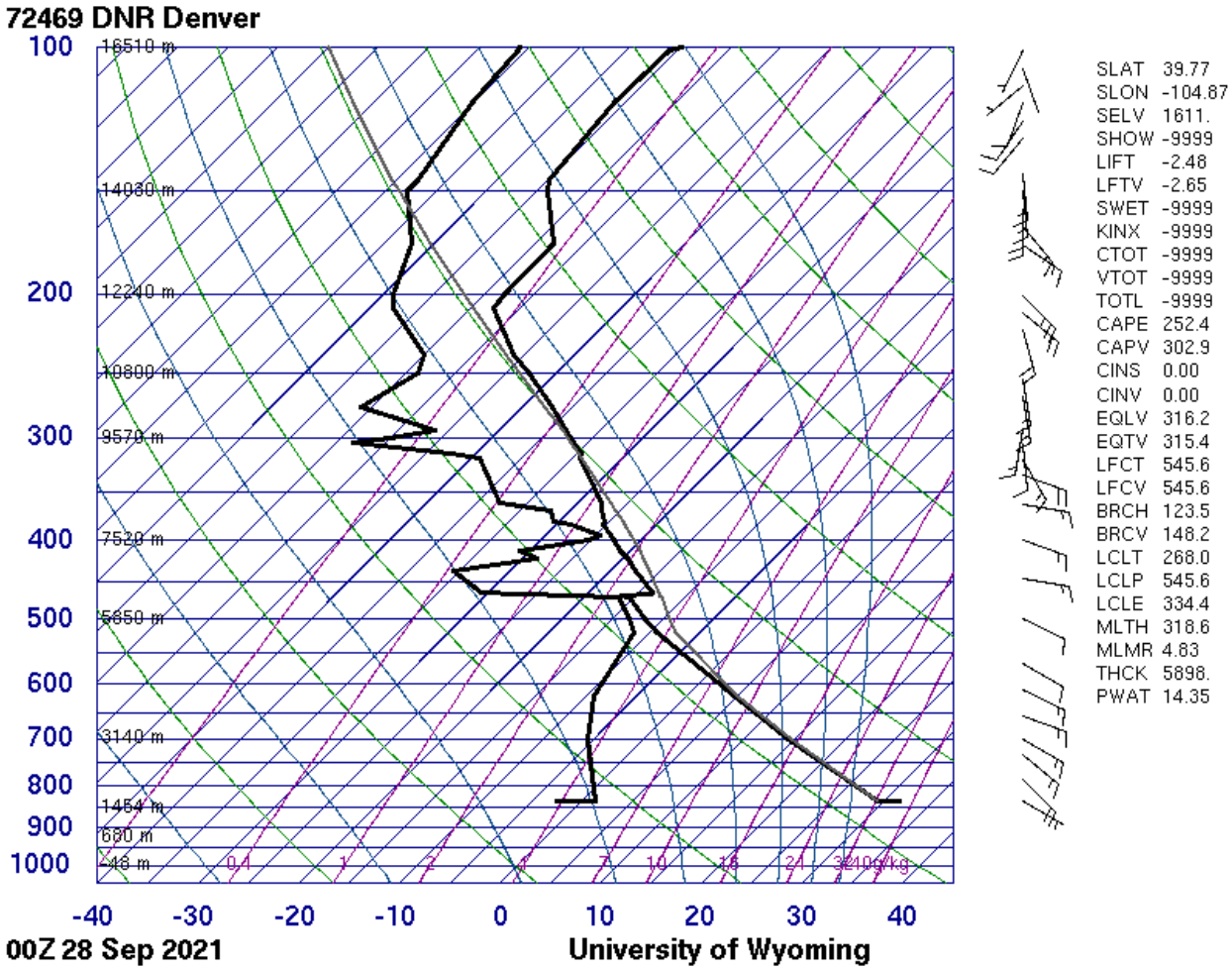

Figure 2. Skew-T from the Denver station on the evening of September 28th at 6pm.[1]

Analysis:

As it can be seen from the Skew-T diagrams above, the cumulus clouds evolved over the morning time, with the atmosphere becoming increasingly turbulent as the morning progressed. This can be concluded due to the evolution of the cumulus clouds as well as the increasing CAPE value from the Skew-T diagrams (0 at 6am becoming 252.4 by 6pm). Furthermore, it can be seen in the lower altitudes that the temperature is rising throughout the day.

The environmental sounding and dewpoint lines in the Skew-T are close to each other around 5800-5900m. Due to this, and the fact that in the second Skew-T the dew point line closely follows the saturated adiabat line (curved blue), it can be concluded that the cumulus clouds are most likely at an altitude of around 5900m, which makes sense as cumulus clouds typically are around 200-2000m from ground elevation.[2]

Another interesting aspect of the Skew-T diagrams is the evolution of wind pattern in the upper atmosphere, in which the velocity of the wind increases and consolidates in the downward

direction as the day evolves. This is most likely due to the cloud formation at the lower altitudes which would cause the pressure in the atmosphere above to drop, causing a downward wind from the upper atmosphere as seen in the Skew-T.

Clouds form when the air reaches a saturation point, often characterized by the dew point temperature.[3] At a specific elevation, a parcel of air will have a certain pressure, and related to that pressure is the temperature of the air. If the temperature of the air drops low enough to reach the dew point, then water will condense out of the saturated parcel to form a cloud. This is how the cumulus clouds in the image formed. Cumulus clouds can sometimes evolve into much higher structures called cumulus-nimbus clouds. These tall columnar clouds often lead to rainfall and thunderstorms.

Technique:

This photo was captured with an iPhone XR camera. Ideally, I would have liked to capture it with a DSLR camera but I did not have one on me when these clouds formed. The photo was taken with a shutter speed of 1/6897, as it was midday and the clouds were reflecting a lot of sunlight. The aperture of the image was set to f/1.8, to allow a large amount of light into the camera. This way, the specific details between parts of the cloud could be differentiated. Since the clouds were such a strong light source compared to the rest of the image, it was important to ensure enough light was let into the image to capture the variation of light within the clouds themselves. Finally the ISO was set low, to ISO25 so as to not overexpose the shot.

The field of view for the image is most likely around a mile wide and much taller. This is difficult to estimate however due to the lack of reference in the photo. This was intentionally done from an artistic standpoint to highlight the forms of the clouds themselves, and not their context in the surroundings. The clouds were forming just past the base of the foothills, around 2.5 miles west.

The image was edited to highlight the form of the clouds, bringing contrast up, shadows up, and highlights down. Below the original image can be seen before post processing.

Figure 3. The image before post processing.

Conclusion:

This image shows the development of cumulus clouds in the Boulder region, and also includes a small contrail and some cirrus clouds for reference. I personally like how the scale and texture of the clouds is apparent in the picture. The visual appeal of the clouds against a bright blue sky is what compelled me to take the original image. In the future, I would be curious to find some cumulonimbus clouds for imaging. The cloud on the back right side could be characterized as evolving into a cumulonimbus, but a large grouping could be really interesting to see. Furthermore, in terms of editing, I would like to try taking the next image in black and white like Ansel Adams. It was interesting to take the photo in a time frame that was in between Skew-T time frames, but I would also like to take an image closer to when the data is collected to more accurately compare the formations seen to the Skew-T diagram.

Sources:

1. "Atmospheric Soundings." *Atmospheric Soundings*, 28 Sept. 2021, http://weather.uwyo.edu/upperair/sounding.html.

2. US Department of Commerce, NOAA. “NWS Cloud Chart.” *NWS JetStream*, NOAA's National Weather Service, 12 Aug. 2019, https://www.weather.gov/jetstream/cloudchart.
3. “Clouds and How They Form.” *Clouds And How They Form | UCAR Center for Science Education*, 2019, https://scied.ucar.edu/learning-zone/clouds/how-clouds-form.