

# Cloud Image 1

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MCEN 4151 Flow Visualization

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Dedicated to Collin Lovett

This image is for the first cloud assignment in Flow Visualization. The primary goal of the assignment is to capture how clouds visualize the patterns in the air and wind. Furthermore, I wanted to take a beautiful and well-composed image, which can be difficult to do with clouds.

I took this picture of the clouds and the Flatirons from the fourth floor window on the south side of the Gold Biosciences Building on the CU campus. The image faces southwest, and the camera was raised about 5 degrees from horizontal. It was taken at 10:04 am Mountain Standard Time on Thursday, January 23, 2014.

These clouds are cumulus clouds created from the vents on the CU Powerhouse. As the warm moist air quickly rises from the vents, it suddenly encounters the cold air, which cannot hold as much water as the warm air. The excess water condenses into clouds. The warm air is ejected from the vents at a relatively high velocity compared to the air. Since the rapidly ejected, warm air is less dense than the colder air, it forms a turbulent buoyant jet, which is visualized with the water droplets in the cloud. In this jet, the different densities quickly induce turbulent flow within the cloud<sup>1</sup>. This promotes convection within the cloud as the warm air rises in the center faster than the cooler air on the edges. The convection is responsible for the undulating shape of the clouds in the image, and it is a characteristic of cumulus clouds<sup>2</sup>. While this cloud is not at the usual height of cumulus clouds, this is a cumulus cloud because of this convection.

When this image was taken, the skies above campus were clear, and a light southeast breeze was blowing the cloud sideways at about 3 mph<sup>3</sup>. It had snowed the night before, as a cold front passed through Boulder. By 10:04 am when the image was taken, the skies had cleared, and the rest of the day had clear, sunny skies. From the Skew-T diagram below, the CAPE index is zero, so the atmosphere is stable overall. At the ground, the dew point (-14 C) is very close to the air temperature (-10 C), and the relative humidity was high at 72%<sup>4</sup>. These conditions promote cloud formation, and when the warm moist air from the vents mixes with the cold air, a large cloud plume forms above the vents. I estimate that the top of the cloud from the vents was around 45 meters above the ground.

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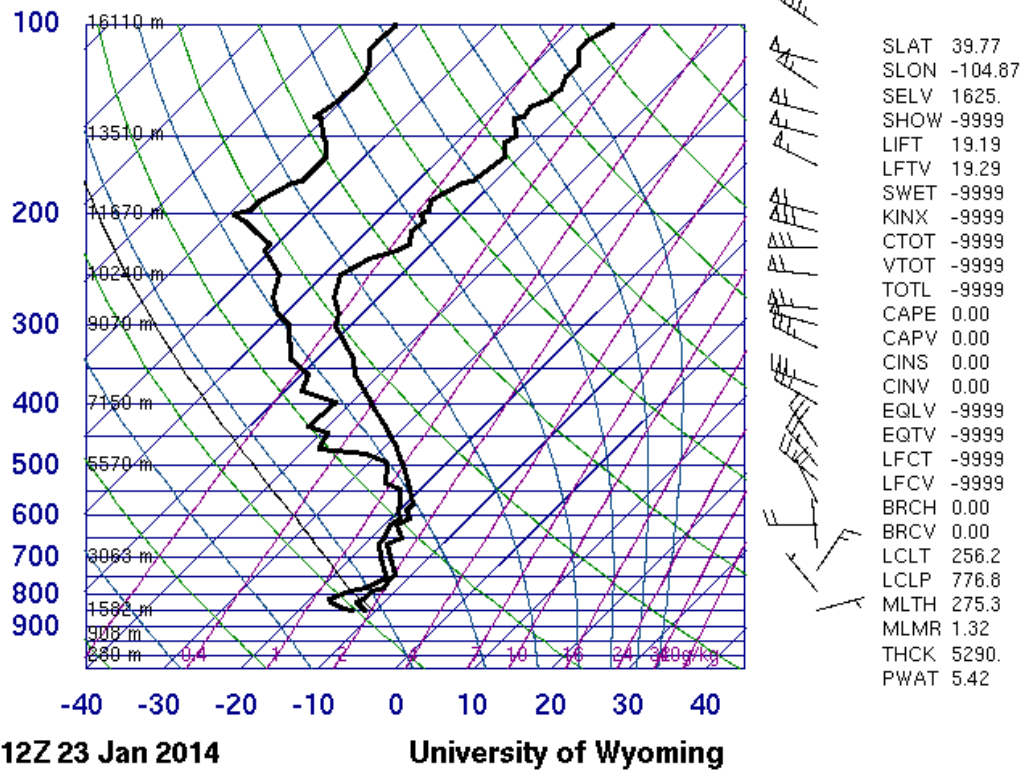
<sup>1</sup> Shabbir, Aamir, and William K. George. "Experiments on a round Turbulent Buoyant Plume." *Journal of Fluid Mechanics* 32nd ser. 275.1 (1994): 1-32. Web. 23 Feb. 2014.

<sup>2</sup> "Cumulus Clouds." *MetLink Resources for Teaching Weather and Climate in School*. Royal Meteorological Society, 2005. Web. 23 Feb. 2014.

<sup>3</sup> "WeatherSpark Beta." *Beautiful Weather Graphs and Maps*. Cedar Lake Ventures, Inc, n.d. Web. 23 Feb. 2014.

<sup>4</sup> "WeatherSpark Beta." *Beautiful Weather Graphs and Maps*. Cedar Lake Ventures, Inc, n.d. Web. 23 Feb. 2014.

## 72469 DNR Denver



I took this image with my Canon PowerShot SX280 HS digital camera that has 12.1 megapixels. The camera lens has a 4.5 - 90.0 mm focal length and a 20 times optical zoom with image stabilization. The aperture ranges between 1:3.5 and 1:6.8, and the camera supports an ISO from 80 to 6400. This cloud image was taken with an F Number of 5.6, an ISO of 80, and a shutter speed of 1/250 of a second. The focal length was 35 mm. From looking at a map, the clouds are about 80 meters from the lens, and the Flatirons are about 3 kilometers away. This gives the image a field of view of about 120 meters. The original image was 4000 by 3000 pixels with a bit depth of 24. It was cropped slightly to improve the composition with GIMP 2.0. This created a final image that is 3918 by 3000 pixels. No other post processing was done on the image. All light in this image is natural sunlight.

Since the beginning of the semester, I have been trying to capture an image of a steam vent on campus. I find the rotation in the clouds appealing and beautiful. I particularly like this image, because the gap in the clouds frames the top of the Flatiron on the right side. This composition occurred by chance, because the cloud was changing every few seconds. I am

satisfied with this picture, because it shows a relatively common cloud type in a unique setting with a beautiful background. I feel like sky in this image is a little dark. I tried to lighten it in post processing, but it oversaturated the clouds and reduced the texture. If I could, I would like to try taking this image again with a higher exposure and a slightly slower shutter speed to produce a lighter image overall. Since groupings of three are visually appealing, I would also like to try this image from a slightly different angle so that I can capture all three of the primary Flatirons in the background with the clouds in the foreground.