Clouds in Space

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MCEN 5151- Flow Visualization
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Purpose

This image was produced for the first cloud assignment in the Flow Visualization course offered at the University of Colorado at Boulder. We were asked to observe various cloud formations and study the science behind them and what gives them their unique appearance. Due to the weather conditions that week, there were only a few days of blue sky and clouds, so the options were limited. However, I was able to capture a beautiful demonstration of a cloud formation as well as getting an artistic vantage point as well. I only wish I had started earlier so that I had a wider range of atmospheric conditions to choose from.

Image Settings

For this image I was stationed on top of the engineering parking garage in Boulder, CO on Regent Drive, about 4 stories off the ground. I was facing west with the camera pointed directly at the peaks of the mountain Range easily visible off in the distance. It was approximate 2:45 PM on February 22, 2012.

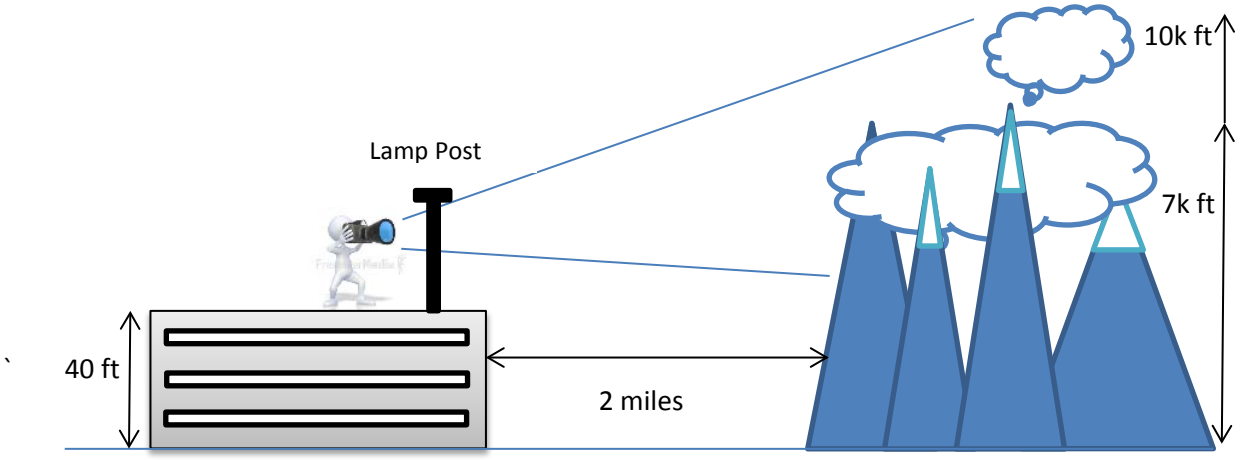

Figure 1: Image Setup

Cloud Appreciation

For something that looks some simple and peaceful, there is great deal of physics behind these cotton balls in the sky. The day the image was taken it was extremely windy, speeds up to 60 mph. There was partial cloud cover with a mostly blue sky. The day before the whole sky was gray and the next day a mild snow storm was expected. The atmosphere was stable, where the cape value is zero, as highlighted in the figure below. The figure below is a skew-t plot of the atmospheric conditions during the morning of the image date. The right line is the temperature and the left line is the dew point and

when they are close you can expect possible cloud formation, however in this skew-t plot there are no obvious locations occurring.

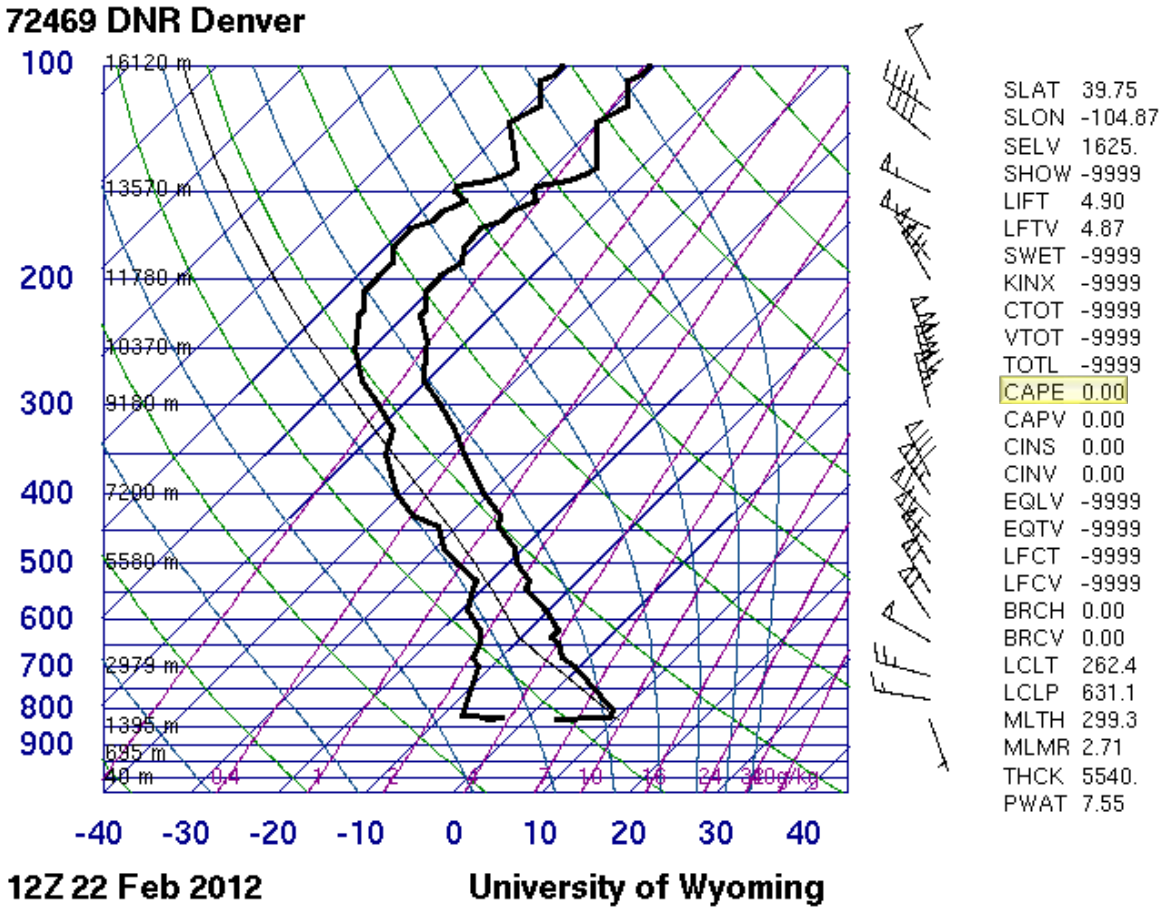

Figure 2: Atmospheric Data for Feb 22 **[4]**

The formation and precipitation of clouds is well known to be influenced by atmospheric aerosols, and also affect the global climate, and the water cycle, however research also believes that biological particles like pollen might also effect cloud formation [1]. Boulder is probably prone to this influence due to its high level of pollens, however since the photo was taken in the winter, this was probably not the case. The clouds present in the image are a rotary cloud above and the Foehn Wall. The main cloud of the image is the Foehn wall which is an orographic cloud since it is influenced greatly by the mountains. The winds come over the mountains and form a Bora which is where the air is cold and strong creating downward sloping winds [5]. The rotor clouds on the other hand are possibly created from a stratocumulus cloud that underwent high winds causing them to roll in the sky. Rotors typically form with large mountain wave clouds and during high turbulent wind which was the case this day causing the clouds to be ripped up and dispersed [6].

Below is another figure referencing the atmospheric date present during that day. It allows us to see how fast the winds were at a certain speed and their direction at that time as well other various conditions. Since the image was taken at approximately 2:45 the winds were moving east at about 50

mph, the temperature was in the high 50's with a dew point of about 16 degrees Fahrenheit. The atmospheric conditions were just right to have a high percentage of cloud cover through the day.

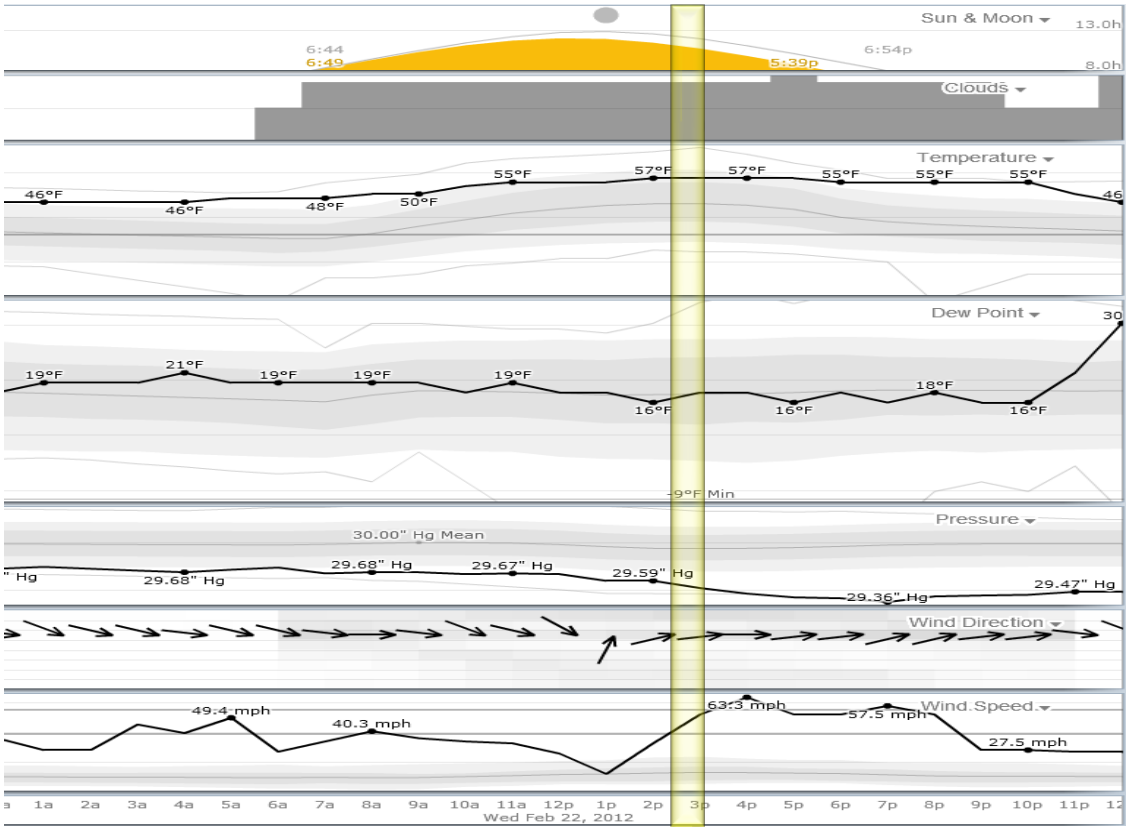

Figure 3: Weather Conditions for Feb 22 (photo time highlighted) [2]

Photographic Technique

This photo was taken by a Nikon Coolpix L105 12.1 MP digital super-zoom camera. The Flatiron Mountains were approximately 2 miles from the location where I took the image. The elevation of the Flatirons is close to 7000 feet, meaning the Foehn wall was at about that height since it is pouring over the mountains. The other cloud is a bit higher so it is probably at a height of about 10,000 feet. Using these estimates of the height of the two clouds, the field of view is about a 2 miles high and 3 miles wide, these are very rough estimates. The image was 4000 x3000 pixels and was trimmed down to 3308 x 2088 pixels. The ISO was set at 80, the exposure time was very fast 1/747 sec, the f-stop was 7.8 and the focal length was 9mm.

In Photoshop CS5 I played with a curve function and pulled the right side of it all the way down enhancing the darks and eliminating the mountains entirely, giving it the outer space appearance. Then I adjusted the contrast and brightness, pulling the contrast all the way down, and finally I cropped it. Below is the original image.

Figure 4: Original Image

Conclusion

This image reveals the beauty of cloud formations and the uniqueness of every cloud. Each one is different from the next, but the science is not. I enjoy this image since it is particularly new to me, as well as I enjoy the concept of expanding my knowledge of the floating wonders. The only aspect I wish I could have changed was the weather during that week, and how little variation of cloud cover that resulted. However, my intent was achieved in that I got a nice image as well as learned a great deal about what was in the image and the science behind it. It is certain that this simple assignment will bring my eyes to the sky much more often.

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[1] O. Mohler, P.J. DeMott, G. Vali, Z. Levin (2007): Microbiology and atmospheric processes: The role of biological particles in cloud physics. Biogeosicences Discuss, 4, 2560 <http://hal.archives-ouvertes.fr/docs/00/29/79/09/PDF/bgd-4-2559-2007.pdf>
[2] http://weatherspark.com/#!graphs;a=USA/CO/Boulder
[3] http://cloudappreciationsociety.org/
[4] http://weather.uwyo.edu/upperair/sounding.html
[5] Flow Visualization Lecture Slides < http://www.colorado.edu/MCEN/flowvis/course/Lecture2012/09b.Clouds3.pdf>
[6] S. Cohn, W. Brown, V. Grubissicc. Wind Profiler Observations of Mountain Waves and Rotors during T-REX. Journal of Applied Meteorology and Climatology. April 2011. Vol. 50 Issue 4, pg. 826-843.