

Linear Clouds



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Purpose

This assignment was the second installment of the Cloud portion for the Flow Visualization course offered by the University of Colorado at Boulder. The reasoning for two of these assignments was to grasp a wider range of cloud formations and weather patterns that appeared from January 2012 to April 2012. My original desire for this image was to get a cloud photo while on the plane from Denver to Orange County, California, but unfortunately I was unable to get one due to poor lighting during the trip. I also attempted to get some unique shots while in California since the clouds seemed to vary drastically from Colorado clouds during that time, but I only got a few shots, most of the clouds were too light and transparent that with the shining light, they were hardly visible in the photo. I finally got a photo I was thrilled about when a formation of linear clouds covered the sky in Boulder one afternoon. I had never seen a formation quite like it before so I was curious to explore what it was.

Image Settings

For this particular image I was once again located on the top of the engineering parking garage located close to the main campus of CU Boulder. The weather data for this particular day can be seen below in figure [1].

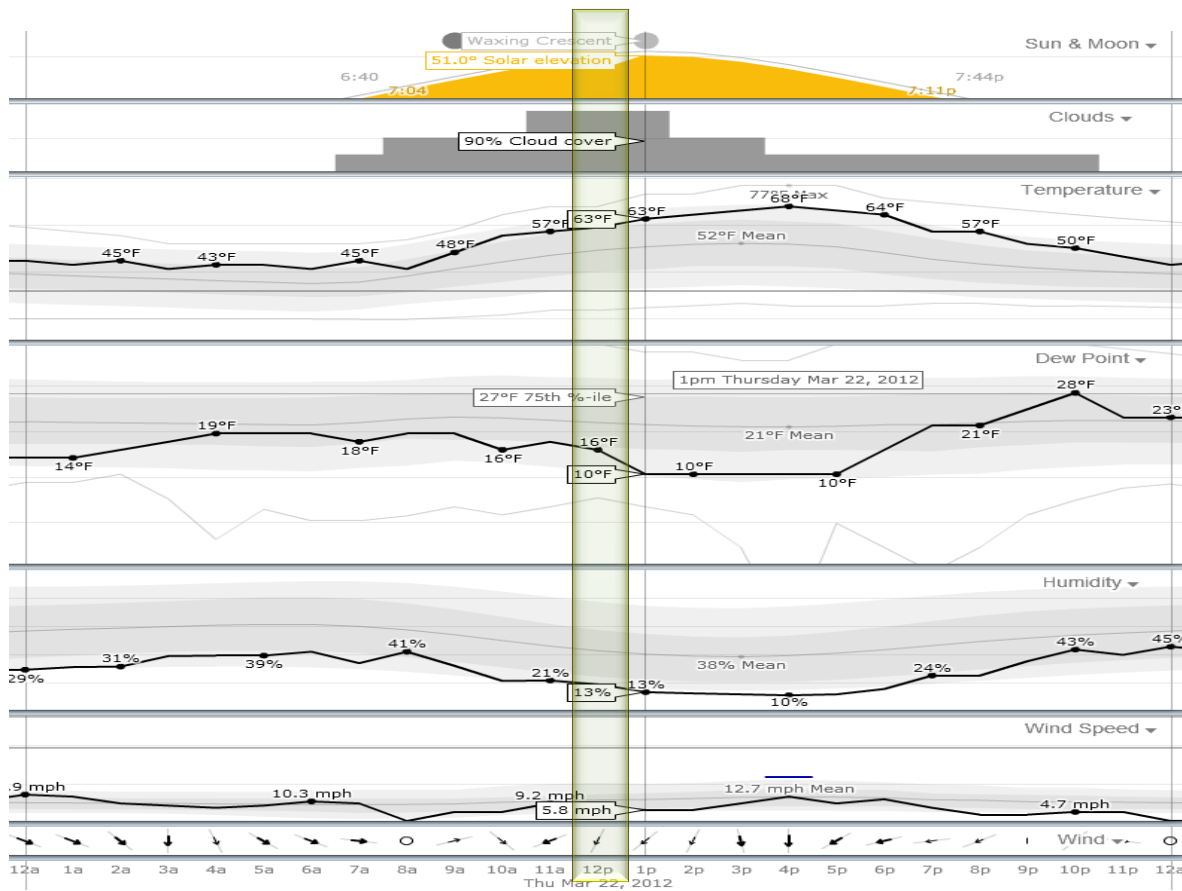


Figure 1: Weather Data for March 22, 2012 [2]

The mountains were to my right so I was facing South and the camera was angled about 20 degrees upward toward the sky, but low enough to where you could see the horizon and adjoining building rooftops. The image was taken on March 22, 2012 at approximately 12 pm. It was a very nice day about 60 degrees around noon with 51% solar elevation, 90% cloud cover, the winds were moving South-West at about 6 mph. The conditions were perfect for some nice clouds. The 90% cloud cover does not seem to go well with the image, but that is what weatherspark.com appears to say.

Cloud Appreciation

From the photo you can tell clearly that these are Cirrus clouds. Cirrus clouds form in the upper Troposphere and lower Stratosphere and they are easily identifiable due to their apparent transparency and wispy attributes [5]. From the Skew-T plot below in figure (2) we can estimate that these Cirrus clouds formed at roughly 12,500 meters, or approximately 40,000 feet. The formation of these clouds along with the cape value of zero provided by the Skew-T plot indicates that atmosphere was very stable throughout the day [5].

72469 DNR Denver

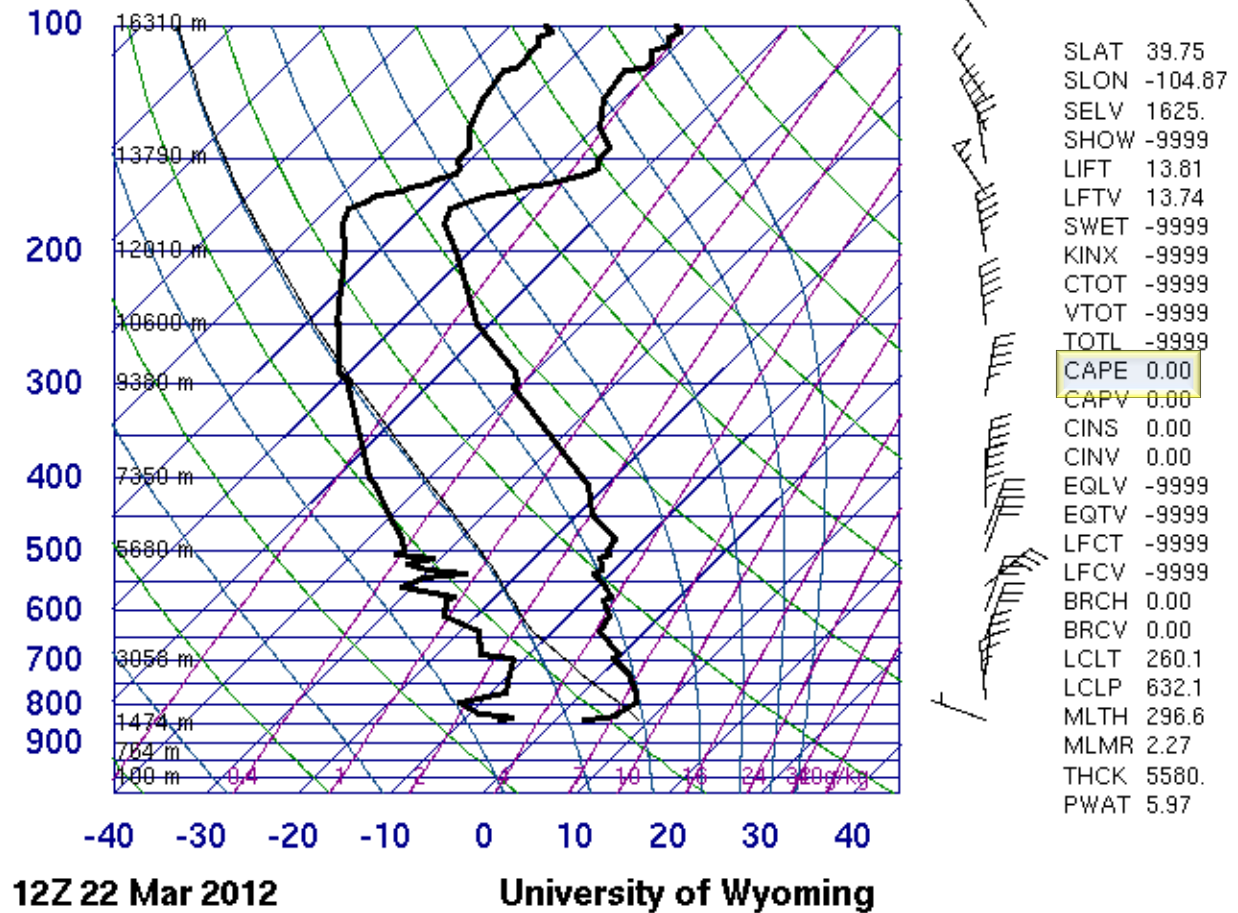


Figure 2: Skew-T Plot for March 22, 2012 [4]

Cirrus clouds in general consist of ice crystals and have a drastic impact on the atmospheric conditions as all clouds do. Cirrus Clouds scatter and reflect incoming solar radiation back into space creating a cool atmosphere, known as the albedo effect. They also absorb and re-emit infrared radiation, leading to warming of the atmosphere, known as the greenhouse effect. It is uncertain as to which of these effects is more dominant on atmospheric conditions due to the complexity of the microphysics of Cirrus clouds [1].

This image does not just represent Cirrus clouds but instead a sub-section of that genus known as Cirrus Radiatus. This particular pattern forms when the clouds run parallel to the wind direction, in this case North-South. If they were formed perpendicular it is known as Cirrus Radiatus Undulatus [3]. This pattern is created when a layer of cloud rolls or clumps in long lines and appears to converge on a single point on the horizon caused by our perspective view. These clouds formed in the high level atmosphere meaning that they might have been generated due to mid-latitude jet streams encompassing the globe, known as “jet-stream Cirrus” [3]. These jet streams can range from 80-140 mph and blow west-east but flow can shift to north-south, and are strongest during the winter seasons since the hot and cold air boundaries are most pronounced during this time [6].

The rest of the sky was bright blue, and there was no weather fronts approaching and there was none the day before. This was by all means an unusual sight, in all my days of living in Colorado I can't recall seeing such a formation, although my eyes weren't quite as fixed to the sky as they are now.

Photographic Technique

I was using my Nikon Coolpix 12.1 MP digital camera with no lens attachments. The original image pre-editing can be seen below in figure (3).



Figure 3: Original Image taken on March 22, 2012

The image was taken with an F-stop of 7, and exposure time of 1/312 sec, a focal length of 5mm, and a low ISO of 80. There was no cropping during the editing so the original and final dimensions were 4000 pixels wide x 3000 pixels high. The field of view is tough to estimate since it is such a large frame, but the distance from the lens to the clouds is roughly 40,000 feet. I didn't really have any influence on my decisions, I was just walking to my car and happened to look up and love the pattern of clouds so I decided to take out my camera and shoot, I didn't play around too much with the settings, but I wish I had.

Conclusion

The image reveals quite a large amount of atmospheric physics simply illustrated by these wispy clouds in the sky. Not only does it highlight this certain cloud formation but it also shows a phenomena not so visible, the jet-streams encircling the globe blowing at speeds of 180 mph, over 40,00 feet in the air. This image does more than just capture the beauty that is formed everyday by clouds, but the science that is very commonly overlooked that comes with these natural formations. I am glad that I got to find such a unique cloud pattern so that I could not only appreciate the beauty and simplicity of it but also to better understand what caused it to appear. My curiosity was peaked and I was able to discover what was behind the scenes. I am very content with this image; my only regret is that I did not take more photos that day so I could have found the perfect image to illustrate the occurrence.

[1] Formation, Lifetime and Climate Impact of Cirrus Clouds on ECHAM. Institute for Atmospheric and Climate Science. December 7, 2011.

< <http://www.iac.ethz.ch/groups/lohmann/research/modeling/cirrus>>

[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] The Jet Stream. National Weather Service. October 21, 2011.

< <http://www.srh.noaa.gov/jetstream/global/jet.htm>>