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ARTF 5200
Clouds I

Introduction

The first cloud assignment for FlowVis (University of Colorado, ARTF 5200) was my first concerted effort to capture an image of a cloud. I was hoping to capture an interesting shape and depth of colors. I took lots of pictures of clouds over the course of a couple weeks. There were a lot of interesting images and shapes but two days before the image was due I was up early and captured the most interesting form I had seen. I elected to use a compilation of three images showing the changing shape of the cloud over the course of about seven minutes and with different focal lengths to try and articulate the context. The resulting compilation is included below.

Scenario

The images were taken near 95th and Baseline Road in Lafayette, Colorado. The photo was taken facing east at sunrise around 6:30 a.m. on Monday February 18th, 2013. The clouds were low on the horizon and so the elevation of the camera was approximately between 20° above the horizon.



Weather and Cloud Analysis

The images I selected were of some stratocumulus or cumulus formations at the edge of a blanket of stratus or altostratus to the east. Data from WeatherSpark.com[1] for Feb 18th 2013 shows 100% cloud cover at 5AM and 50% by 6AM which seems to confirm a blanket of stratus clouds which was beginning to break up along the front range. The previous day was much warmer with clear skies, while on the day of these images there was a cold front pushing down from the north which brought snow the next day, this was a day of transition. The Skew-T diagram[2] (included below) shows a small inversion layer around 2000 m (~6,500 ft). In this vicinity there is also a change in wind directions from the northeast to west. The dew point is also about as close to the temperature plot as it gets in this same region and have a large shift above this point. The clouds in the image were low on the horizon and thus difficult to estimate their height and distance from my vantage point. However the wind profile shown in the skew-T plot showing the change of speed and direction and the inversion seems to indicate the clouds were somewhere between 6,000 and 8,000 feet. This seems reasonable given they were low on the horizon off in the distance. The variety in wind directions is likely what contributed to the formations I observed. The winds below the cloud were blowing the moisture south while above the layer was pushing to the east. Since I was viewing from the west I could see the shear occurring from north to south with the top layer being pulled less than the bottom. The western winds may have made this cloud curve from west to east at the top if viewed from the north but I can't say since I was only viewing from the west. If my estimates of a 20° elevation and 6500' cloud height the hypotenuse of a right triangle will be the distance to the clouds, approximately: $6,500 \text{ ft} / \sin(20^\circ) / 5280 \text{ ft/mi} = 3.6 \text{ miles}$

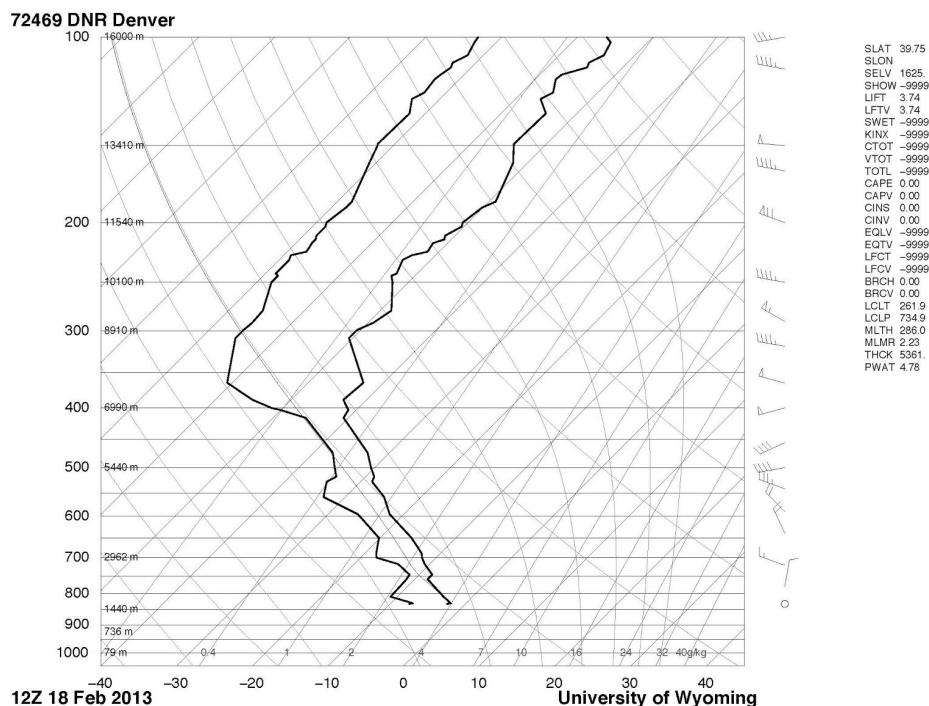


Image details

The three images used progress in time from top to bottom and were taken at 6:28, 6:32 and 6:35 a.m. respectively. I chose these three because they seemed to capture the variety of things observed best. The first image is the clearest shot I got of what I believe to be the Kelvin-Helmholtz instability. The second image (middle) I thought had a nice variety of color and contrast as the sun was rising. I included the third image (bottom) to show the rest of the sky in this direction and to show the rolling undulations from the instability extending far to the north. The images were captured using a Nikon D40 DSLR camera. The exposure settings and focal length for each image are given in the following table.

Image	DSC_7676 (top)	DSC_7686 (middle)	DSC_7700 (bottom)
Shutter Speed	1/400 sec	1/1250 sec	1/320
ISO	800	400	200
F-Stop	f/5.6	f/5.6	f/9
Focal Length	200 mm	200 mm	55 mm

The field of view can be approximated based on the above estimates of height of the clouds and distance from the clouds. For the images with a 200mm focal length the angle of view is approximately 10.3° and the 55mm focal length is an angle of view of 39.6° . Solving for the field of view (w) yields:

$$w = 2 * 3.6 * \tan(10.3^\circ / 2) = .65 \text{ miles}$$

$$w = 2 * 3.6 * \tan(39.6^\circ / 2) = 5.96 \text{ miles}$$

The images were edited into Photoshop where minimal manipulations were applied. Each image was cropped to highlight the cloud formation of interest. The top and bottom images were both slightly color compensated to achieve better contrast while the middle image was only cropped without editing the contrast.

Summary

To me it seems the formation captured shows the Kelvin-Helmholtz instability. There are a number of rather large undulations which I first noticed to the north (left side of the bottom picture) which continue for a long stretch. The most interesting motion was seen further south where there were fewer clouds obstructing my view of the formation. These shapes were changing rather quickly as the sun was peaking over the clouds which made for a wide variety of images showing different shapes and colors over a period of about seven minutes. The movement of the clouds does a nice job of showing the different wind speeds and directions causing the shearing instability. The compilation I made may have drawn away from the artistic impact since its perhaps difficult to follow but I had a hard time narrowing my selection down to one image. If I were to change it I would perhaps try and match the colors more as well as the dimensions of the cropping done (excluding some of the high clouds in the bottom image). I was

really excited to capture what I believe is the Kelvin-Helmholtz instability. It was mesmerizing to watch it morph as the sun was rising. I wish I had been able to find a better perch to capture this from as there were power lines and trees in the way depending on where I stood. I think it would have also been interesting to observe this from further north, however, as I was on my bike I couldn't change vantages very quickly. In the future I may try and get up on a higher hill to see if I can capture some more interesting clouds at sunrise. Taking these into the sun at sunrise was a challenge as the light was changing quickly but it was rewarding to be there to witness these clouds.

[1] -

<http://weatherspark.com/#!dashboard;q=Lafayette%2C%20Colorado%2C%20United%20States>

[2] - <http://weather.uwyo.edu/upperair/sounding.html>

[3] - http://en.wikipedia.org/wiki/Angle_of_view