Flow Visualization
MCEN 4151

Clouds II

Jeremy Parsons

Introduction:

The beauty and physics that drive cloud formations are both often overlooked. Having grown up in Colorado, I have become especially spoiled. However, since the first clouds report I have become more attuned to keeping an eye peeled for unique formations. By persistently scanning the skyline, one can make it second nature to spot the cloud formations that occur due to the natural landscape of Colorado. The goal of this image was to capture the Altocumulus Undulatus formations as they proceed away from the edge of the mountains [1]. These captured my attention particularly because they are very aesthetically pleasing while demonstrating unique behaviors not usually innate to such formations.

Image:

This image was captured April 5, 2013 near 4pm MST. This formation was captured from the roof of a building very near my home in Boulder. In the image I am facing due east perpendicular to the line made by the Flatiron Mountains. This is why such clear oscillatory patterns can be seen in the image as it stretches toward the plains. The image is at a shallow angle relative to the horizon (~15 degrees) in order to establish the depth the formation encompasses. I began watching the formation at bout 2:30, snapping new images every 30 minutes while the formation matured. The image shown is one of the latter most sets as it shows the most developed set of "waves". The clouds moved with impressive speed despite a lack of wind on the ground and it was especially interesting to watch how they would slow as clouds past over the mountain range and speed up as the gaps formed.

Cloud Physics:

The clouds captured in the image are the stereotypical embodiment of Altocumulus Undulatus clouds. The Undulatus formations are somewhat common to Boulder as they form when air streams travel past the last of the Flatirons. The Altocumulus clouds form at 8,000-20,000 feet in the atmosphere, higher than normal cumulus clouds. These specific formations are affiliated with moist streams of air that is converted to clouds as it passes of the mountains. The staggered "Undulatus" effect is due to the turbulence that is formed when the moist air passes over the mountain range. This phenomenon is illustrated in Figure 1 [2]. This formation was unique in that it aged in contrasting fashion as to what would be expected. The further clouds remain primarily in tact while the closer clouds seem to be forming in more random assortments. Typically Undulatus clouds disintegrate as they mature and this shows the opposite. I believe that two possible causes for this could be increasing wind speeds at that altitude or decreases in humidity or cloud forming aerosols. Higher wind speeds, leading to higher turbulence, could be causing the formations to continue to mix past the mountain's edge. Decreases in humidity or aerosols would mean that there is less material to form into clouds, thus the clouds formed would be less dense and less uniform.
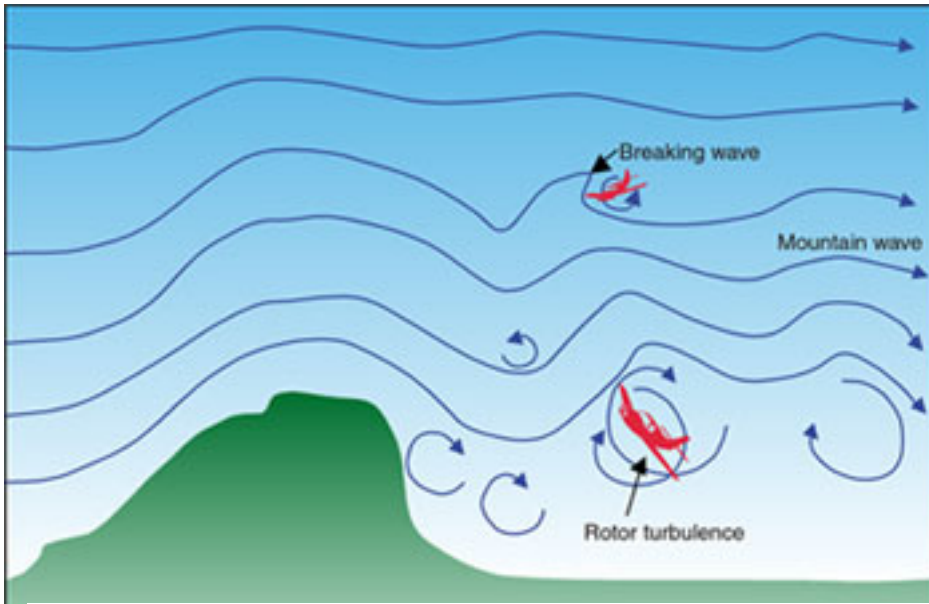
Figure 1

Shown in Figure 2 is the Skew-T plot for April 5, 2013 gathered via weather balloon launched from Denver, CO. The plot shows a time of 12Z meaning 7pm local time, this timeframe most accurately describes the formations in question [3]. The right line depicts the temperature while the left line depicts dew point relative to altitude. The entire temperature curve is steeper than the local adiabat, thus the atmosphere is stable at all altitudes measured.
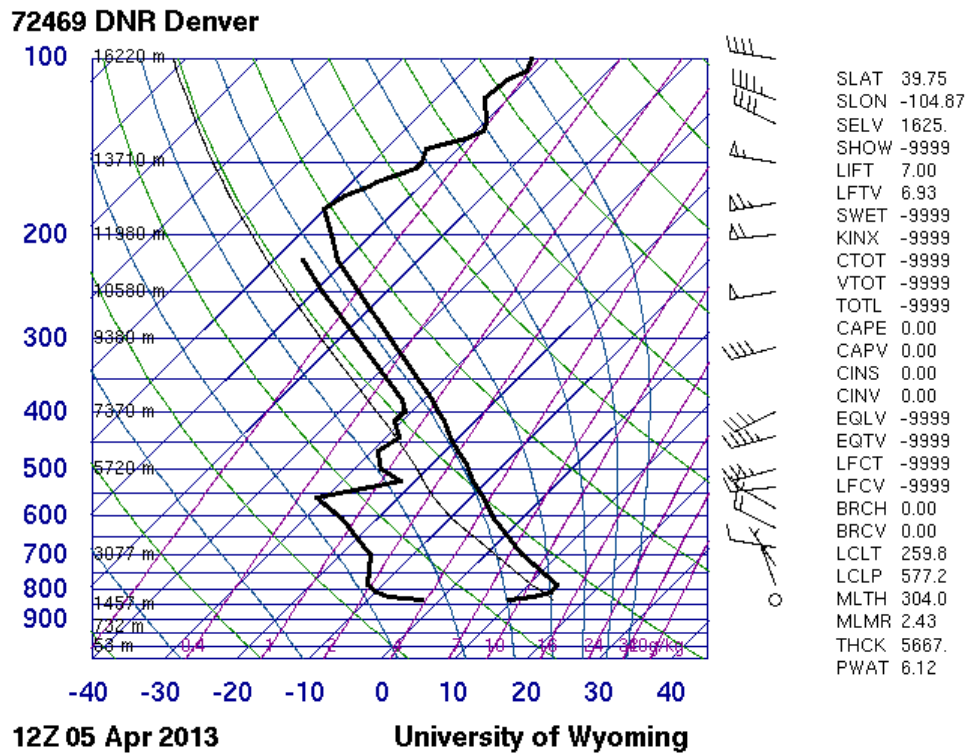

Figure 2

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Photographic Technique:

The following is the settings used to capture the image.

- Camera: Cannon Rebel XT Digital
- Lens: Cannon 80mm Macroscopic Lens
- Image size: Original – 3456x2304 pixels and Edited – 1728x659 pixels
- Exposure Settings: Skyline Mode with ISO-400, F/-4.5
- Exposure Time – 1/60 second
- Editing- Cropping, color enhancement and contrast adjustments were done in Photoshop CS6

Original Image   **Edited Image**

The original and edited images are shown above. The final image was cropped at its top and bottom edges to remove distracting elements on the street and focus on the cloud formations. The curves tool was used in increase the contrast between the clouds and the skyline while the channel mixer tool and the color balance tool were used to bring out the deeper blue colors. Lastly, the clone stamp and spot healing tools were used to remove the remnants of distracting elements from the buildings below.

Commentary:

I especially enjoy this image out of all the images I captured this day because is showed the maturity of the formation by capitalizing on the depth of the cloud formations as it reached toward the eastern skyline. It shows the Undulatus formations while also proving to be unique in the way that it continued to form. I have become more attuned to the skies around me because of these assignments and will continue to strive to search for the beauty and science in cloud formations in the future.

Citations:

1) Pretor-Pinney , Gavin. *The Cloudspotter's Guide*. New York: Penguin Publishing, 2006. Print.

2) . N.p.. Web. 4 Mar 2013. <http://www.atsb.gov.au/publications/2009/mountain-wave-and-associated-turbulence.aspx>.

3) . N.p.. Web. 4 Mar 2013. <http://weather.uwyo.edu/cgi-bin/sounding?region=naconf&TYPE=GIF%3ASKEWT&YEAR=2013&MONTH=04&FROM=0512&TO=0512&STNM=72469>.