Clouds 1

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Flow Visualization – MCEN 4151
Professor Hertzberg
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Purpose

The purpose for this cloud flow visualization was for the "Clouds 1" assignment assigned in the Flow Visualization course given at the University of Colorado at Boulder, led by Professor Hertzberg. The goal of the "Clouds 1" assignment was to display the physics of clouds in both an experimental and artistic way. It was my intent to display the unique clouds that occur over Boulder's Flatiron Mountains.

Location

I believed that finding a high vantage point was the best way to photograph the clouds coming over the Flatirons. I chose to photograph the clouds from the top of the Engineering Parking Lot located at the intersection of Colorado Avenue and Regent Avenue in Boulder, CO on February 25th, 2012 at 1:08 pm. I faced west towards the mountains, and photographed the clouds at roughly a 5 degree angle from horizontal.

Environment

There are three different types of clouds that can be identified in the photograph. First, the clouds on the leftmost side of the image are known as altocumulus lenticularis clouds, also known as mountain wave clouds. These clouds are prominent during wintertime, when westerly winds blow over the mountains. Mountain wave clouds form where stable, moist air flows over a mountain range, resulting in large, standing waves. It is common for the temperature at the crest of the wave to drop below dew point, resulting in the moisture in the air condensing to form the clouds. It is common to see bright colors known as irisation in the mountain wave clouds[1]. This irisation can be seen in the clouds located closest to the sun in the photo I took. Second, the clouds that take up most of the center of the photograph can be labeled as cumulus fractus clouds. Cumulus fractus clouds appear like ragged cumulus clouds. They tend to originate from dissipated cumulus clouds[2]. Third, it's evident that there are cases in the photo in which cumulus fractus gather closer with one another. When this situation occurs, the clouds become classified as cumulus humilis clouds. Cumulus humilis clouds typically occur at low to middle altitudes that are commonly referred to as the "fair weather cumulus" clouds[3]. Over mountainous terrain such as Boulder's Flatirons, these typically occur at up to 6,000 meters in altitude[3] but often occur below that. The cumulus humilis cloud forms through the process of warm air rising that has been heated from the ground[3]. When these types of clouds appear in the sky, they typically indicate that pleasant weather will accompany the region for the next several hours[3].

When I took the image, the sky appeared to be stable. It was seen as a dark, slate blue color with a grey tone. The weather for the day can be seen below:

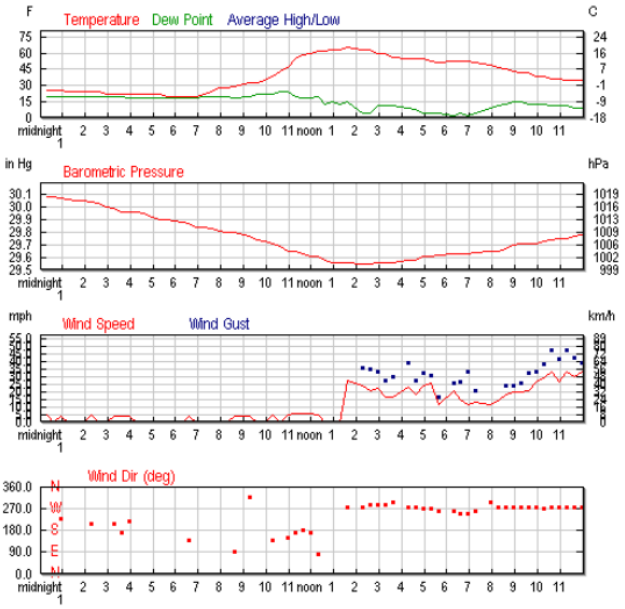

Figure 1[4]: Weather for Boulder, CO on 2/25/2012

The skew-T plot can be seen below:

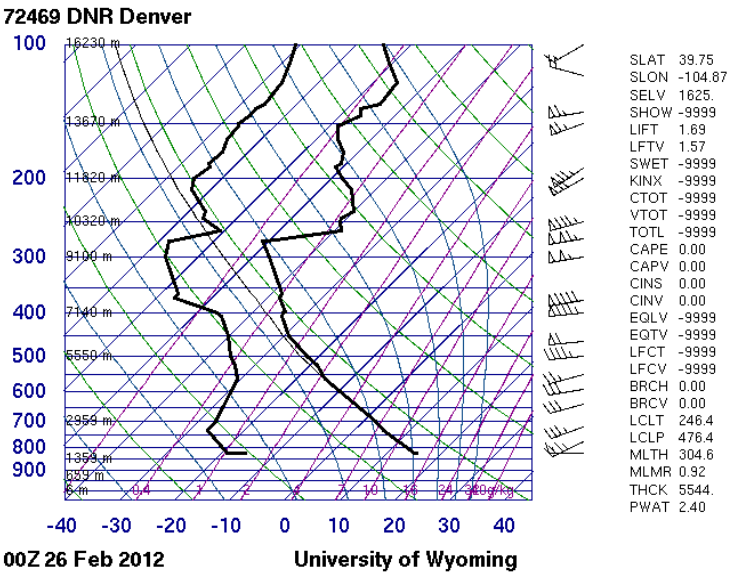

Figure 2[5]: Skew-T Plot for Boulder, CO on 2/25/2012 at 1:08 PM

At 1:08 pm, it was roughly 62 degrees Fahrenheit[4] with a 15 degree Fahrenheit[4] dew point temperature, accompanied by very little wind whatsoever. No precipitation occurred throughout the day. The day previous, February 24th, exhibited no precipitation, but had a mean temperature of 30 degrees Farenheit[6] and very little clouds, while the 25th exhibited a mean temperature of 42 degrees Farenheit[7]. This change in temperature over several hours could explain why the clouds formed on February 25th. The clouds didn't show any signs of a front coming in, and weather from February 26th shows that this statement was true. Although the temperature dropped to a mean of 26 degrees Fahrenheit on the 26th, no precipitation occurred.

The atmosphere was stable at the time I took the photo. At 1 pm, the Weather Underground listed Boulder's wind at 0 mph, although I felt a slight amount of wind. It can be seen in the skew-T plot above that this is true. The CAPE was 0.00. The skew-T plot shows that clouds on the 25th were ranging from 3,000 – 3,500 meters in altitude. This representation coincides with the clouds that I photographed. Figure 3 below shows the calculation of the cloud's altitude and temperature at the time I took the picture:

Unit	Number
Required Data Entry	
Choose Temperature	Degrees F ▾ Designation
Choose Distance	Meters ▾ Designation
Air Temperature (A)	62 Degrees
Dew Point (D)	15 Degrees
Approximate Cloud Altitude	3255.7 Selected Units
Approximate Cloud Temperature	4.3 Degrees

Figure 3[8]: Calculation of Approximate Cloud Altitude and Temperature

All of the data from the Weather Underground and the skew-T plot confirm that altocumulus lenticularis, cumulus fractus, and cumulus humilis clouds would be the proper clouds given the environment and atmosphere at the given time.

Photograph Technique

For this experiment, I chose to use my Fujifilm Finepix J20 Point & Shoot Digital Camera. The field of view for the finished photograph was roughly 2-3 miles in height by 3-4 miles in width. The distance from the top of the Engineering Parking Lot to the mountains is roughly 4-5 miles. The dimensions for the original photo are 3648 pixels in width by 2736 pixels in height, and for the finished photo are 3496 pixels in width by 2132 pixels in height. The horizontal and vertical resolution was 72 dpi. The f-stop was f/7.8, with an exposure time of 1/1100 of a second, ISO of 100, a focal length of 6 mm, and a max aperture of 3.27. I used the GIMP 2 software to perform editing on the image. I recently ran into a tutorial on YouTube explaining how to make your images appear as if they were shot as a HDR image[9]. This tutorial had me download a patch for GIMP 2 known as Dodge and Burn[10]. I found that this process made the image more vivid and pleasing to the eye. Once this editing was complete, I cropped the image, and played around with curves and colors to bring out more blues from the sky and show texture within the clouds.

Conclusion

It was my goal of this assignment to demonstrate the flow of the unique cumulus clouds that occur often around the Flatirons Mountains in Boulder, CO. I believe that I achieved my goal, and have been able to demonstrate these great clouds scientifically while also being artistic. I really enjoy the new editing method that I discovered within GIMP and I continue to use it on every picture that I take from now on. I really liked seeing the blues come out in the image, the irisation within the clouds, and the bright radiance of the sun. In the future, I'd like to use a nicer camera to capture these clouds, in hope of obtaining a more crisp and clean image, detailing more of its flow design. This assignment has definitely made me more aware of weather systems occurring currently and what could happen in the future. I'll never look at the sky the same way again after this experience.

Original Photo

References

1. “Lenticular Cloud”. *Wikipedia. The Free Encyclopedia.* http://en.wikipedia.org/wiki/Lenticular_cloud. Accessed on 3/5/2012.
2. “Fractus Cloud.” *Wikipedia. The Free Encyclopedia.* http://en.wikipedia.org/wiki/Fractus_cloud. Accessed on 5/6/2012.
3. “Cumulus Humilis Cloud.” *Wikipedia. The Free Encyclopedia.* http://en.wikipedia.org/wiki/Cumulus_humilis_cloud. Accessed on 5/6/2012.
4. “History for Boulder, CO”. *Weather Underground.* http://classic.wunderground.com/history/airport/KEIK/2012/2/25/DailyHistory.html?req_city=NA&req_state=NA&req_statename=NA. Accessed on 3/5/2012.
5. “Skew-T Diagram”. *The University of Wyoming College of Engineering.* http://weather.uwyo.edu/upperair/sounding.html. Accessed on 3/5/2012.
6. “History for Boulder, CO”. *Weather Underground.* http://classic.wunderground.com/history/airport/KEIK/2012/2/24/DailyHistory.html?req_city=NA&req_state=NA&req_statename=NA. Accessed on 3/5/2012.
7. “History of Boulder, CO.” *Weather Underground.* http://classic.wunderground.com/history/airport/KEIK/2012/2/26/DailyHistory.html?req_city=NA&req_state=NA&req_statename=NA. Accessed on 3/5/2012.
8. “Cloud Altitude and Temperature Calculator.” *CSGNetwork.* http://www.csgnetwork.com/cloudaltcalc.html. Accessed on 5/6/2012.
9. “More vivid images in Gimp (HDR)”. *YouTube.* http://www.youtube.com/watch?v=R8_tL7UCXuc&list=UUrV7q3aNoJzRKh8zntUBhkA&index=35&feature=plcp. Accessed on 3/5/2012.
10. “Fake HDR Look in Gimp.” *Gimpology.* http://gimpology.com/submission/view/fake_hdr_look_in_gimp/. Accessed on 3/5/2012.

Image Assessment Form

Flow Visualization

Spring 2010

Name(s): Ryan Kelly

Assignment: Clouds 1 Date: 3/6/12

Scale: +, ! = excellent √ = meets expectations; good. ~ = Ok, could be better. X = needs work. NA = not applicable

Art	Your assessment	Comments
Intent was realized	!	
Effective	!	
Impact	!	
Interesting	!	
Beautiful	!	
Dramatic	!	
Feel/texture	!	
No distracting elements	!	
Framing/cropping enhances image	!	

Flow	Your assessment	Comments
Clearly illustrates phenomena	!	
Flow is understandable	!	
Physics revealed	!	
Details visible	!	
Flow is reproducible	!	
Flow is controlled	NA	
Creative flow or technique	!	
Publishable quality	√	Could shoot with better camera

Photographic technique	Your assessment	Comments
Exposure: highlights detailed	!	
Exposure: shadows detailed	!	
Full contrast range	!	
Focus	!	
Depth of field	!	
Time resolved	!	
Spatially resolved	!	
Clean, no spots	!	

Report		Your assessment	Comments
Describes intent	Artistic	!	
	Scientific	!	
Describes fluid phenomena		!	
Estimates appropriate scales	Reynolds number etc.	!	
Calculation of time resolution etc.	How far did flow move during exposure?	!	
References:	Web level	!	
	Refereed journal level	X	No refereed journal
Clearly written		!	
Information is organized		!	
Good spelling and grammar		!	
Professional language (publishable)		!	
Provides information needed for reproducing flow	Fluid data, flow rates	!	
	geometry	!	
	timing	!	
Provides information needed for reproducing vis technique	Method	!	
	dilution	!	
	injection speed	!	
	settings	!	
lighting type	(strobe/tungsten, watts, number)	!	
	light position, distance	!	
Provides information for reproducing image	Camera type and model	!	
	Camera-subject distance	!	
	Field of view	!	
	Focal length	!	
	aperture	!	
	shutter speed	!	
	film type and speed or ISO setting	!	
	# pixels (width X ht)	!	
	Photoshop techniques	!	
	Print details	!	
	"before" Photoshop image	!	