Flow Visualization

MCEN 5151

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2nd Cloud Assignment

4/20/11

Cumulus Fractus swiftly moving over Boulder Canyon taken on 2/8/11

Image Purpose: The goal of this image was to capture a specific cloud, the cumulus fractus (known for its rapid transformation). The image can then be used to draw light on the physics behind the cloud. As presented the picture has a dizzying feel, the sun is directly behind the clouds giving the feeling the image is taken high above the horizon. The trees ground the picture and try to pull the feel for horizon down.

Image Location & orientation: This picture was taken in Boulder Canyon, Boulder CO on 4/8/2011 at approximately 3:00pm. The camera was facing south by south west. The tress seen at the bottom of the picture are at the top of the canyon, the camera was aimed approximately 60 degrees above the horizontal.

Cloud Types: The image is dominated by one type of cloud:

Cumulus Fractus: Defined as clouds with strong but tattered edges and rapidly changing contours. [1] Below in figure 1 the defining characteristic, the tattered edges, are highlighted in circle one. Figure 2 shows a sequence taken approximately 20 seconds apart. The left image is the image under analysis, while the right image is a picture taken with the same orientation 20 seconds later. The same cloud mass is circled in both images. The drastic difference in cloud contours between the two images proves the second defining characteristic of cumulus fractus.

Figure 1, Image showing the cloud's tattered edges, a defining characteristic of cumulus fractus.

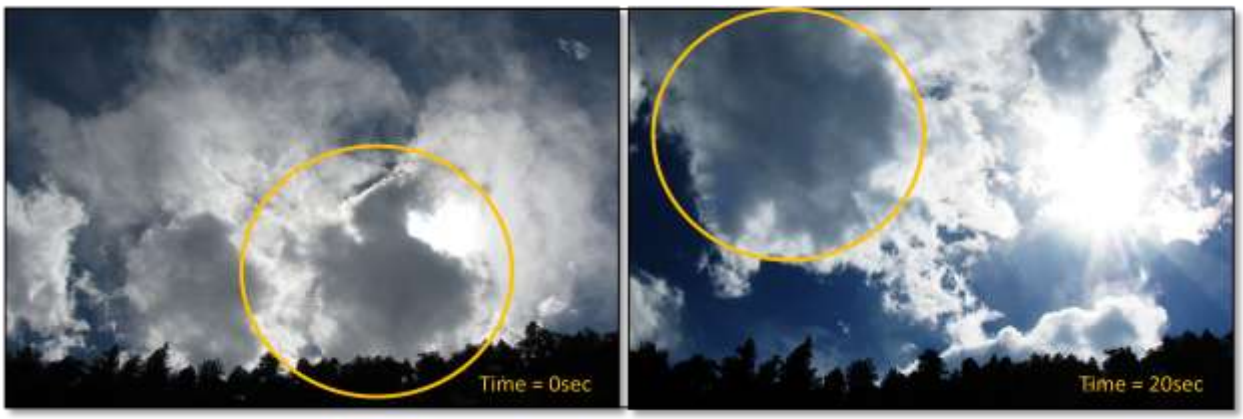

Figure 2, Image sequence taken approximately 20 seconds apart. Notice the drastic difference in cloud contours.

Atmospheric Events:

Weather: Two days prior to this image on April 6th it rained in Boulder, CO. After that the weather improved by increasing temp.[2] The high temperature on the 6th was 55°F while just two days later the high temperature had risen to 75°F.[2] At the time of photo the temperature was 68°F with 90% cloud cover. However, it is important to note that all of these clouds were moving very fast.[2] The winds were very high due to the rapidly changing temperature. Gusts exceeded 22mph, at around 4pm, with an average wind speed of 9 to 12 mph throughout the day. [3] The majority of the clouds were cumulus fractus.

Skew-T Plots: Figure 3 shows the two skew-t plots for April 8th. The left plot was recorded from April 8th at 6am and the right plot was recorded for 6pm. Both plots have 0.00 CAPE supporting the fact that the atmosphere was stable. This reinforces the fact that fractus clouds are often present in a stable atmosphere. Because the atmosphere is so stable the clouds change rapidly and often evaporate. Again this is a common characteristic of cumulus fractus clouds. The 6am plot suggests there was fog and clouds at approximately 21,500ft (6600m) while the 6pm plot suggests there were clouds at 23,500ft (7200m). However, we know from our knowledge that cumulus fractus clouds exist at a much lower elevation, approximately 6,500ft. But the mountains, canyon and ground elevation complicate approximating the height of the clouds. On the 8th the clouds did not seem to be low enough to be interacting with the peaks directly in foreground, however they were moving very rapidly and felt very close to the ground. It is safe to assume that the clouds were only a few thousand feet above the tree ridge seen in the photo, making the elevation of the clouds about 8 to 9 thousand feet above sea level.

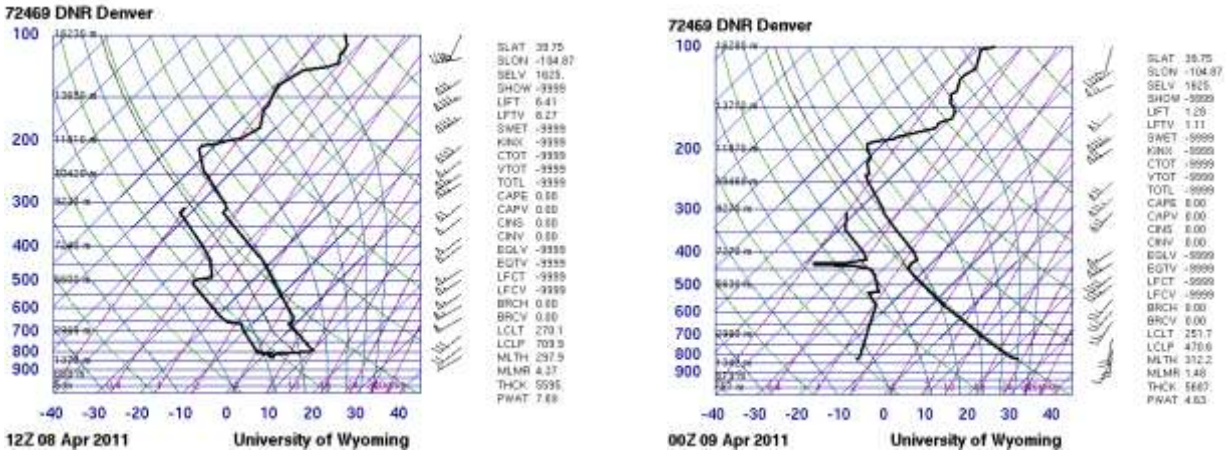

Figure 3, Skew-T Plots for Denver, CO on April 8th at 6am(12Z) and 6pm (00Z)

Interesting fact: Mountains play big role in cloud formation. Mountains can be considered obstacles in the way of the wind, and therefore have a direct impact of the dynamics of the wind flow. [5] Furthermore the mountains can be thought of as elevated heat sources for the wind flow. [5] These two features play a direct role of the flow of the wind and the formation of clouds. As obstacles, the mountains cause local instabilities and vortices often on the leeward side of the mountain which can cause erratic cloud formation. [5] Additionally as wind ascends a windward slope it the air local to the

slopes surface can be heated, adding to the energy of the air. [5] As the wind crests over the peak and begins to descend the leeward slope the added heat may have introduced enough energy to cause instability and cloud formation. [5] The clouds in the picture are cumulus fractus. They are fragments of larger cumulus clouds formed deeper within the mountain range. As the air blows over the leeward side it carries these cloud fragments and breaks them up further. The high speed winds cause tattered edges, rapid evaporation, and quickly changing cloud formations. [6]

Photographic Technique: From an artistic point of view, the image is dizzying. This feeling is established by the high angle of the camera orientation. The sun is directly behind the clouds creating the feeling that image is taken far from the horizontal. The tree line establishes a horizon that, by intuition should be low, but here it is high. The dizzying was enhanced when I increased the contrast. The tree line became a dark profile while the sun bleached areas became more prominent. I believe this feeling compliments the nature of the clouds and the geography well. Clouds whipping over a canyon create a dizzying environment for any individual standing at the canyons base. Figure 4 shows the pre and post edited photos, where the left is unedited, the right is edited. The editing was done in photo shop. Notice home much more dizzying the right is after a little crop and contrast boost. Specific Meta data for the pre digital enhanced photo can be found in table 1.

Figure 4, Pre digital enhancement (left) & Post digital enhancement (right)

Table 1, Image Details and Meta data for the un-edited image

Field Of View		
	Tree Profile	200
	Cloud Level	3000ft
Approximate distance to objects		
	Tree Profile	200ft
	Cumulus Clouds	3000ft
Camera Type		Cannon PowerShot SX 100IS
Image Specs.		
	Aperture	f/6.3
	Sutter Speed	1/1250sec
	ISO	80
	Number of Pixels Pre Edit	3264x2448

Conclusions: From a scientific or physical perspective I believe this image leaves a little to be desired. There is no unique or over powering physical phenomenon happening in the picture. I wish the image could have incorporated such an entity, it would have made the analysis that much more interesting. From an artistic point of view, however, I believe this image has a lot to offer. The picture effectively instills dizziness on the viewer. It is very disorienting, the image feels as if the picture was taken near vertical because of the sun is directly behind the clouds. While the horizon grounds the picture. It is two opposing perspectives which contradict each other resulting in the dizziness. The contrast boost does remove some of the detail, however after comparing the pre edit to the post edit I believe the contrast boost add much more than it takes away. It makes the image feel much more dramatic, adding to the disorientating feeling. I believe this feeling to compliment the clouds in the image perfectly. The clouds are fast moving highly erratic and constantly changing. While on is looking at these clouds especially from within a canyon it does become dizzying.

References:

[1] Clouds Online, Cloud Atlas. Germany. http://www.clouds-online.com/cloud_atlas/cumulus /cumulus.htm

[2] Weather Sparck Beta, weather graphs for Boulder Colorado April 6th through the 8th. http:// weatherspark.com /#!graphs;a=USA/CO/Boulder

[3] Weather Spark Beta, weather reports for Boulder Colorado April 8th. http:// weatherspark.com/#!reports;a=USA/CO/Boulder;tr=4/8

[4] Skew-T Plots for Denver, CO on April 8th 6am & 6pm. http://weather.uwyo.edu/upperair/sounding.html

[5] D. Rife, "The effects of mountains and complex terrain on airflow and development of clouds and precipitation" Western Region Technical Attachment No. 96-16, (1996)

[6] J. D. Price, "Observation of stratocumulus cloud break-up over land," Quarterly Jo. Of the Royal Meteorological Society, Vol. 125, 554 (1999) pp.441-468