Cloud Image 2

Flow Visualization
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Cloud 2

Purpose:

In the second round of cloud images a more interesting approach was taken to capturing the dynamics of the clouds above Boulder, CO. Instead of making a still image and using post processing a time-lapse was made to show the evolution of the clouds in two locations. This time-lapse gives the viewer an added dimension toward understanding the dynamic and physics of clouds. Initially it was attempted to create a time-lapse from a couple hours of imaging but due to time constraints and prevailing winds it was required that the camera was monitored at all times. Thus leading to a reduced time interval for each shooting location.

Image Staging:

Each series of images was taken on the afternoon of March 31, 2014 just off the beaten path out of bustling Boulder city center. Figure one shows the locations of each shooting location. The first location is off of Cherryvale road, right next to the Baseline Reservoir. Sadly this lake is private and admittance was not allowed so the images were shot from the side of the road. Looking directly east at 4:00 pm, the camera was set on a tripod and left for 10 minutes to take images intermittently. It was chosen to include the tall grasses in the frame to add an extra element of motion to the time-lapse. The second location was looking southeast toward the NREL wind turbine testing location. The foothills are directly to the west of this shot and gave the clouds an extra dynamic element as time progressed. This series of images was shot on the same day at roughly 4:40 pm. The late afternoon was chosen to ensure decent lighting that would be at the back just before the sun passed below the mountain ridge line. Providing excellent contrast and visibility.

Figure 1: Location Map

Cloud Physics:

The clouds in this image are stratus and cumulus clouds. An altostatus cloud is defined by the cloud spotters guide as, " mid-level layers or patches of cloudlets, in the shape of rounded clumps, rolls, or almonds/lenses".[1] A cumulus cloud is defined by the cloud spotters guide as, " A low, detached, puffy cloud that developed vertically in rising mounds, domes or towers, and have generally flat bases".[1] Figure 2 shows the skew-T diagram from 00Z 01 April, 2014. This means

that this is the sounding data from Denver International Airport at 6:00 pm on the 31st of March, when these images were taken. The CAPE value from this data is 0.00 which indicates a stable atmosphere and this is in good agreement with the physical weather, there were no storms before or after this photo was taken by a few days. We can see that the dew point line is a bit jagged which would indicate the reason for clouds forming despite the CAPE value of 0.00. In addition to this skew-T diagram a graph has been acquired for the day of March 31st from the skywatch team at the University of Colorado, Boulder. This data shown in Figure 3 will give a good estimate for the relative cloud heights

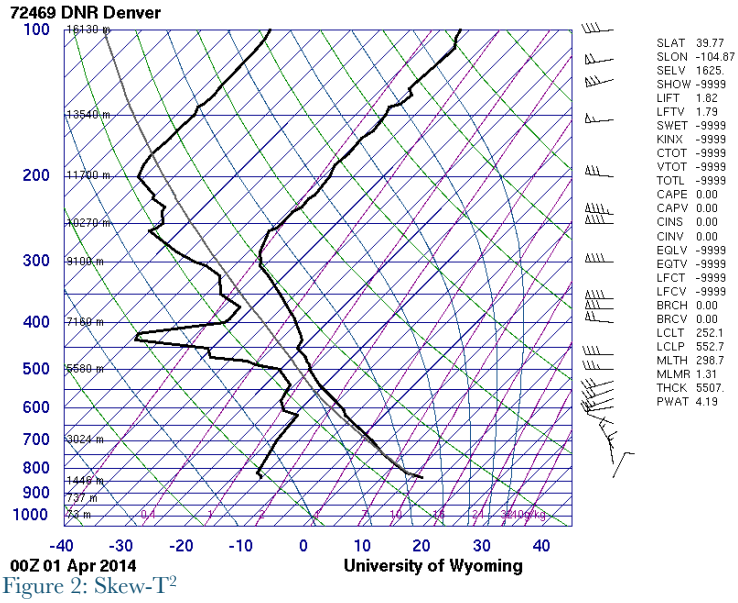

Figure 2: Skew-T[2]

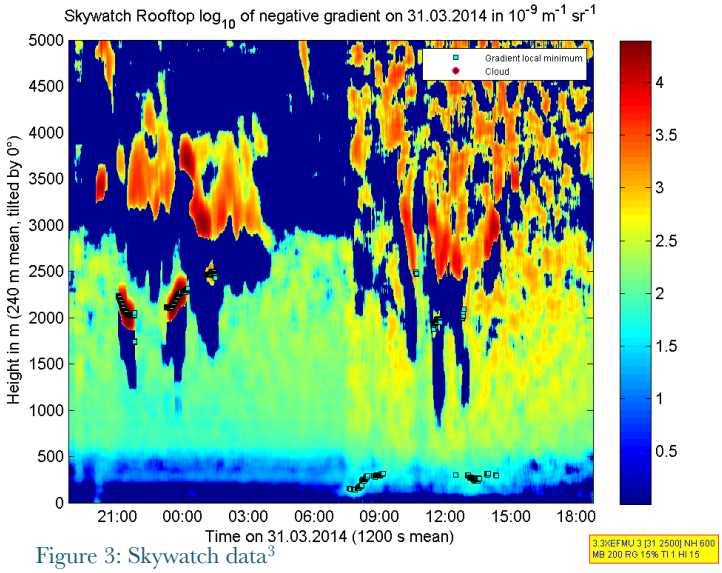

Figure 3: Skywatch data[3]

that are shown in the time-lapse video presented here. Based on the description of an altostratus and a cumulus cloud, their relative heights should be in the range of 2,000 to 5,500 m. This data from Figure 3 agrees with the heights of the clouds that were imaged. Cloud formations in red on the graph at ~2,500 m are the cumulus clouds shown and cloud formations in red at ~5,000+ m are the altostratus clouds that most notably formed in the second location of the time-lapse.

The data was collected using a ceilometer, which is a device that measures the optical backscatter intensity of the air at a specified wavelength.[4] This backscatter is a result of the moisture in the air and there is a lot of moisture in clouds, so this technique can be used to find the base heights of clouds via their relative backscatter characteristics. Which is then dependent on the wavelength of light that is then emitted by the laser in the ceilometer. The backscatter is what is graphed in Figure 3.

Photo Technique:

To capture this image a Nikon D5000 was used with a lens of focal length 18mm - 55mm. In the first image series a shutter speed of 1/60 of a second with a corresponding aperture of f 23 was used. The very small aperture was used to develop an extended depth of field to keep the grass in the foreground un focus while ensuring that the landscape and clouds were crisp and clear as well. The choice to use an ISO 200 was made in an effort to minimize noise and grain as much as possible. In the second image series a shutter speed of 1/100 of a second was used with a corresponding aperture of f 14. The aperture was reduced for this image

because it was no longer necessary to establish such a large depth of field as in the first series. The focal length in the first series was at 18mm to give a nice wide angle shot of the whole reservoir and the clouds. In the second series a focal length of 25 was used to get a bit closer to the wind turbine in the background of the shot. Each image was then set to back taken at an interval of every 10 seconds. This resulted in a total time of 10 minutes for each series and 60 images per series.

Figure 4: Before and After

The images were slightly less contrasty than hoped so the saturation and contrast levels were adjusted in Photoshop Camera Raw. Figure 4 shows the difference between the before and after for an image from each series. In the first series the saturation was increased by +38 and the contrast was increased by +25. For the second series of images the saturation was increased by +29 and the contrast increased by +25 again. In this second set the exposure value was also adjusted by +1.15. After these adjustments iMovie was used to compile all the images into one video and then the speed was increased by 150% to produce a video that is 21 seconds long.

Conclusion:

Overall the reception to this image was good and the only request was that the sequences be made longer. This is a good point to truly understand the dynamics of the clouds it is hard to do so in 20 second increments. Next time a more sturdy set up will be established to ensure that a longer sequence of images can be taken. These status and cumulus clouds are seemingly normal and unusual but they way the video is presented makes them more unique and interesting.

References:

1. Pretor-Pinney, Gavin. *The Cloud Spotter's Guide*. Pergee Press, 2006. Print.
2. "Sounding Data." . University of Wyoming. Web. 27 Feb 2014. <http://weather.uwyo.edu/upperair/sounding.html>.
3. "Skywatch Observatory." *Skywatch Observatory*. N.p., 31 Mar. 2014. Web. 31 Mar. 2014. <http://skywatch.colorado.edu>.
4. Illingworth, A. J., et al. "Cloudnet: Continuous evaluation of cloud profiles in seven operational models using ground-based observations." *Bulletin of the American Meteorological Society* 88.6 (2007): 883-898.