Cloud 2 Assignment

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Flow Visualization

The purpose of this assignment is to observe, photograph, and understand the fluid dynamics of clouds. Since the first cloud assignment I have tried to keep an eye out for clouds as much as possible. When driving back from Kansas I saw a set of clouds that needed to be photographed. I had known from weather reports that I would be driving into some weather during this part of the trip. Therefore, for this assignment I had decided to try and capture some of the cloud formations before poor weather.

The image was taken on April 1, 2006 at 5:04 pm and was taken about an hour and a half East of Denver along I-70. The image was taken facing south to observe how the cloud was building from East to West. When looking West from where the picture was taken you could see that the cloud was getting much darker and might lead to poor weather. Noticing this I came to the conclusion that these cloud must be Stratocumulus.

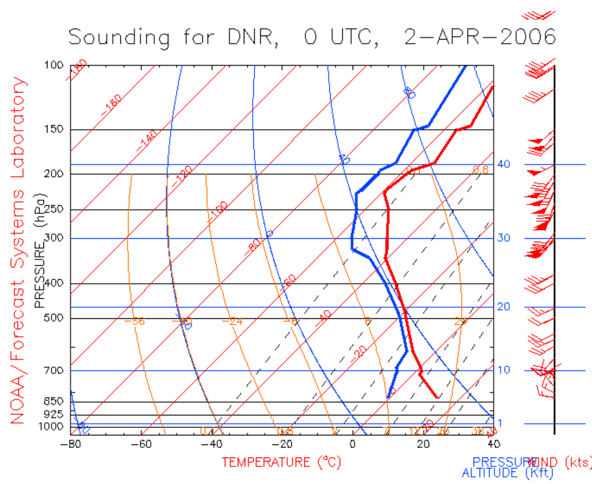

Figure 1: Skew-T plot near time of photo

Stratocumulus clouds are low level clouds that resemble cotton balls that are elongated by shearing winds. Knowing the altitude where stratocumulus clouds typically occur, (surface up to 8500 ft or 2591 m) we can use a Skew-T plot to gather more information. From the Skew-T plot in Figure 1 you can see that the speed of the air in the region where the clouds occur. There speeds range from 9.3 - 11.3 meters per second. When looking at Figure 2 the wind is blowing from the right of the image to the left. If you look at the top and left parts of the clouds you can see that the clouds are being dragged and sheared to the left. Stratocumulus clouds are composed of water droplets and are often are accompanied by precipitation of weak intensity in the form of rain. Since the poor weather was moving from West to East and I was driving East to West I had an accelerated sense of the storm, and as it were, I ran into some light rain. If we estimate the diameter of the top cloud in Figure 2 to be 807 m, and the cloud to have similar properties to air, we can find the Reynolds number to be 6.25×10^8. A Reynolds number that high means that the flow is extremely turbulent. Estimating the height of the cloud and its distance across the ground the depth of field can be found to be approximately 4.78 km. From the Skew T plot the cloud could have an estimated speed of 11.3 m/s. Knowing that the pixel field of view and the aperture speed, we can find the temporal resolution. The temporal resolution shows us that the object will move .014 meters. Since the pixel field of view 3.2 meters, when compared to the distance the object will move, the motion blur will not be a concern.

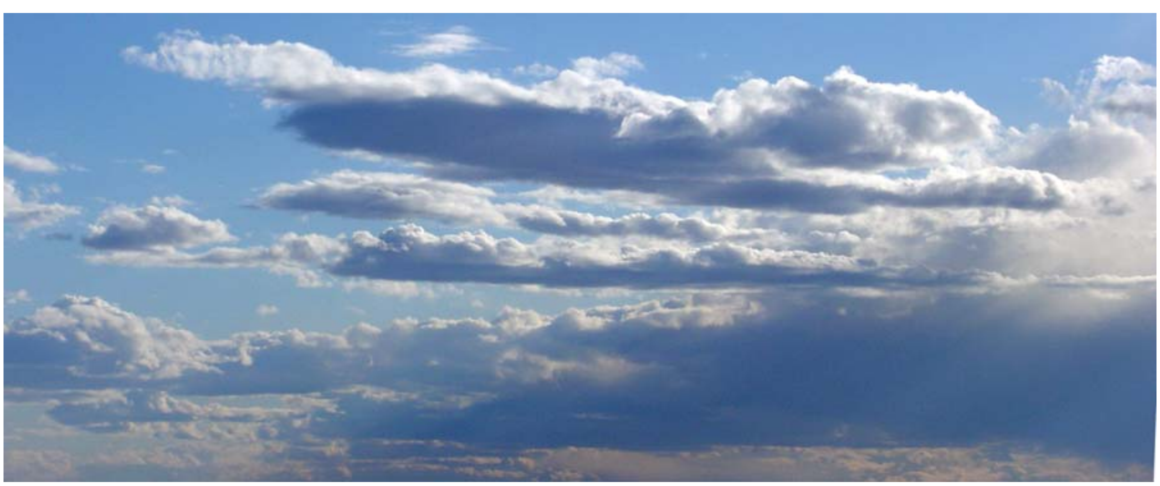

Figure 2: Final Image

The visual technique was a photo taken later into the afternoon and early evening. The attempt of this image was to capture as much of the cloud from the start and show the buildup as the poor weather approached. Sunlight was used as the only lighting.

The photographic technique for this case relied on the use of a Sony DSC-P92 Cyber-shot 5 Mega Pixels digital camera and some slight Photoshop processing. The image in Figure 2 was taken approximately 4.78 km away from the object with a focal length of 24 mm. The focus for the image had been manually set at infinity. The ISO was set at 100 while the shutter speed was 1/800. The aperture was set at a value of 2.8. There was slight Photoshop manipulation done to this image. The image levels were adjusted to sharpen and bring out some subtle characteristics. Also the original image had distracting elements in the landscape, a building and telephone poles. In order to eliminate these elements the image was rotated 2 degrees clockwise. Then, the portion of the image that would become the final was cropped out.

The image in Figure 2 shows the Stratocumulus clouds as it is builds as the storm moves across the area. You can see some of the characteristics of this type of cloud, such as the shearing of the clouds. If I were to farther classify the cloud I would add Opacus, to the right side of the image. The clouds on the right grow increasingly thicker beginning to block out the sun light, and as a result darkens the area below the clouds. A future suggestion would be to try and find a spot higher to be able to photograph over the building and telephone poles. This would allow for the image to have a clear view of the landscape to show the clouds height above the surface. Another future suggestion would be to obtain a time-lapse camera in order to see the development of the storm. Overall the image is dramatic, interesting, and beautiful.

References:

1.http://www.wunderground.com/history/airport/KLIC/2006/4/1/DailyHistory.html?req_city=NA&req_state=NA&req_statename=NA

2. http://raob.fsl.noaa.gov/ (for Skew-T plot)

3. http://www.bookrags.com/sciences/earthscience/clouds-and-cloud-types-woes-01.html

4. International Cloud Atlas, World Meteorological Organization, 1956

5. Munson, Young, Okiishi, Fundamentals of Fluid Mechanics, John Wiley & Sons 2002

6. Cloud Chart, Dept of Earth and Atmospheric Science, Purdue University

Original Image

The Pixel Dimensions - X:2592 Y:1944

Final Image

The Pixel Dimensions - X:2548 Y:1038
Resolution - X:72 Y:72