The Photography of Clouds

Introduction

The purpose of this assignment is to capture a picture of clouds in order to observe the atmospheric conditions around the earth. Clouds are formed when air containing water vapor is cooled below a critical temperature called the dew point and the resulting moisture condenses into droplets on microscopic dust particles in the atmosphere [1]. As of the first assignment of clouds 1, our knowledge on clouds behavior is enriched, and more time is given to us in order to capture a better image of cloud formation. The goal of this assignment is to visualize the formation of clouds due to certain particular atmospheric phenomena. The clouds formation can be classified into different categories and each category has its own behavior which will be identified later on in this report.

Information of Image

Figure1: Original image of clouds

The picture shown in figure 1 is the original image of clouds which was taken on Wednesday, the 12th of April, at around 3:30 in the afternoon. The location of the image that has been taken was at the top floor of the parking structure of lot 436 near by the engineering center on the University of Colorado at Boulder. The image was

taken facing the west direction, towards the mountain, from lot 436. The weather on Tuesday was clear and sunny in the morning and turning slightly cloudy around noon, and it stayed cloudy until sunset. The average high temperature on that day is 62°F and average low temperature is about 33 °F.

Classification of Clouds

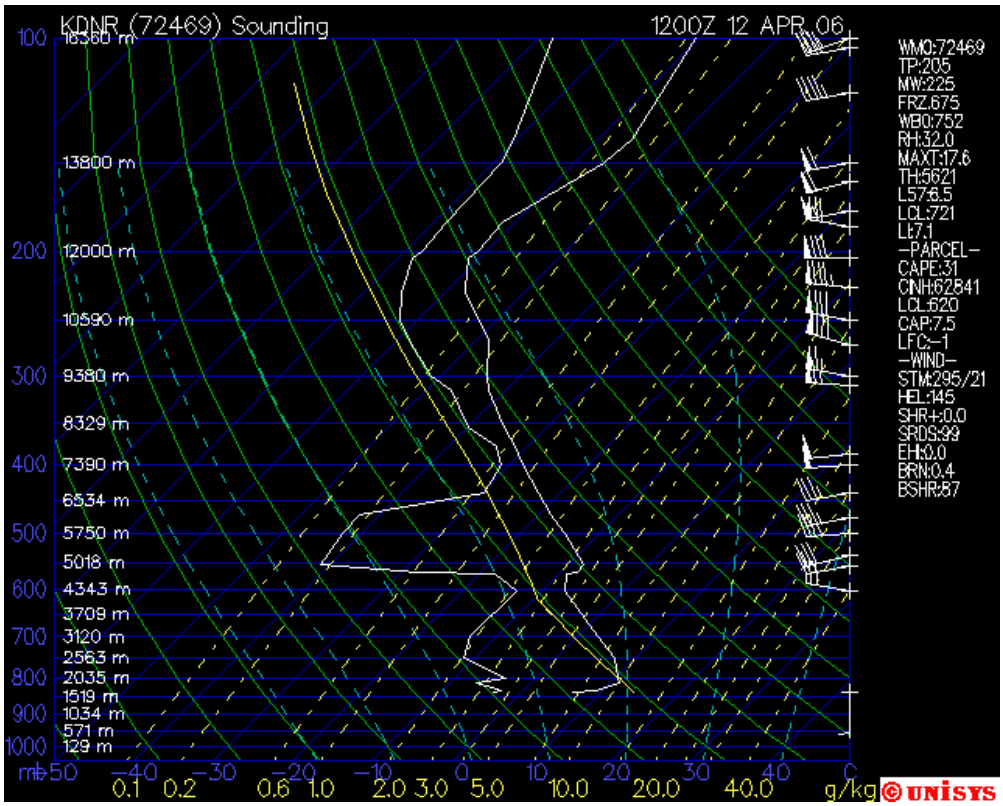

Figure2: Skew-T plot on the 12th of April at 12:00pm [2].

The clouds shown in figure 1 is most likely to be a mountain wave clouds which is formed by wind flows across a mountain range and tends to form air waves on the lee side of the mountains. The height of the clouds in figure 1 is estimated to be approximately 14,500 ft. This estimation is based on the height of the mountain and the skew-T plot. The skew-T plot, which is shown in figure 2, shows the temperature profile in the atmosphere on the 12th of April at noon, which is close to the time of the image that has been taken. The temperature lines of the Skew T plot are in blue; the green lines are called dry adiabats; the light blue dashed lines are saturation adiabats; and the yellow dashed lines are lines of constant mixing ratio. The sounding is plotted as two white lines where the right line is the temperature profile and the left line is the dew point profile. The yellow line in figure 2 seems to transition at about 14,500 ft, which suggests the formation of clouds at this level. Clouds at this range of height are usually said to be middle clouds. By comparing

with other documented clouds formations [3], the image of clouds shown in figure 1 can be classified as cumulus. Cumulus clouds are usually detached clouds, which is generally dense and with sharp outlines. It is developed vertically in the form of rising mounds, domes or towers, of which the bulging upper part often resembles a cauliflower. The sunlit parts of these clouds are mostly brilliant white while their base is relatively dark and nearly horizontal [4]. Furthermore, on the Skew-T plot, the temperature (white line on the right) is steeper than the adiabatic cooling line (solid yellow), therefore the atmosphere is stable and the clouds can be identified as laminar. According to [5], laminar flow can be proved by calculating the Reynolds number for the system which is given by:

$$Re = V*D/\nu$$

Where V is the velocity of the clouds, D is the length of the clouds, and ν is the kinematics viscosity of air. The velocity of the cloud is estimated to be about 20 ft/s. With $\nu = 1.6\text{x}10^{-4}$ ft^2/s, V = 20 ft/s, and D = 100 ft, the Reynolds number is calculated to be $Re = 1.25\text{x}10^5$ which is less than the critical point $Re_L < 5\text{x}10^5$, and therefore, the flow is laminar. One reason for clouds form in stable atmosphere is when they form in a stable layer that is a thin layer of the atmosphere where the temperature does not decrease very much with height, or even increases with height. Since the cloud is very stable, the cloud moved very tiny during the exposure and it could be neglect. By observation, the cloud can be identified as horizontal propagation wave.

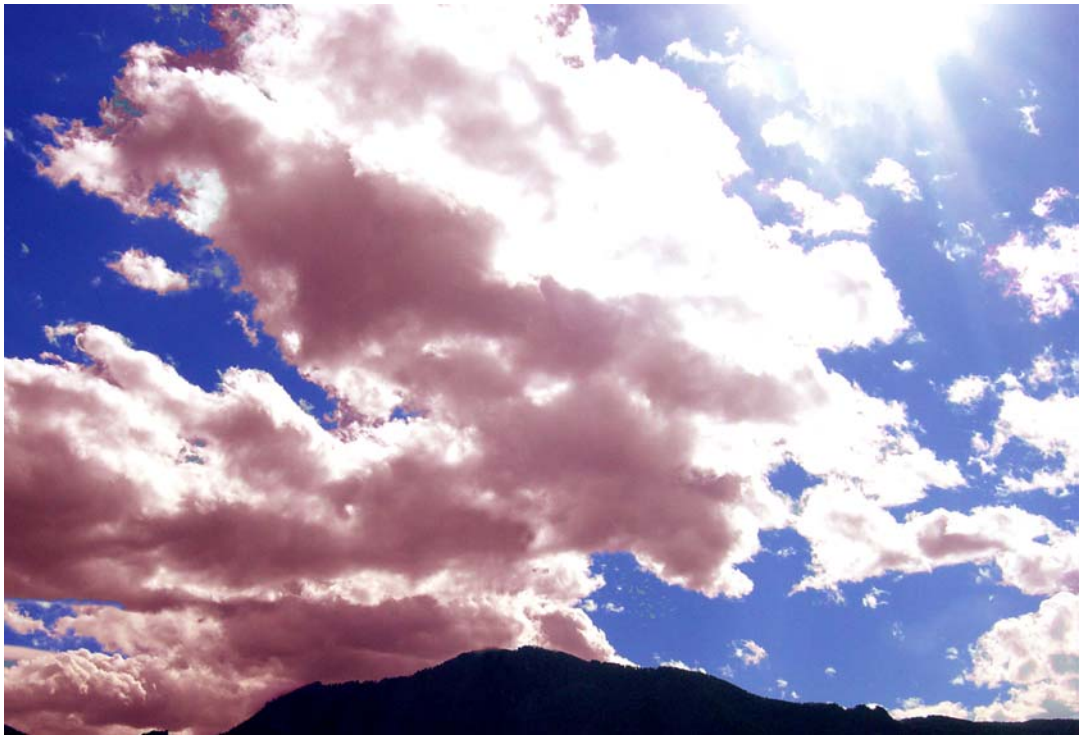

Figure3: Final image after Photoshop

Photographic Techniques

The camera used to take the image was a Sony Cybershot Digital Still Camera DSC-P9 with 4.0 Megapixel. The focus of the camera was manually set to infinity for better view of the image. Some of the details of the photographic techniques are listed below:

- Field of view – 1000 ft by 1000 ft
- Distance from object to lens – 15,000 ft
- Lens focal length and other lens specs:
  - Focal length – 9.3 mm
  - ISO light sensitivity of 100
- Type of camera – Sony Cybershot DSC-P9
- # pixels – 2080 x 1418
- Exposure specs
  - Aperture – 6.3
  - Shutter speed – 1/125 sec
  - F-Number – F/5.6
  - Exposure time – 1/40 sec

Adobe Photoshop CS is used to process the image shown in figure 3, which is the final image. The bottom of the image on figure 1 is trimmed for any unnecessary distraction of the image. Some adjustments have been made to create a more dramatic image, and they are:

- Color balancing – The sky color level of blue is increased to maximum in order to bring out a better distinguish between the blue sky and the clouds, and the cloud color level of red is increased to maximum to create a more dramatic image
- Contrast and brightness – Contrast level is increased to +30 to bring out the contrast of the clouds and the brightness level is increased to +8
- Rubber stamp – The stamp is used to remove the light pole as well as any distraction created by the reflection of light

Conclusion

The image in figure 3 clearly illustrated the middle level cloud formation in the atmosphere which is identified as cumulus cloud types. The most I like from the image is the clear contrast between the blue sky and the white clouds. The most I dislike from the image is the sun, which was too bright and distracted the quality of the image. The fluid physics shown are the mountain wave clouds which are formed by wind blowing across a mountain range and tend to form air waves on the lee side

of the mountains. I was able to examine a particular clouds type in this assignment so I have fulfilled my intent of the image. For improvement, I would like to have more time in order to observe and capture more different clouds formation for comparison purposes. Further work can be done in the future is to capture more other clouds formation and compare the physics between them.

References

[1] Information Please, updated on 4-16-06.
http://www.infoplease.com/ce6/weather/A0857399.html
[2] Unisys Weather, updated on 4-18-06
http://weather.unisys.com/upper_air/skew/skew_KDNR.html
[3] Cloud Chart, Purdue University, Department of Earth and Atmospheric Sciences
[4] Abridged Atlas, “International Cloud Atlas”. World Meteorological Organization. Reprinted in 1969
[5] Principles of Heat Transfer, by Frank Kreith, Mark S. Bohn.