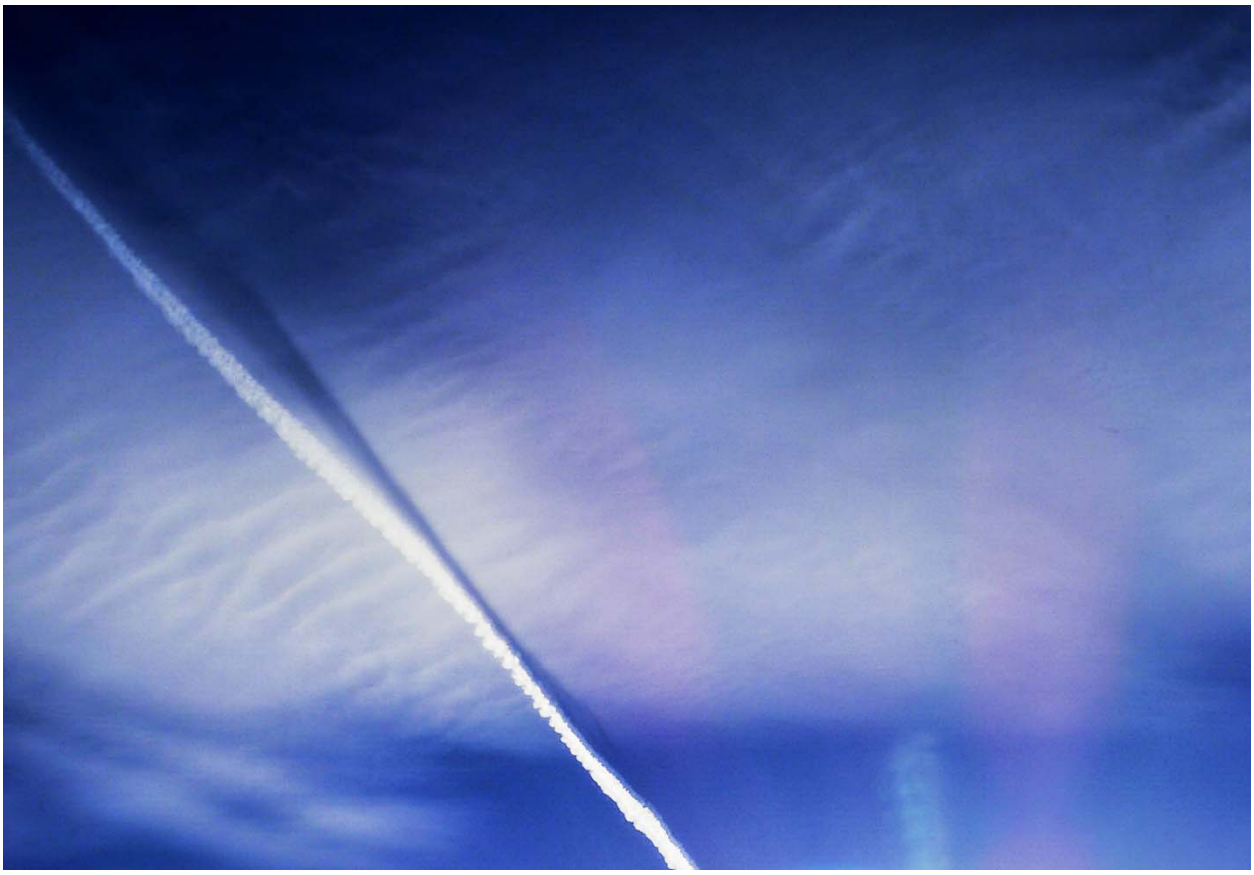
Clouds



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Flow Visualization

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Introduction:

The perfect day to me is a day without a single cloud in sight, but now it is time to appreciate the funny shaped objects floating above us. The tree main types of clouds I could think of before taking this class were clouds that carry lots of snow, summer thunderstorm clouds, and small ones that would annoyingly block the sun. After discussing actual classifications of clouds, the purpose of this image assignment was to capture at least one type of cloud and be able to classify it. Luckily Colorado has many types of clouds to offer and sometimes you only have to wait 15 min for the sky to paint a totally different picture.

Image:

This image was taken on March 29th 2013 at 5:20 PM Mountain Standard Time. It was taken from the parking lot of the CU research park located at Foothills and Colorado Avenue in Boulder CO, facing west towards the mountains. For the original image, the camera was held level and simply pointed at the sky trying to capture the two attractions. The outside temperature the day the picture was taken was 63°F with a 10.3 mph North-West wind. The humidity during that time was 21%. The same day last year had an outside temperature of 72 °F, a 9.2 mph South-West wind, and a humidity of 9%.

Cloud Physics:

There are at least two types of clouds captured in this image, Cirrus clouds and vapor contrails formed by an airplane. Cirrus clouds occur at altitudes between 30000 and up to 50000 feet. Cirrus clouds usually occur in a stable atmosphere. Airplane contrails form since one of the combustion products of the airplane engines is water vapor. At high altitudes the water vapor is exposed to a cold environment and therefore raises the relative humidity of the air past its saturation point. The water vapor then condenses, the tiny water droplets immediately freeze, and the contrails are formed.

To accurately identify what types of clouds are occurring, one has to look at an appropriate Skew-T diagram for the area. The Skew-T diagram shows if the atmosphere is stable or not and indicates the most likely altitude where clouds have the potential to form. Figure 1 is the appropriate diagram for the day and location the image was taken. The left solid black line shows the dew point temperature in the atmosphere based on altitude, and the right black line shows the temperature in the atmosphere at a given altitude. When the two lines are closest together, the likelihood of clouds occurring is greatest. Based on this Skew-T diagram, clouds are likely to occur anywhere from 6000m to about 11800m above sea level. Since the elevation in Boulder is about 1600m, the clouds are likely to occur between 4400m

and 10200m above ground. The CAPE number indicates if the atmosphere is stable or not. Since this number is zero, the atmosphere on 3/29/13 was stable.

Based on the fact that the atmosphere was stable that day, the possible range of altitudes for clouds to form goes up to 11800 meters, and the airplane contrail is below the cloud, it is most likely that the cloud is way up there.

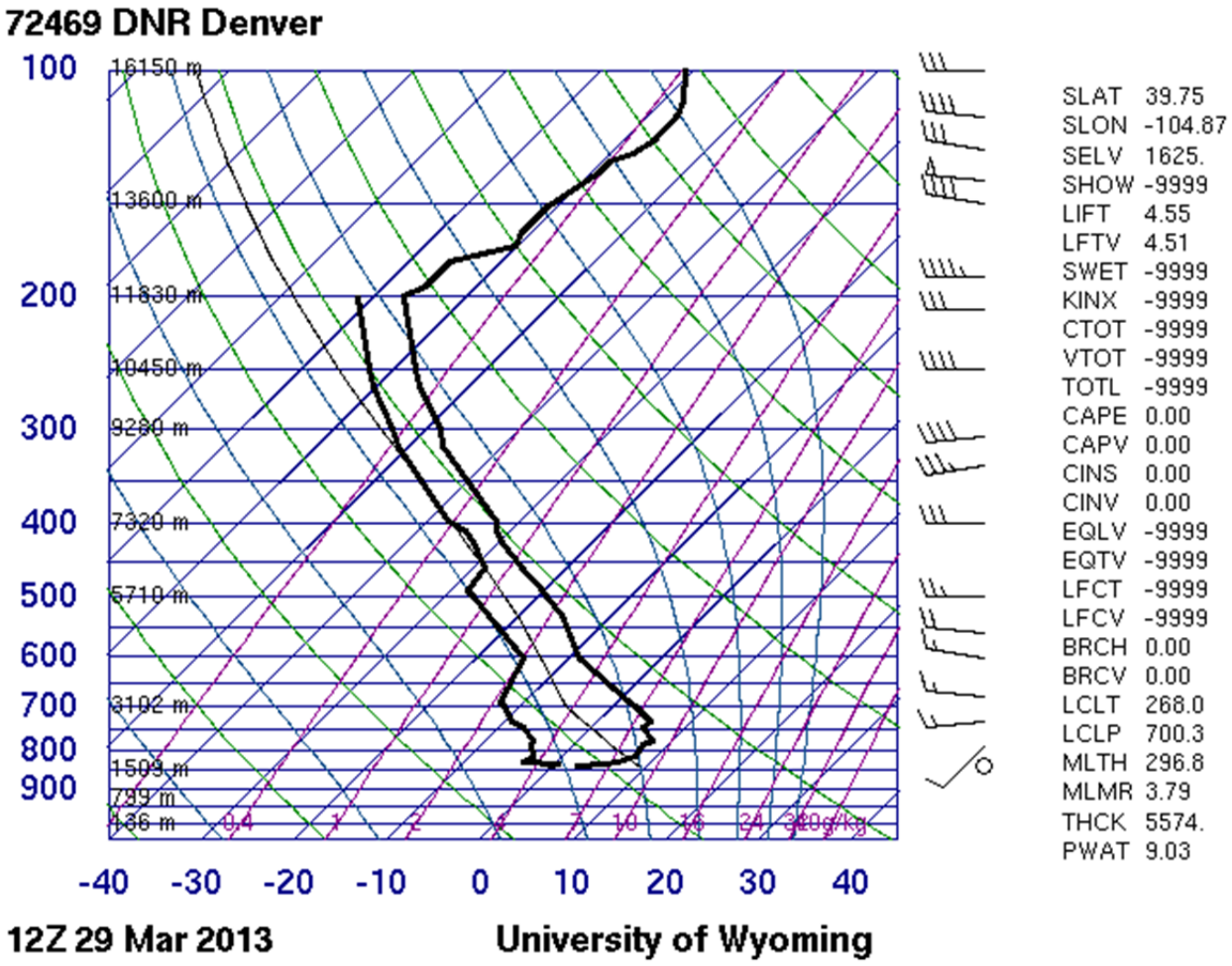

Figure 1: Skew-T diagram for Denver CO 3/29/13

Photographic Technique:

This image was taken with a CASIO EX-ZR 100 with an F-Stop of f/12, ISO of 100, and a shutter speed of 1/800 sec. The original image dimensions were 3872 by 2592 pixels. The approximate cloud height was 11800m above ground.

The processing techniques used, in Adobe Photoshop, to arrive at the final image were the use of the copping tool, and curves for slight contrast adjustments. A comparison of original and final image can be seen in Figure 2. The final image dimensions were 2736 by 1892 pixels.

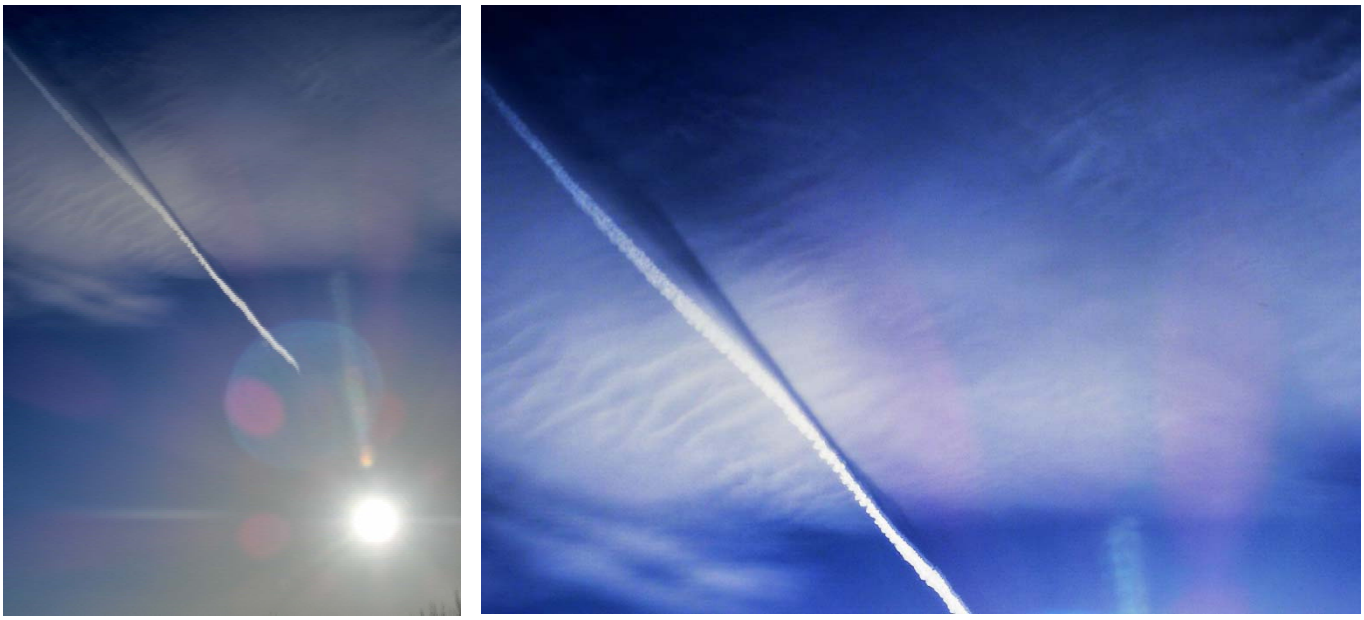

Figure 2: Original Image (left) Final Image (right)

Discussion:

The final image shows two types of cloud phenomena and the types of clouds were confirmed using the skew-t diagram, and the contrail was observed to follow an airplane. The special event captured in this image is that the contrail is below the cirrus cloud, and the sun is low enough that a shadow of the contrail is projected onto the cirrus cloud. Some of the glare from the lens can still be found in the final image, but it adds some unusual color to the image which makes it a bit more interesting. There are ripples formed in the cirrus cloud which suggests high winds at that altitude. I'm fairly happy with the final image since it captured this rare event and highlights several cloud physic phenomena.

References:

[1] "UNDERSTANDING A SOUNDING/SKEW-T." *Lead to Learn*. N.p., n.d. Web. 18 Feb 2013. <http://www.atmos.millersville.edu/~lead/SkewT_HowTo.html>.
[2] "Boulder Weather Graph." *WeatherSpark*. N.p., n.d. Web. 18 Apr 2013. <http://weatherspark.com/