Iridescent Clouds

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Clouds First Assignment, MCEN 4151

March 4, 2018, 1:41 pm, Boulder, CO

This image is intended to capture the shape and structure of several altocumulus clouds, as well as the diffraction that occurs as sunlight shines through the clouds. The intent is to not only show the structure of the clouds, but also to visualize the effect that clouds have on sunlight passing through them, specifically the colors that arise from the bending of the light around cloud droplets, a phenomenon called iridescence.

The image was taken on March 4, 2018 at 1:41 pm near the intersection of Arapahoe Ave. and 28th St. in Boulder, Colorado. The camera was facing northeast and had an elevation angle above the horizon of about 15 degrees.

The clouds that appear in the image are altocumulus, and they are tenuous, most likely because they are in the process of evaporating. The image was taken on a day that was clear in the morning and became overcast in the late afternoon and evening as a cold front moved in. At the time the image was taken, the sky was mostly clear, but it was only about two hours before high winds began, signaling the incoming cold front. Figure 1 is a Skew-T plot for 6 pm on March 4th, included because this time was the closest to the time the image was taken. A CAPE value of zero indicates that the atmosphere was stable at that time, and it was most likely stable at the time of the image, due to the lack of wind or other clouds, but the atmosphere was unstable between these two times because of the cold front. This means that the atmosphere may have been transitioning from stable to unstable when the image was taken. Examination of the Skew-T plot indicates that the altitudes at which clouds occurred were 5530 to about 6500 m, or 18100 to 21300 ft. This is consistent with what was observed, and means that the clouds were altocumulus, as they were located in the middle of the atmosphere, they have visible depth, and individual cloud elements are visible and are one to three fingers in size (*Cloud Identification Guide*). This is also consistent with what would be expected, as the day was fairly warm, which meant that warm, moist air would have to rise to a high altitude before the surrounding air was cool enough for the water vapor to condense into clouds.

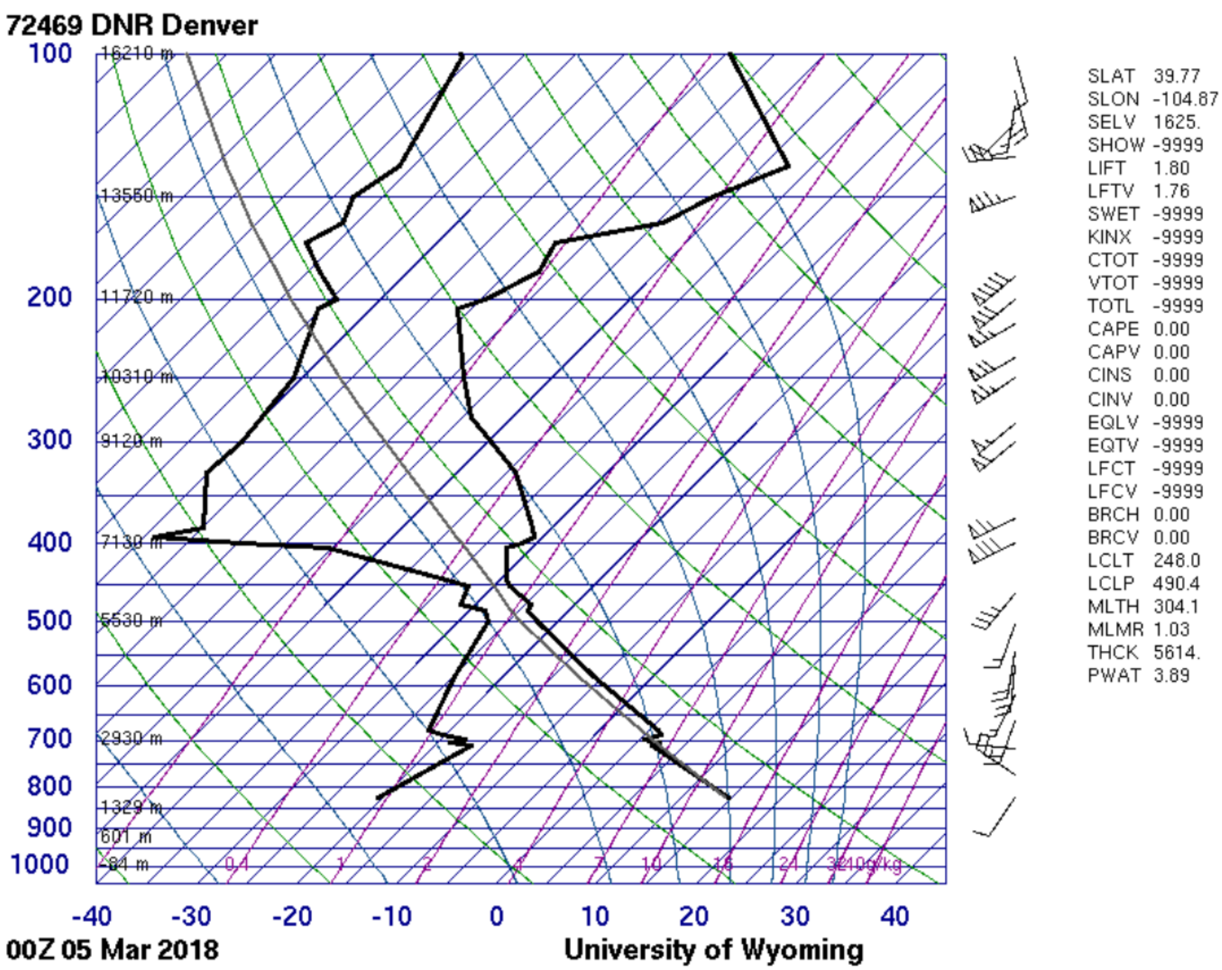

Figure 1. Skew-T Plot

An additional element to the image was the colors produced by the sunlight passing through the cloud. The large light rays and the small blue dot in the lower right corner are artifacts caused by the sun shining directly into the lens and reflecting off lens elements. However, the colors of the cloud that the sun is behind are caused by diffraction of the sunlight that enters it. Diffraction occurs when light, which can be considered an electromagnetic wave for the purposes of this discussion, interacts with cloud particles, bending around their edges (*Diffraction of Light*). Different wavelengths of light bend by different amounts, and therefore the white light, which consists of all colors, is separated into different colors as it passes through the cloud. Red light, which has the largest wavelength, is redirected by the largest angle, while violet is deflected by the smallest, thus separating the wavelengths so that individual colors can be seen. Yellow, red, blue, and green can be seen in the image. The colors are visible around the edge of the cloud because the cloud is thin there; regions where the cloud is thick result in scattering of the light which eliminates the colors (Ackerman).

When taking this image, the field of view was approximately ft, and the clouds were about 20,000 ft from the camera lens. The image was taken with an iPhone 6 camera, which has a focal length of 4 mm and a fixed aperture of f/2.2. The shutter speed was 1/7692 seconds and the ISO setting was 25. The high dynamic range (HDR) functionality of the iPhone was used in this image. In postprocessing, the very bottom of the image was cropped to remove part of a building; this changed the size of the image from 4032 by 3024 pixels to 4028 by 2988 pixels. The image was edited with the open-source editing software GIMP. The upper portion of the curve for all color channels was altered to bring out the bright colors of the iridescent cloud, and then the blue channel curve was altered to make the color of the sky a more pleasing and natural blue. The unedited image is included below in Figure 2.

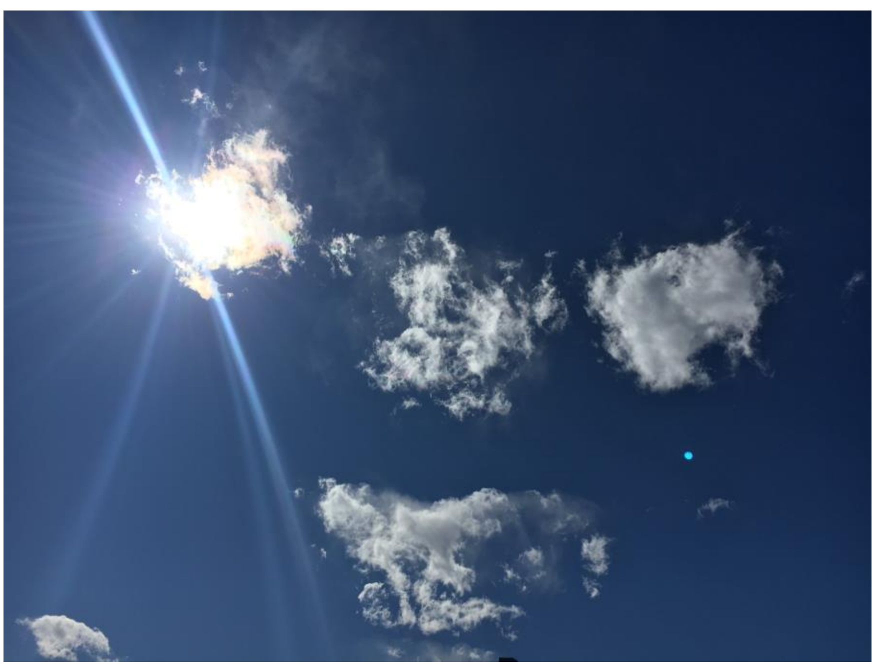

Figure 2. Unprocessed Image

All in all, the image fulfills my intent and in fact even surpasses it. I originally intended it to show primarily the structure of altocumulus clouds, with the sunlight shining through the cloud meant as an aesthetically pleasing aside due to the artifacts it creates creating a centerpiece for the image. Only upon closer inspection did I realize that I had also captured cloud iridescence, a fascinating and somewhat unique phenomenon. It was really only pure luck that I captured the iridescence, but I am glad I did because it adds a lot to both the aesthetics of the image and the science behind it.

References

Ackerman, Steve. *Iridescent Clouds*. cimss.ssec.wisc.edu/wxwise/class/iredsnce.html

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