

Alto cumulus and Cirro cumulus over Boulder, Colorado



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INTRODUCTION

The beauty of clouds is often realized during sunsets, when the light pours through the atmosphere and illuminates the clouds and the sky with a brilliant array of colors. Clouds provide the perfect white canvas to reflect these colors. The shapes and depths of the clouds are often revealed during a sunset or when the sun is low in the sky. This particular image was taken for the Flow Visualization course at the University of Colorado at Boulder. It is the second cloud image assignment and this photo in particular captures multiple species and varieties of clouds in the same shot across the Colorado sky above Boulder. This report will discuss the photography methods and techniques used to take the image, physics of the clouds with atmospheric conditions, and the post-processing of the image.

METHODS AND POST PROCESSING

This image was taken off the foothills highway in Boulder on March 2, 2011. The civil sunset was predicted at 5:53pm [1] and the image was taken at 6:43pm. The picture was taken facing southwest after the sun had cast a shadow over the mountains but still illuminated the sky 50 min after the sunset. The shot was aimed about 35° above the horizon. The camera used was a Panasonic DCM-TZ3 with an F-Stop of 4.2 and a shutter speed of 1/320 of a second. The ISO was 100 with no flash and a white balance set to bring out the sunset colors more vividly, specifically to emphasize red. The resulting image was 3072 pixels by 2304 pixels. No cropping was done in the post-processing but the color balance was tweaked to make the gold and pink tones stand out. The mountains were “blacked-out” by using the foreground select tool in GIMP photography software. After selecting the foreground the full tool was used to isolate the mountains. This allowed for the clouds to stand out more predominately in the image by eliminating the distracting elements in the mountains but still leaving their silhouette, providing a frame for the shot.

ANALYSIS

The weather that day was mostly cloudy with between 50% and 90% cloud cover. There was a predicted 90% cover at the time of the shot. The temperature was approximately 52°F [2].

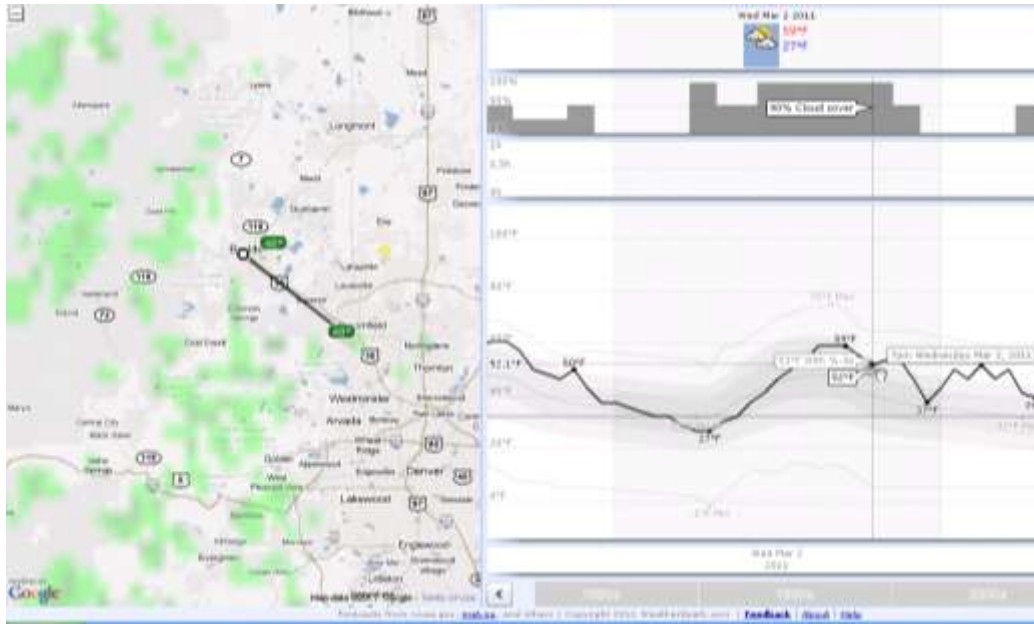


Figure 1: Weatherspark.com Cloud Cover and Temperature Plot [2]

A cold front had recently passed and Boulder was sitting in a warm front for the 2 days before, day of and day after the image. After that another cold front rolled through. The 4 days during the warm front averaged mid 60's while the cold fronts before and after averaged low 50's with snow 3 days before and 4 days after March 2nd. The atmosphere that day was stable as according to the Skew-T provided by Denver International Airport, although many times this data is inaccurate. DIA is over 40 miles southeast from Boulder and can have drastically different weather and atmospheric conditions due to the mountain climate in Boulder. The Skew-T can be very helpful but must be analyzed carefully knowing where the data comes from. The altocumulus clouds in the lower left of the image were predicted at 6000 m and the cirrocumulus were slightly higher, predicted at around 10,000 m [3].

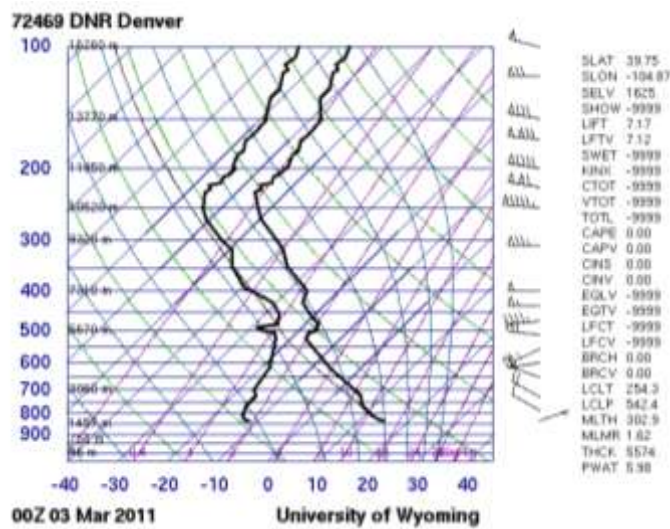


Figure 2: Skew-T Plot from DIA

The Convective Available Potential Energy (CAPE) and Planetary Boundary Layer (PBL) values from the plot are both zero which indicates a stable atmosphere during the day. Using this data and the approximate altitude of the clouds, it appears that the clouds were in the troposphere. Looking at the shapes of the clouds and cloudlets it appears the species of the altocumulus clouds is stratiformis and the variety is undulatus. This is due to the parallel nature of the clouds and the large area of the sky that is covered.

The beauty of this image comes partially from the cloud formations, but also from the colors splashed onto the clouds. The colors from the sunset exist due to the scattering of the light through the atmosphere. This only occurs when the angle between the sun and the horizon is less than 10%. The pink and reddish colors are the only colors that are not refracted in the atmosphere and therefore give the clouds their pink wash. The clouds in the lower right corner of the picture appear dark because they are at a lower altitude and only infrared light is able to get through the atmosphere. Water is able to absorb the solar radiation at the infrared wavelength and therefore the clouds appear dark grey or black [5].

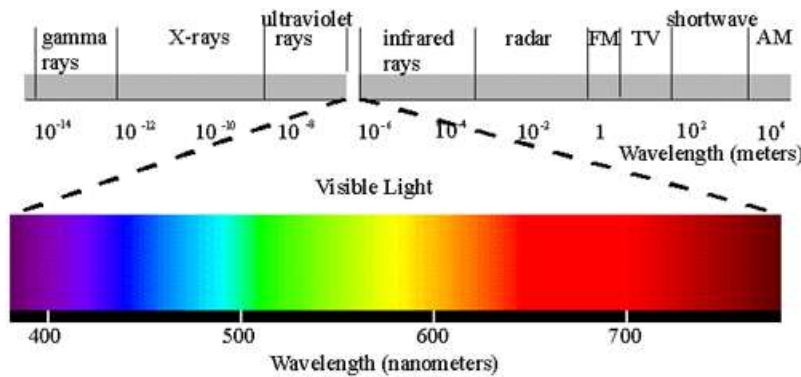


Figure 3: Wavelength Light Spectrum

CONCLUSION

Overall, this image shows a variety of clouds that can be seen in the Colorado sky and the brilliance that a sunset can add to a seeming normal white cloud. The physics of these clouds and the sunset can be extracted from this image to a trained eye while also creating a visually pleasing photo to all, therefore the intent of the image was fulfilled. With more practice and little atmosphere luck, more images like this will be taken and frozen in time for more to see.

References:

- [1] Earth System Research Laboratory, Physical Sciences Division, Boulder Colorado: Sunrise/Sunset data and length of twilight, 2011.
<http://www.esrl.noaa.gov/psd/boulder/boulder.sunset.html#March>
- [2] Norda, Jacob and Diebel, James. Weather Spark Interactive Weather Charts, 2011.
<http://weatherspark.com/#!/graphs;q=Boulder,+CO,+USA>
- [3] University of Wyoming College of Engineering Department of Atmospheric Science. Atmospheric Soundings. <http://weather.uwyo.edu/upperair/sounding.html>
- [4] Pretor-Pinney, The Cloud Spotter's Guide, The Science, History and Culture of Clouds. The Berkley Publishing Group, 2006, New York NY.
- [5] Victoria Supply Inc. 2010. http://www.topbulb.com/find/full_spectrum.asp