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Cloud Image Report #2

4/10/2012

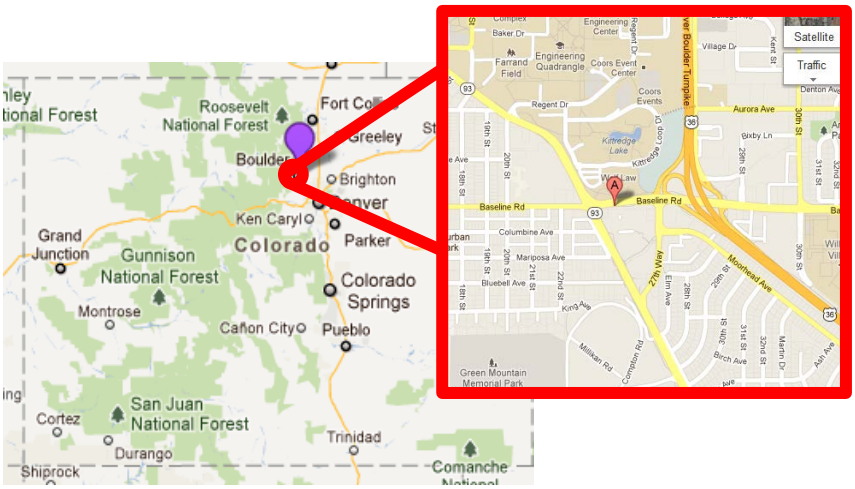
Context and Purpose of Image:

The cloud image above was taken to fulfill the requirements of the second cloud picture. For this picture, I was interested in capturing a more "rare" cloud phenomenon. For example, I see interesting clouds on a daily basis, but according to the *Cloudspotters' Guide*, cirrocumulus clouds are one of the more elusive varieties of clouds[1,3] . It also states that the "stratiformis" species is also elusive. In this case, when I saw cirrocumulus stratiformis covering much of the sky early one morning, I knew I had to capture the image. I also observed some rippling "undulatus" and knew that I hit the cloud jackpot, so to speak.

Image Circumstances:

This photo was taken in the parking lot of the Baseline Shopping Center in Boulder, Colorado. See **Figure 1** for the location.

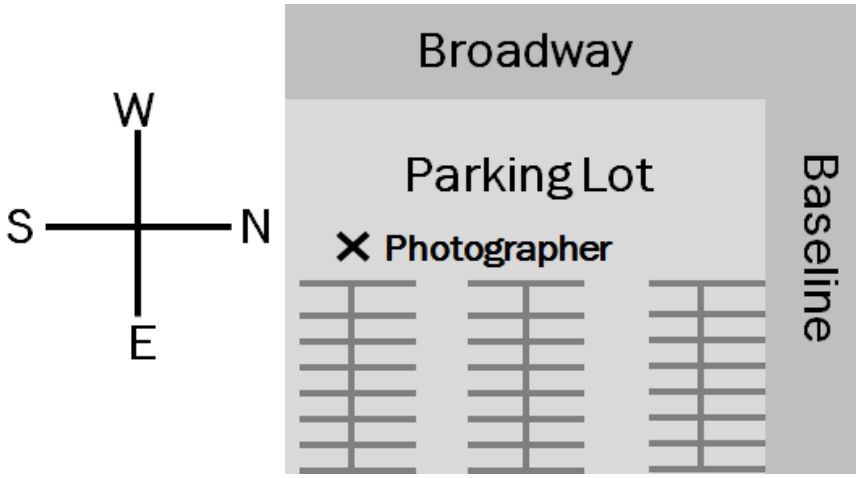
Figure 1 (right): A map of the location of where the image was taken. The red circle shows specifically where in Boulder the photo was taken.



This photo was taken at 6:45 am on Monday, April 9, 2012 . The elevation of the parking lot was slightly lower than the horizon, but the clouds were directly upwards. Thus, the camera was held at about an 85° degree angle from the horizontal. See **Figure 2** for a schematic of photographer position.

Statement of Clouds:

Figure 2: A schematic of the location of the photographer (me) and the camera.



Analyzing the Skew-T plot of the atmosphere is helpful in understanding the types of clouds depicted in the image. **Figure 3 (below)** shows the Skew-T[2] plot for Denver, Colorado for the morning of April 9, 2012. There are many things to be gleaned from the Skew-T plot. For example, on the right side of the chart, we see figures indicating the wind speed. More "lines" and "flags" on the indicators show stronger wind speeds. Throughout the atmosphere there are moderately high wind speeds. Next, we can analyze the stability of the atmosphere by looking at the temperature plots compared to the dry adiabats (in green). The atmosphere tends to be stable if the adiabats and black temperature plots are approximately parallel. We we see some layers of stability alternating with layers of instability. Generally, where the two black lines touch (the dew point temperature on the left and the atmospheric temperature on the right) we can expect to find a cloud. The two

temperature lines do not touch. However, there were clearly clouds in the sky on the date that the photo was taken. However, it should be noted that the visible clouds (cirrocumulus) are high-altitude clouds. So, the clouds could be forming where the two lines come relatively close at around 12,000 meters. We can also look at the CAPE (Convective Available Potential Energy) value. For our plot, CAPE is equal to zero. This normally corresponds to a stable atmosphere, ie, no chance of thunderstorms.

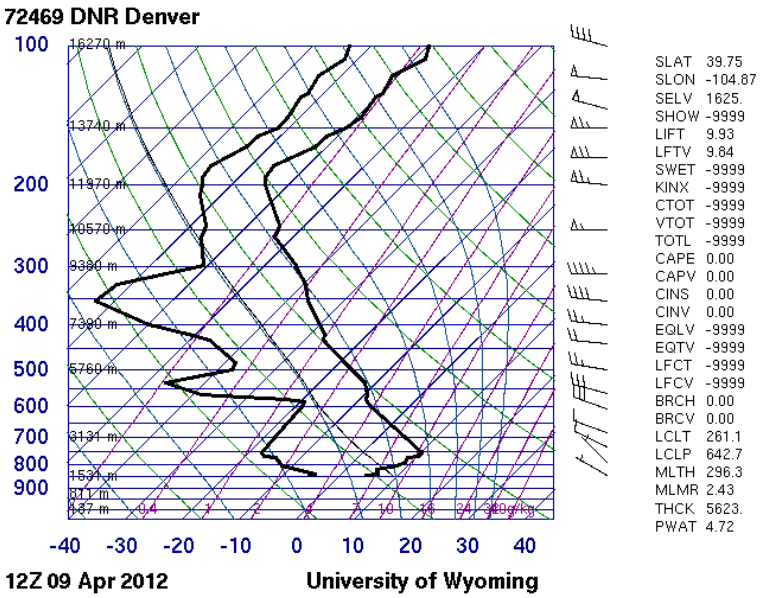


Figure 3: Skew-T plot for Denver, CO on the date the picture was taken.

Now that the Skew-T diagram has shed some light on the meteorological situation, let's analyze the types of clouds visible in the image. Cirrocumulus clouds are generally only visible above 6,000 meters. We can be relatively confident that they are cirrocumulus clouds because of their "grainy" appearance and texture. Additionally, we can see some undulatus behavior, which is exemplified in the ripple-y consistency. Since cirrocumulus clouds are formed of ice particles, they do not last very long, especially in the morning as the temperature rises. Indeed, these clouds were gone within the next hour. The cirrocumulus are most often observed in conjunction with cirrus clouds, which are known as "ice clouds." The "streakiness" of the higher level clouds helps to indicate that the clouds are likely made of ice crystals.

We can also notice the reported wind speeds from the Skew-T diagram. The wind looks fairly substantial (at the higher altitudes, upwards of 40 knots). Cirrocumulus often forms in areas of "wind shear" when air above the cloud sheath is moving at a different speed than below the cloud. The Skew-T diagram definitely shows some wind speed variations at the high altitudes in which the cirrocumulus is generally found. The region between the two wind

speeds are where we see “undulations”, much like the ripples we would see on the surface of a lake.

The next day was beautiful and warm, with no reported precipitation. It is also generally a fair assumption that the physical obstruction of the nearby mountains influence the happenings in the atmosphere. Recall that not only is the atmosphere cooler at higher elevations, but there is also simply *less* air. As warm moist air encounters a mountain, the air parcel will tend to swell as air pressure drops and water contained in the air tends to condense and form clouds [4].

Photographic Technique

This photograph was taken with a Nikon D40 DSLR. It’s hard to predict the width of the image and the depth of field, but I estimate that the entire image encompasses approximately 10 miles across. The bulk of the clouds are right above me, the viewer. The image is 2992 by 1768 pixels in size. The ISO was 1300 and the shutter speed was 1/200 s, at F 5.6. Only marginal post-processing was done on the image. A few lens scratches were removed in Photoshop, and the colors were adjusted slightly. Due to feedback from classmates, I increased the contrast so that the clouds were more visible. See **Figure 4 (right)** for the original photo. The edited photo size is 2658 x 1650 pixels.

Figure 4: Un-edited photo.

Conclusions

Overall, I enjoy this picture because of the rarity and transient nature of the cirrocumulus. I think I am lucky to live in such a beautiful place. On top of that, I think I am lucky to live in a place with such beautiful cloud physics. I think this picture might have been even better if

the sun was slightly higher in the sky so that the clouds stood out against the blue sky. However, I think I would have been less likely to capture the image later in the day as the temperature increased steadily.

References:

1. Pretor-Pinney, Gavin. The Cloudspotters Guide: The Science, History, and Culture of Clouds. PERIGREE: 2006.
2. University of Wyoming, College of Engineering. Weather Soundings. Accessed: 25 February 2012. <http://weather.uwyo.edu/upperair/sounding.html>.
3. Sun, B. et al. "Recent Changes in Cloud-Type Frequency and Inferred Increases in Convection over the United States and the Former USSR". *American Meterological Society Journal*. Vol 14: 8. April 2001.
4. Orville, H.D. "Ambient Wind Effects on the Initiation and Development of Cumulus Clouds over Mountains*." Journal of Atmospheric Science* 25 (1968): 385-203.