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MCEN 4228 Flow Visualization

Clouds 1

This is the first cloud assignment for Flow Visualization. The objective was to take a nice picture that revealed a cloud's physics and to study how the atmosphere affected the formation of the cloud. I'll admit that I wasn't looking for a certain type of cloud when I was taking these pictures, but rather I was looking for clouds that were appealing and that would look good in an HDR (high dynamic range) photograph.

Some of the best clouds I had seen were found from the view just off my balcony at my apartment on the 28th frontage road and Aurora Ave. The Flatirons are in view from there, and there are usually good clouds coming over the tops of them. This is where I found the clouds for my image; looking south and a little west, with the camera about 30 degrees above horizontal, I photographed these clouds on February 5th at about 10:30 a.m.

As I stated before, these clouds were coming over the Flatirons, which affected their physics significantly. They were mountain wave clouds, as can be seen by the wave geometry and the parallel layered effect. More specifically, they were altocumulus lenticularis, as can be seen from their slight dome shape on top and flat bottoms. These are fairly common clouds for a town by mountains, because as the cold air rushes over the mountains, it sinks on the downhill side and gains a lot of momentum, making it overshoot down into air that is colder than it. At this point the air is warmer than its neighbors, and it starts to rise back up. When it overshoots and rises too high again, it becomes cooler than its neighbors, creating a streak of cloud and coming back down. The air can repeat this oscillating sine type process multiple times, creating long, thin clouds at each peak. The long clouds in the middle of my photo with a patch of sky showing through between them are good examples of the tops of these "mountain waves." Because the rest of the sky was very clear, it was a nice rest of the day without any snow or rain. As best I can remember, the clouds, calm weather, and low winds were similar the few days before and after this photo was taken. My faulty memory was further confirmed by the skew-T plot of the morning's weather, which shows a stable atmosphere overall (Fig. 1). As we compare the line that represents the neighbor air's temperature (dark black line on right) with the parcel air slope (thin black line), we see that the slope of the neighbor air's temperature is greater than that of the parcel, which would result in a sinking parcel and a stable atmosphere. At about 10,200 m there is an inversion, which means warmer air over cooler air, and that is also stable. Another indication of the calm atmosphere is that the CAPE (Convective Available Potential Energy) value is 0, which reflects the low potential energy for convection in the atmosphere and therefore lack of weather effects. Also, a higher CAPE points to more fluffy clouds like cumulonimbus thunderheads, so the general flat shape of the imaged clouds makes sense with this low CAPE. The dark black line on the left represents the dew point temperatures, and it is closest to the neighbor air temperature line at about 5000 m. This indicates cloud formation at this altitude, which seems about right. Boulder is at about 5400 ft from sea level, which means the clouds would be about 3200 meters from the ground. These were relatively low clouds, so this seems like a reasonable elevation estimate.

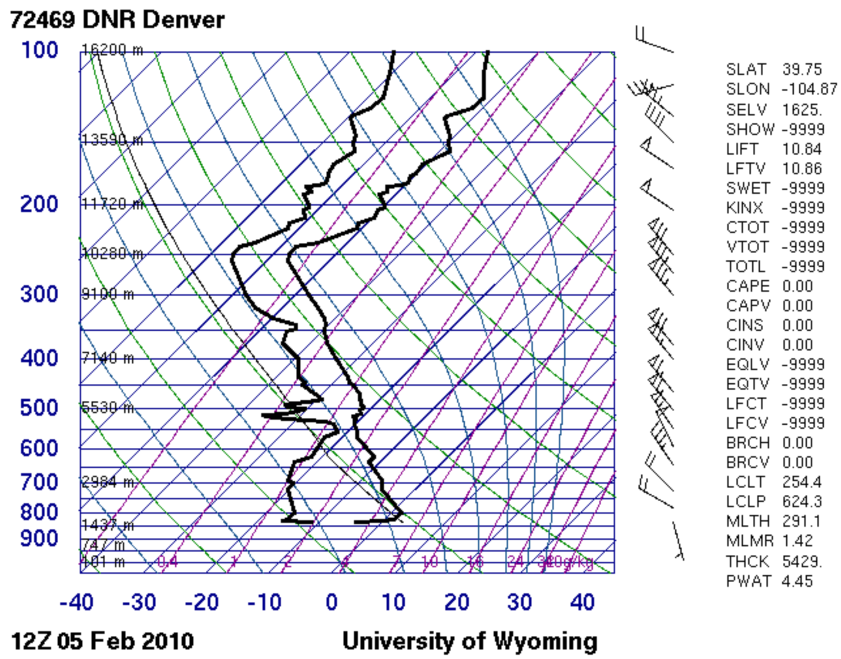

Figure 1: Skew-T plot for the morning of February 5, 2010

This picture was taken with my Sony Cyber-Shot H20 digital camera. I wanted to include a wide range of clouds, so I framed the picture as wide as I could (~5000ft) and got clouds from about 9000 feet away to maybe 15000 feet away. The image is HDR as I briefly mentioned, which means that three pictures were taken in quick succession; one at normal exposure, one at a darker exposure value, and one at a lighter exposure. The order of exposure time from lowest to highest is 1/2000 sec, 1/1000 sec, and 1/500 sec, all at 6.3mm focal length and an f-stop of 8. To make an HDR image, these three photos were overlapped in a special program called Photomatix. From there I was able to adjust luminosity levels, saturation, light smoothing, etc. to produce many great effects. I was a bit more conservative on some of these features because I wanted the colors to really pop out while keeping the picture realistic looking. The most unbelievable part of the photo is the buildings in the lower right corner, because they still look perfectly exposed. I decided to leave them in to give a sense of the scaling and to leave the picture more complete. So no cropping was done on the image, and the pixel count came out to be 3626 x 2710.

I like the final image, and I think I got what I wanted out of it. There was a good amount of detail in the clouds, which is always more appealing for study purposes, and the color of the sky was artificially deepened, but it provides nice contrast and a more aesthetically pleasing picture. It was also apparent what physics were taking place from the image. Things like mountain waves, the lenticularis aspect of the clouds, and the slight ruffling from the wind are all clearly seen in this image. One thing I wasn't completely happy about was the foreground. If I had the same picture without the buildings in the way I think it would be a bit better. It would have also been nice to include the Flatirons in the final image, but there were difficulties with framing and with the general location having walls and trees in the way. For the second cloud photo I think it would be better for me to be more intentional about these things and maybe make a road trip to get an ideal cloud picture.

References

Skew-T plot. Denver sounding. Department of Atmospheric Sciences. <http://weather.uwyo.edu/cgi-bin/sounding?region=naconf&TYPE=GIF%3ASKEWT&YEAR=2010&MONTH=02&FROM=0512&TO=0512&STNM=72469>. University of Wyoming. 28 Feb. 2010.