Clouds Over the Flatirons

Flow Visualization

Professor Hertzberg

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For this first cloud image I was drawn to the mountains to establish the shot. The mountains to our west play so much of a role in the weather over the foothills that I had to

include them. On the particular day that this shot was taken there was a typical mountain wave cloud formed over the flatirons; a combination of lenticular and cumulus clouds. I enjoyed capturing this image because I believe it really shows the interaction between the landscape and the atmosphere.

After that early February snowstorm rolled through I couldn't wait to get outside and explore the mountains with my camera. It snowed so hard on Friday we had our first snow day in years. That night it snowed a little more, but on Saturday the 4th I awoke to beautiful blue skies and big piles of snow. After some sledding at Chatauqua for a few hours with my friends I headed alone into the woods to get some shots. The clouds had been slowly building all day into a large fan that extended out over the foothills and up and down the front range. I kept hiking through feet of snow to find the right vantage point for my perfect shot. I knew the big puffy piles of snow sitting on the rocks would be a good comparison to the cloud body, so I looked for those as well. As the shadows started to get long in the afternoon the sunlight filtering through the clouds over the horizon gave me pause. After an hour or so of wandering through the hills I found myself alongside a rock that would make a good foreground, and took this shot. The time was 3:30 in the afternoon, the sun is just peering over the hills. The camera was facing into the southwest sky, the bottom of the frame reaches down to maybe 10 degrees above the horizontal.

The phenomena seen in the image here are loosely known as mountain wave clouds. This classification covers most clouds that form in the leeward zones of mountains, and these clouds are particularly good examples. Central to the shot is a cumulus cloud, formed just over the mountaintop. This cap cloud forms as relatively stable, fast moving air moves over an abrupt mountain range and the air is forced upward over the mountains[1]. As the air is deflected upward its temperature decreases because of the increased elevation and decreased pressure. As the temperature drops below the dew point clouds form. Most cap clouds appear stationary, as the conditions that create the necessary pressure to see it are very localized. However, it was lucky this day we could see the cumulus cloud thinning into stratocumulus type clouds as the water vapor freezes. There were no other clouds in the sky that day, meaning the post-cold front winds blowing through did not have much moisture. Usually, wave clouds like this appear in parallel rows, characteristic of an underdamped system. Even though there were no other clouds visible, it is still likely that there were many leeward waves in the sky that day. The closest skew-T, see Figure 1, from Denver indicate that there were clouds likely at

3000m that day, up to 8000m where there is a sudden jog along an isotherm [2]. This is consistent with my analysis of lower cumulus clouds rising in adiabatic expansion to stratocumulus clouds.

So for this shot I was standing in thigh deep snow on a steep slope in the foothills above Chatauqua. The top of Bear Peak in the background is a couple miles away, and the cloud above it extends as much as 24000 feet into the sky. I brought my trusty Nikon D70 along to get the shot. It's a good camera, but only has 6 MP. To get the widest possible field of view I used a short 18mm focal length, and a small f/22 aperture to get the greatest depth of field. This helped me capture the rocks in the foreground as well as the brilliant clouds. Seeing as it was into the clouds I used an ISO of 500 and a shutter speed of 1/160, which still brought out the character of the dark rock. I did not feel any cropping of the image was necessary, so it is the original 2000x3008 pixels. In Adobe Lightroom I modified the image by turning down the exposure a bit. I also brought out the shadows and highlights by subduing the mid tones. By doing this I was able to bring out the contrast of the central barrel shaped cloud.

The more I talk about this image the more I love it. I really enjoy how the cloud interacts with the mountain, visually and physically; both are represented so the relationship can be examined. This image actually has all I love about nature: there are elements of some interesting geology, a bit of flora, a cooling element from the snow, and a large cloud wall. I totally fulfilled my intent of learning about mountain wave clouds with this image and paper. I would, however, like to learn more about the intricacies of cloud classification and how to read the associated skew-T diagram. I wondered for a while whether to classify the fan cloud as a strato or an alto type cloud. Lastly, I would like to see more lenticular clouds in the future.

References

[1] NWS Albuquerque Local Studies and Special Features.
http://www.srh.noaa.gov/abq/?n=features_acsl

[2] Hertzberg, 09 Cloud Physics; Skew-T, stable vs unstable.
http://www.colorado.edu/MCEN/flowvis/course/Lecture2012/09.Clouds3.pdf

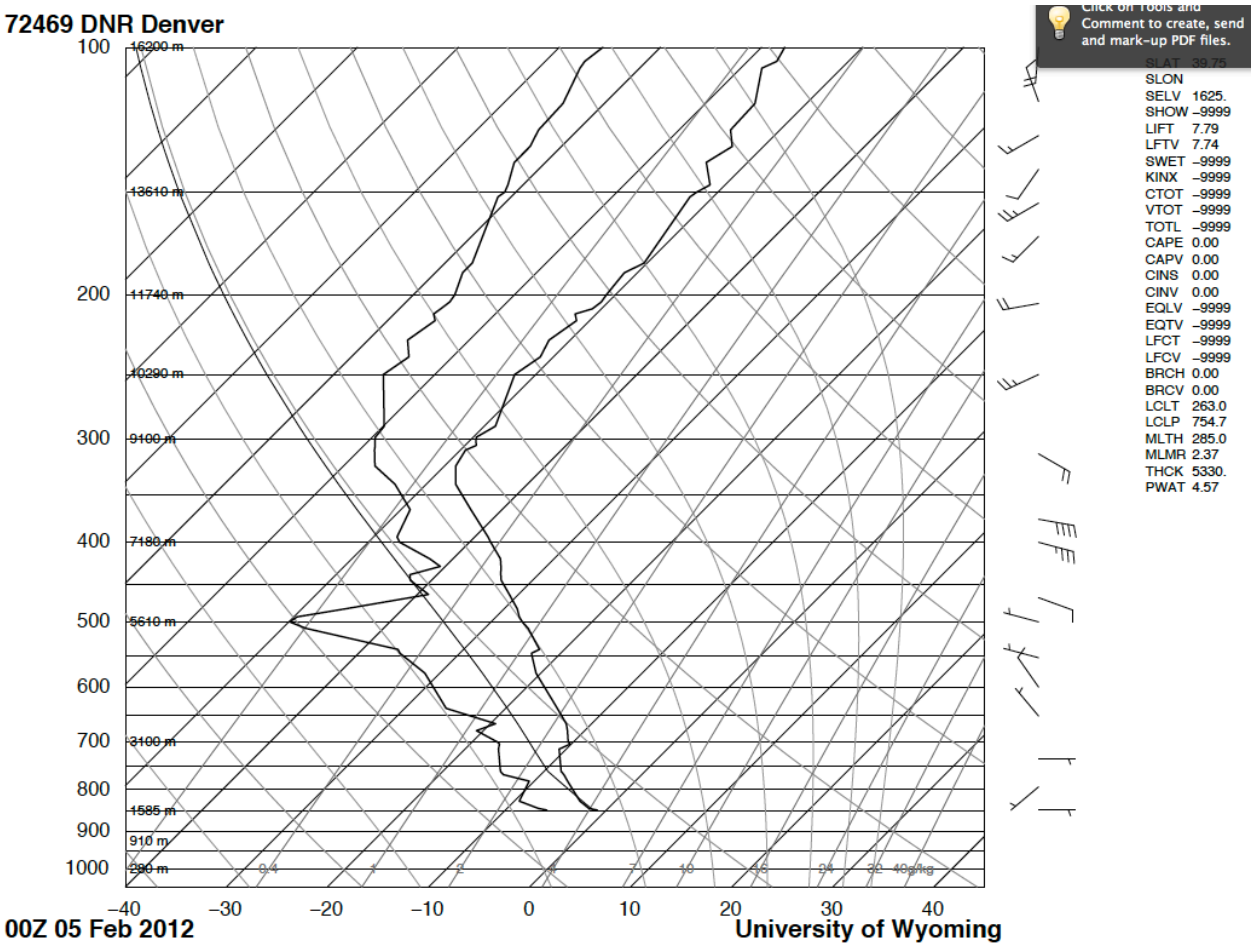

Figure 1 - Skew T from Feb 4 1200Hrs