Cloud Assignment 1

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Clouds can take on many forms from high wispy cirrus, layered stratus, or puffy cumulus. They can be seen daily, except for that rare clear blue sky day, and change shape continuously based on what the conditions are in the atmosphere. The purpose of the first cloud assignment was to capture an interesting cloud formation, and discuss what the conditions in the atmosphere were in order for that cloud to form. Growing up on the west coast I never really got to experience mountain wave clouds, or Altocumulus Lenticularis, and I've admired them ever since I've moved to Boulder. This is why I chose this type of cloud for the first cloud assignment. I particularly like the smooth defined edges that these types of clouds can have, and their tendency to look like UFOs.

This cloud image was captured on Monday, February 20, 2012, at roughly 4:00pm MST, and was taken from the top of a parking garage located at Broadway St. and Spruce St. in Boulder, CO. The cloud formed almost directly above the Flatiron Mountains and blocked the sun that was setting behind it. While photographs of the cloud formation were being taken several jets flew above it leaving contrails that appeared to pierce the cloud. The camera angle above the horizon was roughly 60 degrees.

Mountain Wave clouds can be identified by their smooth lens shaped form and dense shaded appearance. They form when air is forced upward as it passes over an obstacle such as a mountain, and occur above 6500ft. If an air stream riding up a mountain side contains enough moisture and cools enough as it gains altitude a cloud can form. If the air stream moving over the mountain takes on a wave like motion on the lee side of the mountain then mountain wave clouds can form. These clouds appear to be stationary as they park themselves on the lee side of mountains, but the air is actually continuously moving through the cloud. Water droplets form on the front side of the crest of the air stream wave, and then evaporate as the air stream moves back down after the wave crest. Even though the air stream is continuously flowing, the point at which the water droplets form is fixed and the cloud appears to not move [1].

Also seen in the image are Cirrus clouds and a jet contrail. The day before this image was taken the sky was almost clear all day long. The day the image was taken the winds picked up in the afternoon to wind gusts of 25 mph. On Wednesday a cold front moved in, which could explain the presence of the Cirrus clouds, which typically precede a weather front [2]. The jet contrail forms as the hot exhaust gases cool in the surrounding air and form water droplets [3]. Also seen in the photograph is irisation or iridescence, which is caused by sunlight being diffracted in the clouds. This phenomenon occurs frequently in lenticular clouds because of their uniform water droplets [4]. It can easily be seen in this instance since the sun was directly behind the cloud when the photograph was taken.

The skew-T plot for 2 hours after the photograph was taken shows a highly stable atmosphere. For the mountain wave clouds to form you would want winds that were roughly perpendicular to the Flatirons, or a westerly wind. These winds occurred at roughly 2600m, as seen from figure 1, which would explain the location of the wave clouds that were directly above the Flatirons which have an altitude of about 2300m. The skew-T plot also shows the dew point and temperature profiles approaching each other above 10000m, which would explain the formation of cirrus clouds pictured in the photograph.

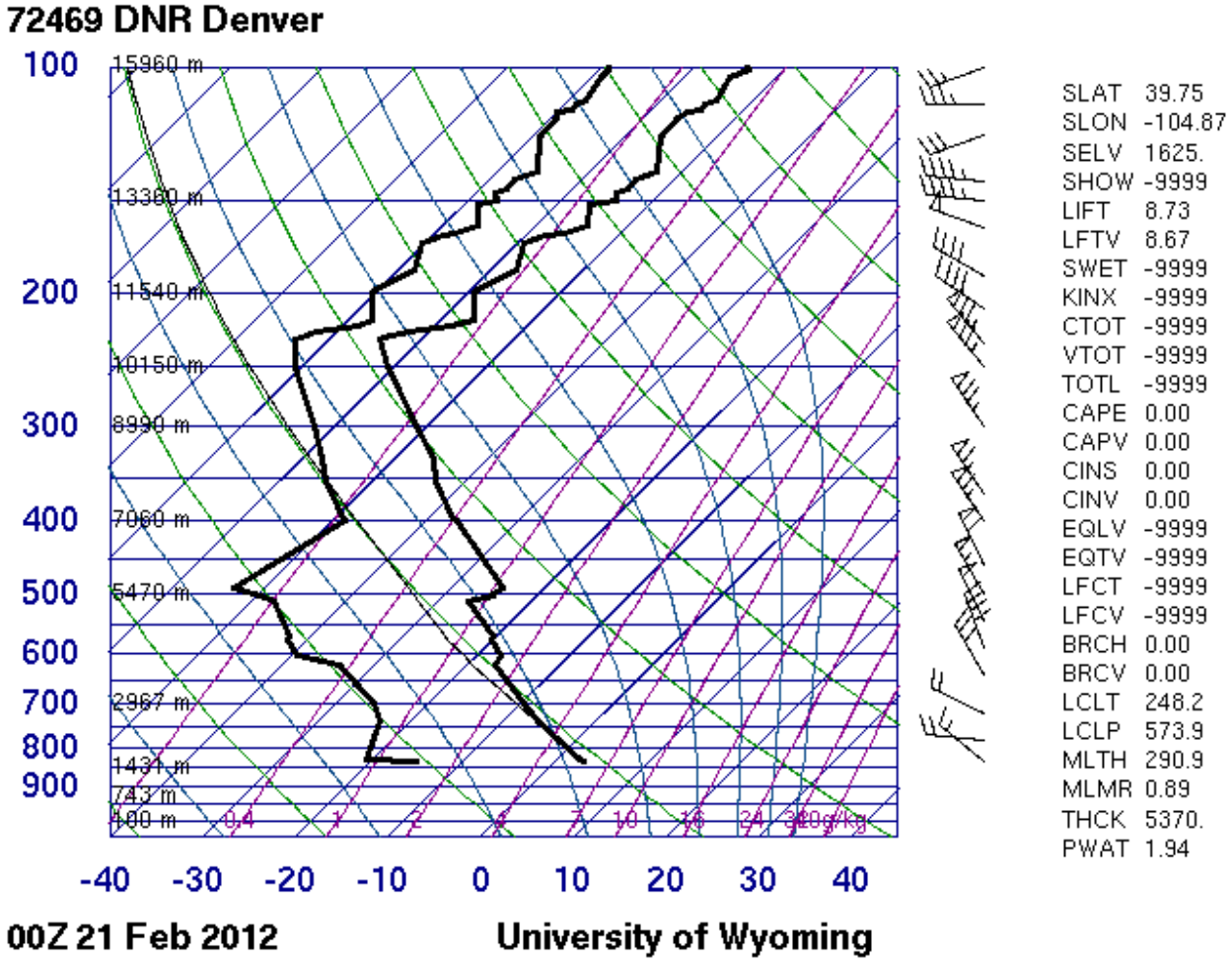

Figure 1 Skew-T Plot for Atmospheric Conditions on February 20, 2012 4pm MST

The photograph was taken with a D5100 Nikon DSLR camera. The only available lens was a VR 18-55mm F/3.5-5.6. Distance to the object was roughly 2 km with an estimated field of view of 3.5km. The focal length was 32 mm to cut down on later cropping out of the mountains. The ISO was set to 640 since the sun was behind the cloud a lower ISO was probably needed. Aperture was set to F/5.6 and the shutter speed was 1/4000s again because the bright sun was behind the cloud the faster shutter speed was needed to decrease the brightness in the photo. The image size is 4928 x 3264 pixels and was edited in GIMP to increase the blue sky color and decrease the brightness of the cloud that was directly over the sun. The original image is shown in Fig. 2.

Figure 1 Original photograph of Mountain Wave Cloud.

This photograph shows a fairly well developed mountain wave cloud with possibly a second forming below the first. The iridescence is also demonstrated nicely with the sun placement relative to the cloud. I think a wider angle lens would have been useful in capturing the entire wave cloud. Several images of this cloud were taken both with and without a jet contrail. I thought the contrail added a nice contrast looking like it was piercing the cloud and also casting a shadow. Overall I think the image captures a nice example of a wave cloud.

References

1. Pretor-Pinney G, (2006) Cloudspotter's Guide: The Science, History, and Culture of Clouds.
2. http://en.wikipedia.org/wiki/Cirrus_cloud
3. http://en.wikipedia.org/wiki/Contrail
4. http://en.wikipedia.org/wiki/Irisation